1988 TRUCK SHOP MANUAL

Vol. A
Light Truck Body/Chassis/ Electrical

Bronco
Econoline
F150 - F350
F - Series Super Duty

VOL A

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Ford Parts and Service Division
Training and Publications Department

IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This Shop Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This Manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

NOTES, CAUTIONS, AND WARNINGS

As you read through the procedures, you will come across NOTES, CAUTIONS, and WARNINGS. Each one is there for a specific purpose. NOTES give you added information that will help you to complete a particular procedure. CAUTIONS are given to prevent you from making an error that could damage the vehicle. WARNINGS remind you to be especially careful in those areas where carelessness can cause personal injury. The following list contains some general WARNINGS that you should follow when you work on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires you to be under the vehicle.
- Be sure that the ignition switch is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on the vehicle. If you have an automatic transmission, set it in PARK unless instructed otherwise for a specific operation. If you have a manual transmission, it should be in REVERSE (engine OFF) or NEUTRAL (engine ON) unless instructed otherwise for a specific operation. Place wood blocks (4" x 4" or larger) to the front and rear surfaces of the tires to provide further restraint from inadvertent vehicle movement.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep yourself and your clothing away from moving parts, when the engine is running, especially the fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter and muffler.
- Do not smoke while working on the vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle. Tie long hair securely behind the head.
- Keep hands and other objects clear of the radiator fan blades. Electric cooling fans can start to operate at any time by an increase in underhood temperatures, even though the ignition is in the OFF position. Therefore, care should be taken to ensure that the electric cooling fan is completely disconnected when working under the hood.

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foreword . . .

This 1988 Truck Shop Manual has been prepared to provide information covering normal Body, Chassis and Electrical service repairs and maintenance for the 1988 Bronco, Econoline (E-150 through E-350) and F-150 through F-350 Ford Trucks manufactured in the United States and Canada.

Engine, Pre-Delivery, Maintenance and Lubrication service repairs are covered in the 1988 Light Truck Engine Manual, the 1988 Engine/Emissions Diagnosis Manual and the 1988 Truck Pre-Delivery, Maintenance and Lubrication Manual.

This manual is divided into Groups covering a general system. The basic part number for components covered in the Group is also included in parenthesis after the Group number. For example:

Example:	Brakes	Group 12	(2000)
	General System Covered in Group	Group Number	Basic Part Number for Brake System Components

Some components covered within a Group do not have the same basic part number. In these cases, more than one basic part number will appear on the Group index.

Example:	Suspension	Group 14	(3000	&	5000)
	General System Covered in Group		Basic Part Number for Suspension Components		Basic Part Number for Exhaust Components

Within each Group, the information is further divided into smaller Sections. There is one Section for each component in the system, as well as a General Service Section in some Groups to cover procedures common to several Sections within the Group. In general, each Section contains the Description, Operation, Diagnosis and Testing, Removal and Installation and Disassembly and Assembly procedures for the component covered in the Section. Diagnosis Charts are also included in some Sections to help you systematically locate and correct problems encountered. In most cases, specifications are included at the end of each Section.

To aid in locating specific items in this manual, use the Alphabetical Subject Index in the back of the manual, or the Group and Section Index on the following pages.

As a further aid there is an index on the first page of each Group listing the Section title and Basic Part number for components covered within the Group. The first page of each Section contains an index to locate service operations covered in that Section. This Group-Section breakdown is also indicated in the page number located at the top of each page.

Example: 11-02-21 = (Group) 11 — (Section) 02 — (Page) 21

The descriptions, testing procedures, and specifications in this manual were in effect at the time the manual was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications, design or testing procedures without notice and without incurring obligation. Any reference to brand names in this manual is intended merely as an example of the types of tools, lubricants, materials, etc. recommended for use. Equivalents if available may be used. The right is reserved to make changes at any time without notice.



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A	Body, Chassis, Electrical	Bronco, Econoline (E-150 through E-350) and F-150 through F-350
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E	Engine	F-, FT-, B-, C-600 through 8000 Series
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VEHICLE APPLICATION

E-150 Through E-350, F-150 Through F-350, F-Super Duty, and Bronco Truck Models.

GENERAL INFORMATION

Vehicle Safety Compliance Certification Label

The English Safety Compliance Certification Label (Figs. 1 and 2), is attached to the drivers door lock pillar. The French Safety Compliance Certification Label is attached to the door latch edge on the passenger's side door (Fig. 1). The label contains the name of the manufacturer, the month and year of manufacture, the certification statement, and the Vehicle Identification Number. The label also contains Gross Vehicle Weight Ratings, Wheel and Tire data, and information codes for additional vehicle data.

Vehicle Identification Number (VIN)

Refer to Fig. 3

A seventeen digit combination of numbers and letters forms the Vehicle Identification Number (VIN). The VIN is stamped on a metal tab that is riveted to the instrument panel close to the windshield. The VIN number is viewable by looking through the front windshield on the driver's side. The VIN number is also found on the Safety Compliance Certification Label.

By looking at the seventeen digit VIN number a variety of information about the vehicle can be determined. The first three digits identify the manufacturer and the vehicle make and type. The fourth digit determines the Gross Vehicle Weight Rating (GVWR-Class) and Brake System for Ford completed Trucks and MPV's. For Buses and incompleted vehicles, the fourth digit determines the brake system (only). Digits five, six and seven identify the model or line, series, chassis, and cab or body type. The eighth digit points out the particular engine found in the vehicle. Digit nine is the VIN check digit. The tenth digit identifies the model year of a Ford-completed vehicle, or the model year of the incomplete vehicle, if sold by Ford as an incomplete vehicle. The eleventh digit determines the assembly plant. Digits twelve through seventeen make up the sequence serial and warranty number. Digit twelve uses the letter "A" until the production or sequence of 99,999 units (digits thirteen through seventeen) is reached. Letter "A" then becomes "B" for the next production sequence of vehicles.

Refer to Fig. 3 to help in further explanation of the Vehicle Identification Number (VIN).

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SAFETY COMPLIANCE CERTIFICATION LABELS
COMPLETE VEHICLES

(UNITED STATES)

MFD. BY FORD MOTOR CO. IN U.S.A.
DATE: 2/88 **GVWR:** 4900 LB/2222 KG
FRONT GAWR: 2684 LB | **REAR GAWR:** 3750 LB
1217 KG **WITH** | 1700 KG **WITH**
P195/75R15SL **TIRES** | P195/75R15SL **TIRES**
15x6.0 JK **RIMS** | 15x6.0 JK **RIMS**
AT 35 **PSI COLD** | AT 35 **PSI COLD**

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VEHICLE IDENTIFICATION NO.
1FTBF15G5 JLA00000
TYPE TRUCK

EXTERIOR PAINT COLORS | DSO
WB | TYPE GVW | BODY | TRANS | AXLE | TAPE | SPRING

(CANADA)

MFD. BY FORD MOTOR CO. OF CANADA LTD.
DATE: **GVWR:**
FRONT GAWR: | **REAR GAWR:**
WITH TIRES RIMS | **WITH TIRES RIMS**
AT PSI COLD | **AT PSI COLD**

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VEH. IDENT. NO.
TYPE UTILIZE SAME TYPE DATA AS U.S.A.

EXTERIOR PAINT COLORS | DSO
WB | TYPE GVW | BODY | TRANS | AXLE | TAPE | SPRING
MADE IN CANADA

(QUEBEC)

FABR. AUX E-U PAR LA FORD MOTOR CO.
DATE: **PNBV:**
PNBE AV: **PNBE AR:**
AVEC
◂PNEUS▸
◂JANTES▸
A LB/PO² A FROID **A LB/PO² A FROID**

CE VEHICULE EST CONFORME A TOUTES LES NORMES FEDERALES DE SECURITE DES V.A. EN VIGUEUR A LA DATE DE FABR. INIQUEE CI-DESSUS.

N° D'IDENT. DU VEH.
TYPE

COULEUR | N° COMM SPEC.
EMPATT. | TYPE/PBV | CARR | TRANSM. | PONT | BANDE | RESSORT

(QUEBEC)

FABR. PAR FORD DU CANADA LIMITEE
DATE: **PNBV:**
PNBE AVANT: **PNBE ARRIERE:**
AVEC
◂PNEUS▸
◂JANTES▸
A LB/PO² A FROID **A LB/PO² A FROID**

CE VEHICULE EST CONFORME A TOUTES LES NORMES FEDERALES DE SECURITE DES V.A. EN VIGUEUR A LA DATE DE FABR. INIQUEE CI-DESSUS.

N° D'IDENT. DU VEH.
TYPE

COULEUR | N° COMM SPEC
EMPATT | TYPE/PBV | CARR | TRANSM | PONT | BANDE | RESSORT
MADE IN CANADA

FOR VEHICLES MFD IN U.S.A. FOR QUEBEC, CANADA.

FOR VEHICLES MFD. IN CANADA FOR QUEBEC, CANADA.

INCOMPLETE VEHICLES

THE INCOMPLETE VEHICLE RATING DECAL IS INSTALLED ON THE DRIVER'S DOOR LOCK PILLAR IN PLACE OF THE SAFETY COMPLIANCE CERTIFICATION LABEL.



DECAL APPLIED TO ALL CANADIAN BUILT UNITS AND ALL U.S.A. BUILT UNITS SOLD IN CANADA

INCOMPLETE VEHICLE MANUFACTURED BY

GVWR: 3020 LB/1369 KG
VEHICLE IDENTIFICATION NUMBER 1FTBF25G5 JLA00000

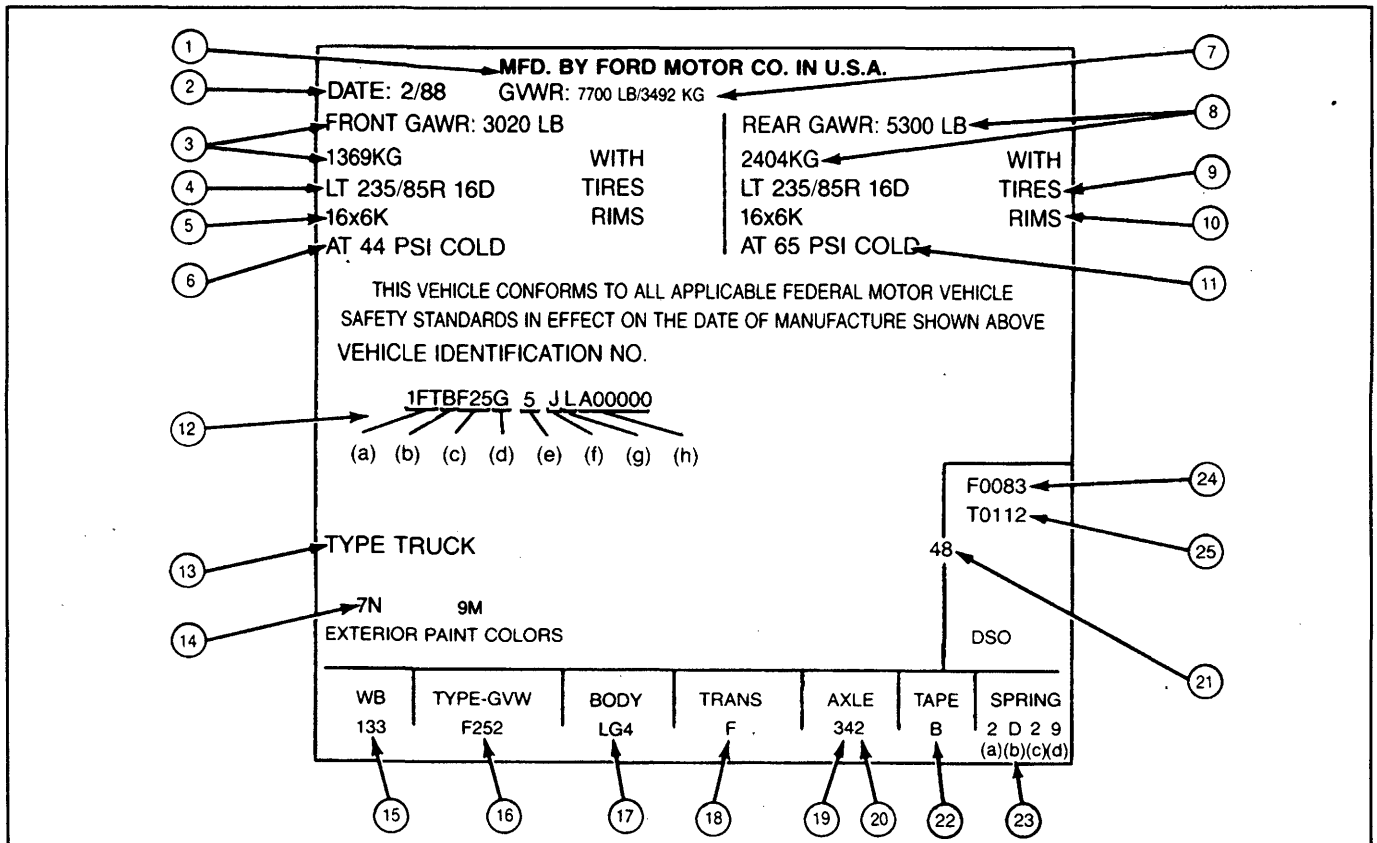
EXTERIOR PAINT COLORS 51 | 48 DSO

WB	TYPE GVW	BODY	TRANS	AXLE	TAPE	SPRING 2D29
133	F270	AB4	F	38	B	1988

CY2666-2E

FIG. 1 Typical Truck Safety Compliance Certification Labels and Vehicle Rating Decal

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① Name and Location of Manufacturer
② Date of Manufacture
③ Front Gross Axle Weight Ratings in Pounds (LB) and Kilograms (KG)
④ Front Tire Size
⑤ Rim Size
⑥ Front Tire Cold PSI
⑦ Gross Vehicle Weight Rating in Pounds (LB) and Kilograms (KG)
⑧ Rear Gross Axle Weight Rating in Pounds (LB) and Kilograms (KG)
⑨ Rear Tire Size
⑩ Rim Size
⑪ Rear Tire Cold PSI
⑫ Vehicle Identification Number
(a) World Manufacturer Identifier
(b) Brake System and Gross Vehicle Weight Rating (GVWR) Class for Ford completed Trucks and MPV's. For Buses and Incomplete Vehicles, the fourth digit determines the brake system (only).
(c) Model or Line, Series, Chassis, Cab or Body Type
(d) Engine Type
(e) Check Digit
(f) Model Year (Ford-Complete Trucks and MPV's)
(g) Assembly Plant Code
(h) Sequence Number
⑬ Type Vehicle
⑭ Exterior Paint Codes (two sets of figures designates a two-tone)
⑮ Wheelbase in Inches
⑯ Model Code and GVW
⑰ Interior Trim, Seat and Body/Cab Type
⑱ Transmission Code
⑲ Rear Axle Code
⑳ Front Axle Code if so Equipped
㉑ District/Special Order Codes
㉒ External Body Tape Stripe Code
㉓ Suspension Identification Codes
(a) Aux./Opt. Usage Code (Front)
(b) Front Spring Code
(c) Aux./Opt. Usage Code (Rear)
(d) Rear Spring Code
㉔ Front Axle Accessory Reserve Capacity in Pounds
㉕ Total Accessory Reserve Capacity in Pounds

CW1017-2V

FIG. 2 Typical Truck Safety Compliance Certification Label

Refer to the code definition portion of this Section for specific definitions of the numbers and letters of the Vehicle Identification Number (VIN).

Build Date Stamp Locations

The vehicle build date stamp is located as follows: On Bronco and Light Trucks (F-150—F-250—F-350) the vehicle build date is stamped on the front surface of the radiator support on the passengers side of the vehicle. On Econoline vehicles (E-150—E-250—E-350), the build date is stamped on top of the radiator support. Following is a sample of the four digit number that indicates the month and day of build.

Actual Date of Build

Date Stamp on Vehicle

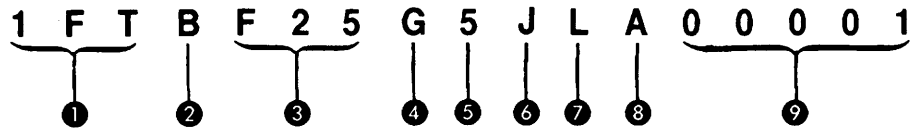
January 24 0124

October 21 1021

Yellow ink is used for the date stamp. When the marking surface is painted the body color, the date stamp will be marked in red ink. Units from the Ontario Truck Plant (Code C) will be marked with silver ink.

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SAMPLE VIN NUMBER



1. Position 1, 2 and 3 — Manufacturer, Make and Type (World Manufacturer Identifier)
2. Position 4 — Brakes System/GVWR Class for Ford-completed Trucks and MPV's. For Buses and Incomplete Vehicles, Brake System (only).
3. Position 5, 6 and 7 — Model or Line, Series, Chassis, Cab or Body Type
4. Position 8 — Engine Type
5. Position 9 — Check Digit
6. Position 10 — Model Year (Ford-completed vehicles)
7. Position 11 — Assembly Plant
8. Position 12 — Constant "A" until sequence number of 99,999 is reached, then changes to a constant "B" and so on
9. Position 13 through 17 — Sequence number — begins at 00001

CY2376-2G

Vehicle Data

The Vehicle Data appears on the Safety Compliance Certification Label on the second and third lines following the identification number. The code set (two numbers, or a number and letter) above COLOR identify the exterior paint color (two sets of codes designate a two-tone). The three digits under W.B. designate the wheelbase in inches. The letter and three digits under TYPE/G.V.W. designate the truck model within a series and the gross vehicle weight rating. The letters and/or numeral under BODY designate the interior trim, seat and body type. The transmission installed in the vehicle is identified under TRANS by an alphabetical code. A letter and a number or two numbers under AXLE identify the rear axle ratio (when required, a letter is also stamped or number after the rear axle code to identify the front axle). The letters and/or numerals under TAPE designate the external bodyside tape stripe. The spring usage codes for the vehicle is identified under SPRING.

A two-digit number is stamped above D.S.O. to identify the district which ordered the vehicle. If the vehicle is built to special order (Domestic Special Order, Foreign Special Order, Limited Production Option, or other special order), the complete order number will also appear above D.S.O. The following charts list the various vehicle data codes.

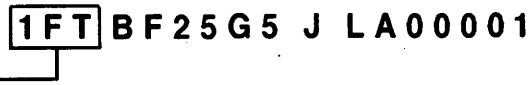
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VEHICLE IDENTIFICATION NUMBER

(VIN) Codes

VEHICLE IDENTIFICATION NUMBER (VIN) CODES

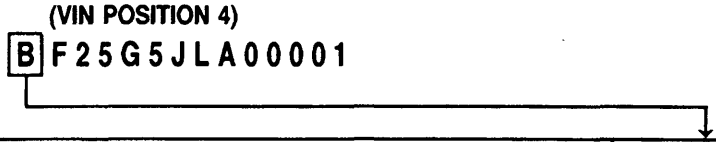
WORLD MANUFACTURER IDENTIFIER
(VIN POSITIONS 1, 2 AND 3)



VIN Code	Manufacturer	Make	Type
1FM	Ford Motor Company, USA	Ford	Multi-Purpose Passenger Vehicle (MPV)
1FT	Ford Motor Company, USA	Ford	Truck (Complete Vehicle)
1FD	Ford Motor Company, USA	Ford	Incomplete Vehicle (IV)
1FC	Ford Motor Company, USA	Ford	Basic (Stripped) Chassis
1FB	Ford Motor Company, USA	Ford	Bus
1FF	Ford Motor Company, USA	Ford	Motor Vehicle Equipment without Engine/Powertrain (Glider)
2FM	Ford Motor Company of Canada, Ltd.	Ford	MPV
2FT	Ford Motor Company of Canada, Ltd.	Ford	Truck (Complete Vehicle)
2FD	Ford Motor Company of Canada, Ltd.	Ford	Incomplete Vehicle
2FC	Ford Motor Company of Canada, Ltd.	Ford	Basic (Stripped) Chassis
2FB	Ford Motor Company of Canada, Ltd.	Ford	Bus
2FF	Ford Motor Company of Canada, Ltd.	Ford	Motor Vehicle Equipment without Engine/Powertrain (Glider)

CY2377-2G

BRAKE SYSTEM AND GVWR CLASS FOR TRUCKS AND MPV'S —
BRAKE SYSTEM (ONLY) FOR BUSES AND INCOMPLETE VEHICLES
(VIN POSITION 4)



BRAKE SYSTEM	GVWR CLASS	GVWR RANGE	VIN CODE
Hydraulic	Class A	Not greater than 3,000 pounds	A
Hydraulic	Class B	3,001 — 4,000 pounds	B
Hydraulic	Class C	4,001 — 5,000 pounds	C
Hydraulic	Class D	5,001 — 6,000 pounds	D
Hydraulic	Class E	6,001 — 7,000 pounds	E
Hydraulic	Class F	7,001 — 8,000 pounds	F
Hydraulic	Class G	8,001 — 8,500 pounds	G
		8,501 — 9,000 pounds	H
Hydraulic	Class H	9,001 — 10,000 pounds	J
Hydraulic	Class 3	10,001 — 14,000 pounds	K
Hydraulic	Class 4	14,001 — 16,000 pounds	L
Hydraulic	Class 5	16,001 — 19,500 pounds	M

CY2674-2E

DAVE GRAHAM INC. 2012
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MODEL OR LINE, SERIES, CHASSIS, CAB OR BODY TYPE (VIN POSITIONS 5, 6, AND 7)

1FTB **F25** G5JLA00001

VIN Code		Line	Series	ChassisType	Cab or Body Type	Vehicle Type ①
Club Wagon	Super Wagon					
E11	—	Club Wagon XL	E150	4x2	Club Wagon	MPV
E21	—	Club Wagon XL	E250	4x2	Club Wagon	MPV or Bus ⓐ
—	S31	Club Wagon XL	E350	4x2	Super Wagon	MPV or Bus ⓐ

Memo: One of the following optional exterior nameplates (indicating different trim levels) may also be affixed to the vehicle in addition to the Club Wagon XL nameplate:
●XLT ●No Nameplate (Trim credit option-deletes XL trim components) ⓐExcludes School Bus

Regular Van	Super Van					
E14	S14	Econoline	E150	4x2	Cargo Van — Regular Van/Super Van	Truck or IV
E24	S24	Econoline	E250	4x2	Cargo Van — Regular Van/Super Van	Truck or IV
E34	S34	Econoline	E350	4x2	Cargo Van — Regular Van/Super Van	Truck or IV
Other						
E37	—	Econoline	E350	4x2	Commercial Cutaway	IV
E30	—	Econoline	E350	4x2	RV Cutaway	IV
E39	—	Econoline	E350	4x2	Commercial Basic (Stripped) Chassis	IV
E33	—	Econoline	E350	4x2	RV Basic (Stripped) Chassis	IV

①"MPV" means Multi-Purpose Vehicle. "IV" means Incomplete Vehicle. "Truck" means Complete Vehicle.
Memo: For all Econoline except Basic (Stripped) Chassis, the optional exterior nameplate "XL" (indicating trim level) may also be affixed to the vehicle in addition to the Econoline nameplate.
Note: All 1988 model Commercial and RV Basic (Stripped) Chassis incomplete vehicles are designated by a "1FC" or "2FC" World Manfacturer Identifier (WMI) code. The RV Basic (Stripped) Chassis is available only on a Special Order Basis.

VIN Code	Line	Series	Chassis Type	Cab or Body Type	Vehicle Type ①
U15	Bronco	U150	4x4	Bronco	MPV

Memo: One of the following optional exterior nameplates (indicating higher trim levels) may also be affixed to the vehicle in addition to the Bronco nameplate:
● XLT ● Eddie Bauer

Regular Cab	Super Cab or Crew Cab					
F14	X14	F-Series	F150	4x4	Pickup — Regular Cab/Super Cab	Truck
F15	X15	F-Series	F150	4x2	Pickup — Regular Cab/Super Cab	Truck
F25	X25	F-Series	F250	4x2	Pickup — Regular Cab/Super Cab	Truck
F26	X26	F-Series	F250	4x4	Pickup — Regular Cab/Super Cab	Truck
F35	W35	F-Series	F350	4x2	Pickup — Regular Cab/Crew Cab	Truck
F37	—	F-Series	F350	4x2	Regular Cab (Chassis Cab)	IV
F36	W36	F-Series	F350	4x4	Pickup — Regular Cab/Crew Cab	Truck
F38	—	F-Series	F350	4x4	Regular Cab (Chassis Cab)	IV
F47	—	F-Series	F-Super Duty	4x2	Regular Cab (Chassis Cab)	IV

① "MPV" means Multi-Purpose Passenger Vehicle. "IV" means Incomplete Vehicle.
Memo: One of the following optional exterior nameplates (indicating higher trim levels) may also be affixed to the vehicle in addition to the F-Series nameplates:
● XL ● XLT Lariat ● Explorer (excluding Crew Cab and Chassis Cab)
Note: Special Order (DSO) units will be coded with the appropriate series VIN codes listed above.

CY2379-2G

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ENGINE TYPE, DISPLACEMENT, CYLINDERS, FUEL TYPE, AND MANUFACTURER (VIN POSITION 8)

1 F T B F 2 5 [G] 5 J L A 0 0 0 0 1

VIN Code	Displacement		Cylinders	Fuel	Manufacturer
	Liter	CID			
Y	4.9	300	I-6	Gasoline	Ford
N	5.0	302	V-8	Gasoline	Ford
H	5.8	351	V-8	Gasoline	Ford
G	7.5	460	V-8	Gasoline	Ford
M	7.3	445	V-8	Diesel	Navistar

CY2380-2G

CHECK DIGIT FOR ALL VEHICLES (VIN POSITION 9)

1 F T B F 2 5 G [5] J L A 0 0 0 0 1

CY2381-1G

VEHICLE MODEL YEAR FOR FORD-COMPLETED VEHICLES (VIN POSITION 10)

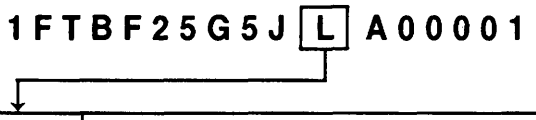
1 F T B F 2 5 G 5 [J] L A 0 0 0 0 1

VIN Code	Year
J	1988
K	1989
L	1990
M	1991
N	1992

CY2382-1G

DAVE GRAHAM INC. 2012
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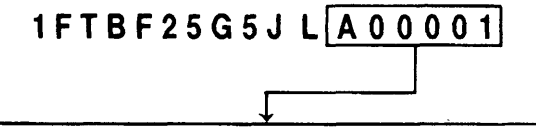
ASSEMBLY PLANT CODES (VIN POSITION 11)



VIN Code	Vehicle Assembly Plant — Name and Location
C	Ontario Truck: Oakville, Ontario
H	Lorain: Lorain, Ohio
K	Kansas City: Claycomo, Missouri
L	Michigan Truck: Wayne, Michigan
N	Norfolk: Norfolk, Virginia
P	Twin Cities: St. Paul, Minnesota
U	Louisville: Louisville, Kentucky

CY2383-1G

PRODUCTION SEQUENCE NUMBER (VIN POSITIONS 12 THROUGH 17)

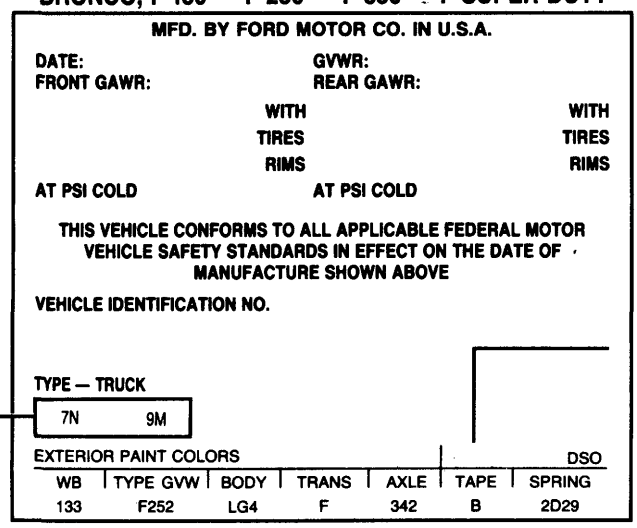


SEQUENCE NUMBER
A 00001 — A 99,000 B 00001 — B 99,999 and so on.

CY2384-1G

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EXTERIOR PAINT COLOR CODES
BRONCO, F-150 — F-250 — F-350 — F-SUPER DUTY



BRONCO EXTERIOR PAINT COLOR CODES

Code	Color
1C	Black
1D	Smoke Metallic
1G	Light Smoke Metallic
2D	Medium Scarlet
2H	Medium Cabernet
7H	Bright Regatta Blue Metallic
7N	Dark Shadow Blue Metallic
9M	White
9N	Desert Tan Metallic
9T	Light Chestnut
42	Alpine Green Metallic
95	Dark Chestnut Metallic
99	Prime
Fiberglass Roof Colors	
A	Black
B	Blue
H	Desert Tan
W	White

NOTE — TWO SETS OF CODES INDICATE TWO-TONE PAINT

F-150 — F-350 AND F-SUPER DUTY EXTERIOR PAINT COLOR CODES

Code	Color
1C	Black
1D	Smoke Metallic
1G	Light Smoke Metallic
2D	Medium Scarlet
2H	Medium Cabernet
7H	Bright Regatta Blue Metallic
7N	Dark Shadow Blue Metallic
9M	White
9N	Desert Tan Metallic
9T	Light Chestnut
42	Alpine Green Metallic
95	Dark Chestnut Metallic
99	Prime

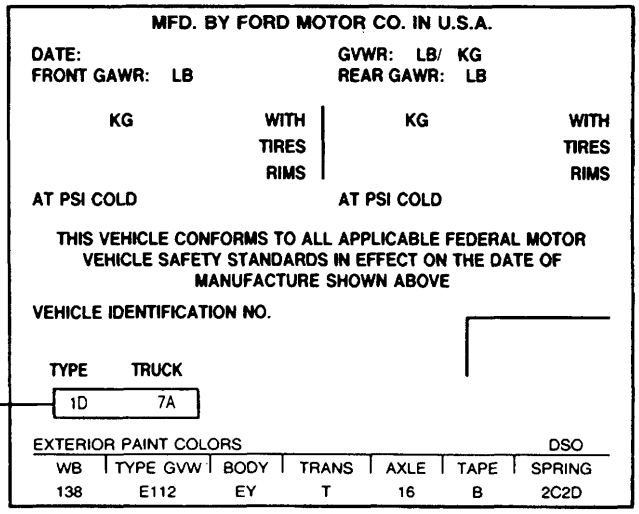
CLEAR COAT (CC) COLOR CODES

Code	Color
3E	Medium Regatta Blue Metallic
4U	Alpine Green Metallic
7K	Dark Shadow Blue Metallic
9Z	Silver Metallic
49	Graphite Metallic
93	Chestnut Metallic
97	Dark Chestnut Metallic

CY2668-2E

DAVE GRAHAM INC. 2012
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EXTERIOR PAINT COLOR CODES
E-150 — E-250 — E-350



E-150 — E-350

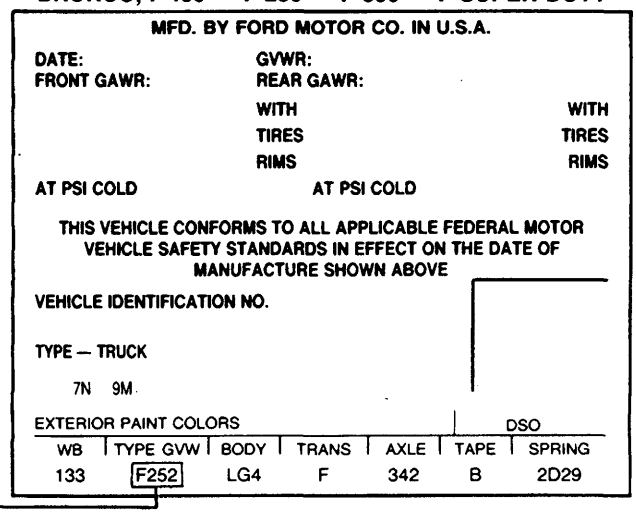
Code	Color
1D	Smoke Metallic
1G	Light Smoke Metallic
3R	Medium Shadow Blue Metallic
7A	Spinnaker Blue
7N	Dark Shadow Blue Metallic
9M	White
9N	Desert Tan Metallic
9T	Light Chestnut
27	Medium Red
95	Dark Chestnut Metallic
99	Prime

NOTE: Two sets of codes indicate two-tone paint.

CY2794-2D

DAVE GRAHAM INC. 2012
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TYPE — GROSS VEHICLE WEIGHT (GVW) CODES
BRONCO, F-150 — F-250 — F-350 — F-SUPER DUTY



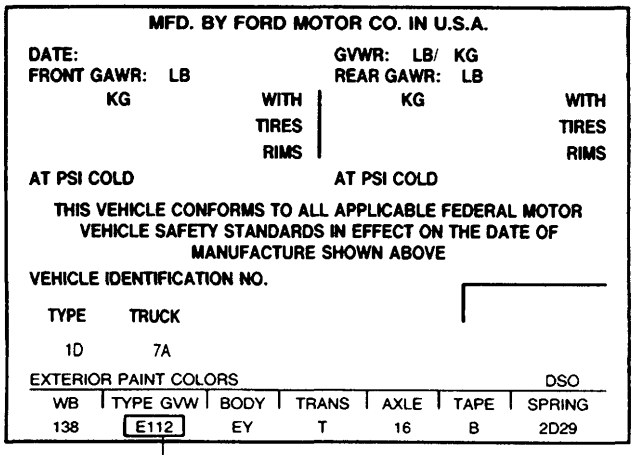
F25 | 2

Series	Series Code	GVWR Code	GVWR (lb.)	Wheelbase (in.)
Bronco				
U150	U15	2	6050	105
	U15	4	6300	105
	U15	5	6450	105
F-150 — F-250 — F-350				
F-150 (4x2)	F15	3	5250	117
	F15	4	5450	133
	F15	5	6250	133
	X15	1	6050	139
	X15	2	6250	155
F-150 (4x4)	F14	1	6100	117
	F14	2	6250	133
	X14	3	6250	139
	X14	1	6250	155
F-250 (4x2) Light Duty	F25	1	6600	133
	F25	2	7700	133
F-250 (4x2) Heavy Duty	F25	7	8600	133
	X25	9	8800	155
F-250 (4x4)	F26	1	6800	133
	X26	8	8800	155
	F26	8	8600	133
F-350 (4x2)	F35	2	10,000	133
	F37	4	8800	133
	F37	8	10,000	137, 161
	F37	9	11,000	137, 161
	W35	2	9200	168
	W35	3	10,000	168
	X35	1	10,000	155
F-350 (4x4)	F36	1	9000	133
	F38	2	8800	133
	F38	4	11,000	137
	W36	1	9200	168
F-Super Duty (4x2)	F47	6	14,500	137, 161

CY2669-2E

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

TYPE — GROSS VEHICLE WEIGHT (GVW) CODES
E-150 — E-250 — E-350



E-150 — E-350 CLUB — CUSTOM AND CHATEAU WAGONS

Series	Series Code	GVWR Code	GVWR (lb.)
E-150 Conventional	E11	2	6,500
E-250 Conventional	E21	P	8,550
E-350 Super	S31	5	9,100

E-150 — E-350 CARGO VANS

Series	Series Code	GVWR Code	GVWR (lb.)
E-150 Conventional Cargo	E14	1	5,500
	E14	2	6,100
	E14	3	6,500
E-150 Super Cargo	S14	1	6,200
E-250 Conventional Cargo	E24	1	7,200
	E24	2	7,900
E-250 Super Cargo	S24	1	8,100
E-350 Conventional Cargo	E34	1	9,400
	E34	2	9,500
E-350 Super Cargo	S34	1	9,000

E-350 REGULAR CUTAWAY VANS

Series	Series Code	GVWR Code	GVWR (lb.)
E-350 Regular Cutaway Van	E30	2	10,500 DR
	E30	3	11,000 DR

SR: Single Rear Wheels
DR: Dual Rear Wheels

E-350 COMMERCIAL CUTAWAY VANS

Series	Series Code	GVWR Code	GVWR (lb.)
E-350 Commercial Cutaway Van	E37	1	10,000 DR
	E37	2	10,300 DR
	E37	3	10,700 DR

SR: Single Rear Wheels
DR: Dual Rear Wheels

E-350 STRIPPED CHASSIS VAN

Series	Series Code	GVWR Code	GVWR (lb.)
E-350 Stripped Chassis Van	E39	U	9,400 SR
	E39	W	10,000 DR

SR: Single Rear Wheels
DR: Dual Rear Wheels

E-350 COMMERCIAL CUTAWAY STRIPPED CHASSIS

Series	Series Code	GVWR Code	GVWR (lb.)
E-350 Commercial Cutaway Stripped Chassis	E33	3	11,500 DR

CY2779-2D

DAVE GRAHAM INC. 2012
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BODY CODES
BRONCO, LIGHT TRUCK,
(F-150 — F-250 — F-350 — F-SUPER DUTY)

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE: GVWR:
FRONT GAWR: REAR GAWR:

	WITH	WITH
	TIRES	TIRES
	RIMS	RIMS
AT PSI COLD	AT PSI COLD	

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VEHICLE IDENTIFICATION NO.

TYPE — TRUCK
1D 7A

EXTERIOR PAINT COLORS

WB	TYPE GVW	BODY	TRANS	AXLE	TAPE	DSO SPRING
133	F252	LG4	F	342	B	2D29

L G 4

LIGHT TRUCK

Code	Fabric	Seat Type
B	Vinyl	Bench
D	Knit & Vinyl	Bench
L	Bodycloth	Bench
R	Cloth	Captains Chair
S	Cloth	Bench
T	Bodycloth	Flight Bench

BRONCO AND F-SERIES

Trim Color	
Code	Color
B	Regatta Blue
D	Canyon Red
G	Smoke
K	Chestnut

BRONCO

Code	Fabric	Seat Type
A	Vinyl	Bucket
L	Cloth	Bench
M	Cloth	Bucket
H	Bodycloth	Captains Chair
R	Cloth	Captains Chair

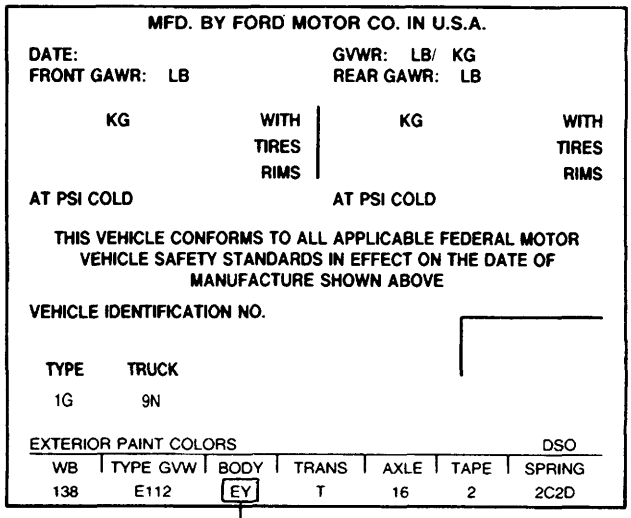
F-SERIES ONLY
CAB/BACK OF CAB

Super Cab	Crew Cab	Regular	Specifications
M	D	3	Flareside Pickup
		4	Styleside Pickup
		8	Chassis Cab

CY2388-2G

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

BODY CODES
E-150 — E-250 — E-350



E Y

SEAT TRIM AND STYLE

Code	Trim	Type
A	Vinyl	Bucket
E	Vinyl	Bucket
K	Cloth	Bucket
L	Cloth	Captain Chairs

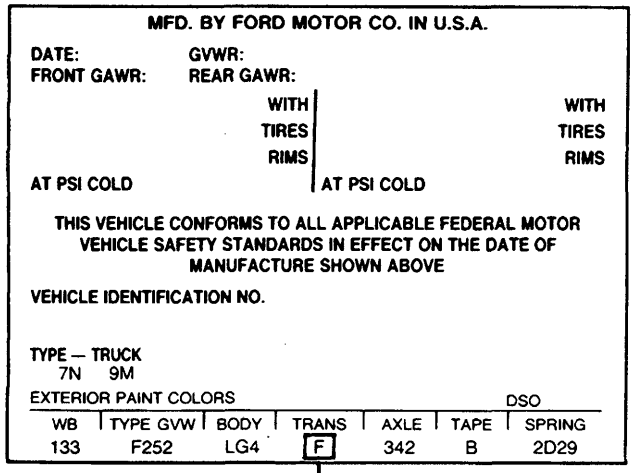
TRIM COLOR

Code	Color
B	Regatta Blue
D	Canyon Red
G	Smoke
K	Chestnut

CY2780-2D

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

TRANSMISSION CODES
BRONCO, E-150 — E-250 — E-350,
F-150 — F-250 — F-350 — F-SUPER DUTY



Code	Description
BRONCO	
K	Automatic C6
T	Automatic — AOD
M	Manual — 5-Speed Overdrive (M5OD)
Z	Manual — 5-Speed H.D. Overdrive (M5OD-HD)

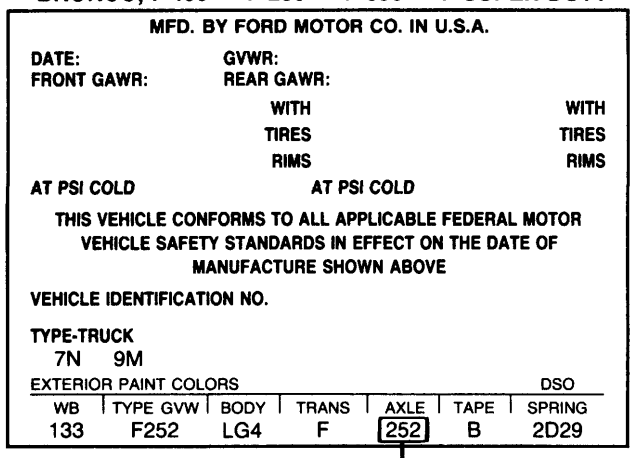
E-150 — E-250 — E-350	
K	Automatic — C6
T	Automatic 4-Speed AOD
M	Manual — 5-Speed Overdrive (M5OD)
Z	Manual — 5-Speed H.D. Overdrive (M5OD-HD)

F-150 — F-250 — F-350	
K	Automatic — C6
T	Automatic — AOD
M	Manual — 5-Speed Overdrive (M5OD)
Z	Manual — 5-Speed H.D. Overdrive (M5OD-HD)

CY2390-2G

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

AXLE CODES
BRONCO, F-150 — F-250 — F-350 — F-SUPER DUTY



REAR AXLE CODES

Code	Capacity (lbs.)	Ratio
12	3800	2.73
18	3800	3.08
19	3800	3.55
H5	3800	4.10
H8	3800	3.08
H9	3800	3.55
25	3800	4.10
27	5300	3.73
29	5300	3.55
B5	5300	4.10
B9	5300	3.55
35	6250	4.10
39	6250	3.55
C5	6250	4.10
C9	6250	3.55
45	7400	4.10
49	7400	3.55
D5	7400	4.10
65	8250	4.10
69	8250	3.55
F5	8250	4.10
72	11,000	4.63
73	11,000	5.13

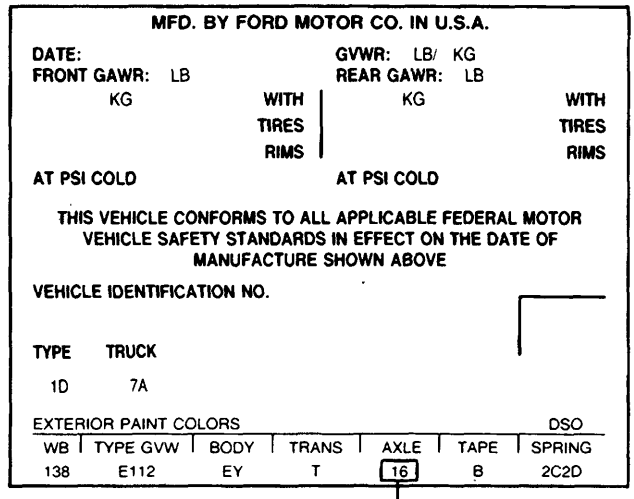
FRONT AXLE CODES (Not Applicable On E-150 — E-250 — E-350)

Bronco and F-150 — F-250 — F-350	
Code	Description
2	Front Axle Limited Slip

CY2671-2E

DAVE GRAHAM INC. 2012
ALL RIGHTS RESERVED

AXLE CODES
E-150 — E-250 — E-350



E-150 — E-250 — E-350 REGULAR REAR AXLE

Code	# Capacity	Ratio
18	3750	3.08
19	3750	3.55
23	5300	3.54
24	5300	3.73
33	6340	3.54
52	7400	4.10
53	7400	3.54

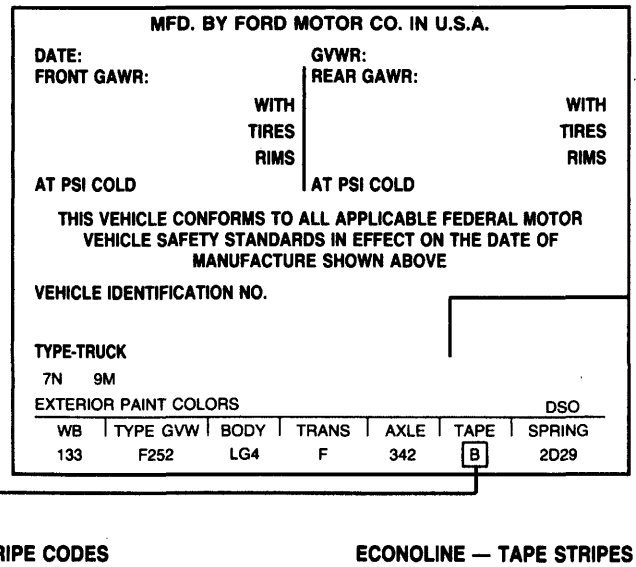
E-150 — E-250 — E-350 LIMITED SLIP REAR AXLE

Code	# Capacity	Ratio
H9	3750	3.08
B4	5300	3.73
C2	6340	4.10
C3	6340	3.54
E2	7400	4.10

CY2781-2C

DAVE GRAHAM INC. 2012
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EXTERNAL BODY TAPE STRIPE CODES
BRONCO, E-150 — E-250 — E-350, F-150 — F-250 — F-350 — F-SUPER DUTY



BRONCO EXTERNAL BODY TAPE STRIPE CODES

Code	Tape Stripe
1	Light Blue/Bright Blue
2	Medium Tan/Dark Tan
3	Medium Charcoal/Red Orange
U	Light Desert Tan — Paint Stripe with Medium Tan/Dark Tan — Tape Break Stripe

F-150 — F-350 EXTERNAL BODY TAPE STRIPE CODES
XL SRW STYLESIDE SOLID PAINT (PAINT STRIPE)
LESS CHAMFER STRIPES

Code	Tape Stripe
1	Red Orange
2	Grabber Blue
3	Copper
4	Light Desert Tan
5	Light Charcoal

ECONOLINE — TAPE STRIPES

Code	Tape Stripe
1	Bright Coral/Red Orange
2	Medium Light Blue/Bright Blue
3	Bright Mandarin/Orange
4	Medium Light Desert Tan/Desert Tan

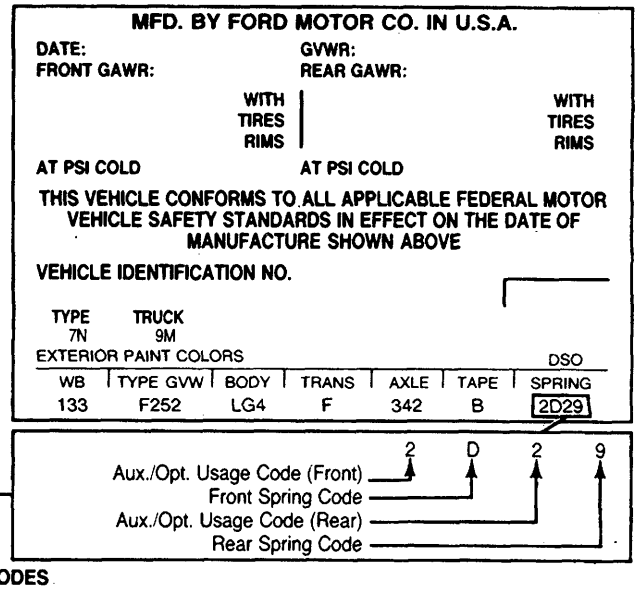
F-150 — F-350 ALL TUTONES (TAPE)
REGULAR AND VICTORIA TUTONES (TAPE)

Code	Tape Stripe
1	Light Blue/Bright Regatta Blue
2	Light Chestnut/Light Desert Tan
3	Medium Charcoal/Red Orange

CY2672-2E

DAVE GRAHAM INC. 2012
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SUSPENSION — SPRING IDENTIFICATION CODES
BRONCO, F-150 — F-250 — F-350 — F-SUPER DUTY



BRONCO SPRING IDENTIFICATION CODES

Aux./Opt. Usage Code (Front) — Not Applicable **Aux./Opt. Usage Code (Rear) — Not Applicable**

FRONT SPRING CODES — BRONCO

Code	Part Number
B	E0TA-5310-BC
C	E0TA-5310-CC
G	E0TA-5310-GC
U	E0TA-5310-UC
V	E0TA-5310-VB

REAR SPRING CODES — BRONCO

Code	Part Number
Z	E3TA-5560-ANA

F-150 — F-250 — F-350 — F-SUPER DUTY
AUX./OPT. FRONT SPRING USAGE CODE

Code	Description
3	Maximum Front GAWR Package
4	Heavy Duty Front Suspension Package

F-150 — F-250 — F-350 — F-SUPER DUTY
FRONT SPRING CODES

Code	Part Number
A	E0TA-5310-AC
B	E0TA-5310-BC
C	E0TA-5310-CC
D	E0TA-5310-DC
E	E0TA-5310-EC
F	E0TA-5310-FC
G	E0TA-5310-GC
H	E3TA-5310-XA
J	E3TA-5310-YA
K	E3TA-5310-ZA
M	E3TA-5310-AAA
N	E5TS-5310-BA
R	E5TA-5310-RA
S	E5TA-5310-SA
T	E5TA-5310-TA
U	E0TA-5310-UC
V	E0TA-5310-VB
1	E8TA-5310-AA
5	E0TA-5310-AAB
6	E0TA-5310-ABB
7	E0TA-5310-ACB
8	E5TA-5310-NA
9	E3TA-5310-ABA

F-150 — F-250 — F-350 — F-SUPER DUTY
AUX./OPT. REAR SPRING USAGE CODE

Code	Description
3	Heavy Duty Rear Suspension Package
—	Auxiliary Rear Springs
4	400# — F-150
7	710# — F-250 — F-350
9	900# — F-350

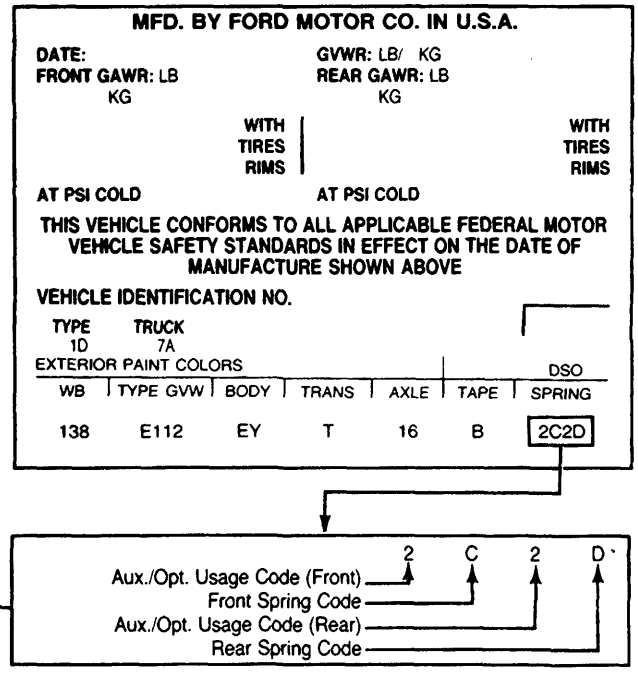
F-150 — F-250 — F-350 — F-SUPER DUTY
REAR SPRING CODE

Code	Part Number
A	E4TA-5560-SA
D	E6TA-5560-NA
F	E7TA-5560-FA
H	E6TA-5560-LA
L	E3TA-5560-KA
V	E6TA-5560-RA
W	E4TA-5560-TA
Y	E7TA-5560-YA
6	E4TA-5560-EA
7	E7TA-5560-KA
8	E8TA-5A975-AA
9	E4TA-5560-HA

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SUSPENSION-SPRING IDENTIFICATION CODES
E-150 — E-250 — E-350



E-150 — E-250 — E350
AUX./OPT. FRONT SPRING USAGE CODE

Code	Description
2	Heavy Duty Front Springs
4	Front Spring 3,850/4,200 # GAWR Rating

E-150 — E-250 — E350
FRONT SPRING CODES

Code	Part Number
A	D5UA-5310-BA
B	D5UA-5310-CA
C	D5UA-5310-DA
D	D5UA-5310-EA
E	D5UA-5310-FA
F	D5UA-5310-HB
G	D5UA-5310-JB
H	D5UA-5310-KA
J	D5UA-5310-LB
K	D5UA-5310-MA
L	D5UA-5310-RA
M	D5UA-5310-SA
N	D5UA-5310-UA
O	D5UA-5310-VA
P	D5UA-5310-ALB
R	D5UA-5310-AMB
S	D5UA-5310-ARB
T	D5UA-5310-AUB
V	D7UA-5310-AHA
W	D7UA-5310-AJA
Y	D8TA-5310-HA

E-150 — E-250 — E-350
AUX./OPT. REAR SPRING USAGE CODES

Code	Description
2	Heavy Duty Rear Springs
4	Handling Package

E-150 — E-250 — E-350
REAR SPRING CODES

Code	Part Number
A	D9TA-5560-ZA
C	E1TA-5560-ACA
D	E1TA-5560-ADA
E	E1TA-5560-AEA
F	E1TA-5560-ALA
H	E1TA-5560-AFA
J	D9TA-5560-LA
K	D9TA-5560-HA
L	E2TA-5560-ARA
M	E1TA-5560-AGA
N	E1TA-5560-AHA
P	D9TA-5560-AYA
Q	E0TA-5560-BVA
T	D9TA-5560-KA
U	D9TA-5560-MA
W	E4UA-5560-RA
Y	D9TA-5560-AVA
Z	D9TA-5560-JA

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DISTRICT SALES OFFICE (DSO) AND WHEELBASE (WB) CODES BRONCO, E-150 — E-250 — E-350, F-150 — F-250 — F-350 — F-SUPER DUTY

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE: GVWR:
FRONT GAWR: REAR GAWR:
WITH TIRES RIMS AT PSI COLD
WITH TIRES RIMS AT PSI COLD

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR VEHICLE SAFETY STANDARDS IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE

VEHICLE IDENTIFICATION NO.

TYPE-TRUCK
7N 9M 21

EXTERIOR PAINT COLORS

WB	TYPE GVW	BODY	TRANS	AXLE	TAPE	DSO SPRING
133	F252	LG4	F	342	B	2D29

DSO — FSO — PTO (DOMESTIC, FOREIGN AND SPECIAL ORDER)

The D.S.O. space will show a two-digit code number of the district which ordered the unit (see chart below). This code will appear on all units — domestic or export. If unit is built on a D.S.O., F.S.O., P.T.O. (special orders), the complete order number is under the D.S.O. spacer **after** the district code number.

Wheelbase (inches)
Bronco
105

F-150 — F-250 — F-350		F-Super Duty
117		137
133	155	161
137	161	
139	168	

E-150 — E-250 — E-350 (Econoline and Club Wagon)
124
138
158
176

Code	District
11	Boston
12	Buffalo
13	New York
14	Pittsburgh
16	Philadelphia
17	Washington
21	Atlanta
22	Charlotte
23	Memphis
24	Jacksonville
26	New Orleans
28	Louisville
41	Chicago
42	Cleveland
43	Milwaukee
46	Indianapolis
47	Cincinnati
48	Detroit

Code	District
52	Dallas
53	Kansas City
54	Omaha
55	St. Louis
57	Houston
58	Twin Cities
71	Los Angeles
72	San Jose
74	Seattle
75	Phoenix
76	Denver
83	Government
84	Home Office Reserve
85	American Red Cross
86	Recreation Vehicles
87	Body Company
89	Transportation Services
90's	Export
00	Special

Ford of Canada	
Mercury Regions	**Ford Regions**
A1 Central	B1 Central
A2 Eastern	B2 Eastern
A3 Atlantic	B3 Atlantic
A4 Midwestern	B4 Midwestern
A6 Western	B6 Western
A7 Pacific	B7 Pacific
A8 Great Lakes	B8 Great Lakes
11 Export	11 Export

CY2392-2G

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SECTION 10-02 Maintenance

SUBJECT	PAGE	SUBJECT	PAGE
MAINTENANCE		VEHICLE APPLICATION	10-02-1
Scheduled Maintenance Emissions	10-02-1		

VEHICLE APPLICATION

E-150 Through E-350, F-150 Through F-350 and F-Super Duty, and Bronco Truck Models.

MAINTENANCE

The scheduled and non-scheduled maintenance recommendations are included in this Section for reference. The emission systems scheduled maintenance services and the vehicle maintenance services are separated. Be sure to perform all maintenance services by referring to both Sections of the schedule.

It should be noted, however, that any modification of the emission control systems could create liability under Federal Law (U.S.) if made prior the first sale and registration and, under the laws of some states, if made thereafter. Further, federal law prohibits vehicle manufacturers or dealers and other persons engaged in the business of repairing, servicing, selling, leasing, or trading motor vehicles as well as fleet operations from knowingly removing or rendering an emission control system inoperative after sale and delivery to an ultimate purchaser. In Canada, modifications of the emission control system could create liability under applicable Federal or Provincial laws.

Scheduled Maintenance Emissions

An Emission Systems Required Maintenance Chart for each truck model is listed on the following pages.

The Emission Systems Required Maintenance Chart lists the items required to maintain the vehicle emission systems at levels determined by the Federal Government (Environmental Protection Agency). Refer to the appropriate Sections of the Engine Shop Manual and the Engine/Emission Diagnosis Manual* for the Maintenance Procedures, which are related to the items listed on the maintenance schedule. Use these procedures to perform the required emission system maintenance items listed on the maintenance charts.

Maintenance service adjustments must conform to specifications contained in the Engine/Emissions Diagnosis Manual*, to those listed in the Truck Performance Specifications issue of the Technical Service Bulletin or shown on the Vehicle Emission Control Information Decal which is located on or near the engine, or the emission systems may become inoperative.

If an engine is equipped with a "Dura-Spark" ignition system and any high tension ignition wire was detached from a spark plug, the distributor cap, or the coil to perform a maintenance operation, Silicone Dielectric Compound [WA-10, D7AZ-19A331-A (ESA-M1C171-A) or equivalent] must be applied to the boot before reconnection. Using a small clean screwdriver, apply a thin layer of Silicone Dielectric Compound on the entire interior surface of the boot.

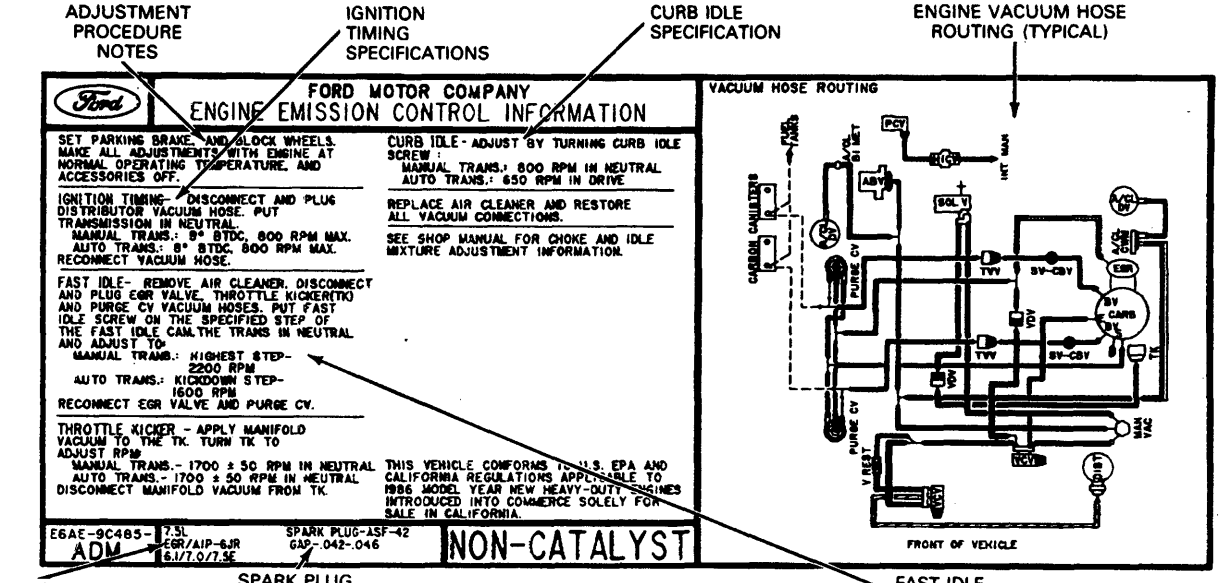
*Can be purchased as a separate item.

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MAINTENANCE (Continued)

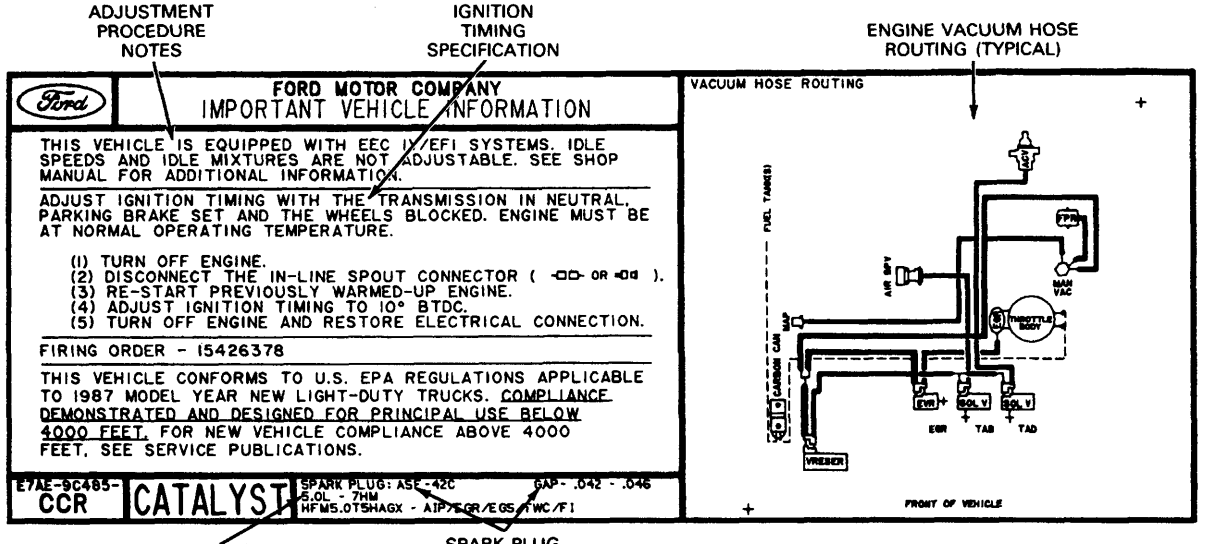
As a safety precaution, before starting the engine to perform maintenance, make sure the transmission selector is in Park (Automatic Transmission) or Neutral (Manual Transmission), the parking brake set and the wheels blocked.

IN GENERAL, MAINTENANCE REPLACEMENT, OR SERVICE OF THE EMISSION CONTROL DEVICES OR SYSTEMS IN YOUR NEW FORD VEHICLE OR FORD ENGINE MAY BE PERFORMED AT YOUR EXPENSE BY ANY AUTOMOTIVE REPAIR ESTABLISHMENT OR INDIVIDUAL USING AUTOMOTIVE PARTS EQUIVALENT TO THOSE WITH WHICH YOUR VEHICLE OR ENGINE WAS ORIGINALLY EQUIPPED. IF OTHER THAN FORD OR MOTORCRAFT SERVICE PARTS OR FORD AUTHORIZED, REMANUFACTURED PARTS ARE USED FOR MAINTENANCE REPLACEMENTS OR FOR THE SERVICE OF COMPONENTS AFFECTING EMISSION CONTROL, THE OWNER SHOULD ASSURE HIMSELF THAT SUCH PARTS ARE WARRANTED BY THEIR MANUFACTURER TO BE EQUIVALENT TO GENUINE FORD MOTOR COMPANY PARTS IN PERFORMANCE AND DURABILITY. PLEASE CONSULT YOUR WARRANTY FACTS BOOKLET FOR WARRANTY INFORMATION.



TYPIAL VEHICLE EMISSION CONTROL INFORMATION DECAL (OVER 8500 GVW)

A10417-2A



TYPICAL VEHICLE EMISSION CONTROL INFORMATION DECAL (UNDER 8500 GVW)

A10418-2A

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MAINTENANCE (Continued)

Maintenance Schedule Applicable To Bronco, E-150, E-250, E-350 and F-150, F-250, F-350, F-Super Duty Trucks

Three maintenance schedules are specified for the 1988 model Bronco, Econoline and F-Series trucks. They are identified by the letters B, E and G. The application of the various maintenance schedules are as follows:

Catalyst Equipped Vehicles Require Unleaded Fuel Only

Maintenance Schedule "B"—Gasoline Engine Equipped Vehicles (Under 8500 Pounds GVW)

The following catalyst equipped vehicles, designated for use with "Unleaded Fuel Only" should be maintained according to Maintenance Schedule "B."

- F-150
- F-250 except "Heavy Duty"
- E-150
- E-250 except Club Wagon
- Bronco

Non-Catalyst Equipped Vehicles Using Leaded Fuel

Maintenance Schedule G—Gasoline Engine Equipped Vehicles (Over 8500 Pounds GVW)

The "G" maintenance schedule is used for the following unleaded fuel vehicles with 4.9L EFI/5.8L EFI/7.5L EFI engines.

- F-250/F-350
- F-Super Duty
- E-250/E-350 and Club Wagon

Maintenance Schedule "E"—7.3L Diesel Engine Equipped Vehicles

The "E" maintenance schedule is used for the following Diesel Engine Equipped Vehicles:

- Heavy Duty F-250
- F-350
- F-Super Duty
- Heavy Duty E-250
- E-350

REQUIRED MAINTENANCE SERVICE PROCEDURES

Refer to the appropriate Sections of the Engine Shop Manual and the Engine/Emission Diagnosis* manual for the required maintenance service procedures.

*Can be purchased as a separate item.

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MAINTENANCE (Continued)

EMISSION SYSTEMS SCHEDULED MAINTENANCE — BRONCO, ECONOLINE AND F-SERIES (LIGHT TRUCK) UNDER 8,500 (GVWR).
MAINTENANCE SCHEDULE B
All Vehicles Using Unleaded Fuel

SERVICE INTERVAL — Miles (000)	7.5	15	22.5	30	37.5	45	52.5	60	67.5	75	82.5	90	97.5	105	112.5	120
Kilometers (000)	12	24	36	48	60	72	84	96	108	120	132	144	156	168	181	193
MAINTENANCE OPERATION																
Change Engine Oil & Oil Filter ③⑦ Every 6 months or	B	B	B	B	B	B	B	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Replace Spark Plugs①③				B				(b)				(b)				(b)
Replace Engine Coolant② Every 36 months or				B				(b)				(b)				(b)
Check Cooling System, Hoses and Clamps④⑧	ANNUALLY															
Replace Air Cleaner Filter⑤				B				(b)				(b)				(b)
Replace Crankcase Emission Filter⑤				B				(b)				(b)				(b)
Clean Idle Speed Control Air Bypass Control Valve								(b)								(b)
Replace PCV Valve								(b)⑥								(b)
Replace Ignition Wires								(b)								(b)
Check Thermactor Hoses and Clamps (4.9, 5.0, 5.8L)⑨								(b)								(b)

B Required for 49S, Canada & California vehicles
(b) Required for 49S vehicles and recommended for California and Canada vehicles

NOTES:

① Refer to the Vehicle Emission Control information Decal for specification.

② Replace coolant every 3 years (36 months) or at the specified mileage, whichever occurs first.

③ **UNIQUE DRIVING CONDITIONS — IF YOUR DRIVING HABITS FREQUENTLY INCLUDE ONE OR MORE OF THE FOLLOWING CONDITIONS:**
- **SHORT TRIPS OF LESS THAN 10 MILES (16 KM) WHEN OUTSIDE TEMPERATURES REMAIN BELOW FREEZING.**
- **OPERATING DURING HOT WEATHER IN STOP-AND-GO "RUSH HOUR" TRAFFIC.**
- **HIGH SPEED OPERATION WITH A FULLY LOADED VEHICLE (MAX. G.V.W.).**
- **TOWING A TRAILER, USING A CAMPER OR CAR-TOP CARRIER, OR CARRYING MAXIMUM LOADS.**
- **OPERATING IN SEVERE DUST CONDITIONS.**
- **EXTENSIVE IDLING, SUCH AS POLICE, TAXI, OR DOOR-TO-DOOR DELIVERY USE.**
- **SNOW PLOWING OR LOW SPEED OPERATION.**

CHANGE ENGINE OIL AND FILTER EVERY 3 MONTHS OR 3,000 MILES (4 800 KM) WHICHEVER OCCURS FIRST, AND CHECK/REGAP SPARK PLUGS EVERY 15,000 MILES (24 000 KM).

④ Coolant protection checks should be made annually just prior to the onset of freezing weather, where applicable. If coolant is dirty or rusty in appearance, the system should be drained, flushed, and refilled with the prescribed solution of cooling system fluid and water. Use only a permanent type coolant that meets Ford specification: ESE-M97B44-A.

⑤ More often if operated in severe dust conditions.

⑥ At 60,000 miles the dealer will replace the PCV valve at no cost on 4.9L, 5.0L and 5.8L engines except California and Canada vehicles.

⑦ Every 6 months or at mileage shown, whichever occurs first.

⑧ Check means a functional measurement of a system's operation (performance, leaks or condition of parts) — correct as required.

⑨ Identifies emission related checks or inspection. Eligibility for emission control systems, defect and performance warranties, and emission recalls are not contingent upon the performance of emission related checks or inspections.

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MAINTENANCE (Continued)

EMISSION SYSTEMS REQUIRED MAINTENANCE
Maintenance Schedule — G Gasoline Engine Equipped Vehicles (Over 8500 GVWR). F-250/F-350/F-SUPER DUTY/E-250/E-350 and Club Wagon — Unleaded Fuel Vehicles with 4.9L, 5.8L and 7.5L E.F.I. Engines and Heavy Duty Emissions.

SERVICE INTERVAL — Miles (000)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
Kilometers (000)	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168	177	184	193
MAINTENANCE OPERATION																								
Change Engine Oil and Oil Filter③⑨	G	G	G	G	G	G	G	G	G	G	g	g	g	g	g	g	g	g	g	g	g	g	g	g
Replace Spark Plugs①③						G						g						g						g
Replace Coolant②						G						g						g						g
Check Coolant System, Hoses and Clamps④⑦	ANNUALLY																							
Replace Air Cleaner Filter⑤						G						g						g						g
Replace Crankcase Emission Filter⑤						G						g						g						g
Check Exhaust Heat Control Valve and Apply Lube (if equipped) (5.8L)⑦						G						g						g						g
Replace PCV Valve												g⑥												g
Replace Ignition Wires												g												g
Check Thermactor Hoses and Clamps⑧												g												g
Clean Idle Speed Control Air By-pass Valve												g												g

G = Required for all vehicles
g = Recommended for all vehicles.

NOTES:

① Refer to the Vehicle Emission Control Information Decal for specification.

② Replace coolant every 3 years (36 months) or at the specified mileage, whichever occurs first.

③ **UNIQUE DRIVING CONDITIONS — IF YOUR DRIVING HABITS FREQUENTLY INCLUDE ONE OR MORE OF THE FOLLOWING CONDITIONS:**
- **OPERATING WHEN OUTSIDE TEMPERATURES REMAIN BELOW FREEZING AND MOST TRIPS ARE LESS THAN 5 MILES (8 KM).**
- **OPERATING DURING HOT WEATHER (ABOVE 90°F, 32°C) AND:**
  - **— DRIVING CONTINUOUSLY IN EXCESS OF NORMAL HIGHWAY SPEEDS;**
  - **— DRIVING IN STOP-AND-GO "RUSH HOUR" TRAFFIC.**
  - **— TOWING A TRAILER, USING A CAMPER OR CAR-TOP CARRIER, OR CARRYING MAXIMUM LOADS.**
- **OPERATING IN SEVERE DUST CONDITIONS.**
- **EXTENSIVE IDLING, SUCH AS POLICE, TAXI, OR DOOR-TO-DOOR DELIVERY USE.**
- **SNOW PLOWING**

CHANGE ENGINE OIL AND FILTER EVERY 3 MONTHS OR 3,000 MILES (4 800 KM) WHICHEVER OCCURS FIRST, AND CHECK/REGAP SPARK PLUGS EVERY 6,000 MILES (9 600 KM).

④ Coolant protection checks should be made annually just prior to the onset of freezing weather, where applicable. If coolant is dirty or rusty in appearance, the system should be drained, flushed, and refilled with the prescribed solution of cooling system fluid and water. Use only a permanent type coolant that meets Ford Specification: ESE-M97B44-A.

⑤ More often if operated in severe dust conditions.

⑥ At 60,000 miles the dealer will replace the PCV valve at no cost on 4.9/5.8 and 7.5L engines except California and Canada vehicles.

⑦ Check means a functional measurement of a system's operation (performance, leaks or condition of parts) correct as required.

⑧ Identifies emission related checks or inspections. Eligibility for emission control systems defect and performance warranties and emission recalls are NOT contingent upon the performance of emission related checks or inspections.

⑨ Every 6 months or at the specified mileage, whichever occurs first.

CA10419-2B

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MAINTENANCE (Continued)

EMISSION SYSTEMS REQUIRED MAINTENANCE
Maintenance Schedule E — 7.3L Diesel Engine Equipped Vehicles Econoline and F-Series (Light Truck)

SERVICE INTERVALS Perform at 6 months or the distance shown whichever comes first	Miles (000)	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
	Kilometers (000)		16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
MAINTENANCE OPERATION																					
Change Engine Oil and Replace Oil Filter Every 6 Months or at Mileage ①		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Check Engine Idle Speed (Adjust as Required)④		X		X			X			X			X			X			X		
Check Throttle Operation and Idle Return Spring ④		X		X			X			X			X			X			X		
Inspect, Clean and Lubricate Face Cam of Fuel Injector Pump		X		X			X			X			X			X			X		
Check Vacuum Regulator and Adjust if Required (Automatic Transmission Only⑤		X		X			X			X			X			X			X		
Check Coolant Level in Radiator and Overflow Bottle		Monthly																			
Check Coolant Condition and Protection⑥		Annually																			
Check Cooling System/Hoses/Clamps⑥		Annually																			
Replace Coolant Every 36 Months							X						X						X		
Check and Inspect Drive Belt Condition and Tension ②				X			X						X						X		
Replace Air Cleaner Element ②							X						X						X		
Replace Fuel Filter②													X			X					
Fuel/Filter Bowl — Drain Water③		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Inspect Air Induction System							X						X						X		

NOTE: Beyond 160 000 km (100,000 miles) continue recommended maintenance at the intervals for 0-160 000 km (0-100,000 miles).

① SEVERE SERVICE OPERATION
WHEN OPERATING YOUR VEHICLE UNDER ANY OF THE FOLLOWING CONDITIONS, CHANGE ENGINE OIL AND FILTER EVERY 3 MONTHS OR 2,500 MILES (4 000 KM) WHICHEVER OCCURS FIRST. USE AN ENGINE OIL CONFORMING TO FORD SPECIFICATIONS OR THE EQUIVALENT OIL CONFORMING TO API SERVICE CATEGORIES OF *BOTH SF AND CD*. DO NOT USE OILS LABELED AS *ONLY SF* OR *ONLY CD*, AS THEY COULD CAUSE ENGINE DAMAGE. THE OIL SHOULD BE OF THE PROPER VISCOSITY (THICKNESS).
- SUSTAINED HIGH SPEED DRIVING AT GVWR DURING HOT WEATHER (OVER 90°F/32°C).
- OPERATION IN SEVERE DUST CONDITIONS.
- TRAILER TOWING FOR LONG DISTANCES (OVER 1000 MILES/1 600 KM).
- FREQUENT OR EXTENDED IDLING (OVER 10 MINUTES PER HOUR OF NORMAL DRIVING).

② More often if operated in severe service or dust conditions. An instrument panel warning light will glow during normal engine operation when filter replacement is required.

③ More frequent intervals may be required dependent on fuel quality and vehicle usage. An instrument panel warning light will glow when servicing is required, or as a bulb function test when the ignition key is in the START position.

④ Every 12 months or at mileage.

⑤ Vacuum Regulator Valve must be adjusted to specifications. Any setting outside the specified range may lead to transmission malfunction (Automatic Transmission Only).

⑥ Prior to cold weather.

CA10420-2B

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MAINTENANCE (Continued)

NON-EMISSION SYSTEM SCHEDULED MAINTENANCE CHARTS
MAINTENANCE SCHEDULE B — Bronco, Econoline and F-Series (Light Truck) Under 8500 (GVWR) — Unleaded Fuel

NORMAL DRIVING SERVICE INTERVALS Perform at the months or distances shown, whichever comes first.								
Miles (Thousands)	7.5	15	22.5	30	37.5	45	52.5	60
MAINTENANCE OPERATION — Kilometers (Thousands)	12	24	36	48	60	72	84	96
Check wheel lug nut torque ①	B	B	B	B	B	B	B	B
Inspect drive belt condition and tension				B				B
Check clutch reservoir fluid level	B	B	B	B	B	B	B	B
Lubricate Transfer Case Shift Lever Pivot Bolt and Control Rod Connecting Pins		B		B		B		B
Check and lubricate clutch release lever pivot. (Bronco F-Series)	B	B	B	B	B	B	B	B
Inspect and lubricate automatic transmission shift linkage (bellcrank system)	B	B	B	B	B	B	B	B
Inspect and lubricate front wheel bearings				B				B
Inspect disc brake system				B				B
Inspect drum brake systems, hoses and lines				B				B
Inspect exhaust system for leaks, damage or loose parts				B				B
Inspect parking brake system for damage and operation				B				B
Lubricate throttle ball stud				B				B
Lubricate steering linkage, driveshaft U-joints, and slip-yoke if equipped with grease fittings	B	B	B	B	B	B	B	B
Lubricate caliper slide rails		B		B		B		B
Lubricate front drive axle R.H. axle shaft slip yoke (4x4)				B				B
Lubricate front axle spindle pins (F-350 4x4) (E-150-E-350)	B	B	B	B	B	B	B	B
Inspect spindle needle bearing lubrication (4x4)				B				B
Inspect hub lock lubrication (4x4)				B				B
Change transfer case oil (4x4)								B
Change Manual Transmission Oil (H.D. M50D/S5-42)								B
NOTE: Beyond 96 000 kilometers (60,000 miles) continue recommended maintenance at intervals for 0-96 000 kilometers (0-60,000 miles)								

NOTES:
①Wheel lug nuts must be retightened to proper torque specifications at 800 km (500 miles) of new vehicle operation (160 km or 100 miles and 800 km or 500 miles for vehicles equipped for snowplowing). Also retighten to proper torque specificatoin at 800 km (500 miles) after any wheel change or any other times the wheel lug nuts have been loosened.

UNIQUE DRIVING CONDITIONS

IF YOUR DRIVING HABITS **FREQUENTLY** INCLUDE ONE OR MORE OF THE FOLLOWING CONDITIONS:

- SHORT TRIPS OF LESS THAN 10 MILES (16 KM) WHEN OUTSIDE TEMPERATURES REMAIN BELOW FREEZING.
- OPERATING DURING HOT WEATHER IN STOP-AND-GO "RUSH HOUR" TRAFFIC.
- HIGH SPEED OPERATION WITH A FULLY LOADED VEHICLE (MAX. G.V.W.).
- TOWING A TRAILER USING A CAMPER OR CAR-TOP CARRIER, OR CARRYING MAXIMUM LOADS.
- OPERATING IN SEVERE DUST CONDITIONS.
- EXTENSIVE IDLING, SUCH AS POLICE, TAXI, OR DOOR-TO-DOOR DELIVERY USE.
- SNOW PLOWING OR LOW SPEED OPERATION.

AUTOMATIC TRANSMISSION FLUID

CHANGE EACH 30,000 MILES (48 000 KM) IF YOUR DRIVING HABITS **FREQUENTLY** INCLUDE ONE OR MORE OF THE FOLLOWING CONDITIONS:

- OPERATING DURING HOT WEATHER (ABOVE 90°F, 32°C) AND CARRYING HEAVY LOADS AND DRIVING IN HILLY TERRAIN.
- TOWING A TRAILER OR SLIDE-IN CAMPER.
- DOOR-TO-DOOR DELIVERY, POLICE OR TAXI.

EXTREME SERVICE ITEMS

IF YOUR VEHICLE IS OPERATED **OFF-HIGHWAY**, PERFORM THE FOLLOWING ITEMS EVERY 1,000 MILES (1 600 KM). IF YOUR VEHICLE IS OPERATED IN MUD AND/OR WATER, PERFORM THE FOLLOWING ITEMS DAILY:

- LUBRICATE FRONT AXLE SPINDLE PINS, STEERING AND CLUTCH LINKAGES, AXLE AND DRIVESHAFT U-JOINTS AND SLIP YOKE IF EQUIPPED WITH FITTINGS.
- INSPECT FRONT WHEEL BEARINGS AND LUBRICATION.
- LUBRICATE AUTOMATIC TRANSMISSION EXTERNAL CONTROLS (BELLCRANK SYSTEM).
- INSPECT DISC BRAKE SYSTEM, LUBE CALIPER SLIDE RAILS.
- INSPECT DRUM BRAKE SYSTEM, HOSES AND LINES.
- INSPECT EXHAUST SYSTEM FOR LEAKS, DAMAGE OR LOOSE PARTS.
- LUBRICATE CLUTCH RELEASE LEVER PIVOT (7.5L).

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MAINTENANCE (Continued)

NON-EMISSION SYSTEM SCHEDULED MAINTENANCE
MAINTENANCE SCHEDULE-G GASOLINE ENGINE EQUIPPED VEHICLES (OVER 8500 GVWR) F-250/F-350/F-SUPER DUTY, E-250/E-350 AND CLUB WAGON — UNLEADED FUEL VEHICLES WITH 4.9L, 5.8L/7.5L E.F.I. ENGINES AND HEAVY DUTY EMISSIONS.

NORMAL DRIVING SERVICE INTERVALS Perform at the months or distances shown, whichever comes first.												
Miles (Thousands)	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**
Kilometers (Thousands)	**8**	**16**	**24**	**32**	**40**	**48**	**56**	**64**	**72**	**80**	**88**	**96**
Check Wheel Lug Nut Torque ①	G	G	G	G	G	G	G	G	G	G	G	G
Inspect Drive Belt Condition and Tension			G			G			G			G
Check Clutch Reservoir Fluid Level	G	G	G	G	G	G	G	G	G	G	G	G
Lubricate Transfer Case Shift Lever Pivot Bolt and Control Rod Connecting Pin			G			G			G			G
Check and Lubricate Clutch Release Lever Pivot (7.5L)	G	G	G	G	G	G	G	G	G	G	G	G
Lubricate Automatic Transmission Linkage (Bellcrank System)	G	G	G	G	G	G	G	G	G	G	G	G
Lubricate Steering (F-250-350 4x4 Only) Linkages, Front Drive Axle (4x4) and U-Joints if Equipped with Zerk Fittings, Front Axle Spindle Pins (E-150-E-350 and F-250-350 4x2 Only) and Driveshaft U-Joints & Slip Yokes if Equipped with Fittings	G	G	G	G	G	G	G	G	G	G	G	G
Inspect Disc Brake System, Lube Caliper Slide Rails			G			G			G			G
Inspect Drum Brake System, Hoses and Lines						G						G
Inspect and Lubricate Front Wheel Bearings						G						G
Inspect Spindle Needle Bearing Lubrication (4x4)						G						G
Inspect Hub Lock Lubrication (4x4)						G						G
Lubricate Front Drive Axle R.H. Axle Shaft Slip Yoke (4x4)						G						G
Inspect Exhaust System for Leaks, Damage or Loose Parts						G						G
Inspect Engine Air Induction System (E-350, F-350 Over 10,000 GVWR Only)						G						G
Inspect Fan & Shroud for Damage (E-350, F-350 Over 10,000 GVWR Only)						G						G
Inspect Parking Brake System for Damage and Operation						G						G
Inspect Parking Brake Fluid Level (F-Super Duty)						G						G
Change Transfer Case Oil (4x4)												G
Lubricate Throttle Ball Stud						G						G
NOTE: Beyond 80 000 kilometers (50,000 miles) continue recommended maintenance operations at intervals for 0-80 000 kilometers (50,000 miles).												

NOTES:
①Wheel lug nuts must be retightened to proper torque specifications at 800 km (500 miles) of new vehicle operation (160 km or 100 miles and 800 km or 500 miles for vehicles equipped for snowplowing). Also retighten to proper torque specification at 800 km (500 miles) after any wheel change or any other times the wheel lug nuts have been loosened.

UNIQUE DRIVING CONDITIONS

IF YOUR DRIVING HABITS **FREQUENTLY** INCLUDE ONE OR MORE OF THE FOLLOWING CONDITIONS:

- SHORT TRIPS OF LESS THAN 10 MILES (16 KM) WHEN OUTSIDE TEMPERATURES REMAIN BELOW FREEZING.
- OPERATING DURING HOT WEATHER IN STOP-AND-GO "RUSH HOUR" TRAFFIC.
- HIGH SPEED OPERATION WITH A FULLY LOADED VEHICLE (MAX. G.V.W.)
- TOWING A TRAILER USING A CAMPER OR CAR-TOP CARRIER, OR CARRYING MAXIMUM LOADS.
- OPERATING IN SEVERE DUST CONDITIONS.
- EXTENSIVE IDLING, SUCH AS POLICE, TAXI, OR DOOR-TO-DOOR DELIVERY USE.
- SNOW PLOWING OR LOW SPEED OPERATION.

AUTOMATIC TRANSMISSION FLUID

CHANGE EACH 30,000 MILES (48 000 KM) IF YOUR DRIVING HABITS **FREQUENTLY** INCLUDE ONE OR MORE OF THE FOLLOWING CONDITIONS:

- OPERATING DURING HOT WEATHER (ABOVE 90°F, 32°C) AND CARRYING HEAVY LOADS AND DRIVING IN HILLY TERRAIN.
- TOWING A TRAILER OR SLIDE-IN CAMPER.
- DOOR-TO-DOOR DELIVERY, POLICE OR TAXI.

EXTREME SERVICE ITEMS

IF YOUR VEHICLE IS OPERATED **OFF-HIGHWAY**, PERFORM THE FOLLOWING ITEMS EVERY 1,000 MILES (1 600 KM). IF YOUR VEHICLE IS OPERATED IN MUD AND/OR WATER, PERFORM THE FOLLOWING ITEMS DAILY:

- LUBRICATE FRONT AXLE SPINDLE PINS, STEERING AND CLUTCH LINKAGES, AXLE AND DRIVESHAFT U-JOINTS AND SLIP YOKE IF EQUIPPED WITH FITTINGS.
- INSPECT FRONT WHEEL BEARINGS AND LUBRICATION.
- LUBRICATE AUTOMATIC TRANSMISSION EXTERNAL CONTROLS (BELLCRANK SYSTEM).
- INSPECT DISC BRAKE SYSTEM, LUBE CALIPER SLIDE RAILS.
- INSPECT DRUM BRAKE SYSTEM, HOSES AND LINES.
- INSPECT EXHAUST SYSTEM FOR LEAKS, DAMAGE OR LOOSE PARTS.
- LUBRICATE CLUTCH RELEASE LEVER PIVOT (7.5L).

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MAINTENANCE (Continued)

NON-EMISSION SYSTEM REQUIRED MAINTENANCE-E — E- AND F-SERIES (LIGHT TRUCK) — 7.3L DIESEL ENGINE

SERVICE INTERVALS Perform at the months or the distances shown, whichever comes first	Miles (Thousands)	5	10	15	20	25	30	35	40	45	50	55	60
	KM (Thousands)	8	16	24	32	40	48	56	64	72	80	88	96
Check and Adjust Wheel Lug Nut Torque①		X	X	X	X	X	X	X	X	X	X	X	X
Inspect Exhaust System/Shields/Joints for Leaks, Breakage, Looseness, and Corrosive Damage							X						X
Inspect Fan and Fan Shroud (E-and F-350 Over 10,000 lbs. GVWR Only)				X			X			X			X
Lubricate Driveshaft Slip Yoke and U-Joint if Equipped with Grease Fittings		X	X	X	X	X	X	X	X	X	X	X	X
Lubricate Steering Linkage (Only if Equipped with Grease Fittings)		X	X	X	X	X	X	X	X	X	X	X	X
Lubricate Front Axle Spindle Pins (Econoline Only)		X	X	X	X	X	X	X	X	X	X	X	X
Inspect and Lubricate Automatic Transmission Shift Linkage (Bellcrank System)②		X	X	X	X	X	X	X	X	X	X	X	X
Change Automatic Transmission Fluid②							X						X
Check Clutch Reservoir Fluid Level		X	X	X	X	X	X	X	X	X	X	X	X
Lubricate Clutch Release Lever Pivots		X	X	X	X	X	X	X	X	X	X	X	X
Check Brake Master Cylinder Fluid Level							X						X
Inspect Disc Brake System and Lube Caliper Slide Rails				X			X			X			X
Inspect Parking Brake System for Damage and Operation				X			X			X			X
Inspect Drum Brake Linings, Lines, Hoses				X			X			X			X
Lubricate Throttle Ball Stud							X						X
Inspect and Lubricate Front Wheel Bearings							X						X
Inspect Hub Lock Lubrication (4x4)							X						X
Inspect (4x4) Spindle Needle Bearing Lubrication							X						X
Change Transfer Case Oil (4x4)													X
NOTE: Beyond 96 000 km (60,000 miles) continue recommended maintenance operations at intervals for 0-96 km (0-60 miles).													

NOTES:

①Wheel lug nuts must be retightened to proper torque specifications at 800 km (500 miles) of new vehicle operation (160 km or 100 miles and 800 km or 500 miles for vehicles with dual rear wheels or vehicles equipped for snowplowing). Also retighten to proper torque specification at 800 km (500 miles) after any wheel change or any other times the wheel lug nuts have been lossened.

②SEVERE SERVICE OPERATION

For severe service only change fluid every 30,000 miles. The definition of severe service for automatic transmission is as follows:
The automatic transmission fluid should be changed every 30,000 miles (48 000 km) if your vehicle(s) operate under any of the following conditions:
— Sustained high speed driving during hot weather (+90°F, + 32°C).
— Towing a trailer for long distances.
— Accumulating 5,000 miles (8 000 km) or more per month.
— Continuous running service.

EXTREME SERVICE ITEMS

IF YOUR VEHICLE IS OPERATED **OFF-HIGHWAY,** PERFORM THE FOLLOWING ITEMS EVERY 1,000 MILES (1 600 KM). IF YOUR VEHICLE IS OPERATED IN MUD AND/OR WATER, PERFORM THE FOLLOWING ITEMS DAILY:

- LUBRICATE FRONT AXLE SPINDLE PINS, STEERING AND CLUTCH LINKAGES, AXLE AND DRIVESHAFT U-JOINTS AND SLIP YOKE IF EQUIPPED WITH FITTINGS.
- INSPECT FRONT WHEEL BEARINGS AND LUBRICATION.
- LUBRICATE AUTOMATIC TRANSMISSION EXTERNAL CONTROLS (BELLCRANK SYSTEM).
- INSPECT DISC BRAKE SYSTEM, LUBE CALIPER SLIDE RAILS.
- INSPECT DRUM BRAKE SYSTEM, HOSES AND LINES.
- INSPECT EXHAUST SYSTEM FOR LEAKS, DAMAGE OR LOOSE PARTS.

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MAINTENANCE (Continued)

OWNER MAINTENANCE CHECKS

Listed below are vehicle maintenance checks and inspections that should be performed by the owner or qualified service technician at the indicated intervals. The Owner's Guide contains supporting specifications and service information.

Any adverse conditions should be brought to the attention of the dealer or qualified service technician as soon as possible.

These Owner Maintenance checks are generally not covered by warranties and the owner may be charged for labor, parts and lubricants used.

When an Owner Stops for Fuel:

- Check the engine oil level.
- Check the windshield washer fluid level.
- Look for low or under-inflated tires.

While Operating the Vehicle:

- Note any changes in the sound of the exhaust or any smell of exhaust fumes in the vehicle.
- Check for vibrations in the steering wheel. Notice any increased steering effort or looseness in the steering wheel, or change in its straight ahead position.
- Notice if the vehicle **constantly turns slightly** or "pulls" to one side when traveling on smooth, level road.
- When stopping, listen and check for strange sounds, **pulling to one side,** increased brake pedal travel or "hard" to push brake pedal.
- If any slipping or changes in the operation of the transmission occurs, check the transmission fluid level.
- Check automatic transmission PARK function.
- Check parking brake.

At Least Monthly:

- Check and adjust tire pressure (cold).
- Check coolant level in the coolant recovery reservoir.
- Check operation of lights, horn, turn signals, windshield wipers and washers, and hazard warning flasher.
- Check for fluid leaks by inspecting the surface beneath the vehicle for oil, coolant, or other fluid drips. Clean water from the air conditioning system is normal.

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SECTION 10-03 Lubrication Chart and Lubricant Specifications

SUBJECT	PAGE	SUBJECT	PAGE
LUBRICATION CHART		SPECIFICATIONS	10-03-9
Lubrication Charts	10-03-1	VEHICLE APPLICATION	10-03-1

VEHICLE APPLICATION

All E-150—E-350, F-150—F-350 and F-Super Duty, and Bronco Models

LUBRICATION CHART

Important lubrication points for typical chassis and engines are shown in the following illustrations. Vehicles with optional equipment may have slightly different or additional lubrication points. When special equipment or accessories are installed on the truck, consult the manufacturer's literature for lubrication procedures. A table of recommended lubricants is included at the end of this Section.

WARNING: THE AMERICAN PETROLEUM INSTITUTE (API) HAS ANNOUNCED THAT CONTINUOUS CONTACT WITH USED MOTOR OIL HAS CAUSED SKIN CANCER IN LABORATORY MICE. THE EFFECTS OF USED MOTOR OIL ON HUMANS HAS NOT BEEN ESTABLISHED. IT IS RECOMMENDED, HOWEVER, THAT AS A PRECAUTIONARY MEASURE, HUMANS PROTECT THEIR SKIN BY WASHING WITH SOAP AND WATER AFTER COMING IN CONTACT WITH USED MOTOR OIL.

Lubrication Charts

Important lubrication points for typical chassis and engines are shown in the following illustrations. Vehicles with optional equipment may have slightly different or additional lubrication points. When special equipment or accessories are installed on the truck, consult the manufacturer's literature for lubrication procedures. A table of recommended lubricants is included at the end of this Section.

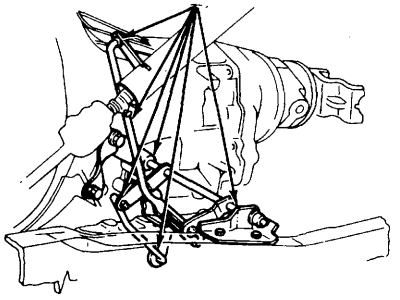
WARNING: THE AMERICAN PETROLEUM INSTITUTE (API) HAS ANNOUNCED THAT CONTINUOUS CONTACT WITH USED MOTOR OIL HAS CAUSED SKIN CANCER IN LABORATORY MICE. THE EFFECTS OF USED MOTOR OIL ON HUMANS HAS NOT BEEN ESTABLISHED. IT IS RECOMMENDED, HOWEVER, THAT AS A PRECAUTIONARY MEASURE, HUMANS PROTECT THEIR SKIN BY WASHING WITH SOAP AND WATER AFTER COMING IN CONTACT WITH USED MOTOR OIL.

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LUBRICATION CHART (Continued)

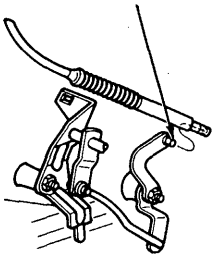
F-150-250-350 (4 x 4) AND BRONCO CHASSIS LUBRICATION POINTS

LUBRICATE WITH POLYETHLENE GREASE – D7AZ-19584-A (ESR-M1C159-A) OR MULTI-PURPOSE LONG-LIFE LUBRICANT, C1AZ-19590-B (ESA-MIC75-B) OR EQUIVALENT

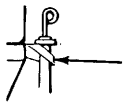


AUTOMATIC TRANSMISSION LINKAGE

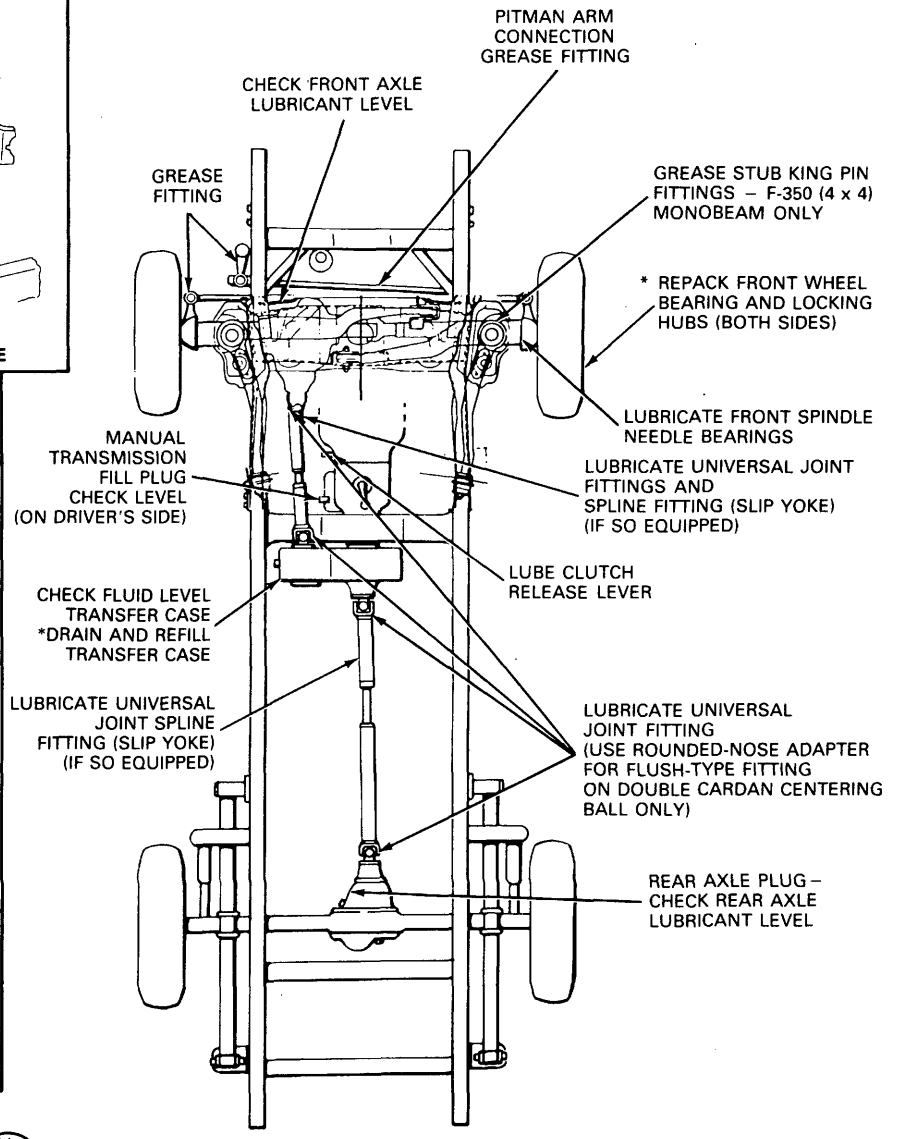
BALL STUD-LUBRICATE WITH POLYETHYLENE GREASE D7AZ-19584-A OR MULTI-PURPOSE LONG-LIFE LUBRICANT CIAZ-19590-B (ESA-MIC75-B) OR EQUIVALENT

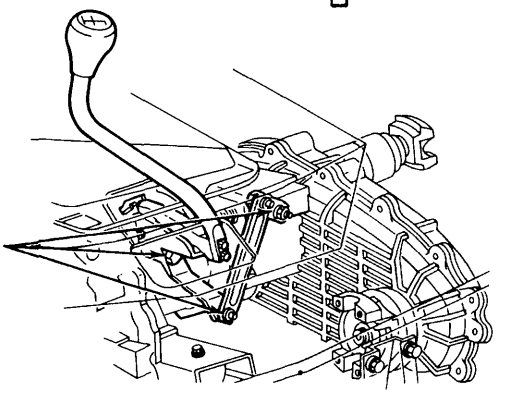


THROTTLE VALVE (TV) CABLE LINKAGE 5.0L E.F.I. AOD TRANSMISSION ONLY KICKDOWN CABLE LINKAGE 4.9L E.F.I. AND 7.5L E.F.I. C-6 TRANSMISSION ONLY



TRANSMISSION DIPSTICK (AUTOMATIC)





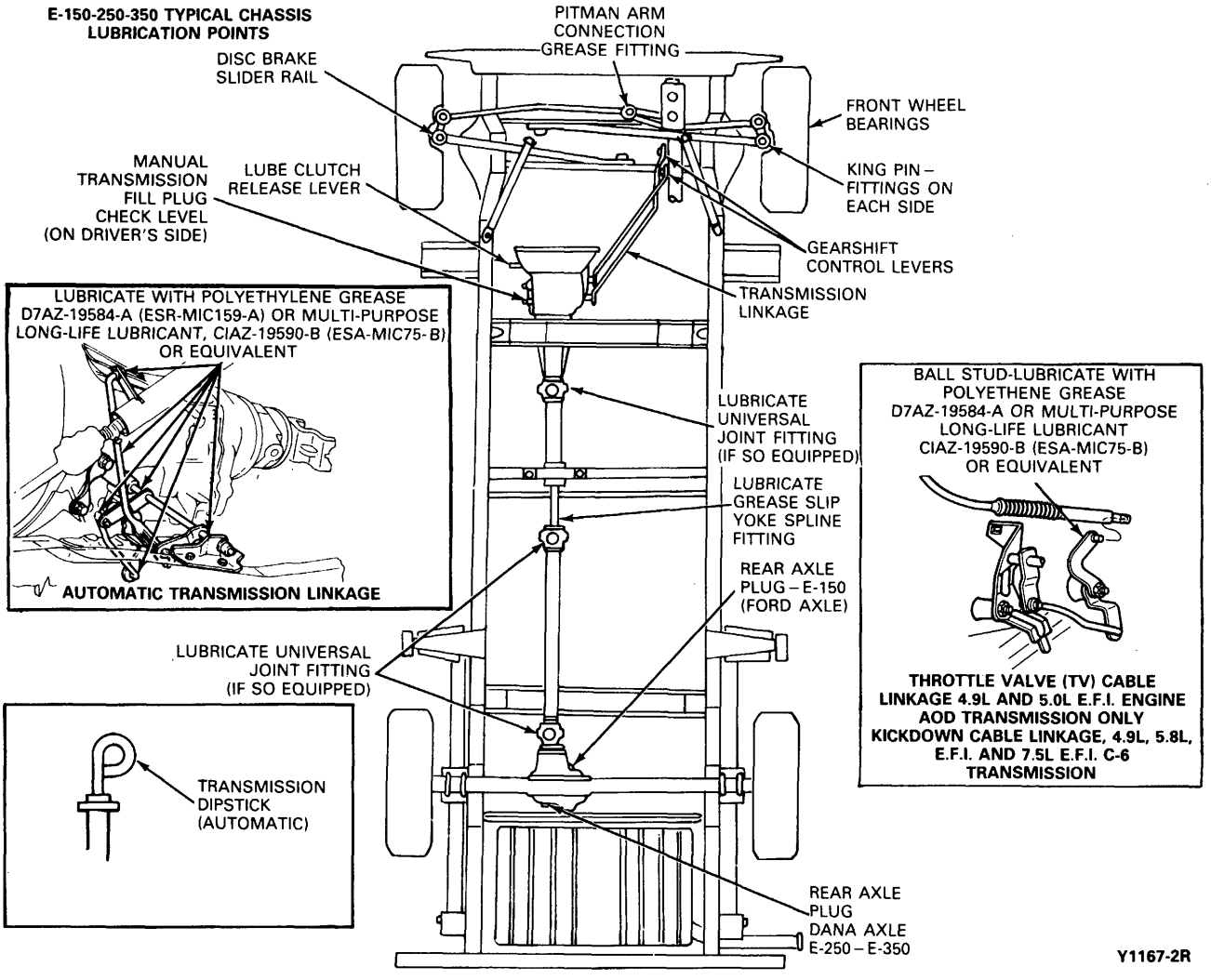
LUBRICATE TRANSFER CASE SHIFT LEVER PIVOT BOLT AND CONTROL ROD CONNECTING PINS

*DAILY WHEN OPERATING IN DEEP WATER

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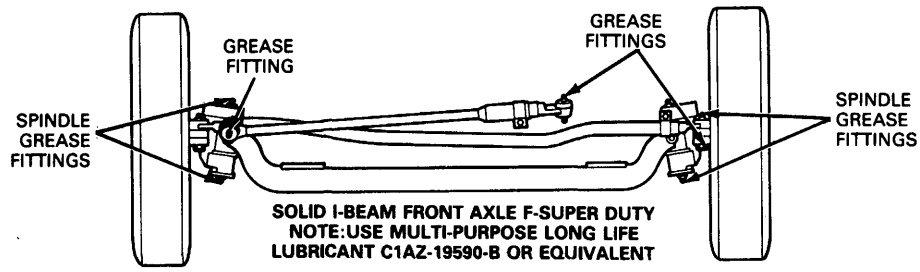
LUBRICATION CHART (Continued)



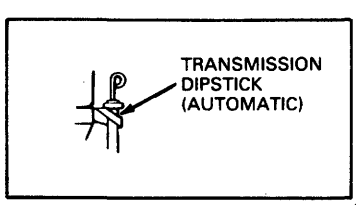
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LUBRICATION CHART (Continued)

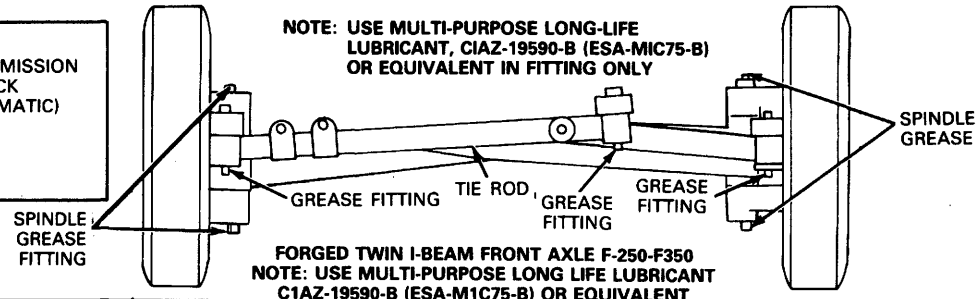
F-150-250-350 (4 x 2) AND F-SUPER DUTY CHASSIS LUBRICATION POINTS



SOLID I-BEAM FRONT AXLE F-SUPER DUTY
NOTE:USE MULTI-PURPOSE LONG LIFE LUBRICANT C1AZ-19590-B OR EQUIVALENT

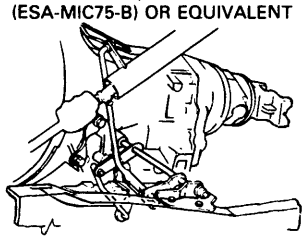


NOTE: USE MULTI-PURPOSE LONG-LIFE LUBRICANT, CIAZ-19590-B (ESA-MIC75-B) OR EQUIVALENT IN FITTING ONLY

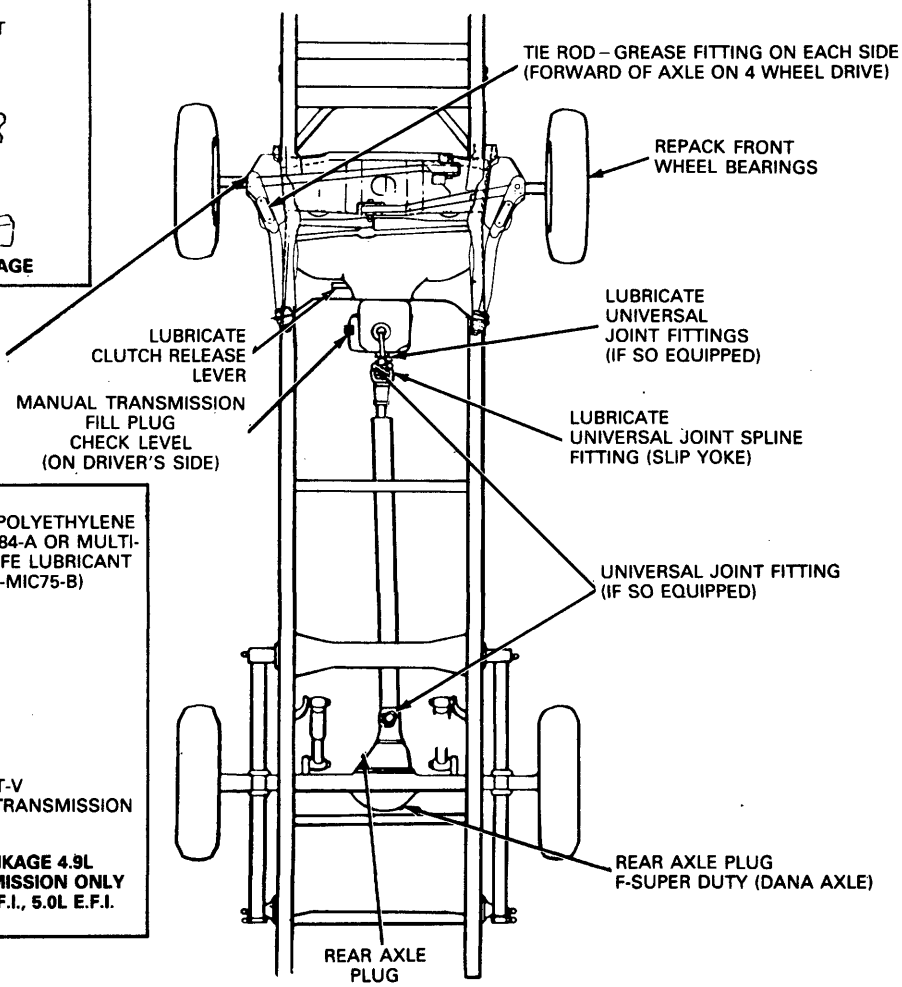


FORGED TWIN I-BEAM FRONT AXLE F-250-F350
NOTE: USE MULTI-PURPOSE LONG LIFE LUBRICANT C1AZ-19590-B (ESA-M1C75-B) OR EQUIVALENT
NO GREASE FITTINGS ON STAMPED FRONT AXLE

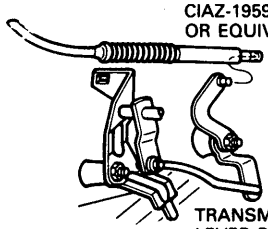
LUBRICATE WITH POLYETHLENE GREASE-D7AZ-19584-A OR MULTI-PURPOSE LONG-LIFE LUBRICANT, C1AZ-19590-B (ESA-MIC75-B) OR EQUIVALENT



AUTOMATIC TRANSMISSION LINKAGE



BALL STUD
LUBRICATE WITH POLYETHYLENE GREASE D7AZ-19584-A OR MULTI-PURPOSE LONG-LIFE LUBRICANT CIAZ-19590-B (ESA-MIC75-B) OR EQUIVALENT



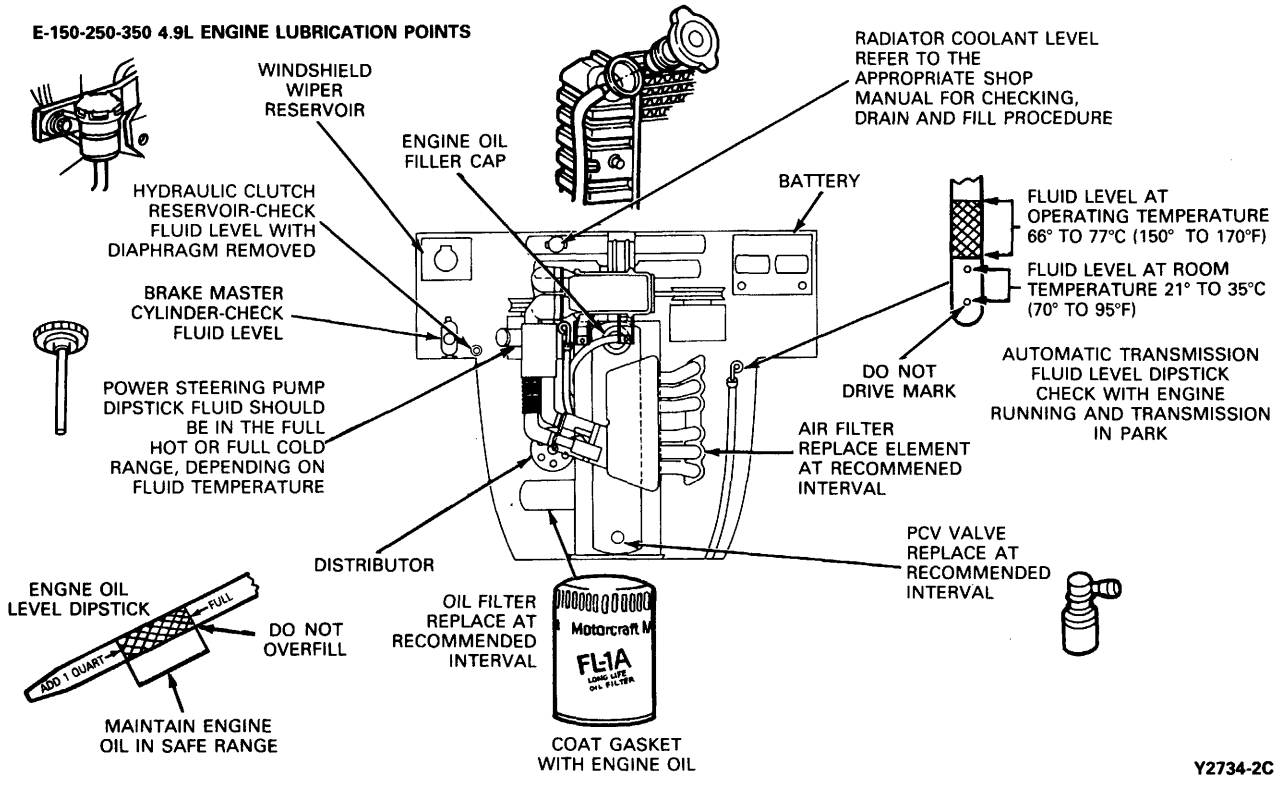
TRANSMISSION T-V LEVER PART OF TRANSMISSION REFERENCE

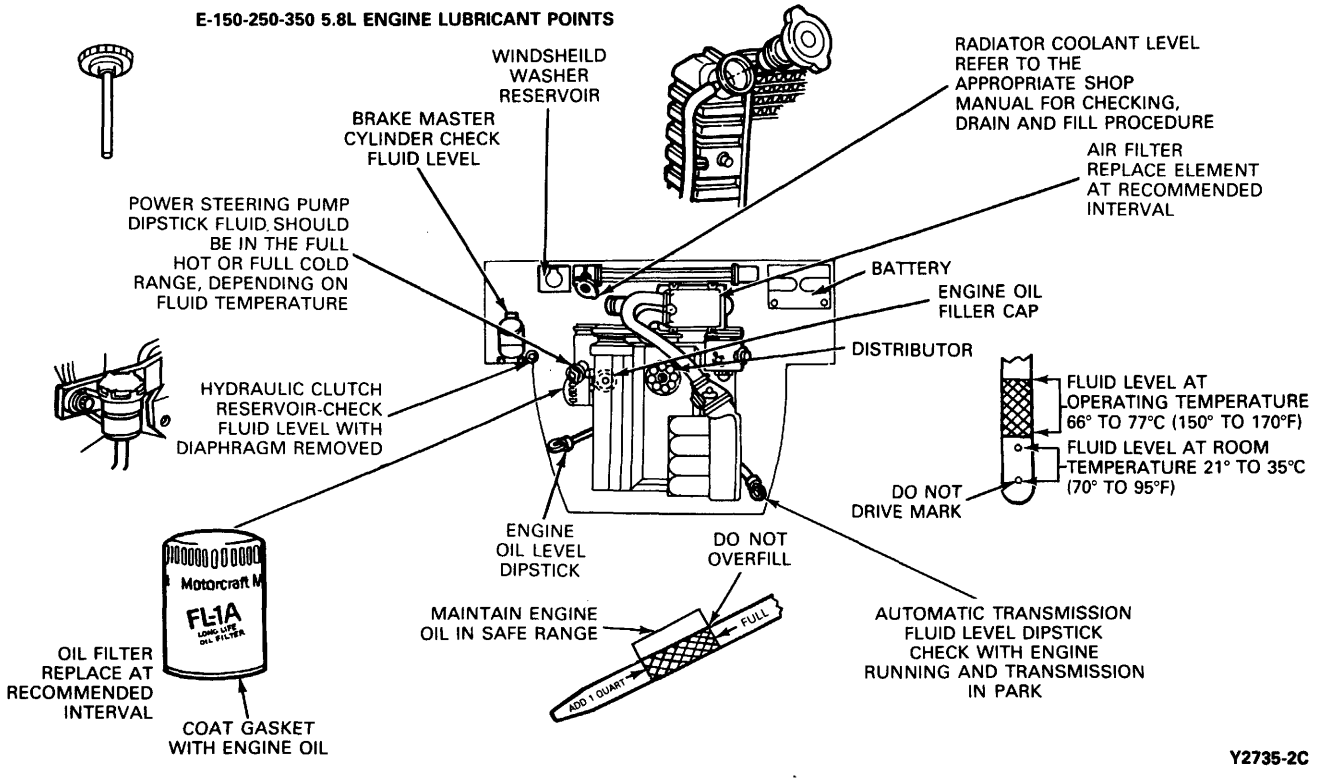
THROTTLE VALVE (TV) CABLE LINKAGE 4.9L AND 5.0L E.F.I. ENGINE AOD TRANSMISSION ONLY
KICKDOWN CABLE LINKAGE, 4.9L E.F.I., 5.0L E.F.I. 5.8L E.F.I., 7.5L E.F.I.

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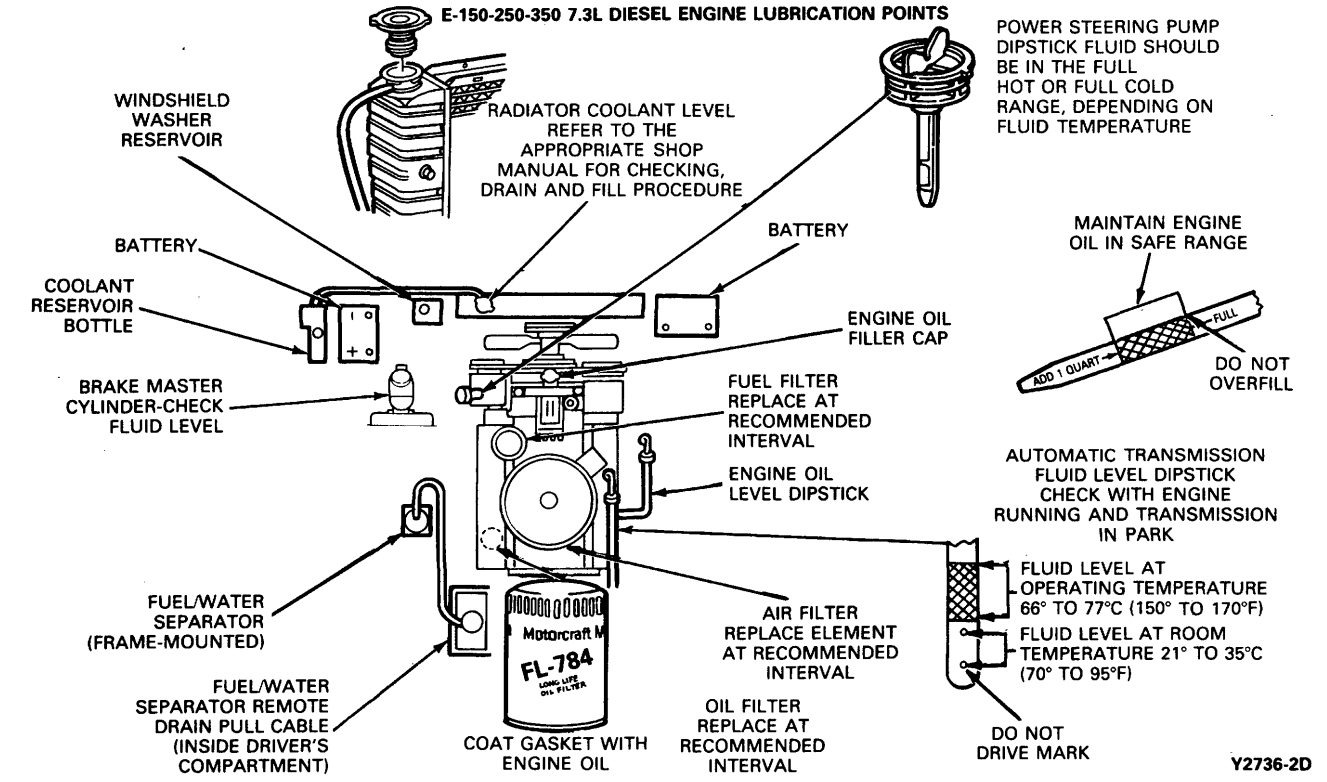
LUBRICATION CHART (Continued)

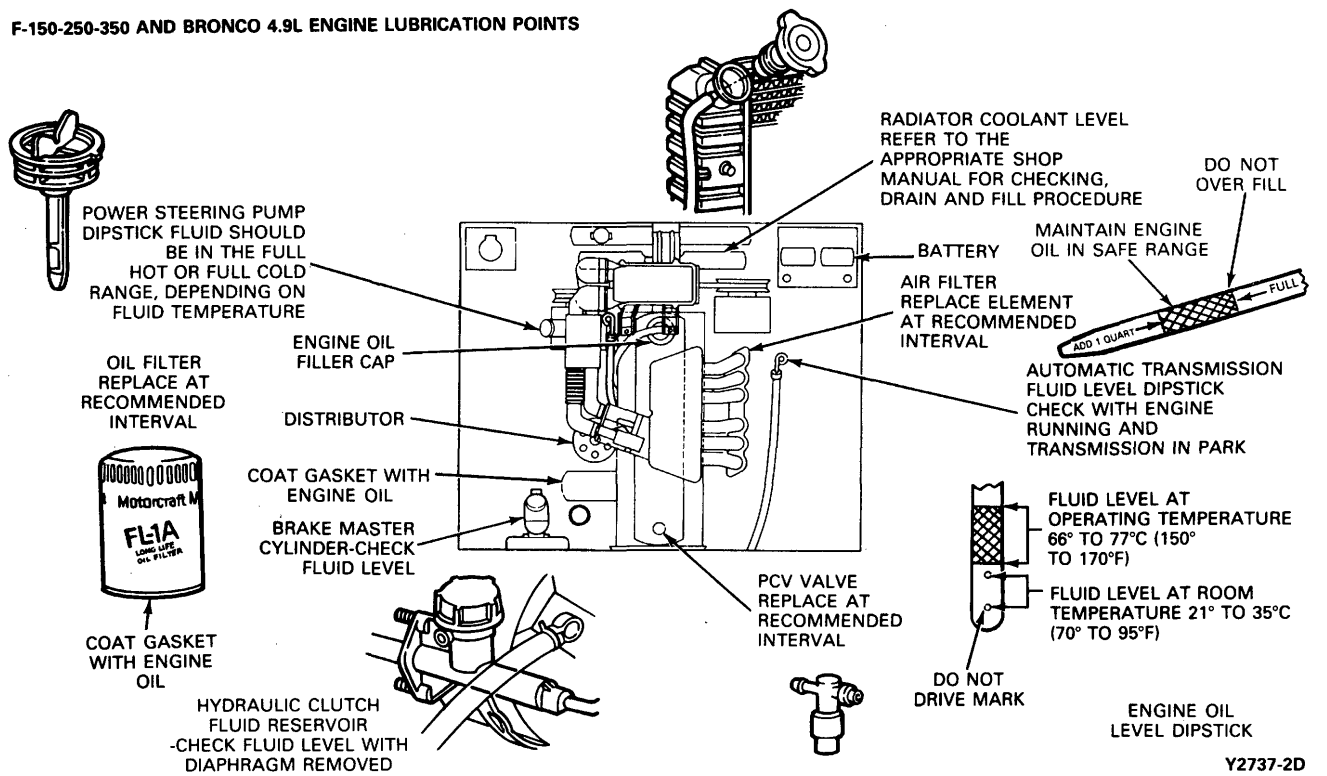




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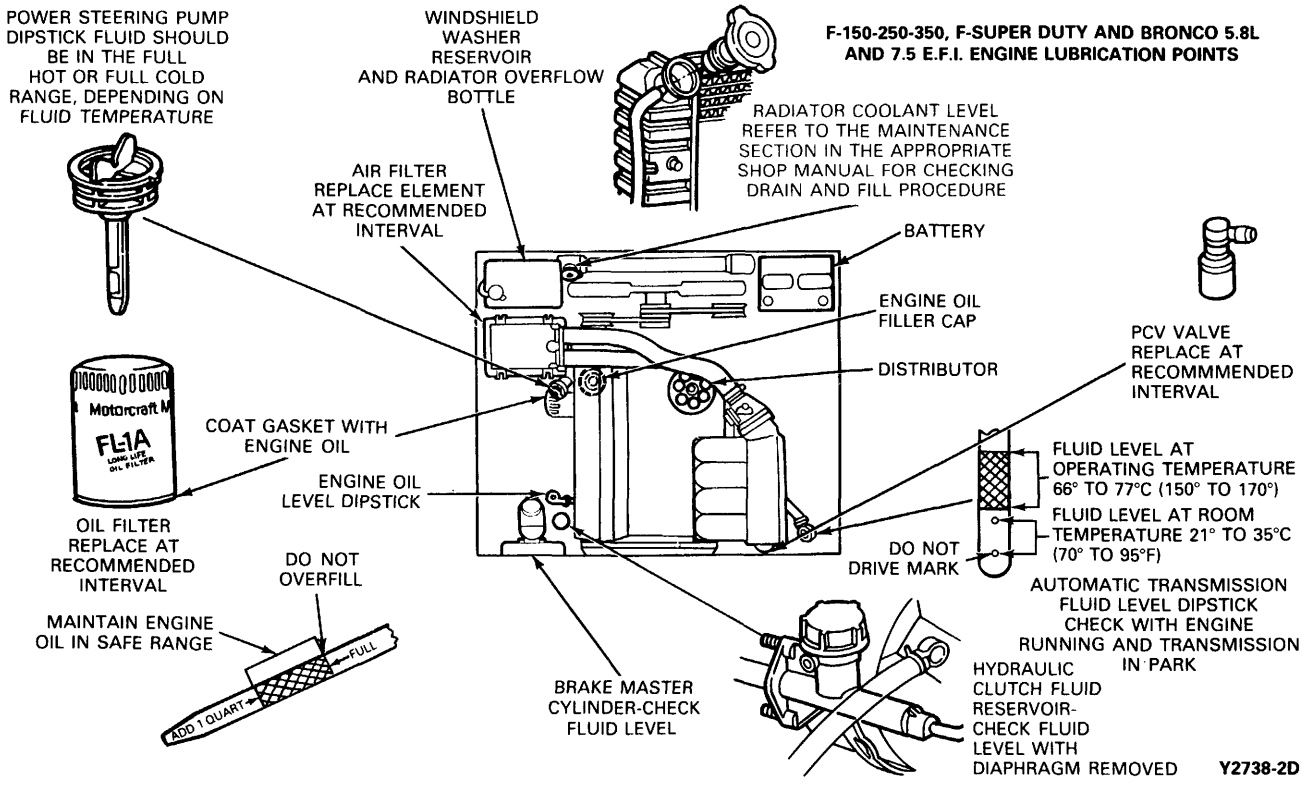
LUBRICATION CHART (Continued)

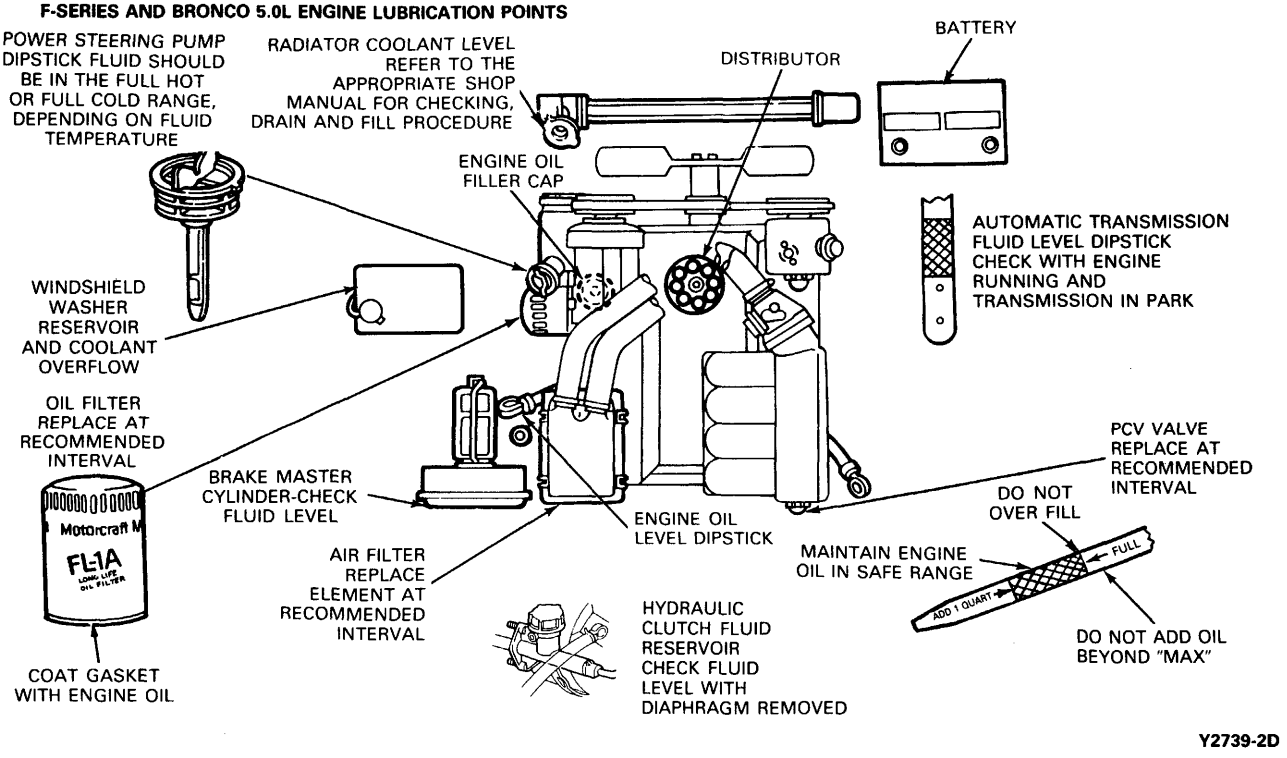




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LUBRICATION CHART (Continued)

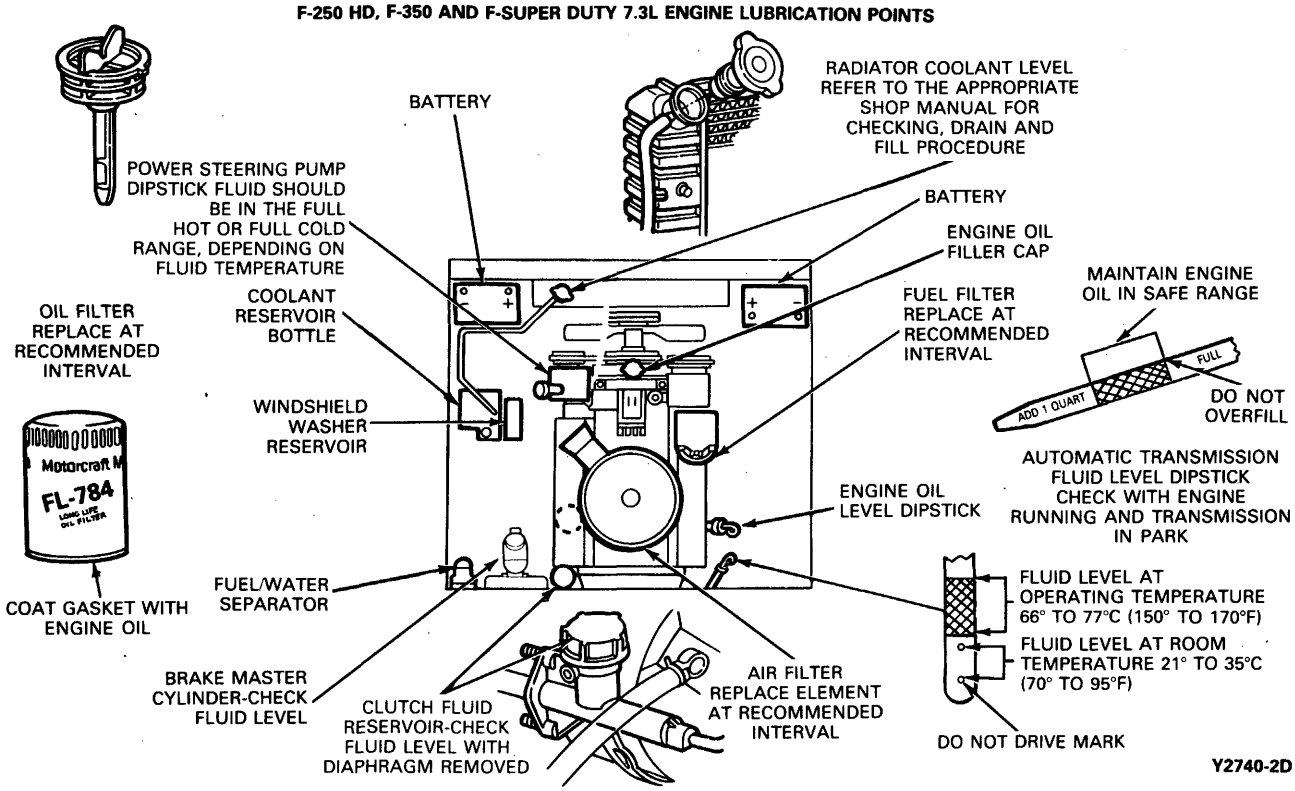




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LUBRICATION CHART (Continued)

F-250 HD, F-350 AND F-SUPER DUTY 7.3L ENGINE LUBRICATION POINTS



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SPECIFICATIONS

LUBRICANT SPECIFICATIONS — E-150 — E-250 — E-350, F-150 — F-250 — F-350, F-SUPER DUTY AND BRONCO

Item	Ford Part Name	Ford Part Number	Ford Specification
Windshield Washer Reservoir	Ultra-Clear Windshield Washer Solvent	C9AZ-19550-A or B	ESR-M17P5-A
Body Hinges, Latches, Door Striker Plates and Rotor, Seat Tracks, Door Tracks and Checks, Hood Latch and Auxiliary Latch, Spare Tire Carrier Latch	Polyethylene Grease	D7AZ-19584-A	ESR-M1C159-A
Lock Cylinders, Outside Spare Tire Lock	Lock Lubricant	D8AZ-19587-A	ESB-M2C20-A
Front Axle Spindle Pins, Front and Rear Spring Shackle Pins, Steering Column U-Joints, Clutch Linkage Fittings, Universal Joints, Joints with Zerk Fittings, and Slip Yoke Pivots, Parking Brake Linkage Pivots and Clevises, Transmission Control Linkage Pivots	Multi-Purpose Long-Life Lubricant	C1AZ-19590-B	ESA-M1C75-B
Front Wheel Bearings and Rear Wheel Bearings Brake and Clutch Pedal Shaft, Front Drive Axle, Spindle Needle Bearings	Multi-Purpose Long-Life Lubricant	C1AZ-19590-B	ESA-M1C75-B
Power Steering Reservoir	Motorcraft Auto. Trans. Fluid-Type "F"	XT-1-QF	ESW-M2C33-F
Clutch Release Lever at Pivots	Multi-Purpose Long-Life Lubricant	C1AZ-19590-B	ESA-M1C75-B
Engine Oil — All Gasoline Engines	Motorcraft Motor Oil 5W30 and 10W40 Super Premium 10W30 and 20W40 Premium SAE-30 and 15W40 Super Duty	XO-5W30-QSP XO-10W40-QSP XO-10W30-QP XO-20W40-QP XO-30-QSD XO-15W40-QSD	ESE-M2C153-D and API SF or SF/CC or SF/CD
Engine Oil — Diesel② (Consult respective engine owners guide for recommendations)	Motorcraft Motor Oil 15W40 Super Duty SAE-30 Super Duty	XO-15W40-QSD XO-30-QSD	API SF/CD and ESE-M2C153-D
Engine Oil Filter — Diesel	Oil Filter	E3TZ-6731-A (FL-784)	—
Engine Oil Filter — Gasoline	Motorcraft Long Life Oil Filter	D9AZ-6731-A (FL-1A)	ES-E1ZE-6714-AA
C6 and AOD Automatic Transmission	MERCON®	XT-2-QDX	MERCON®
Accelerator Control Kickdown (Automatic 6 Cyl.)	Multi-Purpose Long-Life Lubricant	C1AZ-19590-B	ESA-M1C75-B
Speedometer, Parking Brake Cable	Speedometer Cable Lubricant	D2AZ-19581-A	ESF-M1C160-A
Steering Linkage — Lubricate only where equipped with grease fittings	Multi-Purpose Long-Life Lubricant	C1AZ-19590-A	ESA-M1C75-B
Accelerator Linkage — Ball Socket	Multi-Purpose Long-Life Lubricant	C1AZ-19590-B	ESA-M1C75-B
Ford Axles (Conventional and Limited-Slip) ③	Hypoid Gear Lubricant	E0AZ-19580-A	ESP-M2C154-A
Transfer Case — Four-Wheel Drive	Motorcraft DEXRON®-II Automatic Transmission Fluid	XT-2-QDX	DEXRON®-II
Transfer Case Shift Lever Pivot Bolt and Control Rod Connecting Pins	Multipurpose Long Life Lubricant	C1AZ-19590-A	ESA-MIC75-B
Front and/or Rear Dana Axles and Dana Limited Slip Rear Axles ①	Hypoid Gear Lubricant	C6AZ-19580-E	ESW-M2C105-A
5-Speed Manual Overdrive Transmission — Mazda (R2)	DEXRON® II	XT-2-QDX	DEXRON® II
5-Speed Manual Overdrive Transmission ZF(S5-42)	Motorcraft MERCON®	XT-2-QDX	MERCON®
Automatic Transmission Shift Linkage	Polyethylene Grease	D7AZ-19584-A	ESA-M1C159-A
Transmission Throttle Valve (TV) Lever — AOD Only Transmission Kickdown Lever C6 (EFI Engines)	Multi-Purpose Long-Life Lubricant	C1AZ-19590-A	ESA-M1C75-B
Disc Brake, Caliper Rails	Disc Brake Caliper Slide Grease	D7AZ-19590-A	ESA-M1C172-A
F-Super Duty Parking Brake	MERCON®	XT-4-H	MERCON®

① Add EST-M2C118-A (Friction Modifier Part No. C8AZ-19B546-A) or equivalent to refill Dana limited slip axles.
② For arctic winter operation below −25°C (−10°F) but not above −7°C (20°F), use engine oil SAE 5W-30 or SF/CD.
③ For Ford design rear axles: Add 4 oz. of EST-M2C118-A (Friction Modifier Part No. C8AZ-19B546-A) for complete refill of 8.8 inch ring gear limited slip rear axles. For F-250, F-350 with 10.25 inch ring gear limited slip rear axles add 8 oz. of EST-M2C118-A (Friction Modifier Part Number C8AZ-19B546-A).

CY2439-2G

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SPECIFICATIONS (Continued)

LUBRICANT SPECIFICATIONS — E-150 — E-250 — E-350, F-150 — F-250 — F-350 AND BRONCO (Cont'd.)

Item	Ford Part Name	Ford Part Number	Ford Specification
Hydraulic Brake Master Cylinder — Hydraulic Clutch Master Cylinder③	Heavy-Duty Brake Fluid	C6AZ-19542-A or B	ESA-M6C25-A
Brake and Clutch Pedal Pivots and Clevises	Engine Oil SAE-10W	—	ESE-M2C153-D API-SF
Front Wheel Free Running Hubs on 4x4	Steering Gear Grease	C3AZ-19578-A	ESW-M1C87-A
Driveshaft, Universal Joints (if equipped with fitting), Slip Yoke and Spring Stud Shackles	Multi-Purpose Long-Life Lubricant	C1AZ-19590-B	ESA-M1C75-B
Exhaust Control Valve	Rust Penetrant and Inhibitor	D7AZ-19A501-A	ESR-M99C56-A
Engine Coolant	Cooling System Fluid	E2FZ-19549-A	ESE-M97B44-A
Door Weatherstrips	Silicone Lube	C0AZ-19553-A	ESR-M13P4-A
Drive Shaft, Slip Yoke, Double Cardan Joint Center Ball	Multi-Purpose Long-Life Lubricant	C1AZ-19590-B	ESA-M1C75-B
Transfer Case Shift Linkage	Multi-Purpose Long-Life Lubricant	C1AZ-19590-B	ESA-M1C75-B
Automatic Locking Hubs — 4x4	Automatic Hublock Grease	E1TZ-19590-A	ESL-M1C193-A

③As the clutch disc wears, the fluid level in the reservoir will rise. Fluid level above the "step" is an indication of disc wear, NOT overfill. **CY2440-2G**

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SECTION 10-04 Towing

SUBJECT	PAGE
TOWING	
General Wrecker Towing Procedure	10-04-1
Towing Slings/Chains/Hooks	10-04-2
TOWING CONNECTIONS—LIGHT TRUCK	
Front Wheels Off Ground	10-04-3
TOWING CONNECTIONS—LIGHT TRUCK (Cont'd.)	
Rear Wheels Off Ground	10-04-10
VEHICLE APPLICATION	10-04-1

VEHICLE APPLICATION

E-150 Through E-350, F-150 Through F-Super Duty and Bronco Truck Models.

TOWING

General Wrecker Towing Procedure

E-150—E-250—E-350; F-150—F-250—F-350—F-Super Duty and Bronco

Preparatory Steps

Release the parking brake and place the transmission in neutral. As a general rule, towed vehicles should be pulled with the driving wheels off the ground. If the vehicle is to be towed on its drive wheels, the transmission and differential must be operable. If not, place the rear wheels on a dolly or disconnect the rear driveshaft.

When a vehicle is towed on its front wheels, the steering wheel must be clamped in the straight ahead position with a steering wheel clamping device designed for towing service use, such as those provided by towing system manufacturers.

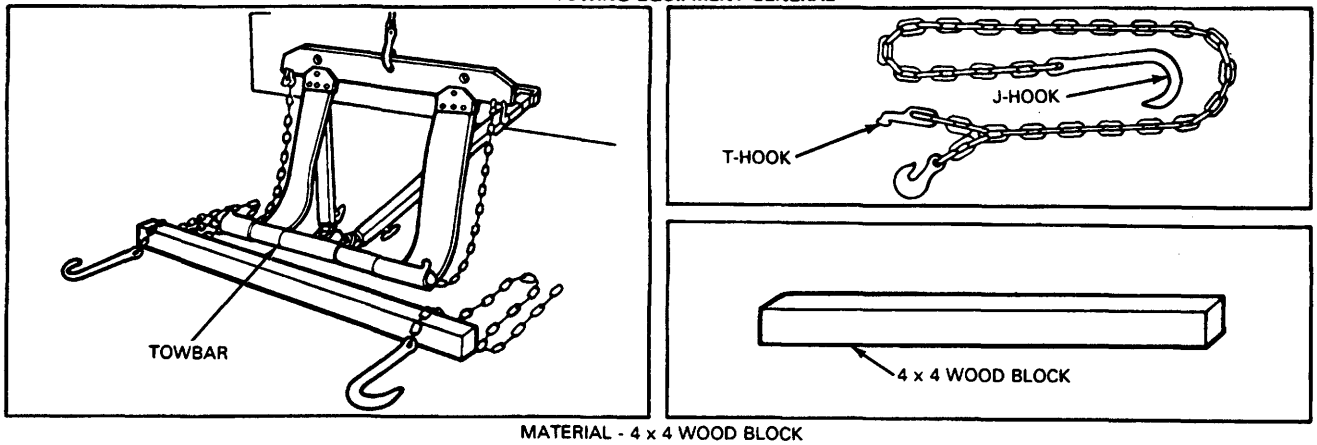
Do not use the vehicle's steering column lock to lock the wheels in a straight ahead position when pulled from the rear. If the ignition key is not available, place a dolly underneath the driving wheels of the vehicle and tow with the non-driving wheels raised.

4-wheel drive vehicles are to be handled as follows:

1. On vehicles equipped with manual hubs, place hubs in FREE position.
2. Place transfer case in neutral.

CAUTION: Improper towing of the vehicle could result in transmission and/or transfer case damage. Always follow the outlined towing procedures. It is recommended that only an unloaded vehicle be towed when either the front or rear wheels are off the ground.

TOWING EQUIPMENT-GENERAL



MATERIAL - 4 x 4 WOOD BLOCK
2×4 LUMBER ACTUALLY MEASURES 1-1/2" × 3-1/2"
4×4 LUMBER ACTUALLY MEASURES 3-1/2" × 3-1/2"

Y2731-2D

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TOWING (Continued)

If towing with a minimal load is unavoidable, care must be taken to properly restrain load from shifting and distribute the load evenly in the pickup box.

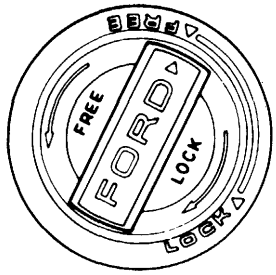
Towing Slings/Chains/Hooks

To avoid metal to metal contact and possible damage to chrome or lower body panels, a special wide-belt sling should be used to lift and tow ALL trucks. When attaching towing slings, take care to avoid damage to the license plate and frame, and air dam.

CAUTION: Use caution when attaching tow hooks and safety chains to vehicle. Position and remove hooks with care to avoid damage to brake hoses, brake lines and steering linkage components.

NOTE: On vehicles equipped with bumper guards, make sure the towbar is under the bumper and the weight of the vehicle is not supported by the bumper guards.

UNLOCKING MANUAL HUBS
TWO-WHEEL DRIVE



FREE POSITION Y3355-1A

Towing Speeds

4x2 Vehicles

On 4x2 vehicles, when towing with the rear wheels on the ground, or all four wheels on the ground, do not exceed a maximum speed of 56 km/h (35 mph) and a maximum distance of 80 km (50 miles).

On 4x2 vehicles, when towing with the rear wheels off the ground, do not exceed a maximum speed of 80 km/h (50 mph). There is no maximum distance for towing.

4x4 Vehicles

When towing 4x4 vehicles, do not exceed a maximum speed of 88 km/h (55 mph). There is no maximum distance for towing.

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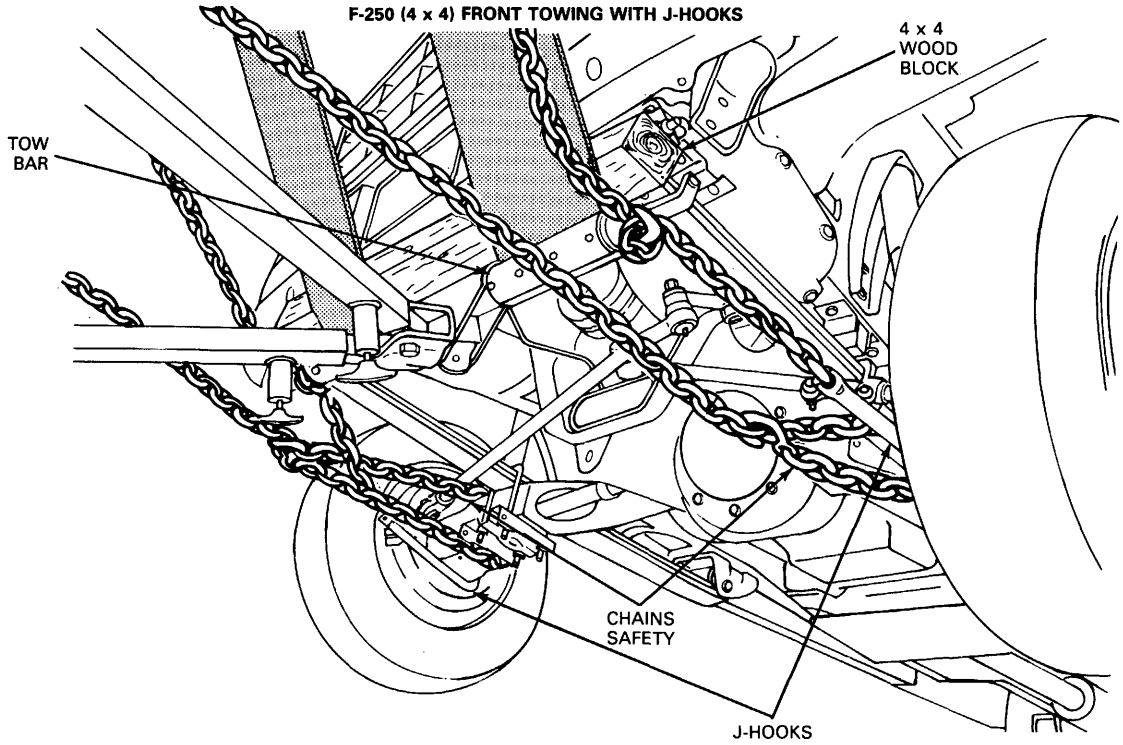
TOWING CONNECTIONS—LIGHT TRUCK

Front Wheels Off Ground

F-250 (4x4) Front Towing With J-Hooks

1. Attach J-hooks under axle outboard of the leaf spring.
2. Position 4x4 on spring under shackle.
3. Position towbar against 4x4.
4. Attach safety chains around axle outboard of leaf spring.

CAUTION: Use of T-hooks is not recommended for F-250 (4x4).



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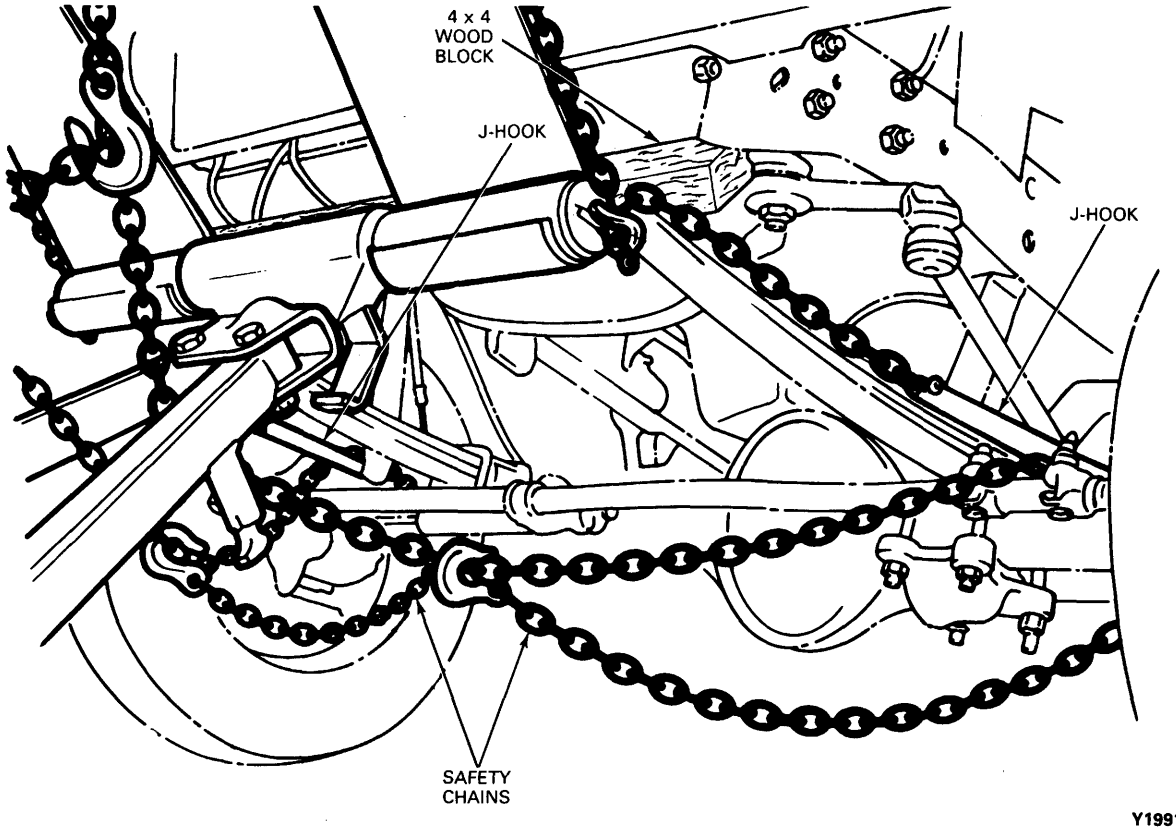
TOWING CONNECTIONS—LIGHT TRUCK (Continued)

F-350 (4x4)—Dana Monobeam Front Drive Axle—Front Towing With J-Hooks

CAUTION: Use of T-hooks is not recommended for F-350 (4x4) monobeam front drive axle.

1. Attach J-hooks outboard of the leaf springs over the axle from above the tie rod (hook in inverted position) as shown.
2. Position 4x4 on spring under shackle.
3. Position towbar against 4x4.
4. Attach safety chains around axle outboard of leaf spring.

F-350 (4 x 4) FRONT TOWING WITH J-HOOKS



Y1991-2C

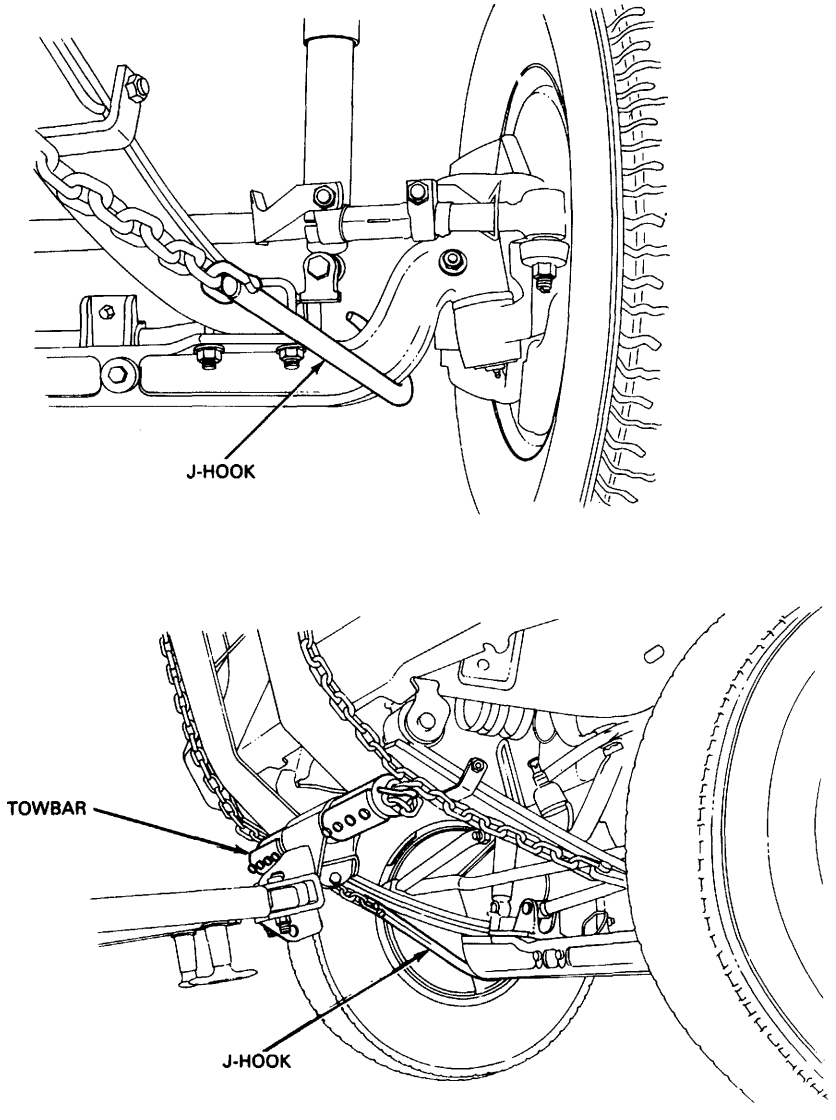
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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

F-Super Duty—Front Towing with J-Hooks

1. Attach J-hooks to the axle outboard of the leaf spring (as shown).
2. Position towbar behind bumper.
3. Attach safety chains around axle outboard of leaf spring.

F-SUPER DUTY – FRONT TOWING WITH J-HOOKS



Y3356-2A

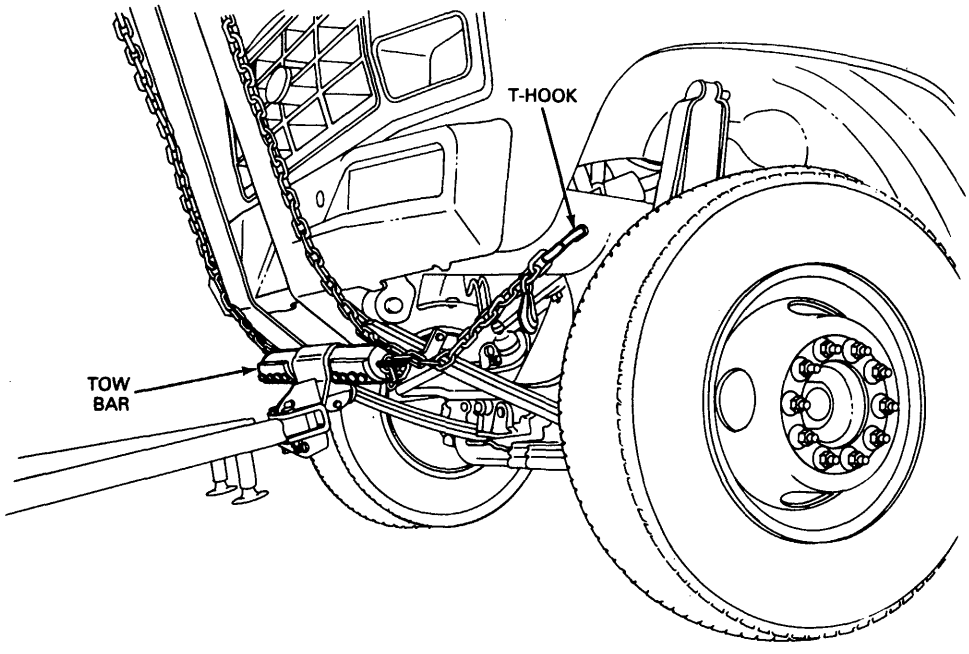
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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

F-Super Duty—Front Towing with T-Hooks

1. Insert T-hooks in T-hook slot in frame from outboard of leaf spring (as shown).
2. Positions towbar behind bumper.
3. Attach safety chains to front axle outboard of leaf springs.

F-SUPER DUTY – FRONT TOWING WITH T-HOOKS



Y3357-2A

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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

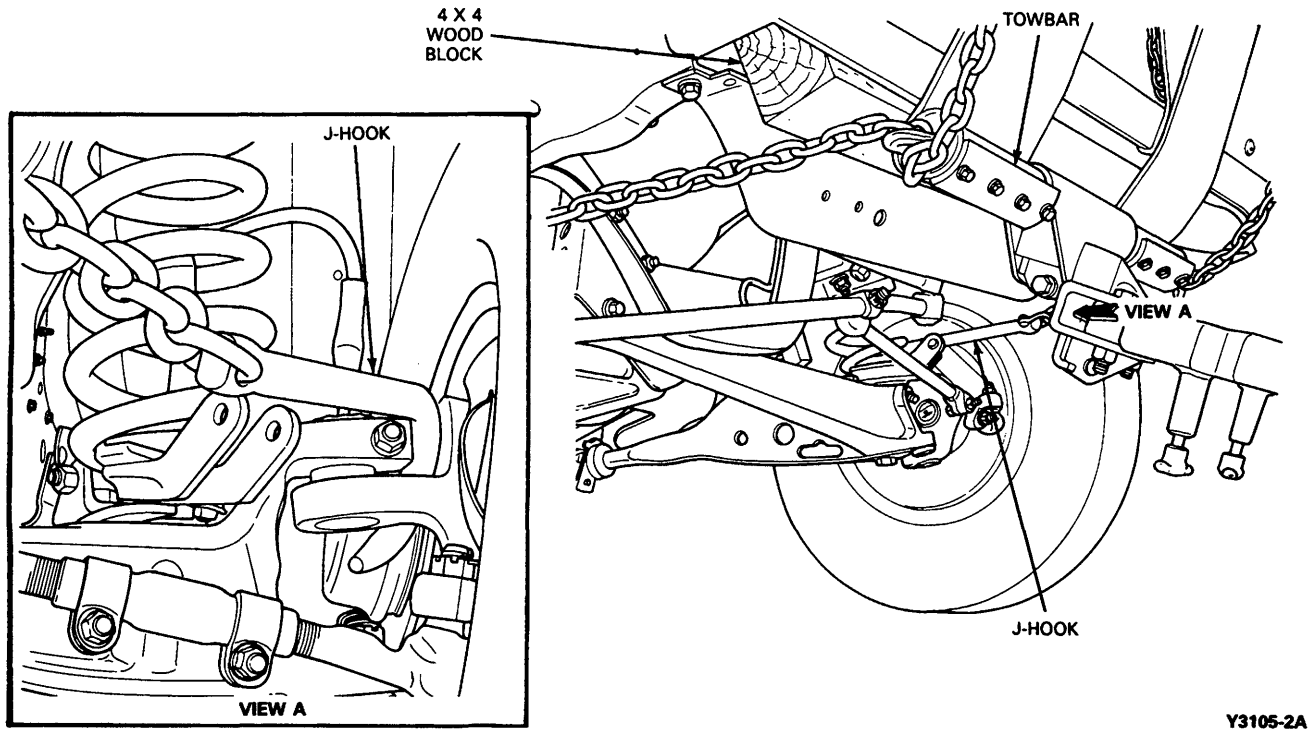
F-150—F-350 (4x2), F-150 (4x4) and Bronco— Front Towing With J-Hooks

NOTE: Use of J-hooks are not recommended for vehicles equipped with stabilizer bar. Use T-hooks only.

CAUTION: On vehicles equipped with an air dam, the towbar will deform the rubber air dam. Wheel lift equipment may be advisable.

1. Attach J-hooks over I-beam axle outboard of coil spring.
2. Place a 4x4 on frame behind air dam.
3. Position towbar against 4x4.
4. Attach safety chains around I-beam axle outboard of the coil spring.

FRONT TOWING - J-HOOKS - F-150 - 250 - 350 (4 X 2), F-150 (4 X 4) AND BRONCO



Y3105-2A

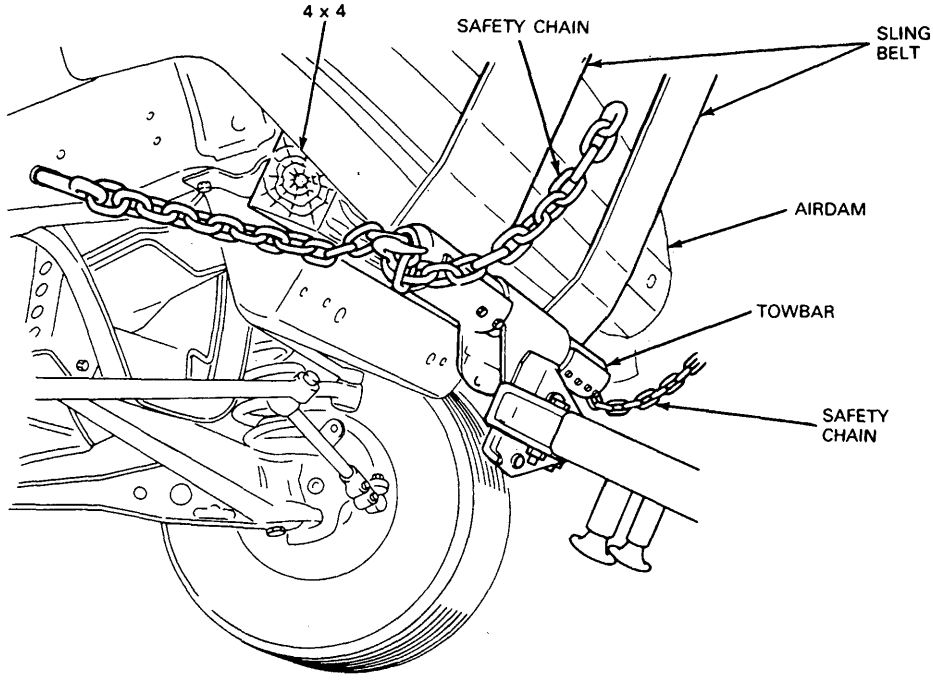
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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

F-150—F-350 (4x2), F-150 (4x4) and Bronco—Front Towing With T-Hooks

CAUTION: On vehicles equipped with an air dam, the towbar will deform the rubber air dam. Wheel lift equipment may be advisable.

1. Insert T-hook in T-hook slot in frame.
2. Place 4x4 on frame behind air dam.
3. Position towbar against 4x4.
4. Attach safety chains around axle outboard of coil spring.



F-150-250-350 (4 x 2), F-150 (4 x 4) AND BRONCO FRONT TOWING WITH T-HOOKS

Y3358-2A

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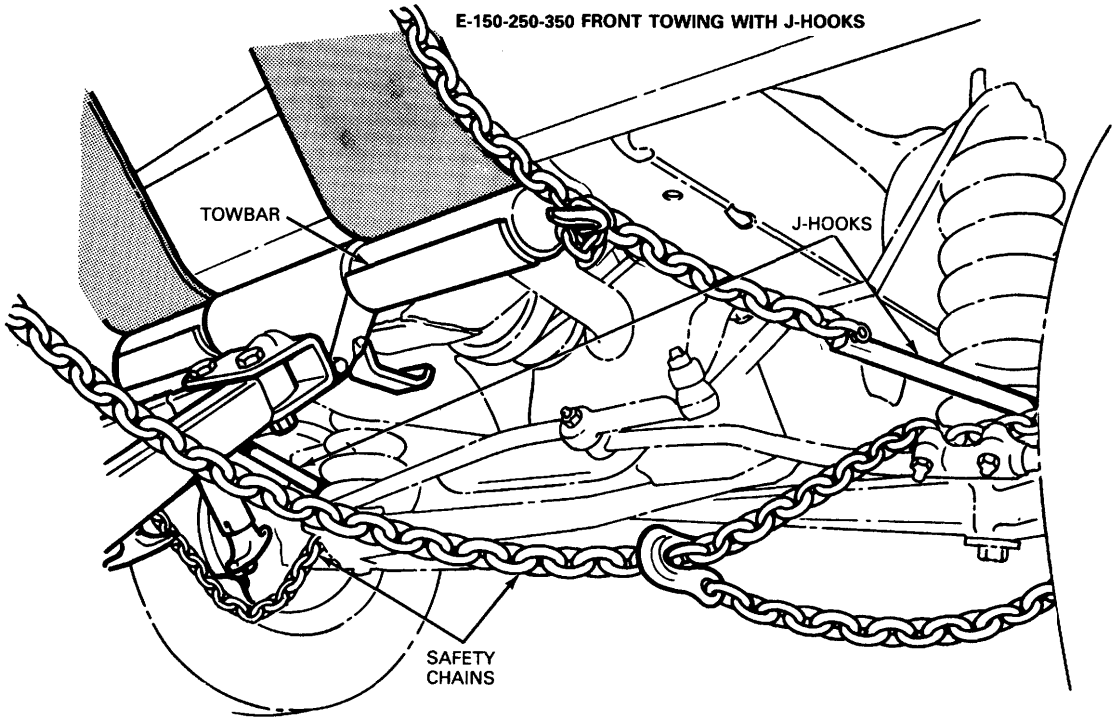
TOWING CONNECTIONS—LIGHT TRUCK (Continued)

E-150/E-250/E-350 Front Towing With J-Hooks

CAUTION: Do not use a 4x4 under the frame to clear the air dam. A 4x4 will damage the radiator.

CAUTION: A towbar will deform the air dam. Wheel lift equipment is recommended.

1. Attach J-hooks outboard of the coil springs over the I-beam suspension arms from above the tie rod (hook in inverted position).
2. Position towbar behind bumper.
3. Attach safety chains around axle outboard of coil springs.



Y1998-2E

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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

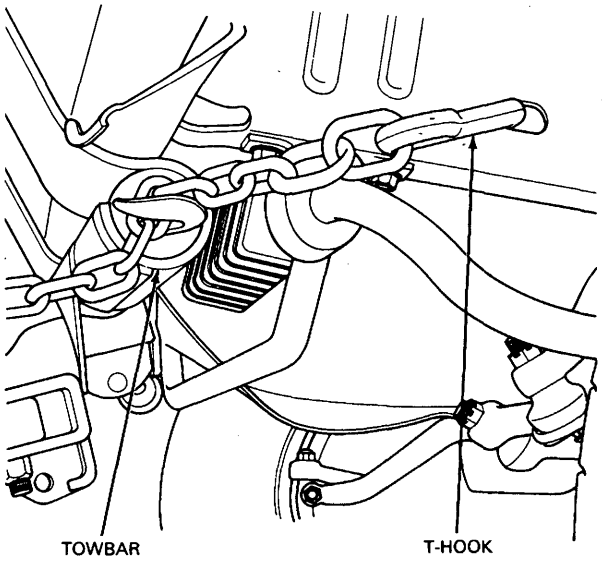
E-150—E-250—E-350 Front Towing With T-Hooks

CAUTION: On vehicles equipped with an air dam, the towbar will deform the rubber air dam. Wheel lift equipment may be advisable.

CAUTION: Do not use a 4x4 under the frame to clear the air dam. A 4x4 will damage the radiator.

1. Insert T-hooks in horizontal T-hook slot in frame.
2. Position towbar behind bumper.
3. Attach safety chains around axle outboard of coil springs.

E-150-250-350 FRONT TOWING WITH T-HOOKS



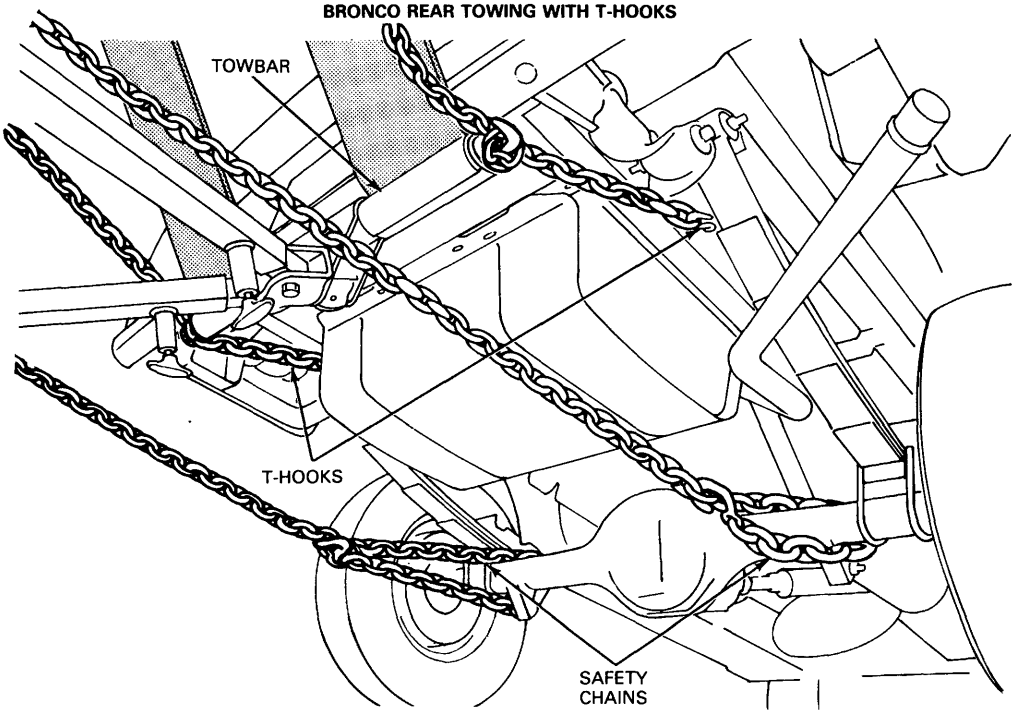
Y3107-1B

Rear Wheels Off Ground

Bronco Rear Towing With J-Hooks

1. Attach J-hooks under axle outboard of leaf springs.
2. Position towbar under bumper on frame.
3. Attach safety chains around axle inboard of leaf spring seat.

BRONCO REAR TOWING WITH T-HOOKS



Y2096-2D

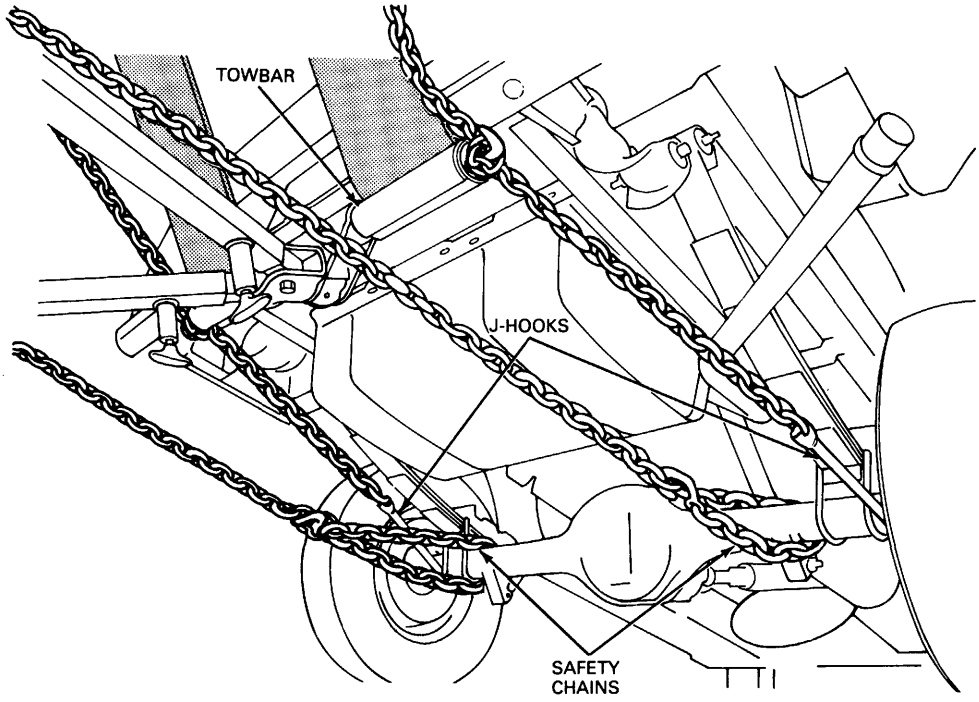
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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

Bronco Rear Towing With T-Hooks

1. Insert T-hooks in horizontal T-hook slot in frame.
2. Position towbar under bumper.
3. Attach safety chains around rear axle inboard of leaf spring seat.

BRONCO REAR TOWING WITH J-HOOKS



Y2095-2D

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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

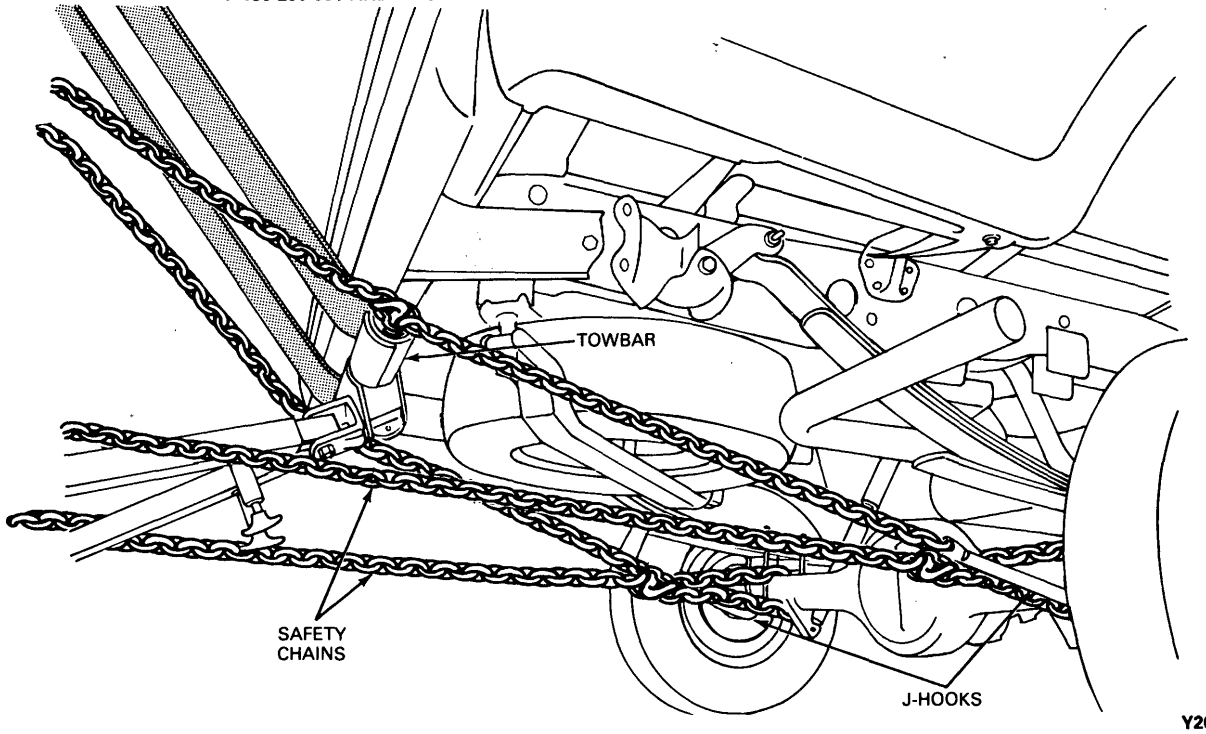
F-150—F-250—F-350 (4x2) (4x4) and F-Super Duty Rear Towing With J-Hooks

1. Attach J-hook under axle outboard of spring seat.

NOTE: A 4x4 wood block is required to be placed against the rear spring brackets on vehicles not equipped with a rear bumper and on all Flareside models. If the vehicle is also equipped with an under frame spare tire, the tire must be removed to allow installation of the 4x4 wood block.

2. Position towbar under bumper.
3. Attach safety chains around axle inboard of the leaf spring seat.

F-150-250-350 AND F-SUPER DUTY WITH REAR BUMPER – REAR TOWING WITH J-HOOKS

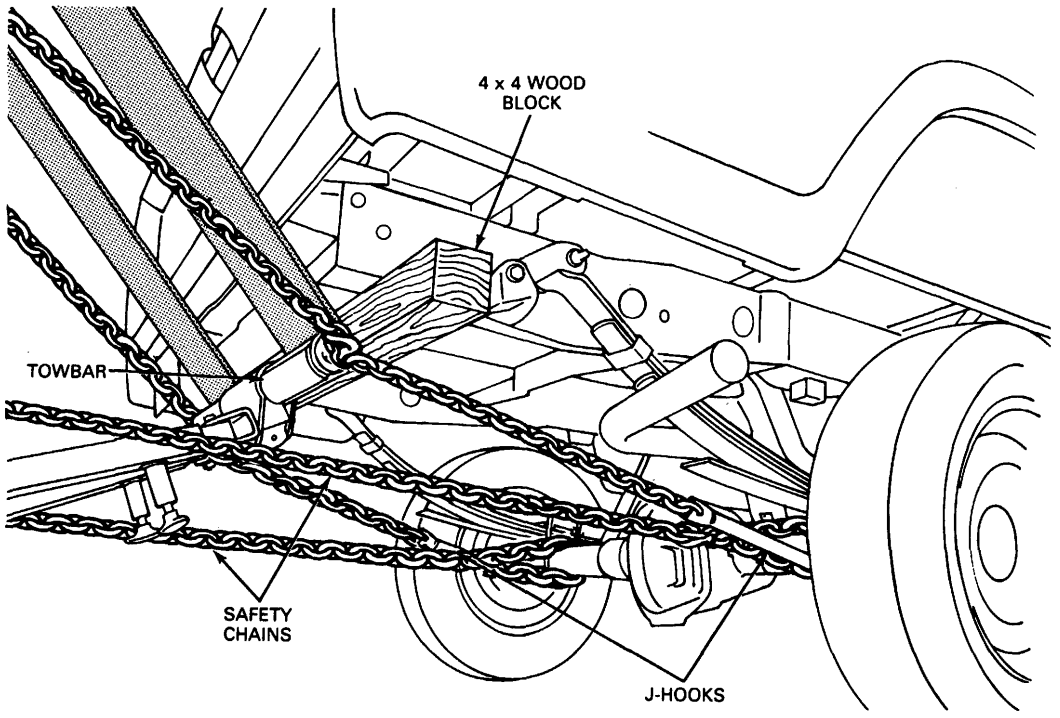


Y2097-2D

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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

F-150-250-350 AND F-SUPER DUTY WITHOUT REAR BUMPER – REAR TOWING WITH J-HOOKS



Y2098-2D

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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

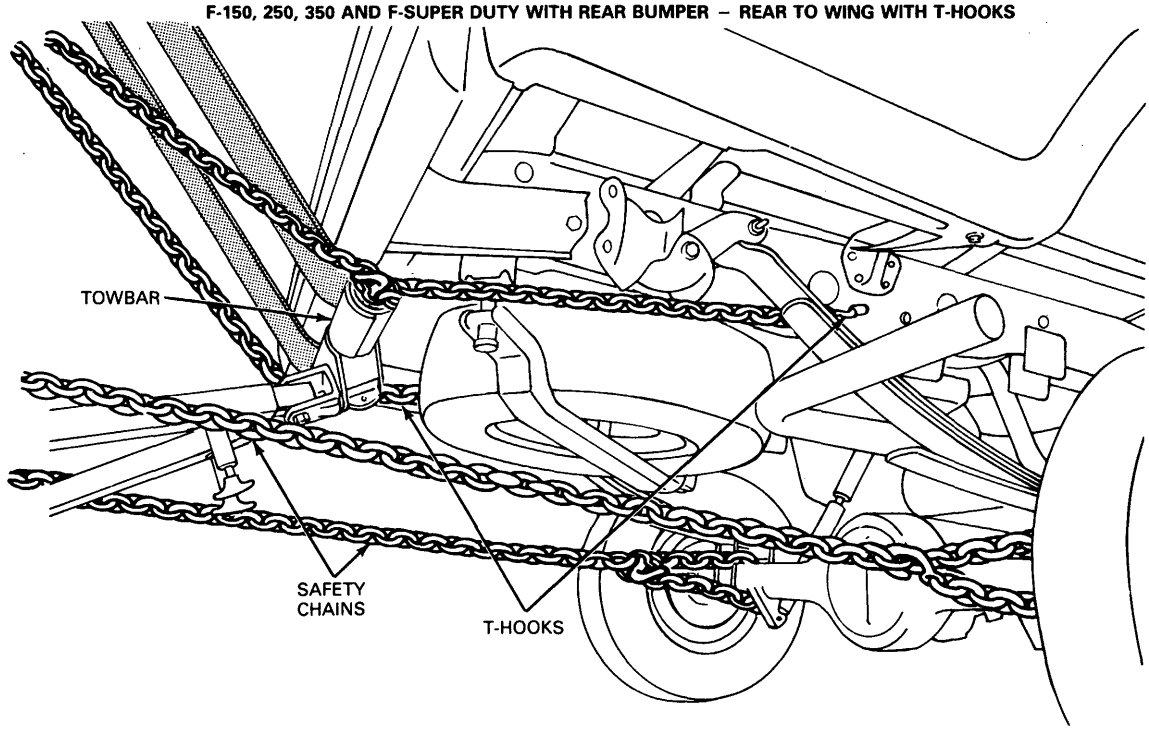
F-150—F-250—F-350 (4x2) (4x4) and F-Super Duty Rear Towing With T-Hooks

1. Position T-hooks in horizontal T-hook slot in frame.

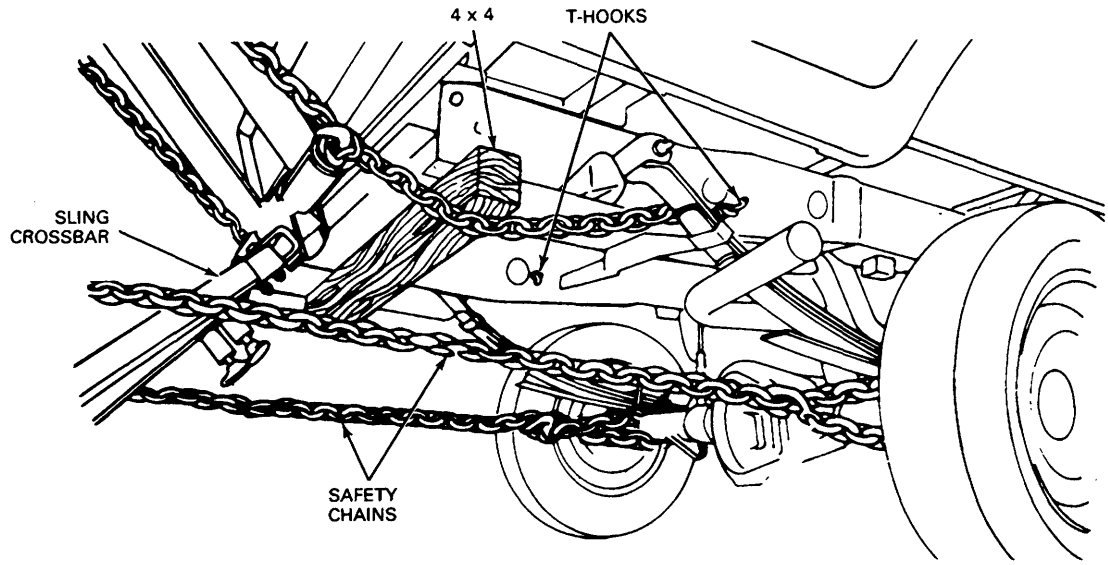
NOTE: A 4x4 wood block is required to be placed against the rear spring brackets on vehicles not equipped with a rear bumper and on all Flareside models. If the vehicle is also equipped with an underframe spare tire, the tire must be removed to allow installation of the 4x4 wood block.

2. Place towbar under bumper.
3. Attach safety chains around the axle inboard of the leaf spring seat.

F-150, 250, 350 AND F-SUPER DUTY WITH REAR BUMPER – REAR TO WING WITH T-HOOKS



Y2099-2D



F-150-250-350 AND F-SUPER DUTY WITHOUT REAR BUMPER
REAR TOWING WITH T-HOOKS

Y3359-2A

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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

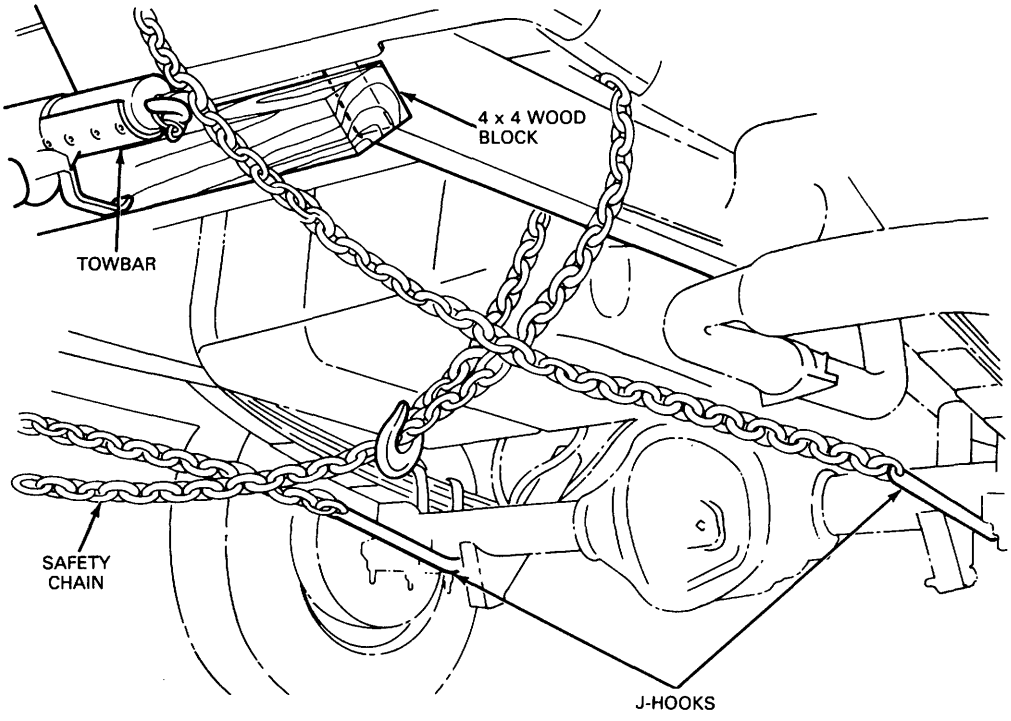
E-150—E-250—E-350 Rear Towing With J-Hooks

1. Attach J-hooks under the axle inboard of the leaf springs.
2. Position a 4x4 wood block across frame rails ahead of the bumper. Position the towbar against the 4x4 wood block rear face.

CAUTION: This hookup is designated to minimize the risk of bumper damage during normal towing. It is important that sling crossbar be tight against the 4x4 wood block lower rear face to minimize rear bumper tow load. The 4x4 wood block must be located ACROSS the frame rails and NOT under the bumper.

3. Attach safety chains around the frame rails or axle.

E-150-250-350 – REAR TOWING WITH J-HOOKS



Y2126-2F

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TOWING CONNECTIONS—LIGHT TRUCK (Continued)

E-150—E-250—E-350 (with Frame Mounted Rear Bumper) Rear Towing With T-Hooks

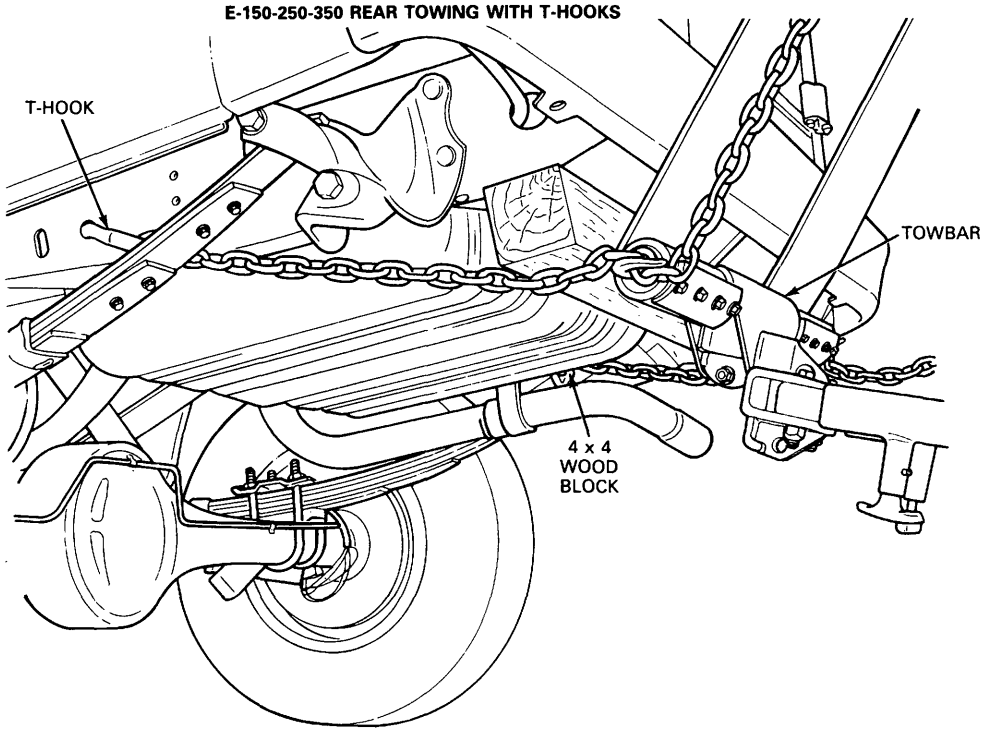
CAUTION: Do not use T-hooks on Econoline with 124 inch wheelbase.

1. Insert T-hook in angled T-hook slot in frame.
2. Position a 4x4 wood block across the frame rails ahead of the bumper. Position towbar against the 4x4 wood block rear face.

CAUTION: This hookup is designated to minimize the risk of bumper damage during normal towing. It is important that sling crossbar be tight against the 4x4 wood block lower rear face to minimize rear bumper tow load.

3. Attach safety chains around the frame rails or axle.

E-150-250-350 REAR TOWING WITH T-HOOKS



REAR TOWING – T-HOOKS – E-SERIES Y3109-2B

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GROUP

WHEELS AND TIRES 11

(1000 & 2000)

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GENERAL WHEEL AND TIRE SERVICE	11-01-1
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VEHICLE APPLICATION

All E-150, 250 and 350, F-150, 250 and 350, F-Super Duty and Bronco Trucks.

SAFETY

Wheels must be properly maintained because improperly maintained wheels and wheel components can adversely affect the life of the tire and the wheel. A tire when inflated is potentially very destructive. Accidents are caused by careless handling and inexperience. You must follow the safety procedures as outlined in this manual and obtain safety literature from your wheel and rim distributor, a wheel and rim manufacturer, NHTSA or OSHA. If you have any questions, consult the distributor or manufacturer directly. The load carrying requirements of each vehicle should also be determined before selecting the proper tire/wheel combination. Always remember that the weakest weight carrying component of the vehicle (i.e., tire, wheel, axle, bearings, etc.) determines its overall maximum and safe load carrying capacity for the vehicle.

WARNING: THE TIRE AND WHEEL MUST ALWAYS BE PROPERLY MATCHED. DO NOT MOUNT A 16 INCH TIRE ON A 16.5 INCH WHEEL. FAILURE TO STRICTLY ADHERE TO THESE IMPORTANT INSTRUCTIONS WILL RESULT IN AN EXPLOSIVE SEPARATION AND WILL CAUSE SERIOUS BODILY INJURY OR DEATH. IT IS VERY IMPORTANT TO DETERMINE THE SIZE OF EACH COMPONENT BEFORE ANY ASSEMBLY OPERATIONS COMMENCE.

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When replacing tires, use the same size, load range and construction type (bias, bias belted or radial) as originally installed on your vehicle. When replacing wheels, use original equipment manufacturers wheels or equivalent available from your Ford dealer with equivalent capacity, width, offset and mounting configuration as those originally installed on your vehicle. Use of improper replacement wheels and tires may adversely affect ride, handling, load carrying capacity, wheel bearing life, tire clearance to body and chassis components, vehicle ground clearance, vehicle width and brake cooling.

E-350, F-350 and F-Super Duty vehicles equipped with dual wheel rear axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lug nuts.

WARNING: DO NOT ATTEMPT TO USE PAST MODEL LUG NUTS (CONE SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUG NUTS. IF SO USED, PAST MODEL LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

Safety Precautions When Servicing Truck Tires

CAUTION AND SAFETY FIRST are important bywords when handling tires, **particularly truck tires.** Careful attention to the suggestions that follow may prevent crippling injuries, or even death. **Make it a rule to respect the terrific force contained in an inflated tire.** You may be glad some day that you did.

Prepare for any tire repair operation in a safe and efficient way. In changing tires on drop center wheels, remove the wheel and tire from the truck, **as changing tires with the wheel on the truck is hazardous, more difficult, and takes more time.** In servicing of all tires use caution not to drop them (or the wheels or assemblies) on the feet, hands or body, or heavily on the floor (Fig. 1). Practice good methods of lifting; use your legs as well as your arms and your body. This will help to prevent painful, internal injury. When carrying tires or wheels don't step in oil or grease. **Keep the floor clean and dry.**

Deflating a tire properly is very important to your safety. First, reduce the pressure as much as you possibly can by pushing the valve core plunger. **Only then should you remove the valve core.** Keep your eyes away from the valve: Fig. 2 shows the safe way to do it.

NOTE: If the tire is to be reinstalled on an original equipment wheel, mark the tire at the valve stem hole so that they can be reassembled in the same relative position.

Demounting tires from wheels or rims requires special care. Tires on drop center rims are best handled on a wheel holder, or tire-changing machine such as Rotunda Model 084-00001 or equivalent (Fig. 3).



FIG. 1 Handling Wheels and Tires



FIG. 2 Safe Air Removal

This can help prevent cuts on hands and wrists and will make it unnecessary to use a mallet for unseating the tire beads.

Use only standard tire mounting tools and equipment. The use of makeshift tools, screwdrivers or pliers to force tires on or off rims or wheels is dangerous.

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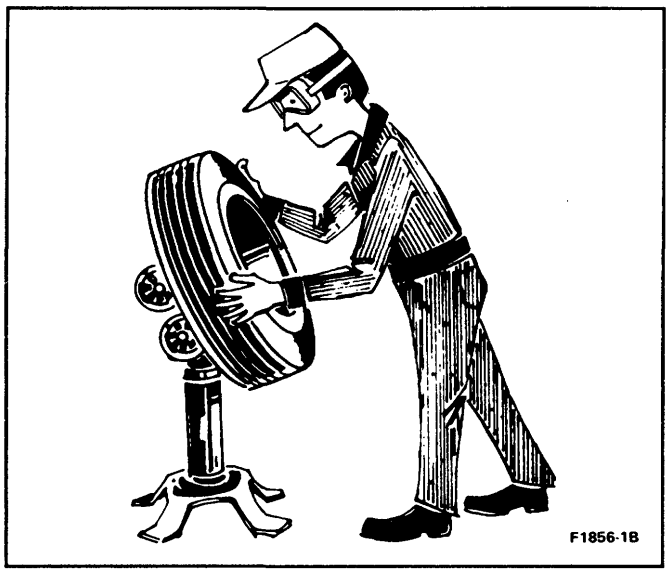


FIG. 3 Changing Tire on Drop Center Rim

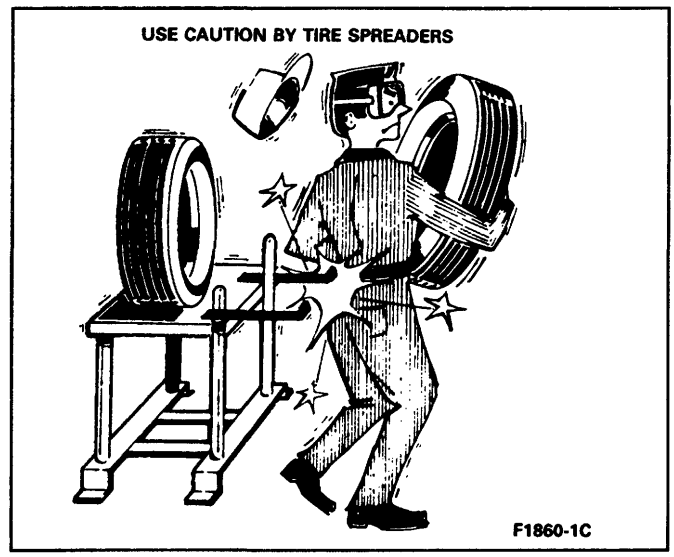


FIG. 4 Tire Spreader

Always lubricate tire beads to assure sealing of tire beads on rim with Rubber Lubricant D9AZ-19583-A (ESA-M1B6-A) or equivalent.

The Rotunda tire changer, 084-00001 or equivalent includes a bead seater/inflator using an automatically adjustable inflation ring, which aids in properly seating the bead for inflation. To properly operate the Rotunda tire changer, follow the instructions provided.

A careful inspection should be made of the tire and all necessary repairs should be performed. A tire spreader Rotunda Number 084-00002 is very helpful but use care when working around it. Keep the spreader arms closed when the machine is idle (Fig. 4).

Replace damaged or corroded parts. Abuse during road operations or in mounting tires can cause damage that may weaken the parts. Parts that are excessively corroded are weakened. Always inspect for and replace damaged or heavily rusted parts.

Inspect for and remove light rust and other foreign matter. Accumulation of such material on the engagement surfaces of the rim base and side can prevent the proper fit of these parts. Use of a rust preventative during mounting will minimize rust.

Tires and rims often require a buffing operation before being mounted once the regular repairs have been made.

Always wear safety goggles, or a face shield when performing any buffing operation.

Avoid hammering rims with steel hammers. Small bits of steel may be broken off the hammer or rim, flying into the eyes (wear safety goggles) face or body. Use rubber-covered, steel-headed hammers wherever possible. Rubber mallets only should be used on tires; although with modern tire changing equipment no pounding is necessary.

Stand away from the valve stem as far as possible while inflating tires. Avoid a position where the face or body is immediately over the work being done on any tire in which there is pressure.

Always use a safety cage or portable safety device while inflating tires. Protect yourself from possible improper assembly, inadvertently mis-matched parts and other assembly errors. Remember that even the most experienced personnel can be careless on occasion and that an inflated tire contains potentially explosive energy.

Use only accurate, tested gauges to insure proper air pressure as specified on the Certification label attached to the vehicle. Check all gauges regularly with a master gauge.

The vehicle should not exceed the recommendations of load rating capacity specified on the vehicle safety certification decal (located on door pillar) relative to front and rear GAWR and vehicle GVWR.

Play it SAFE. Set a good example for others who work with you. Follow the above suggestions completely. **If you are ever tempted to take a short cut because you are in a hurry, that is the time that you could get hurt.**

Finally, always remember, a jack is provided for wheel and tire maintenance only. **Never run the engine when the vehicle is supported by a jack.**

DIAGNOSIS AND TESTING

Diagnosis Guides

The diagnosis guides in this Section can be used as an aid in wheel and tire service diagnosis.

Diagnosis Guides

ADJUSTMENTS

Wheel and Tire Checking Procedure

Inspect tires for wear from incorrect mounting misalignment, loose wheel bearings, bent wheels, or cupping or scalping from inbalance. Tires which show irregularities and definite roughness must be replaced.

Make certain that the brakes are not dragging and wheel bearings are properly adjusted before attempting to spin the wheels. On disc brakes, push the brake shoes into the caliper to free the rotor.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Tires show excess wear on edge of tread.	1. Under inflated tires. 2. Vehicle overloaded. 3. High-speed cornering. 4. Incorrect toe setting.	1. Adjust air pressure in tires. 2. Correct as required. 3. Correct as required. 4. Set toe to specification.
Tires show excess wear in center of tread.	1. Tires over inflated.	1. Adjust air pressure in tires.
Other excessive tire wear problems.	1. Improper tire pressure. 2. Incorrect tire/wheel usage. 3. Loose or leaking shock absorbers. 4. Front end out of alignment. 5. Front wheel bearings out of adjustment. 6. Loose, worn or damaged suspension components, bushings and ball joints. 7. Wheels and tires out of balance. 8. Excessive lateral and/or radial runout of wheel or tire. 9. Tires need rotating.	1. Adjust air pressure in tires. 2. Install correct tire and wheel combination. 3. Tighten or replace as necessary. 4. Align front end. 5. Adjust front wheel bearings. 6. Inspect, repair or replace as required. 7. Balance wheels and tires. 8. Check, repair or replace as required. Use dial indicator to accurately determine runout. 9. Rotate tires.
Excessive vehicle vibration, rough steering, or severe tire wear.	1. Loose or improper attaching parts. 2. Overloading or unbalanced loads.	1. Tighten or replace. 2. Check wheel and tire specs against work load requirements. Recommend correct tire and rim. Check on loading procedure.
Vehicle vibrations.	1. Loose or worn driveline or suspension parts. 2. Improper front end alignment. 3. Excessive lateral runout (wheel or tire). Use a dial indicator to accurately verify runout reading. 4. Bent or distorted wheel disc from overloading, road impact hazards or improper handling. 5. Loose mountings — damaged studs, cap nuts, enlarged stud holes, worn or broken hub face or foreign material on mounting surfaces. 6. Out-of-balance wheel and/or tire or hub and drum assembly. 7. Out-of-round wheel or tire (excessive radial runout). Use a dial indicator to accurately verify runout reading. 8. Wheel stud runout. 9. Water in tires.	1. Identify location of vibration carefully as it may be transmitted through frame making a rear end vibration appear to come from the front. Repair or replace loose and worn parts. 2. Align front end. 3. Replace wheel or tire. 4. Replace wheel. Attempts to straighten wheel can result in fractures in the steel and weakening of the disc or the weld between disc and rim. Check loading and operating conditions and shop practices. 5. Tighten and/or replace worn or damaged parts. Clean mounting surfaces. 6. Determine the out-of-balance component and balance or replace. 7. Replace the wheel or tire and check for overloading and unbalanced loads, rugged operating conditions, proper wheel and tire specifications. 8. Replace hub or axle shaft. 9. Remove water.
Wheel mounting is difficult.	1. Improper application or mismatched parts, including studs and nuts. 2. Corroded or worn parts.	1. Follow manufacturers' specifications. 2. Clean or replace.
Wheel-rust or corrosion.	1. Poor maintenance.	1. Keep clean and protect with paint.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Cracked or broken wheel discs. Cracks develop in the wheel disc from hand hole to hand hole, from hand hole to rim, or from hand hole to stud. Stud holes become worn, elongated or deformed. Metal builds up around stud hole edges, cracks develop from stud hole to stud hole. Related driver complaints: unusual operating noise or vibration and on the road failures.	1. Metal fatigue resulting from abusive handling.	1. Replace wheel. Check position of wheel on vehicle for working load specifications.
	2. Truck operated with loose wheel mounting.	2. Replace wheel and check for: — Installation of correct studs and nuts, and recommend exact specifications. — Cracked or broken studs, and replace. — Worn hub face. Machine if not excessive, or replace if severe. — Broken or cracked hub barrel, replace. — Worn stud grooves, replace or install recommended serrated bolts. — Clean mounting surfaces and re-torque cap nuts periodically. — Rust streaks fanning out from stud holes are a sure indication that the cap nuts are or have been loose.
Cracks develop in rim base back (rim bead seat) or the gutter area (drop well radii).	1. Overloading or abusive use.	1. Replace wheel. Check loading and operating conditions. Avoid over inflation of tires. Check specs for rim load capacity, working loads, tire size, ply rating and tire construction.
	2. Improper use of tools.	2. Check mounting, demounting, and maintenance procedures.
Dual tires rubbing (kissing).	1. Insufficient wheel spacing.	1. Check tire and wheel sizes. Make certain proper size tire and wheels are used.
	2. Overloading.	2. Reduce weight.
Damaged stud threads.	1. Sliding wheel across studs during assembly.	1. Replace studs. Follow proper wheel installation procedure.
Loose drum.	1. Stud too long.	1. Replace stud with proper length stud.
Loose inner wheel.	1. Excessive stud standout from mounting face of hub permitting wheel nut to bottom out.	1. Replace stud with proper length stud.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Broken studs.	1. Loose lug nuts.	1. Replace studs. Follow proper torque procedure.
	2. Overloading.	2. Replace studs. Compare actual load against vehicle load ratings.
Stripping threads.	1. Excessive torque.	1. Replace studs. Follow proper torque procedure.
Rust streaks from stud holes.	1. Loose lug nuts.	1. Check complete assembly. Replace damaged parts. Follow proper torque procedure.
Damaged lug nuts.	1. Loose wheel assembly.	1. Replace lug nuts. Follow proper torque procedure.
	2. Overtightened lug nuts.	
Frozen lug nuts.	1. Corrosion or galling.	1. If corrosion is slight, wire brush away corrosion. If corrosion is excessive, replace studs and nuts. If condition persists, lubricate first three threads of each stud with a graphite-based lubricant. **CAUTION:** Do not permit lubricant to get on ball seats of stud holes or on ball face of lug nuts.
	2. Overloading.	2. Reduce weight.

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Wheel and Tire Vibration Diagnosis Procedures

Refer to Section 18-01, Noise, Vibration and Harshness—Diagnosis for wheel and tire vibration diagnosis procedures.

Front Wheel Bearing Maintenance

Wheel bearings are adjustable. Satisfactory operation and long life of bearings depend on proper adjustment and correct lubrication. **If bearings are adjusted too tightly, they will overheat and wear rapidly. An adjustment that is excessively loose can cause pounding and contribute to uneven tire wear, steering difficulties and inefficient brakes. The bearing adjustment should be checked at regular inspection intervals.**

For Front wheel bearing adjustment procedures, refer to Section 11-10, Wheel Hubs and Bearings-Front (except Front drive) and Section 11-12, Wheel Hubs and Bearings-Front Wheel Drive.

MAINTENANCE

Wheels

Wheel lug nuts should be inspected and tightened twice within the first 800 kilometers (500 miles) of operation. After the first 1600 Kilometers (1000 miles) of operation, they should again be inspected and tightened at the intervals specified by Section 10-02, Maintenance. Also retighten to specifications at 800 km (500 miles) after any wheel change or any other time the lug nuts have been loosened. Improperly tightened wheel nuts could allow the wheel to come off while the vehicle is in motion, causing loss of control. Loose wheel stud nuts may cause shimmy stud damage and/or stud failure, possible wheel damage, and vibration. Elongated stud holes in the wheels may also result from the loose stud nuts.

For vehicles equipped with dual rear wheels, tighten wheel lug nuts to specifications after 160 km (100 miles) and again after 800 km (500 miles) of new vehicle operation, and at the intervals specified in the maintenance section, according to the Wheel Removal and Installation instructions in Section 11-02, Wheels and Tires. This is required to permit the wheel clamping system to seat properly so that the wheel lug nuts will hold a uniform clamp load and remain fully tightened. Retightening to specification is also required at 800 km (500 miles) after any wheel change and any other time the lug nuts have been loosened. Improperly tightened wheel lug nuts could allow the wheel to come off while the vehicle is in motion, causing loss of control.

Keep the wheels and hubs clean. Stones or lumps of mud wedged between the wheel and drum will unbalance a wheel and tire.

Check for damage that would affect the runout of the wheels. Wobble or shimmy caused by a damaged wheel will eventually damage the wheel bearings and cause uneven tire wear. Inspect the wheel rims for dents that could permit air to leak from the tires.

WARNING: AFTERMARKET WHEEL ASSEMBLIES MAY NOT BE COMPATIBLE WITH YOUR VEHICLE AND SHOULD NOT BE USED. USE OF INCOMPATIBLE WHEEL ASSEMBLIES MAY RESULT

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TIRE/WHEEL CONDITIONS

TEST STEP	RESULT ▶	ACTION TO TAKE
NOTE: On vehicles equipped with all terrain type tires, a vibrating, drumming or beating noise is often misdiagnosed as a driveline vibration. Replace the all terrain type tires with highway type tires. If condition is eliminated, refer to Section 18-01, Noise Vibration and Harshness. If condition is still present, refer to the procedure below.		
1 EXCESSIVE WEAR OR CUPPING		
• Check tires for excessive wear or cupping.	(OK) ▶	GO to **2**.
	(OK) ▶	REPLACE severely worn tires. CHECK tire inflation, vehicle alignment and suspension. REPAIR, REPLACE or ADJUST as required. GO to **2**.
2 WHEEL BEARING ENDPLAY		
• Check wheel bearing endplay. • Rotate wheel and check for roughness.	(OK) ▶	GO to **3**.
	(OK) ▶	REPLACE wheel bearings, if required. ADJUST to correct endplay. ROAD TEST to verify correction.
3 TIRE WHEEL BALANCE		
• Check tire/wheel balance.	(OK) ▶	GO to **4**.
	(OK) ▶	BALANCE tire/wheel assembly. If assembly cannot be balanced, REPLACE wheel and/or tire. ROAD TEST to verify correction.
4 REINDEX TIRE		
• Reindex tire 180 degrees and rebalance on wheel.	(OK) ▶	ROAD TEST to verify correction.
	(OK) ▶	GO to **5**.

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IN EQUIPMENT FAILURE AND POSSIBLE INJURY. ONLY WHEEL ASSEMBLIES APPROVED FOR VEHICLE APPLICATION SHOULD BE USED.

Tire Maintenance

Refer to Fig. 5.

To maximize tire performance, inspect them for signs of improper inflation and uneven wear, which may indicate a need for balancing, rotation, or front suspension alignment. Tires should also be checked frequently for cuts, stone bruises, abrasions, blisters, and for objects that may have become imbedded in the tread. More frequent inspections are recommended when rapid or extreme temperature changes occur, or where road surfaces are rough or occasionally littered with debris.

As a further visible check of tire condition, tread wear indicators are molded into the bottom of the tread grooves. The tire should be replaced when these indicator bends become visible.

To clean tires, use a mild soap and water solution only, and rinse thoroughly with clear water. Do not use any caustic solutions or abrasive materials. Do not use steel wool, wire brushes or gasoline, paint thinner and similar materials having a mineral oil base. These materials are harmful to the tires and will eventually discolor the whitewalls and raised letters.

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TIRE/WHEEL CONDITIONS (Continued)

TEST STEP	RESULT ▶	ACTION TO TAKE
5 TIRE RUNOUT		
• Check tire runout.	(OK) ▶	GO to **6**.
	(OK) ▶	GO to **7**.
6 WHEEL STUD RUNOUT		
• Check wheel stud runout.	(OK) ▶	CHECK vehicle alignment, suspension and driveline. REPAIR, REPLACE or ADJUST as required. ROAD TEST to verify correction.
	(OK) ▶	REPLACE hub or axle shaft. ROAD TEST to verify correction.
7 WHEEL RUNOUT		
• Check wheel runout.	(OK) ▶	REPLACE tire. ROAD TEST to verify correction.
	(OK) ▶	REPLACE wheel and rebalance. ROAD TEST to verify correction.

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Tire Inflation

The tire inflation pressure is carefully calculated to give the vehicle satisfactory ride and steering characteristics while not compromising long tire tread life.

There is a tire chart (refer to Owner's Guide for location or refer to the chart in the Specifications position of this section) that gives the recommended cold tire inflation pressure. Tire inflation pressures are also listed at the end of this Section under Specifications. The cold tire inflation pressure can be measured after the vehicle has been parked for three hours or has been driven less than 5 km (3 miles).

A higher tire inflation pressure than the recommended pressure can cause a hard ride, tire bruising, carcass damage, and rapid wear at the center of the tire. Low tire pressure can produce tire squeal, hard steering, rim dents, high temperatures, and rapid wear on the outer edges of the tires. Unequal inflation pressures in tires using the same axle can affect uneven braking and reduced handling.

CAUTION: Over- or under-inflated tires can reduce tire life, adversely affect vehicle handling, and possibly lead to a sudden failure that could result in the loss of vehicle control without warning.

Tire Rotation

To equalize tire wear, tires may be rotated, but not until the cause of unusual or uneven tire wear is determined and corrected (Fig. 6). Rotation is recommended at 8000-16000 km (5,000-10,000 miles) intervals.

Tread Wear Indicators

The original equipment tires have built-in tread wear indicators to show when tires need replacement. These indicators will appear as 1/2 inch wide bands when the tire tread depth becomes 1/16 of an inch (Fig. 7). When the indicators appear in two or more adjacent grooves, at three locations around the tire, or when cord or fabric is exposed, tire replacement due to tread wear is required.

Front Wheel Bearings

Wheel bearings are adjustable. Satisfactory operation and long life of bearings depend on proper adjustment and correct lubrication. **If bearings are adjusted too tightly, they will overheat and wear rapidly. An adjustment that is excessively loose can cause pounding and contribute to uneven tire wear, steering difficulties and inefficient brakes. The bearing adjustment should be checked at regular inspection intervals.**

Front hub assemblies and bearings should be cleaned, inspected and lubricated whenever the hub assemblies are removed or at the mileage/time periods indicated in the maintenance schedule.

New hub assembly grease seals should be installed when the hub is removed. A damaged or worn seal may

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TIRE/WHEEL CONDITIONS — NOISE OR VIBRATION — 4x4 VEHICLES ONLY

TEST STEP		RESULT	ACTION TO TAKE
1	VERIFY CONDITION		
	Verify the condition by road-testing the vehicle. **NOTE: Verify the condition by driving the vehicle with known quality conventional tires.**	Condition disappears (OK) ▶	SERVICE or REPLACE tires as described in the appropriate portion of Section 11-01, General Wheel and Tire Service
		Condition still exists (OK) ▶	GO to **2**
2	REMOVE FRONT DRIVESHAFT		
	Unlock the front hubs and remove the front driveshaft. Place the transfer case in the two-wheel drive position (2H) and road test the vehicle.	Condition disappears (OK) ▶	SERVICE the front driveshaft or front drive axle as described in the appropriate section of this manual.
		Condition still exists (OK) ▶	GO to **3**
3	REMOVE REAR DRIVESHAFT		
	Reinstall the front driveshaft. Lock the front hubs and remove the rear driveshaft. Place the transfer case in 4-high (4H), the four-wheel drive position. Road test the vehicle.	Condition disappears (OK) ▶	SERVICE the rear driveshaft or rear axle as described in the appropriate section of this manual.
		Condition still exists (OK) ▶	REFER to driveline diagnosis in Section 15-01, General Driving Axle and Driveshaft Service.

NOTE: Tire and wheel conditions, refer to the procedures found in Section 11-01, General Wheel and Tire Service.

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permit bearing lubricant to reach the brake linings, resulting in ineffective brake operation and necessitating premature replacement of linings.

Bearing adjustment is described in Section 11-10 Wheel Hubs and Bearings—Front (except Front Drive) for front wheels. Section 11-12 Wheel Hubs and Bearings—Front Wheel Drive covers front drive bearing adjustment. Section 11-14 Wheel Hubs and Bearings—Rear (Full Floating Axle) cover rear wheel bearing adjustments.

Aluminum Wheels and Rims

Cleaning

Whenever a tire is removed, thoroughly examine the complete wheel. Remove all grease and road dirt and use a wire brush or steel wool to remove the rubber from the bead seat.

Straightening Wheels

Do not heat wheels in an attempt to soften them for straightening to repair damage from striking curbs, etc. The special alloy used in these wheels is heat-treated, and uncontrolled heating from welding affects the properties of the material. Do not weld the wheels for any reason.

Valves

Wheels for tubeless tires come from the factory with air valve installed. If it becomes necessary to replace an air valve it should be installed using 19 N·m (14 ft-lbs) of torque on the hex nut.

Maintenance and Protection in Corrosive Environments

Due to aluminum's natural resistance to corrosion, aluminum forged or cast wheels do not need to be repainted for most operating conditions. Washing them (do not use highly alkaline cleaning agents) when washing the rest of the vehicle will be enough to keep wheels looking good for many years. Certain environments, as created by some operations, can lead to corrosion. Some of these are: livestock hauling, salt, chloride compounds used for snow removal and highly alkaline materials. When these conditions are encountered, the following practice is recommended:

1. Clean frequently with steam or high-pressure water from a hose. Use of a mild detergent will speed up the cleaning process.
2. When tires are removed, the entire wheel should be cleaned and inspected. For maximum protection, there are various types of coatings

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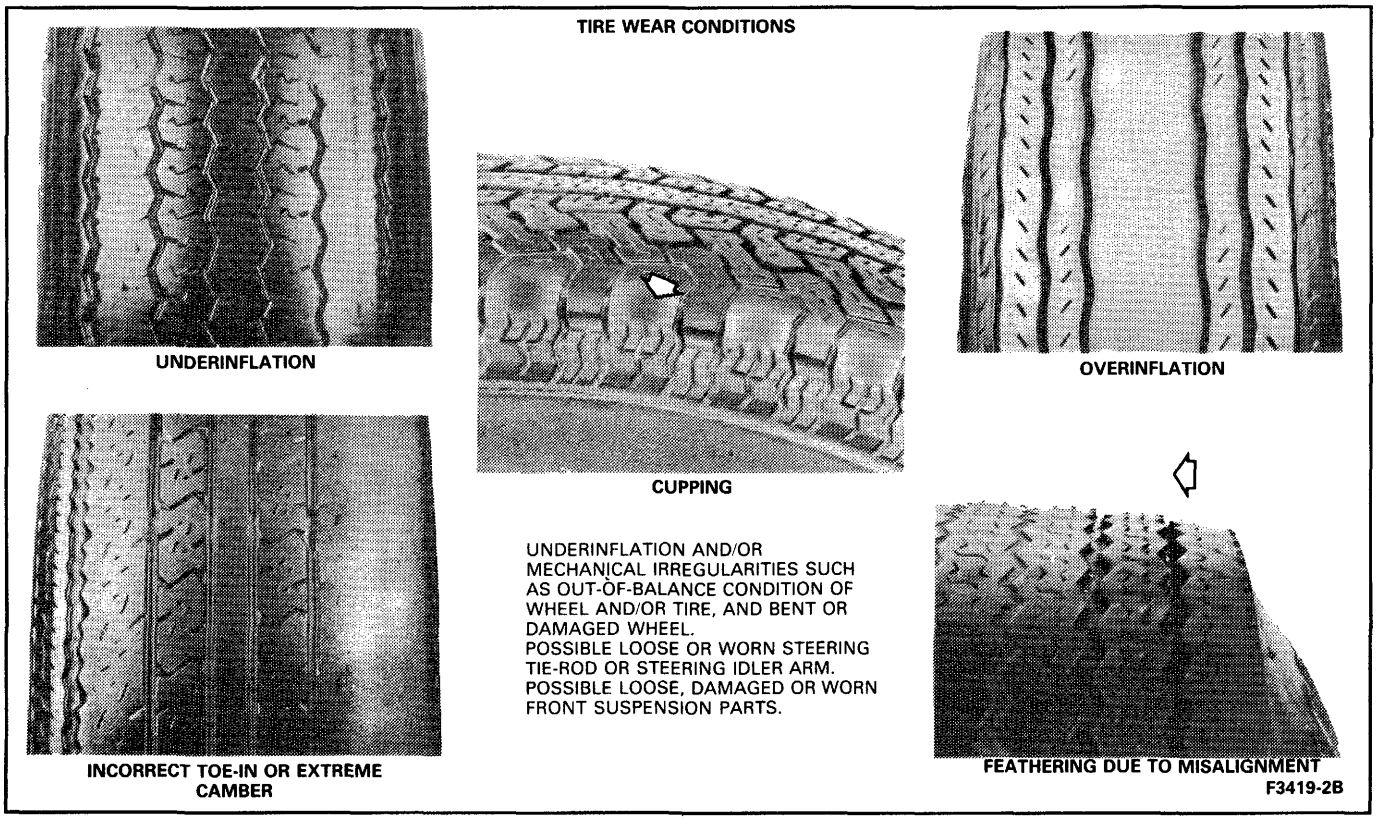


FIG. 5 Tire Wear Conditions

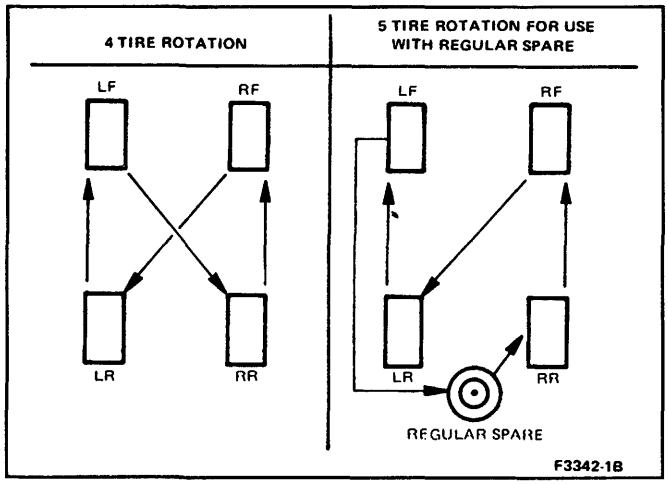


FIG. 6 Tire Rotation Patterns

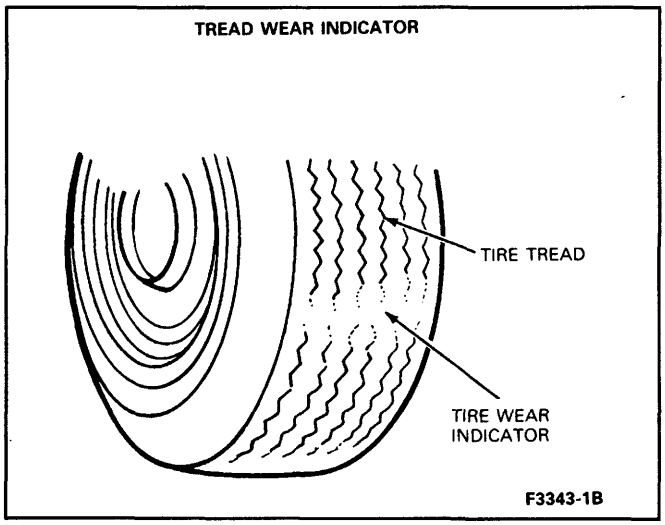


FIG. 7 Tread Wear Indicator

which give good results. The following procedures are suggested:

Surface Preparation

1. Remove all the soil and oil from the wheel surface with either high-pressure steam or solvent. Suitable solvents would be mineral spirits and regular paint thinner, obtained in paint stores.
2. Remove any adherent soil or oxidation products by using a wire brush.
3. Clean the surface again with solvent, using mineral spirits to remove loose products.
4. Apply a clear protective or pigmented product as follows:

Clear Protective Coating

Spray apply about 1 1/2 to 2 mils wet film thickness, air curing clear epoxy polyamide meeting Military Specification MIL-C-22750 (WEP) or equivalent. To properly spray this particular coating, mix components A and B of the two-part organic coating and thin where necessary with 10 percent toluol. Spray apply with a spray gun at a pressure of 207-276 kPa (30-40 psi) (suction feed).

Pigmented Protective Coating

Primer-Spray apply the inhibited primer, meeting Military Specification MIL-C-23377 (SEP) or equivalent.

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Spray this primer at a 1 to 2 mil wet film thickness. Allow to air dry from 2 to 4 hours before top-coating.

Top Coat-Spray a 1 1/2 to 2 mils wet film of a leafing aluminum pigmented epoxy. Allow enough time to air dry before handling; overnight will usually be sufficient.

Rim and Wheel Maintenance

During Tire Inspections

1. Check all metal surfaces thoroughly while making tire inspections, including areas between duals and on inboard side of wheel. Watch for:
   - excessive rust or corrosion build-up
   - cracks in metal
   - bent flanges, resulting from road obstructions
   - loose, missing or damaged nuts
   - bent or stripped studs
2. Remove damaged rims or wheels.

   CAUTION: Excessively corroded or cracked rims can be dangerous. Deflate tires prior to the removal from the wheels.
3. Mark damaged or hazardous areas with chalk so that part will be removed from service.
4. Replace parts as required.
5. Inflate tires only to recommended air pressures.
6. Check the wheel lug nut torque and retighten the lug nuts as specified at the end of this Section.

During Tire Changes

1. Check all metal surfaces. Watch particularly for the following items:
   - Cracks in the rim bead seat or drop well radii areas. These are caused by deep rim tool marks, overloading and overinflating tires or using larger than recommended tire sizes.
   - Cracks in the wheel disc, between the stud holes or hand holes. These are caused by loose wheel nuts, improper installation procedures or the use of incorrect sizes or types of attaching parts.
2. Replace the parts as necessary.

   CAUTION: Insure that replacements are made with the proper sizes and types of wheels.
3. Thoroughly remove rust, dirt and other foreign materials from all surfaces. Hand or electric wire brushes, sand blasting or chemical baths may be used. Bead seat areas of rim should be free of rust and rubber deposits. This is especially important for drop-center tubeless rims, because the bead seat is the air-sealing element.
4. Paint rim by brush or spray with a fast-drying metal primer. Surfaces should be clean and dry prior to painting. Insure that bare metal areas on the outside or tire side of rim are covered. This is especially important on drop-center tubeless rims, because warm and sometimes moist air is in constant contact with the metal surface on the tire side of the rim.
5. Lubricate the tire side of the rim base just prior to mounting tire. Avoid the use of any lubricant which contains water or solvent that is injurious to rubber. A combination lubricant and rust-preventive compound is preferable. This protective measure is of particular importance with drop-center tubeless rims as the air in the tire is contained by the tire-side rim surface.
6. Inflate tire to recommended air pressure.

Safety Precautions

Air tank should incorporate moisture trap when used with drop-center tubeless rims in order to reduce the moisture in contact with the metal rim surfaces.

SERVICE

Tire Replacement

NOTE: When a tire is replaced, use only a tire and wheel combination as recommended on the Safety Compliance Certification Label decal attached to the vehicle. Be sure that all tires and wheels are approved by Ford Motor Company and are of the same size and load carrying capacity. Never mix radial, bias or bias belted type tires.

Use the Rotunda Tire Changer 084-00001 or equivalent to mount or demount tires. Follow the equipment manufacturer's instructions. Do not use hand tools or tire irons alone to change tire because they may damage the tire beads or wheel rim.

Rim bead seats (steel wheels only) should be cleaned with a wire brush or coarse steel wool to remove lubricants, old rubber, and light rust. Aluminum wheel rim bead seats should be cleaned with a non-abrasive cleaner to remove tire mounting lubricants and old rubber. Before mounting or demounting a tire, the bead area should be well lubricated with Rubber Lubricant, D9AZ-19583-A (ESA-M1B6-A) or equivalent tire lubricant.

After initial mounting, inflate the tire, so its beads are completely seated. **CAUTION: Do not inflate to more than 276 kPa (40 psi), then, deflate tire.** Install the valve core, and inflate the tire to the proper pressure shown on the Safety Certification Label. Balance each wheel and tire assembly.

Tire Service

NOTE: If the tire is to be reinstalled on the same wheel, mark the tire and wheel so they can be reassembled in the same position.

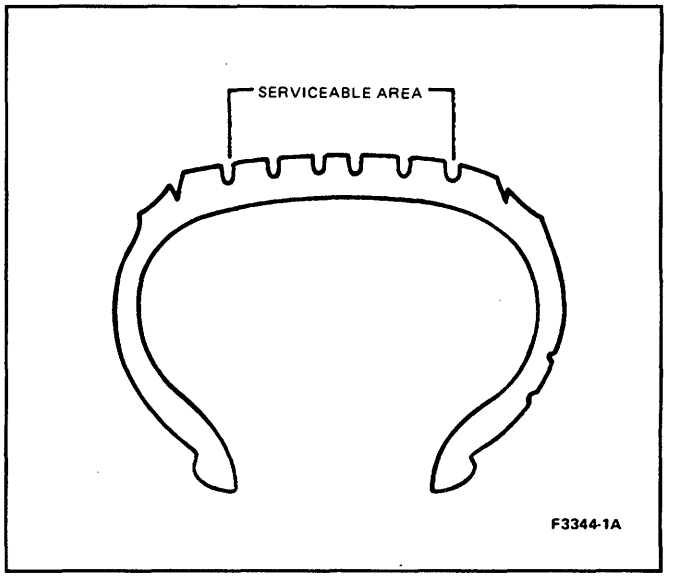


FIG. 8 Tire Service Area

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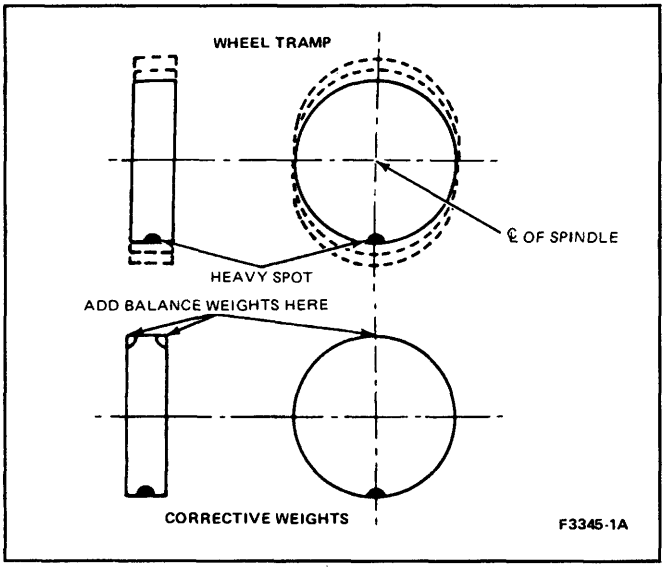


FIG. 9 Static Unbalance

Punctured tires should be removed from the wheel and permanently serviced from the inside using a combination repair plug and vulcanized patch. When servicing a puncture, always follow the manufacturer's instructions for using the service kit.

Punctures in the tread area only are serviceable (Fig. 8). Never attempt to service punctures in the tire shoulders or sidewalls. In addition, do not service any tire that has sustained the following damage:

- Bulges or blisters.
- Ply separation.
- Broken or cracked beads.
- Fabric cracks or cuts.
- Tires worn to the fabric, or if wear indicators are visible.
- Punctures larger than 1/4 inch diameter.

WARNING: TIRE SEALANTS THAT ARE INJECTED THROUGH THE VALVE STEM ARE NOT TO BE USED TO SERVICE PUNCTURED TIRES BECAUSE THEY CAN PRODUCE WHEEL RUST AND TIRE IMBALANCE.

Tire and Wheel Balance

There are two types of wheel and tire balance: static and dynamic.

A static balance is the equal distribution of weight around the wheel. Wheels that are statically unbalanced cause a bouncing action called wheel tramp. This condition will eventually cause uneven tire wear (Fig. 9).

A dynamic balance is the equal distribution of weight on each side of the centerline, so that when the tire spins there is no tendency for the assembly to move from side to side. Wheels that are dynamically unbalanced may cause wheel shimmy (Fig. 10).

Deposits of mud, etc. must be cleaned from the inside of the rim. Stones should be removed from the tread. The tire should be inspected for any damage, then balanced according to the equipment manufacturer's explicit instructions.

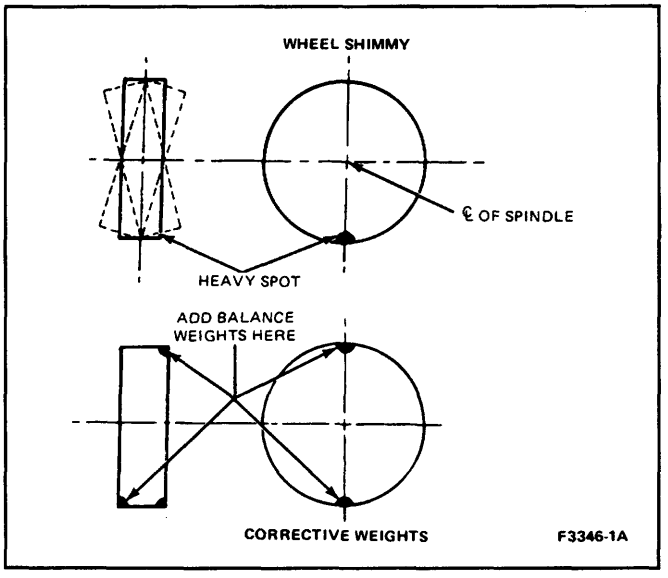


FIG. 10 Dynamic Unbalance

Off-Vehicle Balancing

When balancing wheels off the vehicle, use a balancer which pilots the wheels by the center hole or mounting bolt holes. If the wheel tramp and vehicle vibration is not corrected by the off-vehicle balance, refer to Section 18-01, Noise, Vibration and Harshness.

Vibration

If vehicle vibration persists after the wheels have been balanced, it may be caused by either tire, wheel or wheel bolt runout.

Tire and Wheel Runout

Excessive radial and lateral runout of a wheel and tire assembly can cause roughness, vibration, wheel tramp, tire wear, and steering wheel tremor.

Before checking runout and to avoid false readings caused by temporary flat spots in the tires, check runout only after the vehicle has been driven.

The extent of the runout should be measured with a dial indicator. All measurements should be made on the vehicle with the tires inflated to recommended reduced load inflation pressures and with the front wheel bearings adjusted to specifications.

Tire Runout

Measure radial runout, using Rotunda Radial Runout Gauge 007-00014 or equivalent, of the tire at the center and outside ribs of the tread face (Fig. 11). Measure lateral runout of the tire just above the buffing rib on the tire sidewall (Fig. 11). Mark the high points of lateral and radial runout for future reference. On tires, radial runout should not exceed 0.040 inch, and lateral runout should not be more than 0.045 inch.

Wheel Runout

Measure radial and lateral wheel runout at the positions shown in Figure 11. Runout should not exceed .045 inches in either position.

Wheel Bolt Runout

Wheel bolt runout can affect wheel runout. When measuring the runout on the wheel bolts, it should be noted that the feeler will not be in contact with the bolts

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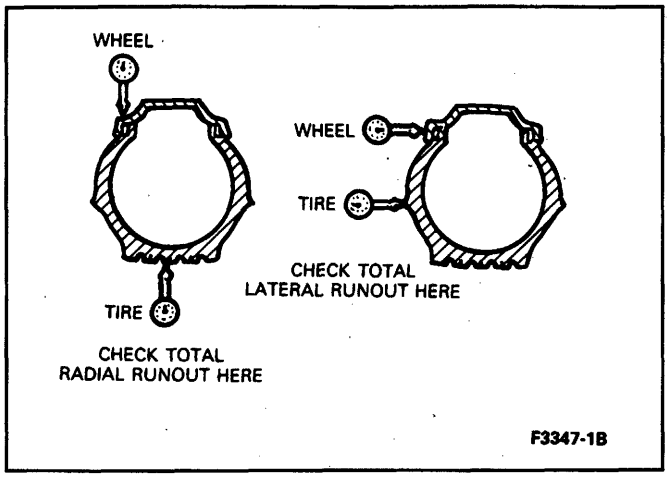


FIG. 11 Radial and Lateral Runout Checks

at all times. Only the measurements taken at the high point of contact of each bolt should be considered.

1. Using a broad point indicator, locate the feeler perpendicular to the bolt (Fig. 12), as close to the flange face as possible. Be careful to zero the indicator so that the pointer can deflect either way, thereby insuring an accurate reading at the lowest as well as the highest contact point.

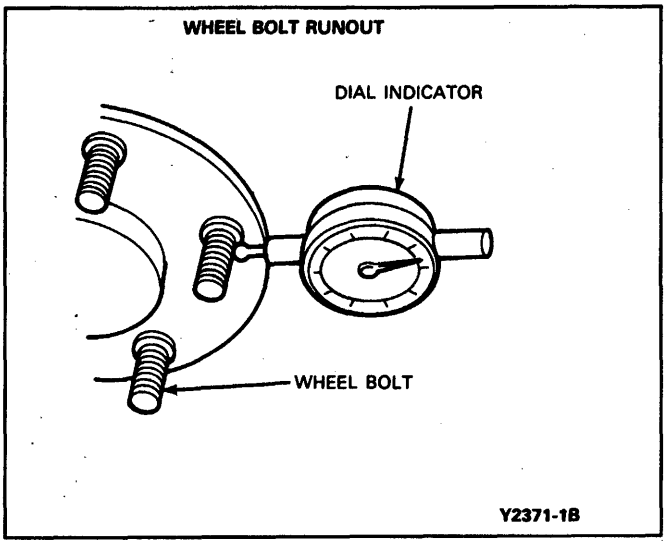


FIG. 12 Measuring Wheel Bolt Runout

2. Rotate the shaft until the next bolt is contacted. Again, record and continue until you have one reading for each point of contact (each bolt). The absolute difference between the maximum and minimum contact reading will be the total indicator reading (or total runout). Wheel bolt circle runout should not exceed .41mm (0.016 inch) TIR (Total Indicated Runout).

SPECIFICATIONS

ROTUNDA EQUIPMENT

Number	Description
084-00001	Truck Tire Changer
084-00002	Tire Spreader
007-00014	Radial Runout Gauge

CF3506-1D

WHEEL TORQUE SPECIFICATIONS

Vehicle	Wheel	Bolt Size	Torque①	
			N-m	Ft-Lbs
E-150, F-150, Bronco	5-Lug Wheel	1/2-20	135	100
E-250, E-350, F-250, F-350	8-Lug Wheel	9/16-18	190	140
F-Super Duty	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. CF3943-2D

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Vehicle	Wheelbase	Gross Vehicle Weight (GVW)	Wheel	Tire	Recommended Cold Inflation Pressure			
					PSI		Kilopascal (kPa)	
					Front	Rear	Front	Rear
F-150 (4x2) RC, SWB	117 inch (2967 mm)	4800	15 x 6.0JK*	P195/75R 15SL	35	35	241	241
			15 x 6.0JK	P215/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	35	41	241	283
		5250	15 x 6.0JK*	P215/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	35	41	241	283
F-150 (4x2) RC, LWB	133 inch (3378 mm)	4900	15 x 6.0JK*	P195/75R 15SL	35	35	241	241
			15 x 6.0JK*	P215/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	35	41	241	283
		5450	15 x 6.0JK*	P215/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	35	41	241	283
		6100	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
F-150 (4x2) SC, SWB	139 inch (3526 mm)	6050	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
F-150 (4x2) SC, LWB	155 inch (3937 mm)	6250	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
F-150 (4x4) RC, SWB	117 inch (2967 mm)	6100	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
F-150 (4x4) RC, LWB	133 inch (3376 mm)	6250	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
			15 x 6.0JK①	P235/75R 15XL	38	41	262	283
F-150 (4x4) SC, SWB	139 inch (3526 mm)	6250	15 x 6.0JK	P235/75R 15XL	35	41	241	283
F-150 (4x4) SC, LWB	155 inch (3937 mm)	6250	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
Bronco	105 inch (2660 mm)	6000	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
			15 x 8.0JJ	31-10.5RX 15C	40	40	276	276
			15 x 6.0JK*①②	P235/75R 15XL	38	41	262	283
			15 x 8.0JJ①②	31-10.5RX 15C	40	40	276	276
		6300	15 x 6.0JK*	P235/75R 15XL	35	41	241	283
			15 x 8.0JJ	31-10.5RX 15C	40	40	276	276
			15 x 6.0JK*①②	P235/75R 15XL	38	41	262	283
			15 x 8.0JJ①②	31-10.5RX 15C	40	40	276	276
F-250 (4x2) RC	133 inch (3378 mm)	6300	16 x 6K*	LT215/85R 16C	51	51	352	352
			16 x 6K	LT215/85R 16D	51	51	352	352
			16 x 6K	LT235/85R 16D	44	44	303	303
			16 x 6K	LT235/85R 16E	44	44	303	303
			16 x 6K	7.50R-16D	40	50	276	345
		7700	16 x 6K*	LT235/85R 16D	44	65	303	448
			16 x 6K	LT235/85R 16E	44	65	303	448
		8600	16 x 6K*	LT235/85R 16E	51	80	352	552
F-250 (4x2) SC	155 inch (3937 mm)	8800	16 x 6K*	LT235/85R 16E	51	80	352	552

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Vehicle	Wheelbase	Gross Vehicle Weight (GVW)	Wheel	Tire	Recommended Cold Inflation Pressure			
					PSI		Kilopascal (kPa)	
					Front	Rear	Front	Rear
F-250 (4x4) RC	133 inch (3378 mm)	6600	16 x 6K*	LT 215/85R 16C	51	51	352	352
			16 x 6K	LT 215/85R 16D	51	51	352	352
			16 x 6K	LT 235/85R 16D	44	44	303	303
			16 x 6K	LT 235/85R 16E	44	44	303	303
			16 x 6K	7.50R 16D	45	50	310	345
		6600	16 x 6K*①	LT 215/85R 16D	65	65	448	448
			16 x 6K①	LT 235/85R 16D	58	58	400	400
			16 x 6K①	LT 235/85R 16E	58	58	400	400
			16 x 6K①	7.50R 16D	60	60	414	414
		8600	16 x 6K*	LT 235/85R 16E	44	80	303	552
			16 x 6K①	LT 235/85R 16E	58	80	400	552
F-250 (4x4) SC	155 inch (3937 mm)	8800	16 x 6K*	LT 235/85R 16E	51	80	352	552
			16 x 6K①	LT 235/85R 16E	58	80	400	552
F-350 (4x2) S/R, CHC	133 inch (3378 mm)	8800	16 x 6K*	LT 235/85R 16E	51	80	352	552
F-350 (4x2) Crew Cab	168 inch (4278 mm)	9200	16 x 6K*	LT 235/85R 16E	51	80	352	552
F-350 (4x4) RC	133 inch (3378 mm)	9000	16 x 6K*	LT 235/85R 16E	51	80	352	552
			16 x 6K①	LT 235/85R 16E	65	80	448	552
F-350 (4x4) CHC	133 inch (3378 mm)	8800	16 x 6K*	LT 235/85R 16E	51	80	352	552
			16 x 6K①	LT 235/85R 16E	65	80	448	552
F-350 (4x4) Crew Cab	168 inch (4278 mm)	9200	16 x 6K*	LT 235/85R 16E	58	80	352	552
			16 x 6K①	LT 235/85R 16E	58	80	400	552
F-350 D/R, RC	133 inch (3378 mm)	10000	16 x 6K*	LT 215/85R 16D	58	65	400	448
			16 x 6K	7.50 16D	45	60	345	414
F-350 D/R, SWB, CHC	137 inch (3475 mm)	10000	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	7.50 16D	45	50	310	345
		11000	16 x 6K*	LT 215/85R 16D	58	65	400	448
			16 x 6K	7.50 16D	50	60	345	414
F-350 D/R, LWB, CHC	161 inch (4085 mm)	10000	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	7.50 16D	45	50	310	345
		11000	16 x 6K*	LT 215/85R 16D	58	65	400	448
			16 x 6K	7.50 16D	50	60	345	414
F-350 D/R Crew Cab	168 inch (4278 mm)	10000	16 x 6K*	LT 215/85R 16D	58	65	400	448
			16 x 6K	7.50 16D	50	60	345	414
F-350 D/R (4x4) CHC	137 inch (3475 mm)	11000	16 x 6K*⑤	LT 235/85R 16E	65	65	448	448
			16 x 6K⑤	7.50 16D	55	60	380	414
			16 x 16K①⑤	LT 235/85R 16E	65	65	448	448
F-Super Duty D/R, SWB, CHC	137 inch (3480 mm)	14500	16 x 6K⑥	LT 235/85R 16E	65	73	448	504
F-Super Duty D/R, LWB, CHC	161 inch (4085 mm)	14500	16 x 6K⑥	LT 235/85R 16E	65	73	448	504

Notes

* Minimum wheel/tire sizes recommended for gross vehicle weight rating (front and rear). All other combinations are optional.

①Vehicles for Heavy Duty Front End option.

②Vehicles with Snow Plow Prep option.

⑤Requires 2500 lb. Wheel

⑥Requires 2750 lb. Wheel

For all tire installations on any vehicle:

- Do not mix tire brands.
- Do not mix radials, bias or bias-belted tires.

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Vehicle	Wheelbase	Gross Vehicle Weight (GVW)	Wheel	Tire	Recommended Cold Inflation Pressure			
					PSI		Kilopascal (kPa)	
					Front	Rear	Front	Rear
E-150 Cargo Van	124 inch	5500	15 x 6.0JK*	P205/75R 15SL	35	35	241	241
			15 x 6.0JK	P225/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	41	41	283	283
		6100	15 x 6.0JK	P225/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	41	41	283	283
	138 inch	5400	15 x 6.0JK*	P205/75R 15SL	35	35	241	241
			15 x 6.0JK⑦	P225/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	41	41	283	283
		6100	15 x 6.0JK*	P225/75R 15SL	35	35	241	241
			15 x 6.0JK	P235/75R 15XL	41	41	283	283
		6500	15 x 6.0JK	P235/75R 15XL	41	41	283	283
E-150 Super Van	138 inch	6200	15 x 6.0JK*	P235/75R 15XL	41	41	283	283
E-150 Club Wagon 4/5 Passenger	138 inch	6500	15 x 6.0JK*	P235/75R 15XL	41	41	283	283
E-150 Club Wagon 8 Passenger	138 inch	6500	15 x 6.0JK*	P235/75R 15XL	41	41	283	283
E-250 Cargo Van	138 inch	7200	16 x 6K*	LT 215/85R 16D	51	58	352	400
			16 x 6K	LT 215/85R 16E	51	58	352	400
		7900	16 x 6K	LT 215/85R 16E	51	73	352	
E-250 Super Van	138 inch	8100	16 x 6K*	LT 215/85R 16E	51	80	352	552
E-250 Club Wagon 8/11/12 Passenger	138 inch	8550	16 x 6K*	LT 215/85R 16E	58	80	400	552
E-350 Cargo Van	138 inch	9400	16 x 6K*⑧	LT 235/85R 16E	51	80	352	552
		9500	16 x 6K	LT 235/85R 16E	51	80	352	552
E-350 Super Van	138 inch	9000	16 x 6K*③	LT 235/85R 16E	51	80	352	552
E-350 Super Wagon 11/12 Passenger	138 inch	9100	16 x 6K*	LT 235/85R 16E	58	80	400	552
E-350 Super Wagon 15 Passenger	138 inch	9100	16 x 6K*	LT 235/85R 16E	58	80	400	552
E-350 S/C, S/R	138 inch	9400	16 x 6K*	LT 235/85R 16E	44	80	303	552
	158 inch	9400	16 x 6K*	LT 235/85R 16E	44	80	303	552

⑦P225 Required with 5.8L Engine
⑧4.9L Engine Only

CF3947-2D

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Vehicle	Wheelbase	Gross Vehicle Weight (GVW)	Wheel	Tire	Recommended Cold Inflation Pressure			
					PSI		Kilopascal (kPa)	
					Front	Rear	Front	Rear
E-350 RV, C/A, D/R	138 inch	10500	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	LT 215/85R 16E	58	58	400	400
	158 inch	11000	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	LT 215/85R 16E	58	58	400	400
	176 inch	11000	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	LT 215/85R 16E	58	58	400	400
E-350 Comm C/A, D/R	138 inch	10300	16 x 6K	LT 215/85R 16D	51	58	352	400
			16 x 6K	LT 215/85R 16E	51	58	352	400
		10000	16 x 6K*④	LT 215/85R 16D	51	58	352	400
			16 x 6K④	LT 215/85R 16E	51	58	352	400
	158 inch	10700	16 x 6K*	LT 215/85R 16D	58	58	400	400
			16 x 6K	LT 215/85R 16E	58	58	400	400
E-350 S/C, D/R	158 inch	10000	16 x 6K*	LT 215/85R 16D	51	58	352	400
			16 x 6K	LT 215/85R 16E	51	58	352	400

NOTES

* Minimum wheel/tire sizes recommended for gross vehicle weight rating (front and rear). All other combinations are optional.

①50 states only. Vehicles over 6000 lb. GVW in Canada only

②For customer selected front spring option

③Available with ambulance prep package

④School bus package only.

For all tire installation on any vehicle:

- Do not mix tire brands
- Do not mix radials, bias or bias-belted tires.

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SECTION 11-02 Wheels and Tires

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Rear Wheel Assembly	11-02-1
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VEHICLE APPLICATION

Applies to F-150, F-250, F-350, E-150, E-250, E-350, F-Super Duty and Bronco.

DESCRIPTION

Front Wheel Assembly

Each front wheel and tire assembly is attached by wheel lug nuts to its respective front hub and rotor assembly. Two opposed tapered roller bearings are installed in each front hub and rotor assembly (Fig. 1). A grease retainer is installed at the inner end of the hub to prevent lubricant from leaking. The entire assembly is retained on its spindle by the adjusting nut, nut lock and cotter pin.

Front Wheel Assembly—Four-Wheel Drive

A description of the front axle used on vehicles equipped with 4-wheel drive is found in Section 15-34, Front Driving Axle—Dana. The locking hub assemblies are described in Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive.

Rear Wheel Assembly

Information on rear wheels (hubs and drums) may be found in Section 11-11, Wheel Hubs and Bearings—Rear (Semi Floating Axle) and 11-14, Wheel Hubs and Bearings—Rear (Full Floating Axle).

New Vehicle Break-In

WARNING: FOR VEHICLES EQUIPPED WITH SINGLE REAR WHEELS, RE-TIGHTEN THE WHEEL LUG NUTS AFTER 800 KM. (500 MILES) OF NEW VEHICLE OPERATION ACCORDING TO THE PROCEDURES FOUND IN THE REMOVAL AND INSTALLATION PORTION OF THIS SECTION. FOR VEHICLES EQUIPPED WITH DUAL REAR WHEELS, RE-TIGHTEN THE WHEEL LUG NUTS TO SPECIFICATIONS AFTER 160 KM. (100 MILES) AND AGAIN AFTER 800 KM. (500 MILES) OF NEW VEHICLE OPERATION, AND AT THE INTERVALS SPECIFIED IN SECTION 50-02, PRE-DELIVERY AND NON-EMISSION SCHEDULED MAINTENANCE ACCORDING TO THE PROCEDURES FOUND IN THE REMOVAL AND INSTALLATION PORTION OF THIS SECTION. THIS IS REQUIRED TO PERMIT THE WHEEL CLAMPING SYSTEM TO SEAT PROPERLY SO THAT THE WHEEL LUG NUTS WILL HOLD A UNIFORM CLAMP LOAD AND REMAIN FULLY TIGHTENED. RETIGHTENING TO SPECIFICATION IS ALSO REQUIRED AT 800 KM. (500 MILES) AFTER ANY WHEEL CHANGE OR ANY OTHER TIME THE LUG NUTS HAVE BEEN LOOSENED. IMPROPERLY TIGHTENED WHEEL LUG NUTS COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL.

DIAGNOSIS AND TESTING

For diagnostic and testing procedures, refer to Section 11-01, General Wheel and Tire Service.

REMOVAL AND INSTALLATION

Wheel Replacement—F-150—F-350, E-150—E-350, and Bronco Equipped with Single Rear Wheels

Refer to Fig. 2.

Removal

WARNING: AFTERMARKET WHEEL ASSEMBLIES MAY NOT BE COMPATIBLE WITH THE VEHICLE. USE OF INCOMPATIBLE WHEEL ASSEMBLIES MAY RESULT IN EQUIPMENT FAILURE AND POSSIBLE INJURY. USE ONLY APPROVED WHEEL ASSEMBLIES.

1. Set parking brake and block diagonally opposite wheel. On vehicles equipped with an automatic transmission, place selector lever in the "P" position. On vehicles equipped with a manual transmission place the shift lever in reverse.
2. If equipped, remove the hub cap or wheel cover.
3. Loosen but do not remove the wheel lug nuts.
4. Raise the vehicle until the wheel and tire clear the floor.
5. Remove the wheel lug nuts. Remove the wheel and tire assembly.

Installation

1. **WARNING: WHENEVER A WHEEL IS INSTALLED, ALWAYS REMOVE ANY**

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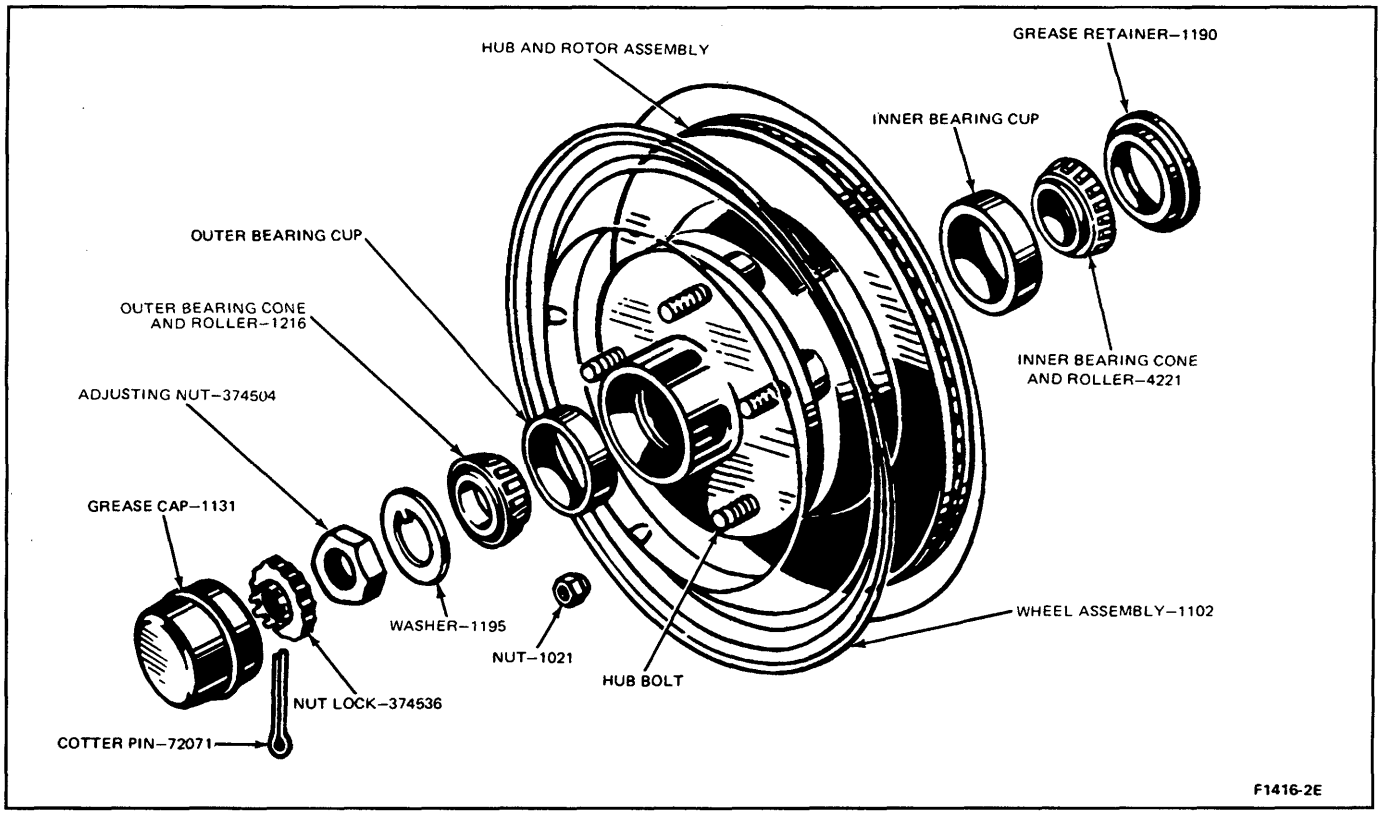


FIG. 1 Front Hub, Bearings and Grease Retainer—Disc Brakes—E-150—E-350, F-150—F-350 (4x2) (Typical)

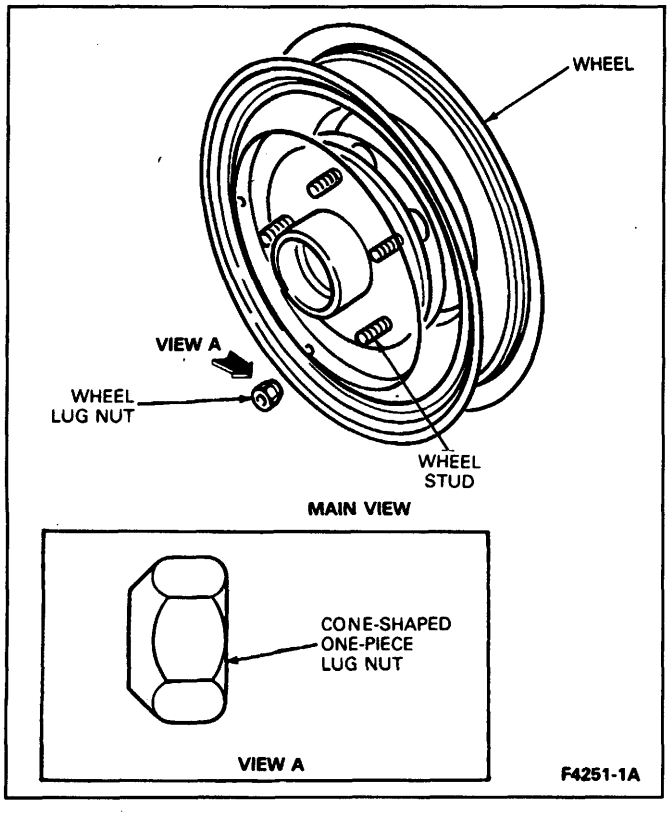


FIG. 2 Front and Rear Wheel Installation—F-150—F-350, E-150—E-350 and Bronco Equipped with Single Rear Wheels

CORROSION, DIRT OR FOREIGN MATERIAL THAT MAY BE PRESENT ON THE MOUNTING SURFACES OF THE WHEEL OR THE SURFACE OF THE HUB, DRUM OR ROTOR THAT CONTACTS THE WHEEL. INSTALLING WHEELS WITHOUT PROPER METAL-TO-METAL CONTACT AT THE WHEEL MOUNTING SURFACES CAN CAUSE THE WHEEL LUG NUTS TO LOOSEN AND COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL.

2. Position the wheel on the hub and rotor or the hub and drum assembly.
3. Install the lug nuts making sure that the cone ends of the nuts face inward.
4. With the lug nuts loosely installed, turn the wheel until one nut is at the top of the bolt circle. Tighten the nut until snug. In a criss-cross type manner, tighten the remaining nuts until snug to minimize runout. Lower the vehicle.
5. Evenly tighten the nuts in the torque sequence shown in Fig. 3 to the torque listed in the Specifications portion of this section.

Front Wheel Replacement—F-350, E-350 and F-Super Duty Equipped With Dual Rear Wheels

Refer to Fig. 4.

Removal

WARNING: AFTERMARKET WHEEL ASSEMBLIES MAY NOT BE COMPATIBLE WITH THE VEHICLE. USE OF INCOMPATIBLE WHEEL ASSEMBLIES MAY RESULT IN EQUIPMENT FAILURE AND POSSIBLE INJURY. USE ONLY APPROVED WHEEL ASSEMBLIES.

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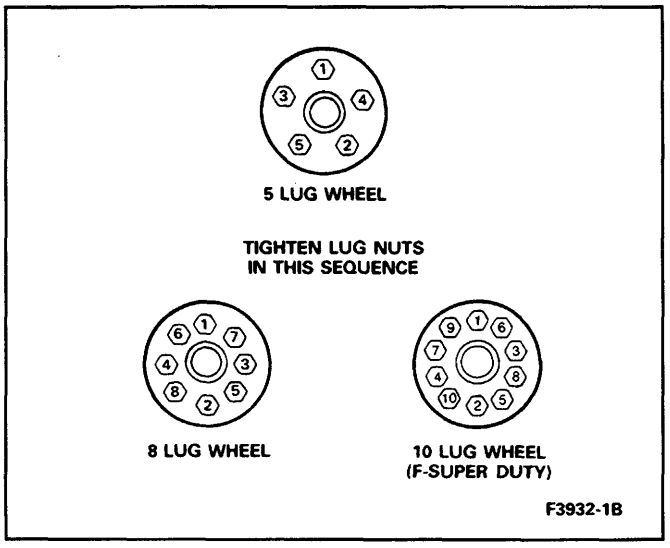


FIG. 3 Wheel Lug Nut Torque Sequence

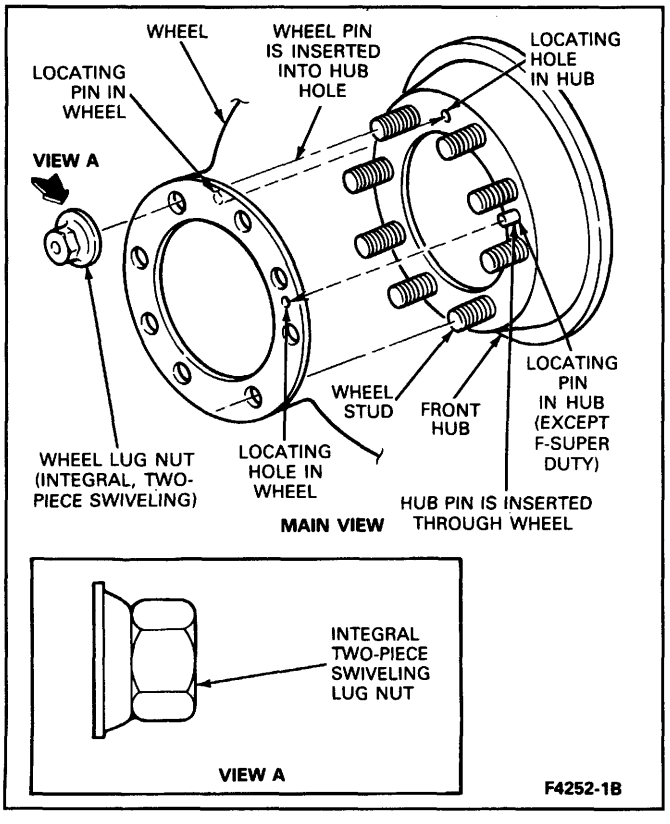


FIG. 4 Front Wheel Installation—F-350, E-350 Equipped with Dual Rear Wheels, F-Super Duty (Similar Except 10 Studs Hub)

WARNING: USE ONLY INTEGRAL TWO-PIECE SWIVELING LUG NUTS ON VEHICLES EQUIPPED WITH DUAL REAR WHEELS. DO NOT ATTEMPT TO USE CONE SHAPED ONE-PIECE LUG NUTS ON THESE VEHICLES. IF USED, CONE SHAPED ONE-PIECE LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS ON THIS VEHICLE. DO NOT ATTEMPT TO USE PRESENT DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE.

1. Set parking brake and block diagonally opposite wheel. On vehicles equipped with an automatic transmission, place selector lever in the "P" position. On vehicles equipped with a manual transmission, place the shift lever in reverse.
2. If equipped, remove the hub cap or wheel cover.
3. Loosen but do not remove the wheel lug nuts.
4. Raise the vehicle until the wheel and tire clear the floor.
5. Remove the wheel lug nuts. Remove the wheel and tire from the hub and rotor.

Installation

1. **WARNING: WHENEVER A WHEEL IS INSTALLED, ALWAYS REMOVE ANY CORROSION, DIRT OR FOREIGN MATERIAL THAT MAY BE PRESENT ON THE MOUNTING SURFACES OF THE WHEEL OR THE SURFACES OF THE HUB AND ROTOR THAT CONTACTS THE WHEEL. INSTALLING WHEELS WITHOUT PROPER METAL-TO-METAL CONTACT AT THE WHEEL MOUNTING SURFACES CAN CAUSE THE WHEEL LUG NUTS TO LOOSEN AND COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL.**
2. Mount the front wheel on the front hub and rotor with the wheel dish facing inboard. Align the wheel with the small indexing hole (located in the wheel between the stud holes) with the alignment pin in the hole in the gap. Make sure that the wheel is flush with the hub mounting surface so there is no gap between the hub and wheel.
3. Install and tighten until snug the 8 integral two-piece swiveling lug nuts (nut and washer assembly).
4. With the lug nuts loosely installed, turn the wheel until one nut is at the top of the bolt circle. Tighten the nut until snug. In a criss-cross type manner, tighten the remaining lug nuts until snug to minimize runout. Lower the vehicle to the floor.
5. Evenly tighten the nuts in the torque sequence shown in Fig. 3 to the torque listed in the Specifications portion of this section.

Rear Wheel Replacement—F-350, E-350 and F-Super Duty Equipped with Dual Rear Wheels

Refer to Fig. 5 and Fig. 6.

Removal

WARNING: AFTERMARKET WHEEL ASSEMBLIES MAY NOT BE COMPATIBLE WITH THE VEHICLE. USE OF INCOMPATIBLE WHEEL ASSEMBLIES MAY RESULT IN EQUIPMENT FAILURE AND POSSIBLE INJURY. USE ONLY APPROVED WHEEL ASSEMBLIES.

WARNING: USE ONLY INTEGRAL TWO-PIECE SWIVELING LUG NUTS ON VEHICLES EQUIPPED WITH DUAL REAR WHEELS. DO NOT ATTEMPT TO USE CONE SHAPED ONE-PIECE LUG NUTS ON THESE VEHICLES. IF USED, CONE SHAPED ONE-PIECE LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST

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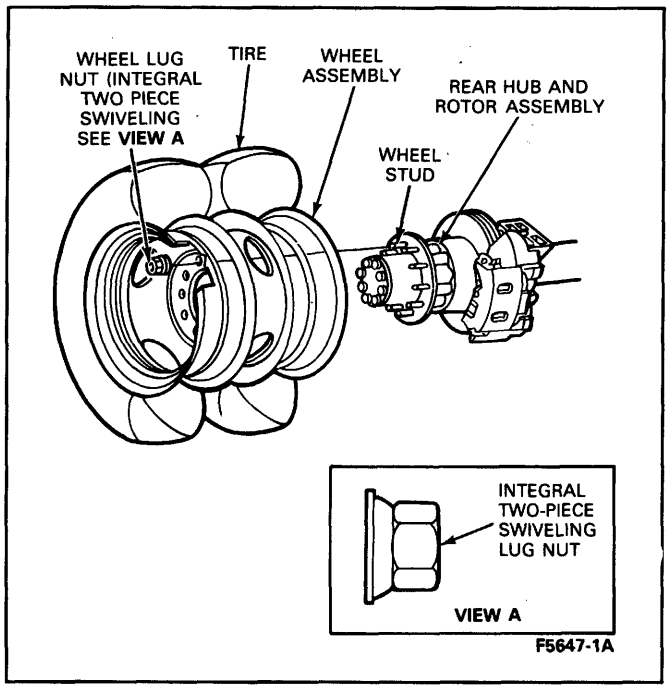


FIG. 5 Rear Wheel Installation—F-Super Duty—Dual Rear Wheels

MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS ON THIS VEHICLE. DO NOT ATTEMPT TO USE PRESENT DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE.

NOTE: F-Super Duty vehicles require usage of center-pilot design wheel

1. Set parking brake and block diagonally opposite wheel. On vehicles equipped with an automatic transmission, place selector lever in the "P" position. On vehicles equipped with a manual transmission, place the shift lever in reverse.
2. If equipped, remove the hub cap or wheel cover.
3. Loosen but do not remove the wheel lug nuts.
4. Raise the vehicle until the wheel and tire clear the floor.
5. Remove the wheel lug nuts. Remove the wheel and tire from the hub and drum.

Installation

1. **WARNING: WHENEVER A WHEEL IS INSTALLED, ALWAYS REMOVE ANY CORROSION, DIRT OR FOREIGN MATERIAL THAT MAY BE PRESENT ON THE MOUNTING SURFACES OF THE WHEELS OR THE SURFACES OF THE HUB AND DRUM THAT CONTACTS THE WHEEL. INSTALLING WHEELS WITHOUT PROPER METAL-TO-METAL CONTACT AT THE WHEEL MOUNTING SURFACES CAN CAUSE THE WHEEL LUG NUTS TO LOOSEN AND COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL.**
2. Mount the inner wheel on the rear hub with the wheel dish facing inboard. Align the wheel with the small indexing hole (located in the wheel between the stud holes) with the alignment pin in the hole in the hub. Make sure that the wheel is flush with the hub mounting surface so there is no gap between the hub and wheel.

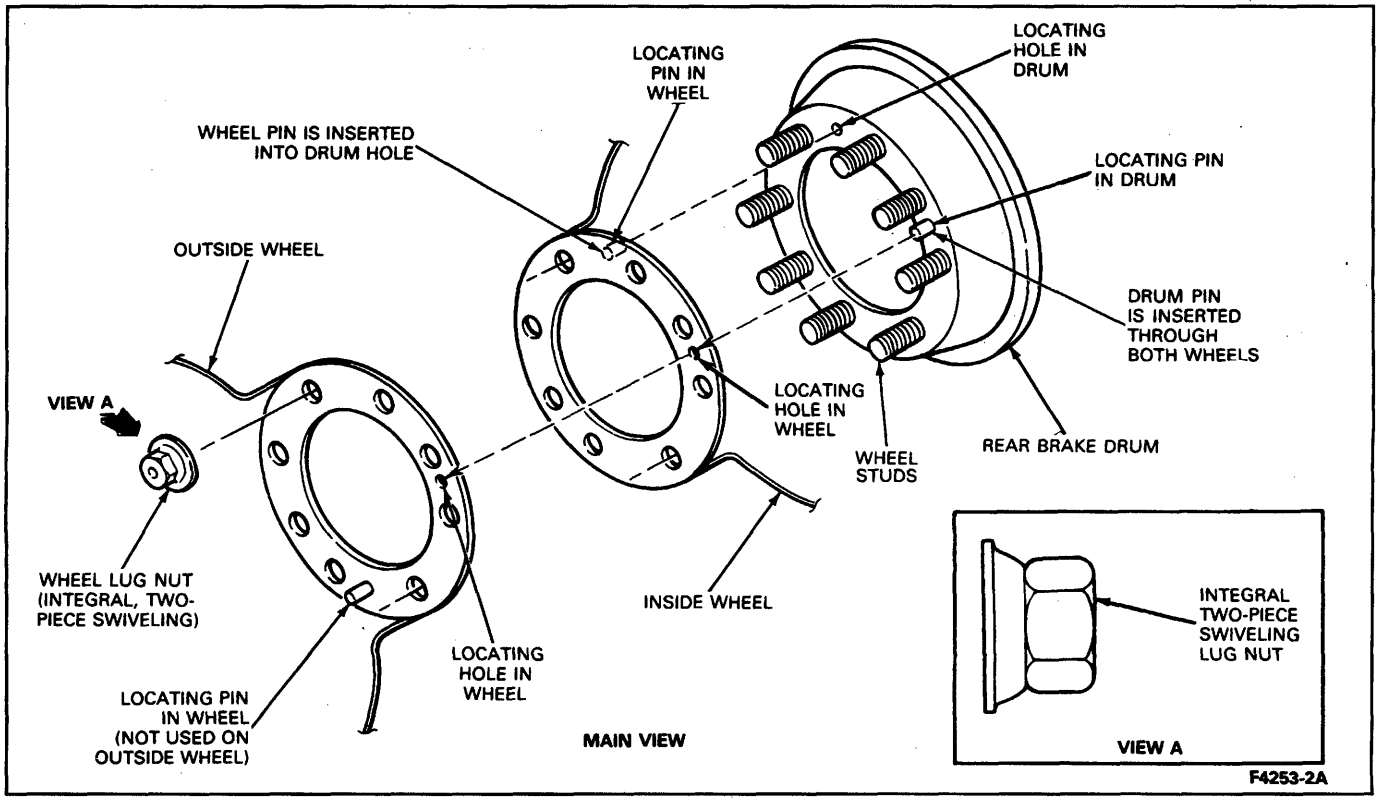


FIG. 6 Rear Wheel Installation—F-350—E-350 Equipped with Dual Rear Wheels

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3. Install the outer rear so it is flush against the inner wheel with the hub alignment pin protruding through the wheel index hole.
4. Install and tighten until snug the integral two-piece swiveling lug nuts (nut and washer assembly).
5. With the lug nuts loosely installed, turn the wheel until one nut is at the top of the bolt circle. Tighten the nut until snug. In a criss-cross type manner, tighten the remaining lug nuts until snug to minimize runout. Lower the vehicle to the floor.
6. Evenly tighten the nuts in the torque sequence shown in Fig. 3 to the torque listed in the Specifications portion of this Section.

Lug Nut Torque Requirement

WARNING: LUG NUTS MUST BE RETIGHTENED TO PROPER TORQUE SPECIFICATION AT 800 KM (500 MILES) OF NEW VEHICLE OPERATION AND VEHICLES WITH DUAL REAR WHEELS. RETIGHTEN TO PROPER TORQUE SPECIFICATION AT 160 KM (100 MILES) AND ALSO AT 800 KM (500 MILES) OF NEW OPERATION AND AT THE INTERVALS SPECIFIED IN SECTION 10-02, MAINTENANCE.

RETIGHTEN TO PROPER TORQUE SPECIFICATIONS AT 800 KM. (500 MILES) AFTER ANY WHEEL CHANGE OR ANY OTHER TIME THE LUG NUTS HAVE BEEN LOOSENED.

IMPROPERLY TIGHTENED WHEEL LUG NUTS COULD ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL.

Wheel Inspection And Maintenance

Check the wheel nut torque and retighten the lug nuts to the specified torque according to procedures listed in the Removal and Installation portion of this section. Refer to Section 10-02 Maintenance for the torque maintenance schedules.

CAUTION: Replace wheels if they are bent, cracked, leaking air or heavily rusted or if the lug nuts often become loose. Do not use bent wheels that have been straightened and do not use inner tubes in leaking wheels. Do not replace wheels with used wheels. Wheels that have been straightened or are leaking air or are used, may have structual damage and could fail without warning. Check for damage that could affect the runout of the wheels. Wobble or shimmy will eventually damage the wheel bearings.

Tire Replacement Precautions

The tire must be completely deflated before removal, and the bead must not be damaged by a tire iron. (Safety procedures for truck tire servicing is found in Section 11-01, General Wheel and Tire Service under Safety.)

After installation, a tube tire should be inflated to recommended pressure, deflated, and then inflated again to insure that the tube is not folded inside the tire. Be sure the tube flap is properly positioned before inflating the tire. **It is important that each front and rear tire and wheel be balanced.**

When installing tires thoroughly lubricate the tire beads with Rubber Lubricant, D9AZ-19583-A (ESA-M1B6A) or equivalent. Inflate the tire until both beads seat against the rim of the wheel, then deflate to the specified "Tire Inflation Pressures" shown on the safety certification label attached to the L.H. door pillar. To seat the tire beads, the initial inflation for truck-type tubeless tires, 344 kPa (50 psi) maximum; for truck-type tube tires 517 kPa (75 psi) maximum. Follow the instructions supplied with the Rotunda (model 084-00001 or an equivalent) tire changer. Refer to Section 11-01, General Wheel and Tire Service for diagnosis and testing procedures, safety procedures and illustrations.

4 Wheel Disc Brake Hub and Rotor F-Super Duty

Description

The hub and rotor assembly of the F-Super Duty vehicle is designed as a two piece assembly allowing it to be replaced as individual components, or as an assembly. The front and rear brake rotors are the same and are attached to either the front or rear hub assembly with 10 screw and washer assemblies tightened to 100-120 N·m (73-80 ft-lb).

Front or Rear Wheel Stud

Removal

Remove the front or rear hub and rotor assembly as outlined in Section 12-24, Disc Brakes Light and Heavy Duty-Sliding Caliper.

Remove and install the wheel studs as outlined in this Section under front or rear wheel lug nut stud removal and installation.

Front Wheel Lug Nut Stud

Refer to Fig. 7.

Removal

1. Raise the vehicle and install safety stands.
2. Remove the wheel and tire assembly as described in this Section.
3. Remove the rotor as described in Section 12-24, Disc Brakes—Light and Heavy Duty, Sliding Caliper.
4. Position the rotor in a press so ram pressure is not directly exerted on the rotor surface (Fig. 8). With appropriate press stock, press the lug nut stud from the rotor. Discard the stud.

Installation

1. Position a new stud in the hole. Align the serrations of the new stud with the serration marks from the old stud. With a hammer lightly tap the stud until

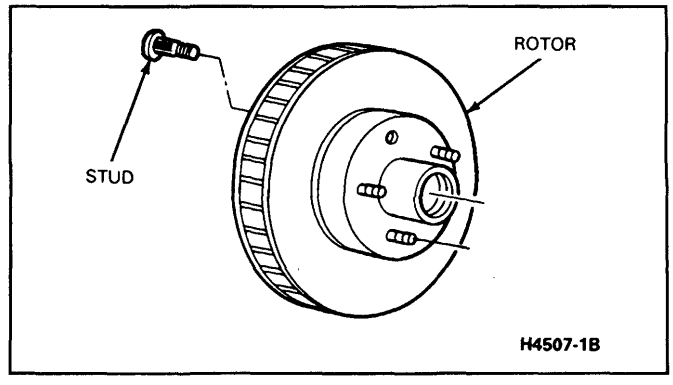


FIG. 7 Front Wheel Lug Nut Stud

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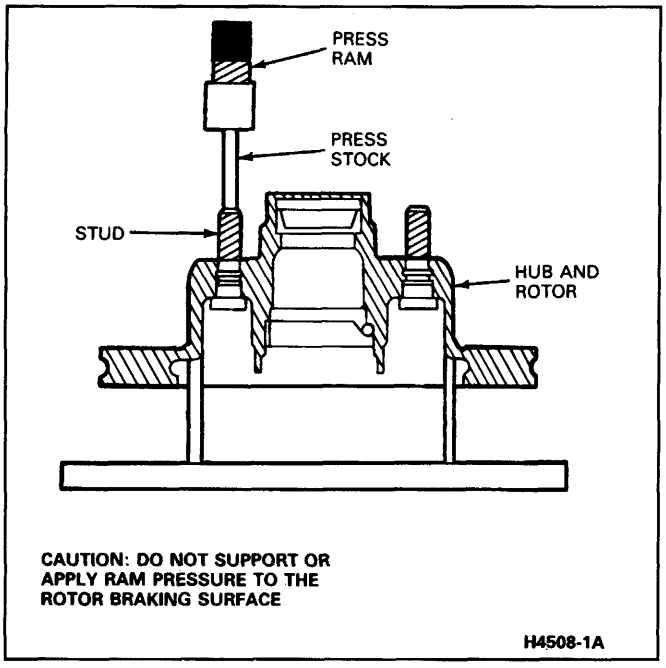


FIG. 8 Front Wheel Lug Nut Stud Removal

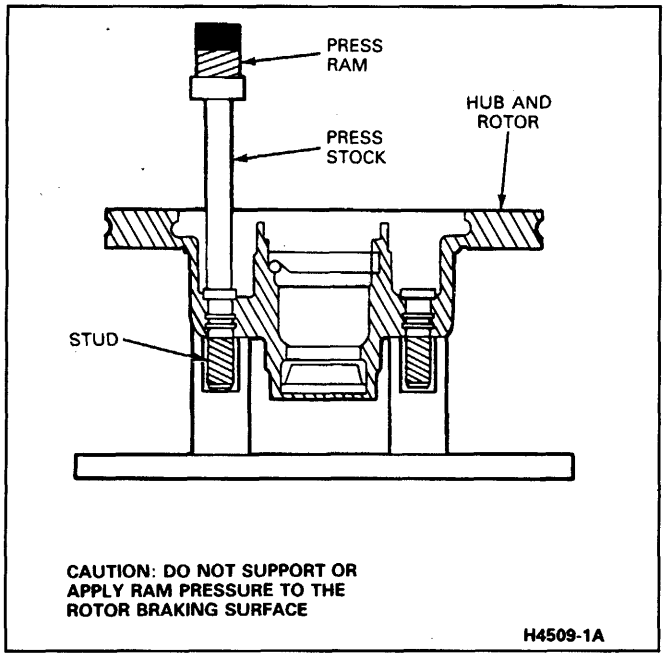


FIG. 9 Front Wheel Lug Nut Stud Installation

the serrations on the stud are started in the hole. Make sure the stud is not installed in an "off-center" position in the rotor hub.

2. Position the rotor in a press so the rotor is supported on the wheel mounting flange. Be sure to allow enough clearance for the stud to pass through the hole. Do not apply ram pressure directly on the rotor surface. With appropriate press stock, press the stud in position until the stud is flush against the inner surface of the rotor hub (Fig. 9).

3. Install the rotor as described in Section 12-24, Disc Brakes Light and Heavy Duty—Sliding Caliper.

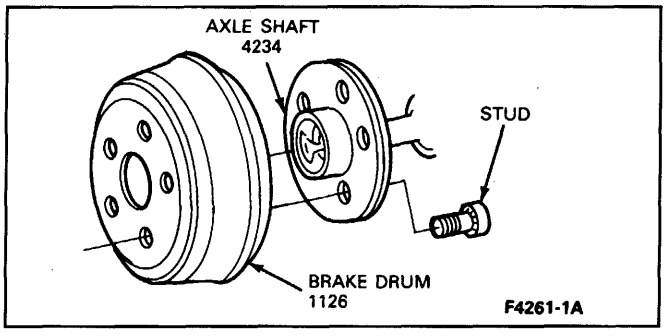


FIG. 10 Rear Wheel Lug Nut Stud

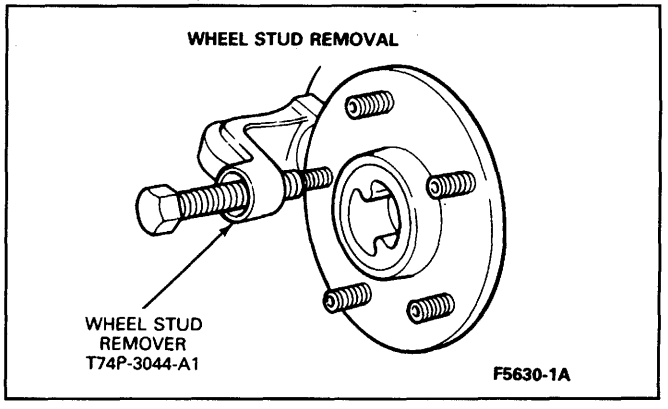


FIG. 11 Rear Wheel Lug Nut Stud Removal

4. Install the wheel and tire as described in this Section.

Rear Wheel Lug Nut Stud

Refer to Fig. 10.

Removal

CAUTION: Never use a hammer to remove the stud. Damage to the hub or bearing may result.

1. Raise the vehicle and install safety stands.
2. Remove the wheel and tire assembly as described in this Section.
3. Remove the brake drum from the axle shaft or hub studs.
4. Using Tool T74P-3044-A1, press the stud from its seat in the hub (Fig. 11). The stud may also be removed by pressing it out using an appropriate sized socket and C-clamp. Discard the stud.

Installation

1. Insert new stud in hole in the shaft or hub. Rotate stud slowly to assure the serrations are aligned with those made by the original stud.
2. Place four flat washers over the outside end of the stud and thread the wheel nut with the flat side against the washers. Tighten the wheel nut until the stud head seats against the back side of the shaft or hub.

   CAUTION: Do not use air tools as the serrations may be stripped from the stud.
3. Remove wheel nut and washers.
4. Install brake drum and wheel as described in this Section.
5. Lower the vehicle.

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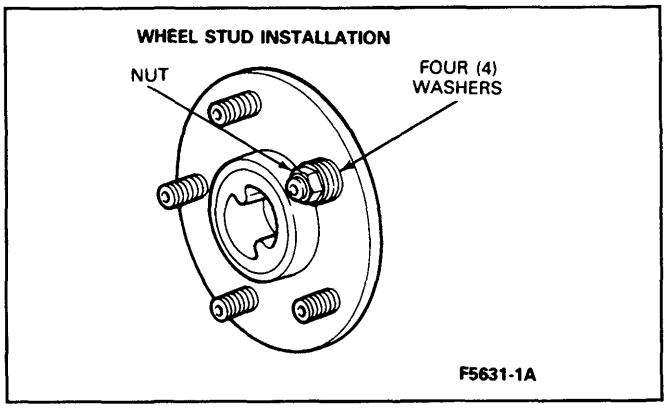


FIG. 12 Rear Wheel Lug Nut Stud Installation

SPECIFICATIONS

WHEEL TORQUE SPECIFICATIONS

Vehicle	Wheel	Bolt Size	Torque①	
			N-m	Ft-Lbs
E-150, F-150, Bronco	5-Lug Wheel	1/2-20	135	100
E-250, E-350, F-250, F-350	8-Lug Wheel	9/16-18	190	140
F-Super Duty	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. **CF3943-2D**

SPECIAL SERVICE TOOLS

Number	Description
T74P-3044-A1	Wheel Stud Remover

CF5642-1A

ROTUNDA EQUIPMENT

Number	Description
084-00001	Tire Changer

CF3416-1D

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SECTION 11-10 Wheels, Hubs and Bearings—Front (Except Front Drive)

SUBJECT	PAGE
ADJUSTMENTS	
Front Wheel Bearing Adjustment	11-10-1
F150—F-350, F-Super Duty (4x2) and E-150—E-350	11-10-1
DESCRIPTION	
Front Wheel Assembly	11-10-1
REMOVAL AND INSTALLATION	
Front Wheel Grease Seal and Bearing	11-10-2
F-150—F-350, F-Super Duty (4x2), E-150—E-350	11-10-2
SPECIFICATIONS	11-10-3
VEHICLE APPLICATION	11-10-1

VEHICLE APPLICATION

E-150—E-350, F-150—F-350 (4x2) and F-Super Duty.

DESCRIPTION

Front Wheel Assembly

Each front wheel and tire assembly is bolted to its respective front hub and rotor assembly. Two opposed tapered roller bearings are installed in each hub, (Fig. 1). A grease retainer is installed at the inner end of the hub to prevent lubricant from leaking onto the rotor. The entire assembly is retained to its spindle by the adjusting nut, washer, retainer, cotter pin and grease cap.

E-350, F-350 and F-Super Duty equipped with dual wheel rear axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lug nuts.

WARNING: DO NOT ATTEMPT TO USE PAST MODEL LUG NUTS (CONE SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUG NUTS. IF SO USED, PAST MODEL LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

ADJUSTMENTS

Front Wheel Bearing Adjustment

F150—F-350, F-Super Duty (4x2) and E-150—E-350

To check the wheel bearing adjustment, raise the front of the vehicle. Then, grasp the tire at the sides, and alternately push inward and pull outward on the tire. If any looseness is felt, adjust the front wheel bearings.

1. Raise the vehicle until the tire clears the floor and install safety stands.
2. Remove the wheel cover. Remove the grease cap from the hub.

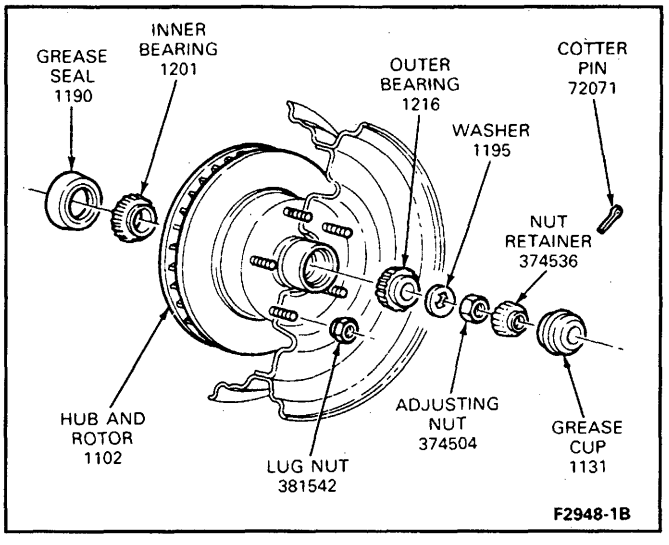


FIG. 1 Front Hub and Rotor Assembly, Bearings and Grease Seal F-150—F-350, F-Super Duty (4x2) and E-150—E-350—Typical

3. Wipe the excess grease from the end of the spindle. Remove the cotter pin and locknut.
4. Loosen the adjusting nut three turns. Attempt to obtain running clearance between the rotor brake surface and the shoe/linings by rocking the wheel, hub and rotor assembly in and out several times to push the shoe and linings away from the rotor, or by light tapping on the caliper housing or some other means that does not damage the rotor lining surfaces. DO NOT PRY ON THE CALIPER PHENOLIC PISTON. If running clearance cannot be maintained throughout bearing adjustment in Steps 5 and 6, the caliper must be removed. Refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
5. Tighten the wheel adjusting nut to 30-33 N·m (22-25 ft-lbs.) while rotating the disc brake rotor in the opposite direction.
6. Back off the adjusting nut 1/8 turn and install the retainer and new cotter pin without additional movement of the adjusting nut. Bearing end play should be 0.025-0.254mm (0.001-0.010 inch). Bend the ends of the cotter pin around the castellated flange of the locknut.

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7. Check front wheel rotation. If the wheel rotates properly, reinstall the grease cap and wheel cover. If rotation is noisy or rough, remove and inspect the bearings. Service as required.
8. Before driving the vehicle, pump the brake pedal several times to restore normal brake pedal travel.

REMOVAL AND INSTALLATION

Front Wheel Grease Seal and Bearing

Removal

F-150—F-350, F-Super Duty (4x2), E-150—E-350

Wheel bearing lubricant is a lithium-base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.

Sodium-base grease is not compatible with lithium-base grease and should not be intermixed. Therefore, do not lubricate front and/or rear wheel bearings without first identifying the type of original wheel bearing lubricant. Usage of incompatible bearing lubricants could result in premature lubricant breakdown.

If bearing adjustment will not eliminate looseness or rough and noisy operation, the hub and bearings should be cleaned, inspected, and repacked with specified wheel grease. If the bearing cups or the cone and roller assemblies are worn or damaged, they should be replaced.

1. Raise the vehicle until the tire clears the floor and remove the wheel and tire assembly from the hub and rotor as described in Section 11-02, Wheels and Tires.
2. Remove the brake caliper, (refer to Section 12-24, Disc Brakes-Light and Heavy Duty—Sliding Caliper), and wire it to the underbody to prevent damage to the brake hose. It is not necessary to disconnect the hose from the caliper. Do not let the caliper hang with its weight on the brake hose or the hose may become stretched, twisted or ruptured.
3. Remove the grease cap, cotter pin, retainer adjusting nut and washer.
4. Remove the outer bearing cone and roller.
5. Pull the hub and rotor off the spindle and remove and discard the grease seal, if necessary.
6. Remove the inner bearing cone and roller from the hub. Remove all traces of old lubricant from bearings, hub and axle spindle.
7. Inspect the cups for scratches, pits or cracks. If the cups are worn or damaged, remove them with a drift. Clean the inner and outer bearing cones and rollers with solvent and dry thoroughly. **Do not spin the bearings dry with compressed air.**
8. Inspect the cones and rollers for cracks, nicks, brinelling, or seized rollers. Inspect the grease retainer and replace it if it is cracked, nicked, dented, or worn.
9. Cover the spindle with a clean cloth and brush all loose dust and dirt from the brake assembly using Rotunda Brake and Clutch Service Vacuum 091-00001 or equivalent. **Remove the cloth from the spindle carefully to prevent dirt from falling on the spindle.**

Installation

1. If inner or outer bearing cups were removed, install replacement inner and outer bearing cups in the hub with the appropriate bearing cup replacer tool (refer to the Special Service Tool chart in the Specifications portion of this section) and Driver Handle T80T-4000-W (Fig. 2). Be sure to seat the cups properly in the hub. The cups will be properly seated when they are fully bottomed. Replace grease retainers. Polish grease retainer journal on spindle with 400 grit sandpaper. Clean with clean cloth.
2. Pack the inside of the hub with lithium-base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent. Fill the hub until the grease is flush with the inside diameters of both bearing cups. Pack the bearing cones and rollers with wheel bearing grease. Use a bearing packer for this operation, Rotunda models 108-00074, 108-00076, or 108-00078, or equivalent. If a packer is not available, work as much lubricant as possible between the rollers and cages. Lubricate the cone surfaces with grease.
3. Place the inner bearing cone and roller in the inner cup and install the new grease seal with Seal Replacer, T73T-1190-B, (Fig. 3). Be sure that the seal is fully bottomed.
4. Install the hub and rotor on the wheel spindle. **Keep the hub centered on the spindle to prevent damage to the grease retainer or the spindle threads.**
5. Install the outer bearing cone and roller and the flat washer on the spindle, then install the adjusting nut, and adjust the wheel bearing as outlined under Adjustments in this Section.

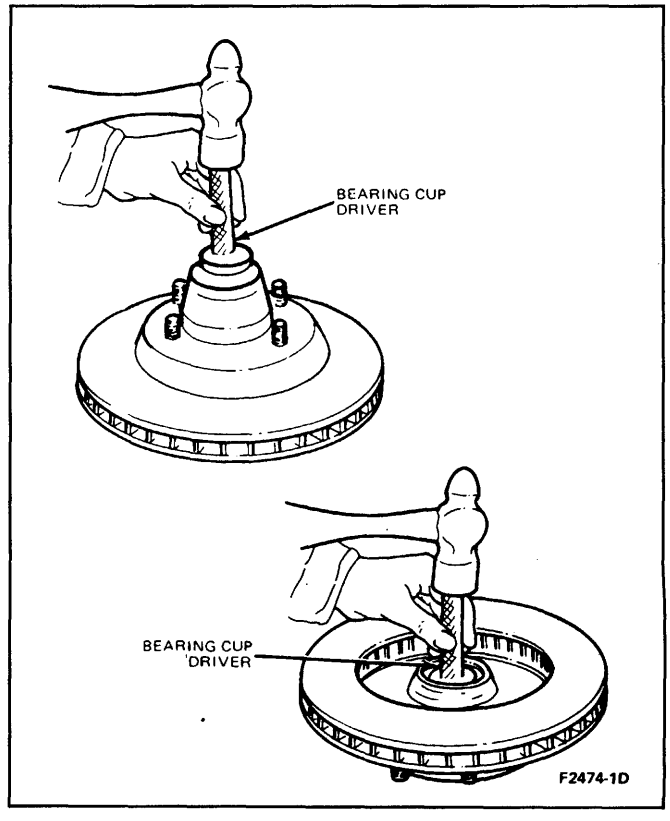


FIG. 2 Installing Bearing Cups

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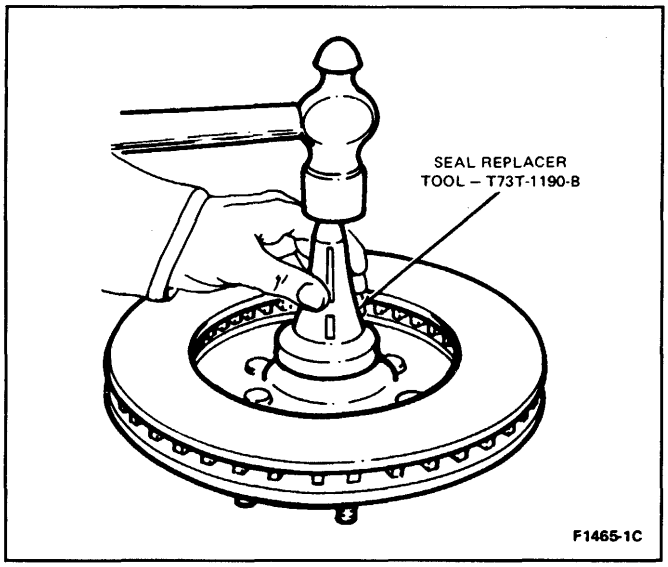


FIG. 3 Installing Grease Seal

6. Install the retainer, new cotter pin, and grease cap.
7. Install the caliper, (refer to Section 12-24, Disc Brakes-Light and Heavy Duty—Sliding Caliper).
8. Install the wheel and tire assembly on the hub as described in Section 11-02, Wheels and Tires.
9. Lower the vehicle and tighten the lug nuts to specification. Re-install the wheel cover or hub cap.
10. Before driving the vehicle, pump the brake pedal several times to restore normal brake pedal travel.
11. After 800 kilometers (500 miles) of operation, retighten the lug nuts to specifications. Failure to retighten the lug nuts could result in the wheel coming off while the vehicle is in motion.

SPECIFICATIONS

WHEEL TORQUE SPECIFICATIONS

Vehicle	Wheel	Bolt Size	Torque①	
			N-m	Ft-Lbs
E-150, F-150, Bronco	5-Lug Wheel	1/2-20	135	100
E-250, E-350, F-250, F-350	8-Lug Wheel	9/16-18	190	140
F-Super Duty	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. CF3943-2D

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lb.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lb.	Universal
D79P-100-A	Impact Slide Hammer — 5 Lb.	Universal
T58L-101-A	Puller Attachment	Universal — Use with Slide Hammer
T77F-1102-A	Bearing Cup Puller	Universal — Use with Slide Hammer
T75T-1170-A	Lock Wedge Replacer	E-250, E-350
Tool 1175-AC	Seal Remover	Universal — Use with Slide Hammer
T75T-1176-A	Threaded Drawbar	E-150 thru E-350 — Bearing Cup Installation
T73T-1190-B	Seal Replacer	Seal No. C77Z-1190-D
T73T-1202-A	Bearing Cup Replacer	F-250, F-350, F-Super Duty, E-250 — Use with Driver Handle and Part No. 8A-1202-A
T73T-1217-B	Bearing Cup Replacer	F-250, E-250 Use with Driver Handle
D78P-1225-B	Bearing Cup Puller	Universal
D79T-4000-A	Outside Thread Chaser	Universal
T80T-4000-W	Driver Handle	Bearing Cup Installation
T73T-4222-A	Bearing Cup Replacer	F-250 — Use with Part No. CIVW-4222-A
T73T-4222-B	Bearing Cup Replacer	F-250, F-350, F-Super Duty — Use with Part No. B7A-4222-A
Rotunda Equipment		
Rotunda — 108-00074	Wheel Bearing Packer	Up to 4" Bearings
Rotunda — 108-00076	Wheel Bearing Packer	Up to 6" Bearings
Rotunda — 108-00078	Wheel Bearing Packer	Up to 6-1/2" Bearings
Rotunda — 091-00001	Brake and Clutch Service Vacuum	—

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SECTION 11-11 Wheel Hubs and Bearings—Rear (Semi-Floating Axle)

SUBJECT	PAGE
DESCRIPTION	
Rear Wheel Assembly	11-11-1
REMOVAL AND INSTALLATION	11-11-1
VEHICLE APPLICATION	11-11-1

VEHICLE APPLICATION

Bronco, E-150 Through E-250, F-150 Through F-250 (4x2), F-150 Through F-250 (4x4) Truck Models under 8500 lb GVW.

DESCRIPTION

Rear Wheel Assembly

E-150, F-150 and Bronco (Ford 8.8 Inch Ring Gear Rear Axle)

The rear wheel brake drum assembly is retained on the studs of the rear axle shaft flange by two retainers. The wheel (and tire) is mounted on the same rear axle shaft flange studs, and is held against the drum and axle shaft flange assembly by the wheel nuts. On the Ford 8.8 inch Ring Gear Axle, the rear wheel bearing and seal are pressed into the outer axle tube housing. The axle shaft is held in place by a C-clip in the differential case. When the C-clip is removed, the axle shaft can be taken out of the axle tube housing.

Rear Wheel Assembly

E-250 UNDER 8500 LBS GVW (DANA 9.75 Inch Ring Gear Axle)

F-250 UNDER 8500 LBS GVW (FORD 10.25 Inch Ring Gear Axle)

Eight studs, pressed into the axle shaft flange, serve as a mounting surface for the brake drum. The wheel and tire assembly mounts on the drum and axle flange assembly and is held in place by eight wheel lug nuts. The rear wheel bearing and seal are pressed into the outer axle tube housing. The axle shaft is held in place by a C-clip in the differential case. When the C-clip is removed, the axle shaft can be taken out of the axle tube housing.

REMOVAL AND INSTALLATION

Refer to Section 15-08, Integral Carrier Axle—Ford 8.8 Inch Ring Gear; Section 15-09 Integral Carrier Axle—10.25 inch Ring Gear and Section 15-05, Integral Carrier Axle-Dana for Removal and Installation Procedures.

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SECTION 11-12 Wheel Hubs and Bearings—Front Wheel Drive

SUBJECT	PAGE
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Front Wheel Bearing Adjustment	11-12-2
Front Wheel Bearing Adjustment with Manual Locking Hubs	11-12-2
Bronco and F-150—F-250 (4x4) With Dana 44IFS or 44IFS/HD Front Driving Axle	11-12-2
DESCRIPTION AND OPERATION	
Automatic Locking Hubs Operation	11-12-1
Manual Locking Hubs Operation	11-12-1
DISASSEMBLY AND ASSEMBLY	
Front Wheel Grease Seal and Bearing Replacement and Repacking	11-12-6
REMOVAL AND INSTALLATION	
Automatic Locking Hubs	11-12-5
Bronco, F-150—F-250 (4x4)	11-12-5
Manual Locking Hubs	11-12-3
SPECIFICATIONS	11-12-8
VEHICLE APPLICATION	11-12-1

VEHICLE APPLICATION

Bronco, F-150 Through F-350 (4x4) Only.

DESCRIPTION AND OPERATION

The hub locks on Bronco and F-150—F-350 (4x4) vehicles equipped with four-wheel drive, either automatically or manually actuate the front driving axle. When actuated, the hub lock body assembly locks the hub and wheel and tire assembly to the front driving axle axleshaft. When released, the front driving axle axleshaft is disengaged from the hub body assembly and the hub and tire and wheel assembly rotate freely on the spindle.

Two tapered opposed roller bearings allow the hub and wheel and tire assembly to rotate on the spindle. A hub seal is installed inboard of the inner bearing to prevent wheel bearing lubricant from contaminating the brake caliper and rotor surfaces.

F-350 (4x4) equipped with dual wheel rear axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lug nuts.

WARNING: DO NOT ATTEMPT TO USE PAST MODEL LUG NUTS (CONE SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUG NUTS. IF SO USED, PAST MODEL LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

Automatic Locking Hubs Operation

Electric Shift Transfer Case

2-WHEEL DRIVE—Shift the transfer case in the 2H position by pushing the LOW RANGE and/or 4 x 4 pushbuttons until both indicator lamps are off.

To disengage the automatic hub locks, shift the transmission to move the vehicle in the opposite direction (forward or reverse) and drive a minimum of 3 meters (10 feet) in a straight line. Always disengage the automatic hub locks before driving on dry, hard-surfaced roads.

NOTE: During axle break-in or operation in extremely cold temperatures (-10°F [-12°C] or below) and if the axle lubrication has had time to cool, the automatic hub locks may not disengage completely. It may be necessary to keep the hub locks engaged for 10 to 15 minutes while driving before they will disengage.

SHIFTING BETWEEN 2H AND 4H—The transfer case can be shifted between 2H and 4H with the vehicle stopped or at normal road speed by pushing the 4 x 4 button. The amber indicator lamp will illuminate when the transfer case is in 4-wheel drive.

HI/LOW RANGE SHIFTING—To shift to or from low range, stop the vehicle and shift automatic transmission to N (NEUTRAL) or disengage clutch on manual transmission before pushing the LOW RANGE button. The LOW RANGE indicator lamp will illuminate in low range.

Attempting to shift to or from low range with the vehicle in motion will cause the LOW RANGE lamp to flash. The LOW RANGE lamp will continue to flash until the prior shift position is reselected or the previous procedure is followed.

The 4 x 4 and Low Range button will illuminate with the headlamps or parking lamps on. It may be dimmed or brightened by rotating the instrument panel thumb wheel.

NOTE: Do not shift transfer case from 2H to 4H with the rear wheels spinning while accelerating vehicle from a standstill, or with vehicle in motion with temperature at -15°C (5°F) or below, otherwise damage can occur to the drivetrain.

NOTE: Initial shifts from 2H to 4H, with vehicle in motion, may cause a driveline clunk noise which is the result of the front axle automatic locking hubs engaging. This engagement noise is normal and will not occur with subsequent shifts between 2H and 4H.

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Manual Locking Hubs Operation

(Refer to Fig. 1).

Two-Wheel Drive

Shift the transfer case to the two-wheel drive position (2H) and turn the hub lock selector knob counter clockwise to the "FREE" position.

Four-Wheel Drive

Lock both hubs by turning the selector knob clockwise to the "LOCK" position. If the hub teeth do not engage with the knob in this position, a slight movement of the wheel in either direction will complete the lock.

If the vehicle is stopped, place the transmission in neutral and select transfer case shift position.

If the vehicle is moving, the transfer case may be shifted between 2H and 4H only, providing that the hub locks are in the "LOCK" position.

Shifting to or from the 4L position requires that the vehicle be fully stopped and the transmission in neutral.

CAUTION—Both hubs must be set in the same function to avoid excess front differential wear on Non-Traction-Lok front axles or steering pull on Traction-Lok front axles.

CAUTION—Clashing of gears and resulting transfer case damage will occur if you attempt to shift to or from 4L while the vehicle is in motion or if you attempt to shift from 2H to 4H with the hub locks in the "FREE" position while the vehicle is in motion. If it is necessary to shift to or from 4L, bring the vehicle to a full stop before doing so.

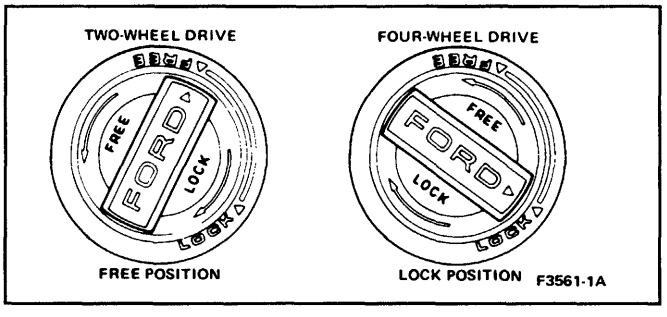


FIG. 1 Four Wheel Drive Wheel Hubs—Manual Locking Hubs

ADJUSTMENTS

Front Wheel Bearing Adjustment with Manual Locking Hubs

Bronco and F-150—F-250 (4x4) With Dana 44IFS or 44IFS/HD Front Driving Axle

1. Raise the vehicle and install safety stands.
2. Remove the hub lock assembly. Refer to Automatic Locking Hub or Manual Locking Hub removal and installation procedures in this Section.
3. Using a torque wrench and Spanner Locknut Wrench, T86T-1197-A, apply inward pressure to unlock the adjusting nut locking splines, and turn the nut clockwise to tighten to 68-81 N·m (50-60 ft-lbs) while rotating the wheel back and forth to seat the bearing (Fig. 2).

   NOTE: After 95 N·m (70 ft-lbs.) of torque, the adjusting nut will no longer tighten. The threaded nut portion will ratchet in the assembly upon approaching the specified torque. Continue tightening until the specified torque is obtained.
4. Apply inward pressure on the Spanner Locknut Wrench to disengage the adjusting nut locking splines and back off the adjusting nut approximately 180 degrees (Fig. 2).
5. Retighten the adjusting nut to 20 N·m (15 ft-lbs.). Remove the tool and torque wrench.
6. Check that the final end play of the wheel on the spindle is 0.00-0.15mm (0.00-0.006 inch).
7. Install the hub lock assembly as described in this Section.
8. Remove the safety stands. Lower the vehicle.

Front Wheel Bearing Adjustment

F-150 with Automatic Locking Hubs—F-250 H.D.—F-350 (4x4) with Dana 44, 50IFS and Dana 60 Monobeam Front Driving Axle

Refer to Fig. 3.

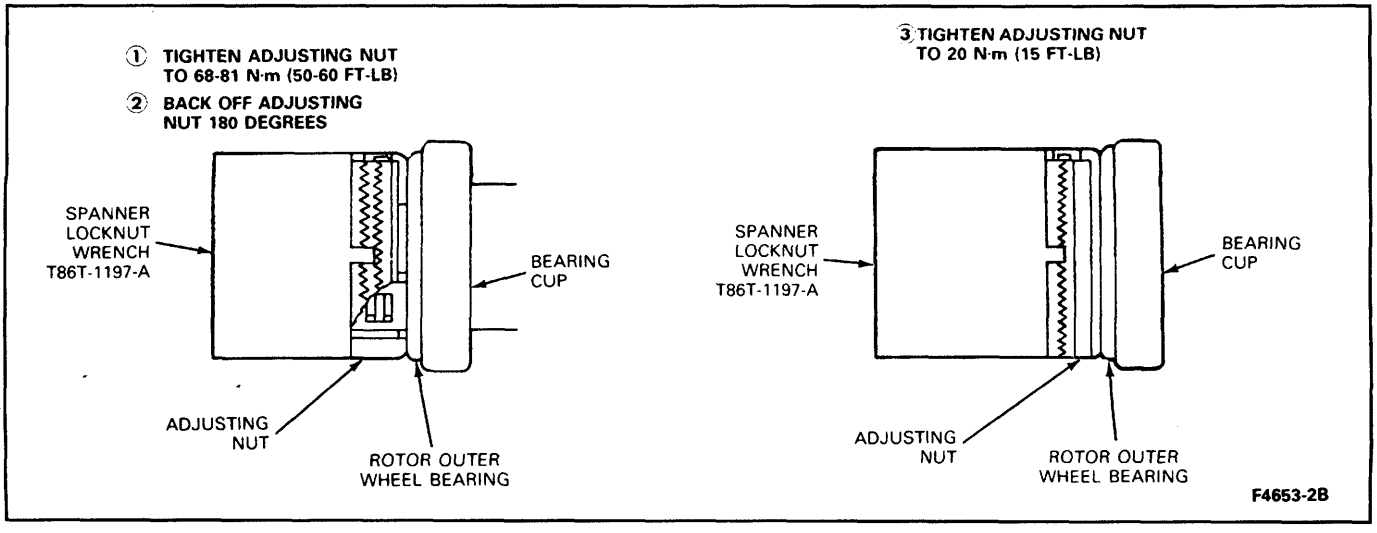


FIG. 2 Front Wheel Bearing Adjustment—Bronco and F-150—F-250 (4x4) with Dana 44 Front Driving Axle

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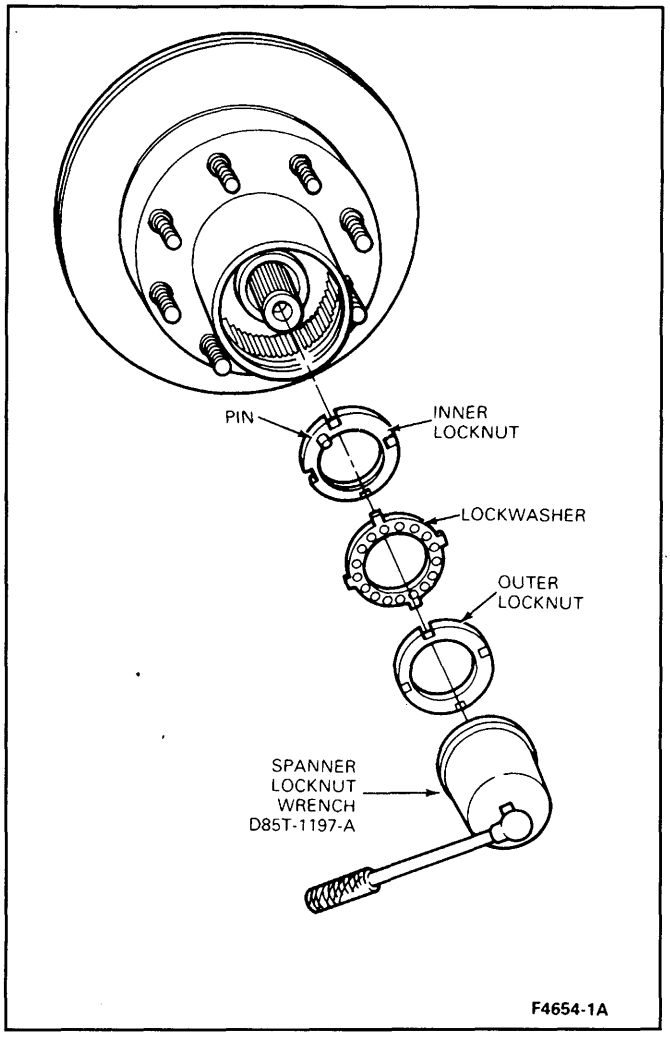


FIG. 3 Outer Locknut, Lockwasher and Inner Locknut—F-250—F-350 (4x4) with Dana 50 IFS and Dana Model 60 Monobeam Front Driving Axle

1. Raise the vehicle and install safety stands.
2. Remove the hub lock assembly. Refer to Manual Locking Hub in the Removal and Installation portion of this Section.
3. Remove the outer locknut with Spanner Locknut Wrench, D85T-1197-A. Remove the lockwasher.
4. Using Spanner Locknut Wrench, D85T-1197-A, tighten the inner locknut to 68 N·m (50 ft-lbs.) to seat the bearing.
5. Back off the inner locknut and retighten to 41-54 N·m (31-39 ft-lbs.).
6. While rotating the hub, back off the locknut 135-150 degrees.
7. Install the lockwasher so the key is positioned in the spindle groove. Rotate the inner locknut so the pin is aligned into the nearest lockwasher hole.
8. Install the outer locknut and tighten to 217-278 N·m (160-205 ft-lbs.) using Spanner Locknut Wrench, D85T-1197-A.
9. Check the final end play of the spindle, it should be 0.00-0.15mm (0.000-0.006 inch).
10. Install the hub locks as described in this Section.

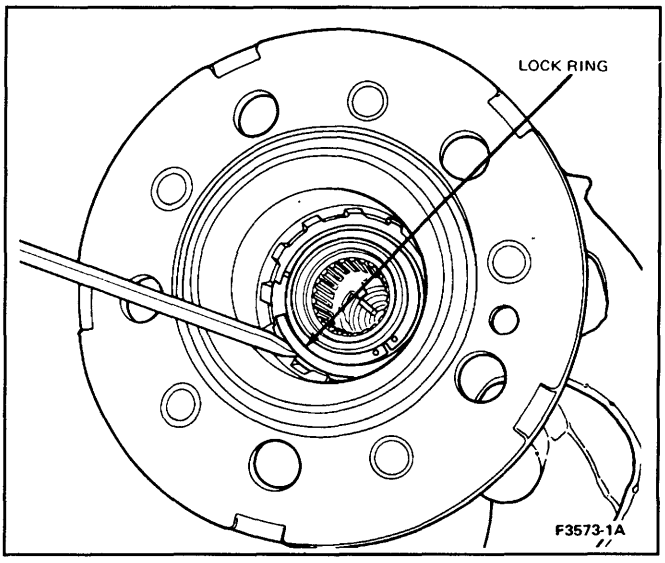


FIG. 4 Outer Lock Ring Removal—Manual Locking Hub

11. Remove the safety stands. Lower the vehicle.

REMOVAL AND INSTALLATION

Manual Locking Hubs

Bronco and F-150 (4x4)

Removal

1. Raise the vehicle and install safety stands.
2. Remove the wheel lug nuts and remove the wheel and tire assembly.
3. Remove the retainer washers from the lug nut studs and remove the manual locking hub assembly.
4. To remove the internal hub lock assembly from the outer body assembly, remove the outer lock ring seated in the hub body groove (Fig. 4).
5. The internal assembly, spring and clutch gear will now slide out of the hub body.

CAUTION: Do not remove the screw from the plastic dial.

6. Rebuild the hub assembly in the reverse order of disassembly.

Installation

1. Install the manual locking hub assembly over the spindle and place the retainer washers on the lug nut studs.
2. Install the wheel and tire assembly. Install the lug-nuts and tighten to 135 N·m (100 ft-lbs).

F-250—F-350 (4x4)

Refer to Fig. 5.

Removal

1. Separate the cap assembly from the body assembly by removing the six Allen-head capscrews and remove the cap from the body (Fig. 6).
2. Remove the snap ring that retains the axle shaft in the hub body assembly (Fig. 7).

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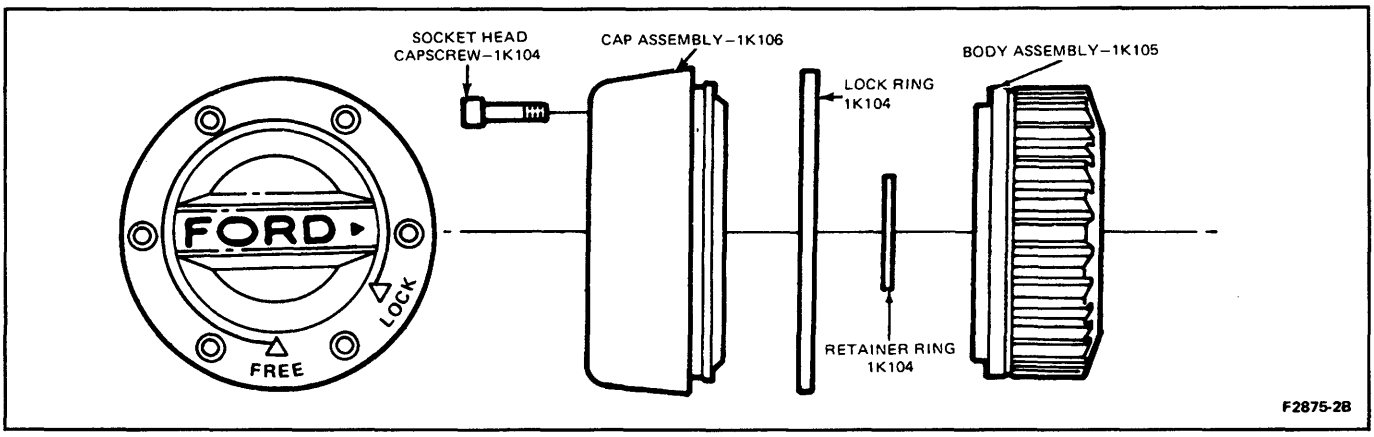


FIG. 5 Manual Locking Hubs (Warner)—Bronco, F-150—F-350 (4x4)

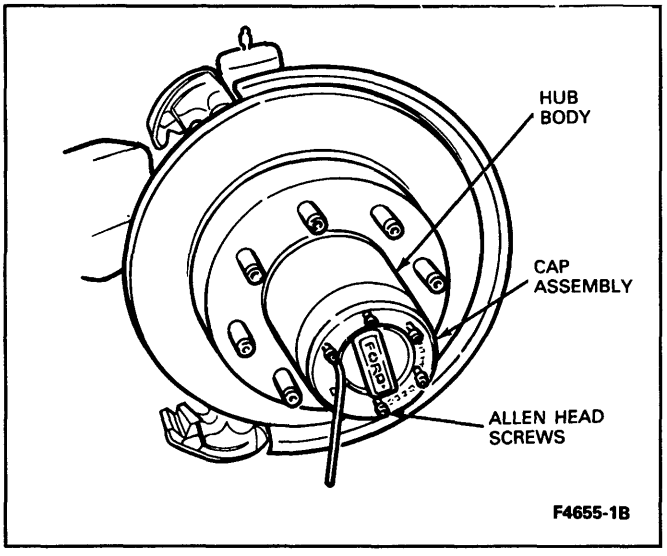


FIG. 6 Cap Removal—Manual Locking Hub

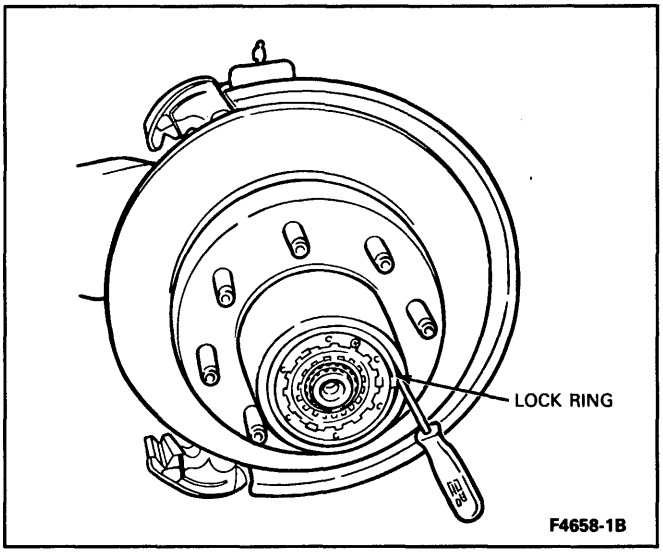


FIG. 8 Lockring Removal—Manual Locking Hub

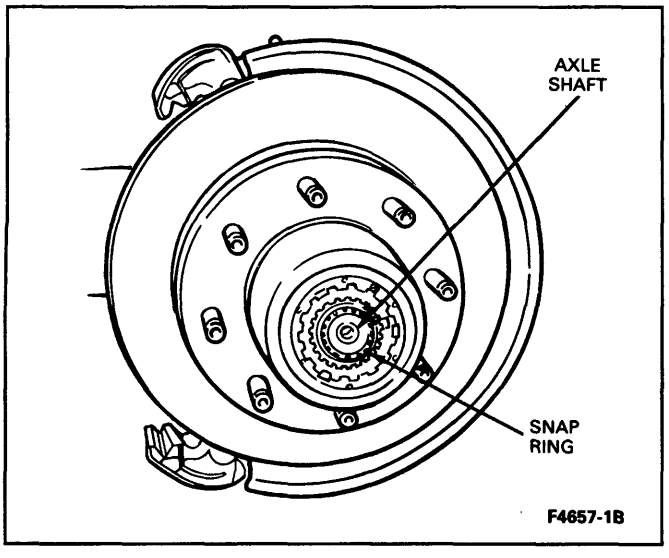


FIG. 7 Snap Ring Removal—Manual Locking Hub

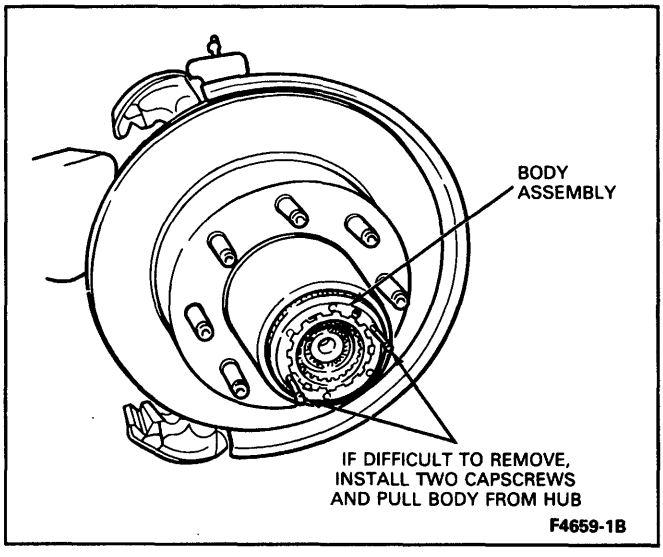


FIG. 9 Body Removal—Manual Locking Hub

3. Remove the lockring seated in the groove of the wheel hub (Fig. 8).
4. Remove the body assembly from the hub. If the body is difficult to remove, install two capscrews and pull the body assembly out of the hub (Fig. 9).

Installation

1. Insert the body assembly in the hub.

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2. Install the lockring in the groove to retain the body in the hub.
3. Install the snap ring that retains the axle shaft to the body.
4. Position the cap assembly on the body. Install the six Allen-head capscrews and tighten to 4.0-6.0 N·m (40-60 in-lbs).

   NOTE: Do not pack the cap assembly with grease. Excessive grease can cause excessive dialing effort.

Automatic Locking Hubs

Bronco, F-150—F-250 (4x4)

Refer to Fig. 10.

Removal:

1. To remove hub, first separate cap assembly from body assembly by removing the five (5) capscrews, using Torx® bit TX25, from the cap assembly.
2. Remove cover.

   CAUTION: Do not drop spring, ball bearing, bearing race, or retainer.
3. Remove rubber seal.
4. Remove seal bridge retainer (small metal stamping) from retainer ring space.
5. Remove retainer ring by closing the ends with needle nose pliers while pulling hub lock from wheel hub.

If wheel hub and spindle are to be removed:

6. Remove C-washer from stub shaft groove.
7. Remove splined spacer from shaft.

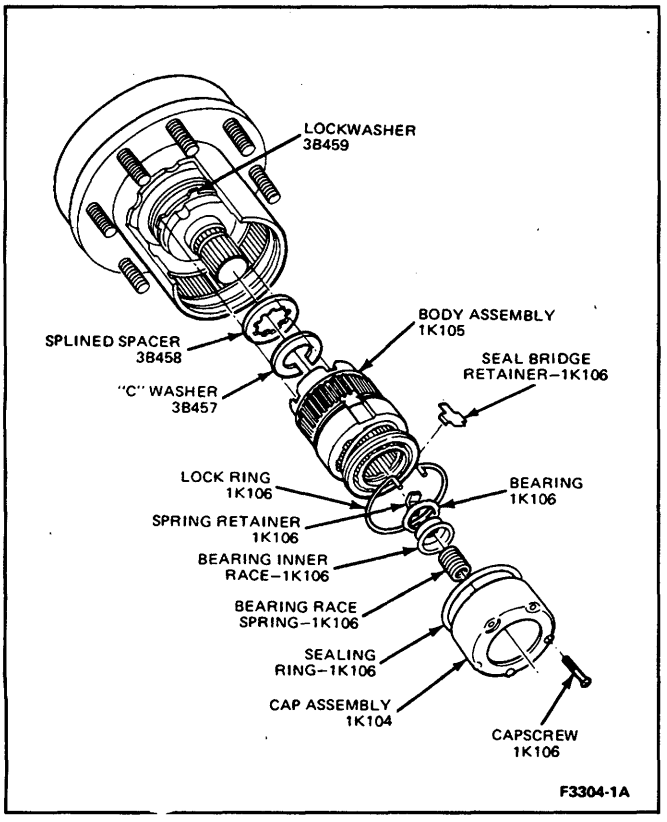


FIG. 10 Automatic Locking Hub (Warner)—Exploded View

8. Remove wheel bearing lock nuts and lock washer.
9. If the hub assembly requires cleaning, refer to steps 10-13.
10. Wash the cap bearing, race and retainer assembly in cleaner solvent and thoroughly dry the components. Repack the bearing with a lithium base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent. Refer to Figs. 11 and 12 for proper positioning of the bearing on the race.
11. Remove the snap ring and flat washer (Fig. 13) from the inner end of the hub lock assembly. Pull the hub sleeve and attached parts out of the drag sleeve, then cock the drag sleeve to unlock the tangs of the brake band and remove the drag sleeve assembly (Fig. 14). (NOTE: Never remove the brake band from the drag sleeve). Wash in cleaner solvent and air dry the drag sleeve and brake band. Lubricate the brake band and drag sleeve assembly with 1.5 grams (0.05 oz.) of Automatic Hublock Grease, E1TZ-19590-A (ESL-M1C193-A) (Darmex Spec. DX-123-LT.) or equivalent. Work the lubricant over the spring and the area of the drag sleeve under the spring.
12. The body assembly (excludes cap assembly, and brake band and drag sleeve assembly) should be dipped in Automatic Transmission Fluid-DEXRON® -II, XT-2-QDX or equivalent and permitted to drip dry for a few minutes before proceeding with re-assembly.

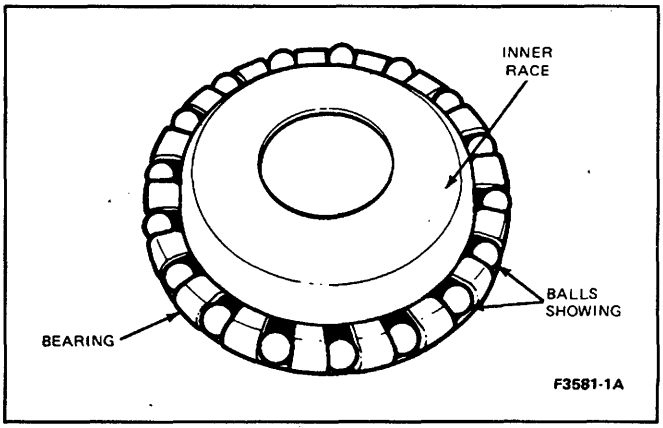


FIG. 11 Bearing Over Inner Race Installation

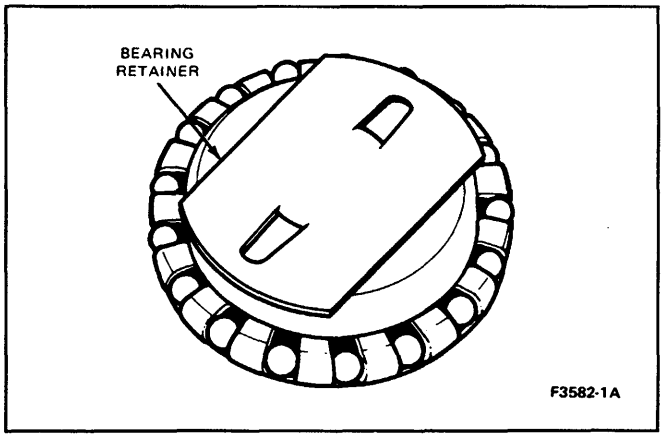


FIG. 12 Bearing Retainer Installation

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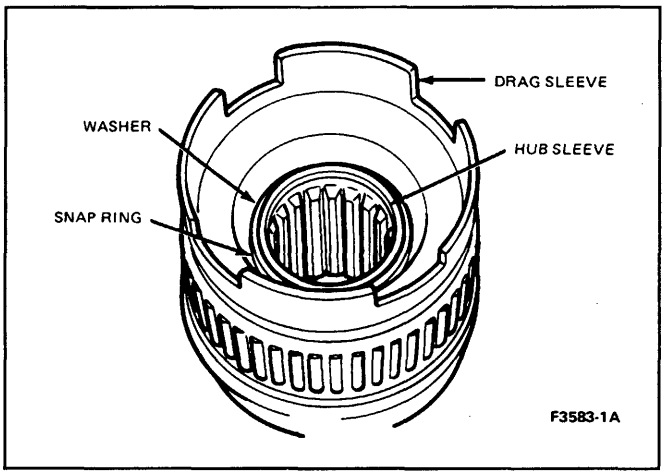


FIG. 13 Washer and Snap Ring

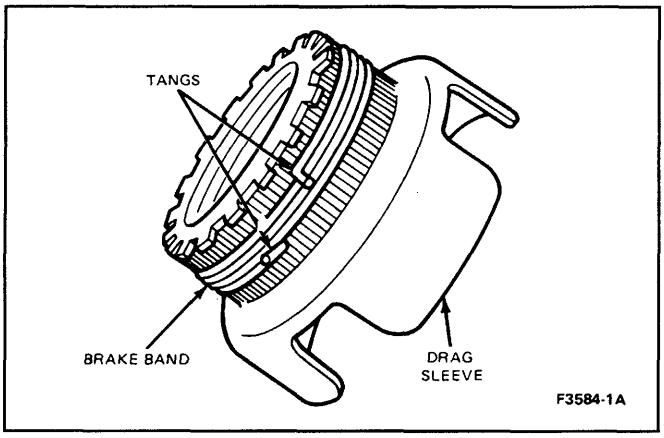


FIG. 14 Drag Sleeve and Brake Band

13. Assemble one of the two tangs of the brake band on each side of the plastic outer cage which is located in the window of the steel inner cage. It will be necessary to cock these parts to engage the tangs in this position as the drag sleeve is positioned against the face of the cam follower (Fig. 15). Install the washer and snap ring (Fig. 13).

Installation

1. Wheel bearing locknut and lockwasher installation is the same as with manual hub locks except for tightening the outside wheel bearing locknut to 203 N·m (150 ft-lb).
2. Install the splined spacer and the C-washer on the axle shaft.

NOTE: Remove excessive grease from hub-lock and hub splines prior to installation.

3. Start hub lock assembly into hub making sure the large tangs are lined up with the lock washer and the outside diameter and inside diameter splines are in line with the hub and axle shaft splines.
4. Install retainer ring by closing the ends with needle nose pliers and at the same time push hub lock assembly into the hub.
5. Install seal bridge retainer (small metal stamping) with narrow end first.
6. Install rubber seal over hub lock.

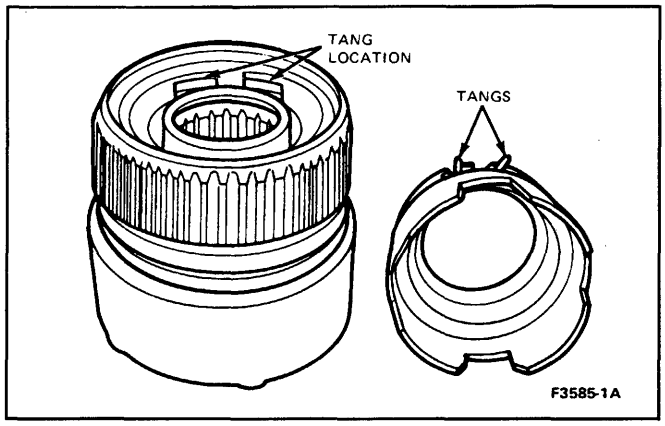


FIG. 15 Brake Band and Drag Sleeve Assembly to Body Assembly Installation

7. Install cover (make sure ball bearing, spring, bearing race and retainer are in place).
8. Tighten the 5 screws to 4.5-5.6 N·m (40-50 in-lb) using Torx® Bit TX25 in following sequence: tighten one, skip one, etc.

DISASSEMBLY AND ASSEMBLY

Front Wheel Grease Seal and Bearing Replacement and Repacking

Bronco and F-150, F-250, F-350 (4x4)

The recommended wheel bearing lubricant is the lithium-base grease, Multi-Purpose Long-Life Lubricant C1AZ-19590-B (ESA-M1C75-B) or equivalent.

Sodium-base grease is not compatible with lithium-base grease and should not be intermixed. Therefore, before lubricating front and/or rear wheel bearing, **note which type was used as the original wheel bearing lubricant.** Usage of incompatible bearing lubricant could result in premature lubricant breakdown.

If bearing adjustment does not eliminate looseness or rough and noisy operation, clean, inspect and repack the hub and bearings with specified wheel grease. If bearing cups or the cone and roller assemblies are worn or damaged, they should be replaced.

Disassembly

1. Raise the vehicle and install safety stands.
2. If equipped with locking hubs, refer to Manual or Automatic Locking Hub Removal and Installation, this Section and remove the locking hub.
3. Remove the wheel lug nuts and the wheel and tire from the hub and rotor assembly as described in Section 11-02, Wheel and Tires.
4. For Bronco and F-150—F-250 (4x4) vehicles equipped with Dana Model 44 front drive axle and manual hub lock, remove the adjusting nut with Spanner Locknut Wrench, T86T-1197-A. Apply inward pressure on the Locknut Wrench to disengage the adjusting nut locking splines and turn the nut counter-clockwise to loosen and remove the nut from the spindle. For F-150 with automatic hub locks—F-250—F-350 (4x4) vehicles equipped with Dana Model 50, 44 and Model 60 Monobeam front drive axles, remove the outer locknut, lockwasher and inner locknut with Spanner Locknut Wrench D85T-1197-A (Figs. 3 and 16).

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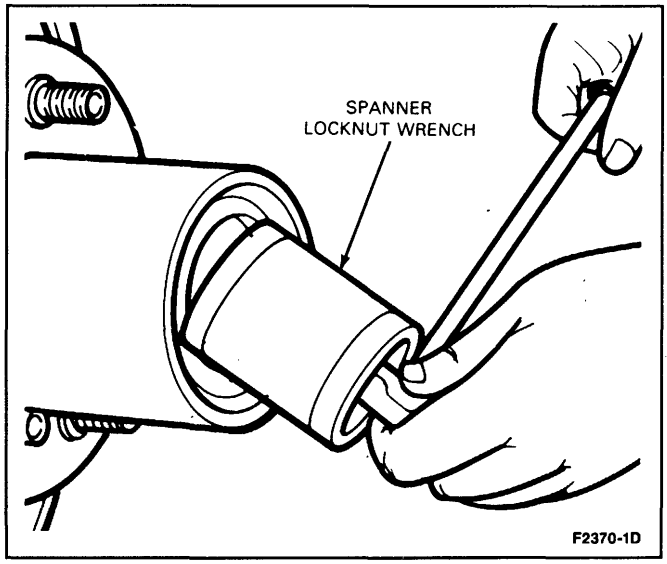


FIG. 16 Locknut, Lock Ring and Adjusting Nut Removal

5. Remove the brake caliper (refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper) and wire it to the frame to prevent damage to the brake hose. Do not let the caliper hang only by the brake hose to prevent damage to the hose or the caliper.
6. Remove the hub and disc assembly. The outer wheel bearing cone and roller assembly will slide out as the hub is removed (Fig. 17).
7. Remove the spindle retaining nuts, then carefully remove the spindle from the knuckle studs and axle shaft.
8. Clean all old grease from the needle bearings and the spindle bore seal.
9. Clean any old grease or dirt from these parts and replace if signs of excessive wear are noted.

Assembly

1. Using Multi-Purpose Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent, thoroughly lubricate the needle bearing and pack the spindle face that mates with the spindle bore seal.
2. Assemble the spindle over the axle shaft onto the knuckle studs. On F-350, adjust the retaining nuts to 68-81 N·m (50-60 ft-lb). On F-150—F-250 and Bronco, adjust the retaining nuts to 27-41 N·m (20-30 ft-lb).
3. Remove the inner bearing cone and grease seal and bearing cups from the hub using Bearing Cup Puller, T77F-1102-A and Impact Slide Hammer, T50T-100-A or equivalent.
4. Inspect the bearing cups for pits or cracks. If necessary, remove them with a drift. **If new cups are installed, install new cone and roller assemblies.**
5. Lubricate the bearings with Multi-Purpose Lubricant C1AZ-19590-B, (ESA-MIC75-B) or equivalent. Clean all old grease from the hub. Pack the cones and rollers. If a bearing packer is not available, work as much lubricant as possible between the rollers and the cages.
6. Position the inner bearing cone and roller in the inner cup and install the grease seal.
7. Carefully position the hub and disc assembly on the spindle.
8. Install the outer bearing cone and roller, and the adjusting nut or locknuts and lockwashers.

NOTE: On Dana Model 44 Front drive axles, the metal stamping on the adjusting nut must face inboard (towards the spindle). Make sure the inner diameter key on the nut enters the spindle keyway.

9. Adjust the wheel bearings as described in this Section under Adjustments.
10. Install tire and wheel as described in Section 11-02, Wheels and Tires.
11. Install the locking hubs as described in this Section under Removal and Installation.
12. Remove the safety stands and lower the vehicle.

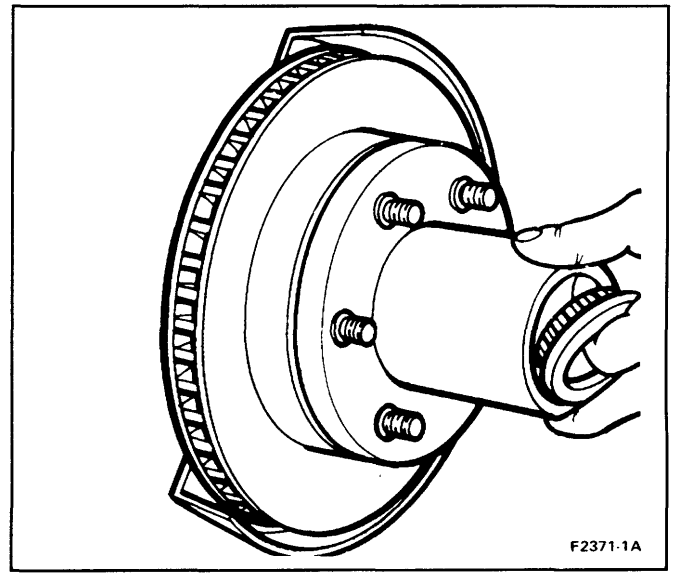


FIG. 17 Hub, Disc, and Outer Bearing Removal

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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lb.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lb.	Universal
D79P-100-A	Impact Slide Hammer — 5 Lb.	Universal
T58L-101-A	Puller Attachment	Universal — Use with Slide Hammer
D80L-927-A	Wheel Hub Cap Remover	Universal
T77F-1102-A	Bearing Cup Puller	Universal — Use with Slide Hammer
Tool 1175-AC	Seal Remover	Universal — Use with Slide Hammer
D85T-1197-A	Spanner Locknut Wrench	Dana Model 50 and Model 60 Monobeam Front Drive Axles
T86T-1197-A	Spanner Locknut Wrench	Dana Model 44 Front Drive Axle
D78P-1225-B	Bearing Cup Puller	Universal
D79T-4000-A	Outside Thread Chaser	Universal
T-80T-4000-W	Driver Handle	Bearing Installation

CE4329-2E

WHEEL TORQUE SPECIFICATIONS

Vehicle	Wheel	Bolt Size	Torque①	
			N-m	Ft-Lbs
E-150, F-150, Bronco	5-Lug Wheel	1/2-20	135	100
E-250, E-350, F-250, F-350	8-Lug Wheel	9/16-18	190	140
F-Super Duty	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. CF3943-2D

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SECTION 11-14 Wheel Hubs and Bearings—Rear DANA Full Floating Axle

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VEHICLE APPLICATION

HD E-250 Through E-350 DRW and F-Super Duty.

DESCRIPTION

On HD E-250—E-350 full-floating rear axle wheel hubs with tapered roller bearings, a seal is installed behind the inner bearing to keep the wheel bearing lubricant from the brake lining and brake drum (Figs. 1 and 2). The F-Super Duty axle is disc brake-equipped (Fig. 3) and contains larger tapered roller bearings and a unique inner seal and shaft-hub gasket.

The wheel bearings are packed with a lithium base grease, Multi-Purpose Lubricant C1AZ-19590-B (ESA-M1C75-B) or equivalent to provide initial lubrication until axle lubricant flows into the wheel hubs and bearings during vehicle operation. On these axles the wheel hub is vented through the axle housing vent hose in the LH axle tube.

Vehicles equipped with dual rear wheel (DRW) axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lug nuts (Fig. 1).

WARNING: ON REAR AXLES WITH DUAL REAR WHEELS DO NOT ATTEMPT TO USE PRE-1985 LUG NUTS (CONE SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUG NUTS. IF SO USED, PAST MODEL LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

ADJUSTMENTS

For rear wheel bearing adjustments refer to bearings, cups and seals under Disassembly and Assembly in this Section.

DISASSEMBLY AND ASSEMBLY

Bearings, Cups and Seals

HD E-250—E-350

Vehicles equipped with dual rear wheel (DRW) axles have the wheel and tire assembly attached to the drum with integral two-piece swiveling lug nuts.

WARNING: DO NOT ATTEMPT TO USE PAST MODEL LUG NUTS (CONE SHAPED, ONE-PIECE) TO REPLACE THE INTEGRAL TWO-PIECE SWIVELING LUG NUTS. IF SO USED, PRE-1985 LUG NUTS CAN COME LOOSE IN VEHICLE OPERATION. DO NOT ATTEMPT TO USE PAST MODEL WHEELS, WHICH HAVE CONE SHAPED LUG NUT SEATS, ON THIS VEHICLE. DO NOT ATTEMPT TO USE THE NEW DESIGN WHEELS AND LUG NUTS ON PAST MODEL WHEEL HUBS. ATTEMPTED USE OF INTERMIXED WHEELS CAN LEAD TO DAMAGE TO THE WHEEL MOUNTING SYSTEM AND COULD RESULT IN WHEELS COMING LOOSE IN OPERATION.

Disassembly

1. Set the parking brake and **loosen** the axle shaft attaching bolts (Fig. 1).
2. Raise the rear wheels off the floor and place safety stands under the rear axle housing so that the axle is parallel with the floor. Release parking brake and back off the rear brake adjustment, if necessary.
3. Remove the axle shaft attaching bolts and lock washers and discard them.
4. Using a heavy duty dolly such as the Rotunda model 014-00030 or equivalent as shown in Fig. 4, raise the wheel to the point that all weight is removed from the wheel bearings.
5. Remove brake drum. If so equipped, push-on sheet metal drum retainer nuts may be discarded.
6. Remove the axle shaft and discard the gasket.
7. Remove the wheel bearing hub nuts using Hub Wrench T85T-4252-AH so the drive tangs of the tool engage the four slots in the hub nut (Fig. 5).
8. Remove the outer bearing cone, pull the wheel assembly straight out and away from the axle. If it had not been done in step 4, remove hub assembly and set aside.

CAUTION: The hub nuts are right hand (thread on the right spindle) and left hand (thread on the left spindle). Each hub nut is stamped RH or LH to identify thread direction. Do not use power impact tools when performing operations on the hub nuts (Fig. 6).

NOTE: The hub nuts will ratchet during this operation, unless the tool for the F-Super Duty is used, Tool T88T-4252-A.

9. Thoroughly clean the spindle of the axle housing.

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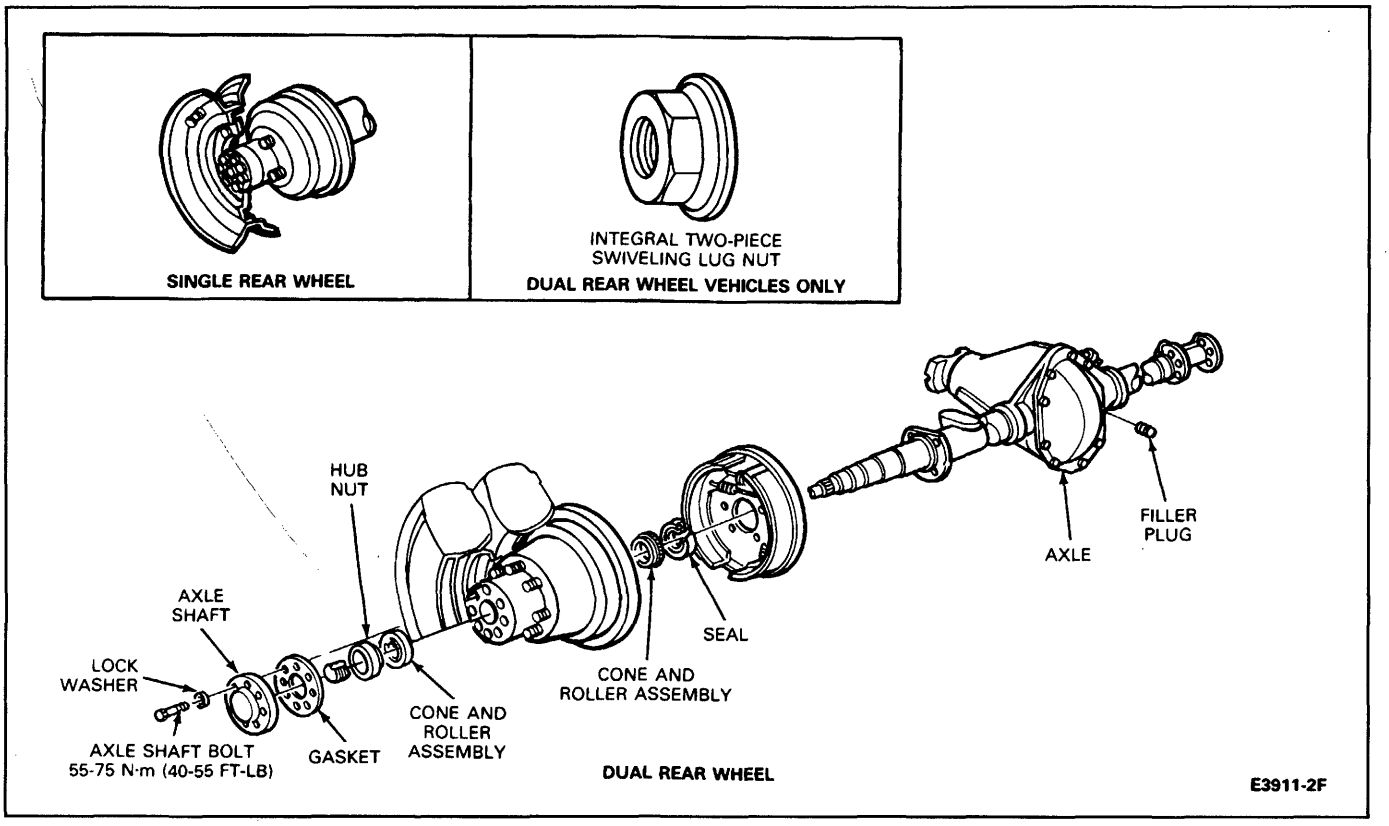


FIG. 1 Rear Wheel Hub—Dana Full-Floating Axle HD E-250—E-350

10. Carefully remove inner seal from hub assembly with screwdriver, avoiding damage to the bearing or hub bore. Discard the seal.
11. Clean all old grease and axle lubricant out of the wheel hub.
12. Inspect the bearing races and rollers for pitting, galling or erratic wear patterns. Inspect the rollers for end wear (Fig. 7).
13. Remove the bearing cups by driving them out with a brass drift. Inspect the cups for galling or excessive wear. If either component (cup or cone and roller) of the tapered roller bearing is not usable, both components should be replaced. Install the new cups with special tool Bearing Cup Replacer T75T-1225A or B and Threaded Drawbar T75T-1176-A (Fig. 8).

Assembly

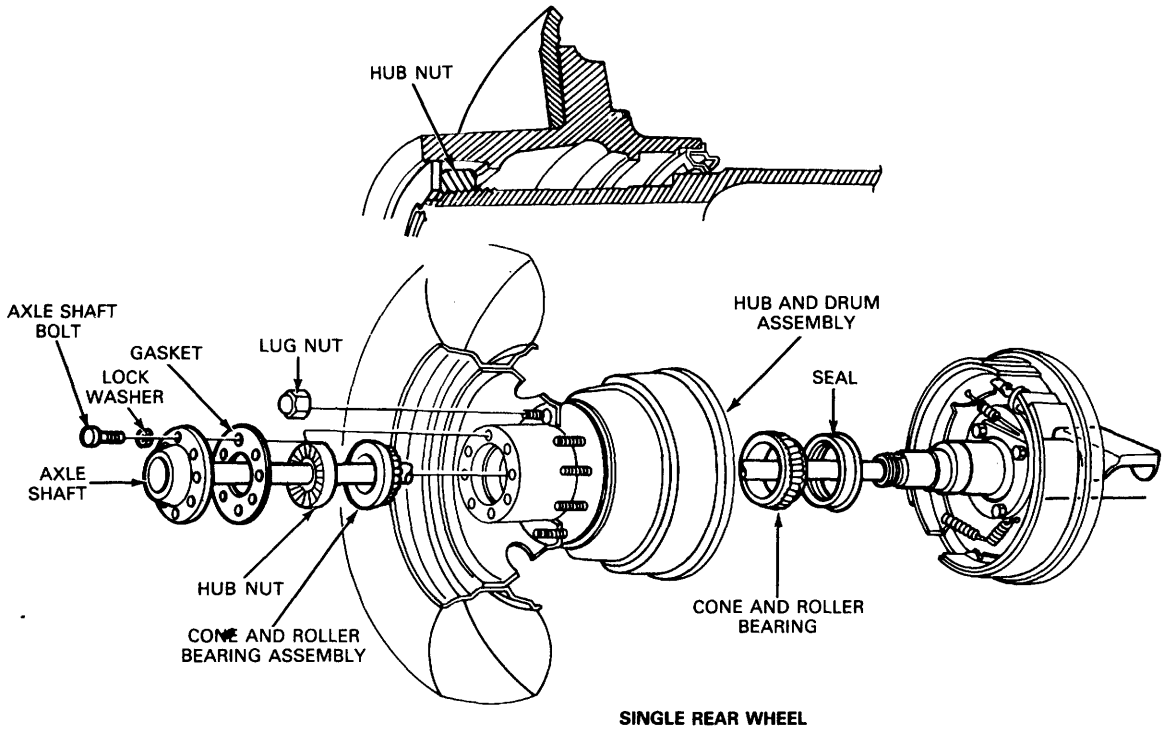
1. Check for proper seating of the new bearing cups by trying to insert a 0.038 mm (0.0015 inch) feeler gauge between the cups and the wheel hub. The gauge should not enter beneath the cup. Check several places to make sure that the cups are squarely seated.
2. Pack each bearing cone and roller assembly with a bearing packing tool such as Rotunda 108-00078 or equivalent, using a lithium base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.
3. Place the inner bearing cone and roller assembly in the wheel hub. Install a new hub inner seal with Replacer Tool, T75T-1175-B and Threaded Drawbar, T75T-1176-A (Fig. 7).
4. Position the hub assembly at the axle housing. Wrap the threads of the spindle with electricians tape. **Carefully slide the hub assembly straight (to avoid seal damage) onto the axle housing spindle.** Remove the electricians tape.
5. Install the outer wheel bearing cone and roller and start the bearing hub nut making sure the hub tab is properly located in the keyway prior to thread engagement (Fig. 9).
6. Install Hub Wrench Tool T85T-4252-AH so the drive tangs of the tool engage the four slots in the nut (Fig. 9). Install torque wrench and tighten hub nut to 88-102 N·m (65-75 ft-lb). Rotate hub occasionally while tightening to set bearings.

NOTE: Hub will ratchet as torque is applied.

The hub wrench for the F-Super Duty can be used in place of Tool T85T-4252-AH. The F-Super Duty tool has tangs 0.3 inches long and when fully engaged by applying inward pressure it will disengage the ratcheting mechanism in the nut. Eliminating ratcheting will provide more even bearing preloads, and will optimize bearing life.

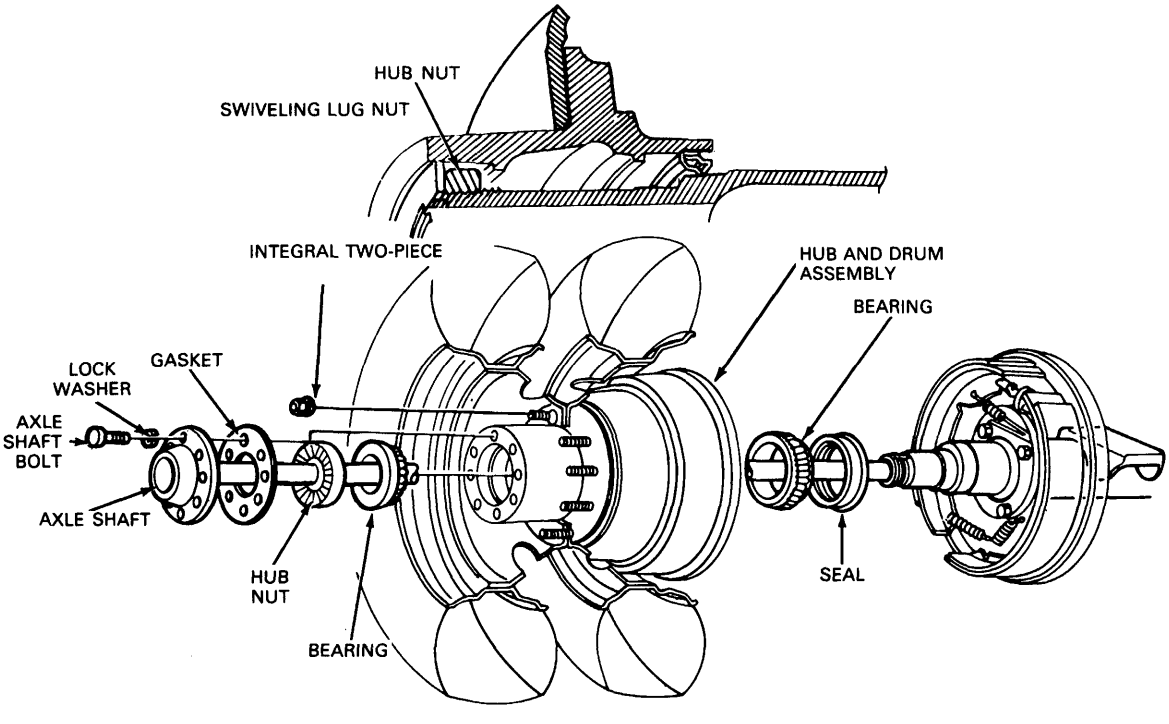
7. After tightening to specification, ratchet back 90 degrees, then tighten to 20-27 N·m (15-20 ft-lb).
8. Prior to reinstallation of the axle shaft, clean and remove any metallic debris in the hub bolt holes. Also inspect for cracked material around the holes, depth of the threaded hole (minimum 25.4 mm or 1 inch) and oversized threaded holes, and replace hub if any of these conditions are present. Install the axle shaft and new axle flange gasket, lock washers and new axle shaft retaining bolts. Coat the bolt thread with a suitable thread adhesive. Tighten the bolts until they seat.

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SINGLE REAR WHEEL

SINGLE REAR WHEEL HUB HD E-250 - E350



DUAL REAR WHEEL - E-350

F1874-2M

FIG. 2 Rear Wheel Hub—Dana Full Floating Axle—HD E-250—E-350

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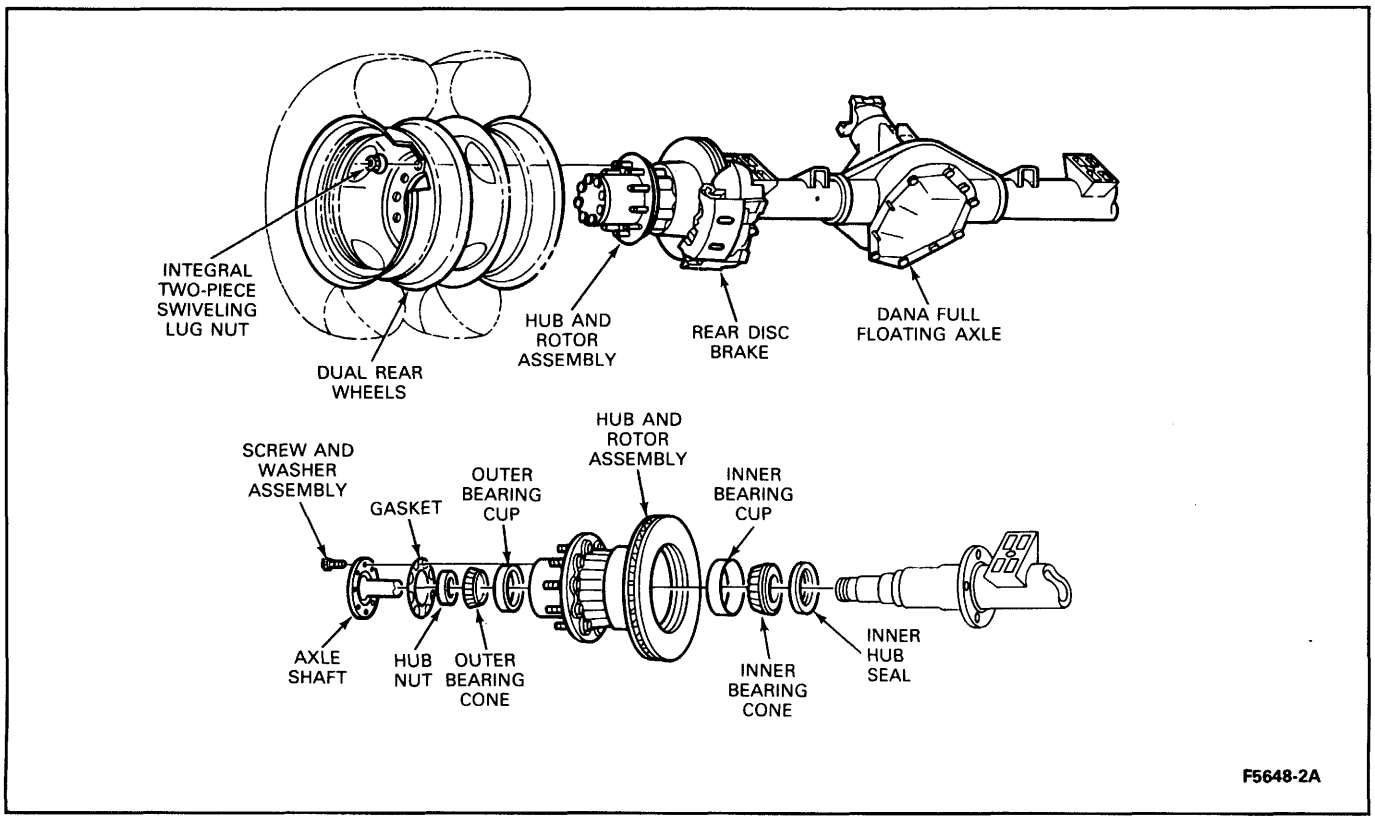


FIG. 3 Rear Wheel Hub—Dana Full Floating Axle F-Super Duty

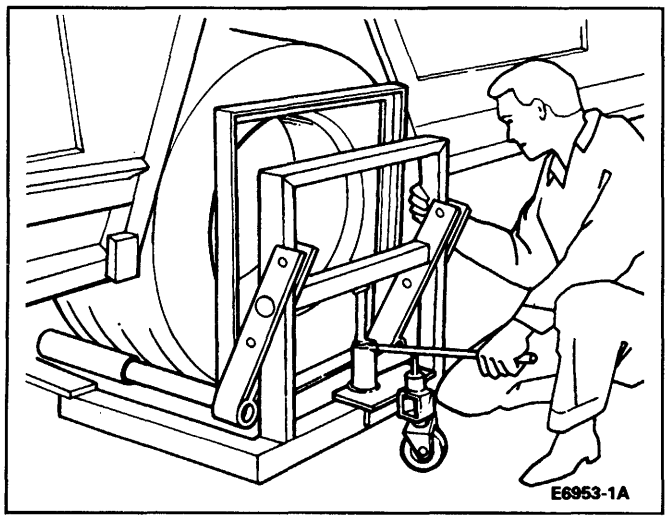


FIG. 4 Heavy Duty Wheel Dolly—014-00030

9. Install the brake drum.
10. Install the wheel and tire assembly.
11. Lower vehicle after removing safety stands.
12. Adjust the brakes.
13. Tighten wheel lug nuts to specification.
14. Tighten axle shaft retaining bolts to 55-75 N·m (40-55 ft-lb).

Bearings, Cups and Seals

F-Super Duty

Disassembly

1. Set the parking brake and loosen the axle shaft attaching bolts (Fig. 3).
2. Raise the rear wheels off the floor and place safety stands under the rear axle housing. Release the parking brake.
3. Remove the axle shaft attaching bolts and washers and discard them.
4. Using a heavy duty dolly such as the Rotunda Model 014-00030 or equivalent as shown in figure 4, raise the wheel to the point that all weight is removed from the wheel bearings. If a dolly is unavailable, remove the wheel and tire assembly.
5. Remove the axle shaft and discard the gasket.
6. Remove the caliper as outlined in section 12-24.
7. Remove the wheel bearing hub nuts using Tool T88T-4252-1A, so that the drive tangs of the socket engage the four slots of the nut (Fig. 5).
8. Remove the outer bearing cone, pull the wheel assembly straight out and away from the axle. If it had not been done in step 4, remove hub assembly and set aside.

CAUTION: The hub nuts are right hand thread for the right side and left hand thread for the left side. Each hub nut is stamped RH or LH to identify thread direction. Do not use power impact tools when performing operations on the hub nuts.

NOTE: The hub nuts will ratchet during this operation unless the F- Super Duty tool is used.

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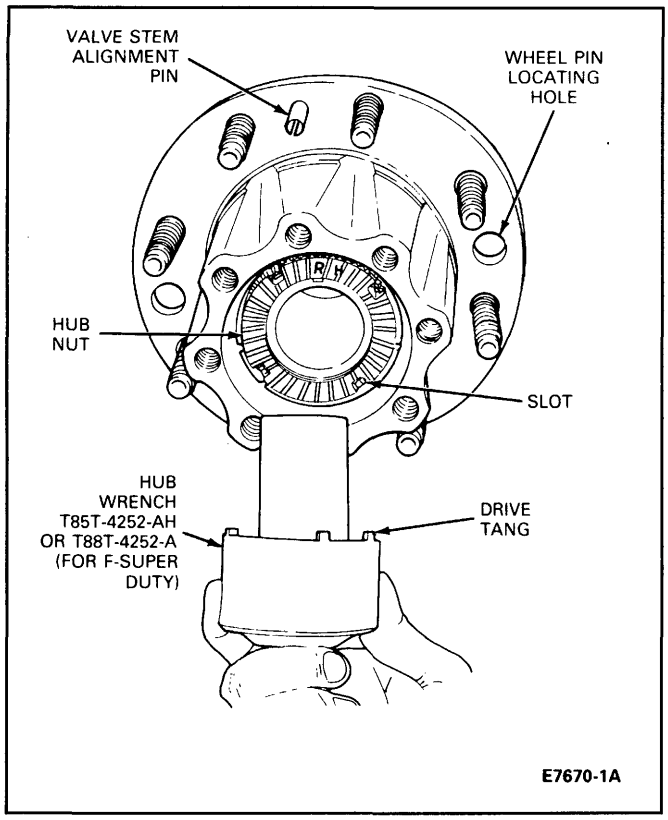


FIG. 5 Hub Wrench Engagement

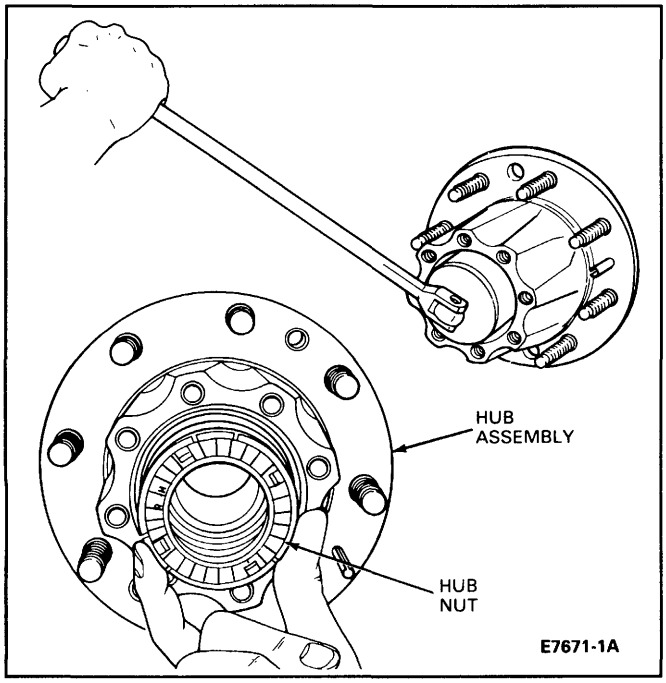


FIG. 6 Tightening Hub Nut

9. Thoroughly clean the spindle of the axle housing.

10. Carefully remove the inner seal from the hub assembly with a screwdriver, avoiding damage to the bearing or hub bore. Discard the seal.

11. Clean all old grease and axle lubricant out of the wheel hub.

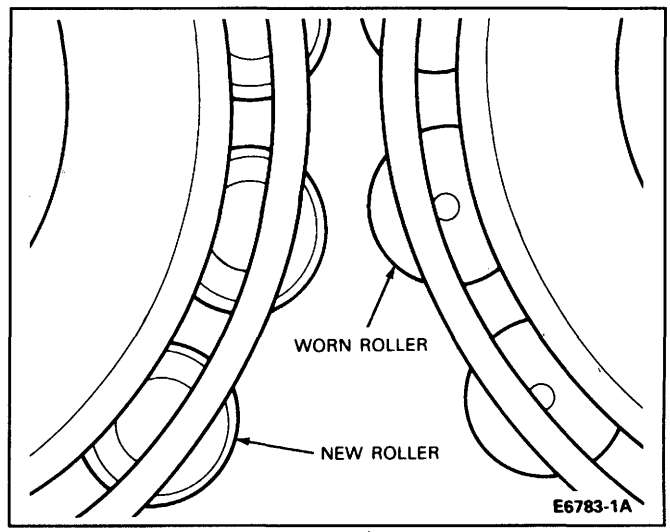


FIG. 7 Roller Bearing End Wear

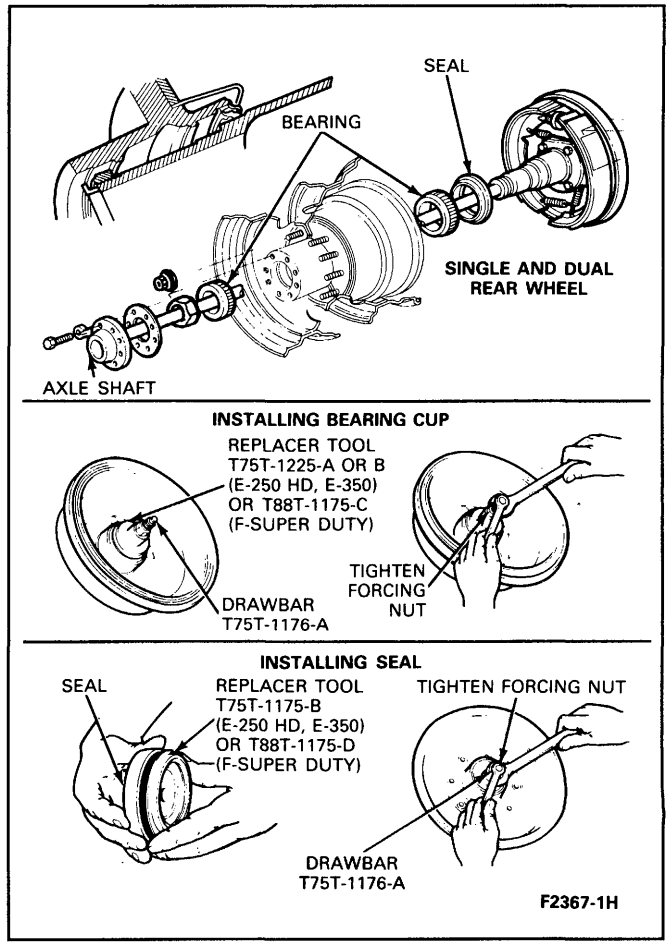


FIG. 8 Installation of Rear Wheel Bearings and Seal

12. Inspect the bearing races and rollers for pitting, galling or erratic wear patterns. Inspect the rollers for end wear (Fig. 7).

13. Remove the inner bearing cup with Tool T88T-1175-B. Remove the outer bearing cup with Tool T88T-1175-A. Inspect the bearing races and rollers for pitting, galling or excessive wear. If either component (cup or cone and roller) of the tapered roller bearing is not usable, both components

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should be replaced. Install the new cups with special tool Bearing Cup Replacer 788T-1175-C and Threaded Drawbar T75T-1176-A (Fig. 8).

Assembly

1. Check for proper seating of the new bearing cups by trying to insert a 0.038mm (0.0015 inch) feeler gauge between the cups and the wheel hub. The gauge should not enter beneath the cup. Check in several places to be sure the cups are squarely seated.
2. Pack each bearing cone and roller assembly with a bearing packing tool such as Rotunda 108-00078 or equivalent, using a lithium base grease, Multi-Purpose Long Life Lubricant. C1AZ-19590-B (ESA-M1C75-B) or equivalent.
3. Place the inner bearing cone and roller assembly in the hub. Install a new inner seal with Tool T88T-1175-D and threaded drawbar, T75T-1176-A (Fig. 8).
4. Position the hub and rotor assembly at the axle housing. Wrap the threads of the spindle with electricians tape. Carefully slide the hub and rotor assembly over the axle housing spindle. Remove the electricians tape.
5. Install the outer wheel bearing cone and roller and start the bearing hub nut making sure the hub tab is properly located in the keyway prior to thread engagement (Fig. 9).
6. Install the F-Super Duty Hub Wrench T88T-4252-A so that the drive tangs of the tool engage the four slots of the nut. Apply inward pressure to the socket to separate the ratcheting components of the nut, tighten to 88-102 N·m (65-75 ft-lb). Back off 90 degrees, then re-tighten to 20-27 N·m (15-20 ft-lb). Rotate hub occasionally while tightening to set the bearings.
7. Prior to installation of the axle shaft, clean and remove any debris in the hub bolt holes. Inspect for cracked material around the holes, depth of the holes (40mm total, threaded for 25mm), or oversized holes. Replace the hub if any of these conditions are present. Install the axle shaft, new gasket, and new bolts. Coat the bolt threads with a suitable thread adhesive, and install the bolts until they seat.
8. Install the wheel and tire assemblies.
9. Remove safety stands and lower the vehicle to the floor.
10. Tighten the wheel lug nuts to specifications.
11. Tighten the axle shaft hub retaining bolts to 95-115 N·m (70-85 ft-lb).

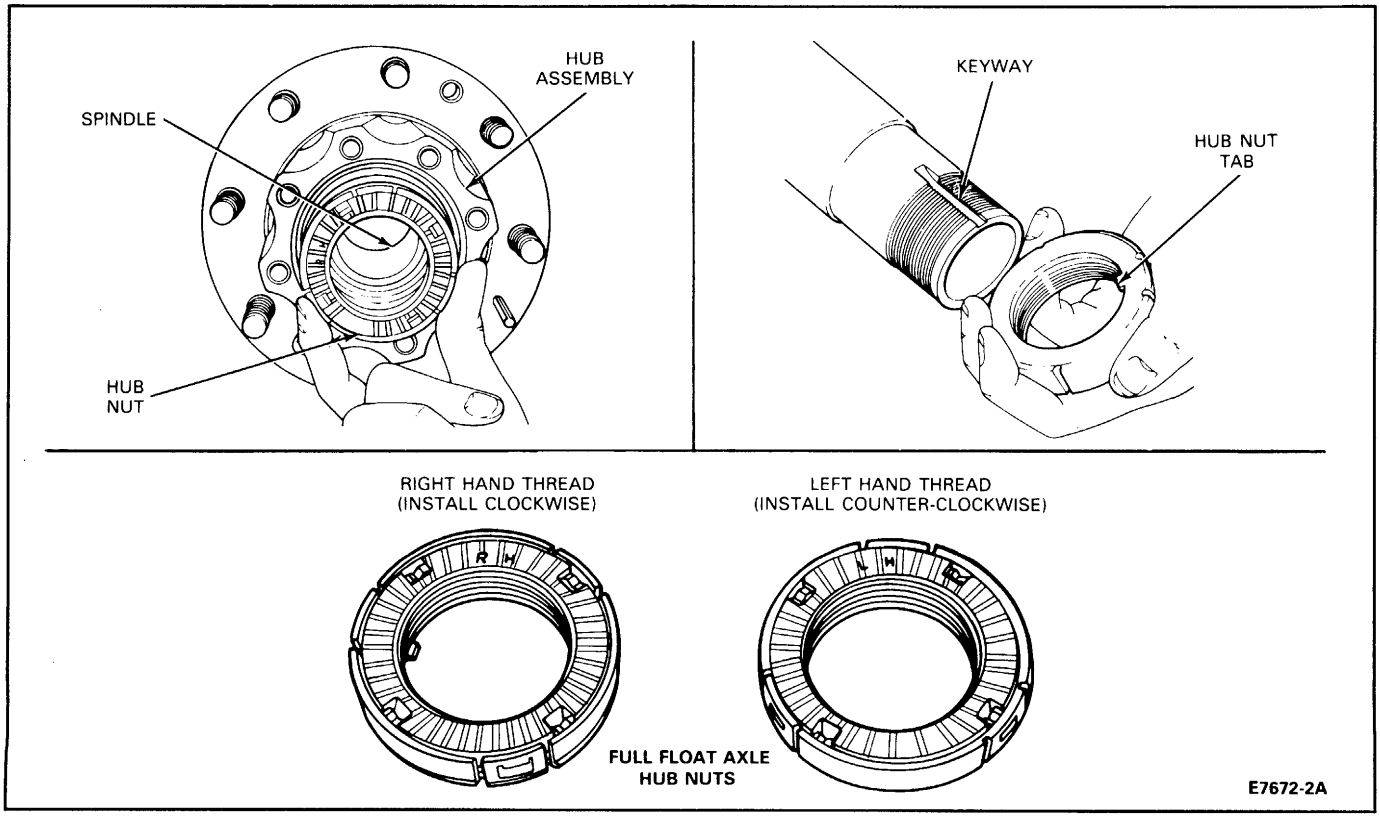


FIG. 9 Hub Nut Installation

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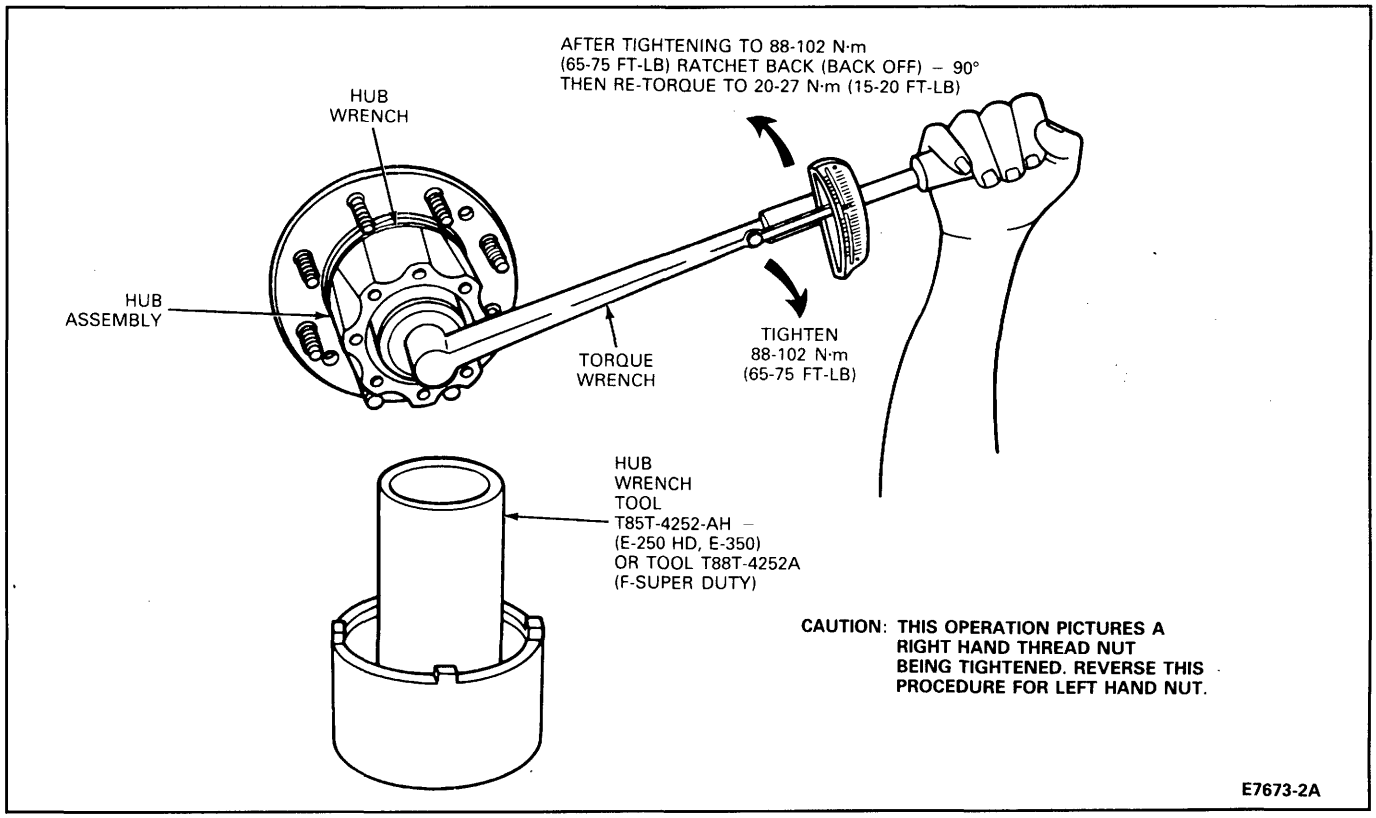


FIG. 10 Tightening Hub Nut

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lb.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lb.	Universal
D79P-100-A	Impact Slide Hammer — 5 Lb.	Universal
T58L-101-A	Puller Attachment	Universal — Use with Slide Hammer
T77F-1102-A	Bearing Cup Puller	Universal — Use with Slide Hammer
Tool-1175-AC	Seal Remover	Universal
T75T-1175-A	Seal Replacer	Use with Threaded Drawbar
T75T-1175-B	Seal Replacer	Use with Threaded Drawbar
T75T-1176-A	Threaded Drawbar	—
T73T-1202-A	Bearing Cup Replacer	Use with Driver Handle
T75T-1225-A	Bearing Cup Replacer	Use with Threaded Drawbar
T75T-1225-B	Bearing Cup Replacer	Use with Threaded Drawbar
T76T-1225-C	Bearing Cup Replacer	E-350 with DRW
D79T-4000-A	Outside Thread Chaser	Universal
T80T-4000-W	Driver Handle	Bearing Installation
T85T-4252-AH	Hub Wrench	—
T70T-4252-D	2-9/16" Hex Locknut Wrench	—
T70T-4252-E	2-9/16" Octal Locknut Wrench	—
T88T-1175-A	Hub Outer Bearing Cup Remover	F-Super Duty
T88T-1175-B	Hub Inner Bearing Cup Remover	—
D80T-4200-H	Hub Inner Bearing Cup Replacer	—
T88T-1175-C	Hub Outer Bearing Cup Replacer	—
T88T-1175-D	Hub Seal Replacer	—
T88T-4252-A	Hub Wrench	F-Super Duty and HDE-250, E-350

CE4331-2G

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ROTUNDA EQUIPMENT

Number	Description
014-00030	Heavy Duty Wheel Dolly
108-00078	Bearing Packer

CF3417-1C

WHEEL TORQUE SPECIFICATIONS — FULL FLOAT REAR AXLES

Vehicle	Wheel	Bolt Size	Torque①	
			N-m	Ft-Lbs
E-250, E-350 — Single Rear Wheel Vehicles	8-Lug Wheel	9/16-18	190	140
E-350 — Dual Rear Wheel Vehicles With Integral Two-Piece Swiveling Lug Nuts	8-Lug Wheel	9/16-18	190	140
F-Super Duty — Dual Rear Wheel Vehicles with Integral Two-Piece Swiveling Lug Nuts	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. CE5841-2C

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GROUP

BRAKES 12

(2000)

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VEHICLE APPLICATION

E-150 through E-350, F-150 through F-350, F-Super Duty and Bronco Truck Models.

DESCRIPTION AND OPERATION

Hydraulic brakes are standard equipment on all vehicles.

Hydraulic rear drum brakes on all Bronco, F-150—F-350 and E-150—E-350 trucks use automatic rear brake shoe adjusters. Hydraulic disc brakes are used on all front brake systems, and for F-Super Duty rear brakes.

Dual Master Cylinder Brake System

Refer to Figures 1, 2 and 3.

The dual master cylinder contains a double hydraulic cylinder with a plastic see thru reservoir, (FLI-Fluid Level Indicator), primary and secondary hydraulic pistons.

The dual master cylinder performs in the following manner:

REAR WHEEL BRAKES—the rear wheel brakes are connected to the secondary outlet port and are actuated by the secondary piston assembly.

FRONT WHEEL BRAKES—the front wheel brakes are connected to the primary outlet port (farthest from dash panel) and are actuated by the primary piston assembly.

Both primary and secondary pistons function together.

The hydraulic brake system is assisted by a vacuum booster installed as standard equipment. Information about the vacuum booster is given in Sections 12-50 Vacuum Brake Booster—Single Diaphragm—Dash Mounted (Bendix) and 12-52 Vacuum Brake Booster—Tandem Diaphragrm—Dash Mounted (Bendix), and Hydroboost.

The proportioning valve, integral to the master cylinder (Figs. 2 and 3) proportions pressure to the rear system. During heavy brake application, the proportioning valve reduces pressure (By-Pass feature) to the rear brakes to inhibit lock-up.

The Height Sensing Brake Proportioning Valve (Fig. 4) is used on the E-250—E-350 and F-Super Duty. The height sensing valve regulates rear brake hydraulic pressure when the vehicle is in the empty condition and provides full braking pressure to the rear brakes when the vehicle is carrying a full load.

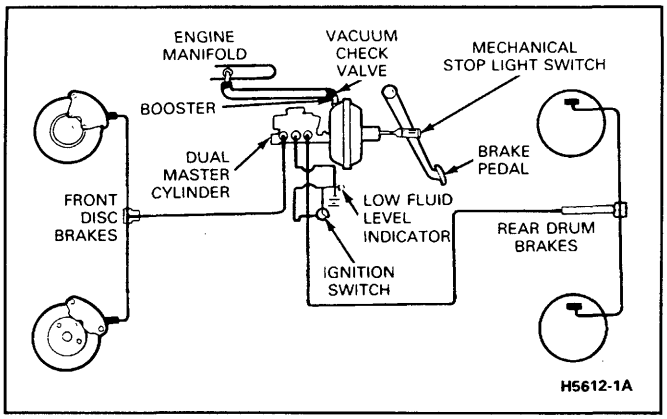


FIG. 1 Hydraulic Brake System with Dash-Mounted Booster—Typical

The valve is located on the number four crossmember (Fig. 5) and is activated through a linkage system that is connected to the rear axle housing cover. Pressure on the lever from the vehicle load will activate the height sensing valve to regulate the hydraulic pressure to apply the rear brakes.

For more information on the Height Sensing Brake Proportioning Valve, refer to Section 12-30, Brake Pedal, Master Cylinder and Valves.

Disc Brakes

All F-150 through F-350 Series, E-150 through E-350 Series, and Bronco are equipped with front disc brakes. The F-Super Duty is equipped with Four-wheel disc brakes. (Refer to Section 12-24 Disc Brakes—Light and Heavy Duty Sliding Caliper).

Drum Brakes

The rear brakes are drum type with internal expanding shoes. The rear drum brakes are of the single anchor type, mounted to the same anchor, and actuated by one wheel cylinder. The wheel cylinder has two pistons. One piston exerts force against the upper end of the primary shoe; the other piston exerts force against the upper end of the secondary shoe (Figs. 6 and 7).

Rear Antilock Brakes

The Rear Antilock Brake System (RABS) is used on F-150—F-350 and Bronco vehicles. The system consists of a computer module, RABS Valve speed

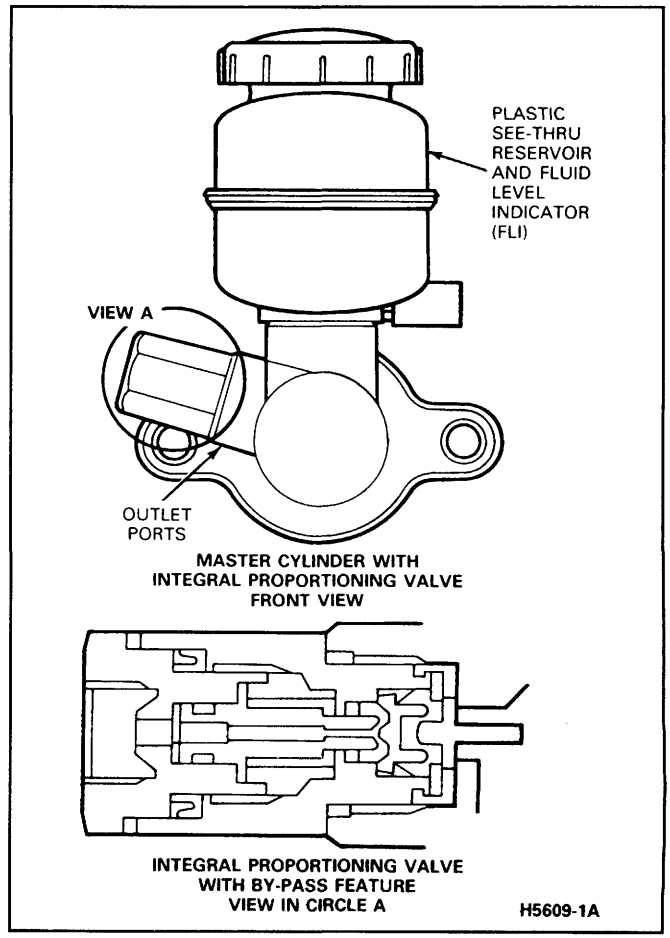


FIG. 2 Master Cylinder Assembly with Integral Proportioning Valve

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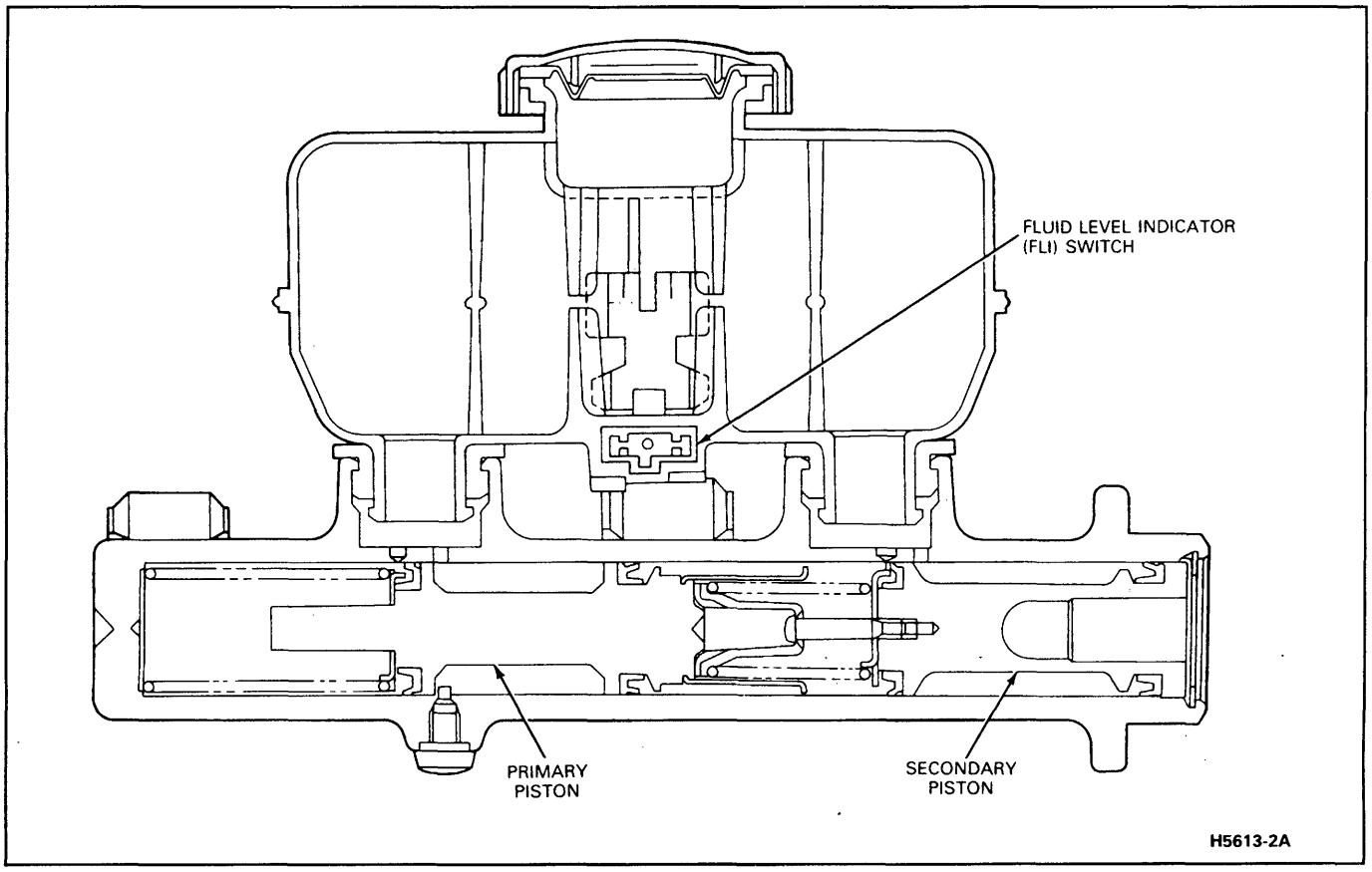


FIG. 3 Master Cylinder Assembly

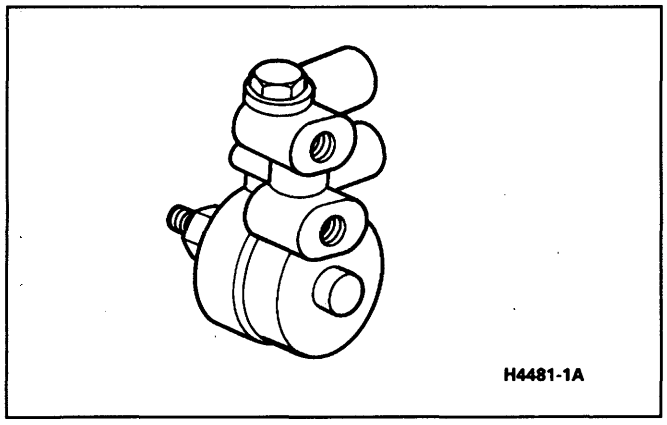


FIG. 4 Height Sensing Brake Proportioning Valve E-250—E-350

sensor and an excitor ring. For more information, refer to Section 12-31, Rear Antilock Brakes.

SAFETY

Breathing Asbestos Dust

WARNING: DO NOT INHALE DUST FROM BRAKES, CLUTCHES OR ASSOCIATED COMPONENTS. INHALATION OF DUST CONTAINING ASBESTOS FIBERS CAN BE INJURIOUS TO YOUR HEALTH AND COULD CAUSE CANCER OR ASBESTOSIS. COMPRESSED AIR OR BRUSHES MUST NOT BE USED TO CLEAN BRAKES, BRAKE DRUMS, CLUTCHES AND ASSOCIATED COMPONENTS. A VACUUM CLEANER EQUIPPED FOR THIS PURPOSE SHOULD BE CAREFULLY USED TO REMOVE ANY DUST (ROTUNDA MODEL 091-00001). ADHERENT DUST SHOULD BE REMOVED WITH A DAMP RAG. ANY DUST SHOULD BE CONTAINED IN A SEALED AND LABELED BAG FOR DISPOSAL. WEAR AN APPROVED HIGH EFFICIENCY CARTRIDGE OR AIR LINE RESPIRATOR AND USE EXTRA CAUTION TO AVOID BREATHING THIS DUST. USE NON-ASBESTOS REPLACEMENT PARTS WHENEVER POSSIBLE.

The following procedures are recommended to minimize asbestos dust exposures during brake and clutch servicing of trucks, tractors and trailers. These procedures are consistent with asbestos regulations set forth by the Occupational Safety and Health Administration (OSHA). Adherence to these procedures will eliminate exposures to asbestos during brake and clutch servicing.

An area should be designated for all brake and clutch services. Entrances to this area must be posted with the following sign:

ASBESTOS

Dust Hazard

Avoid Breathing Dust

Wear Assigned Protective Equipment

Do Not Remain in Area Unless Your Work Requires It

Breathing Asbestos Dust May Cause Asbestosis and Cancer

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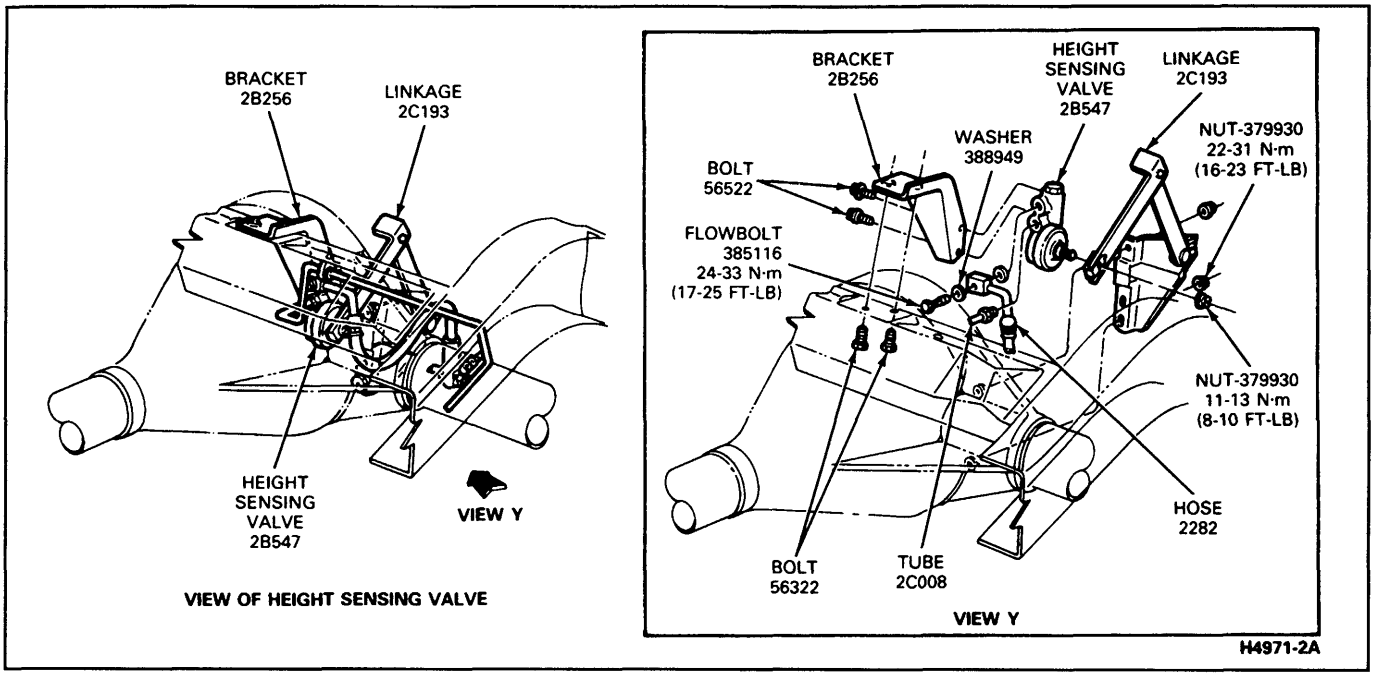


FIG. 5 Height Sensing Brake Proportioning Valve Installation E-250—E-350

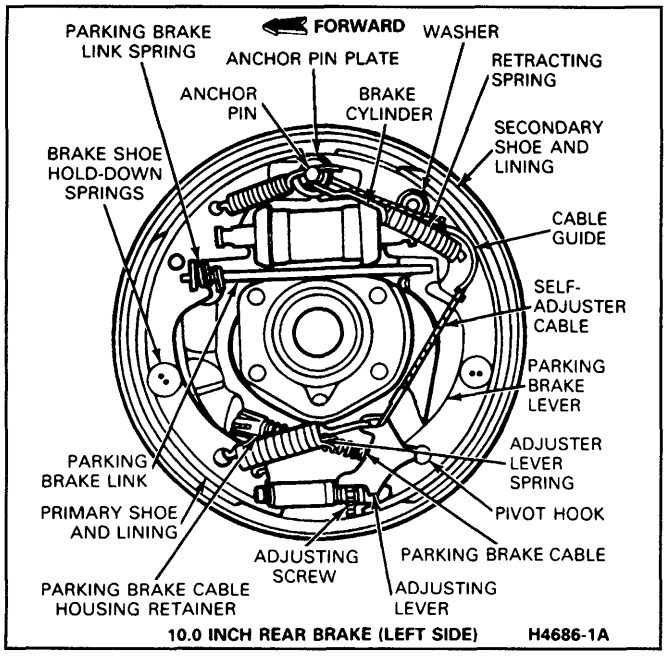


FIG. 6 Self Adjusting Brake Assemblies Standard—E-150, F-150 (4x2) (4x4) and Bronco

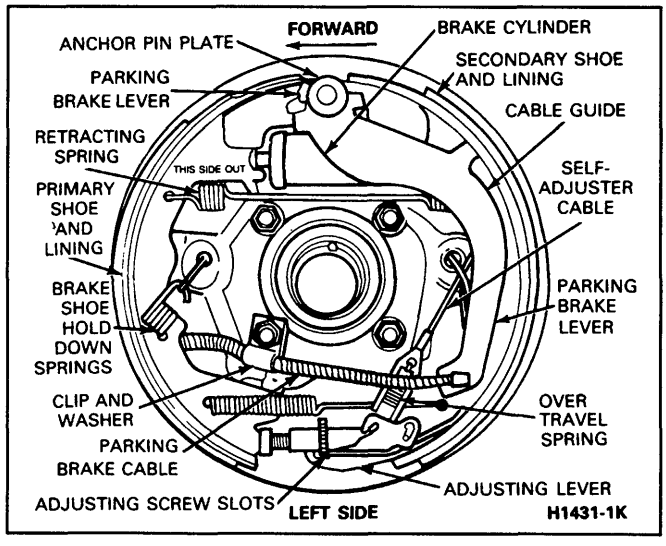


FIG. 7 Self Adjusting Brake Assemblies—F-250—F-350 (4x2) (4x4) and E-250—E-350

Only essential personnel should be present in the immediate maintenance area during brake and clutch servicing.

During brake servicing, use a toxic dust air purifying respirator of either single-use or replaceable cartridge type. It must be approved by the Mine Safety and Health Administration (MSHA) or by the National Institute of Occupational Safety and Health (NIOSH). It shall be worn during all procedures from removal of wheels to reassembly. An example of an acceptable respirator is the 3M-9910 or 9920 (or equivalent).

Wheel brake assemblies must be cleaned carefully using a vacuum cleaner recommended for use with asbestos fibers. A vacuum for this purpose is available from the Rotunda Equipment Catalog, Model Number 091-00001 or equivalent. Similar vacuums are also manufactured by Nilfish and Hako ("Minuteman"). If additional cleaning is necessary, a rag soaked with water or a brake washer (Rotunda model 065-00016 or equivalent) must be used.

Grinding or sanding on brake linings, pads, rotors or drums, shall be done only while using properly exhaust-ventilated equipment. A respirator must be worn while performing these operations.

During removal of vacuum bags, an approved respirator, as described above, shall be worn. Industrial vacuum cleaner bags containing asbestos dust, cloths used for wiping brake assemblies, and other asbestos-contaminated debris shall be sealed in plastic bags and labeled with the following warning label printed in letters

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of sufficient size and contrast to be readily visible and legible:

CAUTION

Contains Asbestos Fibers

Avoid Breathing Dust

Breathing Asbestos Dust May Cause

Asbestosis and Cancer

All asbestos waste must be disposed in accordance with OSHA and Environmental Protection Agency (EPA) asbestos regulations. Asbestos waste must not be incinerated or disposed of in community water supplies.

All floor cleaning in the asbestos servicing area and clean-up of waste from grinding or sanding must be done using an approved vacuum cleaner while wearing a proper respirator.

DIAGNOSIS AND TESTING

Occasional brake squeal can be caused by environmental conditions such as cold, hot, wet, snow, salt, mud etc. This occasional squeal is not a functional problem and does not indicate any loss in brake effectiveness.

Brake System Preliminary Checks

Always make the following preliminary checks before testing the brake system:

1. Check the fluid level in the brake master cylinder reservoir(s). If the fluid level is not within 3.17mm (1/8 inch) of the top of the reservoir, add Ford Heavy Duty Brake Fluid, C6AZ-19542-A or B (ESA-M6C25-A) or equivalent. **Do not mix low temperature brake fluids with the specified brake fluid.**
2. Push the brake pedal down as far as it will go. If the pedal travels more than halfway to the floor, adjust the rear brakes. The vehicle is equipped with automatic rear brake adjusters, adjust brakes by driving the vehicle forward and backward and applying brakes several times sharply in each direction.
3. If the brakes will apply and the vehicle can be safely stopped, road test the vehicle and apply the brakes at a speed of about 32 km (20 mph) to see if the vehicle stops evenly. If it does not, manually adjust the brakes.

Dual Brake Warning Light System Tests

1. Turn the ignition switch to the ACC or ON position. If the light on the brake warning lamp remains on, there may be a shorted or broken switch, grounded switch wires, or low brake fluid. If the warning lamp still remains on, check for a grounded switch connector or wire and repair or replace the wire assembly. If the wire is in good condition, replace the brake warning lamp switch.
2. Turn the ignition switch to the START position. If the brake warning lamp does not light, check the light and wiring and replace or repair wiring, if necessary.

   The brake warning lamp should light only when the ignition key is in the START position or when the ignition key is on and the parking brake is applied, or for diesel engines, when the vacuum is low.

Hydraulic Leak Test

1. With the brakes applied, visually inspect all hydraulic lines, connections, and hoses for evidence of leaks. Replace leaking parts as necessary.
2. If the leak has not been found, on rear drum brakes, remove the brake drums and inspect all wheel cylinders for evidence of leaks. Replace or re-build wheel cylinders as necessary. On disc brakes, inspect for leakage at the caliper. Replace or rebuild the calipers as necessary.
3. If the leak has not been found, disconnect the hydraulic tubes from the master cylinder and plug the output ports using the appropriate size flared tube type plugs. Push the brake pedal down as hard as possible. If the pedal slowly moves downward, the master cylinder is leaking internally and should be re-built or replaced.

Power Brake Function Test

1. With the engine stopped, eliminate all vacuum from the system by pumping the brake pedal several times. Then push the pedal down as far as it will go, and note the effort required to hold it in this position. If the pedal gradually moves downward under pressure, the hydraulic system is leaking and should be subjected to a hydraulic leak test.
2. With the brake pedal pushed all the way down, start the engine. If the vacuum system is operating properly, the pedal will move downward. If pedal position does not change, the vacuum system is not operating properly and should be subjected to a vacuum system test.

Vacuum System Test

Shut the engine off. If the vacuum does not drop more than one inch Hg. in one minute, omit Steps 3 through 8.

1. Disconnect the engine vacuum line from the booster (vehicle with dash mounted booster) and connect a vacuum gauge, Rotunda model 059-00008 or equivalent to the vacuum line with a T-fitting. With the engine thoroughly warmed up, the gauge should read 18-21 inches Hg. at idle with the transmission in neutral. If the idle vacuum is not at least 18-21 inches Hg. the engine requires a tune up.
2. With the engine properly tuned, connect the vacuum line back up.
3. Inspect the plastic check valve, rubber grommet, and all vacuum plumbing for cracks, holes, bad connections, or missing clamps that might cause leaks. Perform Step 2 of the Power Brake Function Test to determine if the problem has been corrected.
4. Disconnect the vacuum line and connect a vacuum gauge with a T-fitting to the lower part of the dash mounted plastic check valve. Start the engine and let it idle until the gauge reads 17.5-21 inches Hg. Shut the engine off. If the vacuum drops more than one inch in one minute, replace the check valve.
5. If the problem persists, reconnect the test gauge to the same point, leaving the rest of the vacuum system connected this time. Check the vacuum leak down rate as in Step 3. If the system does not pass the test, disconnect the booster and check

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the vacuum leak down rate holding a thumb over the open end of the line. Only one item should be disconnected at a time. When the system passes the leak down test, the item that is disconnected should be repaired or replaced.

6. If the vehicle is equipped with a dash mounted booster, the plastic check valve should be replaced.
7. With the test gauge connected as in Step 4 or 5, with 17.5-21 inches Hg. of vacuum and the engine shut off, depress the brake pedal one time and release it after holding it down for a few seconds. If the vacuum drops to zero, a booster diaphram (control or power) is ruptured and the booster should be re-built or replaced.

Master Cylinder

Normal Conditions: The following conditions are considered normal and are not indications that the master cylinder is in need of service:

Condition 1: During normal operation of the master cylinder, the fluid level in the reservoir will rise during brake application and fall during release. The net fluid level, i.e., after brake application and release, will remain unchanged.

Condition 2: A trace of brake fluid existing on the booster shell below the master cylinder mounting flange. This results from the normal lubricating action of the master cylinder bore and seal.

Condition 3: Fluid level will decrease with pad wear.

Abnormal Conditions: Changes in brake pedal feel or travel are indicators that something could be wrong in the brake system. The following conditions use brake pedal feel and the warning lamp along with reservoir fluid level, as indicators in diagnosing brake system complaints.

Condition 1: Pedal goes down fast. This could be caused by an external leak, internal leak or air in the system.

Condition 2: Pedal eases down slowly. This could be caused by an external leak or internal leak.

Condition 3: Pedal is low and/or feels spongy. This condition may be caused by: no fluid in the reservoir, reservoir cap vent holes clogged, rear brakes out of adjustment, or air in the hydraulic system.

Condition 4: Pedal effort excessive. This may be caused by a bind or obstruction in pedal/linkage, or insufficient booster vacuum.

Condition 5: Brake warning lamp on. This may be caused by low fluid level, ignition wire routing too close to fluid level indicator assembly/or float assembly damage.

NOTE: Prior to performing any diagnosis, make certain the brake system warning lamp is functional.

The diagnostic techniques and service procedures are referenced in the Brake Master Cylinder Diagnosis charts. Please refer to these charts for proper use of diagnostic techniques in diagnosing brake hydraulic system problems.

CHECKING BRAKE SYSTEM FOR EXTERNAL FLUID LEAKS

It is possible that all evidence of fluid leakage may have washed off if the vehicle has been operated in rain or snow, as brake fluid is water soluble. Refill system, bleed, and apply the brakes several times. Examine the system to verify that the reservoir fluid level is actually dropping. Locate and correct the external leak. If fluid level drops and no external leak can be found, check for a master cylinder bore end seal leak.

A MASTER CYLINDER BYPASS CONDITION—CHECKING

1. Check fluid in master cylinder. Fill reservoir if low or empty.
2. Observe fluid level in reservoir. If after several brake applications the fluid level remains the same, measure wheel turning torque required to rotate wheels with brakes applied as follows:
   - Place transmission in Neutral and raise front wheels off the ground.
   - Apply brakes with a minimum of 445 N (100 lbs) and hold for approximately 15 seconds. With brakes still applied, exert torque on front wheels to 101 N·m (75 lb-ft). If either wheel rotates, check internals of master cylinder and replace damaged parts.

CHECKING FOR RESERVOIR SEALING POINTS

An empty reservoir condition may be caused by two types of non-pressure external leaks.

Type 1: An external leak may occur at the master cylinder reservoir cap because of improper positioning of the gasket and cap. Reposition cap and gasket.

Type 2: An external leak may occur at the reservoir mounting grommets. Service such a leak by installing new grommets and reservoir assembly.

CHECKING FOR BRAKE PEDAL RESERVE

Where a low pedal or the feel of a bottomed out condition exists, check for brake pedal reserve.

1. Operate engine at idle with the transmission in either Park or Neutral position.
2. Depress brake pedal lightly three to four times.
3. Allow 15 seconds for vacuum to replenish booster.
4. Apply brake pedal until it stops moving downward or an increased resistance to the pedal travel occurs.

NOTE: This increased resistance may feel like something has bottomed out.

5. Hold pedal in applied position and raise the engine speed to approximately 2,000 rpm.
6. Release accelerator pedal and observe that brake pedal moves downward as engine returns to idle speed.

NOTE: The additional movement of the brake pedal is the result of the increased engine manifold vacuum which exerts more force on the brake booster during engine rundown. This means that additional stroke is available in the master cylinder, and the brake system is not bottoming out as a customer may believe.

Diagnosis Guides

The diagnosis guides in this Section can be used as an aid in diagnosing hydraulic brake systems.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• Brake warning light on.	1. Low fluid level.	1. Add fluid, bleed system and check for leaks.
	2. Low vacuum level (diesel only)	2. Refer to Section 12-56, Brake Booster Vacuum Pump — 6.9L Diesel Engine for diagnosis and testing procedures.
	3. Shorted light circuit.	3. Correct short in warning circuit.
	4. Worn or damaged brake warning switch.	4. Replace switch.
	5. Leak in brake system.	5. Repair leak.
• Brakes not working, excessive pedal travel, brake pedal feels spongy when fully applied.	1. Rear brakes out of adjustment.	1. Adjust rear brakes.
	2. Front wheel bearing out of adjustment.	2. Adjust front wheel bearings.
	3. Master cylinder or booster dash unit mounting loose.	3. Tighten nuts and bolts to specification.
	4. Disc brake caliper attachment loose.	4. Replace or tighten as required.
	5. Worn or damaged self-adjusters.	5. Remove drum and check lining for proper adjustment. Replace self-adjusters.
	6. Glazed, worn, scored or damaged brake linings.	6. Replace brake shoes and linings in sets.
	7. Drum out of round or rotors with excessive runout.	7. Refinish, or replace if wear exceeds limits.
	8. Brake tubing improperly positioned.	8. Check brake tubing for misposition near heat source. Hot fluid can boil and result in spongy pedal response.
• Excessive pedal travel or pedal goes to floor consistently.	1. Hydraulic system.	1. Perform master cylinder diagnosis test. Refer to master cylinder diagnosis chart. Repair as required.
	2. Drum brakes out of adjustment, worn, bad wear pattern, or cracked drums.	2. Repair or replace as required.
	3. Loose or improper attachment of pedal, pedal support booster and master cylinder.	3. Repair or replace as required.
	4. Misaligned anchor plate.	4. Refer to misaligned disc brake anchor plate diagnosis. Repair as required.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• Excessive pedal effort to fully apply brakes.	1. Overloaded vehicle.	1. Lighten load and advise owner of correct load limits of vehicle.
	2. Insufficient vacuum to brake booster.	2. Replace damaged or leaking vacuum hoses.
	3. Restricted air filter on power brake booster.	3. Clean or replace filter.
	4. Booster and brake pedal linkage binding caused by worn bushings or corrosion.	4. Replace worn bushings or clean and lubricate linkage.
	5. Worn or damaged brake booster.	5. Replace booster.
	6. Brake lining worn, glazed, contaminated or improper type.	6. Replace brake lining in axle sets.
	7. Brake shoe and lining improperly installed.	7. Reposition brake shoes properly and eliminate any binding.
	8. Seized pistons in wheel cylinders or seized calipers.	8. Repair or replace as required.
	9. Restricted brake lines or hoses.	9. Repair or replace as required.
	10. Inoperative height sensing valve. (E-250—E-350 only.)	10. Check vehicle ride height and control linkage.
• Intermittent loss of pedal.	1. Hydraulic system.	1. Perform master cylinder diagnosis. Repair as required.
	2. Front wheel bearings out of adjustment.	2. Adjust front wheel bearings.
	3. Drum brakes out of adjustment, worn, bad wear pattern or cracked drums.	3. Repair or replace as required.
	4. Loose or improper attachment of pedal, pedal support, booster and master cylinder.	4. Repair or replace as required.
	5. Misaligned anchor plate.	5. Refer to misaligned disc brake anchor plate diagnosis. Repair as required.
• Brakes pull to one side.	1. Unequal air pressure in tires.	1. Inflate tires to correct pressure.
	2. Grease or fluid on linings. Contaminated linings.	2. Clean, sand and/or replace linings.
	3. Improper size or type of lining on one wheel.	3. Replace with correct brake linings in sets.
	4. Improper size wheel cylinder on one wheel.	4. Replace with correct wheel cylinder.
	5. Stuck or seized pistons in wheel cylinders of seized calipers.	5. Repair or replace as required.
	6. Restricted brake lines or hoses.	6. Repair or replace as required.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• Brakes pull to one side. (Continued)	8. Other brake components. — Improper adjustment of drum brakes. — Improper positioning of disc brake shoe and lining in the caliper. — Improperly adjusted, damaged or worn wheel bearings. — Distorted drum brake shoes. — Worn brake linings. — Missing, broken or stretched retracting or retaining springs and clips. 9. Should brake system check OK and complaint still exists, see suspension, steering and tire section of this manual for front end, toe-alignment, etc.	8. Inspect, adjust, repair or replace as required.
• Brakes grab or lock up when applied.	1. Tires worn or incorrect pressure. 2. Grease or fluid on linings — damaged linings. 3. Improper size or type of linings. 4. Over-reaction of brake booster. 5. Rear brakes continually lock up at low pedal effort. 6. Other brake system components. — Worn, damaged or dry wheel bearings. 7. Parking brake cable binding or out of adjustment. 8. Parking brake cable control assembly binding.	1. Inflate tires to correct pressure. Replace tires with worn tread. 2. Inspect, repair, or replace linings in sets. 3. Replace with correct brake linings in sets. 4. Check brake booster for over-reaction by comparing with a known quality vehicle. Replace brake booster if required. 5. Replace rear Antilock Brake (RAB) Valve on F-150—F-350 and Bronco or Height Sensing Valve on E-150—E-350. 6. Inspect, repair, or replace as required. 7. Adjust cables. Repair, lubricate, or replace if required. 8. Repair, lubricate or replace if required.
• Brakes drag, slow or incomplete release.	1. Parking brake control or cables binding. 2. Brake pedal binding. 3. Front wheel bearing out of adjustment.	1. Repair, lubricate, or replace parts as required. 2. Repair, lubricate, or replace parts as required. 3. Check bearings for adjustment, wear, damage. Adjust bearings.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• Brakes drag, slow or incomplete release. (Continued)	4. Worn or damaged master cylinder.	4. Check master cylinder for open compensator ports. Repair or replace.
	5. Brakes out of adjustment.	5. Adjust brakes.
	6. Restriction in hydraulic system.	6. Repair or replace as required.
	7. Seized wheel cyinders or caliper pistons.	7. Repair or replace as required.
	8. Stoplight switch out of adjustment.	8. Adjust switch.
	9. Lack of lubricant on disc brake caliper slides.	9. Lubricate disc brake caliper slides.
	10. Speed control dump valve inoperative.	10. Repair or replace as required.
• Noise at wheels when brakes are applied — snap or clicks.	1. Cracked welds as brake shoe web.	1. Replace brake shoe and lining assemblies in axle sets.
	2. Brake shoes binding at backing plate ledges.	2. Clean and lubricate ledges.
	3. Machining marks on brake drums.	3. Refinish, or replace brake drums.
	4. Backing plate ledges worn.	4. Replace backing plate and lubricate ledges.
	5. On disc brakes — loose or missing anti-rattle clips.	5. Replace.
	6. Other brake system components.	6. Inspect, repair or replace.
	— Loose outer shoe crimping.	

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ADJUSTMENTS

Brake Pedal Adjustment

On dual-brake master cylinder or dash mounted vacuum booster equipped vehicles, the brake systems are designed to permit a full stroke of the master cylinder when the brake pedal is fully depressed. A brake pedal clearance adjustment is not required.

To release the brakes, fluid must flow back to the master cylinder through a return port when pedal pressure is released. To be sure the piston moves back far enough to expose the return port, free-travel is built into the pedal linkage on standard and frame-mounted booster systems. This prevents the piston from becoming trapped in a partially released position. Pedal free travel is not always perceptible in dash-mounted booster systems, because the operating clearance for the piston is adjusted at the booster push-rod, rather than the pedal linkage. (Refer to Sections 12-50 Vacuum Brake Booster—Single Diaphragm—Dash Mounted (Bendix) and 12-52 Vacuum Brake Booster—Tandem Diaphragm—Dash Mounted (Bendix) for instructions on a dash-mounted booster push rod adjustment).

Dump Valve Adjustment

(Vehicles with Speed Control Only)

NOTE: Installation and adjustment of the Dump Valve must be done prior to draining and filling of the master cylinder.

The brake pedal must be pulled back toward the driver's seat to the full extension of the master cylinder pushrod. Do not apply more than 15 lbs. of force to the brake pedal to establish the maximum rearward position.

Front Disc Brakes

F-150-F-350 (4x2), F-150-F-350 (4x4), Bronco, E-150-E-350 and F-Super Duty

The front disc brake assembly is designed so that it is self-adjusting. Refer to Section 12-24 Disc Brake-Light and Heavy Duty—Sliding Caliper.

Rear Disc Brakes

F-Super Duty

The rear disc brake assembly is designed so that it is self-adjusting. Refer to Section 12-24 Disc Brake—Light and Heavy Duty—Sliding Caliper.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Noise at wheels — brakes applied — squeak or squeal. A loud, sharp, high-pitched moderately prolonged sound that occurs while braking. Occasional or intermittent brake squeal/squeak may result from environmental conditions such as cold, heat, wetness, snow, salt, mud, etc. This condition is not a functional one and will not affect brake effectiveness.	1. Brake lining and/or rotor surface contamination.	1. Remove caliper assembly from spindle and remove inner and outer linings. Hand sand the linings and both braking surfaces of rotor. Use Garnett Paper 100A (medium grit) or equivalent or aluminum oxide 150J (medium) or equivalent. Turning or replacing rotors is not an effective repair for squeal.
	2. Disc Brakes — Missing or damaged brake pad insulators.	2. Replace insulators or replace shoe and lining assembly if pads are worn.
	3. Improper lining parts.	3. Inspect for correct usage. Replace as required.
	4. Drum Brakes — Loose lining rivets, weak, damaged or incorrect shoe retracting springs, loose or damaged shoe retainer pins, springs and clips, and grooved backing plate ledges.	4. Inspect, repair or replace as required.
Noise at wheels — brakes not applied — squeak or squeal.	1. Wheel covers improperly attached.	1. With a rubber mallet, seat the wheel covers. Repair flanges or repair cover.
	2. Loose wheel lug nuts.	2. Tighten to specified torque. Replace wheel if stud holes are elongated.
	3. Worn, dry or improperly adjusted wheel bearings.	3. Replace worn or damaged wheel bearings. Lubricate and adjust.
	4. Bent or warped backing plate causing interference with drum or rotor.	4. Repair or replace as required.
	5. Contaminated linings — adjustment too tight (Rear brakes).	5. Remove contamination from linings. Adjust brakes properly.
	6. Improper machining of drum, causing interference with backing plate or shoe.	6. Replace shoe.
	7. Other brake system components: — Loose or extra parts in brakes. — Drum Brakes — Weak, damaged or incorrect retracting springs. — Drum Brakes — Grooved backing plate ledges. — Improper positioning of shoe in caliper. — Outside diameter of rotor rubbing caliper housing. — Lack of correct lubricant on disc brake caliper slides and pins. — Improper installation of disc brake anti-rattle clips. — Excessive runout of disc brake rotor.	7. Inspect, repair or replace as required.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Noise at wheels when brakes are applied — scrape or grind (loud, harsh rubbing noise).	1. Contaminated linings — If caliper is not bound, brake linings are not worn to rivets, and rotor is scored at least 13mm (0.5 inch) wide by 1.5mm (1/16 inch) deep.	1. Replace or turn rotor. Remove and replace contaminated lining as required.
	2. Wheel bearings not lubricated. Verify noise is coming from bearings.	2. Lubricate and replace bearings and seals as required.
	3. Worn brake linings, loose rivets or foreign material between lining and drum or rotor.	3. Replace shoes and linings in sets. Refinish brake drums or rotors if excessively scored.
	4. Brake shoe interference with back of drum, or shield-to-rotor clearance also binding at backing plate guide ledges.	4. Inspect. Replace as required. Lubricate guide ledges.
	5. Caliper to wheel or rotor interference.	5. Replace as required.
	6. Other brake system components: — Warped or bent backing plate or splash shield causing interference with brake drum. — Cracked drums or rotors.	6. Inspect and repair as required.
	7. Tires rubbing against chassis or body.	7. Inspect and service as required.
	8. Rotor to spindle interference.	8. Replace as required.
Noise at wheels — brakes applied — groan, roughness or chatter at wheel. A harsh feeling while braking in neutral evidenced by a pulsating brake pedal feel.	1. Loose wheel lug nuts.	1. Tighten to specified torque. Replace wheel if stud holes are elongated.
	2. Corrosion build-up on rotor surfaces.	2. Hand sand corrosion from rotor braking surfaces and contamination from linings.
	3. Worn, damaged, dry or improperly adjusted wheel bearings.	3. Inspect, lubricate and/or replace as required.
	4. Loose or worn front suspension components.	4. Inspect, repair or replace as required.
	5. Rotor thickness variation.	5. Replace or turn rotor.
	6. Disc brake caliper backing plate and anchor plate loose or missing parts. Also, loose or bent dust shield.	6. Replace or repair as required.
	7. Rear brake roughness.	7. Attempt stopping the vehicle using the parking brake. If roughness is present, check drums for excessive wear or runout. Refinish or replace as required.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Noise at wheels — brakes applied — groan, roughness or chatter at wheel. A harsh feeling while braking in neutral evidenced by a pulsating brake pedal feel. (Continued)	8. Brake drum cracked or out-of-round. 9. Wheel/tire imbalance. 10. Drivetrain imbalance.	8. Refinish or replace drum as required. 9. Verify and repair as required. 10. Attempt stopping the vehicle in the neutral transmission position. If roughness is gone, drivetrain should be inspected.
Noise at wheels — brakes not applied — growling, click, rattle, clunk or knock. Defined by a series of sharp, short sounds in quick succession.	1. Stones or foreign material trapped inside. 2. Loose wheel lug nuts. 3. Worn, damaged or dry wheel bearings. 4. Disc brake caliper assembly. — Loose or missing anti-rattle clips or poor crimping on outer shoe. 5. Drum brakes loose or extra parts. 6. Dust shield bent, loose or missing. 7. Loose grease cap. 8. Drum brakes — brake shoes binding at backing plate ledges in three places. 9. Drum brakes — backing plate ledges worn in three places.	1. Remove stones or foreign material as required. 2. Tighten to specified torque. Replace wheel if stud holes are elongated. 3. Inspect, lubricate or replace. Adjust bearings properly. 4. Inspect, repair or replace as required. 5. Inspect, remove or repair as required. 6. Repair as required. 7. Repair or replace as required. 8. Lubricate ledges. 9. Replace plate and lubricate ledges.

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Rear Drum Brakes

F-150—F-350 (4x2), F-150—F-350 (4x4), Bronco and E-150—E-350

Rear drum brakes are adjusted automatically by alternately driving the vehicle forward and reverse, and sharply applying the brakes when the vehicle is driven in reverse. Manual brake adjustment is required only when the brake shoes are relined or replaced. Refer to Section 12-02, Drum Brakes—Single Cylinder, Dual Piston.

Hydraulic System Bleeding

When any part of the hydraulic system has been disconnected for repair or replacement, air may get into the lines and cause spongy pedal action. This requires the bleeding of the hydraulic system after it has been properly connected to be sure all air is expelled from the brake cylinders and lines. The hydraulic system can be bled with pressure bleeding equipment such as Rotunda brake bleeder (model 104-00064) or equivalent.

Bleed one brake cylinder at a time. On F-150—F-350 and Bronco vehicles, start the bleeding at the right rear brake wheel cylinder and then to the left rear wheel brake cylinder. After completing; proceed to the Rear Antilock Brake (RAB) Valve. Then proceed to bleed the front brakes, starting with the right front brake and finish bleeding on the left front brake. On E-150—E-350 vehicles, start the bleeding at the right rear brake, then the left rear brake. After completing, proceed to bleed the right front brake and then the left front brake. Keep the master cylinder reservoir filled with the specified Ford Heavy Duty Brake Fluid, C6AZ-19542-A or -B (ESA-M6C25-A) or equivalent. **Never use brake fluid that has been drained from the system.**

Pressure Bleeding—Dual Brake System Hydraulic Master Cylinder

Bleed the longest lines first. Be sure the bleeder tank contains enough specified brake fluid (Ford Heavy Duty Brake Fluid C6AZ-19542-A or B (ESA-M6C25-A) or equivalent) to complete the bleeding operation. Charge the tank with approximately 69-206 kPa (10-30 psi) of air pressure. **Never exceed 345 kPa (50 psi) of pressure. Never re-use brake fluid that has been drained from the hydraulic system.**

1. Clean all dirt from the master cylinder cap.
2. Remove the master cylinder reservoir cap, and fill the master cylinder reservoir with the specified brake fluid. Install the pressure bleeder adapter

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• Vibration when brakes are applied — Front Brakes.	1. Loose lug nuts.	1. Tighten lug nuts to specification. Replace rim if stud holes are elongated.
	2. Cracked drums or rotors.	2. Replace drum or rotor.
	3. Drums or rotors out-of-round or improper machining.	3. Machine drums or rotors or replace as required.
	4. Excessive rotor runout.	4. Replace rotor.
	5. Worn or improperly adjusted wheel bearings.	5. Adjust or replace wheel bearings as required.
	6. Loose or worn front suspension components.	6. Tighten loose components to specifications. Replace worn or damaged components.
	7. Excessive radial or lateral run-out on wheel and tire.	7. Adjust tire and wheel to eliminate excessive run-out or tire and/or wheel as required.
• Vibration when brakes are applied — Rear Brakes.	1. Loose lug nuts.	1. Tighten lug nuts to specification. Replace rim if stud holes are elongated.
	2. Cracked drums.	2. Replace drums.
	3. Drums out-of-round or improperly machined.②	3. Machine drums or replace as required.
	4. Excessive radial and lateral run-out on wheel and tire.①	4. Adjust tires and wheels to eliminate run-out or replace wheel and/or tire as required.
• Parking brake will not hold.	1. Parking brake cable out of adjustment.	1. Adjust parking brake cable(s).
	2. Rear brakes out of adjustment.	2. Adjust rear brakes.
	3. Parking brake linkage, cable release lever, clevis and ratchet binding, worn or damaged.	3. Repair or replace linkage or cables as required.
• Parking brake will not release or fully return.	1. Manual release brake control components binding or damaged.	1. Repair or replace manual parking brake control.
	2. Parking brake linkage and cables binding.	2. Repair or replace as required.
	3. Worn or damaged rear brake components.	3. Check rear brake shoe retracting springs and parking brake levers. Repair as required.
• Rough engine idle or stall — power brake only.	1. Vacuum leak.	1. Check vacuum hoses and connections for leaks. Repair or replace as required.
	2. Worn or damaged vacuum booster.	2. Check vacuum booster for internal leaks. Replace if required.
• Misaligned disc brake anchor plate.	1. Worn or damaged anchor plate.	1. Measure distance between outer disc brake shoe (not lining) and rotor at both upper and lower corners. The shoe must be seated flat against the caliper legs when checks are made. Replace the disc brake anchor plate on the affected side and shoe and lining assemblies on both front brakes.

① TIRE AND WHEEL RUNOUT SPECIFICATIONS:
Radial Runout — Tire — 1.77mm (0.070 Inch)
— Wheel — 1.14mm (0.045 Inch)
Lateral Runout — Tire — 1.77mm (0.070 Inch)
— Wheel — 1.14mm (0.045 Inch)

② DRUM RUNOUT SPECIFICATIONS MEASURED
19.05mm (3/4 Inch)
11-Inch Brakes — 0.177mm (0.007 Inch) TIR Maximum
12-Inch Brakes — 0.177mm (0.007 Inch) TIR Maximum

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MASTER CYLINDER DIAGNOSIS

TEST STEP		RESULT	ACTION TO TAKE
1.0	FLUID LEVEL CHECK		
• Check fluid level in master cylinder reservoir.		Full reservoir (OK) ▶	GO to **2.0**.
		Low or empty reservoir with no brakelight (OK) ▶	REPLACE reservoir.
2.0	FLUID LEVEL CONDITION		
• Apply and release brake pedal one full stroke. Observe reservoir fluid level of both chambers as pedal is released.		Level remains constant (OK) ▶	GO to **3.0**.
		Fluid level drops (OK) ▶	External leak in brake system cylinder. REPAIR leak.
3.0	MASTER CYLINDER CONDITION		
• Wipe off exterior of master cylinder, cover and gasket with clean cloth. • Road test vehicle and pump brakes. • Check if master cylinder exterior is dry or wet. Check for fluid from bore end of booster or dash.		Dry master cylinder exterior ▶	GO to **4.0**.
		Wet master cylinder exterior or dripping fluid from booster or dash ▶	External leak in master cylinder. REPAIR master cylinder.
4.0	MASTER CYLINDER CONDITION		
• Hold pressure on pedal unit pedal goes down.		Pedal goes down 3.175mm (1/8 inch) each time pedal is released ▶	CHECK entire brake system for major leak. REPAIR as required.
		▶	REFER to BRAKES NOT WORKING, EXCESSIVE PEDAL TRAVEL, BRAKE PEDAL FEELS SPONGY WHEN FULLY APPLIED in diagnosis guide.

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tool to the master cylinder, and attach the bleeder tank hose to the fitting on the adaptor.

Master cylinder pressure bleeder adapter tools are available from various manufacturers of pressure bleeding equipment. Follow the instructions of the manufacturer when installing the adaptor.

3. Place a 3/8-inch box wrench on the bleeder fitting on the right rear brake wheel cylinder. Attach a bleeder tube snugly around the bleeder fitting.
4. Open the valve on the bleeder tank to admit pressurized brake fluid to the master cylinder reservoir.
5. Submerge the free end of the tube in a partially filled container with clean brake fluid and loosen the bleeder fitting.
6. When air bubbles no longer appear in the fluid at the submerged end of the bleeder tube, close the bleeder fitting and remove the tube.
7. When the bleeding operation is completed, close the bleeder tank valve and remove the tank hose from the adaptor fitting.
8. **Remove the Pressure Bleeder Adapter Tool. Fill the master cylinder reservoir to the minimum level line. Install the master cylinder cap.**

Hydraulic Line Repair

Steel tubing is used in the hydraulic lines between the master cylinder and the front brake tube connector and between the rear brake tube connector (Fig. 8) and the rear brake cylinders. Flexible hoses connect the brake tube to the front brake cylinders and to the rear brake tube connector.

When replacing hydraulic brake tubing, hoses, or connectors, tighten all connections securely. After replacement, bleed the brake system at the wheel cylinders and at the booster, if equipped.

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MASTER CYLINDER DIAGNOSIS GUIDE
PEDAL GOES DOWN FAST

TEST STEP		RESULT	ACTION TO TAKE
A0	VERIFY CONDITION		
• Road test vehicle and depress brake pedal.		OK ▶	Vehicle OK.
		~~OK~~ ▶	GO to **A1**.
A1	BRAKE FLUID LEVEL		
• Check master cylinder brake fluid reservoir level.		OK ▶	GO to **A2**.
		~~OK~~ ▶	CHECK reservoir sealing points. ADD fluid and BLEED system. REPEAT test **A0**.
A2	PRESSURIZE SYSTEM		
• Pump brake pedal rapidly (five times).		Pedal height builds up, then sinks. ▶	GO to **A3**.
		Pedal height builds up and holds. ▶	CHECK rear brake adjustment and ADJUST if necessary. If condition still exists, BLEED system for air. REPEAT test **A0**.
A3	BRAKE SYSTEM LEAKS		
• Check for external brake system leaks. As detailed in this section.		OK ▶	GO to **A4**.
		~~OK~~ ▶	SERVICE as necessary. ADD fluid and BLEED system. REPEAT test **A0**.
A4	MASTER CYLINDER BY-PASS TEST		
• Test for master cylinder by-pass. As detailed in this section.		OK ▶	System OK.
		~~OK~~ ▶	REPLACE damaged parts. ADD fluid and BLEED system. REPEAT test **A0**.

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Brake Tube

If a section of the brake tube is damaged, replace the entire section with tubing of the same type, size, shape, and length. **Copper tubing should not be used in the hydraulic system. Use only SAE J526 or J527 steel tubing, or equivalent.** Be careful not to kink or crack the tubing when bending it to fit the frame or rear-axle forms.

Double flare brake tubing as described below should provide good leak-proof connections. Always clean the inside of a new brake tube with clean isopropyl alcohol.

Flaring A Line (Split-Die Type)

Refer to Figs. 9 and 10.

1. Cut off and straighten the required length of line (A tubing cutter tool will simplify making a clean and square cut).
2. Square off the ends of the line with a file, and chamfer the end of the line to be flared.
3. Select the split die for the line to be used and insert the die into the tapered hole in the body.
4. Push the tube through the die until the line is even with the face of the die. Lock the line in this position by tightening the wing nut securely.
5. The punches are marked Op. 1 and Op. 2. Slide the first operation punch into the hole in the center of the body and tighten the screw securely to form the single flare.

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MASTER CYLINDER DIAGNOSIS GUIDE (Cont'd.)
PEDAL EASES DOWN SLOWLY

TEST STEP		RESULT ▶	ACTION TO TAKE
B0	VERIFY CONDITION		
• Check if condition occurs during actual stopping application by depressing the brake pedal while the vehicle is moving.		Condition occurs only when vehicle is stationary. ▶	No action required. (SEE Normal Condition #1.)
		Condition occurs while vehicle is moving and braking performance is affected. ▶	GO to **B1**.
B1	BRAKE SYSTEM LEAKS		
• Check for external brake system leaks. As detailed in this section.		(OK) ▶	GO to **B2**.
		(OK) ▶	SERVICE as necessary, ADD fluid and BLEED system. REPEAT Test **B0**.
B2	MASTER CYLINDER BY-PASS TEST		
• Test for master cylinder by-pass. As detailed in this section.		(OK) ▶	System OK.
		(OK) ▶	REPLACE damaged parts, ADD fluid and BLEED SYSTEM. REPEAT Test **B0**.

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MASTER CYLINDER DIAGNOSIS GUIDE (Cont'd.)
PEDAL EFFORT EXCESSIVE

TEST STEP		RESULT ▶	ACTION TO TAKE
D0	VERIFY CONDITION		
• Depress brake pedal fully several times.		Pedal has short stroke and requires excessive effort. ▶	GO to **D1**.
		Pedal has long stroke and requires excessive effort. ▶	GO to **D1**.
D1	BRAKE PEDAL LINKAGE TEST		
• Detach booster push rod from pedal pin and depress brake pedal fully.		Pedal moves freely. ▶	CHECK booster vacuum availability as described under Vacuum Booster Diagnosis in this Section.
		Condition persists. ▶	SERVICE or REPLACE brake pedal linkage. REPEAT Test **D0**.

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MASTER CYLINDER DIAGNOSIS GUIDE (Cont'd.)
PEDAL IS LOW AND/OR FEELS SPONGY

TEST STEP		RESULT	ACTION TO TAKE
C0	VERIFY CONDITION		
	• Road test vehicle and apply brake pedal.	OK ▶	Vehicle OK.
		⊘K ▶	GO to **C1**.
C1	BRAKE FLUID LEVEL CHECK		
	• Check master cylinder brake fluid reservoir level.	OK ▶	GO to **C2**.
		⊘K ▶	CHECK reservoir sealing points. ADD fluid and BLEED system.
C2	FILLER CAP VENT CHECK		
	• Check if filler cap vent holes are clogged or dirty.	OK ▶	GO to **C3**.
		⊘K ▶	CLEAN as necessary. REPEAT Test **C0**.
C3	BLEED BRAKE SYSTEM		
	• Bleed brake system as described in this section.	Condition corrected ▶	Vehicle OK.
		Condition persists ▶	GO to **C4**.
C4	FRONT WHEEL BEARING ADJUSTMENT		
	• Check front wheel for proper adjustment.	OK ▶	CHECK rear brake adjustment and ADJUST if necessary. REPEAT Test **C0**.
		⊘K ▶	Adjust front wheel bearings. REPEAT Test **C0**.

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6. Release the screw and replace the first operation punch with the second punch and tighten the screw to form the double flare.
7. Release the screw, wing nut, punch, and dies.
8. Remove the line and inspect the flare for cracks or poor flare form. If the flare is not correct, cut it off and repeat the process.

   The finished flare must be square with the line, free of cracks and have a smooth mating surface to ensure a leakproof connection.

Flaring A Line (Flaring-Bar Type)

Refer to Fig. 11.

1. Cut off and straighten the required length of line. (A tubing cutter tool will simplify making a clean and square cut).
2. Square off the ends of the line with a file, and chamfer the end of the line to be flared.
3. Insert the line through its appropriate ribbed hole in the bar assembly until the end of the line sticks out about as far as the thickness of the adapter above the bar, or even with the bar, depending on the tool used.
4. Fit the adapter onto the line and slide the bar into the yoke. Lock the bar in position with the line beneath the yoke screw.
5. Form the single flare by tightening the yoke screw securely.
6. Release the screw and remove the adaptor.
7. Form the double flare by tighening the yoke screw again, with second adaptor fitted, depending on the tool used.
8. Release the screw bar, and flared line. Inspect the flare for cracks or poor flare form, and repeat the process if the flare is not correct.

Brake Hose

Replace a flexible brake hose if it shows signs of softening, cracking or other damage.

When installing a new brake hose, position the hose to avoid contact with other vehicle parts.

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FRONT DISC BRAKE VIBRATION — SHUDDER — E-250-350 AND F-250-350 WITH DANA AXLE

	TEST STEP	RESULT	ACTION TO TAKE
1	ROAD TEST		
	• With standard wheels and tires installed, road test the vehicle and verify the condition.	Front brake chirp	Normal condition. No repair required.
		No shudder/vibration	Brake system not responsible. REFER to Section 18-01, Noise, Vibration and Harshness.
		Shudder/vibration	GO to **2**.
2	APPLY PARKING BRAKE		
	• Lightly apply the parking brake and road test the vehicle.	No shudder/vibration	CHECK the front brakes. GO to **3**.
		Shudder/vibration	CHECK the rear brakes. GO to **4**.
3	DISC BRAKES		
	• Resurface rotors and road test vehicle.	No shudder/vibration (OK)	STOP.
		Shudder/vibration (OK)	REPLACE rotors.
4	DRUM BRAKES		
	• Refinish brake drums and road test vehicle.	No shudder/vibration (OK)	STOP.
		Shudder/vibration (OK)	REPLACE drums.

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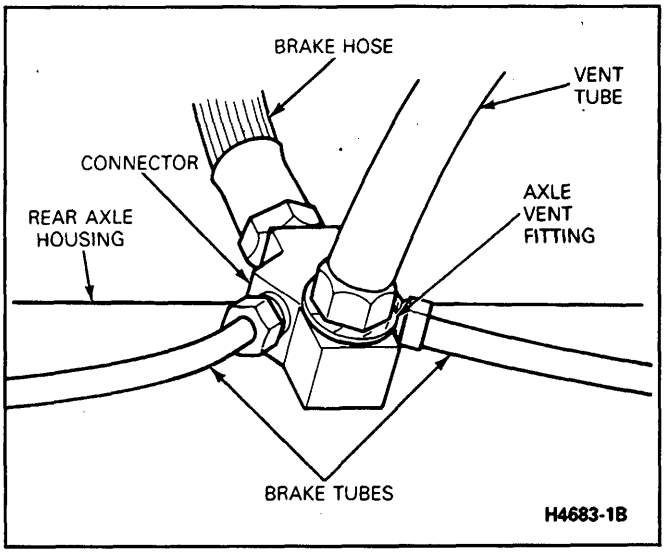


FIG. 8 Rear Brake Tube Connector

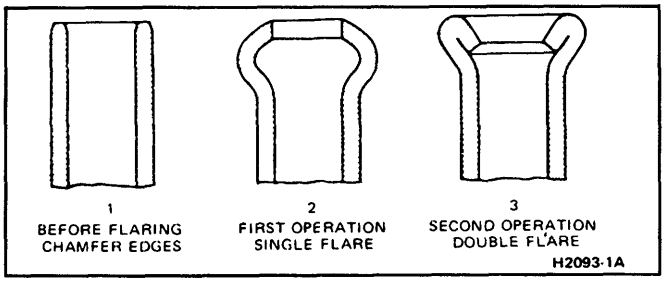


FIG. 9 Line Flaring Sequence

OVERHAUL

WARNING: DO NOT INHALE DUST FROM BRAKES, CLUTCHES OR ASSOCIATED COMPONENTS. INHALATION OF DUST CONTAINING ASBESTOS FIBERS CAN BE INJURIOUS TO YOUR HEALTH AND COULD CAUSE CANCER OR ASBESTOSIS. COMPRESSED AIR OR BRUSHES MUST NOT BE USED TO CLEAN BRAKES, BRAKE DRUMS, CLUTCHES AND ASSOCIATED COMPONENTS. A VACUUM CLEANER EQUIPPED FOR THIS PURPOSE SHOULD BE CAREFULLY USED TO REMOVE ANY DUST (ROTUNDA MODEL 091-00001). ADHERENT DUST SHOULD BE REMOVED WITH A DAMP RAG. ANY DUST SHOULD BE CONTAINED IN A SEALED AND LABELED BAG FOR DISPOSAL. WEAR AN APPROVED HIGH EFFICIENCY CARTRIDGE OR AIR LINE RESPIRATOR AND USE EXTRA CAUTION TO AVOID BREATHING THIS DUST. USE NON-ASBESTOS REPLACEMENT PARTS WHENEVER POSSIBLE.

Removal of dust and dirt from brake assemblies should be done by using the Rotunda brake vacuum (model 091-00001) or Rotunda brake parts washer (model 065-00016) or an equivalent. Brake assembly

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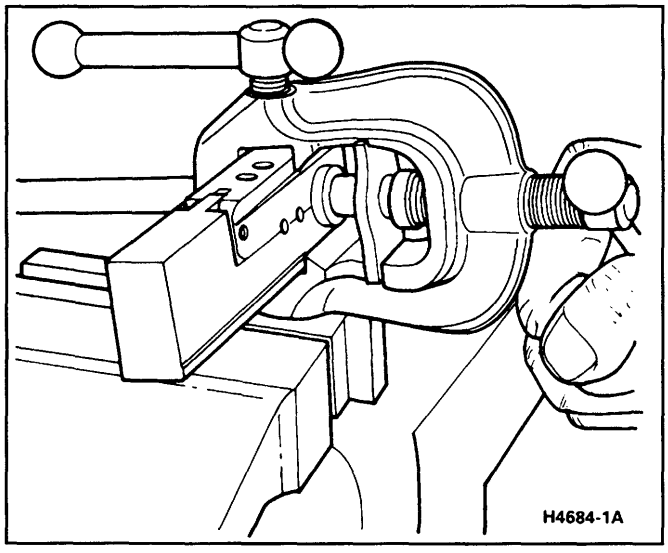


FIG. 10 Line Flaring (Split Die Type)

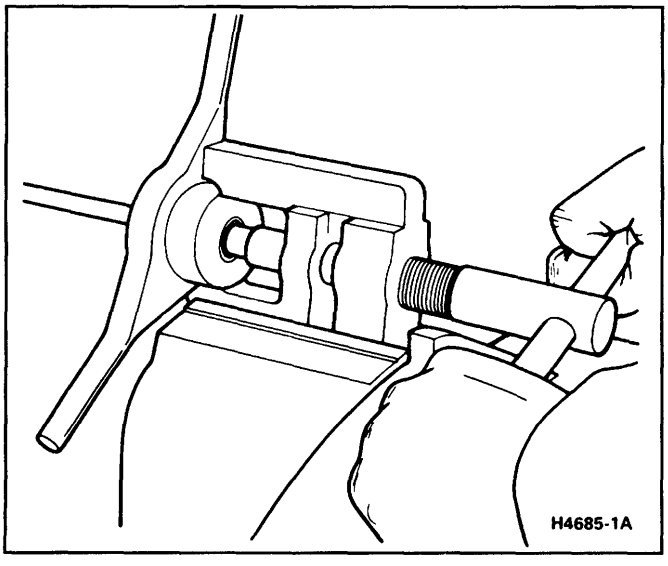


FIG. 11 Line Flaring (Flaring Bar Type)

dust and dirt should **not** be removed by either blowing off with an air gun or vacuuming with a standard industrial vacuum cleaner because a health hazard from breathing in asbestos dust may develop. Also, any machining done on brake linings or pads should be done using properly exhaust ventilated equipment. Also, any machining done on brake linings or pads should be done using properly exhaust ventilated equipment.

Brake Drum Refinishing

Minor scores on a brake drum can be removed with fine emery cloth, provided the emery is thoroughly cleaned off the drum after the operation.

A badly scored, rough, or out-of-round drum should be ground or turned on a drum lathe. (Refer to the lathe manufacturers instructions.) Do not remove any more material from the drum than is necessary to provide a smooth surface for the brake shoe contact. Brake drum maximum braking surface diameter is shown on each brake drum (Fig. 12). Brake drums which exceed the maximum braking surface diameter shown on the brake drum, either through wear or refinishing, must be replaced. The maximum braking surface diameter

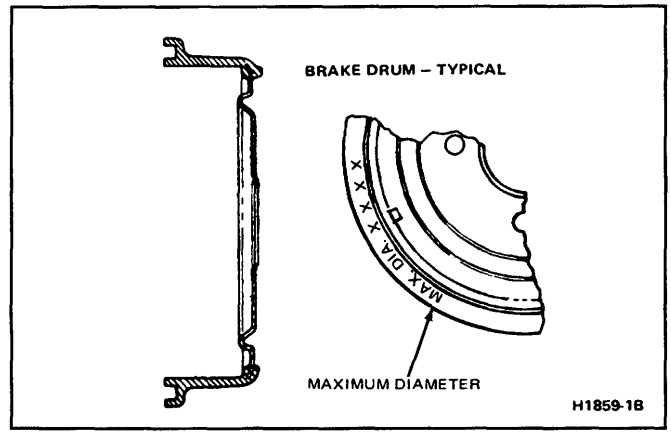


FIG. 12 Rear Brake Drum Maximum Inside

specification, which is shown on each brake drum (Fig. 12), allows for a 1.52mm (0.060 inch) machining cut over the original drum diameter plus 0.762mm (0.030 inch) additional wear before reaching the drum-discard diameter. Braking Surface Diameter Marking Location—E-150—E-350, Bronco, and F-150—F-350

Front Disc Brakes

1. Remove the shoe and linings as described in Section 12-24 Disc Brakes—Light and Heavy Duty—Sliding Caliper.
2. Measure the thickness of the brake lining. If the lining thickness at any point on the assembly is less than 1.5mm (1/16 inch) above the backing plate or 0.794mm (1/32 inch) above the rivets, or if the lining shows evidence of brake fluid or oil contamination that is causing a brake pull, replace all four shoe and lining assemblies.
3. To check rotor runout, first eliminate the wheel bearing end play by tightening the adjusting nut. Then check to be sure the rotor can still be rotated.
4. Clamp a dial indicator TOOL-4201-C, or equivalent to the spindle so the stylus contacts the rotor approximately one inch from the outer edge. Rotate the rotor and take an indicator reading. If the reading exceeds allowable total lateral runout (as given in Section 12-24) within a six inch radius on the indicator, replace or re-surface the disc brake rotor. **The following requirements must be met when re-surfacing disc brake rotors.**

   Use a disc brake lathe to re-finish the disc brake rotors. (Follow the manufacturers instructions.)

   No more than 0.508mm (0.020 inch) of material may be machined equally off each surface (A and B, Fig. 13). If rotor thickness falls below the minimum shown on each rotor, it must be replaced. Refer to the specifications at the end of Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper for maximum rotor brake surface lateral runout, thickness variation, and surface finish.

   When the runout check is finished, adjust the bearings as described in Section 11-10, Wheel Hubs and Bearings—Front (except Front Wheel Drive) to prevent bearing failure.
5. Check the rotor for scoring. Remove minor scores with a fine emery cloth. If the rotor is excessively scored, re-finish or replace the rotor if necessary.

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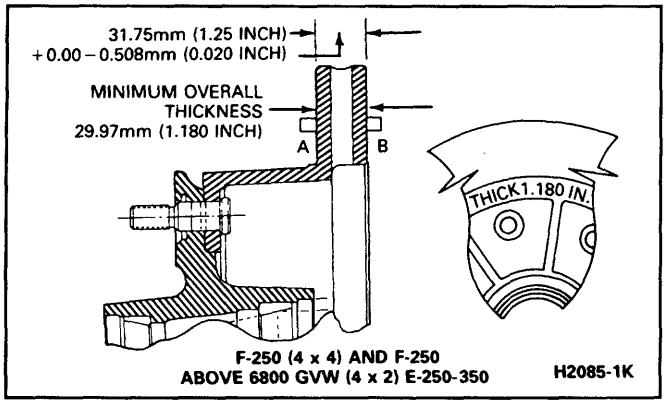


FIG. 13 Disc Brake Rotor Service Limits

6. Check the caliper. If it is cracked or shows any signs of leakage, replace it. If the caliper is leaking around the dust boot, remove and repair it.
7. Check brake hoses for signs of cracking, leaks or abrasion. Replace them, if necessary.

Rear Disc Brakes

1. Remove the shoe and linings as described in Section 12-24 Disc Brakes—Light and Heavy Duty—Sliding Caliper.
2. Measure the thickness of the brake lining. If the lining thickness at any point on the assembly is less than 1.5mm (1/16 inch) above the backing plate or 0.795mm (1/32 inch) above the rivets, or if the lining shows evidence of brake fluid or oil contamination that is causing a brake pull, replace all four shoe and lining assemblies.
3. In checking rotor runout on rear disc brakes it is important not to disturb the rear axle bearing setting.
4. Clamp a dial indicator to the spindle so the stylus contacts the rotor approximately one inch from the outer edge. Rotate the rotor and take an indicator reading. If the reading exceeds 0.254mm (0.010 inch) total lateral runout within a six inch radius on the indicator, replace or re-surface the disc brake rotor. **The following requirements must be met when re-surfacing disc brake rotors.**

   Use a disc brake lathe to re-finish the disc brake rotors. (Follow the manufacturers instructions.)

No more than 0.508mm (0.020 inch) of material may be machined equally off each surface (A and B, Fig. 13). If rotor thickness falls below the minimum shown on each rotor, it must be replaced. Refer to the specifications at the end of Section 12-24, Disc Brakes, for maximum rotor brake surface lateral runout, thickness variation, and surface finish.

When the runout check is finished, adjust the bearings as described in Section 11-10, Wheel Hubs and Bearings—Front (except Front Wheel Drive) to prevent bearing failure.

5. Check the rotor for scoring. Remove minor scores with a fine emery cloth. If the rotor is excessively scored, re-finish or replace the rotor if necessary. If either the rotor or the hub assembly needs replacing, see Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper, for proper procedure.
6. Check the caliper. If it is cracked or shows any signs of leakage, replace it. If the caliper is leaking around the dust boot, remove and repair it.
7. Check brake hoses for signs of cracking, leaks or abrasion. Replace them, if necessary.

Brake Cylinder

1. Clean all brake cylinder parts in clean isopropyl alcohol or use the Rotunda brake parts washer (model 065-00016) or equivalent. Inspect all parts for wear or damage. Check the cylinder bore for rust, scores, or other damage. Be sure the bleeder screw passage is clean and open. Replace all parts that are worn or damaged.
2. If dirt is found in any part of the hydraulic system, flush the entire system with clean isopropyl alcohol.

Master Cylinder

1. Clean all master cylinder parts in clean isopropyl alcohol, or use the Rotunda brake parts washer (model 065-00016) or equivalent and inspect the parts for wear or damage. Replace them if required. **When a master cylinder repair kit is used, follow the instructions in the kit and install all of the parts provided.**
2. Make sure that all ports and vents in the master cylinder are open and free of foreign matter.

Brake Drums and Linings

1. Remove all wheels and drums from the vehicle, and inspect the drums and brake shoe linings for wear or damage that would affect brake operation. **Do not let brake fluid, oil or grease touch the drum or linings.**
2. Re-line any brake shoe that is worn to within 0.794mm (1/32 inch) of any rivet head, or when the lining is soaked with brake fluid, oil, or grease. **If a worn lining is not replaced, the brake drum may become severely damaged. Always replace the primary and secondary brake shoe lining assemblies on both front or both rear brake assemblies at the same time.**
3. Before relining a brake shoe, inspect the shoe for distortion, cracks, elongated rivet holes, or looseness between the rim and web. If any of these conditions are visible, replace the shoe. **Do not attempt to repair a damaged brake shoe.**
4. If the drum and linings are in good condition, install the wheel and drum. **The condition of the drums and linings of the opposite wheel will usually be about the same as the wheel that was removed.**
5. Fill the master cylinder reservoir with the specified brake fluid to within 6.35 mm (1/4 inch) of the top of the filler neck.
6. Be sure that the parking brake is fully released before making any brake adjustment.
7. On brake assemblies with an adjustable anchor pin, check the front brake anchor pin nut with a wrench. If the nut is loose, tighten it to 109-135 N·m (80-100 ft-lbs).

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SPECIFICATIONS

SPECIAL TOOLS

Number	Description	Application
T73L-2196-A	Disc Brake Piston Remover	Use with Slide Hammer
D79L-2196-A	Disc Brake Pad Spreader	Universal
T73T-2208-A	Front Brake Bleeder Wrench	E-150 thru E-350, F-150 thru F-350, Bronco
T73T-2300-A	Hold Down Spring Tool	F-150 thru F-350
Tool-4201-C	Dial Indicator	Universal

CH2700-2H

ROTUNDA EQUIPMENT

Model Number	Description
104-00064	Brake Bleeder
021-00014	Vacuum Tester
091-00001	Brake and Clutch Service Vacuum
065-00016	Brake Parts Washer
059-00008	Vacuum and Pressure Tester

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SECTION 12-02 Drum Brakes—Single Cylinder, Dual Piston

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VEHICLE APPLICATION

Bronco, E-150 Through E-350, F-150 Through F-350 (4x2), F-150 Through F-350 (4x4) Model Trucks.

DESCRIPTION

The rear brakes are drum type with internal expanding shoes. The rear drum brakes are of the single anchor type, mounted to the same anchor, and actuated by one wheel cylinder. The wheel cylinder has two pistons. One piston exerts force against the upper end of the primary shoe; the other piston exerts force against the upper end of the secondary shoe.

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service, for drum brake diagnosis and testing procedures.

ADJUSTMENTS

Rear Brake Shoe Adjustment

Self Adjusting Drum

The rear brake shoes are automatically adjusted when the vehicle is driven forward and reverse and the brakes applied several times sharply. Manual brake adjustment is required only after the brake shoes have been relined or replaced. Perform the manual adjustment with the drums removed, using the tool and the procedure described below. Refer to Figs. 1 and 2 for typical brake system installations.

When adjusting the rear brake shoes, check the parking brake cables for proper adjustment. Make sure the equalizer operates freely.

With Drums Removed

1. With drums removed, clean away all rust and dirt on the points where the shoes touch the backing plate.
2. Apply a small amount (1/32 inch thick) of Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent or Disc Brake Caliper Slide Grease, D7AZ-19590-A (ESA-M1C172-A) or equivalent to the ledges where the shoes touch the backing plate. Be careful not to get the lubricant on the linings. Also lubricate the adjusting cable eye and the anchor pin area.
3. Use a brake shoe adjustment gauge Tool D81L-1103-A or equivalent: for E-150, F-150 and Bronco. For the following vehicles, use Rotunda Tool 104-00063 or equivalent: E-250—E-350 and F-250—F-350 (Fig. 3). Adjust to the inside diameter of the drum braking surface.
4. Reverse the tool as shown in Fig. 4 and adjust the brake shoes until they touch the gauge. The gauge contact points on the shoes (Fig. 4) must be parallel to the vehicle with the center line through the center of the axle. Hold the automatic adjusting lever out of engagement while rotating the adjusting screw, to prevent burring the screw slots. Make sure the adjusting screw rotates freely. If necessary, lubricate the adjusting screw threads with a thin, uniform coating of lithium-base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.
5. Install the drums. Install the retaining nuts and tighten securely.
6. Install the wheels on the drums and tighten the mounting nuts to specification, as listed at the end of this Section.
7. Complete the adjustment by applying the brakes sharply several times while driving the vehicle in reverse.
8. After adjusting the brake shoes, check brake operation by making several stops while driving forward.

With Drums Installed

Adjust the single anchor brake by turning an adjusting screw located between the lower ends of the shoes (Figs. 5 and 6).

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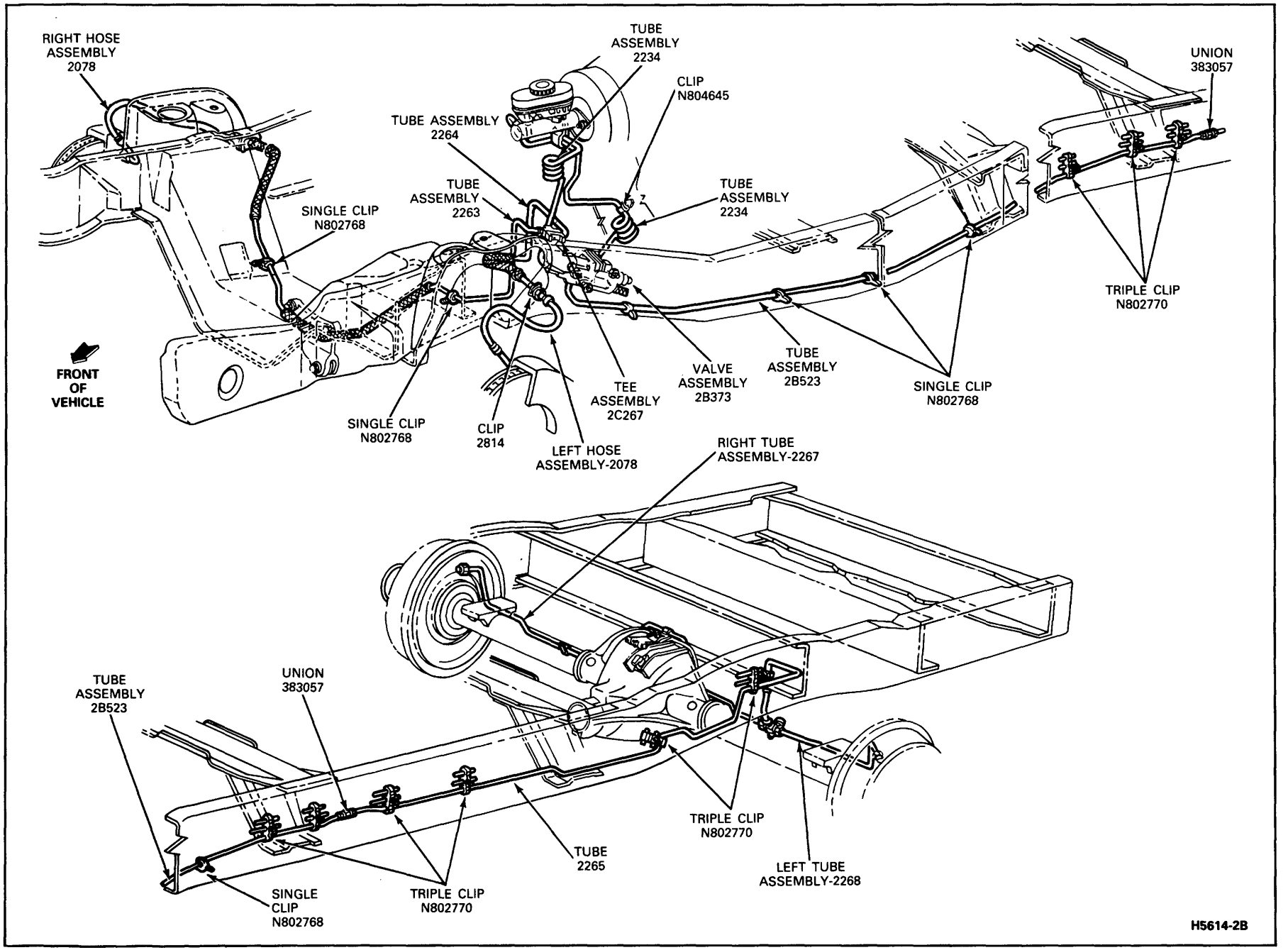


FIG. 1 Brake System—F-150—F-350 and Bronco—Typical

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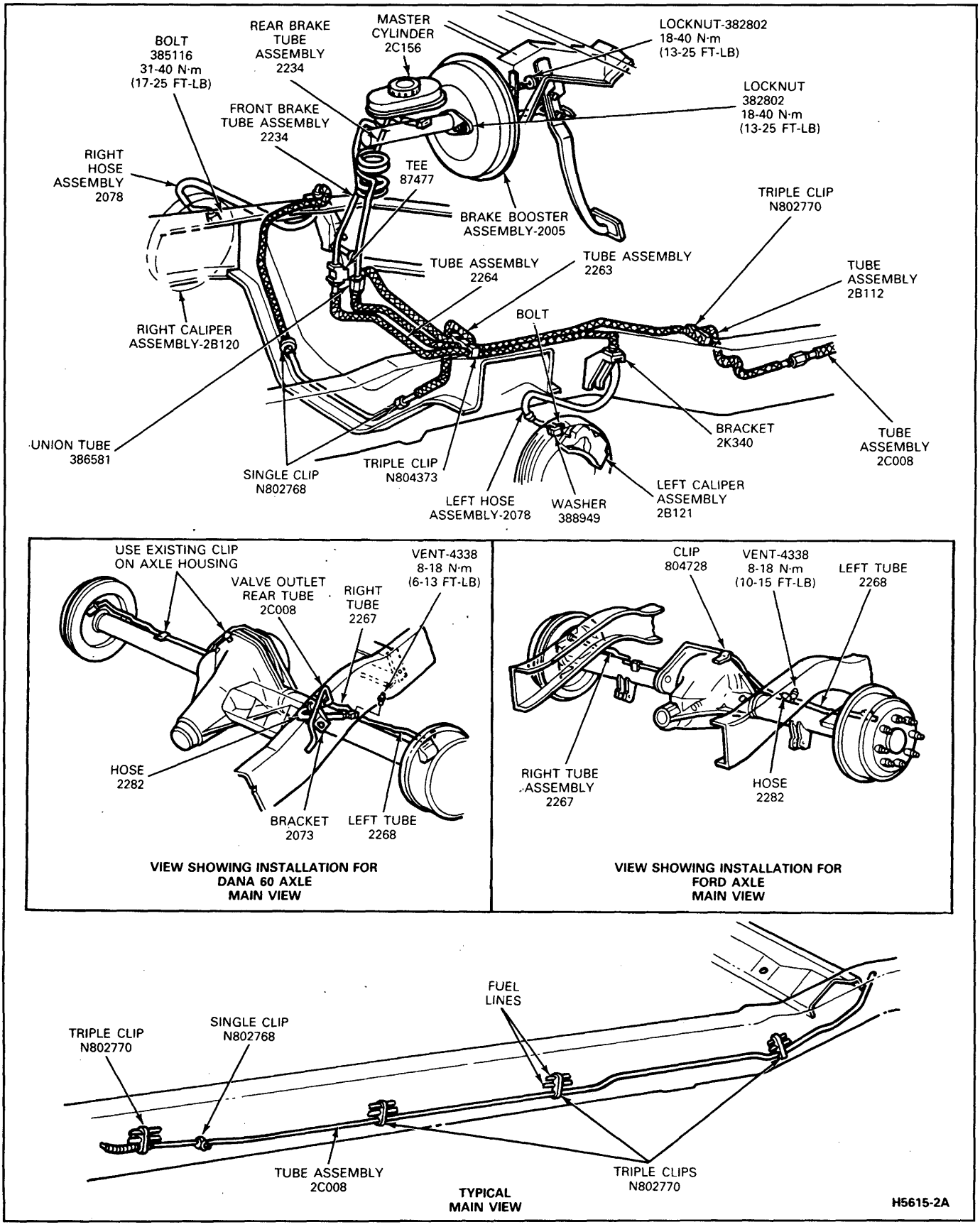


FIG. 2 Brake System—E-150—E-350—Typical

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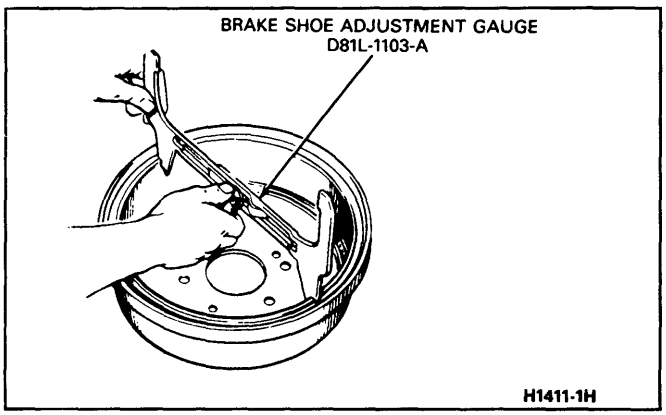


FIG. 3 Measuring Drum

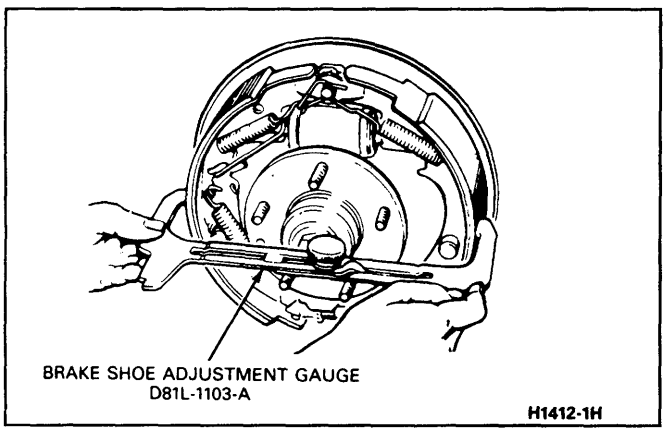


FIG. 4 Measuring Shoes

1. Raise the vehicle until the tires clear the floor. Install safety stands under the axle.
2. Remove the cover from the adjusting hole at the bottom of the brake backing plate, and turn the adjusting screw (inside the hole) to expand the brakes shoes until they drag against the brake drum as shown in Figs. 5 and 6.
3. When the shoes are against the drum, loosen the adjusting screw an additional 10 to 12 notches so that the drum rotates freely without drag (Fig. 5). If the drum does not rotate freely, remove the wheel and drum, and vacuum out any dust and dirt from the linings. Using sand paper, remove any rust from the points where the shoes touch the backing plate. Apply a light coating of lithium-base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent, Disc Brake Caliper Lubricant, D7AZ-19590A (ESA-M1C172A) or equivalent. Do not get the lubricant on the linings. Install the wheel and drum and adjust the shoes.
4. Install the adjusting hole cover on the brake backing plate.
5. Check and adjust the other brake assembly.
6. Apply the brakes. If the pedal travels more than halfway to the floor, there is too much clearance between the brake shoes and the drums. Repeat Steps 2 and 3 above.
7. When all brake shoes have been properly adjusted, lower the vehicle and road test to check brake operation. Perform the road test only when the brakes will apply and the vehicle can be safely stopped.

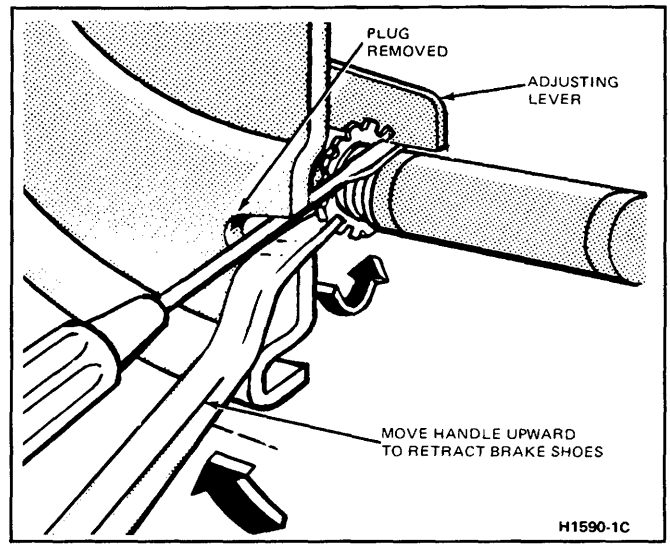


FIG. 5 Backing Off Brake Adjustment—E-150, F-150 and Bronco

SAFETY

Breathing Asbestos Dust

WARNING: DO NOT INHALE DUST FROM BRAKES, CLUTCHES OR ASSOCIATED COMPONENTS. INHALATION OF DUST CONTAINING ASBESTOS FIBERS CAN BE INJURIOUS TO YOUR HEALTH AND COULD CAUSE CANCER OR ASBESTOSIS. COMPRESSED AIR OR BRUSHES MUST NOT BE USED TO CLEAN BRAKES, BRAKE DRUMS, CLUTCHES AND ASSOCIATED COMPONENTS. A VACUUM CLEANER EQUIPPED FOR THIS PURPOSE SHOULD BE CAREFULLY USED TO REMOVE ANY DUST (ROTUNDA MODEL 091-00001). ADHERENT DUST SHOULD BE REMOVED WITH A DAMP RAG. ANY DUST SHOULD BE CONTAINED IN A SEALED AND LABELED BAG FOR DISPOSAL. WEAR AN APPROVED HIGH EFFICIENCY CARTRIDGE OR AIR LINE RESPIRATOR AND USE EXTRA CAUTION TO AVOID BREATHING THIS DUST. USE NON-ASBESTOS REPLACEMENT PARTS WHENEVER POSSIBLE.

The following procedures are recommended to minimize asbestos dust exposures during brake and clutch servicing of trucks, tractors and trailers. These procedures are consistent with asbestos regulations set forth by the Occupational Safety and Health Administration (OSHA). Adherence to these procedures will eliminate exposures to asbestos during brake and clutch servicing.

An area should be designated for all brake and clutch services. Entrances to this area must be posted with the following sign:

ASBESTOS

Dust Hazard

Avoid Breathing Dust

Wear Assigned Protective Equipment

Do Not Remain in Area Unless Your Work Requires It

Breathing Asbestos Dust May Cause

Asbestosis and Cancer

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Only essential personnel should be present in the immediate maintenance area during brake and clutch servicing.

During brake servicing, use a toxic dust air purifying respirator of either single-use or replaceable cartridge type. It must be approved by the Mine Safety and Health Administration (MSHA) or by the National Institute of Occupational Safety and Health (NIOSH). It shall be worn during all procedures from removal of wheels to reassembly. An example of an acceptable respirator is the 3M-9910 or 9920 (or equivalent).

Wheel brake assemblies must be cleaned carefully using a vacuum cleaner recommended for use with asbestos fibers. A vacuum for this purpose is available from the Rotunda Equipment Catalog, model number 091-00001 or equivalent. Similar vacuums are also manufactured by Nilfish and Hako ("Minuteman"). If additional cleaning is necessary, a rag soaked with water or a brake washer (Rotunda model 065-00016 or equivalent) must be used.

Grinding or sanding on brake linings, pads, rotors or drums, shall be done only while using properly exhaust-ventilated equipment. A respirator must be worn while performing these operations.

During removal of vacuum bags, an approved respirator, as described above, shall be worn. Industrial vacuum cleaner bags containing asbestos dust, cloths used for wiping brake assemblies, and other asbestos-contaminated debris shall be sealed in plastic bags and labeled with the following warning label printed in letters of sufficient size and contrast to be readily visible and legible:

CAUTION

Contains Asbestos Fibers

Avoid Breathing Dust

Breathing Asbestos Dust May Cause

Asbestosis and Cancer

All asbestos waste must be disposed of in accordance with OSHA and Environmental Protection Agency (EPA) asbestos regulations. Asbestos waste must not be incinerated or disposed of in community water supplies.

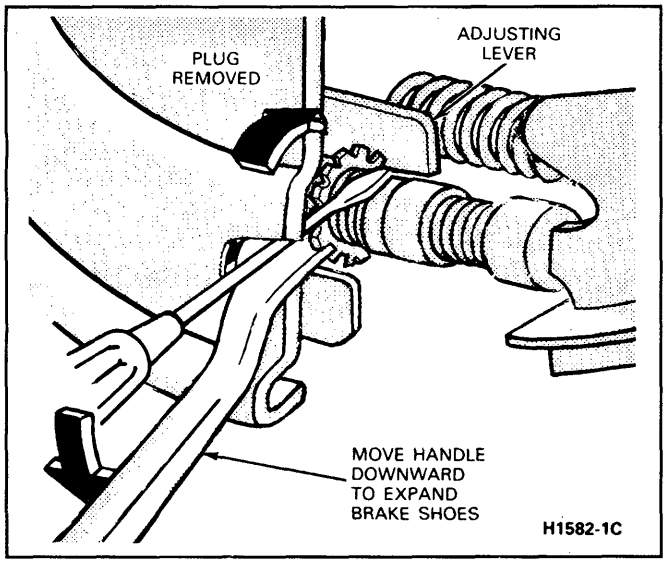


FIG. 6 Expanding Brake Shoes—F-250—F-350, E-250—E-350 Rear

All floor cleaning in the asbestos servicing area and clean-up of waste from grinding or sanding must be done using an approved vacuum cleaner while wearing a proper respirator.

REMOVAL AND INSTALLATION

Rear Brake Drum

Bronco, F-150—F-250—F-350, E-150—E-250—E-350

WARNING: DO NOT INHALE DUST FROM BRAKES, CLUTCHES OR ASSOCIATED COMPONENTS. INHALATION OF DUST CONTAINING ASBESTOS FIBERS CAN BE INJURIOUS TO YOUR HEALTH AND COULD CAUSE CANCER OR ASBESTOSIS. COMPRESSED AIR OR BRUSHES MUST NOT BE USED TO CLEAN BRAKES, BRAKE DRUMS, CLUTCHES AND ASSOCIATED COMPONENTS. A VACUUM CLEANER EQUIPPED FOR THIS PURPOSE SHOULD BE CAREFULLY USED TO REMOVE ANY DUST (ROTUNDA MODEL 091-00001). ADHERENT DUST SHOULD BE REMOVED WITH A DAMP RAG. ANY DUST SHOULD BE CONTAINED IN A SEALED AND LABELED BAG FOR DISPOSAL. WEAR AN APPROVED HIGH EFFICIENCY CARTRIDGE OR AIR LINE RESPIRATOR AND USE EXTRA CAUTION TO AVOID BREATHING THIS DUST. USE NON-ASBESTOS REPLACEMENT PARTS WHENEVER POSSIBLE.

Removal

1. Raise the vehicle so the wheel and tire assembly is clear of the floor and install safety stands under the axle.
2. Remove the hub cap if equipped, and wheel and tire assembly. Remove the spring retaining nuts and remove the brake drum.
3. Check the brake surface drum runout. If surface is worn or run out exceed the specifications, the drum should be turned.

   If the brake drum will not come off, insert a narrow screwdriver through the brake adjusting hole in the backing plate, and disengage the adjusting lever from the adjusting screw. While holding the adjusting lever away from the adjusting screw, loosen the adjusting screw with the Brake Adjusting Tool D81L-1103-C or equivalent. **Loosen the adjusting screw only if the drum cannot be removed. Do not burr, chip, or damage the notches in the adjusting screw or the self adjusting mechanism will not function properly.**

   If the adjusting screw was loosened, check to be sure the adjusting lever is still properly seated in the shoe web.

Installation

1. Remove the protective coating from a new drum with carburetor degreaser.
2. Adjust the brakes as described in this Section.
3. Install the drum onto the axle shaft flange or hub assembly.
4. Install the brake drum retaining nuts and tighten securely. Install the wheel on the axle shaft flange or hub studs against the drum, and tighten the

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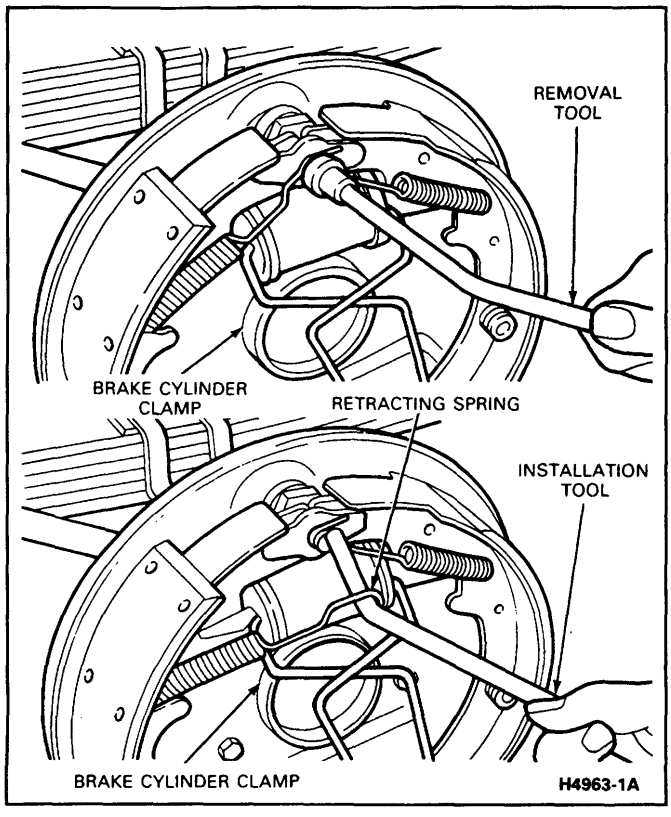


FIG. 7 Spring Replacement—Typical

wheel retaining nuts to specification listed at the end of this Section.

Brake Shoe and Adjusting Screw

F-150, E-150 and Bronco

Removal

1. Remove the wheel and drum and install a clamp over the ends of the brake cylinder as shown in Fig. 7.
2. Contract the shoes as follows:
   a. Disengage the adjusting lever from the adjusting screw by pulling backward on the adjusting lever cable (Fig. 8).
   b. Move the outboard side of the adjusting screw upward and back off the pivot nut as far as it will go.
3. Pull the adjusting lever, cable and automatic adjuster spring down and toward the rear to unhook the pivot hook from the large hole in the secondary shoe web. **Do not pry the pivot hook out of the hole.**
4. Remove the automatic adjuster spring and adjusting lever.
5. Remove the secondary shoe-to-anchor spring using a brake spring removal/installation tool (Fig. 7). Using the same tool, remove the primary shoe-to-anchor spring and unhook the cable anchor. Remove the anchor pin plate (if equipped).
6. Remove the cable guide from the secondary shoe (Fig. 8).
7. Remove the shoe hold-down springs, shoes, adjusting screw, pivot nut, and socket. **Note the color and position of each hold-down spring.**

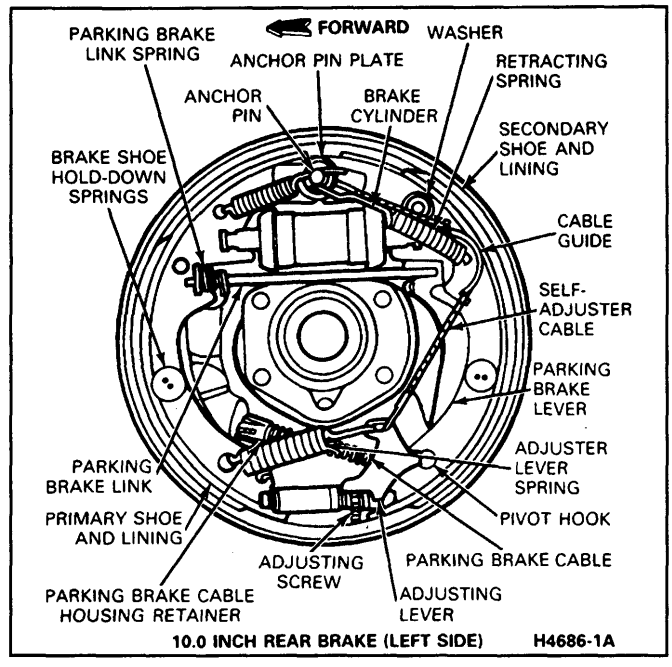


FIG. 8 Self Adjusting Brake Assemblies Standard—F-150 and E-150 Rear and Bronco

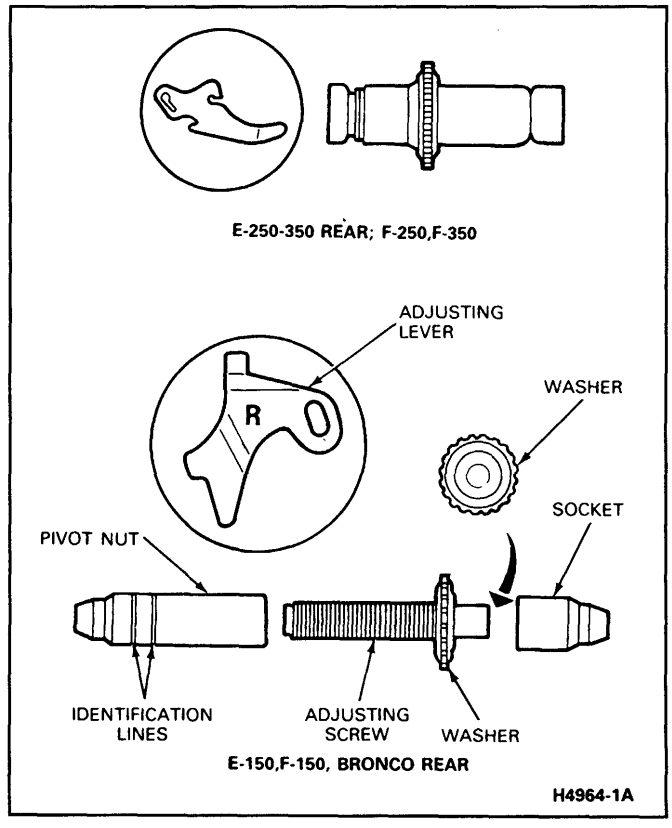


FIG. 9 Adjusting Screw and Lever Bronco, E and F Series-150-350 Rear

They must be re-assembled in the same position.

8. Remove the parking brake link and spring. Disconnect the parking brake cable from the parking brake lever.
9. Remove the brake secondary shoe and disassemble the parking brake lever from the shoe

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by removing the retaining clip and spring washer (Fig. 8).

Installation

1. Clean the ledge pads on the backing plate. Sand lightly to bare metal.
2. Apply a light coating (1/32 inch thick) of high temperature lithium-base grease Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent, Disc Brake Caliper Lubricant D7AZ-19590A (ESA-M1C172A), or equivalent at the points where the brake shoes touch the backing plate. Also lubricate the adjusting cable eye and the anchor pin area.
3. Before installing the rear brake shoes, assemble the parking brake lever on the secondary shoe and secure with the spring washer and retaining clip.
4. Position the brake shoes on the backing plate, and install the hold-down spring pins, springs, and cups. Install the parking brake link, spring, and washer. Connect the parking brake cable to the parking brake lever (Fig. 8).
5. Install the anchor pin plate, (if equipped), and place the cable anchor over the anchor pin with the crimped side toward the backing plate.
6. Install the primary shoe-to-anchor spring using a brake spring removal/installation tool (Fig. 7).
7. Install the cable guide on the secondary shoe with the flanged hole fitted into the hole in the secondary shoe. Thread the cable around the cable guide groove (Fig. 8).

   Be sure the cable is positioned in this groove, and not between the guide and the shoe web.
8. Install the secondary shoe-to-anchor (long) spring (Fig. 8).

   Be sure the cable end is not cocked or binding on the anchor pin when installed. All parts should be flat on the anchor pin. Remove the brake cylinder clamp.
9. Apply a lithium-base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent, or Disc Brake Caliper Lubricant D7AZ-19590A (ESA-M1C172A) or equivalent, to the threads and the socket end of the adjusting screw. Turn the adjusting screw into the adjusting pivot nut to the end of the threads and then loosen it one-half turn.

   Install the adjusting screw assembly in the same location from which it was removed. Interchanging the brake shoe adjusting screw assemblies from one side of the vehicle to the other will cause the brake shoes to retract rather than expand each time the automatic adjusting mechanism is operated. To prevent incorrect installation, the socket end of each adjusting screw is stamped with R or L (Fig. 9) to indicate their installation on the right or left side of the vehicle. The adjusting pivot nuts can be distinguished by the number of lines machined around the body of the nut. Two lines indicate a right hand nut; one line indicates a left hand nut.
10. Place the adjusting socket on the screw and install the assembly between the shoe ends with the adjusting screw nearest the secondary shoe.
11. Hook the cable hook into the hole in the adjusting lever from the outboard plate side. The adjusting levers are also stamped with an R or L to indicate their installation on the right or left hand brake assembly (Fig. 9).
12. Place the hooked end of the adjuster spring in the large hole in the primary shoe web, and connect the loop end of the spring to the adjuster lever hole.
13. Pull the adjuster lever, cable and automatic adjuster spring down toward the rear to engage the pivot hook in the large hole in the secondary shoe web (Fig. 8).
14. After installation, check the action of the adjuster by pulling the section of the cable between the cable guide and the adjusting lever toward the secondary shoe web far enough to lift the lever past a tooth on the adjusting screw wheel. The lever should snap into position behind the next tooth, and releasing the cable should cause the adjuster spring to return the lever to its original position. This return action of the lever will turn the adjusting screw one tooth.

    If pulling the cable does not produce the action described, or if lever action is sluggish instead of positive and sharp, check the position of the lever on the adjusting screw toothed wheel. With the brake in a vertical position (anchor at the top), the lever should contact the adjusting wheel one tooth above the center line of the adjusting screw. If the contact point is below this center line, the lever will not lock on the teeth in the adjusting screw wheel, and the screw will not be turned as the lever is actuated by the cable.

    To find the cause of this condition:

    a. Check the cable end fittings. The cable should completely fill or extend slightly beyond the crimped section of the fittings. If this does not happen, the cable assembly may be damaged, and should be replaced.

    b. Check the cable guide for damage. The cable groove should be parallel to the shoe web, and the body of the guide should lie flat against the web. Replace the guide if it shows damage.

    c. Check the pivot hook on the lever. The hook surfaces should be square with the body on the lever for proper pivoting. Repair the hook or replace the lever if the hook shows damage.

    d. Be sure the adjusting screw socket is properly seated in the notch in the shoe web.

Brake Shoe Adjusting Screw

Web Ledge Design-Rear—E-250-E-350, F-250 and F-350

Removal

1. Raise the vehicle so the wheels clear the floor and install safety stands under the axle.
2. Remove the wheel and drum. If the drum does not clear the brake shoes, retract the brake shoes as shown in Fig. 5.

   Remove the parking brake lever assembly retaining nut from behind the backing plate and remove the parking brake lever assembly (Fig. 10).

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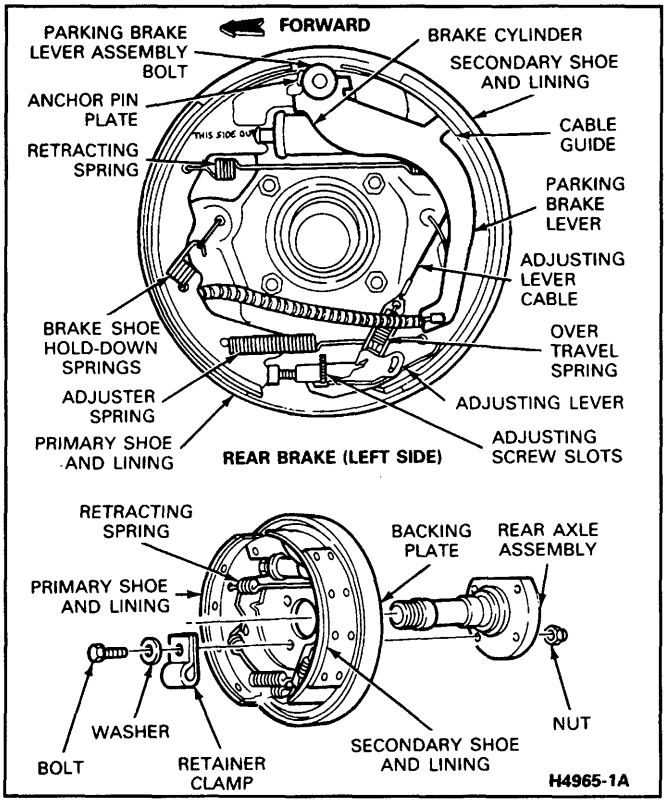


FIG. 10 Self Adjusting Brake Assemblies-Heavy Duty—E-250—E-350, F-250—F-350

3. Remove the adjusting cable assembly from the anchor pin, cable guide, and adjusting lever.
4. Remove the brake shoe retracting springs.
5. Remove the brake shoe hold-down spring (use Tool Number T73T-2300-A or equivalent) from each shoe.
6. Remove the brake shoes and adjusting screw assembly.
7. Disassemble the adjusting screw assembly.

Installation

1. Clean the ledge pads on the backing plate. Sand lightly to bare metal.
2. Apply a lithium-base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent, or Disc Brake Caliper Lubricant D7AZ-19590A (ESA-M1C172A) or equivalent to the retracting and hold-down spring contacts on the brake shoes and backing plate.
3. Apply a lithium-base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent, Disc Brake Caliper Lubricant D7AZ-19590A (ESA-M1C172A), or equivalent or to the threads and socket end of the adjusting screw.
4. Install the upper retracting spring on the primary and secondary shoes as shown in Fig. 10, and position the shoe assembly on the backing plate with the wheel cylinder push rods in the shoe slots.
5. Install the brake shoe hold-down springs (Fig. 11). Use tool number T73T-2300-A or equivalent.
6. Install the brake shoe adjustment screw assembly with the slot in the head of the adjusting screw toward the primary shoe. Install the lower retracting spring, adjusting lever spring, adjusting lever assembly, and connect the adjusting cable to the adjusting lever. Position the cable in the cable guide and install the cable anchor fitting on the anchor pin.

   Install the adjusting screw assemblies in the same locations from which they were removed. Interchanging the brake shoe adjusting screw assemblies from one side of the vehicle to the other will cause the brake shoes to retract rather than expand each time the automatic adjusting mechanism is operated. To prevent incorrect installation, the socket end of each adjusting screw is stamped with an R or L (Fig. 9) to indicate their installation on the right or left side of the vehicle. The adjusting pivot nuts can be distinguished by the number of lines machined around the body of the nut. Two lines indicate a right hand nut; one line indicates a left hand nut.
7. Install the parking brake assembly in the anchor pin and secure with the retaining nut behind the backing plate.
8. Adjust the brakes before installing the drums as described in this Section.

Brake Wheel Cylinder

Removal

1. Remove the wheel, drum, and brake shoes. Remove the cylinder-to-shoe connecting links.
2. Disconnect the brake line from the brake cylinder.
3. Remove the brake cylinder retaining bolts and lockwashers, and then remove the cylinder from the backing plate.

Installation

1. Place the brake cylinder on the backing plate and install the retaining bolts and lockwashers.
2. Install a new gasket on the brake line fitting (if equipped) and connect the brake line to the brake cylinder.
3. Install the brake shoes and the connecting links between the shoes and cylinder. Install the drum and the wheel.
4. Adjust the brakes (described in this Section) and bleed the system as described in Section 12-01, General Hydraulic Brake Service. Check pedal operation before moving the vehicle.

Rear Brake Backing Plate

Removal

1. On F-150—F-250, E-150—E-250 and Bronco remove the rear wheel and brake drum. Disconnect the brake line from the brake cylinder and submerge the end of the brake line in a can containing a small amount of brake fluid to prevent air from entering the system. Remove the brake shoes and brake cylinder. Disconnect the parking brake lever from the cable.
2. If the rear backing plate is being removed from a Ford 8.8 inch ring gear axle on a F-150, E-150, Bronco refer to Section 15-08. For the Dana Semi-Float axle installed on a E-250 refer to Section 15-05. Ford Semi-float rear axle for F-250, refer to Section 15-09, Integral Carrier Axle 10.25 Inch Ring Gear. Remove the C-clip in the differential

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case which holds the axle shaft in place. After the C-clip has been removed, slide the axle shaft out of the housing. Remove the backing plate after the axle shaft has been removed.

3. For backing plate removal procedures from a Dana Full Float rear axle installed on E-250 HD; E-350, refer to Section 11-14. For Ford Full Float rear axle for F-250 HD and F-350, refer to Section 15-09 Integral Carrier Axle-10.25 inch Ring Gear. Remove the backing plate after the axle shaft has been removed.

Installation

1. Position the rear backing plate on the retaining bolts in the axle housing flange. Insert the axle shaft assembly into the housing so the splines engage the differential side gear, with the bearing retainer sliding onto the retaining bolts and against the backing plate. Install the retaining nuts through the access hole in the axle shaft flange. On E-250 equipped with Dana semi-float rear axles, install axle shafts after referring to Axle Shaft Installation in Section 15-05 Integral Carrier Axle—Dana. On F-250 vehicles with Ford Semi-Float rear axles, refer to Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear. On F-250 HD with Ford Full-Float rear axles, refer to Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear. On E-250 HD and E-350 vehicles with Dana Full-Float rear axles, refer to Section 15-05 Integral Carrier Axle—Dana.
2. Install the brake cylinder and brake shoes. On rear brakes, connect the parking brake cable to the lever.
3. Connect the brake line to the brake cylinder and install the wheel and brake drum. Adjust the brake shoes (described in this Section) and bleed air from the system as described in Section 12-01, General Hydraulic Brake Service.

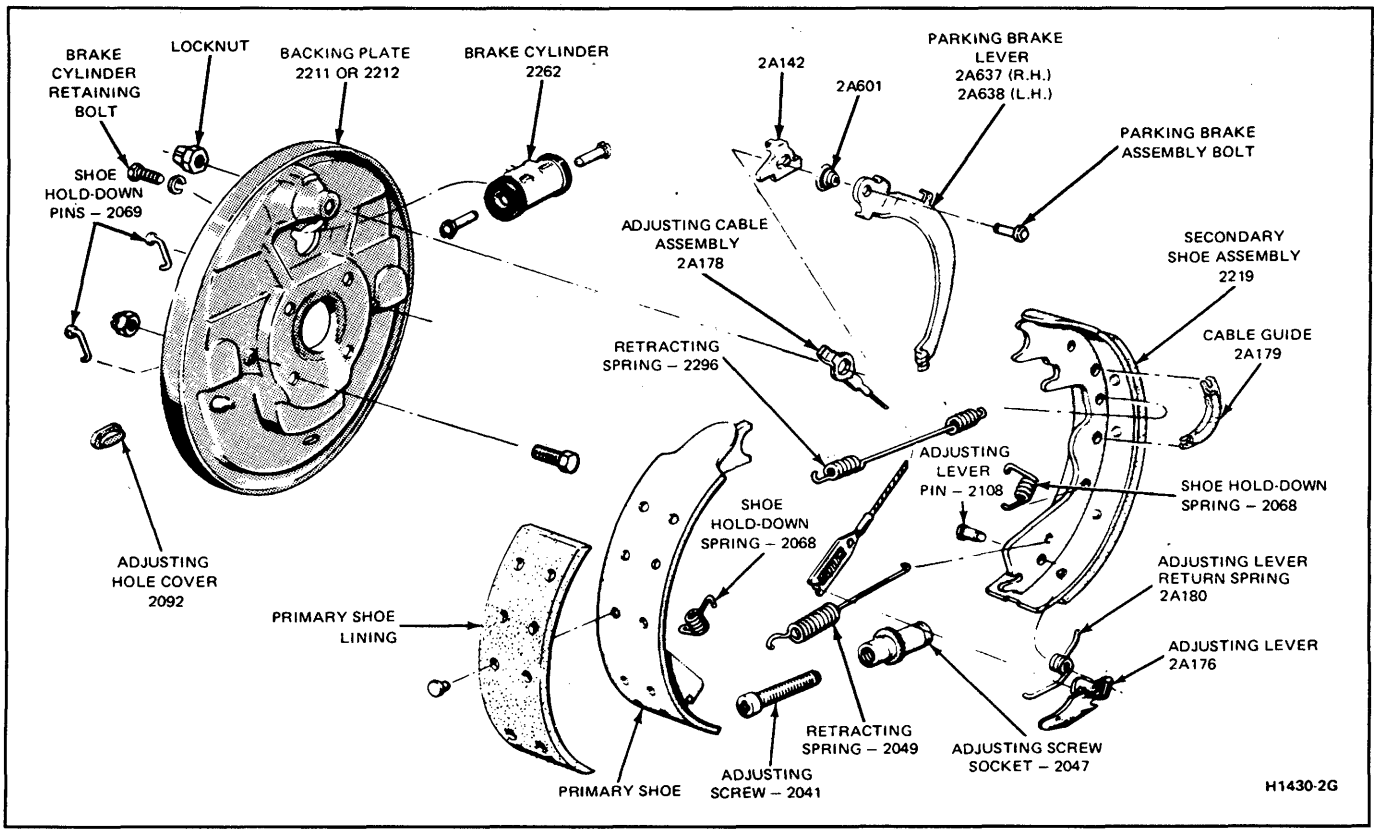


FIG. 11 F-250, F-350 and E-250, E-350 Rear Web Ledge Single Anchor Brake—Disassembled

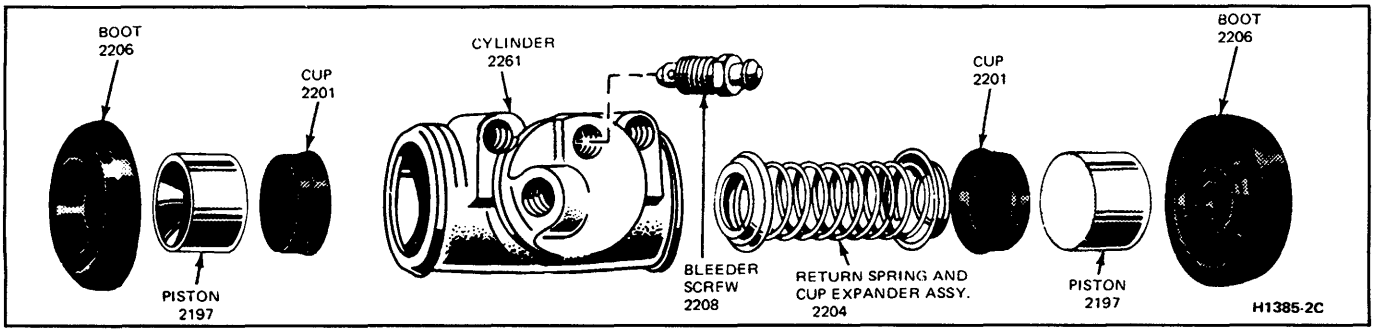


FIG. 12 Double Servo Rear Brake Wheel Cylinder

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DISASSEMBLY AND ASSEMBLY

Brake Wheel Cylinder

Disassembly

1. With the wheel cylinder removed, remove the rubber boots from the ends of the brake cylinder. Remove the pistons, cups, and piston return spring and piston expander assembly from the cylinder (Fig. 12).
2. Remove the bleeder screw from the cylinder.

Assembly

1. Coat all brake cylinder parts with clean Heavy Duty Brake Fluid C6AZ-19542-A or B (ESA-M6C25-A) or equivalent.
2. Install the bleeder screw (Fig. 12) in the brake cylinder.
3. Place the piston return spring and piston expander assembly, cups, and pistons in the cylinder bore, and install a boot and link over each end of the cylinder. Clamp the brake cylinder pistons against the ends of the cylinder. **When using a brake cylinder repair kit follow the instructions in the kit and use all of the parts provided.**

SPECIFICATIONS

WHEEL TORQUE SPECIFICATIONS

Vehicle	Wheel	Bolt Size	Torque①	
			N·m	Ft-Lbs
E-150, F-150, Bronco	5-Lug Wheel	1/2-20	135	100
E-250, E-350, F-250, F-350	8-Lug Wheel	9/16-18	190	140
F-Super Duty	10-Lug Wheel	9/16-18	190	140

①Torque specifications are for clean, dirt-and-paint-free dry bolt and nut threads. Never use oil or grease on studs or nuts. CF3943-2D

SPECIAL SERVICE TOOLS

Number	Description	Application
T73T-2208-A	Front Brake Bleeder Wrench	E-150 thru E-350, F-150 thru F-350, Bronco
T73T-2300-A	Hold Down Spring Tool	F-150 thru F-350
D81L-1103-A	Brake Shoe Adjusting Gauge	Universal
D81L-1103-C	Brake Adjustment Tool	Universal
T85T-4252-AH	Locknut Wrench	F-250, F-350

CH2706-2J

ROTUNDA EQUIPMENT

Model Number	Description
091-00001	Brake and Clutch Service Vacuum
065-00016	Brake Parts Washer
104-00063	Brake Shoe Adjusting Gauge
108-00078	Bearing Packer

CH3536-1D

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SECTION 12-24 Disc Brakes—Light and Heavy Duty—Sliding Caliper

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VEHICLE APPLICATION

F-150 through F-350 (4x2), (4x4) and E-150 through E-350 Truck Models, and F-Super Duty.

DESCRIPTION AND OPERATION

HD (Heavy Duty) Pin Rail Slider Caliper Disc Brakes

F-250—F-350 (4x2), (Fig. 1), E-250-E350, (Fig. 3), F-250—F-350 (4x4), (Fig. 4), and F-Super Duty, (Fig. 5), model trucks are equipped with dual piston, pin rail slider caliper disc-brakes in the front, and conventional drum brakes in the rear. The system has a dual master cylinder and vacuum booster. F-Super Duty trucks are equipped with dual piston, pin rail slider caliper disc brakes in the front and rear. The system uses a dual master cylinder and a Hydro-Boost.

The disc brake is of the pin rail slider caliper design, with two pistons on the same side of the rotor. The unit consists of a caliper which slides on two pins that also attach the caliper to the spindle (or anchor plate on F-Super Duty rear disc brakes).

The caliper contains the two pistons. The pistons and cylinder bores are protected by boot seals fitted to a groove in the piston and a groove in the cylinder housing. The spindle mounting positions the caliper assembly over the rotor rearward.

LD (Light Duty) Pin Rail Slider Caliper Disc Brakes

The disc brake assembly used on F-150 (Fig. 6), E-150 (Fig. 2), and Bronco and F-150 (4x4) vehicles (Fig. 5) is a pin rail sliding caliper, single piston type and attaches to its supporting member similarly to the dual piston pin rail slider design.

The ends of the inner shoe and lining assembly are confined within the spindle assembly. An anti-rattle clip is positioned between the shoe and spindle assembly at the bottom of the caliper. The outer shoe flange bearing rests against the shoe locating and torque surfaces on the caliper housing.

The linings are riveted to the shoes. The inner and outer shoes are not interchangeable.

The caliper housing is a single piece finished casting positioned on the spindle (knuckle on 4x4) assembly.

Pin rails are inserted between the machined surfaces of the caliper and spindle assemblies (View 2, Fig. 6). These pin rails retain the calipers to the spindle assemblies and are held in place by retention tabs.

A single hydraulic piston is located in the cylinder bore in the caliper housing, with the hydraulic fluid inlet at the top of the bore. A square section seal fitted into an annular groove in the caliper cylinder bore, and a rubber boot seal the piston and caliper bore from road splash and contamination. A bleeder screw located above the cylinder bore is used to bleed air from the system.

For F-150—F-350 (4x2), and E-150—E-350 with SRW (Single Rear Wheels), the hub and ventilated rotor is an integrally cast assembly. The F-150—F-350 (4x4) and the E-350 and F-350 and F-Super Duty with DRW (Dual Rear Wheels) utilize separate hub and rotor assemblies which are bolted together. A single piece splash shield, bolted to the spindle, protects the bearings and inboard surface of the rotor from road splash. The wheel protects the outboard surface of the rotor and brake assembly.

When the brake pedal is depressed, brake fluid from the master cylinder passes into the caliper cylinder. This moves the piston outward and forces the inner shoe and lining assembly against the inboard surface of the rotor.

The inner lining pressing against the rotor moves the caliper housing slightly inboard. The outer legs of the caliper housing force the outer shoe and lining assembly against the outboard surface of the rotor.

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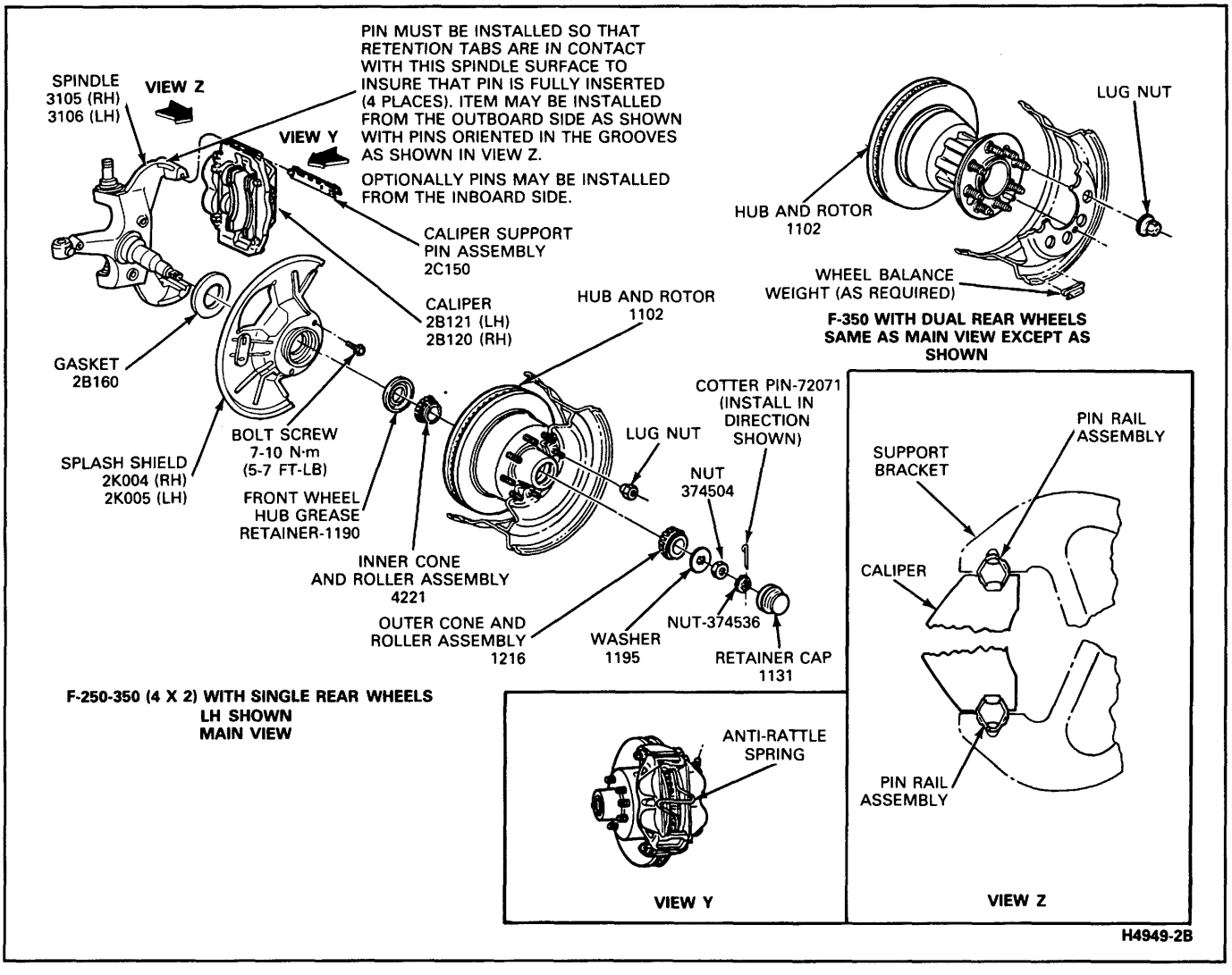


FIG. 1 Disc Brake—F-250 (Above 6900 GVWR)—F-350, (4x2)

The two shoe and lining assemblies clamp the rotor in a vise-type movement to provide the braking action. Braking torque is transferred from the linings to the shoes. For F-150, torque from the inner shoe is transferred directly to the spindle (knuckle on 4x4) assembly, while the torque from the outer shoe is transferred through the caliper to the spindle (knuckle on 4x4) assembly.

When the brake pedal is released, the piston seal retracts the piston into the cylinder, and the caliper housing slides slightly outboard, releasing the brakes.

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service, for disc brake diagnosis and testing procedures not covered below.

Disc Brake Rotor

Each time the brakes are serviced, the disc brake rotor should be checked for scoring, runout, parallelism and thickness.

Rotor scoring and runout may be checked on most brakes with the caliper either on or off. To check parallelism and thickness, the caliper must be removed.

Rotor specifications are listed in the Specifications at the end of this Section.

Rotor Runout

Rotor runout is the side-to-side movement or wobble of the rotor as it rotates. Excessive runout may cause vibration, pedal pumping or brake chatter. Use the following procedure to check rotor runout.

1. Tighten the spindle nut (front brakes only) to eliminate all end play from the bearings. Be sure the hub and rotor can be turned. Do not disturb the rear bearing setting when measuring rear rotor runout.
2. Attach a dial indicator (TOOL-4201-C or equivalent) to some part of the vehicle suspension so the stylus of the indicator touches the surface of the rotor approximately one inch from outer edge of the rotor as shown in Fig. 8.

   NOTE: Installing the wheel nuts helps to obtain more accurate readings on two-piece (bolted) hub and rotor assemblies.
3. Set the dial indicator to zero, slowly turn the rotor one complete turn and note the high and low readings on the dial. The total between the high

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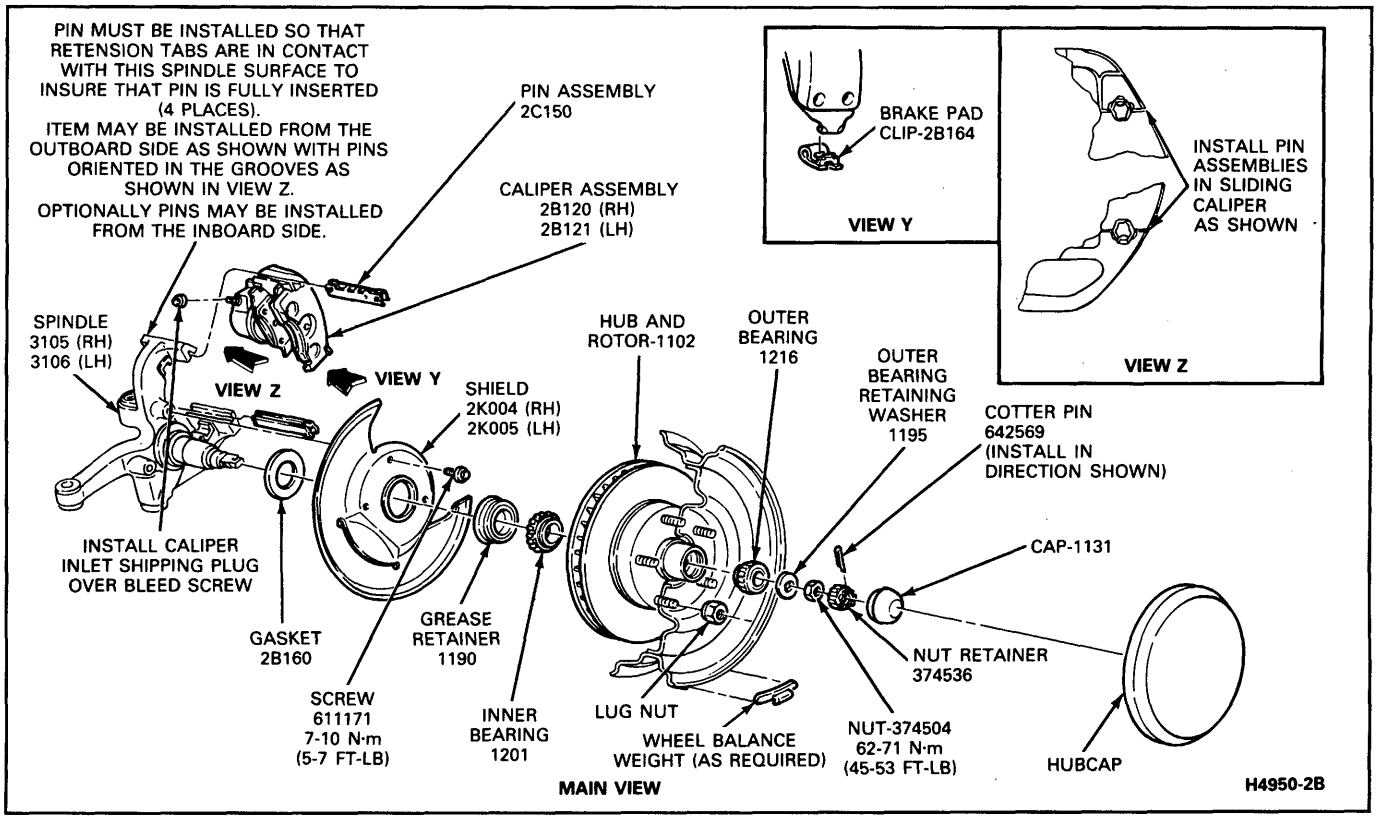


FIG. 2 Disc Brake System—E-150

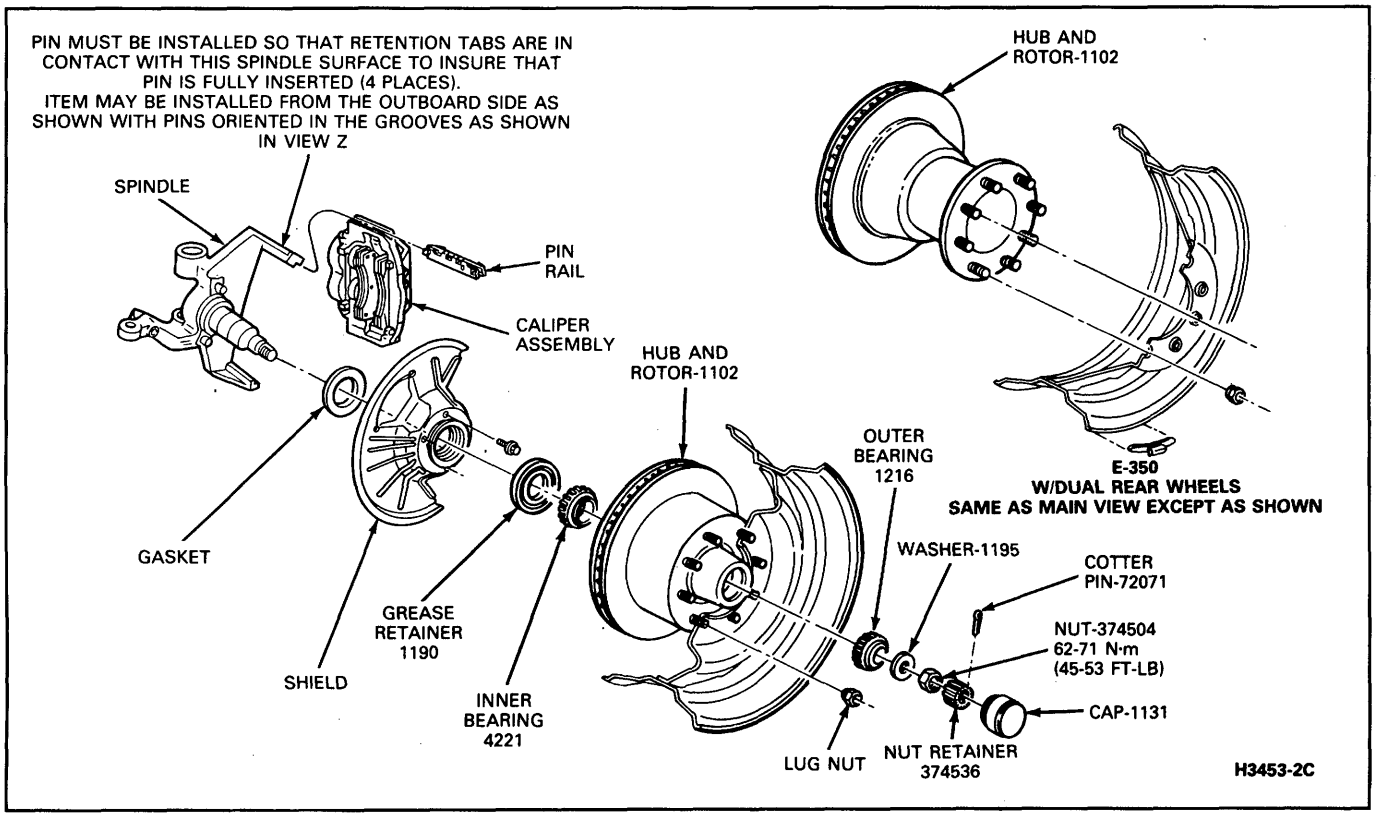


FIG. 3 Disc Brake System—E-250—E-350

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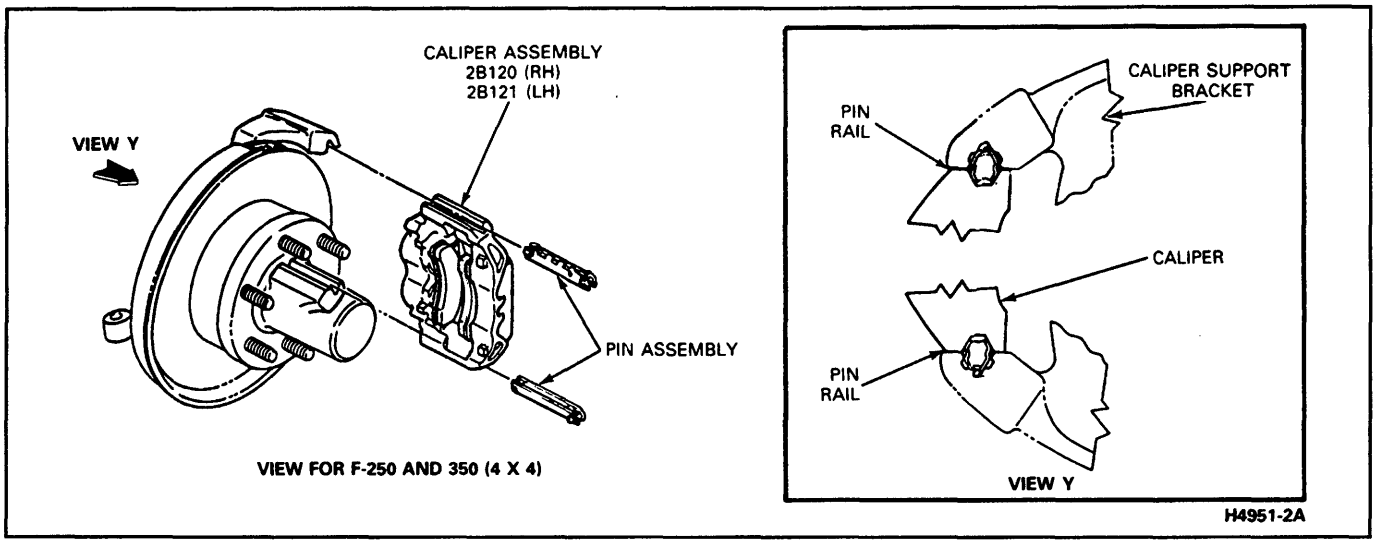


FIG. 4 Disc Brake System—F-250, F-350 (4x4)

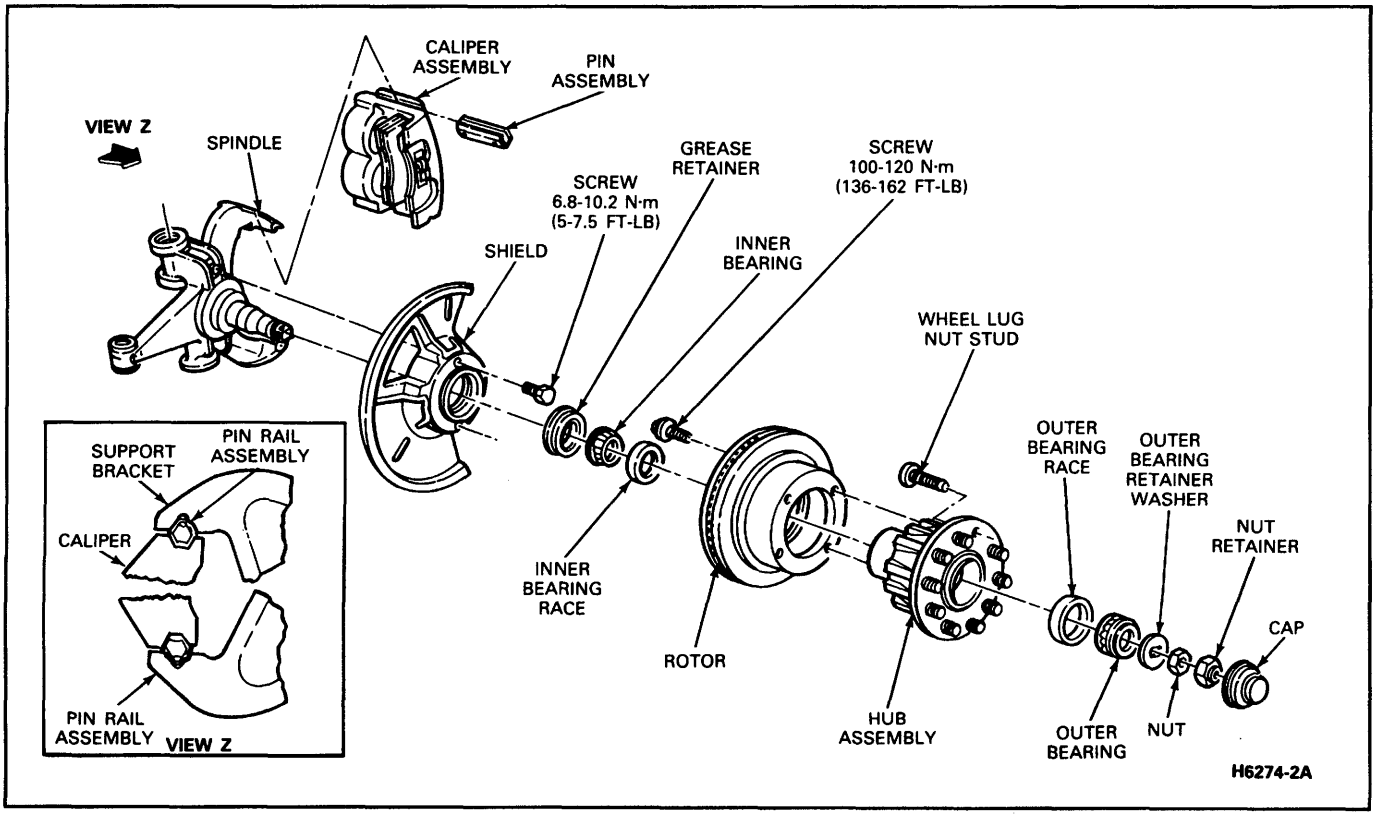


FIG. 5 Disc Brake System—F-Super Duty

and low reading must not exceed the specified runout limit.

4. Refinish or replace the rotor as required.

CAUTION: Be sure to adjust the spindle nut to specifications after the runout check.

Parallelism

Parallelism is the variations in the thickness of the rotor. If the two rubbing surfaces of the rotor are not parallel, the rotor may cause excessive pedal travel, a pulsating pedal, or noise.

Two methods can be used to check if the two faces of a rotor are parallel. A micrometer can be used to measure the rotor thickness at 12 points approximately 30 degrees apart and one inch from the outer edge of the rotor.

The other method is to measure the rotor on a precision lathe designed for machining disc brake rotors. Attach two dial indicators, one on each side of the rotor, so that the stylus of each indicator contacts the rubbing surface, directly opposite each other, approximately one inch from the outer edge of the rotor.

Zero both indicators and rotate the rotor while watching both dials. If the total readings of both indicators exceed the specified limit for parallelism, the rotor must be refinished or replaced.

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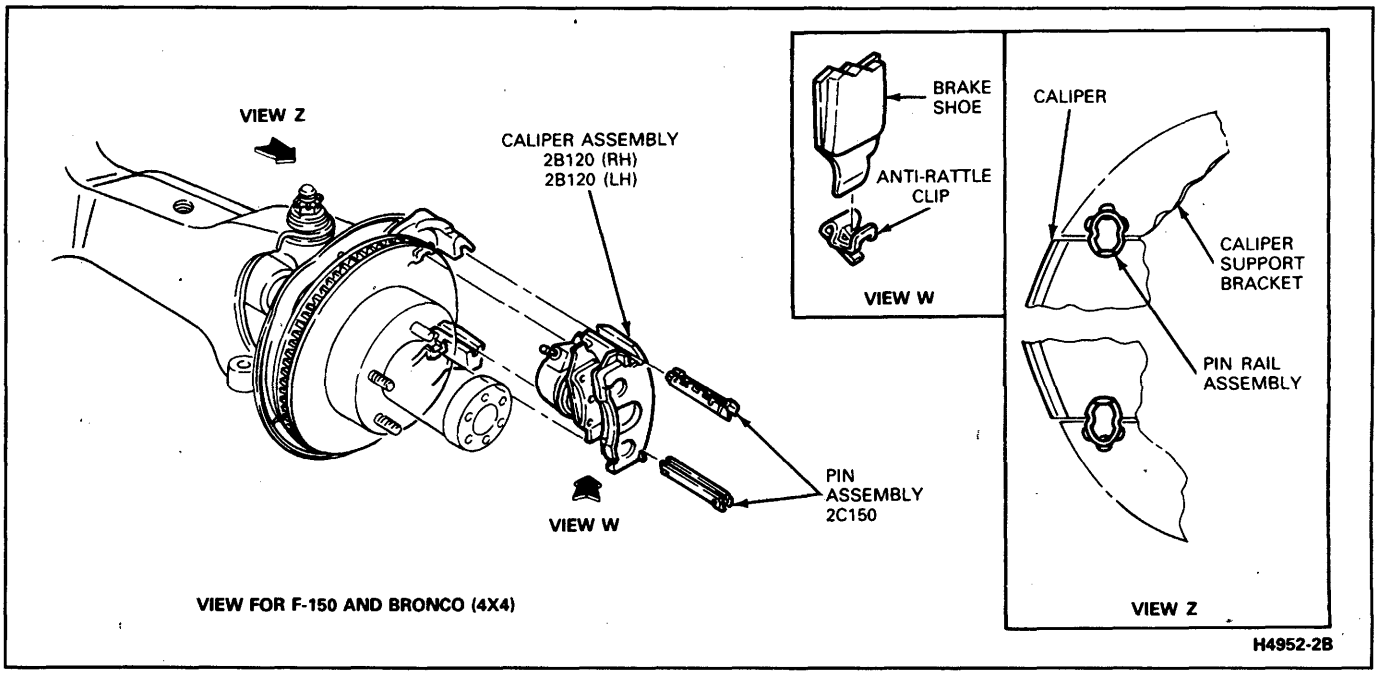


FIG. 6 Disc Brake System—F-150, (4x4) and Bronco

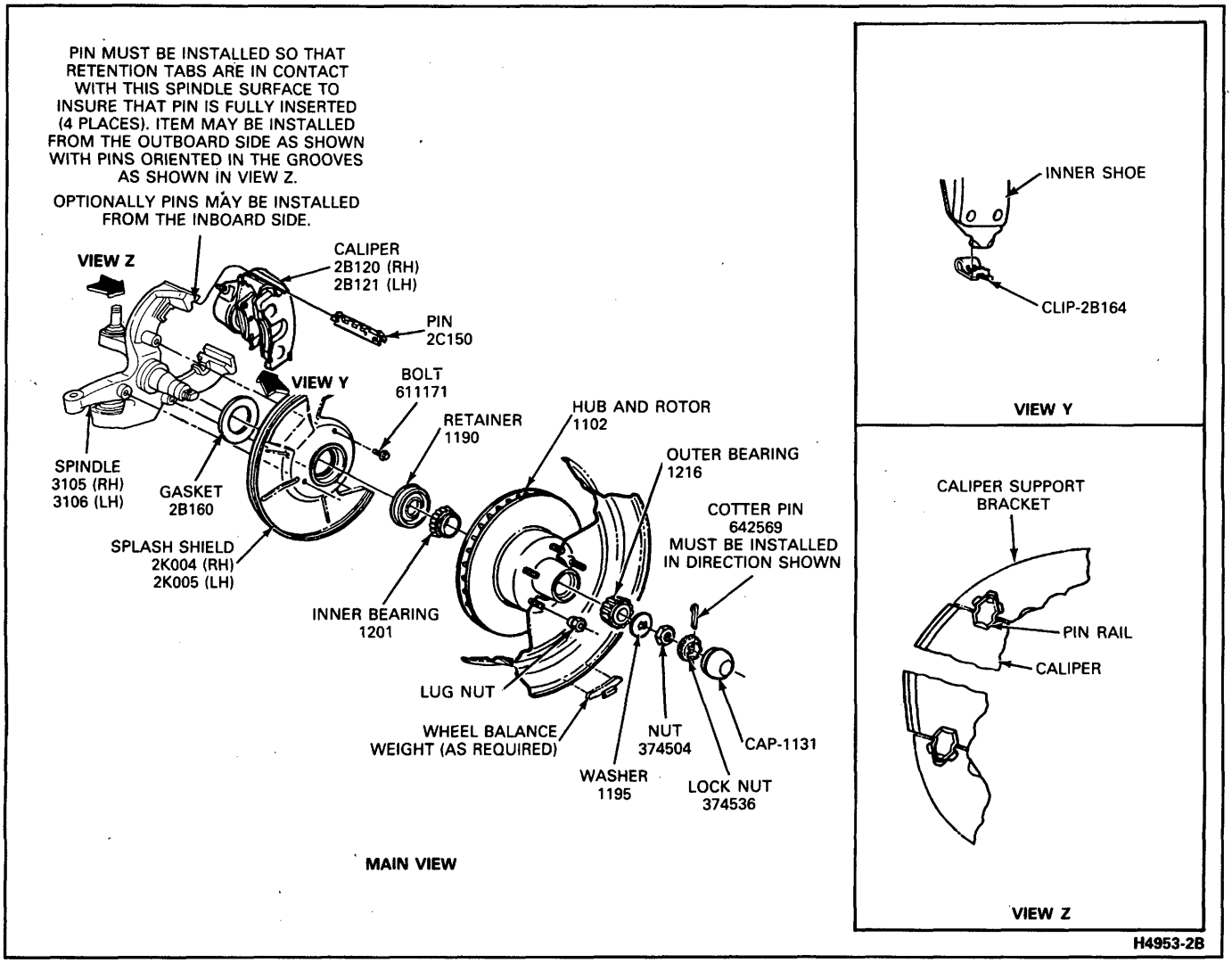


FIG. 7 Sliding Caliper Disc Brake Installation—F-150

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Rotor Thickness

Measure the thickness of the rotor to determine if it is within the specifications listed at the end of this Section. Disc brake rotors have a minimum thickness dimension (minimum wear thickness or discard thickness). This is not the refinishing dimension.

CAUTION: Never refinish a rotor to the minimum wear or discard thickness.

Refinishing

Use a disc brake lathe to refinish the disc brake rotors.

A maximum of 0.508mm (0.020 inch) of material may be machined equally off each surface (A and B, Fig. 8). Replace the rotor if thickness falls below the minimum thickness shown on the rotor. Refer to Specifications at the end of this Section for maximum rotor brake surface lateral runout, thickness variation, and surface finish.

ADJUSTMENTS

Disc Brake Shoe Adjustment

The disc brake assembly is designed so that it is inherently self-adjusting and requires no manual adjustment.

Automatic adjustment for lining wear is achieved by the piston sliding outward in the cylinder bore. The piston assumes a new position in the cylinder and maintains the correct adjustment.

Hydraulic System Bleeding

When any part of the hydraulic system has been disconnected for repair or replacement, air may get into the lines and cause spongy pedal action. This requires the bleeding of the hydraulic system after it has been properly connected to be sure all air is expelled from the brake cylinders and lines. The hydraulic system can be bled manually or with pressure bleeding equipment such as the Rotunda brake bleeder (model 104-00064) or equivalent.

When bleeding the brake system, bleed one brake cylinder at a time, beginning at the cylinder with the longest hydraulic line first. This will be the right rear brake, then bleed the left rear brake. Next, bleed the rear Anti-Lock Brake System Valve if applicable. Then bleed the right front brake, finally the left front brake. Keep the master cylinder reservoir filled with the specified brake fluid during the bleeding operation.

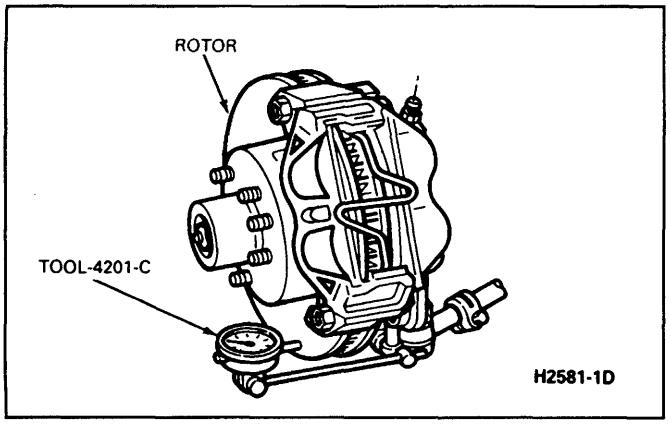


FIG. 8 Checking Rotor Runout (Typical)

Never use brake fluid which has been drained from the hydraulic system.

Manual Bleeding

Bleed the front and rear hydraulic brake systems separately. Bleed the longest line first on each system. **DO NOT allow the reservoir to run dry during the bleeding operation. Keep the master cylinder reservoirs filled with Ford Heavy Duty Brake Fluid C6AZ-19542-A or B (ESA-M6C25-A) or equivalent DOT 3 fluid. Never reuse the fluid that has been drained from the hydraulic system.**

1. On the master cylinder, loosen the master cylinder-to-hydraulic line fitting.
2. Wrap a shop cloth around the tubing below the fitting to absorb escaping brake fluid.
3. Push the brake pedal down slowly to the floor of the cab. This will force air trapped in the master cylinder to escape at the fitting.
4. Hold the pedal down and tighten the fitting. Release the brake pedal. Do not release the brake pedal until the fitting is tightened or air will re-enter the master cylinder.
5. Repeat this procedure until air ceases to escape at the fitting and the brake pedal is firm.
6. Place a 3/8-inch box wrench on the bleeder fitting on the brake wheel cylinder. Attach a rubber drain tube to the bleeder fitting making sure the end of the tube fits snugly around the bleeder fitting.
7. Submerge the free end of the tube in a container partially filled with clean brake fluid. Loosen the bleeder fitting approximately three-quarters of a turn.
8. Slowly push the brake pedal all the way down. Close the bleeder fitting, and return the pedal to the fully-released position. Repeat this operation until air bubbles no longer appear at the submerged end of the bleeder tube.
9. When the fluid is completely free of air bubbles, close the bleeder fitting and remove the bleeder tube.
10. Repeat this procedure at the brake wheel cylinder on the opposite side. Refill the master cylinder reservoir after each wheel cylinder is bled. When the bleeding operation is complete, fill the master cylinder to within 3mm (1/8 in) from the top of the reservoirs.

Pressure Bleeding

Be sure the bleeder tank contains enough of the specified brake fluid to complete the bleeding operation. Charge the tank with approximately 69-206 kPa (10-30 psi). **Never exceed 345 kPa (50 psi). Never use brake fluid that has been drained from the hydraulic system. Bleed the longest lines first.**

1. Clean all dirt from the master cylinder reservoir cap.
2. Remove the master cylinder reservoir cap and fill the master cylinder reservoir with the specified brake fluid. Install the pressure bleeder adapter tool on the master cylinder, and attach the bleeder tank hose to the fitting on the adapter.

   Master cylinder pressure bleeder adapter tools are available from the manufacturers of pressure

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bleeding equipment. Follow the manufacturer's instructions when installing the adapter.

3. Place a 3/8 inch box wrench on the bleeder fitting on the right rear brake wheel cylinder. Attach a bleeder tube snugly to the bleeder fitting.
4. Open the valve on the bleeder tank and admit pressurized brake fluid to the master cylinder reservoir.
5. Submerge the free end of the tube in a container partially filled with clean brake fluid, and loosen the bleeder fitting.
6. When air bubbles no longer appear in the fluid at the submerged end of the bleeder tube, close the bleeder fitting and remove the tube.
7. Repeat Steps 3 through 6 at the opposite wheel cylinder. On front brakes, bleed the right front caliper first.
8. When the bleeding operation is completed, close the bleeder tank valve and remove the tank hose from the adapter fitting.
9. Remove the pressure bleeder adapter tool. Fill the master cylinder reservoirs with the specified brake fluid to within 3mm (1/8 in) from the top of the filler neck. Install the master cylinder cover.

SAFETY

Breathing Asbestos Dust

WARNING: DO NOT INHALE DUST FROM BRAKES, CLUTCHES OR ASSOCIATED COMPONENTS. INHALATION OF DUST CONTAINING ASBESTOS FIBERS CAN BE INJURIOUS TO YOUR HEALTH AND COULD CAUSE CANCER OR ASBESTOSIS. COMPRESSED AIR OR BRUSHES MUST NOT BE USED TO CLEAN BRAKES, BRAKE DRUMS, CLUTCHES AND ASSOCIATED COMPONENTS. A VACUUM CLEANER EQUIPPED FOR THIS PURPOSE SHOULD BE CAREFULLY USED TO REMOVE ANY DUST (ROTUNDA MODEL 091-00001). ADHERENT DUST SHOULD BE REMOVED WITH A DAMP RAG. ANY DUST SHOULD BE CONTAINED IN A SEALED AND LABELED BAG FOR DISPOSAL. WEAR AN APPROVED HIGH EFFICIENCY CARTRIDGE OR AIR LINE RESPIRATOR AND USE EXTRA CAUTION TO AVOID BREATHING THIS DUST. USE NON-ASBESTOS REPLACEMENT PARTS WHENEVER POSSIBLE.

The following procedures are recommended to minimize asbestos dust exposures during brake and clutch servicing of trucks, tractors and trailers. These procedures are consistent with asbestos regulations set forth by the Occupational Safety and Health Administration (OSHA). Adherence to these procedures will eliminate exposures to asbestos during brake and clutch servicing.

An area should be designated for all brake and clutch services. Entrances to this area must be posted with the following sign:

ASBESTOS

Dust Hazard

Avoid Breathing Dust

Wear Assigned Protective Equipment

Do Not Remain in Area Unless Your Work Requires It

Breathing Asbestos Dust May Cause Asbestosis and Cancer

Only essential personnel should be present in the immediate maintenance area during brake and clutch servicing.

During brake servicing, use a toxic dust air purifying respirator of either single-use or replaceable cartridge type. It must be approved by the Mine Safety and Health Administration (MSHA) or by the National Institute of Occupational Safety and Health (NIOSH). It shall be worn during all procedures from removal of wheels to reassembly. An example of an acceptable respirator is the 3M-9910 or 9920 (or equivalent).

Wheel brake assemblies must be cleaned using a vacuum cleaner recommended for use with asbestos fibers. A vacuum for this purpose is available from the Rotunda Equipment Catalog model 091-00001. Similar vacuums are also manufactured by Nilfish and Hako ("Minuteman"). If additional cleaning is necessary, a rag soaked with water or a brake washer (Rotunda Model 065-00016 or equivalent) must be used.

Grinding or sanding on brake linings, pads, rotors or drums, shall be done only while using properly exhaust-ventilated equipment. A respirator must be worn while performing these operations.

During removal of vacuum bags, an approved respirator, as described above, shall be worn. Industrial vacuum cleaner bags containing asbestos dust, cloths used for wiping brake assemblies, and other asbestos-contaminated debris shall be sealed in plastic bags and labeled with the following warning label printed in letters of sufficient size and contrast to be readily visible and legible:

CAUTION

Contains Asbestos Fibers

Avoid Breathing Dust

Breathing Asbestos Dust May Cause Asbestosis and Cancer

All asbestos waste must be disposed in accordance with OSHA and Environmental Protection Agency (EPA) asbestos regulations. Asbestos waste must not be incinerated or disposed in community water supplies.

All floor cleaning in the asbestos servicing area and clean-up of waste from grinding or sanding must be done using an approved vacuum cleaner while wearing a proper respirator.

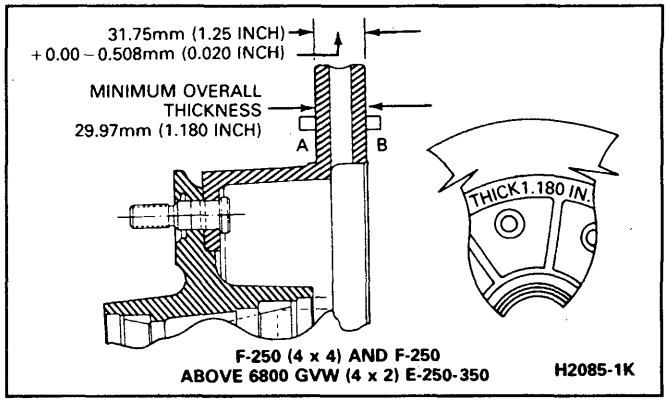


FIG. 9 Disc Brake Rotor Service Limits

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REMOVAL AND INSTALLATION

HD Pin Rail Slider Caliper, Brake Shoes and Linings

F-250, F-350, E-250—E-350, F-250—F-350 (4x4) and F-Super Duty

Replace shoe and lining assemblies as follows when the lining is worn to a minimum thickness of 0.794 mm (1/32 inch) above the backing plate. Always replace all shoes and lining assemblies on an axle. Never service one wheel only.

Removal

1. To avoid fluid overflow when the caliper pistons are pressed into the caliper cylinder bores, siphon or dip part of the brake fluid out of the master cylinder reservoir. Discard the removed fluid.
2. Raise the vehicle and install safety stands. Remove the front wheel and tire assembly.
3. Place an appropriate size C-clamp on the caliper (Fig. 10) and tighten the clamp to bottom the caliper pistons in the cylinder bores. Remove the clamp.

   NOTE: Do not use a screwdriver or similar tool to pry piston away from the rotor.
4. Clean excess dirt from area around pin tabs.
5. Tap upper caliper pin towards inboard side until pin tabs touch the spindle face.
6. Insert a screwdriver into the slot provided behind the pin tabs on the inboard side of the pin.
7. Use needle nose pliers to compress the outboard end of the pin while prying at the same time with the screwdriver, until the tabs slip into the spindle groove (Fig. 11).
8. Place one end of a punch (approximately 7/16 inch diameter) against the end of the caliper pin and drive the caliper pin out of the caliper slide groove.
9. Repeat removal procedure for lower pin.
10. Remove the caliper from the rotor. If the caliper is to be removed for service, remove the brake hose from the caliper.

CAUTION: Do not let the caliper hang by the flexible hose. The hose could become stretched or twisted and cause premature brake failure.

11. Remove the outer and inner lining and remove the anti-rattle spring.

Installation

1. Install new inner and outer shoe. Install anti-rattle spring. **Always replace all shoe and lining assemblies on an axle. Never service one wheel only.**

   NOTE: There is a raised section at one end of each shoe so that installation can be made in one direction only.
2. Install the caliper on the spindle, making sure the mounting surfaces are free of dirt and lubricate the caliper grooves with Disc Brake Caliper Grease, D7AZ-19590-A (ESA-M1C72-A) or equivalent.
3. Position pin with the pin retention tabs oriented adjacent to the spindle groove (Fig. 17).
4. Tap the pin on the outboard end with a hammer. Continue tapping the pin inward until the retention tabs on the sides of the pin contact the spindle face. Repeat procedure for the lower pin.

CAUTION: During the installation procedure do not allow the tabs of the caliper pin to be tapped too far into the spindle groove. If this happens it will be necessary to tap the other end of the caliper pin until the tabs snap into place. The tabs on each end of the caliper pin must be free to catch on the spindle flanks. See Figure 18.

5. If removed, install the brake hose to the caliper and bleed the brakes as described in Section 12-01, General Hydraulic Brake Service.
6. Install the wheel and tire assembly.
7. Lower the vehicle, check the brake fluid level and fill as necessary. Check brakes for proper operation.

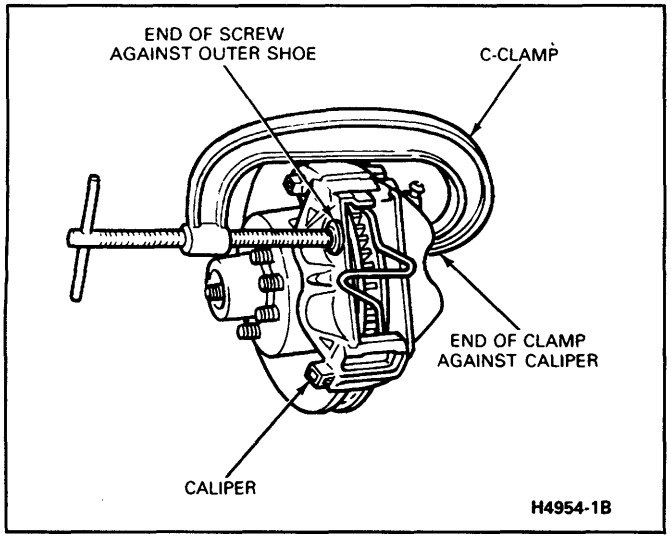


FIG. 10 Bottoming Caliper Piston

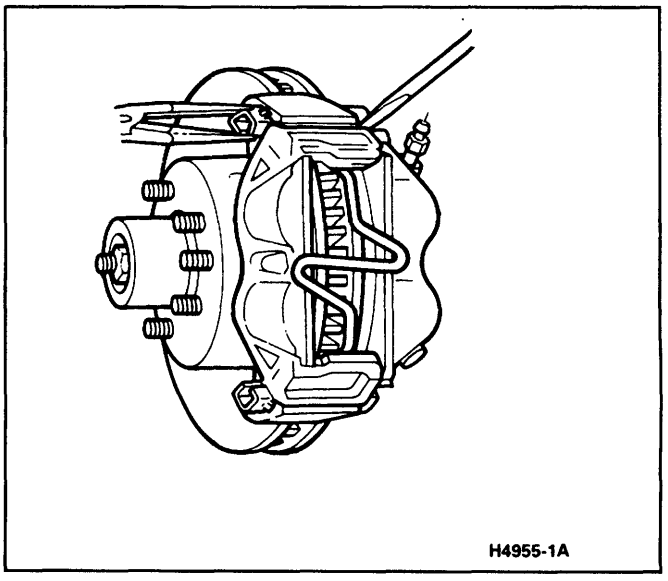


FIG. 11 Compressing Spring Tabs

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LD Pin Rail Sliding Caliper, Brake Shoes and Linings

F-150 (4x2) E-150, Bronco, F-150 (4x4)

Removal

Replace shoe and lining assemblies as follows when the lining is worn to a minimum thickness of 1.5mm (1/16 inch) above the shoe plate. **Always replace all shoe and lining assemblies on an axle. Never service one wheel only.**

1. To avoid fluid overflow when the caliper piston is pressed into the caliper cylinder bores, siphon or dip part of the brake fluid out of the master cylinder reservoir. Discard the removed fluid.
2. Raise the vehicle and install safety stands. Remove a front wheel and tire assembly.
3. Place an eight-inch C-clamp on the caliper (Fig. 12) and tighten the clamp to bottom the caliper piston in the cylinder bore. Remove the clamp.

   NOTE: Do not use a screwdriver or similar tool to pry piston away from the rotor.
4. Clean excess dirt from area around pin tabs.
5. Tap upper caliper pin towards inboard side until pin tabs touch the spindle face.
6. Insert a screwdriver into the slot provided behind the pin tabs on the inboard side of the pin.
7. Use needle nose pliers to compress the outboard end of the pin while prying at the same time with the screwdriver, until the tabs slip into the spindle groove (Fig. 13).
8. Place one end of a punch (approximately 7/16 inch diameter) against the end of the caliper pin and drive the caliper pin out of the caliper slide groove.
9. Repeat removal procedure for lower pin.
10. Remove the caliper from the rotor. If the caliper is to be removed for service, remove the brake hose from the caliper. If the caliper is not going to be removed, wire it up to the vehicle to avoid damage to the brake hose.
11. Remove the outer lining. Remove the anti-rattle clips and remove the inner lining.

Installation

1. Place a new anti-rattle clip on the lower end of the inner shoe (Fig. 14). Be sure the tabs on the clip are positioned properly and the clip is fully seated.

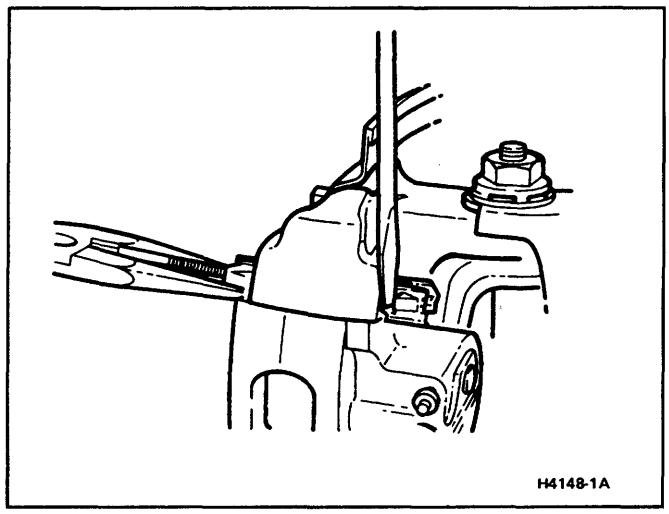


FIG. 13 Compressing Pin Tabs

2. Position the inner shoe and anti-rattle clip in the shoe abutment with the anti-rattle clip tab against the shoe abutment and the loop-type spring away from the rotor (Fig. 15). Compress the anti-rattle clip and slide the upper end of the shoe in position.
3. Install the outer shoe. Crimp or bend outer shoe tabs to prevent shoes from rattling in caliper.
4. Install the caliper on the spindle, making sure the mounting surfaces are free of dirt and lubricate the caliper grooves with Disc Brake Caliper Grease, D7AZ-19590-A (ESA-M1C72-A) or equivalent.
5. Position pin with the pin retention tabs oriented adjacent to the spindle groove Fig. 16.

   NOTE: Do not use the bolt and nut with the new pin.
6. Tap the pin on the outboard end with a hammer. Continue tapping the pin inward until the retention tabs on the sides of the pin contact the spindle face. Repeat procedure for the lower pin.

CAUTION: During the installation procedure do not allow the tabs of the caliper pin to be tapped too far into the spindle groove. If this happens it will be necessary to tap the other end of the caliper pin until the tabs snap into place. The tabs on each end of the caliper pin MUST be free to catch on the spindle flanks. See Figure 17.

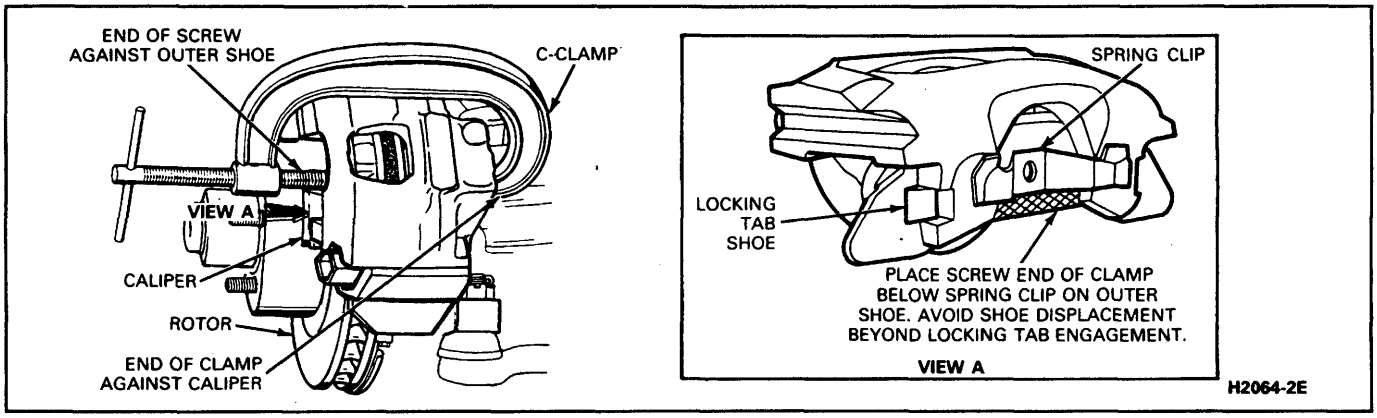


FIG. 12 Bottoming Caliper Piston (Typical)

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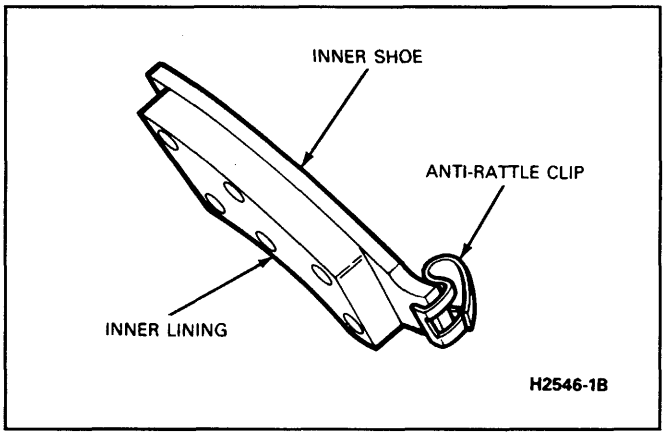


FIG. 14 Installing Anti-Rattle Clip-On Inner Shoe

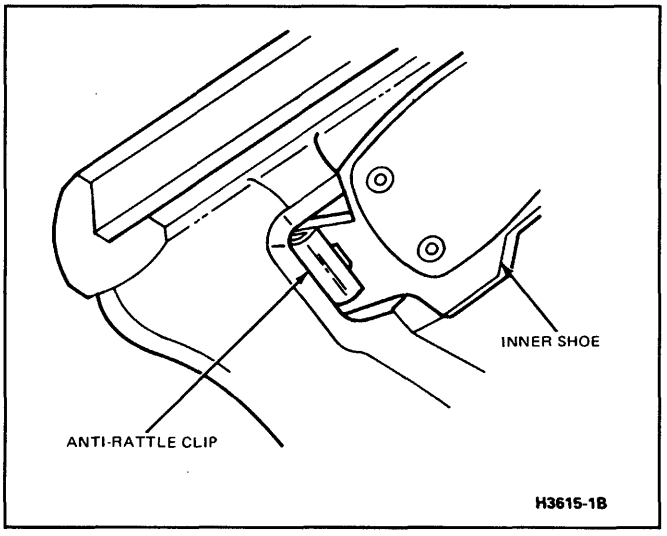


FIG. 15 Installing Inner Shoe and Anti-Rattle Clip

7. If removed, install the brake hose to the caliper and bleed the brakes as described in Section 12-01, General Hydraulic Brake Service.
8. Install the wheel and tire assembly.
9. Lower the vehicle, check the brake fluid level and fill as necessary. Check brakes for proper operation.

Disc Brake Hub and Rotor

Removal

1. Raise the front of the vehicle and install safety stands.
2. Remove the wheel and tire assembly.
3. Remove the caliper assembly from the rotor and hold it out of the way with wire. Refer to Caliper Removal instructions in this Section.
4. Remove the dust cap, cotter pin, nut, washer, and outer bearing, and remove the rotor from the spindle. (4x4 vehicles refer to Section 11-12, Wheels, Hubs and Bearings—Front Wheel Drive for procedures). Check the condition of the rotor as described under Disc Brake Rotor in the Disassembly and Assembly portion of this Section.
5. Remove inner bearing cone and seal. Discard the seal.

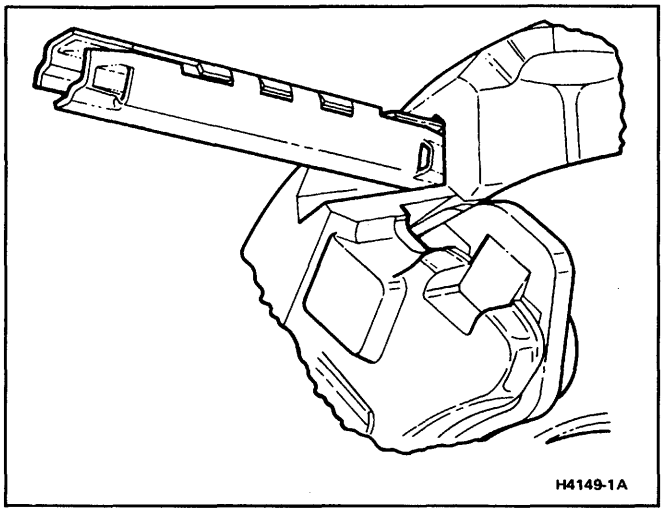


FIG. 16 Caliper Pin Installation

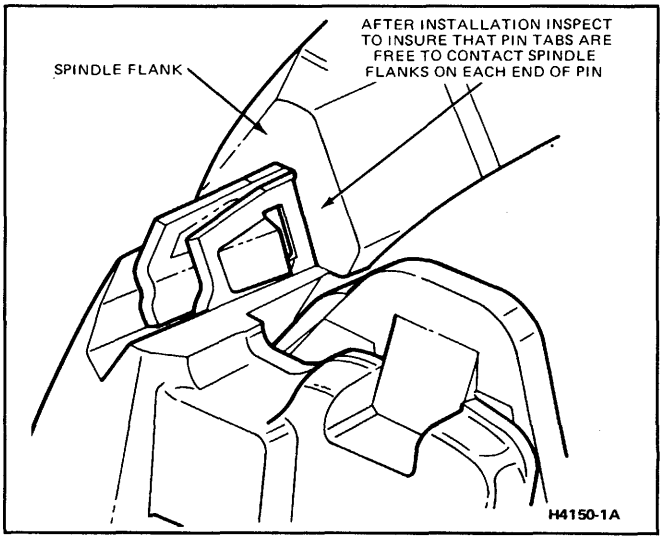


FIG. 17 Correct Caliper Pin Installation

6. On F-Super Duty the rotor can be removed from the hub by removing the ten (10) M 12 x 1.75 x 32.50mm E-18 External Torx machine screws.

Installation

1. If a new hub and rotor will be installed, remove the protective coating or any dirt or grease deposits with degreaser. On F-Super Duty the machine screw threads must be coated with a suitable adhesive before attaching the rotor to the hub. Tighten screws to 90-110 N·m (66-81 ft-lb).
2. Pack the inner and outer bearing cone with a lithium-base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B, (ESA-M1C75-B), or equivalent.
3. Install the inner bearing cone and seal as described in Section 11-10, Wheels, Hubs, and Bearings—Front (Except Front Drive). (4x4 vehicles refer to Section 11-12, Wheels, Hubs and Bearings—Front Wheel Drive, for procedures).
4. Install the hub and rotor on the spindle.
5. Install the outer bearing cone, washer, and nut. Adjust bearing end play and install the cotter pin and dust cap as described in Section 11-10,

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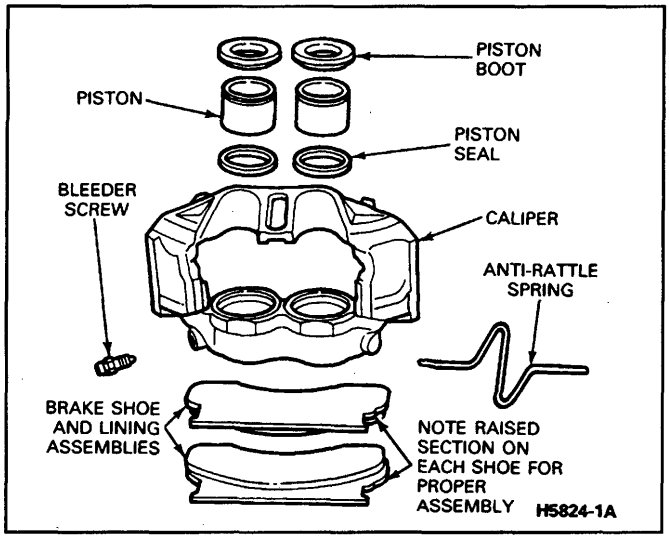


FIG. 18 Front Disc Brake Caliper Disassembled—HD Rail Slider

Wheels, Hubs and Bearings—Front (Except Front Drive). (4x4 vehicles refer to Section 11-12, Wheels, Hubs, and Bearings—Front Wheel Drive, for procedures).

6. Install the caliper as described in this Section.
7. Install the wheel and tire assembly.
8. Lower the vehicle.

Hydraulic Line Repair

Steel tubing is used in the hydraulic lines between the master cylinder and the front brake tube connector, and between the rear brake tube connector and the rear brake cylinders. Flexible hoses connect the brake tube to the front brake cylinders and to the rear brake tube connector.

When replacing hydraulic brake tubing, hoses, or connectors, tighten all connections securely. After replacement, bleed the brake system at the wheel cylinders and at the booster (if equipped).

Brake Tube

If a section of the brake tube is damaged, replace it with tubing of the same type, size, shape, and length. **Do not use copper tubing in the hydraulic system. Be careful not to kink or crack the tubing when bending it to fit the frame or rear axle.**

Double flare the brake tubing (Section 12-01, General Hydraulic Brake Service) to provide good leak-proof connections. Always clean the inside of a new brake tube with clean isopropyl alcohol.

Brake Hose

Replace a flexible brake hose if it shows signs of softening, cracking, or other damage.

When installing a new brake hose, position the hose to avoid contact with other vehicle parts. Whenever a brake hose is disconnected from a wheel cylinder or brake caliper, install a **new copper washer connecting the hose.**

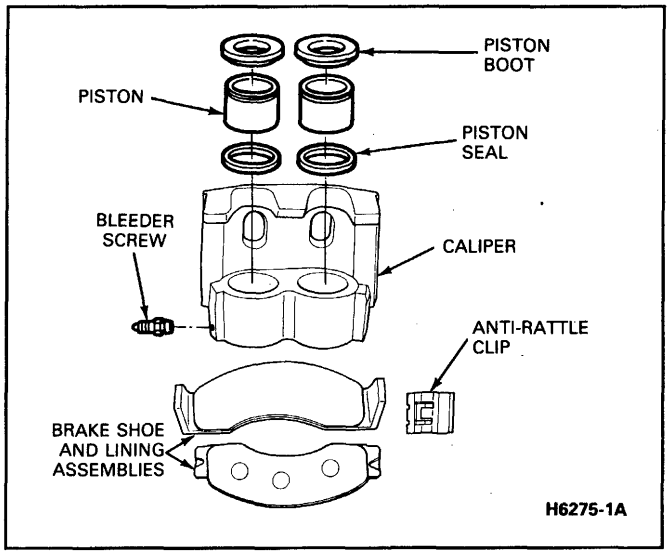


FIG. 19 Disc Brake Caliper Front and Rear—F-Super Duty

DISASSEMBLY AND ASSEMBLY

Disc Brake Caliper—HD Rail Sliding Caliper

Disassembly

Refer to Fig. 18.

1. Disconnect the flexible brake hose and plug the end to prevent brake fluid leakage. Remove the caliper assembly.
2. Remove the brake shoe and lining assemblies and anti-rattle spring.
3. Drain the fluid from the cylinders.
4. Secure the caliper assembly in a vise.
5. Place a block of wood between the caliper bridge and the cylinders, and apply low pressure air to the brake hose inlet. The pistons will be forced out to the wood block. Refer to Fig. 19.
6. Remove the wood block, and remove the pistons.
7. Remove and discard the piston seals and boots.
8. If the caliper assembly is leaking, replace the piston assemblies. If the cylinder bores are scored, corroded or excessively worn, replace the caliper. Do not hone the cylinder bores. Piston assemblies are not available for oversize bores.

Assembly

Never re-use piston seals and dust boots. Install a new set each time the caliper is assembled.

1. Lubricate new piston seals with clean brake fluid C6AZ-19542-A or B or equivalent and install them in the seal grooves in the cylinder bores.
2. Apply a film of clean brake fluid to the cylinder bores.
3. Lubricate the retaining lips of the dust boots with clean brake fluid and install them in the boot retaining grooves in the cylinder bores.
4. Apply a film of clean brake fluid to the pistons.
5. Insert the pistons into the dust boots and start them into the cylinders by hand until they are beyond the piston seals. **Be careful not to damage or dislodge the piston seal.**

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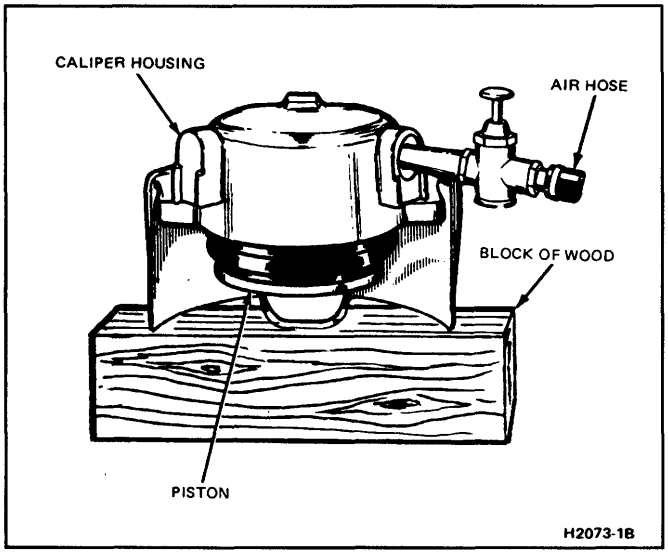


FIG. 20 Removing Caliper Piston

6. Place a wood block over one piston and press the piston into the cylinder being careful not to cock the piston in the cylinder. Install the second piston in the same manner. Make certain that boots are correctly seated.
7. Install the shoe and lining assemblies and anti-rattle spring in the caliper assembly. Place the caliper assembly on the support and install the caliper pins, as outlined in this Section.
8. Install the flexible brake hose with new copper washers and tighten to specification listed at the end of this Section.
9. Bleed the brake system. **Do not move the vehicle until a firm brake pedal is obtained.**

Disc Brake Caliper—Sliding Caliper—LD

NOTE: Do not use a screwdriver or any similar tool to pry piston into or out of the bore to prevent chipping or scuffing damage to the phenolic piston.

Disassembly

Refer to Fig. 21.

1. Remove the caliper assembly from the vehicle as outlined in Caliper Removal. Remove outer brake shoe to avoid damage to lining material. Substitute shoe with a piece of wood of similar size and shape, or use a worn out shoe and lining assembly. Place a cloth over the piston before applying air pressure to prevent damage to the piston.

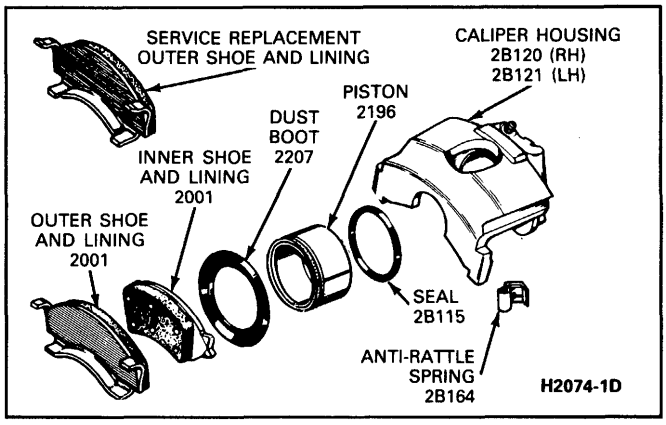


FIG. 21 Disc Brake Caliper—Disassembled—LD Sliding Caliper

2. Apply air pressure to the fluid port in the caliper with a rubber-tipped nozzle (Tool 7000-DD or equivalent), as shown in Fig. 20 to remove the piston. If the piston is seized and cannot be forced from the caliper, tap lightly around the piston while applying air pressure. **Use care because the piston can develop considerable force from pressure build-up.**
3. Remove the dust boot from the caliper assembly.
4. Remove the rubber piston seal from the cylinder, and discard it.

NOTE: Do not remove the steel ring from the piston.

Cleaning and Inspection

Clean all metal parts with isopropyl alcohol. Then, clean out and dry the grooves and passageways with compressed air. Make sure that caliper bore and component parts are thoroughly clean.

Check the cylinder bore and piston for damage or excessive wear.

Assembly

1. Apply a film of clean brake fluid to the new caliper piston seal, and install it in the cylinder bore. Be sure the seal does not become twisted but is firmly seated in the groove.
2. Install a new dust boot by setting the flange squarely in the outer groove of the caliper bore.
3. Coat the piston with brake fluid, and install the piston in the cylinder bore. Spread the dust boot over the piston as it is installed. Seat the dust boot in the piston groove, behind the pressed on steel ring.
4. Install the caliper over the rotor as outlined.

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SPECIFICATIONS

TORQUE LIMITS

Description	N·m	(ft-lbs)
Brake Hose to Caliper Attaching Bolt	24-33	17-25

TORQUE LIMITS — HYDRAULIC NUTS (FT-LBS)

Thread Size	N·m	(ft-lbs)①
3/8-24	14-20	10-15
7/16-24	14-20	10-15
1/2-20	14-23	10-17
9/16-18	14-23	10-17

①All hydraulic line connections (nuts) must be tightened to the specified value and free of fluid leakage.

ROTOR REPAIR DIMENSIONS

Vehicle	Minimum Rotor Thickness (Discard Thickness)		Rotor Thickness Maximum Variation		Brake Surface Lateral Runout (Maximum)		Rotor Surface Finish
	MM	Inch	MM	Inch	MM	Inch	Micro-Inches
E-150, F-150 (4x2)	28.50	1.12	0.013	0.0005	0.08	0.003	
F-150, Bronco (4x4) (Integral)	28.50	1.12	0.013	0.0005	0.08	0.003	
F-150, Bronco (4x4) (2-Piece)	28.50	1.12	0.018	0.0007	0.13	0.005	15
E-250-350, F-250-350 (4x2) SRW (Integral)	30.00	1.18	0.018	0.0007	0.08	0.003	to
F-350, E-350 (4x2) DRW (2-Piece)	30.00	1.18	0.025	0.0010	0.13	0.005	80
F-250-350, (4x4) SRW	30.00	1.18	0.025	0.0010	0.13	0.005	
F-350 (4x4) DRW	30.00	1.18	0.025	0.0010	0.13	0.005	
F-Super Duty DRW	36.3	1.43	0.025	0.0010	0.20	0.008	15-80

CH2487-2L

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer – 2-1/2 lb.	Universal
D79P-100-A	Impact Slide Hammer – 5 lb.	Universal
T59L-100-B	Impact Slide Hammer – 2-1/2 lb.	Universal
T71P-1102-A	Disc Rotor Surface Gauge	Universal
T73L-2196-A	Disc Brake Piston Remover	Use with Slide Hammer
D79L-2196-A	Disc Brake Pad Spreader	Universal
T73T-2208-A	Front Brake Bleeder Wrench	E-150 thru E-350, F-150 thru F-350, Bronco
Tool-4201-C	Dial Indicator with Bracketry	Universal

CH2701-2E

ROTUNDA EQUIPMENT

Model Number	Description
104-00064	Brake Bleeder
091-00001	Asbestos Vacuum
065-00016	Brake Parts Washer

CH3539-1E

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SECTION 12-30 Brake Pedal, Master Cylinder and Valves

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Master Cylinder	12-30-1
Plastic Reservoir with Fluid Level Indicator	12-30-1
Proportioning Valve	12-30-1
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VEHICLE APPLICATION

E-150 through E-350, F-150 through F-350, Bronco and F-Super Duty Truck Models.

DESCRIPTION AND OPERATION

Master Cylinder

The dual master cylinder contains a plastic "see-thru" fluid reservoir with a Fluid Level Indicator (FLI) and primary and secondary hydraulic pistons and an integral proportioning valve.

The dual master cylinder performs in the following manner:

REAR WHEEL BRAKES —the rear wheel brakes are connected to the secondary outlet port and are actuated by the secondary piston assembly.

FRONT WHEEL BRAKES —the front wheel brakes are connected to the primary outlet port (farthest from the dash panel) and are actuated by the primary piston assembly.

Both primary and secondary pistons function together.

Refer to Fig. 2 for an illustration of the econoline master cylinder operation.

On all vehicles (except F-Super Duty) the master cylinder is assisted by a vacuum booster. On F-Super Duty a Bendix Hydroboost is used. Information about the vacuum booster is given in Sections 12-50, Vacuum Brake Booster—Single Diaphragm—Dash Mounted (Bendix) and 12-52 Vacuum Brake Booster—Tandem Diaphragm—Dash Mounted (Bendix). Information on the Bendix Hydroboost is given in Section 12-57.

Brake Pedal

The brake pedal transfers and intensifies the force applied by the operator to the front discs and rear drums to stop or slow down the vehicle. A brake stoplamp switch is mounted on the pedal and whenever the pedal is depressed the rear brake lamps are illuminated.

Plastic Reservoir with Fluid Level Indicator

Refer to Fig. 4.

The fluid level indicator is an integral part of the fluid reservoir. It is serviced as a part of the plastic reservoir assembly. It consists of a float containing a magnet and a reed switch. When the fluid in the reservoir gets to a predetermined level, the magnet actuates the reed switch, causing the warning lamp to light. Loss of fluid from either the primary (front) or secondary (rear) system will cause this system to actuate.

If the fluid level indicator is deemed to be inoperative, the plastic reservoir must be replaced.

Proportioning Valve

The proportion valve is integral to the master cylinder on F-Series, Bronco, and E-150 vehicles (Fig. 4). The valve functions to recirculate rear brake system hydraulic pressure. A plug and tube seat is pressed into the outlet port of the master cylinder. A hole through the center of the plug and tube seat directs the hydraulic fluid down the valve to the rear brake system outlet port. In case of the front brake system malfunction, the proportioning valve with a bypass feature allows full hydraulic pressure to the rear brake system. Refer to Fig. 5.

Height Sensing Brake Proportioning Valve

The Height Sensing Brake Proportioning Valve is used on all E-250—E-350 and F-Super Duty vehicles. The height sensing valve regulates rear brake hydraulic pressure when the vehicle is in the lightly loaded condition and allows full braking pressure to the rear brakes when the vehicle is carrying a full load (Fig. 6).

The valve is located on the number five crossmember (Fig. 15) and is activated through a linkage system that is connected to the rear axle housing cover. Movement

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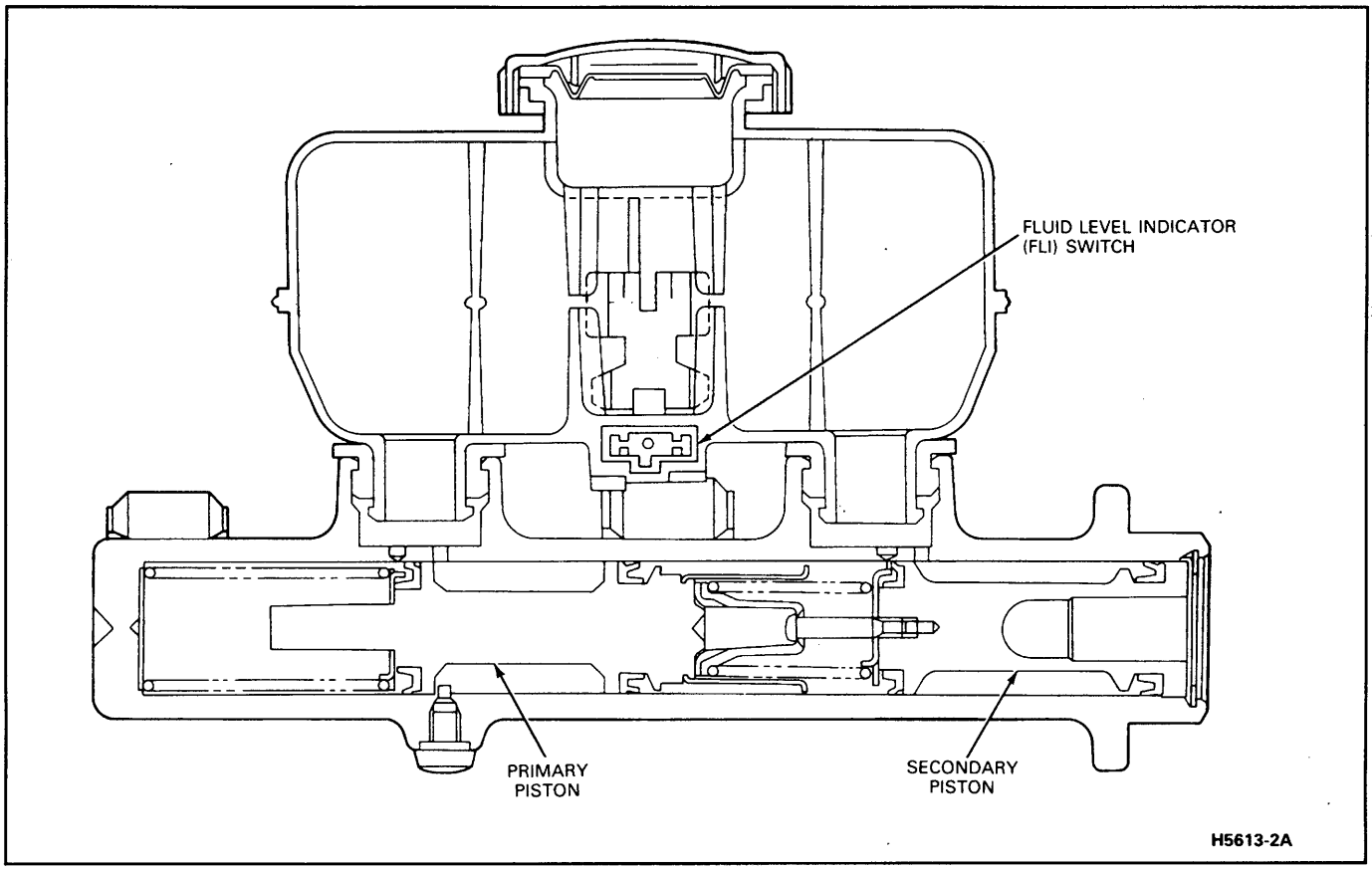


FIG. 1 Master Cylinder—Cutaway View

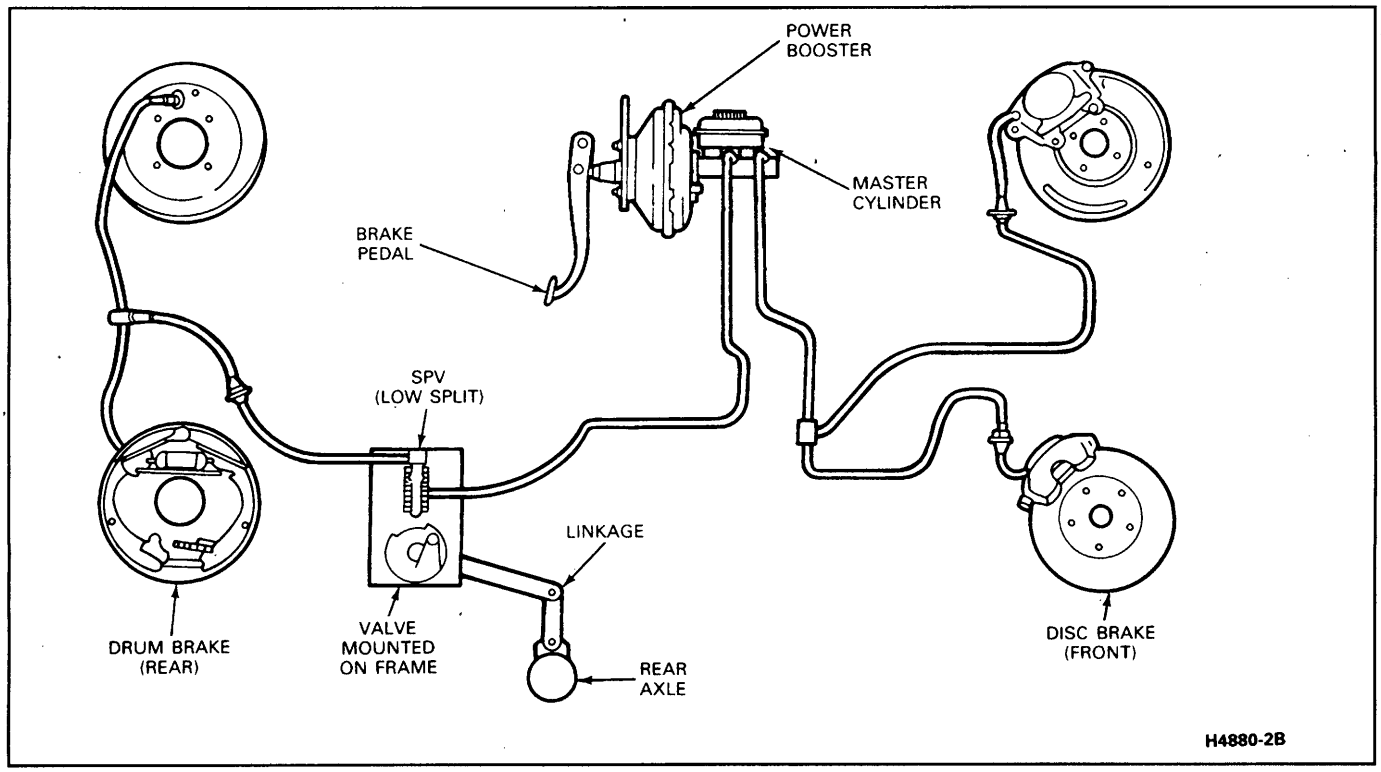


FIG. 2 Master Cylinder Operation Econoline 250—350

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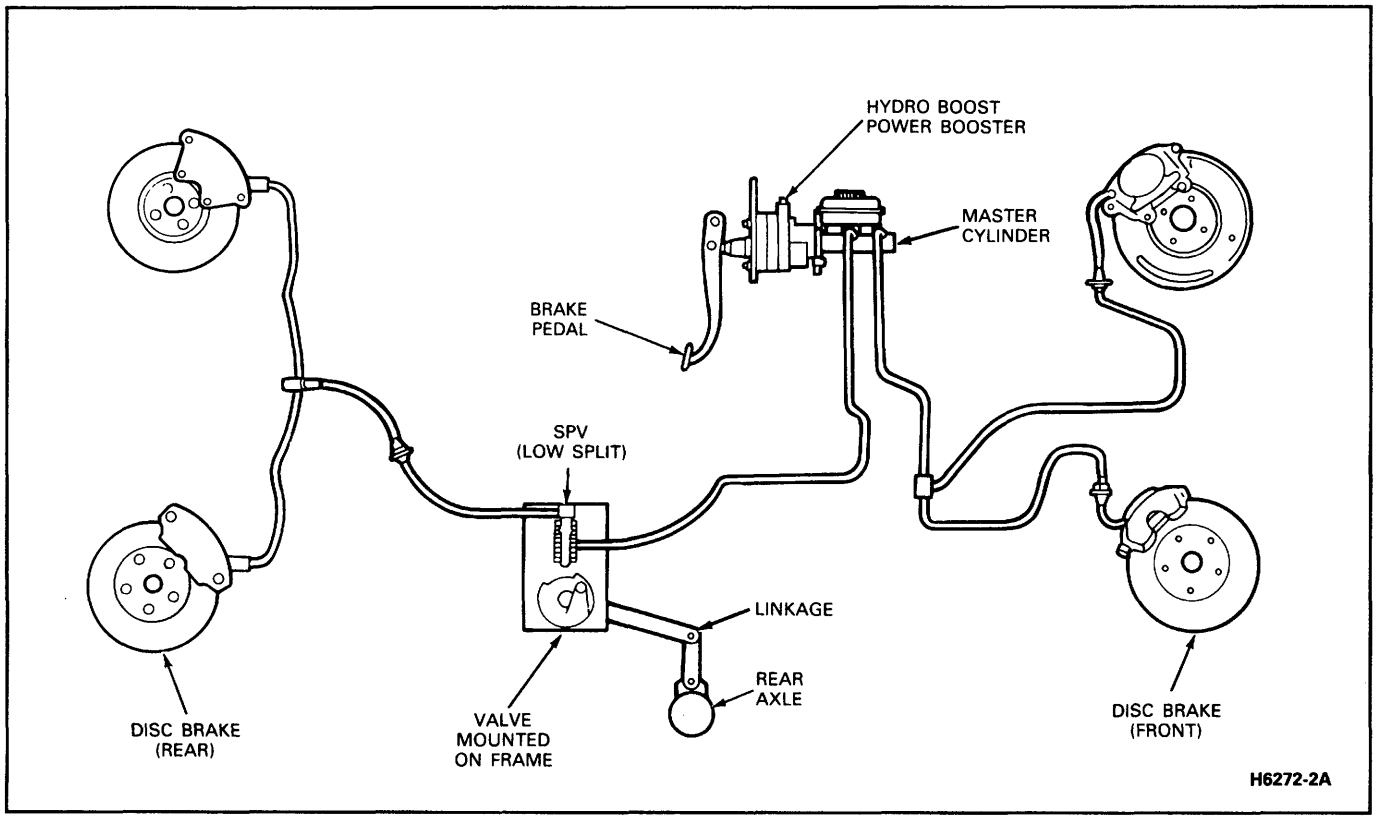


FIG. 3 Master Cylinder Operation F-Super Duty

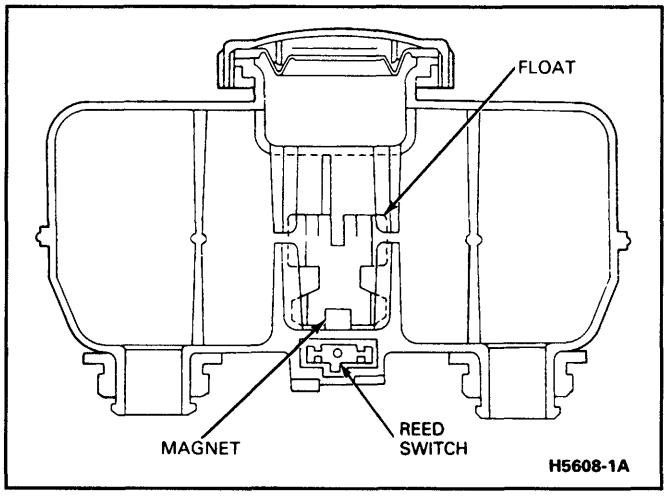


FIG. 4 Plastic Reservoir with Fluid Level Indicator

of the lever from vehicle loading will rotate the valve cam allowing the plunger to shift position. As vehicle load increases the plunger shifts farther and allows more pressure to the rear brakes.

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake System.

ADJUSTMENTS

Refer to Section 12-01, General Hydraulic Brake Service, for master cylinder and brake system bleeding procedures.

REMOVAL AND INSTALLATION

Master Cylinder

Refer to Figs. 7 and 8.

Removal

1. With the engine turned off, push the brake pedal down to expel vacuum from the brake booster system. Disconnect fluid level indicator switch connector from the master cylinder.
2. Disconnect the hydraulic lines from the brake master cylinder.
3. Remove the wrap around clip and attaching nut from the booster master cylinder mounting stud.
4. Remove the brake booster - to - master cylinder retaining nuts. Remove the master cylinder from the brake booster.

Installation

1. Before installing the master cylinder, check the distance from the outer end of the booster assembly push rod, to the front face of the brake booster assembly. Turn the push rod adjusting screw in or out as required to obtain the specified length (Fig. 9).
2. Position the master cylinder assembly over the booster push rod and onto the two studs on the booster assembly. Install the attaching nuts and tighten to 24-34 N·m (18-25 ft-lbs).
3. Loosely connect the hydraulic brake system lines to the master cylinder.
4. Position the wrap around clip over the mounting stud. Install and tighten the attaching nut.

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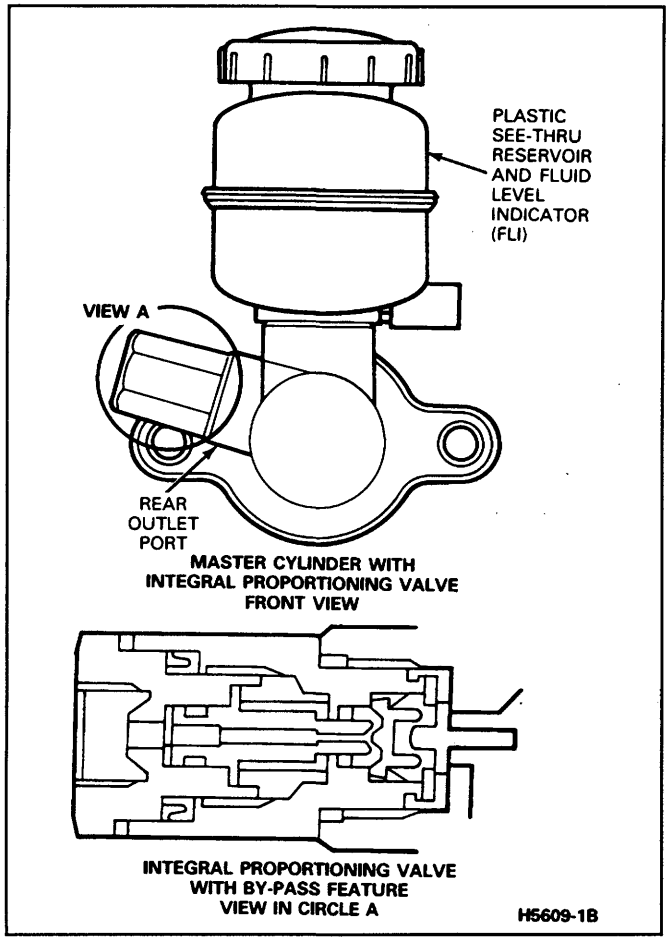


FIG. 5 Master Cylinder Assembly and Integral Proportioning Valve

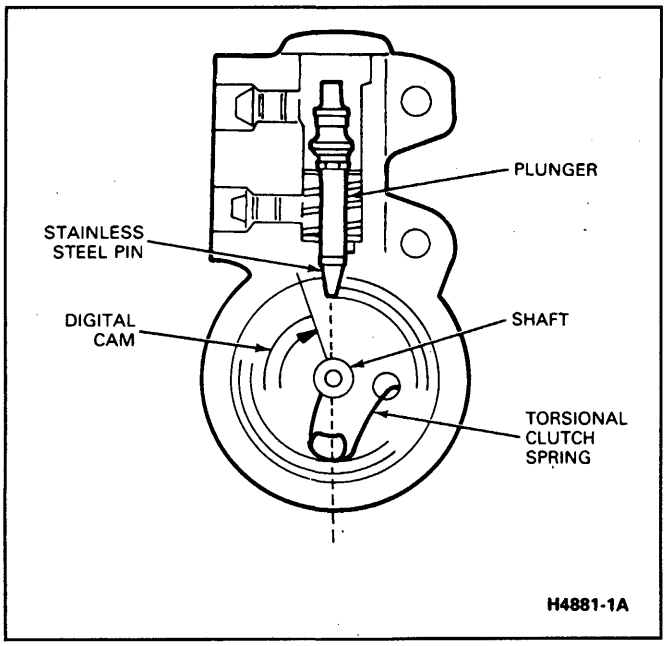


FIG. 6 Height Sensing Brake Proportioning Valve—Cutaway View

5. Tighten the attaching nut to 24-34 N·m (18-25 ft-lb).

6. Connect fluid level indicator switch.

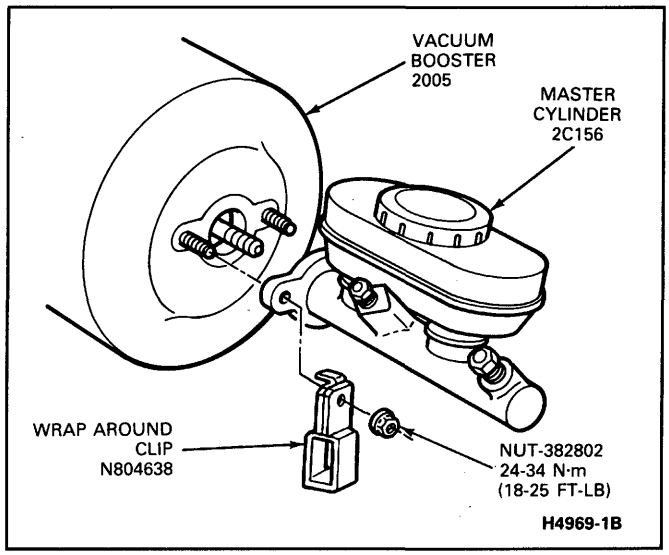


FIG. 7 Master Cylinder Installation—F-150—F-350 and Bronco

7. Bleed the master cylinder as described in Section 12-01, General Hydraulic Brake Service. Fill the plastic reservoir of the master cylinder with Heavy Duty Brake Fluid C6AZ-19542-A or B (ESA-M6C25-A) or an equivalent to the fluid fill line. Install gasket and bleed the hydraulic brake system as described in Section 12-01.

Brake Pedal Assembly

F-150—F-350, Bronco and F-Super Duty

Refer to Figs. 10 and 11.

Removal

1. Working inside the cab, below the instrument panel, disconnect the wires from the stop lamp switch. Remove the cotter pin and spacer connecting the brake pedal assembly, stop lamp switch assembly and master cylinder push rod together. Remove the stop lamp switch and master cylinder push rod from the pin on the brake pedal.
2. On vehicles equipped with manual transmissions, disconnect the clutch pedal retracting spring. Remove the nut (by the brake pedal) on the clutch rod lever and remove the lever, washer spring, and bushing. Push the clutch pedal assembly to the side enough for the brake pedal assembly to come off the shaft. Take off the brake pedal bushings.
3. On vehicles equipped with automatic transmission, remove one spring retainer and bushing from the brake pedal shaft. From the other end, pull out the shaft and remove the brake pedal assembly. Remove the bushings and washer spring from the brake pedal.
4. Remove the stop lamp switch from the bracket on the brake pedal.
5. Remove the pedal pad, if required.

Installation

1. Install the pedal pad on the brake pedal assembly, if required.
2. Install the stop lamp switch on the brake pedal bracket.

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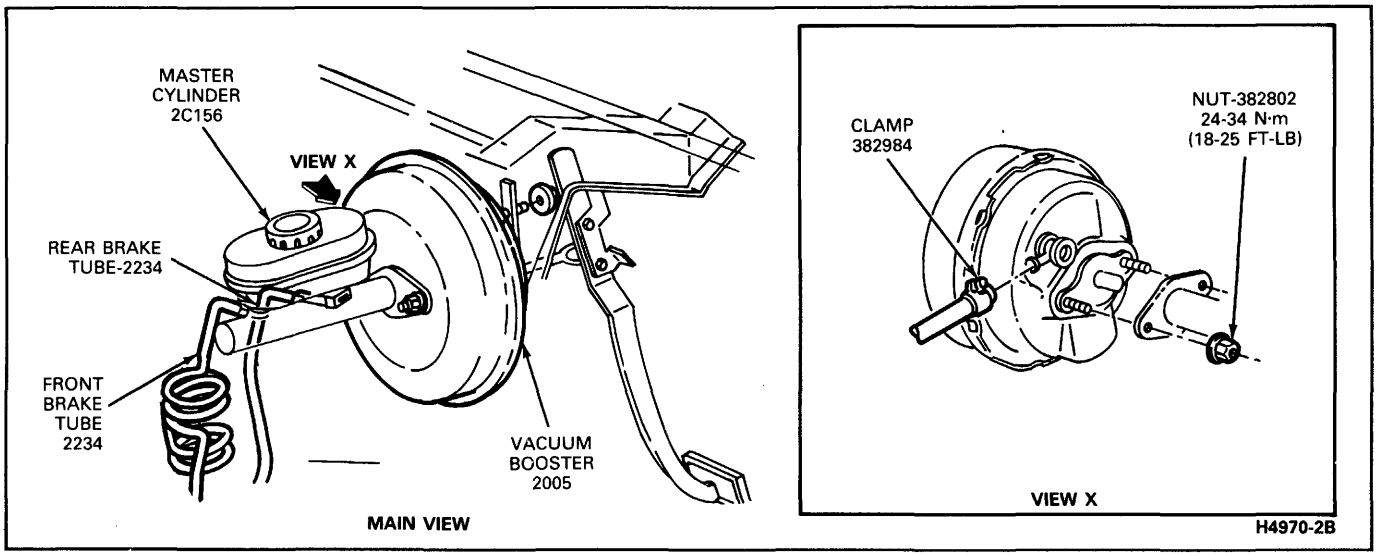


FIG. 8 Master Cylinder Installation—E-150—E-350

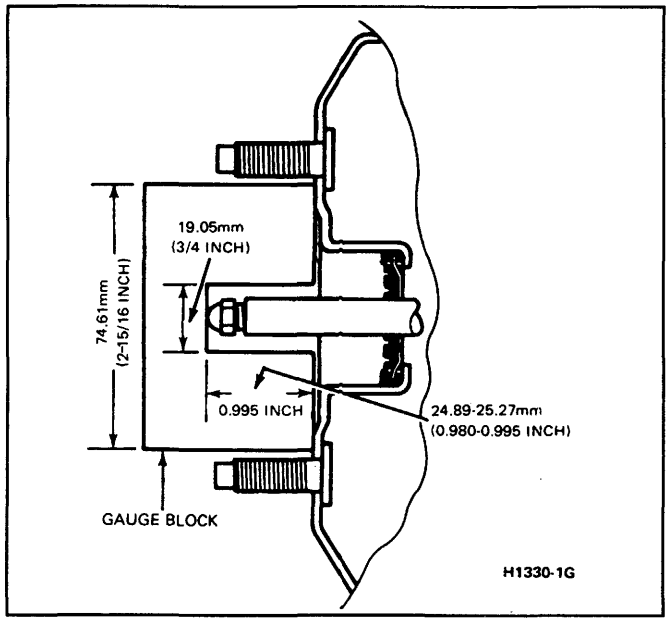


FIG. 9 Bendix Booster Push Rod Gauge Dimensions and Adjustment

3. Place bushings and washer spring in position on the brake pedal assembly.
4. On vehicles equipped with manual transmissions, move the pedal assembly into the bracket. Slide the clutch pedal assembly so the clutch shaft goes through the hub of the brake pedal assembly. Install the bushing and clutch rod and lever onto the clutch shaft. Position the nut holding the clutch lever to clutch shaft and tighten. Connect the clutch pedal retracting spring.
5. On vehicles equipped with automatic transmission, move the brake pedal assembly into the bracket. Slide the brake pedal shaft through the bracket and hub on the brake pedal. Install bushings and spring retainers on the shaft.
6. Place the bushing spacer stop lamp switch assembly and master cylinder push rod onto the pin on the brake pedal. Install the spacer and cotter pin.
7. Connect wires to stop lamp switch. Check unit for correct operation.

Brake Pedal

E-150—E-350

Refer to Figs. 12 and 13.

Removal

1. Remove the retainer to disconnect the stoplamp switch assembly and master cylinder push rod from the brake pedal.
2. Remove the cotter pin and nut holding the pedal shaft to the bracket.
3. Remove the pedal from the bracket by removing the nut.
4. Remove the bushings from the pedal shaft.

Installation

1. Install the pedal assemblies through the brackets. Install the washer, nut and cotter pin.
2. Position the brake master cylinder push rod on the pedal assembly. Install the stop lamp switch and retainer.

Height Sensing Brake Proportioning Valve

E-250—E-350 and F-Super Duty

Refer to Fig. 14.

NOTE: The height sensing valve is not to be disassembled or repaired, it is serviced as a complete assembly only.

Removal

1. Raise the vehicle on a hoist so that the rear suspension hangs in the fully extended position.
2. Remove the nut holding the linkage arm to the height sensing valve and disconnect the linkage arm.
3. Remove the flow bolt holding the flexible brake hose to the valve.
4. Disconnect the brake line from the valve.

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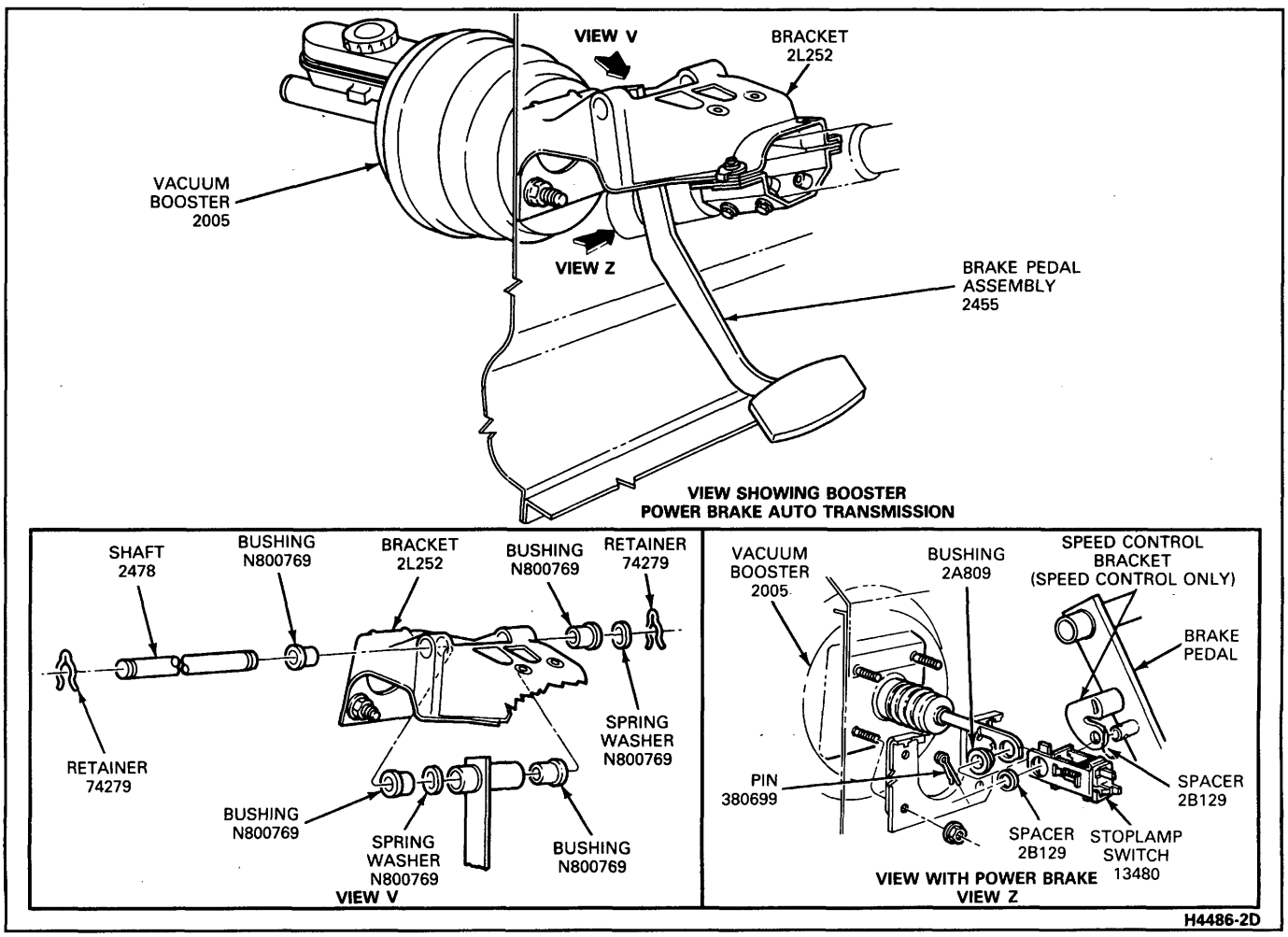


FIG. 10 Brake Pedal Installation—F-150—F-350 and Bronco with Automatic Transmission

5. Remove the two bolts securing the height sensing valve to its mounting bracket, and remove the valve.

Installation

1. Place the height sensing valve on its mounting bracket. Install the two mounting bolts and tighten to 17-24 N·m (12-18 ft-lbs).
2. Install the flexible brake hose using new copper gaskets. Tighten the flow bolt to 37-46 N·m (28-34 ft-lbs).
3. Install the brake line to the lower port on the valve and tighten securely.
4. Position the linkage arm on the height sensing valve and tighten the retaining nut to 11-14 N·m (8-10 ft-lbs).
5. Bleed the brakes as described in Section 12-01, General Hydraulic Brake Service. Check for proper brake operation.

Master Cylinder Reservoir

Refer to Fig. 15.

Removal

1. Disconnect the brake warning lamp indicator wire from the plastic reservoir fluid level indicator socket. Drain the brake fluid from the master cylinder assembly.
2. Using a large screwdriver, pry between the reservoir and the master cylinder body (Fig. 16) and remove the reservoir.

Installation

1. Lubricate the two grommets included in Service Kit 2K478 with Heavy Duty Brake Fluid, C6AZ-19542-A or B (ESA-M6C25-A) or an equivalent DOT 3 fluid. Insert the grommets into the master cylinder body.

NOTE: Whenever the master cylinder plastic reservoir is replaced, the grommets must also be replaced.

2. Press the plastic reservoir into the grommets with the fluid level indicator socket facing outboard. The reservoir should snap in place, indicating that it is secure.
3. Connect the brake warning lamp indicator wire to the fluid level indicator socket.
4. Fill the reservoir with Heavy Duty Brake Fluid, C6AZ-19542-A or -B (ESA-M6C25-A) or an equivalent DOT 3 brake fluid. Bleed the system as outlined in this Section.

DISASSEMBLY AND ASSEMBLY

Master Cylinder

Refer to Fig. 17.

Remove the master cylinder from the vehicle for overhaul.

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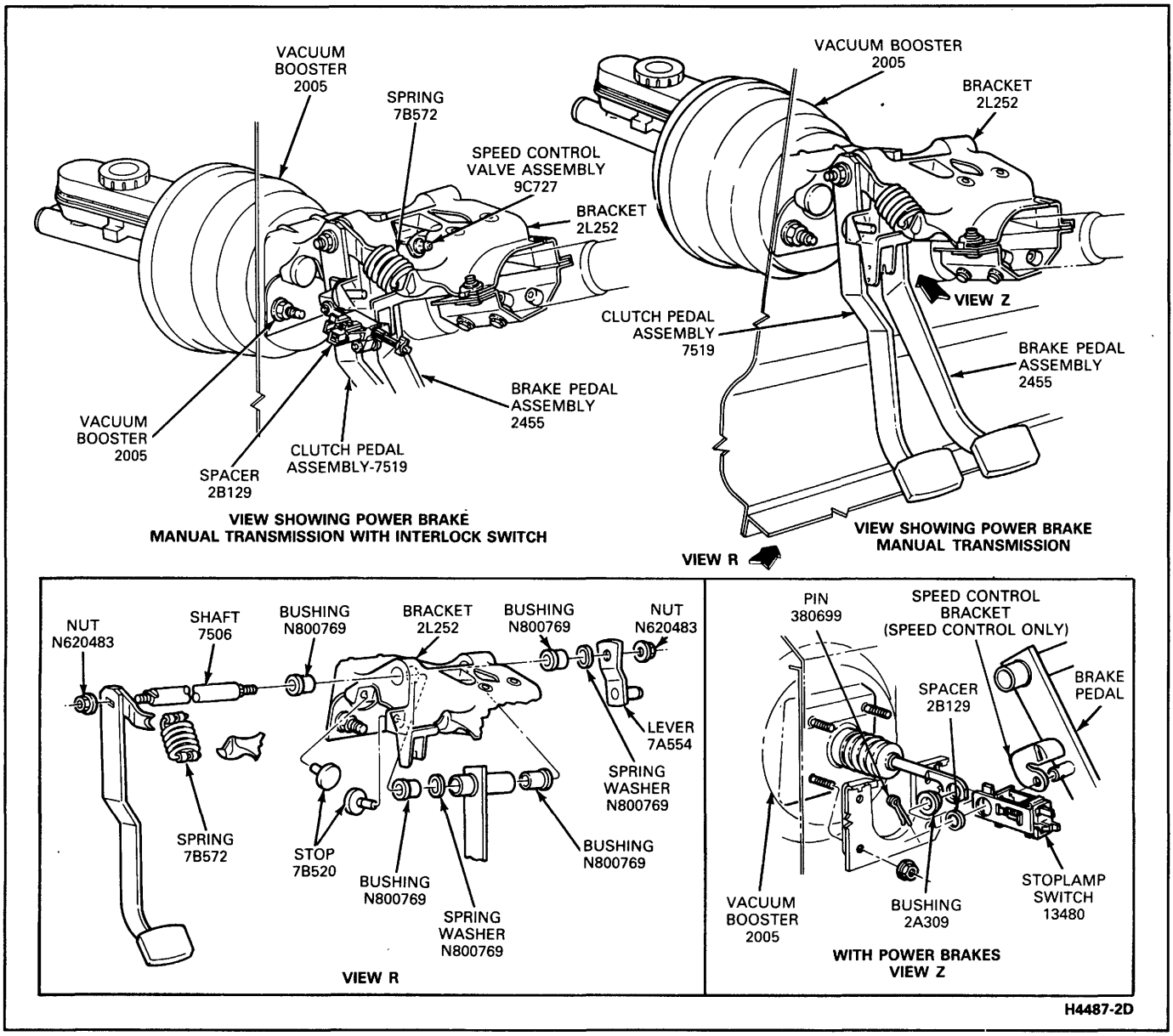


FIG. 11 Brake Pedal Installation—F-150—F-350 and Bronco with Manual Transmission

Disassembly

1. Clean the outside of the master cylinder and remove the plastic cap and gasket. Drain and discard any brake fluid that remains in the cylinder.
2. Remove the proportioning valve from the master cylinder.
3. Remove step-bolt from the bottom of the master cylinder assembly.
4. Depress the secondary piston and remove snap ring (Fig. 18) from retaining groove at the rear of the master cylinder bore.
5. Remove secondary piston assembly from the master cylinder bore and inspect for seal damage or twisting. Record condition of piston assembly on repair order and discard assembly.
6. Remove the primary piston assembly by directing compressed air into the outlet port at the blind end of the bore while plugging the other outlet port. Inspect for seal damage or twisting. Record condition of piston assembly on repair order and discard assembly.
7. Inspect the master cylinder bore for signs of etching, pitting, scoring or other damage.
   a. If bore is damaged, discard and replace with new master cylinder assembly. **Do not attempt to hone bore.**
   b. If bore is not damaged, rebuild master cylinder assembly using the proper repair kit and the procedure outlined below.

Assembly

1. Clean the master cylinder body with clean isopropyl alcohol to remove any contamination.
2. Dip the repair kit piston assemblies in clean Heavy Duty Break Fluid C6AZ-19542-A or -B (ESA-M6C25-A) or equivalent to lubricate seals.
3. Carefully insert the complete primary piston assembly in the master cylinder bore.

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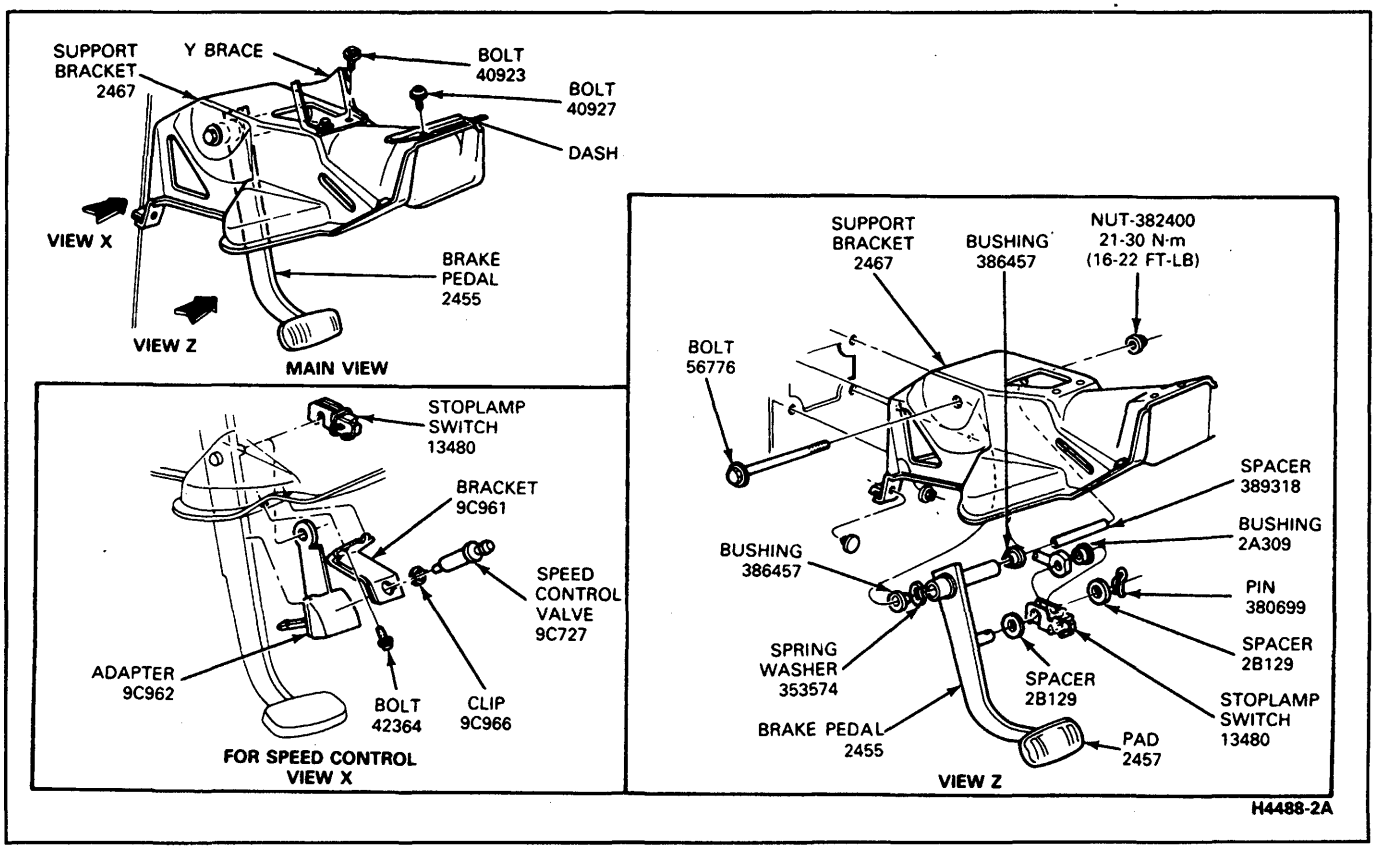


FIG. 12 Brake Pedal Installation—E-150—E-350 with Automatic Transmission

4. Carefully insert the secondary piston assembly in the master cylinder bore.
5. Depress the secondary piston and install the snap ring in the cylinder bore groove.
6. Install the step-bolt into the bottom of the master cylinder.
7. Install the proportioning valve assembly into the master cylinder.
8. Install the plastic cap on the master cylinder.

Bleeding the Master Cylinder

1. Support the master cylinder body in a vise, and fill both fluid reservoirs with Heavy Duty Brake Fluid C6AZ-19542-A or B (ESA-M6C25-A) or equivalent DOT 3 brake fluid.
2. Install plugs in the front and rear brake outlet ports. Bleed the front brake system first.
3. Loosen the plug in the front brake outlet port. Depress the secondary piston slowly to force the air out of the master cylinder. Tighten plug while piston is depressed or air will enter the master cylinder.
4. Repeat this procedure until air ceases to exit at the outlet port.
5. Repeat steps 3 and 4 for the rear brake outlet port with the front brake outlet plugged.
6. Tighten the plugs and try to depress the piston. Depressing the piston should be harder after all air is expelled.
7. Install the plastic cap.
8. Install the master cylinder in the vehicle and bleed the hydraulic system as outlined in Section 12-01.

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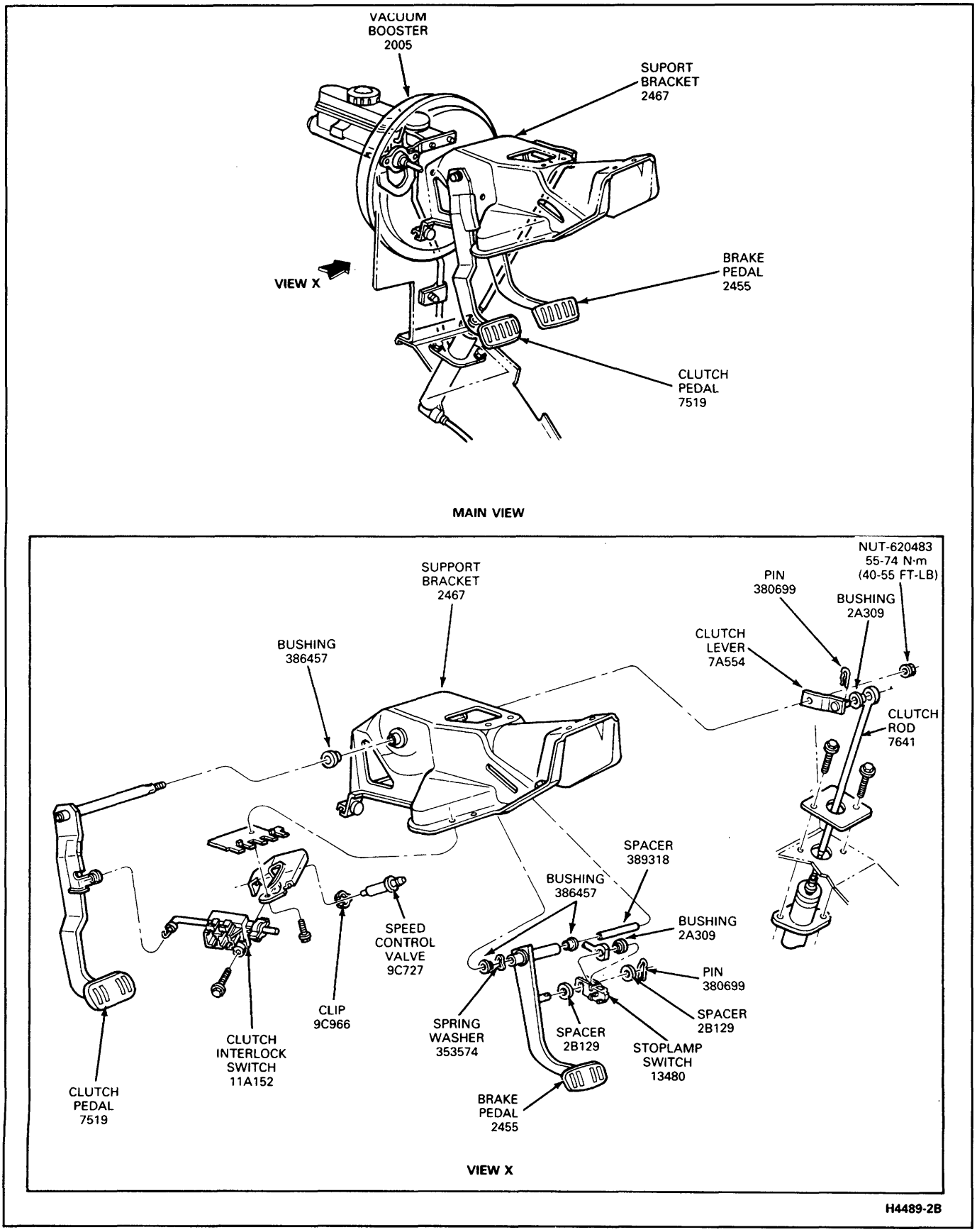


FIG. 13 Brake Pedal Installation—E-150—E-350 with Manual Transmission

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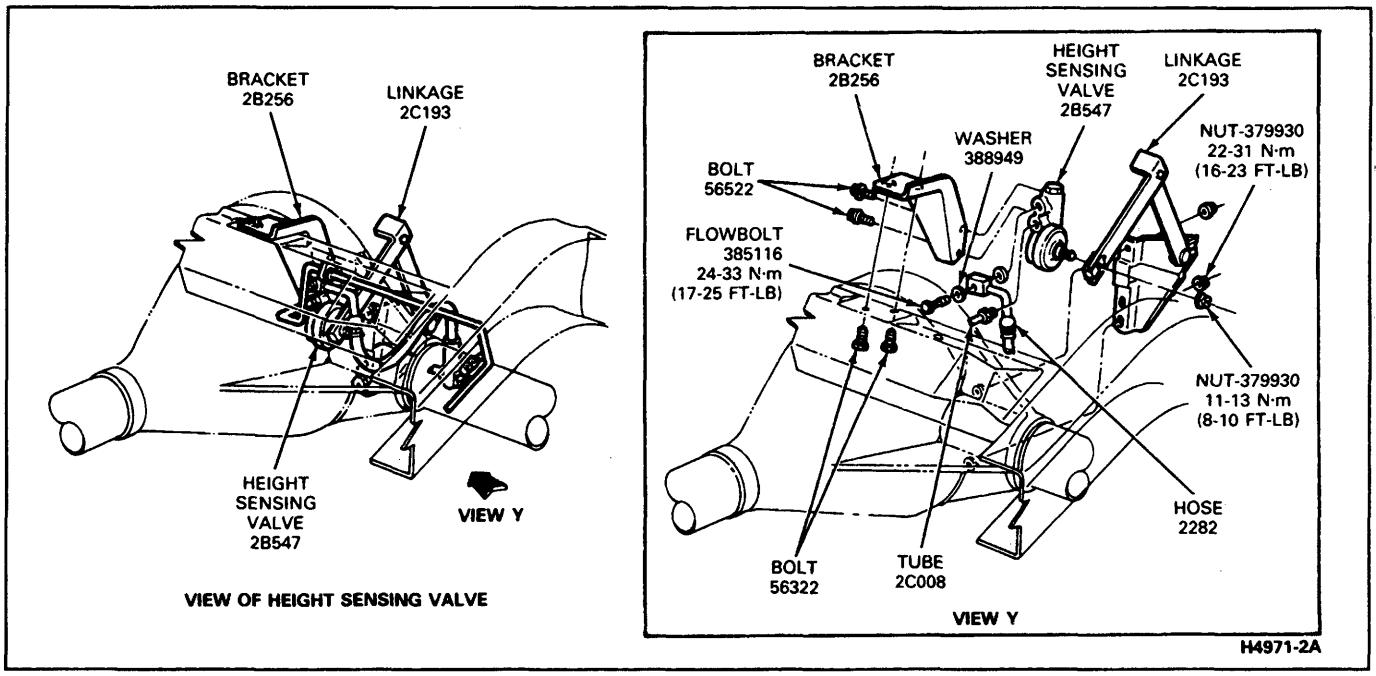


FIG. 14 Height Sensing Valve Installation—E-250—E-350

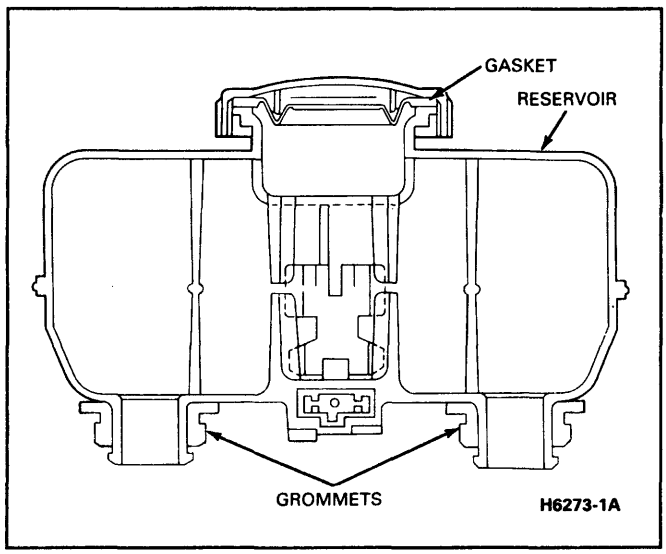


FIG. 15 Plastic Reservoir Assembly

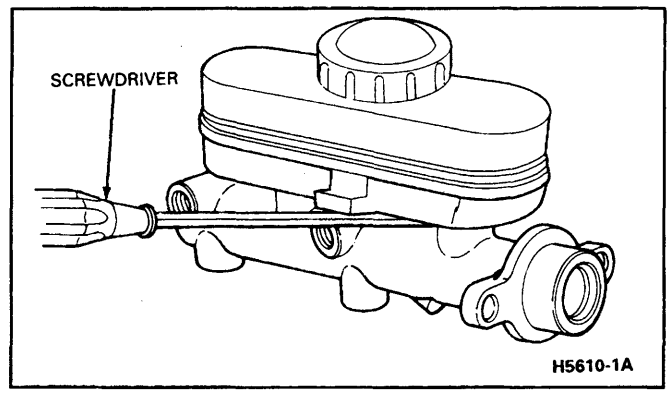


FIG. 16 Reservoir Removal

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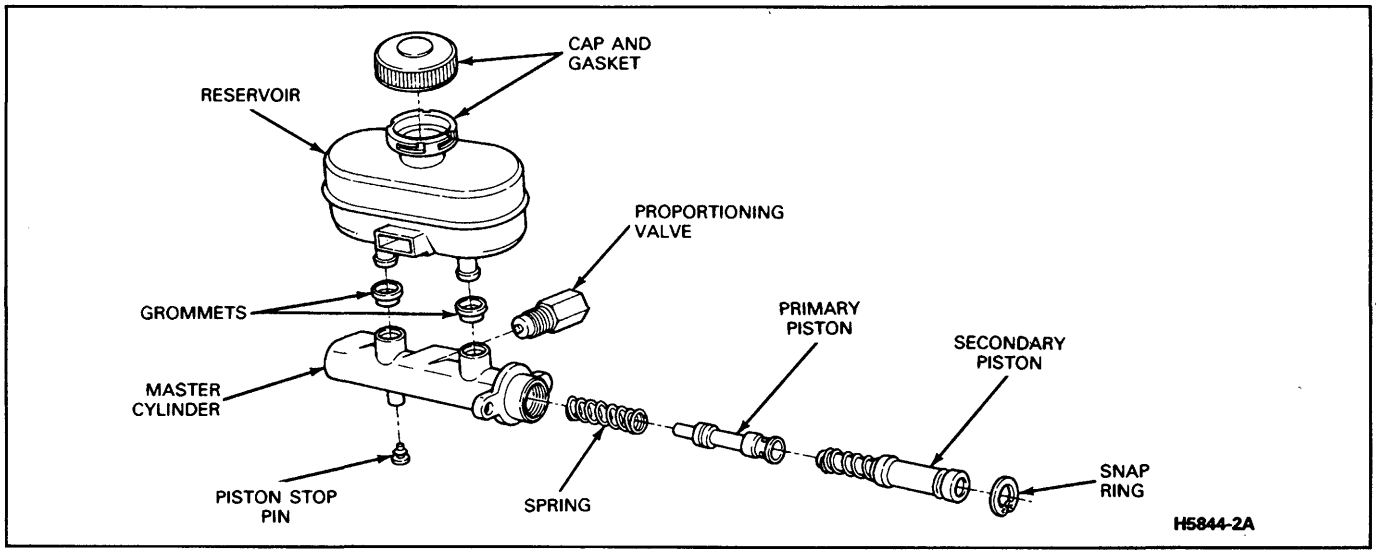


FIG. 17 Master Cylinder

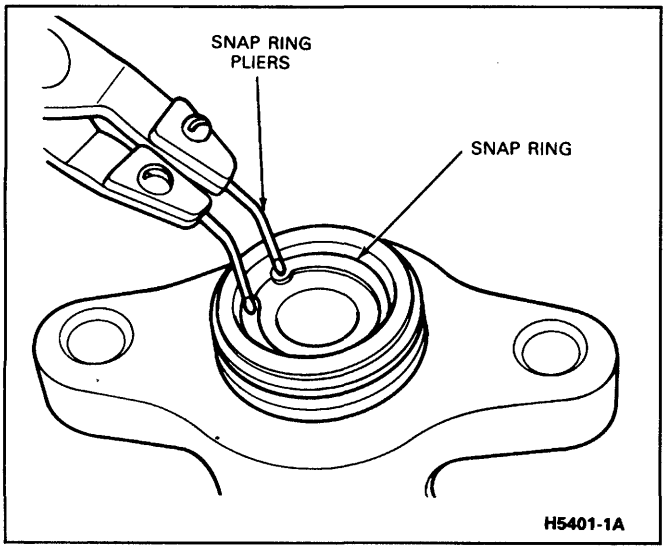


FIG. 18 Removing Snap Ring—Typical

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Application	Torque Limits	
		N·m	Ft-Lbs
Master Cylinder to Vacuum Booster Nut	All	18-33	13-25
Vacuum Booster to Firewall and Pedal Support Nut	All	18-33	13-25
Pedal Shaft Nut — Auto Trans.	All	29-40	21-30
Pedal Shaft Nut — Manual Trans.	F-150—F-350	29-40	21-30
Pedal Shaft Nut — Manual Trans.	E-150—E-350	34-40	25-30

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SECTION 12-31 Rear Antilock Brakes

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Operation	12-31-1
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Flashout Codes Chart	12-31-6
Obtaining the Flashout Code	12-31-5
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VEHICLE APPLICATION

F-150-250-350 and Bronco Truck Models.

DESCRIPTION AND OPERATION

Operation

The Rear Antilock Brake System (RABS) continually monitors rear wheel speed with a sensor mounted on the rear axle. When the teeth on an excitor ring, mounted on the ring gear, pass the sensor pole piece, an AC voltage is induced in the sensor circuit with a frequency proportional to the average rear wheel speed. In the event of an impending lockup condition during braking, the RABS modulates hydraulic pressure to the rear brakes. This inhibits rear wheel lockup.

When the brake pedal is applied, the RABS module senses the drop in rear wheel speed. If the rate of deceleration is too great, indicating that wheel lockup is going to occur, the RABS module activates the electro-hydraulic valve causing the isolation valve to close. With the isolation valve closed, the rear wheel cylinders are isolated from the master cylinder and the rear brake pressure cannot increase. If the rate of deceleration is still too great, the RABS module will energize the dump solenoid with a series of rapid pulses to bleed off rear wheel cylinder fluid into an accumulator built into the RABS valve. This will reduce the rear wheel cylinder pressure and allow the rear wheels to spin back up to vehicle speed. Continuing under RABS module control, the dump and isolation solenoids will be pulsed in a manner that will keep the rear wheels rotating while still maintaining high levels of deceleration during braking.

At the end of the stop, when the operator releases the brake pedal, the isolation valve de-energizes and any fluid in the accumulator is returned to the master cylinder. Normal brake operation is resumed.

System Self Test

The RABS module performs system tests and self-tests during start-up and normal operation. The valve, sensor, and fluid level circuits are monitored for proper operation. If a fault is found the RABS will be deactivated and the REAR ANTILOCK light will be illuminated. Most faults will cause the light to stay illuminated until the ignition is turned off. While the light is illuminated a diagnostic flashout code may be obtained. However, there are certain faults (those associated with the fluid level switch or loss of power to the module) that will cause the system to be deactivated and the REAR ANTILOCK light to be illuminated but will not provide a diagnostic flashout code.

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DESCRIPTION AND OPERATION (Continued)

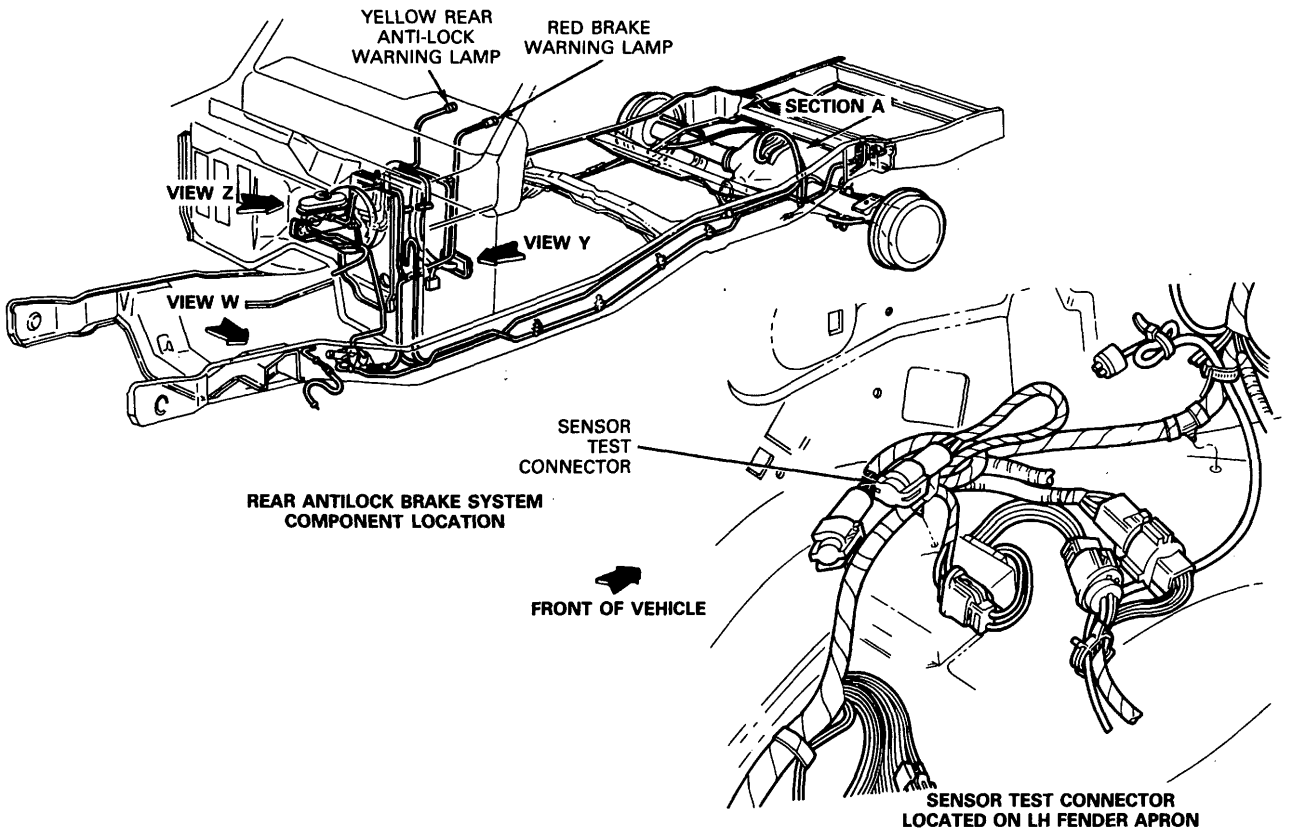
Component Location

The RABS consists of the following components:

- RABS module located in the cab to the right of the brake pedal under the upper dash panel.
- RABS valve (dual solenoid electro-hydraulic) located on the left frame rail just behind the number 1 crossmember.
- RABS speed sensor and excitor ring located in the rear axle carrier.
- Yellow REAR ANTILOCK warning light in the instrument cluster.
- RABS diagnostic connector located in the cab and clipped on the main instrument panel wiring harness about six inches from the firewall near the parking brake pedal.
- Diode/resistor element located on the main trunk of the instrument panel wiring harness where the RABS module connector pigtail intersects the main trunk.
- Sensor test connector with cap located under the hood on the left wheel well.

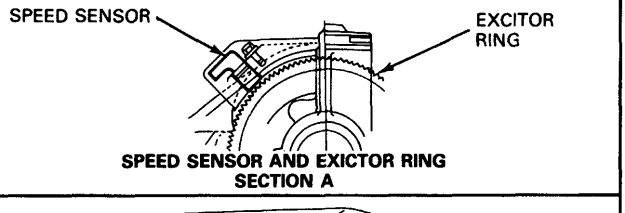
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DESCRIPTION AND OPERATION (Continued)

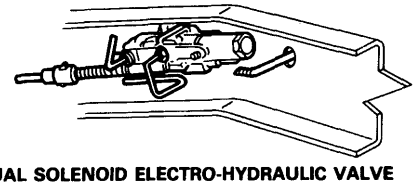


REAR ANTILOCK BRAKE SYSTEM COMPONENT LOCATION

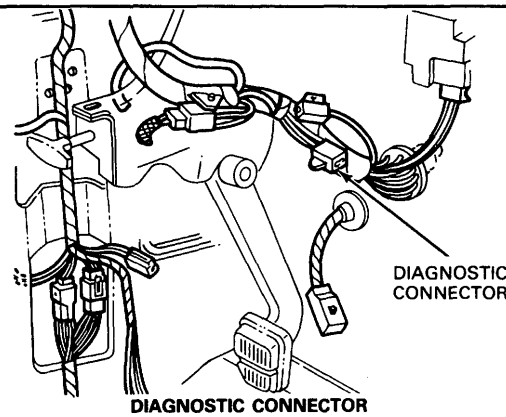
SENSOR TEST CONNECTOR LOCATED ON LH FENDER APRON



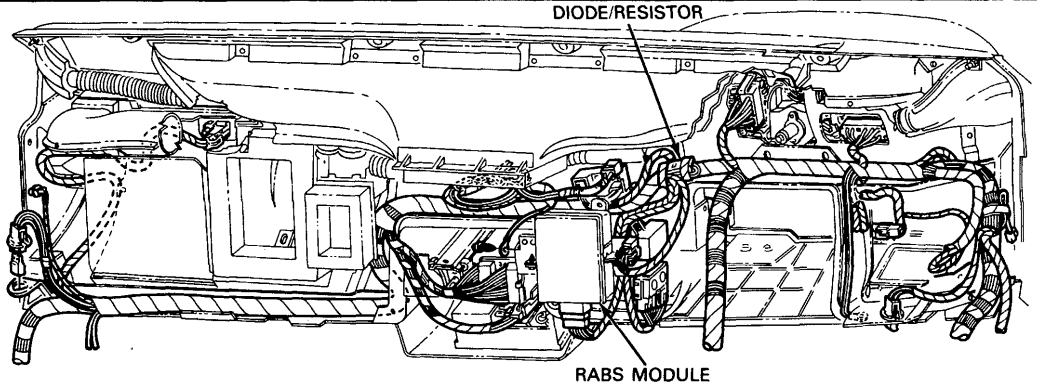
SPEED SENSOR AND EXICTOR RING SECTION A



DUAL SOLENOID ELECTRO-HYDRAULIC VALVE VIEW W



DIAGNOSTIC CONNECTOR VIEW Y



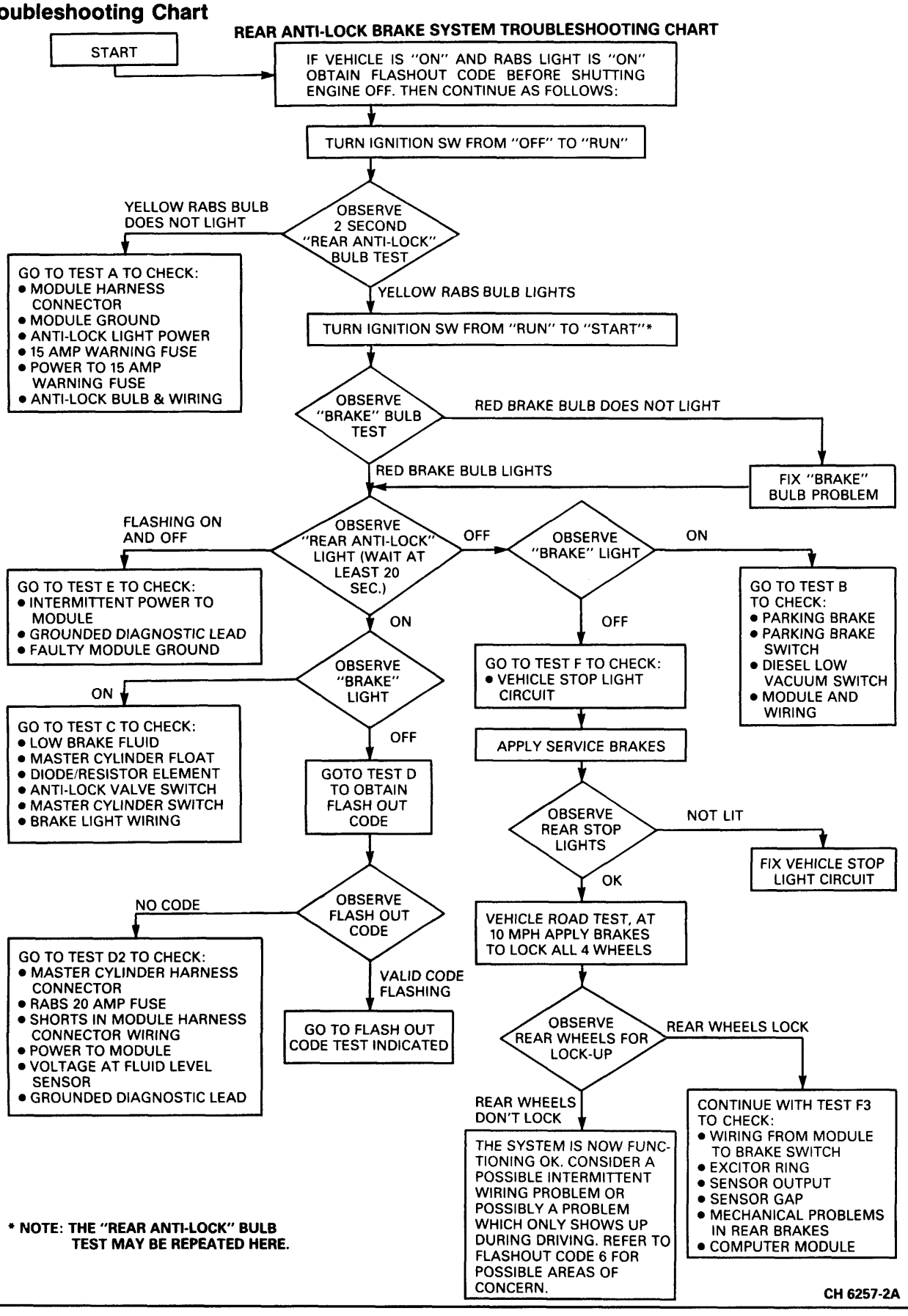
VIEW Z

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DIAGNOSIS AND TESTING

Troubleshooting Chart



*** NOTE: THE "REAR ANTI-LOCK" BULB TEST MAY BE REPEATED HERE.**

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DIAGNOSIS AND TESTING (Continued)

Following the sequence developed in the RABS Troubleshooting Chart will ensure accurate and efficient problem diagnosis and correction.

CAUTION: Following the wrong sequence or bypassing steps will lead to unnecessary replacement of parts and/or incorrect resolution of the symptom.

NOTE: If the RABS light is on, obtain the flashout code before shutting off the vehicle. Failure to do so may result in the loss of the code when the key is turned to the off position. Refer to Flashout Codes later in this Section for a detailed explanation.

Warning Lights

The RABS uses both the BRAKE and REAR ANTILOCK instrument panel warning lights to alert the driver to a system malfunction. Both lights must be working properly to assist in problem diagnosis. The red BRAKE warning light is used to indicate a low fluid level condition, parking brake applied condition or, for vehicles equipped with diesel engines, a low vacuum condition. To check this light, insert the key in the ignition lock cylinder and turn it to the start position. The light should glow in this position. If it fails to glow, service of the electrical system is required.

NOTE: If the red brake light continues to glow after the key is in the run position, repair the brake system as required. If the brake system checks out OK, follow the Troubleshooting Chart to diagnose the problem.

The yellow REAR ANTILOCK warning light is used to indicate a malfunction in and a deactivation of the RABS. To check this light, insert the key in the ignition lock cylinder and turn it to the on or start positions. The light should perform a self-check, glowing for approximately 2 seconds. If the light fails to glow or continues to glow after 2 seconds, refer to the Brake and Antilock Warning Lights Condition Chart for the proper diagnostic and testing procedure.

Warning Lights Condition Chart

The Brake and Antilock Warning Lights Condition Chart defines which test to be used to diagnose a problem depending on the condition of the BRAKE and REAR ANTILOCK warning lights.

Flashout Codes

Whenever the yellow REAR ANTILOCK light comes on during normal operation, a flashout code may be obtained to aid in problem diagnosis. If the vehicle is shut off before the code is read, the code will be lost. In some cases the code may reappear when the vehicle is restarted. In other cases the vehicle may have to be driven to reproduce the problem and, if the problem was associated with an intermittent condition, it may be difficult to reproduce. Therefore, whenever possible, it is recommended that the code be read before the vehicle is shut off.

WARNING: PLACE BLOCKS BEHIND THE REAR WHEELS AND IN FRONT OF THE FRONT WHEELS TO PREVENT THE VEHICLE FROM MOVING WHILE THE FLASHOUT CODE IS BEING TAKEN.

NOTE: If the red BRAKE light is also on, due to a grounding of the fluid level circuit (perhaps low brake fluid), no flashout code will be flashed and the REAR ANTILOCK light will remain on steadily.

NOTE: If there is more than one system fault only the first recognized flashout code may be obtained.

Obtaining the Flashout Code

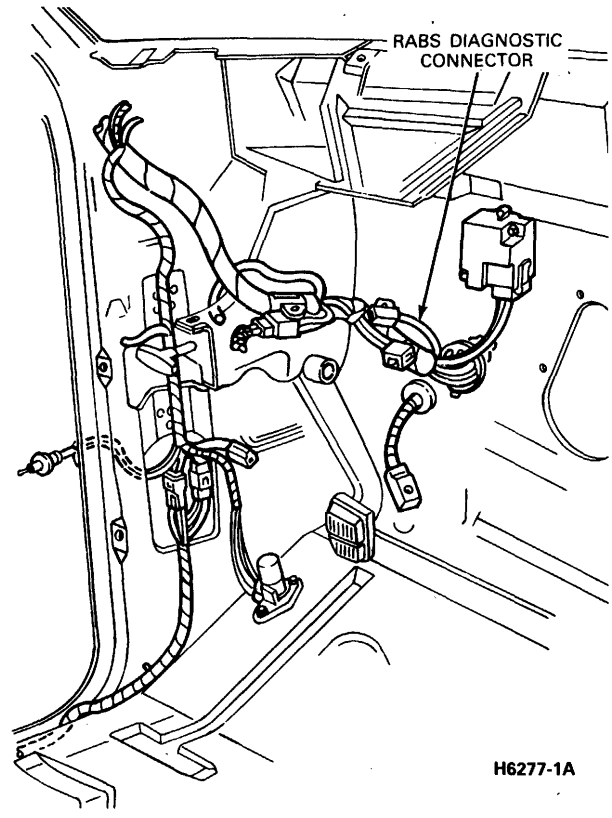
Before obtaining the flashout code, drive the vehicle to a level area, place the shift lever in park for automatic transmissions and neutral for manual transmissions, apply the parking brake, and keep the ignition key in the on position so that the code will not be lost.

To obtain the flashout code, locate the RABS diagnostic connector, attach a jumper wire and momentarily ground it to the chassis. When the ground is made and broken the REAR ANTILOCK light will begin to flash.

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DIAGNOSIS AND TESTING (Continued)

The code consists of a number of short flashes and ends with a long flash. Count the short flashes and include the following long flash in the count to obtain the code number. For example, three short flashes followed by one long flash indicates Flashout Code Four. The code will continue to repeat itself until the key is turned off. It is recommended that the code be verified by reading it several times. In addition, the first code flashed may be too short because it may have been started in the middle. It should be ignored.



Flashout Codes Chart

The possible flashout codes are listed and explained in the FLASHOUT CODES CHART. Note that Codes 1, 12, and 16 are not used.

When a code has been obtained go to the Test indicated by the number of flashes. For example, if the flashout code is nine, go to Flashout Code 9 for the next step in diagnosing the problem.

Wiring Diagram

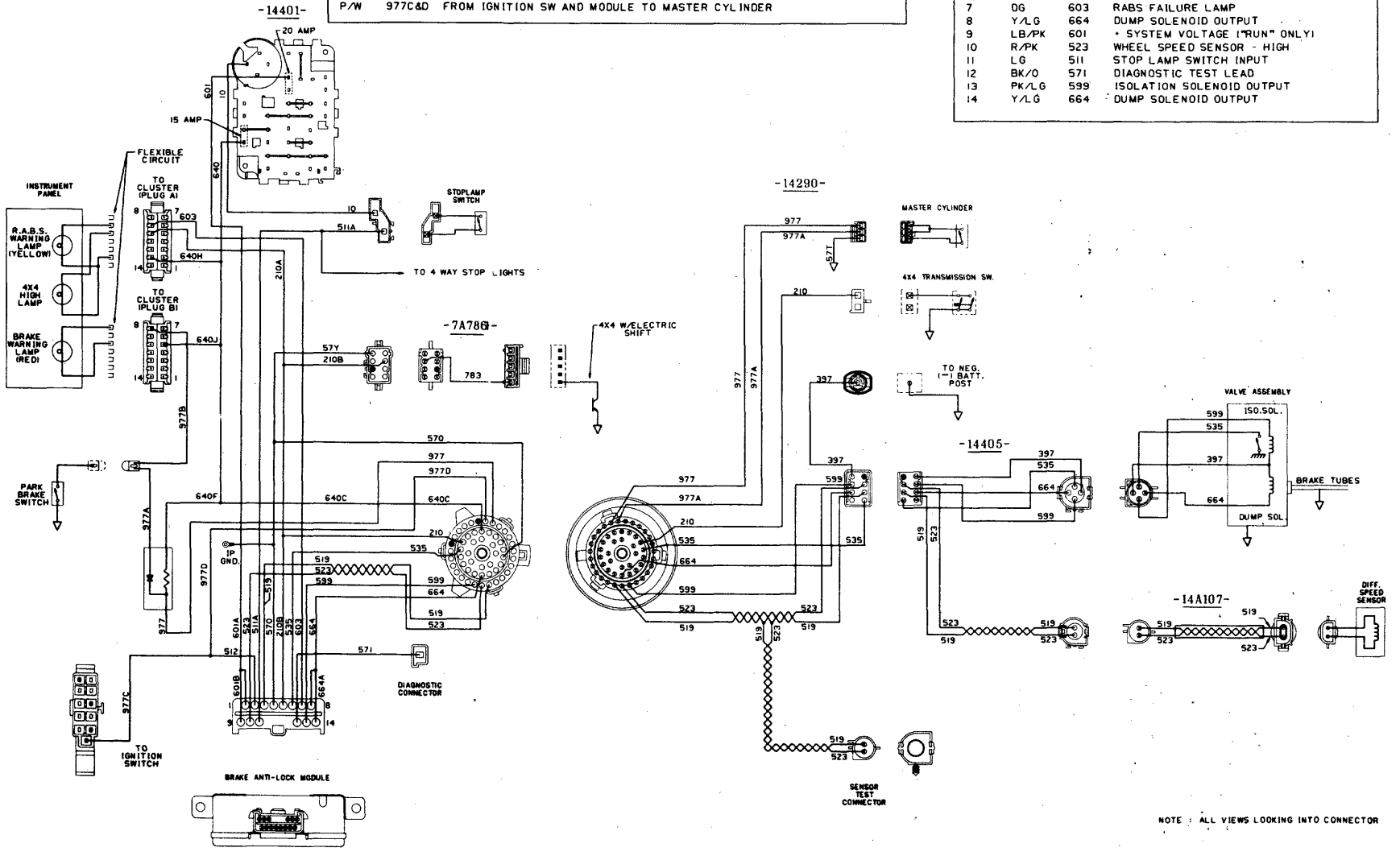
A wiring diagram is provided which represents the RABS electrical system. The diagram provides the wire circuit numbers, color codes, connectors, and connections to principal system components. If, after following a particular test procedure, the result is not as indicated, the problem may be located in the wiring itself. This diagram will assist in diagnosing these problems.

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REAR ANTI-LOCK BRAKE SYSTEM WIRING DIAGRAM

ADDITIONAL WIRE CIRCUIT NUMBERS USED		
COLOR	WIRE #	FUNCTION
LG/R	10	CONTINUOUS HOT TO STOP LAMP SWITCH
BK	57T	FLUID LEVEL SW GROUND
BK/W	397	RABS VALVE GROUND TO BATTERY TERMINAL
R/Y	640	HOT IN "RUN" OR "START" TO FLUID LEVEL SWITCH
GY	783	4X4 SHIFT ON THE FLY LIGHT SWITCH
P/W	977A&B	FROM PARK BRK SW TO MASTER CYLINDER
P/W	977C&D	FROM IGNITION SW AND MODULE TO MASTER CYLINDER

14 PIN CONNECTOR			
PIN #	COLOR	WIRE #	FUNCTION
1	LB/PK	601	HOT IN "RUN" ONLY (+ SYSTEM VOLTAGE)
2	T/LG	512	BRAKE FLUID LEVEL SWITCH
3	LG/BK	519	WHEEL SPEED SENSOR - LOW
4	BK/W	570	MODULE GROUND
5	LB	210	4X4 SIGNAL INPUT (LOW WHEN IN 4X4)
6	LB/R	535	VALVE RESET INPUT
7	DG	603	RABS FAILURE LAMP
8	Y/LG	664	DUMP SOLENOID OUTPUT
9	LB/PK	601	+ SYSTEM VOLTAGE ("RUN" ONLY)
10	R/PK	523	WHEEL SPEED SENSOR - HIGH
11	LG	511	STOP LAMP SWITCH INPUT
12	BK/O	571	DIAGNOSTIC TEST LEAD
13	PK/LG	599	ISOLATION SOLENOID OUTPUT
14	Y/LG	664	DUMP SOLENOID OUTPUT



NOTE : ALL VIEWS LOOKING INTO CONNECTOR

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DIAGNOSIS AND TESTING (Continued)

Diagnosis Charts

BRAKE AND ANTILOCK WARNING LAMPS CONDITION CHART

Condition	Action to Take
Yellow ANTILOCK Light Off and Does Not Self-Check	See Test A
Yellow ANTILOCK Light Off, and ANTILOCK Light Does Self-Check, Red BRAKE Light On	See Test B
Yellow ANTILOCK Light On and Red BRAKE Light On	See Test C
Yellow ANTILOCK Light On, Red BRAKE Light Off	See Test D
Yellow ANTILOCK Light Flashing, Red BRAKE Light Off	See Test E
Rear Wheels Lock with Hard Stops — Both Lamps Functioning Properly (Light Self-Checks are OK and Lights are OFF)	See Test F
Flashout Code is Known	See Flashout Codes Chart

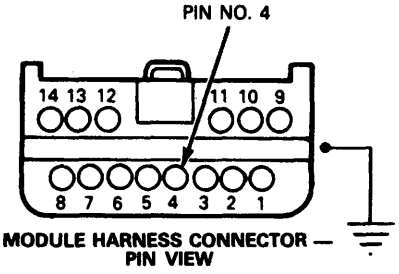
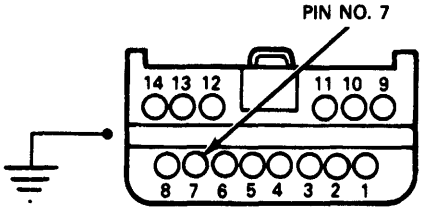
CAUTION: WHEN CHECKING RESISTANCE IN THE ANTILOCK BRAKE SYSTEM, ALWAYS DISCONNECT THE BATTERY. IMPROPER RESISTANCE READINGS WILL OCCUR WITH THE VEHICLE BATTERY CONNECTED. **CH6278-2A**

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light Off and Does Not Self-Check

Test A

TEST STEP	RESULT ▶	ACTION TO TAKE
A1 MODULE HARNESS CONNECTOR		
• Check to make sure module harness is fully plugged into computer module.	Harness is fully plugged in ▶	GO to Test **A2**.
	Harness is not fully plugged in ▶	CONNECT harness to module.
A2 COMPUTER MODULE GROUND		
• Check for good computer module ground: 1. Disconnect Battery 2. Remove harness connector from module. 3. Set ohmmeter on the 200 ohm scale. 4. Check for resistance between harness connector pin 4 and chassis ground  MODULE HARNESS CONNECTOR — PIN VIEW **CAUTION: WHEN CHECKING RESISTANCE IN THE ANTILOCK SYSTEM, ALWAYS DISCONNECT THE BATTERY. IMPROPER RESISTANCE MAY OCCUR WITH THE VEHICLE BATTERY CONNECTED.**	Resistance less than 1 ohm ▶	GO to Test **A3**.
	Resistance 1 ohm or greater ▶	CHECK for open in module ground wire. CHECK for loose, dirty or broken connector pins.
A3 ANTILOCK LIGHT POWER		
• Check for voltage to ANTILOCK light: 1. Reconnect the battery. 2. Set voltmeter on 20 VDC scale position. 3. Turn ignition to the on position. 4. Check voltage between harness connector pin 7 and a known good chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW	Voltage greater than 9V ▶	REPLACE Module.
	Voltage less than 9V ▶	GO to Test **A4**

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light Off and Does Not Self-Check (Cont'd)

Test A

TEST STEP	RESULT ▶	ACTION TO TAKE
A4 RABS 15 AMP LIGHT FUSE		
• Remove and inspect RABS 15 amp light fuse.	Fuse is OK ▶	REPLACE fuse and GO to Test **A5**.
	Fuse is blown ▶	CHECK for short to ground between fuse panel and warning lamps. REPAIR short and replace 15 amp fuse.
A5 POWER TO RABS LIGHT FUSE		
• Check for voltage to fuse. 1. Set voltmeter to 20 VDC scale. 2. Turn ignition to the on position. 3. Check voltage between panel fuse connector and known good chassis ground.	Voltage greater than 9V ▶	GO to Test **A6**.
	Voltage less than 9V ▶	REPAIR fuse panel or vehicle electrical system.
A6 RABS LIGHT BULB		
• Check RABS light bulb.	Bulb is OK ▶	REPAIR open between RABS light fuse and pin 7 of the module wiring harness connector.
	Bulb is not OK ▶	REPLACE bulb.

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DIAGNOSIS AND TESTING (Continued)

Red BRAKE Light On, Yellow ANTILOCK Light Off, and ANTILOCK Light Does Self-Check — Test B

TEST STEP	RESULT ▶	ACTION TO TAKE
B1 PARKING BRAKE		
• Check parking brake application: 1. Turn ignition key to the on position. 2. Check the parking brake pedal and release if applied.	BRAKE light goes off ▶	PERFORM road test. If lockup occurs GO to Test **B2**.
	BRAKE light stays on ▶	GO to Test **B2**.
B2 PARKING BRAKE SWITCH		
• Check parking brake switch: 1. Disconnect the parking brake switch connector.	BRAKE light goes off ▶	ADJUST parking brake or REPLACE parking brake switch.
	BRAKE light remains on ▶	Diesel vehicles GO to Test **B3**. Gas vehicles GO to Test **B4**.
B3 DIESEL LOW VACUUM SWITCH		
• Check for low brake vacuum: 1. Disconnect vacuum warning switch connector.	BRAKE light goes off ▶	REFER to vacuum pump diagnosis in Section 12-56 to correct problem in vacuum system.
	BRAKE light stays on ▶	GO to Test **B4**.
B4 MODULE AND WIRING		
• Remove module harness connector from module.	BRAKE light goes off ▶	REPLACE the computer module.
	If BRAKE light remains on ▶	CHECK for short to ground in wiring from BRAKE light to the RABS diode/resistor.

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light On and Red BRAKE Light On — Test C

TEST STEP	RESULT ▶	ACTION TO TAKE
C1 LOW BRAKE FLUID		
• Check the brake fluid level at the master cylinder reservoir.	Brake fluid level OK ▶	GO to Test **C2**.
	Brake fluid level low ▶	CHECK for fluid leaks in vehicle brake system and repair as required. Fill master cylinder to required level.
C2 MASTER CYLINDER FLOAT		
• Check master cylinder float for buoyancy: 1. Remove cap from master cylinder reservoir. 2. Using a clean steel implement, push down on float in reservoir.	Float moves down ▶	GO to Test **C3**.
	Float does not move down (sits at the bottom of the reservoir) ▶	REPLACE master cylinder reservoir. REFER to Section 12-30, Brake Pedal, Master Cylinder and Valves for procedure.
C3 DIODE/RESISTOR ELEMENT		
• Check for proper functioning of the diode/resistor element. 1. Turn ignition key to the on position. 2. Check parking brake and release if applied.	Both the ANTILOCK and BRAKE warning lamps go off ▶	REPLACE RABS diode/resistor element.
	Both the ANTILOCK and BRAKE warning lamps stay on ▶	GO to Test **C4**.
C4 DIODE/RESISTOR ELEMENT CONTINUED		
• Continue to check for proper functioning of the diode/resistor element. 1. Remove the parking brake switch and the diesel low vacuum switch, if so equipped.	Both the ANTILOCK and BRAKE warning lamps go off ▶	REPLACE RABS diode/resistor element.
	Both the ANTILOCK and BRAKE warning lamps stay on ▶	GO to Test **C5**.

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light On and Red BRAKE Light On — Cont'd

Test C

TEST STEP	RESULT	ACTION TO TAKE
C5 ANTILOCK VALVE SWITCH		
• Obtain the flashout code as described in Diagnosis and Testing in this Section.	Flashout code is obtained ▶	REFER to Flashout Codes Charts in this Section.
	ANTILOCK and BRAKE warning lamps stay on steady ▶	GO to Test **C6**.
C6 MASTER CYLINDER SWITCH		
• Check for proper functioning of the master cylinder fluid level indicator switch: 1. Remove the connector from the master cylinder. 2. Connect a jumper wire between the two purple/white wires in the connector. 3. Turn the ignition key to the on position.	ANTILOCK and BRAKE warning lamps stay on ▶	GO to Test **C7**.
	ANTILOCK and BRAKE warning lamps go off ▶	REPLACE the master cylinder reservoir. REFER to Section 12-30, Brake Pedal, Master Cylinder and Valves for procedure.
C7 BRAKE LIGHT WIRING		
• Check for shorts in brake light wiring. 1. Disconnect module harness connector from module. 2. Turn ignition key to the on position.	ANTILOCK light goes off and BRAKE light stays on ▶	CHECK for short to ground in the 977 circuit. REFER to wiring diagram in this Section.
	Both ANTILOCK and BRAKE warning lamps go off ▶	REPLACE module.

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light On, Red BRAKE Light Off — Test D

TEST STEP	RESULT	ACTION TO TAKE
D1 OBTAIN THE FLASHOUT CODE		
• Obtain the flashout code as described in Diagnosis and Testing in this Section.	Flashout code cannot be obtained ▶	GO to Test **D2**.
 RABS DIAGNOSTIC CONNECTOR — PIN VIEW	Flashout code is obtained ▶	Refer to the Flashout Code Charts in this Section.
D2 MASTER CYLINDER CONNECTOR		
• Make sure master cylinder connector is fully plugged in.	Master cylinder connector is not fully plugged in ▶	PLUG in the master cylinder connector.
	Master cylinder connector is plugged in ▶	GO to Test **D3**.
D3 RABS 20 AMP FUSE		
• Remove and inspect the RABS 20 amp fuse.	Fuse is OK ▶	REPLACE Fuse. GO to Test **D4**.
	Fuse is blown ▶	Short to ground between the fuse panel and the module wiring harness connector. REPAIR short in the 601 circuit and REPLACE the 20 amp. fuse. REFER to the Wiring Diagrams in this Section.
D4 SHORTS IN MODULE HARNESS CONNECTOR WIRING		
• Check wiring for short to ground: 1. Turn ignition switch to the on position. 2. Remove the module harness connector from the module. 3. Observe the REAR ANTILOCK light.	Light goes off ▶	GO to Test **D5**.
	Light remains on ▶	CHECK for a short to ground in the 603 Circuit. REFER to Wiring Diagram in this Section.

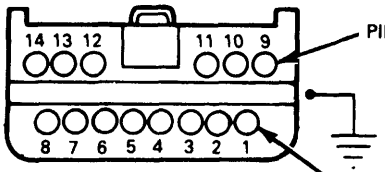
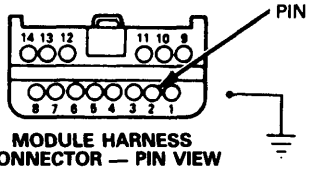
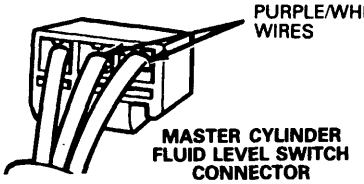
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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light On, Red BRAKE Light Off (Cont'd)

Test D

TEST STEP	RESULT ▶	ACTION TO TAKE
D5 POWER TO THE MODULE		
• Check for an open in the circuit supplying power to the module: 1. Set the voltmeter on the 20 VDC scale. 2. Turn the ignition switch to the on position. 3. Measure the voltage between pin 1 (or pin 9) and chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW	Voltage less than 9V. ▶ Voltage greater than 9V. ▶	REPAIR the open in the 601 circuit or power to the fuse panel. See Wiring Diagram. GO to Test **D6**.
D6 VOLTAGE AT THE FLUID LEVEL CIRCUIT		
• Check the voltage from the fluid level switch circuit: 1. Set the voltmeter on the 20 VDC Scale. 2. Turn the ignition switch to the on position. 3. Measure the voltage between pin 2 and chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW	Voltage less than 8V. ▶ Voltage greater than 8V. ▶	GO to Test **D7**. GO to Test **D8**.
D7 FLUID LEVEL SENSOR AND WIRING		
• Check for voltage at the fluid level sensor: 1. Set voltmeter on the 20 VDC scale. 2. Turn the ignition switch to the on position. 3. Measure the voltage at each of the purple/white wires at the back of the master cylinder fluid level switch connector without disconnecting the connector.  MASTER CYLINDER FLUID LEVEL SWITCH CONNECTOR	Voltage greater than 8V at both wires. ▶ Voltage less than 8V at both wires. ▶ Voltage greater than 8V at one wire and less than 8V at the other wire. ▶	CHECK for open in 977 circuit. REPLACE diode resistor element or open in 640 circuit. CHANGE the master cylinder reservoir. REFER to Section 12-30, Brake Pedal, Master Cylinder and Valves for procedure.

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light On, Red BRAKE Light Off (Cont'd)

Test D

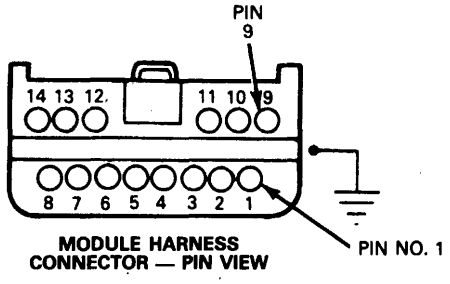
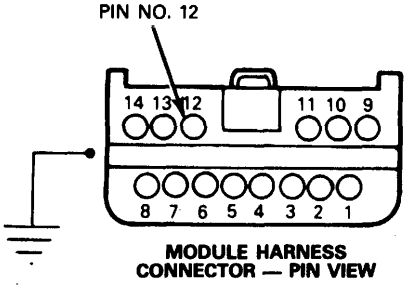
TEST STEP	RESULT ▶	ACTION TO TAKE
D8 GROUNDED DIAGNOSTIC LEAD		
• Check the voltage at the diagnostic lead. 1. Reconnect the module harness connector. 2. Set the voltmeter on the 20 VDC scale. 3. Turn the ignition to the on position. 4. Measure the voltage between the diagnostic lead and chassis ground.  RABS DIAGNOSTIC CONNECTOR PIN VIEW	Voltage is less than 1V ▶ Voltage is greater than 1V ▶	CHECK for a short in the 577 diagnostic circuit. If no short is found, GO to Test **D9**. GO to Test **D9**.
D9 COMPUTER MODULE		
• Replace computer module and retest.		

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DIAGNOSIS AND TESTING (Continued)

Yellow ANTILOCK Light Flashing, Red BRAKE Light Off — Test E

TEST STEP	RESULT ▶	ACTION TO TAKE
E1 INTERMITTENT POWER TO MODULE		
• Check for intermittent open in the 601 circuit, power to module. 1. Remove the module harness connector from the module. 2. Set the voltmeter on the 20 VDC scale. 3. Turn the ignition to the on position. 4. Shake the instrument panel harness. Check for battery voltage between pin 1 (or pin 9) and chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW	Voltage is steady and greater than 9V ▶ Voltage is intermittent or less than 9V ▶	GO to Test **E2**. REPAIR break in the 601 circuit. REFER to Wiring Diagram in this Section.
E2 GROUNDED DIAGNOSTIC LEAD		
• Check for an intermittent ground to chassis in the diagnostic lead circuit: 1. Turn the ignition switch off. 2. Disconnect the battery. 3. Set the ohmmeter on the 200K ohm scale. 4. Shake the instrument panel harness and check the resistance between pin 12 and chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW	Resistance is steady and greater than 100K ohms ▶ Resistance is below 100K ohms or fluctuates ▶	GO to Test **E3**. REPAIR short in the 571 circuit. REFER to Wiring Diagram in this Section.

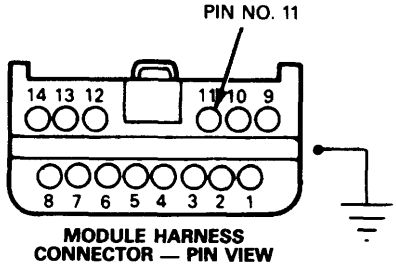
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DIAGNOSIS AND TESTING (Continued)

Rear Wheels Lock with Hard Stops — Both Lamps Functioning Properly

Test F

TEST STEP	RESULT	ACTION TO TAKE
F1 STOPLAMPS		
• Check for stoplamp operation: 1. Apply the service brakes and observe the rear brakelamps.	Rear stoplamps not illuminated ▶ Rear stoplamps OK ▶	REPAIR the stoplamp circuit. GO to Test **F2**.
F2 VEHICLE ROAD TEST		
• Perform a low speed vehicle road test: 1. At approximately 10 mph apply the service brakes in an attempt to lock all four wheels while observing the left rear wheel in the side mirror.	Rear wheels lock ▶ Rear wheels do not lock ▶	GO to Test **F3**. The system is now functioning OK. Consider a possible intermittent wiring problem or possibly a problem which only shows up during driving. REFER to Flashout Code 6 in this Section.
F3 WIRING FROM MODULE TO BRAKE SWITCH		
• Check for an open between the brake switch and the module: 1. Turn the ignition off. 2. Set the voltmeter on the 20 VDC scale. 3. Remove the module harness connector. 4. Measure the voltage between pin 11 and chassis ground while stepping on the brake pedal.  MODULE HARNESS CONNECTOR — PIN VIEW	Voltage is less than 9V ▶ Voltage is 9V or more ▶	REPAIR the open in the 511 circuit. GO to Test **F4**.
F4 EXCITOR RING INSPECTION		
• Remove sensor from carrier and check for: 1. Presence of the excitor ring 2. Condition of the teeth.	Ring is present with the teeth intact ▶ Ring is not present or the teeth are damaged ▶	REINSTALL the sensor and GO to Test **F5**. REPAIR axle. REFER to the appropriate Section in Group 15 for procedure.

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DIAGNOSIS AND TESTING (Continued)

Rear Wheels Lock with Hard Stops — Both Lamps Functioning Properly (Continued)

Test F

TEST STEP	RESULT ▶	ACTION TO TAKE
F5 SENSOR OUTPUT		
• Check for low sensor signal output: 1. Set the voltmeter on the 2000 mV AC scale. 2. Position the vehicle on the hoist and raise the rear wheels off the ground. 3. Remove the cap from the sensor test connector and connect the voltmeter across the connector leads. 4. Start the engine and turn the rear wheels at 5 mph. 5. Measure the voltage output of the sensor.  CONNECTOR PINS **SENSOR TEST CONNECTOR – PIN VIEW**	Voltage is 650 mV (RMS) or greater ▶ Voltage is less than 650 mV (RMS) ▶	REINSTALL the sensor test connector cap and GO to Test **F7**. REPLACE the sensor, RETEST, and REINSTALL the sensor test connector cap. If the voltage is still low, GO to Test **F6**.
F6 SENSOR GAP		
• Determine the sensor gap: 1. Remove the sensor from the carrier. 2. Measure the height of the sensor pole piece from the mounting face of the sensor flange. Pole should be 1.07-1.08 inch. 3. Measure the depth to the top of the excitor ring teeth from the sensor mounting face on the carrier. 4. Subtract the two measurments. This is the sensor gap.	Gap is less than 0.050 inches ▶ Gap is greater than 0.050 inches ▶	GO to Test **F7**. The gap is too large. CHECK for defective sensor or carrier housing.
F7 MECHANICAL PROBLEMS IN REAR BRAKES		
• Check the rear brakes for mechanical problems such as grabbing, locking or pulling.	Rear Brakes OK ▶ Rear brakes lock, grab or pull ▶	GO to Test **F8**. REPAIR and RETEST.
F8 COMPUTER MODULE		
• Replace computer module and retest.		

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DIAGNOSIS AND TESTING (Continued)

FLASHOUT CODES CHART

CONDITION	ACTION TO TAKE
No Flashout Code	See Flashout Code 0
Yellow REAR ANTILOCK Light Flashes 1 Time This Code Should Not Occur	See Flashout Code 1
Yellow REAR ANTILOCK Light Flashes 2 Times Open Isolate Circuit	See Flashout Code 2
Yellow REAR ANTILOCK Light Flashes 3 Times Open Dump Circuit	See Flashout Code 3
Yellow REAR ANTILOCK Light Flashes 4 Times Red Brake Warning Light Illuminated RABS Valve Switch Closed	See Flashout Code 4
Yellow REAR ANTILOCK Light Flashes 5 Times System Dumps Too Many Times in 2WD (2WD and 4WD vehicles) Condition Occurs While Making Normal or Hard Stops. Rear Brake May Lock	See Flashout Code 5
Yellow REAR ANTILOCK Light Flashes 6 Times (Sensor Signal Rapidly Cuts In and Out) Condition Only Occurs While Driving	See Flashout Code 6
Yellow REAR ANTILOCK Light Flashes 7 Times No Isolate Valve Self Test	See Flashout Code 7
Yellow REAR ANTILOCK Light Flashes 8 Times No Dump Valve Self Test	See Flashout Code 8
Yellow REAR ANTILOCK Light Flashes 9 Times High Sensor Resistance	See Flashout Code 9
Yellow REAR ANTILOCK Light Flashes 10 Times Low Sensor Resistance	See Flashout Code 10
Yellow REAR ANTILOCK Light Flashes 11 Times Stop Lamp Switch Circuit Defective. Condition Indicated Only When Driving Above 35 mph	See Flashout Code 11
Yellow REAR ANTILOCK Light Flashes 12 Times This Code Should Not Occur	See Flashout Code 12
Yellow REAR ANTILOCK Light Flashes 13 Times Speed Processor Check	See Flashout Code 13
Yellow REAR ANTILOCK Light Flashes 14 Times Program Check	See Flashout Code 14
Yellow REAR ANTILOCK Light Flashes 15 Times Memory Failure	See Flashout Code 15
Yellow REAR ANTILOCK Light Flashes 16 Times or More 16 or More Flashes Should Not Occur	See Flashout Code 16

NOTE: Refer to Obtaining the Flashout Code in this Section for procedure to obtain flashout code.

CAUTION: WHEN CHECKING RESISTANCE IN THE RABS SYSTEM, ALWAYS DISCONNECT THE BATTERY. IMPROPER RESISTANCE READINGS MAY OCCUR WITH THE VEHICLE BATTERY CONNECTED.

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DIAGNOSIS AND TESTING (Continued)

No Flashout Code

Flashout Code 0

TEST STEP		RESULT ▶	ACTION TO TAKE
0a	NO FLASHOUT CODE BUT RABS LIGHT IS ILLUMINATED		
• There are some faults that illuminate the REAR ANTILOCK light but will not provide a Flashout Code. Refer to Obtaining the Flashout Code in this Section for procedure. Also, be sure to make a good, momentary ground from the diagnostic lead.		No Flashout Code ▶	GO to Test **D2**.

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 1 Time This Code Should Not Occur

Flashout Code 1

TEST STEP	RESULT ▶	ACTION TO TAKE
1a NO TEST • This code should not occur. Refer to Obtaining the Flashout Code in this Section for procedures involved in getting the code.	Flashout Code is 1 ▶	If after repeated attempts to take the Flashout Code, Code 1 is still obtained GO to Test **E**.

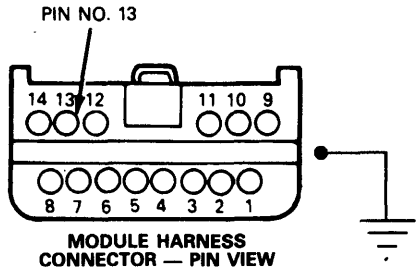
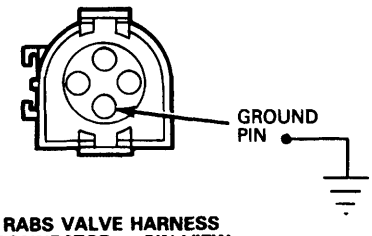
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 2 Times (Open Isolate Circuit)

Flashout Code 2

TEST STEP	RESULT ▶	ACTION TO TAKE
2a CHECK FOR OPEN RABS VALVE ISOLATION SOLENOID WIRING OR MODULE		
1. Turn ignition switch to the OFF position. 2. Disconnect battery. 3. Set the ohmmeter to the 200 ohm scale. 4. Disconnect module harness connector from module. 5. Check for resistance between harness connector Pin 13 and chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW	Resistance less than 6 ohms ▶ Resistance over 6 ohms ▶	REPLACE RABS module. GO to **2b**.
2b CHECK FOR OPEN RABS VALVE GROUND WIRE		
1. Disconnect battery. 2. Disconnect RABS Valve harness connector from valve connector. 3. Set ohmmeter on the 200 ohm scale. 4. Check for resistance between ground pin of valve harness connector and chassis ground.  RABS VALVE HARNESS CONNECTOR — PIN VIEW	Resistance less than 1 ohm ▶ Resistance 1 ohm or more ▶	GO to **2c**. REPAIR open in 397 circuit, isolation solenoid wire. CHECK for dirty or loose connector pins.

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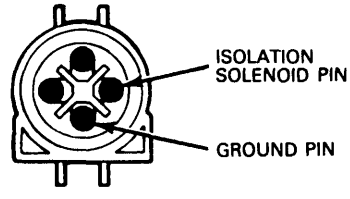
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 2 Times (Open Isolate Circuit) — Continued

Flashout Code 2

TEST STEP		RESULT ▶	ACTION TO TAKE
2c	CHECK FOR OPEN RABS VALVE ISOLATION SOLENOID OR WIRING		
1. Disconnect battery. 2. Set ohmmeter to 200 ohm scale. 3. Check resistance between valve connector isolation solenoid pin and connector ground pin.		Resistance less than 6 ohms ▶	REPAIR open in 599 circuit, isolation solenoid wire from valve to computer module. CHECK for dirty or loose connector pins.
		Resistance over 6 ohms ▶	REPLACE RABS valve.



RABS VALVE CONNECTOR — PIN VIEW

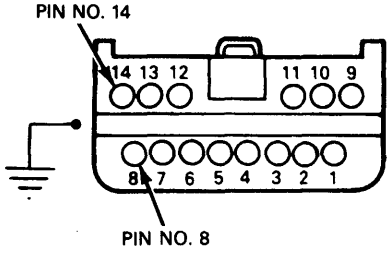
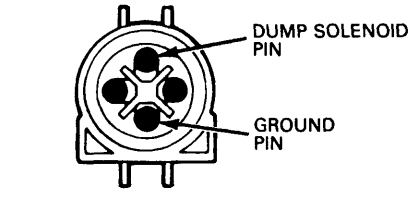
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 3 Times (Open Dump Circuit)

Flashout Code 3

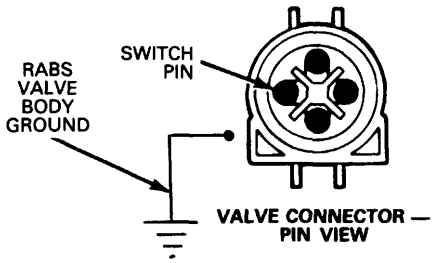
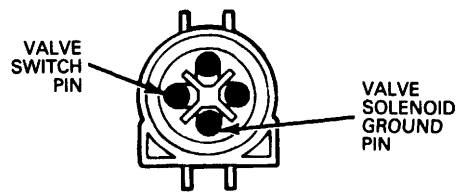
TEST STEP	RESULT ▶	ACTION TO TAKE
3a CHECK FOR OPEN RABS VALVE DUMP SOLENOID WIRING OR COMPUTER MODULE		
1. Turn ignition switch to the off position. 2. Disconnect the battery. 3. Disconnect module harness connector from module. 4. Place the ohmmeter on the 200 ohm scale. 5. Check resistance between pin 8 (or pin 14) and chassis ground.  **MODULE HARNESS CONNECTOR — PIN VIEW**	Resistance less than 3 ohms ▶ Resistance greater than 3 ohms ▶	REPLACE computer module. GO to Test **3b**.
3b CHECK FOR OPEN RABS VALVE DUMP SOLENOID OR WIRING		
1. Turn the ignition switch to the off position. 2. Disconnect the battery. 3. Disconnect RABS valve harness connector from valve connector. 4. Check resistance between valve connector dump solenoid pin and ground pin.  **RABS VALVE CONNECTOR — PIN VIEW**	Resistance less than 3 ohms ▶ Resistance greater than 3 ohms ▶	REPAIR open in 664 circuit, dump solenoid wire, from valve to module. CHECK for loose or dirty connector pins. REPLACE RABS valve.

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 4 Times Red Brake Warning Light Illuminated RABS Valve Switch Closed	Flashout Code 4

TEST STEP	RESULT ▶	ACTION TO TAKE
4a CHECK FOR CLOSED RABS VALVE SWITCH		
1. Disconnect RABS valve harness connector from valve connector. 2. Place ohmmeter on the 20K scale. 3. Check resistance between valve connector switch pin and valve body.  VALVE CONNECTOR — PIN VIEW	Resistance greater than 10K ohms ▶ Resistance less than 10k ohms ▶	GO to Test **4B**. REPLACE RABS valve.
4b CHECK FOR SHORT BETWEEN RABS VALVE SWITCH AND VALVE GROUND LEAD		
1. Set the ohmmeter on the 20K ohm scale. 2. Check resistance between valve connector switch pin and valve solenoid ground pin.  VALVE CONNECTOR — PIN VIEW	Resistance greater than 10K ohms ▶ Resistance less than 10K ohms ▶	GO to Test **4C**. REPLACE RABS valve.

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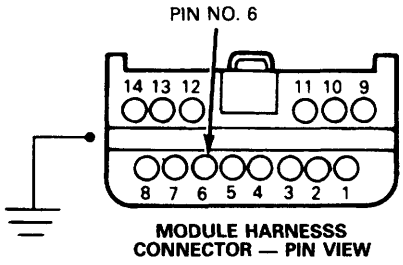
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 4 Times
Red Brake Warning Light Illuminated
RABS Valve Switch Closed (Continued)

Flashout Code 4

TEST STEP		RESULT ▶	ACTION TO TAKE
4c	CHECK FOR RABS VALVE SWITCH WIRE SHORTED TO GROUND OR MODULE		
1. Disconnect battery. 2. Set the ohmmeter on the 200K scale. 3. Disconnect the module harness connector from the module. 4. Check for resistance between harness connector pin 6 and chassis ground.		Resistance greater than 100K ohms ▶	REPLACE computer module.
		Resistance less than 100K ohms ▶	REPAIR short in 535 circuit, valve switch wire from valve to computer module.



MODULE HARNESSS CONNECTOR — PIN VIEW

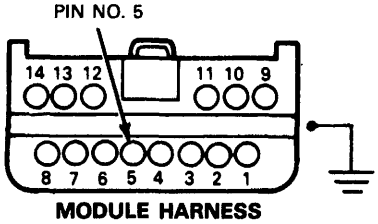
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 5 Times System Dumps Too Many Times in 2WD (2WD and 4WD Vehicles) Condition Occurs While Making Normal or Hard Stops. Rear Brakes May Lock	Flashout Code 5

TEST STEP	RESULT ▶	ACTION TO TAKE
5a		
For 4x2 vehicles or 4x4 vehicles for which the problem was initiated in 4x2 mode		GO to Step **5b**.
For 4x4 vehicles for which the problem was initiated in 4x4 mode only		GO to Step **5c**.
5b CHECK FOR MECHANICAL PROBLEMS IN REAR BRAKE SYSTEM		
1. Disconnect the RABS module harness connector from the module to deactivate the RABS. 2. Drive the vehicle (in 4x2 mode). 3. Make normal stops in a safe area to determine the condition of the rear brake system.	Rear brakes are grabby or tend to lock up easily ▶	REPAIR rear brake system and RETEST.
	Rear brakes are satisfactory for normal braking ▶	REPLACE RABS valve.
5c CHECK FOR MISSING SIGNAL FROM 4 WD SWITCH TO COMPUTER MODULE		
1. Disconnect the RABS module harness from the module. 2. Turn ignition switch on. 3. Shift into 4x4 mode. 4. Set voltmeter to 20 VDC scale. 5. Measure voltage between pin 5 and chassis ground.	Voltage is less than 1 volt ▶	REPLACE RABS valve.
	Voltage is greater than 1 volt ▶	REPAIR 4x4 indicator switch. REFER to the appropriate section in Group 16 for procedures.



MODULE HARNESS CONNECTOR – PIN VIEW

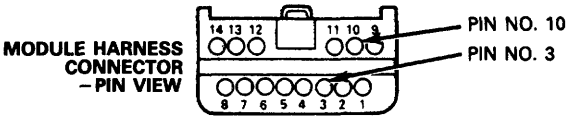
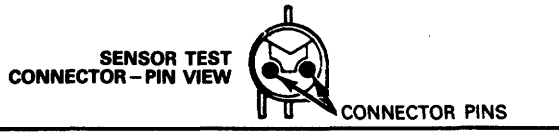
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 6 Times (Sensor Signal Rapidly Cuts In and Out) Condition Only Occurs While Driving

Flashout Code 6

TEST STEP	RESULT ▶	ACTION TO TAKE
6a CHECK FOR ERRATIC SENSOR SIGNAL AND LOOSE WIRE CONNECTIONS		
1. Turn ignition off. 2. Disconnect battery. 3. Set ohmmeter on the 2000 ohm scale. 4. Check resistance between Pin 10 and Pin 3 of the harness connector while shaking the harness from sensor to module.  	Constant reading of 1000 to 2000 ohms ▶ Reading is erratic ▶	GO to Step **6b**. REPAIR loose connection in the 519 or 523 circuits (sensor leads). CHECK for dirty or loose pins, frayed or shorted connectors.
6b CHECK FOR METAL CHIPS ON SENSOR MAGNET POLE PIECE		
• Remove the sensor from the differential and inspect for a build-up of metal chips on sensor magnetic pole.	No metal chips are present ▶ Metal chips are present ▶	GO to Step **6c**. DRAIN and CLEAN differential. CHECK the excitor ring for broken or chipped teeth.
6c CHECK FOR EXCITOR RING DAMAGE		
1. Remove sensor from carrier. 2. Rotate excitor ring and check for damage to teeth.	Teeth are intact and no visible lateral runout is observed ▶ Teeth are damaged or lateral runout of excitor ring is visible ▶	REINSTALL sensor and GO to Test **6d**. REPAIR axle. REFER to the appropriate section in Group 15 for procedure.
6d CHECK FOR ERRATIC OR LOW SENSOR OUTPUT ON COMPUTER MODULE		
1. Locate the sensor test connector. 2. Position vehicle on a hoist and raise the rear wheels to clear the floor. 3. Start the engine and turn the wheels at 5 mph. 4. Place voltmeter on the 2000 mv AC scale. 5. Measure voltage at the two pins of the sensor test connector.  	Voltage greater than 650 mV RMS and steady ▶ Voltage less than 650 mV RMS or erratic ▶	REPLACE module. REPLACE sensor and recheck output and replace the sensor test connector cap.

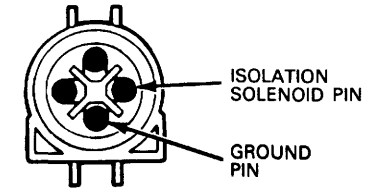
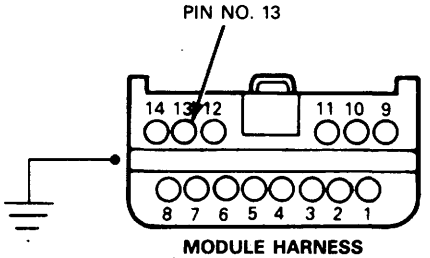
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 7 Times No Isolate Valve Self Test

Flashout Code 7

TEST STEP		RESULT	ACTION TO TAKE
7a	CHECK FOR RABS VALVE ISOLATION SOLENOID OR WIRING SHORTED TO GROUND		
1. Turn ignition off. 2. Disconnect the valve harness connector from the valve connector. 3. Set the ohmmeter on the 200 ohm scale. 4. Measure the resistance between the valve isolation solenoid pin and the valve ground pin in the valve connector.  VALVE CONNECTOR PIN VIEW		Resistance is greater than 3 ohms ▶ Resistance is less than 3 ohms ▶	GO to Test **7B**. REPLACE RABS valve.
7b	CHECK FOR BLOWN INTERNAL FUSE IN THE MODULE		
1. Turn ignition off. 2. Disconnect the battery. 3. Disconnect the valve harness connector from the valve. 4. Disconnect the module harness connector from the module. 5. Place the ohmmeter on the 20K ohm scale. 6. Measure the resistance between module harness connector pin 13 and chassis ground.  MODULE HARNESS CONNECTOR — PIN VIEW		Resistance greater than 20K ohms ▶ Resistance less than 20K ohms ▶	REPLACE module. REPAIR short in 599 circuit between RABS valve and module. RECONNECT module and valve.

CH6298-2A

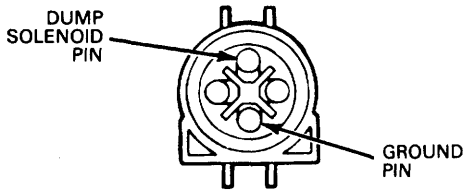
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DIAGNOSIS AND TESTING (Continued)

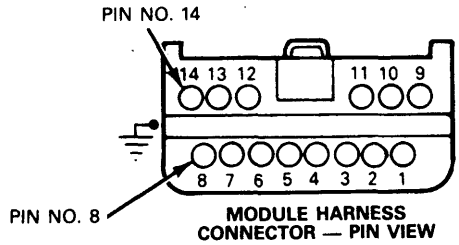
Yellow REAR ANTILOCK Light Flashes 8 Times No Dump Valve Self Test

Flashout Code 8

TEST STEP	RESULT ▶	ACTION TO TAKE
8a CHECK FOR RABS VALVE SOLENOID OR WIRING SHORTED TO GROUND		
1. Turn ignition switch off. 2. Disconnect valve harness connector from valve connector. 3. Set the ohmmeter on the 200 ohm scale. 4. Measure the resistance between the valve dump solenoid pin and the valve ground pin in the valve connector.	Resistance greater than 1 ohm ▶	GO to Test **8b**.
	Resistance is less than 1 ohm ▶	REPLACE RABS valve.
8b CHECK COMPUTER MODULE		
1. Turn ignition off. 2. Disconnect battery. 3. Disconnect valve harness connector from valve connector. 4. Disconnect the module harness connector from the module. 5. Set the ohmmeter on the 20K ohm scale. 6. Measure the resistance between module harness connector pin 8 (or pin 14) and chassis ground.	Resistance greater than 20K ohm ▶	REPLACE module.
	Resistance less than 20K ohm ▶	REPAIR short in 664 circuit between RABS valve and RABS module. RECONNECT module and valve.



VALVE CONNECTOR — PIN VIEW



MODULE HARNESS CONNECTOR — PIN VIEW

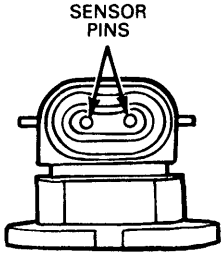
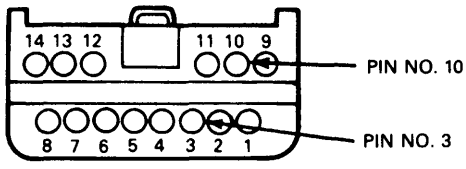
CH6299-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 9 Times High Sensor Resistance

Flashout Code 9

TEST STEP	RESULT ▶	ACTION TO TAKE
9a CHECK FOR OPEN SENSOR OR SENSOR WIRING		
1. Turn key off. 2. Disconnect sensor harness connector from the sensor on the differential. 3. Set the ohmmeter on the 20K ohm scale. 4. Measure the resistance at the two sensor pins.  SENSOR — PIN VIEW	Resistance less than 2500 ohms ▶ Resistance greater than 2500 ohms ▶	GO to Test **9b**. REPLACE sensor.
9b CHECK FOR OPEN SENSOR HARNESS WIRING		
1. Turn key off. 2. Disconnect battery. 3. Reconnect sensor harness connector to sensor. 4. Disconnect module harness connector from module. 5. Set the ohmmeter on the 20K ohm scale. 6. Measure the resistance between harness connector pins 3 and 10.  MODULE HARNESS CONNECTOR — PIN VIEW	Resistance less than 2500 ohms ▶ Resistance greater than 2500 ohms ▶	REPLACE module. REPAIR open in circuits 519 or 523, sensor wires between the sensor and module. CHECK for loose or dirty pin connectors. If defect is found in 14A107 — Jumper Harness (from sensor to left frame rail), REPLACE with original equipment high flex wire.

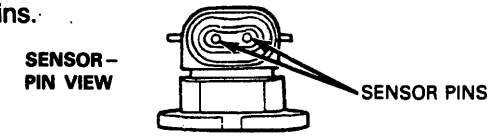
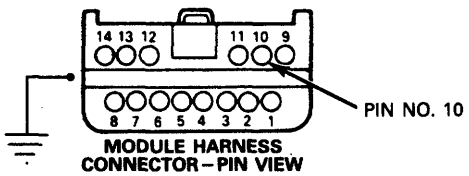
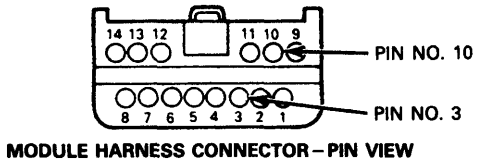
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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 10 Times Low Sensor Resistance

Flashout Code 10

TEST STEP	RESULT ▶	ACTION TO TAKE
10a CHECK FOR SHORTED SENSOR		
1. Turn ignition off. 2. Disconnect the sensor harness from the sensor. 3. Place the ohmmeter on the 20K ohms scale. 4. Measure the resistance at the two sensor pins.  	Resistance less than 1000 ohms ▶ Resistance is greater than 1000 ohms ▶	REPLACE sensor. GO to Test **10b**.
10b CHECKING FOR GROUNDED SENSOR WIRING		
1. Turn ignition off. 2. Disconnect the battery. 3. Disconnect the sensor harness connector from the sensor. 4. Disconnect the module harness connector from the module. 5. Set the ohmmeter on the 20K ohm scale. 6. Measure the resistance from pin 10 of the harness connector to chassis ground.  	Resistance less than 20K ohms ▶ Resistance is greater than 20K ohms ▶	REPAIR short to ground in 523 circuit, sensor HI lead to module. CHECK for frayed wires or shorted connectors. If defect is found in the 14A107 Jumper Harness (from sensor to left frame rail), REPLACE with original equipment high flex wire. GO to Test **10c**.
10c CHECK FOR SHORTED SENSOR WIRING		
1. Turn ignition off. 2. Disconnect sensor harness connector from the sensor. 3. Disconnect the module harness connector from the module. 4. Place the ohmmeter on the 20K ohms scale. 5. Measure the resistance from pin 3 to pin 10 of the harness connector.  	Resistance less than 20K ohms ▶ Resistance greater than 20K ohms ▶	REPAIR short between the 523 and 519 sensor circuits. CHECK for frayed wires or shorted connectors. If defect is found in the 14A107 Jumper Harness (from sensor to left frame rail), REPLACE with original equipment high flex wire. REPLACE the RABS module.

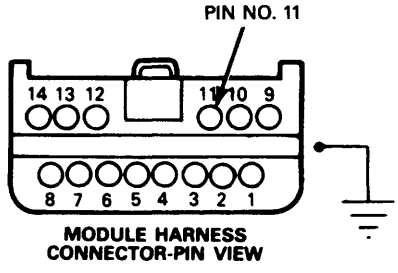
CH6301-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 11 Times. Stop Lamp Switch Always Closed or Stop Lamp Switch Circuit Defective. Condition Indicated Only When Driving Above 35 mph.	**Flashout Code 11**

TEST STEP	RESULT ▶	ACTION TO TAKE
11a CHECK VEHICLE STOP LIGHTS		
• Apply the service brakes and observe the rear brake lamps.	Lamps illuminate ▶	GO to Test **11b**.
	Lamps do not illuminate ▶	REPAIR or REPLACE vehicle stop light switch. CHECK for blown stop light switch fuse. Investigate reason for blown fuse. CHECK for open stop light switch wiring or blown stop lamps. REPAIR as needed.
11b WIRING FROM MODULE TO BRAKE SWITCH		
• Check for an open between the brake switch and the module: 1. Turn the ignition off. 2. Set the voltmeter on the 20 VDC scale. 3. Remove the module harness connector. 4. Measure the voltage between pin 11 and chassis ground while stepping on the brake pedal.	Voltage is less than 9V ▶	REPAIR the open in the 511 circuit.
	Voltage is 9V or more ▶	CHECK 4 way flasher and directional wiring. This condition could create feedback through the stop light circuit. Also, cruise controls may not operate correctly.



MODULE HARNESS CONNECTOR-PIN VIEW

CH6302-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 12 Times This Code Should Not Occur

Flashout Code 12

TEST STEP	RESULT ▶	ACTION TO TAKE
12a NO TEST		
• This code should not occur. Refer to obtaining the Flashout Code in this Section for procedures involved in getting the code.	Flashout Code is 12 ▶	If after repeated attempts to take the Flashout Code, Code 12 is still obtained, REPLACE RABS module.

CH6303-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 13 Times Speed Processor Check

Flashout Code 13

TEST STEP	RESULT ▶	ACTION TO TAKE
13a NO TEST		
• RABS module speed circuit phase lock loop failure detected during module self test.	13 flashes are present ▶	REPLACE RABS module.

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 14 Times Program Check

Flashout Code 14

TEST STEP	RESULT ▶	ACTION TO TAKE
14a NO TEST • RABS module program check sum failure detected during self test.	If 14 flashes are present ▶	REPLACE RABS module.

CH6305-2A

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 15 Times Memory Failure

Flashout Code 15

TEST STEP	RESULT ▶	ACTION TO TAKE
15a NO TEST • RABS module RAM failure detected during self test.	If 15 flashes are present ▶	REPLACE RABS module.

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DIAGNOSIS AND TESTING (Continued)

Yellow REAR ANTILOCK Light Flashes 16 Times or More 16 or More Flashes Should Not Occur

Flashout Code 16

TEST STEP	RESULT ▶	ACTION TO TAKE
16a NO TEST • This code should not occur. Refer to obtaining the Flashout Code in this Section for procedures involved in getting the code.	Flashout Code is 16 ▶	If after repeated attempts to take the Flashout Code, Code 16 is still obtained, REPLACE RABS module.

CH6307-2A

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DISASSEMBLY AND ASSEMBLY

The RABS module, valve and sensor are serviced as assemblies and are not to be disassembled. The excitor ring is pressed on the differential case and, if removed for any reason, must be discarded.

REMOVAL AND INSTALLATION

Fuses

Three replaceable fuses are involved with the RABS. The fuses are located in the fuse box. A 20 amp fuse protects the total RABS. A 15 amp fuse protects the red BRAKE and yellow REAR ANTILOCK warning lights. Another 15 amp fuse protects the four-way stop lamp cluster. Refer to Section 34-31, Fuses, Circuit Breakers and Fuse Links.

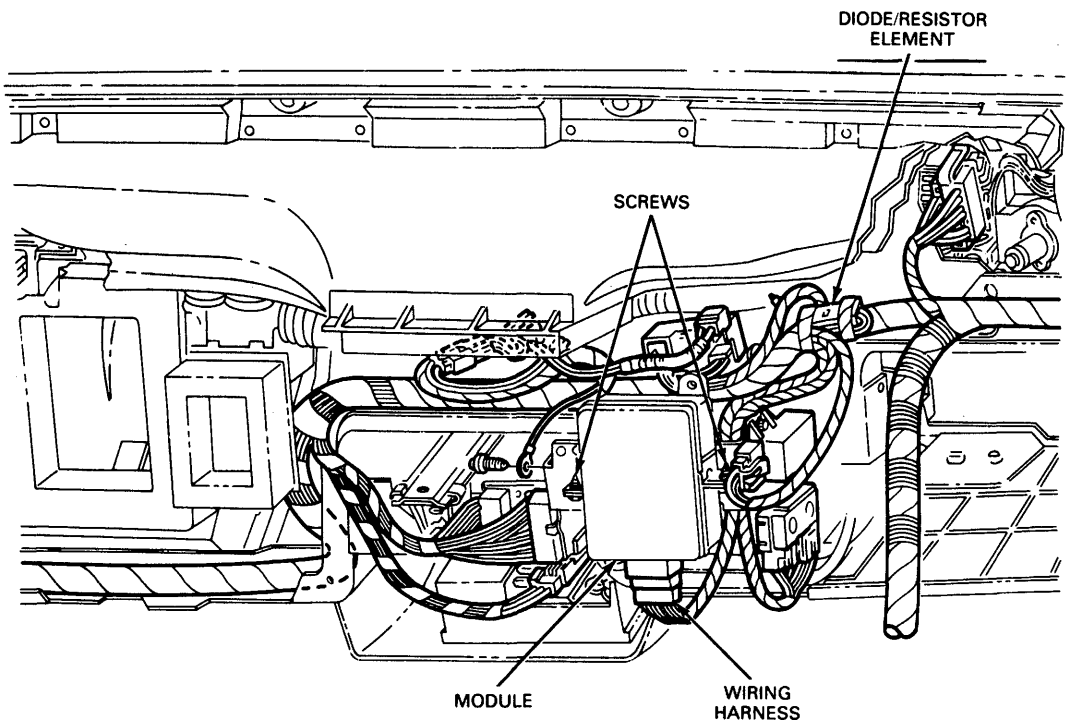
RABS Module

Removal

1. Disconnect the wiring harness from the RABS module by depressing the plastic tab on the connector and pulling the connector off.
2. Remove the two screws that retain the module to the dash panel. Remove the module.

Installation

1. Place the module in position on the dash panel. Install and tighten the two retaining screws.
2. Connect the wiring harness to the module.
3. Check the system for proper operation.



H6308-2A

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REMOVAL AND INSTALLATION (Continued)

RABS Valve

Removal

1. Disconnect and plug the two brake lines connected to the RABS valve.
2. Disconnect the wiring harness to the valve.
3. Remove the three nuts retaining the valve to the frame rail and remove the valve.

Installation

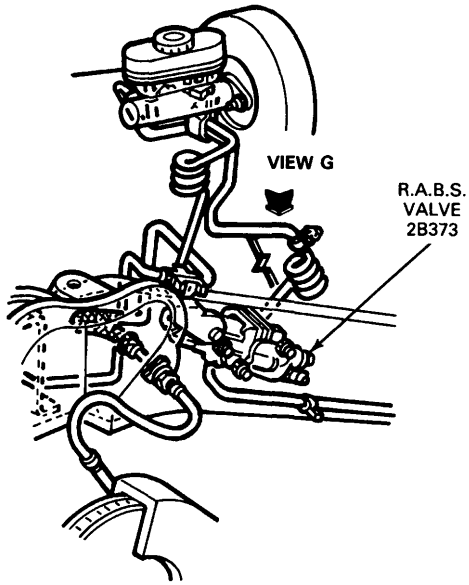
1. Position the RABS valve on the frame rail. Install the three nuts and tighten to 17-23 N·m (12-17 ft-lb).
2. Connect the brake valve wiring harness connector.
3. Connect the brake lines to the valve and tighten as follows:

   1/2-20 threaded fitting use 14-23 N·m (10-17 ft-lb)

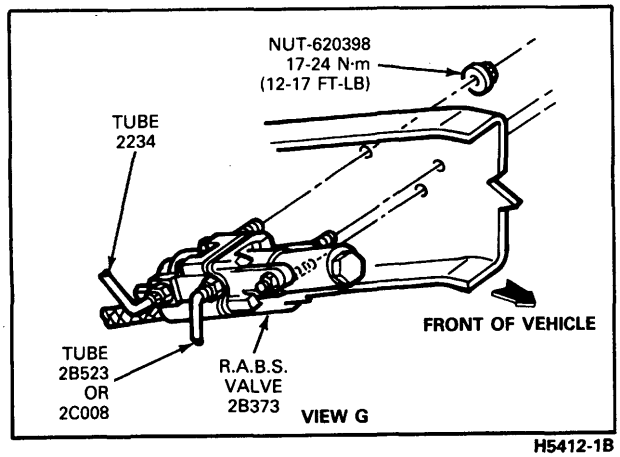
   7/16-24 threaded fitting use 14-20 N·m (10-15 ft-lb)

CAUTION: Do not overtighten the fittings.

4. Bleed the brake system as described in Section 12-01, General Hydraulic Brake Service. It is not necessary to energize the valve electrically to bleed the rear brakes.



MAIN VIEW



H5412-1B

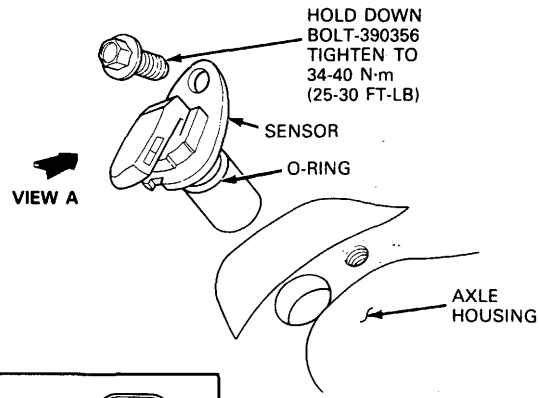
RABS Sensor

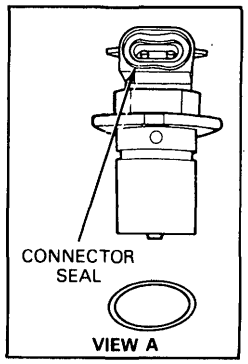
Removal

1. Pull the wiring harness connector off.
2. Remove the sensor hold down bolt and remove the sensor from the axle housing.

Installation

1. Clean the axle mounting surface. Use care to prevent dirt from entering the axle housing.
2. Inspect and clean the magnetized sensor pole piece to ensure that it is free from loose metal particles which could cause erratic system operation. Inspect the sensor O-ring for damage and replace if necessary.
3. Lightly lubricate the sensor O-ring with motor oil, align the sensor bolt hole, and install. Do not apply force to the plastic sensor connector. The sensor flange should slide to the mounting surface. This will insure the air gap setting is between 0.005 and 0.045 inches.
4. Install the hold down bolt and tighten to 34-40 N·m (25-30 ft-lb).
5. Inspect the blue sensor connector seal and replace if missing or damaged. Push the connector on the sensor.





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REMOVAL AND INSTALLATION (Continued)

Excitor Ring

Inspection

1. Remove the sensor as described above.
2. View the excitor ring teeth through the sensor hole. Rotate the rear axle and check the excitor ring teeth for damage or breakage. Dented or broken teeth could cause the RABS system to function when not required.

Removal

To service the excitor ring, the differential case must be removed from the axle housing, and the excitor ring pressed off the case. UPON REMOVAL, THE EXCITOR RING IS TO BE DISCARDED. IT IS NOT TO BE REUSED. For service procedures, refer to the appropriate Axle Section in Group 15.

SPECIFICATIONS

ROTUNDA EQUIPMENT

Number	Description
007-00001	Digital Volt-Ohm Meter

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SECTION 12-50 Vacuum Brake Booster—Single Diaphragm—Dash-Mounted (Bendix)

SUBJECT	PAGE
ADJUSTMENTS	
Push Rod Adjustment	12-50-1
DESCRIPTION	12-50-1
DIAGNOSIS AND TESTING	12-50-1
REMOVAL AND INSTALLATION	
Vacuum Booster	12-50-2
REMOVAL AND INSTALLATION (Cont'd)	
Vacuum Booster (Cont'd)	
E-150—E-250	12-50-3
F-150, F-250 Bronco	12-50-2
SPECIFICATIONS	12-50-5
VEHICLE APPLICATION	12-50-1

VEHICLE APPLICATION

F-150 through F-250 (4x2), E-150 through E-250, F-150 through F-250 (4x4) and Bronco.

DESCRIPTION

Service information (vacuum boosters only) is given in this Section. Adjustments and repairs for the hydraulic brake systems are given in Sections 12-01, General Hydraulic Brake Service 12-02, Drum Brakes—Single Cylinder, Dual Piston and 12-24 Disc Brakes—Light and Heavy Duty—Sliding Caliper.

The single diaphragm vacuum booster is a self-contained vacuum hydraulic power braking unit. It is a vacuum-suspended unit that uses engine manifold vacuum and atmospheric pressure for its power. The booster (Fig. 1) consists of three basic elements combined into a single unit.

The three basic elements are:

1. A vacuum power chamber consisting of a front and a rear shell, diaphragm, diaphragm plate, hydraulic push rod, and vacuum diaphragm return spring.
2. A mechanically actuated booster check valve, integral with the vacuum power diaphragm, which controls the degree of power brake application and release in accordance with foot pressure applied to the valve operating rod through the brake pedal linkage.
3. A hydraulic dual master cylinder which supplies hydraulic pressure to the brake system.

The Bendix single diaphragm, dash-mounted-booster is not repairable and booster must be replaced as a unit. The booster check valve is the only component which can be serviced on the booster assembly.

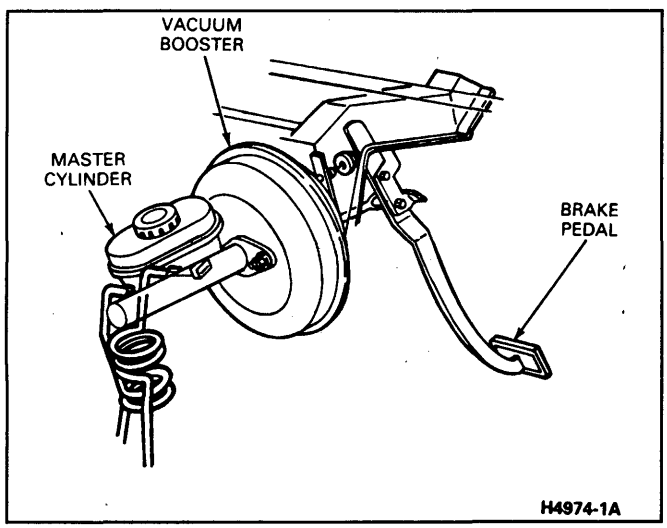


FIG. 1 Booster and Dual Master Cylinder—Typical

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service for diagnostic and testing procedures.

ADJUSTMENTS

Push Rod Adjustment

The push rod has an adjustment screw to maintain the correct relationship between the booster control valve plunger and the master cylinder piston. If the plunger is too long it will prevent the master cylinder piston from completely releasing hydraulic pressure,

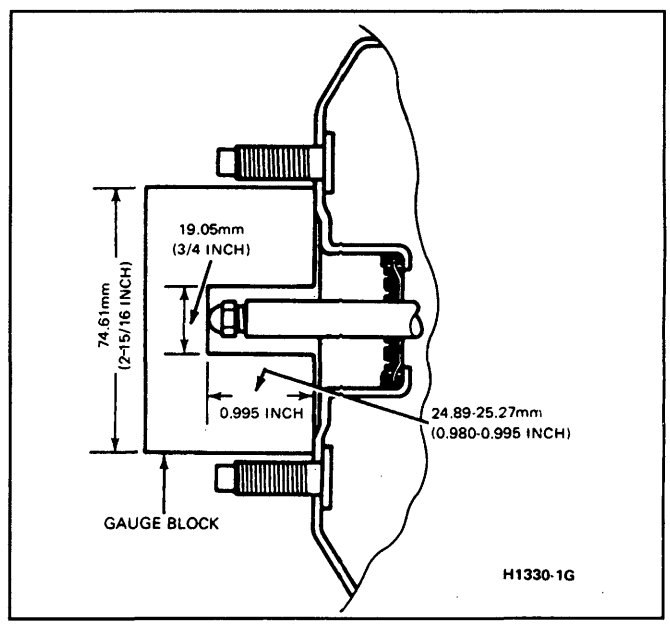


FIG. 2 Booster Push Rod Gauge Dimensions and Adjustment

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causing the brakes to drag. If the plunger is too short it will cause excessive pedal travel and an undesirable clunk in the booster area. Remove the master cylinder for access to the booster push rod.

To check the adjustment of the screw, fabricate a gauge and place it against the master cylinder mounting surface of the booster body as shown in Fig. 2. Adjust the push rod screw by turning it until the end of the screw just touches the inner edge of the slot in the gauge.

REMOVAL AND INSTALLATION

Vacuum Booster

F-150, F-250 Bronco

Refer to Figs. 3 and 4.

NOTE: Make sure that the booster rubber reaction disc is properly installed as shown in Fig. 5 if the master cylinder push rod is removed or accidentally pulled out, a dislodged disc may cause excessive pedal travel and extreme operation sensitivity. The disc is black compared to the silver colored valve plunger that will be exposed after the push rod and front seal are removed. The booster unit is serviced as an assembly and must be replaced if the reaction disc cannot be properly installed and aligned, or if it cannot be located within the unit itself.

Removal

1. Disconnect the stop lamp switch wiring to prevent running the battery down.
2. Support the master cylinder from the underside with a prop.
3. Loosen the clamp that secures the manifold vacuum hose to the booster check valve, and remove the hose (Fig. 4). Remove the booster check valve.
4. Remove the master cylinder-to-booster retaining nuts.
5. Pull the master cylinder off the booster and leave it supported by the prop, far enough away to allow removal of the booster assembly.
6. From inside the cab, remove the cotter pin and slide the stop lamp switch, spacers and bushing off the brake pedal arm.
7. From inside the cab, remove the nuts retaining the booster to the dash. Remove the booster from the engine compartment.

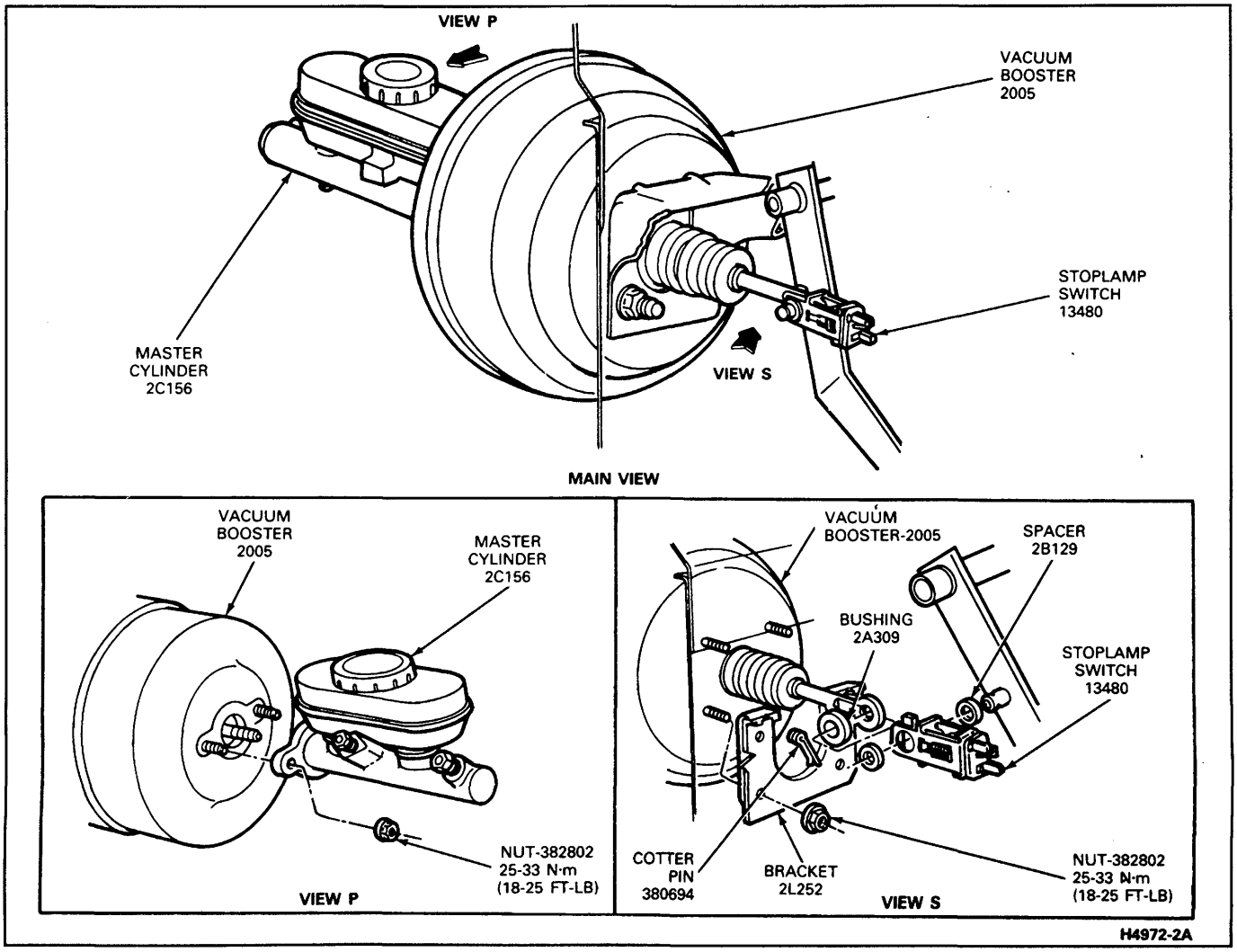


FIG. 3 Brake Booster Installation—F-150, F-250 and Bronco

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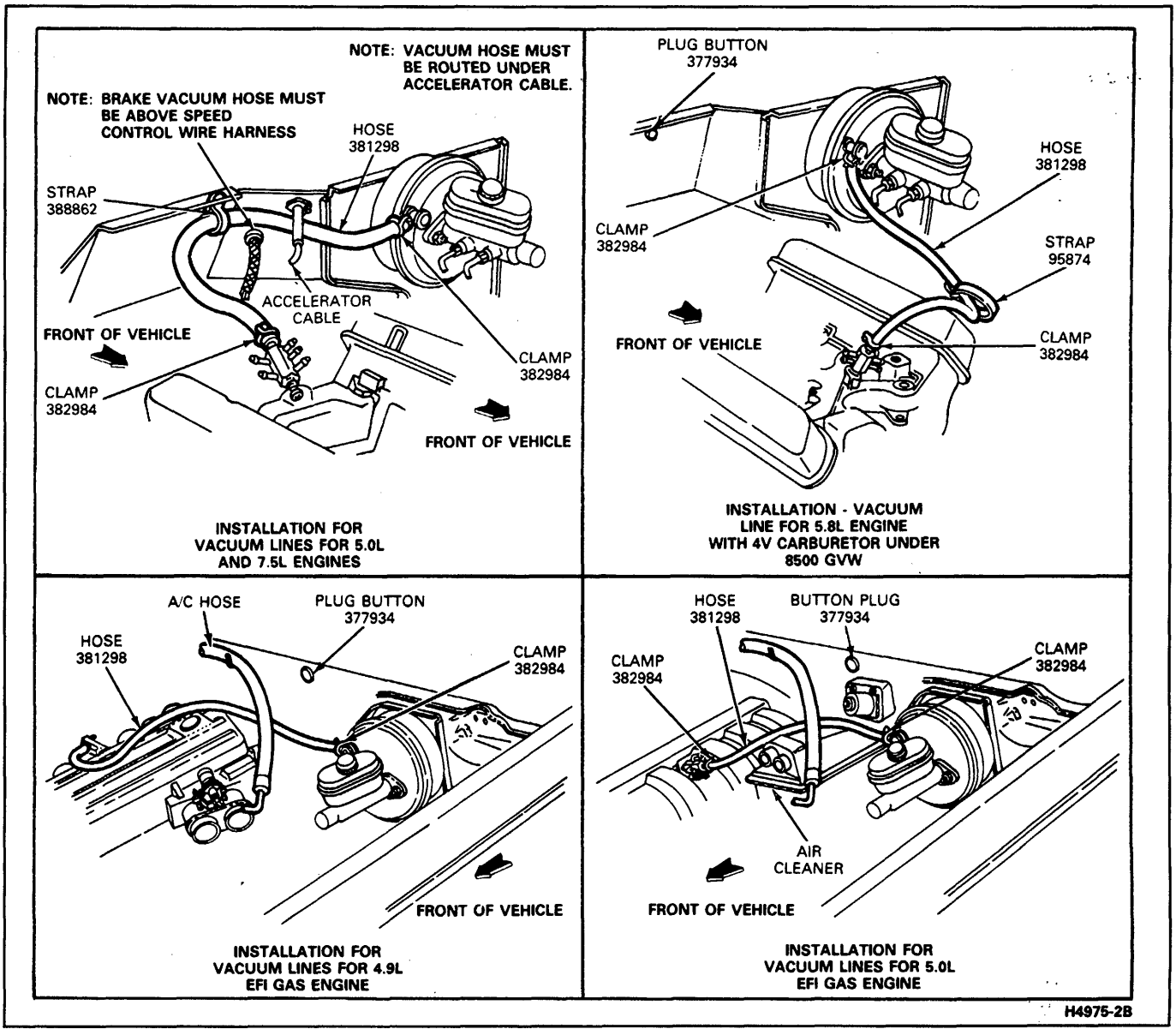


FIG. 4 Brake Booster Vacuum Hose Routing—F-150—F-250 and Bronco

Installation

1. Mount the booster assembly on the engine side of the dash panel by sliding the bracket mounting bolts and valve operating rod in through the holes in the dash panel.

   NOTE: Make certain that the booster push rod is positioned on the correct side of the master cylinder to install onto the push pin prior to tightening the booster assembly to the dash.

2. From inside the cab, install the booster mounting bracket-to-dash panel retaining nuts. Tighten nuts to 18-33 N·m (13-25 ft-lb).
3. Position the master cylinder on the booster assembly, install the retaining nuts, and remove the prop from underneath the master cylinder. Tighten nuts to 18-33 N·m (13-25 ft-lb).
4. Install the booster check valve. Connect the manifold vacuum hose to the booster check valve and secure with the clamp. Make sure the vacuum hose is routed as shown in Fig. 4.
5. From inside the cab, install the bushing and position the switch on the end of the push rod. Then install the switch and rod on the pedal arm, along with spacers on each side, and secure with the cotter pin.
6. Connect the stop lamp switch wiring.
7. Start the engine and check brake operation.

Vacuum Booster

E-150—E-250

Refer to Figs. 6 and 7.

NOTE: Make sure that the booster rubber reaction disc is properly installed as shown in Fig. 5. If the master cylinder push rod is removed or accidentally pulled out, a dislodged disc may cause excessive pedal travel and extreme operation sensitivity. The disc is black compared to the silver colored plunger that will be exposed after the push rod and front seal is removed. The booster unit is serviced as an assembly and must be replaced if the reaction disc cannot be properly

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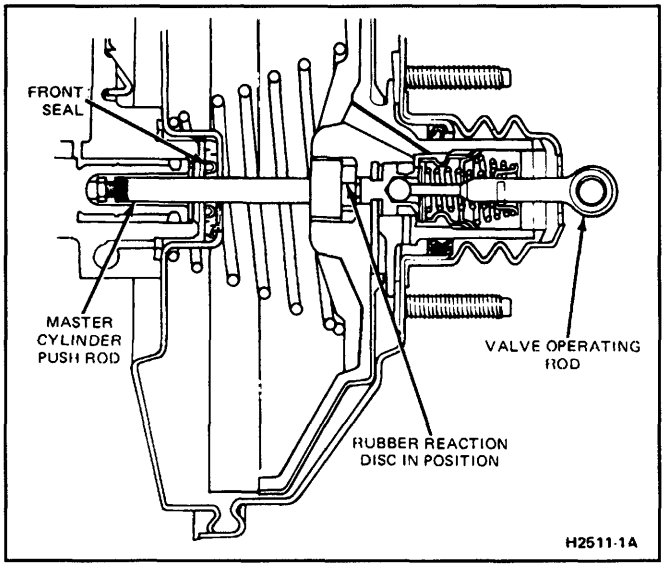


FIG. 5 Checking Reaction Disc Installation—Single Diaphragm 11 Inch Vacuum Booster

installed and aligned, or if it cannot be located within the unit itself.

Removal

1. Disconnect the stop lamp switch to prevent running the battery down.
2. Support the master cylinder from the underside with a prop.
3. Loosen the clamp that secures the vacuum hose to the booster check valve and remove the hose (Fig. 7). Remove the booster check valve.
4. Remove the nuts retaining the clutch master cylinder and retainer to the booster. Remove and position the clutch master cylinder and retainer so fluid does not spill out of the cylinder. Note that the two lower holes on the retainer are used for installation purposes.
5. Remove the master cylinder to booster retaining nuts.
6. Pull the master cylinder off the booster and leave it supported by the prop, far enough away to allow removal of the booster assembly.
7. From inside the cab, remove the cotter pin and slide the stop lamp switch, spacers and bushing off the brake pedal arm.
8. From inside the cab, remove the nuts retaining the booster to the bracket. Remove the booster from the engine compartment.

Installation

1. Mount the booster assembly on the engine side of the dash panel by sliding the bracket mounting bolts and valve operating rod in through the holes in the dash panel.

   NOTE: Make sure that the booster push rod is positioned on the correct side of the master cylinder to install onto the push pin prior to tightening the booster assembly to the dash.
2. From inside the cab, install the booster mounting bracket-to-dash panel retaining nuts. Tighten the nuts to 13-25 N·m (10-18 ft-lbs).
3. Position the master cylinder on the booster assembly, install the retaining nuts and remove the

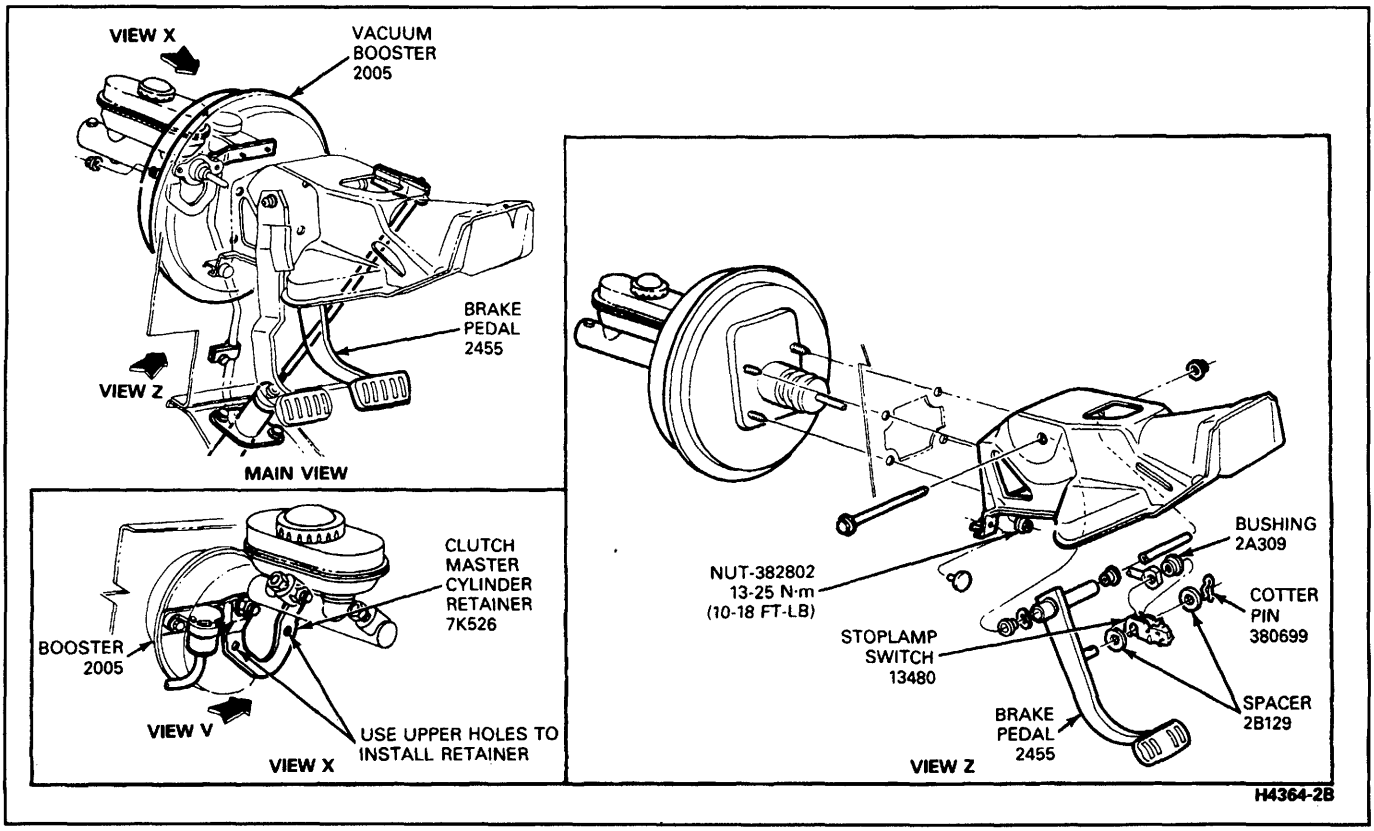


FIG. 6 Brake Booster Installation—E-150—E-250

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prop from underneath the master cylinder. Tighten the nuts to 13-25 N·m (10-18 ft-lb).

4. Position the two lower holes of the retainer and clutch master cylinder over the studs and nuts. Install the nuts and tighten to 13-25 N·m (10-18 ft-lb).

5. Install the booster check valve. Connect the vacuum hose to the booster check valve and secure with a clamp. Make sure the vacuum hose is routed as shown in Fig. 7.

6. From inside the cab, install the bushing and position the switch on the end of the push rod. Then install the switch and rod on the pedal arm along with spacers on each side and secure the assembly with the cotter pin.

7. Connect the stop lamp switch.

8. Start the engine and check brake operation.

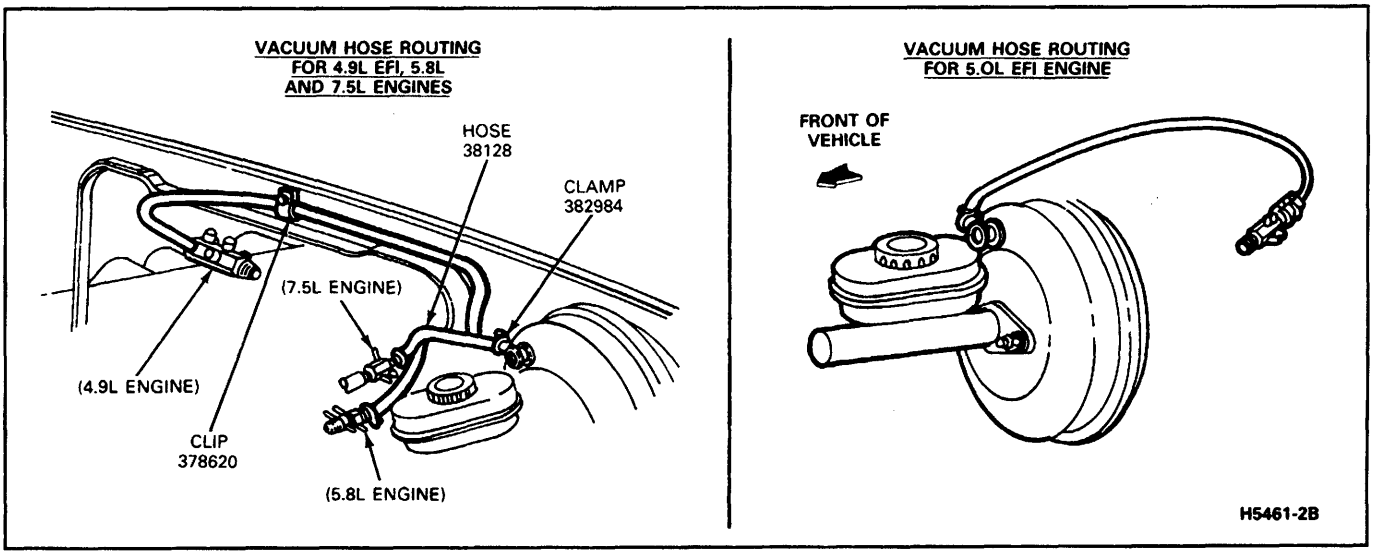


FIG. 7 Brake Booster Vacuum Hose Routing—E-150—E-250

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Application	Torque Range	
		N·m	Ft-Lbs
Master Cylinder to Booster	E-150, E-250	13-25	10-18
Master Cylinder to Booster	F-150, F-250, Bronco	18-33	13-25
Booster to Dash Panel	E-150, E-250	13-25	10-18
Booster to Dash Panel	F-150, F-250, Bronco	18-33	12-25
Clutch Master Cylinder Retainer to Booster	E-150, E-250	13-25	10-18

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SECTION 12-52 Vacuum Brake Booster—Tandem Diaphragm—Dash-Mounted (Bendix)

SUBJECT	PAGE
ADJUSTMENTS	
Push Rod	12-52-1
DESCRIPTION	12-52-1
DIAGNOSIS AND TESTING	12-52-1
REMOVAL AND INSTALLATION	
Vacuum Booster	12-52-1
SPECIFICATIONS	12-52-5
VEHICLE APPLICATION	12-52-1

VEHICLE APPLICATION

E-Series, F-Series and Bronco.

DESCRIPTION

Service information for only the vacuum booster is given in this Section. Adjustments and repairs for the hydraulic brake-system are given in Sections 12-01, General Hydraulic Brake Service, 12-02 Drum Brakes—Single Cylinder, Dual Piston, and 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.

The tandem diaphragm vacuum booster, is a self-contained vacuum hydraulic power braking unit. It is a vacuum suspended unit that uses engine manifold vacuum and atmospheric pressure for its power. The booster consists of three basic elements combined into a single unit.

The three basic elements are:

1. A vacuum power chamber consisting of a front and a rear shell, center plate, front and a rear diaphragm, hydraulic push rod, and vacuum diaphragm return spring.
2. A mechanically actuated booster check valve, integral with the vacuum power diaphragms, which controls the degree of power brake application and release in accordance with the foot pressure applied to the valve operating rod throughout the brake pedal linkage.
3. A hydraulic dual master cylinder which supplies hydraulic pressure to the brake system.

The Bendix tandem diaphragm, dash-mounted booster is not repairable and must be replaced as a unit.

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service for diagnostic and testing procedures.

ADJUSTMENTS

Push Rod

The push rod has an adjustment screw to maintain the correct relationship between the booster control valve plunger and the master cylinder piston. If the plunger is too long it will prevent the master cylinder piston from completely releasing hydraulic pressure, causing the brakes to drag. If the plunger is too short it will cause excessive pedal travel and an undesirable clunk in the booster area. Remove the master cylinder for access to the booster push rod.

To check the adjustment of the screw, fabricate a gauge and place it against the master cylinder mounting surface of the booster body as shown in (Fig. 1). Adjust the push rod screw by turning it until the end of the screw just touches the inner edge of the slot in the gauge.

REMOVAL AND INSTALLATION

Vacuum Booster

F-150, F-250, F-350

Refer to Figs. 2 and 3.

Removal

1. Disconnect the stop lamp switch wiring to prevent running the battery down.
2. Support the master cylinder from the underside with a prop.

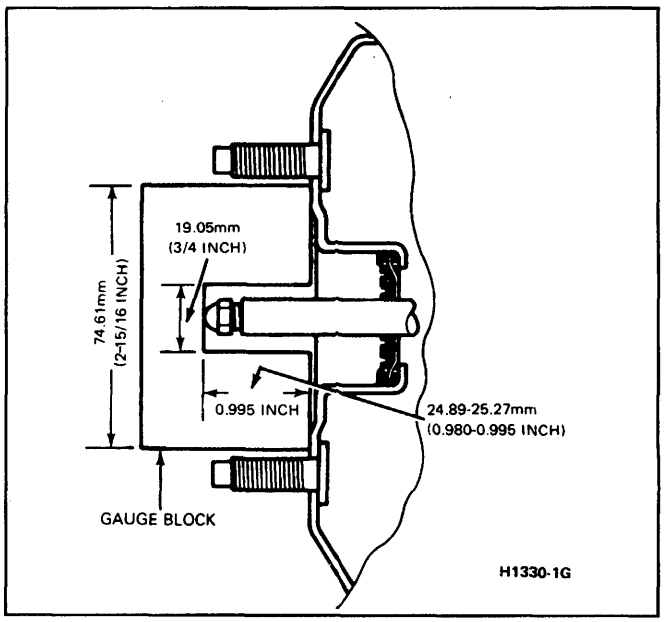


FIG. 1 Bendix Booster Push Rod Gauge Dimensions and Adjustments—Bronco, E-150—E-350 and F-150—F-350

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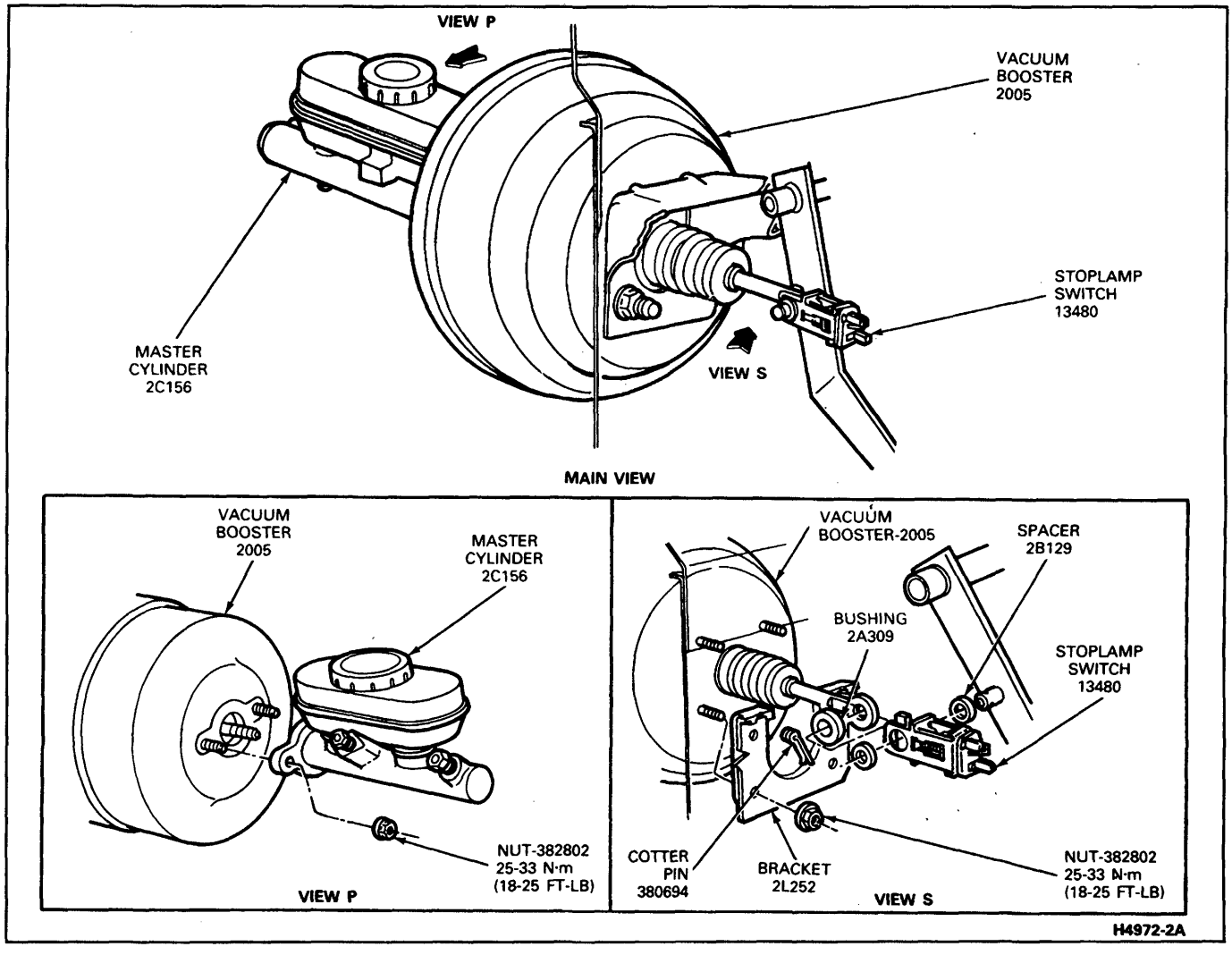


FIG. 2 Brake Booster Installation—F-150, F-250, F-350 and Bronco

3. Loosen the clamp that secures the manifold vacuum hose to the booster, and remove the hose (Fig. 3).
4. Remove the wraparound clip from the booster inboard stud.
5. Remove the master cylinder-to-booster retaining nuts.
6. Pull the master cylinder off the booster and leave it supported by the prop, far enough away to allow removal of the booster assembly.
7. From inside the cab, remove the cotter pin and slide the stop lamp switch, push rod, spacers and bushing off the brake pedal arm.
8. From inside the cab, remove the nuts retaining the booster to the dash. Remove the booster from the engine compartment.

Installation

1. Mount the booster and bracket assembly on the engine side of the dash panel by sliding the valve operating rod in through the holes in the dash panel and securing it with nuts from engine compartment. Tighten the nuts to 18-33 N·m (13-25 ft-lb).
2. Position the master cylinder on the booster assembly, install the retaining nuts, and remove the prop from underneath the master cylinder. Tighten the nuts to 18-33 N·m (13-25 ft-lbs).
3. Install the wraparound clip on the booster inboard stud.
4. Connect the manifold vacuum hose to the booster and secure with the clamp. Make sure the hose is routed as shown in Fig. 3.
5. From inside the cab, install the bushing and position the switch on the end of the push rod. Then install the switch and rod on the pedal arm, along with spacers on each side and secure with the cotter pin.
6. Connect the stop lamp switch wiring.
7. Start the engine and check brake operation.

Vacuum Booster

E-150, E-250, E-350

Refer to Figs. 4 and 5.

Removal

1. Disconnect the stop lamp switch to prevent running the battery down.

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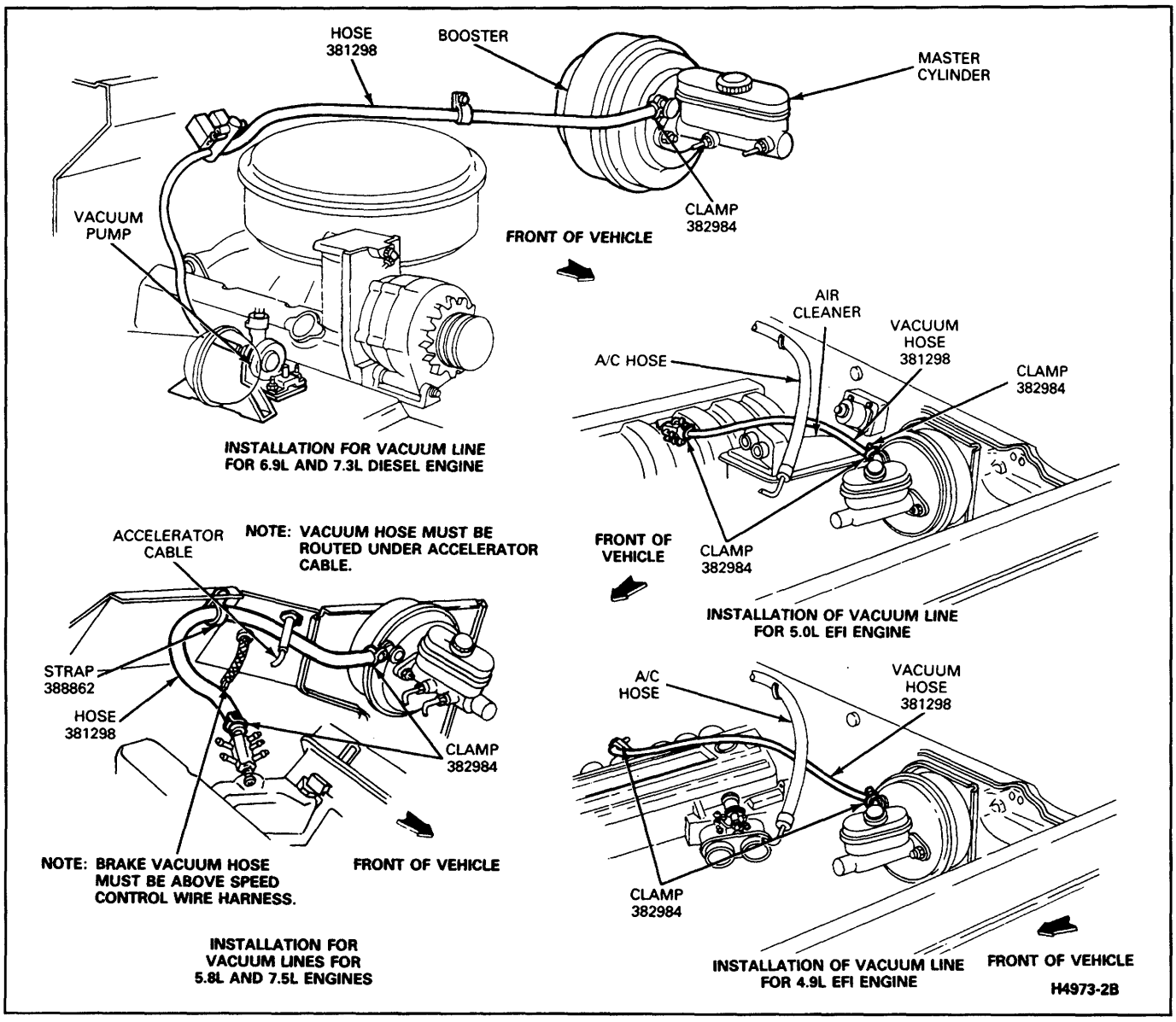


FIG. 3 Brake Booster Vacuum Hose Routing—F-150, F-250, F-350 and Bronco

2. Support the master cylinder from the underside with a prop.
3. Loosen the clamp that secures the vacuum hose to the booster check valve and remove the hose (Fig. 5). Remove the booster check valve.
4. Remove the nuts retaining the clutch master cylinder and retainer to the booster. Remove and position the clutch master cylinder and retainer so fluid does not spill out of the cylinder. Note that the two upper holes on the retainer are used for installation purposes.
5. Remove the master cylinder to booster retaining nuts.
6. Pull the master cylinder off the booster and leave it supported by the prop, far enough away to allow removal of the booster assembly.
7. From inside the cab, remove the cotter pin and slide the stop lamp switch, spacers and bushing off the brake pedal arm.
8. From inside the cab, remove the nuts retaining the booster to the bracket. Remove the booster from the engine compartment.

Installation

1. Mount the booster assembly on the engine side of the dash panel by sliding the bracket mounting bolts and valve operating rod in through the holes in the dash panel.

   NOTE: Make sure that the booster push rod is positioned on the correct side of the master cylinder to install onto the push pin prior to tightening the booster assembly to the dash.

2. From inside the cab, install the booster mounting bracket-to-dash panel retaining nuts. Tighten the nuts to 13-25 N·m (10-18 ft-lb).
3. Position the master cylinder on the booster assembly, install the retaining nuts and remove the prop from underneath the master cylinder. Tighten the nuts to 13-25 N·m (10-18 ft-lb).

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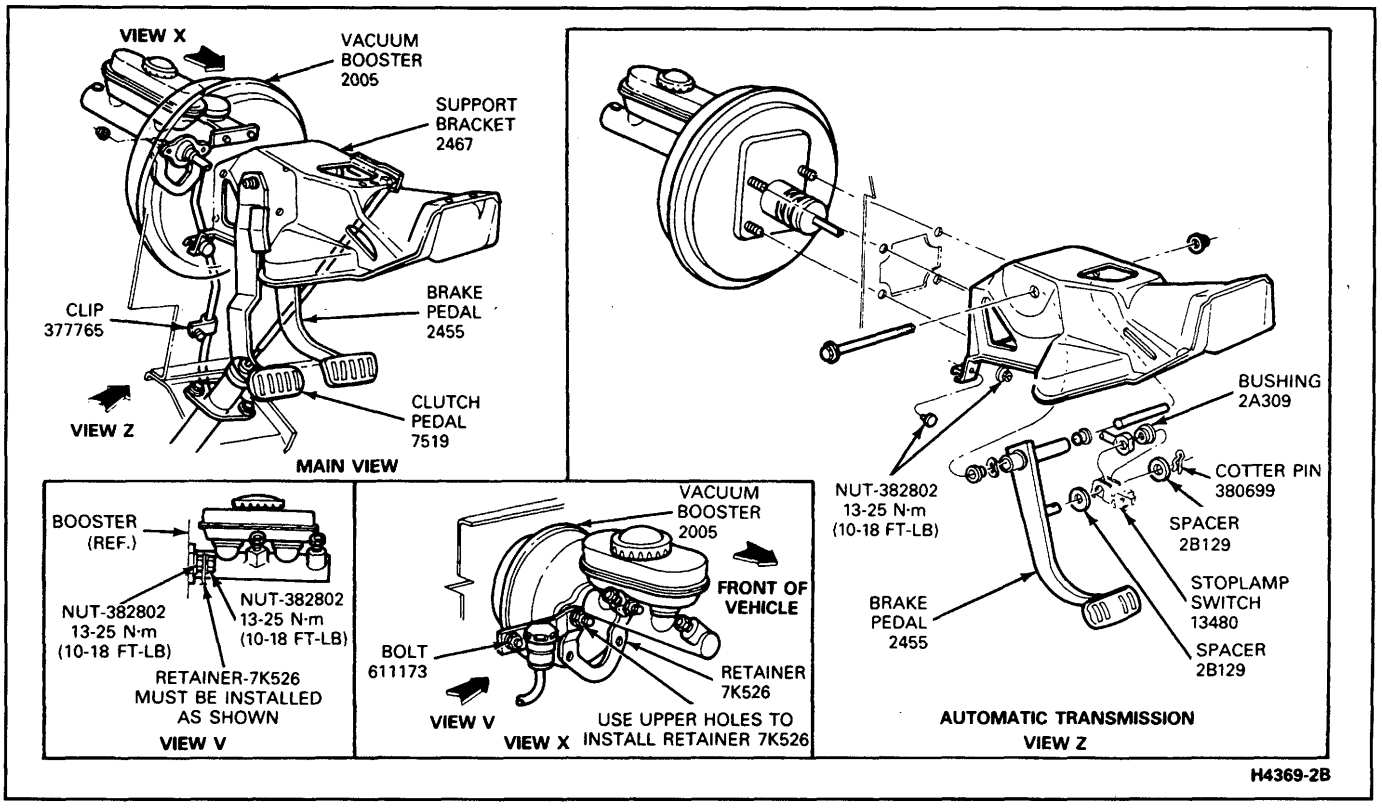


FIG. 4 Brake Booster Installation—E-150, E-250, E-350

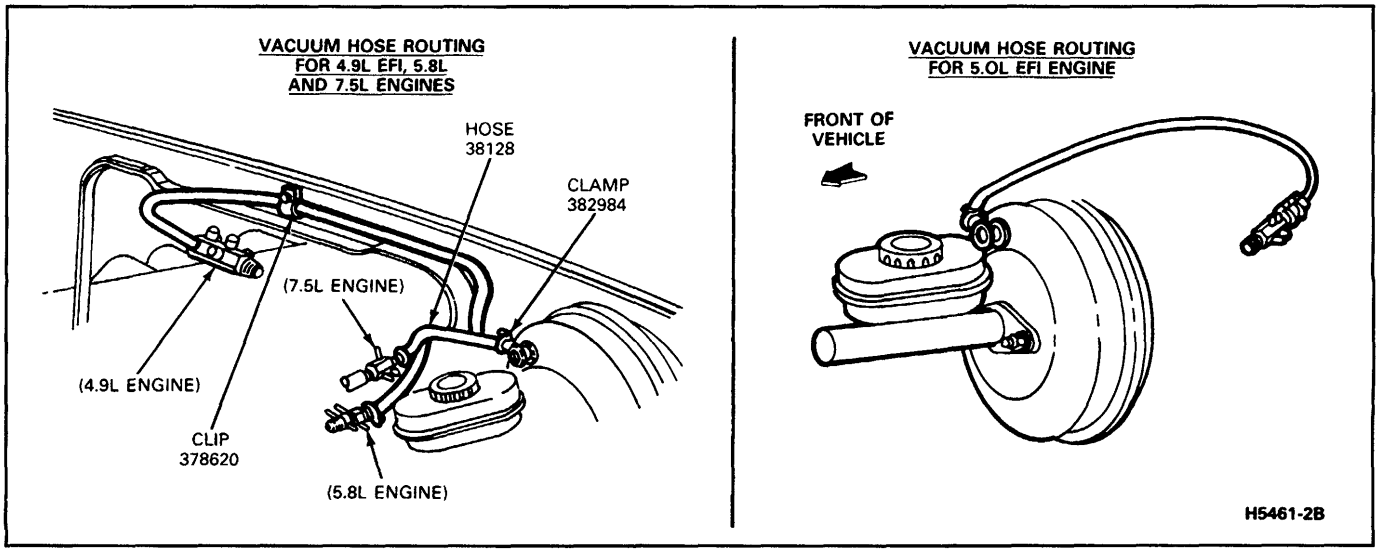


FIG. 5 Brake Booster Vacuum Hose Routing—E-150, E-250, E-350

4. Position the two upper holes of the retainer and clutch master cylinder over the studs and nuts. Install the nuts and tighten to 13-25 N·m (10-18 ft-lb).
5. Install the booster check valve. Connect the vacuum hose to the booster check valve and secure with a clamp. Make sure the vacuum hose is routed as shown in Fig. 5.
6. From inside the cab, install the bushing and position the switch on the end of the push rod. Then install the switch and rod on the pedal arm along with spacers on each side and secure the assembly with the cotter pin.
7. Connect the stop lamp switch.
8. Start the engine and check brake operation.

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SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Application	Torque Range	
		N•m	Ft-Lbs
Master Cylinder to Booster	E-150, E-250	13-25	10-18
Master Cylinder to Booster	F-150, F-250, Bronco	18-33	13-25
Booster to Dash Panel	E-150, E-250	13-25	10-18
Booster to Dash Panel	F-150, F-250, Bronco	18-33	12-25
Clutch Master Cylinder Retainer to Booster	E-150, E-250	13-25	10-18

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SECTION 12-56 Brake Booster Vacuum Pump—7.3L Diesel Engine

SUBJECT	PAGE
ADJUSTMENTS	
Vacuum Pump Belt Tension	12-56-1
DESCRIPTION	12-56-1
DIAGNOSIS AND TESTING	12-56-1
REMOVAL AND INSTALLATION	
Low Vacuum Indicator Switch	12-56-1
REMOVAL AND INSTALLATION (Cont'd)	
Vacuum Pump	12-56-1
SPECIFICATIONS	12-56-7
VEHICLE APPLICATION	12-56-1

VEHICLE APPLICATION

E-250—E-350 and F-250—F-350 Equipped w/ 7.3L Diesel Engine.

DESCRIPTION

On gasoline engine vehicles, engine vacuum is used to power the vacuum booster brake. On diesel engines, however, insufficient vacuum is available for vacuum booster brake operation.

On diesel engine vehicles, vacuum is supplied from a pump located on the top right side of the engine (Fig. 1). The diesel engine vacuum pump is driven by a single belt off the alternator (Fig. 2).

Diesel engine equipped vehicles employ the use of a low-vacuum indicator switch which actuates the BRAKE warning lamp when vacuum is beneath a specified level (Fig. 1). The switch senses vacuum through a fitting in the vacuum manifold that intercepts the vacuum flow from the pump.

The low-vacuum switch for E-250—E-350 models is mounted to the left side fender panel. On F-250—F-350 models the switch is located on the right side of the engine compartment adjacent to the vacuum pump.

The vacuum pump, low-vacuum indicator switch and connecting hoses are shown in Fig. 1.

Service information (Brake Booster Vacuum Pump—7.3L Diesel Engines) is given here. Adjustments and repairs for the hydraulic brake systems are given in Sections 12-01, General Hydraulic Brake Service; 12-02, Drum Brakes—Single Cylinder, Dual Piston; and 12-20, Disc Brakes—Single Piston—Sliding Caliper.

DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service for diagnostic and testing procedures other than those listed in the chart.

ADJUSTMENTS

Vacuum Pump Belt Tension

Refer to Figs. 2 and 3.

NOTE: When tightening all drive belts, refer to the sequence described in Section 27-06, Accessory Drive Belt Service.

1. Loosen the vacuum pump adjustment bolt and the pivot bolt.
2. Insert a 3/8 inch drive breaker bar or ratchet in the adjustment plate slot. Lift up on the assembly until the specified tension is obtained. Measure the tension with Belt Tension Gauge, T63L-8620-A, or equivalent. (For belt tension specifications, refer to Specifications at the end of this Section.)
3. With tension still applied, tighten the adjustment bolt and the pivot bolt to 15-25 N·m (11-18 ft-lbs).

REMOVAL AND INSTALLATION

Low Vacuum Indicator Switch

Refer to Fig. 1.

NOTE: The low vacuum switch for E-250—E-350 models is mounted to the left side fender panel. On F-250—F-350 models the switch is located on the right side of the engine compartment adjacent to the vacuum pump.

Removal

1. Disconnect vacuum hose from low-vacuum indicator switch.
2. Remove two attaching screws and remove switch and bracket assembly.

Installation

1. Position switch and bracket assembly to panel and secure with two screws. Tighten screws to 8-11 N·m (5.8-7.5 ft-lbs).
2. Connect vacuum hose to low vacuum indicator switch.

Vacuum Pump

Refer to Fig. 3.

Removal

1. Remove the hose clamp and disconnect the pump from the hose on the manifold vacuum outlet fitting (Fig. 1).
2. Loosen the vacuum pump adjustment bolt and the pivot bolt. Slide the pump downward and remove the drive belt from the pulley.
3. Remove the pivot and adjustment bolts and the bolts retaining the pump to the adjustment plate. Remove the vacuum pump and adjustment plate.

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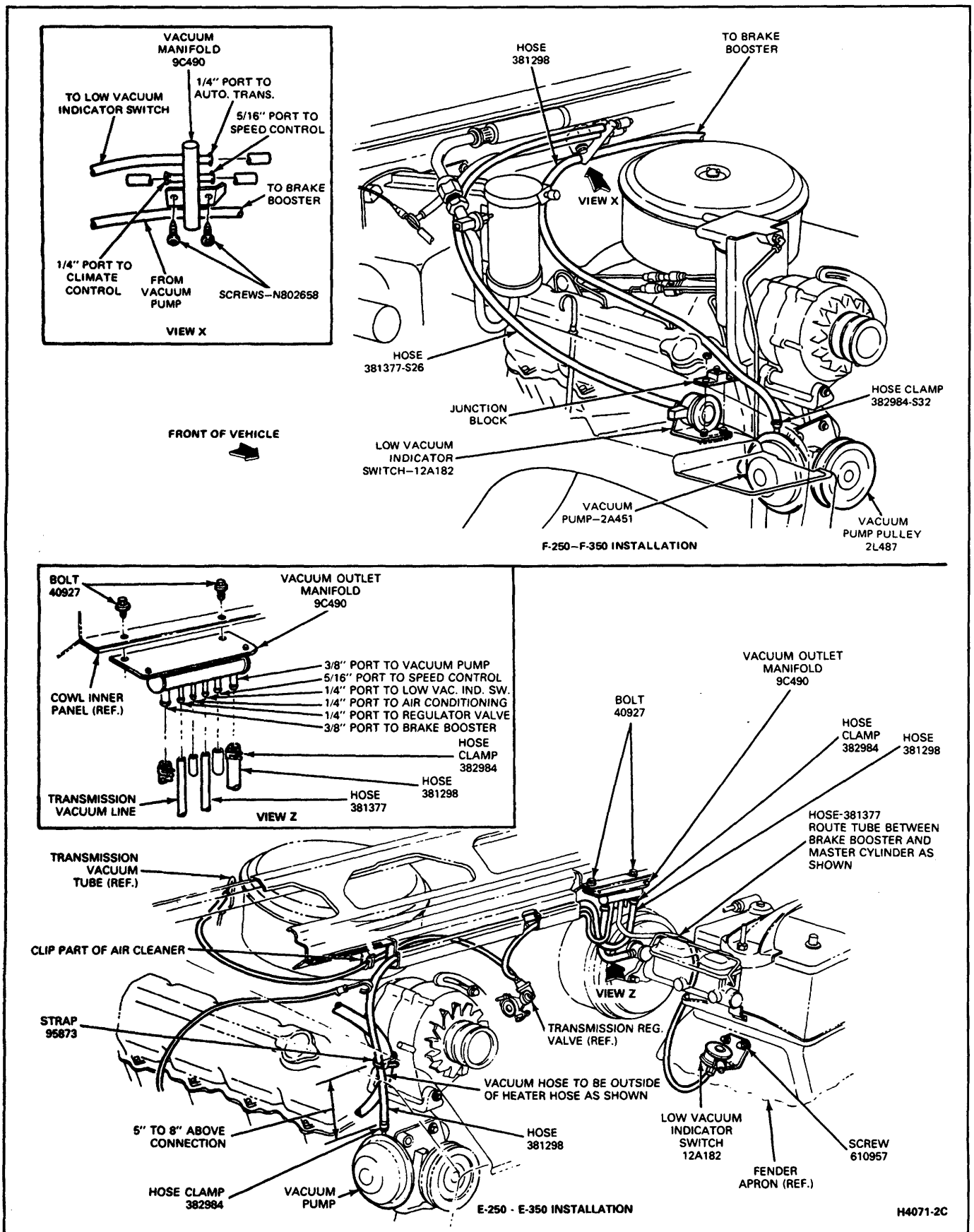


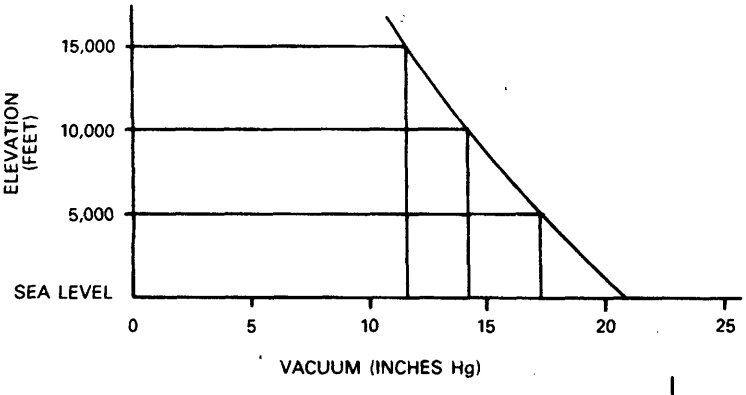
FIG. 1 Brake Booster Vacuum Pump—7.3L Diesel Engine Installation—E-250—E-350 and F-250—F-350

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VACUUM PUMP DIAGNOSIS

TEST STEP	RESULT	ACTION TO TAKE
1.0 CONDITION ISOLATION		
Disconnect the low-vacuum switch. Run engine at normal idle speed. Apply brakes.	Brake Warning Light illuminates	Condition related to the hydraulic system. REFER to Section 12-01, General Hydraulic Brake Service.
	Brake Warning Light doesn't illuminate	Condition related to the vacuum pump. GO to **2.**
NOTE: Before proceeding with the procedures, block the wheels, apply the parking brake and place the transmission selector in "PARK" or "NEUTRAL" before starting engine.		
2.0 VACUUM PUMP OUTPUT		
Disconnect the vacuum pump hose from the brake booster and insert a vacuum gauge, Rotunda Model 059-00008 or equivalent, in the hose end. Run the engine at normal curb idle and check vacuum. Gauge should read 70 kPa (21 inches Hg) at sea level within 30 seconds. (Refer to graph below for vacuum at other elevations.)	Vacuum at or above specified level (OK)	GO to **4.**
	Vacuum below specified level or fluctuating gauge reading (OK)	GO to **3.**
3.0 SYSTEM INTEGRITY CHECK		
Check gauge and connections for leaks. Check pulley fit-to-shaft. Check for belt tension to specified tension. Check that engine curb idle RPM is at specifications. Repeat procedure in Step 2.0 — "Vacuum Pump Output" Test.	Vacuum at or above specified level (OK)	GO to **4.**
	Vacuum below specified level (OK)	REPLACE vacuum pump.

MINIMUM ACCEPTABLE VS. ALTITUDE



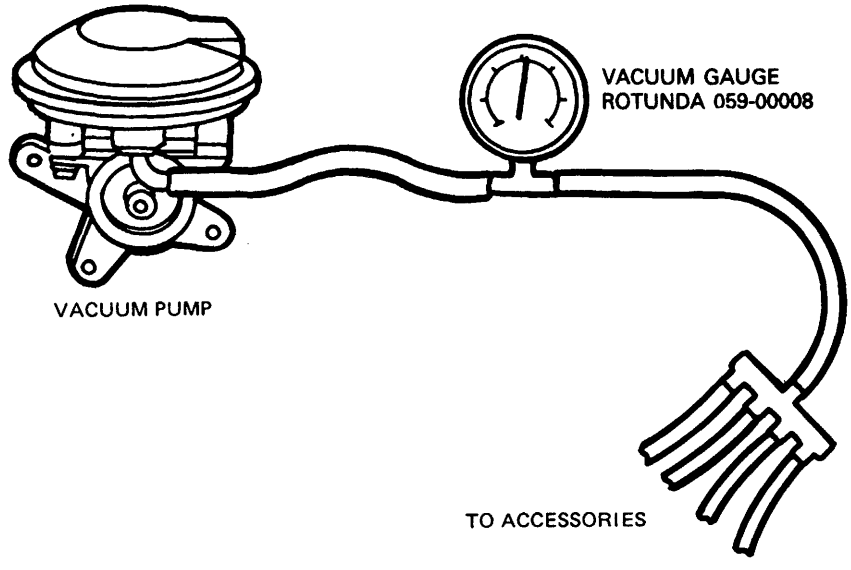
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VACUUM PUMP DIAGNOSIS (Cont'd.)

TEST STEP	RESULT	ACTION TO TAKE
4.0 VACUUM SYSTEM CHECK Reconnect the vacuum hose with a T-fitting and connect vacuum gauge so gauge is located near pump inlet. Run engine at curb idle speed. The maximum allowable vacuum drop to be 10 kPa (3 in. Hg.) from the specified level of vacuum described in Step 2.0 — "Vacuum Pump Output" Test.	Vacuum at or above specified level (OK) ▶	GO to **5.**
	Vacuum below specified level (OK) ▶	GO to **6.**
5.0 BRAKE BOOSTER CHECK Repeat Step 4.0 — "Vacuum System Check" with brake pedal depressed and held in position.	Vacuum at or above specified level (OK) ▶	CHECK Hydraulic System. REFER to Section 12-01, General Hydraulic Brake Service.
	Vacuum below specified level (OK) ▶	REPLACE brake booster.
6.0 LEAK CHECK Check all attaching hoses for leaks.	Vacuum hoses leak (OK) ▶	SERVICE as required.
	Vacuum hoses do not leak (OK) ▶	If vacuum is still low, check all vacuum accessories for out of specification leaks. REPAIR or REPLACE as required.

VACUUM SYSTEM CHECK



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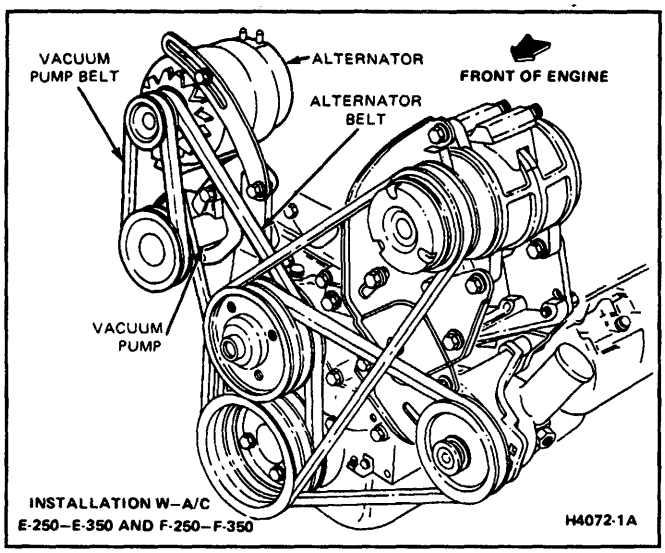


FIG. 2 Vacuum Pump Belt Tension

NOTE: The vacuum pump is not to be disassembled. It is only serviced as a unit. The pulley is serviced as a separate item.

Installation

1. Install the bolts attaching the pump to the adjustment plate and tighten the bolts to 15-25 N·m (11-18 ft-lbs). Position the pump and plate on the vacuum pump bracket and loosely install the pivot and adjustment bolts.
2. Connect the hose from the manifold vacuum outlet fitting to the pump and install the hose clamp (Fig. 1).
3. Install the drive belt on the pulley. Place a 3/8 inch drive breaker bar or ratchet into the slot on the vacuum pump adjustment plate. Lift up on the assembly until the specified belt tension is obtained. Measure tension with Belt Tension Gauge, T63L-8620-A or equivalent. (For belt tension specifications, refer to Specifications at the end of this Section.) Tighten the pivot and adjustment bolts to 15-25 N·m (11-18 ft-lbs).
4. Start the engine and verify proper operation of the brake system.

   NOTE: The BRAKE lamp will glow until vacuum builds up to the normal level.

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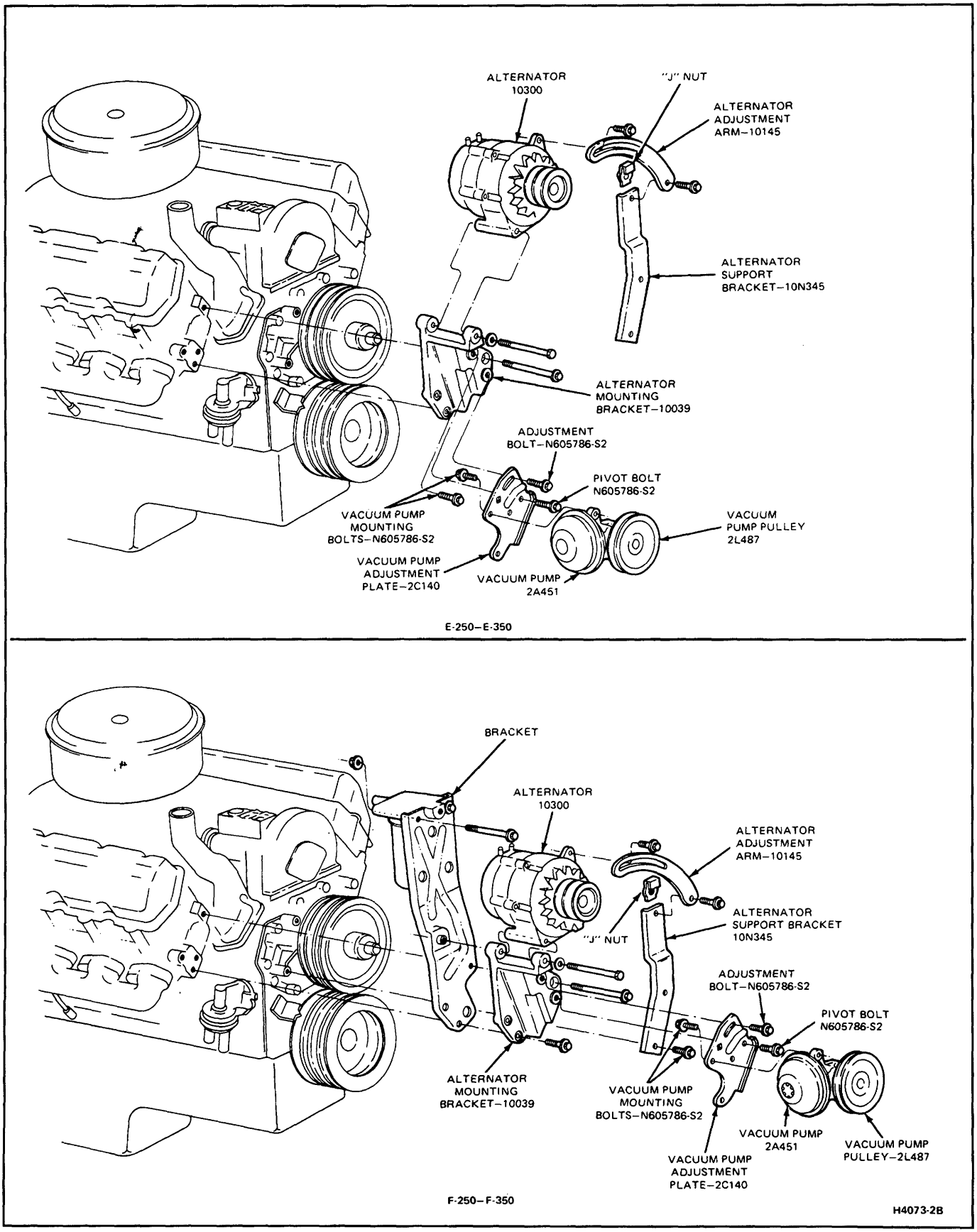


FIG. 3 Vacuum Pump Installation—Disassembly View

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SPECIFICATIONS

VACUUM PUMP BELT TENSION SPECIFICATIONS — 7.3L DIESEL ENGINE

Belt	New Belt				Used Belt			
	Cold Engine ①		Hot Engine		Minimum		Readjustment	
	Lbs	N	Lbs	N	Lbs	N	Lbs	N
Vacuum Pump Belt	90-130	400-578	110-150	489-667	60	266	80-100	355-444

①Engine not run in 3 hours.

CH4074-2B

TORQUE SPECIFICATIONS

Description	Torque	
	N·m	Ft-Lbs
Vacuum Pump to Adjustment Plate Bolts	15-25	11-18
Vacuum Pump Adjustment Bolt	15-25	11-18
Vacuum Pump Pivot Bolt	15-25	11-18
Low-Vacuum Indicator Switch Bracket Screws	8-11	5.8-7.5

CH4075-2A

SPECIAL SERVICE TOOLS

Tool No.	Description
T63L-8620-A	Belt Tension Gauge

CH4076-1A

ROTUNDA EQUIPMENT

Tool Number	Description
059-00008	Vacuum/Pressure Tester

CH5402-1A

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SECTION 12-57 Hydro-Boost Brake Booster

SUBJECT	PAGE
DESCRIPTION AND OPERATION	
Description	12-57-1
Operation	12-57-4
DIAGNOSIS AND TESTING	
Diagnosis Guide	12-57-9
Diagnosis Guides	12-57-8
Hydro-Boost Normal Noise Characteristics	12-57-7
DIAGNOSIS GUIDES	
Adjustments	12-57-11
DISASSEMBLY AND ASSEMBLY	12-57-12
REMOVAL AND INSTALLATION	12-57-12
SPECIFICATIONS	12-57-12
VEHICLE APPLICATION	12-57-1

VEHICLE APPLICATION

Applies to all F-Super Duty Truck Models.

DESCRIPTION AND OPERATION

Description

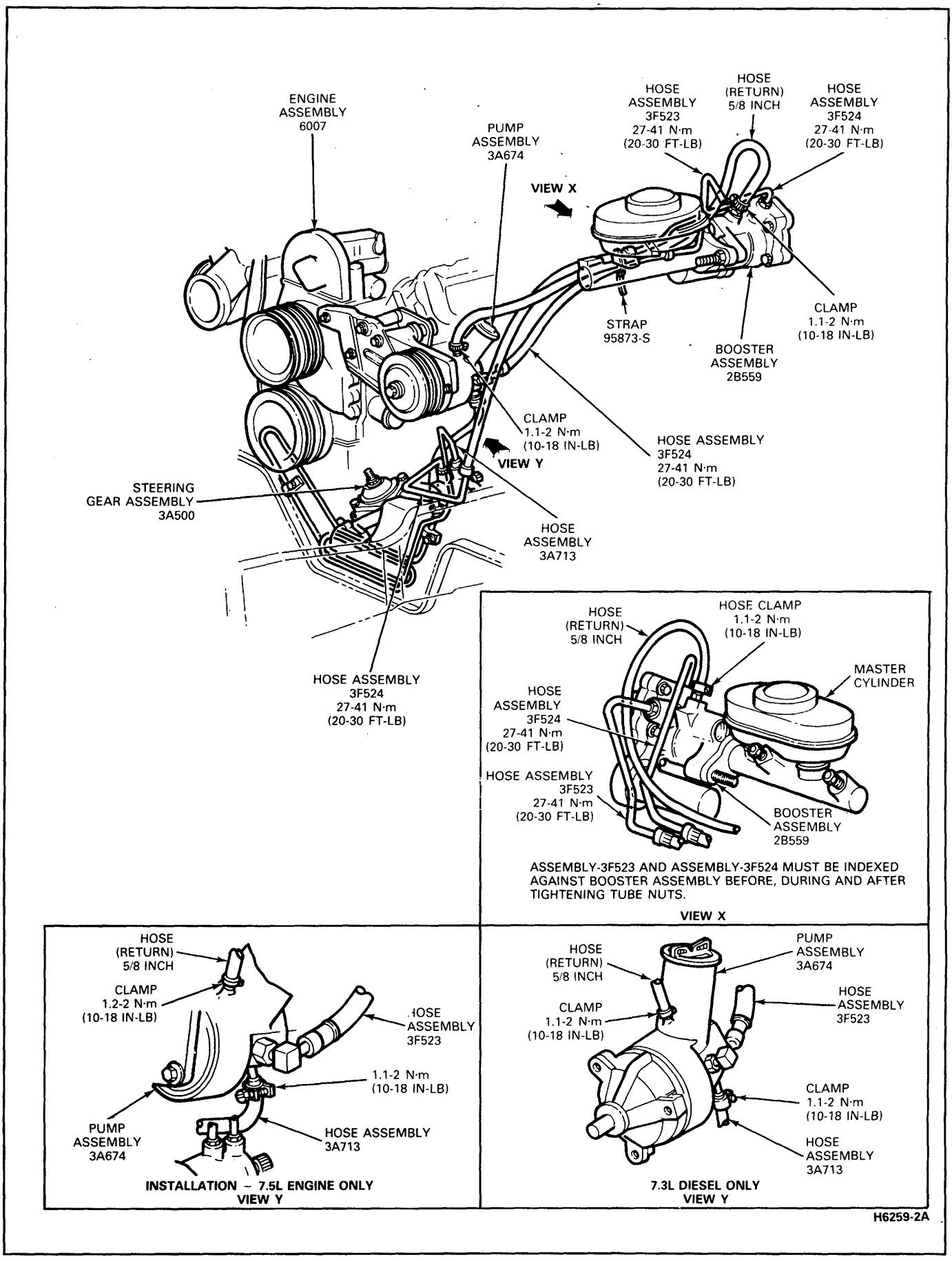
The Bendix Hydro-Boost brake booster is a hydraulically operated brake booster powered by the power steering system. The power steering pump provides the fluid pressure to operate both the hydraulically-powered brake booster (hydro-boost) and the power steering gear. It provides a variable power assist that is regulated by the brake pedal application pressure.

The hydro-boost also has a reserve system (compressed gas accumulator) that is designed to store sufficient fluid under pressure to provide at least two brake applications in the event that the fluid flow from the power steering pump is not available. The brakes can also be applied manually if the reserve system is depleted.

Hydro-Boost model identification is stamped into the booster housing near the inlet line.

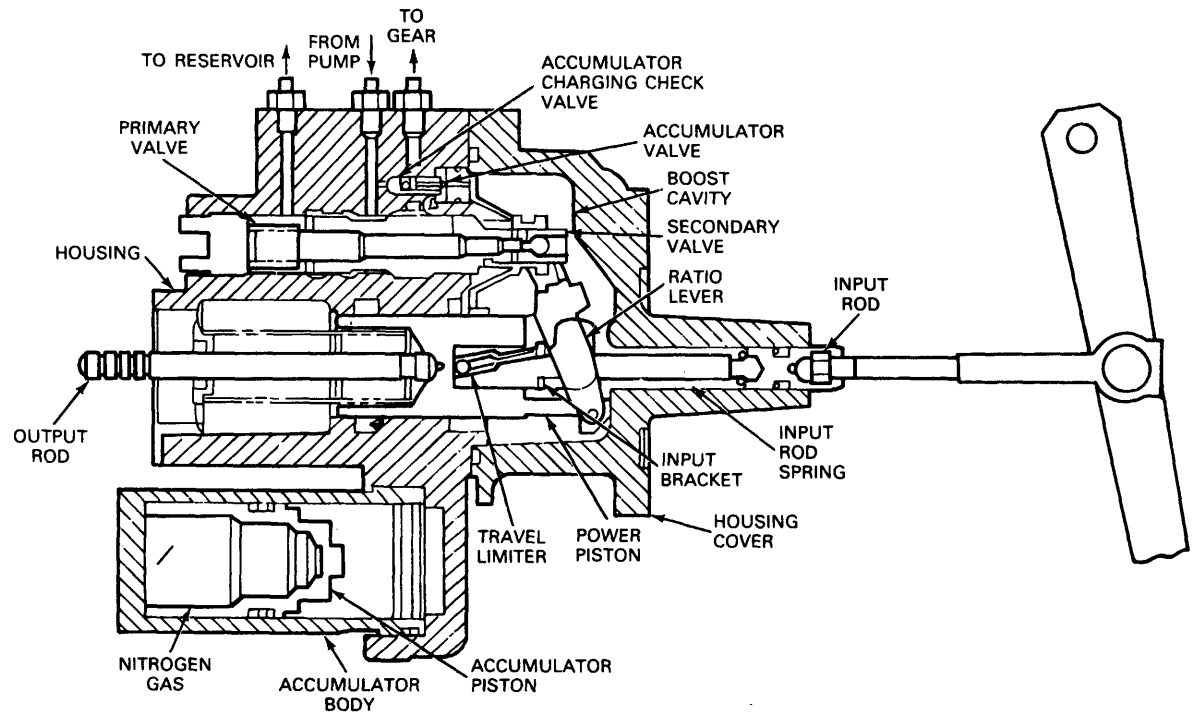
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DESCRIPTION AND OPERATION (Continued)



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DESCRIPTION AND OPERATION (Continued)

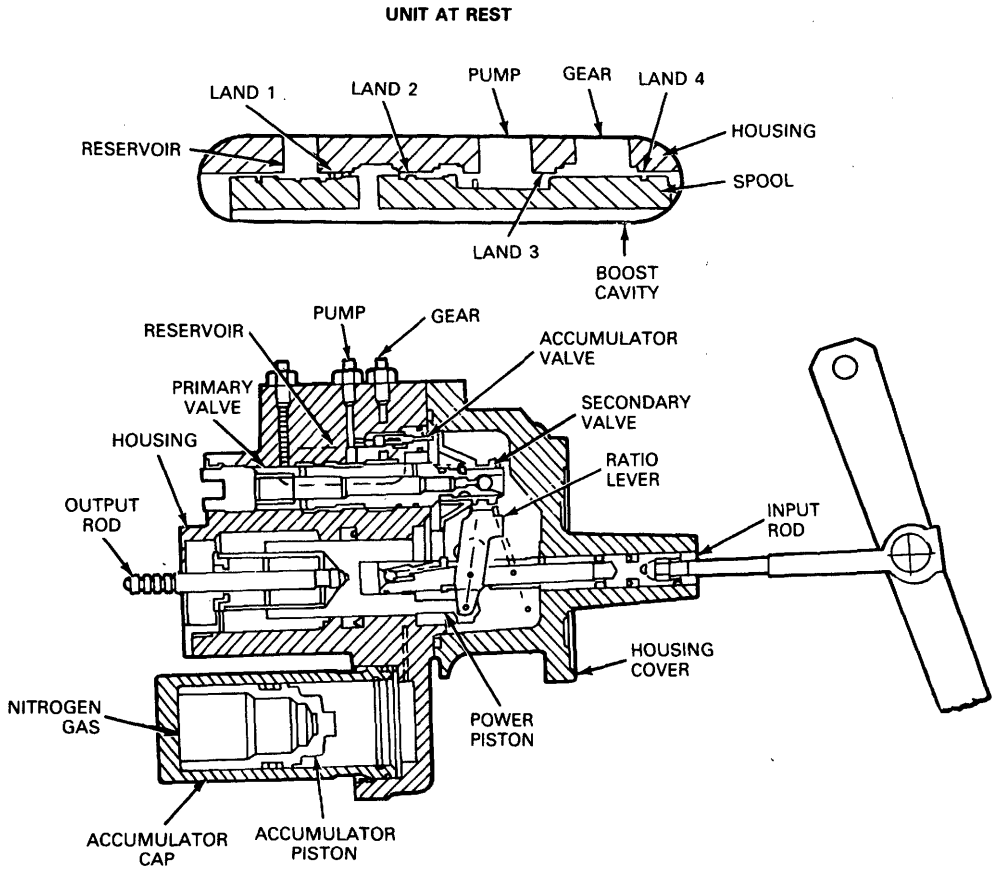


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DESCRIPTION AND OPERATION (Continued)

Operation

With the Hydro-Boost at rest (engine on, brakes released) oil flows from the inlet (pump) port, across the number 3 land and out the gear port. In this position, steering pressure created by the steering gear and pump is isolated from the boost cavity by the spool valve. Lands 2 and 4 block this steering pressure avoiding activation of the unit.

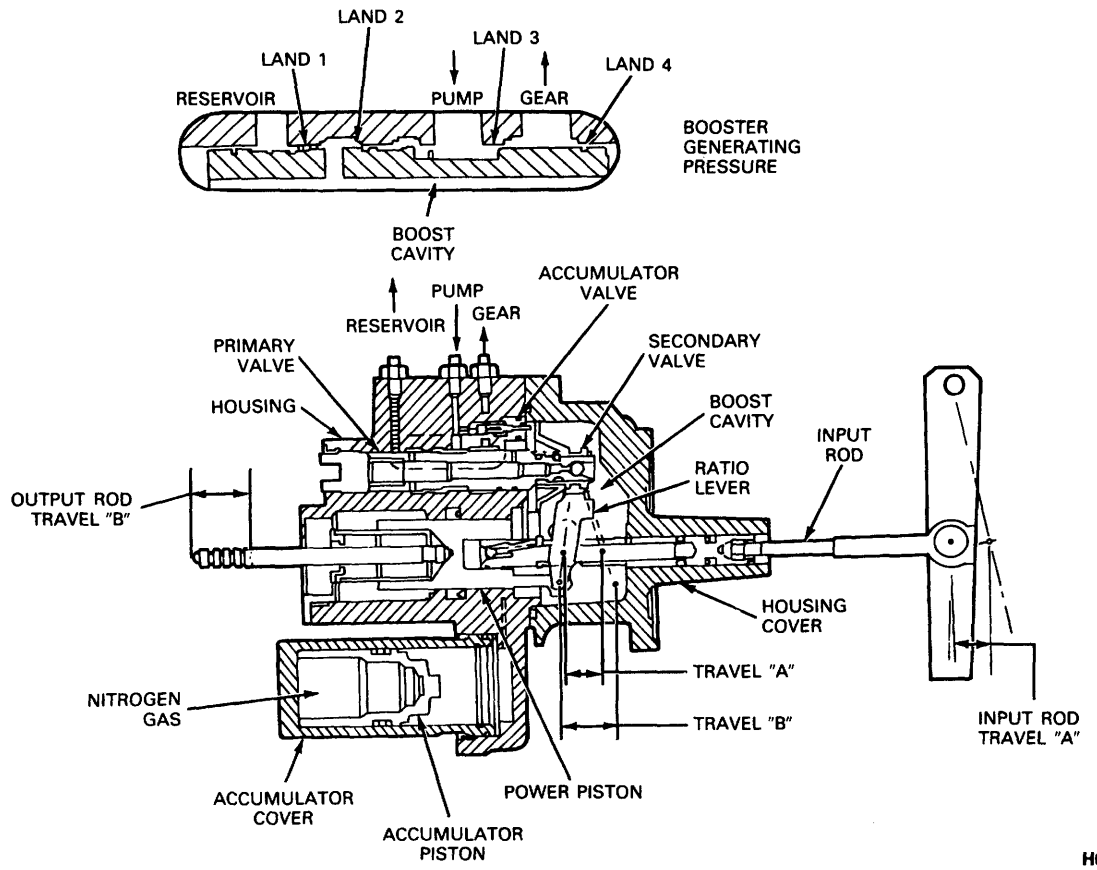


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DESCRIPTION AND OPERATION (Continued)

During normal power operation the brake pedal is applied as shown by input travel A. The movement of the ratio lever operates the spool valve creating hydraulic pressure due to the restriction at land 3. Fluid traverses land 2 and flows through the center of the spool into the boost cavity. This pressure acts against the power piston to give the power assist and against the reaction rod to provide the effort level of the brake pedal.

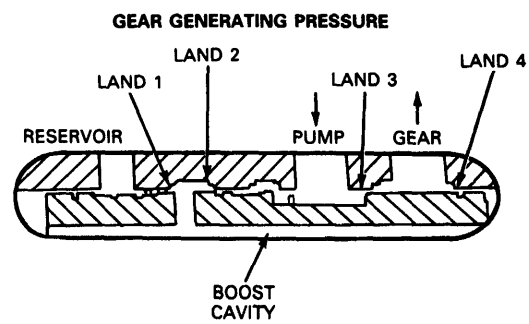
If while braking, fluid pressure is required for steering, pump pressure will rise and the spool valve will shift in an open direction allowing more fluid to flow to the steering gear. Even under extremes of braking, the fluid flow to the steering gear is fully sufficient for steering the vehicle.



H6262-2A

The enlarged view of the spool valve shows the relationship of the valve lands during normal power operation. Land 1 is closed blocking the oil flow to the reservoir. Land 3 meters the flow of oil from the supply pump to the steering gear and generates the hydraulic pressure that is metered across land 2 to apply the brakes.

The enlarged view of the valve shows the same operation except pressure is generated by the steering gear and is also being used for braking. During this mode of operation, the spool travel is slightly less than the first case.



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DESCRIPTION AND OPERATION (Continued)

Reserve System

The reserve braking system consists of a charging valve, an accumulator valve and a compressed gas accumulator. The system is open to the pressure port of the hydro-boost.

The accumulator is charged by the pump pressure during normal steering or braking operation through a check valve that communicates with the pump port.

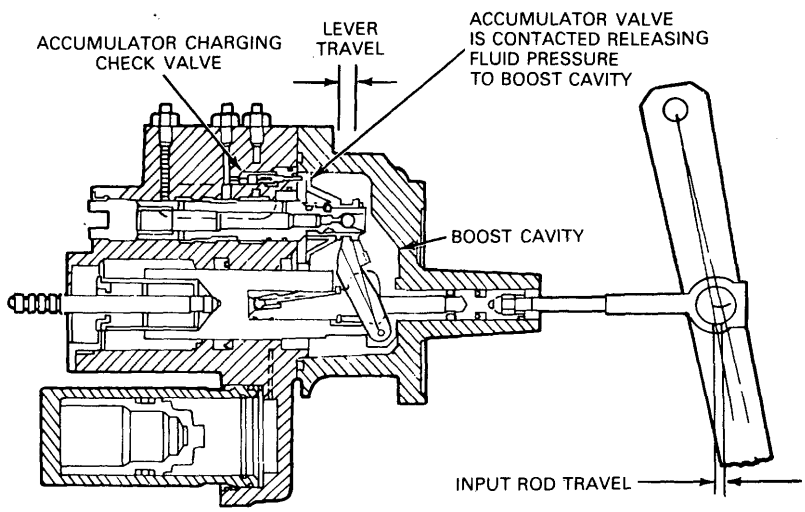
The charging valve has an orifice and a check valve. Fluid from the pump passes around the check valve into the accumulator if the pump pressure exceeds the pressure in the accumulator. The charging rate is controlled by the orifice to minimize its effect on fluid flow to the steering gear. The check valve prevents reverse flow when the accumulator pressure is greater than pump pressure.

The accumulator valve is a small poppet-type valve held closed by the pressure stored in the accumulator. An actuator on the spool valve sleeve opens the accumulator valve when a stop with no pump pressure is made that requires use of the reserve system pressure.

Fluid pressure can also enter the accumulator from the boost chamber through the accumulator valve. This condition occurs whenever boost chamber pressure momentarily exceeds accumulator pressure.

A pressure relief valve vents the accumulator to the pump pressure port whenever pressure in the accumulator exceeds approximately 1,400 psi.

RESERVE OPERATION



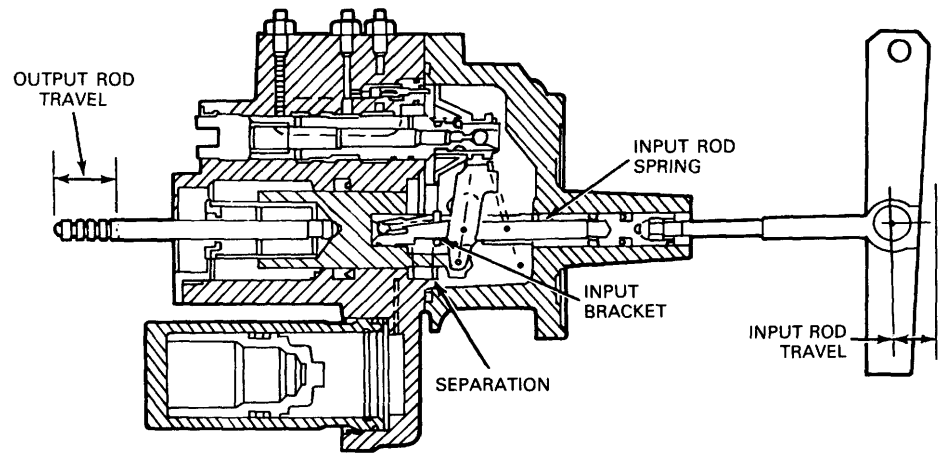
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DESCRIPTION AND OPERATION (Continued)

When reserve power is depleted (manual operation) pressure on the brake pedal will cause the input bracket to separate from a shoulder on the input rod, compresses the input spring and allows a change in the ratio of the brake pedal travel. This increase in brake pedal ratio will cause the brake pedal to travel further and increases the mechanical force applied to the master cylinder.

MANUAL OPERATION



H6265-2A

DIAGNOSIS AND TESTING

Hydro-Boost Normal Noise Characteristics

Normal hydro-boost brake units will produce certain characteristic noises that current technology cannot correct. These noises occur, for the most part, when the brake pedal is manipulated in a manner not associated with the everyday braking habits. The general categories of normal operating noise are hissing noise and clunk, click and chatter noises.

The hydro-boost will emit normal hissing noises when above normal pedal efforts are applied. The hiss sounds are particularly noticeable with the vehicle motionless and will increase in intensity as pedal efforts increase and system operating temperatures increase. Loud hissing sounds at or below normal 111-156 N (25-35 lbs) pedal effort warrants investigation and possible correction.

Clunk, chatter or clicking noises will be heard when the brake pedal is quickly released from hard pedal efforts. Due to "quick release for hard application" requirement for the noises, they will most likely be heard with the vehicle motionless or during a fast stop-start condition.

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DIAGNOSIS AND TESTING (Continued)

Diagnosis Guides

Refer to the following diagnosis guides for aid in diagnosing Hydro-Boost conditions. Additional information is available in Section 13-53 Power Steering Pump-C-11.

CONDITION	POSSIBLE CAUSE	RESOLUTION
Slow brake pedal return	1. Excessive seal friction in booster.	1. Replace booster.
	2. Flared reaction end.	2. Replace booster.
	3. Broken piston return spring.	3. Replace booster.
	4. Restriction in return line from booster to pump reservoir.	4. Clear or replace line.
	5. Return line incorrectly connected.	5. Correct plumbing.
	6. Broken spool return spring.	6. Replace booster.
	7. Heavy brake pedal.	7. Reposition pedal or add retracting spring.
Grabbing brakes	1. Broken spool return spring.	1. Replace booster.
	2. Faulty spool action due to contamination.	2. Flush steering while pumping brake pedal.
	3. Low pump flow.	3. Tighten belt.
Booster chatter, pedal vibration	1. Slipping pump belt.	1. Tighten belt.
	2. Low fluid level in pump.	2. Fill reservoir. Check for external leaks.
Accumulator leaks down. Reserve system does not hold charge.	1. Two-function valve is faulty.	1. Replace booster.
	2. Accumulator seal is faulty.	2. Replace booster.
	3. Pneumatic accumulator is faulty.	3. Replace booster.

CH6266-2A

CONDITION	POSSIBLE CAUSE	RESOLUTION
Excessive brake pedal efforts	1. Loose, glazed, or broken pump belt.	1. Tighten or replace belt.
	2. No fluid in pump reservoir.	2. Fill reservoir and check for external leaks.
	3. Leaks in system hoses.	3. Replace faulty parts.
	4. Leaks at tube fittings and connections.	4. Tighten fittings or replace tube seats or O-rings.
	5. Leakage at pneumatic accumulator seal.	5. Replace booster.
	6. Leakage at piston seal.	6. Replace booster.
	7. Leakage at input seal.	7. Replace booster.
	8. Leakage at cover-to-housing seal.	8. Replace booster.
	9. Leakage at spool plug seal.	9. Replace booster.
	10. Leakage at ball plug.	10. Replace booster.
Unit self-applies	1. Restriction in booster return line.	1. Clear or replace line.
	2. Return line incorrectly connected.	2. Correct plumbing.
	3. Dump valve faulty.	3. Replace booster.

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DIAGNOSIS AND TESTING (Continued)

Basic Test

With the engine off, depress and release the brake pedal several times to deplete all hydraulic pressure from the Hydro-Boost. Depress and hold the brake pedal with light pressure, then start the engine. If the Hydro-Boost is operating, the pedal will fall slightly and then hold. Less pressure will be required to hold the pedal at this position.

Brake Hydraulic Leak Test

Depress and release the brake pedal several times, then hold the brake pedal down with medium pressure (11-15 kg [25-35 lbs.]). If the pedal falls away, the brake system is leaking. Check for leaks at the disc brake calipers, brake lines, master cylinder, and hoses. If there is no external leakage, there may be internal leakage in the master cylinder. If the pedal does not fall away during this test then the hydraulic system is not leaking.

Hydro-Boost Leak Test

Thoroughly clean the Hydro-Boost unit, and all hoses and hose connections.

Start the engine and run at idle speed. If the hose connections do not leak, check the Hydro-Boost for leakage. Apply the brakes with approximately 45 kg (100 pounds) pressure at the pedal, and hold while checking the Hydro-Boost hoses for leaks.

CAUTION: Do not hold the brake pedal at 45 kg (100 Pounds) effort for more than five seconds at a time.

If the Hydro-Boost leaks, it is worn or damaged and must be replaced.

Reserve Retention Check

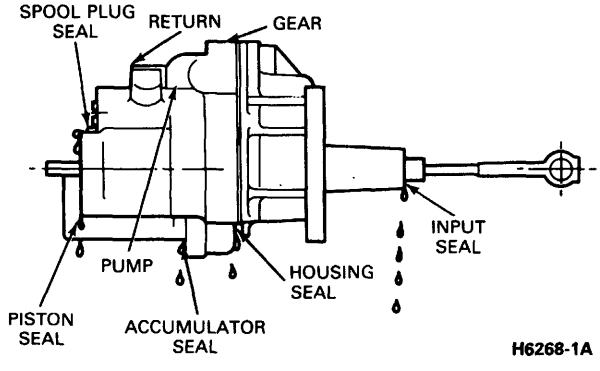
Charge the system with pressure by holding the steering on the stop, or by holding the brake pedal with 45 kg (100 pounds) of force for five seconds with the engine running at idle. Turn the engine off. Eight to twelve hours later depress the brake pedal with the engine off. There should be some degree of power reserve.

If there is no power reserve replace the Hydro-Boost unit.

Seal Leak Diagnosis

Possible sources of leakage from the Hydro-Boost unit are:

- Input seal
- Piston seal
- Housing seal
- Spool valve seal
- Accumulator cap seal
- Return port fitting seal



Diagnosis Guide

Preliminary Inspection

Road test the vehicle (if possible) to verify the complaint. Perform the preliminary inspection as listed below.

1. Check the power steering fluid level and condition.
2. Check the brake fluid level and condition.
3. Check the power steering pump belt for tension, glazing, and cracks.
4. Check the power steering hoses for leaks.
5. Check the brake pedal linkage for binding or sticky operation.

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DIAGNOSIS GUIDES

HYDRO-BOOST DIAGNOSIS GUIDE
NO POWER ASSIST

TEST STEP		RESULT ▶	ACTION TO TAKE
A0	VERIFY CONDITION		
	• Road test the vehicle and check for booster operation.	(OK) ▶	Vehicle OK.
		(OK) ▶	GO to **A1**.
A1	FLUID LEVEL		
	• Check power steering pump fluid level.	(OK) ▶	GO to **A2**.
		(OK) ▶	Check Hydro-Boost leak points, add fluid. REPEAT test **A0**.
A2	BELT CHECK		
	• Check the power steering belt tension, and condition.	(OK) ▶	GO to **A3**.
		(OK) ▶	ADJUST belt tension. REPEAT test **A0**.
A3	PUMP SPEED		
	• Check engine idle speed against specifications.	(OK) ▶	GO to **A4**.
		(OK) ▶	SET engine idle speed to specifications. REPEAT test **A0**.
A4	PUMP FLOW AND RELIEF		
	• Test the power steering pump for proper flow and relief pressure (Section 13-53).	(OK) ▶	REPLACE booster.
		(OK) ▶	REPAIR or REPLACE pump. REPEAT test **A0**.

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DIAGNOSIS GUIDES (Continued)

HYDRO-BOOST DIAGNOSIS GUIDE — Continued
ERRATIC OPERATION — STICKS, BINDS, OR GRABS

TEST STEP	RESULT	ACTION TO TAKE
B0 VERIFY COMPLAINT • Road test the vehicle, check operation.	OK	Vehicle OK.
	Not OK	GO to **B1**.
B1 PEDAL OPERATION • Perform the brake pedal operation test, as outlined in this section.	Pedal is free	GO to **B2**.
	Pedal binds	CORRECT pedal linkage binding. REPEAT test **B0**.
B2 HOSE CHECKS • Check for obstructions in the return line and connections between the Hydro-Boost and pump reservoir.	OK	GO to **B3**.
	Not OK	REMOVE obstruction or REPLACE line. REPEAT test **B0**.
B3 BOOSTER OPERATION • Check the brake fluid in the reservoir while rapidly applying the brake pedal one inch.	Brake fluid shows some movement or spouting	System OK.
	No fluid movement	REPLACE Hydro-Boost unit.

CH6270-2A

Adjustments

Bleeding the Hydro-Boost Unit

1. Fill the pump reservoir with Ford Automatic Transmission Fluid, ESP-M2C138-CJ, DEXRON II®, or equivalent.
2. Crank the engine for several seconds, with the coil wire disconnected (do not start the engine).
3. Check the fluid level, and add if necessary.
4. Start the engine.
5. With the engine running, turn the wheels lock to lock two times. Turn the engine off.
6. Depress the brake pedal several times to discharge the accumulator.
7. Repeat Steps 4 and 5.
8. If foaming occurs, stop the engine and allow the foam to dissipate.
9. Repeat Steps 4 and 5 as required, until all the air is removed from the system.

NOTE: The Hydro-Boost is generally self-bleeding, and the above procedure will normally bleed the air from the booster. Normal operation of the vehicle will further remove any additional trapped air.

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REMOVAL AND INSTALLATION

Removal

1. With the engine off, depress the brake pedal several times to discharge the accumulator.
2. Remove the master cylinder from the Hydro-Boost unit. Prop the master cylinder up and out of the way.

CAUTION: Do not apply the booster with the master cylinder removed.

3. Disconnect all three hydraulic lines from the booster.
4. Disconnect the input pushrod from the brake pedal assembly.
5. Remove the booster mounting nuts, and remove the booster from the vehicle.

CAUTION: The booster should not be carried by the accumulator, nor should it ever be dropped on the accumulator. The snap ring on the accumulator should be checked for proper seating before the booster is used. The accumulator contains high pressure nitrogen gas and can be dangerous if mishandled.

CAUTION: If the accumulator is to be disposed of it must not be exposed to excessive heat, fire or incineration. Before discarding the accumulator, drill a 1/16 inch diameter hole in the end of the accumulator can to relieve the gas pressure. Always wear safety glasses when performing this operation.

Installation

1. Install the booster in the vehicle and tighten the mounting nuts to 25-33 N·m (18-25 ft-lbs.).
2. Connect the input pushrod to the brake pedal assembly.
3. Position the master cylinder against the booster and tighten the mounting nuts to 25-33 N·m (18-25 ft-lbs.).
4. Connect the three hoses to the Hydro-Boost unit. Refill the system and bleed as required.

DISASSEMBLY AND ASSEMBLY

The Hydro-Boost power brake booster is not to be disassembled and is to be serviced as a unit.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	Torque	
	N·m	Ft-Lb.
Booster Mounting Nuts	25-33	18-25
Booster Cover to Booster Body	30-32	22-24
Bracket to Booster Nut	149-155	110-114
Master Cylinder to Booster Nuts	25-33	18-25

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SECTION 12-70 Parking Brake—Cable Actuated, Rear Wheels and Transmission Mounted

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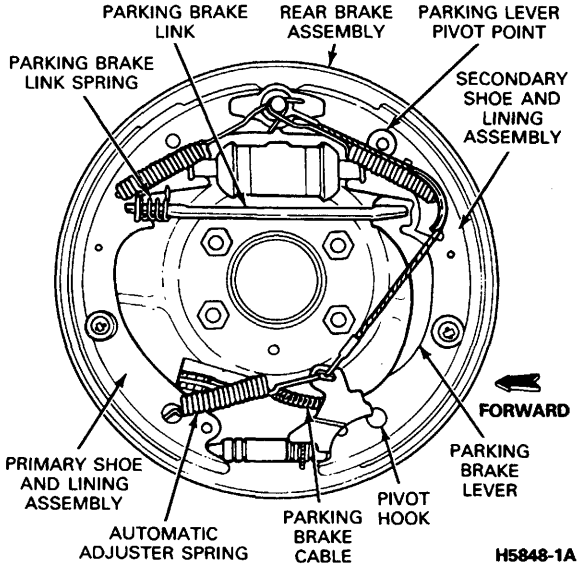
VEHICLE APPLICATION

Applies to Bronco, E-150—E-350, F-150—F-350, and F-Super Duty Trucks. /h3/DESCRIPTION

Cable Actuated Rear Wheel Parking Brake

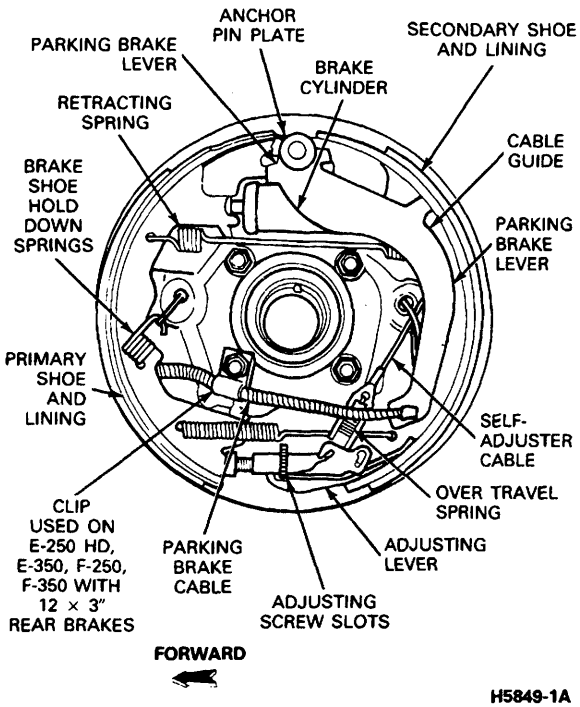
On F-150—F-350, E-150—E-350 and Bronco, each rear wheel brake assembly contains a cable actuated parking brake assembly.

PARKING BRAKE ASSEMBLY – E-150, F-150 AND BRONCO



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PARKING BRAKE ASSEMBLY – E-250, E-350, F-250, F-350 REAR BRAKES – WEB LEDGE BRAKE

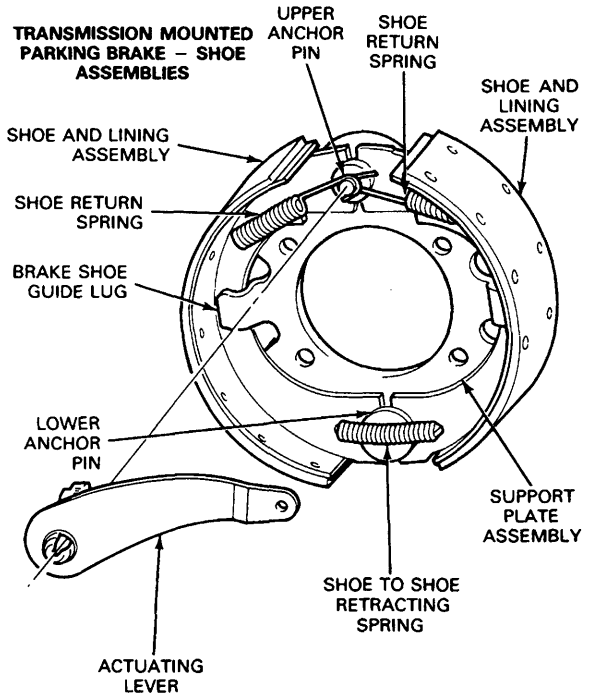


H5849-1A

Cable Actuated Transmission Mounted Parking Brake

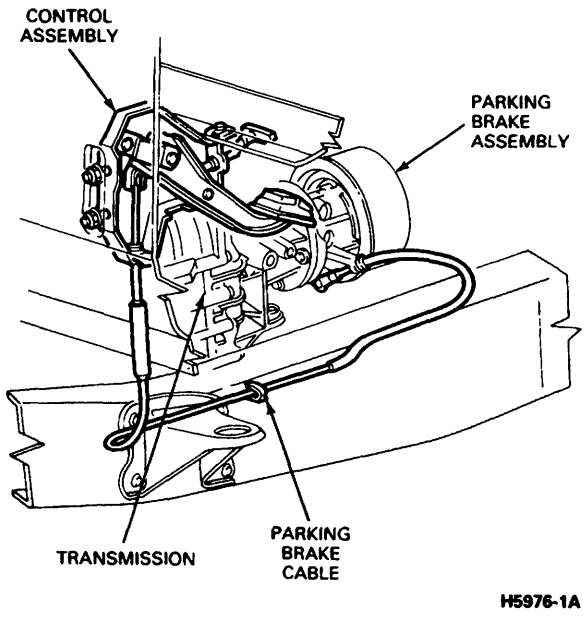
On the F-Super Duty vehicle the parking brake assembly is attached to the rear of the transmission and is connected by the driveshaft to the rear axle. The parking brake cable connects the parking brake control assembly to the parking unit mounted on the transmission extension housing.

TRANSMISSION MOUNTED PARKING BRAKE – SHOE ASSEMBLIES



H5850-1A

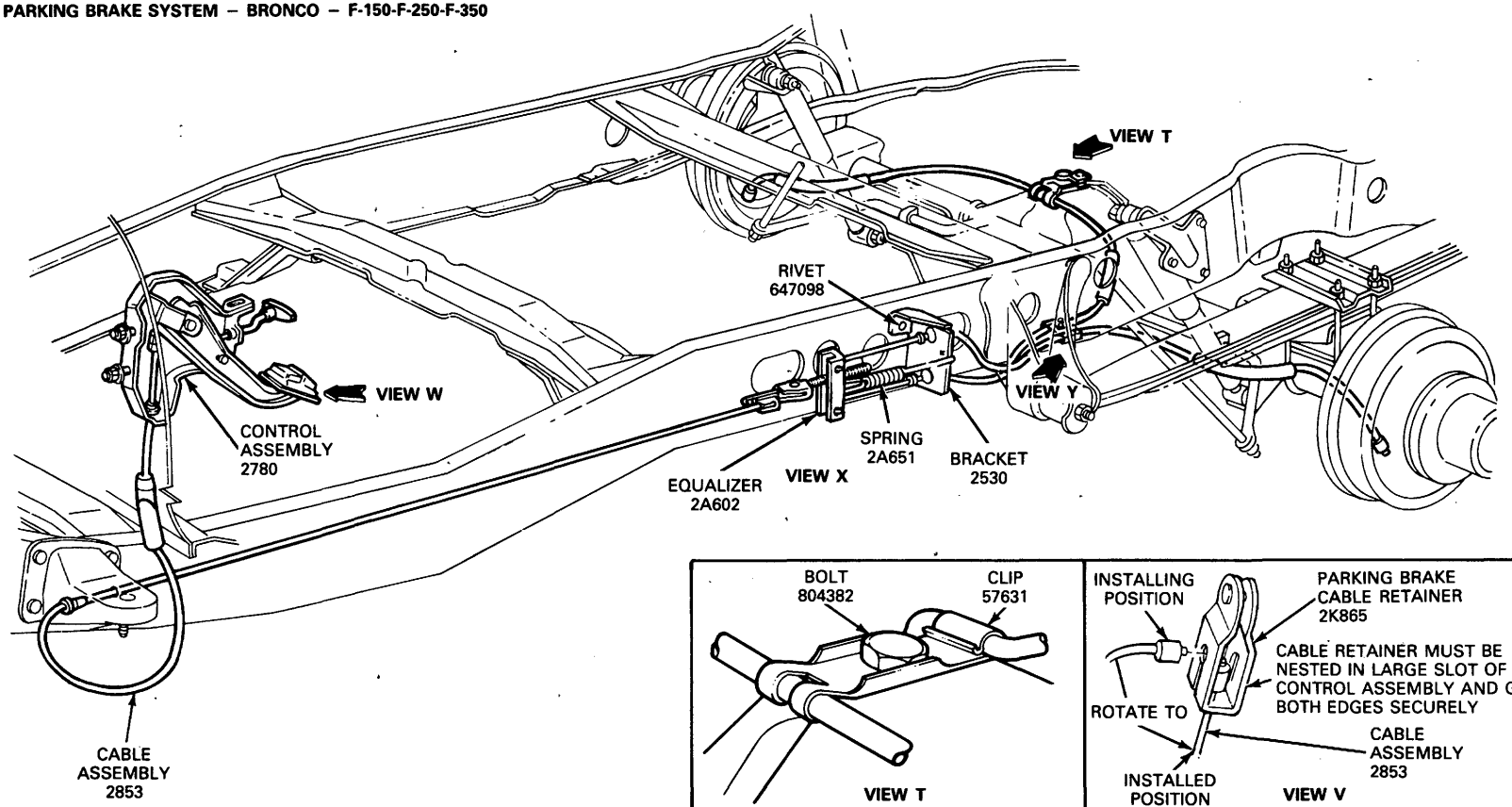
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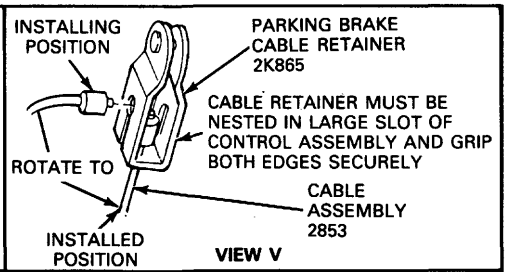


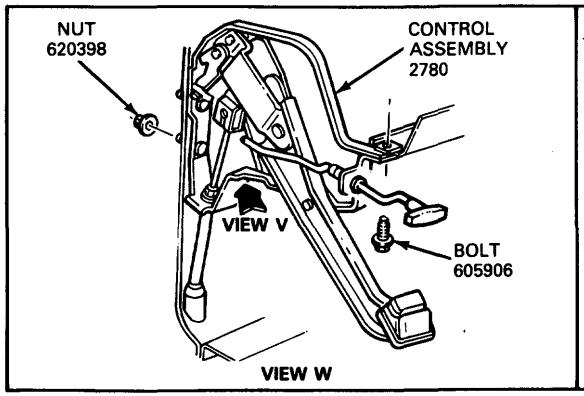
On F-150—F-350, E-150—E-350 and Bronco, the manually operated parking brake lever cable is routed to the equalizer lever which connects to the parking brake lever assembly in each rear wheel, through the equalizer assembly and brake cables.

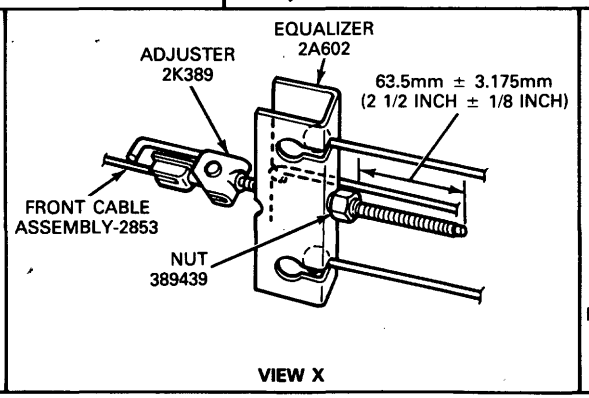
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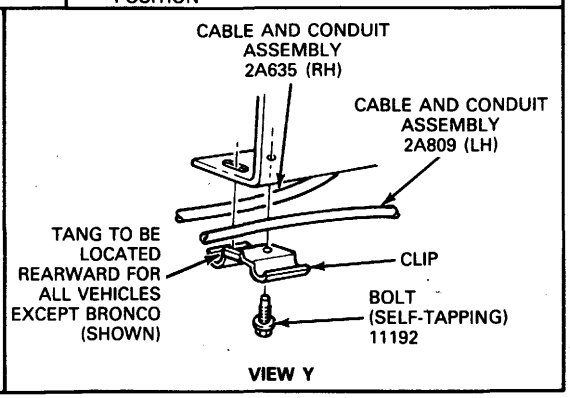
PARKING BRAKE SYSTEM – BRONCO – F-150-F-250-F-350





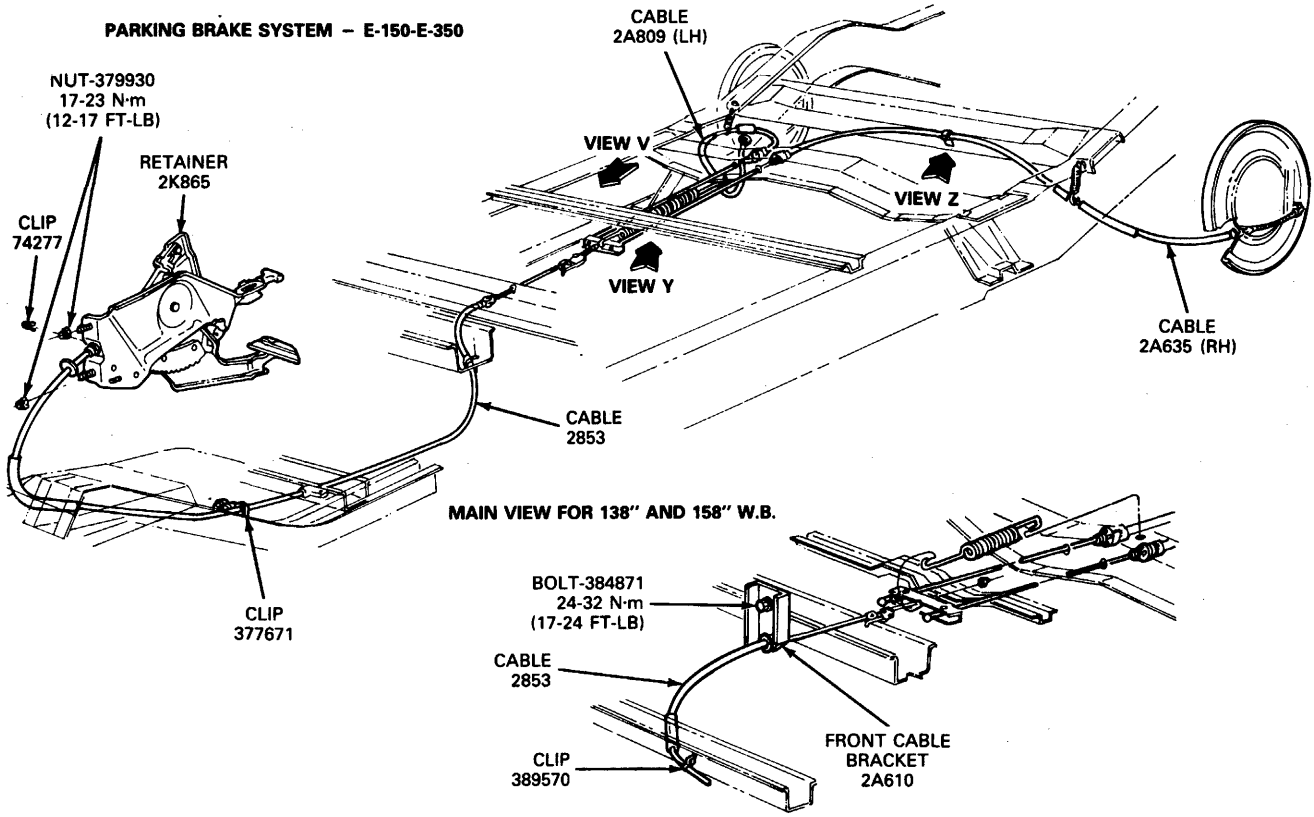


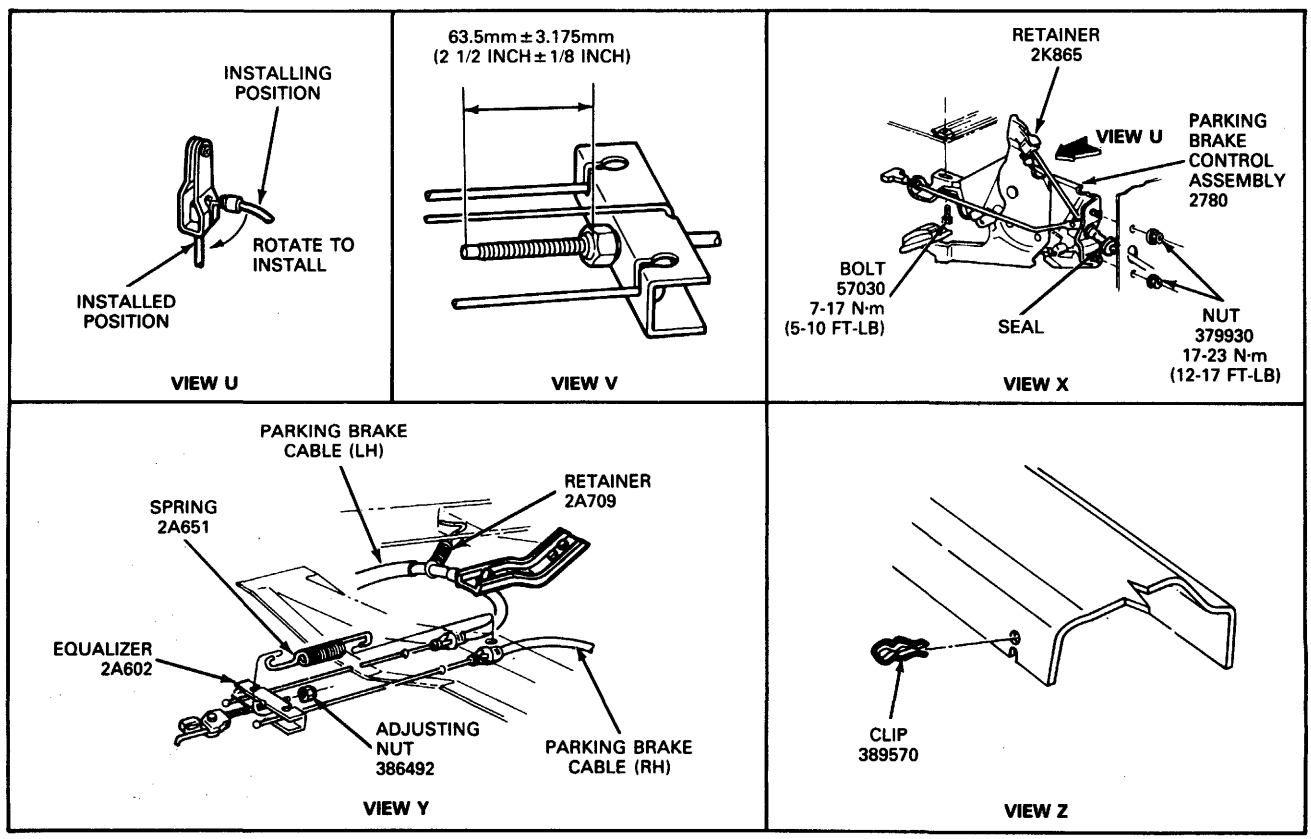




H2877-2F

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H2090-2L

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DIAGNOSIS AND TESTING

Refer to Section 12-01, General Hydraulic Brake Service for diagnostic and testing procedures.

ADJUSTMENTS

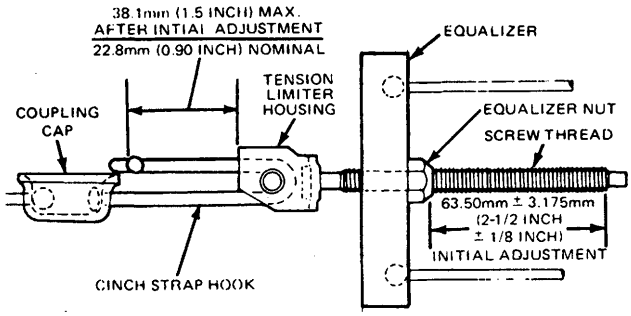
Cable Actuated Rear Wheel Parking Brake

F-150—F-350, Bronco, E-150—E-350 with Foot Operated Parking Brake Control

Adjust the drum brakes before adjusting the parking brake cables. Refer to the Adjustments portion of Section 12-02, Drum Brakes—Single Cylinder, Dual Piston.

Initial Adjustment Procedure All Light Trucks (Use this procedure when a new Tension Limiter is installed).

1. Depress the parking brake pedal fully to the last detent position.
2. Grip the Tension Limiter housing to prevent it from spinning and tighten the equalizer nut 63.50mm ± 3.175mm (2 1/2 inch ± 1/8 inch) up the rod.
3. Check to make sure cinch strap has slipped (less than 34.925mm or 1 3/8 inch remaining).



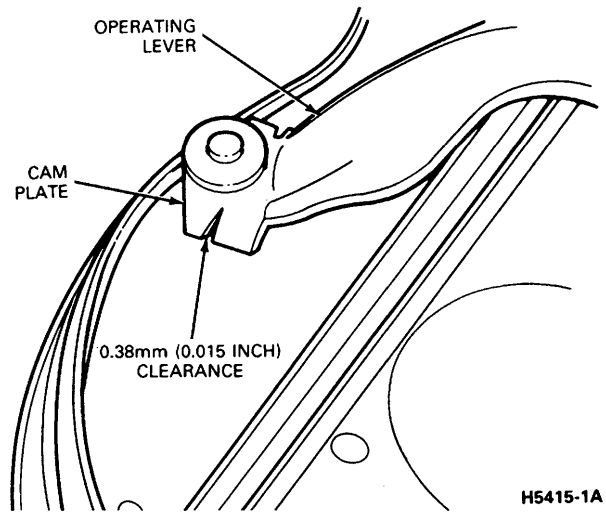
CABLE TENSION LIMITER ASSEMBLY

H2876-1E

Field Adjustment All Light Trucks (Use this procedure to correct a slack system if new Tension Limiter is not installed.)

E-150—E-350, F-150—F-350, Bronco

1. Make sure brake drums are cold for correct adjustment.
2. Release the parking brake control.
3. Grip the Tension Limiter housing to prevent it from spinning and tighten the equalizer nut 6 full turns past its original position on the threaded rod.
4. Fully depress pedal to the last detent position and check for proper rear cable tension of 1556 N or (350 lbs). If tension is low repeat steps 2 and 3.
5. Release parking brake and check for rear wheel drag.
6. If rear wheel brake drag is noted after adjustment on E-250—E-350 and F-250—F-350 (with web ledge rear brakes) the rear drums must be removed after the service and parking brakes have been adjusted. Check the clearance between the parking brake lever and the cam plate. The clearance should be 0.38mm (0.015 inch) with the brakes fully released. If the clearance is not within specifications, readjust the parking brake cable.



H5415-1A

NOTE: The Tension Limiter will reset the parking brake tension anytime the system is disconnected provided the distance between the bracket and the cinch strap hook is reduced during adjustment. When the cinch strap hook contacts the bracket, the system tension will increase significantly and over tensioning may result. If all available adjustment travel has been used, the tension limiter must be replaced.

7. Place the parking brake pedal in the fully released position, then check the slack in the parking brake two rear cables.

The cables should be tight enough to provide full application of the rear brake shoes, when the parking brake lever or foot pedal is placed in the fully applied position, yet loose enough to ensure complete release of the brake shoes when the lever is in the released position.

Cable Actuated Rear Wheel Parking Brake E-350 (Stripped Chassis)

Orscheln Parking Brake Lever

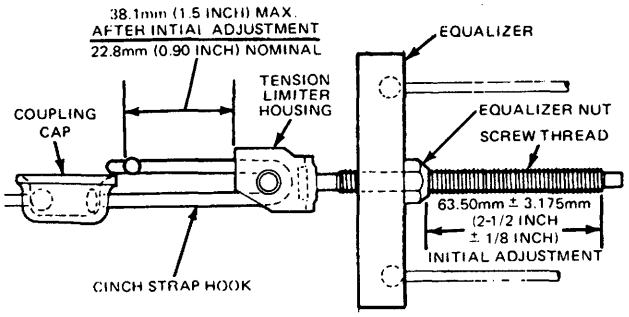
Adjust the drum brakes before adjusting the parking brake cables. Refer to the Adjustments portion of Section 12-02, Drum Brakes—Single Cylinder, Dual Piston.

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ADJUSTMENTS (Continued)

Initial Adjustment Procedure (Use this procedure when a new Tension Limiter is installed)

1. Turn the Orscheln parking brake handle adjustment knob clockwise to maximum travel and position the handle to the 'ON' position.
2. Grip the tension limiter housing to prevent it from spinning and tighten the equalizer nut 63-50mm ± 3.175mm (2 1/2 inch ± 1/8 inch) up the rod.

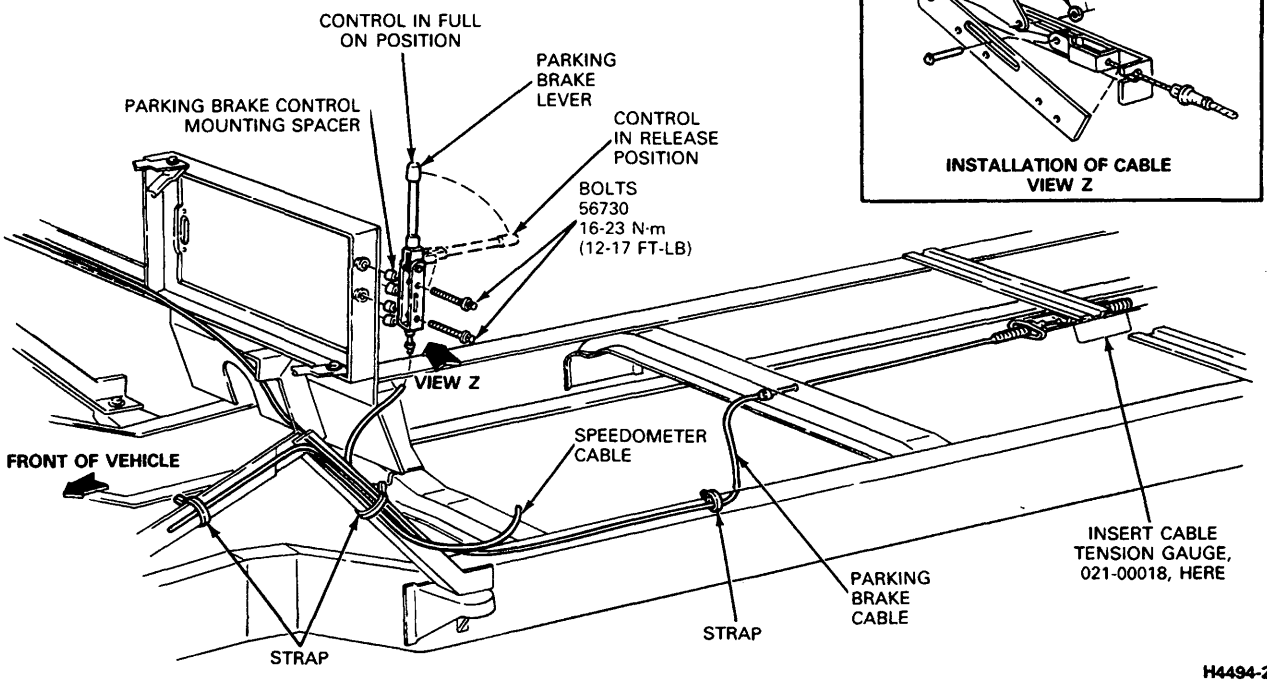


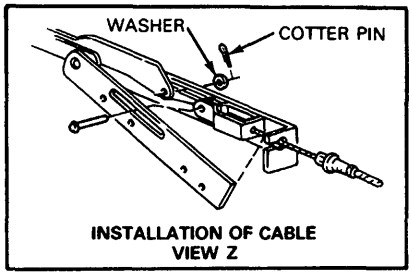
CABLE TENSION LIMITER ASSEMBLY

H2876-1E

3. Check to make sure the cinch strap has slipped (less than 34.925mm or 1 3/8 inch remaining).
4. Release the parking brake handle to the 'OFF' position.
5. Back off the parking brake handle adjustment knob counter-clockwise to meet Cable Tension Gauge, 021-00018. (Reference dimension 63.5mm ± 3.175mm or 2 1/2 inch ± 1/8 inch.
6. With the parking brake lever in the full 'ON' position, the front parking brake cable tension should be a minimum of 1556 N (350 lbs).

PARKING BRAKE SYSTEM – E-350 WITH ORSCHELN PARKING BRAKE LEVER (STRIPPED CHASSIS MODEL)





INSTALLATION OF CABLE VIEW Z

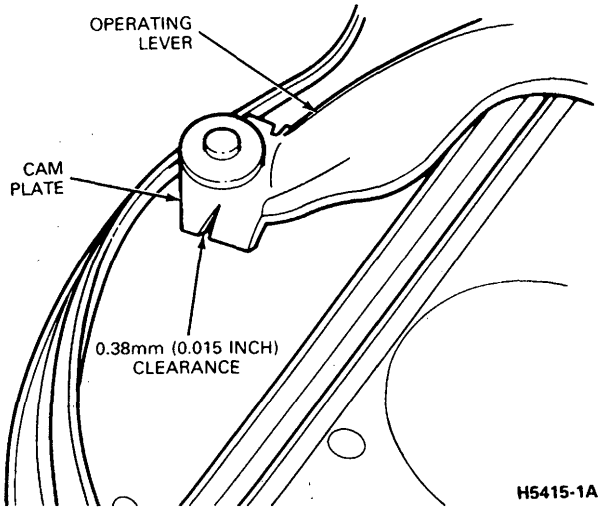
H4494-2C

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ADJUSTMENTS (Continued)

Field Adjustment (Use this procedure to correct a slack system if a new Tension Limiter is not installed)

1. Make sure brake drums are cold for correct adjustment.
2. Place handle in the 'ON' (brake applied) position.
3. Grip the tension limiter housing to prevent it from spinning. Tighten the equalizer nut until the front cable tension measures 1556 N (350 lbs).
4. Place the handle in the released position then re-apply the parking brake system. Check that the front cable tension is at least 1378 N (310 lbs).
5. Release the parking brake and check for rear wheel drag.
6. If rear wheel brake drag is noted after adjustment, the rear drums must be removed after the service and parking brakes have been adjusted. Check the clearance between the parking brake lever and the cam plate. The clearance should be 0.38mm (0.015 inch) with the brakes fully released. If the clearance is not within specifications, readjust the parking brake cable.



NOTE: The Tension Limiter will reset the parking brake tension anytime the system is disconnected provided the distance between the bracket and the cinch strap hook is reduced during adjustment. When the cinch strap hook contacts the bracket, the system tension will increase significantly and over tensioning may result. If all available adjustment travel has been used the tension limited must be replaced.

7. Place the parking brake pedal in the fully released position, then check the slack in the parking brake two rear cables.

The cables should be tight enough to provide full application of the rear brake shoes, when the parking brake lever or foot pedal is placed in the fully applied position, yet loose enough to ensure complete release of the brake shoes when the lever is in the released position.

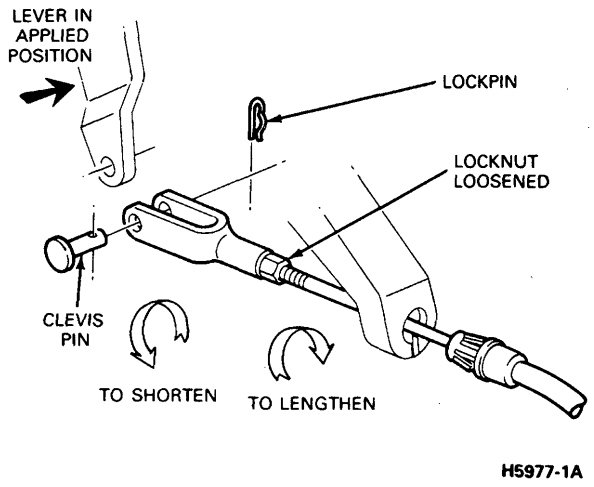
Cable Actuated Transmission Mounted Parking Brake

F-Super Duty

Field Adjustment

Use this adjustment to correct excessive parking brake control pedal travel.

1. Raise the vehicle on a twin post hoist and install safety stands.
2. Place the transmission in neutral, and release the parking brake.
3. Loosen the parking brake adjusting clevis jam nut several turns (spray the adjusting nut, threaded rod and the clevis with penetrating oil to ease adjustment).



4. Remove the locking pin and the clevis pin from the adjusting clevis.
5. While the lever is being held tight in the applied position, screw the clevis (clockwise) onto the threaded end of the cable until the clevis pin can be inserted freely into the clevis and the brake actuating lever while the lever is being held tight in the applied position, and the cable is tight.
6. Remove the clevis pin. Rotate the clevis 1O full turns in a counterclockwise (loosening) direction (about 1/2 inch). Install the clevis pin into position. Install the locking pin and tighten the clevis jam nut tight against the clevis. Recheck rotation of the driveshaft for freedom from drag.
7. Remove the safety stands and lower the vehicle down off the hoist.

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ADJUSTMENTS (Continued)

High Pedal Efforts

E-150—E-350, F-150—F-350 and Bronco

1. Make sure the brake drums are cold for correct adjustment.
2. Depress the parking brake pedal all the way to the floor to the fully applied position.
3. Release the parking brake pedal and repeat Step No. 2. Release the parking brake.

NOTE: Trucks that have a cable system that incorporates a 'tension limiter'. Depressing the pedal to the floor will automatically set the proper tension and pedal feel.

On F-Super Duty Trucks inspect the operation of the transmission mounted parking brake.

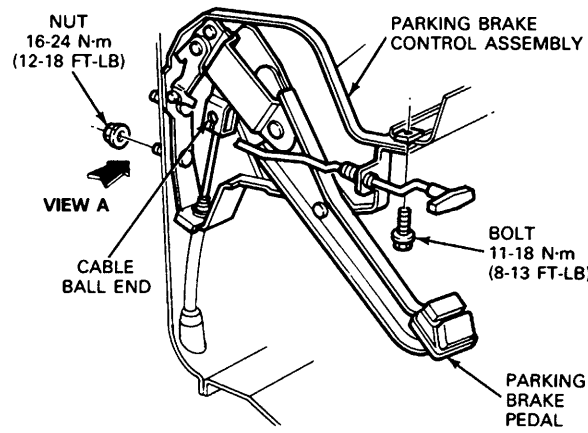
REMOVAL AND INSTALLATION

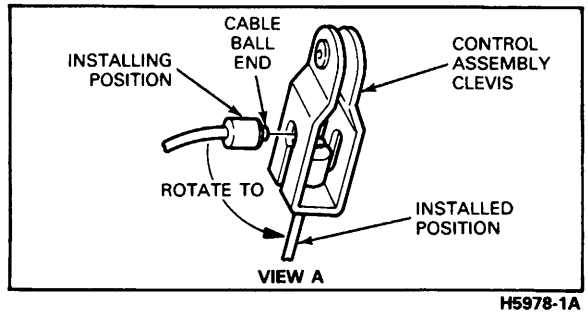
Parking Brake Control

F-150—F-350, E-150—E-350, Bronco and F-Super Duty

Removal

1. Loosen the adjusting nut at the equalizer.
2. Working from the engine compartment, remove the nuts attaching the parking brake control assembly to the dash panel.
3. Working under the instrument panel, remove the bolt attaching the control assembly to the lower flange of the instrument panel.
4. Remove the parking brake cable from the control assembly clevis by compressing the conduit end fitting prongs (using a 1/2 inch box wrench) holding the cable assembly to the control, remove the cable from the control. Remove the control.





H5978-1A

Installation

1. Connect the forward ball end of the parking brake cable to the clevis of the control assembly, and insert the cable assembly into the control assembly. Install hair pin retainer.
2. Position the control assembly on the lower flange of the instrument panel and install the attaching bolt.
3. Working from the engine compartment, install and tighten the nuts that attach the parking brake control assembly to the dash panel 20.3 N·m (15 ft-lbs) torque.
4. Adjust the parking brake equalizer lever to its original position. Check cable tension and adjust if necessary, as described in this Section.

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REMOVAL AND INSTALLATION (Continued)

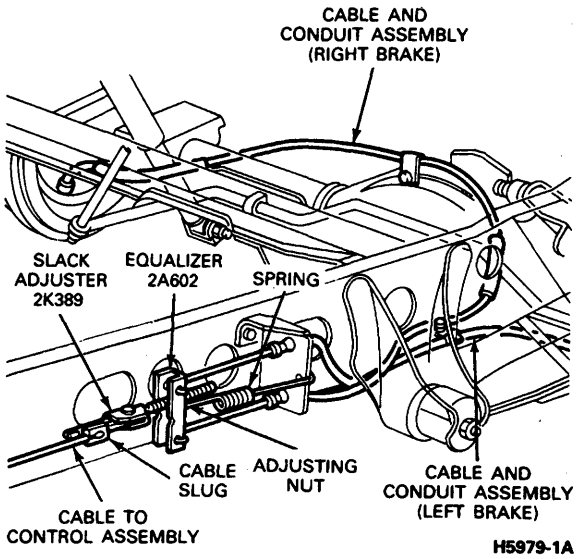
Parking Brake Equalizer to Control Assembly Cable

F-150—F-350, E-150—E-350, Bronco

Removal

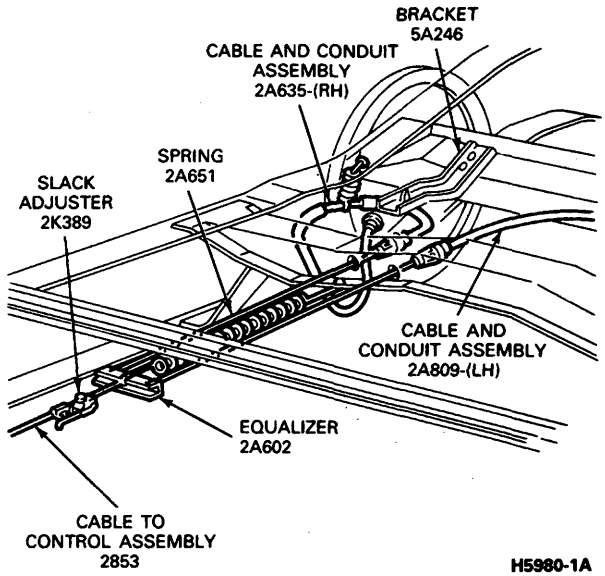
1. Raise the vehicle on a hoist. Back off the equalizer nut and remove slug of front cable from the tension limiter.
2. Remove the parking brake cable from the cab mount (F-Series and Bronco) or crossmember (Econoline) and all retaining clips.
3. Lower the vehicle. Remove the forward ball end of the parking brake cable from the control assembly clevis.
4. Remove the cable from the control assembly by compressing the conduit end fitting prongs (use 1/2 inch box wrench).
5. Using a fish wire or cord attached to the control lever end of the cable, remove the cable from the vehicle.

EQUALIZER INSTALLATION
F-150 – F-350 AND BRONCO – TYPICAL



H5979-1A

EQUALIZER INSTALLATION E-150 – E-350 – TYPICAL



H5980-1A

Installation

1. Transfer the fish wire or cord to the new cable. Position the cable in the vehicle, routing the cable through the dash panel. Remove the fish wire and secure the cable to the control.
2. Connect the forward ball end of the brake cable to the clevis of the control assembly. Raise the vehicle on a hoist.
3. Route the cable through cab mount (F-Series) or through the cross members (Econoline) and secure in place with retaining clips (Econoline).
4. Connect the slug of the cable to the Tension Limiter connector. Adjust the parking brake cable at the equalizer using initial adjustment or field adjustment, as appropriate.
5. Rotate both rear wheels to be sure that the parking brakes are not dragging.

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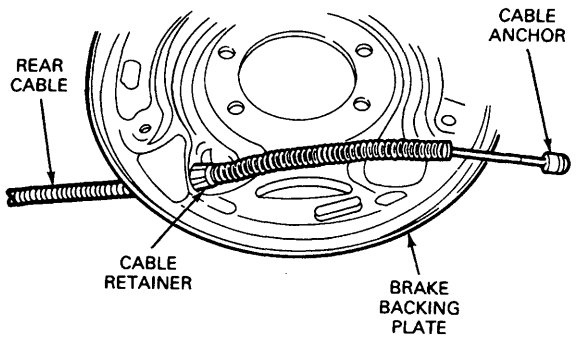
REMOVAL AND INSTALLATION (Continued)

Parking Brake Equalizer to Rear Wheel Cable

F-150—F-350, E-150—E-350, Bronco

Removal

1. Raise the vehicle and remove the hub cap, wheel, Tension Limiter and brake drum. Remove the locknut on the threaded rod and disconnect the cable from the equalizer.
2. Compress the prongs that retain the cable housing to the frame bracket (F-Series and Bronco) or crossmember (Econoline), and pull the cable and housing out of the bracket or crossmember.
3. Working on the wheel side compress the prongs on the cable retainer so they can pass through the hole in the brake backing plate. Draw the cable retainer out of the hole.



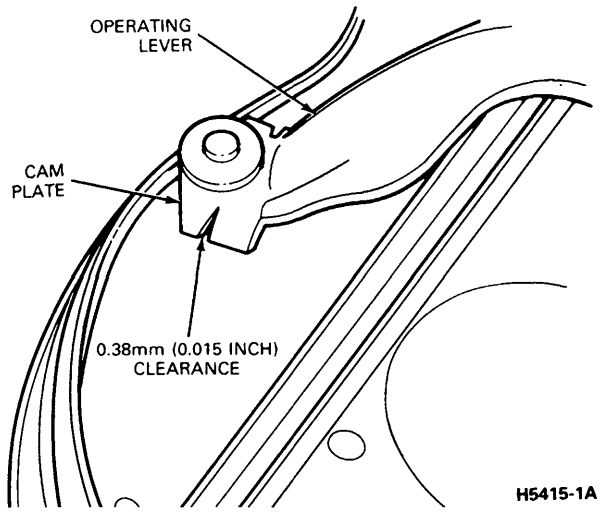
H5981-1A

4. With the spring tension off the parking brake lever, lift the cable out of the slot in the lever, and remove the cable through the brake backing plate hole.

Installation

1. Pull the cable through the brake backing plate until the end of the cable is inserted over the slot in the parking brake lever. Pull the excess slack from the cable and insert the cable housing into the brake backing plate access hole until the retainer prongs expand.
2. Insert the front end of the cable housing through the frame crossmember bracket until the prong expands. Insert the ball end of the cable into the key hole slots on the equalizer, rotate the equalizer 90° and recouple the Tension Limiter threaded rod to the equalizer.

   On **vehicles with web ledge brakes,** check the clearance between the parking brake operating lever and cam plate. The clearance should be 0.38mm (0.015 inch) when the brakes are fully released.



H5415-1A

3. Install the rear brake drum, wheel, and hub cap, and adjust the rear brake shoes.
4. Adjust the parking brake tension using initial adjustment or Field Adjustment procedure as outlined in this Section.
5. Rotate both rear wheels to be sure that the parking brakes are not dragging.

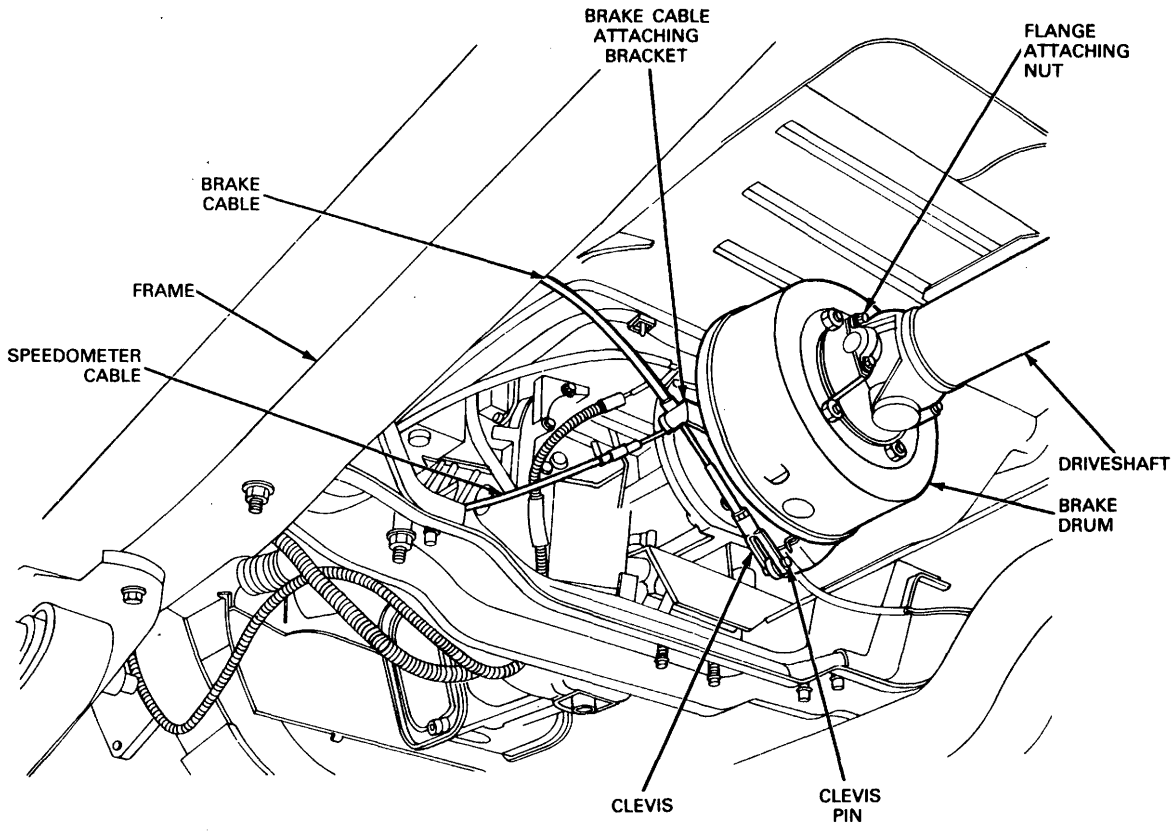
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DESCRIPTION AND OPERATION

Description

Transmission Mounted Parking Brake Assembly—ZF

F-Super Duty Vehicles



A transmission mounted manually operated parking brake is used on F-Super Duty vehicles.

It is mounted to the transmission extension housing and it incorporates a case assembly and a cable actuated 9 x 3 inch Bendix brake assembly.

The case assembly consists of opposed mounted roller bearings, companion flange and mainshaft assembly installed in a one piece aluminum housing. The speedometer and speedometer cable assembly are driven by the speedometer drive gear, splined to the mainshaft.

Operation

The manually activated brake assembly is controlled from the driver's side of the cab by means of a pedal operated control cable.

DIAGNOSIS AND TESTING

Refer to the trouble shooting chart at the end of this Section for Diagnosis and Testing Procedures.

ADJUSTMENTS

Refer to the appropriate areas outlined in this Section.

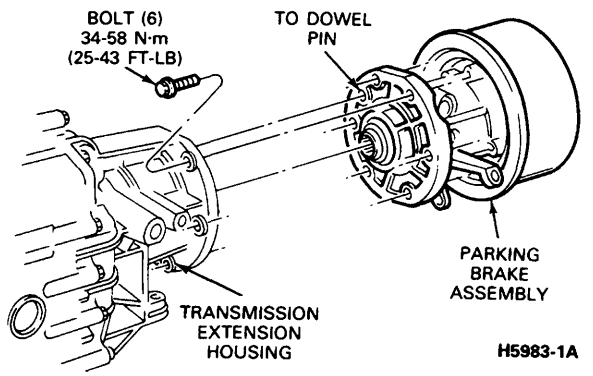
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ADJUSTMENTS (Continued)

Transmission Mounted Parking Brake Assembly—F-Super Duty

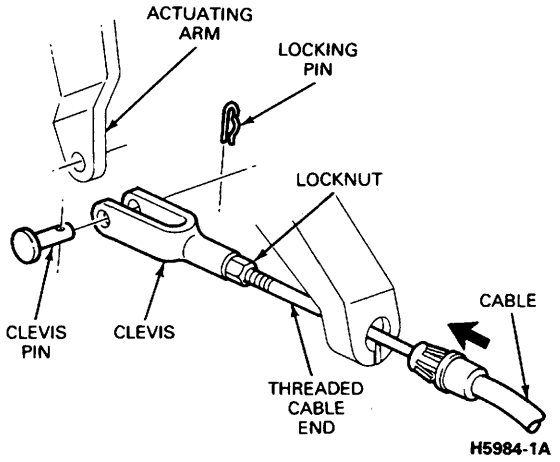
Removal

1. Place the transmission into gear and release the parking brake control cable. The pedal must be in the fully released position.
2. Raise the vehicle on a twin post hoist and install safety stands.
3. Disconnect and remove the speedometer cable from the left hand side of the parking brake assembly.
4. Apply penetrating oil to the adjusting clevis, jam nut and the threaded end of the brake cable.
5. Loosen the jam nut and remove the locking pin from the clevis pin. Remove clevis pin, clevis, and jam nut from the brake cable. Remove cable from the bracket on the case.
6. Remove the bolts attaching the drive shaft to the parking brake assembly output flange. Remove the driveshaft and move it to one side out of the way. Wire it up to the frame.
7. Remove the 6 hex head bolts attaching the parking brake assembly to the transmission extension housing and remove the complete parking brake assembly from the transmission.

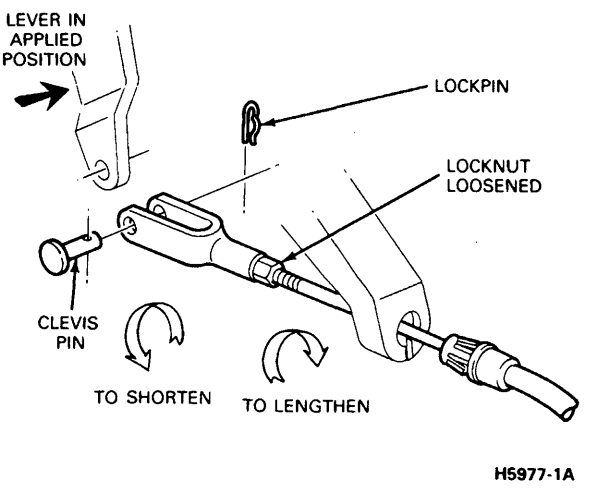


Installation

1. With the parking brake assembly in the as installed position, fill the parking brake assembly with Ford transmission fluid (Type H) ESP-M2C166H lubricant to the bottom of the filler hole. Install and tighten the filler plug to 59-63 N·m (43-47 ft-lb).
2. Using two guide bolts or drift pins, attach the parking brake assembly to the transmission splined output shaft, and transmission extension housing.
3. Install 6 new hex head bolts to attach parking brake assembly to the transmission extension housing (Do not reuse old bolts). Tighten the bolts to 34-58 N·m (25-43 ft-lbs).
4. Attach the driveshaft to the output flange, and tighten the bolts to 20-27 N·m (15-20 ft-lbs).
5. Install the parking brake cable into the mounting bracket, and snap into position.



6. Screw the jam nut and adjusting clevis onto the threaded end of the brake cable.



7. Screw the clevis clockwise (tightening) until the clevis pin can be inserted freely into the clevis and the brake actuating lever, while the lever is being held tight in the applied position, and the cable is held tight.
8. Remove the clevis pin. Rotate the clevis 10 full turns in the counter clockwise (loosening) direction (about 1/2 inch).

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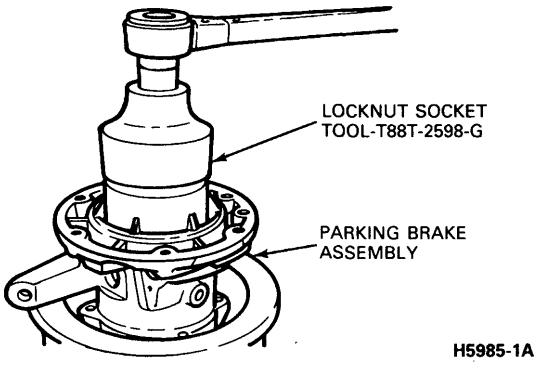
DISASSEMBLY AND ASSEMBLY

Transmission Mounted Parking Brake

Disassembly

NOTE: To replace the brake assembly, brake shoe and lining assemblies, or other operational components the complete parking brake assembly must be removed from the vehicle.

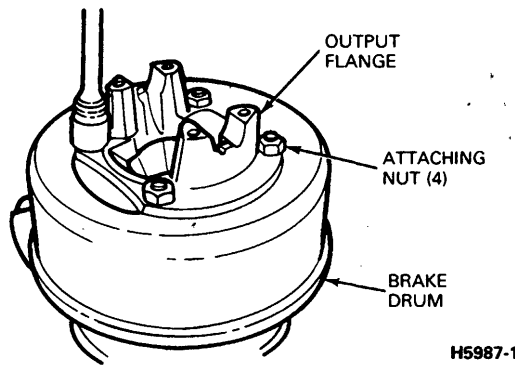
1. Remove the parking brake assembly as outlined in Removal and Installation—Transmission Mounted Parking Brake, in this Section.
2. Remove the 4 bolts holding the yoke flange and drum. Remove the yoke flange and drive.
3. Using Tool T88T-2598-G remove the 75mm hex locknut from the mainshaft.



H5985-1A

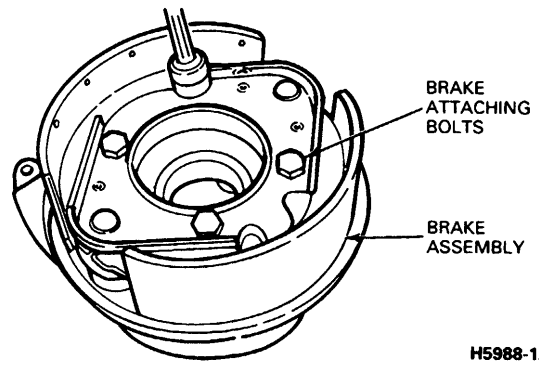
4. Using a suitable press, remove the mainshaft, brake drum and output flange out of the case assembly.
5. Remove the snap ring retaining the speedometer drive onto the shaft. Remove the speedometer drive gear.
6. Using puller D80L-1002-2 with bearing cone remover D79L-4621-A and stop plate D80L-630-6, remove the outer bearing cone from the mainshaft.
7. Remove the output shaft and brake assembly from the vise. Turn the shaft assembly over and put the threaded end in the vise. Be sure to use soft jaw inserts to protect the mainshaft.
8. Remove the 4 hex nuts attaching the flange and brake drum to the output shaft. Remove the drum and flange from the output shaft.

NOTE: The drum, yoke/flange, and mainshaft are balanced as a unit, and must be marked to assure that they are assembled in the same position. Leave the bolts in the output flange.



H5987-1A

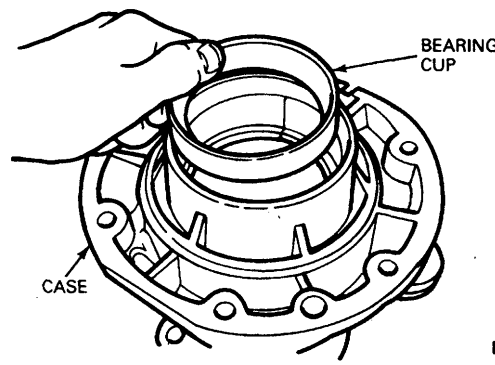
9. Remove the input shaft oil seal, spacer, O-ring, bearing cone assembly and bearing cup from the input shaft end of the case using tool number T77F-1102-A, or equivalent.
10. Remove the 4 bolts attaching the splash shield and brake assembly to the case. Remove the brake assembly and splash shield from the case.



H5988-1A

11. Remove the brake actuating lever and the lever spring from the case.

NOTE: For brake assembly component repair, refer to brake component repair in this Section.



H5989-1A

12. Using tool T77F-1102-A remove the outer bearing cup. The bearing removal will remove the oil seal.
13. Unscrew and remove the vent from the case.

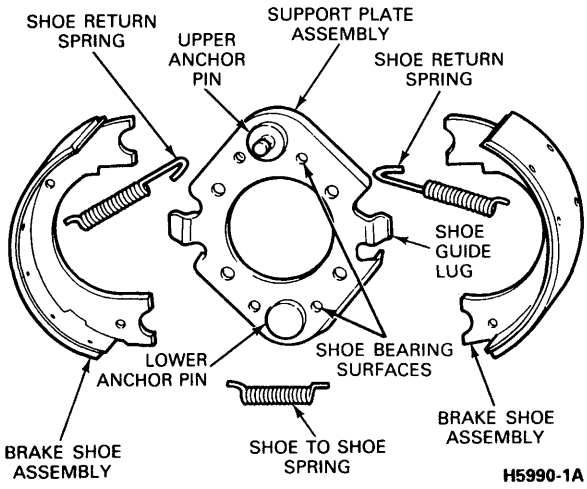
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DISASSEMBLY AND ASSEMBLY (Continued)

Brake Shoes

Disassembly

1. Holding the brake assembly securely, remove the two brake shoe return springs using a suitable brake spring tool.
2. Spread the free ends of the brake shoes apart and remove the brake shoes from the lower anchor pin. Remove the shoe-to-shoe spring.
3. Clean any grease or contamination from the support plate. Remove contamination from the shoe guide lugs and other shoe bearing surfaces with sand paper.

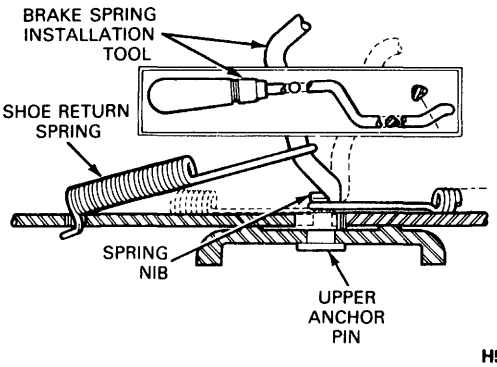


4. Coat the following areas with Ford Disc Brake Caliper Slide Grease D7AZ-19590-A. Use only a light application of grease at these points.
   - Camshaft lugs and ball of actuating lever.
   - Shoe guide lugs and shoe bearing points of the support plate assembly.
   - Upper and lower anchor pins.
   - Anchor pin contact points of the brake shoes.

Brake Shoes

Assembly

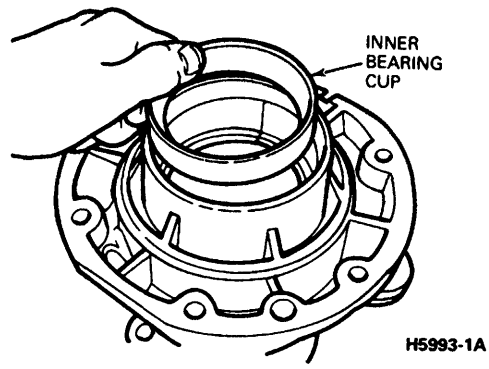
1. Using new brake shoe and lining assemblies, install new shoe-to-shoe springs into the lower holes of the brake shoes.
2. Spread the opposite ends of the shoes and assemble the lower ends of the shoes over the shoulder of the lower anchor pin, twisting the shoes into position. Move the upper ends of the shoes to the upper anchor pin, inserting the shoe webs between the shoe guide lugs and the bearing surfaces of the support plate.
3. With the upper ends of the shoes against the upper anchor pin, install two new shoe return springs. Install the short hooked end of each spring into the upper holes of the brake shoes and hook the opposite end of each spring over the anchor pin nib, using a suitable spring installation tool. Be sure the open end of the spring hook faces toward the brake centerline.



Transmission Mounted Parking Brake

Assembly

1. Press the plug into the output flange if plug was previously removed. Apply sealer to the lip of the plug. Press into place with the lip of the plug facing outward. The plug must be flush with the edge of the bore.
2. Install the inner bearing cup into the bore in the case using tool T88T-2598-D, or equivalent. Press the cup into the case until it bottoms in the bore.

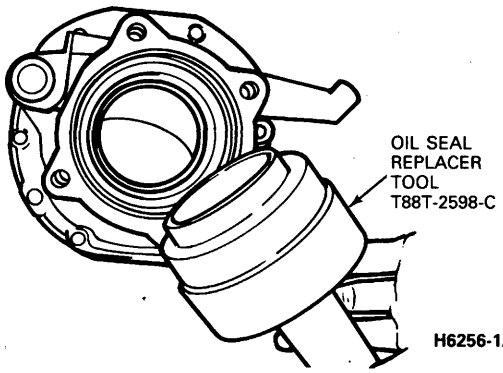


3. Turn the case over and install the outer bearing cup into the case. Press in using tool T88T-2598-E (or equivalent) until the bearing cup bottoms in the bore.
4. Install the outer bearing cone assembly into the cup.

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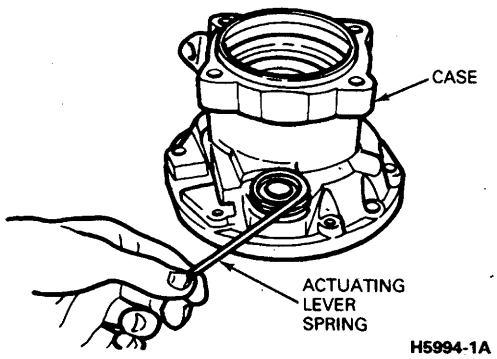
DISASSEMBLY AND ASSEMBLY (Continued)

5. Apply a light coating of sealer to the outer edge of the outer oil seal. Position the oil seal in the bore of the case with the sealing lip facing inward. Press the seal into the bore of the case using tool T88T-2598-C, or equivalent. Press the seal in flush with the bore surface.



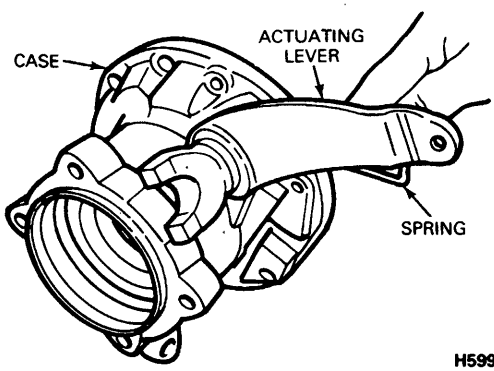
H6256-1A

6. Install the actuating lever spring in the boss in the case.



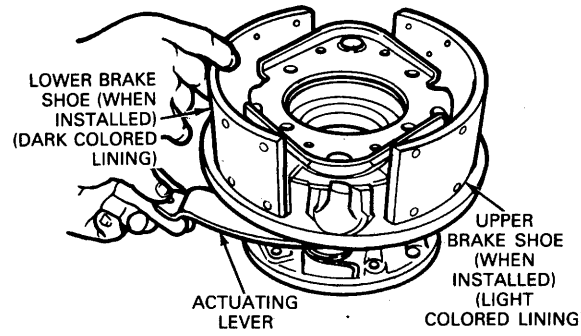
H5994-1A

7. Apply a light coating of Ford Disc Brake Caliper Slide Grease D7AZ-19590-A, or equivalent to the ball of the actuating lever. Install the lever (ball end) into the hole in the boss of the case, through the coiled end of the spring.



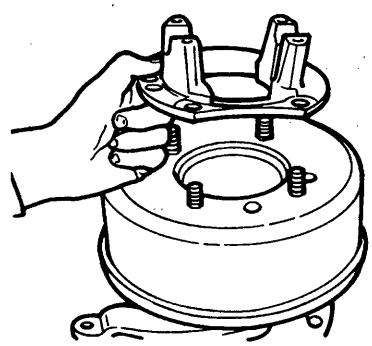
H5995-1A

8. Position the backing plate and brake assembly into position on the case. Insert the actuating lever (cam end) into position in the brake assembly.



H5996-1A

9. Attach the brake assembly and backing plate to the case with 4 hex head bolts. Tighten the bolts to 118-122 N·m (87-91 ft-lb). Attach retracting spring to the actuating lever while bending the long end to snap over the lever.
10. Place the mainshaft in a vise with the flanged end up. Protect the shaft with soft jaw inserts.
11. Install the brake drum and output flange onto the flange end of the mainshaft.
12. Install the output flange onto the brake drum, aligning the marks made during disassembly (to insure that the balance is not disturbed). Install the 4 hex nuts and tighten to 113-117 N·m (83-87 ft-lb).

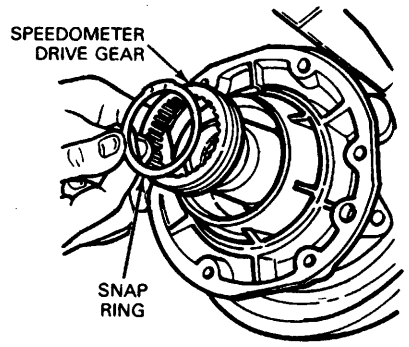

H5997-1A

13. Remove the mainshaft with brake assembly from the vise. Turn the unit over and clamp it securely in the vise.
14. Install the case, with the outer bearing cone installed loosely onto the mainshaft guiding the shaft through the oil seal and bearing cone.

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DISASSEMBLY AND ASSEMBLY (Continued)

15. Install the outer bearing cone onto the mainshaft using tool T88T-2598-F or equivalent, seat the bearing on the shaft.
16. Install the speedometer drive gear onto the mainshaft. Install the snap ring into the groove locking the speedometer gear to the shaft.

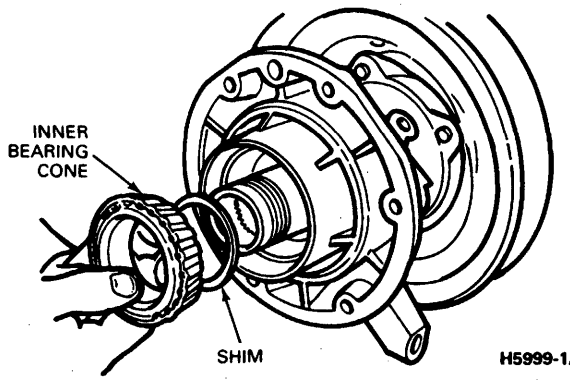


H5998-1A

17. Install the shim on the mainshaft.

NOTE: This shim determines mainshaft end play, and it is available in thicknesses in variances of 0.0019 inches.

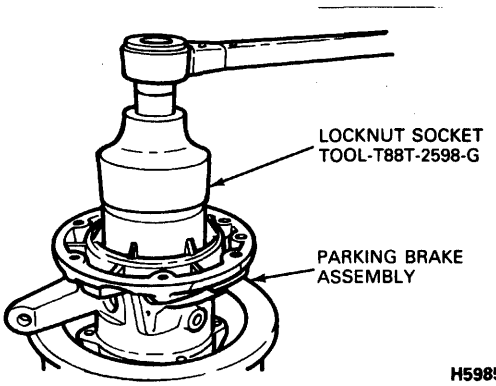
18. Install the inner bearing cone onto the mainshaft.



H5999-1A

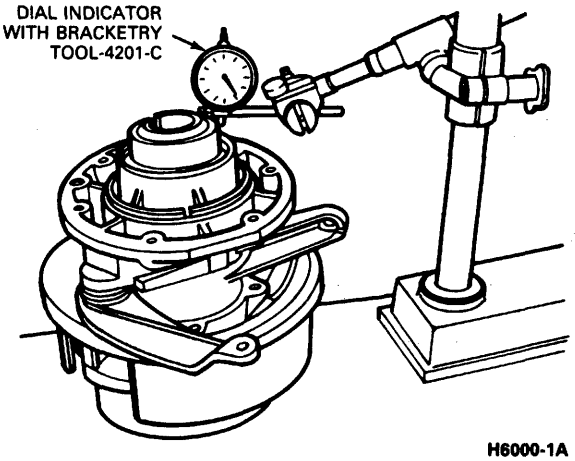
In order to measure mainshaft end play, install the bearing spacer without the O-ring onto the mainshaft.

19. With the case assembly and mainshaft clamped firmly in the vise, screw the hex locknut onto the mainshaft. Tighten the nut to 288-292 N·m (212-216 ft-lb).



H5985-1A

20. Mount a dial indicator between the mainshaft and the case to check end play. Use dial indicator with bracketry Tool-4201-C or equivalent.



H6000-1A

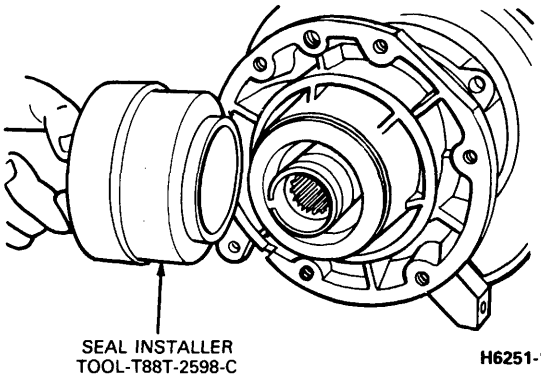
21. While rotating the case assembly on the mainshaft to center the bearings. Apply pressure up and down while taking an end play reading. A reading of 0.0019-0.0039 inches is required. If the reading is not to specification, a thicker or thinner shim must be used.

22. Remove the locknut and the bearing spacer from the shaft.
23. Remove the inner bearing cone and add the necessary additional shims to obtain the specified end play.

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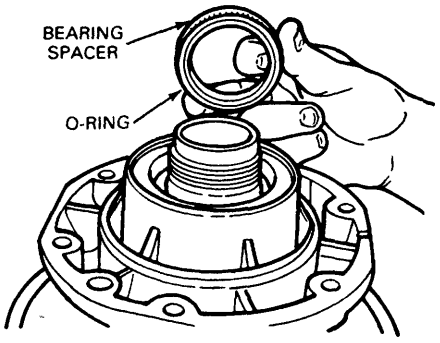
DISASSEMBLY AND ASSEMBLY (Continued)

24. Reinstall the inner bearing cone on the shaft.
25. Coat the outer shell of a new inner oil seal with sealer and install it in the bore of the case until it seats inside the bore. The sealing lip of the seal must face inward.



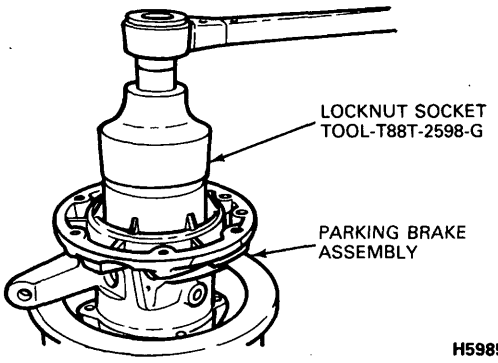
H6251-1A

26. Install a new O-ring in the notch of the bearing spacer and install both parts onto the mainshaft until the space butts against the shoulder of the shaft.



H6252-1A

27. Install a new locknut on the shaft, and tighten to 288-292 N·m (212-216 ft-lb).
28. Upset the outer lip of the locknut into the slot in the shaft, using tool T88T-2598-G, or equivalent.



H5985-1A

29. Screw the vent into the case, and tighten it to 12-16 N·m (8-12 ft-lb).
30. Remove the parking brake assembly from the vise.
31. With the parking brake in the as installed position, fill the case with Ford Automatic Transmission Fluid (type H) XT-4-H, through the filler hole. Fill to the bottom of the filler hole, and install and tighten the fill plug to 59-63 N·m (43-47 ft-lb).
32. Reinstall the parking brake assembly as outlined in this Section.

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DISASSEMBLY AND ASSEMBLY (Continued)

Transmission Mounted Parking Brake Trouble Shooting Procedure

The following chart can be used when diagnosing transmission mounted parking brake units.

CONDITION	POSSIBLE CAUSE	RESOLUTION
Squeals or groans	Glazed linings	Remove glaze from linings using a file or emery cloth.
	Misalignment of parts	Correct misalignment by tightening any loose brake or drum mounting bolts.
	Dirt in drum	Remove drum and clean out lining dust and dirt.
Scraping noise	Worn out lining	Check for lining worn down to rivets — reline shoes if necessary.
	Bent or misaligned shoe	Check for misaligned shoe, rubbing against drum. Reline shoes if necessary.
Clicks	Excessive clearance	Adjust cable clevis.
	Eccentric or wobbling drum	Inspect drum runout. Also check for worn or loose bearing on mainshaft. Check drum mounting bolts for tightness.
	Excessive linkage friction	Check linkage pivot points for rust, binding, or lack of lubrication.

CH6253-2A

CONDITION	POSSIBLE CAUSE	RESOLUTION
Grabbing	Brake lubricant or transmission oil on linings	Replace brake linings. Clean oil and excess brake lubricant from brake and drum. Replace faulty oil seal at mainshaft.
Brake does not hold	Excessive clearance prevents complete brake application	Adjust brake lining cable to take up slack in brake linkage.
	Grease soaked linings	Repair source of leak, install new linings.
	Excessive linkage friction	Check for linkage binding, and misalignment. Lubricate all pivot points.
	Worn out linings	Reline brake shoes. Check drum/yoke for scoring and replace if necessary.
Excessive lining wear	Brake drag	Brake lever and camshaft adjustment too tight. Also, inspect for broken or missing springs.
	Rough drum surface or abrasive dirt in drum	Smooth drum with emery paper, or replace drum, if drum is badly scored. **CAUTION: Drum to be replaced if inside diameter exceeds 9.030 inches.**

CH6254-2A

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SPECIFICATIONS

PARKING BRAKE CABLE TENSION ADJUSTMENT

Model	Rear Cable Tension ①	
	Lbs.	Newtons
F-150—F-350	350 Min.	1556
Bronco	350 Min.	1556
E-150—E-350	350 Min.	1556

①Check rear cable tension with the parking brake control fully in the last detent position.

CH2506-1H

ROTUNDA EQUIPMENT

Model Number	Description
021-00018	Cable Tension Gauge

CH3535-1B

SPECIAL SERVICE TOOLS

Tool Number	Description
T88T-2598-G	Locknut Socket — 75mm
D80L-1002-L	2 — Jaw Puller
D79L-4621-A	Bearing Cone Remover
D80L-630-6	Step Plate
T77F-1102-A	Bearing Cup Puller
T88T-2598-D	Inner Bearing Cup Installer
T88T-2598-E	Outer Bearing Cup Installer
T88T-2598-C	Oil Seal Replacer
T88T-2598-F	Bearing Replacer
TOOL-4201-C	Dial Indicator with Bracketry

CH6311-1A

TRANSMISSION MOUNTED PARKING BRAKE — TORQUE SPECIFICATIONS

Description	N·m	Ft-Lb
Parking brake case to transmission bolts	34-58	25-43
Driveshaft to output flange	20-27	15-20
Brake backing plate to housing	118-122	87-91
Output yoke flange to brake drum	113-117	83-87
Mainshaft locknut	288-292	212-216
Vent to housing	12-16	8-12
Fill plug	59-63	43-47

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GROUP 13 STEERING

(3000)

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VEHICLE APPLICATION

Applies to All E-150—350, F-150—350, Bronco and F-Super Duty Models.

DESCRIPTION

Steering Gear Model Identification

Steering gears are identified by a service identification tag fastened to the assembly. Tags are located and contain information as shown in Fig. 1.

DIAGNOSIS AND TESTING

Power Steering—Preliminary Checks

Make the following preliminary checks before servicing the power steering system. Check the fluid level, belt tension and the system for any signs of leakage. If hoses are to be disconnected, label them prior to removal so they can be easily identified for re-assembly.

Pump Belt Check

Check and adjust the power steering pump drive belt as described in Section 27-06, Accessory Drive Belt Service, Light Truck Engine Manual.

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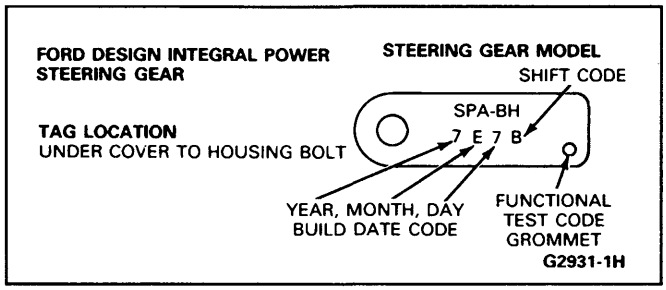


FIG. 1 Steering Gear Identification

Fluid Level Check

Ford C-II Pump

1. Run the engine until the fluid reaches normal operating temperatures, 74° to 79°C (165 to 175°F).
2. Turn the steering wheel all the way to the left and right several times. Turn off the engine.
3. Check the fluid level in the power steering reservoir. If the level is low, add Motorcraft Automatic Transmission Fluid—Type 'F', XT-1-QF (ESW-M2C33-F) or equivalent. Do not overfill the reservoir.

Saginaw Pumps

NOTE: Fluid level should be checked when performing required maintenance checks.

1. Run the engine until the fluid is at normal operating temperature (approximately 74°-79°C 165°-175°F). Turn the steering wheel all the way from left to right several times. Shut off the engine. Remove the reservoir filler cap and check the fluid level on the dipstick. Level should be between the HOT mark and the end of the dipstick.
2. If the fluid level is low, add power steering fluid, Motorcraft Automatic Transmission Fluid—Type 'F', XT-1-QF, (ESW-M2C33-F) or equivalent to the proper level on the dipstick.
3. When checking the fluid level after the steering system has been serviced, air must be bled from the system.
4. With the engine off, add power steering fluid to the COLD mark on the dipstick.
5. Start the engine, run it at fast idle and re-check the fluid level. Add fluid if necessary to the COLD mark.
6. Bleed the system by turning the wheels from side to side without hitting the stops. Maintain the fluid level just above the internal pump casting. Air must be eliminated from the fluid before normal steering action can be obtained.
7. Return the wheels to the center position and continue to run the engine for two or three minutes. Shut the engine off.
8. Re-check the fluid level as described in Steps 1 and 2. The fluid should be at the HOT mark on the dipstick after the system has stabilized at its normal operating temperature.
9. Road test the vehicle to be certain the steering functions normally and is free from noise.

External Leak Check

Ford Power Steering Gear

Refer to Fig. 2.

1. With the vehicle engine off, wipe the complete power system dry (gear, pump, hoses, and connections).
2. Check oil level in pump's reservoir and adjust as directed in this Section.
3. Start the engine and turn the steering wheel from stop to stop several times. **Do not hold the wheel against the stops to prevent damage to the pump.**
4. Determine the exact source of leakage by carefully observing the leakage areas shown in Fig. 2.
5. To stop leakage in the sector shaft nut (Point A, Fig. 2), clean any contamination from nut and cover surface. Tighten the nut to 48-61 N·m (35-45 ft-lbs). Replace nut if leakage continues. Check the cover housing for damage.
6. If leakage is observed at the sector shaft cover (Point B, Fig. 2), Tighten bolts to 75-94 N·m (55-70 ft-lbs). Replace seal if leakage persists. Examine sealing surfaces for damage when replacing seal.
7. For leakage at hose connections (Point C, Fig. 2) tighten the fitting nuts to specifications. If leakage persists upon tightening, remove the hose. If leakage is due to damaged hose threads, replace the hose. If tube seats are damaged, replace the tube seats. If housing threads are badly stripped, replace the **valve housing only.**
8. To stop leakage at the input shaft seals (Point D, Fig. 2), replace the input shaft seals and snap ring. Check the shaft surface for damage. Check the housing seal bore for damage if leak continues.
9. For leakage at the control valve housing, (Point E, Fig. 2), tighten the control valve housing bolts to 41-62 N·m (30-45 ft-lbs). If leakage continues replace the O-ring seals. Examine sealing surfaces for damage.
10. If leakage is observed in the sector shaft seals (Point F, Fig. 2), replace the sector shaft seals and snap ring. Check the shaft surface for rust or other damage. Check the seal bore and snap ring groove for damage. Check housing roller bearing for damage.
11. If leakage is observed at any point in the housing casting, (Point G, Fig. 2), replace the gear housing.

Saginaw Pump

Refer to Fig. 3.

1. For leakage between the pressure hose fitting nut and hose tube (View A, Fig. 3), tighten the nut to 34-47 N·m (25-34 ft-lbs) torque. If leakage persists, replace the pump pressure fitting and reface the hose tube flare. Replace the O-rings or replace the hose as required.
2. To stop leakage between the discharge fitting and the pump body (View A, Fig. 3), tighten the fitting to 38 N·m (35 ft-lbs) torque. If leakage persists, replace both O-ring seals.
3. For leakage shown in View B, Fig. 3, replace the reservoir O-ring.

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4. To stop leakage at the pump driveshaft (View C, Fig. 3), replace the driveshaft seal.
5. For leakage between the return hose and pump inlet line, assure the clamp is located as shown in Fig. 3. Tighten clamp. If leakage is still evident, replace the return hose.
6. If leakage is observed at the bottom of the filler neck or at the inlet line, (Fig. 4), replace the reservoir. If there is leakage at the filler cap, check the oil level and correct as required. If leakage persists, with correct oil level and the cap tight, replace the cap.

Ford C-II Pump

Refer to Fig. 5.

1. For leakage in rotor shaft seal (View A, Fig. 5), replace rotor shaft seal.
2. If the reservoir O-ring seal leaks (View B, Fig. 5), replace O-ring seal.
3. For leakage at the return hose (View C, Fig. 5), tighten return hose clamp.
4. For leakage at the outlet fitting (View D, Fig. 5), tighten the outlet fitting to specification. If leakage continues:
   a. Replace O-ring seals, if leak continues.
   b. Check for damaged threads (cross-threaded) on the outlet fitting. If threads are damaged, replace outlet fitting. If housing cover threads are stripped, replace the pump housing cover.
5. If pressure hose tube nut leaks (View E, Fig. 5), tighten pressure hose tube nut to specifications. If leak continues:
   a. Replace O-ring, if leak continues;
   b. Replace pressure hose assembly.
6. If leakage occurs at filler cap check the oil level and correct as required. If leakage persists, replace the filler cap O-ring seal. See View F, Fig. 5.

Fitting and O-Ring Leak Inspection

Since most fluid leaks occur at the fittings and connections in a power steering hydraulic system, these parts should be checked before any other part is replaced.

1. Clean the outside of the steering gear, the bottom surfaces of the pump, and all lines and fittings. Be sure all dirt, oil, and grease is removed from areas where leaks may exist.
2. Tighten all fittings, using a flare-nut wrench. **Do not tighten the fittings with a standard open-end wrench.** If a properly tightened fitting leaks, replace the tube seat.

Power Steering Tests

The pump flow and pressure tests will confirm or rule out the pump as the cause of steering system problems. Follow the steps below.

Prior to performing the pump flow and pressure tests, the following checks, for conditions which could cause loss of power assist, must be performed and corrective action taken if necessary.

1. Check pump reservoir for proper fluid level.
2. Check tires for correct air pressure.
3. Check pump belt for proper tension.
4. Check pump for correct model and vehicle application.

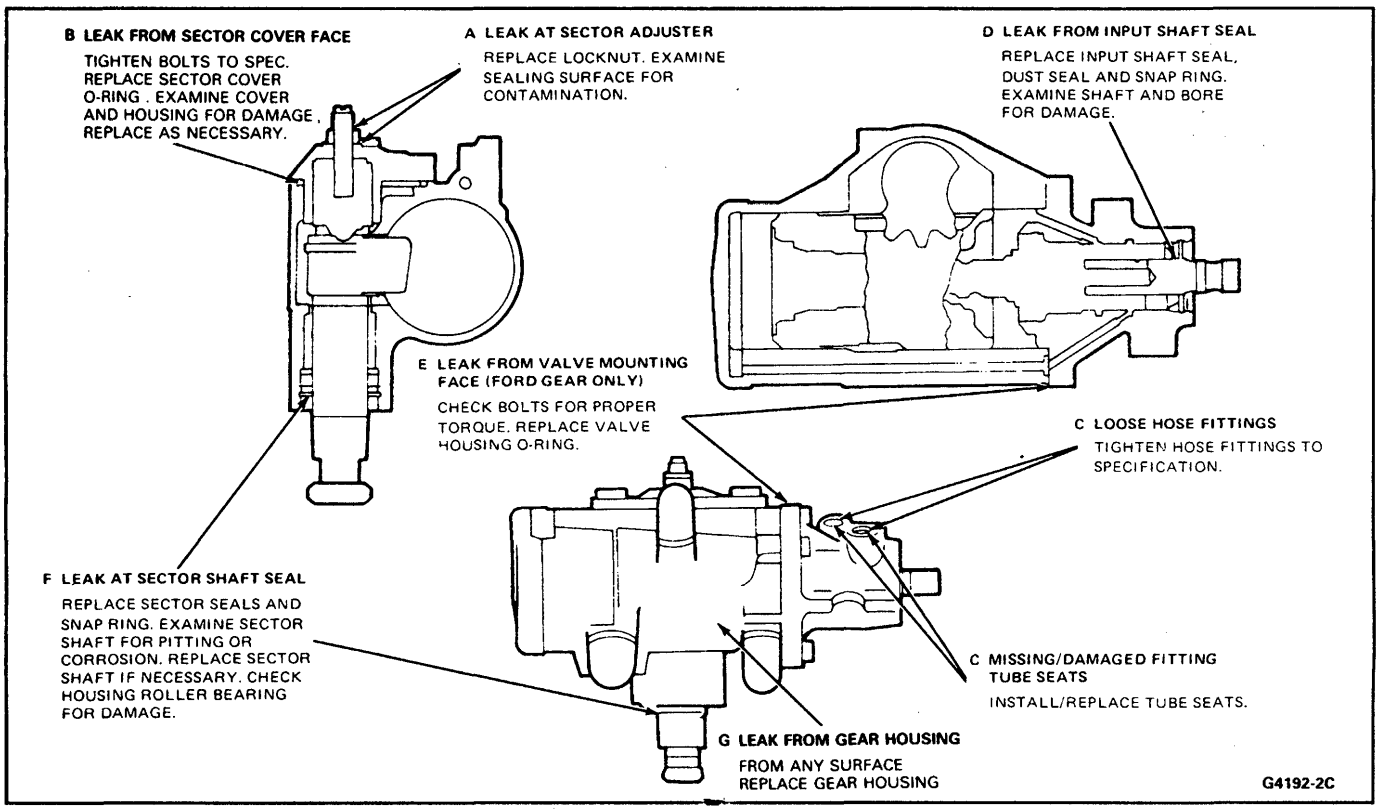


FIG. 2 Oil Leakage Areas—Ford Power Steering Gear

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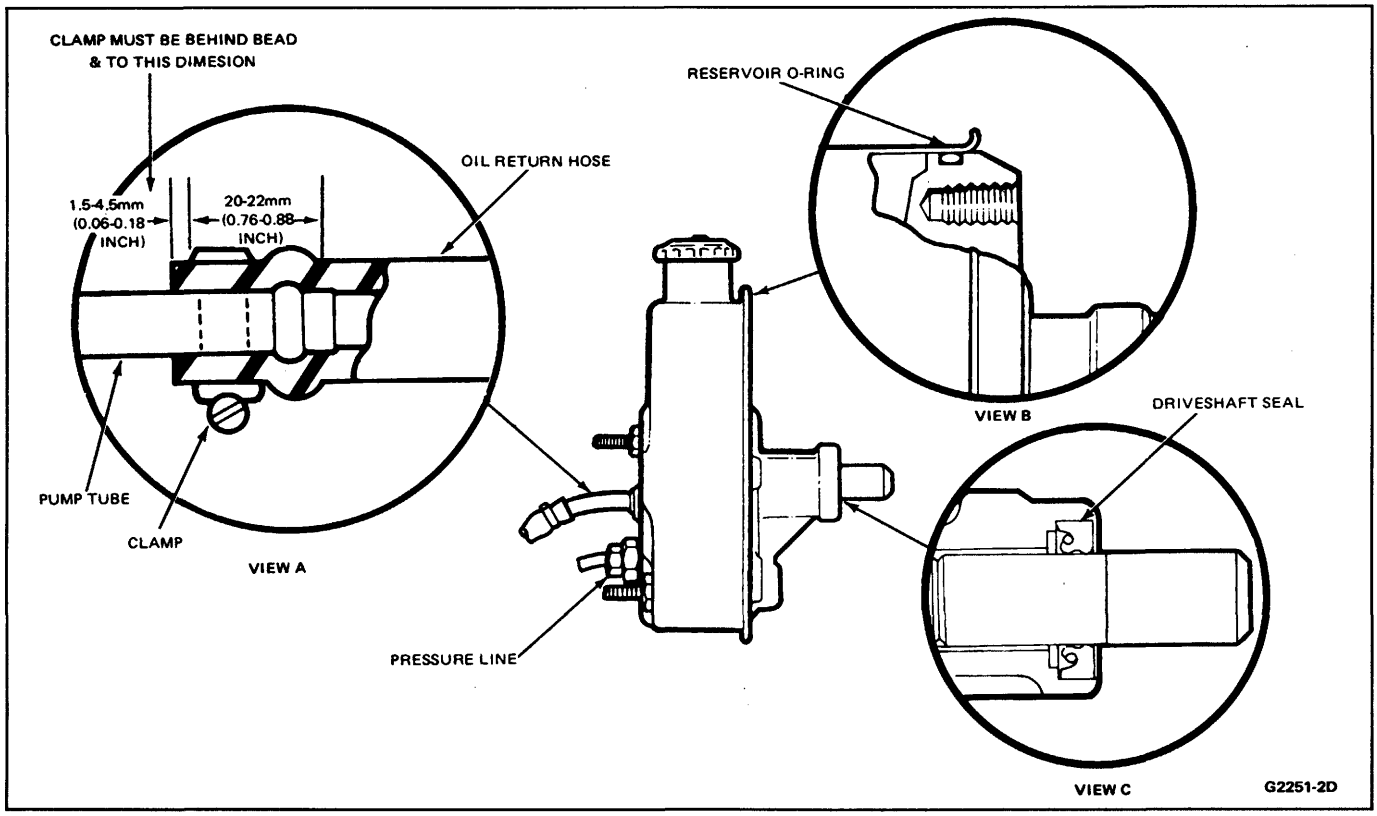


FIG. 3 Reservoir and Pump Leakage Areas—Discharge Line, O-Ring and Driveshaft—Saginaw Power Steering Pump

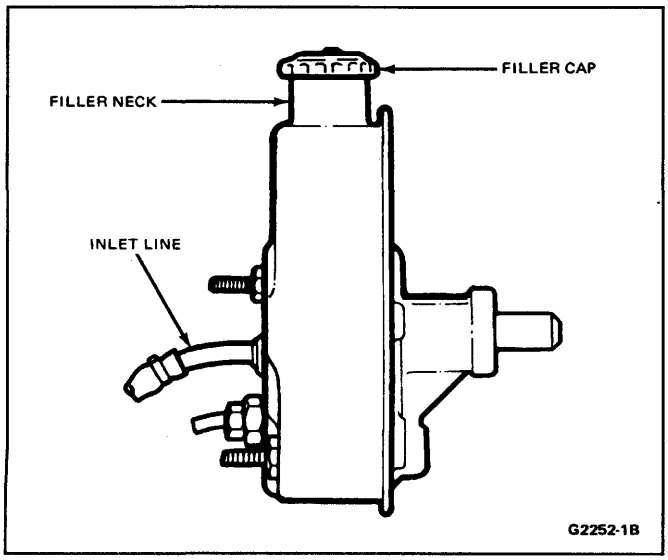


FIG. 4 Reservoir and Pump Leakage Areas—Inlet Line, Filler Neck, and Cap—Saginaw Power Steering Pump

5. Check for correct size pulleys on pump and engine.

6. Check entire system for damage, replacing parts as necessary.

If the above items are to specifications, or have been corrected, and the loss of assist still exists, test the power steering pump flow and pressure to determine whether the trouble is in the pump, power steering gear, or control valve using the following test equipment.

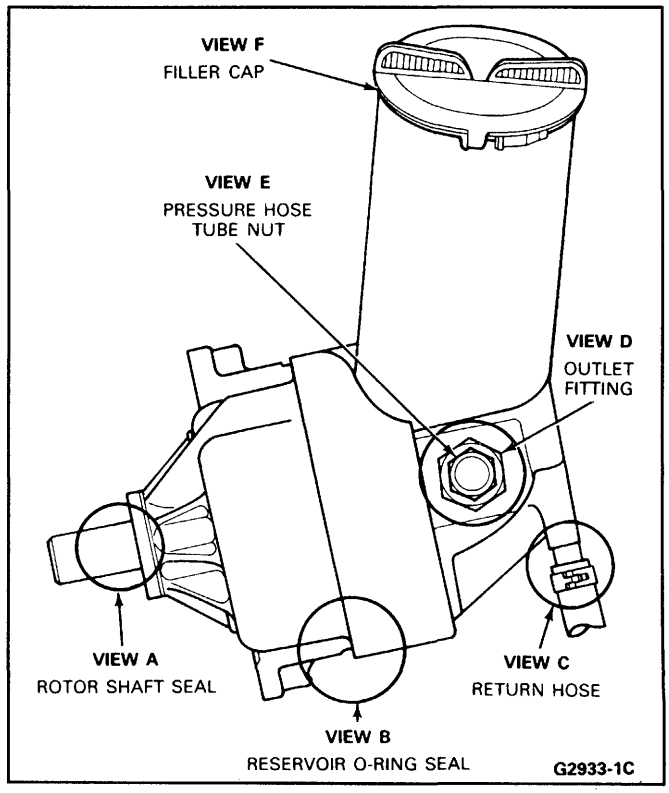


FIG. 5 Filler Cap Fitting and Connection Leakage Areas—Ford CII Pump

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Test Equipment

1. Engine tachometer
2. Thermometer—-17°-140°C (0° to 300°F).
3. One (1) Power Steering Analyzer, D79L-33610-A or equivalent.
4. One set of adapter fittings.

Testing of Pump and Gear

The following test procedure used in conjunction with the Power Steering Analyzer, D79L-33610-A (Rotunda Model) 014-00207, or equivalent provides a method for checking the complete power steering system. The Flow/Pressure Power Steering Analyzer can be used to determine the cause of hard steering and/or lack of assist problems. The analyzer provides readouts for the following:

CAUTION: Possible contamination of the power steering system fluid may cause permanent damage to gauges and instruments incorporated in the analyzer.

1. System backpressure
2. Pump flow
3. Steering gear internal leakage
4. Power steering control valve and cylinder internal leakage

The interpretation of the above readouts will determine which of the following conditions or components are the cause of the problem:

1. Restriction in hoses or fittings
2. Control valve and cylinder
3. Sticking gear valve
4. Inefficient pump cam pack
5. Sticking relief valve
6. Binding in suspension

Test Procedure

Refer to Fig. 6.

1. To connect the analyzer into the steering system, remove the pressure fitting from the pump and connect it into the appropriate adapter of the analyzer.
2. Thread the other adapter of the analyzer into the pump.
3. Connect the analyzer to the adapters and tighten both connections to 15 foot-pounds maximum.

   NOTE: The analyzer may be connected at alternate points between the pump and the gear as illustrated for convenience.
4. Add power steering fluid to the pump if required. Start the engine and run it for approximately two (2) minutes with the idle set at manufacturer's specifications.
5. Record the flow (gallons/min @ 170° ±5°F). If the flow is below two (2) gallons/min., the pump may require repair; however at this point continue the diagnosis. Check specification charts at the end of this Section for flow and relief pressure against the pump model being tested.
6. Record the pressure (psi @ 170° ±5°F). If the pressure is above 150 psi, check hoses for restrictions and check the steering gear.
7. Partially close the gate valve to build up 740 psi for C-II pumps, 620 psi for Saginaw pumps. Record flow (gallons/min. @ 170° ±5°F). If the flow drops to a level lower than the value on Chart I or II, in the Specifications Section at the end of this Section. Disassemble the pump and replace the cam pack. If the pressure plates are cracked or worn, replace them. Continue the diagnosis.
8. Completely close and partially open the gate valve three (3) times. (Do not allow the valve to remain closed for more than five (5) seconds.) Record the pressure (psi). Check Chart I or II in the specifications Section at the end of this part for the pressure specification for the applicable pump model. If the pressure recorded is lower than the minimum specification listed, replace the flow control valve in the pump. If the pressure recorded is above the maximum specification listed, the flow control valve in the pump should be removed and cleaned or replaced.
9. Increase the engine speed from idle to approximately 1500 RPM. Record the flow (gallons/min.). If the flow varies more than one (1) gallon/min. from the flow recorded in Step 5, the flow control valve in the pump should be removed, and cleaned or replaced.
10. Turn (or have someone turn) the steering wheel to the left and right stops. Record the pressure (psi) and flow (gallons/min.) at the stops. The pressure developed at both stops should be nearly the same

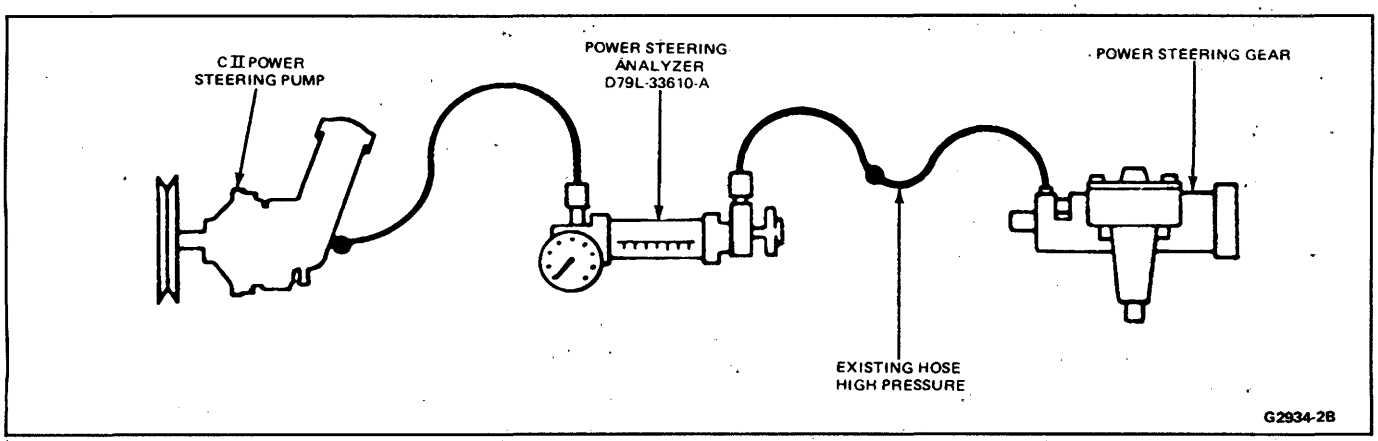


FIG. 6 Power Steering Analyzer Hook Up—Typical Installation

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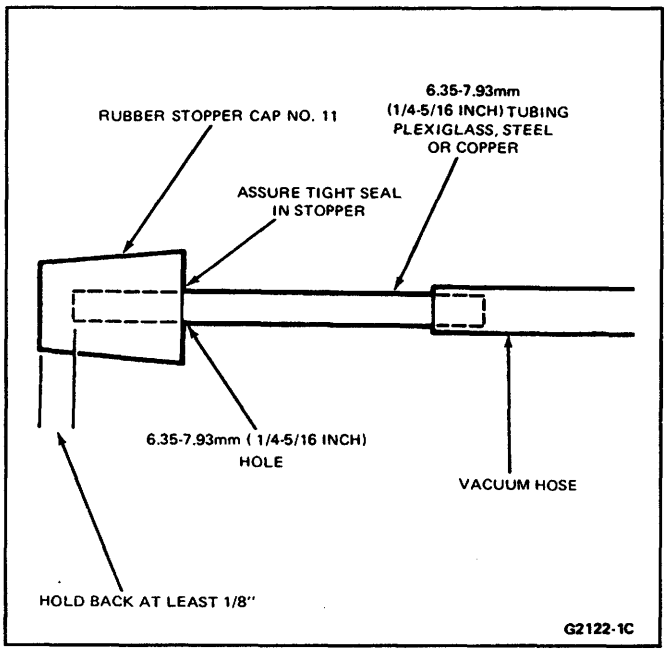


FIG. 7 Power Steering System Purging Tool—For Ford C-II Pump

as the maximum pump output pressure recorded in Step 8. At the same time the flow should drop below .5 gallons/min.

If the pressure does not reach maximum output or the flow does not drop below specified value, excessive internal leakage is occurring. Remove and disassemble the steering gear and remove the control valve. Replace damaged or broken parts.

11. Turn (or have someone turn) the steering wheel slightly in both directions and release quickly while watching the pressure gauge. The needle should move from the normal backpressure reading and snap back as the wheel is released. If it comes back slowly, or sticks, the rotary valve in the steering gear is sticking. Remove, disassemble and clean the rotary valve. If the system is severely contaminated, both gear hoses, control valve, and pump must be completely disassembled and cleaned before reassembly.

    NOTE: If problem still exits, check ball joints, linkage, "etc.".

    Installation of the analyzer at the pump outlet is preferred (Fig. 6). If it is difficult to attach the analyzer at the pump, it may be installed at any convenient location between the pump and the gear.

Purging Power Steering System of Air

Air trapped in the power steering system, which causes a whine-type noise between 17-39 km/h (20-45 mph) on light acceleration, can be removed by using a power steering pump air evacuator assembly (DEVAC Tool) or the VACUUM FILL PROCESS.

Devac System

Fabricate a DEVAC purging tool as shown in Fig. 7 for Ford C-II pump, or Fig. 8 for Saginaw pump.

The procedure for removing entrapped air is as follows:

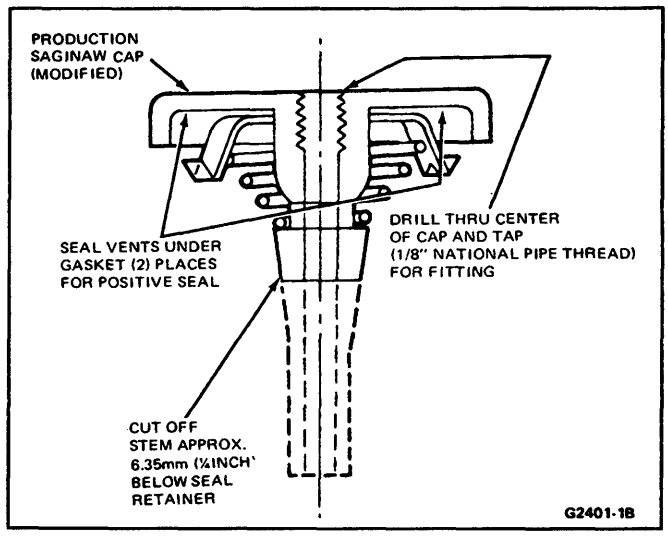


FIG. 8 Modified Pump Reservoir Cap—Saginaw Pump

1. Check the pump reservoir oil level to make certain the fluid level is correct (add fluid if low, siphon out fluid if level is above full mark).
2. Insert the rubber stopper end of the air evacuator assembly tightly into the filler tube.
3. Connect a suitable length of hose from the other end of the air evacuator to a distributor machine or air-conditioner vacuum pump. **Do Not Use Engine Vacuum.**
4. Let the engine idle for approximately 15 minutes. Turn steering wheel one full cycle every five minutes. (Do not hit the stops.) This assists in removing air trapped in the system.
5. Disconnect and remove the evacuator and reinstall the filler tube dipstick.

Start-Up Procedure (After Power Steering Pump or Gear Overhaul)

Upon initial engine start-up after a power steering pump or gear overhaul (particularly the pump), there is very frequently much noise and aeration. This is due to air trapped in the overhauled unit which mixes with the surging fluid and causes aeration. The problem can be minimized if the following procedure is used:

1. Disconnect the coil wire.
2. Fill the reservoir.
3. Crank the engine with the starter and continue adding fluid until the level remains constant. Be careful to avoid prolonged cranking as the battery may be drained and the starter damaged.
4. Rotate the steering wheel approximately 30 degrees each side of center while continuing to crank the engine.
5. Re-check the fluid level and fill as required.
6. Reconnect the coil wire.
7. Start the engine and allow it to run for several minutes.
8. Rotate the steering wheel from stop to stop.
9. Shut off the engine and re-check the fluid level—add as required.

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Diagnosis Guides

The diagnosis guides in this Section can be used as an aid in diagnosing steering system problems. For additional diagnosis procedure, refer to Section 19-01, Roadability.

NOTE: Refer to Specification Guide for correct lubricant.

ADJUSTMENTS

Clear Vision Adjustment

E-150—E-250—E-350

Steering wheel misalignment (improper clear vision) on E-150—E-250—E-350 vehicles can be corrected only by removing and recentering the steering wheel. Because the E-150—E-250—E-350 steering linkage has only one tie rod adjustment, improper clear vision cannot be corrected by adjustment of the steering linkage or suspension components. If improper clear vision is attempted to be corrected by adjustment of the tie-rod sleeve, grossly misadjusted toe may result.

F-150—F-250—F-350, and Bronco

Steering wheel clear vision is preset at assembly prior to toe adjustment and cannot be adjusted by removing the steering wheel and arbitrarily mis-indexing the wheel and center shaft alignment. Improper clear vision is an indication that toe is incorrect.

Refer to Section 13-06, Steering Column—Shift Rod Within Tube and Section 14-01, General Suspension Service for the clear vision adjustment.

CLEANING AND INSPECTION

Power Steering Gear

Cleaning

Disassembly and assembly of the steering gear and the sub-assemblies must be made on a clean workbench. As in repairing any hydraulically-operated unit, cleanliness is of utmost importance. The bench, tools, and parts must be kept clean at all times. Thoroughly clean the exterior of the unit with a suitable solvent and, when necessary, drain as much of the hydraulic fluid (or gear grease) as possible. Handle all parts very carefully to avoid nicks, burrs, scratches and dirt, which could make the parts unfit for use.

Do not clean, wash or soak seals in the cleaning solvent.

Inspection

1. Check input shaft bearing for damage. Replace if necessary.
2. Inspect the valve housing for scoring or burrs.
3. Inspect the tube seats in the pressure and return ports in the housing for nicks, etc. If necessary, replace tube seats.
4. Check all fluid passages for obstruction or leakage.
5. Inspect the steering gear housing for cracks, stripped threads, and mating surfaces for burrs. Inspect the piston bore of the housing or scoring. Check roller bearings for damage. If necessary, replace the housing.
6. Check the input shaft bearing after installation to be sure that it rotates without binding or roughness.
7. Check the piston rack teeth and sector shaft teeth for nicks and burrs.

Flushing

Should it be necessary to replace an inoperative power steering pump when fluid contamination could have occurred, flushing the steering gear is required when installing the repaired pump.

1. Remove the power steering pump and remove the pulley as outlined in Section 13-52, Power Steering Pump—Saginaw, or 13-53 Power Steering Pump C-II.
2. Install the pulley on the repaired pump. Install the pump and connect only the pressure hose to the pump.
3. Place the fluid return line from the gear in a suitable container and plug the reservoir return tube.
4. Fill the reservoir with Motorcraft Automatic Transmission Fluid—Type 'F', XT-1-QF (ESW-M2C33-F) or equivalent on Ford C-II pumps and on Saginaw Pumps.
5. Disconnect the coil wire to prevent the engine from starting and raise the front wheels off the ground.
6. While approximately two quarts of steering gear fluid are being poured into the reservoir, turn the engine over using the ignition key. At the same time, cycle the steering wheel from stop to stop. Be careful to avoid excessive cranking as the battery will be drained and the starter damaged.
7. As soon as all of the lubricant has been poured in, turn off the ignition key, and attach the coil wire.
8. Remove the plug from the reservoir return tube, and attach the return hose to the reservoir.
9. Check the reservoir fluid level. If low, add fluid to the proper level. Do not overfill.
10. Lower the vehicle.
11. Start the engine and cycle the steering from stop to stop to expel any trapped air from the system.

Ford C-II and Saginaw Power Steering Pump

Flushing

When contamination is noted while overhauling the gear, it will be necessary to flush the power steering pump.

1. Leave all hoses connected, except the pressure line at the gear.
2. Place the pressure line in a suitable container.
3. Fill the reservoir with power steering fluid, Motorcraft Automatic Transmission Fluid—Type 'F', XT-1-QF (ESW-M2C33-F) or equivalent on Ford C-II and Saginaw Pumps.
4. Disconnect the coil wire to prevent the engine from starting.
5. While approximately two quarts of the steering gear fluid are being poured into the reservoir, engage the starter.
6. As soon as all the fluid has been poured in, turn off the ignition.
7. Attach the pressure hose at the gear.
8. Check the reservoir fluid level.

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9. Crank the engine with the starter and continue adding fluid until the level remains constant. Lower the vehicle and attach the coil wire.
10. Start the engine and cycle the steering wheel from stop to stop to expel any air from the system.

Cleaning

Wash all parts except seals in a chlorinated solvent and dry with compressed air.

Inspection (Ford C-II Pump)

To determine when to replace power steering pump components follow these guidelines. Some components must be replaced regardless of condition.

1. Re-use the outlet fitting if the corners are not rounded and the threads intact.
2. Replace all seals.
3. Re-use the reservoir assembly if the reservoir seal areas are not damaged. Check for a broken or missing baffle.
4. Re-use the housing or housing assembly if the O-ring and and snap ring surfaces are not damaged.
5. Re-use the rotor and cam assembly if wear is limited to removal of the phosphate coating on the cam contour. Do not disassemble the unit. Push the rotor part way through the cam insert, being careful not to dislodge the slippers and springs. Check the cam inside diameter for scoring or burring. Check the rotor faces and outside diameter for scoring and chipping. Do not repair or refinish the upper and lower pressure plates, cam or rotor assembly. If wear or burring is evident, replace them with new components.
6. Install a new rotor and cam assembly if the slippers are worn.
7. Re-use the rotor shaft if the thrust faces, bushing diameter and shaft seal diameter are not excessively worn or scored.
8. Re-use the housing and bushing assembly if all the threaded holes are not damaged beyond repair, and the bushing diameter is not scored or worn, 0.0127mm (0.0005 inch) over the 17.50mm (0.6891 inch) maximum. Repair the threaded holes by drilling out the damaged threads and installing helicoil inserts. If the bushing is scored or excessively worn, install a new housing and bushing assembly.
9. Re-use the valve body if valve bore is free of nicks, scoring and the valve screen is clean. Valve must fall freely in valve bore. Replace valve housing and or valve if valve sticks in bore.

Inspection (Saginaw Pump)

The following describes the components of the power steering pump which must be replaced regardless of condition and how to determine when other components should be replaced:

All seals must be replaced with new components except the rotor shaft seal which should be reused unless it was leaking.

The flow control valve assembly may be reused unless it is damaged (score marks, wear, burrs, etc).

The housing assembly may be reused if there is no damage (scratches, burrs, etc.) at machined surfaces, especially mating surfaces on O-ring seats.

If the shaft bushing in the pump housing is scored or excessively worn the pump housing assembly must be replaced.

The pressure plate may be reused unless the V-shaped notches at the edges of the discharge ports are damaged or other visual damage (cracks, etc.) is evident. These notches must be clean and undamaged if pump noise is to be avoided, as they cushion the hydraulic shock when each vane passes the port.

The cam ring may be re-used if it is not damaged (score marks, cracks, etc.).

The cam ring is treated with Lubrite which leaves a dull grey-black finish on the wear surface. A wavy grain appearance inside the cam ring is normal.

The vanes should be removed from the rotor and examined for wear; the vanes and rotor may be reused if not damaged.

The rotor shaft may be reused if there is no damage (score marks, excessive wear, etc.) at splines, keyway, bearing and seal surfaces.

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STEERING SYSTEM PROBLEMS

CONDITION	POSSIBLE CAUSE	RESOLUTION
Power steering pump leaks.	1. Fluid, cap and dipstick.	1. Check for indications of false leakage — overfilled reservoir, improperly installed, damaged or lost cap or dipstick.
	2. Loose or damaged hose connections.	2. Repair or replace as required.
	3. Leakage between reservoir and housing.	3. Repair or replace as required.
	4. Leakage at pump shaft seal area.	4. Replace shaft seal or pump.
Noise in steering column.	1. Steering column cover interference.	1. Adjust or reposition as required.
(Squeak or creak)	2. Steering column out of alignment.	2. Align or adjust as required.
	3. Lack of lubrication where horn brush contacts rub plate of steering wheel.	3. Lube or adjust as required.
	4. Loose steering column mounting bolts.	4. Tighten to specification.
(Clunk)	5. Flex coupling bottoming.	5. Align or adjust as required.
	6. Loose pot coupling to steering column bolt.	6. Tighten to specification.
	7. Improper steering gear mesh load.	7. Readjust to specification.
Excessive Steering Effort	1. Improper oversized tires.	1. Install correct tire and wheel combination.
	2. Tires not uniform.	2. Install correct tire and wheel combination.
	3. Tire pressure.	3. Adjust air pressure in tires.
	4. Misaligned flexible coupling (if so equipped) to gear interference.	4. Align or adjust as required.
	5. Steering wheel to column interference.	5. Align or adjust as required.
	6. Steering column alignment.	6. Align or adjust as required (E-150 — E-350).
	7. Steering linkage or front axle spindle pins for a binding condition or lack of lubrication.	7. Lube, inspect, adjust or replace as required.
	8. Bind in front axle spindle thrust bearings.	8. Lube, inspect, adjust or replace as required.
	9. Steering gear adjustment.	9. Adjust to specification.

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STEERING SYSTEM PROBLEMS (Cont'd.)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Excessive Steering Effort (Cont'd.)	10. Power steering pump belt loose, glazed or broken.	10. Inspect, adjust belt tension or replace as required.
	11. Power steering pump fluid level and possible leak in system.	11. Add fluid, tighten connections and correct as necessary.
	12. Power steering pump pressure and flow below specification.	12. Conduct pump flow and relief pressure tests and adjust or repair as necessary.
	13. Air in power steering system.	13. Add fluid, tighten connections and bleed system.
	14. Contaminated fluid, incorrect fluid.	14. Replace with correctly specified fluid.
	15. Obstruction within steering gear or lines (including bent or kinked steel tubing).	15. Inspect, remove obstruction(s) and repair or replace as required.
	16. Steering gear valve binding or gear out of adjustment (Integral Power Steering).	16. Inspect, repair or replace as required (Meshload Only).
	17. Excessive internal gear leakage.	17. Inspect, repair or replace as required.
Wanders Side to Side — Loose Steering	1. Vehicle overloaded or unevenly loaded.	1. Correct as required.
	2. Improper (mismatched) tires and wheels.	2. Install correct tire and wheel combination.
	3. Tire pressure.	3. Adjust air pressure in tires.
	4. Loose steering gear mounting.	4. Adjust to specification.
	5. Front and rear suspension components for looseness, wear or damage.	5. Tighten or replace as necessary.
	6. Steering linkage connections for looseness, wear or damage.	6. Tighten or replace as necessary.
	7. Loose wheel lug nuts.	7. Tighten to specifications.
	8. Spindle pin (king pin) binding.	8. Lubricate suspension.
	9. Front wheel bearing adjustment.	9. Adjust to specification.
	10. Flexible coupling fractured.	10. Replace as required.
	11. Incorrect toe setting.	11. Set to specifications.
	12. Steering gear conditioning and adjustments.	12. Adjust to specification.

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STEERING SYSTEM PROBLEMS (Cont'd.)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Pulls To One Side	1. Check tire sizes of each wheel to be sure they are the same size and type.	1. Install correct tire and wheel combination.
	2. Tire pressure.	2. Adjust air pressure in tire.
	3. Vehicle unevenly loaded.	3. Correct as required.
	4. Improper brake operation or adjustment.	4. Inspect, adjust and correct as required.
	5. Front wheel bearing adjustment or faulty rear wheel bearing.	5. Adjust or replace as required.
	6. Broken or sagging springs on front and/or rear suspension.	6. Inspect and replace as required.
	7. Loose steering gear mountings.	7. Tighten to specification.
	8. Loose, worn or damaged steering linkage.	8. Tighten and replace as required.
	9. Bent spindle or spindle arm.	9. Inspect and replace as required.
	10. Bent rear axle housing and/or loose, worn or damaged spring, shock absorber and suspension arm attaching points.	10. Inspect, tighten and replace as required.
	11. Frame or underbody out of alignment.	11. Correct as required.
	12. Front wheel alignment.	12. Set to specification.
	13. Belted tires (misaligned belts).	13. Replace as required.
	14. Steering gear valve binding or out of adjustment.	14. Clean and replace as necessary.
Returnability Poor	1. Tire pressure.	1. Adjust air pressure in tires.
	2. Steering column alignment.	2. Align or adjust as required.
	3. Steering linkage for a binding condition or lack of lubrication.	3. Lube, adjust or replace as required.
	4. Spindle pin (king pin) binding.	4. Lubricate Suspension.
	5. Tight front axle spindles.	5. Lube, correct as required.
	6. Bind in front axle spindle bolt thrust bearings.	6. Lube, correct as required.
	7. Set toe to specifications.	7. Adjust as required.
	8. Steering gear adjustment.	8. Adjust to specification.
	9. Kinked return hose or tube.	9. Inspect and repair or replace as required.
	10. Obstruction with steering gear or lines.	10. Inspect, remove obstructions and repair or replace as required.

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STEERING SYSTEM PROBLEMS (Cont'd.)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Shaking Shift Lever — Manual Steering Column	1. Check engine for proper tuning.	1. Tune engine.
	2. Check the steering column mounting, the adjacent sheet metal area, the shift tube bushing and the shift linkage.	2. Repair or replace the column and/or components as required.
	3. Check engine and transmission insulators and mounts for alignment and movement.	3. Repair, replace or adjust as required.
	4. Check transmission shift lever(s) detent torque loading.	4. Repair or replace transmission shift components as required.
Clear Vision Complaint — Steering Wheel Spokes Obscure View of Instrument Panel with Wheels in Straight Ahead Position	E-150 — E-250 — E-350	
	1. Steering wheel mis-indexed on steering column.	1. Remove steering wheel and align on column.
	2. Toe out of adjustment.	2. Adjust toe setting per Section 14-01, General Suspension Service.
	3. Damaged or twisted sector shaft.	3. Replace sector shaft.
	F-150 — F-250 — F-350 and Bronco	
	1. Toe out of adjustment.	1. Adjust toe setting per Section 14-01, General Suspension Service.
	2. Damaged or twisted sector shaft.	2. Replace sector shaft.
Power Steering	1. Check belt for proper tension or glazing.	1. Tighten or replace belt as required.
Pump Noisy	2. Low fluid level and possible leakage.	2. Refill to specified level. Purge air from system. Check for leaks. Repair as required.
Swish Type Noise	3. Fluid flow into the bypass valve of the pump valve housing with fluid temperature below 54°C (130°F).	3. Normal noise.
Whine Type Noise	4. Aerated fluid or cam contour damaged.	4. Purge system of air. If condition not resolved, replace rotor assembly.
	5. Check valve cover "O"-ring seal.	5. Replace valve cover "O"-ring seal.
Clicking Mechanical Type Noise	6. Pump slippers too long, excessive wear of pumping elements, excessive slipper to slot clearance, or out of square slipper springs.	6. Replace rotor assembly.
Chatter Type Noise	7. Chipped corners on rotor outside diameter or distorted slipper spring.	7. Replace rotor assembly.

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STEERING SYSTEM PROBLEMS (Cont'd.)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Other Cause of Noise	8. Improper assembly of components such as slippers.	8. Rebuild pump and replace components as required.
	9. Imperfections on rotor outside diameter or rotor end surface.	9. Replace rotor assembly.
	10. Damaged rotor splines.	10. Replace rotor assembly.
	11. Hairline crack on cam inner surface.	11. Replace rotor assembly.
	12. Interference between rotor and cam.	12. Replace rotor assembly.
	13. Excessively worn or scored pumping elements and pressure plates.	13. Replace rotor assembly and pressure plates.

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AUTOMATIC TRANSMISSION SELECTOR SHIFTER LEVER HARD TO ROTATE (EXCEEDING 37.8N OR 8.5 LBS. AT SHIFT LEVER KNOB)

TEST STEP		RESULT	ACTION TO TAKE
1	LUBRICATE SHIFT LINKAGE • Lubricate the shift linkage with Multi-Purpose Long-Life Lubricant C1AZ-19590-B (ESA-M1C75-B) or equivalent.	OK ▶	GO to **6.**
		~~OK~~ ▶	GO to **2.**
2	VISUAL INSPECTION • Inspect for bent rods or levers, damaged bushings.	OK ▶	GO to **3.**
		~~OK~~ ▶	REPLACE bent or damaged rods, levers, bushings and/or as required. GO to **6.**
3	CHECK SHIFT EFFORT • Disconnect linkage at the adjusting stud and check shift effort at shift lever knob. Shift effort must be below 8.9N (2 lbs.).	Shift effort below 8.9N (2 lbs.) OK ▶	GO to **5.**
		Shift effort at or above 8.9N (2 lbs.) ~~OK~~ ▶	GO to **4.**
4	BEARING RETAINER FIT • Remove the lower bearing retainer and check the rotational fit to shift tube.	Bearing retainer rotates freely in shift tube OK ▶	GO to **4a.**
		Bearing retainer binds during rotation ~~OK~~ ▶	REPLACE shift tube assembly or retainer. GO to **6.**
4a	SHIFT SOCKET FIT • Check the rotational fit between the shift socket and flange.	Shift socket rotates freely OK ▶	GO to **4b.**
		Shift socket binds during rotation ~~OK~~ ▶	REPLACE shift socket and/or flange as required. GO to **6.**
4b	AXIAL CLEARANCE • Check for 0.127mm (0.005 inch) minimum axial clearance between socket and flange.	Clearance at or below 0.127mm (0.005 inch) OK ▶	DISASSEMBLE the steering column and REPLACE the shift linkage as required. REFER to Section 13-06, Steering Column.
		Clearance above 0.127mm (0.005 inch) ~~OK~~ ▶	REPLACE the outer tube assembly. GO to **6.**

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AUTOMATIC TRANSMISSION SELECTOR SHIFTER LEVER HARD TO ROTATE (EXCEEDING 37.8N OR 8.5 LBS. AT SHIFT LEVER KNOB) (Cont'd.)

	TEST STEP	RESULT ▶	ACTION TO TAKE
5	TRANSMISSION SHIFT EFFORT		
	• Attach the fish scale to the adjusting stud. Measure the force required to shift the transmission.	Shifting force less than 86.7N (19.5 lbs.) ▶	INSTALL nut on the adjusting stud and ROTATE stud by hand. If stud does not rotate freely, REMOVE 'c'-clip and LUBE under stud. GO to **6.**
		Shifting force greater than 86.7N (19.5 lbs.) ▶	GO to **5a.**
5a	RECHECK SHIFT EFFORT		
	• Disconnect the shift rod at the transmission lever. Attach a fish scale to the transmission lever and test shift effort.	Shifting force less than 77.8N (17.5 lbs.) ▶	REMOVE the bellcrank support bracket from the transmission and LUBE the bushing thoroughly. CHECK all other bushings for hard rotational effort. GO to **6.**
		Shifting force greater than 77.8N (17.5 lbs.) ▶	Condition is associated with transmission. REFER to Section 16-10 General Manual Transmision Service under Diagnosis.
6	VERIFY CONDITION		
	• Replace any bushing or 'c'-clip that was disconnected and adjust linkage per appropriate section in Group 16. Retest for correct shift effort.		

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SPECIFICATIONS

STEERING TORQUE LIMITS
F-150 — F-250 — F-350, F-Super Duty — E-150 — E-250 — E-350 AND BRONCO

Description	Model	Torque (ft-lbs)	Torque N·m
Steering Gear to Frame — Power and Manual	All	70	68-88
Pitman Arm to Steering Gear	All	170-230	230-310
Drag Link/Tie Rod End Studs	All	52-74	70-100
Linkage Adjusting Sleeve Clamp	F-150 — F-350, E-150 — E-350, Bronco	29-41	40-57
Linkage Adjusting Sleeve Clamp	F-Super Duty	60-93	81-126
Power Steering Support Bracket to Engine or A/C Bracket	E-150 — E-350 (8 Cyl.)	30-45	41-61
Power Steering Adjusting Bracket to Support Bracket	E-150 — E-350 (8 Cyl.)	30-45	41-61
Power Steering Pump to Adjusting Bracket	E-150 — E-350 (All)	30-45	41-61
Power Steering Bracket to Engine	E-150 — E-350 (6 Cyl.)	40-60	55-61
Power Steering Adjusting Bracket to Brace	E-150 — E-350 (6 Cyl.)	30-45	41-61
Power Steering Cooler to Frame Bracket	E-150 — E-350 (All)	11-16	15-21
Power Steering Pressure Hose (Pump) (Gear)	E-150 — E-350 (All)	35-34	34-46
Power Steering Pressure and Return Hose	All	20-30	27-41
Flange and Insulator Assembly to Steering Gear	F-150 — F-350, Bronco	25-34	34-46
Coupling Shaft to Steering Shaft	F-150 — F-350, Bronco	35-50	61-80
Flange and Insulator to Steering Column	E-150 — E-350	14-21	18-28
Steering Wheel to Steering Shaft	All	30-42	41-56
Support Bracket to Steering Column	All	13-20	18-27
Steering Column (Support Bracket to Pedal Bracket)	F-150 — F-350	13-27 8-20	18-37 11-27
Steering Column (Floor Opening Cover Plate to Floor)	F-150 — F-250 — F-350 E-150 — E-250 — E-350	9-13 8-20	12-18 11-27
Steering Column (Floor Opening Cover Plate Clamp)	F-150 — F-350, Bronco	8-18	11-24
Description	**Model**	**Torque (ft-lbs)**	**Torque N·m**
Shroud	All	10-15	1.1-1.7
Ignition Switch to Steering Column	All	40-60	4.5-7.3
Flange and Insulator Assembly to Steering Gear	E-150 — E-350	20-35	27-47

CG1766-2P

POWER STEERING PUMP SPECIFICATIONS — FLOW AND PRESSURE — CHART I — FORD CII PUMP

Pump Model	Minimum Flow @ 740 PSI		Minimum Pressure Relief		Maximum Pressure Relief	
	Liters/Minute 76°C + −15°C	Gallons/Minute 170°F + 5°F	kPa	PSI	kPa	PSI
HBC-HG	5.3	1.4	8960	1300	10542	1530
HBC-HN	5.7	1.5	9300	1350	10542	1530

CHART II — SAGINAW PUMP

Pump Model	Minimum Flow @ 620 PSI		Minimum Relief Pressure		Maximum Relief Pressure	
	Liters/Minute 76°C + 15°F	Gallons/Minute 170°F + 5°F	kPa	PSI	kPa	PSI
HBA-HA	6.8	1.8	8620	1250	9997	1450

CG2935-2G

SPECIAL SERVICE TOOLS

Number	Description	Application
T63L-8620-A	Belt Tension Gauge	Universal
D79L-33610-A	Power Steering Pump Analyzer	All Vehicles

CG3681-2D

ROTUNDA EQUIPMENT

Number	Description
014-00207	Power Steering Analyzer

CG3682-1B

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SECTION 13-06 Steering Column—Shift Rod Within Tube

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VEHICLE APPLICATION

Applies to F-150—F-350, E-150—E-350, Bronco and F-Super Duty Trucks.

DESCRIPTION

Steering Column

F-150—F-350, Bronco and F-Super Duty

The F-150—F-350, Bronco and F-Super Duty vehicles are equipped with a slip-joint coupling shaft which attaches between the steering gear and the steering column lower shaft. The column itself features a concentric outer tube, internal shift tube, and steering shaft. The components are designed to collapse in the event of an accident.

Once the column is collapsed, a new column and support bracket must be installed.

E-150—E-350

The E-150—E-350 vehicles are equipped with a steering column which attaches the steering shaft directly to the steering gear. The column design features a concentric outer tube, internal shift tube, and steering shaft. The components are designed to collapse in the event of an accident.

Once the column is collapsed a new column and support bracket must be installed.

E-150—E-350, F-150—F-350, Bronco and F-Super Duty

Four steering column versions are offered. There are two fixed wheel (non-tilting) columns; manual 4-speed floor shift, and automatic column shift. There are two tilt columns; manual 4-speed floor shift and automatic column shift. The tilt columns feature five driving positions (two up, two down, and a center position). Both fixed and tilt columns feature an emergency warning flasher control, a turn signal indicating switch with lane change position, and are equipped with an anti-theft device which locks the steering system and, on automatic transmission equipped vehicles, the transmission linkage.

DIAGNOSIS AND TESTING

Refer to Section 13-01, General Steering Service, for diagnostic and testing procedures.

ADJUSTMENTS

NOTE: If the flexible coupling has been driven in a non-flat condition for more than 10,420 km (12,000 miles), it is recommended that it be replaced.

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Steering Column Alignment

F-150—F-350, Bronco and F-Super Duty

There is no alignment adjustment of the steering column and coupling shaft. Alignment is maintained by the slip-joint coupling shaft attaching the steering column to the steering gear. If misalignment exists, check for indications of damage, such as bent or displaced components. For proper installation follow procedure per this Section.

E-150—E-350

Any stress or misalignment in the steering column tube and steering shaft should be eliminated before checking the steering gear adjustments.

1. Loosen the steering column-to-brake and clutch support bracket bolts.
2. Loosen the steering column opening cover plate-to-dash panel bolts.
3. Loosen the steering column opening cover clamp bolt.
4. Verify the coupling pin to flange cut-out clearance of 4.06mm (0.160 inch) (Fig. 1).
5. If required, loosen and retighten the flange coupling nuts to 19-28 N·m (14-21 ft-lbs).
6. Tighten the steering column-to-support bracket bolts to 26-37 N·m (19-27 ft-lbs).
7. Tighten the steering column floor opening cover plate-to-dash panel bolts to 16-24 N·m (12-18 ft-lbs).
8. Tighten the steering column opening cover clamp bolt to 16-24 N·m (12-18 ft-lbs).

Automatic Transmission Selector Indicator (PRND21) and (PRNⒹD1)

F-150—F-350 and Bronco

Refer to Fig. 4.

Adjust the indicator flag alignment in the following steps:

NOTE: The shroud must be removed.

1. With the engine stopped and the parking brake applied, place the transmission selector lever at the steering column in the D position (C6) or the Ⓓ position (AOD), and hold the lever against the stop by applying an 8 pound weight to the selector lever.

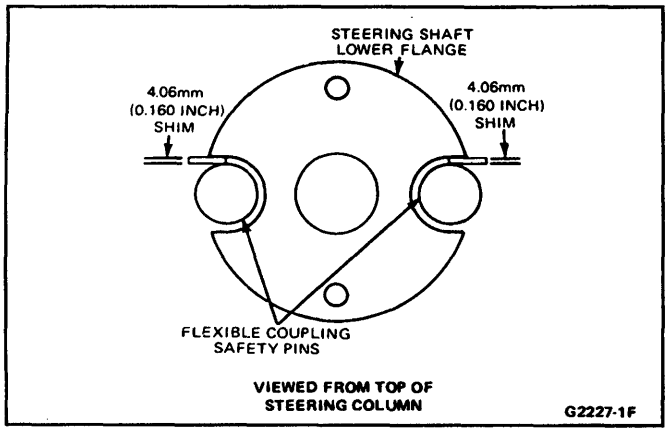


FIG. 1 Flexible Coupling Alignment E-150—E-350

NOTE: This adjustment must be made in the D or Ⓓ position only.

2. Place the cable loop over the retainer pin on the shift socket casting (Fig. 6). Place the cable bracket in the "T" slot in the column outer tube. Press the cable retainer into hole(s) provided in the column outer tube.
3. Adjust cable bracket in slot until the indicator flag totally fills the D or "Ⓓ" (for C6 and AOD respectively).
4. Tighten bracket screw to 2.25 N·m (20 in-lb) without disturbing the flags position. Release lever.
5. In all "R", "N", "2", and "1" or "R", "N", "D" and "1", the indicator flag should totally fill the shift position letters or numerals.

NOTE: After the shift lever indicator flag has been adjusted the manual linkage must be checked as detailed in Section 17-02, Shift Control Linkage.

Ignition Switch Adjustment

The ignition switch is operated by a rod through the lock actuator rack and pinion driven by the key cylinder. Rotating the key clockwise from the full counter-clockwise stop, the positions are: ACCESSORY, LOCK, OFF, ON, and START.

If the switch is properly adjusted:

(a) In ACCESSORY, the accessory circuit is operative and the steering wheel is locked.

(b) In LOCK, all ignition switch electrical circuits are inoperative and the steering wheel is locked.

(c) In OFF, all ignition switch electrical circuits are inoperative and the steering wheel is unlocked for all gear shift lever positions.

(d) In ON (RUN), all ignition switch circuits (or "Accessory" Circuits) are operative except the starter circuit and warning lamp proof circuit and the steering wheel is unlocked.

(e) In START, the engine ignition, warning lamp proof circuit and starter circuits only are operative and the steering wheel is unlocked.

If the switch is out of adjustment see Section 33-71, Ignition Switch under Adjustments.

Steering Wheel Alignment for Spoke Position—Clear Vision

F-150—F-350, Bronco and F-Super Duty

Steering wheel clear vision (Figs. 2 and 3) is preset at vehicle assembly prior to toe-adjustment and cannot be adjusted by removing the steering wheel and reindexing the steering wheel and steering shaft. Mating flats on the wheel hub and steering shaft assure that misindexing of these components is prevented. The alignment of the notches on the steering wheel hub and steering shaft confirm correct orientation.

Positive indexing of intermediate shaft pot joint to steering shaft and flex coupling to intermediate shaft are additional features to assure correct assembly. These are noted as follows: Refer to Fig. 5.

- Pot joint alignment notch is at 12 o'clock when steering wheel is in straight ahead position (refer to Fig. 5).

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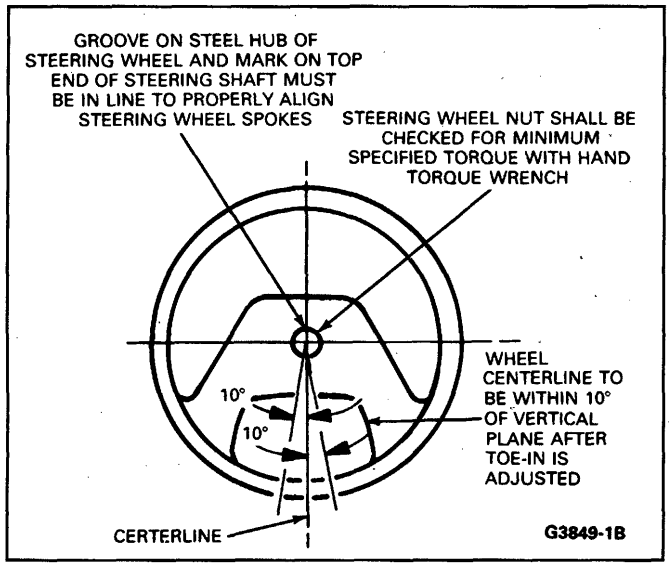


FIG. 2 Acceptable Steering Wheel Position—Measured From Normal Spoke Angle F-150—F-350, Bronco and F-Super Duty

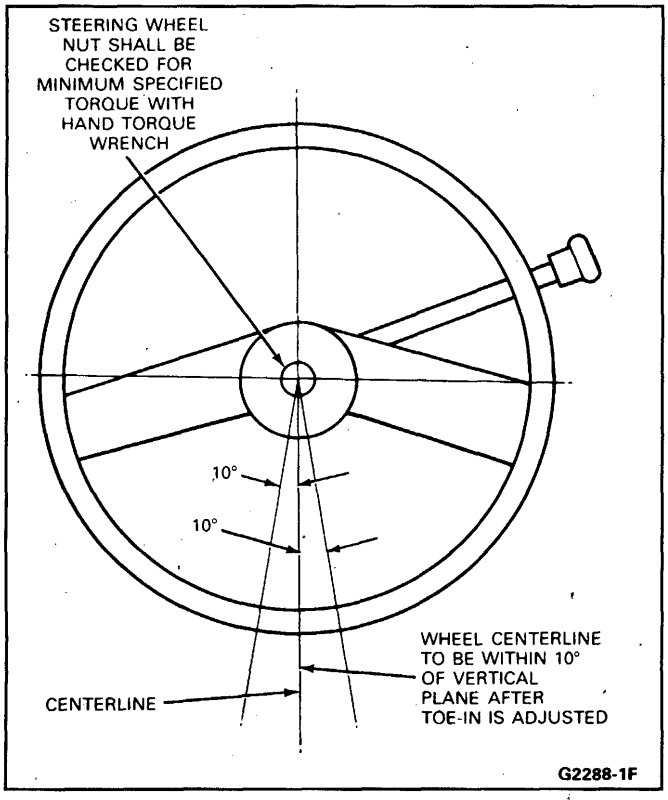


FIG. 3 Acceptable Steering Wheel Installation—Measured From Normal Spoke Angle E-150—E-350

Resolve the clear vision complaint by re-adjusting toe as described in Section 14-01, General Suspension Service.

E-150—E-350

Note that the E-150—E-350 does not have any clear vision indexing feature between the steering gear input shaft and the steering wheel since the toe adjustment operation, with one toe adjusting sleeve in the tie rod only, may result in a non-centered gear condition. The alignment flat and mark on the Econoline steering shaft

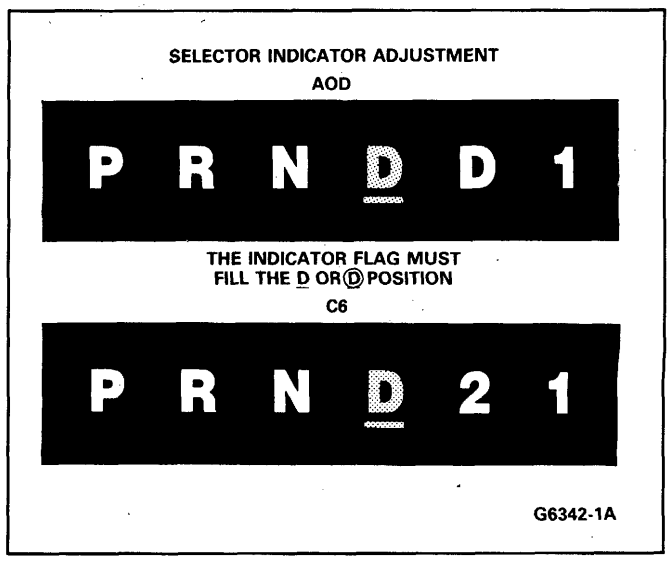


FIG. 4 Selector Indicator Adjustment

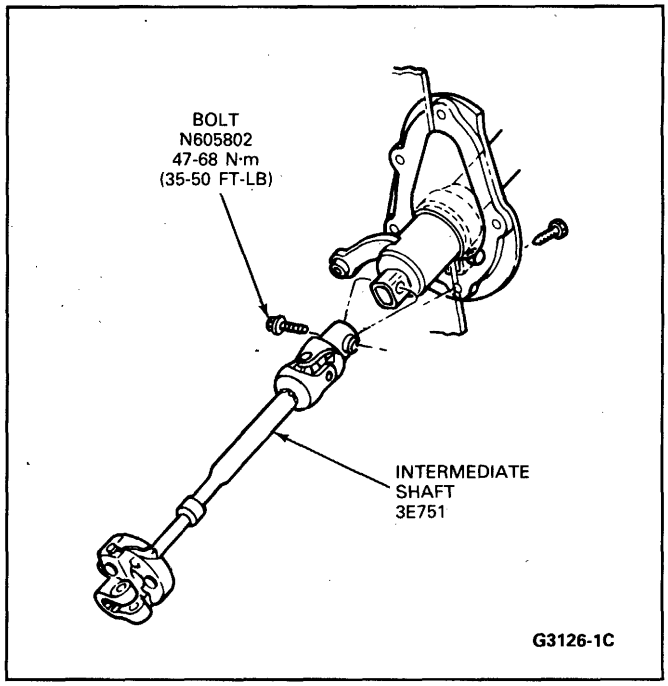


FIG. 5 Pot Joint Alignment F-150—F-350, Bronco and F-Super Duty

are not used in the wheel installation. The steering wheel can be installed in any position relative to the steering shaft.

1. Set wheels in straight ahead position by driving vehicle a short distance and mark the steering wheel and steering column relationship with a chalk mark.
2. Note the steering wheel position with toe adjusted on E-Series, if off center (spokes in horizontal position) more than plus or minus 10 degrees in a vertical plane (Fig. 3), remove the steering wheel as described in this Section.
3. Install the steering wheel on the steering column so that the steering wheel is within 10 degrees plus or minus from horizontal.

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4. Position steering wheel into place with retaining nut.
5. Install a new lock nut (389530-S2) and tighten to 41-57 N·m (30-42 ft-lb).
6. Connect the spade terminal of the horn switch wire to the blade connector, and press the "J" clip ground terminal fully into the threaded hole.
7. Center the horn switch (pad) on the steering wheel, and install the two attaching screws.

REMOVAL AND INSTALLATION

Steering Wheel

E-150—E-350

Removal

1. Park the vehicle with the front wheels in the straight ahead position. Mark the steering wheel in relationship to the steering column with chalk or two pieces of tape (E-150—E-350 only).
2. Disconnect the battery ground cable.
3. Remove one screw from the underside of each steering wheel spoke, and lift the horn switch assembly (steering wheel pad) from the steering wheel.
4. Disconnect the horn switch wires by pulling the spade terminal from the blade connectors. On vehicles equipped with speed control, squeeze or pinch the "J" clip ground wire terminal firmly and pull it out of the hole in the steering wheel. Do not pull the ground terminal out of the threaded hole without squeezing the terminal clip to relieve the spring retention of the terminal in the threaded hole.
5. Remove the horn switch assembly.
6. Remove steering wheel retaining nut.
7. Use the Steering Wheel Puller, T67L-3600-A or equivalent and remove steering wheel from shaft. Do not hammer on the steering wheel or center shaft or use a knock-off type steering wheel puller as either procedure will damage the steering column.

Installation

The steering wheel can be installed in any position. Therefore, with front wheels in the straight ahead position install the steering wheel on the steering column so the steering wheel is within 10 degrees plus or minus from horizontal.

Steering Wheel

F-150—F-350, Bronco and F-Super Duty and E-150—E-350

Place the steering wheel on the steering column upper shaft, so that the mark and flat on the steering wheel is in line with the mark and flat on the steering column center shaft.

1. Install a steering wheel lock nut (382412-S2 or equivalent). Tighten the nut to 41-57 N·m (30-42 ft-lb).
2. Connect the horn and speed control wires (if equipped).
3. Install the steering wheel horn cover pad. Tighten the screws to 0.8-1.2 N·m (7-11 in-lbs).
4. Connect the negative (-) battery cable to the terminal.
5. Test the steering column for proper operation.

Steering Intermediate Shaft and Flex Coupling

F-150—F-350, Bronco

Removal

Refer to Fig. 6.

1. Remove bolt and nut connecting intermediate shaft to steering column.
2. Remove the cover from the flexible coupling.
3. Remove the pinch bolts and disengage the lower end of the intermediate shaft from the steering gear.

Installation

1. Install the intermediate shaft to steering gear and tighten the pinch bolt to 34-46 N·m (25-34 ft-lbs).
2. Install the cover over the intermediate shaft and attach to steering gear.
3. Attach intermediate shaft to steering column, making sure notch in pot joint is matched to the flat on the column shaft (Fig. 4). Install nut and bolt and tighten to 46-68 N·m (35-50 ft-lbs).

Steering Column

F-150—F-350, Bronco and F-Super Duty

Refer to Fig. 6.

Removal

Set parking brake before proceeding. Also remove the battery cable from the negative terminal.

1. Remove bolt and nut attaching intermediate shaft to steering column.
2. Disconnect shift linkage rod(s) from column.
3. Remove steering wheel per this section. If a tilt steering column is being serviced, the steering wheel must be in the full "UP" position when it is removed, be sure the full "UP" position is attained.
4. Remove the steering column floor opening cover plate screws.
5. Remove shroud by loosening screw at bottom, selecting position "1" on manual 3 speeds and automatics and spreading shroud open. Pull shroud out of instrument panel opening, while pulling up and away from column.
6. Remove PRND21 indication actuation cable (automatics).
7. Remove the instrument panel column opening cover.
8. Remove the bolts attaching the column support bracket to the pedal support bracket.
9. Disconnect the turn signal-hazard warning and ignition switch wiring harnesses.
10. Remove column from vehicle.
11. Remove column support bracket from steering column.

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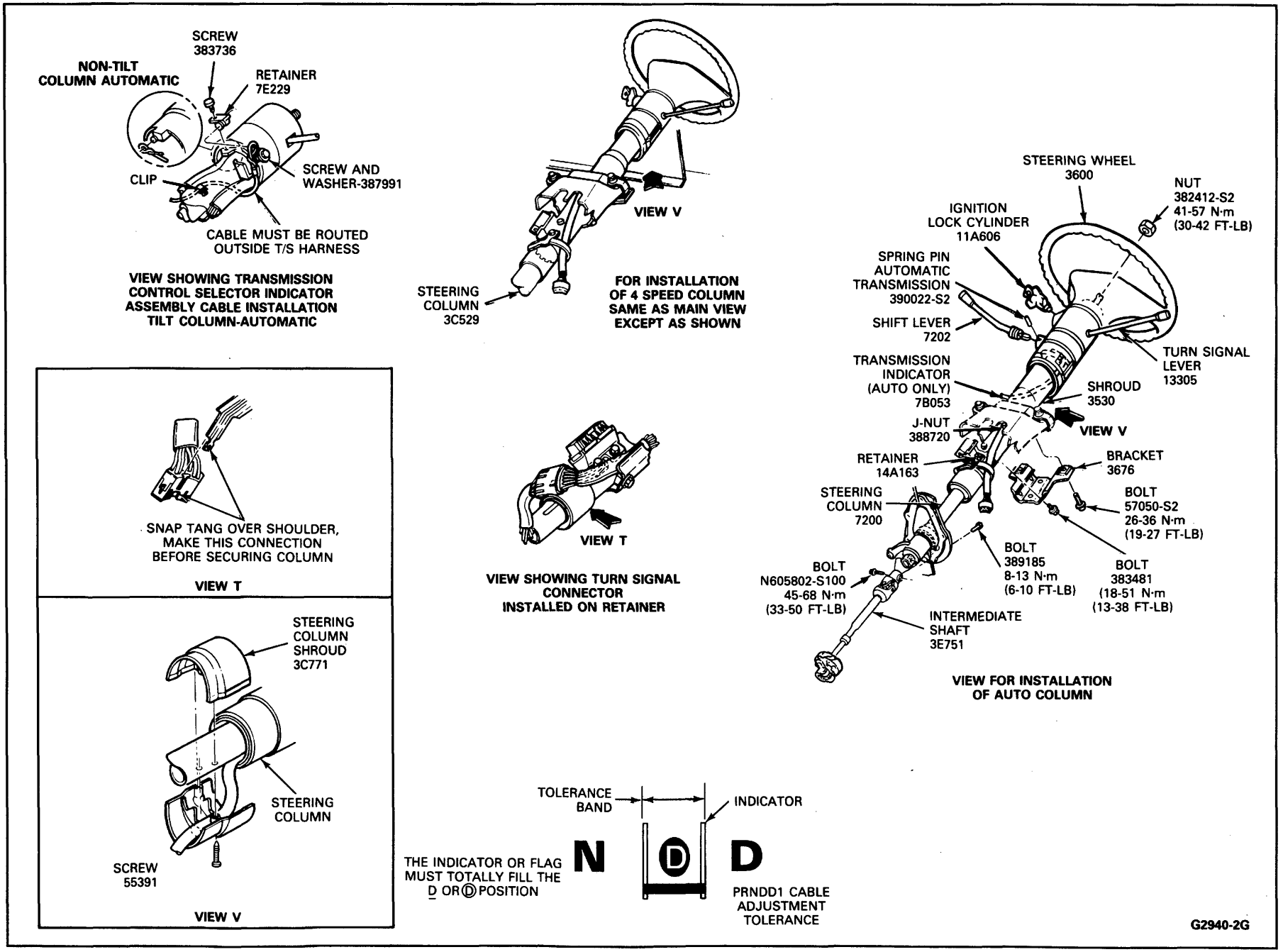


FIG. 6 Steering Column Installation—F-150—F-350, Bronco and F-Super Duty

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Installation

1. Attach steering column support bracket making sure turnsignal-hazard warning wiring is on outboard side of column. Tighten nuts to 18-51 N·m (13-38 ft-lbs).
2. Start the floor opening cover clamp bolt and press the plate until clamp flats touch the stops on column outer tube.
3. Load column into vehicle through opening in floor.
4. Connect turnsignal-hazard warning and ignition switch wiring harnesses.
5. Raise column up to pedal support bracket and hand start the 2 bolts.
6. Fasten floor opening cover plate to floor. Tighten to 8-14 N·m (6-10 ft-lbs).
7. Tighten the 2 support bracket bolts 26-37 N·m (19-27 ft-lbs).
8. Tighten the cover plate clamp bolt 11-24 N·m (8-18 ft-lbs).
9. Install and adjust the PRND21 indication actuation cable on automatics per this Section.
10. Install instrument panel steering column opening cover.
11. Mount shroud by selecting position "1" on automatic transmissions, spreading shroud around steering column and through opening in instrument panel. Post on interior will index shroud when properly positioned.
12. Tighten screw at bottom of shroud 1.1-1.7 N·m (10-15 in-lbs).
13. Attach shift linkage rod(s) to column.
14. Fasten intermediate shaft to steering column tighten to 46-68 N·m (35-50 ft-lbs).

Steering Column

E-150—E-350

Refer to Fig. 7.

Removal

1. Set the parking brake.
2. Remove the battery cable from the negative (-) post.
3. Remove the 2 nuts attaching the flexible coupling to the steering shaft flange (Fig. 7).
4. Remove the shift linkage rod(s) from the steering column.

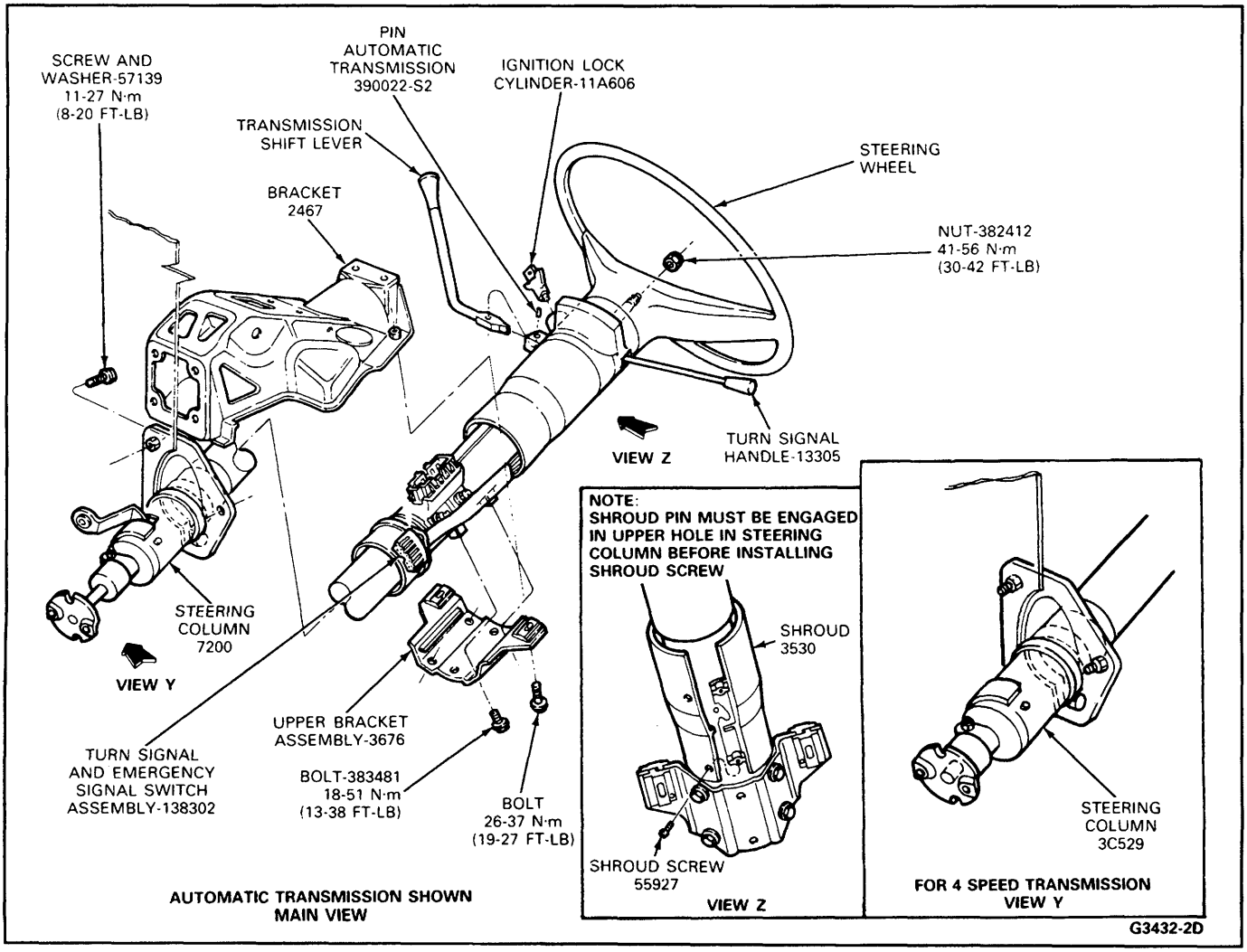


FIG. 7 Steering Column Installation—E-150—E-350

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5. Remove the steering wheel per this Section. If a tilt steering column is to be serviced, the steering wheel must be in the full "UP" position when it is removed. Be sure the full "UP" position is attained.
6. Remove the steering column floor opening cover plate screws.
7. Remove the shroud by loosening the screw at the bottom. Place the shift lever in "1" on automatic transmission models. Spread the shroud and withdraw it from the instrument panel opening while pulling up and away from the column.
8. Remove the instrument cluster column opening cover.
9. Remove the 2 bolts attaching the column bracket to the pedal support bracket.
10. Disconnect the turnsignal-hazard warning and ignition switch wiring harnesses.
11. Remove the steering column from the vehicle.
12. Remove the steering column support bracket from the column.

Installation

1. Place the steering column in the vehicle.
2. Connect the turn signal-hazard warning and ignition switch wiring harnesses.
3. Inserting the steering shaft flange through the floor opening such that the flange engages the flexible coupling, raise the steering column up to the pedal support bracket. Loosely install the column support bolts.
4. When the column has been removed, the flange assembly will be fully telescoped into the column. Gently tap the flange down to engage the flexible coupling.
5. Loosely install the flexible coupling flange nuts and floor plate fasteners.
6. Align the steering column and flexible coupling as described in Steering Column Alignment and Adjustments in this Section (Steps 4-8). Install the steering wheel and align as described in this Section.
7. Attach the shift linkage rod(s).
8. Connect the battery.

Upper Components—Steering Column: Upper Shaft Bearing, Flange, and Shift Socket/ Flange Extension

To facilitate service of upper steering column components, steering column removal and disassembly is recommended. Refer to Disassembly and Assembly—Steering Column in this Section.

Lower Bearing Retainer

F-150—F-350, Bronco and F-Super Duty

Refer to Fig. 21.

The bearing retainer may be removed and disassembled without disassembling the rest of the column.

NOTE: For E-150—E-350 columns must be removed. See Disassembly and Assembly in this Section.

Removal—From The Vehicle Without Column

1. Disconnect steering coupling shaft from steering column.
2. Remove the 3 bearing retainer screws.
3. Remove the bearing retainer assembly.

Installation—While Column Is In Vehicle

1. Install the bearing retainer assembly on steering shaft aligning flats on shaft with flats on shaft retainer.
2. Slide bearing retainer onto shaft and into position, being careful not to compress telescoping steering shaft.
3. Fasten the bearing retainer assembly to column outer tube 1.4-2.3 N·m (12-20 in-lbs).
4. Centerline of coupling shaft attachment hole must extend 20.3mm (0.8 inches) below bearing retainer lower face. Minor adjustments may be made by gentle tapping in the appropriate direction on the shaft.
5. Attach the coupling shaft and tighten to 61-80 N·m (45-59 ft-lbs).

Floor Opening Cover Plate

Removal

1. Remove the steering column from the vehicle per this Section.
2. Remove the lower bearing retainer as described in the preceding procedure.
3. Drill out the shift tube retention rivet on automatic transmissions.
4. Drive out the shift lever pivot pin and remove the shift lever on automatic transmission vehicles.
5. Partially withdraw the shift tube assembly on automatic transmissions.
6. Remove the cover plate clamp and remove cover plate.

Installation

1. Install cover plate on steering column outer tube so that the dished surface is facing up the column. Reinstall clamp ensuring clamp engages cover plate tabs.
2. Hand start the clamp bolt.
3. Reverse the removal procedure. Install a new 3/16 inch pop rivet.

Column Lock Actuator and Steering Wheel Lock Pin

Removal

1. Remove the steering column from the vehicle per this Section.
2. Disassemble the column per this Section to remove the flange.
3. Remove the ignition lock drive gear detailed in this Section.
4. Withdraw the steering wheel lock pin—ignition switch actuator assembly.
5. Remove and discard the retaining clip at the lower end of the lock pin. Remove the pin and spring

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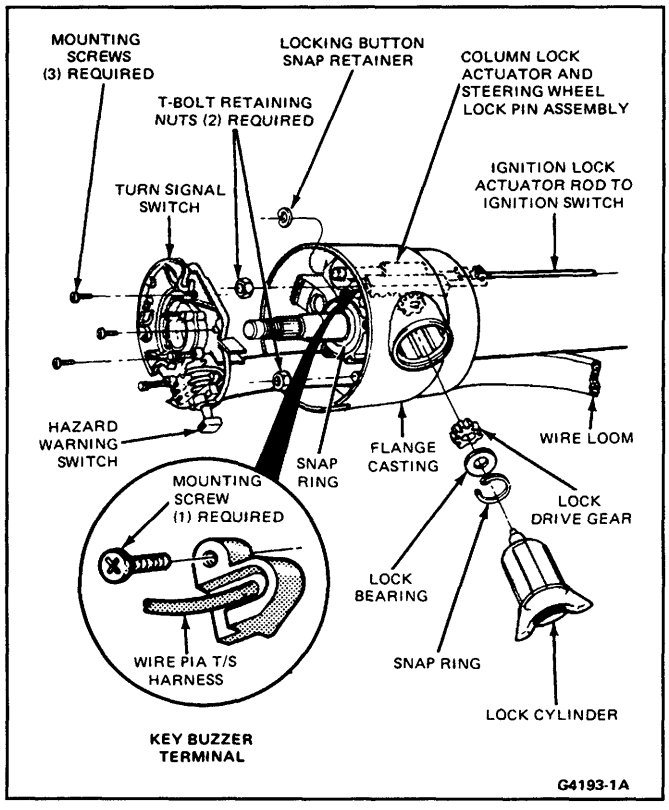


FIG. 8 Non-Tilting Column Mechanism

from the ignition switch actuator. **Do not lose the spring.**

Installation

1. Install a new lock pin and clip, and the old lock pin spring in the actuator.
2. Place the steering wheel lock pin-ignition switch actuator assembly in the flange casting.
3. Install the lock drive gear per this Section.
4. Assemble the column per this Section.
5. Install the steering column per this Section.

Ignition Lock Cylinder Assembly (With Key)

Refer to Fig. 8.

Removal

1. Disconnect the battery ground cable.
2. Remove the steering wheel trim pad and the steering wheel as described earlier in this Section for Non-Tilt Steering Columns only.
3. Place the gear shift in PARK (with automatic transmission) and turn the lock cylinder with the ignition key to ON position.
4. Place 3.17mm (1/8 inch) diameter wire pin or small drift punch and depress the retaining pin while pulling out on the lock cylinder to remove it from the column housing. The pin is located inside the column near the base of the lock cylinder on Non-Tilt Steering Column (Fig. 9). On Tilt Steering Columns the pin is located adjacent to the Hazard Warning Button (Fig. 10).

Installation

1. Lubricate the lock cylinder with grease.

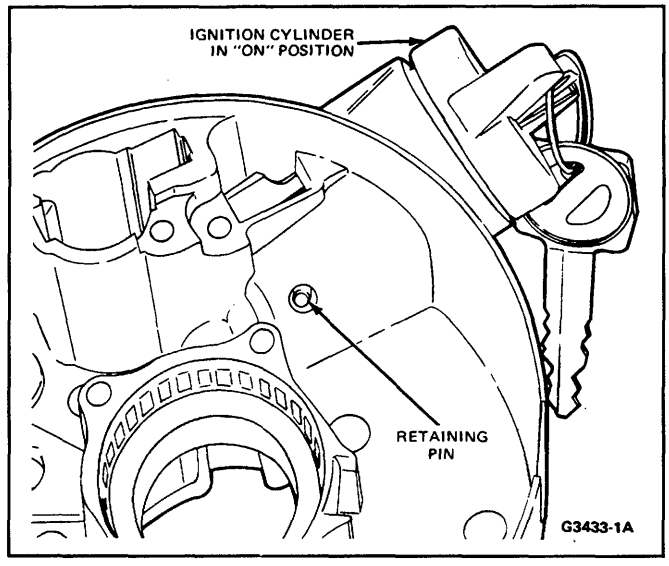


FIG. 9 Lock Retaining Pin Access Slot—Non-Tilt Column

2. To install the lock cylinder, turn the lock cylinder to the ON position and depress the retaining pin, then insert the lock cylinder into its housing in the flange casting. Assure that the cylinder is fully seated and aligned into the interlocking washer before turning the key to the OFF position. This action will permit the cylinder retaining pin to extend into the cylinder casting housing hole.
3. Using the ignition key, rotate the lock cylinder to insure correct mechanical operation in all positions.
4. Install the steering wheel and trim pads as described earlier in this Section on Non-Tilt Steering Columns only.
5. Connect the battery ground cable.
6. Check for proper start in Park or Neutral. Also check to make certain that the start circuit cannot be actuated in the Drive and Reverse positions.

Ignition Lock Cylinder (Without Key)

NOTE: The following procedure applies to vehicles where the ignition lock is inoperative and the lock cylinder cannot be rotated due to a lost or broken ignition key and the key number not known or the lock cylinder cap is damaged and/or broken to the extent that the lock cylinder cannot be rotated.

Removal (Non-Tilting Column)

1. Disconnect the battery ground cable.
2. Remove the steering wheel and pad assembly as described earlier in this Section.
3. Remove the turn signal lever from the steering column.
4. To gain access to the ignition switch remove the steering column trim shrouds from the steering column. Detach and lower the steering column assembly from the brake pedal support bracket as described earlier in this Section.
5. Remove the ignition switch and key warning buzzer terminal and pin it in the LOCK position as described in this Section under Adjustments.

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6. Remove the turn signal switch from the column assembly as described in this Section.
7. Remove the upper bearing snap ring and the (2) T-bolt retaining nuts that secure the flange casting to the outer tube. Remove the entire flange casting assembly, the upper shaft bearing, the lock cylinder assembly, the ignition switch actuator and the ignition switch actuator rod by pulling the assembly over the end of the steering column shaft (Fig. 11).
8. Remove the lock actuator insert, the T-bolts, and the PRND21 insert on automatic transmissions or the key release lever assembly on 4-speed transmissions.
9. Replace the above assembly with a new assembly consisting of:

   (1) 3511 Flange

   (1) 11582 Lock Cylinder Assembly

   (1) 3E717 Lock Gear, Steering Column Lock

   (1) 3E700 Bearing, Steering Column Lock

   (1) 3C610 Retainer, Steering Column Upper Bearing

   (1) 3E723 Actuator Assembly, Steering Column Lock
10. Install the key release lever assembly on 4-speed equipped vehicles and the PRND21 insert on vehicles with automatic transmission. Install the T-bolts and lock actuator insert.

    NOTE: Retain the ignition switch actuating rod from the removed casting assembly and use it with the new flange casting assembly.

Installation (Non-Tilting Column)

1. Reassemble the above parts, install a new upper shaft bearing (3517) and set the actuator to drive gear as described earlier in this Section.
2. Install the turn signal—hazard warning switch and key warning buzzer as described earlier in this Section.
3. Install the ignition switch, check and/or adjust for proper function as specified in Section.
4. Install the steering column assembly to the brake pedal support bracket as specified earlier in this Section.
5. Install the steering column trim shrouds, steering wheel and pad assembly as specified earlier in this Section.
6. Install the turn signal lever.
7. Using the ignition key, rotate the lock cylinder to insure correct mechanical operation in all positions.
8. Connect the battery ground cable.
9. Check for proper start in Park and Neutral. Also check to make certain that the start circuit cannot be actuated in the Drive and Reverse positions.

Removal (Tilting Column)

1. Disconnect the battery ground cable. Remove the steering column trim shrouds as described earlier in this Section.
2. Tape the gap between the steering wheel hub and the cover casting. Cover the entire circumference of the casting. Also cover the adjacent seat and floor area with a suitable covering to protect the surrounding interior upholstery. Pull out the hazard flasher switch and tape it down toward the floor as

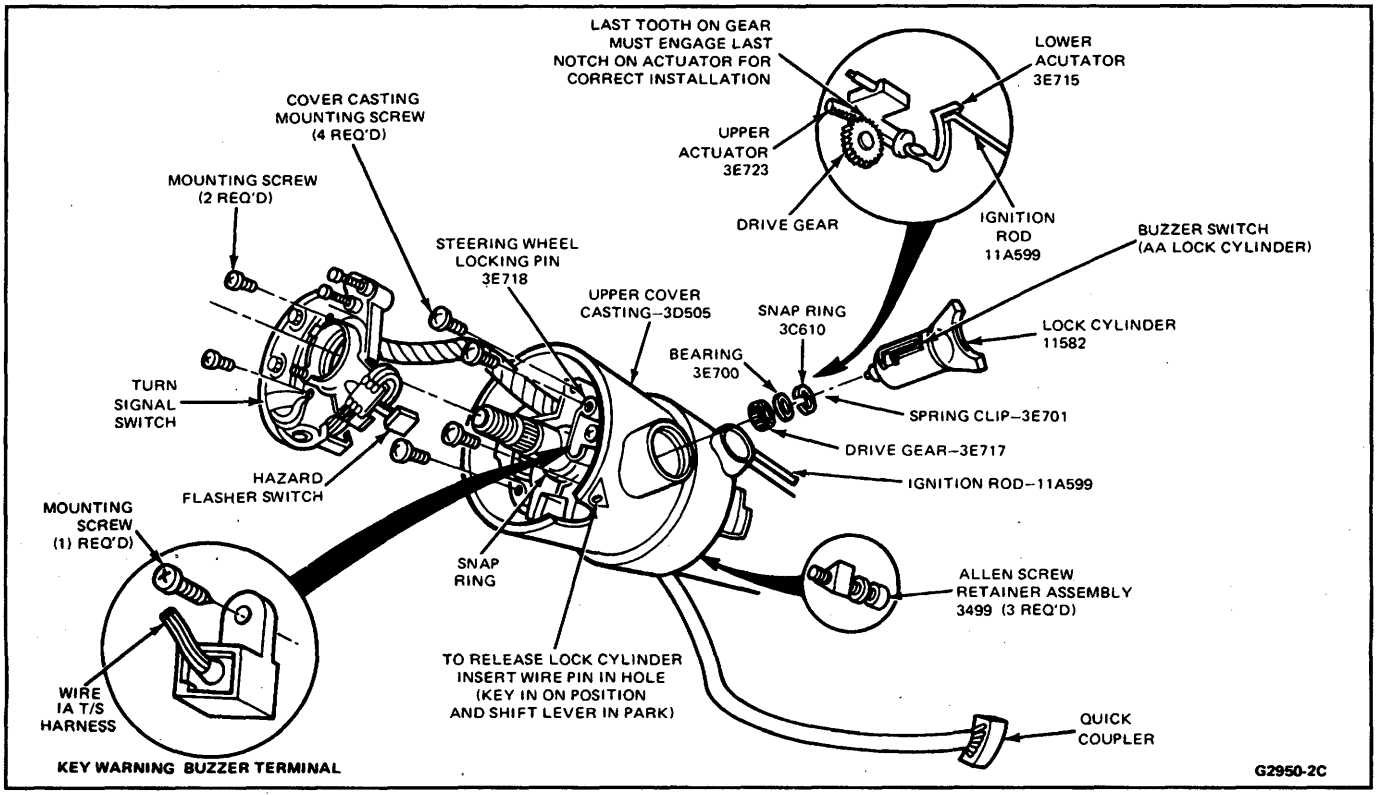


FIG. 10 Tilt Column Mechanism

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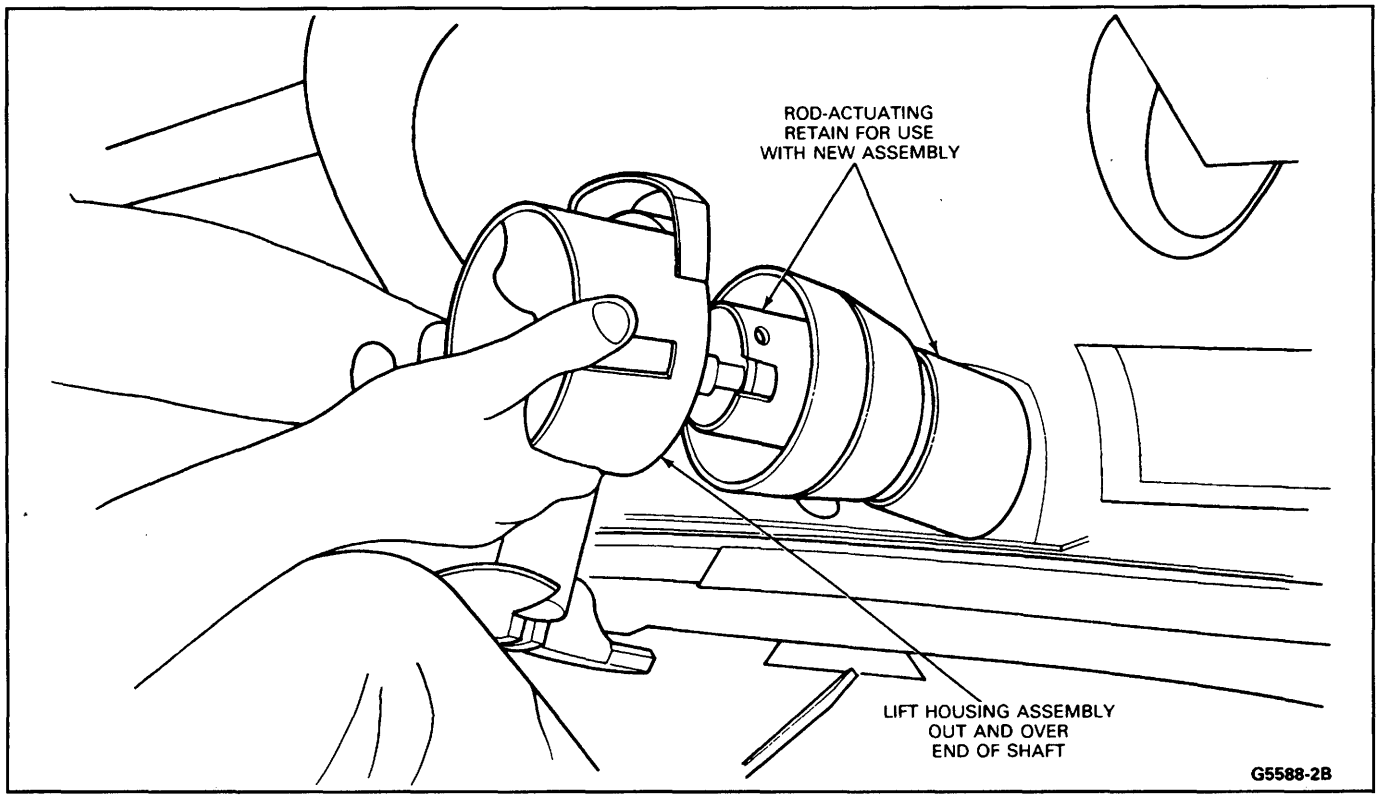


FIG. 11 Removing Flange Casting

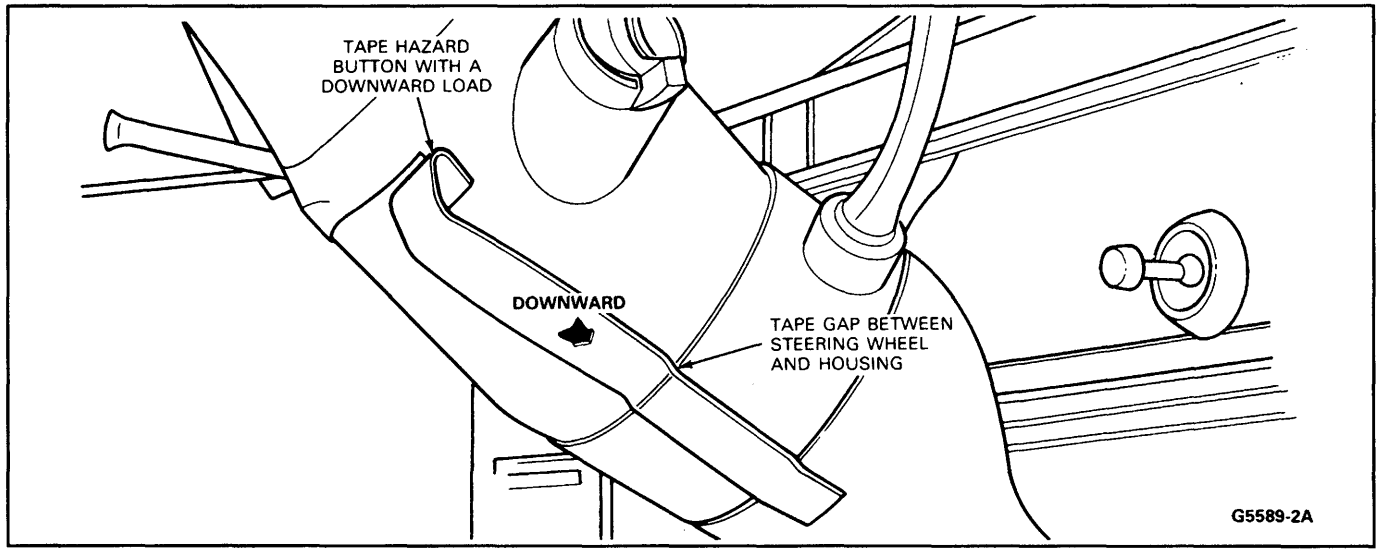


FIG. 12 Taping Hazard Switch

shown in Fig. 12 to provide clearance for drilling out the lock cylinder retainer pin.

3. The tilt column lock cylinder retaining pin is located on the outside of the steering column cover casting adjacent to the hazard flasher button.

4. Tilt the steering column to the full up position and prepunch the lock cylinder retaining pin with a prick punch. Using a 3.17mm (1/8 inch) diameter drill with a right angle drive, drill out the retaining pin, going no deeper than 12.7mm (1/2 inch). (Fig. 13).

   NOTE: When drilling out the retaining pin, take care not to damage the cover cast housing or the hazard flasher switch.

5. Tilt the steering column to the full down position. Place a chisel at the base of the ignition lock cylinder cap, and, using a hammer, strike the chisel with sharp blows to break the cap away from the lock cylinder. (Fig. 14).

6. Using a 9.8mm (3/8 inch) diameter drill, drill down the middle of the ignition lock key slot approximately 45mm (1-3/4 inch) until the lock cylinder breaks loose from the steering column cover casting. Remove the lock cylinder, and the drill shavings from the base of the cover cast housing (Fig. 15).

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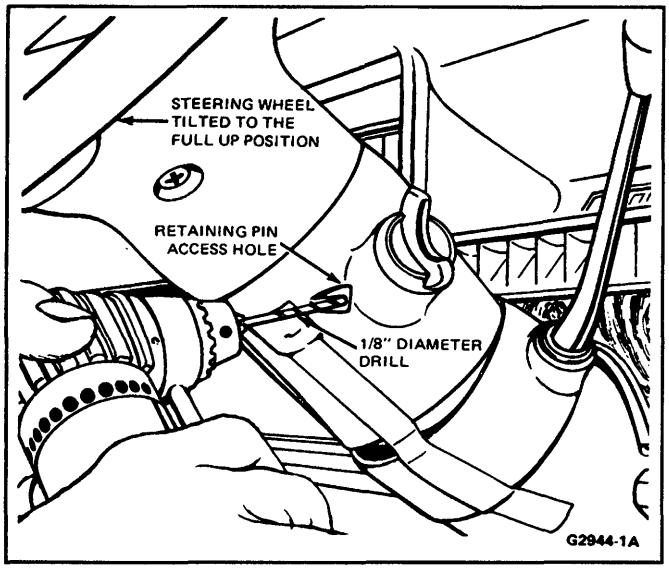


FIG. 13 Drilling Out The Lock Retaining Pin

7. Remove the steering wheel and pad as described earlier in this Section.
8. Remove the turn signal lever from the column and then remove the two attaching screws from the turn signal switch and one attaching screw from the key warning buzzer terminal. Lift the turn signal switch up and over the end of the steering shaft but do not disconnect it from the wiring harness.
9. Remove the four attaching screws from the cover casting and lift the casting over the end of the steering shaft allowing the turn signal switch to pass through the cover casting. The removal of the cover casting will expose the upper actuator (3E723). Remove the upper actuator.
10. Remove the drive gear, snap ring and washer from the cover casting along with the upper actuator mentioned above. Thoroughly clean the components in an acceptable cleaning solution. Carefully inspect all components for any damage resulting from the drilling operation. If any of the components show signs of damage, they must be replaced. Clean the removed cover casting with compressed air to remove any drill shavings or foreign particles and carefully inspect it for damage. If the cover casting is damaged, replace it with a new one primed and painted to match the existing column.

Installation (Tilting Column)

1. Lubricate the tang of the lock cylinder with grease.
2. Attach the upper actuator to the lower actuator and lubricate the upper actuator. Reassemble the cover casting, upper actuator, turn signal switch and lever, lock drive gear, lock cylinder, steering wheel and pad, and the steering column trim shrouds as described earlier in this Section.
3. Using the ignition key, rotate the lock cylinder to insure correct mechanical operation in all positions.
4. Connect the battery ground cable.
5. Check for proper start in Park or Neutral. Also check to make certain that the start circuit cannot be actuated in the Drive and Reverse positions.

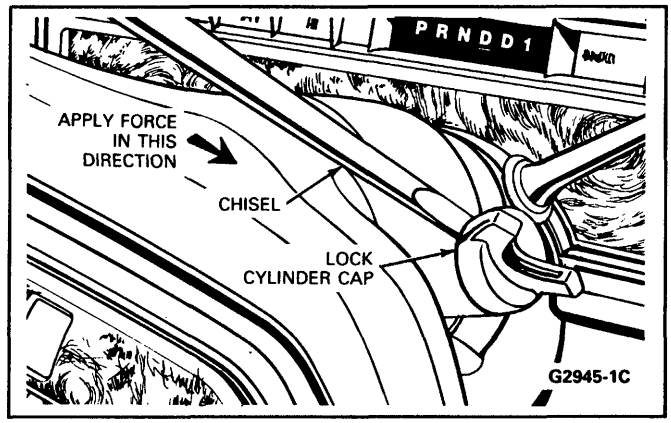


FIG. 14 Breaking The Cap Away From The Lock Cylinder

Ignition Lock Drive Gear

Refer to Figs. 8 and 10.

Removal

1. Remove the lock cylinder assembly as detailed in this Section.
2. Insert a flat-bladed screwdriver in the recess of the drive gear at the bottom of the lock cylinder housing. Turn the lock drive gear counterclockwise three notches.
3. Remove the snap ring, washer and lock drive gear from the lock cylinder housing. Note the position of the drive gear to the rack teeth.

Installation

1. Install the lock drive gear in the housing in the same position as noted during removal. Installation is correct if the last tooth on the drive gear is meshed with the last tooth on the rack. Install the washer and snap ring.
2. Using the screwdriver blade, turn the drive gear clockwise three notches.
3. Install the lock cylinder.

Manual Transmission Key Release Button and Lever

Refer to Fig. 16.

NOTE: All manual transmission equipped vehicles require the column to be removed from the vehicle to service these components.

Removal

1. Remove the steering wheel per this Section.
2. Remove the shroud.
3. Remove the 3 screws retaining the flange extension. Allow the extension to slide down the column. (Manual 4-speed only).
4. Remove the turn signal lever (non-tilt only).
5. Remove the turn signal-hazard warning switch and key warning buzzer terminal retaining screws. Withdraw the switch from the flange, over the steering shaft, and allow it to hang (non-tilt only).
6. Remove and discard the snap ring from the release lever pivot pin.
7. Remove the release lever and spring from the flange casting.

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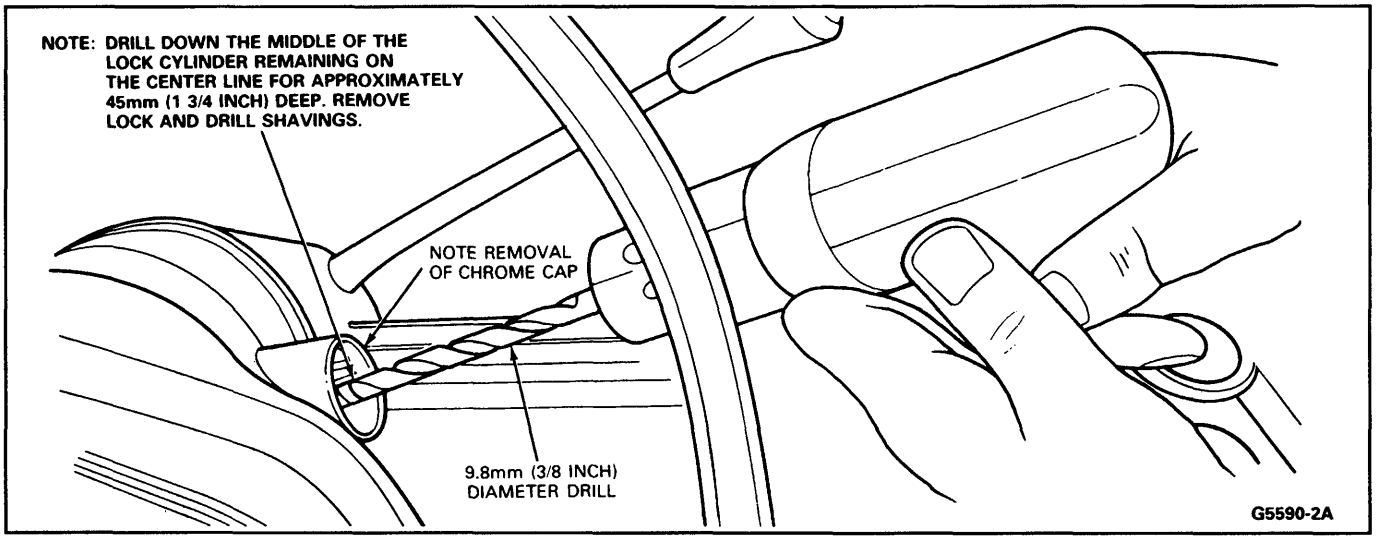


FIG. 15 Drilling Out the Cylinder

8. Remove the spring from the release lever.

Installation

1. Install the spring to the release lever.
2. Install the lever and spring on to the flange making certain that the spring is against the flange providing the automatic return of the lever.
3. Install a new snap ring.
4. Install the flange per this Section.
5. Install the turn signal-hazard warning switch and key warning buzzer terminal (non-tilt) tighten screws to 1.7-2.8 N·m (15-25 in-lbs).
6. Install the flange extension. Tighten screws to 1.1-2.2 N·m (10-20 in-lbs) (tilt) extension 1.7-2.5 N·m (15-22 in-lb).
7. Install the turn signal lever. Tighten to 3.4-5.1 N·m (30-45 in-lbs).
8. Install the steering wheel per this Section.

DISASSEMBLY AND ASSEMBLY

Non-Tilting Steering Column

Refer to Figs. 17, 18 and 19.

Disassembly

1. Remove column from vehicle per this Section and clamp in vise.

   CAUTION: Clamping is permitted only on the upper tube. Care is to be taken not to permanently deform the tube wall. Permanent deformation may affect column performance during an accident.

2. Remove turn signal lever.
3. Drive out pivot pin and remove hand shift lever (automatics).
4. Partially withdraw turn signal-hazard warning switch and key warning buzzer terminal from upper flange.
5. Remove snap ring from upper steering shaft.
6. Remove lower bearing retainer from the bottom of the steering column.

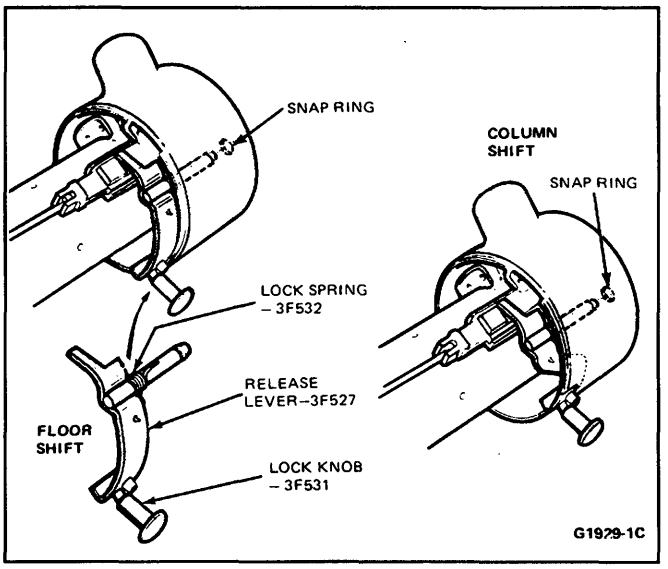


FIG. 16 Locking Button Installation for Non-Tilt Columns

7. Using a light hammer, gently drive the steering shaft out the bottom of the steering column.

   NOTE: Because the steering shaft is a two-piece telescoping type, harsh impacts at either end may alter the shaft in overall length, thus affecting assembly.

8. Using a #10 drill bit, drill out shift tube retaining rivet from bottom of shift socket on vehicles equipped with automatic transmissions (Fig. 20).
9. Withdraw shift tube assembly from column bottom on vehicles equipped with automatics.
10. With the ignition switch clipped in the lock position, remove ignition switch and actuator rod.
11. Remove the PRND21 hood and lens assembly on E-150—E-250—E-350 automatics only.
12. Loosen upper flange retention nuts until one or two threads remain engaged. Pinching nuts toward each other, withdraw upper flange from outer tube.
13. Remove shift socket (automatics) or flange extension (manual 4-speeds), from outer tube.

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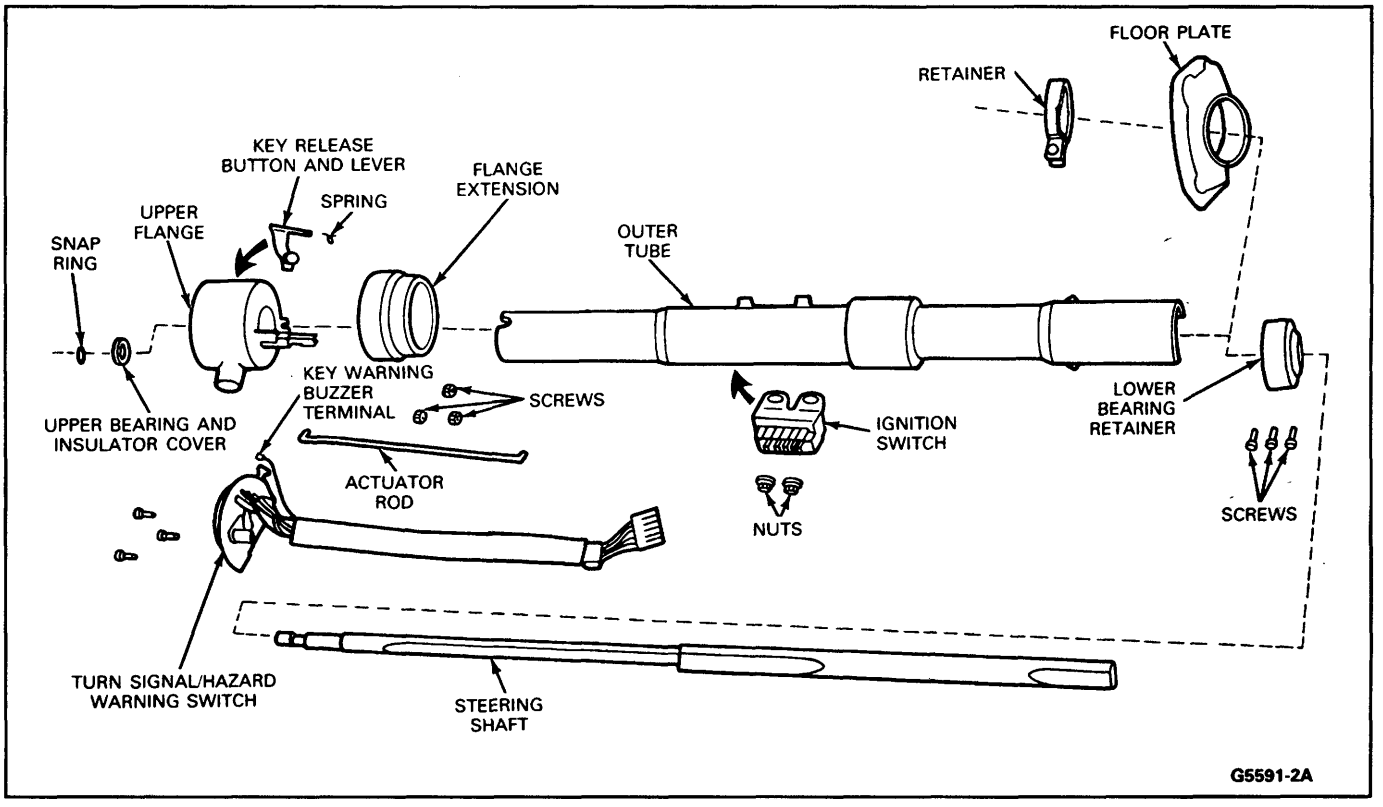


FIG. 17 4-Speed Manual Transmission Non-Tilting Steering Column Exploded View—F-150—F-350, Bronco and F-Super Duty

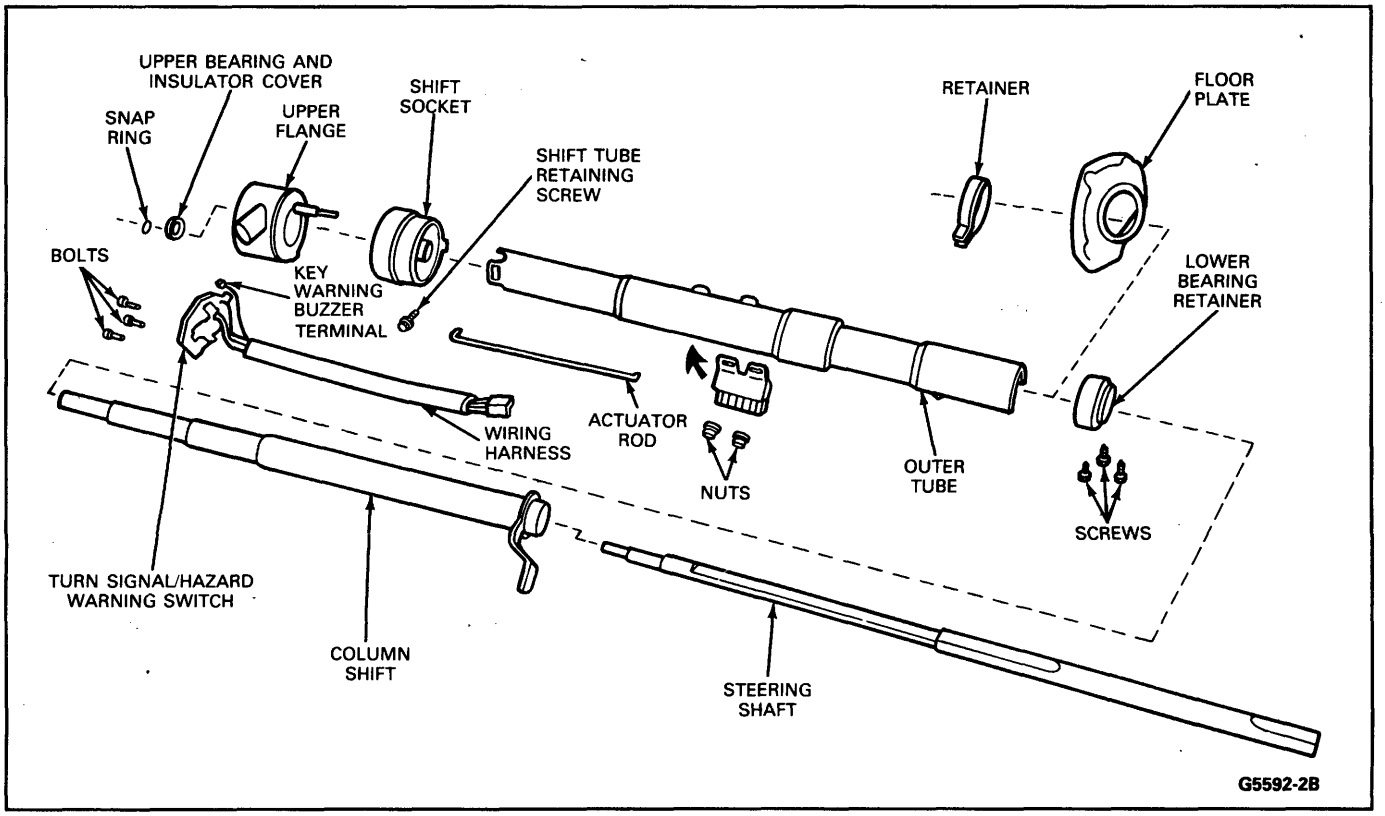


FIG. 18 Automatic Transmission Non-Tilting Steering Column Exploded View—F-150—F-350, Bronco and F-Super Duty

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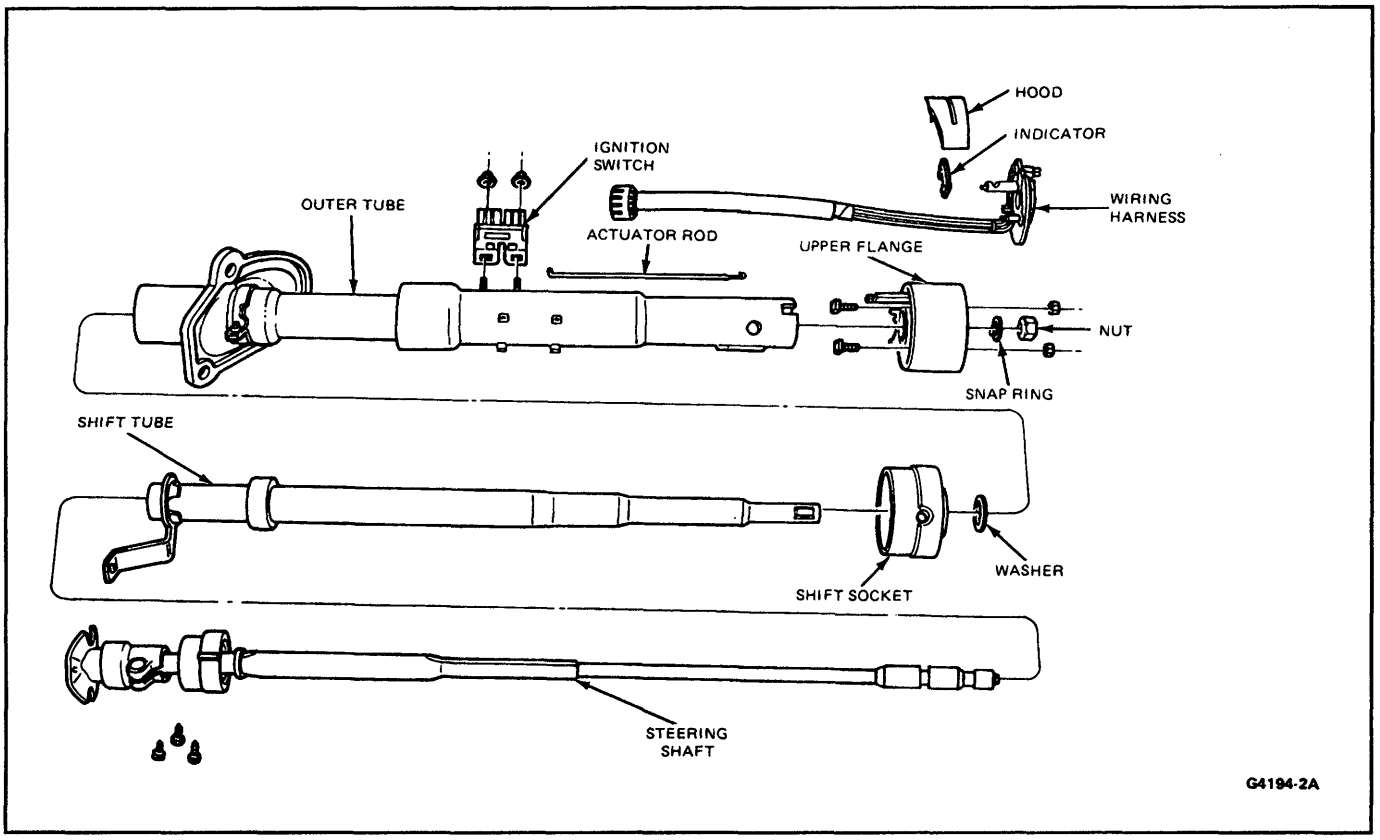


FIG. 19 Non-Tilt Steering Column With Automatic Transmission—E-150—E-350

14. Remove upper bearing and insulator cover from upper flange by gently tapping from opposite side.
15. Disassemble the lower bearing retainer per this Section.

Assembly

1. Place bushing in socket retainer in outer tube (3-speed).
2. Place bushing on upper hub and wave washer on lower hub of shift socket (3-speed).
3. Install shift socket in outer tube (automatics).
4. Install flange extension on outer tube (manual 4-speed).
5. Subassemble upper flange per this Section.
6. Place wave washer in flange hub on automatics.
7. Install subassembled flange onto outer tube by pinching nuts toward each other and pressing flange in place. Retaining bolt "T" head will engage cutouts in outer tube as the nuts are drawn tight. Tighten to 7-8.4 N·m (60-75 in-lbs).
8. Assemble shift tube assembly to shift collar on automatic using pop-rivet (387895 or equivalent) only.
9. Install steering shaft clip below knurl for upper bearing.
10. On F-150—F-350, Bronco and F-Super Duty only, check shaft assembly length to be 90.42 cm (35.6 inch). Adjust by gentle tapping in the appropriate direction.
11. Load shaft up through bottom of column, taking care not to collapse steering shaft on F-150—F-350 and Bronco.
12. Place cover insulator onto upper bearing and press onto knurl of steering shaft until snap ring groove is visible above bearing.
13. Install snap ring on steering shaft in groove above bearing.
14. Install turn signal-hazard warning switch and key warning buzzer terminal and tighten to 1.7-2.8 N·m (15-25 in-lbs).
15. Subassemble lower bearing retainer per this Section.
16. On F-150—F-350, Bronco and F-Super Duty, install lower bearing retainer making sure that the centerline of the coupling shaft attachment hole extends 20.3mm (0.8 in.) below the lower face of the retainer and tighten to 1.4-2.3 N·m (12-20 in-lbs). Minor adjustments in length can be made by gently tapping the shaft in the appropriate direction. On E-150—E-350, install the lower bearing retainer and telescope the steering column lower bayonet shaft (Fig. 21) fully towards the column lower end.

    NOTE: Apply Multi-Purpose Long Life Lubricant C1AZ-19590-B (ESA-M1C75-B) or equivalent to lower bayonnet flange before installing into column.
17. Install the ignition switch actuator rod.
18. Mount the ignition switch and hand start the switch retaining nuts with the lock cylinder in lock position.

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19. Center the switch within the available range of free-play.
20. Tighten the switch retaining nuts to 4.5-7.3 N·m (40-65 in-lbs), and remove clip.
21. Install the hand shift lever and secure by driving in the pivot pin.
22. Install the turn signal switch lever and tighten to 3.4-5.1 N·m (30-45 in-lbs).

Tilt Column

Disassembly

1. Remove the column per this Section and clamp in vise.

   CAUTION: Clamping is permitted only on the upper tube. Care is to be taken not to permanently deform the tube wall. Permanent deformation may affect column performance during an accident.
2. Remove the turn signal lever. Drive out the pivot pin and remove the shift lever (automatics).
3. Remove the lower bearing retainer.
4. To remove the shift tube and/or socket, remove the shift tube retaining rivet from the bottom of the shift socket and withdraw the shift tube from the bottom of the column, (automatics).
5. Remove the lock drive gear as detailed in this Section.
6. Remove the screws securing the turn signal switch and key warning buzzer terminal. Remove the wiring harness-to-steering column tube clips (if required). Remove the turn signal switch and wiring harness from the steering column.
7. Remove the cover casting screws. Lift the cover casting up and over the steering column upper shaft, and remove the casting from the column. Unhook the upper actuator from the lower actuator and remove.
8. Remove and discard the screws that attach the lower flange to the outer tube.
9. Loosen the ignition switch nut and washer assemblies and remove the ignition rod from the switch end.
10. Withdraw the tilt mechanism, steering shaft, and ignition actuator rod from the steering column upper end.
11. Remove the shift socket (automatics).
12. Remove 3 screws retaining the flange extension on manual 4-speeds or PRND21 ring (E-150—E-350 only) (automatics) and remove the extension or ring.
13. Remove the key release lever mechanism from the tilt mechanism (manual 4-speeds).
14. Disassemble the tilt mechanism subassembly per this Section.

Assembly

1. Assemble the tilt mechanism per this Section.
2. Attach the PRND21 or (PRN⓪D1) ring to the tilt mechanism (E-150—E-350 only) (automatics) with 3 screws. Tighten to 1.1-2.2 N·m (10-20 in-lbs).
3. Attach the key release lever mechanism to the tilt mechanism (manual 4-speed) per this Section.
4. Attach the flange extension to the tilt mechanism with 3 screws. Tighten to 1.1-2.2 N·m (10-20 in-lbs).
5. Install the shift socket (automatics).
6. Install the tilt mechanism, feeding the steering shaft down the center of the column and the ignition actuator rod through the shift socket/lower flange extension along the top of the column outer tube. Since the steering shaft is a telescoping type, care should be taken not to change the length of the shaft.
7. Install the 3 flange retainer assemblies using new Allen head screws. Tighten to 5.6-7.7 N·m (50-68 in-lbs). Always use new Allen head screws to be sure the epoxy cement bonds properly.

   Install the lower bearing retainer per this Section.
8. Attach the ignition switch loosely to the outer tube.
9. Connect the upper and lower actuators. Install the cover on the column. Tighten the 3 screws to 4.5-5.6 N·m (40-50 in-lbs).
10. Install the turn signal switch and wiring harness in the steering column. Attach the key warning buzzer terminal and wiring harness-to-steering column tube clips (if required). Install the two screws that attach the turn signal switch to the flange casting and the one screw that attaches the warning buzzer terminal. Tighten the screws to 2.3-3.4 N·m (20-30 lb-in) for the turn signal switch.
11. Install the turn signal lever.
12. Install the lock drive gear.
13. Install the lock cylinder with the key in the ON position. Install the retaining pin flush with the cylinder.
14. Center the ignition within the available range of free play. Tighten the nuts.
15. Install the hand shift lever and pivot pin (automatics).
16. Install the steering column per this Section.

Non-Tilting Steering Column Flange and Locking Mechanism Subassembly

Refer to Fig. 8.

Disassembly

1. Remove nuts and bolts retaining flange to steering column.
2. Remove lock release lever snap ring (manuals).
3. Remove lock release lever and spring.
4. On automatic transmission remove PRND21 insert from front of flange.
5. With the lock cylinder in the "ON" position, depress the retaining pin and remove the lock cylinder.
6. Remove the lock bearing snap ring.
7. Remove the lock bearing.
8. Remove the lock drive gear.
9. Remove lock actuator retaining screw.
10. Remove lock actuator.

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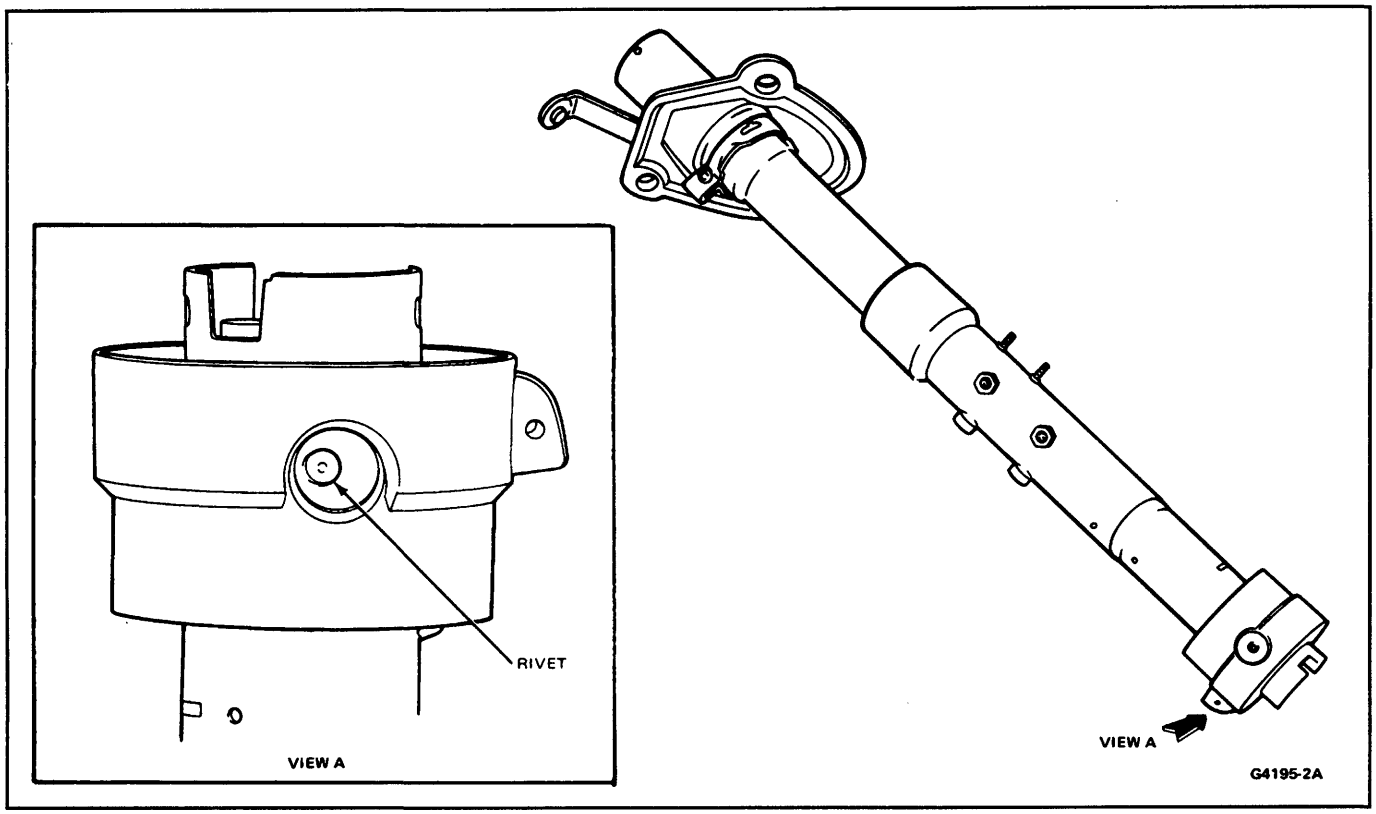


FIG. 20 Rivet Removal—Non-Tilt Steering Column—Automatic Transmission

Assembly

1. Install lock actuator insert in rear of flange and tighten screw. Tighten to 1.7-2.8 N·m (15-25 in-lbs).
2. Insert lock actuator assembly through opening in front of flange until it bottoms against insert.
3. Install lock drive gear through lock cylinder opening such that the last gear tooth aligns, with the last tooth on the actuator assembly when the actuator is fully rearward.
4. Install the lock bearing.
5. Install the lock bearing snap ring.
6. With the lock cylinder in the "ON" position and the retaining pin depressed. Insert the lock cylinder into the flange.
7. Attach PRND21 insert to front of flange on automatic transmissions.
8. Position spring on lock release lever assembly and position lever assembly through hole in front of flange on manual transmissions. Tighten spring until lever assembly is allowed to drop into place.
9. Install snap ring on lock release lever assembly (manuals).
10. Install flange retaining bolts through holes in flange and hand start nuts 1 to 2 threads on rear side.

Tilt Mechanism Upper Shaft, Bearings, and Flange Sub-Assembly

Service of this mechanism requires the steering column to be removed from the vehicle and disassembled on the bench to remove the tilt mechanism.

Disassembly

1. Remove the spring clips holding the wire bale which acts as a release lever for the locking lever. Remove the wire bale (Fig. 22).
2. With a small drift, drive out the pin holding the locking lever. Remove the lever and spring. Use a C-clamp to relieve tension on the pin if necessary.
3. Remove the column upper shaft snap ring.
4. The upper and lower flange castings can now be separated by removing the two pivot pins located in the side of the casting assembly with Tools T70P-3D739-A Pivot Pin Remover and T67P-3D739-C Pivot Pin Remover Handle (Fig. 23).
5. Do not use the pivot pins again if the press fit is loose in the lower flange.

For Bearing Or Upper Flange Service:

6. Place the flange casting on a bench with the smaller bearing facing down.
7. With a small pick, lightly tap on the outer race of the small bearing at each slot. Never drive or apply pressure of any kind to the inner race of the bearing.
8. Invert the flange casting and place it on a bench with the large upper bearing facing down.
9. With a small pick, lightly tap on the outer race of the large bearing at each slot. Never drive or apply pressure of any kind to the inner race of the bearing.

Assembly

1. Position the flange casting on a bench with the large bearing seat facing upward.

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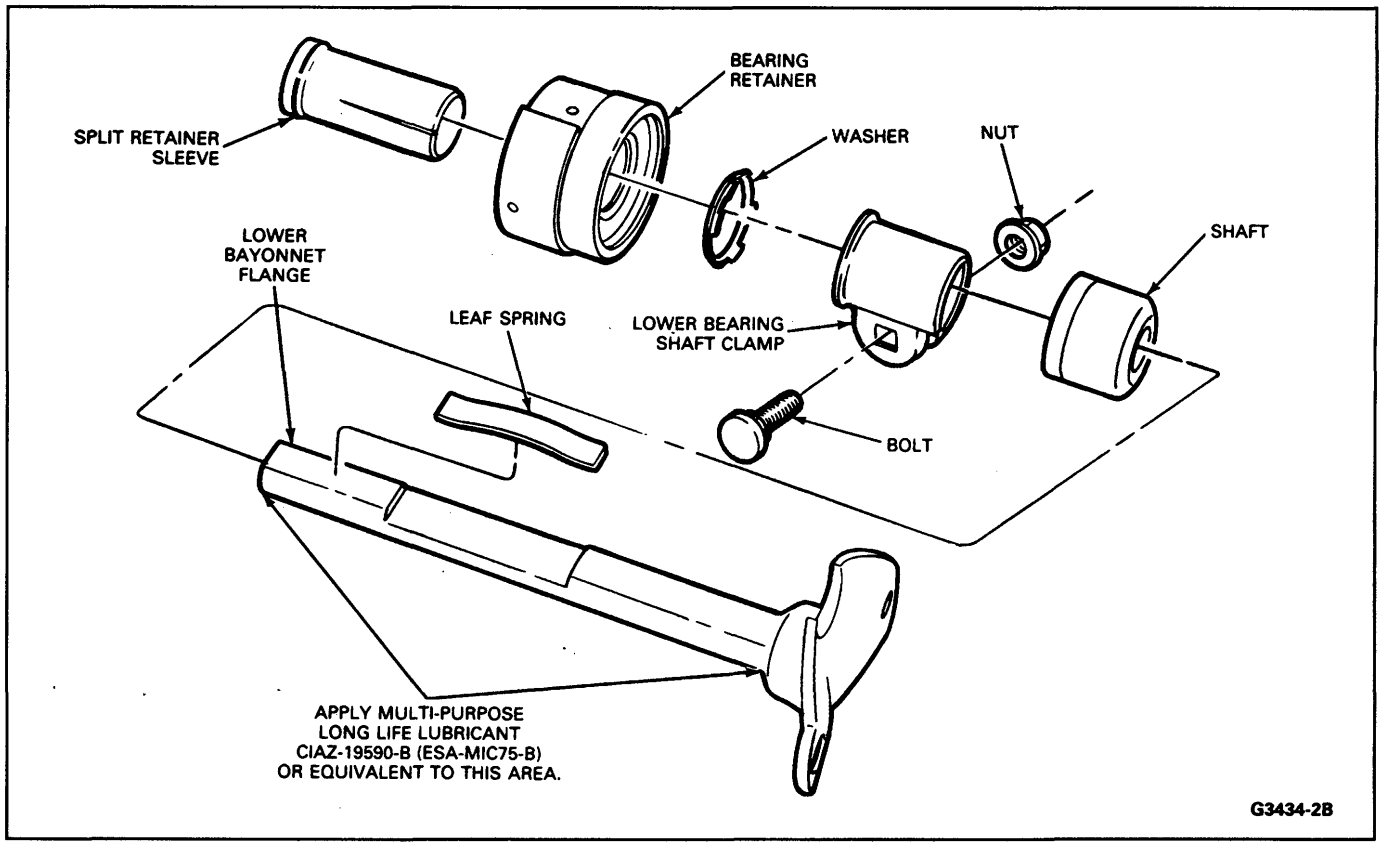


FIG. 21 Lower Bearing Retainer—Exploded View—E-150—E-350

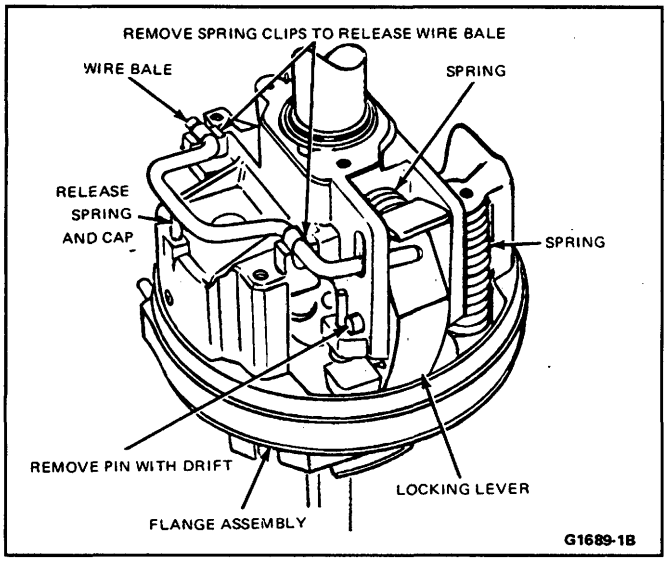


FIG. 22 Removing Wire Bale and Tilt Locking Lever

2. Select a socket wrench that is the same diameter as the outer race of the large upper bearing.
3. Position the large upper bearing over its bearing seat with the open side facing inward.
4. Place the socket wrench on the outer race of the bearing and lightly tap on the socket wrench until the bearing is in place. Be careful not to contact the bearing inner race as damage will result.
5. Invert the flange casting and place it on a bench with the small bearing seat facing upward.
6. Select a socket wrench that is the same diameter as the outer race of the small bearing.
7. Position the small bearing over its bearing seat with the open side facing inward.
8. Place the socket wrench on the outer race of the bearing and lightly tap on the socket wrench until the bearing is in place. Be careful not to contact the bearing inner race as damage will result.

Tilt Mechanism Assembly

1. Install the lower actuator with the ignition switch rod attached.
2. Install the upper and lower flange with the two pivot pins (Fig. 24). Be sure the column position spring is properly seated between the upper and lower flange, and the wavy thrust washer is positioned properly between the lower flange and the socket. Do not re-use loose pivot pins.
3. Install the column upper shaft snap ring.
4. Assemble the locking lever and spring, and insert the pin that holds the lever. Use C-clamp to relieve the tension on the pin, if necessary.
5. Place the wire bale on the upper casting and install the spring clips that hold the bale in place (Fig. 21).

Steering Column Lower Bearing Retainer Subassembly

E-150—E-350

Refer to Fig. 21.

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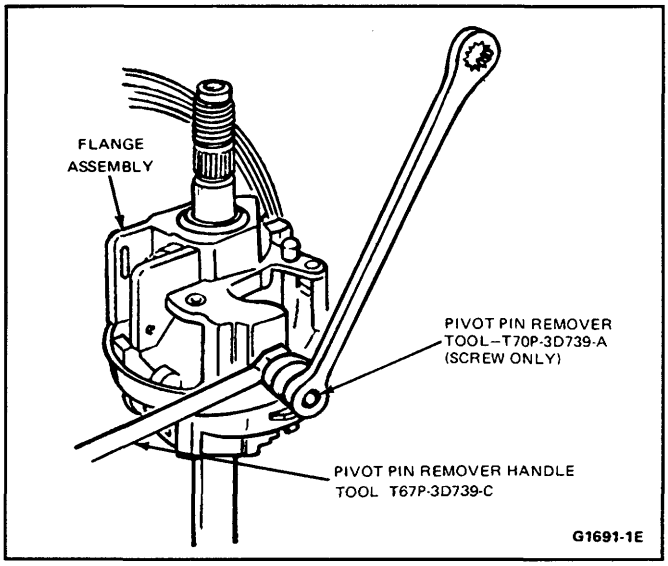


FIG. 23 Removing Pivot Pin

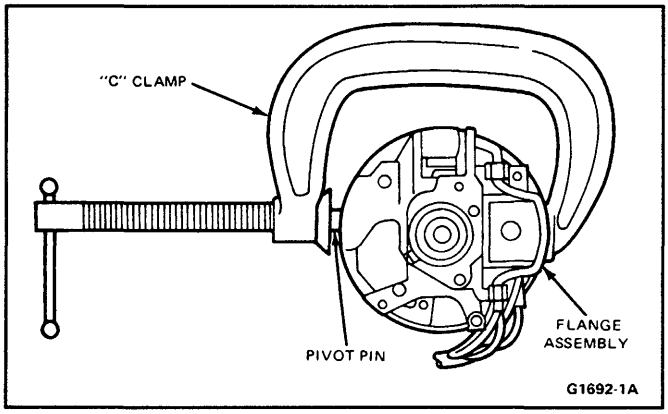


FIG. 24 Installing Flange Assembly Pivot Pins

Disassembly

1. Remove the steering column from the vehicle as described in this Section.
2. Remove the steering column lower bayonet flange and leaf spring.

   NOTE: Do not loosen the leaf spring.
3. Remove the lower bearing shaft clamp, bolt and nut.
4. Remove (3) screws and the lower bearing assembly.
5. Remove the split retainer sleeve from the lower bearing retainer assembly.

Assembly

1. Install the split retainer sleeve into the lower bearing retainer assembly with the sleeve shoulder against the bearing.
2. Loosely assemble the clamp, bolt and nut to the lower bearing retainer assembly. Make sure that the bolt aligns with the round groove in the split retainer sleeve.
3. While pushing down on the split retainer sleeve shoulder and the clamp up towards the bearing, tighten the clamp nut to 13-24 N·m (9-18 ft-lbs).

   NOTE: This step is extremely important to eliminate lash.
4. Install the lower bearing retainer assembly to the column outer tube. Tighten the (3) screws to 1.4-2.3 N·m (12-20 in-lbs).
5. Apply grease to the steering column lower flange bayonet and leaf spring. Assemble and install the flange fully telescoped into the column lower end.
6. Slide seal forward over the flange in the shaft clamp.
7. Install the steering column into the vehicle as described in this Section.

Steering Shaft and Anti-Rattle Clips

Non-Tilting Column

Disassembly

1. Remove the steering column assembly as detailed in this Section.
2. Secure the steering column assembly in a vise.
3. Remove the upper shaft bearing as detailed in this Section.
4. Working from the bottom of the column, remove the steering shaft.
5. Draw a mark on the lower shaft where the upper and lower steering shaft sections form a joint line.
6. Separate the upper and lower steering shaft sections.
7. Remove and discard the two steel anti-rattle clips.

Assembly

1. Install new anti-rattle clips. Be sure both are installed in the same direction.
2. Liberally lubricate the lower six inches of the end of the upper shaft.
3. Secure the lower shaft in a vise. Install the upper shaft to the mark on the lower shaft.
4. Working from the bottom of the column, install the shaft into the column from the bottom.
5. Install the upper shaft bearing.
6. Install the steering column assembly as detailed in this Section.

Tilt Column

Disassembly

1. Remove the steering column assembly as detailed in this Section.
2. Secure the steering column assembly in a vise.
3. It is not necessary to remove the turn indicator switch and wiring harness from the steering column.
4. Working from the top of the column, remove the steering shaft and tilt mechanism.
5. Draw a mark on the lower column where the upper and lower steering shafts form a joint line.
6. Separate the upper and lower steering shafts.
7. Remove and discard the two steel anti-rattle clips.

Assembly

1. Install new anti-rattle clips. Be sure both are installed in the same direction.

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2. Lubricate the lower end of the upper shaft.
3. Secure the lower shaft in a vise and install the upper shaft to the mark on the lower shaft.
4. Install the steering shaft assembly and the tilt mechanism.
5. Install the steering column assembly as detailed in this Section.

SPECIFICATIONS

STEERING COLUMN-SHIFT ROD WITHIN TUBE — TORQUE LIMITS
E-150 — E-250 — E-350, F-150 — F-250 — F-350, BRONCO AND F-SUPER DUTY

Description	Model	Torque (ft-lbs)	Torque (N-m)
Steering Column Coupling Flange Nuts	E-150 — E-250 — E-350	14-21	19-28
Steering Column To Support Bracket Bolts	E-150 — E-250 — E-350	19-27	26-37
Steering Column Floor Opening Cover Plate to Dash Panel Bolts	E-150 — E-250 — E-350	12-18	16-24
Steering Column Opening Cover Clamp Bolt	E-150 — E-250 — E-350	12-18	16-24
Steering Column Cover Plate Clamp Bolt	F-150 — 350, Bronco and F-Super Duty	8-18	11-24
Steering Wheel to Steering Shaft Nut	All	30-42	41-56
Intermediate Shaft Pot Joint to Steering Column Nut	F-150 — 350, Bronco and F-Super Duty	35-50	47-68
Intermediate Shaft Flex Coupling to Steering Gear Bolt	F-150 — 350, Bronco and F-Super Duty	25-34	34-46
Steering Column Support Bracket Nuts	F-150 — 350, Bronco and F-Super Duty	13-38	18-51
Floor Opening Cover Plate	F-150 — 350, Bronco and F-Super Duty	6-10	8-14
Lower Bearing Retainer Clamp Nut	E-150 — E-250 — E-350	9-18	13-24
Pedal Support Bracket Bolts	F-150 — 350, Bronco and F-Super Duty	19-27	26-37
Description	**Model**	**Torque (in-lbs)**	**Torque (N-m)**
Selector Indicator Cable Bracket Screw	F-150 — 350, Bronco and F-Super Duty	20	2.25
Steering Wheel Horn Cover Pad Screws	All	7-11	0.8-1.2
Steering Column Shroud Screw	F-150 — 350, Bronco and F-Super Duty	10-15	1.1-1.7
Upper Bearing Retainer to Column Outer Tube	F-150 — 350, Bronco and F-Super Duty	12-20	1.4-2.3
Lower Bearing Retainer to Column Outer Tube	All	12-20	1.4-2.3
Turn Signal-Hazard Warning Switch Screws (Non-Tilt)	All	15-25	1.7-2.8
(Tilt)	All	20-30	2.3-3.4
Steering Column Flange Extension Screws (Non-Tilt)	All	15-22	1.7-2.5
(Tilt)	All	10-20	1.1-2.2
Turn Signal Lever Screw	All	30-45	3.4-5.1
Subassembled Flange to Outer Tube Nuts	All	60-75	7.0-8.4
Shift Tube Retaining Nut	All	35-50	4.0-5.6
Ignition Switch Retaining Nuts	All	40-65	4.5-7.3
Flange Retainer Allen Head Screws (Tilt)	All	50-68	5.6-7.7
Column Cover (Tilt)	All	40-50	4.5-5.6
PRND21 or PRN D DI Ring to Tilt Mechanism Screws	E-150 — E-250 — E-350	10-20	1.1-2.2
Lock Actuator Insert in Rear of Flange Screws (Non-Tilt)	All	15-25	1.7-2.8

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SPECIAL SERVICE TOOLS

Number	Description	Application
T70P-3D739-A	Pivot Pin Remover	Tilt Column
T67P-3D739-C	Pivot Pin Remover Handle	Tilt Column — Use with Pivot Pin Remover
T67L-3600-A	Steering Wheel Puller	Universal

CG1716-2F

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SECTION 13-24 Steering Linkage

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DIAGNOSIS AND TESTING	13-24-1
REMOVAL AND INSTALLATION	
Drag Link	13-24-3
Pitman Arm	13-24-3
Steering Connecting Rod	13-24-4
Tie Rod Adjusting Sleeve and Ball Stud	13-24-5
REMOVAL AND INSTALLATION (Cont'd)	
Tie Rod Adjusting Sleeve and Ball Stud (Cont'd)	
Rubberized Ball Socket Steering Linkage (R.B.S.)	13-24-5
Tie Rod and Drag Link Assembly	13-24-1
SPECIFICATIONS	13-24-7
VEHICLE APPLICATION	13-24-1

VEHICLE APPLICATION

Applies to F-150—F-350, E-150—E-350, Bronco and F-Super Duty Trucks.

DESCRIPTION

Refer to Figs. 1-6.

The steering linkage is composed of Pitman arm, drag link, steering connecting rod and tie rods. The Pitman arm transfers the steering gear movements through the drag link and steering connecting rod to the tie rods. The tie rod actuates the spindle to the desired steering movement.

The F-150—F-350, Bronco and F-Super Duty steering linkage has adjustments in both the tie rod and the drag link. The E-150—E-350 has an adjustment in the tie rod only.

DIAGNOSIS AND TESTING

Refer to Section 13-01, General Steering Service for diagnostic and testing procedures.

REMOVAL AND INSTALLATION

Tie Rod and Drag Link Assembly

Refer to Figs. 1-6.

Replace the drag link or tie rod if a ball stud is excessively loose, or if the tie rod or drag link is bent. Do not attempt to straighten a drag link or tie rod.

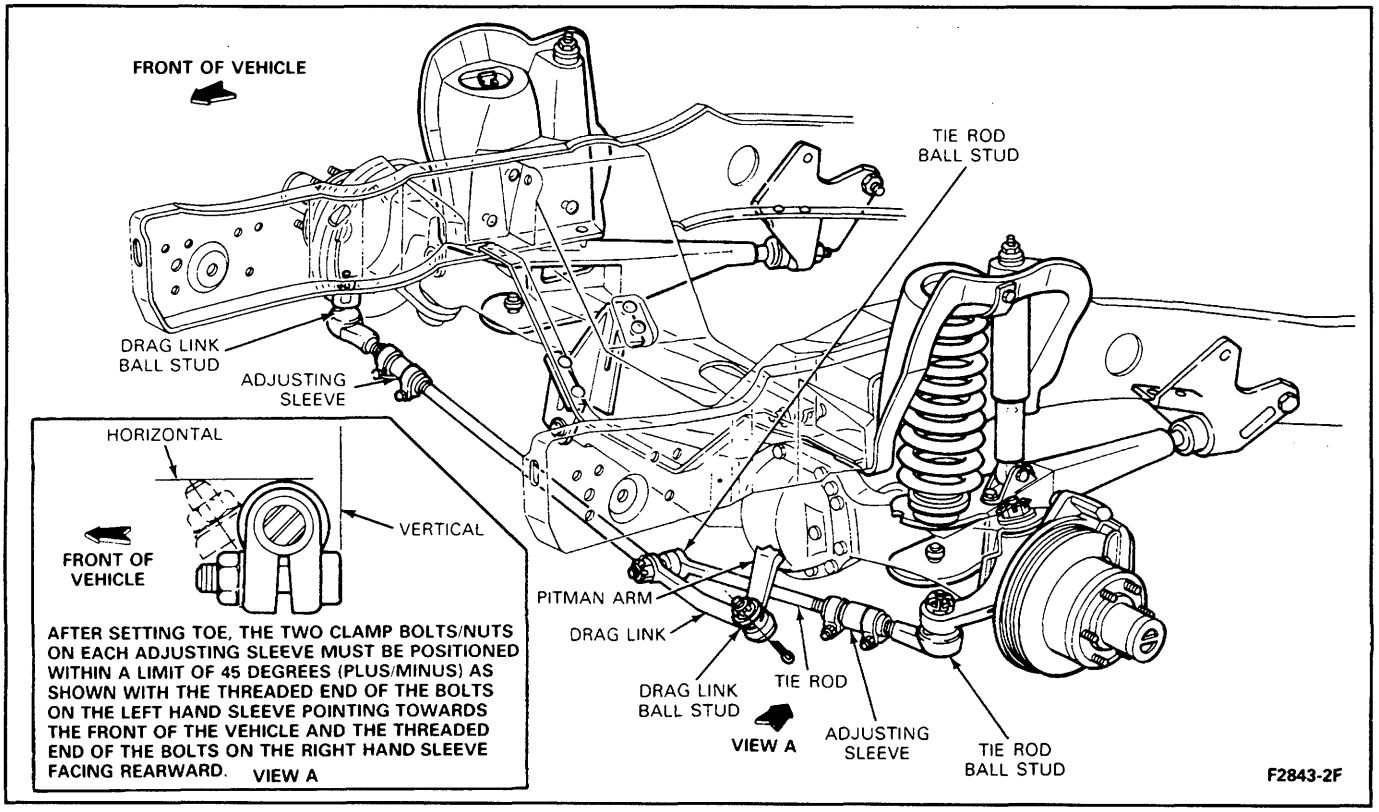


FIG. 1 Steering Linkage F-150 (4x4) and Bronco

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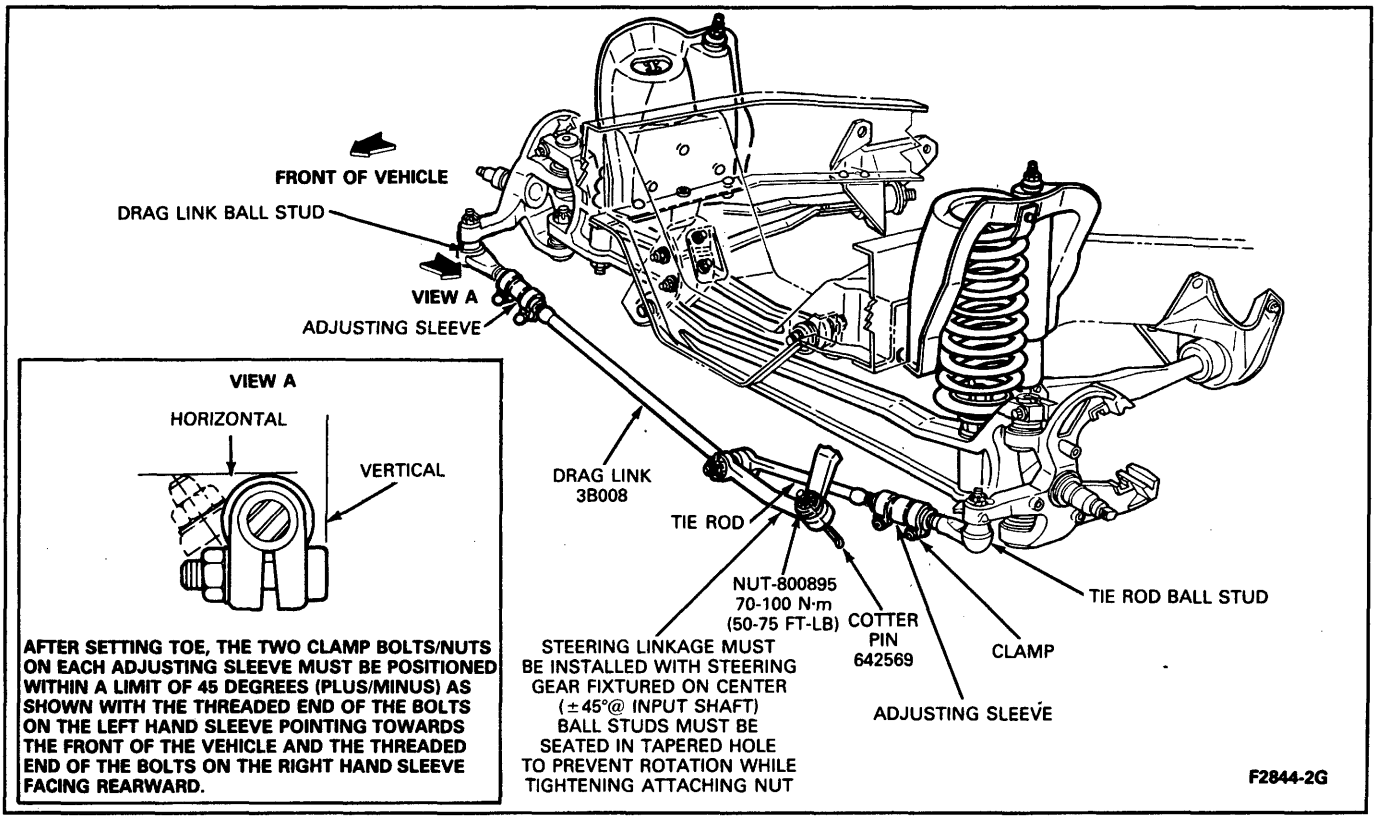


FIG. 2 Steering Linkage F-150—F-350 (4x2)

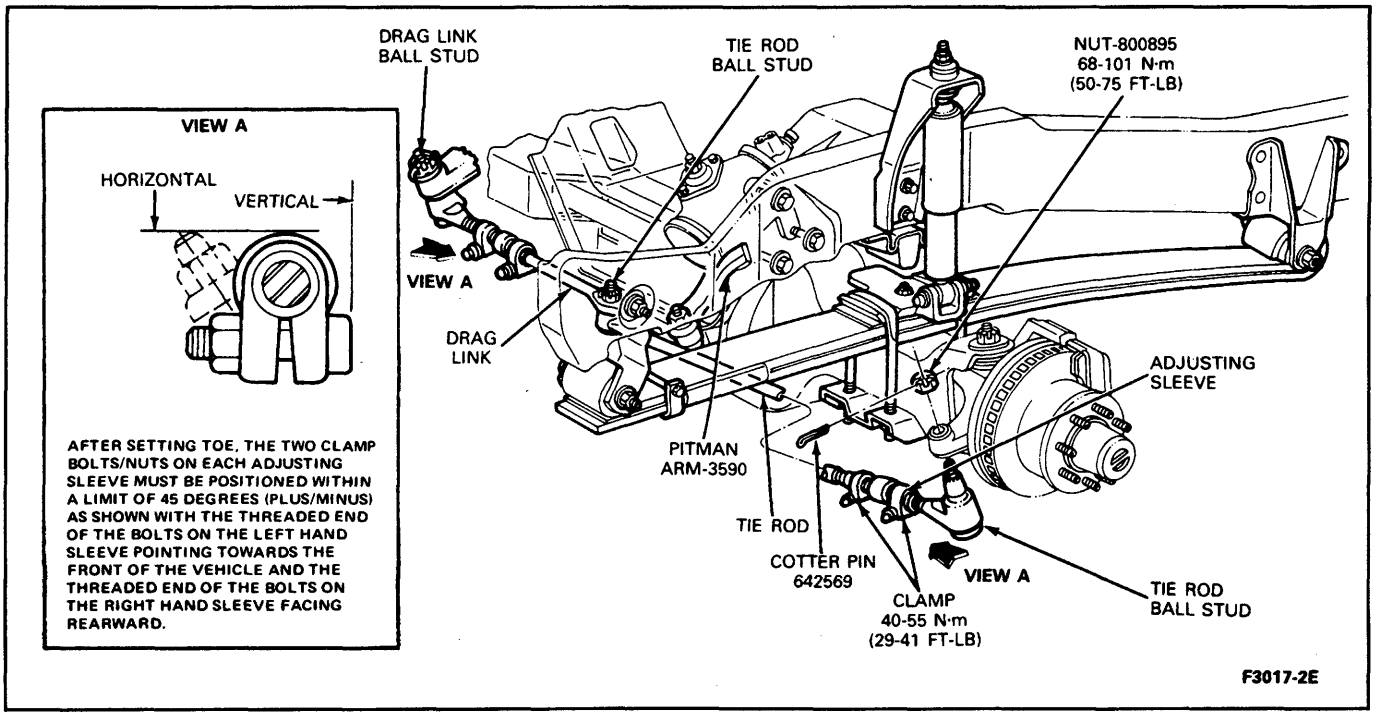


FIG. 3 Steering Linkage—F-250 (4x4)

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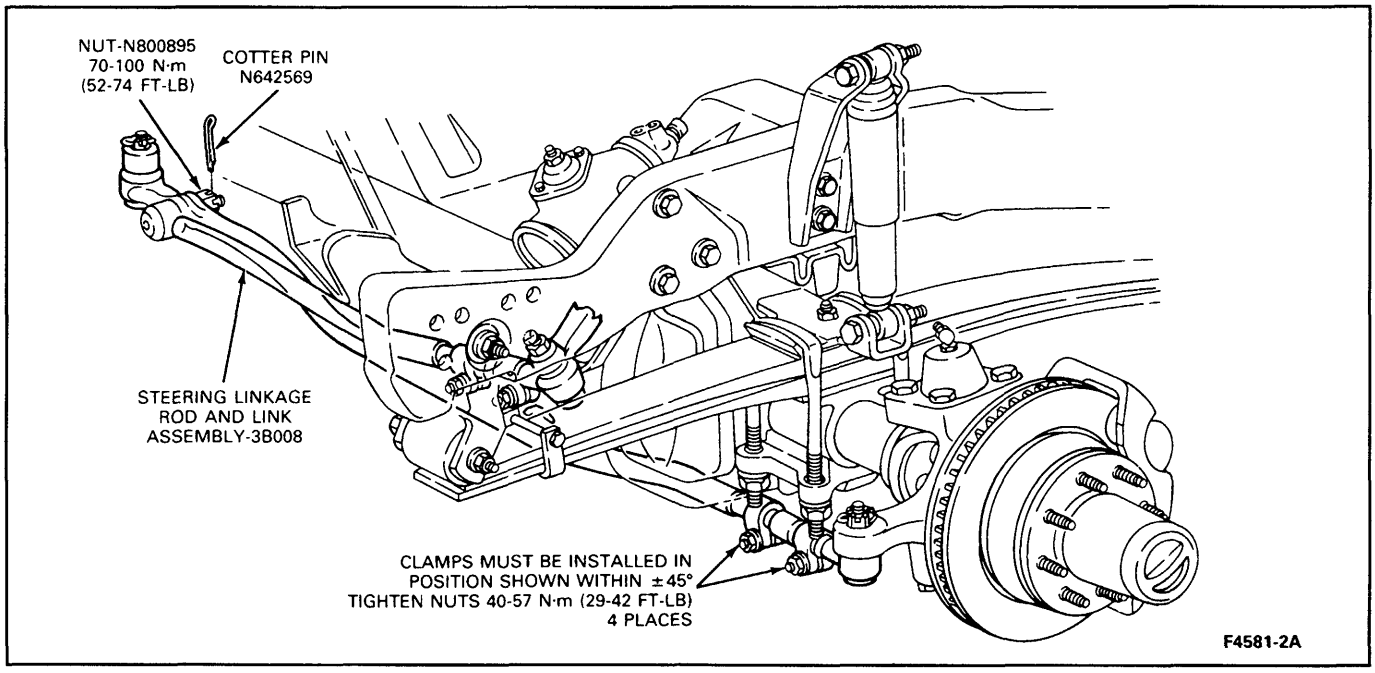


FIG. 4 Steering Linkage—F-350 (4x4) Monobeam Axle

Removal

1. Remove the cotter pins and nuts from the drag link and tie rod ball studs.
2. Using the Tie Rod End Remover Tool-3290-D or equivalent, remove the drag link ball studs from the right hand spindle and the Pitman arm. Remove the tie rod ball studs from the left hand spindle and the drag link.
3. When installing new drag link or tie rod end(s) or adjustment sleeve(s), turn the parts into the adjustment sleeve about the same distance used for the old assembly. Equalize the thread engagement of the short and long rod ends in the adjustment sleeve. This will provide an approximate toe-in setting.

Installation

1. Position the drag link ball studs into the right hand spindle and the Pitman arm. Position the tie rod ball studs into the left hand spindle and the drag link.

NOTE: For installation of components with rubberized ball sockets, be sure that the wheels and Pitman Arm are in the straight ahead position so that the rubber in the rubber ball sockets has no preload in that position. Installation of the linkage in other than the straight ahead position could cause the vehicle to drift toward the installed position.

2. Seat the studs into the tapered hole before tightening the nuts to avoid wrap up of the rubber during tightening. Tighten the nuts to 68-101 N·m (50-75 ft-lb).
3. Install new cotter pins.
4. Check toe-in and set toe-in as described in Section 14-01, GENERAL SUSPENSION SERVICE.
5. After checking or adjusting toe-in, center the adjustment sleeve clamps between the locating nibs and position the clamps as shown in Figs. 1-3 to prevent clamp contact with surrounding components. Tighten the nuts to 40-57 N·m (29-41 ft-lbs). After installing a tie rod or drag link, make sure the tie rod adjustment sleeves are correctly positioned. For the correct tie-rod adjustment sleeve position refer to Figs. 1 through 6.

Pitman Arm

Replace the Pitman arm if the Pitman arm is bent. Do not attempt to straighten the Pitman arm.

Removal

1. Remove the cotter pin and nut from the drag link ball stud at the Pitman arm.
2. Disconnect the drag link ball stud from the Pitman arm using Tie Rod End Remover, TOOL-3290-D or equivalent (Fig. 7).
3. Remove the Pitman arm attaching nut and washer.
4. Remove the Pitman arm from the steering gear sector shaft using Tool T64P-3590-F (Fig. 8). Remove the tool from the Pitman arm.

Installation

1. Install the new Pitman arm assembly on the sector shaft with wheels in straight ahead position. Install the Pitman arm attaching washer and nut. Tighten the nut to 230-310 N·m (170-230 ft-lbs).
2. Install the drag link ball stud on the Pitman arm. Tighten the nut to 68-101 N·m (50-75 ft-lbs) and install the cotter pin.

Drag Link

Refer to Figs. 1, 2 and 6.

Replace the drag link if the ball stud is loose, or the drag link is bent. Do not attempt to straighten a drag link.

Removal

1. Raise the vehicle on a hoist with the wheels in the straight ahead position. Refer to Section 50-04,

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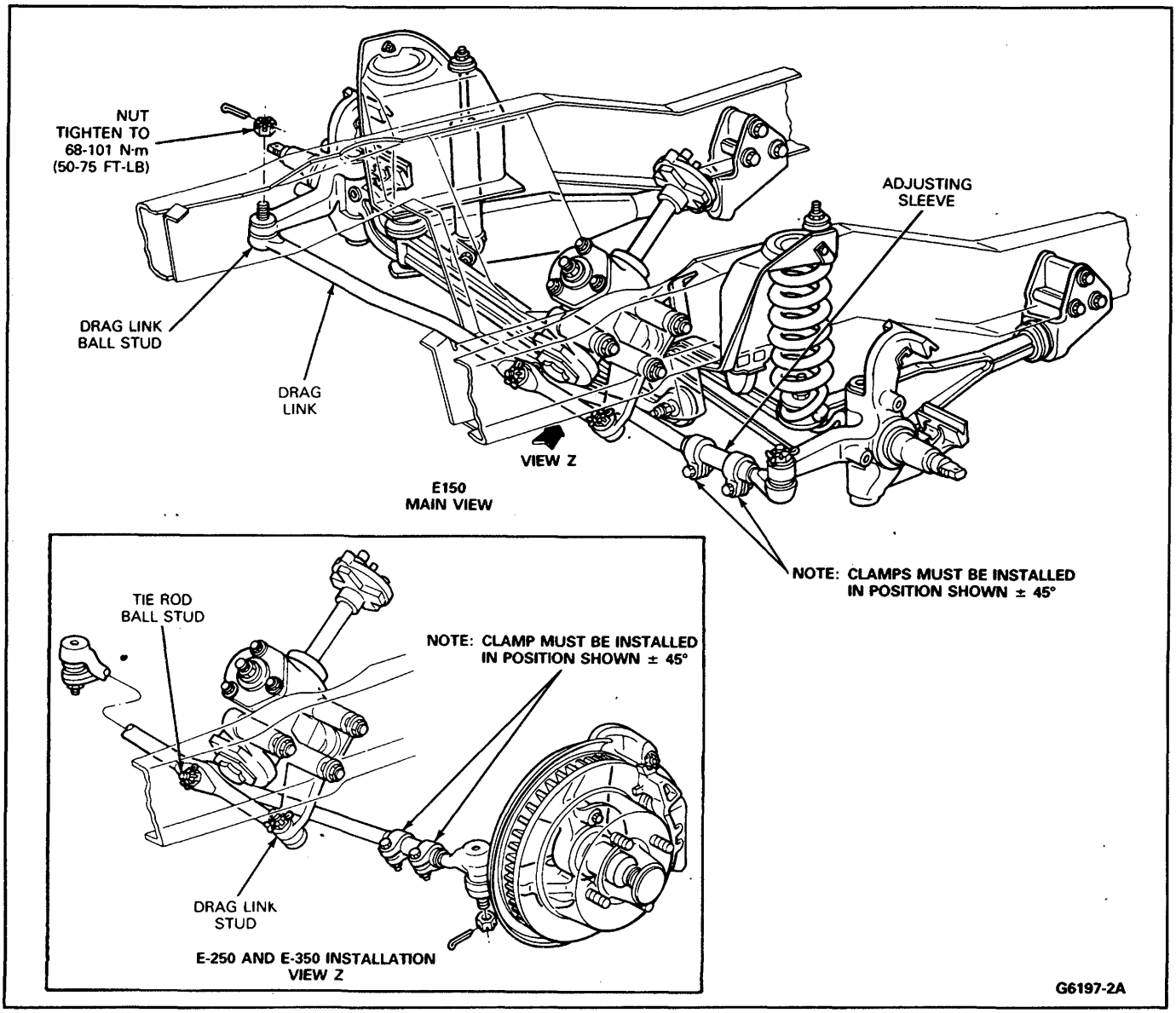


FIG. 5 Steering Linkage—E-150 Through E-350

Hoisting and Jacking in the Light-Medium-Heavy, Pre-Delivery manual.

2. Remove the cotter pins and nuts from the ball stud at the Pitman arm and steering connecting rod. Remove the ball studs from the linkage using Tool-3290-D, Tie Rod End Remover or equivalent as shown in Fig. 7.
3. Loosen the bolts on the adjuster clamp. Count the number of turns it takes to remove the drag link from the adjuster.

Installation

1. Install the drag link the same number of turns it took to remove it from the adjusting sleeve. Note the position of the clamps in Figures 1, 2 and 3. Tighten the adjuster clamp nuts to 40-57 N·m (30-42 ft-lbs).
2. Position the drag link ball stud in the Pitman arm. Position the steering connecting arm ball stud in the drag link. If the outer ball socket is rubberized, it is necessary to maintain the front wheels and steering wheel in the straight ahead position. Make sure the ball studs are seated in the taper to prevent rotation while tightening. Install nuts and tighten to 68-101 N·m (50-75 ft-lbs).
3. Install new cotter pins.
4. Check toe-in and adjust toe-in as described in Section 14-01. General Suspension Service, under Adjustments.

Steering Connecting Rod

Refer to Figs. 1, 2 and 5.

Replace the steering connecting rod if the ball stud is loose or the rod is bent. Do not attempt to straighten a bent rod.

Removal

1. Raise the vehicle on a hoist with the wheels in the straight ahead position. Refer to Section 50-04, Hoisting and Jacking in the Light-Medium-Heavy, Pre-Delivery manual.

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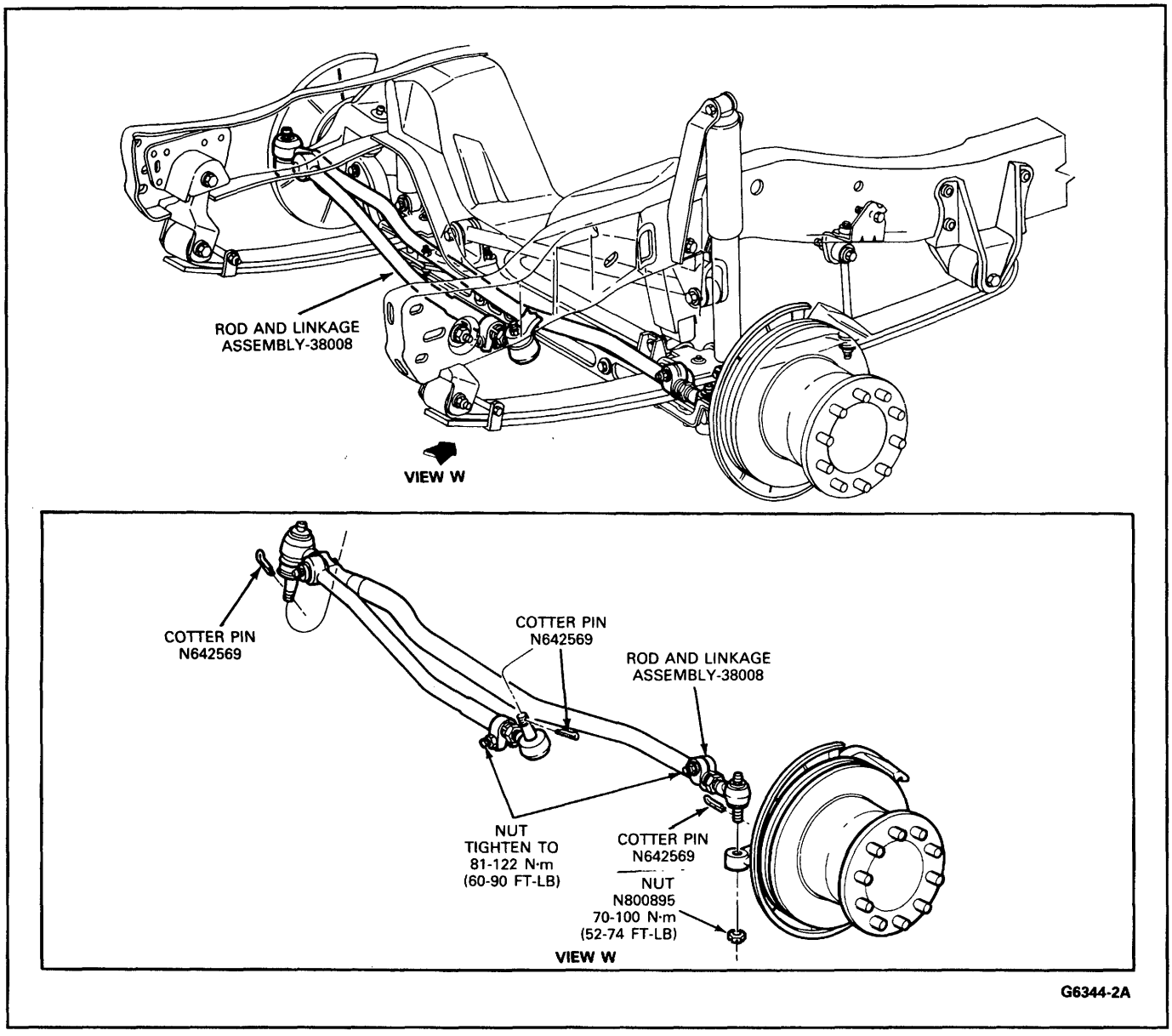


FIG. 6 Steering Linkage—F-Super Duty

2. Remove the nut and cotter pin from the ball stud on the connecting rod. Remove the ball stud from the drag link using Tool 3290-D, Tie Rod End Remover, as shown in Fig. 7.
3. Loosen the bolts on the adjusting sleeve clamps. Count the number of turns it takes to remove the connecting rod from the adjusting sleeve. Remove the connecting rod.

Installation

1. Install the connecting rod in the tie rod sleeve the same number of turns it took to remove it. Tighten the tie rod nuts to 40-57 N·m (30-42 ft-lbs).
2. Position the connecting arm ball stud in the drag link. If the outer ball socket is a rubber design (does not have a grease fitting) it is necessary to maintain the front wheels and steering wheel in the straight ahead position. Make sure the ball stud is seated in the taper to prevent rotation while tightening. Install nut and tighten to 68-101 N·m (50-75 ft-lbs).
3. Install new cotter pins.
4. Check toe-in and adjust toe-in as described in Section 14-01, General Suspension Service, under Adjustments.

Tie Rod Adjusting Sleeve and Ball Stud

Rubberized Ball Socket Steering Linkage (R.B.S.)

Refer to Figs. 1, 2 and 5.

Replace the ball stud if it is loose or the tie rod is bent. Do not attempt to straighten a bent tie rod.

Removal

1. Raise the vehicle on a hoist with the wheels in the straight ahead position. Refer to Section 50-04, Hoisting and Jacking in the Light-Medium-Heavy, Pre-Delivery manual.
2. Remove the ball stud from the Pitman Arm using Tool-3290-D, Tie Rod End Remover as shown in Fig. 7.

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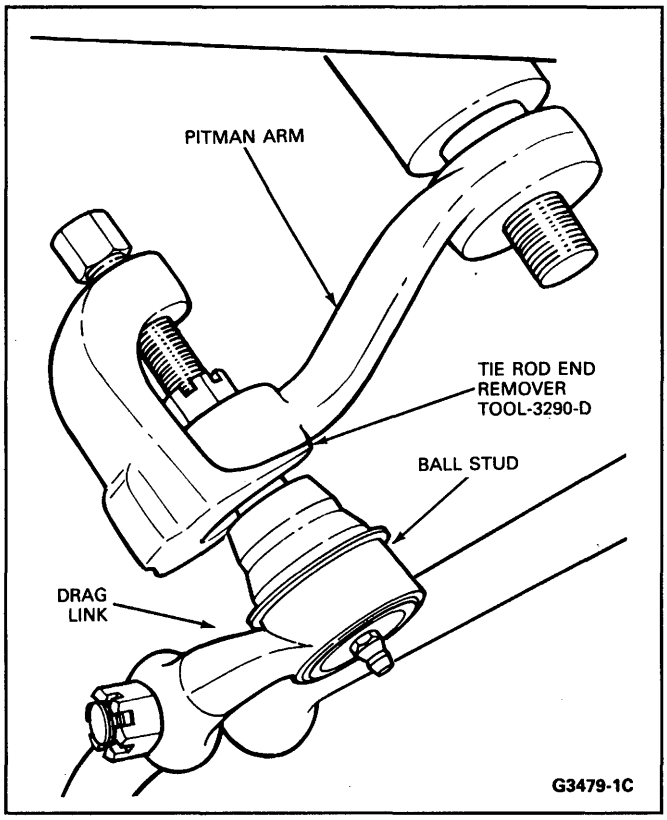


FIG. 7 Ball Stud Removal

3. Loosen the nuts on the adjusting sleeve clamp. Remove the ball stud from adjuster or adjuster from tie rod. Count the number of turns it takes to remove the sleeve from the tie rod or ball stud from sleeve.

Installation

1. Install the adjusting sleeve on the tie rod and/or the ball stud in the sleeve the same number of turns it took to remove it. Tighten nuts to 40-57 N·m (30-42 ft-lbs). Make sure the adjuster clamps are in the correct position as shown in Figs. 1, 2 and 5.
2. Install the ball stud in the spindle arm. Maintain the front wheels and steering wheel in the straight ahead position. If the outer end is being replaced with a rubber ball socket design (does not have a grease fitting), it is necessary to make sure the ball stud is seated in the taper to prevent it from rotating while turning. Install nut and tighten to 68-101 N·m (50-75 ft-lbs). Install new cotter pins.
3. Install the drag link and steering connecting rod as described in this Section.
4. Check toe-in and set toe-in as described in Section 14-01, General Suspension Service, under Adjustments.

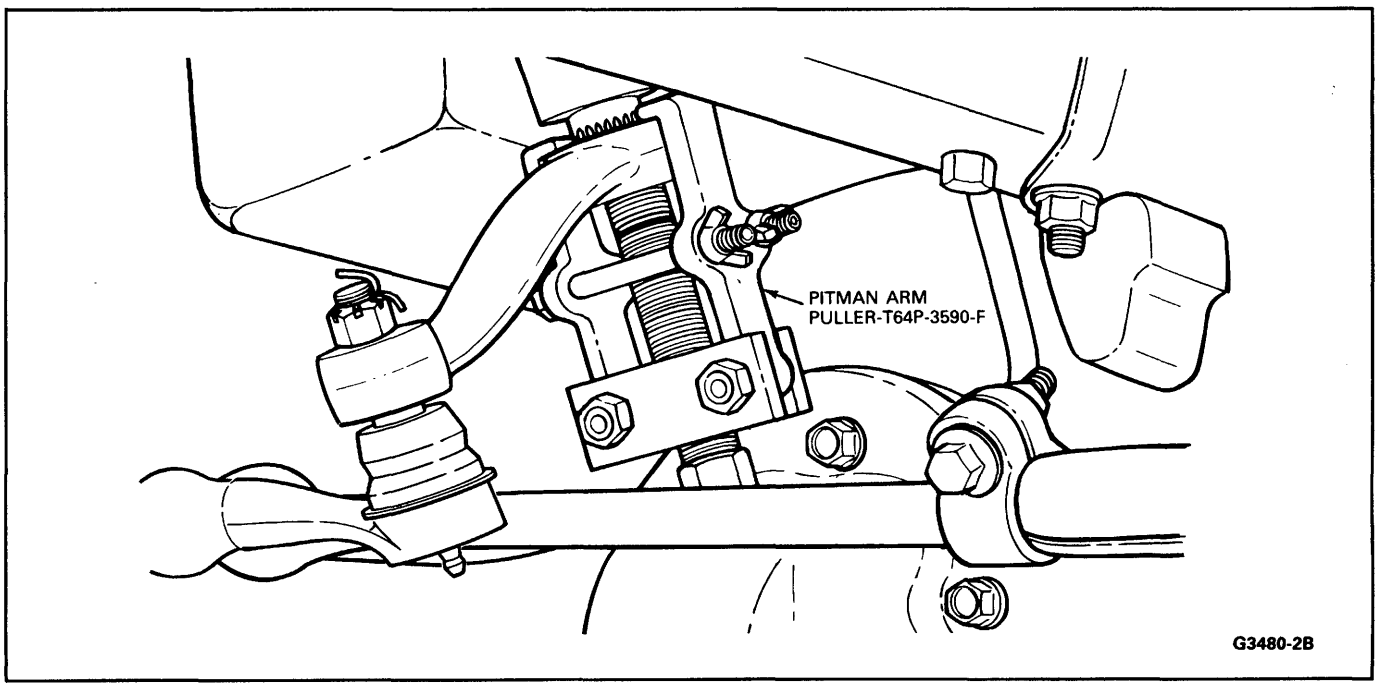


FIG. 8 Pitman Arm Removal

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SPECIFICATIONS

Refer to Section 13-01, General Steering Service, for Specifications not listed here.

SPECIAL SERVICE TOOLS

Number	Description	Application
D79P-3283-A	Tie Rod Adjustment Tool	Universal
TOOL-3290-D	Tie Rod End Remover	Universal
T75T-3527-A	Sector Bushing Tool	E-150 — E-350 — Bushing Removal and Replacement
T64P-3590-F	Pitman Arm Puller	Universal
T67L-3600-A	Steering Wheel Puller	Universal

CF3018-2D

TORQUE SPECIFICATIONS

Description	Torque	
	N·m	Ft-Lbs
Drag Link to Connecting Rod Ball Stud Nut	68-101	50-75
Drag Link to Pitman Arm Ball Stud Nut	68-101	50-75
Pitman Arm to Steering Gear Nut	230-310	170-230
Adjusting Sleeve Nuts	40-57	30-42
Adjusting Sleeve Nuts (F-Super Duty)	81-122	60-90
Tie Rod to Spindle Ball Stud Nut	68-101	50-75

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SECTION 13-41 Integral Power Steering Gear—Ford

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DISASSEMBLY AND ASSEMBLY	
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VEHICLE APPLICATION

Applies to all F-150-350 Trucks, E-150-350 Trucks, Bronco and F-Super Duty Trucks.

DESCRIPTION AND OPERATION

The steering unit is an integral piston and recirculating ball nut, and a hydraulically assisted power steering gear with a rotary type control valve. The gear contains a torsion bar that provides feedback between the steering wheel and the road wheels. The system furnishes power to reduce turning effort at the steering wheel. It also reduces road shock and vibrations.

The power steering unit includes a worm and one-piece rack piston. The piston rack meshes to the gear teeth on the steering sector shaft. The unit also includes a rotary style hydraulic valve consisting of input shaft, control valve sleeve and torsion bar. The valve sleeve is pinned to the worm and the input shaft is connected to the worm through the torsion bar. Hydraulic action is generated by relative rotary motion between input shaft and worm/sleeve assembly.

The power steering gear is designed with the one-piece rack piston; worm and sector shaft in one housing and the rotary valve assembly in an attached housing (Fig. 1). This makes possible internal fluid passages between valve and power cylinder, eliminating all external lines and hoses, except the pressure and return hoses between the pump and gear assembly.

The piston cylinder is an integral part of the gear housing. The piston is double acting, in that fluid pressure may be applied to either side of the piston.

The control valve is a unique rotary design that uses relative rotational motion of the input shaft and valve sleeve to direct and throttle fluid flow. In a neutral (straight ahead) position, where no power assist is required, the valve input shaft and sleeve are held in a central position by the torsion bar. The fluid flows from the inlet port through the valve to the outlet port and back to the pump. No area of the steering gear is under high pressure in this position. The valve and housing cylinder are always full of power steering fluid, which dampens road shock that otherwise would be transmitted to the driver through the steering wheel.

The valve input shaft is attached on one end to the steering column and steering wheel. The other end is connected to the worm through the torsion bar

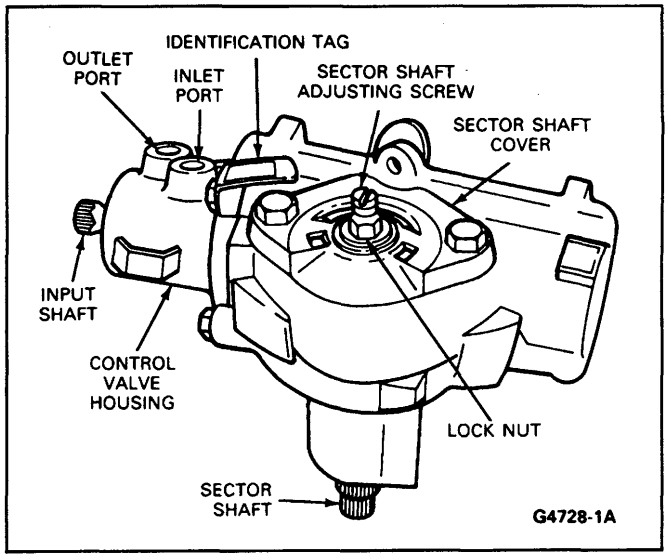


FIG. 1 Ford Integral Power Steering Gear F-150—F-350, E-150—E-350, Bronco and F-Super Duty

providing the link to the road wheel side of the steering system. As a steering maneuver is initiated, rotational force, applied through the steering wheel/column to the input shaft, is transmitted to the worm where it meets the resisting forces of the road wheels. When the steering forces are great enough, rotational deflection (twisting) of the torsion bar occurs. This deflection changes the relative position of the input shaft and control valve sleeve causing throttling of the hydraulic flow and directing high pressure fluid to the appropriate end of the piston in the gear housing.

The difference in pressure forces on the piston helps move the sector shaft, thus assisting in the turning effort. The oil in the opposite end of the gear housing is forced out through the return outlet of the control valve and back to the pump reservoir. With higher steering efforts, increased valve displacement will give the driver proportionately higher assisting pressure. The driver will have a smooth hydraulic assist at all times.

When the driver stops applying steering effort, the valve sleeve and input shaft are returned to a centered position by the torsion bar. When this occurs, pressure is equalized on both sides of the piston. The steering

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geometry will tend to return the front wheels to the straight-ahead position.

NOTE: A hissing noise is a normal characteristic of rotary valve steering gear and in no way affects steering. A replacement valve will also exhibit slight noise; so, it is not always a cure for the complaint. Any metal-to-metal contacts at the flexible steering shaft coupling (due to column misalignment) will transmit severe valve hissing noise into the passenger compartment and should be corrected.

The only service that can be performed on the control valve assembly is the replacement of the four teflon seals on the valve sleeve and replacement of the control valve housing.

DIAGNOSIS AND TESTING

Refer to the following guides for aid in diagnosing steering gear conditions. For other related diagnosis and testing procedures, refer to Section 13-01, General Steering Service.

STEERING GEAR CONDITIONS

COMPLAINT	POSSIBLE CAUSE	RESOLUTION
Feedback (Rattle, Chuckle, Knocking Noise in Steering Gear) Feedback is a condition that is noticed when a truck is driven over rough pavement and this roughness is felt in the steering wheel by the driver. In addition, if the gear is not adjusted properly, excessive rattle, knocking and/or chuckle noises can be heard inside the truck.	1. Deteriorated Shock Absorbers. 2. Loose flex coupling bolt. 3. Gear loose on frame. 4. Steering linkage ball-joints loose/worn. 5. Insufficient meshload. 6. Loose worm race nut. 7. Insufficient worm thrust bearing preload. 8. Damaged/omitted sector shaft bearing (gear might also exhibit external leakage from sector seals).	1. Replace Shock Absorbers. 2. Tighten bolt. 3. Tighten mounting bolts (3) to specification. 4. Replace appropriate tie rod end assemblies. 5. Set meshload to specification. 6. Tighten nut to specification. 7. Replace valve assembly. 8. Replace gear housing.
Hissing Sound There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking. There is no relationship between this noise and the performance of the steering gear.	1. "Hiss" may be expected when the steering wheel is at the end of travel or when turning it at standstill.	1. Hiss is a normal characteristic of rotary valve steering. Do not replace the input shaft and valve assembly unless the hiss is extremely objectionable. A replacement valve will also exhibit a slight noise and is not usually a cure for the condition. Investigate for a grounded column or a loose boot at the dash panel. Any metal to metal contacts will transmit valve hiss into the passenger compartment through the steering column. Verify clearance between flexible coupling components. Be sure steering column shaft and gear are aligned so flexible coupling rotates in a flat plane and is not distorted as shaft rotates.

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STEERING GEAR CONDITIONS (Cont'd.)

COMPLAINT	POSSIBLE CAUSE	RESOLUTION
Front End Wander Front end wander is a condition that is noticed when the truck is driven in a straight ahead position with the wheel held in a firm position, but the truck wanders to either the right or left side. Front end alignment should be checked before any gear service is made.	1. Tire pressure uneven.	1. Adjust tire pressure.
	2. Steering linkage ball joints loose/worn.	2. Replace appropriate tie rod end assemblies (see Section 13-24).
	3. Loose flex coupling bolt.	3. Tighten bolt.
	4. Steering wheel, column or flex coupling binding or misalignment.	4. Service as required.
	5. Gear loose on frame.	5. Tighten mounting bolts (3) to specification.
	6. Incorrect meshload.	6. Set meshload to specification.
	7. Loose worm/piston race nut.	7. Tighten nut to specification.
	8. Insufficient worm thrust bearing preload.	8. Replace valve assembly.
	9. Damaged sector shaft bearing (gear might also exhibit external leakage from sector seals).	9. Replace gear housing assembly.
	10. Center lash.	10. Improper fit of worm to piston. Replace valve assembly. **(Be certain to check meshload prior to replacing valve for center lash.)**
Heavy Steering Efforts, Poor Assist A heavy effort and poor assist condition is recognized by the driver while turning corners and especially while parking. A road test can verify the condition.	Poor Assist — both directions	
	1. Low steering system fluid fill.	1. Add steering fluid to proper level.
	2. Engine idle too low.	2. Set engine idle to specification.
	3. Low power steering pump belt tension.	3. Set belt tension to specification.
	4. Pump flow/relief pressure not to specification.	4. Test pump, and service as necessary.
	5. External leakage giving low fluid level.	5. See diagnosis guide for external leakage.
	6. Piston plastic O-ring cut or twisted.	6. Replace piston plastic O-ring.
	7. Loose/missing rubber backup piston O-ring.	7. Replace/install rubber backup piston O-ring.

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STEERING GEAR CONDITIONS (Cont'd.)

COMPLAINT	POSSIBLE CAUSE	RESOLUTION
Heavy Steering Efforts, Poor Assist (Cont'd.)	8. Valve/gear housing oil passages blocked.	8. Replace gear housing or valve housing as required.
	9. Leakage past piston end cap.	9. Tighten piston end cap to specification.
	10. Porosity in piston bore (housing casting).	10. Replace gear housing.
	11. Porosity in piston.	11. Replace valve assembly.
	12. Valve plastic O-ring(s) damaged.	12. Replace valve plastic O-rings.
	13. Worm seal ring missing or damaged.	13. Replace valve assembly.
External Leakage One of the most common conditions causing repeat repairs is fluid leaks. Make sure you clean the steering gear first before any steering gear external leakage checks are performed.	1. Loose hose fittings.	1. Tighten hose fittings to specification.
	2. Missing/damaged hose fitting tube seats.	2. Install/replace tube seats.
	3. Leak from input shaft seal.	3. Replace input shaft seal. Check shaft for damage. Check housing bore for porosity or damage.
	4. Leak at valve mounting face.	4. Check bolts for proper torque. Replace valve housing O-ring(s).
	5. Leak at sector adjuster screw locknut.	5. Replace locknut (check torque).
	6. Leak at sector shaft seal.	6. Replace sector seals and examine sector shaft for pitting or corrosion. Replace sector shaft if necessary. Check housing seal bore for porosity or damage. Replace housing if necessary.
	7. Leak from gear housing.	7. Replace gear housing.
	8. Leak at sector cover face.	8. Check bolt torques. Check O-ring seal.
Poor Returnability — Sticky Feeling Poor returnability is a condition that is noticed when the vehicle is in a turn and returns to center with effort from the driver. In addition, when the driver returns the steering wheel to center, it may have a sticky or catchy feel.	1. Wheel alignment not to specification.	1. Reset wheel alignment.
	2. Tire pressure too high.	2. Adjust tire pressure.
	3. Binding steering column.	3. Service steering column as required.
	4. Steering column not properly aligned — flex coupling distorted.	4. Align steering column.
	5. Meshload set too tight.	5. Reset meshload to specification.
	6. End lash adjusting screw not properly staked to sector.	6. Replace sector assembly.
	7. Damaged input shaft bearing.	7. Replace valve assembly.
	8. Binding in valve assembly.	8. Replace valve assembly.

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ADJUSTMENTS

Meshload

During the vehicle breaking-in period, some factory adjustments may change. These changes in adjustment will not necessarily affect operation of the steering gear assembly. If excessive steering lash is encountered, then a meshload adjustment may be required.

Adjustment In Vehicle

Adjust total over center position load, to eliminate excessive lash between the sector and rack teeth as follows. See meshload specifications at the end of this Section for checking and setting values. This is the only adjustment required.

1. Disconnect the Pitman arm from the sector shaft using Tool T64P-3590-F, Pitman Arm Puller.
2. Disconnect the fluid return line at the reservoir and cap the reservoir return line pipe.
3. Place the end of the return line in a clean container and turn the steering wheel from left to right several times to discharge the fluid from the gear. Discard the fluid.
4. Turn the steering wheel to 45 degrees from the right stop.
5. Attach an in-lb torque wrench to the steering wheel nut and determine the torque required to rotate the shaft slowly approximately one-eighth turn toward center from the 45 degree position.
6. Turn the steering gear back to center and determine the torque required to rotate the shaft back and forth across the center position (± 90°). See the end of this section for checking and resetting specifications. If reset is required, loosen the adjuster locknut and turn the sector shaft adjuster screw (Fig. 1) until the reading is the specified value greater than the torque at 45 degrees from the stop.

   Hold the sector shaft screw in place, and tighten the lock nut.
7. Re-check torque readings and replace the Pitman arm and steering wheel hub cover.
8. Connect the fluid return line to the reservoir and fill the reservoir to specification (Section 13-01, General Steering Service). Adjust belt tension, if necessary.

   Do not pry against the reservoir to obtain proper belt load. Pressure will deform the reservoir and cause it to leak.

Rotary Valve Centering Check

1. Install a 0-13,789 kPa (0-2000 psi) pressure-gauge (Tool D79L-33610-A, Power Steering Analyzer) in the pressure line between the power steering pump outlet port (Fig. 1) and the integral steering gear inlet port. Be sure that the valve on the gauge is fully open.
2. Check the fluid level in the reservoir and add Motorcraft Automatic Transmission Fluid—Type 'F', XT-1-QF (ESW-M2C33-F) or equivalent, if necessary.
3. Start the engine and turn the steering wheel from stop-to-stop to bring the steering lubricant to normal operating temperature. Turn off the engine and re-check the fluid level. Add Motorcraft Automatic Transmission Fluid—Type 'F', XT-1-QF (ESW-M2C33-F) or equivalent, if necessary.
4. With the engine running at approximately 1000 rpm and the steering wheel centered, attach an in-lb torque wrench to the steering wheel nut. Apply sufficient torque in each direction to get a gauge reading of 1723 kPa (250 psi).
5. The torque wrench readings should be the same in both directions at 1723 kPa (250 psi). If the difference between the readings exceeds 0.68 N·m (6 in-lbs), remove the steering gear and replace the shaft and control assembly.
6. When performing the valve spool centering check outside the vehicle, use the procedures described above, except take the torque and pressure readings at the right and left stops instead of either side of center.

   NOTE: A hissing noise is a normal characteristic of rotary valve steering gears and in no way effects steering. Do not replace the shaft and control assembly unless the hiss is EXTREMELY objectionable. A replacement valve will also exhibit slight noise, and is not always a cure for the complaint. Any metal-to-metal contacts, such as column grounding, coupling grounding, or sheet metal to steering components will transmit valve hiss noise into the passenger compartment.

   The only service that can be performed on the new valve assembly is the replacement of the four valve sleeve O-rings on the valve sleeve and replacement of the control valve housing.

REMOVAL AND INSTALLATION

Steering Gear

Refer to Figs. 2 and 3.

Removal

Remove the steering gear as follows:

1. Disconnect the pressure and return lines from the steering gear. Plug the lines and the ports in the gear to prevent entry of dirt.
2. If equipped, remove the splash shield from the flex coupling. Disconnect the flex coupling at the steering gear by removing the bolt.
3. Raise the vehicle and remove the Pitman arm attaching nut, and washer.
4. Remove the Pitman arm from the sector shaft using Tool T64P-3590-F, Pitman arm remover. Remove the tool from the Pitman arm. **Do not damage the seals.**
5. Support the steering gear, and remove the steering gear attaching bolts.
6. Work the steering gear free of the flex coupling. Remove the steering gear from the vehicle.

Installation

1. If equipped, install the splash shield onto the steering gear lugs.
2. Slide the flex coupling into place on the steering shaft assembly. Turn the steering wheel so the spokes are in the horizontal position.
3. Center the steering gear input shaft with the indexing flat facing down.

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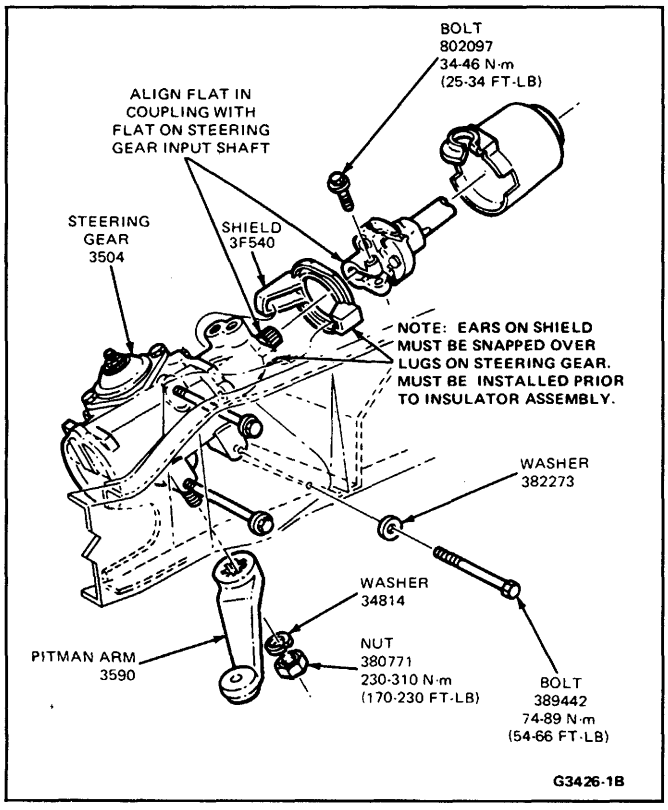


FIG. 2 Steering Gear Installation—F-150—F-350 and Bronco

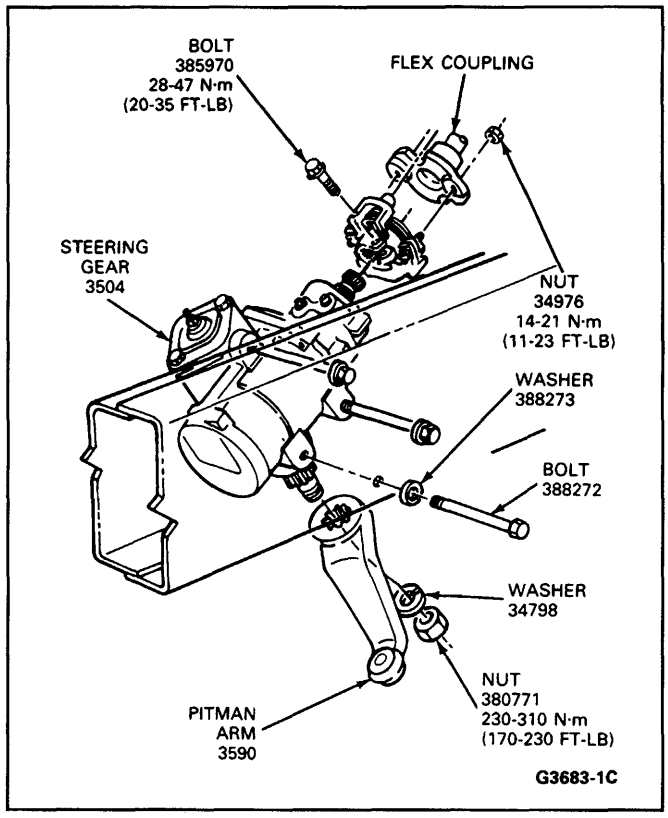


FIG. 3 Steering Gear Installation—E-150—E-350

4. Slide the steering gear input shaft into the flex coupling and into place on the frame side rail. Install the flex coupling attaching bolt and tighten to 34-46 N·m (25-34 ft-lbs) on F-150—F-350 and Bronco and to 28-47 N·m (20-35 ft-lbs) on E-150—E-350. Install the gear to frame attaching bolts and tighten to 74-89 N·m (54-66 ft-lbs).
5. Be sure the wheels are in the straight ahead position, then install the Pitman arm on the sector shaft. Install the Pitman arm attaching washer and nut. Tighten nut to 230-310 N·m (170-230 ft-lbs).
6. Connect and tighten the pressure and the return lines to the steering gear.
7. Snap the Flex-coupling shield over the hose fitting and the splash shield.
8. Disconnect the coil wire. Fill the reservoir to specification (Section 13-01, General Steering Service). Turn on the ignition and turn the steering wheel from left to right to distribute the fluid.
9. Re-check fluid level and add Motorcraft Automatic Transmission Fluid—Type 'F', XT-1-QF (ESW-M2C33-F) or equivalent, if necessary. Connect the coil wire, start the engine and turn the steering wheel from side to side. Inspect for fluid leaks.

DISASSEMBLY AND ASSEMBLY

Take the following precautions when servicing the steering gear:

1. Use a clean workbench and tools.
2. Thoroughly clean the exterior of the gear with solvent and drain off excess hydraulic fluid, if necessary.
3. Handle all parts carefully to avoid nicks, burrs, scratches and dirt.
4. Do not use solvent on seals.

Steering Gear

Disassembly

1. Hold the steering gear upside down over a drain pan and cycle the input shaft several times to drain the fluid from the gear.
2. Secure the gear in a soft-jawed vise.
3. Remove the nut from the sector shaft adjusting screw (Fig. 1).
4. Turn the input shaft to either stop, then turn it back two turns to center the gear.

   NOTE: The indexing flat on the input shaft spline should be facing downward.
5. Remove the sector shaft cover attaching bolts.
6. Tap the lower end of the sector shaft with a soft-hammer to loosen it, and lift the cover and shaft from the housing **as an assembly.** Discard the O-ring.
7. Turn the sector shaft cover counterclockwise and remove it from the sector shaft adjuster screw (hold screw with screwdriver if necessary to prevent turning).
8. Remove the valve housing attaching bolts and identification tag. Lift the valve housing off the steering gear housing. Remove the valve housing and control valve gasket. Discard the gasket.

   NOTE: If valve housing or the valve sleeve seals are to be replaced, proceed to Step 11. If sector shaft seals are to be replaced go to steering gear

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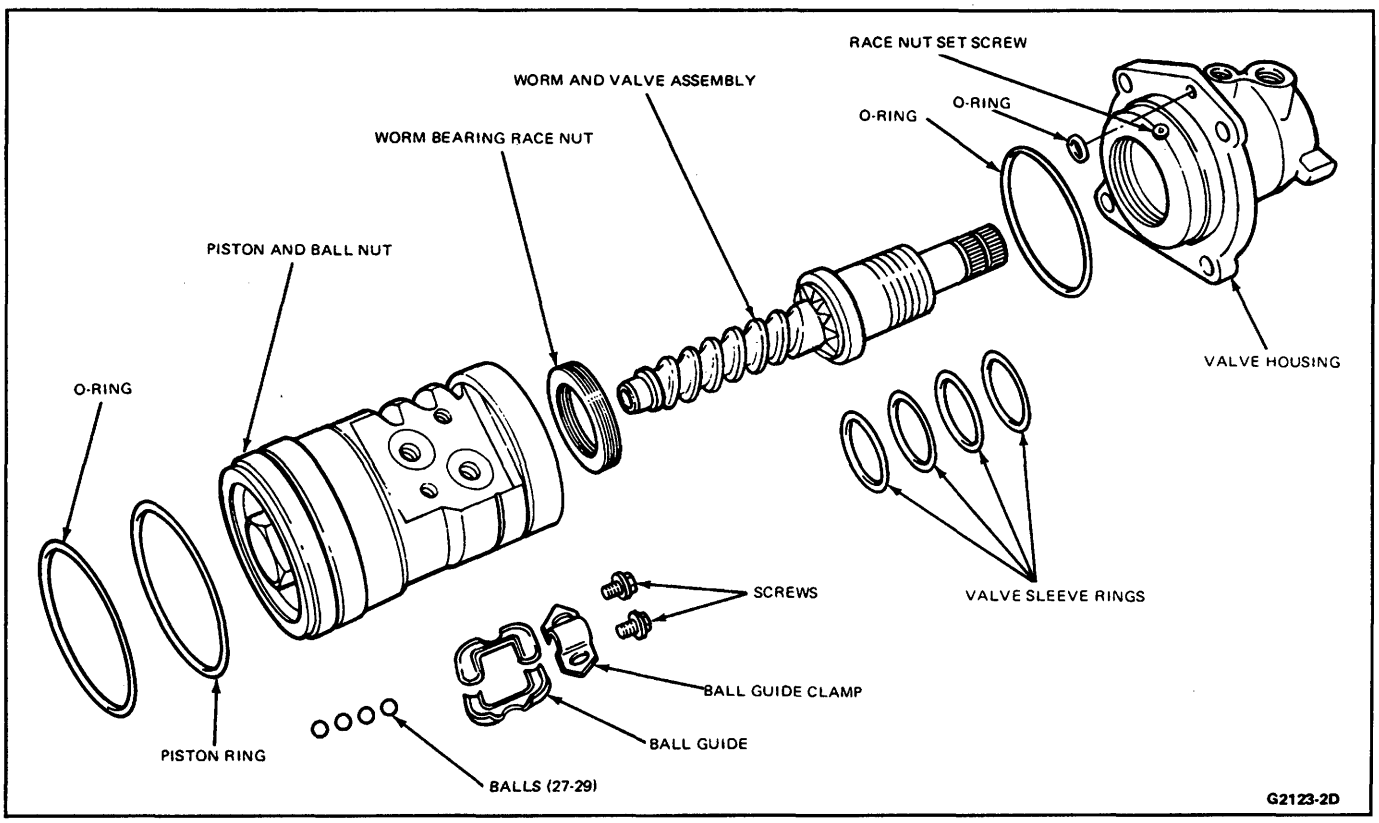


FIG. 4 Ball Nut and Housing Disassembled—Rotary Valve Type

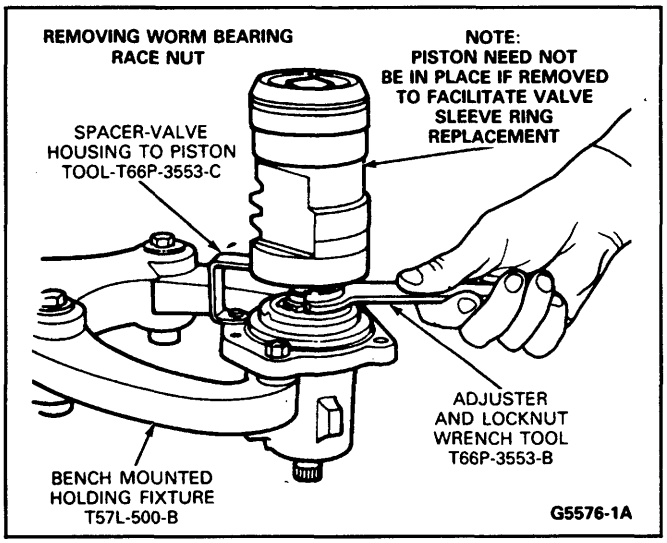


FIG. 5 Removing or Installing Worm Bearing Race Nut

housing section. Balls need only to be removed if valve sleeve rings are to be replaced.

9. With the piston held so that the ball guide faces up, remove the ball guide clamp screws and ball guide clamp. With a finger over the opening in the ball guide, turn the piston so that the ball guide faces down over a clean container. Let the guide tubes drop into the container (Fig. 4).

10. Rotate the input shaft from stop to stop until all balls fall from the piston into the container. The valve assembly can then be removed from the piston. **Inspect the piston bore to insure all balls have been removed.**

11. Install the valve body assembly in the bench mounted holding fixture, Tool T57L-500-B, and loosen the Allen head race nut screw from the valve housing. Remove the worm bearing race nut using Tools T66P-3553-B, Adjuster and Lock Nut Wrench, and T66P-3553-C, Valve Housing to Piston Spacer, as shown in Fig. 5.

12. Carefully slide the input shaft, worm and valve assembly out of the valve housing.

Assembly

1. Mount the valve housing in the bench mounted holding fixture, Tool T57L-500-B, with the flanged end up.

2. Apply a light coat of gear lubricant, Standard Transmission Lubricant (SAE 80W), D8DZ-19C547-A (ESP-M2C83-C) or equivalent to the Teflon rings on the valve sleeve.

3. Carefully install the worm shaft and valve in the housing.

4. Install the worm bearing race nut in the housing and tighten to 75-122 N·m (55-90 ft-lbs)

5. Install the Allen head race nut set screw through the valve housing and tighten to specification 1.7-2.8 N·m (15-25 in-lbs).

6. Place the power cylinder piston on the bench with the ball guide holes facing up. Insert the worm shaft into the piston so that the first groove is in line with the hole nearest the center of the piston (Fig. 6).

7. Place the ball guides in the piston. Turning the worm shaft counterclockwise as viewed from the input end of the shaft, place the same balls as removed in Step 9 of Steering Gear Disassembly in

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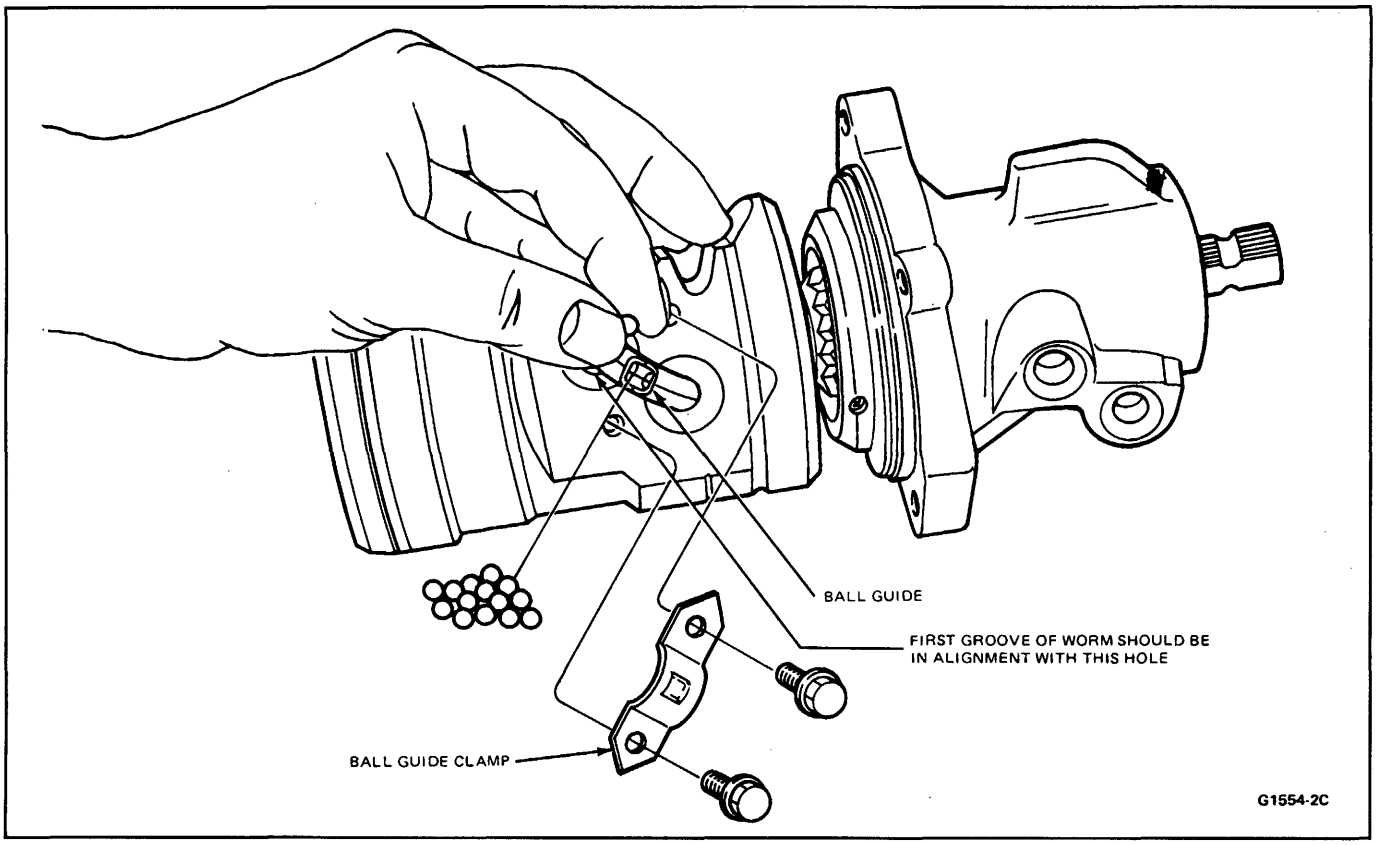


FIG. 6 Assembling Piston on Worm Shaft

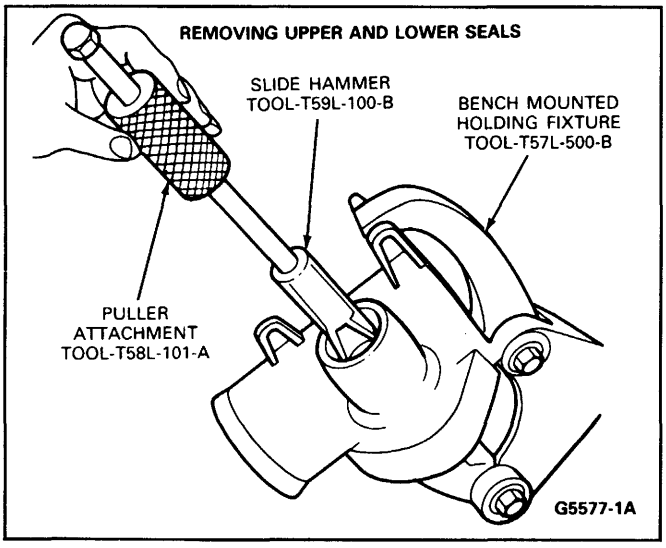


FIG. 7 Removing Upper and Lower Seals

the ball guide (Figure 6). A minimum of 27 balls is required. If all the balls have not been inserted upon reaching the left stop, rotate the input shaft in one direction then the other while inserting the remaining balls.

8. Secure the guides in the ball nut with the clamp (Fig. 4). Tighten screws to 4.8-7.9 N·m (42-70 in-lbs).
9. Appiy petroleum jelly or equivalent to the Teflon seal on the piston.
10. Place a new control valve O-ring on the valve housing.
11. Slide the piston and valve into the gear housing being careful not to damage the piston ring.
12. Align the oil passage in the valve housing with the passage in the gear housing. Place a new O-ring onto the oil passage hole of the gear housing. Install identification tag onto the housing. Install **but do not tighten,** the attaching bolts. Identification tag is to be installed under upper right valve housing bolt (Fig. 1).
13. Rotate the ball nut so that the teeth are in the same plane as the sector teeth. Tighten the valve housing attaching bolts to 40-60 N·m (30-45 ft-lbs)
14. Position the sector shaft cover O-ring in the steering gear housing. Turn the input shaft to center the piston.
15. Apply petroleum jelly or equivalent to the sector shaft journal, and position the sector shaft and cover assembly in the gear housing. Install the sector shaft cover attaching bolts. Tighten the bolts to 75-94 N·m (55-70 ft-lbs).
16. Attach an in-lb torque wrench to the input shaft. Adjust meshload to specification. Refer to specifications at the end of this Section.

Steering Gear Housing

Disassembly

1. Remove the snap ring from the lower end of the housing.
2. Remove dust seal using tools puller attachment T58L-101-A, or T58L-101-B, and slide hammer T59L-100-B or equivalent, (Fig. 7). Discard the seal.

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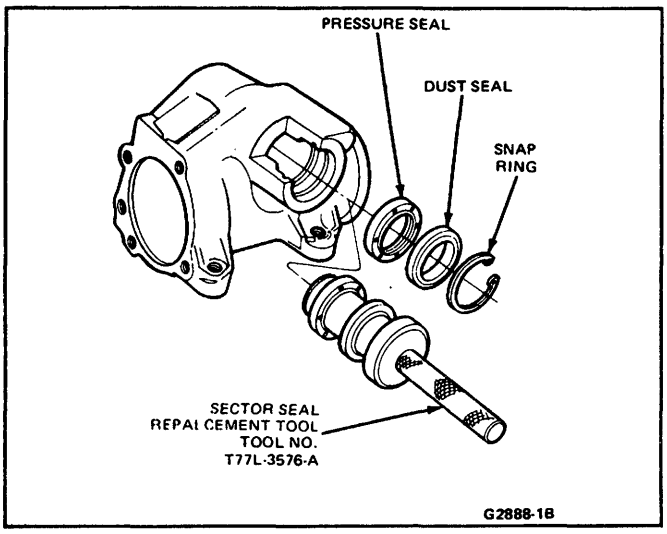


FIG. 8 Installing Sector Shafts Seals

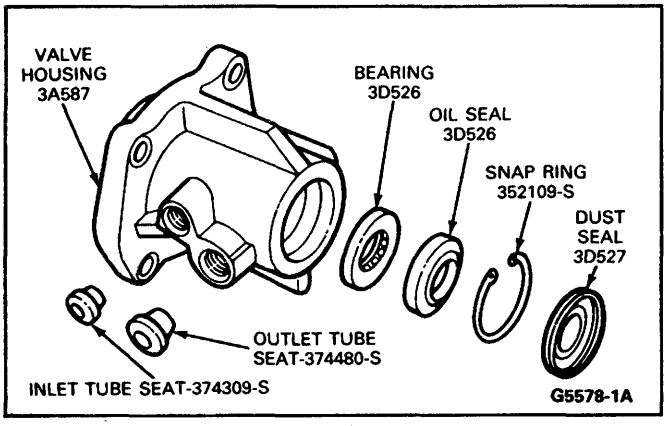


FIG. 9 Valve Housing Disassembled

3. Remove pressure seal in the same manner. Discard the seal.

Assembly

1. Lubricate the new pressure seal and new dust seal with clean Ford Polyethylene Grease, D0AZ-19584-A (ESR-M1C159-A) or equivalent.
2. Apply Ford Polyethylene Grease, D0AZ-19584-A, (ESR-M1C159-A) or equivalent to the sector shaft seal bore.
3. Place the dust seal on Sector Shaft Replacement Tool T77L-3576-A or equivalent, so the raised lip of the seal is towards the tool (Fig. 8).

   Place the pressure seal on the tool with lip away from the tool. The flat back side of the pressure seal should be against the flat side of the dust seal.
4. Insert the seal driver tool into the sector shaft bore and drive the tool until the seals clear the snap ring groove. Do not bottom seals against bearing. **The seal will not function properly when bottomed against the bearing.**
5. Install snap ring in the groove in the housing.
6. Apply a generous amount of Polyethylene Grease, D0AZ-19584-A (ESR-M1C159-A) or equivalent grease to the areas between the seal lips.

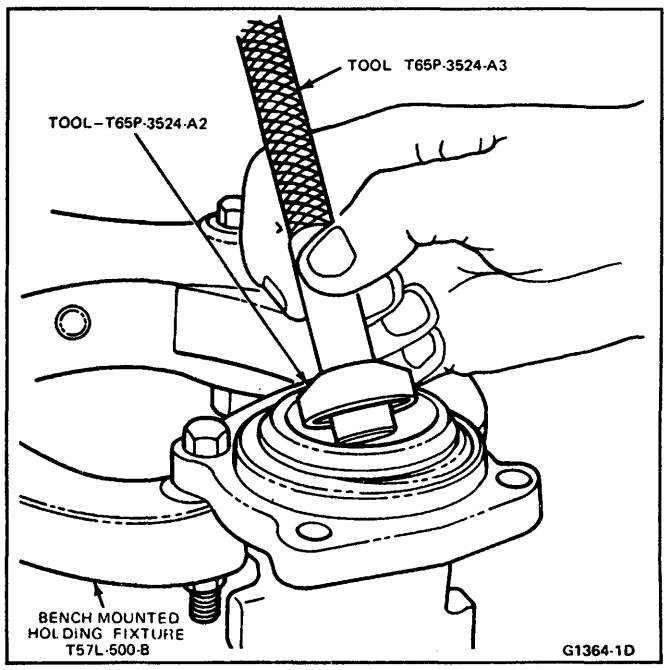


FIG. 10 Removing Bearing and Oil Seal

Valve Housing

Disassembly

1. Remove the dust seal (Fig. 9) from the rear of the valve housing using puller attachment T58L-101-A, or T58L-101-B, and slide hammer T59L-100-B. Discard the seal.
2. Remove the snap ring from the valve housing.
3. Turn the bench mounted holding fixture to invert valve housing.
4. Insert Tools T65P-3524-A2 and T65P-3524-A3 from the Input Shaft Bearing/Seal Tool in the valve body assembly opposite the oil seal end and gently tap the bearing and seal out of the housing as shown in Fig. 10. Discard the seal. **Do not damage the housing when inserting and removing the tools.**
5. Remove the fluid inlet and outlet tube seats with Tube Seat Remover T74P-3504-L if they are damaged.

Assembly

1. Coat the fluid inlet and outlet tube seats with petroleum jelly or equivalent and install them in the housing with a Tube Seat Installer T74P-3504-M.
2. Coat the bearing and seal surface of the housing with petroleum jelly or equivalent.
3. Install the bearing with the metal side covering the rollers facing outward. Seat the bearing in the valve housing using Tool T65P-3524-A1 (Fig. 11). Be sure the bearing rotates freely.
4. Dip a new oil seal in gear lubricant, Standard Transmission Lubricant, (SAE 80W) D8DZ-19C547-A (ESP-M2C83-C) or equivalent and place it in the housing with the metal side facing outward. Drive the seal into the housing until the outer edge does not quite clear the snap ring groove (Fig. 12).

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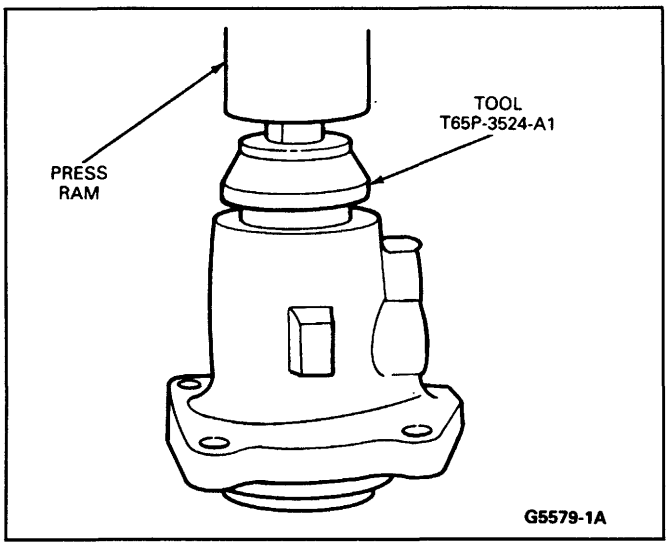


FIG. 11 Installing Valve Housing Bearing

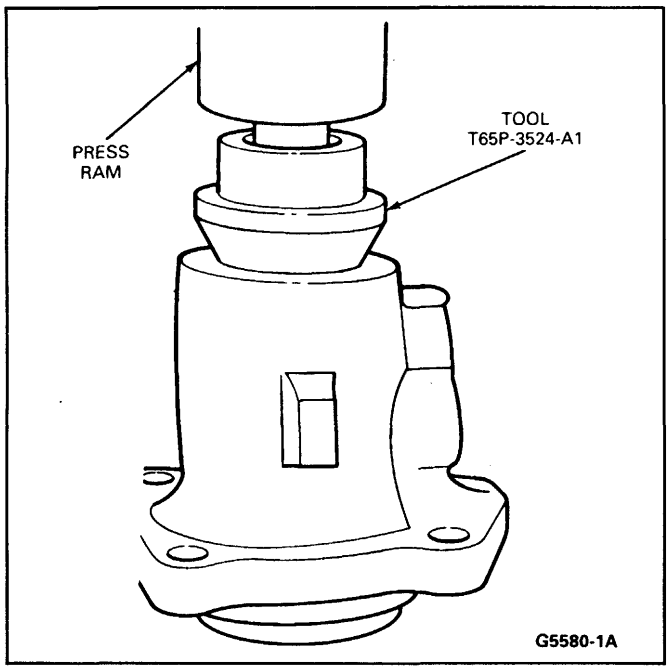


FIG. 12 Installing Oil Seal in Valve Housing

5. Place the snap ring in the housing and drive on the ring using Tool T65P-3524-A1 until the snap ring seats in its groove (Fig. 12).

6. Place the dust seal in the housing with the dished side (rubber side) facing out. Drive the dust seal into place using Tool T65P-3524-A1 (Fig. 12). When properly installed, the seal will be located behind the undercut in the input shaft.

7. Pack the area between the two seals with clean Polyethylene Grease D0AZ-19584-A (ESR-M1C159-A) or equivalent.

Worm and Valve Sleeve

Disassembly

1. Remove valve sleeve rings from sleeve by inserting the blade of a small pocket knife under them and cutting them off (Fig. 13).

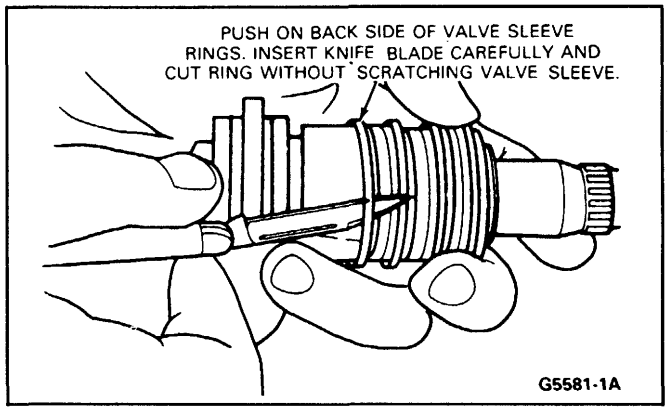


FIG. 13 Removing Valve Sleeve Rings

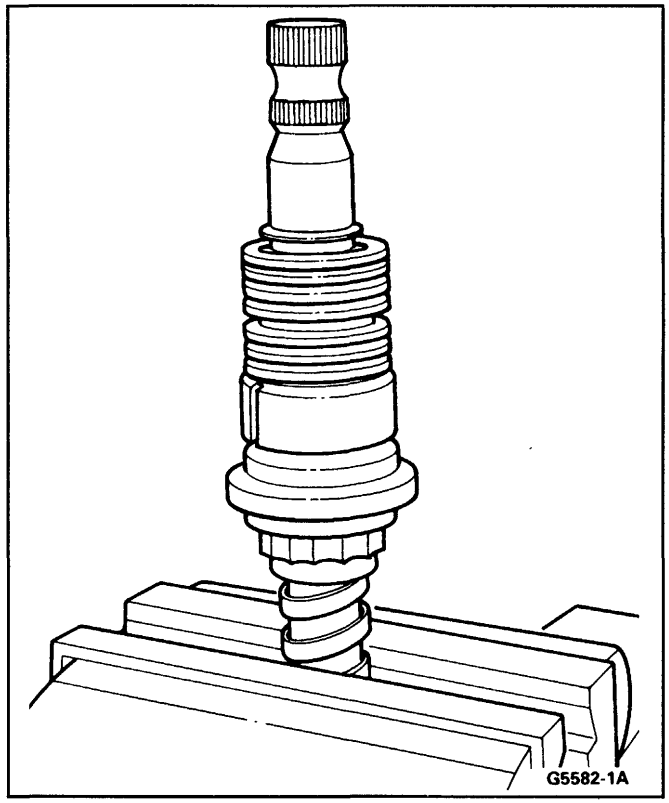


FIG. 14 Worm and Sleeve with Ring Removed

2. Mount the worm end of the worm and valve sleeve assembly into a soft-jawed vise (Fig. 14).

Assembly

1. Install mandrel Tool T75L-3517-A1 from the seal Installation Set over the sleeve; slide one valve sleeve ring over the tool (Fig. 15).

2. Slide the pusher Tool T75L-3517-A2 over the mandrel; rapidly push down on the pusher tool, forcing the ring down the ramp and into the fourth groove of the valve sleeve. Repeat this step three more times, and each time add one of the spacers, Tool T75L-3517-A3, under the mandrel tool. By adding the spacer each time, the mandrel tool will line up with the next groove of the valve sleeve (Figs. 16 and 17).

3. After installing the four valve sleeve rings, apply a light coat of gear lubricant Standard Transmission

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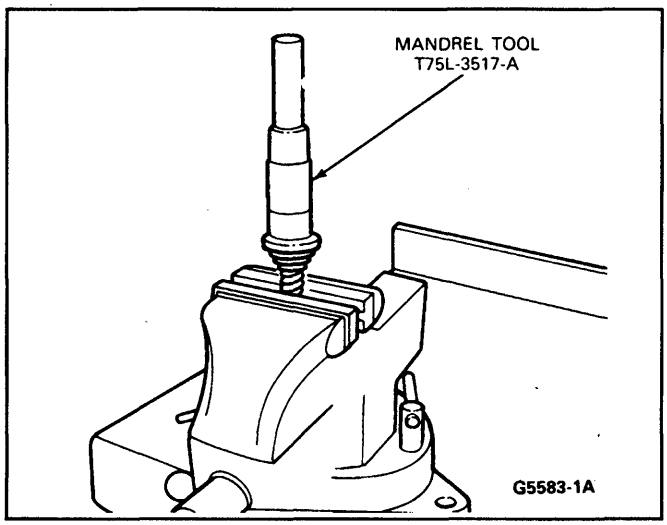


FIG. 15 Mandrel Installed on Sleeve

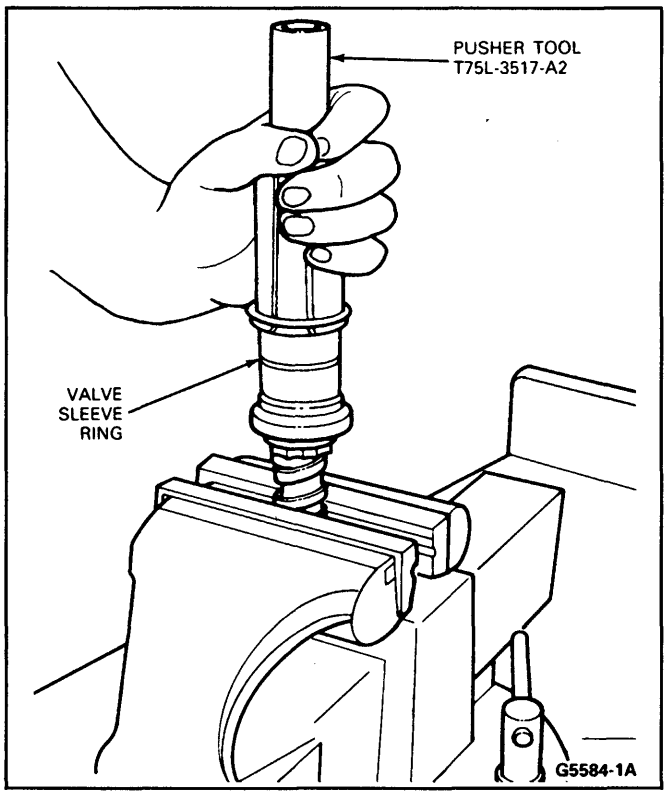


FIG. 16 Installing Ring on Valve

Lubricant (SAE 80W), D8DZ-19C547-A (ESP-M2C83-C) or equivalent to the sleeve and rings.

4. Install one spacer, T75L-3517-A3, over the input shaft as a pilot for installing the sizing tube. Slowly

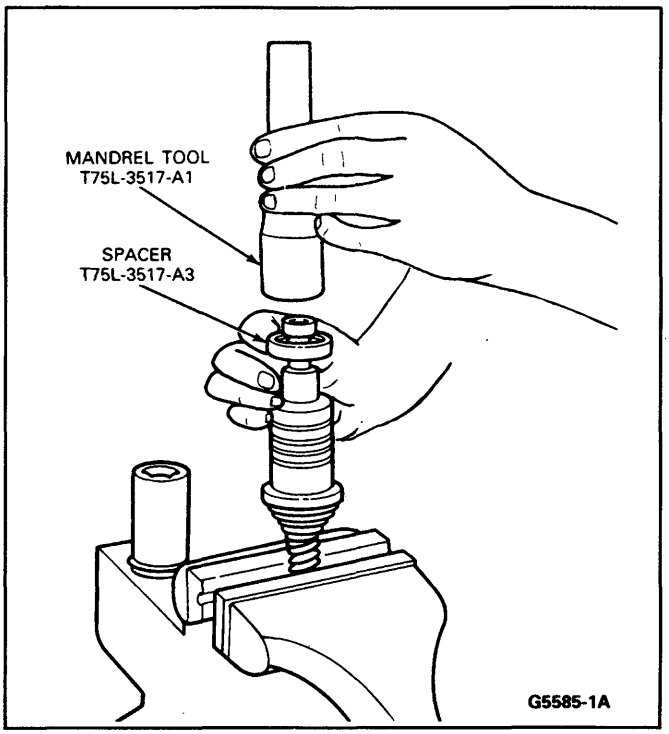


FIG. 17 Adding Spacer to Install Next Ring

install the sizing tube Tool T75L-3517-A4, over the sleeve valve end of the worm shaft onto the valve sleeve rings. Make sure that the rings are not being bent over as the tube is slid over them (Figs. 18 and 19).

5. Remove the sizing tube and check the condition of the rings. Make sure that the rings turn freely in the grooves. Fig. 20 shows the complete set of tools needed to perform the above operations. The tool Kit Number for the complete set is T75L-3517-A.

NOTE: No further service or disassembly of the worm valve assembly is possible. Valve centering will be destroyed if disassembly is attempted.

Piston

Disassembly

1. Remove the Teflon piston ring and O-ring (Fig. 4) from the piston and ball nut. Discard both rings.

Assembly

1. Dip a **new** O-ring in gear lubricant and install it on the piston and ball nut.
2. Install a **new** Teflon piston ring on the piston and ball nut being careful not to stretch it any more than necessary.

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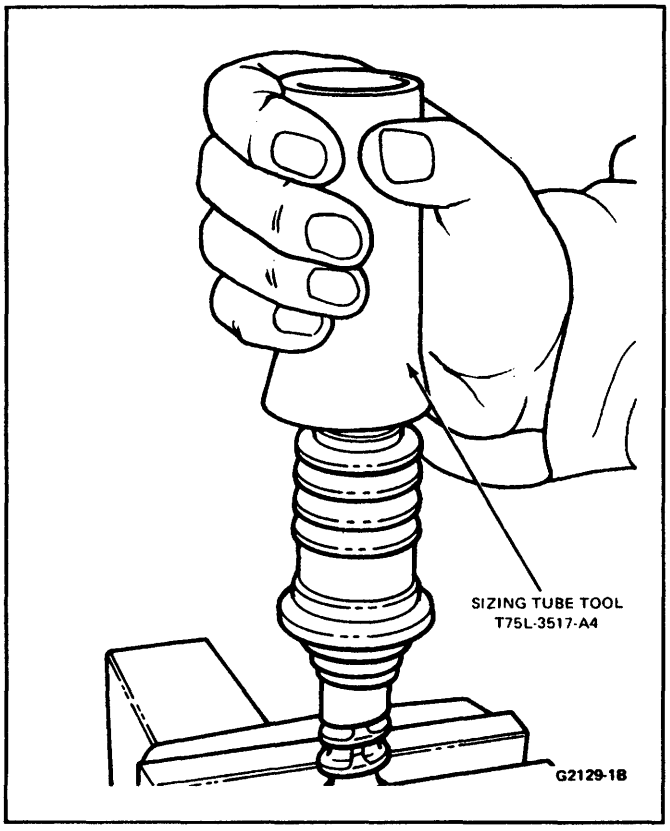


FIG. 18 Sizing Rings—Step 1

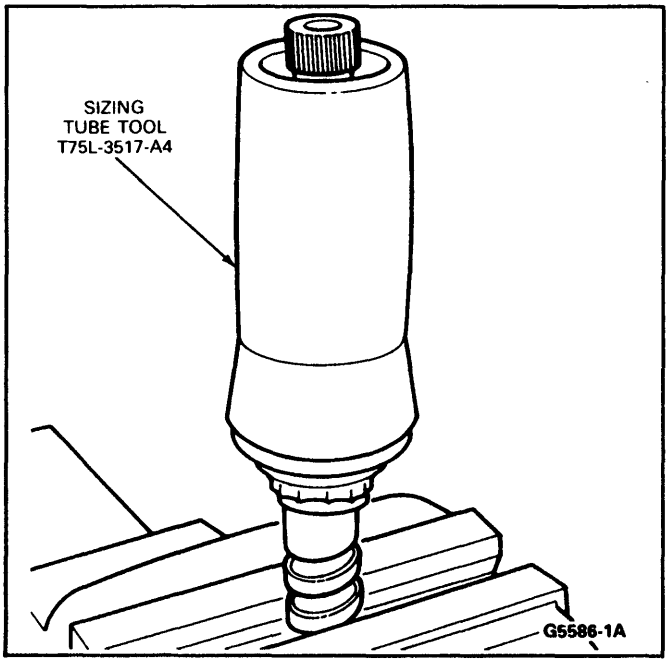


FIG. 19 Sizing Rings—Step 2

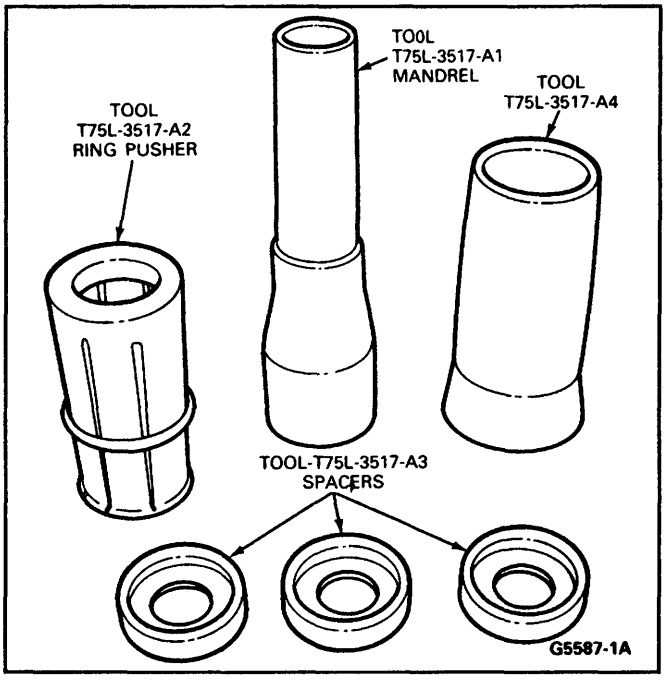


FIG. 20 Seal Installation—Tool T75L-3517-A

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SPECIFICATIONS

FORD INTEGRAL POWER STEERING GEAR SPECIFICATIONS

Description	
Type	Recirc. Ball Torsion Bar
Ratio	17:1
Turns of Steering Wheel (Lock to Lock — Linkage Disconnected)	4
Fluid Capacity (Included in Pump Reservoir Fill)	.75L (1.6 Pint Approx.)
Fluid Specification	ESW-M2C33-F②
Worm Bearing Preload (Overall Input Shaft Torque with Sector Shaft Removed)	0.45-1.0 N•m (4-9 in-lbs)①
Worm to Piston Preload	0.11-0.34 N•m (1-3 in-lbs)①

①Not adjustable in field. Specification given for inspection purposes only.
②C1AZ-19582-A, C, or D or equivalent.

FORD INTEGRAL POWER STEERING GEAR TORQUE LIMITS

Description	Torque Limits (ft-lbs)	Torque Limits N•m
Sector Shaft Cover Bolts	55-70	75-94
Mesh Load Adjusting Screw Lock Nut	34-45	48-61
Valve Housing to Gear Housing Bolt	35-50	48-67
Rack Retaining Nut	55-90①	75-122
Piston End Cap	70-110	95-149
Pressure Hose to Gear	16-25	22-33
Return Hose to Gear	25-34	34-46
Hose Clamps	1-2	1.4-2.7
Pitman Arm to Sector Shaft Nut	190-230	230-310
	(in-lbs)	N•m
Ball Return Guide Clamp Screw	42-70	4.8-7.9
Set Screw Race Nut	15-25	1.7-2.8

①Specified Torque — Because the length of the tool required to torque the nut will affect the observed torque reading on the torque wrench, the torque reading should be computed using the length of the torque wrench and the nominal specified torque as follows:

$$\text{Torque Reading} = \frac{\text{Length of Torque Wrench} \times 72 \text{ ft-lbs}}{\text{Length of Torque Wrench} + 5.5 \text{ Inches}}$$

(Using Tool T66P-3553-B)

Example: With 13 inch torque wrench

$$\frac{13 \text{ In.} \times 72 \text{ ft-lbs}}{13 \text{ In.} + 5.5 \text{ In.}} = \frac{13 \text{ In.} \times 72 \text{ ft-lbs}}{18.5 \text{ In.}} = 0.703 \times 72 \text{ ft-lbs} = 50 \text{ ft-lbs}$$

MESHLOAD CHECKING AND SETTING

Vehicles with 0-8046 km (0-5000 Miles)	Vehicles with More Than 8046 km (500 Miles) or Where Sector Shaft Has Been Replaced
CHECKING: Reset if total meshload over mechanical center is less than 1.9 N•m (15 in-lbs) or greater than 2.9 N•m (25 in-lbs).	**CHECKING:** Reset if meshload measured while rocking input shaft over center is less than 0.8 N•m (7 in-lbs) greater than the torque 45° from the right stop.
RESET: Set torque measured rocking across center to a value of 1.6-2.0 N•m (14-18 in-lbs) greater than that measured 45° from the right stop.	**RESET:** Set torque measured rocking across center to a value 1.13-1.6 N•m (10-14 in-lbs) greater than that measured 45° from the right stop.

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SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T58L-101-A	Puller Attachment	Universal — Use with Slide Hammer
T58L-101-B	Puller Attachment	Replaces T58L-101-A
T57L-500-B	Bench-Mounted Holding Fixture	Universal
Tool-1175-AC	Seal Remover	Universal — Use with Slide Hammer
T74P-3504-L	Brass Tube Seat Remover	Tube Seat Removal
T74P-3504-M	Brass Tube Seat Replacer	Tube Seat Installation
T75L-3517-A	Seal Installation Set	Ford Integral Power Steering Gear
T65P-3524-A	Input Shaft Bearing/Seal Tool	Ford Integral Power Steering Gear — For Needle Bearing Removal and Installation
T66P-3553-B	Adjuster and Locknut Wrench	Ford Integral Power Steering Gear — For Worm Bearing Adjuster and Locknut — Use with Spacer — Valve Housing to Piston
T66P-3553-C	Spacer — Valve Housing to Piston	Ford Integral Power Steering Gear — Use with Adjuster and Locknut Wrench
T65P-3576-A	Sector Shaft Bushing Tool	Ford Integral Power Steering Gear — Use for Bushing Removal and Replacement
T77L-3576-A	Sector Shaft Seal Replacer	Ford Integral Power Steering Gear
T64P-3590-F	Pitman Arm Puller	Universal
D79L-7000-A	Retaining Ring Pliers	Internal and External Retaining Rings
T71P-19703-C	O-Ring Tool	Universal
T68L-33610-AB	Thermometer	Use with Power Steering Analyzer
D79L-33610-A	Power Steering Analyzer	All Vehicles

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SECTION 13-52 Power Steering Pump—Saginaw

SUBJECT	PAGE
ADJUSTMENTS	
Drive Belt Tension	13-52-1
DESCRIPTION	13-52-1
DIAGNOSIS AND TESTING	13-52-1
DISASSEMBLY AND ASSEMBLY	
Power Steering Pump	13-52-4
REMOVAL AND INSTALLATION	
Power Steering Pump	13-52-1
Power Steering Pump Pulley	13-52-2
Rotor Shaft Seal	13-52-2
SPECIFICATIONS	13-52-7
VEHICLE APPLICATION	13-52-1

VEHICLE APPLICATION

Applies To E-150 Through E-350 Truck Models with 4.9L, 5.0L, 5.8L, 7.5L and 7.3LD engines.

DESCRIPTION

The power steering pump (Fig. 1) is a constant displacement vane type providing hydraulic pressure for the steering system. The housing and internal parts of the pump are inside the reservoir so the pump parts operate submerged in oil. The reservoir is sealed against the pump housing, leaving the housing face and the shaft hub exposed. The reservoir has a filler neck with a cap.

The drive shaft is fitted with a pulley and is belt driven from the crankshaft. The rotor is loosely splined to the drive shaft and secured with a retaining ring. Ten vanes are mounted in radial slots in the rotor.

An identification label showing the pump model number is located on the outboard side of the pump reservoir.

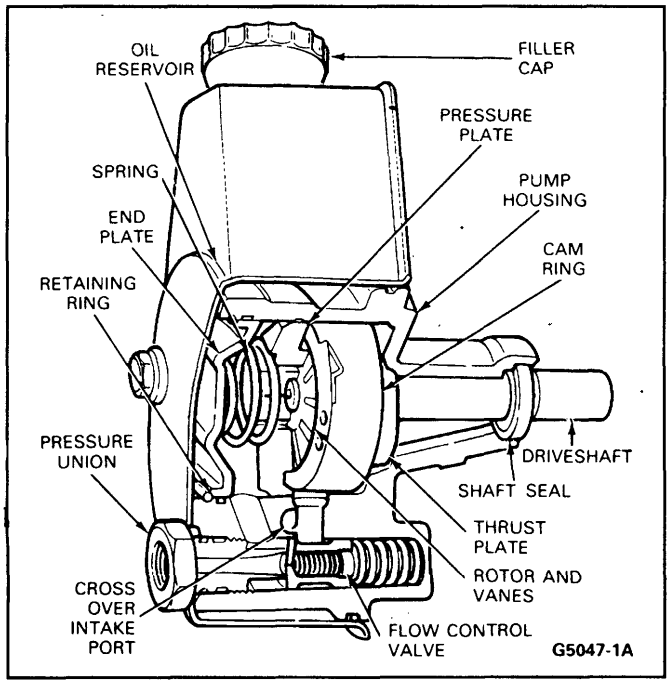


FIG. 1 Power Steering Pump—Sectional View

DIAGNOSIS AND TESTING

Refer to Section 13-01, General Steering Service.

ADJUSTMENTS

Drive Belt Tension

For drive belt tension procedures, refer to Section 27-06, Accessory Drive Belt Service.

REMOVAL AND INSTALLATION

Power Steering Pump

Refer to Figs. 2, 3, 4 and 5.

Removal

1. Disconnect the pressure and return lines from the pump and plug them to prevent loss of fluid or entrance of dirt into the system.
2. Loosen the belt tension adjusting bolt all the way.
3. Remove the bolts attaching the pump mounting bracket to the air conditioning bracket (if equipped).
4. Remove the pump, mounting bracket, and pulley assembly.

Installation

1. Install the pump, bracket and pulley assembly and loosely attach the bolts that secure the pump mounting bracket to the air conditioning bracket (if equipped).
2. Install the drive belts on the pulley.
3. Loosely install the belt tension adjusting nut.
4. On all except the 4.9L (300 CID) and 7.3L diesel engines pry between the pump adjustment bracket and the engine block until correct tension is achieved. On 4.9L (300 CID) and 7.3L diesel engines, insert a 1/2 inch breaker bar in the adjustment slot and move the pump and bracket assembly until the specified belt tension is obtained. While still holding this tension, tighten the adjusting bolt.
5. Tighten all attaching bolts to specification. Refer to Specifications at the end of this Section.
6. Connect the pressure and return lines to the pump.
7. Fill the reservoir as described in Section 13-01 with the specified power steering fluid. Bleed the air from the system by turning the steering wheel from left to right several times. Inspect for leaks.

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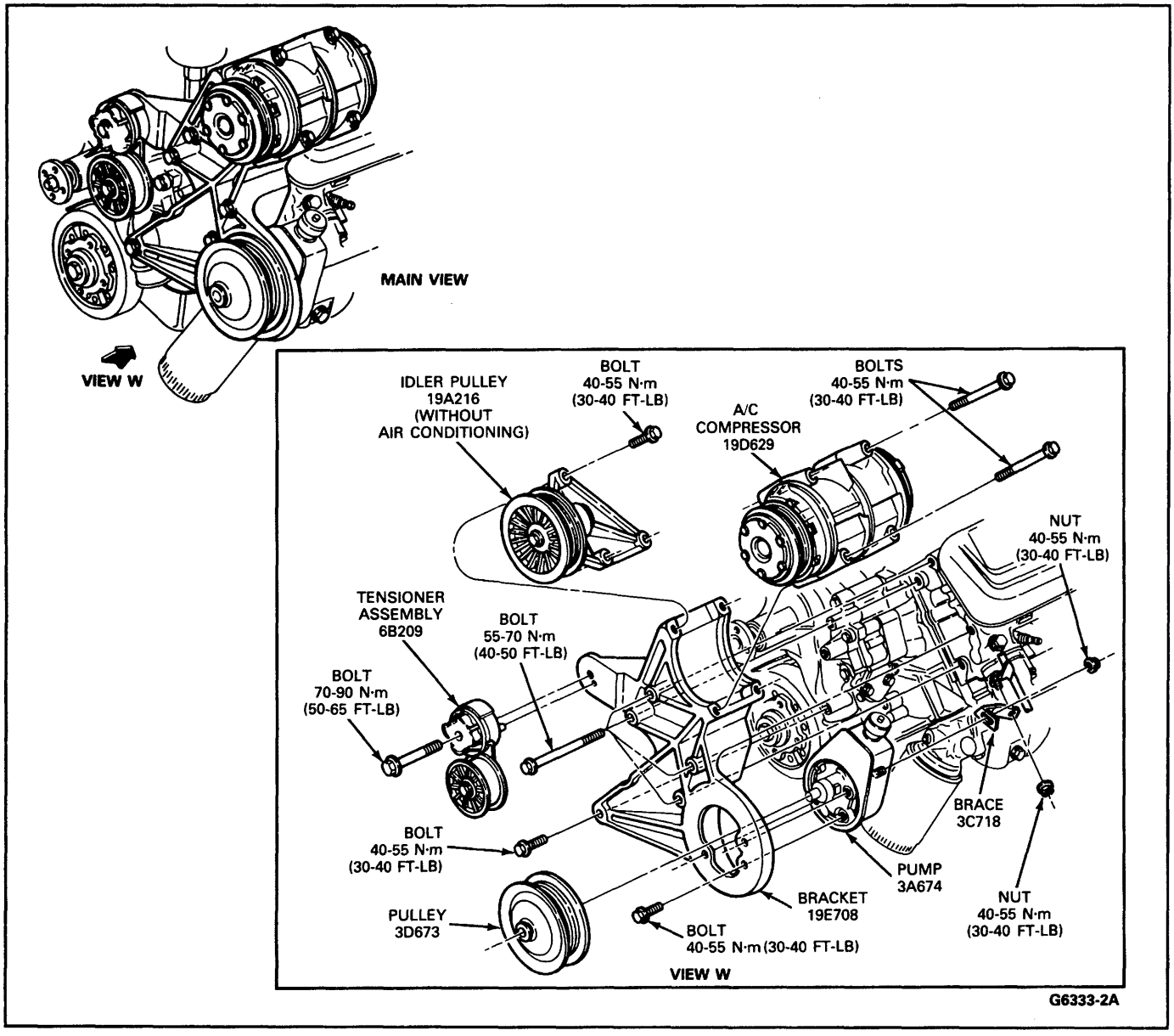


FIG. 2 Power Steering Pump Installation—7.5L EFI Engine

Power Steering Pump Pulley

Removal

1. With the pump removed from the vehicle, drain as much fluid as possible through the filler tube.
2. Clamp the mounting bracket in a vise with the pump attached. Do not clamp too tightly or bearing damage will result.
3. Install the Steering Pump Pulley Remover, T69L-10300-B or equivalent on the unit.
4. Rotate the tool nut counterclockwise to remove the pulley. If the snap ring is damaged, disassemble the pump, as outlined in this Section, and replace the ring. **Do not hammer the tool. This could damage the pulley and the snap ring at the inner end of the shaft.**

Installation

1. Install the pulley on the shaft. Front face of pulley hub must be flush within ±0.25mm (±0.010 inch) with end of pump shaft.

Rotor Shaft Seal

Remove the pump as outlined in this Section to replace the rotor shaft seal.

Removal

1. Drain as much fluid as possible through the filler tube.
2. Remove the pulley from the pump following the procedures described in this Section.
3. Insert a sharp tool between the rotor shaft seal and the pump housing. Pry out the seal. **Do not pry against the shaft or housing bore.**

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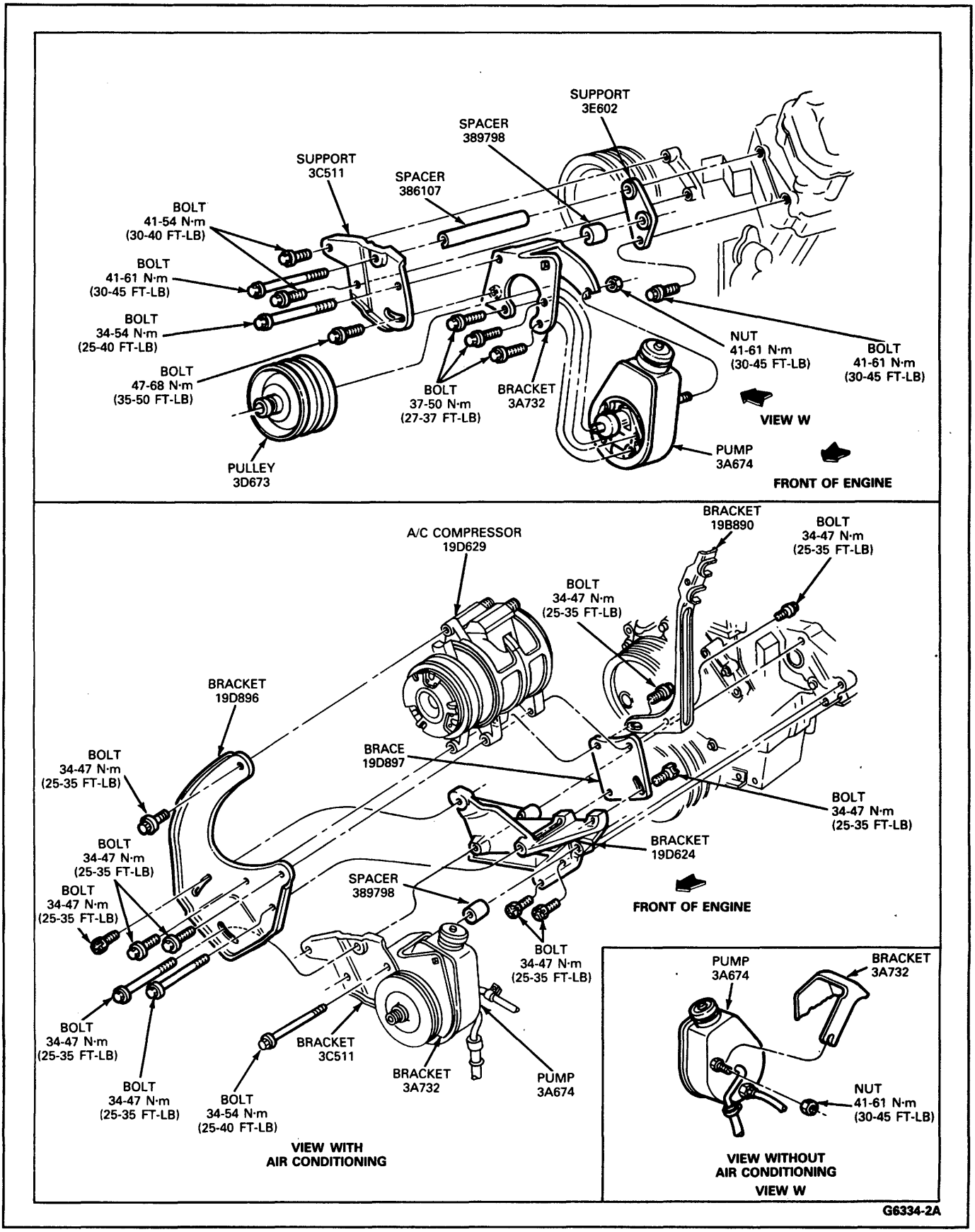


FIG. 3 Power Steering Pump Installation—7.3L Diesel Engine

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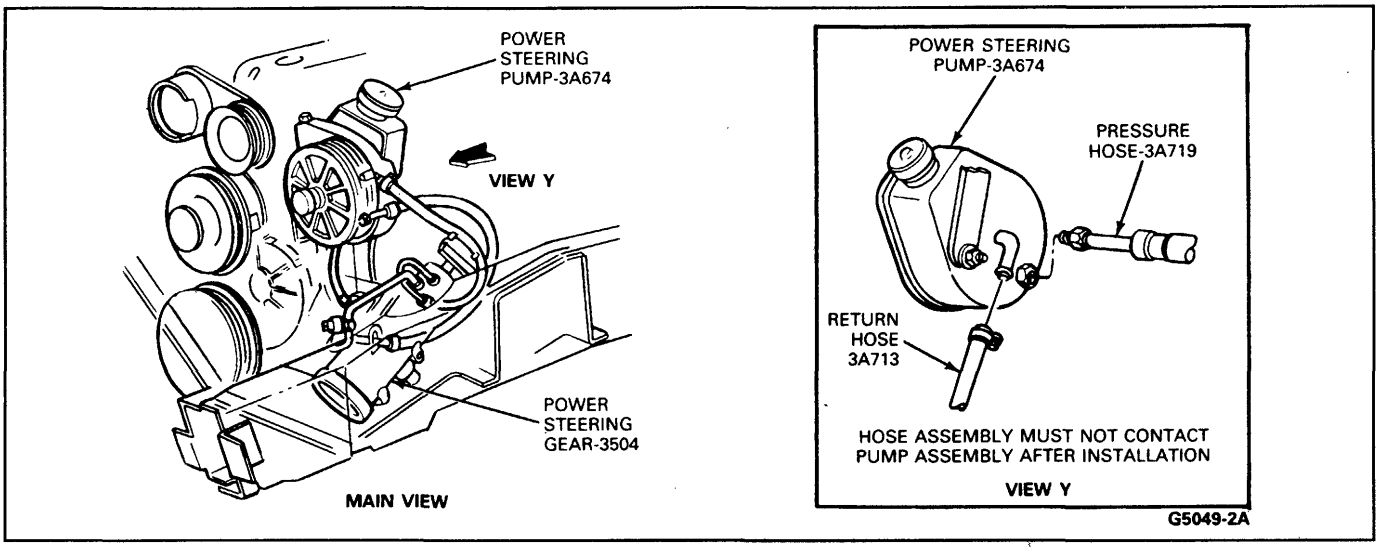


FIG. 4 Power Steering Pump Installation—4.9L EFI Gasoline Engine

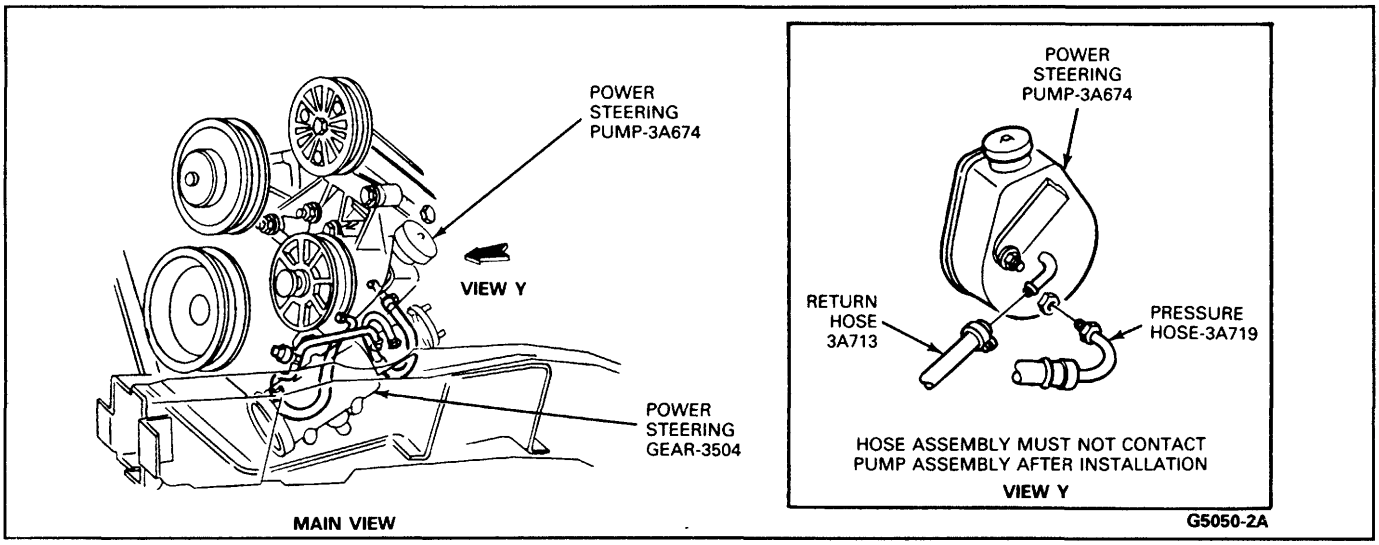


FIG. 5 Power Steering Pump Installation—5.0L and 5.8L EFI Gasoline Engine

Installation

1. Remove the pump and bracket from the vise and lay it flat on the workbench.
2. Place a new rotor shaft seal on the shaft with the metal backing facing the pulley end of the shaft (Fig. 6).
3. Install the seal (Fig. 6) using an appropriate shaft seal installer. Tap the tool lightly with a small hammer until the seal is properly seated in the shaft hub.
4. Install the pulley.

DISASSEMBLY AND ASSEMBLY

Take the following precautions when servicing the power steering pump:

1. **Use a clean work bench and tools.**
2. Clean the exterior of the unit with solvent. Drain as much fluid as possible.
3. If only the rotor shaft seal is being replaced, follow the procedures under Rotor Shaft Seal Removal and Installation in this Section.
4. **Do not use solvent on seals.**

Power Steering Pump

Disassembly

Refer to Fig. 7.

1. Remove the bracket and pulley from the pump as described in this Section under Removal and Installation (Figs. 2-5).
2. Clamp the front hub of the pump in a vise so the extending portion of the shaft points down. **Do not clamp the pump too tightly or bearing damage may result.**
3. Remove the pressure union, O-ring assembly, and both mounting bolts from the back of the reservoir. Discard all seals and O-rings.
4. Rock the reservoir slightly back and forth to unseat the O-ring seal. Remove the O-ring and discard. Remove the reservoir.
5. Remove the mounting bolt and pressure union seals from the counterbored spaces in the pump housing. Discard the seals.

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6. Rotate the end plate retaining ring so that one end of the ring is over the hole in the housing. Insert a small punch in the 1/8 inch diameter hole in the housing side opposite the flow control valve hole. Compress the retaining ring with the punch and remove the ring by twisting a screwdriver under the ring (Fig. 8).
7. Remove the end plate. The end plate is spring loaded and will generally sit above the housing level for easy removal. If the plate sticks, rock it back and forth lightly to free it.
8. Remove the pressure plate spring.
9. Remove the pump from the vise and turn it over allowing the flow control valve and its spring to fall out. Do not disassemble the flow control valve. Service it as a unit.
10. With the end plate O-ring removed, tap very lightly on the end of the shaft until the pressure plate falls free.
11. Remove the cam ring, vanes and rotor (Fig. 9).
12. Remove the cam ring and vanes from the rotor.
13. Remove the retaining ring by clamping the shaft in a soft-jawed vise and prying the ring off the shaft with a pair of long nose pliers or a screwdriver. Do not damage the shaft with the vise jaws. Discard the retaining ring.
14. Remove the thrust plate from the shaft.
15. Remove both dowel pins from the housing.
16. Remove the pressure plate and end plate O-ring seals from the housing bore and discard them.

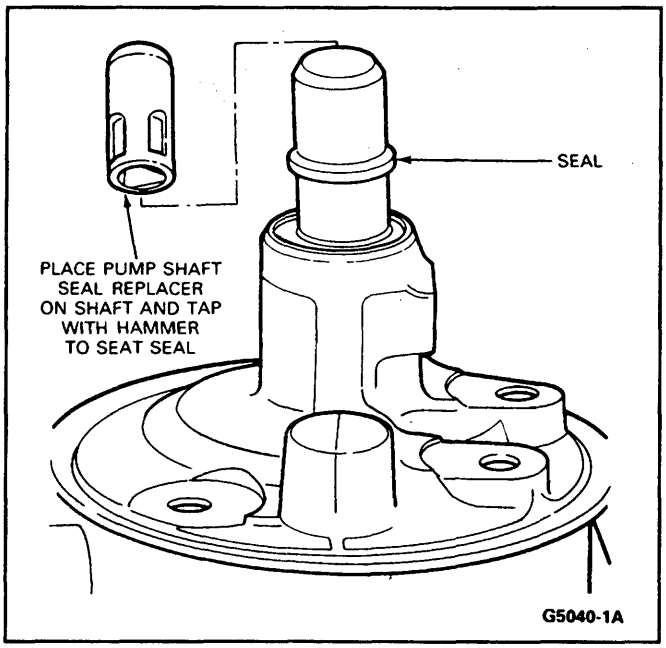


FIG. 6 Installing the Rotor Shaft Seal

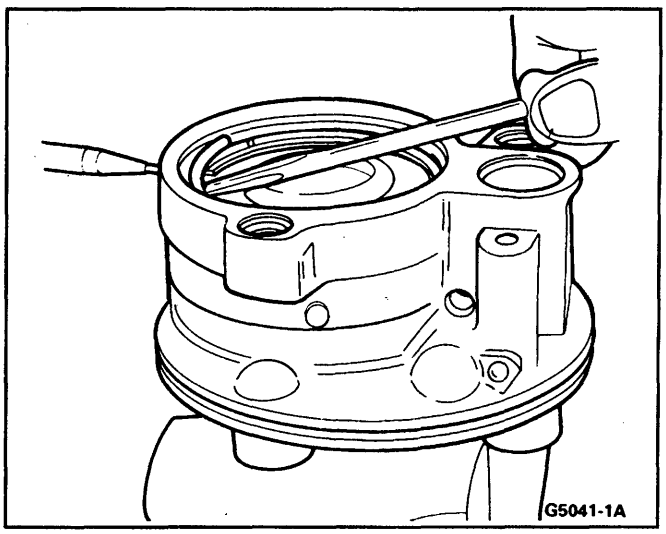


FIG. 8 Removing the End Plate Retaining Ring

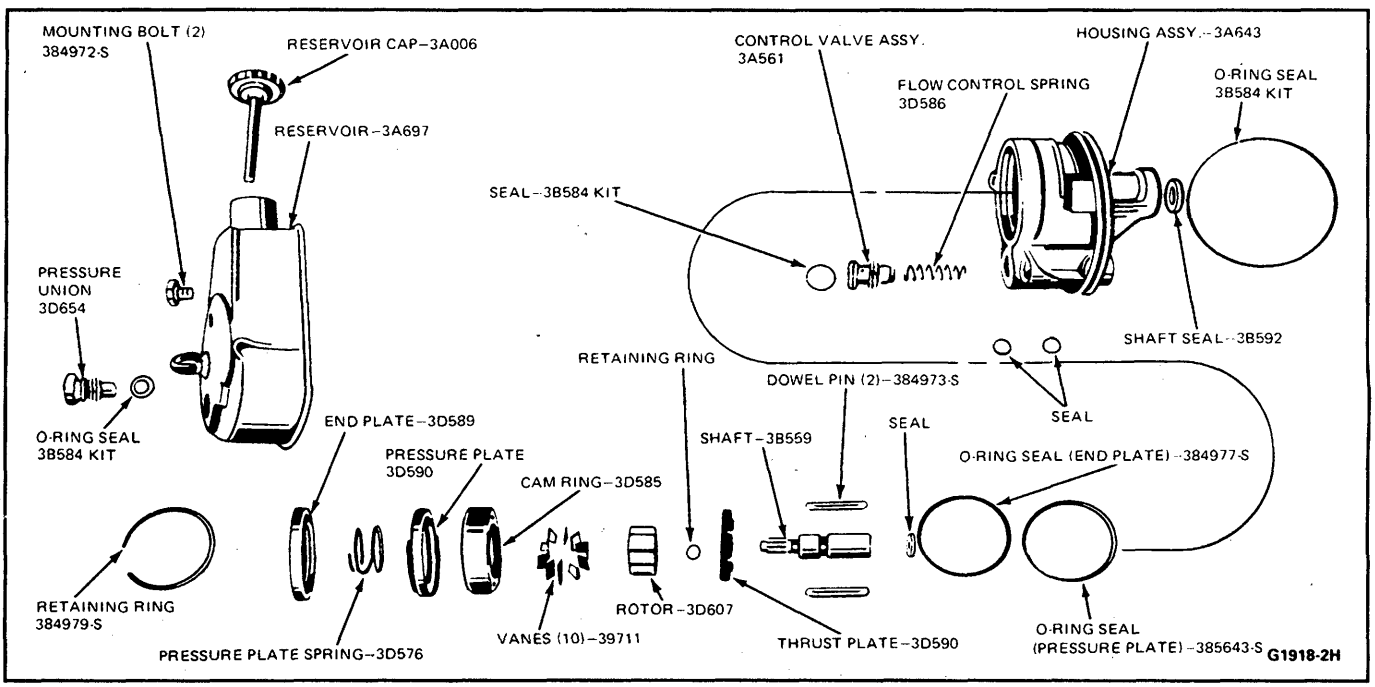


FIG. 7 Power Steering Pump Disassembled

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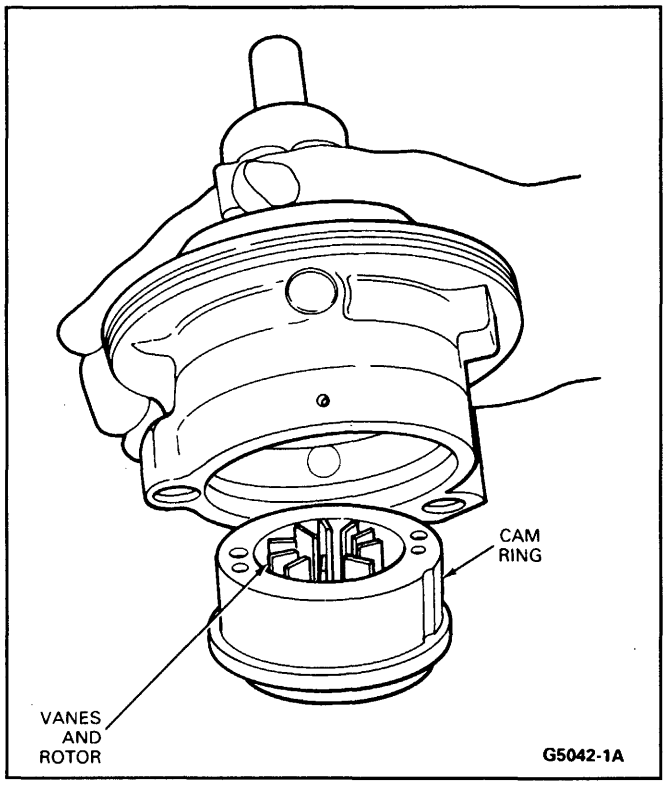


FIG. 9 Removing The Cam Ring, Vanes And Rotor

17. Remove the shaft seal only if it is worn or damaged. Removal will destroy the seal.

Assembly

1. Clean all metal parts with solvent.
2. If the shaft seal was removed, install a new seal following the instructions under Rotor Shaft Seal Removal and Installation in this Section.
3. Lubricate a new pressure plate O-ring seal with Motorcraft Automatic Transmission Fluid—Type 'F', XT-1-QF (ESW-M2C33-F) or equivalent and install it in the third groove from the rear of the housing.
4. Clamp the end hub of the housing in a vise so the extending portion of the shaft points down. Do not clamp the bearing too tightly or damage may occur.
5. Insert both dowel pins.
6. Install the thrust plate on the shaft with the ports toward the splined end of the shaft.
7. Install the rotor on the shaft with the counterbored end toward the thrust plate.
8. Clamp the shaft in a soft-jawed vise. Install a new retaining ring on the splined end of the shaft by prying the ring open and sliding it down over the shaft until it seats in the ring groove. Use the round wire ring from the retaining ring service kit. **Do not damage the shaft.**
9. Insert the shaft in the housing. Lubricate shaft with power steering fluid, and make certain the thrust plate slides properly on the dowel pins.
10. Install the cam ring on the dowel pins with the rotation arrow toward the rear of the housing (Fig. 10).

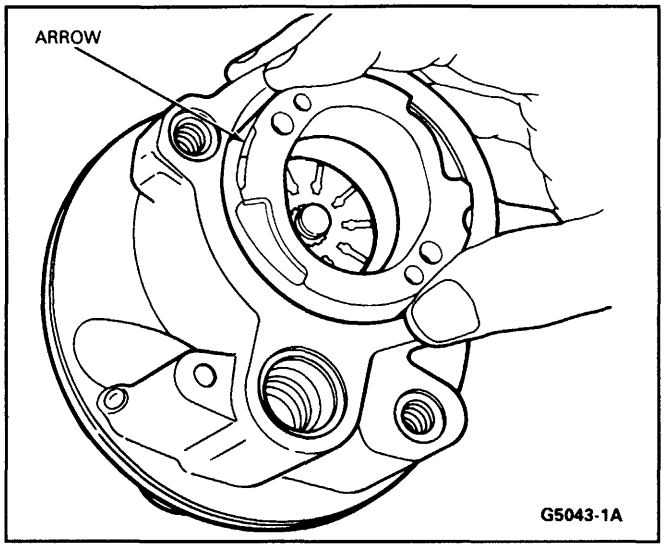


FIG. 10 Installing the Cam Ring

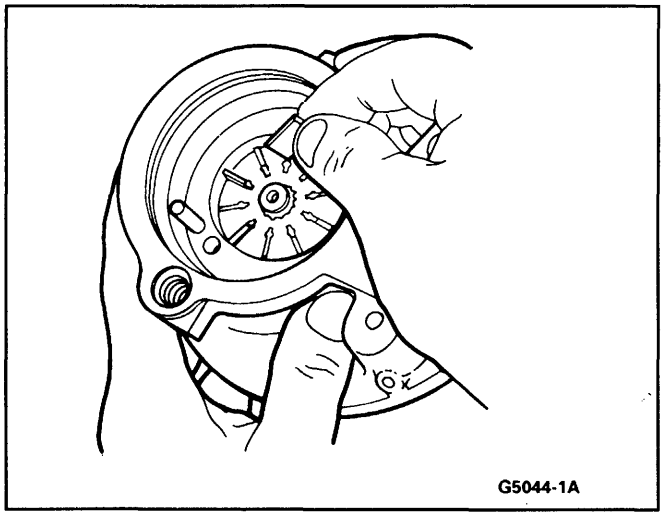


FIG. 11 Installing the Vanes in the Rotor

11. Install the vanes in the rotor slots with the rounded edge of the vanes outward. Be sure the vanes slide freely (Fig. 11).
12. Lubricate the pressure plate with Motorcraft Automatic Transmission Fluid—Type 'F', XT-1-QF (ESW-M2C33-F) or equivalent to prevent damage to the pressure plate O-ring seal.
13. Install the pressure plate on the dowel pins with the circular spring depression toward the rear of the housing (Fig. 12). The narrow slots in the plate should engage the dowel pins. To seat pressure plate, press it about 1.19mm (1/16 inch) over the O-ring.
14. Lubricate a new end plate O-ring with Motorcraft Automatic Transmission Fluid—Type 'F', XT-1-QF (ESW-M2C33-F) or equivalent and install it in the second groove from the rear of the housing.
15. Install the pressure plate spring in the groove in the pressure plate.
16. Lubricate the end plate with power steering fluid to prevent damage to the O-ring, and press it into the housing with an arbor press (Fig. 13). Depress the

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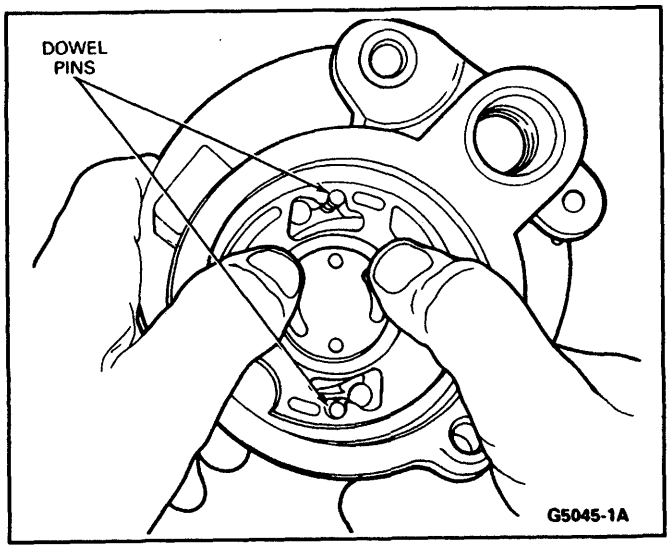


FIG. 12 Installing the Pressure Plate

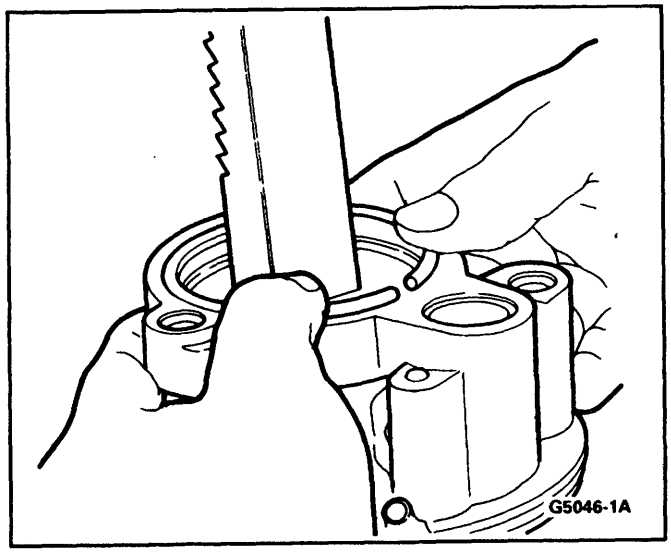


FIG. 13 Installing the End Plate Retaining Ring

end plate only far enough to allow installation of the retaining ring in its groove.

17. Install the end plate retaining ring. Release the arbor press.
18. Place the control valve spring in its hole and insert the control valve with the screened end towards the front of the housing.
19. Install new mounting bolt and pressure union seals in the countersunk holes. Lubricate a new reservoir O-ring seal with Motorcraft Automatic Transmission Fluid—Type 'F', XT-1-QF (ESW-M2C33-F) or equivalent, and install it on the housing.
20. Lubricate the inside edge of the reservoir with power steering fluid and install it on the housing. Align the holes in the reservoir and housing. Replacement reservoirs do not have an identification number. If a new reservoir is installed, imprint the model number of the worn or damaged reservoir on the new part for future identification.
21. Insert the mounting bolt and tighten to 47 N·m (35 ft-lbs).
22. Lubricate a new O-ring with Motorcraft Automatic Transmission Fluid Type "F", XT-1-QF (ESW-M2C33-F) or equivalent and install it on the pressure union in the groove next to the head hex. Insert the pressure union in the flow control valve hole in the back of the reservoir and tighten to specification listed at the end of this Section.

SPECIFICATIONS

SAGINAW POWER STEERING PUMP TORQUE LIMITS — ALL EXCEPT 7.3L DIESEL ENGINE

Description	Size	Engine				Torque	
		4.9L (300 CID) I-6	5.0L (302 CID) V-8	5.8L (351 CID) V-8	7.5L (460 CID) V-8	N·m	Ft. Lbs.
Support bracket to engine bolt	3/8-16 x .75		X	X	X	48-60	30-45
	5/16-18 x 1.25	X				30-43	22-32
	7/16-14 x 1.25	X				55-81	40-60
Adjusting bolt	7/16-14 x .75		X	X	X	57-77	42/57
	3/8-16 x .75	X				40-60	30-45
Pump to adjusting bracket bolt	10mm x 19mm	X	X	X	X	40-60	30-45
Support bracket to adjusting bracket to engine bolt	7/16-14 x 6.00		X	X	X	57-77	42-57
Support bracket to adjusting bracket bolt	3/8-16 x .75	X				40-60	30-45
Pump to adjusting bracket nut	M-10		X	X	X	40-60	30-45
Pressure line to pump nut	—	X	X	X	X	15-25	20-35
Pressure line to gear nut	—	X	X	X	X	15-22	20-30
Return line to gear nut	—	X	X	X	X	15-22	20-30

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SAGINAW POWER STEERING PUMP TORQUE LIMITS — 7.3L DIESEL ENGINE

Description	Size	Torque	
		N•m	Ft-Lbs
Support Bracket to Engine Bolt	3/8-16 x .88	41-61	30-45
	3/8-16 x 6.0	41-61	30-45
Support Bracket to Adjusting Bracket	7/16-14 x 6.12	34-61	25-40
Adjusting Bracket to Pump	M10-1.5 x 18	37-50	28-36
Adjusting Bolt	7/16-14 x 1.0	48-67	35-50
Pressure and Return Line to Gear	—	34-40	25-30
Pressure and Return Line to Pump	—	34-40	25-30

CG4586-2B

DRIVE BELT TENSION

Belt Width	Minimum Tension (for use at maintenance interval only) (Hot Engine)		Installation Tension			
			Used Belt 1		New Belt	
	Lbs	N	Lbs	N	Lbs	N
1/4"	30	133	60	267	80	356
3/8" and 15/32"	50	222	110	489	140	623
1/2"	50	222	110	489	140	623

1 Any belt operated for 10 minutes or more is considered a used belt.

CY2473-2A

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T58L-101-A	Puller Attachment	Universal — Use with Slide Hammer
T57L-500-B	Bench Mounted Holding Fixture	Universal
Tool-1175-AC	Seal Remover	Universal — Use with Slide Hammer
D79L-7000-A	Retaining Ring Pliers	Internal and External Retaining Rings
T63L-8620-A	Belt Tension Gauge	Universal
T69L-10300-B	Steering Pump Pulley Remover	Pump Removal
T71P-19703-C	O-Ring Tool	Universal
T68L-33610-A/B	Thermometer	Use with Power Steering Analyzer
D79L-33610-A	Power Steering Analyzer	All Vehicles

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SECTION 13-53 Power Steering Pump—C-II

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VEHICLE APPLICATION

All Bronco and F-150 through F-350 and F-Super Duty Truck Models.

DESCRIPTION

The C-II power steering pump is used in all F-150—F-350 light trucks and Bronco (Fig. 1).

The C-II power steering pump is a belt driven slipper type pump with a fiberglass reinforced nylon reservoir. The reservoir is attached to the rear side of the pump housing front plate and the pump body is encased within the housing and reservoir. The pressure hose is attached with a quick connect fitting, located below the filler neck at the outboard side of the reservoir, and the fitting allows the line to swivel. This is normal and does not indicate an untorqued fitting.

A pressure sensitive identification tag will be attached to the reservoir. The top line of this tag indicates the basic model number (HBC) and the suffix. Always use these tags when requesting service parts as there may be slight differences in internal components.

DIAGNOSIS AND TESTING

For problem diagnosis refer to Section 13-01, General Steering Service.

ADJUSTMENTS

Pump Belt Tension Adjustment

For the proper belt tensioning sequence, refer to Section 27-06, Accessory Drive Belt Service.

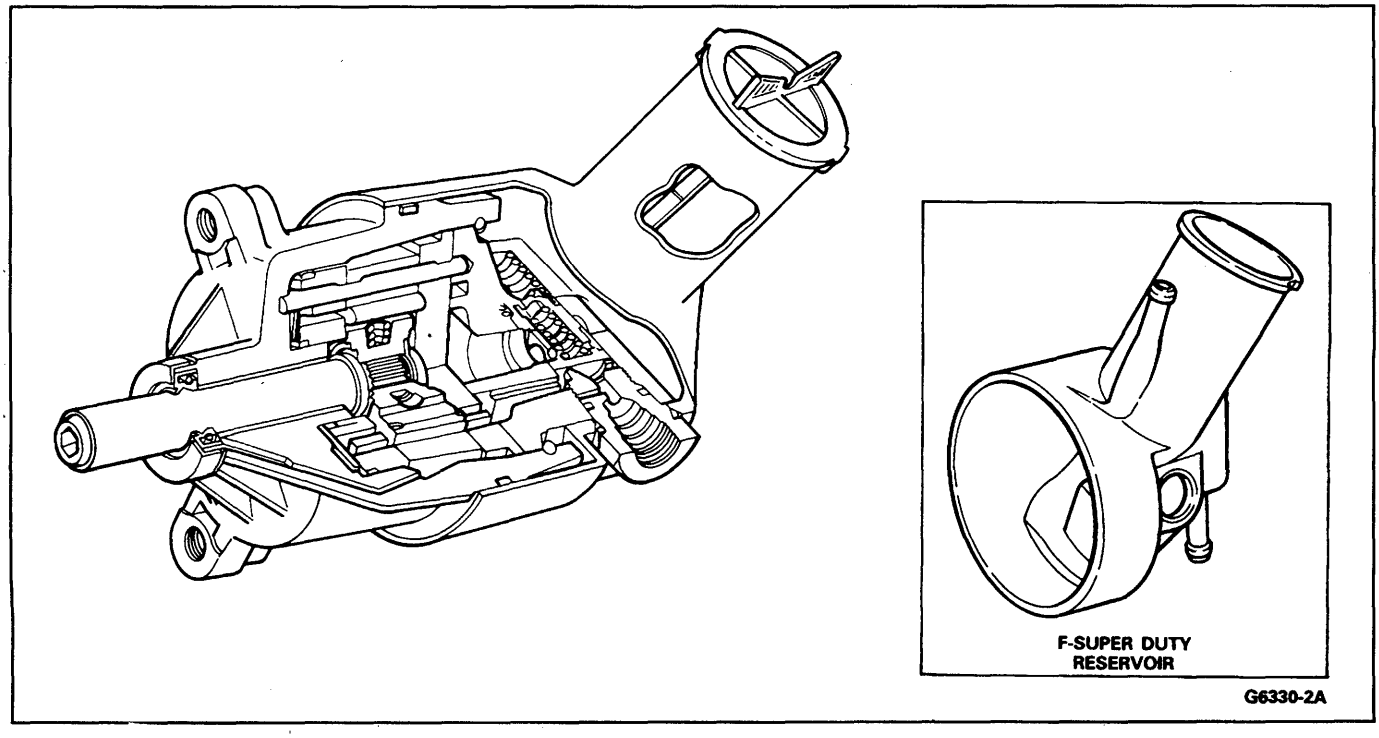


FIG. 1 Ford Model C-II Power Steering Pump—Sectional View

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REMOVAL AND INSTALLATION

Quick Connect Power Steering Fitting Service

The quick connect power steering fitting, under certain conditions may leak and/or result in improper engagement. The leak can be caused by a cut O-ring, imperfections in the outlet fitting inside diameter, or improperly machined O-ring groove. Improper engagement can be caused by an improperly machined tube end, tube nut, snap ring, outlet fitting, or gear port.

If a leak occurs, the O-ring should be replaced with quick connect O-rings (3/8 tube end: 388749-S; 5/16 tube end: 388748-S). The O-rings that are used on the tube-O power steering fitting should not be used on the quick connect fitting because of dimensional and material changes. If O-ring replacement does not solve the leak problem, outlet fitting replacement and, lastly, hose replacement should be made.

If improper engagement occurs due to a missing or bent snap ring, or improperly machined tube nut, it may be repaired with a service snap ring kit (kit includes a new tube nut). The system should then be properly filled, the engine started, and the steering wheel cycled from lock-to-lock to test for positive engagement. If the hose assembly still does not engage, replace the entire hose assembly.

Quick connect hose assemblies for service have tube nuts, snap rings, and O-rings already attached. (Fig. 2).

When the quick connect tube nut is tightened or loosened, a tube nut wrench, not an open end wrench, is recommended. An open end wrench may result in tube nut deformation under excessive torque conditions. Care must be taken not to overtighten the tube nut. Tighten to 14-20 N·m (10-15 ft-lbs). Swivel and/or end play of the quick connect fittings is normal, and does not indicate an undertightened fitting.

Power Steering Pump Pulley

Removal

1. Drain as much fluid as possible from the pump through the filler pipe.

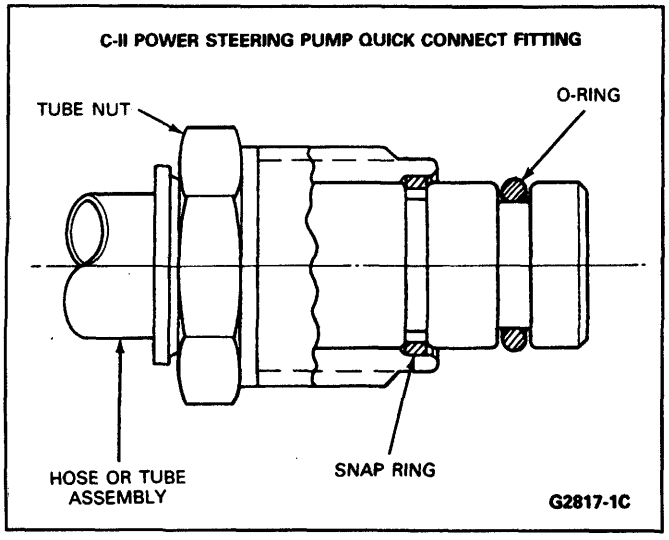


FIG. 2 Quick Connect Fittings

2. Install pulley remover Tool T69L-10300-B or equivalent on the pulley hub, placing the tool and pump in a vise (Fig. 3).
3. Hold the pump and rotate the tool nut counter-clockwise to remove the pulley. Do not apply in and out pressure on the pump shaft. Pressure will damage the internal thrust areas.

Installation

1. Attach pump to adjustment bracket. Place the pulley on the pump shaft and install Tool T65P-3A733-C or equivalent (Fig. 3).

   Hold the pump and rotate the tool nut clockwise to install the pulley on the shaft. The pulley hub face must be flush within ±0.25mm (±0.010 in.) of the end of the pump shaft. Do not apply in and out pressure on the shaft. Pressure will damage the internal pump areas.
2. Remove the tool.

Power Steering Pump

Removal

Refer to Figs. 4-7.

1. To remove the power steering fluid from the pump reservoir, disconnect the fluid return hose at the reservoir and drain the fluid into a container.
2. Remove the pressure hose from the pump.
3. Remove the bolts and nuts from the pump adjustment bracket. Loosen the pump sufficiently to remove the belt off the pulley. Remove the pump (still attached to the adjustment bracket) from the support bracket.
4. Remove the pulley from the pump as described in this Section.
5. Remove the bolts attaching the adjustment bracket to the pump and remove the pump.
6. On 4.9L and 5.0L engines with serpentine drive belt remove the drive belt by lifting the belt tensioner out of position.

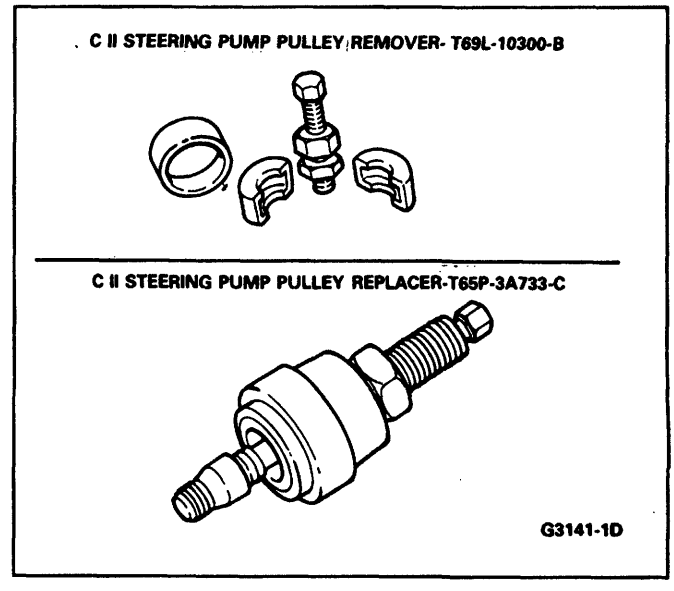


FIG. 3 Pulley Removal and Installation Tools—35.05mm (1 3/8 Inch) Hub Diameter

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7. Remove the pulley from the pump as described in this Section.
8. Remove the bolts attaching the pump to the bracket and remove the pump.

Installation

1. Place the adjustment bracket on the pump. Install and tighten the bolts to specification listed at the end of this Section.
2. On 4.9L and 5.0L engines install the bolts and attach pump to bracket.
3. Install the pulley on the pump as described in this Section.
4. Place the pump with adjustment bracket and pulley on the support bracket. Install the bolts and nuts connecting the support bracket to the adjustment bracket and tighten to specifications.
5. Place the belt on the pulley and adjust belt tension as described in this Section. Tighten bolts on adjustment bracket to specifications. On 4.9L and 5.0L engines, install the serpentine drive belt in position on all pulleys and release the belt tension so that drive belt is tight.
6. Install the pressure hose to the pump fitting.
7. Connect the return hose to the pump, and tighten the clamp.
8. Fill the reservoir with specified power steering fluid, start the engine and turn the steering wheel from stop to stop to remove air from the system.
9. Check for leaks and recheck the fluid level. Add fluid if necessary.

Power Steering Pump Drive Belt Replacement (Pivot Type)

1. On vehicles with air conditioning, loosen the idler pulley attaching bolts and remove the compressor drive belt.
2. Loosen adjusting and pivot bolts attaching the power steering pump adjustment bracket to the pump support bracket, and remove the pump drive belt.
3. Position the new power steering pump drive belt on the pulleys.
4. Adjust the drive belt tension to specifications as outlined in this Section.
5. On vehicles with air conditioning, install the compressor drive belt, and adjust to specifications (refer to Specifications in Section 13-01, General Steering Service).

Power Steering Pump Drive Belt Installation and/or Adjustment (Slider Type)

1. Loosen the bolts so the adjustable bracket is free to slide inboard on the stationary bracket.
2. Loosen the belt adjustment bolt enough to move the pump assembly and adjustable bracket inboard. Remove the belt.
3. If installing a new belt, place it on the proper pulleys.
4. Tighten the adjustment bolt until snug.
5. Install a Belt Tension Gauge, T63L-8620-A or equivalent, and tighten the belt adjustment nut until the proper tension is attained 533-667 N (120 to 150 lbs) for a new belt, 400-533 N (90-120 lbs) for a used belt.
6. Tighten the nuts on the vertical studs to 41-54 N·m (30-40 ft.-lb.).
7. Remove the tension gauge.

Rotor Shaft Seal

Replacement of the rotor shaft seal requires pump disassembly. Refer to the Disassembly and Assembly procedures in this Section for seal replacement.

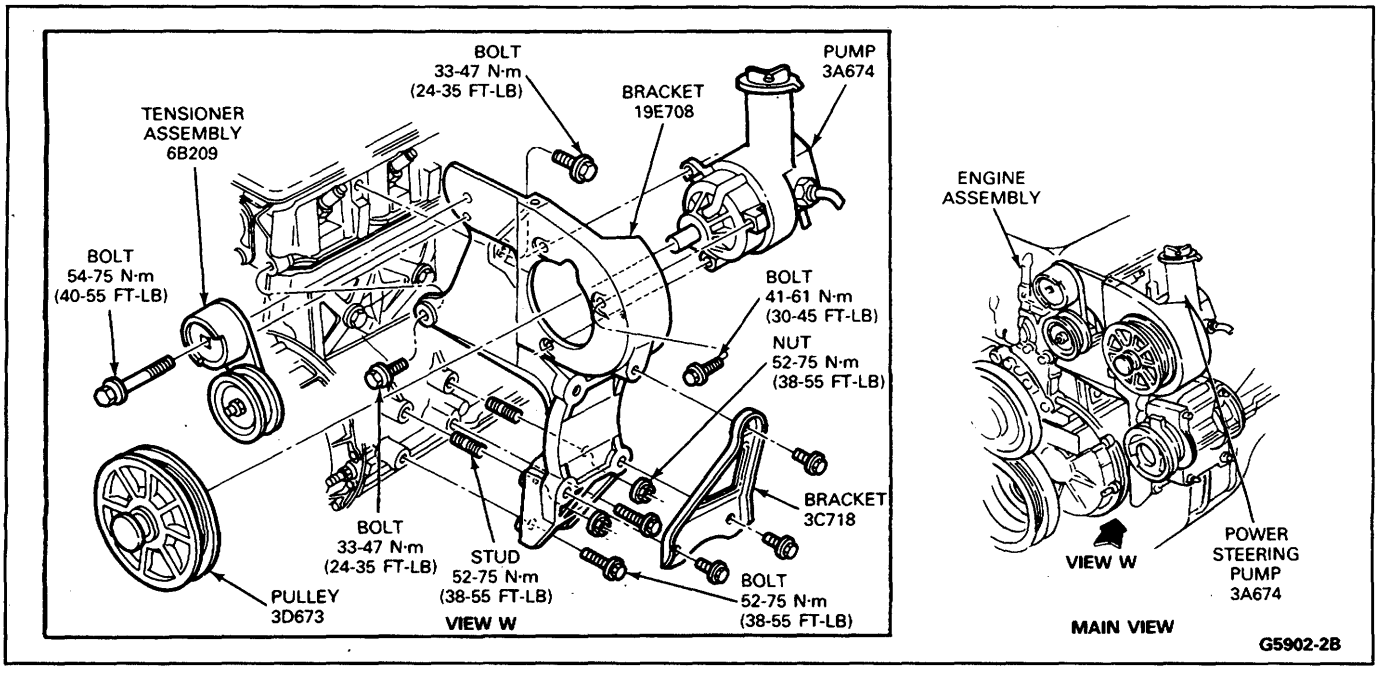


FIG. 4 Power Steering Pump Installation F-150—F-350 (4x2) (4x4), Bronco 4.9L (300 CID) EFI I-6 Gasoline Engine

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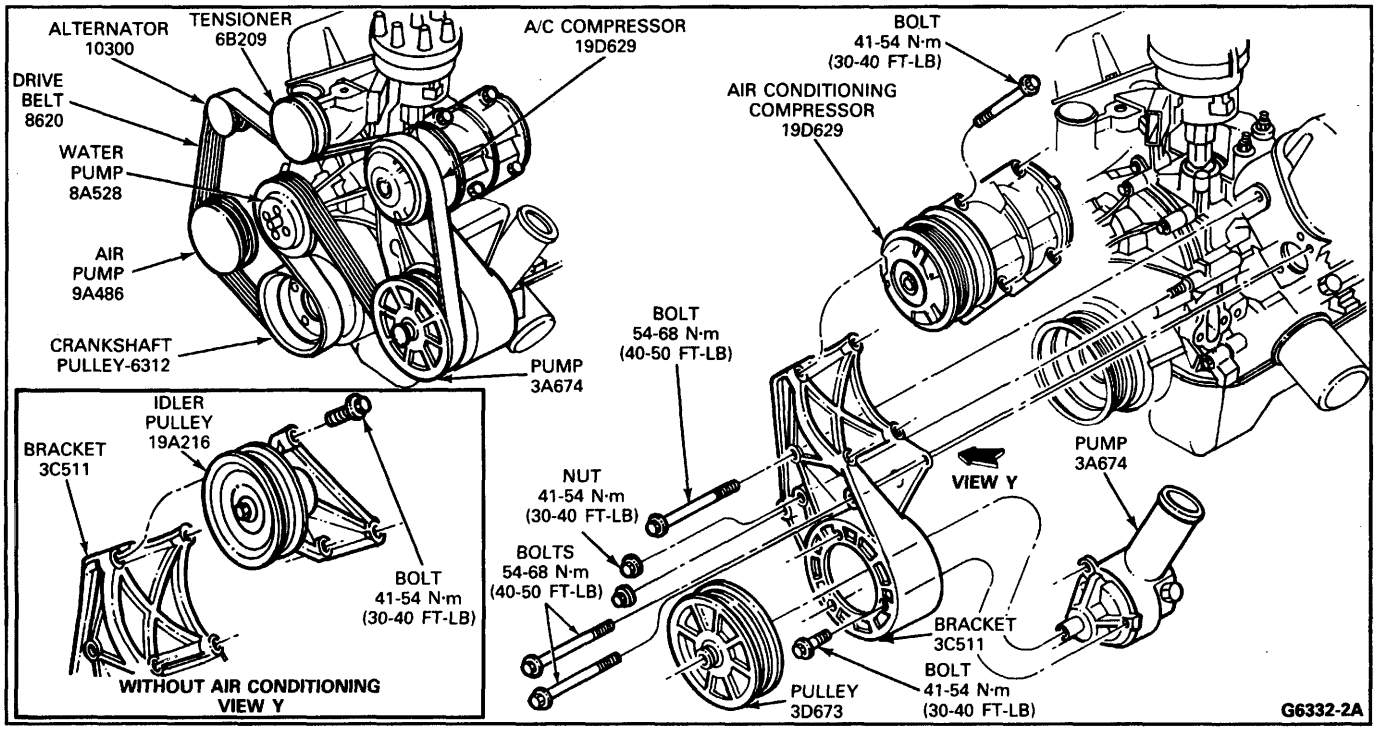


FIG. 5 Power Steering Pump Installation—F-150—F-350 (4x2) (4x4) and Bronco With 5.0L and 5.8L EFI Engine

Power Steering Pump Reservoir

Take the following precautions when servicing the power steering pump reservoir:

1. Use a clean work bench and tools.
2. Plug the inlet and outlet openings of the pump with plugs or masking tape.
3. Thoroughly clean the exterior of the pump with solvent.

Removal

1. Place the pump assembly in a bench vise with soft jaws (Fig. 8), and remove the outlet fitting, flow control valve and spring. Discard all seals.
2. Remove the fiberglass reservoir (Fig. 9).
3. Discard O-ring seal on pump housing plate (Fig. 10).

   NOTE: Do not hammer on the reservoir.

Installation

1. Install a new O-ring seal on the pump housing plate.
2. Apply petroleum jelly to the reservoir O-ring seal and the inside edge of the reservoir. Do not twist the O-ring seal (Fig. 11).
3. Place the reservoir over the pump and align the outlet fitting hole in the reservoir with the hole in the valve cover.
4. Be sure the reservoir is evenly seated on the pump housing plate.
5. Place a new O-ring seal on the outlet fitting. Install the spring, flow control valve and outlet fitting into the reservoir and valve cover. Tighten the fitting to 34-36 N·m (25-34 ft. lb.)

NOTE: If the valve is cocked, it may become stuck in the valve cover. Do not force the valve forward; forcing the valve may shear off metal and carry the metal chips into the valve bore.

DISASSEMBLY AND ASSEMBLY

Power Steering Pump

Refer to Figure 12.

The following precautions must be observed when servicing the power steering pump:

1. Use a clean work bench and tools.
2. Thoroughly clean the exterior of the pump with solvent. Drain as much fluid as possible.
3. If only the reservoir is to be removed, clean as detailed under Reservoir Removal.
4. If only the rotor shaft seal is to be removed, clean as detailed under Reservoir Removal.
5. Do not use cleaning solvent on the seals.

Disassembly

1. Remove the pump pulley as outlined under Pump Pulley Removal in this Section making sure the pump has been removed from the adjustment bracket.
2. Remove the outlet fitting, flow control valve, and spring from the pump. Remove the pump reservoir.
3. Place "C" clamp (Tool No. T74P-3044-A1) or equivalent in a bench vise.
4. Place the lower support plate (Tool No. T78P-3733-A2) or equivalent over the pump rotor shaft (Fig. 13).
5. Install the upper compressor plate (Tool No. T78P-3733-A1) or equivalent into the upper portion of the "C" clamp.
6. Holding the upper compressor tool, place the pump assembly into the "C" clamp with the rotor shaft facing down (Fig. 14).

   NOTE: Position the contour of the upper compressor tool to fit the contour of the pump valve cover.

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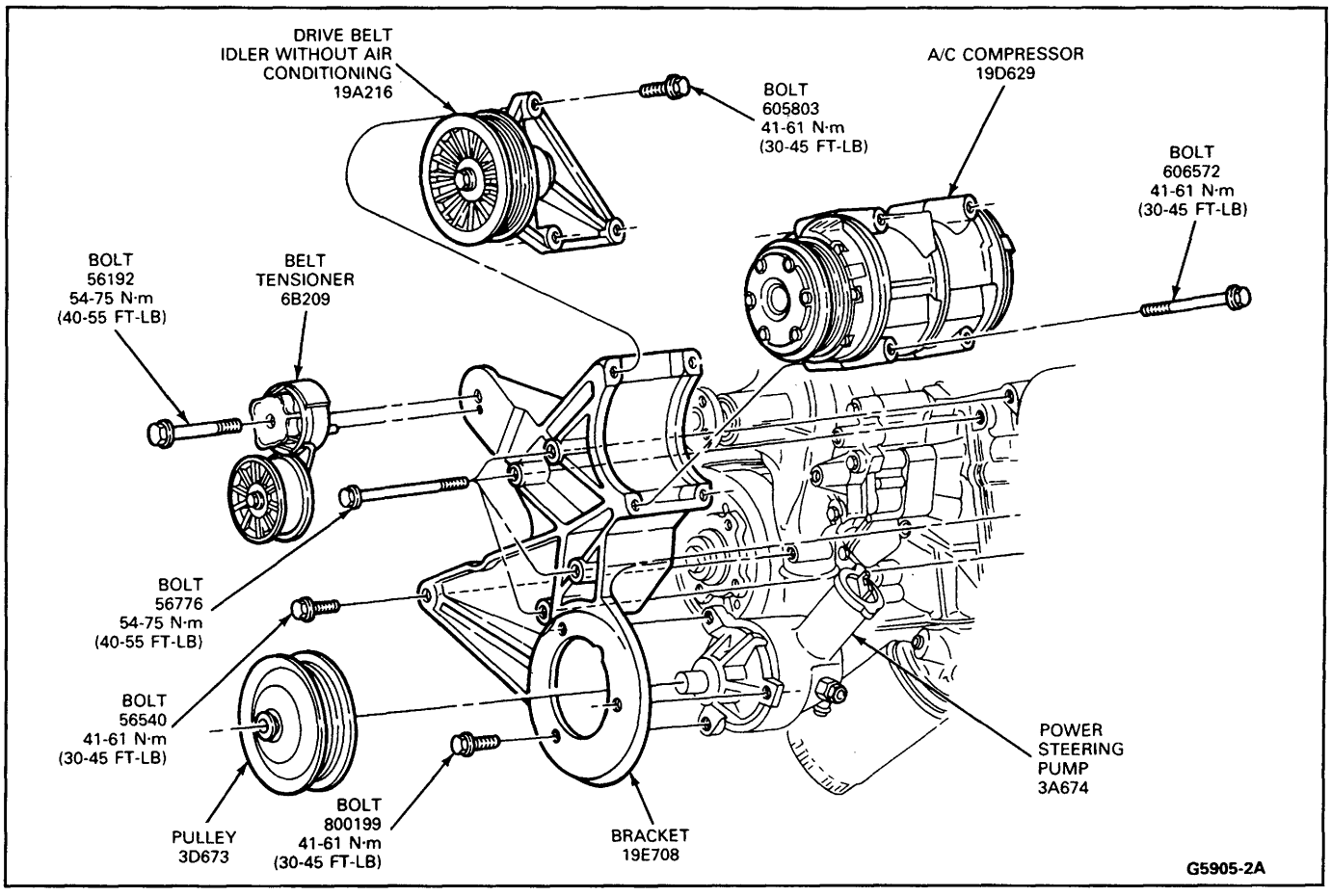


FIG. 6 Power Steering Pump Installation—7.5L EFI Engine

7. Tighten the "C" clamp until a slight bottoming of the valve cover is felt.
8. In the side of the pump housing plate is a small hole. Insert a small drift or suitable tool through this hole and push inward on the valve cover retaining ring. While applying pressure on the retaining ring, place a screwdriver under the edge of the retaining ring and remove the ring (Fig. 15).
9. Loosen the "C" clamp. Remove the upper compressor plate, and remove the pump assembly.
10. Remove the pump valve cover. Discard the O-ring seal.
11. Push on the rotor shaft, and remove the rotor shaft, upper plate, rotor and slippers, cam insert and (2) dowel pins (Fig. 16).
12. The lower plate and the disc spring will remain in the pump housing plate. To remove, place the pump housing plate on a flat surface. Raise slightly and slam the housing plate down flatly until the lower plate and the disc spring fall out. Discard the O-ring seals (Fig. 17).
13. Remove the rotor shaft seal and seal retainer simultaneously by prying out with a screwdriver (Fig. 18).

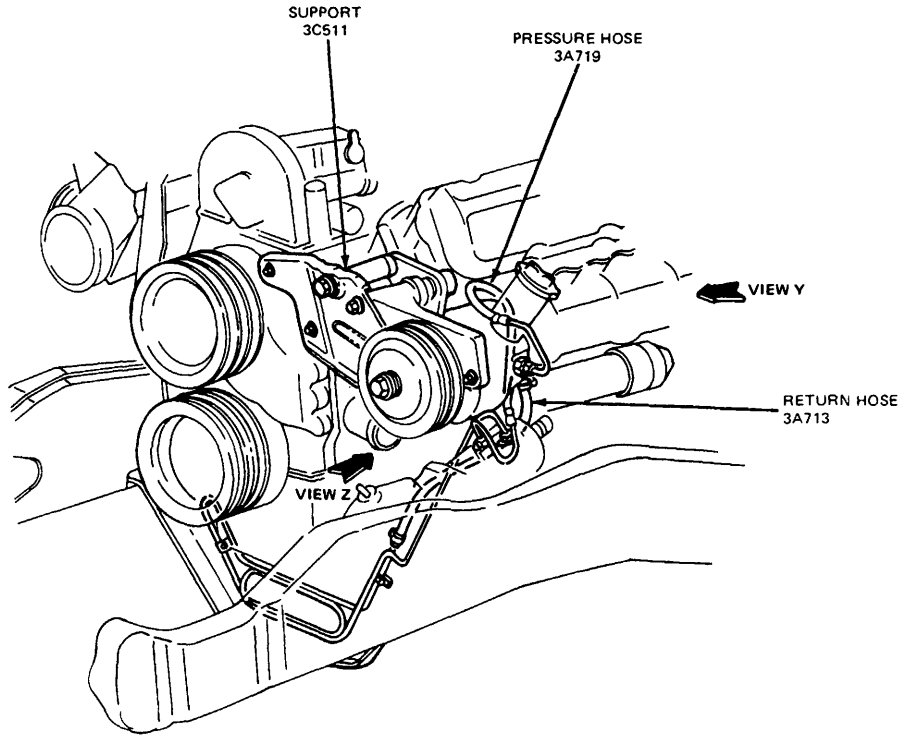
    NOTE: This method is used only when the pump is disassembled.

Assembly

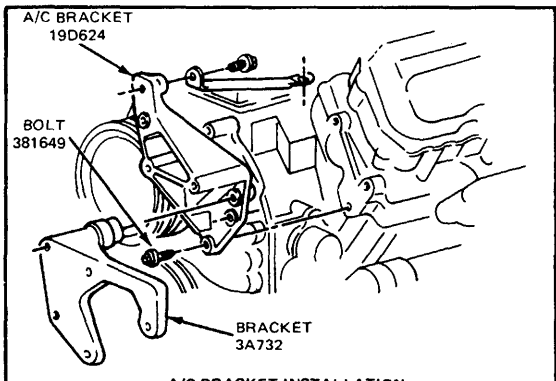
If the rotors, slippers, spring and cam insert were disassembled for cleaning and/or inspection, assemble as follows:

1. Place the rotor on the rotor shaft splines.
2. Install the retaining ring in the groove at the end of the rotor shaft.
3. Place the insert cam over the rotor. Be sure the recessed flat on the insert cam is toward the reservoir.
4. With the rotor extended upward approximately half way out of the cam, insert a spring into a rotor spring pocket.
5. Use one of the slippers to compress the spring and install the slipper with the narrow groove facing upward.
6. Hold the cam stationary, and turn the rotor either right or left one space at a time, and install another spring and slipper until all (10) rotor cavities have been filled. Be careful when turning the rotor, that the springs and slippers already installed do not fall out.
7. Install a new rotor shaft seal using seal driver Tool No. T78P-3733-A3, or equivalent. Using a plastic mallet, drive the seal into the bore until a bottoming is felt (Fig. 19). Install the seal retainer in the same manner.
8. Place the pump housing plate on a flat surface, with the pulley side facing down.

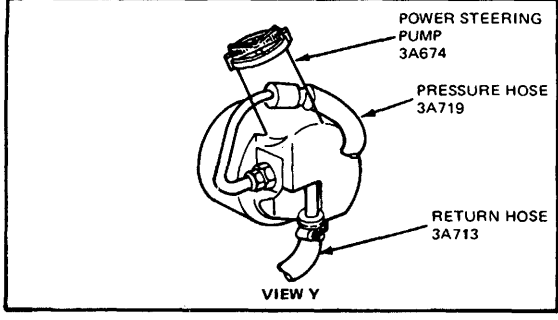
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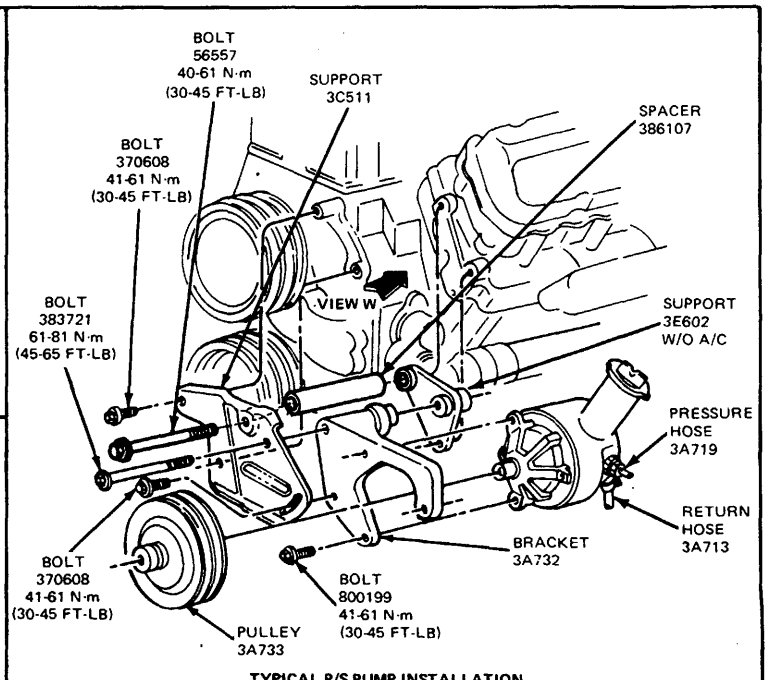
P/S HOSE INSTALLATION
WITH P/S COOLER



A/C BRACKET INSTALLATION
VIEW W



VIEW Y



TYPICAL P/S PUMP INSTALLATION
VIEW Z

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FIG. 7 Power Steering Pump Installation—7.3L Diesel Engine

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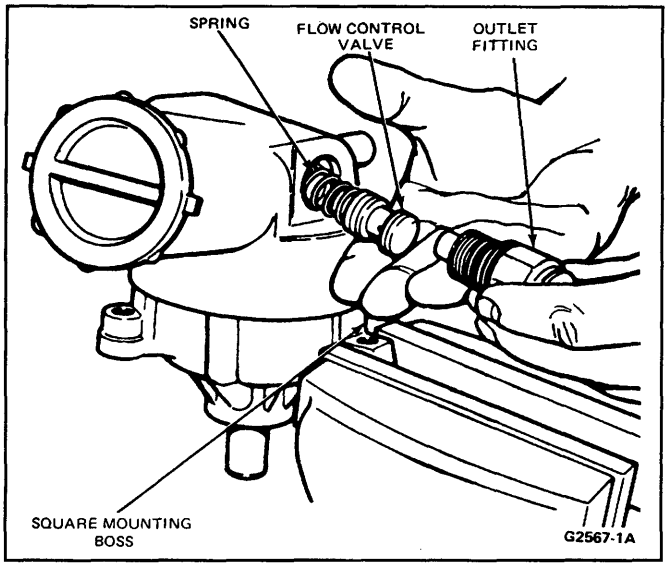


FIG. 8 Removing Outlet Fitting, Flow Control Valve and Spring

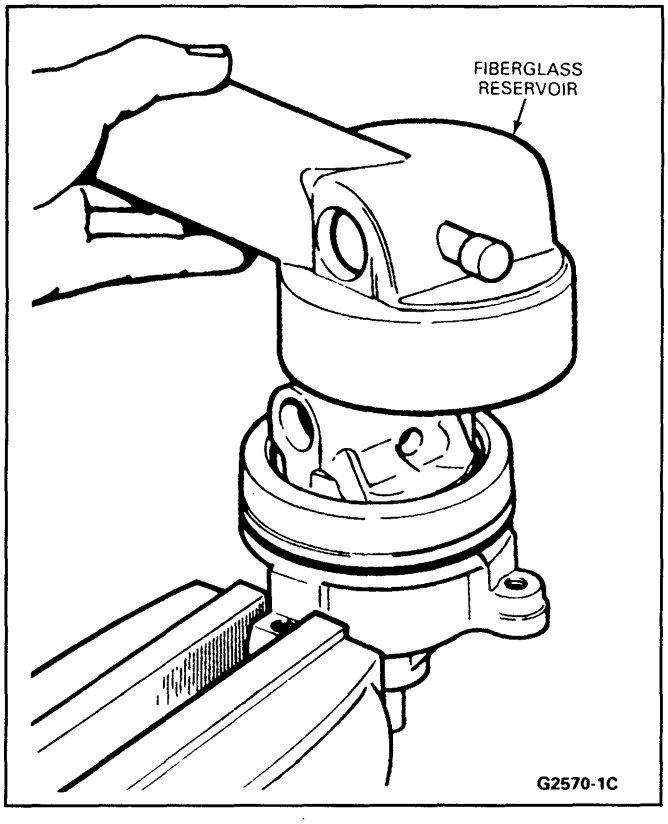


FIG. 9 Removing Reservoir

9. Insert the (2) dowel pins and the disc spring into the housing plate (Fig. 20).

   NOTE: The disc spring must be inserted with the dished surface upward.

10. Lubricate the inner and outer O- ring seals with the specified power steering fluid and install these seals on the lower pressure plate (Fig. 21).

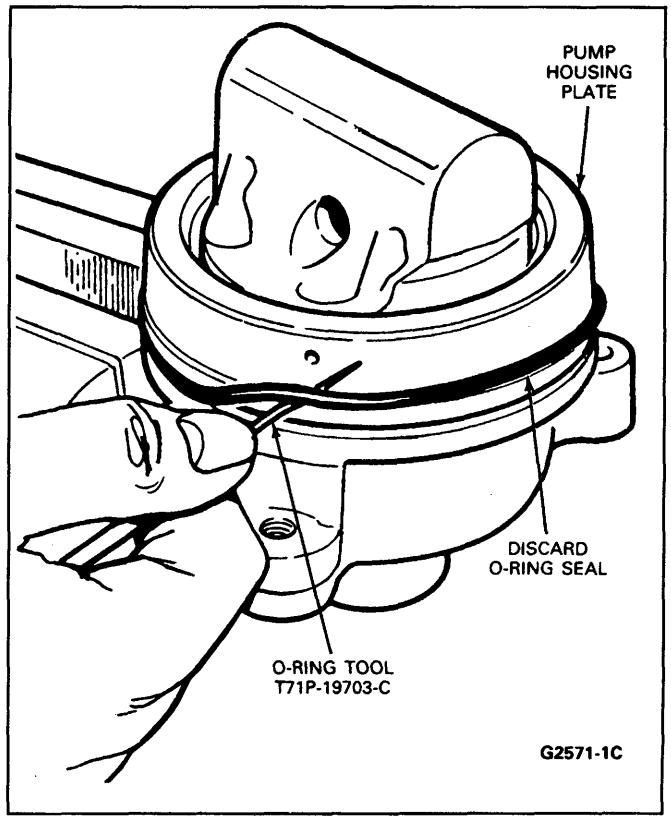


FIG. 10 Discarding O-ring Seal

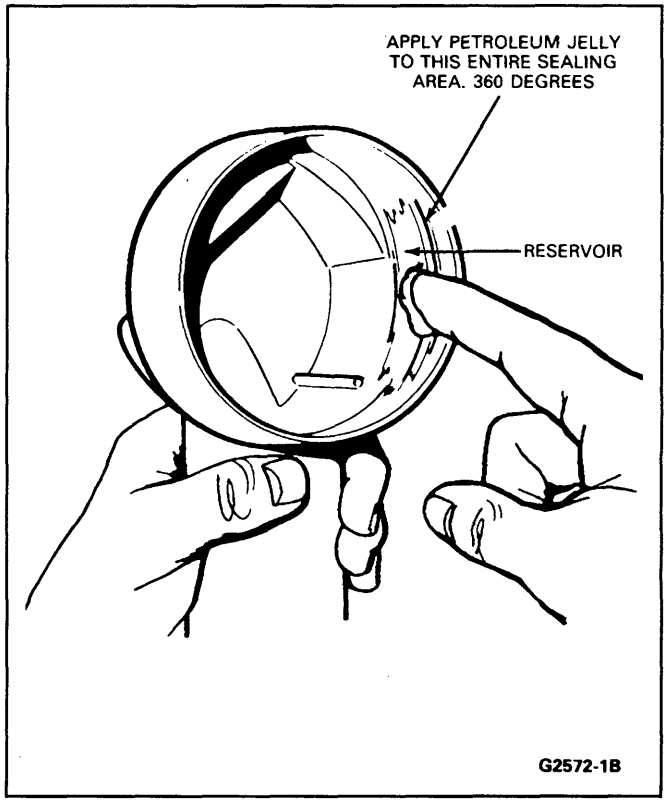


FIG. 11 Lubricating O-ring Seal

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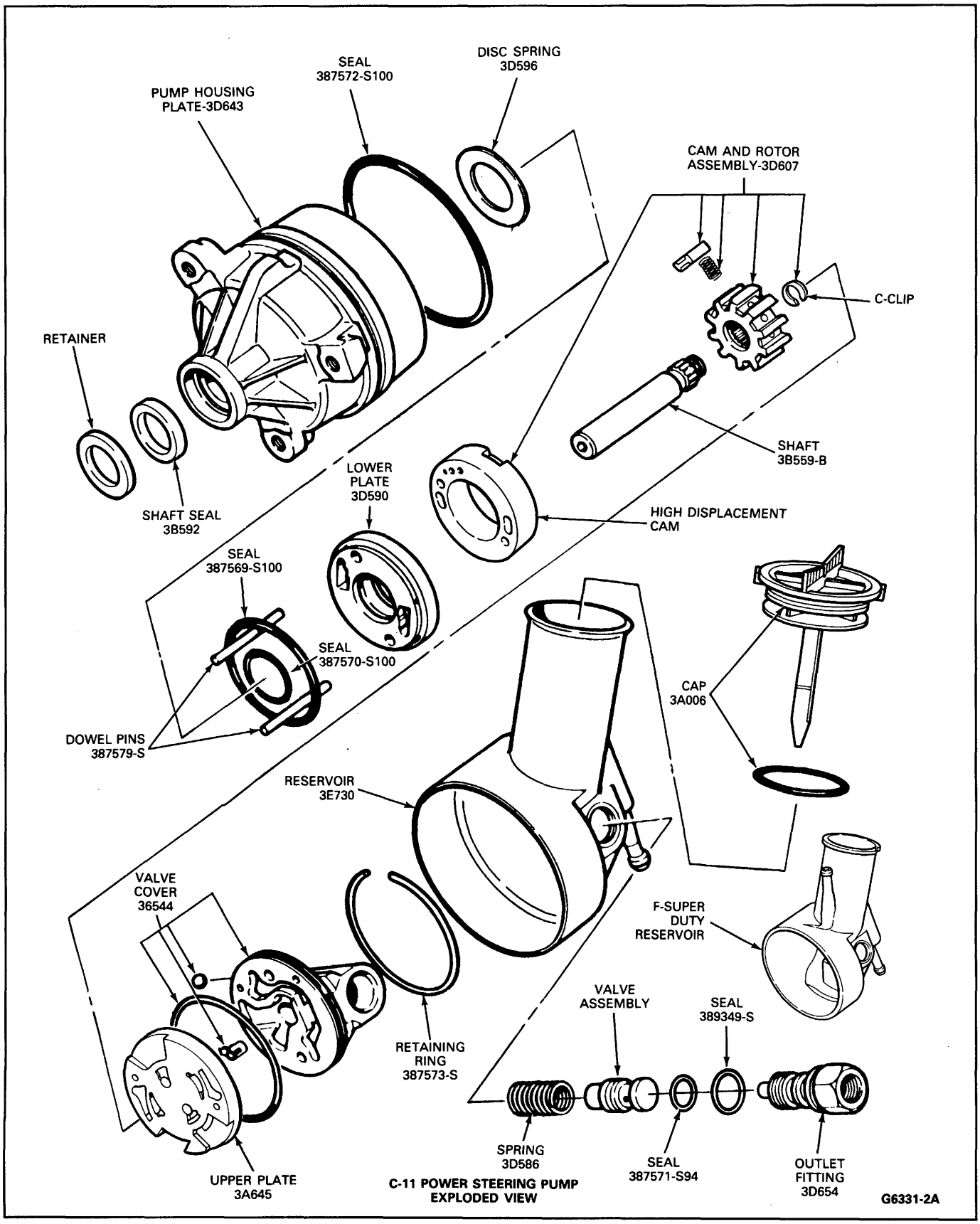


FIG. 12 C-II Power Steering Pump—Exploded View

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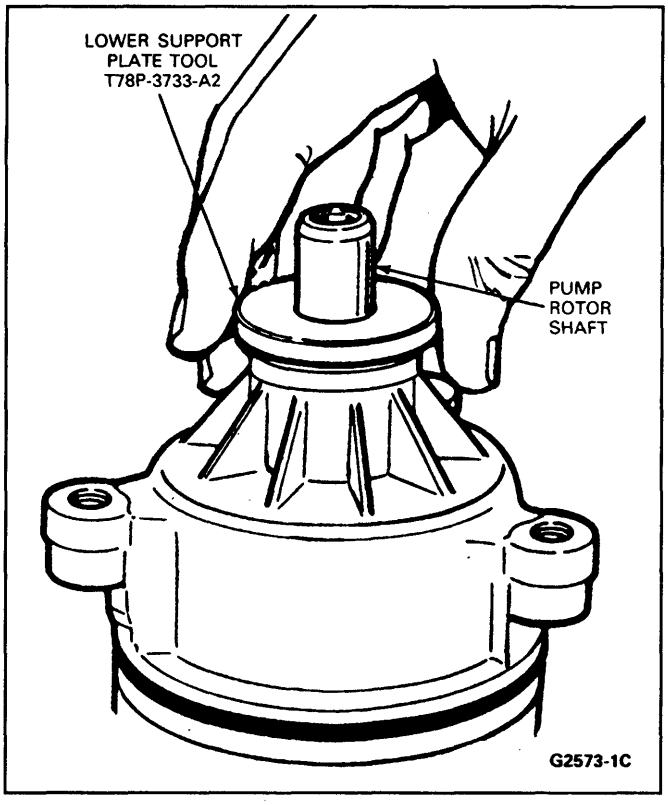


FIG. 13 Installing Lower Support Plate Tool

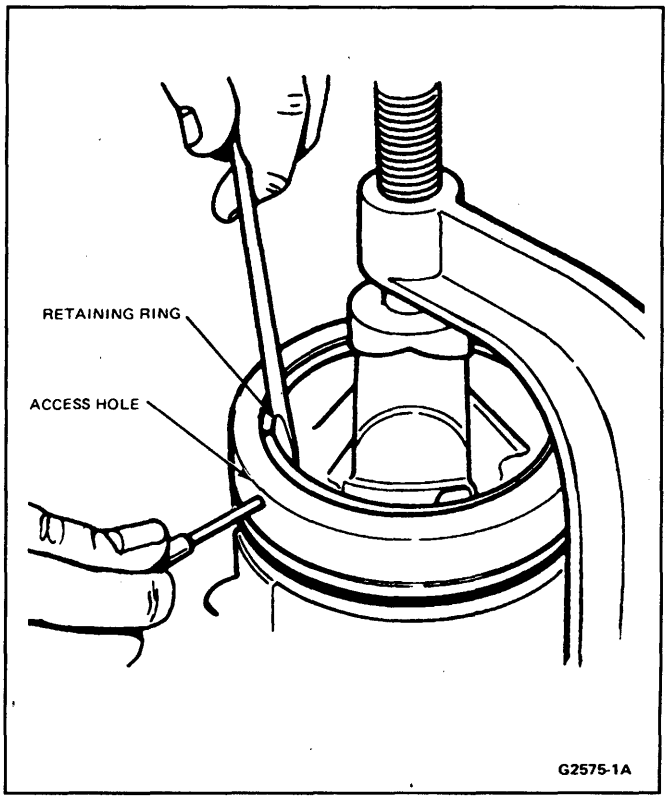


FIG. 15 Removing Retaining Ring

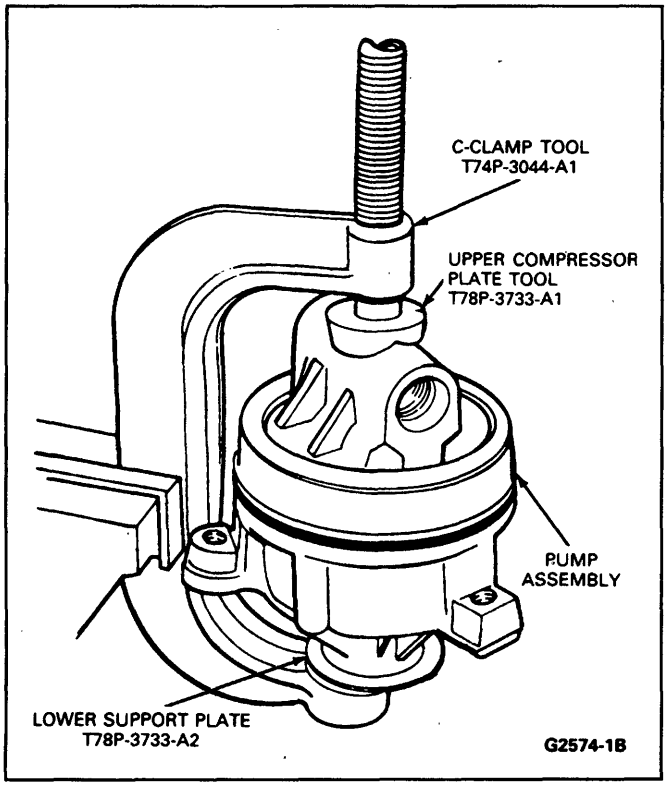


FIG. 14 Installing Compressor Plate Tool

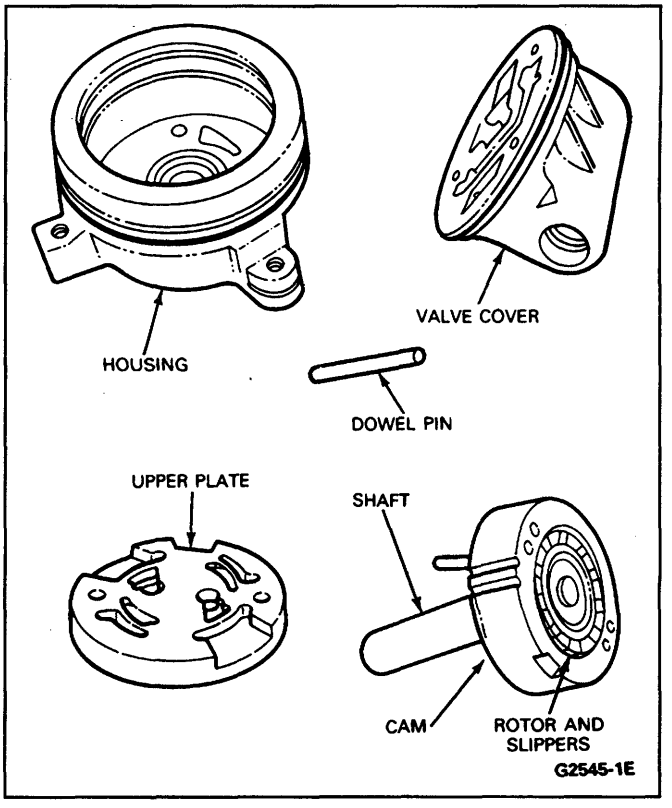


FIG. 16 Pump Housing Components

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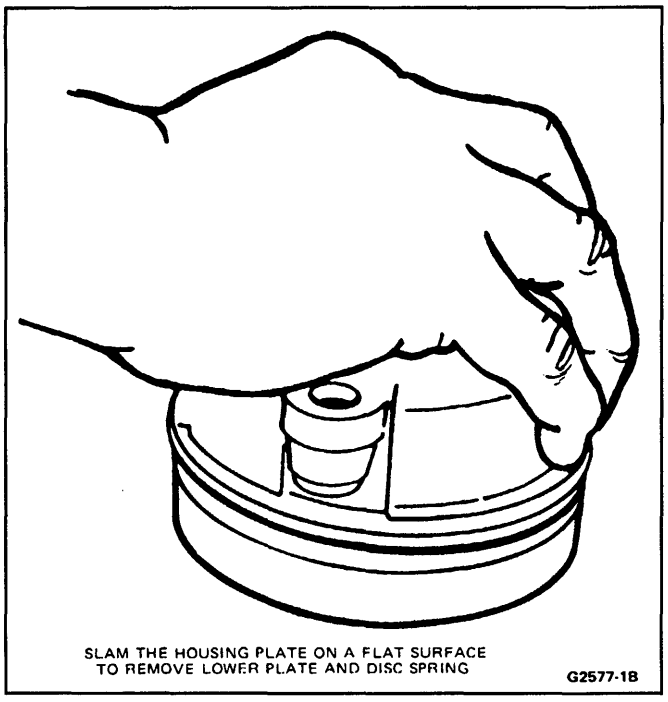


FIG. 17 Slamming the Housing Plate on a Surface to Remove Lower Plate and Disc Spring

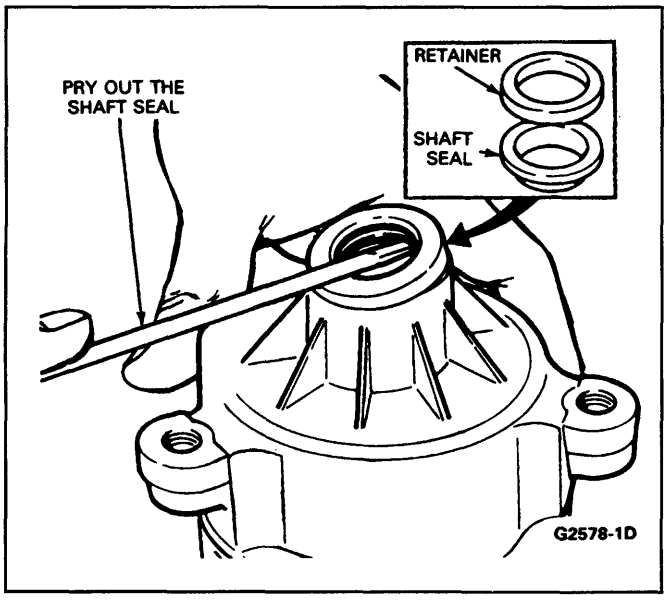


FIG. 18 Removing Rotor Shaft Seal

11. Insert the lower pressure plate with the O-ring seals toward the front of the pump into the pump housing plate (Fig. 22) and over the dowel pins. Place the entire assembly on the "C" clamp. Place driver Tool No. T78P-3733-A3 or equivalent into the rotor shaft hole (Fig. 23) and press on the lower plate lightly until it is felt to bottom into the pump plate housing. This operation will seat the outer O-ring seal (Fig. 24).
12. Install the cam, rotor and slippers, and rotor shaft assembly into the pump housing plate over the dowel pins (Fig. 25).

    NOTE: When installing this assembly into the pump housing plate, the stepped holes must be used for the dowel pins, and the recessed notch in the cam insert must face toward the reservoir and be approximately 180° opposite the square pump mounting boss.

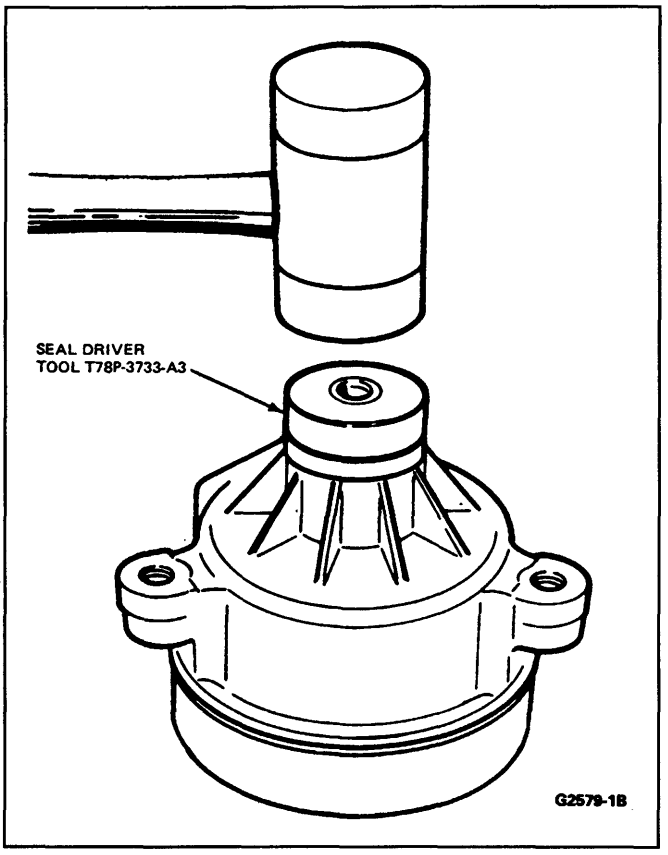


FIG. 19 Installing Rotor Shaft Seal

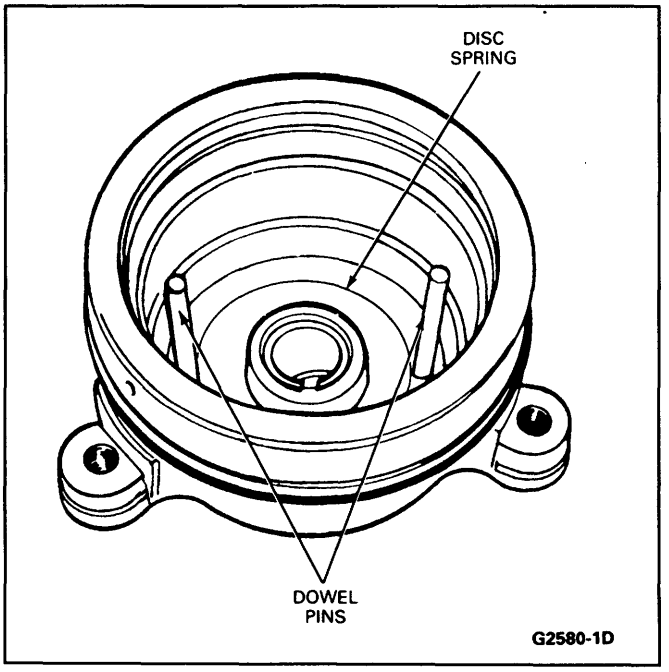


FIG. 20 Installing Disc Spring and Dowel Pins

13. Place the upper pressure plate over the dowel pins (Fig. 26). When installing the upper plate into the pump housing, observe the notch on the outside diameter of the plate. One side has a square recess cast into the plate. This square recess must

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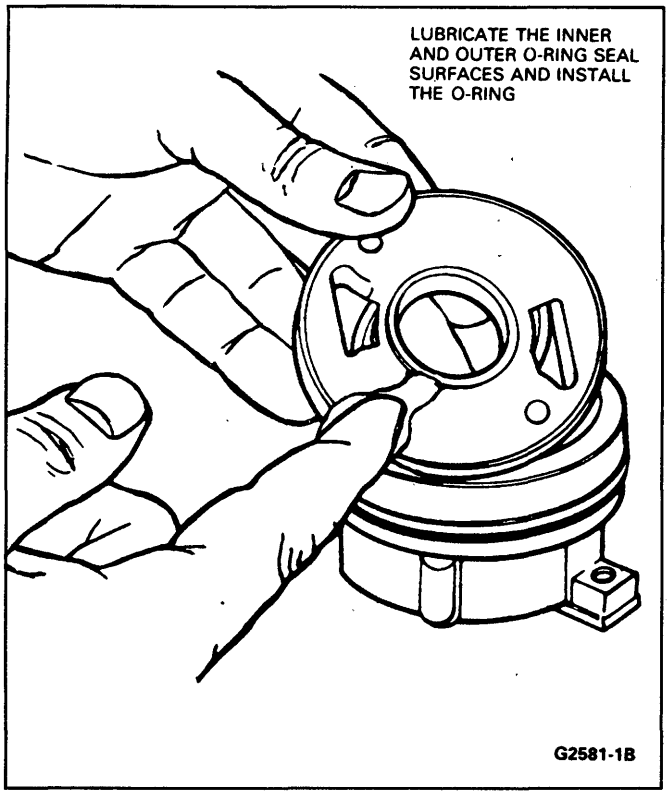


FIG. 21 Lubrication and Installation of O-rings

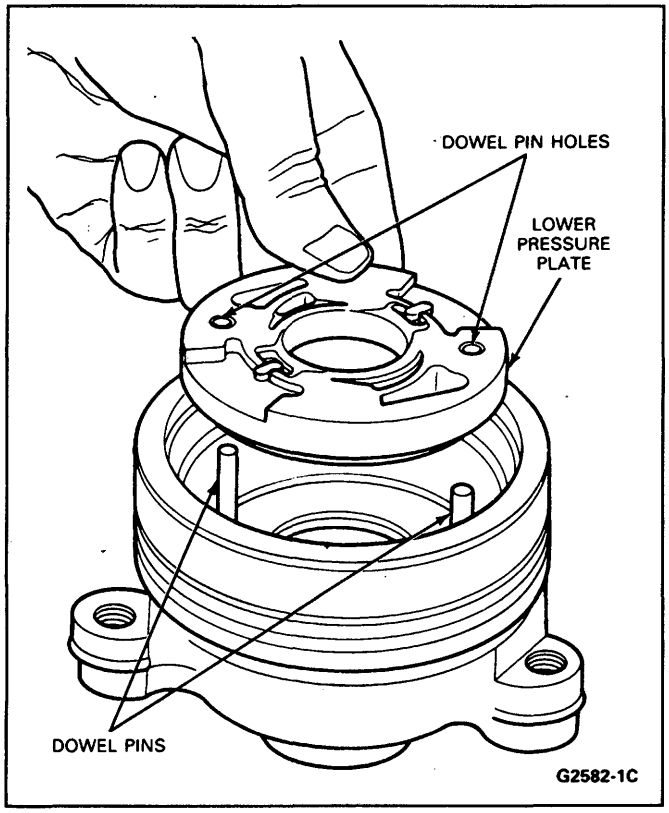


FIG. 22 Installing the Lower Plate with the Seals Facing Toward the Pump Housing

be facing toward the reservoir and positioned approximately 180° opposite the pump square mounting boss.

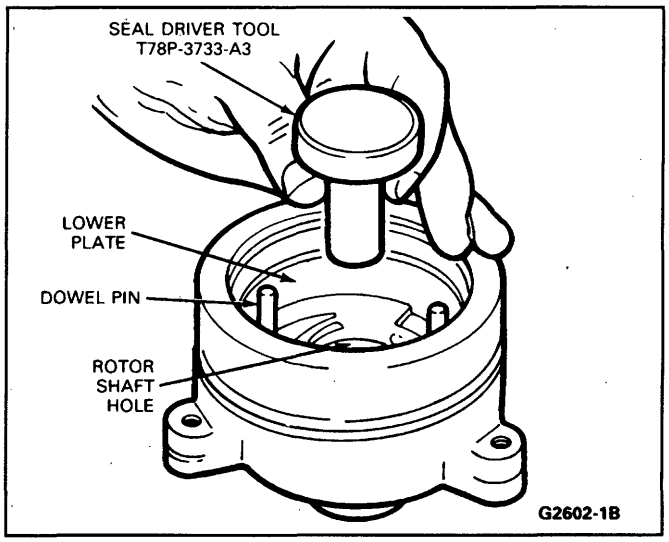


FIG. 23 Place Driver Tool Rotor Shaft Hole

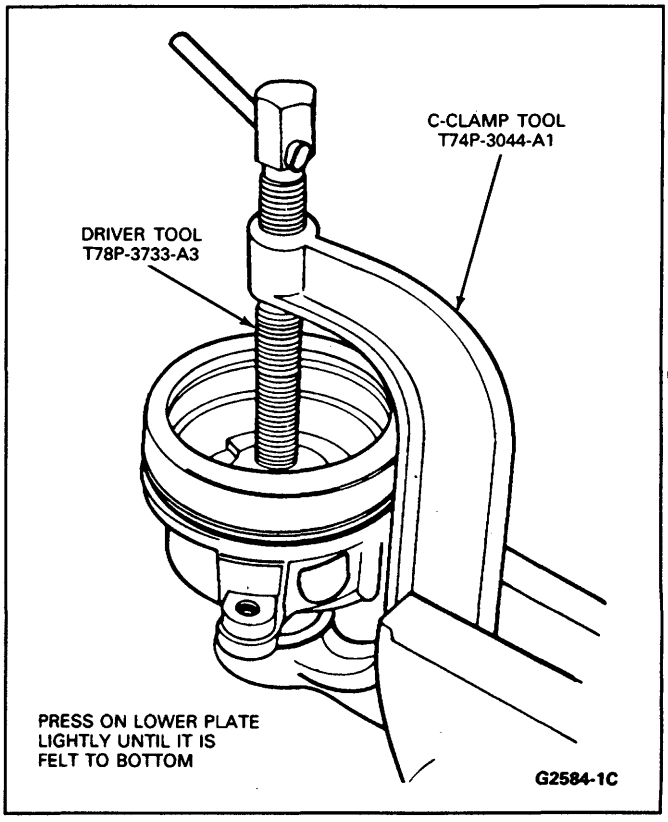


FIG. 24 Seating Outer O-ring Seal

14. Place a new O-ring seal on the valve cover. Lubricate this seal with the specified power steering fluid (Fig. 27).

    NOTE: Be sure the plastic baffle is securely in place in the valve cover. If the baffle is loose, apply a coating of petroleum jelly on the baffle and install it into location on the valve cover.

15. Insert this valve cover over the dowel pins. Be sure the outlet fitting hole in the valve cover is directly in line with the square mounting boss of the pump housing plate (Fig. 28).

16. Place the entire assembly in the "C" clamp tool and compress the valve cover into the pump

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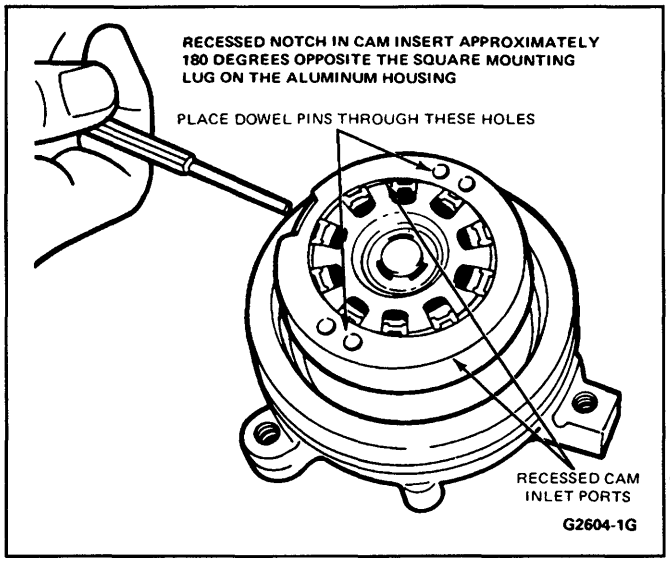


FIG. 25 Installing Cam, Rotor and Slippers

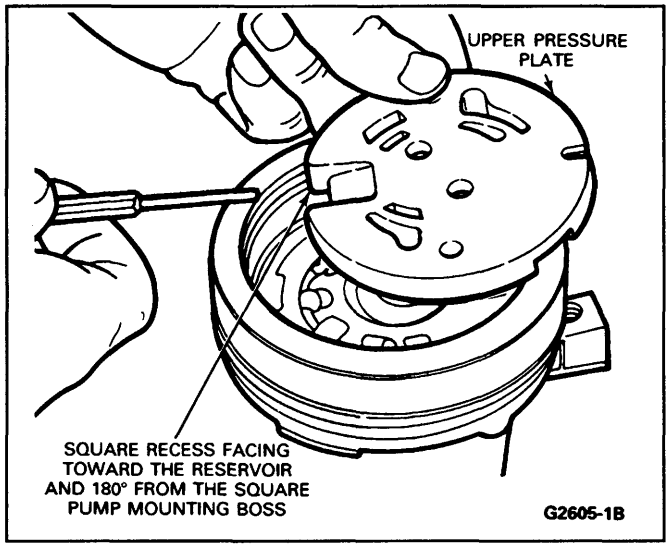


FIG. 26 Installing Upper Pressure Plate

housing plate, until the retaining ring groove is exposed in the pump housing plate.

17. Install the valve cover retaining ring with the ends near the access hole in the pump housing plate (Fig. 29).
18. Remove the pump assembly from the "C" clamp tool.
19. Place a new O-ring seal on the pump housing plate. Lubricate this O-ring seal with automatic transmission fluid Type F.
20. Install the power steering reservoir.
21. Install the flow control spring, and flow control valve into the valve cover.

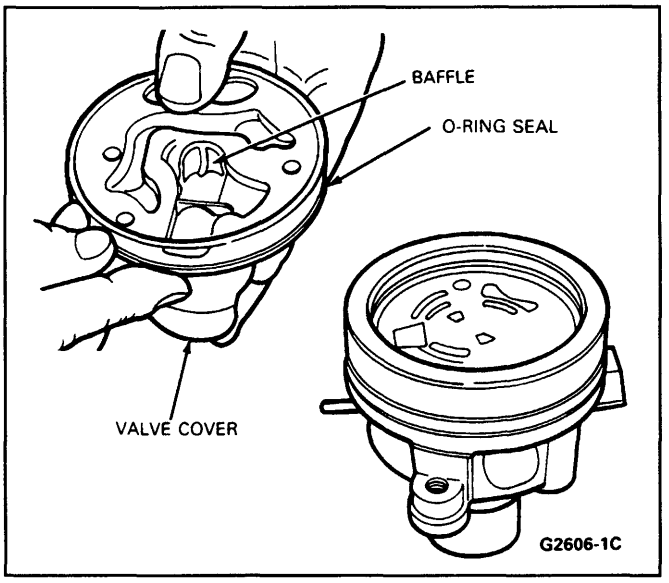


FIG. 27 Installing Valve Cover O-ring Seal

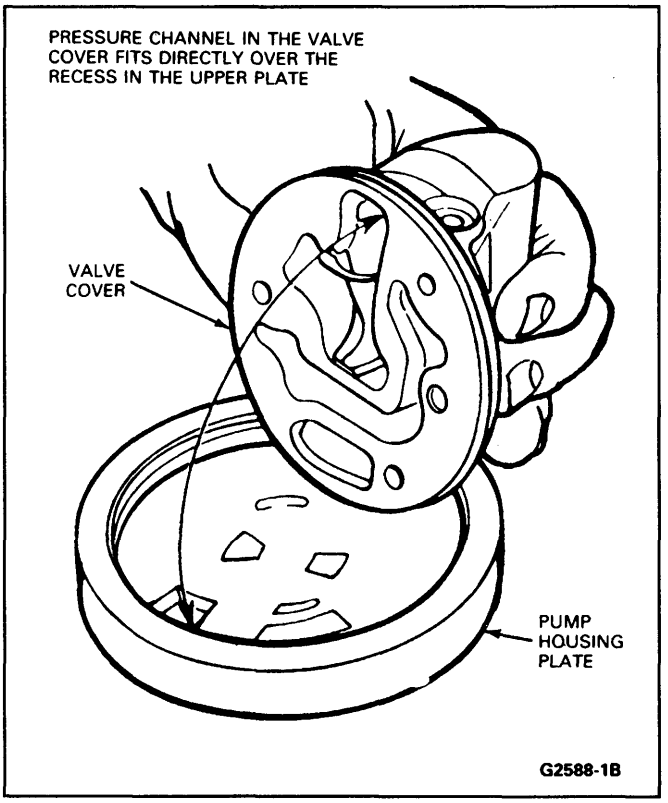


FIG. 28 Installing Valve Cover

22. Place new O-ring seals on the outlet fitting. Lubricate these seals with automatic transmission fluid Type F.
23. Install the outlet fitting into the valve cover and tighten to 34-46 N·m (25-34 ft-lbs) (Fig. 30).

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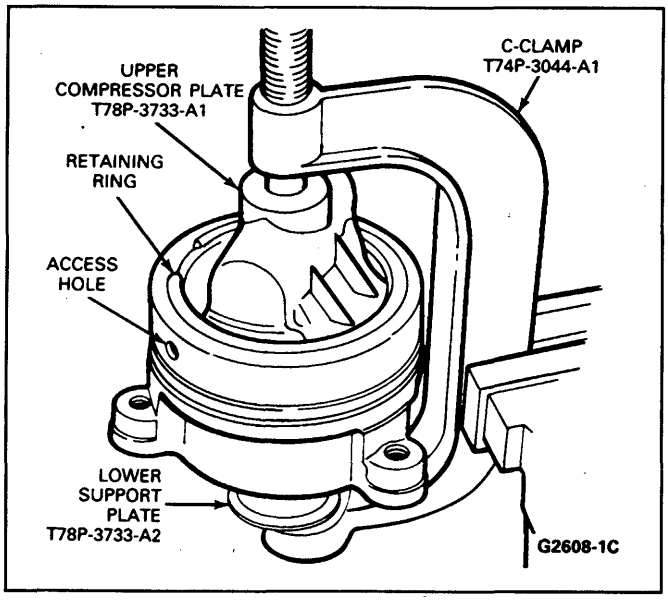


FIG. 29 Installing Valve Cover Retaining Ring

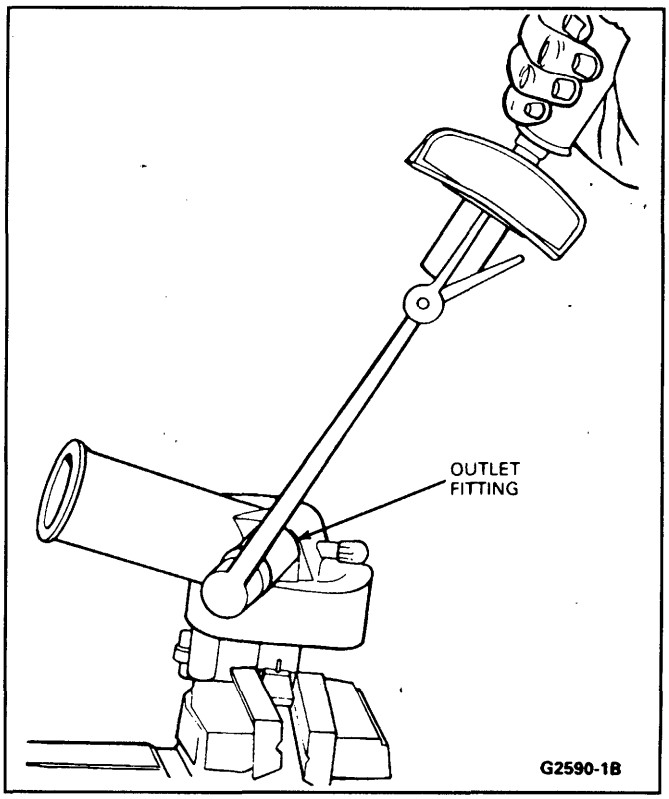


FIG. 30 Installing Outlet Fitting

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T58L-101-A	Puller Attachment	Universal — Use with Slide Hammer
T57L-500-B	Bench Mounted Holding Fixture	Universal
Tool-1175-AC	Seal Remover	Universal — Use with Slide Hammer
T74P-3044-A1	C-Frame and Clamp Assembly	CII Power Steering Pump — Use with Power Steering Pump Tools
T78P-3733-A	Power Steering Pump Tools	CII Power Steering Pump — Use with C-Frame and Clamp Assembly
D79L-7000-A	Retaining Ring Pliers	Internal and External Retaining Rings
T63L-8620-A	Belt Tension Gauge	Universal
T69L-10300-B	Power Steering Pump Pulley Remover	CII — Power Steering Pump
T71P-19703-C	O-Ring Tool	Universal
T68L-33610-AB	Thermometer	Use with Power Steering Pump Analyzer
D79L-33610-A	Power Steering Pump Analyzer	All Vehicles
T65P-3A733-C	Steering Pump Pulley Replacer	CII — Power Steering Pump — 35.05mm (1-3/8 Inches) Wide Pulley

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CII POWER STEERING PUMP TORQUE SPECIFICATIONS

Description	4.9L (300 CID) I-6		5.0L (302 CID) V-8		5.8L (351 CID) V-8 6.6L (400 CID) V-8	
	N·m	(ft-lbs)	N·m	(ft-lbs)	N·m	(ft-lbs)
Pivot Bolt	41-61	30-45	61-88	45-65	—	—
Pump to Adjustment Bracket	41-61	30-45	41-61	30-45	41-61	30-45
Adjustment Bracket to Support Bracket	41-61	30-45	41-61	30-45	41-61	30-45
Support Bracket to Engine	—	—	—	—	61-88	45-65
Support Bracket to Water Pump Housing	16-23	12-17	41-61	30-45	41-61	30-45
Pressure Hose to Rear Fitting	19-39	14-29	19-39	14-29	19-39	14-29
Pump Outlet Fitting to Pump Valve Cover	34-46	25-34	34-46	25-34	34-46	25-34
Return Hose to Gear Fitting	23-43	17-32	23-43	17-32	23-43	17-32
Return Line to Frame	15-21	11-16	15-21	11-16	15-21	11-16
Return Hose to Pump (Hose Clamp)	1.3-2.7	12-24 in-lbs	1.3-2.7	12-24 in-lbs	1.3-2.7	12-24 in-lbs

Description		7.5L (460 CID) Gas Engine		6.9L Diesel Engine	
		N·m	(ft-lbs)	N·m	(ft-lbs)
Pivot Bolt		41-61	30-45	41-61	30-45
Pump to Adjustment Bracket		41-61	30-45	41-61	30-45
Adjustment Bracket to Support Bracket	Long Bolt	61-81	45-65	61-81	45-65
	Short Bolt	41-61	30-45	41-61	30-45
Pressure Hose to Rear Fitting		19-39	14-29	19-39	14-29
Pump Outlet Fitting to Pump Valve Cover		34-46	25-34	34-46	25-34
Return Hose to Gear Fitting		23-43	17-32	23-43	17-32
Return Line to Frame		15-21	11-16	15-21	11-16
Return Hose to Pump (Hose Clamp)		1.3-2.7	12-24 in-lbs	1.3-2.7	12-24 in-lbs

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GROUP

SUSPENSION 14

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REAR SUSPENSION—LEAF SPRINGS	14-31-1

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VEHICLE APPLICATION	14-01-1

VEHICLE APPLICATION

Applies to E-150—E-350, F-150—F-350, Bronco and F-Super Duty Trucks.

DIAGNOSIS AND TESTING

Front End Alignment Checks

The front wheel alignment charts in this Section allow for checking caster and camber against specifications for a wide range of ride heights. This avoids having to remove permanently attached aftermarket equipment, such as tool boxes, that add weight which changes the ride height. However, the front wheel toe specification is for a vehicle at curb height. This curb height is reflected in a vehicle as purchased from the factory before any aftermarket modifications are made, unloaded, with full fluids and no passengers. Toe should be checked against specification at curb height only.

PRE-ALIGNMENT INSPECTION

Do not attempt to check or adjust front end alignment without first making the following preliminary inspections and/or adjustments.

1. Inflate all tires (cold) to the pressure recommended on the Safety Standard Certification Label.
2. Check and replace as necessary any damaged steering or suspension parts including the rubber bushings at the front axle pivots and at the rear of the radius arms.
3. Check all tires. They should be the same size, ply rating and load range side-to-side. Check the condition of the tires as described in Figs. 1 and 2.
4. If the alignment equipment being used attaches to the front wheels the fixtures must be carefully adjusted to compensate for as much wheel runout as possible.

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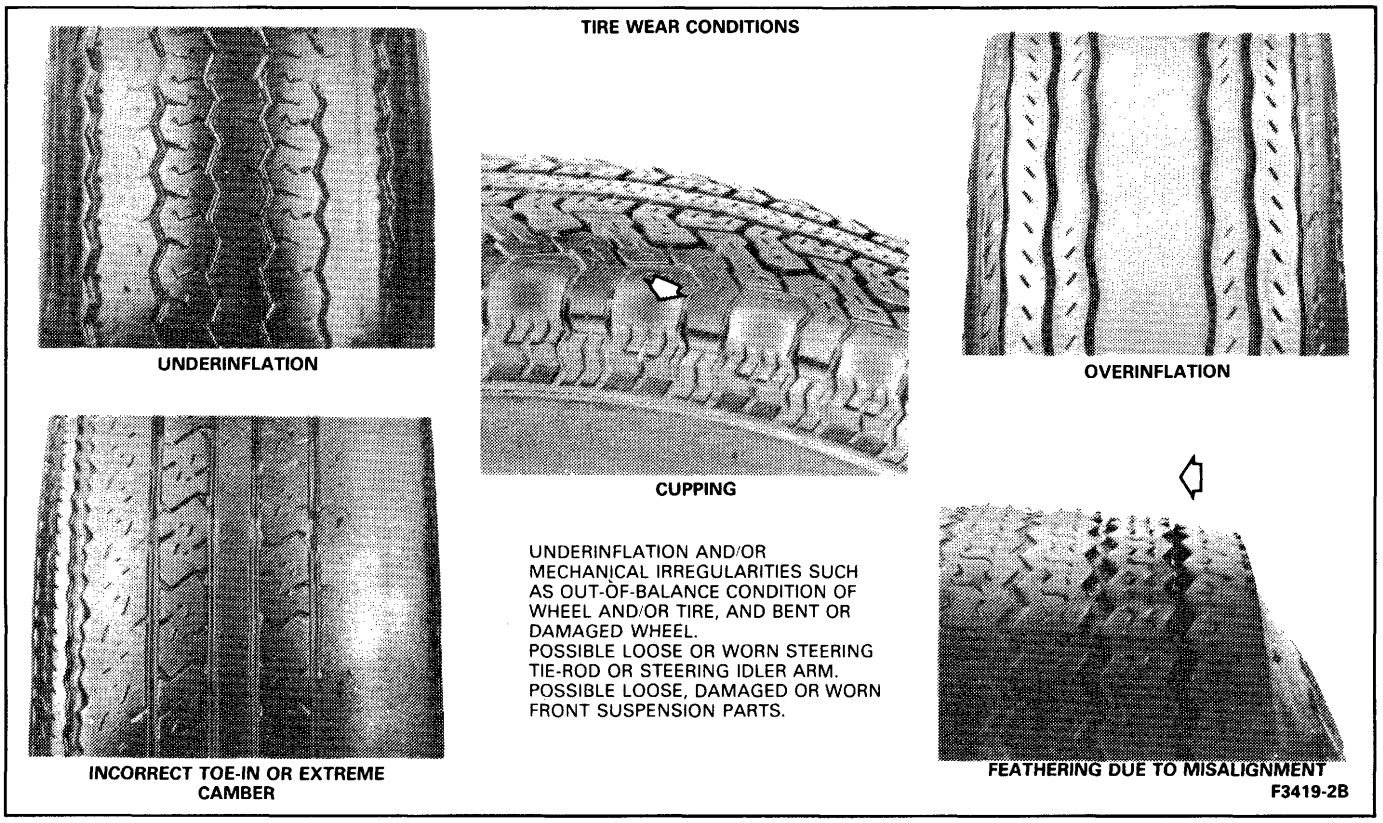


FIG. 1 Tire Wear Conditions

5. With the vehicle set up on the alignment equipment reading toe, push outward on the tires ahead of the axles, then outward behind the axles, then bounce the front end. If toe does not consistently return to the same reading there may be excessive wheel bearing end play or worn steering linkage ball joints. Correct as necessary.

6. Raise the front of the vehicle off the floor. Grasp each front tire at the front and rear, and push the wheel inward and outward. If any free play is noticed between the hub and rotor and front spindle, adjust the wheel bearings. Replace the bearings if they are worn or damaged. Adjust and/or replace worn or damaged bearings as outlined in Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive, or 11-10, Wheels, Hubs and Bearings—Front (Except Front Drive).

7. Grasp each tire at the top and bottom, and shake the wheel while watching the movement of the disc brake support or front spindle assembly. If the front spindle assembly is loose and moves more than 0.794mm (1/32 inch) at the upper or lower arms relative to the axle, or the kingpin, in axles so equipped, then rebush the kingpin spindles or change the ball joints in the axle/spindle. Refer to Section 15-34, Dana Model 44 and 50 Front Drive Axles, for front axle removal and installation procedures on four wheel drive vehicles. Also, refer to "Upper and Lower Ball Joint Inspection" in this Section.

8. Assure a level vehicle side-to-side by comparing measurements found under lateral tilt measurement in Figs. 3 and 4. Check front and rear spring part numbers to verify the same springs are installed side-to-side (refer to NOTE below).

NOTE: Codes identifying the front and rear spring options and springs are printed on the Safety Compliance Certification Label. If a spring should require replacement because it is damaged or worn, it should be replaced only with the same part as specified on the label. In rare instances, the spring codes will not reflect the springs as installed due to a DSO option or Assembly Plant substitution. If a DSO option number is shown on the certification label, the District Office can establish whether springs are affected. In cases of Assembly Plant deviations, the springs will be upgraded by one step. In either case, if the factory installed springs do not agree with the code printed on the Safety Certification Label (right and left spring part number should match), replace the worn or damaged spring with a new spring of the same part number as the worn or damaged spring. It will not be necessary to replace the matching, non-worn or undamaged spring.

TOE: Toe is intended to change slightly with ride height to promote optimum handling and tire life within the vehicle load range limits. It tends to change toward toe-out as the ride height is lowered. If toe is within specification at the curb height described in the text above there should be no need to readjust toe setting with varying loads. However, if aftermarket equipment is added (e.g. snow plow, Second Unit Body, tool boxes, etc.) that significantly affects vehicle attitude or ride height then toe should be adjusted. Toe should be set to the preferred setting, shown in Figures 4 and 5, with the vehicle in the loaded condition that it experiences for more than 50 percent of its use.

TIRE PRESSURE: Set front tire pressure cold at the pressure recommended on the Safety Certification Label. Maintaining correct tire pressure is important since low front tire pressure will aggravate outside shoulder wear.

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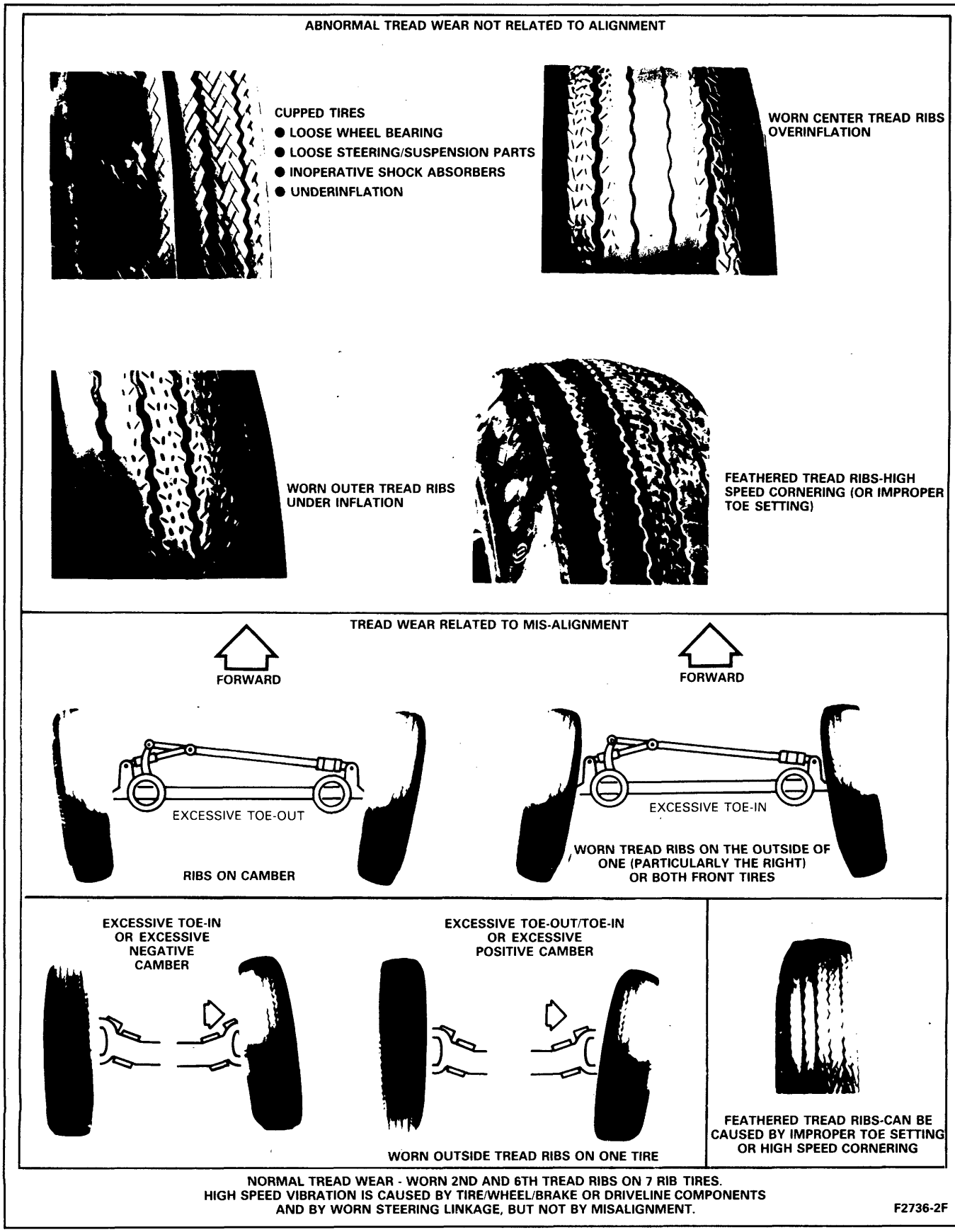


FIG. 2 Twin I-Beam Axle Alignment Diagnosis Chart

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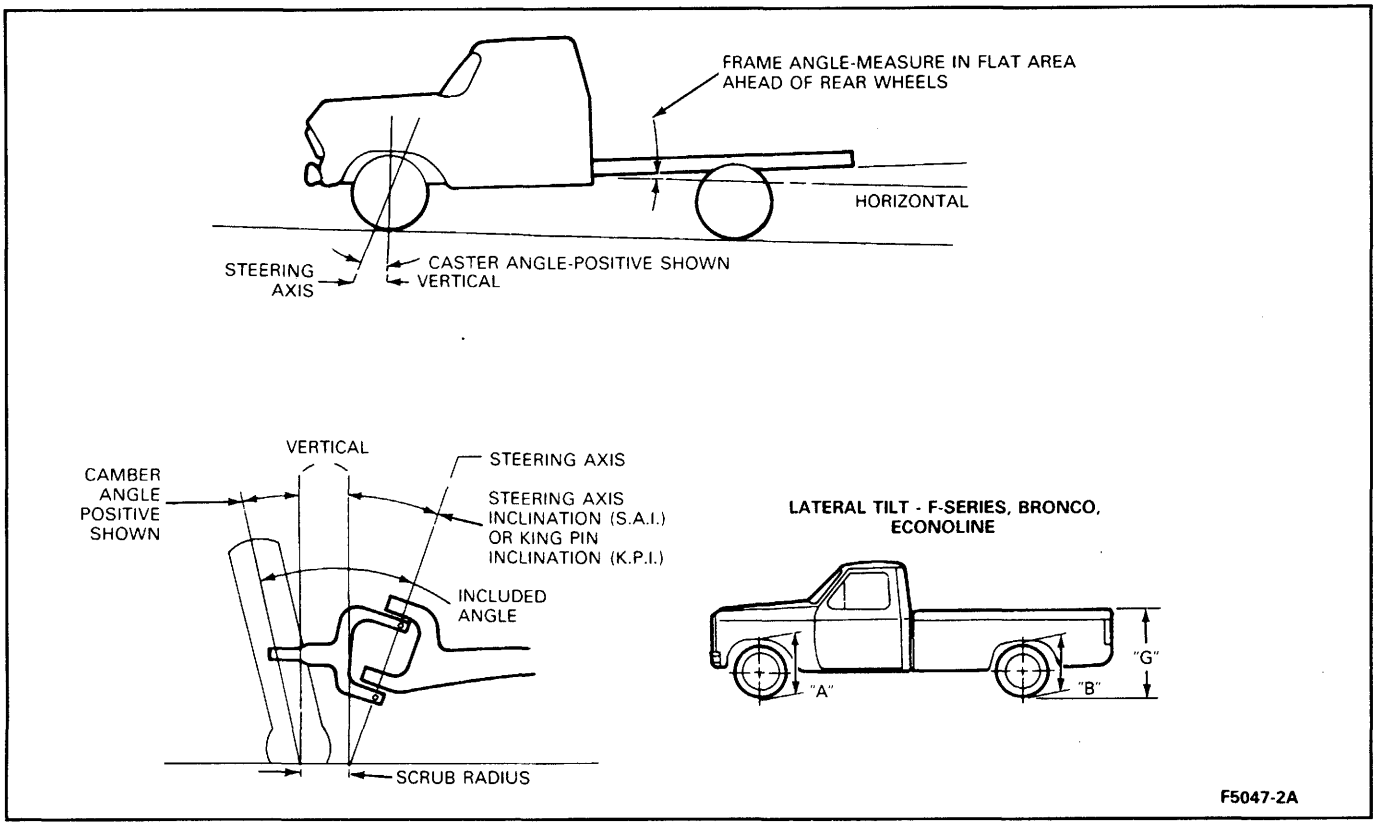


FIG. 3 Front End Alignment Definitions—F-Series, Bronco and Econoline Vehicles

TIRE ROTATION: With radial OEM tires, the original rotating direction of the tire does not need to be maintained. This allows for the cross rotation of tires front-to-rear and side-to-side which limits the development of uneven wear. The tires should be rotated at least annually or every 10,000 miles. (More often if the vehicle sees a lot of turning as with city-delivery service.) Refer to TIRE ROTATION in the owner's guide for specific rotation methods.

Refer to the Adjustments portion of this Section for toe adjusting procedures. Do not attempt to adjust by bending suspension or steering linkage components.

Checking Front Wheel Alignment

The following items are key elements necessary for obtaining an accurate measurement of front wheel alignment:

1. Repair any loose steering and suspension parts found in the Preliminary Inspection.
2. Use alignment equipment known to be accurate.
3. Follow the equipment manufacturer's instructions **carefully.**
4. Compensate for and remove as much wheel runout as possible.

Caster and Frame Angle—The caster angle that the alignment equipment measures is the angle between a line drawn through the steering axis (see Fig. 3) and a vertical line. Any frame angle that is not horizontal will rotate the steering axis with respect to vertical, thus changing the caster angle that the road wheel reacts to and the alignment equipment measures. The caster angle curves charted in this Section show the angles, for various ride heights, that would be read off alignment equipment if the frame was horizontal. One condition for which the frame is near horizontal is when the vehicle is loaded to maximum gross vehicle weight (at GVW not exceeding either front or rear gross axle weight ratings). Generally, a vehicle without any payload will have a frame angle from 1/2 degree to 2 degrees, positive when the front is lower than the rear. Therefore, to check the measured caster against specifications measure and add the frame angle to the measured caster and compare this sum to the charted values. If the vehicle is lower in the rear subtract the frame angle from the measured caster.

Vehicle Lean Check

F-150—F-250—F-350 (4x2), F-150 (4x4) and Bronco

Side to side vehicle lean should be verified by measuring the fender lip to ground dimension before beginning diagnosis and service actions. Normal acceptable limits are:

- Maximum of 5/8 inch variance between left and right front wheel lips to ground.
- Maximum of 3/4 inch variance between left and right rear wheel lips to ground.

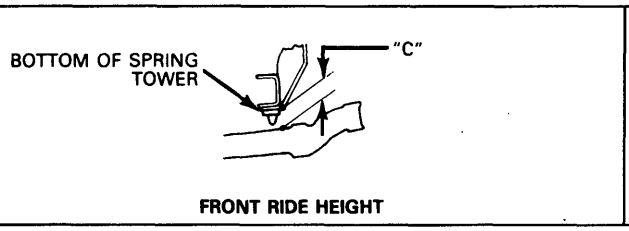
Once a lean condition has been verified, the following procedure should be followed to resolve the condition:

1. Place the vehicle on a flat, smooth surface. Vehicle should be inspected for any heavy add-ons that may cause excessive weight on any corner of the vehicle. Vehicle should be empty, fuel tanks should be full, no cargo in the pick-up box or rear body section of Bronco, such as tools, equipment or debris. Vehicle must be setting on the wheels and tires and not on a hoist, jack or jack stands.

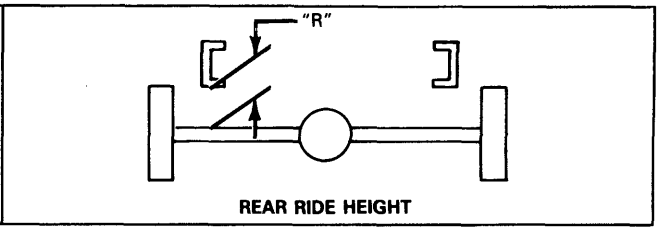
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ALIGNMENT SPECIFICATIONS — ECONOLINE

Model	Included Angle④	Toe-In Specifications			Standard Vehicle Attitude		Dog-Track Centerline Front Tread to Centerline Rear Tread
					Lateral Tilt① (Side to Side Dif.)		
		Preferred Setting	Checking Range		"A"	"B"	
			Min.	Max.			
E-150	8°	1/32" out	3/32" in	5/32" in	5/8"	3/4"	1-1/4"
E-250	8°	1/32" in	3/32" in	5/32" in	5/8"	3/4"	1-1/4"
E-350	8°	1/32" in	3/32" out	5/32" in	5/8"	3/4"	1-1/4"

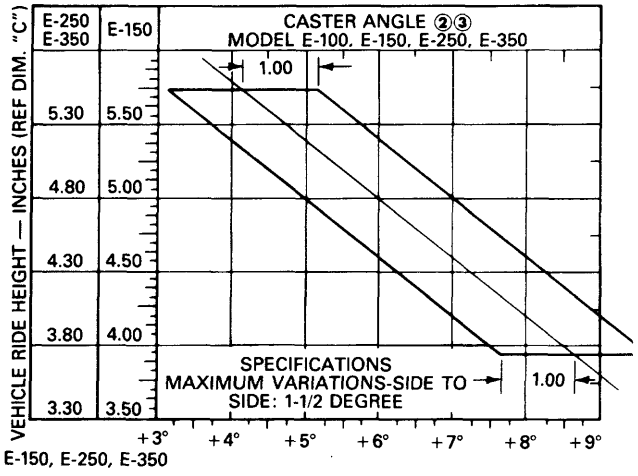


FRONT RIDE HEIGHT



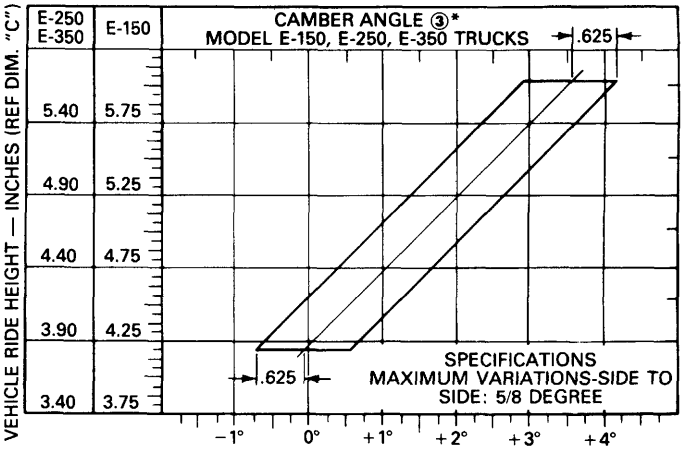
REAR RIDE HEIGHT

CASTER SPECIFICATIONS



E-150, E-250, E-350

CAMBER SPECIFICATIONS



*INCLUDES AXLE & SPINDLE DEFLECTIONS

NOTES:

① Lateral tilt spec's are max. allowable for:
Vehicle at curb weight without occupants.
Vehicle loaded (not exceeding GVW) with equally distributed weight over the cargo and occupant areas.

② The caster angle in the chart assumes a frame angle of zero degrees. Add frame angle to measured caster angle if down in front. Subtract if up in front. (Refer to Fig. 3 for frame angle measurement.) Compare this sum to the charted angle.

③ Caster and camber depend upon ride height dim. "C".

④ Included angle is the angle between the S.A.I. (or K.P.I.) and the tire/wheel centerline. Refer to Fig. 3.

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FIG. 4 Econoline Alignment Specifications

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ALIGNMENT SPECIFICATIONS — ALL F-SERIES AND BRONCO

Truck Model (Axle)	Alignment Factors	Alignment Specifications				Max. Variation Between Wheels	Standard Vehicle Attitude — Ref.				Remarks
		Nominal	Preferred Setting	Checking Range			Lateral Tilt ③ (Side to Side Height Differences)			Dog-Track	
				Min.	Max.		"A" Front Wheel-House Opening	"B" Rear Wheel-House Opening	"G" Rear End of Pickup Box	Centerline of Front Tread to Centerline of Rear Tread	
F-150 (4x2)	Caster ②	—	①	①	①	1.5°	15mm (0.6 inch)	19mm (0.75 inch)	20mm (0.8)	30mm (1.2 inch)	For Caster and Camber at any particular Dimension "C", refer to the Caster and Camber Curves.
	Camber	—	①	①	①	0.7°					
	Toe-In	—	1/32 inch — IN	3/32 inch — OUT	5/32 inch — IN	—					
	Included Angle ⑤	12.5°	—	— OUT	—	—					
F-250/ F-350 (4x2)	Caster ②	—	①	①	①	1.5°	15mm (0.6 inch)	19mm (0.75 inch)	15mm (0.6 inch) at frame siderail	30mm (1.2 inch)	
	Camber	—	①	①	①	0.7°					
	Toe-In	—	1/32 inch — IN	3/32 inch — OUT	5/32 inch — IN	—					
	Included Angle ⑤	12.5°	—	—	—	—					
Bronco, F-150 (4x4)	Caster ②	—	①	①	①	1.5°	15mm (0.6 inch)	19mm (0.75 inch)	20mm (0.8 inch)	30mm (1.2 inch)	
	Camber	—	①	①	①	0.7°					
	Toe-In	—	1/32 inch — IN	3/32 inch — OUT	5/32 inch — IN	—					
	Included Angle ⑤	13°	—	—	—	—					
F-250, (4x4)	Caster ②	—	①	①	①	1.5°	15mm (0.6 inch)	19mm (0.75 inch)	20mm (0.8 inch)	30mm (1.2 inch)	
	Camber	—	①	①	①	0.7°					
	Toe-In	—	1/32 inch — IN	3/32 inch — OUT	5/32 inch — IN	—					
	Included Angle ⑤	13°	—	—	—	—					
F-350 (4x4) Mono Beam	④ Caster ②	5°	—	—	—	1.5°	15mm (0.6 inch)	19mm (0.75 inch)	20mm (0.8 inch)	30mm (1.2 inch)	The Caster and Camber are for a ride Height (Dim. C) of 121mm (4.75 inches)
	④ Camber	1.5°	—	—	—	0.7°					
	Toe-In	—	1/32 inch — IN	3/32 inch — OUT	5/32 inch — IN	—					
	Included Angle ⑤	8.5°	—	—	—	—					
F350 (4x2) Super Duty Chassis Cab	Caster②	5.25°	—	—	—	1.5°	15mm (0.6 inch)	—	—	30mm (1.2 inch)	Caster and Camber are for a ride height of 108mm (4.25 inch)
	Camber④	0.6°	—	—	—	0.7°					
	Toe-In	—	1/32 inch — IN	3/32 inch — OUT	5/32 inch — IN	—					
	Included Angle	9.6°	—	—	—	—					

NOTES:
①Caster and camber depend on ride height. See curves in Fig. 4.
②The caster angles charted in Fig. 4 assumes a frame angle of zero degrees. Add the frame angle to the measured caster if down in front. Subtract if up in front. Compare this sum to the specified angles.
③Lateral vehicle tilt specifications are maximum allowable for:
— Vehicle at curb weight without occupants.
— Vehicle loaded (not exceeding GVW) with equally distributed weight over the cargo and occupant areas.
④Not adjustable in service.
⑤Included angle is the angle between the S.A.I. (or K.P.I) and the tire/wheel centerline. Refer Fig. 3.
⑥Caster and Camber angles are not adjustable on F-Super Duty vehicles. Toe-in adjustment — 3/32 inch IN — 5/32 inch OUT — 1/32 inch IN preferred. **CF3542-2F**

FIG. 5 Alignment Specifications—All F-Series and Bronco

2. Check all wheels and tires:
   - Wheels must be same size and design, right and left side, on each axle.
   - Tires must be same brand, tire size, tread design, and equal tread wear side-to-side on each axle.
   - Wheel size and design, tire size and tire design should be as indicated on the Vehicle Certification Label.
   - Check air pressure of all tires; inflate to specifications indicated on the Vehicle Certification Label.
3. Check front and rear suspension. Make sure the same spring is on the left/right front and left/right rear. The front springs have I.D. Tags indicating the part number. The rear springs have the part number stamped on the bottom just behind the U-bolt attachment.
4. Jounce the vehicle's front and rear suspension to normalize the vehicle static ride height.
5. Measure the height of the right and left fender lip openings as shown in Fig. 3, dimensions A and B, noting dimensions of each and side-to-side differences. If these differences are greater than 5/8 inch between left or right front and/or 3/4 inch between left and right rear, adjustment can be performed following the procedure under Adjustments in this Section.

ADJUSTMENTS

Front Wheel Alignment Adjustments

Refer to Fig. 3.

After front wheel alignment has been checked, make the necessary adjustments as described below.

CAUTION: Do not bend axles or radius arms to change alignment.

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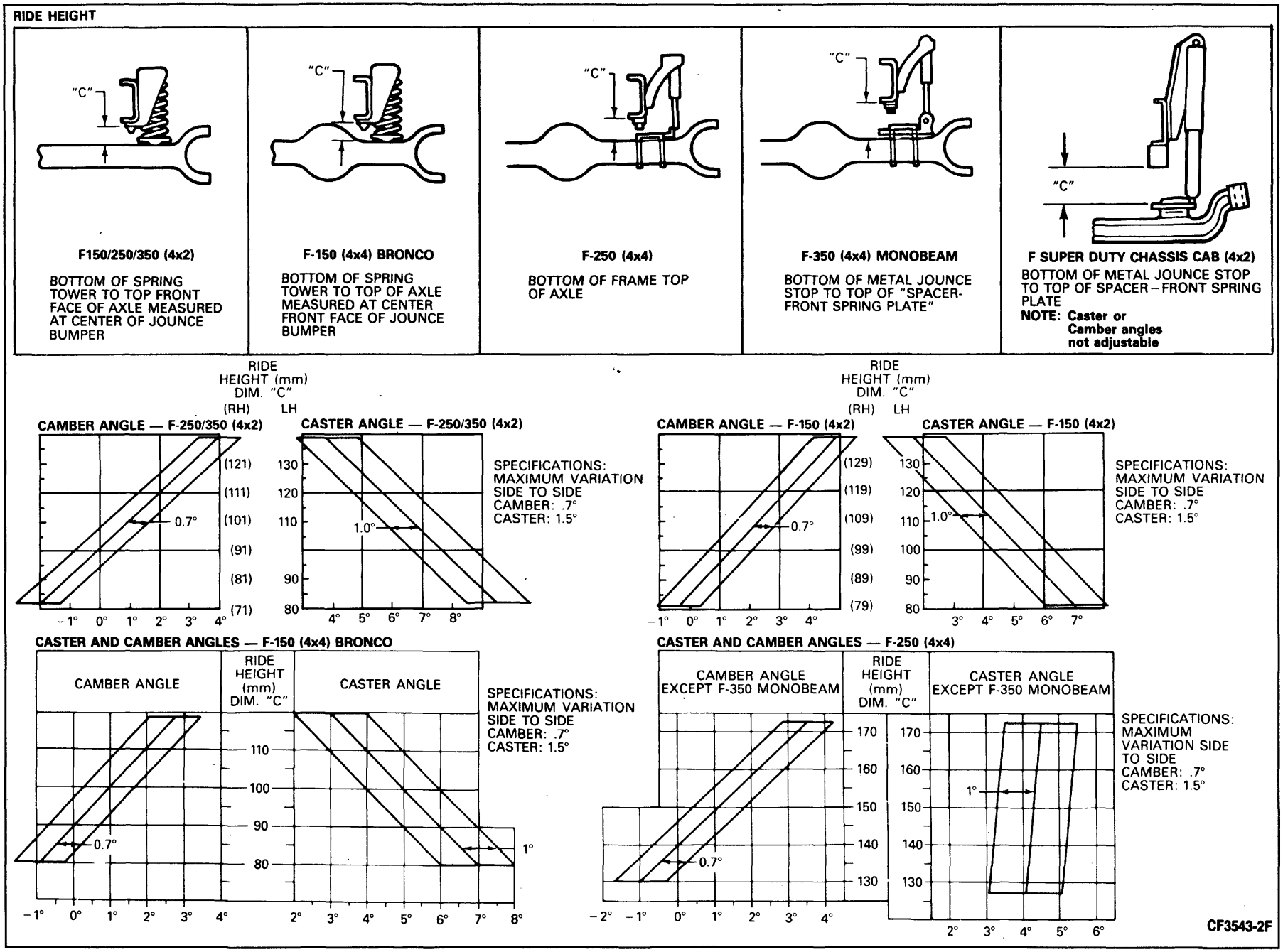


FIG. 6 Caster and Camber Angles F-150/250/350 (4x2) F-150/250 (4x4), Bronco and F-Super Duty (See Fig. 5 for F-350 4x4 Monobeam Front Drive Angle)

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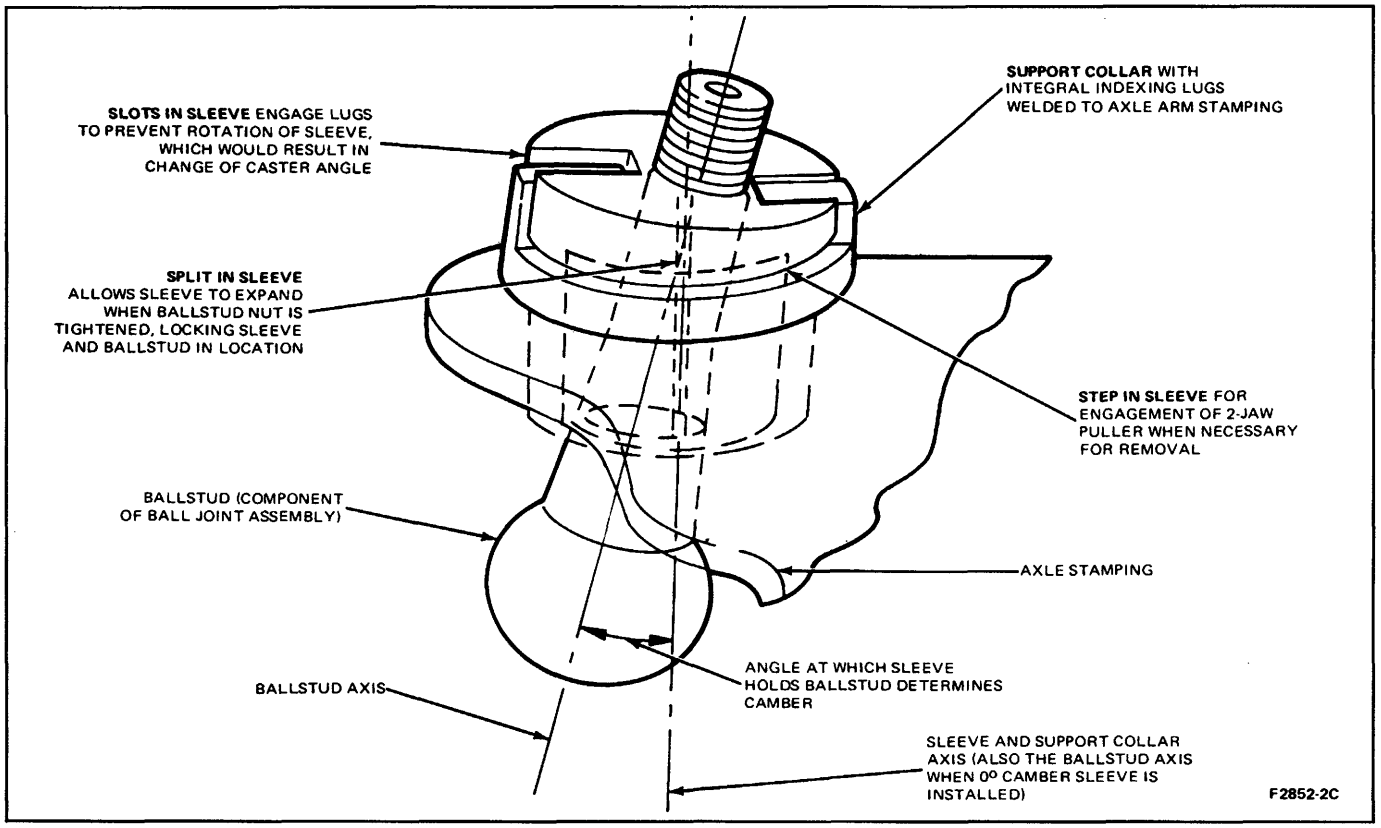


FIG. 7 Camber Adjustment—F-150—F-250 (4x4) and Bronco

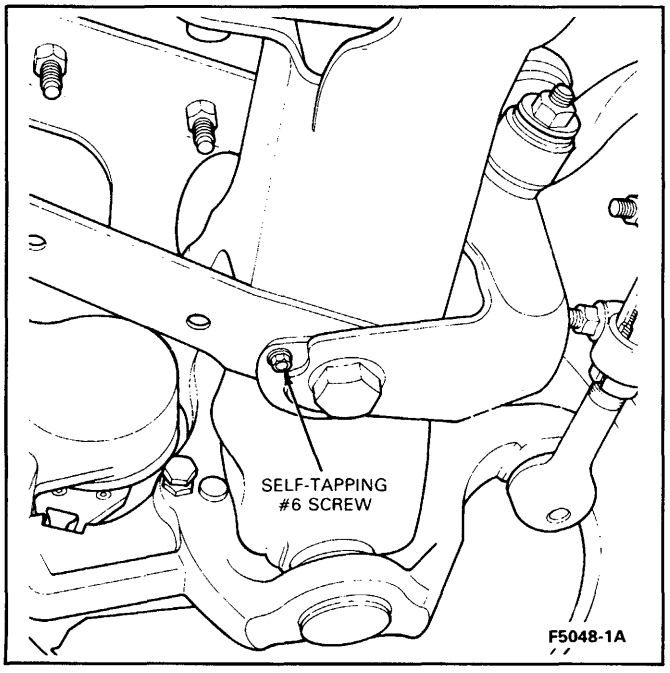


FIG. 8 Caster Adjustment Plate

Camber Adjustment

E-150—E-250—E-350

Camber is not adjustable on Econoline. The caster angle can be adjusted with the use of a service kit (E5TZ-3K064-A) or equivalent.

The kit includes complete instructions for increasing caster in 1/2 degree increments by installing an adjustment cam on the bottom of the front radius arm. Its intended use is to provide a method to correct side-to-side caster splits. Refer to Section 19-01, Roadability.

Camber Adjustment

Bronco and F-150—F-250 (4X4) With Ball Joint System

Refer to Fig. 7.

Camber adjustment is provided by means of a series of interchangeable mounting sleeves (camber adjusters) for the upper ball joint stud. Four sleeves are available in 1/2 degree camber increments, providing a 3 degree range of adjustment (from 1-1/2 degree negative to 1-1/2 degree positive). Refer to Figure 7.

Caster Adjustment

Bronco and F-150 (4x4)

Caster Adjustment

F-250 (4x4)

The caster angle on the F-250—F-350 (4x4) with a leaf spring type front suspension can be adjusted by inserting a shim between the spring and axle. Shims are available from Service in 0 degree, 1 degree and 2 degree increments. The 0 degree shim is used to adjust side to side ride height.

1. To adjust caster, raise the vehicle and support the front axles on safety stands.

NOTE: If possible, caster adjustment should always be done on the right front axle to avoid changing front driveshaft alignment.

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2. Loosen U-bolt nuts and separate spring from axle. Install caster shims between spring and axle. Position the thin edge of the shim towards the front of the vehicle to increase caster, thin edge to the rear to decrease caster.

NOTE: Caster shims installed on the LH axle will change the front driveshaft angle. If a caster shim is used on the LH axle, driveshaft angles must be checked and conform to specifications in Section 15-60, General Driveshaft Service. Always attempt to correct side-to-side caster variations by adjusting the RH axle caster.

Tighten U-bolt nuts until all nuts contact cap. Tighten nuts to 142 N·m (105 ft-lb).

Caster and Camber Adjustment

F-350 (4x4) Monobeam Front Drive Axle and F-Super Duty Monobeam Non-Driving Axle

Caster and camber are not adjustable on F-350 (4x4) or on the F-Super Duty

DIAGNOSIS GUIDES

Refer to Section 19-01, Roadability, for additional Diagnostic Guides related to alignment.

1. Measure camber with available alignment equipment. If camber is out of specification, proceed to Step 2.
2. Raise vehicle on hoist and remove the front wheels.
3. Remove the upper ball joint cotter pin and nut.
4. Loosen the lower ball joint nut to the end of the stud.
5. Strike the inside of the spindle near the upper and lower ball joints to break the spindle loose from the ball joint studs.
6. Remove the camber adjuster sleeve. If required, use Pitman Arm Puller T64P-3590-F or equivalent to remove the adjuster out of the spindle.
7. Install the replacement service adjuster (Fig. 7).
   - To increase camber (more positive) point the arrow on the adjuster outboard.
   - To decrease camber (more negative) point the arrow on the adjuster inboard.
8. Remove the lower ball stud nut and apply Loctite 242 or equivalent to the lower stud.
9. Hand start the lower nut and partially tighten to 54 N·m (40 ft-lb).
10. Install the new upper nut and tighten to 115-135 N·m (85-100 ft-lb). Advance the nut to the next castellation and install a new cotterpin.
11. Finish tightening the lower nut to 128-149 N·m (95-110 ft-lb).
12. Important: Excessive spindle turning efforts, causing poor steering returnability, may result if the fastener tightening sequence described in steps 8, 9 and 11 are not followed exactly.
13. Reinstall the wheel and lower the vehicle.
14. Check camber and set toe (Fig. 9) per alignment procedure.

Caster and Camber Adjustment

F-150—250—350 4x2 with Ball Joint System

Caster and camber adjustment is possible with service adjusters available in 1/2°, 1° and 1-1/2° increments. One adjuster is used to adjust both caster and camber as described below.

1. Measure vehicle caster and camber. Refer to the alignment charts (Figs. 4, 5 and 6) to determine if the vehicle is within specifications. Note any difference between the actual measurements and the specification. This information will be used to select the correct service adjuster.
2. Refer to Fig. 10. Using the information from Step 1, select the correct service adjuster. Note the orientation of the slot required to obtain the correct alignment.

Example: If caster and camber together must be reduced 1° at the LH wheel, select the 1-1/2° service adjuster and orientate the slot 315° from the straight-ahead position in the vehicle.

If the same adjustment was required for the RH side, the orientation would be 225° from the straight-ahead position.

In all cases, select the service adjuster that will bring the alignment into specification with the smallest side-to-side variation (minimize caster and camber splits).

3. Remove the front wheel.
4. Loosen the pinchbolt at the upper ball joint and pry the adjuster out of the axle with the blade of a screwdriver. If required use Pitman Arm Puller T64P-3590-F or equivalent to remove the adjuster.
5. Install the new service adjuster. Orientate the slot as specified in Table 1. A 1-1/2 inch socket may be used to rotate the adjuster into position.
6. Tighten the pinchbolt to 50-65 ft-lbs.
7. Install the front wheel.
8. Check alignment and reset toe to specification.

Checking and Adjusting Toe Alignment

Refer to toe specifications (Fig. 5) for F-150—F-250—F-350 and Bronco and E-150—E-250—E-350 (Fig. 4).

Clear Vision is a term used to describe a level or well-centered steering wheel. Steering wheel misalignment (improper clear vision) on E-150—E-250—E-350 vehicles can be corrected only by removing and recentering the steering wheel after toe is adjusted and the steering gear is centered. Because the steering linkage on E-150—E-250—E-350 has only one rod and link assembly adjustment point (tie rod—left side), improper clear vision (or centering the steering wheel) cannot be corrected by adjustment of the steering linkage or suspension components. If improper clear vision is attempted to be corrected by adjustment of the tie rod sleeve, a steering gear that is grossly off-center may result.

The F-Series steering linkage has adjustments in both the tie rod and the drag link. First, remove the horn pad and insure that the steering wheel is properly installed as described in Section 13-06, Steering Column—Shift Rod. If correct, turn steering wheel from stop to stop to determine the center position. Return the steering wheel to the center position and lock in place

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using a steering wheel holder. With steering wheel locked in place, set toe to correct specification.

1. Loosen the clamp bolts for the adjusting sleeve at each end (left side only E-150—E-250—E-350) of the rod and link assembly connecting to the spindles.
2. Rotate the sleeve until the correct toe alignment is obtained.
3. With the clamps 4.76mm (3/16 inch) from the end of the sleeve on (4x4) models and centered between the adjustment sleeve lock ring nibbs on F-150—F-250—F-350 and F-Super Duty (4x2) and E-150—E-250—E-350 models, position the bolts as shown in Fig. 9.

   NOTE: Lubricate clamp fasteners prior to tightening.
4. Recheck the toe alignment to make sure no changes occurred as the clamp nuts were tightened.

Steering Stop

All F-150—F-250—F-350 (4x2) and F-Super Duty and E-150—E-250—E-350 models have built in steering stops which cannot be altered. E-250-E-350 models have non-adjustable steering stop pins which are pressed into the axle. These stop pins are matched to tire size and may necessitate replacement with different length stop pins if the tire size is changed.

F-150—F-250—F-350 (4x4) models use a welded in screw and locknut which is not adjustable. A spacer cap is used with wide tread tires on F-150 (4x4).

Spindle Arm Stop Adjustments

Fig. 11 shows the degree position of the front wheels when checking the stop adjustment angles.

Refer to Section 19-01, Roadability, for additional Diagnostic Guides related to alignments.

CONDITION	POSSIBLE CAUSE	RESOLUTION
• Vehicle leans to one side	1. Incorrect tire pressure.	1. Assure uniform tire pressure for all tires.
	2. Improper tire/wheel usage.	2. Install correct tire/wheel combination.
	3. Vehicle overloaded or unevenly loaded.	3. Correct as required.
	4. Loose, worn or damaged front or rear suspension components.	4. Visually inspect suspension systems. Repair or replace as required.
	5. Improper spring usage or improperly installed and seated.	5. Correct as required.
	6. Incorrect front axle ride height. • Lateral tilt out of specification (Figs. 3, 4 and 5).	6. To adjust, refer to "Vehicle Lean Correction" in this section.
	7. Incorrect rear axle ride height. • Lateral tilt out of specification (Figs. 3, 4, and 5).	7. To adjust, refer to "Vehicle Lean Correction" in this section.
• Front bottoming or riding low	1. Incorrect tire pressure.	1. Correct as required.
	2. Improper tire/wheel usage.	2. Install correct tire/wheel combination.
	3. Vehicle overloaded or unevenly loaded.	3. Correct as required.
	4. Broken or incorrectly installed front springs.	4. Repair or replace as necessary.
	5. Loose or broken shackles.	5. Tighten or replace as necessary.
	6. Distorted or split jounce bumper.	6. Correct as required.
	7. Incorrect springs.	7. Replace springs.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• Dog tracking of rear wheels	1. Loose or damaged front or rear suspension components.	1. Inspect, repair or replace as required.
	2. Loose rear spring U-bolts.	2. Tighten to specification.
	3. Rear springs improperly installed on axle.	3. Repair as required.
	4. Rear spring center bolt bent.	4. Replace center bolt.
	5. Improperly installed front leaf springs (4x4).	5. Repair as necessary.
• Shimmy or wheel tramp	1. Loose front axle pivot bracket attaching parts.	1. Tighten to specification.
	2. Incorrect tire pressure.	2. Adjust air pressure in tires.
	3. Excessive tire sidewall deflection.	3. Inspect, adjust air pressure and replace as necessary.
	4. Irregular tire wear or tire sizes not uniform.	4. Check front wheel alignment, adjust and replace with same size tires.
	5. Loose wheel lug nuts.	5. Tighten to specifications.
	6. Front wheel bearing adjustment.	6. Adjust to specifications.
	7. Out-of-round wheels.	7. Replace as required.
	8. Out-of-round tires.	8. Replace as required.
	9. Wheel and tire lateral runout not to specifications.	9. Follow tire and wheel runout check — Section 18-01, Noise, Vibration and Harshness Diagnosis.
	10. Incorrect wheel and tire balance.	10. Balance wheels and tires.
	11. Front wheel alignment (toe-in and caster) out-of-specification.	11. Set toe to specifications. Set caster to specifications on vehicles with front leaf springs.
	12. Deteriorated radius arm bushing.	12. Replace.
	13. Loose, worn or damaged shock absorbers.	13. Tighten and replace as necessary.
	14. Loose, worn or damaged steering linkage and idler arm connections.	14. Tighten or replace as necessary.
	15. Broken or sagging springs.	15. Replace as required.
	16. Loose steering gear mounting.	16. Tighten to specifications.
	17. Incorrect steering gear adjustment.	17. Adjust to specifications.
	18. Worn ball joints.	18. Replace ball joints.
	19. Worn spindle (king) pins.	19. Replace spindle pins and spindle pin bushings.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• Sway or roll	1. Unequal load distribution (side-to-side).	1. Correct as necessary.
	2. Excessive load or body height.	2. Correct as necessary.
	3. Incorrect tire pressure.	3. Adjust air pressure in tires.
	4. Loose wheel lug nuts.	4. Tighten to specifications.
	5. Worn or loose stabilizer assembly.	5. Tighten or replace as required.
	6. Broken or sagging spring.	6. Replace as required.
	7. Incorrect steering gear adjustment.	7. Adjust to specifications.
	8. Loose steering gear mounting.	8. Tighten to specifications.
	9. Excessive front or rear overhang.	9. Correct as necessary.
	10. Broken tie bolts on rear spring.	10. Replace as required.

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Vehicle Lean Correction

Front Lean

Measure the LH and RH front wheelhouse openings to ground as depicted in Figure 3. Refer to Figures 4 and 5 for the specified limits on their side-to-side difference or lateral tilt. A vehicle within these limits would not have an objectionable lean appearance. However, if the lean is objectionable perform the following to adjust:

- Vehicles with coil springs:

If the side-to-side difference is less than 19mm (3/4 inch) install a 6.35mm (1/4 inch) Service Shim (P/N 389117-S2) under the lower spring seat on the low side. No more than one shim is to be added.

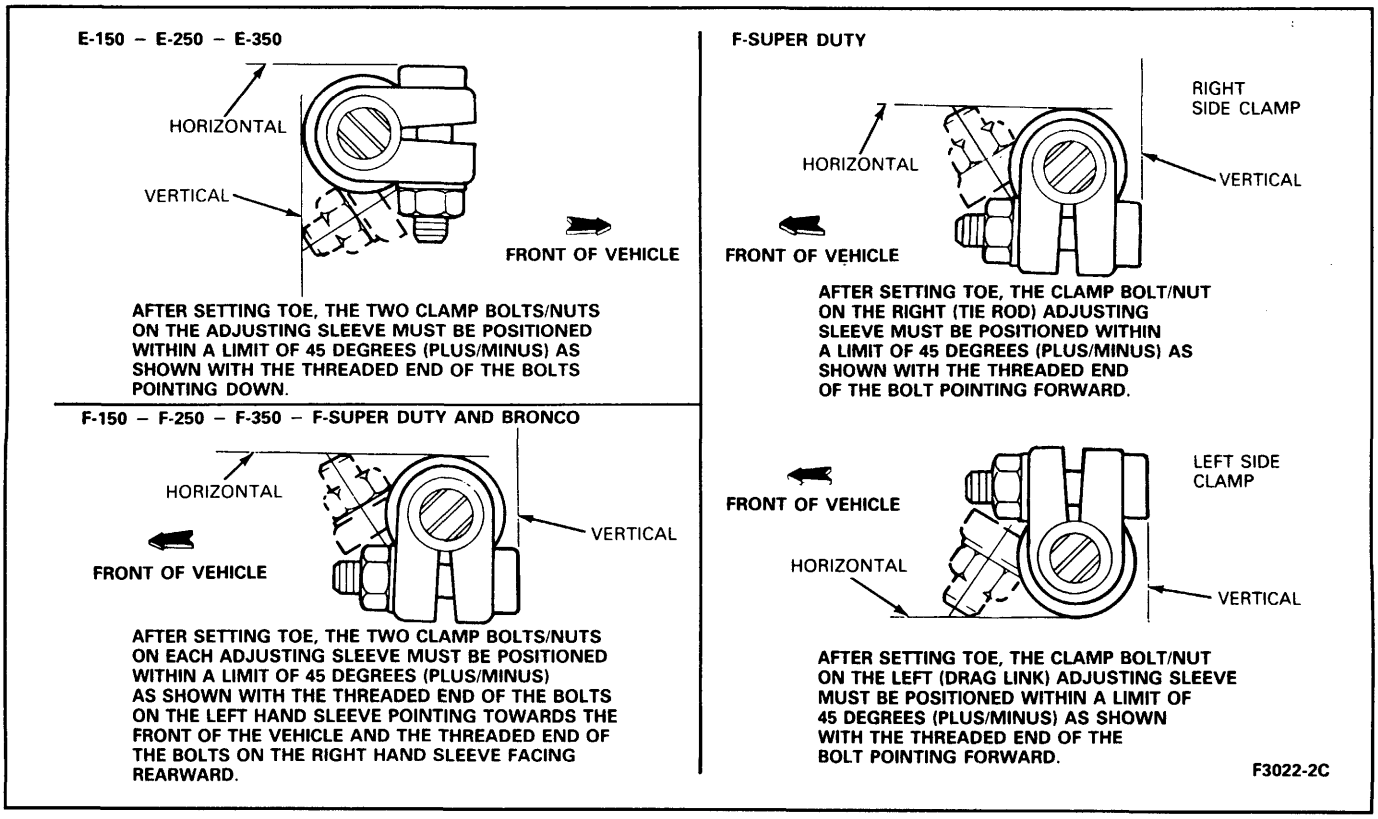
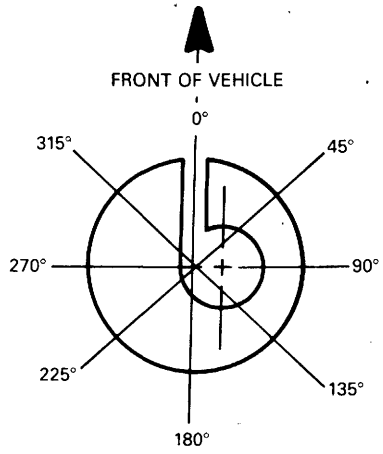


FIG. 9 Toe Adjustment Sleeve Clamp Positions

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F-SERIES 4x2 ADJUSTABLE CAMBER/CASTER

Service Adjuster Type (Degrees)	Position Slot in Axle (Degrees)	LH Axle		RH Axle	
		Camber Change (Degrees)	Caster Change (Degrees)	Camber Change (Degrees)	Caster Change (Degrees)
1/2	0	−0.5	0	+0.5	0
1	0	−1.0	0	+1.0	0
1-1/2	0	−1.5	0	+1.5	0
1/2	45	−0.25	+0.25	+0.25	+0.25
1	45	−0.75	+0.75	+0.75	+0.75
1-1/2	45	−1.00	+1.00	+1.00	+1.00
1/2	90	0	+0.5	0	+0.5
1	90	0	+1.0	0	+1.0
1-1/2	90	0	+1.5	0	+1.5
1/2	135	+0.25	+0.25	−0.25	+0.25
1	135	+0.75	+0.75	−0.75	+0.75
1-1/2	135	+1.00	+1.00	−1.00	+1.00
1/2	180	+0.5	0	−0.5	0
1	180	+1.0	0	−1.0	0
1-1/2	180	+1.5	0	−1.5	0
1/2	225	+0.25	−0.25	−0.25	−0.25
1	225	+0.75	−0.75	−0.75	−0.75
1-1/2	225	+1.00	−1.00	−1.00	−1.00
1/2	270	0	−0.5	0	−0.5
1	270	0	−1.0	0	−1.0
1-1/2	270	0	−1.5	0	−1.5
1/2	315	−0.25	−0.25	+0.25	−0.25
1	315	−0.75	−0.75	+0.75	−0.75
1-1/2	315	−1.00	−1.00	+1.00	−1.00



TOP VIEW OF CAMBER ADJUSTER
(POSITION SLOT IN AXLE TO OBTAIN DESIRED ALIGNMENT)

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FIG. 10 F-150—250—350 (4x2) with Ball Joint System Caster/Camber Service Adjuster Selection Table

If there is a side-to-side difference of 19mm (3/4 inch) or more remove the high side spring from the vehicle and compare it with a service replacement part having the same part number.

If the free height of the original equipment spring exceeds the free height of the service part by 13mm (1/2 inch), install the service part in this location. If the free height of the original spring is less by at least 13mm (1/2 inch), remove the low side spring. Compare the service spring to both of the original springs and select the two springs most evenly matched. Install the higher spring at the low side.

- Vehicles with front leaf springs.

A service shim is available that installs between the spring and the axle.

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Rear Lean

A side-to-side lean at the rear of the vehicle can be adjusted by approximately 10mm (3/8 inch) by installing a shim between the rear spring and axle on the low side of the vehicle. A "low at the rear" vehicle can be raised approximately 10mm (3/8 inch) by installation of one shim on each side. Use the following procedure to install the shim (D7TZ-5742-AZ):

1. Raise the vehicle frame until the weight is off the rear springs but with the tires still touching the floor.
2. Loosen the spring U-bolts to allow the axle to separate from the spring approximately 13mm (1/2 inch).
3. Position the shim (D7TZ-5742-AZ) between the spring and the spring seat and with the tie bolt head through the hole in the shim. On 4x4 vehicles, position the shim between the rear spring and axle spacer. Tape may be used to hold the shim in position.
4. Assure that the spring leaves are properly aligned and the spring U-bolts contact the edges of the spring assembly or axle seat.
5. Tighten the spring U-bolt sufficiently to assure that the spring tie bolt head that extends through the shim enters the hole in the axle seat.
6. Tighten U-bolt nuts to 102-135 N·m (75-100 ft-lbs) on F-150 (4x2 and 4x4)/Bronco and E-150—E-250—E-350 and to 204-284 N·m (150-210 ft-lbs) on F-250—F-350 (4x2) and E-250—E-350.

Shock Absorber Checks

Both the hydraulic shock absorbers and the low pressure gas shock absorbers are of the direct, double-acting type. They provide a continuous dampening effect both on compression and rebound. These shock absorbers are of telescopic design with rubber grommets at the mounting points for quiet operation. The low pressure gas shock absorbers are sealed and charged with nitrogen gas to reduce shock absorber fade and improve vehicle ride. The shock absorbers are sealed, non-adjustable units and must be replaced as complete assemblies.

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi) for 1 inch and 1 3/16 inch bore, and 1034 kPa (150 psi) for 1 3/8 inch bore. Do not attempt to open, puncture or apply heat to the shock absorbers.

Before replacing a shock absorber, check the action of the shock absorbers as follows:

On Vehicle Tests

1. Check the shock absorber to be sure it is securely and properly installed. Check the shock absorber insulators for damage and wear. Replace any worn or damaged insulators and tighten attachments to the specified torque (on a shock absorber which incorporates integral insulators, replace the shock absorbers). Tighten shock absorber attachments to torque specifications in Specifications Section of each suspension group.
2. Inspect the shock absorber for evidence of fluid leakage. A light film of fluid is permissible. Be sure any fluid observed is not from sources other than the shock absorber.

Vehicle Type	Spindle Arm Stop Angle — Degrees*	
	Kingpin	Ball Joint
F-150 (4x2) Regular & Super Cab	36.8	36.8
F-250/350 (4x2) Regular Cab, Super Cab and Crew Cab	35.0	35.0
F-150 (4x4) Regular Cab, Super Cab and Bronco	—	36.0①
F-250 (4x4) Regular Cab, Super Cab and Crew Cab	—	33.4
F-350 (4x4) Regular Cab, F-250 HD (4x4)	—	30.3

*All stops are non-adjustable.
①34.0 with 10x15 size tires. CF2364-1J

FIG. 11 Spindle Arm Stop Angle—All Twin-I-Beam Vehicles

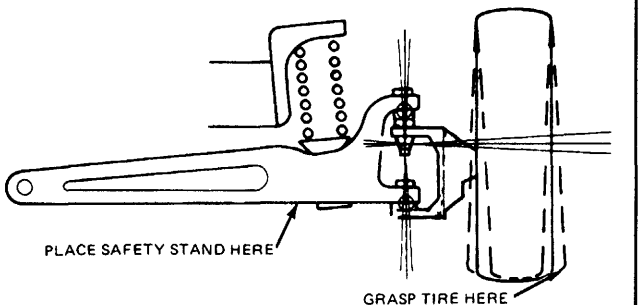


FIG. 12 Lower Ball Joint Inspection

Replace the shock absorber if leakage is severe.

3. Disconnect the lower end of the shock absorber. Extend and compress the shock absorber as fast as possible, using as much travel as possible. Action should become smooth and uniform throughout each stroke. Higher resistance on extension than on compression is a normal condition. Faint swish noises are also normal. **Ensure that the part number of the replacement is the same as that of the original shock absorber.**

Upper and Lower Ball Joint Inspection

F-Series Twin I-Beam Front Axle Equipped with Ball Joints

Prior to performing any ball joint inspection, adjust the front wheel bearings as described in the appropriate Section of Group 11, Wheels and Tires.

1. Raise the vehicle and place safety stands under the I-Beam axle beneath the spring as shown in Fig. 12.
2. Have an assistant grasp the lower edge of the tire and move the wheel in and out.
3. While the wheel is being moved, observe the lower spindle arm and the lower part of the axle jaw.
4. A 0.794mm (1/32 inch) or greater movement between the lower part of the axle jaw and the

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lower spindle arm indicates that the lower ball joint must be replaced.

5. For checking the upper ball joints, grasp the upper edge of the tire and move the wheel in and out. A 0.794mm (1/32 inch) or greater movement between the upper spindle arm and the upper part of the axle jaw indicates that the upper ball joint must be replaced.

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
D79T-3010-B	Four Wheel Drive Ball Joint Set	Dana 44 Front Axle
D81T-3010-B	Ball Joint Removing Tool	F-150 (4x2) with Stamped Twin I-Beam Axles — Removal of Camber Adjusting Sleeve
T80T-3010-A	Ball Joint Tool	F-150-F-350 (4x4), Bronco Upper and Lower Ball Joints
D79P-3283-A	Tie Rod Adjustment Tool	Universal
TOOL-3290-C	Tie Rod End Remover	Universal
T64P-3590-F	Pitman Arm Puller	Universal
T78P-5638-A	Suspension Bushing Service Set	6.75" and 7.5" 4-Bar Rear Axle Vehicles
T80T-5638-A	Front Suspension Bushing Tool	Front Drive Axle Suspension Bushing Removal and Installation

CF3501-2C

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SECTION 14-21 Front Suspension Twin-I-Beam/Solid-I-Beam

SUBJECT	PAGE
ADJUSTMENTS	
Camber Adjustment	14-21-3
DESCRIPTION	
Front Axle	14-21-1
Front Shock Absorber	14-21-1
Front Stabilizer Bar—F-150—F-350	14-21-1
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VEHICLE APPLICATION

F-150 Through F-350 (4x2), E-150 Through E-350 and F-Super Duty.

DESCRIPTION

Front Suspension

The F-150—F-250—F-350 (4x2) and E-150—E-350 vehicles use coil springs with the two I-beam type front axles. The springs are mounted between the frame spring pocket and the axle, (Figs. 1 and 2).

The F-Super Duty vehicle uses two leaf springs attached to a solid I-beam front axle. The springs are mounted to the front axle with U-bolts and are attached to the frame side rails using a "fixed" bracket at the rear and a moveable shackle at the front. (Fig. 3)

Front Axle

The F-150—F-250—F-350 (4x2) and E-150—E-250—E-350 vehicles use two I-beam type front axles (one for each front wheel). One end of each axle is attached to the spindle and a radius arm, and the other end is attached to a frame pivot bracket on the opposite side of the vehicle.

The F-Super Duty vehicle uses a solid I-beam type front axle and is attached by two leaf springs to both frame side rails. The springs are mounted to the axle by U-bolts.

Each spindle is held in place on the axle by ball joints (F-150—F-350 4x2) on I-Beam axles or a spindle pin (kingpin) (E-150—E-350 and F-Super Duty) which pivots in bronze bushings pressed in the upper and lower ends of the spindle on forged I-Beam axles. A thrust bearing is installed between the lower end of the axle and the spindle to support the load on the axle. All vehicles have a steering arm which is an integral part of the spindle (Figs. 1 and 2).

Tracking Bar

On the F-Super Duty vehicles, a tracking bar is attached to the left hand side of the # 1 crossmember and to the right hand side of the axle I-beam inboard of the right hand spring pad.

Front Shock Absorber

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi). Do not attempt to open, puncture or apply heat to the shock absorbers.

The hydraulic shock absorbers and the low pressure gas shock absorbers are of the direct, double-acting type. They provide a continuous dampening effect both on compression and rebound. These shock absorbers are of telescopic design with rubber grommets at the mounting points for quiet operation. The low pressure gas shock absorbers are sealed and charged with nitrogen gas to reduce shock absorber fade and improve vehicle ride. The shock absorbers are sealed, non-adjustable units and must be replaced as complete assemblies.

Front Stabilizer Bar—F-150—F-350 (4x2) and Econoline

The front stabilizer bar is located forward of the front axle and is attached to the I-Beam through a rubber insulated link assembly. Stabilization is acquired through torque loads transmitted to the frame side rails through the stabilizer bar assembly. Refer to Figs. 23, 24 and 25. F-Super Duty—The front stabilizer bar on F-Super Duty vehicles is attached to the rear of the axle

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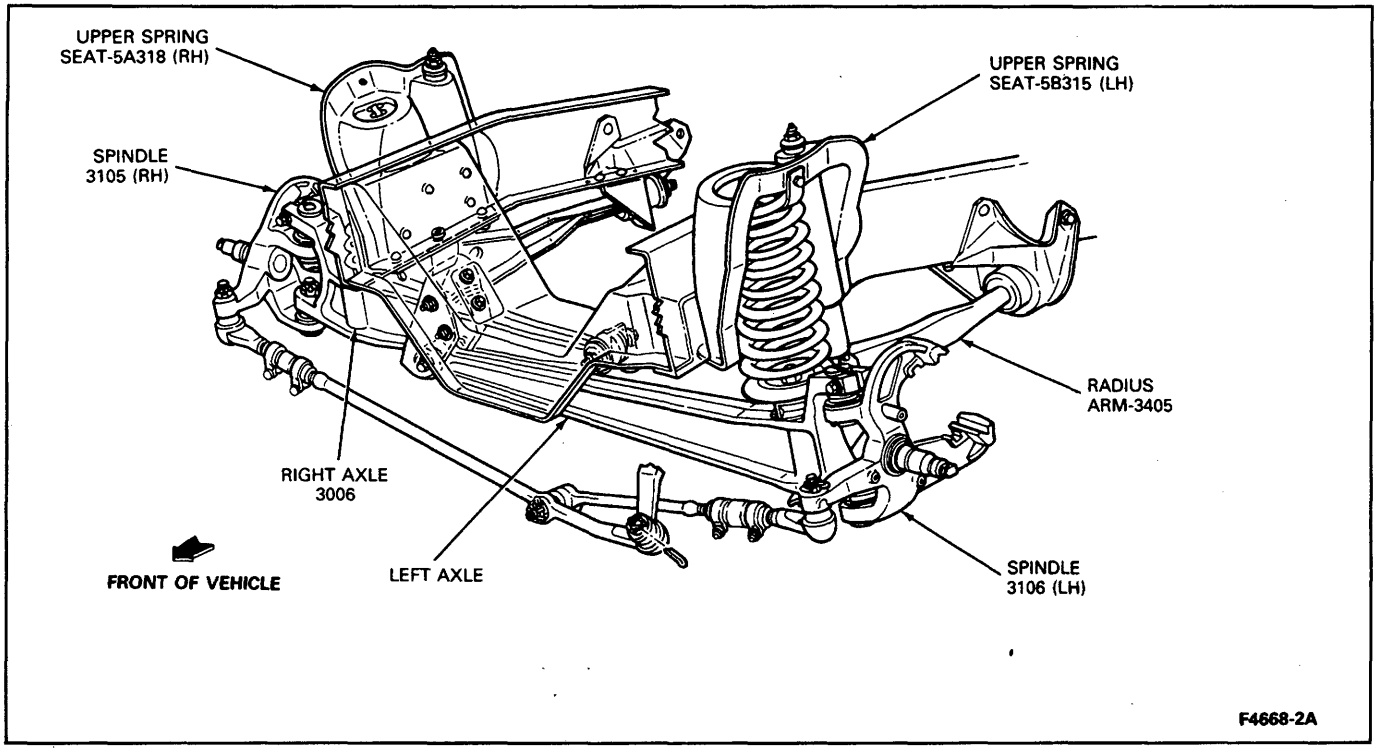


FIG. 1 Front Suspension—Twin I-Beam Axle equipped with Ball Joints—F-150—F-350 (4x2)

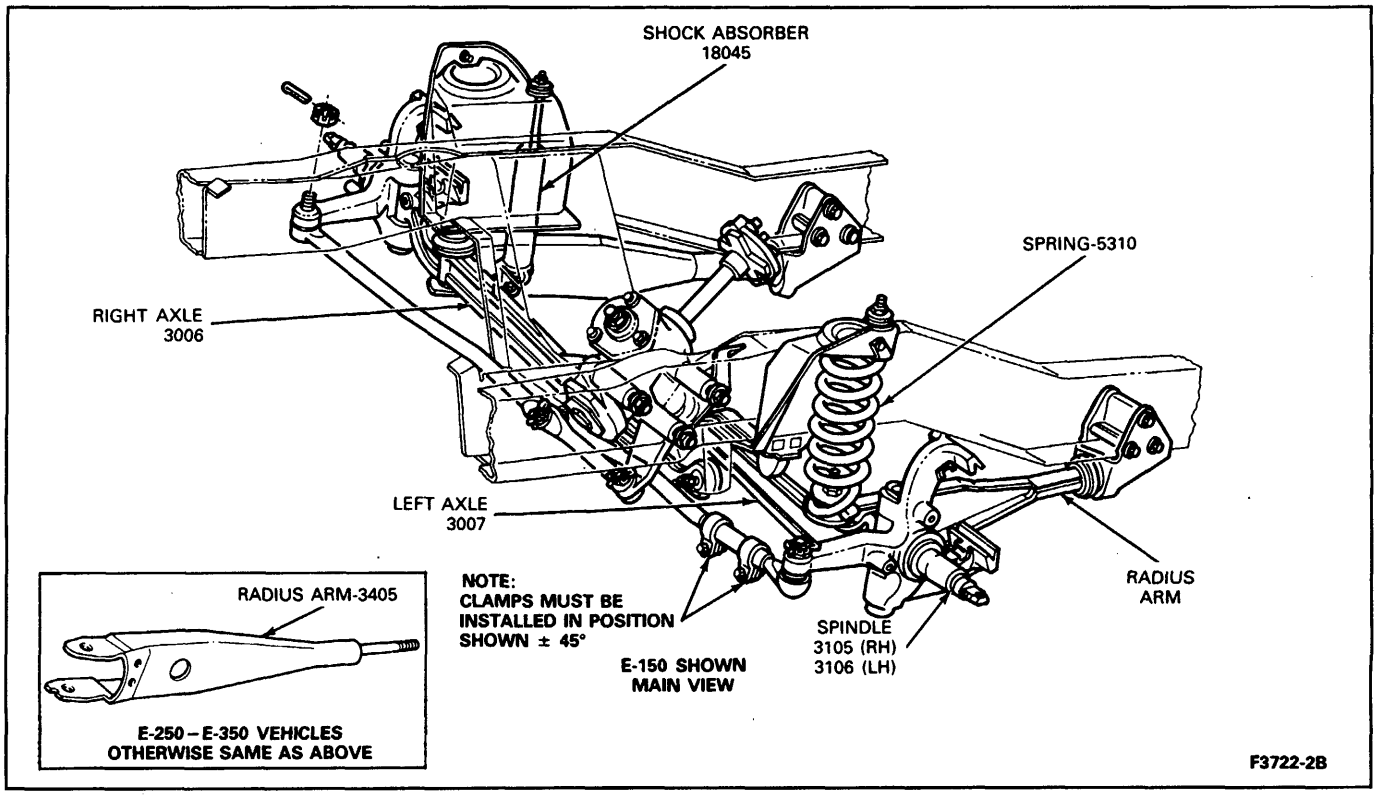


FIG. 2 Front Suspension—Twin I-Beam Axle equipped with Spindle Pins—E-150—E-250—E-350

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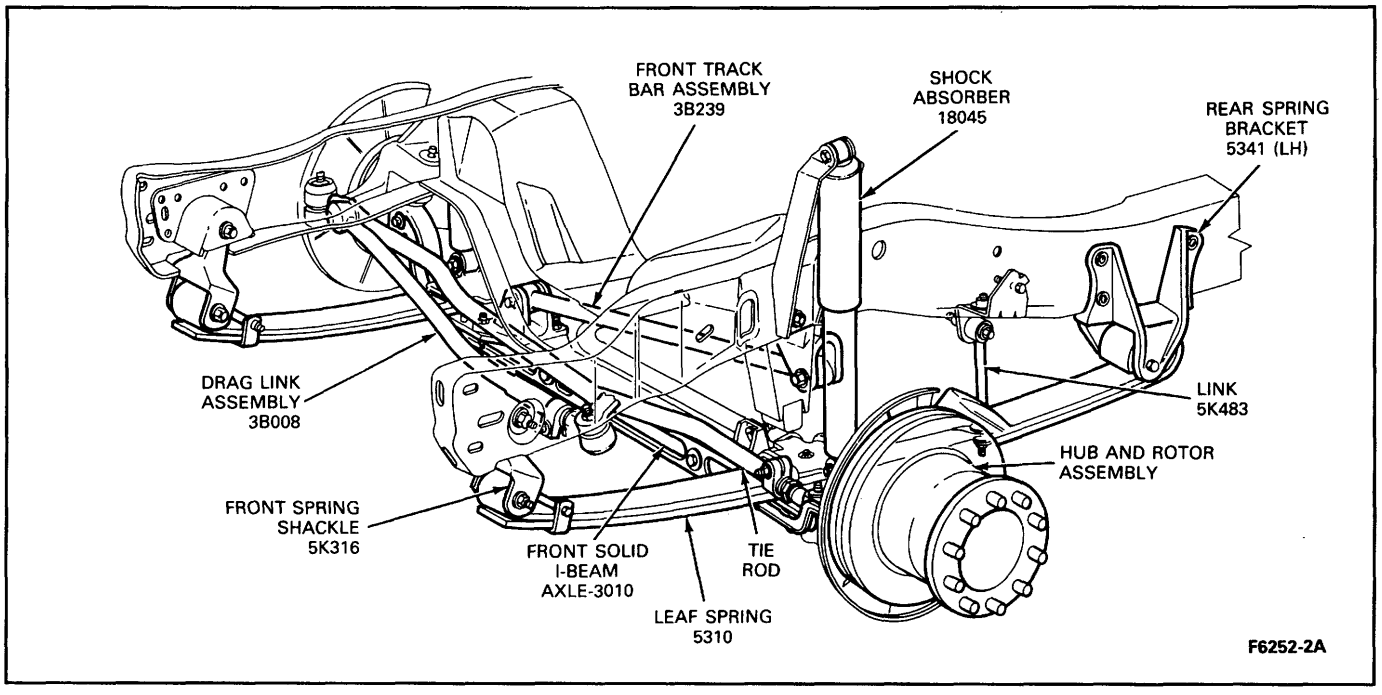


FIG. 3 Front Suspension—Solid-I-Beam Axle Equipped with Spindle Pins and Leaf Springs—F-Super Duty

beam, and is connected to each frame side rail by insulated link assemblies (Fig. 26).

ADJUSTMENTS

Camber Adjustment

Only F-150—F-350 vehicles equipped with ball joints can have the camber setting adjusted. Camber is adjusted by replacing the camber adjuster on the upper ball joint stud. Adjusters are available in 0°, 1/2°, 1° and 1 1/2° increments.

NOTE: On F-Super Duty vehicles, do not attempt to change the camber by bending the axle beam. Camber angle is not adjustable.

If camber needs adjustment, replace the camber adjuster as described in this Section under camber adjuster—Removal and Installation.

REMOVAL AND INSTALLATION

Front Spring

F-150—F-350 (4x2) and E-150—E-350

Refer to Figs. 4 and 6.

Removal

1. Raise the front of the vehicle and place safety stands under the frame and a jack under the axle. Refer to Section 50-04, Hoisting and Jacking Light-Medium-Heavy, Pre-Delivery manual, for hoisting instructions.

   NOTE: The axle must be supported on the Jack throughout spring removal and installation, and must not be permitted to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the spring, the disc brake caliper must be removed from the spindle according to the procedures specified in Section 12-24. Disc Brakes—Light and Heavy Duty—Sliding Caliper. After removal, the caliper must be placed on the frame or otherwise supported to prevent suspending the caliper from the brake hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose assembly.
2. Disconnect the shock absorber from the lower bracket.
3. Remove the spring upper retainer attaching bolts or screws from the top of the spring upper seat and remove the retainer.
4. Remove the nut attaching the spring lower retainer to the lower seat and lower rubber insulator and axle and remove the retainer.
5. Slowly lower the axle and remove the spring.

Installation

1. Place the spring in position and slowly raise the front axle.
2. Position the spring lower retainer over the stud, lower rubber insulator (if so equipped) and lower seat, and install the attaching nut.
3. Position the upper retainer over the spring coil and against the spring upper seat, and install the attaching screw.
4. Tighten the upper retainer attaching bolt and lower retainer attaching nut to specifications which follow:

   F-150 (4x2)

   - Upper Retainer, 18-24 N·m (13-18 ft-lbs)
   - Lower Retainer, 95-135 N·m (70-100 ft-lbs)

   F-250—F-350 (4x2)

   - Upper Retainer, 18-24 N·m (13-18 ft-lbs)
   - Lower Retainer, 95-135 N·m (70-100 ft-lbs)

   E-150—E-250—E-350

   - Upper Retainer 28-40 N·m (20-30 ft-lbs)

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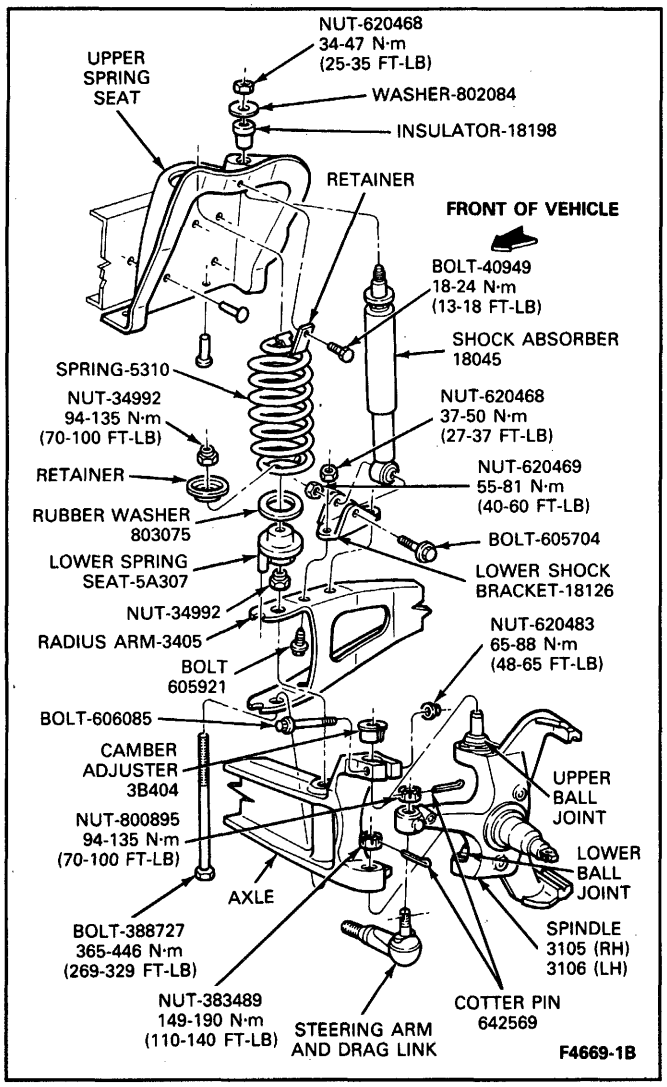


FIG. 4 Front Spring and Shock Absorber Installation—F-150—F-350 (4x2) with Ball Joints (F-250—F-350 Shown)

- Lower Retainer 95-135 N·m (70-100 ft-lbs)

5. Connect the shock absorber to the lower bracket. Install the lower bolt with head towards the tire and tighten nut to 55-81 N·m (40-60 ft-lbs).
6. Remove the jack and safety stands.

Front Spring

F-Super Duty

Refer to Fig. 5

Removal

1. Raise the vehicle frame until the weight is off the front springs with the wheels still touching the floor.
2. Support the front axle with jacks to remove the weight from the spring U-bolts.
3. Remove the nut and bolt that holds the shock absorber to the spring spacer eyes. Disconnect the shock absorber from the spring spacer.
4. Remove the nut and bolt that retains the spring to the front spring shackle.
5. Remove the nut and bolt that retains the spring to the rear spring shackle.
6. Remove the four U-bolt nuts. Remove the jack bracket. Remove the U-bolts.
7. Remove the spring from the vehicle.

Installation

1. Position the spring at the spring seat on the front axle and align the spring eye with its mating hole in the front spring shackle.
2. Prior to installation, coat the bushing with Multi-Purpose Long Life Lubricant C1AZ-19590-B (ESA-M1C75-B) or equivalent. Gently guide the bolt through the shackle and spring eye.
3. Install the retaining nut. Tighten to 163-203 N·m (120-150 ft-lbs.).
4. Align the rear spring eye with its mating hole in the rear spring shackle.
5. Coat the bushing with Multi-Purpose Long Life Lubricant C1AZ-19590-B (ESA-M1C75-B) or equivalent. Gently guide the bolt through the shackle and spring eye.
6. Position the spring spacer on the locating boss in the spring.
7. Install the U-bolts. Install the jack bracket on the forward U-bolt. Install the four U-bolt nuts and tighten to 115-163 N·m (85-120 ft-lbs.).
8. Remove the nut and bolt that holds the shock absorber to the spring spacer eyes. Align the shock absorber mounting holes with the eyes on the spring spacer. Install the nut and bolt that holds the shock absorber to the spring spacer and tighten to 70-100 N·m (52-74 ft-lbs.).
9. Remove the jacks from under the front axle.
10. Lower the vehicle.

Front Shock Absorber

E-150—E-250—E-350

Refer to Fig. 6.

CAUTION: The low pressure gas shock absorbers are charged with Nitrogen gas to 931 kPa (135 psi). Do not attempt to open, puncture or apply heat to the shock absorbers.

Removal

1. Insert a wrench from the rear side of the spring upper seat to hold the shock absorber upper retaining nut. Loosen the stud by turning the hex provided on the exposed (lower) part of the stud and remove the nut.
2. Disconnect the lower end of the shock absorber from the lower bracket (bolt and nut).
3. Remove the shock absorber, washers and rubber insulators.

Installation

1. When installing a new shock absorber, use new rubber insulators. Install the lower washer and insulator on the stud end, and position the shock absorber in the spring upper seat. Install the upper insulator, washer and self-locking nut. While holding the nut as described in Step 1 of Removal, tighten to 25-37 N·m (18-28 ft-lbs) by turning the hex provided on the stud.

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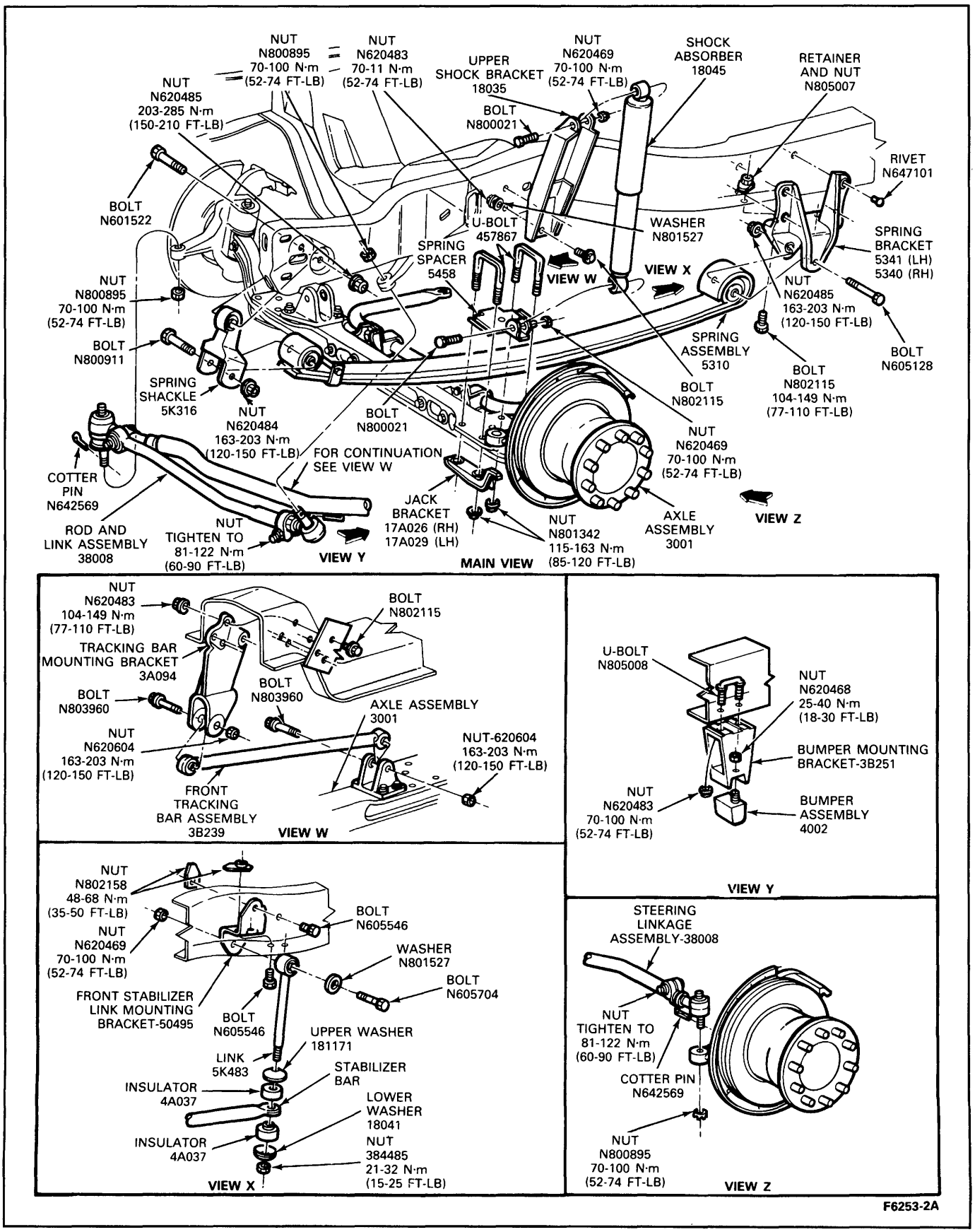


FIG. 5 Front Spring, Shock Absorber and Tracking Bar Installation—F-Super Duty

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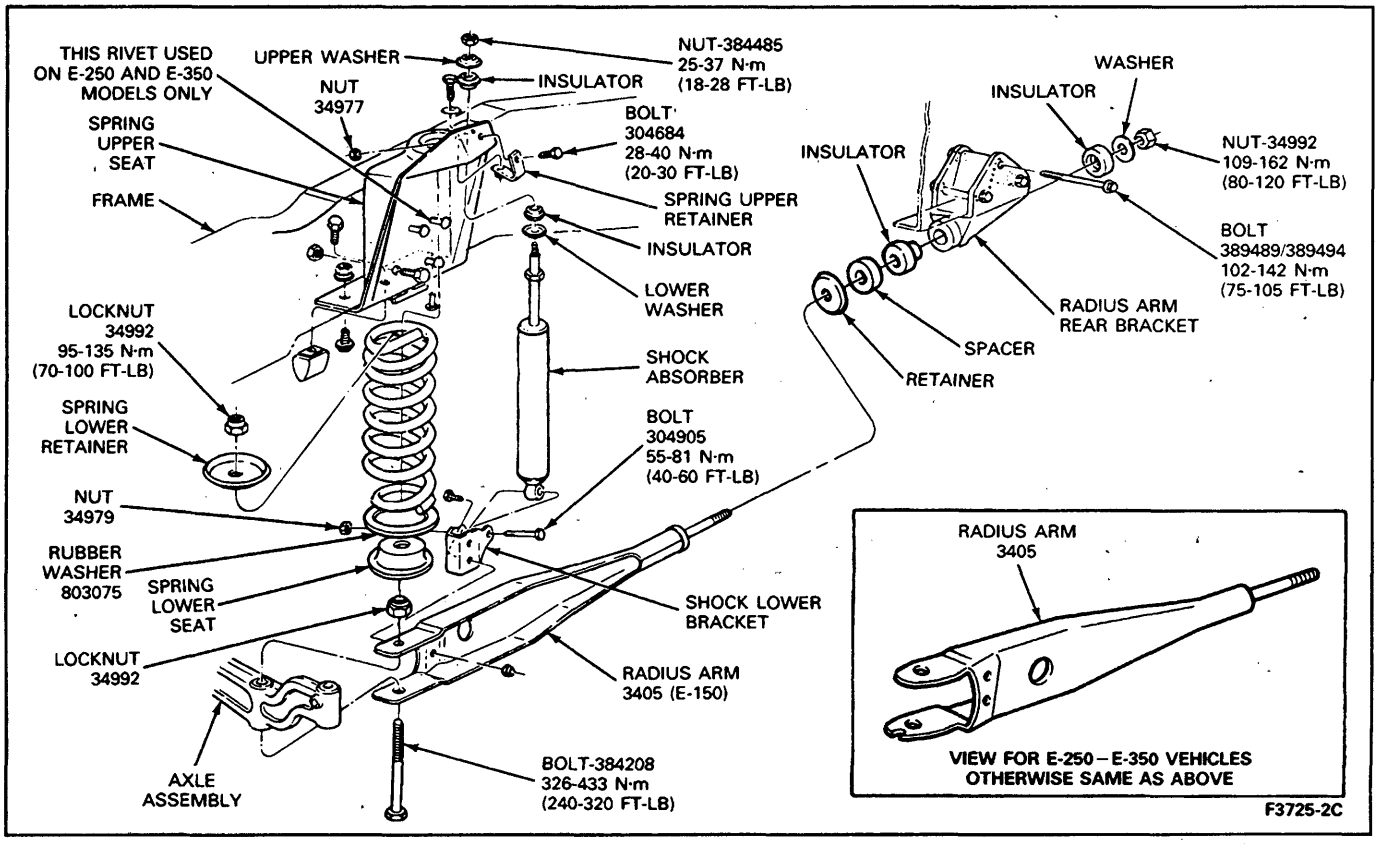


FIG. 6 Front Spring and Shock Absorber Installation—E-150—E-250—E-350 with Spindle Pins with Spindle Pins

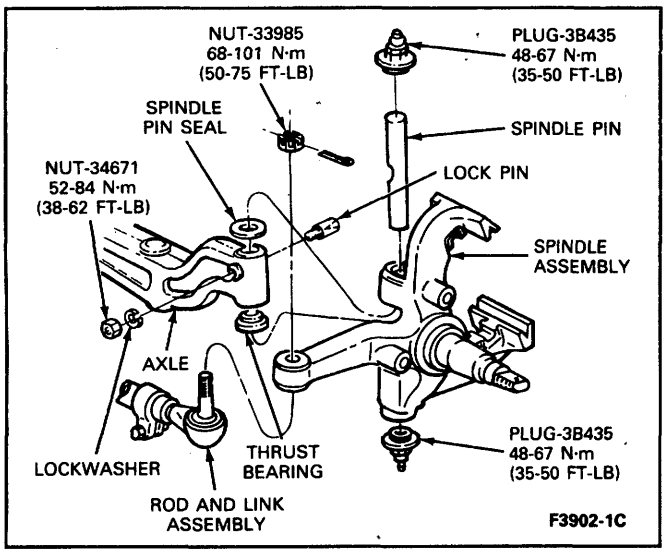


FIG. 7 Front Wheel Spindle Installation—E-150 with Spindle Pins

2. Connect the lower end of the shock absorber to the lower bracket by installing the bolt and nut. Tighten to 55-81 N·m (40-60 ft-lbs).

Front Shock Absorber

F-150—F-250—F-350

Refer to Fig. 4.

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi).

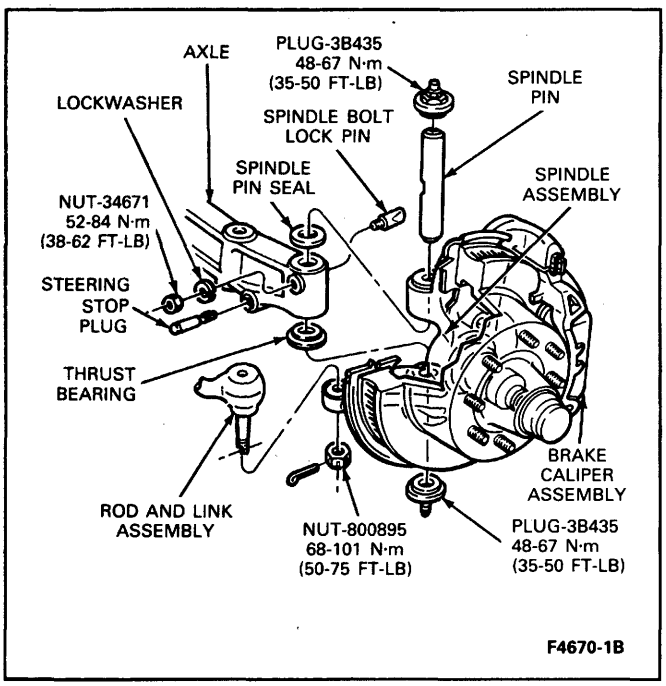


FIG. 8 Front Wheel Spindle Installation—E-250—E-350 with Spindle Pins

Do not attempt to open, puncture or apply heat to the shock absorbers.

Removal

1. Insert a wrench from the rear side of the upper spring seat to hold the shock absorber retaining nut in place. Loosen the stud by turning the hex

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provided on the exposed (lower) part of the stud and remove the nut and washer.

2. Disconnect the lower end of the shock absorber from the lower bracket by removing the nut and bolt.
3. Compress the shock absorber and remove it from the vehicle.
4. Cut out the insulator from the upper spring seat.

Installation

1. Coat the upper spring seat with a soap solution and install a new one-piece insulator in the seat.
2. Insert the upper shock absorber stud through the insulator. Install the steel washer and hand start the nut. Insert a wrench from the rear of the upper spring seat to hold the upper nut stationary. Tighten the hex on the shock absorber to 30-47 N·m (25-35 ft-lbs).
4. Position the shock absorber in the lower bracket. Install the bolt so the bolt head faces the tire. Install the nut and tighten to 55-81 N·m (40-60 ft-lbs).

Front Shock Absorber

F-Super Duty

Refer to Fig. 5

Removal

1. Remove the nut and bolt that retains the shock absorber to the upper shock bracket.
2. Remove the nut and bolt that retains the shock absorber to the eyes on the spring spacer.
3. Remove the shock absorber from the vehicle.

Installation

1. Position the shock absorber in the upper shock bracket. Install the nut and bolt and tighten to 70-100 N·m (52-74 ft-lbs).
2. Position the lower end of the shock absorber in the spring spacer eyes. Install the nut and bolt and tighten to 70-100 N·m (52-74 ft-lbs).

Front Wheel Spindle

E-150—E-250—E-350 and F-Super Duty

Removal Refer to Figs. 7, 8 and 9

1. Raise the front of the vehicle and install safety stands.
2. Remove the wheel and tire assembly.
3. Remove the caliper assembly from the rotor and hold it out of the way with wire. Refer to Caliper Removal instructions in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
4. Remove the dust cap, cotter pin, nut retainer, nut, washer, and outer bearing, and remove the rotor from the spindle.
5. Remove inner bearing cone and seal. Discard the seal.
6. Remove brake dust shield. Refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
7. Disconnect the steering linkage from the integral spindle and spindle arm by removing the cotter pin and nut, and then removing the tie rod end from the spindle arm with TOOL-3290-D or equivalent.
8. Remove the nut and lockwasher from the lock pin, and remove the lock pin.

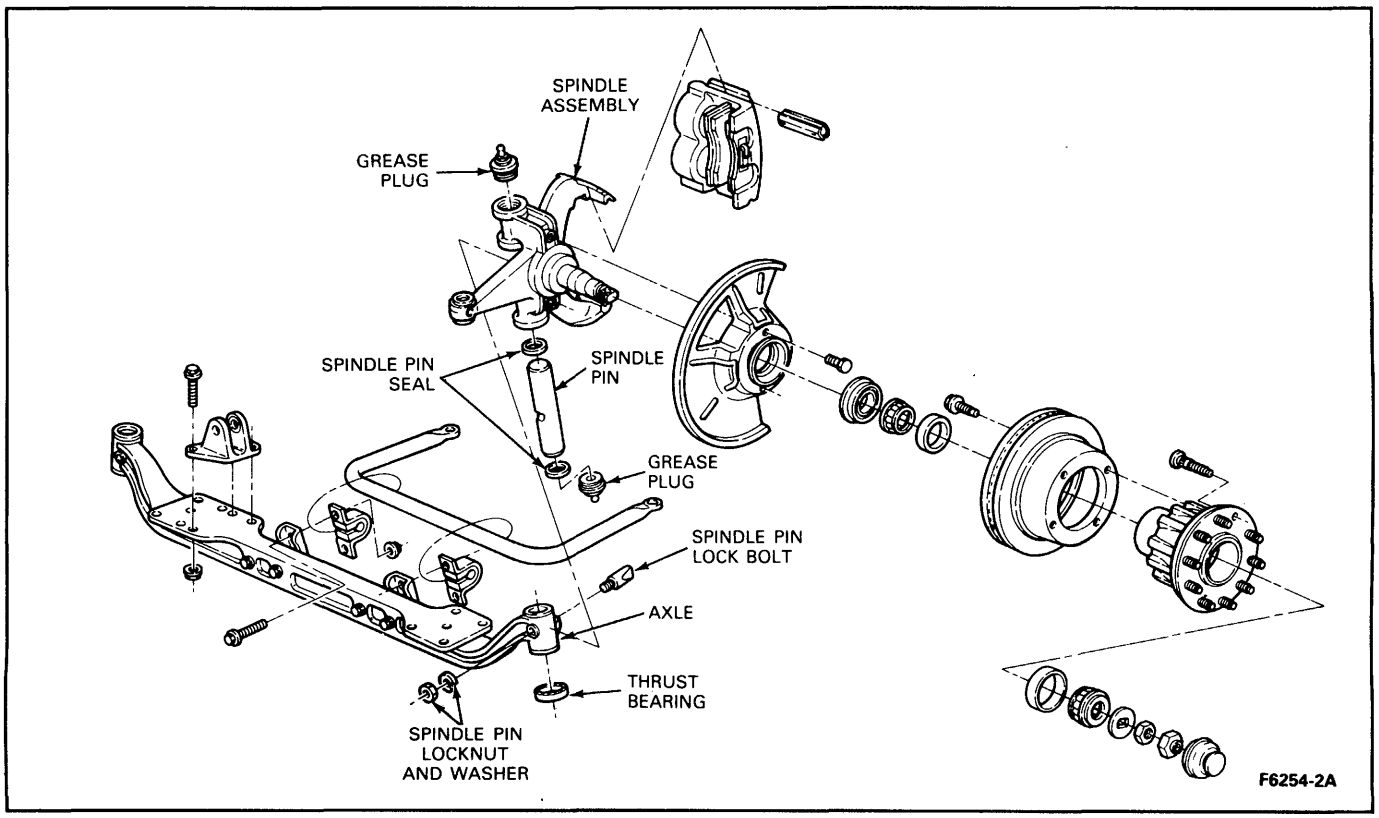


FIG. 9 Front Wheel Spindle Installation—F-Super Duty with Spindle Pins

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9. Remove the upper and lower spindle pin plugs; then, drive the spindle pin out from the top of the axle and remove the spindle and thrust bearing (Figs. 7, 8, 9 and 10). Remove the spindle pin seal and thrust bearing.

Installation

1. Make sure the spindle pin hole in the axle is free of nicks, burrs, corrosion or foreign material. Clean up the bore as necessary and lightly coat the surface with a lithium-base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.
2. Install a new spindle pin seal with the metal backing facing up towards the bushing into the spindle as shown in Fig. 7. Gently press seal into position, being careful not to distort the casing.
3. Install a new thrust bearing with the lip flange facing down towards the lower bushing as shown in Fig. 7. Press until the bearing is firmly seated against the surface of the spindle.
4. Lightly coat the bushing surfaces with grease and place the spindle in position on the axle.
5. Install the spindle pin with the "T" stamped on one end towards the top, and the notch in the pin aligned with the lock pin hole in the axle. Insert the spindle pin through the bushings and axle from the top until the spindle pin notch and axle lock pin hole are in line.
6. Install the lock pin with the threads pointing forward and the wedge groove facing the spindle pin notch. Firmly drive the lock pin into position and mount the lockwasher and nut. Tighten the nut to 52-84 N·m (38-62 ft-lbs).
7. Install the spindle pin plugs into the threads at the top and bottom of the spindle. Tighten the plugs to 48-67 N·m (35-50 ft-lbs).
8. Lubricate the spindle pin and bushings with C1AZ-19590-B (ESA-M1C75-B) Multi-Purpose Long-Life Lubricant, or equivalent, through both fittings until grease is visible seeping past the upper seal at the top and from the thrust bearing slip joint at the bottom. If grease does not appear, recheck the installation procedure to correct the problem. Lack of adequate lubrication will result in rapid failure of the spindle components.
9. Install the dust shield. Refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
10. Pack the inner and outer bearing cone with bearing grease. Use a bearing packer. If a bearing packer is unavailable, pack the bearing cone by hand working the grease through the cage behind the rollers.
11. Install the inner bearing cone and seal as described in Section 11-10, Wheel Hubs and Bearings—Front (except Front Drive). Install the hub and rotor on the spindle.
12. Install the outer bearing cone, washer, and nut. Adjust bearing end play and install the nut retainer, cotter pin and dust cap as described in Section 11-10.
13. Install the caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
14. Connect the steering linkage to the spindle. Tighten the nut to 94-135 N·m (70-100 ft-lbs) and advance the nut as required for installation of the cotter pin.
15. Install the wheel and tire assembly.
16. Lower the vehicle.
17. Check and, if necessary adjust the toe setting. Refer to Section 14-01, General Suspension Service under Adjustments. Check the brakes for proper operation.

Front Wheel Spindle—F-150—F-350 (4x2) with Ball Joints

Removal

Refer to Fig. 11.

1. Raise the front of the vehicle and install safety stands.
2. Remove the wheel and tire assembly.

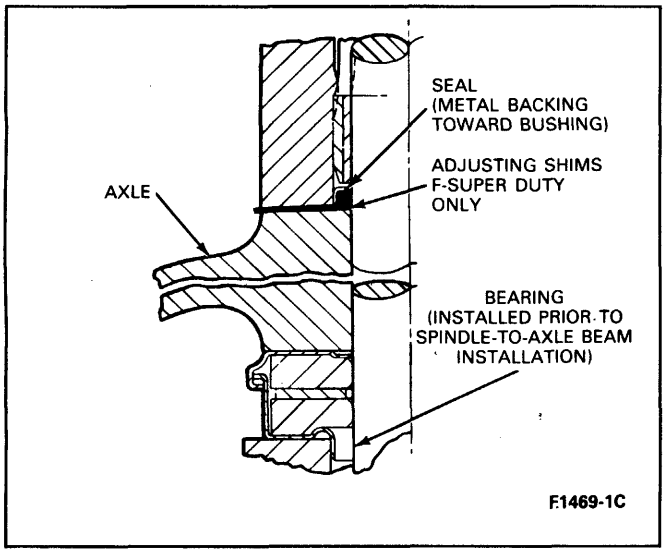


FIG. 10 Bearing Seal Installation, E-150—E-250—E-350 and F-Super Duty—Typical

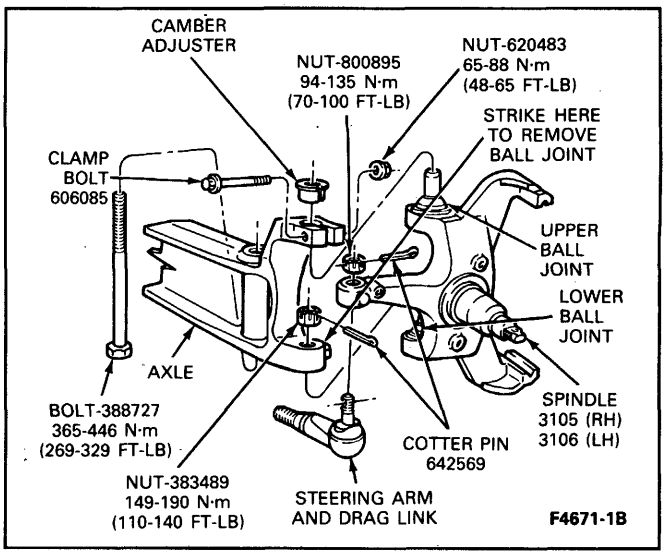


FIG. 11 Front Wheel Spindle Installation—F-150—F-350 (4x2) with Ball Joints

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3. Remove the caliper assembly from the rotor and hold it out of the way with wire. Refer to Caliper Removal instructions in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
4. Remove the dust cap, cotter pin, nut retainer, nut, washer, and outer bearing, and remove the rotor from the spindle.
5. Remove inner bearing cone and seal. Discard the seal.
6. Remove brake dust shield. Refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
7. Disconnect the steering linkage from the integral spindle and spindle arm by removing the cotter pin and nut and then removing the tie rod end from the spindle arm with TOOL 3290-D or equivalent.
8. Remove the cotter pin and castilated nut from the lower ball joint stud.
9. Remove the nut from the axle clamp bolt and remove the bolt from the axle.
10. Remove the camber adjuster from the upper ball joint stud and axle beam.
11. Strike the inside area of the axle as shown in Fig. 12 to pop the lower ball joints loose from the axle beam.

    CAUTION: Do not use a pickle fork to separate the ball joint from the axle as this will damage the seal and the ball joint socket.
12. Remove the spindle and ball joint assembly from the axle.

Installation

1. Prior to assembly, make sure the upper and lower ball joint seals are in place in the spindle.
2. Place the spindle and the ball joints into the axle.
3. Install the nut on the lower ball joint stud and partially tighten to 47 N·m (35 ft-lbs).
4. Install the camber adjuster in the upper spindle over the upper ball joint stud. Be sure the adjuster is aligned properly. If camber adjustment is necessary, special adjusters must be installed. Refer to Adjustments in this Section.
5. Tap the adjuster lightly into the spindle. Tighten the lower ball joint stud nut to 149-190 N·m (110-140 ft-lbs) and continue tightening the castellated nut until it lines up with the hole in the stud. Install the cotter pin.
6. Install the clamp bolt and nut into the axle boss. Tighten the nut to 65-88 N·m (48-65 ft-lb).
7. Install the dust shield. Refer to Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
8. Pack the inner and outer bearing cone with a lithium-base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent. Use a bearing packer. If a bearing packer is unavailable, pack the bearing cone by hand working the grease through the cage behind the rollers.
9. Install the inner bearing cone and seal as described in Section 11-10, Wheels, Hubs and Bearings—Front (except Front Drive). Install the hub and rotor on the spindle.
10. Install the outer bearing cone, washer, and nut. Adjust bearing end play and install the nut retainer, cotter pin and dust cap as described in Section 11-10 Wheels, Hubs and Bearings—Front (Except Front Drive).
11. Install the caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
12. Connect the steering linkage to the spindle. Tighten the nut to 94-135 N·m (70-100 ft-lbs) and advance the nut as required for installation of the cotter pin.
13. Install the wheel and tire assembly.
14. Lower the vehicle.
15. Check and, if necessary adjust the toe setting. Refer to Section 14-01, General Suspension Service under Adjustments. Check the brakes for proper operation.

Camber Adjuster—F-150—F-350 (4x2) with Ball Joints

Removal

1. Remove the cotter pin and loosen the nut on the lower ball joint. Loosen the nut to the end of the stud only.
2. Remove the upper ball joint camber adjuster clamp bolt nut and remove the clamp bolt from the axle.
3. Remove the camber adjuster from the axle using Tool D81T-3010-B to wedge the adjuster out of the axle.

Installation

1. Install the correct camber adjuster into the axle aligning the slot in the adjuster correctly.
2. Tighten the nut on the lower ball joint stud to 47 N·m (35 ft-lb).

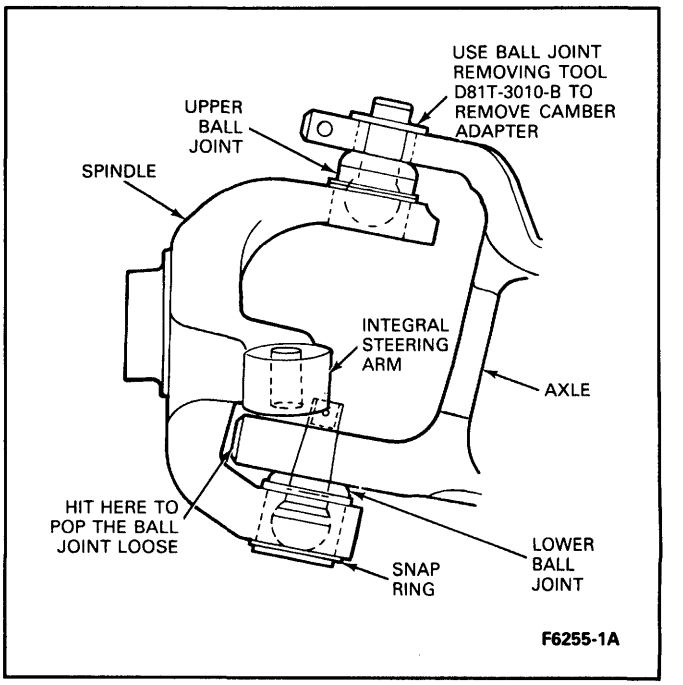


FIG. 12 Spindle Removal

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3. Install the adjuster on the upper ball joint stud and tap the adjuster into the axle.
4. Install the clamp bolt and nut in the axle. Tighten the nut to 65-88 N·m (48-65 ft-lb).
5. Tighten the lower ball joint stud nut to 149-190 N·m (110-140 ft-lb).

Upper and Lower Ball Joints—F-150—F-350 (4x2) with Ball Joints

Removal

1. Remove the spindle and ball joint assembly from the axle as described in this section under Front Wheel Spindle-F-150—F-350 (4x2) with ball joints.
2. Install the spindle assembly in a vise and remove the snap ring from the lower ball joint. Remove the lower ball joint from the spindle using tool T74P-4635-C C-frame, and receiver cup D81T-3010-A4. Turn the forcing screw clockwise until the ball joint is removed from the spindle.
3. Assemble C-Frame assembly and receiver cup on the upper ball joint and turn forcing screw clockwise until ball joint is removed from the spindle.

   NOTE: Always remove lower ball joint first.

CAUTION: Do not heat the ball joint or the spindle to aid in removal.

Installation

NOTE: Lower ball joint must be installed into the spindle first.

1. To install the lower ball joint, assemble C-Frame assembly, Ball Joint Receiver Cup (D81T-3010-A5) and Installation Cup (D81T-3010-A1 and D81T-3010-A3) inside cup (D81T-3010-A4) in position on the spindle. Turn forcing screw clockwise until ball joint is seated.

   CAUTION: Do not heat the ball joint or axle to aid in installation.
2. Install the snap ring onto the ball joint.
3. To install the upper ball joint, assemble the C-frame in position on the spindle and repeat Step 1.
4. Install the spindle and ball joint assembly as described in this Section.

Axle Pivot Bushing

Removal

Refer to Fig. 17.

1. Remove front coil spring as described in this Section under Front Spring Removal and Installation.
2. Remove the axle pivot nut and bolt. Pull the pivot end of axle down until bushing is exposed.
3. Install Forcing Screw (T78P-5638-A1), Bushing Remover T80T-5638-A2 and Receiver Cup (T78P-5638-A3) or their equivalents onto pivot bushing. Turn the forcing screw clockwise to remove the pivot bushing.

Installation

Refer to Fig. 18.

1. Place pivot bushing in axle. Assemble Receiver Cup (T78P-5638-A4), Forcing Screw (T78P-5638-A1) and Bushing Replacer (T78P-5638-A3), as shown in Fig. 18 and install bushing into axle.
2. Position axle in pivot bracket and install axle pivot bolt through the bracket and axle. Install nut but do not tighten at this time.
3. Install spring, following the procedure in this Section. Make sure spring is seated.
4. Lower vehicle and with the weight on the suspension, tighten pivot bushing bolt and nut to 163-203 N·m (120-150 ft-lbs).

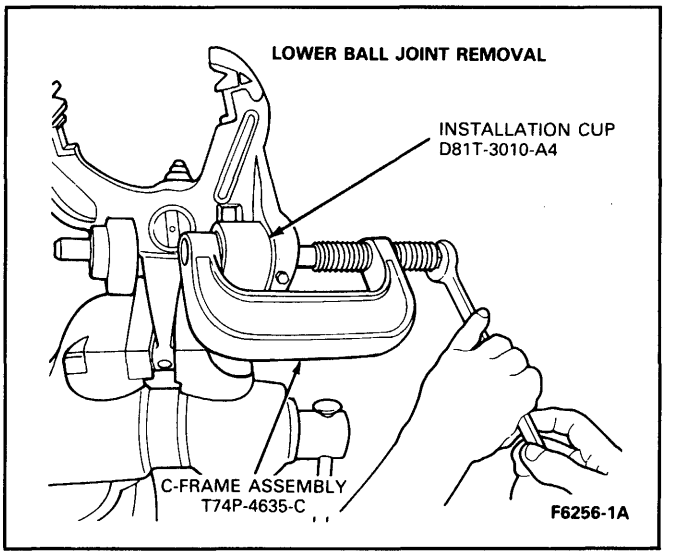


FIG. 13 Lower Ball Joint Removal

Radius Arm

Refer to Figs. 19 and 20.

Removal

1. Raise the front of the vehicle, and place safety stands under the frame. Place a jack under the axle.

   NOTE: The axle must be supported on the jack throughout spring removal and installation, and must not be permitted to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the spring, the disc brake caliper must be removed from the spindle according to the procedures specified in Section 12-24 Disc Brakes—Light and Heavy Duty-Sliding Caliper. After removal, the caliper must be placed on the frame or otherwise supported to prevent suspending the caliper from the brake hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose assembly.
2. Disconnect the lower end of the shock absorber from the shock lower bracket (bolt and nut).
3. Remove the front spring as outlined in this Section.
4. Remove the spring lower seat from the radius arm, and then remove the bolt and nut that attaches the radius arm and stabilizer bracket (if so equipped) to the axle.
5. Remove the nut, rear washer, insulator and spacer (F-150—F-250—F-350) from the rear side of the radius arm rear bracket.

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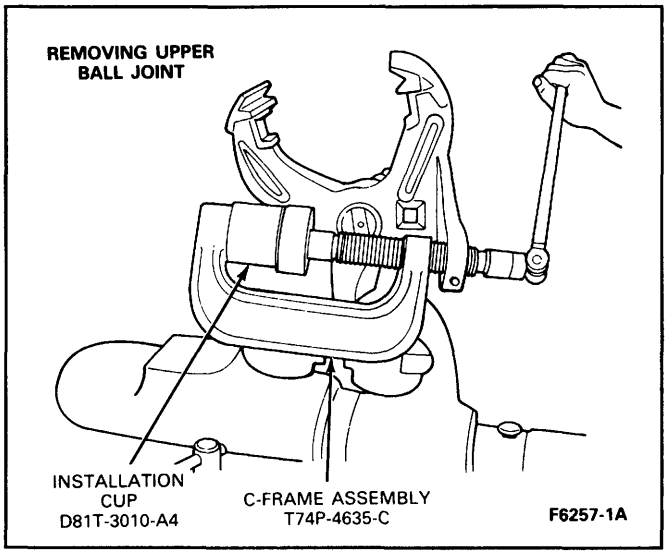


FIG. 14 Upper Ball Joint Removal

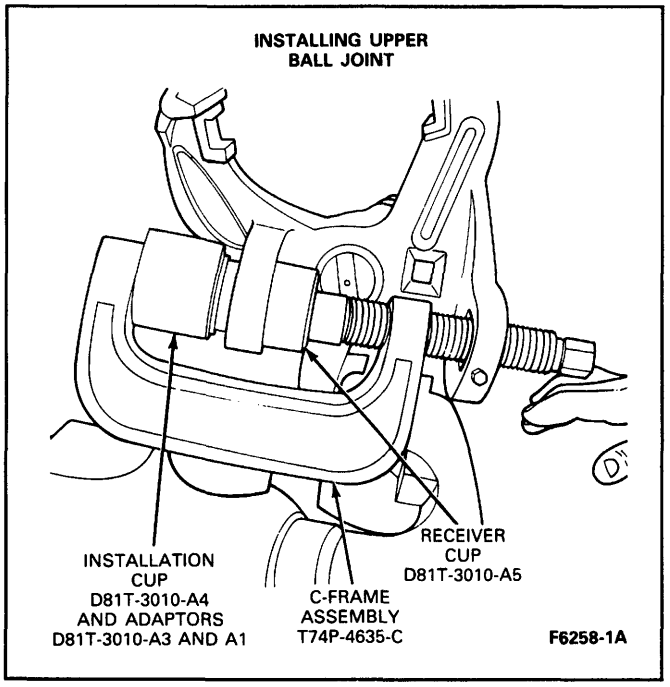


FIG. 15 Upper Ball Joint Installation

6. Remove the radius arm from the vehicle, and remove the spacer (E-150—E-250—E-350) inner insulator and retainer from the radius arm stud.

Installation

1. Position the front end of the radius arm to the axle. Install the attaching bolt from underneath through the stabilizer bracket (if so equipped), radius arm and axle, and then install the nut finger-tight.
2. Install the retainer, inner insulator and spacer (E-150—E-250—E-350) on the radius arm stud and insert the stud through the radius arm rear bracket.
3. Install the spacer (F-150—F-250—F-350), insulator, rear washer and nut on the arm stud at the rear side of the arm rear bracket. Tighten the nut to 109-162 N·m (80-120 ft-lbs).

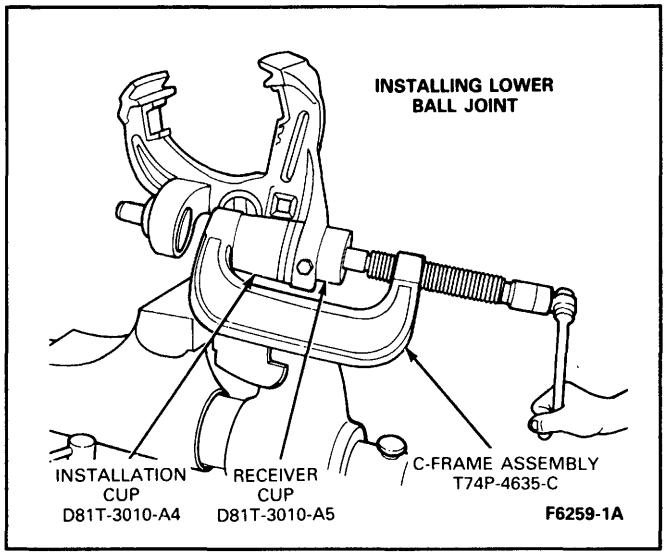


FIG. 16 Lower Ball Joint Installation

4. Install the spring lower seat and spring insulator (F-150—F-250—F-350) on the radius arm so that the hole in the seat goes over the arm-to-axle bolt.
5. Install the front spring as outlined in the foregoing procedures in this Section.
6. Connect the lower end of the shock absorber to the lower bracket on the radius arm with the attaching bolt and nut. The bolt head must be installed towards tire. Tighten the nut to 55-81 N·m (40-60 ft-lbs). Lower the vehicle.

Radius Arm Rear Bracket—E-150-E-250-E-350

With the radius arm removed, remove the three rear bracket-to-frame bolts and nuts and remove the bracket. Position the replacement bracket to the frame and install the three attaching bolts and nuts (Fig. 6). **Do not completely tighten one at a time. Partially tighten all three and repeat in sequence until specified torque of 102-142 N·m (75-105 ft-lbs) is obtained for all.**

Jounce Bumper

Refer to Fig. 21

Removal

1. Remove hex head bolt that holds jounce bumper to Frame. Remove jounce bumper.

Installation

1. Place the jounce bumper in position under the frame and spring upper seat. For F-150—F-250—F-350 (4x2) vehicles, position jounce bumper in rearward set of holes on R.H. side of the frame.

   NOTE: The rearward set of holes are for F-150—F-250—F-350 (4x2) vehicles only. The forward set of holes are for F-150 (4x4) and Bronco only.
2. Install bolt and tighten to 19-29 N·m (14-22 ft-lbs) for F-150—F-250—F-350, 25-40 N·m (20-30 ft-lbs) for E-150—E-250—E-350.

Jounce Bumper

F-Super Duty

Refer to Fig. 22

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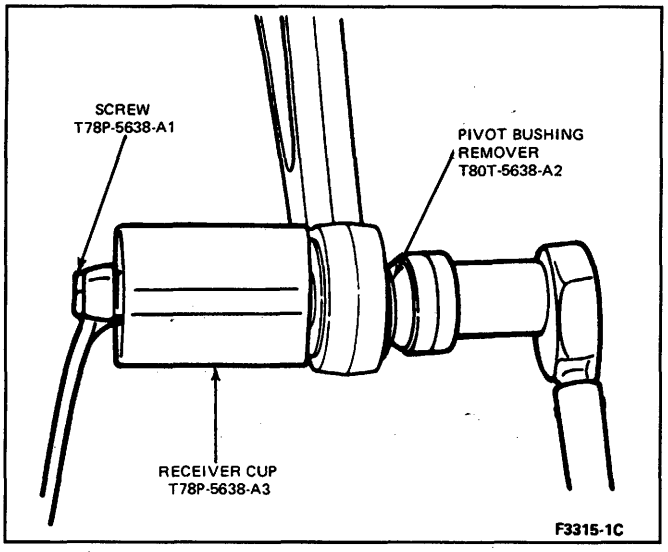


FIG. 17 Removing Axle Pivot Bushing

Removal

1. Remove the two nuts from the U-bolt that holds the bumper mounting bracket to the side rail.
2. If required, remove the nut that holds the bumper assembly to the bumper mounting bracket.

Installation

1. If removed, install the bumper assembly to the bumper mounting bracket. Tighten the nuts to 25-40 N·m (18-30 ft-lbs).
2. Position the bumper and mounting bracket assembly on the frame side rail. Install the U-bolt and tighten the retaining nuts to 25-40 N·m (18-30 ft-lbs.).

Axle Pivot Bracket (Right Side)

F-150—F-250—F-350 (4x2)

Refer to Fig. 23

Removal

1. Remove front spring and radius arm as described in this Section and remove the I-Beam Axle and wheel spindle assembly.
2. Remove the four attaching nuts and bolts and remove the axle pivot bracket.

Installation

1. Position the axle pivot bracket to the crossmember. Loosely install the bolts, bolt and retainer nuts. Do not tighten at this time.

   NOTE: The two rearward vertical bolts must be installed with the bolt heads next to the engine oil pan to maintain the required clearance. The bolt and retainer assembly must be installed with the bolt heads on the inside surface of the pivot bracket.

2. To ensure correct positioning of the axle pivot brackets, tighten the two forward (horizontal) fasteners to 149 N·m (110 ft-lbs) first. Then, tighten the two rearward (vertical) bolts and nuts (at top of crossmember) to 149 N·m (110 ft-lbs).

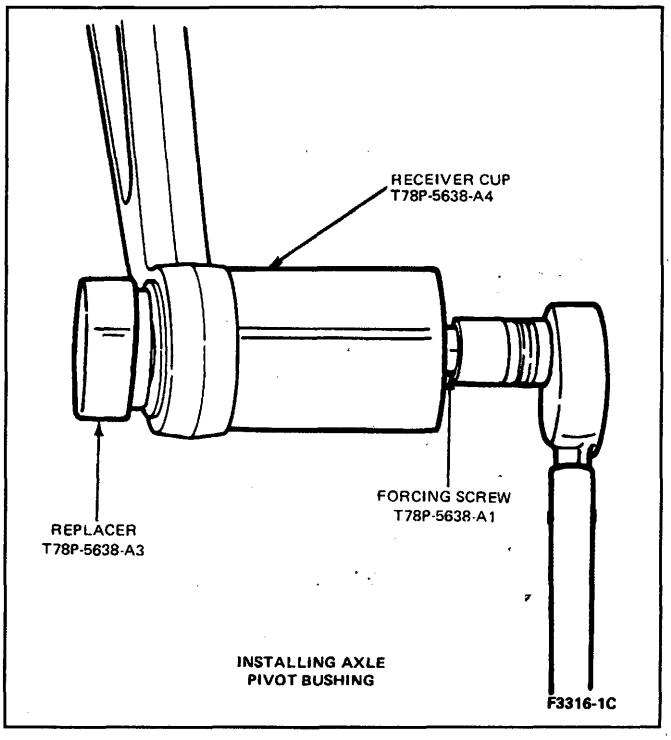


FIG. 18 Installing Axle Pivot Bushing

3. Install the I-beam axle and wheel spindle assembly, front spring and radius arm as described in this Section.

Front Stabilizer Bar

E-150—E-250—E-350

Removal

1. Disconnect the left and right ends of the front stabilizer bar from the link assembly attached to the I-Beam bracket (Fig. 24).
2. Disconnect the retainer bolts and remove the stabilizer bar.
3. Disconnect the stabilizer link assemblies by loosening the right and left locknuts from their respective I-Beam brackets.

Installation

1. Connect the right and left stabilizer links to their respective I-Beam brackets by sliding the bolt with washer through the link, the I-Beam bracket hole and toward the inside of the side rail. Tighten the washer and locknut to 55-81 N·m (40-60 ft-lbs). **The link must be installed with the bend facing forward on E-150—E-250—E-350 as shown in Fig. 24.**
2. Connect the stabilizer bar to the frame side rails by placing the two retainers on the bottom of the side rails and tightening the four through bolts to 21-33 N·m (15-25 ft-lbs) torque (Fig. 24).
3. Connect the stabilizer bar left and right ends to the left and right link assemblies respectively making sure that the washers and insulators are properly positioned as in Fig. 24. Tighten the retaining nuts to 25-37 N·m (18-28 ft-lbs).

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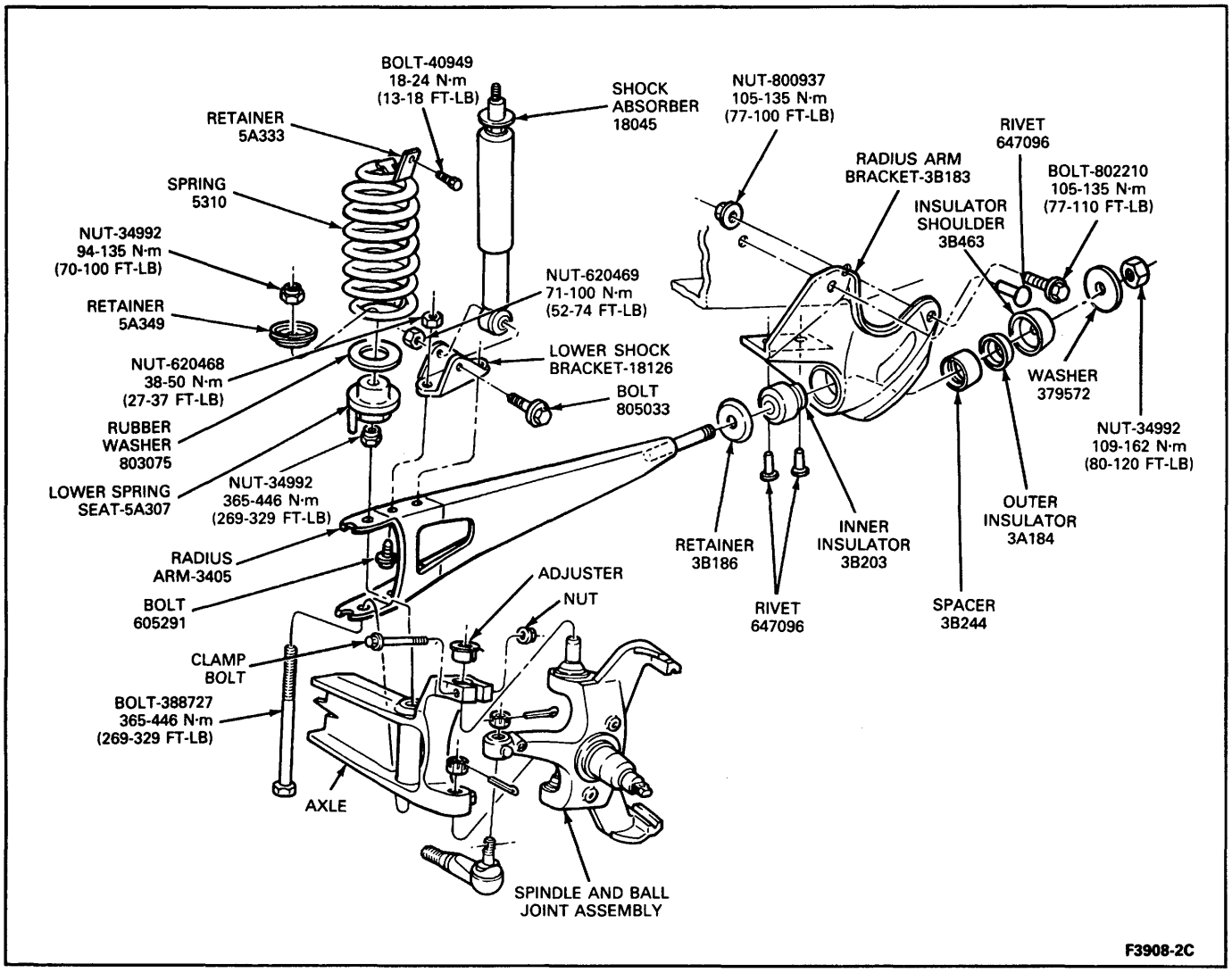


FIG. 19 Radius Arm Installation—F-150—F-250—F-350 (4x2)—F-250—F-350 Shown

Front Stabilizer Bar

F-150—F-250—F-350 (4x2)

Refer to Fig. 25

Removal

1. Disconnect the left and right ends of the front stabilizer bar from the link assembly attached to the I-Beam bracket (Fig. 25).
2. Disconnect the retainer bolts and remove the stabilizer bar.
3. Disconnect the stabilizer link assemblies by loosening the right and left locknuts from their respective I-Beam brackets.

Installation

1. Loosely assemble the entire stabilizer bar system with both link assemblies outboard of the stabilizer bar. To help identify the right and left link assemblies an "R" or "L" is stamped on the shaft of the link. Force the stabilizer bar rearward to connect the bar ends to the link assemblies.
2. Tighten the nuts and bolts retaining the link assemblies to the stabilizer bar and axle brackets to 71-100 N·m (53-74 ft-lbs).
3. Check to be sure the insulators are seated in the retainers and that the stabilizer bar is centered in the assembly.

   On F-250—F-350, tighten the stabilizer bar-to-frame retainer nuts and bolts to 37-50 N·m (27-37 ft-lbs). Tighten the frame mounting bracket nuts and bolts to 65-88 N·m (48-65 ft-lbs). On F-150, tighten six (6) bolts attaching the stabilizer bar to the No. 1A frame front crossmember to 37-50 N·m (27-37 ft-lbs).

Front Stabilizer Bar

F-Super Duty

Refer to Fig. 26

Removal

1. Disconnect the left and right ends of the front stabilizer bar from the link assembly attached to the frame side rail mounting brackets.
2. Disconnect the retainer bolt and remove the stabilizer bar from the front axle.
3. Disconnect the stabilizer link assemblies by removing them from the frame side rail mounting brackets.

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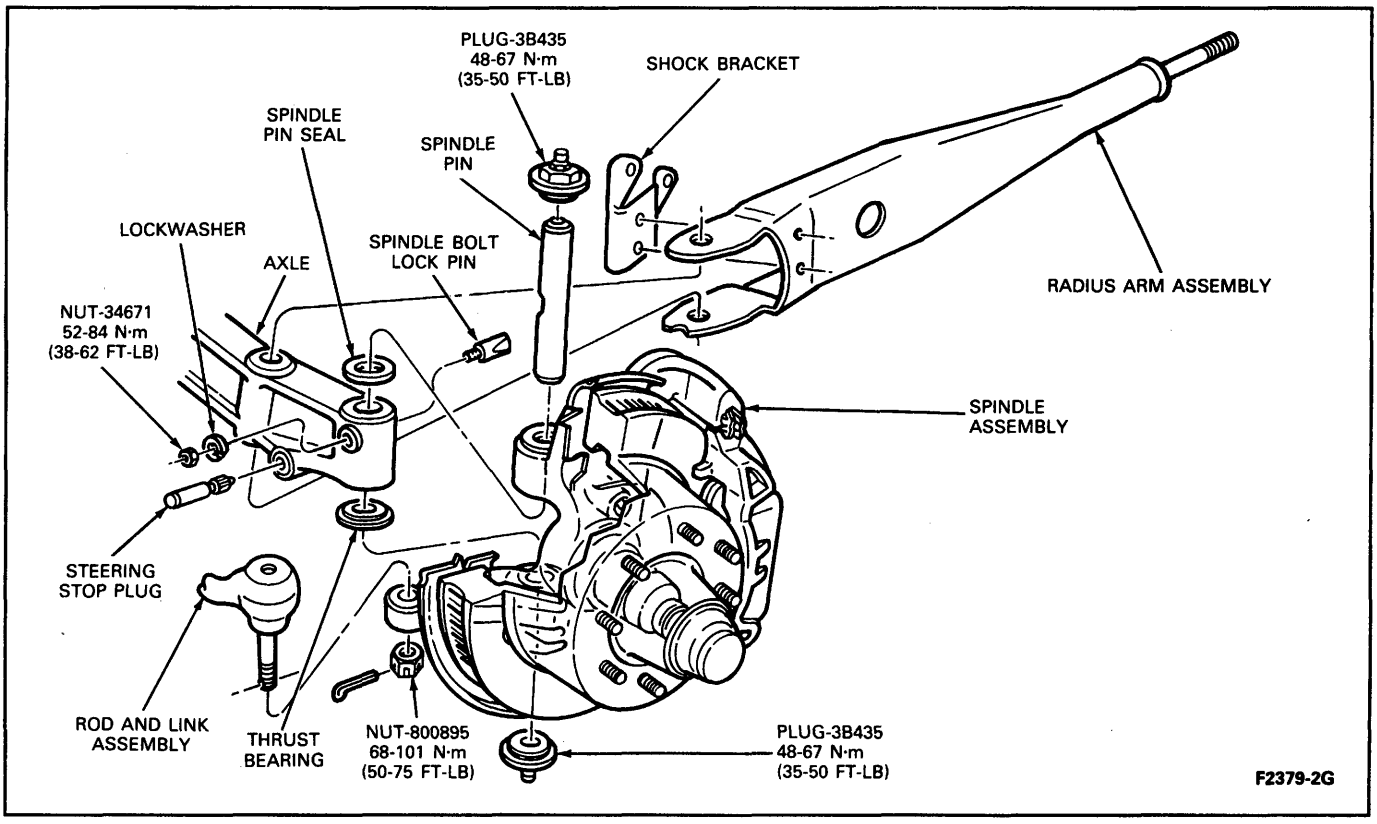


FIG. 20 Radius Arm Assembly—E-250 and E-350

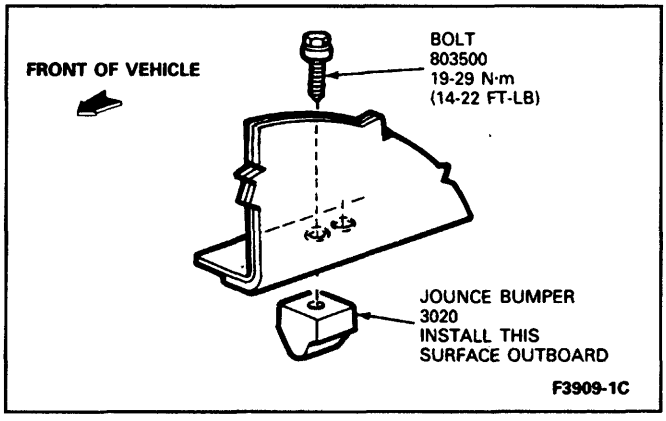


FIG. 21 Jounce Bumper Installation

Installation

1. Loosely assemble the entire stabilizer bar system with both link assemblies loosely attached to the frame mounting brackets, and the stabilizer bar in position on the axle.
2. Check to be sure the stabilizer bar insulators are seated in the retainers and that the stabilizer bar is centered on the axle. Attach the stabilizer bar to the axle by assembling the retainers to the axle mounting brackets. Tighten the retainer screws to 48-68 N·m (35-50 ft-lb).
3. Install the link assemblies to the frame mounting brackets using the bolts, washers and locknuts. Tighten the locknut to 70-100 N·m (52-74 ft-lb).
4. Install the link assembly to the stabilizer bar with 2 cup washers, 2 rubber insulators and 1 locknut. Tighten the locknut to 21-32 N·m (15-25 ft-lb).

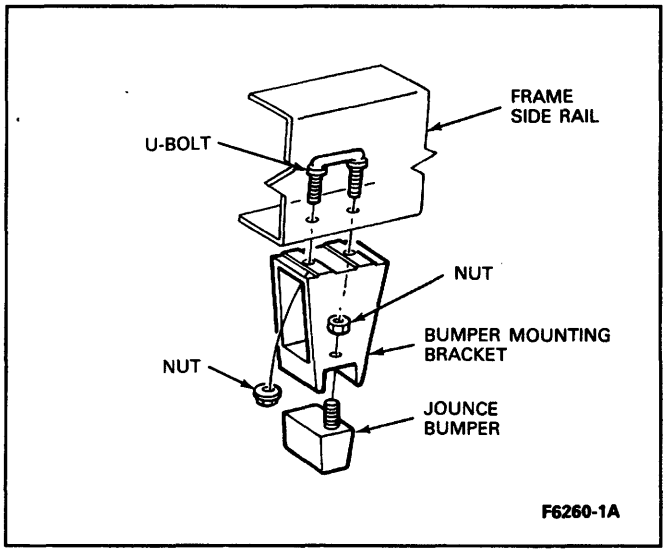


FIG. 22 Front Axle Jounce Bumper—F-Super Duty

Track Bar

F-Super Duty

Removal

1. Remove the bolt and nut attaching the track bar assembly to the mounting bracket attached to the number 1 crossmember (Fig. 27).
2. Remove the bolt and nut attaching the track bar to the mounting bracket at the axle.
3. Remove the track bar.

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Installation

1. Attach the track bar to the number 1 crossmember mounting bracket with a bolt and locknut. Tighten the nut to 163-203 N·m (120-150 ft-lb).
2. Attach the track bar to the axle mounting bracket with the bolt and nut. Tighten the nut to 163-203 N·m (120-150 ft-lb).

Front Twin-I-Beam Axle

Refer to Figs. 23 and 28.

Removal

1. Remove the front wheel spindle, the front spring, and the stabilizer bar (if so equipped) as outlined in the foregoing procedures.
2. Remove the spring lower seat from the radius arm, and then remove the bolt and nut that attaches the stabilizer bar bracket (if so equipped) and radius arm to the (I-Beam) front axle.
3. Remove the axle-to-frame pivot bracket bolt and nut.

Installation

1. To install, position the axle to the frame pivot bracket and install the bolt and nut finger-tight.
2. Position the opposite end of the axle to the radius arm and stabilizer bar bracket; install the attaching bolt from underneath through the bracket, the radius arm, and the axle.
3. Install the spring lower seat on the radius arm so that the hole in the seat indexes over the arm-to-axle bolt.
4. Install the front spring as outlined in this Section.
5. Install the front wheel spindle and, if so equipped, the stabilizer bar as outlined in this Section.
6. Lower the vehicle and with the weight on the suspension, tighten the axle-to-frame pivot bolt to 163-203 N·m (120-150 ft-lbs).

Front Axle

F-Super Duty

Refer to Fig. 5

Removal

1. Using a hoist, raise the vehicle by the frame until the weight is off the front spring with the wheel still touching the floor.
2. Remove the nuts that hold the stabilizer links to the stabilizer bar. Remove the lower washer and insulator and disconnect the link from the bar.

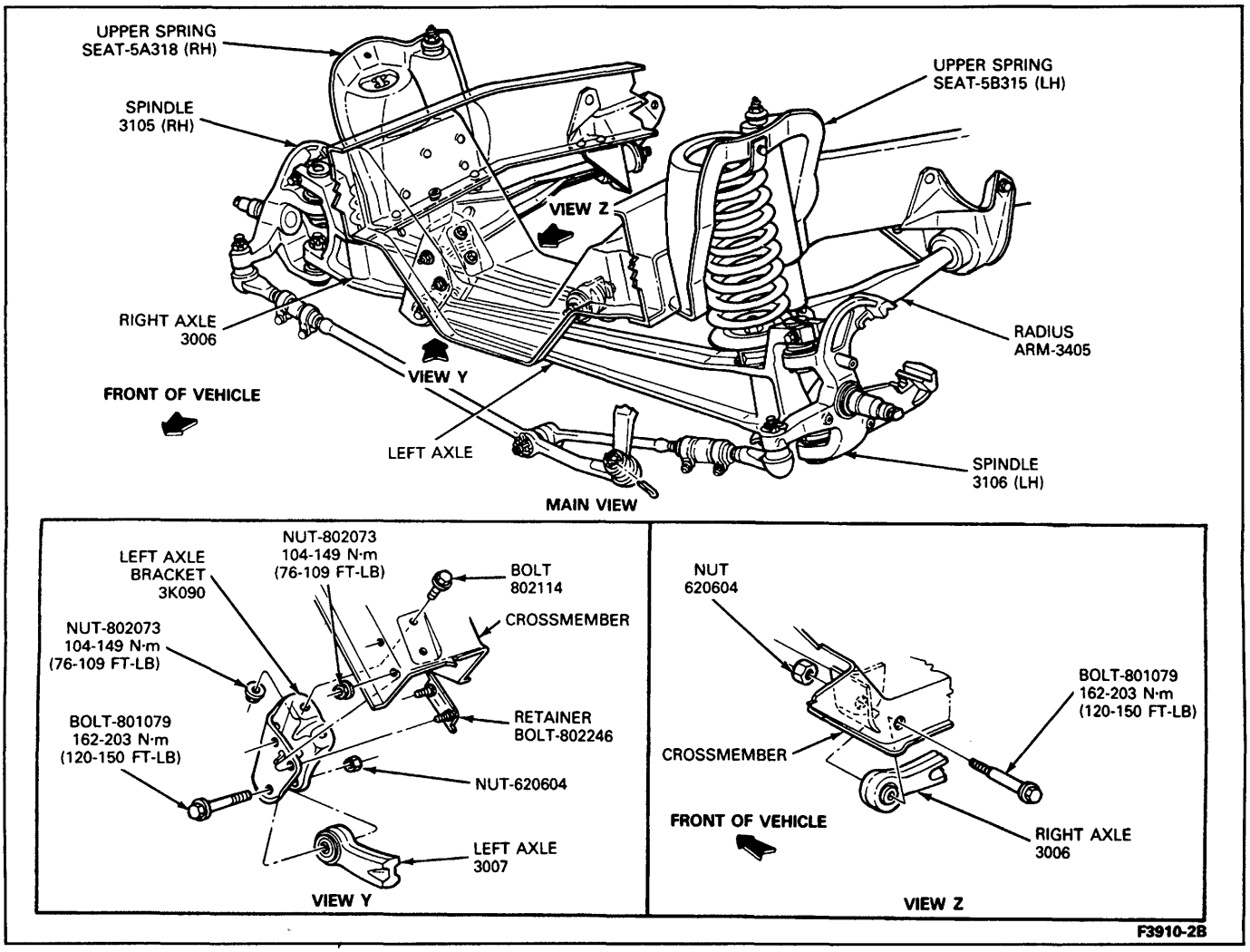


FIG. 23 Axle Pivot Bracket and Axle Arm Installation—F-150—F-250—F-350—F-150 Shown

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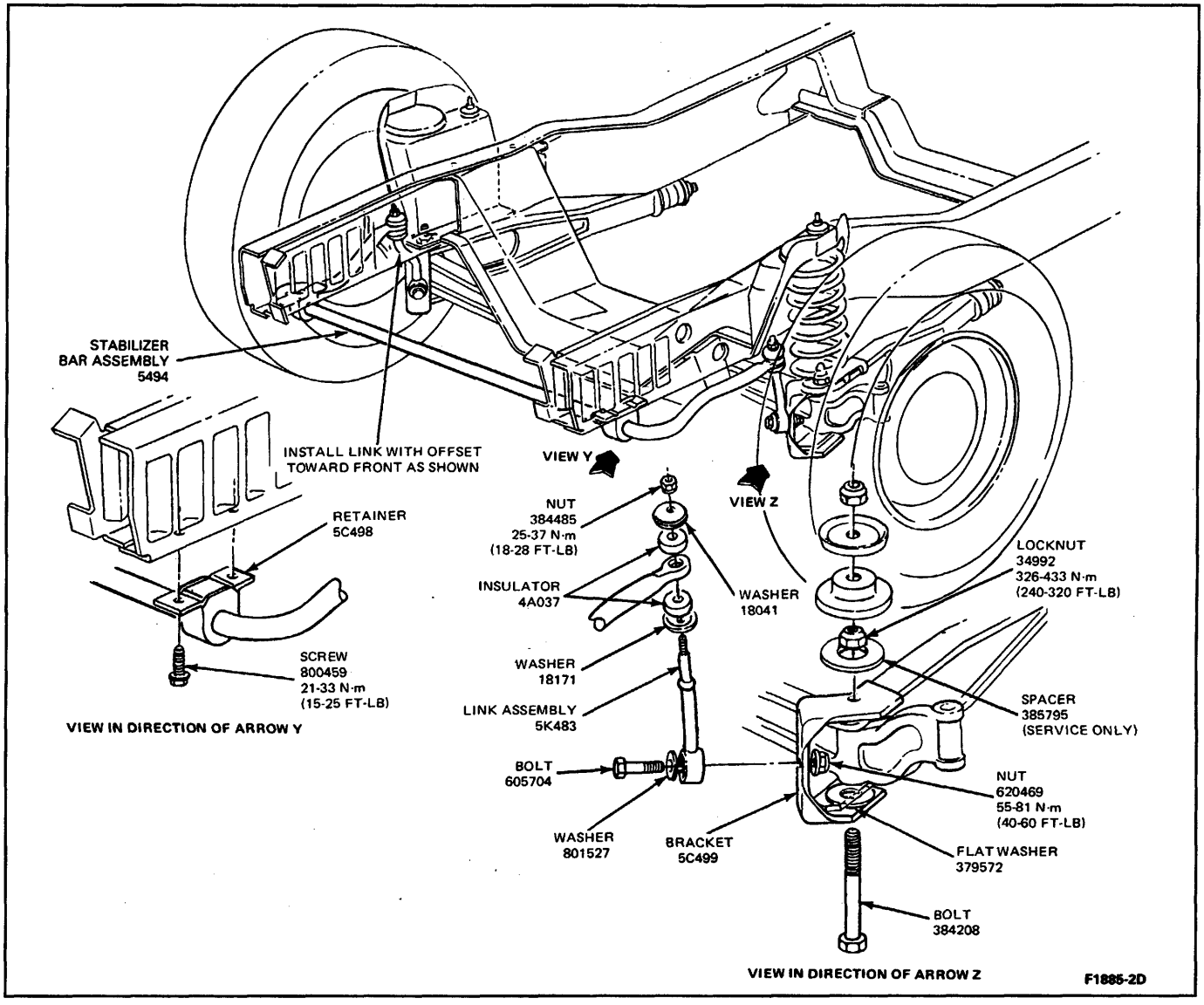


FIG. 24 Front Stabilizer Bar Installation—E-150—E-250—E-350

3. Disconnect the steering linkage assembly from the steering arms on the spindle using Tool-3290-D. Wire the steering linkage to the frame.
4. Remove the nut and bolt that holds the tracking bar to the axle. Disconnect the tracking bar from the axle mounting bracket.
5. Remove the nuts from the U-bolts that hold the springs to the axle. Remove the U-bolts and jack bracket.
6. Raise the vehicle slightly higher on the hoist and roll the axle from under the vehicle.

Installation

1. Position the axle so the spring seats on the I-beam line up with the locating boss on the spring.
2. Install the U-bolts and the jack brackets. Tighten the U-bolt nuts to 115-163 N·m (85-120 ft-lbs.).
3. Position the tracking bar in the axle assembly mounting bracket. Install the nut and bolt and tighten to 163-203 N·m (120-150 ft-lbs.).
4. Connect the steering linkage assembly to the steering arms on the spindle. Install the castellated nuts and tighten to 70-100 N·m (52-74 ft-lbs.). Install the cotter pins.
5. Position the end of the stabilizer link onto the stabilizer bar. Install the lower insulator, lower washer and nut and tighten to 21-32 N·m (15-25 ft-lbs.).
6. Lower the vehicle.

Spindle Bushing—Bronze

Refer to Fig. 29

Removal and Installation

1. Remove the spindle as described in this Section. Install the spindle in a vise.
2. On E-150 vehicles (bronze spindle bushings have an inside diameter of 0.8600/0.8610 inch) use the following tools: Reamer, T53T-3110-DA Bushing Remover/Installer Driver, D82T-3110-G and Driver Handle, D82T-3110-C. (Fig. 30)

   On E-250—E-350 vehicles (bronze spindle bushings have an inside diameter of 1.0552/1.0562 inch) use the following tools: Reamer,

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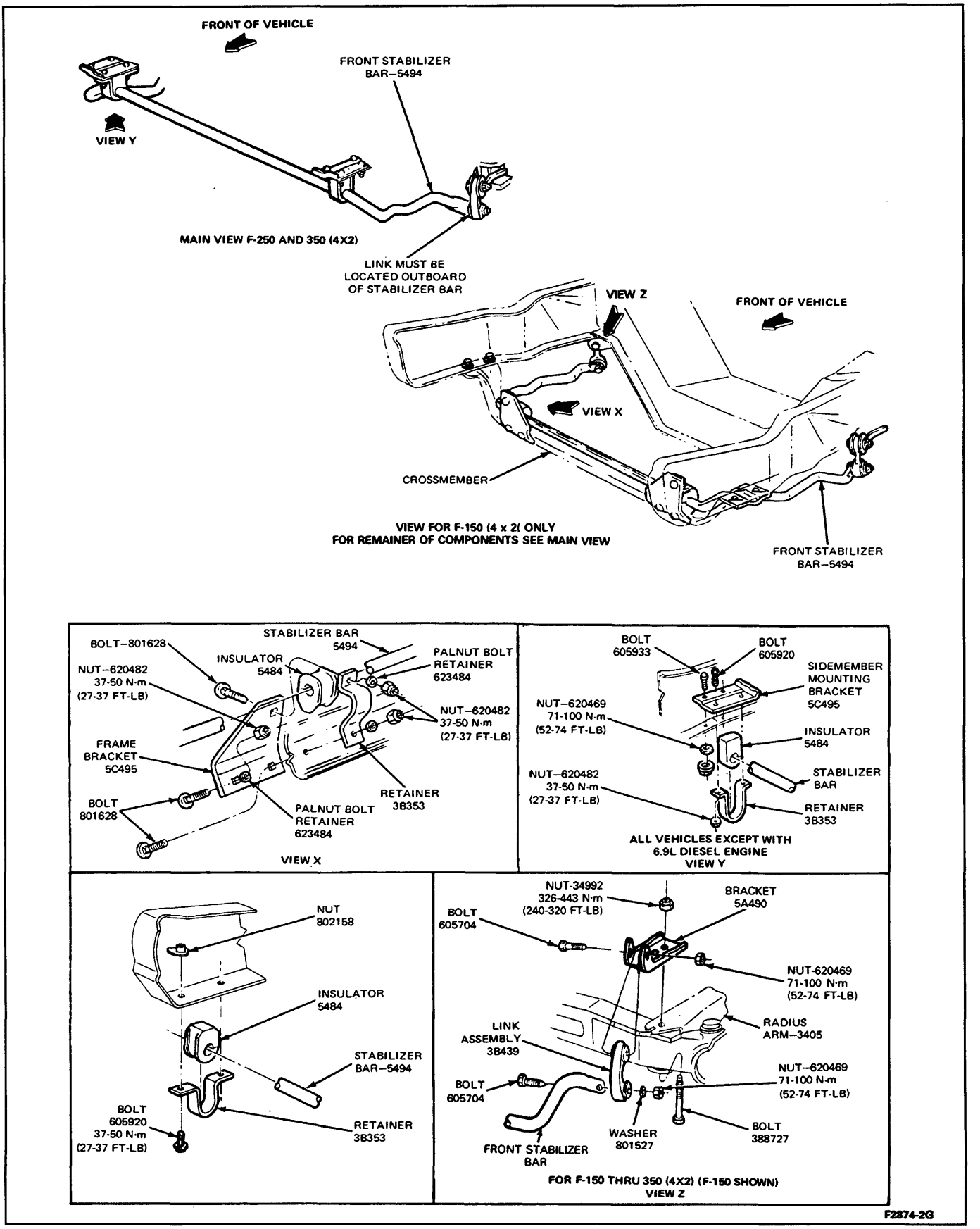


FIG. 25 Front Stabilizer Bar Installation—F-150—F-250—F-350 (4x2)

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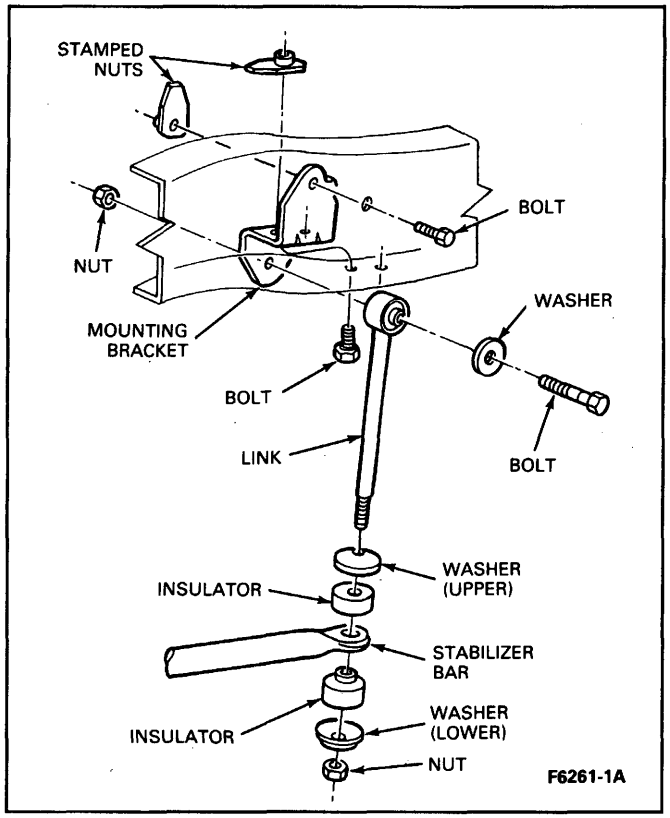


FIG. 26 Front Stabilizer Bar Installation—F-Super Duty

D82T-3110-A, Bushing Remover/Installer Driver, D82T-3110-B and Driver Handle, D82T-3110-C (Fig. 30).

On the F-Super Duty, the bronze spindle bushings have an inside diameter of 1.301/1.302 inch and use the following tools: Reamer, D88T-3110-B, Bushing Remover/Installer Driver, D88T-3110-A and Driver Handle, D82T-3110-C.

Each side of the Bushing Remover/Installer Driver tool is marked with a 'T' or a 'B'. Use the side with the 'T' stamping to install the top spindle bushing. Use the side with the 'B' stamping to install the bottom spindle bushing.

3. Remove and discard the seal from the bottom of the upper bushing bore of the upper spindle joke.
4. Remove and install the top spindle bushing first. Install the driver handle through the bottom bore. Position a new bushing on the 'T' side stamping of the bushing Remover/Installer Driver. The bushing must be installed on the tool so the open end grooves will face outward when installed. Position the new bushing and driver over the old bushing, insert the handle into the driver and drive the old bushing out while the new bushing is driven in (Fig. 31). Drive until the tool is seated. The bushing will then be seated at the proper depth (0.080 inch minimum from bottom of upper spindle boss).

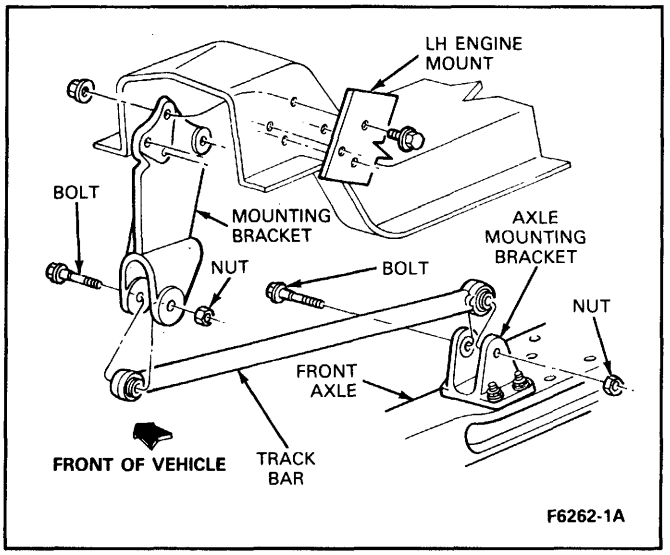


FIG. 27 Track Bar Installation—F-Super Duty

5. Remove and install the bottom spindle bushing. Install the Driver Handle through the top bushing bore. Position a new bushing on the 'B' side stamping of the Bushing Remover/Installer Driver. The bushing must be installed on the tool so the open-end grooves will face outward when installed. Position the new bushing and driver over the old bushing in the bottom spindle bore. Insert the handle into the driver and drive the old bushing out while the new bushing is driven in (Fig. 32). Drive until the tool is seated. The bottom bushing will then be seated at the proper depth (0.130 inch minimum from the top of the lower spindle boss).
6. Ream the new bushings to 0.025-0.076mm (0.001-0.003 inch) larger than the diameter of a new spindle pin. Ream the top bushing first with the reamer tool. Install the smaller diameter of the tool through the top bore and into the bottom bore until the reaming threads are in position in the top bushing. Turn the tool until the threads exit the top bushing. Ream the bottom bushing (Fig. 33). The larger diameter portion of the tool will act as a pilot in the top bushing to properly ream the bottom bushing.
7. Clean all the metal shavings from the bronze bushings after reaming. Coat the bushings and spindle pin with Multi-Purpose Long Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.
8. Install a new seal on Bushing Remover/Installer Driver tool on the side with the 'T' stamping. Install the handle into the driver and push the seal into position in the bottom of the top bushing bore.

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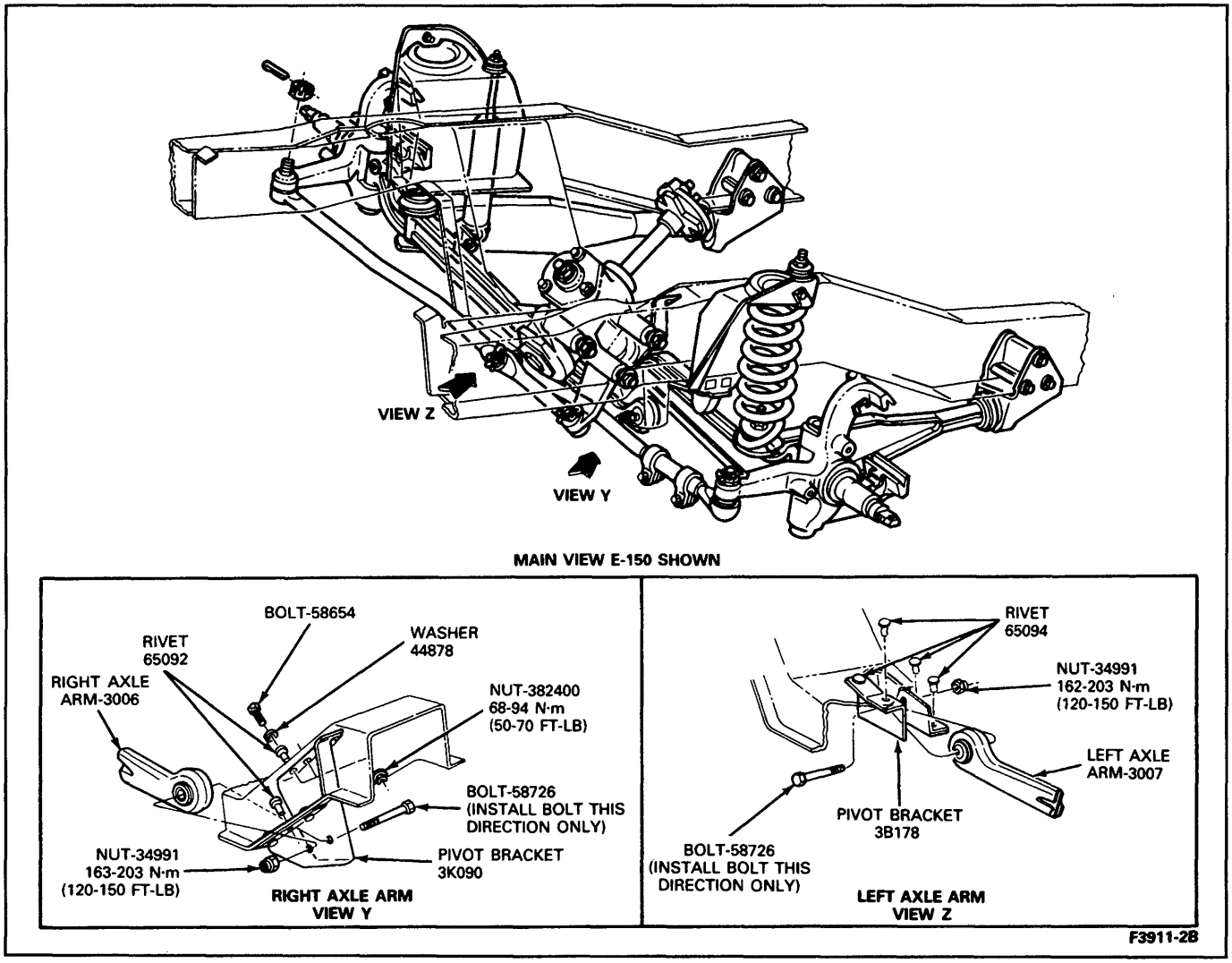


FIG. 28 Axle Arm Installation—E-150—E-250—E-350

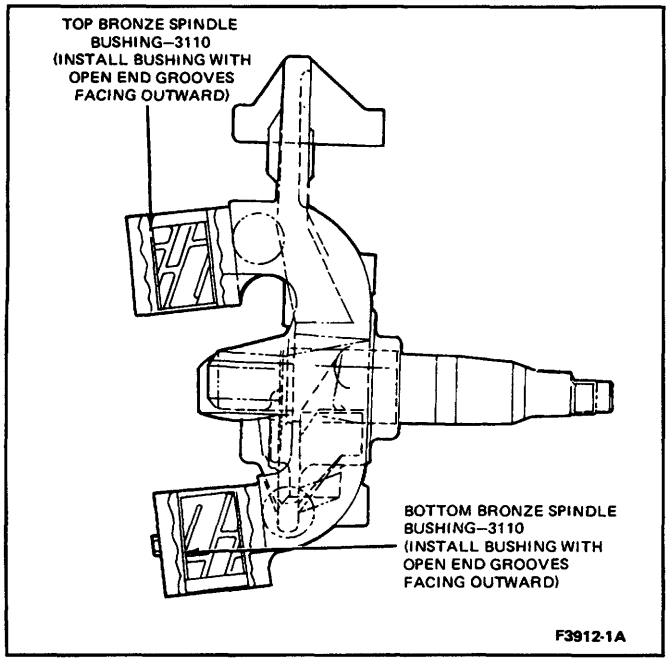


FIG. 29 Spindle Bushing Installation—Cutaway View

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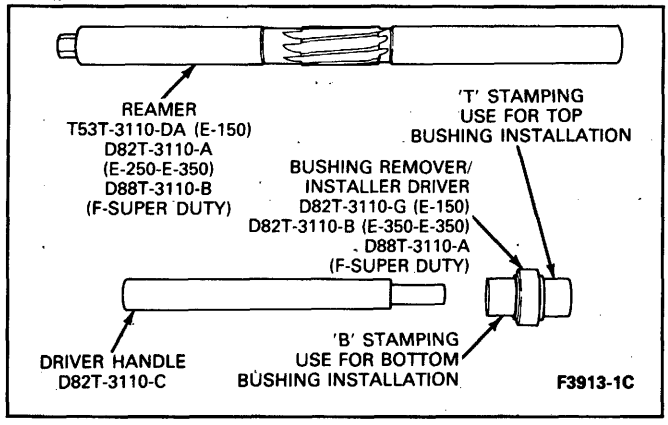


FIG. 30 Spindle Bushing Removal/Installation Tools

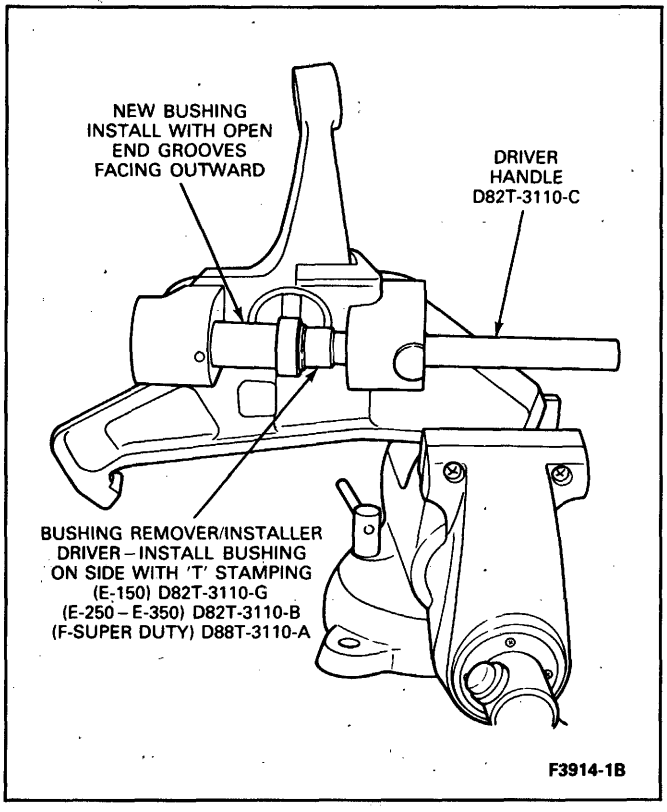


FIG. 31 Top Spindle Bushing Removal and Installation

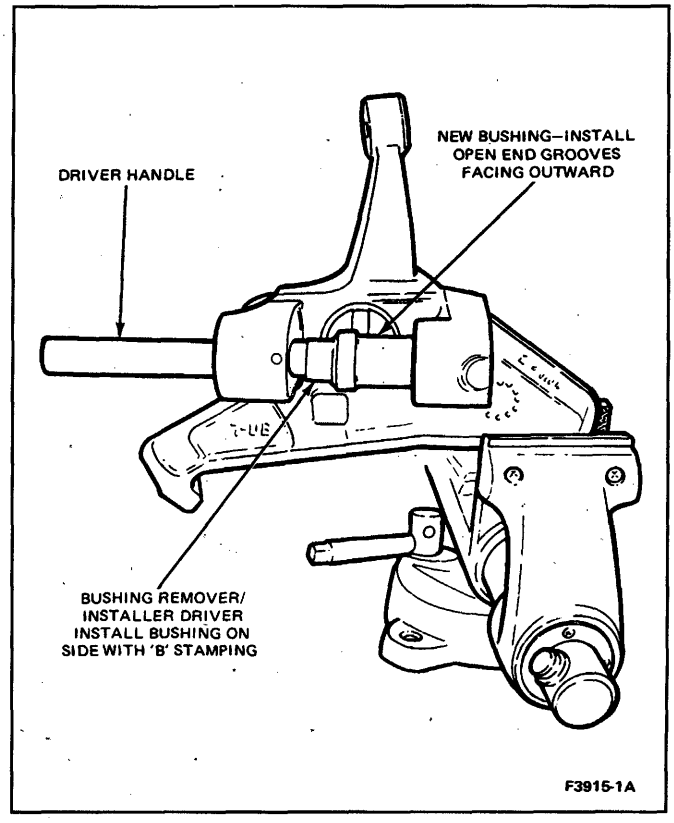


FIG. 32 Bottom Spindle Bushing Removal and Installation

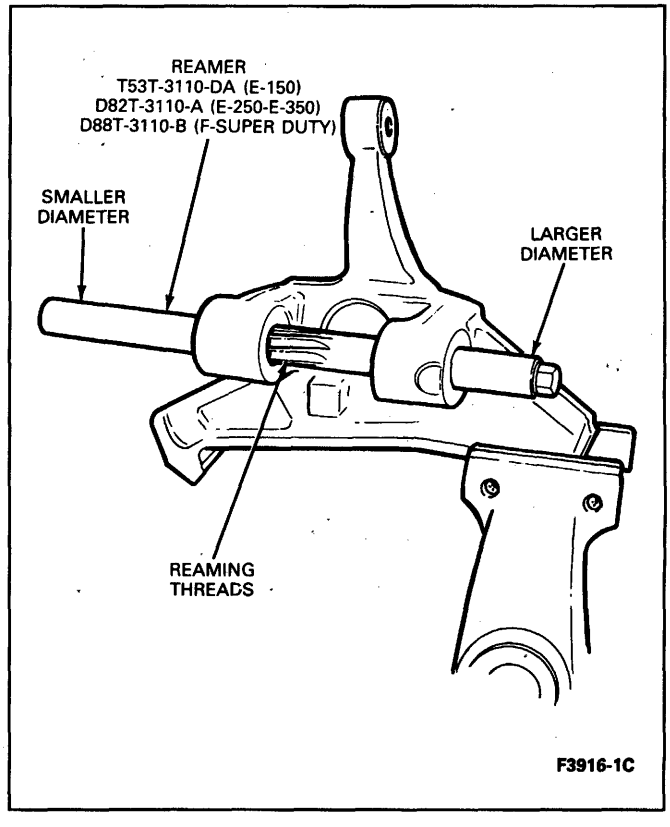


FIG. 33 Reaming Bushings

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SPECIFICATIONS

Description	F-150 (4x2)		F-250 — F-350 (4x2)		E-150 — E-250 — E-350	
	N-m	Ft-Lbs	N-m	Ft-Lbs	N-m	Ft-Lbs
Axle to Pivot Bracket Nut and Bolt	162-203	120-150	162-203	120-150	162-203	120-150
Axle to Radius Arm Nut and Bolt	365-446	269-329	365-446	269-329	326-433	240-320
Axle Pivot Bracket (Left) to Upper Frame Nut	76-109	104-149	76-109	104-149	—	—
Axle Pivot Bracket (Left) Side Retainer to Frame Nut	76-109	104-149	76-109	104-149	—	—
Axle Pivot Bracket (Right) to Frame Nut	—	—	—	—	68-94	50-70
Ball Joint (Upper) to Spindle Nut	149-190	110-140	—	—	—	—
Coil Spring to Lower Retainer Nut	95-135	70-100	75-135	70-100	95-135	70-100
Coil Spring Upper Retainer to Spring Seat Nut and Bolt	18-24	13-18	18-24	13-18	28-40	20-30
Jounce Bumper to Frame Bolt	19-29	14-22	19-29	14-22	—	—
Lock Pin to Spindle Nut	—	—	52-84	38-62	52-84	38-62
Radius Arm to Rear Bracket Nut	109-162	80-120	109-162	80-120	109-162	80-120
Radius Arm Rear Bracket to Frame Bolt	105-135	77-100	105-135	77-100	102-142	75-105
Shock Absorber to Lower Bracket Nut and Bolt	71-100	52-74	71-100	52-74	55-81	40-60
Shock Absorber to Upper Spring Seat Nut	34-47	25-35	34-47	25-35	25-37	18-28
Shock Absorber Bracket to Radius Arm Nut and Bolt	37-50	27-37	37-50	27-37	95-128	70-95
Spindle Pin Plug to Spindle Nut	—	—	48-67	35-50	48-67	35-50
Stabilizer Bar Link to Bracket	71-100	52-74	71-100	52-74	55-81	40-60
Stabilizer Bar Link to Stabilizer Bar	71-100	52-74	71-100	52-74	25-37	18-28
Stabilizer Bar Retainer to Frame Crossmember Mounting Bracket	37-50	27-37	37-50	27-37	21-33	15-25
Steering Linkage to Spindle Nut	94-135	70-100	94-135	70-100	94-135	70-100

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F-SUPER DUTY FRONT SUSPENSION TORQUE SPECIFICATIONS

Description	N-m	Ft-Lbs
Drag Link to Pitman Arm Nut	70-100	52-74
Steering Linkage to Spindle Nut	70-100	52-74
Spring Shackle to Frame Nut	203-285	150-210
Spring to Spring Shackle Nut	163-203	120-150
Axle to Spring U-Bolt Nut	115-163	85-120
Tracking Bar Retaining Nuts and Bolts	163-203	120-150
Tracking Bar Mounting Bracket Nuts and Bolts	104-149	77-110
Jounce Bumper Bracket U-Bolt Nuts	70-100	52-74
Jounce Bumper Bracket Mounting Nuts	25-40	18-30
Stabilizer Link Mounting Bracket Nut	48-68	35-50
Stabilizer Link to Stabilizer Bar Nut	21-32	15-25
Upper Shock Bracket Nuts	70-100	52-74
Upper and Lower Shock to Bracket Nuts	70-100	52-74
Linkage Adjusting Clamp Nut	81-122	60-90

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SPECIAL SERVICE TOOLS

Number	Description	Application
D81T-3010-A	Ball Joint Service Set (Adapter Tools)	F-150-250-350 (4x2)
D81T-3010-B	Remover Tool	F-150-250-350 (4x2) Twin I-Beam Axles
T53T-3110-A	Tie Rod Adjusting Tool	King Pin Bushing Removal and Installation Tool
D82T-3110-A	Reamer	Spindle Bushing Service — E-250 — E-350
D82T-3110-B	Bushing Remover/Installer Driver	Spindle Bushing Service — E-250 — E-350
D82T-3110-C	Driver Handle	Spindle Bushing Service
T53T-3110-DA	Reamer	Spindle Bushing Service — E-150
D82T-3110-G	Bushing Remover/Installer Driver	Spindle Bushing Service — E-150
D79P-3283-A	Tie Rod Adjusting Tool	Universal
TOOL-3290-C	Tie Rod End Remover	Universal
D80T-4020-F49	Gauge Tube (2.892 O.D.)	Replaces T79P-4020-A16
T74P-4635-C	C-Frame Assembly	Ball Joint Removal and Installation
T78P-5638-A	Suspension Bushing Service Set	Axle Pivot Bushing
T80T-5638-A2	Front Suspension Bushing Tool	Use with T78P-5638-A
T85T-5638-A	I-Beam Bushing Remover/Replacer	I-Beam Bushing Service
D88T-3110-B	Reamer	F-Super Duty
D88T-3110-A	Bushing Remover/Installer Driver	F-Super Duty

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SECTION 14-22 Front Suspension—4-Wheel Drive

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VEHICLE APPLICATION

Applies to F-150 Through F-350 (4x4) and Bronco.

DESCRIPTION

Front Suspension

Bronco, F-150 (4X4)

The Bronco and F-150 (4x4) Independent Front Suspension (IFS) system (Fig. 1) is composed of a two-piece front driving axle assembly, two coil springs and two radius arms.

The front driving axle consists of two independent axle arm assemblies. One end of each axle arm assembly is anchored to the frame. The other end of each axle arm assembly is supported by the coil spring and radius arm.

F-250 (4X4) with Dana 44 or 50 Front Drive Axle

The F-250 (4x4) Independent Front Suspension (IFS) system (Fig. 2) has a Dana 44 or 50 two-piece driving axle attached to the frame with two semi-elliptic, leaf-type springs. Each spring is clamped to the axle arm assembly with two U-bolts. The rear eye of the spring is attached to the hanger bracket. The front of the spring is attached to a shackle bracket.

The shock absorbers are the direct, double-acting type. They are attached to a frame bracket at the top and to the U-bolt spacer plate at the bottom.

F-350 (4x4) with Dana 60 Monobeam Front Drive Axle

The F-350 (4x4) has a Dana 60 Monobeam one-piece driving axle attached to the frame with two semi-elliptical, leaf-type springs (Fig. 3). Each spring is clamped to the axle assembly with two U-bolts. The rear eye of the spring is attached to the hanger bracket. The front of the spring is attached to a shackle bracket. On the right spring cap, a tracking bar is attached with the opposite end mounted on the crossmember.

The shock absorbers are the direct double-acting type. They are attached to a frame bracket at the top and to the U-bolt spacer plate at the bottom.

Front Shock Absorber

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi). Do not attempt to open, puncture or apply heat to the shock absorbers.

The hydraulic shock absorbers are of the direct, double-acting type. They provide a continuous dampening effect both on compression and rebound. These shock absorbers are of telescopic design with rubber grommets at the mounting points for quiet operation. The shock absorbers are sealed, non-adjustable units and must be replaced as complete assemblies.

REMOVAL AND INSTALLATION

Front Spring

F-150 (4x4), Bronco

Removal

1. Raise the vehicle and remove the shock absorber-to-lower bracket attaching bolt and nut (Figs. 1 and 4). Refer to Section 50-04 Hoisting and Jacking, Light-Medium-Heavy, Pre-Delivery manual, for Hoisting instructions.
2. Remove spring lower retainer attaching nuts from inside of the spring coil.
3. Remove spring upper retainer attaching screw and remove the upper retainer.
4. Position safety stands under the frame side rails and lower the axle enough to relieve tension from the spring.

   NOTE: The axle must be supported on the jack throughout spring removal and installation, and must not be permitted to hang by the brake hose. If

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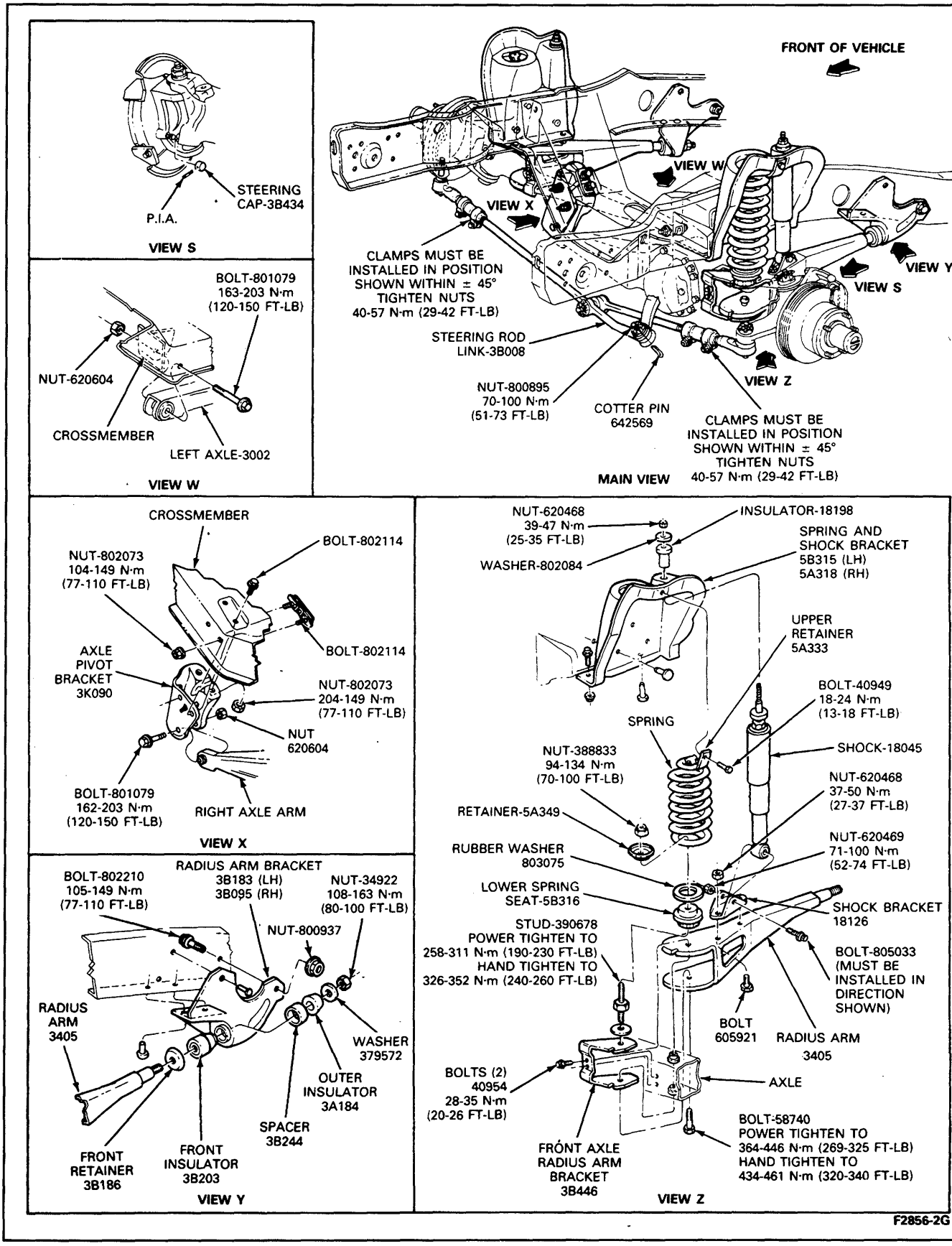


FIG. 1 Front Suspension Bronco, F-150 (4x4)

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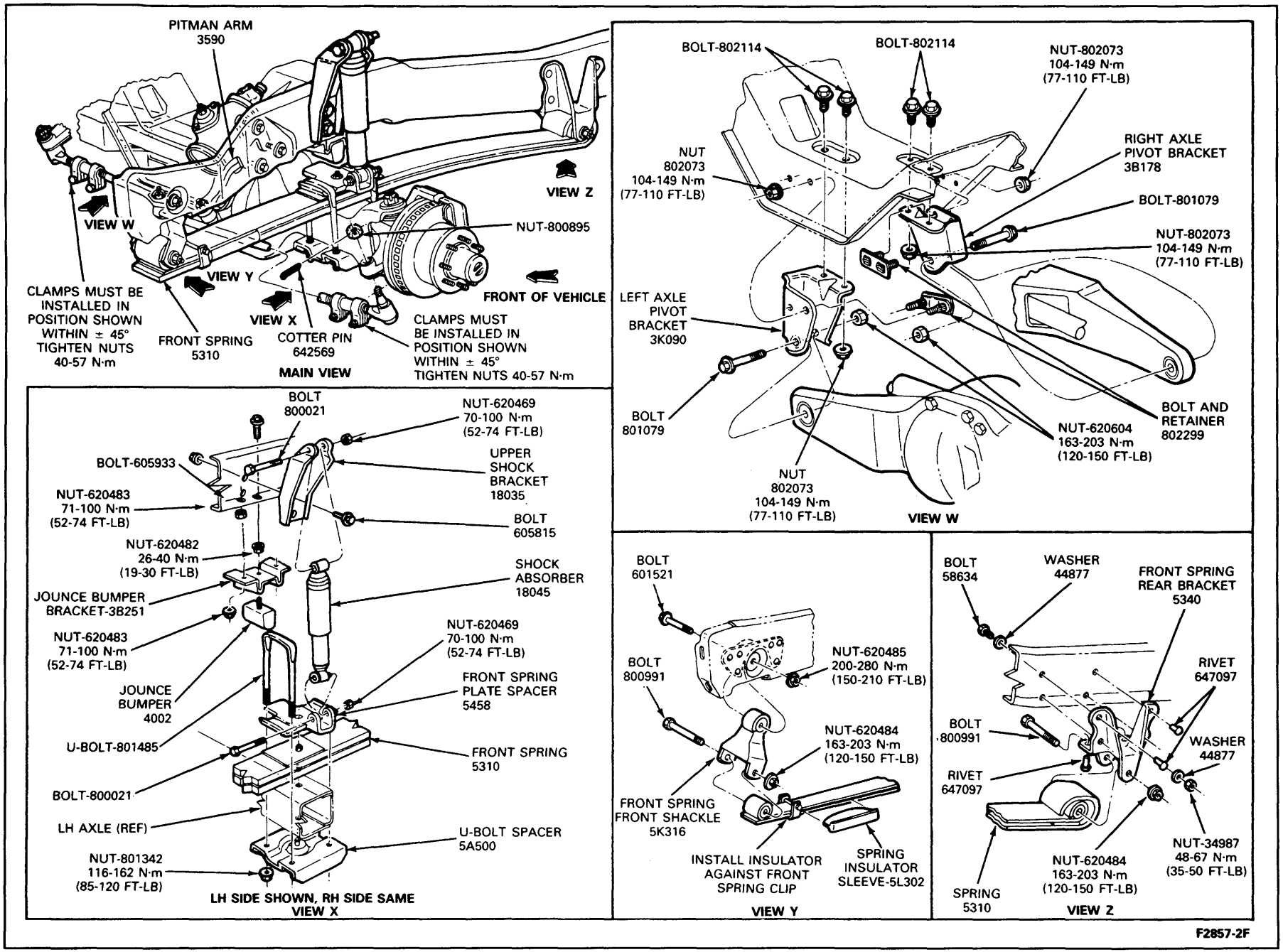


FIG. 2 Front Suspension—F-250 (4x4) with Dana 44-IFS-HD and 50 IFS—Front Drive Axle

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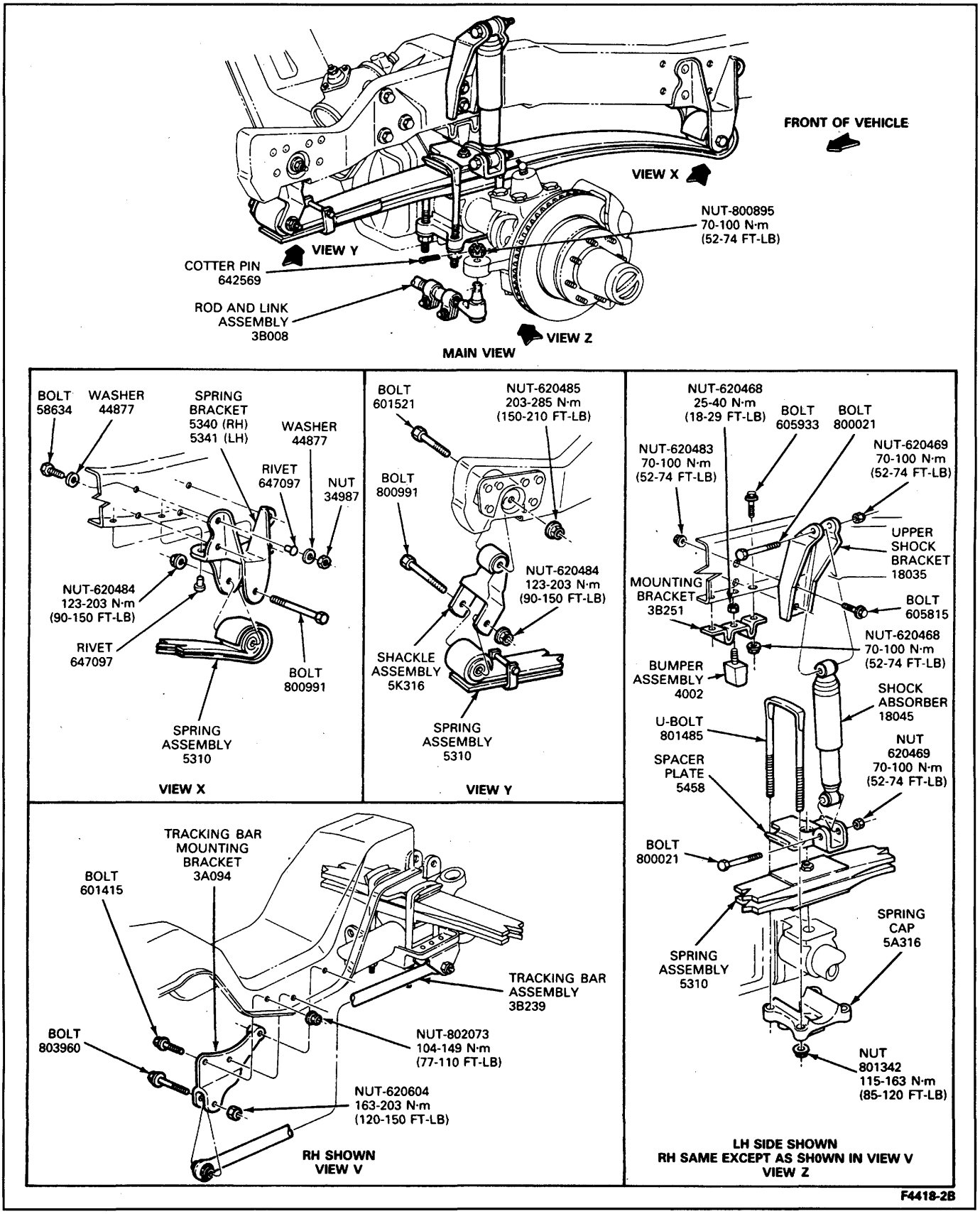


FIG. 3 Front Suspension—F-350 (4x4) with Dana Model 60 Monobeam Front Drive Axle

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the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the spring, the disc brake caliper must be removed from the spindle according to the procedures specified in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper. After removal, the caliper must be placed on the frame or otherwise supported to prevent suspending the caliper from the caliper hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose assembly.

5. Remove the spring, lower retainer, and lower the spring from the vehicle.

Installation

1. Place the spring in position and slowly raise the front axle. Insure springs are positioned correctly in the upper spring seats.
2. Position the spring lower retainer over the stud and lower seat and install the attaching nut 94-134 N·m (70-100 ft-lbs).
3. Position the upper retainer over the spring coil and install the attaching screws 18-24 N·m (13-18 ft-lbs).
4. Position the shock absorber to the lower bracket and install the attaching bolt and nut with the bolt head towards the tire. Tighten the bolt and nut to 66-88 N·m (48-65 ft-lbs) as listed at the end of this Section. Remove safety stands and lower the vehicle.

Front Spring

F-250, F-350 (4x4)

Removal

1. Raise the vehicle frame until the weight is off the front spring with the wheels still touching the floor. Support the axle to prevent rotation.
2. Disconnect the lower end of the shock absorber from the U-bolt spacer. Remove the U-bolts, U-bolt cap and spacer. For those vehicles equipped with a Dana Model 60 Monobeam front drive axle, remove the two bolts which retain the tracking bar to the right spring cap and tracking bar mounting bracket (Figs. 2 and 3).
3. Remove the nut from the hanger bolt retaining the spring at the rear. Drive out the hanger bolt.
4. Remove the nut connecting the front shackle and spring eye. Drive out the shackle bolt and remove the spring.

Installation

1. Position the new spring on the spring seat. Install the shackle bolt, (Fig. 2), through the shackle and spring 163-203 N·m (120-150 ft-lbs).
2. Position the rear of the spring to allow the rear hanger bolt to be installed. Install the nut and tighten to 163-203 N·m (120-150 ft-lbs).
3. Position the U-bolt spacer and place the U-bolts in position through holes in the spring seat cap. Install but do not tighten the U-bolt nuts. For those vehicles equipped with a Dana Model 60 Monobeam front drive axle, with the vehicle in the "CURB" position, connect the tracking bar to the tracking bar mounting bracket and right spring cap.
4. Connect the lower end of the shock absorber to the U-bolt spacer.
5. Lower the vehicle and tighten the U-bolt nuts to 115-163 N·m (85-120 ft-lbs).

Front Wheel Spindle

Refer to Section 15-34, Dana Model 44 and 50 Front Driving Axle and Section 15-32, Dana Model 60 Monobeam Front Drive Axle under Steering Knuckle, Removal and Installation for spindle replacement on 4-wheel drive front axles.

Front Shock Absorber

F-250/F-350 (4x4)

Refer to Figs. 2 and 3.

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi) for 1 inch and 1 3/16 inch bore, and 1034 kPa (150psi) for 1 3/8 inch bore. Do not attempt to open, puncture or apply heat to the shock absorbers.

Removal

1. Remove the nut and bolt that retains the shock absorber to the upper shock bracket.
2. Disconnect the lower end of the shock absorber from the U-bolt plate (bolt and nut).
3. Compress the shock absorber and remove.

Installation

1. Insert shock absorber into the upper shock bracket. Insert bolt and tighten nut to 70-100 N·m (52-74 ft-lbs).
2. Attach the lower end of the shock absorber to the U-bolt plate by installing the nut and bolt. Tighten to 70-100 N·m (52-74 ft-lbs).

F-150 (4x4) and Bronco Equipped with Quad Front Shock Absorbers

Refer to Fig. 4.

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kPa (135 psi) for 1 inch and 1 3/16 inch bore and 1034 kPa (150 psi) for 1 3/8 inch bore. Do not attempt to open, puncture or apply heat to the shock absorbers.

Removal

1. For forward and rearward of front axle shock absorber installation, insert a wrench to hold the upper shock absorber retaining nut. Loosen the stud by turning the hex provided on the exposed (lower) part of the stud and remove nut and washer.
2. Disconnect the lower end of the shock absorber from the bracket, bolt and nut for rearward of front axle installation, and nut and washer for forward of front axle installation.
3. Compress the shock absorbers and remove.
4. Cut out insulators from upper spring seat.

Installation

1. Insert new one-piece insulators into the top surface of the upper spring seat (use soap solution to aid in installation).
2. Insert shock absorber stud through insulator. Replace steel washer and hand start nut. While

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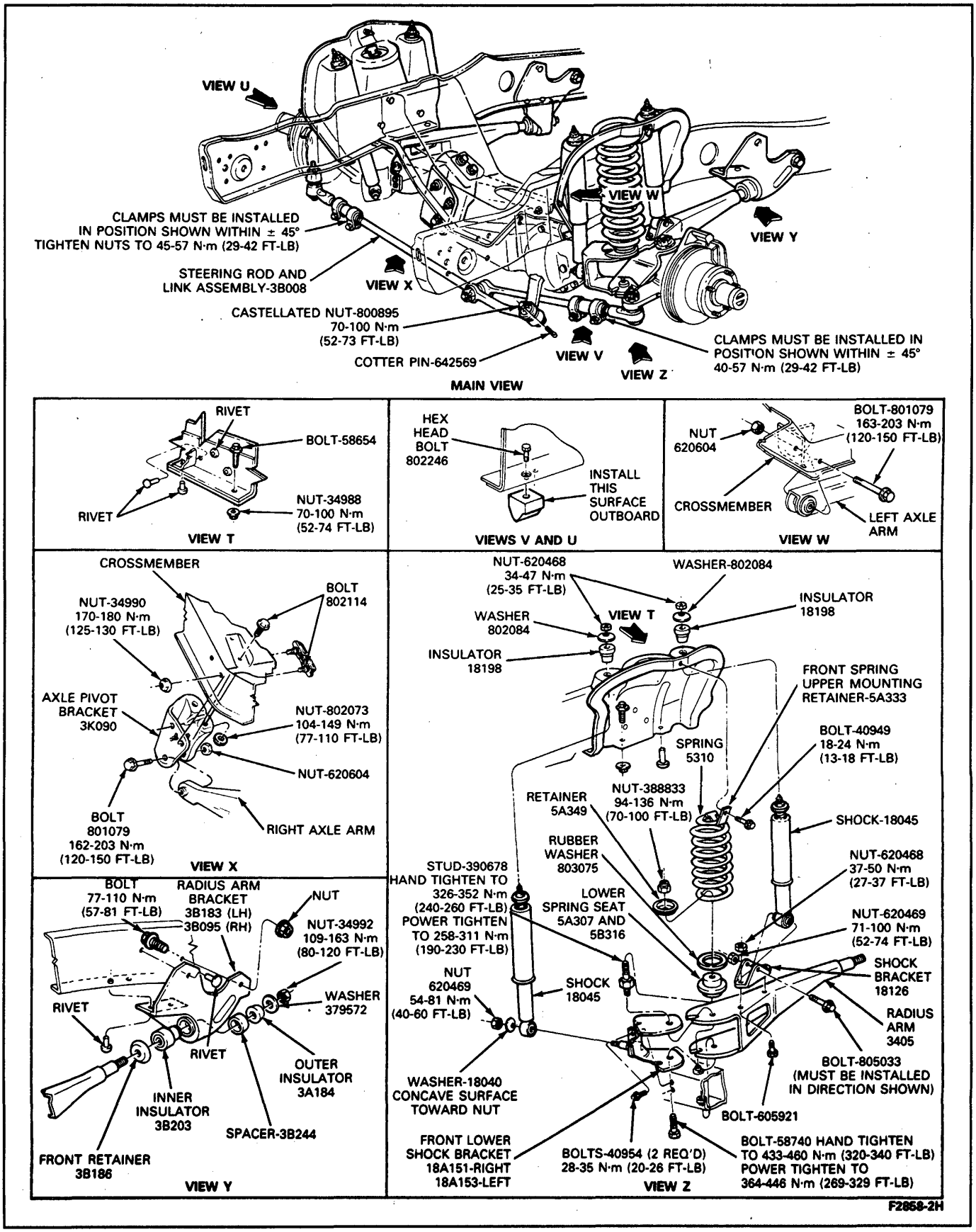


FIG. 4 Quad Shocks—Installation—Bronco and F-150 (4x4)

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holding the nut as described in Step 1 of Removal, tighten to 34-47 N·m (25-35 ft-lbs) by turning the hex provided on the stud.

3. For the rearward of front axle shock absorber installation, attach the lower end of the shock absorber to the bracket by installing the nut and bolt with the bolt head installed toward the tire. Tighten to 55-81 N·m (40-60 ft-lbs). For the forward of front axle shock absorber installation, attach the lower end of the shock absorber to the bracket by installing washer (concave surface to nut) and tighten nut to 55-81 N·m (40-60 ft-lbs).

Front Driving Axle

Refer to Section 15-34, Dana Model 44 and 50 Front Driving Axle and Section 15-32, Dana Model 60 Monobeam Front Drive Axle for front axle removal and installation procedures on Bronco, F-150—F-250—F-350 (4x4) 4-wheel drive vehicles.

Radius Arm

F-150 (4x4), Bronco

Removal

Refer to Figs. 1 and 4.

1. Raise the vehicle and position safety stands under the frame side rails.
2. Remove the shock absorber-to-lower bracket attaching bolt and nut and pull the shock absorber free of the radius arm.
3. Remove spring lower retainer attaching bolt from inside of the spring coil.
4. Loosen the axle pivot bolt.
5. Remove the nut attaching the radius arm to the frame bracket and remove the radius arm rear plastic spacer and insulator. Lower the axle and allow axle to move forward.

   NOTE: The axle must be supported on the jack throughout spring removal and installation, and must not be permitted to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for removal and installation of the spring, the disc brake caliper must be removed from the spindle according to the procedures specified in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper. After removal, the caliper must be placed on the frame or otherwise supported to prevent suspending the caliper from the caliper hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose assembly.
6. Remove the two bolts attaching the front axle to radius arm bracket to axle tube.
7. Remove the bolt and stud attaching radius arm to axle.
8. Move the axle forward and remove the radius arm from the axle. Remove the radius arm from the frame bracket.

Installation

1. Clean all the mating surfaces between the radius arm, axle and bracket prior to re-assembly.
2. Position the forward washer and insulator on the rear of the radius arm and insert the radius arm into the frame bracket.
3. Position the rear insulator and washer on the radius arm and loosely install the attaching nut.
4. Position the radius arm and front axle to radius arm bracket on the axle.
5. Loosely install a new stud and bolt attaching the radius arm to the axle.

   NOTE: New stud and bolt are required because of the adhesive coating on the original bolts. If new fasteners are not available, thoroughly clean the old fasteners and apply Loctite No. 242 or equivalent to the threads of the fasteners.
6. Tighten the radius arm rear attaching nut to 109-163 N·m (80-120 ft-lbs).
7. Install and tighten the bracket to axle attachment screws to 27-35 N·m (20-26 ft-lbs).
8. Tighten the radius arm (hand tighten) to axle lower bolt to 432-460 N·m (320-340 ft-lbs) and the upper stud type bolt to 324-351 N·m (240-260 ft-lbs) (hand tighten).
9. Position the spring lower seat with the locating tab positioned in the radius arm notch spring insulator and retainer to the spring and axle. Install the lower spring retainer and tighten nut to 94-134 N·m (70-100 ft-lbs). Position the upper retainer over the spring coil and install the attaching screws and tighten to 18-24 N·m (13-18 ft-lb).
10. Tighten the axle pivot bolt to 162-203 N·m (120-150 ft-lbs) with the axle in a normally loaded position.
11. Position the shock absorber to the lower bracket and install the attaching bolt and nut and tighten to 55-81 N·m (40-60 ft-lbs).

    NOTE: It is important that the bolt be installed with the head toward the tire to maximize clearance to brake system components.

Axle Housing Pivot Bushing

Removal and Installation

Refer to Section 15-34, Dana Models IFS-44, IFS-44HD and IFS-50 Front Driving Axle and 15-32, Dana Model 60 Monobeam Front Drive Axle, under Axle Housing Pivot Bushing—Removal and Installation for correct service procedures on Bronco—F-150—F-250—F-350 (4x4) vehicles.

Axle Pivot Bracket

F-150 (4x4) and Bronco

Refer to Fig. 1.

Removal

1. Remove the front axle as described in the Removal and Installation portion of Section 15-34, Dana Models IFS-44, IFS-44HD and IFS-50 Front Driving Axle.
2. Remove the retainer and bolts attaching the pivot bracket to frame. Refer to View X in Fig. 1.

Installation

1. Position the axle pivot bracket to the crossmember and loosely assemble the bolts, retainer assembly and nuts. Do not tighten at this time.

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NOTE: The two rearward vertical fasteners must be installed with bolt heads adjacent to the engine oil pan to maintain required clearance. The bolt and retainer assembly must be installed with bolt heads on the inside of the pivot bracket surface.

2. To ensure correct positioning of the axle pivot bracket, tighten the two forward fasteners to 149 N·m (110 ft lbs) first. Then tighten the two rearward vertical nuts and bolts in the top of the crossmember to 149 N·m (110 ft lbs).
3. Install the axle, front spring, radius arm, and wheel spindle as described in this Section.

Axle Pivot Bracket

F-250—(4x4)

Refer to Fig. 2.

Removal

1. Place supports securely under the axle arms and remove the axle pivot bolts.

   WARNING: IF THE AXLE ARMS ARE NOT SECURELY SUPPORTED, THE AXLE ARMS WILL DROP SUDDENLY 4-6 INCHES.

2. If necessary, pry the axle out of the bracket and lower the axle.
3. Remove and discard all axle pivot bracket to crossmember fasteners and remove the axle pivot brackets (Refer to View W, Fig. 2).

   NOTE: If necessary, raise the engine to provide access to the vertical fasteners in the top of the crossmember as follows:

   A. Loosen the right and left engine mount bolts.
   B. Align the fan blade to clear the shroud and raise the engine 2 inches. Make sure the air cleaner does not come in contact with the firewall.
   C. Block engine securely in place.

Installation

1. Position the axle pivot bracket to the crossmember and loosely assemble the bolts retainer assembly and nuts. Do not tighten at this time.

   NOTE: The vertical fasteners for each pivot bracket must be installed with bolt heads adjacent to the engine oil pan to maintain required clearance. Horizontal fasteners must be installed with the bolt heads on the inside surface of the pivot brackets. Refer to View W in Fig. 2.

2. To ensure correct positioning of the axle pivot brackets, tighten the horizontal fasteners in the side of the crossmember first. Tighten to 149 N·m (110 ft-lbs). Tighten the vertical fasteners in the top of the crossmember to 149 N·m (110 ft-lbs).
3. Position the axles in the pivot bracket. Install the pivot bolt and tighten nut to 200 N·m (150 ft-lbs).
4. Remove the blocks under the engine and lower the engine into position. Tighten the bolts to specification listed in the appropriate engine Section in Group 21 or Group 22, Light Truck Engine Shop Manual (Volume B)*.

Jounce Bumper

Refer to Figs. 2 and 3.

Removal

1. Remove the hex head bolt that holds jounce bumper to frame. Remove jounce bumper.

Installation

1. Position jounce bumper in forward set of holes in frame.

   NOTE: The rearward set of holes on the right bumper only are for F-150—F-350 (4x2) vehicles only. The forward set of holes are for F-150 (4x4) and Bronco only.

2. Install the hex head bolt and tighten to 19-29 N·m (14-22 ft-lbs).

Front Stabilizer Bar

Bronco and F-150 (4x4)

Refer to Fig. 5.

1. Remove nuts, bolts and washers connecting the stabilizer bar to connecting links. Remove nuts and bolts of the stabilizer bar retainer.
2. Remove stabilizer bar insulator assembly.
3. To remove the stabilizer bar mounting bracket/spring seat casting, the coil spring must be removed as described above under Spring Removal.

NOTE: The stud does not have to be removed.

The bracket to frame assembly may be removed but not the #1A crossmember.

4. To reinstall the stabilizer bar mounting bracket/spring seat casting, locate the casting so that the locating tang is positioned in the radius arm notch (or quad shock bracket notch if vehicle has quad shocks).

   Reinstall the spring and retainers as described under Spring Removal and Installation in this Section.

5. To reinstall the stabilizer bar insulator assembly, assemble all nuts, bolts and washers to the bar, brackets, retainers and links loosely. With the bar positioned correctly, tighten retainer nuts 37-50 N·m (27-37 ft-lbs.) with retainer around the insulator. Then tighten all remaining nuts at the link assemblies to 71-100 N·m (52-74 ft-lb).

   To reinstall the F-150 (4x4) Regular Cab brackets to No. 1A crossmember, tighten the six carriage bolt nuts to 37-50 N·m (27-37 ft-lbs). For the F-150 (4x4) Supercab, tighten the nuts for the frame bracket to 71-100 N·m (52-74 ft-lb). On the F-150 (4x4) Snow-Fiter, tighten the bolts for the frame bracket to 37-50 N·m (27-37 ft-lbs).

F-250 (4X4)

Refer to Fig. 6.

1. Remove bolts, washers and nuts securing the links to spring seat caps (both sides). For those vehicles equipped with a Dana Model 60 Monobeam Front Drive axle, remove the nut, washer, and bolt securing the links to the mounting brackets (both sides). Remove nuts, washers and insulators

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connecting links to stabilizer bar. Remove link assemblies.

2. Remove nuts and bolts securing retainers to mounting bracket and remove retainers.
3. Remove stabilizer bar.
4. To reinstall, replace the components in reverse order of disassembly without tightening bolts.
5. Tighten nuts connecting links to spring seat caps on both sides, 70-100 N·m (52-74 ft-lbs).
6. Tighten nuts connecting links to stabilizer bar, 21-33 N·m (15-25 ft-lbs).
7. Tighten nuts and bolts connecting retainers to mounting bracket, 34-48 N·m (25-35 ft-lbs).

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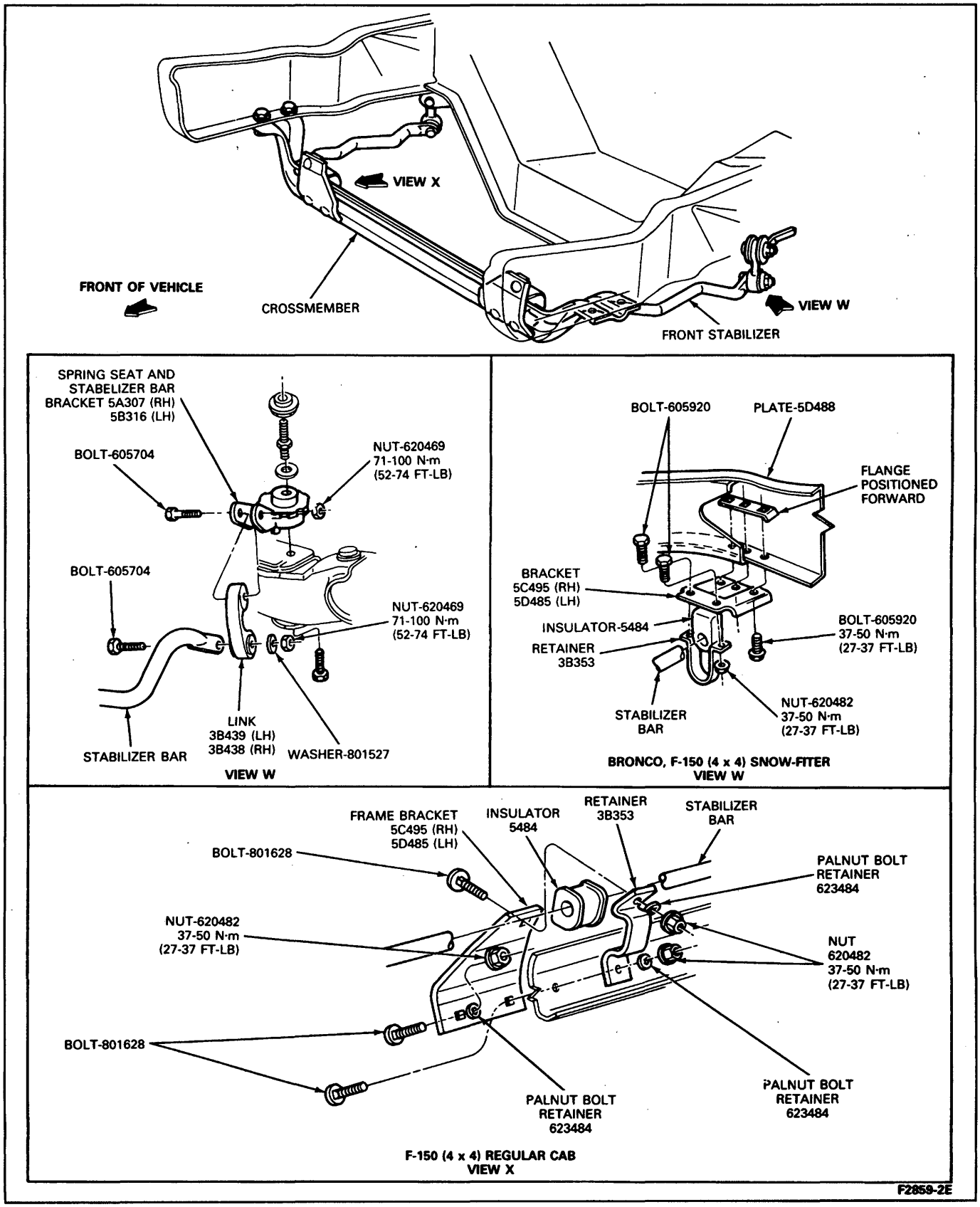


FIG. 5 Front Stabilizer Bar Installation—F-150 (4x4), Bronco

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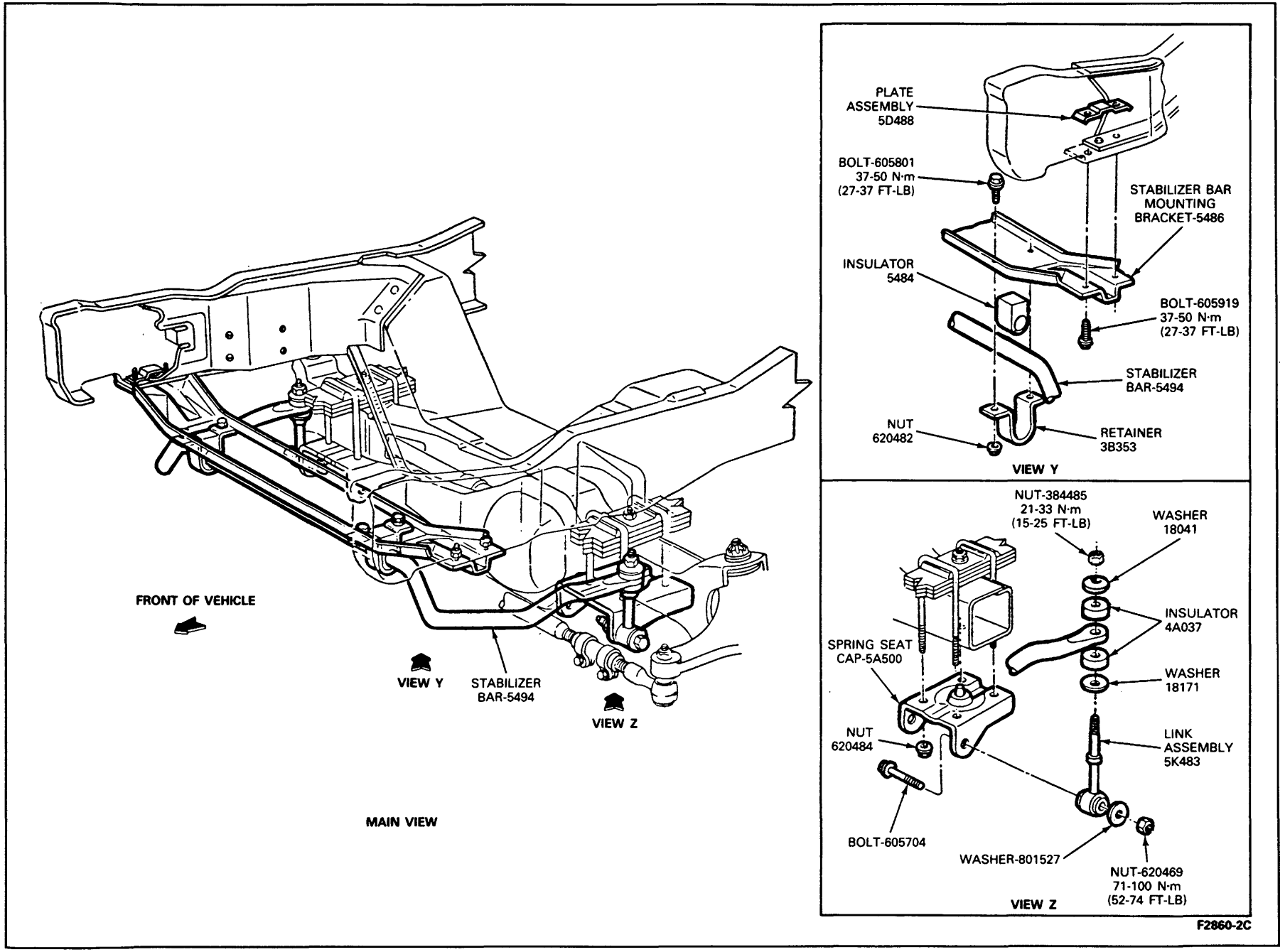


FIG. 6 Front Stabilizer Bar Installation—F-250 (4x4) with Dana 44 IFS-HD and 50 IFS—Front Drive Axle

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SPECIFICATIONS

FRONT SUSPENSION TORQUE LIMITS — F-150/F-250 (4x4), BRONCO

Description	Model	Torque	
		(ft-lbs)	N-m
Radius Arm to Axle, Upper Stud	Bronco, F-150 (4x4)	240-260 (Hand Tighten)	326-352
Radius Arm to Axle, Lower Belt	Bronco, F-150 (4x4)	320-340 (Hand Tighten)	434-461
Front Spring to Axle U-Bolt	F-250 (4x4)	85-120	115-163
Front Spring Assembly to Hanger Bracket	F-250 (4x4)	120-150	163-203
Front Spring Shackle to Shackle Bracket	F-250 (4x4)	150-210	203-285
Front Spring to Shackle	F-250 (4x4)	120-150	163-203
Radius Arm to Bracket	Bronco, F-150 (4x4)	80-120	109-163
Spring Retainer to Upper Spring Seat	Bronco, F-150 (4x4)	Screw 13-18	18-24
Lower Spring Retainer to Radius Arm	Bronco, F-150 (4x4)	70-100	94-134
Front Shock Bracket to Frame	F-250 (4x4)	52-74	71-100
Front Shock to Shock Bracket — Lower	Bronco, F-150 (4x4)	52-74	71-100
Front Shock Absorber Stud — Upper	Bronco, F-150 (4x4)	25-35	34-37
Front Shock to Front Spring Plate Spacer — Lower	F-250 (4x4)	52-74	70-100
Front Shock to Bracket — Upper	F-250 (4x4)	52-74	70-100
Front Jounce Bumper to Bumper Bracket	F-250 (4x4)	19-30	26-41
Bumper Bracket to Frame	F-250 (4x4)	52-74	71-100
Front Jounce Bumper to Upper Spring Seat	Bronco, F-150 (4x4)	13-18	18-24
Radius Arm Pivot Bracket to Frame	Bronco, F-150 (4x4)	77-110	104-149
Stabilizer Bar Link to Bracket	Bronco, F-150 (4x4)	52-74	71-100
Stabilizer Bar Link to Stabilizer Bar	Bronco, F-150 (4x4)	52-74	71-100
Stabilizer Bar Retainer to Bracket and Bracket to Frame	Bronco, F-150 (4x4) — Sno-Fiter	27-37	37-50
Stabilizer Bar Bracket to Bracket	F-150 (4x4) Super Cab	27-37	37-50
Stabilizer Bar Retainer to Frame	F-150 (4x4) Super Cab	52-74	71-100
Stabilizer Bar Retainer to Crossmember and Mounting Bracket	F-150 (4x4) Regular Cab	27-37	37-50
Axle Pivot Bracket to Frame	F-150 (4x4) Bronco	77-110	104-149
Axle Pivot Bracket to Frame	F-250 (4x4)	77-110	104-149

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FRONT SUSPENSION TORQUE LIMITS — F-350 (4x4) WITH DANA 60 MONOBEAM FRONT DRIVE AXLE

Description	Torque	
	(Ft-Lb)	N-m
Bumper Mounting Bracket to Frame	52-74	70-100
Bumper to Mounting Bracket	18-29	25-40
Front Shock Bracket to Frame	52-74	70-100
Front Shock to Shock Bracket — Upper	52-74	70-100
Front Shock to Spacer Plate Bracket — Lower	52-74	70-100
Front Spring Assembly to Shackle	90-150	163-203
Front Spring Assembly to Spring Bracket	90-150	163-203
Front Spring Shackle to Frame	150-210	203-285
Stabilizer Bar Link Assembly Mounting Bracket to Frame	35-50	48-68
Stabilizer Bar Link Assembly to Mounting Bracket	52-74	70-100
Stabilizer Bar to Link Assembly	15-25	21-33
Tie Rod End to Spindle Arm	52-74	70-100
Tracking Bar Assembly to Mounting Bracket	120-150	163-203
Tracking Bar Mounting Bracket to Crossmember	77-110	104-149
U-Bolt to Front Spring Cap	85-120	115-163
U-Bolt to Stabilizer Bar Mounting Bracket — R.H	35-50	48-68
Stabilizer Bar to Mounting Bracket — L.H	35-50	48-68

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SPECIAL SERVICE TOOLS

Number	Description	Application
D79T-3010-A	4WD Ball Joint Set	Use with Ball Joint Set Removal and Installation
T80T-3010-A	Ball Joint Set	F-150-350 (4x4) Upper and Lower Ball Joint Removal and Installation
T80T-3010-A1	Part of 4WD Ball Joint Set	—
T80T-3010-A2	Part of 4WD Ball Joint Set	—
T80T-3010-A3	Part of 4WD Ball Joint Set	—
T80T-3010-A4	Part of 4WD Ball Joint Set	—
D79P-3283-A	Tie Rod Adjustment Tool	Universal
T00L-3290-C	Tie Rod End Remover	Universal
T78P-5638-A1	Forcing Screw	—
T78P-5638-A2	Receiving Cup	—
T78P-5638-A4	Receiving Cup	—
T80T-5638-A	Front Suspension Bushing Tool Set	Front Drive Axle Suspension Bushing Removal and Installation

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SECTION 14-31 Rear Suspension—Leaf Springs

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VEHICLE APPLICATION

Applies to E-150—E-350, F-150—F-350, F-Super Duty and Bronco Trucks.

DESCRIPTION

Rear Suspension

Semi-elliptic, leaf-type springs are used for the rear axle suspension. The forward end of each spring is attached to a bracket on the frame side member. The rear end of each spring is shackled to a bracket on the frame side member. (Figs. 1 through 8).

Optional auxiliary rear springs are mounted on top of the main spring with free ends. These provide load carrying capacity and stability. Auxiliary springs are standard on F-350 Chassis Cab and all F-Super Duty. (Figs. 3, 4, 5 and 7).

Rear Shock Absorber

Both the hydraulic shock absorbers and the low pressure gas shock absorbers are of the direct, double-acting type. They provide a continuous dampening effect both on compression and rebound. These shock absorbers are of telescopic design with rubber grommets at the mounting points for quiet operation. The low pressure gas shock absorbers are sealed and charged with nitrogen gas to reduce shock absorber fade and improve vehicle ride. The shock absorbers are sealed, non-adjustable units and must be replaced as complete assemblies.

DIAGNOSIS AND TESTING

Rear Leaf Spring Squeak

To correct a squeaking condition at the rear leaf springs, first determine whether it is the spring or the shackle bushings squeaking. If it is determined to be the bushings, replace them. If it is the springs, install spring tip liners to correct the squeak. If the original spring clip is damaged during removal, install a new service spring clip.

Tip Liner Installation

1. Raise the vehicle by the frame so that the rear axle hangs freely.
2. Bend the spring clip to provide clearance between the spring leafs, allowing insertion of the liners. A pry-bar may be used between the leaves to provide additional clearance for insertion of liners.
3. Slide the liner (5586) between the leaves until the liner extends approximately 6.35mm (0.25 inch) beyond the tip of the lower leaf. Do not attempt to install a liner between the lowest primary leaf and the short, 12.70mm (0.50 inch) thick secondary leaf found at the bottom of the leaf stack on some assemblies.
4. Set the rear axle on a stand to load the rear leaf springs placing the leafs in contact with one another at the clip locations.
5. Reinstall production clips or install the replacement service clip.

NOTE: On some of the tip liners, sections of the edge used to center the liner on the spring leaves may need to be trimmed off to accommodate the spring clip.

Service Spring Clip Installation

Refer to Fig. 11.

1. Load the rear leaf springs with the rear of the vehicle supported, either directly by the rear axle or by the tires. The spring leaves should all be in contact with one another at the intended clip location.
2. Remove the damaged clip by prying back the ends of the clip which are folded across the leaf spring until the clip can be freed from the spring. On some clips it will also be necessary to pry the locating pin out of the locating hole. (Locating holes are the holes punched out of the lowest leaf the clip encircles which indicate the proper spring clip location.)
3. Make sure the locating hole is clean and free of debris.
4. Position the lower part of the service clip (5724) across the width of the underside of the spring, such that the hole in the clip lines up with the locating hole in the spring. The legs of the clip lower half should extend down from the bottom of the spring.

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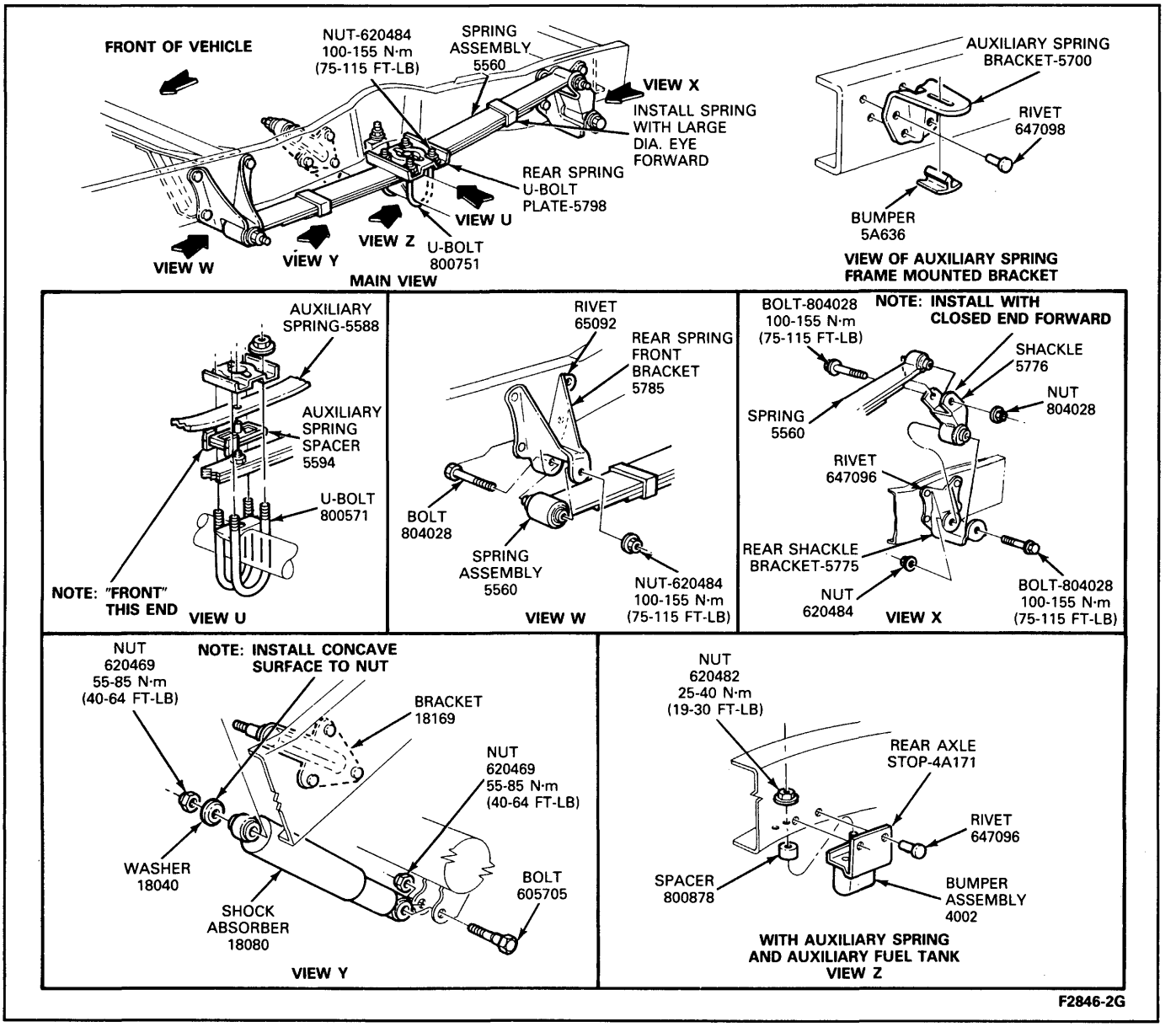


FIG. 1 Rear Spring Installation—F-150 (4x2)

5. Insert the drive rivet that comes with the clamp through the hole in the lower part of the service clip into the hole in the spring leaf. The flat face of the rivet flange should rest against the clip lower half.

6. Fully seat the rivet with a hammer. If there is not enough room to hit the rivet directly with a hammer, a punch may be used. The slotted legs of the clip lower half should extend downward, the outer surface of the legs flush with the sides of the leaf spring.

7. Place the rubber service clip liner across the top of the leaf spring, directly above where the bottom half of the clip attaches to the spring, with the flat surface against the leaf and the clip locating edges extending upward.

8. Place the clip upper half between the locating edges of the rubber liner and align the threaded holes in the clip upper half with the slots in the clip lower half.

9. Hand start the two screws through the clip lower half slot into the clip upper half threaded hole. The screw heads will be located under the spring, ultimately pressing against the inner surface of the clip lower half.

10. Squeeze the clip to the spring with one hand while tightening the screws. Tighten to 21-27 N·m (15-20 ft-lbs).

ADJUSTMENTS

Vehicle Lean

F-150—F-250—F-350 (4x2) (4x4), F-Super Duty and Bronco

A side-to-side lean at the rear of the vehicle can be adjusted by approximately 9.52mm (3/8 inch) by installing a shim between the rear spring and axle on the low side of the vehicle. A "low at the rear" vehicle can be raised approximately 9.52mm (3/8 inch) by installation of one shim on each side. If side to side lean

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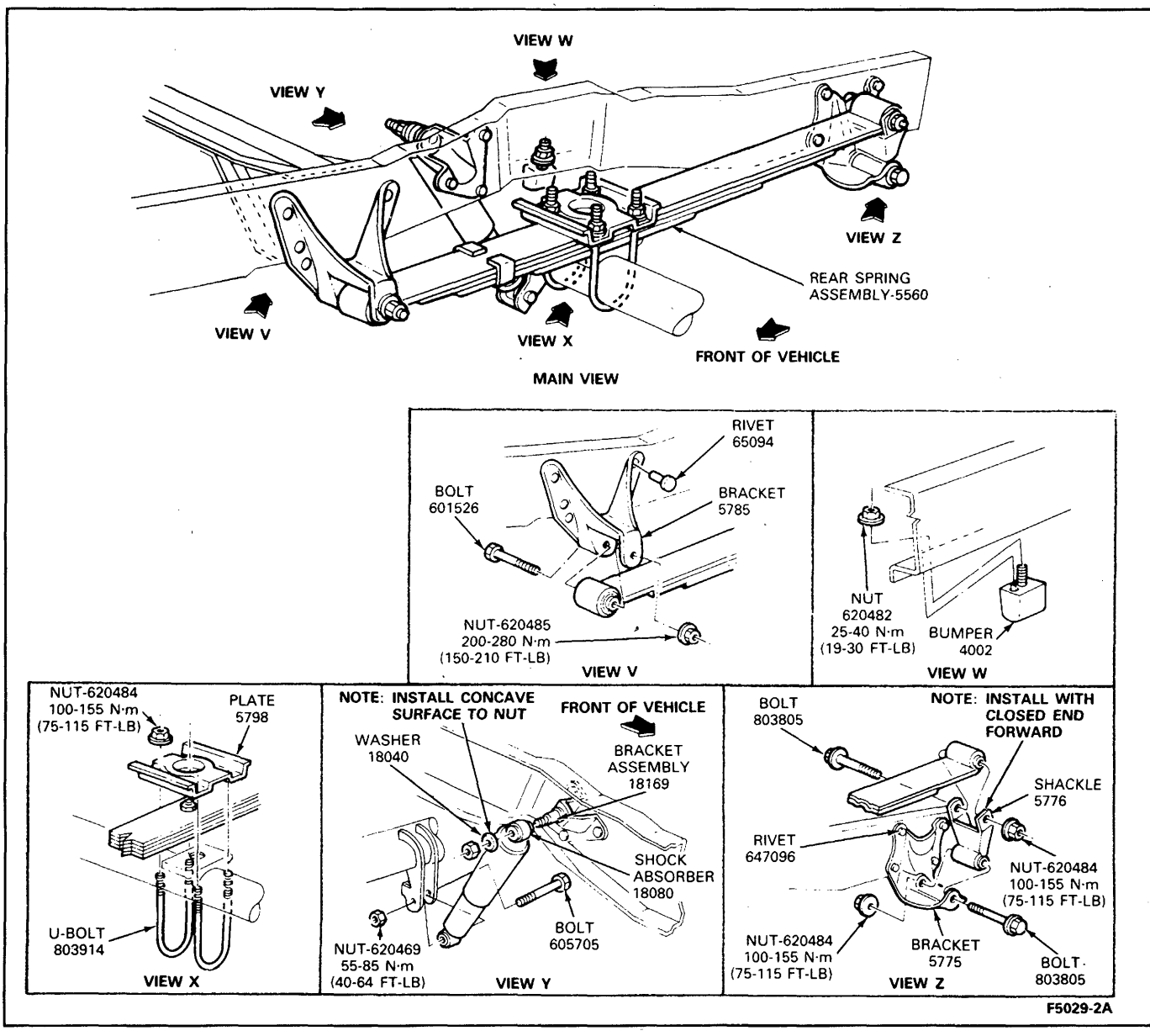


FIG. 2 Rear Spring Installation-Conventional—F-250—F-350 (4x2) Regular Cab and Super Cab

at rear is greater than 12-70mm (1/2 inch), switch the rear springs side to side. Use the following procedure to install the shim (D7TA-5742-AA):

1. Raise the vehicle frame until the weight is off the rear springs but with the tires still touching the floor.
2. Loosen the spring U-bolts to allow the axle to separate from the spring approximately 12.70mm (1/2 inch).
3. Position the shim (D7TA-5742-AA) between the spring and axle with the long edge of the shim parallel to the side of the spring and the spring tie bolt head through the hole in the shim. On 4x4 vehicles, position the shim between the rear spring and axle spacer. Tape may be used to hold the shim in position.
4. Assure that the spring leaves are properly aligned and the spring U-bolts contact the edges of the spring assembly or axle seat.
5. Tighten the spring U-bolt sufficiently to assure that the spring tie bolt head that extends through the shim enters the hole in the axle seat.

REMOVAL AND INSTALLATION

Rear Shock Absorber

CAUTION: The low pressure gas shock absorbers are charged with nitrogen gas to 931 kpa (135 psi). Do not attempt to open, puncture or apply heat to the shock absorbers.

Removal

1. Raise the vehicle on a hoist.
2. Remove the shock absorber lower attaching nut and bolt, and swing the lower end free of the mounting bracket on the axle housing (Fig. 10).
3. Remove the attaching nut from the upper mounting stud, and remove the shock absorber.

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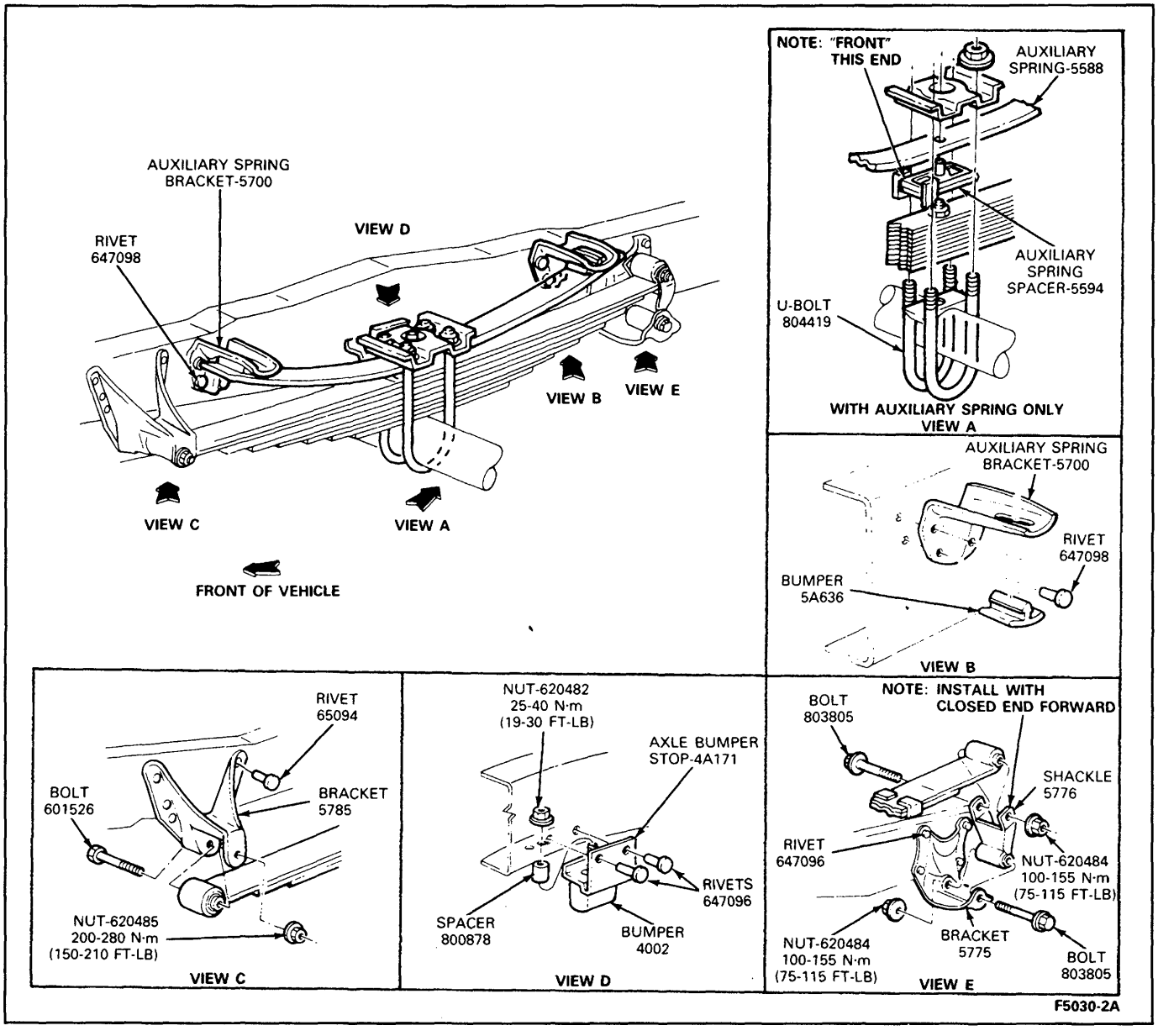


FIG. 3 Rear Spring Installation with Auxiliary Spring—F-250—F-350 (4x2)—Regular and Super Cab

Installation

1. Position the replacement shock absorber with rubber bushings and steel washers to the upper mounting bolt.
2. Swing the lower end of the shock absorber into the mounting bracket on the axle housing. Install the mounting bolt, and self-locking nut. Tighten the nut to specifications listed at the end of this Section.
3. Install the washer and self-locking nut on the upper mounting bolt. Tighten the nut to specifications listed at the end of this Section.

Rear Spring

F-150—F-250—F-350 (4x2) (4x4), F-Super Duty and Bronco

Refer to Figs. 1-8.

Removal

1. Raise the vehicle frame, until the weight is off the rear spring, with the tires still touching the floor.
2. Remove the nuts from the spring U-bolts and drive the U-bolts from the U-bolt plate. If so equipped, remove the auxiliary spring and spacer.
3. Remove the spring-to-bracket nut and bolt at the front of the spring.
4. Remove the shackle upper and lower nuts and bolts at the rear of the spring. Remove the spring and shackle assembly from the rear shackle bracket.

Installation

1. Position the spring in the shackle, and install the upper shackle-to-spring bolt and nut with the bolt head facing outboard.
2. Position the front end of the spring in the bracket and install the bolt and nut.

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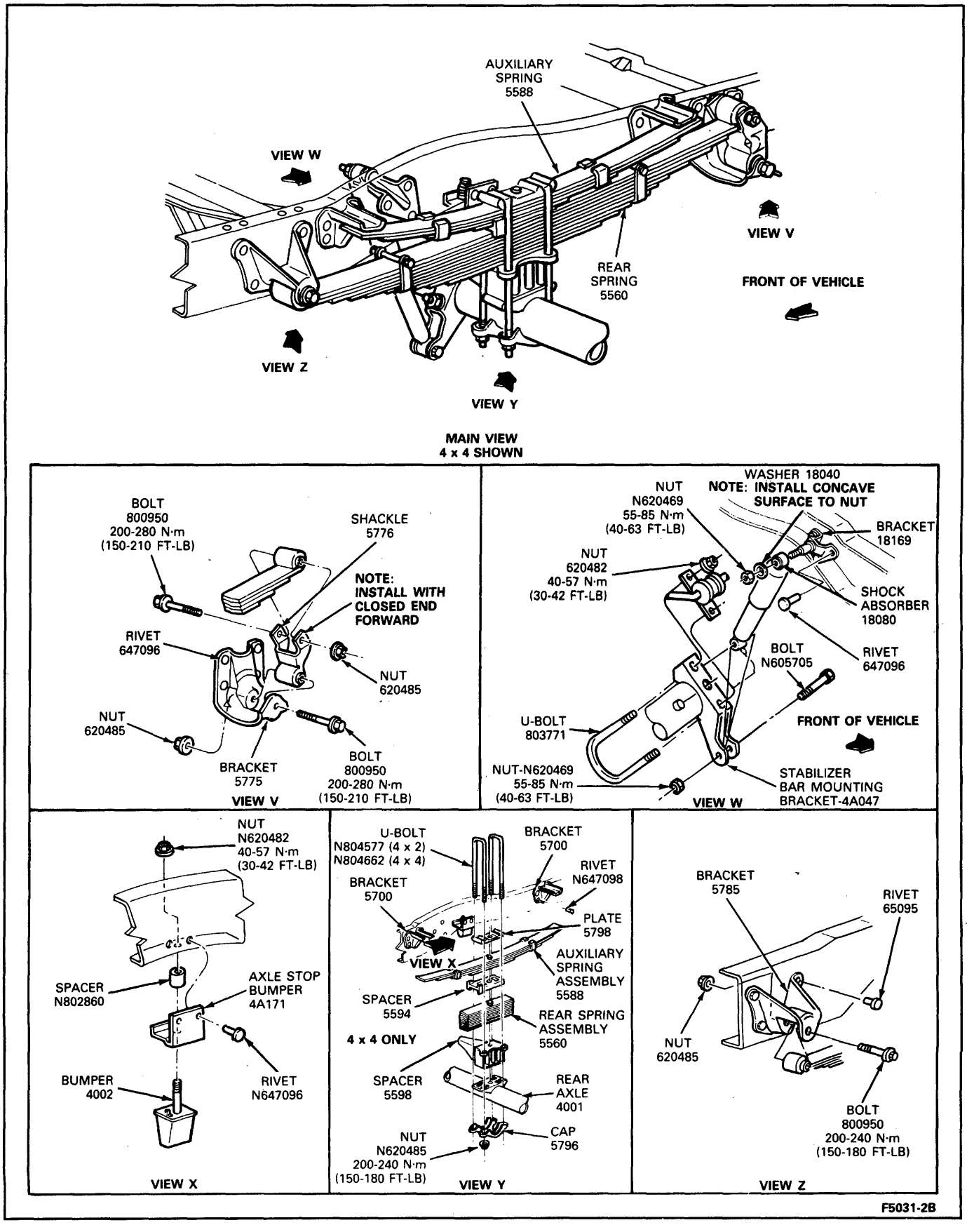


FIG. 4 Rear Spring Installation—F-250—F-350 (4x2) Chassis Cab with Ford Axles

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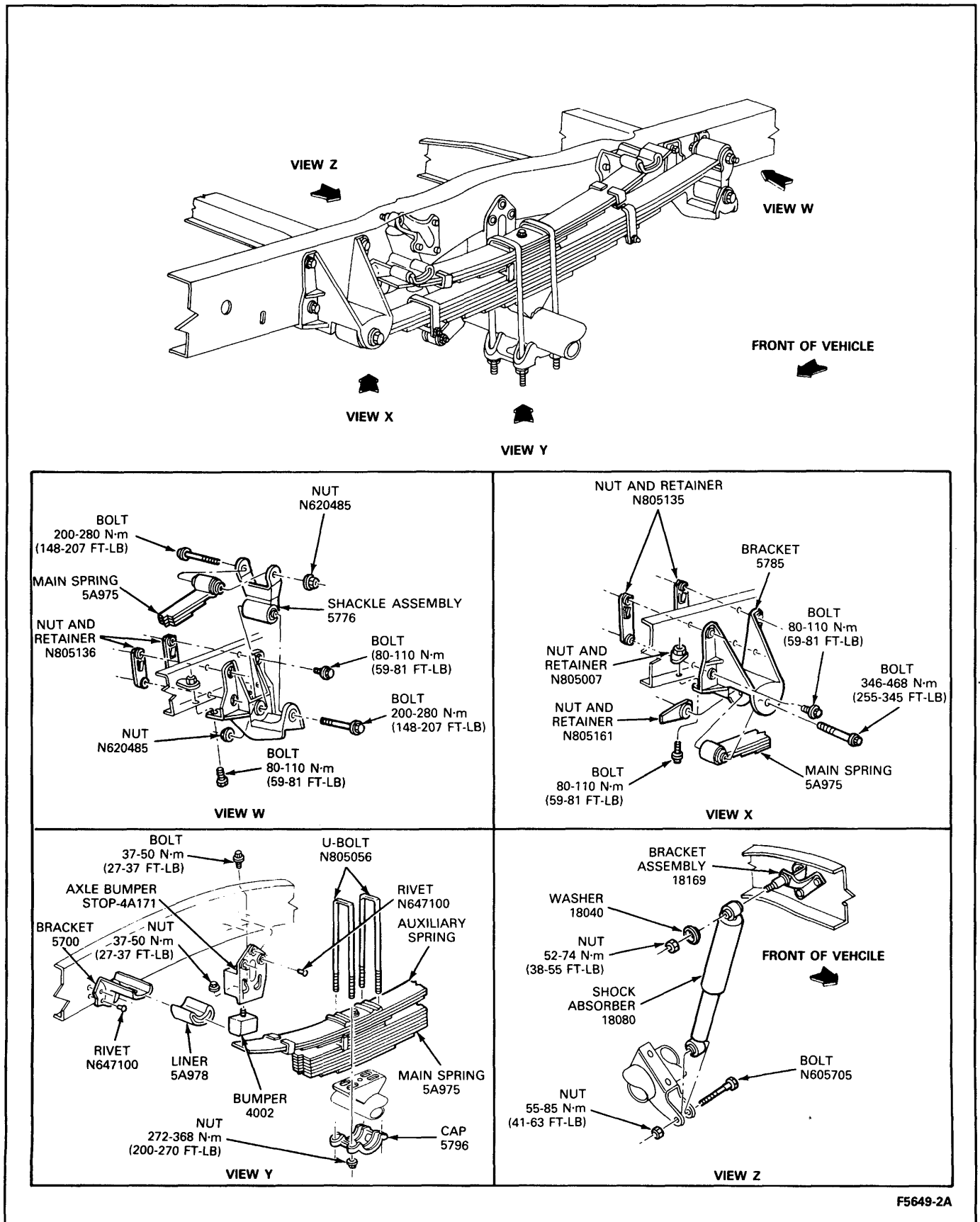


FIG. 5 Rear Spring Installation—F-Super Duty

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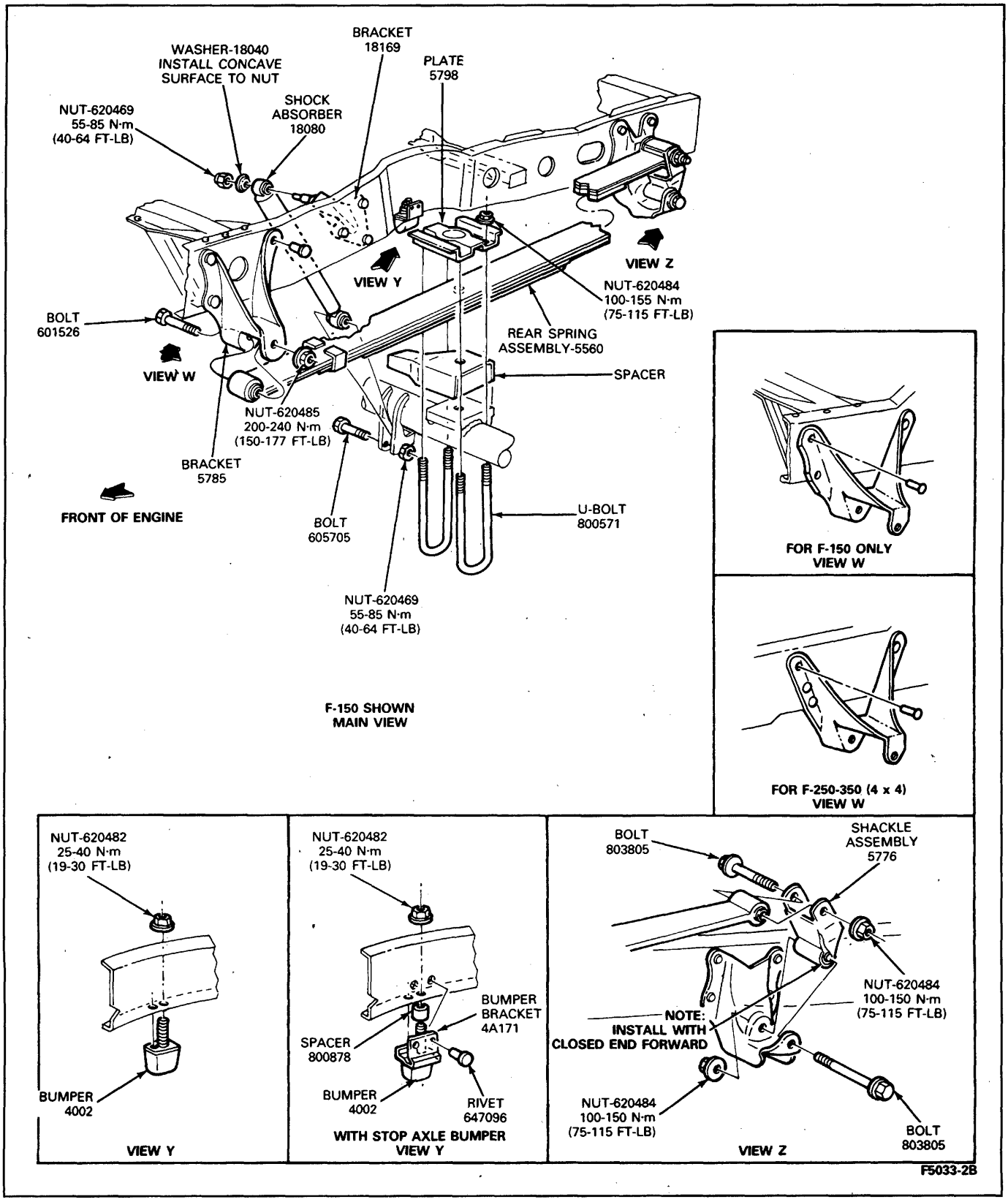


FIG. 6 Rear Spring Installation—F-150—F-350 (4x4)

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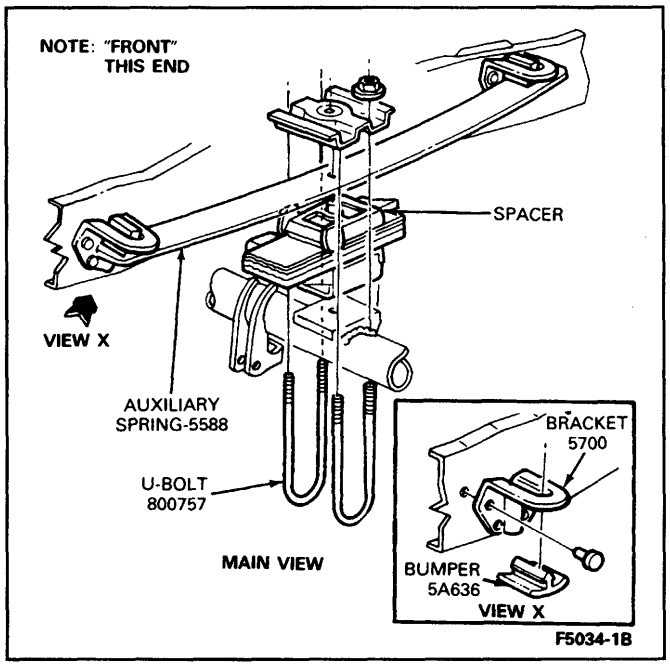


FIG. 7 Rear Spring Installation with Auxiliary Spring—F-150—F-350 (4x4)

3. Position the shackle in the rear bracket and install the bolt and nut.
4. Position the spring on top of the axle with the spring tie bolt centered in the hole provided in the seat. If so equipped, install the auxiliary spring and spacer.
5. Install the spring U-bolts, U-bolt plate and nuts.
6. Lower the vehicle to the floor. Tighten the spring U-bolt nuts to specifications as listed at the end of this Section. Tighten the front spring bolt and nut and the rear shackle bolts and nuts to specifications as listed at the end of this Section.

Rear Spring

E-150

Refer to Fig. 9.

Removal

1. Raise the rear end of the vehicle and support the chassis with safety stands. Support the rear axle with a floor jack or hoist.
2. Disconnect the lower end of the shock absorber from the bracket on the axle housing.
3. Remove the two U-bolts and plate.
4. Lower the axle and remove the upper and lower rear shackle bolts.
5. Pull the rear shackle assembly from the bracket and spring.
6. Remove the nut and mounting bolt that secures the front end of the spring. Remove the spring assembly from the front shackle bracket.

Installation

1. Assemble the front eye of the spring to the front bracket with the front mounting bolt and nut. Do not tighten the nut.
2. Mount the rear end of the spring with the upper bolt of the rear shackle assembly passing through the eye of the spring. Insert the lower bolt through the rear spring, shackle bracket.
3. Assemble the spring center bolt in the pilot hole in the axle and install the plate. Install the U-bolts through the plate. Do not tighten the attaching nuts at this time.
4. Raise the axle with a floor jack or hoist until the vehicle is free of the stands. Connect the lower end of the shock absorber to the bracket on the axle housing.
5. Tighten the spring front mounting bolt and nut, the rear shackle nuts and the U-bolt nuts. Tighten all bolts and nuts to specifications as listed at the end of this Section.
6. Remove the safety stands and lower the vehicle.

Rear Spring

E-250-E-350

Refer to Fig. 10.

Removal

1. Raise the rear end of the vehicle and support the chassis with safety stands. Support the rear axle with a floor jack or hoist.
2. Disconnect the lower end of the shock absorber from the bracket on the axle housing (Fig. 10).
3. Remove the two spring U-bolts and the U-bolt plate.
4. Lower the axle and remove the spring front bolt from the hanger.
5. Remove the two attaching bolts from the rear of the spring. Remove the spring and the shackle.

Installation

1. Assemble the upper end of the shackle to the spring with the attaching bolt as shown in Fig. 10.
2. Connect the front of the spring to the front bracket with the attaching bolt.
3. Assemble the spring and shackle to the rear bracket with the attaching bolt.
4. Place the U-bolt plate over the nut of the center bolt.
5. Raise the axle with a jack. Install the center bolt head through the pilot hole in the pad on the axle housing.
6. Install the spring U-bolts and attaching nuts. Tighten the nuts snugly.
7. Connect the lower end of the shock absorber to the lower bracket.
8. Tighten the spring front mounting bolt and nut, the rear shackle nuts and spring U-bolt nuts. Tighten to specifications as listed at the end of this Section.
9. Remove the safety stands and lower the vehicle.

Rear Stabilizer Bar

F-150—F-250—F-350 (4x2) (4x4), F-Super Duty and Bronco

Refer to Figs. 13 and 14.

Removal

1. Remove nut from lower end of stabilizer bar link.

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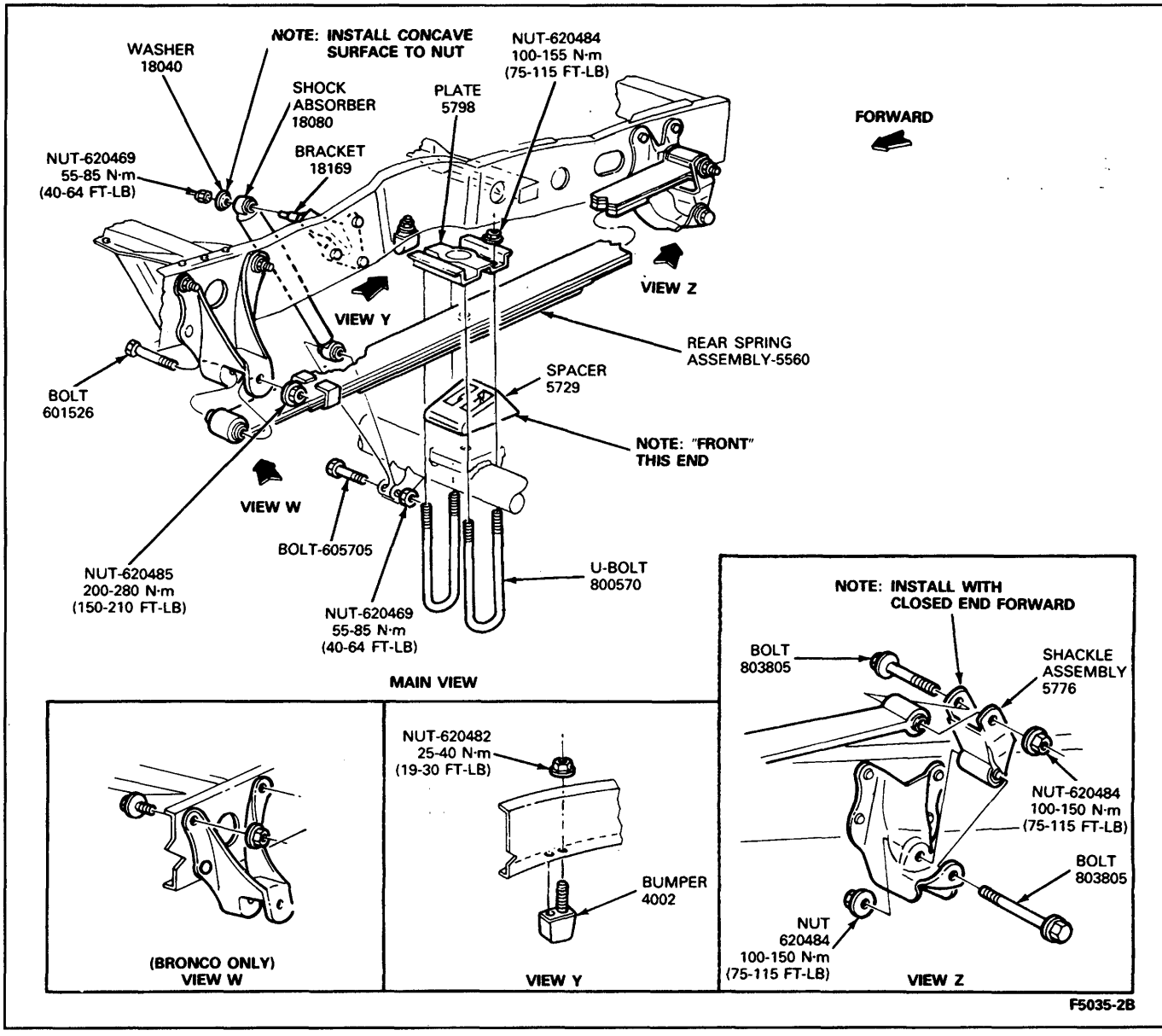


FIG. 8 Rear Spring Installation—Bronco

2. Remove outer washer and insulator. Disconnect stabilizer bar from link.
3. Remove inner insulators and washers. Disconnect link from frame by removing nuts and bolts.
4. Remove nuts which fasten U-bolts, brackets and retainers.

Installation

1. Install outer insulator and washer on link. Install and tighten nuts to specification.
2. Position U-bolts, brackets and retainers to frame. Install and tighten nuts to specification.
3. Install inner insulator and washer on link. Connect link to stabilizer bar.
4. Install outer insulator and washer on link. Install and tighten nuts to specification.

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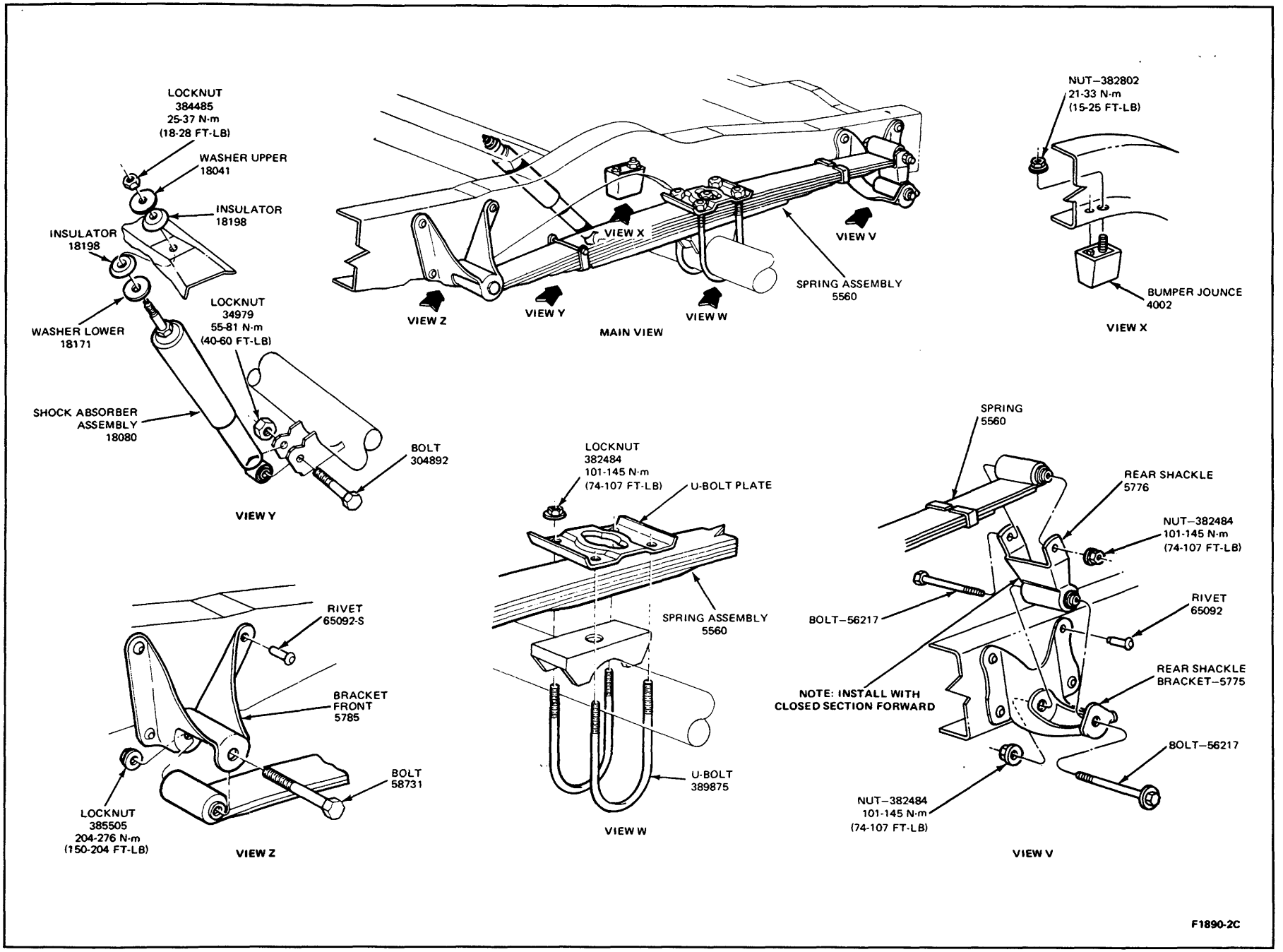


FIG. 9 Rear Spring Installation—E-150

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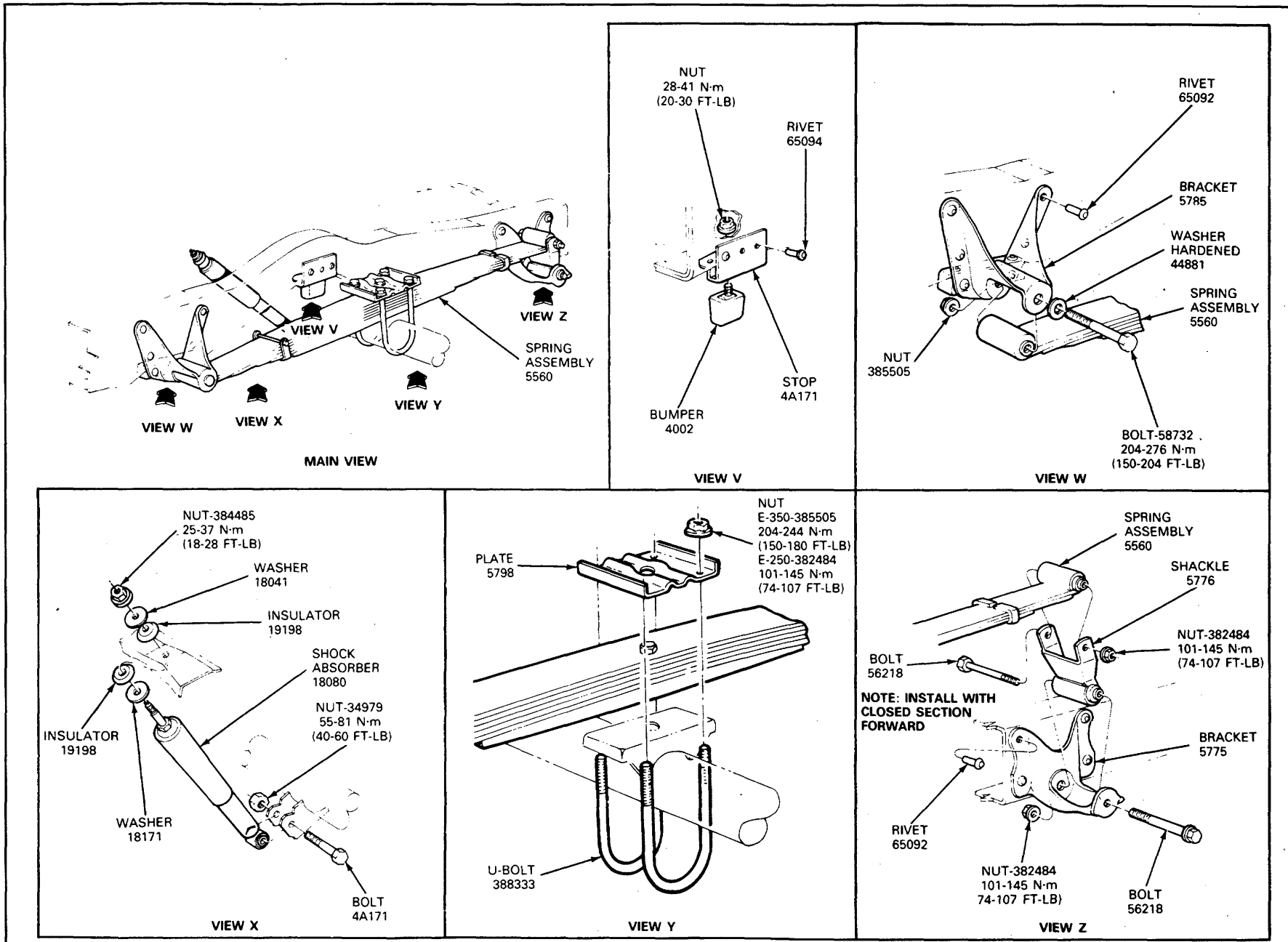


FIG. 10 Rear Spring Installation—E-250—E-350

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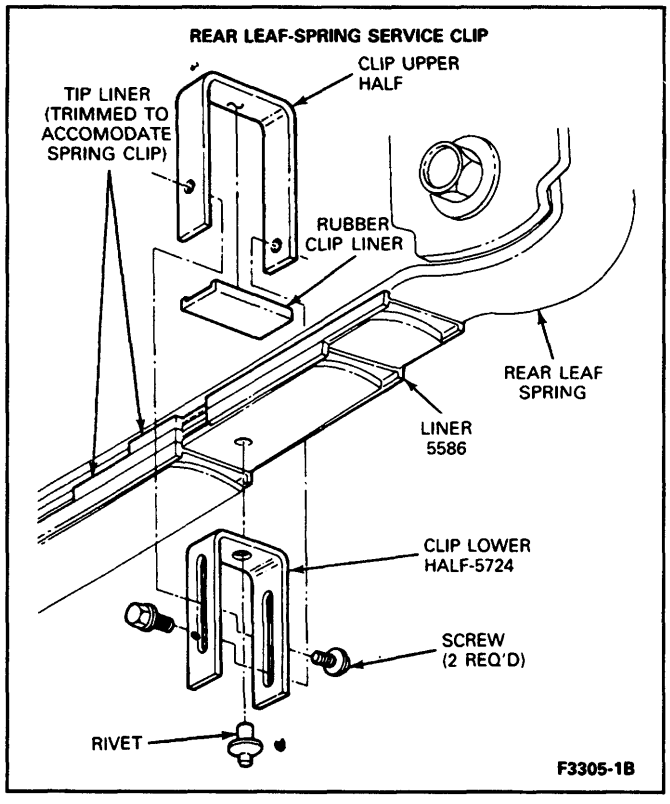


FIG. 11 Service Spring Clip Installation

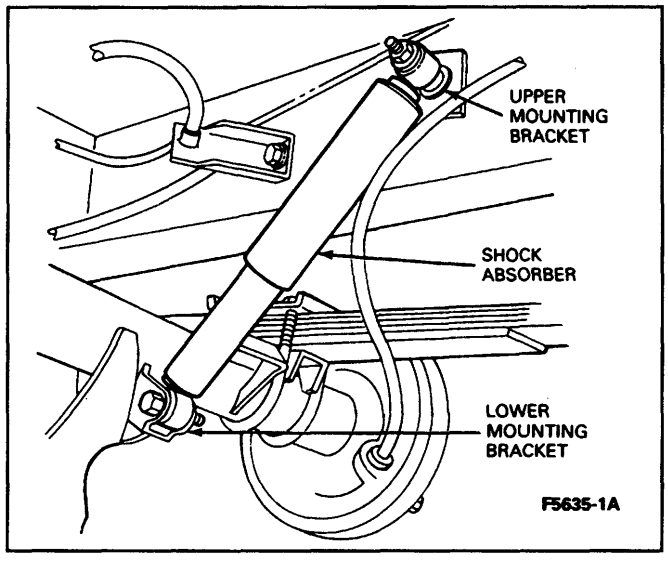


FIG. 12 Rear Shock Absorber Installed (F-Series Only)—Typical

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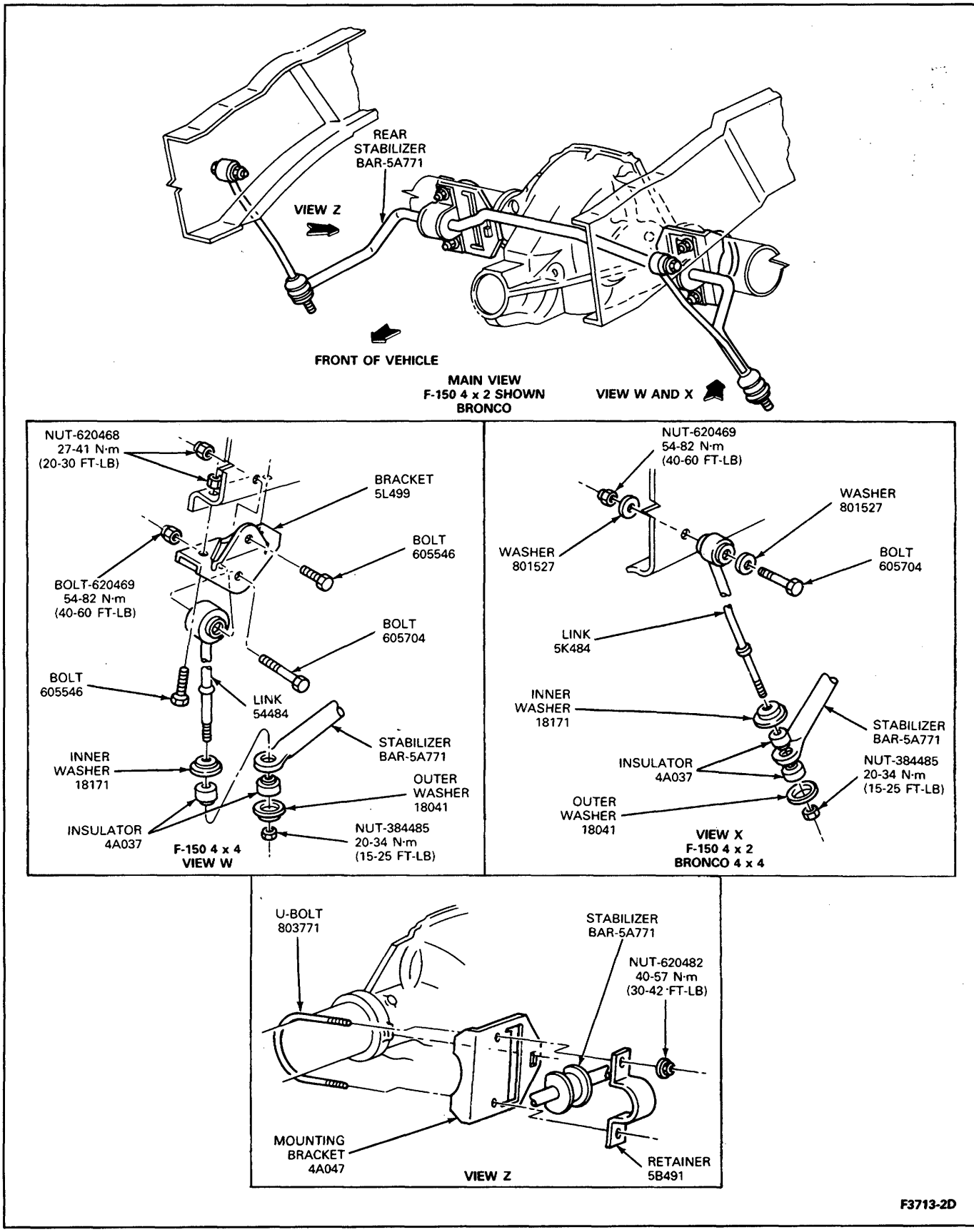


FIG. 13 Rear Stabilizer Bar Installation—Bronco, F-150 (4x2), (4x4)

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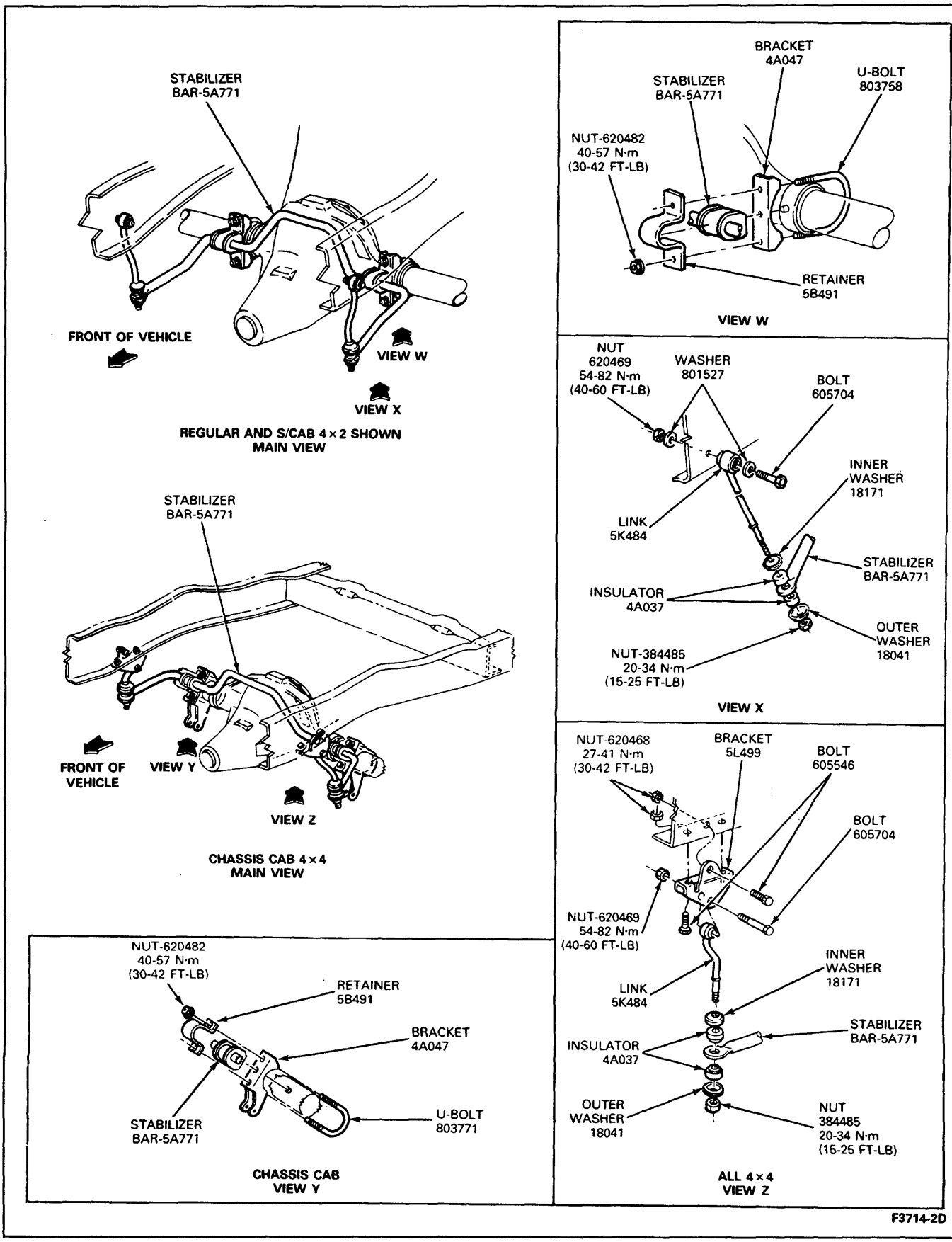


FIG. 14 Rear Stabilizer Bar Installation—F-250—F-350 with Ford Rear Axle

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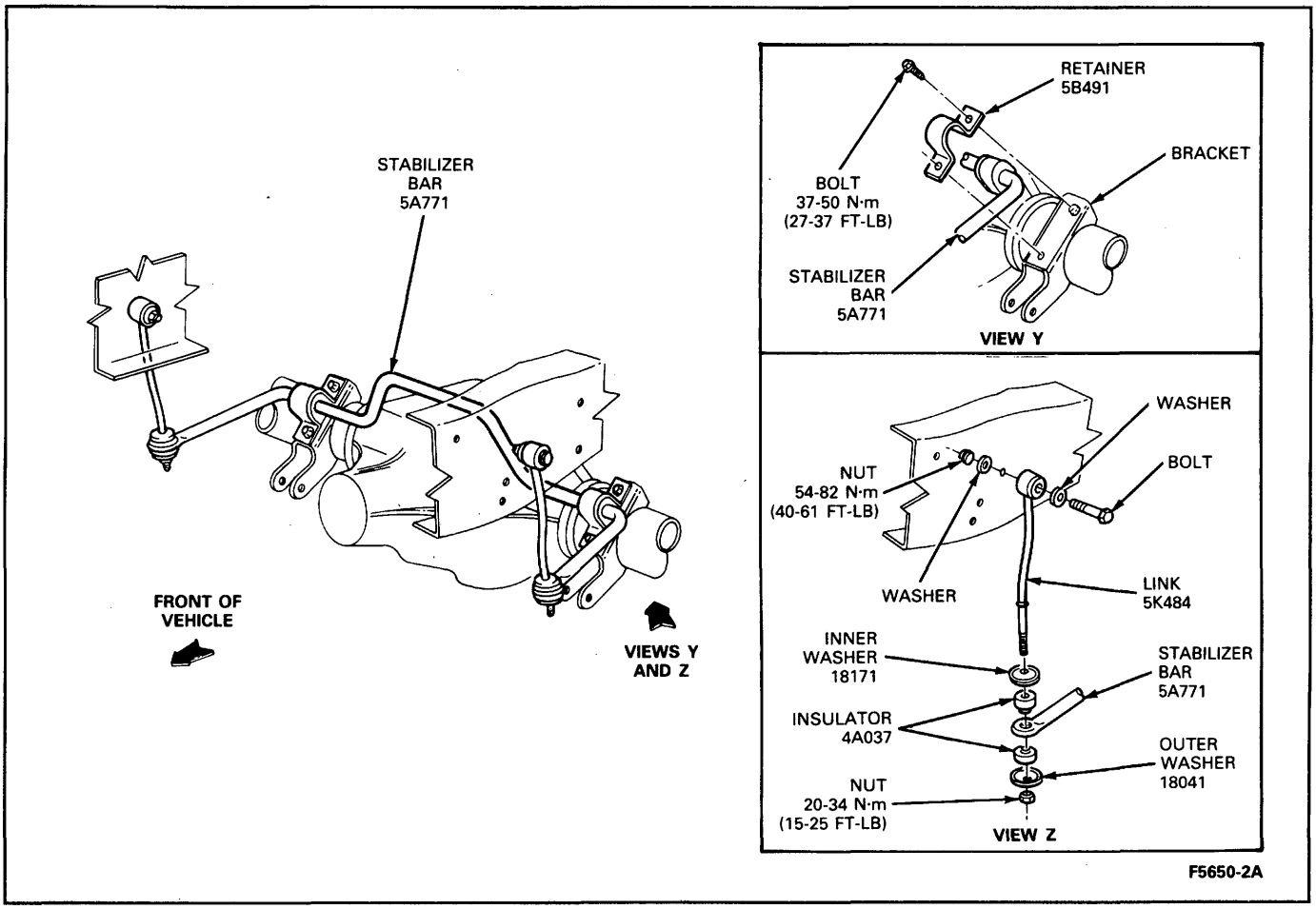


FIG. 15 Rear Stabilizer Bar Installation—F-Super Duty

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SPECIFICATIONS

TORQUE SPECIFICATIONS — F-150 — F-250 — F-350 (4x2), (4x4), F-SUPER DUTY AND BRONCO

Description	Application	Torque Range	
		N•m	Ft-Lbs
Jounce Bumper to Frame Nut	All	25-40	19-30
Leaf Spring to Axle U-Bolt Nut	F-150 — F-250 (under 8500 GVW)	100-155	75-115
	F-250 — F-350 (4x2) Chassis Cab (over 8500 GVW)	200-280	150-210
	F-Super Duty	272-368	200-270
Leaf Spring to Front Bracket Nut and Bolt	F-250-F-350 (4x2) Bronco	200-280	150-210
	F-150 (4x2)	100-155	75-115
	F-150-F-250-F350 (4x4)	200-240	150-177
	F-Super Duty	346-468	255-345
Leaf Spring to Rear Shackle Nut and Bolt	All except F-250 — F-350 (4x2) Chassis Cab	100-150	75-115
	F-250 — F-350 (4x2) Chassis Cab and F-Super Duty	200-280	150-210
Rear Shackle to Frame Nut and Bolt	All except F-250 — F-350 (4x2) Chassis Cab	100-150	75-115
	F-250 — F-350 (4x2) Chassis Cab and F-Super Duty	200-280	150-210
Shock Absorber (Lower Mount) to Axle Nut and Bolt	All	55-85	40-64
Shock Absorber (Upper Mount) to Frame Nut	All	55-85	40-64
Shock Absorber/Stabilizer Bar Bracket to Axle Nut	F-250 — F-350 (4x2) Chassis Cab	40-57	30-42
Stabilizer Bar to Axle Nut	All	40-57	30-42
Stabilizer Bar to Axle Bolt	F-Super Duty	37-50	27-37
Stabilizer Link Bracket to Frame Nut and Bolt	All 4x4 Vehicles	27-41	20-30
Stabilizer Link to Bracket Nut and Bolt	All 4x4 Vehicles	54-82	40-60
Stabilizer Link to Frame Nut and Bolt	All 4x2 Vehicles	54-82	40-60
Stabilizer Link to Stabilizer Bar Nut	All	20-34	15-25
TORQUE SPECIFICATIONS — E-150 — E-250 — E-350			
Jounce Bumper to Frame Nut	E-150	21-33	15-25
	E-250 — E-350	28-41	20-30
Leaf Spring to Axle U-Bolt Nut	E-150	101-145	74-107
	E-250 (Light Duty — 4050)	101-145	74-107
	E-250 — E-350	204-244	150-180
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Leaf Spring to Rear Shackle Nut and Bolt	E-150 — E-250 — E-350	101-145	74-107
Rear Shackle to Frame Nut and Bolt	E-150 — E-250 — E-350	101-145	74-107
Shock Absorber (Lower Mount) to Axle Nut and Bolt	E-150 — E-250 — E-350	55-81	40-60
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GENERAL DRIVING AXLES AND DRIVESHAFTS

GROUP 15

(4000)

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VEHICLE APPLICATION

Applies to E-150—E-350, F-150—F-350 (4x2, 4x4) Bronco and F-Super Duty Trucks.

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DIAGNOSIS AND TESTING

Axle Testing

Certain rear axle and driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires, and other parts of the vehicle. For this reason, be sure that the cause of the trouble is in the rear axle before adjusting, repairing, or replacing any of its parts. See Group 18, Noise Vibration and Harshness.

Certain trouble symptoms may be caused by limited-slip differentials. Check the vehicle certification and axle ratio tag to determine the type of differential.

Location of the axle identification code on the rating plate is shown in Figs. 1 and 2. Refer to Section 10-00 for a complete listing of the codes.

Ford Design Axles

The plant code on the axle identification tag is to be used as the official service identifier (Fig. 3).

The Plant Code for a particular axle assembly will not be duplicated. In addition, the Plant Code will not change as long as that particular axle assembly never undergoes an external design change. If, however, an internal design change takes place during the production life of the axle and that internal change affects service parts interchangeability, a dash and numerical suffix will be added to the Plant Code (Fig. 4).

Note that Plant Codes in Figs. 3 and 4 are identical except Fig. 3 shows a numeric. This means that AS AN ASSEMBLY both axles are interchangeable; however, internally they are different. Therefore, each would require different internal service parts at service time.

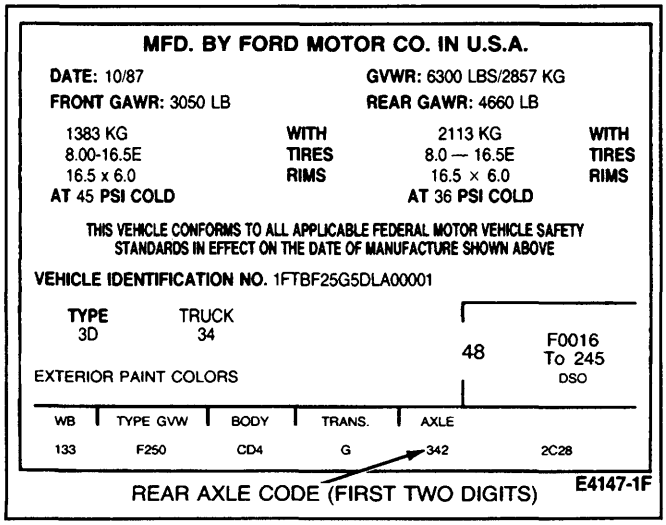


FIG. 1 Truck Safety Compliance Certification Label—Rear Axle Code Location

Dana Design Axles

Rear axles have a metal tag secured under adjacent cover bolt heads listing Ford and Dana part numbers and the ratio. Front drive axles have a similar tag.

Noise Acceptability

A gear driven unit especially a truck drive axle, will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions. For example, as on a newly paved blacktop road. The slight noise is in no way detrimental to operation of the rear axle and must be considered normal.

Rear Antilock Braking System

F-150 through F-350 series and Bronco vehicles use the Rear Antilock Braking System (RABS). Axles in vehicles equipped with the RABS contain a sensor and excitor ring mounted in the carrier. For a detailed description of the RABS see Section 12-31 in this Manual. The system features a multi-tooth excitor ring that is pressed on the differential case behind the ring gear. If the excitor ring is removed, it must be discarded and replaced with a new one. The excitor ring works in conjunction with an electronic speed sensor. This sensor is retained in a bore at the top of the carrier

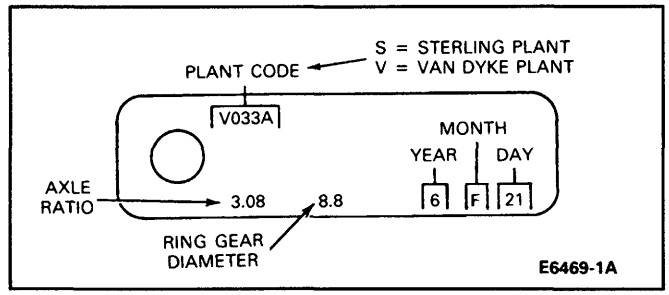


FIG. 3 Rear Driving Axle Model Identification Tag

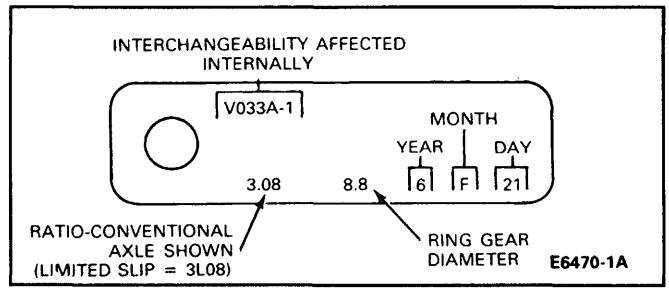


FIG. 4 Internal Change Identification Tag

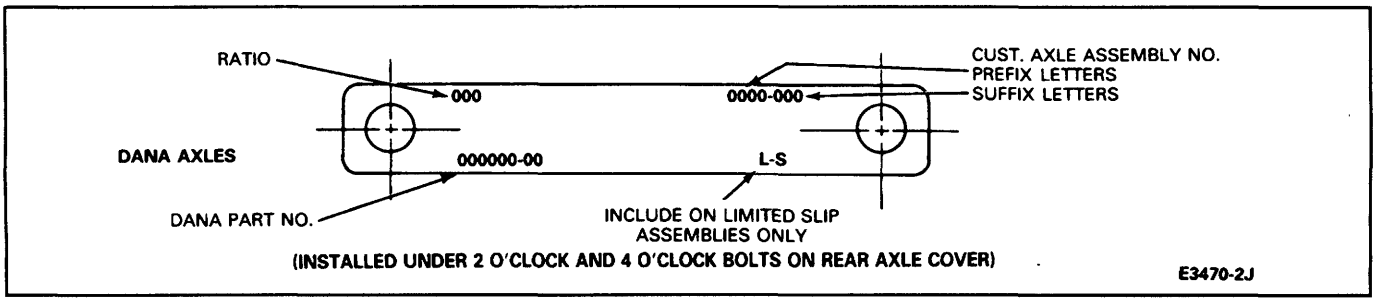


FIG. 2 Axle Identification Tags—Dana

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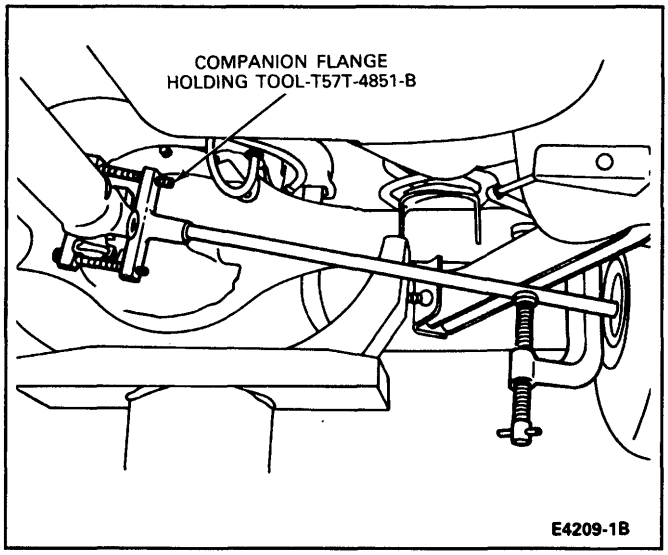


FIG. 5 Lock Axle for Total Backlash Check—Ford F-Series Axles

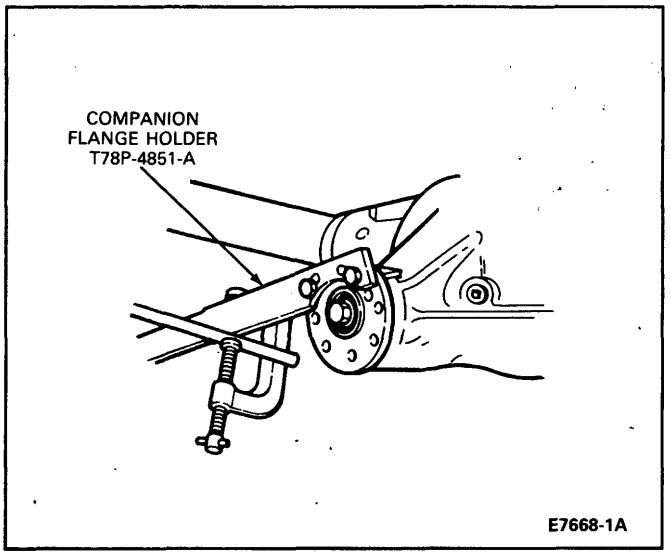


FIG. 6 Lock Axle for Total Backlash Check—Ford E-Series Axles

housing and fastened by one bolt. There is a space provided between the ring gear and excitor ring for measuring the ring gear backface runout. For excitor ring removal and installation procedures refer to the appropriate rear axle Section.

Limited-Slip Differential Operation Check

Refer to Section 15-42 for Limited-Slip Differential—Dana (E-250/350), Section 15-41 for Limited-Slip Differential—Ford-8.8 inch ring gear (F150/Bronco), and Section 15-43 for Limited-Slip Differential—Ford-10.25 inch ring gear (F-250/350).

To demonstrate the proper performance of the limited-slip differential:

Place one wheel on good, dry surface and the other wheel on ice, mud, snow or greased sheet of plywood.

Gradually open throttle to obtain maximum traction prior to "break-away". The ability to move the vehicle will demonstrate proper performance of a limited slip axle.

When starting with one wheel on an excessively slippery surface, a slight application of the parking brake may be necessary to help energize the limited slip feature of the differential. Release the brake when traction is established. Use light throttle on starting to provide maximum traction.

In vehicle operation, it should be noted that:

1. If, with unequal traction, both wheels slip, the limited-slip axle has done all it can possibly do.
2. In extreme cases of differences in traction, the wheel with the least traction may spin after the limited slip has transferred as much torque as possible to the non-slipping wheel.

WARNING: A VEHICLE EQUIPPED WITH A LIMITED-SLIP DIFFERENTIAL WILL ALWAYS HAVE BOTH WHEELS DRIVING. DRIVING THE AXLE WITH THE ENGINE AND ONLY ONE WHEEL RAISED OFF THE GROUND IS NOT A RECOMMENDED PRACTICE WITH EITHER THE LIMITED-SLIP OR CONVENTIONAL AXLE DUE TO THE DANGER OF THE VEHICLE DRIVING OFF THE STAND OR JACK.

Total Axle Backlash Check

Ford Axles

Raise vehicle on hoist. Use a rigid bar or pipe of suitable length and clamp one end to the axle companion flange using Companion Flange Holding Tool T57T-4851-B, for F-Series (half-round flange), and T78P-4851-A for E-Series (circular flange), and the other end to the frame or body member in order to prevent movement of the companion flange (Fig. 5 or Fig. 6).

NOTE: Remove driveshaft when performing this procedure on E-Series.

Lower the vehicle so that one rear wheel is resting on a wheel chock to prevent it from turning. The other rear wheel will then be used to measure total axle backlash.

Rotate the free wheel slowly until a feel of driving the axle is encountered. Position a crayon or chalk firmly on the side of the tire 305 mm (12 inches) from the center of the wheel. Rotate the wheel slowly in the opposite direction until the feel of driving the axle is encountered again.

Measure the length of the crayon or chalk mark on the tire. If the length of the mark is 25.4mm (1 inch) or less, the axle backlash is within allowable limits.

If the chalk mark is greater than 1 inch, check for these conditions:

1. Elongation of the differential pinion shaft holes in the differential case.
2. Missing differential, pinion, or side gear thrust washers.
3. Galling of the differential pinion shaft and bore.
4. Excessive gear set backlash. Follow procedure for type of axle, to check backlash.

Dana Axles

Apply parking brake to keep both rear wheels from turning. Mount a dial indicator Tool D78P-4201-B on the carrier housing with the indicator point positioned to contact the pinion yoke 38.1mm (1-1/2 inch) from the center line of the pinion shaft.

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With the transmission in neutral and engine not running, check the total rotational movement of the pinion yoke. If the total reading on the dial indicator is 1.9mm (0.075 inch) or less, the axle backlash is within allowable limits.

Diagnosis Guides

The diagnosis guides in this Section can be used when diagnosing rear axle and driveline systems.

ADJUSTMENTS

Axle Adjustments

Certain rear axle and driveline trouble symptoms are also common to the engine, transmission, wheel bearing, tires, and other parts of the vehicle. For this reason, be sure that the cause of the trouble is in the rear axle before adjusting, repairing or replacing any of the parts. See Section 18-01, Noise, Vibration and Harshness and the appropriate Section in Group 14 Rear Suspension.

Pinion and Ring Gear Adjustments (All Except Dana)

Two adjustments affect drive pinion and ring gear tooth contact. They are drive pinion depth and backlash (Fig. 7).

The pinion depth adjusting shims are installed between the drive pinion Head and Rear pinion bearing, therefore, adding shims moves the drive pinion towards the ring gear, and removing shims moves the drive pinion away from the ring gear.

On Ford integral axles, backlash is adjusted by adding or removing shims between the differential case side bearings and carrier housing.

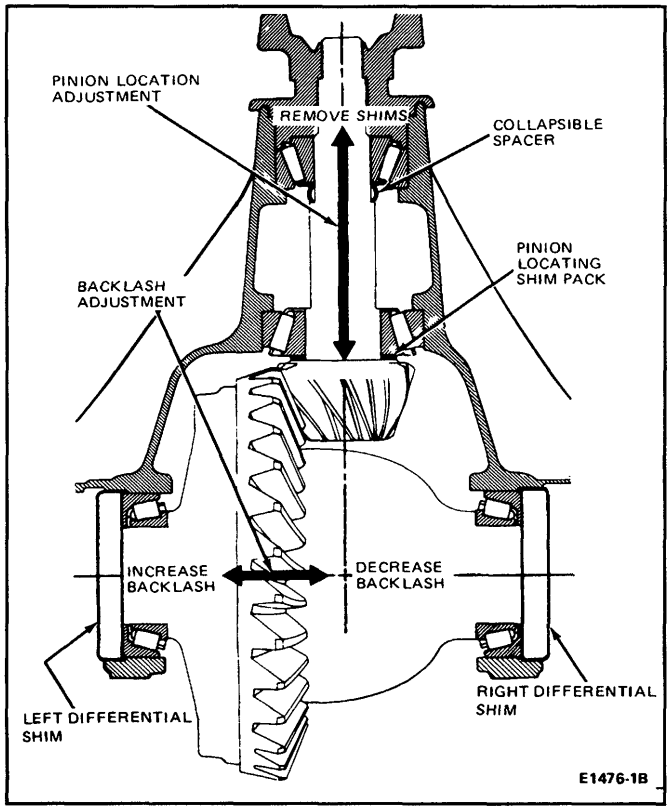


FIG. 7 Pinion and Ring Gear Tooth Contact Adjustment—Integral Carrier Axles

Shim Selection

Individual differences in matching the differential housing and the rear pinion bearing require the use of shims between the drive pinion bearing retainer sleeve and the carrier housing to locate the pinion for correct contact with the ring gear.

Ring Gear Replacement Dana Axles

New Ring Gear bolts should be used to attach a new ring gear to the differential case. Grade 9 bolts with increased torque requirements are now required. Refer to Section 15-0 Integral Carrier Axle—Dana.

Place the new ring gear on the differential case and insert the bolts through the ring gear and into the case and tighten the ring gear bolts to specifications at the end of this Section.

Rear Axle Lubrication

The ability of any axle to deliver quiet, trouble-free operation over a period of years is largely dependent upon the use of good quality gear lubricants. To insure long life for gears and bearings, use only specified hypoid gear lubricants. Dana and Ford axles use different lubricants as follows:

- Ford requires ESP-M2C154-A (E0AZ-19580-A)
- Dana requires ESW-M2C105-A (C6AZ-19580-E)

Draining

Dana Axles

Dana axles do not have a drain plug. The cover should be loosened and removed from the housing to allow drainage. The RTV Sealer must be removed from the cover and axle housing. Reseal with fresh RTV sealer Silicone Rubber, meeting Ford Specifications ESL-M4G273-A or sealant meeting specifications, ASTM1, GE503, Z1, Z2 and Z3 or equivalent.

Filling

Ford Axle

The filler hole is in the carrier casting, fill to the bottom of the hole with the exception of Bronco.

To check these axles for proper lubricant level, the filler plug should be backed out slowly. If seepage occurs around the threads of the plug, immediately turn the plug back in to avoid any drainage. This condition indicates that the specified amount of lubricant is in the axle.

NOTE: The Bronco lube level may be 6.3 mm (1/4 inch) below the filler hole. It is not necessary to fill above this level.

Dana Front and Rear Axles

Fill the axle through the cover filler hole until oil flows from the bottom of the hole. After filling the axle with the specified amount of lubricant, install the oil filler hole plug.

Rear Wheel Bearing and Seal Removal and Installation

Two types of rear wheel bearing assemblies are used in truck axles, full floating and semi floating. Refer to Section 15-05 Integral Carrier Axle—Dana; Section 15-08, Integral Carrier Axle—Ford—8.8 Inch Ring Gear; and Section 15-09, Integral Carrier Axle—Ford—10.25 Inch Ring Gear for removal and installation details.

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The following charts can be used when diagnosing rear axle and driveline systems:

CONDITION	POSSIBLE CAUSE	RESOLUTION
• Excessive rear axle noise.	1. N.V.H. problem. (Noise, vibration and harshness.)	1. Perform the N.V.H. tests to determine whether the noise is a N.V.H. caused by an axle problem. Refer to group 18.
	2. Worn or damaged wheel bearing.	2. Perform wheel bearing noise test. Refer to group 18. Replace bearings if required.
	3. Worn or damaged differential carrier assembly.	3. Remove rear cover. Inspect before disassembly. Repair and replace parts as required.
• Loud "clunk" in the driveline when shifting from reverse to forward.	1. High idle speed.	1. Adjust idle speed.
	2. Loose engine mounts.	2. Inspect, repair as required.
	3. Loose or worn driveshaft components, companion flange attaching nut below specs.	3. Inspect, repair or replace as required.
	4. Inoperative shock absorbers and/or loose rear springs or suspension arms.	4. Inspect, repair or replace as required.
	5. Excessive backlash in axle, or transmission.	5. Perform total backlash check of axle. Repair or replace as necessary.
	6. Insufficient lubrication.	6. Add lubricant as required.
• Driveline "clunk" as vehicle starts to move following a brake stop (2-piece driveshaft).	1. Loose rear spring U-bolts.	1. Tighten U-bolts to specification.
	2. Worn or galled output shaft splines.	2. Remove the driveshaft from the vehicle. Clean the male splines and inspect for worn or galled splines. Replace if necessary.
	3. Worn or galled slip yoke splines.	3. Clean and inspect the female splines of the slip yoke for worn or galled condition. Replace if necessary.
	4. Damaged slip yoke seal.	4. Replace seal.
	5. Insufficient lubrication.	5. Using a long handle (stencil type) brush, apply long life lube evenly on all the splines of the slip yoke. Reinstall driveshaft and using a hand grease gun lubricate the slip yoke thru the zerk fitting with long life lube C1AZ-19590-B (ESA-M1C75-B) or equivalent. NOTE: Install the slip yoke making sure that the coupling shaft and driveshaft are in phase.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
• On turns, DANA limited slip axle has a high pitched chattering noise.	1. Improper lubricant.	1. If axle chatters, siphon or drain lubricant from axle and refill with specified rear axle lubricant, and dosage of friction modifier additive.
• DANA limited slip axle does not work in snow, mud or ice.	1. Worn or damaged axle unit.	1. Starting with one wheel on a slippery surface, slightly apply the parking brake. Gradually open throttle. If the vehicle moves, the axle is operating satisfactorily.
• Driveline concerns.	1. Rear spring U-bolt loose.	1. Retighten U-bolts and driveshaft.
	2. U-joint worn or improperly installed.	2. Reinstall or replace U-joint.
	3. Coupling shaft center support bearing improperly installed.	3. Correctly install bearing and replace if damaged.
	4. Excessive runout in companion flange and damaged U-joint.	4. Rotate flange 180° and reinstall. Recheck and if not acceptable, replace flanges and/or U-joint and repair as required.
	5. Excessive lateral and radial tire and wheel runout.	5. Refer to Section 11-01, General Wheel and Tire Service.
	6. Excessive driveshaft runout.	6. Replace driveshaft or rotate driveshaft 180° and check for out-of-balance condition.
	7. Driveshaft out-of-balance.	7. Rebalance driveshaft.
	8. Driveline and pinion angles out-of-specification.	8. Adjust to specifications.
	9. Binding, damaged or galled splines on slip yoke.	9. Check transmission for proper lubricant, and clean and lap splines. Lubricate splines with Multi-Purpose Long-Life Lube C1AZ-19590-B (ESA-M1C75-B) or equivalent.

CE5570-2B

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REAR AXLE DIAGNOSIS GUIDE — FORD AXLES

CONDITION	POSSIBLE CAUSE	RESOLUTION
Excessive rear axle noise.	1. Differential carrier.	1. Road test vehicle to assure problem is rear axle noise rather than other system noise. Refer to General Diagnostic Procedure. Repair and replace parts as required.
Loud "clunk" in the driveshaft when shifting from reverse to forward.	1. Driveshaft. 2. Rear axle shafts or carrier.	1. Raise vehicle, rotate driveshaft by hand to isolate problem as driveshaft or rear axle problem. Repair or replace as required. 2. Remove and inspect. Repair as necessary.
Limited-slip axle does not work in snow, mud or on ice.	1. Differential.	1. Perform Differential Operation Check in this Section. Repair as required.
On turns, the rear axle has a high pitched chattering noise (Limited-slip axles only).	1. Lubricant. 2. Differential.	1. Road test vehicle — drive truck in tight circles, 5 clockwise and 5 counterclockwise. If chatter is still evident, flush and replace lubricant. (See Lubricant Specifications at the end of this Section.) 2. Remove differential, repair as required.
Noise is the same on drive or coast.	1. Road noise. 2. Tire noise. 3. Front wheel bearing noise.	1. Normal Condition. 2. Rebalance or replace tire. 3. Adjust or replace wheel bearings.
Noise changes with type of road.	1. Road noise. 2. Tire noise.	1. Normal Condition. 2. Rebalance or replace tire.
Noise tone lowers as truck speed is lowered.	1. Tire noise.	1. Rebalance or replace tire.
Similar noise is produced with truck standing and driving.	1. Engine noise. 2. Transmission noise.	1. Refer to Section 21-01, Engine — Volume B*. 2. Refer to Section 17-01, General Automatic Transmission Service.
Vibration.	1. Refer to Noise, Vibration and Harshness, Section 18-01.	1. Refer to Noise, Vibration and Harshness, Section 18-01.
Noise most pronounced on turns.	1. Differential side gears and pinion gears.	1. Replace gears.
Drive noise, coast noise, or float noise.	1. Wheel bearings or differential side bearings. 2. Ring and pinion gear.	1. Adjust or replace wheel or differential side bearings. 2. Check ring and pinion gear. Adjust or replace.
Clunk on acceleration or deceleration.	1. Worn differential pinion shaft in case.	1. Replace differential pinion shaft.

*Engine manual — Volume B may be purchased separately. CE3742-2E

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CHATTERS ON TURNS WITH NO LIMITED SLIP DIFFERENTIAL

TEST STEP		RESULT ▶	ACTION TO TAKE
1.0	DRIVE VEHICLE		
	Drive vehicle in fairly tight figure 8's — ten times total. (Five clockwise and five counterclockwise).	No Chatter ▶	STOP.
		Chatter still present ▶	GO to **2.**
2.0	CHANGE LUBRICANT		
	Siphon or drain lubricant from axle and refill with specified rear axle lubricant①. Drive vehicle in fairly tight figure 8's — ten times total. (Five clockwise and five counterclockwise).	No Chatter ▶	STOP.
		Chatter still present ▶	GO to **3.**
3.0	DRIVE VEHICLE		
	Drive vehicle 40-80 km (25-50 miles) in addition to figure 8's.	No Chatter ▶	STOP.
		Chatter still present ▶	REMOVE the differential and REPAIR as required.

① F-150, Bronco, E-150 with Ford 8.8 Limited Slip add 4 oz. of friction modifier (EST-M2C118-A) C8AZ-19B546-A. E-250—350 with Dana Limited Slip or F-250-350 with Ford 10.25 Limited Slip add 8 oz. of friction modifier (EST-M2C118-A) C8AZ-19B546-A.

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LIMITED SLIP DIFFERENTIAL DOES NOT OPERATE IN MUD OR SNOW OR ON ICE

TEST STEP		RESULT ▶	ACTION TO TAKE
1.0	ALL FORD AND DANA MODEL 60 AND 70		
	Starting with one wheel on an excessively slippery surface, slightly apply the parking brake. Gradually open throttle, if the vehicle moves, the axle is operating properly.	Vehicle moves ▶	Unit OK. STOP.
		Vehicle doesn't move ▶	REPAIR Unit as required.

CE4768-2C

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DRIVELINE COMPLAINTS

CONDITION	POSSIBLE CAUSE	RESOLUTION
Driveline Concerns	1. Rear spring U-bolt loose.	1. Retighten U-bolts and driveshaft.
	2. U-joint worn or improperly installed.	2. Install or replace U-joint.
	3. Coupling shaft center support bearing improperly installed.	3. Correctly install bearing and replace if damaged.
	4. Excessive runout in companion flange and damaged U-joint.	4. Rotate flange 180 degrees and install. Recheck, and if not acceptable, replace flanges and/or U-joint and repair as required.
	5. Excessive lateral and radial tire and wheel runout.	5. Refer to Section 11-01, General Wheel and Tire Service.
	6. Excessive driveshaft runout.	6. Replace driveshaft or rotate driveshaft 180 degrees and check for out-of-balance condition.
	7. Driveshaft out-of-balance.	7. Rebalance driveshaft.
	8. Driveline and pinion angles out-of-specification.	8. Adjust to specifications.
	9. Binding, damaged or galled splines on slip yoke.	9. Check transmission for proper lubricant, and clean and lap splines. Lubricate splines with Multi-Purpose Long-Life Lubricant C1AZ-19590-B (ESA-M1C75-B).
Noise on Drive or Coast	1. Improper driveline angles or phasing.	1. Adjust or correct as required.
Loud clunk in the Driveline when shifting from reverse to forward.	1. Loose or worn driveshaft components, companion flange attaching nut below specifications.	1. Inspect, repair, replace as required.

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Light series vehicles with semi-floating axles are equipped with straight roller bearings. The oil seal is outboard of the bearings. Full service procedures for these bearings and seals are provided in Section 15-05 Integral Carrier Axle—Dana and Section 15-08, 15-09 Integral Carrier Axle—Ford—8.8/10.25 Inch Ring Gear.

Rear Axle Companion Flange Runout Check—F-Series

1. Raise the vehicle on a hoist that supports the rear axles (twin-post hoist).
2. Remove the driveshaft assembly (Section 15-60 Driveshaft—Single Snap Ring Type U-Joint).
3. Check the companion flange for damage to the universal joint bearing locating lugs. If the lugs are shaved (worn) or damaged, replace the flange (Fig. 8).
4. The companion flange runout is checked with a dial indicator with 25.40mm (1.000 inch) minimum travel, and a cup-shaped dial indicator adapter Tool 6565-AC (Fig. 9). To fabricate the checking tool, modify a universal joint assembly by removing two bearing cups that are opposite each other, and cutting or grinding off one of the universal joint bearing flanges (Fig. 9).
5. Install the cup-shaped adapter on the dial indicator stem. Install the dial indicator on the pinion retainer or pinion nose bumper bracket. Position the indicator to allow an indication at the ends of the universal joint bearing cups and the remaining exposed journal of the cross-shaft.
6. Turn the companion flange so that the dial indicator cup-type adapter rests on the machined surface of the bearing cup (Fig. 9). Rotate the companion flange side-to-side slightly to obtain a reading indicating that the bearing cup surface is perpendicular to the adapter. **This will be the point at which the dial indicator cup is closest to the center of companion flange rotation. It is also the point at which the dial indicator hand will reverse direction as the companion flange is turning.**
7. Carefully retract the dial indicator stem and rotate the companion flange 180 degrees to position the machined surface of the opposite universal bearing under the dial indicator adapter tool. Again, slightly rotate the flange side-to-side to position the bearing perpendicular to the dial indicator adapter. Again, this is the point at which the indicator hand will reverse direction as the flange is rotated. Record the flange bearing cup runout reading obtained from the indicator (Fig. 10).

   Rotate the companion flange 90 degrees and position the dial indicator adapter on the machined end of the exposed journal (Fig. 11). **Be sure the end surface of the journal is perpendicular to the adapter.** This requires that the cross-shaft be moved fore and aft on the flange bearing cups.

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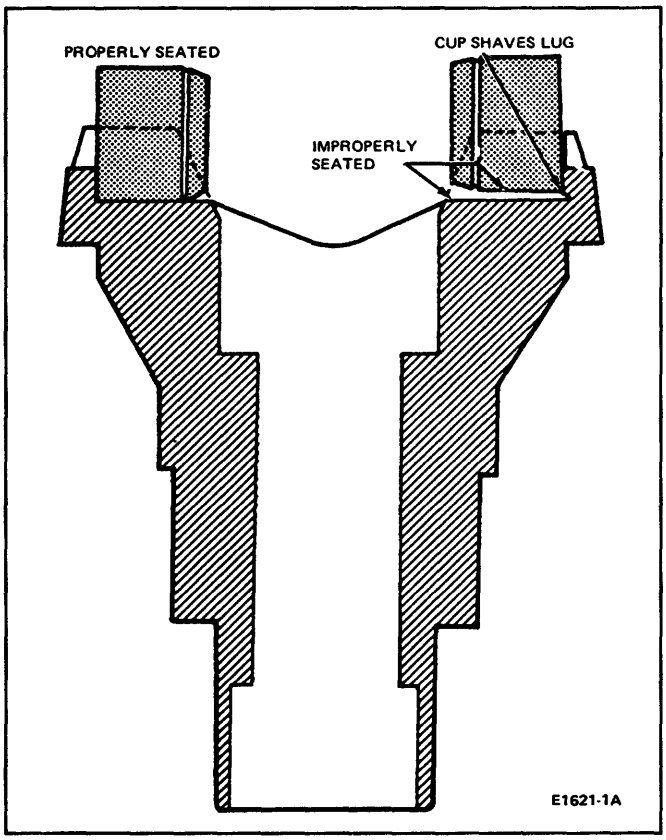


FIG. 8 Checking Companion Flange

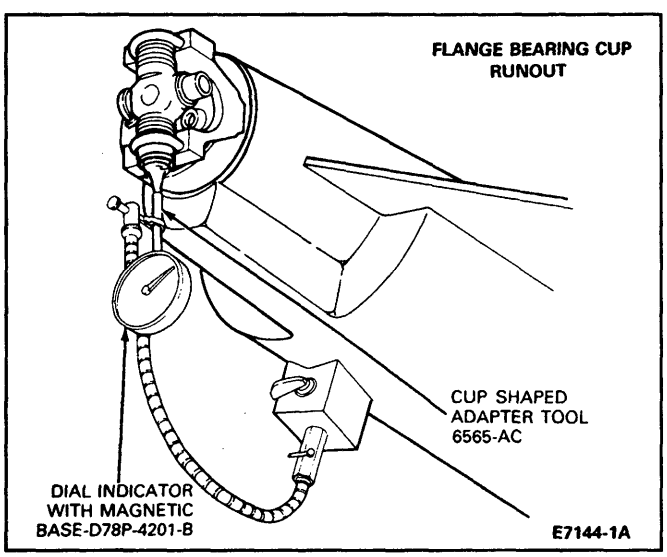


FIG. 9 Flange Bearing Cup Runout

Note the point at which the indicator hand reverses direction.

Rotate the flange assembly side-to-side until the cross-shaft is perpendicular to the pinion shaft axis, and the indicator hand reverses direction. Zero the dial indicator and check the zero point again by slightly moving the cross-shaft fore and aft; then, rotate the companion flange from side-to-side.

8. With the indicator at zero, carefully retract the dial stem and rotate the flange 180 degrees. Rotate the cross-shaft 180 degrees on the flange bearing cups to position the exposed journal under the dial indicator adapter. Rock the cross-shaft fore and aft and the companion flange side-to-side to establish the point at which the indicator hand reverses direction. This will determine the driveshaft universal cross-shaft runout. Record this reading (Fig. 11).

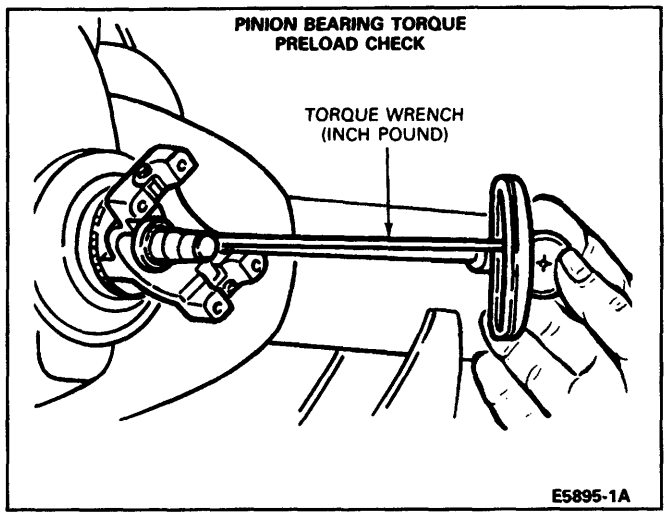


FIG. 10 Pinion Bearing Torque, Preload Check

Indicator Reading	Flange Bearing Cup Runout—Inch	Driveshaft Universal Cross-Shaft Runout—Inch
1	0.004	0.005
2	0.002	0.004
3	0.003	0.003
Average	0.003	0.004

CE1943-1B

FIG. 11 Flange Bearing Cup and Cross-Shaft (V2) Runout Averaging Chart—Typical Reading

9. **Repeat Steps 5 through 8 at least three times and average the indicator readings obtained (Fig. 10).**

10. To determine the total (combined) companion flange runout, use the combined runout guide (Fig. 12). With an indicated 0.003-inch flange bearing cup runout and an indicated 0.004-inch universal cross-shaft runout (Fig. 11), the combined companion flange runout will be 0.005-inch (Fig. 12).

11. If the reading obtained in Step 10 exceeds specifications, re-position the companion flange 180 degrees on the pinion shaft and repeat Steps 1 through 11.

CAUTION: BEFORE removing the companion flange, check and record the pinion nut torque. Also, check and record the pinion bearing preload, (Fig. 10). Original readings must be repeated after the companion flange is repositioned.

Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible pinion spacer and pinion nut must be installed.

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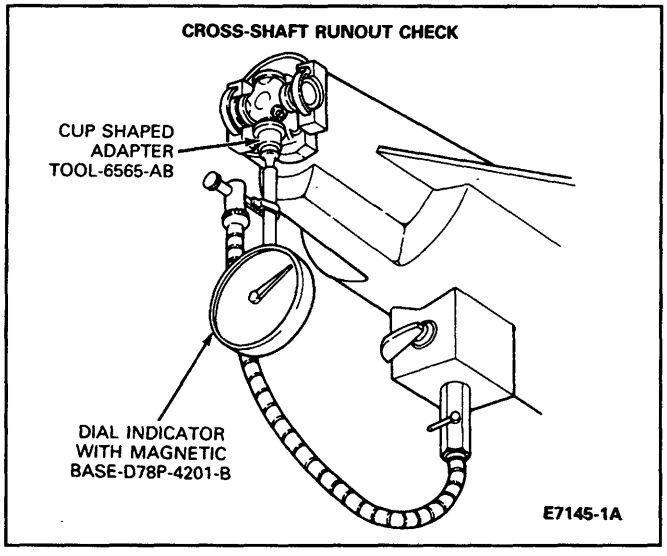


FIG. 12 Cross-Shaft Runout Check

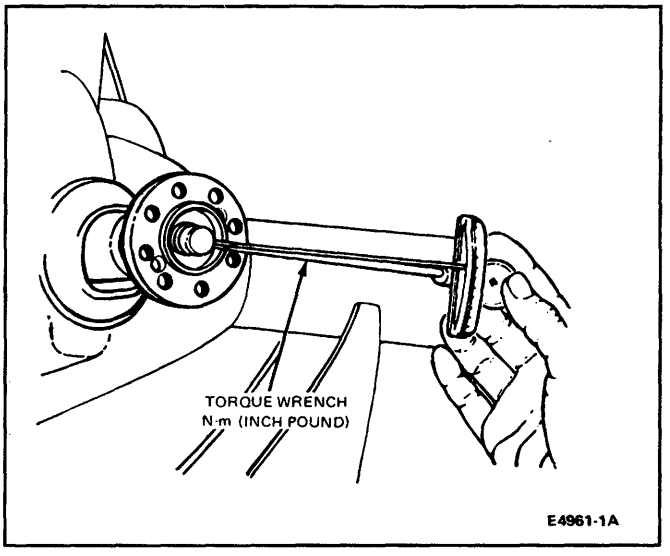


FIG. 13 Pinion Bearing Torque Preload Check

12. If the repeat readings still exceed specifications, re-position the flange an additional 90 degrees on the pinion shaft and check the runout (Steps 4 through 10).
13. If the runout is still excessive, replace the companion flange and check the runout. If necessary, rotate the new flange on the pinion shaft until an acceptable runout is obtained.

    If excessive runout is still evident after replacement of the companion flange, replace the ring gear and pinion and repeat the above checks until the runout is within specifications.
14. Install the driveshaft assembly (Section 15-60 General Driveshaft Service). **Make sure the universal joint bearing cups are properly positioned between the companion flange lugs.**
15. Lower the vehicle. Road test the vehicle. If driveshaft vibrations are evident during the road test, remove the driveshaft from the companion flange and rotate it 180 degrees. Road test the vehicle again.

Rear Axle Companion Flange Runout Check-8.8 inch Ring Gear—E-Series

1. Raise the vehicle on a hoist that supports the rear axle (twin post hoist). Refer to the Pre-Delivery manual, Section 50-04.
2. Remove the driveshaft assembly. Refer to Sections 15-60 and 15-66.
3. Check the companion flange for damage.
4. To check radial runout, set up dial indicator.
5. Rotate the companion flange with the dial indicator in place. If the runout exceeds specifications (refer to specific axle Section for specifications), remove the flange and install it 180 degrees from original position. Follow the procedure in Sections 15-60 and 15-66 for companion flange installation.

CAUTION: BEFORE removing the companion flange, check and record the pinion nut torque. Also, check and record the pinion bearing preload, (Fig. 13). Original readings must be repeated after the companion flange is repositioned.

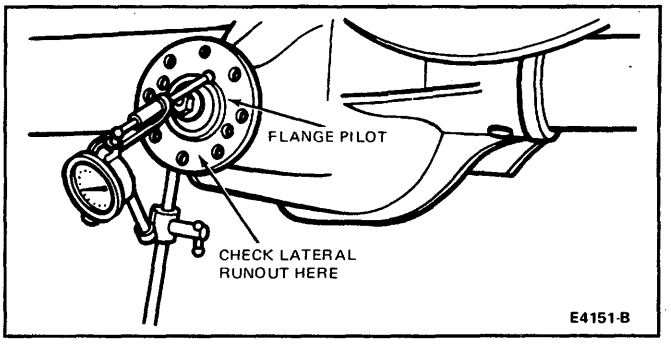


FIG. 14 Lateral Runout Check

Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible pinion spacer and pinion nut must be installed.

6. If runout is still excessive, remove and install flange an additional 90 degrees and check runout.
7. To check lateral (face) runout, set up the dial indicator. Repeat Steps 5 and 6.
8. If runout is still excessive, replace companion flange and check runout. If necessary, rotate the new flange on the pinion shaft until an acceptable runout is obtained.

   If excessive runout is still evident after replacement of the companion flange, it will be necessary to replace the ring and pinion gear, and repeat the above checks until runout is within specifications.
9. Install the driveshaft assembly as described in Sections 15-60 and 15-66.

CLEANING AND INSPECTION

Inspection Before Carrier Disassembly

The differential case assembly and drive pinion should be inspected before they are removed from the carrier casting. These inspections can help find the cause of the concern and determine the correction needed.

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Flange Bearing Cup Runout	Driveshaft Universal Cross-Shaft Runout — Inch												
	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.010	0.011	0.012
0.000	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.010	0.011	0.012
0.001	0.001	0.0013	0.0022	0.0032	0.0042	0.0051	0.0061	0.0071	0.0081	0.0091	0.0010	0.011	0.012
0.002	0.002	0.0022	0.0027	0.0037	0.0045	0.0053	0.0062	0.0072	0.0082	0.0092	0.0101	0.0111	0.0121
0.003	0.003	0.0032	0.0036	0.0042	0.005	0.0058	0.0067	0.0077	0.0085	0.0094	0.0104	0.0113	0.0123
0.004	0.004	0.0042	0.0045	0.005	0.0057	0.0064	0.0072	0.0081	0.009	0.0097	0.0107	0.0116	0.0126
0.005	0.005	0.0051	0.0053	0.0058	0.0063	0.0071	0.0078	0.0087	0.0094	0.0102	0.0111	0.012	0.013
0.006	0.006	0.0061	0.0062	0.0068	0.0072	0.0078	0.0085	0.0092	0.010	0.0108	0.0116	0.124	0.0134
0.007	0.007	0.0071	0.0073	0.0075	0.0081	0.0087	0.0093	0.0099	0.0103	0.0114	0.0122	0.013	0.0138
0.008	0.008	0.0081	0.0082	0.0087	0.009	0.0094	0.010	0.0104	0.011	0.012	0.0128	0.0135	0.0144
0.009	0.009	0.0091	0.0092	0.0094	0.0097	0.102	0.108	0.0114	0.012	0.0127	0.0134	0.0141	0.015
0.010	0.010	0.010	0.0101	0.0104	0.0107	0.0111	0.0116	0.0122	0.0128	0.0134	0.0141	0.0148	0.0156
0.011	0.011	0.011	0.0111	0.0113	0.0116	0.012	0.0124	0.013	0.0135	0.0141	0.0148	0.0154	0.0162
0.012	0.012	0.012	0.0121	0.0123	0.0126	0.013	0.0134	0.0138	0.0144	0.015	0.0156	0.0162	0.0169

The total (combined) companion flange runout is located in the square where the columns containing the flange bearing cup runout and universal cross shaft runout readings intersect.

CE3683-2A

FIG. 15 Companion Flange Combined Runout Chart

1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.
2. Rotate the gears to see if there is any roughness which would indicate worn or damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.
4. Set up a dial indicator (Figs. 16, 17 and 18), and check ring gear backlash and ring gear backface runout.

   NOTE: On F-Series and Bronco vehicles equipped with Rear Antilock Brakes (RAB), mount Dial Indicator with Bracketry, TOOL-4201-C, or equivalent on the carrier so the tip of the dial indicator contacts the backface of the ring gear (Fig. 17). There is a space provided between the excitor ring and the ring gear for measuring ring gear backface runout.
5. Proper gear set assembly must be checked using the Pinion Depth Gauge T79P-4020-A or equivalent which shows correct pinion shim required to assure acceptable running condition.

Inspection After Carrier Disassembly

All Axles

Thoroughly clean all parts. Synthetic seals must not be cleaned, soaked or washed in cleaning solvents. Always use clean solvent when cleaning bearings. Oil the bearings immediately after cleaning, to prevent rusting. Inspect the parts for wear or damage. If rust is present, remove with a wire brush mounted on a power drill or equivalent. Rinse clean with metal-prep solvent on sponge or rag to remove all particles. With a clean sponge, coat tube interior with Dupont 3012-5 Red Oxide Preparakote or equivalent. Allow to dry for a minimum of one hour.

When a scored gear set is replaced, the axle housing should be washed thoroughly. This can only be done effectively if the axle shafts and shaft seals are removed from the housing. Inspect individual parts as outlined below.

Gears

Examine the pinion and ring gear teeth for scoring or excessive wear. Worn gears cannot be rebuilt to correct a noisy condition. Gear scoring is the result of excessive shock loading or the use of an incorrect lubricant. Scored gears cannot be reused. Examine the teeth and thrust surfaces of the differential gears. Wear on the hub of the differential side gear can cause a chucking noise known as chuckle when the vehicle is driven at low speeds. Wear of splines, thrust surfaces, or thrust washers, can contribute to excessive driveline backlash.

Sensor

Inspect the Rear Antilock Brake System Sensor (RABS) pole piece for loose metal particles and clean if required.

Excitor Ring

Examine the Rear Antilock Brake System (RABS) excitor ring to see that it is firmly pressed on to the differential case and check it for damaged (dented, chipped or missing) teeth that could result in erratic RABS performance. If damage is found, remove and replace excitor ring.

Bearing Cups and Cone and Roller Assemblies

Check bearing cups for rings, scores, galling, or excessively worn wear patterns. Pinion bearing cups must be solidly seated in the housing bores. Check for seating by attempting to insert a 0.04mm (0.0015-inch) feeler between these cups and the bottoms of their bores.

Dana (Models 60, 61-1, 70, and 70-HD only) rear axle differential bearing cups are bonded to the housing with anerobic adhesive ESE-M4G167-A4 (Loctite No. 680 or equivalent) to prevent the cups from spinning under load and damaging the housing. Always clean residue of old adhesive before applying a new 1 inch x 1/8 inch bead to the housing upon assembly.

When operated in the bearing cups, cone and roller assemblies must turn without roughness. Examine the large roller ends for wear. If the original blend radius has worn to a sharp edge, the bearing should be replaced.

If inspection reveals either a worn bearing cup or a worn cone and roller assembly, both parts should be replaced to avoid damage.

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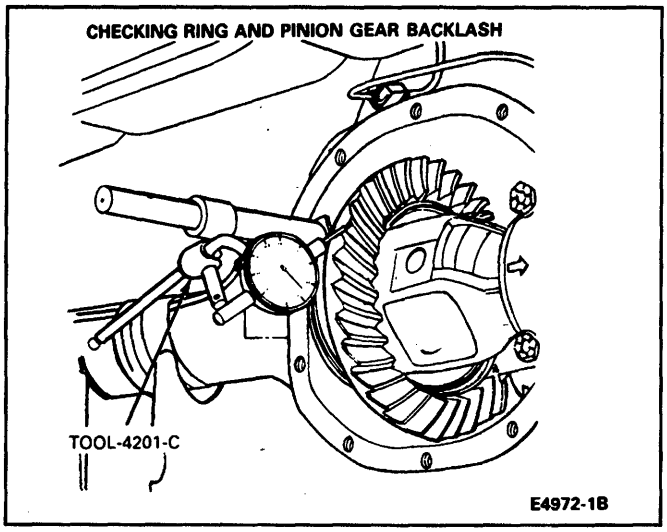


FIG. 16 Ring and Pinion Gear Backlash Check

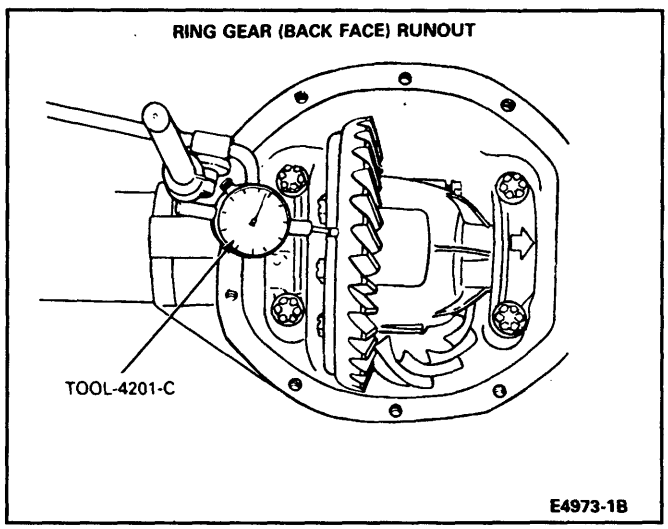


FIG. 17 Ring Gear Runout Check—Vehicles Not Equipped with Rear Antilock Brakes

Pinion Flange

Be sure that the surfaces of the pinion flange have not been damaged in removing the driveshaft or in removing the flange from the axle. The end of the pinion flange that contacts the front pinion bearing inner race or slinger washer, as well as the flat surface of the pinion nut counterbore, must be smooth. Polish these surfaces if necessary. Roughness aggravates backlash noises and causes wear of the flange and pinion nut, with a resultant loss in pinion bearing preload.

Carrier Housing

Make sure that the differential bearing bores are smooth (if applicable). Remove any nicks or burrs from the mounting surfaces of the carrier housing.

On Dana rear axles, note particularly the bearing seat ledge in the housing adjacent to the outboard surface of the differential bearing cup. If the cups have spun, a step may be worn into the ledge. If the wear is less than 0.020 inch/side (0.040 inch maximum/housing) AND it can be cleaned up to full face contact with a new bearing cup square with the bore, the housing is repairable and may be re-used.

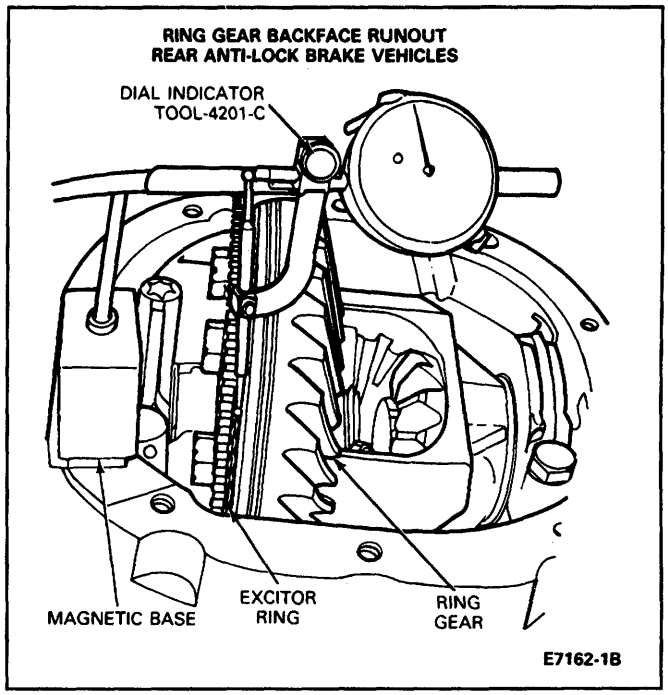


FIG. 18 Ring Gear Backface Runout Check—Vehicles Equipped with Rear Antilock Brakes

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores.

NOTE: Care should be taken to prevent damage to the RABS excitor ring while handling and servicing the differential case.

Limited-Slip Differential Parts

Inspect the clutch plates for uneven or extreme wear. The dog eared clutch plates must be free from burrs, nicks or scratches which could cause excessive or erratic wear to the internally splined clutch plates. The internally splined clutch plates should be inspected for condition of the material, and wear. Replace the plates if their thickness is less than 1.5mm (0.058-inch) or if the material is scored or badly worn. Inspect the plate internal teeth for wear. Replace them, if excessive wear is evident.

Plates should be replaced as a set only. Examine all thrust surfaces and hubs for wear. Abnormal wear on these surfaces can contribute to a noisy axle.

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SPECIFICATIONS

FRONT AND REAR AXLE LUBRICANT CAPACITIES

Axle Model	Vehicle	Approximate Capacity		
		U.S. Pints	Imperial Pints	Liters
Ford Axle — 8.8 Inch Ring Gear③	F-150 Bronco	5.5	4.6	2.6
	E-150	5.5	4.6	2.6
Ford Axle 10.25 Inch Ring Gear⑤	F-250-350 (4x2) — Dual Rear Wheels F-250-350 (4x4)	7.5④	6.3	3.5
Dana 44 IFS — Front ①	F-150 (4x4), Bronco	3.6	3.0	1.7
Dana 44 IFS-HD — Front①	F-250 (4x4)	3.6	3.0	1.7
Dana 50-IFS — Front①	F-250 (4x4) HD	3.8	3.2	1.8
Dana 60 — Front	F-350 (4x4)	5.9	4.9	2.8
Dana 60-IU	E-250	7.0	5.8	3.3
Dana 60-3 — Rear②	E-250 Under 8500 GVW	6.25	5.2	3.0
Dana 61-1 — Rear②	E-250 Over 8500 GVW, E-350 SRW	5.8	4.8	2.8
Dana 70 — Rear②	E-350 Dual Rear Wheel	6.6	5.5	3.1
Dana 80 — Rear	F-Super Duty	8.25	6.9	3.9

①Add 2 U.S. ounced of Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent to Dana Front Drive Axle with limited slip differential.
②Add 8 U.S. ounces of Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent to Dana rear axles with limited slip differentials.
③Add 4 U.S. ounces of Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent to Ford 8.8 inch limited slip rear axles.
④7.5 pints is the factory fill. In vehicle fill is 6.5 pints. Ford 10.25 inch Axles with Limited Slip differentials.
⑤Add 8 oz. of friction modifier, C8AZ-19B546-A(EST-M2C118-A) or equivalent to Ford 10.25 inch ring gear Limited-Slip Axles. **CE5089-2F**

RING GEAR TORQUE SPECIFICATIONS

Model	Torque Limits	
	N-m	Ft-Lbs
Ford 8.8 inch ring gear	95-115	70-85
Ford 10.25 inch ring gear	136-163	100-120
Dana 44	61-81	45-60
Dana 60-3	163-190	120-140*
Dana 70, 70-H.D.	163-190	120-140*
Dana 61-1	163-190	120-140*
Dana 80	285-311	210-230

*Grade 9 screws. Identified by 7 radial lines on head. Grade 8 screws are no longer recommended for service. **CE4770-1F**

ROTUNDA EQUIPMENT

Model	Description
006-01400	Transducer/Balancer

CE5577-1C

SPECIAL SERVICE TOOLS

Number	Description	Application
TOOL-4201-C	Dial Indicator with Bracketry	Axle Adjustments
D78P-4201-B	Dial Indicator — Magnetic Base	Axle Adjustments
T57T-4851-B	Pinion Flange Holding Tool	Axle Adjustments
TOOL-6565-AB	Cup Shaped Adapter	U-Joint Checking
TOOL-6565-AC	Cup Shaped Adapter	U-Joint Checking
T78P-4851-A	Pinion Flange Holding Tool	Axle Checking

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VEHICLE APPLICATION

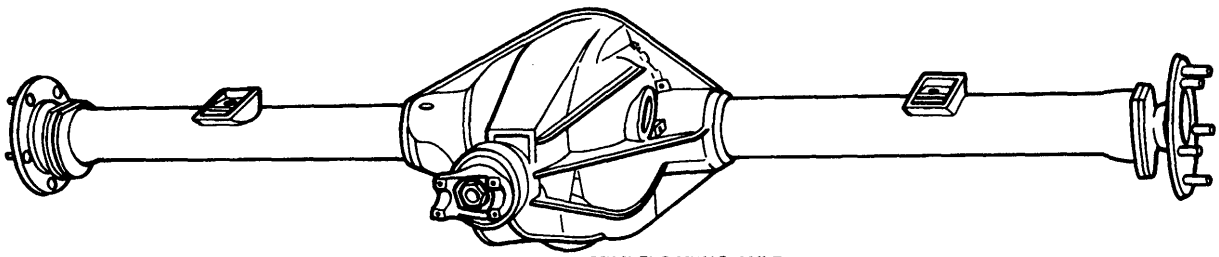
E-250 Through E-350 and F-Super Duty Truck Models.

DESCRIPTION AND OPERATION

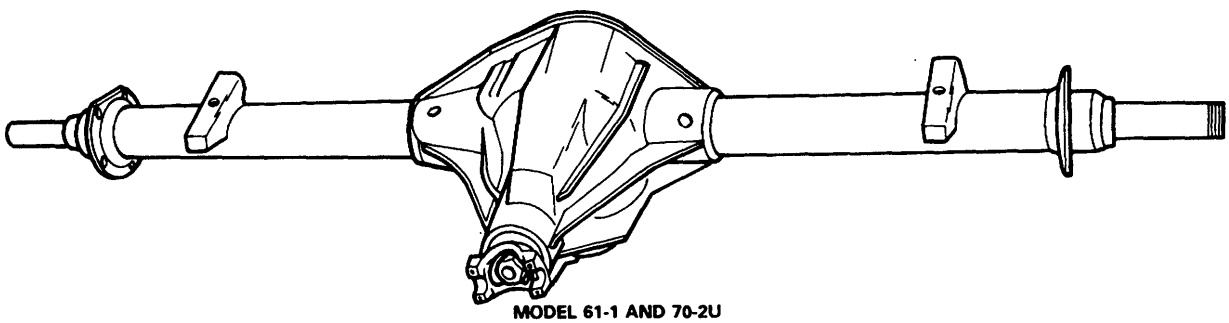
Several models of Dana rear axles are used in regular production or are available as options on the E-250—E-350 and F-Super Duty Truck Models.

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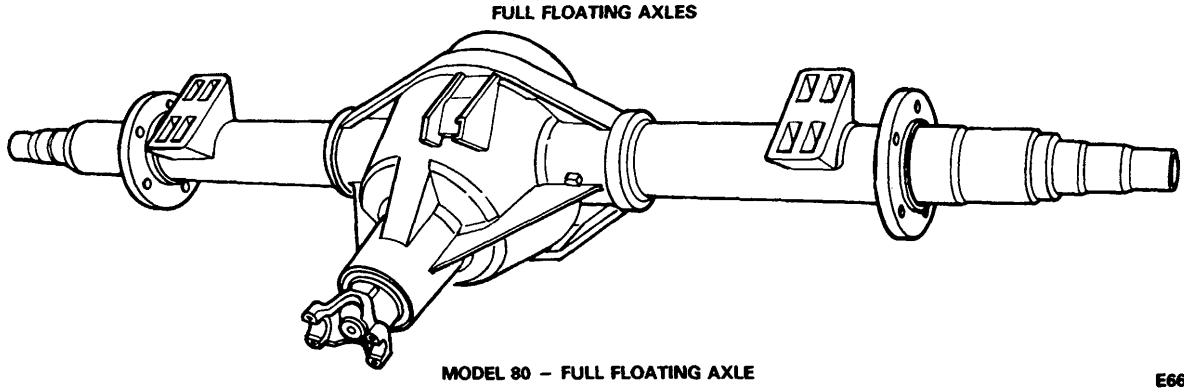
DESCRIPTION AND OPERATION (Continued)



MODEL 60-3 – SEMI-FLOATING AXLE



MODEL 61-1 AND 70-2U
FULL FLOATING AXLES



MODEL 80 – FULL FLOATING AXLE

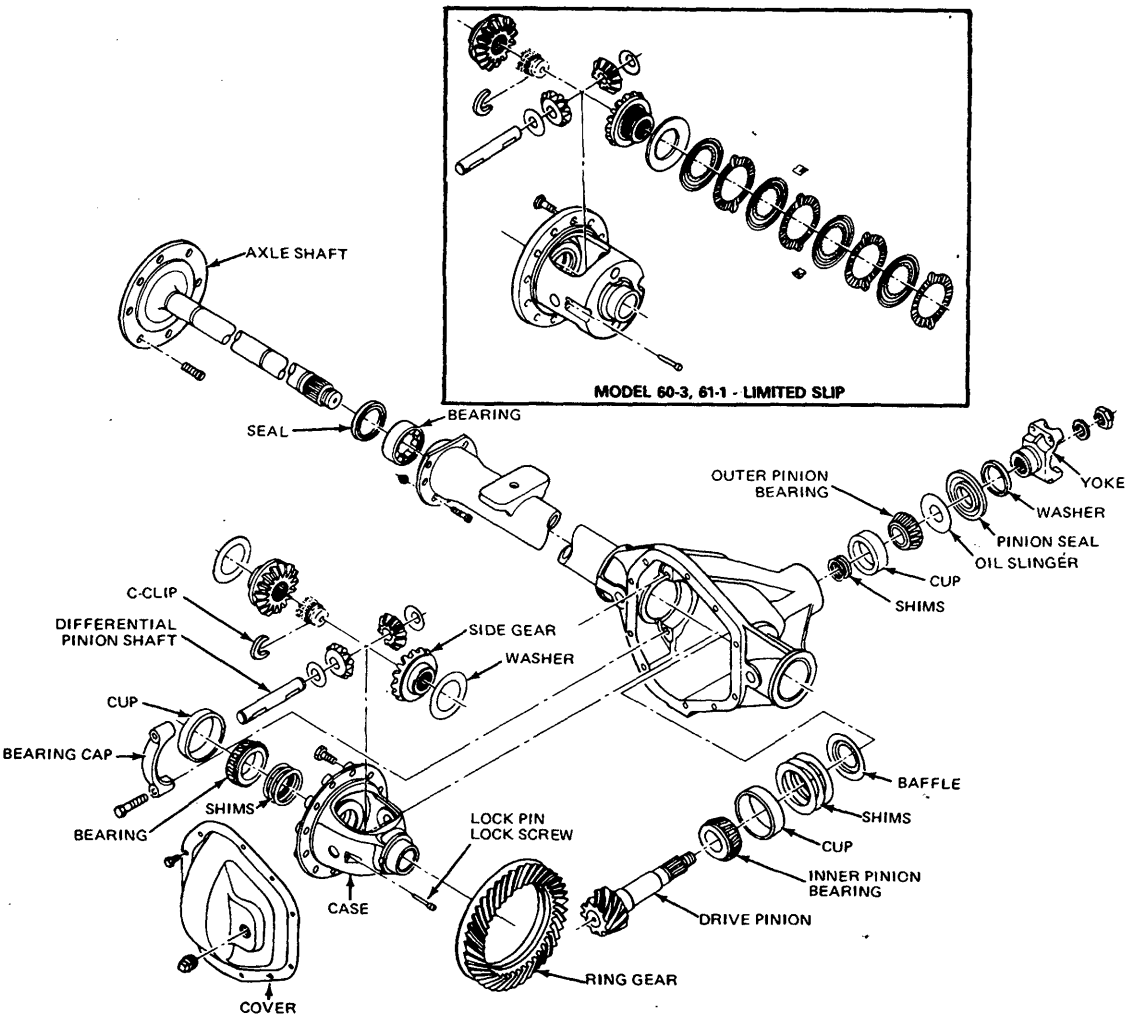
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DESCRIPTION AND OPERATION (Continued)

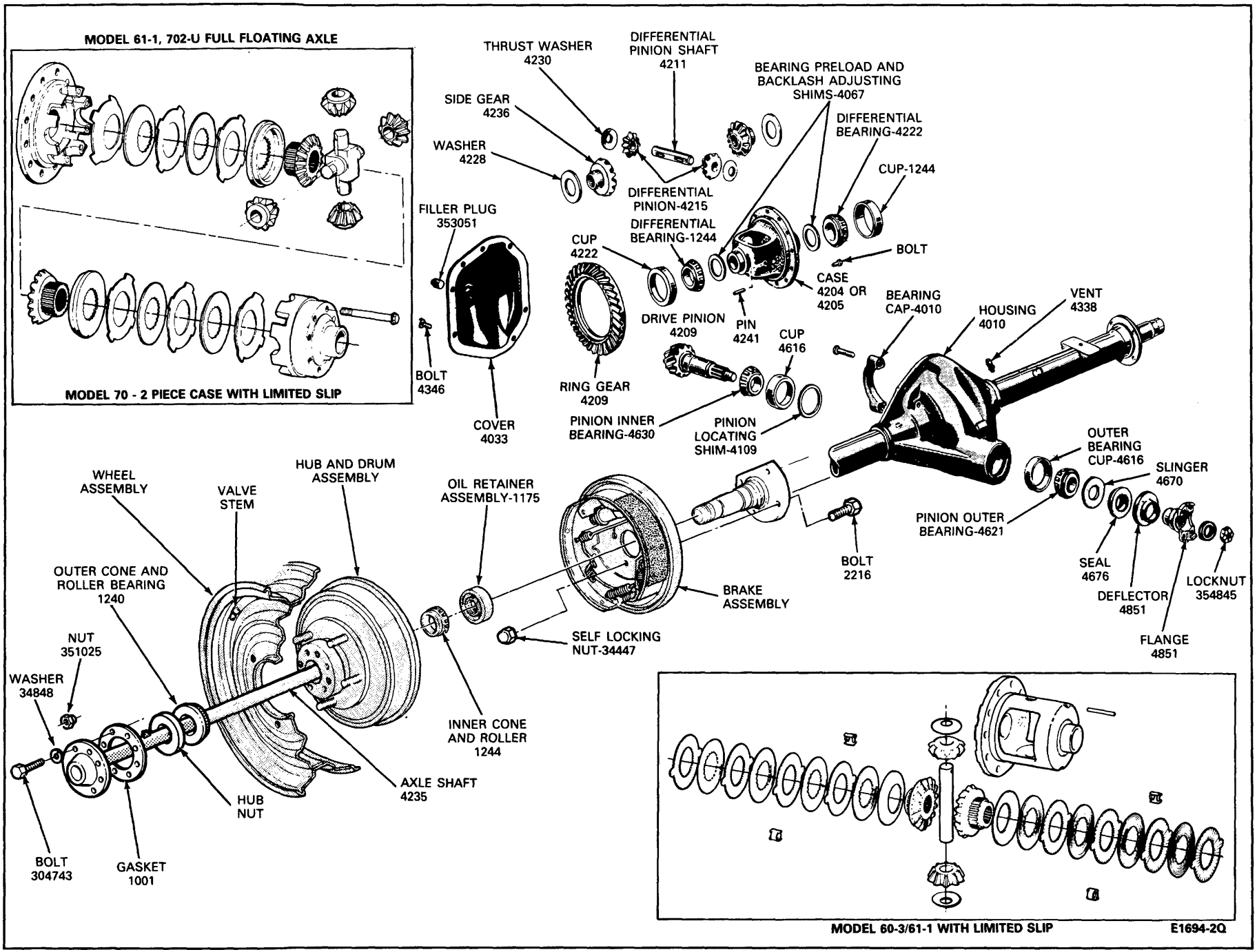
The Model 60-3 semi-floating rear axle is used on light duty E-250. The Model 61-1 full floating rear axle with single rear wheels is used on heavy duty E-250 and E-350. The model 70-1HD and 70-2U full-floating dual rear wheel axle are found on E-350. The Model 80 full-floating, dual rear wheel axle is used on F-Super Duty vehicles.

MODEL 60-3 SEMI-FLOATING AXLE



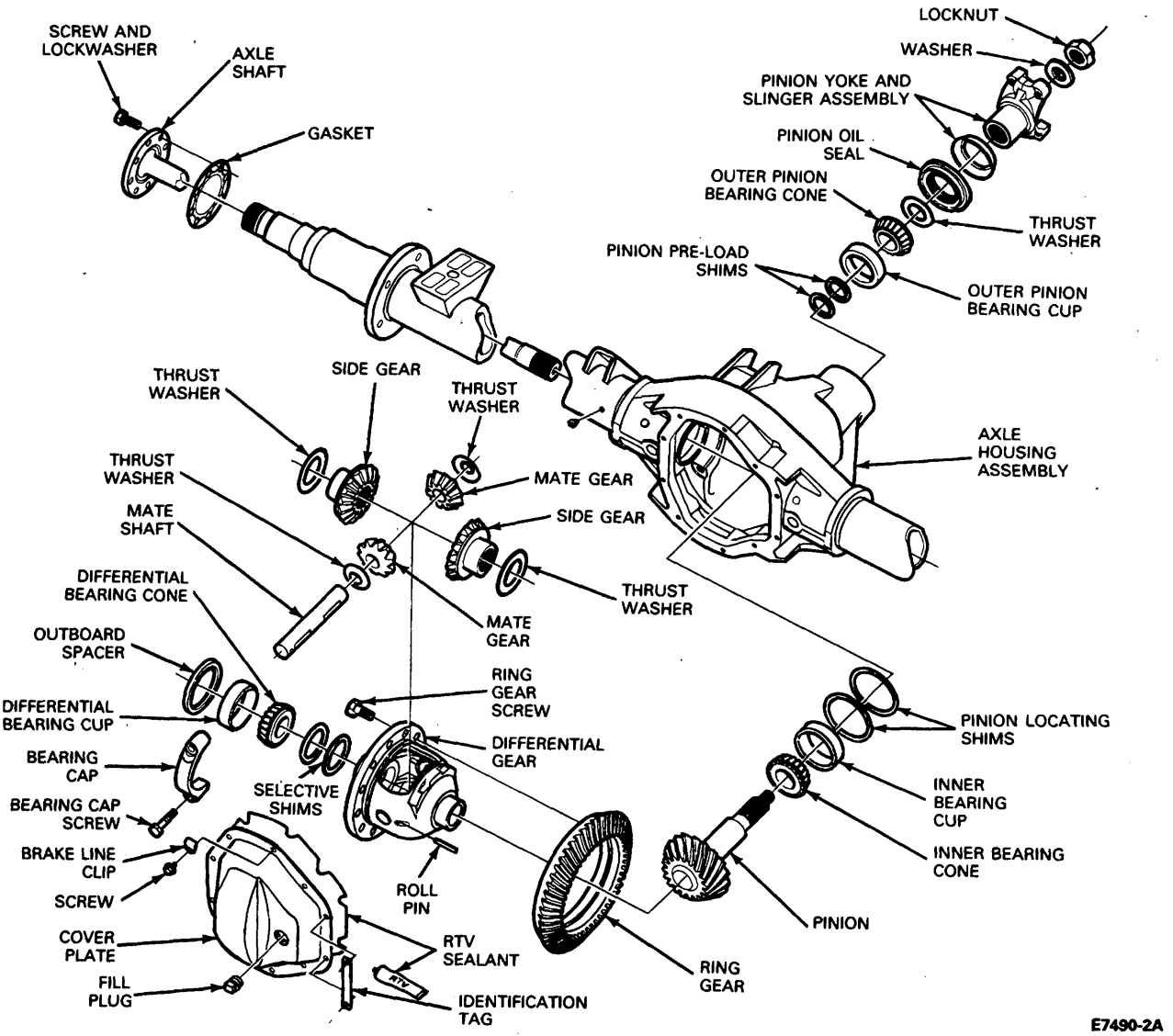
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DESCRIPTION AND OPERATION (Continued)



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DESCRIPTION AND OPERATION (Continued)



The pinion gear and shaft is supported by two opposed tapered roller bearings which are assembled in the forward side of the carrier housing. Pinion locating shims, installed between the rear bearing cup and the cup seat, control the drive pinion depth adjustment. The pinion bearing preload is controlled by shims located between the pinion front bearing and the shoulder on the drive pinion shaft.

The differential case assembly is supported by two opposed tapered roller (side) bearings and cups, which are retained in the housing by removable caps. Shims, installed between each differential side bearing and the shoulder on the case, perform three functions: they take up the differential case side clearance; they adjust the backlash between ring gear and pinion; and they establish differential side bearing preload. The Model 80 axle has hardened spacers outboard of the differential bearing bore to protect the housing if the bearing cup has spun in the housing.

A cover on the rear of the carrier housing provides access for inspection, removal and installation of the differential assembly and drive pinion. A metal tag, stamped with the gear ratio, part numbers and limited slip (if applicable), is secured to the housing by two of the cover bolts.

The Model 60-3 rear axle has semi-floating axle shafts, meaning the axle shaft supports the load.

The Model 80, 70-1HD, 70-2U and 61-1 rear axles are equipped with full-floating axle shafts, meaning that loads are supported by the axle housing. The axle shafts can be removed without disturbing the wheel bearings, which are opposed tapered roller bearings and are part of the hub assembly.

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DESCRIPTION AND OPERATION (Continued)

The rear hub and rotor assembly on the Model 80 axle is supported or "floats" on the axle spindle on two opposed tapered roller bearings. It is retained on the spindle by a ratcheting nut that is tabbed to a slot on the spindle. If, for any reason, the hub is removed from the spindle, the old hub seal must be removed and a new hub seal installed.

The Dana Model 60, 70, and 80 rear axles have an integral type housing, hypoid gear design with the centerline of the pinion set below the centerline of the ring gear.

The hypoid gear set consists of a ring gear and an overhung drive pinion which is supported by two opposed tapered roller bearings. Pinion bearing preload is maintained by the pinion nut and selective shims assuring the seating of the inner and outer bearings and cups.

The housing assembly consists of a cast center section with two steel tube assemblies and a stamped rear cover. The cover uses RTV E7TZ-19562-A (ESL-M4G6273-A) or equivalent as a gasket.

The differential case is a one-piece design with two openings to allow for assembly of the internal components and lubricant flow. The differential pinion mate shaft is retained with a threaded bolt lockpin assembled into the differential case.

Functional differences between the semi-float integral rear side assembly and the full-float integral rear axle assembly are as follows:

1. The semi-float axle shafts are retained in the axle by C-washer locks positioned in a slot on the axle shaft splined end. These C-washers also fit into a machined recess in the differential side gears within the differential case.
2. The full-float axle shafts are retained by bolts attached to the hub. The hub rides on two bearings at the outboard end of the axle tube.
3. A semi-float axle shaft rides on one straight-roller bearing at the outboard end.
4. Differential bearing preload and ring gear backlash are adjusted by the use of shims located between the differential bearing cup/races and the carrier housing in the semi-float and the full-float axles.

DIAGNOSIS AND TESTING

Refer to Section 15-01, General Driving Axle and Driveshaft Service. Also refer to Section 18-01 Noise, Vibration and Harshness Diagnosis.

ADJUSTMENTS

For adjustments refer to the specific adjustments in this Section under Disassembly and Assembly and Section 15-01, General Driving Axle and Driveshaft Service.

Refer to Section 11-14 Wheel Hubs and Bearings—for rear wheel bearing adjustment procedures and rear hub specific adjustments.

Refer to Section 12-24 for rear disc brake assembly and/or disassembly procedures for F-Super Duty Model 80 rear axle usage.

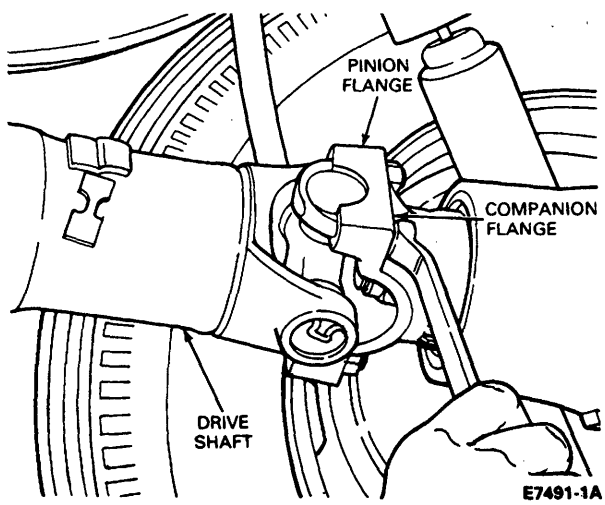
REMOVAL AND INSTALLATION

Drive Pinion Oil Seal

Removal

The drive pinion oil seal can be replaced without removing the axle assembly from the vehicle. Compounded or synthetic rubber seals do not require soaking.

1. Raise the vehicle on a hoist or raise the rear end of the vehicle with a jack. Install safety stands under the frame rails and lower the jack or hoist far enough to allow the axle to drop into the rebound position for working clearance.
2. Remove the nuts and two U-bolts from the rear axle pinion flange and disconnect the driveshaft from the rear axle pinion flange. The Model 80 axle uses straps and bolts which are threaded into the pinion flange. Wire the driveshaft to the frame.

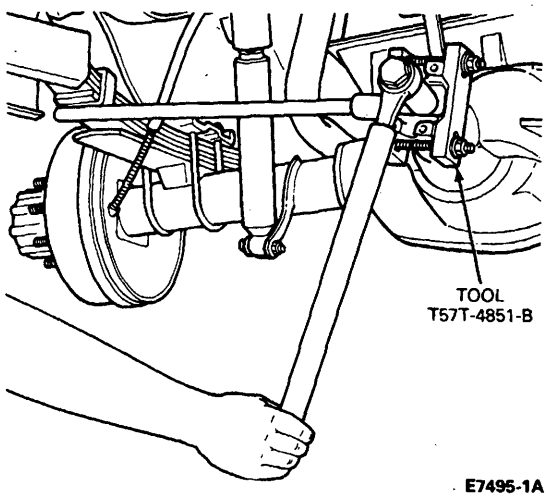


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REMOVAL AND INSTALLATION (Continued)

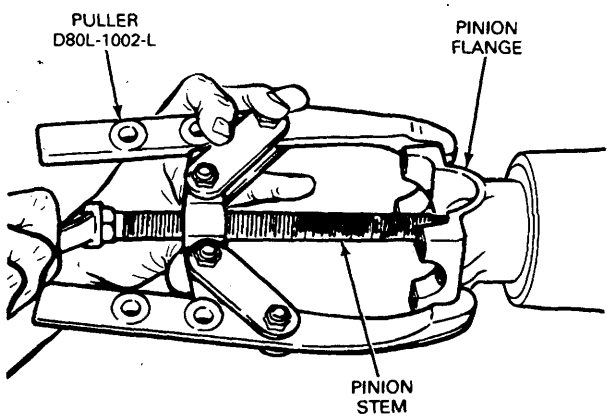
3. Using Tool T57T-4851-B to hold the pinion flange, remove the pinion shaft nut.

NOTE: The Model 80 pinion nut is tightened to 440-500 ft. lb.



E7495-1A

4. Using Tool T65L-4851-B or D80L-1002-L, remove the pinion flange.
5. Using TOOL-1175-AC puller, in combination with Slide Hammer T50T-100A, remove the pinion oil seal.

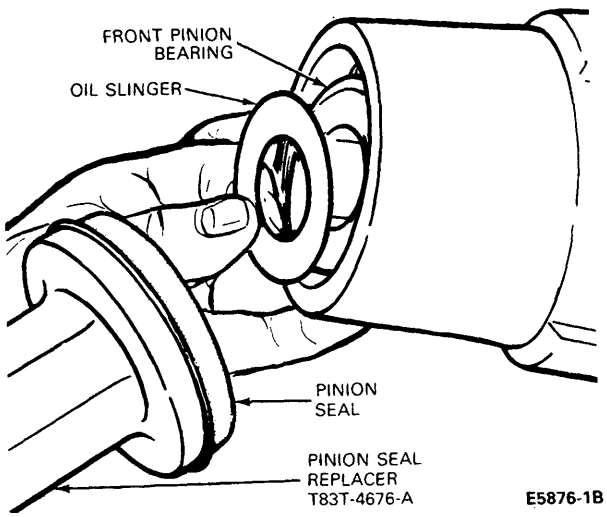


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Installation

1. Clean the pinion oil seal seat. Coat the sealing edge of the new seal with a small amount of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent. Do not put sealer on the sealing lip. Drive the seal into the housing, using Tool T83T-4676-A. For Econoline axles, use Tool T88T-4676-A for F-Super Duty Axles.

CAUTION: Installation without the proper tool may result in early seal failure. If seal becomes cocked during installation, remove it and install new one.



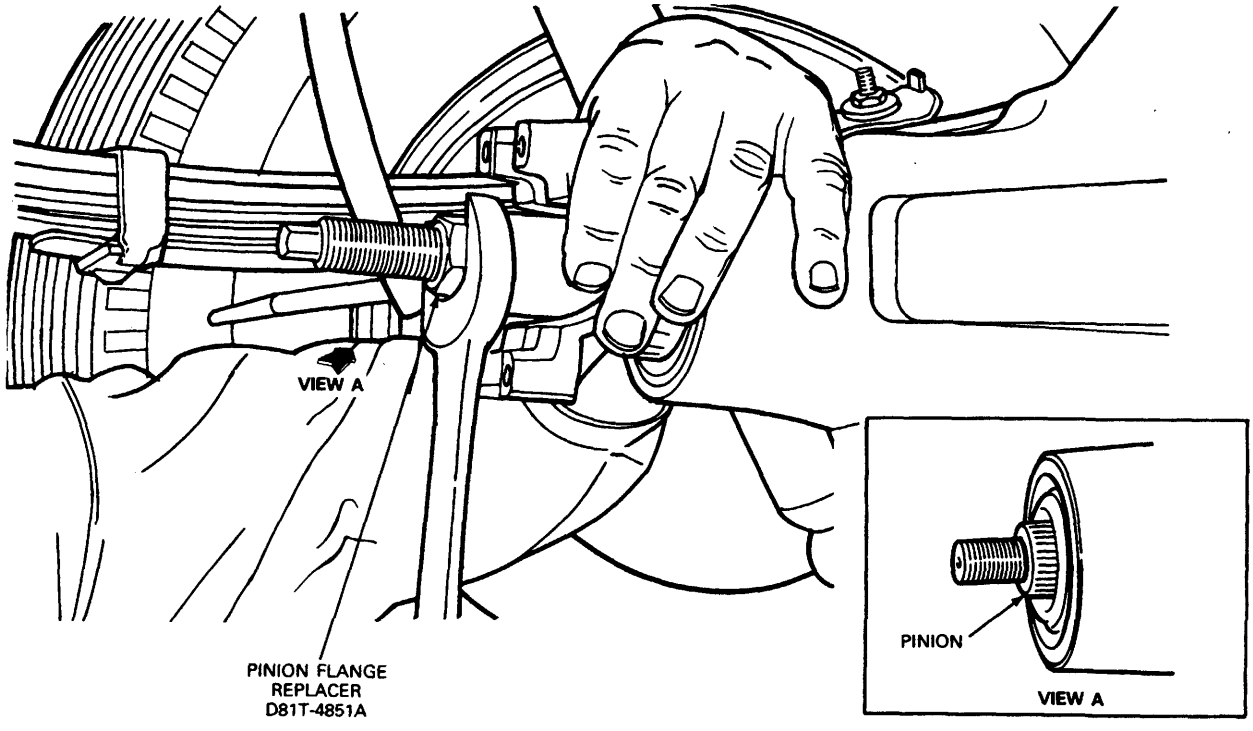
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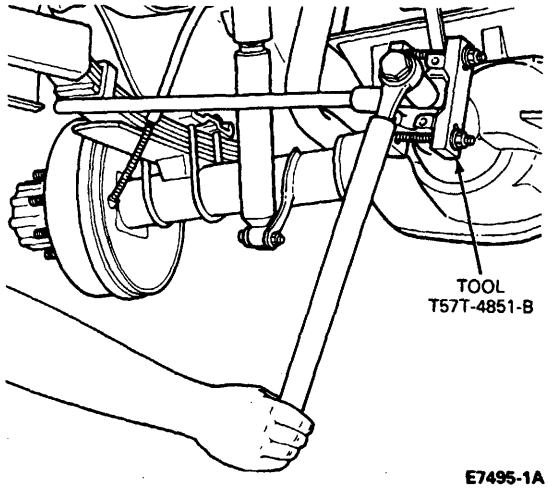
REMOVAL AND INSTALLATION (Continued)

2. Coat the inside of the pinion flange with a small quantity of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent, and install the flange on the pinion shaft, using Tool D81T-4858-A.

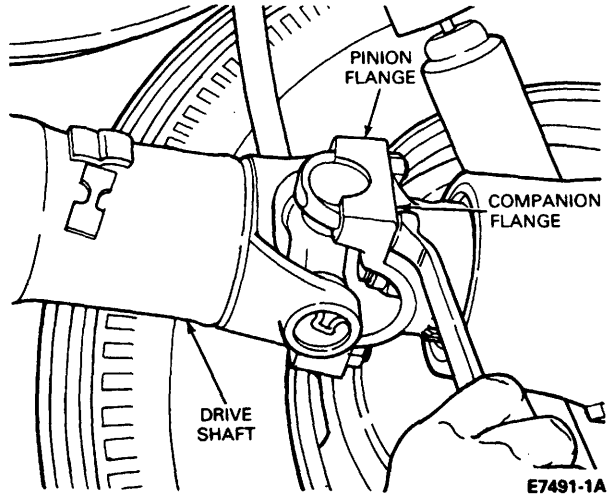
NOTE: The pinion flange must never be hammered on or installed with power tools.



3. Install the pinion attaching nut on the pinion shaft and tighten to specifications listed at the end of this Section. Hold the pinion flange with Tool T57T-4851-B while tightening the nut.



4. Connect the driveshaft to the front axle pinion flange, secure with nuts and U-bolts of studs and bolts (F-Super Duty) and tighten to specifications listed at the end of this Section.



5. Raise the vehicle, remove the safety stands and then lower the vehicle to road position. Check the level of axle lubricant and add the specified lubricant as necessary.

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REMOVAL AND INSTALLATION (Continued)

Rear Axle

Removal

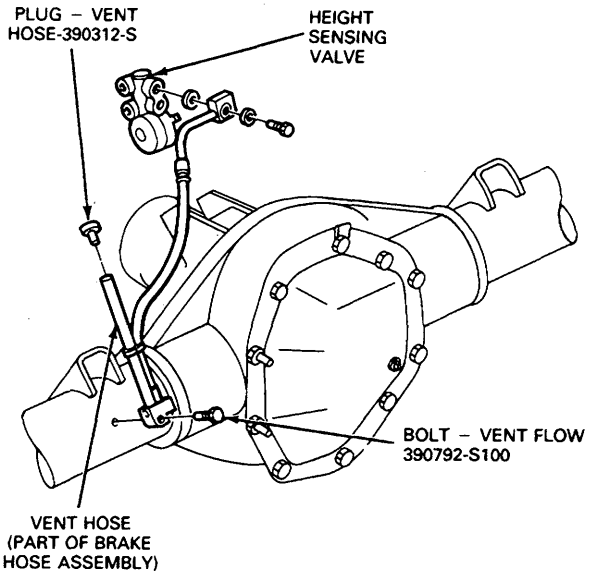
NOTE: Axle shafts, wheel hubs, wheel hub bearings, and the wheel hub grease seals can be replaced without removing the differential assembly from the axle housing or the rear axle assembly from the vehicle.

The axle shafts, wheel hubs, bearings and grease seals may be replaced, lubricated, or adjusted as outlined in Section 11-14, Wheel Hubs and Bearings—Rear (Full Floating Axle).

1. Loosen the wheel stud nuts and the axle shaft to hub retaining bolts.
2. Disconnect the rear shock absorbers from the rear axle, and unclamp the rear stabilizer bar. Then raise the rear end of the vehicle frame until the weight is off the rear springs. Place safety stands under the frame in this position.
3. Disconnect the flexible hydraulic brake line at the frame.
4. Disconnect the parking brake cable (if so equipped) at the equalizer, and remove the cables from the cable support brackets.
5. Disconnect the driveshaft from the rear U-joint flange.
6. Remove the nuts from the rear spring clips (U-bolts), and remove the spring seat caps.
7. Roll the axle from under the vehicle, and drain the lubricant. Remove the wheels. Mount the axle in a work stand. To remove axle shafts, hubs and drums or hub and rotor assemblies refer to Section 11-14, Wheel Hubs and Bearings—Rear (Full Floating Axle).

Installation

1. Apply a coating of Multi-Purpose Long Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or an equivalent lubricant to the lip surface; then, replace the hub inner grease seal. Refer to Section 11-14 for hub and bearing installation (use new axle shaft gaskets); then, install the axle shafts through the housing ends so that they will spline to the differential side gears. Prior to re-installation of the axle shaft, clean and remove any metallic debris in the hub bolt holes. Also inspect for cracked material around the holes, depth of the threaded hole, (minimum 1.0 inch), and oversized threaded holes, and replace hub if any of these three conditions are present. Install **new** shaft retaining bolts (with loctite-type adhesive) and lockwashers.
2. After installing the rear wheels, roll the axle assembly under the vehicle.
3. Install the rear spring clips (U-bolts) and spring seat caps. On Econoline tighten the nuts to 150-217 N·m (110-160 ft-lbs). Tighten F-Super Duty nuts to 200-270 ft.-lbs (267-360 N·m).
4. Connect the rear shock absorbers, and install the stabilizer bar in position.
5. Connect the drive shaft to the rear universal joint flange. Refer to Section 15-61 for installation instructions and torque specifications.
6. Connect and adjust the parking brake cables (if so equipped). Refer to Section 12-70, Parking Brake.
7. Connect the hydraulic brake hose and bleed the brakes. Also connect the axle vent hose to the axle fitting on Econoline vehicles. The F-Super Duty axle vent hose is part of the brake hose assembly and uses a special "flow" bolt to secure the hose block assembly to the axle.
8. Fill the axle with the proper grade and specified amount of axle lubricant.
9. Lower the vehicle to the floor.



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REMOVAL AND INSTALLATION (Continued)

Rear Axle Shaft

Model 60-3—Semi-Floating Axle, E-250

Removal

1. Lift vehicle and install safety stands.
2. Remove wheel and brake drum.
3. Drain lubricant from the axle. Remove cover plate to drain lubricant. Clean the gasket material from the cover and axle housing.
4. Remove the differential pinion mate shaft lockscrew as shown in the illustration. Discard lockscrew and replace with new one upon assembly.

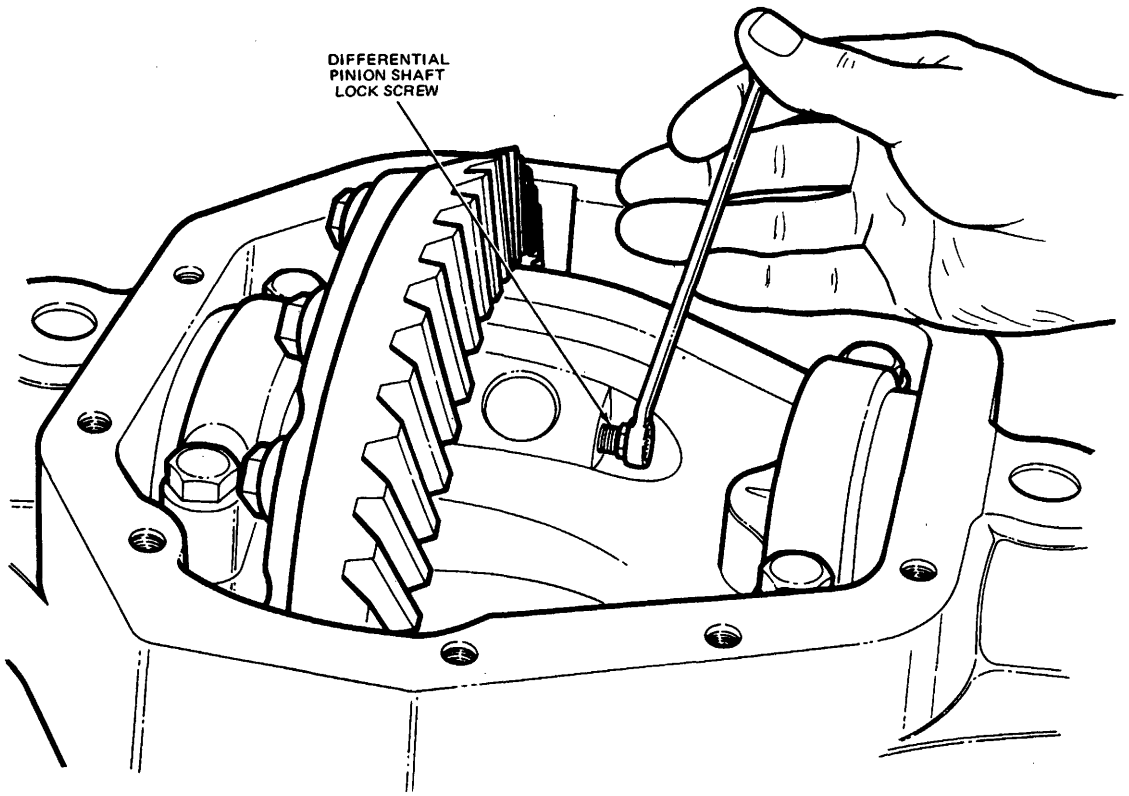
NOTE: It is possible for Dana semi-float axles to be equipped with lockscrew coated with either a Loctite treated thread (or equivalent) or torque prevailing threads. The two types of lockscrew may be identified as follows.

- the Loctite (or equivalent) treated lockscrew have a 5/32 inch hexagram socket head.
- The torque prevailing lockscrew has a 12-point drive head.

If the axle is equipped with a Loctite (or equivalent) treated lockscrew, it must not be re-used under any circumstances.

If the axle is equipped with the torque prevailing lockscrew, it may be re-used up to four times (four removals and installations). When in doubt about the number of times the torque prevailing lockscrew was removed, replace the lockscrew.

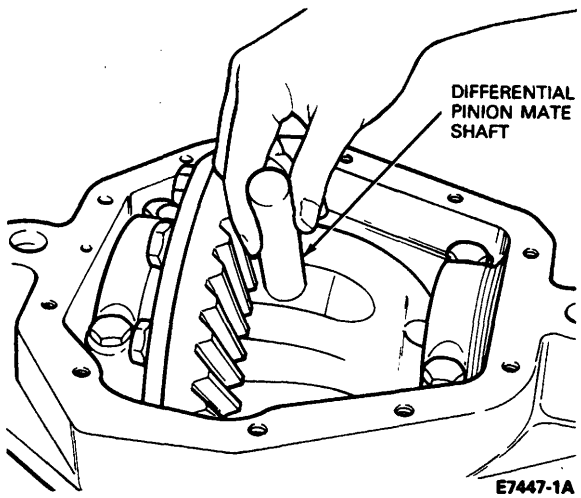
5. Lift out the differential pinion mate shaft as shown. Shaft is a slip-fit design and may be removed by hand.

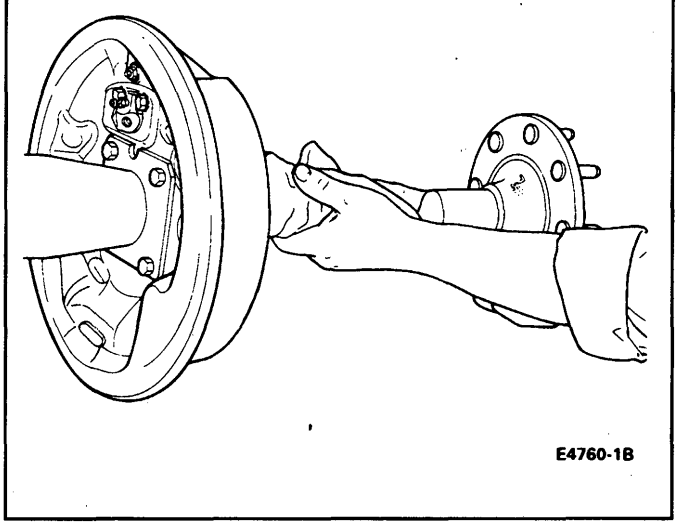


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REMOVAL AND INSTALLATION (Continued)

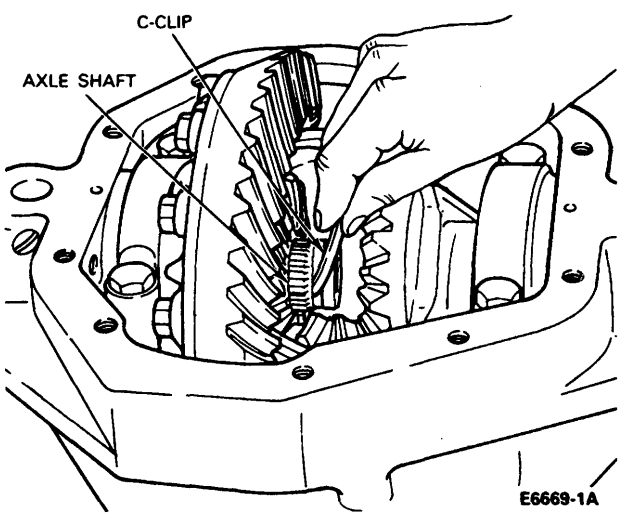




6. Push the flanged end of axle shaft toward the center of the vehicle and remove the C-clip from button end of shaft as shown in the illustration.
7. Pull the axle shaft from the axle tube being careful not to damage oil seals.

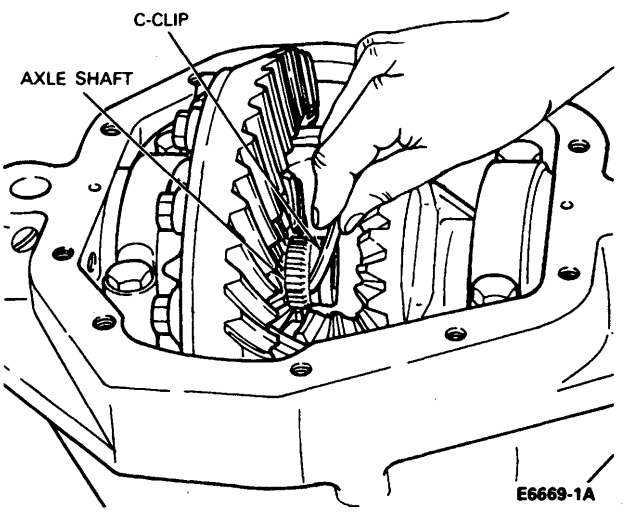
NOTE: When removing axle shafts, do not rotate differential side gears. Rotating side gears causes the pinion mate gears and thrust washers to turn to the differential case opening and fall out.

NOTE: In semi-floating axles, after the axle shafts have been removed, assemble the pinion mate shaft and lockscrew back in the differential case. Use old lockscrew and assemble finger-tight to prevent the side gear and mate gears from rotating and dropping out of the differential case.



Installation

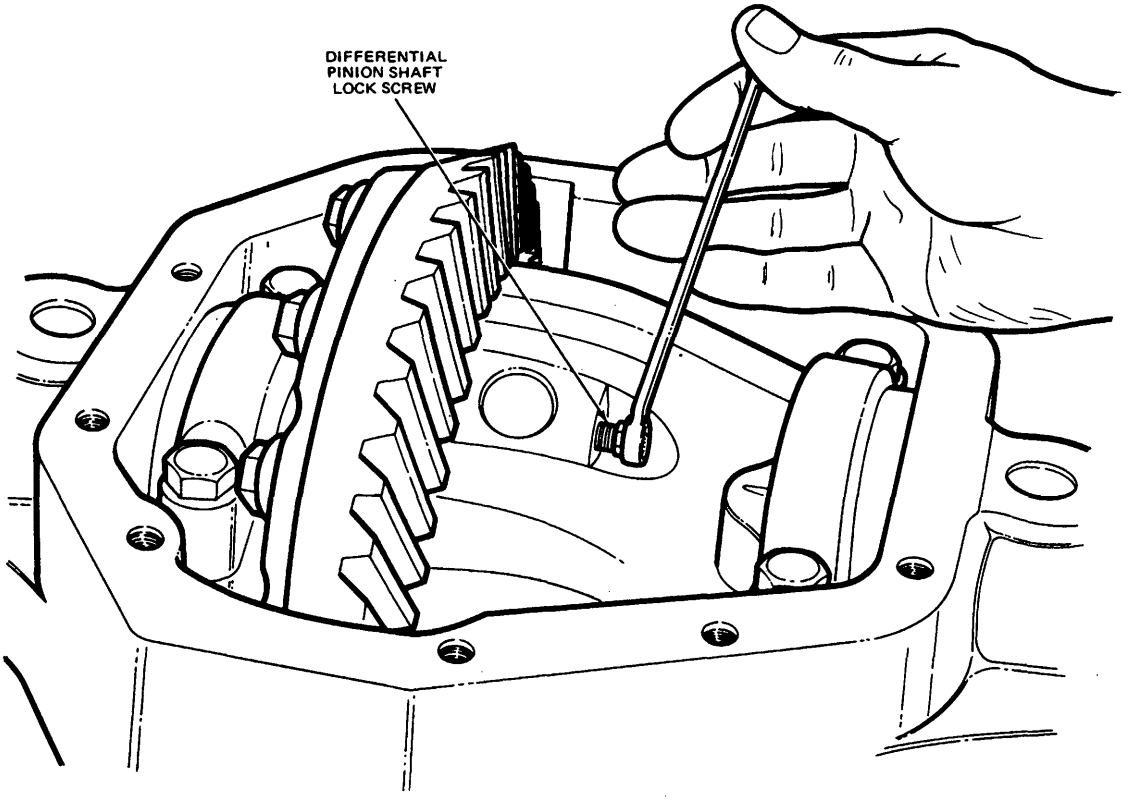
1. Push axle shaft into axle tube, making sure splined shaft end engages side gears. Be careful not to damage oil seals and bearings.
2. Push the flanged end of axle shaft towards center of axle and install C-clip. Pull flanged end outward until C-clip locks into side gear.



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REMOVAL AND INSTALLATION (Continued)

3. Install pinion mate shaft. Be sure lockscrew hole of the shaft is lined up with the lockscrew hole in case. Be sure pinion gear side washers are in correct position.
4. Install the new lockscrew, making sure the hole in the differential cross shaft is lined up with the screw hole in the case. Make sure the threads in the differential case and on the lockscrew are free of dirt and oil. Tighten lockscrew to 27-34 N·m (20-25 ft-lbs).



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REMOVAL AND INSTALLATION (Continued)

5. Add RTV or an equivalent sealer to the cover plate. Install cover plate.

A flat mounting surface cover plate is used on all Dana design axles. This cover plate requires the use of a silicone rubber sealer material, Silicon Rubber-ESL-M4G273-A (E7TZ-19562-A), or equivalent rather than a gasket.

The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.

CAUTION: Clean both flat surfaces with a suitable solvent to remove all traces of oil film. Sealant material must meet specifications of ESL-M4G273-A, B, ASTM1, GE503, Z1, Z2, Z3 sealant or equivalent.

Apply RTV Gasket sealer, E7TZ-19562-A (ESL-M4G273-A), or equivalent to cover plate surface. Ensure that the sealer bead is laid on the inside of the cover screw holes. The bead is not to pass through the holes or outside of the holes.

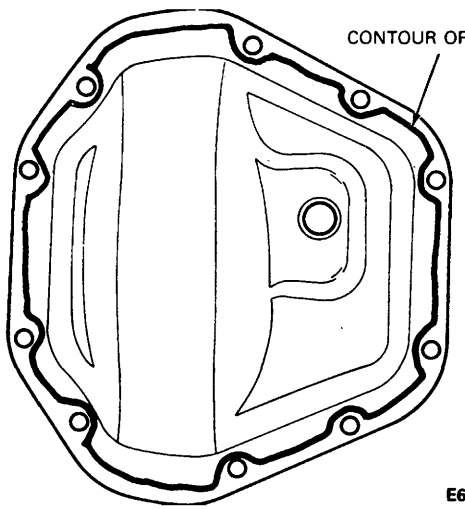
The bead is to be 3.18-6.35mm (1/8-1/4 inch) high and 3.18-6.35mm (1/8-1/4 inch) wide.

- NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.

Assemble two cover screws into cover at 8 o'clock and 2 o'clock position. Use these two holes to guide cover plate into position on the carrier.

Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft-lbs).

Allow one hour cure time before filling carrier with the proper amount of specified lubricant and vehicle operation.



6. Fill the axle housing with the specified amount of axle lubricant.
7. Install brake drum in position of on axle shaft flange.
8. Install wheel and tire assembly in position to axle shaft flange. Tighten nuts to specifications listed in Section 11-01, General Wheel and Tire Service.
9. Lower vehicle and road test.

Rear Axle Shaft

Models 61-1; 70-2U; 80 full-floating axle, E-350 with dual rear wheels, F-Super Duty for removal and installation of rear axle shafts. Refer to Section 11-14, Wheel Hubs and Bearings—Rear Dana Full Floating Axle.

Oil Seal and Wheel Bearing

Model 60-3 Semi-Floating Axle

E-250

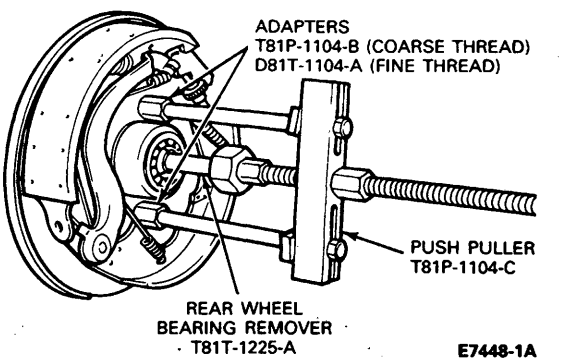
Removal

1. Remove axle shaft as described in this Section.
2. Remove the oil seal from the axle tube. Discard the seal.
3. Pull the bearing from the axle tube using Push Puller T81P-1104-C, Adapters T81P-1104-B (coarse thread) or D81T-1104-A (fine thread) and Rear Wheel Bearing Remover, T81T-1225-A, as shown.

CAUTION: Wear safety glasses when removing the bearing in the event the bearing explodes or shatters during removal.

4. Use a standard metal cleaning solvent to clean out the bearing bore in the housing. Wipe this area clean, making sure it is free from dirt or any other contamination that might be present.

NOTE: The bearing bore must be free from nicks and burrs. Wipe the bore with emery cloth to assure a smooth surface. Clean bore out with a standard metal cleaning solvent. If bore has burrs or spalled areas and a new bearing is installed, it may lead to early fatiguing.



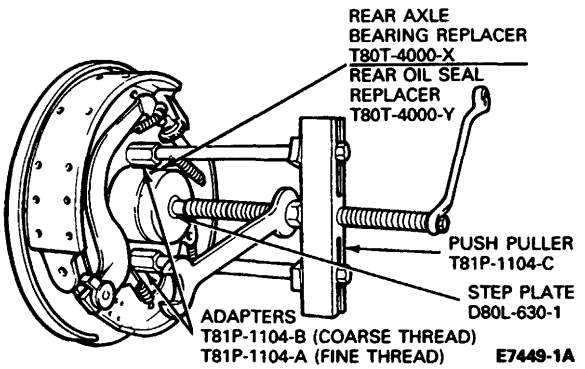
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REMOVAL AND INSTALLATION (Continued)

Installation

1. Coat the bearing with differential lube for easier assembly and to prevent possible scoring of the tube bore.
2. Install bearing in the tube bore using Push-Puller T81P-1104-C, Adapters T81P-1104-B or D81T-1104-A, Step Plate D80L-630-1 and Rear Axle Bearing Replacer T80T-4000-X.

NOTE: When installing bearing make sure the bearing is not cocked in the bore during installation.



3. Install a new oil seal in the bore using Push Puller T81P-1104-C, Adapters T81P-1104-B or D81T-1104-A, Step Plate D80L-630-1 and Rear Oil Seal Replacer T80T-4000-Y, as shown. An alternate method of installing the seal is to drive the seal into place with Rear Oil Seal Replacer T80T-4000-Y and Driver Handle, T80T-4000-W.

NOTE: Make sure the seal is not cocked in the bore during installation.

4. Lubricate cavity between seal lips and bearing with ESA-M1C75B (C1AZ-19590B) Multi-Purpose Long-Life Lubricant.
5. Install axle shafts as described in this Section.

Seals and Bearings

Model 60-1U, 61-1, 70-2U, 80 Full Floating Axle

Removal and Installation

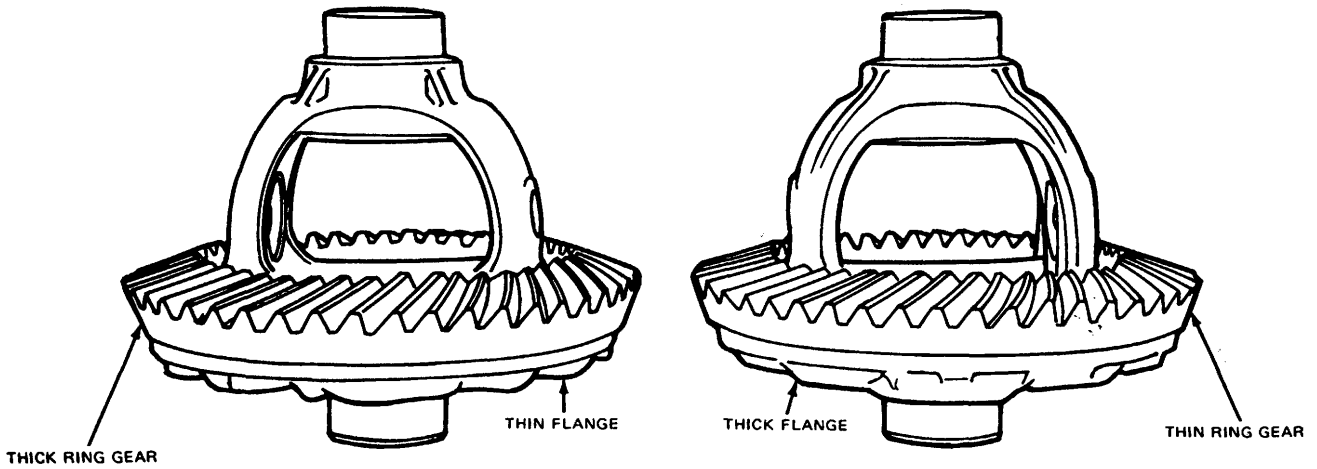
Refer to Section 11-14, Wheels, Hubs and Bearings (Full Floating Axle) for removal and installation procedures.

DISASSEMBLY

NOTE: When changing ratios on the Model 60 and Model 70 Series rear axles, it may be necessary to change the differential case along with the ring gear and drive pinion.

In the 60-1U, 60-3 and 70 Series axles, ratios '3.54 to 1' up to '4.10 to 1' incorporate a thick differential case flange and a thin ring gear. Ratios '4.56 to 1' and up incorporate a thin differential case flange and a thick ring gear.

In the 61-1 rear axle, ratios 3.54 through 4.56 use a thin ring gear and thick differential case flange ratios 3.31 and lower numerically use a thick ring gear and thin differential case flange.



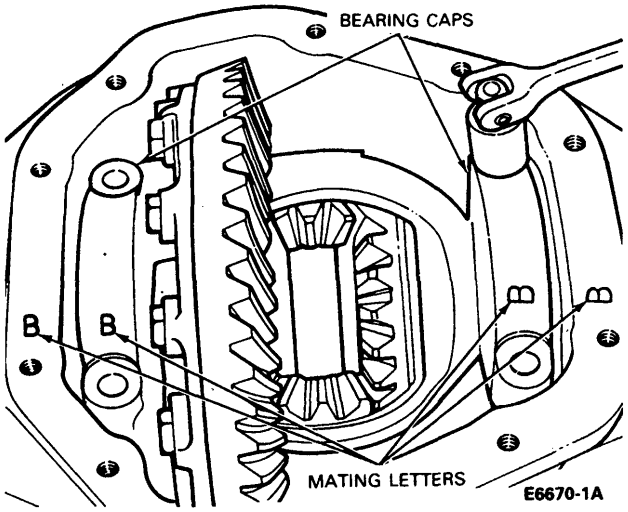
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DISASSEMBLY (Continued)

Disassembly

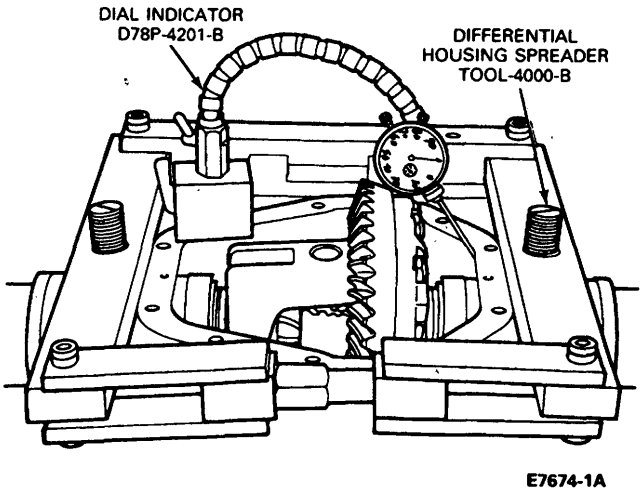
1. Remove the rear axle from the vehicle as outlined in Removal and Installation.
2. Remove cover plate and drain lubricant from axle. The lube will drain out as the cover plate is removed.
3. Remove cover plate screws, and cover plate. Tip carrier to allow lube to drain completely. Also during this time clean the cover face of the carrier, making sure it is free from any nicks and remove old RTV gasket material.
4. Remove bearing caps.

NOTE: Mating letters are stamped on caps and carrier. This is important at time of assembly as they are to be assembled exactly as removed. Letters are in vertical and horizontal positions.



CAUTION: Before removing differential case and ring gear, make sure the axle shafts are pulled out far enough for clearance to remove differential. Refer to Section of manual covering the type of axle assembly being serviced.

5. Place Differential Housing Spreader, on the case. Install Dial Indicator, Tool-D78P-4201-B on the carrier housing. Do not spread housing more than 0.38mm (0.015 inch).



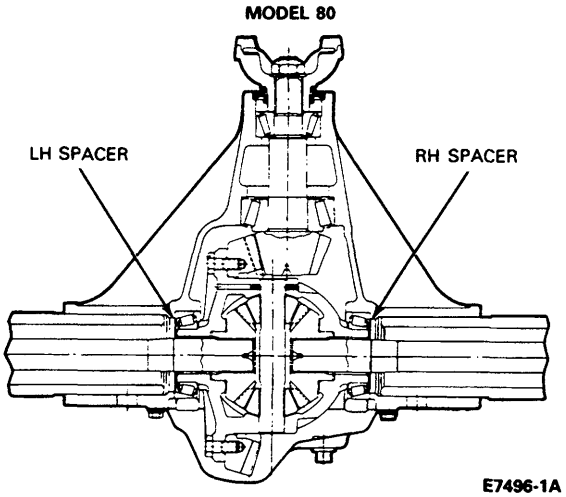
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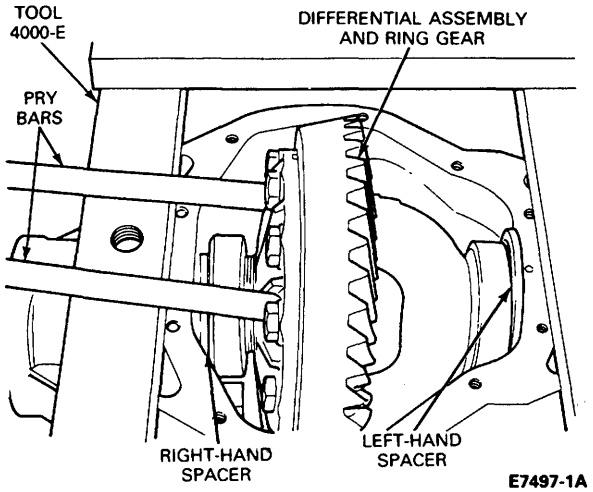
DISASSEMBLY (Continued)

6. Pry differential case from carrier with two pry bars. After differential case has been removed, remove spreader. Use caution to avoid damage to ring and pinion. Mark or tag bearing cups indicating from which side they were removed. Dana rear axle differential bearing cups are bonded to the housing with anerobic adhesive ESE-M4G167-A4 (Loctite #680 or equivalent) to prevent the cups from spinning under load and damaging the housing. Always clean residue of old adhesive before applying a new 1 inch x 1/8 inch bead to the housing upon assembly.

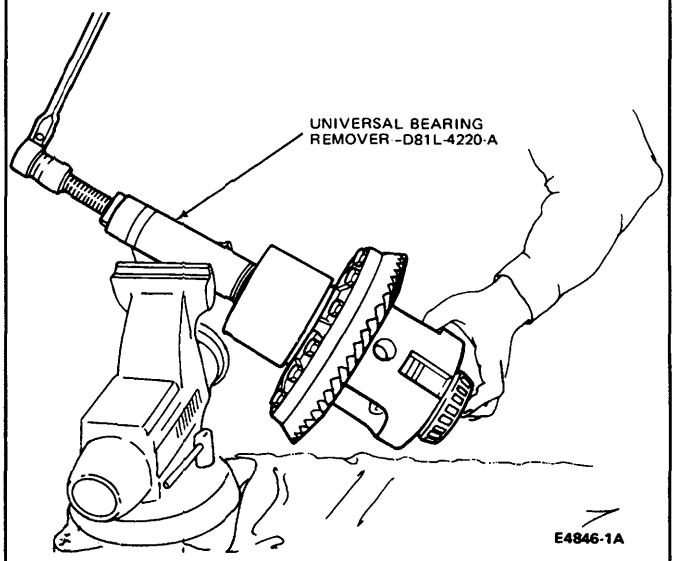
NOTE: Also inspect the bearing seat ledge in all Econoline housings adjacent to the outboard surface of the differential bearing cup. If the cups have spun, a step may be worn into the ledge. If the wear is less than 0.508mm (0.020 inch)/side (1.016mm or 0.040 inch) maximum/housing) and it can be machined to maintain full face contact with a new bearing cup square to the bore, the housing is repairable and may be used.

The Model 80 rear axle incorporates hardened spacers installed outboard of each differential bearing cup. Remove both spacers and tag each indicating the side each was removed from. Inspect both spacers for damage, bent or grooved conditions. Replace if required.





7. Remove differential bearings with special tool, Universal Bearing Remover D81L-4220-A. Place the tool in a vise when removing bearing. Wire shims, bearing cup and bearing cone together. Identify from which side they were removed. (Ring gear side or opposite side). If shims are damaged, replace with new ones at time of assembly. Shims are available in thicknesses of mm .08, .13, .25, and .76 (.003 inch, .005 inch, .010 inch, and .030 inch). Reposition case in puller and remove other bearing cone as described above. Replace bearings whenever they are removed from the carrier.

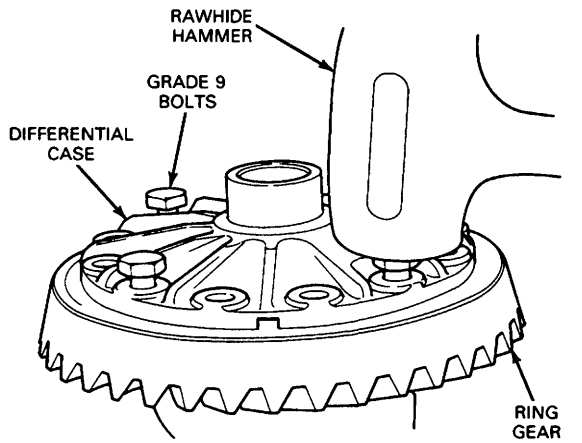


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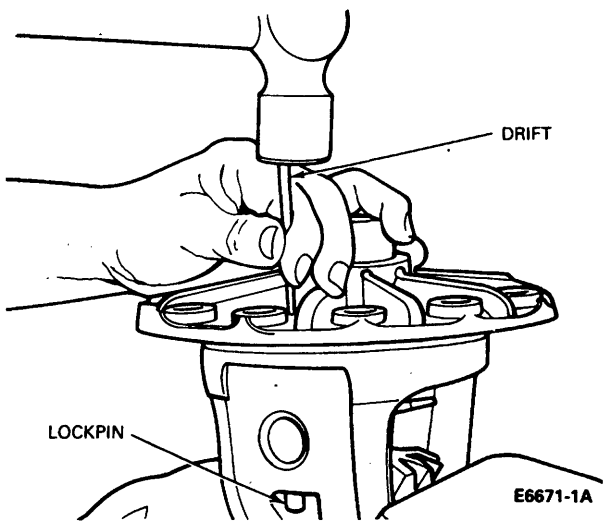
DISASSEMBLY (Continued)

8. Place a few shop towels over the vise to prevent the ring gear teeth from being nicked. Place case in vise. Remove ring gear bolts. Leave four bolts loosely assembled 90 degrees apart. Tap each bolt head alternately with a rawhide hammer to loosen the ring gear. Remove bolts and ring gear.

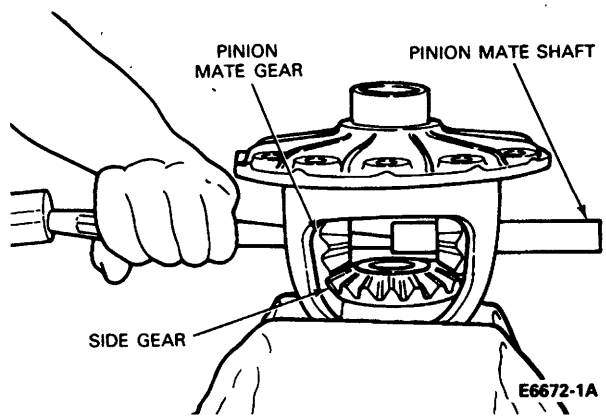
NOTE: Whenever removing the ring gear bolts, always replace with new bolts upon assembly. Use grade 9 bolts for service replacement for all axles.



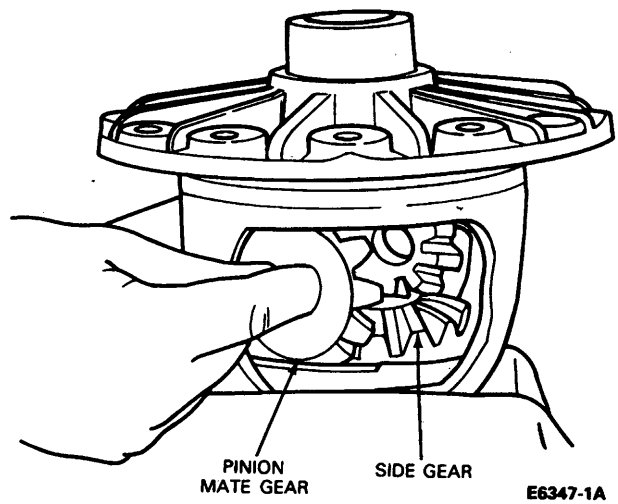
9. Replace case in vise and drive out lock pin which secures the pinion mate shaft. Use a small drift as shown.



10. Remove pinion mate shaft with drift as shown.



11. To remove side gears and pinion mate gears, rotate the side gears. This will allow the pinion mate gears to turn to the opening of the case. Remove pinion mate gears and also the spherical washers behind the gears. Lift out side gears and thrust washers. Inspect all parts, including the machined surfaces of the case itself. If excessive wear is visible on all parts, it is suggested that the complete differential assembly be replaced. If any one of the gears are to be replaced, THEY ARE TO BE REPLACED AS A SET.

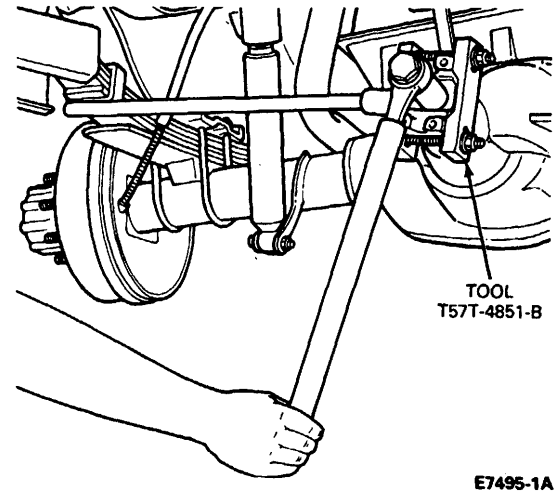


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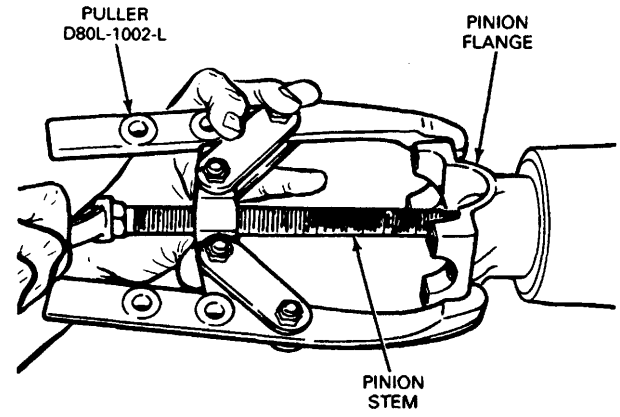
DISASSEMBLY (Continued)

12. Turn nose of carrier in a horizontal position, remove pinion nut. Hold pinion flange with Tool T57T-4851-B Pinion Flange Holding Tool, and remove pinion nut and washer.

NOTE: Pinion nut for Model 80 axle requires 596-678 N·m (440-500 ft-lbs.) of torque to remove.

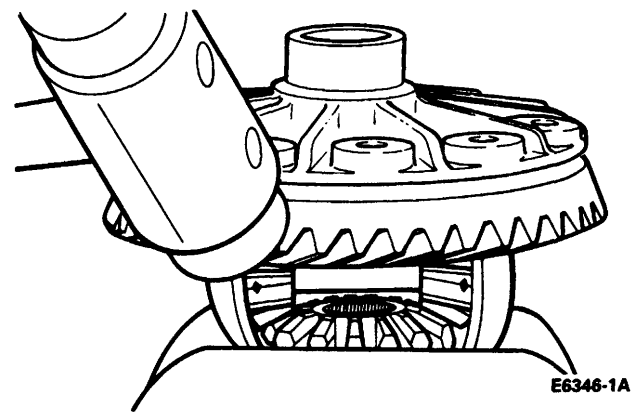


13. Remove pinion flange with Tool-D80L-1002-L. If the pinion flange shows wear in the area of the seal contact, it should be replaced.



14. Remove pinion by tapping with a rawhide hammer. Catch the pinion with your hand to prevent it from falling to the ground and being damaged.

CAUTION: Handle ring gear carefully to prevent injury.



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DISASSEMBLY (Continued)

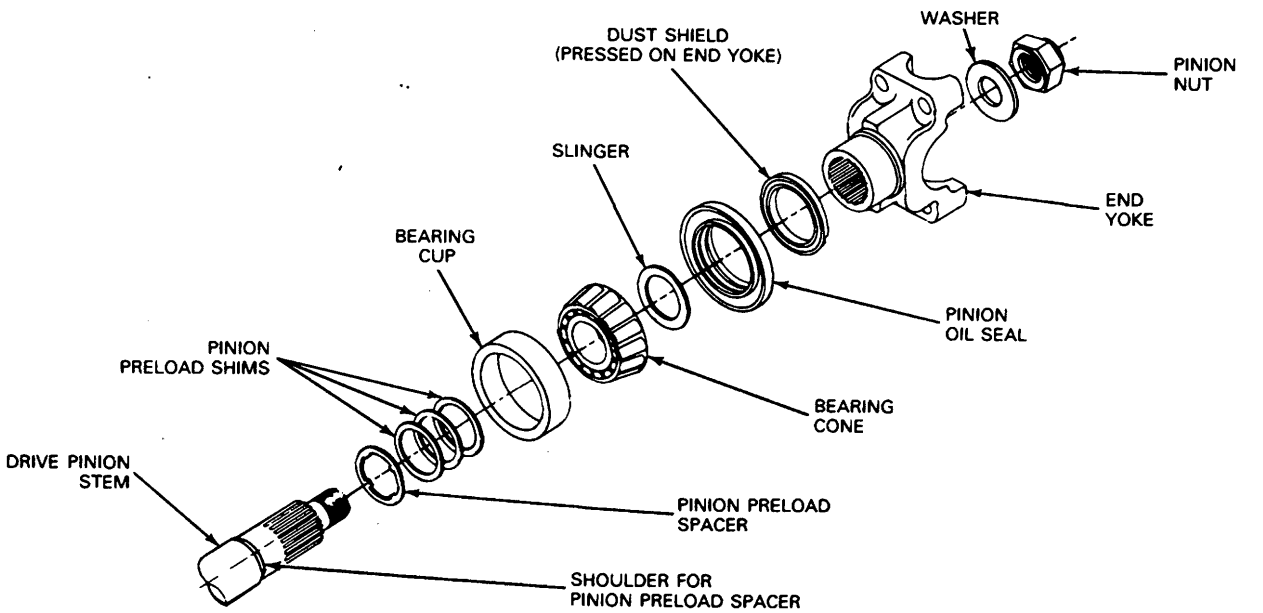
NOTE: On the spline end of the pinion, there are bearing preload shims. These shims may stick to the pinion or bearing or even fall out. These shims are to be collected and kept together since they will be used later in assembly. Try not to damage shims. If shims are damaged, replace with new ones. Shims are available in thicknesses of mm .08, .13, .25, and .76 (.003 inch, .005 inch, .010 inch, and .030 inch).

Model 70 axle may also include a pinion bearing preload spacer with the inner pinion bearing preload shims.

The illustration shows the assembly sequence for the drive pinion preload spacer that is included in the service kit and must be used with the drive pinion kit.

The drive pinion preload spacer and preload shims assembly sequence must be followed. If sequence is not followed and components are improperly assembled, it may cause unit failure.

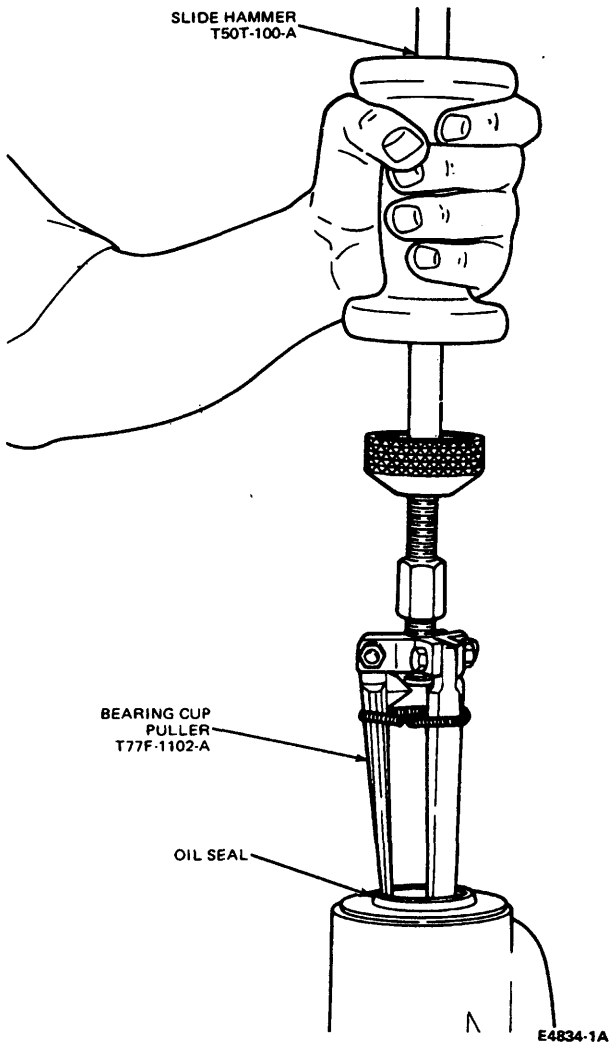
Axle assemblies manufactured without and prior to the use of the pinion preload spacer may be serviced with this drive pinion and preload spacer.



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DISASSEMBLY (Continued)

15. Pull out pinion seal with Puller T77F-1102-A, Bearing Cup Puller and T50T-100-A, Slide Hammer (Fig. 15). Discard seal. REPLACE WITH NEW ONE AT TIME OF ASSEMBLY. Remove bearing cone and outer oil slinger.



16. Turn nose of carrier down. Remove outer pinion bearing cup with tool Bearing Cup Remover D81T-4628-D and Driver Handle D81L-4000-A. For Model 61 and 70, use Cup Remover T88T-4628-A for Model 80. Locate driver on back edge of cup; drive cup out of carrier.

CAUTION: Do not nick carrier bore.

NOTE: The front and rear carrier section may vary in pinion bore depth due to the possibility of the need for either a baffle or slinger or both.

The baffle serves the same purpose as a dam, to assure that the pinion bearings are maintained with lubricant.

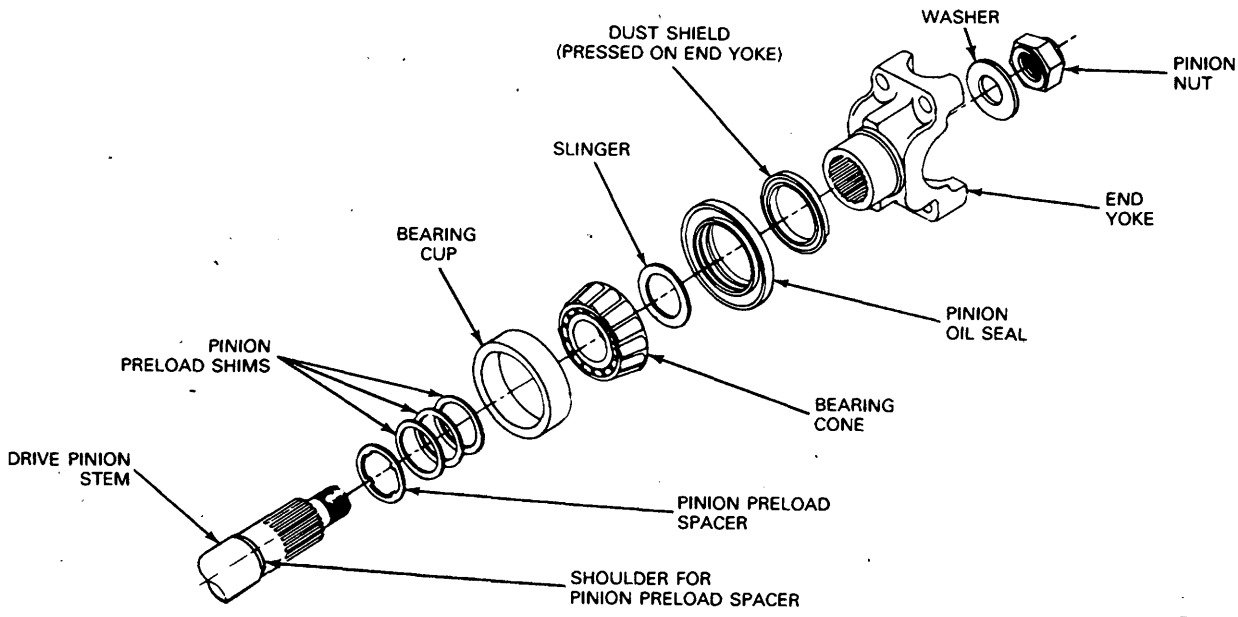
The slinger serves the purpose of assisting the lube to flow up through the oil channels to lubricate the pinion bearings. If used, they are part of the pinion setting adjustment.

17. Remove the inner bearing cup with Bearing Cup Remover, D81T-4628-A for Model 60 and 70-2U axles or D81T-4628-B for Model 70-1HD or T88T-4628-A (Model 80) axles and Driver Handle D81L-4000-A.

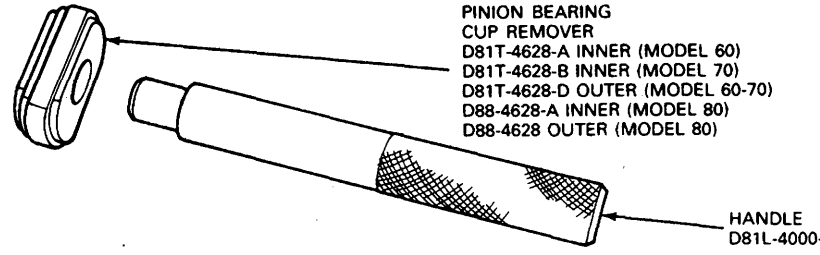
    NOTE: Shims are located between the bearing cup and carrier bore and may also include an oil baffle. If shims and baffles are bent or nicked, they should be replaced at time of assembly. Wire shim stacks together and measure each. If stack has to be replaced, replace with same thickness.

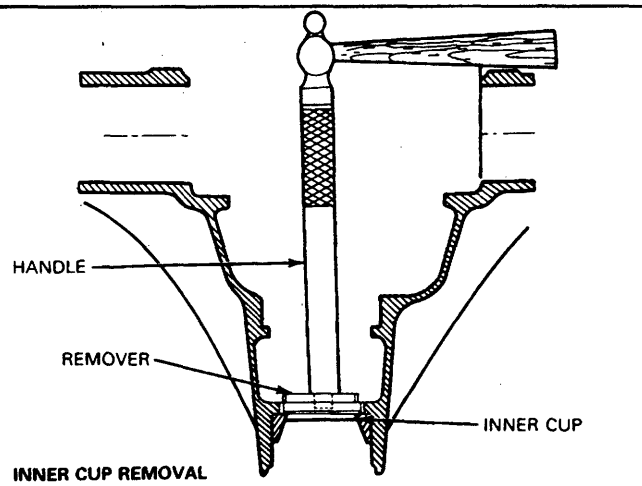
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DISASSEMBLY (Continued)

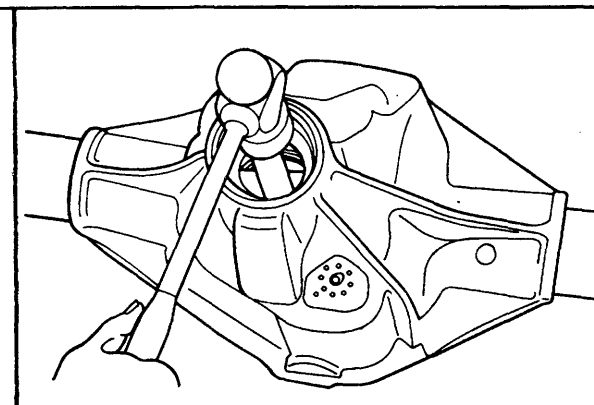


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INNER CUP REMOVAL

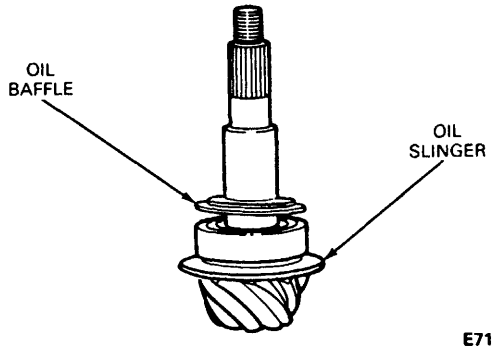


OUTER CUP REMOVAL

E4835-2E

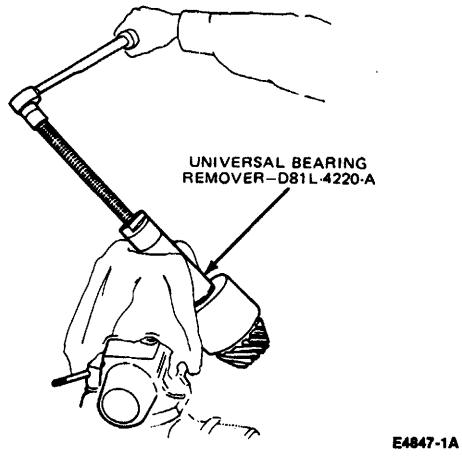
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DISASSEMBLY (Continued)



18. Remove bearing from pinion with Universal Bearing Remover, D81L-4220-A.

NOTE: Both baffle and slinger are part of the pinion adjustment shims and are to be kept intact for assembly.



CLEANING AND INSPECTION

Inspection Before Disassembly

The differential case assembly and drive pinion should be inspected before they are removed from the axle assembly. These inspections can find the cause of the concern and determine the resolution.

1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.
2. Rotate the gears to see if there is any roughness which would indicate damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.
4. Set up dial indicator Tool D78P-4201-B and check ring gear and pinion backlash and ring gear backface runout.

Check ring gear and pinion backlash in three equally spaced points with dial indicator.

Backlash tolerance is 0.127-0.203mm (0.005-0.008 in) and cannot vary more than 0.05mm (0.02 in) between points checked.

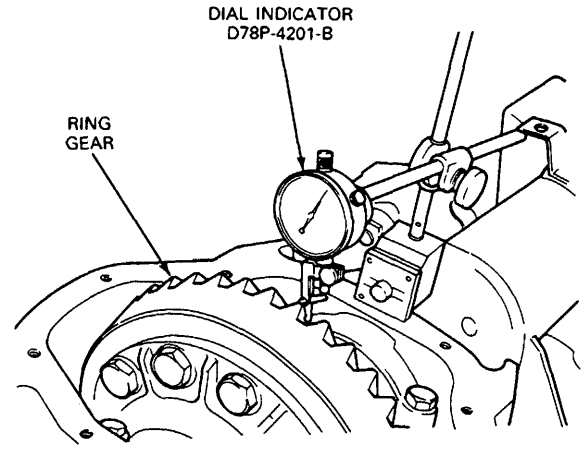
High backlash is corrected by moving the ring gear away from the pinion.

Low backlash is corrected by moving the ring gear away from the pinion.

These corrections are made by switching shims from one side of the differential case to the other.

To check ring gear backface runout, mount Dial Indicator D78P-4201-B on the carrier so the tip of the dial indicator contacts the backface of the ring gear. Backface runout should be no more than 0.101mm (0.004 inch).

5. A contact pattern is not an acceptable guide to check for noise. Proper gear set assembly must be checked using the Rear Axle Pinion Depth Gauge Tool set which shows the correct pinion depth required to assure acceptable running condition. See Section on Drive Pinion and Gear Set.



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CLEANING AND INSPECTION (Continued)

Inspection After Disassembly

Thoroughly clean all parts. Always use new solvent when cleaning bearings. Do not spin dry bearings with compressed air. Oil the bearings immediately to prevent rusting. Inspect the parts for any major damage. Clean the inside of the housing before rebuilding. When a scored or chipped gear set is replaced, the axle housing must be washed thoroughly. Inspection procedures for individual parts are outlined as follows.

Bearing Cups

Check bearing cups for deep scores, galling, or spalling. If a 0.0381mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup must be re-seated.

Cone and Roller Assemblies

When operated in the cups, bearing rollers must turn without roughness. Examine the roller ends for stop wear. If inspection reveals either a damaged cup or a damaged cone and roller assembly, both parts should be replaced.

Pinion Flange

Be sure that the flange half-rounds and lugs have not been damaged in removing the driveshaft or in removing the flange from the pinion. The end of the flange that contacts the bearing cone as well as the nut counterbore and seal surface must be smooth and free of nicks.

Gears

Examine the pinion and ring gear teeth for scoring, excessive wear, nicks and excessive chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Carrier Housing

Make sure that the differential and pinion bearing bores are smooth. Remove any nicks or burrs from the mounting surfaces of the carrier housing.

Differential Case

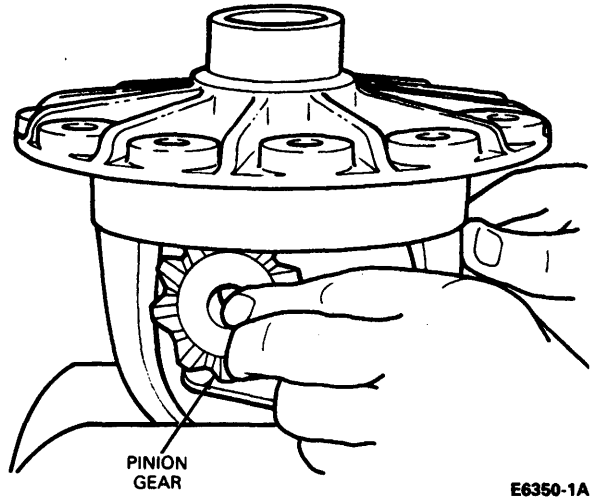
Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores.

ASSEMBLY

Differential Case

Assembly

1. Place differential case in vise. Apply grease, Multi-Purpose Long Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent, to new side gear thrust washers and to hubs and thrust face of the new side gears. Install both side gears. Apply grease to the new pinion mate spherical washers and the new pinion mate gears.
2. Assemble both side gears and thrust washers, hold in place with hand, then assemble the pinion mate gears and washers to hold the side gears in place. An easy way to assemble the side gears and pinion mate gears is to have all parts lubricated with ESW-M2C105A Rear Axle Lubricant before assembly.
3. Rotate the side gears until the holes of the washers and pinion gears line up with the holes of the case. If the gears cannot be rotated by hand, install one of the axle shafts into the side gear spline and use a pipe wrench to turn the shaft.

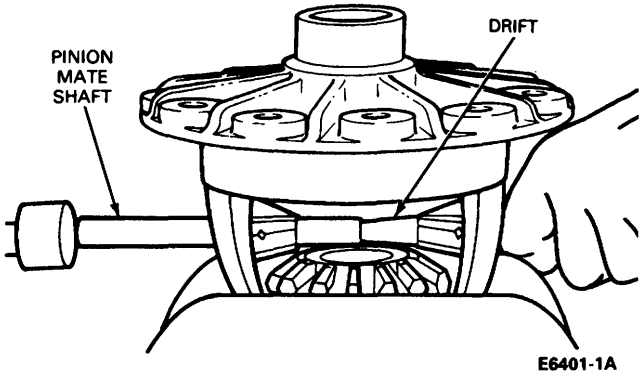


E6350-1A

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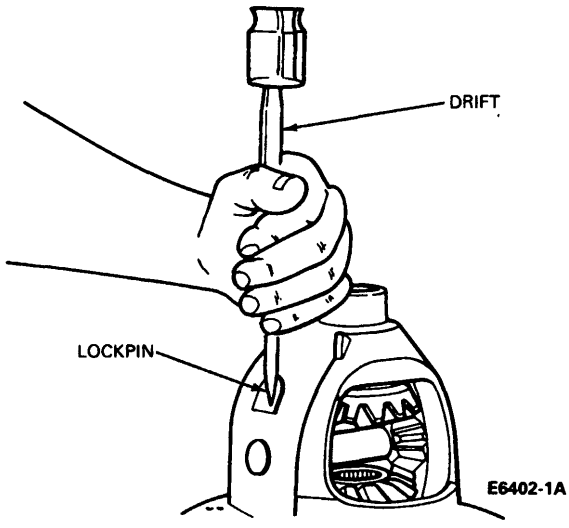
ASSEMBLY (Continued)

4. Use a drift to line up the holes with those of the differential case.
5. Assemble pinion mate shaft, drive on shaft to remove drift. Be sure lock pin hole of the shaft is lined up with the lock pin hole of the case.



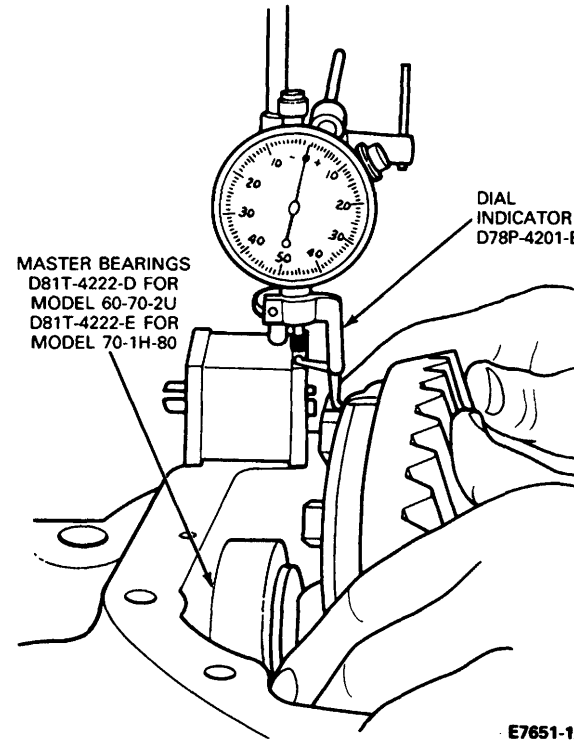
6. Assemble lock pin. Peen metal of case over pin to lock in place.

NOTE: The semi-float shaft riding bearing design uses a lock pin that is assembled with the use of a 12 point socket wrench. Use a new lock pin and assemble finger tight only. This procedure is necessary to prevent differential side gears and differential pinion mate gears from rotating in the case and dropping out when servicing the carrier section. A new lock pin should be installed after assembling the axle shafts.



7. Be sure flange face of the case is free of nicks or burrs. Assemble ring gear to case. Line up holes of the ring gear with those of the case. Use new ring gear bolts. Draw up gear bolts alternately and evenly. Tighten ring gear bolts to 136-163 N·m (100-120 ft-lbs) for grade 8 bolts. Tighten grade 9 bolts 169-183 N·m (125-135 ft-lbs) for Model 60, 61, 70 axles. Tighten Model 80 ring gear bolts to 285-312 N·m (210-230 ft-lbs).
8. Install Master Differential Bearings, Tool D81T-4222-D for Model 60 and 70-2U axles. Use Tool D81T-4222-E for 70-HD and Model 80 axles onto the differential case. Remove all nicks, burrs, dirt, etc., from hubs to allow bearings to rotate freely.
9. Assemble differential case into carrier (less pinion). Mount dial indicator with a magnetic base Tool D78P-4201-B as shown. Locate tip of indicator on flat surface of one of the ring gear screw spot faces. Force differential assembly as far as possible in the direction towards the indicator. With force still applied, set indicator at zero (0).

   NOTE: Dial indicator should have a minimum travel of 5.08mm (0.200 inch).

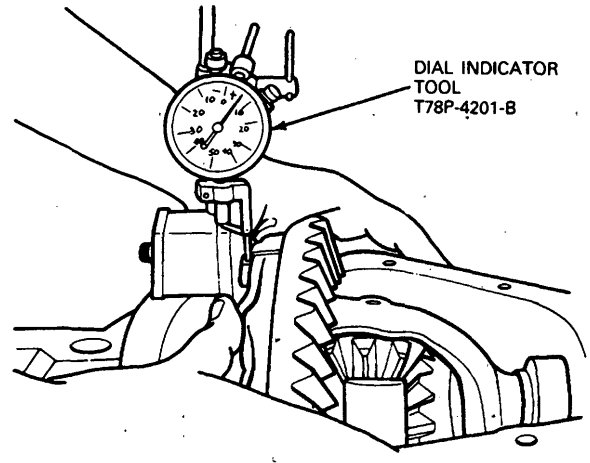


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ASSEMBLY (Continued)

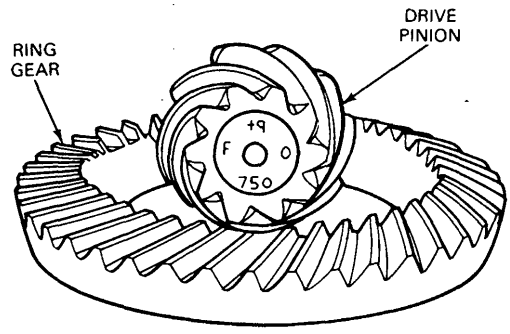
10. Force the differential assembly as far as it will go in the opposite direction. Repeat these steps until you have obtained the same reading. Record the reading of the indicator. This will be the total amount of shims required (less preload) and will be calculated later during assembly. After making sure the readings are correct, remove indicator and differential assembly from housing. DO NOT REMOVE MASTER BEARINGS FROM DIFFERENTIAL CASE AT THIS TIME.

This reading is the Total Differential Case Endplay which will be needed in Step 6 of Assembly of Differential into Housing in this Section.



E7652-1A

11. Ring gears and pinions are supplied in matched sets only. Matching numbers on both the pinion and ring gear are etched for verification. If a new gearset is being used, verify the numbers of each pinion and ring gear before proceeding with assembly.



STANDARD PINION

E7117-1A

The distance from the centerline of the ring gear to the button end of the pinion for the Models 60-1, 61-1 is 79.37mm (3.125 inch). For Model 70 and 80, the distance is 3.50 inch (88.9mm).

On the button end of each pinion, there is etched a plus (+) number, a minus (-) number, or a zero (0) number which indicates the best running position for each particular gear set. This dimension is controlled by the shimming behind the inner pinion bearing cup.

For example—If a pinion is etched a plus m+8 (+3), this pinion would require .08mm (.003 inch) less shims than a pinion etched "0". This means by removing shims, the mounting distance of the pinion is increased to 98.45mm (3.128 inch), which is just what a m+8 (+3) indicates. Or if a pinion is etched m-8 (-3), we would want to add .08mm (.003 inch) more shims than would be required if the pinion were etched "0". By adding .08mm (.003 inch) shims, the mounting distance of the pinion was decreased to 98.29mm (3.122 inch) which is just what a m-8 (-3) indicated.

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ASSEMBLY (Continued)

If the old ring and pinion set is to be reused, measure the old shim pack and build a new shim pack to this same dimension. If a baffle is used in the axle assembly, it is considered as part of the shim pack.

To change the pinion adjustment, shims are available in thicknesses of mm .08, .13, and .25 (.003 inch, .005 inch, and .010 inch).

NOTE: If baffle or slinger is bent or mutilated, it should be replaced.

Measure each shim separately with a micrometer and add together to get the total shim pack thickness from the original build up.

If a new gear set is being used, notice the (+) or (-) etching on both the old and new pinion and adjust the thickness of the new shim pack to compensate for the difference of these two figures.

For example—If the old pinion reads m+5 (+2) and the new pinion is m-5 (-2), add .10mm (.004 inch) shims to the original shim pack.

SHIM SELECTION CHART — INCHES

Old Pinion Marking	New Pinion Marking								
	−4	−3	−2	−1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003
0	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004
−1	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005
−2	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006
−3	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007
−4	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007	−0.008

SHIM SELECTION CHART — METRIC

Old Pinion Marketing	New Pinion Marking								
	−10	−8	−5	−3	0	+3	+5	+8	+10
+10	+.20	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0
+8	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03
+5	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05
+3	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08
0	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10
−3	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13
−5	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15
−8	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15	−.18
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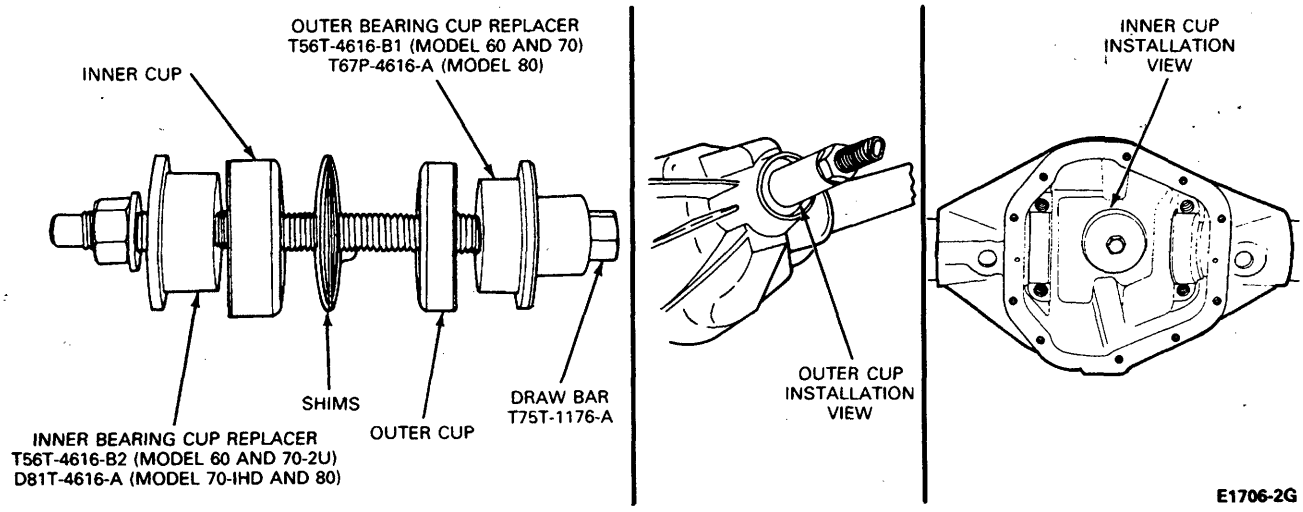
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ASSEMBLY (Continued)

Pinion Bearing Cup Installation

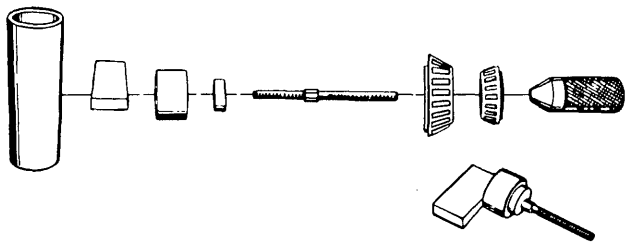
1. Place the required amount of preload shims under the inner cup as shown.
2. Place the inner and outer bearing cups into the carrier bore.
3. Place the Inner Bearing Cup Replacer Tool on the inner bearing cup. For Model 60 and 70-2U axles, use T56T-4616-B2. For Model 70-1HD and 80 axles, use D81T-4616-A.
4. Place the Outer Bearing Cup Replacer Tool on the outer bearing cup. For Model 60 and 70 use T56T-4616-B1. For Model 80 axles, use T67P-4616-A.
5. Install the Threaded Drawbar, T75T-1176-A into the replacer tools and tighten the drawbar to install the cups into the carrier bore.



Depth Gauge Check

1. Refer to the following tool usage chart for the correct tools for the particular axles. Tool T80T-4020-A

NOTE: If any of the gauge surfaces become nicked, the high spots must be removed with a medium India oilstone to ensure no erroneous readings.



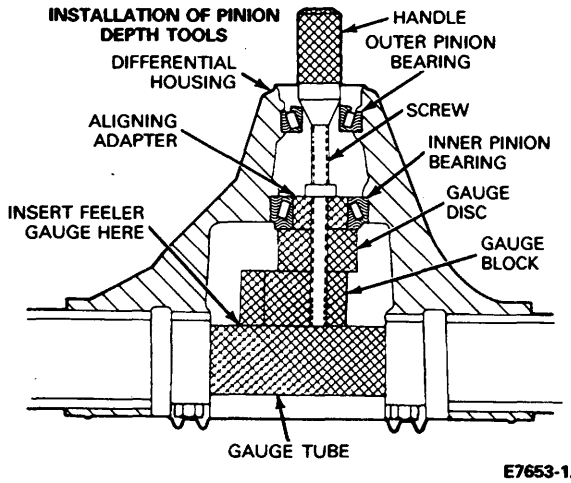
Description	Number	Model 60	Model 1HD	Model 70-2u	Model 80
Handle	T76P-4020-A11	X	X	X	T88T-4020-B
Screw	T80T-4020-F43	X	X	X	X
Gauge Block	T80T-4020-F42	X	X	X	X
Aligning Adapter	T76P-4020-A3	X			D80T-4020-R60
	T80T-4020-F48		X	X	
Gauge Disc	T78P-4020-A15	X			T88T-4020-A
	D80T-4020-F45		X	X	
Gauge Tube	D80T-4020-F48	X	X	X	D81T-4020-F51
Final Check Gauge Block	D81T-4020-F54	X			D81T-4020-F56
	D81T-4020-F55		X	X	

CE4093-2F

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ASSEMBLY (Continued)

2. Place a new inner pinion bearing cone over the proper aligning adapter and insert into the axle carrier bore. Place the outer pinion bearing cone (new or used if in good condition) into the bearing cup and assemble the handle onto the screw and hand tighten. Note the 3/8 inch square drive in the handle to be used for obtaining the proper pinion bearing preload and tighten to preload of 2.26-4.53 N·m (20-40 in-lbs).



3. Center the proper gauge tube into the differential bearing bore. Install the bearing caps and tighten to 109-147 N·m (80-90 ft-lbs).
4. Using a feeler gauge tool or shims, select the thickest feeler shim that will enter between the gauge tube and the gauge block. Insert the feeler gauge directly along the gauge block to insure a correct reading. The feeler gauge fit between the gauge tube and the gauge block should be a slight drag-type feeling. Make sure the shims or feeler gauges are free of dirt to prevent an incorrect reading.
5. After the correct feeler gauge feel is obtained, check the reading and this is the thickness of shim(s) required providing that upon inspection of the service pinion gear, there are no markings.

NOTE: If the service pinion gear is marked with a plus (+) reading, this amount must be subtracted from the thickness dimension obtained in step 4.

If the service pinion gear is marked with a minus (-) reading, this amount must be added to the thickness dimension obtained in step 4.

In addition you must use the exact same new inner pinion bearing that was used in the previous steps.

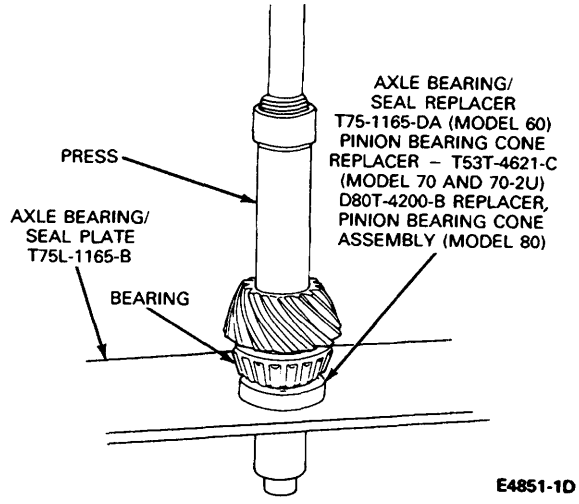
6. Remove the inner pinion bearing cup and install the correct thickness of shims in the carrier bore. Re-install the bearing cup and oil slinger (if used) on the pinion and press on the bearing with T53T-4621-C, for Model 70, T75L-1165DA for Model 60, or D80T-4200-B for Model 80.

NOTE: If a baffle or slinger is used, replace with a new one upon assembly and measure as part of the shim stack.

7. After following these procedures, continue to build the remaining components with proper pinion and differential bearing preload torques and ring gear backlash.

Pinion Bearing Preload and Final Depth Check

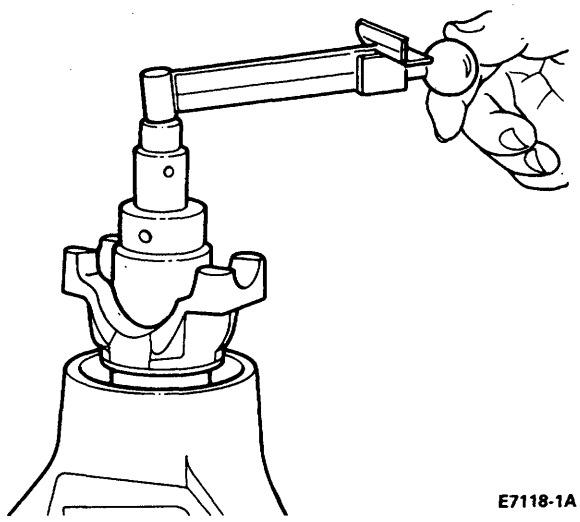
1. Assemble preload shims and spacer or slinger (if used) onto pinion. Assemble bearing cone and roller assembly. Using T75L-1165-B, Axle Bearing/Seal Plate and T75L-1165-DA, Axle Bearing/Seal Replacer for Model 60 axles or T53T-4621-C, Pinion Bearing Cone Replacer for Model 70 axles. For Model 80 axle use D80T-4200-B, Pinion Bearing Cone Replacer.



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ASSEMBLY (Continued)

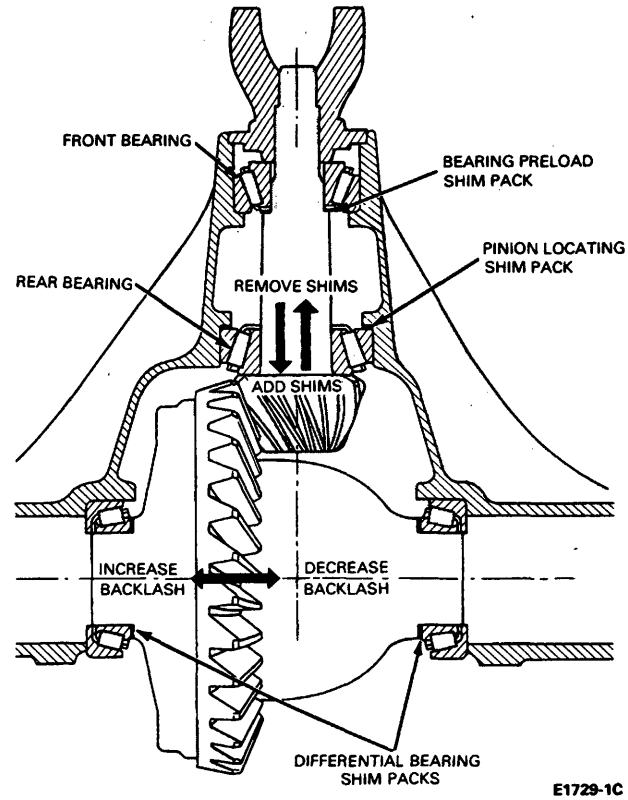
2. Assemble end yoke, washer and new pinion nut on the pinion shaft. Tighten nut to 325-406 N·m (240-300 ft-lbs) for Model 60 and 70 Axles. For Model 80 axles tighten nut to 596-677 N·m (440-500 ft-lbs).



E7118-1A

3. Using an inch-pound torque wrench, rotate pinion. Torque to rotate pinion should read between 2.26-4.53 N·m (20-40 in-lbs). To increase preload, remove shims from drive pinion. To decrease preload, add shims to pinion.

The following illustration shows the arrow in the pinion pointing in two directions. The direction pointing towards the end yoke indicates that by removing pinion position shims, the distance from the centerline of the axle to pinion button is increased giving a plus reading. The pinion bearing preload shim pack does not affect the pinion depth setting. Arrows on the ring gear illustrate the method to increase or decrease backlash and differential bearing preload.



E1729-1C

4. Install the Gauge Tube D80T-4020-F48 for Model 60 and Model 70 axles. Use D81T-4020-F51 for Model 80 axle. Install bearing caps and bolts and tighten to 109-147 N·m (80-90 ft-lbs).
5. Insert the Final Check Gauge Block, D81T-40-20-F54 for Model 60 axles or D81T-4020-F55 for Model 70 or D81T-4020-F56 for Model 80 axle on top of the pinion button under the Gauge Tube. Place thumb on the Gauge Block to make sure that the block is level.

Insert feeler gauges or shims between the gauge tube and the Final Check Gauge Block until a slight drag is felt.

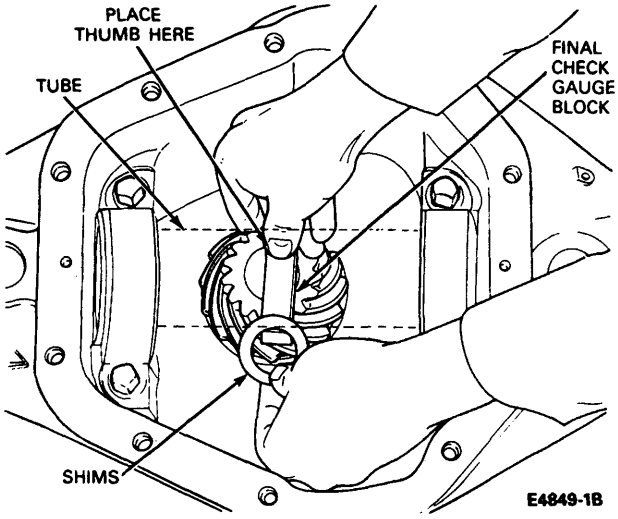
The reading should be 0.050mm (0.020 inch) added to the drive pinion etching, which could be 'plus' (+) or 'minus' (-) with a tolerance (±) of 0.050mm (0.002 inch).

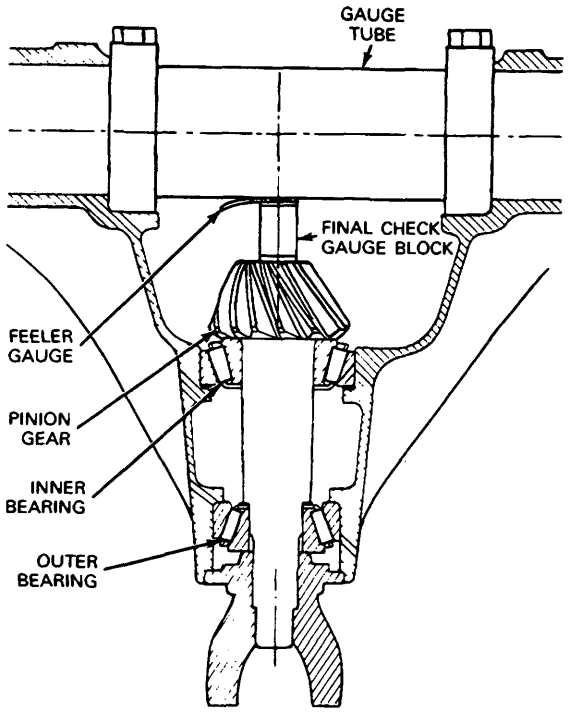
For example: a drive pinion with a '-2' etching would have a 0.45mm (0.018 inch) distance and a tolerance of 0.050mm (0.002 inch), would require 0.40-0.50mm (0.016-0.020 inch) amount of shims.

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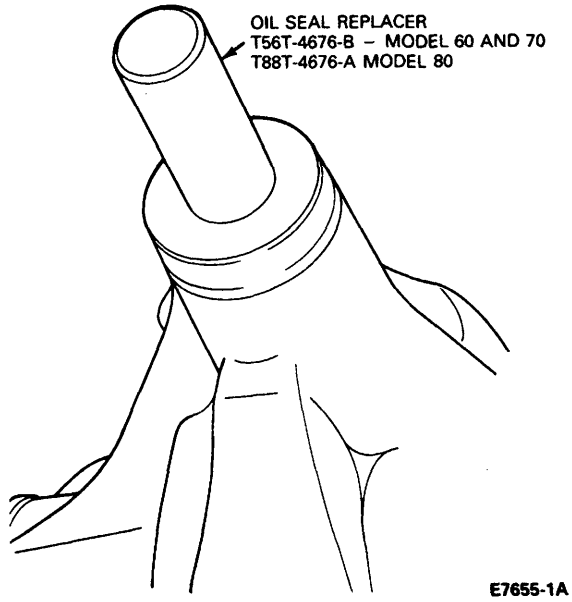
ASSEMBLY (Continued)

If the distance must be increased, remove shims from beneath the inner pinion bearing cup. If the distance must be decreased, add shims beneath the inner pinion bearing cup.





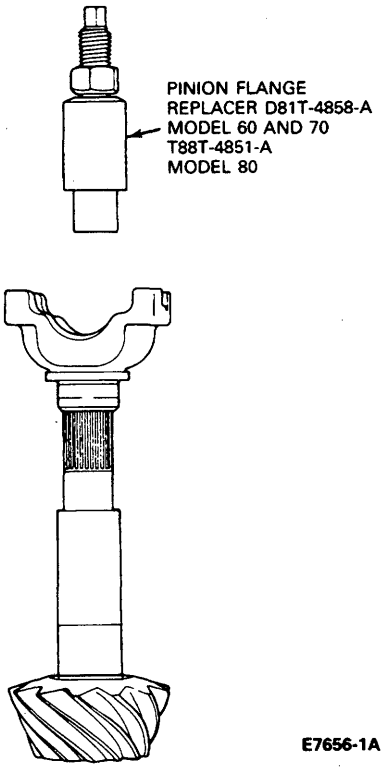
6. With the drive pinion at the correct depth, remove the yoke with Holding Tool, T57T-4851-B and Yoke Remover, T65L-4851-B for Model 60, 70 and 80 axles. Remove the yoke, nut and washer.
7. Coat the oil seal with grease. Install the drive pinion oil seal with Oil Seal Replacer, T56T-4676-B (Model 60 and 70). For Model 80 axle use Pinion Seal Replacer T88T-4676-A. After installation, make sure the garter spring did not pop out. If the garter spring pops out, remove and replace seal.



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ASSEMBLY (Continued)

8. Install the yoke with Pinion Flange Replacer, D81T-4858-A for Model 60-70 axles if necessary to draw the drive pinion up to engage the nut (Fig. 31). Install the washer and nut and tighten nut to 339-366 N·m (250-270 ft-lbs). For Model 80 axles, tighten to 440-500 ft-lbs (596-677 N·m) Use pinion flange replacing tool T88T-4851-A.

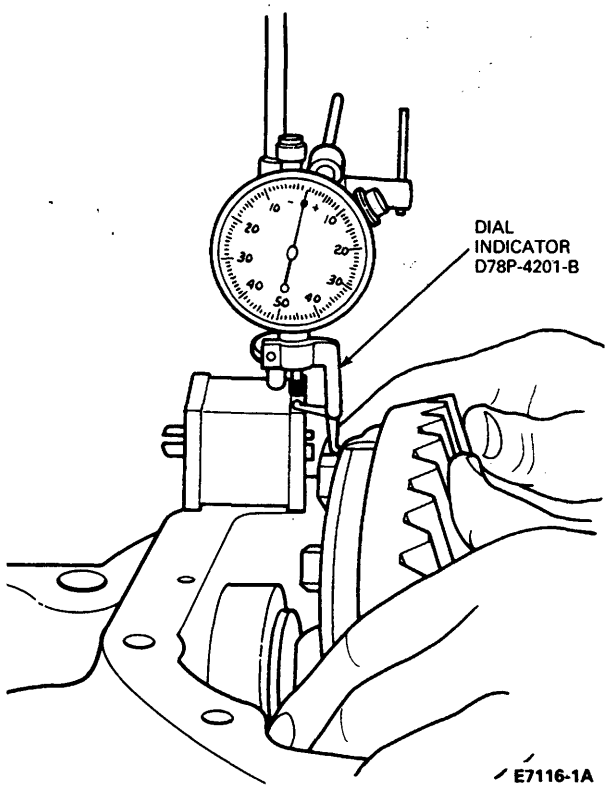


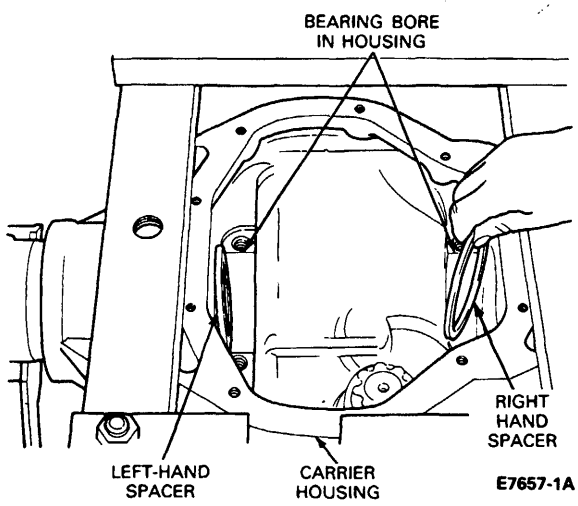
Assembly of Differential Into Housing

Ring Gear and Pinion Backlash

1. Place differential assembly (Model 60-70 axles with pinion installed) into housing. Differential master bearings should still be assembled to case. On Model 80 axle, install our board spacers.
2. Set up dial indicator as shown. Be sure to locate dial indicator on same location as shown.

Force ring gear into mesh with the pinion. Rock ring gear to allow the teeth of the gears to mesh. With force still applied to the differential case, set indicator at zero "0".

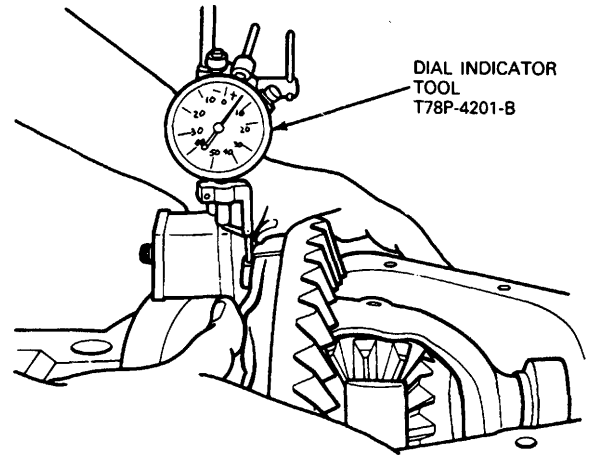




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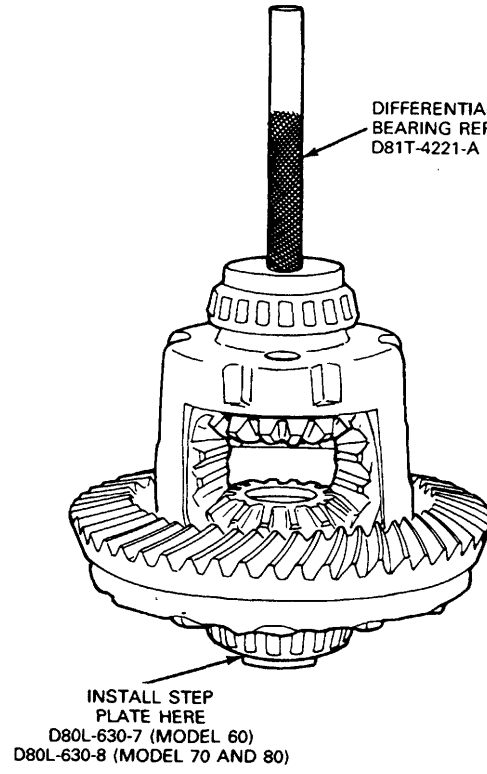
ASSEMBLY (Continued)

3. Force the differential case (ring gear) away from the pinion gear to obtain an indicator reading. Repeat until the same reading is obtained each time. This reading will be the necessary amount of shims required between the differential case and differential bearings on the ring gear side. Remove indicator and differential case from the carrier. Remove master bearings from differential case.
4. As determined in Step 3 place the required amount of shims on the ring gear hub of the differential case. For example: if the reading in Step 3 was 1.14mm (0.045 inch), place 1.14mm (0.045 inch) amount of shims on the hub of the ring gear side of the differential case.



E7652-1A

5. Install the bearing cone on the ring gear side of the differential case. Drive the bearing onto the hub using Differential Side Bearing Replacer, D81T-4221-A.



E4837-1C

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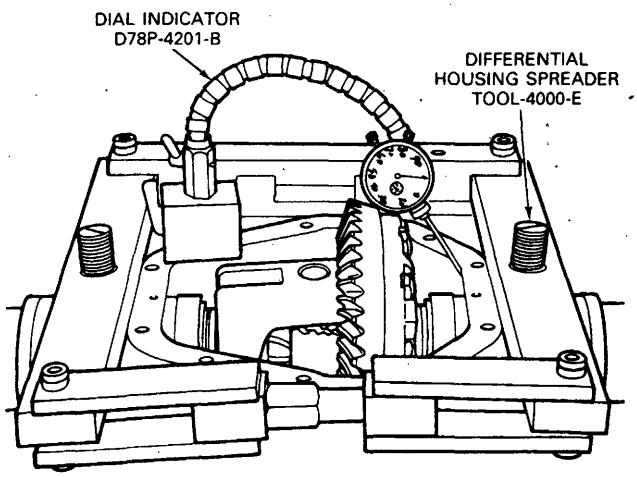
ASSEMBLY (Continued)

6. To determine the correct amount of shims to be placed on the hub of the drive pinion side of the differential case, subtract the reading obtained in step 3 from the Total Differential Case Endplay. Total Case Endplay was determined under Steps 9 and 10 of Differential Case-Assembly. When this amount is determined, add 0.36mm (0.015 inch) to the amount. This is the required amount of shims to be placed on the hub of the drive pinion side of the differential case.

For example: Total Differential Case Endplay was 2.30mm (0.091 inch). The reading in Step 3 was 1.14mm (0.045 inch), and when subtracted from 2.30mm (0.091 inch) gives 1.16mm (0.046 inch). 0.36mm (0.015 inch) is added to give 1.52mm (0.061 inch) amount of shims to be placed on the hub of the drive pinion side of the differential case.

7. Place the required amount of shims on the hub of the drive pinion side of the differential case.
8. Install the bearing cone on the hub of the drive pinion side of the differential case. Place Step Plate D80L-630-7 for Model 60 axles and D80L-630-8 on Model 70 and 80 axles on the ring gear side bearing to protect the bearing during installation of the drive pinion side bearing. Place the bearing on the drive pinion side hub and drive it on using Differential Side Bearing Replacer, D81T-4221-A.
9. Install spreader Tool-4000-E and indicator Tool-4201-C to carrier. Do not spread carrier over 0.38mm (0.015 inch). Remove indicator.

CAUTION: Do not spread carrier over 0.38mm (0.015 inch).



E4833-1B

Ring Gear and Pinion Backlash Model 80

For service it will be necessary to use a differential bearing adjustment shim pack which will prompt the necessity of shimming the differential bearings both inboard and outboard.

Inboard shims which are located between the differential case and the bearing are not to exceed .050 per side.

The service shim pack is as follows:

(1) Outboard Spacer .150 Thickness

(1) Outboard Spacer .120 Thickness

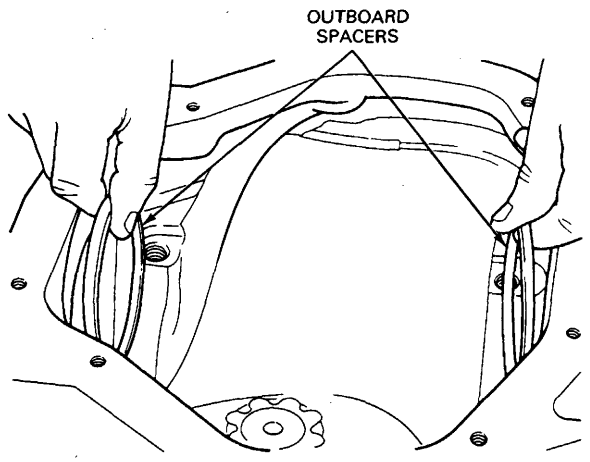
(6) Inboard Shims .003 Thickness

(2) Inboard Shims .005 Thickness

(4) Inboard Shims .010 Thickness

(2) Inboard Shims .030 Thickness

Install the master differential bearing into the trunnions of the differential case. The outboard spacers are installed in the carrier between the master bearings and the carrier.

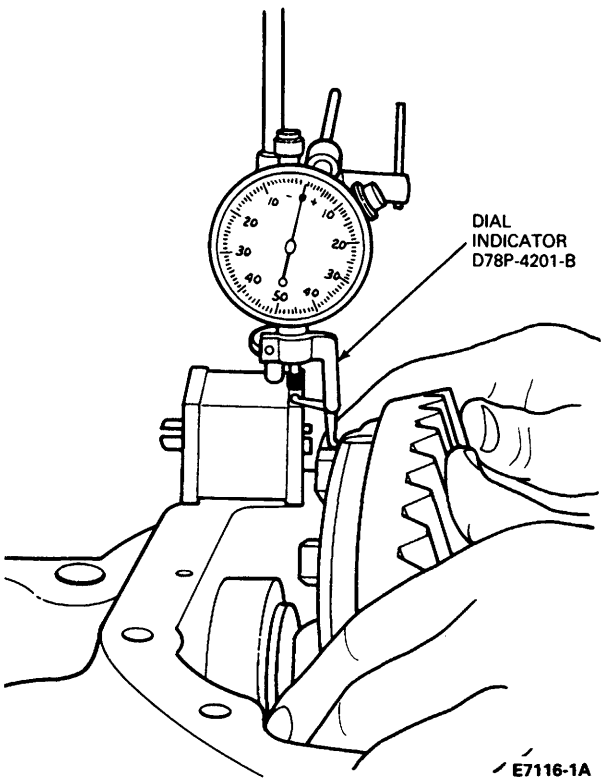


E7658-1A

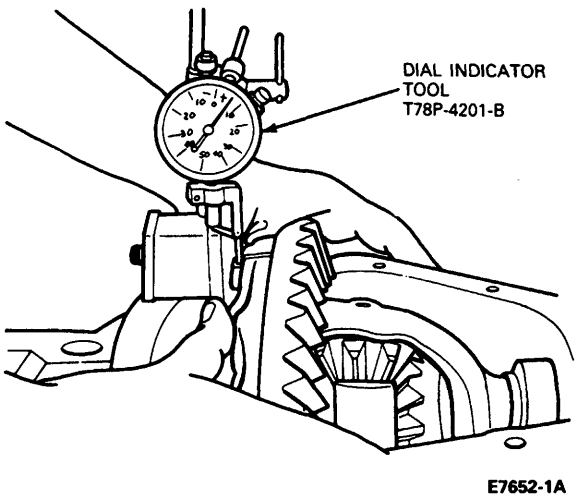
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ASSEMBLY (Continued)

1. Assemble case with master bearings installed into carrier (less pinion).
2. Measure outboard spacer with a micrometer—record reading.
3. Install outboard spacer between master bearing and carrier on ring gear side. Apply grease to spacer to hold in position.
4. Mount dial indicator Tool D78P-4201-B on ring gear side. Locate tip of indicator on ring gear screw. Force differential assembly as far as possible in the direction of the indicator. With force still applied set indicator at zero "0".



5. Force the differential assembly as far as it will go in the opposite direction. Repeat these steps until the same reading is obtained. Record the reading of the indicator plus the thickness of the spacer. Add together; this will be the total amount of spacers and shims required and will be calculated after assembly of the pinion.



6. Install differential case assembly with master bearings still installed into carrier. Install same spacer used in Step 3 between carrier and master bearing. Install dial indicator as indicated in Step 4.
7. Force differential assembly (with ring gear) to mesh with the pinion gear. With force still applied set indicator at zero "0".
8. Force differential assembly away from the pinion gear to obtain an indicator reading. Repeat these steps until the same reading is obtained each time. Record reading. Remove indicator and differential case from carrier.

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ASSEMBLY (Continued)

9. Remove master bearings from differential case. Install the required amount of shims.

For example:

STEP #1 Less pinion	
Spacer	.150 inch Thickness
Indicator Reading	.162
Total Shims Required	.312 inch
STEP #2 With Pinion	
Spacer	.150 inch Thickness
Indicator Reading	.022
Total Shims Required Ring Gear Side	.172 inch
Total Amount of Shims Required for Opposite Side	.140 inch Less Preload

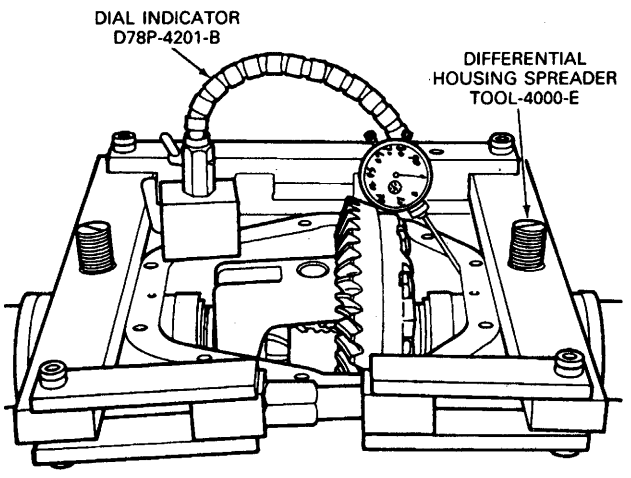
In Step #5 (less pinion) a total of .312 was recorded including the .150 spacer.

In Step #8 (with pinion) a total of .172 was recorded including the .150 spacer.

Assemble .022 inboard shims between the case and bearing on the ring gear side. With .150 spacer added to the ring gear side this leaves a balance of .140 for the opposite side. The shims for the opposite side include .120 spacer plus .020 inboard shims. This adds up to the .312 which was recorded in Step #5.

Assemble .020 inboard shims between the case and bearing on the opposite side. Add an additional .003 for differential bearing preload and backlash.

10. After shims have been assembled to their respective sides of the case, assemble differential bearings using bearing installer Tool D80L-630-7 and Tool D81T-4221-A.
11. Mount spreader and dial indicator Tool-4000-E and Tool-4201-C to the carrier. Spread carrier .015. Assemble differential case assembly into carrier.



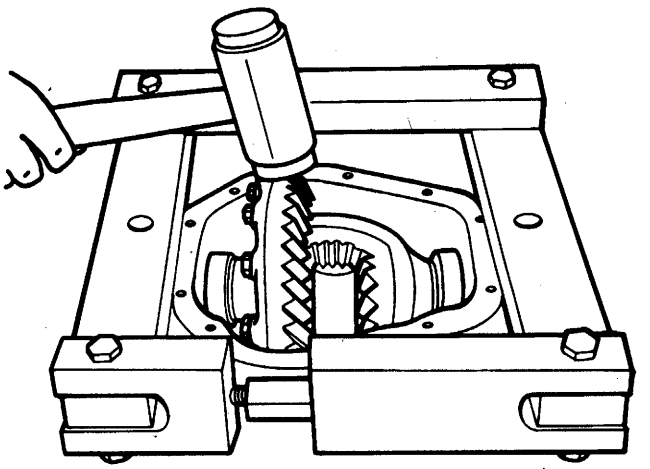
E4833-1B

12. Assemble .150 spacer between carrier and bearing on ring gear side.
13. Assemble .120 spacer between carrier and differential bearing on opposite side.

Final Assembly—Differential into Housing—Model 80

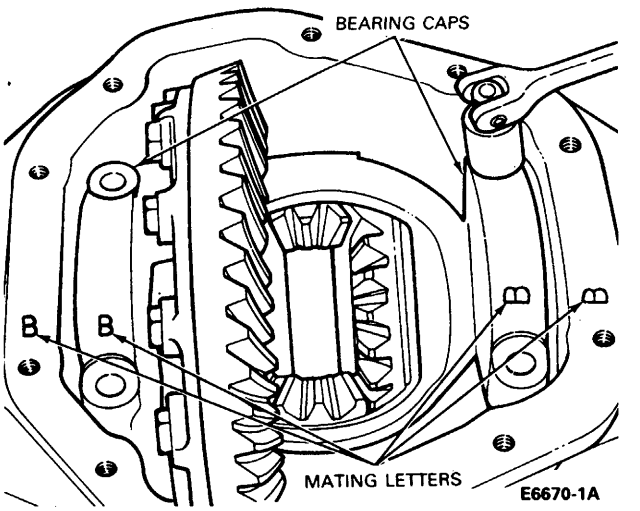
14. Assemble differential bearing cups to differential bearing cones on Model 60 and Model 70. Install differential assembly into carrier.

Use a rawhide hammer to seat differential assembly into crossbore of carrier. Care should be taken to avoid nicking the teeth of the ring gear and pinion during assembly. Remove the spreader from the carrier.



E6409-1A

15. Install bearing caps. Make sure the letters stamped on the caps correspond with those on the carriers. Tighten bearing cap screws to 108-122 N·m (80-90 ft-lbs).



E6670-1A

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ASSEMBLY (Continued)

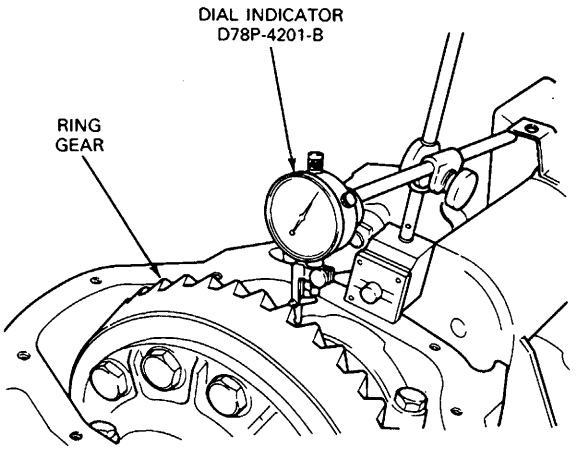
16. Check ring gear and pinion backlash in three equally spaced points with dial indicator.

Backlash tolerance is 0.13-0.203mm (0.005-0.008 inch) and cannot vary more than 0.05mm (0.002 inch) between points checked.

High backlash is corrected by moving the ring gear closer to the pinion.

Low backlash is corrected by moving ring gear away from the pinion.

These corrections are made by switching shims from one side of the differential case to the other.



E7500-1A

17. Install new cover gasket and install cover plate. Tighten screws to 41-54 N·m (30-40 ft-lbs.).

Figure shows the flat mounting surface cover plate on Dana design axles. This cover plate requires the use of a silicone rubber sealer material, Silicone Rubber or equivalent rather than a gasket.

The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.

CAUTION: Clean both flat surfaces with a suitable solvent to remove all traces of oil film.

Sealant material must meet specifications of ESL-M4G273-A, ASTM1, GE503, Z1, Z2 and Z3 sealant or equivalent.

Apply RTV Gasket sealant E7TZ-19562-A (ESL-M4G273-A) or equivalent to cover plate surface. Ensure that the sealer bead is laid on the inside of the cover screw holes. The bead is not to pass through the holes or outside of the holes.

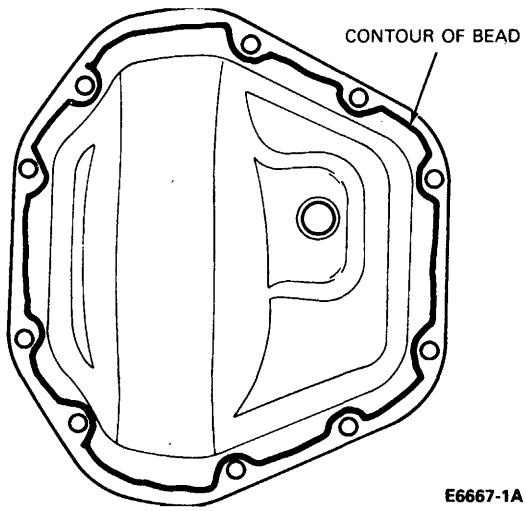
The bead is to be 3.18-6.35mm (1/8 inch to 1/4 inch) wide.

NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.

Assemble two cover screws into cover at 8 o'clock and 2 o'clock position. Use these two holes to guide cover plate into position on the carrier.

Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft-lbs.).

ALLOW ONE HOUR CURE TIME BEFORE FILLING CARRIER WITH THE PROPER AMOUNT OF SPECIFIED LUBRICANT. Refer to the Specifications portion of this Section.



E6667-1A

18. Install axle shafts as outlined under axle shaft removal in section 11-14.
19. Fill axle housing with specified amount of ESW-M2C105-A rear axle lubricant.

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SPECIFICATIONS

Axle Model	Ford Specification	Approx. Capacities		
		U.S. Pts.	Imp. Pts.	Liters
60-3	ESW-M2C105-A (C6AZ-19580-E)	6.3	5.2	3.0
60-1u	ESW-M2C105-A (C6AZ-19580-E)	7.0	5.8	3.3
61-1	ESW-M2C105A (C6AZ-19580-E)	5.8	4.8	2.8
70-2u	ESW-M2C105A (C6AZ-19580-E)	6.6	5.5	3.1
80	ESW-M2C105-A (C6AZ-19580-E)	8.5	6.8	4.0

NOTE: Add EST-M2C118-AC Friction Modifier, (8AZ-19B546-A) or equivalent for complete refill of Dana limited-slip axles. Add 0.2 liter (8 oz.) for E250—E-350 complete refill.

CE4098-2J

DANA AXLE ADJUSTMENTS

Description	Specification	Description	Specification
Backlash Between Ring Gear and Pinion	0.13-0.20 mm (0.005-0.008 inch)	Pinion Bearing Preload (with new bearings)	2.26-4.53 N•m (20-40 in-lbs)
Backlash Maximum Variation Between Teeth	0.05 mm (0.002 inch)		

CE7675-2A

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SPECIFICATIONS (Continued)

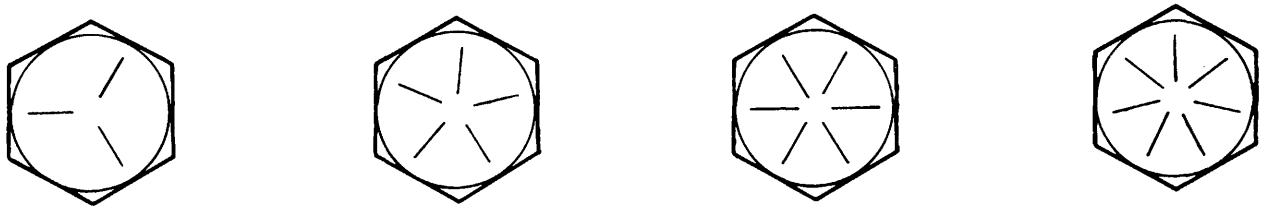
DANA AXLE TORQUE LIMITS

Description	Axle Model					
	60, 61		70		80	
	Ft-Lbs	N·m	Ft-Lbs	N·m	Ft-Lbs	N·m
Pinion Shaft Nut	250-270	339-366	250-270	339-366	440-500	596-677
Differential Bearing Cap Bolts	80-90	109-147	80-90	109-147	80-90	109-147
Ring Gear Attaching Bolts*	100-120	136-163	100-120	136-163	145-165	196-223
Oil Filler Plug	20-30	28-40	20-30	28-40	20-30	28-40
U-Joint Bolts	15-20	21-27	15-20	21-27	—	—
Cover to Housing Bolts	30-40	41-54	30-40	41-54	30-40	41-54

*If special high strength screws are used, torque is 125-135 ft-lbs. (169-183 N·m). High strength screws can be identified by 7 radial lines on screw head. Grade 8 screws will have 6 radial lines on screw heads.

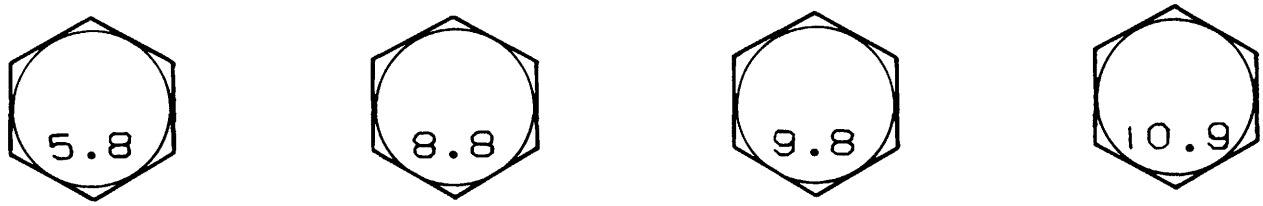
WARNING

IF FASTENERS OF A LOWER GRADE OR CLASS ARE TORQUED TO THE REQUIREMENTS OF A HIGHER GRADE OR CLASS FASTENER, IT MAY RESULT IN COMPONENT FAILURE. (E.G. GRADE 5 FASTENER TORQUED TO THE REQUIREMENTS OF A GRADE 8 FASTENER.)



GRADE 5 GRADE 7 GRADE 8 SPECIAL GRADE (High Strength Applications)

Customary (Inch) Bolts-identification marks correspond to bolt strength-increasing numbers represent increasing strength.



Metric Bolts-identification class numbers correspond to bolt strength-increasing numbers represent increasing strength.

Inch grade fasteners can be identified by the radial lines embossed upon the head of the fastener and will correspond to the fastener strength by two-lines less than actual grade (i.e., grade 8 fastener will display 6 radial lines on the head).

Metric fastener strength can be identified with the class identification embossed on the head of each fastener. Increasing numbers represent increasing strength.

CE7751-2A

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SPECIFICATIONS (Continued)

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Oil Seal Removal
D80L-630-1	Step Plate	Wheel Bearing Installation
D80L-630-7	Step Plate	Differential Side Bearing Installation — Model 60
D80L-630-8	Step Plate	Differential Side Bearing Installation — Model 70-80
T77F-1102-A	Bearing Cup Puller	Oil Seal Removal
D81T-1104-A	Adapter — Fine Thread	Wheel Bearing Removal
T81P-1104-B	Adapter — Coarse Thread	Wheel Bearing Removal
T81P-1104-C	Push Puller	Wheel Bearing Removal
T75L-1165-B	Axle Bearing/Seal Plate	Drive Pinion Bearing Installation
T75L-1165-DA	Axle Bearing/Seal Replacer	Drive Pinion Bearing Installation — Model 60
T75T-1176-A	Threaded Drawbar	Bearing Cup Installation
T81T-1225-A	Rear Wheel Bearing Remover	Wheel Bearing Removal
Tool-4000-E	Housing Spreader	Differential Case Removal and Installation
D81L-4000-A	Drive Handle	Bearing Cup Removal
T80T-4000-W	Driver Handle	Bearing Cup Removal and Installation
T80T-4000-X	Rear Axle Seal Wheel Bearing Replacer	Wheel Bearing Installation
T80T-4000-Y	Rear Oil Seal Replacer	Oil Seal Installation
T80T-4020-A	Pinion Depth Gauge	Axle Adjustments — Model 60 and 70
D80T-4020-F48	Aligning Adapter	Axle Adjustments — Model 60-70
D78P-4201-B	Dial Indicator, Magnetic Base	Axle Adjustments
D81L-4220-A	Universal Bearing Puller	Bearing Removal
D81T-4221-A	Differential Bearing Cone Replacer	Differential Side Bearing Installation — Model 60-70
D81T-4222-D	Master Bearings	Axle Adjustments — Model 60 and 70-2u
D81T-4616-A	Bearing Cup Replacer	Inner Bearing Cup Installation — Model 70-80
T56T-4616-B1	Bearing Cup Replacer	Outer Bearing Cup Installation — Model 60-70
T56T-4616-B2	Bearing Cup Replacer	Inner Bearing Cup Installation — Model 60 Outer Bearing Cup Installation — Model 70
T53T-4621-C	Pinion Bearing Cone Replacer	Drive Pinion Bearing Replacer — Model 70
D81T-4628-A	Bearing Cup Remover	Inner Bearing Cup Removal — Model 60-70
D81T-4628-B	Bearing Cup Remover	Inner Bearing Cup Removal — Model 70
D81T-4628-D	Bearing Cup Remover	Outer Bearing Cup Removal
D81T-4628-X	Pinion Bearing Cup Remover Set	Model 60 and 70 — Model 60-70
T56T-4676-B	Oil Seal Replacer	Oil Seal Installation
T57T-4851-B	Companion Flange Holding Tool	Yoke Removal and Installation
T65L-4851-B	Companion Flange Remover	Yoke Removal — Model 60-70-80
D81T-4858-A	Companion Flange Replacer	Yoke Installation — Model 60-70

CE5576-2D

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SPECIFICATIONS (Continued)

Number	Description	Application
TOOL-1175-AC	Oil Seal Remover	Pinion Oil Seal
D80L-1002-L	2-Jaw Puller	Pinion Flange Removal
D80T-4020-R60	Aligning Adapter	Axle Adjustment
D81T-4020-F51	Gauge Tube	Axle Adjustment Model 80
D81T-4020-F54	Gauge Block	Axle Adjustment Model 60
D81T-4020-F55	Gauge Block	Axle Adjustment Model 70
D81T-4020-F56	Gauge Block	Axle Adjustment Model 80
D88T-4020-A	Gauge Disc	Axle Adjustment
D88T-4020-B	Gauge Handle	Axle Adjustment
D80T-4200-B	Bearing Cone Replacer	Pinion Bearing Model 80
D81T-4222-E	Master Bearing-Diff. Case	Axle Adjustment Model 80
T67P-4616-A	Bearing Cup Replacer	Outer Pinion Bearing Cup Model 80
T88T-4628-A	Bearing Cup Remover	Inner Pinion Bearing Model 80
T88T-4628-B	Bearing Cup Installer	Outer Pinion Bearing Model 80
T88T-4676-A	Oil Seal Replacer	Pinion Oil Seal Model 80
T88T-4676-B	Oil Seal Remover	Pinion Oil Seal Model 80
T83T-4676-A	Oil Seal Replacer	Pinion Oil Seal Model 60-70
T88T-4851-A	Pinion Flange Replacer	Model 80
T85T-4851-AH	Pinion Flange Replacer	Model 60-70

CE7753-2A

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SECTION 15-08 Integral Carrier Axle—8.8 Inch Ring Gear

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VEHICLE APPLICATION

Applies to E-150, F-150 and Bronco Truck Models.

DESCRIPTION AND OPERATION

Description

The Ford Truck Integral Carrier rear axle assembly is an integral type housing, hypoid gear design with the centerline of the pinion set below the centerline of the ring gear.

The hypoid gear set consists of an 8.8 inch diameter ring gear and an overhung drive pinion which is supported by two opposed tapered roller bearings. Pinion bearing preload is adjusted by the pinion nut and a collapsible spacer maintains the seating of the inner race.

The housing assembly consists of a cast center section with two steel tube assemblies and a stamped rear cover. The cover uses a silicone sealant as a gasket.

The differential case is a one-piece design with two openings to allow for assembly of the internal components and lubricant flow. The differential pinion shaft is retained with a threaded bolt assembled to the case. The differential case assembly is mounted in the carrier between two opposed tapered roller bearings. The bearings are retained in the carrier by removable bearing caps.

The axle is available in two models to accommodate tread width differences between the vehicle lines. They are similar except for minor suspension bracket connections and variations in axle shaft and housing tube lengths.

- Differential Bearing Preload and Ring Gear Backlash are adjusted by the use of shims located between the Differential Bearing Cup/Races and the Carrier Housing.
- The use of a Pinion Depth Gauge Tool for drive pinion shim selection in conjunction with a dial indicator for differential case shim selection is required for proper gear set adjustment.
- The Semi-Floating Axle Shafts are held in the Housing by C-washer locks positioned in a slot on the Axle Shaft Splined End. These C-washers also fit into a machined recess in the differential side gears within the differential case.

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DESCRIPTION AND OPERATION (Continued)

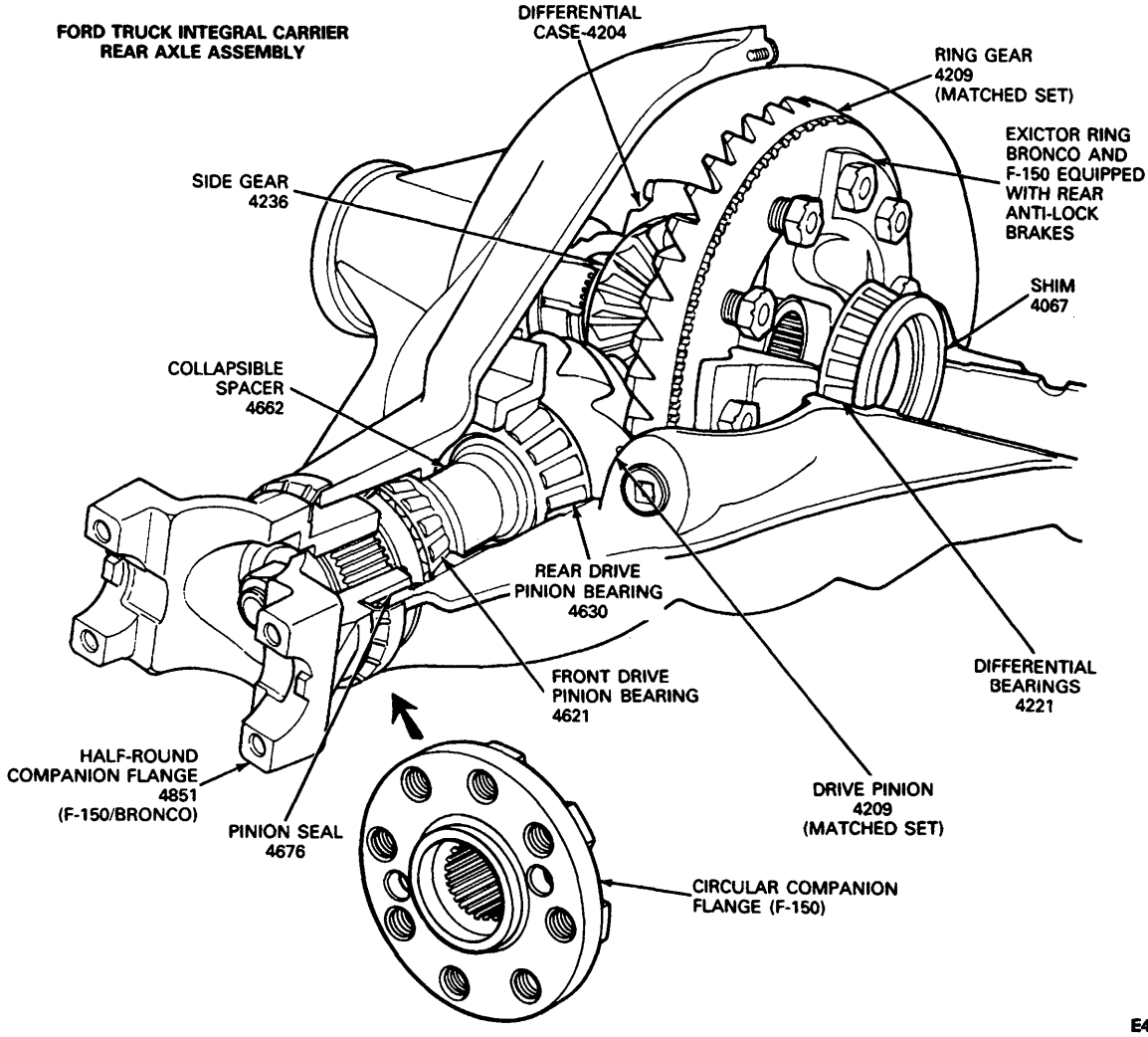
Rear Antilock Brakes

F-150 and Bronco vehicles use the Rear Antilock Brake System (RABS). The system features a multi-tooth exciter ring that is pressed on the differential case behind the ring gear. If the exciter ring is removed, it must be discarded and replaced with a new one. The exciter ring works in conjunction with an electronic speed sensor. This sensor is retained in a bore at the top of the carrier housing and fastened by one bolt. There is a space provided between the ring gear and exciter ring for measuring the ring gear backface runout.

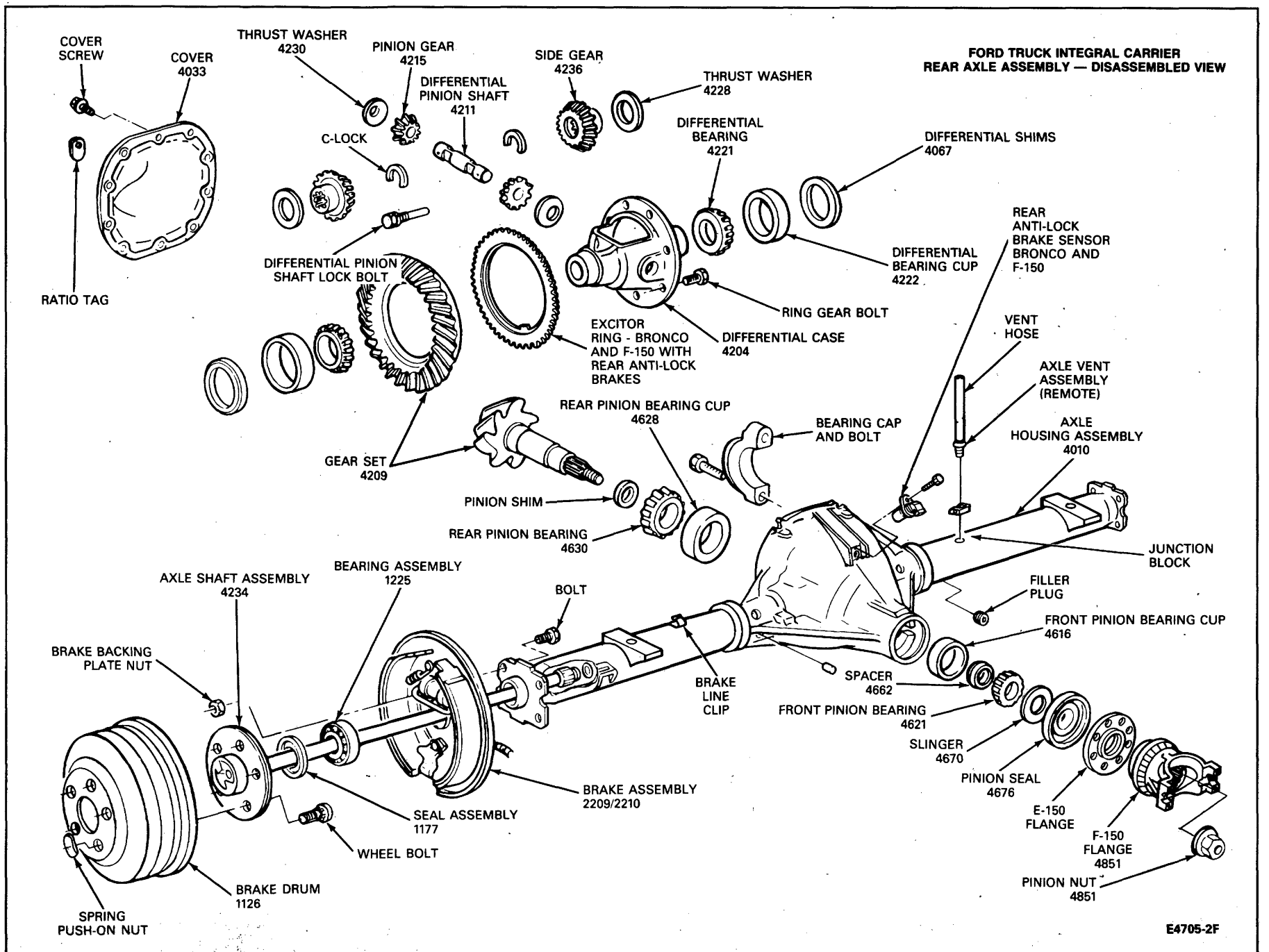
Operation

The rear axle drive pinion receives its power from the engine through the transmission and driveshaft. The pinion gear rotates the differential case through engagement with the ring gear, which is bolted to the case outer flange.

Inside the case, two differential pinion gears are mounted on the differential pinion shaft which is pinned (with lock bolt) to the case. These pinion gears are engaged with the side gears, to which the axle shafts are splined. Therefore, as the differential case turns, it rotates the axle shafts and rear wheels. When it is necessary for one wheel and axle shaft to rotate faster than the other, the faster turning side gear causes the pinions to roll on the slower turning side gear to allow differential action between the two axle shafts.



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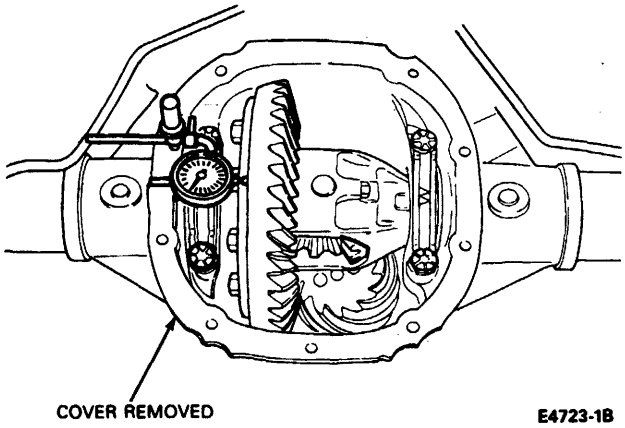
CLEANING AND INSPECTION

Inspection Before Disassembly

The differential case assembly and drive pinion should be inspected before they are removed from the carrier. These inspections can find the cause of the concern and determine the resolution.

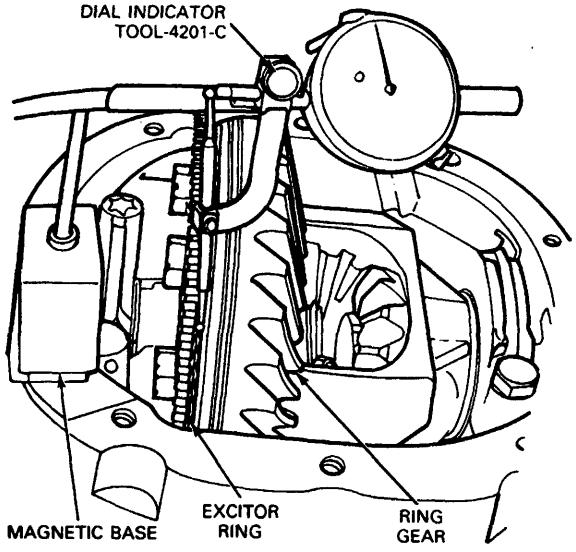
1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.
2. Rotate the gears to see if there is any roughness which would indicate damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.

RING GEAR BACKFACE RUNOUT



E4723-1B

RING GEAR BACKFACE RUNOUT
REAR ANTI-LOCK BRAKE VEHICLES



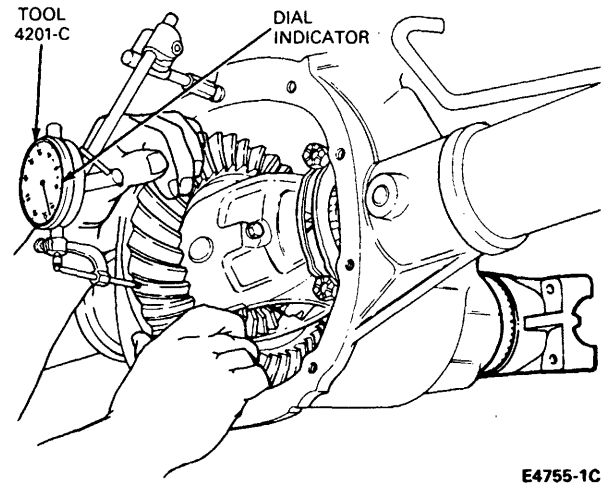
E7162-1B

4. On E-150 vehicles, set up a dial indicator and check ring gear backlash and ring gear backface runout. On Bronco and F-150 vehicles equipped with rear Antilock brakes, mount Dial Indicator, TOOL-4201-C, or equivalent, on the carrier so the tip of the dial indicator contacts the backface of the ring gear.

NOTE: There is a space provided between the exciter ring and the ring gear for measuring ring gear backface runout. Backlash should be 0.008 inch to 0.015 inch (0.012-0.015 inch preferred) and backface runout should be no more than 0.004 inch.

5. A contact pattern is not an acceptable guide to check for noise. Proper gear set assembly must be checked using the pinion depth gauge Tool T79P-4020-A which shows the correct pinion shim required. See Section on Drive Pinion and Gear Set.

RING GEAR BACKLASH



E4755-1C

Inspection After Disassembly

Thoroughly clean all parts. Always use new solvent when cleaning bearings. Do not spin dry bearings with compressed air. Oil the bearings immediately to prevent rusting. Inspect the parts for any major damage. Clean the inside of the housing before rebuilding. When a scored or chipped gear set is replaced, the axle housing must be washed thoroughly. Inspection procedures for individual parts are outlined as follows.

Sensor

Inspect the Rear Antilock Brake System (RABS) Sensor pole piece for loose metal particles and clean if required.

Excitor Ring

Examine the Rear Antilock Brake System (RABS) excitor ring to see that it is firmly pressed onto the differential case and check it for dented, chipped or missing teeth that could result in erratic RABS preformance. If damage is found, remove and replace excitor ring.

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CLEANING AND INSPECTION (Continued)

Gears

Examine the pinion and ring gear teeth for scoring, excessive wear, nicks and excessive chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Bearing Cups

Check bearing cups for deep scores, galling, or spalling. If a 0.038mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup must be reseated.

Cone and Roller Assemblies

When operated in the cups, bearing rollers must turn without roughness. Examine the roller ends for step wear. If inspection reveals either a damaged cup or a damaged cone and roller assembly, both parts should be replaced.

Companion Flange

Be sure that the flange half-rounds and lugs have not been damaged in removing the driveshaft or in removing the flange from the pinion. The end of the flange that contacts the bearing cone as well as the nut counterbore and seal surface must be smooth and free of nicks.

NOTE: Bronco and F-150 vehicles are equipped with half-round companion flanges. E-Series vehicles are equipped with a circular companion flange.

Carrier Housing

Make sure that the differential and pinion bearing bores are smooth. Remove any nicks or burrs from the mounting surfaces of the carrier housing.

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores.

DISASSEMBLY AND ASSEMBLY

Axle—Disassembly

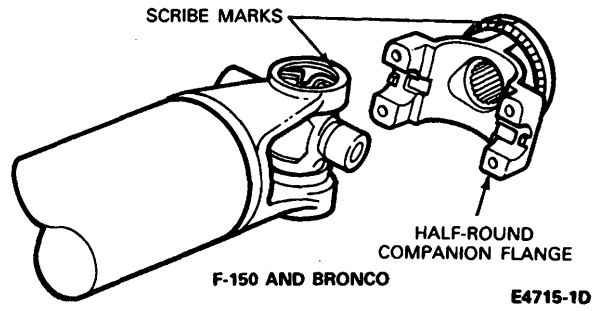
Pinion Oil Seal

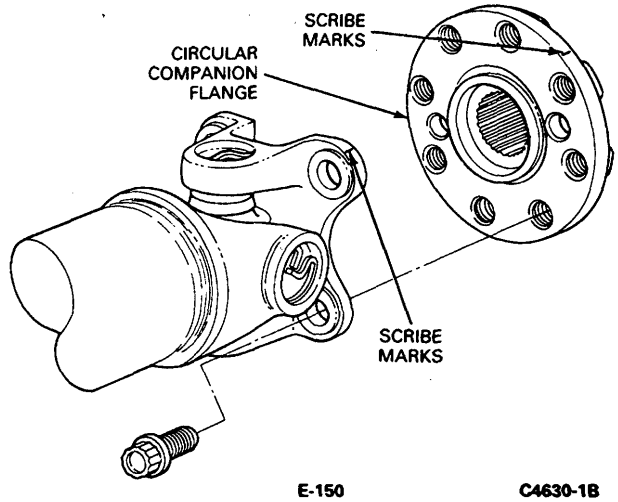
Removal

Replacement of the pinion oil seal involves removal and installation of only the drive pinion shaft nut and the companion flange.

CAUTION—This operation disturbs the pinion bearing preload, and this preload must be carefully reset when assembling.

1. Raise the vehicle and install safety stands. Remove the rear wheels and brake drums to prevent brake drag during drive pinion bearing preload adjustment.
2. Mark the driveshaft axle end flange and the axle companion flange to insure proper position of the driveshaft during assembly. Disconnect the driveshaft from the rear axle companion flange. Remove the driveshaft from the transmission extension housing. Install an oil seal replacer tool in the transmission extension housing to prevent oil leakage.

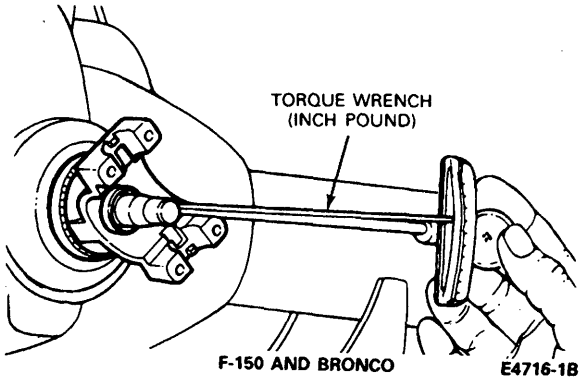




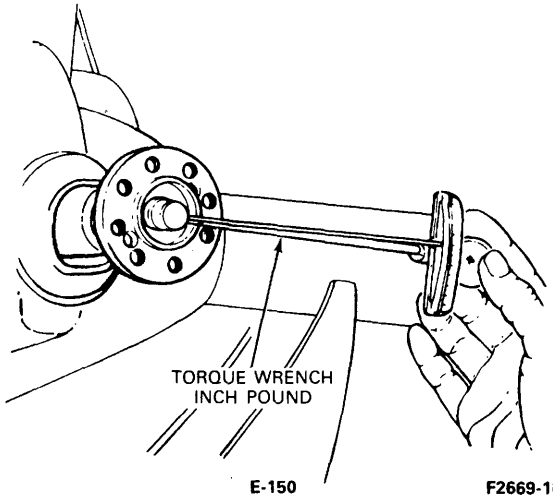
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DISASSEMBLY AND ASSEMBLY (Continued)

3. Install an inch pound torque wrench on the pinion nut. Record the torque required to maintain rotation of the pinion through several revolutions.

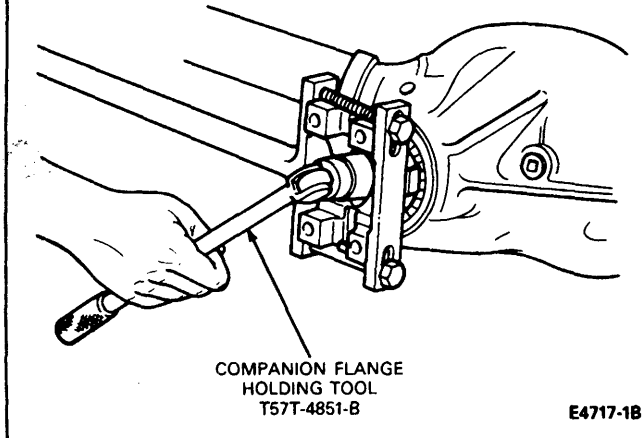


F-150 AND BRONCO E4716-1B

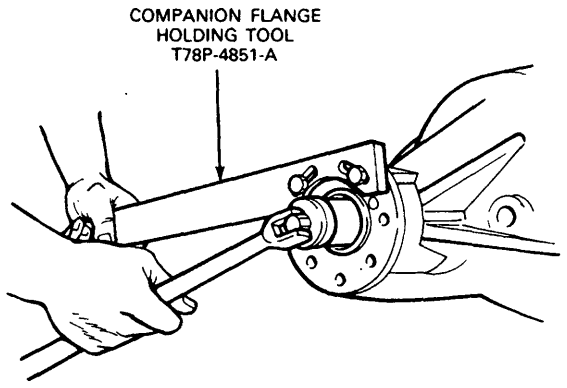


E-150 F2669-1B

4. While holding the companion flange with Companion Flange Holding Tool, T57T-4851-B or equivalent, remove the pinion nut.



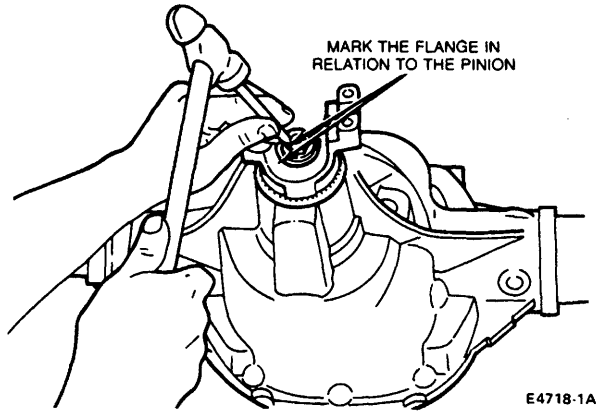
E4717-1B



E-150 F5646-1A

5. Clean the area around the oil seal. Place a drain pan under the seal, or raise the front of the vehicle higher than the rear.

   Mark the companion flange in relation to pinion so flange can be reinstalled in the same position.

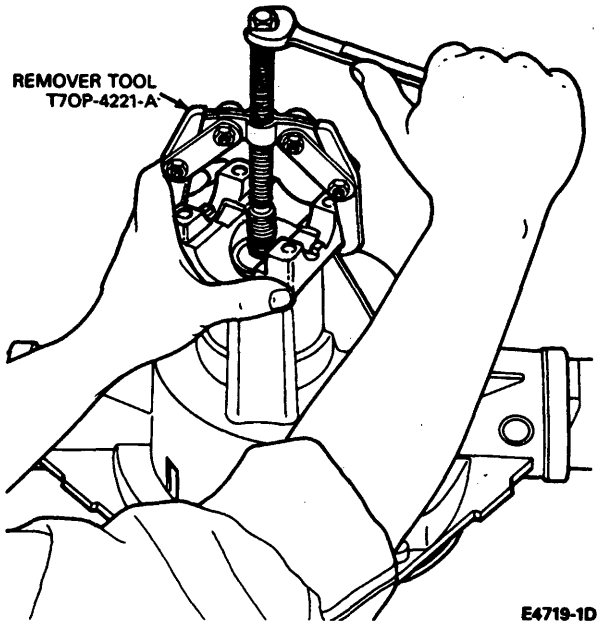


E4718-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

6. Using Remover Tool, T70P-4221-A or equivalent remove the rear axle companion flange.



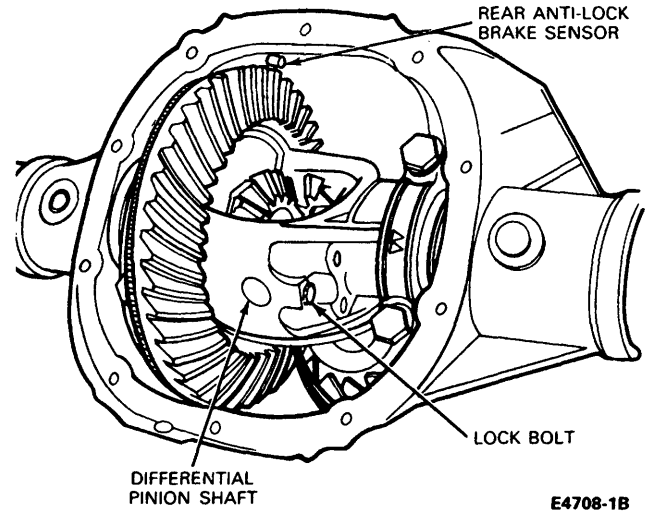
AXLE SHAFT

Removal

8. Clean all dirt from the area of carrier cover with a wire brush and/or cloth.

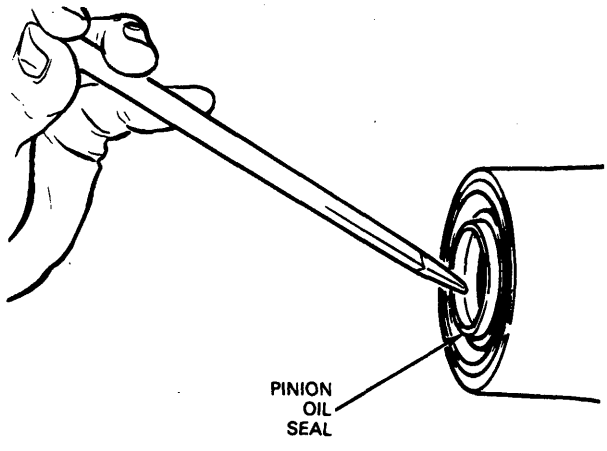
   Drain rear axle lubricant by removing the housing cover.

   Remove differential pinion shaft lock bolt and differential pinion shaft.



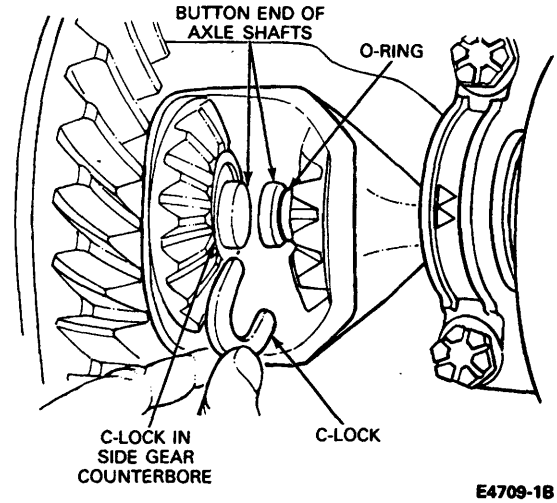
7. Remove the drive pinion oil seal.

CAUTION: Use care not to damage seal bore in housing.



9. Push the flanged end of the axle shafts inboard and remove the C-lock from the button end of each axle shaft.

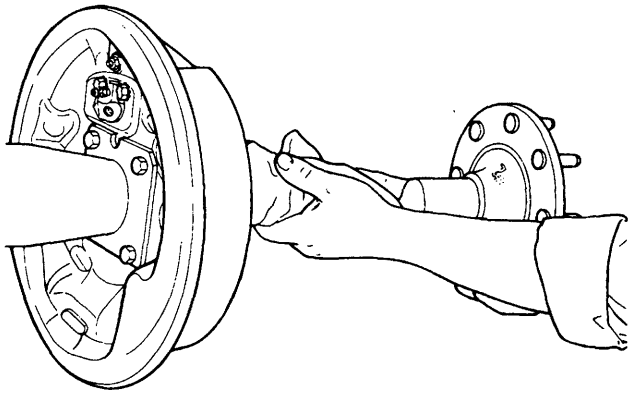
NOTE: Use care not to lose or damage the rubber O-ring which is in the axle shaft groove under the C-lock.



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DISASSEMBLY AND ASSEMBLY (Continued)

10. Remove the axle shaft from the housing, being careful not to damage the oil seal.

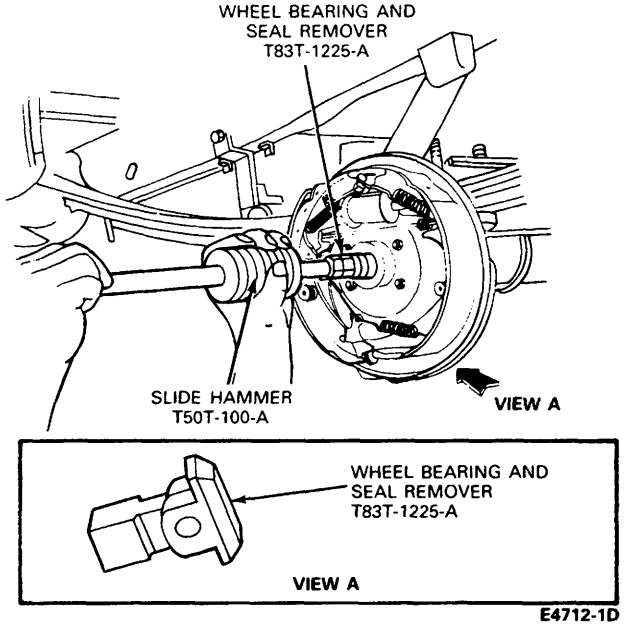


E4760-1B

Oil Seal and Wheel Bearing

Removal

11. Using Slide Hammer, T50T-100-A and Seal Remover, T83T-1225-A or their equivalents insert into the bore as shown and position it behind the bearing so the tangs on the tool engage the bearing outer race. Remove the bearing and seal as a unit, using the slide hammer Tool.



E4712-1D

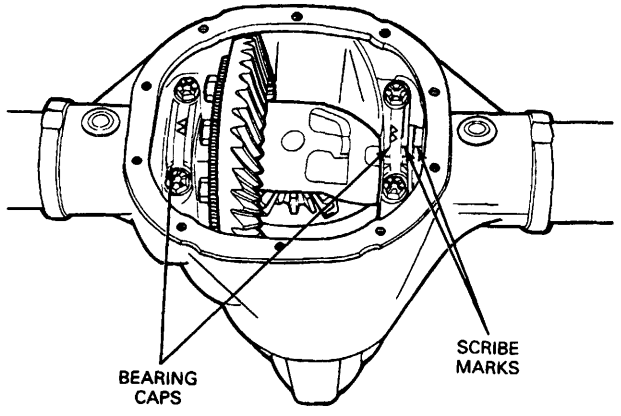
Differential Case

Removal

NOTE: Before removing the differential case, check the ring gear runout as described under Inspection After Disassembly in the Cleaning and Inspection portion of this Section. If ring gear runout exceeds 0.004 inch, the differential case and ring gear must be removed to perform the Differential Runout Check. The Differential Runout Check will isolate the cause of excessive Ring Gear Runout.

12. Mark one differential bearing cap to ensure the caps will be installed in their original positions.

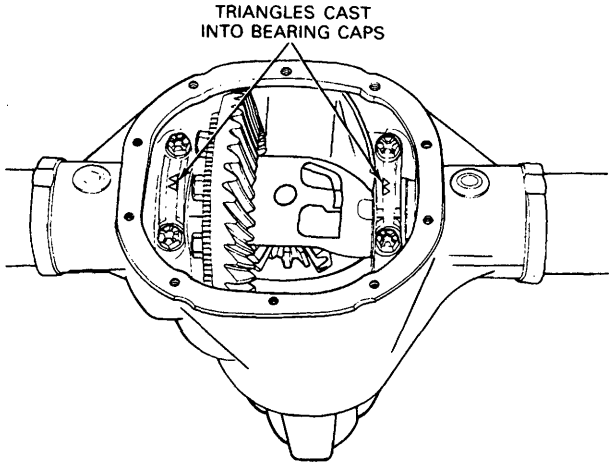
CAUTION: Right and left bearing caps MUST NOT be interchanged.



E4707-1C

13. Loosen the differential bearing cap bolts and bearing caps.

NOTE: The direction of triangles on bearing caps must be noted. When reassembled the triangles must be pointing in the same direction (outboard) as before removal.



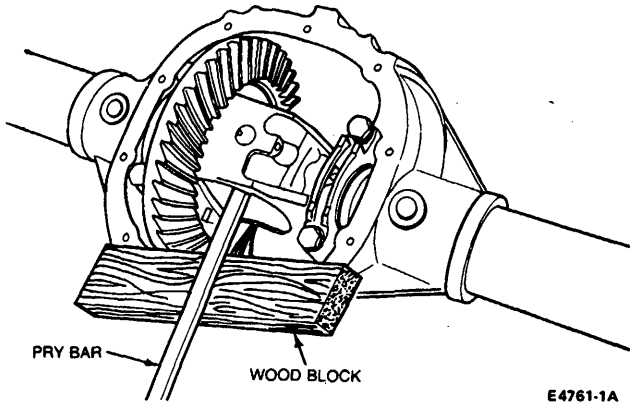
E4763-1B

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DISASSEMBLY AND ASSEMBLY (Continued)

14. Pry the differential case, bearing cups and shims out until they are loose in the bearing caps. Remove the bearing caps and remove the differential assembly from the carrier.

CAUTION: When using the pry bar, place a wood block between the pry bar and the axle housing to protect the carrier face from damage.

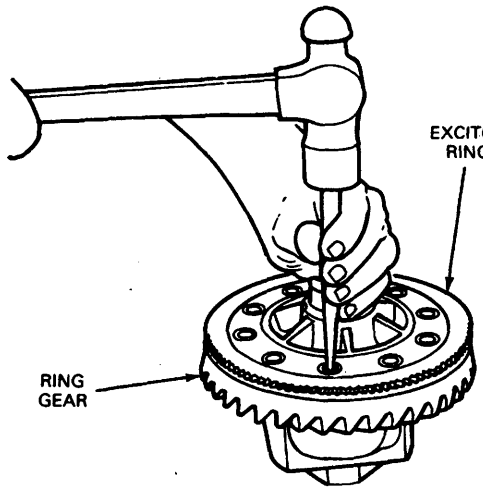


E4761-1A

Ring Gear

Removal

15. Remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case by striking at alternate holes around the gear.



E7210-1A

EXCITER RING

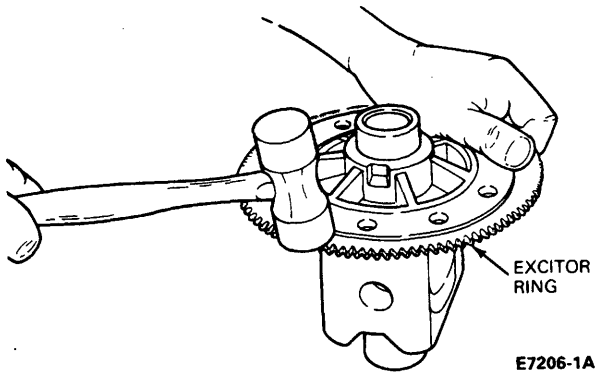
NOTE: While E-150 vehicles are NOT equipped with an exciter ring, the ring gears are removed the same as shown here.

Removal

On vehicles equipped with an exciter ring, first remove the ring gear bolts. As shown above remove ring gear by striking at alternate holes around the gear.

NOTE: The ring gear can be removed and installed without removing the exciter ring.

Remove the exciter ring with a soft faced hammer. Discard exciter ring.



E7206-1A

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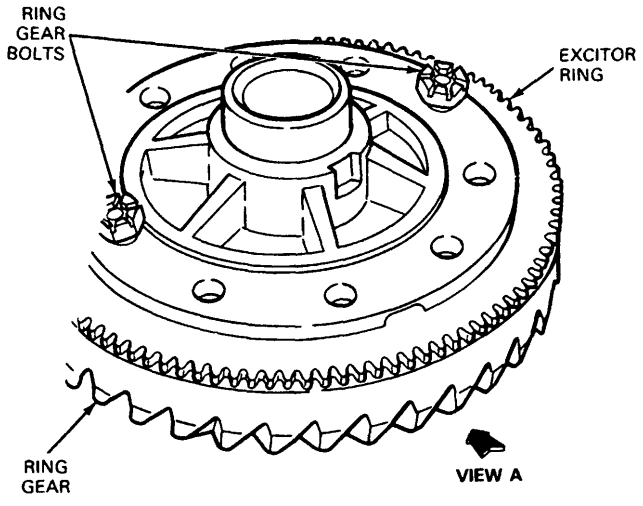
DISASSEMBLY AND ASSEMBLY (Continued)

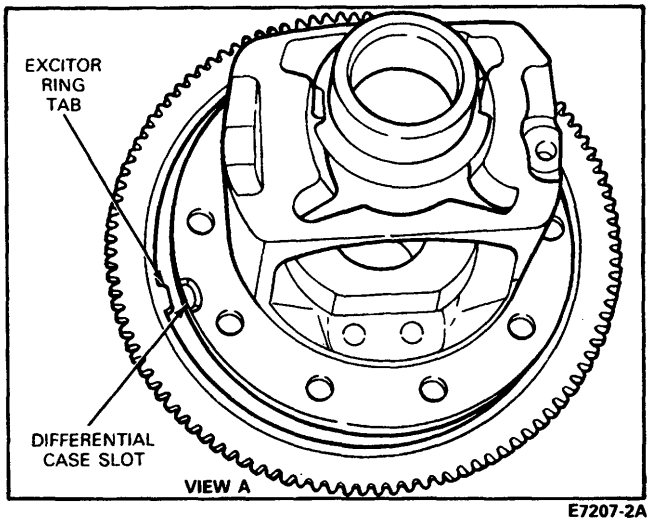
EXCITER RING

Installation

Align tab on exciter ring with slot in differential case. Start two ring gear bolts through the case into the ring gear to ensure case to ring gear bolt hole alignment.

CAUTION: Tab on exciter ring MUST BE aligned with slot in differential case.

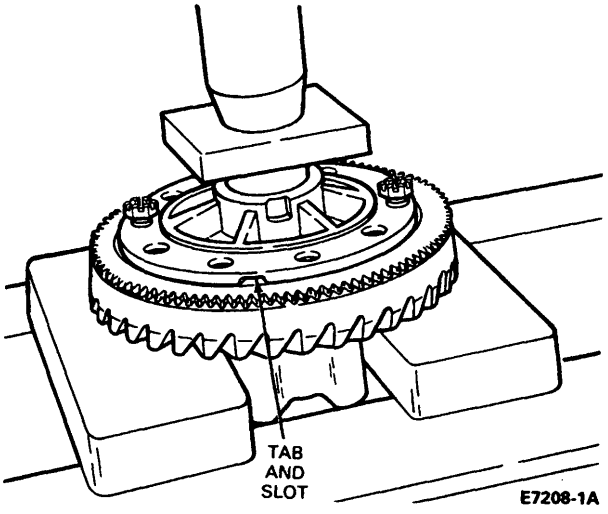




E7207-2A

Press the exciter ring on the differential case using the ring gear as a pilot. Apply Loctite E0AZ-19554-B (ESE-M4G167-A2) or equivalent to ring gear bolts.

Install ring gear bolts and tighten to 95-115 N·m (70-85 ft-lbs).



E7208-1A

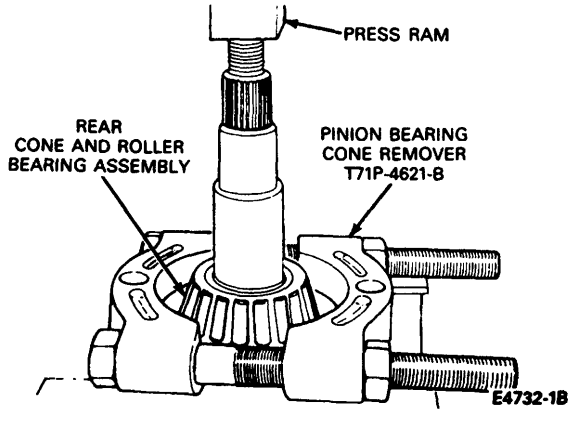
Drive Pinion

Removal

16. With a soft-faced hammer, drive the pinion out of the front bearing cone and remove it through the rear of the carrier.

    To remove the pinion rear cone and roller bearing assembly, use the Pinion Bearing Cone Remover, T71P-4621-B or equivalent as shown.

NOTE: Measure the shim, which is found under the bearing cone, with a micrometer and record the thickness (as a reference to be compared to the shim gauge reading prior to installing the bearing).



E4732-1B

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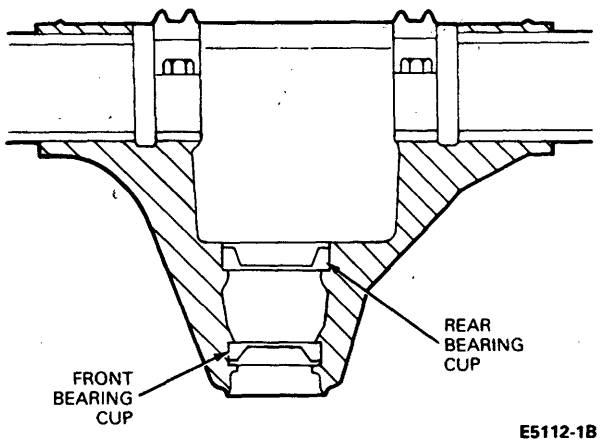
DISASSEMBLY AND ASSEMBLY (Continued)

Pinion Bearing Cup

Removal

NOTE: Do not remove the pinion bearing cups from the carrier casting unless the cups are damaged.

17. If the pinion bearing cups are to be replaced, tap alternately (with a brass drift of suitable length) on the opposite side of the cups during removal to prevent cups from cocking in the casting.

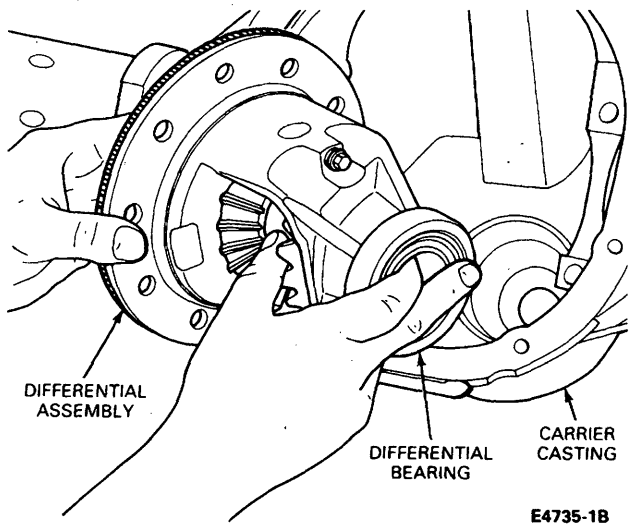


E5112-1B

Differential Runout Check

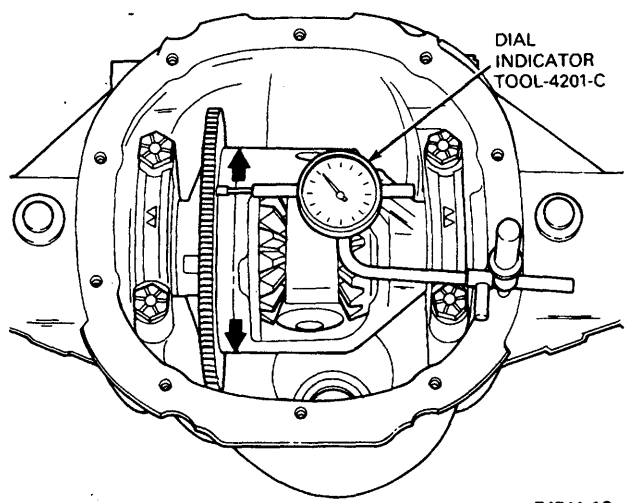
If the ring gear runout check (before disassembly) exceeds specification, the condition may be caused by a warped ring gear, a damaged case, excessively worn differential bearings or foreign material between mating surfaces (burrs, shavings, etc.). To determine the cause of excessive runout proceed as follows:

18. Remove the differential case from the axle housing (refer to Differential case and Drive Pinion Removal in this Section) and remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case with a hammer and drift.
19. Install the differential assembly with the bearing cups and shims. Tighten the bearing cup bolts to 95-115 N·m (70-85 ft-lbs.)



E4735-1B

20. Check the runout of the differential case flange with a dial indicator (Tool-4201-C). If the runout is within specification, (Max. 0.003 inch), install a new ring and pinion gear. If the runout exceeds specification, the ring gear is true and the concern is due to either a damaged case or bearings. Visually inspect the bearings. If bearings are not damaged replace both the case and bearings. Recheck the runout with new parts (case and bearings). Visually inspect the excitor ring for damage and replace if required.

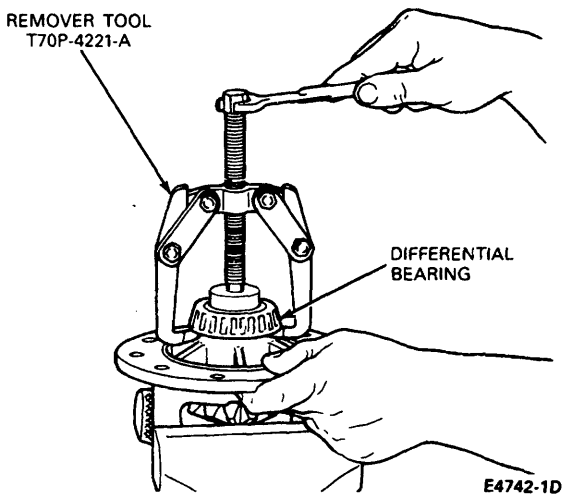


E4741-1C

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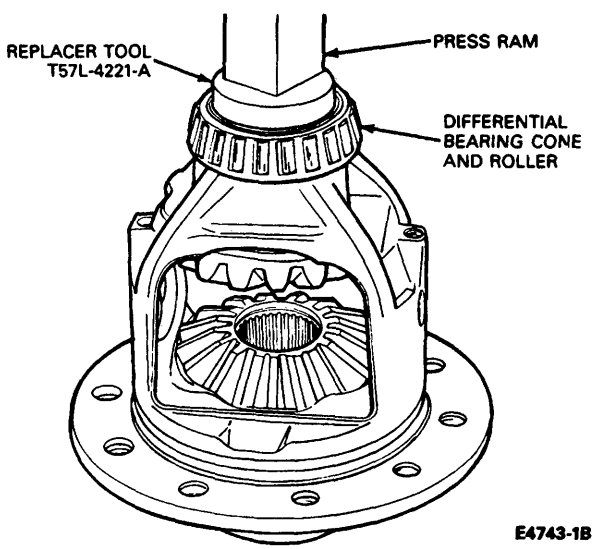
DISASSEMBLY AND ASSEMBLY (Continued)

21. Remove the differential case from the integral carrier and remove the differential bearings from the case using Remover Tool T70P-4221-A or equivalent.

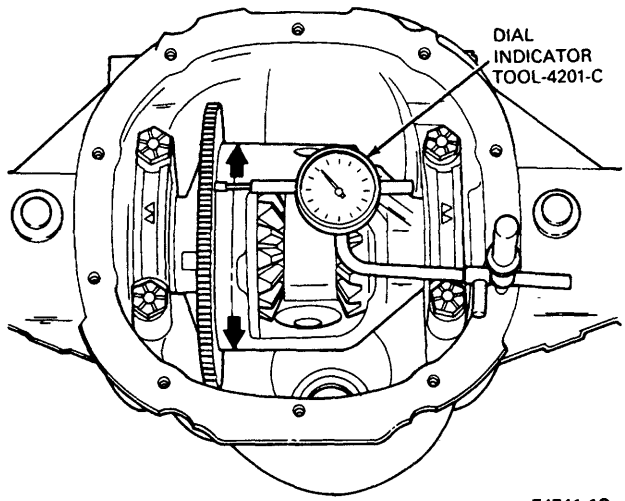


22. Install new differential bearings on the case hubs using Replacer Tool, T57L-4221-A or equivalent and install the differential assembly in the carrier without the ring gear.

NOTE: Press against the bearing cone only.



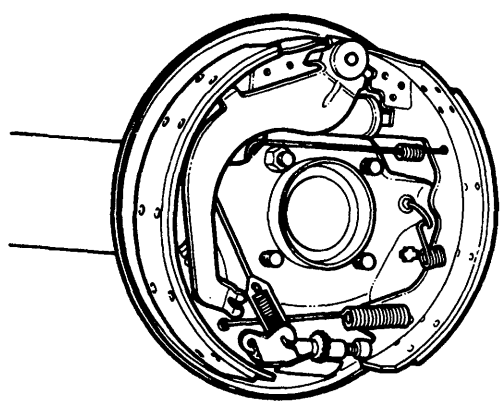
23. Check the case runout again with the new bearings. If the runout is now within 0.076mm (Max. 0.003 inch), use the new bearings for assembly. If the runout is still excessive, the case is damaged and should be replaced.



Axle Housing

Removal

24. Remove the four retaining nuts from each backing plate and wire the backing plate to the underbody.

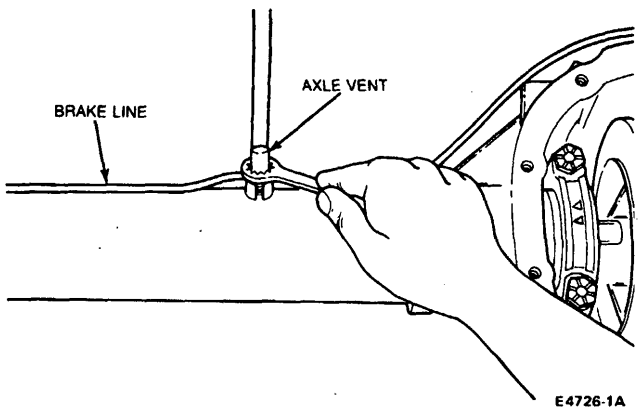


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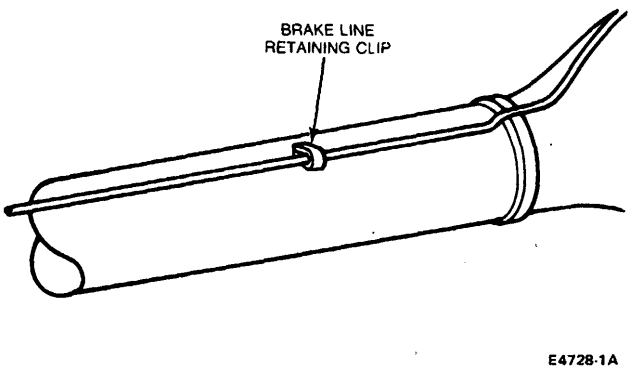
DISASSEMBLY AND ASSEMBLY (Continued)

25. Disconnect the vent hose from the vent and the vent from the rear axle housing.

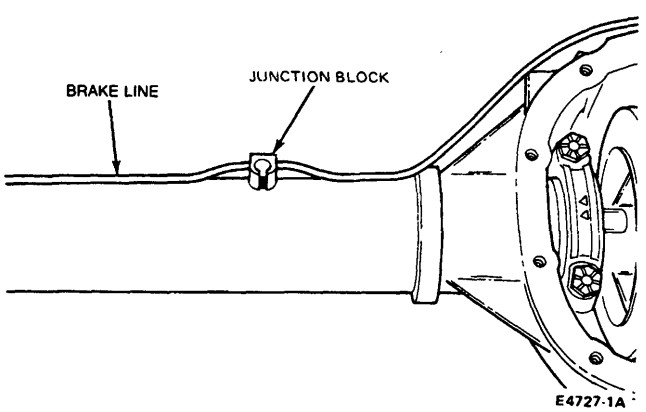
NOTE: The axle vent is secured to the housing assembly through the brake junction block.



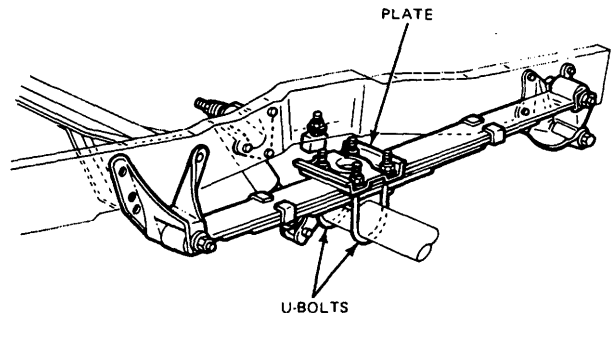
26. Disengage the brake line from the clips that retain the line to the axle housing and carrier.



27. Remove the hydraulic brake junction block from the axle housing. **Do not open the hydraulic brake system lines.**

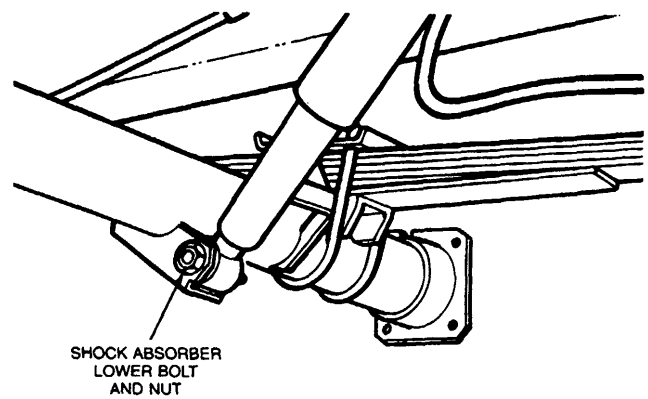


28. Support the rear axle housing on a jack, and then remove the U-bolt nuts. Remove the U-bolts and plates.



29. Disconnect the shock absorber lower bolts from the mounting brackets on the axle housing.

Remove the housing from the vehicle.



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DISASSEMBLY AND ASSEMBLY (Continued)

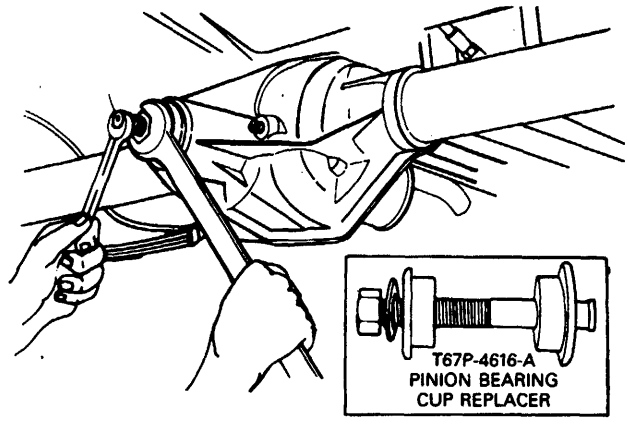
Axle—Assembly

Pinion Bearing Cup

Installation

NOTE: Do not remove the pinion bearing cups from the carrier casting unless the cups are damaged.

1. Install the new cups with Pinion Bearing Cup Replacer, T67P-4616-A as shown. Make sure the cups are properly seated in their bores. If a 0.038mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup is not properly seated. Whenever the cups are replaced, the cone and roller assembly should also be replaced.



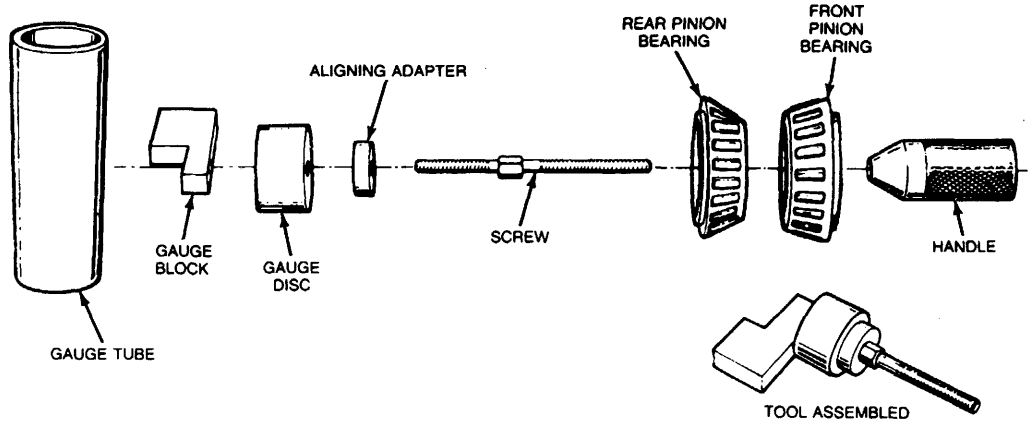
E4733-1B

Drive Pinion Shim Selection

Individual differences in machining the carrier casting and the gear set and variation in bearing widths require a shim between the pinion rear bearing and pinion head, in order to locate the pinion for correct tooth contact with the ring gear.

When replacing a ring and pinion gear, the correct shim thickness for the new gear set to be installed is determined by the following procedure using Pinion Depth Gauge T79P-4020-A.

2. Assemble the appropriate aligning adapter, gauge disc and gauge block to the screw.



REAR AXLE PINION DEPTH GAUGE TOOL

Tool Number*	Description
T76P-4020-A3	Aligning Adapter (1.612" O.D.)
T76P-4020-A9	Screw
T76P-4020-A10	Gauge Block (1.700" thick)
T76P-4020-A11	Handle
T79P-4020-A18	Gauge Disc (1.1884" thick)
T79P-4020-A19	Gauge Tube (3.0630" O.D.)

* The Tool numbers shown in column are part of Tool kit T79P-4020-A.

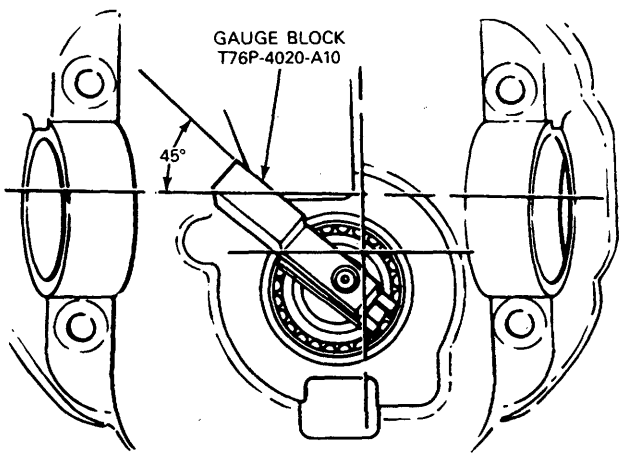
E4744-2A

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DISASSEMBLY AND ASSEMBLY (Continued)

3. Place the rear pinion bearing (new, or used if in good condition) over the aligning tool and insert it into the rear pinion bearing cup of the carrier. Place the front bearing into the front bearing cup and assemble the tool handle into the screw (refer to illustration in Step 4). Roll the assembly back and forth a few times to seat the bearings while tightening the tool handle by hand. Tighten the tool handle to 27 N·m (20 ft-lbs).

NOTE: The gauge block must be offset (45°) to obtain an accurate reading.



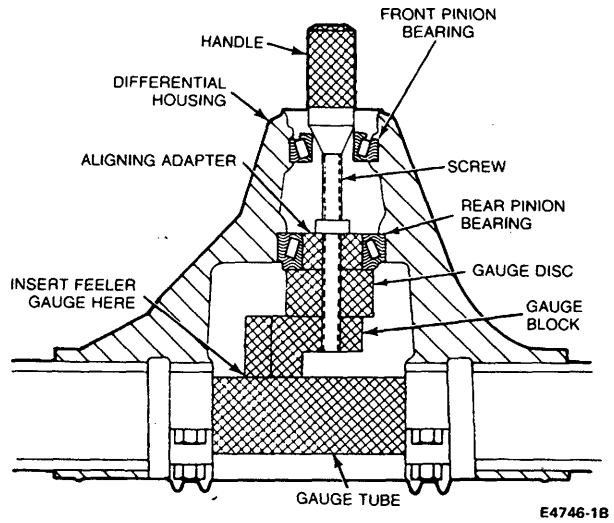
E4745-1B

4. Center the gauge tube into the differential bearing bore. Install the bearing caps and tighten the bolts to 95-115 N·m (70-85 ft-lbs). (Caps are to be installed with the triangles pointing outboard.)

Utilize PINION SHIMS as the gauge for shim selection. This will minimize errors in attempting to stack feeler gauge stock together or simple addition errors in calculating correct shim thickness.

NOTE: Shims must be flat. Do not use dirty, bent, nicked or mutilated shims as a gauge.

It is important to feel a slight drag on the shim for correct selection. Do not attempt to force the shim between the gauge block and the gauge tube. This will minimize selection of a shim thicker than required, which results in a deep tooth contact in final assembly of integral axles.

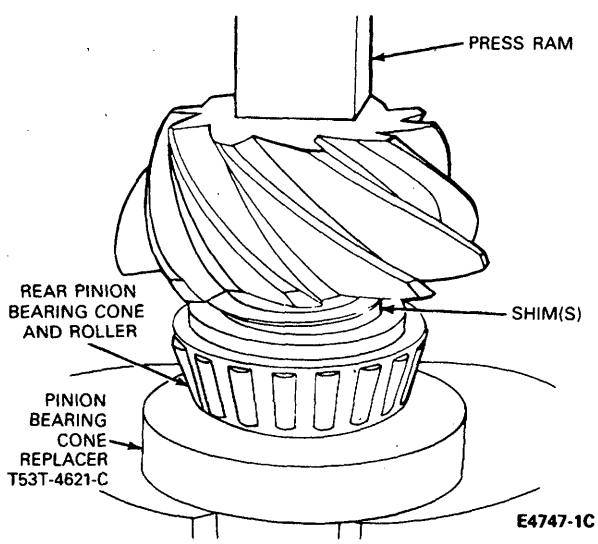


E4746-1B

5. Place the selected shim(s) on the pinion and press the pinion bearing cone and roller assembly until it is firmly seated on the shaft.

NOTE: The same rear pinion bearing used in this procedure must be used in final assembly of the axle.

NOTE: Be sure that press load is not applied to the bearing cage.



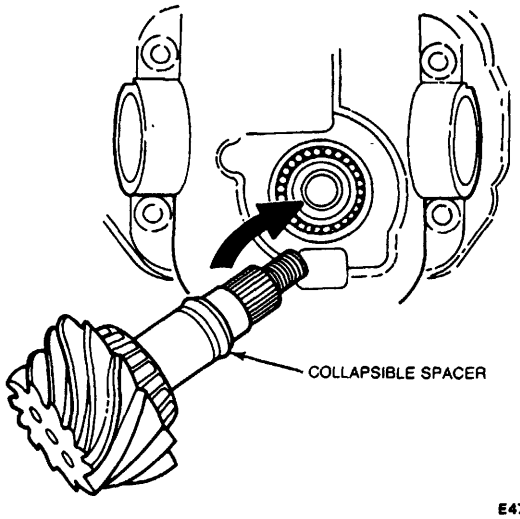
E4747-1C

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DISASSEMBLY AND ASSEMBLY (Continued)

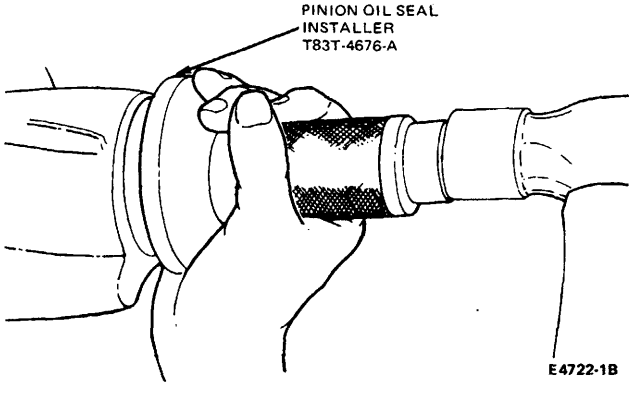
DRIVE PINION INSTALLATION

6. Check splines on the pinion shaft to be sure they are free of burrs. If burrs are evident, remove them by using a fine crocus cloth, working in a rotational motion. Wipe the pinion clean.
7. Place the collapsible spacer on the pinion stem shoulder.
8. From the rear of the axle housing, install the drive pinion assembly (drive pinion, shim(s), rear bearing cone and roller, and collapsible spacer) into the housing pinion bore.



9. Install the front cone and roller, and oil slinger on the pinion.
10. Clean the oil seal seat surface. Install the seal in the carrier using Pinion Oil Seal Installer, T83T-4676-A. Coat the lips of the seal with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.

CAUTION: Installation without the proper tool may result in early seal failure. If seal becomes cocked during installation, remove it and install new one.



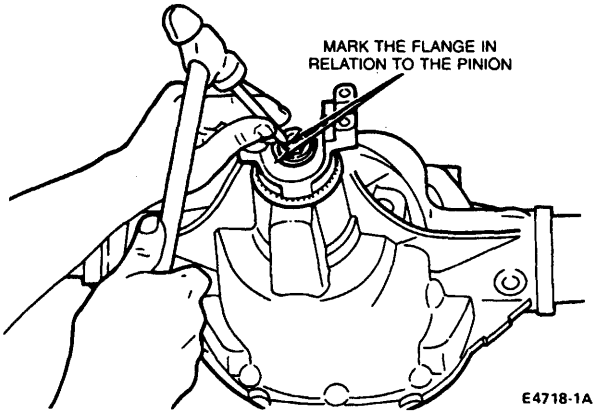
Companion Flange Installation

11. Apply a small amount of lubricant to the companion shaft splines. Align the mark on the companion flange with the mark on the pinion shaft. Install the flange.

    Install a new pinion nut on the pinion stem.

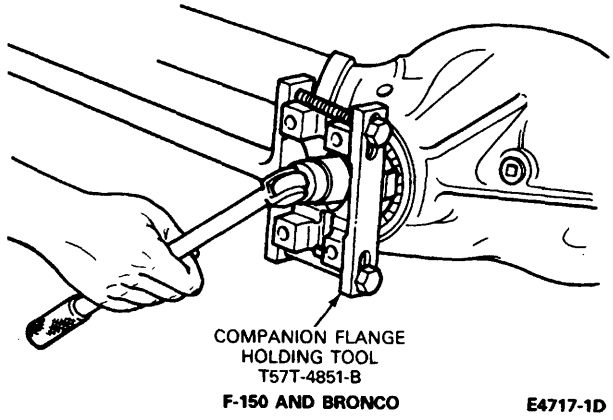
NOTE: If a new companion flange is being installed, disregard the scribe mark on the pinion shaft.

NOTE: The companion flange must never be hammered on or installed with power tools.



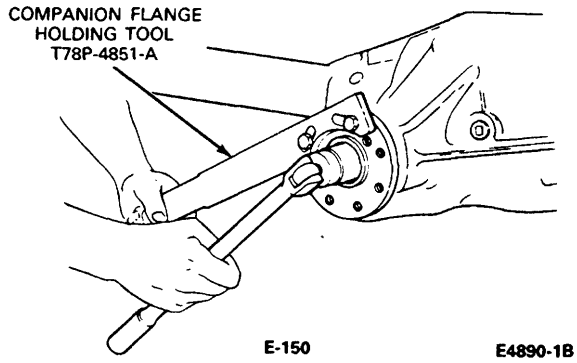
12. For F-150 and Bronco hold the half-round companion flange with Companion Flange Holding Tool, T57T-4851-B or equivalent while tightening the pinion nut (see Step 13).

For E-150 hold the circular companion flange with Companion Flange Holding Tool, T78P-4851-A or equivalent while tightening the pinion nut (see Step 13).



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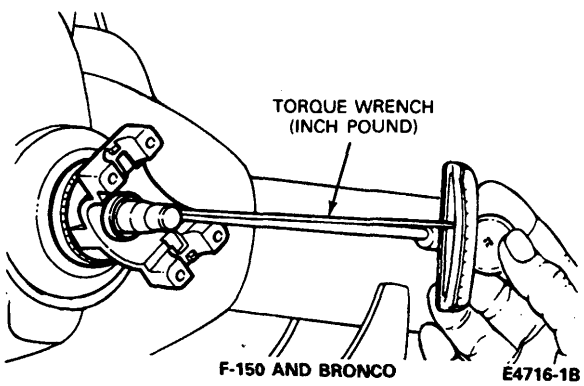
DISASSEMBLY AND ASSEMBLY (Continued)

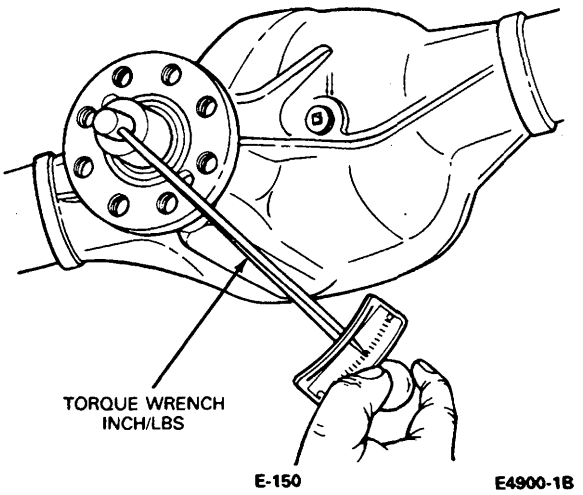


13. Tighten the pinion nut to a minimum torque of 217 N·m (160 ft-lbs), rotating the pinion occasionally to insure proper bearing seating. Take frequent drive pinion bearing torque preload readings until the original recorded preload reading is obtained.

    If the original recorded preload is lower than specification (used bearings .9-1.5 N·m [8-14 in-lbs]; new bearings 1.8-3.3 N·m [16-29 in-lbs]) tighten to specification. If the preload is higher than specification, tighten to original reading as recorded.

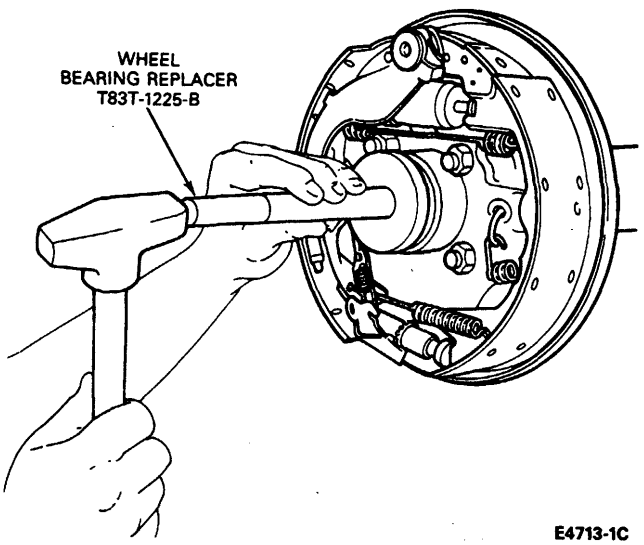
    Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible pinion spacer and pinion nut must be installed.





Wheel Bearing and Oil Seal Installation

14. Lubricate the new bearing with rear axle lubricant and install the bearing into the housing bore using Axle Bearing Replacer T83T-1225-B or equivalent.

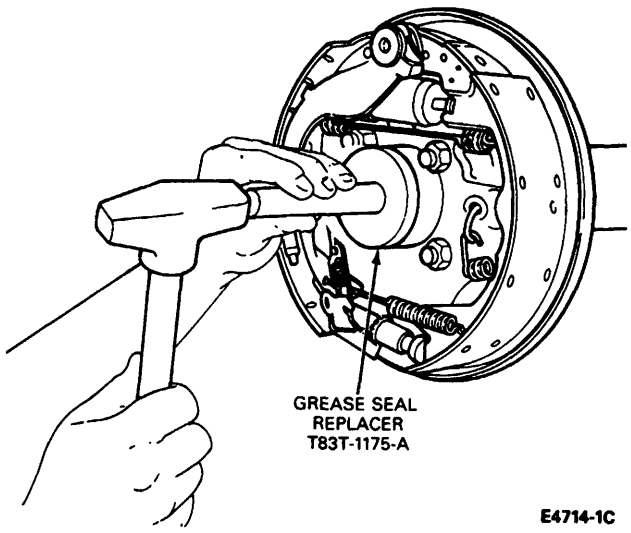


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DISASSEMBLY AND ASSEMBLY (Continued)

15. Coat the lips of the seal with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent and install the axle shaft seal using Grease Seal Replacer T83T-1175-A.

CAUTION: Installation of the bearing or seal assembly without the proper tool may result in an early bearing or seal failure. If seal becomes cocked in the bore during installation, remove it and install a new one.

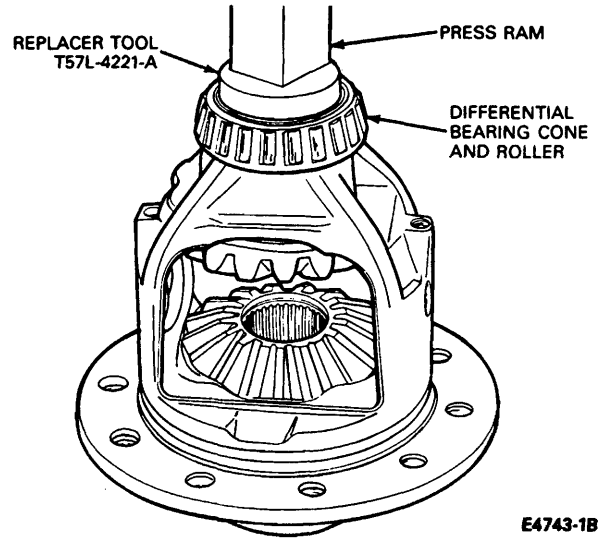


Differential Case

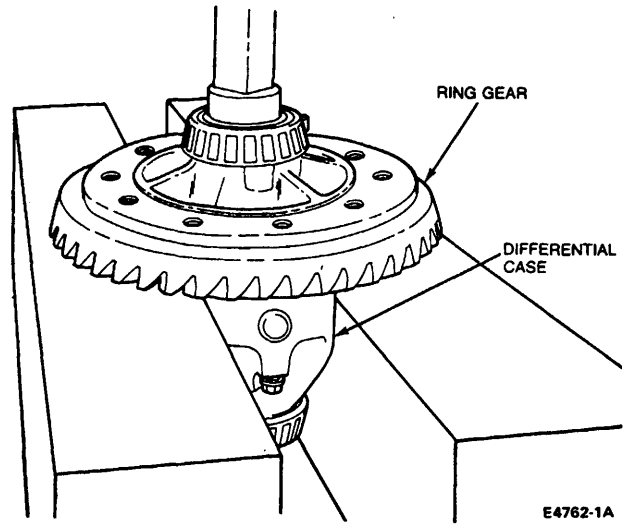
Installation

16. Install differential bearings on the case hubs using Differential Side Bearing Replacer, T57L-4221-A or equivalent.

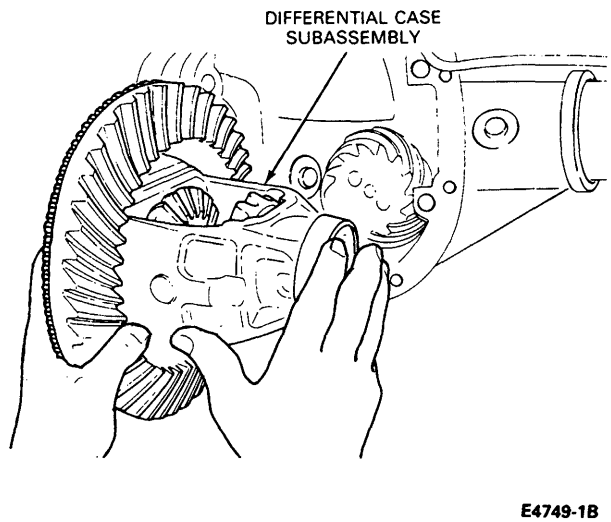
NOTE: Press against the bearing cone only.



17. Press on the NEW excitor ring and ring gear if removed onto the differential case. Refer to procedure in this Section. Apply Loctite E0AZ-19554-B (ESE-M4G167-A2) or equivalent to ring gear bolts and install. Tighten the bolts to 95-115 N·m (70-85 ft-lbs).



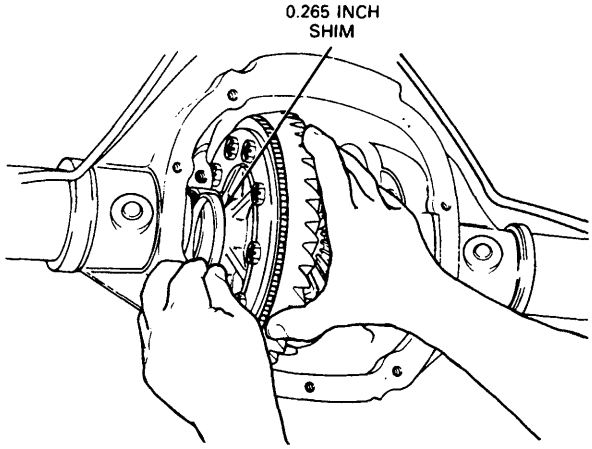
18. With pinion depth set and pinion installed, place differential case subassembly (with ring gear, exciter ring, thrust washers, side gears, bearings and cups) in carrier.



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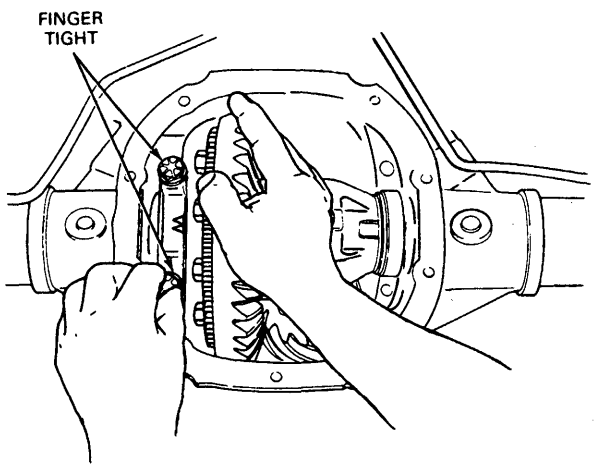
DISASSEMBLY AND ASSEMBLY (Continued)

19. Install a 0.265 inch shim on left side.



E4750-1C

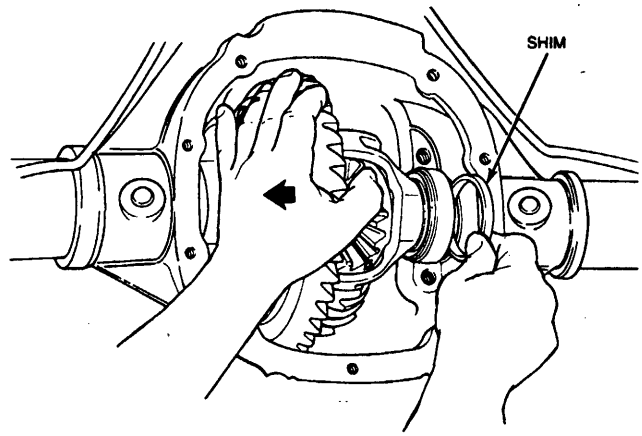
20. Install left bearing cap and tighten bolts finger tight.



E4751-1B

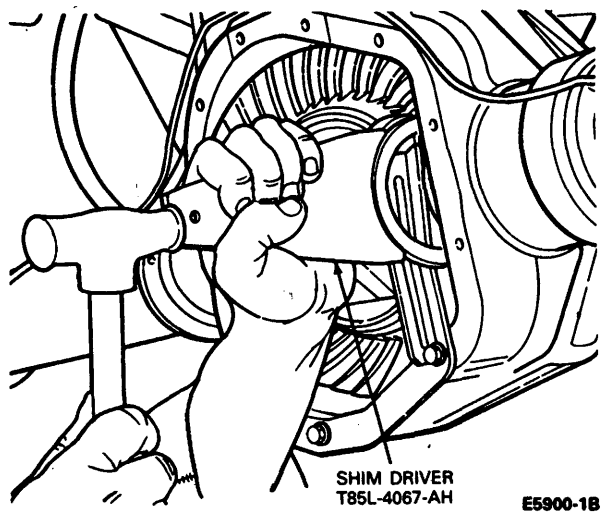
21. Install progressively larger shims on the right side until the largest shim selected can be assembled with a slight drag feel.

NOTE: Apply pressure towards left side to insure that the left bearing cup is seated.



E4752-1A

22. Install the rest of the shims by driving into position with Shim Driver, T85L-4067-AH.

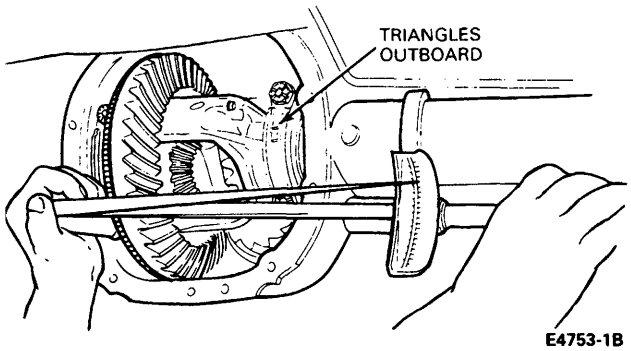


E5900-1B

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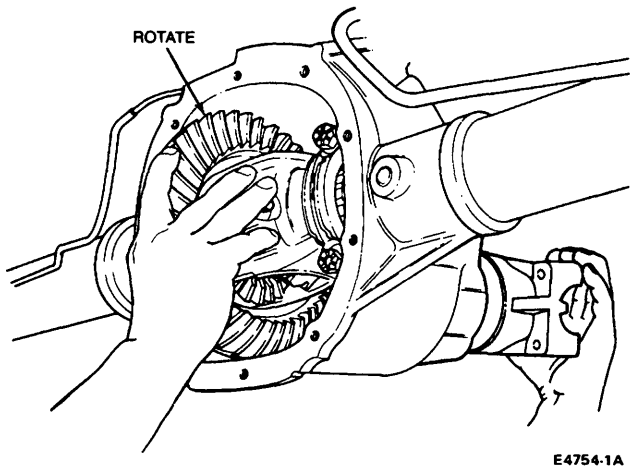
DISASSEMBLY AND ASSEMBLY (Continued)

23. Install right side bearing cap and tighten bearing cap bolts to 95-115 N·m (70-85 ft-lbs).



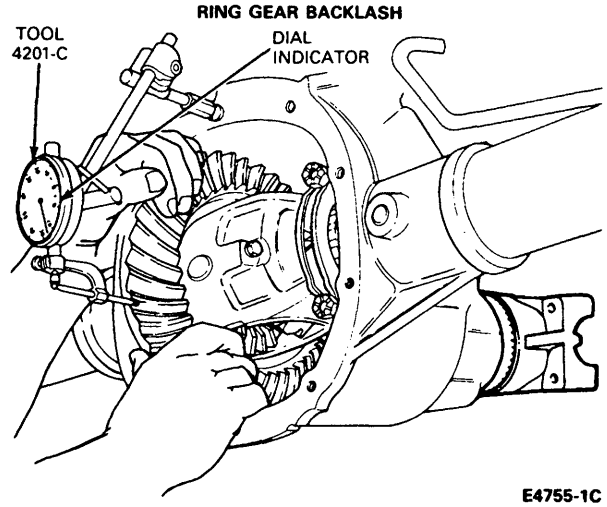
E4753-1B

24. Rotate assembly to insure free rotation.



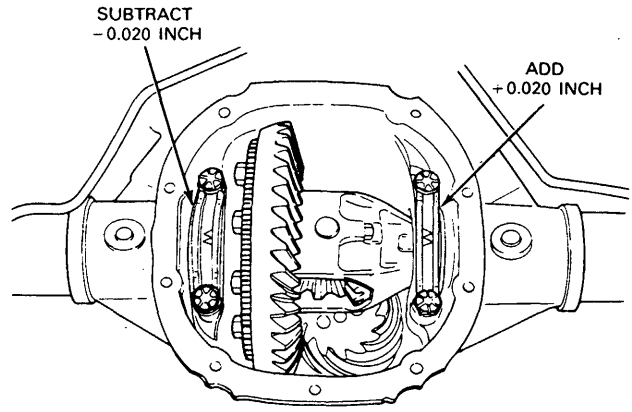
E4754-1A

25. Check ring gear and pinion backlash. If the backlash is 0.008 inch to 0.015 inch (0.012 inch to 0.015 inch preferred) proceed to Step 32. If the backlash is zero, go to Step 26. If the backlash is not zero, but is less than 0.008 inch, or more than 0.015 inch, then go to Step 28.



E4755-1C

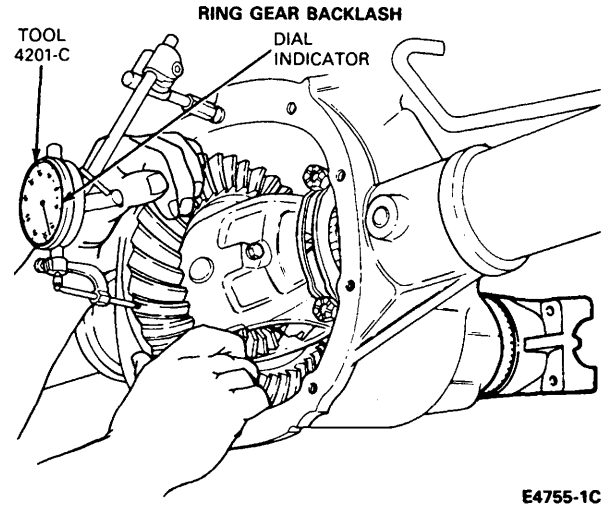
26. If a zero backlash condition occurs, add 0.020 inch to the right side and subtract 0.020 inch from the left side to allow for a backlash reading.



E4756-1A

27. Recheck backlash. See Step 28, if backlash is not within specification. Backlash specification: 0.008 inch to 0.015 inch. Preferred range: 0.012 inch to 0.015 inch.

    If backlash is within specification, go to Step 29.



E4755-1C

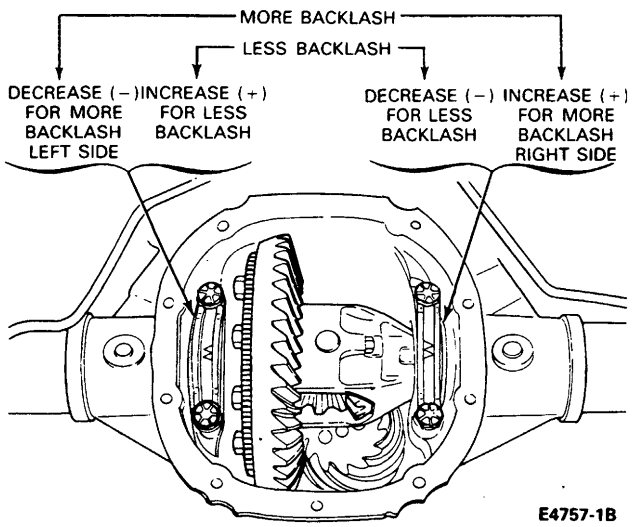
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DISASSEMBLY AND ASSEMBLY (Continued)

28. If backlash is not to specification, correct backlash by increasing thickness of one shim and decreasing thickness of the other shim by the same amount. Refer to chart for approximate shim change.

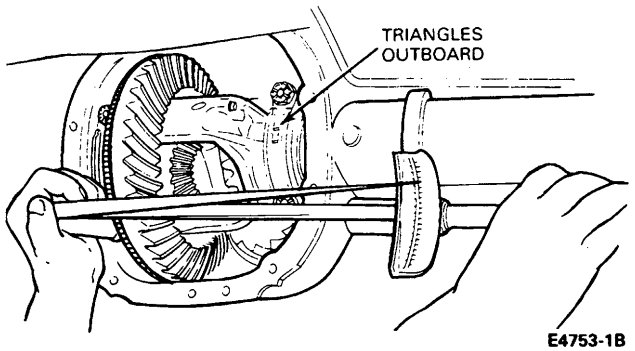
Backlash Change Required	Thickness Change Required	Backlash Change Required	Thickness Change Required
.001	.002	.009	.012
.002	.002	.010	.014
.003	.004	.011	.014
.004	.006	.012	.016
.005	.006	.013	.018
.006	.008	.014	.018
.007	.010	.015	.020
.008	.010		

CE5113-1A



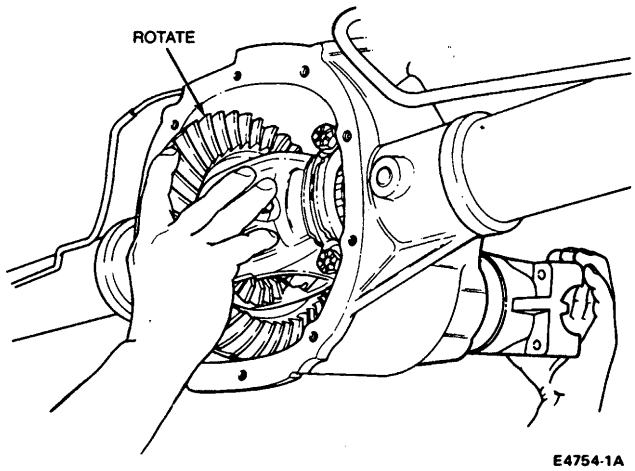
E4757-1B

29. Install shim and bearing caps. Tighten cap bolts to 95-115 N·m (70-85 ft-lbs).



E4753-1B

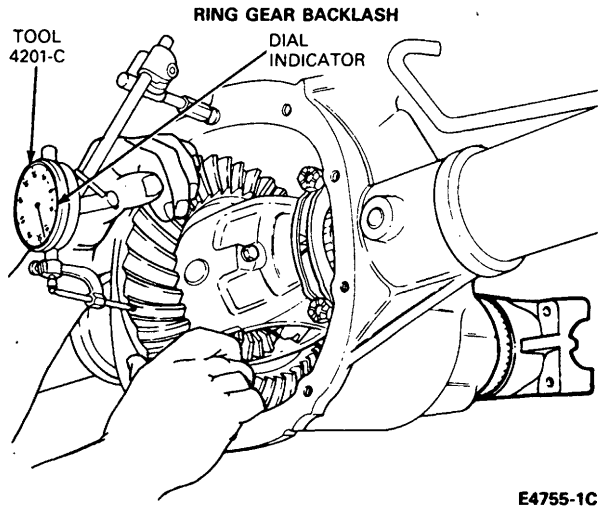
30. Rotate assembly several times to insure proper seating of differential bearings.



E4754-1A

31. Recheck backlash. If backlash is within specification, go to Step 32. If backlash is not within specification, repeat Step 28.

Backlash Specification: 0.008 inch to 0.015 inch. Preferred range: 0.012 inch to 0.015 inch.

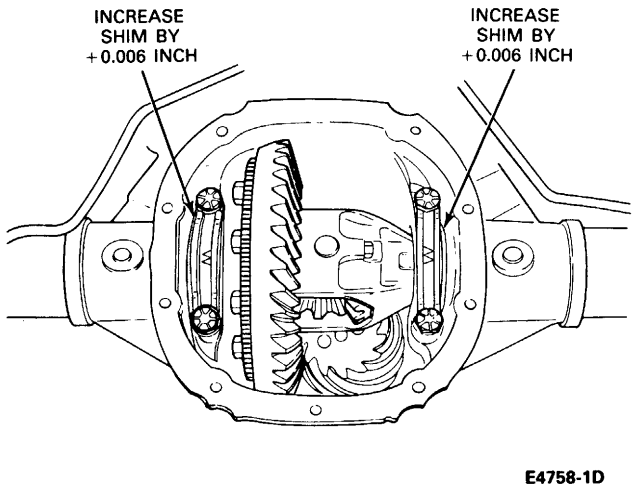


E4755-1C

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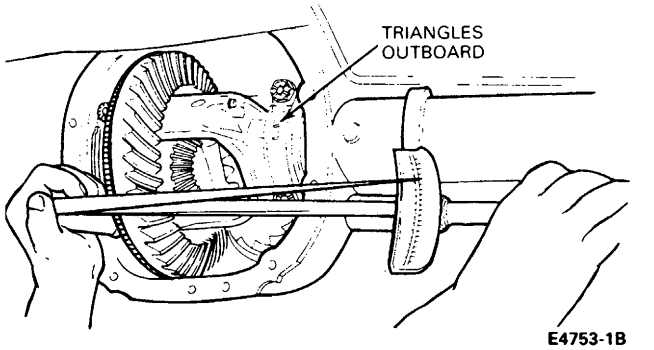
DISASSEMBLY AND ASSEMBLY (Continued)

32. Remove bearing caps and bolts. To establish differential bearing preload, increase both left and right shim sizes by 0.006 inch. Make sure shims are fully seated and assembly turns freely.



33. Install bearing caps and tighten cap bolts to 95-115 N·m (70-85 ft-lbs). Recheck backlash. If not to specification, repeat Step 28.
34. Utilize white marking compound to obtain a tooth mesh contact pattern in your assembly. Pattern legibility can be improved by connecting the driveshaft and rotating both tires in drive and coast direction.

    Reincorporation of pattern inspection is intended to allow technician the ability to detect gross errors in set-up prior to complete reassembly. Pattern contact should be within the primary area of the ring gear tooth surface avoiding any "narrow" or "hard" contact with outer perimeter of tooth (top to root, toe to heel). Pattern inspection should be on the drive (pull) side. Assembly with correct drive pattern will result in satisfactory coast performance. If gross pattern error is detected, with preferred backlash (0.012 inch-0.015 inch), recheck pinion shim selection.



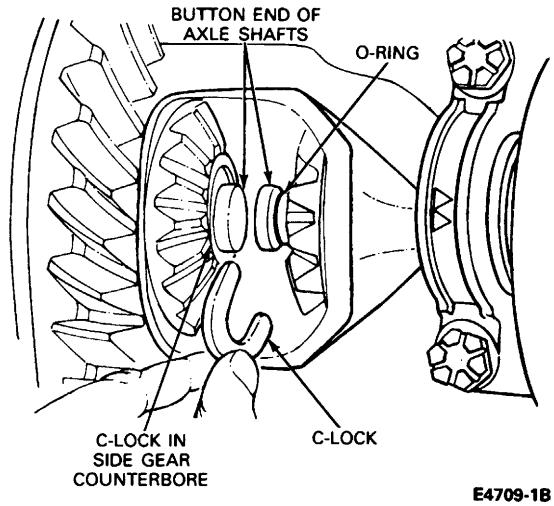
Axle Shaft

Installation

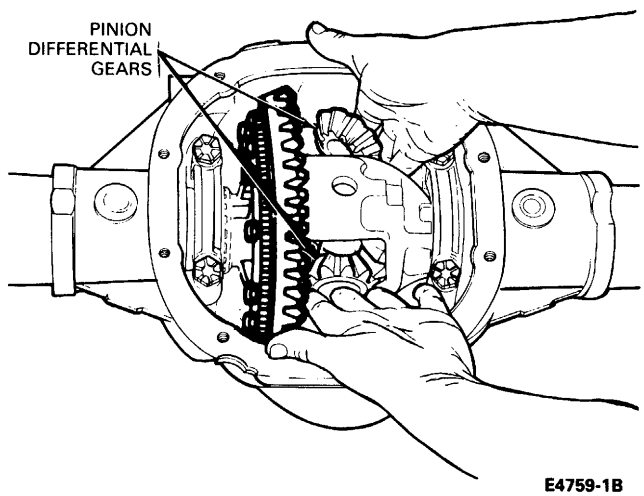
35. Slide the axle shafts into place in the axle housing. Exercise care so that the splines or any portion of the axle shafts do not damage the oil seals. Push the shafts inboard enough to allow installation of the C-lock.

    Install the axle shaft C-locks on the button end of the axle shafts and push the shafts outboard so that the shaft lock seats in the counterbore of the differential side gear.

NOTE: A rubber O-ring is used to hold the C-lock in position on the axle shaft. Be sure that the O-ring is in the groove at the button end of the axle shaft before installing the C-lock.



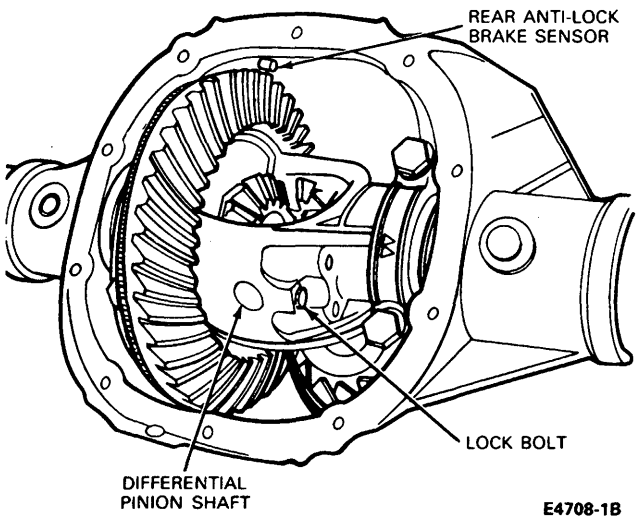
36. Position the differential pinion gears and thrust washers (180 degrees apart) to the differential side gears. Turn the gear assembly to move the pinion gears and thrust washers into the proper position in the differential case (washer and pinion gear bores aligned with pinion shaft holes in case).



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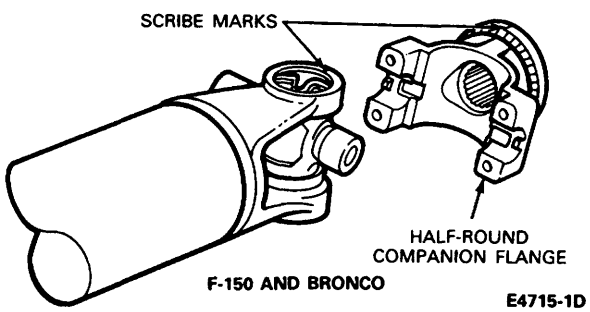
DISASSEMBLY AND ASSEMBLY (Continued)

37. Position the differential pinion shaft through the case and pinions, aligning the hole in the shaft with the lock bolt hole. Apply Stud and Bearing Mount, E0AZ-19554-B (ESE-M4G167-A2) or equivalent to the lock bolt threads. Install lock bolt and tighten to 20-40 N·m (15-30 ft-lbs).

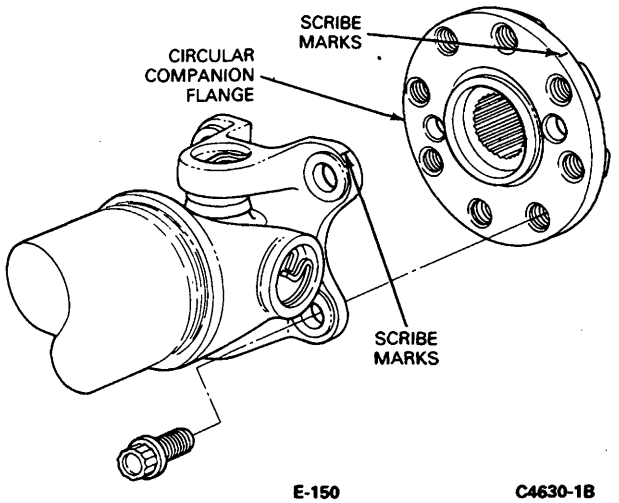


E4708-1B

38. Remove the oil seal replacer from the transmission extension housing. Install the driveshaft in the extension housing. Align the scribe marks on the flange and driveshaft and connect the driveshaft at the axle companion flange. Tighten attaching bolts and nuts to 10-20 N·m (8-15 ft-lbs) for half round companion flange and 95-128 N·m (70-95 ft-lb) for circular companion flange.



F-150 AND BRONCO
E4715-1D



E-150 C4630-1B

39. Install the brake drums.

    Install the wheels and tires. Tighten the wheel lug nuts to specification. Install the wheel covers.

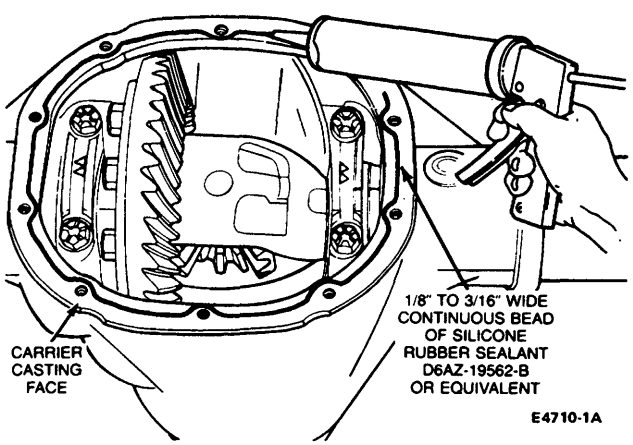
Rear Cover

Installation

40. Clean the gasket mating surface of the rear axle carrier casting and cover.

    Apply a new continuous bead of Silicone Rubber, D64Z-19562-B (ESB-M4G92-A and ESE-M4G195-A) or equivalent to the carrier casting face inside the cover bolt holes.

CAUTION: Make sure machined surfaces on both cover and carrier are clean and free of oil before installing the new silicone sealant. Inside of axle must be covered when cleaning the machined surface to prevent contamination.



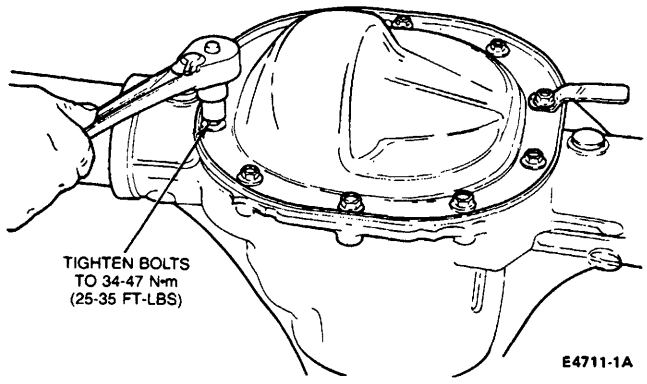
E4710-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

41. Install cover and tighten cover bolts to 34-47 N·m (25-35 ft-lbs) as shown. Tighten the cover bolts in a cross-wise pattern to insure uniform draw on cover.

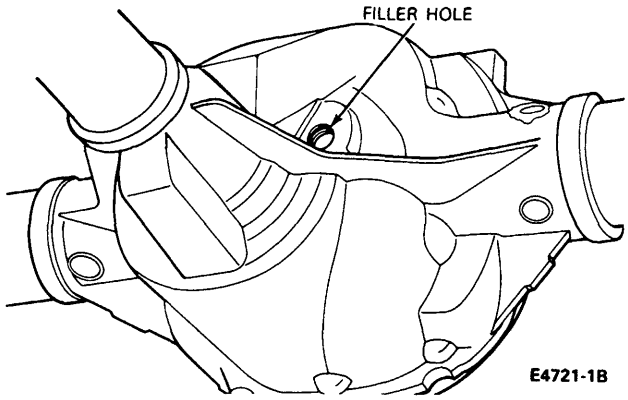
NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.



E4711-1A

42. Add lubricant through the filler hole until the lubricant level reaches the bottom of the filler hole with the axle in the running position. For axles with conventional differentials, use Hypoid Gear Lubricant (SAE 90) E0AZ-19580-A (ESP-M2C154-A) lubricant or equivalent. Install the filler plug and tighten to 20-40 N·m (15-30 ft-lb).

Lower vehicle and road test.

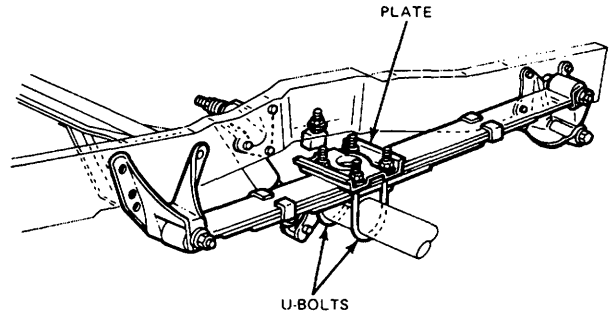


E4721-1B

Axle Housing

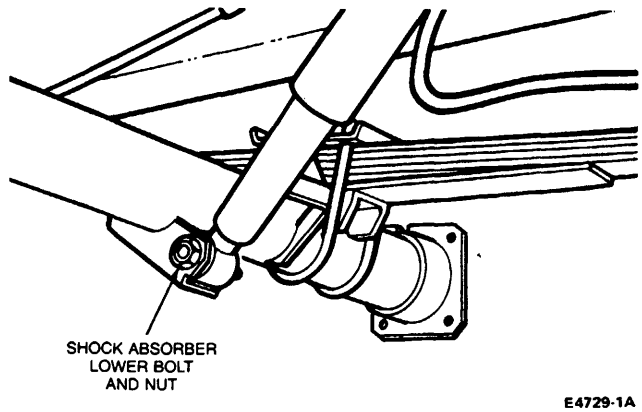
Installation

43. Raise the axle housing into position so that the U-bolt plates can be installed. Tighten the U-bolts to the specification listed in Section 14-31, Rear Suspension—Leaf Springs. (There are different specifications, depending on the vehicle.)



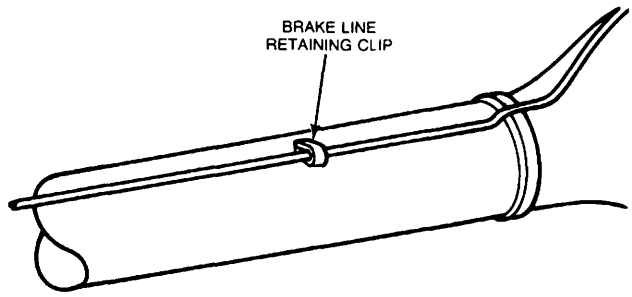
E4730-1A

44. Connect the shock absorber lower bolts to the mounting bracket on the axle housing. Install the attaching nuts and tighten to the specification listed in Section 14-31, Rear Suspension—Leaf Springs.



E4729-1A

45. Insert the vent fitting into the hydraulic junction block and position the assembly over the housing vent hole. Hand start the vent fitting and tighten.



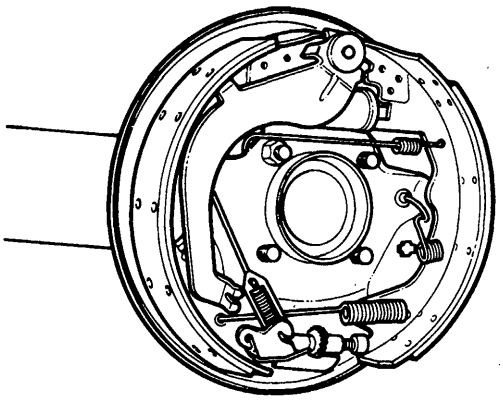
E4728-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

46. Position the brake lines to the axle housing and secure with the retaining clips at the right hand axle tube and vent fitting through the junction block.

    Install the brake backing plates on the axle housing flanges (no gaskets required). Tighten the attaching nuts to 28-54 N·m (20-40 ft-lbs).



E4725-1A

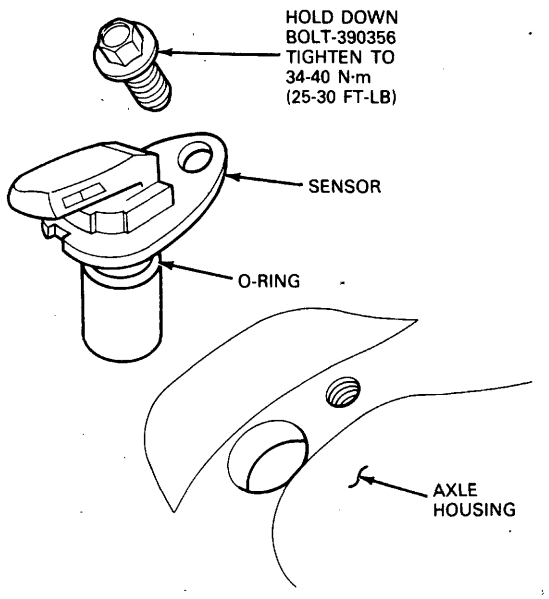
Rear Antilock Brake System Sensor (F-150 and Bronco only)

Removal

1. Remove Sensor Hold Down Bolt. Remove sensor.
2. Clean axle mounting surface, using caution to prevent dirt from entering axle housing.

Installation

1. If new sensor is to be installed, lightly lubricate O-ring with motor oil.
   a. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.
   b. Install hold down bolt and tighten to 34-41 N·m (25-30 ft-lb).
2. If old sensor is to be reinstalled, clean and blow off metal particles using shop air.
   a. Remove and replace O-ring with a new O-ring.
   b. Apply a light film of motor oil to O-ring.
   c. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.
   d. Install hold down bolt and tighten to 34-41 N·m (25-30 ft-lb).



E7209-1A

SPECIFICATIONS

ADJUSTMENT TORQUE SPECIFICATIONS (INTEGRAL CARRIER) — CONVENTIONAL

Description	Torque (In-Lb) N·m	Torque (Ft-Lb) N·m
Approximate torque required to tighten pinion flange nut to obtain correct pinion bearing preload	—	(160) ① 217
Pinion Bearing Preload — (Collapsible Spacer) ②		
Used Bearings — 8.8 inch	(8-14) .9-1.5	—
New Bearings — 8.8 inch	(16-29) 1.8-3.3	—

①If pinion bearing preload exceeds specification before this torque is obtained, install a new collapsible spacer.

②With oil seal.

CE5117-1C

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SPECIFICATIONS (Continued)

DRIVING AXLE IDENTIFICATION (INTEGRAL CARRIER) — CONVENTIONAL

Identification Tag	Ratio	Ring Gear Diameter (Inches)	Differential Type
720C	3.08:1	8.8	C2
724S	3.55:1	8.8	C2
730D	3.55:1	8.8	C2
806D	3.08:1	8.8	C2
808D	3.55:1	8.8	C2
812D	2.73:1	8.8	C2
814P	3.55:1	8.8	C2

CE5116-1E

CLEARANCE, TOLERANCE AND ADJUSTMENTS (INTEGRAL CARRIER)

Description	Inches
Maximum Runout of Back Face of Ring Gear	0.004
Maximum Runout of Back Face of Differential Case Flange	0.003
Differential Side Gear Thrust Washer Thickness	0.030-0.032
Differential Pinion Gear Thrust Washer Thickness	0.030-0.032
Nominal Pinion Locating Shim	0.030
Available Pinion Gear Shims in Steps of 0.001 Inch	0.021-0.037
Backlash Between Ring Gear & Pinion Teeth	0.008-0.015 (0.012-0.015 Preferred)
Maximum Backlash Variation Between Teeth	0.004
Maximum Radial Runout of Companion Flange in Assembly	0.012 T.I.R.
Sensor Pole to Top of Exciter Ring Gap	0.005-0.045

CE5118-1C

SPECIAL SERVICE TOOLS

Tool Number	Description
T50T-100-A	Impact Slide Hammer
T58L-101-A	Puller Attachment
T83T-1225-A	Grease Seal Remover (Use with Slide Hammer T50T-100-A)
T83T-1175-A	Grease Seal Replacer
T83T-1225-B	Axle Bearing Replacer
T85L-4067-AH	Differential Shim Driver
TOOL-4201-C	Differential Backlash and Runout Gauge with Universal Bracket
TOOL-4201-D	Dial Indicator Tip 1/4 Inch
T57L-4220-A	Differential Side Bearing Remover
T79P-4020-A	Pinion Depth Gauge
T57L-4221-A	Differential Side Bearing Replacer
T70P-4221-A	Differential Side Bearing Remover
T68P-4602-A	Pinion Angle Level Gauge
T68P-4602-AA	Frame
T68P-4602-AB	Vial
T68P-4602-AC	Magnet
T60K-4616-A	Pinion Bearing Cups Replacer (Inner and Outer)
T67P-4616-A	Pinion Bearing Cups Replacer
T71P-4616-A	Pinion Bearing Cup Replacer
T53T-4621-C	Pinion Bearing Cone Replacer
T71P-4621-B	Pinion Bearing Cone Replacer
T83T-4676-A	Pinion Seal Replacer
T65L-4851-B	Companion Flange Remover
T57T-4851-B	Companion Flange Holding Tool — Half-Round Flange
T78P-4851-A	Companion Flange Holding Tool — Circular Flange

CE5115-1E

TORQUE SPECIFICATIONS (INTEGRAL CARRIER) — CONVENTIONAL

Description	Torque	
	N·m	Ft-Lbs
Differential Bearing Cap Bolt — Inch	95-115	70-85
Differential Pinion Shaft Lock Bolt ①	20-40	15-30
Ring Gear Attaching Bolts — Inch ①	95-115	70-85
Rear Cover Screw	34-47	25-35
Oil Filler Plug	20-40	15-30
Axle Vent	20-34	15-25
Brake Backing Plate Nuts	28-54	20-40
Driveshaft to Axle Circular Companion Flange Attaching Bolts — E-150	95-128	70-95
Driveshaft to Axle Half-Round Companion Flange Attaching Bolts-F-150 and Bronco②	10-20	8-15

①Using Loctite E0AZ-19554-B (or equivalent).
②See Step 38 for Half-Round Type Companion Flange.

CE5119-1D

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SPECIFICATIONS (Continued)

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER) — CONVENTIONAL

Vehicle	Engine	Axle	Approximate Lubricant Capacity ①			Lubricant Level ②
			U.S. Pints	Imperial Pints	Liters	
F-150	All	8.8 Inch Ring Gear	5.50	4.58	2.60	0.2 inch
Bronco	All	8.8 Inch Ring Gear	5.50	4.58	2.60	0.6 inch
E-150	All	8.8 Inch Ring Gear	5.50	4.58	2.60	0.2 inch

①All conventional and Traction-Lok Axles use Hypoid Gear Lubricant, E0AZ-19580-A (ESP-M2C154-A) or equivalent plus 4 ounces of friction modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent for complete refill of Traction-Lok Rear Axles.
②Below bottom of filler plug hole with vehicle in running position plus or minus 1/8 inch.

CE5120-2D

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SECTION 15-09 Integral Carrier Axle—Ford 10.25 Inch Ring Gear

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VEHICLE APPLICATION

Semi-Floating Feature—F-250 Light Duty, Full-Floating Feature—F-250/350 Regular and Chassis Cab.

DESCRIPTION AND OPERATION

Description

The Ford Truck Integral Carrier rear axle assembly is an integral type housing, hypoid gear design with the centerline of the pinion set below the centerline of the ring gear.

The hypoid gear set consists of an 10-1/4 inch diameter ring gear and an overhung drive pinion which is supported by two opposed tapered roller bearings. Pinion bearing preload is adjusted by the pinion nut and a collapsible spacer maintains the seating of the inner race.

The housing assembly consists of a cast center section with two steel tube assemblies and a stamped rear cover. The cover uses a silicone sealant as a gasket.

The differential case is a one-piece design with two openings to allow for assembly of the internal components and lubricant flow. The differential pinion shaft is retained with a threaded bolt assembled to the case. The differential case assembly is mounted in the carrier between two opposed tapered roller bearings. The bearings are retained in the carrier by removable bearing caps.

The full-floating rear axle features **brake drums that are mounted outboard of the hub.** Therefore, when brake inspection or replacement is required the hub assembly need not be removed.

The hub is supported or "floats" on the axle spindle on two opposed tapered roller bearings. It is retained on the spindle by a ratcheting nut that is tabbed to a slot on the spindle. **If, for any reason, the hub is removed from the spindle, the old hub seal must be removed and a new hub seal installed.**

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DESCRIPTION AND OPERATION (Continued)

Functional differences between the semi-float integral rear axle assembly and the full-float integral rear axle assembly are as follows:

1. The semi-float axle shafts are retained in the axle by C-washer locks positioned in a slot on the axle shaft splined end. These C-washers also fit into a machined recess in the differential side gears within the differential case.
2. The full-float axle shafts are retained by bolts attached to the hub. The hub rides on two bearings at the outboard end of the axle tube.
3. A semi-float axle shaft rides on one straight-roller bearing at the outboard end.
   - Differential Bearing Preload and Ring Gear Backlash are adjusted by the use of shims located between the differential bearing cup/races and the carrier housing.
   - The use of a Pinion Depth Gauge Tool for drive pinion shim selection in conjunction with a dial indicator for differential case shim selection is required for proper gear set adjustment.

Rear Antilock Brakes

F-250/F-350 vehicles use the Rear Antilock Braking System. The system is designed to automatically reduce brake pressure when brake lock-up is detected during braking or on slippery surfaces. The system features a multi-tooth excitor ring that is pressed on the differential case behind the ring gear. If the excitor ring is removed, it must be discarded and replaced with a new one. The excitor ring works in conjunction with an electronic speed sensor. This sensor is retained in a bore at the top of the carrier housing and fastened by one bolt. There is a space provided between the ring gear and excitor ring for measuring the ring gear backface runout.

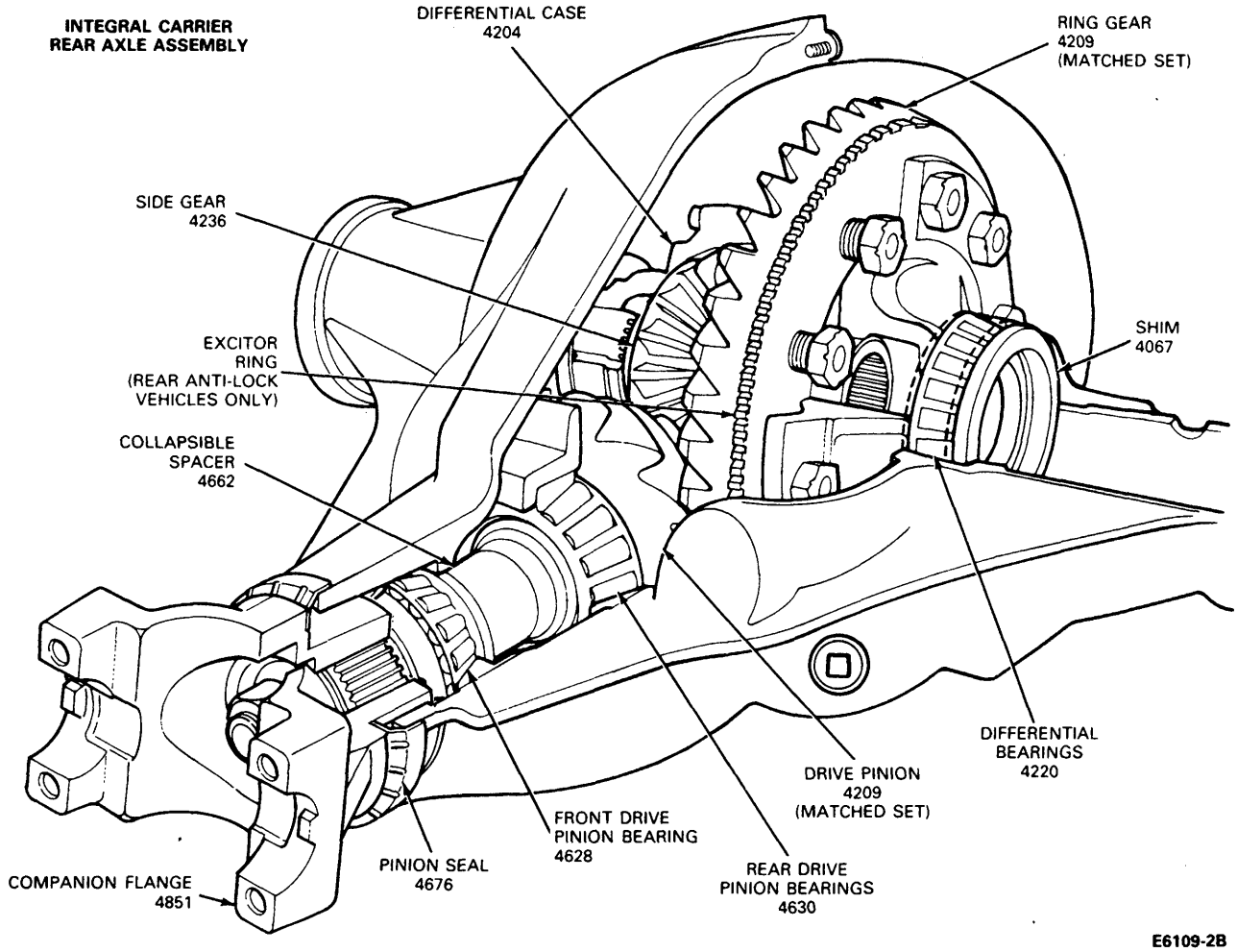
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DESCRIPTION AND OPERATION (Continued)

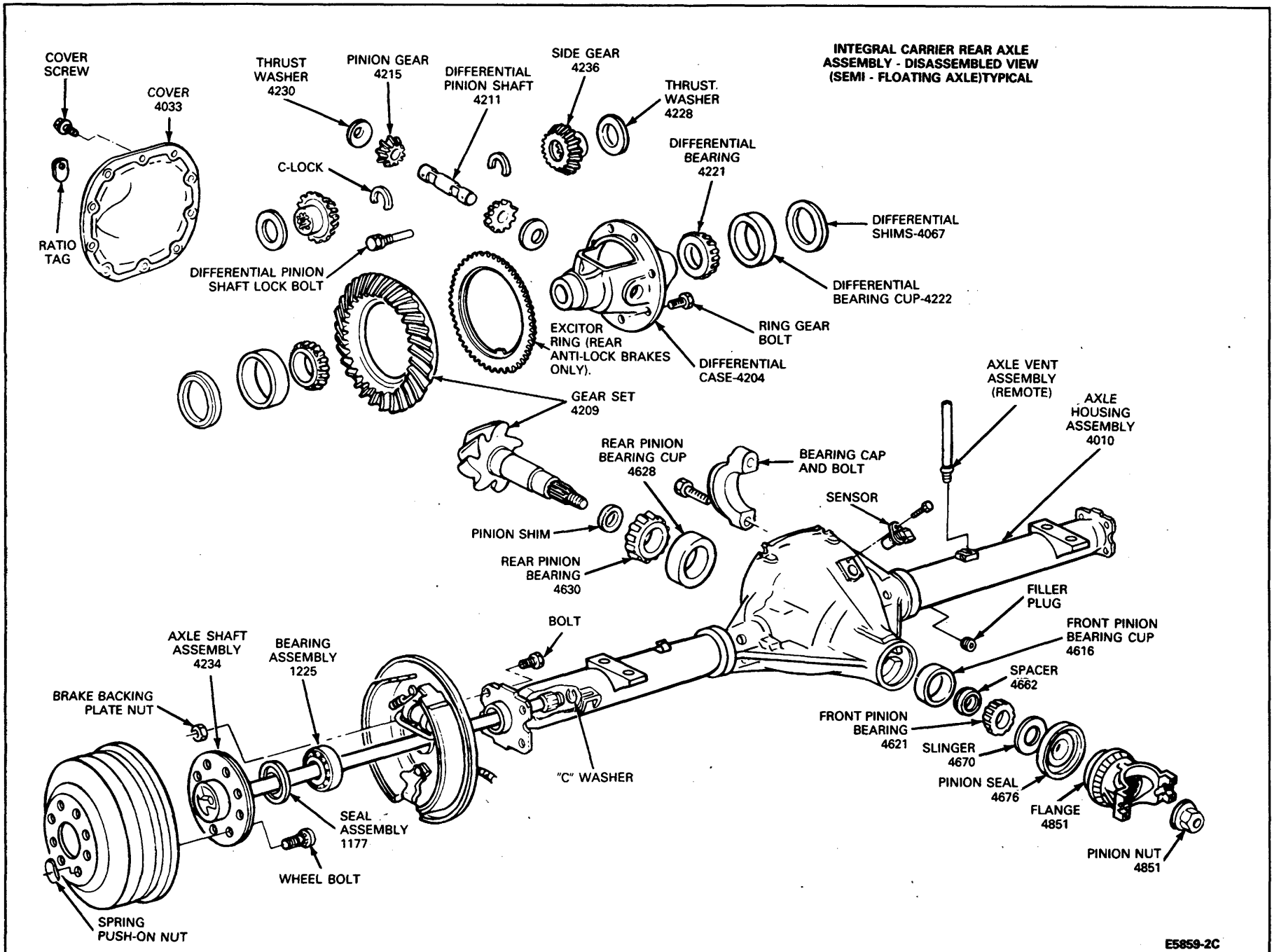
Operation

The rear axle drive pinion receives its power from the engine through the transmission and driveshaft. The pinion gear rotates the differential case through engagement with the ring gear, which is bolted to the case outer flange.

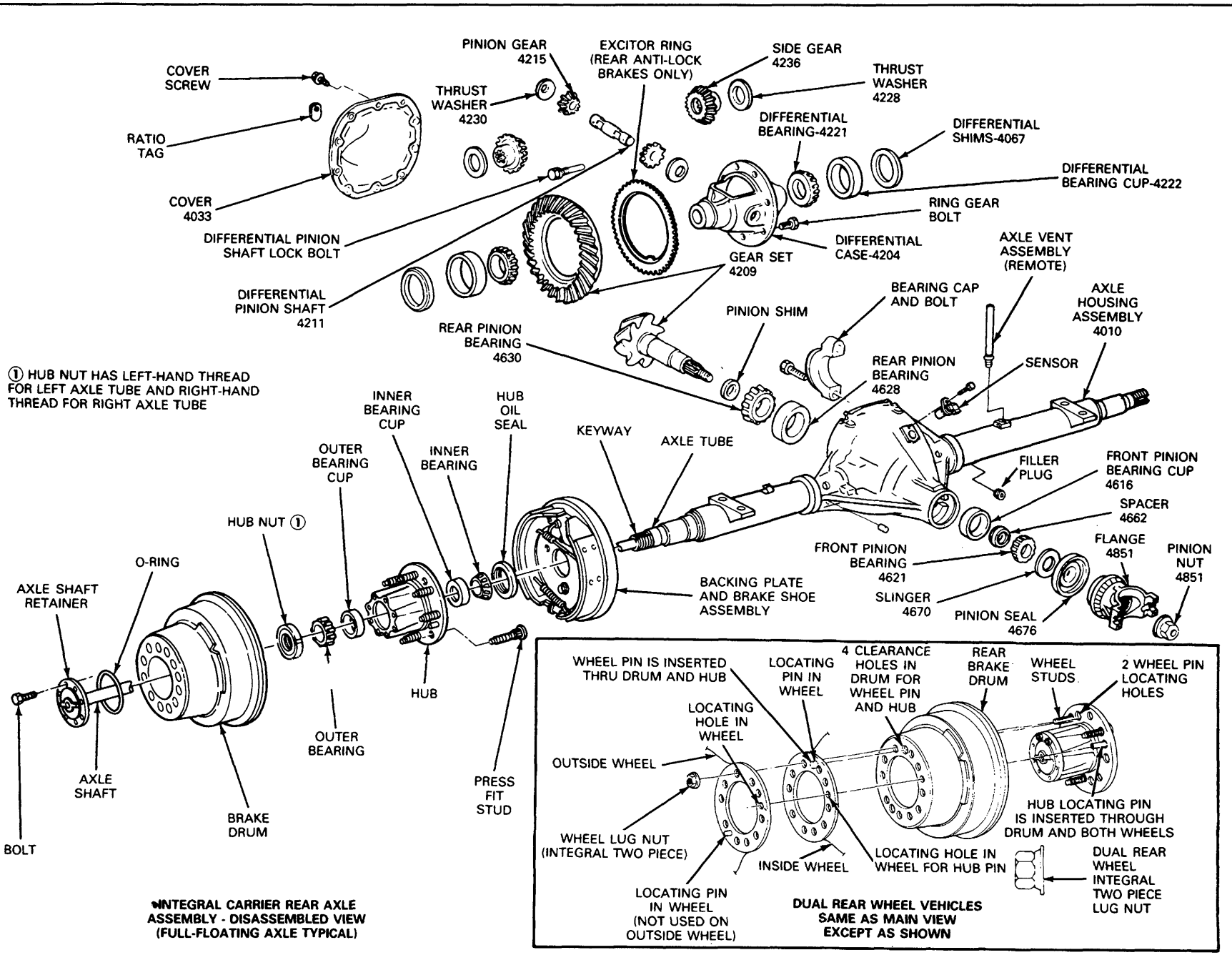
Inside the case, two differential pinion gears are mounted on the differential pinion shaft which is pinned (with lock bolt) to the case. These pinion gears are engaged with the side gears, to which the axle shafts are splined. Therefore, as the differential case turns, it rotates the axle shafts and rear wheels. When it is necessary for one wheel and axle shaft to rotate faster than the other, the faster turning side gear causes the pinions to roll on the slower turning side gear to allow differential action between the two axle shafts.



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INTEGRAL CARRIER REAR AXLE ASSEMBLY - DISASSEMBLED VIEW (FULL-FLOATING AXLE TYPICAL)

DUAL REAR WHEEL VEHICLES SAME AS MAIN VIEW EXCEPT AS SHOWN

E6472-2C

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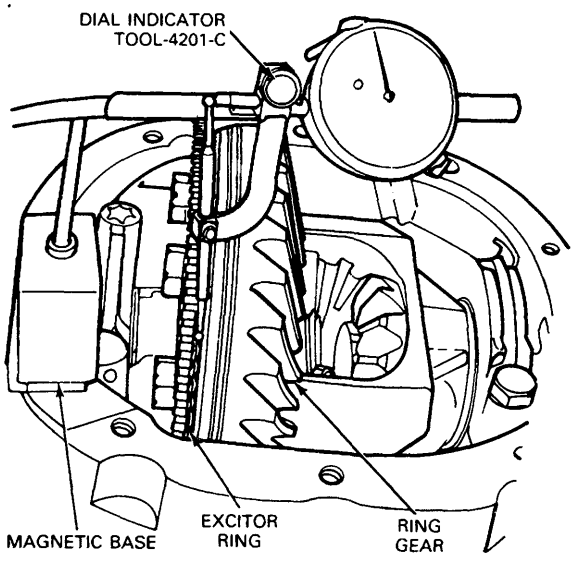
CLEANING AND INSPECTION

Inspection Before Disassembly

The differential case assembly and drive pinion should be inspected before they are removed from the carrier casting. These inspections can find the cause of the concern and determine the resolution.

1. Wipe the lubricant from the internal working parts and visually inspect the parts for wear and/or damage.
2. Rotate the gears to see if there is any roughness which would indicate damaged bearings or gears.
3. Check the ring gear teeth for signs of scoring, abnormal wear or nicks/chips.

RING GEAR BACKFACE RUNOUT
REAR ANTI-LOCK BRAKE VEHICLES



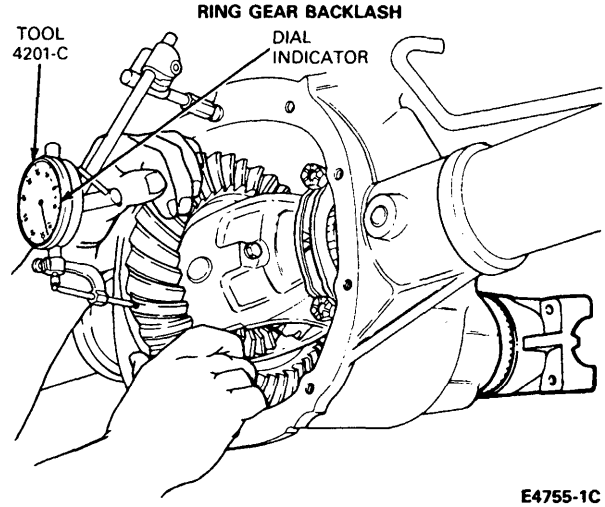
E7162-1B

4. Set up a dial indicator and check ring gear backlash and ring gear backface runout. Backlash should be 0.008 inch to 0.015 inch (0.012-0.015 inch preferred). To check ring gear backface runout, mount Dial Indicator with Bracketry, TOOL-4201-C, or equivalent on the carrier so the tip of the dial indicator contacts the backface of the ring gear. Backface runout should be no more than 0.101mm (0.004 inch).

NOTE: There is a space provided between the excitor ring and the ring gear for measuring ring gear backface runout.

5. A contact pattern is not an acceptable guide to check for noise. Proper gear set assembly must be checked using the Rear Axle Pinion Depth Gauge Tool set which shows the correct pinion shim required to assure acceptable running condition. See section on Drive Pinion and Gear Set.

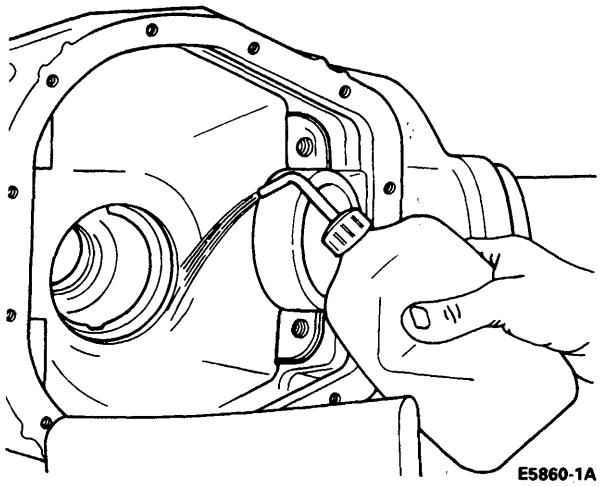
RING GEAR BACKLASH



E4755-1C

Inspection After Disassembly

Thoroughly clean all parts. Always use new solvent when cleaning bearings. Do not spin dry bearings with compressed air. Oil the bearings immediately to prevent rusting. Inspect the parts for any major damage. Clean the inside of the housing before rebuilding. When a scored or chipped gear set is replaced, the axle housing must be washed thoroughly. Inspection procedures for individual parts are outlined as follows.



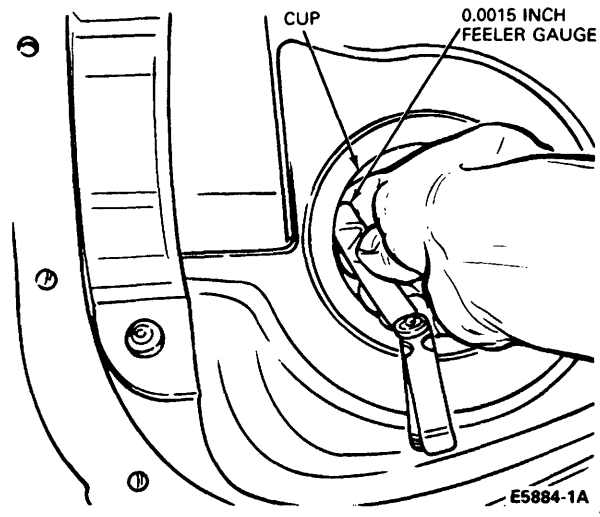
E5860-1A

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CLEANING AND INSPECTION (Continued)

Bearing Cups

Check bearing cups for deep scores, galling, or spalling. If a 0.0381mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup must be re-seated.



Cone and Roller Assemblies

When operated in the cups, bearing rollers must turn without roughness. Examine the roller ends for step wear. If inspection reveals either a damaged cup or a damaged cone and roller assembly, both parts should be replaced.

Companion Flange

Be sure that the flange half-rounds and lugs have not been damaged in removing the driveshaft or in removing the flange from the pinion. The end of the flange that contacts the bearing cone as well as the nut counterbore and seal surface must be smooth and free of nicks.

Gears

Examine the pinion and ring gear teeth for scoring, excessive wear, nicks and excessive chipping. Worn, scored and damaged gears cannot be rebuilt to correct a noisy condition.

Carrier Housing

Make sure that the differential and pinion bearing bores are smooth. Remove any nicks or burrs from the mounting surfaces of the carrier housing.

Differential Case

Make sure that the hubs where the bearings mount are smooth. Carefully examine the differential case bearing shoulders, which may have been damaged when the bearings were removed. The bearing assemblies will fail if they do not seat firmly against the shoulders. Check the fit (free rotation) of the differential side gears in their counterbores.

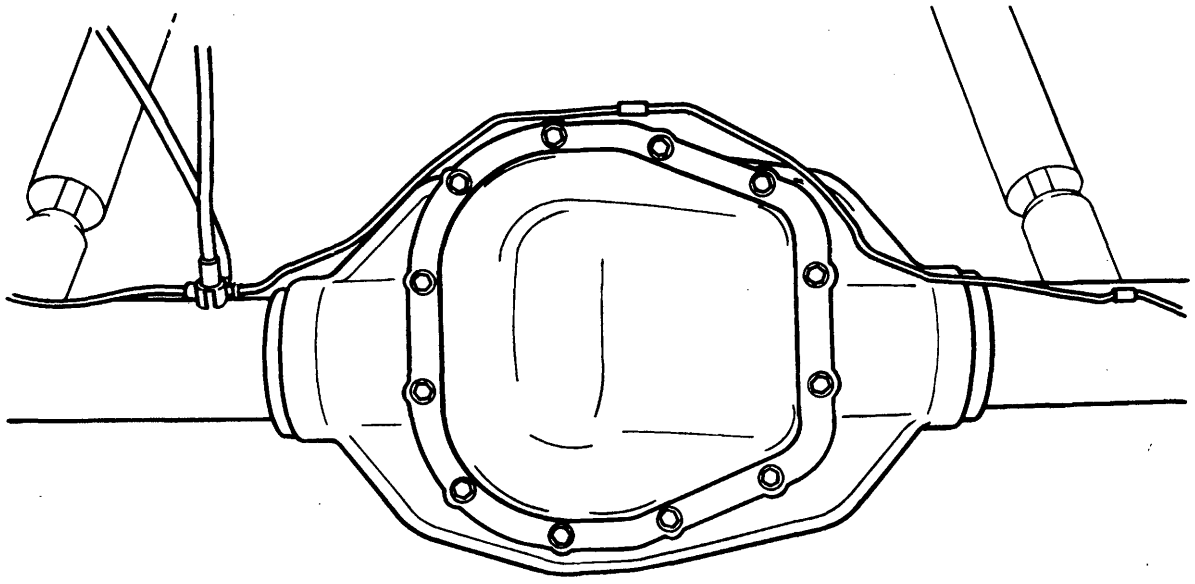
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REMOVAL AND INSTALLATION

Axle Shaft—Semi-Floating Axle

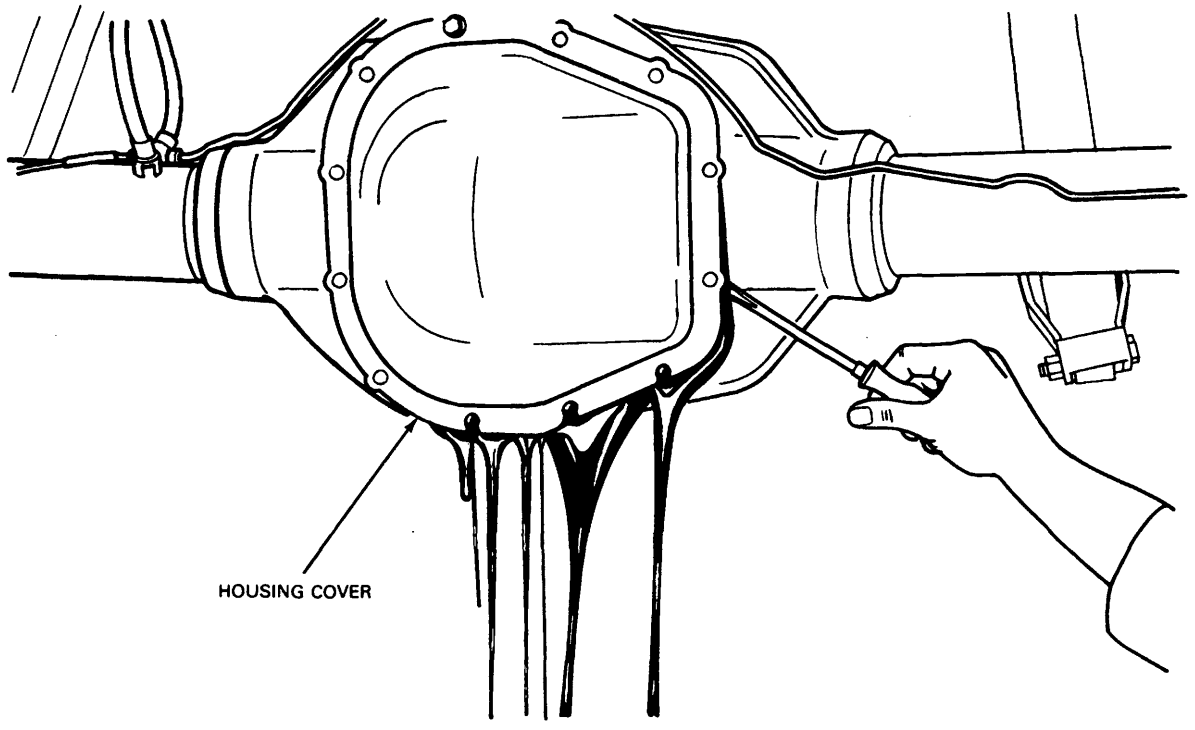
Removal

1. Clean all dirt from the area of carrier cover with a wire brush and/or cloth.



E5863-2A

2. Drain rear axle lubricant by REMOVING THE HOUSING COVER.

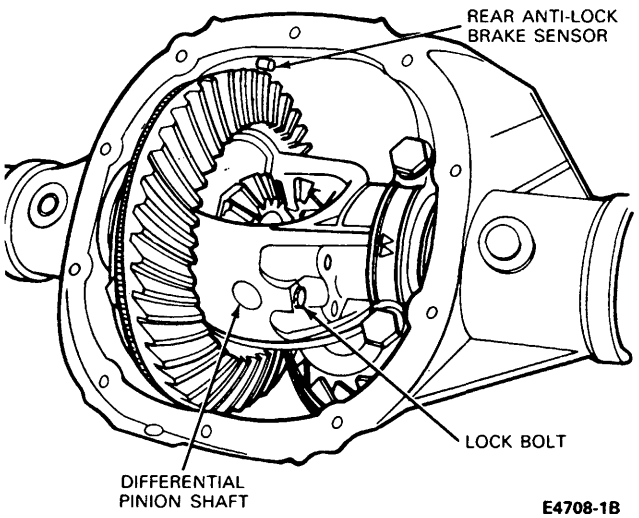


E5864-2A

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REMOVAL AND INSTALLATION (Continued)

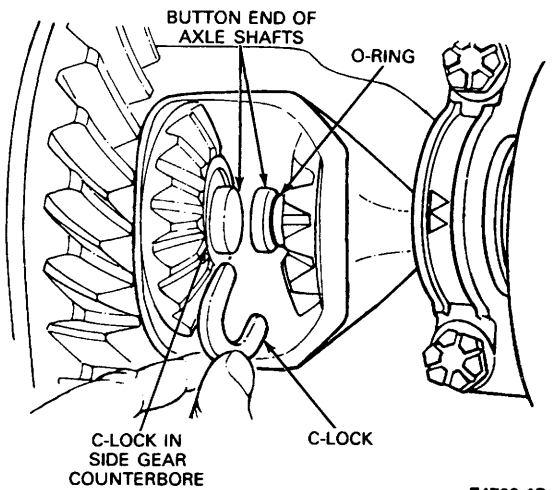
3. Remove differential pinion shaft lock bolt and differential pinion shaft.



E4708-1B

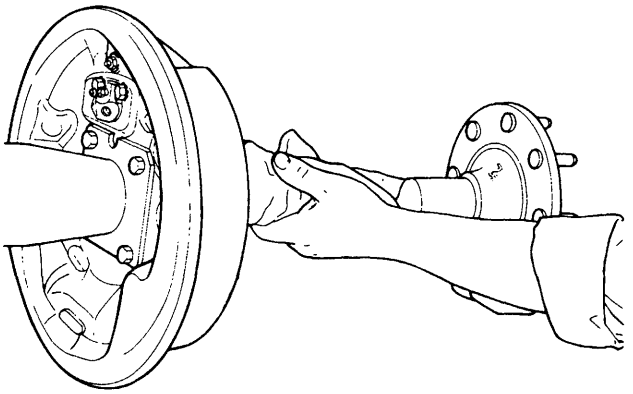
4. Push axle shafts inboard. Remove C-lock from the button end of each axle shaft.

NOTE: Use care not to lose or damage the rubber O-ring which is in the axle shaft groove under the C-lock.



E4709-1B

5. Remove the axle shaft from the housing, being careful not to damage the oil seal.

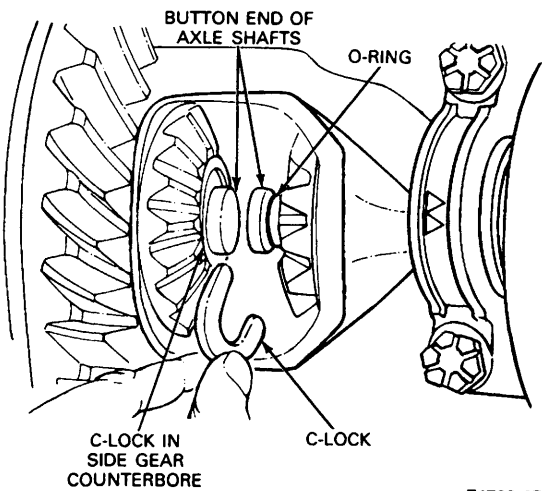

E4760-1B

Installation

1. Slide the axle shafts into place in the axle housing. Exercise care so that the splines or any portion of the axle shafts do not damage the oil seals. Push the shafts inboard (toward the center of the vehicle) enough to allow installation of the C-lock.

   Install the axle shaft C-locks on the button end of the axle shafts and push the shafts outboard so that the shaft lock seats in the counterbore of the differential side gear.

NOTE: A rubber O-ring is used to hold the C-lock in position on the axle shaft. Be sure that the O-ring is in the groove at the button end of the axle shaft before installing the C-lock.

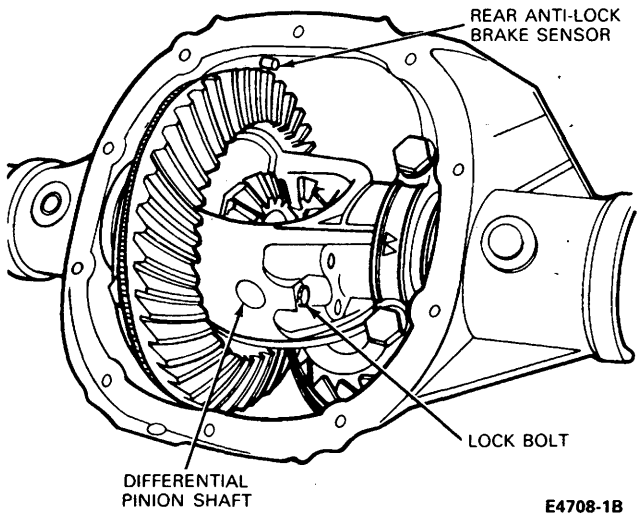


E4709-1B

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REMOVAL AND INSTALLATION (Continued)

2. Position the differential pinion shaft through the case and pinions, aligning the hole in the shaft with the lock bolt hole. Apply Loctite (E0AZ-19554-B or equivalent) to the lock bolt threads. Install lock bolt and tighten to 20-40 N·m (15-30 ft-lbs).

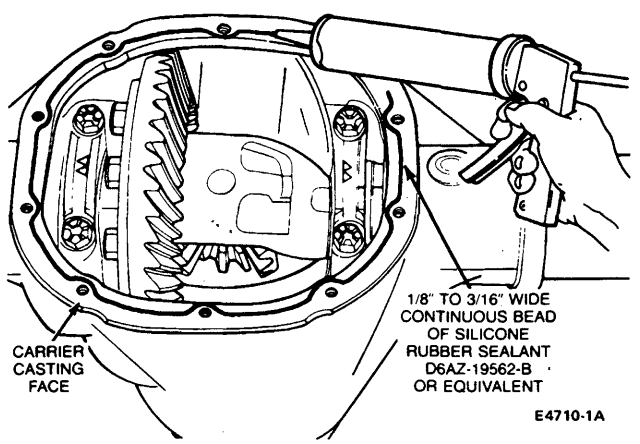


E4708-1B

3. Clean the gasket mating surface of the rear axle carrier casting and cover.

   Apply a new continuous bead of silicone rubber sealant (D6AZ-19562-B or equivalent) to the carrier casting face inside the cover bolt holes.

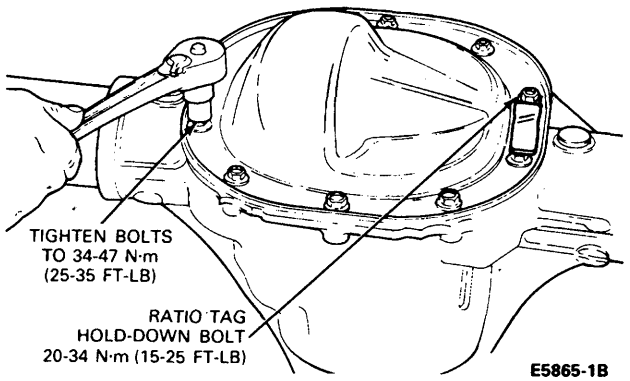
CAUTION: Make sure machined surfaces on both cover and carrier are clean and free of oil before installing the new silicone sealant. Inside of axle must be covered when cleaning the machined surface to prevent contamination.



E4710-1A

4. Install cover and tighten cover bolts to 34-47 N·m (25-35 ft-lbs) as shown. Tighten the cover bolts in a cross-wise pattern to insure uniform draw on cover. Tighten the ratio tag hold-down bolt to 20-34 N·m (15-25 ft-lbs).

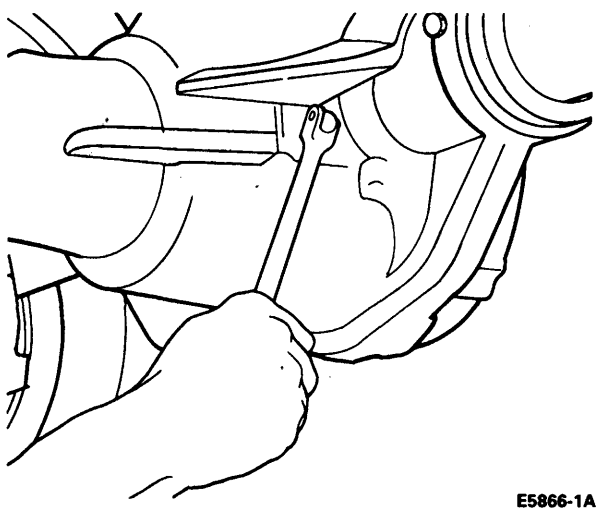
NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.



E5865-1B

5. For in-vehicle repairs, add lubricant through the filler hole until the lubricant level reaches the bottom of the filler hole with the axle in the running position (approximately 6.5 U.S. pints). For out-of-vehicle repairs, add 7.5 U.S. pints of lubricant. Use Hypoid Gear Lubricant E0AZ-19580-A (ESP-M2C154-A) or equivalent for conventional axles, plus 8 ounces of C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for complete refill of Limited-Slip Applications.

   Lower vehicle and road test.


E5866-1A

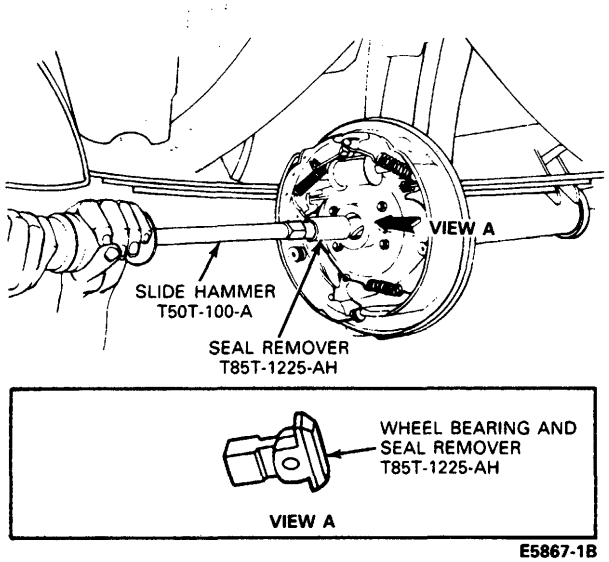
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REMOVAL AND INSTALLATION (Continued)

Oil Seal and Wheel Bearing—Semi-Floating Axle

Removal

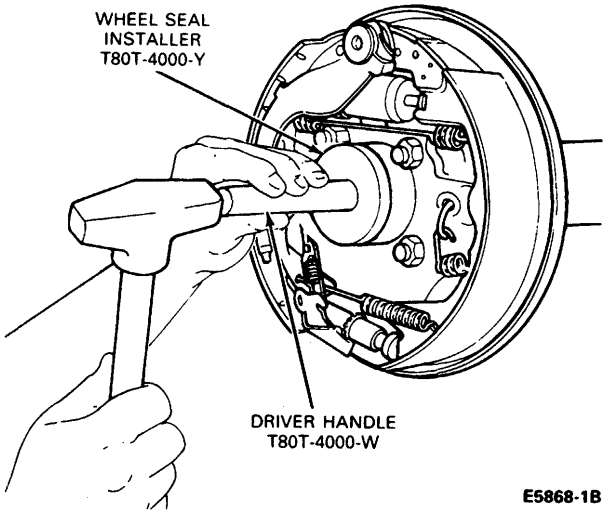
1. Using Slide Hammer, T50T-100-A and Seal Remover, T85T-1225-AH or equivalents, insert into the bore as shown and position it behind the bearing so the tangs on the tool engage the bearing outer race. Remove the bearing and seal as a unit, using the slide hammer.



E5867-1B

Installation

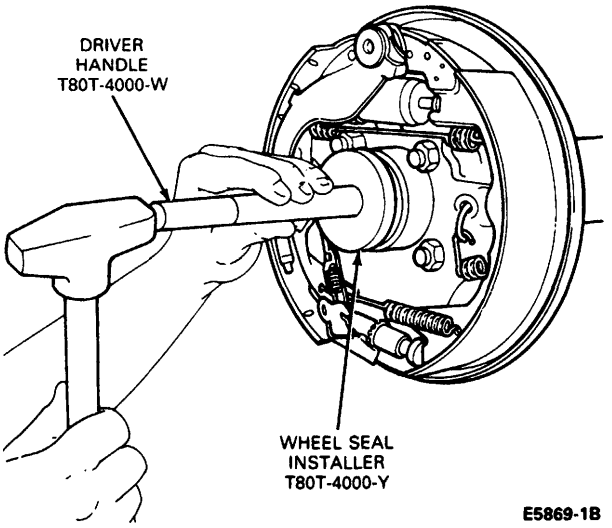
1. Lubricate the new bearing with rear axle lubricant and install the bearing into the housing bore using Driver Handle, T80T-4000-W and Wheel Seal Installer, T80T-4000-Y.



E5868-1B

2. Coat the lips of the seal with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent and install the axle shaft seal.

CAUTION: Installation of the bearing or seal assembly without the proper tool may result in an early bearing or seal failure. If seal becomes cocked in the bore during installation, remove it and install a new one.



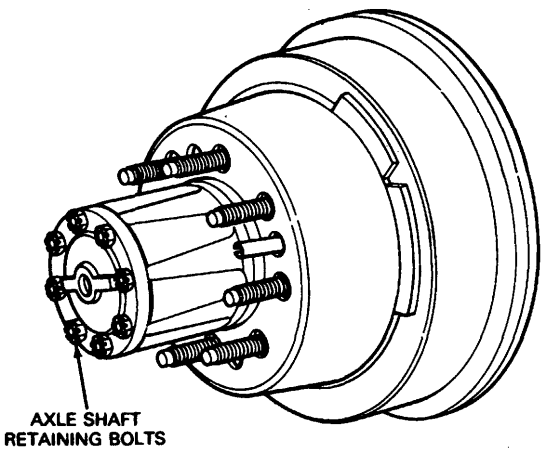
E5869-1B

Axle Shaft, Hub, Oil Seal and Outer Wheel Bearing

Full Floating Axle

Removal

1. Set the parking brake and **loosen** the eight axle shaft retaining bolts.
2. Raise the vehicle to the desired working height, keeping the axle parallel with the floor.
3. Release parking brake and back off the rear brake adjustment, if necessary.
4. Remove the wheel and tire assembly.



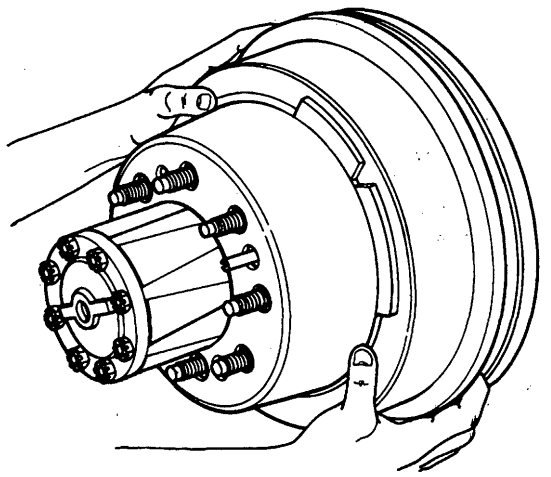
E6473-1A

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REMOVAL AND INSTALLATION (Continued)

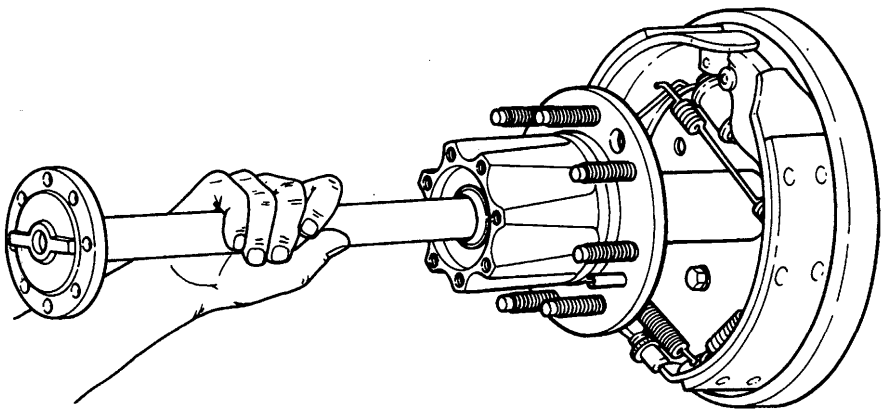
5. Remove brake drum. If equipped, push-on (sheet metal) drum retainer nuts may be discarded.

NOTE: Push-on retainer nuts are used for shipping purposes only and have no effect on vehicle function.



E6474-1A

6. Remove the eight 7/16-inch axle shaft bolts and remove the axle shaft.



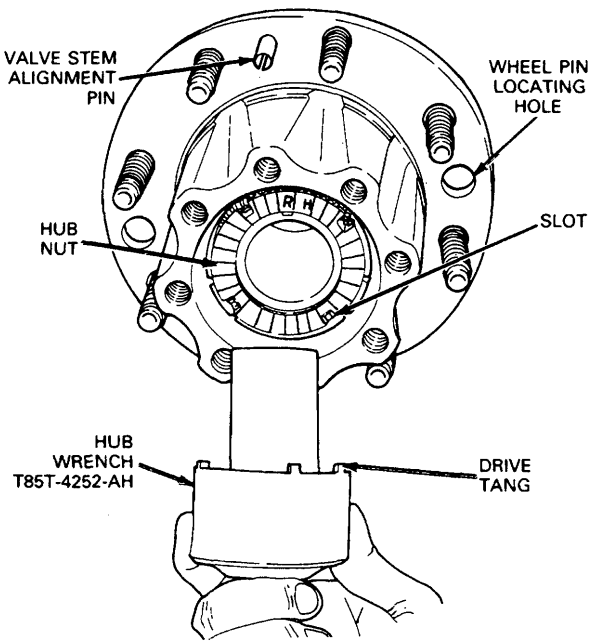
E6475-2A

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REMOVAL AND INSTALLATION (Continued)

7. Install Hub Wrench T85T-4252-AH so that the drive tangs of the tool engage the four slots in the hub nut.

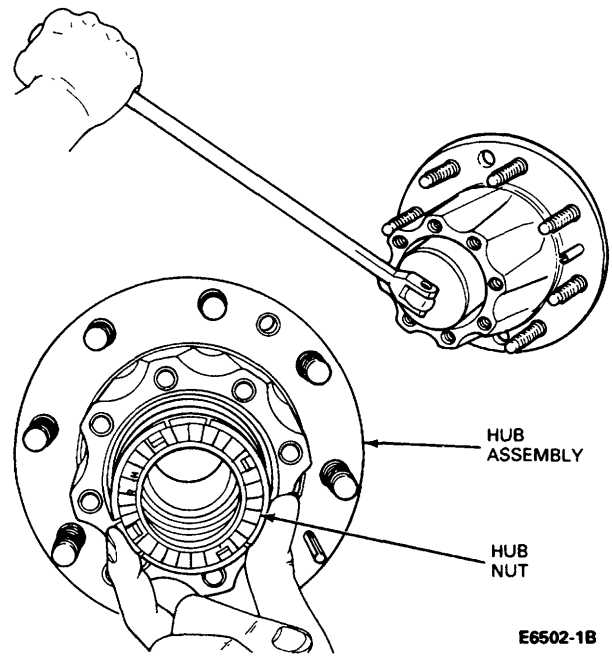
CAUTION: The hub nuts are right hand thread (right hub) and left hand thread (left hub). Each hub nut is stamped RH for right hub nuts or LH for left hub nuts.



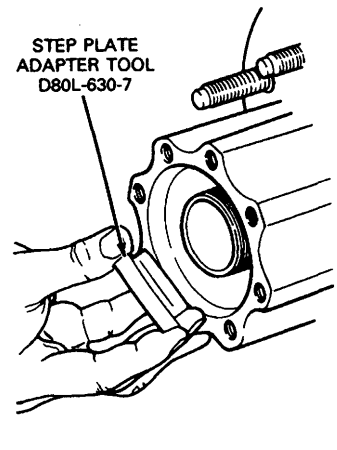
8. Remove hub nut (counterclockwise for right hand thread; clockwise for left hand thread).

CAUTION: Under no circumstances are power impact tools to be used when performing these operations.

NOTE: The hub nut will ratchet during this operation.



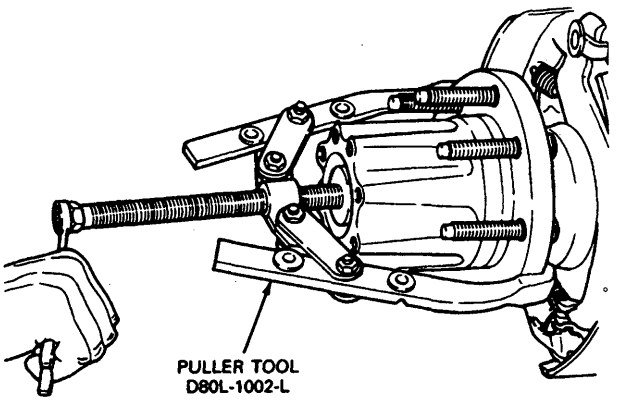
9. Install Step Plate Adapter Tool D80L-630-7.



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REMOVAL AND INSTALLATION (Continued)

10. Install Puller Tool D80L-1002-L or equivalent and loosen hub to the point of removal. Remove puller tool and step plate.



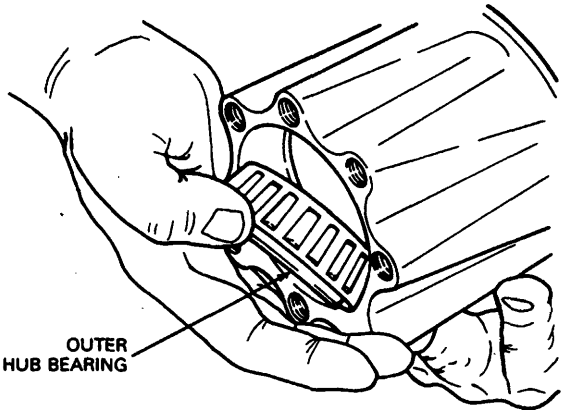
E6504-1A

11. Remove hub assembly.

CAUTION: Do not drop outer hub bearing.

12. To replace hub oil seal, refer to HUB DISASSEMBLY AND ASSEMBLY in this Section.

NOTE: The inner bearing is located behind the hub oil seal.



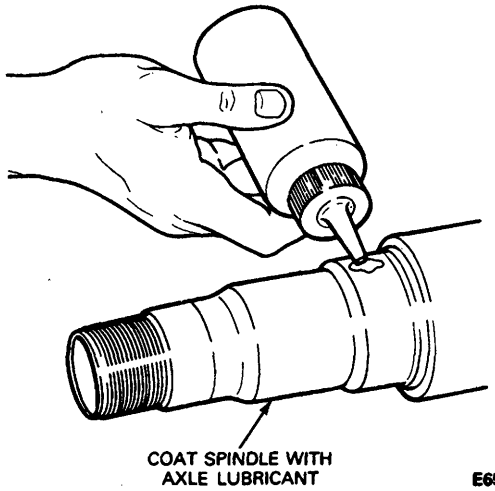
E6505-1A

Installation

1. Clean spindle thoroughly after hub removal, then coat the spindle with axle lubricant.

NOTE: Hub bearings must be prelubed with grease prior to installation. Use Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.

2. Pack each bearing cone and roller assembly with a bearing packing tool, using lithium base Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.



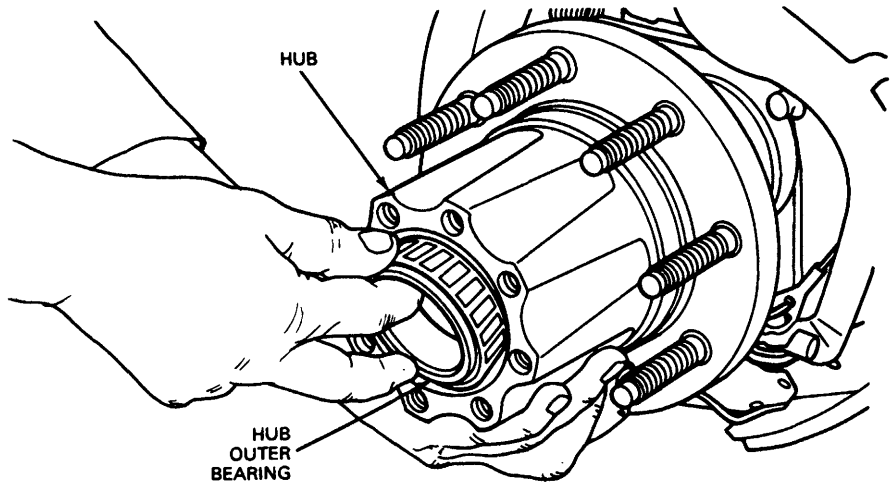
E6506-1A

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REMOVAL AND INSTALLATION (Continued)

3. Push hub **and hub outer bearing** onto spindle.

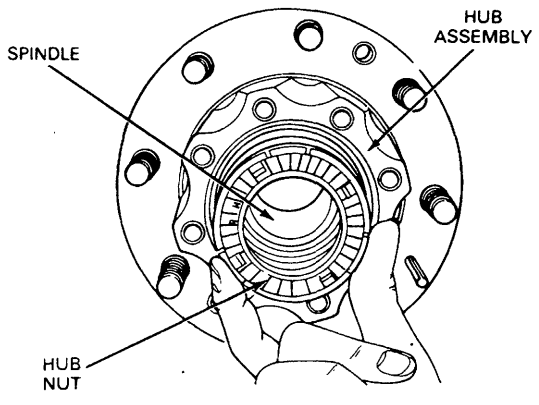
NOTE: Installing the hub in this manner causes the hub outer bearing to act as a pilot making the installation easier.

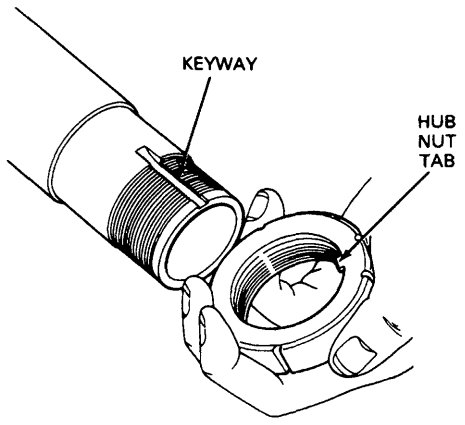


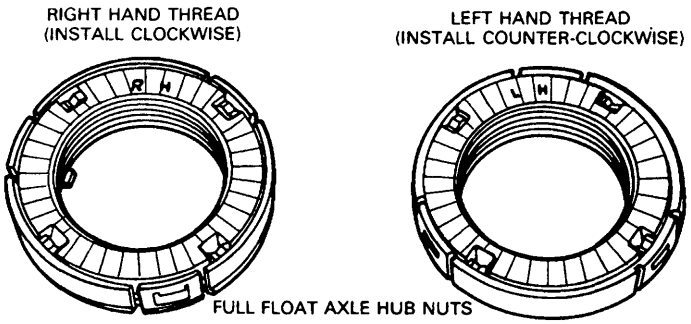
E6507-2A

4. Install the hub nut on the spindle. Turn hub nut clockwise for right hand (RH) thread, counterclockwise for left hand (LH) thread.

CAUTION: Make sure the hub nut tab is located in the keyway prior to thread engagement.







FULL FLOAT AXLE HUB NUTS

E6508-2C

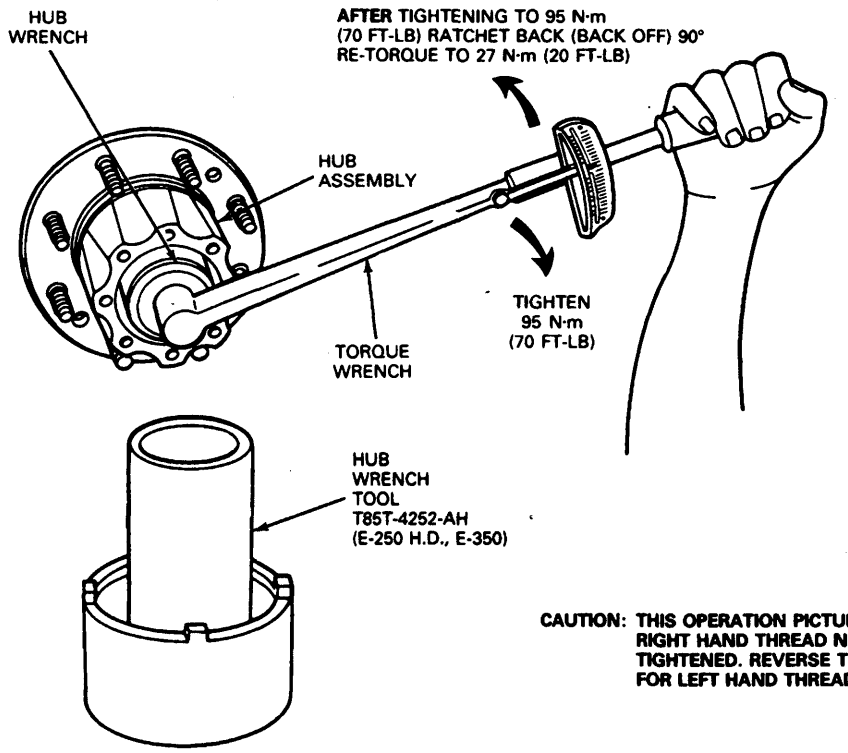
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REMOVAL AND INSTALLATION (Continued)

5. Install Hub Wrench Tool T85T-4252-AH on spindle.
6. Install torque wrench and tighten hub nut to 75-88 N·m (55-65 ft-lbs). Rotate hub occasionally while tightening.

NOTE: The hub nut will ratchet as torque is applied.

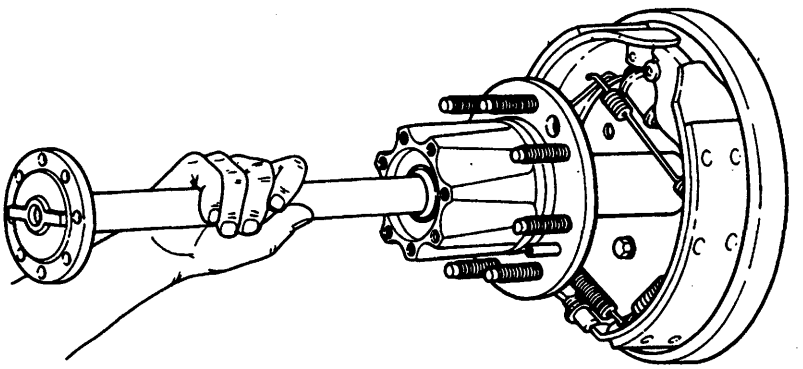
7. After tightening to specification (75-88 N·m [55-65 ft-lbs]), ratchet back five (5) teeth or notches on the hub nut. **Five (5) "clicks" must be heard** during this operation in order to have performed it correctly.

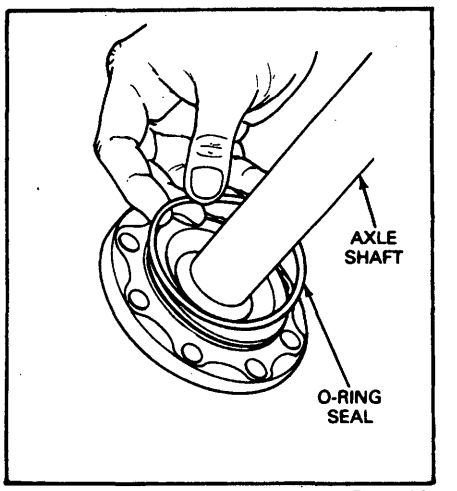


CAUTION: THIS OPERATION PICTURES A RIGHT HAND THREAD NUT BEING TIGHTENED. REVERSE THIS PROCEDURE FOR LEFT HAND THREAD NUT.

E6509-2B

8. Inspect axle shaft O-ring seal for cracks, nicks or wear and replace if required.
9. Install the axle shaft.
10. Coat the threads of all eight (8) axle shaft retaining bolts with Loctite or equivalent.
11. Install and tighten axle shaft retaining bolts until they seat.





E6510-2A

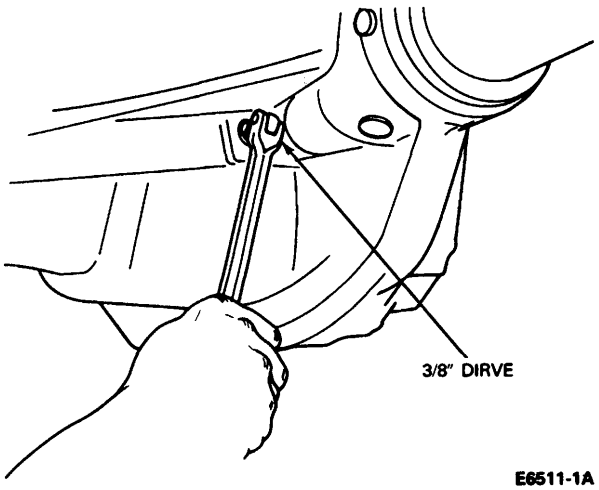
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REMOVAL AND INSTALLATION (Continued)

NOTE: Prior to installing drum, adjust brake so that brake diameter is 0.762mm (0.030 inch) less than drum diameter.

CAUTION: Remember, the last step of this procedure is to tighten the axle shaft bolts to specification, after the wheel lug nuts have been tightened.

12. Install brake drum.
13. Install wheel and tire assembly.
14. Loosen filler plug. If axle lube begins to seep out, retighten filler plug. If there is no lubricant seepage, remove filler plug and fill to bottom of filler plug hole with specified lubricant.
15. Install filler plug and tighten to 21-40 N·m (15-30 ft-lbs).
16. Lower the vehicle.
17. Make brake adjustments if necessary.
18. Tighten wheel lug nuts, Single Rear Wheel (SRW) and/or Dual Rear Wheels (DRW) to 190 N·m (140 ft-lbs).
19. Tighten (8) axle shaft retaining bolts to 82-108 N·m (60-80 ft-lbs).



E6511-1A

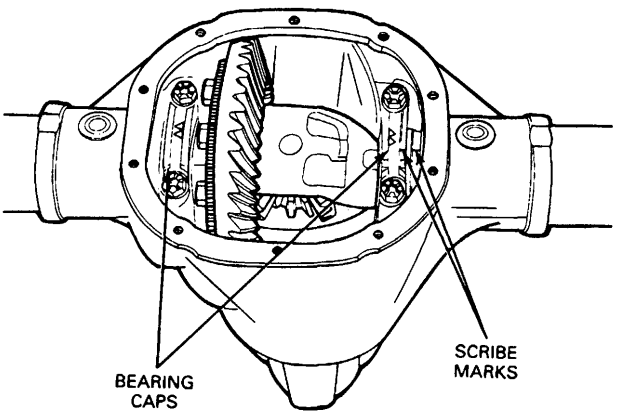
Differential Case and Drive Pinion

Removal

1. If not removed, remove the axle shafts as described in this Section.
2. Mark one differential bearing cap to ensure the caps are installed in their original positions during assembly.

CAUTION: Right and left bearing caps must not be interchanged.

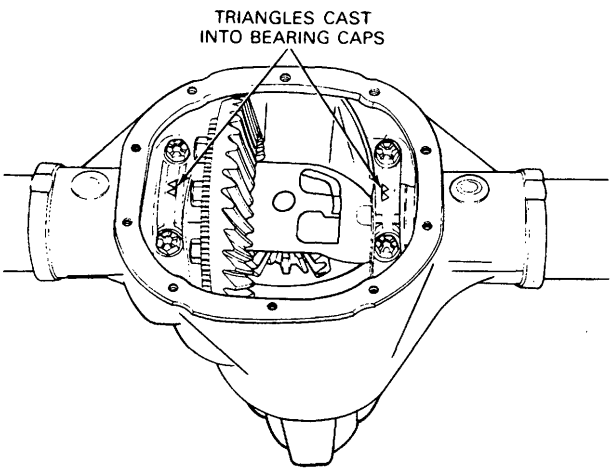
NOTE: Before removing the differential case, check the ring gear runout as described under Inspection Before Disassembly in the Cleaning and Inspection portion of this Section. If ring gear runout exceeds 0.101mm (0.004 inch), the differential case and ring gear must be removed to perform the Differential Runout Check. The Differential Runout Check will isolate the cause of excessive Ring Gear Runout.



E4707-1C

3. Loosen the differential bearing cap bolts and bearing caps.

NOTE: The direction of triangles on bearing caps must be noted. When re-assembled the triangles must be pointing in the same direction (out-board) as before removal.



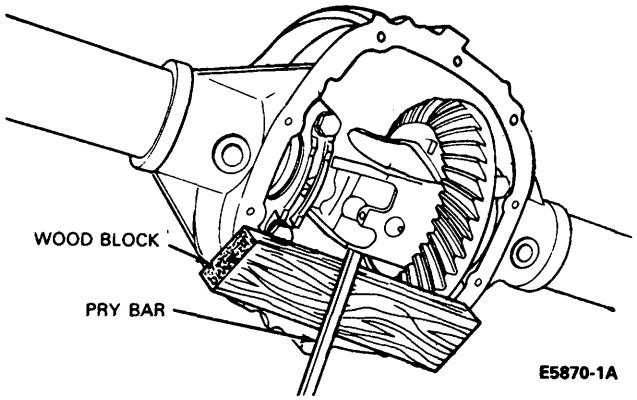
E4763-1B

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REMOVAL AND INSTALLATION (Continued)

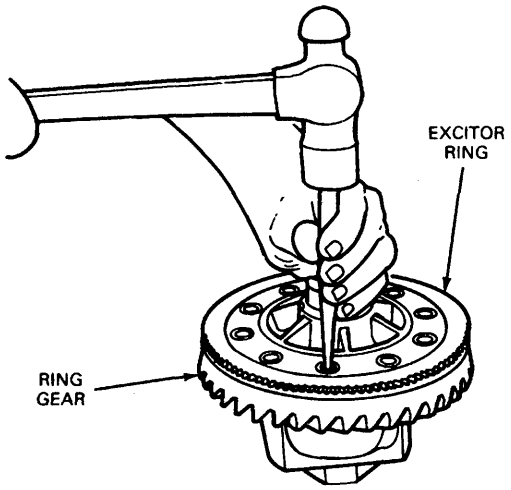
4. Pry the differential case, bearing cups and shims out until they are loose in the bearing caps. Remove the bearing caps and remove the differential assembly from the carrier.

CAUTION: When using the pry bar, place a wood block between the pry bar and the axle housing to protect the machined surface from damage.

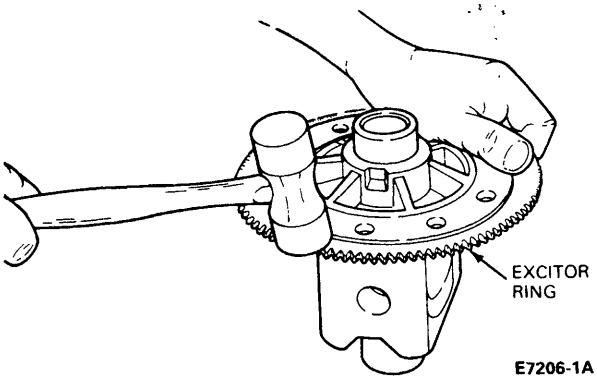


5. If required, remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case by striking at alternate holes around the gear.

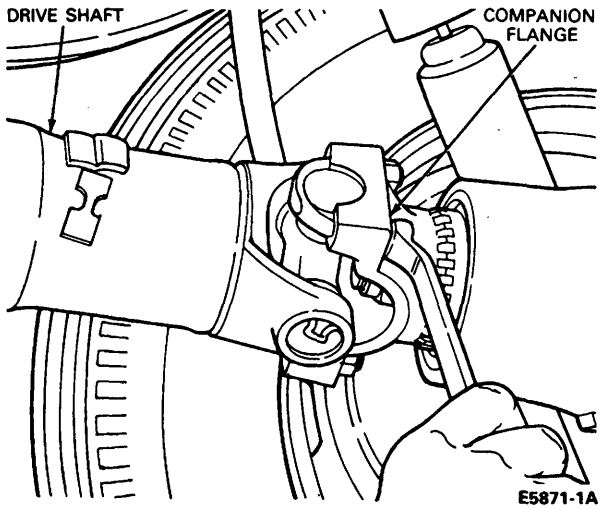
CAUTION: Do not damage excitor ring when removing ring gear. If excitor ring is removed, it must be replaced with a new one.



6. If required remove the excitor ring with a soft faced hammer. Discard the excitor ring.



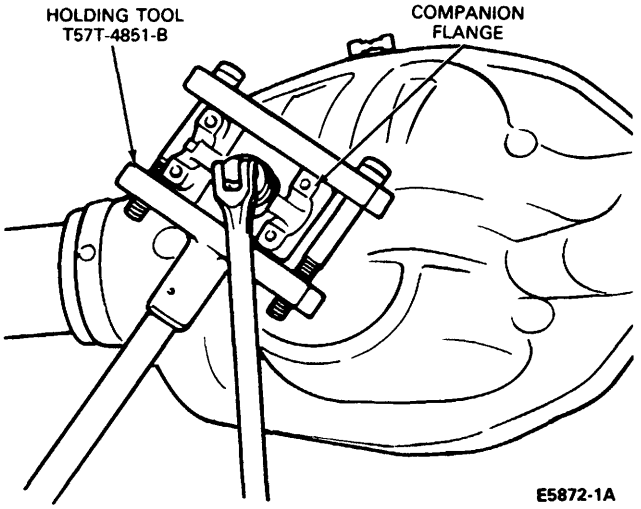
7. Mark the driveshaft in relation to the companion flange. Remove the drive shaft-to-axle-companion flange U-bolts and nuts. Remove the driveshaft assembly.



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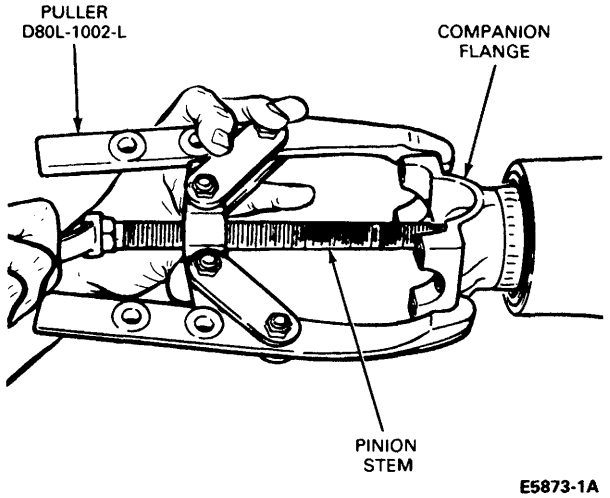
REMOVAL AND INSTALLATION (Continued)

8. Install Holding Tool, T57T-4851-B on the companion flange and remove the pinion nut.



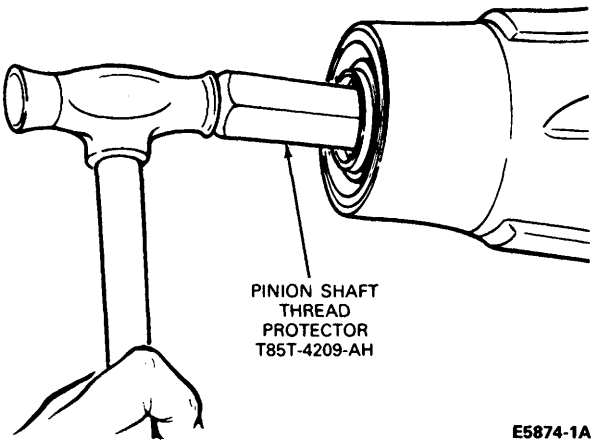
9. Remove the companion flange using Puller, D80L-1002-L or equivalent. Care should be taken not to allow the drive pinion to fall from the housing.

NOTE: Scribe a mark on the companion flange and pinion stem and align the marks when reassembling.



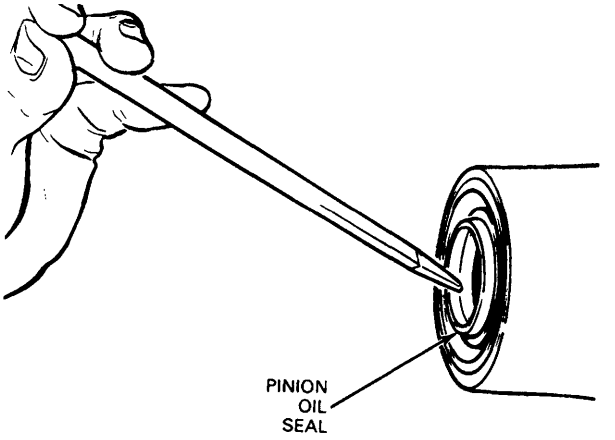
10. With a soft-faced hammer, drive the pinion out of the front bearing cone and remove it through the rear of the housing.

If available, install Pinion Shaft Thread Protector, T85T-4209-AH on the pinion threads and drive the pinion from the housing.



11. Remove the drive pinion oil seal.

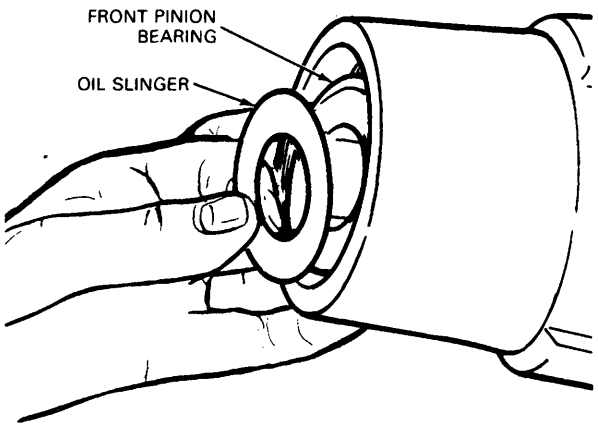
CAUTION: Use care not to damage seal bore in housing.



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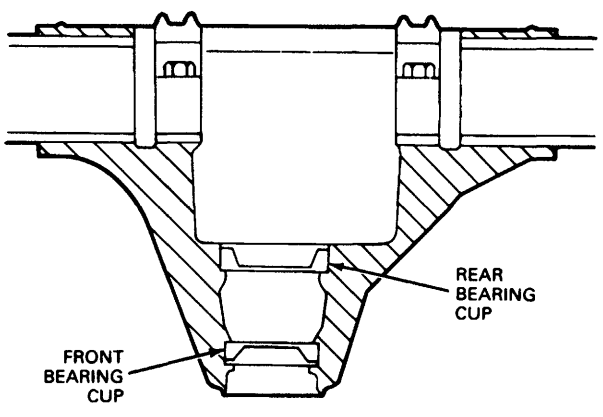
REMOVAL AND INSTALLATION (Continued)

12. Remove oil slinger and front pinion bearing from axle housing.

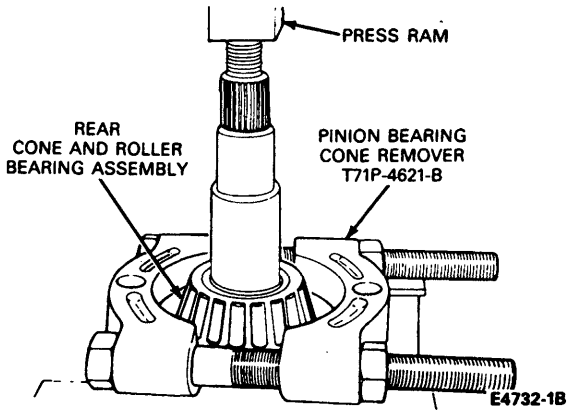


13. NOTE: Do not remove the pinion bearing cups from the carrier casting unless the cups are damaged.

    If the pinion bearing cups are to be replaced, tap alternately (with a brass drift of suitable length) on the opposite side of the cups during removal to prevent cups from cocking in the casting.



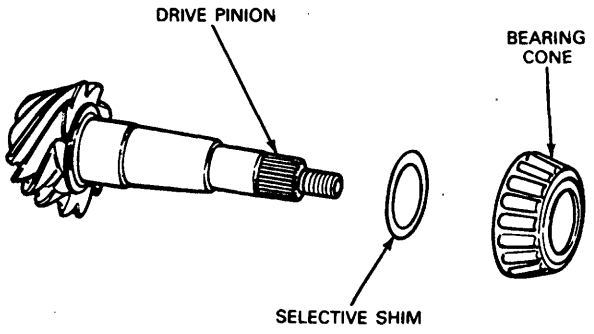
14. To remove the pinion rear cone and roller bearing assembly, use the Pinion Bearing Cone Remover, T71P-4621-B or equivalent as shown.



15. Remove the selective shim from the drive pinion.

NOTE: Measure the shim, which is found under the bearing cone, with a micrometer and record the thickness (as a reference to be compared to the shim gauge reading prior to installing the bearing).

16. For differential case disassembly procedures, refer to Differential Case—Disassembly and Assembly in this Section.



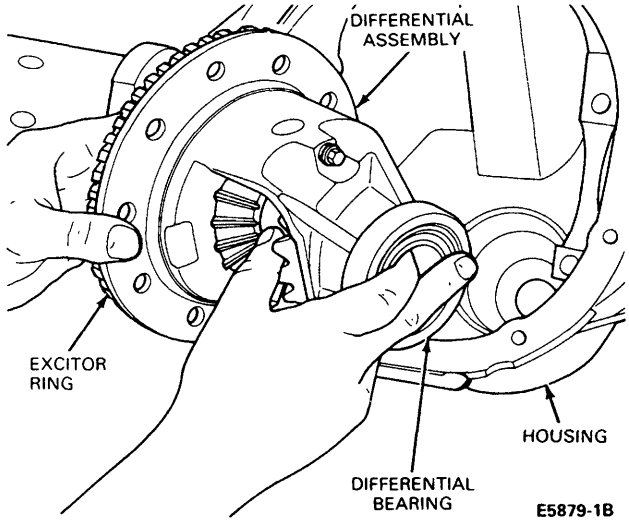
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REMOVAL AND INSTALLATION (Continued)

Differential Runout Check

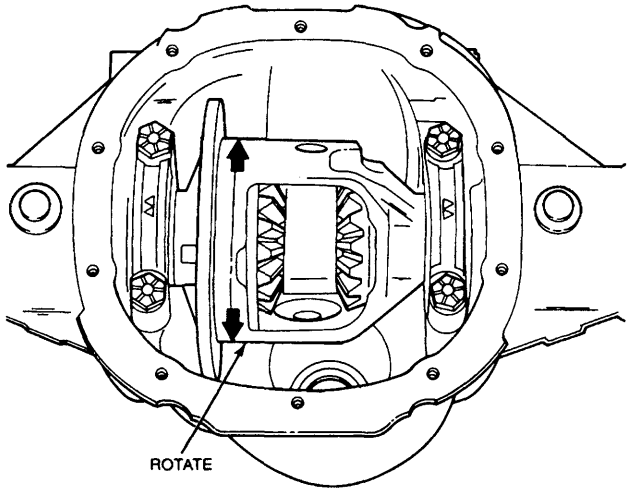
If the ring gear runout check (before disassembly) exceeds specification, the condition may be caused by a warped ring gear, a damaged case, excessively worn differential bearings or foreign material between mating surfaces (burrs, shavings, etc.). To determine the cause of excessive runout, proceed as follows:

1. Remove the differential case from the axle housing (refer to Differential case and Drive Pinion Removal in this Section) and remove the bolts that attach the ring gear to the differential case. Remove the ring gear from the case with a hammer and a drift.
2. Install the differential assembly including the bearing cups and shims in the axle housing. Tighten the bearing cap bolts to 109-128 N·m (80-95 ft-lbs).



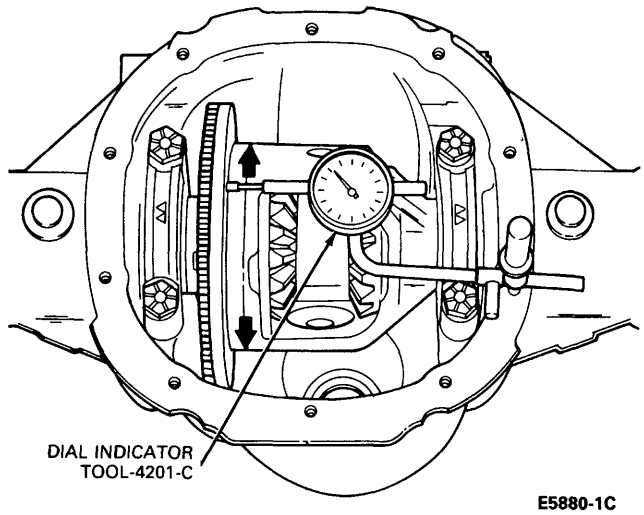
E5879-1B

3. Rotate assembly to insure proper seating of differential bearings.



E4740-1A

4. Check the runout of the differential case flange with a dial indicator D78P-4201-B or equivalent. If the runout is within specification, (Max. 0.003 inch), install a new ring and pinion gear. If the runout exceeds specification, the ring gear is true and the trouble is due to either a damaged case or bearings. Visually inspect the bearings. If bearings are not damaged, replace both the case and bearings. Recheck the runout with new parts (case and bearings).

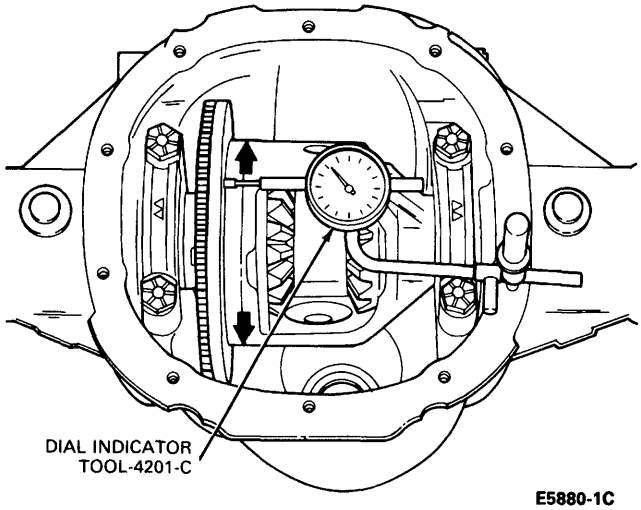


E5880-1C

5. Install new differential bearings on the case hubs using Replacer Tool, D81T-4221-A or equivalent and install the differential assembly in the carrier without the ring gear.

NOTE: Press against the bearing cone only.

6. Check the case runout again with the new bearings. If the runout is now within limits, use the new bearings for assembly. If the runout is still excessive, the case is damaged and should be replaced.



E5880-1C

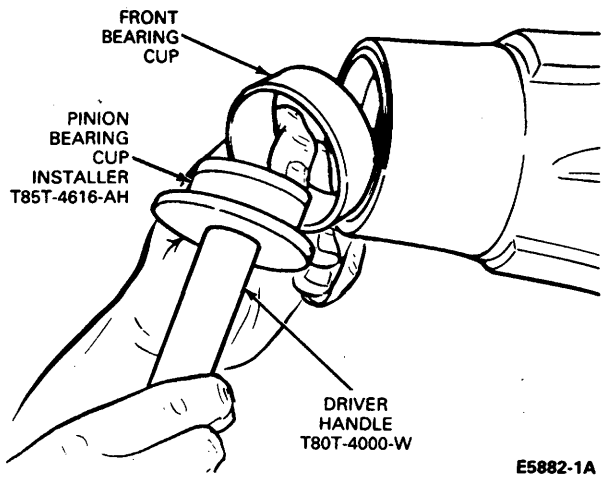
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REMOVAL AND INSTALLATION (Continued)

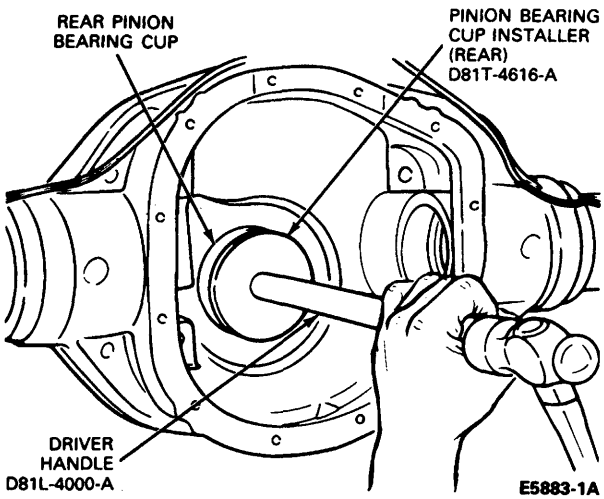
Front and Rear Pinion Bearing Cups

Installation

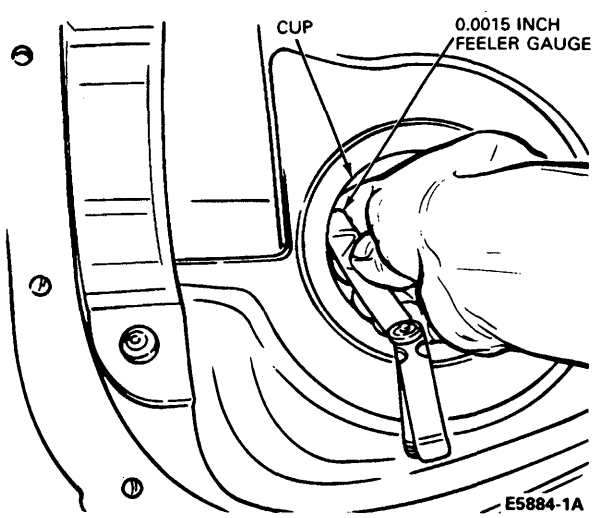
1. Drive the front pinion bearing cup into the housing using Pinion Bearing Cup Installer (Front), T85T-4616-AH and Driver Handle, T80T-4000-W.



2. Drive the rear pinion bearing cup into the housing using Pinion Bearing Cup Installer (Rear), D81T-4616-A and Driver Handle, D81L-4000-A.



3. Make sure the cups are properly seated in their bores. If a 0.038mm (0.0015 inch) feeler gauge can be inserted between a cup and the bottom of its bore at any point around the cup, the cup is not properly seated. Whenever the cups are replaced, the cone and roller assembly should also be replaced.



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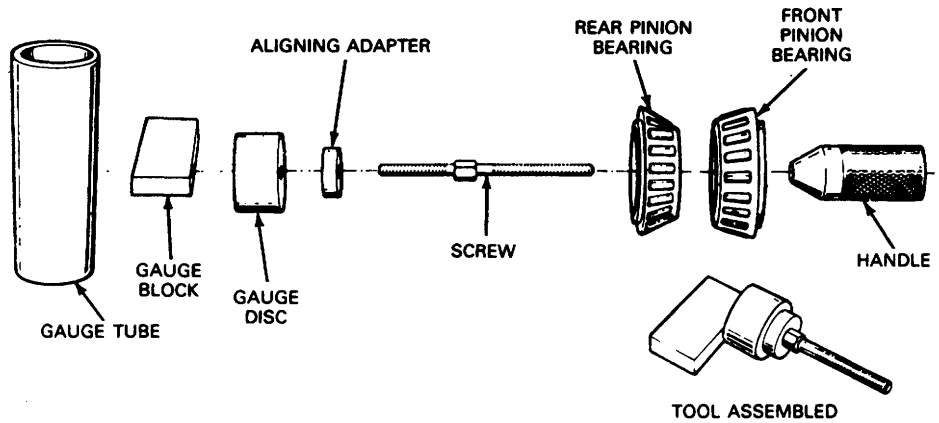
REMOVAL AND INSTALLATION (Continued)

Drive Pinion Shim Selection

1. Individual differences in machining the carrier casting and the gear set and variation in bearing widths require a shim between the pinion rear bearing and pinion head, in order to locate the pinion for correct tooth contact with the ring gear.

   When replacing a ring and pinion gear, the correct shim thickness for the new gear set to be installed is determined by the following procedure using the tools listed below.

2. Assemble the appropriate aligning adapter, gauge disc and gauge block to the screw.



REAR AXLE PINION DEPTH GAUGE TOOL

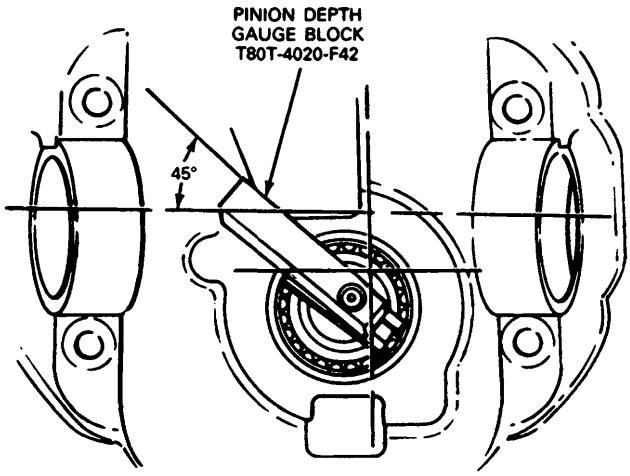
Tool Number*	Description
T85T-4020-AH1	Aligning Adapter
T80T-4020-F43	Screw
T80T-4020-F42	Gauge Block
T76P-4020-A11	Handle
T85T-4020-AH2	Gauge Disc
D81T-4020-F51	Gauge Tube

*The Tool numbers shown in column are part of Tool kit T79P-4020-A.

E5885-2A

3. Place the rear pinion bearing (new, or used if in good condition) over the aligning tool and insert it into the rear pinion bearing cup of the carrier. Place the front bearing into the front bearing cup and assemble the tool handle into the screw. Roll the assembly back and forth a few times to seat the bearings while tightening the tool handle by hand. Tighten the tool handle to 27 N·m (20 ft-lbs).

NOTE: The gauge block must be off-set (45°) to obtain an accurate reading.



E5886-1A

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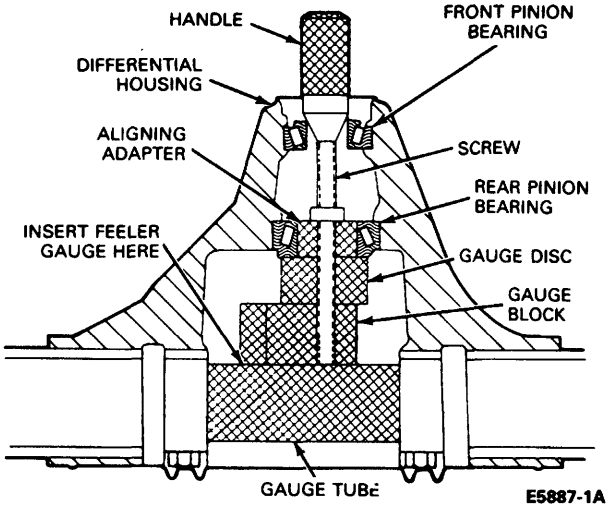
REMOVAL AND INSTALLATION (Continued)

4. Center the gauge tube into the differential bearing bore. Install the bearing caps and tighten the bolts to 95-115 N·m (70-85 ft-lbs). (Caps are to be installed with the triangles pointing outboard.)

Utilize Pinion Shims as the gauge for shim selection. This will minimize errors in attempting to stack feeler gauge stock together or simple addition errors in calculating correct shim thickness.

NOTE: Shims must be flat. Do not use dirty, bent, nicked or mutilated shims as a gauge.

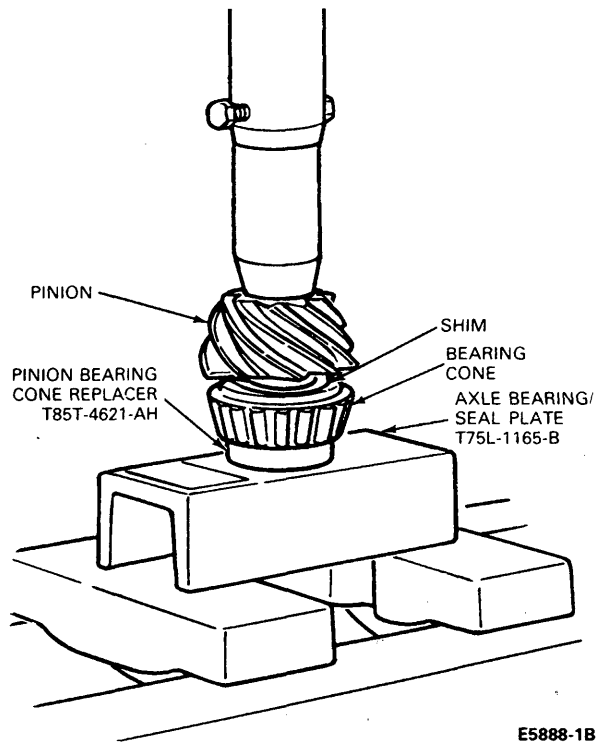
It is important to feel a slight drag on the shim for correct selection. Do not attempt to force the shim between the gauge block and the gauge tube. This will minimize selection of a shim thicker than required which results in a deep tooth contact in final assembly of integral axles.



5. Place the selected shim(s) on the pinion and press the pinion bearing cone and roller assembly until it is firmly seated on the shaft using Pinion Bearing Cone Replacer, T85T-4621-AH and Axle Bearing/Seal Plate, T75L-1165-B.

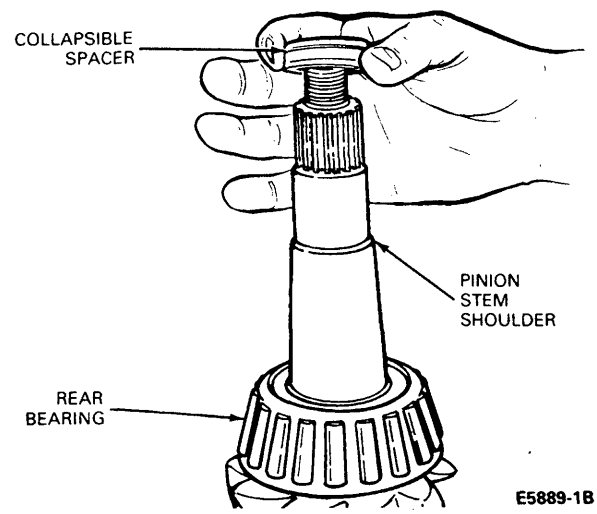
NOTE: The same rear pinion bearing used in this procedure must be used in final assembly of the axle.

NOTE: Be sure that press load is not applied to the bearing cage.



6. Check splines on the pinion stem to be sure they are free of burrs. If burrs are evident, remove them by using a fine crocus cloth, working in a rotational motion. Wipe the pinion clean.

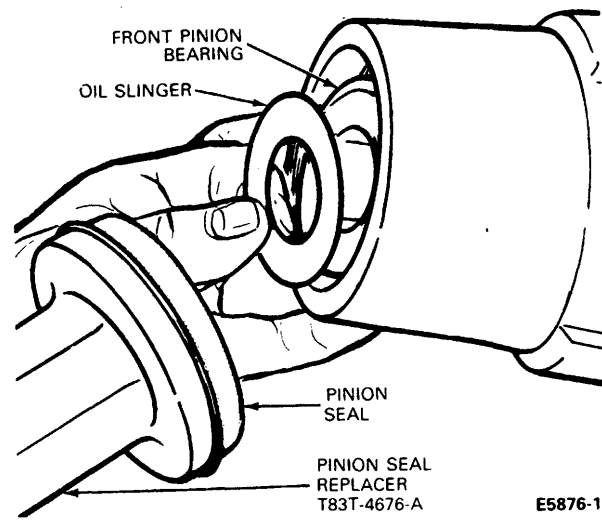
7. Place the collapsible spacer on the pinion stem against the pinion stem shoulder.



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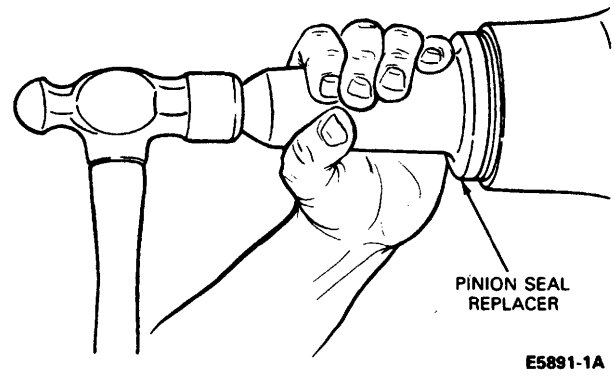
REMOVAL AND INSTALLATION (Continued)

8. Install the front pinion bearing and oil slinger in the housing bore and install the pinion seal on the Pinion Seal Replacer, T83T-4676-A.



9. Clean the oil seal seat surface. Install the seal in the housing bore using Pinion Seal Replacer, T83T-4676-A. Coat the lips of the seal with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.

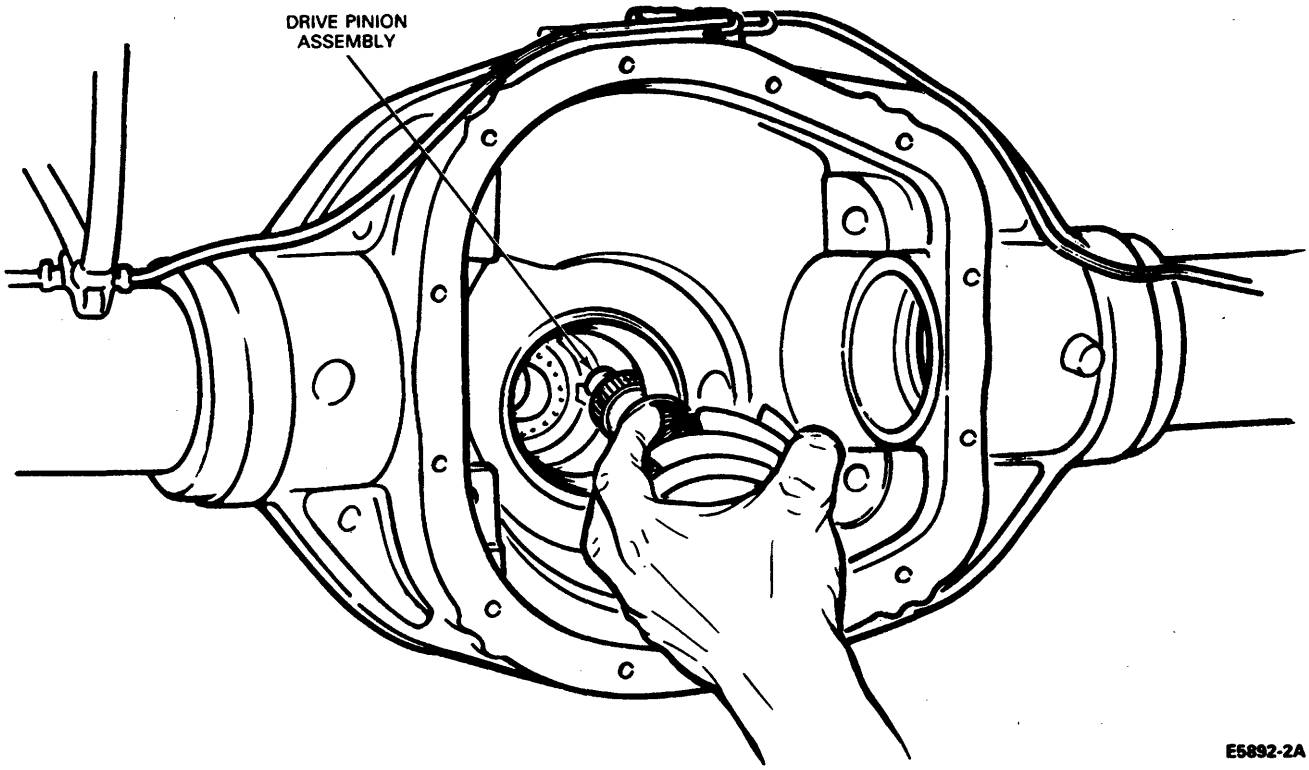
CAUTION: Installation without the proper tool may result in early seal failure. If seal becomes cocked during installation, remove it and install new one.



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REMOVAL AND INSTALLATION (Continued)

10. From the rear of the axle housing, install the drive pinion assembly (drive pinion, shim(s), rear bearing cone and roller, and collapsible spacer) into the housing pinion shaft bore.



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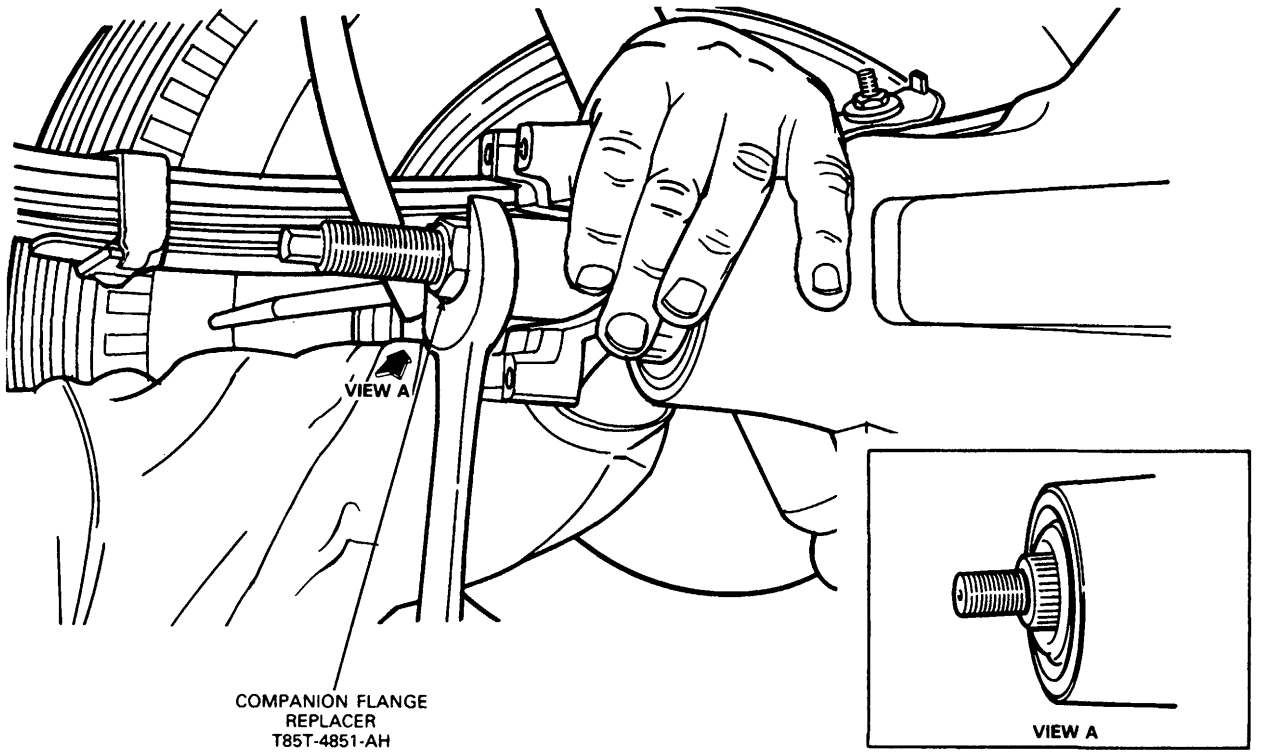
REMOVAL AND INSTALLATION (Continued)

11. Apply a small amount of lubricant to the companion flange shaft splines. Align the mark on the companion flange with the mark on the pinion stem.

    With the drive pinion in place in the housing, install companion flange using Companion Flange Replacer, T85T-4851-AH or equivalent.

NOTE: If a new companion flange is being installed, disregard the scribe mark on the pinion stem.

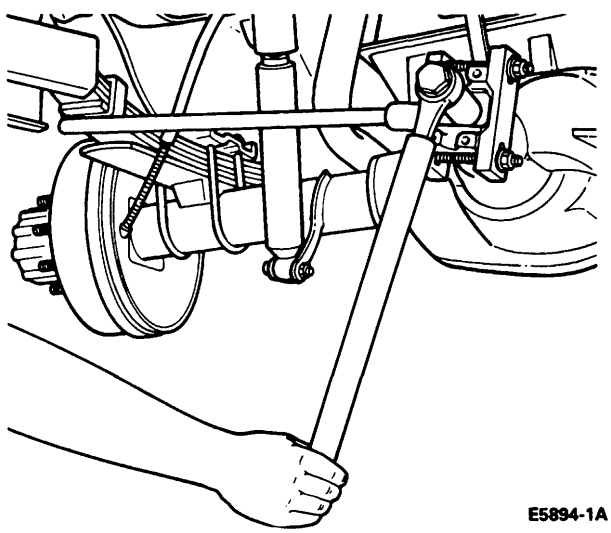
NOTE: The companion flange must never be hammered on or installed with power tools.



E5893-2A

12. Hold the companion flange with Companion Flange Holding Tool, T57T-4851-B or equivalent while tightening the nut.

Tighten the pinion nut (minimum torque of 217 N·m or 160 ft-lbs), rotating the pinion occasionally to insure proper bearing seating. Take frequent pinion bearing torque preload readings until the original recorded preload reading is obtained by rotating the pinion with an inch pound torque wrench.



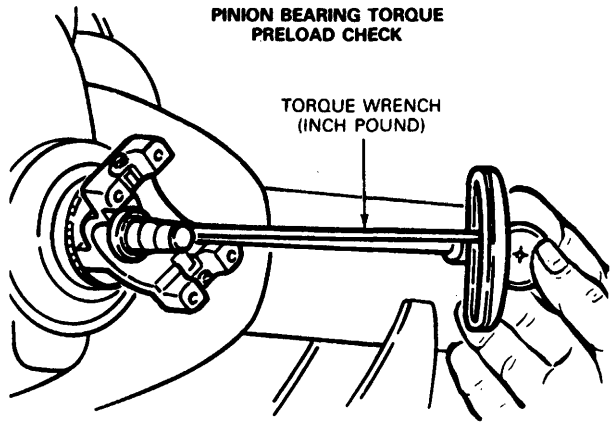
E5894-1A

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REMOVAL AND INSTALLATION (Continued)

If the original recorded preload is lower than specification (original bearings .9-1.5 N·m [8-14 in-lbs]; new bearings 1.8-3.3 N·m [16-29 in-lbs]), tighten to specification. If the preload is higher than specification, tighten to original reading as recorded.

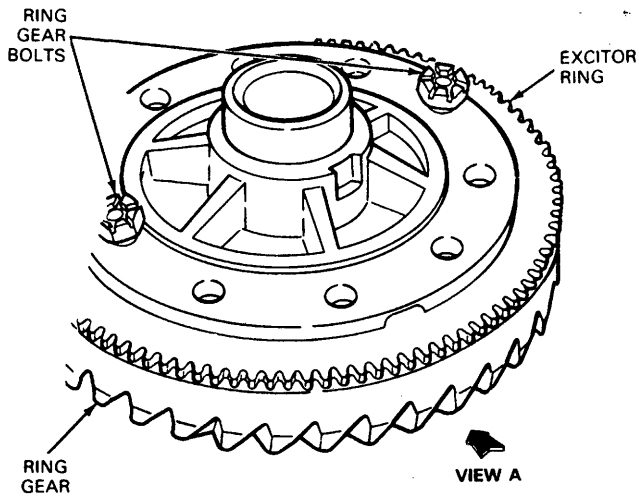
Under no circumstances should the pinion nut be backed off to reduce preload. If reduced preload is required, a new collapsible pinion spacer and pinion nut must be installed.

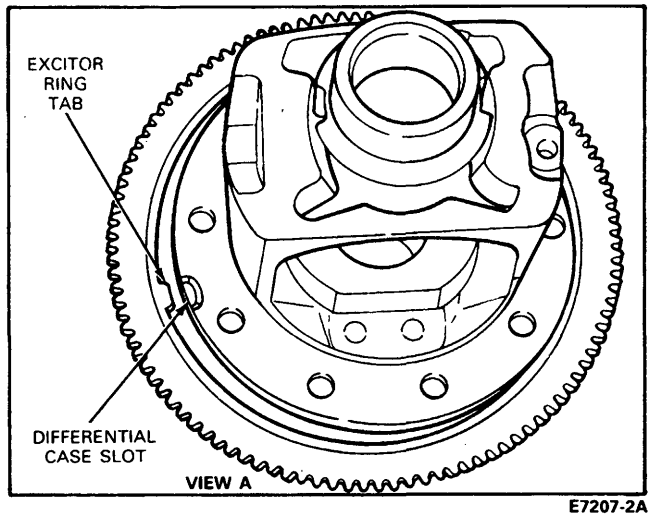


E5895-1A

13. Align tab in excitor ring with slot in differential case. Start two ring gear bolts through the case into the ring gear to ensure case to ring gear bolt hole alignment.

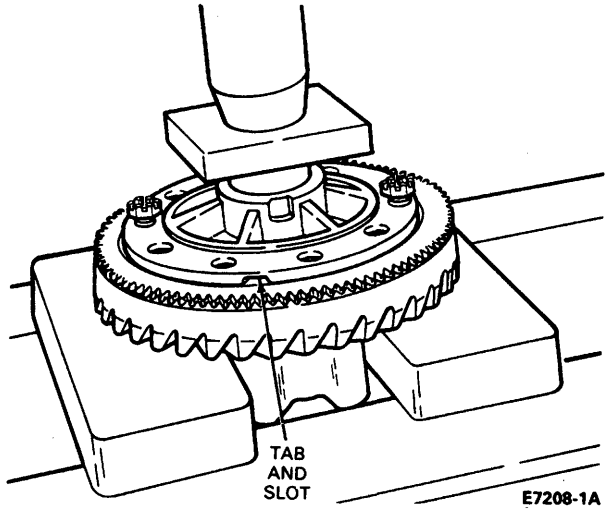
CAUTION: Tab on excitor ring must be aligned with slot in differential case.





E7207-2A

14. Press the excitor ring and ring gear on the differential case. The ring gear acts as a pilot for the excitor ring. Apply Loctite E0AZ-19554-B or equivalent to ring gear bolts and tighten to 135-162 N·m (100-120 ft-lbs).

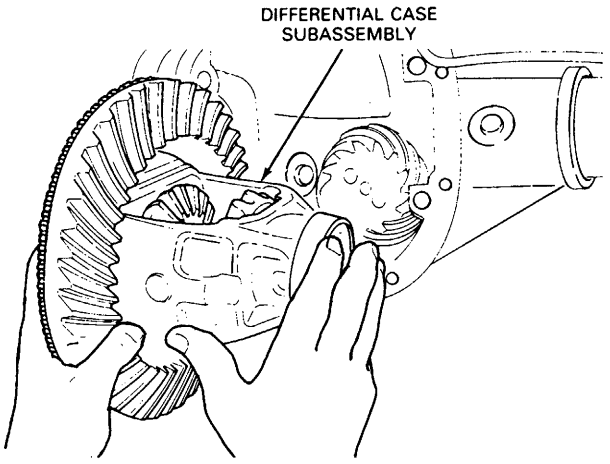


E7208-1A

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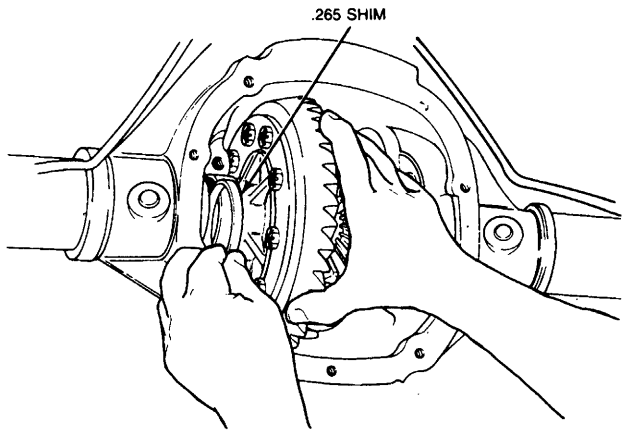
REMOVAL AND INSTALLATION (Continued)

15. With pinion depth set and pinion installed, place differential case subassembly (with ring gear, excitor ring, thrust washers, side gears, bearings and cups) in carrier.



E4749-1B

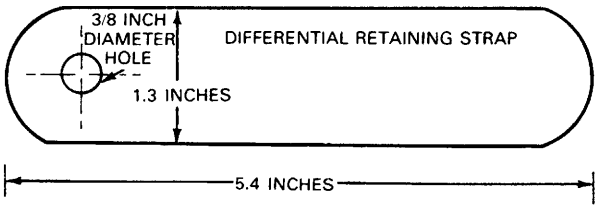
16. Install a 0.265 inch shim on left side.



E4750-1A

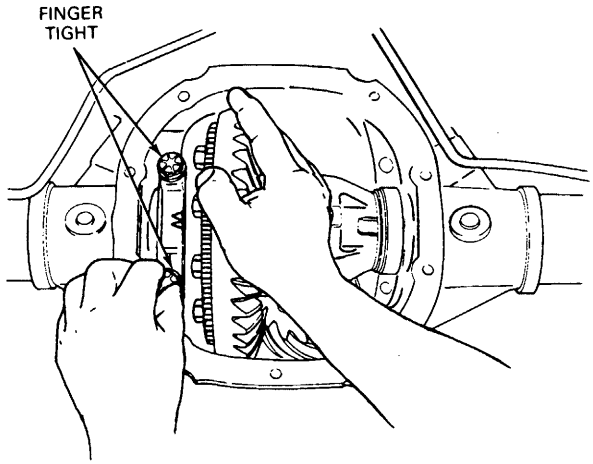
NOTE: To simplify installation, fabricate two differential case retaining straps from metal stock as shown. These retaining straps will prevent the differential from falling out of the housing.

Attach the straps at the 11 o'clock and 1 o'clock positions in the cover bolt holes. Install bolts and rotate straps to contact the bearing cups. Make sure access is available for shim installation.



E5896-1A

17. Install left bearing cap and tighten bolts finger tight.



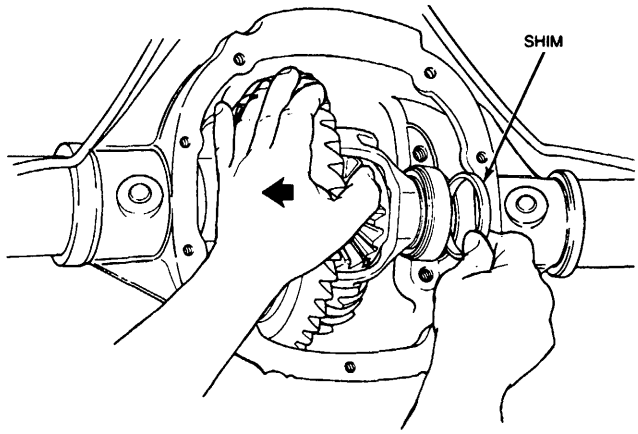
E4751-1B

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REMOVAL AND INSTALLATION (Continued)

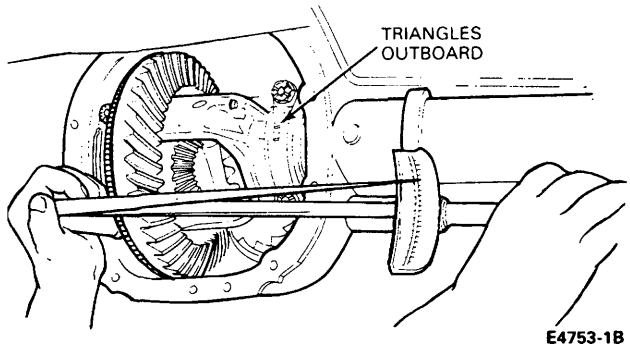
18. Install progressively larger shims on the right side until the largest shim selected can be installed by hand.

NOTE: Apply pressure towards left side to insure that the left bearing cup is seated.



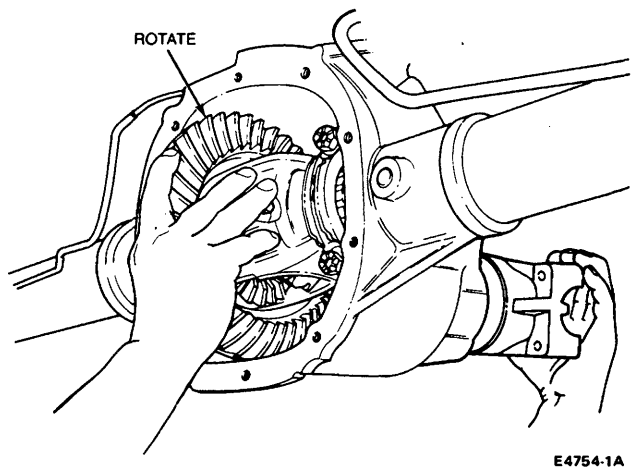
E4752-1A

19. Install right side bearing cap and tighten bearing cap bolts to 95-115 N·m (70-85 ft-lbs).



E4753-1B

20. Rotate assembly to insure free rotation.



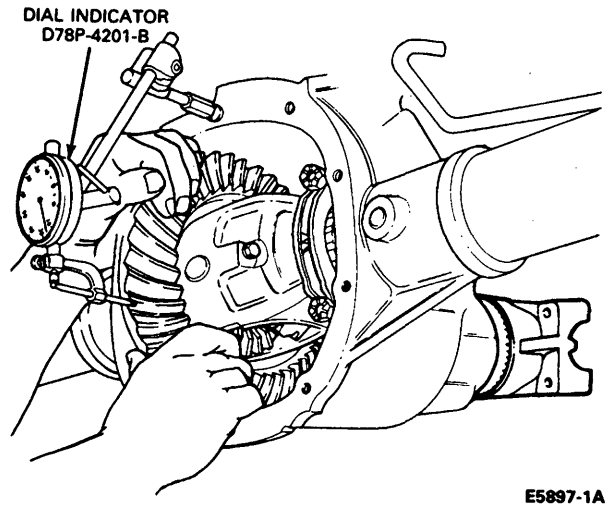
E4754-1A

21. Check ring gear and pinion backlash with a Dial Indicator, D78P-4201-B.

If the backlash is 0.008-0.015 inch (0.012-0.015 inch preferred), proceed to Step 27.

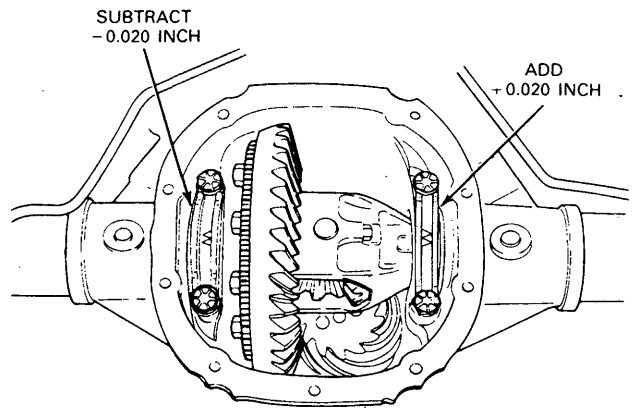
If the backlash is zero, proceed to Step 21.

If the backlash is 0.001-0.007 inch or greater than 0.015 inch, proceed to Step 23.



E5897-1A

22. If a zero backlash condition occurs, add 0.020 inch to the right side and subtract 0.020 inch from the left side.



E4756-1A

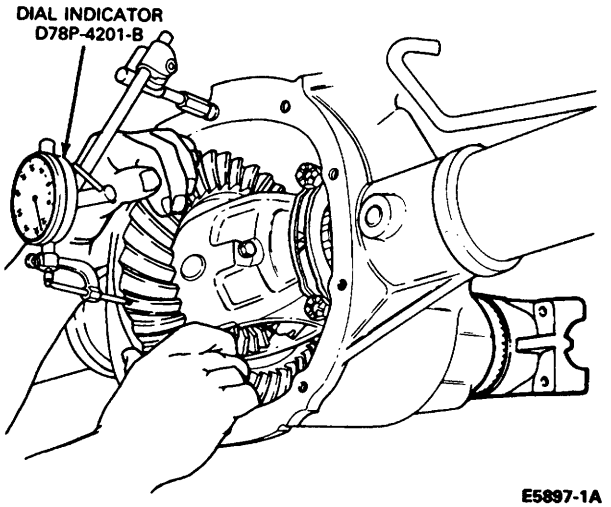
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REMOVAL AND INSTALLATION (Continued)

23. Recheck backlash.

    If backlash is within specification, go to Step 28.

    If backlash is not within specification, proceed to Step 24.

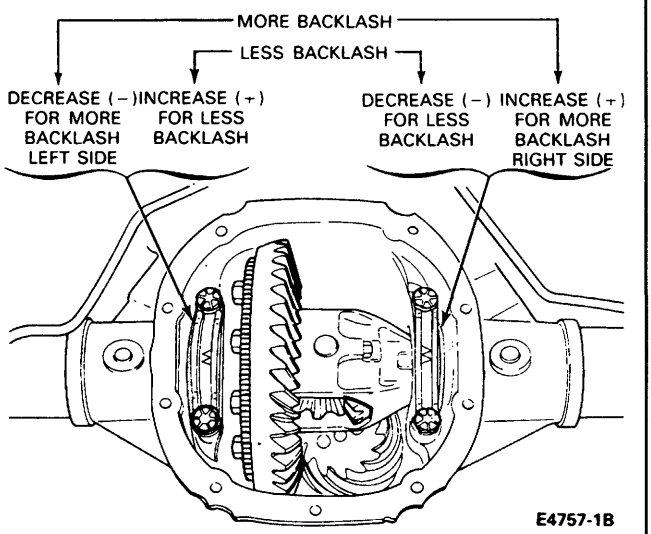


E5897-1A

24. If backlash is 0.001-0.007 inch, or greater than 0.015 inch, correct backlash by increasing thickness of one shim and decreasing thickness of the other shim by the same amount. Refer to chart for approximate shim change.

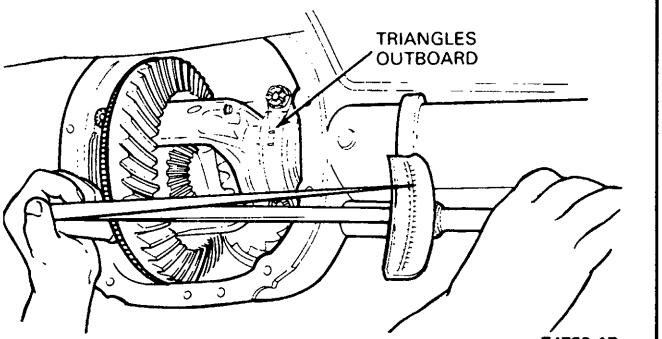
Backlash Change Required	Thickness Change Required	Backlash Change Required	Thickness Change Required
.001	.002	.009	.012
.002	.002	.010	.014
.003	.004	.011	.014
.004	.006	.012	.016
.005	.006	.013	.018
.006	.008	.014	.018
.007	.010	.015	.020
.008	.010		

CE5113-1A



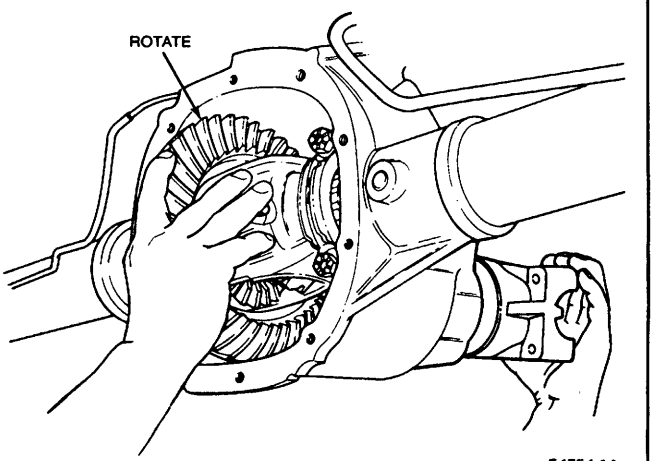
E4757-1B

25. Install shim and bearing caps. Tighten cap bolts to 109-128 N·m (80-95 ft-lbs).



E4753-1B

26. Rotate assembly several times to insure proper seating of differential bearings.



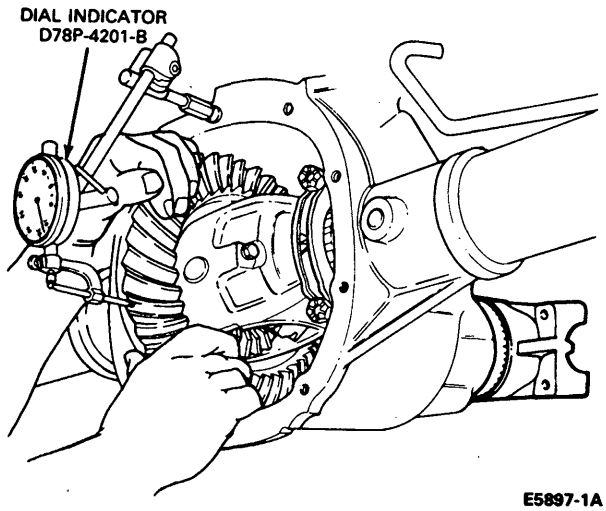
E4754-1A

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REMOVAL AND INSTALLATION (Continued)

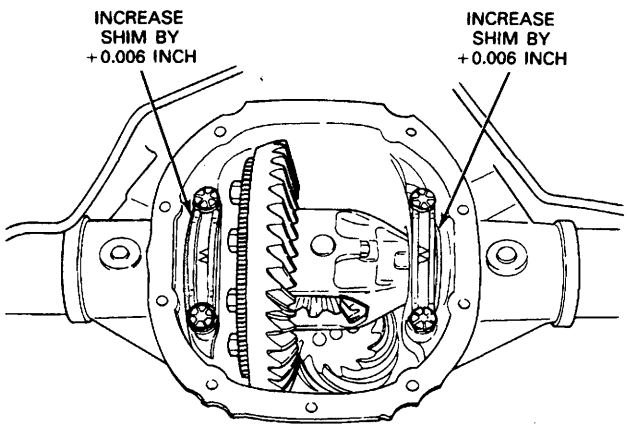
27. Recheck backlash. If backlash is within specification, go to Step 28. If backlash is not within specification, repeat Step 24.

    Backlash Specification: 0.008 inch to 0.015 inch. Preferred range: 0.012 inch to 0.015 inch.



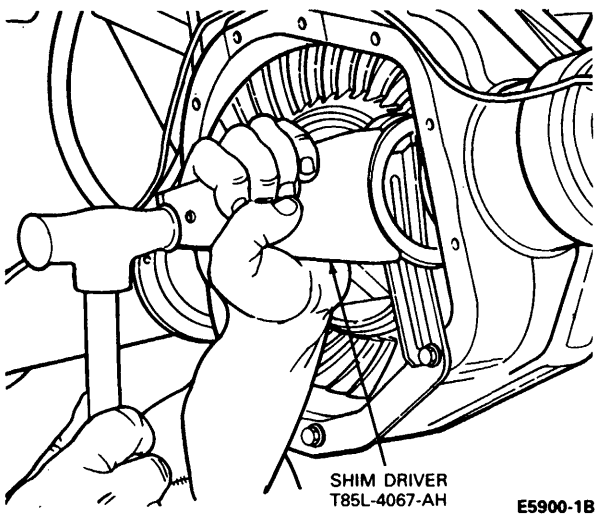
E5897-1A

28. Remove bearing caps and bolts. To establish differential bearing preload, increase both left and right shim sizes by 0.006 inch. Make sure shims are fully seated and assembly turns freely.



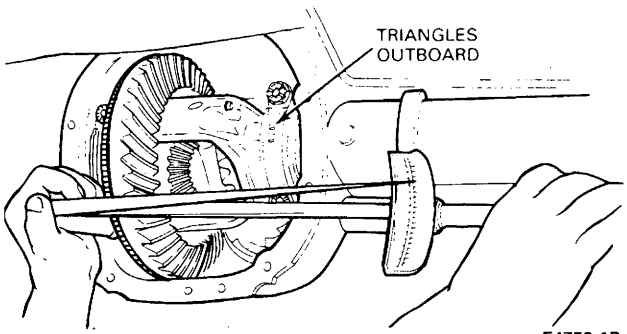
E4758-1D

    Install the shims by driving into position with Shim Driver, T85T-4067-AH.



E5900-1B

29. Install bearing caps and tighten cap bolts to 109-128 N·m (80-95 ft-lbs). Recheck backlash. If not to specification, repeat Step 20.



E4753-1B

30. Install the driveshaft in the extension housing. Align the scribe marks on the axle companion flange and driveshaft and connect the driveshaft.

    Tighten attaching bolts and nuts to 11-20 N·m (8-15 ft-lbs).

31. Install the axle shafts and axle housing cover as described under Axle Shafts in the Removal and Installation portion of this Section.

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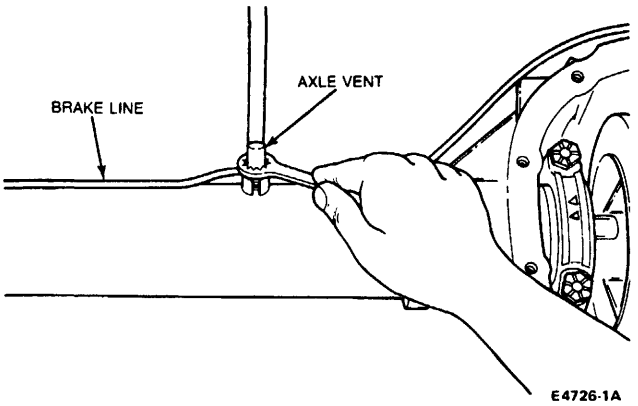
REMOVAL AND INSTALLATION (Continued)

Axle Housing

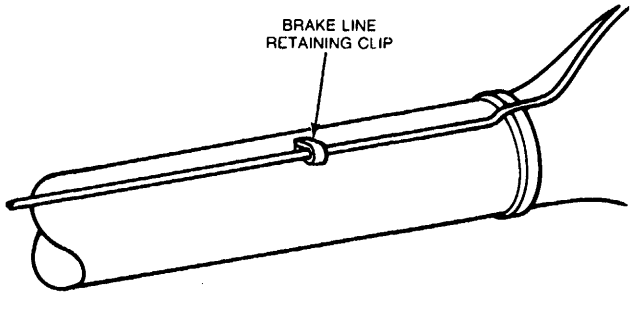
Removal

1. Raise the vehicle and install safety stands. Remove the rear wheels and tires and the brake drums.
2. Mark the driveshaft axle end flange and the axle companion flange to insure proper position of the driveshaft during assembly. Disconnect the driveshaft from the rear axle companion flange. Remove the driveshaft.
3. Remove axle shafts (semi-float axle) or hub (full-float axle).
4. Remove the four retaining nuts from each backing plate.
5. Disconnect the vent hose from the vent and the vent from the rear axle housing.

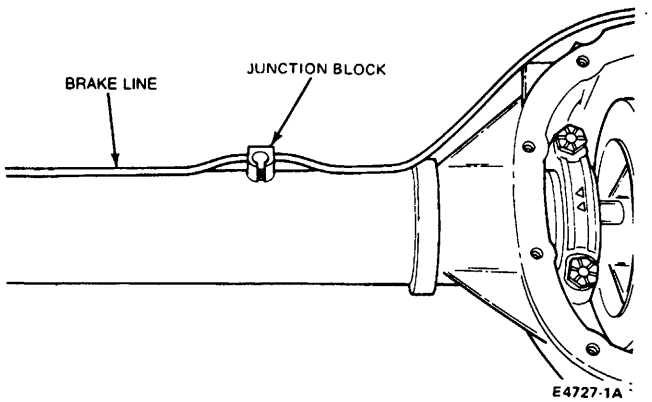
NOTE: The axle vent is secured to the housing assembly through the brake junction block.



6. Disengage the brake line from the clips that retain the line to the axle housing and carrier.



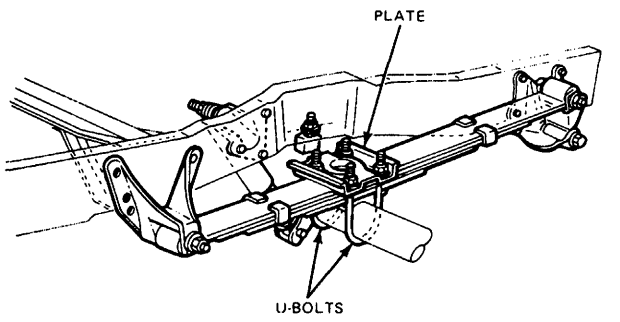
7. Remove the hydraulic brake junction block from the axle housing. **Do not open the hydraulic brake system lines.**

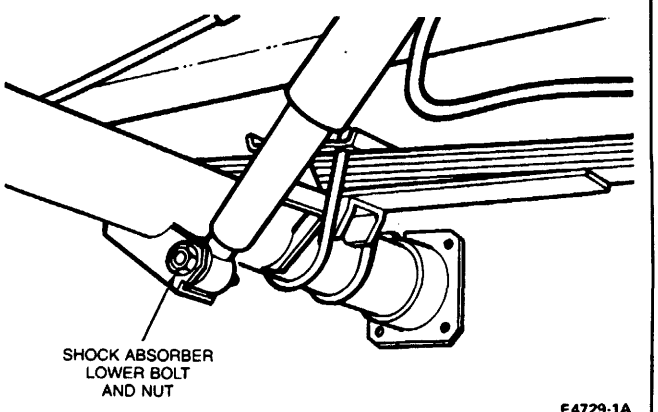


8. Support the rear axle housing on a jack, and then remove the U-bolt nuts. Remove the U-bolts and plates.

   Disconnect the shock absorber lower bolts from the mounting brackets on the axle housing.

   Remove the housing from the vehicle.



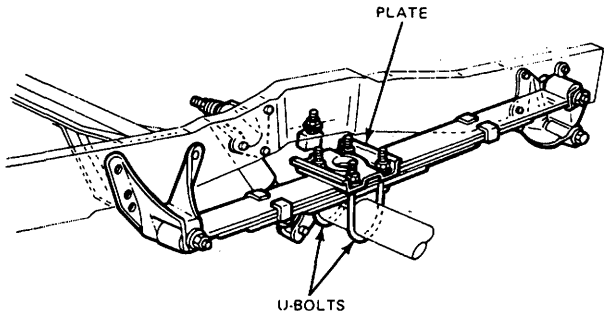


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REMOVAL AND INSTALLATION (Continued)

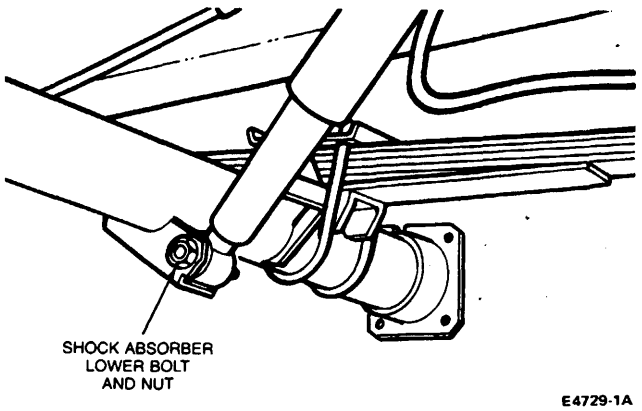
Installation

1. Raise the axle housing into position so that the U-bolt plates can be installed. Tighten the U-bolt nuts to the specification listed in Section 14-31, Rear Suspension—Leaf Springs. (There are different specifications, depending on the vehicle.)



E4730-1A

2. Connect the shock absorber lower bolts to the mounting bracket on the axle housing. Install the attaching nuts and tighten to the specification listed in Section 14-31, Rear Suspension—Leaf Springs.



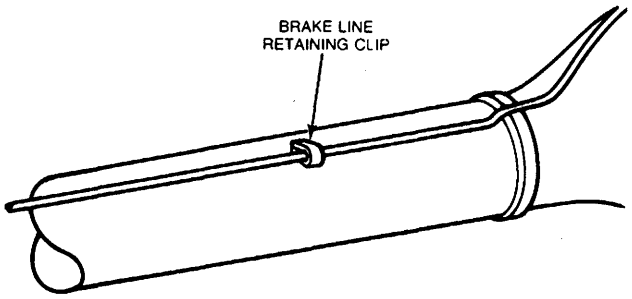
E4729-1A

3. Insert the vent fitting into the hydraulic junction block and position the assembly over the housing vent hole. Hand start the vent fitting and tighten to 20 N·m (15 lbs-ft).

   Position the brake lines to the axle housing and secure with the retaining clips at the right hand axle tube and vent fitting through the junction block.

   Install the brake backing plates on the axle housing flanges (no gaskets required). Tighten the attaching bolts to 68-115 N·m (50-85 ft-lbs).

4. Align the scribe marks on the axle companion flange and driveshaft and connect the driveshaft. Tighten attaching bolts and nuts to 11-20 N·m (8-15 ft-lbs).
5. Install the brake drums.
6. Install the wheel and tire. Tighten the wheel lug nuts to specification. Install the wheel covers.



E4728-1A

Rear Antilock Brake System Sensor

Removal

1. Remove Sensor Hold Down Bolt. Remove sensor.
2. Clean axle mounting surface, using caution to prevent dirt from entering axle housing.

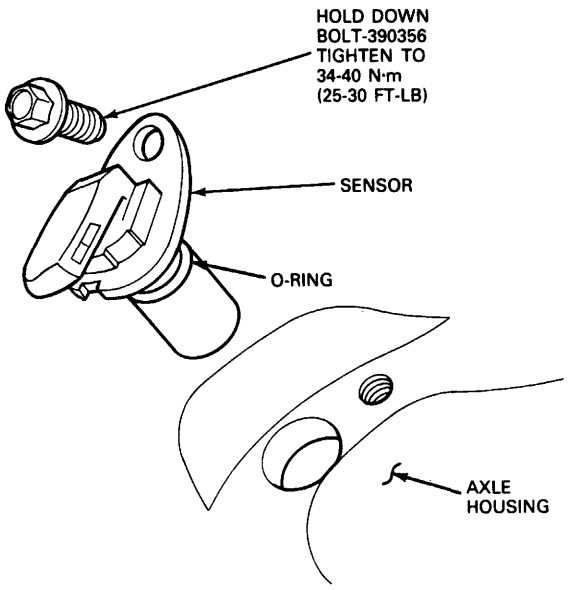
Installation

1. If new sensor is to be installed, lightly lubricate O-ring with motor oil.
   a. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.
   b. Install Hold Down Bolt and tighten to 34-40 N·m (25-30 ft-lb).
2. If old sensor is to be reinstalled, clean and blow off metal particles using shop air.
   a. Remove and replace O-ring with a new O-ring.
   b. Apply a light film of motor oil to O-ring.
   c. Firmly grasp sensor at sides (do not install by applying force on connector) and push into axle housing, aligning mounting flange hole with threaded hole in axle housing.

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REMOVAL AND INSTALLATION (Continued)

d. Install Hold Down Bolt and tighten to 34-40 N·m (25-30 ft-lb).

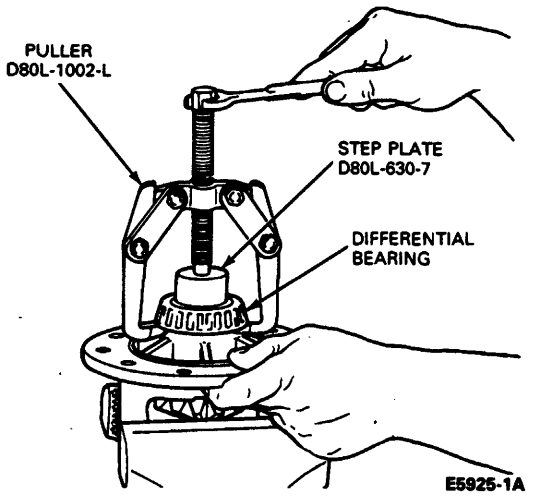


DISASSEMBLY AND ASSEMBLY

Differential Case

Disassembly

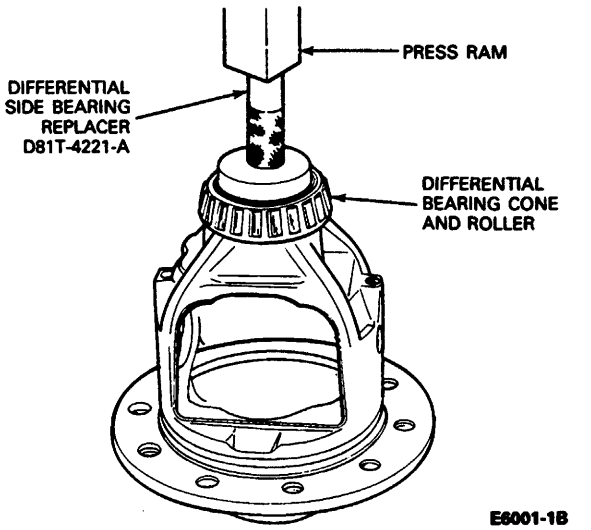
1. If required, remove the ring gear, excitor ring, side gears, pinion gears and thrust washers.
2. Remove the differential case from the housing and remove the differential bearings from the case using Puller, D80L-1002-L or equivalent.



Assembly

1. Install differential bearings on the case hubs using Differential Bearing Cone Replacer, D81T-4221-A.

NOTE: Press against the bearing cone only.



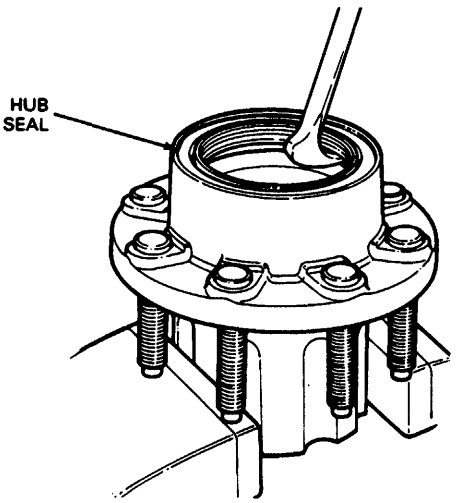
2. Press the ring gear and excitor ring onto the differential case, and install the attaching bolts. Tighten the bolts to 135-162 N·m (100-120 ft-lbs).

CAUTION: Before performing this Step, refer to ring gear/excitor ring installation procedures in this Section.

Hub—Full Floating Axle Only

Disassembly

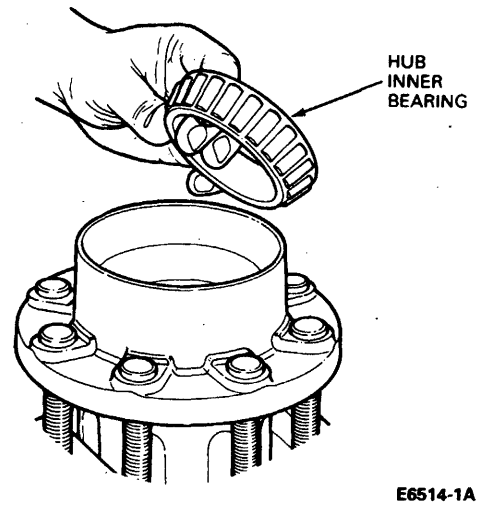
1. Install hub in soft jawed vise.
2. Remove hub seal.



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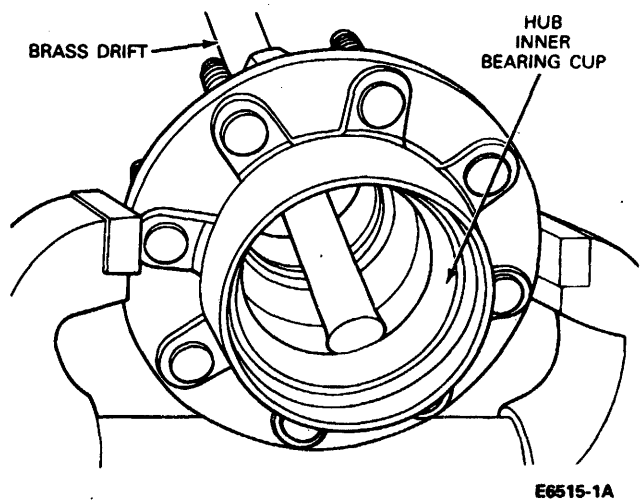
DISASSEMBLY AND ASSEMBLY (Continued)

3. Remove hub inner bearing.

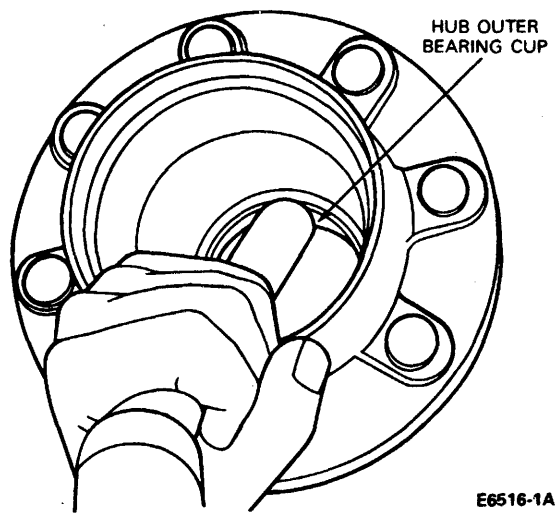


4. Re-position the hub in the vise and remove the hub inner bearing cup with a brass drift.

CAUTION: Make sure hub is secure in vise.



5. Re-position the hub in the vise and remove the hub outer bearing cup with a brass drift.



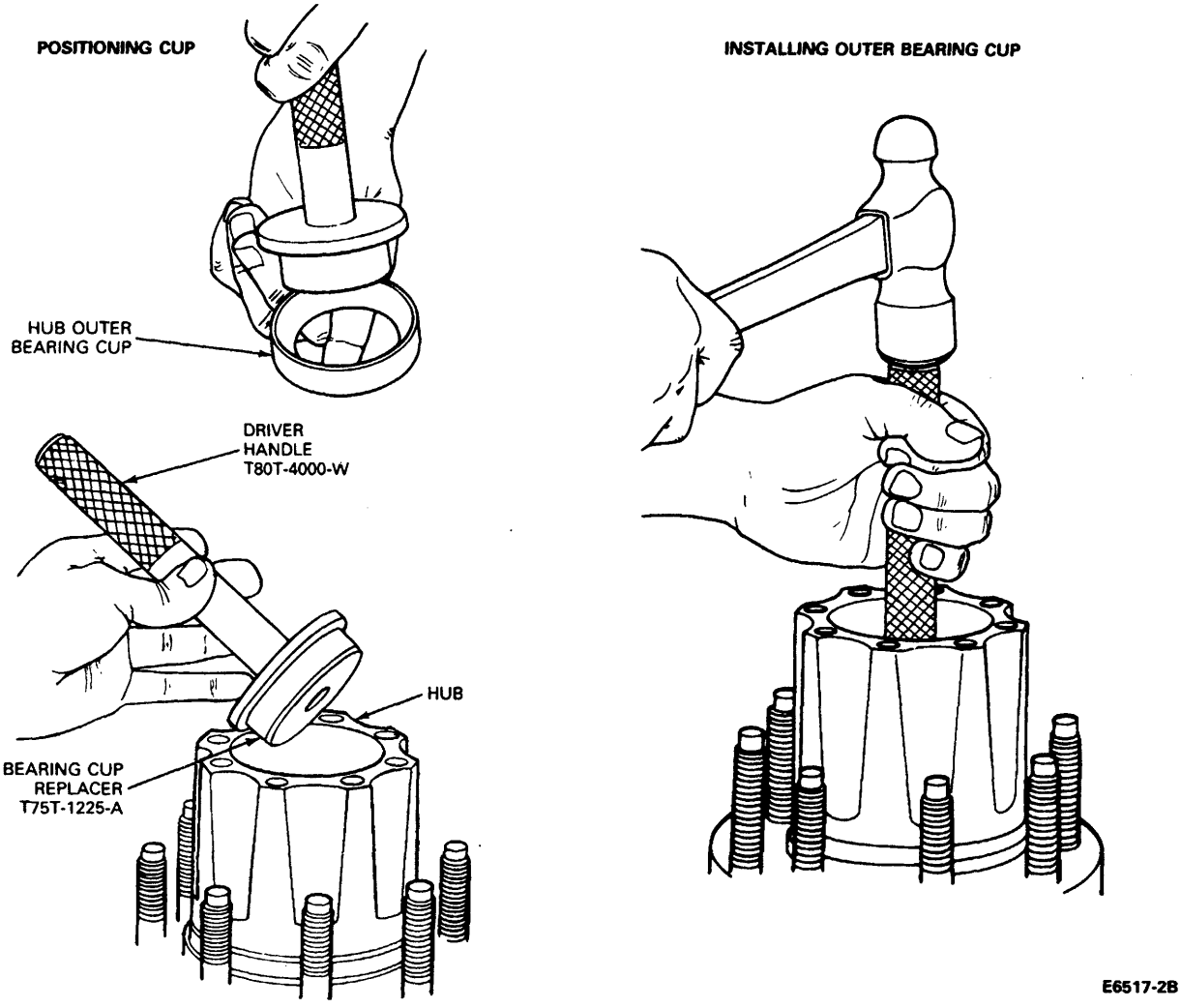
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DISASSEMBLY AND ASSEMBLY (Continued)

Assembly

1. Place the outer bearing cup in the hub.
2. Insert tool squarely into hub and strike handle until outer bearing cup is seated.

CAUTION: Bearing cup replacer must be held straight during installation to assure proper seating of bearing cup.

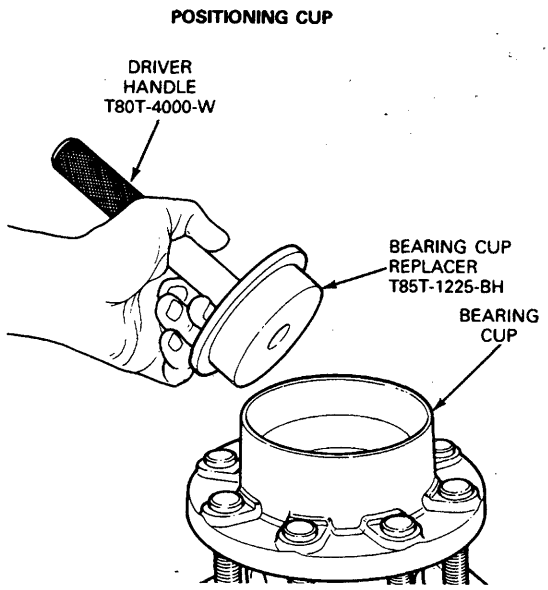


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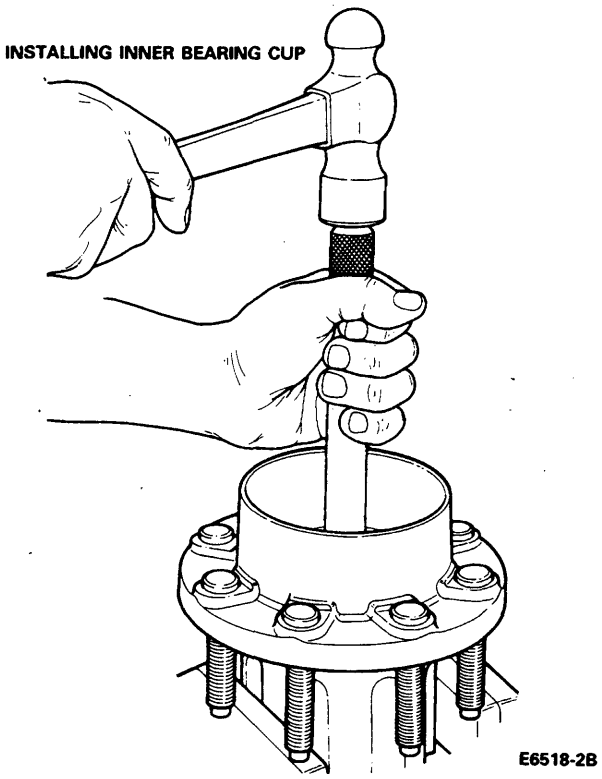
DISASSEMBLY AND ASSEMBLY (Continued)

3. Place the inner bearing cup in the hub.
4. Insert tool squarely into hub and strike handle until inner bearing cup is seated.

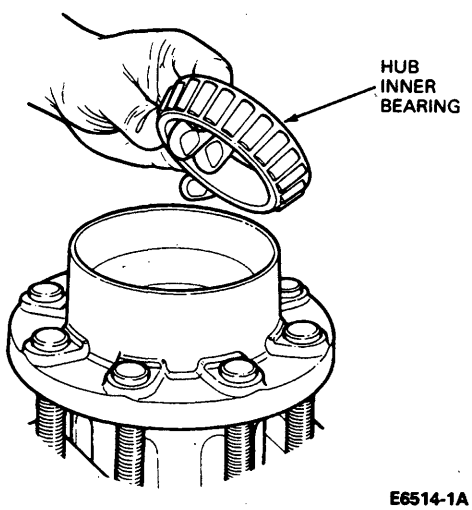
CAUTION: Bearing cup replacer must be held straight during installation to assure proper seating of bearing cup.



HUB **INNER** BEARING CUP INSTALLATION



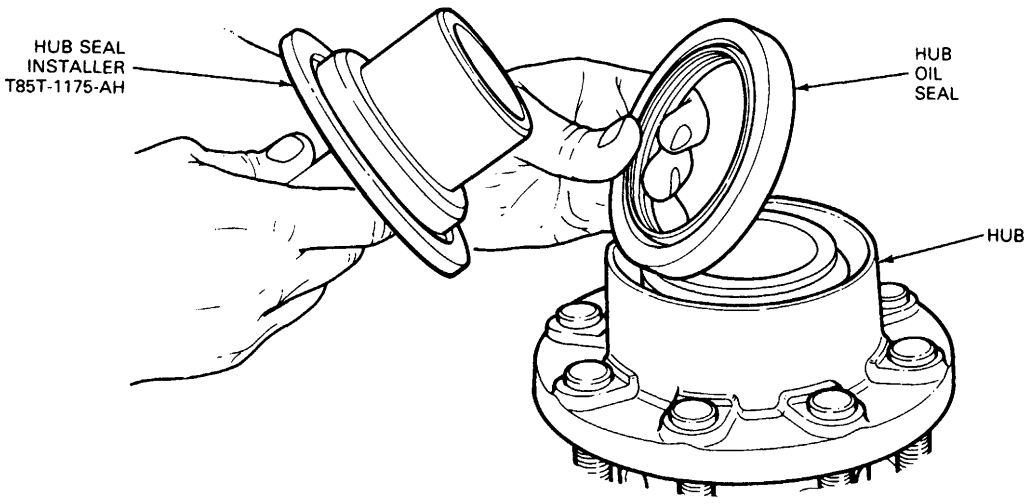
5. Place hub inner bearing in the cup.



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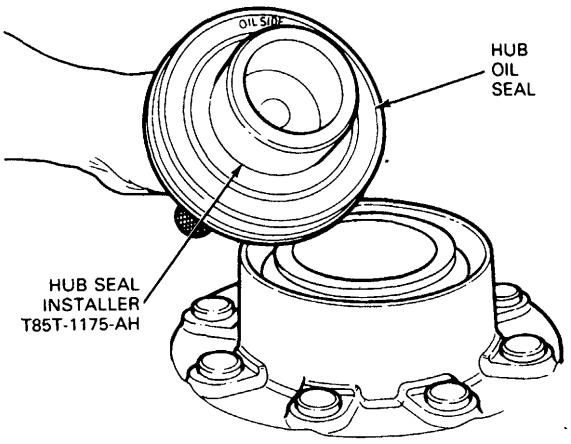
DISASSEMBLY AND ASSEMBLY (Continued)

6. Install hub oil seal on Hub Seal Installer Tool as shown in drawing.



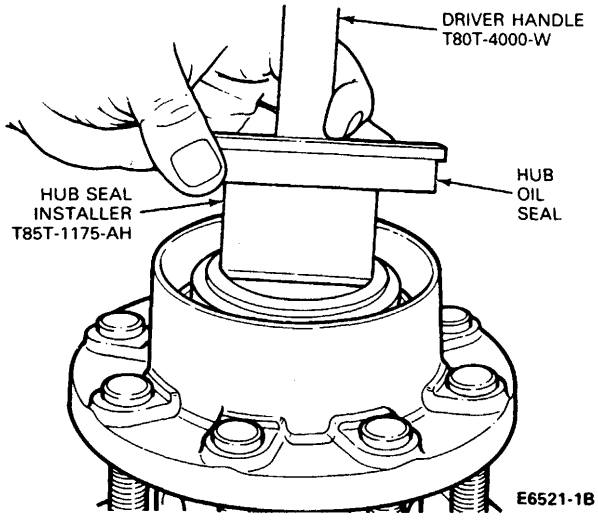
E6519-2B

CAUTION: It is mandatory that the words "oil side" appear as shown when hub oil seal is installed on Hub Seal Installer Tool T85T-1175-AH. "Oil side" must face toward hub inner bearing.



E6520-1B

7. Insert tool with seal squarely into hub.



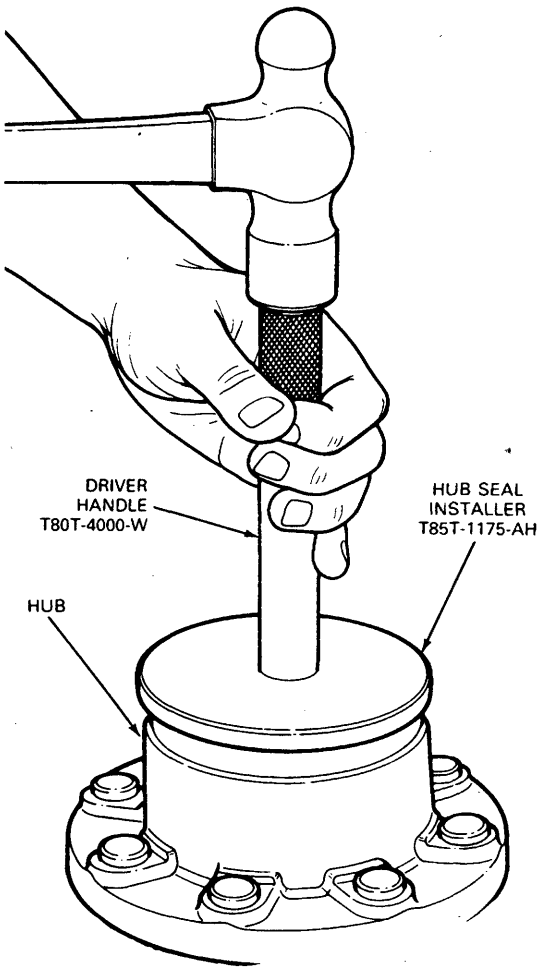
E6521-1B

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DISASSEMBLY AND ASSEMBLY (Continued)

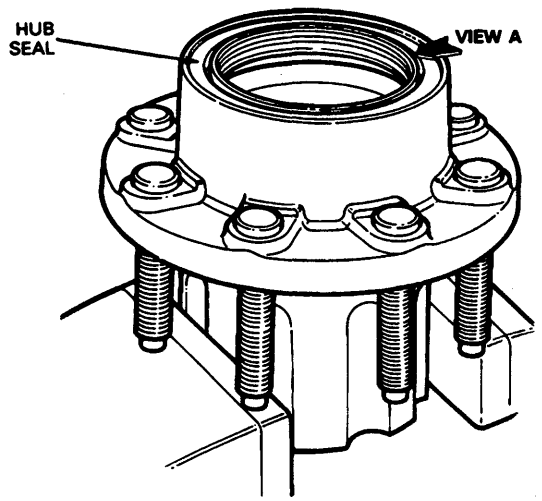
8. **Hold tool straight.** Strike handle until hub seal is fully seated (until tool strikes hub).

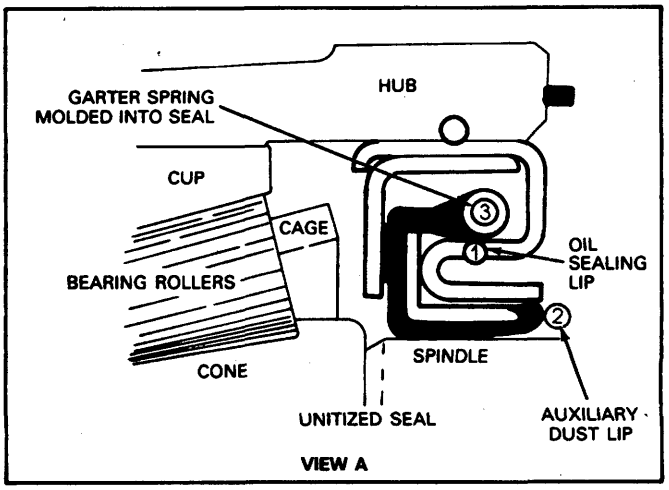
CAUTION: Install new seal if seal is misaligned during or after installation.



E6522-1B

Unitized wheel seals are standard items on full floating rear axles. The unitized wheel seal combines the function of a wear sleeve and the seal in one self-contained unit with the seal and sleeve surface inside. The unitized design provides maximum protection for the sealing surface during installation and operation.





E6523-2A

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SPECIFICATIONS

ADJUSTMENT TORQUE SPECIFICATIONS (INTEGRAL CARRIER)

Description	Torque (In-Lb) N-m	Torque (Ft-Lb) N-m
Minimum torque required to tighten pinion flange nut to obtain correct pinion bearing preload	—	(160)① 217
Pinion Bearing Preload — (Collapsible Spacer)		
Used Bearings	(8-14) 0.9-1.5	—
New Bearings —	(16-29) 1.8-3.3	—

①If pinion bearing preload exceeds specification before this torque is obtained, install a new collapsible spacer. **CE5904-1C**

TORQUE SPECIFICATIONS (INTEGRAL CARRIER)

Description	Torque N-m	Torque (Ft-Lb)
Differential Bearing Cap Bolt	109-129	80-95
Differential Pinion Shaft Lock Bolt①	20-40	15-30
Ring Gear Attaching Bolts①	135-162	100-120
Rear Cover Screw	34-47	25-35
Oil Filler Plug	20-40	15-30
Brake Backing Plate Nuts — E-250, F-250	68-95	50-70
Driveshaft to Axle Companion Flange	11-20	8-15
Axle Vent	20	15
Wheel Lug Nut (Both Single and Dual Rear Wheel)	190	140
RABS Sensor Bolt	34-40	26-30

①Using Loctite E0AZ-19554-B (or equivalent) **CE5905-1D**

DRIVING AXLE APPLICATION AND IDENTIFICATION FULL-FLOATING AXLES (INTEGRAL CARRIER)

"F" Series Truck — Full Float

Identification Tag	Ratio	Conventional Differential	Limited-Slip Differential	Single Rear Wheel	Dual Rear Wheel
125C	3.55:1	X		X	
126C	3.55:1	X		X	
127C	3L55:1		X	X	
128C	3L55:1		X	X	
129C	4.10:1	X		X	
130C	4.10:1	X		X	
131C	4L10:1		X	X	
132C	4L10:1		X	X	
163C	3.55:1	X		X	
166C	3.55:1	X			X
168C	4.10:1	X			X
169C	4L10:1		X		X
170C	4.10:1	X			X
171C	4L10:1		X		X

"F" Series Truck — Chassis Cab — Full Float

Identification Tag	Ratio	Conventional Differential	Limited-Slip Differential	Dual Rear Wheel
186C	3.55	X		X
190C	4.10:1	X		X
191C	4L10:1		X	X
183C	3.55:1	X		X
189C	4.10:1	X		X
192C	4.10:1		X	X

CE6526-2C

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SPECIFICATIONS (Continued)

SPECIAL SERVICE TOOLS

Tool Number	Description	Tool Number	Description
T50T-100-A	Impact slide Hammer	T80T-4020-F42	Pinion Depth Gauge Block
D80L-630-7	Step Plate	T80T-4020-F43	Pinion Depth Gauge Screw
D80L-1002-L	Puller	D81T-4020-F51	Pinion Depth Gauge Tube
D81L-1002-A	Puller	T85T-4067-AH	Shim Driver
T75L-1165-B	Axle Bearing/Seal Plate	D78P-4201-B	Dial Indicator
T75T-1225-A	Bearing Cup Replacer-Outer	T85T-4209-AH	Pinion Shaft Thread Protector
T85T-1175-AH	Hub Seal Installer	T57L-4221-A	Differential Side Bearing Replacer
T85T-1225-AH	Bearing Remover	D81T-4221-A	Differential Bearing Cone Replacer
T85T-1225-BH	Bearing Cup Replacer — Inner	T85T-4252-AH	Hub Wrench
D81L-4000-A	Driver Handle	D81T-4616-A	Pinion Bearing Cup Installer
T80T-4000-W	Driver Handle	T85T-4616-AH	Pinion Bearing Cup Installer
T80T-4000-X	Rear Axle Bearing Replacer	T71P-4621-B	Pinion Bearing Cone Remover
T80T-4000-Y	Rear Axle Shaft Seal Replacer	T85T-4621-AH	Pinion Bearing Cone Installer
T76P-4020-A11	Pinion Depth Gauge Handle	T83T-4676-A	Pinion Seal Replacer
T85T-4020-AH1	Aligning Adapter	T57T-4851-B	Companion Flange Holding Tool
T85T-4020-AH2	Gauge Disc	T85T-4851-AH	Companion Flange Replacer

CE5903-2B

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER)

Vehicle	Axle	Approximate Lubricant Capacity (In-Vehicle Repair)①②		
		U.S. Pints	Imperial Pints	Liters
F-250, F-350 Regular & Chassis CAB, F-250/350 H.D.	10-1/4 Inch Ring Gear	6.5③④	5.4	3.0

① All conventional Axles use Hypoid Gear Lubricant, E0AZ-19580-A (ESP-M2C154-A) or equivalent.
② For out-of-vehicle repair, use 7.5 U.S. Pints (6.2 imperial pints, 3.5 Liters)
③ Below bottom of filler hole with vehicle in running position.
④ Plus 8 oz. (U.S. measure) additive friction modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent for limited-slip applications. CE6524-2B

TORQUE SPECIFICATION — FULL FLOATING AXLE ONLY

Description	Torque	
	N·m	(Ft-Lbs)
Hub Nut	75-88①	55-65①
Wheel Lug Nut (both Single & Dual Rear Wheel)	190	140
Axle Shaft Bolts	82-108	60-80

①Before ratcheting back 5 notches. CE6525-1B

F-SERIES TRUCK — SEMI-FLOAT APPLICATION AND IDENTIFICATION

Identification Tag	Ratio	Conventional Differential	Limited-Slip Differential	Single Rear Wheel
106C	3.55:1	X	—	X
110C	4.10:1	X	—	X
107C	3.55:1	—	X	X
111C	4.10:1	—	X	X

CE5902-1D

CLEARANCE, TOLERANCE AND ADJUSTMENTS (INTEGRAL CARRIER)

Description	Inches
Maximum Runout of Back Face of Ring Gear	0.004
Maximum Runout of Back Face of Differential Case Flange	0.003
Differential Side Gear Thrust Washer Thickness	0.030-0.032
Differential Pinion Gear Thrust Washer Thickness	0.030-0.032
Nominal Pinion Locating Shim	0.030
Available Pinion Gear Shims in Steps of 0.001 Inch	0.021-0.037
Backlash Between Ring Gear & Pinion Teeth	0.008-0.015 (0.012-0.015 Preferred)
Maximum Backlash Variation Between Teeth	0.004
Maximum Radial Runout of Companion Flange in Assembly	0.012 T.I.R.
Sensor Pole to Top of Exciter Ring Gap	0.005-0.045

CE5118-1C

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SECTION 15-32 Front Driving Axle

SUBJECT	PAGE
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DESCRIPTION AND OPERATION	
Front-Wheel Drive Free-Running Hub	15-32-1
DIAGNOSIS AND TESTING	15-32-2
DISASSEMBLY AND ASSEMBLY	
Assembly of Differential Into Housing	15-32-28
Axle Shaft	15-32-31
Depth Gauge Check	15-32-25
Differential Case	15-32-21
Pinion, Drive Gear and Differential Case Carrier	15-32-16
DISASSEMBLY AND ASSEMBLY (Cont'd.)	
Pinion Bearing Cup Installation	15-32-25
Pinion Bearing Preload and Final Depth Check	15-32-26
REMOVAL AND INSTALLATION	
Axle Shaft	15-32-2
Drive Pinion Oil Seal	15-32-15
Front Axle	15-32-11
Steering Knuckle and Upper and Lower Kingpins	15-32-7
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VEHICLE APPLICATION	15-32-1

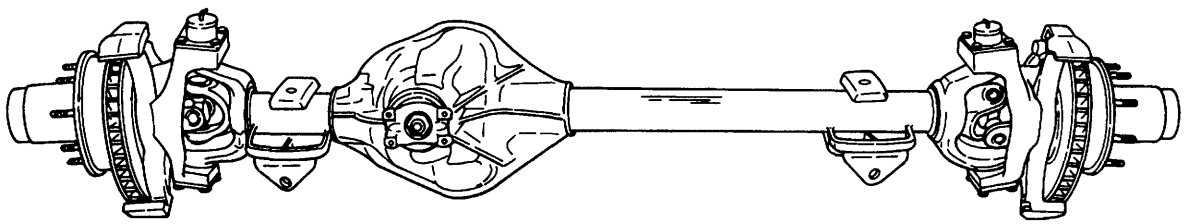
VEHICLE APPLICATION

Applies to F-350 (4x4).

DESCRIPTION AND OPERATION

Dana Model 60 monobeam front drive axle is used on the F-350 4x4 vehicles and has open yoke design.

Other than the unique parts required for front-wheel drive, these axles are mechanically identical to Model 60 rear axles. It should be noted that the manual locking hubs are standard.



DANA MODEL 60 MONOBEAM FRONT DRIVE AXLE

E6532-2A

Front-Wheel Drive Free-Running Hub

The free-running hub is standard equipment for the Dana 60 front axle on F-350 (4X4) vehicles. It is the internal locking type.

Lock Position

When the transfer case is to be shifted into the position for driving the front axle, the pointer on the center bar of the hub must point to the notch under the word LOCK on the hub lock cap. If the clutch teeth do not engage with the knob turned to this position, the clutch teeth are butted and a slight movement of the wheel in either direction will complete the lock. The front axle will now drive the wheels. Do not operate in four-wheel drive with the hubs disengaged.

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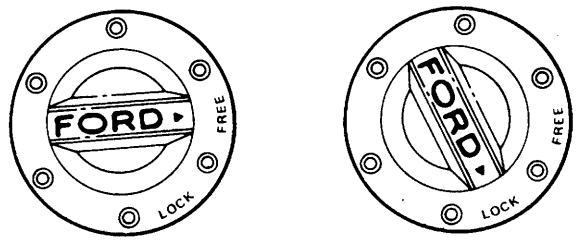
DESCRIPTION AND OPERATION (Continued)

Free-Running Position

When the transfer case is to be shifted into the position for driving the rear axle only, turn the pointer on the center bar of the hub so it points to the notch under the word FREE on the hub lock cap. This will disengage the clutch teeth and wheel hubs from the axle shafts. The wheels will turn freely on the axles.

Be certain that the transfer case is shifted into two-wheel drive position before disengaging the free-running hubs.

MANUAL LOCKING HUBS (STANDARD)



FREE RUNNING POSITION

LOCK POSITION

E4102-1D

DIAGNOSIS AND TESTING

Refer to Section 15-01, General Driving Axle Service, for diagnosis and testing procedures.

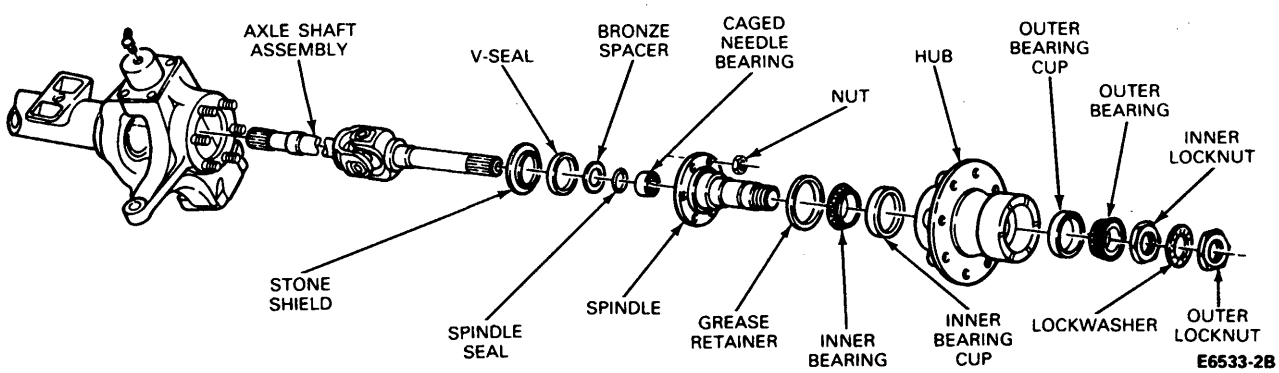
ADJUSTMENTS

Front Wheel Bearing Adjustment

Refer to Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive, for front wheel bearing adjustment procedures.

REMOVAL AND INSTALLATION

Axle Shaft



E6533-2B

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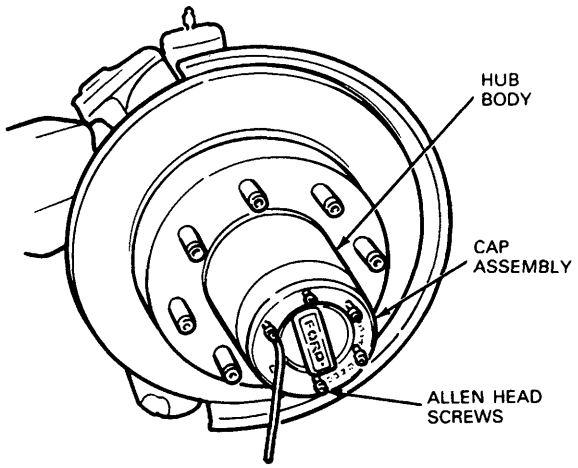
REMOVAL AND INSTALLATION (Continued)

Removal

1. Raise the front of the vehicle and install safety stands.
2. Remove the lug nuts and remove the front wheel and tire assembly.
3. Remove the caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper. Securely wire the caliper to the frame.

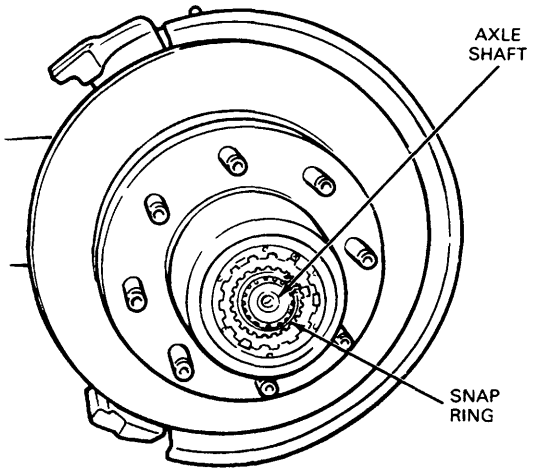
CAUTION: After removal, the caliper must be wired to the frame or otherwise supported to prevent suspending the caliper by the flexible hose. If securing the caliper is not practical, disconnect and plug the hose to the caliper. Upon caliper installation, bleed the system as described in Section 12-01, General Hydraulic Brake Service.

4. Remove the six allen-head capscrews retaining the cap to the hub body and remove the cap.



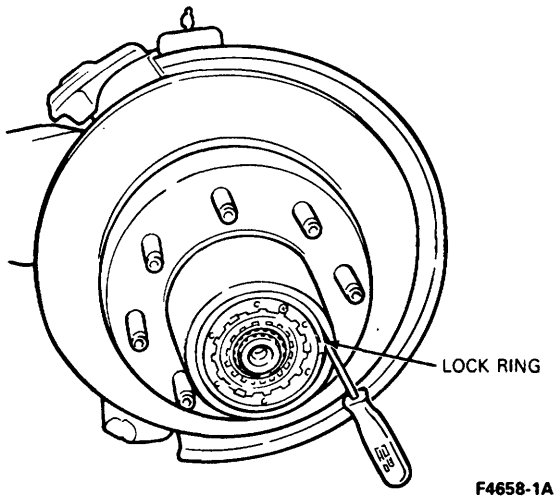
F4655-1A

5. Remove the snap ring that retains the axle shaft in the hub body assembly.



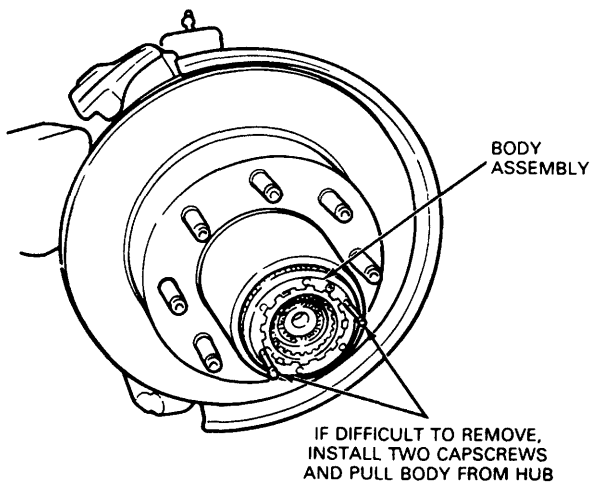
F4657-1A

6. Remove the lockring seated in the groove of the wheel hub.



F4658-1A

7. Remove the body assembly from the hub. If the body is difficult to remove, install two capscrews and pull the body assembly out of the hub.

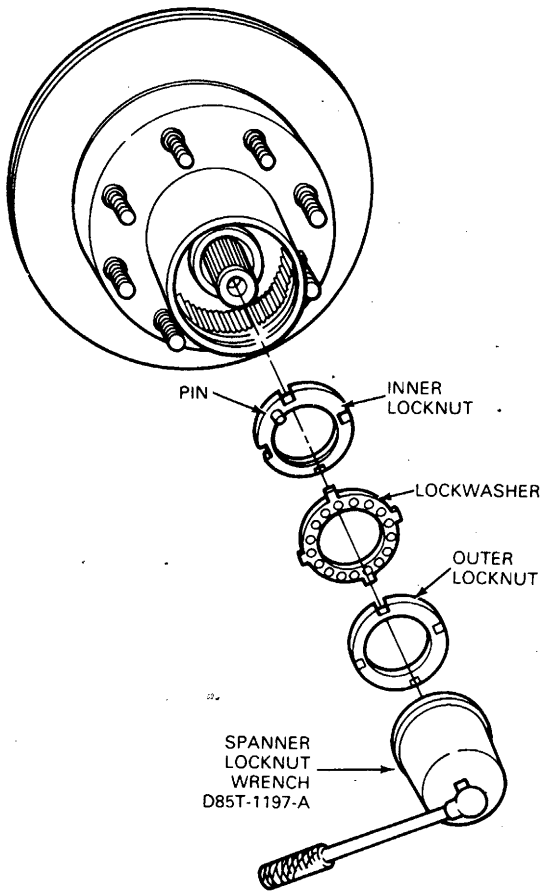


F4659-1A

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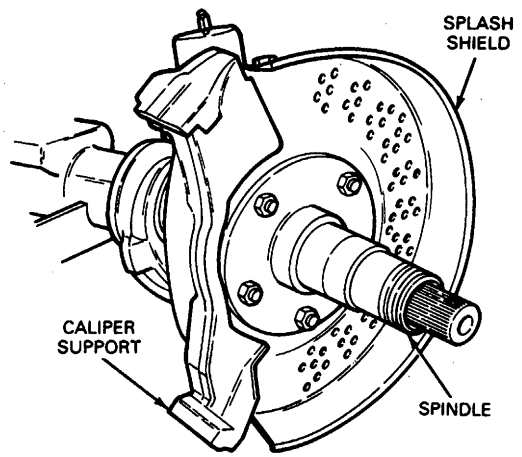
REMOVAL AND INSTALLATION (Continued)

8. Remove the outer locknut from the spindle with Spanner Locknut Wrench, D85T-1197-A or equivalent.
9. Remove the lockwasher from the spindle.
10. Remove the inner locknut from the spindle using Spanner Locknut Wrench, D85T-1197-A or equivalent.



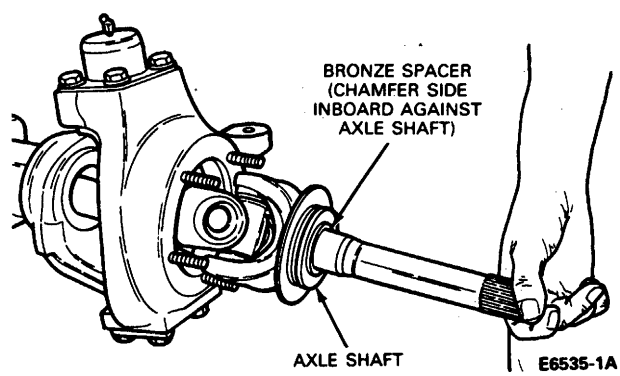
F4654-1A

11. Remove the hub and rotor assembly from the spindle.
12. Remove the nuts retaining the spindle to the knuckle. Lightly tap the spindle with a rawhide hammer to remove it from the knuckle.
13. Remove the splash shield and caliper support from the knuckle.



E6534-1A

14. Pull the axle shaft assembly out of the steering knuckle. If required, remove the bronze spacer from the axle shaft assembly.

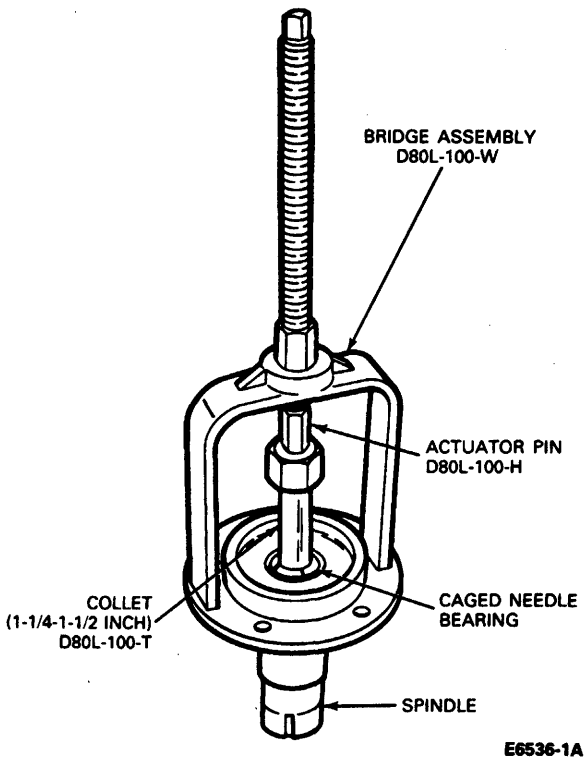


E6535-1A

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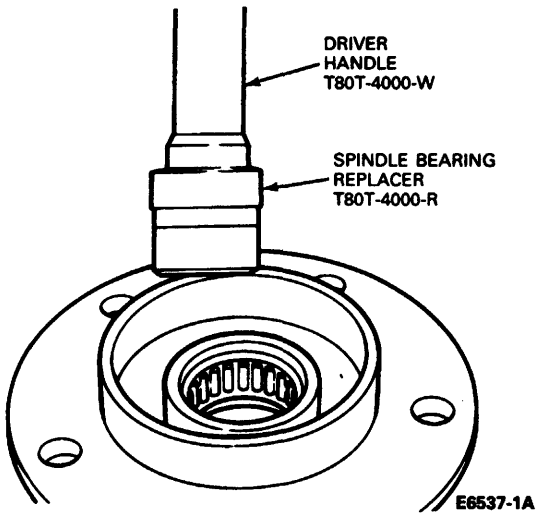
REMOVAL AND INSTALLATION (Continued)

15. If required, remove the caged needle bearing from the spindle. Remove the seal. Pull the bearing out of the spindle using Collet (1-1/2 to 1-3/4 inch), D80L-100-T, Actuator Pin, D80L-100-H and Bridge Assembly, D80L-100-W or equivalents.



Installation

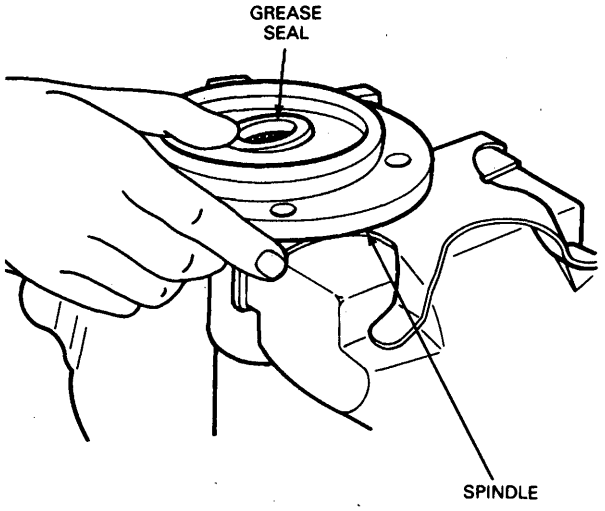
1. If removed, position a new caged needle bearing in the spindle bore. The writing on the bearing must face the rear of the spindle. Drive the bearing in the spindle with Spindle Bearing Replacer, T80T-4000-R and Driver Handle, T80T-4000-W or their equivalents. Pack the bearing with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent. Install the seal in the bore against the bearing.

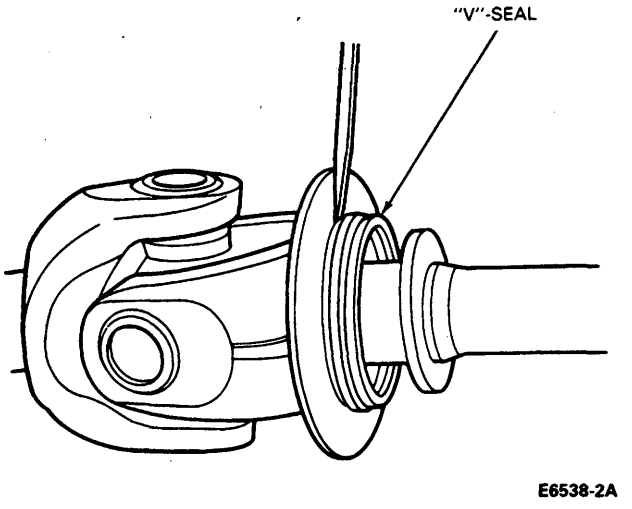


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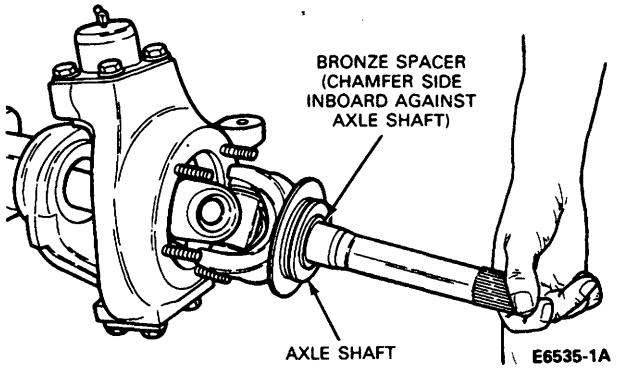
REMOVAL AND INSTALLATION (Continued)

2. Pack the thrust face of seal in the spindle bore and the V-seal on the axle shaft with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.

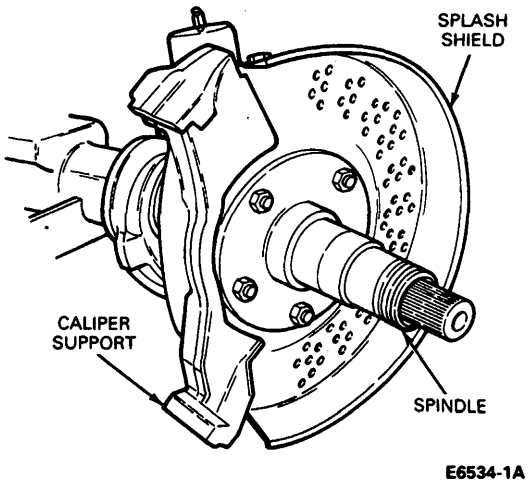




3. Carefully guide the axle shaft through the knuckle and into the axle housing. Make sure that the axle shaft splines are engaged in the differential side gear splines.
4. Install the bronze spacer on the axle shaft assembly. The chamferred side of the spacer must be inboard against the axle shaft.



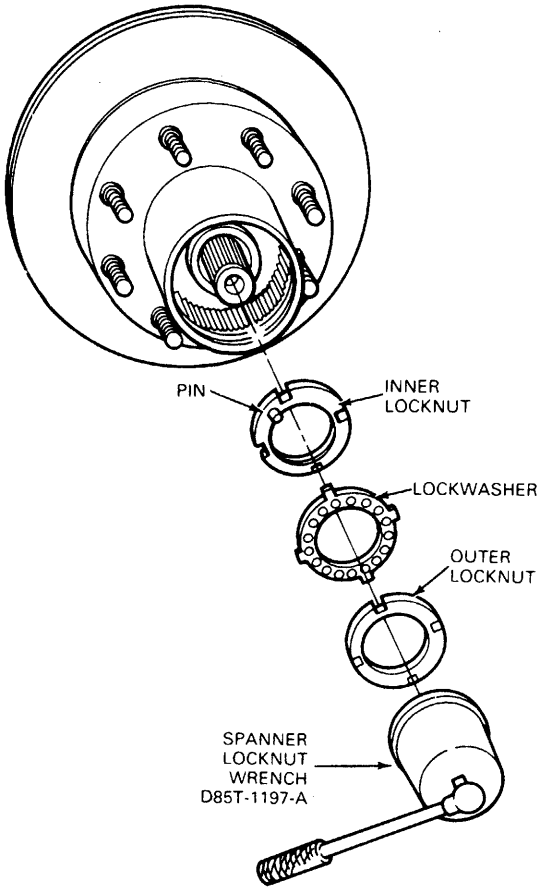
5. Install the splash shield and caliper support bracket on the steering knuckle.
6. Place the spindle on the steering knuckle. Install the nuts and tighten.



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REMOVAL AND INSTALLATION (Continued)

7. Install the hub and rotor assembly on the spindle.
8. Install the inner locknut on the spindle and seat the bearing by tightening the locknut to 68 N·m (50 ft-lb) with Spanner Locknut Wrench, D85T-1197-A or equivalent.
9. Back off the inner locknut and retighten to 41-54 N·m (31-39 ft-lb).
10. While rotating the hub and rotor, back off the locknut 135°-150°.
11. Install the lockwasher so the key is positioned in the spindle groove. Rotate the inner locknut so the pin is aligned into the nearest hole in the lockwasher.



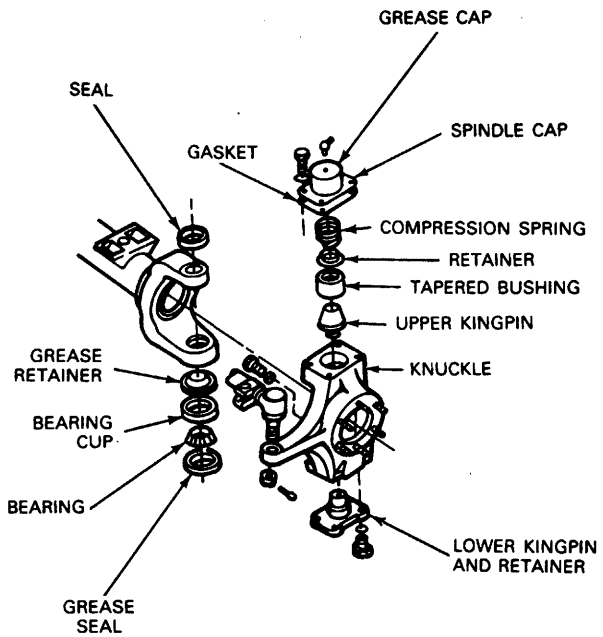
F4654-1A

12. Install the outer locknut and tighten to 217-278 N·m (160-205 ft-lb) using Spanner Locknut Wrench, D85T-1197-A.

NOTE: The final spindle end play should be 0.00-0.15mm (0.000-0.006 inch).

13. Install the manual locking hub body assembly in the hub and rotor.
14. Install the lockring in the hub groove to retain the body in the hub.
15. Install the snap ring on the end of the axle shaft to retain the shaft to the body.
16. Position the cap assembly on the body. Install the six allen-head capscrews and tighten to 4.0-6.0 N·m (35-45 in-lb).
17. Install the caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
18. Install the front wheel and tire assembly. Install the lug nuts and tighten to specification.

Steering Knuckle and Upper and Lower Kingpins



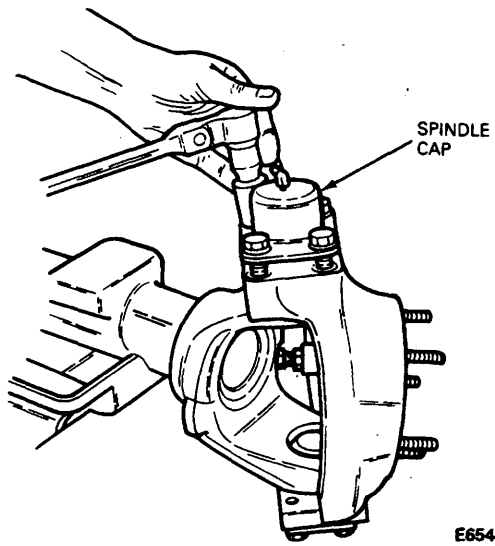
E6539-1A

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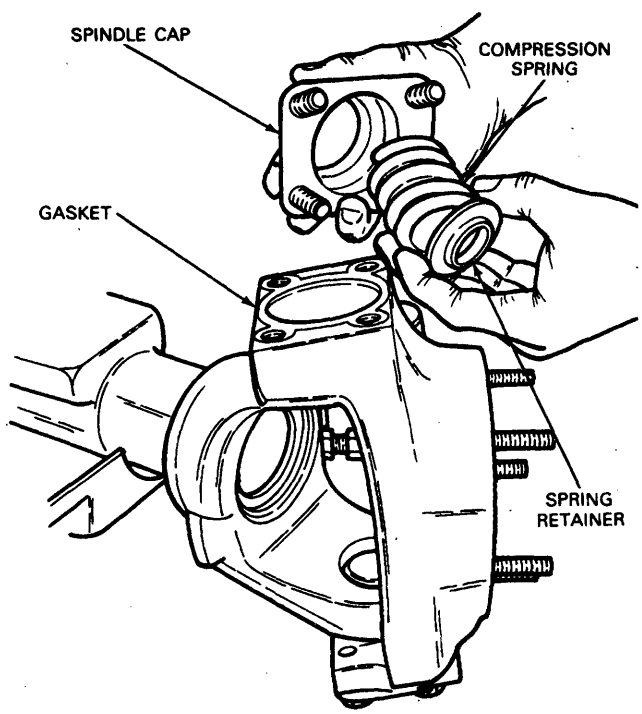
REMOVAL AND INSTALLATION (Continued)

Removal

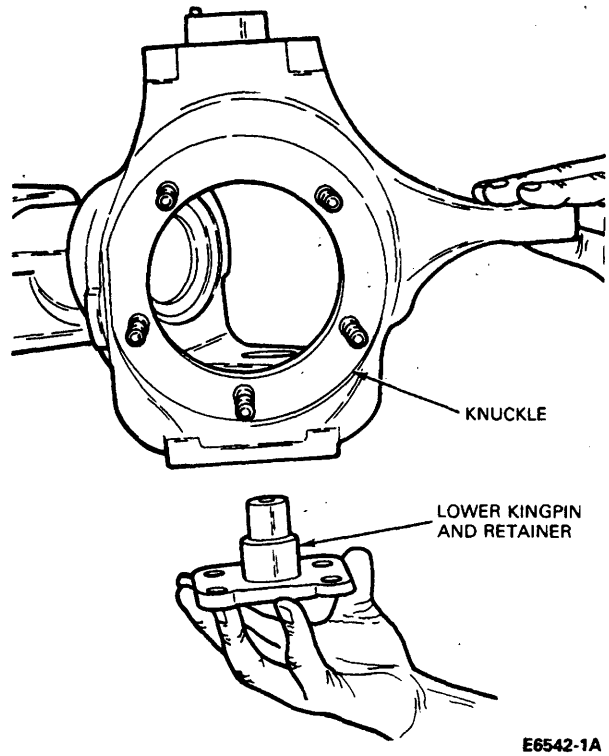
1. Remove the axle shaft as described under Axle Shaft in the Removal and Installation portion of this Section.
2. Alternately and evenly loosen the four bolts retaining the spindle cap to the knuckle. Loosening the bolts in this manner relieves the spring compression. Remove the bolts.



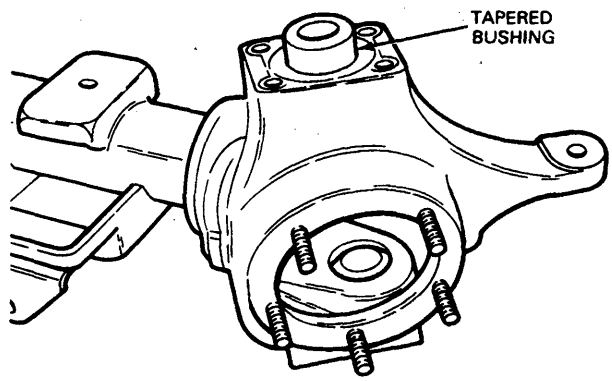
3. Remove the spindle cap, compression spring and retainer. Remove and discard the gasket.



4. Remove the four bolts retaining the lower kingpin and retainer to the knuckle. Remove the lower kingpin and retainer from the knuckle.



5. Remove the tapered bushing from the top of the upper kingpin in the knuckle. Remove the knuckle from the axle yoke.

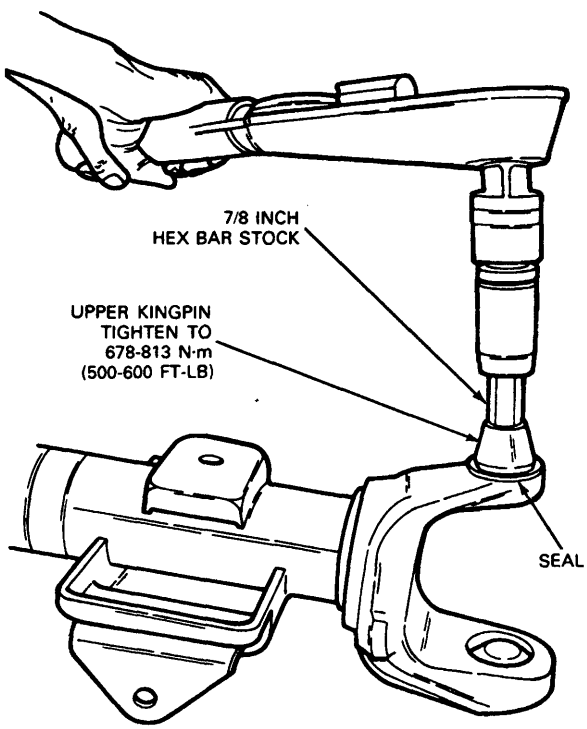


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REMOVAL AND INSTALLATION (Continued)

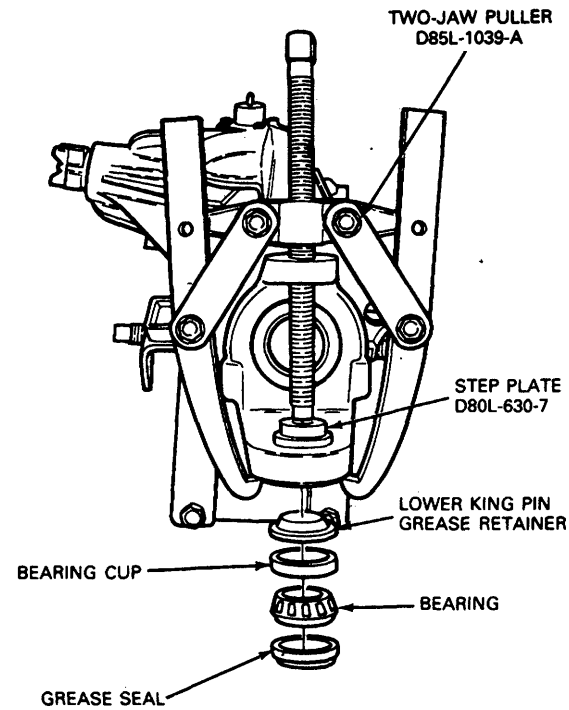
6. Remove the upper kingpin from the axle yoke with a piece of 7/8 inch hex-shaped case hardened metal stock or with 7/8 Inch Hex Socket, Snap-On, IMA-283 or equivalent. Discard the upper kingpin and seal.

NOTE: The upper kingpin is tightened to 678-813 N·m (500-600 ft-lb).



E6544-1A

7. Press the lower kingpin grease retainer, bearing cup, bearing and seal from the axle yoke lower bore with Two-Jaw Puller, D85L-1039-A and Step Plate, D80L-630-7 or equivalents. Discard the grease seal and retainer, and lower bearing cup.



E6545-1A

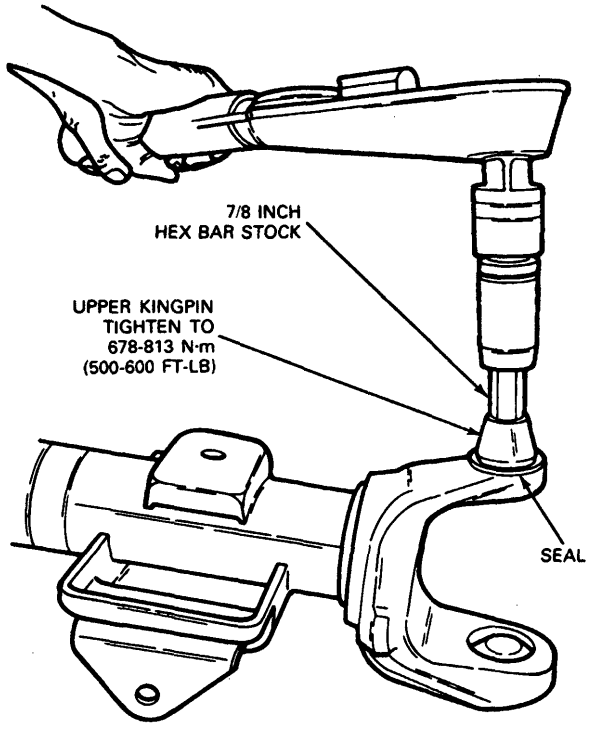
Installation

1. Coat the mating surface of a new lower kingpin grease retainer with RTV sealant such as Silicone Rubber, D6AZ-19526-B (ESB-M4G92-A and ESE-M4G195-A) or equivalent.
2. Install the sealant covered lower kingpin grease retainer in the axle yoke bore so the concave portion of the retainer faces the upper kingpin.
3. With an appropriate driver, drive a new bearing cup in the lower kingpin bore until it bottoms against the grease retainer.
4. Pack the lower kingpin bearing and the yoke bore with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.
5. With an appropriate driver, drive a new seal in the lower kingpin bore.

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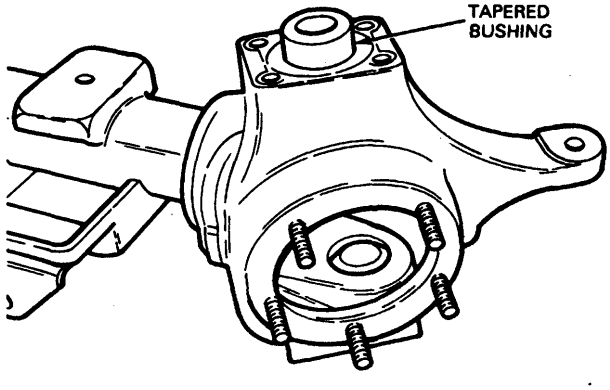
REMOVAL AND INSTALLATION (Continued)

6. Install a new seal, using Kingpin Seal Installer T86T-3110-AH or equivalent. Install upper kingpin assembly in the yoke. Tighten the kingpin to 678-813 N·m (500-600 ft-lb) using a piece of 7/8 inch hex-shaped case hardened metal stock or 7/8 Inch Hex Socket, Snap-On, IMA-283 or equivalent.



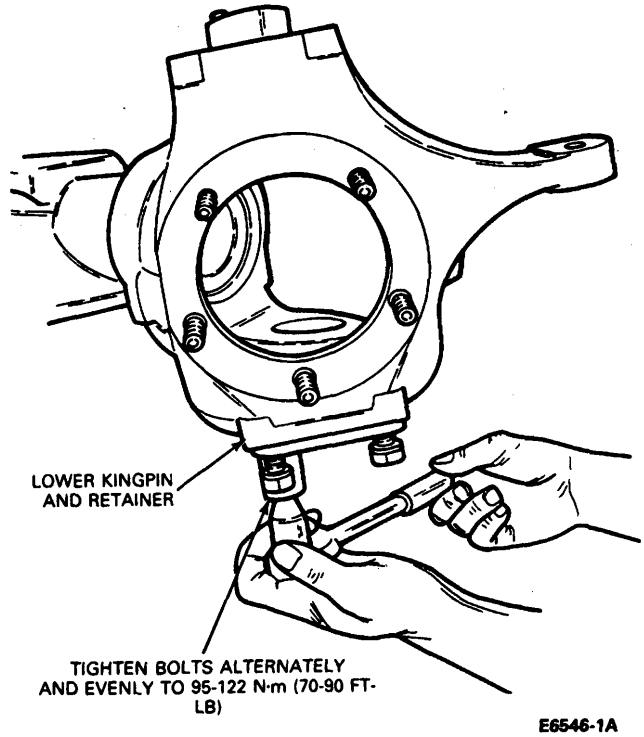
E6544-1A

7. Install the knuckle on the axle yoke.
8. Place the tapered bushing over the upper kingpin in the knuckle bore.



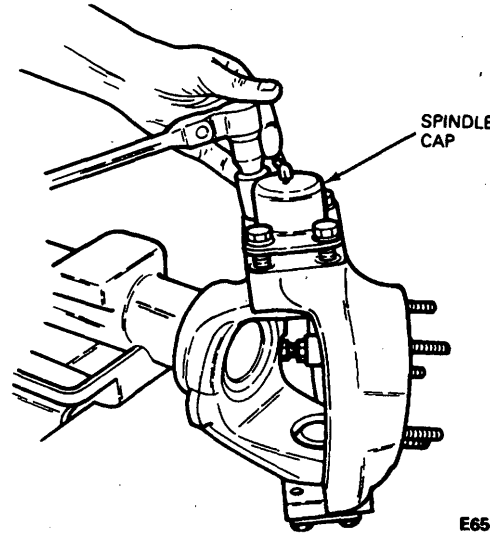
E6543-1A

9. Place the lower kingpin and retainer assembly in the knuckle and axle yoke. Install the four bolts and alternately and evenly tighten to 95-122 N·m (70-90 ft-lb).



E6546-1A

10. Place the retainer and compression spring on the tapered bushing.
11. Install a new gasket on the steering knuckle. Position the spindle cap on the gasket and knuckle. Install the four bolts, and alternately and evenly tighten to 95-122 N·m (70-90 ft-lb).

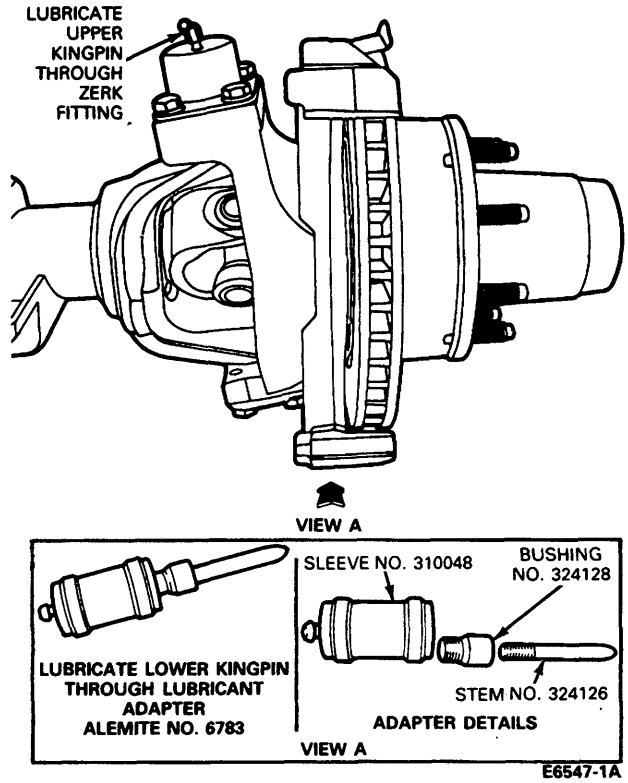


E6540-1A

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REMOVAL AND INSTALLATION (Continued)

12. Install the axle shaft as described under Axle Shaft in the Removal and Installation portion of this Section.
13. Lubricate the upper kingpin through the zerk fitting in the spindle cap with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.
14. Lubricate the lower kingpin through the flush type fitting in the retainer with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent. Lubricate the flush type fitting using Lubricant Adapter, Alemite No. 6783 or equivalent.



Front Axle

Removal

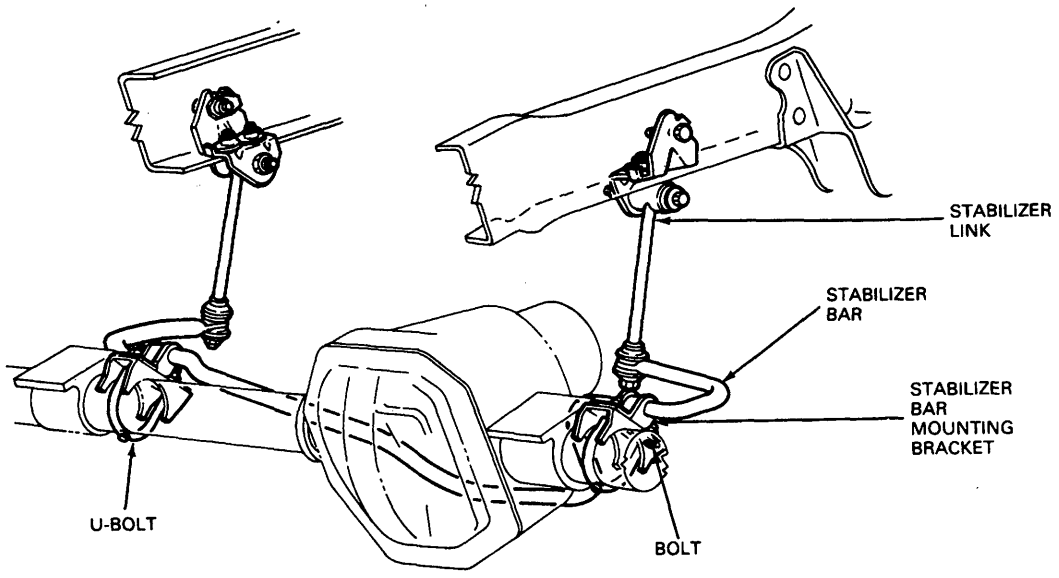
1. Raise the vehicle on a twin-post hoist.
2. Remove the front wheel and tire assemblies from the vehicle. Remove the hubs according to the procedures outlined in Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive. When removing hubs, use Hub Removal Tool D85T-1197-A or equivalent.
3. Remove the brake caliper from the rotor according to the procedures outlined in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.

CAUTION: After removal, the brake caliper must be wired to the spring or otherwise supported to prevent suspending the caliper by the flexible hose. Allowing the caliper to hang by the flexible hose could result in brake line failure. If caliper suspension is not practical, remove it according to the procedures outlined in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.

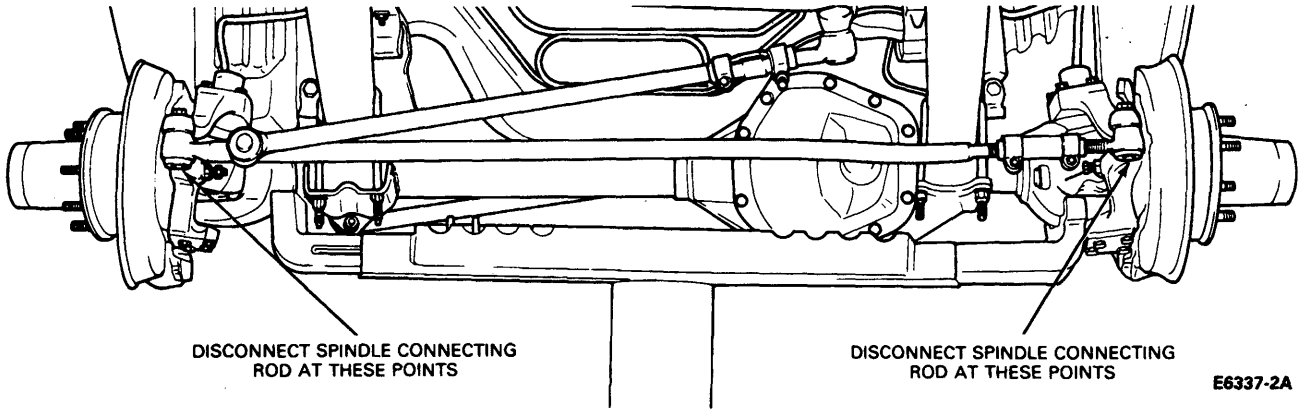
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REMOVAL AND INSTALLATION (Continued)

4. Remove the washers and nuts securing the stabilizer links to the stabilizer bar. Disconnect the stabilizer links from the stabilizer bar. If required, remove the U-bolts and bolts and nuts retaining the stabilizer bar and mounting brackets to the axle and remove the stabilizer bar.



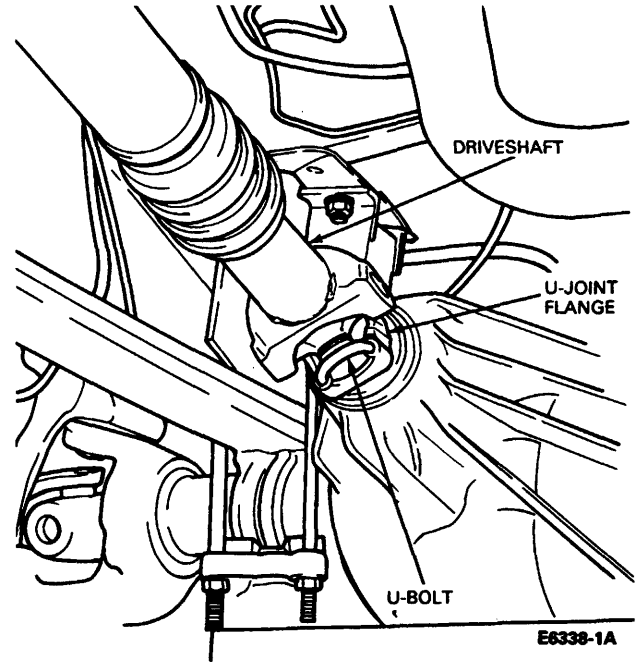
5. Remove the cotter pins and castellated nuts securing the spindle connecting rod to the steering knuckles. Separate the connecting rods from the steering knuckles using Pitman Arm Puller T64P-3590-F or equivalent. Wire the steering linkage to the spring.



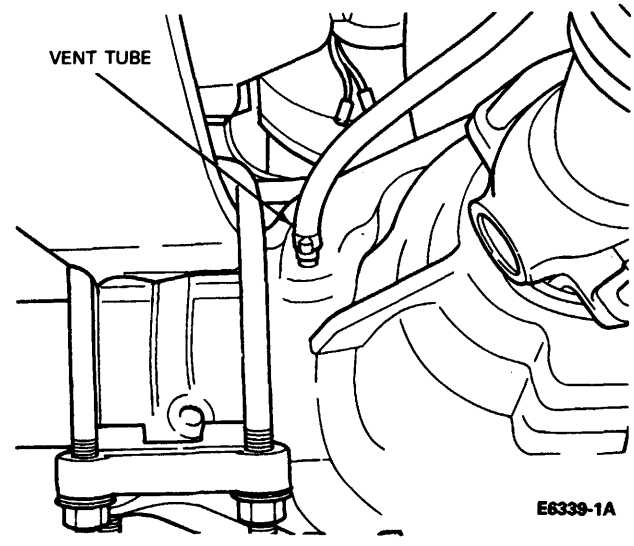
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REMOVAL AND INSTALLATION (Continued)

6. Remove the two nuts and U-bolts from the front axle U-joint flange and disconnect the axle from the front axle pinion flange. Securely wire the driveshaft to the frame.



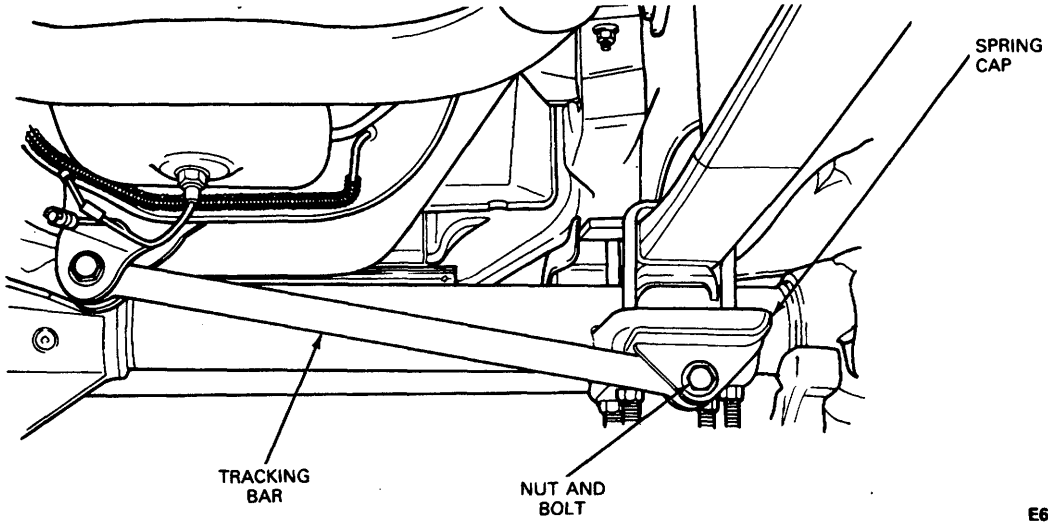
7. Disconnect the vent tube at the axle housing. Plug the vent fitting.



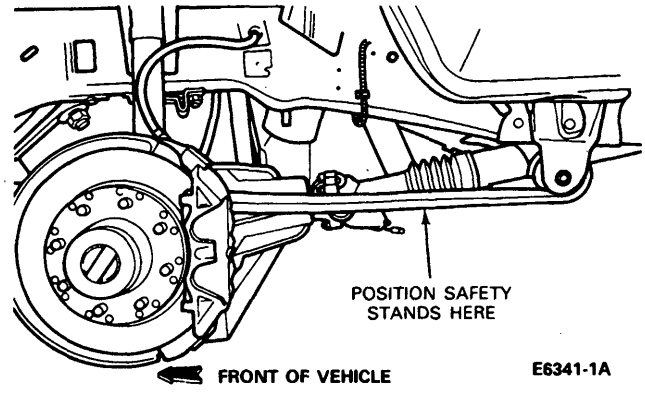
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REMOVAL AND INSTALLATION (Continued)

8. On the right-hand side of the vehicle, remove the nut and bolt and disconnect the tracking bar from the right-hand spring cap.

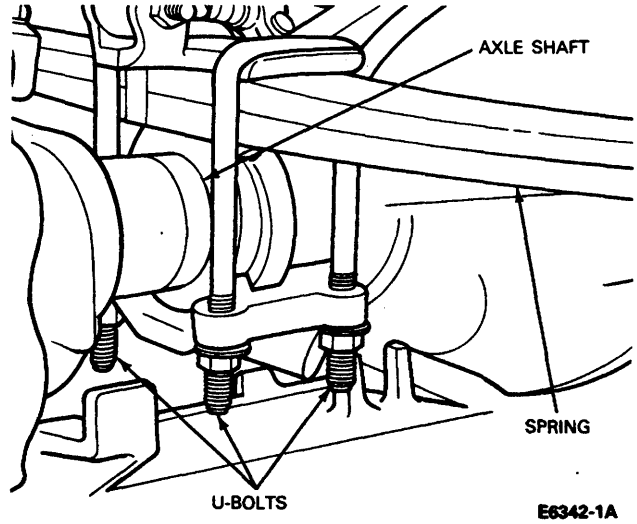


9. Carefully lower the twin-post hoist until the vehicle is approximately three feet from the floor. Position safety stands on the front leaf springs about halfway between the front axle leaf spring and the rear mounting shackle. Lower the vehicle so that the springs rest on the safety stands.



WARNING: BEFORE PROCEEDING, MAKE SURE THAT THE VEHICLE IS SECURELY SUPPORTED.

10. Support the axle under the differential carrier with a suitable jack, such as Rotunda Tool 077-00008 or equivalent.
11. Remove the U-bolts and nuts securing the axle to the spring.
12. Carefully lower the axle from the vehicle.
13. If required, place the axle in a differential carrier repair stand, such as Rotunda Tool 014-00257 or equivalent.

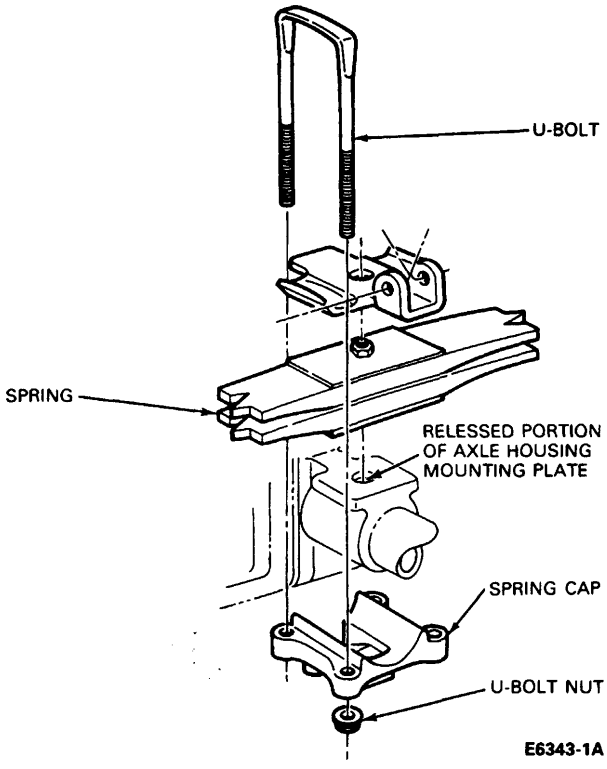


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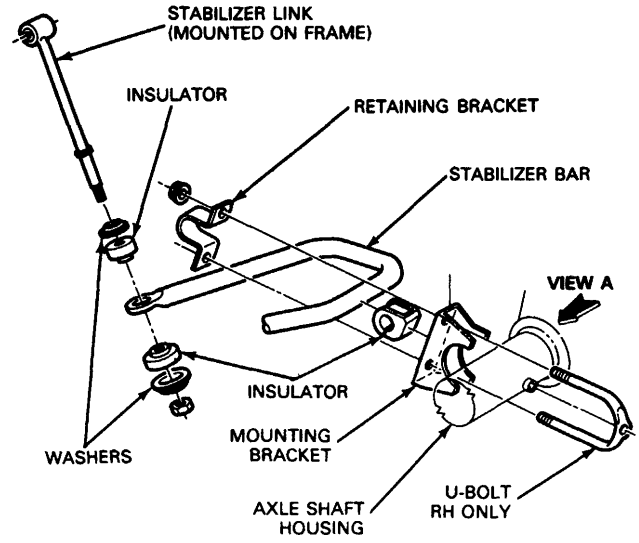
REMOVAL AND INSTALLATION (Continued)

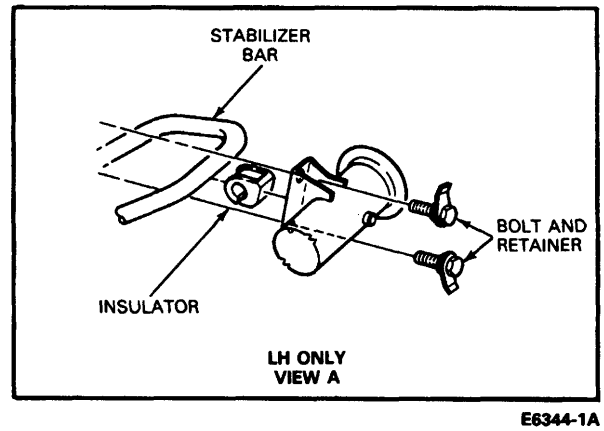
Installation

1. With the axle supported under the differential carrier by a suitable transmission jack, carefully raise the axle to the vehicle. Ensure that the retaining bolt head protruding from the leaf spring plate seats in the recessed portion of the axle spring mounting plate.
2. Install the nuts, U-bolts and spring caps securing the axle to the spring. Tighten to specifications listed at the end of this Section. Raise the vehicle to a suitable working height and remove safety stands.



3. Connect the driveshaft to the front axle pinion flange, secure with nuts and U-bolts and tighten to torque specifications listed at the end of this Section. For detailed instructions and procedures, see Section 15-60, Driveshafts—Single Type U-Joint.
4. On the right-hand side of the vehicle, connect the tracking bar to the spring cap, secure with nut and bolt and tighten to specifications listed at the end of this Section.
5. Connect the vent tube to the axle housing.
6. Connect the spindle connecting rods to the steering knuckles. Secure the connecting rod ends with castellated nuts and tighten to torque specifications listed at the end of this Section. Install cotter pins. (If necessary, advance nut to next castellation to install cotter pin.)
7. Connect stabilizer link to stabilizer bar. Tighten nuts and washers to specifications listed at the end of this Section. If removed, position stabilizer bar and mounting brackets on axle shaft housing and tighten to specifications listed at the end of this Section.
8. Install brake calipers and rotors as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.
9. Install the hubs according to the procedures outlined in Section 11-12, Front Wheel Drive. Install the wheel and tire assemblies on the vehicle.
10. Lower the vehicle to the ground.





Drive Pinion Oil Seal

Removal

The drive pinion oil seal can be replaced without removing the axle assembly from the vehicle. Compounded or synthetic rubber seals do not require soaking.

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REMOVAL AND INSTALLATION (Continued)

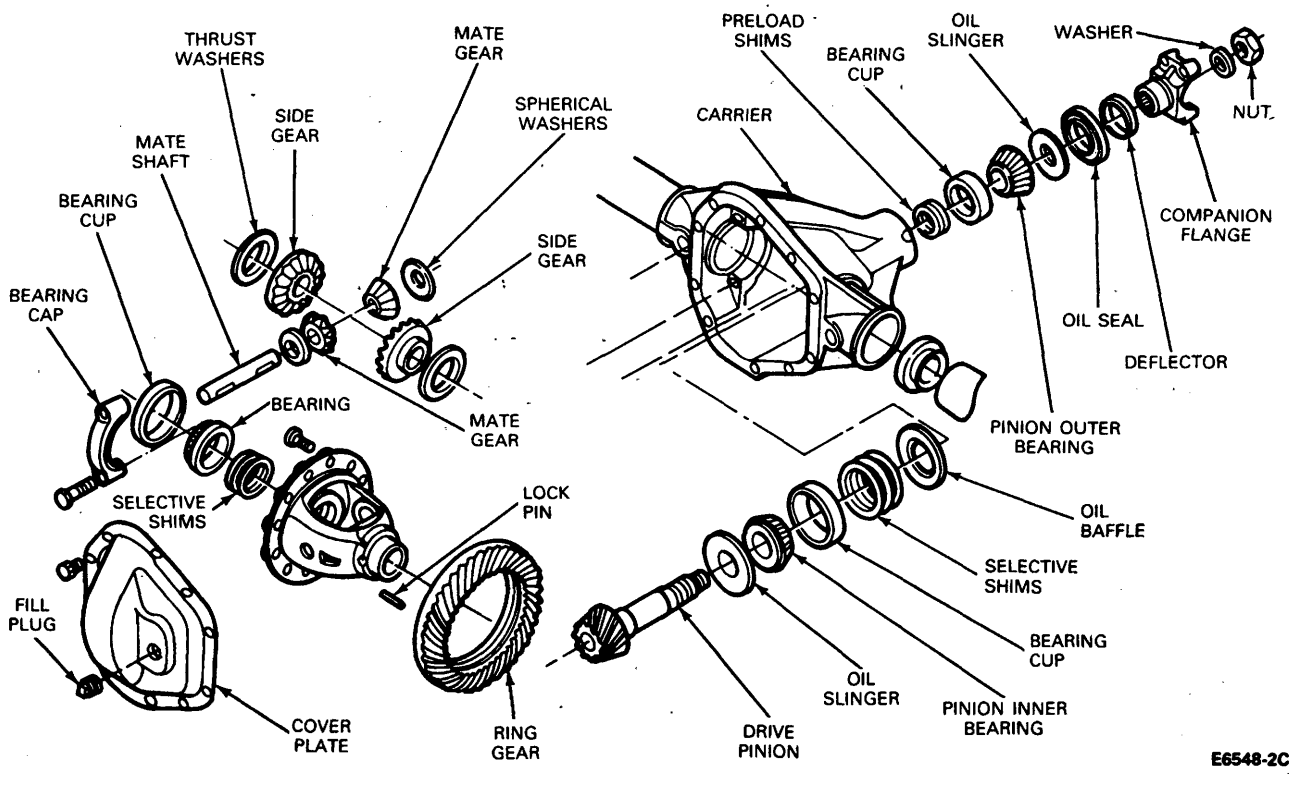
1. Raise the vehicle on a hoist or raise the front end of the vehicle with a jack. Install safety stands under the frame rails and lower the jack or hoist far enough to allow the axle to drop into the rebound position for working clearance.
2. Remove the nuts and two U-bolts from the front axle U-joint flange and disconnect the driveshaft from the front axle pinion flange. Wire the driveshaft to the frame.
3. Using Tool T75T-4851-B or equivalent to hold the pinion companion flange, remove the pinion shaft nut.
4. Using Tool T65L-4851-B or equivalent, remove the companion flange.
5. Using TOOL-1175-AC or equivalent, puller, in combination with slide hammer T50T-100A, remove the pinion oil seal.

Installation

1. Clean the pinion oil seal seat. Coat the sealing edge of the new seal with a small amount of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent. **Do not put sealer on the sealing lip.** Drive the seal into the housing, using Tool T83T-4676-A or equivalent.
2. Coat the inside of the pinion flange with a small quantity of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent, and install the flange on the pinion shaft, using Tool-4858-E or equivalent.
3. Install the pinion attaching nut on the pinion shaft and tighten to torque specifications listed at the end of this Section.
4. Connect the driveshaft to the front axle pinion flange, secure with nuts and U-bolts and tighten to specifications listed at the end of this Section.
5. Raise the vehicle, remove the safety stands and then lower the vehicle to road position. Check the level of axle lubricant and add the specified lubricant as necessary.

DISASSEMBLY AND ASSEMBLY

Pinion, Drive Gear and Differential Case Carrier



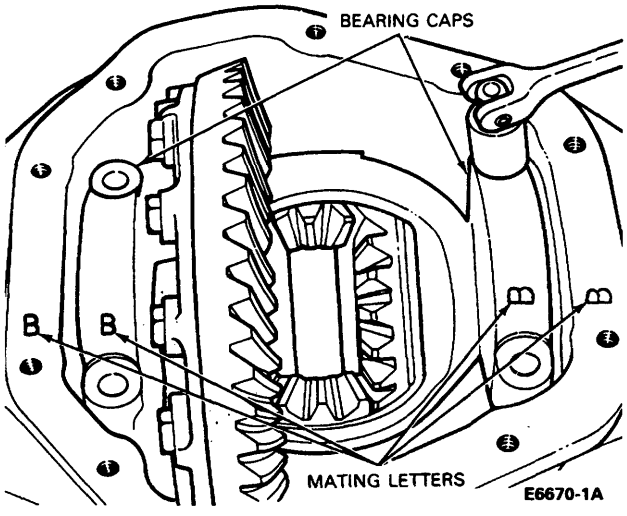
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DISASSEMBLY AND ASSEMBLY (Continued)

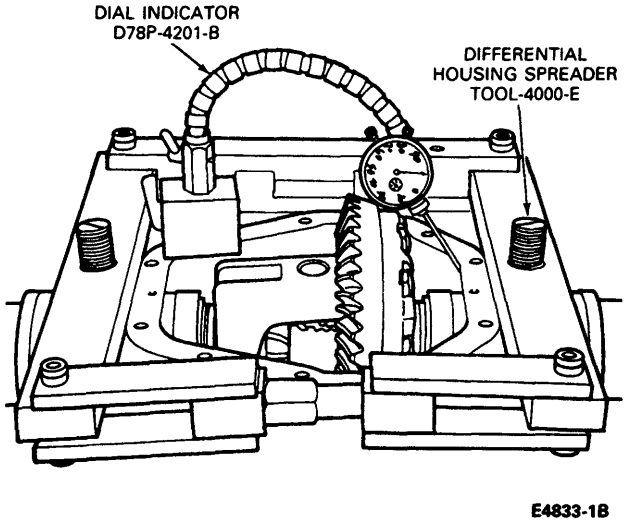
Disassembly

1. Remove the front axle from the vehicle as outlined in Removal and Installation—Front Axle in this Section.
2. Disconnect the steering linkage from the spindle. Remove the axle shafts as outlined in the Removal and Installation portion of this Section.
3. Position suitable container under differential carrier. Remove cover plate and drain lubricant from axle. The lubricant will drain out as the cover plate is removed. Tip carrier to allow lubricant to drain completely.
4. Remove any residual gasket material from carrier mating surface. Also clean cover face of carrier, making sure it is free of any nicks or burrs.
5. Loosen capscrews and remove bearing caps.

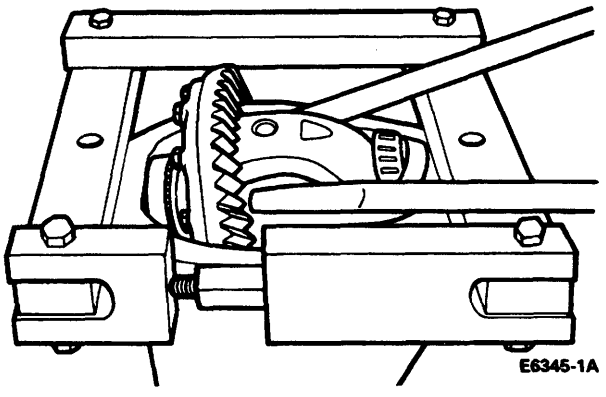
NOTE: Mating letters are stamped on bearing caps and carrier. This is important at time of assembly as they are to be assembled exactly as removed. Letters are in vertical and horizontal positions.



6. Place Differential Housing Spreader, Tool-4000-E or equivalent on the case. Install Dial Indicator, Tool-4201-C on the carrier housing. Do not spread housing more than 0.38mm (0.015 inch).



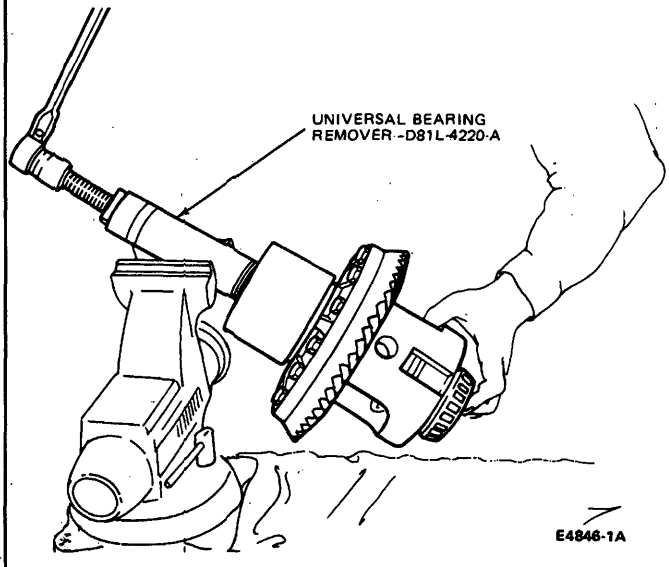
7. Pry differential case from carrier with two pry bars. After differential case has been removed, remove spreader. Use caution to avoid damage to ring and pinion. Mark or tag bearing cups for correct positioning during reassembly.



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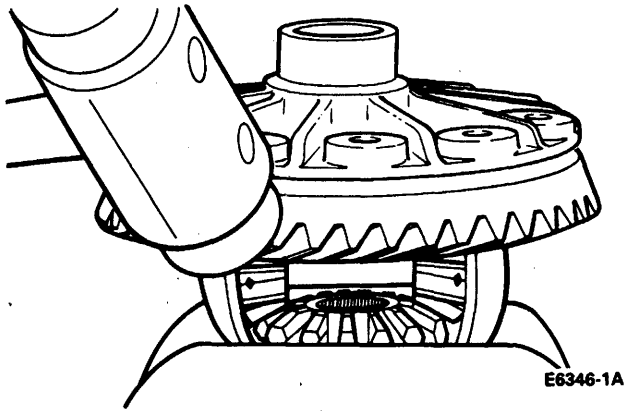
DISASSEMBLY AND ASSEMBLY (Continued)

8. Remove differential bearings with special tool, Universal Bearing Remover D81L-4220-A or equivalent. Place the tool in a vise when removing bearing. Wire shims, bearing cup and bearing cone together. Identify from which side they were removed. (Ring gear side or opposite side.) If shims are damaged, replace with new ones at time of assembly. Shims are available in thicknesses of 0.08, 0.13, 0.25, and 0.76mm (0.003, 0.005, 0.010, and 0.30 inch). Reposition case in puller and remove other bearing cone as described above. Replace bearings whenever they are removed from the carrier.

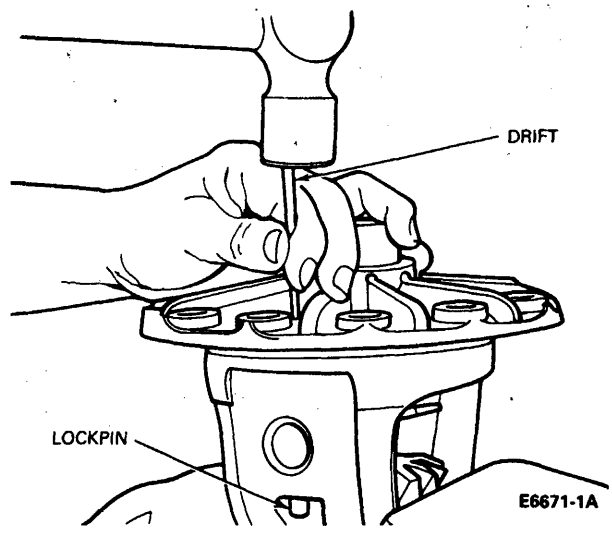


9. Place a few shop towels over the vise to prevent the ring gear teeth from being nicked when it falls from the differential carrier. Place case in vise. Remove ring gear bolts. Tap ring gear with a rawhide hammer to free it from the case. Remove case and ring gear from vise.

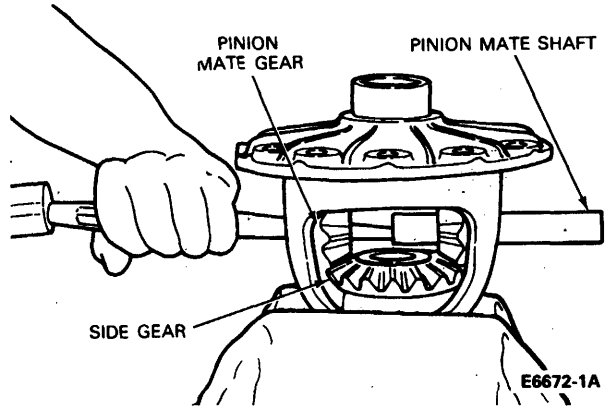
NOTE: Whenever removing the ring gear bolts, always replace with new bolts upon assembly.



10. Replace case in vise and use a small drift to drive out the lockpin that secures the pinion mate shaft.



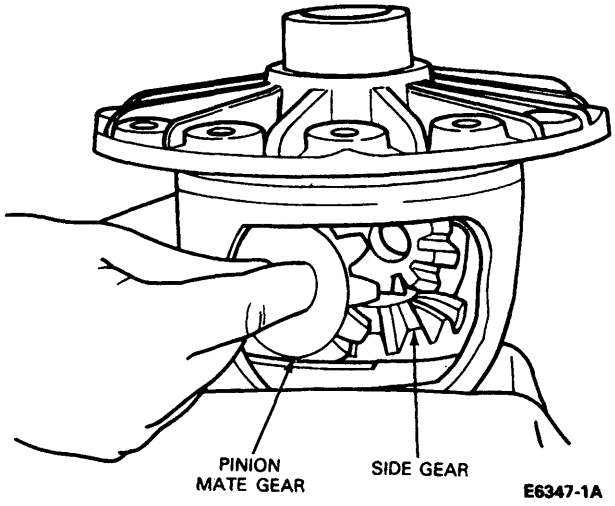
11. Remove pinion mate shaft with drift.



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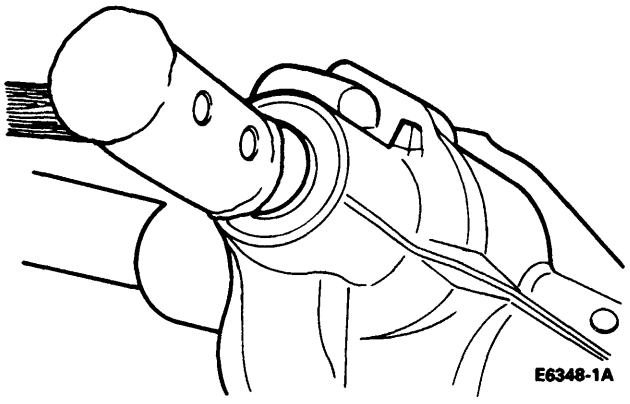
DISASSEMBLY AND ASSEMBLY (Continued)

12. To remove side gears and pinion mate gears, rotate the side gears. This will allow the pinion mate gears to turn to the opening of the case. Remove pinion mate gears and also the spherical washers behind the gears. Lift out side gears and thrust washers. Inspect all parts, including the machined surfaces of the case itself. If excessive wear is visible on all parts, it is suggested that the complete differential assembly be replaced. If any one of the gears are to be replaced, THEY ARE TO BE REPLACED AS A SET.

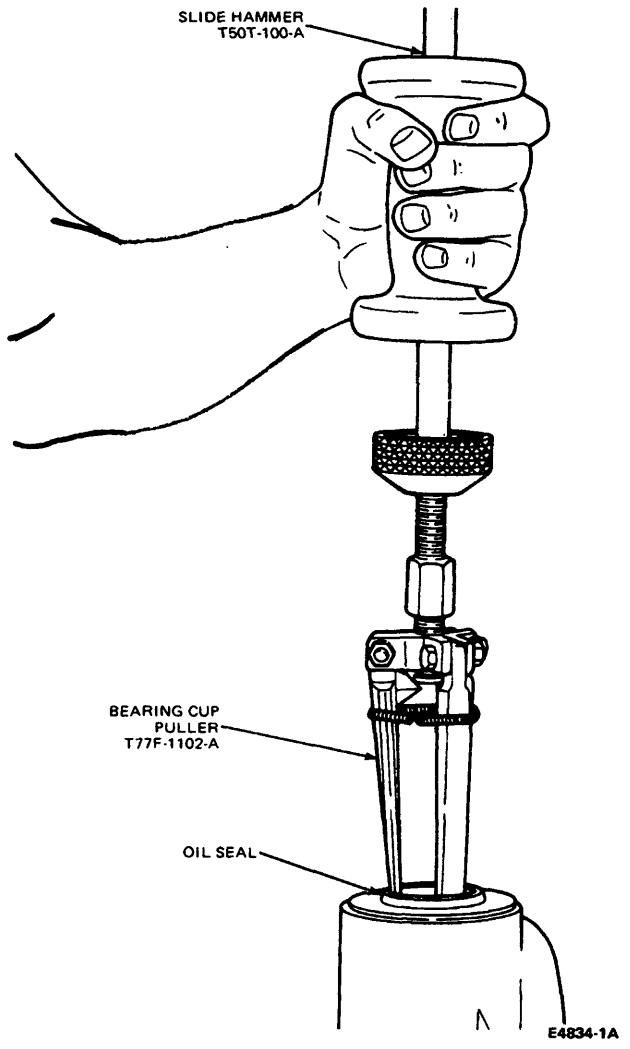


13. Turn nose of carrier in a horizontal position, remove pinion nut. Hold end yoke or flange with Tool T57T-4851-B (or equivalent) Companion Flange Holding Tool, and remove pinion nut and washer.
14. Remove end yoke or flange with T65L-4851-B or equivalent, Yoke Remover. If end yoke or flange shows wear in the area of the seal contact, it should be replaced.
15. Remove pinion by tapping with a rawhide hammer. Catch the pinion with your hand to prevent it from falling to the ground and being damaged.

NOTE: On the spline end of the pinion, there are bearing preload shims. These shims may stick to the pinion or bearing or even fall out. These shims are to be collected and kept together since they will be used later in assembly. Try not to damage shims. If shims are damaged, replace with new ones. Shims are available in thicknesses of 0.08, 0.13, 0.25, and 0.76mm (0.003, 0.005, 0.010, and 0.030 inch).



16. Pull out pinion seal with Puller T77F-1102-A, Bearing Cup Puller and T50T-100-A, Slide Hammer. Discard seal. REPLACE WITH NEW ONE AT TIME OF ASSEMBLY. Remove bearing cone and outer oil slinger.



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DISASSEMBLY AND ASSEMBLY (Continued)

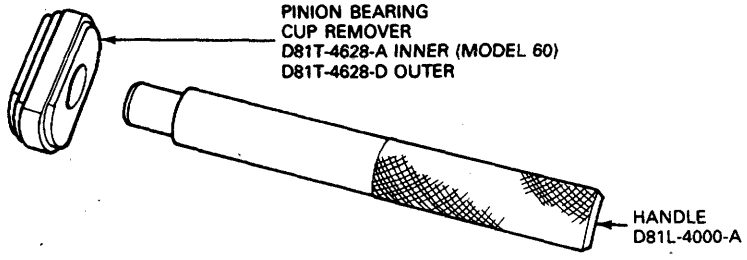
17. Turn nose of carrier down. Remove outer pinion bearing cup with Bearing Cup Remover D81T-4628-D and Driver Handle D81L-4000-A or their equivalents. Locate driver on back edge of cup; drive cup out of carrier.

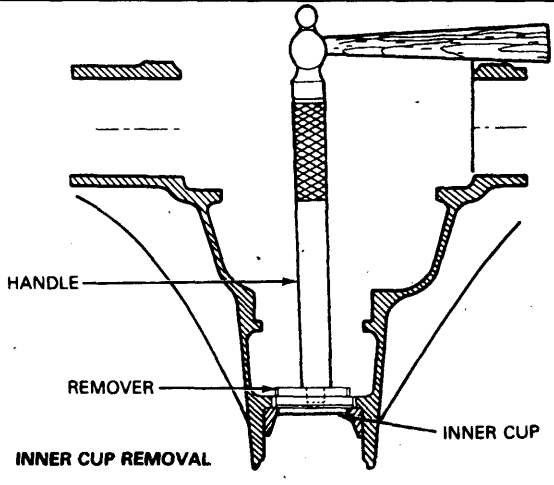
CAUTION: Do not nick carrier bore.

NOTE: The front carrier section may vary in pinion bore depth due to the possibility of the need for either a baffle or slinger or both.

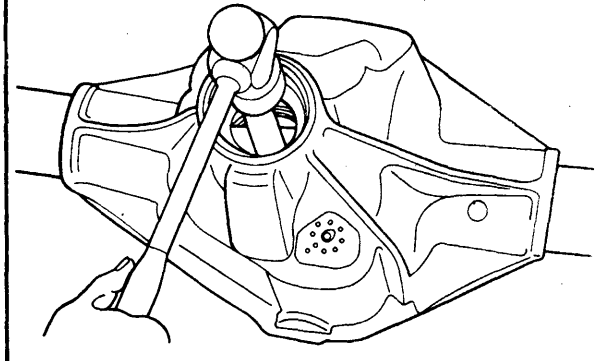
18. Remove the inner bearing cup with Bearing Cup Remover, D81T-4628-A and Driver Handle D81L-4000-A or equivalents.

NOTE: Shims are located between the bearing cup and carrier bore and may also include an oil baffle. If shims and baffles are bent or nicked, they should be replaced at time of assembly. Wire shim stacks together and measure each. If stack has to be replaced, replace with same thickness.





INNER CUP REMOVAL



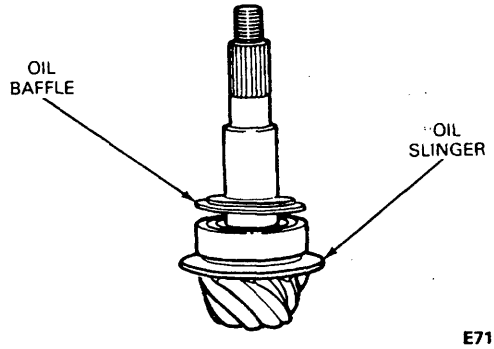
OUTER CUP REMOVAL

E6349-2A

NOTE: Both baffle and slinger are part of the pinion adjustment shims and are to be kept intact for assembly.

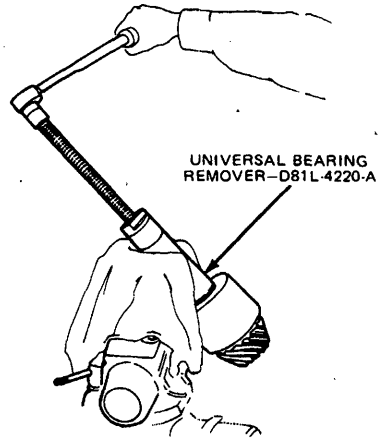
The baffle serves the same purpose as a dam, to assure that the pinion bearings are maintained with lubricant.

The slinger serves the purpose of assisting the lubricant to flow up through the oil channels to lubricate the pinion bearings. If used, they are part of the pinion setting adjustment.



E7115-1A

19. Remove bearing from pinion with Universal Bearing Remover, D81L-4220-A or equivalent. Bend the slinger as required to obtain clearance for remover tool installation. Discard the slinger.



E4847-1A

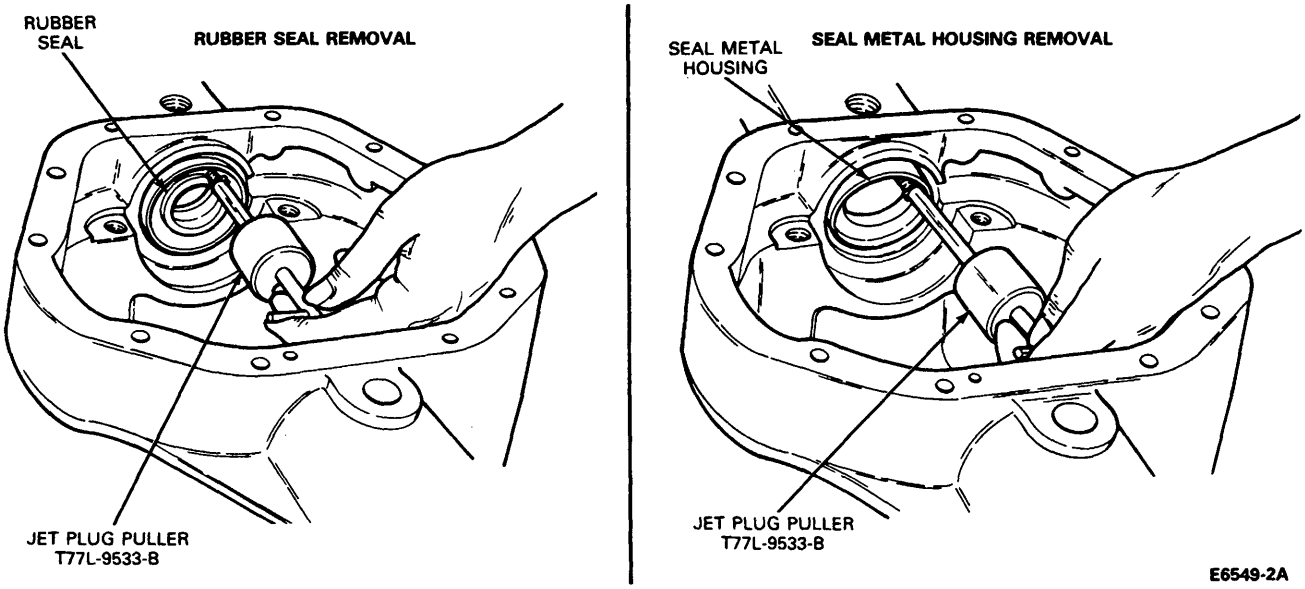
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DISASSEMBLY AND ASSEMBLY (Continued)

20. If required, remove the inner axle shaft seals with Jet Plug Remover, T77L-9533-B or equivalent. Thread the remover tool into the rubber seal and remove and discard the seal. Thread the remover tool into the metallic seal housing and remove and discard the seal housing.

NOTE: The inner axle shaft seal is serviced as a two-piece, rubber seal and metallic housing assembly.

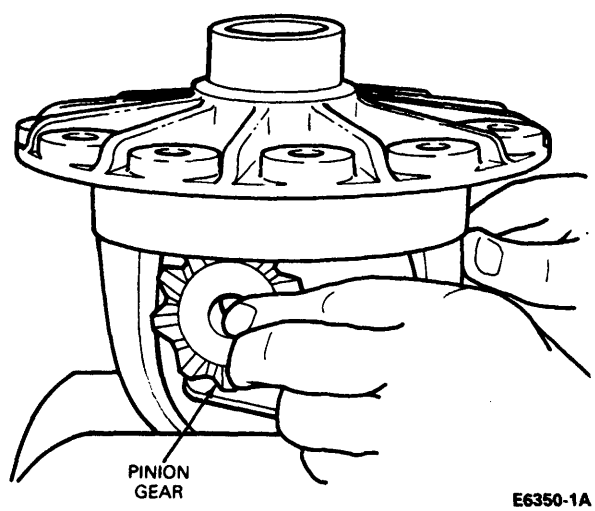
INNER AXLE SHAFT SEAL REMOVAL



Differential Case

Assembly

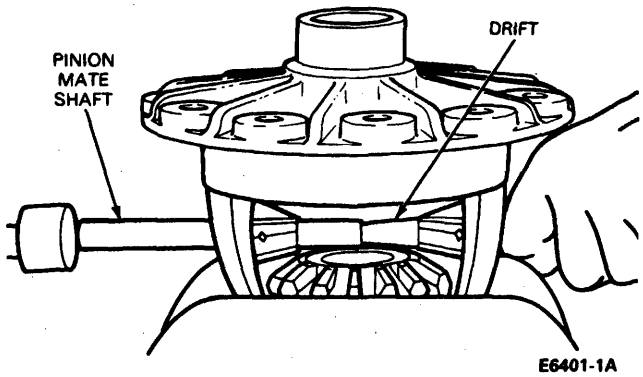
1. Place differential case in vise. Apply grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent, to new side gear thrust washers and to hubs and thrust face of the new side gears. Assemble both side gears. Apply grease to the new spherical washers, and the new pinion mate gears. Assemble new pinion mate gears and washers.
2. Assemble both side gears and thrust washers, hold in place with hand, then assemble the pinion mate gears and washers to hold the side gears in place. An easy way to assemble the side gears and pinion mate gears is to have all parts lubricated before assembly.
3. Rotate the side gears until the holes of the washers and pinion gears line up with the holes of the case. If the gears cannot be rotated by hand, install one of the axle shafts into the side gear spline and use a pipe wrench to turn the shaft.



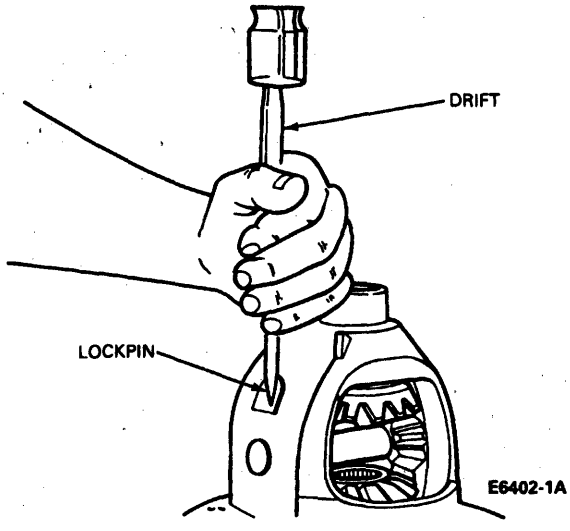
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DISASSEMBLY AND ASSEMBLY (Continued)

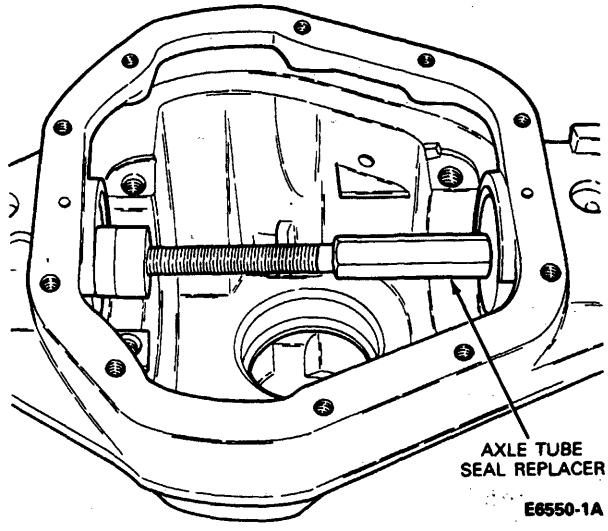
4. Use a drift to line up the holes with those of the differential case.
5. Assemble pinion mate shaft, drive on shaft to remove drift. Be sure lockpin hole of the shaft is lined up with the lockpin hole of the case.



6. Assemble lockpin (roll pin). Peen metal of case over pin to lock in place.



7. Be sure flange face of the case is free of nicks or burrs. Assemble ring gear to case. Line up holes of the ring gear with those of the case. Use new ring gear bolts. Draw up bolts alternately and evenly. Tighten ring gear bolts to 136-163 N·m (100-120 ft-lb).
8. Place the inner axle seals in the axle tube housing. Press both seals in at the same time with an appropriate installation tool. Make sure the seals are pressed in straight and not cocked in the bore. Coat the lips of the seals with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.
9. Install Master Differential Bearings, Tool D81T-4222-D or equivalent onto case. Remove all nicks, burrs, dirt, etc., from hubs to allow bearings to rotate freely.

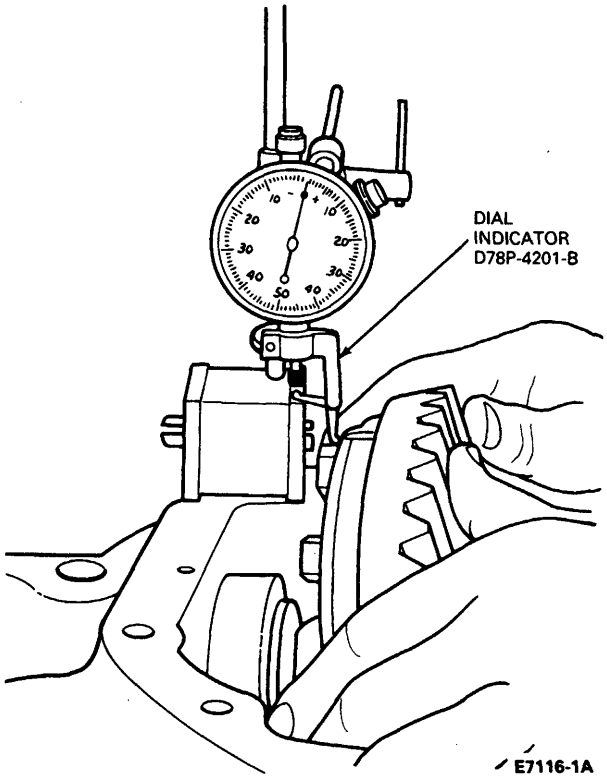


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DISASSEMBLY AND ASSEMBLY (Continued)

10. Assemble differential case into carrier (less pinion). Mount Dial Indicator D78P-4201-B or equivalent with a magnetic base as shown. Locate tip of indicator on flat surface of one of the ring gear bolt spot faces. Force differential assembly as far as possible in the direction towards the indicator. With force still applied, set indicator at zero.

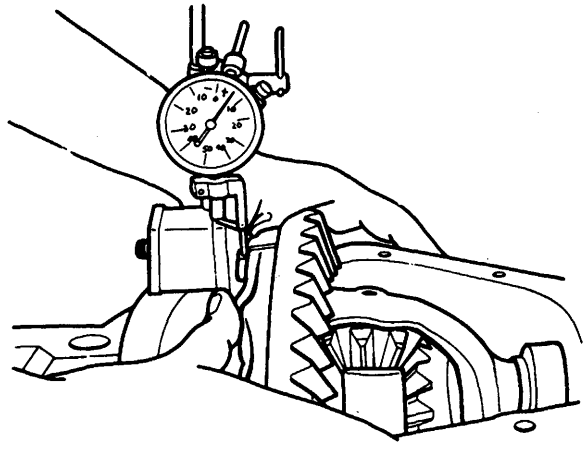
NOTE: Dial indicator should have a minimum travel of 5.08mm (0.200 inch).



E7116-1A

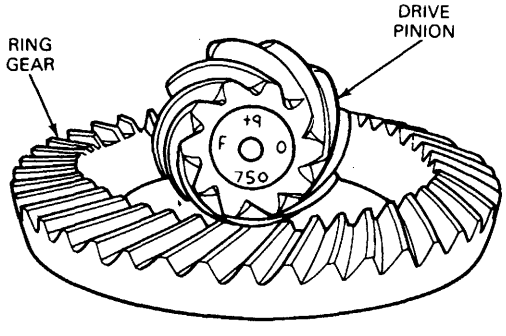
11. Force the differential assembly as far as it will go in the opposite direction. Repeat these steps until you have obtained the same reading. Record the reading of the indicator. This will be the total amount of shims required (less preload) and will be calculated later during assembly. After making sure the readings are correct, remove indicator and differential assembly from housing. DO NOT REMOVE MASTER BEARINGS FROM DIFFERENTIAL CASE AT THIS TIME.

This reading is the total differential case end play which will be needed in Step 6 of Assembly of Differential into Housing in this Section.



E6403-1A

12. Ring gears and pinions are supplied in matched sets only. Matching numbers on both the pinion and ring gear are etched for verification. If a new gearset is being used, verify the numbers of each pinion and ring gear before proceeding with assembly.



STANDARD PINION

E7117-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

The distance from the centerline of the ring gear to the button end of the pinion is 79.37mm (3.125 inch).

On the button end of each pinion, there is etched a plus (+) number, a minus (-) number, or a zero (0) number which indicates the best running position for each particular gearset. This dimension is controlled by the shimming behind the inner pinion bearing cup.

For example—If a pinion is etched a plus m+8 (+3), this pinion would require 0.08mm (0.003 inch) less shims than a pinion etched "0". This means by removing shims, the mounting distance of the pinion is increased to 79.45mm (3.128 inch), which is just what m+8 (+3) indicates. Or if a pinion is etched m-8 (-3), we would want to add 0.08mm (0.003 inch) more shims than would be required if the pinion were etched "0". By adding 0.08mm (0.003 inch) shims, the mounting distance of the pinion was decreased to 98.29mm (3.122 inch), which is just what m-8 (-3) indicated.

If the old ring and pinion set is to be reused, measure the old shim pack and build a new shim pack to this same dimension. If a baffle is used in the axle assembly, it is considered as part of the shim pack.

To change the pinion adjustment, shims are available in thicknesses of 0.08, 0.13, and 0.25mm, (0.003, 0.005, and 0.010 inch).

NOTE: If baffle or slinger is bent or mutilated, it should be replaced.

Measure each shim separately with a micrometer and add together to get the total shim pack thickness from the original buildup.

If a new gearset is being used, notice the (+) or (-) etching on both the old and new pinion and adjust the thickness of the new shim pack to compensate for the difference of these two figures.

For example—If the old pinion reads m+5 (+2) and the new pinion is m-5 (-2), add 0.10mm (0.004 inch) shims to the original shim pack.

PINION SETTING CHART — METRIC

Old Pinion Marking	New Pinion Marking								
	−4	−3	−2	−1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003
0	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004
−1	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005
−2	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006
−3	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007
−4	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007	−0.008

CE6651-2A

PINION SETTING CHART — ENGLISH

Old Pinion Marking	New Pinion Marking								
	−10	−8	−5	−3	0	+3	+5	+8	+10
+10	+.20	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0
+ 8	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03
+ 5	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05
+ 3	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08
0	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10
− 3	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13
− 5	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15
− 8	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15	−.18
−10	0	−.03	−.05	−.08	−.10	−.13	−.15	−.18	−.20

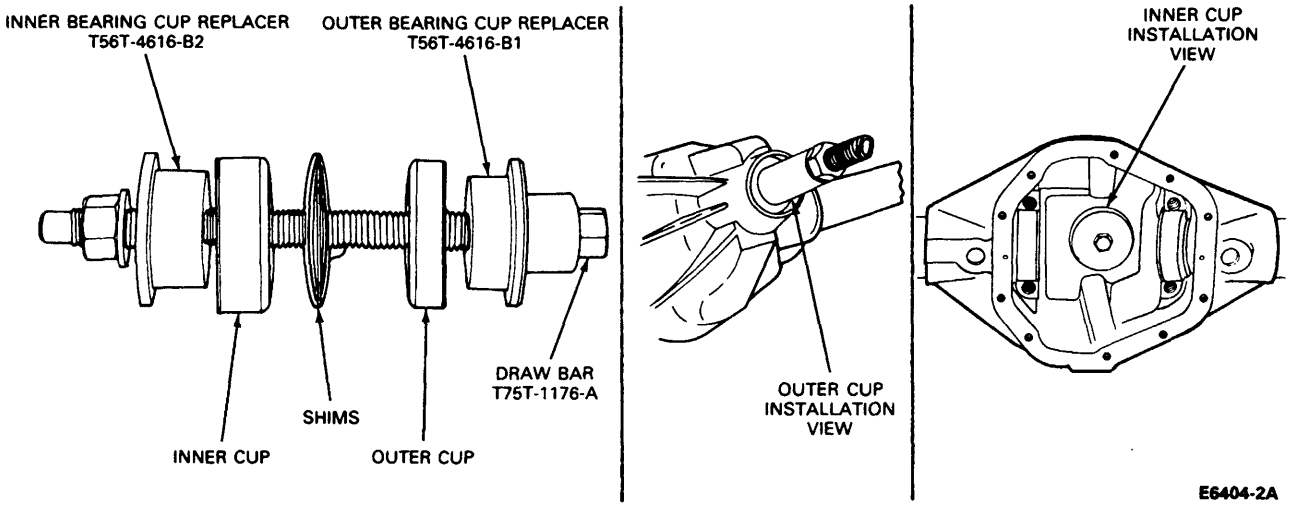
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DISASSEMBLY AND ASSEMBLY (Continued)

Pinion Bearing Cup Installation

1. Place the preload shims under the inner cup as shown.
2. Place the inner and outer bearing cups into the carrier bore.
3. Place the Inner Bearing Cup Replacer Tool T56T-4616-B2 or equivalent on the inner bearing cup.
4. Place the Outer Bearing Cup Replacer Tool T56T-4616-B1 or equivalent on the outer bearing cup.
5. Install the Threaded Drawbar, T75T-1176-A or equivalent, into the replacer tools and tighten the drawbar to install the cups into the carrier bore.



Depth Gauge Check

1. Refer to the chart below for the correct tools for the particular axles.

NOTE: If any of the gauge surfaces become nicked, the high spots must be removed with a medium India oilstone to ensure correct readings.

2. Place a new inner pinion bearing over the proper aligning adapter and insert into the pinion bearing retainer assembly. Place the outer pinion bearing (new or used if in good condition) into the bearing cup and assemble the handle onto the screw and hand tighten. Note the 3/8 inch square drive in the handle to be used for obtaining the proper pinion bearing preload. Tighten to preload of 2.26-4.53 N·m (20-40 in-lb).
3. Center the proper gauge tube into the differential bearing bore. Install the bearing caps and tighten capscrews to 109-147 N·m (80-90 ft-lb).
4. Using a feeler gauge tool or shims, select the thickest feeler shim that will enter between the gauge tube and the gauge block. Insert the feeler gauge directly along the gauge block to insure a correct reading. The feeler gauge fit between the gauge tube and the gauge block should be a slight drag-type feeling. Make sure the shims or feeler gauges are free of dirt to ensure a correct reading.

Description	Number
Handle	T76P-4020-A11
Screw	T80T-4020-F43
Gauge Block	T80T-4020-F42
Aligning Adapter	T76P-4020-A3
Gauge Disc	T78P-4020-A15
Gauge Tube	D80T-4020-F48
Final Check Gauge Block	D81T-4020-F54

CE6653-1A

5. After the correct feeler gauge feel is obtained, check the reading. This is the thickness of shim(s) required providing that, upon inspection of the service pinion gear, there are no markings.

NOTE: If the service pinion gear is marked with a plus (+) reading, this amount must be subtracted from the thickness dimension obtained in Step 4.

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DISASSEMBLY AND ASSEMBLY (Continued)

If the service pinion gear is marked with a minus (-) reading, this amount must be added to the thickness dimension obtained in Step 4.

In addition, you must use the exact same new inner pinion bearing that was used in the previous steps.

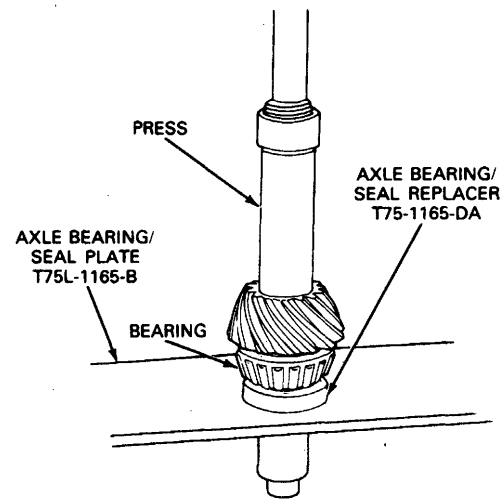
6. Remove the inner pinion bearing cup and install the correct thickness of shims in the carrier bore. Re-install the bearing cup and oil slinger (if used) on the pinion and press on the bearing with T53T-4621-C or equivalent.

NOTE: If a baffle or slinger is used, replace with a new one upon assembly and measure as part of the shim stack.

7. After following these procedures, continue to build the remaining components with proper pinion and differential bearing preload torques and ring gear backlash.

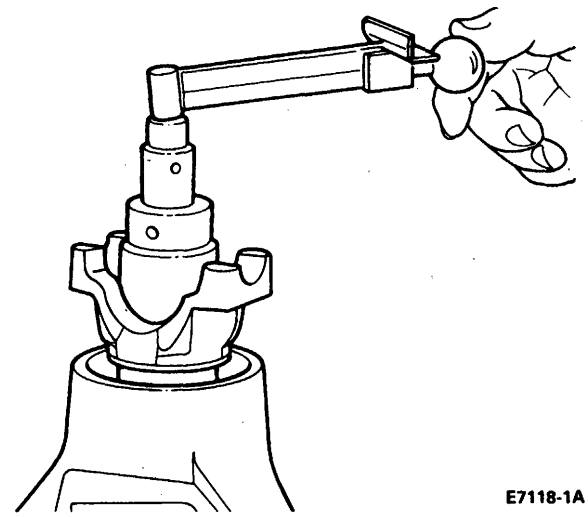
Pinion Bearing Preload and Final Depth Check

1. Assemble preload shims and slinger (if used) onto pinion. Assemble bearing cone. Using T75L-1165-B, Axle Bearing/Seal Plate and T75L-1165-DA, Axle Bearing/Seal Replacer or their equivalents.



E6405-1A

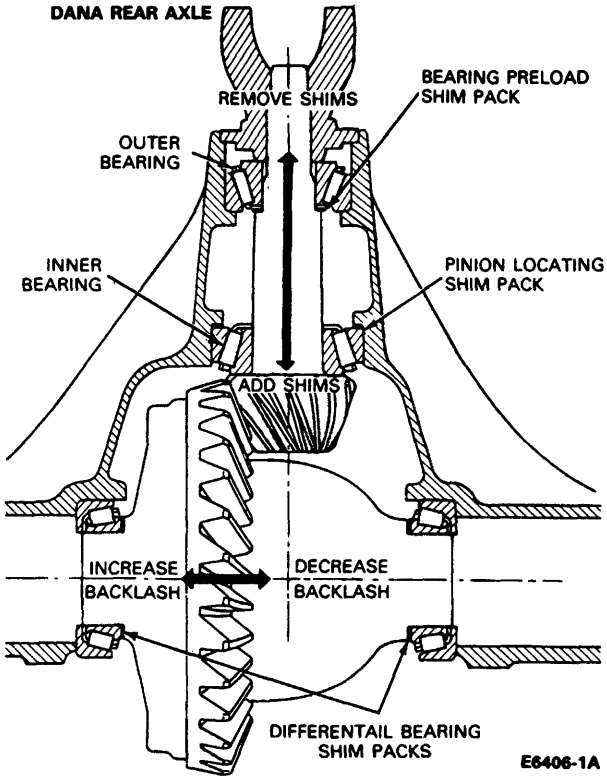
2. Assemble end yoke, washer and new pinion nut. Tighten nut to torque specifications listed at the end of this Section.
3. Using an inch-pound torque wrench, rotate pinion. The torque required to rotate the pinion should be between 2.26-4.53 N·m (20-40 in-lb). To increase preload, remove shims from drive pinion. To decrease preload, add shims to pinion.


E7118-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

The illustration shows the arrow in the pinion pointing in two directions. The arrow pointing towards the end yoke indicates that by removing pinion position shims, the distance from the centerline of the axle to the pinion button is increased giving a plus reading. The arrow pointing toward the drive pinion indicates that by adding pinion shims, the distance from the centerline of the axle to the pinion button is decreased, giving a minus reading. The pinion bearing preload shim pack does not affect the pinion depth setting. The arrows on the ring gear show the method for increasing or decreasing ring gear backlash by inserting or removing differential bearing shims.



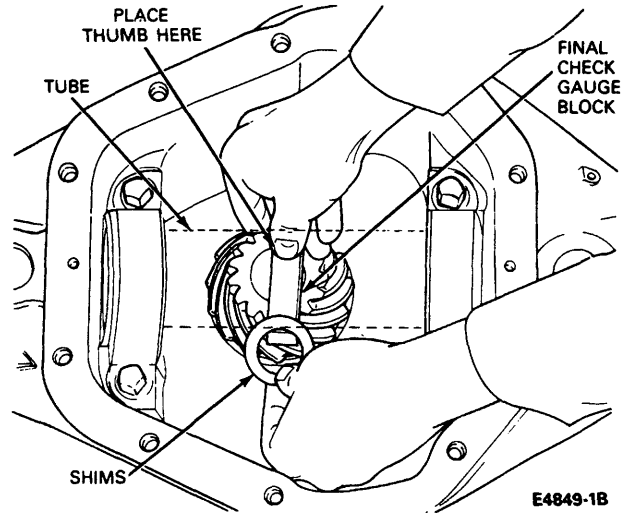
4. Insert the Final Check Gauge Block, D81T-4020-F54 on top of the pinion button under the Gauge Tube. Place your thumb on the Gauge Block to make sure that the block is level.

   Insert feeler gauges or shims between the gauge tube and the Final Check Gauge Block until a slight drag is felt.

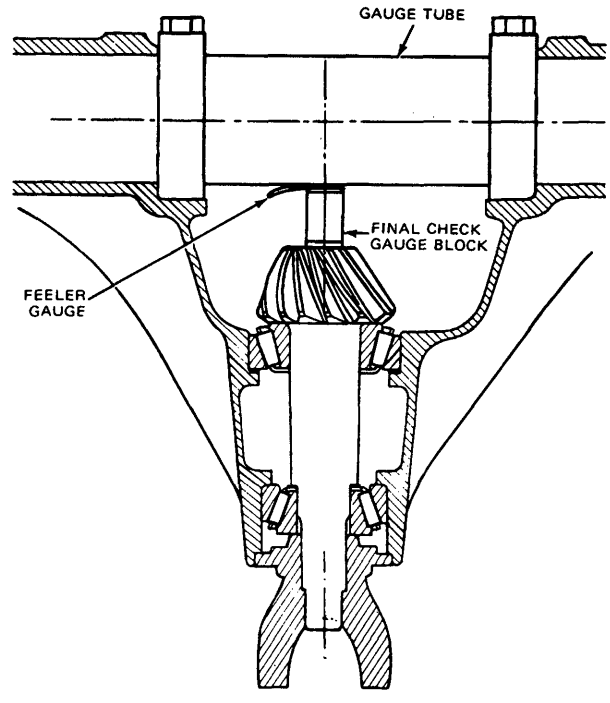
   The reading should be 0.050mm (0.020 inch) added to the drive pinion etching, which could be plus (+) or minus (-) with a tolerance (±) of 0.050mm (0.002 inch).

For example: a drive pinion with a -2 etching would have a 0.45mm (0.018 inch) distance and a tolerance of 0.050mm (0.002 inch), would require 0.40-0.50mm (0.016-0.020 inch) amount of shims.

If the distance must be increased, remove shims from beneath the inner pinion bearing cup. If the distance must be decreased, add shims beneath the inner pinion bearing cup.



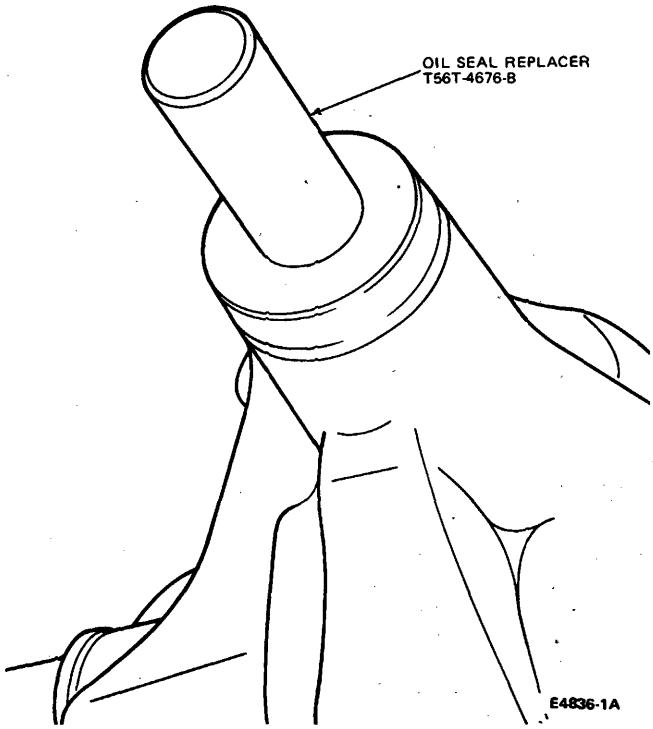
5. Install the Gauge Tube D80T-4020-F48. Install bearing caps and tighten capscrews to 109-147 N·m (80-90 ft-lb).



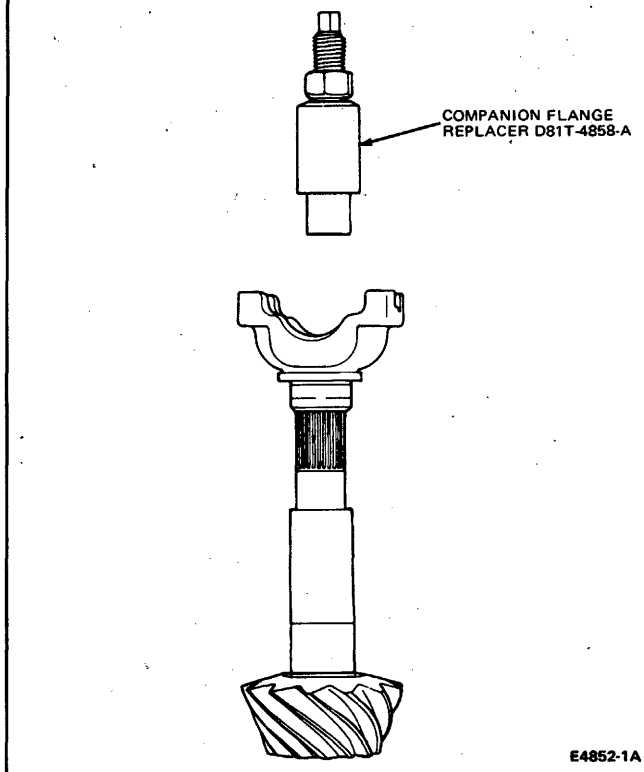
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DISASSEMBLY AND ASSEMBLY (Continued)

6. With the drive pinion at the correct depth, remove the yoke with Holding Tool, T78P-4851-A and Yoke Remover, T65L-4851-B or equivalents. Remove the yoke, nut and washer.
7. Coat the oil seal with grease. Install the drive pinion oil seal with Oil Seal Replacer, T56T-4676-B or equivalent. After installation, make sure the garter spring did not pop out. If the garter spring pops out, remove and replace seal.



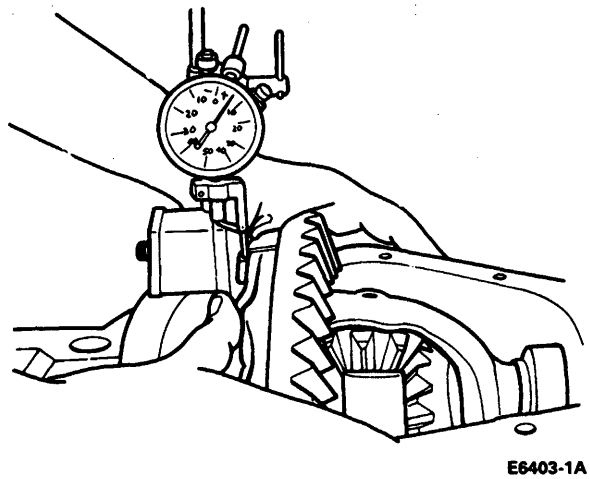
8. Install the yoke with Companion Flange Replacer, D81T-4858-A or equivalent, if necessary to draw the drive pinion up to engage the nut. Install the washer and nut and tighten nut to torque specifications listed at the end of this Section.



Assembly of Differential Into Housing

RING GEAR AND PINION BACKLASH

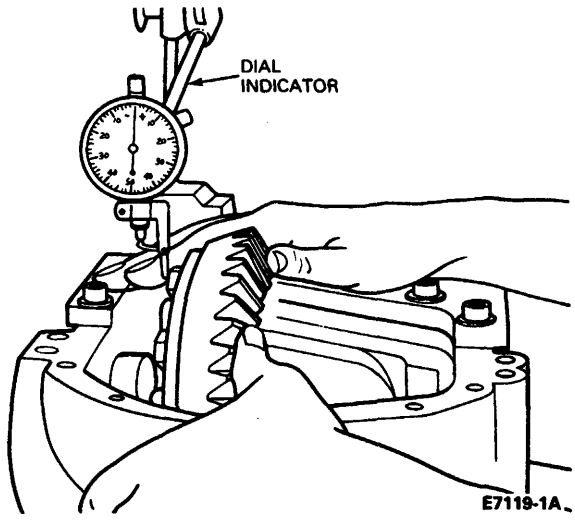
1. Place differential assembly (with pinion installed) into housing. Differential master bearings should still be assembled to case.
2. Set up dial indicator. Force ring gear into mesh with the pinion. Rock ring gear to allow the teeth of the gears to mesh. With force still applied to the differential case, set indicator at zero.



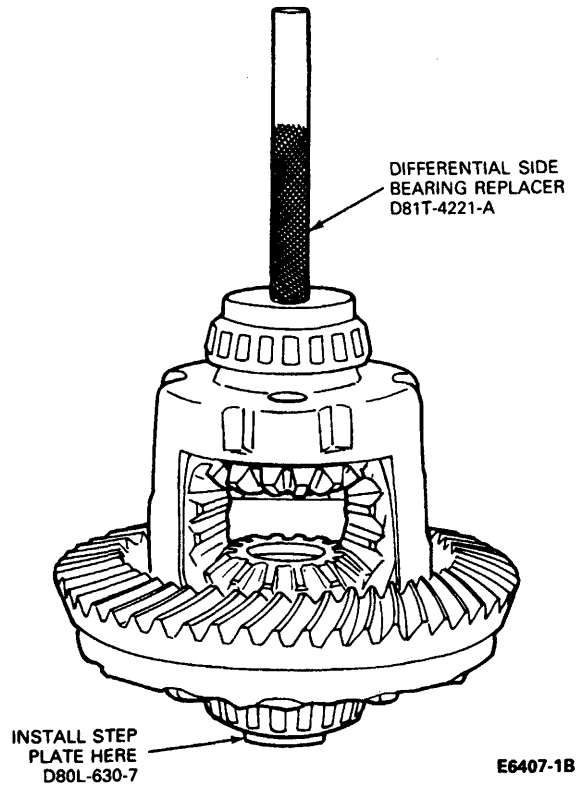
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DISASSEMBLY AND ASSEMBLY (Continued)

3. Force the differential case (ring gear) away from the pinion gear to obtain an indicator reading. Repeat until the same reading is obtained each time. This reading will be the necessary amount of shims required between the differential case and differential bearings on the ring gear side. Remove indicator and differential case from the carrier. Remove master bearings from differential case.



4. As determined in Step 3, place the required amount of shims on the ring gear hub of the differential case. For example: if the reading in Step 3 was 1.14mm (0.045 inch), place 1.14mm (0.045 inch) amount of shims on the hub of the ring gear side of the differential case.
5. Install the bearing cone on the ring gear side of the differential case. Drive the bearing onto the hub using Differential Side Bearing Replacer, D81T-4221-A or equivalent as shown.



6. To determine the correct amount of shims to be placed on the hub of the drive pinion side of the differential case, subtract the reading obtained in Step 3 from the total differential case end play. Total case end play was determined under Steps 9 and 10 of Differential Case—Assembly. When this amount is determined, add 0.36mm (0.015 inch) to the amount. This is the required amount of shims to be placed on the hub of the drive pinion side of the differential case.

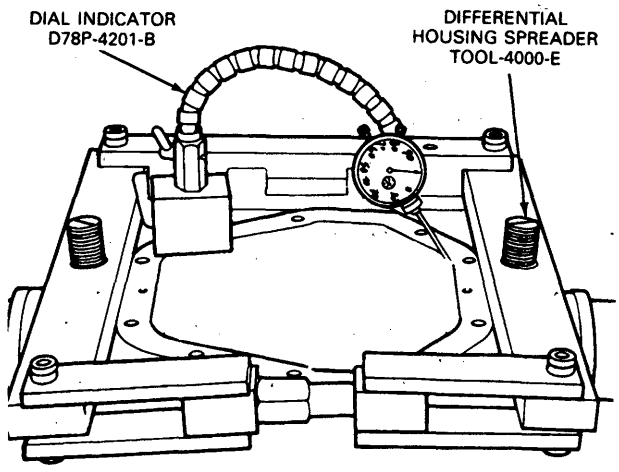
   For example: Total Differential Case End Play was 2.30mm (0.091 inch). The reading in Step 3 was 1.14mm (0.045 inch), and when subtracted from 2.30mm (0.091 inch) gives 1.16mm (0.046 inch). 0.36mm (0.015 inch) is added to give 1.52mm (0.061 inch) amount of shims to be placed on the hub of the drive pinion side of the differential case.
7. Place the required amount of shims on the hub of the drive pinion side of the differential case.
8. Install the bearing cone on the hub of the drive pinion side of the differential case. Place Step Plate D80L-630-7 or equivalent for Model 60 axles on the ring gear side bearing to protect the bearing during installation of the drive pinion side bearing. Place the bearing on the drive pinion side hub and drive it on using Differential Side Bearing Replacer, D81T-4221-A or equivalent.

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DISASSEMBLY AND ASSEMBLY (Continued)

9. Install spreader and indicator to carrier. Remove indicator.

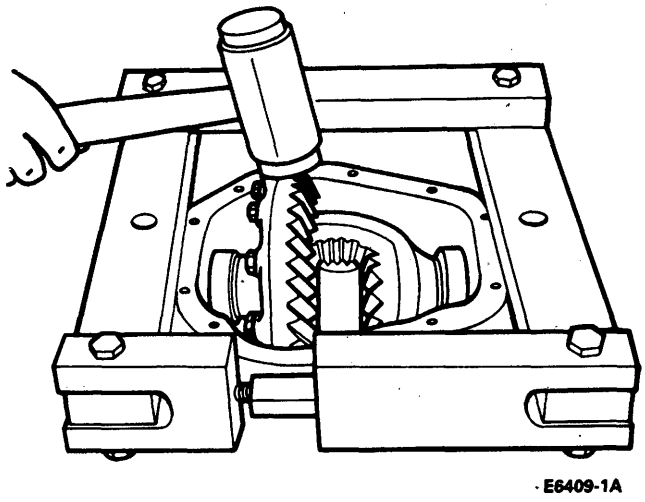
CAUTION: Do not spread carrier over 0.38mm (0.015 inch).



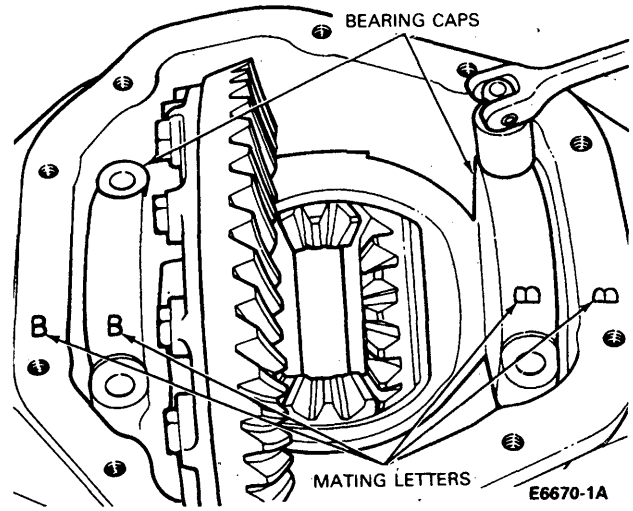
10. Assemble differential bearing cups to differential bearing cones.

Install differential assembly into carrier.

Use a rawhide hammer to seat differential assembly into crossbore of carrier. Care should be taken to avoid nicking the teeth of the ring gear and pinion during assembly. Remove the spreader from the differential case.



11. Install bearing caps. Make sure the letters stamped on the caps correspond with those on the carriers. Tighten bearing cap screws to torque specifications listed at the end of this Section.



12. Check ring gear and pinion backlash in three equally spaced points with dial indicator.

Backlash tolerance is 0.13-0.23mm (0.005-0.009 inch) and cannot vary more than 0.05mm (0.003 inch) between points checked.

High backlash is corrected by moving the ring gear closer to the pinion.

Low backlash is corrected by moving ring gear away from the pinion.

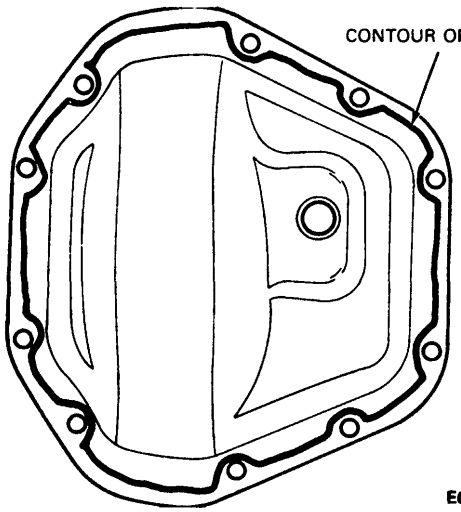
These corrections are made by switching shims from one side of the differential case to the other.

13. Install new cover gasket and install cover plate. Tighten screws to torque specifications listed at the end of this Section.

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DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: The flat mounting surface cover plate on Dana design axles requires the use of a silicone rubber sealer material, Silicone Rubber D6AZ-19562-A (clear) or D6AZ-19562-3 (black) (ESB-M4G92-A and ESE-M4G195-A) or equivalent rather than a gasket.



E6667-1A

The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.

Sealant material must meet specifications of D6AZ-19562-A or B, ASTM1, GE503, Z1, Z2 and Z3 sealant or equivalent.

Apply RTV Gasket Sealer D6AZ-19562-A or B, or equivalent to cover plate surface. Ensure that the sealer bead is laid on the inside of the cover screw holes. The bead is not to pass through the holes or outside of the holes.

The bead is to be 3.18-6.35mm (1/8 to 1/4 inch) wide.

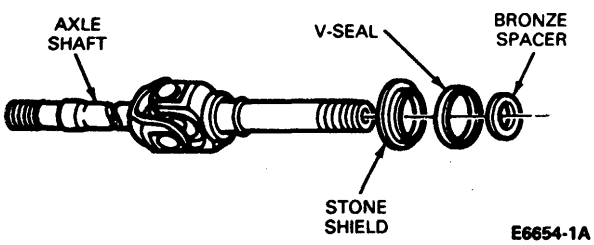
Install two cover screws into cover at 8 o'clock and 2 o'clock positions. Use these two holes to guide cover plate into position on the carrier.

Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft-lb).

Allow one hour curing time before filling carrier with the proper amount of specified lubricant and vehicle operation.

14. Install the axle shafts as described under Axle Shaft in the Removal and Installation portion of this Section. Connect the steering linkage to the spindle.

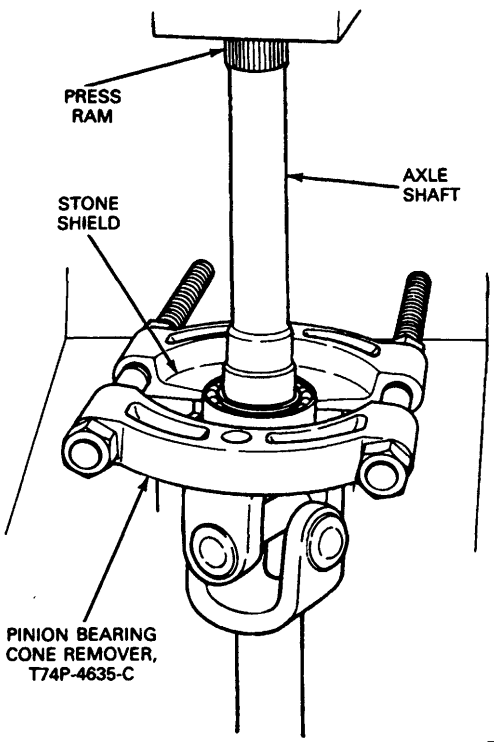
Axle Shaft



E6654-1A

Disassembly

1. Remove the axle shaft as described under Axle Shaft in the Removal and Installation portion of this Section.
2. If installed, remove the bronze spacer from the axle shaft.
3. Remove the rubber V-seal from the stone shield and axle shaft.
4. If required, remove the stone shield from the axle shaft with a press and Pinion Bearing Cone Remover, D79L-4621-C or equivalent. Discard the stone shield.
5. Remove the snap rings that retain the bearings in the yoke and axle shaft.
6. Position U-Joint Tool, T74P-4635-C or equivalent on the shaft and press the bearings out of the yoke. If the bearing cannot be pressed completely out of the yoke, remove the bearing with vise grip or channel lock pliers. Mark the yoke and shaft so they can be assembled in the same position.
7. Re-position the tool to press on the spider in order to remove the bearing from the opposite side of the yoke.
8. Remove the yoke from the spider.
9. Remove the bearings and spider from the axle shaft in the same manner.



E6655-1A

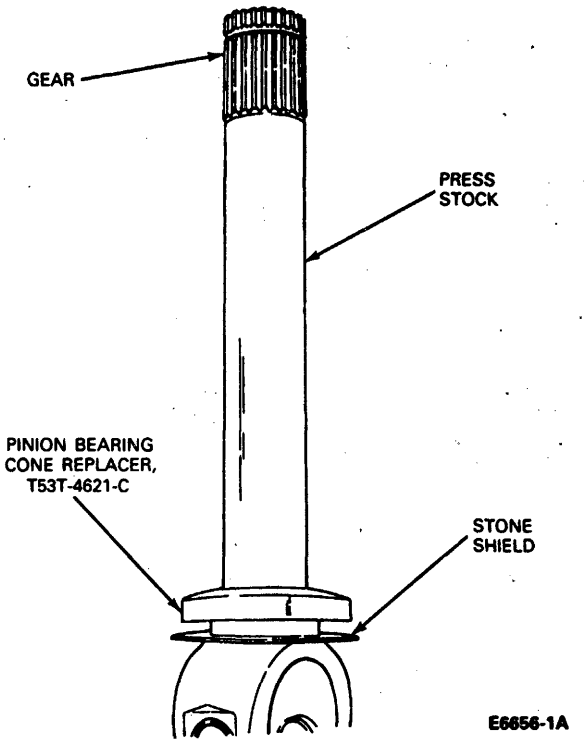
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DISASSEMBLY AND ASSEMBLY (Continued)

Assembly

1. Start a new bearing into the axle shaft.
2. Position the spider in the axle shaft and press the bearing 6mm (1/4 inch) below the axle shaft surface using U-Joint Tool, T74P-4635-C or equivalent.
3. Remove the tool and install a new snap ring.
4. Start a new bearing on the opposite side of the axle shaft.
5. Install the U-Joint Tool and press the bearing until the snap ring of the opposite bearing contacts the axle shaft.
6. Remove the tool and install a new snap ring.
7. Install the yoke on the spider in position marked during disassembly.
8. Install two new bearings and snap rings in the yoke and spider in the same manner as the axle shaft.
9. Check the U-joint for freedom of movement. If a binding condition results, tap the ears of the axle shaft sharply to relieve the binding. **DO NOT INSTALL AN AXLE SHAFT IF THE U-JOINT SHOWS SIGNS OF BINDING.**
10. If removed, press a new stone shield on the axle shaft with an appropriate piece of press stock and Pinion Bearing Cone Replacer, T53T-4621-C or equivalent.
11. Install the rubber V-seal on the stone shield and axle shaft. The lip of the seal should face towards the spindle.
12. If removed, install the bronze spacer on the axle shaft. The chamferred side of the spacer should be inboard against the axle shaft.

STONE SHIELD INSTALLATION



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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Number	Description
D78P-4201-B	Dial Indicator	T57T-4851-B	Companion Flange Holding Tool
D79L-4621-C	Pinion Bearing Cone Remover	T64P-3590-F	Pitman Arm Puller
D80L-100-H	Actuator Pin	T65L-4851-B	End Yoke Remover
D80L-100-W	Bridge Assembly	T74P-4635-C	U-Joint Tool
D80L-100-T	Collet	T75L-1165-B	Axle Bearing/Seal Plate
D80L-630-7	Step Plate	T75L-1165-DA	Axle Bearing/Seal Replacer
T86T-3110-AH	King Pin Seal Installer	T75T-1176-A	Threaded Drawbar
D80T-4020-F48	Gauge Tube	T76P-4020-A3	Aligning Adapter
D81L-4000-A	Driver Handle	T76P-4020-A11	Handle
D81T-4020-F54	Final Check Gauge Block	T77F-1102-A	Bearing Cup Puller
D81L-4220-A	Universal Bearing Remover	T77L-9533-B	Jet Plug Puller
D81T-4221-A	Differential Side Bearing Replacer	T78P-4020-A15	Gauge Disc
D81T-4222-D	Master Differential Bearings	T78P-5851-A	Holding Tool
D81T-4628-A	Bearing Cup Remover	T80T-4000-R	Bearing Replacer
D81T-4628-D	Bearing Cup Remover	T80T-4000-W	Driver Handle
D81T-4858-A	Companion Flange Replacer	T80T-4020-F42	Gauge Block
D85L-1039-A	Two-Jaw Puller	T80T-4020-F43	Screw
D85T-1197-A	Spanner Locknut Wrench	T83T-4676-A	Oil Seal Replacer
T50T-100-A	Slide Hammer	TOOL-1175-AC	Seal Remover
T53T-4621-C	Pinion Bearing Cone Replacer	TOOL-4000-E	Differential Housing Spreader
T56T-4616-B1	Outer Bearing Cup Replacer	TOOL-4201-C	Dial Indicator
T56T-4616-B2	Inner Bearing Cup Replacer	TOOL-4858-E	Companion Flange Replacer
T56T-4676-B	Oil Seal Replacer		

CE6660-2B

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SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS — DANA MODEL 60 FRONT DRIVE AXLE

Description	N·m	Ft-Lbs
Pinion Shaft Nut	326-406	240-300
Differential Bearing Cap Capscrews	108-122	80-90
Ring Gear Bolts/Nuts ①	136-163	100-120
Oil Filler Plug	28-40	20-30
U-Joint U-Bolt Nuts	21-27	15-20
Cover-To-Housing Bolts	41-54	30-40
Tracking Bar Nut & Bolt	221-275	163-203
Kingpin	678-813	500-600
Steering Cap Nuts	95-122	70-90
Stabilizer Link Nut	28-48	21-33
Stabilizer Bar U-Bolt	65-92	48-68
Spindle Connecting Rod To Steering Knuckle Castellated Nut	95-136	70-100
Stabilizer Bar Bracket U-Bolt	65-92	48-68

① If equipped with Grade 9 bolts C7 lines on bolt head, tighten to 163-190 N·m (120-140 ft-lbs).

CE6657-1A

ROTUNDA EQUIPMENT

Model Number	Description
014-00257	Differential Repair Stand
077-00008	Low Lift Transmission Jack

CE6662-1A

DANA AXLE ADJUSTMENTS

Description	Specification	Description	Specification
Backlash Between Ring Gear and Pinion	0.13-0.23 mm (0.005-0.009 inch)	Pinion Bearing Preload (with new bearings)	2.26-4.53 N·m (20-40 in-lbs)
Backlash Maximum Variation Between Teeth	0.05 mm (0.002 inch)		

CE6659-2A

AXLE LUBRICANT CAPACITIES

Axle Model	Ford Specification	Approx. Capacities		
		U.S. Pts.	Imp. Pts.	Liters
60	Hypoid Gear Lubricant, C6AZ-19580-E (CESW-M2C105-A) or equivalent	5.8	4.8	2.8

CE6658-2A

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SECTION 15-34 Dana Model 44 and 50 Front Drive Axles

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Front-Wheel Drive Manual Hub	15-34-1
Lock Position	15-34-1
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Bearing Cup and Drive Pinion Installation	15-34-22
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Carrier	15-34-18
Depth Gauge Check	15-34-21
Differential Case	15-34-24, 25
Drive Pinion Installation	15-34-20
Drive Pinion Preload Check and Final Depth Check	15-34-23

SUBJECT	PAGE
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Spindle, and Right and Left Shaft and Joint Assembly	15-34-11
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VEHICLE APPLICATION	15-34-1

VEHICLE APPLICATION

Applies to F-150 Through F-250 (4x4) and Bronco Trucks.

DESCRIPTION AND OPERATION

Three types of Dana front-drive axles are available for Ford light truck application. The Dana 44-IFS (Independent Front Suspension) is available on Bronco and F-150 (4x4). The Dana 44-IFS-HD (Independent Front Suspension—Heavy Duty) is available on F-250 (4x4). The Dana 50-IFS (Independent Front Suspension) is available on F-250 (4x4) equipped with Heavy Duty Front End option or F-250 Super Cab models.

All axles are basically alike with some differences between the three. The 44-IFS is on vehicles equipped with front coil springs. The 44IFS HD and 50 IFS are on vehicles equipped with front leaf springs.

The 44-IFS (Fig. 1) is equipped with automatic hubs and is equipped with manual hublocks (Fig. 2). The 44-IFS-HD (Fig. 3) and 50-IFS (Fig. 4) axles equipped with manual locking hubs only.

The differential carrier is mounted to the left hand axle arm. Adjustment of the differential bearings is accomplished by means of shims placed between the bearings and the differential case. The differential bearings are preloaded by the squeezing action of the carrier housing. A spreader must be used on the axle housing to relieve the tension on the differential bearings and permit removal or installation of the differential.

The front axle is of the integral carrier-housing, hypoid-gear type, in which the centerline of the drive pinion is mounted above the centerline of the ring gear.

The integral drive pinion gear and shaft is supported by two opposed tapered roller bearings which are assembled in the carrier housing. Pinion locating shims, installed between the inner bearing cup and the cup seat, control the drive pinion depth adjustment. The pinion bearing preload is controlled by shims located between the pinion outer bearing and the shoulder on the drive pinion shaft.

The differential case assembly is supported by two opposed tapered roller bearings and cups, which are retained in the housing by removable caps. Shims, installed between each differential bearing and the shoulder on the case, perform three functions: they take up the differential case side clearance; they adjust the backlash between ring gear and drive pinion, and they establish differential side bearing preload.

On IFS front driving axles, the cover on the front of the carrier housing is intregal with the left hand axle arm assembly. A metal tag, stamped with the gear ratio and part number is secured to the housing by one of the carrier mounting bolts (Section 15-01, General Driving Axle and Driveshaft Service).

Front-Wheel Drive Manual Hub

For service procedures on front hubs, refer to Section 11-12 Wheel Hubs and Bearings Front Wheel Drive.

The manual locking hub is standard equipment for the Dana front axle of the Bronco and F-150 (4x4). It is the internal locking type. The automatic locking hubs are optional on F-150 (4x4) and Bronco.

Lock Position

Refer to Fig. 5.

When the transfer case is to be shifted into the position for driving the front axle, the pointer on the

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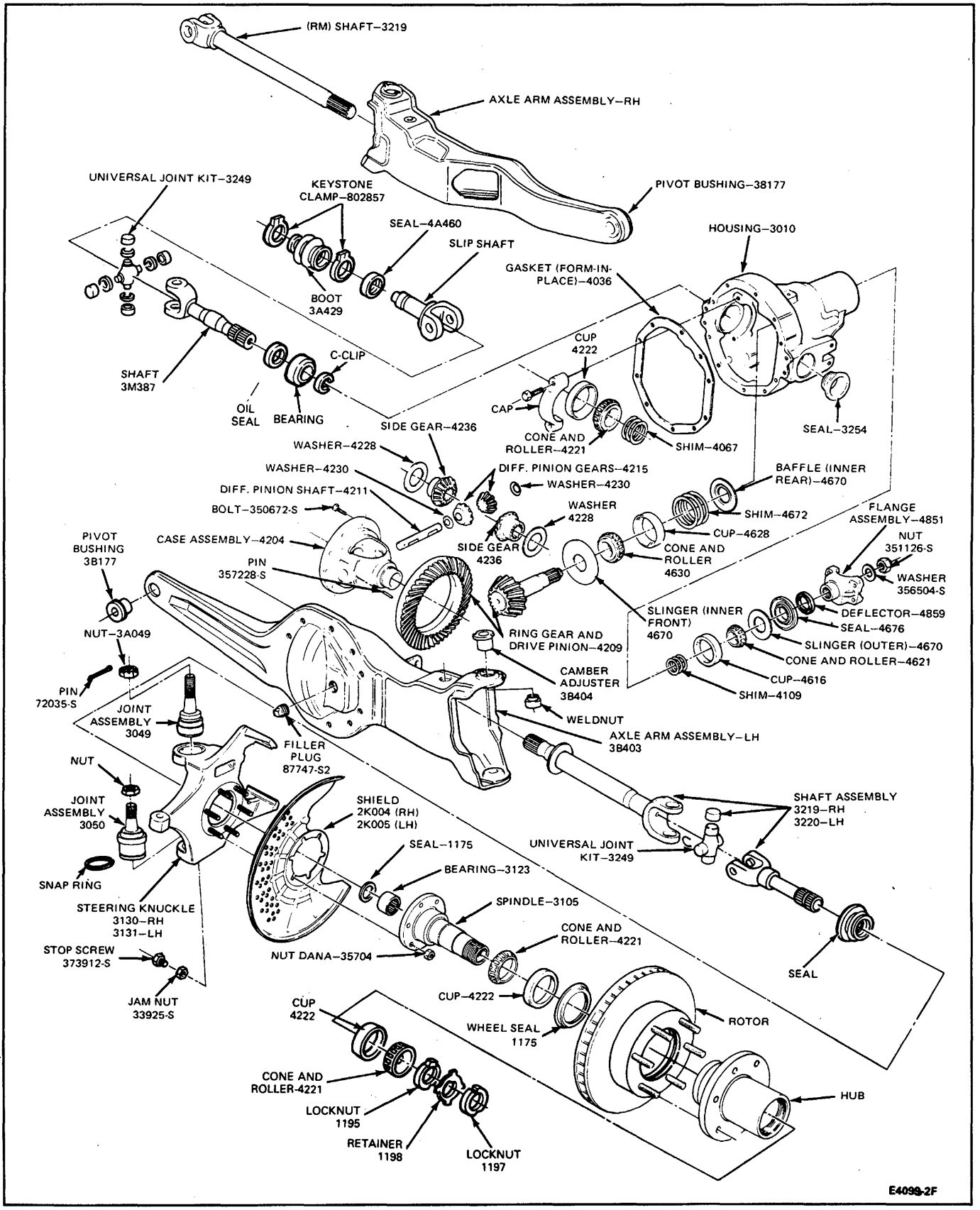


FIG. 1 Dana 44-IFS Front Drive Axle Bronco and F-150 (4x4) with Automatic Hublocks

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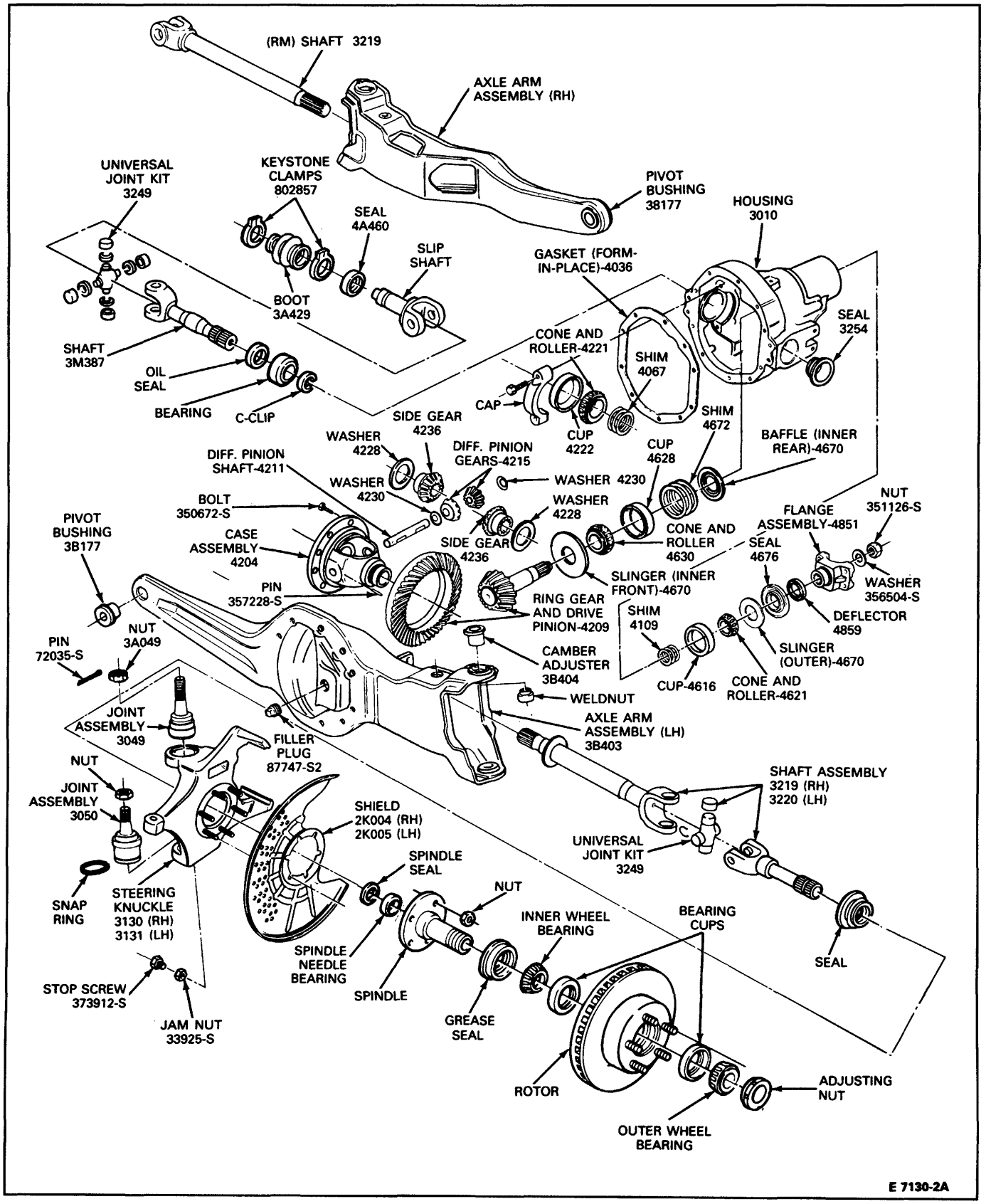


FIG. 2 Dana 44-IFS Front Drive Axle Bronco and F-150 (4x4) with Manual Hublocks

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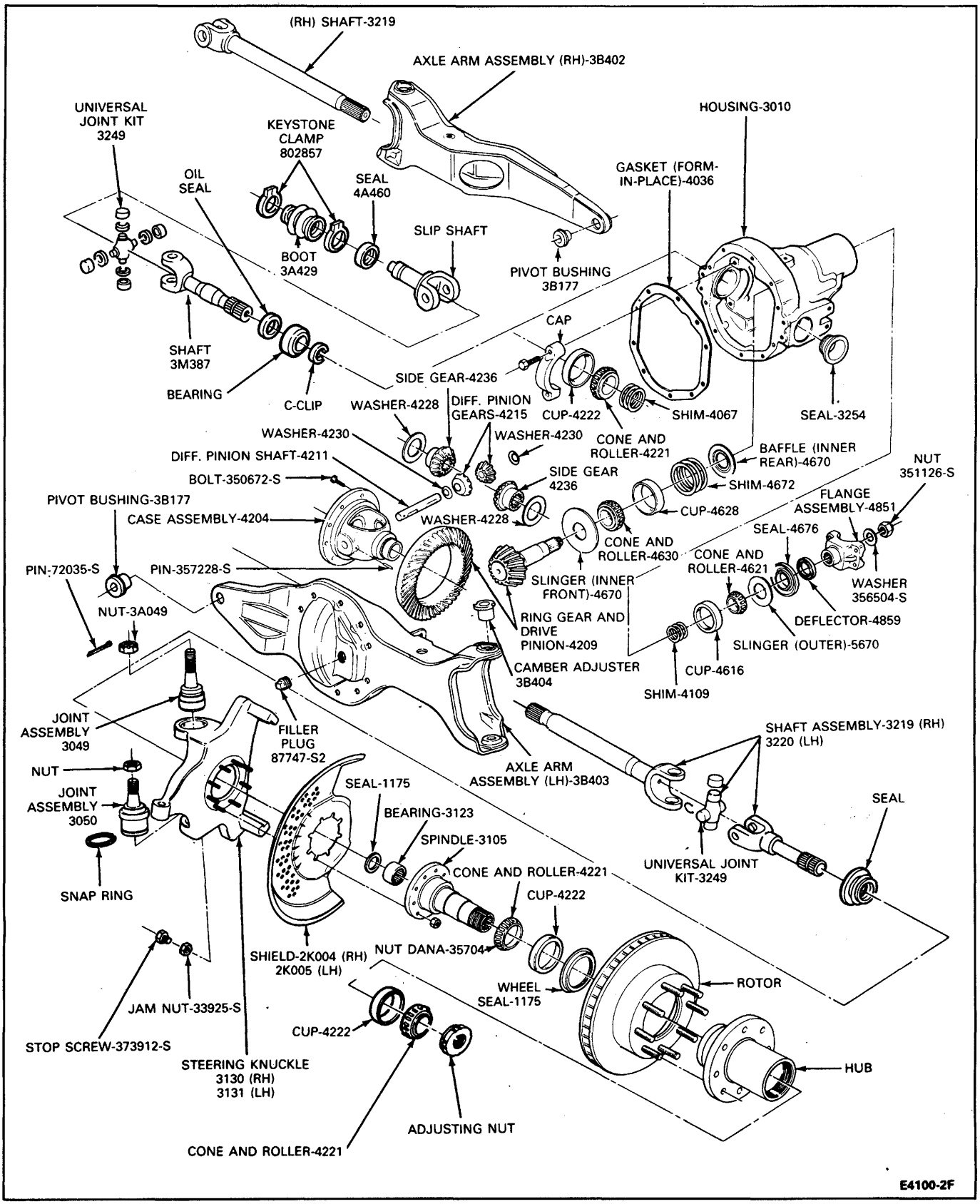


FIG. 3 Dana 44-IFS-HD-Front Driving Axle F-250 (4x4)

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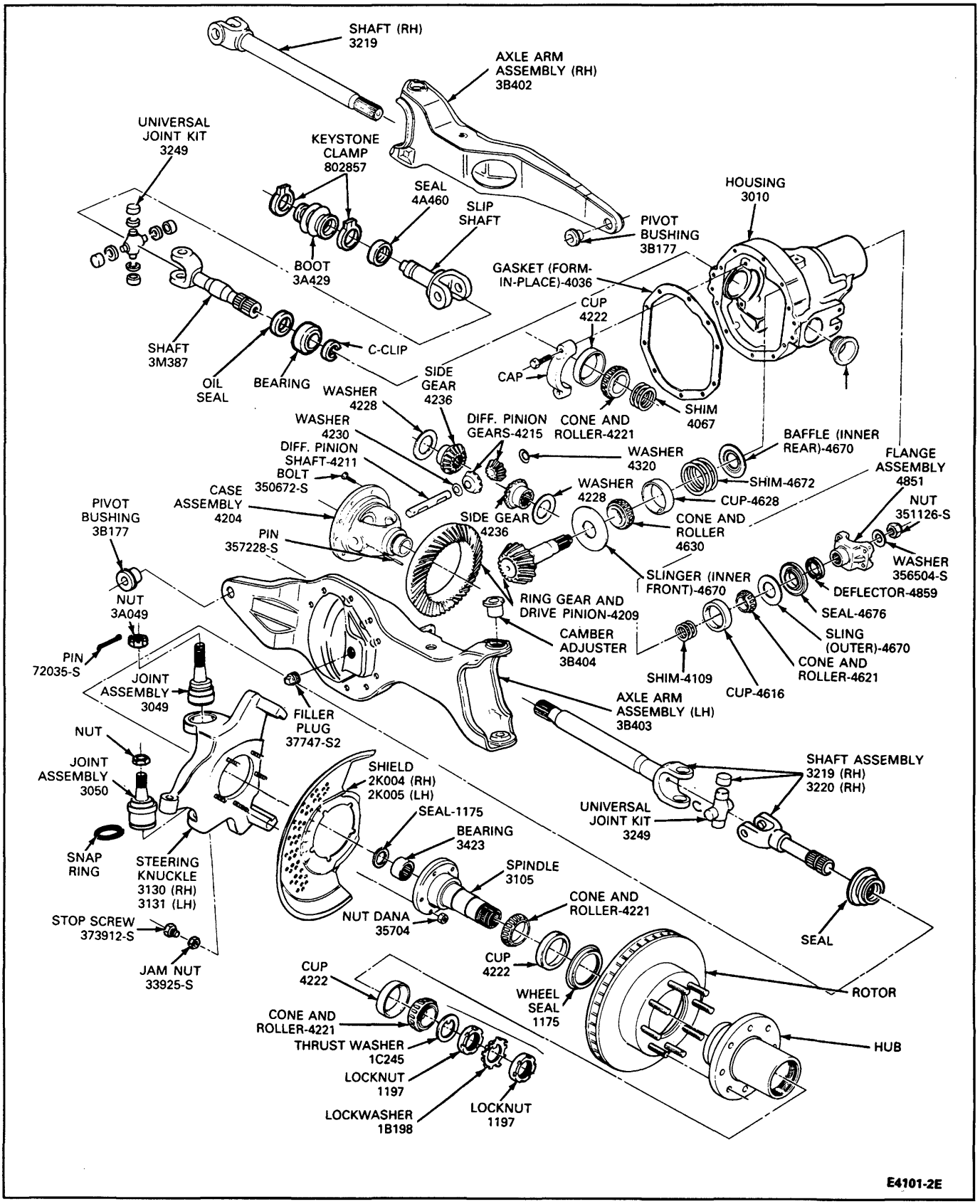


FIG. 4 Dana 50-IFS-Front Drive Axle F-250 (4x4)

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center bar of the hub must point to the pointer over the word LOCK on the Hub Lock Cap. If the clutch teeth do not engage with the knob turned to this position, the clutch teeth are butted and a slight movement of the wheel in either direction will complete the lock. The front axle will now drive the wheels. Do not operate in four-wheel drive with the hubs disengaged.

Free Running Position—Manual Locking Hubs

When the transfer case is to be shifted into the position for driving the rear axle only, turn the pointer on the center bar of the hub so it points to the pointer over the word FREE on the Hub Lock Cap. This will disengage the clutch teeth and thus unlock the wheel hubs from the axle shafts. The wheels will turn freely on the axles.

Be certain that the transfer case is shifted into two-wheel drive position before disengaging the free running hubs.

If difficulty is experienced in disengagement of the free running hubs, a slight movement of the vehicle in either direction with the transfer case in 2 wheel drive position, will reduce driveline wrap-up and ease disengagement.

Automatic Locking Hubs Operation (Optional on Bronco and F-150 (4x4))

Four-Wheel Drive—The vehicle must be stopped when you first shift into four-wheel drive. Place the transmission in neutral and the transfer case selector in the 4H or 4L position. The hublocks will automatically engage when the vehicle is driven. The transfer case may then be shifted between 2H and 4H with the vehicle moving, as long as the automatic hub locks remain engaged. The hubs will remain engaged until the disengage sequence is performed.

Two-Wheel Drive—Place the transfer case in the 2H position. To disengage the automatic hub locks, shift the transmission to move the vehicle in the opposite direction (forward or reverse) and drive a minimum of 10 ft. (30 m) in a straight line.

CAUTION—Never shift from 2H to 4H with the automatic hub locks disengaged while the vehicle is in motion. If it is necessary to shift to or from 4L, bring the vehicle to a full stop before doing so.

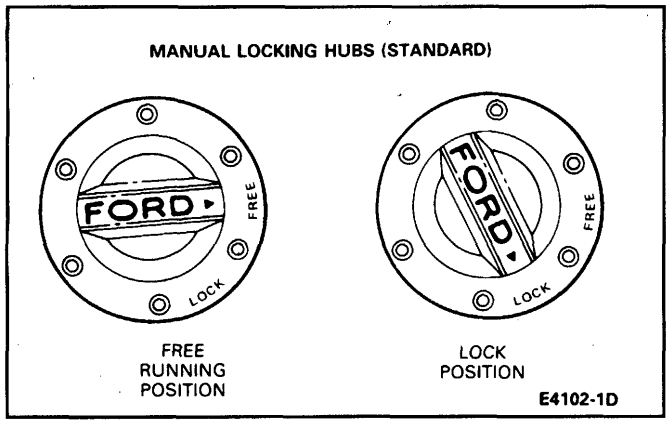


FIG. 5 Four Wheel Drive Wheel Hubs

DIAGNOSIS AND TESTING

Refer to Section 15-01, General Driving Axle Service Under Diagnosis and Testing.

ADJUSTMENTS

Refer to Section 14-01, General Suspension Service for alignment procedures.

REMOVAL AND INSTALLATION

Dana Four Wheel Drive Front Axle

F-150 (4x4) and Bronco With Coil Springs (Fig. 6)

Removal

1. Raise the vehicle on a hoist or jack and install safety stands under the radius arm brackets.
2. Remove the wheel and tire assembly and brake caliper.
3. Position jack under axle arm assembly and remove the upper coil spring retainers. Lower the jack and remove the coil spring, spring cushion and lower spring seat.

   NOTE: The axle arm assembly must be supported on the jack throughout spring removal and installation, and must not be permitted to hang by the brake hose. If the length of the brake hose is not sufficient to provide adequate clearance for the removal and installation of the spring, the disc brake caliper must be removed according to the procedures specified in Section 12-24, Disc Brakes—Light and Heavy Duty Sliding Caliper. After removal, the caliper must be placed on the frame or otherwise supported to prevent suspending the caliper from the caliper hose. These precautions are absolutely necessary to prevent serious damage to the tube portion of the caliper hose assembly.
4. Disconnect the shock absorber at the radius arm and upper mounting bracket.
5. Remove the stud and spring seat at radius arm and axle arm. Remove bolt securing upper attachment to axle arm radius arm to lower attachment axle arm.
6. Disconnect the vent tube at the differential housing and discard the hose clamps. Remove the vent fitting and install a 1/8 inch pipe plug.
7. Remove the pivot bolt securing the right hand axle arm assembly to crossmember. Remove and discard the keystone clamps and remove the boot from the shaft. Remove the right drive axle assembly and pull the axle shaft from the slip shaft.
8. Position a jack under the differential housing. Remove the bolt securing the left hand axle assembly to the crossmember. Remove the left hand drive axle assembly.

Installation

1. Raise the vehicle on a hoist or a jack and position the left drive axle assembly at the radius arm. Secure the drive axle to crossmember with the pivot bolt. Tighten bolt to 163-203 N·m (120-150 ft-lbs).
2. Position the right hand axle assembly at the crossmember and radius arm. Align the axle shaft

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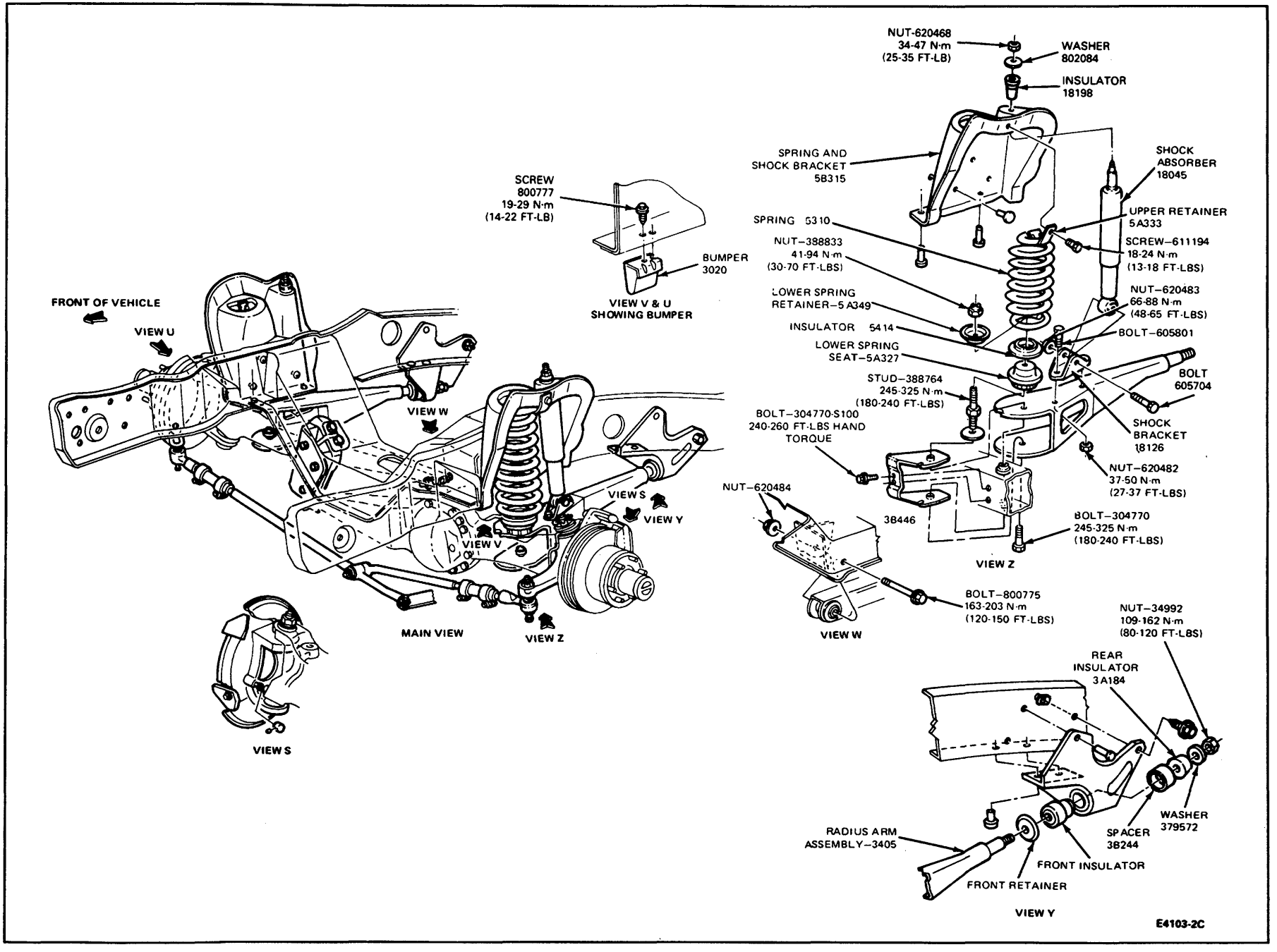


FIG. 6 Front Suspension Bronco F-150 (4x4)

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and install in slip shaft. Install the boot on the shaft so the boot seats in the grooves. Position new Keystone Clamps over the grooves on the boot and crimp the clamp with Keystone Clamp Pliers, T63P-9171-A or equivalent. Secure axle assembly to crossmember with pivot bolt. Tighten to 163-203 N·m (120-150 ft-lbs).

3. Install vent fitting in differential housing. Connect vent tube to vent fitting using new hose clamps.
4. Position spring seat and install a new stud at axle arm and upper radius arm. Install new bolt at axle assembly and lower radius arm. Tighten bolts to 245-325 N·m (180-240 ft-lbs).
5. Position coil spring insulator and coil spring on lower spring seat. Install nut and tighten to 41-94 N·m (30-70 ft-lbs). Position jack under axle assembly and raise coil spring into position. Install upper spring retainer and screw. Tighten to 18-24 N·m (13-18 ft-lbs).
6. Lower the jack.
7. Connect shock absorbers to upper and lower frame brackets.
8. Install brake caliper and wheel and tire assembly.
9. Lower the vehicle and check and adjust camber and toe-in according to Section 14-01, General Suspension Service.

F-250 (4x4)—Leaf Spring Front Suspension

Refer to Fig. 7.

Removal

1. Raise vehicle on a hoist or jack and install safety stands.
2. Remove the wheel and tire assemblies, and brake calipers.

   NOTE: Do not let the caliper hang with it's weight on the brake hose or the hose may become stretched or twisted.
3. Position jack under right hand axle assembly. Remove the two U-bolts securing the shock absorber mounting plate and leaf springs to tube and yoke assembly.
4. Disconnect the vent tube at the differential housing. Remove the vent fitting and install a 1/8 inch pipe plug.
5. Remove the pivot bolt that secures the right hand axle assembly to crossmember. Remove the RH axle assembly. Remove and discard the keystone clamps and remove the boot from the shaft. Pull the axle shaft out of the slip shaft.
6. Position the jack under the left hand axle assembly. Remove the two U-bolts securing the shock absorber mounting plate and leaf spring to tube and yoke assembly.
7. Position a jack under the differential housing.
8. Remove the pivot bolt securing the left hand axle assembly to crossmember. Remove the left axle assembly.

Installation

1. Raise vehicle on a hoist or a jack and position left hand axle assembly at leaf spring assembly. Install the pivot bolt that secures the axle assembly to the crossmember. Secure the shock absorber mounting plate to the leaf spring and axle assembly with the two U-bolts. Tighten bolts to 116-162 N·m (85-120 ft-lbs).
2. Position the right hand axle assembly at crossmember. Install the boot on the shaft so the boot seats in the grooves. Position new Keystone Clamps over the grooves on the boot and crimp the clamp with Keystone Clamp Pliers, T63P-9171-A or equivalent. Align the axle shaft and install in slip shaft. Install the pivot bolt that secures the axle assembly to crossmember. Tighten bolt to 123-203 N·m (120-150 ft-lbs). Install shock absorber mounting plate, leaf spring and axle assembly using two U-bolts. Tighten bolts to 116-162 N·m (85-120 ft-lbs).
3. Install vent fitting to differential housing and connect vent tube to vent using a new hose clamp.
4. Install brake caliper and wheel and tire assembly.
5. Check and adjust caster, camber and toe-in.

Steering Knuckle

Removal

Refer to Fig. 8.

1. Remove the spindle and the right and left shaft and joint assembly as described in this Section.
2. If the tie rod has not been removed, then remove cotter pin from the tie rod nut and then remove nut. Tap on the tie rod stud to free it from the steering arm.
3. Remove the cotter pin from the top ball joint stud. Loosen the nut on the top stud and the bottom nut inside the knuckle (Fig. 9). Remove the top nut.
4. Sharply hit the top stud with a plastic or rawhide hammer to free the knuckle from the axle arm. Remove and discard bottom nut. Use new nut upon assembly.
5. Remove camber adjuster by hand or if difficulty is encountered use Pitman Arm Puller T64P-3590-F or equivalent (Fig. 10).

   Note the orientation of the camber adjuster to assure the same camber setting.
6. Place knuckle in vise and remove snap ring from bottom ball joint socket if so equipped.
7. Remove plug from C-Frame Assembly (T74P-4635-C) and replace with Plug (T80T-3010-A4) or equivalent. (View A, Fig. 11.)
8. Assemble C-Frame Assembly and Receiving Cup (T80T-3010-A2 for F-350 or D79T-3010-BG for F-150 and F-250) as shown in View B, Fig. 11.
9. Turn forcing screw clockwise until ball joint is removed from steering knuckle.
10. Assemble C-Frame Assembly and Receiving Cup (D79T-3010-BG) or equivalent on upper ball joint and turn forcing screw clockwise until ball joint is removed.

    NOTE: Always remove bottom ball joint first.

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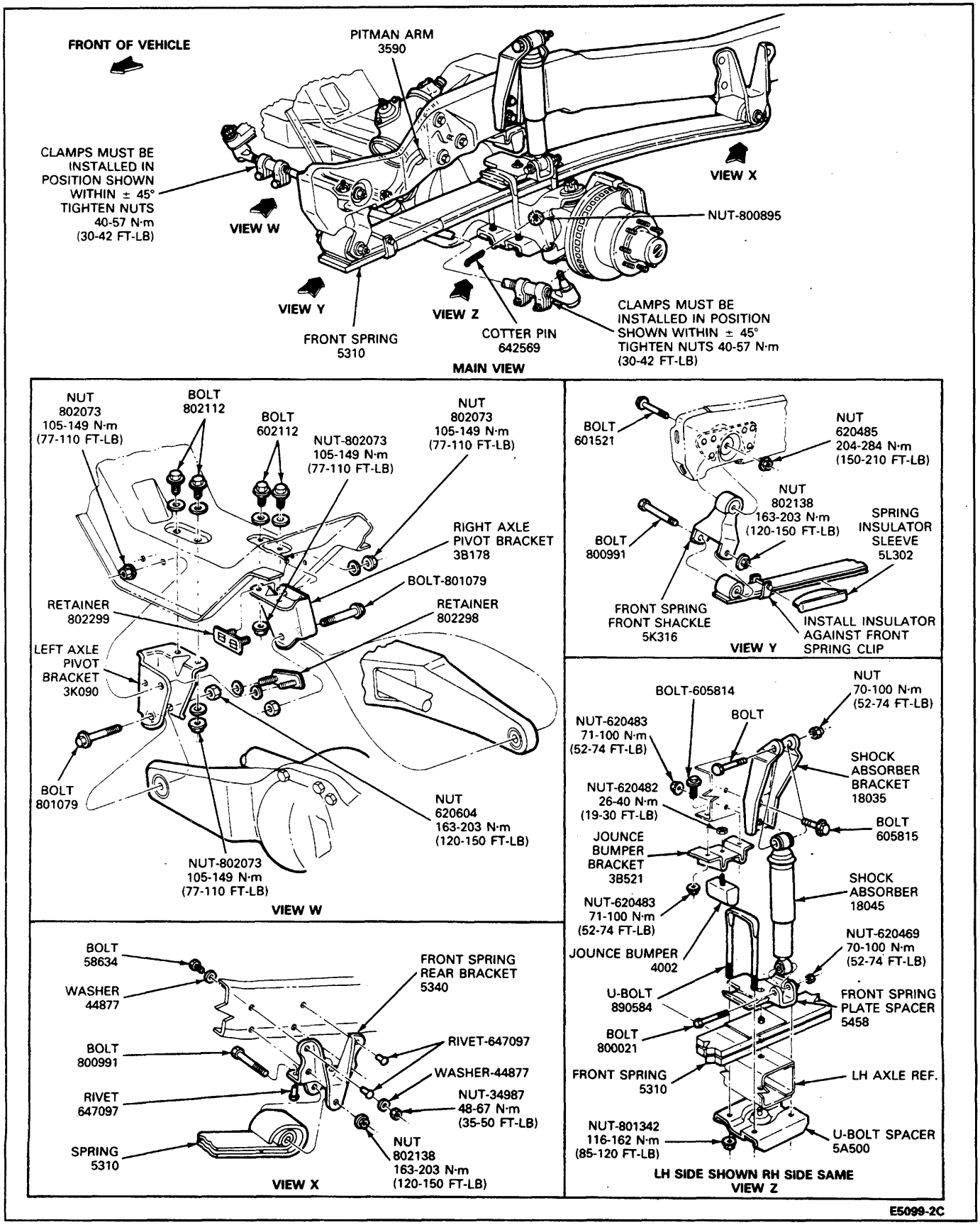


FIG. 7 Front Driving Axle—F-250 (4x4)

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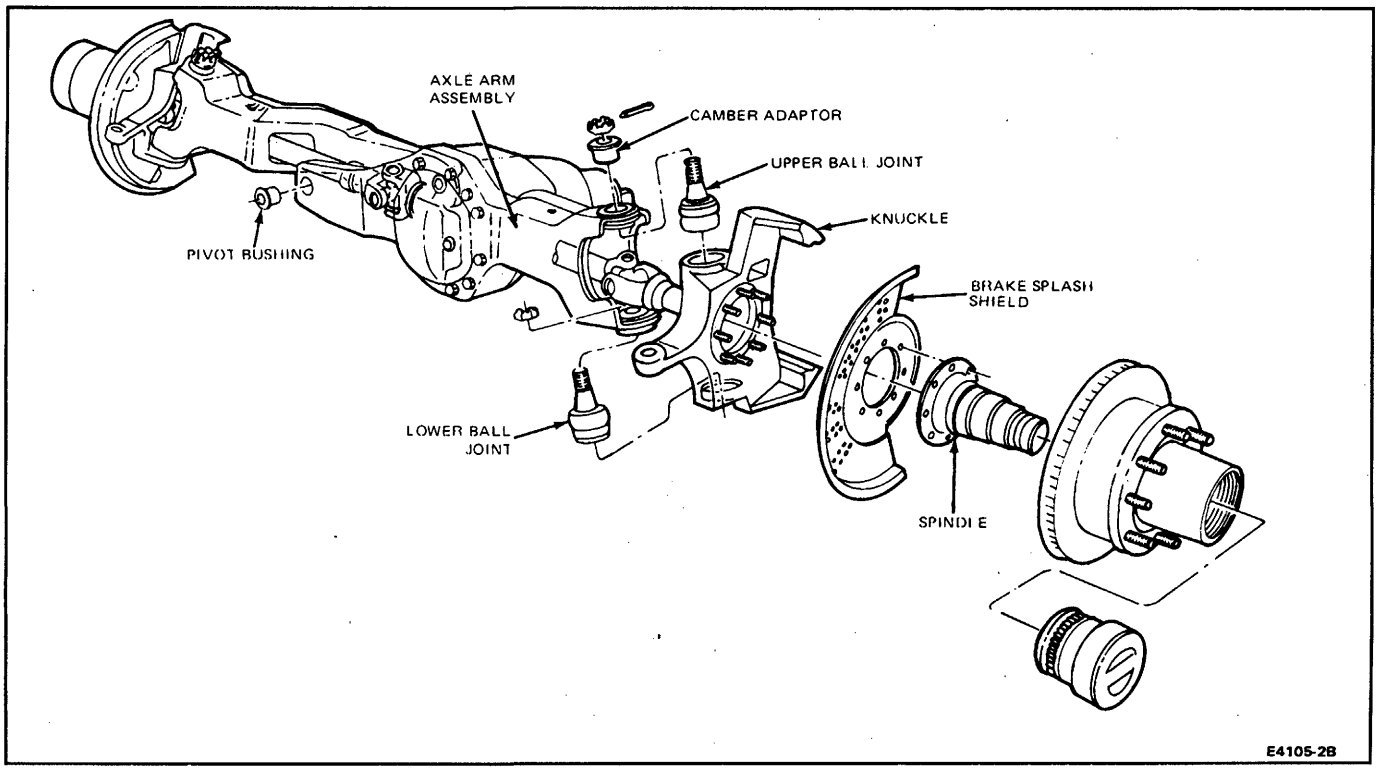


FIG. 8 Knuckle and Spindle—Exploded View

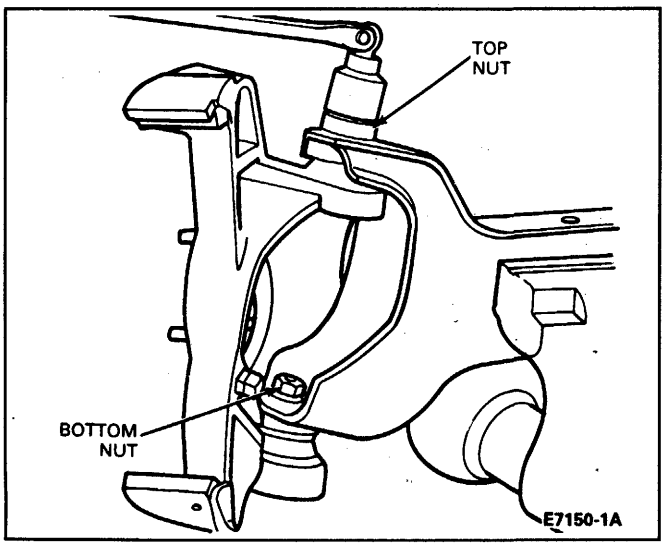


FIG. 9 Removing Steering Knuckle Nut

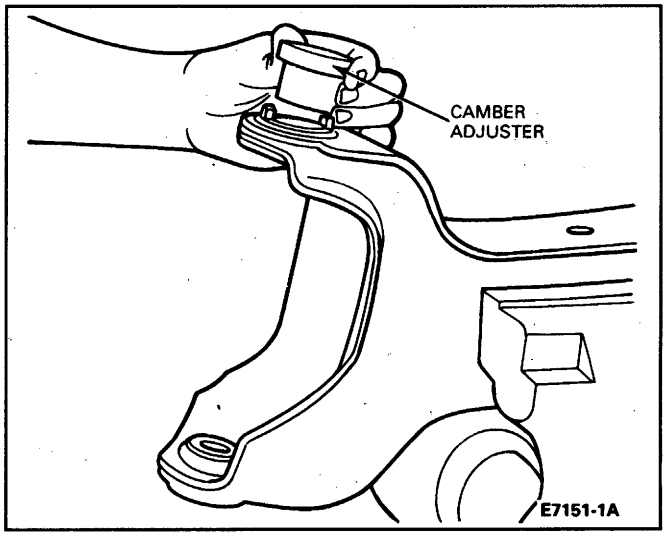


FIG. 10 Removing Camber Adjuster

Installation

1. Clean steering knuckle bore and insert lower ball joint as straight as possible.
2. Assemble C-Frame Assembly, Ball Joint Receiving Cup (T80T-3010-A3) and installing Cup (D79T-3010-BF) or equivalents as shown in View A, Fig. 12 to replace the lower ball joint on the F-150—F-250 and Bronco (Dana 44).
3. Assemble C-Frame, Receiving Cup (T80T-3010-A3) and Receiving Cup (D79T-3010-BG) or equivalents as shown in View B, Fig. 12 to replace the lower ball joint on the F-350 (Dana 50).
4. Turn forcing screw clockwise until ball joint is firmly seated.

NOTE: If ball joint cannot be installed to the proper depth, realignment of Receiving Cup (T80T-3010-A3) will be necessary. Install the snap ring on the lower ball joint.

5. To install upper ball joint on the F-150, F-250, F-350 and Bronco assemble the C-Frame, Receiving Cup (T80T-3010-A3) and Replacer (T80T-3010-A1) or their equivalents as shown in View C, Fig. 12 and repeat Step 4.
6. Assemble knuckle to axle arm assembly. Install Camber adjuster on top ball joint stud with the arrow pointing outboard for "positive" camber, pointed inboard for "negative" camber.

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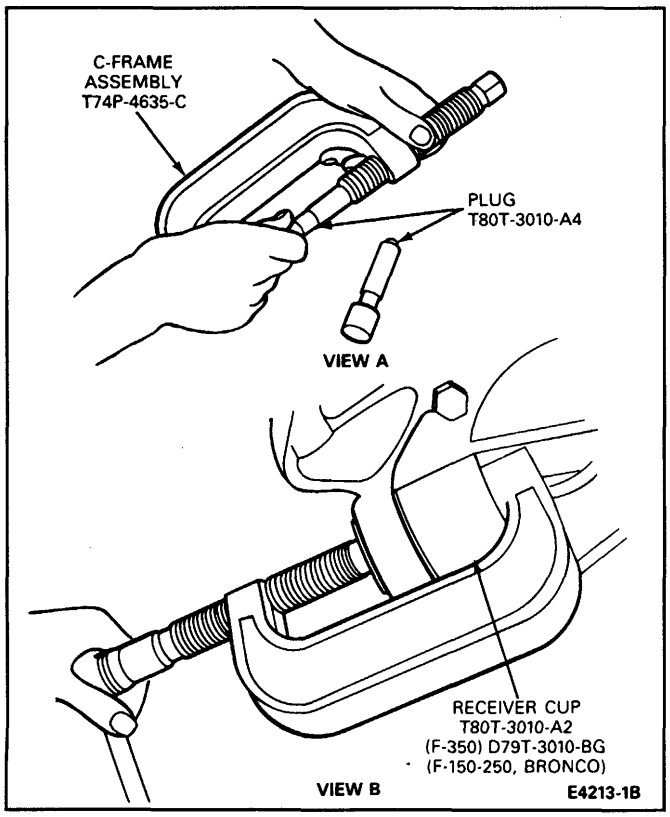


FIG. 11 Upper Ball Joint Removal

7. Install new nut on bottom socket finger tight. Install and tighten nut on top socket finger tight. Tighten bottom nut to 109 N·m (80 ft-lbs).
8. Tighten top nut to 136 N·m (100 ft-lbs), then advance nut until castellation aligns with cotter pin hole. Install cotter pin.

   NOTE: Do not loosen top nut to install cotter pin.
9. Retighten bottom nut to 123-150 N·m (90-110 ft-lbs).
10. Install the spindle and the right and left shaft and joint assembly as described in this Section.

Spindle, and Right and Left Shaft and Joint Assembly

Refer to Figs. 13 and 14.

Removal

1. Raise the vehicle and install safety stands.
2. Remove the wheel and tire assembly.
3. Remove the caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper. Securely wire the caliper to the frame.

CAUTION: After removal, the caliper must be wired to the frame or otherwise supported to prevent suspending the caliper by the flexible hose. If securing the caliper is not practical, disconnect and plug the hose to the caliper. Upon caliper installation, bleed the brake system as described in Section 12-01, General Hydraulic Brake Service.

4. Remove hub locks, wheel bearings, and lock nuts per Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive.

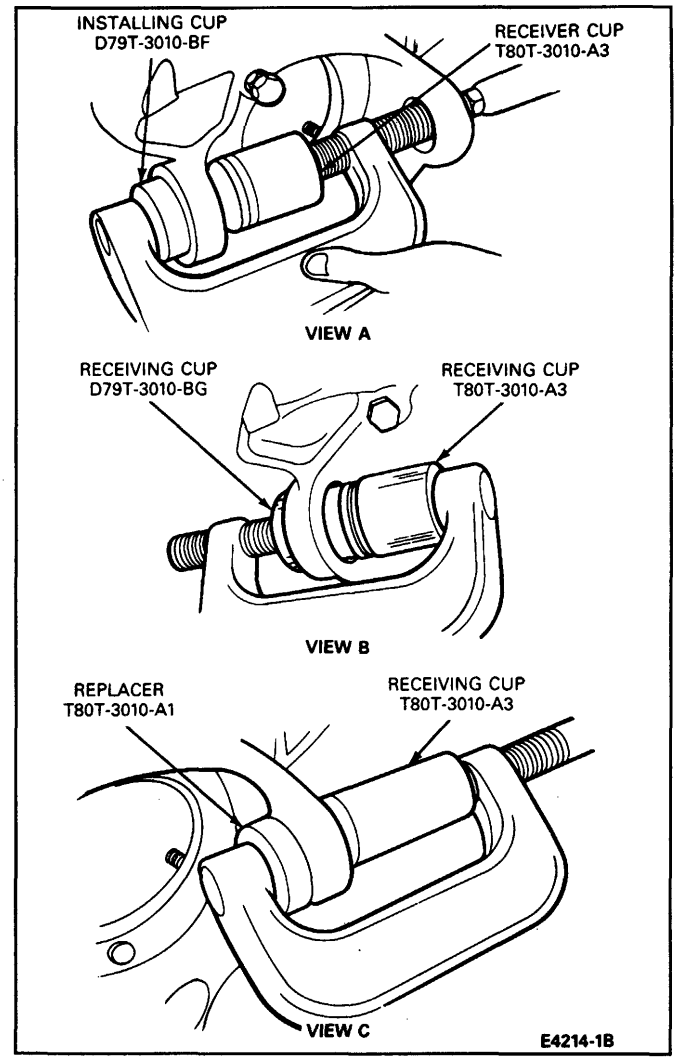


FIG. 12 Ball Joint Installation

5. Remove the hub and rotor assembly and outer bearing from the spindle.
6. Remove the nuts retaining the spindle to the steering knuckle. Tap the spindle with a plastic or rawhide hammer to jar the spindle from the knuckle. Remove the splash shield.
7. On the right side of the vehicle remove the shaft and joint assembly by pulling the assembly out of the carrier (Fig. 15).
8. On the right side of the carrier, remove and discard the keystone clamp from the shaft and joint assembly and the stub shaft. Slide the rubber boot onto the stub shaft and pull the shaft and joint assembly from the splines of the stub shaft (Fig. 16).
9. Place the spindle in a vise on the second step of the spindle. Wrap a shop towel around the spindle or use a brass-jawed vise to protect the spindle.
10. Remove the oil seal and needle bearing from the spindle with Slide Hammer T50T-100-A and Bearing Cup Puller, T77F-1102-A or their equivalents (Fig. 17).
11. Inspect the sealing surfaces of the spindle for severely corroded, pitted, worn or galled sealing

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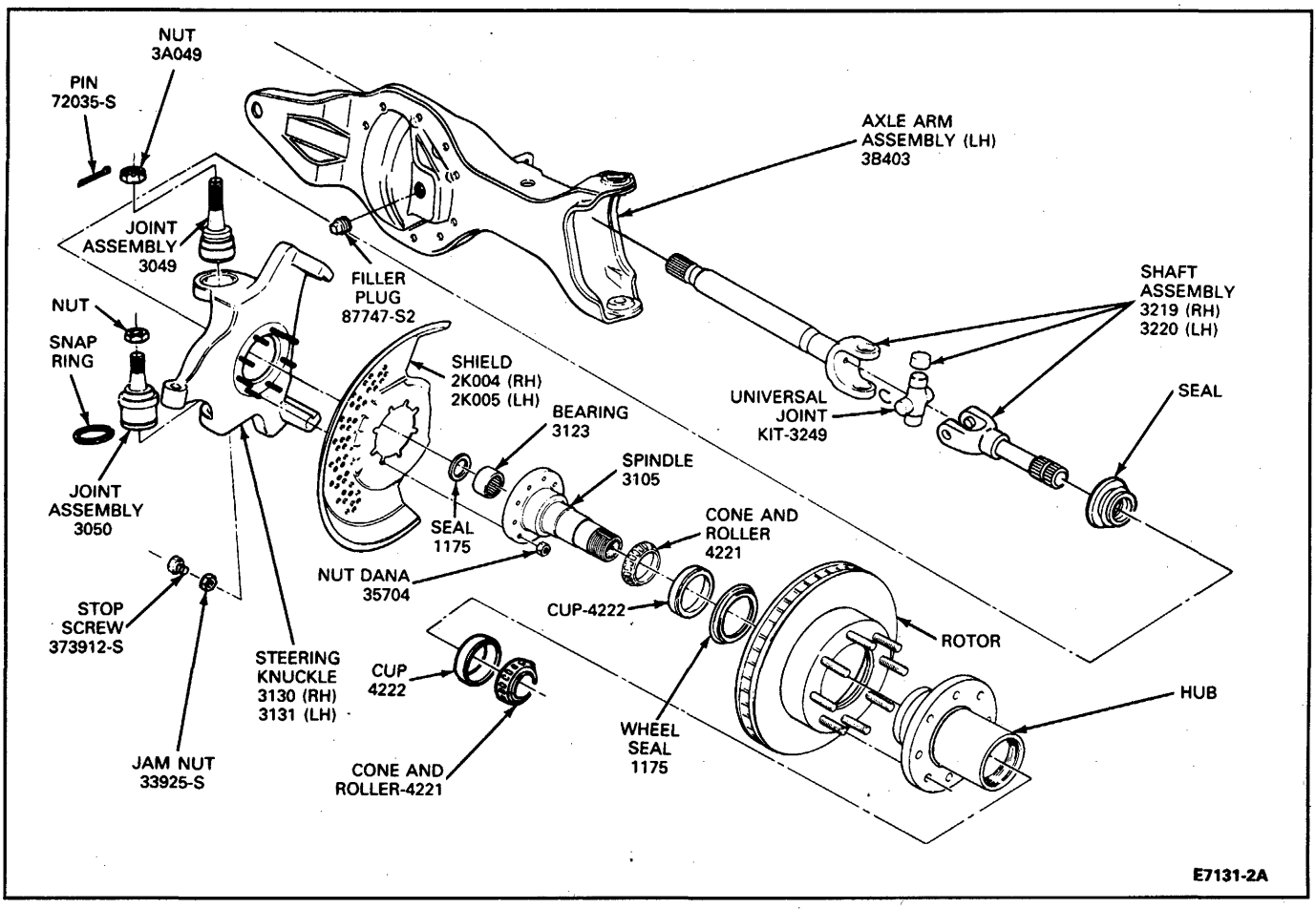


FIG. 13 Spindle and Left Shaft and Joint Installation—Typical

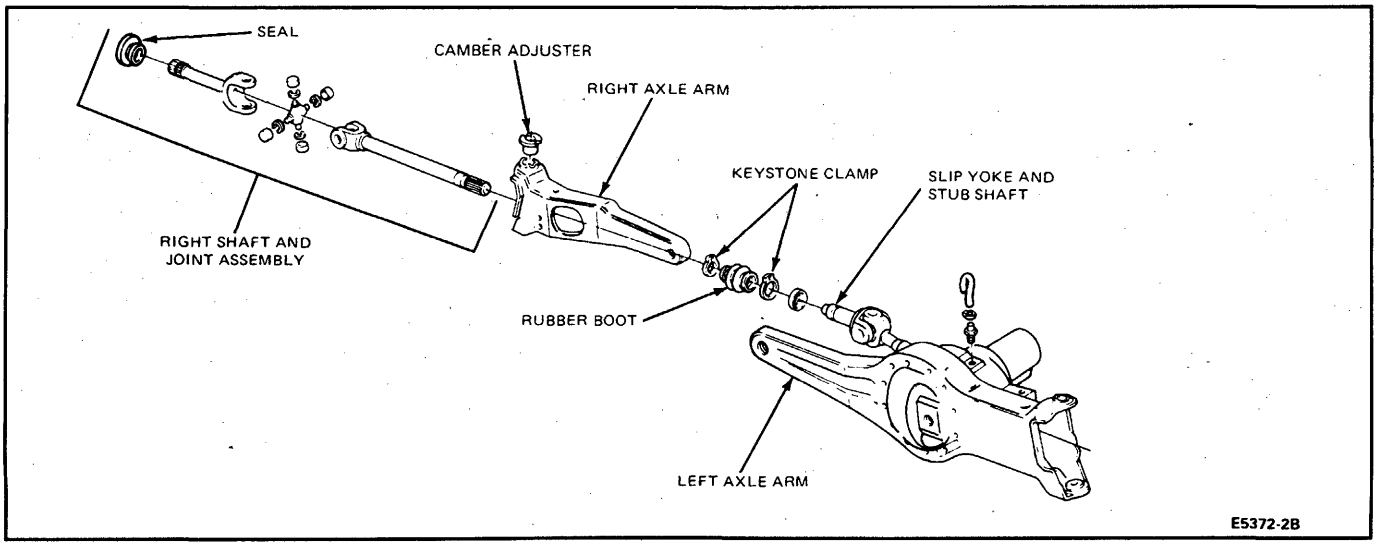


FIG. 14 Right Hand Shaft and Joint Assembly Installation—Typical

surfaces. Replace spindle if damaged. Refer to Figure 18.

12. Inspect the outer shaft of the axle shaft assembly for corroded, pitted, worn or galled surfaces in the inner oil seal and/or needle bearing areas. If damage to this area is evident, replace the outer shaft. Repair axle shaft as follows: Refer to Section 15-66, Driveshaft, Single Snap Ring Type U-Joint.

Installation

1. Clean all dirt and grease from the spindle bearing bore. Bearing bores must be free from nicks and burrs.
2. Install a new needle bearing with writing facing outward in the spindle bore with Spindle Bearing Replacer, T80T-4000-R (or equivalent) on the F-350 or T80T-4000-S (or equivalent) for F-150—

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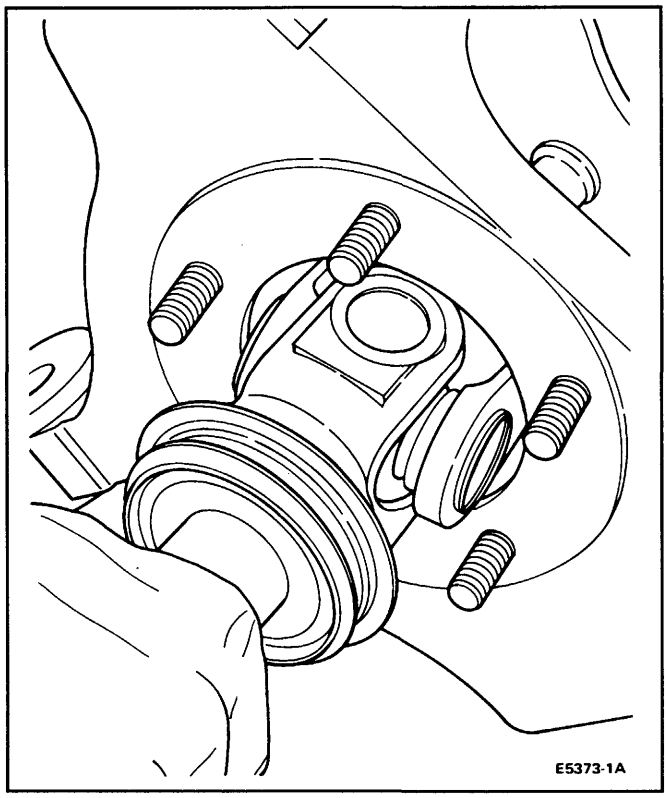


FIG. 15 Right Shaft and Joint Removal

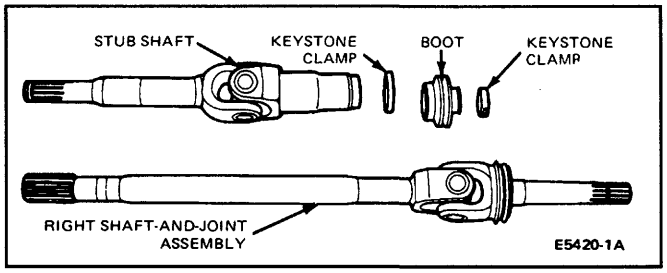


FIG. 16 Right Shaft and Joint—Exploded View

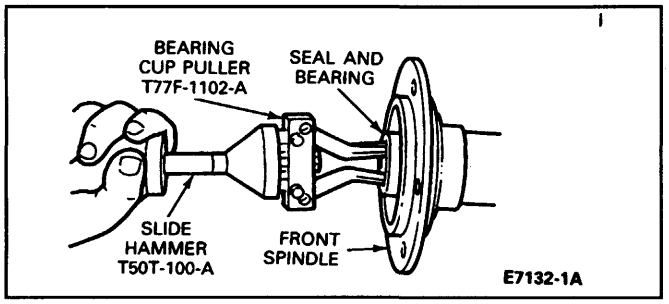


FIG. 17 Spindle Seal and Bearing Removal

F-250 and Bronco, and Driver Handle T80T-4000-W (Fig. 19). Install a new needle bearing seal with the seal lip directed away from the spindle. Pack bearing and hub seal with grease. Install seal with Seal Replacer T80T-4000-T, and Driver Handle T80T-4000-W, or their equivalents (Fig. 20).

3. Remove and install the seal on top of the needle bearing. Apply coating of grease to leading edge of seal lip. Place the thrust washer on the axle shaft.
4. Press a new slinger on the axle shaft with an appropriate piece of press stock. Refer to Fig. 21.

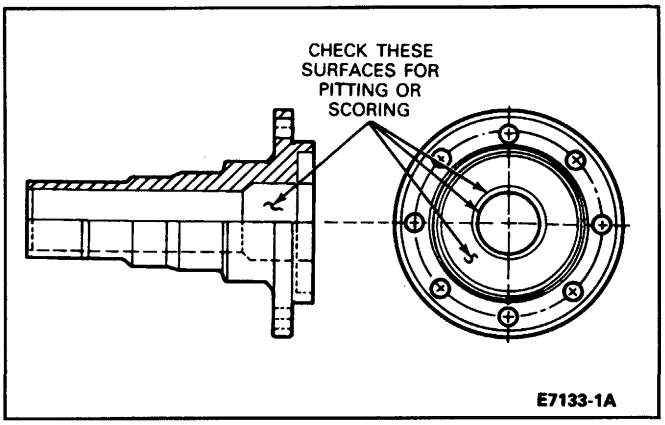


FIG. 18 Spindle Inspection Areas

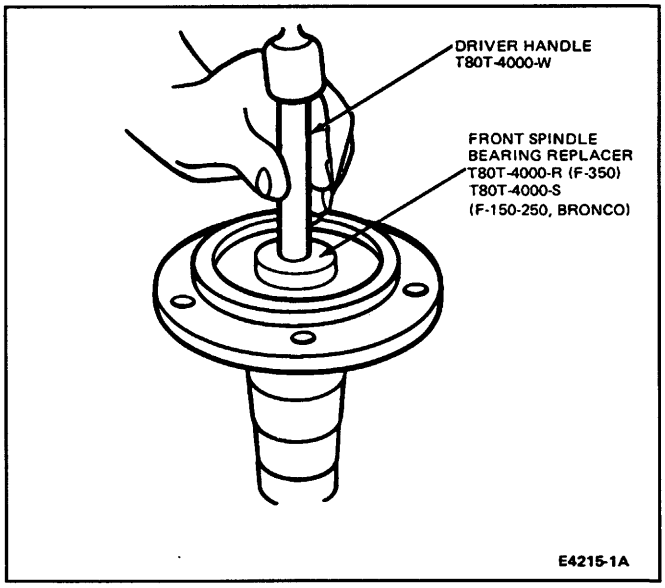


FIG. 19 Spindle Needle Bearing Installation

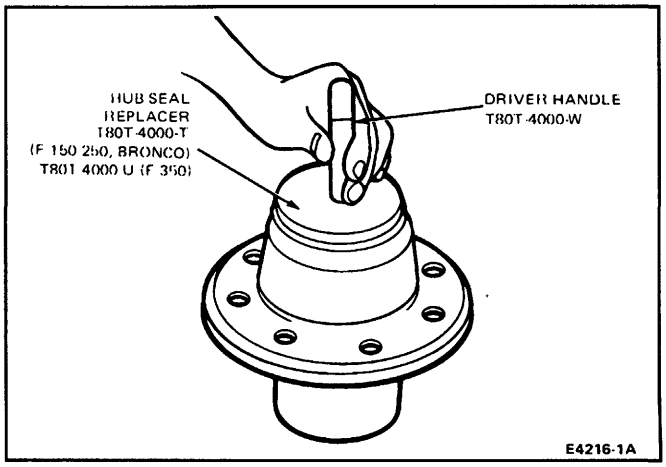


FIG. 20 Hub Seal Installation

5. Install the rubber V-seal on the slinger and axle shaft. The lip of the seal should face towards the spindle. Refer to Figure 22.
6. Install the plastic spacer on the axle shaft. The chamferred side of the spacer should be inboard against the axle shaft. Refer to Figure 23.

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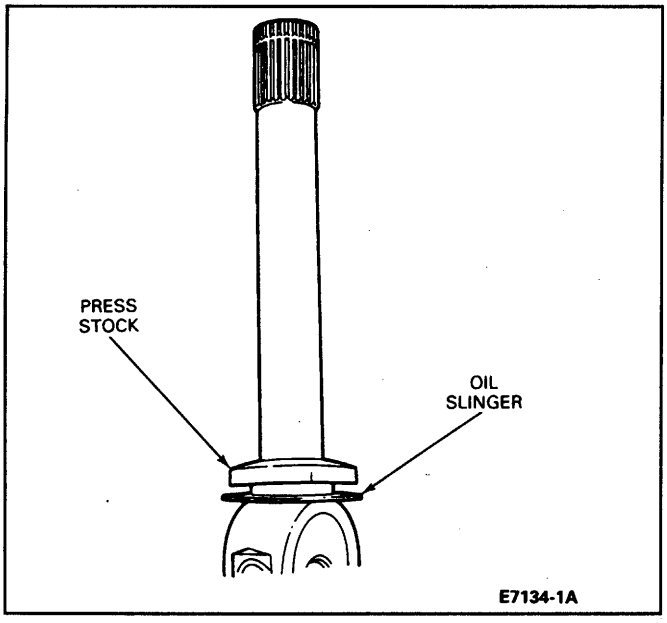


FIG. 21 Oil Slinger Installation

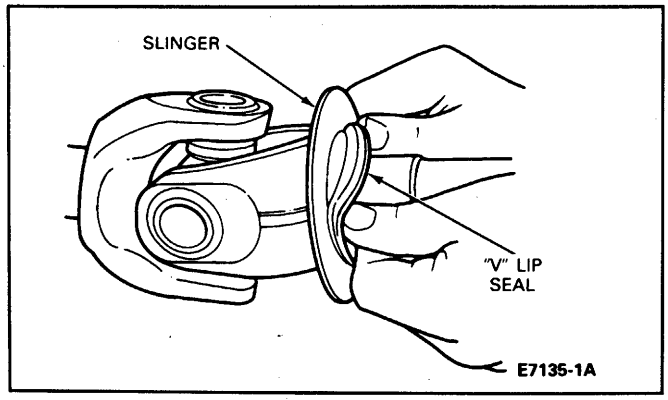


FIG. 22 V-Seal Installation

7. Pack the thrust face of the seal in the spindle bore and the V-seal on the axle shaft with Long Life Lubricant (C1AZ-19590-B) ESA-M1C75-B or equivalent. Refer to Figure 24.

8. On the right side of the carrier, install the rubber boot and new keystone clamps on the stub shaft slip yoke. Since the splines on the shaft are phased, there is only one way to assemble the right shaft and joint assembly into the slip yoke. Align the missing spline in the slip yoke barrel with the gapless male spline on the shaft and joint assembly. Slide the right shaft and joint assembly into the slip yoke making sure the splines are fully engaged. Slide the boot over the assembly and crimp the keystone clamp using Keystone Clamp Pliers, T63P-9171-A, or equivalent.

9. On the left side of the carrier slide the shaft and joint assembly through the knuckle and engage the splines on the shaft in the carrier.

10. Install the splash shield and spindle onto the steering knuckle. Install and tighten the spindle nuts to 68-81 N·m (50-60 ft-lb).

11. Install the rotor on the spindle. Install the outer wheel bearing into the cup.

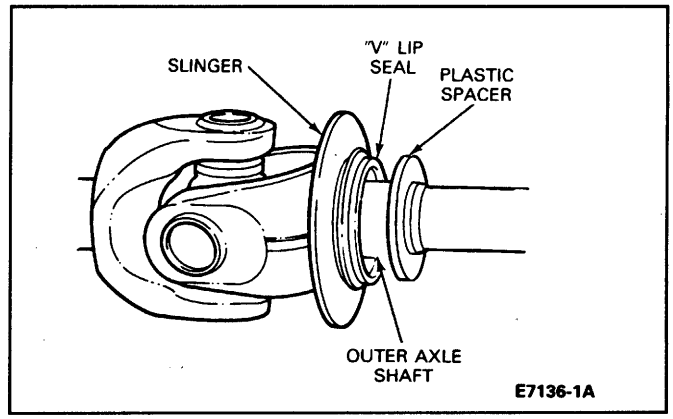


FIG. 23 Spacer Installation

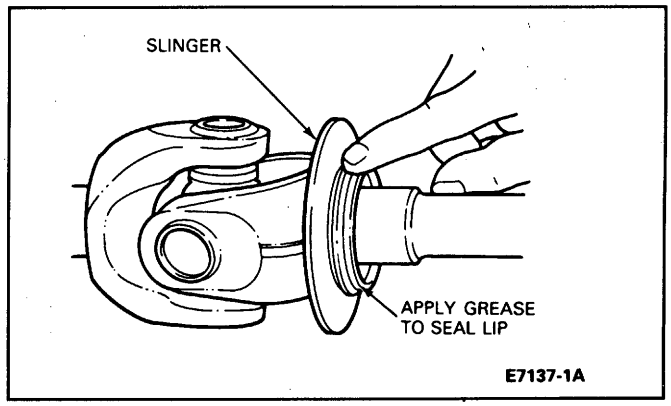


FIG. 24 V-Seal Lubrication

NOTE: Verify that the grease seal lip totally encircles the spindle.

12. Install the wheel bearing, locknut, thrust bearing, snap ring, and locking hubs per Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive.

13. Install the disc brake caliper as described in Section 12-24, Disc Brakes—Light and Heavy Duty—Sliding Caliper.

Right Hand Slip Yoke and Stub Shaft Assembly, Carrier, Carrier Oil Seal, and Bearing

Refer to Fig. 25.

Removal

1. Remove the nuts and U-bolts connecting the driveshaft to the yoke. Disconnect the driveshaft from the yoke. Wire the driveshaft out of the way, so it will not interfere in the carrier removal process.

2. Remove both spindles and the Left and Right Shaft and U-joint assemblies as described in the Removal and Installation portion of this Section under Spindle and Left and Right Shaft and U-Joint Assemblies.

3. Support the carrier with a suitable jack and remove the bolts retaining the carrier to the support arm. Separate the carrier from the support arm and drain the lubricant from the carrier. Remove the carrier from the vehicle.

4. Place the carrier in a Holding Fixture, T57L-500-B and Adapters, T80T-4000-B or equivalent (Fig. 26).

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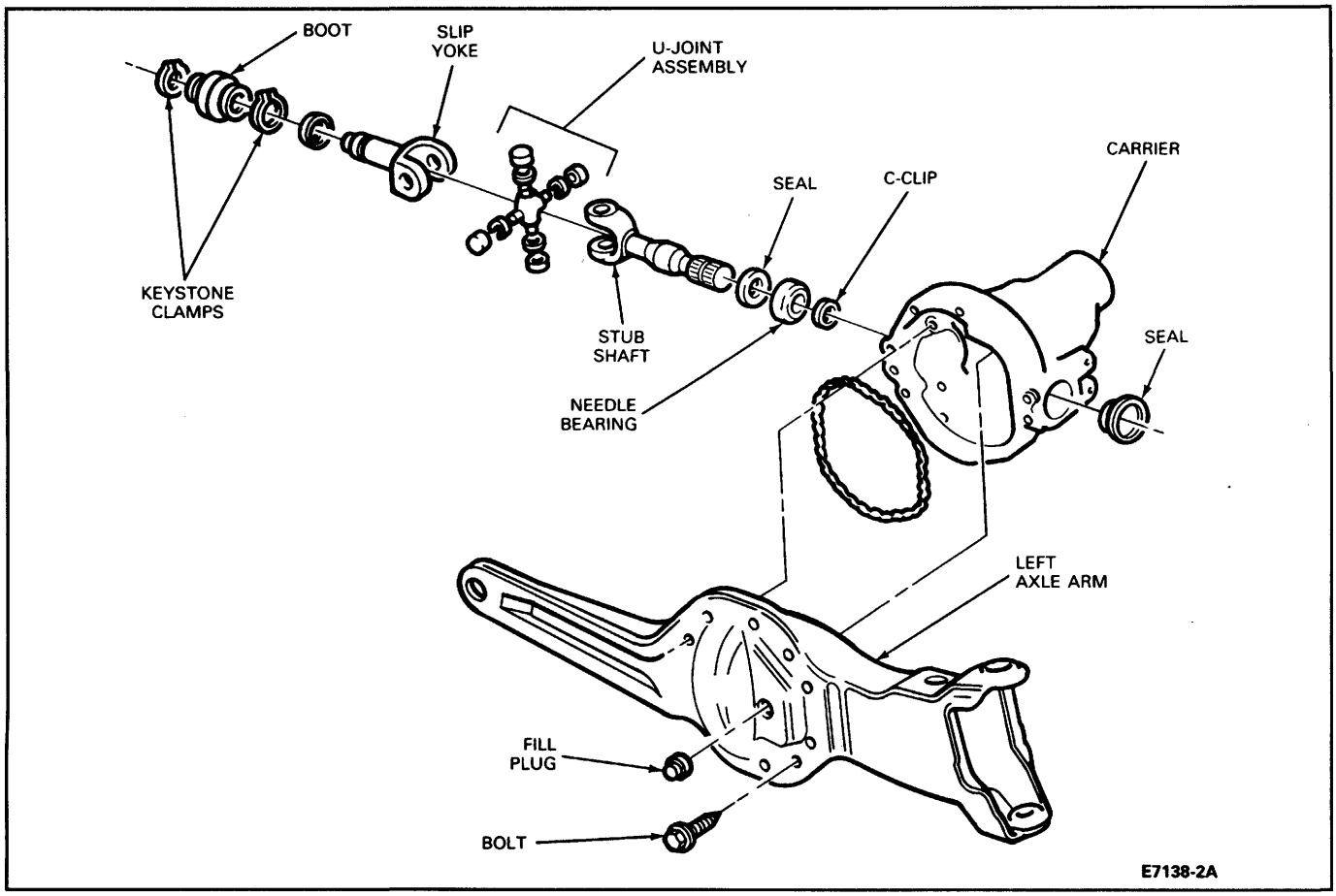


FIG. 25 Carrier and Slip Yoke and Stub Shaft Installation

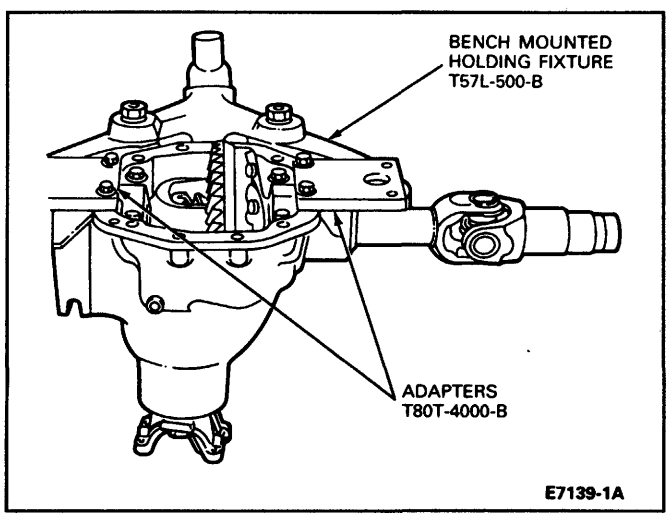


FIG. 26 Installing Carrier in Holding Fixture

5. Rotate the slip yoke and shaft assembly so the open side of the snap ring is exposed as shown in Fig. 27. Remove the snap ring from the shaft.
6. Remove the slip yoke and shaft assembly from the carrier.
7. Remove the oil seal and caged needle bearings at the same time, using Slide Hammer, T50T-100-A and Collet, (part of Blind Hole Puller Set), D80L-100-A or equivalent as shown in Fig. 28. Discard the seal and needle bearing.

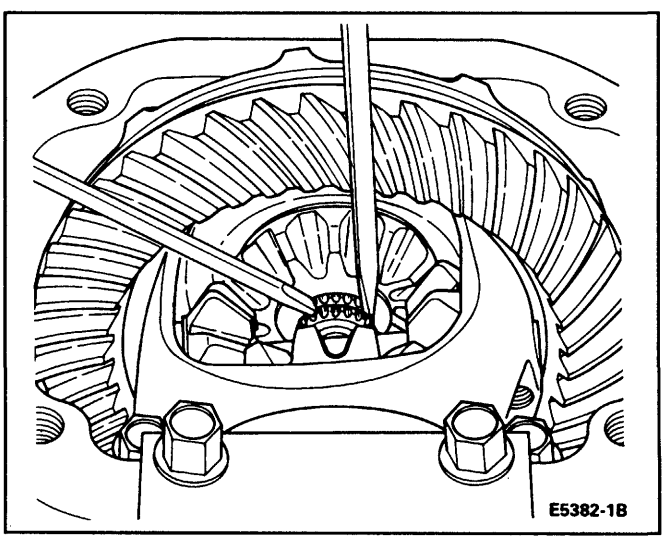


FIG. 27 Snap Ring Removal

Installation

1. Make sure the bearing bore is free from nicks and burrs. Install a new caged needle bearing on Needle Bearing Replacer, T83T-1244-A or equivalent with the manufacturer name and part number facing outward towards the tool. Drive the needle bearing until it is seated in the bore (Fig. 29).
2. Coat the seal with Long-Life Multi-Purpose Lubricant, C1AZ-19590-B (ESA-M1C75-B) or

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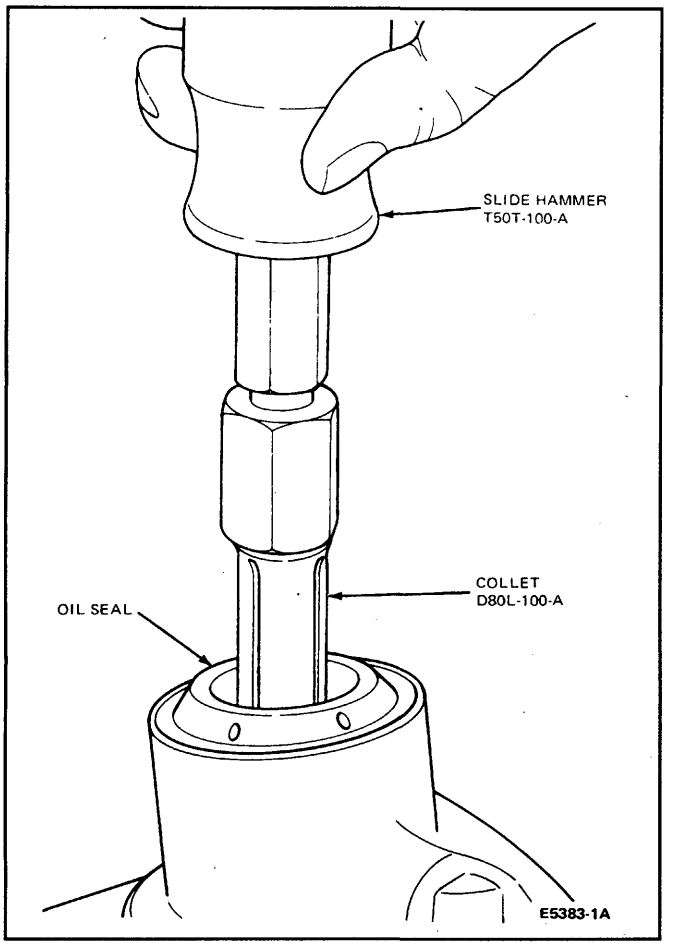


FIG. 28 Needle Bearing and Oil Seal Removal

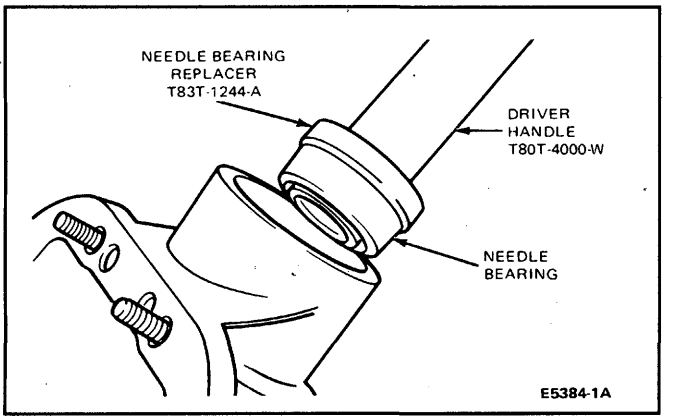


FIG. 29 Needle Bearing Installation

equivalent. Drive the seal into the carrier using Needle Bearing Replacer T83T-1244-A or equivalent (Fig. 30).

3. Install the slip yoke and shaft assembly into the carrier so the groove in the shaft is visible in the differential case.

4. Install the snap ring in the groove in the shaft. Force the snap ring into position with a screwdriver as shown in Fig. 31. Remove the carrier from the holding fixture.

NOTE: Do not tap on the center of the snap ring. This may damage the snap ring.

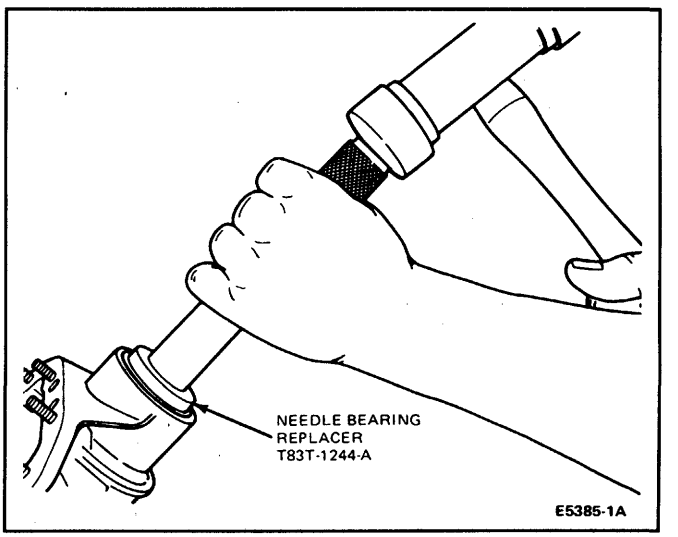


FIG. 30 Seal Installation

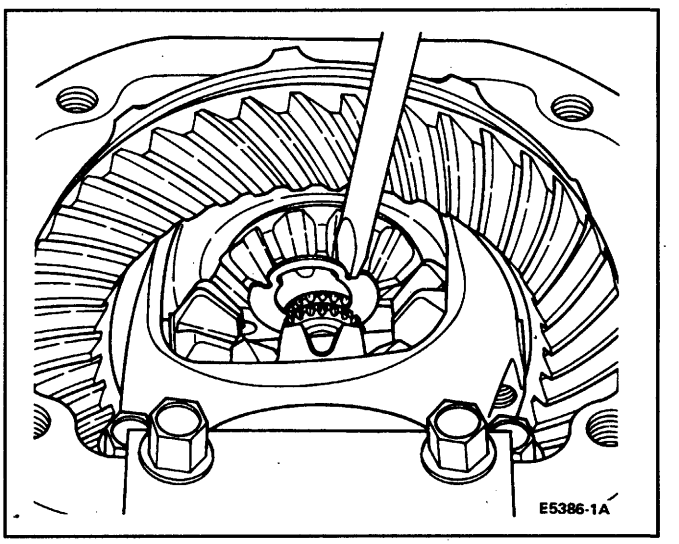


FIG. 31 Snap Ring Installation

5. Clean all traces of gasket RTV sealant from the surfaces of the carrier and support arm and make sure the surfaces are free from dirt and oil. Apply a bead of RTV sealant, D6AZ-19562-A (clear) or -B (black) (ESB-M4G92-A and ESE-M4G195-A) or equivalent, in a bead between 6.35-9.53mm (1/4-3/8 inch) wide. The bead should be continuous and should not pass through or outside the holes.

NOTE: The carrier must be installed on the support arm within five minutes after applying the RTV sealant.

6. Position the carrier on a suitable jack and install it in position on the support arm using guide pins to align it. Install the attaching bolts and hand tighten. Tighten the bolts in a clockwise or counter-clockwise pattern to 41-54 N·m (30-40 ft-lb).

7. Install support arm tab bolts to side of carrier and tighten to 115-136 N·m (85-100 ft-lbs).

8. Install both spindles and the left and right shaft and joint assemblies as described in the removal and installation portion of this Section.

9. Connect the driveshaft to the yoke. Install the nuts and U-bolts and tighten to 11-20 N·m (8-15 ft-lbs).

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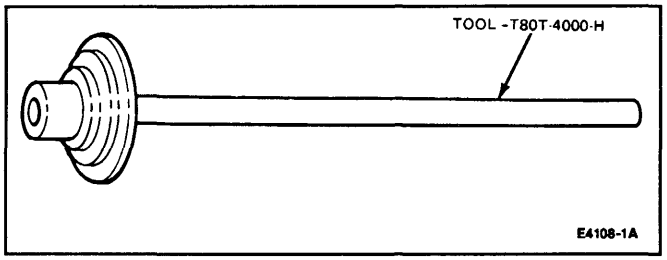


FIG. 32 Inner Axle Seal Installation Tool

Left Differential Seal

Removal

1. Remove the spindle and left shaft assembly as described in this Section.
2. Pull out the seal with the appropriate Puller Tool T58L-101-A or equivalent. Remove and discard seal.

Installation

1. Install a new seal on the Differential Seal Replacer Tool T80T-4000-H or equivalent (Fig. 32).
2. Slide the seal and tool into the carrier housing bore. Seat the seal with a plastic or rawhide hammer.
3. Install the spindle and left shaft assembly as described in this Section.

Axle Shaft Bearing (IFS Front Drive Axle)

Removal

1. Remove the axle shaft assembly as described under Steering Knuckle Removal.
2. Remove screws from carrier to cover support arm. Drain lube by separating carrier assembly from support arm.
3. Place carrier assembly in a fixture. Rotate axle shaft so that open side of snap ring is exposed. Hold one side of snap ring firmly with a screwdriver, while pushing on other side. Remove snap ring.
4. Pull slip yoke/shaft assembly from unit.
5. Remove right hand trunnion axle shaft seal from housing. Pry seal out and discard. When removing a seal, be careful so as to avoid nicking or denting housing.
6. Remove the right hand trunnion axle shaft bearing.

   NOTE: The bearing bore must be free from nicks and burrs. Clean bore out with standard metal cleaning solvent.

Installation

1. Install bearing assembly into bearing bore of right hand trunnion, with bearing name and part number facing outward towards installing Tool T80T-4000-N or equivalent. The tool will stop against housing when bearing is seated to proper depth.
2. Apply a light coat of grease on the lip of the seal and assembly into trunnion of the carrier.
3. Install slip yoke/shaft assembly into carrier and through side gear spline exposing snap ring groove inside differential.

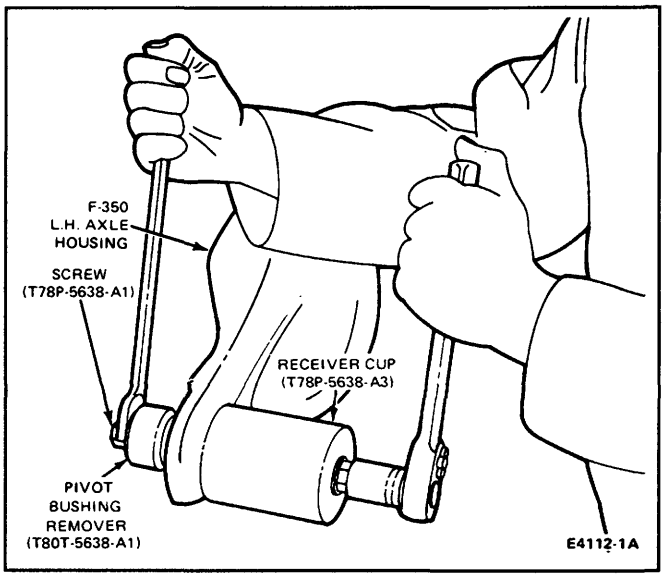


FIG. 33 Removing Axle Pivot Bushing

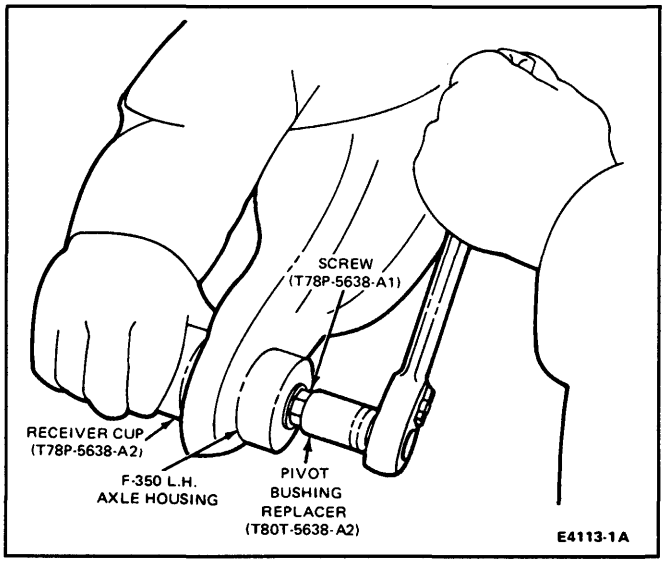


FIG. 34 Installing Axle Pivot Bushing

4. Place the snap ring in the groove. Force the snap ring into place using two screwdrivers or other suitable tools.
5. Hold shaft and joint assembly in a heavy duty vise. Install a new spindle seal on outboard yoke shaft.

Axle Housing Pivot Bushing (IFS Front Drive Axle)

Removal

Refer to Fig. 33.

1. Remove axle as described in this Section under Front Drive Axle Removal and Installation.
2. Install Forcing Screw (T78P-5638-A1), Bushing Remover (T80T-5638-A1) and Receiver Cup (T78P-5638-A3), or equivalent onto the pivot bushing. Turn the forcing screw and remove the pivot bushing.

Installation

Refer to Fig. 34.

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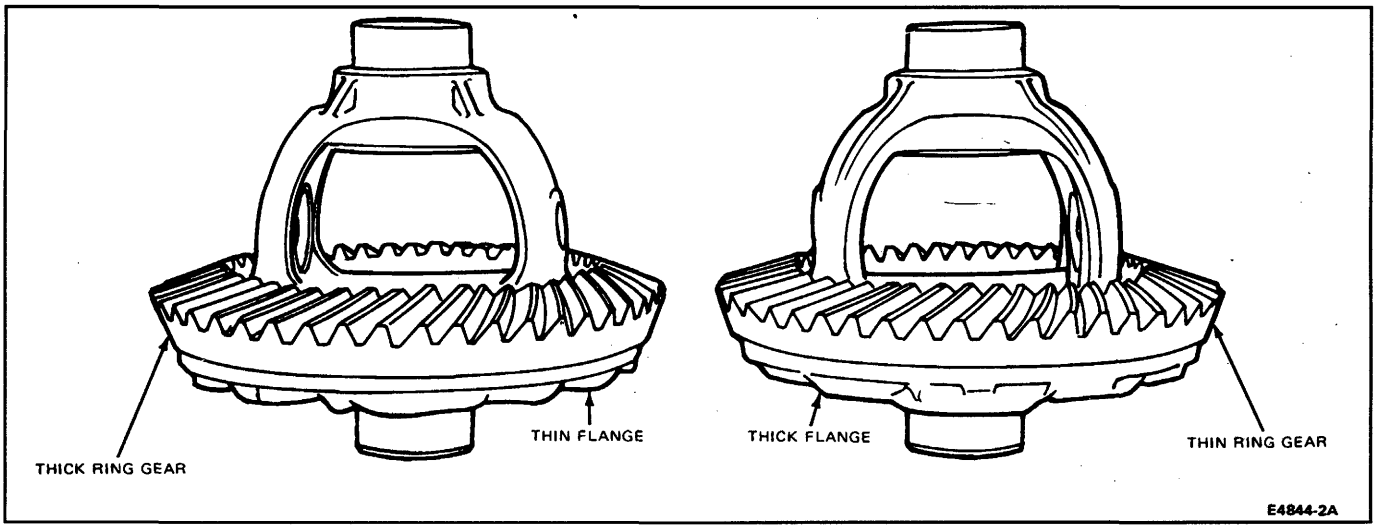


Fig. 35 Differential Cases and Ring Gear

1. Place pivot bushing in axle housing. Install Receiver Cup, (T78P-5638-A2), Forcing Screw (T78P-5638-A1) and Bushing Replacer (T80T-5638-A2), or equivalent into housing and install bushing.
2. Install the axle as described in this Section under Front Driving Axle-Installation.

DISASSEMBLY AND ASSEMBLY

Cardan Type U-Joints

For disassembly and assembly procedures for cardan-type U-joints refer to Section 15-66, Driveshaft Single Snap Ring Type U-Joint.

Carrier

NOTE: When changing ratios on the 44 Series front drive axle, it may be necessary to change the differential case along with the ring gear and drive pinion. Ratios 2.72 to 1 up to 3.73 to 1 incorporate a thick differential case flange and a thin ring gear (Fig. 35). Ratios 3.92 to 1 up to 4.09 to 1 incorporate a thin differential case flange and a thick ring gear (Fig. 35).

Disassembly

1. Remove the left hand axle arm assembly as described in this Section under Removal and Installation.
2. Loosen the bolts retaining the carrier to the axle arm and drain lubricant. Remove the bolts retaining the support arm to the carrier and remove the carrier.
3. Place the carrier in a holding fixture, remove and clean all gasket surfaces and remove the bearing caps (Fig. 36). Note the matched numbers or letters stamped on the cap and carrier. These numbers or letters must be matched upon assembly.
4. Mount Spreader Tool 4000-E and Spreader Adapter T80T-4000-B on carrier. Place a dial indicator, TOOL-4201-C or equivalent, on the carrier and spread the housing (Fig. 37). **Do not spread the carrier over 0.25mm (0.010 inch).**
5. Remove the differential case from the carrier. It may be necessary to pry the case from the carrier with pry bars. Use caution to avoid damaging any machined surfaces. Remove and tag bearing cups

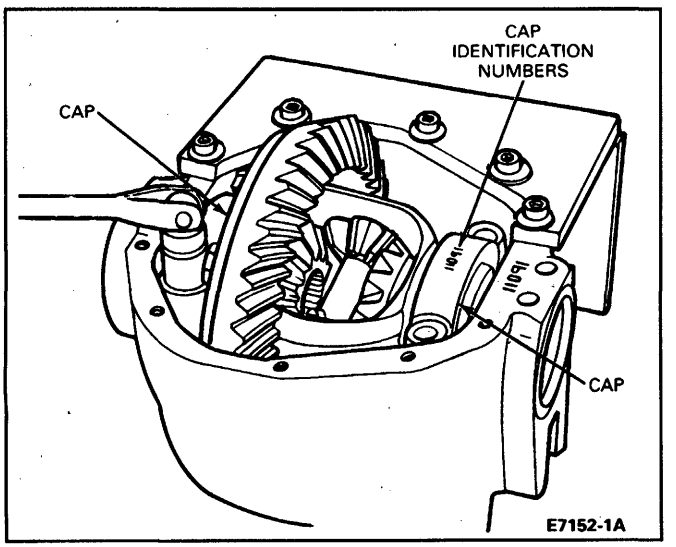


FIG. 36 Removing Bearing Caps

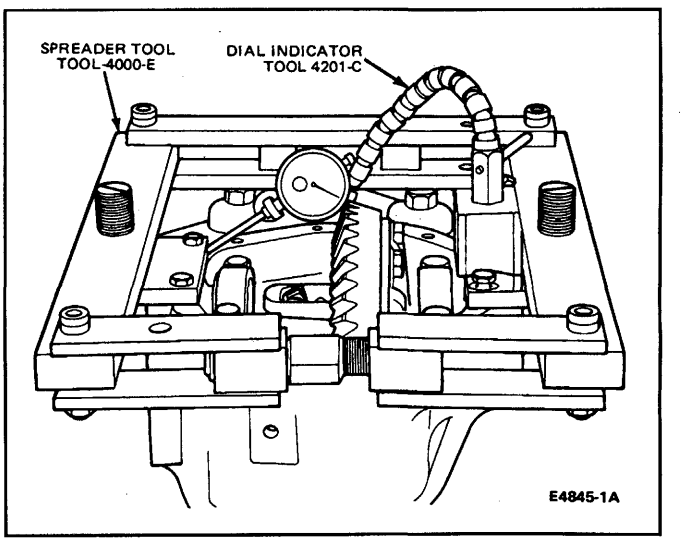


FIG. 37 Installing Spreader

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to indicate from which side of the carrier they were removed. Remove the spreader tool.

6. Turn the nose of the carrier up. Hold the end yoke with Holding Tool T78P-4851-A or equivalent and remove the pinion nut and washer from the pinion shaft.

7. Remove the end yoke with T65L-4851-B, Yoke Remover. If the yoke shows any signs of wear in the area of seal contact, replace the yoke.

8. Remove the drive pinion by tapping on the drive pinion shaft with a rawhide or plastic hammer. Catch the pinion to prevent damage to the pinion.

   CAUTION: Be careful not to damage the pinion bearing preload shims located on the splined end of the pinion. If damaged, replace with shims of equal thickness. Do not lose the shims.

9. Remove the drive pinion oil seal from the carrier bore by using Bearing Cup Puller, T77F-1102-A, and Slide Hammer, T50T-100-A or equivalent (Fig. 38). Replace the oil seal with a new seal during assembly.

10. Remove the outer pinion bearing and the oil slinger from the carrier input bore.

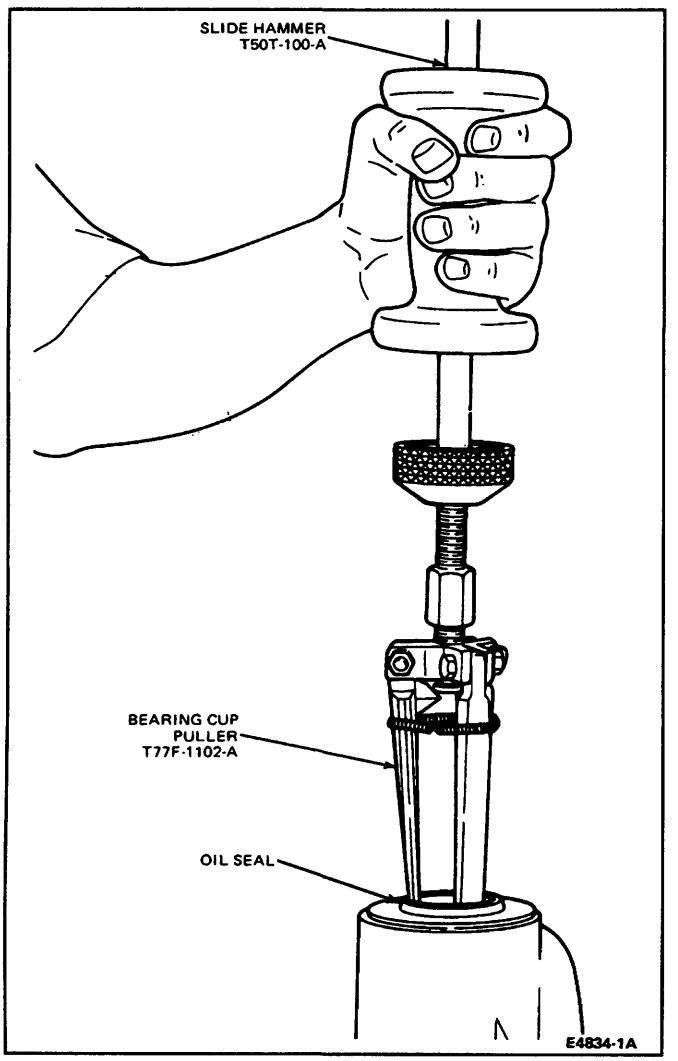


FIG. 38 Oil Seal Removal

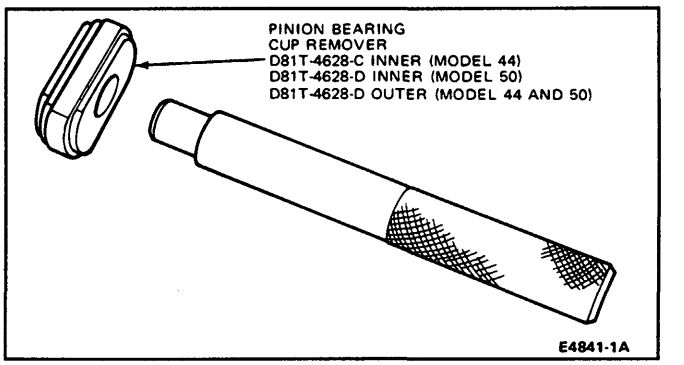


FIG. 39 Bearing Cup Removal

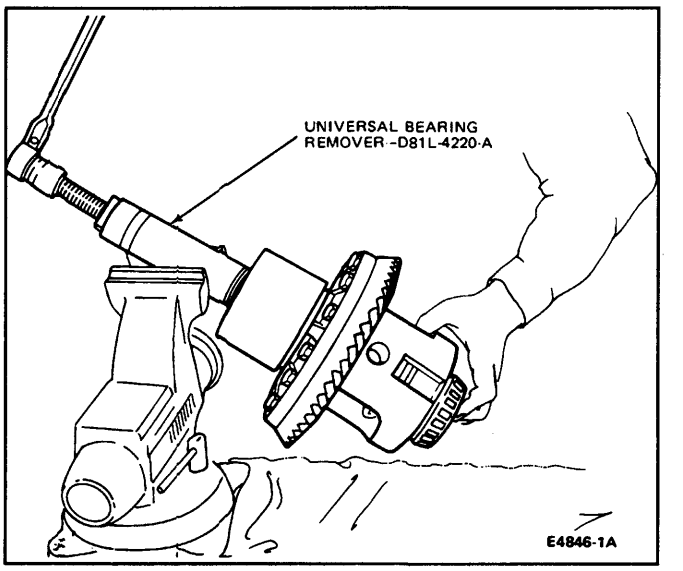


FIG. 40 Differential Side Bearing Removal

Remove the pinion bearing preload shims. Make sure all shims are removed from the carrier. Replace any damaged shims. Shims are available in thicknesses of 0.08, 0.13, 0.25 and 0.76mm (0.003, 0.005, 0.010 and 0.030 inch).

11. Remove the inner pinion bearing cup and baffle using Pinion Bearing Cup Remover, D81T-4628-C (Model 44 axles) or D81T-4628-D (Model 50 axles) and Driver Handle, D81L-4000-A or equivalent (Fig. 39). Drive the bearing cup out of the bore.

    NOTE: Oil baffle and shims are located between the inner bearing cup and carrier bore. Be careful not to damage the shims when removing the bearing cup. If any shims are damaged, measure the thickness and replace with shims of equal thickness.

12. Turn the nose of the carrier down and remove the outer pinion bearing cup. Drive the cup from the carrier using Pinion Bearing Cup Remover D81T-4628-D (Model 44 and 50 axles) and Driver Handle D81L-4000-A or equivalent (Fig. 39).

13. Remove the differential case bearings and shims from the case. Place Step Plate, D80L-630-5 or equivalent under bearing to protect the bearing. Install Universal Bearing Remover, D81L-4220-A (or equivalent) and remove the bearing as shown in Fig. 40. Turn the case over and remove the other bearing.

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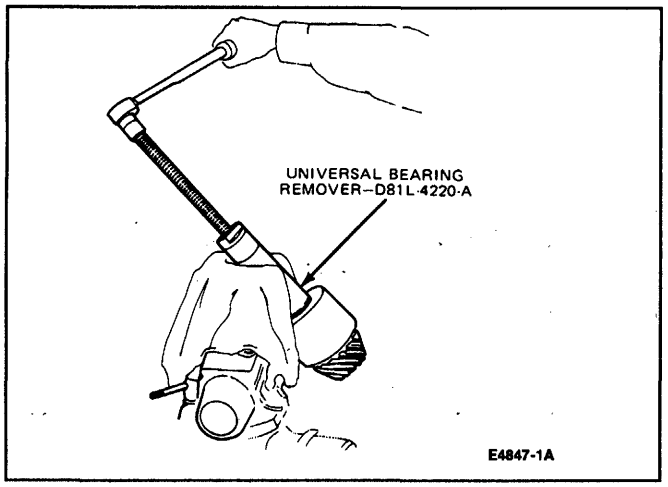


FIG. 41 Drive Pinion Bearing Removal

14. Wire the shims, bearing cup and cone together and identify from which side of the differential case they were removed. If any shims are damaged, replace with new shims upon assembly.
15. Place a few shop towels over the vise to prevent the ring gear teeth from being nicked, after it is free from the case. Place the case in a vise. Remove the ring gear bolts. Tap the ring gear with a rawhide hammer to free it from the case. Remove the case and ring gear from the vise.

    NOTE: Whenever removing the ring gear bolts, discard the bolts and replace with new bolts upon assembly.
16. Remove the bearing and oil slinger from the drive pinion with Universal Bearing Remover, D81L-4220-A or equivalent (Fig. 41).
17. Inspect all parts for damage and replace as required.

Total Differential Case Endplay

Assembly

1. Attach the ring gear to the differential case using new bolts. Tighten bolts alternately and evenly to 68-81 N·m (50-60 ft-lbs).
2. Clean the trunnions on the differential and install the Master Differential Bearings D81T-4222-B for Model 44 axles or D81T-4222-C or their equivalents for Model 50 axles (Fig. 42) onto the differential case. Remove all burrs and nicks from hubs so master bearings rotate freely.
3. Place the differential case into carrier (without pinion). The differential case should move freely in the carrier. Mount dial indicator (D78P-4201-B or Tool 4201-C, or equivalent) against the differential case flange as shown in Fig. 43. Locate the tip of the indicator on the flat surface of one ring gear bolt. Force the differential case toward the dial indicator as far as possible and zero the dial indicator with force still applied.

    NOTE: Dial indicator should have a minimum of 5.08mm (0.200 inch) travel.
4. Force the differential case away from the dial indicator as far as it will go. Repeat this procedure until the same reading is obtained. Record the dial indicator reading. This reading indicates the amount of shims needed behind the differential side bearings to take up total clearance between the differential bearing and case. This reading will be used under Pinion and Ring Gear Backlash.
5. Remove the differential case from the carrier. Do not remove the master differential bearings at this time.

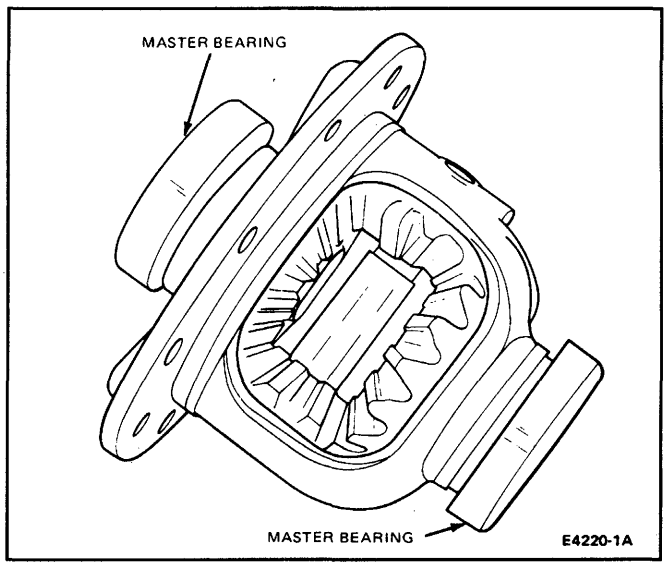


FIG. 42 Master Bearing Installation

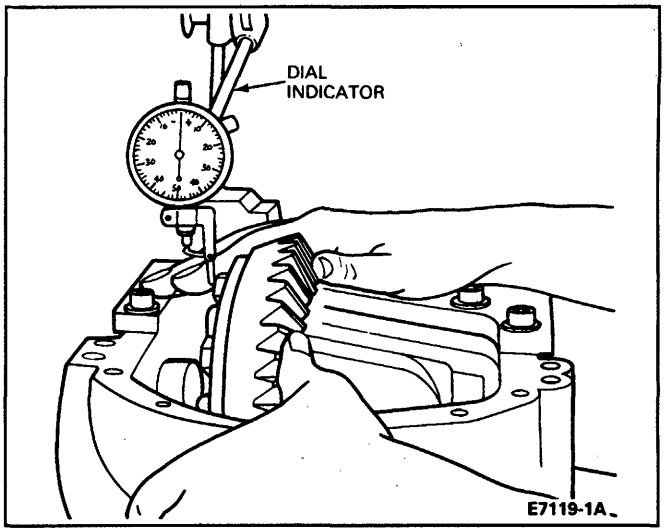


FIG. 43 Checking Differential Case Endplay

Drive Pinion Installation

Two separate adjustments affect drive pinion and ring gear tooth contact. They are pinion depth (location) and backlash. The pinion locating shim pack is installed between the drive pinion inner bearing cup and carrier housing (Fig. 44). This shim pack and inner oil slinger and oil baffle controls the position of the pinion. Adding shims moves the pinion toward the ring gear and removing shims moves the pinion away from the ring gear.

Ring gears and pinions are supplied in matched sets with standard or metric markings (Fig. 45).

On the button of each drive pinion is marked a plus figure (+), a minus figure (-) or a zero (0). These figures indicate the position for each gear set. The position is determined by the amount of shims between the inner

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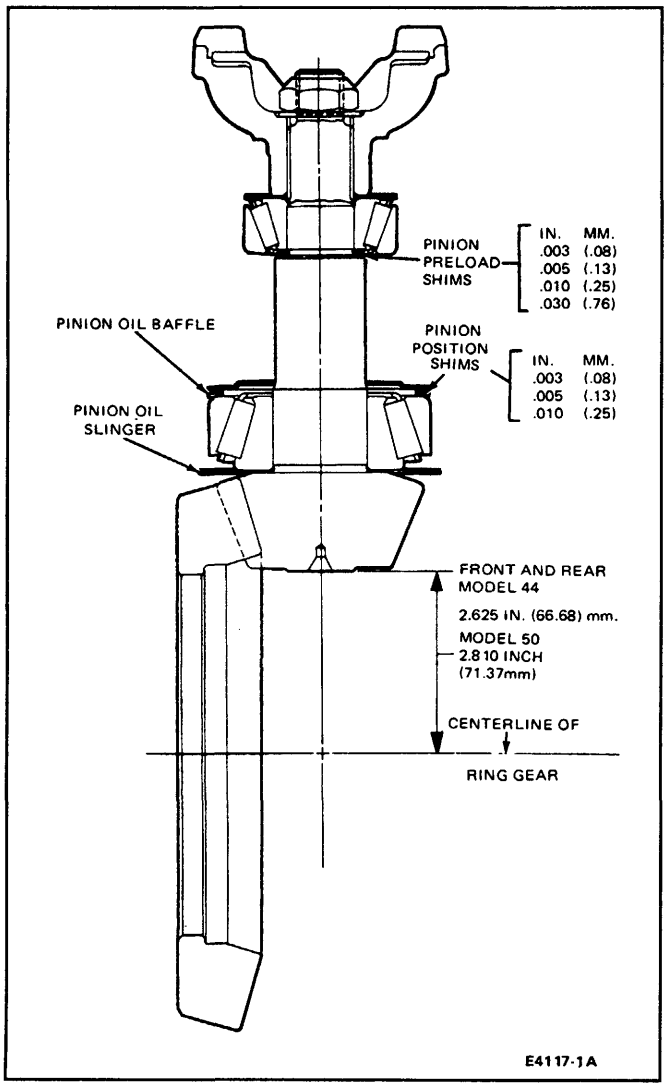


FIG. 44 Ring Gear and Tooth Contact

pinion bearing cup and carrier bearing bore. Refer to the charts in Figs. 46 and 47.

For example, if a new pinion is marked 'positive' +3 (+8-metric) and an old pinion is marked 'O', shims measuring (0.003 inch) 0.08mm must be removed between the drive pinion and inner bearing cup and retainer.

If the old ring and pinion shim pack is used, measure the slinger and baffle and each shim separately and add each shim measurement to total the original measurement. Replace the old shims with new shims that equal this measurement.

If a new ring and pinion is being installed, note the plus (+), minus (-) or zero (0) marking on the button of the pinion. Refer to the chart in Fig. 46 or Fig. 47. Add or subtract shims, according to the chart to compensate for differences between the old and new pinion.

A new ring gear and drive pinion is always installed as a matched set and never separately. **Be sure that the same matching number appears on both the drive pinion and ring gear.**

Install the correct shim pack of the drive pinion and place the pinion in the carrier. Check pinion depth.

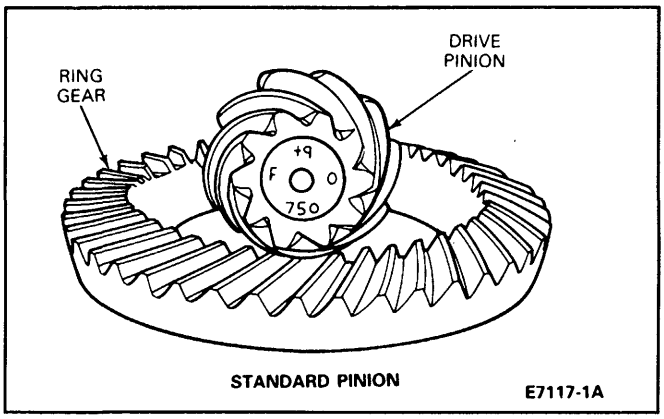


FIG. 45 Ring Gear and Drive Pinion—Standard and Metric

Depth Gauge Check

1. Refer to Fig. 48 for the correct tools for the particular axles.

   NOTE: If any of the gauge surfaces become nicked, the high spots must be removed with a medium India oilstone to ensure no erroneous readings.

2. Install inner and outer pinion cups with Forcing Screw T75T-1176-A and Pinion Bearing Cup Replacers, T80T-4000-D, (inner cup) and T80T-4000-E (outer cup) or equivalents (Fig. 51).

3. Place a new rear pinion bearing over the proper aligning adapter and insert into the pinion bearing retainer assembly. Place the front pinion bearing (new or used if in good condition) into the bearing cup in the carrier and assemble the handle onto the screw and hand tighten. Note the 3/8 inch square drive in the handle to be used for obtaining the proper pinion bearing preload.

4. Center the proper gauge tube into the differential bearing bore. Install the bearing caps and tighten to proper specifications. To preload the bearing, tighten the handle to 2.3-4.5 N·m (20-40 in-lbs).

5. Using a feeler gauge tool or shims, select the thickest feeler shim that will enter between the gauge tube and the gauge block. Insert the feeler gauge or shims directly along the gauge block to insure a correct reading. The feeler gauge fit between the gauge tube and the gauge block should be a slight drag-type feeling.

6. After the correct shims or feeler gauge feel is obtained, check the reading and this is the thickness of shim(s) required providing that upon inspection of the service pinion gear, the button is etched "0".

   NOTE: If the service pinion gear is marked with a plus (+) reading, this amount must be subtracted from the thickness dimension obtained in step 5 (Example: +2 (-0.002)).

   If the service pinion gear is marked with a minus (-) reading, this amount must be added to the thickness dimension obtained in step 5 (Example: —2 (+0.002)).

   In addition you must use the exact same new rear pinion bearing that was used in the previous steps.

7. Measure shims with a micrometer to verify the shim size. Place the oil slinger (if used) (Fig. 49) on

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Old Pinion Marking	New Pinion Marking								
	−4	−3	−2	−1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003
0	+0.004	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004
−1	+0.003	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005
−2	+0.002	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006
−3	+0.001	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007
−4	0	−0.001	−0.002	−0.003	−0.004	−0.005	−0.006	−0.007	−0.008

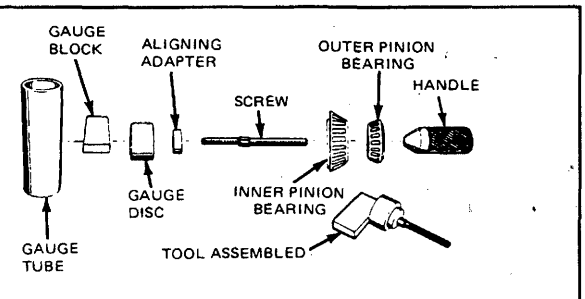
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FIG. 46 Shim Adjustment for Pinion Replacement—Standard

Old Pinion Marking	New Pinion Marking								
	−10	−8	−5	−3	0	+3	+5	+8	+10
+10	+.20	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0
+8	+.18	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03
+5	+.15	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05
+3	+.13	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08
0	+.10	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10
−3	+.08	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13
−5	+.05	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15
−8	+.03	0	−.03	−.05	−.08	−.10	−.13	−.15	−.18
−10	0	−.03	−.05	−.08	−.10	−.13	−.15	−.18	−.20

E4092-2A

FIG. 47 Shim Adjustment for Pinion Replacement—Metric



Tool	Tool Number	Axle Model 44	Axle Model 50
Aligning Adapter	T75P-4020-A2	X	X
Gauge Disc	T80T-4020-F40		X
	D80T-4020-F44	X	
Gauge Block	T80T-4020-F42	X	X
Screw	T80T-4020-F43	X	X
Handle	T76P-4020-A11	X	X
Gauge Tube	T80T-4020-F41		X
	D80T-4020-F47	X	

E4118-1B

FIG. 48 Depth Gauge Tool Selection

the pinion and press on the bearing using Tool T70P-4625, Pinion Bearing Replacer for Model 50 Axles or T53T-4621-B, Pinion Bearing Cone Replacer for Model 44 Axles and T75L-1165-B, Axle Bearing/Seal Plate (or equivalent tools) as shown in Fig. 50.

NOTE: If a baffle and/or slinger is used, replace with a new one upon assembly and measure as part of the shim stack.

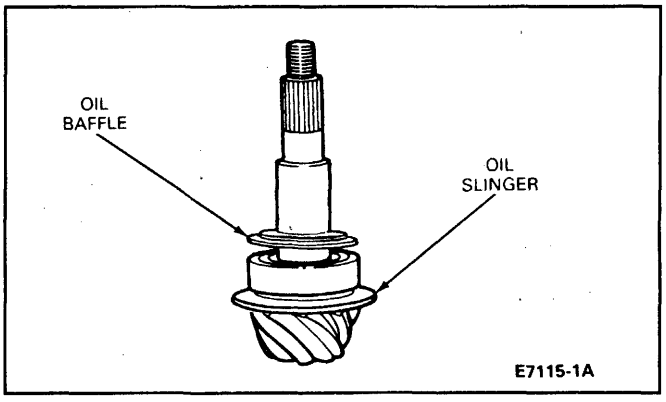


FIG. 49 Baffle and Oil Slinger Positions

8. After following these procedures, continue to build the remaining components with proper pinion and differential bearing preload torques and ring gear backlash.

Bearing Cup and Drive Pinion Installation

1. Clean the bore, and if installed, remove the cup. Place the oil baffle first and the required amount of shims in the inner pinion bearing bore and drive the inner pinion bearing cup in place with special Tool T80T-4000-D, Inner Pinion Bearing Cup Replacer (for Model 44 axles) or T80T-4000-F (for Model 50 axles) and Forcing Screw T75T-1176-A (or equivalents). Be careful not to cock the cup.
2. Place the outer pinion cup into the carrier and drive in place with special Tool T80T-4000-E or equivalent. For Model 44 and 50 axles Outer Pinion Cup Replacer, install Forcing Screw T75T-1176-A

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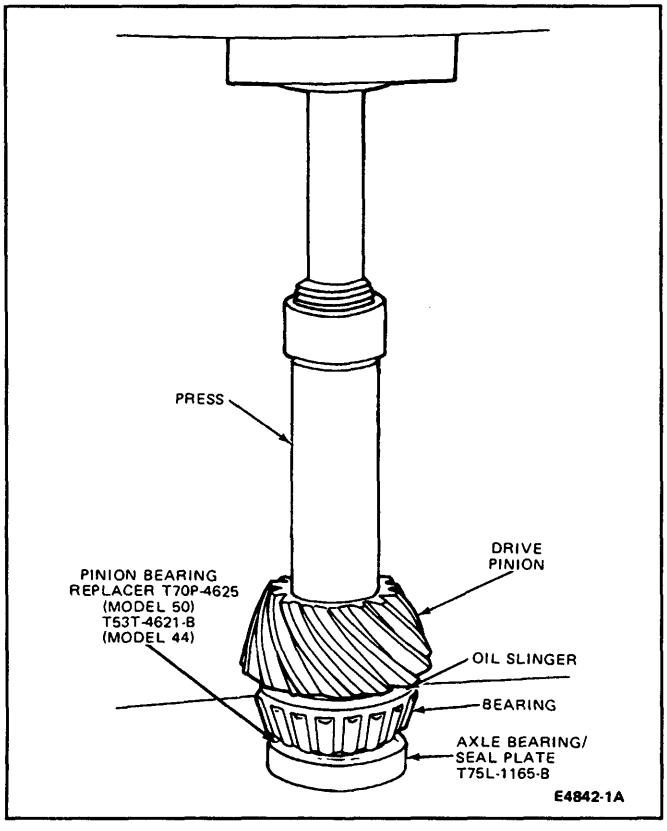


FIG. 50 Drive Pinion Bearing Installation

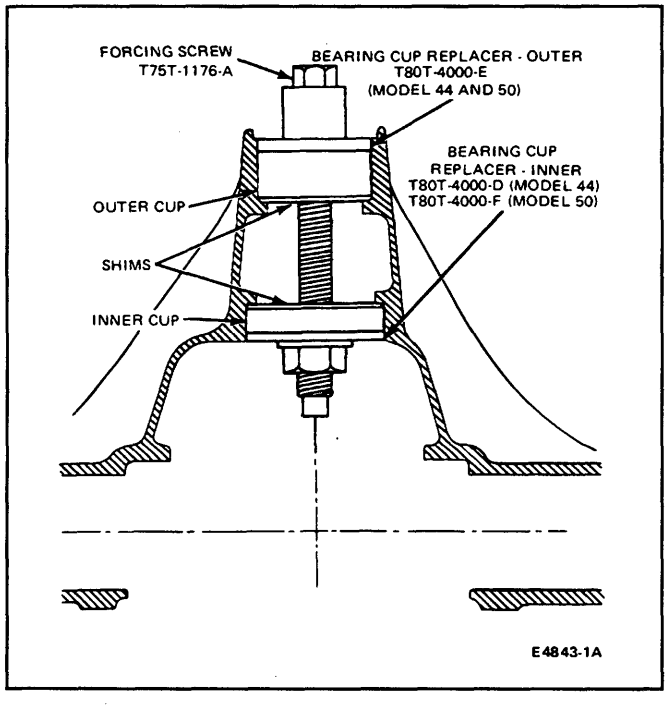


FIG. 51 Pinion Inner and Outer Cup Installation

or equivalent and draw the cups into the bore (Fig. 51).

3. Lubricate the ends of outer pinion bearings rollers with Multi-Purpose Long Life Lubricant, C1AZ-19590-B (ESA-M1C175-B) or equivalent. Install the outer bearing cone in place in outer bearing cup.

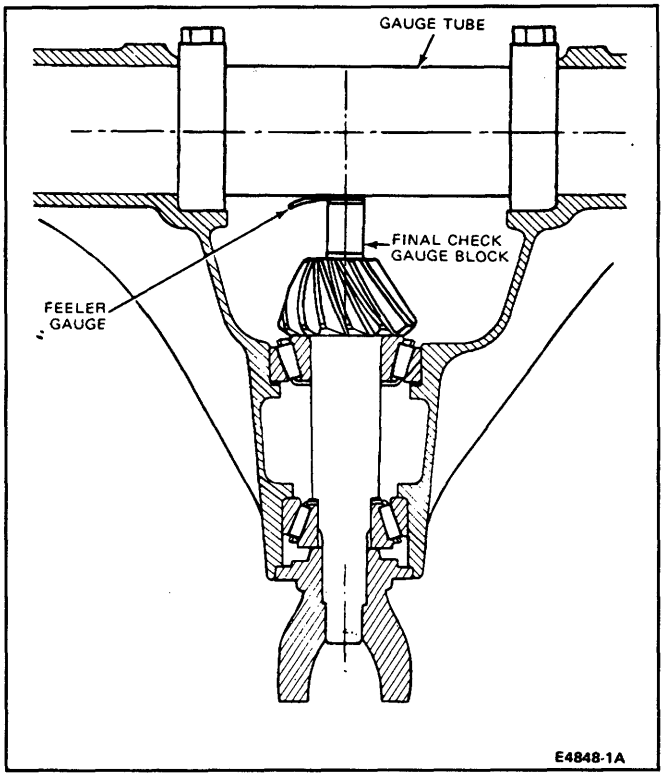


FIG. 52 Final Pinion Depth Check

4. Install the inner bearing cone and slinger on the pinion. Drive the bearing on the pinion shaft until fully seated using Pinion Bearing Replacer, T70P-4625 (Model 50 axles) or T53T-4621-B (Model 44 axles) and Axle Bearing/Seal Plate, T75L-1165-B or equivalents as shown in Fig. 50.

Drive Pinion Preload Check and Final Depth Check

1. Measure original preload shims and replace with new shims of equal size.
2. Install the pinion into the carrier.
3. Install new preload shims over the pinion. Install the outer pinion bearing cone and oil slinger.
4. Assemble end yoke, washer, deflector, and slinger on pinion shaft and align with special Tool T80T-4000-G and T78P-4851-A, Companion Flange Holder (or equivalents) to seat the yoke (Fig. 55). Install a new pinion nut and tighten nut to 271-298 N·m (200-220 ft. lb).
5. Rotate pinion nut with an inch-pound torque wrench. Rotating torque should be 2.25-2.43 N·m (20-40 in-lbs). To increase preload, remove shims. To decrease preload, add shims.
6. Install the Gauge Tube, D80T-4020-F47 (for Model 44 axles) or T80T-4020-F41 or equivalents (for Model 50 axles) (Fig. 52). Install bearing caps and tighten to 108-122 N·m (80-90 ft-lbs).
7. Insert the Final Check Gauge Block, D81T-4020-F52 (for Model 44 axles) or D81T-4020-F53 or equivalents, (for Model 50 axles (Fig. 52) on top of the pinion button under the gauge tube. Place a thumb on the gauge block to make sure the block is level (Fig. 53).

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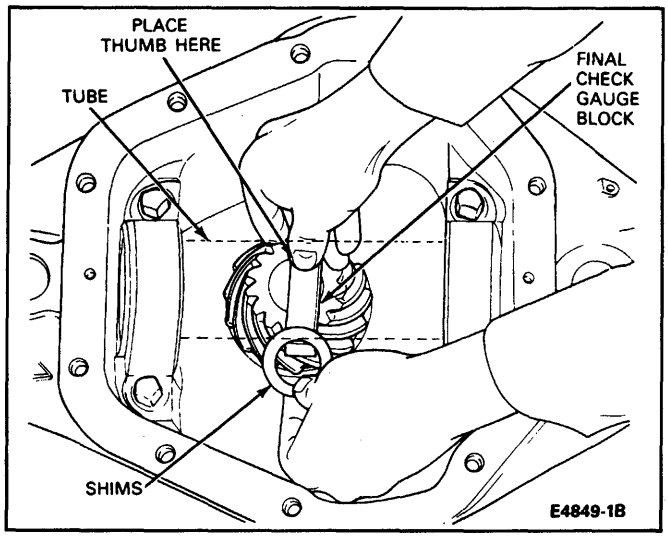


FIG. 53 Checking Final Pinion Depth

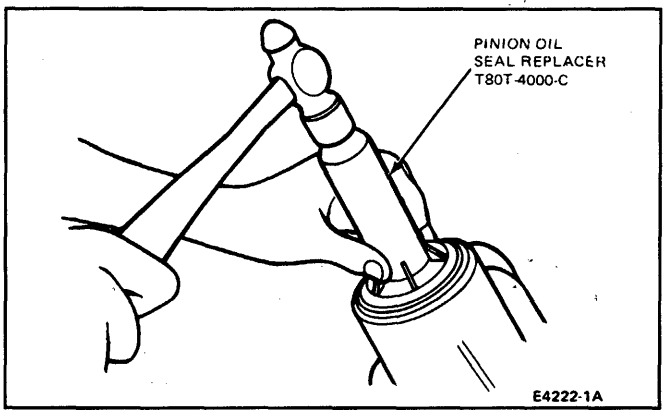


FIG. 54 Pinion Oil Seal Installation

Insert feeler gauges between the Gauge Tube and the Final Check Gauge Block until a slight drag is felt.

The reading should be 0.50mm (0.020 inch) added to the drive pinion etching, which could be 'plus' (+) or 'minus' (-) with a tolerance of 0.050mm (.002 inch).

For example a drive pinion with an etching of '+2' would have a 0.55mm (0.022 inch) distance and a tolerance of 0.050mm (0.002 inch) would require 0.50-0.60mm (0.020-0.024 inch) amount of shims.

If the distance must be increased, remove shims from beneath the inner pinion bearing cup. If the distance must be decreased, add shims beneath the inner pinion bearing cup.

8. With the drive pinion at the correct depth, remove the yoke with Holding Tool, T78P-4851-A and Yoke Remover, T65L-4851-B. Remove the yoke, nut and washer.
9. Coat the oil seal with Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent. Install the drive pinion oil seal with T80T-4000-C, Oil Seal Replacer (Fig. 54). After installation, make sure the garter spring didn't pop out. If the garter spring pops out, remove and replace the seal.
10. Install the yoke with Companion Flange Replacer, T83T-4851-A (Fig. 55). Install washer and nut and tighten nut to 271-298 N·m (200-220 ft-lbs).

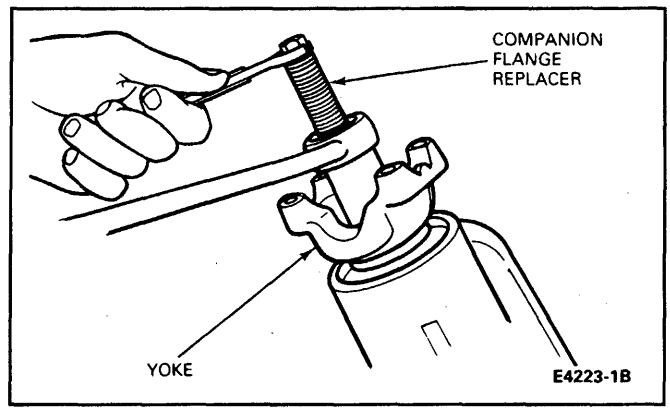


FIG. 55 End Yoke Installation

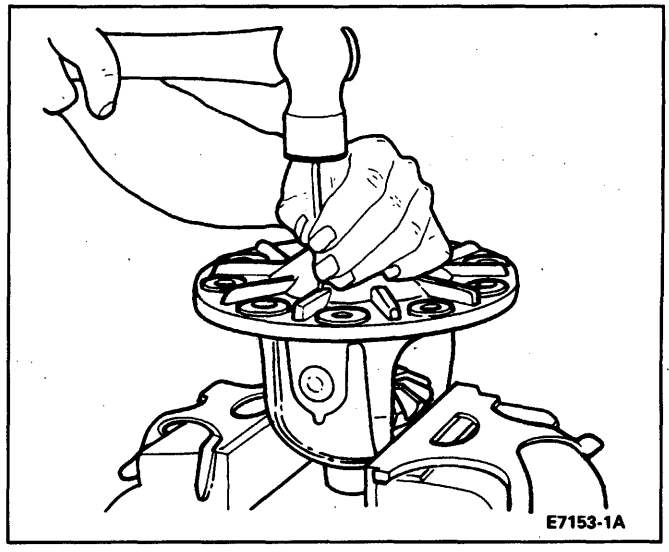


FIG. 56 Removing Lock Pin

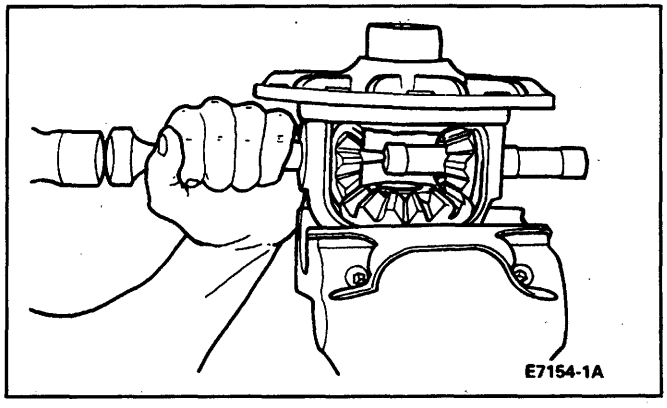


FIG. 57 Removing Mate Shaft

Differential Case

Disassembly

1. Place differential case in vise and drive out lock pin that retains the pinion mate shaft to case (Fig. 56).
2. Remove drive pinion mate shaft with a drift (Fig. 57).
3. Rotate the pinion mate gears and side gears until the pinion mate gears turn to the windows of the case. Remove pinion mate gears and spherical washers (Fig. 58).

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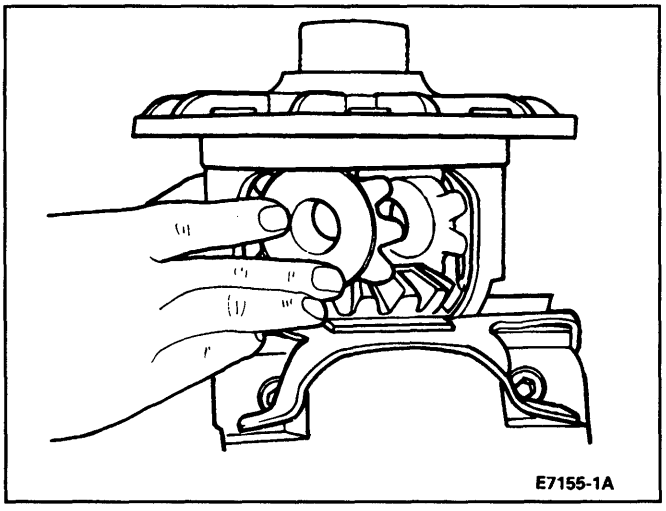


FIG. 58 Removing Pinion Mate Gears

4. Lift side gears and thrust washers from case.
5. Insert lock pin. Peen some metal of the case over the pin to lock it in place.

Assembly

1. Inspect case parts for signs of wear. If wear exists on all parts, replace the entire differential case assembly. If one gear shows signs of wear, replace both pinion mate and side gears as a set.
2. Apply grease Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent to side gear thrust washers, hub and thrust face of side gears. Lubricate pinion mate gears and spherical washer with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75B) or equivalent.
3. Hold side gears in place in case with one hand and install pinion mate gears and spherical washers with other hand. Rotate the side gears and pinion mate gears until the holes in the washers and pinion mate gears line up exactly with the holes in the case.
4. Insert the pinion mate shaft in the case. Make sure the lock pin hole in the shaft lines up with the lock pin holes in the case.

Differential Case

Assembly to Carrier

Pinion and Ring Gear Backlash

1. Assemble ring gear to differential case. Use new bolts and tighten alternately and evenly to 61-81 N·m (45-60 ft. lb).
2. Place the differential case into position in the carrier. (Master bearings should still be installed.)
3. Force the differential case away from the drive pinion gear, until it is completely seated against the cross bore face of the carrier. Position a dial indicator so the indicator tip rests on a differential case bolt as shown in Fig. 43. Zero the dial indicator.
4. Force ring gear against pinion gear. Rock ring gear slightly to make sure gear teeth are in contact. Then, force ring gear away from drive pinion gear, making sure the dial indicator returns to zero.

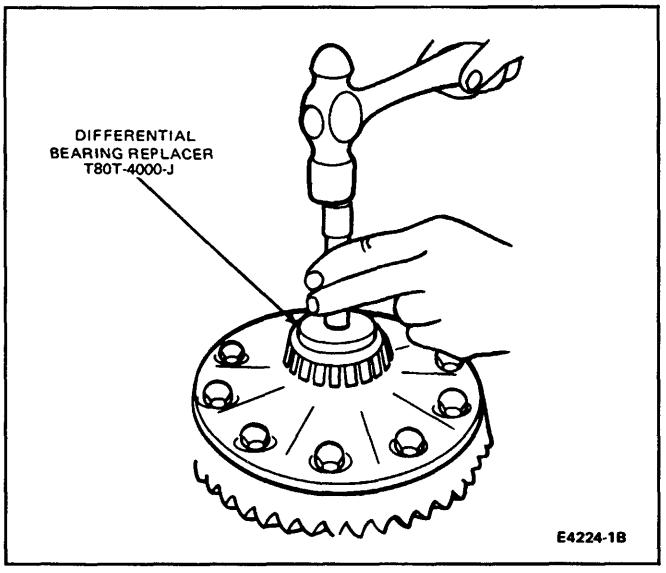


FIG. 59 Differential Side Bearing Installation

Repeat this procedure until the dial indicator reading is the same. This reading reveals the amount of shims necessary between the differential case and differential bearing on the ring gear side.

5. Remove the differential case from the carrier and remove the master bearings from the case.
6. As determined in step 4, place the required amount of shims on the ring gear hub of the differential case. For example: If the reading in step 4 was 1.14mm (0.045 inch), place 1.14mm (0.045 inch) amount of shims on the hub of the ring gear side of the differential case.
7. Install the bearing cone on the hub of the ring gear side of the differential case. Drive the bearing onto the hub using Differential Side Bearing Replacer, T80T-4000-J or equivalent as shown in Fig. 59.
8. To determine the correct amount of shims to be placed on the hub of the drive pinion side of the differential case, subtract the reading obtained in step 4 from the Differential Total Case Endplay. Total Case Endplay was determined in steps 3 and 4 of Differential Total Case Endplay. When this amount is determined, add 0.26mm (0.010 inch) to the amount. This is the required amount of shims to be placed on the hub of the drive pinion side of the differential case.

   For example: Total Case Endplay was 2.30mm (0.091 inch). The reading in step 4 was 1.14mm (0.045 inch), and when subtracted from 2.30mm (0.091 inch) gives 1.16mm (0.046 inch), 0.26mm (0.010 inch) is added to give 1.42mm (0.056 inch) amount of shims to be placed on the hub of the drive pinion side of the differential case.
9. Place the required amount of shims on the hub of the drive pinion side of the differential case.
10. Install the bearing cone on the hub of the drive pinion side of the differential case. Place Step Plate, D80L-630-5 or equivalent on the ring gear side bearing to protect the bearing. Drive the bearing onto the hub of the drive pinion side of the differential case using Differential Side Bearing Replacer, T80T-4000-J (or equivalent).

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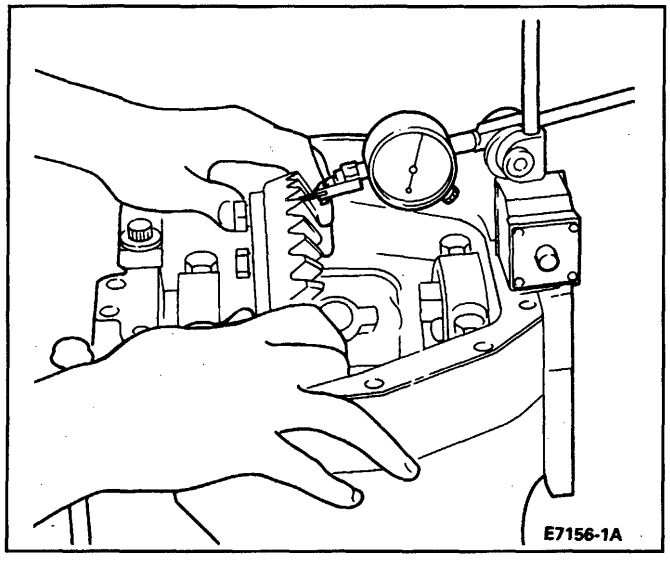


FIG. 60 Ring Gear and Backlash Check

11. Install bearing cone on the pinion side of the differential case with special Tools T80T-4000-J or equivalent, Differential Bearing Replacer (Fig. 59). Place the Pinion Bearing Cone Replacer, T53T-4621-C or equivalent, on the ring gear bearing to prevent damage.
12. Install the differential bearing cups on the bearing cones.
13. **With the spreader and dial indicator installed on the case, spread the carrier housing but do not exceed 0.25mm (0.015 inch).**
14. Install the differential case in the carrier. If necessary use a rawhide or plastic hammer to seat the differential case into the carrier housing cross bore. With partial and non-hunting/partial ring gear and pinion sets, align the marks on the ring gear and drive pinion. Be careful to not nick the teeth of the ring gear or pinion. Remove the spreader and dial indicator from the case.
15. Install bearing caps and bolts. Make sure the letters or numbers stamped on the caps correspond in both position and direction with the letters or numbers stamped into the carrier. Tighten bolts to 108-122 N·m (80-90 ft. lb).

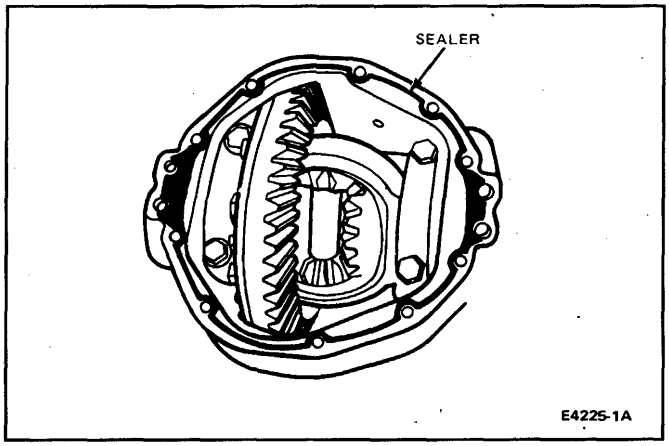


FIG. 61 Bead Surface

16. Install the dial indicator on the case as shown in Fig. 60. Check ring gear and pinion backlash at three equally spaced points on the ring gear. Backlash tolerance is 0.13-0.23mm (0.005-0.009 inch) and cannot vary more than 0.08mm (0.003 inch) between the three points. If backlash is high, the ring gear must be moved closer to the pinion, by moving shims to the ring gear side from the opposite side. If backlash is low, the ring gear must be moved away from the pinion by moving shims from the ring gear side to the opposite side.
17. Apply a bead 3.175-6.35mm (1/8-1/4 inch) high and 3.175-6.35mm (1/4-1/2 inch) wide of RTV sealant, D6AZ-19562-A (clear) or -B (black) (ESB-M4G92-A and ESE-M4G195-A) ASTM1, GE503, Z1, Z2 and Z3. or equivalent on the mating surfaces of the carrier mounting face support arm as shown in Fig. 61. **Allow one hour curing time after the axle carrier is assembled to the axle arm before installing lubricant and operating vehicle.**
18. Mount the differential assembly to the left hand axle arm, using 2 guide pins being careful not to smear gasket sealant. Install and tighten bolts to 41-54 N·m (30-40 ft. lb). Use new bolts with encapsulated adhesive or wire brush the old bolts and apply thread-locking compound, Threadlock and Sealer, E0AZ-19554-A (ESE-M4G204-A) or equivalent. Install support arm tab bolts to side of carrier and tighten to 115-136 N·m (85-100 ft-lbs).

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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Slide Hammer	Oil Seal Removal
D79P-100-A	Slide Hammer	Needle Bearing Removal
D80L-100-A	Blind Hole Puller Set	Universal
D80L-100-B	Forcing Screw	Needle Bearing Removal
D80L-100-T	Collet — 1-1/4 — 1-1/2 Inch	Needle Bearing Removal
T58L-101-A	Sealer Puller	Universal
D80L-630-5	Step Plate	Differential Side Bearing Removal
T77F-1102-A	Bearing Cup Puller	Oil Seal Removal
T75L-1165-B	Axle Bearing/Seal Plate	Drive Pinion Bearing Installation
T75T-1176-A	Forcing Screw	Bearing Cup Installation
D85T-1197-A	Spanner Locknut Wrench	Model 50 Inner Locknut Removal
T86T-1197-A	Spanner Locknut Wrench	Model 44 Adjusting Nut Removal
D79T-3010-B	Ball Joint Set	Ball Joint Removal and Installation
T80T-3010-A1	Replacer	Upper Ball Joint Installation
T80T-3010-A3	Receiving Cup	Ball Joint Installation
T80T-3010-A4	Plug	Ball Joint Removal
D79T-3010-BF	Installing Cup	Ball Joint Installation — F-150-F-250
D79T-3010-BG	Receiving Cup	Ball Joint Removal — F-150-F-250
T80T-3010-A2	Receiver Cup	Ball Joint Installer — F-350
T64P-3590-F	Pitman Arm Puller	Pitman Arm Removal
D81L-4000-A	Driver Handle	Cup Removal
T80T-4000-B	Spreader Adapter	Differential Case Removal and Installation
T80T-4000-C	Oil Seal Replacer	Oil Seal Installation
TOOL-4000-E	Spreader Tool	Differential Case Removal and Installation
T80T-4000-D	Bearing Cup Replacer	Inner Bearing Cup Installation — Model 44
T80T-4000-E	Bearing Cup Replacer	Outer Bearing Cup Installation — Model 44 and 50
T80T-4000-F	Bearing Cup Replacer	Inner Bearing Cup Installation — Model 50
T83T-4851-A	Companion Flange Replacer	Yoke Installation
T80T-4000-H	Differential Seal Replacer	Differential Seal Installation
T80T-4000-J	Differential Bearing Replacer	Differential Side Bearing Installation
T80T-4000-L	Sleeve	Axle Bearing Removal
T80T-4000-M	Axle Bearing Remover	Axle Bearing Removal
T80T-4000-N	Axle Bearing Replacer	Axle Bearing Installation
T80T-4000-S	Spindle Bearing Replacer	Needle Bearing Installation — Bronco — F-150-F-250
T80T-4000-R	Spindle Bearing Installer	Spindle Bearing — F-350
T80T-4000-T	Seal Replacer	Seal Installation — Bronco — F-150-F-250
T80T-4000-U	Seal Replacer	Seal Installation — F-350
T80T-4000-W	Driver Handle	Bearing and Seal Installation
T75P-4020-A2	Aligning Adapter	Axle Adjustments
T76P-4020-A11	Handle	Axle Adjustments
T80T-4020-A	Pinion Depth Gauge	Truck
T80T-4020-F40	Gauge Disc	Axle Adjustments — Model 50
T80T-4020-F41	Gauge Tube	Axle Adjustments — Model 50
T80T-4020-F42	Gauge Block	Axle Adjustments
T80T-4020-F43	Screw	Axle Adjustments
D80T-4020-F44	Gauge Disc	Axle Adjustments — Model 44
D80T-4020-F47	Gauge Tube	Axle Adjustments — Model 44
D80T-4020-F49	Gauge Tube	Axle Adjustments
D81T-4020-FX	Final Check Pinion Depth Gauge	Truck
D81T-4020-F52	Final Check Gauge Block	Axle Adjustments — Model 44
D81T-4020-F53	Final Check Gauge Block	Axle Adjustments — Model 50
TOOL-4201-C	Dial Indicator	Axle Adjustments

CE5100-2E

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SPECIAL SERVICE TOOLS (Cont'd.)

Number	Description	Application
D78P-4201-B	Dial Indicator	Magnetic Base
D81L-4220-A	Universal Bearing Remover	Bearing Removal
D81T-4222-B	Master Bearings	Axle Adjustments — Model 44
D81T-4222-C	Master Bearings	Axle Adjustments — Model 50
T53T-4621-B, C	Pinion Bearing Cone Replacer	Drive Pinion Bearing Installation — Model 44
T71P-4621-B	Pinion Bearing Cone Remover	Axle Bearing Installation
T70P-4625	Pinion Bearing Replacer	Drive Pinion Bearing Installation — Model 50
D81T-4628-C	Pinion Bearing Cup Remover	Inner Bearing Cup Removal — Model 44
D81T-4628-D	Pinion Bearing Cup Remover	Inner Bearing Cup Removal — Model 50 Outer Bearing Cup Removal — 44 and 50
T74P-4635-C	C-Frame Assembly	—
T65L-4851-B	Yoke Remover	—
T78P-4851-A	Holding Tool	Yoke Removal and Installation
T78P-5638-A1	Forcing Screw	Bushing Removal and Installation
T80T-5638-A1	Bushing Remover	Bushing Removal
T78P-5638-A2	Receiver Cup	Bushing Installation
T80T-5638-A2	Bushing Replacer	Bushing Installation
T78P-5638-A3	Receiver Cup	Bushing Removal
T78P-5638-A4	Receiver Cup	Bushing Removal
T57L-500-B	Bench Mounted Holding Fixture	Universal
T80T-4000-K	Differential Bearing Remover	—
T80T-4000-P	Inner Hub Bearing Cup Replacer	F150, Bronco
T80T-4000-Q	Inner Hub Bearing Cup Replacer	F-250
T80T-4000-V	Automatic Hub Locknut Wrench	—
T63P-9171-A	Keystone Clamp Pliers	—

CE5103-2C

TORQUE SPECIFICATIONS — DANA FRONT DRIVE AXLE

Description	Torque	
	N·m	(ft-lbs)
Bottom Ball Joint Nut	122-149	90-110
Top Ball Joint Nut	135 (Minimum)	100 (Minimum)
End Yoke Nut	271-298	200-220
Bearing Cap Bolts	108-122	80-90
Differential Retaining Bolts	41-54	30-40
Ring Gear Bolts	61-81	50-60
Support Arm Tabs to Carrier Bolts	115-136	85-100

DANA AXLE ADJUSMENTS

Description	Specification
Drive Pinion Preload	2.25-2.43 N·m (20-40 in-lbs)
Ring Gear Backlash	0.13-0.23mm (0.005-0.009 inch) No more than 0.08mm (0.003 inch) variation in any three places

LUBRICANT CAPACITY ①

Axle Model	Approximate Capacity		
	U.S. Pints	Imperial Pints	Liters
Dana 44 — IFS	3.9	3.2	1.7
Dana 50 — IFS	4.1	3.4	1.8

①Use Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent.

CE4125-1D

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SECTION 15-41 Traction-Lok Differential—Ford 8.8 Inch Ring Gear

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VEHICLE APPLICATION

Applies to E-150 Through F-150 and Bronco Models Equipped with 8.8 Inch Ring Gear Axle.

DESCRIPTION AND OPERATION

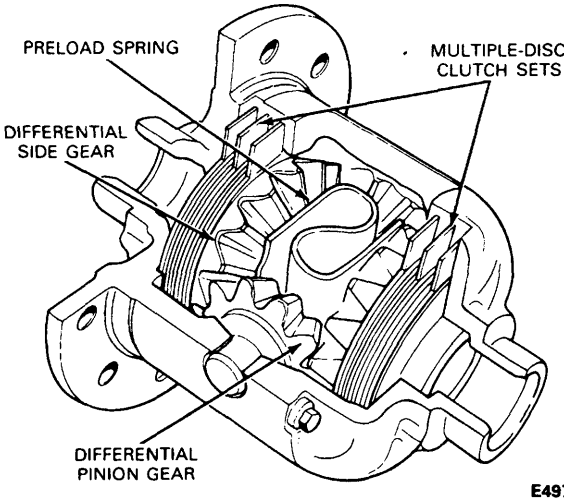
Description

The Limited Slip axle assembly, except for the differential case and its internal components, is identical to the conventional axle.

The Limited Slip differential employs two sets of multiple-disc clutches to control differential action. The side gear mounting distance is controlled by seven plates on each side: four steel, three friction, and one steel shim. This steel shim is of the selective type to control side gear position.

The plates are stacked on the side gear hub and are housed in the differential case. Also located in the differential case, between the side gears, is a one-piece pre-load spring, which applies an initial force to the clutch packs. Additional clutch capacity is delivered from the side gears thrust loads. Splined plates are splined to the side gear hubs which, in turn, are splined to the left and right axle shaft. The eared friction plates are dogged to the case, thus, the clutch packs are always engaged.

SECTIONAL VIEW OF DIFFERENTIAL ASSEMBLY



E4975-1C

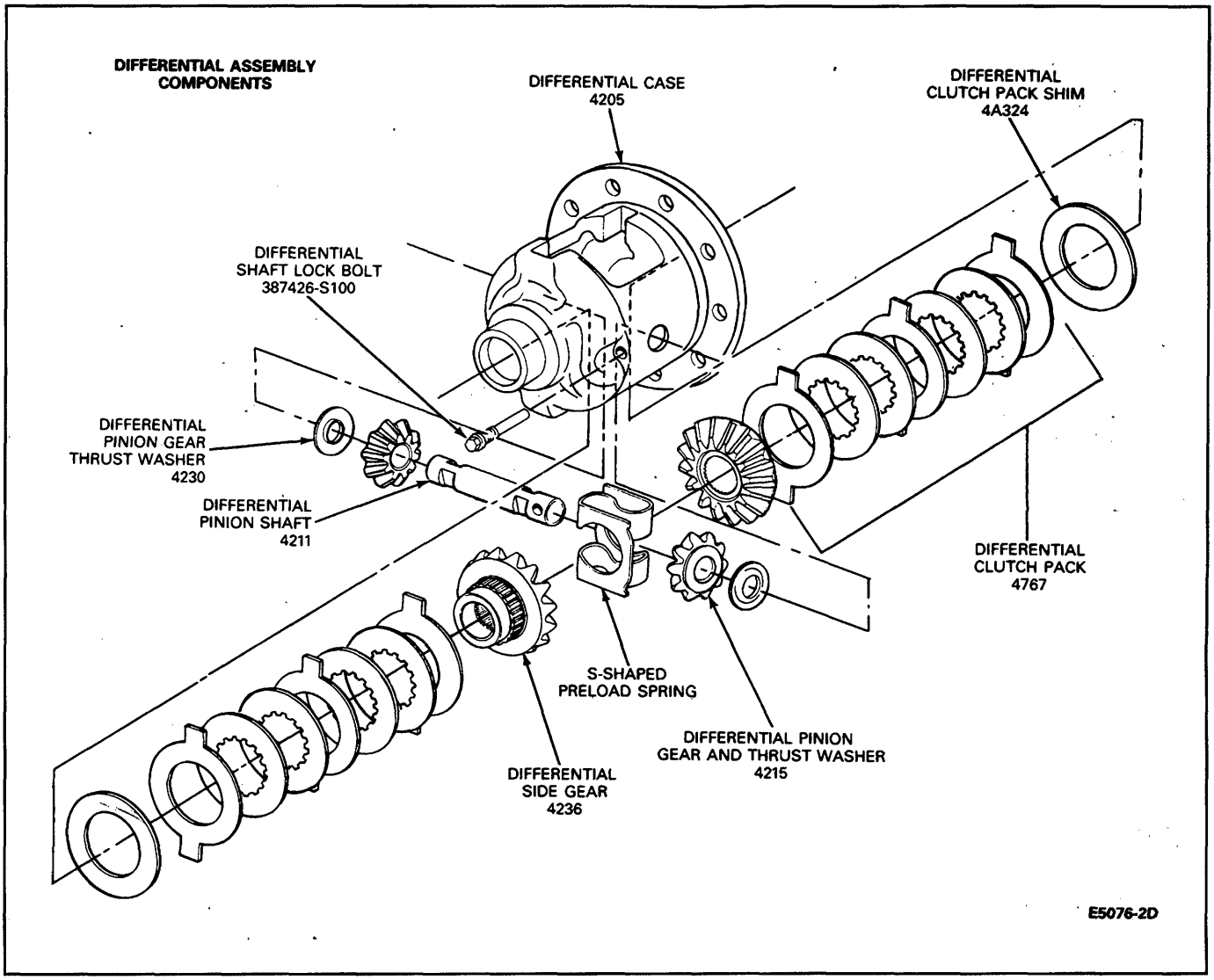
Operation

The pressure between clutch plates opposes differential action at all times. When the vehicle turns a corner the clutch slips, allowing normal differential action to take place. Under adverse weather conditions, where one or both wheels may be on a low-traction surface such as snow, ice or mud, the friction between the clutch plates will transfer a portion of the usable torque to the wheel with the most traction. Thus, the wheel that is on ice or snow will have a tendency to operate with the opposite wheel in a combined driving effort.

CAUTION: Extended use of other than conventional spare tires on a Traction-Lok rear axle could result in reduction in effectiveness (bias torque). This loss of effectiveness does not affect normal driving and should not be noticeable to the driver. However, extended usage will reduce the ability of the axle to provide added traction on slippery surfaces.

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DESCRIPTION AND OPERATION (Continued)



Noise Acceptability

A gear-driven unit (especially on a drive axle) will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions. For example, as on a newly paved blacktop road. The slight noise is in no way detrimental to operation of the rear axle and must be considered normal.

NOTE: Vehicles equipped with a Limited-Slip differential may exhibit a slight stick-slip noise on tight turns after extended highway driving. This is considered acceptable and has no detrimental effect.

DIAGNOSIS AND TESTING

Limited-Slip Differential Operation Check

A Limited-Slip differential can be checked for proper operation without removing the differential from the axle housing.

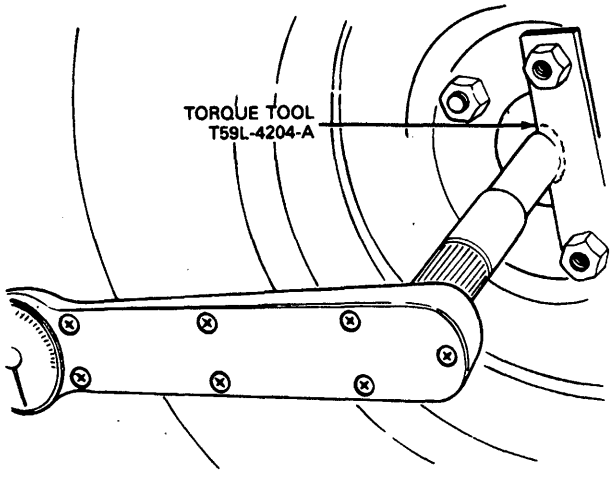
1. Jack up one rear wheel and remove the wheel cover. Install Torque Tool, T59L-4204-A or equivalent on the axle shaft flange studs as shown.

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DIAGNOSIS AND TESTING (Continued)

2. Using a torque wrench of at least 271 N·m (200 ft-lbs) capacity, rotate the axle shaft. Be sure that the transmission is in Neutral, one rear wheel is on the floor, and the other rear wheel is raised off the floor. The break-away torque required to start rotation should be at least 27 N·m (20 ft-lbs). The initial break-away torque may be higher than the continuous turning torque, but this is normal. The axle shaft should turn with even pressure throughout the check without slipping or binding. If the torque reading is less than specified, check the differential for proper assembly.

WARNING: A VEHICLE EQUIPPED WITH A LIMITED-SLIP DIFFERENTIAL WILL ALWAYS HAVE BOTH WHEELS DRIVING. IF, WHILE THE VEHICLE IS BEING SERVICED, ONLY ONE WHEEL IS RAISED OFF THE FLOOR AND THE REAR AXLE IS DRIVEN BY THE ENGINE, THE WHEEL ON THE FLOOR COULD DRIVE THE VEHICLE OFF THE STAND OR JACK.



E5121-1C

ADJUSTMENTS

In-vehicle adjustments are possible on this unit without removing the differential case from the axle housing. If the operation check was not to specification, the following procedure can be used to correct the condition:

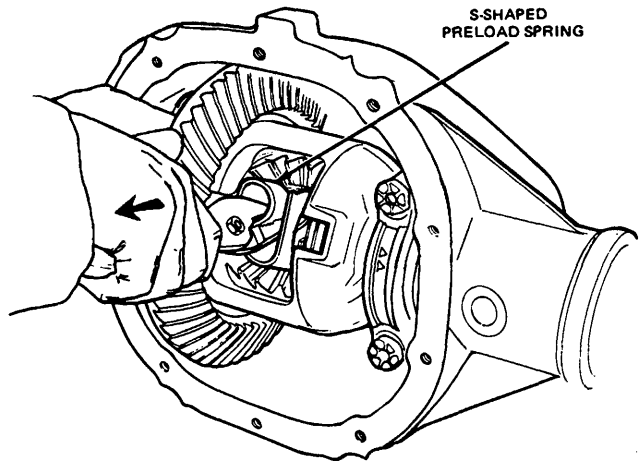
NOTE: Refer to Section 15-08 (Conventional 8.8 inch Ring Gear Axle), for Exciter Ring Service on Antilock brake system equipped vehicles.

Clutch Pack Preload Adjustment

NOTE: Before clutch pack preload can be adjusted, the axle shafts must be removed following the procedure in Section 15-08, Integral Carrier Axle—Ford Truck 8.8 Inch Ring Gear. The shafts must be removed completely from the housing so that the oil seals will not be damaged. After adjustment, install the shafts following the procedure in Section 15-08.

1. With a suitable drift, drive the S-shaped preload spring half-way out of the differential case. Rotate the differential case 180 degrees. Hold the S-shaped preload spring with a pair of pliers and tap the spring until it is removed from the differential.

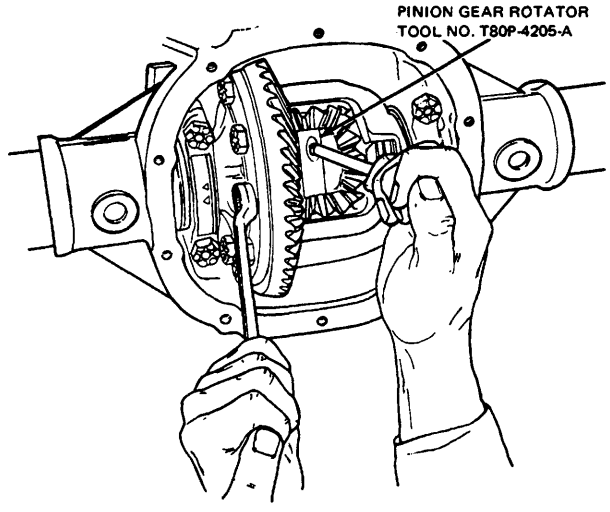
WARNING: CARE MUST BE USED WHEN REMOVING THE PRELOAD SPRING DUE TO THE SPRING TENSION.



E5077-1A

2. Using Gear Rotator T80P-4205-A or equivalent, rotate the pinion gears until the gears can be removed from the differential.

NOTE: A twelve inch extension is required to remove the pinion gears.

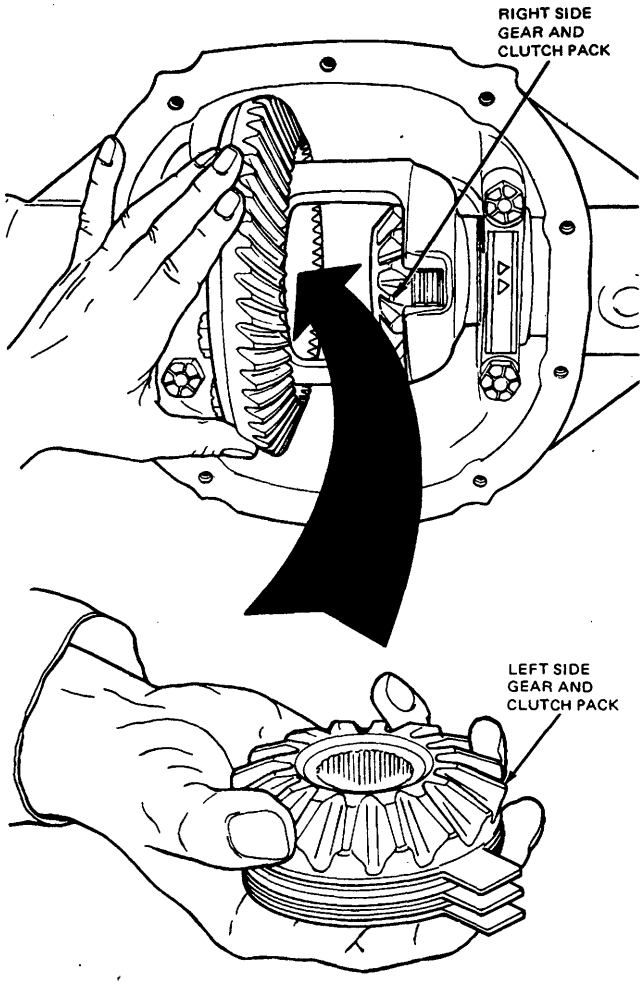


E5078-1A

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ADJUSTMENTS (Continued)

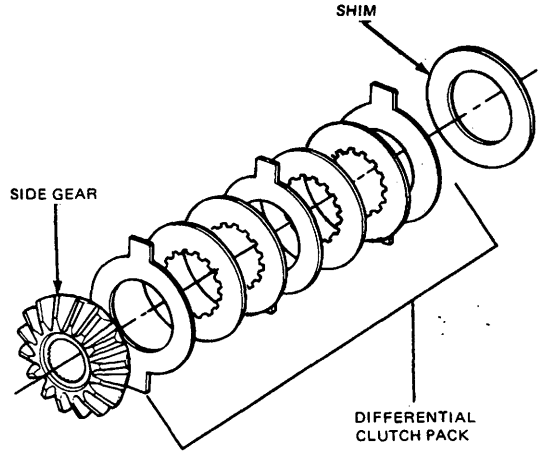
3. Remove the right and left side gear and clutch pack with the shim and tag them R.H. and L.H. Set them aside until Step 4. Clean and inspect the remaining parts of the differential case assembly for wear or damage. Replace parts as required.



E5079-1A

4. Clean and inspect the clutch packs for wear and replace parts as necessary.

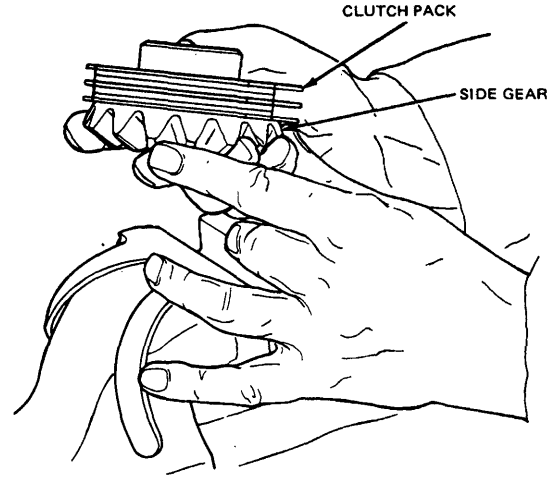
NOTE: Do not use acids or solvents when cleaning clutch components. Wipe components with a clean lint-free cloth only.



E5085-1A

5. Assemble the clutch packs (without shims) on the respective side gears. Pre-lubricate all friction plates with Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent.

NOTE: Do not mix clutch plates or shims from one side with the other.

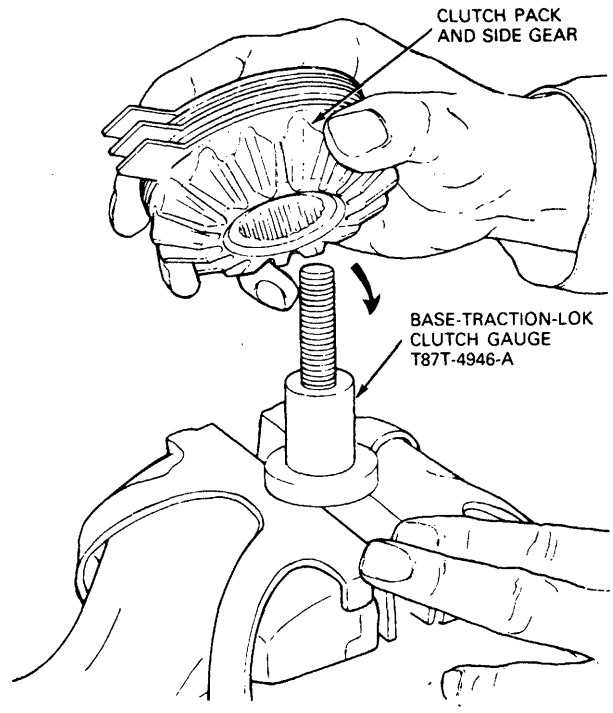


E5080-1A

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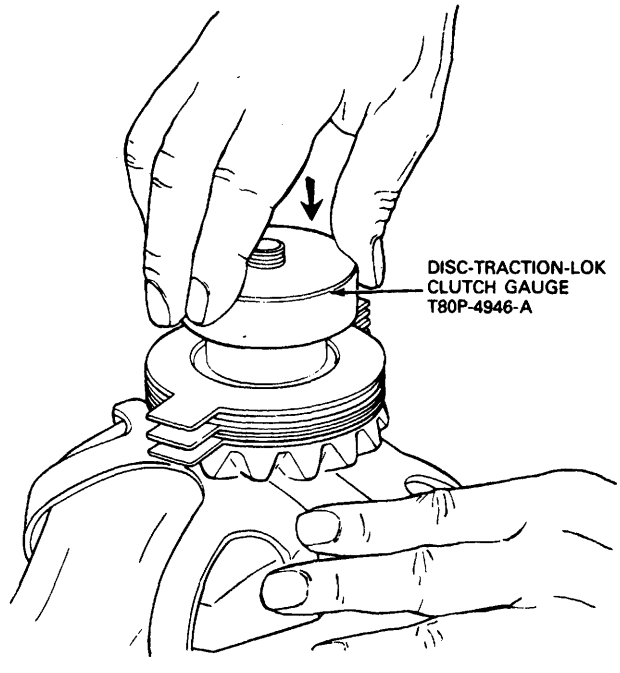
ADJUSTMENTS (Continued)

6. Place the base portion of Traction-Lok Clutch Gauge, T87T-4946-A in a vise. Install the clutch pack and side gear (without the differential clutch pack shim) over the base.



E5723-1B

7. Install the disc of Traction-Lok Clutch Gauge, T80P-4946-A over the base and on top of the clutch pack.

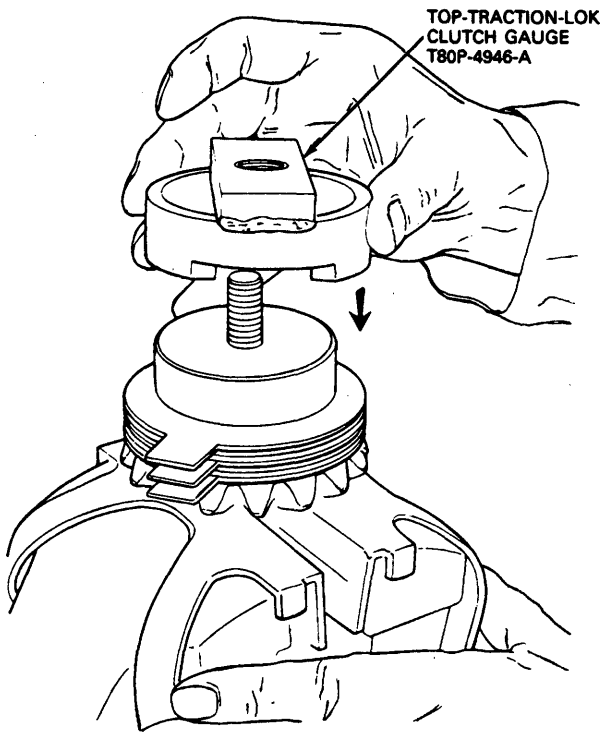


E5724-1A

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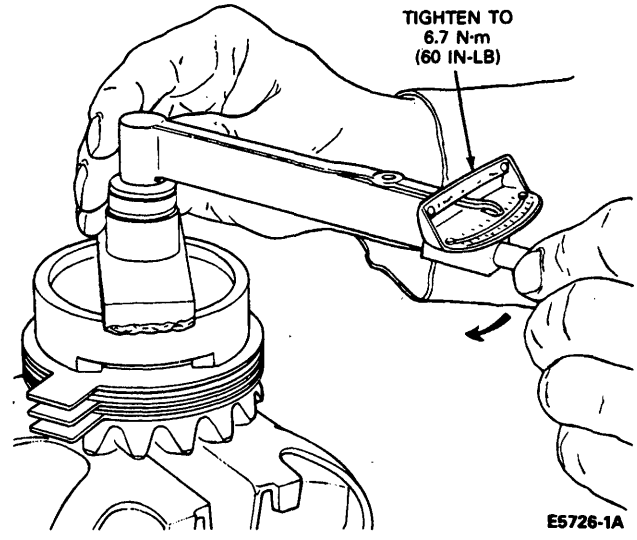
ADJUSTMENTS (Continued)

8. Install the top portion of Traction-Lok Clutch Gauge, T80P-4946-A over the disc and base stud.



E5725-1A

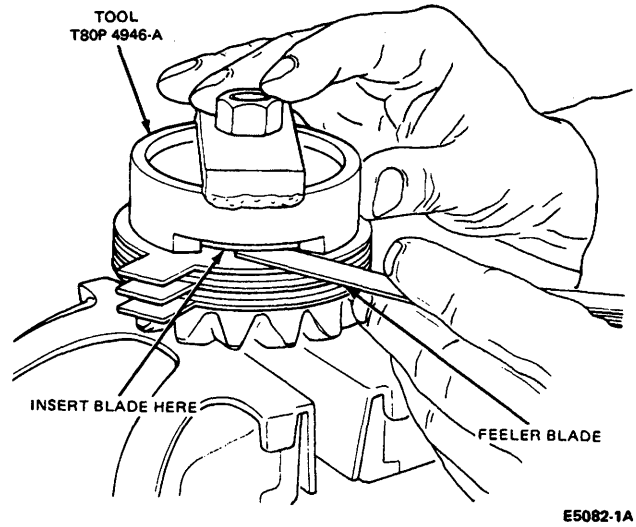
9. Install the nut of Traction-Lok Clutch Gauge, T80P-4946-A over the top and base stud. Tighten the nut to 6.7 N·m (60 in-lbs).



E5726-1A

10. Using a feeler gauge, select the thickest blade that will enter between the tool and the clutch pack. This reading will be the thickness of the new shim.

NOTE: Be sure to lubricate friction plates with the proper Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent prior to reassembly.

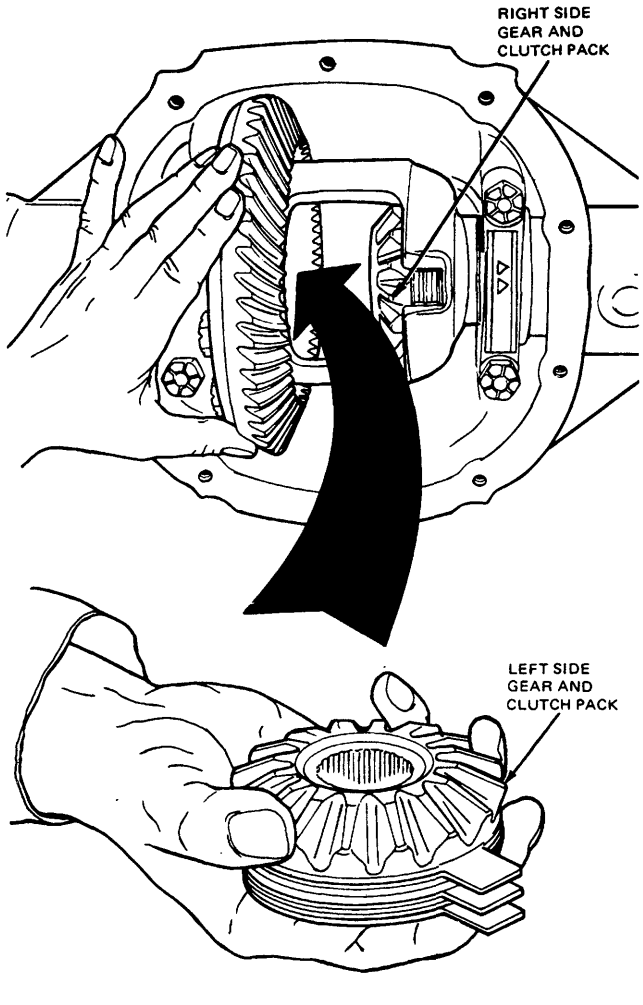


E5082-1A

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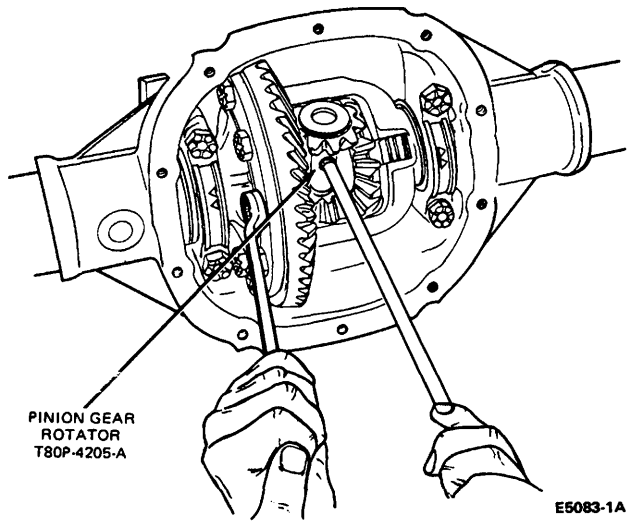
ADJUSTMENTS (Continued)

11. Install the right side-gear, clutch pack and new shim into the cavity in the differential case. Repeat this step for the left side.

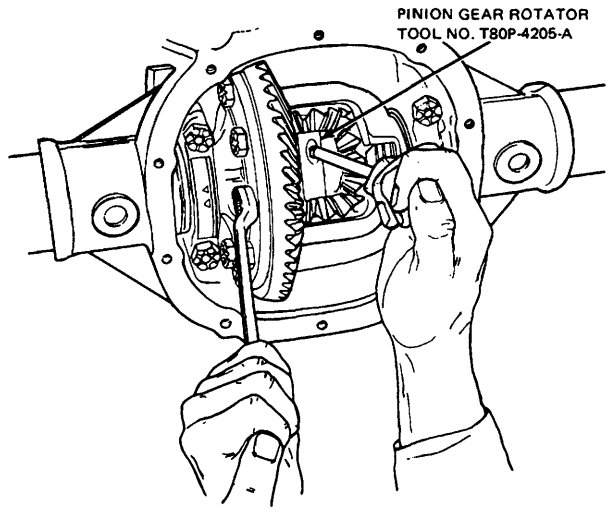


12. Place the pinion gears and thrust washers 180 degrees apart on the side gears. Install Tool T80P-4205-A or equivalent as shown.

NOTE: A twelve inch extension is required to install the pinion gears.



13. Rotate the tool until the pinion gears are aligned with the pinion shaft hole as shown. Remove the tool from the differential case.

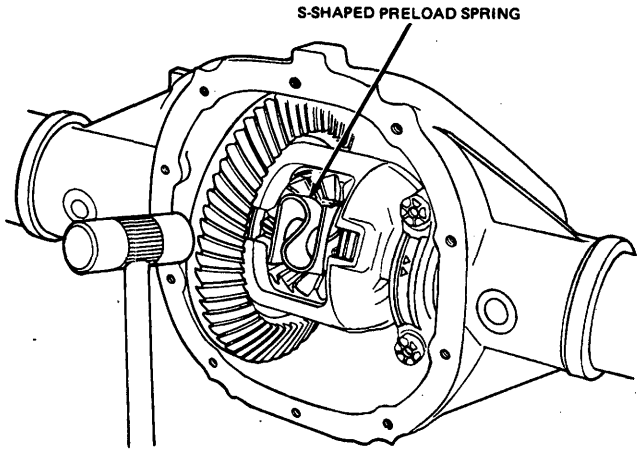


14. Hold the S-shaped preload spring up to the differential case window and with a soft-faced hammer, hammer the spring into position.

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ADJUSTMENTS (Continued)

NOTE: Inspect the pre-load spring for damage.



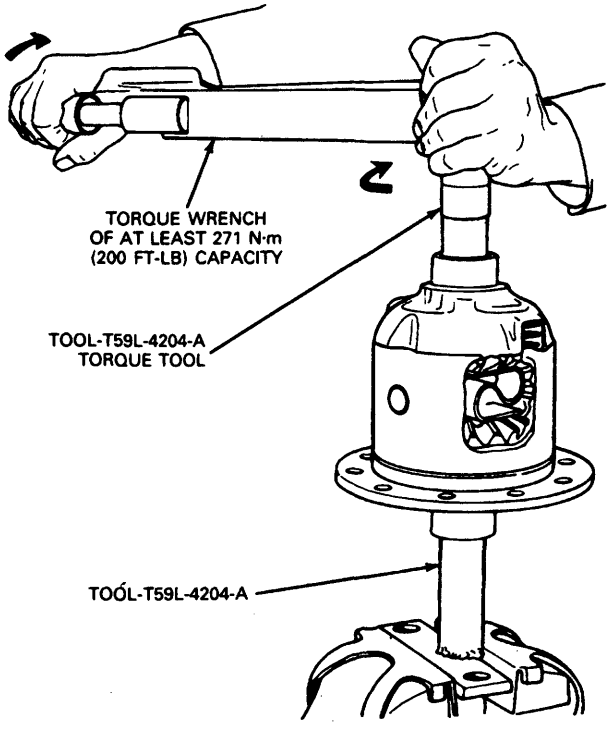
E5084-1A

Bench Torque Test

A bench torque test must be made **if** the differential assembly has been removed from the axle and adjustments have been made.

With the locker tools in T59L-4204-A or equivalent check the torque required to rotate one side gear while the other is held stationary.

The initial break-away torque, if original clutch plates are used, should be at least 27 N·m (20 ft-lbs). The rotating torque required to keep the side gear turning with new clutch plates may fluctuate.



E5712-1B

REMOVAL AND INSTALLATION

Removal and installation procedures for the Limited-Slip differential axle shaft, axle shaft seal and bearing, axle housing and pinion oil seal are the same as those for the Ford truck 8.8 inch ring gear integral carrier axle with a conventional differential. Refer to Section 15-08, Integral Carrier Axle—Ford—8.8 Inch Ring Gear, for these procedures.

DISASSEMBLY AND ASSEMBLY

Differential Case

Refer to Section 15-08, Integral Carrier Axle—Ford—8.8 Inch Ring Gear, Axle Housing Disassembly and Assembly for the procedures for removing and installing the Limited-Slip differential.

The differential is removed and installed in the same manner as a conventional differential.

To disassemble and assemble the case, remove and install the ring gear and differential cone and roller assemblies following the procedures used for the conventional differential.

NOTE: It is not necessary to remove the differential cone and roller assemblies from the case journals unless they are damaged. If the bearings remain on the case during repair, keep them clean and free from foreign material.

To remove and install the preload spring, pinion shaft and gears, and clutch packs, follow the procedure under Adjustments in this section.

SPECIFICATIONS

ADJUSTMENT TORQUE SPECIFICATIONS (INTEGRAL CARRIER) — LIMITED-SLIP

Description	Torque (In-Lb) N·m	Torque (Ft-Lb) N·m
Approximate torque required to tighten pinion flange nut to obtain correct pinion bearing preload	—	(160)① 217
Pinion Bearing Preloader Used Bearings New Bearings	(8-14) .9-1.6 (17-27) 2.0-3.0	—
Minimum rotating torques required during bench check after assembly or in vehicle with one wheel on the ground for original clutch pack.		27 (20)

①If pinion bearing preload exceeds specification before this torque is obtained, install a new spacer.
②With Oil Seal.

CE5105-1D

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SPECIFICATIONS (Continued)

DRIVING AXLE IDENTIFICATION (INTEGRAL CARRIER) — LIMITED-SLIP

Identification Tag	Ratio	Ring Gear Diameter (Inches)	Type
807D	3L55:1	8.8	T2
815D	4L10:1	8.8	T2
817P	3L55:1	8.8	T2
731P	3L55:1	8.8	T2
733D	3L55:1	8.8	T2

CE5107-1E

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER) — LIMITED-SLIP

Vehicle	Engine	Axle	U.S. Measure Capacity (Pints)①	Imperial Capacity (Pints)①	Liters①
E-150, F-150 Bronco	All	8.8 Inch Ring Gear	5.5	4.6	2.6

①Use Hypoid Gear Lubricant E0AZ-19580-A (ESP-M2C154-A) lubricant or equivalent. Add 4 U.S. ounces of Additive Friction Modifier, C8AZ-19B546-A, (EST-M2C118-A) or equivalent.

CE5108-1D

BACKLASH BETWEEN RING GEAR AND PINION

Backlash — 0.20-0.46 mm (0.008-0.18 in.)
Runout — 0.203 mm (0.008 in.)

CE7109-1A

TORQUE SPECIFICATIONS (INTEGRAL CARRIER) — LIMITED-SLIP

Description	Torque (Ft-Lb) N·m
Differential Bearing Cap Bolt — Inch	(70-85) 95-115
Differential Pinion Shaft Lock Bolt	(15-30) 20-40
Ring Gear Attaching Bolts - Inch①	(70-85) 95-115
Rear Cover Screw	(25-35) 34-47
Oil Filler Plug	(15-30) 20-40
Brake Backing Plate Nuts F-150/Bronco	(20-40) 28-54
Driveshaft to Axle Half-Round Companion Flange — F-150 and Bronco	(8-15) 11-20
Driveshaft to Axle Circular Companion Flange — E-150	(70-95) 95-129

①Using Loctite (or equivalent)

CE5106-1C

SPECIAL SERVICE TOOLS

Tool Number	Description
T59L-4204-A	Torque Tool
T80P-4205-A	Differential Gear Rotator
T80P-4946-A	Differential Clutch Gauge
T87T-4946-A	Differential Clutch Gauge — Base

CE5109-1C

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SECTION 15-42 Limited-Slip Differential—Dana

SUBJECT	PAGE
DESCRIPTION AND OPERATION	15-42-1
DIAGNOSIS AND TESTING	15-42-3
DISASSEMBLY AND ASSEMBLY	
Dana Limited-Slip Axles	15-42-4
Differential Case	15-42-4
Model 44IFS, 44IFS-HD, 60-3 and 61-1 2-Pinion (Dana Trac-Lok)	15-42-4
DISASSEMBLY AND ASSEMBLY (Cont'd)	
Differential Case (Cont'd)	
Model 70 (4-Pinion) Power-Lok	15-42-6
REMOVAL AND INSTALLATION	15-42-3
SPECIFICATIONS	15-42-9
VEHICLE APPLICATION	15-42-1

VEHICLE APPLICATION

Applies to E-250 through E-350 Rear Axle, F-150 through F-350 (4x4) and Bronco Front Axle Models.

DESCRIPTION AND OPERATION

The limited-slip Dana Trac-Lok Model 44 IFS, Model 44 IFSHD and Model 60-3 and 61-1 two pinion axle (Fig. 1) and the four pinion Dana Powr-Lok Model 70 (Figs. 2 and 4) have a power flow identical to the conventional rear axle, plus a more direct power flow which automatically takes effect as driving conditions demand. This more direct power flow is from the differential case to each axle shaft through clutches (Fig. 3).

A conventional differential transmits all of the ring gear torque through the differential gears to the axle shafts. Torque is at all times equal on the axle shafts, and if one wheel slips, the other wheel can only put out as much torque as the slipping wheel. The limited-slip differential is similar, except that part of the torque from the ring gear is transmitted through clutch packs between the side gears and differential case. The multiple-disc clutches, with radial grooves on the plates and concentric grooves on the discs, are engaged by a preload from dished springs and separating forces from the side gears. This occurs as torque is applied through the ring gear.

NOTE: Some Model 60 and 70 plates may incorporate a special surface coating in place of the radial grooves. Plates of this design should be soaked in Friction Modifier C8AZ-19B546-A (EST-M2C118-A) prior to assembly for twenty minutes.

Each clutch plate and disc pack consists of steel plates, set between the case and the side gear ring. The clutch plates, having external lugs, are locked to the differential case by the external lugs. The clutch plate that is installed next to the case is a Belleville spring plate. This plate is installed with the concave (dished) side against the case. The remaining clutch discs have internal spline teeth which lock to the splined hub on the side gear ring. The side gear ring is, in turn, splined to the axle shaft and acts as a pressure plate against the clutch pack. Since the side gear ring fits against the pinions on the cross shaft (mate shaft), any outward force exerted by the mate shaft and its pinions will press

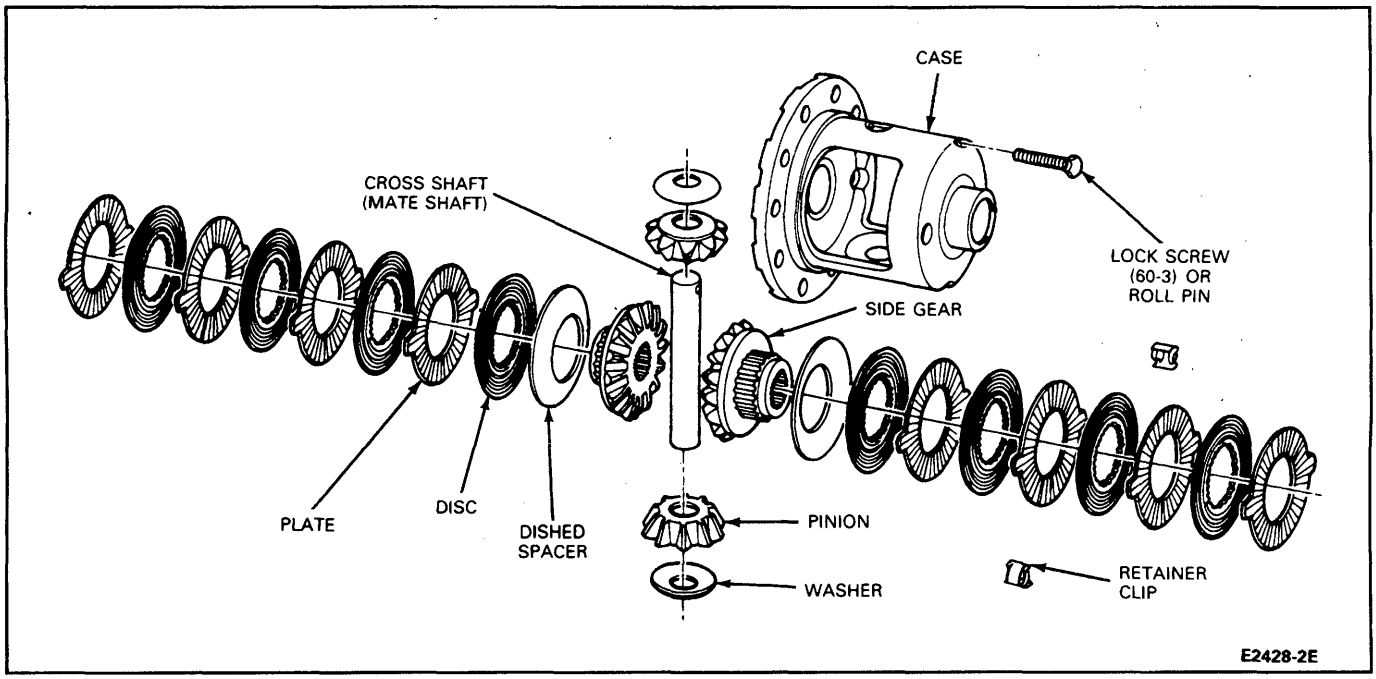


FIG. 1 Two Pinion Limited-Slip Differential—Model 44-IFS and Model 60-3 and 61-1 Trac-Lok

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the ring against the clutch pack and thus connect the differential case directly to the axle shaft.

Unlike the cross shafts of the conventional unit, the 4 pinion limited-slip differential mate shafts are not rigidly attached to the differential case, nor are they attached to each other. At both ends of the mate shafts there are two flat surfaces so arranged that they form a V which mates with corresponding V-shaped surfaces (ramps) cut in the shaft openings of the differential case. The mate shafts are assembled in the case with enough clearance so that when the case tries to rotate, they resist rotation. They are then forced to bear against one side of their V ramps. Since the two V ramps of one mate shaft point in a direction opposite to those of the other pin, the two shafts with their pinions will be forced apart as they resist rotation. This mate shaft movement compresses the clutch pack through the pinion gears and side gear rings.

When the differential case rotates in the opposite direction, the mate shafts will be forced to bear against the opposite side of their V ramps and will again be forced apart to apply against the clutch packs. Therefore, since the ramps are V-shaped, the clutches will apply during either forward or reverse operation. Likewise, the clutches will apply whether the power flow is from the differential case to the axle shafts, or from the axle shaft to the differential case.

The amount of compression on the clutch plates will be proportionate to the load applied to the differential case and the resistance to turning offered by each mate shaft. For example, if the vehicle is driven straight ahead and the traction or load on both wheels is equal, both mate shafts will give equal resistance to the rotating differential case and will thus bear against their respective ramps with equal force. This equal movement of the mate shafts will cause them to exert equal pressure against both right and left clutch packs. Both axle shafts will, therefore, be locked directly to the case with equal force. Fig. 4 shows a cutaway view of a Model 70 axle Powr-Lok differential assembly.

The limited-slip differential prevents momentary spinning of one of the wheels when it leaves the road because of a bump, or encounters poor traction because of a slippery road. Under these conditions, even though the traction load is relieved on the one wheel, the acceleration load is simultaneously applied to the differential case as the engine tries to spin the wheel.

When the rear axle is in a turn, the appropriate clutch releases automatically to allow normal differential operation as required. In the straight-ahead position, the differential case is driving both wheels and thus applies an equal load against both mate shafts. Since both mate shafts offer resistance to this load, both clutches are applied. On a turn, however, the outside wheel turns faster than the inside wheel. The outside wheel, instead of being driven by the case, now tends to drive the case. With the power thus relieved, the differential case releases its load against the outside wheel mate shaft which, in turn, releases its pressure against the outside wheel clutch pack. With the clutch released, normal differential action will take effect.

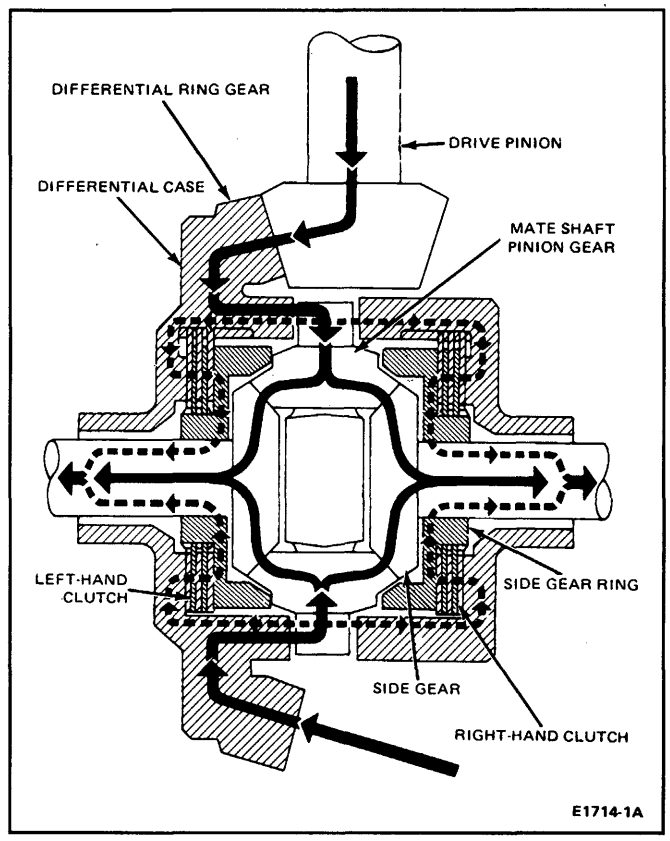


FIG. 3 Limited-Slip Differential Power Flow with Both Wheels Driving

For a complete understanding of limited-slip operation, it is important to recognize two things:

1. If with equal traction, both wheels slip, the axle has done all it can do.

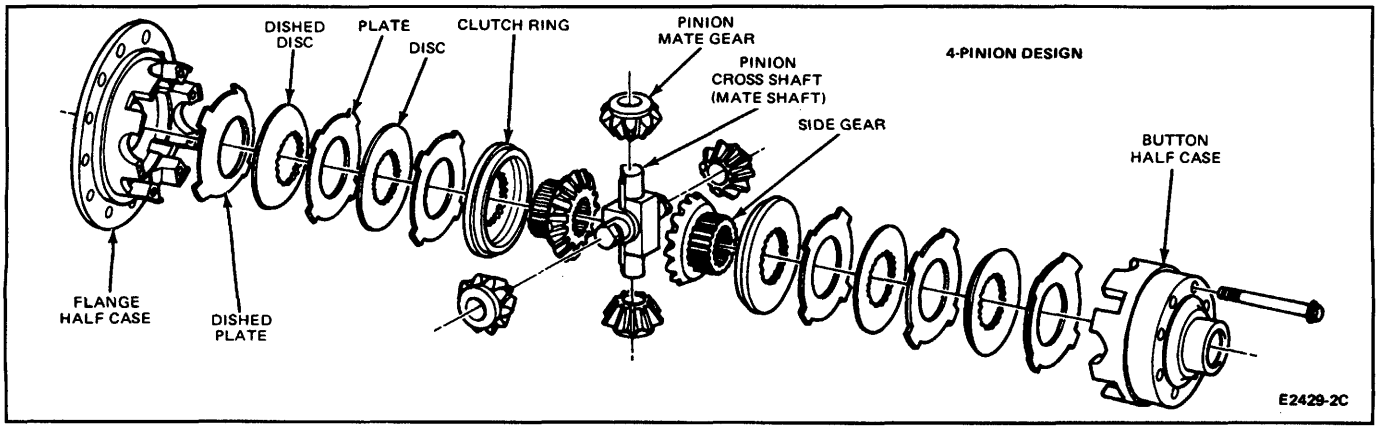


FIG. 2 Four Pinion Limited-Slip Differential—Model 70 and 70HD Powr-Lok

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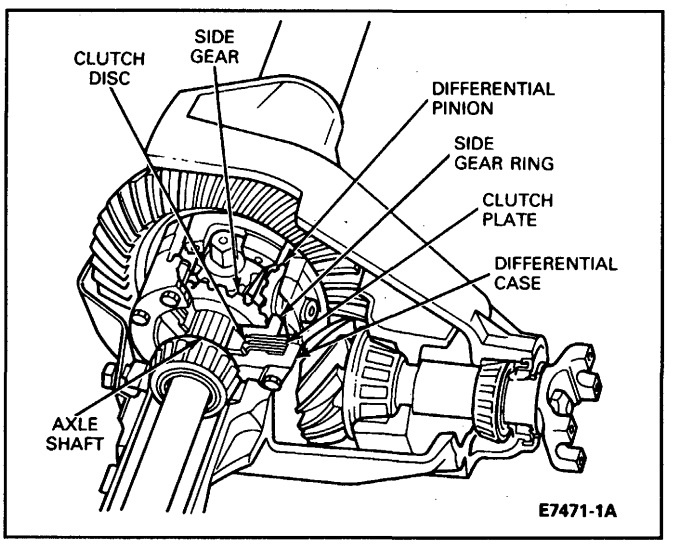


FIG. 4 Limited-Slip Differential—Model 70 and 70HD Powr-Lok

2. In extreme cases of differences of traction, the wheel with the least traction may spin after the axle has transferred as much torque as possible to the non-slipping wheel.

DIAGNOSIS AND TESTING

If noises or roughness such as chatter are present when turning corners, the probable cause is incorrect or contaminated lubricant.

Before any differential is removed and dissassembled for chatter complaints, the correctness of lubricant should be determined.

Verify the axle has the specified quantity of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent and 0.236L (8 ounces) of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for rear axles and 0.059L (two ounces) of Additive Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for front drive axles. Warm the axle up and recheck for chatter by making a minimum of ten figure-eight type turns.

If this is unsuccessful, a complete lubricant drain, flush and refill will usually correct chatter. The following procedure is recommended to ensure that the system is flushed of old lubricant.

1. Warm the lubricant by vehicle road operation or five minutes of operation in gear with both rear wheels off the ground on a hoist.

   CAUTION: Never place the transmission in gear with the engine running when only one wheel of a limited slip differential equipped vehicle is raised. The vehicle might drive itself off the jack and cause damage or injury.

2. Drain lubricant while warm. Remove cover plate to drain completely. If cover plate is removed, it will be necessary to replace gasket at this time.

3. Figure 5 shows the flat mounting surface cover plate on Dana design axles. This cover plate requires the use of a silicone rubber sealer material. ESL-M4G273-A (ASTM1, GE503, Z1, Z2 and Z3) or equivalent rather than a gasket.

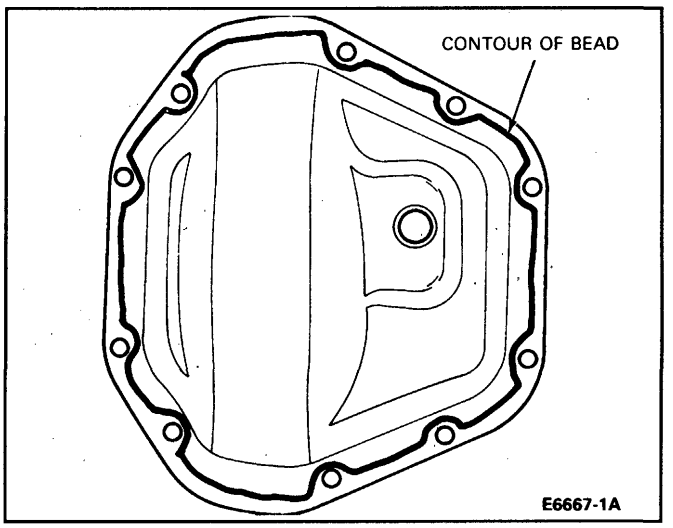


FIG. 5 Cover Plate—Flat Mounting Surface

   The cover face of the carrier and the flat surface of the cover plate must be free of any oil film or foreign material.

   Apply RTV Gasket sealer ESL-M4G273-A, or equivalent to cover plate surface. Ensure that the sealer bead is laid on the inside of the cover screw holes. The bead is not to pass through the holes or outside of the holes.

   The bead is to be 3.18-6.35mm (1/8 inch to 1/4 inch) wide.

   Assemble two cover screws into cover at 8 o'clock and 2 o'clock position. Use these two holes to guide cover plate into position on the carrier.

   Install remaining screws. Tighten alternately and evenly. Tighten screws to 41-54 N·m (30-40 ft-lbs.).

   Allow one hour cure time before filling carrier with the proper amount of specified lubricant and vehicle operation.

4. Refill axle with specified lubricant.

5. Operate the vehicle for approximately 16 Km (10 miles), making at least ten figure eight turns to flush the old lubricant out of the clutch packs.

6. Repeat steps 2, 3 and 4, making sure to replace cover gasket, if required, in Step 2.

7. It is possible that a slight chatter, requiring additional vehicle operation may remain after Step 5. If chatter still persists after 160 Km (100 miles) of operation, or remains severe after Step 5 above, disassembly and repair will be necessary. See also the discussion of the special assembly sequence of the Model 70 Powr-Lok under certain conditions under that paragraph of this Section.

For further diagnostic and testing procedures refer to Section 15-01, General Driving Axle and Driveshaft Service.

REMOVAL AND INSTALLATION

For Dana Models 44-IFS, 44IFS-HD, 60, or 70 limited-slip differential rear axle Removal and Installation procedures, refer to Section 15-05 Integral Carrier Axle-Dana and Section 15-34 Front Driving Axle.

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DISASSEMBLY AND ASSEMBLY

Dana Limited-Slip Axles

Service procedures for the Dana Model 60 and 70 axles with limited-slip differentials are covered separately in this Section.

The Dana limited-slip differential assembly is removed and installed in exactly the same manner as the conventional differential assembly. For these service procedures refer to Section 15-05 Integral Carrier Axle-Dana. Friction Modifier, C8AZ-19B546-A, EST-M2C118-A or equivalent (friction modifier) is the only authorized additive which may be used with these axles.

When axle lubricant has been drained for front or rear axle repair (limited-slip only), refill the axle with the specified quantity of Hypoid Gear Lubricant, C6AZ-19580-E (ESW-M2C105-A) or equivalent and add 0.236L (eight ounces) of Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for rear axles and 0.059L (two ounces) of Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for front-drive axles.

Differential Case

Model 44IFS, 44IFS-HD, 60-3 and 61-1 2-Pinion (Dana Trac-Lok)

Refer to Fig. 1.

Disassembly

The differential bearings need not be removed to overhaul the limited-slip differential.

To remove and install the side gears, washers and clutch packs during disassembly and assembly requires special procedures and tooling.

For Model 60 use, Limited-Slip Differential Tool D83T-4205-A.

An axle shaft placed in a vise, with the splines extending above the jaws of the vise not more than three inches, makes an excellent holding fixture after the case has been removed from the housing.

1. For Model 44IFS and 61-1, use small drift to remove the roll pin retaining the cross pin. For Model 60-3 semi-float axles, a lock screw is used to secure the slip fit cross pin.

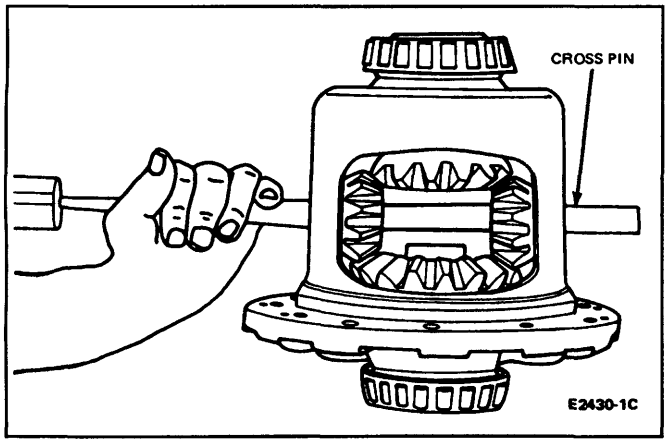


FIG. 6 Removing Cross Pin From Model 44IFS and 61-1 Axles

2. Remove the cross pin for the Model 44IFS and 61-1 axles with a hammer and drift (Fig. 6). The Model 60-3 cross pin is a slip fit and may be lifted out without tools.
3. Position the Step Plate, T83T-4205-A4 or equivalent, into the bottom side gear (Fig. 7). Apply grease to the centering hole of the Step Plate.
4. Install Forcing Nut T83T-4205-A2, and Forcing Screw T83T-4205-A3 or equivalents, into the differential case (Fig. 8).
5. Guide the forcing screw onto the step plate (Fig. 9).
6. Tighten the forcing screw tightly. This will move the side gears away from the differential pinion gears and relieve the normal loaded condition. Using a piece of 0.762mm (0.030 inch) thick shim or gauge stock, push out the differential spherical washers (Fig. 10).

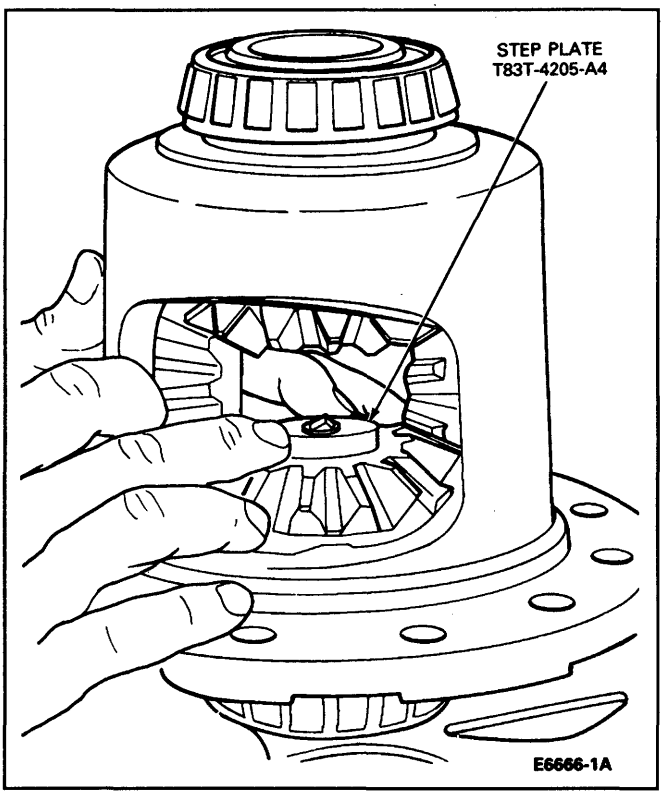


FIG. 7 Step Plate in Position

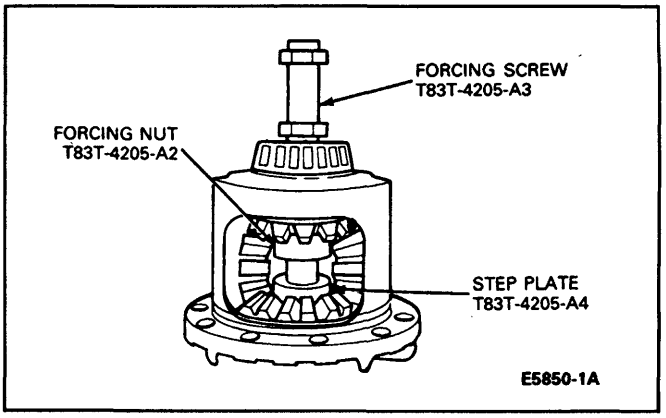


FIG. 8 Forcing Nut and Forcing Screw in Position

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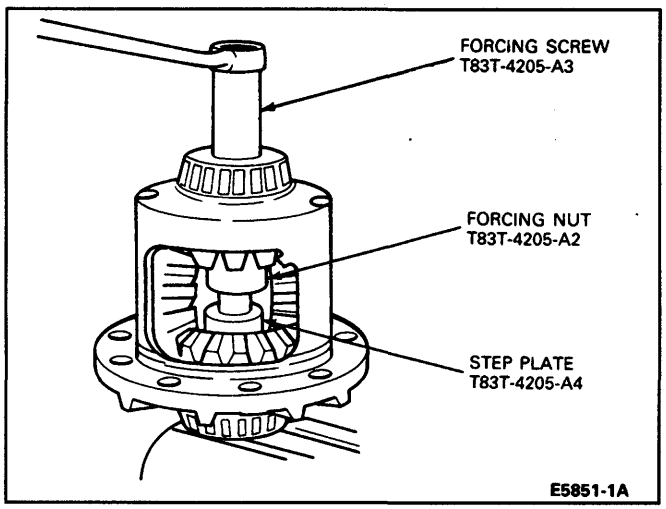


FIG. 9 Guiding Forcing Screw into Step Plate

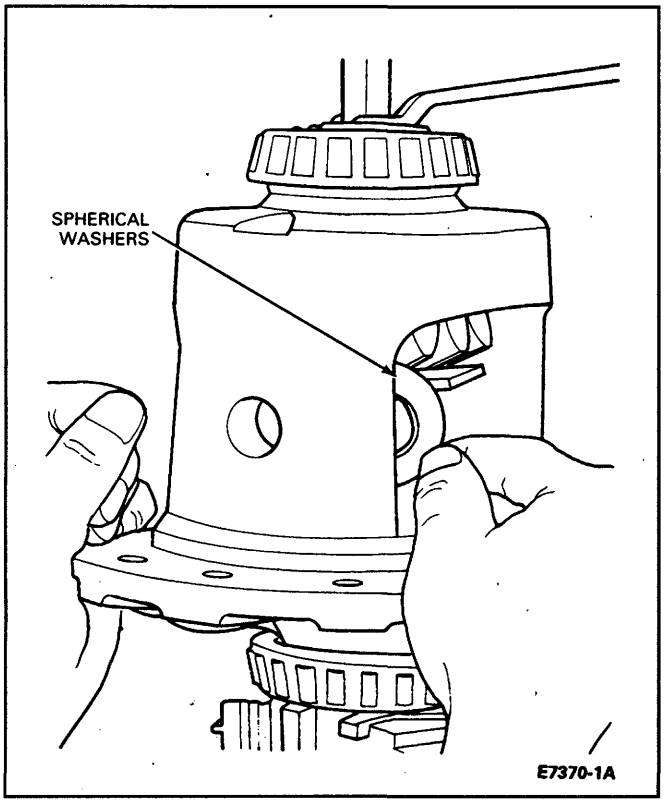


FIG. 10 Removing Spherical Washers

7. Momentarily, loosen the forcing screw. This step is very important to relieve the pressure of the clutch pack.
8. Re-tighten the forcing screw until a very slight movement of the differential pinion gears is seen.
9. Insert Handle T83T-4205-A1 or equivalent, into the pinion mate shaft bore and rotate the case (Fig. 11). Continue this until the differential pinion gears can be removed through the large openings in the case. When attempting to rotate the side gear, some tightening or loosening of the forcing screw will probably be required to permit the gear movement.
10. Retain the top side gear and clutch pack in the case with the hand and remove the forcing screw.

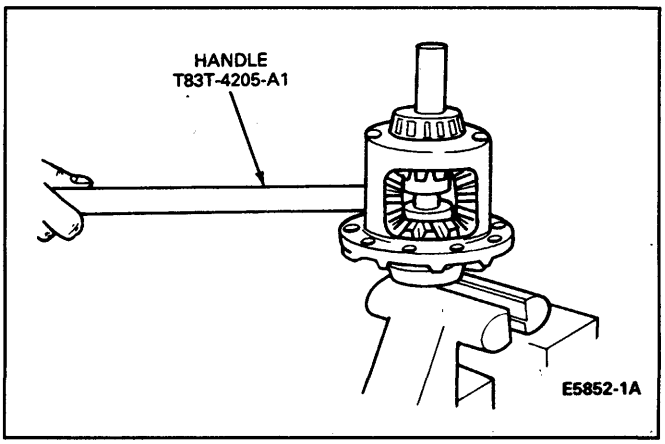


FIG. 11 Rotating Tool Handle in Position

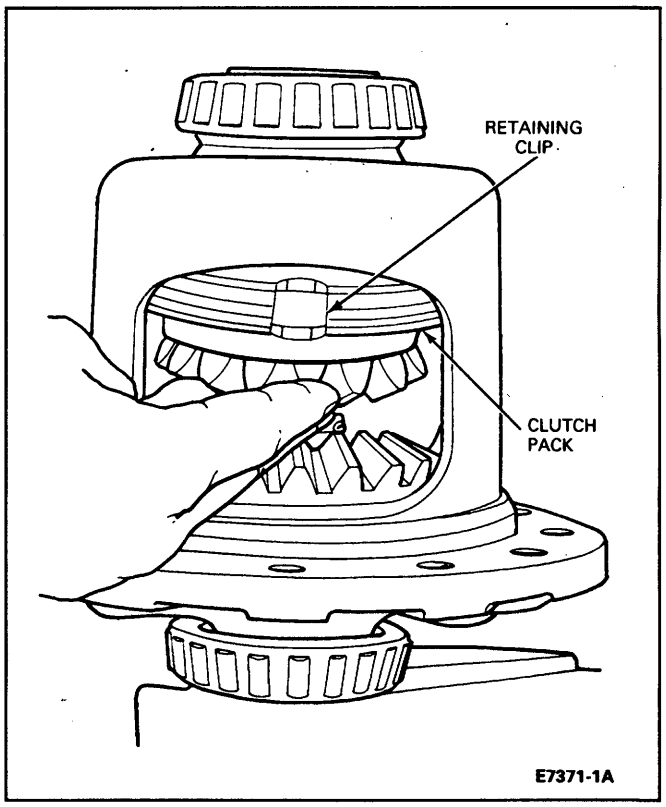


FIG. 12 Holding Clutch Pack

Continue to hold the side gear and clutch pack and remove the gear rotating tool (Fig. 12). Remove the top side gear and clutch pack. Keep the stack of plates and discs in exact order.

11. Turn this case so the flange, or ring gear side is up. As this is done, ease the step plate, side gear and clutch pack out of the case.
12. Remove the retainer clips from both clutch packs to allow separation of the discs and plates for cleaning and inspection. **Be sure to keep them in the exact order (Fig. 13).**

Assembly

1. Install the side gears and thrust washers. To do this, whether the original plates and discs or new ones are used, assemble them in exactly the same order as the originals. Always replace the entire kit

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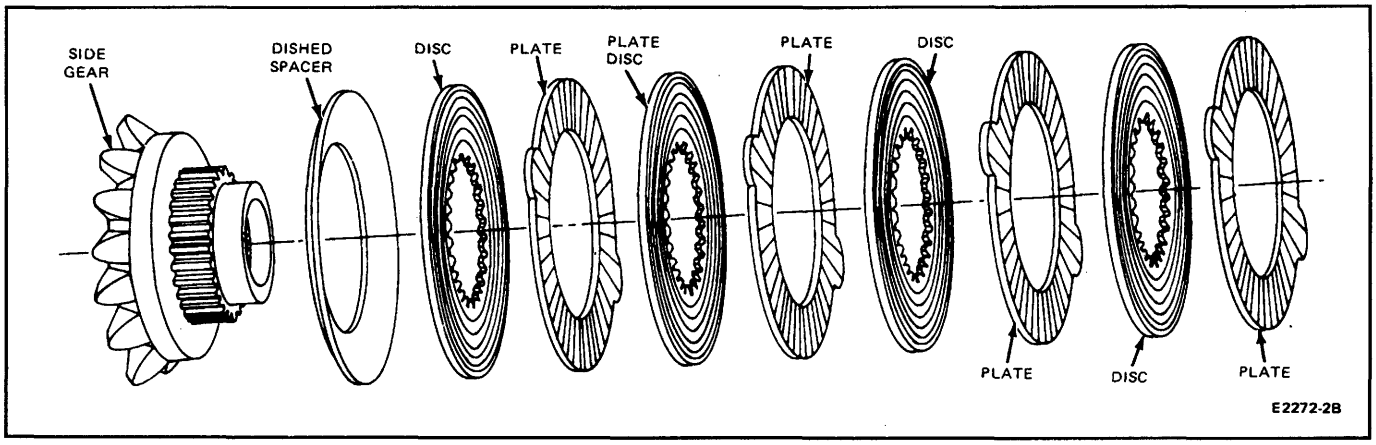


FIG. 13 Plates and Discs to Side Gear—Exploded View

of plates and discs even if only one component requires it. Refer back to illustrations used during disassembly for guidance in subsequent re-assembly operations.

2. Prelubricate the thrust face of the side gear and assemble the plates and discs to the side gear splines, prelubricating each part with Hypoid Gear Lubricant C6AZ-19580-A (ESW-M2C105-A) or equivalent or with Friction Modifier C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier lubricant, both stacks.

NOTE: If the plates are of the newer coated design (without radial grooves), it is important to soak them for twenty minutes in Friction Modifier C8AZ-19B546-A (EST-M2C118-A) before assembly.

3. Assemble the retainer clips to the ears of the plates. Make sure both clips are completely assembled or seated onto the ears of the plates.

   With the differential case positioned as shown, assemble the clutch pack and side gear into the case. Make sure the clutch pack stays assembled to the side gear splines, and that the retainer clips are completely seated into the pockets of the case. To prevent the pack from falling out of the case, hold them in place by hand while re-positioning the case on a bench.

4. Re-position the case on the bench and assemble the step plate into the side gear. Apply a small amount of grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent into the centering hole of the step plate.

5. Assemble the other clutch pack and side gear. Make sure the clutch pack stays assembled to the side gear splines, and that the retainer clips are completely seated into the pockets of the case. Install Step Plate, T83T-4205-A4 or equivalent, on top of the side gear.

6. Hold the side gear in position by hand. Insert the Forcing Screw T83T-4205-A3 down through the top of the case, and thread Forcing Nut, T83T-4205-A2, on the screw. The tip of the Forcing Screw must contact the Step Plate.

7. With tools assembled to the case, position the case onto the axle shaft (as a holding fixture) by aligning the splines of the side gear with those of the shaft.

8. Position both differential pinion gears opposite one another through the openings in the case. Be sure the holes of the gears are lined up with each other. Hold the gears in place by hand.

   Tighten the forcing screw so that the side gears will move away from the differential pinion gears and relieve the loaded condition.

9. While holding the differential pinion gears in place, insert the Handle (T83T-4205-A1 or equivalent) into the pinion mate shaft. Pull on the handle so that the case will rotate and allow the differential pinion gears to rotate and enter into the case.

   As mentioned under Disassembly, it will probably be necessary to adjust the forcing screw by very slightly loosening or tightening it until the required load is applied to allow the side gear and differential pinion gears to rotate.

10. Rotate the case until the holes of both differential pinion gears are lined up exactly with those of the case.

    Prelubricate both sides of the pinion spherical washers with the specified lubricant, Hypoid Gear Lubricant C6AZ-19580-E (ESW-M2C105-A) or equivalent.

11. Apply torque to the forcing screw to allow clearance to assemble the spherical washers.

    CAUTION: Do not overtighten the forcing screw. Overtightening the forcing screw may damage the clutch plate and disc assemblies.

    Assemble washers into the case. Use a very small screwdriver to push the washers into place. **Be sure the holes of the washers and gears are lined up exactly with those of the case.** Remove the forcing screw, forcing nut, handle, and step plate.

    Install the pinion shaft in the differential case. Install the cross shaft locking pin.

12. Install the ring gear on the differential case, and tighten the attaching bolts to specification. Refer to Specifications in Section 15-05 Integral Carrier Axle-Dana.

Differential Case

Model 70 (4-Pinion) Power-Lok

Refer to Fig. 2.

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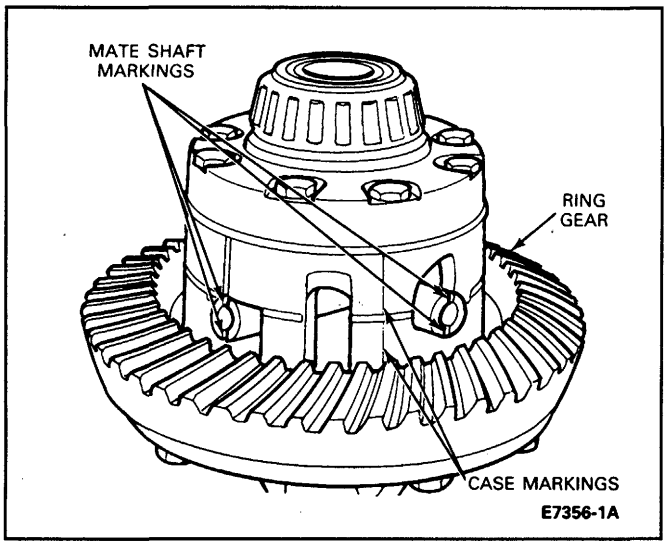


FIG. 14 Case and Mate Shaft Markings (Model 70)

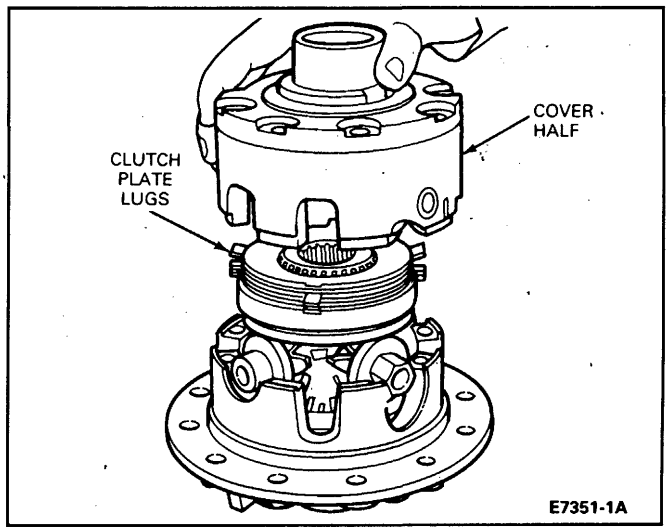


FIG. 15 Removing Cover Half of Case

Disassembly

The differential bearings need not be removed to overhaul the limited-slip differential.

1. Mark the ring gear half and cover half of the differential case so that they can be re-assembled in the same relative positions. Mark the pinion mate shafts and their corresponding ramps so that they too can be re-assembled in the same positions (Fig. 14).
2. Clamp the differential assembly in a soft-jawed vise and loosen, but do not remove the bolts that hold the case halves together.
3. Place the differential assembly on the bench with the ring half of the case down. Remove the case attaching bolts, and then remove the cover half of the case (Fig. 15) on Model 70 differentials.
4. Remove the pinion mate gear, side gear ring, and clutch pack (Fig. 16). Keep these parts with the cover half of the case so that they can be re-installed in their original positions.
5. On Model 70 differentials, remove the corresponding parts from the drive gear half of the case.
6. On all models, clean all parts thoroughly and dry them with compressed air.
7. Inspect the clutch plates and discs for cracks, excessive wear, and distortion. Both the discs and the plates, except the two Belleville spring plates should be flat. Any dished plates or discs, other than the spring plates, must be replaced. If one or more of the plates, discs, or spring plates or discs need replacing, it is suggested that the entire stack of clutch plates on each side be replaced.

   Inspect all other parts and replace any part that appears to be worn or damaged (Fig. 17).
8. Inspect the pinion mate shaft surfaces and the ramp surfaces on the case for excessive wear or pitting.
9. Inspect the side gear and pinion gear teeth. Inspect the pinion gear races that bear on the side gear rings. Inspect the corresponding surfaces on the side gear rings.

Assembly

1. Place the side gear ring from the drive gear half of the case on a pinion flange (Fig. 18) or something similar, so that it is about four inches above the bench. Coat the clutch plates with axle lubricant, Hypoid Gear Lubricant, C6A-Z-19580-E (ESW-M2C105-A) or equivalent Friction Modifier EST-M2C118-A.

NOTE: If the plates are of the newer design (without radial grooves), it is important to soak them for twenty minutes in Friction Modifier C8AZ-19B546-A(EST-M2C118-A) before assembly.

2. Refer to Fig. 16 and assemble the parts in the order indicated for the particular axle model being repaired.
3. Place the ring gear half of the case over the clutch pack and side gear ring. Make sure that the clutch plate lugs enter the slots in the case and that the case bottoms on the clutch pack (Fig. 18).
4. Grasp the flange and the case to hold the assembly together, and then turn the case half upside down.
5. Place the proper side gear in the side gear ring.
6. Place the mate shaft and pinions on the side gear ring (Fig. 19). Align the mate shaft and case markings.
7. Install the cover half mate shaft and pinions. Align the point markings.
8. Place the side gear on the pinions, and then place the side gear ring on the side gear and pinions.
9. Assemble the clutch pack on the side gear according to the arrangement shown in Fig. 20. Align the clutch plate lugs, and install all parts in the case.

NOTE: There may be circumstances of continuing chatter/bumping in turns despite replacement of parts and lubricant, particularly in vehicles operating at close to GVW rating. Typical situations are emergency vehicles and fifth wheel trailers. In these cases, it is permissible to re-assemble the clutch pack with the disc adjacent to the side gear ring, resulting in two plates together. This results in 3 friction surfaces instead of the

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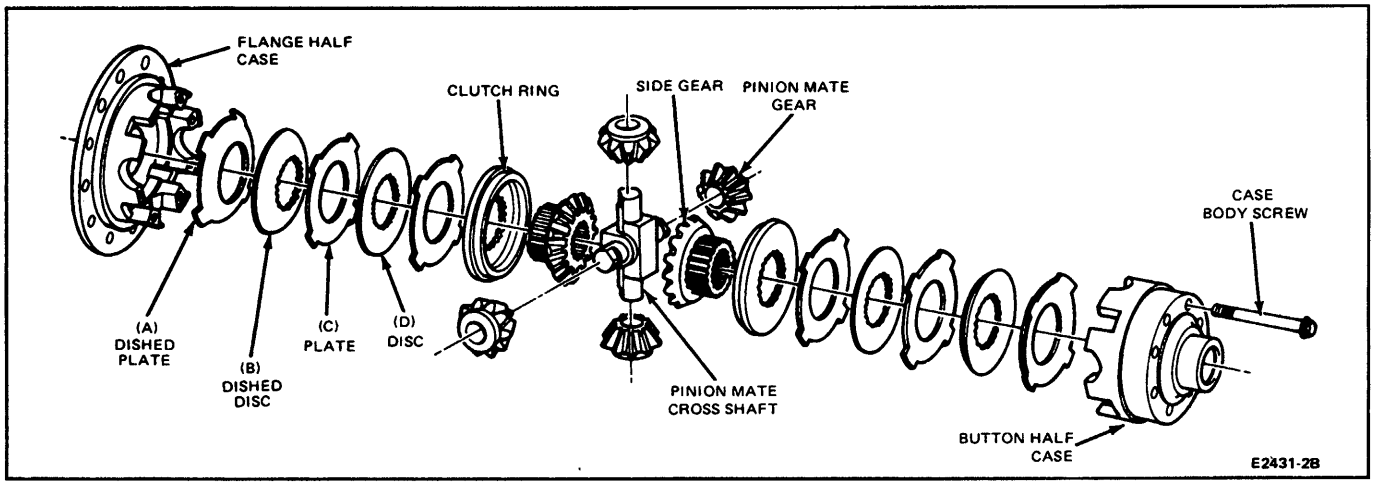


FIG. 16 Limited-Slip Differential (Model 70)—Exploded View

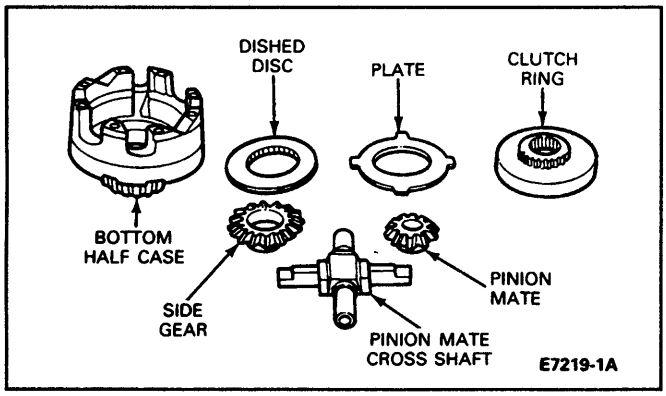


FIG. 17 Components to Check for Excessive Wear or Scoring

normal 5, and will result in lowering the torque to rotate the wheel by 40%.

10. Place the cover half of the case over the assembly (Fig. 15). Align the case marks made before disassembly.

11. Install all the case bolts and turn each one on a few threads. Case bolts must be clean and dry. Using both axle shafts, align the splines of the side gear and the side gear ring (Fig. 16) on both sides of the case. With the axle shafts in position, tighten the case bolts evenly and alternately to 89-94 N·m (65-70 ft-lb) (Fig. 21).

    NOTE: If bolt heads have "180" or 7 radial lines stamped on head, tighten the case bolts to 122-150 N·m (90-110 ft-lbs)

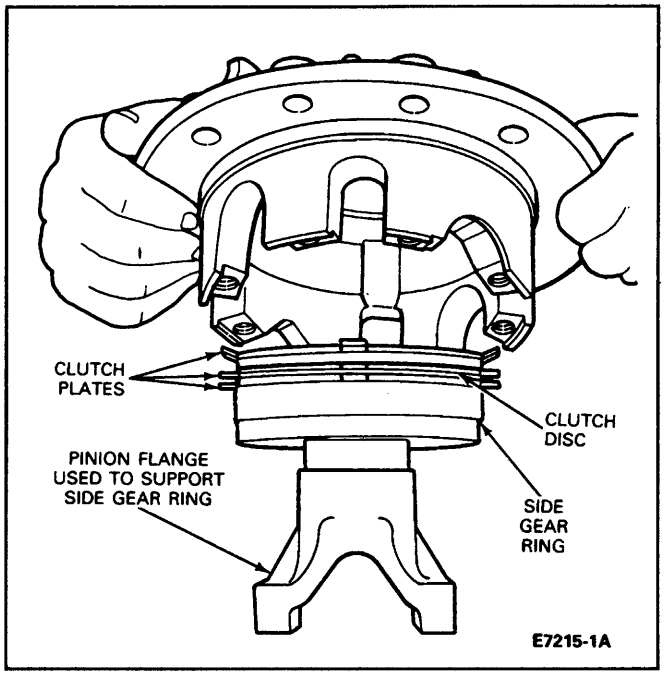


FIG. 18 Clutch Installed in Drive Gear Case Half—Model 70

12. Remove the axle shafts. **If the assembly has been properly assembled, each pinion mate cross shaft should be tight on its ramp; or, if there is clearance between the cross shaft and the ramp, it should be not more than 0.254mm (0.010 inch) and equal at all four cross shaft ends.**

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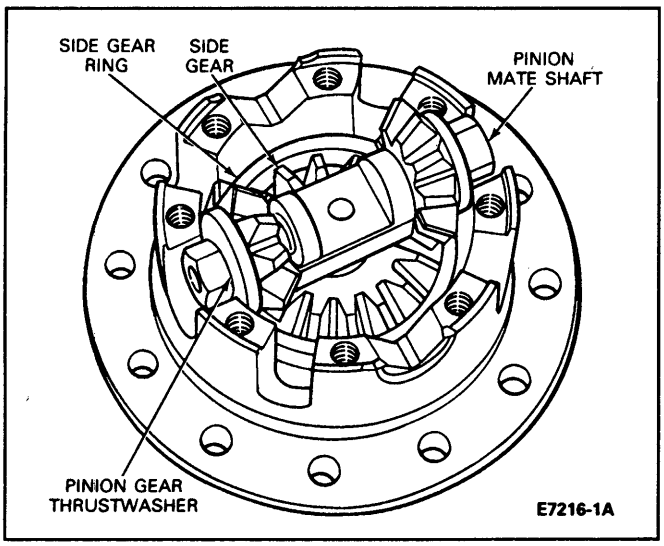


FIG. 19 Mate Shaft Installed—Model 70

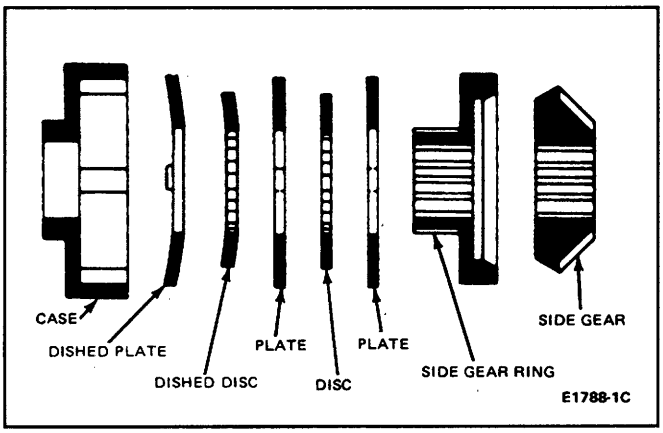


FIG. 20 Plate and Disc Arrangement—One Side of Model 70—Limited-Slip

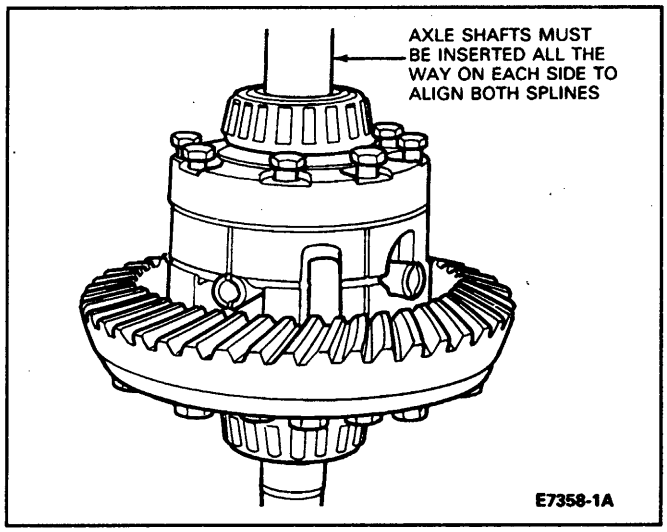


FIG. 21 Spline Alignment of Side Gear and Side Gear Ring

SPECIFICATIONS

Refer to Section 15-01, General Driving Axle and Driveshaft Service and Section 15-05, Integral Carrier Axle-Dana for Specifications.

SPECIAL SERVICE TOOLS

Number	Description	Application
TOOL-4000-E	Differential Housing Spreader	Dana 44,60 Axles
D83T-4205-A	Limited Slip Differential Tool	Dana 60 Axles
T83T-4205-A1	Limited Slip Differential Tool — Handle	Dana 60 Axles
T83T-4205-A2	Limited Slip Differential Tool — Forcing Nut	Dana 60 Axles
T83T-4205-A3	Limited Slip Differential Tool — Forcing Screw	Dana 60 Axles
T83T-4205-A4	Limited Slip Differential Tool — Step Plate	Dana 60 Axles
T53T-4221-C	Differential Side Bearing RPI.	Dana 60 Axles

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SECTION 15-43 Limited-Slip Differential—Ford—10.25 Inch Ring Gear

SUBJECT	PAGE
DESCRIPTION AND OPERATION	
Noise Acceptability	15-43-1
DIAGNOSIS AND TESTING	15-43-1
DISASSEMBLY AND ASSEMBLY	
Differential Case	15-43-3
REMOVAL AND INSTALLATION	
Differential Case	15-43-2
REMOVAL AND INSTALLATION	
Differential Bearings	15-43-10
SPECIFICATIONS	15-43-12
VEHICLE APPLICATION	15-43-1

VEHICLE APPLICATION

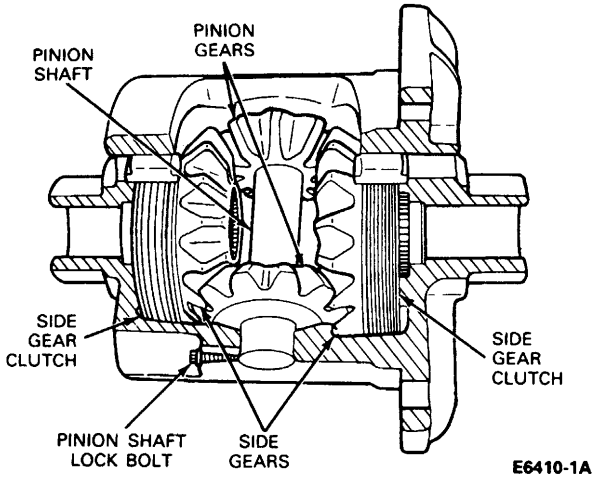
Applies to F-250 And F-350 Models Equipped with 10.25 Inch Ring Gear Axle.

DESCRIPTION AND OPERATION

The Ford Limited-Slip Differential option is available on F-250-F350 vehicles with 10.25 inch ring gear rear axles.

The limited-slip assembly, except for the differential case and its internal components, is identical to the conventional axle. The limited-slip differential employs two sets of multiple-disc clutches to control differential action. The side gear mounting distance is controlled by 10 plates and 1 Belleville spring plate. The clutch pack consists of two plate designs: a splined plate that engages the splines of the side gear hub and alternate-tabbed or stationary plates.

LIMITED SLIP DIFFERENTIAL - CUTAWAY VIEW



Noise Acceptability

A gear-driven unit (especially on a drive axle) will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions. For example, as on a newly paved blacktop road. The slight noise is in no way detrimental to the operation of the rear axle and must be considered normal.

NOTE: For vehicles equipped with a limited-slip differential a slight stick-slip noise on tight turns after extended highway driving is considered acceptable and has no detrimental effect.

DIAGNOSIS AND TESTING

NOTE: Refer to Section 12-31, Rear Antilock Brakes, for diagnostic and testing procedures regarding the excitor ring on the differential case on F-Series and Bronco vehicles equipped with rear Antilock brakes. For excitor ring service procedures, refer to Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear.

If roughness or noises such as chatter are present while turning corners, the probable cause is incorrect or contaminated lubricant.

Before a differential is removed and disassembled for chatter complaints, the lubricant level and grade should be determined.

Refill the axle with the specified quantity of Hypoid Gear Lubricant, E0AZ-19580-A (ESP-M2C154-A) or equivalent and add 0.237L (eight ounces) of Additive Friction Modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent friction modifier for rear axles. Warm the axle up and recheck for chatter by making a minimum of ten figure-eight type turns.

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DIAGNOSIS AND TESTING (Continued)

If this is unsuccessful, a complete lubricant drain, flush and refill will usually correct chatter. The following procedure is recommended to ensure that the system is flushed of old lubricant:

1. Warm the lubricant by vehicle road operation or five minutes of operation in gear with both rear wheels off the ground on a hoist.

WARNING: A VEHICLE EQUIPPED WITH A LIMITED-SLIP DIFFERENTIAL WILL ALWAYS HAVE BOTH WHEELS DRIVING. IF ONE WHEEL IS RAISED OFF THE FLOOR AND THE REAR AXLE IS DRIVEN BY THE ENGINE, THE WHEEL ON THE FLOOR COULD DRIVE THE VEHICLE OFF THE STAND OR JACK. ALWAYS BE SURE THAT BOTH WHEELS ARE OFF THE GROUND.

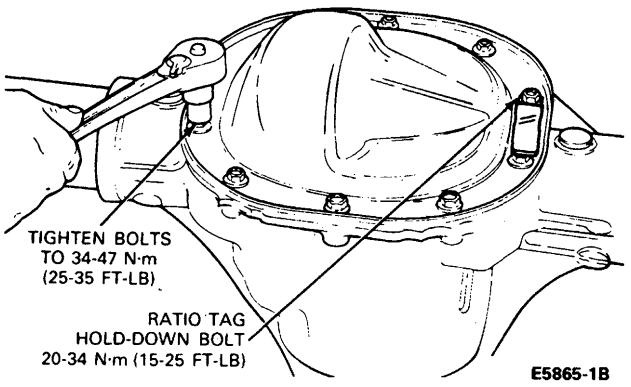
2. Drain lubricant while warm. Remove cover to drain completely. If cover is removed, it will be necessary to replace gasket at this time.
3. Clean the gasket mating surface of the rear axle carrier casting and cover.

   Apply a new continuous bead of Silicone Rubber Sealant (D6AZ-19562-B or equivalent) to the carrier casting face inside the cover bolt holes.

CAUTION: Make sure machined surfaces on both cover and carrier are clean and free of oil before installing the new silicone sealant. Inside of axle must be covered when cleaning the machined surface to prevent contamination.

4. Install cover and tighten cover bolts to 34-47 N·m (25-35 ft-lb) as shown. Tighten the cover bolts in a cross-wise pattern to insure uniform draw on cover.

NOTE: Cover assembly must be installed within 15 minutes of application of the silicone or new sealant must be applied.



5. Add lubricant through the fill hole until the lubricant level reaches the bottom of the fill hole with the axle in the running position (approximately 6.5 U.S. pints). For out-of-vehicle repairs, add 7.5 U.S. pints of lubricant. Install the fill plug and tighten to 20-41 N·m (15-30 ft-lb).
6. Operate the vehicle for approximately 16 km (10 miles), making at least ten figure-eight turns to flush the old lubricant out of the clutch packs.
7. Repeat Steps 2, 3, 4 and 5, making sure to replace cover gasket.
8. It is possible that a slight chatter, requiring additional vehicle operation may remain after Step 5. If chatter still persists after 160 km (100 miles) of operation, or remains severe after Step 6 above, disassembly and repair will be necessary.

For further diagnostic and testing procedures refer to Section 15-01, General Driving Axle Service.

REMOVAL AND INSTALLATION

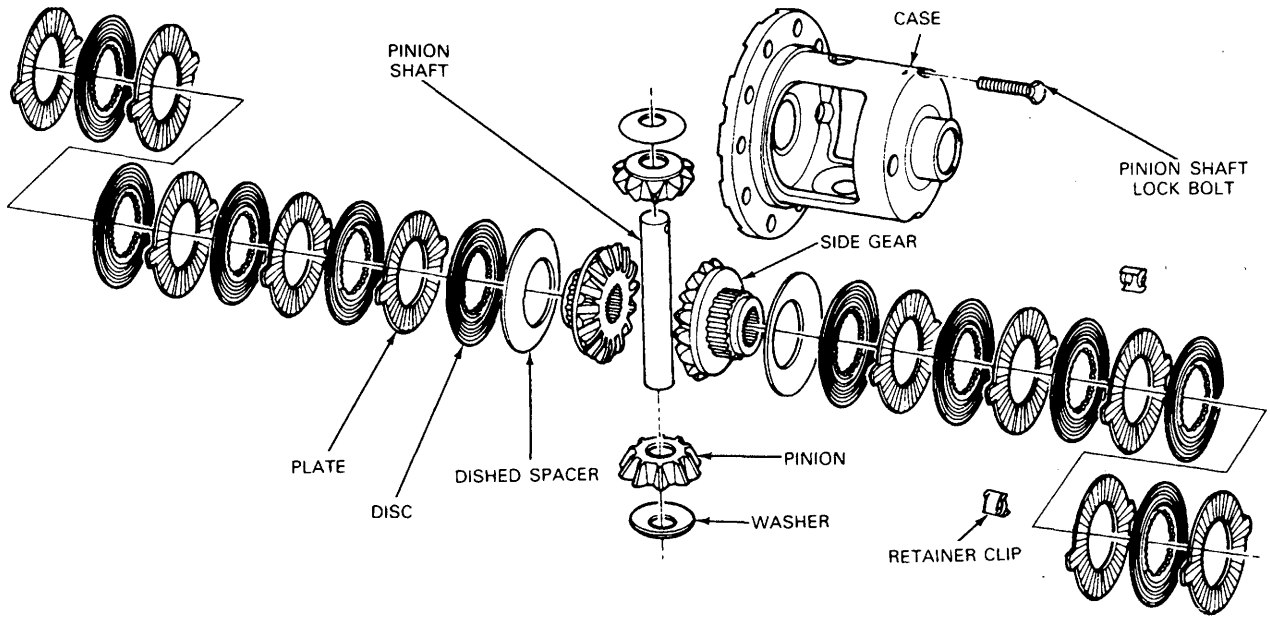
Differential Case

For Removal and Installation Procedures, refer to Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear.

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DISASSEMBLY AND ASSEMBLY

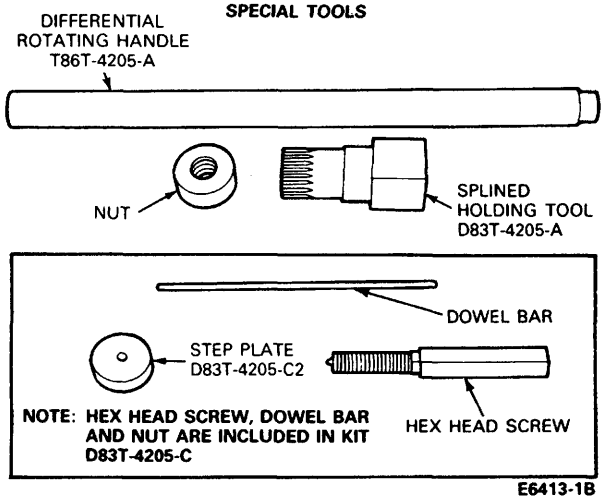
Differential Case



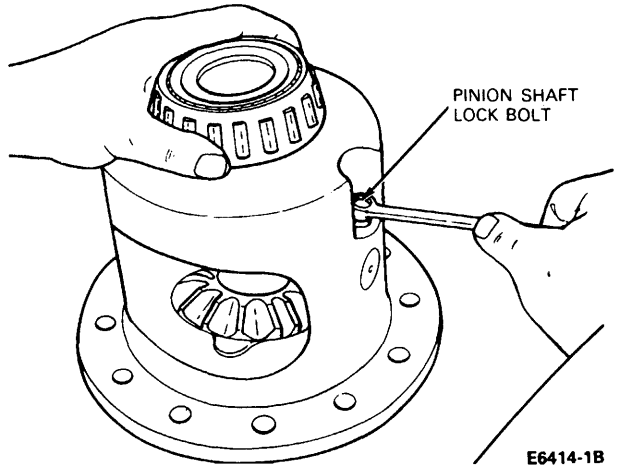
Disassembly

NOTE: The differential bearings need not be removed to overhaul the Ford Limited-Slip Differential. If bearing removal is required, refer to Differential Bearings—Removal and Installation in this Section. Removal and installation of the side gears, clutch packs, pinion gears and thrust washers require special procedures and tools as described below.

SPECIAL TOOLS



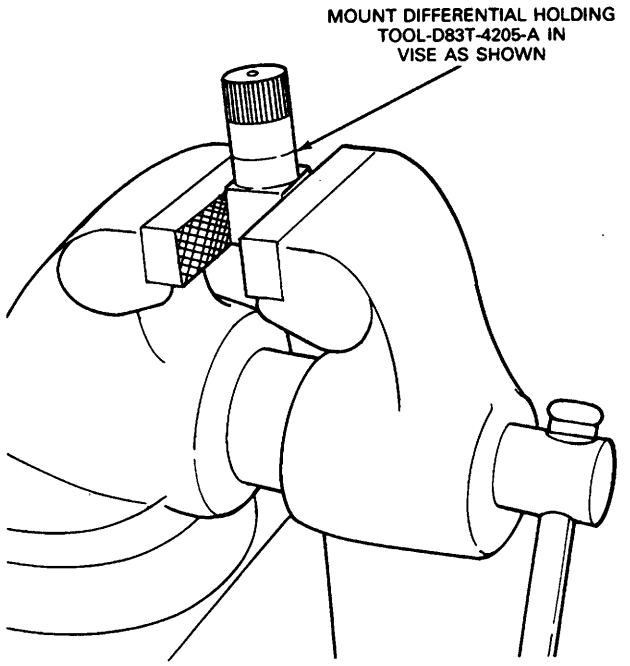
1. Remove the differential pinion shaft lockbolt.



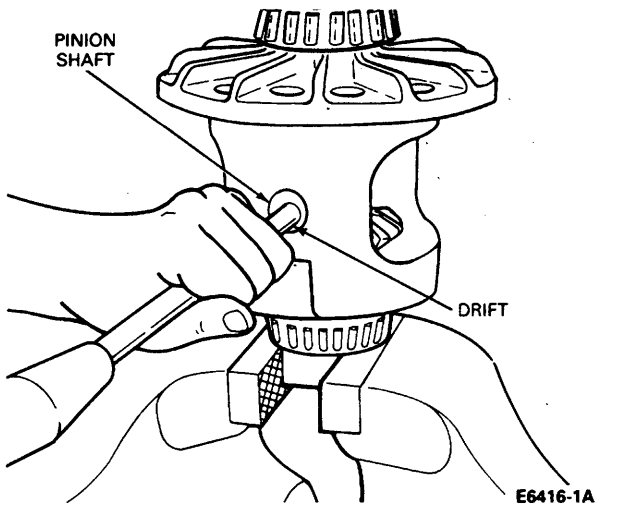
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DISASSEMBLY AND ASSEMBLY (Continued)

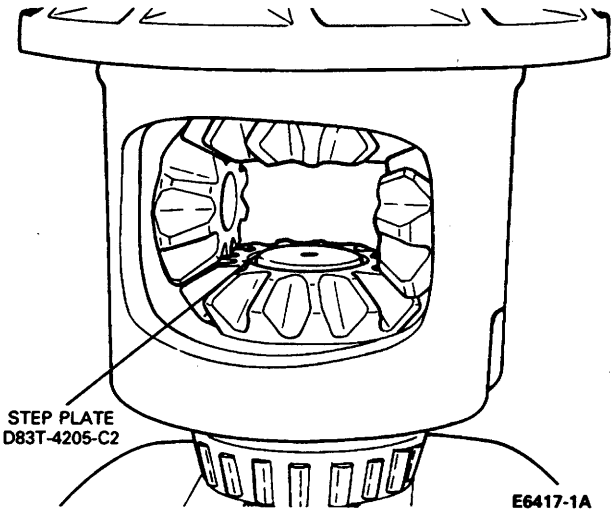
2. Install differential assembly Holding Tool, D83T-4205-A, in a suitable vise. Install differential assembly in the vise with the ring gear side facing up.



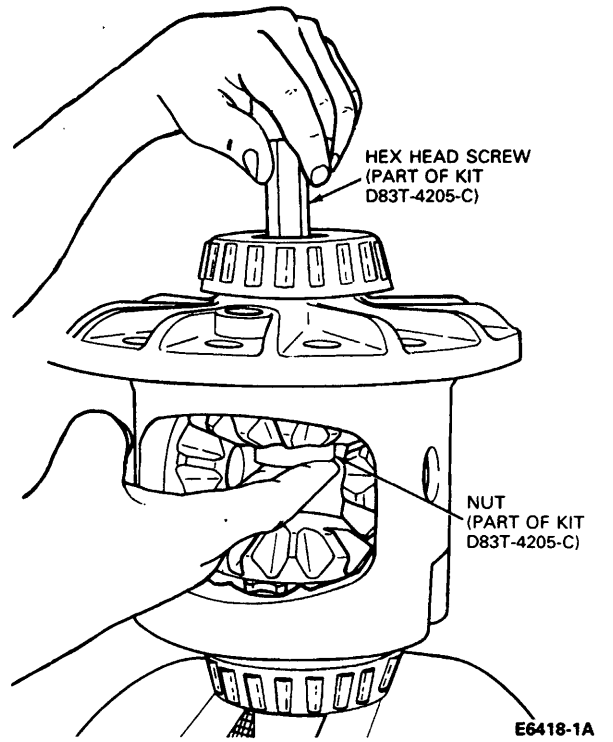
3. With a hammer and drift, drive the pinion shaft from the differential case.



4. Install Step Plate, D83T-4205-C2, in bottom side gear bore. Apply a small amount of grease to centering hole of the step plate.



5. Install nut in upper side gear. Hold nut in position while installing Hex Screw Tool (part of D83T-4205-C).

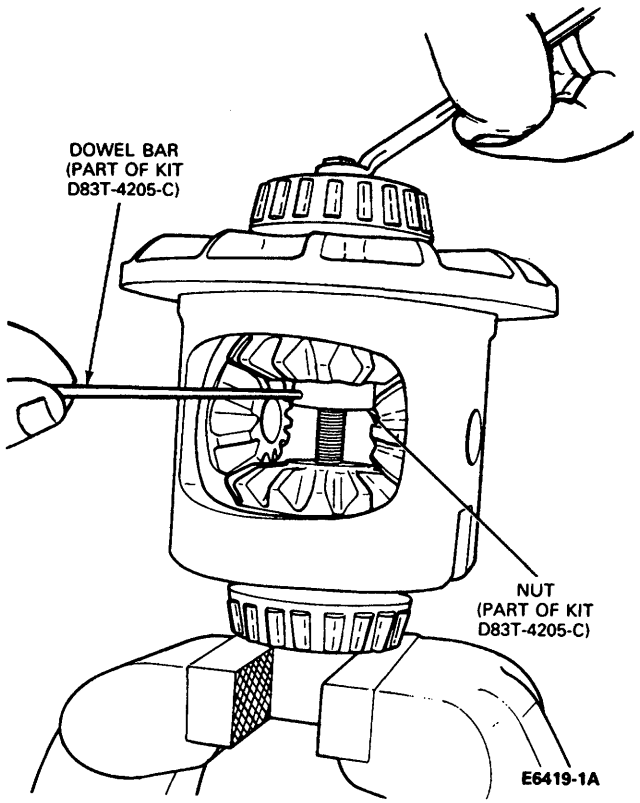


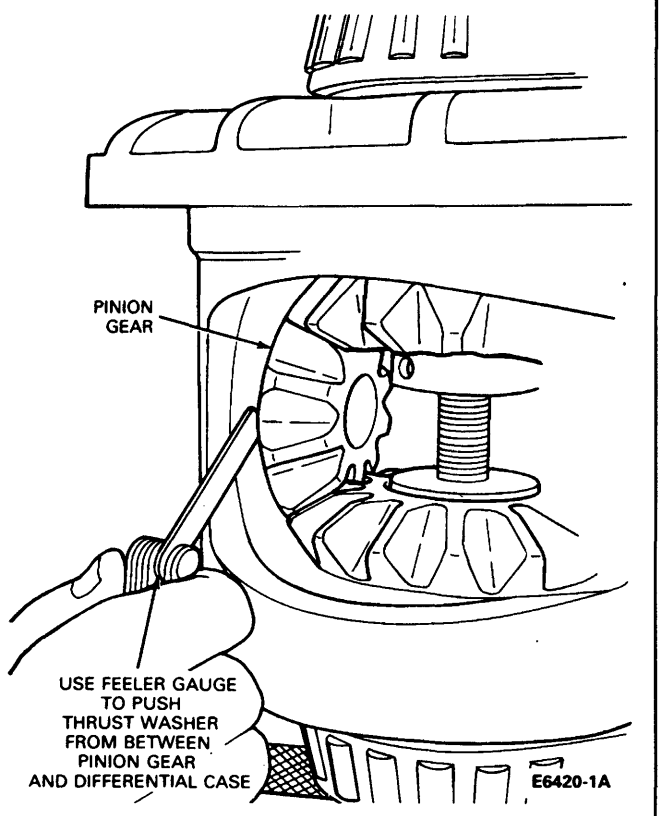
6. Insert Dowel Bar or equivalent, part of D83T-4205-C, in hole of nut. Tighten forcing screw to force side gears away from the pinion mating gears. The dowel bar is used to keep the nut from turning when the forcing screw is tightened.

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DISASSEMBLY AND ASSEMBLY (Continued)

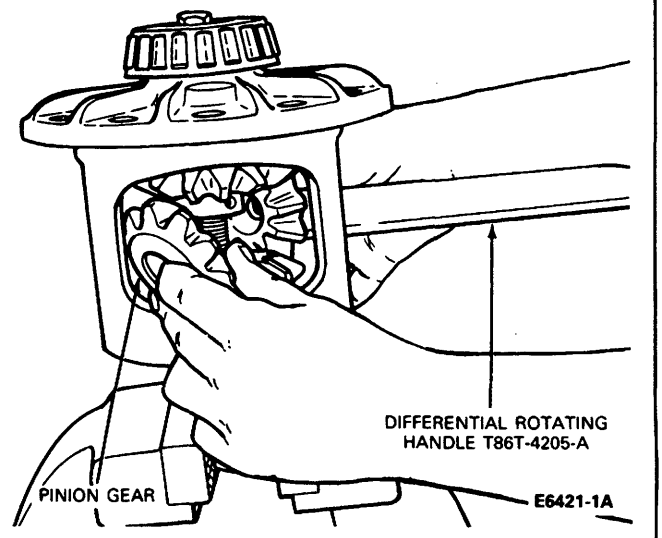
7. With an appropriate size feeler gauge, push the pinion gear thrust washers out from between the pinion gears and the differential case. Remove the thrust washers, then back off the forcing screw until it is loose (approximately one turn).





8. Insert Rotating Tool T86T-4205-A in the pinion shaft bore and turn the case to "walk" the pinion gears out to the differential case windows. Remove the pinions.

NOTE: Make sure vise is tightened securely during this Step.

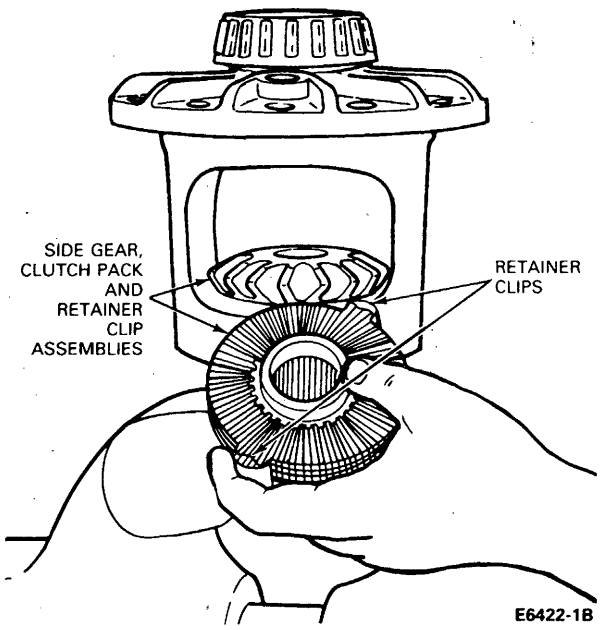


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DISASSEMBLY AND ASSEMBLY (Continued)

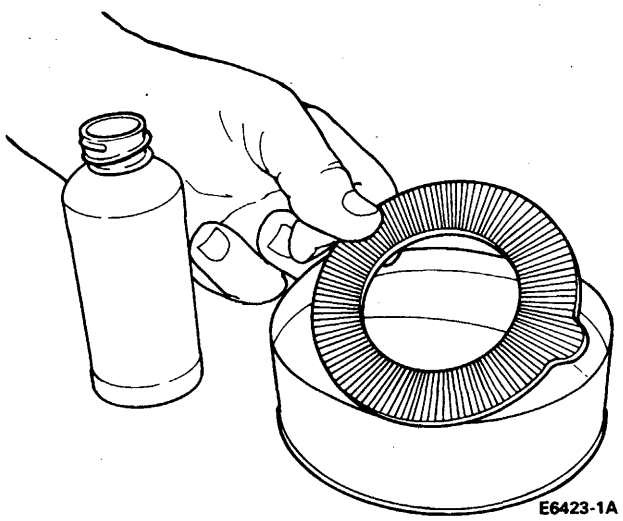
9. Remove the forcing screw and step plates. Remove the side gears, retainer clips and clutch pack assemblies.
10. Remove the retainer clips from both clutch packs to allow separation of the discs and plates for cleaning and inspection. Refer to the exploded view at the beginning of this procedure.

CAUTION: When separating the clutch plates and discs, note the sequence in which they are disassembled. They must be reassembled in the same sequence.



Assembly

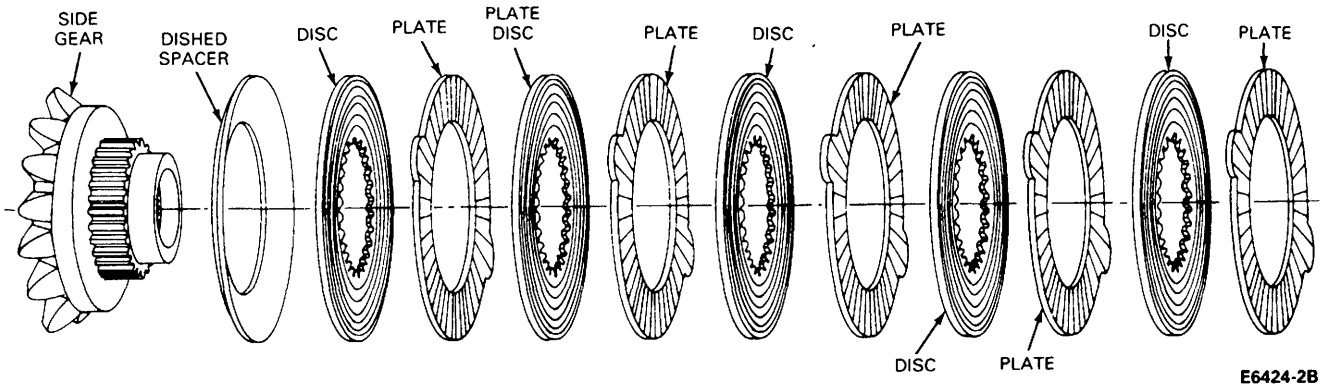
1. Prelubricate each disc and plate with Friction Modifier C8AZ-19B546-A (EST-M2C118-A), or equivalent friction modifier lubricant.



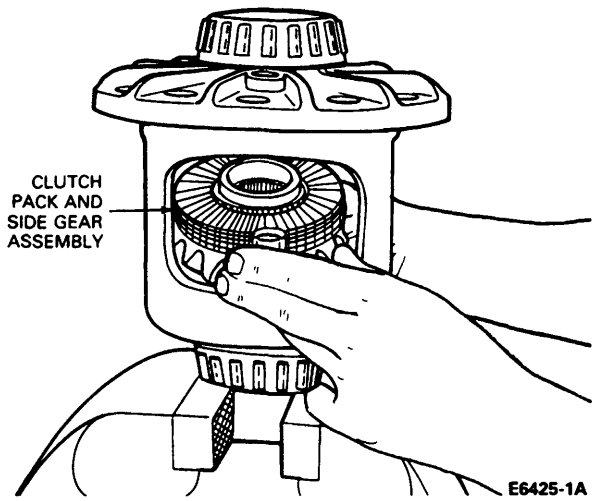
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DISASSEMBLY AND ASSEMBLY (Continued)

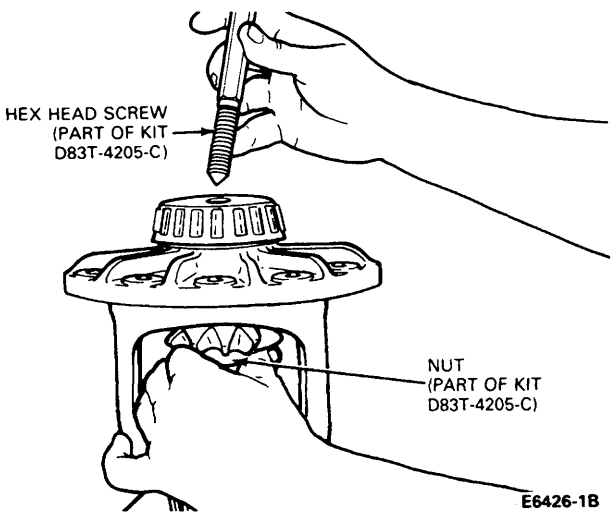
2. Prelubricate the thrust face of the side gear. Assemble the plates and discs to the side gear splines in exactly the same sequence in which they were removed. Assemble the retainer clips to the ears of the plates. Make sure both clips are completely assembled and seated onto the ears of the plates.



3. Install Differential Holding Tool, D83T-4205-A in a suitable vise. Place differential case on holding tool with ring gear side facing up. Insert the clutch pack and side gear assemblies into the differential case. Make sure that the clutch packs stay assembled to the side gear splines, and that the retainer clips are completely seated in the pockets of the differential case. Hold the upper clutch pack and side gear assembly in place to prevent it from falling out of the differential case.

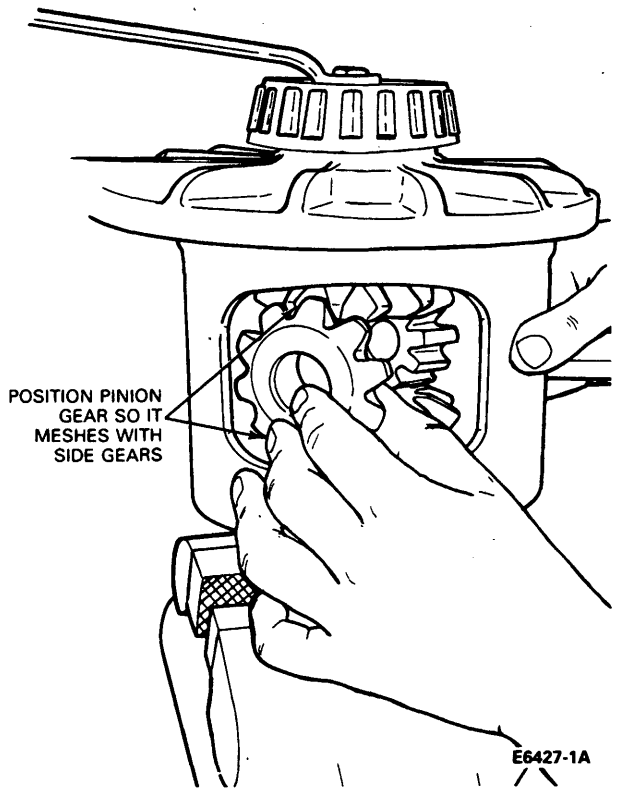


4. Position Step Plate, D83T-4205-C2, in the bottom side gear bore. Apply a small amount of grease to the step plate bore. Position nut, part of D83T-4205-C, in the top side gear bore and hold it in place. Install the Hex Screw Tool, part of D83T-4205-C, and tighten it two turns after it contacts the bottom step plate. Insert the Dowel Bar or equivalent, part of D83T-4205-C, in nut bore to keep the nut from turning as the hex screw is tightened.
5. Position the pinion gears in the window of the differential case so that they mesh with the side gear teeth. Hold the pinion gears in place. Make sure that the pinion gears are 180° apart so they will correctly align with the pinion shaft bore.



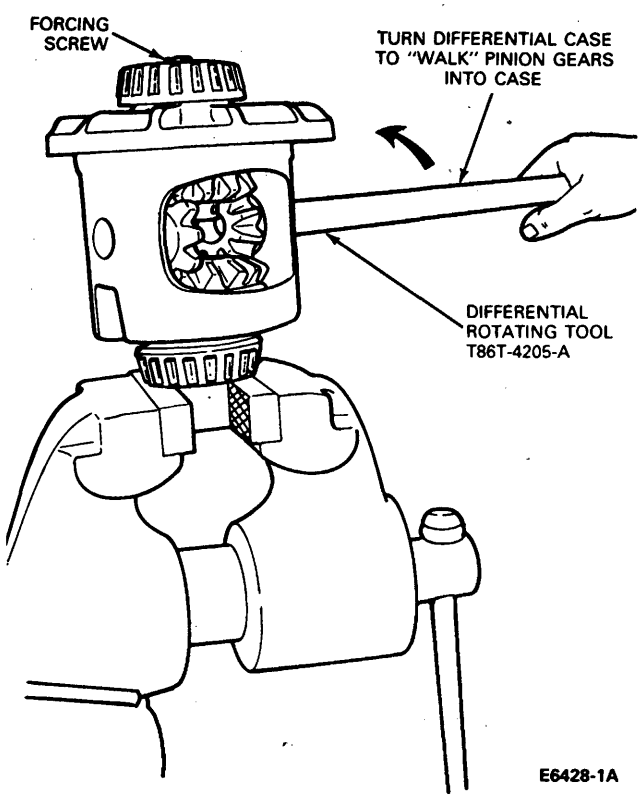
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DISASSEMBLY AND ASSEMBLY (Continued)



6. Insert the Rotating Tool, T86T-4205-A, into the pinion shaft bore and turn the differential case. This will cause the pinion gears to engage the side gears and "walk" into the differential case. Rotate the differential case until the pinion mating shaft holes are lined up exactly with the holes in the pinion gears.

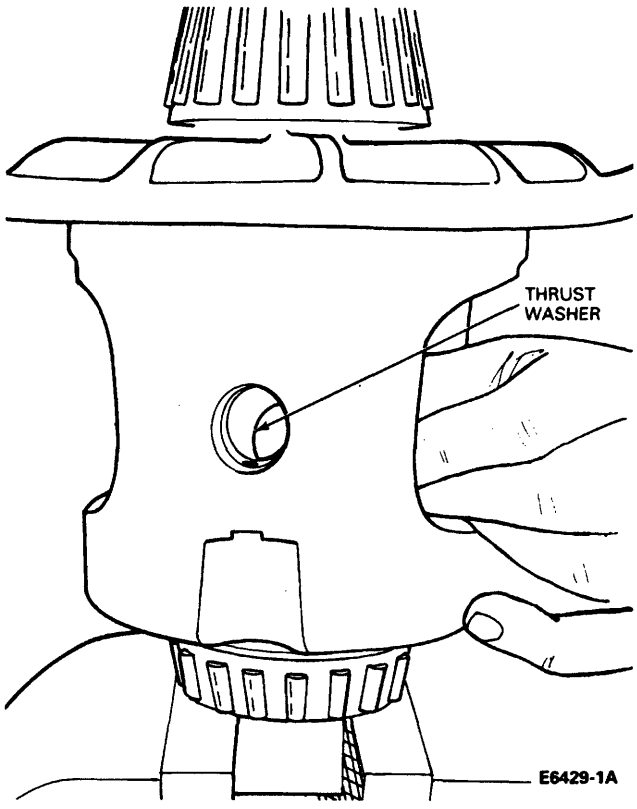
NOTE: It will probably be necessary to loosen or tighten the forcing screw to allow the pinions and side gears to rotate.



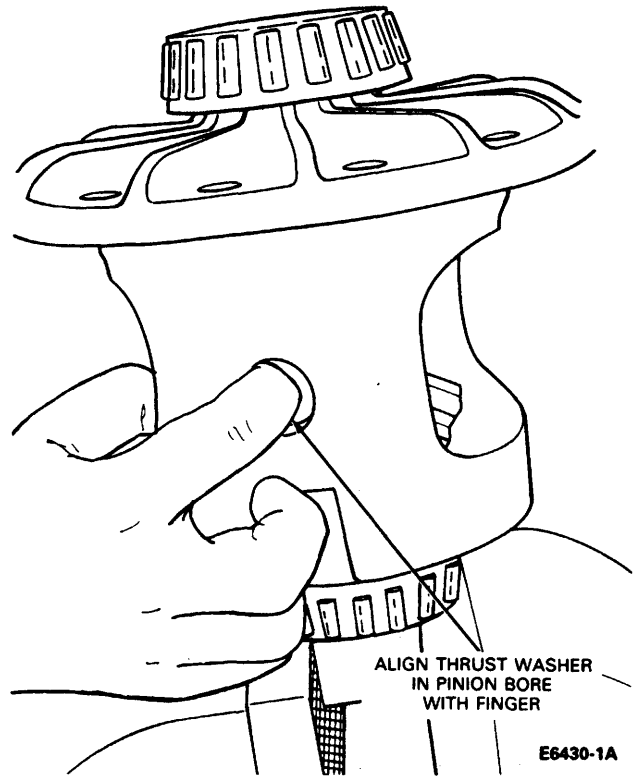
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DISASSEMBLY AND ASSEMBLY (Continued)

7. Prelubricate both sides of the pinion thrust washers with Hypoid Gear Lubricant, E0AZ-19580-A (ESP-M2C154-A) or equivalent. Apply torque to the forcing screw to allow clearance to insert the thrust washers. Insert the pinion gear thrust washers between the pinion gears and the differential case with the concave side facing in.



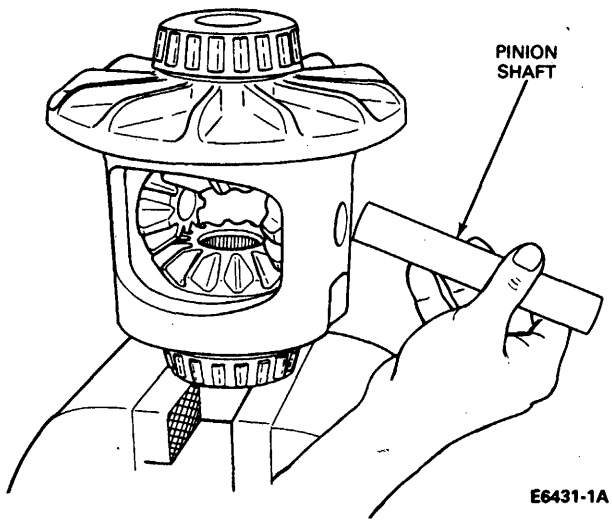
8. Be sure to align the thrust washer holes with the bore in the differential case PRIOR to installing differential pinion shaft.



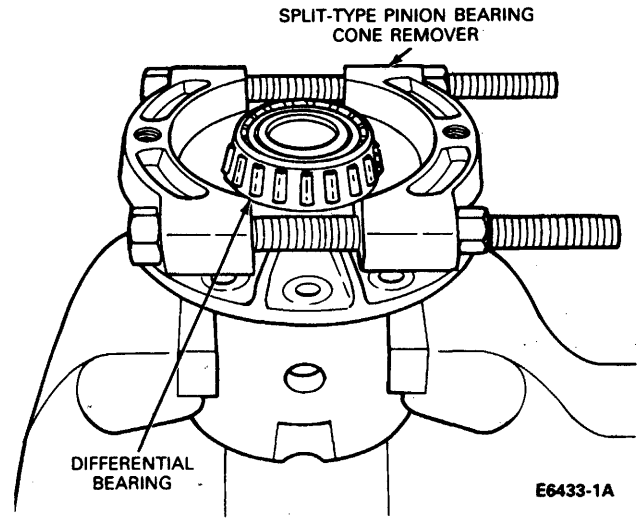
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DISASSEMBLY AND ASSEMBLY (Continued)

9. Loosen the forcing screw and remove the step plate and nut from the side gear bores. Install the pinion shaft in the differential case. Install the pinion shaft lock bolt and tighten to 20-40 N·m (15-30 ft-lb).
10. If removed, install the ring gear on the differential case and tighten the attaching bolts to specifications. For detailed procedures and specifications, refer to Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear.



1. Mount the differential case in a vise. Use brass pads on vise jaws to prevent damage. Mount split-type Pinion Bearing Cone Remover D79L-4621-A on the differential case. Tighten bolts on puller to separate the bearing cone from the case face.



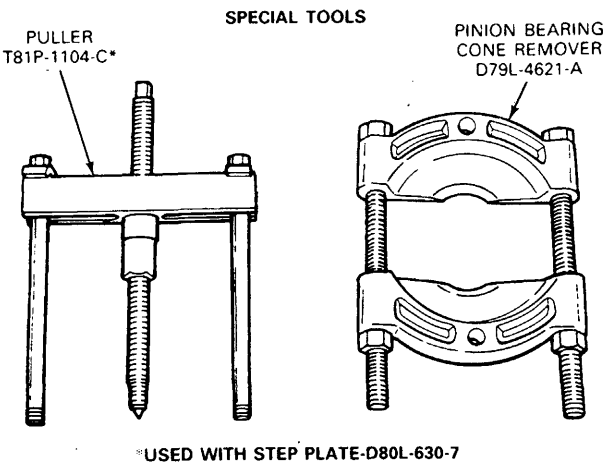
REMOVAL AND INSTALLATION

Differential Bearings

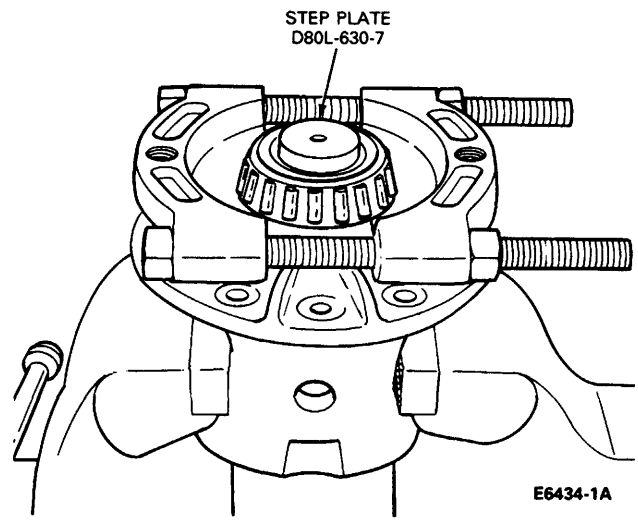
Removal

NOTE: It is not necessary to remove the differential bearings as a part of the differential case disassembly procedure. However, the following procedure assumes that the differential side gears, clutch packs and pinion gears are removed from the differential case prior to removing the bearings.

NOTE: Differential bearing removal requires special tools and procedures.



2. Place step plate (available as part of Step Plate Set D80L-630-7) on bearing inner cone. Apply a small amount of grease to the step plate bore.



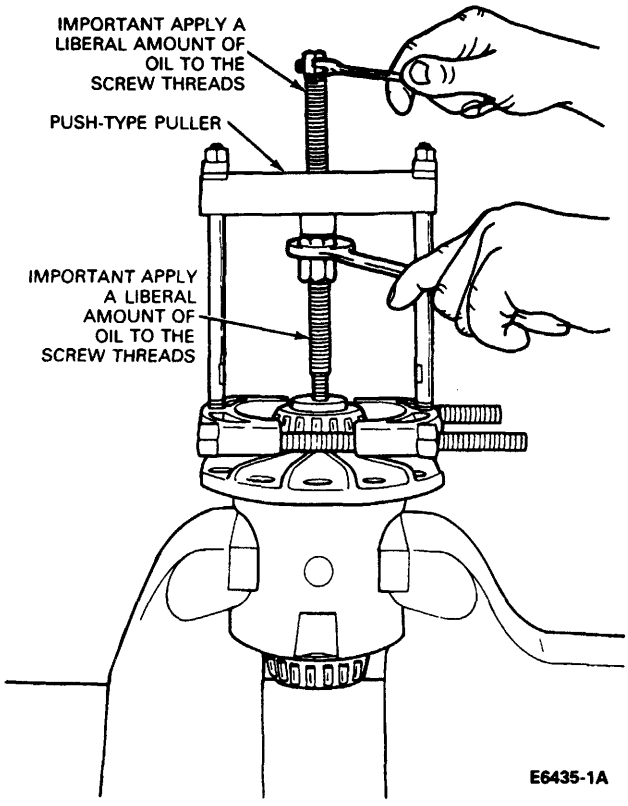
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REMOVAL AND INSTALLATION (Continued)

3. Mount push-type Puller T81P-1104-C on the bearing cone remover, making sure that the puller shaft seats in the bore of the step plate. Pull the bearing off the differential case.

CAUTION: It is extremely important to apply a liberal amount of oil to the screw threads of Tool T81P-1104-C.

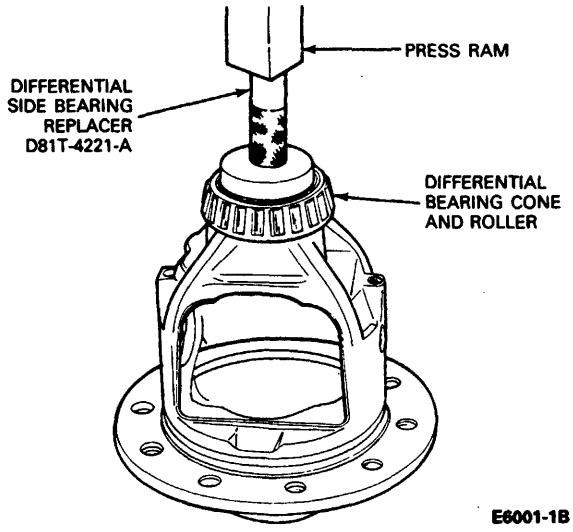
NOTE: Replace bearings whenever they are removed from the differential.



Installation

1. Install differential bearings on the case hubs using Differential Bearing Cone Replacer, D81T-4221-A.

NOTE: Press against the bearing cone only.



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SPECIFICATIONS

Refer to Section 15-01, General Driving Axle Service and Section 15-09, Integral Carrier Axle—10.25 Inch Ring Gear for specifications.

SPECIAL SERVICE TOOLS

Tool Number	Description
T86T-4205-A	Differential Rotating Handle
D83T-4205-A	Splined Holding Tool
D83T-4205-C	Differential Service Kit Kit includes: Hex Head Screw Dowel Bar Nut
D83T-4205-C2	Step Plate
D79L-4621-A	Pinion Bearing Cone Remover
Part of D80L-603-7 set	Step Plate
D81T-4221-A	Differential Bearing Cone Replacer
T81P-1104-C	Front Hub Remover/Replacer

CE6529-1C

LUBRICANT CAPACITIES AND CHECKING PROCEDURES (INTEGRAL CARRIER)

Vehicle	Axle	Approximate Lubricant Capacity (In-Vehicle Repair)①②		
		U.S. Pints	Imperial Pints	Liters
F-250, F-350 Regular & Chassis CAB, F-250/350 H.D.	10-1/4 Inch Ring Gear	6.5③④	5.4	3.0

① All conventional Axles use Hypoid Gear Lubricant, E0AZ-19580-A (ESP-M2C154-A) or equivalent.
② For out-of-vehicle repair, use 7.5 U.S. Pints (6.2 imperial pints, 3.5 Liters)
③ Below bottom of filler hole with vehicle in running position.
④ Plus 8 oz. (U.S. measure) additive friction modifier, C8AZ-19B546-A (EST-M2C118-A) or equivalent for limited-slip applications. CE6524-2B

LIMITED-SLIP DIFFERENTIAL IDENTIFICATION

Identification Tag	Ratio
127C	3L55:1
131C	4L10:1
132C	4L10:1
169C	4L10:1
171C	4L10:1
191C	4L10:1
192C	4L10:1

CE7662-1A

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SECTION 15-60 General Driveshaft Service

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Driveshaft Balancing	15-60-14
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Rear Driveshaft	15-60-1
DIAGNOSIS AND TESTING	
Coupling Shaft/Center Bearing Alignment	15-60-10
Diagnosis Guides	15-60-13

SUBJECT	PAGE
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Driveline Vibration	15-60-3
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Two-Piece Driveshaft Service	15-60-10
U-Joint Phasing	15-60-5
SPECIFICATIONS	15-60-18
VEHICLE APPLICATION	15-60-1

VEHICLE APPLICATION

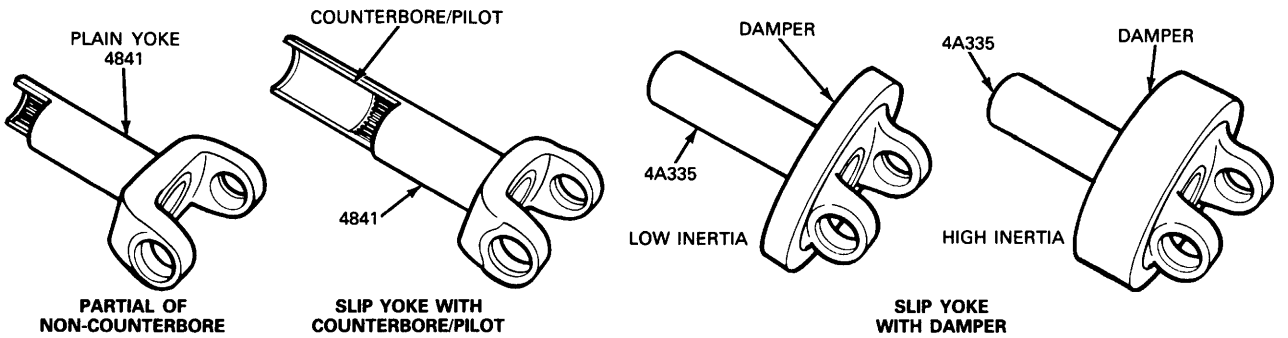
Applies to E-150 through E-350, F-150 through F-350, F-Super Duty and Bronco Trucks.

DESCRIPTION

Rear Driveshaft

The driveshaft or coupling shaft is composed of the universal joints (U-joints), connecting shafts, attaching flanges, and slip yokes. The number of shafts and U-joints used depends on the vehicle application.

Some vehicles use a one piece steel or aluminum, slip-yoke type driveshaft. A universal joint and splined slip yoke are located at the transmission end of the shaft, where they are held in alignment by a bushing in the transmission rear extension. The splined slip yoke and transmission output shaft allow fore and aft movement of the driveshaft as the rear axle moves up and down. This provides smooth performance during vehicle operation. An oil seal at the transmission prevents leakage and protects the slip yoke from dust, dirt and other harmful material. A second universal joint attached by two U-bolts is used where the driveshaft mates with the companion flange at the rear.



Others use a coupling shaft in conjunction with a driveshaft. Care must be taken to align the shafts as shown in the Figures. The two-piece driveline system incorporates a "necked down" coupling shaft stub with a "blindspline" feature which assures positive phasing action.

All two piece driveshaft vehicles are equipped with center support bearings that are prelubricated and sealed for the bearing life.

All U-joints are of the lubed for life needle-bearing type. U-joints equipped with grease fittings should be lubricated at the specified intervals. The U-joint bearings are retained on the U-joint spiders by snap rings and U-bolts on some applications.

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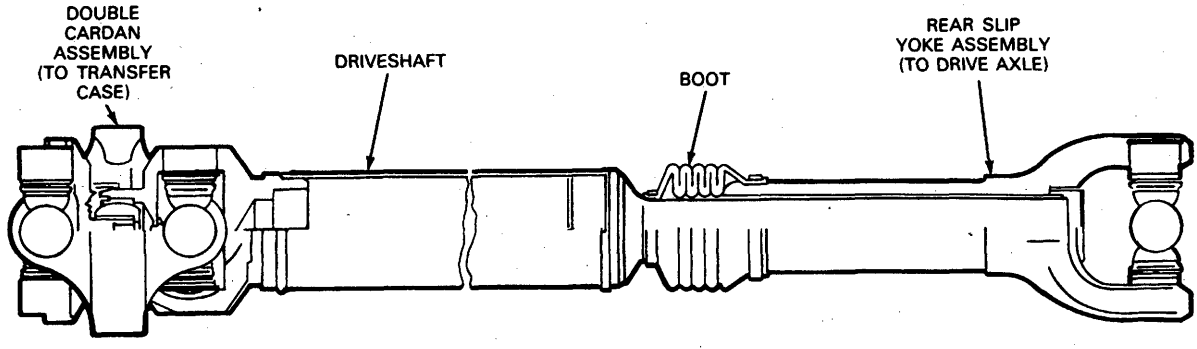
DESCRIPTION (Continued)

All driveshafts and coupling shafts are balanced; therefore, if the vehicle is being undercoated, the shafts and all open spline areas must be covered to prevent undercoating material from getting on the shafts.

Three types of driveshaft connecting joints are available on different vehicles, they are:

1. Single Cardan U-Joint.
2. Double Cardan U-Joint.
3. Constant Velocity Joint.

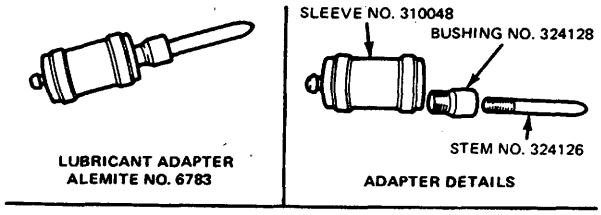
The Bronco rear driveshaft assembly is of the double Cardan type which incorporates two U-joints, a centering socket yoke, and a center yoke at the transfer case end of each shaft. A single U-joint is used at the axle end of the shafts.

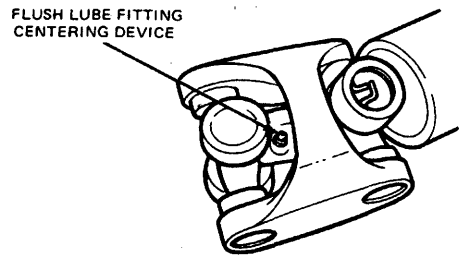


E7158-2A

There is only one flush type fitting for the centering device. The slip yoke only has one lube fitting. U-joints equipped with grease fittings should be lubricated at the specified intervals. They should be lubricated periodically with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.

CAUTION: Under no circumstances is the driveshaft assembly to be clamped in the jaws of a vise or similar holding fixture. Denting or localized fracture of the tube may result, which could cause driveshaft failure during vehicle operation.





E2707-1F

Front Driveshaft

The front driveshaft connects the power flow from the transfer case to the front drive axle. It incorporates two single cardan universal joint (U-joint) assemblies, a driveshaft with a splined stub shaft end, a boot with two clamps (one large and one small), and a slip yoke which attaches to the transfer case.

NOTE: Whenever the vehicle is raised on a hoist, inspect the rubber boot for rips or tears. Replace if required.

CAUTION: Under no circumstances are aluminum driveshafts to be clamped in the jaws of a vise or similar holding fixture. Denting or localized fracture of the tube may result which could cause driveshaft failure during vehicle operation.

DIAGNOSIS AND TESTING

For additional information refer to Section 15-01, General Driving Axle Service and Section 18-01, Noise, Vibration and Harshness for driveshaft diagnostic and testing procedures.

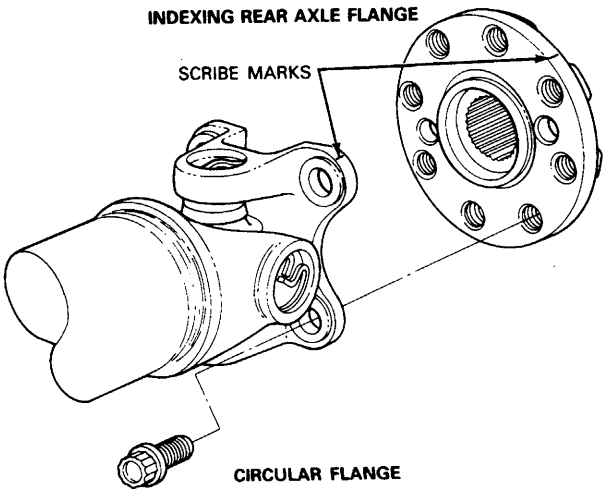
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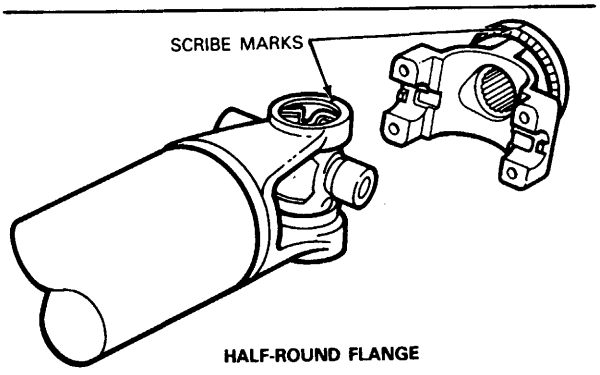
DIAGNOSIS AND TESTING (Continued)

Driveline Vibration

This is a higher-frequency, lower-amplitude vibration than high-speed shake, directly related to road speed, and usually more noticeable at higher road speeds, 72 km/h (45 mph) and up. It is felt in the floor pan or heard as a rumble, hum or boom. It will exist in all drive modes, but may vary somewhat in acceleration, deceleration, float or coast modes. If the vibration is particularly responsive to heavy acceleration or deceleration, especially at lower speeds, driveline angles should be checked. A driveline vibration can usually be duplicated with the axle supported on a hoist or jack stands; through light brake application while accelerating and decelerating, to simulate road load resistance, may be necessary to bring it out.

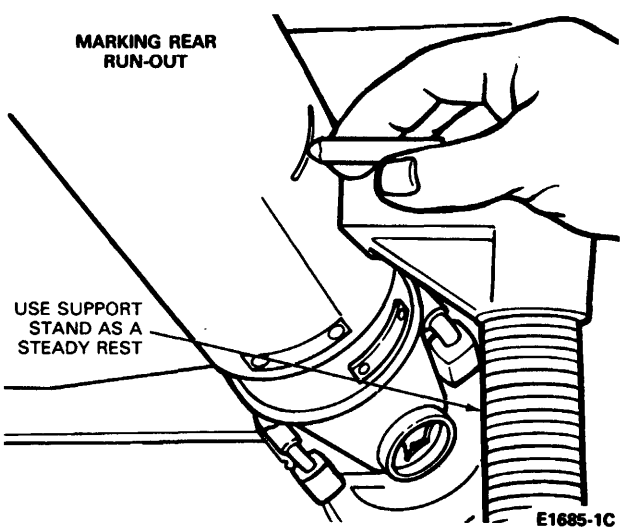
1. Raise vehicle promptly after road-testing, on twinpost hoist or jack stands, to prevent tire flat-spotting. Engage drive train and run-up to observed road test speed to verify presence of vibration. If not evident, check non-driving wheels with wheel-balancer spinner to rule out imbalance as a possible cause. On 4x4's, unlock front hubs or remove hub covers before spinning wheels. If required, balance non-driving wheels and repeat road test. If vibration is still evident, proceed to driveshaft inspection, Step 3.
2. If vibration appeared in road-speed hoist-test, mark relative position of drive wheels on axle or hub lugs to permit re-installation in original position, and remove wheels. Secure brake drums, if present, by installing all lug nuts in reversed position, and repeat road-speed run-up. If vibration is gone, see drive wheel run-out and balance procedures in this Section. If vibration persists, proceed to Step 3.
3. Inspect driveshaft for signs of physical damage, missing balance weight, undercoating, or improperly seated, worn, or binding universal joints. Check the index marks (paint spots) on rear of shaft and pinion yoke or companion flange. If these marks are more than 90° apart, disconnect shaft and re-index to align marks as close as possible. Clean shaft and repair or replace universal joints as necessary, or replace shaft if damaged. After any corrections are made, re-check vibration at road test speed. If gone, re-install wheels and road test. If vibration persists, proceed to run-out check, Step 4.





F3931-1B

4. With vehicle on hoist and wheels off, measure runout at front, center, and rear of driveshaft with indicator, rotating shaft by turning a brake drum or rotor. On a one-piece shaft, if run-out exceeds .89mm (.035 inch) at front or center, the driveshaft must be replaced. If front and center are within this limit, but rear run-out is not, mark the rear run-out high point and proceed to Step 5. If run-out is within limits at all points, proceed to driveshaft balancing, Step 7.

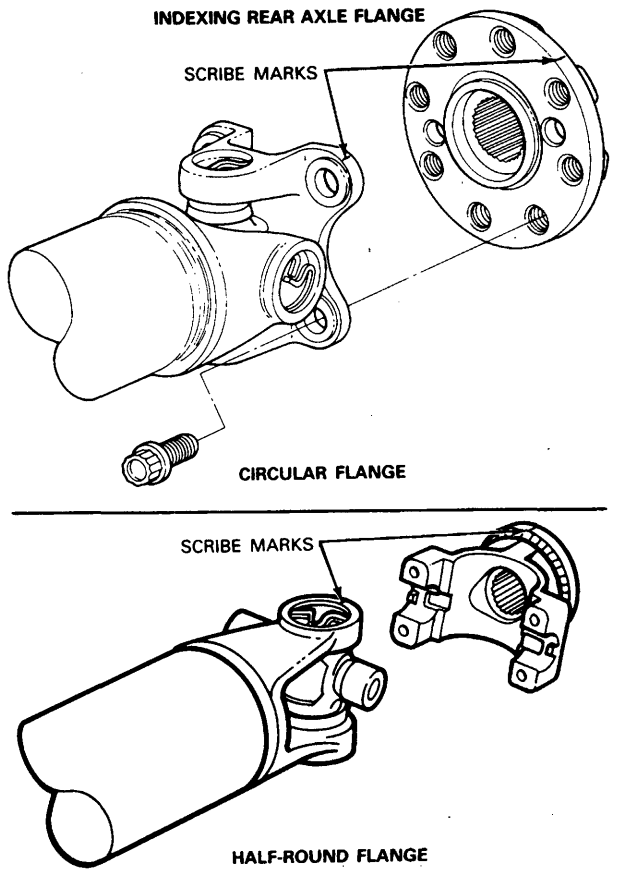


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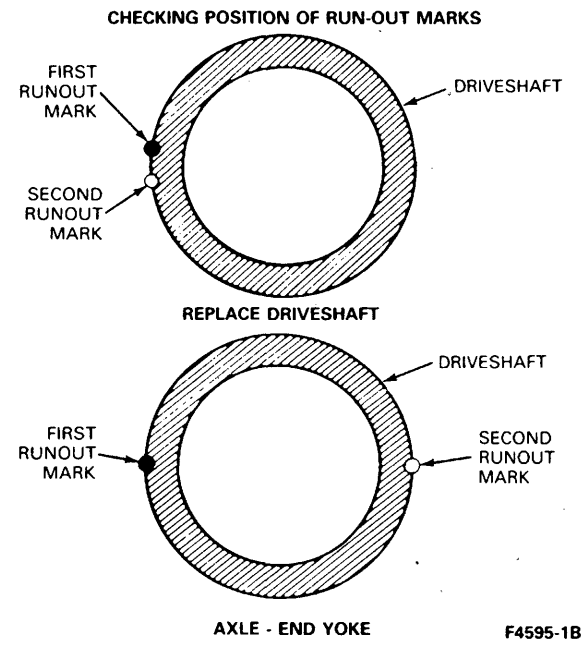
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DIAGNOSIS AND TESTING (Continued)

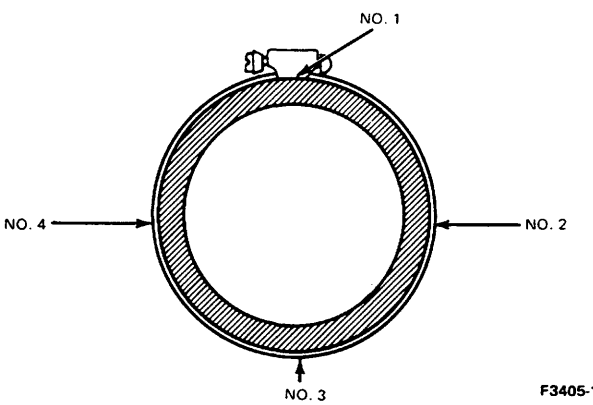
5. Note or mark the indexing of driveshaft to rear axle pinion flange. Disconnect the shaft, re-index 180°, and re-connect. Check run-out at shaft rear, and if still over .89mm (.035 inch), mark high point and see Step 6. If run-out is no longer excessive, check for vibration at road test speed, and, if still present, proceed to Step 7, driveshaft balancing under Adjustments.



6. Excessive driveshaft run-out may originate in the shaft itself or in the companion flange. To determine which, compare the two high points marked in Steps 4 and 5. If the marks are close together, within about 25mm or 1 inch, the shaft is eccentric, and should be replaced and checked for vibration. If the marks are on opposite sides of the shaft, about 180° apart, the yoke or flange is responsible. After replacing check for run-out. When replacing a yoke-type flange, driveshaft runout should not exceed .89mm (.035 inch). When run-out is within limits, recheck for vibration at road speed. If vibration persists, balance the driveshaft.



7. Driveshaft balancing involves installing one or two hose clamps on the driveshaft, near the rear end of a one-piece shaft. Best positioning of the hose clamp head(s) can be determined by trial-and-error, if special balancing equipment is not available. If transducer-and-strobe equipment is available, see Adjustments in this Section for balancing procedure.
8. If the driveshaft was not previously indexed to correct run-out, mark original position of shaft relative to companion flange, index 180°, and roadtest. If after roadtest, the condition is not improved, return the shaft to the original position.
9. Mark off the rear of the driveshaft into four approximately equal sectors, and number the marks 1 through 4. Install a hose clamp on the shaft with its head at position No. 1. Check for vibration at road speed. Re-check with the clamp at each of the other positions, to find the position for minimum vibration. If two adjacent positions show equal improvement, position the clamp head between them.

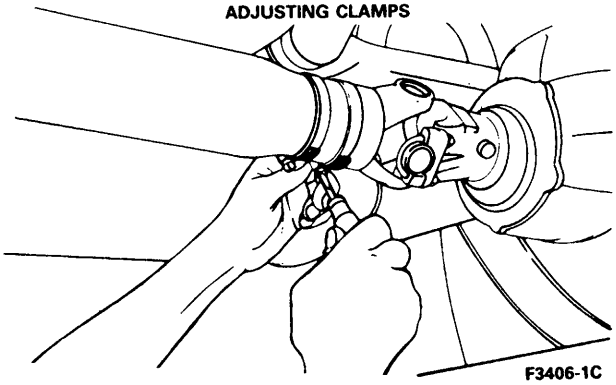


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DIAGNOSIS AND TESTING (Continued)

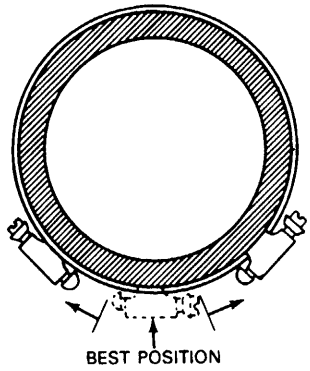
10. If condition is still not acceptable, add a second clamp at the same position and re-check vibration. If no improvement is noted, rotate the clamps in opposite directions, equal distances from the best position determined in Step 9. Initially, separate the clamp heads about 12mm or 1/2 inch, and re-check vibration at road speed.

ADJUSTING CLAMPS



F3406-1C

DETERMINING BEST POSITION FOR CLAMP POSITION



F3407-1B

Repeat the process with increasing separation until the best combination is found, or vibration is reduced to an acceptable level.

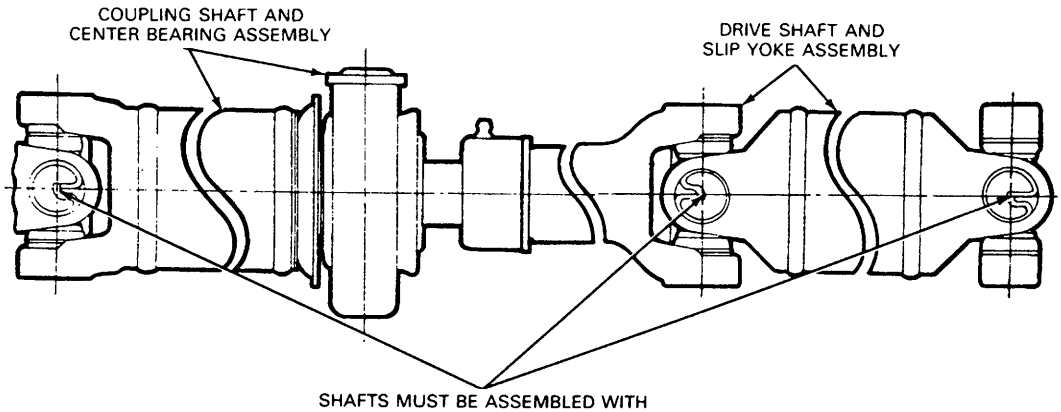
11. Install wheels and road test, since vibration noticeable on the hoist may not be evident during the road test. If vibration is still not acceptable, replace the axle pinion nose damper. If road test is not acceptable, replace axle ring gear and pinion set.

U-Joint Phasing

When U-joint yokes are assembled to their shafts in the same plane, they are in phase. When they are assembled to the shafts in different planes, they are out of phase.

To obtain vibration-free operation, check and correct as necessary.

U-JOINT PHASING-TWO-PIECE DRIVELINE SYSTEM



E3670-2C

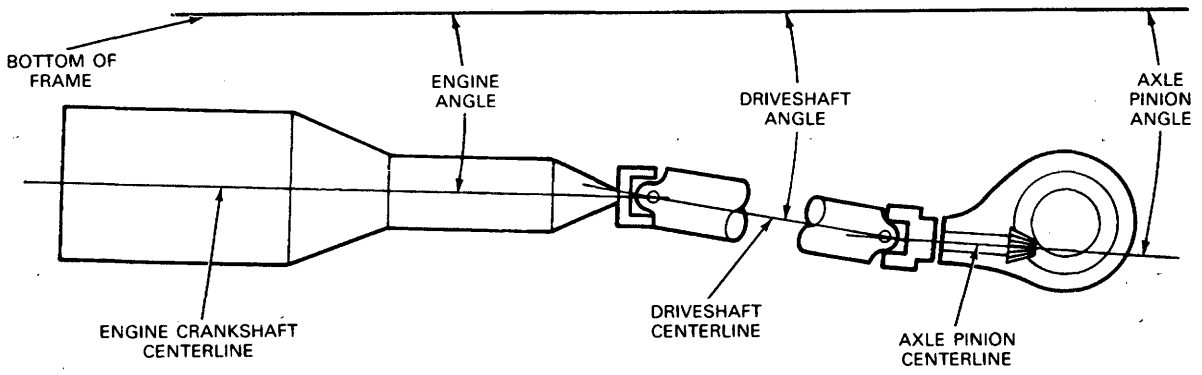
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DIAGNOSIS AND TESTING (Continued)

Driveline Angularity

Driveline angularity is the angular relationship between the engine crankshaft, the driveshaft and the rear axle pinion. Factors determining driveline angularity include ride (spring) height, and engine mounts.

Low speed vibration, less than 72 km/h (45 mph), especially when the vehicle is subjected to heavy acceleration or deceleration is an indication of improper driveline angles. When these conditions exist, check the universal joints for proper seating, mounting and operation.



F4559-2A

Universal Joint Inspection

Prior to checking driveline angularity, inspect the universal joints on the driveshaft for proper operation.

Place the vehicle on a frame hoist and rotate the driveshaft by hand. Check for rough operation or seized U-joints. If the U-joint shows signs of seizure, excessive wear or improper seating, scribe alignment marks on the driveshaft and rear axle companion flange. Remove the driveshaft and remove and replace the U-joint. Install the driveshaft in the marked original position.

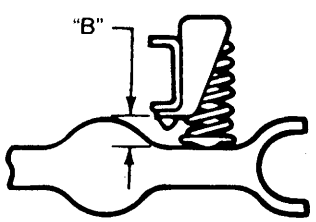
Driveline Angle Check

1. Raise the vehicle on a drive-on type hoist or back onto a front-end alignment rack. Jounce the vehicle to normalize the suspension. This ensures that the suspension components are in the normal-load condition.

NOTE: Driveline angles are given in relation to a 0° longitudinal (fore-aft) unibody frame rail angle and are specified for individual components. Refer to the Specifications portion of this Section for the specified engine, driveshaft and pinion angle.

2. Measure the Ride Height. The vehicle must be in the curb weight (unloaded) condition. Find the recorded ride height in the Driveline Angle chart in the Specifications portion of this Section. The specified driveline angles correspond to the measured ride height.

RIDE HEIGHT MEASUREMENT



BOTTOM OF SPRING TOWER TO TOP OF AXLE MEASURED AT OUTBOARD FRONT FACE OF JOUNCE STOP

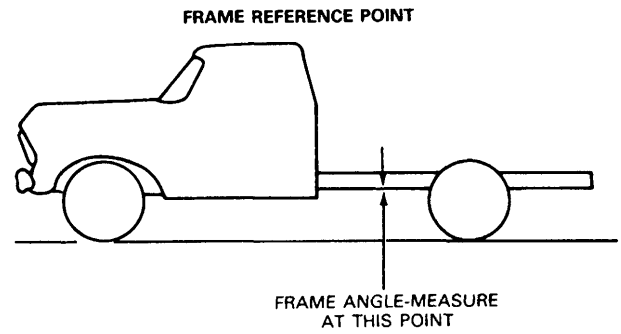
F5027-1A

3. Driveline angles are measured with Pinion Angle Level Gauge, T68P-4602-A or equivalent, as described in Step 4, or with an adjustable bubble (spirit level) protractor as described in Step 5. The protractor is used when the tool kit is not available or when the angles to be measured are more than 12 degrees. All angles should be read within 1/2 degree with the tool or protractor held plumb on a clean, flat surface.

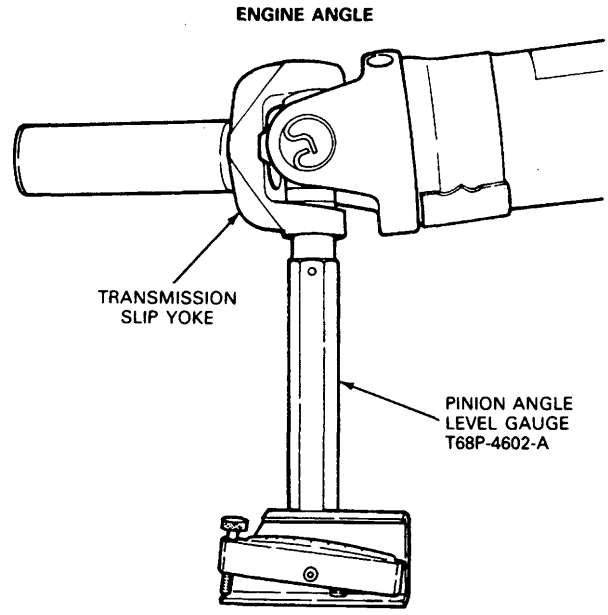
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DIAGNOSIS AND TESTING (Continued)

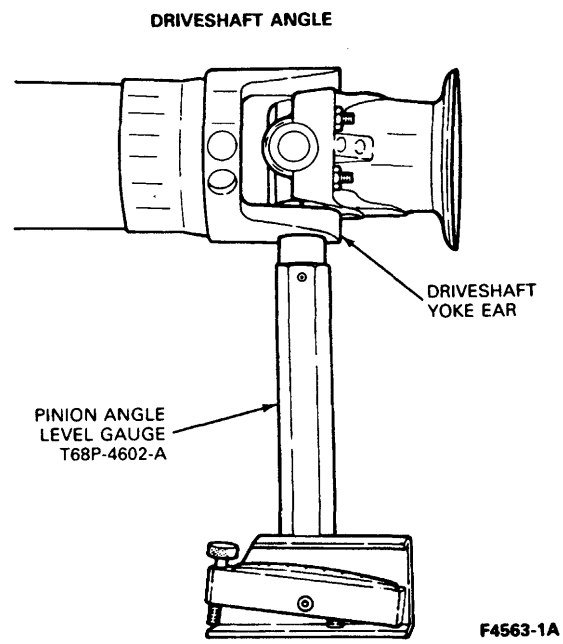
4. **DRIVELINE ANGLE CHECK WITH PINION ANGLE LEVEL GAUGE, T68P-4602-A (or equivalent).** Place the vee magnet of the tool on the bottom of the vehicle frame as shown and calibrate the tool to a 'zero' bubble reading. This gives the 0° frame angle. Take and average the readings from both sides to obtain a more accurate reading.



Check the engine angle by rotating the driveshaft until one transmission slip yoke ear is parallel to the floor. Remove the retaining snap ring from the yoke. Install the Pinion Angle Level Gauge and record the angle reading. If the angle reading differs from the specified angle by 1° or more, proceed to Engine Angle Adjustment and neutralize the engine and transmission mounts. With the Engine Angle at specifications, check the Driveshaft and Pinion Angles. Re-install the snap ring.



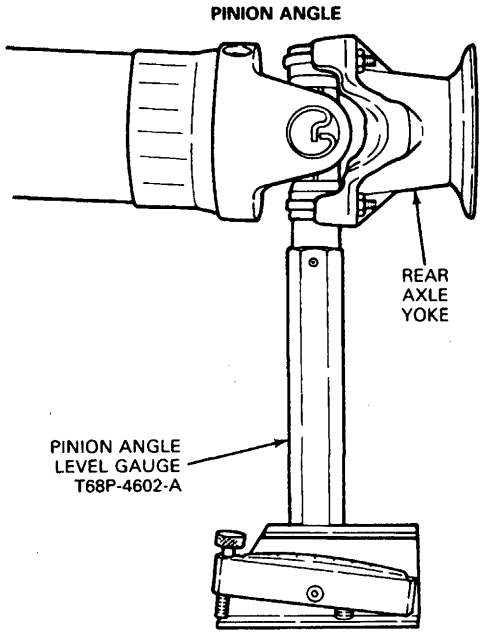
To check the driveshaft angle, rotate the driveshaft so one driveshaft yoke ear is parallel to the floor. Remove the retaining snap ring from the yoke. Install the magnetic Pinion Angle Level Gauge on the U-Joint bearing cup and record the angle reading. Reinstall the snap ring. Check the Pinion Angle and if both or either reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.



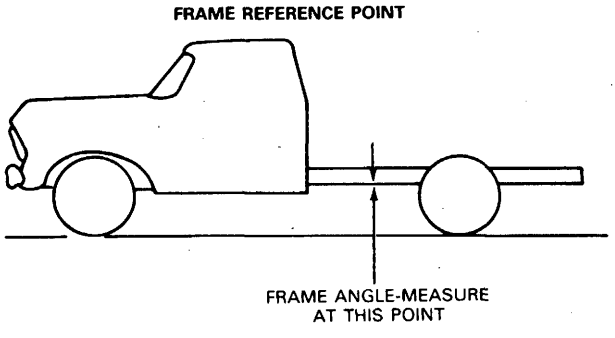
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DIAGNOSIS AND TESTING (Continued)

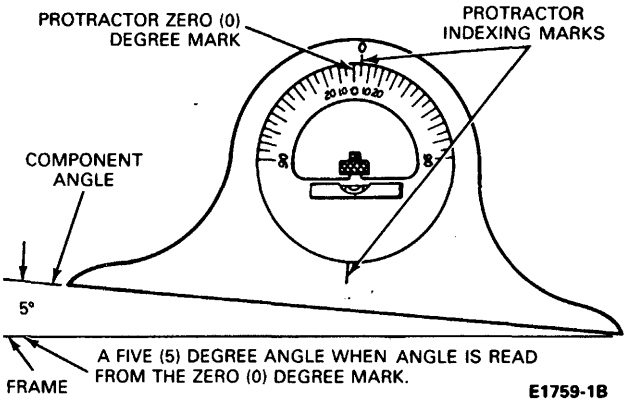
To check the Pinion angle, rotate the driveshaft so that one ear of the rear axle yoke is parallel to the floor. Remove the retaining snap ring from the yoke. Install the Pinion Angle Level Gauge and record the reading. If the reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.



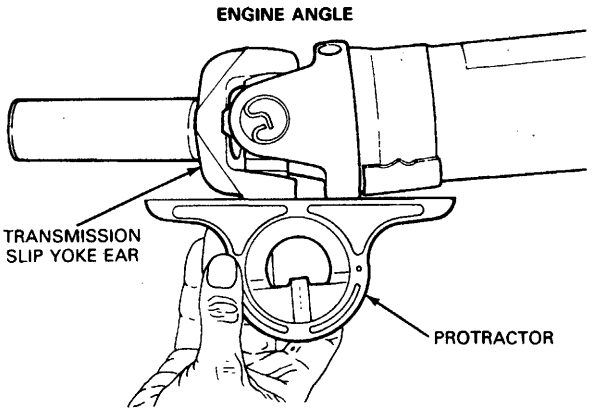
5. DRIVELINE ANGLE CHECK WITH ADJUSTABLE BUBBLE (SPIRIT LEVEL) PROTRACTOR: Place the protractor on the bottom of the vehicle frame directly below the front driver/passenger seat. This gives the 0° frame angle. Take and average the readings from both sides to obtain a more accurate reading. Calibrate the level to a 0° bubble reading.



NOTE: When using a bubble (spirit level) protractor, the angles are read from the 0° frame angle. The 90° mark on the protractor is read as the 0° frame angle. For example, when the protractor is placed on the component and the protractor reads 85°, the component angle is actually 5°.



To check the Engine Angle, rotate the driveshaft until one transmission slip yoke ear is parallel to the floor. Place the protractor so it is flush against the slip yoke ear. Make sure the protractor is not resting against any portion of the driveshaft assembly. Record the angle reading. If the engine angle reading differs from the specified angle by 1° or more, proceed to Engine Angle adjustment and normalize the engine and transmission mounts. Refer to diagnosis and testing following this Section. With the Engine Angle at specifications, check the driveshaft and pinion angles. Refer to angle specifications following this Section.

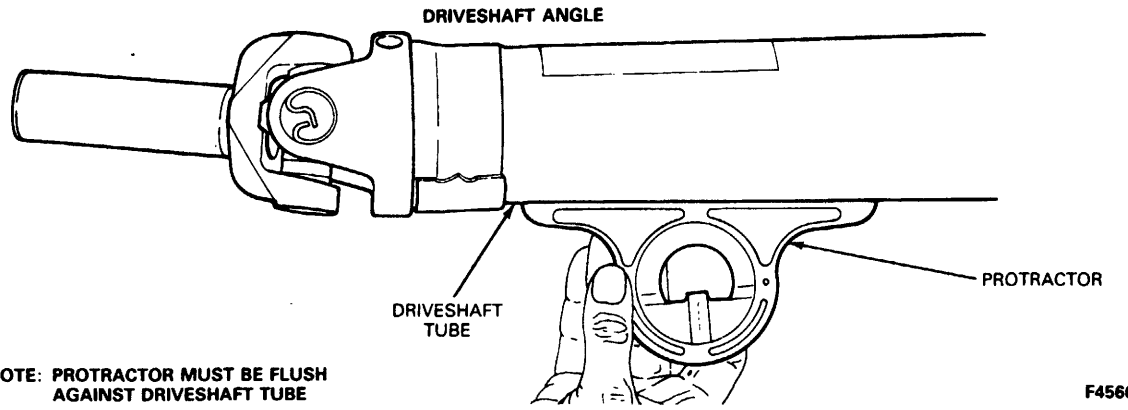


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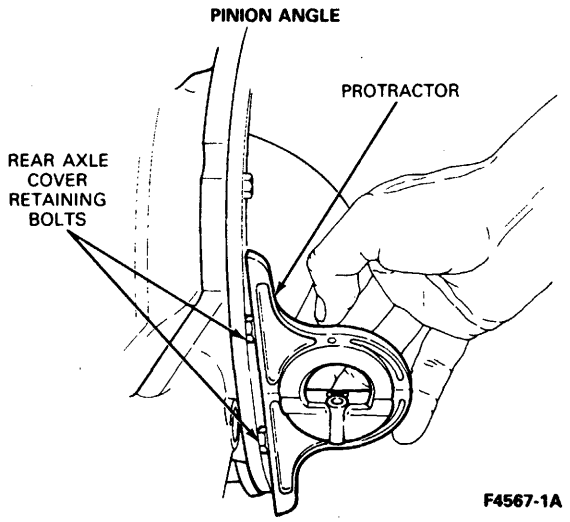
DIAGNOSIS AND TESTING (Continued)

To check the Driveshaft Angle, place the protractor on any portion of the driveshaft tube so the plane surface of the protractor is flush against the bottom surface of the tube and parallel to the floor.

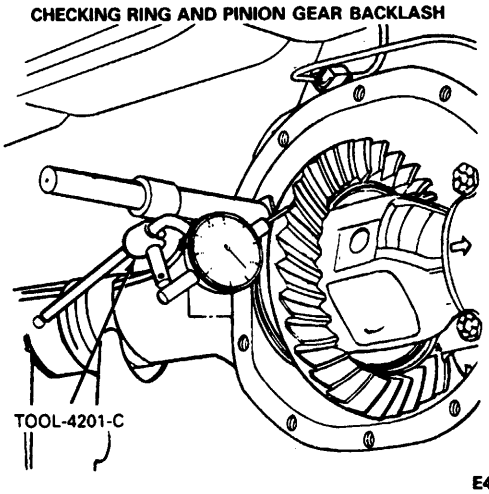
Record the reading. Check the Pinion Angle and if both or either reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.



To check the Pinion Angle, place the protractor in a vertical position so it is flush against two rear axle cover retaining bolts. Rotate the protractor bubble indicator so the 90° marks align with the indexing marks. Calibrate the bubble to the 'level' marking and read the protractor. For example, if the protractor indicates a reading of 85°, the Pinion Angle reading is 5°. Record the reading. If the reading is not to specifications, refer to Driveshaft and Pinion Angle Adjustment.



6. Road test to verify resolution of condition. If driveline angle correction and driveline runout/ balance procedures (refer to Driveshaft Balancing—Strobe and Transducer Method in this Section) do not eliminate the vibration condition, the axle ring gear and pinion gearset should be checked for backlash variation. Remove the axle cover plate as described in the appropriate Rear Axle Section. Measure ring gear backlash on thirty consecutive ring gear teeth and note the variation between the high and low readings. If over 0.10mm (0.004 inch) replace the gearset as described in the appropriate Rear Axle Section.



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DIAGNOSIS AND TESTING (Continued)

DRIVELINE ANGLE CORRECTION

Engine Angle Adjustments

The engine angle is adjusted by normalizing the engine mounts. The engine mounts are normalized by operating the engine until normal operating temperature is obtained. Stop the engine and loosen but DO NOT REMOVE the engine and transmission mount fasteners. Operate the engine at curb idle and place the transmission in Drive or first gear and then stop the engine. Tighten all fasteners to the specified torque. Recheck the engine angle, if the angle is still out of specification, place shims under the transmission to rear crossmember mount until the specified angle is obtained. If the engine transmission angle is still out of specification, place shims under the transmission to rear crossmember mount until the specified angle is obtained.

Coupling Shaft Angle Adjustment

Check coupling shaft angle (if so equipped) and adjust to specification by shimming the center support bearing. Refer to center support Bearing Shimming in the Two Piece Driveshaft Service portion of this Section.

DRIVESHAFT AND PINION ANGLE ADJUSTMENT

Check the driveshaft angle and adjust to specifications by shimming between the rear springs and the spring seats.

Adjust the pinion angle by placing tapered shims between the springs and spring seats. On F-150, a 63-5mm (2 1/2 inch) wide shim (Part No. C3TZ-5A313-A or equivalent) is available for a 2° change. On E-150 and Bronco, a 63.5mm (2 1/2 inch) wide shim (Part No. C3TZ-5A313-E or equivalent) is available for a 3° change. On E-250—E-350, F-250—F-350, and F-Super Duty, a 76.2mm (3 inch) wide shim (Part No. C6TZ-5A313-B or equivalent) is available for a 3° change.

Two-Piece Driveshaft Service

The two-piece driveshaft used in longer wheelbase light truck models introduces some special considerations to diagnosis and testing. As compared with a one-piece installation, the two-piece design includes a front, or "coupling" shaft, a rubber-insulated frame-mounted center bearing, a splined slip joint and an intermediate universal joint at the front of the rear driveshaft.

Center Support Bearing Shimming

Drive-away shudder is the predominant symptom associated with driveline angles condition on F-150—F-250 vehicles with two piece driveshafts. After eliminating coupling shaft phasing condition as the possible cause, drive away shudder can usually be serviced by shimming down the center support bearing in 1/4 inch increments using shims, E0TA-4A209-AA, or equivalent until the drive away shudder is eliminated. Plate stock must be used to maintain proper preload compression of the rubber insulator.

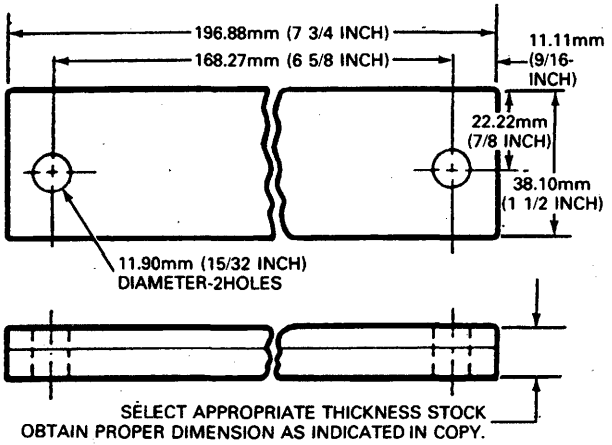
Replace the existing bolts with the appropriate length 7/16-14 hex head bolts.

Tighten bolts to 51-73 N·m (37-54 ft-lb).

Road test to verify resolution of condition.

If the drive away shudder cannot be serviced by shimming down the center support bearing proceed to the driveline angle checking and service procedure in the following paragraphs.

CENTER SUPPORT SHIM DIMENSIONS



MATERIAL: HOT ROLLED LOW CARBON STEEL

Y1978-1C

Coupling Shaft/Center Bearing Alignment

E-150—E-250—E-350 and F-150—F-250—F-350—F-Super Duty Vehicles with Two Piece Driveshaft

Vehicle noise and vibration can be caused by dislocated and/or failed center bearing rubber insulator, contaminated center bearing or excessive compression of the rubber insulator.

The service for this condition is as follows:

1. Remove the coupling shaft assembly from the vehicle.
2. Perform the following steps:
   - A. Remove the support bracket and retainer.
   - B. Remove the rubber insulator.
   - C. Press center bearing assembly and bearing retainer off the coupling shaft.
   - D. Press the dust slinger off the coupling shaft.
3. Replace with center bearing assembly kit D9TZ-4800-A or equivalent in all cases except E4TZ-4800-A for F-250 HD, F-350 and F-Super Duty with M5HD transmission.
4. Reassemble the coupling shaft.

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DIAGNOSIS AND TESTING (Continued)

NOTE: First install bearing in rubber insulator and press bearing on shaft with the turned in lip toward the dust slinger (forward). The support bracket must be installed with the deep flange rearward.

5. Reinstall the driveline in the vehicle with the yokes phased properly.
6. Road test to verify resolution of condition.
7. If vibration still exists, insert 1.19mm (1/16 inch) shims between support bracket and support plate (on bolt ends of support bracket) to reduce compression of the rubber insulator as required.

Slip Yoke Spline

E-150—E-350, F-150—F-350 and F-Super Duty Vehicles With Two Piece Driveshaft

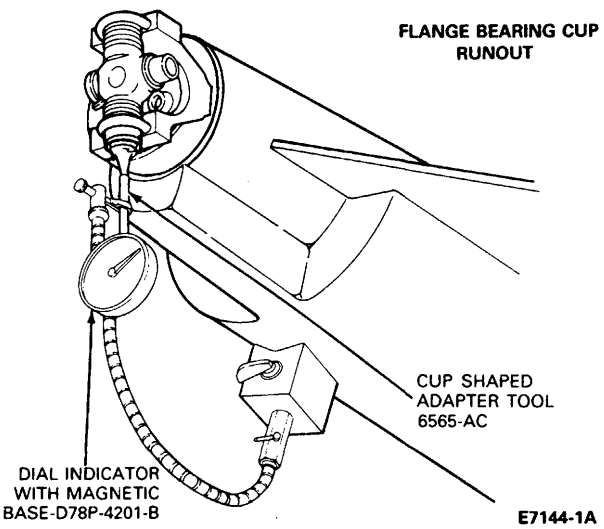
Vehicle noise and vibration can be caused by a seized driveshaft slip yoke spline resulting in the rubber isolator being pulled out of the center bearing support.

The service resolution to minimize slip yoke spline contamination and ultimate seizure is as follows:

1. Disconnect the driveshaft from the rear axle yoke and remove it from the truck.
2. Clean the male splines of the coupling shaft using care not to damage the plastic coating. Fine abrasive cloth may be required to dress and polish the male spline. Remove all hardened grease deposits, dirt, or rust. Inspect for worn or galled splines. The plastic coating on the stub spline must not be removed. Replace coupling shaft if necessary.
3. Clean and inspect the female splines of the slip yoke, removing any hardened grease deposits, dirt or rust. Inspect splines for worn or galled conditions, replace slip yoke if necessary.
4. Apply a coating of Multi-Purpose Long Life Lubricant C1AZ-19590-B (ESA-M1C75-B) or equivalent to the entire splined stub end of the coupling shaft assembly prior to the assembling of the driveshaft to the coupling shaft.
5. Using a clean long handle (stencil type) brush apply Multi-Purpose Long Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent spread evenly on all the female splines of the slip yoke. The spline joint must slide freely by hand.
6. Assemble the driveshaft to the coupling shaft with the yokes phased properly. Attach driveshaft to rear axle yoke.
7. Using a hand type grease gun, lubricate the driveshaft slip yoke through the zerk fitting with Multi-Purpose Long Life Lubricant C1AZ-19590-B (ESA-M1C75-B) or equivalent.

Rear Axle Companion Flange Runout Check

1. Raise the vehicle on a hoist that supports the rear axles (twin-post hoist).
2. Remove the driveshaft assembly (Section 15-60 Driveshaft—Single Snap Ring Type U-Joint).
3. Check the companion flange for damage to the universal joint bearing locating lugs. If the lugs are shaved (worn) or damaged, replace the flange.
4. The companion flange runout is checked with a dial indicator with 25.40mm (1.000 inch) minimum travel, and a cup-shaped dial indicator adapter Tool 6565-AB or equivalent. To fabricate the checking tool, modify a universal joint assembly by removing two bearing cups that are opposite each other, and cutting or grinding off one of the universal joint bearing flanges.
5. Install the cup-shaped adapter on the dial indicator stem. Install the dial indicator on the pinion nose. Position the indicator to allow an indication at the ends of the universal joint bearing cups and the remaining exposed journal of the cross-shaft.



6. Turn the companion flange so that the dial indicator cup-type adapter rests on the machined surface of the bearing cup. Rotate the companion flange side-to-side slightly to obtain a reading indicating that the bearing cup surface is perpendicular to the adapter. This will be the point at which the dial indicator cup is closest to the center of companion flange rotation. It is also the point at which the dial indicator hand will reverse direction as the companion flange is turning.

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DIAGNOSIS AND TESTING (Continued)

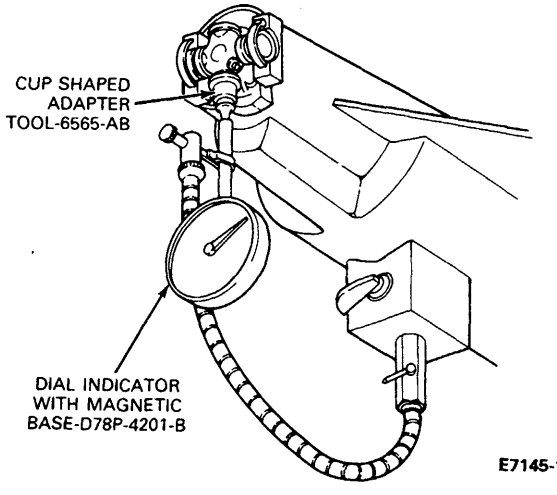
7. Carefully retract the dial indicator stem and rotate the companion flange 180 degrees to position the machined surface of the opposite universal bearing under the dial indicator adapter tool. Again, slightly rotate the flange side-to-side to position the bearing perpendicular to the dial indicator adapter. Again, this is the point at which the indicator hand will reverse direction as the flange is rotated. Record the flange bearing cup runout reading obtained from the indicator.

Rotate the companion flange 90 degrees and position the dial indicator adapter on the machined end of the exposed journal. Be sure the end surface of the journal is perpendicular to the adapter. This requires that the cross-shaft be moved fore and aft on the flange bearing cups. Note the point at which the indicator hand reverses direction.

Rotate the flange assembly side-to-side until the cross-shaft is perpendicular to the pinion shaft axis, and the indicator hand reverses direction. Zero the dial indicator and check the zero point again by slightly moving the cross-shaft fore and aft; then, rotate the companion flange from side-to-side.

8. With the indicator at zero, carefully retract the dial stem and rotate the flange 180 degrees. Rotate the cross-shaft 180 degrees on the flange bearing cups to position the exposed journal under the dial indicator adapter. Rock the cross-shaft fore and aft and the companion flange side-to-side to establish the point at which the indicator hand reverses direction. This will determine the driveshaft universal cross-shaft runout. Record this reading.
9. Repeat Steps 5 through 8 at least three times and average the indicator readings obtained.

CROSS-SHAFT RUNOUT CHECK



E7145-1A

10. To determine the total (combined) companion flange runout, use the combined runout guide. With an indicated 0.003-inch flange bearing cup runout and an indicated 0.004-inch universal cross-shaft runout, the combined companion flange runout will be 0.005-inch.

Flange Bearing Cup Runout	Driveshaft Universal Cross-Shaft Runout — Inch												
	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.010	0.011	0.012
0.000	0.000	0.001	0.002	0.003	0.004	0.005	0.006	0.007	0.008	0.009	0.010	0.011	0.012
0.001	0.001	0.0013	0.0022	0.0032	0.0042	0.0051	0.0061	0.0071	0.0081	0.0091	0.0010	0.011	0.012
0.002	0.002	0.0022	0.0027	0.0037	0.0045	0.0053	0.0062	0.0072	0.0082	0.0092	0.0101	0.0111	0.0121
0.003	0.003	0.0032	0.0036	0.0042	0.005	0.0058	0.0067	0.0077	0.0085	0.0094	0.0104	0.0113	0.0123
0.004	0.004	0.0042	0.0045	0.005	0.0057	0.0064	0.0072	0.0081	0.009	0.0097	0.0107	0.0116	0.0126
0.005	0.005	0.0051	0.0053	0.0058	0.0063	0.0071	0.0078	0.0087	0.0094	0.0102	0.0111	0.012	0.013
0.006	0.006	0.0061	0.0062	0.0068	0.0072	0.0078	0.0085	0.0092	0.010	0.0108	0.0116	0.124	0.0134
0.007	0.007	0.0071	0.0073	0.0075	0.0081	0.0087	0.0093	0.0099	0.0103	0.0114	0.0122	0.013	0.0138
0.008	0.008	0.0081	0.0082	0.0087	0.009	0.0094	0.010	0.0104	0.011	0.012	0.0128	0.0135	0.0144
0.009	0.009	0.0091	0.0092	0.0094	0.0097	0.102	0.108	0.0114	0.012	0.0127	0.0134	0.0141	0.015
0.010	0.010	0.010	0.0101	0.0104	0.0107	0.0111	0.0116	0.0122	0.0128	0.0134	0.0141	0.0148	0.0156
0.011	0.011	0.011	0.0111	0.0113	0.0116	0.012	0.0124	0.013	0.0135	0.0141	0.0148	0.0154	0.0162
0.012	0.012	0.012	0.0121	0.0123	0.0126	0.013	0.0134	0.0138	0.0144	0.015	0.0156	0.0162	0.0169

The total (combined) companion flange runout is located in the square where the columns containing the flange bearing cup runout and universal cross shaft runout readings intersect.

CE3683-2A

11. If the reading obtained in Step 10 exceeds specifications, re-position the companion flange 180 degrees on the pinion shaft and repeat Steps 1 through 11.
12. If the repeat readings still exceed specifications, re-position the flange an additional 90 degrees on the pinion shaft and check the runout (Steps 4 through 10).
13. If the runout is still excessive, replace the companion flange and check the runout. If necessary, rotate the new flange on the pinion shaft until an acceptable runout is obtained.

If excessive runout is still evident after replacement of the companion flange, replace the ring gear and pinion and repeat the above checks until the runout is within specifications.

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DIAGNOSIS AND TESTING (Continued)

Diagnosis Guides

The diagnosis guides in this Section can be used when diagnosing driveshaft conditions.

DRIVELINE COMPLAINTS

CONDITION	POSSIBLE CAUSE	RESOLUTION
Driveline Concerns	1. Rear spring U-bolt loose.	1. Retighten U-bolts and driveshaft.
	2. U-joint worn or improperly installed.	2. Install or replace U-joint.
	3. Coupling shaft center support bearing improperly installed.	3. Correctly install bearing and replace if damaged.
	4. Excessive runout in companion flange and damaged U-joint.	4. Rotate flange 180 degrees and install. Recheck, and if not acceptable, replace flanges and/or U-joint and repair as required.
	5. Excessive lateral and radial tire and wheel runout.	5. Refer to Section 11-01, General Wheel and Tire Service.
	6. Excessive driveshaft runout.	6. Replace driveshaft or rotate driveshaft 180 degrees and check for out-of-balance condition.
	7. Driveshaft out-of-balance.	7. Rebalance driveshaft.
	8. Driveline and pinion angles out-of-specification.	8. Adjust to specifications.
	9. Binding, damaged or galled splines on slip yoke.	9. Check transmission for proper lubricant, and clean and lap splines. Lubricate splines with Multi-Purpose Long-Life Lubricant C1AZ-19590-B (ESA-M1C75-B).
Noise on Drive or Coast	1. Improper driveline angles or phasing.	1. Adjust or correct as required.
Loud clunk in the Driveline when shifting from reverse to forward.	1. Loose or worn driveshaft components, companion flange attaching nut below specifications.	1. Inspect, repair, replace as required.

CE4771-2E

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DIAGNOSIS AND TESTING (Continued)

DRIVESHAFT VIBRATES

TEST STEP	RESULT	ACTION TO TAKE
1.0 VERIFY CONDITION The following procedure should be used to isolate part or parts causing concern when a vibration condition exists which is thought to be caused by driveline components. • Road test vehicle to determine critical vibration points. Note road speed, engine RPM, and shift lever positions at which vibration occurs. • Stop vehicle and run engine with clutch depressed through critical speed ranges noted above.	OK ▶ OK ▶	If excessive vibration is present, correct engine or clutch condition causing vibration. GO to **2.**
2.0 TRANSMISSION CHECK • With transmission in neutral and clutch engaged, run engine through critical speed ranges and note if any excessive vibration is apparent.	OK ▶ OK ▶	STOP. GO to **3.**
3.0 TRANSMISSION ALIGNMENT • Check transmission to clutch housing alignment.	OK ▶	Align transmission and clutch housing.

CE4769-2B

ADJUSTMENTS

Driveshaft Balancing

Vibration or shudder which is noticeable either on fast acceleration, when coasting, or when using the engine for braking, may be caused by the rear axle housing being loose on the rear suspension, improper tire balance, improper driveline installation, or driveline balance.

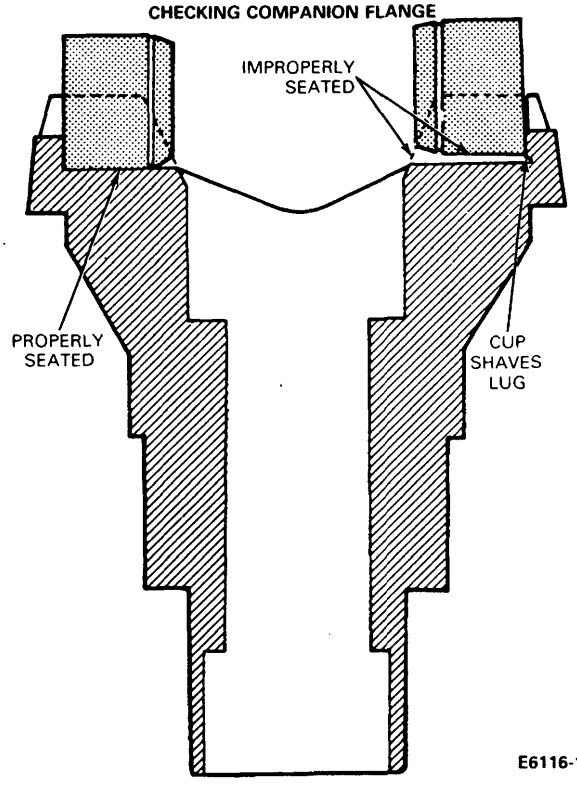
If driveshaft components are replaced and shaft vibration is encountered after installation, disconnect the shaft and remove the slip yoke. Rotate the slip yoke 180 degrees; then, reconnect the shaft to the slip yoke and reinstall in vehicle. If the vibration persists, disconnect the shaft at the rear axle companion flange. Rotate the companion flange 180 degrees and reconnect the shaft to the flange.

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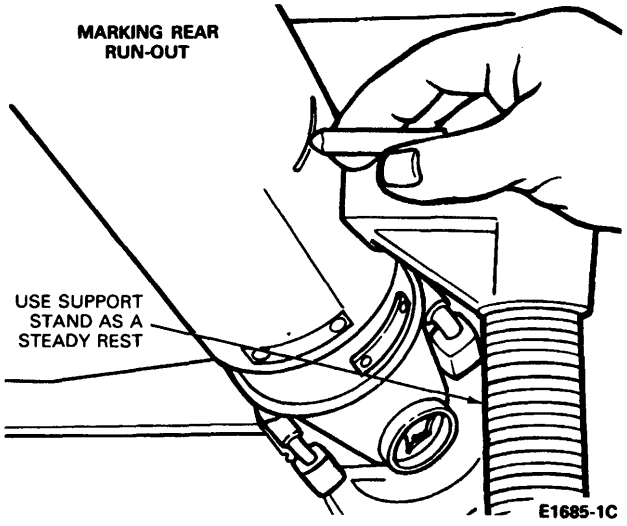
ADJUSTMENTS (Continued)

If rotating the driveshaft 180 degrees does not eliminate vibration, the driveshaft may be balanced, using the following procedure:

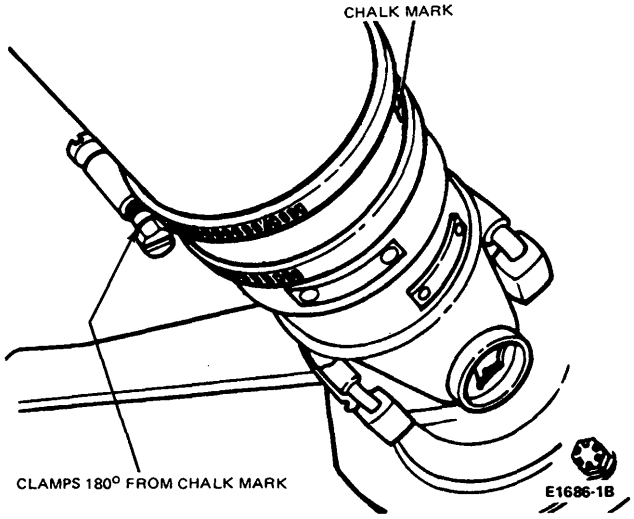
1. Raise the vehicle on a twin-post hoist so that both the front and rear axles are safely supported with all wheels free to rotate.
2. With the transmission in gear, increase the vehicle speed to the maximum vibration level. Note and record the speed of this vibration period as a baseline speed.
3. Check the attachment of all U-joint bearing caps of the driveshaft to the transmission yoke for improper installation or damaged U-joint bearing cap locating lugs. All yokes with worn, shaved, or damaged locating lugs must be replaced.



4. With the transmission in gear, run the vehicle with the driveshaft rotating at a speedometer speed of 64-80 km (40-50 miles); have an assistant carefully bring a crayon, piece of chalk, or colored pencil up until it just barely contacts the rear end, center and front end of the driveshaft. The chalk marks will indicate the heavy side of the driveshaft. Use caution when checking the driveshaft near the balance weights to prevent injury to the hands.



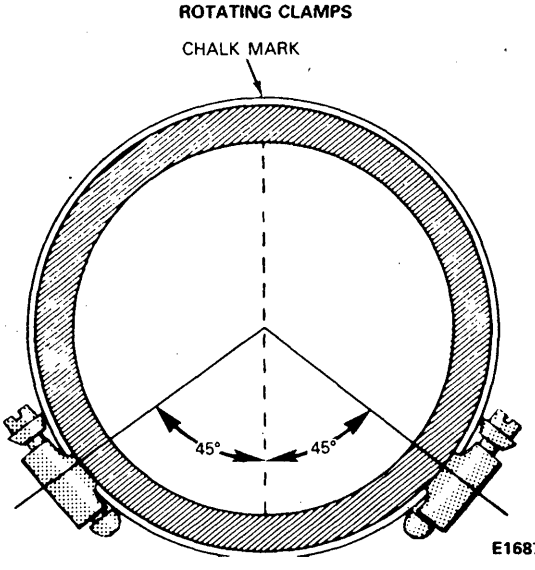
5. Install two screw-type hose clamps on the driveshaft so that their heads are located 180 degrees from the chalk mark, starting at the pinion yoke end of the driveshaft. Tighten the clamps.



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ADJUSTMENTS (Continued)

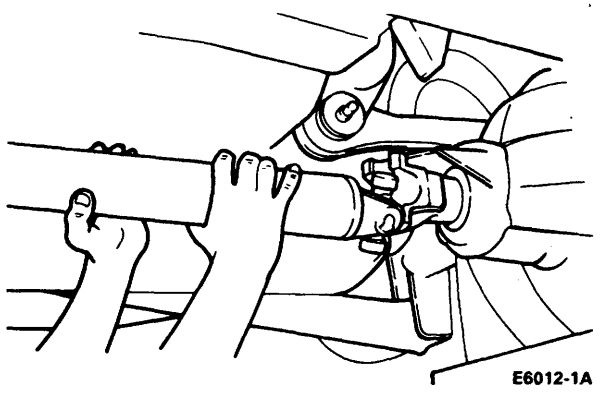
6. Run the vehicle up to the baseline speed. If vibration is still evidenced, rotate the clamps approximately 45 degrees away from each other and test for correction of vibration.
7. If necessary, continue to rotate the clamps apart in smaller increments until the vibration is eliminated or begins to be reduced.
8. If the vibration is not completely eliminated, repeat the foregoing procedure and balance the front end of the driveshaft, checking for elimination or reduction in the vibration level.
9. To prevent overheating, do not run the vehicle on the hoist for an extended period.
10. Remove the vehicle from the hoist and road test.



Alternate In Vehicle Driveshaft Balancing Procedure

ROTUNDA DYNAMIC WHEEL BALANCER (MODEL 006-01400) OR EQUIVALENT EQUIPMENT

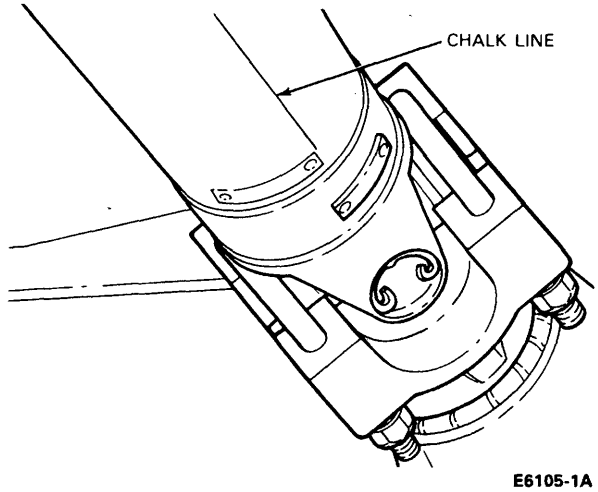
1. Road Test—Evaluate and record road speed at which vibration occurs.
2. Raise vehicle on a frame contact hoist, and re-evaluate by starting the engine, engaging the transmission and accelerating to the indicated speeds at which the vibration was most severe during the road test. Suspending the rear axle makes the driveline more sensitive to vibration.
3. Disconnect the driveshaft from the companion flange. Rotate the driveshaft 180 degrees from its original position and re-install. Repeat evaluation per Step 2 above.



NOTE: In some cases, rotating the driveshaft 180 degrees may decrease the vibration to an acceptable level. However, if the vibration level is increased, install the driveshaft in its original position and proceed to Step 4.

4. A vehicle is more sensitive to excessive imbalance and/or runout at the rearward end of the driveshaft; therefore, locate the heavy side of the driveshaft by the use of the strobe light and transducer, as follows:

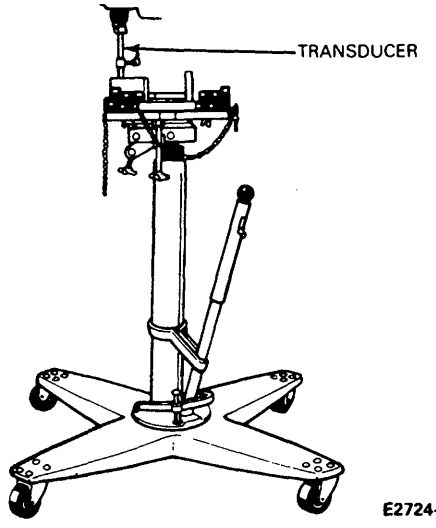
Remove rear wheels and tires; reinstall all the wheel lug nuts in reverse. Flat side of the nuts toward the drum or disc to avoid lug nut imbalance and to prevent the drum or disc from dislodging. Scribe an axial chalk line (at any radial location) approximately 4 inches long at the rear of the driveshaft. Locate the transducer on the bottom side of the carrier, and secure it in place. Run the engine and driveline at the worst vibration speed noted and visually note the position of the chalk line by use of the strobe light. This provides a starting point for the initial location of the clamps.



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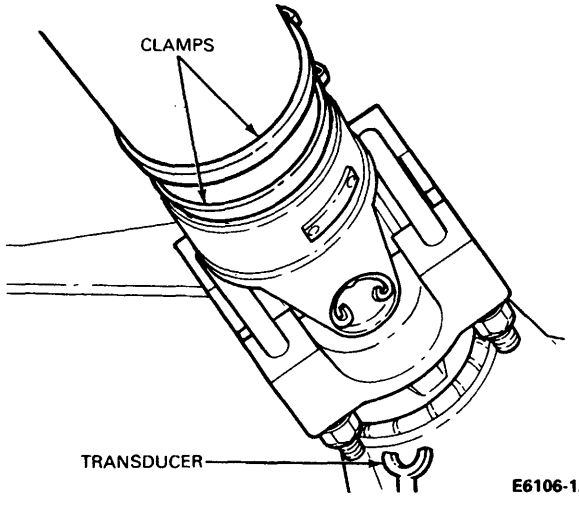
ADJUSTMENTS (Continued)

LOCATING TRANSDUCER



E2724-1B

5. Stop the engine and rotate the driveshaft so that the chalk line is in the same location as it was noted under the strobe light.
6. Install two (stainless steel) hose clamps on the driveshaft. Position the clamp heads 180 degrees from the transducer and tighten the clamps.



E6106-1A

7. Run the engine and driveline through the speed range. If no vibration is felt, remove the lug nuts, install the wheels and tires and reinstall the lug nuts in the correct position and proceed to Step 9. However, if any vibration still exists, the combined weight of the two hose clamp heads may be in excess. To reduce this excess weight, rotate the clamp heads away from each other approximately 15 degrees (one each way from the original position). Run the engine and driveline and note if the vibration has been reduced.

CAUTION: Do not run the engine with the transmission engaged on the hoist for extended periods due to the danger of overheating the engine and/or transmission.

8. Continue to rotate the clamp heads apart in smaller angular increments until the vehicle feel of balance (vibration) is best. At this point, install the wheels and tires per Step 7 above and road test the vehicle to determine the actual degree of improvement. If satisfactory improvement has been obtained, proceed with Step 9. If no improvement has been obtained, the clamps must be removed and diagnosis should be re-directed to other areas, such as wheels, tires, driveline angle, and companion flange runout. For additional information refer to Diagnosis and Testing in this Section.
9. When the vehicle has been corrected to a satisfactory level, as determined by a road test evaluation, tighten the clamps securely. Clean thoroughly with lacquer thinner, and spray the clamps with a commercially available black paint for a finished appearance.

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SPECIFICATIONS

ENGINE ANGLE TO HORIZONTAL — BRONCO

Model	Wheelbase	Engine	Transfer Case	Engine Angle
Bronco	104"	All Engines	Part Time	5-1/2°

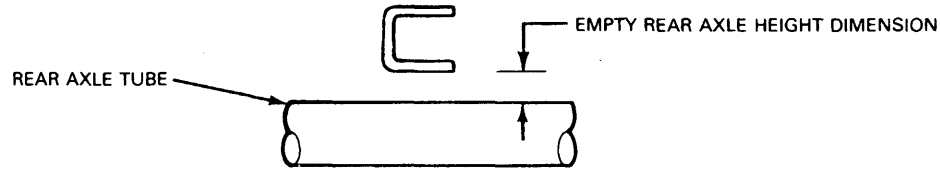
FRONT DRIVESHAFT ANGLE TO HORIZONTAL — BRONCO

Model	Wheelbase	Engine	Transmission	Transfer Case	Curb Load Empty
Bronco	104"	All Engines	All	Part Time	1/4°

REAR DRIVESHAFT ANGLE TO HORIZONTAL — BRONCO

Model	Wheelbase	Engine	Axle	Transmission	Spring Rating at Pad (Lbs)	Transfer Case	Curb Load Empty	Empty Rear Ride Height Axle to Frame ①	
								Inch	mm
Bronco	104	4.9L	3.55	C6	1650	Part Time	11°	6.31	160
	104	5.0L/5.8L	3.50	M4/C6	1650	Part Time	12-1/4°	6.31	160
	104	5.0L	3.55	AOD	1650	Part Time	11-1/4°	6.31	160
	104	5.0L	4.11	AOD	1650	Part Time	12-1/2°	6.31	160

① Measure the emply rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration.



REAR AXLE PINION ANGLE TO HORIZONTAL — BRONCO

Model	Spring Capacity at Pad	Spring Part No. 5560	Curb Load Empty
Bronco	1650#	E3TA-ANA	10-3/4°

FRONT AXLE PINION ANGLE TO HORIZONTAL — BRONCO

Model	Transfer Case	Front Axle Pinion Angle
Bronco	Part Time	2-3/4°

CE3675-2G

COUPLING SHAFT ANGLES TO HORIZONTAL AT CURB LOAD EMPTY — E-150, E-250, E-350

Model	Wheelbase		Engine	Axle Ratio	Transmission	Angle
	mm	Inch				
E-150	3505	138	4.9L	3.50	M3	5-3/4°
					M40D	
					C6	
			4.9L	3.55	AOD	
E-250 U/8500	3505	138	4.9L	3.73	AOD	5-3/4°
			5.0L	3.73		
E-350	4013	158	4.9L	4.10	C6	3-1/2°
			5.8L	3.54/4.10		
			6.9L	3.54/4.10		
			7.5L	3.07/3.54/4.10		
E-350	4470	176	6.9L	3.54/4.10	C6	3-1/2°
			7.5L			

CE5836-2B

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SPECIFICATIONS (Continued)

REAR AXLE PINION ANGLES TO HORIZONTAL — E-150, E-250, E-350

Model	Wheelbase		Spring Capacity at Pad		Spring Part No. (5560)	Curb Load Empty			
	mm	Inch	Lbs.	(Kg)		Ratio	Angle	Ratio	Angle
E-150	3150	124	1250	566	E1TA-ACA	3.55	5°	3.00/3.50	3°
			1450	658	E1TA-ADA	3.55	5°	3.00/3.50	3°
			1685	764	D9TA-AVA	3.55	5°	3.00/3.50	3°
			1750	794	E1TA-AGA	3.55	5-1/4°	3.00/3.50	3°
E-150	3505	138	1250	566	E1TA-AEA	3.55	6-1/2°	3.00/3.50	4-1/4°
			1450	658	E1TA-AFA	3.55	6-1/2°	3.00/3.50	4-1/2°
			1685	764	D9TA-AYA	3.55	7°	3.00/3.50	5°
			1750	794	E1TA-AHA	3.55	6-1/2°	3.00/3.50	4-1/2°
E-250	3505	138	1825	828	D9TA-HA			3.54/3.73	5°
			2100	952	D9TA-JA			3.54/3.73	5°
			2365	1072	E4UA-RA			3.07/3.54/4.10	4°
			2450	1111	D9TA-KA			3.54/3.73	5°
			2700	1224	D9TA-MA			3.07/3.54/4.10	5°
E-350	3505	138	2850	1292	E0TA-BVA			3.07/3.54/4.10	4-1/2
			2950	1338	D9TA-LA			3.07/3.54/4.10	4-3/4°
			3300	1496	E1TA-ALA			3.07/3.54/4.10	5°
E-350	4013	158	3300	1496	E1TA-ALA			3.07/3.54/4.10	5°
E-350	4470	176	3300	1496	E1TA-ALA			3.54/4.10	5°

CE6462-2A

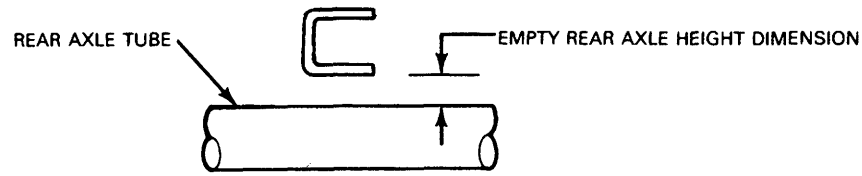
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SPECIFICATIONS (Continued)

DRIVESHAFT ANGLES TO HORIZONTAL AT CURB LOAD EMPTY — E150, E250, E350

Model	Wheelbase		Engine	Rear Axle	Transmission	Spring Rating at Pad (Lbs)	Curb Load Empty Angle	Empty Rear Ride Height (Axle to Frame) ①	
	mm	Inch						Inch	mm
E-150	3150	124	4.9L 5.8L	3.00 3.50	M3 M40D C6	1250	6°	5.08	129
						1450	6-1/2°	5.60	142
						1685	6-1/2°	6.72	171
						1750	7°	5.74	146
E-150	3150	124	4.9L 5.0L	3.55	AOD	1250	4-3/4°	5.08	129
						1450	5-1/4°	5.60	142
						1685	5-1/2°	6.72	171
						1750	5-3/4°	5.74	146
E-150	3505	138	4.9L 5.8L	3.00 3.50	M3 M40D C6	1250	4-1/2°	5.08	129
						1450	4-3/4°	5.60	142
						1685	5-1/4°	6.72	171
						1750	5°	5.74	146
E-150	3505	138	4.9L 5.8L	3.50	M3 M40D C6	1250	4° ②	5.08	129
						1450	4-1/4° ②	5.60	142
						1685	5° ②	6.72	171
						1750	4-3/4° ②	5.74	146
E-150	3505	138	5.0L	3.55	AOD	1250	3-1/2°	5.08	129
						1450	3-3/4°	5.60	142
						1685	4-1/4°	6.72	171
						1750	4°	5.74	146
E-150	3505	138	4.9L	3.55	AOD	1250	2-1/2° ②	5.08	129
						1450	2-3/4° ②	5.60	142
						1685	3-1/2° ②	6.72	171
						1750	3-1/4° ②	5.74	146
E-250	3505	138	4.9L 5.8L	3.54 4.10	AOD C6	1825	6°	7.52	191
						2100	6-1/4°	8.22	209
						2365	5-1/2°	7.20	183
						2450	6°	8.12	206
						2700	6-1/4°		
E-250	3505	138	4.9L 5.0L	3.73	AOD	1825	6° ②	7.52	191
						2100	6-1/2° ②	8.22	209
						2365	5-1/4° ②	7.20	183
						2450	6° ②	8.12	206
						2700	6-1/4° ②		
E-350	3505	138	All	All	C6	2850	6°	9.54	242
						2950	7-1/2°	8.12	206
						3300	6-1/2°	7.50	190
E-350	4013	158	All	All	C6	3300	6-1/4° ②	7.50	190
E-350	4470	176	All	All	C6	3300	4-1/2° ②	7.50	190

① Measure the empty rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration below.
② Two-piece drivelines.



CE6461-2A

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SPECIFICATIONS (Continued)

ENGINE ANGLE TO HORIZONTAL
E-150 — E-250 — E-350

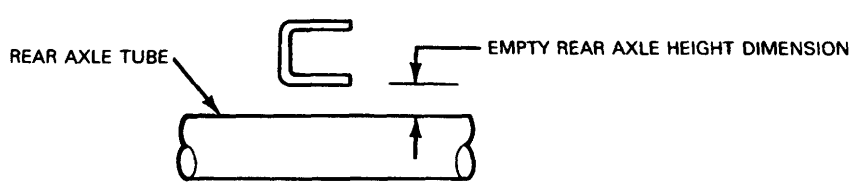
Model	Wheelbase	Engine	Transmission	Angle
All	All	All	All	4°

CE3923-2B

REAR DRIVESHAFT ANGLES TO HORIZONTAL — F-150, F-250, F-350 (4x4) AND BRONCO

Model	Wheelbase		Engine	Rear Axle	Transmission	Spring Rating at Pad (Lbs.)	Curb Load Empty	Empty Rear Ride Height Axle to Frame ①	
	mm	Inch						Inch	mm
F-150 (4x4)	2967	117	4.9L	3.08/3.55	C6/M4/TOD	1654	13°	10.80	274
	2967	117	5.0L	3.50	M4/TOD	1654	14°	10.80	274
	2967	117	5.8L	3.50	C6	1654	14°	10.80	274
	2967	117	5.0L	3.55	AOD	1654	13-1/4°	10.80	274
	2967	117	5.0L	4.11	AOD	1654	14-1/4°	10.80	274
F-150 (4x4)	3378	133	4.9L	3.08/3.55	C6/MA/TOD	1654	9-1/4°	10.80	274
	3378	133	5.0L	3.50	M4/TOD	1654	9-3/4°	10.80	274
	3378	133	5.8L	3.50	C6	1654	9-3/4°	10.80	274
	3378	133	5.0L	3.55	AOD	1654	9-1/4°	10.80	274
	3378	133	5.0L	4.11	AOD	1654	10°	10.80	274
F-250 (4x4) LD	3378	133	All	3.55/4.10	All	1700	9-3/4°	10.62	270
	3378	133	5.0L	4.10	AOD	1700	9-3/4°	10.62	270
F-250 (4x4) HD	3378	133	All	All	All	2590	10°	11.12	282
						2811	10°	10.94	278
F-350 (4x4) SRW	3378	133	All	All	All	2811	12°	10.94	278
F-350 (4x4) DRW	3475	137	All	All	All	3225	11-1/4°		
F-150 (4x4)	3937	155	4.9L	3.08/3.55	C6/M4/TOD	1654	8-1/4°	10.80	274
	3937	155	5.0L/5.8L	3.50	C6/M4/TOD	1654	9-1/4°	10.80	274
	3937	155	5.0L	3.55	AOD	1654	8-1/4°	10.80	274
	3937	155	5.0L	4.11	AOD	1654	9-1/4°	10.80	274
F-250 (4x4) HD	3937	155	All	All	C6	2590	10-1/4°	11.12	282
						2811	10°	10.94	278
	3937	155	All	All	M4T19	2590	10-1/4°	11.12	282
						2811	10°	10.94	278
Bronco	2660	104	4.9L	3.08/3.55	All	1650	11°	6.31	160
	2660	104	5.0L/5.8L	3.50	M4/C6	1650	12-1/4°	6.31	160
	2660	104	5.0L	3.55	AOD	1650	11-1/4°	6.31	160
	2660	104	5.0L	4.11	AOD	1650	12-1/4°	6.31	160

① Measure the empty rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration.



CE5835-2B

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SPECIFICATIONS (Continued)

REAR AXLE PINION ANGLES TO HORIZONTAL — F-150, 250, 350 4x4, BRONCO

Model	Wheelbase		Spring Capacity at Pad		Spring Part No. (5560)	Curb Load Empty			
	mm	Inch	Lbs.	(Kg)		Ratio	Angle	Ratio	Angle
F-150 (4x4)	2967	117	1654	750	E3TA-KA	3.08/3.55	5°	3.50/4.11	5-1/2°
F-150 (4x4)	3378	133	1654	750	E3TA-KA	3.08/3.55	5°	3.50/4.11	5-1/2°
F-150 (4x4)	3937	155	1654	750	E3TA-KA	3.08/3.55	5°	3.50/4.11	5-1/2°
F-250 LD (4x4)	3378	133	1700	771	E4TA-EA	3.55/4.10	7-1/4°		
F-250 HD (4x4)	3378	133	2590	1175	E3TA-AJA	3.55/4.10	6-1/4°		
			2811	1275	E4TA-SA	3.55/4.10	6°		
F-250 HD (4x4)	3937	155	2590	1175	E3TA-AJA	3.55/4.10	6-1/4°		
			2811	1275	E4TA-SA	3.55/4.10	6°		
F-350 (4x4) SRW	3378	133	2811	1275	E4TA-SA	3.55/4.10	6°		
F-350 (4x4) DRW	3475	137	3225	1462	E5TA-YA	4.10	4-1/2°		
BRONCO	2660	104	1650	748	E3TA-ANA	3.08/3.55	10°	3.50/4.11	10-3/4°

CE6460-2A

DRIVESHAFT ANGLE TO HORIZONTAL — F-350 (4x2), F-SUPER DUTY (CURB LOAD EMPTY)

Model	Wheelbase		Driveline	Spring Rating at Pad (Lbs)	Transmission			Empty Rear Ride Height Axle to Frame ①	
	mm	Inch			AOD	C6	M5HD	Inch	mm
F-350	3378	133	One Piece	2811	—	7-3/4°	—	8.54	216
F-350	3378	133	Two Piece	2811	—	9-3/4°	9-1/2°	8.54	216
F-350	3475	137	One Piece	3225	—	7-1/4°	—	8.58	217
F-350	3475	137	Two Piece	3225	—			8.58	217
F-350	4084	161	Two Piece	3225	—	6-1/2°	6-1/2°	8.58	217
F-Super Duty	3475	137	Two Piece	4900	—	—	9°	10.24	260
F-Super Duty	4085	161	Two Piece	4900	—	—	6-3/4°	10.24	260

① Measure the empty rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration.

CE5832-2C

COUPLING SHAFT ANGLE TO HORIZONTAL — F-150, F-250, F-350, F-SUPER DUTY (4x2)

Model	Wheelbase		Transmission		
	mm	Inch	AOD	C6	M5HD
F-150	3378	133	5°	—	—
F-150	3526	139	4-1/2°	4-1/2°	—
F-150	3937	155	4°	3-3/4°	—
F-250	3378	133	5°	5-1/4°	5-1/4°
F-250	3937	155	—	4-1/2°	4-3/4°
F-350	3378	133	—	5°	5-1/4°
F-350	3475	137	—	5-1/4°	5-1/4°
F-350	4084	161	—	4°	4-1/2°
F-Super Duty	3475	137	—	—	7°
F-Super Duty	4084	161	—	—	5-1/2°

CE5830-2C

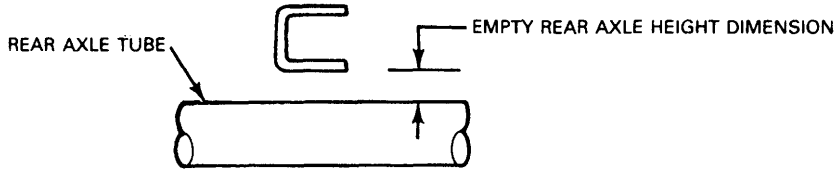
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SPECIFICATIONS (Continued)

DRIVESHAFT ANGLE TO HORIZONTAL — F-150, F-250, F-350 (4x2) (CURB LOAD EMPTY)

Model	Wheelbase		Driveline	Spring Rating at Pad (Lbs)	Transmission							Empty Rear Ride Height Axle to Frame①	
	mm	Inch			AOD	C5	C6	M3	TOD	M4	T19	Inch	mm
F-150	2967	117	One Piece	1235	7-1/4°	7-1/4°	7-1/4°	7-1/4°	7-1/4°	7-1/4°	—	8.87	225
				1375	8°	8°	8-1/4°	8°	8-1/4°	8°	—	8.26	210
F-150	3378	133	One Piece	1235	5-1/2°	5-1/2°	5-1/2°	5-1/2°	5-1/2°	6°	—	8.87	225
				1660	6-1/2°	6-1/2°	6-1/2°	6-1/2°	6-1/2°	7°	—	8.80	223
F-150	3378	133	Two Piece	1235	6°	—	—	6°	6-3/4°	6°	—	8.87	225
				1660	7-3/4°	—	—	7-3/4°	8-3/4°	7-3/4°	—	8.80	223
F-150	3526	139	Two Piece	1660	7-1/2°	—	7-1/2°	—	7-1/2°	—	—	8.80	223
F-150	3937	155	Two Piece	1660	6-1/2°	—	6-1/2°	—	6-1/2°	—	—	8.80	223
F-250 LD	3378	133	One Piece	1700	7°	—	7°	—	—	7°	—	8.58	218
				2450	7-3/4°	—	7-3/4°	—	—	7-3/4°	—	9.44	240
F-250 LD	3378	133	Two Piece	1700		—	8-3/4°	—	—	—	—	8.58	218
				2450		—	10°	—	—	—	—	9.44	240
F-250 HD	3378	133	One Piece	2590	—	—	7-3/4°	—	—	—	—	9.17	233
				2811	—	—	7-3/4°	—	—	—	—	8.54	217
F-250 HD	3378	133	Two Piece	2590	—	—	9-3/4°	—	—	9-3/4°	9-3/4°	9.17	233
				2811	—	—	9-1/2°	—	—	9-1/2°	9-1/2°	8.54	217
F-250 HD	3937	155	Two Piece	2590	—	—	7-1/2°	—	—	7-1/2°	7-1/2°	9.17	233
				2811	—	—	7-1/2°	—	—	7-1/2°	7-1/2°	8.54	217

①Measure the empty rear axle ride height (axle to frame) between the axle tube and the lower flange on the frame as shown in the illustration.



CE5831-2B

FRONT DRIVESHAFT ANGLES TO HORIZONTAL
F-150, F-250 LD, BRONCO (4x4) DANA 44 IFS AND 44 IFSHD AXLE

Model	Wheelbase		Engine	Transmission	Curb Load Empty
	MM	Inch			
F-150 (4x4) Bronco	2660 2967 3378 3937	104 117 133 155	All	All	1/4°
F-250 (4x4) LD	3378	133	All	All	2-3/4°

CE3920-2D

COUPLING SHAFT ANGLE TO HORIZONTAL AT CURB LOAD EMPTY — F-150, F-250 (4x4)

Model	Wheelbase		Engine	Axle Ratio	Trans.	Angle
	mm	Inch				
F-150 (4x4)	3937	155	ALL	ALL	C6, M4, TOD	5°
			ALL	ALL	AOD	5°
F-250 (4x4)	3937	155	5.8L/6.9L/7.5L	ALL	C6, M4	5°
			6.9L/7.5L	ALL	T19	5°

CE6458-2A

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SPECIFICATIONS (Continued)

REAR AXLE PINION ANGLES TO HORIZONTAL — F-150, F-250, F-350, F-SUPER DUTY (4x2)

Model	Wheelbase		Spring Capacity at Pad		Spring Part No. (5560)	Curb Load Empty			
	mm	Inch	Lbs.	(Kg)		Ratio	Angle	Ratio	Angle
F-150	2967	117	1235	560	E6TA-LA	3.08/3.55	5-1/2°	3.50	6°
			1375	623	E6TA-RA	3.08/3.55	6°	3.50	6-3/4"
F-150	3378	133	1235	560	E6TA-LA	3.08/3.55	5-1/2°	3.50	6°
			1375	623	E6TA-RA	3.08/3.55	6°	3.50	6-3/4°
			1666	753	E6TA-NA	3.08/3.55	7-1/4°	3.50	6-1/2°
F-150	3526	139	1660	753	E6TA-NA	3.08/3.55	7-1/4°	3.50	6-1/2°
F-150	3937	155	1660	753	E6TA-NA	3.08/3.55	7-1/4°	3.50	6-1/2°
F-250 LD	3378	133	1700	771	E4TA-EA	ALL	7-1/4°		
			2450	1111	E4TA-HA	ALL	7-1/2°		
F-250 HD SRW	3378	133	2590	1175	E3TA-AJA	ALL	6-1/4°		
			2811	1275	E4TA-SA	ALL	6-1/4°		
F-250 HD SRW	3937	155	2590	1175	E3TA-AJA	ALL	6-1/4°		
			2811	1275	E4TA-SA	ALL	6-1/4°		
F-350 SRW	3378	133	2811	1275	E4TA-SA	ALL	6-1/4°		
F-350 DRW	3475	137	3225	1462	E5TA-YA	ALL	4-1/2°		
	4085	161	3225	1462	E5TA-YA	ALL	4-1/2°		
F-Super Duty	3475	137	4900	2223	E8TA-AA*	ALL	7°		
F-Super Duty	4085	161	4900	2223	E8TA-AA*	ALL	7°		

*Base Part No. 5A975

CE6459-2B

DRIVELINE ANGLES

ENGINE ANGLES TO HORIZONTAL

Engine F-150 — F-250 — F-350 (4x2) (4x4), and Bronco Couplingshaft, Driveshaft & Rear Axle Pinion Angles

Model	Wheelbase	Engine	Transmission	Angles
F-150 — F-250 — F-350 F-Super Duty (4x2) (4x4), Bronco	All	All Engines	All	5-1/2°

CE3913-2D

FRONT AXLE PINION ANGLES TO HORIZONTAL

F-150 — F-250 — F-350, BRONCO (4x4)

Model	Axle	Wheelbase		Curb Load Empty
		mm	Inch	
F-150 (4x4), Bronco	Dana 44 IFS	2260 2967 3378 3937	104 117 133 155	2-3/4°
F-250 (4x4) L D	Dana 44 IFSHD	3378 3937	133 155	6-3/4°
F-250-H D (4x4)	Dana 50 IFS	3378	133	6-3/4°
F-350 (4x4)	Dana 60 Mono Beam	3378 3475	133 137	4-1/2°

CE3918-2E

FRONT DRIVESHAFT ANGLES TO HORIZONTAL DANA 50 IFS FRONT DRIVE AXLE — F-250 H D (4x4)

Model	Wheelbase		Engine	Transmission	Curb Load Empty
	mm	Inch			
F-250 H D (4x4)	3378 3937	133 155	All	All	2-1/2°

CE3919-2F

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SPECIFICATIONS (Continued)

DRIVESHAFT — TORQUE LIMITS

Description	Bolt Size	Torque Limits	
		(Ft-Lb)	N-m
Bolt Yoke to Coupling Shaft	5/8-18 3/4-16 7/8-14 1-2	148-165① 175-240 250-300 160	201-222① 238-325 339-406 216
Nut — U-Joints — U-Bolt	5/16-18 3/8-18 7/16-20	8-15 17-26 30-40	11-20 24-35 41-54
Coupling Shaft Center Bearing Bracket-to-Support	7/16-20	37-54	51-73
Bolt — Drive Shaft U-Joint to Rear Yoke	1/2-20	90-110	123-149
Bolt and Nut — U-Joint Adapter to Rear Axle	1/2-20	60-70	82-94
Circular Flange Bolts	—	70-95	95-129
Driveshaft-to-Transfer Case Bolts	5/16-24	20-28	28-33
Driveshaft-to-Front and Rear Axle U-Bolt Nuts	5/16-18	8-15	11-20
Bolt — Strap②	5/16-24	25-30	34-41

NOTES:
①Dana Axle
②F-250 H.D. and F-350 with M5HD Transmission and F-Super Duty.

CE7160-2B

SPECIAL SERVICE TOOLS

Tool Number	Description
T74P-4635-C	U-Joint Tool
T63P-9171-A	Clamp Pliers
T68P-4602-A	Pinion Angle Level Gauge
T00L-4201-C	Dial Indicator
T00L-6565-AB	Cup Shaped Adapter

CE4887-1D

ROTUNDA EQUIPMENT

Number	Description
006-01400	Strobe Balancer

CE7161-1A

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SECTION 15-61 Driveshaft—Single Type U-Joint

SUBJECT	PAGE
ADJUSTMENTS	15-61-1
DESCRIPTION	15-61-1
DIAGNOSIS AND TESTING	15-61-1
DISASSEMBLY AND ASSEMBLY	
Snap Ring Type U-Joint	15-61-4
REMOVAL AND INSTALLATION	
Driveshaft/Coupling Shaft (All Except One Piece Driveshaft Models)	15-61-2
REMOVAL AND INSTALLATION (Cont'd)	
Driveshaft (One Piece Models)	15-61-2
SPECIFICATIONS	15-61-5
VEHICLE APPLICATION	15-61-1

VEHICLE APPLICATION

Applies to E-150—E-250—E-350, F-150—F-250—F-350, F-Super Duty and Bronco Trucks.

DESCRIPTION

The driveshaft or coupling shaft is composed of the universal joints (U-joints), connecting shafts, attaching flanges, and slip yokes. The number of shafts and U-joints used depends on the vehicle application.

Some vehicles use a one piece slip-yoke type driveshaft (Figs. 1 and 2). A universal joint and splined slip yoke are located at the transmission end of the shaft, where they are held in alignment by a bushing in the transmission rear extension. The splined slip yoke and transmission output shaft permits fore and aft movement of the driveshaft as the rear axle moves up and down. This provides smooth performance during vehicle operation. An oil seal at the transmission prevents leakage and protects the slip yoke from dust, dirt and other harmful material. A second universal joint attached by two U-bolts is used where the driveshaft mates with the companion flange at the rear.

Others use a coupling shaft in conjunction with a driveshaft (Fig. 3). Care must be taken to align the shafts as shown in the Figures. The two-piece driveline system incorporates a "necked down" coupling shaft stub with a "blindspline" feature which assures positive phasing action (Fig. 3).

All two piece driveshaft vehicles are equipped with center support bearings that are prelubricated and seated for the bearing life.

All U-joints are of the lubed for life needle-bearing type. U-joints equipped with grease fittings should be lubricated at the specified intervals. The U-joint bearings are retained on the U-joint spiders by snap rings and U-bolts on some applications.

Driveshafts and coupling shafts are balanced; therefore, if the vehicle is being undercoated, the shafts and all open spline areas must be covered to prevent undercoating material from getting on the shafts.

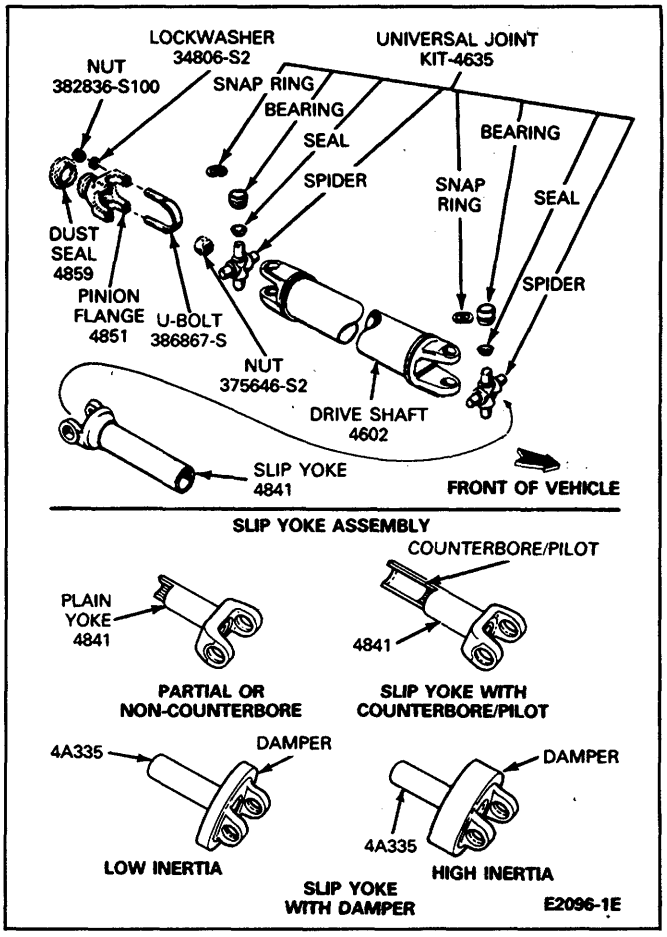


FIG. 1 One Piece Driveshaft Slip-Yoke Design—All Except E-150

DIAGNOSIS AND TESTING

Refer to Section 15-60, General Driveshaft Service and Section 18-01 Noise, Vibration and Harshness—Diagnosis.

ADJUSTMENTS

Refer to Section 15-60, General Driveshaft Service for Adjustment Procedures.

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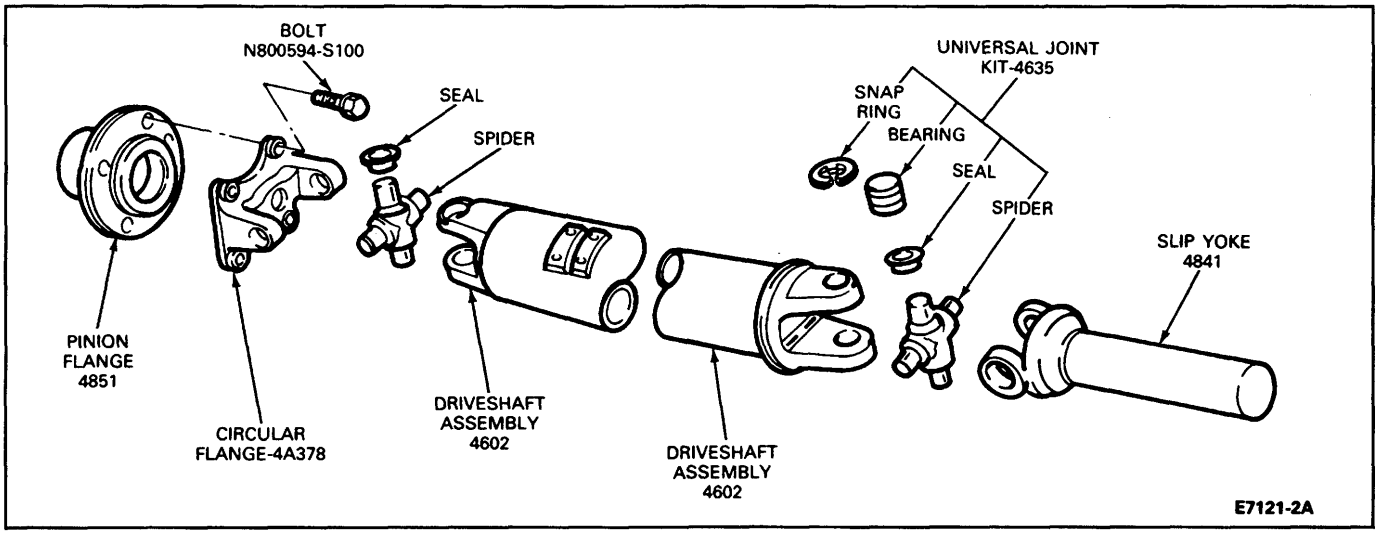


FIG. 2 One Piece Driveshaft Slip-Yoke Design—E-150

REMOVAL AND INSTALLATION

Driveshaft/Coupling Shaft (All Except One Piece Driveshaft Models)

Refer to Fig. 3

To maintain driveline balance, mark the relationship of the rear driveshaft yoke and the rear axle pinion flange before disassembly.

Removal

1. Disconnect the driveshaft from the rear axle flange and disconnect the driveshaft slip yoke from the coupling shaft yoke. Wrap tape around the loose bearing caps to prevent the bearings from falling off the universal joint spiders.
2. Remove the two center bearing support bracket (coupling shaft) to the frame crossmember attaching bolts. Remove the coupling shaft assembly from the transmission extension. Install the appropriate tool in the transmission housing to prevent leakage.
3. Clean the male splines of the coupling shaft and driveshaft with a wire brush and a suitable solvent. Remove all hardened grease deposits, dirt or rust. Do not remove the blue plastic coating from male splines. Inspect for worn or galled splines. Remove any nicks, gouges or burrs using a file or emery cloth. If the driveshaft is worn, warped, or cracked, replace the driveshaft and slip yoke assembly.
4. Using a suitable cleaning fluid, clean all dirt from the slip yoke internal splines and the slip yoke assembly. Carefully inspect the slip yoke splines for wear or evidence of twisting. Check the clearance between the slip yoke splines and the driveshaft splines.
5. Wash all parts except the sealed center bearing and rubber insulator in suitable cleaning fluid. Do not immerse the sealed bearing in the cleaning fluid. Wipe the bearing and rubber insulator clean with a cloth dampened with cleaning fluid.

   NOTE: Inspect the slip yoke seal, replace if necessary.
6. Check the center support bearing for wear or rough action by rotating the inner race while holding the outer race. If any wear or roughness is evident, replace the bearing.
7. Examine the rubber insulator for evidence of hardening, cracking, or deterioration. Replace if damaged in any way.

Installation:

1. Lubricate the coupling shaft front slip yoke splines with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent. Remove the tool preventing leakage from the transmission housing. Install the front yoke of the coupling shaft assembly on the transmission output shaft. Do not allow the slip yoke assembly to bottom on the output shaft with excessive force.
2. Secure the center bearing support bracket to the frame crossmember with the center support attaching bolts. Tighten the bolts to specifications.
3. Apply a coating of Multi-Purpose Long-Life Lubricant C1AZ-19590-B (ESA-M1C75-B) or equivalent to the entire splined stub shaft end of the coupling shaft assembly prior to the assembling of the driveshaft and the slip yoke.
4. Using a clean long handle (stencil type) brush apply—Multi-Purpose Long-Life Lubricant C1AZ-19590-B (ESA-M1C75-B) or equivalent, spread evenly on all the female splines of the slip yoke.
5. Assemble the driveshaft slip yoke to the coupling shaft.
6. Connect the rear U-joint of the driveshaft to the rear axle pinion flange and tighten the U-bolt nuts to specification.
7. Using a hand type grease gun, lubricate the driveshaft slip yoke through the zerk fitting with Multi-Purpose Long-Life Lubricant or equivalent.

NOTE: To assure complete lubrication of the slip yoke splines, temporarily plug the vent hole in the "welch" type plug located at the yoke-end of the slip yoke while applying grease through the zerk fitting.

Driveshaft (One Piece Models)

Refer to Figs. 1 and 2.

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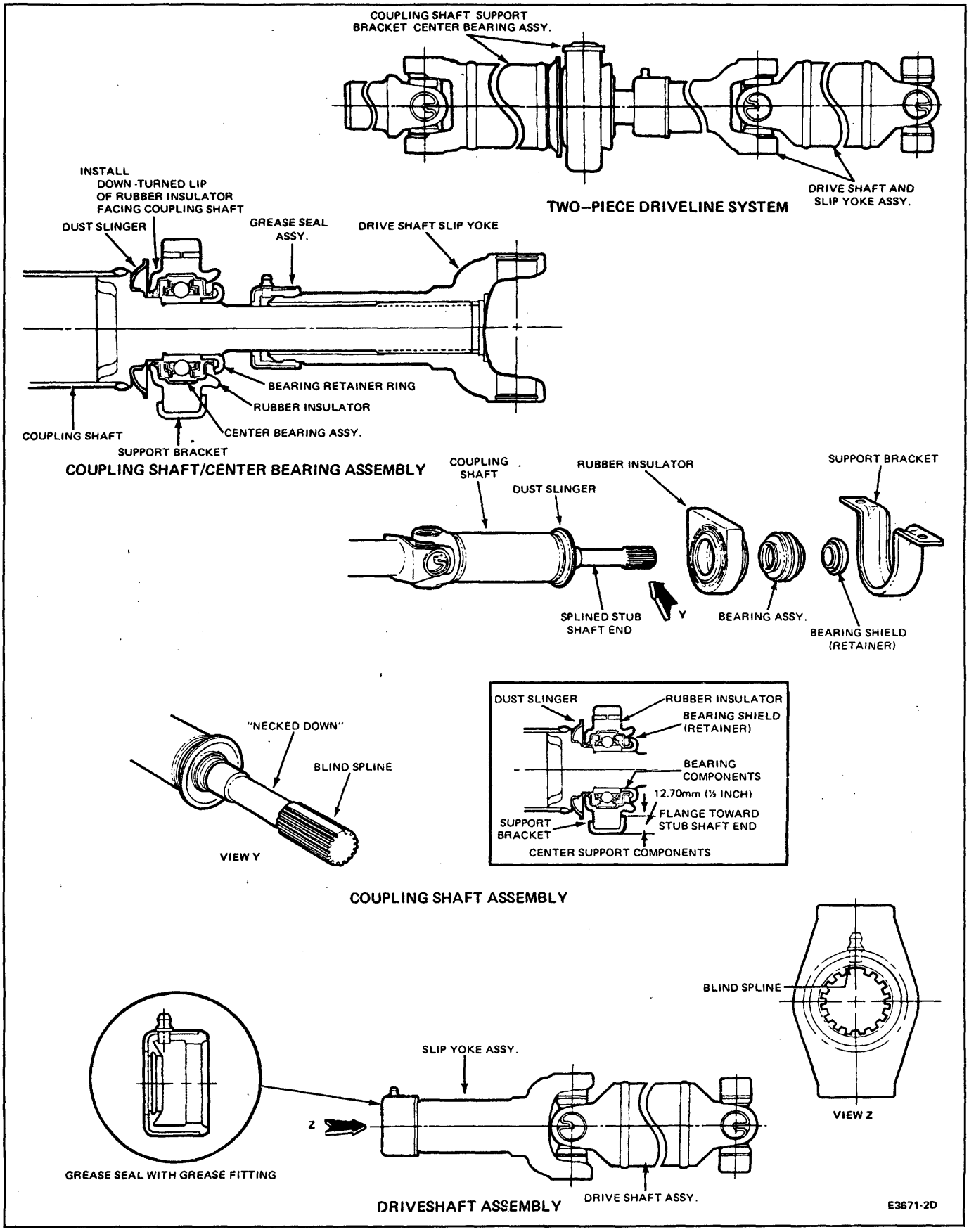


FIG. 3 Two Piece Driveshaft with U-Bolt or Slip Yoke Attachment to the Transmission

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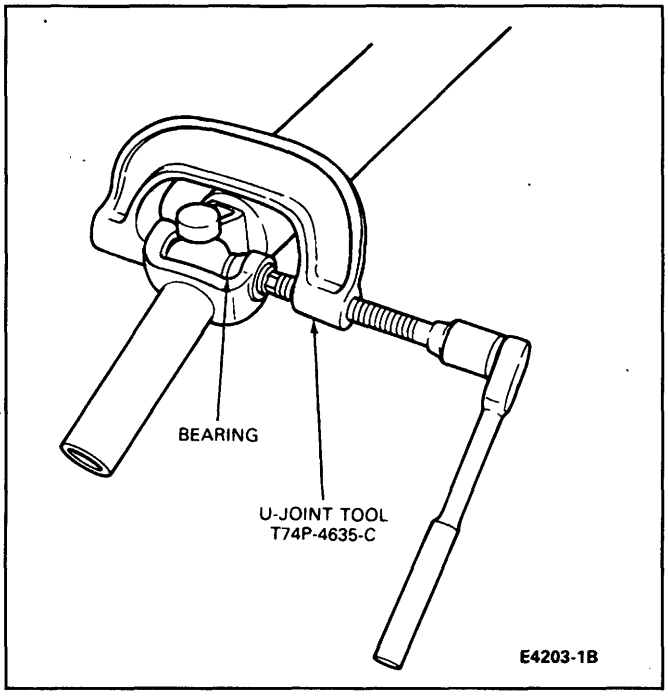


FIG. 4 Removing U-Joint Bearing—Typical

Removal

1. To maintain driveline balance, if the yellow alignment marks are not visible, mark the relationship of the rear drive shaft yoke and the drive pinion flange of the axle in line with the drive shaft so that they may be re-installed in their original positions.
2. On all except E-150, remove the nuts retaining the U-bolts to the companion flange. On E-150, remove the bolts retaining the circular flange to the pinion flange. Disconnect the rear U-joint from the companion flange. Wrap tape around the loose bearing caps to prevent them from falling off the spider. Pull the driveshaft toward the rear of the vehicle until the slip yoke clears the transmission extension housing and the seal. Install the appropriate tool in the housing to prevent lubricant leakage.

Installation

1. If the lugs on the axle pinion flange are shaved or distorted so that the bearings slide, replace the flange.
2. Lubricate the yoke spline with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent. Remove the tool from the extension housing. Install the yoke on the transmission output shaft. Do not allow the yoke assembly to bottom on the output shaft with excessive force.

   Install the driveshaft so that the index marks or the yellow mark (if visible) on the yoke (light side) is in line with the yellow mark on the companion flange. This prevents vibration which occurs when the balance of the shaft and balance of the axle pinion flange become additive instead of neutralizing. If a vibration exists, the driveshaft should be disconnected from the axle, rotated 180 degrees and re-installed.
3. On all except E-150, install the U-bolts and nuts that attach the U-joints to the drive pinion flange.

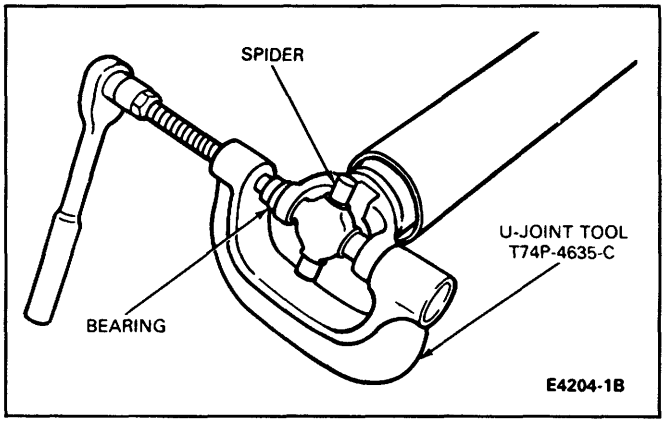


FIG. 5 Installing U-Joint Bearing—Typical

Tighten the U-bolt nuts to 11-20 N·m (8-15 ft-lbs). On E-150, install the bolts retaining the circular flange to the pinion flange. Tighten to 83-117 N·m (61-87 ft-lbs).

DISASSEMBLY AND ASSEMBLY

Snap Ring Type U-Joint

Disassembly

1. Place the driveshaft on a suitable workbench, being careful not to damage the tube.

   CAUTION: Under no circumstances is the driveshaft assembly to be clamped in the jaws of a vise or similar holding fixture. Denting or localized fracture of the tube may result, which could cause driveshaft failure during vehicle operation.
2. Remove the snap rings that retain the bearings in the yoke and in the driveshaft or coupling shaft.
3. Position the U-joint Tool, T74P-4635-C, shown in Fig. 4 on the shaft and press the bearing out of the yoke. If the bearing cannot be pressed all the way out of the flange, remove it with vise grip or channel lock pliers. Mark the yoke and the shaft to be sure that they will be reassembled in the same relative position.
4. Re-position the tool to press on the spider in order to remove the bearing from the opposite side of the flange.
5. Remove the flange from the spider.
6. Remove the bearings and spider from the drive shaft or coupling shaft in the same manner.

Assembly

1. Start a new bearing into the yoke at the rear of the driveshaft.
2. Position the spider in the rear yoke and press the bearing 6.35mm (1/4 inch) below the surface (Fig. 5).
3. Remove the tool and install a new snap ring.
4. Start a new bearing into the opposite side of the yoke.
5. Install the U-Joint Tool T74P-4635-C or equivalent, and press on the bearing until the opposite bearing contacts the snap ring.
6. Remove the tool and install a new snap ring.

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7. Re-position the driveshaft or coupling shaft and install the new spider and two new bearings in the front yoke in the same manner as the rear yoke.
8. Position the flange on the spider and install two new bearings and snap rings.
9. Check the joint for freedom of movement. If a bind has resulted from misalignment during the foregoing procedures, tap the ears of the driveshaft sharply to relieve the bind. Do not install the drive shaft if the U-joints show any signs of binding.

NOTE: The effort required for U-joint movement should not exceed 35 in-lbs when measured with a spring scale.

SPECIFICATIONS

DRIVESHAFT — TORQUE LIMITS

Description	Bolt Size	Torque Limits (Ft-Lb)	Torque Limits N-m
Bolt Yoke to Coupling Shaft	5/8-18 3/4-16 7/8-14 1-20	148-164① 175-240 250-300 160	201-222① 238-325 339-406 216
Nut-U-Joints — U-Bolt	5/16-18 3/-18 7/16-20	8-15 17-26 30-40	11-20 24-35 41-54
Coupling Shaft Center Bearing Bracket-to-Support	7/16-20	37-54	51-73
Bolt — Drive Shaft U-Joint to Rear Yoke	1/2-20	90-110	123-149
Bolt and Nut — U-Joint Adapter to Rear Axle	1/2-20	60-70	82-94
Bolt — Circular Flange to Pinion Flange (E-150 only)	—	70-95	95-130

①Dana

CE1989-2J

SPECIAL SERVICE TOOLS

Tool Number	Description
T74P-4635-C	U-Joint Bearing Remover and Installer

CE3681-1C

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SECTION 15-66 Driveshaft—Double Cardan-Type U-Joint

SUBJECT	PAGE
ADJUSTMENTS	15-66-1
DESCRIPTION	15-66-1
DIAGNOSIS AND TESTING	15-66-1
DISASSEMBLY AND ASSEMBLY	
Driveshaft U-Joints	15-66-1
REMOVAL AND INSTALLATION	
Driveshaft	15-66-1
SPECIFICATIONS	15-66-3
VEHICLE APPLICATION	15-66-1

VEHICLE APPLICATION

Applies To Bronco Rear Driveshaft and F-350 (4x4) Front Driveshafts.

DESCRIPTION

The Bronco rear driveshaft assembly is of the double Cardan type which incorporates two U-joints, a centering socket yoke, and a center yoke at the transfer case end of each shaft (Fig. 1). A single U-joint is used at the axle end of the shafts. All U-joints are "lube for life," and do not require scheduled maintenance lube for life.

All driveshafts are balanced. Therefore, if the vehicle is to be undercoated, cover the driveshaft to prevent undercoating material from getting on the shaft.

DIAGNOSIS AND TESTING

Refer to Section 15-60, General Driveshaft Service and Section 18-01, Noise, Vibration and Harshness for driveshaft diagnostic and testing procedures.

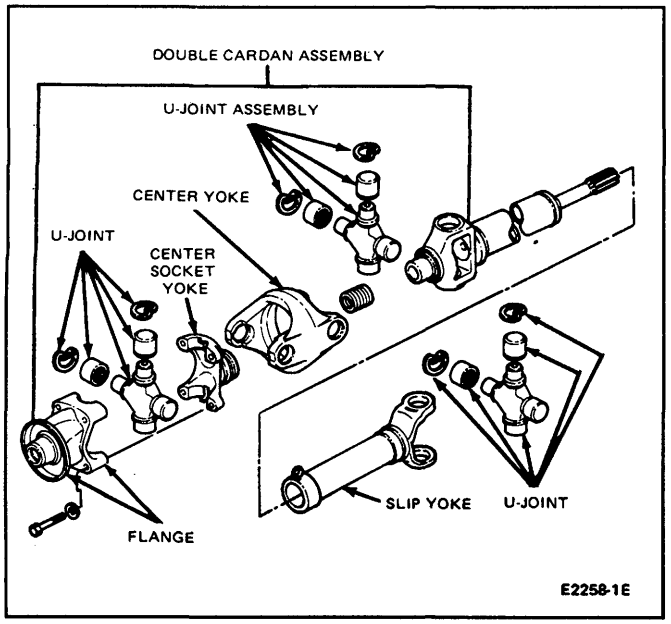


FIG. 1 Driveshaft Disassembled

ADJUSTMENTS

•For Adjustment procedures, refer to Section 15-60, General Driveshaft Service.

REMOVAL AND INSTALLATION

Driveshaft

Removal

1. To remove the rear driveshaft on Bronco, disconnect the double Cardan U-joint from the flange at the transfer case and the single U-joint from the flange at the rear axle. Remove the driveshaft.
2. To remove the front driveshaft on F-350, disconnect the double Cardan joint from the flange at the transfer case and the single U-joint from the flange at the front axle. Remove the driveshaft.

Installation

1. To install the front driveshaft on F-350, position the single U-joint end of the driveshaft to the front axle and install the U-bolts and nuts.
2. Position the U-joint to the transfer case and install the four bolts and lockwashers.
3. Tighten the bolts at the transfer case to 28-33 N·m (20-28 ft-lbs), and the nuts at the front axle to 11-20 N·m (8-15 ft-lbs).
4. To install the rear driveshaft on Bronco, position the single U-joint end of the driveshaft to the rear axle and install the U-bolts and nuts.
5. Position the double Cardan joint to the transfer case and install the four bolts and lockwashers.
6. Tighten the bolts at the transfer case to 28-33 N·m (20-28 ft-lbs) and the nuts at the rear axle to 11-20 N·m (8-15 ft-lbs).

DISASSEMBLY AND ASSEMBLY

Driveshaft U-Joints

Disassembly of Double Cardan U-Joint

1. Place the driveshaft on a suitable workbench being careful not to damage the tube.
2. Mark the positions of the spiders, the center yoke, and the centering socket yoke as related to the stud yoke which is welded to the front of the driveshaft tube. **The spiders must be assembled**

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with the bosses in their original position to provide proper clearance.

3. Remove the snap rings that secure the bearings in the front of the center yoke.
4. Position the U-Joint Tool, T74P-4635-C or equivalent as shown in Fig. 2. Thread the tool clockwise until the bearing protrudes approximately 9.525mm (3/8 inch) out of the yoke.
5. Clamp the bearing in a vise and tap on the center yoke as shown in Fig. 3 to free it from the bearing.
6. Lift the two bearing cups from the spider (Fig. 4).

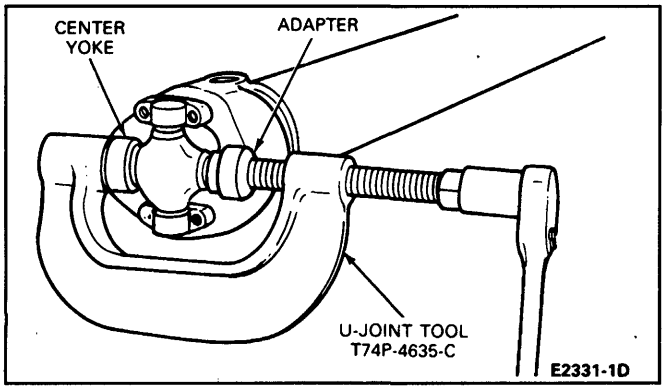


FIG. 2 Partially Pressing Bearing from Center Yoke

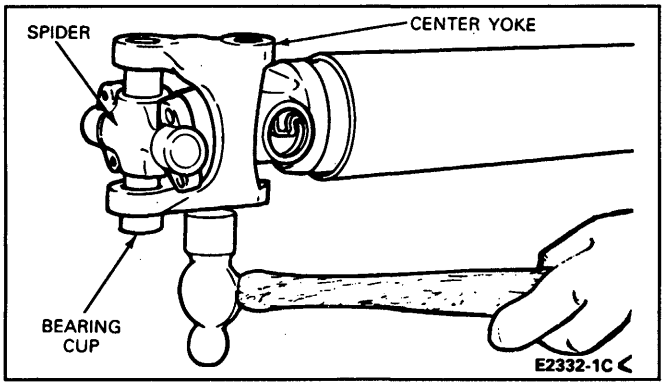


FIG. 3 Removing Bearing from Center Yoke

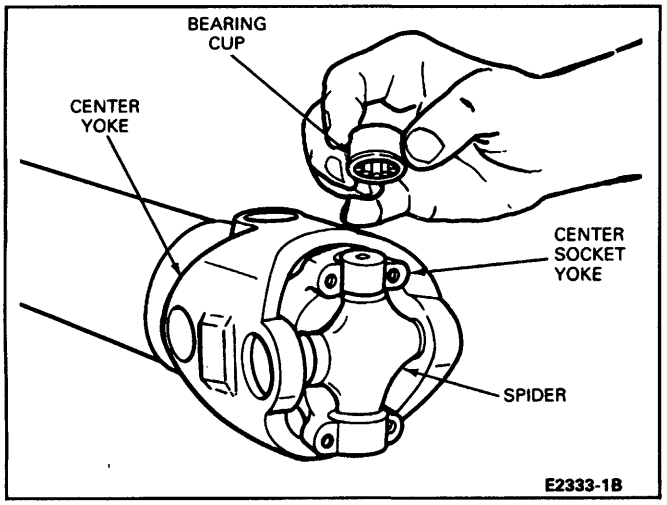


FIG. 4 Removing Bearing Cup from Centering Yoke Socket

7. Re-position the tool on the yoke and move the remaining bearing in the opposite direction so that it protrudes approximately, 9.525mm (3/8 inch) out of the yoke.
8. Clamp the bearing in a vise. Tap on the center yoke to free it from the bearing (Fig. 3).
9. Remove the spider from the center yoke.
10. Pull the centering socket yoke off the center stud (Fig. 5). Remove the rubber seal from the centering ball stud.
11. Remove the snap rings from the center yoke and from the driveshaft yoke.
12. Position the U-Joint Tool T74P-4635-C or equivalent, on the driveshaft yoke (Fig. 6) and press the bearing outward until the inside of the center yoke almost contacts the slinger ring at the front of the driveshaft yoke. Pressing beyond this point can distort the slinger ring. The arrow in Fig. 7 illustrates the interference point.
13. Clamp the exposed end of the bearing in a vise and drive on the center yoke with a soft-faced hammer to free it from the bearing.
14. Re-position the tool and press on the spider to remove the opposite bearing.
15. Remove the center yoke from the spider.

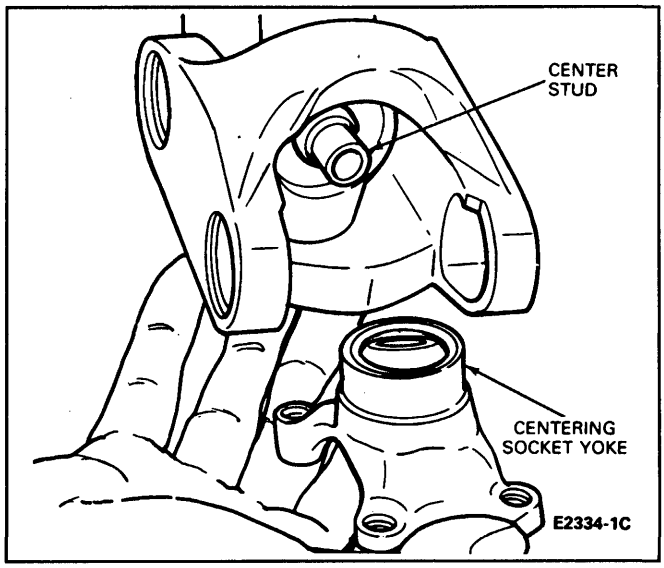


FIG. 5 Removing Center Socket Yoke

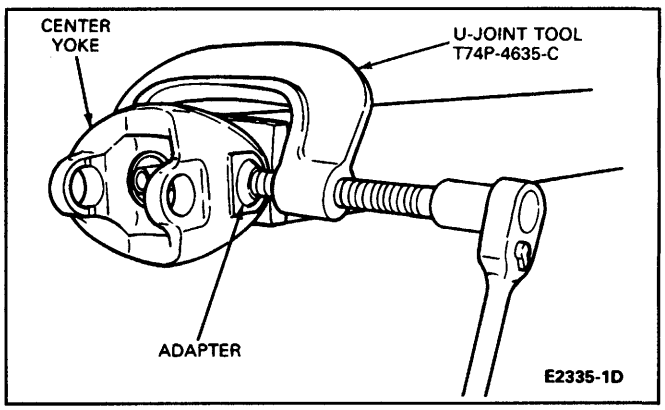


FIG. 6 Removing Bearing from Rear of Center Yoke

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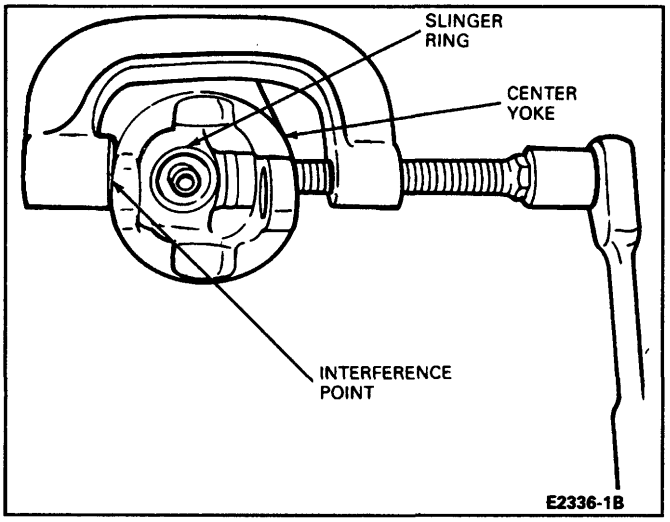


FIG. 7 Center Yoke Interference Point

16. Remove the spider from the driveshaft yoke in the same manner.
17. Clean all serviceable parts in cleaning solvent. If using a repair kit, install all of the parts supplied in the kit. If the driveshaft is damaged, replace the complete shaft to be assured of a balanced assembly.

Assembly

1. To assemble the double Cardan joints, position the spider in the driveshaft yoke. Make sure the spider bosses (or lubrication plugs on kits) will be in the same position as originally installed. Press in the bearing using U-Joint Tool, T74P-4635-C or equivalent. Install the snap rings.
2. Pack the socket relief and the ball with the Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent, then position the center yoke over the spider ends and press in the bearing. Install the snap rings.
3. Install a new seal on the centering ball stud. Position the centering socket yoke on the stud.
4. Place the front spider in the center yoke. Make sure the spider bosses are properly positioned.
5. With the spider loosely positioned on center stop, proceed to seat the first pair of bearings into the centering socket yoke, then press the second pair into the centering yoke. Install the snap rings.
6. Apply pressure on the centering socket yoke and install the remaining bearing cup.

SPECIFICATIONS

TORQUE LIMITS

Nomenclature	Bolt Size and (ft-lbs)
Drive Shaft-to-Transfer Case Bolts	5/16-24 20-28 (28-33 N•m)
Drive Shaft-to-Front and Rear Axle U-Bolt Nuts	5/16-18 8-15 (11-20 N•m)

CE2241-1E

SPECIAL SERVICE TOOLS

Tool No.	Description
T74P-4635-C	U-Joint Bearing Removal-Installation Tool

CE3682-1C

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SECTION 15-67 Front Driveshaft

SUBJECT	PAGE
ADJUSTMENTS	15-67-1
DESCRIPTION	15-67-1
DIAGNOSIS AND TESTING	15-67-1
DISASSEMBLY AND ASSEMBLY	
Front Driveshaft	15-67-2
REMOVAL AND INSTALLATION	
Front Driveshaft	15-67-1
SPECIFICATIONS	15-67-4
VEHICLE APPLICATION	15-67-1

VEHICLE APPLICATION

Applies to F-150, F-250 and F-350 (4x4) and Bronco Trucks.

DESCRIPTION

The front driveshaft connects the power flow from the transfer case to the front drive axle. It incorporates two single cardan universal joint (U-joint) assemblies, (one double cardan on F-350), a driveshaft with a splined stub shaft end, and a boot with two clamps (one large and one small) (Figs. 1 and 2). The F-150, F-250, and Bronco driveshafts must have a length of 35.10 inches (892mm) for C6 and M5HD(ZF) transmissions, 36.10 inches (917mm) for AOD transmissions, and 38.50 inches (978mm) for M5OD(R2) transmissions, from the centerline of the U-joint in the front yoke to the centerline of the U-joint in the rear yoke when in its free state. For F-350 models, the driveshaft must have a length of 819mm (32.25 inches) for C6 transmissions, 832mm (32.75 inches) for M5HD(ZF) transmissions on 7.5L/7.3L, and 905.8mm (35.66 inches) for M5HD(2F) transmissions on 5.8L, from the centerline of the front U-joint to centerline of rear U-joint when in its fully compressed (shortest) state.

NOTE: Whenever the vehicle is raised on a hoist, inspect the rubber boot for rips or tears. Replace if required.

All front driveshaft assemblies are balanced. If the vehicle is to be undercoated, cover the driveshaft and U-joints to prevent application of any undercoating material.

DIAGNOSIS AND TESTING

Refer to Section 15-60, General Driveshaft Service and Section 18-01, Noise, Vibration and Harshness Diagnosis for diagnostic and testing procedures.

ADJUSTMENTS

For Adjustment procedures, refer to Section 15-60, General Driveshaft Service.

REMOVAL AND INSTALLATION

Front Driveshaft

Removal

1. To maintain driveshaft balance, mark the rear slip yoke in relation to the transfer case yoke for correct positioning during installation.
2. Remove the nuts and U-bolts, (bolts for F-350 at transfer case) that connect the rear slip yoke to the transfer case and the front yoke to the front drive axle.
3. Remove the driveshaft from the vehicle. Wrap tape around the lose bearing caps to prevent the bearings from falling out of the U-joint spiders.

Installation

NOTE: If the slip yoke and rubber boot have been separated from the splined stub shaft on the driveshaft refer to Front Driveshaft-Disassembly and Assembly in this Section.

1. Install the driveshaft so the marks on the rear slip yoke and transfer case yoke are in alignment.

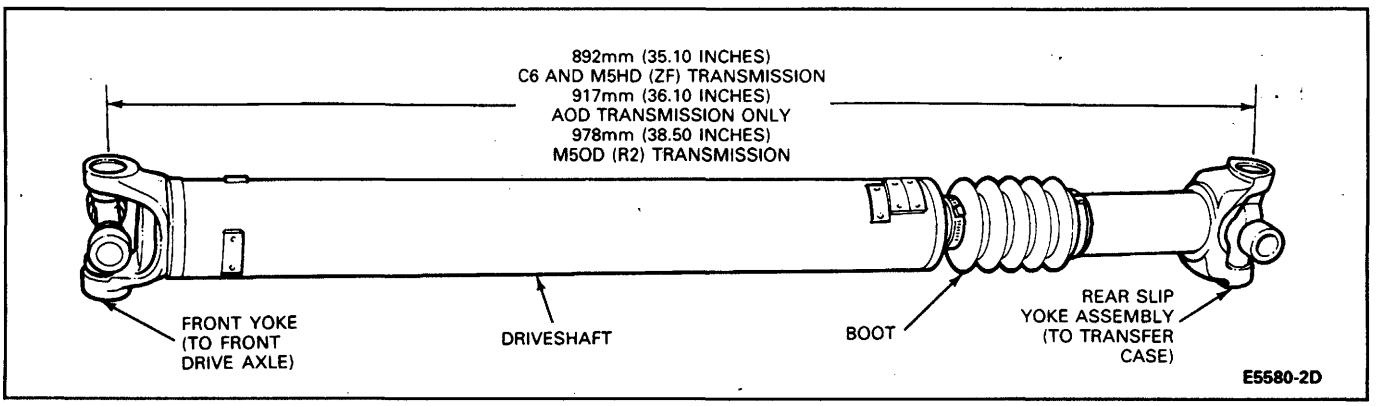


FIG. 1 Front Driveshaft—F-150—F-250 (4x4) and Bronco (4x4)

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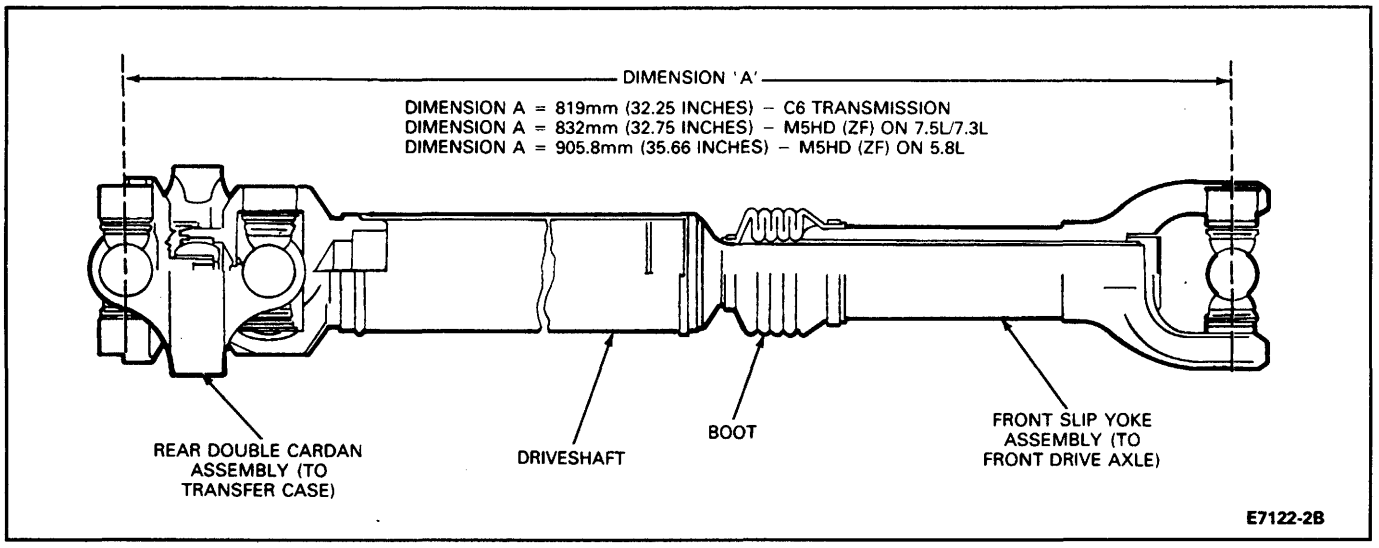


FIG. 2 Front Driveshaft—F-350 (4x4)

2. Install the nuts and U-bolts that retain the rear slip yoke to the transfer case yoke. Tighten nuts to 11-20 N·m (8-15 ft-lbs). On F-350 tighten bolts to 28-33 N·m (20-28 ft-lbs).
3. Install the nuts and U-bolts that retain the front driveshaft yoke to the front drive axle yoke. Tighten nuts to 11-20 N·m (8-15 ft-lbs).

DISASSEMBLY AND ASSEMBLY

Front Driveshaft

Refer to Fig. 3

Disassembly

1. With the front driveshaft assembly on a bench, cut the boot clamps with sidecutters (Fig. 4). Remove and discard the clamps.
2. Separate the rear slip yoke from the splined stub shaft on the driveshaft.
3. Remove the rubber boot. Inspect the boot for rips or tears and replace if required.

   If during inspection, the driveshaft boot is found to be cracked or split, the grease should be checked for contamination (Fig. 5). If driveshaft was operating satisfactorily and the grease does not appear to be contaminated, add grease as described in the assembly portion of this procedure and replace the boot. If the grease appears contaminated, disassemble the driveshaft and inspect the stub shaft and slip yoke for wear.
4. If required, remove and install the U-joints as described under Snap Ring Type U-Joint in the Disassembly and Assembly portion of Section 15-61, Driveshaft-Single Type U-Joint (Section 15-66 for F-350 with double cardan type U-joint).

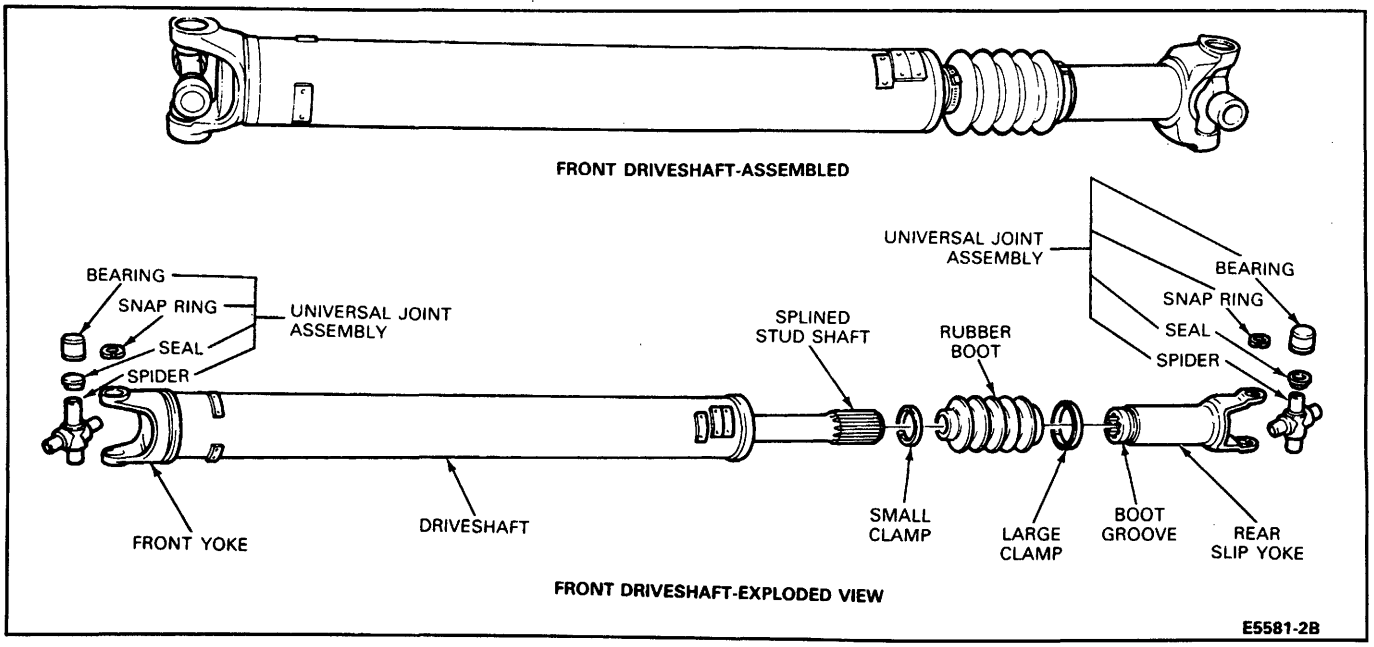


FIG. 3 Front Driveshaft—Exploded View

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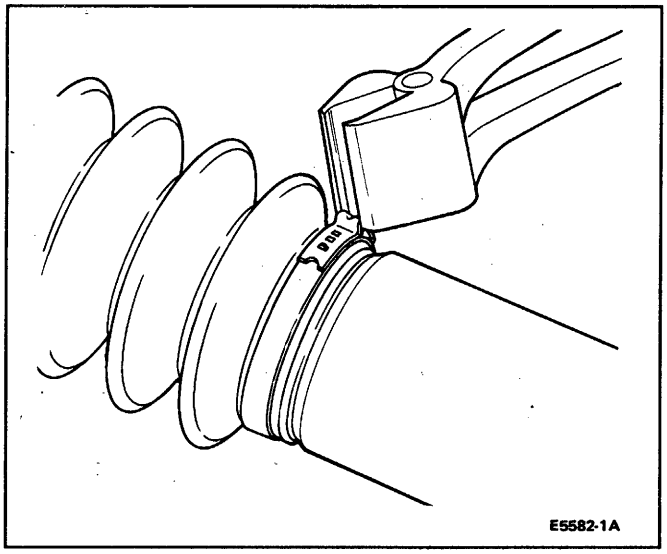


FIG. 4 Clamp Removal

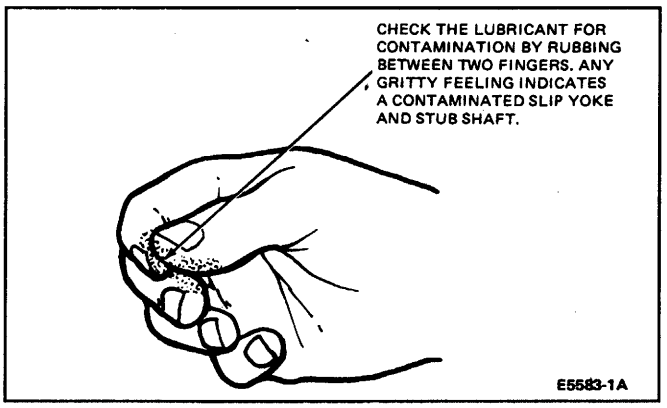


FIG. 5 Inspecting Grease for Contamination

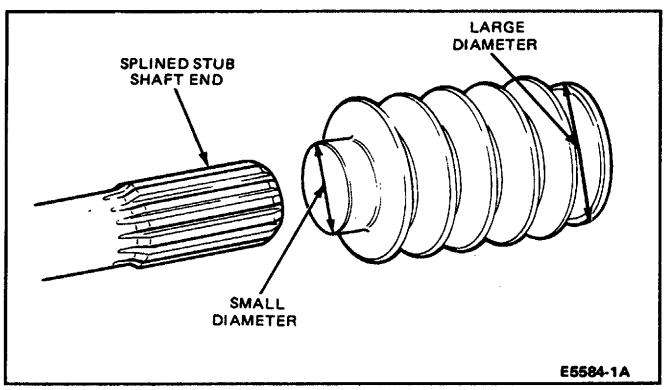


FIG. 6 Rubber Boot Installation

Assembly

1. Install the rubber boot with the small diameter side spacing the splined stub shaft on the stub shaft as far as it will go (Fig. 6).

2. Install a new small clamp and crimp the clamp using Clamp Pliers, T63P-9171-A or equivalent (Fig. 7).

   NOTE: Use ORIGINAL EQUIPMENT CLAMPS when installing boots. Use of other clamps may cause the driveshaft to become out of balance.

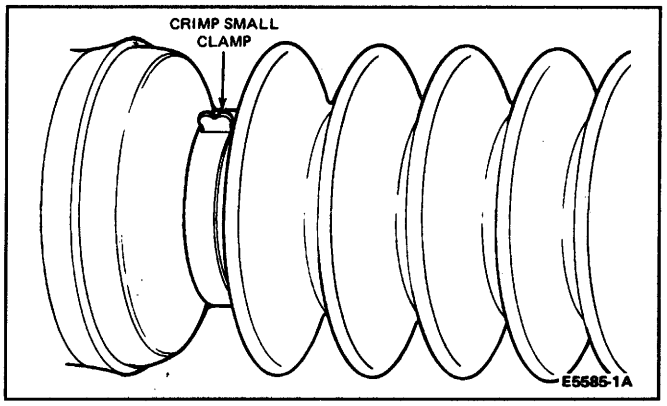


FIG. 7 Clamp Installation

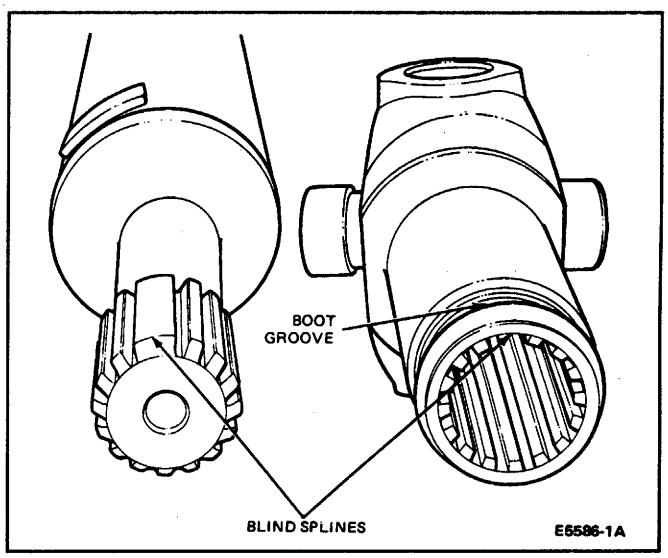


FIG. 8 Blind Spline Alignment

3. Pull the boot towards the driveshaft and coat the stub shaft splines with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.

4. Fill the boot with approximately 10 grams of Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent.

5. Slide the large clamp onto the barrel of the rear slip yoke.

6. Align the blind splines on the splined stub shaft and in the rear slip yoke as shown in Fig. 8. Push the slip yoke onto the stub shaft, making sure both blind splines are matched.

7. Remove all excess grease from the boot and slip yoke surfaces. Position the boot over the slip yoke boot groove.

8. Move the slip yoke in or out (making sure the boot stays in its groove) as required to adjust the front driveshaft to a length of 892mm (35.10 inches) for all except AOD transmissions and 917mm (36.10 inches) for AOD transmissions. This distance is measured from the centerline of the U-joint assembly in the front yoke to the centerline of the U-joint assembly in the rear slip yoke (Fig. 1). For F-350 double cardan type, collapse the driveshaft to its shortest length (Fig. 2).

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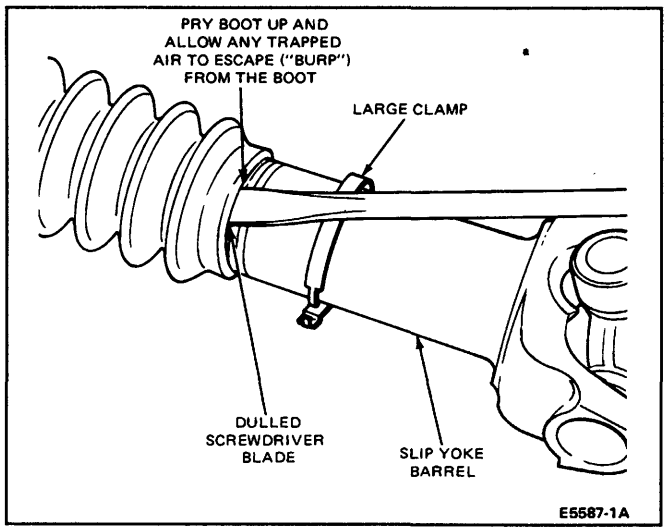


FIG. 9 Releasing Air from Boot

9. Before installing the new large clamp, make sure that any air pressure which may have built up in the boot is relieved. Insert a dulled screwdriver between the boot and the rear slip yoke and allow the trapped air to escape ("burp") from the boot (Fig. 9). THE AIR MUST BE RELEASED ONLY AFTER THE DRIVESHAFT IS SET AT THE SPECIFIED LENGTH.
10. Position the new large clamp over the boot and groove in the slip yoke. Crimp the clamp with Clamp Pliers, T63P-9171-A or equivalent.

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Tool Number	Description
T 63P-9171-A	Clamp Pliers

CE6464-1A

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CLUTCH AND MANUAL TRANSMISSION

GROUP 16

(7000)

SECTION TITLE	PAGE
BORG-WARNER T-18 FOUR-SPEED TRANSMISSION	16-23-1
BORG-WARNER T-19A AND T-19C FOUR-SPEED TRANSMISSION	16-24-1
BORG-WARNER 13-56 ELECTRONIC SHIFT TRANSFER CASE	16-80-1
BORG-WARNER 13-56 TRANSFER CASE—MANUAL SHIFT	16-81-1
BORG-WARNER 1345 TRANSFER CASE	16-86-1
CLUTCH	16-02-1
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VEHICLE APPLICATION

Applies to E-150, F-150-F350, Bronco and F-Super Duty Trucks Equipped with Manual Transmissions.

DIAGNOSIS AND TESTING

Diagnosis Guides

The diagnosis guides in this Section can be used as an aid in clutch diagnosis.

Testing Procedures

Squeak or Scrubby Noise Test

1. Work the clutch pedal back and forth.
2. Note any binding condition or lack of lubrication in the linkage. To help pinpoint noise it may be necessary to disconnect and isolate some components.

Transmission Gear Rollover or Transmission Bearing Noise Test

1. Let engine idle, placing transmission shift selector in neutral position.
2. Depress clutch pedal.

With the clutch pedal fully depressed, the transmission input shaft will stop rotating. If the input shaft bearing or transmission gears were causing a noise, the noise should stop.

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If noise is still present, perform Clutch Release Bearing (Rotational Underload) Noise Test.

Clutch Release Bearing (Rotational Underload) Noise Test

NOTE: A light intermittent clicking or rattling noise may result during pedal application due to the clutch solenoid lockout switch and cruise control clicking. Some noise under these conditions will not adversely affect clutch function and does not necessarily indicate a failed release bearing or out of plane pressure plate release fingers. Inspection of these components is not required unless the noise is excessive.

1. Let the engine idle with the transmission shift selector in neutral position.
2. Depress clutch pedal.
3. Listen for any change in noise level.

If the release bearing is the cause of the noise; the noise should stop with pedal depressed. Replace the release bearing.

BEARING TRAVEL MEASUREMENT

F-Series and Bronco with 7.3L Diesel and 7.5L Gasoline Engines

1. Remove the slave cylinder dust shield.
2. With the clutch pedal depressed fully to the floor measure the external slave cylinder push rod travel.
3. The push rod should extend 13.5mm (0.53 inch) minimum. Do not replace the clutch hydraulic system if the measurement exceeds this distance.

NOTE: If the slave cylinder travel does not meet the travel requirements, check the hydraulic reservoir fluid level.

Clutch Squeal Test

A clutch noise sometimes referred to as a "squeal" may be evident as the clutch pedal is held down.

1. Let engine idle, placing transmission shift selector in neutral position.
2. Depress to floor and SLOWLY release clutch pedal.

If the noise is reduced or eliminated as the clutch pedal is released and the input shaft begins to turn, the pilot bearing could be the possible cause.

Replace pilot bearing. Refer to flywheel housing alignment, and inspection and alignment procedure in this Section.

Clutch Chatter and Slippage Test

A clutch or vehicle vibration called "chatter" is evident just as the clutch is released and the vehicle starts to move.

Contamination of the clutch disc friction surfaces, causing uneven friction, may make the power transfer uneven and result in a "chatter."

CONDITION	POSSIBLE CAUSE	RESOLUTION
Clutch thud	1. Excessive engine crankshaft end play.	1. Repair engine per specifications.
Clutch vibration (torsional) vehicle moving — 8 cyl. engine @ road speed 49-96 km/h (30-60 mph) 6 cyl. engine @ 49-96 km/h (30-60 mph)	1. Incorrect clutch disc installed (wrong friction lag specifications). 2. After market (off-brand) clutch disc installed. 3. Malfunctioning engine. 4. Incorrect installation of coupling shaft or drive shaft assembly.	1. Install specified clutch disc. 2. Install specified clutch disc. 3. Check engine performance, tune up engine. 4. Install correct parts. Align driveline.
Clutch linkage clicking (popping noise)	1. Clutch release lever requires lubrication.	1. Lubricate conical seat of release lever with Multi-Purpose Long-Life Lubricant C1AZ-19590-B (ESA-M1C75-B) lubricant or equivalent. Reposition override release lever.
Gear clash	1. Clutch disc warped or bent preventing full release. 2. Warped pressure plate. 3. Transmission housing misalignment. 4. Pressure plate attaching bolts loose.	1. Replace clutch disc. 2. Replace pressure plate. 3. Realign housing. 4. Tighten bolts.
Gear jump-out	1. Transmission housing misalignment.	1. Realign housing.
Noise — clutch fully engaged	1. Transmission problem.	1. Refer to transmission problems diagnosis for corrective action.
Start-up chatter during light clutch engagement in low or reverse	1. Engine roughness.	1. Tune engine. Set idle speed to specifications.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Clutch pedal hangs up at top of stroke.	1. Pedal or cross shaft lever interfering with dashboard wiring.	1. Reroute or tie interfering wires.
	2. Broken or missing clutch pedal assist spring.	2. Replace spring.
	3. Loose clutch pedal attaching nut.	3. Tighten nut.
	4. Improperly positioned cross shaft lever.	4. Replace cross shaft lever. Refer to Section 16-04 Hydraulic Clutch System for push rod length adjustment.
	5. Release bearing and hub grinding on transmission input shaft bearing retainer.	5. Lubricate bearing hub with Ford Multi-Purpose Long Life Lubricant C1AZ-19590-B (ESA-M1C75-B), or equivalent. Replace transmission input shaft retainer if worn.
	6. Hydraulic System (piston) binds internally.	6. Replace master cylinder or slave cylinder as required.
Heavy pedal efforts on a fast pedal stroke, but normal pedal efforts on a slow pedal stroke.	1. Restriction in hydraulic tubing.	1. Replace hydraulic tubing.

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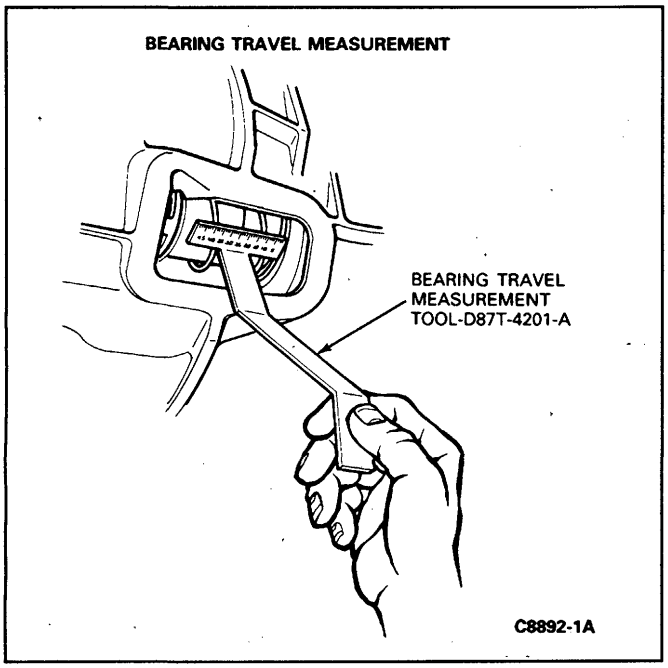


FIG. 1 Measuring Release Bearing Travel

Oil leakage or grease on the clutch disc is the major cause of chatter.

Loose, misaligned or broken engine mounting(s) can cause clutch chatter.

Overheated clutch from excessive slippage or abuse can cause chatter.

Clutch slippage may have several causes (oil leakage on clutch disc, operator abuse, excessively worn disc).

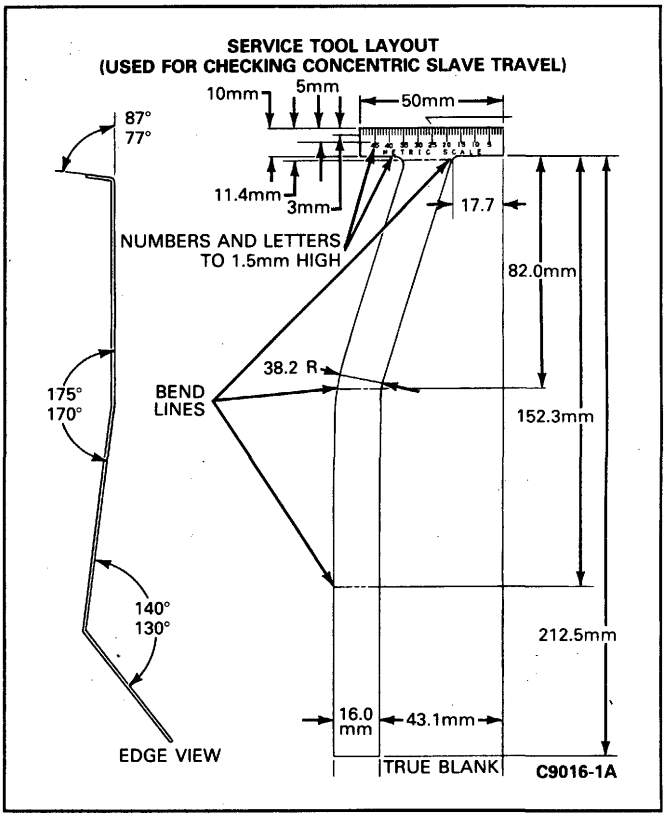


FIG. 2 Bearing Travel Measurement Tool Fabrication

ADJUSTMENTS

Dowel Replacement Procedure

Use a drift pin on through holes and vice grip pliers or a similar tool on blind holes to remove dowels.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Start-up chatter during light clutch engagement in low or reverse (Cont'd.)	2. Throttle linkage improperly adjusted.	2. Readjust.
	3. Engine misaligned. Not properly seated on mounts.	3. Loosen engine mount bolts, align and center engine so engine mounts center in teardrop holes.
	4. Body mounts improperly tightened (incorrect torque).	4. Check for correct front and rear body mounts, proper installation and bolt torque.
	5. Oil or grease on clutch disc.	5. Correct leak, replace disc, clean pressure plate and flywheel friction surfaces with clean solvent (alcohol base). Deglaze flywheel.
	6. Glazed flywheel surface.	6. Deglaze flywheel surface with coarse emery cloth, stroke parallel to machining lines.
	7. Clutch disc warped or bent (little or no reserve).	7. Replace clutch disc.
	8. Pressure plate attaching bolts loose or missing.	8. Replace broken or missing bolts, tighten to specification.
	9. Loose engine mount attaching bolts.	9. Tighten bolts.
	10. Loose transmission and/or clutch housing attaching bolts.	10. Tighten bolts.
	11. Clutch housing loose or misaligned.	11. Realign.
	12. Pressure plate fingers bent, out-of-plane or sticking (will not return hung-up).	12. Replace pressure plate.
	13. Release lever (fork) bent, broken or cracked.	13. Replace release lever.
Clutch inoperative	1. Release lever broken.	1. Replace release lever.
	2. Pressure plate worn or warped.	2. Replace pressure plate.
	3. Clutch hydraulic system leaking externally or internally.	3. Replace hydraulic component that leaks externally, or replace clutch master cylinder if suspected of internal leakage.
	4. Disc worn or warped.	4. Replace clutch disc.
	5. Flywheel worn or warped.	5. Re-face or replace flywheel.
Clutch noise squeal (engine idling — clutch released when cold).	1. Pilot bearing in crankshaft not square with crankshaft (misaligned).	1. Replace pilot bearing — seat properly in crankshaft, **do not grease,** clean input shaft pilot and apply coat of light oil for initial lube only.

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NOTE: Dowels should be pulled or driven from their seat using care not to damage the surface area around the dowel.

All solid type dowels can be installed by driving them into place using a brass or plastic mallet.

NOTE: Care should be exercised to drive the dowel squarely into place until fully seated and not to damage the surrounding surface area.

CLEANING AND INSPECTION

Clutch Release Bearing

Wipe all oil and dirt off the release bearing. The bearing is prelubricated and should not be cleaned with solvent. On all vehicles, the clutch release bearing and hub are serviced as a single unit. Do not disassemble them for inspection or replacement.

Inspect the release bearing as follows:

1. Hold the bearing, hub and back plate and rotate the outer race while applying a compressive pressure. If the bearing rotation is rough, replace the bearing.
2. Inspect/remove any surface scoring or burrs that may impede the sliding motion of the release bearing on the transmission input shaft retainer. Any scoring or burrs should be polished off with a fine grade emery paper.

Prior to re-installation, lubricate for release bearing operation with lithium base grease, Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent, at the following points:

1. Fill annular groove of release bearing.
2. Thin coat on inside diameter of release bearing.
3. Fingers of clutch release lever (7.3L diesel and 7.5L gas engines only).
4. Fulcrum point of clutch release lever (7.3L diesel and 7.5L gas engines only).

Failure situations for release bearing operation:

1. Misalignment of clutch release lever (7.3L diesel and 7.5L gas engines only).
2. Misalignment between engine and the transmission. This condition will exhibit symptoms as transmission jumping out of gear, driveshaft vibration, excessive spin time resulting in gear clash, and clutch chatter on start-up.

NOTE: Also see Section 16-04, Hydraulic Clutch System for information on concentric slave cylinders.

Pressure Plate and Cover

The coil spring design and the Belleville design pressure plate assemblies do not need to be lubricated.

Inspect the surface of the pressure plate for burn marks, scores, flatness or ridges. If the pressure plate is badly heat-checked or deeply scored, replace the pressure plate and cover assembly. Clean the pressure plate and flywheel surfaces with a suitable commercial alcohol base solvent to be sure that surfaces are free from any oil film. **Do not use cleaners with a petroleum base, and do not immerse the pressure plate in the solvent.**

If a substantial difference in finger wear exists, the heavily worn finger is binding. Replace the pressure plate.

Clutch Disc

Inspect the clutch disc facings for oil or grease. **Eliminate the source of any oil or grease before replacing the disc.** An excessive amount of grease on the bearing hub will find its way to the disc facings. Too much lubricant in the transmission or a plugged transmission vent will force the transmission lubricant out the input shaft and onto the disc facings. Leaking rear engine seals or loose or unsealed flywheel housing attaching bolts will allow engine oil to flow onto the disc facings.

Inspect the clutch disc for worn or loose facings. Check the disc for warpage and for loose rivets at the hub. Check for broken springs. **Springs loose enough to rattle will not cause noise when the vehicle is operating.**

Replace the disc if any of these conditions are present. When installing a new disc, be careful upon handling as not to drop it or contaminate it with oil or grease.

Flywheel Runout

Crankshaft End Play Check

1. Mount the dial indicator base on the rear of the engine with the indicator tip resting on the flywheel toward the outer edge.
2. Using a suitable pry bar, shift the engine crankshaft forward and rearward while taking an indicator reading. Compare reading with specifications found in the Light Truck Engine Shop Manual.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Clutch noise squeal (engine idling — clutch released when cold). (Cont'd.)	2. Release bearing.	2. Replace release bearing.
	3. Clutch housing misalignment (pilot bore and face runout).	3. Align housing.
Squeak (engine off)	1. No lube on release rod bushings or clutch pedal shaft bushings.	1. Replace all worn bushings. Apply Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) lubricant or equivalent to inside and outside of bushing prior to assembly.
	2. No lube on release lever at fulcrum and/or release bearing hub retaining clips.	2. Remove release lever and bearing. Daub Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) lubricant or equivalent under leading edge of retaining clips of release bearing and in fulcrum seat of release lever.
	3. Loose steering column cover or brake and clutch pedal support bracket at instrument panel.	3. Tighten all attaching parts to specifications.
	4. Clutch master cylinder push rod rubbing in rubber boot.	4. Lubricate boot with silicon lubricant spray.
Scrubby pedal action and feel	1. No lube at release lever fingers or rear face of release bearing.	1. Daub Multi-Purpose Long-Life Lubricant C1AZ-19590-B (ESA-M1C75-B) lubricant or equivalent at leading edge of release lever fingers.
	2. No lube in release bearing hub. Scored transmission input shaft retainer.	2. Replace release bearing and transmission input shaft retainer. Fill annular groove of release bearing hub with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) lubricant or equivalent.
	3. Clutch pedal binding in pedal support.	3. Lubricate clutch pedal shaft, bushings and pedal support.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Rattle — engine idling, clutch engaged or on light engagement	1. Pedal hang-up (pedal does not return to stop).	1. Dry pedal shaft — lube pedal shaft and bushings. Check for broken or missing clutch pedal assist spring. Replace if necessary.
Slipping clutch	1. Oil on disc assembly. (Also caused clutch clatter).	1. Replace disc after washing flywheel and pressure plate friction surfaces with clean solvent. Deglaze flywheel and pressure plate.
	2. Broken pressure plate.	2. Replace pressure plate.
	3. Worn clutch facings.	3. Replace facings or complete driven disc assembly.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Clutch "squeaks" or "scrapes" when pedal is depressed.	1. Clutch linkage under dash panel shows lack of lubrication, binding, interference(s), excessive wear or misalignment.	1. Lubricate, repair or replace as required, then road test.
	2. Linkage inside clutch housing shows lack of lubrication, binding, excessive wear or misalignment.	2. Lubricate, repair or replace as required, then road test.
	3. Pressure plate binds or has interference, broken or bent Belleville spring.	3. Replace pressure plate, then road test.
	4. Other (1, 2, and 3 OK).	4. Perform "Inspection and Alignment Procedure — All Models" (Section 16-01, General Clutch Service). Repair as required, then road test.
Clutch chatters during starts.	1. Engine rough idle hesitation during acceleration.	1. Adjust or correct engine idle as required.
	2. Engine misaligned, not properly seated on mounts.	2. Align and center engine mounts in tear drop holes.
	3. Engine, transmission, or cab mounts misaligned and/or loose.	3. Align, replace, and tighten mounts as required.
	4. Release bearing or transmission retainer inadequately lubricated, misaligned, worn or galled.	4. Replace release bearing or transmission retainer as required.
	5. Flywheel housing bore and face out of alignment.	5. Correct per shop manual procedure in this Section.
	6. Loose or missing pressure plate attaching bolts.	6. Replace and/or tighten to specification.
	7. Bent or out-of-plane pressure plate fingers.	7. Replace pressure plate if release fingers are more than 0.060 inch out-of-plane.
	8. Clutch disc contaminated with oil.	8. Correct leak, replace disc and clean pressure plate as required.
	9. Clutch disc warped, cracked, or friction material loose.	9. Replace disc.
	10. Pressure plate warped or shows hot spots.	10. Replace pressure plate.
	11. Flywheel warped, or discolored (excessive heat).	11. Reface or replace flywheel.
NOTE: A light chatter or shudder in the vehicle when engaging the clutch at light throttle is a normal occurrence. This condition results from the new lower numerical axle ratio. It may be more pronounced in heavily loaded vehicles. Drive train function and durability are not affected by this chatter condition. Therefore, drive train components, particularly clutches, should not be replaced or rebuilt in attempts to eliminate this condition.		

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Clutch noisy.	1. Release bearing worn or damaged. 2. Pressure plate release fingers worn or damaged. 3. Flywheel housing and engine crankshaft out of alignment. 4. Transmission front extension not properly engaged.	1. Replace bearing. 2. Replace pressure plate assembly. 3. Align or replace housing as required. 4. Repair as required.
Clutch slips after the pedal is fully released.	1. Clutch pedal linkage binding (outside of flywheel housing). 2. Transmission input shaft bearing retainer and pressure plate worn, damaged or lack lubrication. Clutch disc worn.	1. Lubricate, repair and replace linkage parts as required. 2. Lubricate or replace parts as required.
Clutch does not disengage completely.	1. Clutch linkage and bushings (outside of flywheel housing) worn, cracked or bent. 2. Damaged or worn clutch disc, pressure plate or release lever. 3. Damaged or worn crankshaft pilot bearing. 4. Clutch disc hub spline does not move freely on transmission input shaft spline. 5. Clutch hydraulic system inoperative. 6. Incorrect clutch disc installed.	1. Repair or replace the damaged or worn bushings, levers and rods. 2. Replace damaged or worn parts as required. 3. Replace bearing as required. 4. Repair or replace parts as required. 5. Replace clutch hydraulic system. 6. Replace clutch disc.

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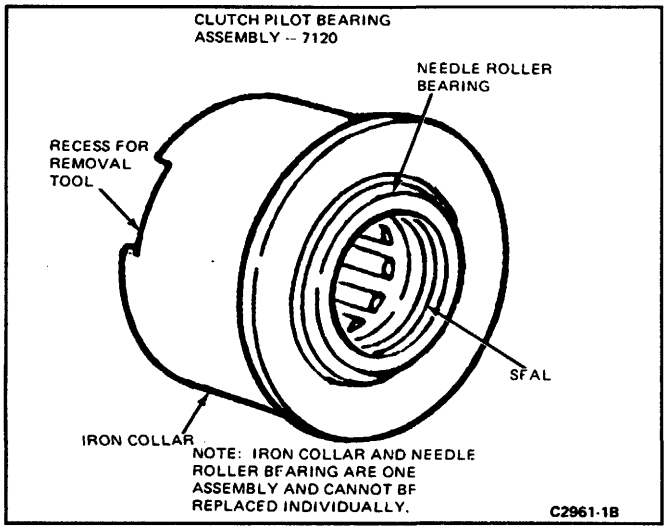


FIG. 3 Pilot Bearing (Needle Roller Type)

Flywheel Face Runout

Refer to Section 16-10, General Manual Transmission Service for flywheel face runout checks.

Crankshaft End Play

Pilot Bearing Assembly

Refer to Fig. 3.

Check the fit of the clutch pilot bearing in the bore of the crankshaft. The bearing is pressed into the crankshaft and should not be loose.

Check the pilot bearing (needle type) assembly for mis-alignment and press fit condition in the crankshaft. Visibly inspect the bearing surfaces (needle rollers and transmission input shaft) for scoring, worn or broken rollers, inadequate grease and discoloration due to heating. Check the condition of the bearing's seal. There should be no visible grease leakage on the bearing retainer or the crankshaft.

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SYMPTOM: CLUTCH NOISE

TEST STEP		RESULT ▶	ACTION TO TAKE
1.0	PEDAL ACTION (ENGINE OFF)		
	With engine off, check for noise and binding condition when pedal is depressed and then released.	(OK) ▶	GO to **2.**
		Noise/Binding ▶	GO to "Squeaks" or "Scrapes" Diagnosis Charts.
2.0	PEDAL ACTION (ENGINE RUNNING)		
	With engine running, depress pedal.(See note below.)	(OK) ▶	GO to **3.**
		Noise ▶	GO to **4.**
3.0	CLUTCH ENGAGEMENT		
	With engine running, check for squealing noise when engaging clutch.	(OK) ▶	ROAD TEST.
		Squealing Noise ▶	GO to **5.**
4.0	RELEASE BEARING/PRESSURE PLATE FINGERS		
	Inspect the release bearing and pressure plate fingers for wear.	(OK) ▶	ROAD TEST.
		Bearing Rough/Noisy Pressure Plate Fingers Worn ▶	REPLACE bearing; REPLACE pressure plate if release fingers are more than 1.52mm (0.060 inch) out-of-plane as installed on flywheel. CHECK flywheel housing bore and face alignment, then ROAD TEST.
5.0	PILOT BEARING		
	Inspect pilot bearing for proper installation, wear and loss of lubrication.	(OK) ▶	ROAD TEST.
		Bearing Worn ▶	REPLACE as required.

NOTE: A light intermittent clicking noise may result during pedal application. Some noise under these situations will not adversely affect clutch function and does not ncessarily indicate a failed release bearing or out-of-plane pressure plate release fingers. Inspection of these components is not required unless the noise is excessive.

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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T59L-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
D79P-100-A	Impact Slide Hammer — 5 Lbs.	Universal
T58L-101-A	Puller Attachment	Universal — Use with Slide Hammer
T57L-500-B	Bench-Mounted Holding Fixture	Universal
D78P-4201-B	Dial Indicator with Magnetic Base	Universal
TOOL-4201-C	Dial Indicator with Bracketry	Universal
D79T-7550-A	Clutch Alignment Shaft	10 Spline — 1-1/2 Inch Outside Diameter
D79T-7550-B	Clutch Alignment Shaft	10 Spline — 1-3/4 Inch Outside Diameter
D79T-7550-C	Clutch Alignment Shaft	10 Spline — 2 Inch Outside Diameter

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SECTION 16-02 Clutch

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VEHICLE APPLICATION

All E-150, F-150—F-350, F-Super Duty and Bronco Trucks Equipped with Manual Transmission.

DESCRIPTION AND OPERATION

The purpose of the clutch is to connect and disconnect a manually operated transmission and the remainder of the power-transmission system from the engine. This permits starting and stopping the vehicle, shifting and changing speeds that correspond to the engine speed through gear reductions for both forward and reverse directions.

The clutch consists of a driven plate (clutch disc) splined for the input shaft of the transmission and the clutch housing (pressure plate).

This forms a continuous system by which rotation of the engine is connected to the transmission by solid member when engaged (clutch assembly). For power at the output shaft of the transmission or rear wheel rotation (forward or reverse), the driven plate is a metal disc, faced on both sides with woven friction materials. The pressure plate is a metal member bolted on the flywheel which houses the driven plate held in position by the transmission input shaft. A clutch sleeve mounted over the input shaft of the transmission carries a throwout bearing that is pressed against the fingers of the clutch that pushes it away from the driven plate causing disengagement—breaking the connection between the engine (flywheel) and the clutch. Reverse action or the release of the throwout bearing engages the clutch. The release lever is actuated by a hydraulic system (refer to Section 16-04, Hydraulic Clutch System).

Other internal clutch parts are a pilot bearing mounted in the crankshaft which supports the end of the input shaft. Bearings are designed for long life and require no lubrication.

DIAGNOSIS AND TESTING

Refer to Section 16-01, General Clutch Service.

REMOVAL AND INSTALLATION

Clutch Pilot Bearing

A needle roller bearing and collar assembly is used as a clutch pilot bearing on E-150—F-150—F-250—F-350, F-Super Duty and Bronco vehicles (Fig. 1). It is inserted directly into the engine crankshaft. The bearing and collar assembly is a one piece unit that cannot be serviced separately. The needle bearing clutch pilot can only be installed with the seal end of the bearing facing the transmission. The bearing and seal are pregreased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed.

Removal

1. Remove the transmission, clutch pressure plate, and disc following the procedures in Group 16.
2. Using Impact Slide Hammer Puller, T58L-101-B (or equivalent) remove the pilot bearing (Fig. 2).

Installation

1. Using Pilot Bearing Replacer T74P-7137-A and Clutch Aligner T71P-7137-H or equivalent, install the pilot bearing with the seal facing the transmission (Fig. 3) so that the adaptor is not cocked.
2. Install the clutch pressure plate, disc, and transmission following the procedure in this Section and the appropriate transmission section in Group 16.

   NOTE: Care must be taken not to damage the bearing during transmission installation while the transmission input shaft is being inserted into the bearing.

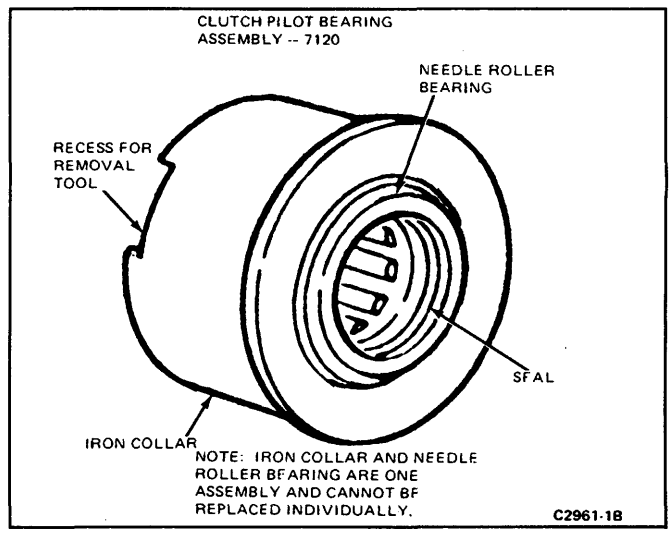


FIG. 1 Pilot Bearing Assembly (Needle Roller Type)

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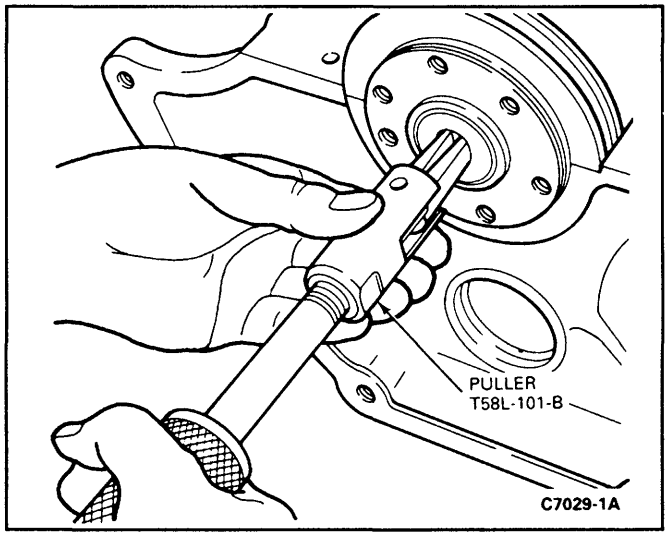


FIG. 2 Removing Clutch Pilot Bearing Assembly

Clutch Release Lever—7.3L Diesel and 7.5L Gas Engines Only

Refer to Fig. 5.

Removal

1. Raise the vehicle and install safety stands.
2. Remove the dust boot from the opening in the clutch bell housing.
3. Push the release lever forward to compress the slave cylinder.
4. On 7.3L diesel and 7.5L gas engines, the steel retainer clip is permanently attached to the slave cylinder. Remove the slave cylinder by prying on the clip to disengage the tangs while pulling the slave cylinder free of the bracket.
5. Remove the release lever by pulling the lever outward.

Installation

1. Install the release lever on the release bearing hub and the pivot stubs, making sure it is properly positioned. Push the lever inward until it snaps onto the studs.
2. Install the slave cylinder and attaching clip.
3. Install the dust shield in the opening in the bell housing.
4. Lower the vehicle. Depress the clutch pedal ten times to refill the slave cylinder and seat the components. Check the clutch system for proper operation.

Single-Disc-Type Clutch

Standard Disc and Pressure Plate Assembly—10.0 Inch/11.0 Inch

Removal

1. Disconnect the battery negative cable.
2. Remove clutch slave cylinder, or the hydraulic line quick disconnect using quick disconnect Tool T88T-70522-A.
3. Remove the release lever if so equipped.
4. Remove the dust cover if so equipped.

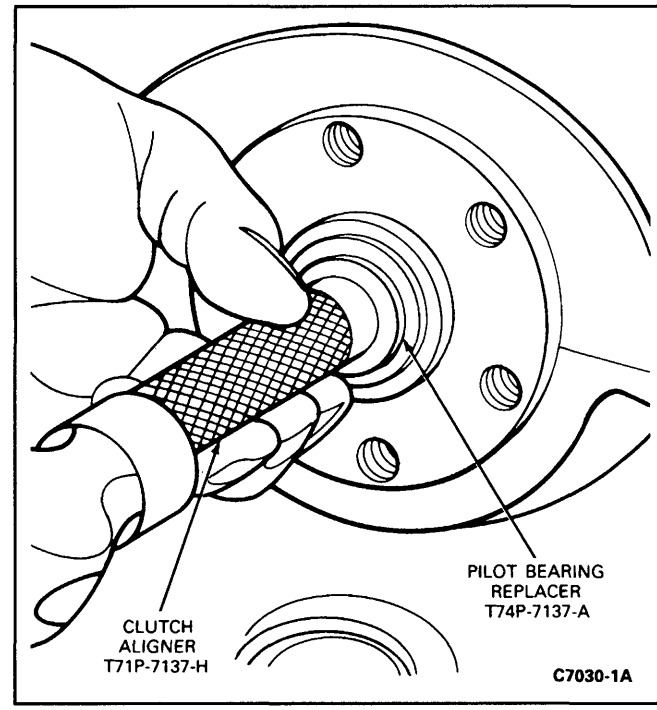


FIG. 3 Installing Clutch Pilot Bearing Assembly

5. Refer to the appropriate transmission Section of this Manual for instructions and remove the transmission from the vehicle.
6. Mark the assembled position of the pressure plate and cover to the flywheel (for re-assembly).
7. Remove the pressure plate and cover assembly and the clutch disc from the flywheel. **Remove the pilot bearing only for replacement.**

Installation

1. Position the clutch disc on the flywheel so that the Clutch Alignment Shaft D79T-7550-A or equivalent can enter the clutch pilot bearing and align the disc.
2. When re-installing the original pressure plate and cover assembly, align the assembly and flywheel according to the marks made during the removal operations. Position the pressure plate and cover assembly on the flywheel, align the pressure plate and disc, and install the retaining bolts that fasten the assembly to the flywheel. Tighten the bolts to specification (refer to Figs. 4 and 5). and remove the clutch disc pilot tool.
3. On 7.3L diesel and 7.5L gas engines, clean and lubricate the transmission bearing retainer. Clean the bearing hub bore and install on the retainer. Clean and lubricate the release lever pivot stud.
4. Reinstall the transmission.
5. Correctly position the release lever (if so equipped) in its release bearing hub, and align with the pivot stud. Push inward on the lever until it snaps into position.
6. Reinstall the external slave cylinder, or attach the hydraulic tube quick connect fitting.
7. Install the dust boot if so equipped.
8. Install the starter motor.

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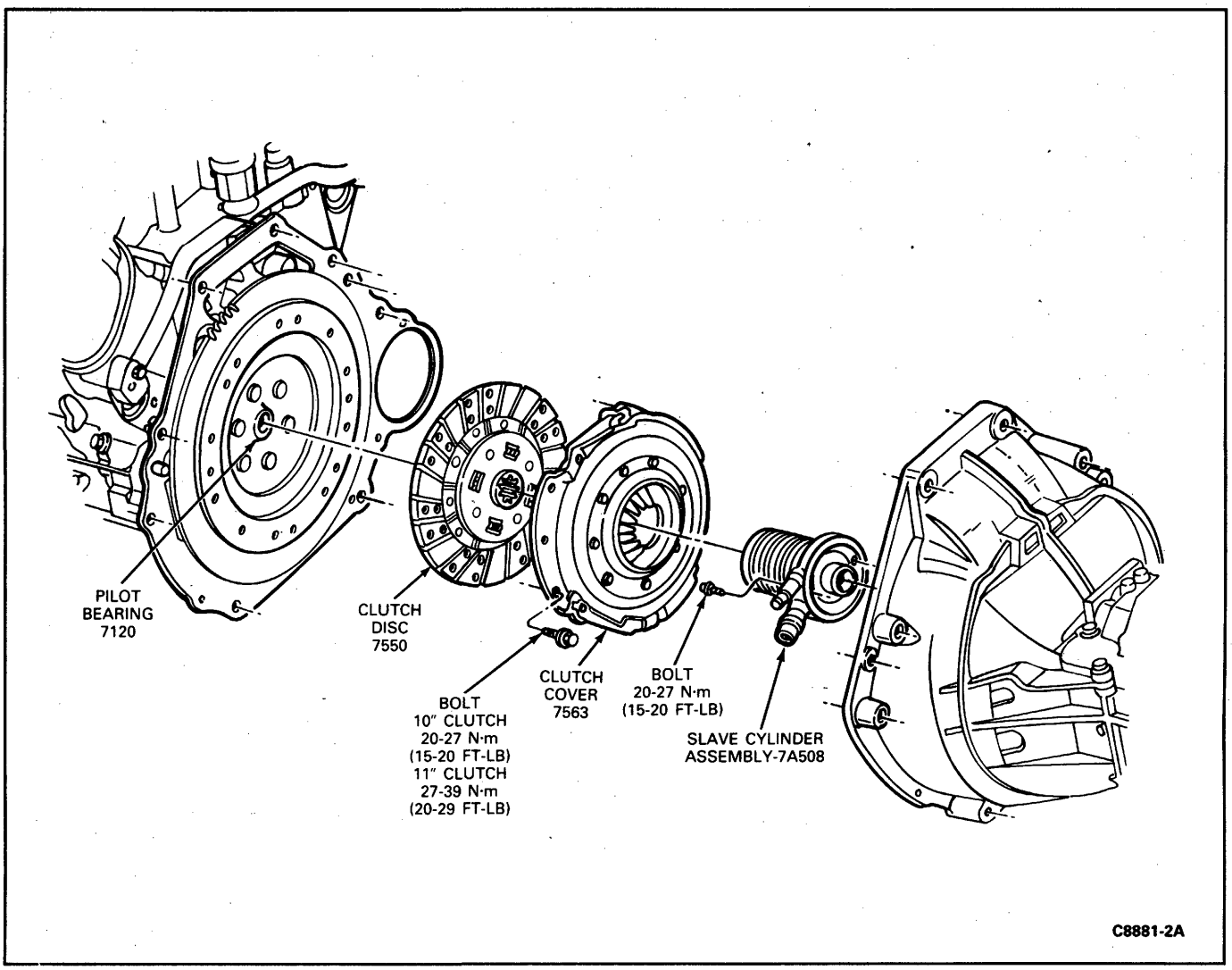


FIG. 4 Clutch Installation—E-150, F-150—F-250, Bronco with 4.9L, 5.0L and 5.8L Engines

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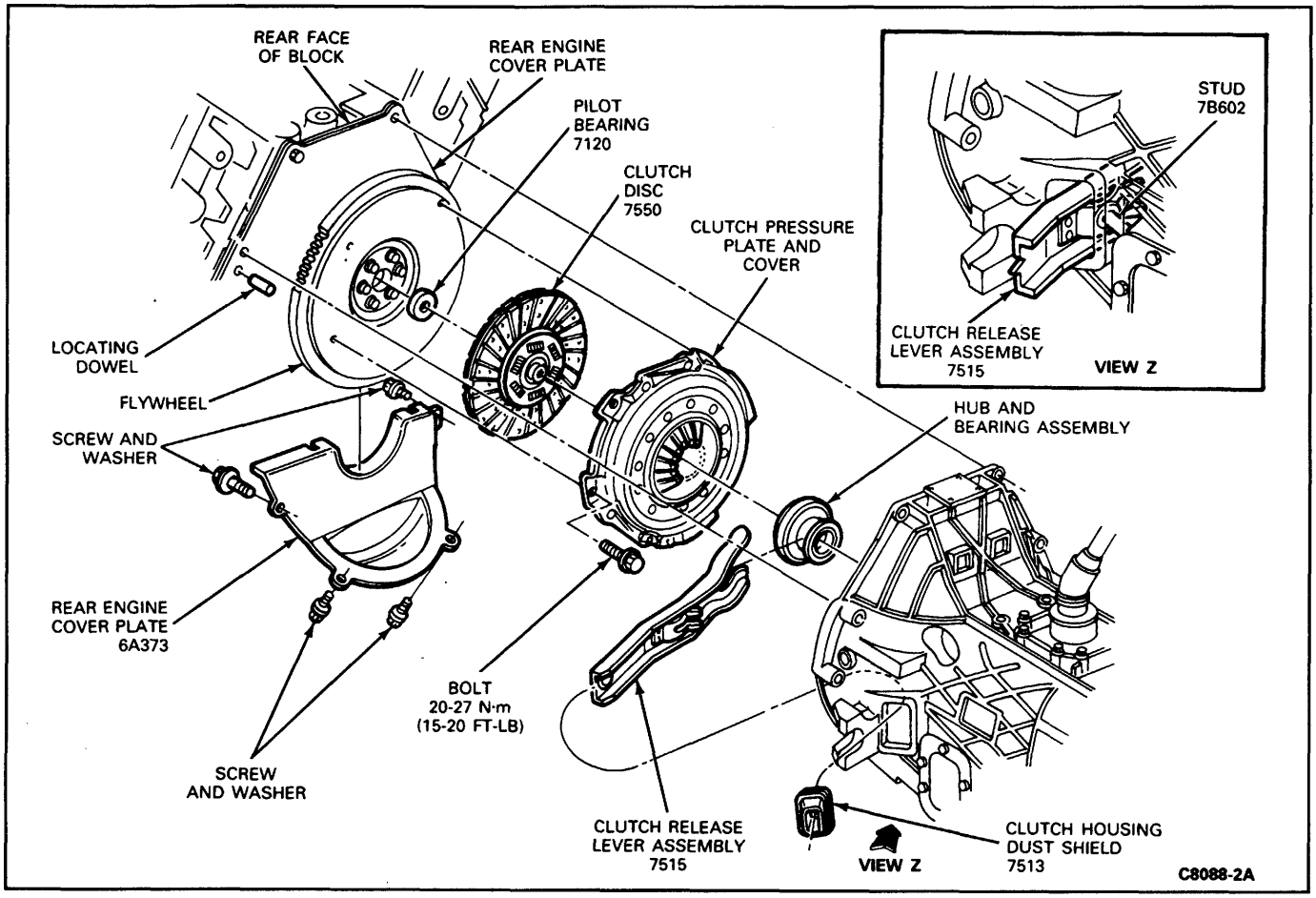


FIG. 5 Clutch Installation—F-250 H.D.—F-350 and F-Super Duty with 7.3L Diesel Engine and 7.5L (460 CID) V-8 Engine

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 Lbs.	Universal
T59L-100-B	Impact Slide Hammer — 2-1/2 Lbs.	Universal
D79P-100-A	Impact Slide Hammer — 5 Lbs.	Universal
T58L-101-B	Puller	Universal
T57L-500-B	Bench Mounted Holding Fixture	Universal
T00L-1175-AC	Seal Remover	Universal — Use with Slide Hammer
T75L-4201-A	Clutch Housing Alignment Adapter	Universal — For Right Angle Measurements
T75L-4201-B	Clutch Housing Alignment Adapter	Universal
D78P-4201-B	Dial Indicator with Base	Universal
T00L-4201-C	Dial Indicator with Bracketry	Universal
T75L-6392-A	Clutch Housing Alignment Tool	Use with Clutch Housing Alignment Adapters and Dial Indicator
D79L-7000-A	Retaining Ring Pliers	Universal
T74P-7137-A	Pilot Bearing Replacer	Use with Clutch Aligner
T71P-7137-H	Clutch Aligner	Universal
D79T-7550-A	Clutch Alignment Shaft	1-1/2 Inch Outside Diameter — 10 Spline
D79T-7550-B	Clutch Alignment Shaft	1-3/4 Inch Outside Diameter — 10 Spline

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SECTION 16-04 Hydraulic Clutch System

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VEHICLE APPLICATION

Applies to All E-150, F-150—F-350, F-Super Duty and Bronco Trucks Equipped with Manual Transmission.

DESCRIPTION AND OPERATION

The hydraulic clutch control system consists of a combination clutch fluid reservoir and master cylinder assembly, a slave cylinder and connecting tubing (Figs. 1 and 2).

The combination clutch reservoir and master cylinder is located inboard of the brake vacuum booster. Fluid level is checked at the reservoir. The master cylinder converts mechanical clutch pedal movement into hydraulic fluid movement.

The clutch external slave cylinder is mounted on the transmission bell housing, for all trucks equipped with the 7.3L diesel or 7.5L gas engines. All other vehicles use a concentric mounted slave cylinder in the transmission bell housing. The slave cylinder converts the hydraulic fluid movement to mechanical movement to activate the clutch release lever.

The hydraulic clutch system provides automatic clutch adjustment. No adjustment of clutch linkage or pedal position is required.

NOTE: As the clutch disc wears, the fluid level in the reservoir will rise. The fill line step in the reservoir is the normal level for a new system.

Clutch/Starter Interlock Switch-Econoline

All Econoline vehicles with manual transmissions are equipped with a starter/clutch interlock system which requires the clutch pedal to be depressed all the way to the floor in order to start the engine. The system operates by means of a switch located on the brake and clutch pedal support bracket (Fig. 3). The switch plunger is attached to the clutch pedal and extends as the clutch pedal is depressed to actuate the switch. The switch is electrically connected across the ignition switch and the starter motor relay coil to maintain an open starter circuit with the clutch engaged (pedal up) position. The switch is designed with a self-adjusting feature which provides for the switch to be set automatically with the first flooring of the clutch pedal. The self-adjusting feature consists of a two piece clip which is snapped together over a serrated plunger (rod). When the switch plunger or rod is extended, the clip bottoms out on the switch body and causes the rod to ratchet over the serrations to a position determined by the clutch pedal travel limit. The switch is now adjusted to close the starter circuit when the clutch pedal is floored.

NOTE: Care must be taken to prevent mis-adjustment of the switch by avoiding operation or changing the "as shipped" position of the self-adjusting clip on the plunger (rod).

Clutch Interlock Three Function Switch—F-Series and Bronco

Refer to Fig. 4.

All F-Series and Bronco Trucks with manual transmissions are equipped with a switch which is concentrically located on the master cylinder push rod. The switch has three functions:

- It requires the clutch pedal to be depressed to the floor in order to start the engine.
- It cuts off the speed control system when the clutch pedal is depressed.
- It provides a fuel control signal to the EEC system.

DIAGNOSIS AND TESTING

For diagnostic and testing procedures, refer to Section 16-01, General Clutch Service.

If release bearing travel does not meet the travel requirements (see Release Bearing Travel Measurement in Section 16-01), check the reservoir fluid level (Figs. 1 and 2). The slave cylinder must be in place when checking the fluid level. The proper level is indicated by a step on the reservoir. Fill to the specified level with Ford Heavy Duty Brake Fluid C6AZ-19542-A or -B (ESA-M6C25-A) or equivalent DOT 3 fluid. Do not overfill. The upper portion of the reservoir must accept fluid that is displaced from the slave cylinder as the clutch wears.

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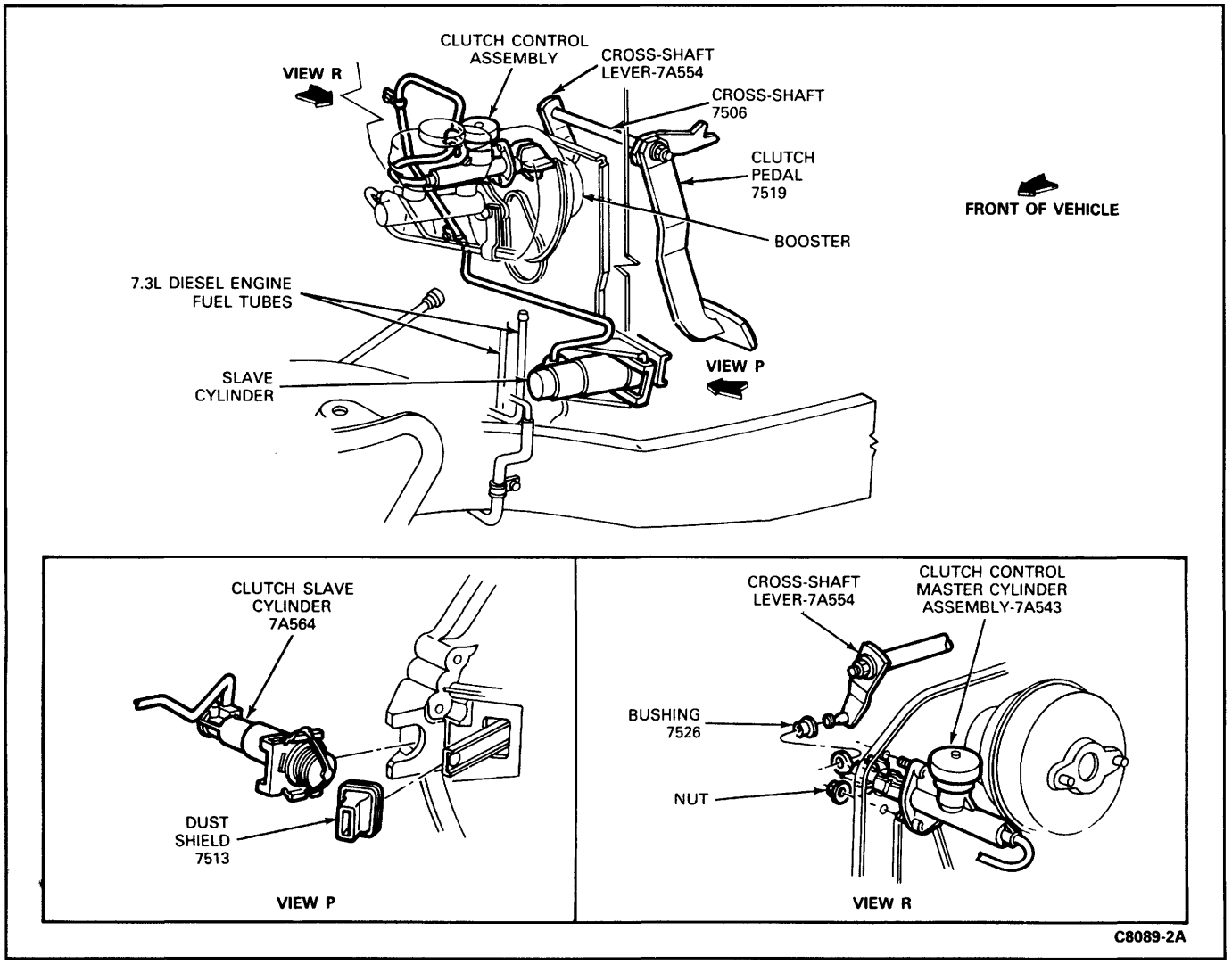


FIG. 1 Hydraulic Clutch System 7.3L Diesel Engine and 7.5L (460 CID) Gas Engine

CAUTION: Carefully clean the top and sides of the reservoir before opening to prevent contamination of the system with dirt, water and other foreign material. Remove the reservoir diaphragm when checking or adding fluid. Carefully replace the diaphragm, cover gasket and cover after filling.

If the reservoir requires any fluid, check the hydraulic system components for leakage. Remove the rubber boots from the cylinder and check for leakage past the pistons. A slight wetting of the surfaces is acceptable. If excessive leakage is evident, replace the leaking component.

Clutch/Starter Interlock Switch

For switch diagnosis and testing, refer to Section 37-01 Speed Control System.

ADJUSTMENTS

Clutch/Starter Interlock Switch Adjustment-Econoline only

Refer to Fig. 3.

If the adjusting clip is out of position on the rod, remove both halves of the clip. Position both halves of the clip closer to the switch and snap the clips together on the rod. Depress the clutch pedal to the floor to adjust the switch.

Hydraulic Clutch—Master Cylinder Pushrod Length Adjustment

The proper position of Clutch Master Cylinder pushrod relative to the cross-shaft lever (7A554) pin is controlled by the procedure used when installing the cross-shaft lever.

To determine if the Clutch Master Cylinder pushrod and lever pin are in the correct relationship, disconnect the pushrod and note if it will reassemble to the pin. (When the pushrod is disconnected from the pin, the clutch Master Cylinder piston is fully retracted (rearward) and the clutch pedal blade is contacting the rubber bumper stop.)

If the two components are not in alignment, perform the following ONLY IN THIS SEQUENCE:

1. Tighten the clutch pedal attaching nut (L.H. side).
2. Reinstall the Clutch Master Cylinder pushrod to the cross-shaft lever pin.
3. Stroke the clutch pedal several times to reset the position of the shaft to the pedal slot. **This step is mandatory.**

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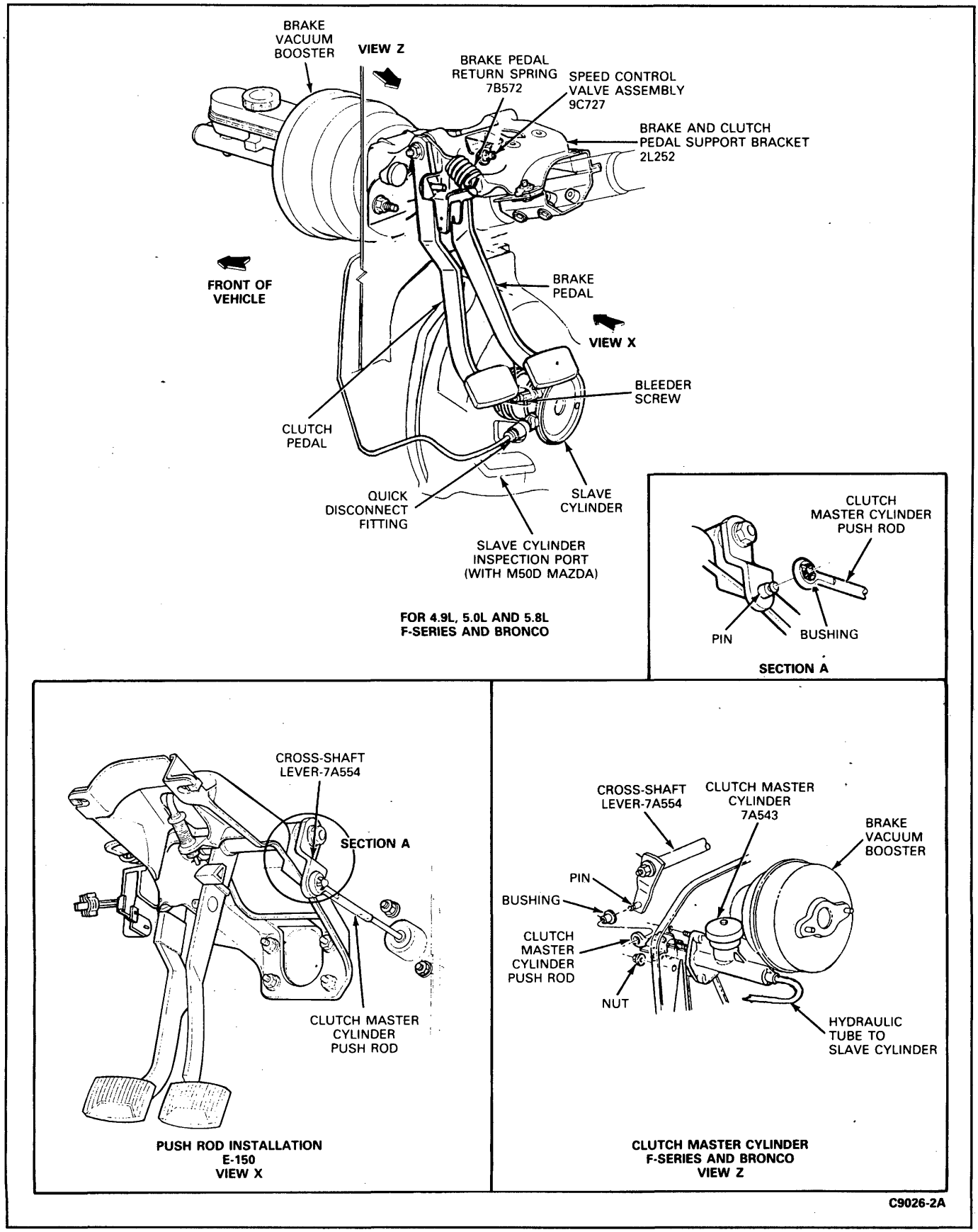


FIG. 2 Hydraulic Clutch System—4.9L, 5.0L and 5.8L Gas Engines—Typical

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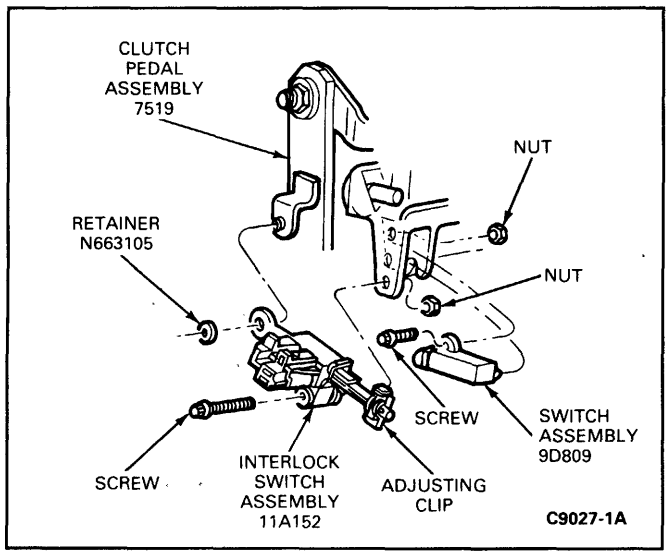


FIG. 3 Clutch/Starter Interlock Switch—Econoline

4. Again, remove the Clutch Master Cylinder pushrod from the lever pin and evaluate the alignment. If the two components are still not in alignment, replace the cross-shaft lever. (If the pushrod is aligned with the pin, no further action is required.)

REMOVAL AND INSTALLATION

Cross-Shaft Lever

Removal

1. Disconnect the Master Cylinder pushrod from the cross-shaft lever pin (Fig. 4). (Use a small screw driver or putty knife to wedge between the lever and the snap-in bushing.)
2. Remove the attaching nut.
3. Pry the lever from the cross-shaft.

Installation

1. Snap the new lever (pin) to the Clutch Master Cylinder pushrod bushing.
2. Install the lever onto the cross-shaft.
3. Install the attaching nut, finger tight.
4. Inspect pedal position to insure that it is against the "up" stop.
5. Tighten the attaching nut. This will permit the knurled teeth on the shaft to cut matching teeth in lever, which then results in the correct positioning of the two components.

Clutch Hydraulic System

Refer to Figs. 1 and 2.

NOTE: For vehicles equipped with external slave cylinders, prior to any vehicle service that requires removal of the slave cylinder, (i.e.; transmission removal), the master cylinder push rod must be disconnected from the clutch pedal. If not disconnected, permanent damage to the slave cylinder will occur if the clutch pedal is depressed while the slave cylinder is disconnected.

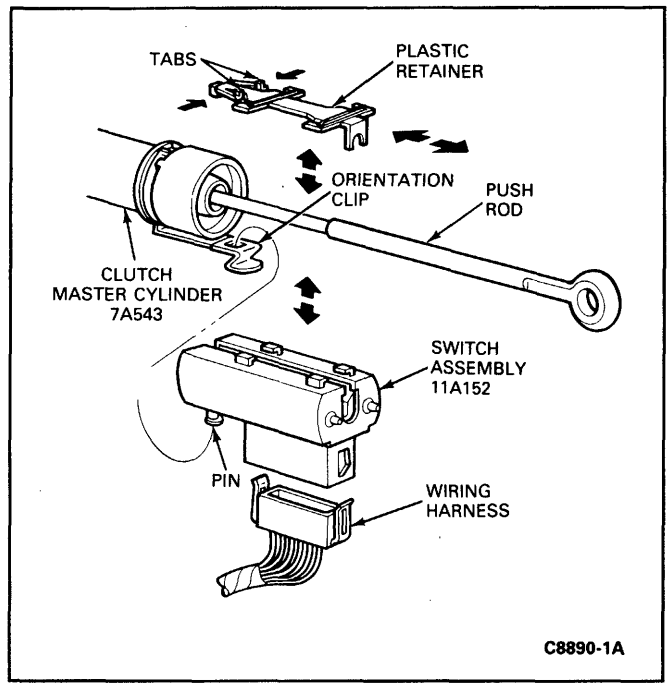


FIG. 4 Clutch/Starter Interlock Switch—F-Series and Bronco

Removal

1. From the inside of the cab, carefully pry the pushrod and retainer bushing from the cross-shaft lever pin.
2. Disconnect the interlock switch connector plug.
3. Remove the two nuts retaining the clutch reservoir and master cylinder assembly to the firewall.
4. From the engine compartment, first note the clutch tube routing to the slave cylinder, then remove attaching hardware for the hydraulic tube retaining clips.
5. From the engine compartment, remove the clutch reservoir and master cylinder assembly from the firewall. On F-Series and Bronco, when the master cylinder studs are free of the dash panel, rotate the cylinder 105 degrees counter-clockwise to permit the interlock switch to exit the dash panel.
6. On 7.3L diesel and 7.5L gas engine vehicles, use a screwdriver or a similar tool and lift the two retaining tabs of the slave cylinder retaining bracket. Disengage the tabs from the bell housing lugs and then slide outward to remove. On 4.9/5.0/5.8L engine vehicles, depress the released ring on the tube quick disconnect and gently pull the connector free.
7. Remove the clutch hydraulic system from the vehicle.

Installation

1. Position the clutch fluid reservoir and master cylinder assembly into the firewall from inside the cab install the two nuts and tighten.
2. Correctly route the hydraulic tubing and slave cylinder to the transmission bell housing.

   NOTE: Care must be taken during routing of the nylon line to keep away from engine exhaust system components.

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3. Reinstall the clutch tube retaining clips.
4. On 7.3L diesel and 7.5L gas engines install the slave cylinder by pushing the slave cylinder push rod into the cylinder. Engage the push rod into the release lever and slide the slave cylinder into the bell housing lugs. Seat the cylinder into the recess in the lugs. For 4.9/5.0/5.8L engine vehicles, push the tube quick disconnect back onto the concentric slave cylinder fitting.

   NOTE: When installing a new hydraulic system, the external slave cylinder (7.3L diesel and 7.5L gas) contains a shipping strap that pre-positions the push rod for installation and also provides a bearing insert. Following installation of the new slave cylinder, the first actuation of the clutch pedal will break the shipping strap and give normal system operation.
5. From inside the cab, press the pushrod with the retainer bushing onto the cross-shaft lever pin until the bushing tabs snap into position in the groove.

   The flanged side of the bushing must be towards the cross-shaft lever.
6. Check the clutch reservoir and add fluid if required. Depress the clutch pedal at least ten times to verify smooth operation and proper release.

   NOTE: The proper fluid level is indicated by a step on the reservoir. Do not overfill. The upper portion of the reservoir must accept fluid that is displaced from the slave cylinder as the clutch wears.

Clutch Pedal

Removal

Refer to Figs. 5 and 6.

1. On F-Series and Bronco, disconnect the clutch pedal retracting spring from the clutch pedal and bracket. On Econoline models disconnect the barbed retainer bushing on the clutch/starter interlock switch rod from the clutch pedal (Fig. 2).
2. Remove the nut that retains the clutch pedal to the shaft and remove the clutch pedal. If the brake pedal is to be removed, refer to Section 12-30, Brake Pedal, Master Cylinder and Valves.

Installation

1. Position the clutch pedal on the shaft and install and tighten the nut.
2. Install the retracting spring. Make sure the spring engages the slots in the pedal and bracket.

NOTE: Spring installation is easier if the spring is first compressed in a vise and retained in a compressed

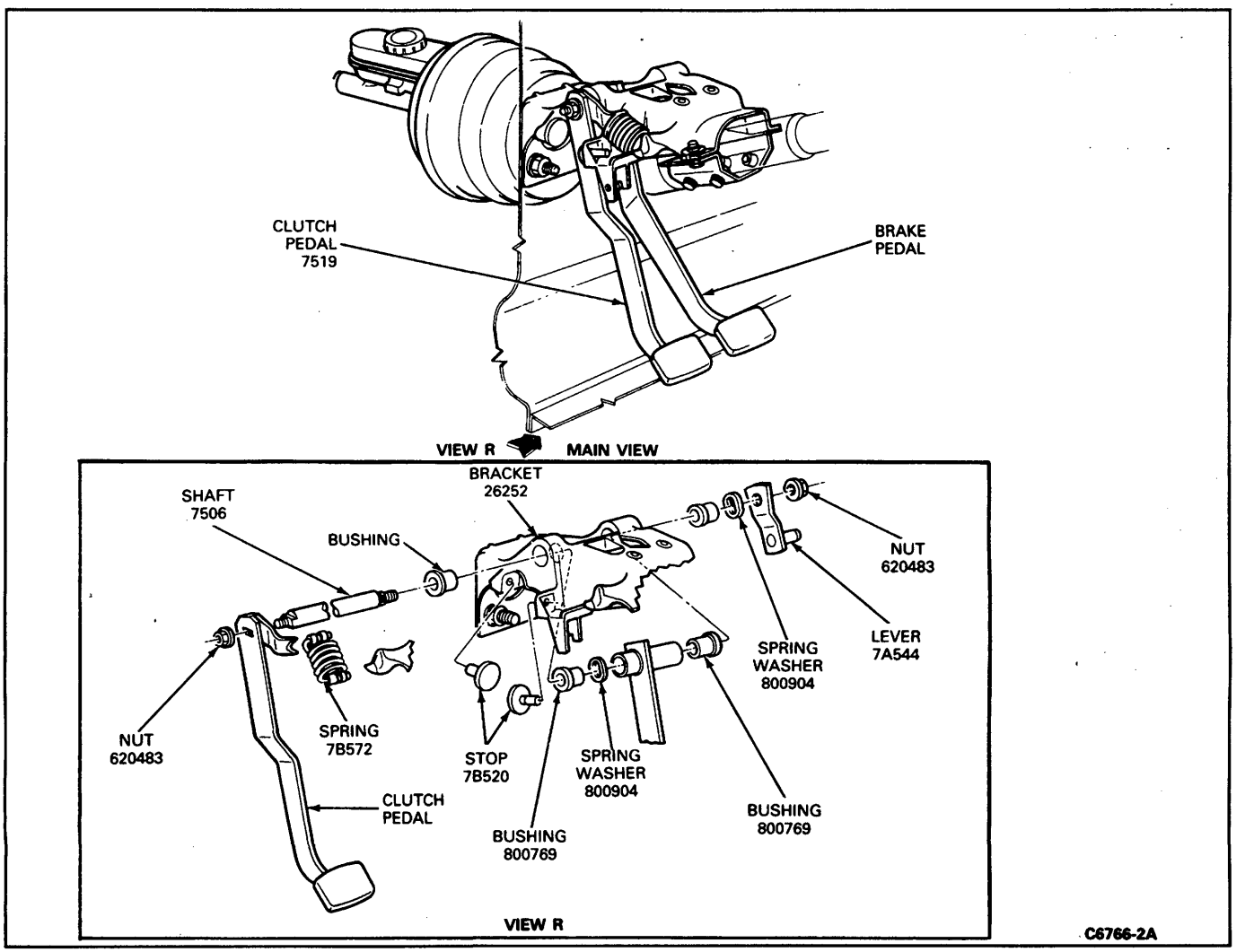


FIG. 5 Clutch Pedal Installation—F-150—F-350 and Bronco

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state with mechanics wire until it is in place. Once in place cut the mechanics wire and remove.

3. On Econoline insert the clutch/starter interlock switch rod and barbed retainer bushing onto the clutch pedal pin, until the bushing barbs snap into position in the groove. If required, adjust the clip on the interlock switch rod as described in the Adjustment portion of this Section.

Bleeding Procedure—Concentric Slave Cylinder

Refer to Fig. 7.

Under normal conditions disconnecting the clutch coupling will not introduce air into the system. However if there appears to be air in the system (spongy pedal, or insufficient bearing travel) the system must be bled. The following procedure is used with the hydraulic system installed on the vehicle. The largest portion of bleeding is carried out by gravity.

1. Clean dirt and grease from the cap.
2. Remove cap and diaphragm and fill reservoir to the top with approved brake fluid only. (Brake fluid must be certified to DOT 3 specification.)

NOTE: To keep brake fluid from entering the clutch housing, route a suitable rubber tube of appropriate inside diameter from the bleed screw to a container.

3. Loosen bleed screw (located in the slave cylinder body) next to the inlet connection.
4. Fluid will now begin to move from the master cylinder down the tube to the slave cylinder.

NOTE: The reservoir must be kept full at all times to ensure no additional introduction of air into the system.

5. It will be noticeable at this point, that bubbles will appear at the bleed screw outlet. This means that air is being expelled. When the slave is full, a steady flow of fluid will come from the slave outlet. Tighten bleed screw. NOTE: Maintain brake fluid level at the step in the reservoir at all times.
6. Depress the clutch pedal to the floor and hold for 1-2 seconds. Release pedal as rapidly as possible. Pedal must be released completely. Pause for 1-2 seconds. Repeat ten times.
7. Check fluid level in reservoir. The fluid should be level with the step when the diaphragm is removed.
8. Repeat steps 6 and 7 five times. Replace reservoir diaphragm and cap.
9. Hold pedal to floor, crack open bleed screw to allow any additional air to escape. (If bleed screw is opened too far, fluid will spray out.) Close screw then release pedal.

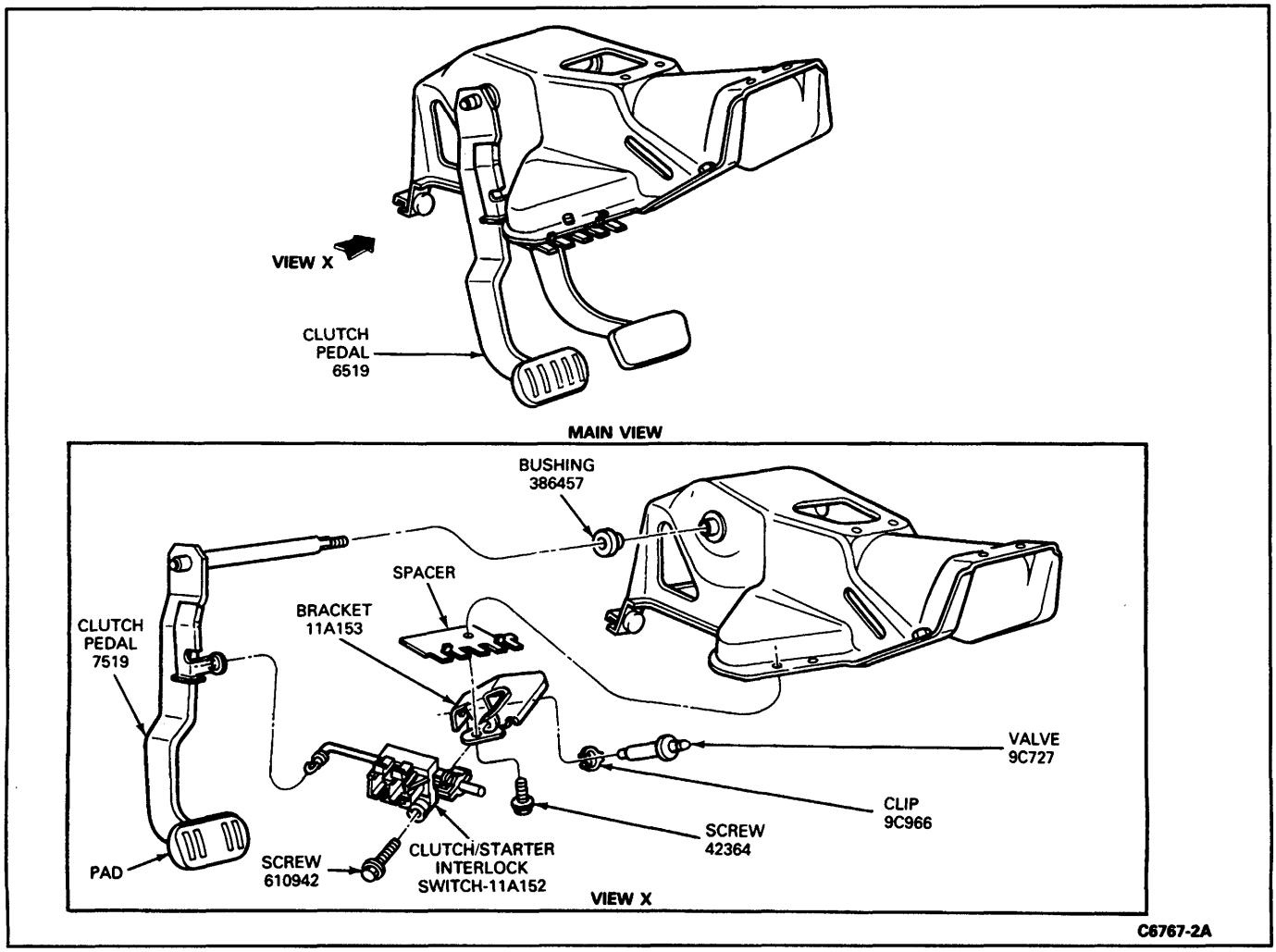


FIG. 6 Clutch Pedal Installation—E-150

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10. Check fluid level. The hydraulic system should now be fully bled and should release the clutch.

Bleed Procedure for External Slave Cylinder

7.3L Diesel and 7.5L Gas

1. Clean reservoir cap and slave cylinder in area of the tube connection.
2. Remove slave cylinder from the transmission bell housing.
3. Use 3/32 inch diameter punch to drive out the pin that holds the tube. Remove the tube from the slave cylinder and place the tube end into a container for waste fluid. The tube will still be connected to the master cylinder, so keep the reservoir cap tight to minimize fluid loss.
4. Hold slave cylinder so that connector port is at highest point, by tipping the cylinder to approximately 30 degrees (Fig. 8). Fill with approved Dot 3 brake fluid through connector port. It may be necessary to "rock" slave cylinder around or push gently on the pushrod to expel all the air. Pushing on pushrod too hard will cause fluid to spray out of the connector hole. Cleanliness is very important. Be sure not to let any moisture or foreign matter to enter the slave with the brake fluid.
5. When all of the air has been expelled from the slave cylinder and no more bubbles come out of the port hole, reinstall the slave cylinder back on the vehicle.

   NOTE: Some fluid will be expelled from the connector port, as the pushrod is compressed attaching it to the transmission and lever.
6. Gravity fill the master cylinder and tube as follows: Remove the reservoir cap and diaphragm fluid should flow out the open end of the tube into the waste container. Be sure to keep the reservoir full. When fluid is flowing out in a steady, uninterrupted flow and fluid is level with step in reservoir, reinstall the cap and diaphragm. Install end of tube into slave cylinder. Replace pin that holds tube to slave cylinder body.
7. System should now be bled and functioning properly. To verify proper system function set parking brake and put vehicle in neutral. Start vehicle and shift into reverse gear. If gears grind, other components may be causing the concern. Check the slave cylinder pushrod travel as detailed in Section 16-01 General Clutch Service.

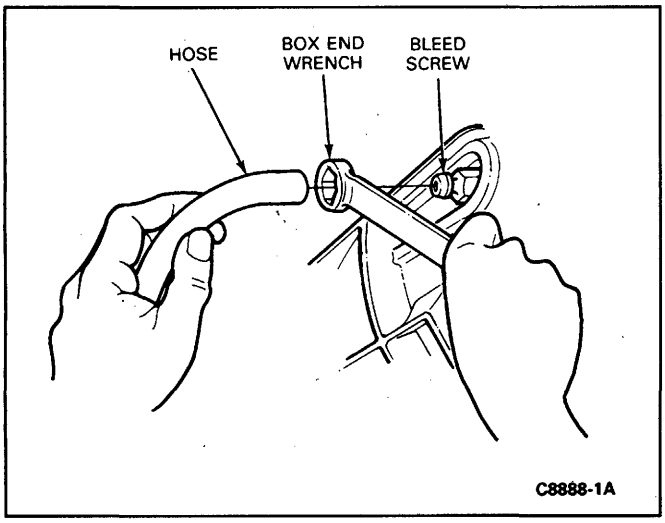


FIG. 7 Bleeding the Concentric Slave Cylinder

Clutch Interlock Three Function Switch

F-Series and Bronco

Removal

Refer to Fig. 4.

1. Disconnect the wiring harness from the switch.
2. Pull down on the orientation clip to separate it from the tab on the switch.
3. Rotate the switch 1/2 turn to expose the plastic retainer.
4. Push the tabs together to allow the retainer to slide rearward and separate from the switch.
5. Remove the switch from the push rod.

Installation

1. Install the switch on the master cylinder push rod.
2. Install the plastic retainer.
3. Rotate the switch into the position required to attach the orientation clip.
4. Connect the wiring harness.

Hydraulic Clutch Line

Removal

1. Depress the white retainer bushing with disconnect tool T88T-70522-A, or equivalent, while pulling on the line.

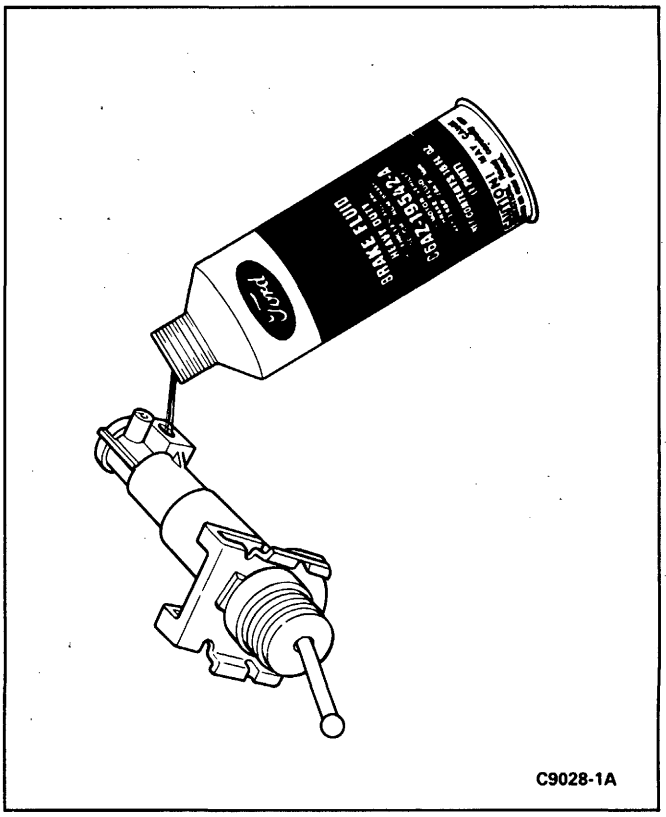


FIG. 8 Bleeding External Slave Cylinder

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Installation

1. Push the male connector onto the female connector of the clutch slave cylinder.

NOTE: No loss of fluid should occur during removal and installation, and bleeding should not normally be required unless the vehicle shows signs of hard shifting and lack of clutch reserve.

Clutch Release Bearing

4.9L, 5.0L and 5.8L Engines

Removal

1. Twist the release bearing and carrier assembly until resistance is felt (FIG. 10). Turning the assembly further will allow the preload spring to push the bearing assembly off the slave cylinder.

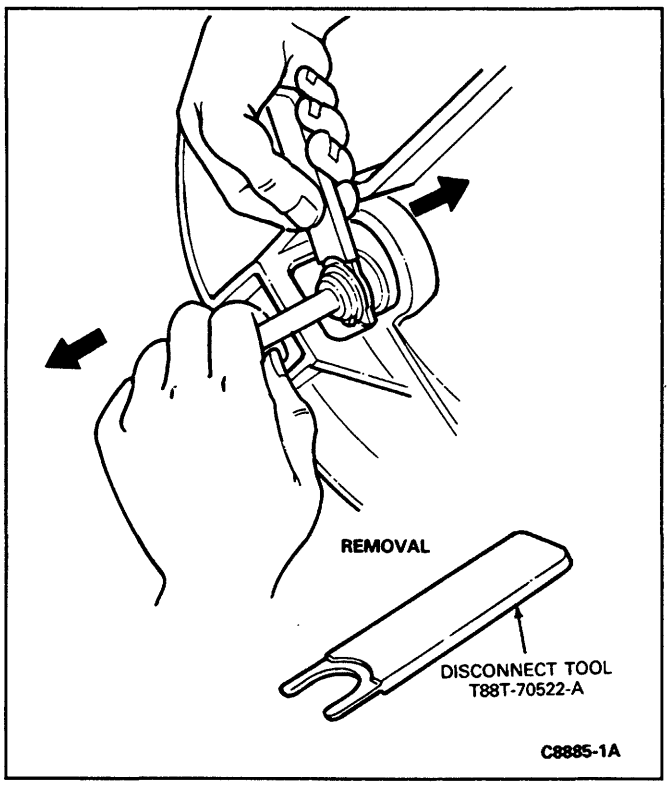


FIG. 9 Clutch Hydraulic Line Removal

Installation

NOTE: Prior to re-installation, lubricate the bore of the bearing and bearing carrier with Ford Multi-Purpose Long Life Lubricant C1AZ-19590-B(ESA-M1C75-B) or equivalent.

1. Install the release bearing assembly to the clutch slave cylinder by pushing into place.

Clutch Slave Cylinder

Concentric Slave Cylinder

Removal

1. Disconnect the coupling at the transmission with disconnect tool T88T-70522-A, or equivalent, by sliding the white plastic sleeve toward the slave cylinder while applying a slight tug on the tube (Fig. 9).
2. Remove the transmission as described in the appropriate transmission section.
3. Remove the bolts retaining the slave cylinder to the transmission (Fig. 11).
4. Remove the slave cylinder from the transmission input shaft.

Installation

1. Position the slave cylinder over the transmission input shaft with the bleed screw and coupling facing the left side of the transmission.
2. Install the slave cylinder attaching bolts, and tighten to 20-27 N·m (15-20 ft-lb).
3. Install the transmission as described in the appropriate transmission section.
4. Insert the male coupling into the female coupling on the clutch slave cylinder, and check that the connection is secure.
5. Bleed the clutch hydraulic system as required.

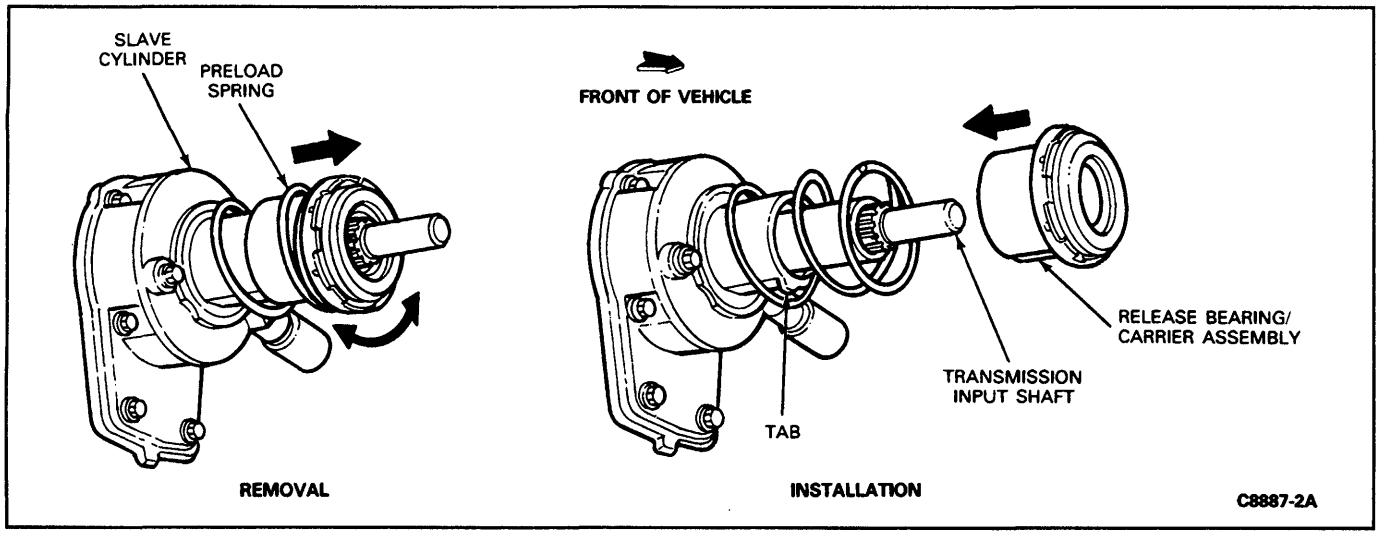


FIG. 10 Clutch Release Bearing Removal—with Concentric Slave Cylinder

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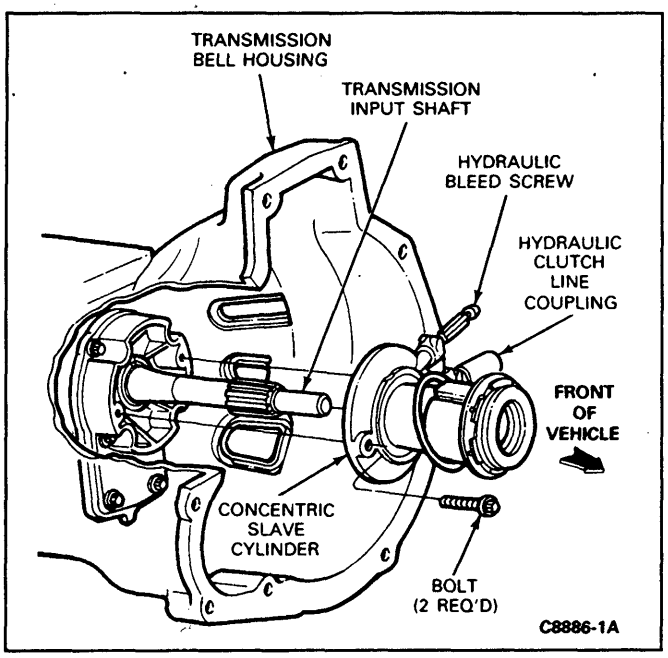


FIG. 11 Slave Cylinder Removal and Installation

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Application
T88T-70522-A	Hydraulic Line Disconnect Tool

CC9029-1A

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VEHICLE APPLICATION

Applies to All E-150, E-350, F-150—F-350, Bronco and F-Super Duty Trucks Equipped with Manual Transmissions.

DESCRIPTION

Identification

Transmission identification codes are found on the Vehicle Safety Compliance Certification Label found on the driver's door lock pillar. For identification of the label transmission code, refer to Section 10-00, Identification codes.

Manual transmissions have service identification tags to identify assemblies for service purposes. Ford truck manual transmissions have the identification tag located on the right side of the transmission case at the front (Fig. 1 and 2).

DIAGNOSIS

Diagnosis Guides

The diagnosis guides in this Section can be used as an aid when diagnosing manual transmissions.

CLEANING AND INSPECTION

Transmission

Cleaning

After the transmission has been disassembled, soak the parts except the bearings, in a cleaning solvent until all the old lubricant is dissolved or loosened. Brush or scrape all foreign matter from the parts. Be careful not to damage any of the parts with the scraper.

An excessive amount of foreign material usually results from a bearing failure, gear seizure, tooth breakage, extreme synchronizer wear, or clashing gears. **In such cases, the input and output shaft bearings should be carefully inspected and replaced if necessary. Since countershaft bearings, output shaft pilot bearings, and reverse idler bearings are not so susceptible to damage from foreign material in the lubricant, they need not be replaced if they seem satisfactory.**

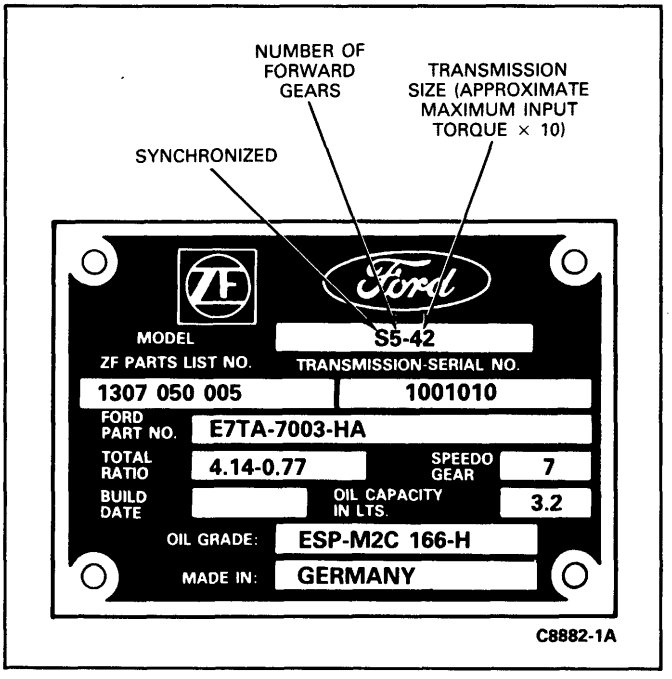


FIG. 1 Transmission Identification Tag—5 Speed Manual—ZF

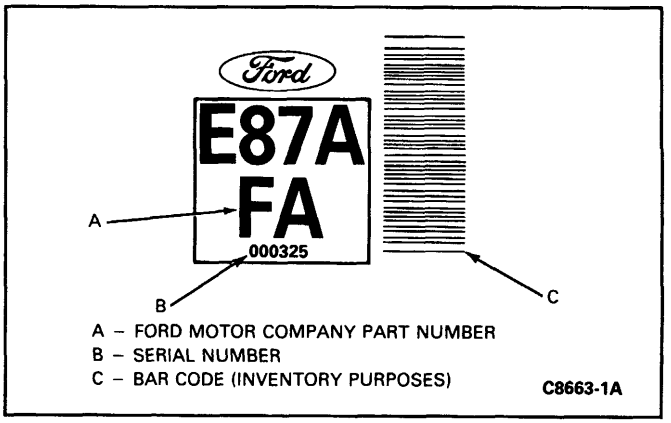


FIG. 2 Transmission Identification Tag—5 Speed Manual—Mazda

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Transmission shifts hard.	1. Clutch does not completely release.	1. Refer to "Clutch does not disengage completely," Section 16-01, General Clutch Service.
	2. Transmission fluid low or improper type.	2. Add lubricant or change lubricant as required.
	3. Worn or damaged internal shift mechanism.	3. Remove transmission cover. Check internal shift mechanism by shifting into and out of all gears. Repair or replace as required.
	4. Binding of sliding gears and/or synchronizers.	4. Check for free movement of gears and synchronizers. Repair or replace as required.
	5. Housings and/or shafts out of alignment.	5. Remove transmission and check for binding condition between input shaft and engine crankshaft pilot bearing or bushing. Check flywheel housing alignment. Repair or replace as required.
Noisy in forward gears.*	1. Lubricant level low, or improper type.	1. Add lubricant, or refill with specified lubricant.
	2. Components grinding on transmission.	2. Check for screws, bolts, etc., of cab or other components grounding out. Correct as required.
	3. Component housing bolts loose.	3. Check torque on transmission to flywheel housing bolts, output shaft flange nut and flywheel housing to engine block bolts. Tighten bolts to specification.
	4. Flywheel housing to engine crankshaft alignment.	4. Check and align flywheel housing to engine crankshaft.
	5. Noisy bearings or gears.	5. Remove and disassemble transmission. Inspect input, output and countershaft bearings. Inspect speedometer gear and gear teeth for wear or damage. Replace as required.
*While verifying the condition, determine whether the noise is gear roll-over noise, release bearing rub or some other transmission related noise. Gear roll-over noise, inherent in manual transmissions, is caused by the constant mesh gears turning at engine idle speed, while the clutch is engaged and the transmission is in neutral; and release bearing rub are sometimes mistaken for mainshaft bearing noise. Gear roll-over noise will disappear when the clutch is disengaged or when the transmission is engaged in gear. Release bearing rub will disengage when the clutch is engaged in the event that a bearing is damaged, the noise is more pronounced while engaged in gear under load or coast than in neutral.		

CC5152-2B

Wipe the parts or blow compressed air on them until they are thoroughly dry.

To clean the bearings, rotate them in clean solvent until all lubricant is removed. Hold the bearing assembly, to prevent it from rotating, and dry it with compressed air.

When the bearings are dry, lubricate them thoroughly with transmission lubricant, and cover them with a clean, lint-free cloth until ready for use.

Inspection

Inspect all transmission parts before reassembly to determine if they should be replaced.

Sub-Assemblies

Gear Shift Housing

Check the operation and condition of the shift levers, forks, and shift rails. If binding occurs when the levers are operated, disassemble the housing assembly, and replace the worn or damaged parts.

Transmission Case

Inspect the case for cracks, worn or damaged bearing bores, damaged threads, or similar damage. If such is found, replace the case.

Holes smaller than 6.35mm (1/4 inch) diameter, such as sand holes or casting porosity can be repaired using Metallic Plastic Repair Kit, Part No. C6AZ-19554-A or equivalent as directed.

Holes larger than 6.35mm (1/4 inch) can be repaired by drilling, tapping and plugging.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Gears clash when shifting from one forward gear to another.	1. Engine idle speed too high.	1. Adjust engine idle speed.
	2. Pilot bearing binding.	2. Remove transmission and check for a binding condition between input shaft and engine crankshaft pilot bearing. Replace as required.
	3. Damaged gear teeth and/or synchronizer.	3. Disassemble transmission, repair or replace as required.
Transmission jumps out of gear.	1. Stiff shift boot. Improper fit of form isolation pad.	1. Replace shift boot if exceptionally stiff. Replace or rework pad to provide clearance.
	2. Loose transmission to engine mounting bolts, or loose levers.	2. Tighten transmission to engine block bolts to specifications. Loosen all bolts and reseat flywheel housing. Tighten all bolts. Tighten levers if necessary.
	3. Flywheel housing to engine crankshaft out of line.	3. Shim or replace housing as required.
	4. Crankshaft pilot bearing worn.	4. Replace bearing.
	5. Interior components damage.	5. Disassemble transmission. Inspect the synchronizer sleeves for free movement on their hubs. Inspect the synchronizer blocking rings for widened index slots, rounded clutch teeth and smooth internal surface. Check countershaft cluster gear for excessive end play. Check shift forks for worn or loose mounting on shift rails. Check fork pads for excessive wear. Inspect synchronizer sliding sleeve and gear clutch teeth for wear or damage. Repair or replace as required.
	6. Worn gear teeth due to partial engagement.	6. Replace worn or damaged gears.

CC5204-2C

The recommended procedure for using the Metallic Plastic Repair Kit is as follows:

Steam clean the transmission or transfer unit case to remove grease, oil, or road dirt. Clean the repair area thoroughly. Metallic plastic will not stick to a dirty or oily surface.

1. Prepare the surface to be repaired by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut the hole or porous area to a greater depth than the rest of the cleaned surface. Solid metal must surround the hole.
2. Mix the metallic plastic base and hardener as directed on the container. Stir thoroughly until uniform.
3. Apply the repair mixture with a suitable clean tool (putty knife, wood spoon, etc.), forcing the mixture into the hole or porosity.
4. Allow the repair mixture to harden by either of two methods: heat cure with a 250-watt lamp placed 254mm (10 inches) from the repaired surface, or air dry for 10 to 12 hours at temperatures above 10°C (50°F).
5. Sand or grind the repaired area, blending it with the general contour of the surrounding surface. **Do not use this method to repair casting cracks.**

Bearings

Examine the bearing assemblies (Fig. 3) for cracked cups or races. Check the races for roughness. Inspect the balls and rollers for looseness, wear, chipping, flaking or other damage. Check the bearings for binding on the shafts or looseness in the bores. If any of these conditions are present, replace the bearings.

Gears

Some forms of grind marks and tooth wear contact patterns are acceptable and should not be considered as a source of gear noise. Grind marks are distinctive from wear or damage which are local swells (polished raised projections), nicks and chips. All gears have possible factory repair grind marks. Phosphate coated

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Transmission will not shift into one gear — all others OK.	1. Manual-shift linkage damaged or worn.	1. Lubricate, repair or replace parts as required.
	2. Back-up switch ball frozen.	2. If reverse is problem, check back-up switch for ball frozen in extended position (if so equipped).
	3. Internal components.	3. Remove transmission. Inspect shift rail and fork system synchronizer system and gear clutch teeth for restricted travel. Repair or replace as required.

CC5205-2B

gears are especially easy to recognize since the grind operation removes a patch of phosphate and base metal exposing the lighter metallic color. Figs. 4, 5 and 6 show normal and abnormal gear tooth contact patterns, normal tooling marks, and approved and unapproved chip/nick removal procedures.

Reverse Idler Gear

Replace the reverse idler gear if the gear, bushing or roller bearings are badly worn or if the teeth are chipped or burred. Replace the reverse idler gear shaft if it is excessively worn or scored.

Input Shaft

Replace the input shaft if it is worn, bent, or twisted, if the gear has chipped, nicked, worn, or missing teeth, or if the cone surface is damaged. If the pilot bearing bore is scored, replace the gear and gear rollers.

Output Shaft

Replace all output shaft gears that are chipped, nicked, burred, or badly worn. Replace the output shaft if it is out of round or worn, or if the pilot bearing surface is scored.

Replace the speedometer drive gear if the gear teeth are worn or broken. Be sure to install the correct replacement gear.

Thrust Washers and Bearing Covers

Check the surfaces of all thrust washers. Replace washers that are scored and/or reduced in thickness.

Replace bearing covers that are grooved or showing wear from the thrust or adjacent bearings. Check the oil return threads in the bearing covers. If the sealing action of the threads has been destroyed by contact from the input or output shafts, replace the covers.

Synchronizer Blocking Rings

Inspect the synchronizer blocking rings for widened index slots, rounded clutch teeth and smooth internal surfaces (must have machined grooves). With the blocking ring on the cone, the distance between the face of the gear clutching teeth and the face of the blocking ring must not be less than 0.6mm (0.024 inch) for ZF 1-2 and 3-4 synchronizers, 0.2mm (0.008 inch) for ZF 5-Reverse synchronizer, and 1.5mm (0.059 inch) for Mazda synchronizers.

Check the synchronizer sleeves for free movement on the hubs. Make sure the alignment marks (etched or paint marks) are properly indexed.

Replace the seal in the input shaft bearing retainer.

Replace the seals on the cam and shafts.

Seals and Gaskets

Examine and replace if necessary, input and output shaft bearing retainer seals and gaskets.

Flywheel Clutch Face Runout

Install a dial indicator Tool D78P-4201-F, G or equivalent so that the indicator point bears against the flywheel face (Fig. 7). Turn the flywheel making sure that it is full forward or rearward so that crankshaft end play will not be indicated as flywheel runout.

If the flywheel clutch face runout exceeds specifications, (refer to the appropriate engine Section) remove the flywheel and check for burrs between the flywheel and the face of the crankshaft mounting flange. If no burrs exist, check the runout of the crankshaft mounting flange. Replace the flywheel or machine the crankshaft-flywheel mounting face if the mounting face flange runout is excessive. If the ring gear runout exceeds 0.25mm (0.010 inch), check installation of the gear to the flywheel flange. If it is not properly seated, re-install it to the flywheel. If it is properly seated, replace it. Refer to Ring Gear Replacement in Section 21-01 General Gasoline Engine Service, in the Light Truck—Engine manual volume B,* for the proper procedure. For flywheel runout specifications, refer to the appropriate engine Section under Specifications.

*Can be purchased separately.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Transmission is locked in one gear. It cannot be shifted out of that gear.	1. Internal components.	1. Remove transmission. Inspect problem gears, shift rails and forks and synchronizer for wear or damage. Repair as required.
	2. Loose fork on rail.	2. Check shift rail interlock system.
Transfer case makes noise.	1. Incorrect tire inflation pressures and/or incorrect size tires and wheels.	1. Assure that all tires and wheels are the same size, and that inflation pressures are correct.
	2. Excessive tire tread wear.	2. Check tire tread wear to see if there is more than .06 inch difference in tread wear between front and rear. Interchange one front and one rear wheel. Re-inflate tires to specifications.
	3. Internal components.	3. Operate vehicle in all transmission gears with transfer case in 2HI, or Hi range. — If there is noise in transmission in neutral gear, or in some gears and not in others, remove and repair transmission. — If there is noise in all gears, operate vehicle in all transfer case ranges. If noisy in all ranges or HI range only, disassemble transfer case. Check input gear, intermediate and front output shaft gear for damage. Replace as required. If noisy in LO range only, inspect intermediate gear and sliding gears for damage. Replace as required.
4-wheel drive transfer case jumps out of gear.	1. Incomplete shift linkage travel.	1. Adjust linkage to provide complete gear engagement.
	2. Loose mounting bolts.	2. Tighten mounting bolts.
	3. Front and rear driveshaft slip yokes dry or loose.	3. Lubricate and repair slip yokes as required. Tighten flange yoke attaching nut to specifications.
	4. Internal components.	4. Disassemble transfer case. Inspect sliding clutch hub and gear clutch teeth for damage. Replace as required.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Transmission leaks.	1. Improper amount of lubricant — wrong type.	1. Check level and type. Fill to bottom of filler plug hole.
	2. Other component leaking.	2. Identify leaking fluid as engine, power steering or transmission. Repair as required.
	3. False report.	3. Remove all traces of lube on exposed transmission surfaces. Check vent for free breathing. Operate transmission and inspect for new leakage. Repair as required.
	4. Internal components.	4. Remove transmission. Inspect for leaks at the input shaft bearing retainer seal and shift rail expansion plug. Inspect for leaks at the top cover gasket. Inspect case for sand holes or cracks. Repair or replace as required.
	5. Improper installation torque on fill and drain plugs.	5. Tighten to specified torque value.

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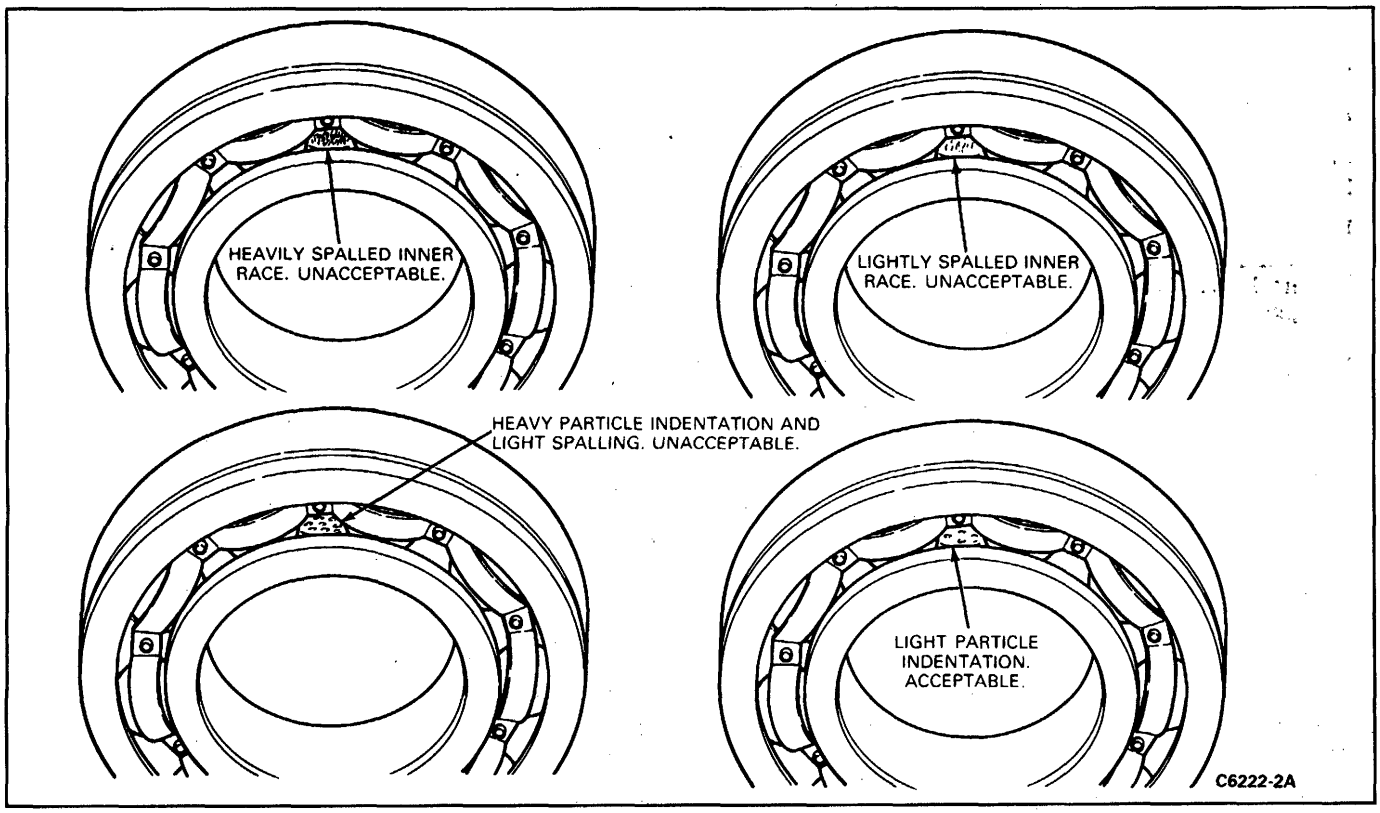


FIG. 3 Ball Bearing Inspection

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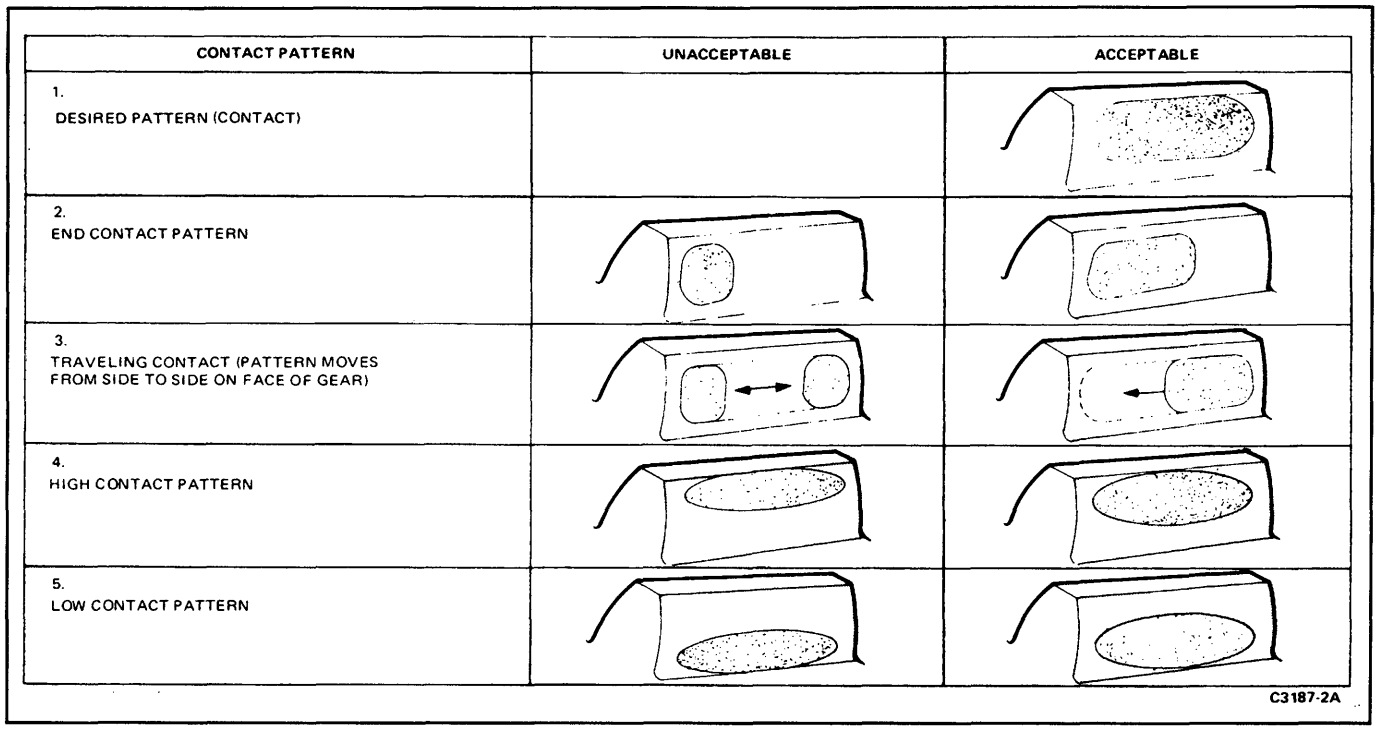


FIG. 4 Typical Transmission Gear Tooth Contact Patterns

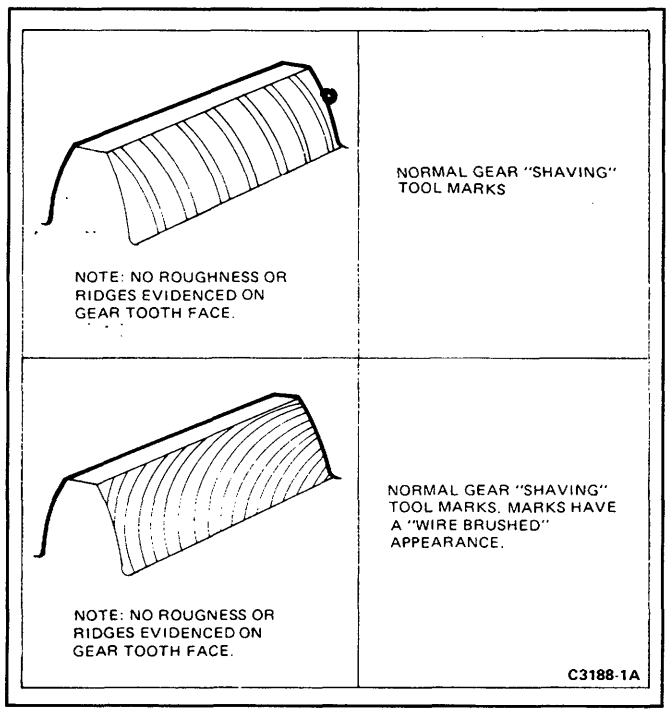


FIG. 5 Normal Tool Marks—Typical

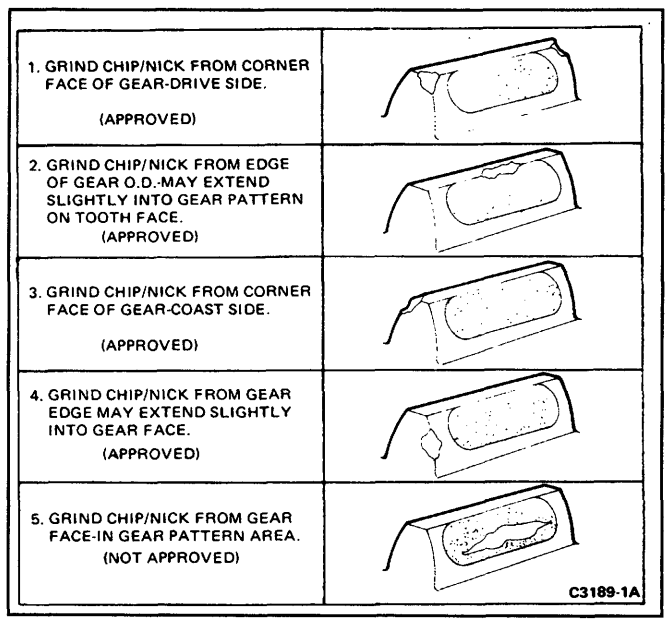


FIG. 6 Approved Transmission Gear Tooth Chip/Nick Removal Procedure

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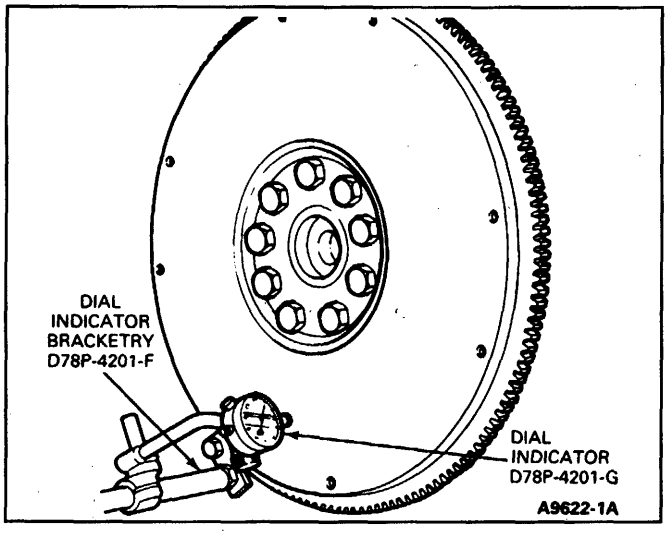


FIG. 7 Checking Flywheel Face Runout—Manual Transmission

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
D78P-4201-B	Dial Indicator with Magnetic Base	Universal
TOOL-4201-C, D78P-4201, F, G	Dial Indicator with Bracketry	Universal

CC4860-2C

MANUAL TRANSMISSION LUBRICANT CAPACITIES①

Transmission	Approximate Refill Capacity	
	U.S. Pints	Liters
Mazda M50D Five Speed Transmission②	7.6	3.6
ZF M50D-HD Five Speed Transmission③	6.8	3.2

①Fill transmissions to bottom of filler hole.
②Fill with ESP-MC2138-CJ (DEXRON II®) or equivalent.
③Fill with ESP-M2C166-H (Motorcraft Mercon) or equivalent.

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SECTION 16-20 Mazda M5OD Five-Speed Manual Overdrive Transmission

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General Inspection	16-20-17
Transmission	16-20-21
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DIAGNOSIS AND TESTING	16-20-1
DISASSEMBLY AND ASSEMBLY	
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VEHICLE APPLICATION

F-Series, Bronco, Econoline

DESCRIPTION

The M5OD is a top shift, fully synchronized, five-speed manual transmission, equipped with an overdrive fifth gear ratio. All gear changes including reverse are accomplished with synchronizer sleeves.

The transmission main case, top cover, and extension housing are constructed of aluminum alloy. Steel bearing race inserts provide durability in appropriate areas.

The extension housing contains a bronze alloy bushing. This bushing cannot be serviced. The extension housing must be replaced as a unit if the bushing requires service.



A – FORD MOTOR COMPANY PART NUMBER
B – SERIAL NUMBER
C – BAR CODE (INVENTORY PURPOSES)

C8663-1A

IDENTIFICATION

The Vehicle Safety Compliance Certification Label (located on the driver's door lock pillar) lists applicable transmission identification codes. For identification of the label codes, refer to Section 10-00, Identification codes.

Manual transmissions are equipped with service identification tags. The M5OD-R2 transmission service tag is located on the driver's side of the transmission.

DIAGNOSIS AND TESTING

For diagnosis and testing procedures, refer to Section 16-10, General Manual Transmission Service.

REMOVAL AND INSTALLATION

Removal and installation procedures unavailable at time of publication.

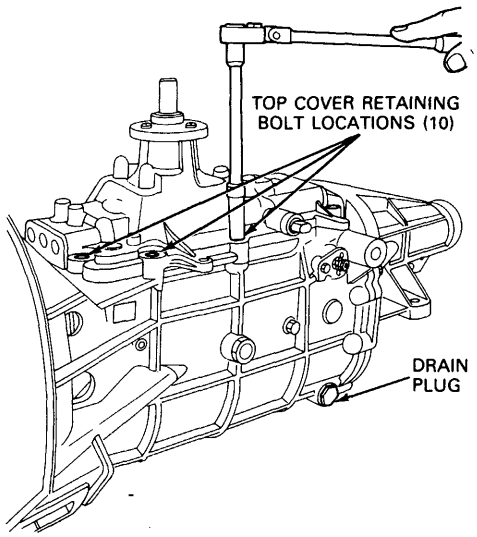
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DISASSEMBLY AND ASSEMBLY

Transmission

Disassembly

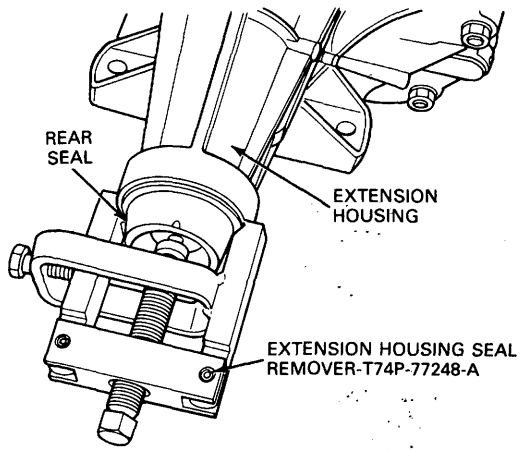
1. Using a 24mm wrench, remove transmission drain plug and drain transmission.



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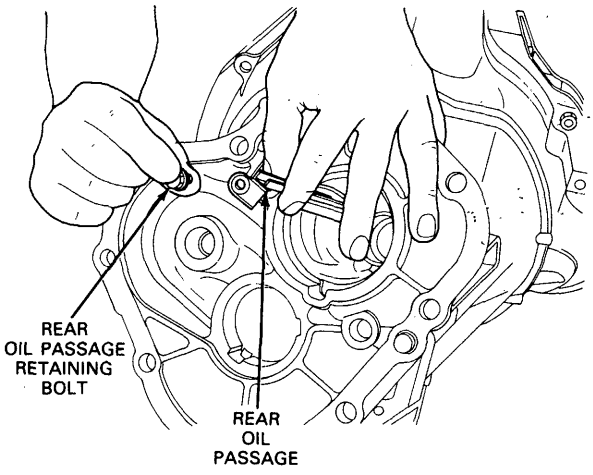
2. Remove shift lever and dust boot if necessary.
3. Using a 12mm wrench, remove ten top cover assembly retaining bolts. Remove top cover assembly.
4. Using a 14mm socket; remove nine extension housing retaining bolts. Pry gently at locations provided on extension housing and transmission case. Remove extension housing from case.

NOTE: On 4 x 2 models, if it is necessary to remove rear seal from extension housing, extension housing must be installed to transmission case. Remove extension housing rear seal using Seal Remover T74P-77248-A or equivalent.



C6720-1A

5. If necessary, remove rear oil passage from extension housing using a 10mm socket (4 x 2 models only).



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6. Remove and discard anti-spill oil seal from output shaft (On 4 x 2 models).

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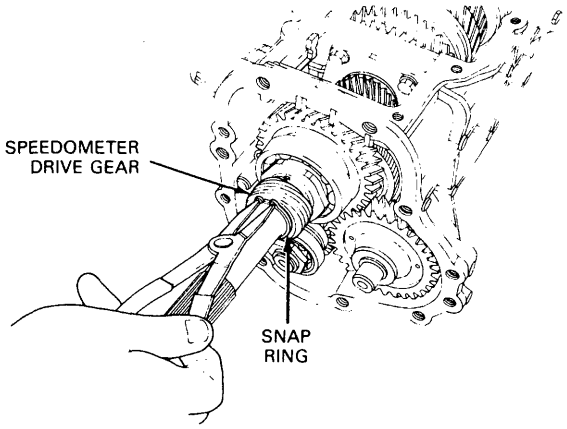
DISASSEMBLY AND ASSEMBLY (Continued)

7. Remove the speedometer drive gear and steel ball (On 4 x 2 models).

NOTE: For reference during assembly, observe and record speedometer drive gear color. Depending upon application, one of two different speedometer drive gears may be installed. It will be color-coded either green or white. Speedometer drive gear colors and corresponding part numbers are as follows:

White (Natural)—E8TZ-17285-B

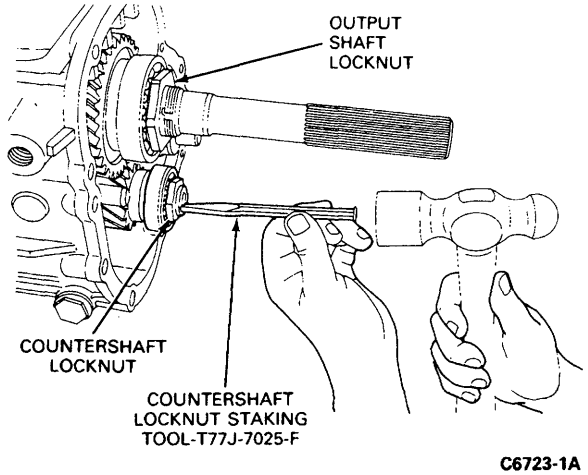
Green—E8TZ-17285-C



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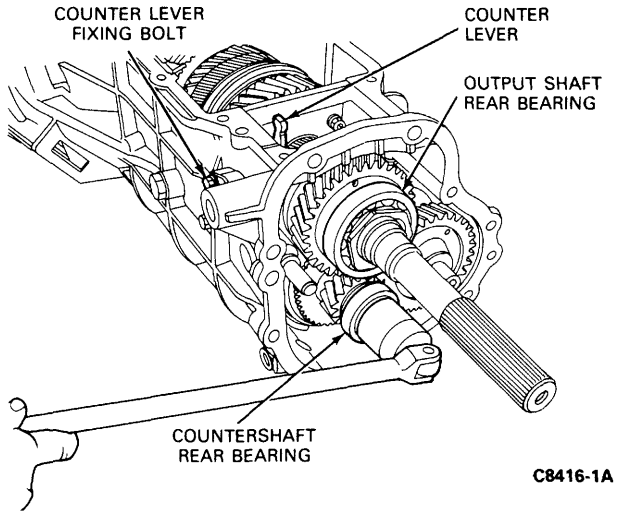
8. Lock transmission into first and third gears.
9. Using Countershaft Locknut Staking Tool T77J-7025-F or equivalent, release the staked areas securing output shaft and countershaft locknuts.

CAUTION: Staked areas of locknuts must be fully released or damage to shaft threads will result.



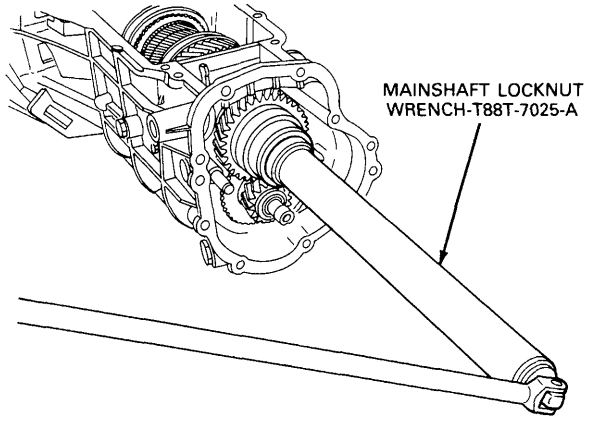
C6723-1A

10. Using a 32mm socket, remove and discard the countershaft rear bearing locknut. Remove the countershaft bearing and thrust washer.



C8416-1A

11. Using Mainshaft Locknut Wrench T88T-7025-A and Remover Tube T75L-7025-B or equivalents, remove and discard output shaft locknut.

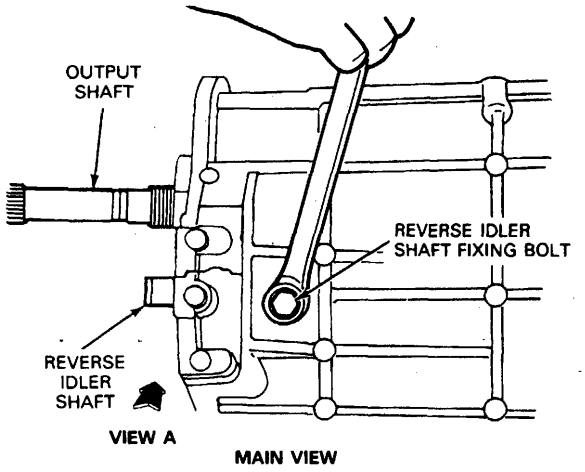


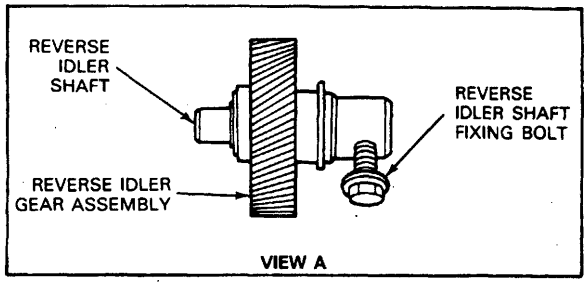
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DISASSEMBLY AND ASSEMBLY (Continued)

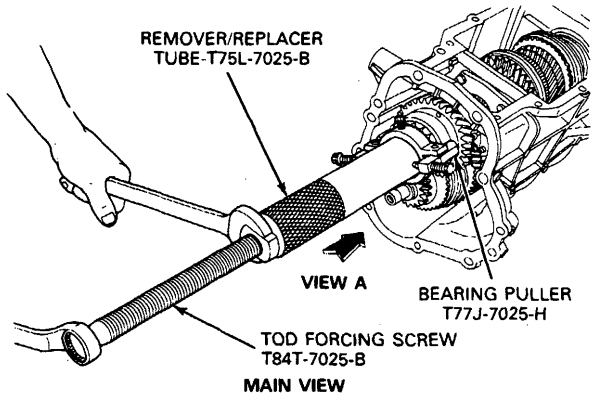
12. Using a 17mm wrench, remove reverse idler shaft fixing bolt. Remove reverse idler gear assembly by grasping and pulling rearward.

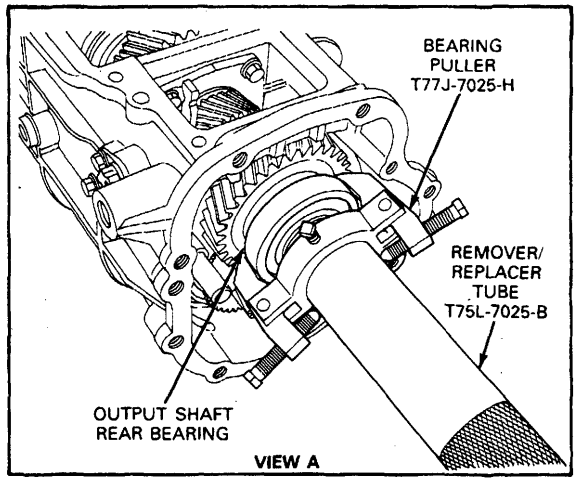




C6724-1A

13. Remove output shaft rear bearing from output shaft using Remover/Replacer Tube T75L-7025-B, TOD Forcing Screw T84T-7025-B, Bearing Puller T77J-7025-H, and Puller Ring T77J-7025-J or equivalents.



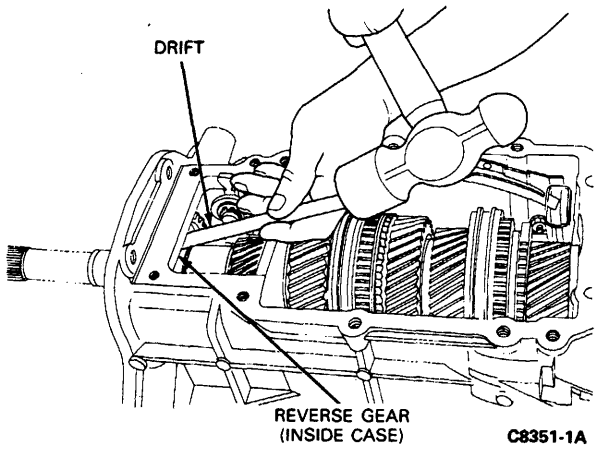


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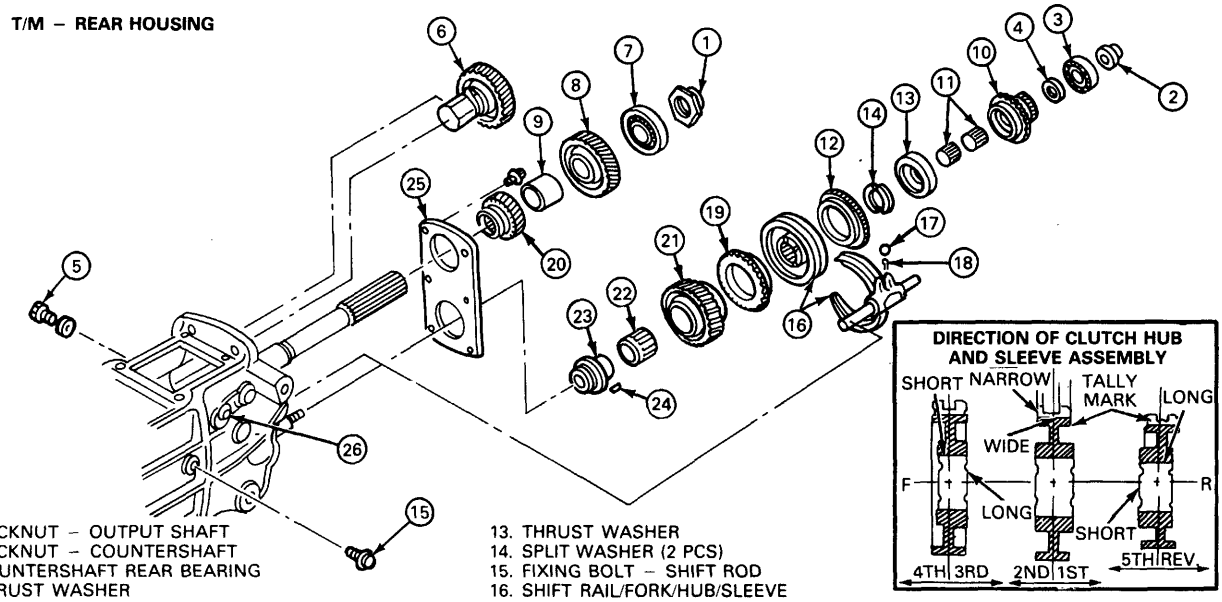
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DISASSEMBLY AND ASSEMBLY (Continued)

14. Using a brass drift and hammer, drive reverse gear from output shaft.



15. Remove sleeve from output shaft.
16. Remove counter reverse gear with two needle bearings and reverse synchronizer ring.



1. LOCKNUT – OUTPUT SHAFT
2. LOCKNUT – COUNTERSHAFT
3. COUNTERSHAFT REAR BEARING
4. THRUST WASHER
5. FIXING BOLT – REVERSE IDLER GEAR
6. REVERSE IDLE GEAR ASSEMBLY
7. BEARING – OUTPUT SHAFT REAR
8. REVERSE GEAR – OUTPUT SHAFT
9. SLEEVE – OUTPUT SHAFT
10. COUNTERSHAFT REVERSE GEAR
11. NEEDLE BEARINGS
12. SYNCHRONIZER RING – REVERSE
13. THRUST WASHER
14. SPLIT WASHER (2 PCS)
15. FIXING BOLT – SHIFT ROD
16. SHIFT RAIL/FORK/HUB/SLEEVE ASSEMBLY
17. LOCK BALL (STEEL) SHIFT RAIL
18. SPRING – SHIFT RAIL
19. SYNCHRONIZER RING – 5TH GEAR
20. 5TH GEAR – OUTPUT SHAFT
21. 5TH GEAR – COUNTERSHAFT
22. NEEDLE BEARING – 5TH GEAR
23. SLEEVE – 5TH GEAR
24. WOODRUFF KEY
25. CENTER BEARING COVER
26. 5TH/REVERSE COUNTER LEVER LOCKPLATE RETAINING BOLT

C8352-2A

17. Remove thrust washer and split washer from countershaft.
18. Using a 12mm wrench, remove fifth/reverse shift rod fixing bolt.
19. Remove the following parts as an assembly:
    - Fifth/reverse synchronizer hub and sleeve assembly (countershaft)
    - Fifth/reverse shift fork and rod

NOTE: Do not separate steel ball and spring (removed from shift fork groove) unless necessary.

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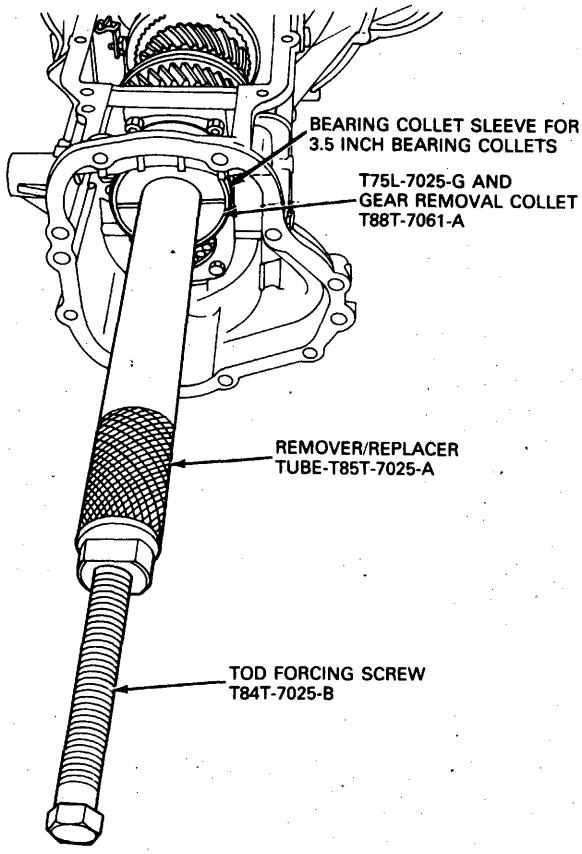
DISASSEMBLY AND ASSEMBLY (Continued)

20. Remove fifth gear synchronizer ring.
21. Remove the fifth/reverse counter lever lockplate retaining bolt and inner circlip. Remove counter lever assembly from transmission case.

NOTE: Do not remove the Torx® nut retaining the counter lever pin at this time.

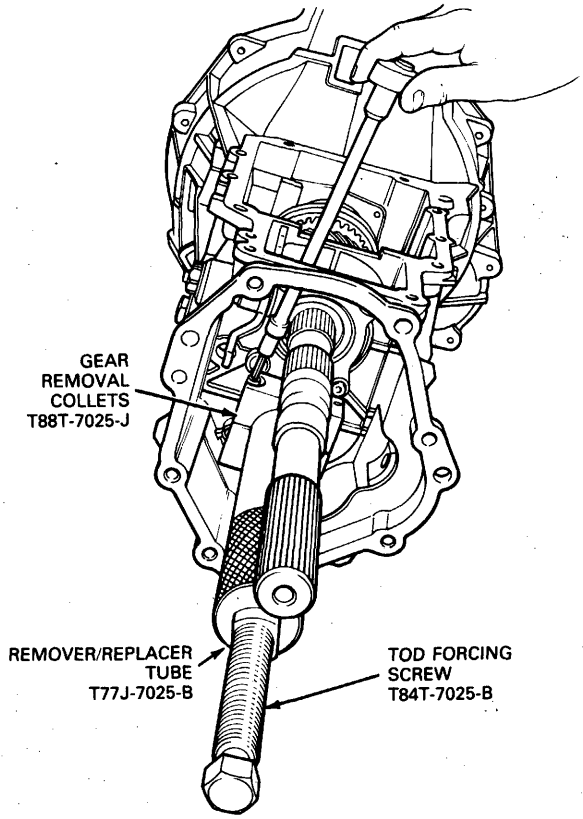
22. Remove fifth gear (counter) with needle bearing.
23. Remove fifth gear from output shaft using Bearing Collet Sleeve for 3.5-inch Bearing Collets T75L-7025-G, Remover/Replacer Tube T85T-7025-A, TOD Forcing Screw T84T-7025-B and Gear Removal Collet T88T-7061-A or equivalents.

NOTE: For reference during assembly, observe that the longer of the two collars on fifth gear faces forward.



C8673-1A

24. Remove fifth gear sleeve and (positioning) Woodruff key using TOD Forcing Screw T84T-7025-B, Countershaft Fifth Gear Sleeve Puller T88T-7025-J, Gear Removal Collets T88T-7025-J1, and Remover/Replacer Tube T77J-7025-B, or equivalents.



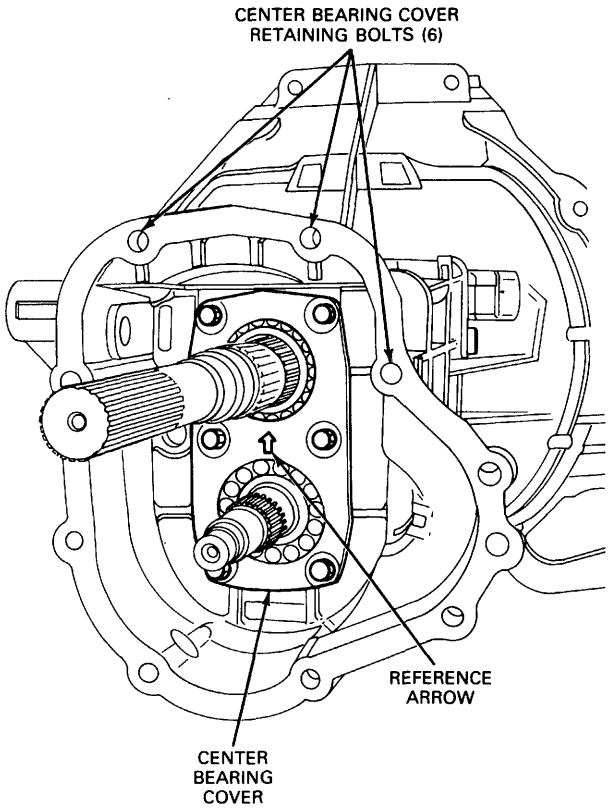
C9025-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

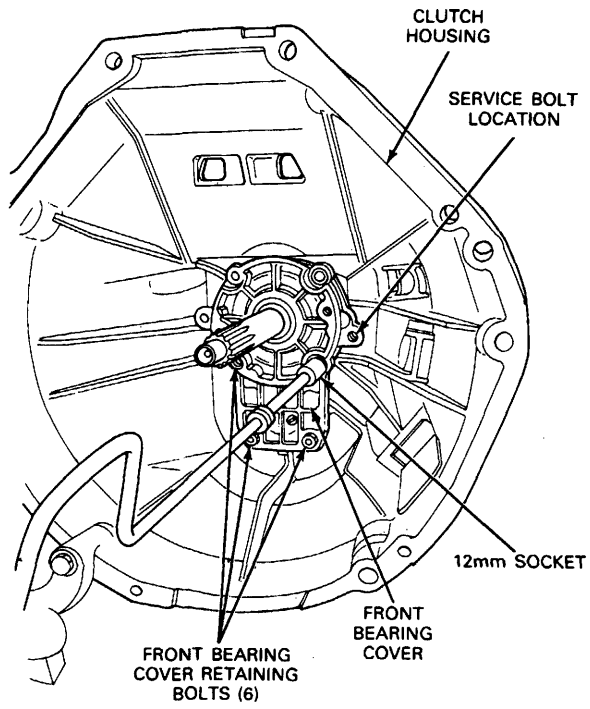
25. Using a 12mm socket, remove six center bearing cover retaining bolts. Remove center bearing cover.

NOTE: For reference during assembly, observe that reference arrow in middle of center bearing cover points upward. Observe that flanged side of center bearing cover faces inward.



C8354-1A

26. Using a 12mm socket, remove six front bearing cover attaching bolts.

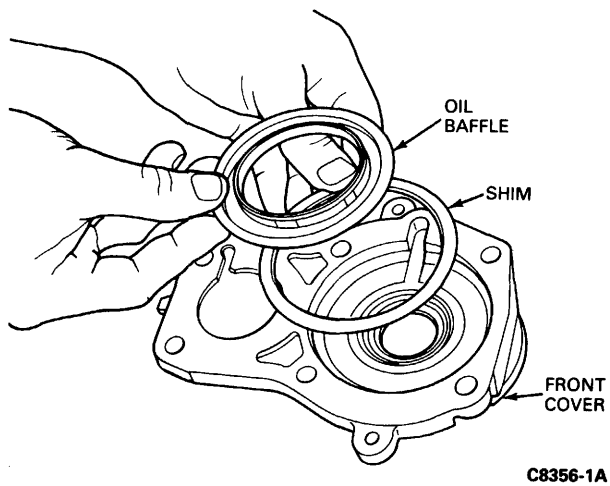


C8355-1A

27. Remove front bearing cover by threading two of the originally installed retaining bolts into the front bearing cover service bolt locations (nine o'clock and three o'clock). Alternately tighten bolts until front bearing cover can be lifted away by hand. Remove and discard front bearing cover oil baffle.

NOTE: Bolts threaded into service bolt locations will bottom out and lift front bearing cover away from transmission case.

NOTE: Do not remove plastic scoop ring from input shaft at this time.

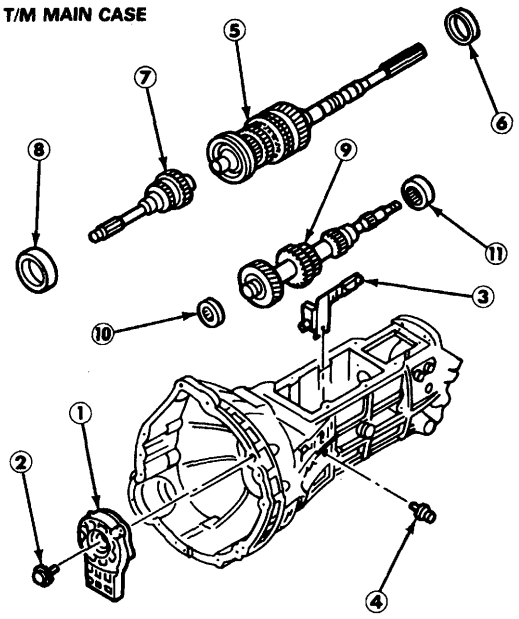


C8356-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

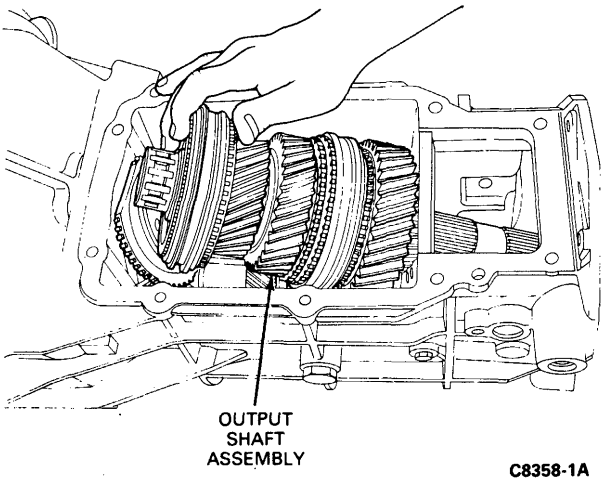
28. Using a 10mm socket, remove oil trough retaining bolt and oil trough from upper transmission case.



1. FRONT BEARING COVER
2. FRONT COVER RETAINING BOLT
3. OIL TROUGH
4. RETAINING BOLT – OIL TROUGH
5. OUTPUT SHAFT ASSEMBLY
6. OUTPUT SHAFT CENTER BEARING OUTER RACE
7. INPUT SHAFT ASSEMBLY
8. INPUT SHAFT BEARING OUTER RACE
9. COUNTER SHAFT ASSEMBLY
10. COUNTERSHAFT FRONT BEARING OUTER RACE
11. CONTERSHAFT REAR BEARING OUTER RACE

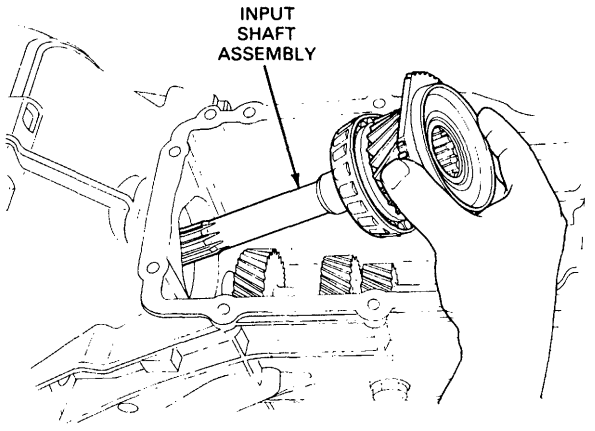
C8357-1A

29. Pull input shaft forward and remove input bearing outer race. Pull output shaft rearward.
30. Pull input shaft forward and separate it from output shaft. Incline output shaft upward and lift it from transmission case.



C8358-1A

31. Remove input shaft from transmission case.



C8359-1A

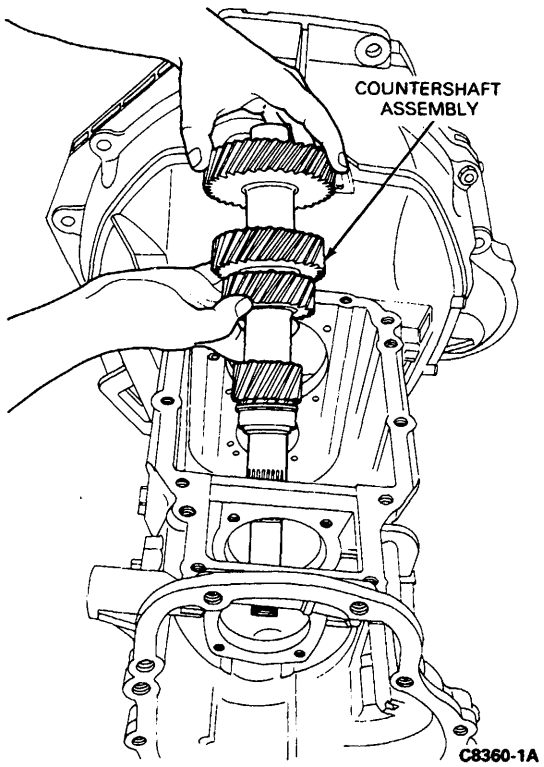
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DISASSEMBLY AND ASSEMBLY (Continued)

32. Remove countershaft bearing outer races (front and center) by moving countershaft forward and rearward. Pull countershaft rearward far enough to permit tool clearance behind front countershaft bearing. Using Bearing Race Puller T88T-7120-A and Slide Hammer T50T-100-A or equivalents, remove front countershaft bearing.

CAUTION: Tap gently during bearing removal. A forceful blow can cause damage to bearing or transmission case.

33. Remove countershaft through upper opening of transmission case.

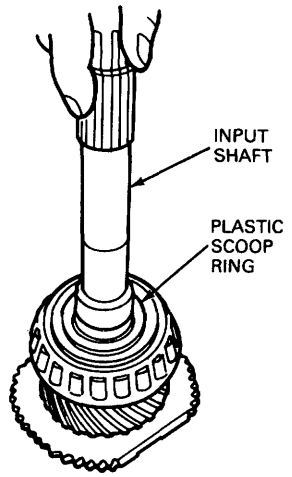


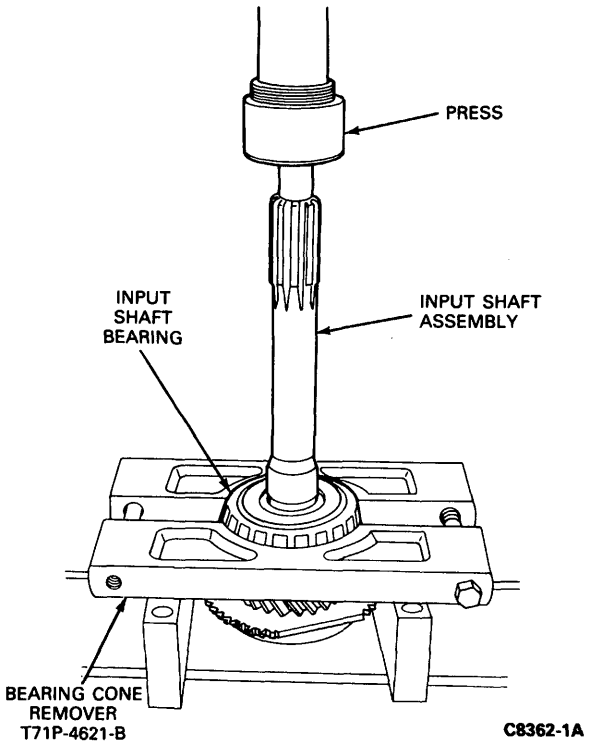
SUBASSEMBLIES

Input Shaft

Disassembly

1. Remove and discard plastic scoop ring.
2. Press tapered roller bearing from input shaft using Bearing Cone Remover T71P-4621-B or equivalent, and arbor press.



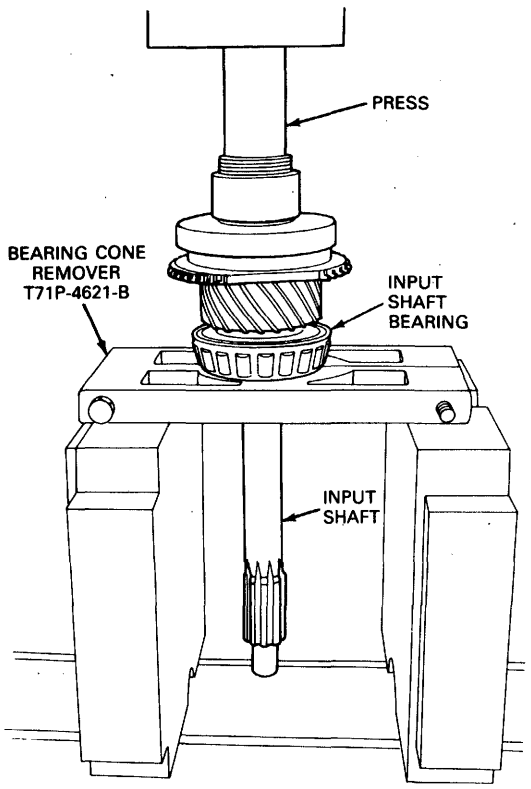


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SUBASSEMBLIES (Continued)

Assembly

1. Install input shaft tapered roller bearing onto input shaft using a press and Bearing Cone Replacer T88T-7025-B or equivalent.

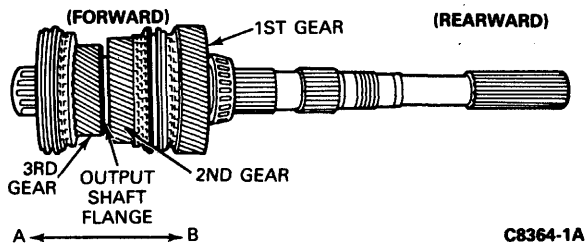


2. Install plastic scoop ring onto input shaft. Manually rotate ring clockwise to ensure that input shaft oil holes properly engage scoop ring. A click should be heard as scoop ring notches align with input shaft oil holes.

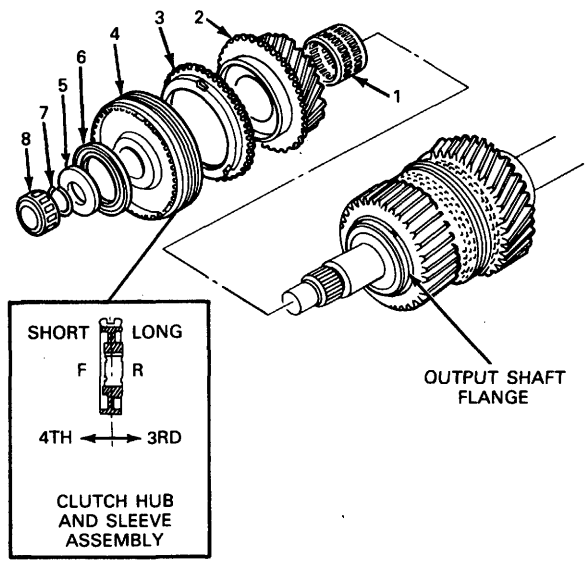
Output Shaft

Disassembly

1. Position output shaft front flange as illustrated. Use this flange as a reference point and dividing line during assembly and disassembly procedures.



2. Remove pilot bearing (needle roller), snap ring, needle bearing, and spacer from front (short side of flange) of output shaft.



1. NEEDLE BEARING – 3RD GEAR
2. THIRD GEAR
3. SYNCHRONIZER RING – 3RD GEAR
4. CLUTCH HUB AND SLEEVE ASSEMBLY – 3RD/4TH
5. SPACER
6. NEEDLE BEARING (PLAIN)
7. RETAINING RING
8. ROLLER BEARING – PILOT BEARING

C8365-1A

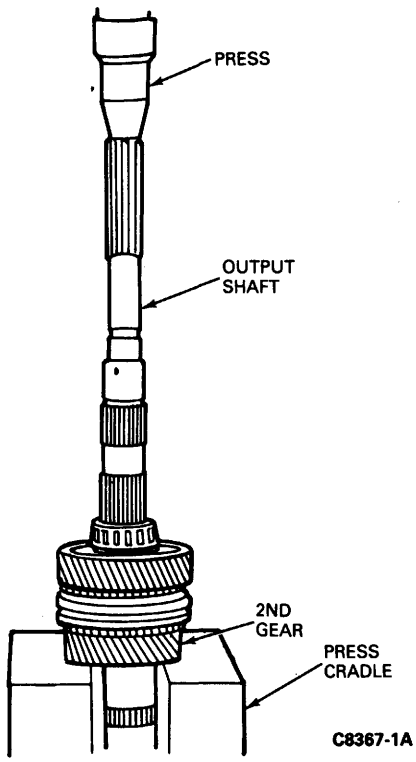
3. Position the front (short side of flange) of output shaft so that it faces upward. Lift off the following components as a unit:
   - Clutch hub and sleeve assembly (third/fourth).
   - Synchronizer ring (third).
   - Third gear.
   - Needle bearing.

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SUBASSEMBLIES (Continued)

4. Position output shaft with rear end (long side of flange) facing upward. Position output shaft into press with press cradle contacting lower part of second gear.

NOTE: Ensure that output shaft flange does not contact or ride up onto press cradle. Improper positioning of output shaft can cause component damage.

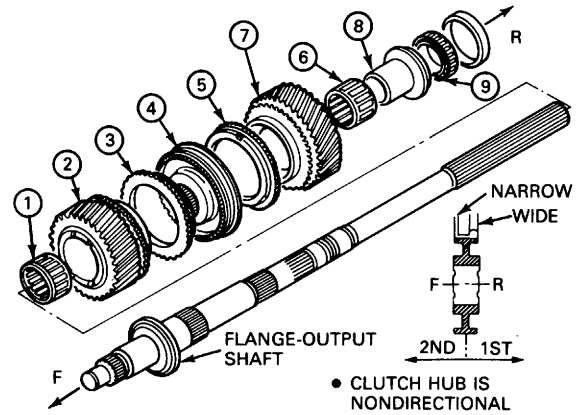


5. Press off the following components as a unit: Center bearing, first gear sleeve, first gear, needle bearing, first/second clutch hub and sleeve assembly, first/second synchronizer rings, second gear, and needle bearing using Bearing Replacer T53T-4621-B and Bearing Cone Replacer T88T-7025-B or equivalents. (Use T53T-4621-B as a press plate, and Bearing Cone Replacer T88T-7025-B to protect inner race rollers.)

Assembly

1. Position output shaft so that the rear end (long side of flange) faces upward. Install the following parts in the order listed.

NOTE: To install components onto output shaft, position components as shown. Press components into position using Bearing Replacer T53T-4621-B and Bearing Plate T75L-1165-B or equivalents.



- Second gear needle bearing
- Second gear
- Second gear synchronizer ring
- First/second clutch hub and sleeve assembly
- First gear synchronizer ring
- First gear needle bearing
- First gear
- First gear sleeve
- Center bearing (inner)

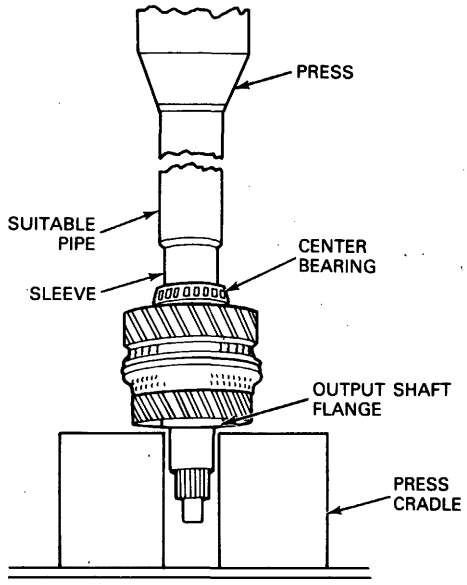
NOTE: Ensure that center bearing race is installed into transmission case.

NOTE: When installing first/second clutch hub and sleeve, ensure that smaller width of sleeve faces second gear (front) side. Ensure that reference marks face rear of transmission; they reference synchronizer key installation position.

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SUBASSEMBLIES (Continued)

2. Install center bearing to output shaft.

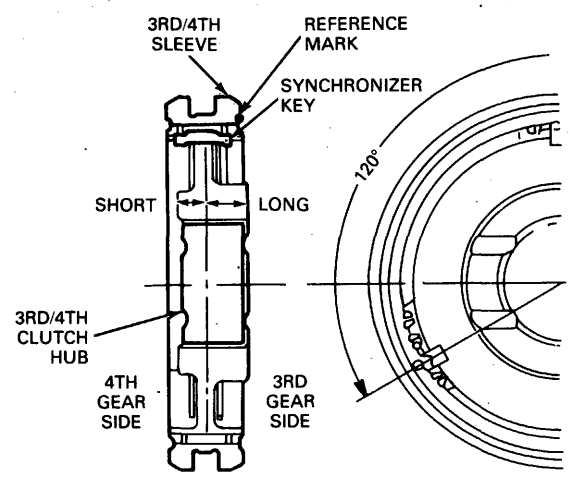


C8368-1A

3. Position output shaft so that front (short side) of output shaft flange faces upward. Install the following parts in the order listed.
   - Third gear needle bearing
   - Third gear
   - Third gear synchronizer ring

4. Install third/fourth clutch hub and sleeve as follows:
   - Mate clutch hub synchronizer key groove with reference mark on the clutch hub sleeve. The mark should face rearward.
   - Install longer flange on clutch hub sleeve toward third gear (rear) side.

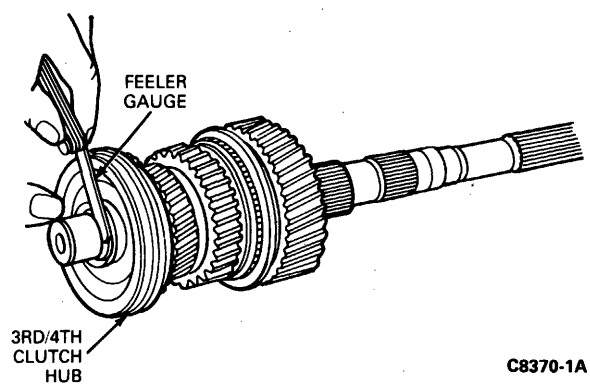
NOTE: The front and rear sides of the clutch hub are the same except for the reference mark on one side.



C8369-1A

5. Install the following parts in the order listed.
   - Spacer
   - Needle bearing—install with rollers upward (visible)
   - Retaining ring
   - Pilot bearing (roller)

6. Install original retaining ring. Check clutch hub end play using a feeler gauge.



C8370-1A

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SUBASSEMBLIES (Continued)

7. If necessary, adjust third/fourth clutch hub end play to 0.00-0.05mm (0.00-0.0019 inch) by selecting required retaining ring according to the chart. Install a new retaining ring if necessary.

NOTE: During installation, apply Dexron-II® or equivalent to all rotating or sliding parts.

RETAINING RING SELECT CHART

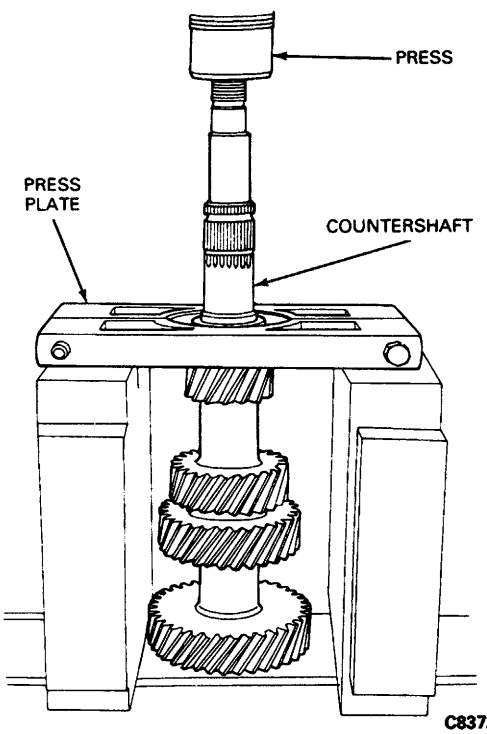
Part Number	Thickness	Part Number	Thickness
E8TZ-7030-A	1.50mm (0.059 in.)	E8TZ-7030-F	1.75mm (0.0688 in.)
E8TZ-7030-B	1.55mm (0.061 in.)	E8TZ-7030-G	1.80mm (0.0708 in.)
E8TZ-7030-C	1.60mm (0.0629 in.)	E8TZ-7030-H	1.85mm (0.0728 in.)
E8TZ-7030-D	1.65mm (0.0649 in.)	E8TZ-7030-J	1.90mm (0.0748 in.)
E8TZ-7030-E	1.70mm (0.0669 in.)	E8TZ-7030-K	1.95mm (0.0767 in.)

CC8371-2A

Countershaft

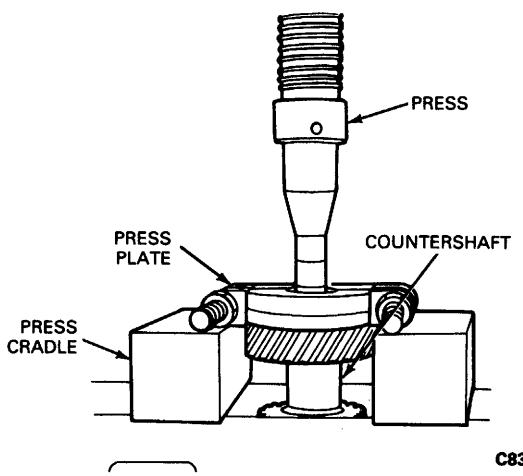
Disassembly

1. Using a press and Bearing Cone Remover T71P-4621-B or equivalent, remove the countershaft center bearing inner race.



C8372-1A

2. Using a press and Bearing Splitter D84L-1123-A or equivalent, remove the countershaft front bearing inner race.



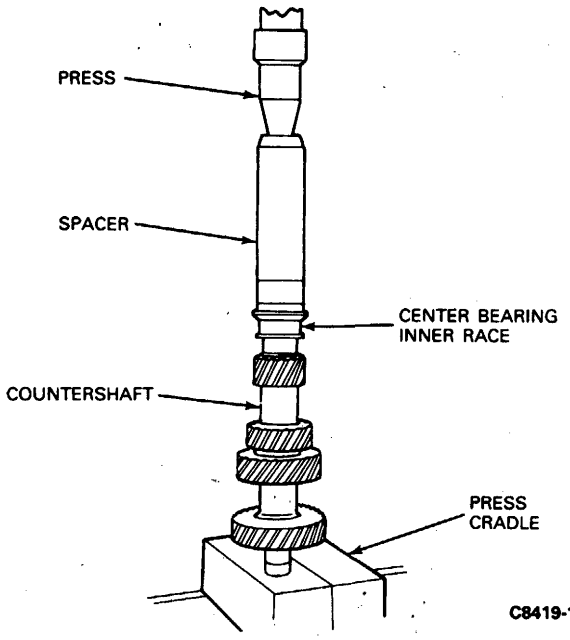
C8373-1A

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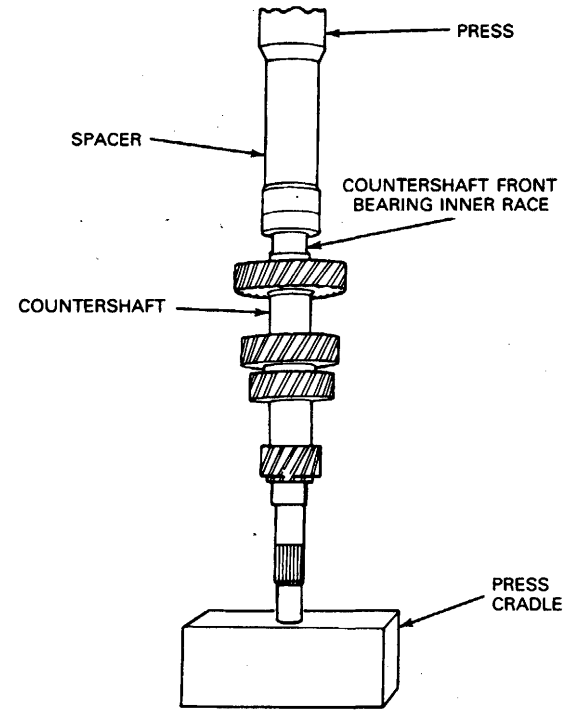
SUBASSEMBLIES (Continued)

Assembly

1. Using a press, a suitable press plate, and Bearing Replacer T53T-4621-B or equivalent, install center bearing inner race.



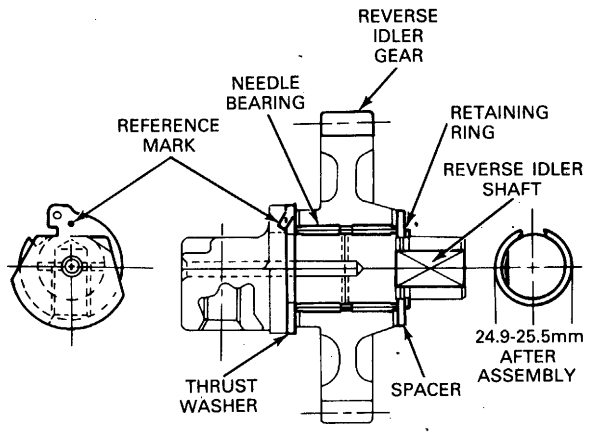
2. Using a press, a suitable press plate and Bearing Replacer T53T-4621-B or equivalent, install countershaft front bearing inner race.



Reverse Idler Gear Shaft

Disassembly

1. Remove the following parts from reverse idler gear shaft:
   - Retaining ring
   - Spacer
   - Idler gear
   - Needle bearings
   - Thrust washer



Assembly

1. Install thrust washer onto reverse idler gear shaft. Ensure that tab on thrust washer mates with groove on reverse idler shaft to prevent rotation of thrust washer.
2. Install the following parts onto reverse idler gear shaft in the order listed.
   - Needle bearings
   - Idler gear
   - Spacer
3. Install original retaining ring onto reverse idler gear shaft. Insert a feeler gauge between retaining ring and reverse idler gear to measure reverse idler gear end play. Using the chart, adjust reverse idler gear end play to 0.1-0.2mm (0.0039-0.0078 inch) by installing a retaining ring of necessary thickness.

REVERSE IDLER GEAR RETAINING RINGS

Part Number	Thickness
E8TZ-7156-F	1.5mm (0.059 in.)
E8TZ-7156-E	1.6mm (0.0629 in.)
E8TZ-7156-D	1.7mm (0.0669 in.)
E8TZ-7156-C	1.8mm (0.0708 in.)
E8TZ-7156-B	1.9mm (0.0748 in.)

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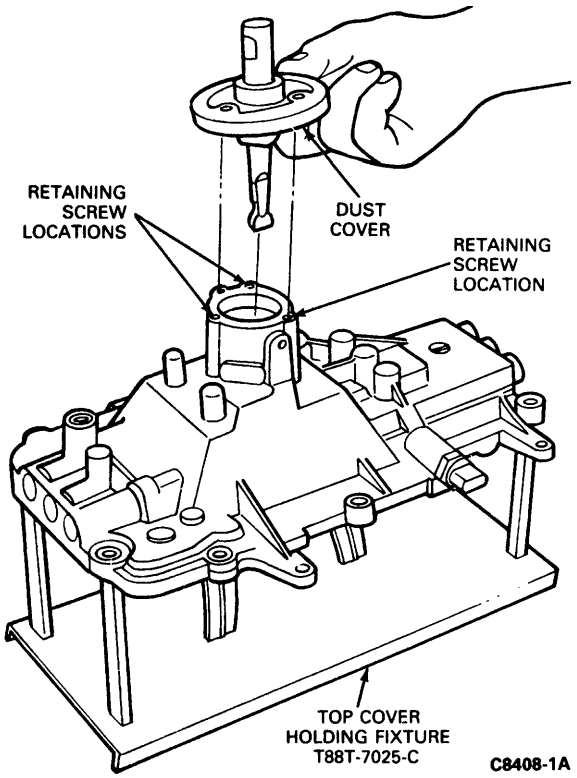
SUBASSEMBLIES (Continued)

Top Cover

Disassembly

1. If necessary, remove dust boot and shift lever from top cover. Remove three dust cover retaining screws using a 4mm Allen wrench. Remove dust cover.

NOTE: For reference during assembly, notice that grooves in bushing align with slots in lower shift lever pivot ball. Notice that the notch in the lower shift lever faces toward front of transmission.



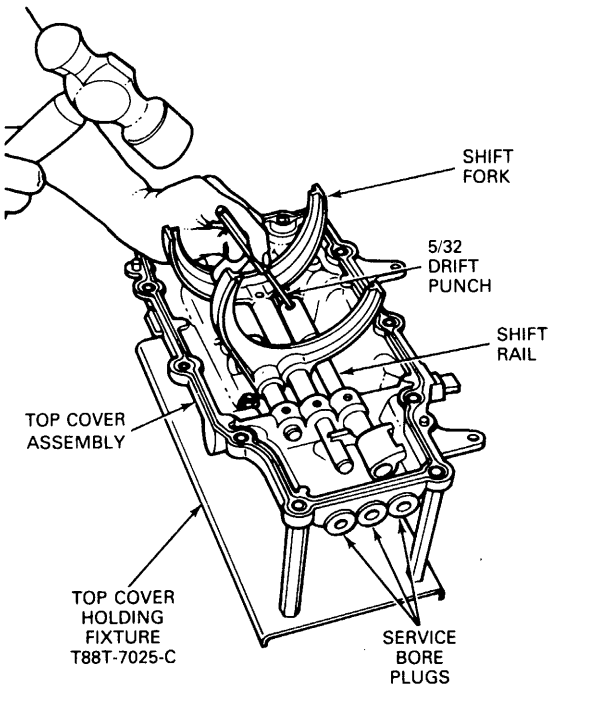
2. Position top cover assembly into Top Cover Holding Fixture T88T-7025-C or equivalent.

3. Remove backup lamp switch from top cover. Remove backup lamp switch pin from groove in top cover.

NOTE: Only one type of backup lamp switch pin is used.

4. Using a 5/32-inch drift punch, remove spring pins retaining shift forks to shift rails.

NOTE: Discard original spring pins.



5. Ensure that fifth/reverse shift rail is in fully forward position. Remove spring pin from end of fifth/reverse rail.

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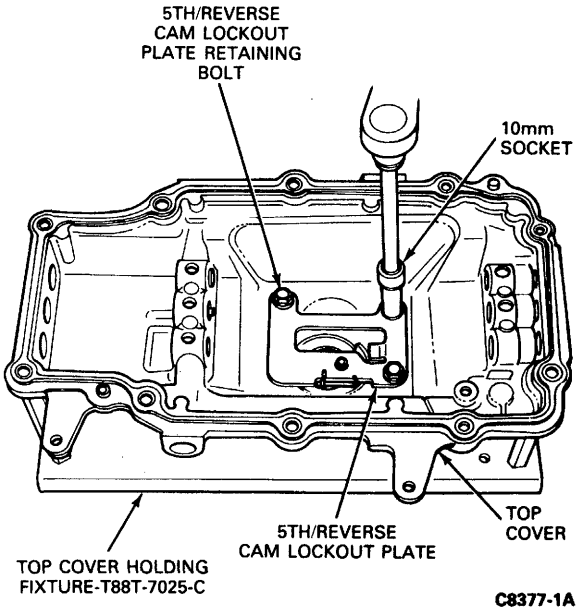
SUBASSEMBLIES (Continued)

6. Remove three rubber plugs blocking shift rod service bores.

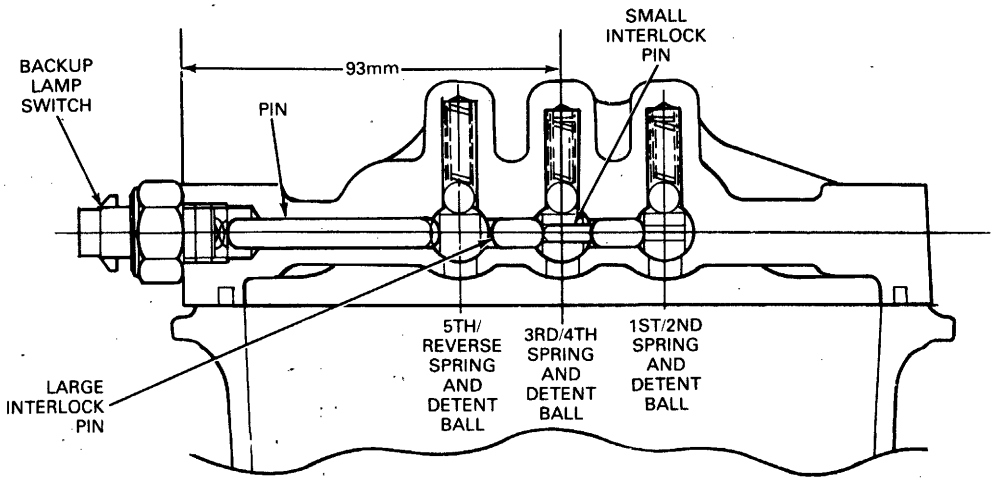
CAUTION: Perform the following shift rail removal procedures with great care. Cover the lock ball bores and friction device and spring seats with a clean cloth held firmly in place during shift rail removal. Failure to firmly cover lock ball bores and friction device can result in component loss when the ball/friction device and spring forcefully leave their installed positions.

WARNING: WEAR SAFETY GLASSES WHILE PERFORMING SHIFT RAIL REMOVAL PROCEDURE.

7. Remove fifth/reverse shift rail from top cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.
8. Remove first/second shift rail from top cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.
9. Remove third/fourth shift rail from top cover through service bore. If necessary, insert a drift punch through spring pin bore and gently rock shift rail from side to side while maintaining rearward pressure.
10. Remove fifth/reverse cam lockout plate retaining bolts using a 10mm socket. Remove fifth/reverse cam lockout plate.



C8377-1A



C8394-2A

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SUBASSEMBLIES (Continued)

Assembly

1. Position top cover into Top Cover Holding Fixture T88T-7025-C or equivalent.
2. Position fifth/reverse cam lockout plate to top cover. Install fifth/reverse cam lockout plate retaining bolts and tighten to 8-10-N·m (6-7 ft-lb).
3. Position third/fourth shift rail into top cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining forward pressure. Engage third/fourth shift fork with shift rail. Position detent ball and spring into top cover spring seats. Compress the detent ball and spring assembly using a suitable tool, and push shift rail into position over detent ball. Position friction device and spring into top cover spring seats. Compress friction device and spring assembly using a suitable tool, and push shift rail into position over friction device. Install spring pins retaining shift rail to top cover. Install spring retaining third/fourth shift fork to shift rail.
4. Position first/second shift rail into top cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock shift rail from side to side while maintaining forward pressure. Engage first/second shift fork with shift rail. Position detent ball and spring into top cover spring seats. Compress the detent ball and spring assembly using a suitable tool and push shift rail into position over detent ball. Position friction device and spring into top cover spring seats. Compress friction device and spring assembly using a suitable tool, and push shift rail into position over friction device. Install spring pins retaining shift rail to top cover. Install spring pin retaining first/second shift fork to shift rail.
5. Position fifth/reverse shift rail to top cover through service bore. If necessary, insert a 5/16-inch drift punch through spring pin bore and gently rock from side to side while maintaining forward pressure. Engage fifth/reverse shift fork with shift rail. Position detent ball and spring into spring seats. Compress the detent ball and spring using a suitable tool, and push shift rail into position over detent ball. Install spring pins retaining shift rail to top cover. Install spring pin retaining fifth/reverse shift fork to shift rail.
6. Install rubber plugs into service bores.
7. Install interlock pins into first/second and third/fourth shift rails. Ensure that large and small interlock pins are installed into their original positions.

NOTE: *Improper installation of interlock pins will prevent activation of neutral switch and/or backup lamp switch.*

8. Apply sealant to backup lamp switch and neutral switch threads. Install switches to top cover and tighten to 25-35 N·m (18-26 ft-lb).
9. Position lower shift lever and dust cover assembly to top cover. Install three retaining screws and tighten to specification.

CLEANING AND INSPECTION

Cleaning

1. Wash all parts, except ball bearings and seals, in a suitable cleaning solvent. Brush or scrape all foreign matter from the parts. Be careful not to damage any parts with the scraper. Do not clean, wash, or soak transmission seals in cleaning solvent. Dry all parts with compressed air.
2. Rotate the bearings in a cleaning solvent until all lubricant is removed. Hold the bearing assembly to prevent it from rotating while drying it with compressed air.
3. Lubricate the bearings with approved transmission lubricant. Wrap them in a clean, lint-free cloth or paper, until ready for use.

General Inspection

1. Inspect transmission case and housing for cracks, worn or damaged bores, damaged threads, or any other damage that could affect operation of the transmission. Inspect the machined mating surfaces for burrs, nicks or damage.
2. Inspect the front face of case for small nicks or burrs that could cause misalignment of transmission with flywheel housing. Remove all small nicks or burrs with a fine stone.
3. Inspect bell housing for cracks. Make sure the machined mating surfaces are free from burrs, nicks, or any other damage.
4. Check the condition of shift levers, forks, shift rails and shafts.
5. Inspect ball bearings. Refer to Ball Bearing Inspection.

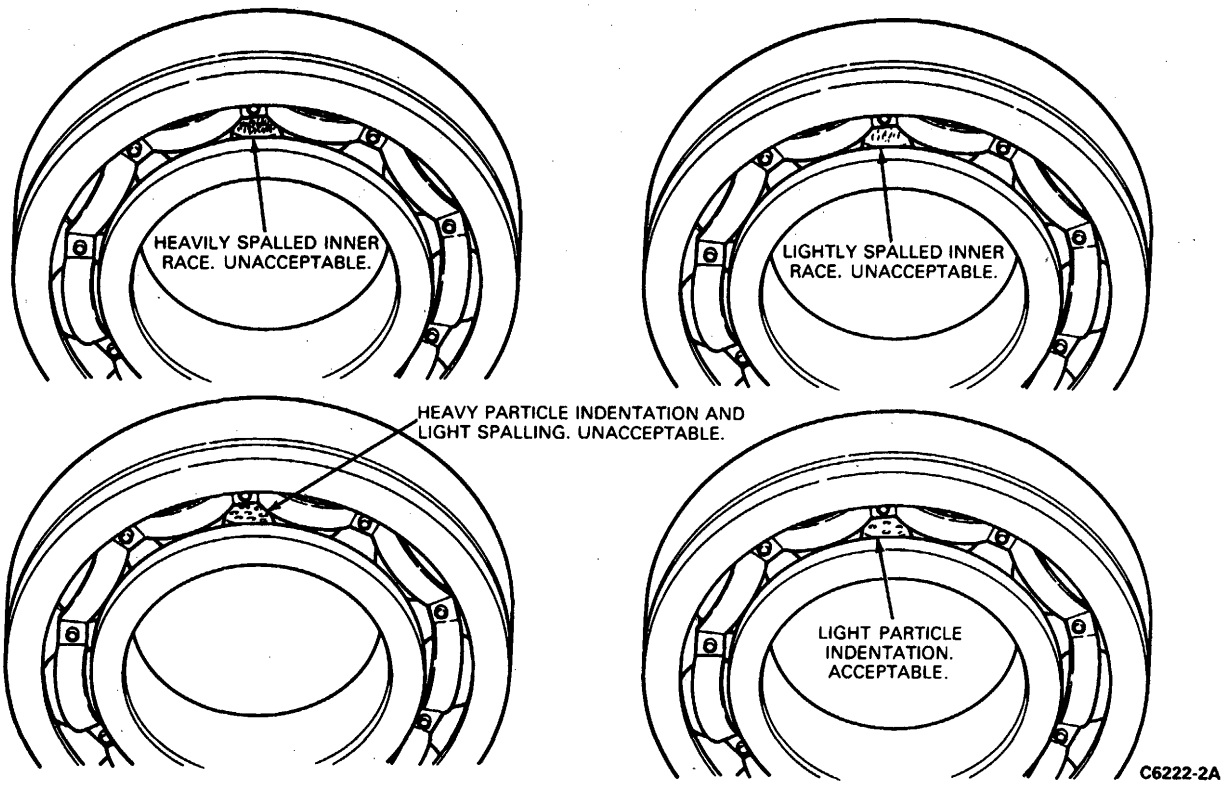
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CLEANING AND INSPECTION (Continued)

Ball Bearing Inspection

Bearing Raceways

1. Inner Ring Raceway—While holding outer ring stationary, rotate inner ring at least three revolutions. Examine raceway of inner ring for pits or spalling. If pits or spalling are unacceptable, replace the bearing assembly. Light particle indentation is acceptable.
2. Outer Ring Raceway—While holding inner ring stationary, rotate outer ring at least three revolutions. Examine raceway of the outer ring from the same side as the raceway of the inner ring. If raceway is spalled or pitted, similar to that shown, replace the bearing assembly. Light particle indentation is acceptable.



Bearing External Surfaces

The bearing must be replaced if damage is found in any of the following areas:

1. Radial cracks on front and rear faces of outer or inner rings.
2. Cracks on outside diameter or outer ring (particularly around snap ring groove).
3. Deformation or cracks in ball cage (particularly around rivets).

Spin Test

1. Lubricate bearing raceways with a slight amount of clean oil. Turn the bearing back and forth slowly until raceways and balls are coated with oil.
2. Hold bearing by inner ring in a vertical position. Vertical movement between the inner and outer rings in acceptable. Spin outer ring several times by hand (do not use an air hose). If roughness or vibration is noticeable or the outer ring stops abruptly, the bearing should be cleaned again and lubricated. Roughness in a bearing is usually caused by foreign particles in the bearing, which comes from inside the transmission case. If bearing is still rough after cleaning and relubricating three times, it must be replaced.
3. Hold bearing by the inner ring in a horizontal position with the snap ring groove up. Spin outer ring several times by hand (do not use an air hose). If bearing is still rough after cleaning and re-lubricating three times (if not done in Step 2), it must be replaced. If bearing passes the visual inspection and spin tests, it can be re-installed in transmission.

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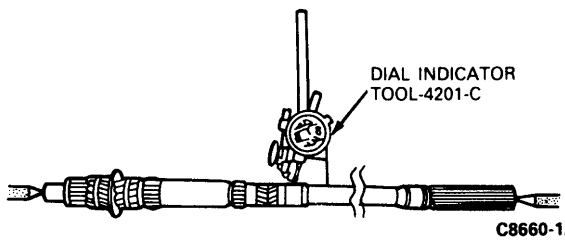
CLEANING AND INSPECTION (Continued)

Gear Inspection

Inspect the teeth of each gear. If excessively worn, broken or chipped, replace the gear. Excessive wear increases backlash, which results in noise and unacceptable operating characteristics.

Output Shaft Inspection

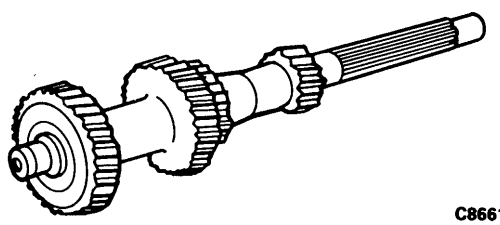
1. Check output shaft for run-out by mounting the shaft between V-blocks and applying dial indicator TOOL-4201-C or equivalent to several places along shaft. The standard reading of the indicator for run-out should be less than 0.05mm (0.002 in.). If run-out exceeds 0.05mm (0.002 in.), replace mainshaft.
2. Replace input shaft if spines are damaged. If needle bearing surface in bore of bearing is worn or rough, or if cone surface is damaged, replace shaft.



C8660-1A

Countershaft Inspection

Check countershaft gear teeth and countershaft splines for wear or damage. Replace countershaft if bent, scored, or worn.

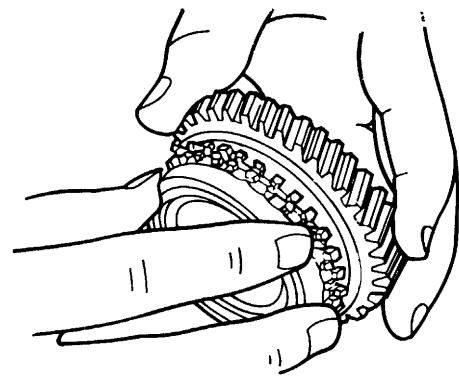

C8661-1A

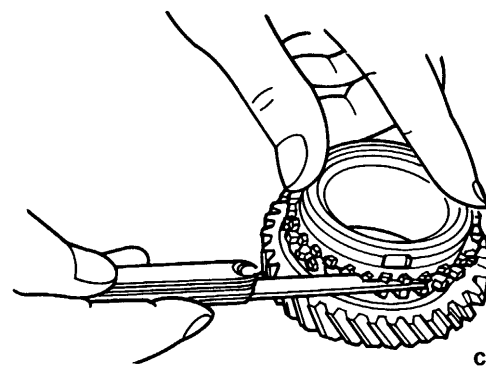
Synchronizer Mechanism Inspection

1. Inspect gear teeth on synchronizer ring. If there is evidence of chipping or excessively worn teeth, replace with new parts.
2. Inspect synchronizer ring for wear. To check the wear of synchronizer ring, fit synchronizer ring evenly to gear cone. Measure clearance between side faces of synchronizer ring and gear with a feeler gauge. If clearance is less than 0.8mm (0.031 in.), replace synchronizer ring or gear.

NOTE: First/second, third/fourth and fifth/reverse synchronizer-to-gear clearance specifications are the same.

3. Inspect contact between inner surface of synchronizer ring and cone surface of gear. To inspect, apply a thin coat of Prussian Blue or equivalent on cone surface of gear and fit in into the ring. If the contact pattern is poor, correct this by applying compound and lapping surfaces together.
4. Make sure clutch sleeve slides easily onto clutch hub.
5. Check synchronizer inserts (keys), inner surface of clutch sleeve, and insert groove on clutch hub for wear.
6. Check synchronizer insert spring for tension.


C8656-1A

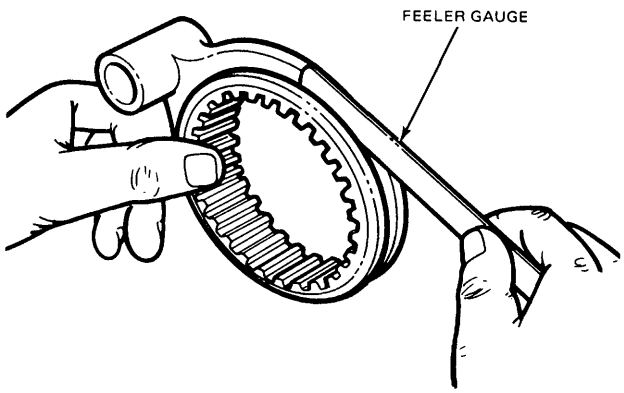

C8657-1A

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CLEANING AND INSPECTION (Continued)

Shift Fork/Clutch Hub Sleeve Inspection

Check the contact surfaces of the shift fork and clutch hub sleeve for evidence of wear or damage. Measure from shift fork to the clutch hub sleeve. Clearance should not exceed 0.8mm (0.031 in.).



C3437-1A

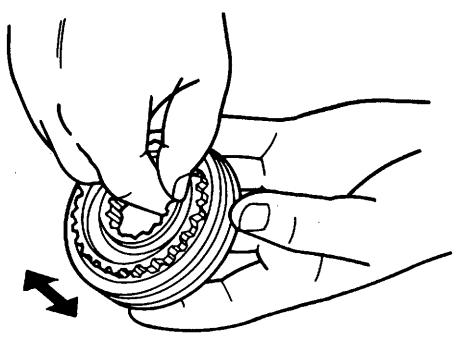
CLUTCH HUB SLEEVE-TO-SHIFT FORK CLEARANCE (R2)

Standard	Maximum
1st/2nd 0.1-0.358mm (0.003-0.014 in.)	0.8mm (0.314 in.)
3rd/4th 0.1-0.358mm (0.003-0.014 in.)	0.8mm (0.314 in)
5th/Rev 0.1-0.358mm (0.003-0.014 in.)	0.8mm (0.314 in.)

CC8662-1A

Clutch Hub Inspection

1. Check operation of clutch hub sleeve installed onto hub.
2. Position clutch hub and sleeve horizontally. Lift the hub approximately three-quarters of the way off the sleeve. Release the hub, and observe downward motion. Hub should slide downward into sleeve on its own. It should not be necessary to push hub into sleeve. Service as necessary.



C8658-1A

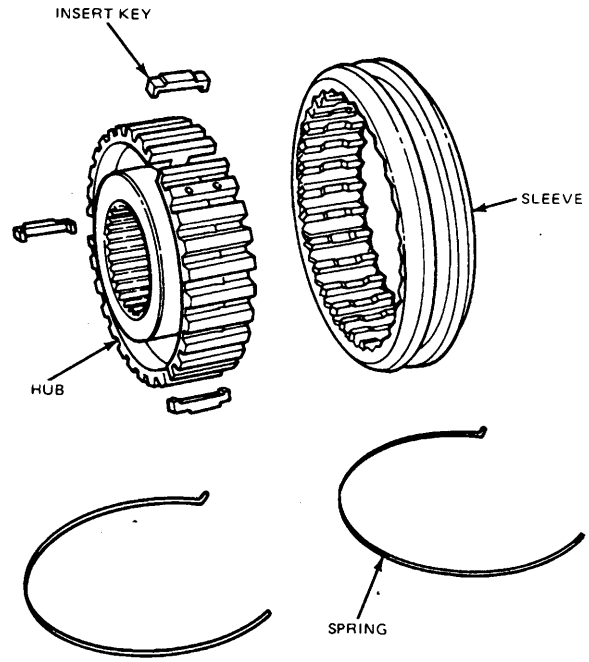
Extension Housing Inspection

Inspect the extension housing for cracks. Ensure that the machined mating surfaces are free from burrs, nicks, or any other damage. If necessary, replace the oil seal after the extension housing has been installed onto the transmission.

NOTE: The extension housing rear bushing cannot be serviced. If it requires service, the extension housing must be replaced as a unit.

Speedometer Gears Inspection

Check the drive gear and driven gear, and the driven gear shaft for wear or damage. Check the O-ring and oil seal for weakness or damage.



C2652-1A

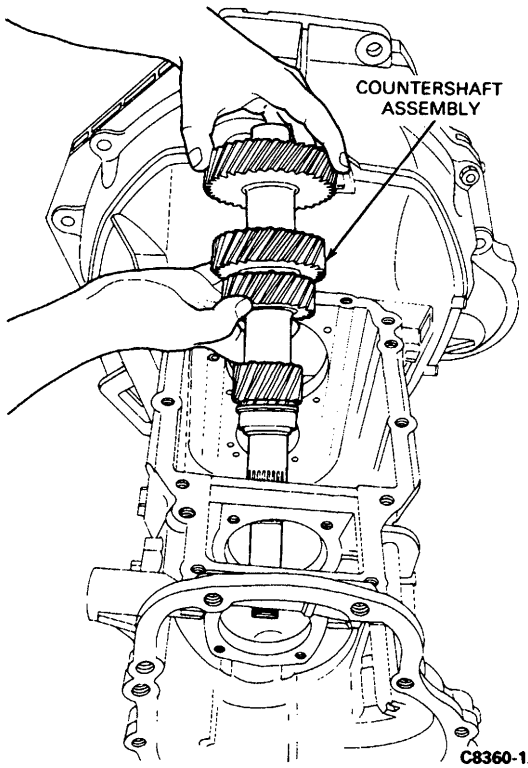
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CLEANING AND INSPECTION (Continued)

Transmission

Assembly

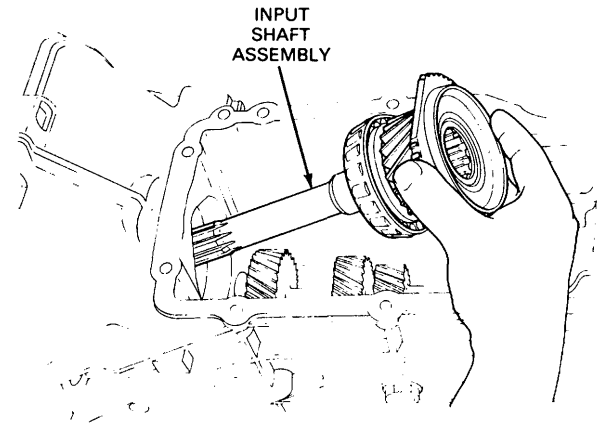
1. Position countershaft into transmission case through top opening.



C8360-1A

2. Position input shaft into transmission case through top opening.

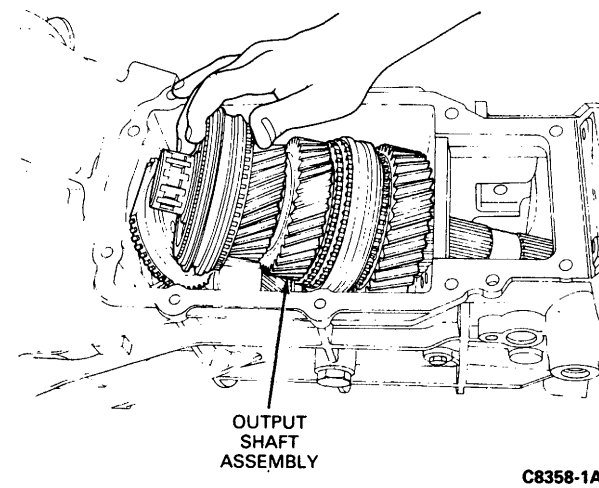
NOTE: Ensure that needle roller bearing is installed into input shaft.



C8359-1A

3. Position output shaft assembly into transmission case. Mate input and output shaft assemblies by positioning them at an upward angle and setting them together.

NOTE: Ensure that fourth gear synchronizer ring is installed at this time.

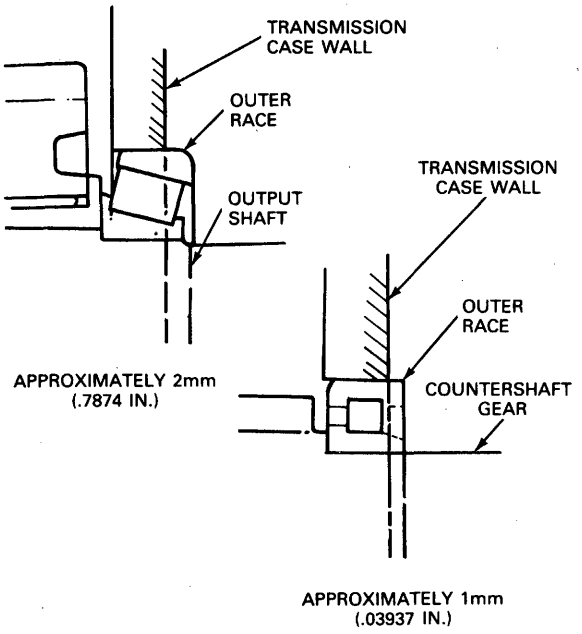


C8358-1A

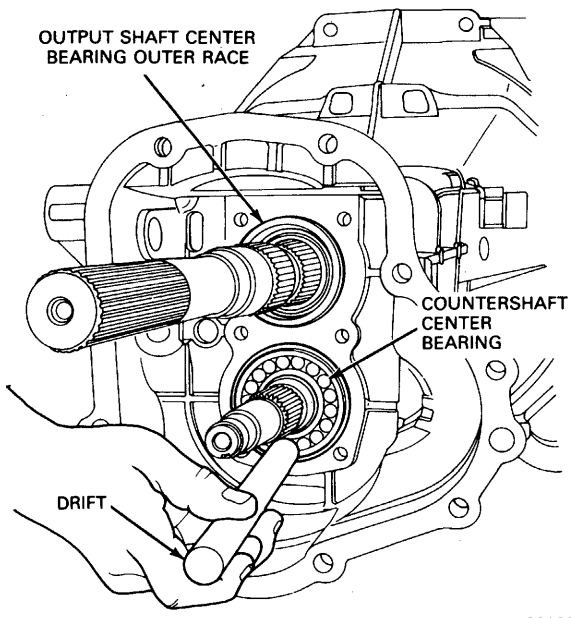
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CLEANING AND INSPECTION (Continued)

4. Install output shaft center bearing outer race using a brass drift. Seat center bearing outer races, maintaining bearing position illustrated.



C8406-1A



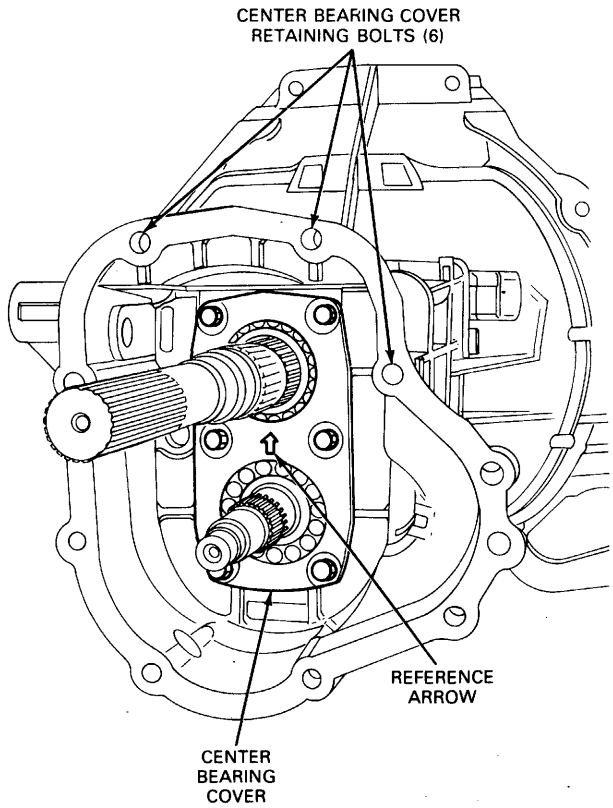
C8380-1A

5. Install countershaft center bearing (not race).

NOTE: Ensure that center bearing outer races are squarely positioned in bores.

6. Position center bearing cover to transmission case with reference arrow pointing upward. Install and tighten center bearing cover retaining bolts to 18-26 N·m (14-19 ft-lb).

NOTE: Ensure that all center bearing cover retaining bolt heads are marked with an "8".

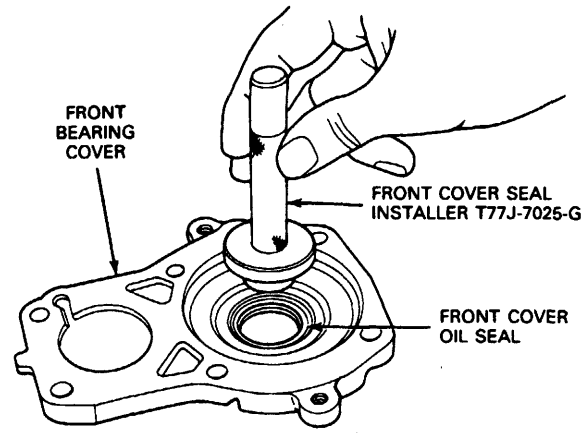


C8354-1A

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CLEANING AND INSPECTION (Continued)

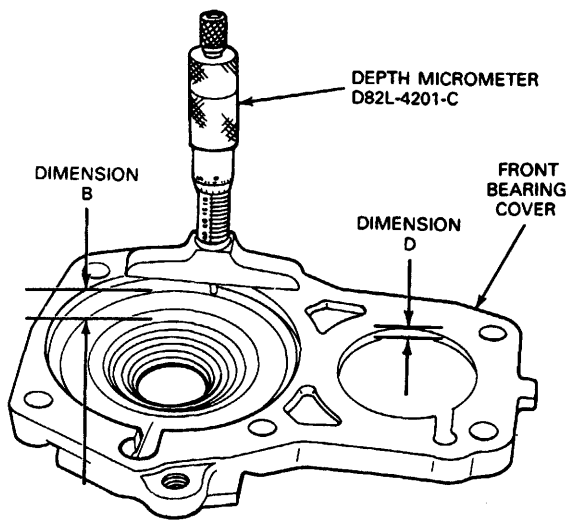
7. Position transmission vertically (input shaft and clutch housing facing upward). Ensure that input shaft front bearing outer race is squarely positioned in bore. If removed, install front cover oil seal using Front Cover Seal Installer T77J-7025-G or equivalent.



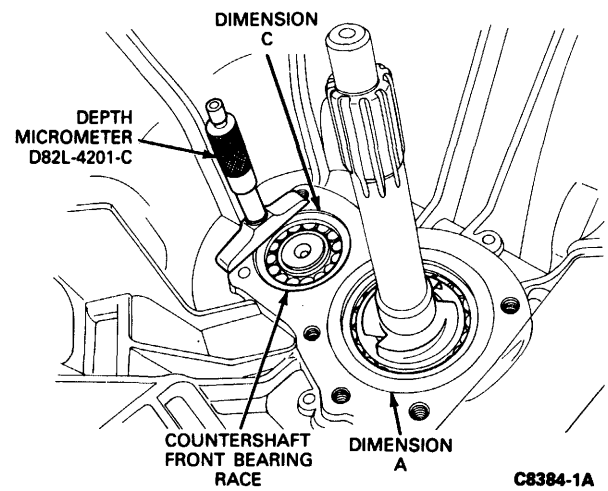
C8412-1A

8. Install countershaft front bearing by hand.

NOTE: If any related parts (such as output shaft, bearing, etc.) have been replaced, measure dimensions A, B, C, and D as illustrated. After measuring all dimensions, select bearing shim to maintain end play within specified limits.



C8383-1A

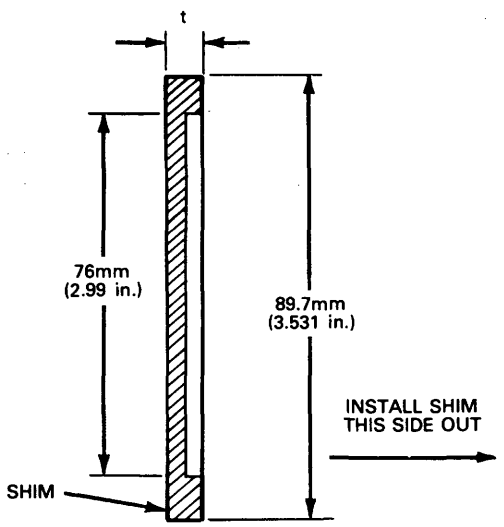


C8384-1A

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CLEANING AND INSPECTION (Continued)

- **Dimension A:** Height of input shaft bearing outer race above transmission front bearing cover mating surface.
- **Dimension B:** Depth of front cover outer race bore (input shaft).
- **Dimension C:** Depth of countershaft front bearing race (transmission case to front cover mating surface).
- **Dimension D:** Depth of front cover outer race bore (countershaft).



- Shim computation equations are as follows:

  Dimension B - (Dimension A + shim thickness) = 0.05 to 0.15mm (0.002 to 0.006 inch)

  Dimension C + (Dimension D - shim thickness) = 0.15 to 0.25mm (0.006 to 0.010 inch)

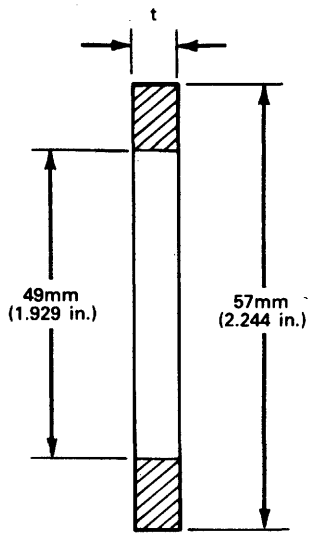
SHIM SELECT CHART — M50D R2

Part Number	Thickness (t)
E8TZ-7029-FA	1.4mm (0.0551 in.)
E8TZ-7029-GA	1.5mm (0.0590 in.)
E8TZ-7029-Ha	1.6mm (0.0629 in.)
E8TZ-7029-Ja	1.7mm (0.0669 in.)
E8TZ-7029-S	1.8mm (0.0708 in.)
E8TZ-7029-T	1.9mm (0.0748 in.)
E8TZ-7029-U	2.0mm (0.0787 in.)
E8TZ-7029-V	2.1mm (0.0826 in.)
E8TZ-7029-W	2.2mm (0.0866 in.)
E8TZ-7029-X	2.3mm (0.0905 in.)
E8TZ-7029-Y	2.4mm (0.0944 in.)
E8TZ-7029-Z	2.5mm (0.0984 in.)
E8TZ-7029-AA	2.6mm (0.1023 in.)
E8TZ-7029-BA	2.7mm (0.1062 in.)
E8TZ-7029-CA	2.8mm (0.1102 in.)
E8TZ-7029-DA	2.9mm (0.1141 in.)
E8TZ-7029-EA	3.0mm (0.1181 in.)

CC8395-2A

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CLEANING AND INSPECTION (Continued)



SPACER SELECT CHART — M50D-R2

Part Number	Thickness (t)
E8TZ-7C434-K	3.1mm (0.122 in.)
E8TZ-7C434-L	3.2mm (0.125 in.)
E8TZ-7C434-M	3.3mm (0.129 in.)
E8TZ-7C434-N	3.4mm (0.133 in.)
E8TZ-7C434-P	3.5mm (0.137 in.)
E8TZ-7C434-R	3.6mm (0.141 in.)
E8TZ-7C434-S	3.7mm (0.145 in.)
E8TZ-7C434-T	3.0mm (0.1181 in.)

CC8396-2A

9. Remove any sealant residue remaining on mating surfaces of transmission and front cover.

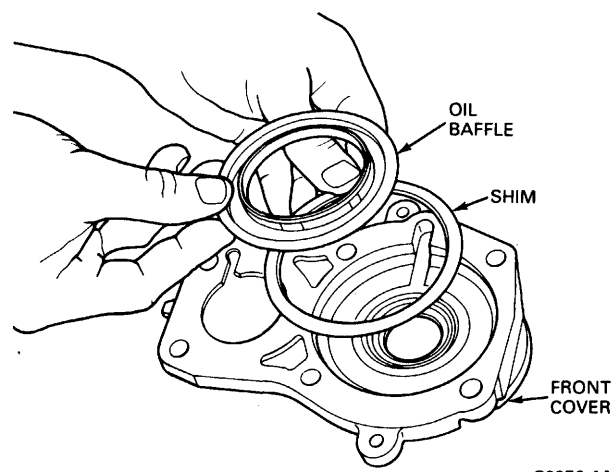
NOTE: To prevent damage to oil seal lip during assembly, tape the input shaft splines along their entire length.

10. Apply a thin coat of oil to front cover oil seal lip. Position bearing shim and baffle plate into front cover (install shim with groove showing). Install spacer to transmission case countershaft front bearing bore.

NOTE: If necessary, apply a sufficient quantity of grease to shim, bearing cover and oil baffle to retain them in position during assembly.

11. Apply a 1/8-inch bead of Silicone Rubber D6AZ-19562-B or equivalent to front cover and front cover retaining bolt threads. Install front bearing cover to transmission case. Install and tighten front bearing cover retaining bolts to 12-16 N·m (9-12 ft-lb).

NOTE: Ensure that front bearing cover retaining bolt heads are marked with a "6".



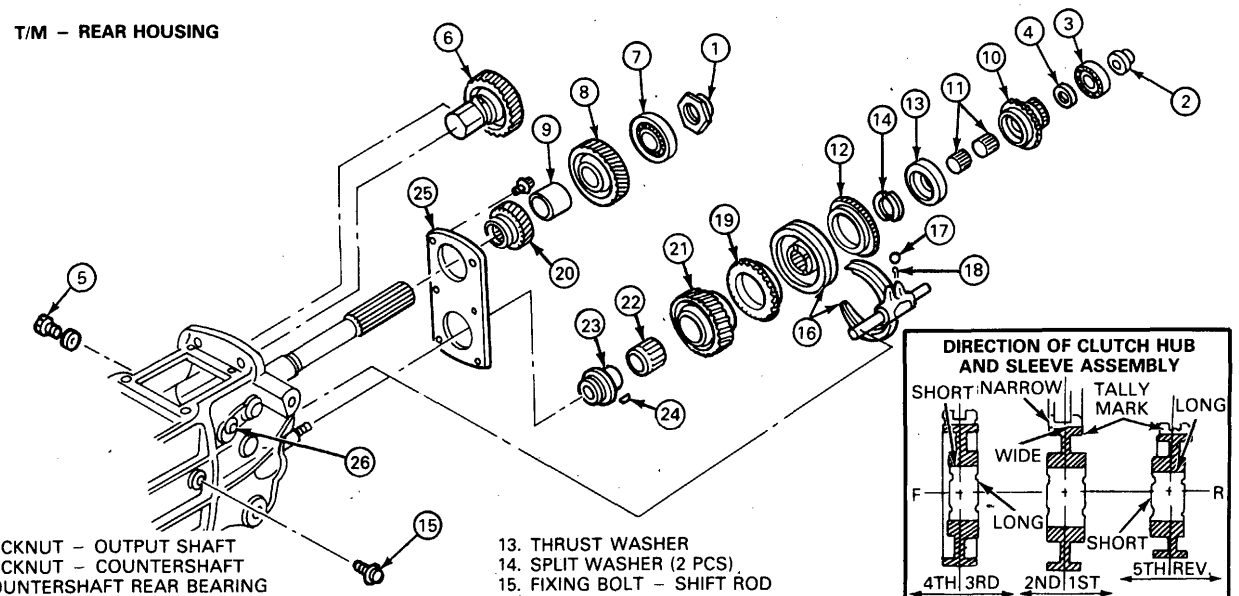
C8356-1A

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CLEANING AND INSPECTION (Continued)

12. Position transmission horizontally in holding fixture. Assemble the following parts in the order listed.
    - Woodruff key
    - Fifth gear sleeve

NOTE: Install fifth gear sleeve using nut, Shaft Adapter-Replacing, T75L-7025-L, Adapter T88T-7025-J2, and Remover/Replacer Tube T75L-7025-B, or equivalents.



1. LOCKNUT – OUTPUT SHAFT
2. LOCKNUT – COUNTERSHAFT
3. COUNTERSHAFT REAR BEARING
4. THRUST WASHER
5. FIXING BOLT – REVERSE IDLER GEAR
6. REVERSE IDLE GEAR ASSEMBLY
7. BEARING – OUTPUT SHAFT REAR
8. REVERSE GEAR – OUTPUT SHAFT
9. SLEEVE – OUTPUT SHAFT
10. COUNTERSHAFT REVERSE GEAR
11. NEEDLE BEARINGS
12. SYNCHRONIZER RING – REVERSE
13. THRUST WASHER
14. SPLIT WASHER (2 PCS)
15. FIXING BOLT – SHIFT ROD
16. SHIFT RAIL/FORK/HUB/SLEEVE ASSEMBLY
17. LOCK BALL (STEEL) SHIFT RAIL
18. SPRING – SHIFT RAIL
19. SYNCHRONIZER RING – 5TH GEAR
20. 5TH GEAR – OUTPUT SHAFT
21. 5TH GEAR – COUNTERSHAFT
22. NEEDLE BEARING – 5TH GEAR
23. SLEEVE – 5TH GEAR
24. WOODRUFF KEY
25. CENTER BEARING COVER
26. 5TH/REVERSE COUNTER LEVER LOCKPLATE RETAINING BOLT

C8352-2A

13. Install fifth gear needle bearing onto fifth gear (countershaft).

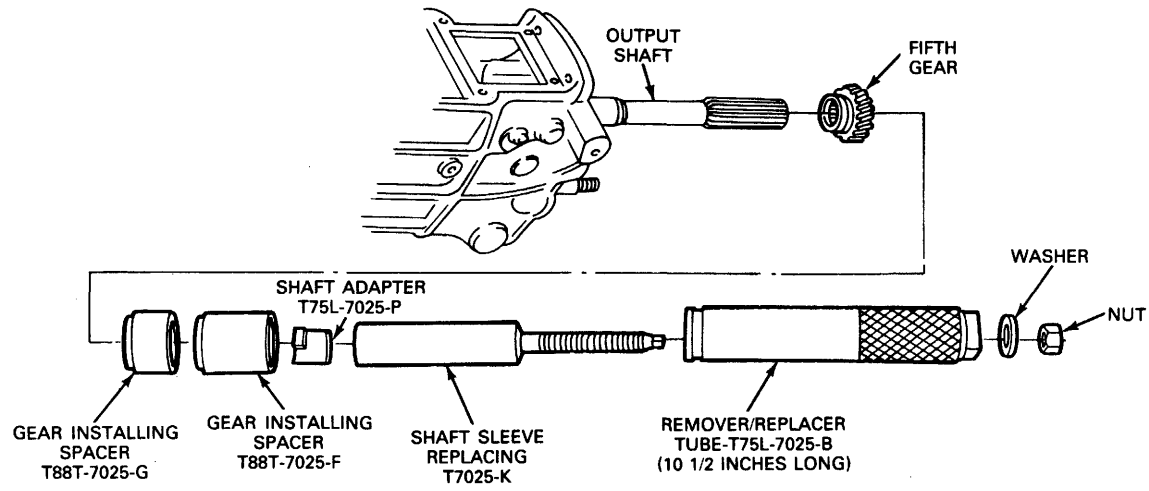
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CLEANING AND INSPECTION (Continued)

14. Install fifth gear onto output shaft using Gear Installing Spacer T88T-7025-F, Gear Installing Spacer T88T-7025-G, Shaft Adapter T75L-7025-P, Shaft Adapter Screw T75L-7025-K, Remover/Replacer Tube T75L-7025-B (4 x 2 models only), or Remover/Replacer Tube T85T-7025-A (4 x 4 models only) nut, and washer, or equivalents. Ensure that long flange on fifth gear faces forward.

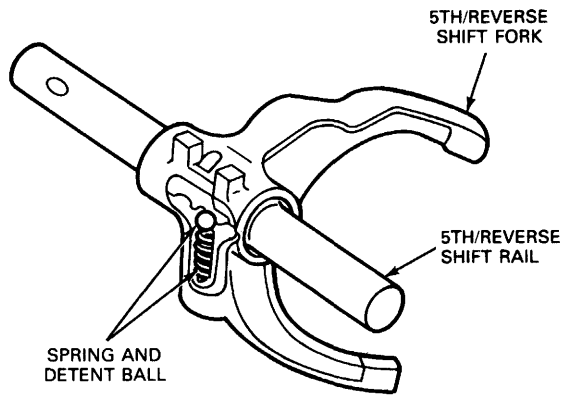
NOTE (4 x 2 models): To install fifth gear assembly, perform the process in two steps. First, install Gear Installing Spacer T88T-7025-F. When tool bottoms, add Gear Installing Spacer T88T-7025-G, and press fifth gear assembly the rest of the way into position.

NOTE (4 x 4 models): Installation of fifth gear assembly is similar to 4 x 2 installation except that Remover/Replacer Tube T85T-7025-A and TOD Bearing Remover/Replacer Adapter T84T-7025-A are used.



C8665-2A

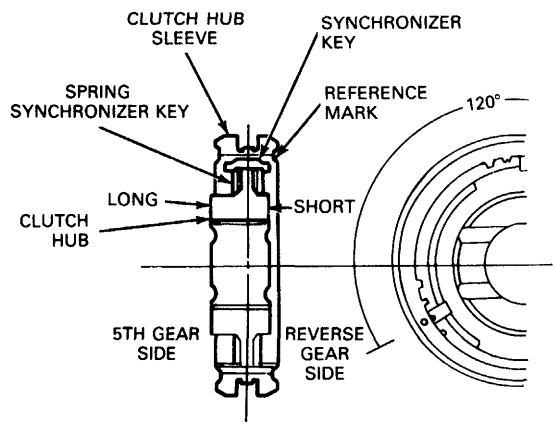
15. Position counter lever assembly to transmission and install thrust washer and retaining ring. Apply sealant to counter lever fixing bolt threads. Install counter lever fixing bolt and tighten to 8-10 N·m (6-7 ft-lb).
16. If removed, position fifth/reverse shift fork and shift rail to top cover. Insert fifth/reverse shift rail through top cover bore and fifth/reverse shift fork. Install spring and detent ball to lower part of rod.



C8386-1A

17. Assemble the fifth/reverse synchronizer hub, sleeve, and fifth gear synchronizer ring to fifth/reverse shift fork and rod assembly.

NOTE: Install the longer flange (on the fifth/reverse hub, sleeve, and synchronizer assembly) toward the front of transmission. The reference mark on synchronizer sleeve must be installed toward reverse gear side.



C8387-1A

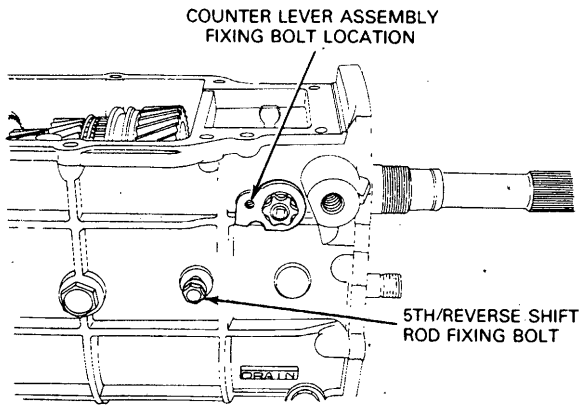
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CLEANING AND INSPECTION (Continued)

18. Install fifth/reverse shift fork and shift rail assembly (including fifth/reverse synchronizer hub, sleeve, and fifth gear synchronizer ring) to countershaft. Mate shift fork gate to fifth/reverse counter lever end. Install fifth/reverse fork and shift rail assembly with threaded fixing bolt bores (in rail and transmission case) aligned with each other.

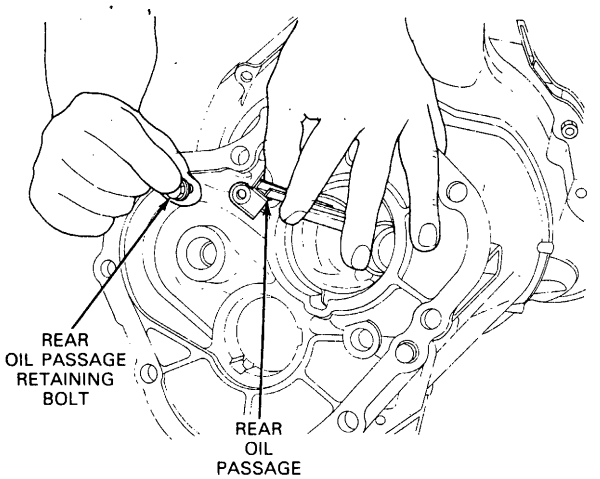
NOTE: For ease of assembly, position the fifth/reverse shift fork into the rearmost of the three detent positions (rearmost from threaded bore). Return shift fork to neutral gear position after installation.

a. Apply sealant to fifth/reverse shift rail fixing bolt threads. Install fifth/reverse shift rail fixing bolt to transmission case. Tighten fifth/reverse shift rail fixing bolt to 20-30 N·m (16-22 ft-lb).



C8418-1A

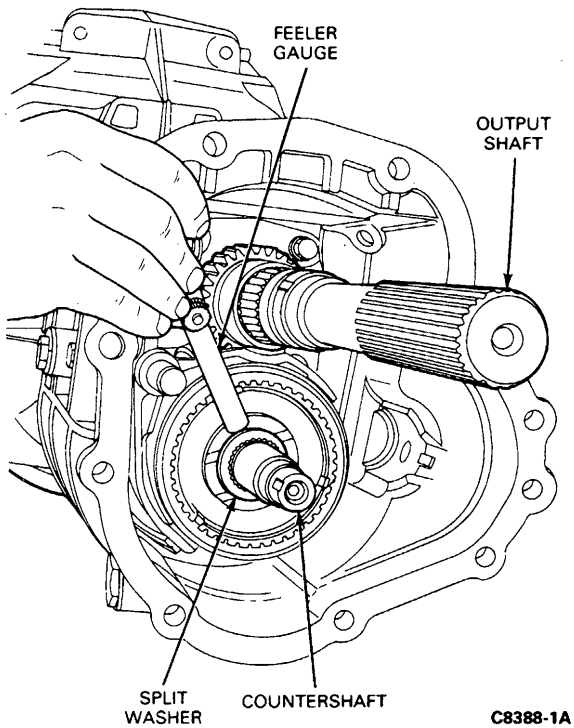
19. Apply sealant to oil passage retaining bolt. Position oil passage to transmission case and install retaining bolt. Tighten oil passage retaining bolt to 8-10 N·m (6-8 ft-lb).



C6721-1A

20. Install split washer and thrust washer onto countershaft.

NOTE: If clutch hub and/or counter reverse gear have been replaced, new split washers must be selected to maintain end play within specified limits. Measure end play using a feeler gauge. Select replacement split washers using the chart. Ensure that split washers are a matched set of identical thickness.



C8388-1A

SPLIT WASHER SELECT CHART

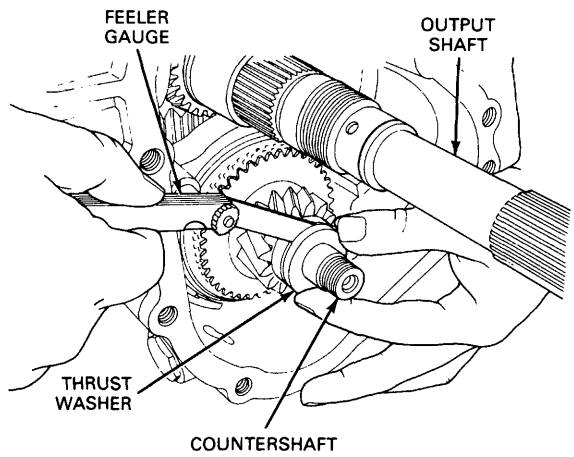
Part Number	Thickness
E8TZ-7R482-A	3.0mm (0.118 in.)
E8TZ-7R482-B	3.1mm (0.122 in.)
E8TZ-7R482-C	3.2mm (0.125 in.)
E8TZ-7R482-D	3.3mm (0.129 in.)
E8TZ-7R482-E	3.4mm (0.133 in.)
To Be Determined	3.05mm (0.120 in.)
To Be Determined	3.15mm (0.124 in.)
To Be Determined	3.25mm (0.127 in.)
To Be Determined	3.35mm (0.131 in.)
To Be Determined	3.45mm (0.135 in.)
To Be Determined	3.50mm (0.137 in.)

CC8389-1A

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CLEANING AND INSPECTION (Continued)

21. Install reverse synchronizer ring and needle bearings into counter reverse gear. Install counter reverse gear and needle bearings onto countershaft as an assembly. Install thrust washer to countershaft.
22. Press thrust washer forward (by hand) against shoulder on countershaft. Maintain forward pressure against thrust washer and insert feeler gauge between thrust washer and counter reverse gear. Using the chart, determine correct thrust washer to obtain specified end play. Counter reverse gear end play: 0.20-0.30mm (0.007-0.011 inch).



C8390-1A

THRUST WASHER SELECT CHART

Part Number	Thickness
E8TZ-7C340-A	7.5mm (0.2952 in.)
E8TZ-7C340-B	7.7mm (0.3031 in.)
E8TZ-7C340-C	7.9mm (0.3110 in.)
E8TZ-7C340-D	7.4mm (0.2913 in.)
E8TZ-7C340-E	7.6mm (0.2992 in.)
E8TZ-7C340-F	7.8mm (0.3070 in.)

CC8397-1A

23. Temporarily install a suitable spacer (inner bore larger than 21mm, outer bore smaller than 36mm, 15-20mm O/A length) in place of countershaft bearing. Loosely install countershaft locknut to retain components.

NOTE: Installation of a suitable spacer prevents thrust washer and split washers from slipping off shaft, and avoids interference with reverse idler gears.

24. Install reverse idler gear assembly. Apply sealant to reverse idler gear fixing bolt threads. Install and tighten fixing bolt to 79-116 N·m (58-86 ft-lb).
25. Drive sleeve and reverse gear assembly onto output shaft using Gear Installing Spacer T88T-7025-G, Shaft Adapter T75L-7025-P, Shaft Adapter Screw T75L-7025-K, Remover/Replacer Tube T75L-7025-B (4 x 2 models only), Remover/Replacer Tube T85T-7025-A (4 x 4 models only), nut, and washer, or equivalents.

NOTE: Install reverse gear with longer flange facing rearward.

26. Install output shaft rear bearing using Gear Installing Spacer T88T-7025-G, Shaft Adapter T75L-7025-P, Shaft Adapter Screw T75L-7025-K, Remover/Replacer Tube T75L-7025-B (4 x 2 models only), or Remover/Replacer Tube T85T-7025-A (4 x 4 models only), nut, and washer, or equivalents.
27. Remove temporary spacer from countershaft.
28. Install countershaft rear bearing by hand.

NOTE: Tightening shaft locknuts without fully seating bearing can cause damage to output shaft threads.

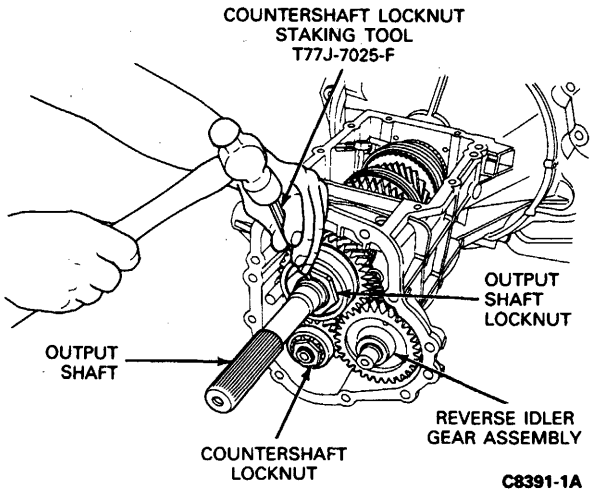
29. Lock transmission into first and third gears. Install new output and countershaft locknuts hand tight. Tighten output shaft locknut to 216-274 N·m (160-200 ft-lb). Tighten countershaft locknut to 128-196 N·m (94-144 ft-lb).

NOTE: Always install new output and countershaft locknuts when assembling transmission. Locknuts unstaked during disassembly cannot be reused.

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CLEANING AND INSPECTION (Continued)

30. Stake (tightened) locknuts to bottom of shaft groove using Countershaft Locknut Staking Tool T77J-7025-F or equivalent.



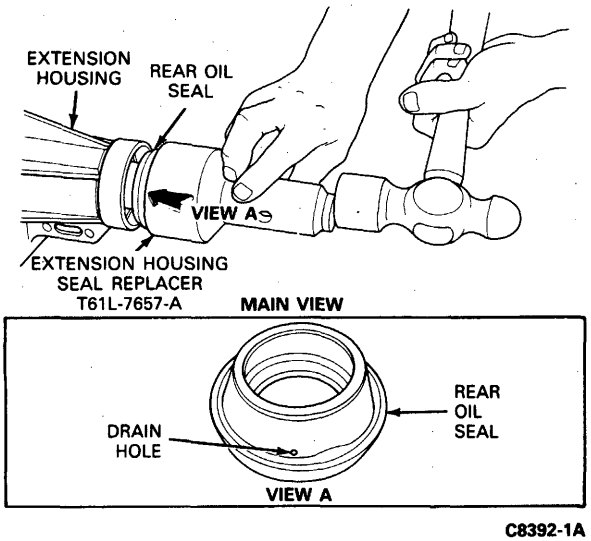
31. Install speedometer drive gear and steel ball to output shaft. Install snap ring retaining speedometer drive gear to output shaft (4 x 2 models only).

NOTE: The speedometer drive gear contains three detents into which the steel drive ball can be installed. The steel drive ball can be installed into any of the three detents.

NOTE: Depending upon application, one of two different speedometer drive gears may be installed. They are color coded (green, and white). When installing a speedometer drive gear, ensure that replacement gear is the same color as original. Speedometer drive gear part numbers and corresponding colors are as follows:

White (Natural)—E8TZ-17285-B

Green—E8TZ-17285-C



32. Remove any sealant residue from mating surfaces of transmission case and extension housing. Apply a 1/8-inch bead of Silicone Rubber D6AZ-19562-B or equivalent to transmission case.

NOTE: Extension housing bushing cannot be serviced. If bushing requires service, extension housing must be replaced as a unit.

33. Position extension housing to transmission to case, and install extension housing retaining bolts. Tighten bolts to 32-46 N·m (24-34 ft-lb).

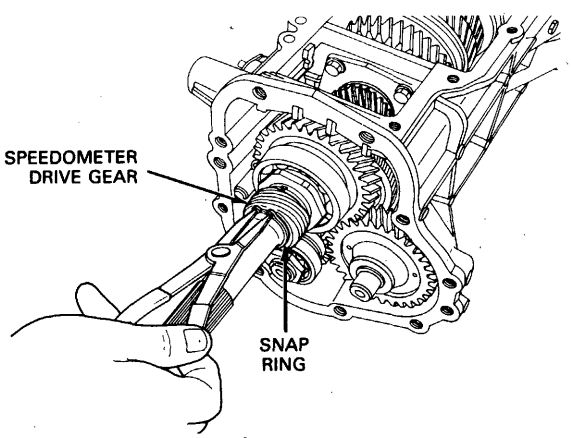
34. Place synchronizers into neutral gear position. Ensure that shift forks on top cover assembly are in neutral gear position.

35. Position top cover to transmission case, and carefully engage shift forks with synchronizers. Apply sealant to the two rearmost top cover retaining bolts, and install them into top cover rear retaining bolt locations. Install remaining top cover retaining bolts (no sealant). Tighten top cover retaining bolts to 16-22 N·m (12-16 ft-lb).

NOTE: Do not apply sealant to top cover or transmission case mating surfaces. If necessary, apply a small quantity of grease to sealing gasket to retain gasket in position during assembly.

36. Install transmission drain plug and tighten to 40-58 N·m (29-43 ft-lb).

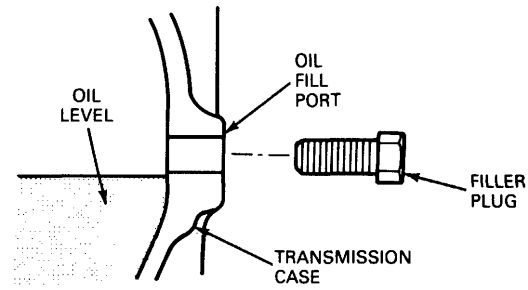
37. If removed, install rear oil seal into extension housing using Extension Housing Seal Replacer T61L-7657-A or equivalent. Ensure that oil seal drain hole faces downward.



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CLEANING AND INSPECTION (Continued)

38. Fill transmission with specified quantity of Dexron-II® transmission fluid.



C8651-1A

SPECIFICATIONS

FIVE-SPEED MANUAL OVERDRIVE TRANSMISSION — GEAR RATIOS

FIRST	3.90
SECOND	2.25
THIRD	1.50
FOURTH	1.00
FIFTH	.80
REVERSE	3.41

CC8403-1A

FIVE-SPEED MANUAL OVERDRIVE TRANSMISSION INSPECTION STANDARDS

	Tolerance	
Component	Inches	Millimeters
Mainshaft Runout Not to Exceed	0.002	0.05
Shift Fork to Clutch Sleeve Not to Exceed		0.8
Synchronizer Ring to Conical Face of Gear	0.059	1.5

CC8399-1A

TORQUE SPECIFICATIONS

Description	N-m	ft-lb
Output Shaft Locknut	216-274	160-203
Countershaft Locknut	128-196	94-144
Extension Housing Retaining Bolts	32-46	24-34
Reverse Idler Shaft Fixing Bolt	79-116	58-86
Center Bearing Cover	18-26	14-19
Front Bearing Cover	16-22	12-17
Fifth/Reverse Cam Lockout Plate	8-10	6-7
Dust Boot	8-10	6-7
Top Cover	16-22	12-16
Filler Plug	40-58	29-43
Front Oil Passage	8-10	6-8
Counter Lever Shaft Fixing Bolt	8-10	6-8
Rock Plate	8-10	6-7
Drain Plug	40-58	29-43
Backup Lamp Switch	25-35	18-26
Neutral Switch (If Equipped)	25-35	18-26
Rear Oil Passage (Extension Housing)	8-9	5-7
5th/Reverse Shift Rail Fixing Bolt	20-30	16-22

CC8402-1A

APPROXIMATE LUBRICANT REFILL CAPACITY

Transmission	U.S. Pints	Imperial Pints	Liters
Five-Speed Manual Overdrive Transmission Dexron-II® or Equivalent	7.6		3.6

CC8409-1A

FIVE-SPEED MANUAL OVERDRIVE TRANSMISSION ASSEMBLY STANDARDS

	Tolerance	
Component	Inches	Millimeters
3rd/4th Clutch Hub Play	0.00-0.0019	0.00-0.05mm
Reverse Idler Gear End Play	0.0039-0.0078	0.1-0.2mm
5th/Rev Hub End Play	0.00-0.0019	0.00-0.05mm
Counter Reverse Gear	0.0078-0.0118	0.20-0.30

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SPECIAL SERVICE TOOLS

Number	Description	Number	Description
T74P-77248-A	Extension Housing Seal Remover	T71P-4621-B	Bearing Cone Remover
T77J-7025-F	Countershaft Locknut Staking Tool	D84L-1123-A	Bearing Splitter
T88T-7025-A	Mainshaft Locknut Wrench	T88T-7025-C	Top Cover Holding Fixture
T77J-7025-B	Remover/Replacer Tube	D84L-7000-B	Roll Pin Punch Set
T75L-7025-B	Remover/Replacer Tube	T88T-7025-F	Gear Installing Spacer
T84T-7025-B	TOD Forcing Screw	T88T-7025-G	Gear Installing Spacer
T77J-7025-H	Bearing Puller	T75L-7025-P	Shaft Adapter
T77J-7025-J	Puller Ring	T75L-7025-K	Shaft Adapter Screw
T75L-7025-G	Bearing Collet Sleeve For 3.5 Inch Bearing Collets	T61L-7657-A	Extension Housing Seal Replacer
T85T-7025-A	Remover/Replacer Tube	TOOL-4201-C	Dial Indicator
T84T-7025-A	TOD Bearing Remover/Replacer Adapter	T77J-7025-G	Front Cover Seal Installer
T88T-7061-A	Gear Removal Collet	T75L-7025-L	Shaft Adapter — Replacing
T88T-7120-A	Bearing Race Puller	T88T-7025-J2	Adapter
T50T-100-A	Slide Hammer	T88T-7025-J	Countershaft Fifth Gear Sleeve Puller
T53T-4621-B	Bearing Replacer	T88T-7025-J1	Gear Removal Collets
T88T-7025-B	Bearing Cone Replacer	D84L-4201-C	Depth Micrometer
T75L-1165-B	Bearing Plate		

CC8410-2A

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SECTION 16-34 Model S5-42 ZF Manual Transmission

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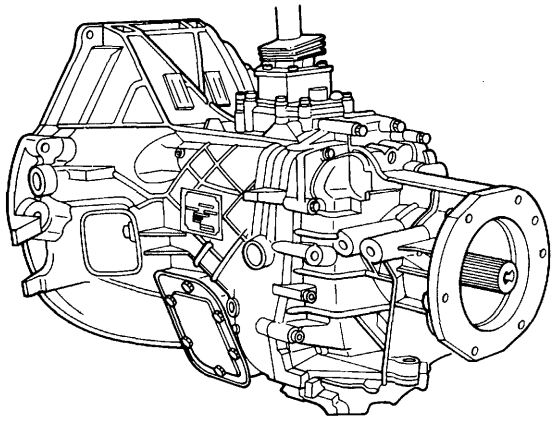
VEHICLE APPLICATION

E-350 Stripped Chassis, F-150—350, F-Super Duty and Bronco Truck Models equipped with the ZF S5-42 Heavy Duty Transmission.

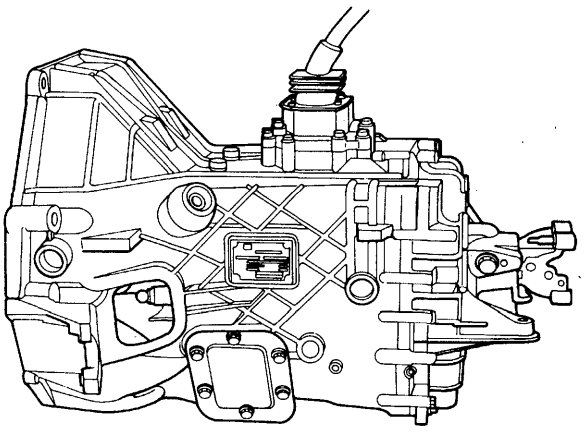
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DESCRIPTION

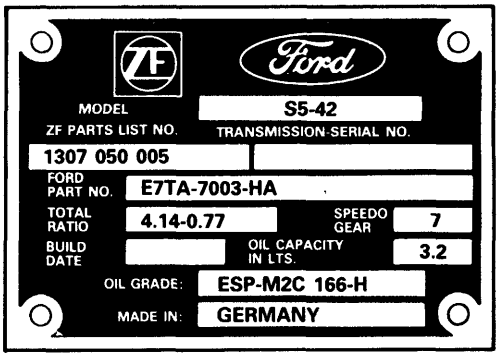
The model number for the ZF Transmission is S 5-42. This model number can be divided into three parts. First, "S" designates a synchronized transmission. Second, "5" designates the number of forward gears. Finally, "42" is the approximate maximum input torque capacity in hundreds of ft-lbs. In this case 42 equals 420 ft-lbs. input torque capacity.



ZF S5-42 TRANSMISSION – 4 x 4 AND F-SUPER DUTY VERSION



ZFS 5-42 TRANSMISSION – 4 x 2 VERSION



TRANSMISSION IDENTIFICATION PLATE

C8192-2A

The S5-42 ZF Transmission is available in a wide ratio for gasoline engines (7.5L, 5.8L, 4.9L) and a close ratio for diesel engines (7.3L). The ratios are as follows:

	1st	2nd	3rd	4th	5th	Reverse
Close Ratio (Diesel)	4.14	2.37	1.42	1.0	0.77	3.79
Wide Ratio (Gasoline)	5.72	2.94	1.61	1.0	0.76	5.24

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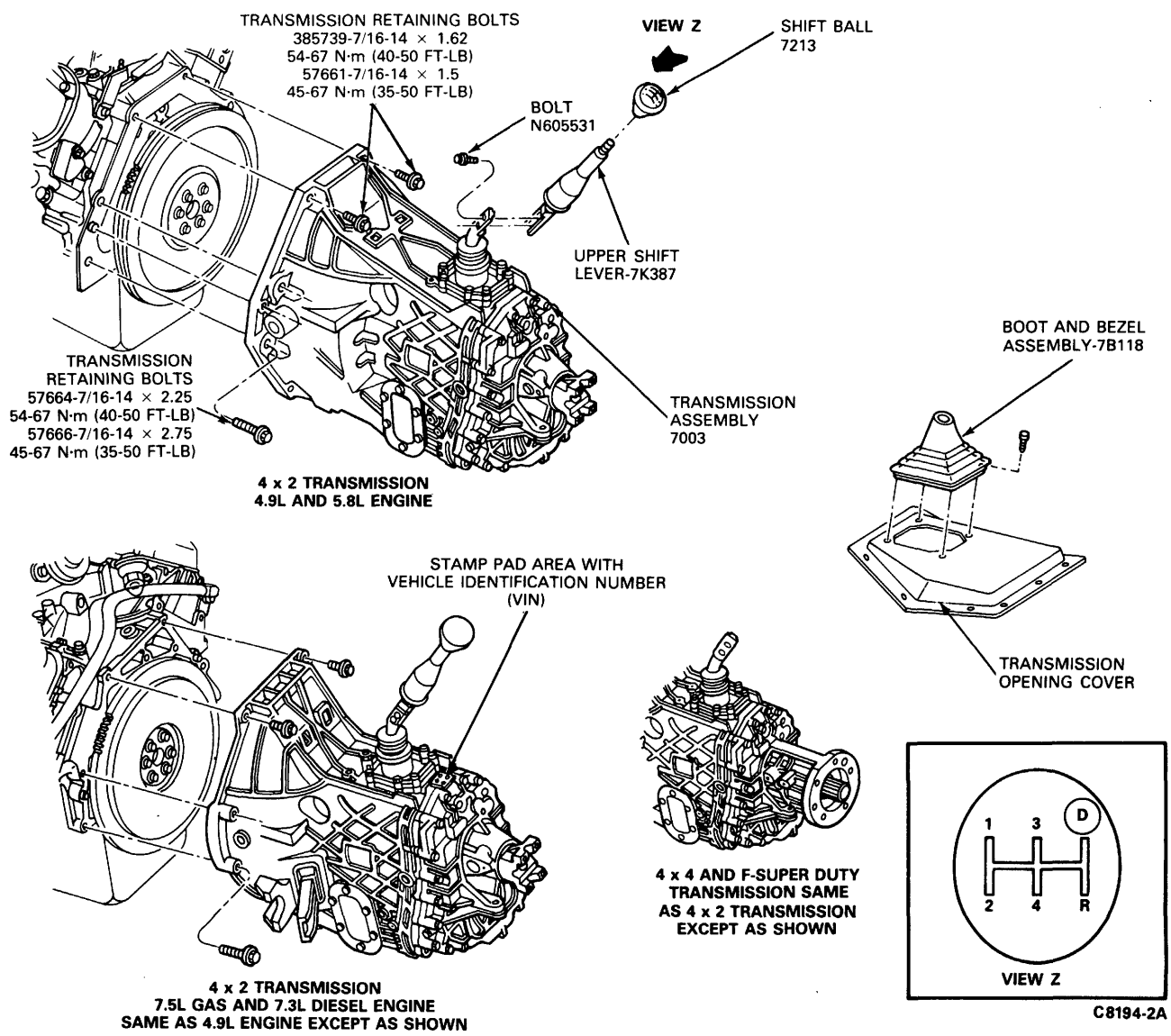
The transmission features an aluminum housing with an integral clutch housing. Because of the aluminum housing, the tapered roller bearings of the transmission shafts must be fitted under preload. This is because heat expansion of the aluminum transmission cases is greater than that of the steel alloy mainshaft and countershaft. If the bearings were not pre-loaded, this would result in excessive end play when the transmission case expands in warm, loaded operating conditions. The transmission also features shrink fit gears on the countershaft. Shrink fit gears are connected to the countershaft by friction only, rather than connected to the countershaft through splines. The gear is heated and lightly pressed onto the shaft. The subsequent cooling of the gear provides the shrink fitting.

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DIAGNOSIS AND TESTING

For diagnosis and testing procedures, refer to Section 16-10, General Manual Transmission Service. Also refer to Section 16-01, General Clutch Service.

REMOVAL AND INSTALLATION



Transmission (4x2)

Removal

1. Shift the transmission into neutral.
2. Remove the carpet or floor mat. Refer to Section 45-26, Carpets and Floor Mats, for removal procedure.
3. Remove the ball from the upper shift lever.
4. Remove the four screws and remove the boot and bezel assembly from the transmission opening cover.
5. Remove the two bolts and remove the upper shift lever from the lower shift lever.
6. Raise the vehicle on a hoist and position safety stands under the vehicle.
7. Disconnect the speedometer cable.

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REMOVAL AND INSTALLATION (Continued)

8. Disconnect the back-up lamp switch located at the top left hand side of the transmission.
9. Remove the drain plug and drain the oil from the transmission.
10. Position a transmission jack, such as Rotunda Transmission Jack 077-00008 or equivalent under the transmission.
11. Disconnect the driveshaft and clutch linkage from the transmission and wire it to one side. Refer to Section 15-62, Driveshafts and Section 16-04, Hydraulic Clutch System for detailed procedures.
12. On F-Super Duty vehicles remove the transmission parking brake from the transmission. Refer to Section 12-70, Parking Brake, for procedure.
13. Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in Crossmember removal and installation in this Section.
14. Remove the bolts that retain the transmission to the engine block.
15. Move the transmission to the rear until the input shaft clears the engine flywheel. Lower the transmission from the vehicle.

Installation

1. Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent. Install guide studs in the front case and raise the transmission until the input shaft splines are aligned with the clutch disc splines. The clutch release bearing and hub must be properly positioned in the release lever fork.
2. Slide the transmission forward on the guide studs until it is in position on the front case. Install the attaching bolts and tighten them to 54-67 N·m (40-50 ft-lb.). Remove the guide studs and install the two remaining attaching bolts.
3. Install the crossmember as described under Crossmember Removal and Installation in this Section. Position the insulator and retainer between the transmission and crossmember. Install bolts and tighten to 60-80 N·m (45-60 ft-lbs). Install the nut retaining the insulator and retainer to crossmember. Tighten to 68-94 N·m (50-70 ft-lbs). Remove the transmission jack.
4. Connect the speedometer cable and driven gear and clutch linkage.
5. Connect the backup lamp switch.
6. On F-Super Duty vehicles, install the transmission parking brake. Refer to Section 12-70, Parking Brake — Cable Actuated.
7. Connect the driveshaft. Refer to Section 15-62, Driveshaft, for procedure.
8. Install the upper shift lever to the lower shift lever.
9. Install the boot and bezel assembly to the transmission opening cover.
10. Install the upper shift lever to the lower shift lever and tighten the two retaining screws to 12-18 N·m (16-24 ft-lbs.).
11. Install the isolator pad assembly. Install the floor pan cover and floor mat.
12. Install the shift ball on the upper shift lever.

Transmission (4x4)

Removal

1. Shift the transmission into neutral.
2. Remove the carpet or floor mat. Refer to Section 45-26, Carpets and Floor Mats, for removal procedure.
3. Remove the four screws and remove the boot and bezel assembly from the transmission opening cover.
4. Remove the two bolts and remove the upper shift lever from the lower shift lever.
5. Raise the vehicle on a hoist.
6. Remove the drain plugs and drain the transmission and transfer case.
7. Disconnect the rear driveshaft from the transfer case and wire it out of the way. Refer to Section 15-62, Driveshafts.
8. Disconnect the front driveshaft from the transfer case and wire it out of the way. Refer to Section 15-62, Driveshafts.
9. Disconnect the backup lamp switch.
10. Remove the speedometer cable from the transfer case.
11. If equipped, remove the skid pan from beneath the transfer case.
12. Position a transmission jack such as Rotunda Transmission Jack 077-00008, under the transfer case. Remove the six bolts holding the transfer case to the transmission and carefully lower the transfer case from the vehicle, using care to ensure that the transfer case shift lever clears the opening in the floor pan.
13. Remove the transmission rear insulator and lower retainer. Remove the crossmember as described in Crossmember removal and installation in this Section.
14. Remove the bolts that retain the transmission to the engine block.
15. Move the transmission to the rear until the input shaft clears the engine flywheel housing. Lower the transmission from the vehicle.

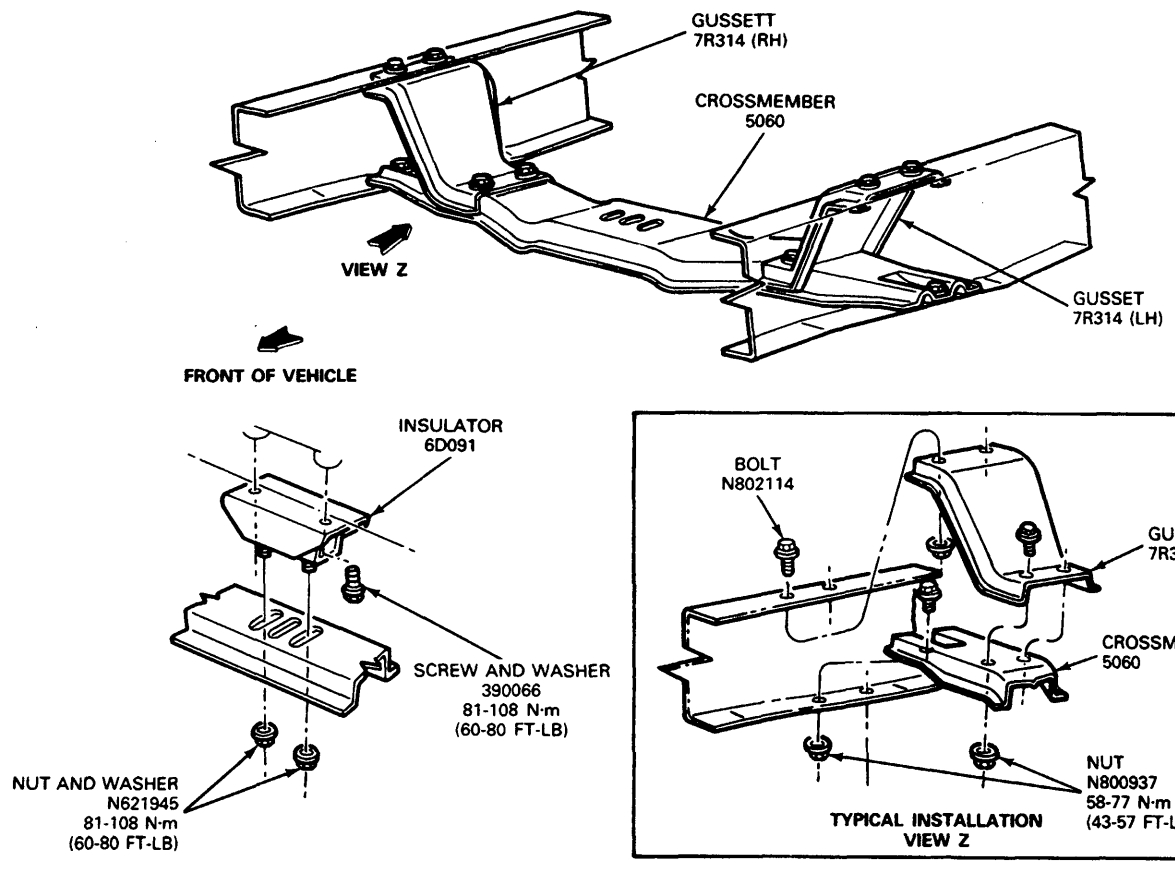
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REMOVAL AND INSTALLATION (Continued)

Installation

1. Place the transmission on a transmission jack such as Rotunda Transmission Jack 077-00008 or equivalent, and install two guide studs in the transmission front case top holes, to guide the transmission into position. Join together the transmission and engine block mating surfaces.
2. Install the two lower bolts and tighten to 54-67 N·m (40-50 ft-lbs). Remove the guide studs and install the upper bolts.
3. Place the rear support bracket in position and install the retaining bolts. Refer to crossmember installation in this Section. Tighten the bolts to 60-80 N·m (45-60 ft-lbs.).
4. Install the two bolts at the rear support insulator bracket. Remove the transmission jack.
5. Position the transfer case on the transmission jack. Position the transfer case on the transmission, using care to guide the transfer case shift lever through the opening in the floor pan. Install the gasket and six retaining bolts. Tighten the bolts to specifications listed in the appropriate transfer case section in Group 16 in this manual.
6. Install the speedometer cable to the transfer case.
7. Connect the front driveshaft to the transfer case yoke or flange.
8. Connect the rear driveshaft to the transfer case yoke or flange.
9. Fill transfer case and transmission with Mercon®, XT-2-QDX or equivalent automatic transmission fluid.
10. Connect the back-up lamp switch.
11. Lower vehicle.
12. Install the upper shift lever to the lower shift lever. Tighten the retaining bolts to 12-18 N·m (16-24 ft-lbs.).
13. Install the boot and bezel assembly to the transmission opening cover. Install the four retaining screws.
14. Install the isolator pad assembly. Install the floor pan cover and floor mat.
15. Install the shift ball on the upper shift lever and on the transfer case shift lever.

Crossmember



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REMOVAL AND INSTALLATION (Continued)

Removal

1. Raise vehicle on a hoist.
2. Remove skid plate, if so equipped. Remove heat shield from catalytic converter.

CAUTION: Use extreme caution when working in the area of the catalytic converter because of the extremely high temperatures generated by the converter.

3. Remove two nuts connecting upper gusset to frame on both sides of frame.
4. Remove nut and bolt assembly connecting gusset to crossmember. Remove gusset on left side.
5. Remove bolts holding transmission to transmission support plate on crossmember.
6. Raise transmission with a transmission jack.
7. Remove the nut and bolt assemblies connecting the support plate to the crossmember. Remove support plate. Remove right gusset.
8. Remove nut and bolt assemblies connecting crossmember to frame. Remove crossmember.

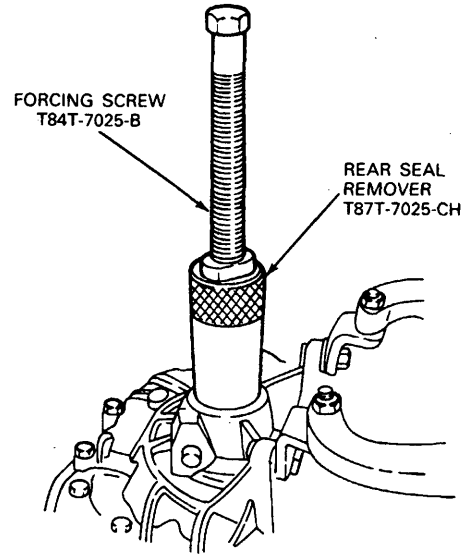
Installation

1. Install crossmember and transmission support plate, and position right and left gussets on bolts on frame. Install nuts on upper gusset to frame bolts and tighten to specification.
2. Install crossmember to frame nut and bolt assembly and tighten to specification.
3. Install nut and bolt assembly connecting gusset to crossmember and tighten to specification.
4. Install nut and bolt assemblies connecting transmission support plate to crossmember and tighten to specification.
5. Lower the transmission.
6. Install bolts connecting transmission support plate to transmission and tighten to specification.
7. Install skid plate, if so equipped. Install heat shield over catalytic converter. Tighten all nuts and bolts to specification.

Rear Oil Seal—4x2 Transmissions

Removal

1. Disconnect the driveshaft from the output flange. Refer to Section 15-62, Driveshaft.
2. Using a chisel, bend back the tab on the output flange retaining locknut.
3. Attach Companion Flange Holding Tool T78P-4851-A or equivalent to the transmission output flange with four hex bolts.
4. Loosen the hex nut that holds the output flange to the mainshaft with Socket T87T-7025-AH. Remove the flange holding tool after loosening the nut.
5. Remove the output flange from the output end of the mainshaft.
6. Insert Rear Seal Remover T87T-7025-CH or equivalent over output end of mainshaft and tighten into rear seal.
7. Assemble Forcing Screw T84T-7025-B or equivalent into seal remover. Turn forcing screw while holding seal remover to pull seal.



4 x 2 OUTPUT SEAL REMOVAL

C8196-1A

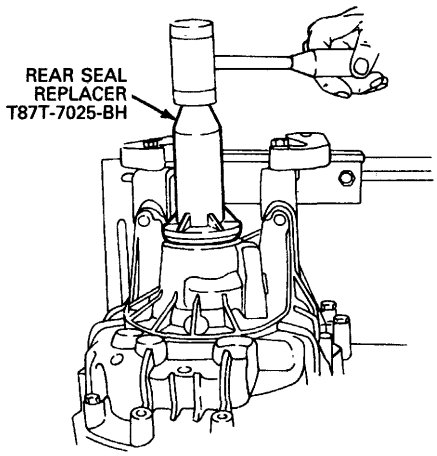
Installation

1. Position the output shaft seal on Output Seal Replacer T87T-7025-LH or equivalent and position the seal and tool over the output end of the mainshaft.
2. Using a soft hammer gently tap the seal in until it seats in the opening. Apply a little liquid soap around the circumference to minimize friction.
3. Install the output flange on the output end of the mainshaft.
4. Attach Companion Flange Holding Tool T78P-4851-A or equivalent to the transmission output flange with four hex bolts.
5. Install a tabbed lockwasher and install the hex nut that holds the output flange to the mainshaft with Socket T87T-7025-AH. Tighten the nut to 250 N·m (184 ft-lbs.). Remove the flange holding tool after tightening the nut.
6. Using a chisel, bend over the tab on the output flange retaining nut lockwasher.

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REMOVAL AND INSTALLATION (Continued)

7. Connect the driveshaft to the output flange. Refer to Section 15-62, Driveshaft.

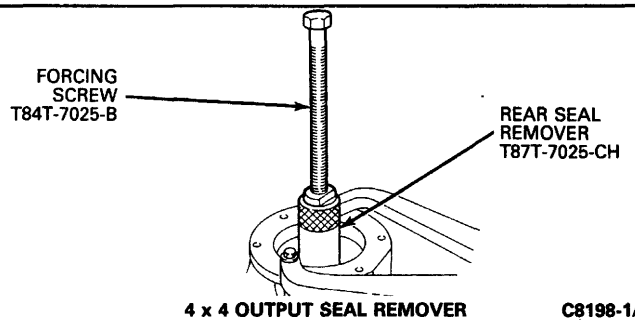


4 x 2 TRANSMISSION REAR OIL SEAL INSTALLATION
C8199-1A

Rear Oil Seal—4x4 and F-Super Duty Transmissions

Removal

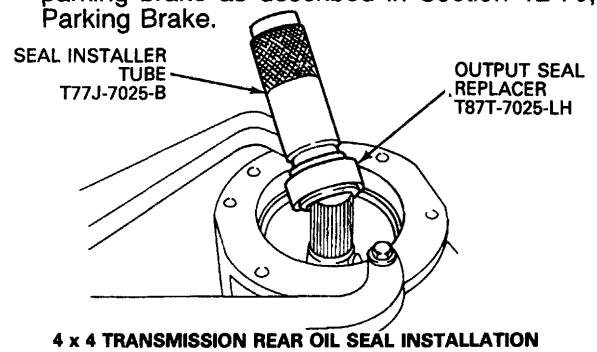
1. On 4x4 vehicles, remove the transfer case as described in the appropriate transfer case section in Group 16 in this manual. On F-Super Duty vehicles, remove the transmission mounted parking brake as described in Section 12-70, Parking Brake.
2. Insert Rear Seal Remover T87T-7025-CH or equivalent over output end of mainshaft and tighten into rear seal.
3. Assemble Forcing Screw T84T-7025-B or equivalent into seal remover. Turn forcing screw while holding seal remover to pull seal.



4 x 4 OUTPUT SEAL REMOVER **C8198-1A**

Installation

1. Place a new oil seal and Output Seal Replacer T87T-7025-LH or equivalent over the output end the mainshaft.
2. Slide Puller Tube T77J-7025-B or equivalent over the output end of the mainshaft.
3. Using a soft hammer, gently tap the seal into place.
4. On 4x4 vehicles, install the transfer case as described in the appropriate transfer case section in Group 16 in this manual. On F-Super Duty vehicles, install the transmission mounted parking brake as described in Section 12-70, Parking Brake.



4 x 4 TRANSMISSION REAR OIL SEAL INSTALLATION
C8197-1A

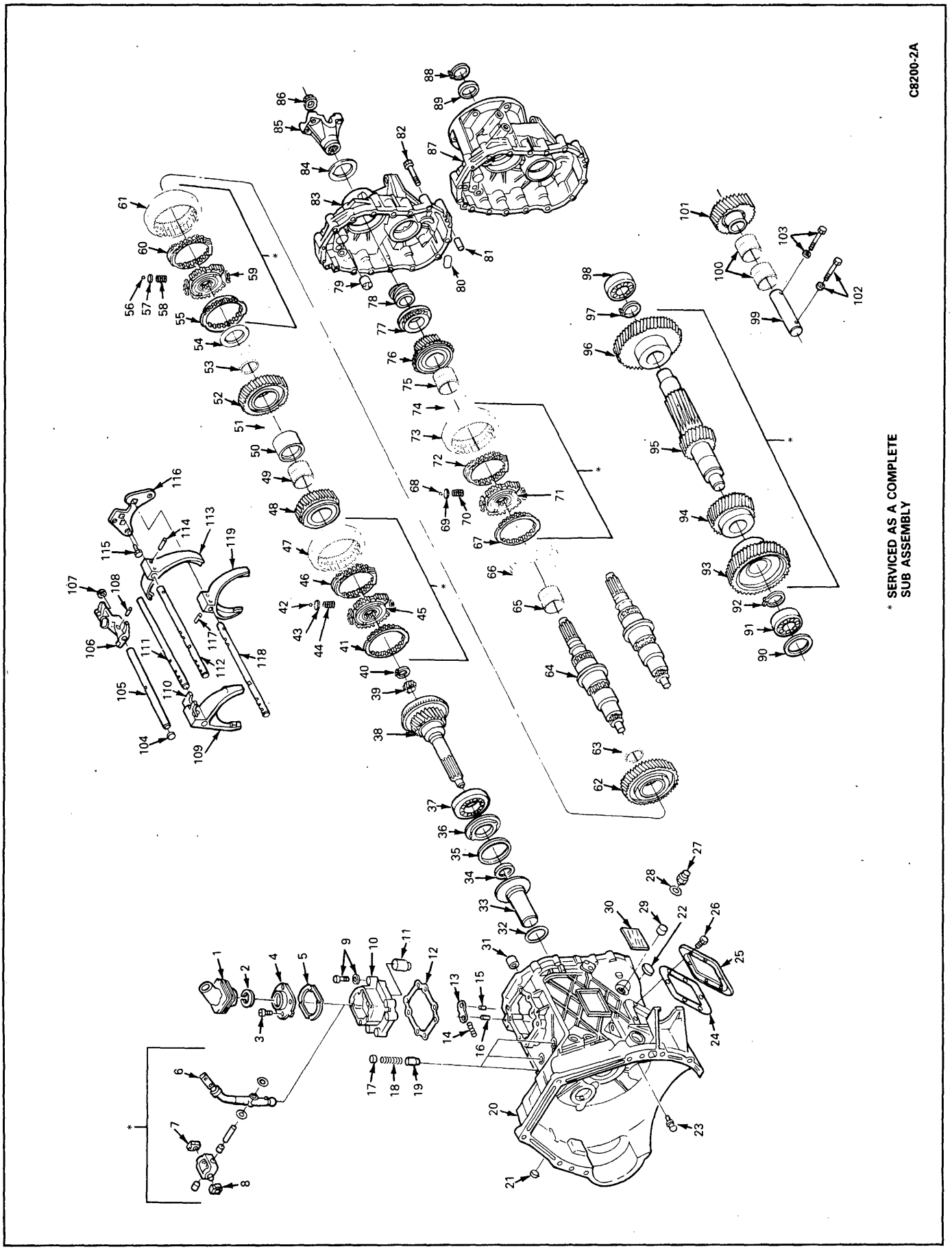
LEGEND

NO.	DESCRIPTION	NO.	DESCRIPTION	NO.	DESCRIPTION	NO.	DESCRIPTION
1.	SHIFT LEVER BOOT	31.	CENTRAL SHIFT RAIL BEARING	61.	1ST-2ND SLIDING SLEEVE	91.	FRONT COUNTERSHAFT BEARING
2.	SNAP RING	32.	O-RING	62.	1ST GEAR	92.	SNAP RING
3.	CAPSCREW	33.	QUILL	63.	NEEDLE ROLLERS	93.	COUNTERSHAFT DRIVE GEAR
4.	SHIFT TOWER COVER	34.	OIL SEAL	64.	MAINSHAFT	94.	COUNTERSHAFT 3RD GEAR
5.	GASKET	35.	SHIM	65.	CAGED NEEDLE ROLLERS	95.	COUNTERSHAFT
6.	LOWER SHIFT LEVER	36.	BAFFLE	66.	REVERSE GEAR	96.	COUNTERSHAFT 5TH GEAR
7.	GUIDE PIECE	37.	INPUT SHAFT BEARING	67.	REVERSE GEAR SYNCHRONIZER RING	97.	SNAP RING
8.	GUIDE PIECE	38.	INPUT SHAFT	68.	BALL	98.	COUNTERSHAFT REAR BEARING
9.	HEX BOLTS	39.	MAINSHAFT BEARING	69.	PRESSURE PIECE	99.	REVERSE IDLER SHAFT
10.	SHIFT HOUSING	40.	SNAP RING	70.	SPRING	100.	CAGED NEEDLE ROLLERS
11.	SHIFT DETENT	41.	4TH GEAR SYNCHRONIZER RING	71.	5TH-REVERSE SYNCHRONIZER BODY	101.	REVERSE IDLER GEAR
12.	GASKET	42.	BALL	72.	5TH GEAR SYNCHRONIZER RING	102.	SCREW AND SEALING RING
13.	5TH-REVERSE INTERLOCK	43.	PRESSURE PIECE	73.	5TH-REVERSE SLIDING SLEEVE	103.	SCREW AND SEALING RING
14.	INTERLOCK SPRING	44.	SPRING	74.	SNAP RING	104.	PLUG
15.	INTERLOCK ROLL PIN	45.	3RD-4TH SYNCHRONIZER BODY	75.	CAGED NEEDLE ROLLERS	105.	CENTRAL SHIFT RAIL
16.	INTERLOCK ROLL PIN	46.	3RD GEAR SYNCHRONIZER RING	76.	5TH GEAR	106.	SHIFT FINGER
17.	SEALING CAP	47.	3RD-4TH SLIDING SLEEVE	77.	MAINSHAFT BEARING	107.	PLUG
18.	SPRING	48.	3RD GEAR	78.	SPEEDOMETER DRIVE GEAR (4 x 2 ONLY)	108.	ROLL PIN
19.	SHIFT RAIL DETENT	49.	CAGED NEEDLE ROLLERS	79.	CENTRAL SHIFT RAIL BEARING	109.	ROLL PIN
20.	FRONT CASE	50.	BEARING RACE	80.	MAGNET	110.	SHIFT FORK
21.	SEALING CAP	51.	THRUST WASHER	81.	DOWEL	111.	SHIFT RAIL
22.	PLUG – DRAIN	52.	2ND GEAR	82.	BOLT	112.	SHIFT RAIL
23.	BOLT	53.	CAGED NEEDLE ROLLERS	83.	REAR CASE (4 x 2)	113.	SHIFT FORK
24.	GASKET	54.	SNAP RING	84.	REAR OIL SEAL (4 x 2)	114.	ROLL PIN
25.	PTO COVER	55.	2ND GEAR SYNCHRONIZER RING	85.	OUTPUT YOKE (4 x 2)	115.	BOLT
26.	BOLT	56.	BALL	86.	LOCKNUT (4 x 2)	116.	INTERLOCK PLATE
27.	BACKUP LAMP SWITCH	57.	PRESSURE PIECE	87.	REAR CASE (4 x 4)	117.	ROLL PIN
28.	SEALING RING	58.	SPRING	88.	SNAP RING (4 x 4)	118.	SHIFT RAIL
29.	PLUG – FILLER	59.	1ST-2ND SYNCHRONIZER BODY	89.	OIL SEAL (4 x 4)	119.	SHIFT FORK
30.	ID PLATE	60.	1ST GEAR SYNCHRONIZER RING	90.	SHIM		

C9030-2A

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DISASSEMBLY AND ASSEMBLY



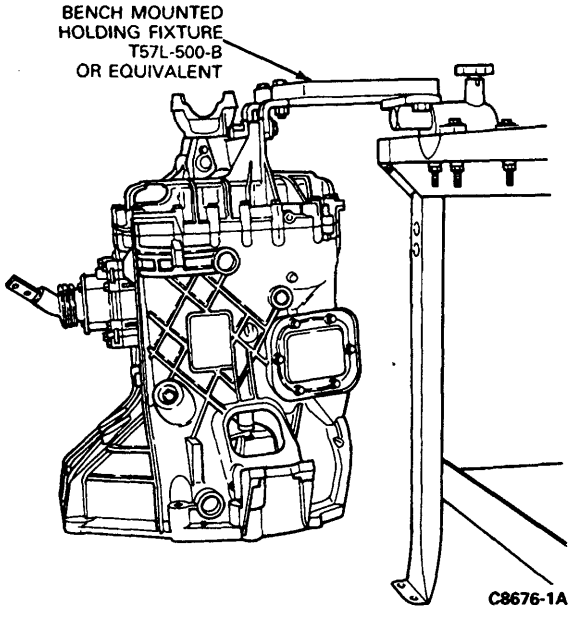
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DISASSEMBLY AND ASSEMBLY (Continued)

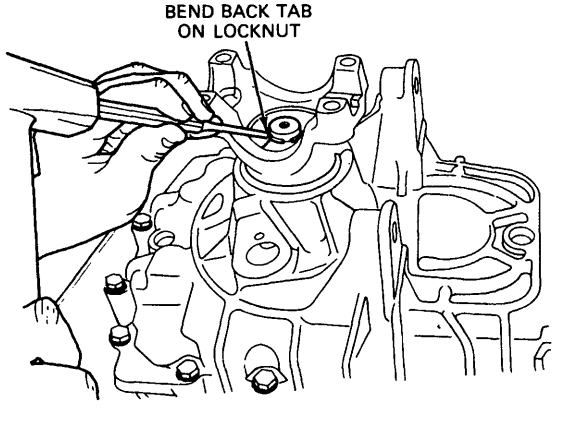
Transmission

Disassembly

1. Attach the transmission to the Bench Mounted Holding Fixture T57L-500-B or equivalent. Place the transmission in a vertical position with the front case pointing downward.

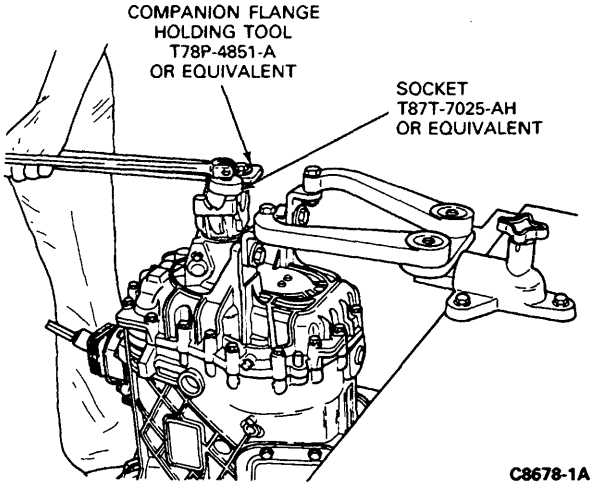


2. Using a chisel, bend back the tab on the output flange retaining locknut.

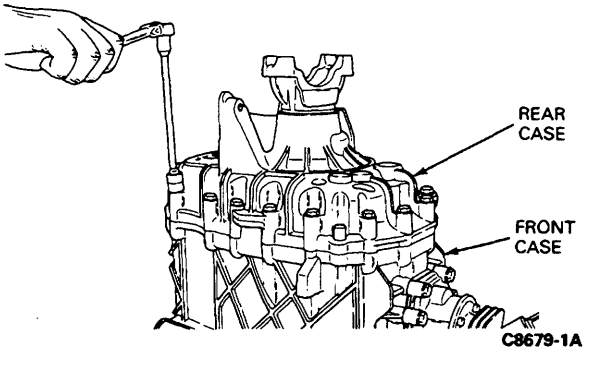


3. Attach Companion Flange Holding Tool T78P-4851-A or equivalent to the transmission output flange.
4. Loosen the hex nut that holds the output flange to the mainshaft with Thin-Walled Socket T87T-7025-AH or equivalent. Remove the flange holding tool after loosening the nut.

CAUTION: Do not remove the hex nut or output flange at this time.



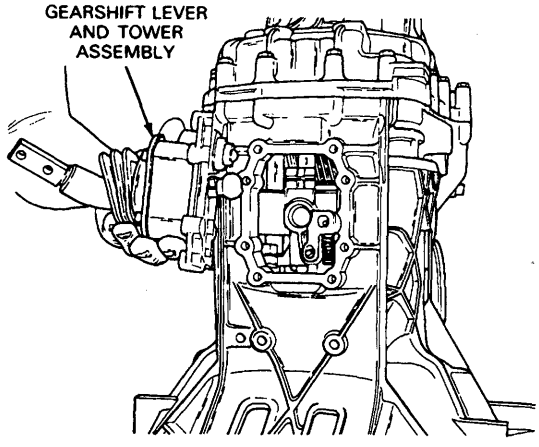
5. Remove 15 of the 17 8mm hex head screws that hold the front and rear cases together. Leave two screws at opposite ends of the case installed.
6. Remove any power take-off equipment installed on the transmission.



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DISASSEMBLY AND ASSEMBLY (Continued)

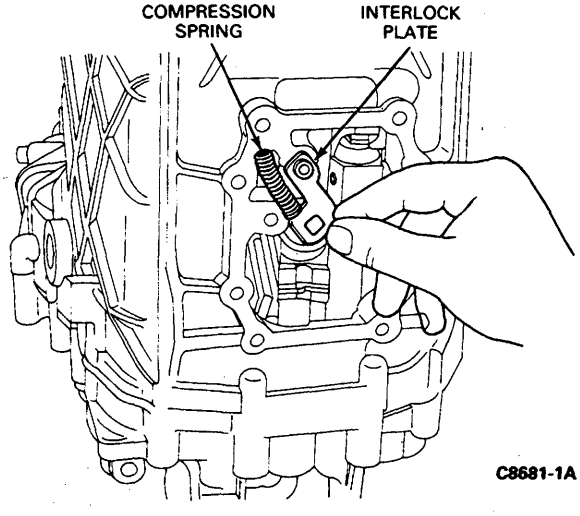
7. Remove the eight 8mm hex bolts that attach the shift tower assembly to the front case. Remove the complete gearshift lever and tower as an assembly.



C8680-1A

8. Remove the interlock plate and compression spring which serves as a reverse gear interlock.

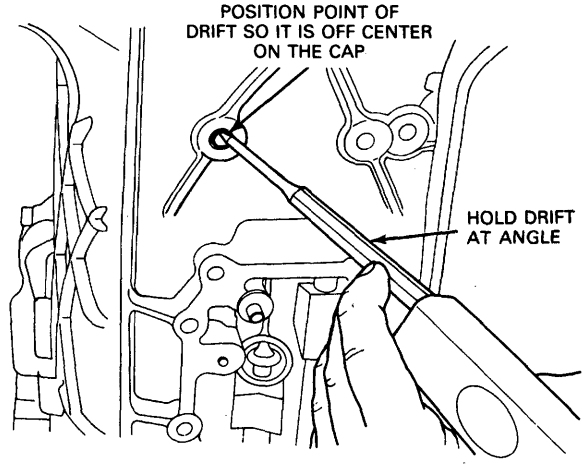
CAUTION: Use care to ensure that parts do not inadvertently fall into transmission.



C8681-1A

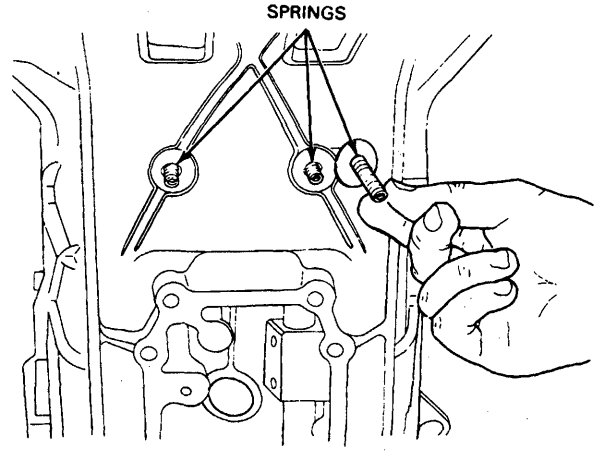
9. Place a drift punch against the detent bolt sealing cap. Hold the drift at an angle. Position the point of the drift punch so it is off center on the cap. Drive the cap inward until spring pressure against its underside forces the cap out of its hole. Repeat this procedure for the other two detent bolt sealing caps in the front case.

WARNING: CAP IS UNDER SPRING PRESSURE. ALWAYS WEAR PROTECTIVE EYEGLASSES WHEN PERFORMING THIS PROCEDURE TO ENSURE THAT CAP DOES NOT STRIKE EYES WHEN IT IS FORCED OUT BY SPRING PRESSURE.



C8682-1A

10. Remove the springs that are now protruding from the sealing cap holes.

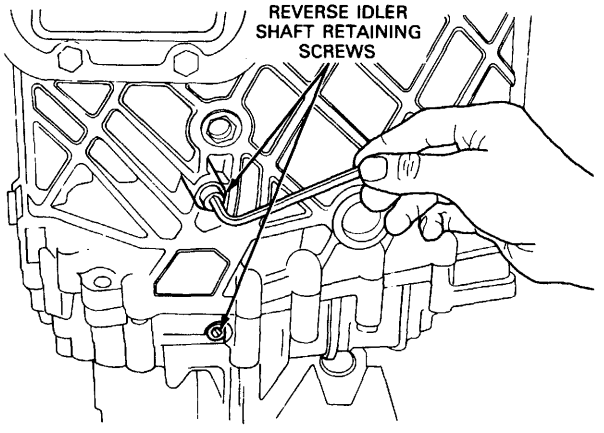


C8683-1A

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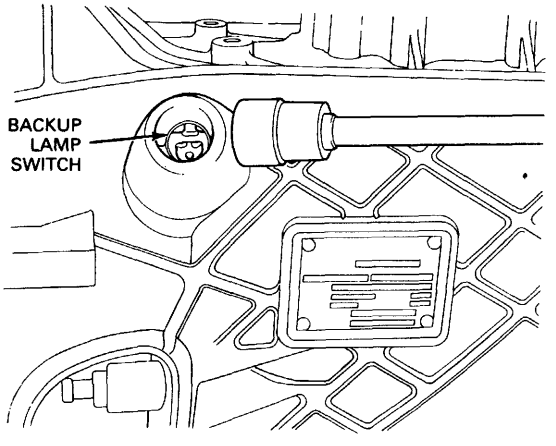
DISASSEMBLY AND ASSEMBLY (Continued)

11. Drive out the sealing caps for the two reverse idler shaft cap screws. Remove the reverse idler shaft cap screws.



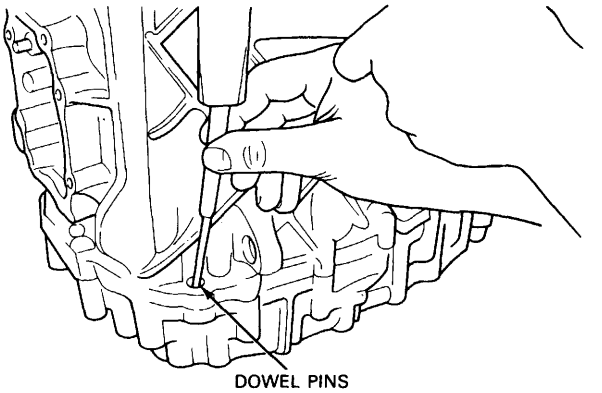
C8684-1A

12. If required, remove the backup lamp switch, located above and slightly forward of the transmission nameplate. Remove the backup lamp switch sealing ring.



C8685-1A

13. Use a suitable punch, remove the two dowel pins from the two upper corners of the rear case to front case mating surfaces. Drive them out toward the rear of the transmission.
14. Remove the two remaining hex bolts from the rear case.



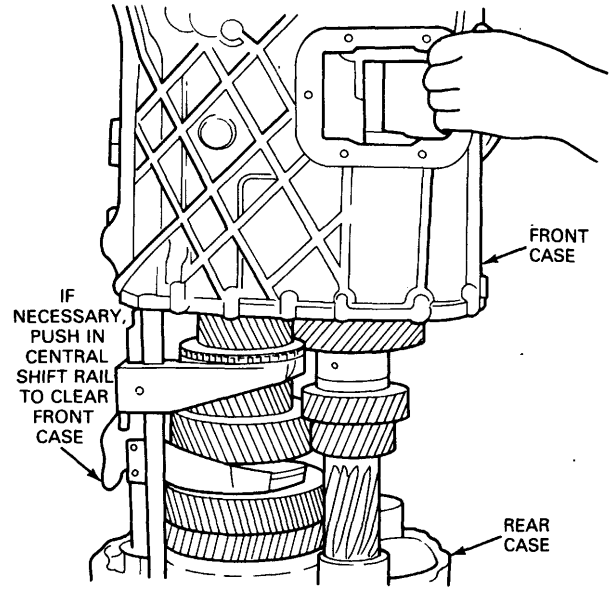
C8687-1A

15. Carefully lift the front case off of the rear case. It may be necessary to push the central shift rail inwards to prevent it from "hanging up" on the front case as it is being removed. Use care to ensure that the central shift rail is not lifted off together with the front case. Refer to Subassemblies in this Section for Front Case disassembly and assembly procedures.

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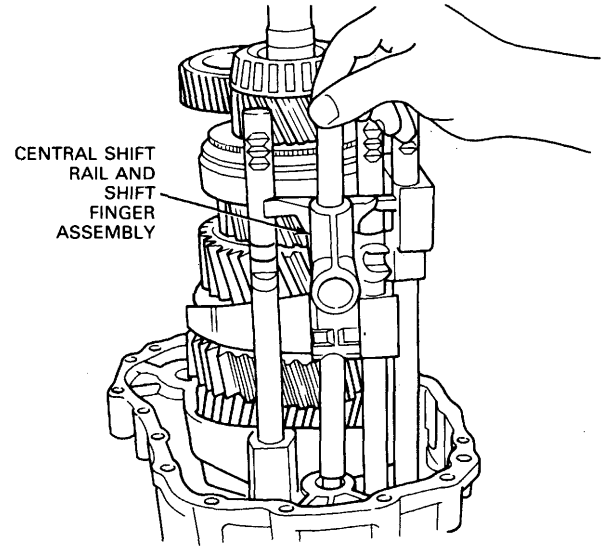
DISASSEMBLY AND ASSEMBLY (Continued)

CAUTION: The mating surfaces of the two housing assemblies are coated with an adhesive sealing agent. If it is difficult to separate the two housings because of this adhesive, carefully tap the front of the front case with a soft hammer until the bond is loosened. Never use a prying device, such as a screwdriver or chisel, to force the housings apart. It could damage the surface and cause leaks.



C8688-1A

16. Remove the central shift rail and shift finger assembly.

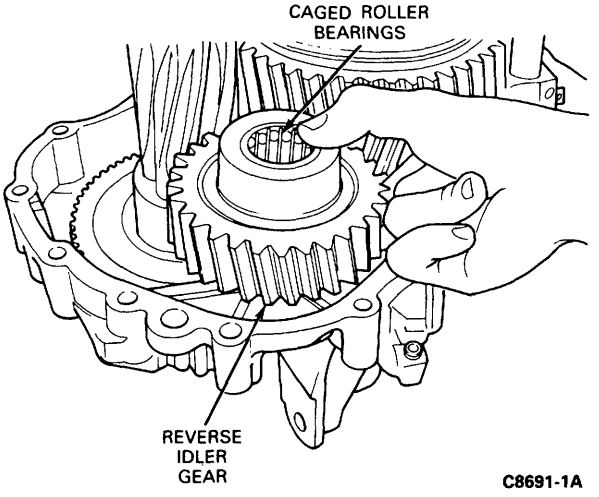


C8689-1A

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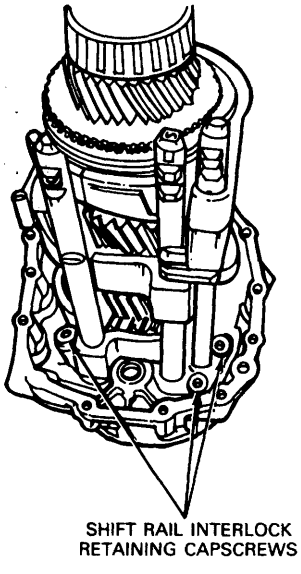
DISASSEMBLY AND ASSEMBLY (Continued)

17. Lift the shaft out of the reverse idler gear, and remove the gear and two caged roller bearings from the rear case.



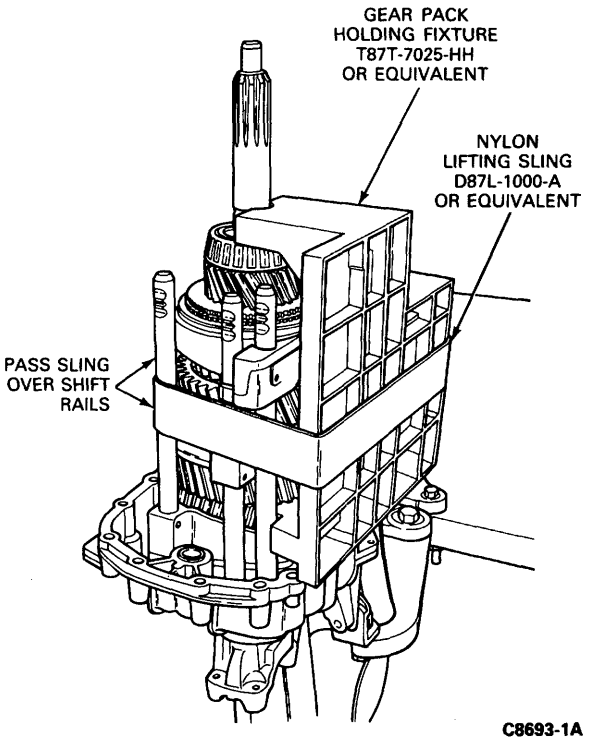
C8691-1A

18. Remove the three capscrews that retain the shift interlock to the rear case.



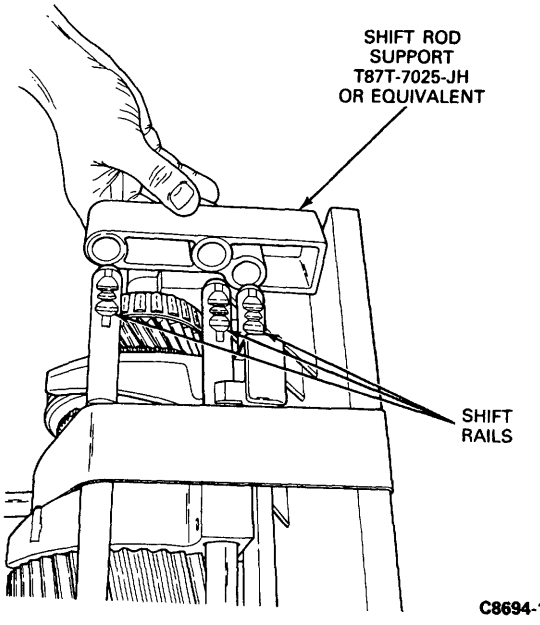
C8692-1A

19. With the transmission in a vertical position, use Nylon Lifting Sling D87L-1000-A or equivalent to strap Gear Pack Holding Fixture T87T-7025-HH or equivalent to the mainshaft and output shaft assemblies. Pass the sling over the shift rails.



C8693-1A

20. Place the Shift Rod Support, T87T-7025-JH or equivalent over the ends of the shift rails.

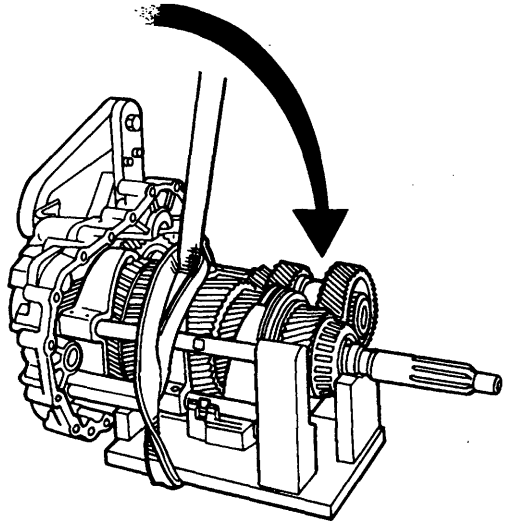


C8694-1A

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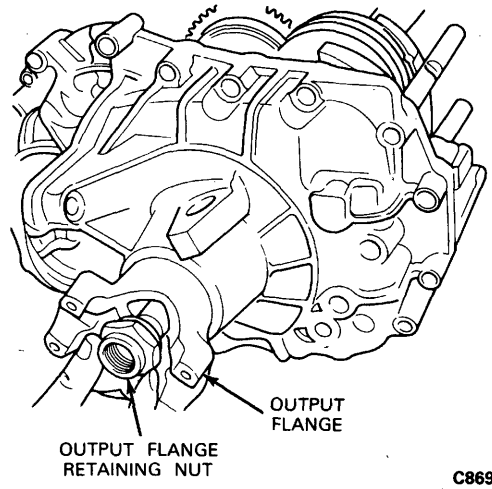
DISASSEMBLY AND ASSEMBLY (Continued)

21. Carefully rotate the transmission, together with the gear pack holding fixture, into a horizontal position with the holding fixture beneath the gear pack.



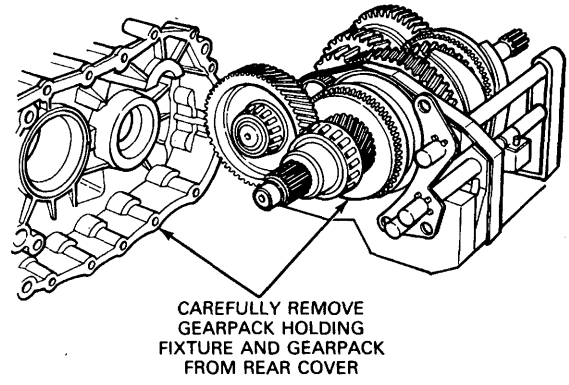
C8695-1A

22. Remove the output shaft flange retaining nut from the output shaft. Remove the flange from the output shaft. If the flange is difficult to remove, tap it loose with a hammer.



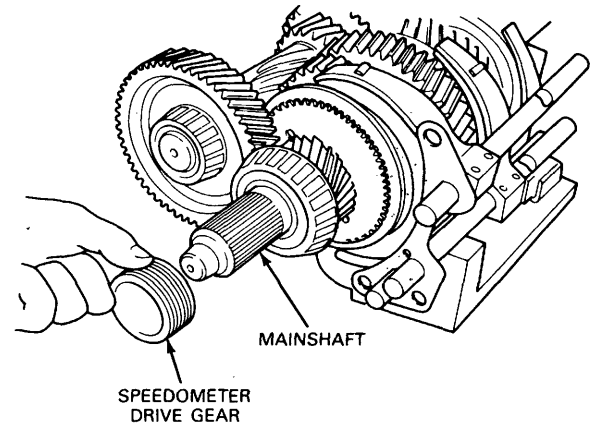
C8696-1A

23. Carefully pull the gearpack and shift rails and their holding fixtures forward to dislodge them from the rear case. Place this assembly on a workbench.



C8697-1A

24. If equipped, remove the speedometer drive gear from the mainshaft.

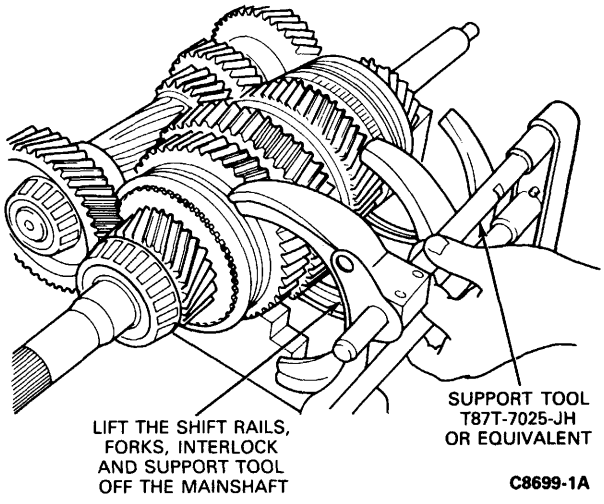


C8698-1A

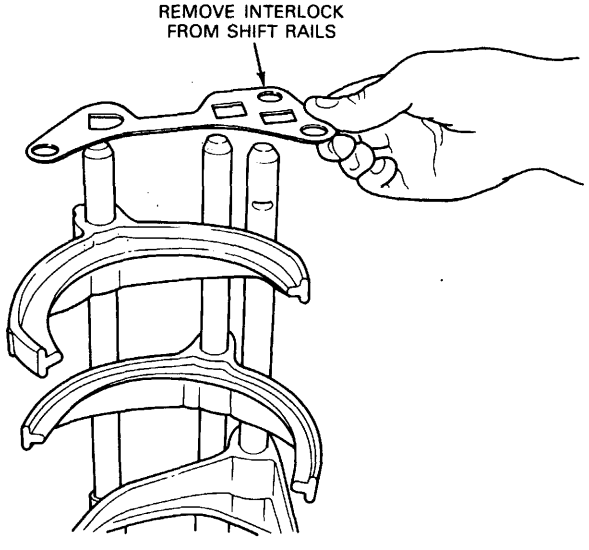
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DISASSEMBLY AND ASSEMBLY (Continued)

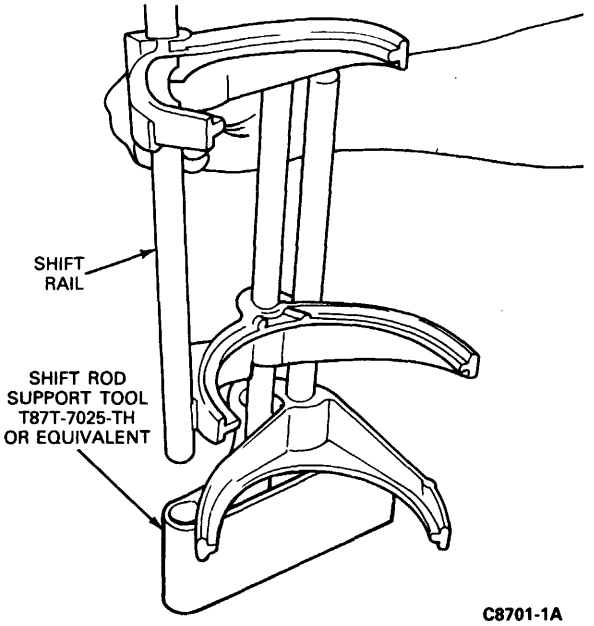
25. Remove the sling from around the shift rails, gearpack, and holding fixture.
26. Turn the gearshift rails approximately 45° to release them from the shift hubs. Lift the gearshift rails, forks and interlock, together with support Tool T87T-7025-JH, off the mainshaft.



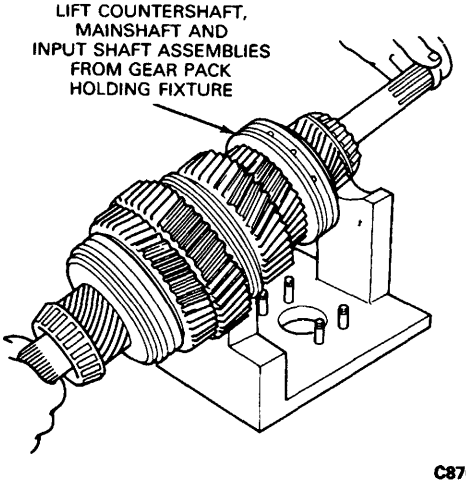
27. Using the shift rod support tool as a base, set the shift rail assembly on a workbench with the shift rails in a vertical position. Remove the interlock.



28. Mark each shift fork, shift rail, and position in the holding fixture to make reassembly easier. Lift the shift rails from the support tool. Refer to Subassemblies in this Section for shift rail disassembly procedures.



29. Lift the countershaft off the bench stand. Separate the input shaft from the mainshaft. Life the mainshaft and output shaft from the stand. Refer to Subassemblies in this Section for mainshaft, countershaft and input shaft disassembly and assembly procedures.
30. Remove the rear cover from the holding fixture. Refer to Subassemblies in this Section for rear case disassembly and assembly procedures.

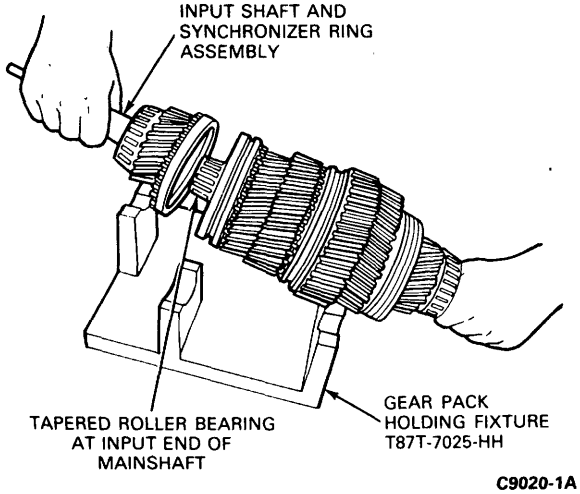


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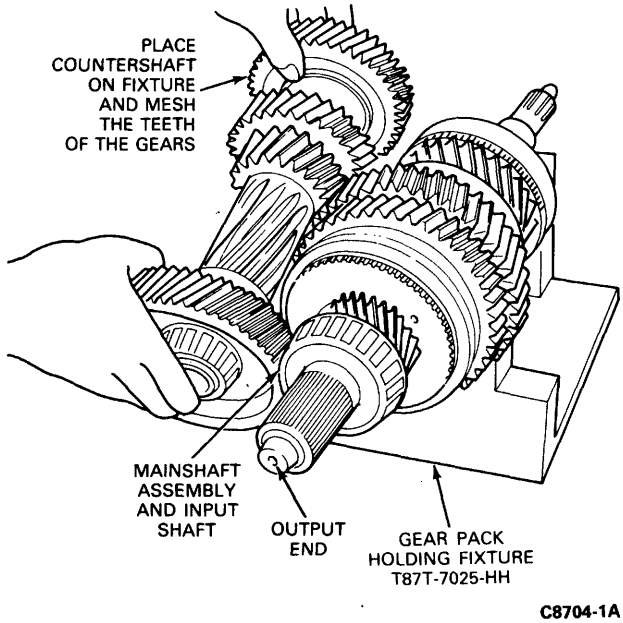
DISASSEMBLY AND ASSEMBLY (Continued)

Assembly

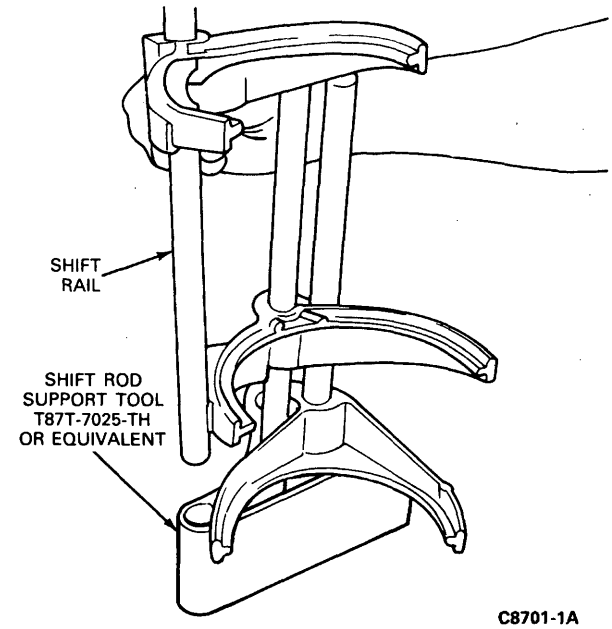
1. Place the input shaft and synchronizer ring assembly over the tapered roller bearing on the input end of the mainshaft.



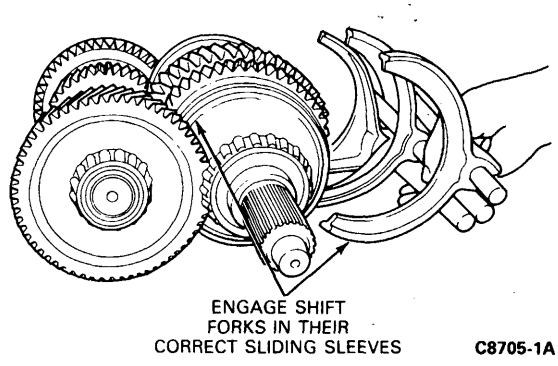
2. Place the mainshaft and input shaft on the Gear Pack Holding Fixture, T87T-7025-HH or equivalent. Place the countershaft on the fixture and mesh the gears of the two shafts.



3. Place the three shift rails and fork assemblies into the Shift Rod Support Tool T87T-7025-JH or equivalent in the position from which they were removed during disassembly.



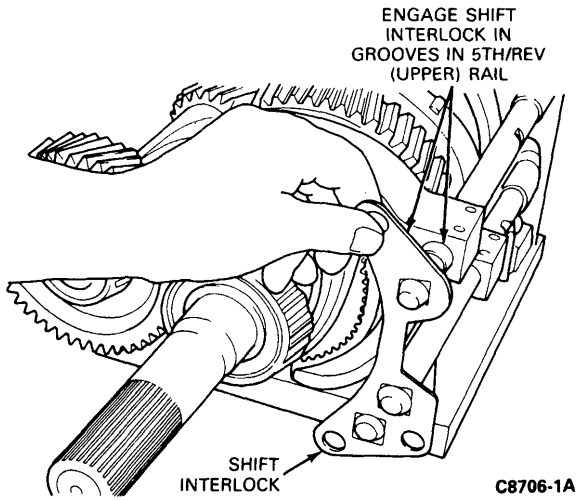
4. Position the three shift rail assemblies together with the shift rod support tool and interlock so that the shift forks engage in the correct mainshaft sliding sleeves.



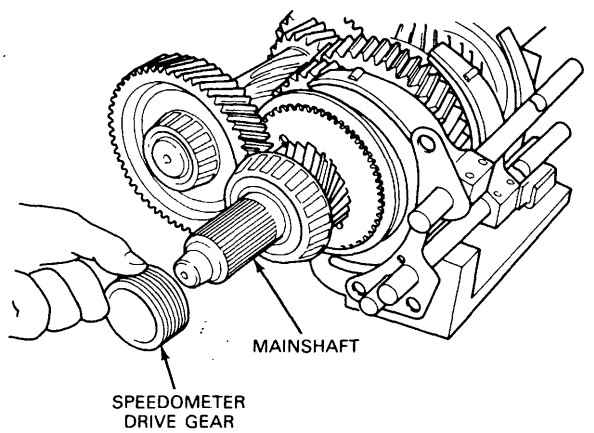
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DISASSEMBLY AND ASSEMBLY (Continued)

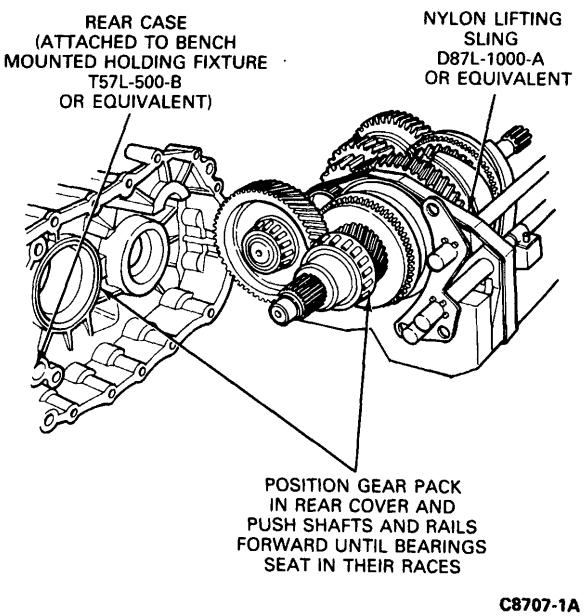
5. Place the shift interlock on the three gearshift rails and engage it in the interlock grooves in the 5th-reverse (upper) rail.



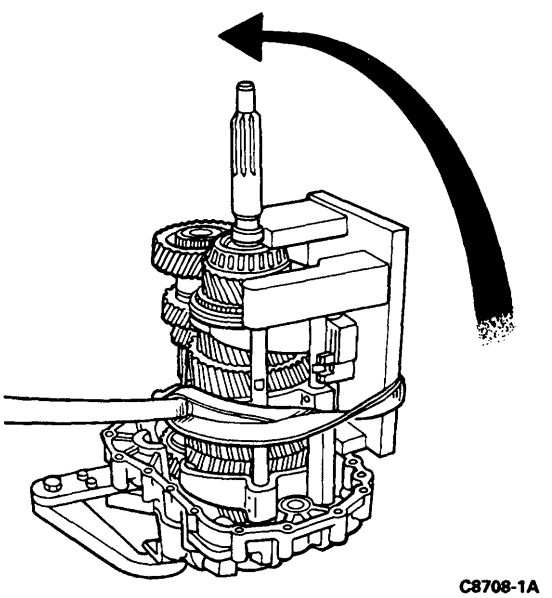
6. If equipped, slide the speedometer worm gear onto the mainshaft until it seats against the stop on the mainshaft.



7. Secure the rear cover into the bench mounted holding fixture T57L-500-B or equivalent.
8. Position Nylon Lifting Sling, D87L-1000-A or equivalent around the shift rails, the holding fixture and the mainshaft and countershaft. Position the gear pack into the rear cover and push the shafts and rails forward until the bearings seat in their outer races in the housing and the gearshift rails slide into their retaining holes in the housing.



9. Rotate the gear pack and rear case upwards 90° so it is in a vertical position with the input shaft pointing upwards.

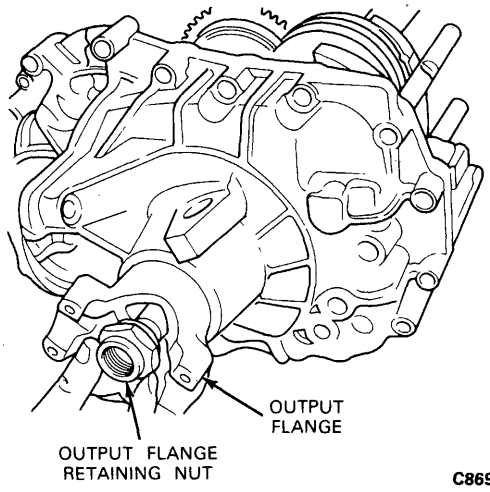


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DISASSEMBLY AND ASSEMBLY (Continued)

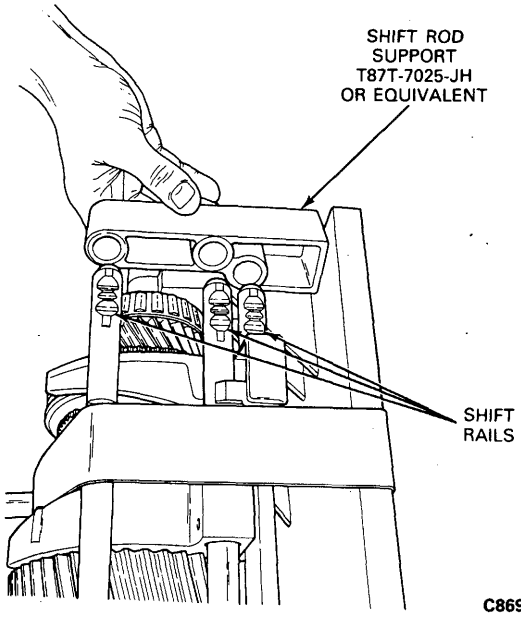
10. If equipped, slide the output flange onto the output end of the mainshaft until it seats against its stop. Screw the hex nut onto the shaft until it is finger-tight.

CAUTION: Use care to ensure that the mainshaft bearing is not pushed off its race when the flange is installed.



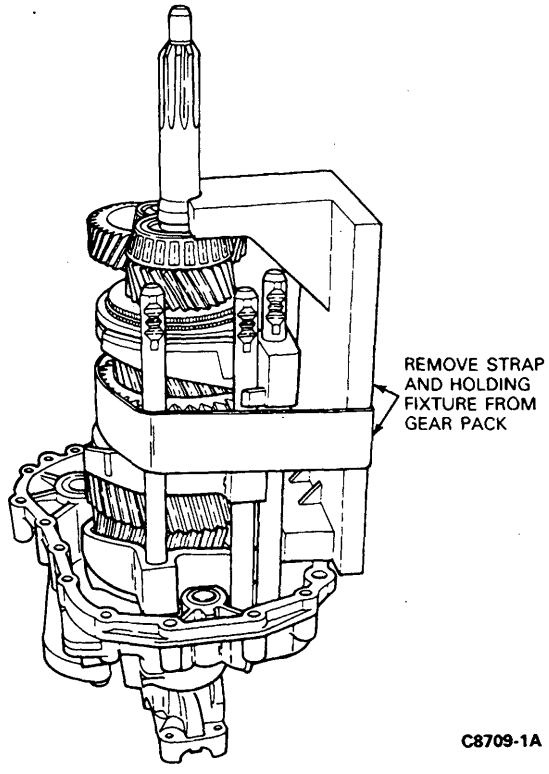
C8696-1A

11. Remove the shift rod support tool from the ends of the shift rails.



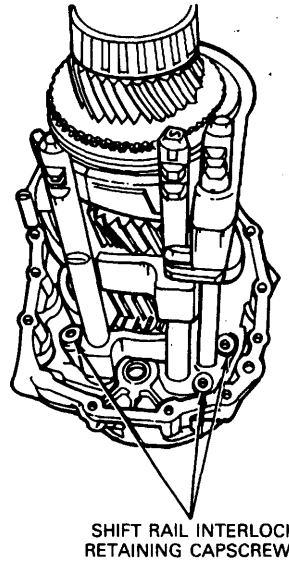
C8694-1A

12. Remove the strap and remove the gear pack holding fixture from the mainshaft and countershaft.



C8709-1A

13. Attach the three cap screws that secure the shift interlock to the rear transmission housing. Tighten them to 10 N·m (7 ft-lbs). Be sure that the interlock moves freely after tightening the screws.

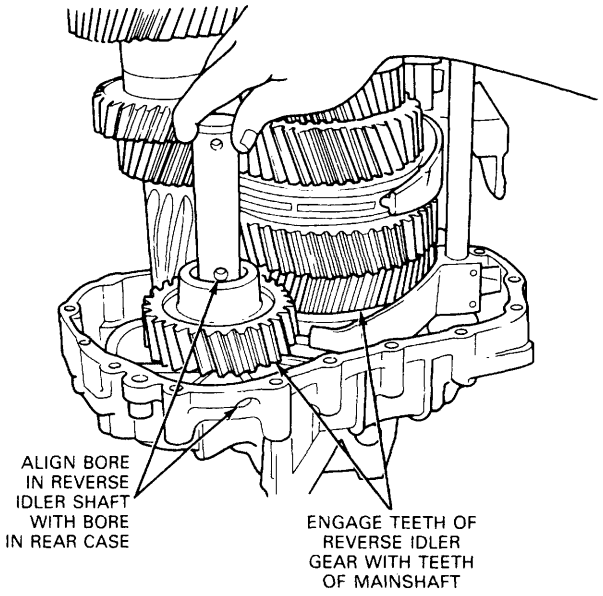


C8692-1A

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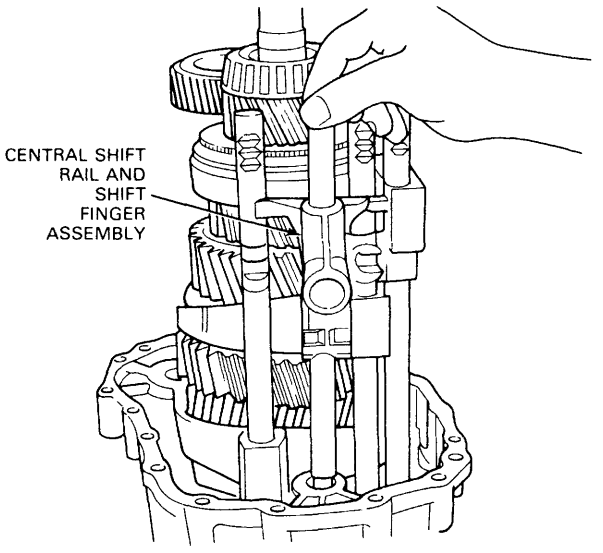
DISASSEMBLY AND ASSEMBLY (Continued)

14. Engage the teeth of the reverse idler gear with the reverse gear on the mainshaft. Slide the reverse idler shaft downward through the bearings and into the rear case. Align the lower of the two threaded holes in the shaft with the bore in the rear case. Place a Usit on the capscrew and attach the screw through the bore in the housing into the shaft. Tighten the screw finger-tight.



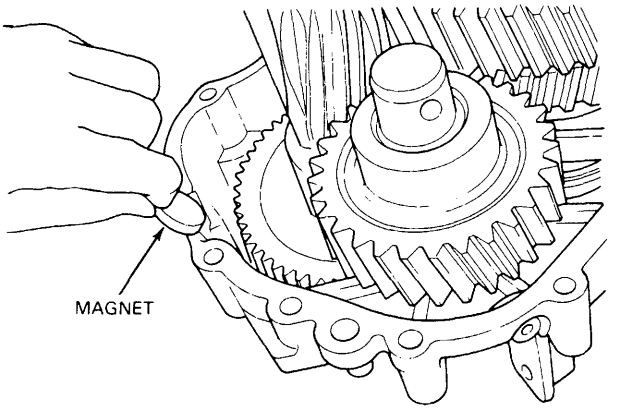
C8710-1A

15. Insert the central shift rail and finger assembly into its bore in the rear case.



C8689-1A

16. If the magnet was removed during disassembly, insert it in the recess in the housing.

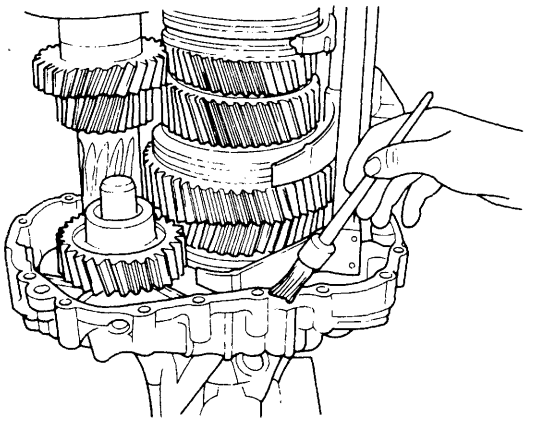


C8711-1A

17. If the tapered roller bearings on the mainshaft, input shaft or countershaft do not have to be adjusted, thinly coat the sealing surface of the rear case with Loctite 574.

CAUTION: Do not use silicon Sealing Compound or equivalent.

NOTE: The tapered roller bearings have to be adjusted if either the front or rear cases, countershaft, mainshaft, input shaft, or a bearing has been replaced. If the tapered roller bearings on the mainshaft, input shaft, or countershaft have to be adjusted, do not apply the sealant at this time.



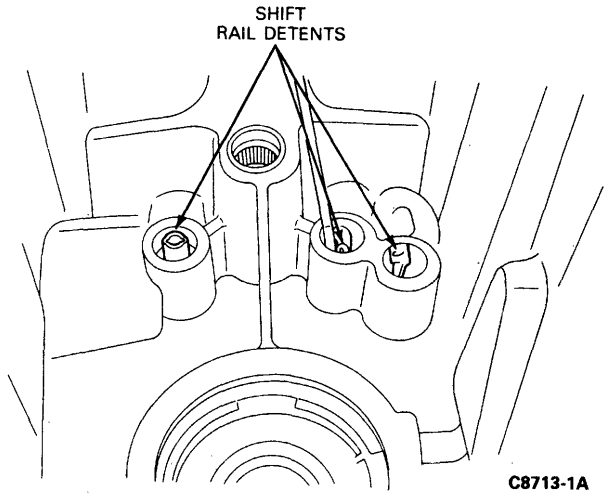
C8712-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

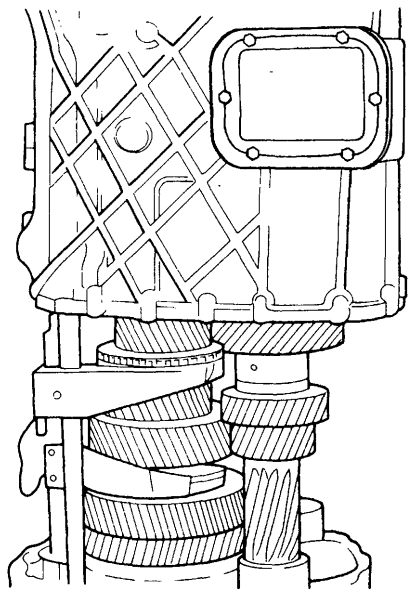
18. If removed, push the three shift rail detents back into their holes in the front case.

CAUTION: Use care to ensure that the shift rail detents do not obstruct entry of the shift rails.



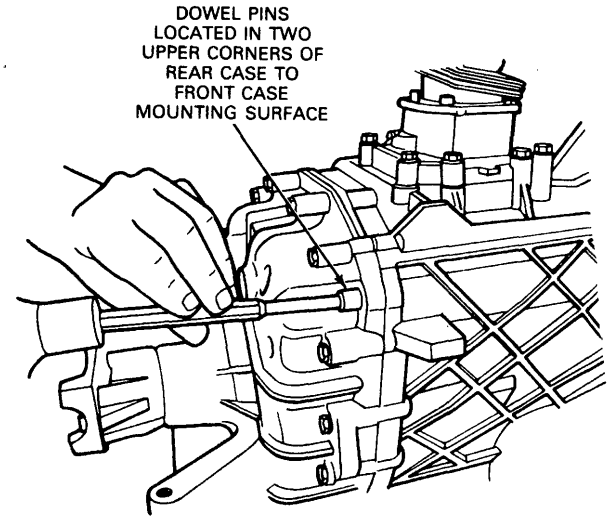
C8713-1A

19. Carefully place the front case over the shafts and gearshift rails until it rests on its mating surface on the rear case. It may be necessary to push the central shift rail inward to clear the inner surfaces of the front case.



C9019-1A

20. Drive in the two dowels that align the rear case and the front case. Next, insert two hex screws and tighten them finger-tight.

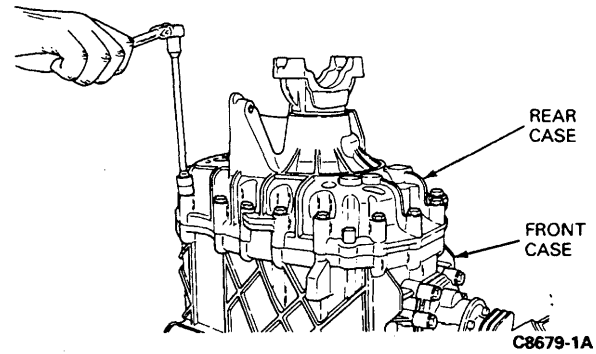


C9022-1A

21. Screw two additional hex screws into the rear case bores near the shafts finger tight.

NOTE: If it is not necessary to adjust the mainshaft/input shaft preload. Install all of the hex screws that attach the two cases and tighten to 25 N·m (18 ft-lb).

CAUTION: Adjustment of tapered roller bearings is necessary if either the front or rear cases, countershaft, mainshaft or input shaft has been replaced, or if a tapered roller bearing on either shaft has been replaced. Refer to adjustments in this section for tapered roller bearing preload adjustment procedure before continuing assembly procedures.



C8679-1A

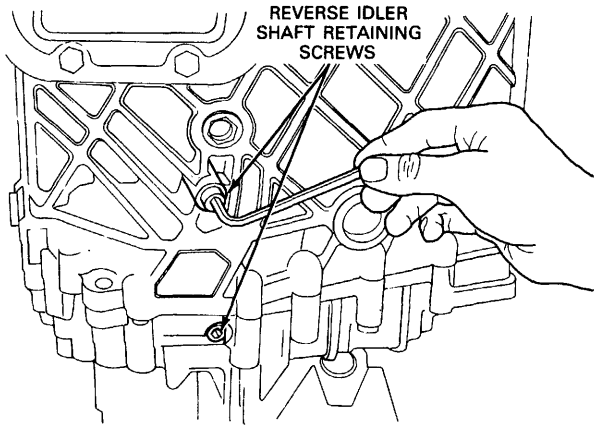
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DISASSEMBLY AND ASSEMBLY (Continued)

22. Fit Usit ring to the reverse idler shaft retaining capscrews. Install the screws into their bores in the front and rear cases and tighten to 22 N·m (16 ft-lbs). With a screwdriver push sealing covers into the capscrews until they are flush with the surface of the screw head.

CAUTION: Use hand pressure for screwdriver only, do not hammer the covers into position.

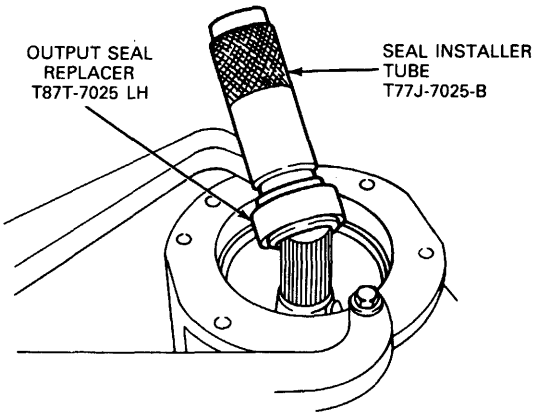
23. Rotate the transmission so the input shaft is pointing down.



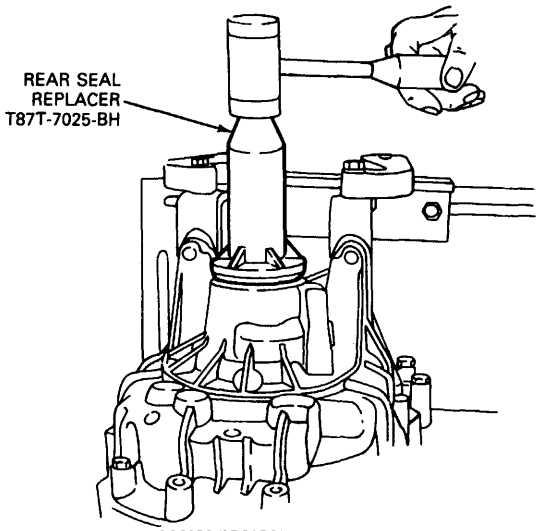
C8684-1A

24. If equipped, install the speedometer drive gear on the mainshaft.
25. On 4x2 transmissions, remove the hex nut that secures the output flange to the mainshaft, then remove the flange from the shaft. Position the output shaft seal on Output Seal Replacer T87T-7025-BH or equivalent and position the seal and tool in the opening in the rear case. Using a soft hammer gently tap the seal in until it seats in the opening. Apply a little liquid soap around the circumference to minimize friction.

On 4x4 applications, Output Seal Replacer T87T-7025-LH or equivalent and Seal Installer Tube T77J-7025-B or equivalent to install the output shaft oil seal. Gently tap on tube with a soft hammer until tool seats against its stop.



4 x 4 TRANSMISSION REAR OIL SEAL INSTALLATION



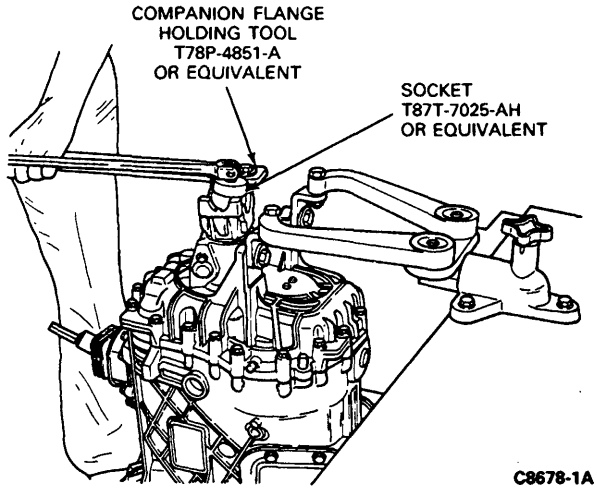
4 x 2 TRANSMISSION REAR OIL SEAL INSTALLATION

C8715-1A

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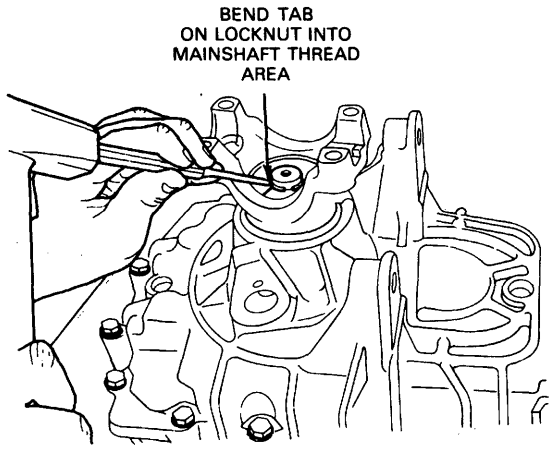
DISASSEMBLY AND ASSEMBLY (Continued)

26. On 4x2 applications, reinstall the output flange on the output shaft. Install Companion Flange Holder T78P-4851-A. Install the hex nut onto the mainshaft using locknut socket Tool T87T-7025-AH. Tighten the nut to 250 N·m (184 Ft-lbs).



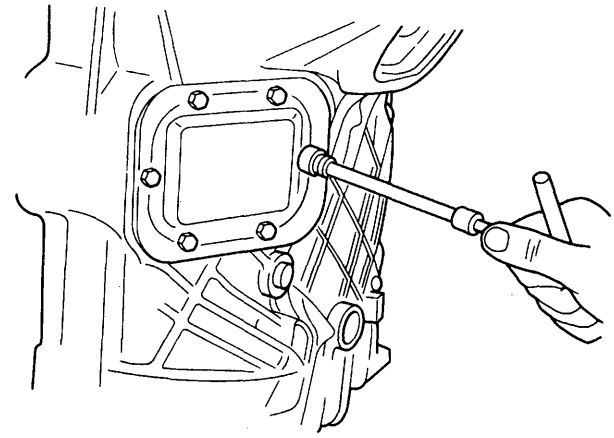
C8678-1A

27. Secure the locknut by bending a tab on the nut into the mainshaft.



C9023-1A

28. If required, install new gaskets and PTO covers over the openings in the front case using the original attaching screws which have self sealing threads and tighten to 38 N·m (28 ft-lbs.).


C8716-1A

29. Position the 5th-reverse gear interlock plate into its installed position as shown in the illustration. Place the gasket over the shift tower mating surface in the front case.

NOTE: Make sure that the stop plate moves freely and that the gasket does not interfere with it. The interlock plate must be in a position which is lower than the gasket so that the plate may move freely.

NOTE: Use care to ensure that the interlock plate or spring do not drop into the front case.

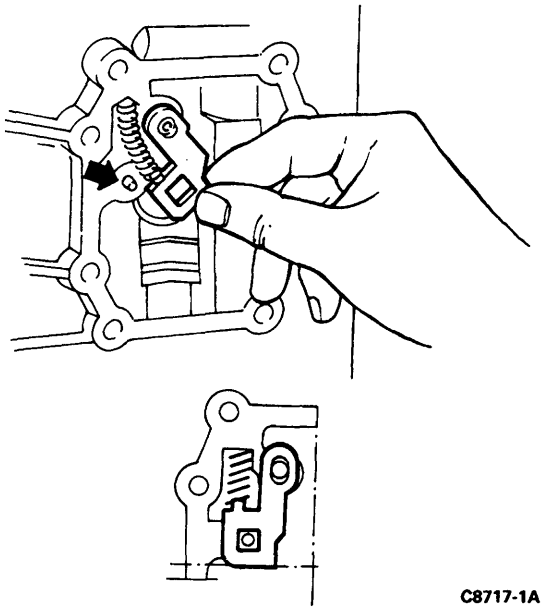
30. Check the interlock plate compression spring against Spring Specifications at the end of this Section to be sure that its unloaded length is satisfactory.

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DISASSEMBLY AND ASSEMBLY (Continued)

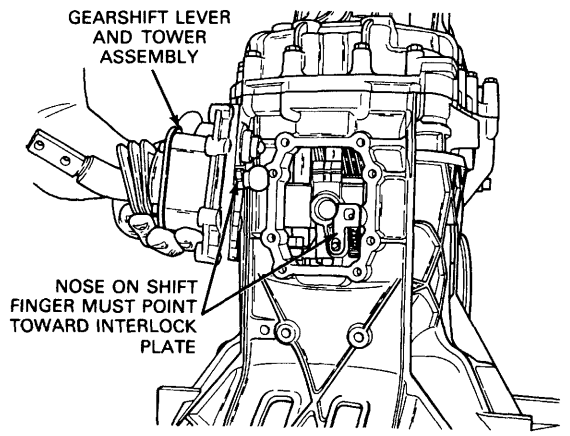
31. Place the spring above the nose in the interlock plate and move both parts into their installed positions.

CAUTION: The procedure must be followed exactly to ensure that the interlock function between fifth gear and reverse gear operates properly.



C8717-1A

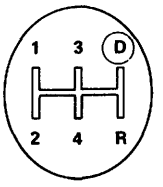
32. Install the shift tower assembly. The nose on the gearshift finger must point toward the interlock plate. Install spring washers and tighten screws to 25 N·m (18 ft-lbs).



C8718-1A

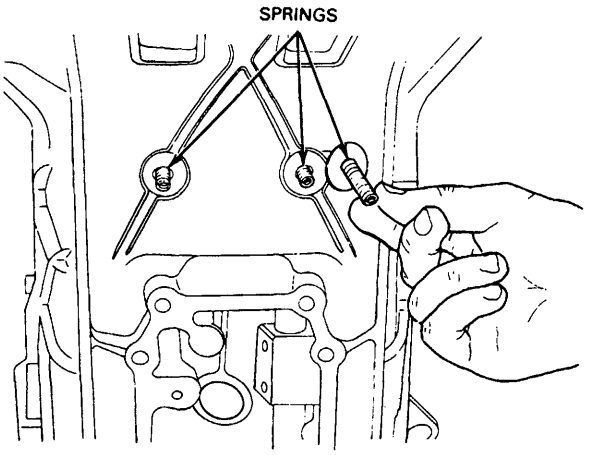
33. Check the functioning of the interlock. The shift lever cannot be shifted between fifth and reverse if the interlock was properly installed.

CAUTION: Do not force the lever to shift into reverse. Damage to the interlock components could occur.



C8719-1A

34. A compression spring is installed over each of the three detent bolts. The positions are shown in the illustration. Before installing the springs, check that their unloaded length is 44.1mm (1.736 in.).



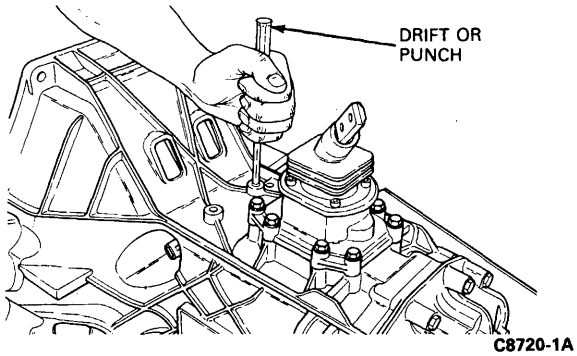
C8683-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

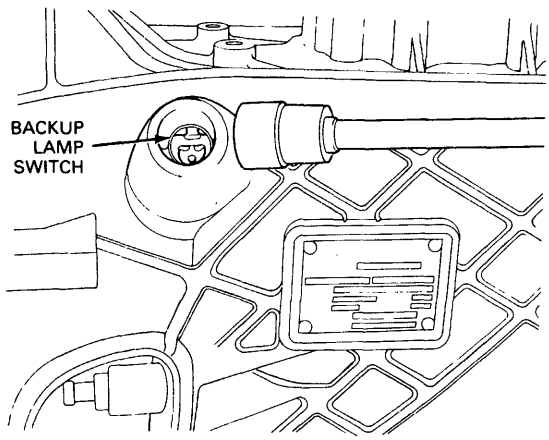
35. Install a sealing cap in each bore in the front case where the detents, bolts and springs were installed. Use a suitable drift or punch to drive each cap in until it seats 1mm (3/64 in.) below the surface of the housing.

NOTE: Deeper installation will cause high shift efforts.



C8720-1A

36. If removed install the backup lamp switch with a new sealing ring into its mounting boss on the side of the front case near the transmission nameplate. Tighten the switch to 20 N·m (15 ft-lbs).



C8685-1A

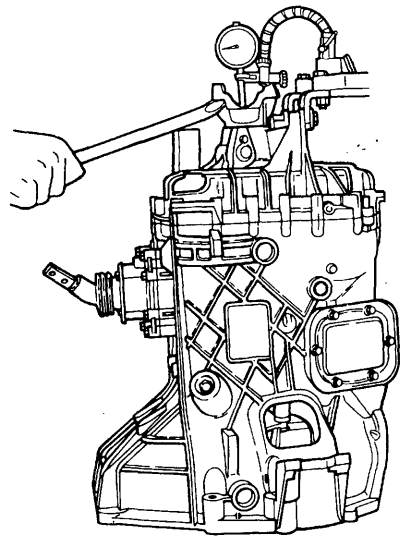
ADJUSTMENTS

Tapered Roller Bearing Preload Measurement and Adjustment

Measurement and adjustment of the tapered roller bearings is necessary if a housing, countershaft, mainshaft or input shaft has been replaced or if a tapered roller bearing per shaft has been replaced. The mainshaft, input shaft, and countershaft should be adjusted to provide a preload of 0.00079 to 0.00434 inch (0.02-0.11 mm). After adjusting the two shafts, each should be rotated a few times to center the rollers in the bearings involved.

Input Shaft and Mainshaft Tapered Roller Bearing Preload Measurement

1. With the transmission mounted to Bench Mounted Holding Fixture T57L-500-B or equivalent with the output flange facing upward, Attach a dial indicator gauge with a magnetic base, Tool D78P-4201-F and G or equivalent) to the output flange in such a manner that the measurement bar will rest on the output end of the mainshaft as shown in the illustration.
2. Zero the dial indicator and, using a pry bar, gently pry up the input shaft and mainshaft. It may be necessary to use a suitable piece of bar stock or one of the insulator bosses on the transmission as a fulcrum.
3. Note the indicator gauge reading. A shim and shaft seal which is to be fitted later must have a combined thickness equal to the dimension recorded on the dial plus 0.00079 to 0.00434 inch (0.02 to 0.11 mm). This will result in obtaining the specified preload after installation of the shims and shaft seal, and mainshaft and countershaft.

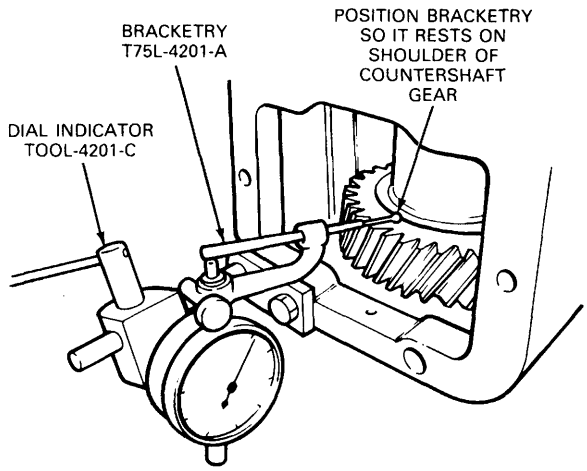

C8721-1A

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ADJUSTMENTS (Continued)

Countershaft Tapered Roller Bearing Preload Measurement

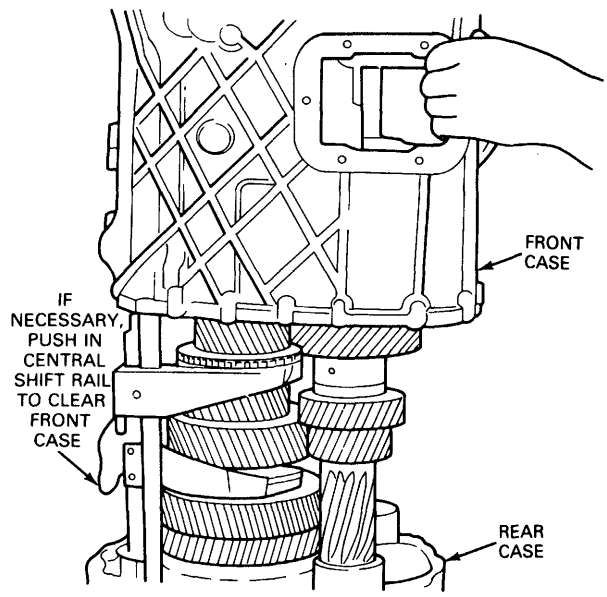
1. Using two 10mm hex screws, attach Dial Indicator with Bracketry D78P-4201-F and G near the P.T.O. opening in the front case as shown in the illustration. Position the dial indicator gauge to the support in such a way that the measurement bar rests against the flat face of the fifth speed helical gear on the countershaft.
2. Set the dial indicator needle to zero.
3. Insert pry bars through each of the two power take-off openings and position them beneath the 5th speed helical gear on the countershaft. Gently pry up on the countershaft.
4. Like the preceding shaft check, the preload should be 0.02 to 0.11mm (0.00079 to 0.00434 inch) after installing the shim and shafts.



C8722-1A

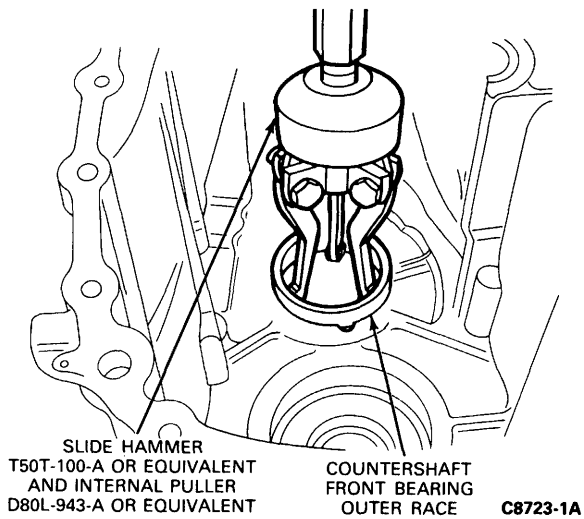
Mainshaft and Input Shaft Tapered Roller Bearing Preload Adjustment

1. After completing the tapered roller bearing preload measurements described previously, place the transmission in an upright position with the input shaft pointing upwards.
2. Drive the two dowel pins out of their holes in the front and rear cases and lift the front case off the rear case.



C8688-1A

3. Using Slide Hammer T50T-100-A or equivalent and Internal Puller D80L-943-A or equivalent, remove the countershaft and mainshaft tapered roller bearing outer races from the front case.

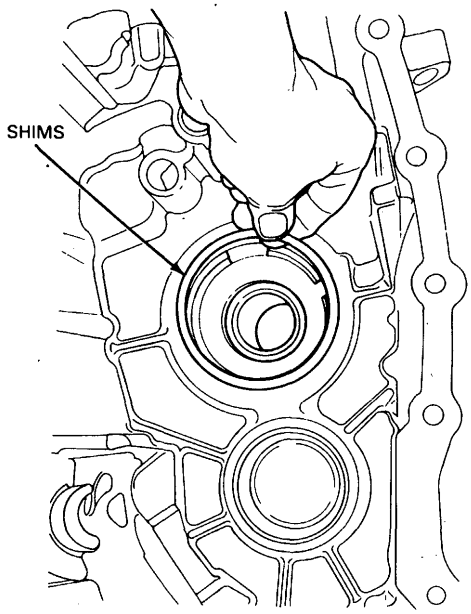


C8723-1A

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ADJUSTMENTS (Continued)

4. Fit each race with a shim washer or shim washer and shaft seal to obtain the required preload determined previously. Countershaft preload is established by using shims alone; input shaft and mainshaft preload is established by using shims and a baffle. In both cases the parts are installed beneath the outer race of the tapered roller bearing which seats in the front case.



C8724-1A

5. Apply Loctite 574 to the mating surfaces of the front and rear cases.

CAUTION: Do not use silicon.

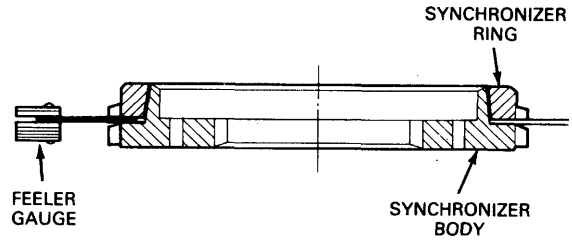
Position the front case on the rear case. Install all of the screws that secure the two front and rear cases and tighten to 22 N·m (16 ft-lbs.).

INSPECTION

For cleaning and inspection procedures other than that listed below, refer to Section 16-10, General Manual Transmission Service.

Synchronizer Ring/Synchronizer Body Wear Check

Position the synchronizer ring on the synchronizer body as shown in the illustration. Insert a feeler gauge and measure clearance at two opposite points. If clearance is less than 0.6mm (0.024 inch) for the 3rd-4th, 1st-2nd and 5th synchronizer assemblies and 0.2mm (0.008 inch) for the reverse synchronizer assemblies, replace the synchronizer ring, synchronizer body, or both if required to bring to within specification.



GEARS	CLEARANCE
1	0.6 mm (0.024 inch)
2	0.6 mm (0.024 inch)
3	0.6 mm (0.024 inch)
4	0.6 mm (0.024 inch)
5	0.6 mm (0.024 inch)
Reverse	0.2 mm (0.008 inch)

C8725-1A

Synchronizer Compression Spring Tension Check

Check the length and tension of all compression springs of synchronizers.

SPRING SPECIFICATIONS

Unloaded Length	O.D.	Wire Diameter
14.8 mm (0.583 in.)	5.960 mm (0.235 in.)	0.95 mm (0.037 in.)

CC8726-1A

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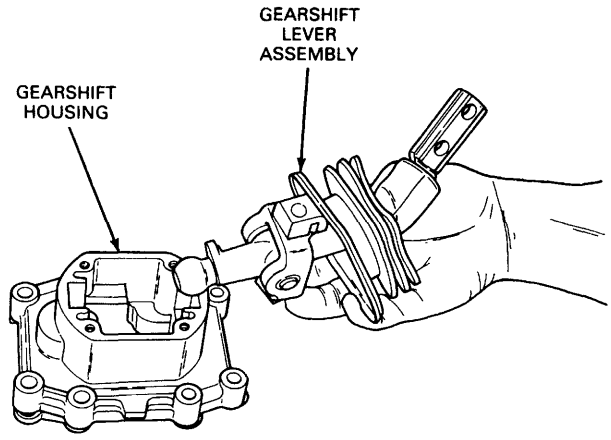
SUBASSEMBLIES

Shift Tower Assembly

Disassembly

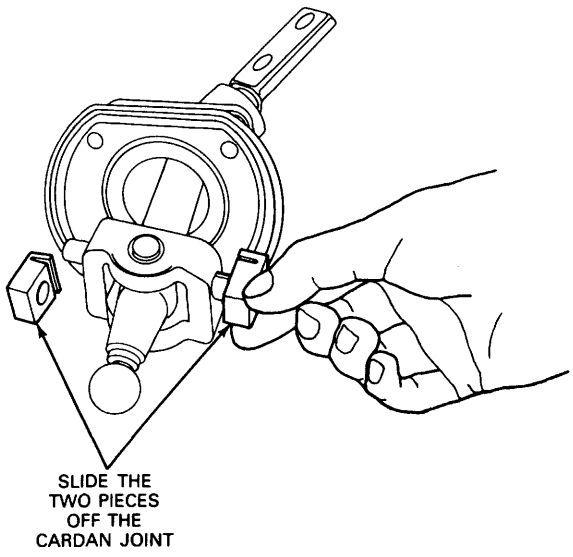
1. Remove the four capscrews that attach the gearshift lever cover to the gearshift housing. Lift the lever, boot, cover and attached parts off the housing as an assembly.

NOTE: Disassembly of parts inside the gearshift housing requires the use of a press that will destroy the detent that has been fitted into the housing by the manufacturer. Removal of housing components should be confined to replacement of the detent when necessary.



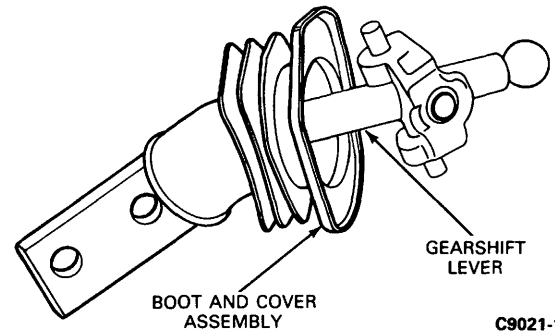
C8727-1A

2. Slide the two pieces off the cardan joint.



C8728-1A

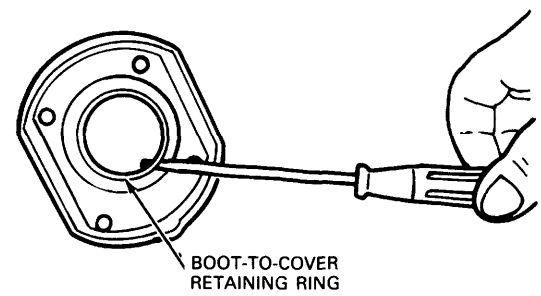
3. Slide the boot and cover as an assembly off past the top of the gearshift lever.



C9021-1A

4. Invert the cover with attached boot and remove the snap ring that secures the two parts.

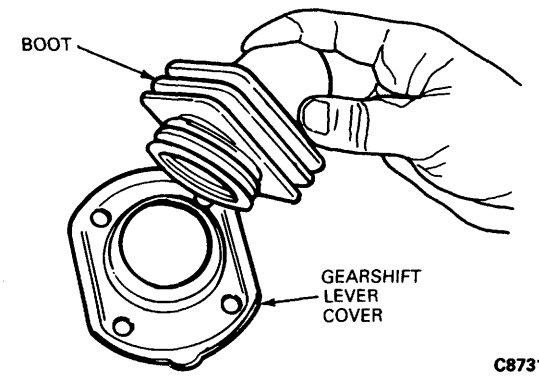
NOTE: A cross shaft passes through the cardan joint and gearshift lever and rides inside sleeved needle bearings that seat in the bores that seat in the joint. Do not disassemble these components.



C8730-1A

Assembly

1. Insert the boot in its upright position in the gearshift lever cover.

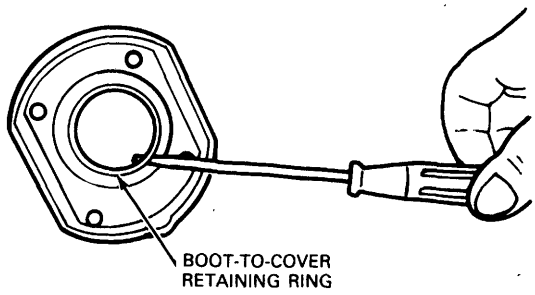


C8731-1A

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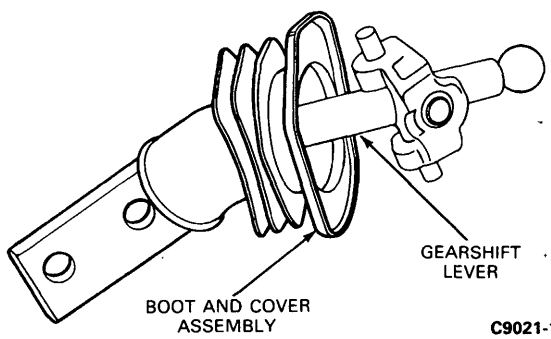
SUBASSEMBLIES (Continued)

2. Using a screwdriver, install the snap ring inside the boot so that the boot and ring will be secured in the groove in the cover.



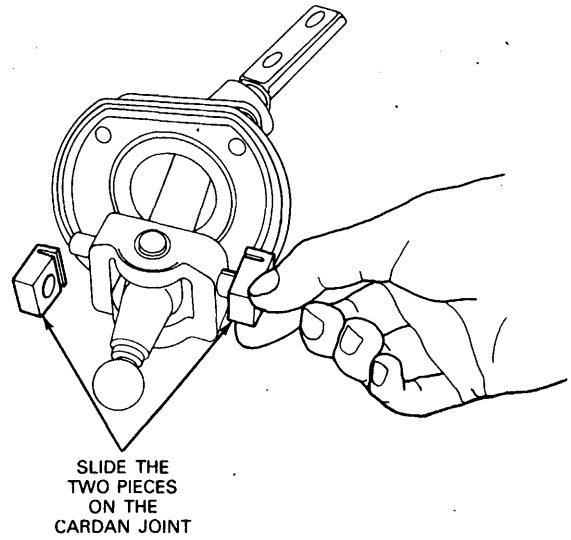
C8730-1A

3. Slide the boot and cover as an assembly on past the gearshift lever.



C9021-1A

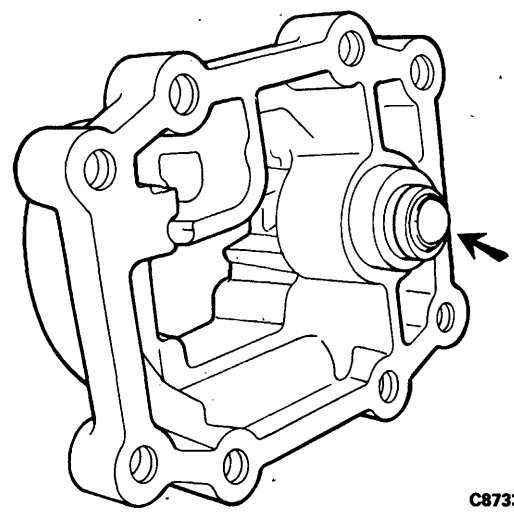
4. Place the two guide pieces on the lugs on the cardan joint. The slotted ends of the guide pieces should be located near the cover pointing inwards toward the shift lever.



C8732-1A

5. If required, install a new detent in the gearshift housing. Using Rotunda Heat Gun 107-00300,

Heat the detent mounting area in the housing to approximately 248°F (120°C). Press the detent into its mounting hole until it rests against its stop in the base of the hole.



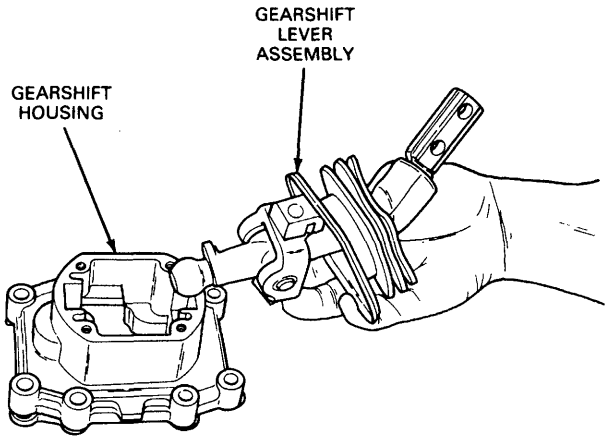
C8733-1A

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SUBASSEMBLIES (Continued)

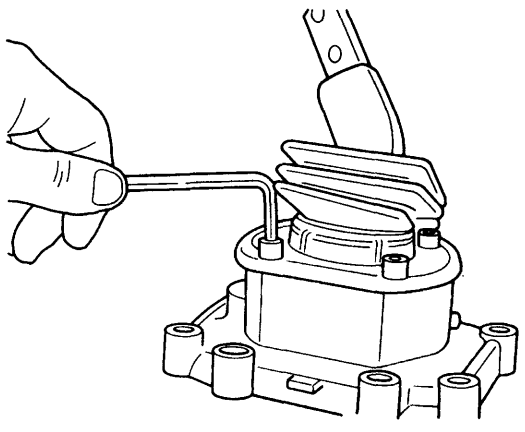
6. Place a new gasket on the upper surface of the gearshift housing. Place the gearshift lever with the attached guide pieces into the guide piece grooves. The slotted ends of these guide pieces must face upward.

NOTE: The nose on the gearshift lever located just above the ball must face toward the location into which the stop plate and compression spring will be subsequently installed.



C8727-1A

7. Tighten the four capscrews that secure the head assembly to the gearshift housing to approximately 10 N·m (8 ft-lbs).

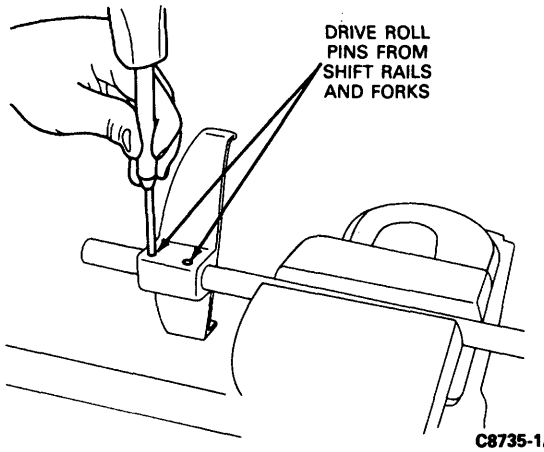


C8734-1A

Shift Rails

Disassembly

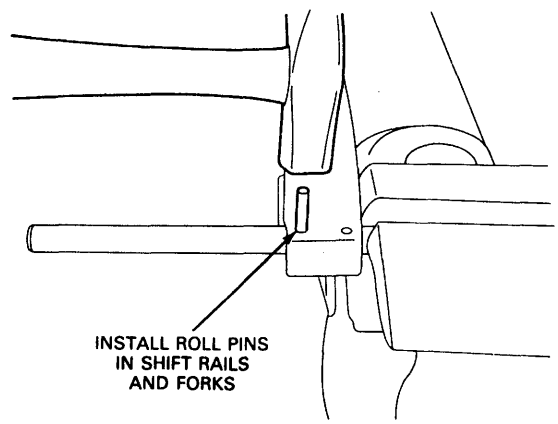
1. Install each rail in a vise with soft jaws or equivalent and, using a suitable drift punch or equivalent, drive two roll pins out of the 1st-2nd and 5th-Reverse shift fork and the gearshift finger on the central shift rail. Slide each of the forks off its rail and the finger off the central shift rail.



C8735-1A

Assembly

1. Position each shift rail in a vise equipped with soft jaws or equivalent to prevent damage.
2. Slide the fork onto the rail from which it was removed.
3. Drive the roll pins through the fork or finger and through the rail.



C8736-1A

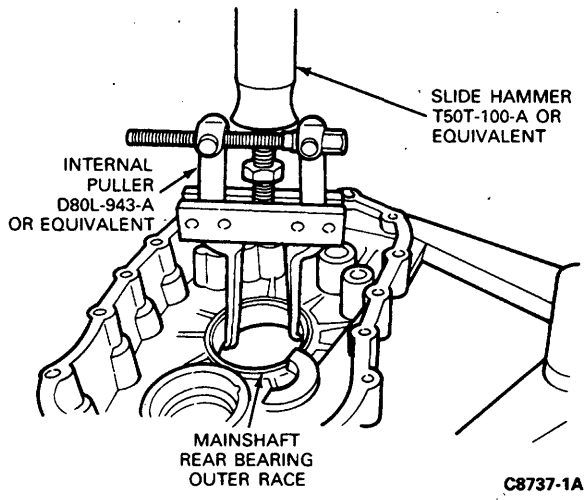
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SUBASSEMBLIES (Continued)

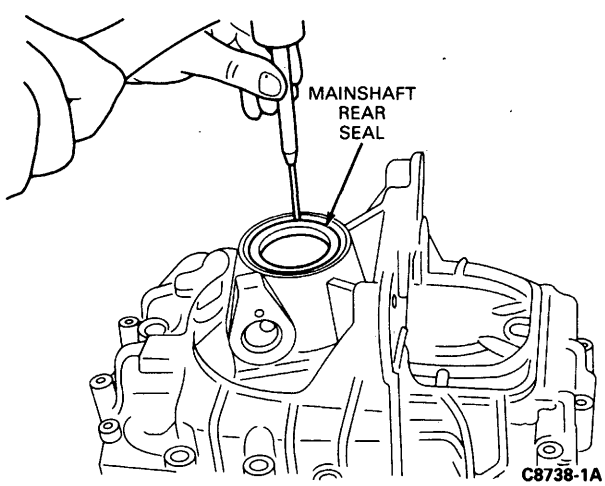
Transmission Rear Case

Disassembly

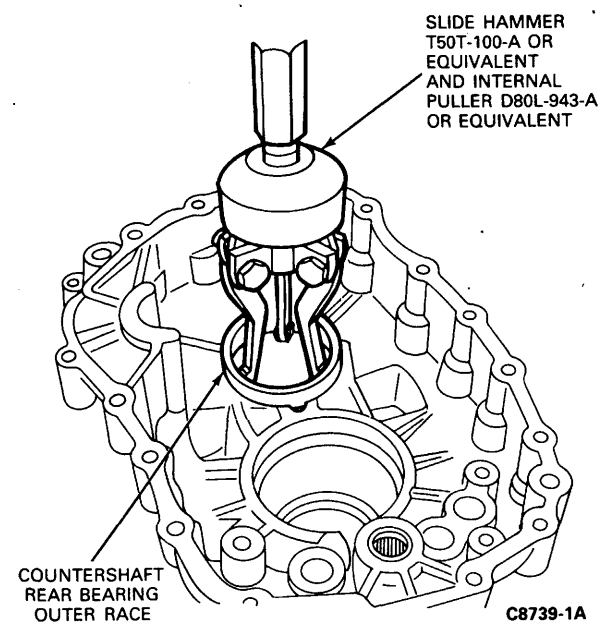
1. If required, drive the two dowel pins out of the rear case.
2. Using Slide Hammer T50T-100-A or equivalent and Internal Puller D80L-943-A or equivalent, remove the mainshaft rear bearing outer race from the rear case.



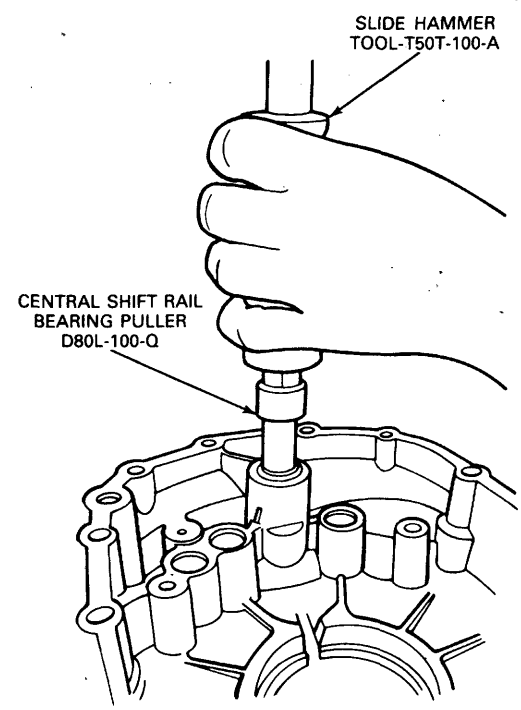
3. Using a suitable drift, drive the mainshaft rear seal out of the rear cover. Discard the seal.



4. Using slide hammer T50T-100-A or equivalent and Bearing Cup Puller T77F-1102-A or equivalent, remove the countershaft rear bearing outer race from the rear case.



5. If required, remove the central shift rail bearing from the rear cover. Use Blind Hole Puller D80L-100-Q and Slide Hammer T50T-100-A to remove the bearing.

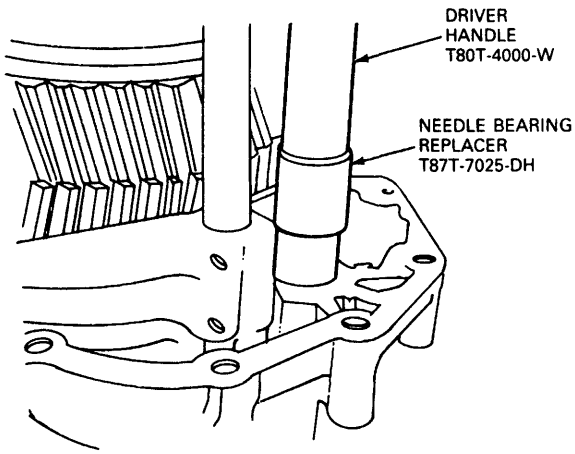


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SUBASSEMBLIES (Continued)

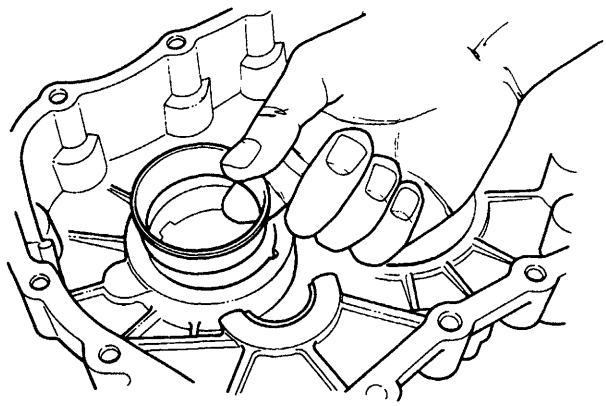
Assembly

1. If removed, install the central shift rail bearing into the rear case. Heat the rear case in the area of the bearing bore to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent. Insert the ball sleeve and drive the bearing in until it seats against its stop using Needle Bearing Replacer T87T-7025-DH.



C8741-1A

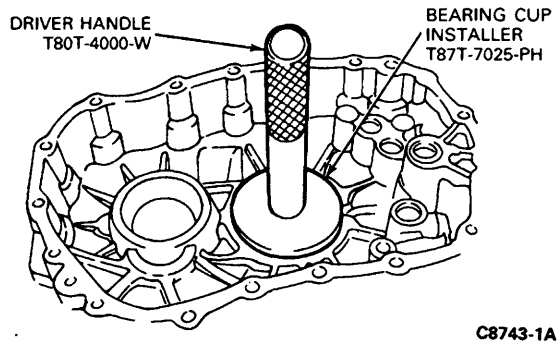
2. Heat the rear case in the area of the countershaft rear bearing outer race to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent. Install the countershaft bearing outer race with Driver Handle T80T-4000-W and Bearing Cup Replacer T73T-4222-A until it seats against its stop.



C8742-1A

3. Heat the rear case in the area of the mainshaft outer race to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent. Using Driver Handle T80T-4000-W and Bearing Cup replacer T87T-7025-PH, tap the bearing cup into its bore until it seats against its stop.

NOTE: Do not install the mainshaft rear seal at this time. The mainshaft rear seal is installed just prior to installing the output flange.



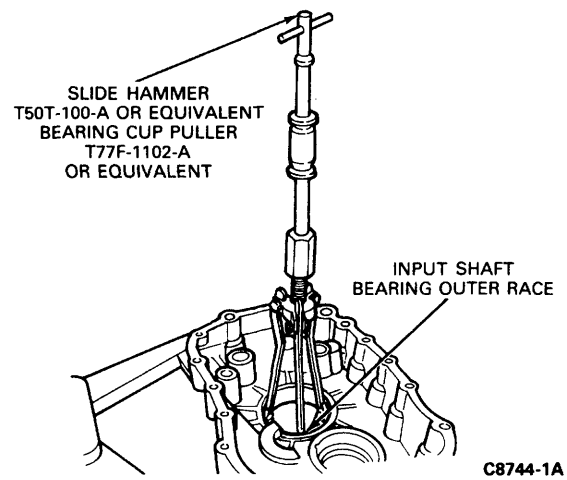
C8743-1A

Transmission Front Case

Disassembly

1. Using Slide Hammer T50T-100-A or equivalent and Bearing Cup Puller T77F-1102-A or equivalent, remove the input shaft bearing outer race from the front case.
2. Remove the baffle and shims.

NOTE: The oil baffle will be destroyed when the race is removed. Discard the oil baffle.



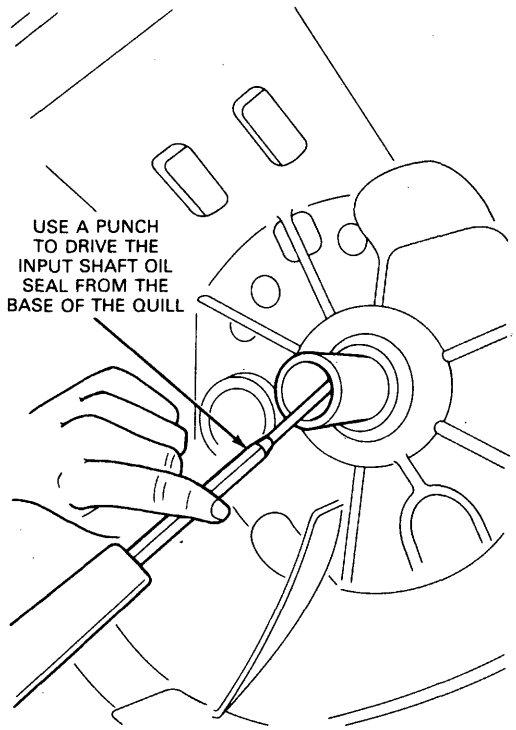
C8744-1A

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SUBASSEMBLIES (Continued)

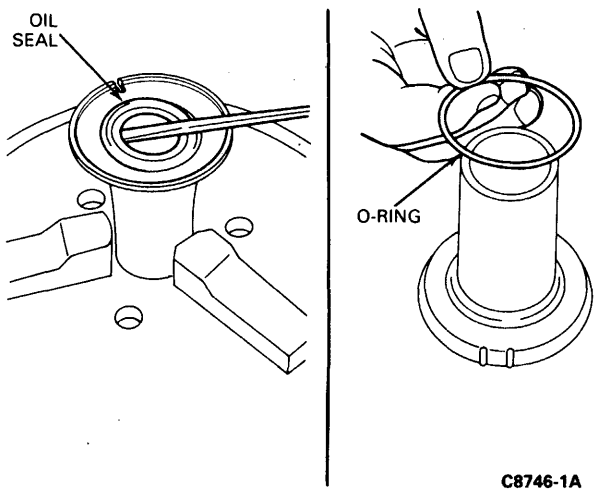
3. Using a punch, remove the input shaft oil seal from the base of the quill.

NOTE: If the quill is being removed, the input shaft seal may be removed later when the quill is out of the housing.



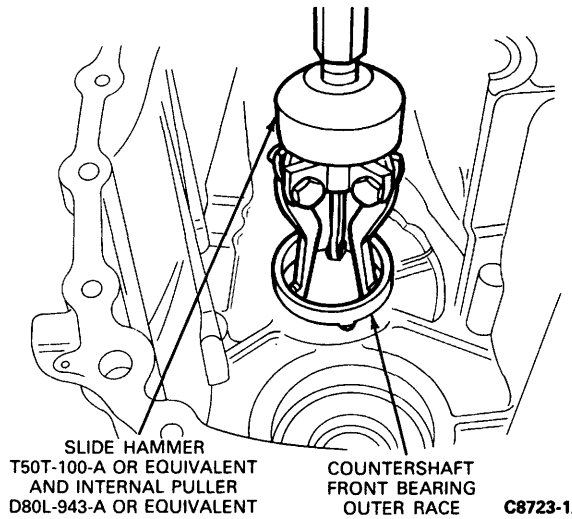
C8745-1A

4. If required, carefully tap the quill from the front case using a soft mallet.
5. Remove the O-ring from the quill. Remove the oil seal if not already removed.



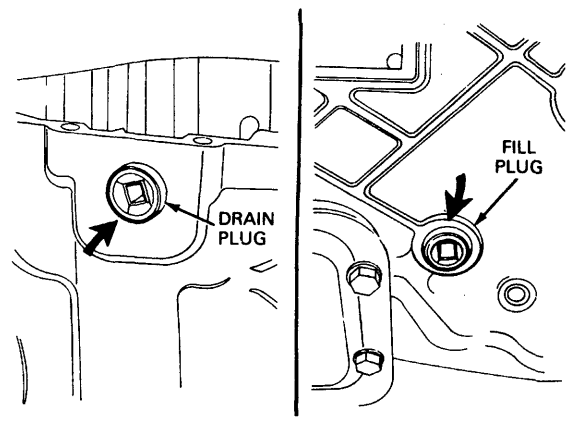
C8746-1A

6. Remove the countershaft front bearing outer race with Slide Hammer T50T-100-A and Internal Puller T77F-1102-A.



C8723-1A

7. If required, remove the fluid drain and fill plugs from the front case.

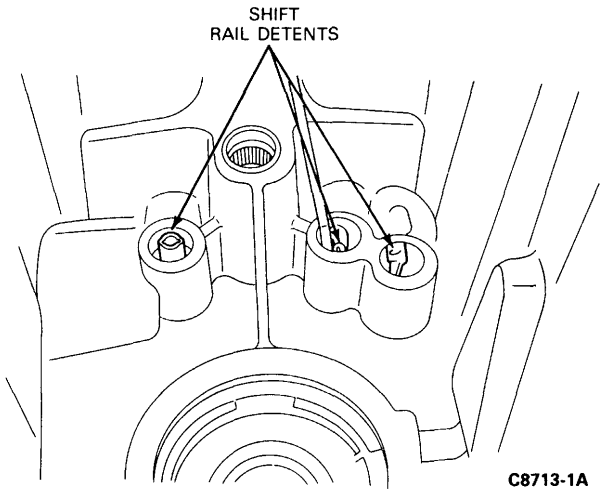


C8747-1A

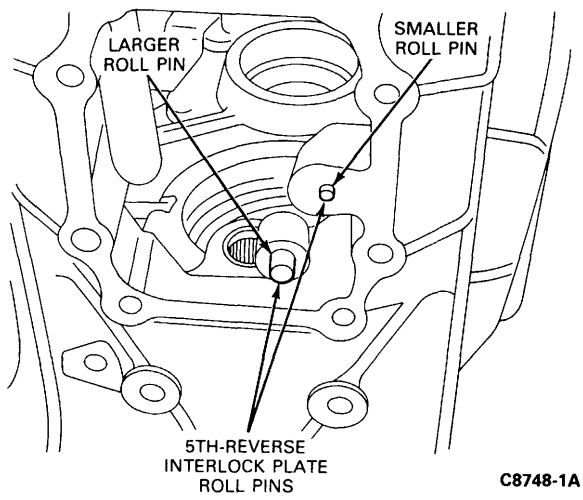
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SUBASSEMBLIES (Continued)

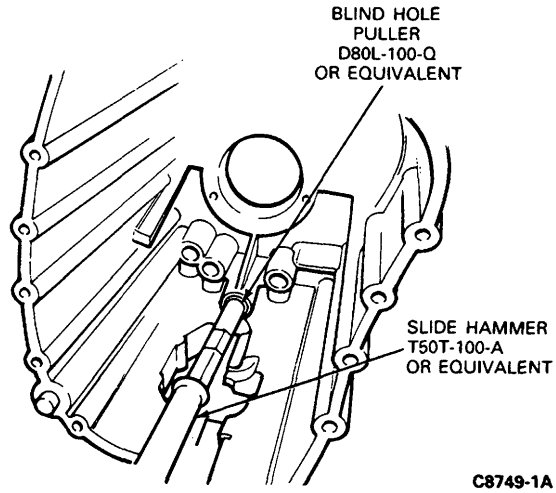
8. If required, remove the sealing caps and three shift rail detents from the front case.



9. If required, remove the roll pins that hold the 5th-reverse interlock plate from their bores in the front case just below the gearshift housing.

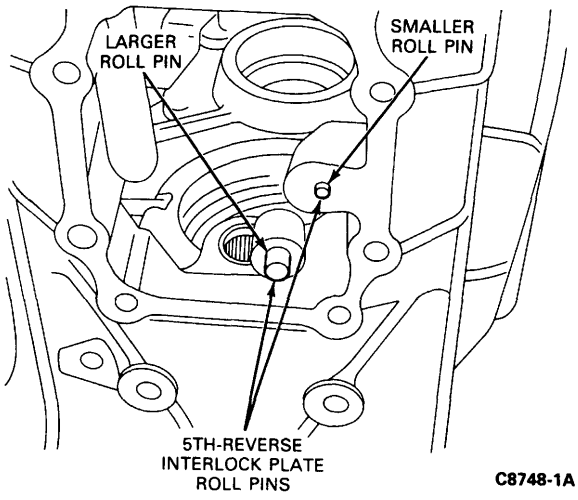


10. If required, remove the central shift rail needle bearing from the front case using Slide Hammer T50T-100-A or equivalent and Blind Hole Puller D80L-100-Q or equivalent.



Assembly

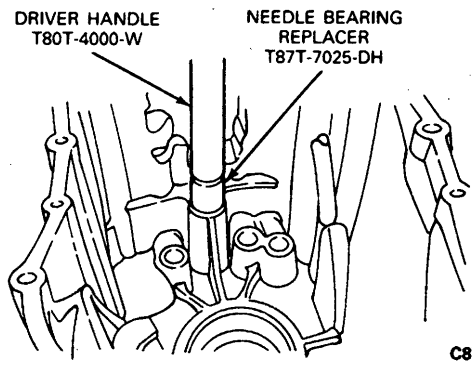
1. If they were removed, tap the 5th-reverse roll pins into their bores in the front case until the bigger one bottoms out (sticks out approximately 8mm (.315 inch); the small one sticks out 4-5mm (.158-.197 inch). Do not allow it to bottom out.



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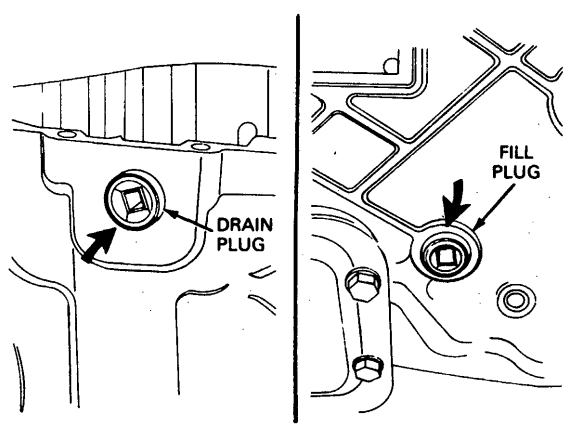
SUBASSEMBLIES (Continued)

2. Heat the front case in the area of the central shift rail bearing bore to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent. Drive the bearing sleeve in with needle bearing replacer T87T-7025-DH and Driver Handle T80T-4000-W or equivalent until it is flush with the surface of the bore.



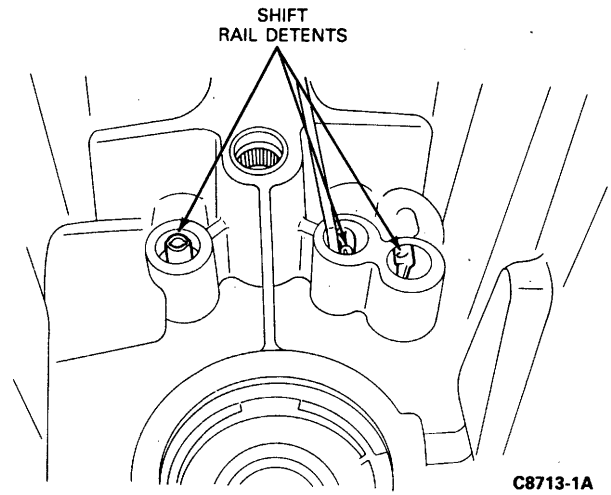
C8750-1A

3. If removed, install the drain and fill plugs into the front case. Tighten to 60 N·m (44 ft-lbs) (These torque values apply to a cold housing).



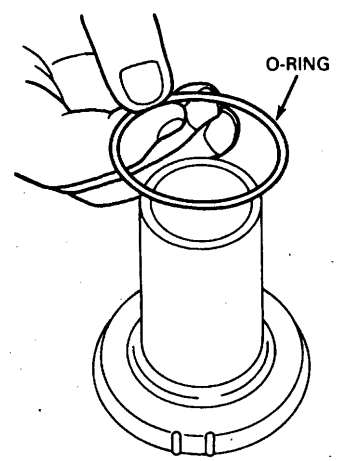
C8747-1A

4. Insert the three shift rail detent bolts into their respective bores in the front case. They must seat in the detents in their respective shift rails and must move freely when in their installed positions.



C8713-1A

5. Place a new O-ring on the input shaft quill.

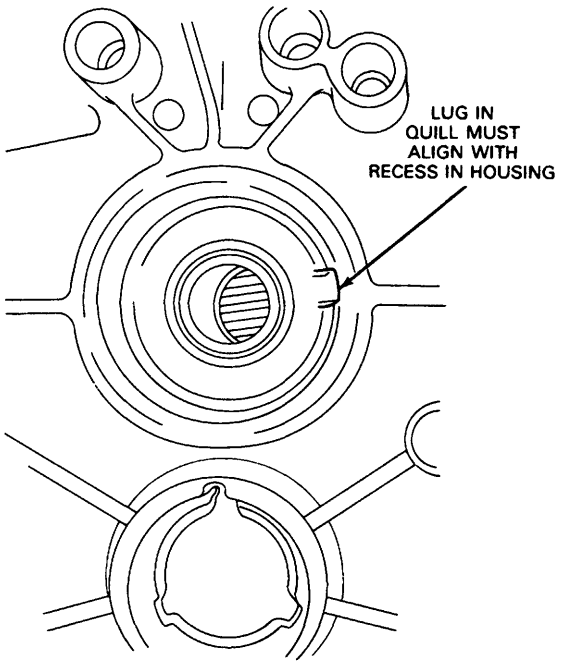


C8751-1A

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SUBASSEMBLIES (Continued)

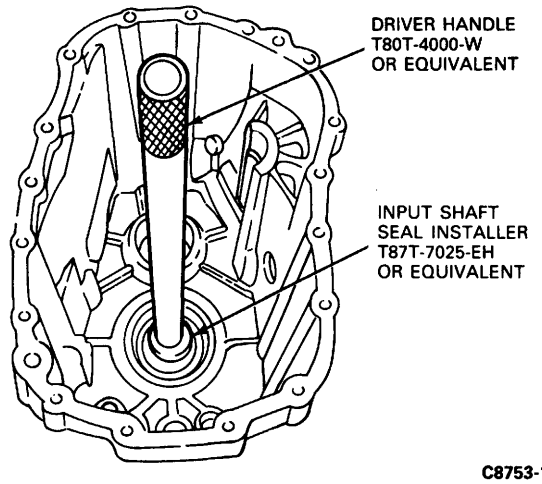
6. Position the quill in the housing in such a way that the lug in the quill is in alignment with the recess in the housing. Push the quill in until it bottoms against its bore in the housing.



C8752-1A

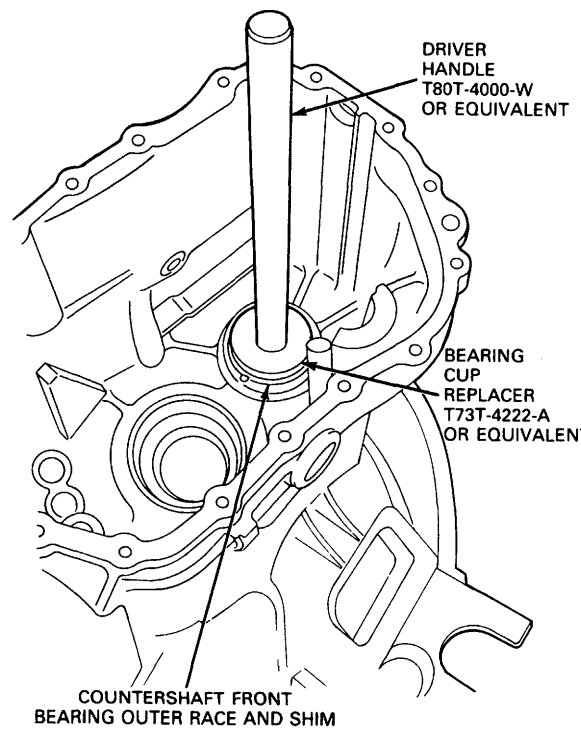
7. Position the seal in the front case. Using Driver Handle T80T-4000-W or equivalent and Input Shaft Seal Installer T87T-7025-EH or equivalent, drive in the seal until it seats against its stop in the quill.

CAUTION: If the countershaft, input shaft, mainshaft or one or more tapered roller bearing has been replaced, it is mandatory that the tapered roller bearings be adjusted to obtain a preload of 0.02 to 0.11mm (0.00079 to 0.00343 inch). Refer to adjustments in this section for procedure.



C8753-1A

8. Heat up the mounting bore in the front case for the taper roller bearing outer race of the countershaft to 160°C (320°F) with Rotunda Heat Gun 107-00300 or equivalent.
9. Position the shim with proper thickness in the bore. Using Driver Handle T80T-4000-W or equivalent and Bearing Cup Replacer T73T-4222-A or equivalent, drive the countershaft bearing outer race in until it seats against the stop in the case.

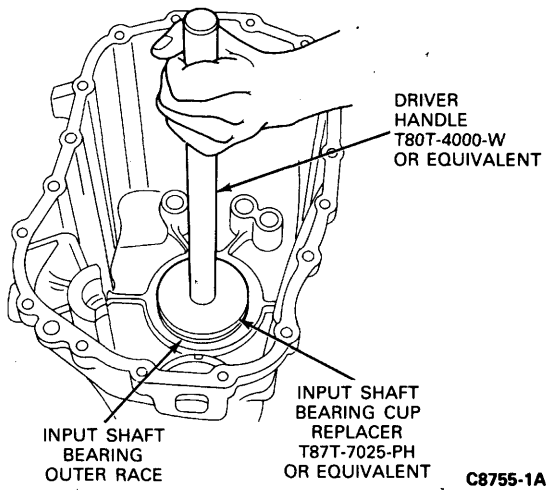


C8754-1A

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SUBASSEMBLIES (Continued)

10. Heat the front case in the area of the input shaft tapered roller bearing outer race to 160°C (320°F) with Rotunda Heat Gun 107-00300.
11. Position the correct shims/sealing disc pack in the bore for the input shaft bearing outer race. Using driver handle T80T-4000-W or equivalent and Mainshaft Bearing Cup Replacer T87T-7025-PH or equivalent, drive the bearing cup in until it seats its stop in the bore.



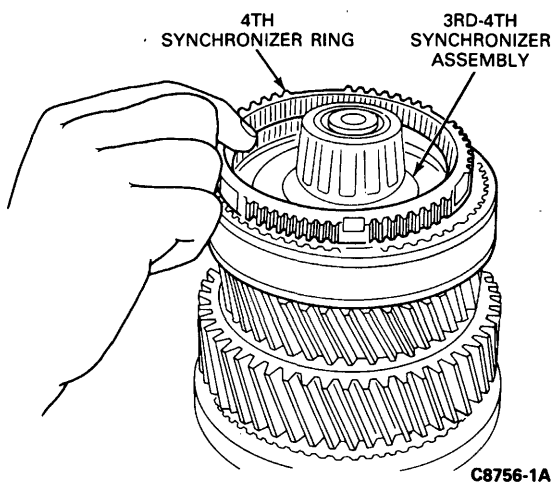
Mainshaft

Disassembly

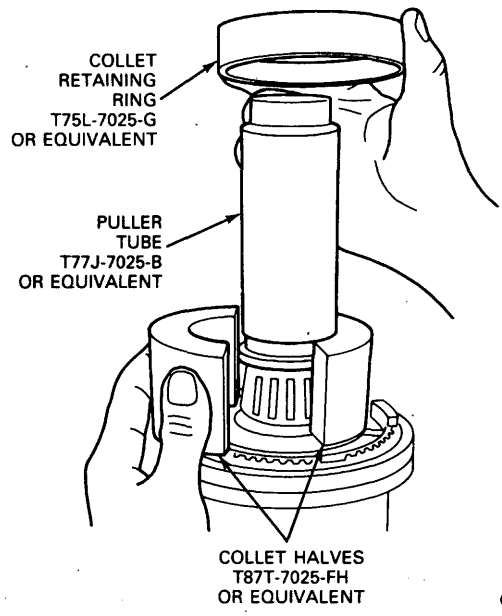
1. Clamp the output end of the main shaft firmly in a vise.

NOTE: Use brass pads or equivalent to prevent damage.

2. Remove the 4th synchronizer ring from the 3rd-4th synchronizer assembly.

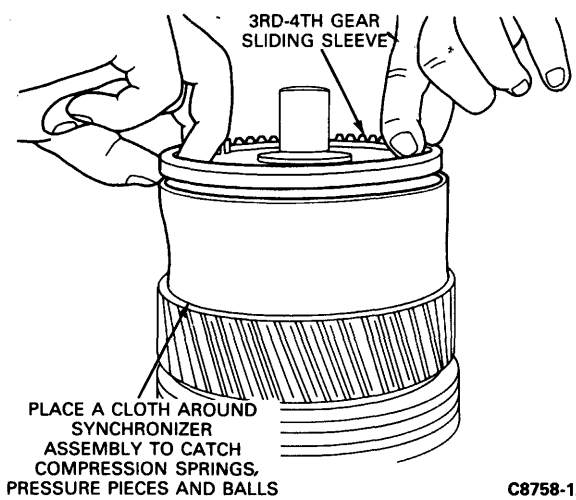


3. Place the Bearing Collets T87T-7025-FH or equivalent on either side of the mainshaft front bearing. Position the Puller Tube T77J-7025-B or equivalent in the collets. Pass the Collet Retaining Ring, T75L-7025-G or equivalent over the Puller and into the collets so they clamp firmly to the bearing. Pull the bearing from the mainshaft.



4. Remove the 3rd-4th gear sliding sleeve from the mainshaft.

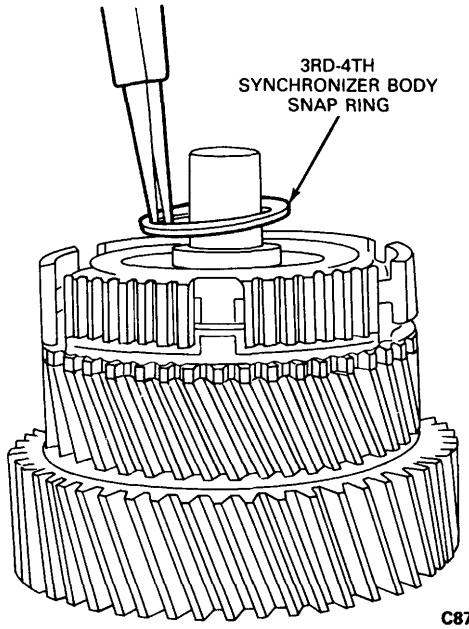
CAUTION: Place a cloth around the synchronizer assembly to catch the compression springs, pressure pieces and balls that will be released when the sliding sleeves are removed.



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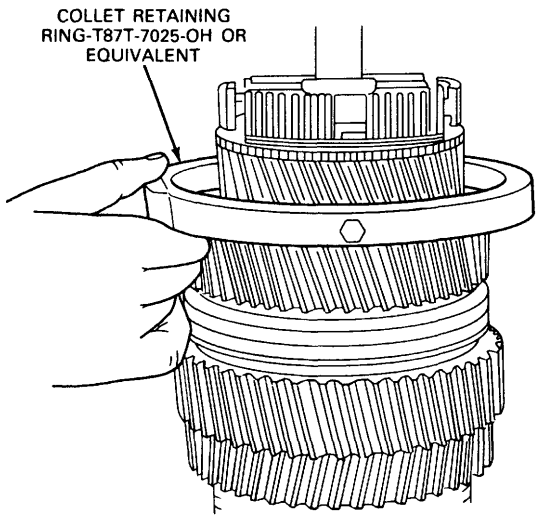
SUBASSEMBLIES (Continued)

5. Remove the cap ring that retains the 3rd-4th synchronizer body to the mainshaft.



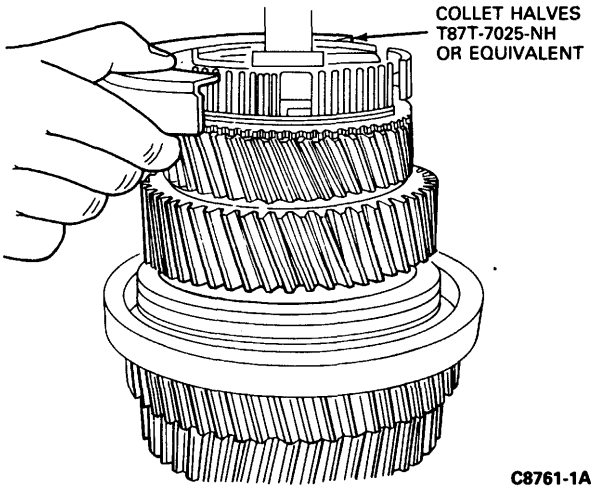
C8759-1A

6. Place the Collet Retaining Ring T87T-7025-OH or equivalent over the mainshaft and let it rest on the mainshaft 1st gear.



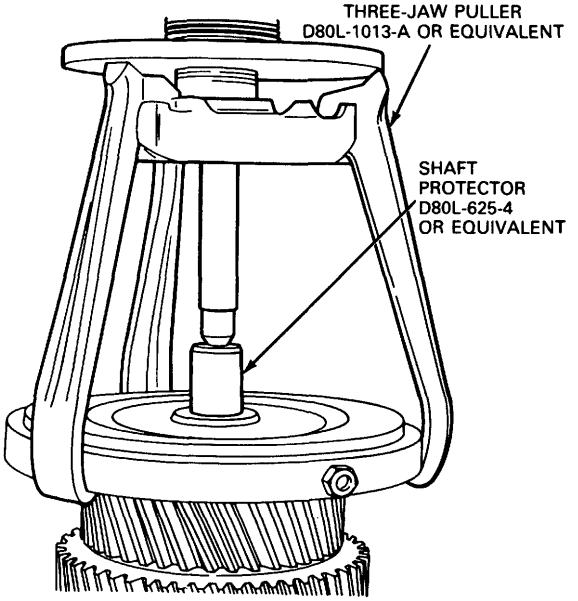
C8760-1A

7. Position the two collet halves T87T-7025-NH or equivalent on the 3rd-4th synchronizer body and slide the collet retaining ring over the collet halves to hold them in place on the synchronizer body.



C8761-1A

8. Place the Shaft Protector D80L-625-4 or equivalent on the end of the mainshaft. Place the Three Jaw Puller D80L-1013-A or equivalent on the assembled collet halves and retaining ring and pull the synchronizer body from the main shaft.

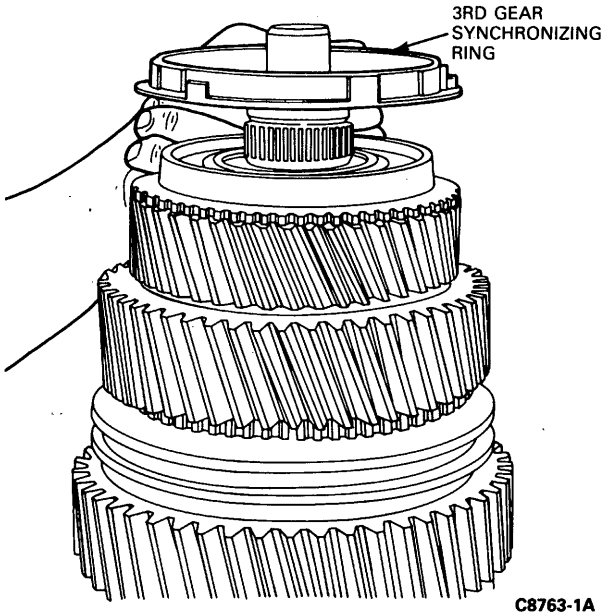


C8762-1A

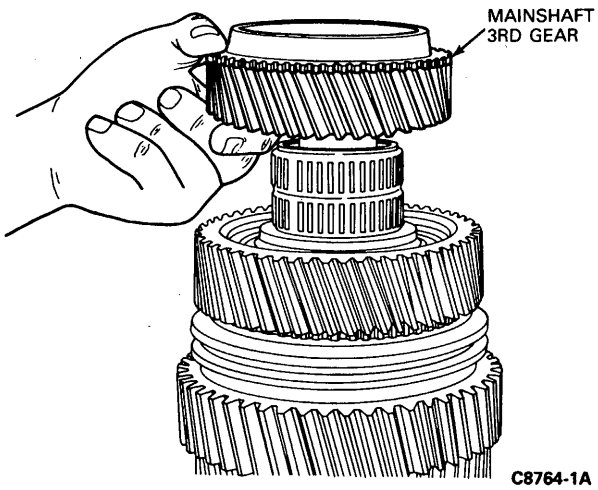
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SUBASSEMBLIES (Continued)

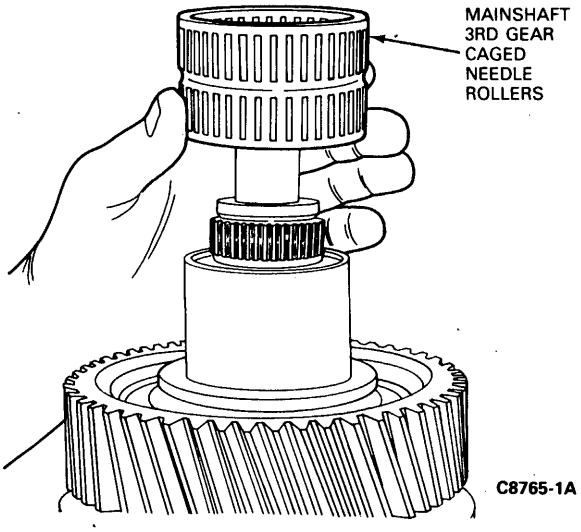
9. Remove the synchronizer ring from the mainshaft 3rd gear.



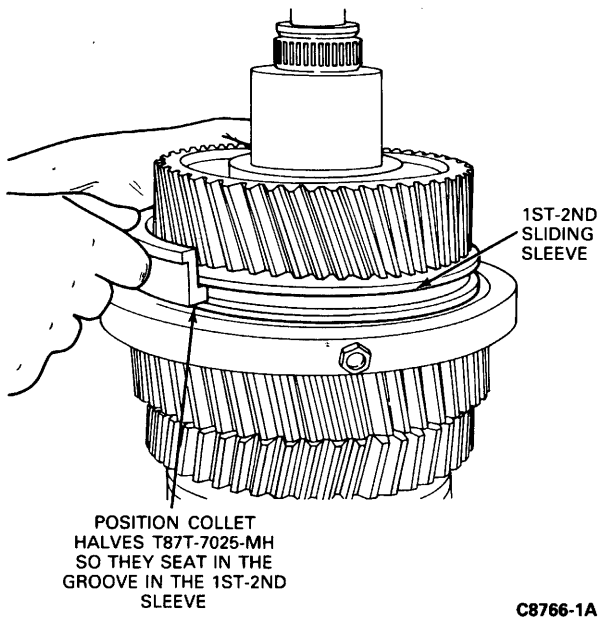
10. Remove the 3rd gear from the mainshaft.



11. Remove the 3rd gear caged needle rollers from the mainshaft.



12. Lift the 1st-2nd gear sliding sleeve up as far as it will slide.
13. Position the Collet Retaining Ring T87T-7025-OH or equivalent over the main shaft and let it rest on the 1st gear.
14. Position the two collet halves, T87T-7025-MH or equivalent so they seat in the groove in the 1st-2nd sliding sleeve. Pass the retaining ring from below over the two halves and secure them to the sliding sleeve.

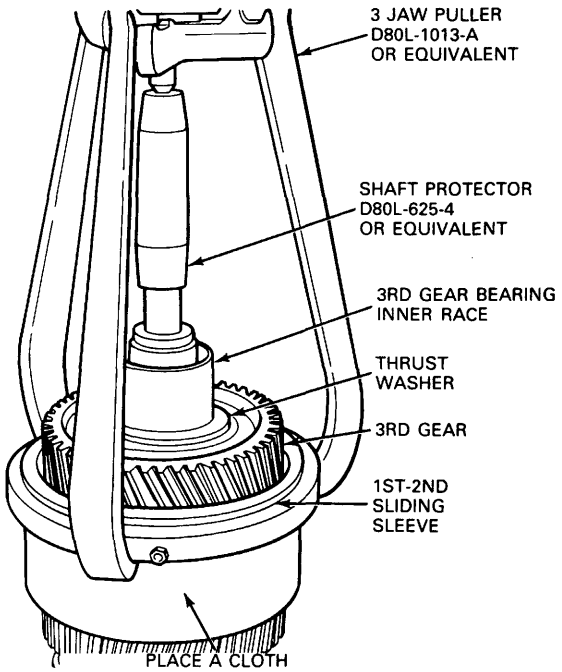


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SUBASSEMBLIES (Continued)

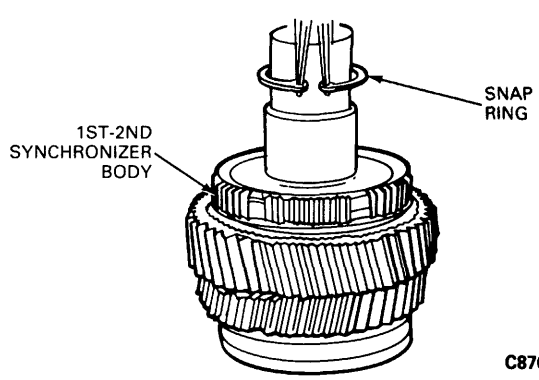
15. Position Shaft Protector D80L-625-4 or equivalent on the end of the mainshaft. Position the Three-Jaw Puller D80L-1013-A or equivalent on the collet retaining ring and pull the 1st-2nd sliding sleeve, 2nd gear, thrust washer, and 3rd gear bearing inner race from the mainshaft.

CAUTION: Position a cloth around the 1st-2nd synchronizer body to catch the springs, pressure pieces and balls that will be released when the sliding sleeve clears the 1st-2nd synchronizer body.



C8767-1A

16. Remove the snap ring retaining the 1st-2nd synchronizer body to the mainshaft.



C8768-1A

17. Reposition the mainshaft in the vise so that the output end of the shaft is now facing up.

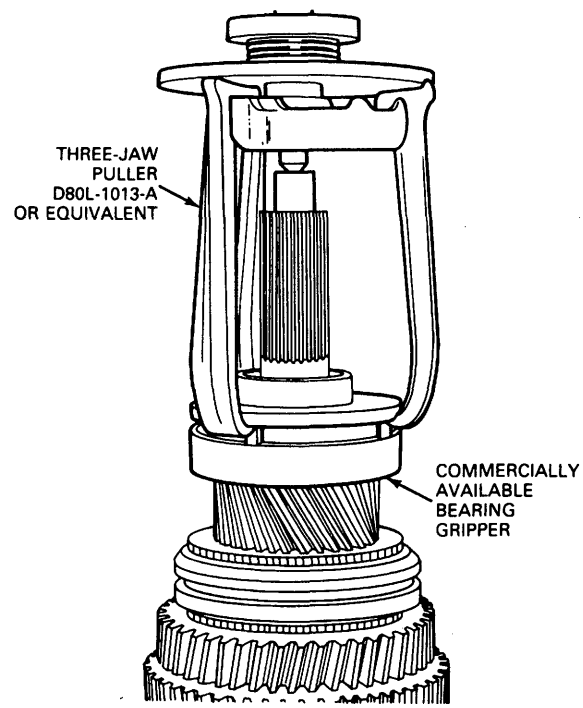
NOTE: Use brass pads or equivalent to prevent damage.

NOTE: On 4x4 versions and F-Super Duty versions, a snap ring retaining the taper roller bearing inner race should be removed.

18. Position a commercially-available bearing gripper such as the one shown in the illustration on the mainshaft rear tapered roller bearing. The gripper used must pull the bearing assembly by the shoulder of the tapered rollers, not from the bearing cage.

CAUTION: Failure to use a bearing gripper will destroy the bearing.

19. Position Three-Jaw Puller D80L-1013-A or equivalent on the bearing gripper and pull the mainshaft rear tapered roller bearing from the mainshaft.

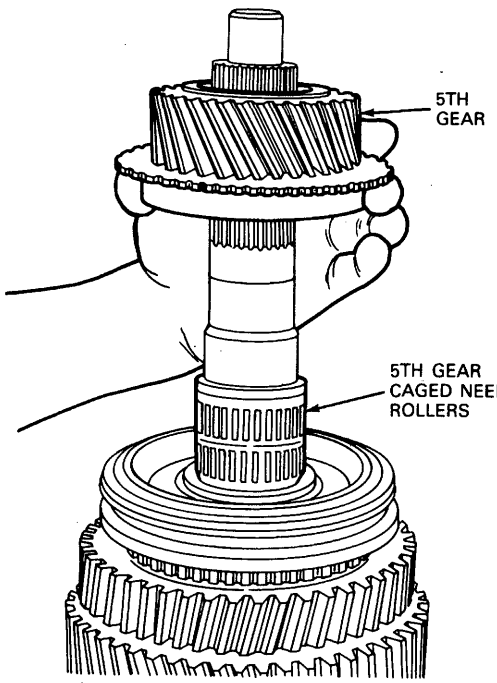


C8769-1A

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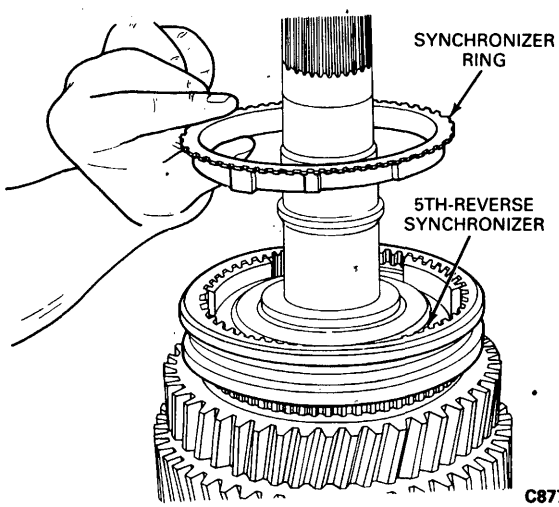
SUBASSEMBLIES (Continued)

20. Remove the 5th gear from the mainshaft.
21. Remove the 5th gear caged needle rollers from the mainshaft.



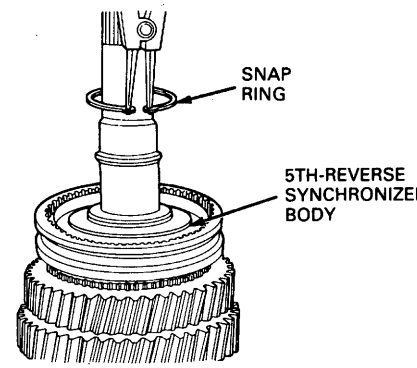
C8770-1A

22. Remove the synchronizer ring from the 5th-reverse synchronizer.



C8771-1A

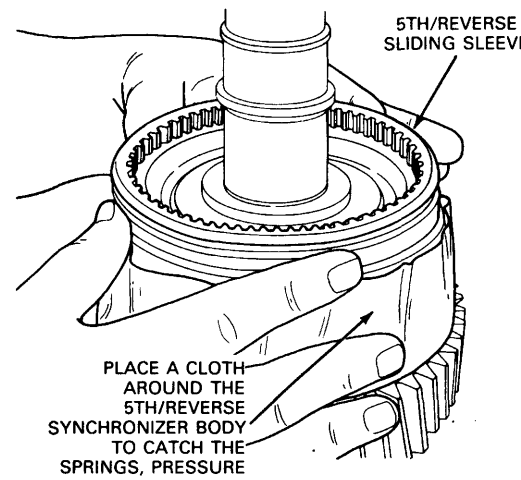
23. Remove the snap ring retaining the 5th-reverse synchronizer body to the mainshaft.



C8772-1A

24. Remove the 5th-reverse sliding sleeve.

CAUTION: Position a cloth around the 5th-rev synchronizer body to catch the springs, pressure pieces and balls that will be released when the sliding sleeve clears the 5th-rev synchronizer body.

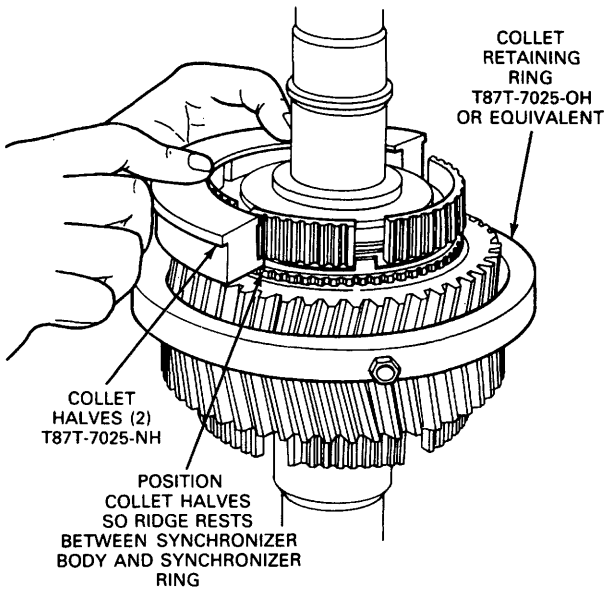


C8773-1A

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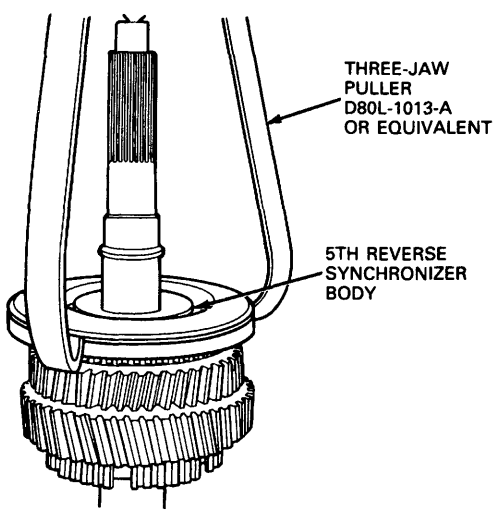
SUBASSEMBLIES (Continued)

25. Place the Collet Retaining Ring T87T-7025-OH or equivalent over the mainshaft and let it rest on the 1st gear. Position the collet halves T87T-7025-NH or equivalent so the ridge rests between the synchronizer body and the synchronizer ring. Slide the retaining ring upwards around the collets to secure them in position.



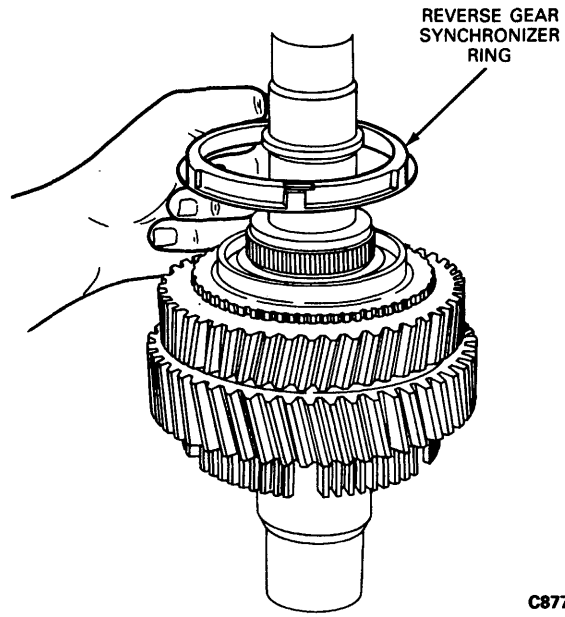
C8774-1A

26. Position a Three Jaw Puller D80L-1013-A or equivalent on the collet retaining ring and pull the 5th-Reverse synchronizer body from the mainshaft.



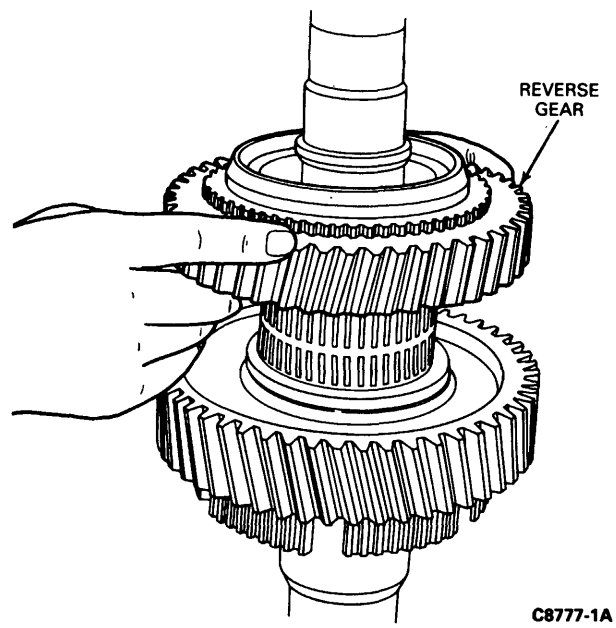
C8775-1A

27. Remove the synchronizer ring from the reverse gear.



C8776-1A

28. Remove the reverse gear from the mainshaft.

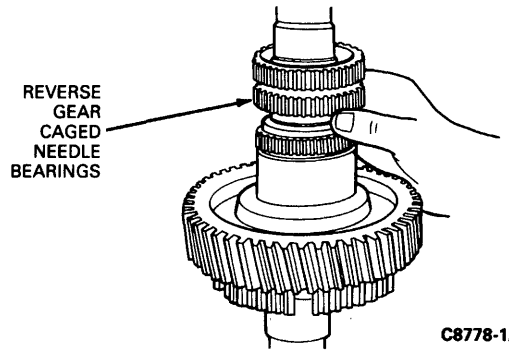


C8777-1A

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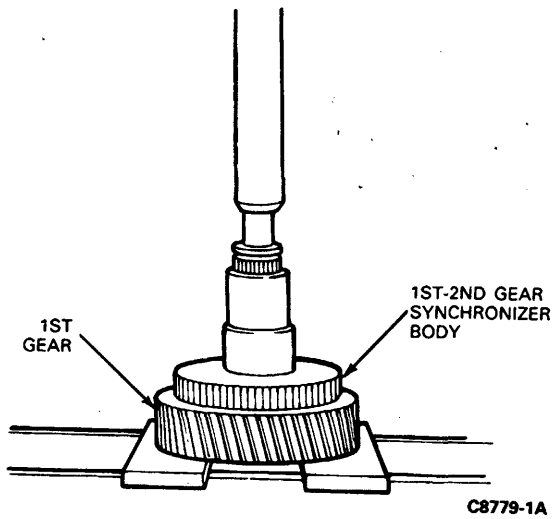
SUBASSEMBLIES (Continued)

29. Remove the reverse gear caged needle bearings from the mainshaft.

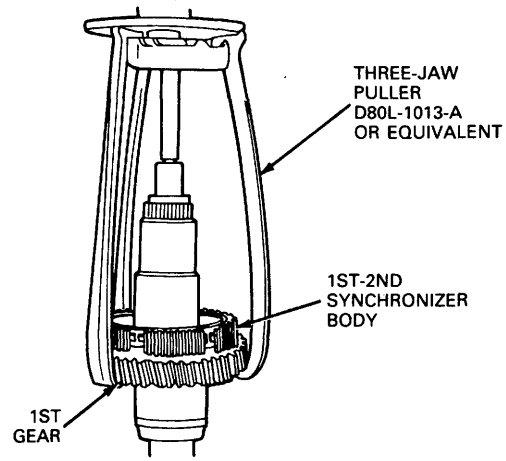


30. Remove the mainshaft from the vise. Position the mainshaft in a press as shown in the illustration and press the 1st gear and the 1st-2nd gear synchronizer body from the mainshaft.

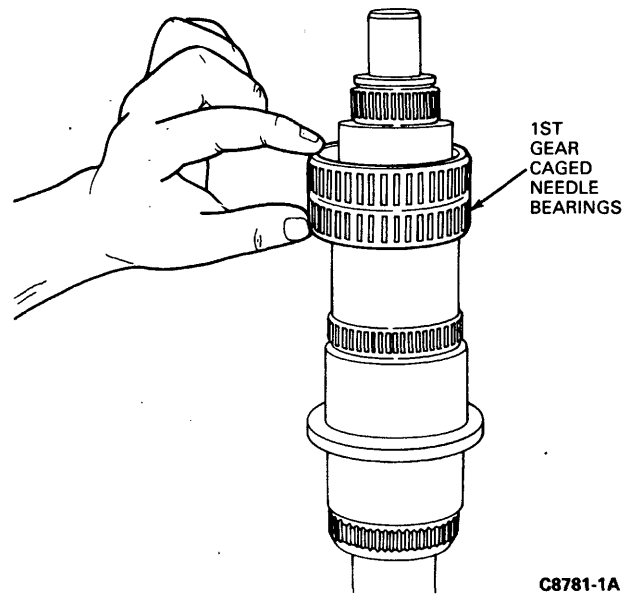
CAUTION: Make sure mainshaft is properly supported to prevent impact of mainshaft.



31. An alternate method is to turn the mainshaft over and clamp it at the output end. Position the jaws of Puller D80L-1013-A or equivalent on the 1st Gear and pull the 1st gear and the 1st-2nd synchronizer body from the mainshaft.



32. Remove 1st gear the caged needle rollers from the mainshaft.



Assembly

1. Clamp the input end of the main shaft in a vise.

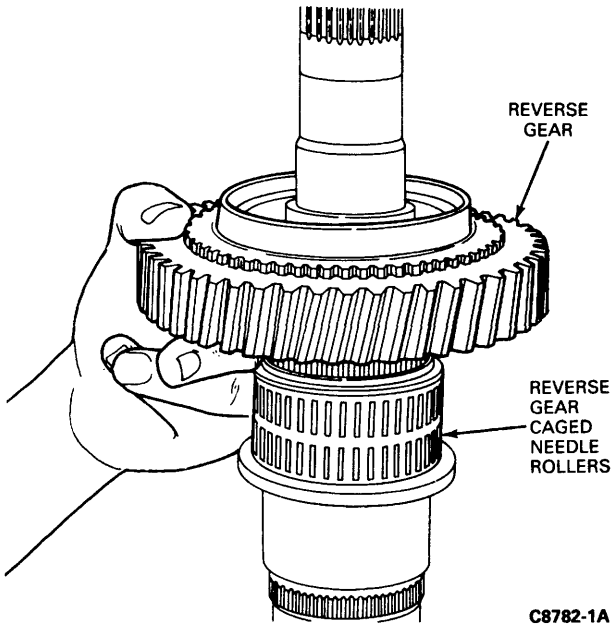
NOTE: Use brass pads or equivalent to prevent damage.

2. Place the reverse gear caged needle rollers on the mainshaft.
3. Place the reverse gear on the mainshaft over the caged needle rollers. The clutching teeth on the reverse gear must face upwards.

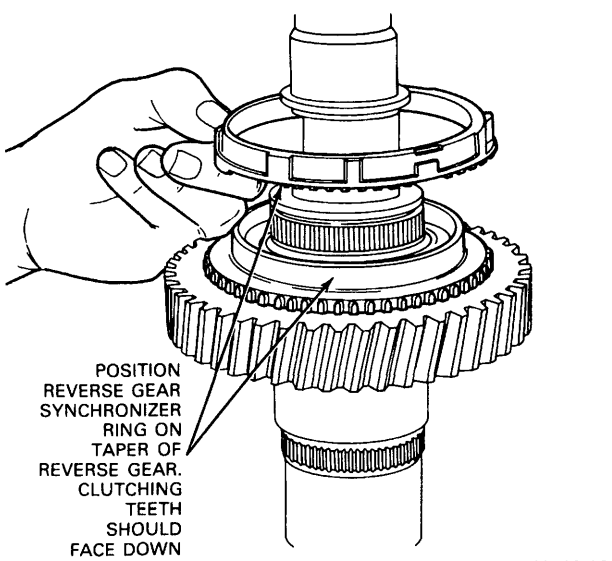
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SUBASSEMBLIES (Continued)

CAUTION: Before installing original synchronizer ring and synchronizer body, check for excessive wear. Refer to synchronizer ring/ synchronizer body wear check under inspection in this section for procedure.

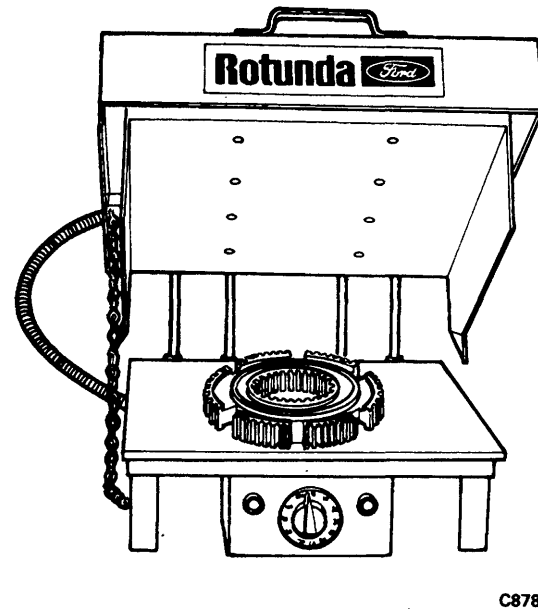


4. Position the reverse gear synchronizer ring on the taper of the reverse gear.

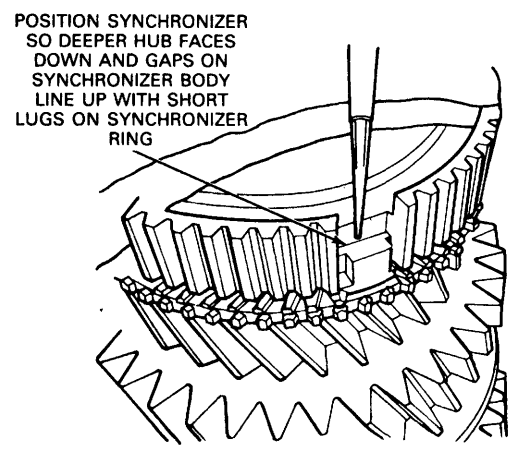


5. Heat the 5th-reverse synchronizer body with a Rotunda Gear Heater 130-00001 to 160°C (320°F).

CAUTION: Do not heat synchronizer body for more than 15 minutes.



6. Position the synchronizer body on the mainshaft splines so that side with the deeper hub on faces down and the short lugs on the synchronizing ring engage in the gaps in the synchronizer body. Push or lightly tap the synchronizer body down until it stops.

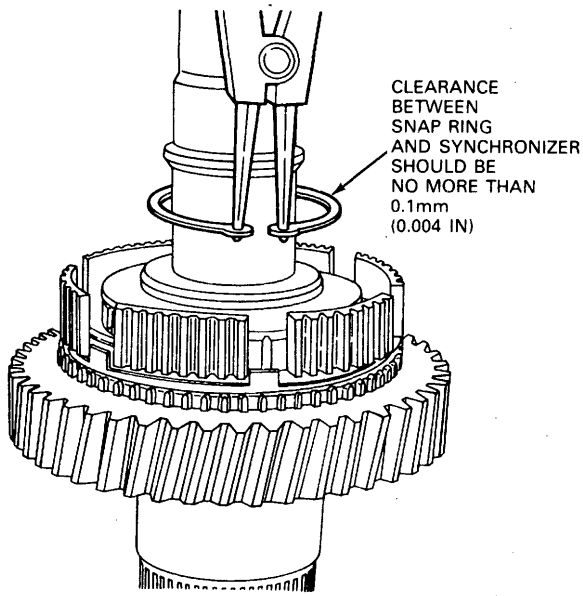


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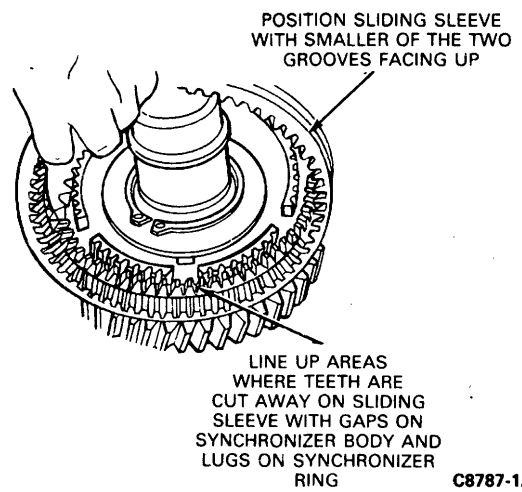
SUBASSEMBLIES (Continued)

7. Install the snap ring on the mainshaft next to the 5th-reverse synchronizer body. The clearance between the snap ring and the synchronizer body should not be more than 0.1mm (0.004 inch) with zero clearance preferable.

CAUTION: Make sure snap ring is free of burrs before checking clearance.



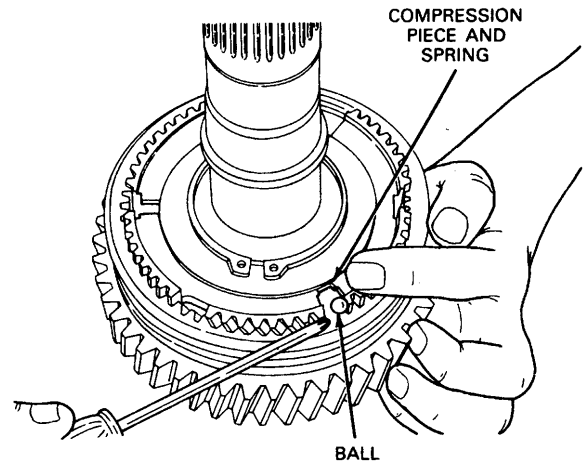
8. Check the reverse gear end play. End play must be between 0.15-0.35mm (0.006-0.014 inch).
9. There are two grooves on the 5th-reverse sliding sleeve. With the two grooves facing up, position the sliding sleeve over the synchronizer body. In three positions on the sliding sleeve, three teeth have been cut away. Align these three areas with the three gaps in the synchronizer body and the three lugs on the synchronizer ring. Slide the sliding sleeve down until it rests against the reverse gear clutching teeth.



10. Insert three compression springs with pressure pieces in the recesses of the synchronizer body.

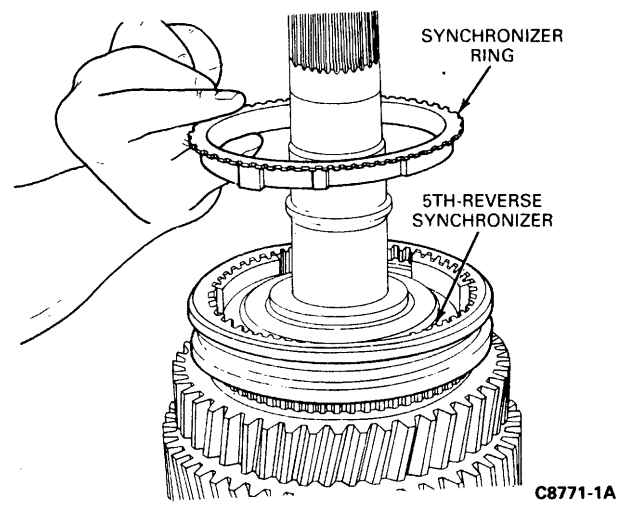
CAUTION: If the original springs are being replaced, inspect them before reuse. Refer to inspection in this section for procedure.

11. Push back the pressure pieces with a screwdriver. Push in the balls with a screwdriver and slide the pressure piece so that it rests against the ball.



12. Place the 5th gear synchronizer ring on the synchronizer body.

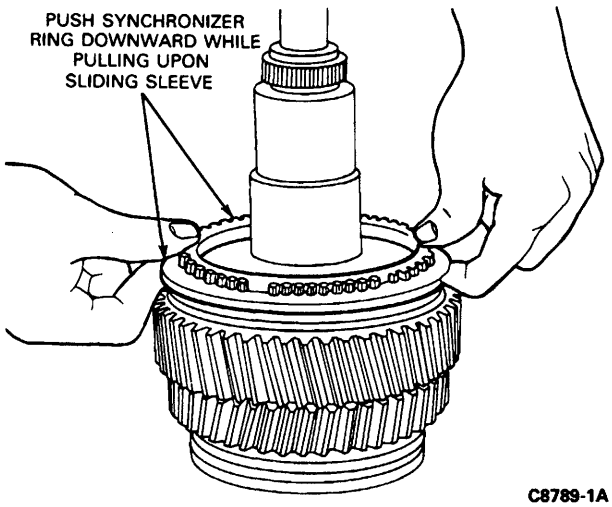
NOTE: The short lugs on the synchronizer ring should be located over the gaps in the 5th-reverse synchronizer body.



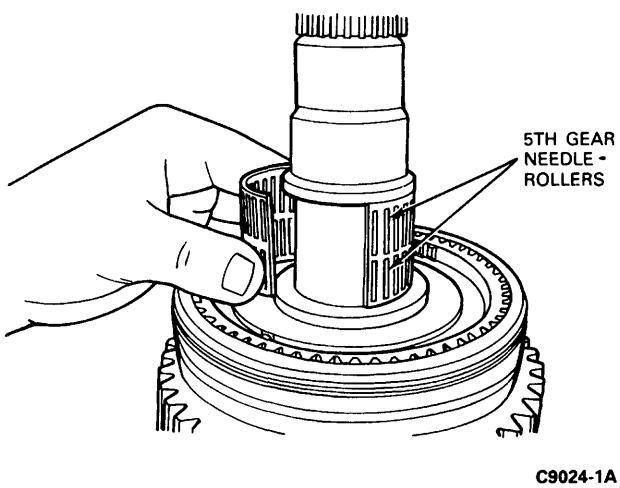
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SUBASSEMBLIES (Continued)

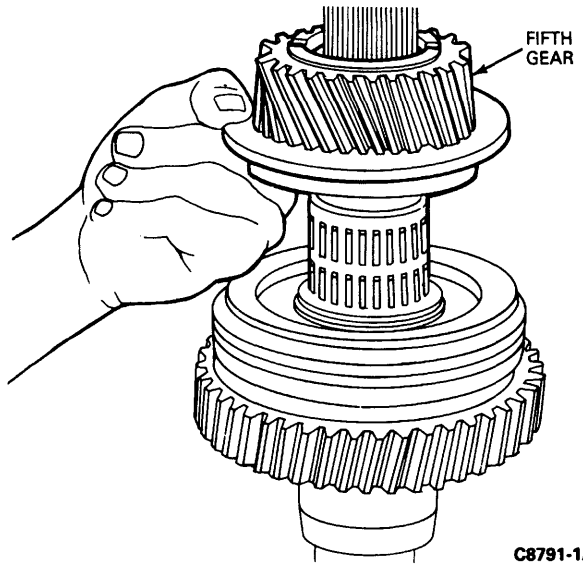
13. Push the 5th gear synchronizer ring downwards while pulling the sliding sleeve into the center position.



14. Place both 5th gear caged needle rollers on the mainshaft.



15. Install the 5th gear on the mainshaft over the caged needle rollers.



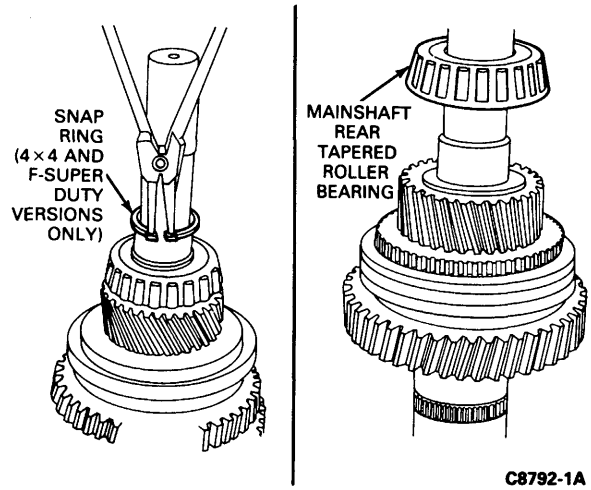
16. Heat the inner race of the mainshaft rear taper roller bearing to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent. Place it on the main shaft and drive it on if necessary until it seats against its stop on the mainshaft.

CAUTION: Do not heat the bearing for more than 15 minutes.

CAUTION: If necessary to drive the bearing on, drive against the inner race only. Do not drive against the bearing cone.

17. Check the end play of the 5th gear. End play must be 0.006 to 0.014 in (0.15 to 0.35 mm).

NOTE: On 4x4 and F-Super Duty versions, fit an additional retaining ring in the annular groove adjacent to the taper roller bearing inner race. It must have an end play of 0.0-0.1mm (0.0-0.004 inch). 0 mm (0.0 inch) should be aimed for.



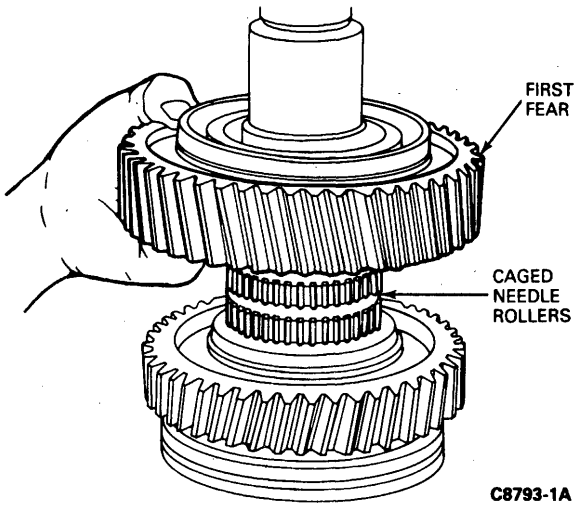
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SUBASSEMBLIES (Continued)

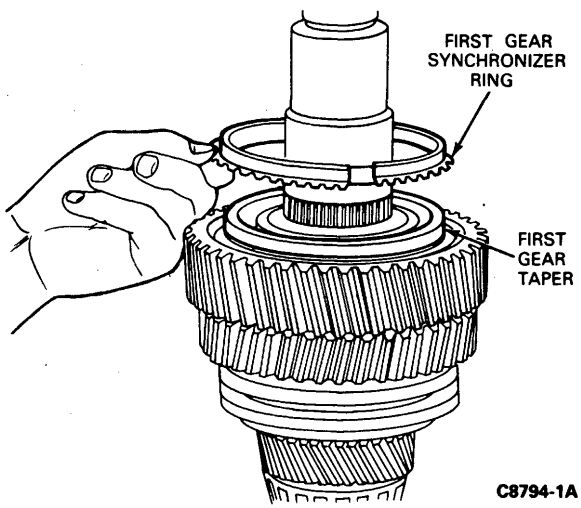
18. Turn the mainshaft over and clamp it at the input end.

NOTE: Use brass pads or equivalent to prevent damage.

19. Place the caged needle rollers for the 1st gear on the mainshaft.
20. Place the 1st gear over the needle rollers on the mainshaft with the taper facing up.

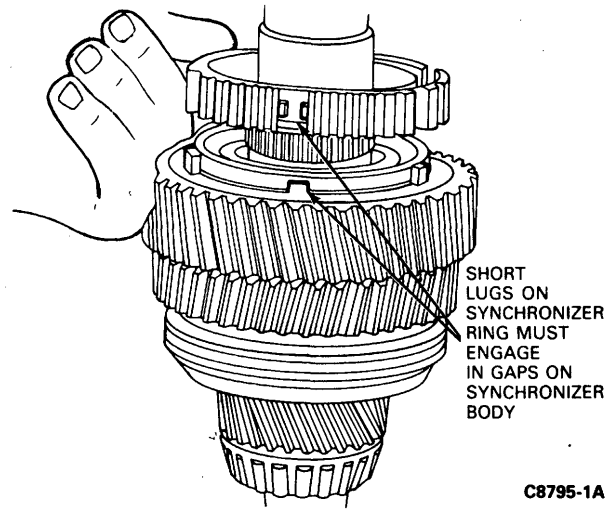


21. Place the 1st gear synchronizer ring on the taper of the 1st gear.



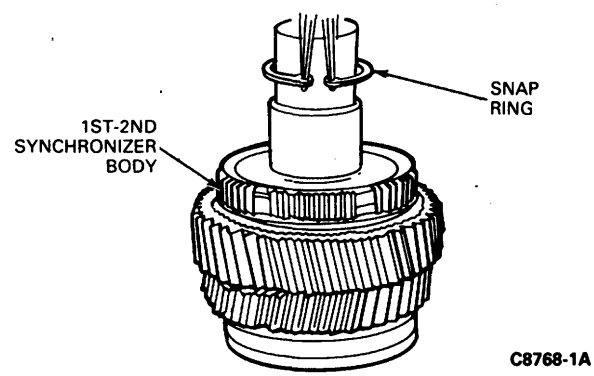
22. Heat the 1st-2nd synchronizer body to max. 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent. Position the synchronizer body on the mainshaft splines so that the short lugs on the synchronizing ring engage in the gaps in the synchronizer body. Push or lightly tap the synchronizer body down until it stops against the synchronizer ring. When proper installation is made, the word "ENGINE" will be visible on the synchronizer body.

CAUTION: Do not heat the synchronizer body for more than 15 minutes.



23. Install a snap ring on the mainshaft next to the 1st-2nd synchronizer body. Clearance between the snap ring and the synchronizer body should not be more than 0.1 mm (0.004 in).

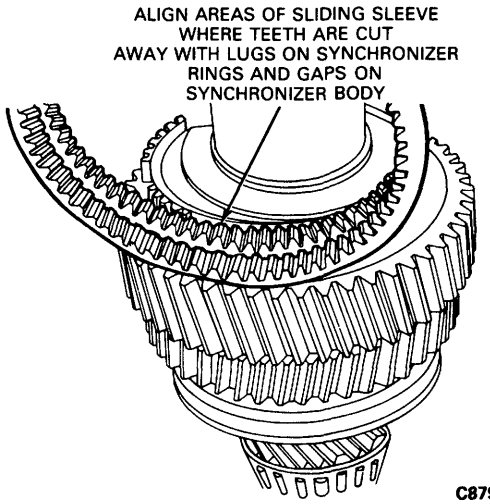
CAUTION: Make sure the snap ring is free of burrs before installing and measuring end play.



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SUBASSEMBLIES (Continued)

24. Check the end play of the 1st gear. It must be between 0.15 and 0.35 mm (0.006 and 0.014 in).
25. Position the sliding sleeve over the synchronizer body with its tappered collar facing down (towards the output end of the mainshaft). In three positions on the sliding sleeve, three teeth have been cut away. Align these three areas with the three gaps in the synchronizer body and the three lugs on the synchronizer ring. Slide the sliding sleeve down until it rests against the 1st gear.

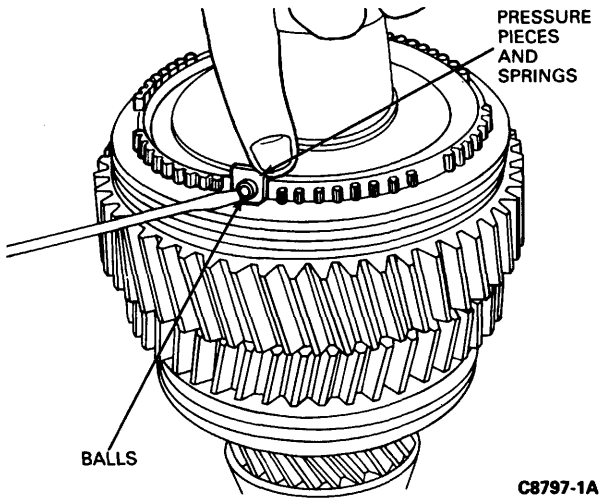


C8796-1A

26. Insert three compression springs with pressure pieces in the recesses of the synchronizer body.

CAUTION: If the original springs are not being replaced, inspect them before reuse. Refer to inspection in this section for procedure.

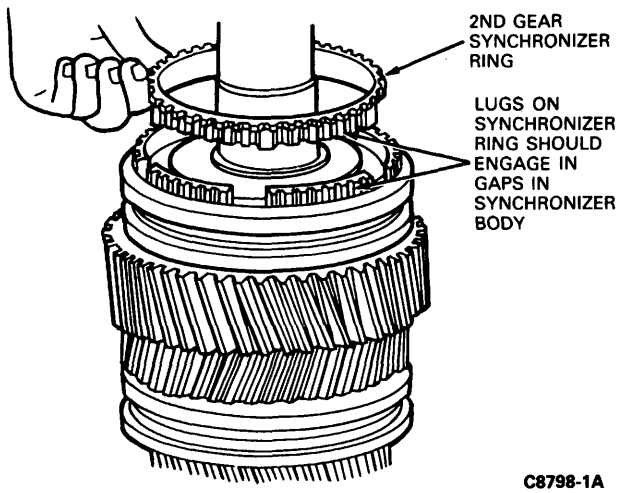
27. Push back the pressure pieces with a screwdriver. Push in the balls with a screwdriver and slide the pressure piece so that it rests against the ball.



C8797-1A

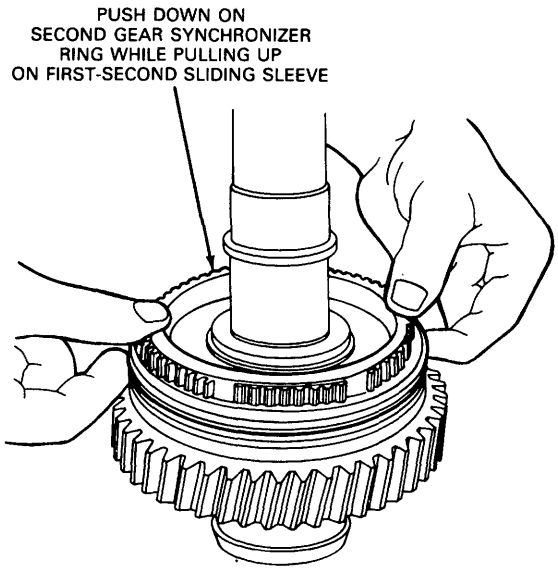
28. Place the 2nd gear synchronizer ring on the 1st-2nd synchronizer body.

NOTE: The short lugs on the synchronizer ring should be located over the gaps in the 1st-2nd synchronizer body.



C8798-1A

29. Push the synchronizer ring downwards while pulling the sliding sleeve into the center position.

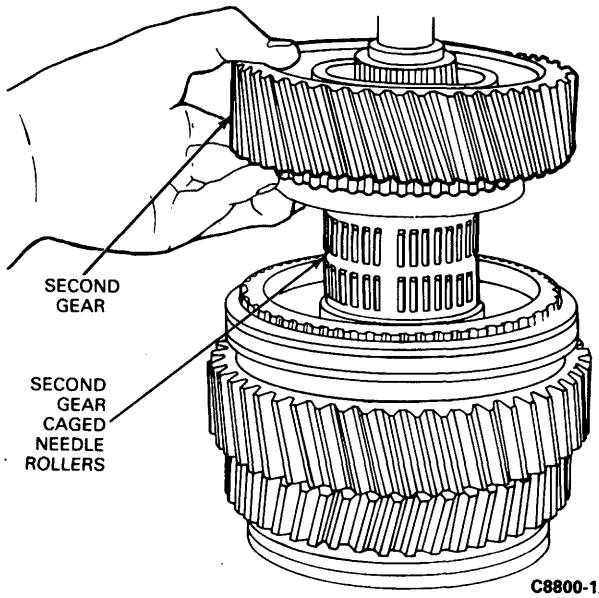


C8799-1A

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SUBASSEMBLIES (Continued)

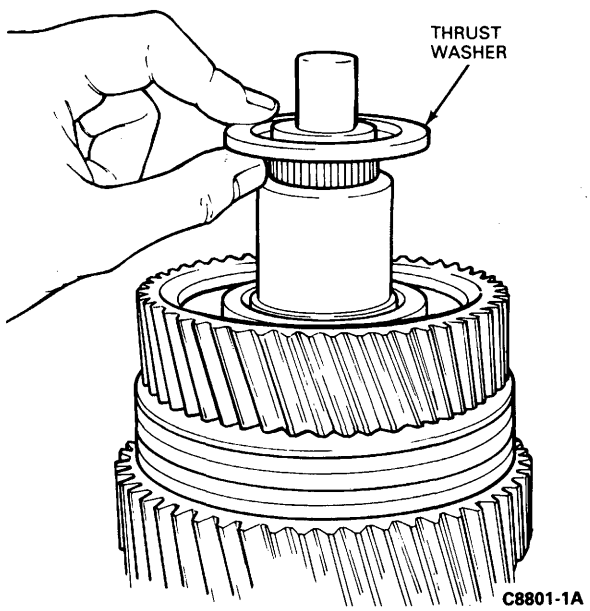
30. Place the caged needle rollers for the 2nd gear on the mainshaft.
31. Place the 2nd gear over the needle bearings on the mainshaft. The taper of the 2nd gear must face down on the mainshaft.



32. Heat the thrust washer to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent.

CAUTION: Do not heat the washer for more than 15 minutes.

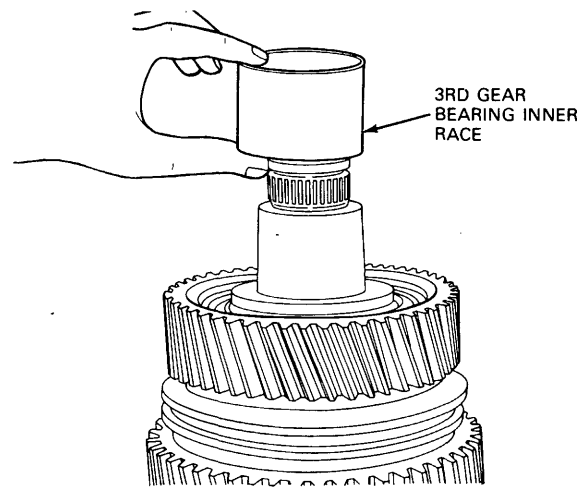
33. Place the thrust washer on the mainshaft and push it down until it seats against its stop on the shaft. If necessary, gently tap the washer to fully seat it.



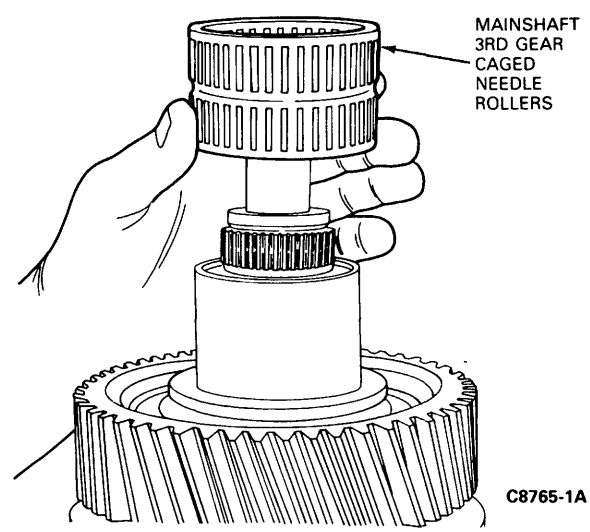
34. Heat the 3rd gear bearing inner race to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent.

CAUTION: Do not heat the race for more than 15 minutes.

35. Place the race on the mainshaft and push it down until it seats against its stop on the shaft. If necessary, gently tap the race to fully seat it.



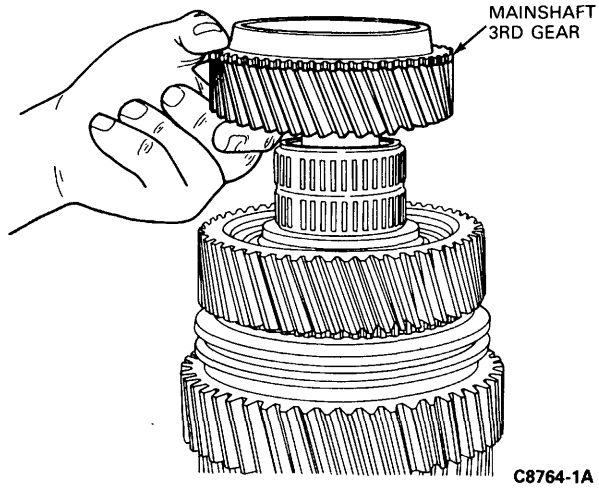
36. Check the end play of the 2nd gear. It must be between 0.15-0.45mm (0.006-0.017 in).
37. After the 3rd gear bearing inner race has fully cooled, place the 3rd gear caged needle rollers over it.



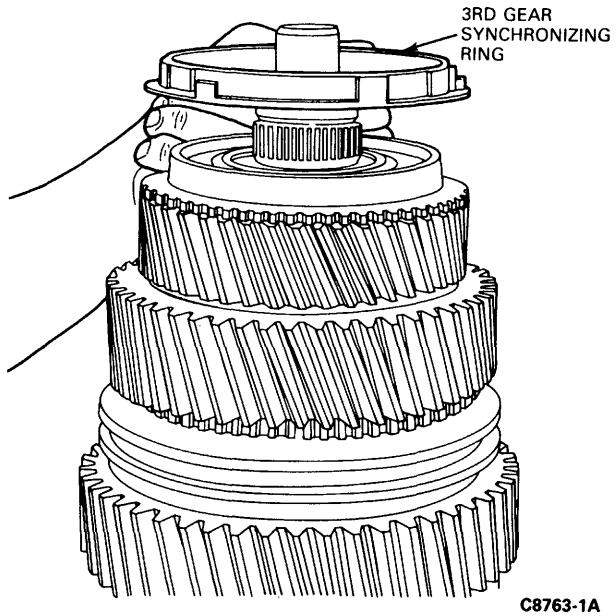
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SUBASSEMBLIES (Continued)

38. Place the 3rd gear over the needle rollers on the mainshaft. The taper of the 3rd gear must face up.



39. Place the 3rd gear synchronizer ring on the taper of the 3rd gear.

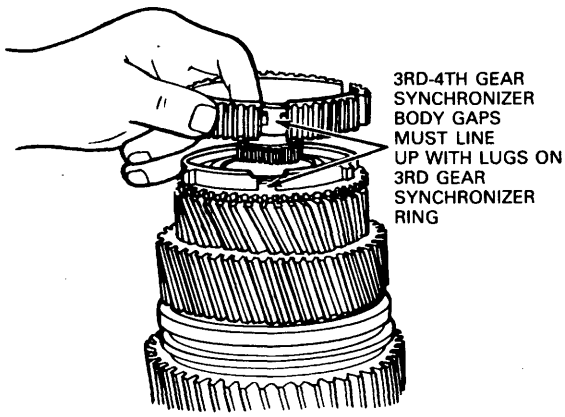


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SUBASSEMBLIES (Continued)

40. Heat the 3rd-4th synchronizer body with Rotunda Gear Heater 130-00001 or equivalent to max. 160°C (320°F). Position the synchronizer body on the mainshaft splines so that the short lugs on the synchronizing ring engage in the gaps in the synchronizer body. Push or lightly tap the synchronizer body down until it stops against the synchronizer ring. The recess in the synchronizer body must face upwards.

CAUTION: Do not heat the synchronizer body for more than 15 minutes.

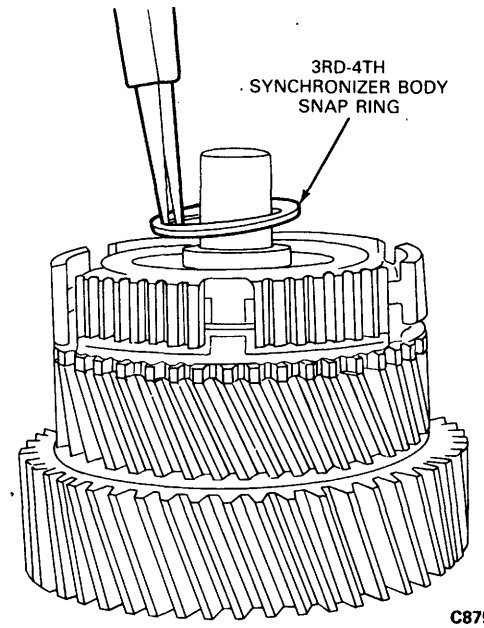


C8803-1A

41. Install a snap ring on the mainshaft next to the 3rd-4th synchronizer body. Clearance between the snap ring and the synchronizer body should not be more than 0.1 mm (0.004 in).

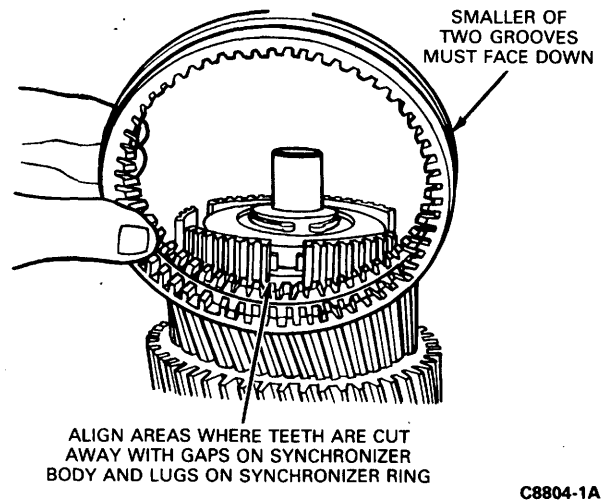
CAUTION: Make sure the snap ring is free of burrs before installing and measuring end play.

42. Check the end play of the 3rd gear. It must be between 0.15 and 0.35 mm (0.006 and 0.014 in).



C8759-1A

43. Position the sliding sleeve over the synchronizer body with the smaller of the two grooves facing down. In three positions on the sliding sleeve, three teeth have been cut away. Align these three areas with the three gaps in the synchronizer body and the three lugs on the synchronizer ring. Slide the sliding sleeve down until it rests against the 3rd gear.



C8804-1A

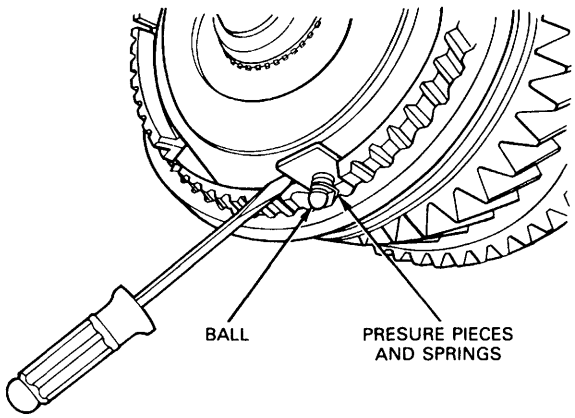
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SUBASSEMBLIES (Continued)

44. Insert three compression springs with pressure pieces in the recesses of the synchronizer body.

CAUTION: If the original springs are being replaced, inspect them before reuse. Refer to inspection in this section for procedure.

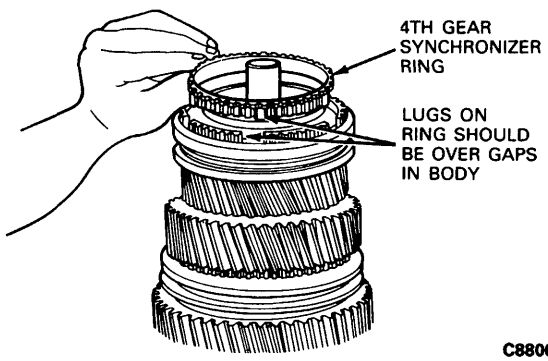
45. Push back the pressure pieces with a screwdriver. Push in the balls with a screwdriver and slide the pressure piece so that it rests against the ball.



C8805-1A

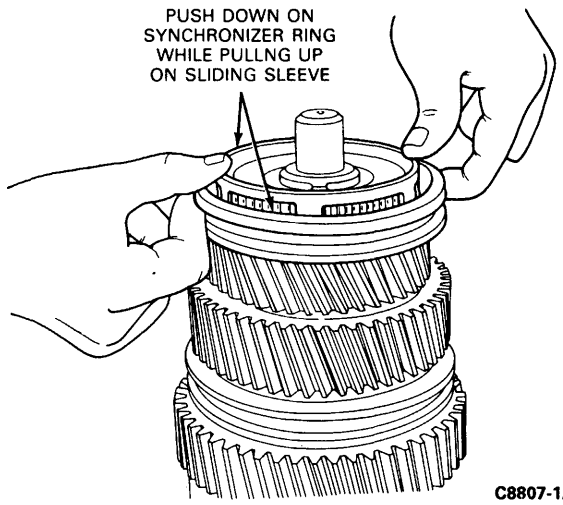
46. Place the 4th gear synchronizer ring on the synchronizer body.

Note: The short lugs on the synchronizer ring should be located over the gaps in the 3rd-4th synchronizer body.



C8806-1A

47. Push the synchronizer ring downwards while pulling the sliding sleeve into the center position.



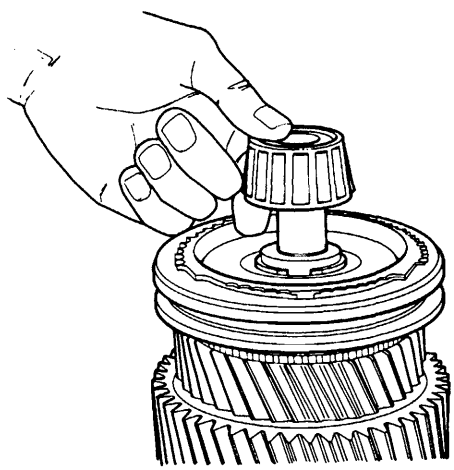
C8807-1A

48. Heat the inner race of the mainshaft front taper roller bearing to 160°C (320°F) with Rotunda Gear Heater 130-00001 or equivalent. Place it on the main shaft and drive it on if necessary until it seats against its stop on the mainshaft.

CAUTION: Do not heat the bearing for more than 15 minutes.

CAUTION: If necessary to drive the bearing on, drive against the inner race only. Do not drive against the bearing cone.

An alternate method is to press tha bearing on using Bearing Cone Replacer T85T-4621-AH.



C8808-1A

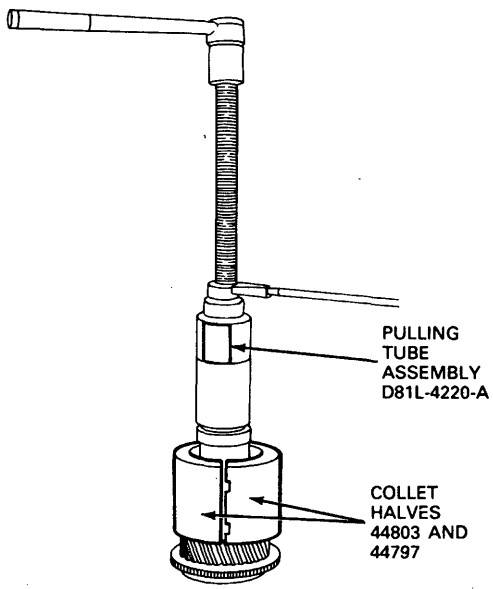
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SUBASSEMBLIES (Continued)

Input Shaft

Disassembly

1. Position the two Collet Halves (44803 and 44797) of the Universal Bearing Remover Set D81L-4220-A or equivalent around the input shaft bearing cone. Install the Pulling Tube Assembly on the collet halves and pull the input shaft bearing from the input shaft.

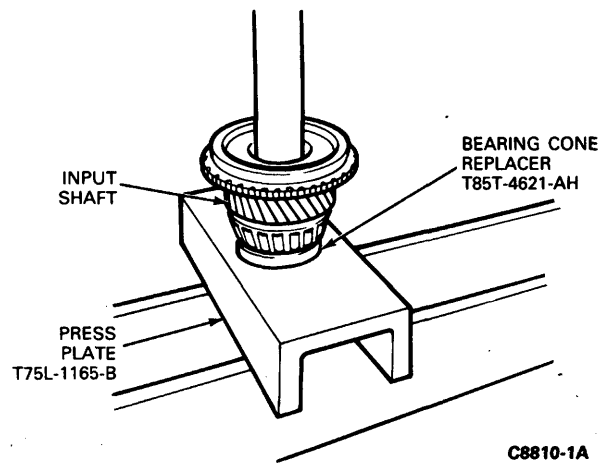


C8809-1A

Assembly

CAUTION: Inspect the surface of the input shaft in the area of the bearing race to make sure it is smooth and free of burrs. Also inspect the condition of the guide splines.

1. Place the bearing on the input shaft.
2. Place Bearing Cone Replacer T85T-4621-AH over the bearing.
3. Position the shaft, bearing, and bearing cone replacer in Press Plate T75L-1165-B as shown in the illustration.
4. Press the bearing on until it seats against its stop on the shaft.

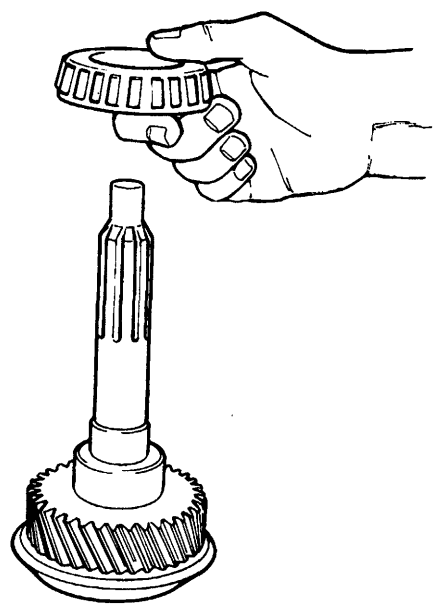


C8810-1A

5. An alternate method is to heat the inner race of the input shaft tapered roller bearing to 160°C (320°F) with Rotunda Gear Heater 130-00001 and fit it on the input shaft. If necessary, use a suitable tool to seat the bearing against its stop.

CAUTION: Do not heat the bearing for more than 15 minutes.

CAUTION: If necessary to drive the bearing on, drive against the inner race only. Do not drive against the bearing cone.



C8811-1A

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SUBASSEMBLIES (Continued)

Countershaft

NOTE: Do not attempt service procedures on the countershaft. It is serviced as an assembly.

SPECIFICATIONS

PRE-LOAD SPECIFICATIONS

Description	mm	inches
Countershaft	0.02-0.11	0.00079-0.00434
Input Shaft and Main Shaft	0.02-0.11	0.00079-0.00434
Mainshaft Reverse Gear	0.15-0.35	0.00591-0.01378
Mainshaft 1st Gear	0.15-0.35	0.00591-0.01378
Mainshaft 2nd Gear	0.15-0.45	0.00591-0.01717
Mainshaft 3rd Gear	0.15-0.35	0.00591-0.01378
Mainshaft 4th Gear	0.15-0.35	0.00591-0.01378
Mainshaft Synchronizer Body Retention Rings	0-0.1	0-0.00394

CC8825-2A

TRANSMISSION LUBRICANT

Description	Liters	U.S. Qts.	Imp. Qts.
Automatic Transmission Fluid ATF-ESP-M2C166-H	3.2	3.5	3.0

CC9018-1A

ROTUNDA EQUIPMENT

Rotunda Transmission Jack	077-00008
Heat Gun	107-00300
Gear Heater	130-00001

CC8827-1A

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SPECIFICATIONS (Continued)

SPECIAL TOOLS

T87T-7025-AH	Locknut Socket	T50T-100-A	Slide Hammer
T87T-7025-BH	Rear Seal Replacer	T80T-4000-W	Handle
T87T-7025-CH	Rear Seal Remover	T77F-1102-A	Bearing Cup Puller
T87T-7025-DH	Needle Bearing Replacer	T73T-4222-A	Bearing Cup Replacer
T87T-7025-EH	Front Seal Replacer	T84T-7025-B	Forcing Screw
T87T-7025-FH	Bearing Collets Pair	T77J-7025-B	Puller/Installer Tube
T87T-7025-HH	Gear Pack Holding Fixture	T75L-7025-G	Collet Retaining Ring
T87T-7025-JH	Shift Rod Support	T75L-4201-A	Alignment Adapter
T87T-7025-LH	Output Seal Replacer	T57L-500-B	Bench Mounted Holding Fixture
T87T-7025-MH	Puller Collets	T53T-4621-C	Differential Side Bearing Replacer
T87T-7025-NH	Puller Collets	T83T-6316-B	Crank/Cam Gear and Damper Replacer
T87T-7025-OH	Collet Retaining Ring	D81L-4220-A	Trans. Puller Set
T87T-7025-PH	Mainshaft Front Bearing Cup Replacer	D78P-4201-G	Dial Indicator
T78P-4851-A	Companion Flange Holder	D79L-4621-A	Bearing Splitter
D78P-4201-F	Dial Indicator Brackets	D80L-943-A	Internal Puller
T75L-1165-B	Press Plate	D80L-100-Q	Blind Hole Puller
T85T-4621-AH	Bearing Cone Replacer	D80L-1013-A	3 Way Puller
T57L-4621-B	Bearing Cone Replacer	D80L-625-4	Shaft Protector

CC8826-2A

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SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS

Description	Quantity	Thread Description	Torque	
			N·m	Ft.-Lbs.
Drain Plug	1	M24x1.5	60	44
Oil Filler Plug	1	M24x1.5	60	44
Extension Adapter to Main Case	17	M8	22	16
End Yoke to Mainshaft	1	M24x1.25	250	184
Shift Tower Cover to Main Case	8	M8	22	16
P.T.O. Cover Plate			38	28
Idler Shaft Retention	2	M8	22	16
Shift Rail Plate	3	M6	10	7
Shift Cover to Tower Cover	3	M6	10	7
Reverse Switch	1	9/16-18NF	20	15

CC8828-2A

SPRING SPECIFICATIONS

	Length	Outer Diameter	Wire Diameter
Detent	44.1 mm	7.880 mm	1.250 mm
Springs	1.736 in.	0.310 in.	0.049 in.
Reverse Gear	35.5 mm	9.040 mm	1.000 mm
Stop Plate Spring	1.398 in.	0.356 in.	0.039 in.
Synchronizer	14.8 mm	5.960 mm	0.950 mm
Spring	0.583 in.	0.235 in.	0.037 in.

CC8829-2A

PRESS-OFF AND PRESS-ON PRESSURES AND MOUNTING TEMPERATURES

	Pressure		Temperature	
	kN	Lbs.	C	F
Taper Roller Bearing Inner Race	—	—	160	320
Synchronizer Bodies	—	—	160	320
Thrust Washer	—	—	160	320
Needle Bearing Inner Race	—	—	160	320
Bearing Outer Race in Cover	—	—	160	320
Ball Bearing Sleeve in Cover	—	—	160	320

CC8830-2A

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SECTION 16-80 Borg-Warner 13-56 Electronic Shift Transfer Case

SUBJECT	PAGE
DESCRIPTION	
Electronic Shift Control System	16-80-1
Transfer Case	16-80-1
DIAGNOSIS AND TESTING	
Electric Shift Operations	16-80-3
Mechanical Operations	16-80-3
OPERATION	
Electronic Shift Control System	16-80-2
OPERATION (Cont'd.)	
Transfer Case	16-80-2
REMOVAL AND INSTALLATION	
Control Module	16-80-8
Electronic Shift Transfer Case	16-80-8
Rear Or Front Output Shaft Oil Seals	16-80-10
SPECIFICATIONS	16-80-23
VEHICLE APPLICATION	16-80-1

VEHICLE APPLICATION

Applies to Bronco (4x4) with Automatic Transmission Only.

DESCRIPTION

Transfer Case

The Borg-Warner 13-56 Electronic Shift Transfer Case is used on Bronco (4x4) vehicles with Automatic Transmission only. The transfer case transfers power from the transmission to the rear axle, and also to the front axle when electronically actuated.

Electronic Shift Control System

This system consists of a two rocker switch control system, an electronic control module, an electric shift motor with an integral shift position sensor, and a speed sensor.

Rocker Switch Control System

There are two rocker control switches located on the lower right hand corner of the instrument panel for fingertip shift control. The two switches are mounted horizontally and are identified as "4x4" and "low range". Two indicator bar lamps are located in the instrument cluster over the speedometer.

ELECTRONIC CONTROL MODULE

The electronic control module, located on the right hand cowl side, controls the operation of the transfer case in response to inputs to the pushbutton control by the vehicle operator.

SPEED SENSOR

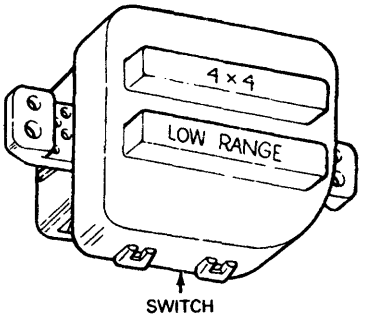
The speed sensor, mounted to the rear of the transfer case, tells the electronic control module the proper speed to shift the transfer case.

SHIFT POSITION SENSOR

The shift position sensor, an integral part of the electric shift motor, tells the electronic control module the shift position of the transfer case.

ELECTRIC SHIFT MOTOR

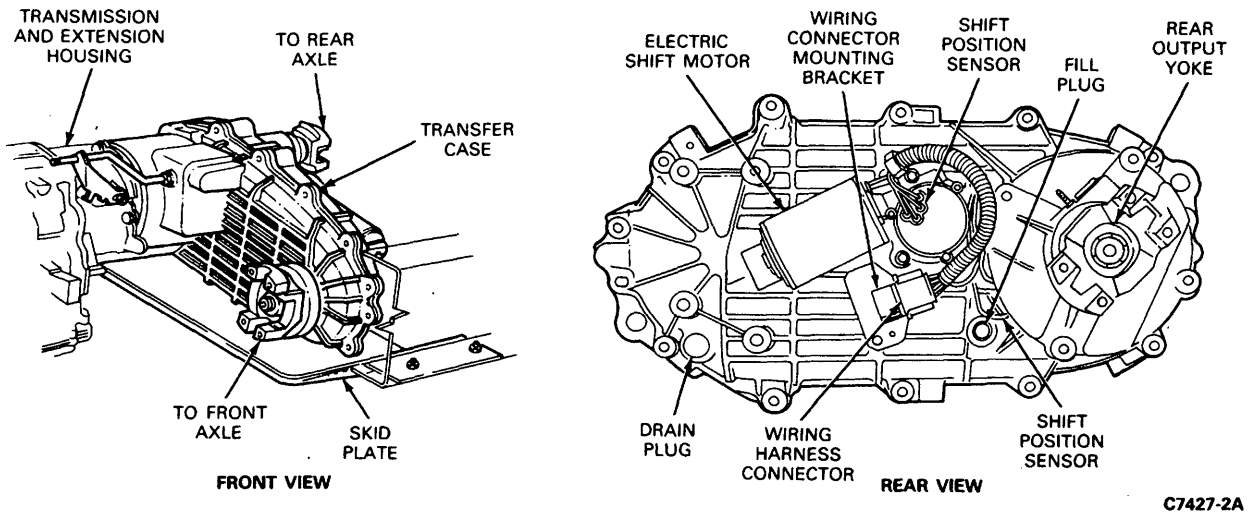
The electric shift motor, mounted externally at the rear of the transfer case, drives a rotary helical cam which moves the 2W-4W shift fork and 4H-4L reduction shift fork to the selected vehicle drive position.



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DESCRIPTION (Continued)



OPERATION

Transfer Case

MECHANICAL OPERATION

In the 4x2 mode, torque from the transmission is transferred to the front input shaft, which in turn drives the rear output shaft that drives the rear axle.

The 2W-4W shift is accomplished when the 2W-4W shift fork moves the 2W-4W lockup collar to engage the front drive sprocket on the output shaft splines. The front drive sprocket turns the chain, which turns the front output shaft driven sprocket on the splined front output shaft and the front driveshaft.

The high-low shift is accomplished when the high-low shift fork moves the high-low lockup collar to engage the planetary gearset assembly to the output shaft. Torque from the input shaft is then transferred through the sun gear, which then turns the planetary gearset. The planetary gearset, which is now engaged to the output shaft, provides the gear reduction.

ELECTRONIC SHIFT OPERATION

The transfer case is equipped with a magnetic clutch, similar to an air conditioning compressor clutch, which is located inside the transfer case adjacent to the 2W-4W shift collar. The clutch is used to spin up the front drive system from zero to vehicle speed in milliseconds. This spin-up allows the shift between 2-high and 4-high to be made at any vehicle speed. When the transfer case rear and front output shafts reach synchronous speed, the spring loaded shift collar mechanically engages the mainshaft hub to the chain drive sprocket and the magnetic clutch is then deactivated. Shifts between 4-high and 4-low can only occur with the clutch interlock or transmission safety switches closed. The vehicle's speed must also be within specified limits as determined by the transfer case speed sensor (3 mph or under).

When the operator selects the drive combination through the pushbutton control, an electric motor turns a helical-cam, which is linked to the high-low and 2W-4W shift forks through fork-mounted roller bushing assemblies. As the electric motor turns the helical-cam, the high-low fork bushing rides in a slotted lobe in the cam to make the low-high or high-low range change; and the 2W-4W fork bushing rides on lobes at the end of the cam to make the 2W-4W or 4W-2W shift.

The unit is lubricated by a positive displacement oil pump that channels oil through the bores in the transfer case output shaft.

Electronic Shift Control System

In operation, when a control switch in the instrument panel is depressed, the Electronic Control Module will analyze information from the transfer case Shift Position Sensor to verify its current position. It also will analyze input information from the Speed Sensor and the Clutch Interlock Switch (or Neutral Safety Switch depending upon transmission application). If all the design conditions of the system are met, the Electronic Control Module will command the Electric Shift Motor to execute the desired function. After the shift takes place and the motor is turned off, the Electronic Control Module will again look at the inputs from the Shift Position Sensor to determine if the transfer case is in the position that the operator selected. Finally, the Electronic Control Module will illuminate the shift indication bar lamps located below the instrument cluster to indicate that the desired function has been completed.

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DIAGNOSIS AND TESTING

Mechanical Operations

For mechanical diagnosis and testing procedures, refer to Section 16-10, General Manual Transmission Service.

Electric Shift Operations

If the system operates improperly, or will not operate at all, a problem could exist in a control switch, the Electronic Control Module, the Speed Sensor, the Electric Shift Motor, the Electro-Magnetic Clutch Assembly or the interconnecting wiring.

Use the following guidelines and test procedures to assist in locating the cause of a problem.

CIRCUIT PROTECTION

The battery feed circuit, through a circuit breaker, provides memory capability for the electronic control module.

Ignition "RUN" and "ACC" feed circuits, through a fuse, provide power for the switches and the electric shift motor.

The headlamp dimmer circuit provides power for nighttime illumination of the switches located in the instrument panel.

CONTROL MODULE SELF-TEST

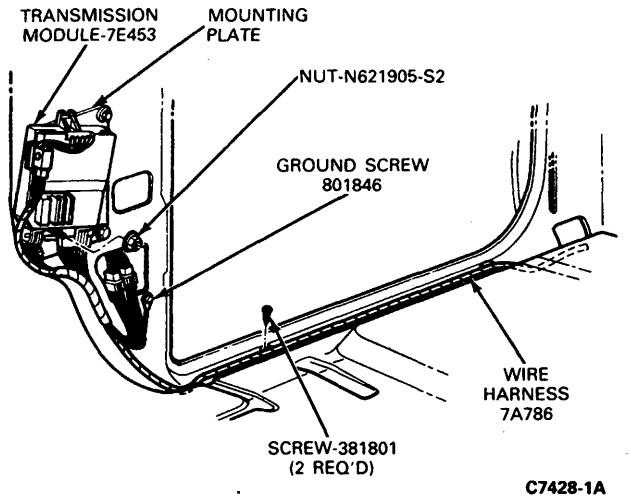
The Electronic Control Module has a diagnostic capability of its own circuitry. The self-test procedure is as follows:

1. Remove the Five-Wire Connector and the Eight-Wire Connector from the Electronic Control Module.
2. Turn the ignition switch to the "RUN" position.
3. Activate the Self-Test switch and note the result: A flashing indicator lamp (approximately one flash per second) indicates that the control module is functioning properly. A steady indicator lamp indicates that the control module is inoperative and must be replaced.

CONTROL MODULE CIRCUITS

There are three wiring harnesses connected to the Electronic Control Module: the Eight-Wire Pigtail Harness Connector; the Five-Wire Harness Connector; and the Eight-Wire Harness Connector.

To check the integrity of these circuits, disconnect the harnesses from the Electronic Control Module and perform the following checks:



Eight-Wire Pigtail Harness Connector

1. Connect a voltmeter between terminal 8 and ground. The voltmeter should indicate battery voltage at all times.
2. Connect a voltmeter between terminal 7 and ground. Then turn the ignition switch to the "RUN" position. The voltmeter should then indicate battery voltage.

CAUTION: In the following sections where the usage of an ohmmeter is specified, always remember that an ohmmeter should NEVER be connected into a "live" or powered circuit. If the ohmmeter is subjected to a powered circuit, severe damage will be done to the instrument. The vehicle's battery should be disconnected before performing checks on any circuit with an ohmmeter to prevent any accidental damage to the instrument.

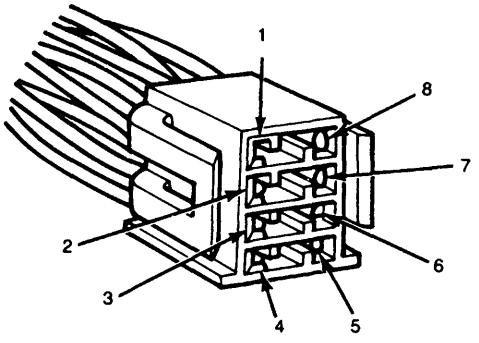
3. Connect an ohmmeter Rotunda Number 007-00001 between terminal 6 and ground. The ohmmeter should indicate a "low" resistance value (less than 10 ohms).

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DIAGNOSIS AND TESTING (Continued)

4. Connect an ohmmeter between terminals 4 and 5 of the wiring harness connector. The ohmmeter should indicate a "low" resistance value (less than 10 ohms).
5. Connect an ohmmeter between terminal 3 and ground. The ohmmeter should indicate 0 ohms.
6. Connect an ohmmeter between terminal 2 and ground. The ohmmeter should indicate 0 ohms.

EIGHT-WIRE PIGTAIL HARNESS CONNECTOR (E25B-14489-GB)



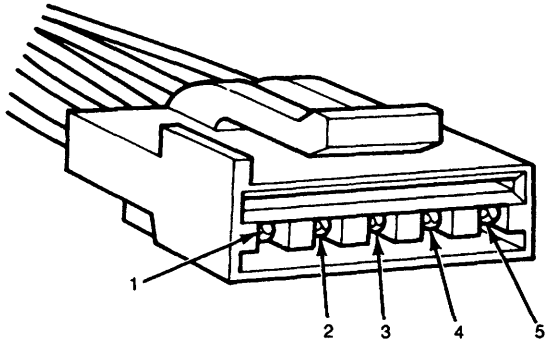
Position	Circuit Number	Color Code	Function
1	OPEN		
2	57	Blk	Ground
	57A	Blk	Ground
3	396	Blk/Org	Logic Ground
4	778	Org	Transfer Case Motor Control (Clockwise) 2H-4H-4L
5	777	Yel	Transfer Case Motor Control (Counterclockwise) 4L-4H-2H
6	779	Brn	Electro-Magnetic Clutch (Feed)
7	296	Wht/Ppl	Ignition Run and Accessory Feed (Fused)
8	517	Blk/Wht	Battery Feed (Circuit Breaker)

CC6599-1A

Five-Wire Harness Connector

1. Connect an ohmmeter between terminals 1 and 2. Then depress the 4x4 (2H-4H) switch in the Overhead Roof Console. The ohmmeter should indicate a very "low" resistance value (less than 50 ohms) while the switch is being depressed.
2. Connect an ohmmeter between terminals 1 and 3. Then depress the "Low Range" switch to the right of the steering column. The ohmmeter should indicate a very "low" resistance value (less than 50 ohms) while the switch is being depressed.
3. Connect a test lead between terminal 4 and ground. Turn the ignition switch to the "RUN" position and observe the Overhead Roof Console. The lamp in the Overhead Roof Console Low Range Bar should illuminate.
4. Connect a test lead between terminal number five and ground. Turn the ignition switch to the "RUN" position and observe the Overhead Roof Console. The lamp in the Overhead Roof Console 4x4 Bar should illuminate.

FIVE-WIRE HARNESS CONNECTOR (D5LB-14489-CA)



Position	Circuit Number	Color Code	Function
1	465	Wht/Lt Blu	Switch Feed
2	780	Dk Blu	4x4 Switch
3	781	Org/Lt Blu	Low Range Switch
4	782	Brn/Wht	Low Range Light
5	783	Gry	4x4 Light

CC6600-1A

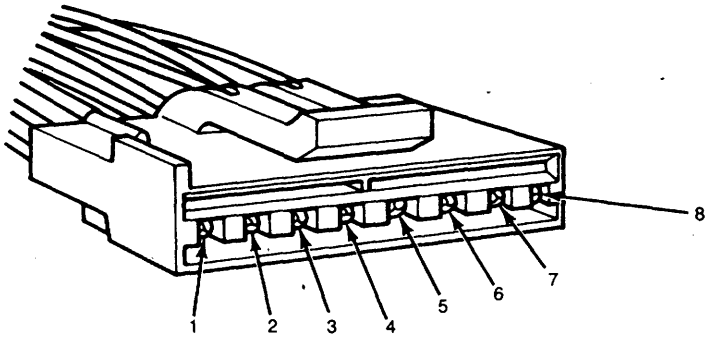
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DIAGNOSIS AND TESTING (Continued)

Eight-Wire Harness Connector

1. Connect an ohmmeter between terminal 1 and ground. On a vehicle equipped with a manual transmission, depress the clutch pedal and observe the ohmmeter. The ohmmeter should indicate a "low" resistance (less than 50 ohms) while the clutch pedal is being depressed. If the vehicle is equipped with an automatic transmission, shift the transmission into the "NEUTRAL" position and observe the ohmmeter. The ohmmeter should indicate a "low" resistance (less than 50 ohms) while the transmission selector lever is in the "NEUTRAL" position.
2. Connect an ohmmeter between terminals 2 and 3. The ohmmeter should indicate a "low" resistance reading (200-350 ohms). This will check the continuity of the speed sensor that is located in the transfer case. The speed sensor picks up the rotating speed of the output shaft from two notches that are cut in opposite sides of the outer ring of the clutch housing assembly.
3. Connect an ohmmeter between terminal 8 and terminals 4, 5, 6, and 7, respectively. Refer to the chart below for the appropriate ohmmeter readings in each transfer case position.

EIGHT-WIRE HARNESS CONNECTOR (E4EB-14489-SA)



Position	Circuit Number	Color Code	Function
1	32	Red/Lt Blu	Manual Transmission Clutch Interlock Switch
	463	Red/Wht	Automatic Transmission Neutral Safety Switch
2	774	Lt Grn	Speed Sensor (Feed)
3	772	Lt Blu	Speed Sensor Return
4	771	Violet	Wire #5, Contact Plate Position Sensor in Transfer Case
5	770	Wht	Wire #4, Contact Plate Position Sensor in Transfer Case
6	764	Brn/Wht	Wire #3, Contact Plate Position Sensor in Transfer Case
7	763	Org/Wht	Wire #2, Contact Plate Position Sensor in Transfer Case
8	762	Yel/Wht	Wire#1, Contact Plate Position Sensor in Transfer Case

OHMMETER READINGS FOR SHIFT MOTOR POSITION SENSOR

Ohmmeter Connection	Transfer Case Gear Position		
	2 High	4 High	4 Low
Meter Reading From Terminal #8 to #4	Short	Open	Short
Meter Reading From Terminal #8 to #5	Open	Open	Short
Meter Reading From Terminal #8 to #6	Short	Short	Open
Meter Reading From Terminal #8 to #7	Open	Short	Open

NOTE: SHORT is a "low" resistance reading on the ohmmeter (zero ohms).
OPEN is a "high" resistance reading on the ohmmeter (infinity).

CC6601-2A

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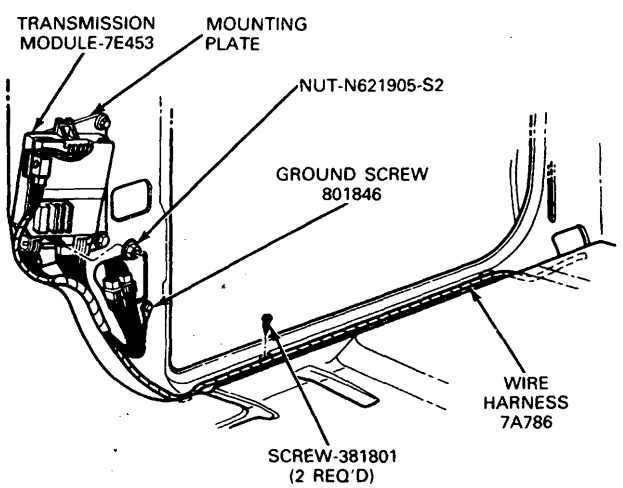
DIAGNOSIS AND TESTING (Continued)

Main Feed Connector Circuits

The Electronic "Touch Drive" Four Wheel Drive System Main Feed Connector to the instrument panel harness connector is located near the middle of the instrument panel.

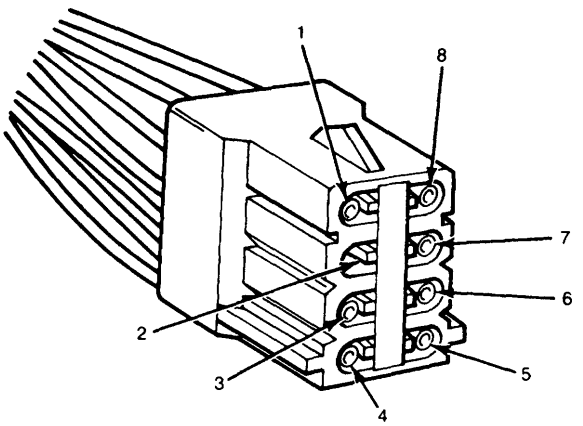
This connector contains the following inputs to the system:

1. The battery feed circuit through a circuit breaker provides memory capability for the electronic control module.
2. Ignition "RUN" and "ACC" feed circuits through a fuse provide power for the switches and the electric shift motor.
3. Dome lamp feed circuits provide power for the reading and map lamps.
4. The side marker lamp feed circuit provides power for nighttime illumination of the overhead roof console vehicle graphics.
5. Transmission interlock and safety switch feed circuits provide input to the control module to help determine whether or not the "Low Range" position can be selected.
6. The chassis ground circuit provides grounding capability for all of the system components except for the "logic ground" of the control module, which is grounded separately.



C7428-1A

MAIN FEED CONNECTOR (D9TB-14489-AA)

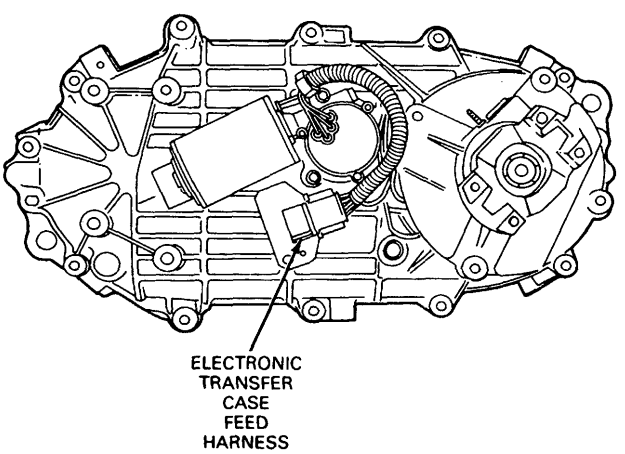


Position	Circuit Number	Color Code	Function
1	782	Red/Yel	Ignition Run and Accessory Feed (Fused)
2 (Used Only on Auto Trans)	463	Red/Wht	Automatic Transmission Neutral Safety Switch
3	296	Wht/Ppl	Ignition Run and Accessory Feed (Fused)
4	57	Blk	Ground
5	780	Lt Blu/Red	Side Marker Lamp (Feed)
6	783	Lt Grn/Yel	Dome Lamp (Feed)
7 (Used Only on Manual Trans)	463	Red/Lt Blu	Manual Transmission Clutch Interlock Switch
8	517	Blk/Wht	Battery Feed (Circuit Breaker)

CC7429-1A

TRANSFER CASE FEED HARNESS CIRCUITS

The electric transfer case feed harness contains ten wires that carry a variety of information to and from the electronic control module.



C7430-1A

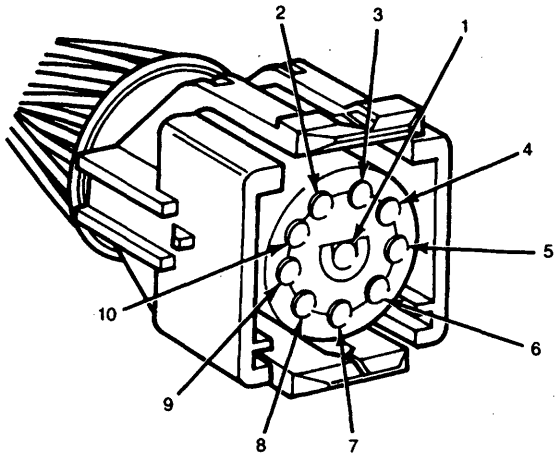
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DIAGNOSIS AND TESTING (Continued)

A listing of the transfer case feed harness circuits and their functions follows:

1. The electro-magnetic clutch feed circuit provides a power signal to the clutch coil, from the control module when shifting from 2W to 4W drive.
2. Clockwise rotation of the electric shift motor circuit provides power to drive the shift motor through the 2H-4H-4L sequence. If a position is selected that would require a shift through an intermediate position, the module will respond as if each intermediate position was selected, even if the 4L position was commanded from 2H. It will then fulfill all of the requirements for shifting into or out of each intermediate position.
3. Counterclockwise rotation of the electric shift motor circuit provides power to drive the shift motor through the 4L-4H-2H sequence. Actuation of the Low Range Switch, while in 4L, will cause a shift to 4H. Actuation of the "Four-by-Four" 2W-4W switch, after a shift to 4H from 4L, will then cause a shift to 2H.
4. The speed sensor coil feed circuit provides a constant signal from the electronic control module to the speed sensor located in the transfer case.
5. The speed sensor coil return circuit provides a varying signal (while the vehicle is in motion) from the speed sensor to the electronic control module. This signal indicates the vehicle speed to the microprocessor so that it can control the application of the "Low Range" gear selection in the transfer case.
6. The shift position sensor feed circuit provides a power signal from the Electronic Control Module to the shift position sensor to energize the sensor.
7. Shift position sensor return circuits provide the output information signals from the transfer case to the electronic control module. This information gives the control module the correct position of the shaft that turns the helical cam in the transfer case.

ELECTRONIC TRANSFER CASE FEED HARNESS (E4DB-14489-AA)



Position	Circuit Number	Color Code	Function
1	779	Brn	Electro-Magnetic Clutch (Feed)
2	778	Org	Transfer Case Motor Control (Clockwise) 2H-4H-4L
3	777	Yel	Transfer Case Motor Control (Counterclockwise) 4L-4H-2H
4	774	Lt Grn	Speed Sensor (Feed)
5	772	Lt Blu	Speed Sensor (Return)
6	771	Violet	Wire #5, Shift Position Sensor in Transfer Case (Output to Module)
7	770	Wht	Wire #4, Shift Position Sensor in Transfer Case (Output to Module)
8	764	Brn/Wht	Wire #3, Shift Position Sensor in Transfer Case (Output to Module)
9	763	Org/Wht	Wire #2, Shift Position Sensor in Transfer Case (Output to Module)
10	762	Yel/Wht	Wire #1, Shift Position Sensor in Transfer Case (Input from Module)

CC6608-1A

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REMOVAL AND INSTALLATION

4X4 SHIFT SWITCH

Removal and Installation

1. Remove the instrument panel assembly as described in that section.
2. Remove the switch mounting screw and remove the switch from the panel.
3. To install, position the switch in the panel and retain with mounting screw.
4. Install the instrument panel assembly.

Control Module

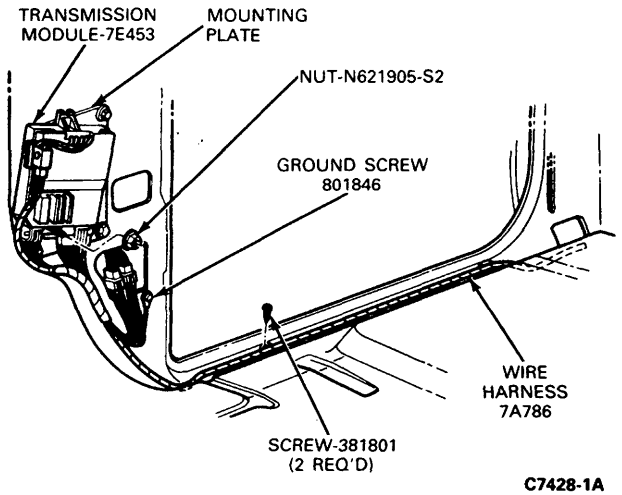
The electronic control module is located on the inside right hand cowl panel.

Removal

1. Remove the right hand cowl panel kick pad.
2. Remove the two module to instrument panel attaching screws.
3. Lift out the module and disconnect the three wiring connectors. Remove module assembly.

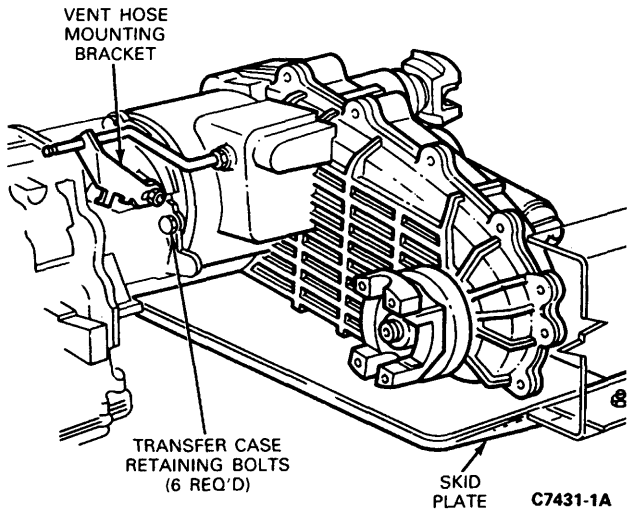
Installation

1. Position module to the instrument panel opening. Connect the three wiring connectors to the module.
2. Place module into the instrument panel opening and install the two attaching screws.
3. Install the instrument panel pad.



C7428-1A

Electronic Shift Transfer Case



C7431-1A

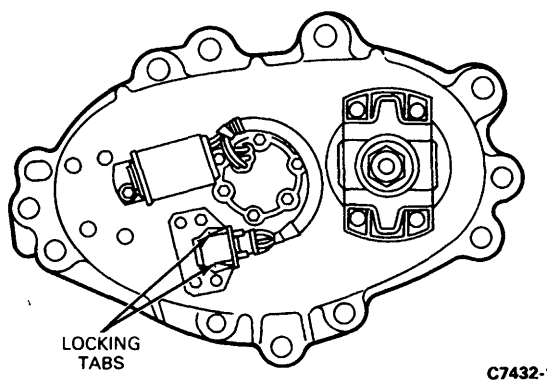
Removal

1. Raise the vehicle on a hoist.
2. If so equipped, remove the nuts, bolts and skid plate from the frame.
3. Place a drain pan under the transfer case. Remove the drain plug and drain the fluid from the transfer case.
4. Remove the wire connector from the feed wire harness at the rear of the transfer case. First squeeze the locking tabs, then pull the connectors apart.

CAUTION: Do not pull directly on the wires.

NOTE: For detailed instructions on front and rear driveshaft removal, refer to the appropriate driveshaft Section in Group 15.

5. Disconnect the front driveshaft from front output shaft yoke.
6. Disconnect the rear driveshaft from the transfer case rear output shaft yoke.



C7432-1A

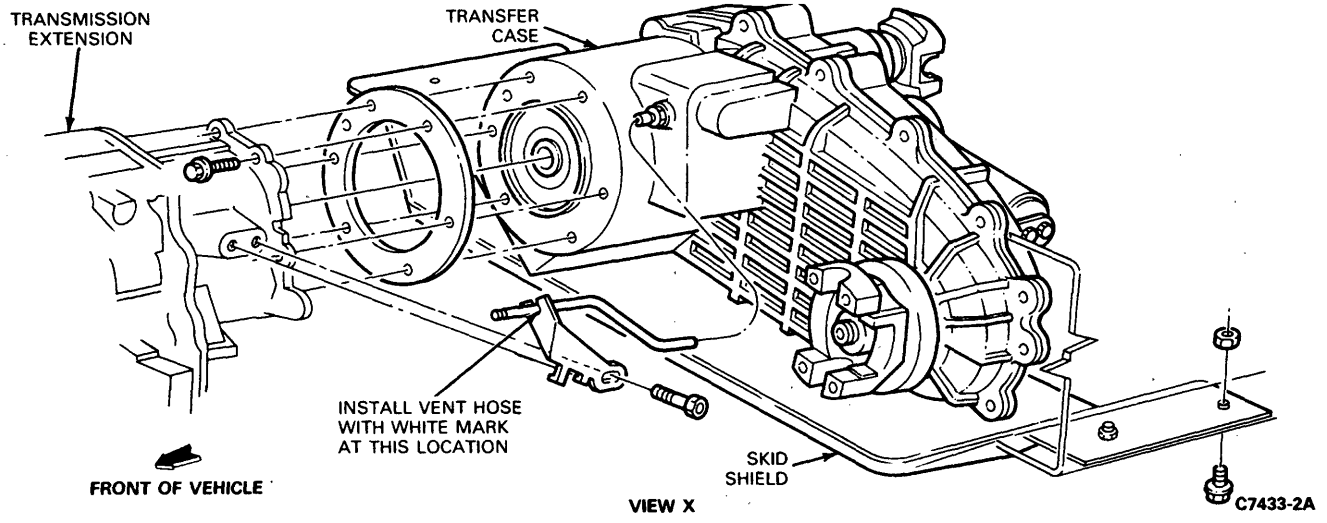
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REMOVAL AND INSTALLATION (Continued)

7. Disconnect the speedometer driven gear from the transfer case rear cover.
8. Disconnect the vent hose from the mounting bracket.

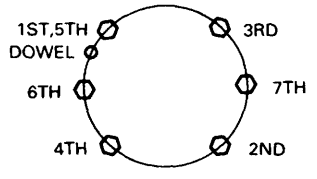
CAUTION: The catalytic converter is located beside the transfer case. Be careful when working around the catalytic converter because of the extreme high temperatures generated by the converter.

9. Support the transfer case with a suitable transmission jack Rotunda Number 066-00017 or equivalent.
10. Remove the six bolts retaining the transfer case to the transmission and the extension housing.
11. Slide the transfer case rearward off the transmission output shaft and lower the transfer case from the vehicle. Remove the gasket from the transfer case and transmission housing.



Installation

1. Place a new gasket between the transfer case and the transmission extension.
2. Raise the transfer case with the transmission jack so that the transmission output shaft aligns with the splined transfer case input shaft. Slide the transfer case forward onto the transmission output shaft and onto the dowel pin. Install the six transfer case retaining bolts to the extension housing. Tighten the bolts to 34-58 N·m (25-43 ft-lb) in the sequence shown.



TIGHTEN CASE TO EXTENSION BOLTS IN THIS SEQUENCE

C7434-1A

3. Remove the transmission jack from the transfer case.
4. Install the vent hose so that the white marking on the hose aligns with the notch in the mounting bracket.
5. Connect the speedometer driven gear to the transfer case rear cover. Tighten the screw to 2.3-2.8 N·m (20-25 in-lb).
6. Connect the rear driveshaft to the transfer case output shaft yoke. Tighten the bolts to 28-33 N·m (20-28 ft-lb).
7. Connect the front driveshaft to the transfer case front output shaft yoke. Tighten the nuts to 11-20 N·m (8-15 ft-lb).
8. Connect the wire connectors on the rear of the transfer case, making sure that the retaining tabs lock.
9. Install the drain plug and tighten to 19-30 N·m (14-22 ft-lb). Remove the fill plug and install 1.9 Liters (2.0 U.S. Quarts) of Motorcraft Dexron®-II Automatic Transmission Fluid XT-2-QDX or equivalent to the bottom of the fill hole. Install fill plug and tighten to 19-30 N·m (14-22 ft-lb).
10. Install the skid plate, bolts and nuts to the frame and tighten to 20-27 N·m (15-20 ft-lb).
11. Lower the vehicle.

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REMOVAL AND INSTALLATION (Continued)

Rear Or Front Output Shaft Oil Seals

Removal

1. Raise the vehicle on a hoist.
2. Remove the rear or front driveshaft from the transfer case output shaft yokes. Wire the driveshaft(s) out of the way.
3. Remove the output shaft yoke by removing the 30mm locknut, steel washer and rubber seal from the rear or front output shaft and remove the yokes.
4. Remove the oil seal from the rear output housing bore with Seal Remover, Tool T74P-77248-A and Impact Slide Hammer, T50T-100-A.
5. Remove the oil seal slinger from each yoke.

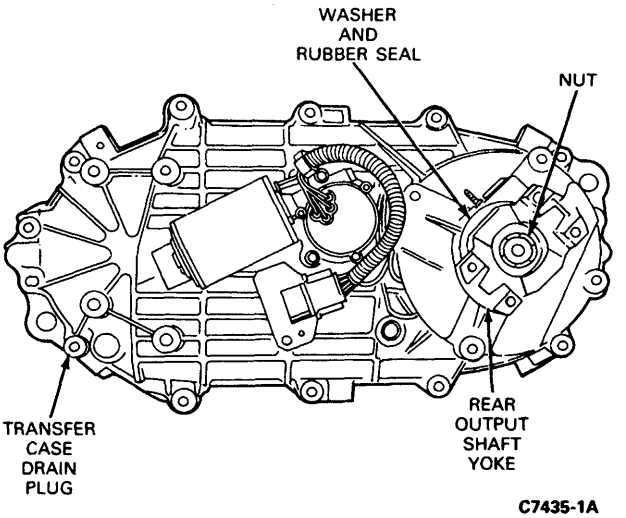
Installation

1. Make sure the front or rear output shaft output housing bores and faces are free from nicks and burrs. Coat the oil seals with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C175-B) or automatic transmission fluid. Position the oil seal into the front or rear output housing bore, making sure that the oil seal is not cocked in the bore. Drive the oil seal into the bore with Output Shaft Seal Installer, T83T-7065-B and Drive Handle, T80T-4000-W (Fig. 24).
2. Install new seal slinger on each yoke. Do not scratch seal surface on yokes.
3. Install the yoke, rubber seal, steel washer and locknut on the front or rear output shaft. Tighten the locknut to 203-244 N·m (150-180 ft-lb).
4. Connect the front or rear driveshaft to the transfer case output shaft yokes. Tighten the bolts to 83-118 N·m (61-87 ft-lb).
5. Lower the vehicle from the hoist.

Disassembly

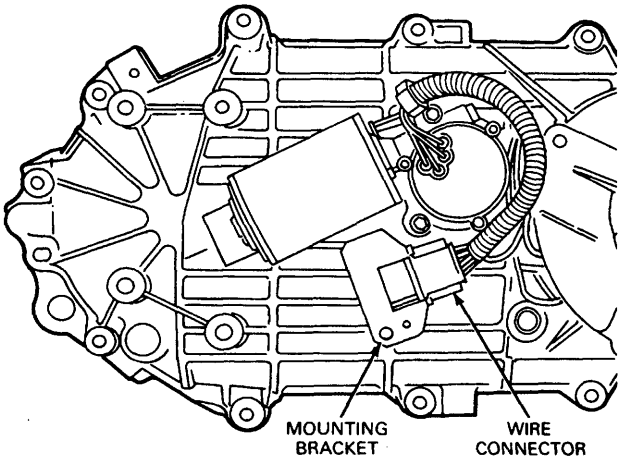
1. Remove the transfer case from the vehicle as described in the Removal and Installation portion of this Section.
2. Remove the transfer case drain plug with a 3/8 inch drive ratchet and drain the fluid.
3. Remove the front and rear output shaft yokes by removing the 30mm locknut, flat steel washer and rubber seal from the output shaft.

4. Remove the rear output shaft seal using Tool T74P-77248-A and T50T-100-A.



C7435-1A

5. Remove the wire connector assembly from the mounting bracket on the rear cover. If required, remove the two bolts and remove the bracket.



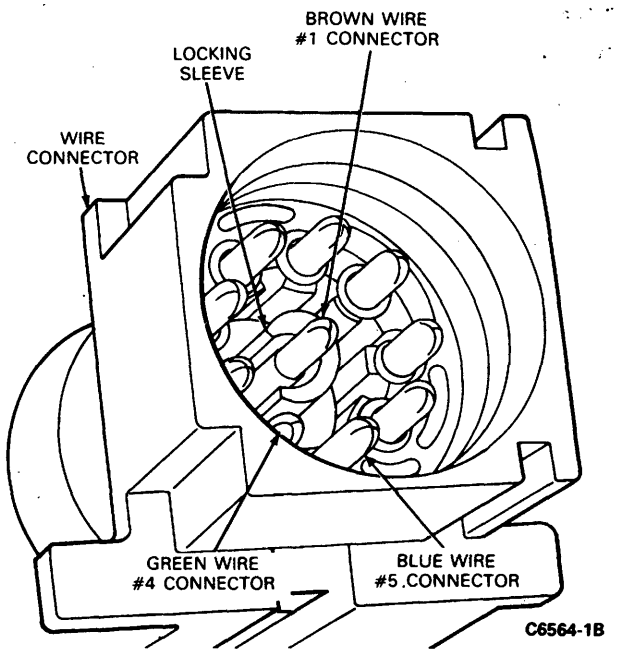
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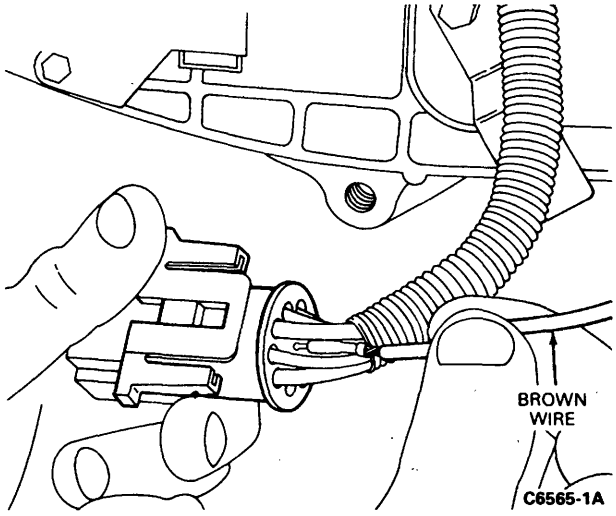
REMOVAL AND INSTALLATION (Continued)

6. Form a small hook at the end of a paper clip or safety pin. Remove the locking sleeve from the wire connector by hooking it with the paper clip or safety pin and pulling it up from the bottom.

CAUTION: Do not damage the wire connector locking sleeve.



7. Remove the brown wire from the No. 1 center position in the connector. If required, remove the speed sensor green wire from the No. 4 connector position and the blue wire from the No. 5 connector position.

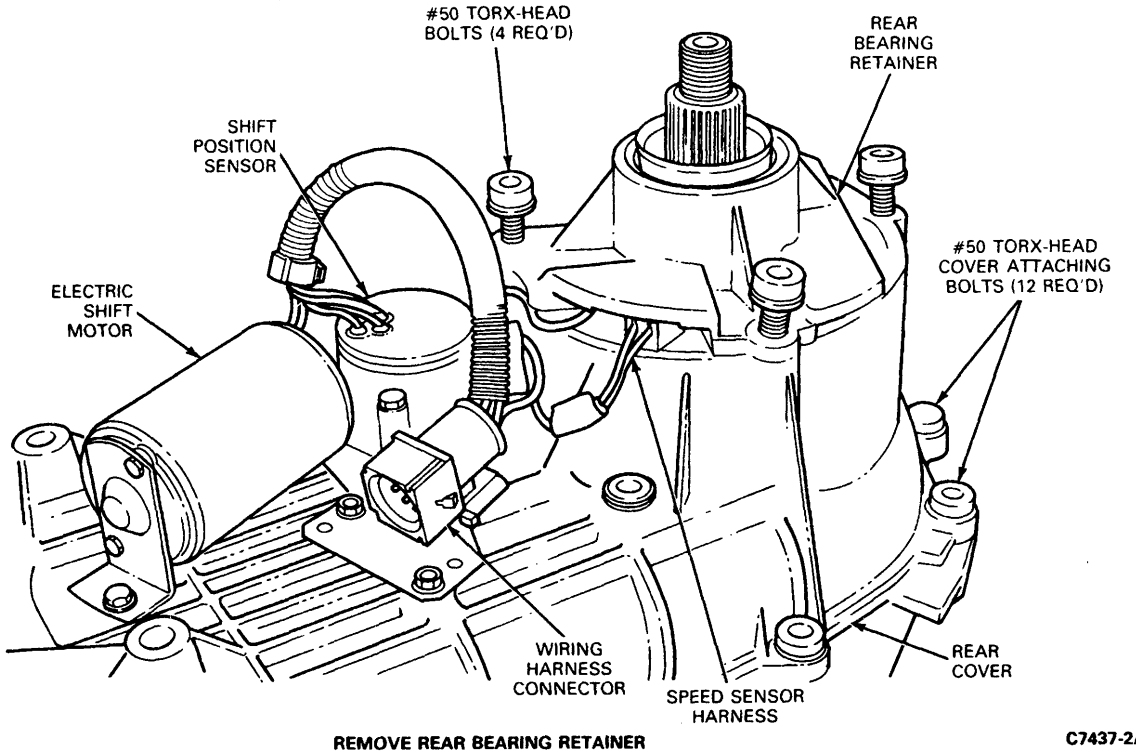


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REMOVAL AND INSTALLATION (Continued)

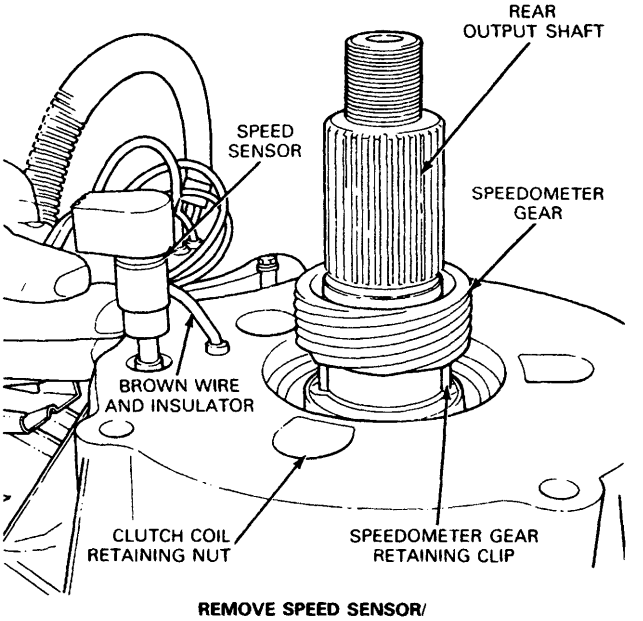
8. Remove the 4 No. 50 Torx® head bolts securing the rear bearing retainer to the cover. Pry the rear bearing retainer from the cover using a 1/2 inch drive breaker bar between the pry bosses and separate the bearing retainer from the cover. Remove all traces of RTV Gasket Sealant from the mating surfaces of the cover and the bearing retainer.

CAUTION: When removing the RTV sealant, use care not to damage the mating surfaces of the magnesium cases.



REMOVE REAR BEARING RETAINER C7437-2A

9. Lift the rear output shaft and remove the speedometer gear retaining clip using a screwdriver.
10. Slide the speedometer gear forward and remove the ball with a small magnet. The speedometer gear can now be removed off of the rear of the output shaft.
11. Remove the speed sensor from the rear cover.



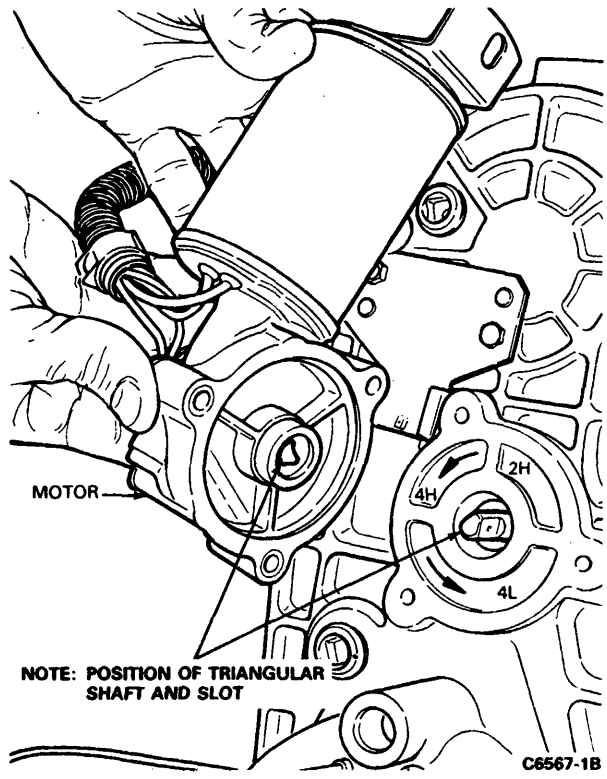
REMOVE SPEED SENSOR/ SPEEDOMETER GEAR C7438-1A

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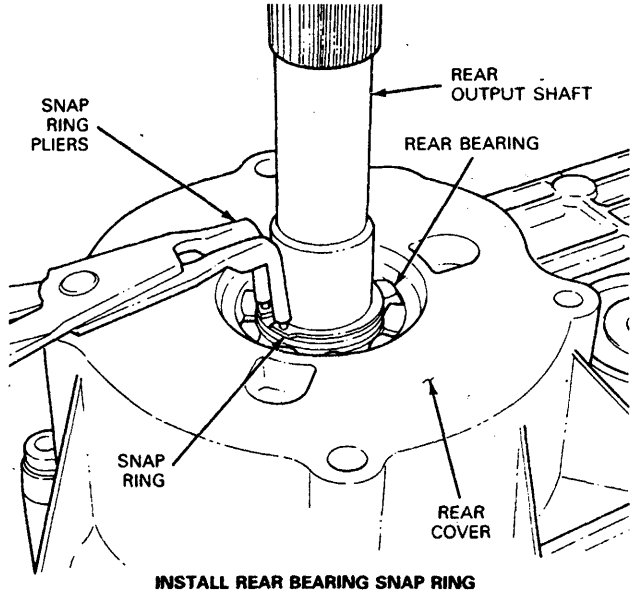
REMOVAL AND INSTALLATION (Continued)

12. Remove the four bolts attaching the shift motor to the rear cover and remove the shift motor. Note the position of the triangular shaft extending out of the rear cover and the triangular slot in the motor. Do not discard the washer under the motor support bracket, if present.

CAUTION: The motor is serviced as a complete assembly. Do not remove the screws that secure the rear cover to the motor gear housing.



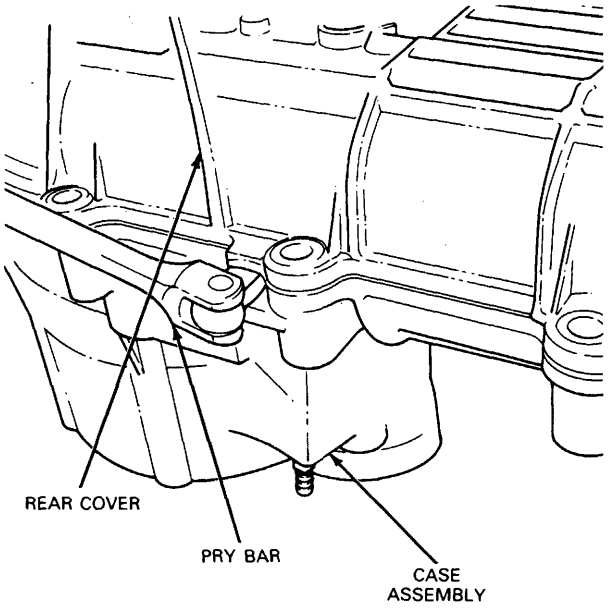
13. Remove the snap ring on the output shaft retaining the upper rear ball bearing using appropriate snap ring pliers.



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REMOVAL AND INSTALLATION (Continued)

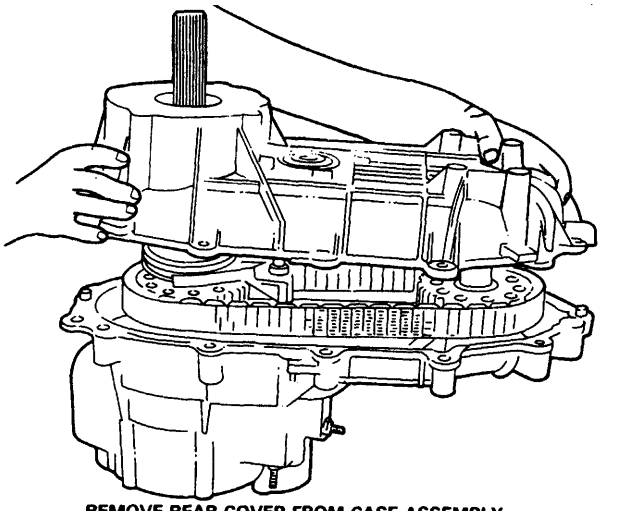
14. Remove the 12 No. 50 Torx head bolts that retain the front case of the rear cover. Insert a 1/2 inch drive breaker bar between the pry bosses and separate the front case from the rear cover. Remove all traces of RTV Gasket Sealant from the mating surfaces of the front case and the rear cover.



REMOVE REAR COVER FROM CASE

C7440-1B

CAUTION: When removing the RTV sealant, use care not to damage the mating surfaces of the magnesium housings.

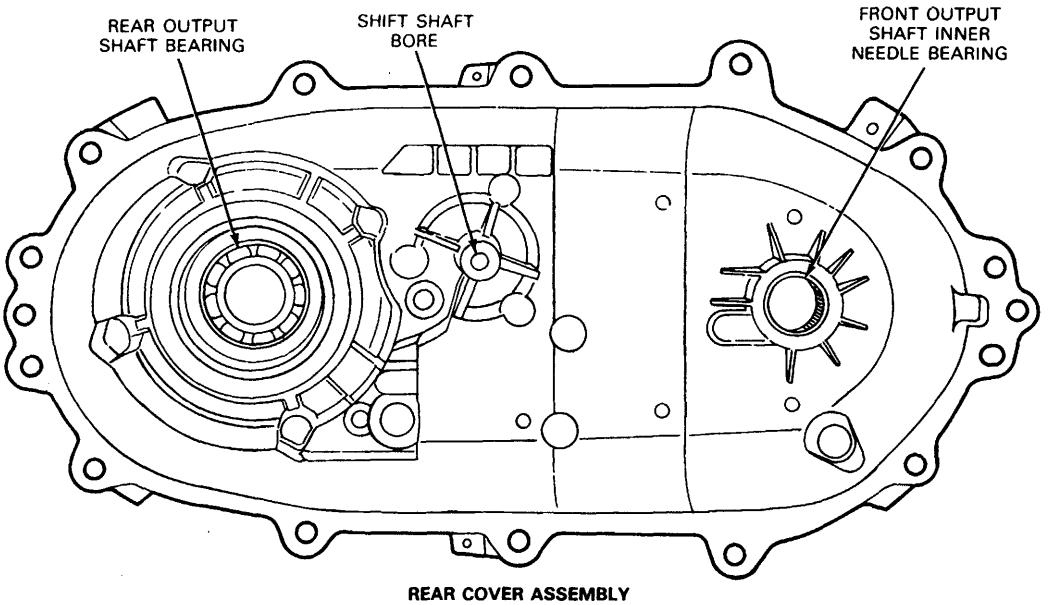


REMOVE REAR COVER FROM CASE ASSEMBLY

C7441-1A

15. Remove the front output shaft caged needle bearing from the rear cover with puller Tool D80L-100-T and impact slide hammer Tool T50T-100-A.

16. Remove the rear output shaft bearing from the inside of the case using a suitable tool.



REAR COVER ASSEMBLY

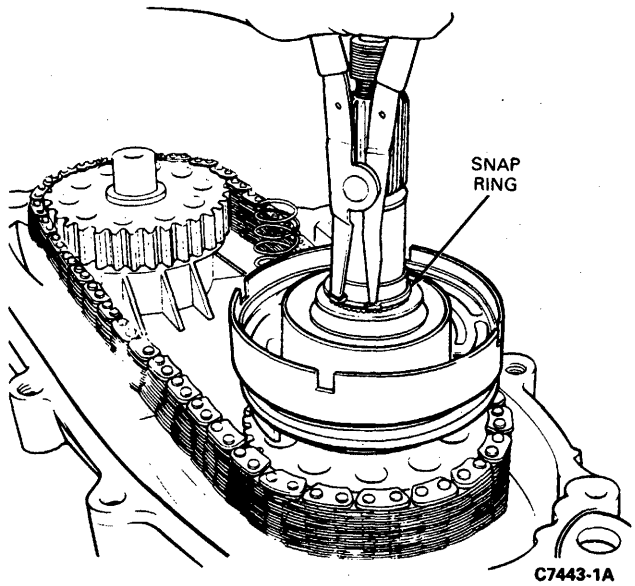
C7442-2A

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REMOVAL AND INSTALLATION (Continued)

17. Remove the nuts retaining the clutch coil assembly to the rear cover. Pull the assembly along with the O-rings and brown wire, from the cover.
18. Remove the shift shaft bushing and seal from the rear cover using appropriate tools.
19. Remove the snap ring on the output shaft securing the clutch housing. Slide the clutch housing and the 4WD hub off of the output shaft.

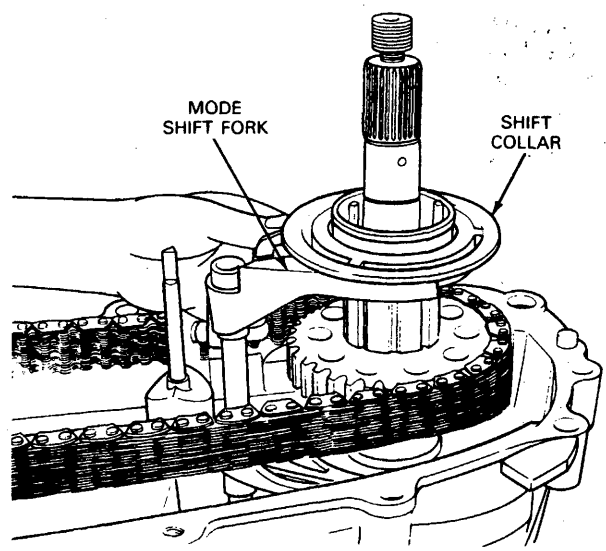
REMOVE CLUTCH HOUSING RETAINING SNAP RING



C7443-1A

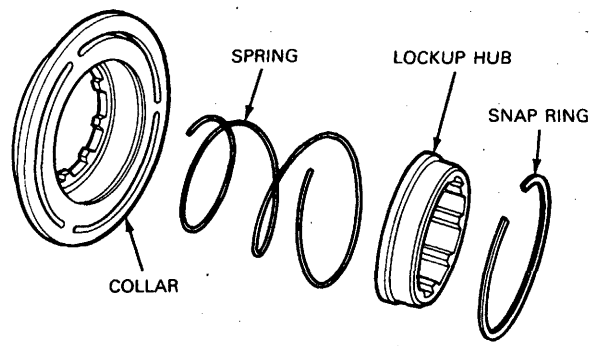
20. Remove the spring from the shift shaft and lift the mode shift fork complete with the shifting collar from the upper rear output shaft sprocket splines.

REMOVE MODE SHIFT FORK AND SHIFT COLLAR



C7444-1A

21. Disassemble the 2W-4W lockup assembly by removing the internal snap ring and pull the lockup hub and spring from the collar.

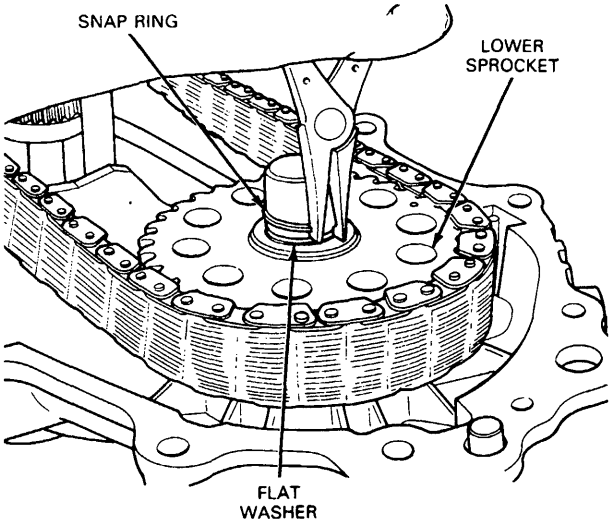


DISASSEMBLY 2W - 4W LOCK-UP ASSEMBLY C7445-1A

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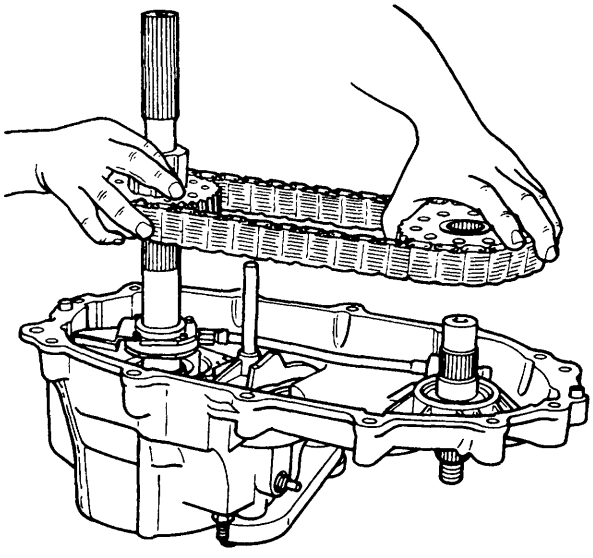
REMOVAL AND INSTALLATION (Continued)

22. Remove the snap ring retaining the lower sprocket to the lower output shaft. Grasp the upper and lower sprocket complete with the chain and lift them at the same time from the upper and lower output shafts.



REMOVE SNAP RING - LOWER SPROCKET

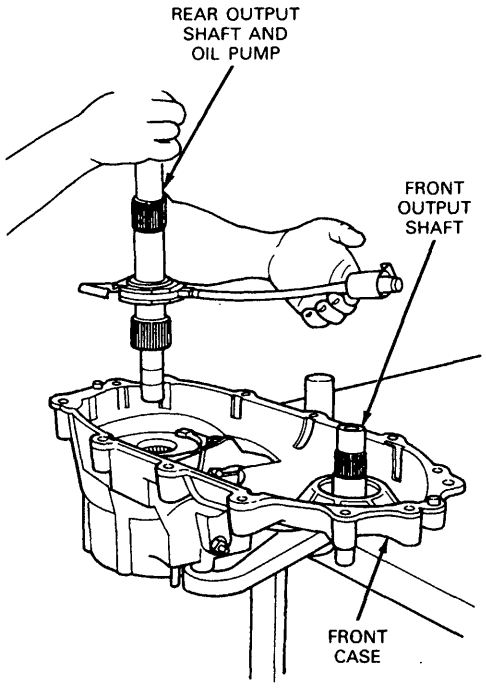
C7446-1A



CHAIN REMOVAL

C7447-1A

23. Remove the shift rail by sliding it straight out from the shift fork.
24. Remove the chip collecting magnet from its slot in the case.
25. Lift out the pump screen and remove the output shaft assembly with the pump assembled on it. If the pump is to be disassembled, remove the four bolts from the pump body. Note the position of the pump front body, pins, spring, rear cover and pump retainer as removed.



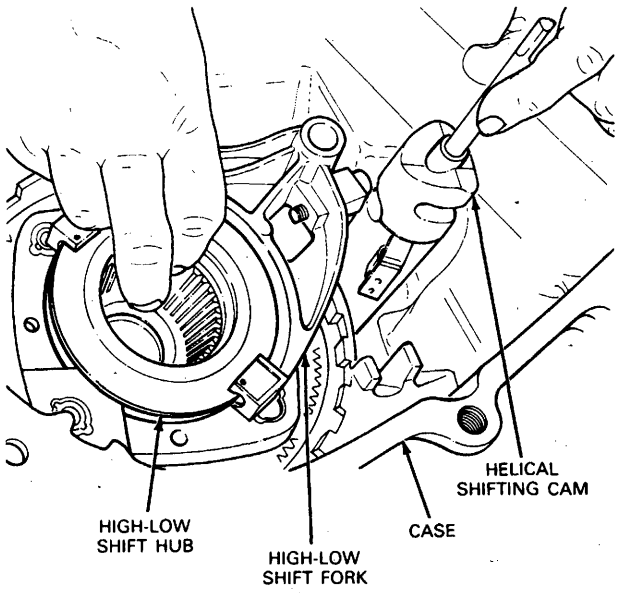
INSTALLATION - REAR OUTPUT SHAFT AND OIL PUMP

C7450-1A

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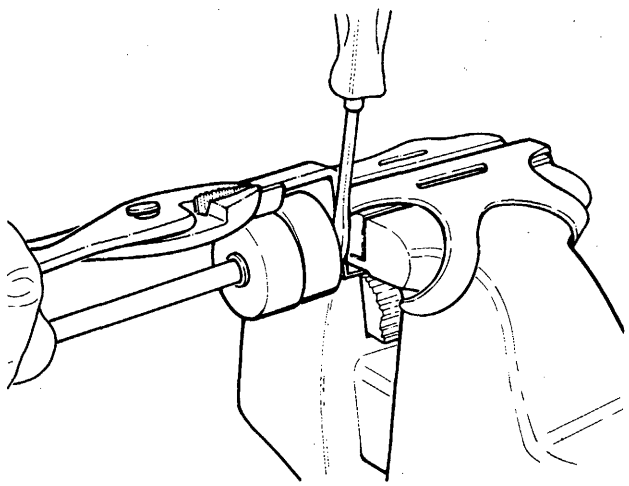
REMOVAL AND INSTALLATION (Continued)

26. Remove the high low shift fork by first rotating it until the roller is free from the cam then sliding out of engagement from the shifting hub.



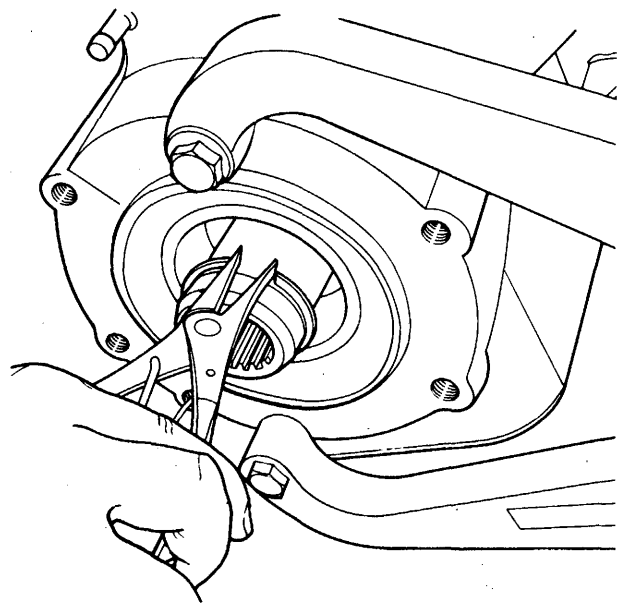
REMOVE HIGH-LOW SHIFT FORK C7448-1A

27. Remove the helical cam assembly from the front case. If it is necessary to disassemble the helical cam assembly care should be exercised as the cam is slid rearward to disengage it from the spring. The spring is energized and can release violently. The spring must be removed from the helical cam and the shaft finger. Do not get your fingers in the way when disengaging the spring. It will rotate to the point that the spring ends will be roughly 180 degrees apart.



DISASSEMBLY OF HELICAL CAM ASSEMBLY C7449-1A

28. Remove the high low shift hub.
29. Remove the front output shaft from the front case.
30. Turn the front case over and remove the front oil seal out of the case using Tool T74P-77248-A and T50L-100-A.
31. Reaching through the front opening of the case with a pair of snap ring pliers, expand the snap ring on the input shaft and carrier assembly allowing it to drop out of the bearing. The carrier assembly, including the input shaft is serviced as an assembly only. If the needle bearing or bushing is to be replaced in the input shaft, drive out both of them through the input shaft splines using appropriate tools.

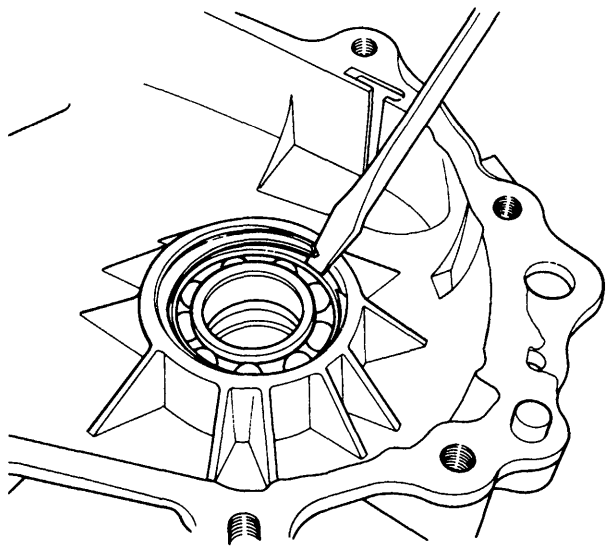


REMOVE INPUT SHAFT BEARING SNAP RING C7851-1A

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REMOVAL AND INSTALLATION (Continued)

32. Remove the ring gear by prying out the internal snap ring and lifting out the gear.
33. Remove the front input shaft bearing by removing the internal snap ring securing the bearing to the case and drive it out from the outside of the case using Tool T73T-7202-B and T80T-4000-W.
34. Remove the front output shaft bearing from case by removing the internal snap ring retaining the output shaft bearing in the case and drive the bearing out of the case from the front of the case using Tool T73T-1202-B and T80T-4000-W.



REMOVE FRONT OUTPUT SHAFT BEARING RETAINING SNAP RING

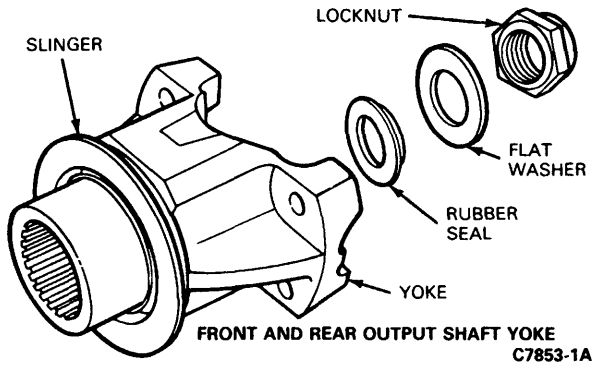
C7852-1A

Assembly

NOTE: Before assembly, lubricate all parts with automatic transmission fluid, DEXRON II, XT2-QDX, or ESP-M2C-138-J or equivalent.

Clean all chips out of the case attaching bolt holes.

1. Install the input shaft bearing and the front output shaft bearing into the case using Tool T80T-4000-P and Tool T80T-4000-W. Install the appropriate internal snap rings retaining the bearings in the case.
2. Install the front output shaft seal into the case until it is fully seated against the case using Tool T86T-7034-CA.
3. Install the front output shaft through the lower bearing of the case. The front output shaft is retained in the case by the front yoke assembly. Install the front yoke assembly onto the output shaft, the rubber seal, the flat washer, and the locknut. Tighten locknut to 203-244 N·m (150-180 ft-lbs).



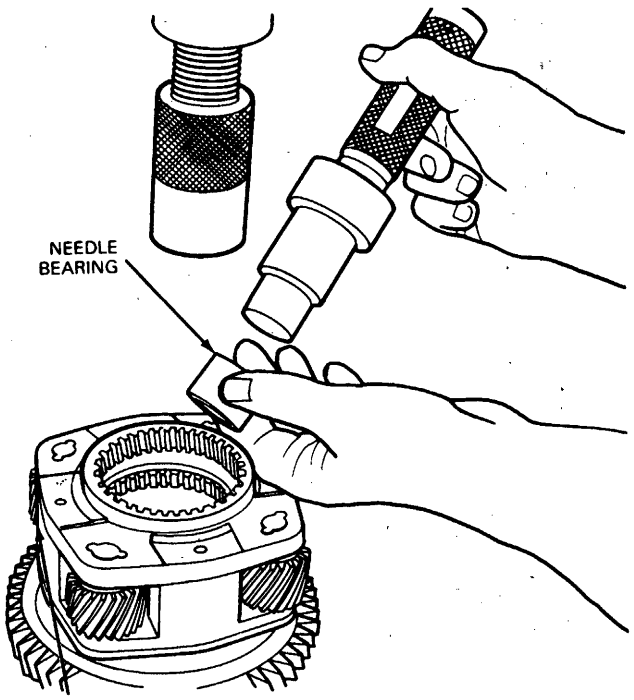
FRONT AND REAR OUTPUT SHAFT YOKE

C7853-1A

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REMOVAL AND INSTALLATION (Continued)

4. Press the needle bearing and bronze bushing into the input shaft with the appropriate tools.



INSTALL INPUT SHAFT NEEDLE BEARING

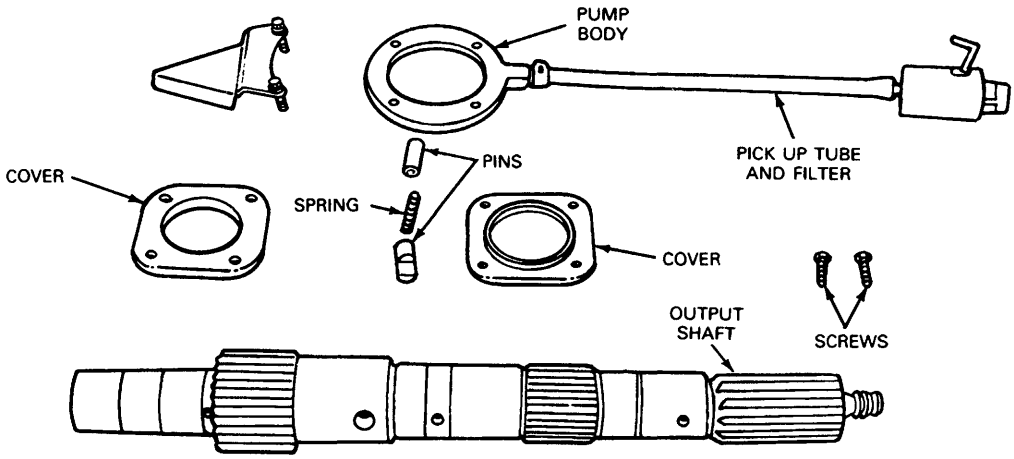
C7854-1A

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REMOVAL AND INSTALLATION (Continued)

5. Install the ring gear into the slots in the case and retain it with the large internal snap ring making sure that it is fully seated.
6. Insert the input shaft and carrier assembly in the case through the input shaft bearing being careful not to damage the gear teeth when aligning them with the ring gear teeth.
7. While supporting the input shaft and carrier assembly in the case, install a new snap ring on the front side of the bearing making sure that it is fully seated in the snap ring groove of the input shaft.
8. Install the upper input shaft oil seal into the case using an appropriate tool until it is fully seated against the case.
9. Reassemble the helical cam assembly by engaging one end of the spring on the shaft finger and the other end of the spring on the cam finger. With the shaft finger secured carefully in a soft jawed vice, turn the cam to wind up the spring until the fingers of the cam and the shaft are in alignment and slide the cam forward to lock the spring in the cocked position.
10. Install the cam assembly in the small hole of the case with the shaft vertical.
11. Reassemble the pump and output shaft as follows: Place the oil pump cover with the word TOP facing the front of the front case. Install the two pins (with the flats facing upwards) with the spring between the pins and place the assembly in the oil pump bore in the output shaft. Place the oil pump body and pick up tube over the shaft and make sure that the pins are riding against the inside of the pump body. Place the oil pump rear cover with the words TOP REAR facing the rear of the case. The word TOP on the front cover and the rear cover should be on the same side. Install the pump retainer with the tabs facing the front of the transfer case. Install the four retaining bolts and rotate the output shaft while tightening the bolts to prevent the pump from binding. Tighten the bolts to 4.-4.5 N·m (36-40 in-lb). Lubricate the assembly with some automatic transmission fluid.

NOTE: The output shaft must turn freely within the oil pump. If binding occurs, loosen the four bolts and retighten again.

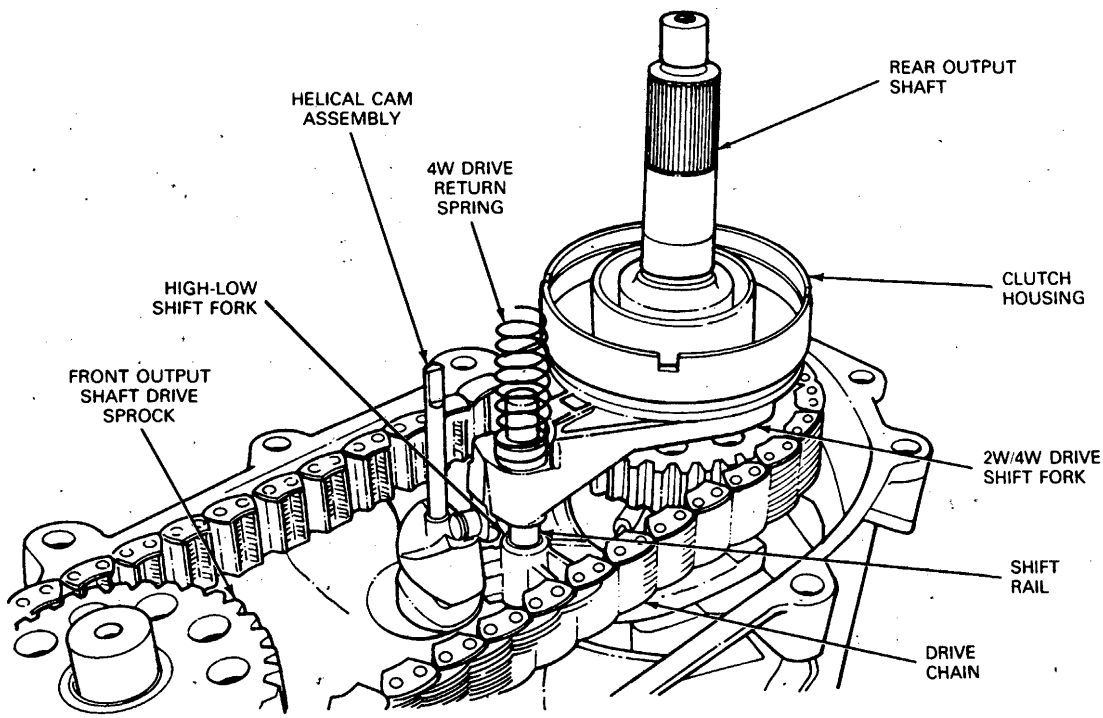


REAR OUTPUT SHAFT AND OIL PUMP ASSEMBLY - EXPLODED VIEW C7855-2B

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REMOVAL AND INSTALLATION (Continued)

12. Install the high low shift hub.
13. Install the high low shift fork by engaging it with the shift hub flange and rotating it until the roller is engaged with the lower groove of the helical cam.
14. Install the shift rail through the high low fork bore and into the rail bore in the case.
15. Install the output shaft and oil pump assembly in the input shaft. Make sure that the external splines of the output shaft engage the internal splines of the high low shift hub. Make sure that the oil pump retainer and oil filter leg are in the groove and notch of the front case. Install the collector magnet in the notch in the front case.
16. Assemble the upper and lower sprockets with the chain and place them as an assembly over the upper and lower output shafts. Install the washer and the snap ring which retain the lower sprocket in position.
17. Assemble the 2W-4W lockup assembly by installing the tapered compression spring in the lockup collar with the small end installed first. Place the lockup hub over the spring and compress the spring while installing the internal snap ring which holds the lockup assembly together.
18. Install the lockup assembly and its shift fork over the external splines of the upper sprocket and the shift rail with the clutch face facing rearward and the long boss of the shift rail facing forward.
19. Assemble the 4WD return spring over the shift rail and against the shift fork.
20. Place the 4WD hub over the external splines of the output shaft.
21. Place the clutch housing over the splines of the output shaft and secure with the appropriate snap ring. Make sure that the snap ring is fully seated in the snap ring groove.



INSTALLATION SHIFT MECHANISM

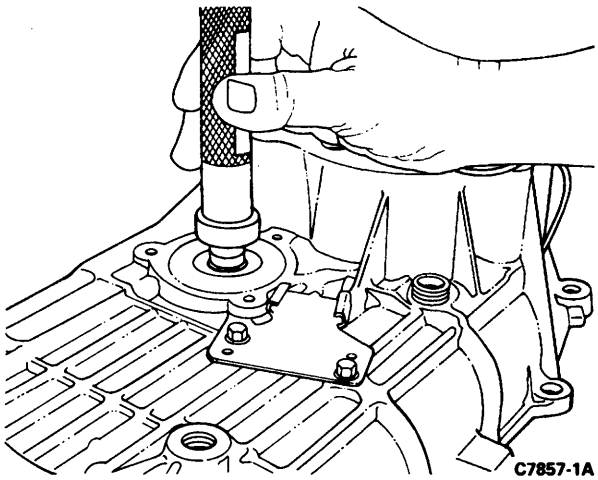
C7856-2A

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REMOVAL AND INSTALLATION (Continued)

22. Press the front output shaft inner needle bearing in the bore in the cover using appropriate tools.
23. Press the rear output shaft bearing into the bore in the cover using appropriate tools.
24. Install a new shift shaft bushing and oil seal into the cover using appropriate tools.

INSTALLATION SHIFT SHAFT BUSHING AND SEAL



25. Install new O-rings (if the old rings are cracked or broken) on the clutch coil assembly studs and grommet. Install the clutch coil assembly from the inside the rear cover until the wire and studs extend through the cover. Install the three nuts and tighten to 8.1-10.8 N·m (6-8 lb-ft).

CAUTION: Do not kink or trap the wire while seating the clutch coil assembly to the cover.

26. Install the rear output shaft oil seal in the bearing retainer using the appropriate tool making sure that it is fully seated.
27. Coat the mating surface of the front case with a bead of non-acidic Silicone Sealant, D6AZ-19562-B.
28. Place the cover on the case making sure that the lower output shaft, shift shaft and shift rail are aligned. Install and tighten the 12 No. 50-Torx® head case to cover bolts to 22-36 lb-ft.
29. Install the rear bearing snap ring on the output shaft making sure that the snap ring is fully seated in the groove of the shaft.
30. Place the speedometer drive gear over the shaft with the slot aligned with the hole for the drive ball. The gear should go completely against the snap ring which retains the output shaft. Place the ball in the hole and pull the speedometer gear over the ball. Snap the retaining clip between the snap ring and the speedometer gear.
31. Install the speed sensor in its bore of the cover.
32. Apply a bead of non acidic Silicone Sealant, D6AZ-19562-B, to the face of the rear bearing retainer.
33. Place the rear bearing retainer onto the rear cover and secure with the 4 Torx® head bolts tightened to 22-36 lb-ft.

CAUTION: Do not trap the brown wire beneath the bearing retainer.

34. Install the rear output shaft yoke assembly onto the rear splines of the output shaft. Install the rubber seal, flat washer and 30mm locknut on the output shaft and tighten to 203-244 N·m (150-180 lb-ft).
35. Using pliers equipped with soft jaws, rotate the triangular shift shaft so it is aligned with the triangular slot in the motor, coat the motor mounting face with non-acidic silicone sealer D6AZ-19562-B. Install the motor along with washer if initially removed from under the support bracket. Tighten with the retaining screws to 8-11 N·m (6-8 lb-ft).

NOTE: If the shaft will not stay in the 4H position, rotate the shaft clockwise to the 2H position. Install the motor and rotate counterclockwise until the motor is aligned with the mounting holes.

36. Install the brown clutch coil wire to the No. 1 center terminal, and, if removed, the speed sensor green wire to the No. 4 connector position and the blue wire to the No. 5 connector position. Install the locking sleeve.
37. Install the wire connector mounting bracket on the rear cover. Install the bolts and tighten to 8-11 N·m (6-8 lb-ft).
38. Install the wire connector to the mounting bracket.
39. Install the drain plug and tighten to 19-30 N·m (14-22 lb-ft).
40. Place a 3/8 inch drive ratchet in the fill plug and remove the plug. Fill the transfer case with 1.9 Liters (2.0 U.S. Quarts) of Motorcraft Dextron®II Automatic Transmission Fluid, XT-2-QDX or equivalent.
41. Install the fill plug and tighten to 19-30 N·m (14-22 lb-ft).
42. Install the transfer case as described in the Removal and Installation portion of this Section.

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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 lb.	Universal
D80L-100-A	Blind Hole Puller Set	Universal
D80L-100-T	Blind Hole Puller	Universal 1-1/4" to 1-1/2"
D80L-100-H	Actuator Pin	Use with Blind Hole Puller
TOOL-1175-AC	Seal Remover	Universal — Use with Impact Slide Hammer
T80T-7127-B	Output Bearing Replacer — Front	Borg Warner #1356 Transfer Case
T80T-7127-C	Output Bearing Replacer — Rear	Borg Warner #1356 Transfer Case
T80T-4000-P	Bearing Installer	Borg Warner #1356 Transfer Case
T74P-77248-A	Oil Seal Remover	Borg Warner #1356 Transfer Case
T61L-7657-B	Oil Seal Installer	Borg Warner #1356 Transfer Case
T86L-7034-AH	Extension Housing Bushing Remover	Borg Warner #1356 Transfer Case
T85T-7034-BH	Extension Housing Bushing Installer	Borg Warner #1356 Transfer Case
T80T-4000-W	Bearing Installer	Borg Warner #1356 Transfer Case
T86T-7034-CH	Oil Seal Installer	Borg Warner #1356 Transfer Case
T73T-1202-B	Bearing Installer	Borg Warner #1356 Transfer Case
T73T-1202-A	Bearing Installer	Borg Warner #1356 Transfer Case

CC7858-2A

TORQUE SPECIFICATIONS — BORG WARNER 1345 TRANSFER CASE

Description	Torque Limits	
	N-m	Ft-Lbs
Case Half Attaching Bolts	48-54	35-40
Four Wheel Drive Indicator Switch	11-16	8-12
Front and Rear Output Yokes to Transfer Case	163-203	120-150
Drain Plug	19-30	14-22
Fill Plug	19-30	14-22
Transfer Case to Transmission Adapter	34-58	25-43
Heat Shield to Transfer Case	54-61	40-45
Skid Plate to Frame	20-27	15-20
Front Driveshaft to Front Output Yoke	11-20	8-15
Rear Driveshaft to Rear Output Yoke — Bolt — Bronco	28-33	20-28
Rear Driveshaft to Rear Output Yoke — Nut — F150-F350 4x4	11-20	8-15

CC7859-2B

ROTUNDA EQUIPMENT

Number	Description
077-00019	Transmission Jack
071-00002	Gasket Compound

CC7406-1B

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SECTION 16-81 Borg-Warner 13-56 Transfer Case—Manual Shift

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ADJUSTMENTS	
Fluid Level Check	16-81-2
DESCRIPTION	16-81-1
DIAGNOSIS AND TESTING	16-81-2
DISASSEMBLY AND ASSEMBLY	
Transfer Case	16-81-6
REMOVAL AND INSTALLATION	
Rear Or Front Output Shaft With Fixed Yokes Oil Seal	16-81-6
REMOVAL AND INSTALLATION (Cont'd.)	
Shift Lever	16-81-4
Transfer Case	16-81-2
SPECIFICATIONS	16-81-21
VEHICLE APPLICATION	16-81-1

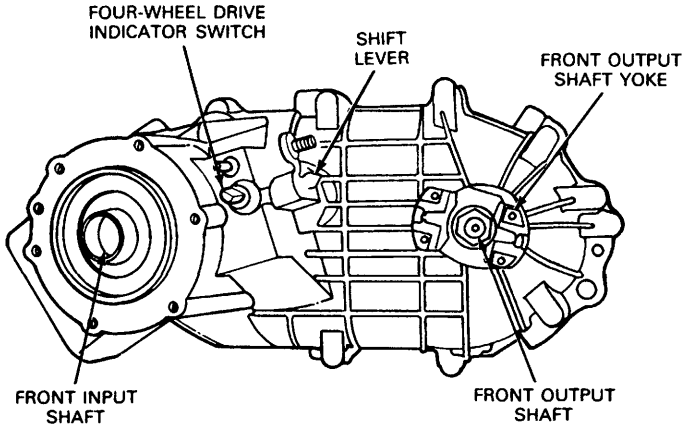
VEHICLE APPLICATION

Applies to Bronco, F-150, F-250, F-350 (4x4) and F-350 (4x4) with PTO.

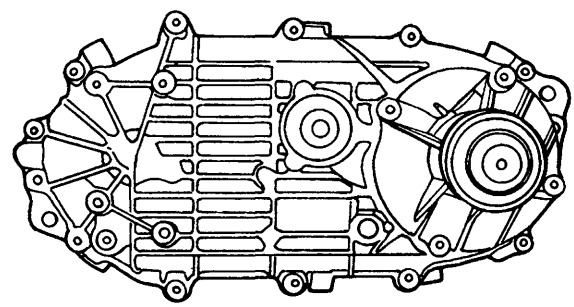
DESCRIPTION

The Borg-Warner 13-56, Manual Shift, part time transfer assembly is a three piece all magnesium design (except for the manual shift unit equipped for a power take off which will have a magnesium case half and an aluminum case half). The unit is lubricated by a positive displacement oil pump that channels oil flow through drilled holes in the rear output shaft. The pump turns with the rear output shaft and allows towing of the vehicle without disconnecting the rear driveshaft.

On the front case half, the front input shaft, front output shaft, four-wheel drive indicator switch, and shift lever are located. On the rear case half, the rear output shaft, output shaft bearing retainer, (or slip yoke-type bearing retainer), and drain and fill plugs are located. Two types of bearing retainers are used: a rear fixed output yoke and a slip yoke type.



FRONT VIEW



BORG-WARNER 13-56 - MANUAL SHIFT TRANSFER CASE - REAR

C7860-2A

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ADJUSTMENTS

Fluid Level Check

Remove the fill plug from the rear case. Fluid level should be just below the fill plug. If the fluid is below the level, fill with automatic transmission fluid, DEXRON®II, Series D (XT-2-QDX) or equivalent to correct level.

DIAGNOSIS AND TESTING

Refer to Section 16-10, General Manual Transmission Service, for diagnosis and testing procedures.

REMOVAL AND INSTALLATION

Transfer Case

Removal

1. Raise vehicle on a hoist.
2. Place a drain pan under transfer case, remove drain plug and drain fluid from transfer case.
3. Disconnect four wheel drive indicator switch wire connector at transfer case.
4. Disconnect front driveshaft from front output yoke.
5. Disconnect rear driveshaft from rear output shaft yoke.
6. Disconnect speedometer cable assembly from transfer case rear bearing retainer.
7. Disconnect vent hose from transfer case.

CAUTION: Catalytic converter is located beside heat shield. Be careful when working around catalytic converter because of the extremely high temperatures generated by the converter.

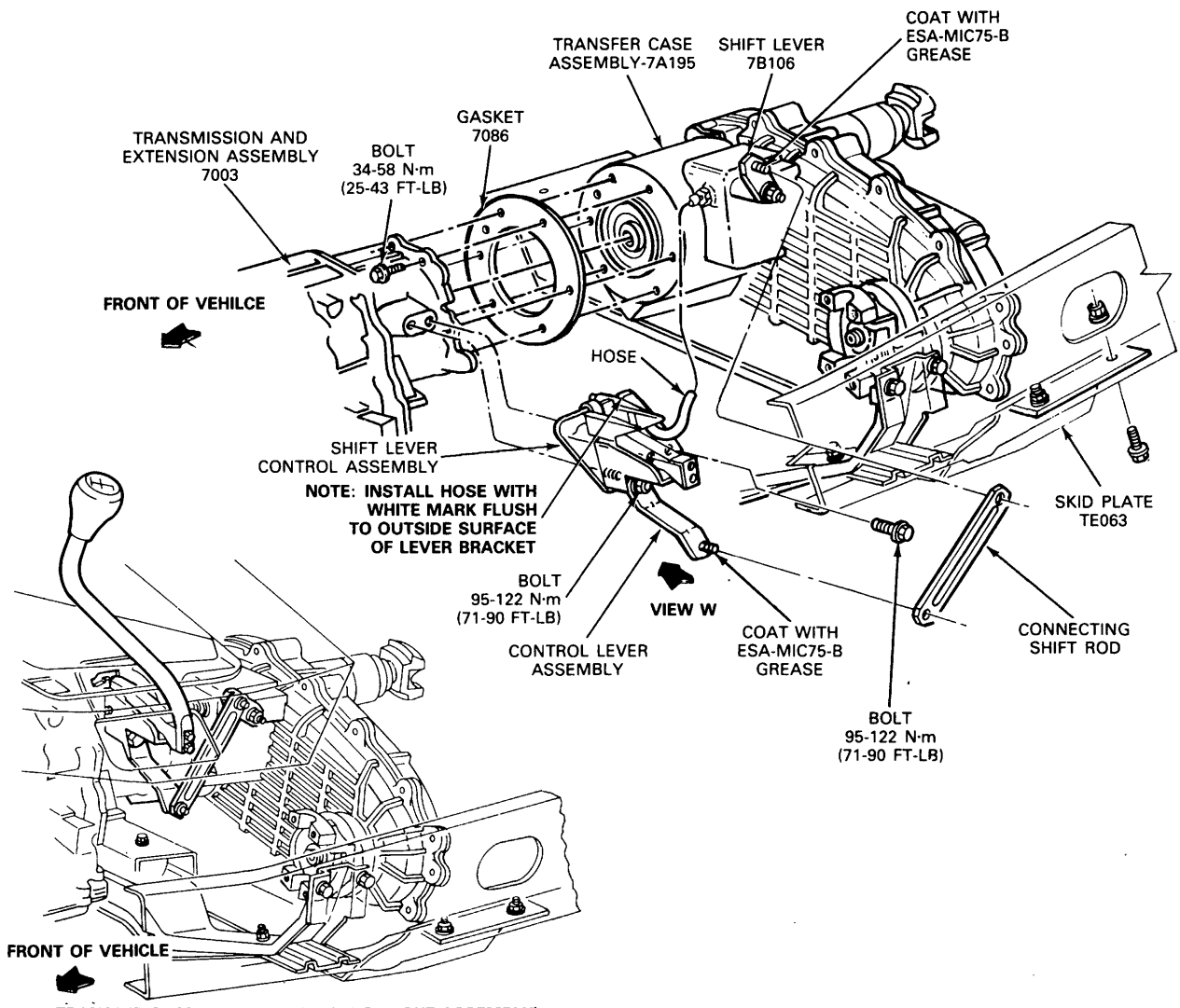
8. Support transfer case with a transmission jack Rotunda Number 077-00019 or equivalent.
9. Remove the bolts retaining transfer case to transmission adapter.
10. Slide transfer case rearward off of the transmission output shaft and lower transfer case from vehicle and remove gasket between transfer case and adapter.

Installation

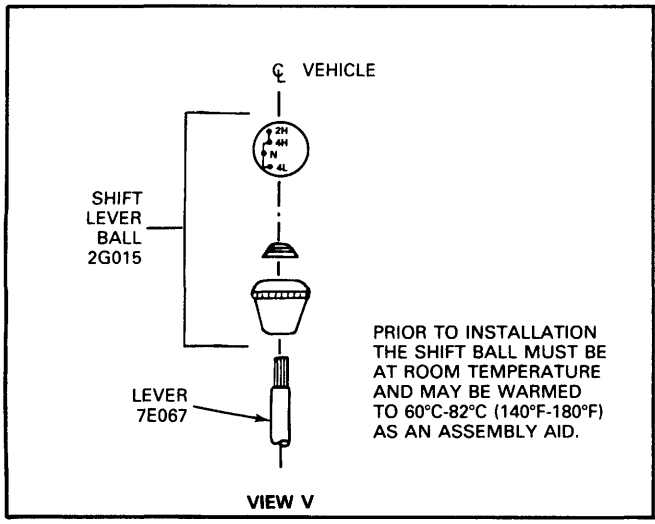
1. Place a new gasket between transfer case and adapter.
2. Raise transfer case with transmission jack so transmission output shaft aligns with splined transfer case input shaft. Slide transfer case forward on to transmission output shaft and onto the dowel pin. Install bolts retaining transfer case to adapter. Tighten bolts in the torque sequence shown in View V. Tighten the bolts to 34-58 N·m (25-43 ft-lb).
3. Remove transmission jack from transfer case.
4. Connect rear driveshaft to rear output shaft yoke. For Bronco, tighten bolts to 28-33 N·m (20-25 ft-lbs), for F150—F350 4x4, tighten nut to 11-20 N·m (8-15 ft-lbs).
5. Attach shift rod between transfer case shift lever and lower shift linkage assembly.
6. Connect speedometer cable assembly to transfer case.
7. Connect four wheel drive indicator switch wire connector at transfer case.
8. Connect front driveshaft to front output yoke. Tighten nut to 11-20 N·m (8-15 ft-lbs).
9. Install skid plate to frame. Tighten nuts and bolts to specification.
10. Install drain plug and tighten to 9-18 N·m (6-14 ft-lbs). Remove filler plug and install automatic transmission fluid, DEXRON®II, XT-2-QDX (ESP-M2C138-CJ) or equivalent to the bottom of the fill plug hole. Install filler plug and tighten to 21-33 N·m (15-25 ft-lbs).
11. Lower vehicle.

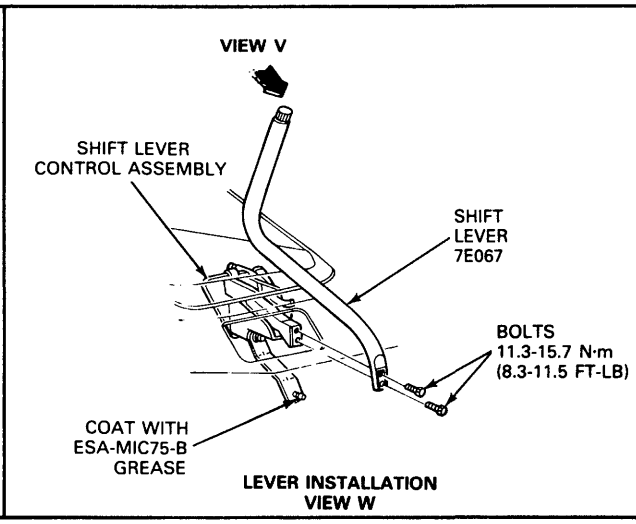
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REMOVAL AND INSTALLATION (Continued)



TRANSFER CASE INSTALLATION (FIXED YOKE ASSEMBLY)





C7861-2C

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REMOVAL AND INSTALLATION (Continued)

Shift Lever

NOTE: Remove the shift ball only if the shift ball, boot or lever is to be replaced. If either the ball, boot or lever is not being replaced, remove the ball, boot and lever as an assembly.

Removal

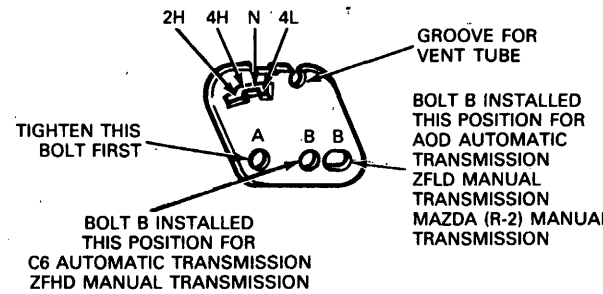
1. Remove the plastic insert from the shift ball. Warm the ball with a heat gun to 60°-82°C (140°-180°F). Knock the ball off the lever with a block of wood and a hammer, taking care not to damage the finish on the shift lever.
2. Remove the rubber boot and floor pan cover.
3. Disconnect the vent hose from the shift lever control assembly detent plate.
4. Disconnect the transfer case shift lever assembly from the transfer case shift lever and connecting rod.
5. Remove the two bolts retaining the shift lever assembly to transmission extension housing. Remove the shift lever and bushings.

Installation

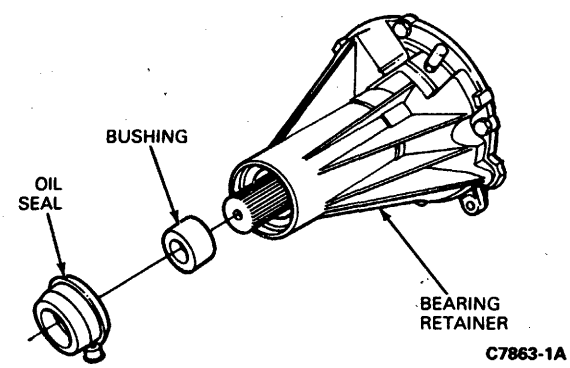
1. Prior to installing the shifter assembly, move the transfer case lever to the "4L" position (lever down as shown by the arrow).
2. Install the shifter assembly with bolts "A" and "B" finger tight, and move the detent plate rearward until the bottom corner of the neutral lug just contacts the forward right edge of the shift lever.
3. Hold the cam plate in this position and tighten bolt "A" first to 95-122 N·m (71-90 ft-lbs) as shown. Then tighten bolt "B" to 95-122 N·m (71-90 ft-lbs).
4. Move the transfer case in-cab shift lever to all positions to check for positive engagement. There should be clearance between the shift lever and cam plate in the "2H" front, "4H" rear and "4L" shift positions.
5. Attach the shift lever to the control lever and tighten to 11.3-15.7 N·m (8.3-11.5 ft-lb).
6. Install the vent assembly so the white marking on the hose is in position in the notch in the detent plate.
7. Install the rubber boot and floor pan cover.
8. Warm the ball with a heat gun to 60°-87°C (140°-180°F) and tap the ball on the lever with a 7/16 socket and a mallet. Install the plastic shift pattern insert.

NOTE: The end of the shift ball should be to the end of the knurl on the upper portion of the shift lever.

9. Check the transfer case for proper shifting and operation.



Rear Output Shaft Bearing Retainer Oil Seal and Bushing—Slip Spline Type

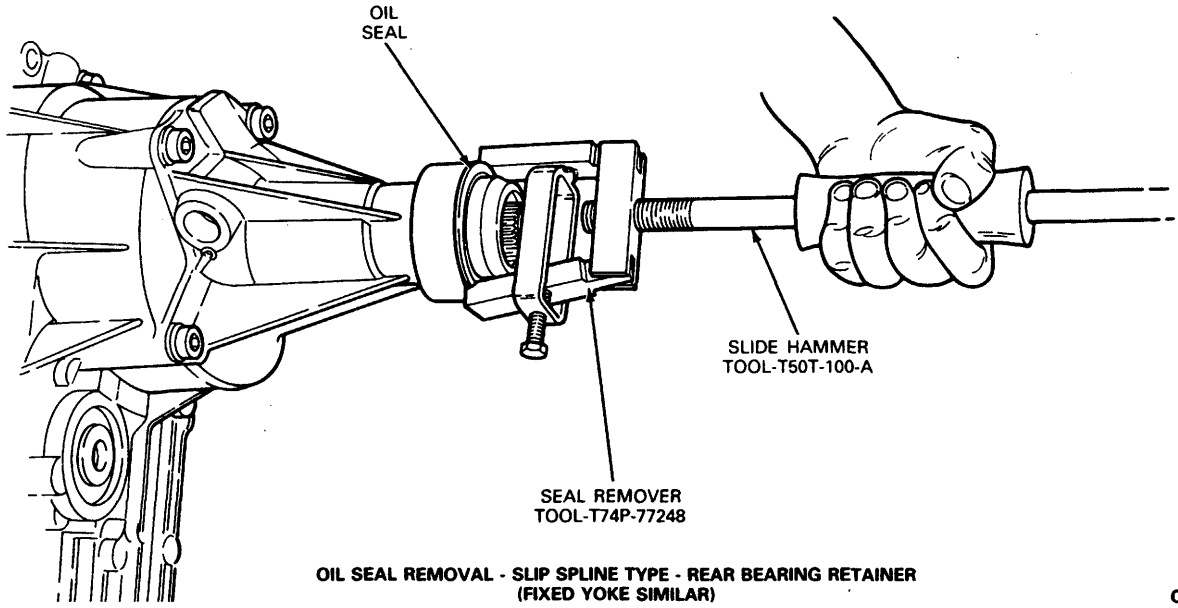


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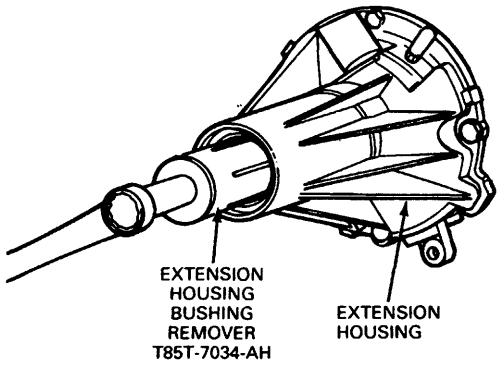
REMOVAL AND INSTALLATION (Continued)

Removal

1. Raise the vehicle on a hoist. Index the driveshaft to the transfer case and to the rear axle.
2. Disconnect the driveshaft at the rear axle flange and remove the driveshaft.
3. With a screwdriver, pry the oil seal from the bearing retainer. The seal may also be removed using Slide Hammer, T50T-100-A and Seal Remover, T74P-77248-A. Discard the oil seal.
4. Remove the bushing from the retainer with Extension Housing Bushing Remover, T85T-7034-AH. Discard the bushing.



OIL SEAL REMOVAL - SLIP SPLINE TYPE - REAR BEARING RETAINER (FIXED YOKE SIMILAR) **C7864-2A**



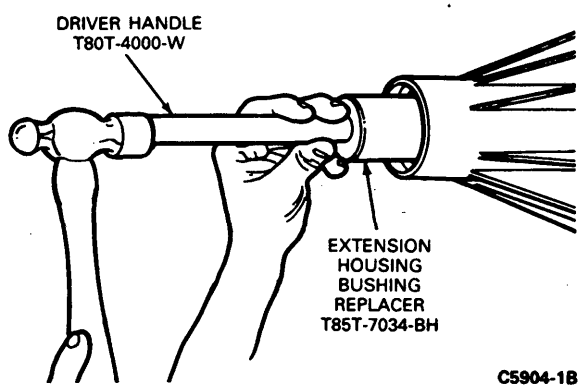
C7865-1A

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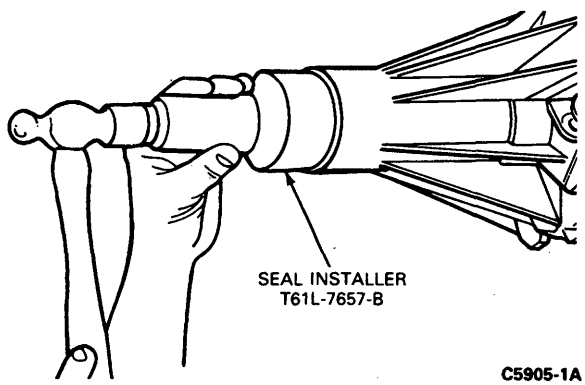
REMOVAL AND INSTALLATION (Continued)

Installation

1. Drive the bushing into the place in the retainer with Extension Housing Bushing Replacer, T85T-7034-BH and Driver Handle, T80T-4000-W.
2. Position the seal in the retainer so the notch on the seal faces upward and the drain hole in the rubber dust boot faces downward. Drive the seal in the retainer using Seal Installer, T61L-7657-B.
3. Position the driveshaft so it aligns with the index marks on the transfer case and rear axle. Install the driveshaft in the slip splines in the transfer case retainer. Install the driveshaft to the rear axle flange. Tighten the fasteners to the specified torque listed in the appropriate driveshaft Section 15-60.



C5904-1B



C5905-1A

Rear Or Front Output Shaft With Fixed Yokes Oil Seal

Removal

1. Raise the vehicle on a hoist.
2. Remove the rear or front driveshaft from the transfer case output shaft yoke. Wire the driveshaft(s) out of the way.
3. Remove the output shaft yoke by removing the 30mm nut, steel washer and rubber seal from the rear or front output shaft and remove the yokes.
4. Remove the oil seal from the rear output housing bore with Seal Remover, Tool-T77248-A, and Impact Slide Hammer, T50T-100-A.
5. Remove the oil seal slinger from each yoke.

Installation

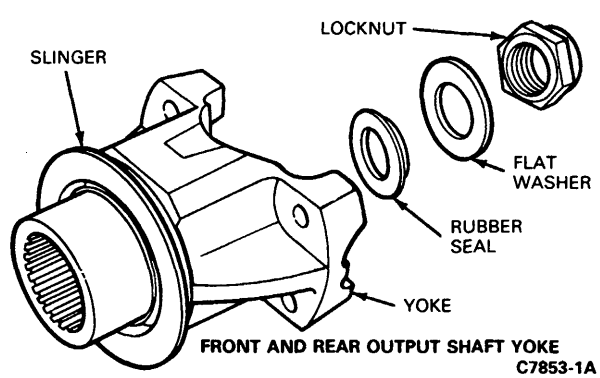
1. Make sure the output housing bore and face are free from nicks and burrs. Coat the oil seal with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C175-B) or automatic transmission fluid. Position the oil seal into the front or rear output housing bore, making sure that the oil seal is not cocked in the bore. Drive the oil seal into the bore with Output Shaft Seal Installer, T86T-7034-CH.
2. Install new oil seal slinger on each yoke. Do not scratch seal surface on yokes.
3. Install the yoke, rubber seal, steel washer and locknut on the front or rear output shafts. Tighten the nut to 203-244 N·m (150-180 ft-lb).
4. Connect the front or rear driveshaft to the transfer case output shaft yoke. Tighten the bolts to 83-118 N·m (61-87 ft-lb).
5. Lower the vehicle from the hoist.

DISASSEMBLY AND ASSEMBLY

Transfer Case

Disassembly

1. Remove transfer case from vehicle as described in this Section.
2. Drain fluid from case by removing filler plug from case half. Remove the speedometer cover. Replace the filler plug.
3. Remove both output shaft yoke nuts, washers, and rubber seals and remove the rear output yoke and the front output yoke from the transfer case.



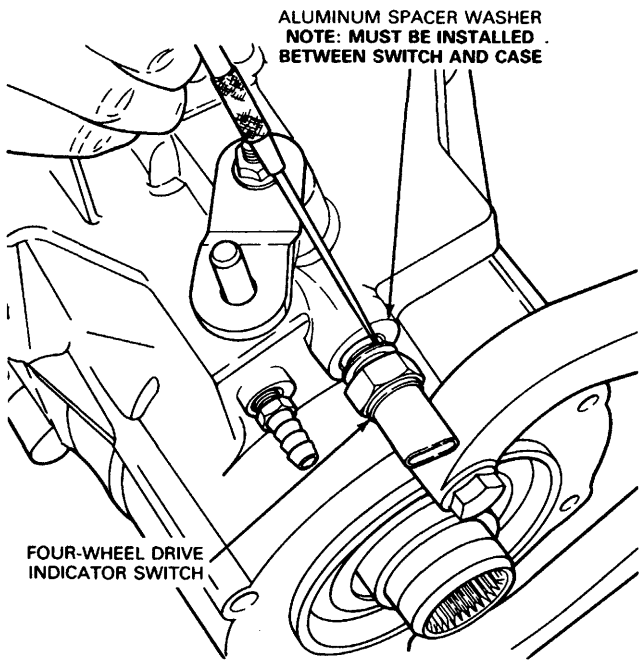
FRONT AND REAR OUTPUT SHAFT YOKE
C7853-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

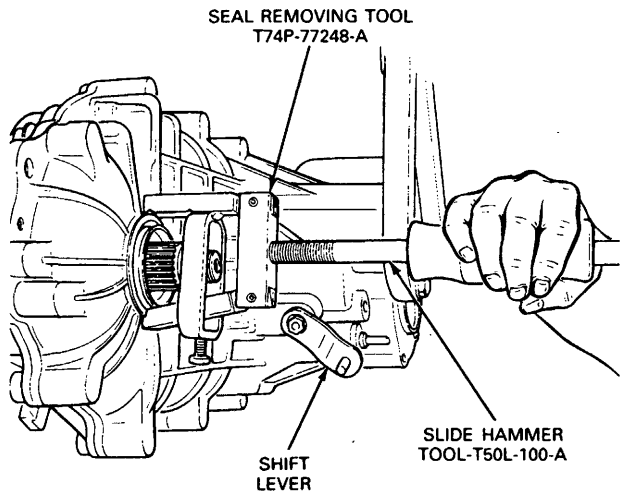
4. Remove the four-wheel drive indicator switch and aluminum washer from the transfer case. Do not lose this washer as it controls the operation of this switch.

REMOVAL FOUR-WHEEL DRIVE INDICATOR SWITCH



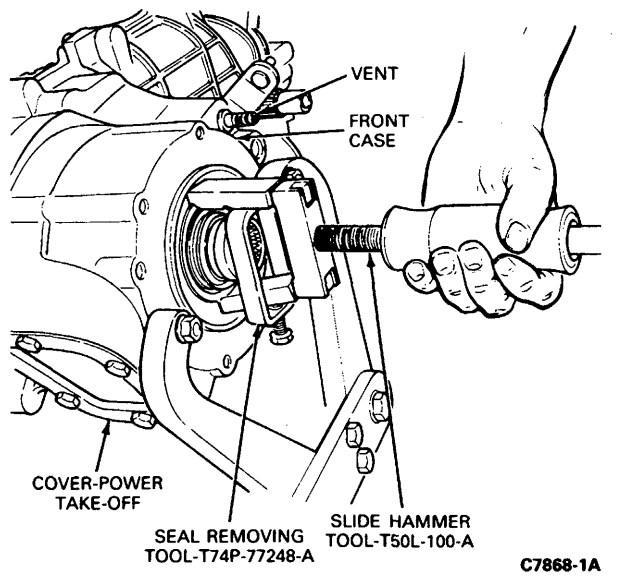
C7866-1A

5. Remove the front and rear output shaft yoke seals using Tool T74P-77248-A and T50L-100-A.
6. Remove the input shaft seals using same tools.



REMOVE FRONT OUTPUT SHAFT SEAL C7867-1A

REMOVE FRONT INPUT SHAFT SEAL



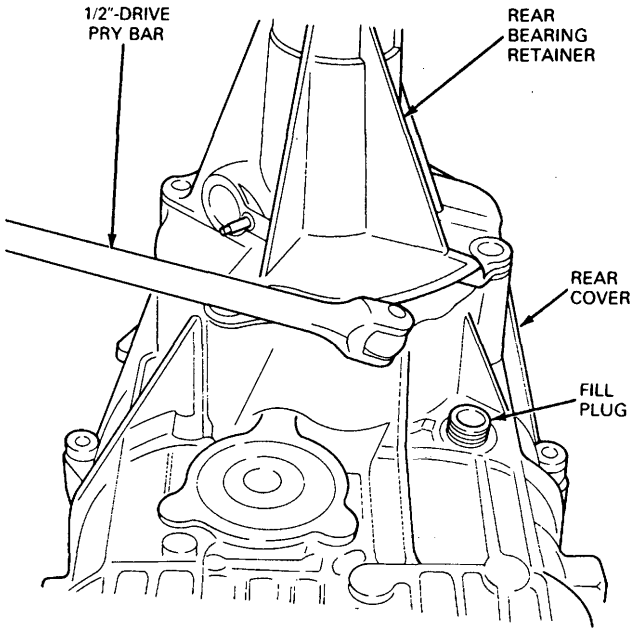
C7868-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

7. Remove the 4 No. 50 Torx® head bolts securing the rear bearing retainer to the cover. Pry the rear bearing retainer from the cover using a 1/2 inch drive breaker bar between the pry bosses and separate and remove the bearing retainer from the cover. Remove all traces of RTV Gasket Sealant from the mating surfaces of the cover and the bearing retainer.

CAUTION: When removing the RTV sealant, use care not to damage the mating surfaces of the magnesium cases.

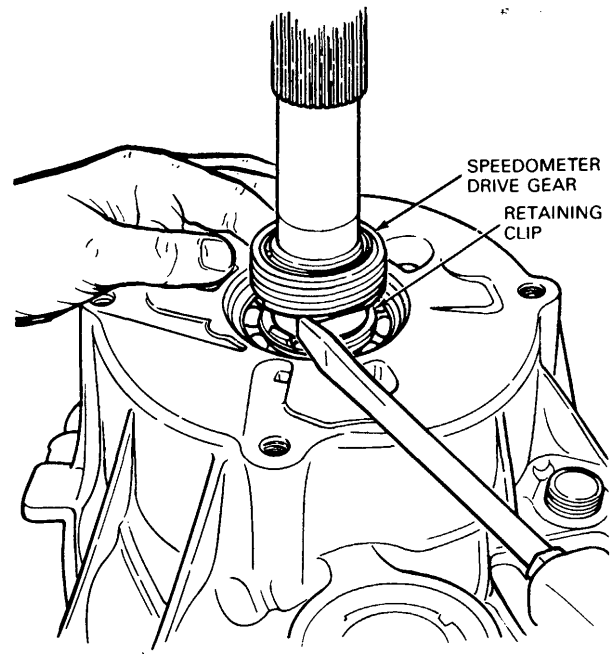


REMOVE REAR BEARING RETAINER

C7869-1A

8. Lift the rear output shaft and using a screwdriver, remove the speedometer gear retaining clip.
9. Slide the speedometer gear forward and remove the ball with a small magnet. The speedometer gear can now be removed off of the rear of the output shaft.
10. Remove the snap ring on the output shaft retaining the upper rear ball bearing using a suitable tool.

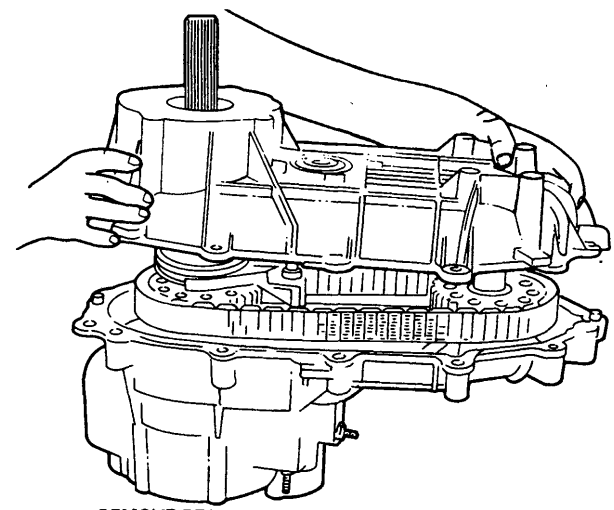
SPEEDOMETER DRIVE GEAR



C7870-1A

11. Remove the 12 No. 50 Torx® head bolts that retain the front case to the rear cover. Insert a 1/2 inch drive breaker bar between the pry bosses and separate. Lift the front case from the rear cover. Remove all traces of RTV Gasket Sealant from the mating surfaces of the front case and the rear cover.

CAUTION: When removing the RTV sealant, use care not to damage the mating surfaces of the magnesium housings.



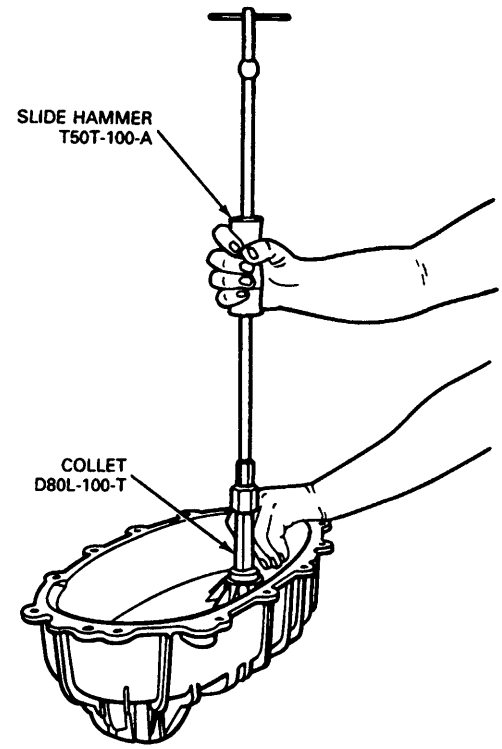
REMOVE REAR COVER FROM CASE ASSEMBLY

C7441-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

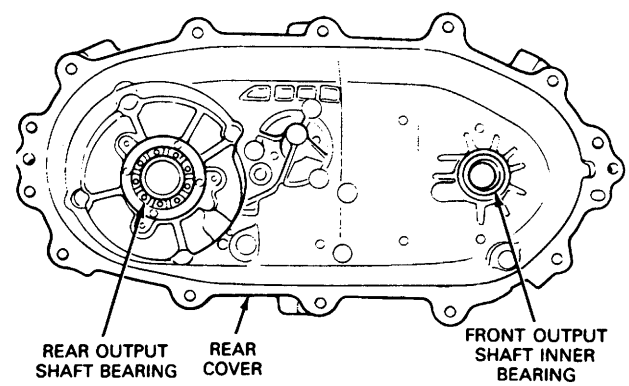
12. Remove front output shaft inner needle bearing from the rear cover with T50T-100-A, Slide Hammer, and D80L-100-T, Collet from D80L-100-A, Blind Hole Puller Set.



C8082-1A

13. Drive out the rear output shaft bearing from the inside of the case using appropriate tools.

REAR COVER - REAR OUTPUT SHAFT BEARING/
FRONT OUTPUT SHAFT INNER BEARING

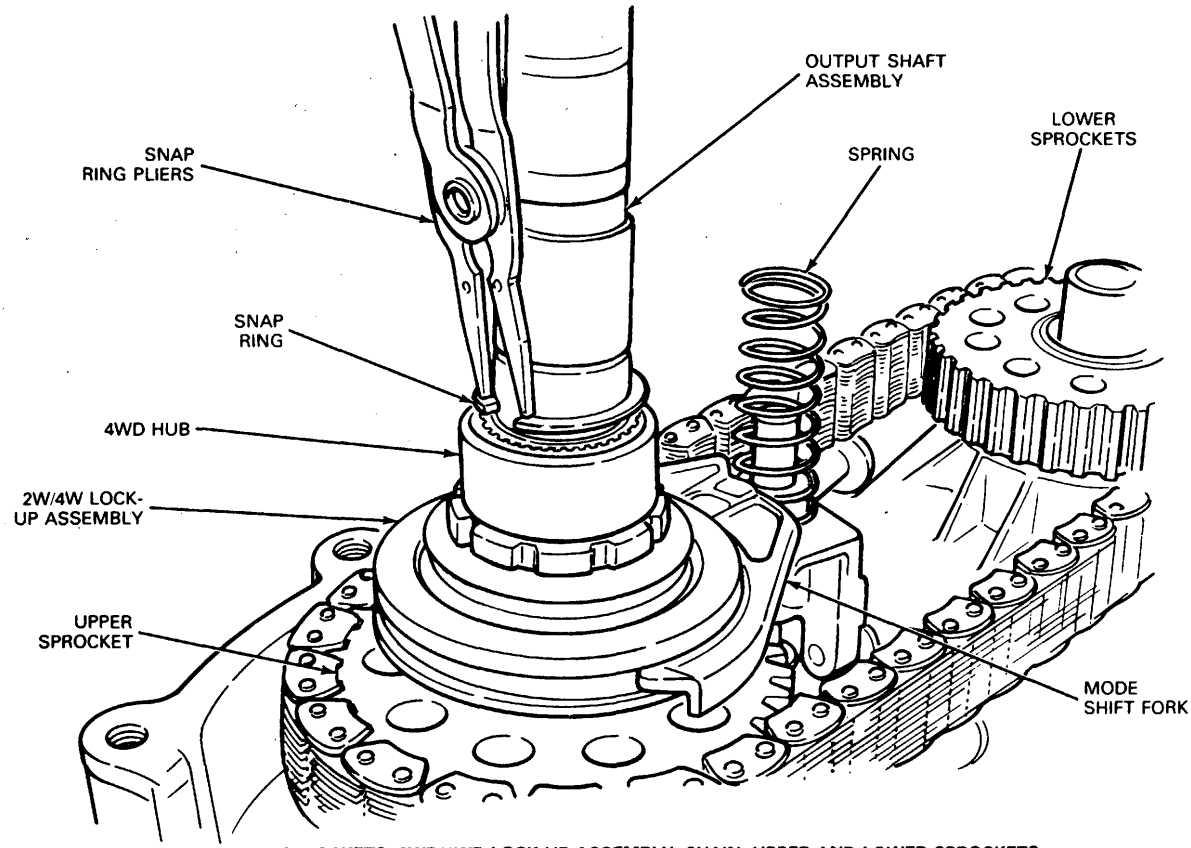


C7871-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

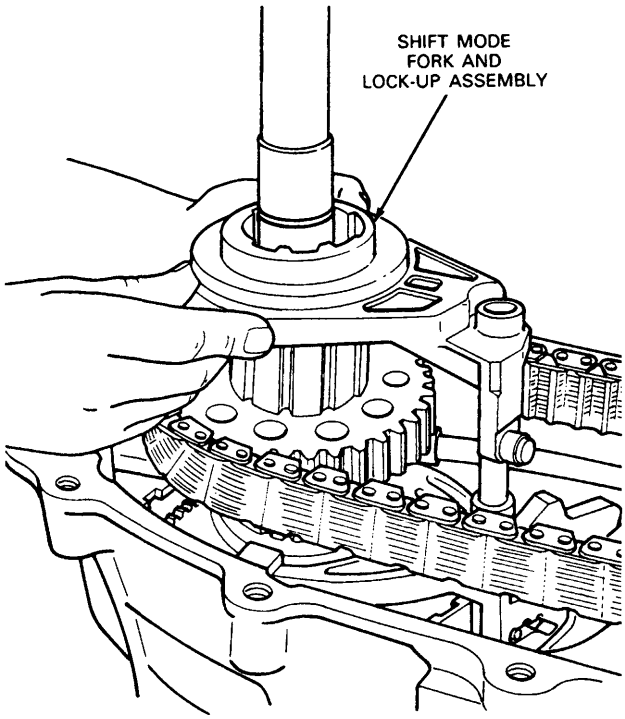
14. Remove the snap ring on the output shaft securing the clutch hub. Slide the 4WD hub off of the output shaft.
15. Remove the spring from the shift rail and lift the mode shift fork complete with the shifting collar from the upper sprocket spline.



2WD/4WD SPROCKETS, 2WD/4WD LOCK-UP ASSEMBLY, CHAIN, UPPER AND LOWER SPROCKETS C7872-2A

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DISASSEMBLY AND ASSEMBLY (Continued)

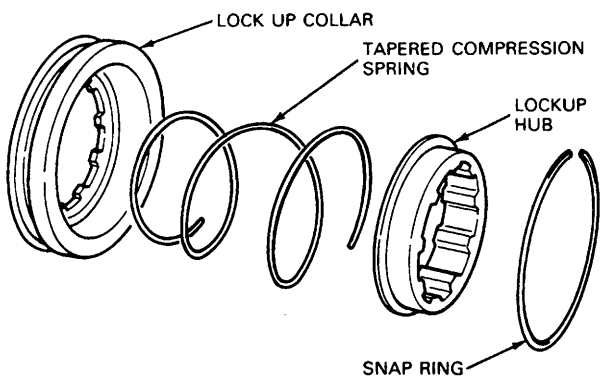


REMOVE SHIFT MODE FORK AND LOCK-UP ASSEMBLY

C7873-1A

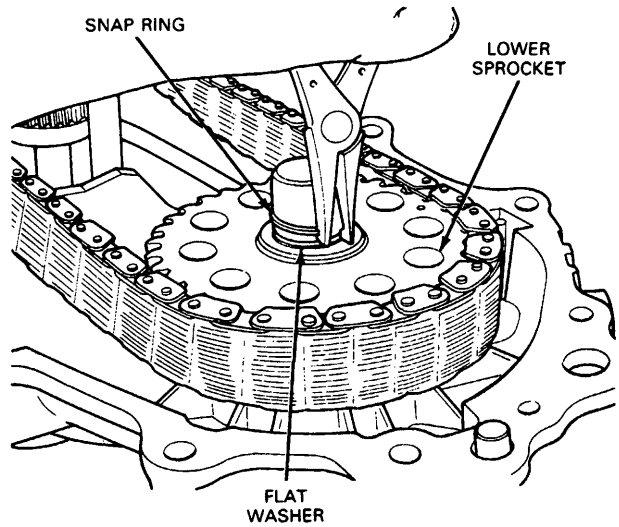
16. Disassemble the 2W-4W lockup assembly by removing the internal snap ring and pull the lockup hub and spring from the collar.

2W/4W LOCK UP COLLAR ASSEMBLY



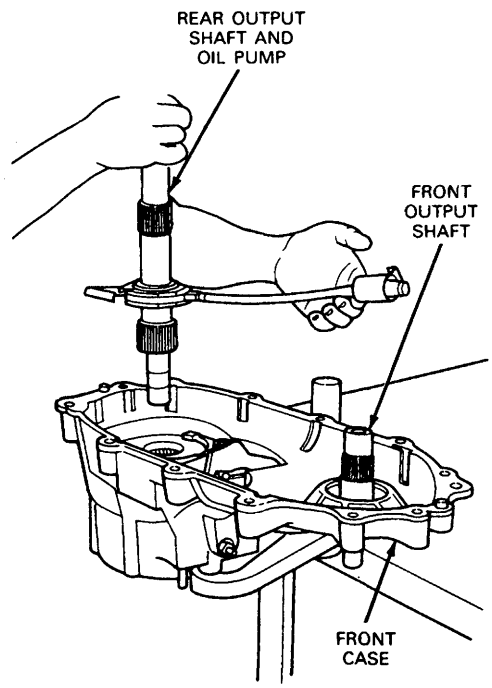
C7874-1A

17. Remove the snap ring retaining the lower sprocket to the lower output shaft. Grasp the upper and lower sprocket complete with the chain and lift them at the same time from the upper and lower output shafts.



REMOVE SNAP RING - LOWER SPROCKET

C7446-1A



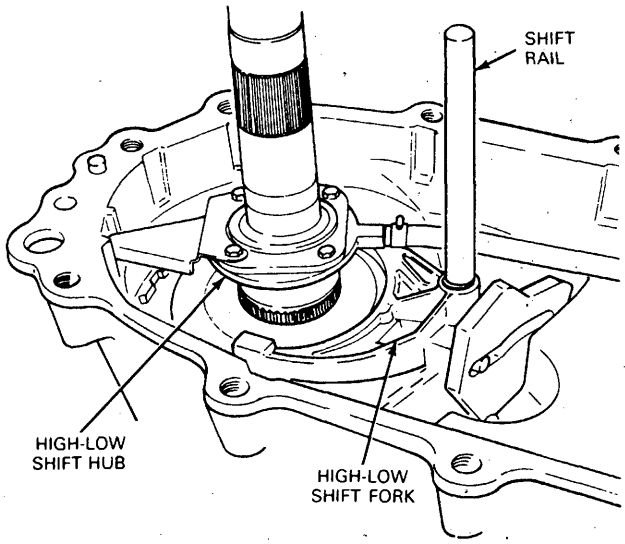
INSTALLATION - REAR OUTPUT SHAFT AND OIL PUMP

C7450-1A

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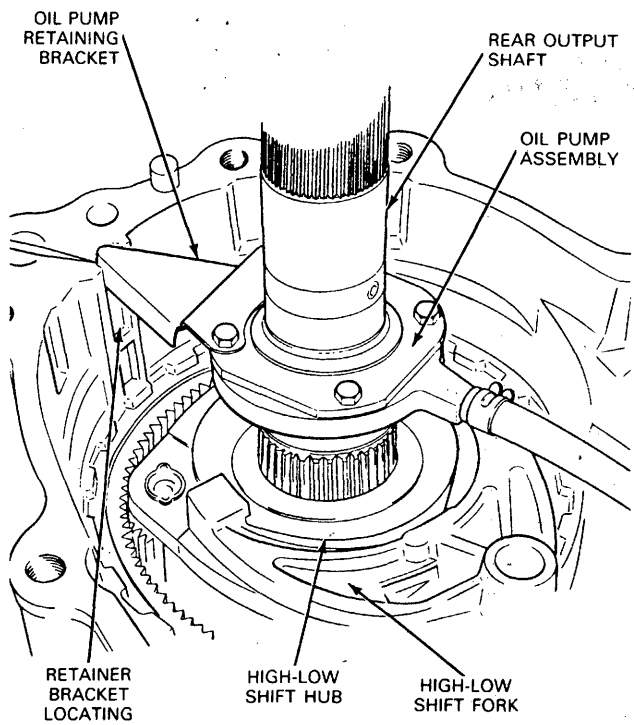
DISASSEMBLY AND ASSEMBLY (Continued)

18. Remove the shift rail by sliding it straight out from the shift fork.
19. Remove the high low shift fork by first rotating it until the roller is free from the cam then sliding out of engagement from the shifting hub.
20. Remove the chip collecting magnet from its slot in the case.



HIGH-LOW SHIFT FORK AND SHIFT RAIL C7875-1A

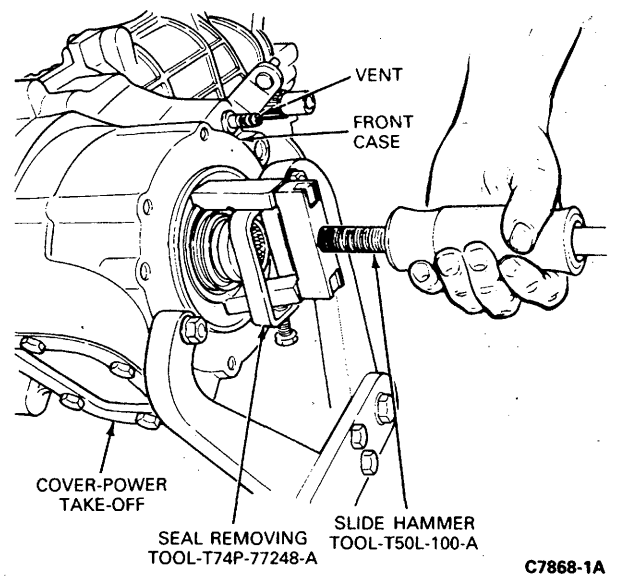
21. Lift out the pump screen and remove the output shaft assembly with the pump assembled on it. If the pump is to be disassembled, remove the four bolts from the pump body. Note the position of the pump front body, pins, spring, rear cover and pump retainer as removed.
22. Remove the high low shift hub.



REMOVE OUTPUT SHAFT ASSEMBLY WITH OIL PUMP ASSEMBLY C7876-1A

23. Remove the front output shaft from the case.
24. Turn the front case over and remove the front oil seal from the case using Tool T74P-77248-A and T50T-100-A.

REMOVE FRONT INPUT SHAFT SEAL

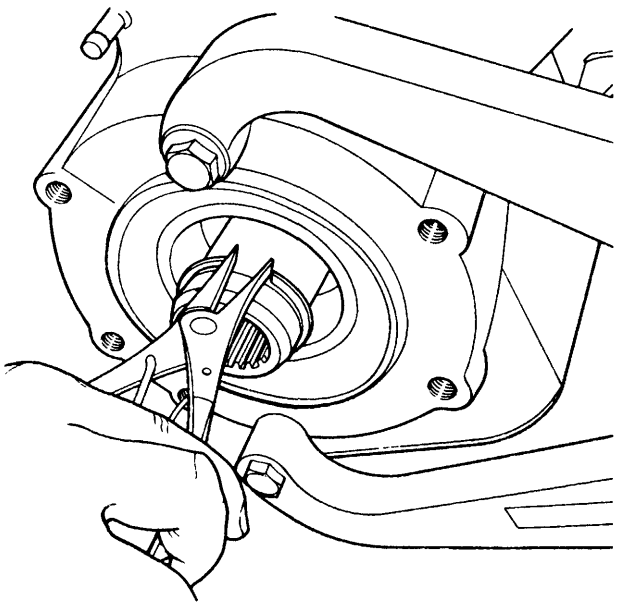


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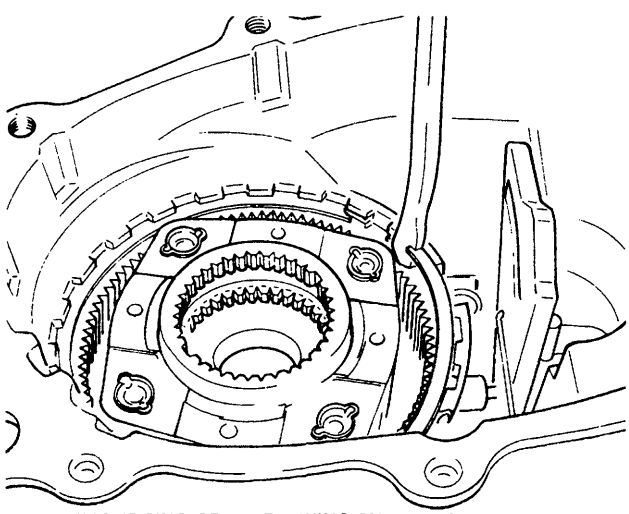
DISASSEMBLY AND ASSEMBLY (Continued)

25. Reaching through the front opening with a pair of snap ring pliers, expand the snap ring on the input shaft allowing it to drop out of the bearing. The carrier assembly, including the input shaft is serviced as an assembly only. If the bearing or bushing is to be replaced, drive out both of them through the input spline using suitable tools.



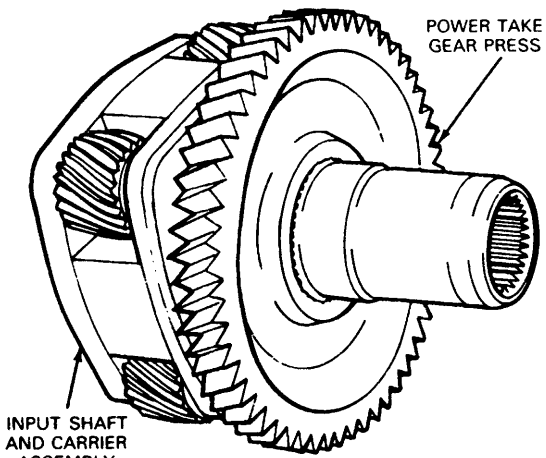
REMOVE INPUT SHAFT BEARING SNAP RING C7851-1A

26. Remove the ring gear by prying out the internal snap ring and lift out the gear.



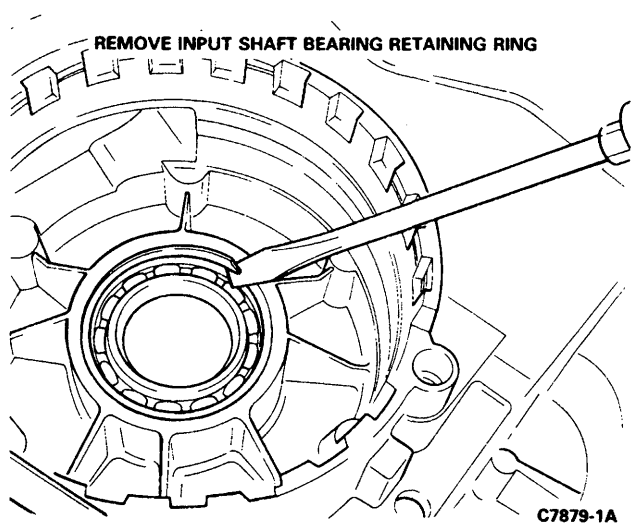
REMOVE RING GEAR RETAINING SNAP RING C7877-1A

27. Remove the PTO drive gear from the input shaft carrier assembly, if equipped, using appropriate tools.



REMOVE INPUT SHAFT CARRIER WITH POWER TAKE OFF GEAR C7878-1A

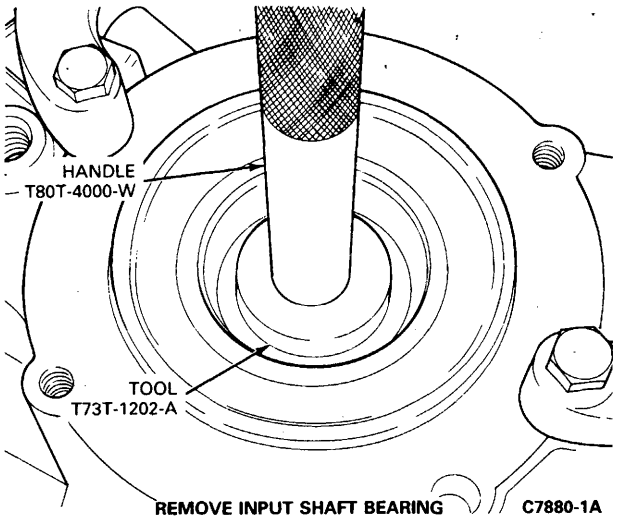
28. Remove the internal snap ring securing the input shaft bearing to the case and drive it out from the outside of the case using Tool T73T-1202-A and T80T-4000-W.



C7879-1A

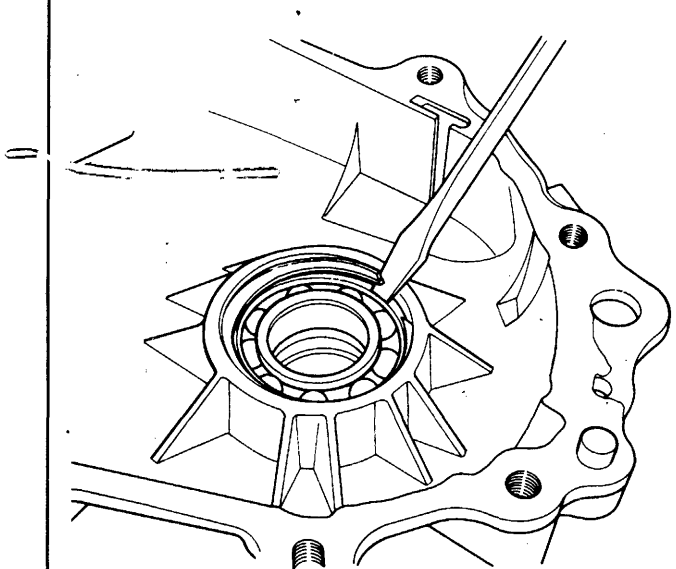
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DISASSEMBLY AND ASSEMBLY (Continued)



REMOVE INPUT SHAFT BEARING C7880-1A

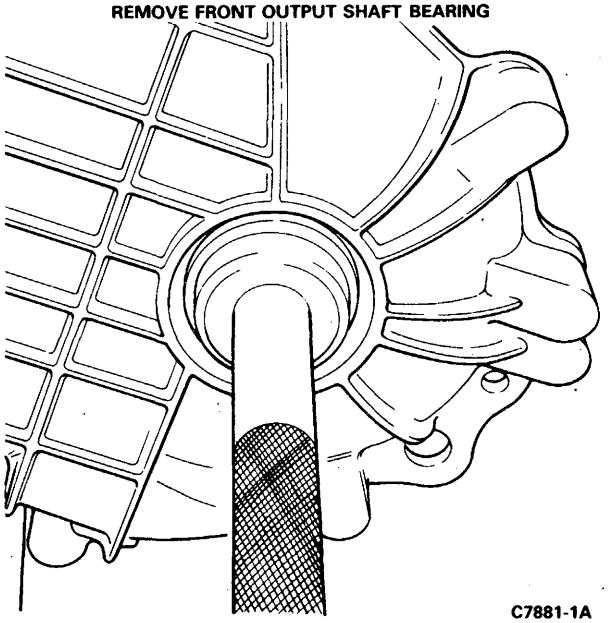
29. Remove the internal snap ring securing the front output shaft bearing in the magnesium housing and drive the bearing out from the front of the case using Tool T73T-1202-B and T80T-4000-W.



REMOVE FRONT OUTPUT SHAFT BEARING RETAINING SNAP RING

C7852-1A

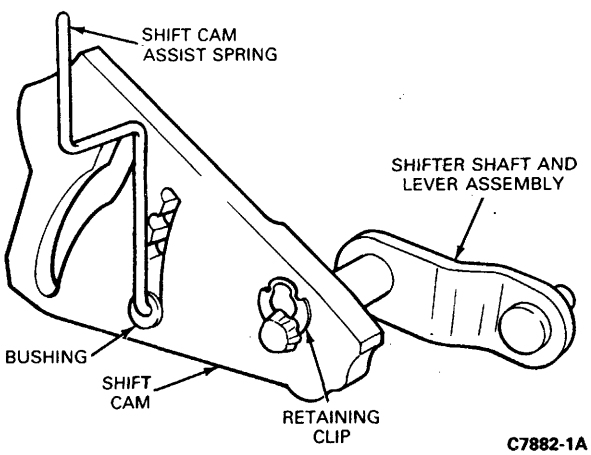
REMOVE FRONT OUTPUT SHAFT BEARING



C7881-1A

30. Remove the shift cam by removing the retaining clip and sliding the shift shaft out of the case.
31. Remove the shift shaft seal by carefully prying it out of the case, being careful not to damage the magnesium.
32. Remove the shift cam, assist spring, and assist spring bushing from the case.

SHIFT CAM, LEVER AND SHAFT INSTALLATION



C7882-1A

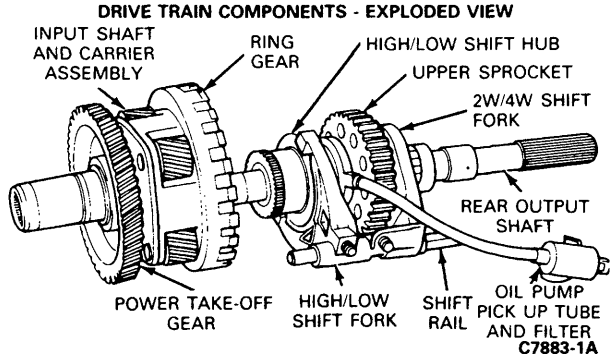
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DISASSEMBLY AND ASSEMBLY (Continued)

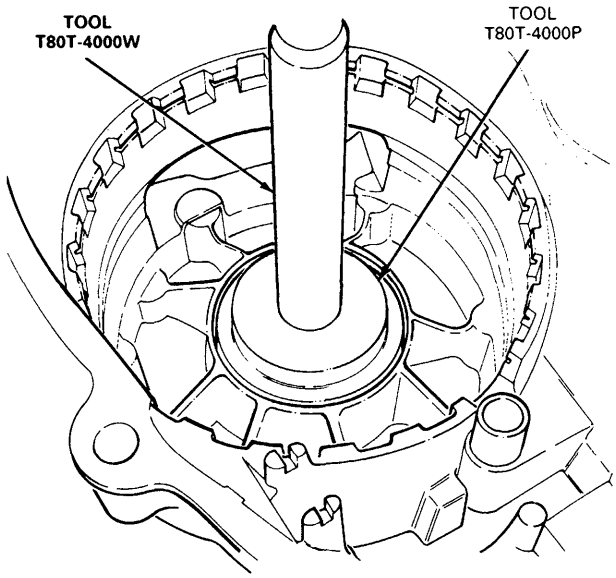
Assembly

Before assembly, lubricate all parts with automatic transmission fluid, DEXRON®II, XT-2-QDX, (ESP-M2C138-CJ) or equivalent. Remove all chips from the bolt holes in the case and rear cover.

DRIVE TRAIN COMPONENTS - EXPLODED VIEW

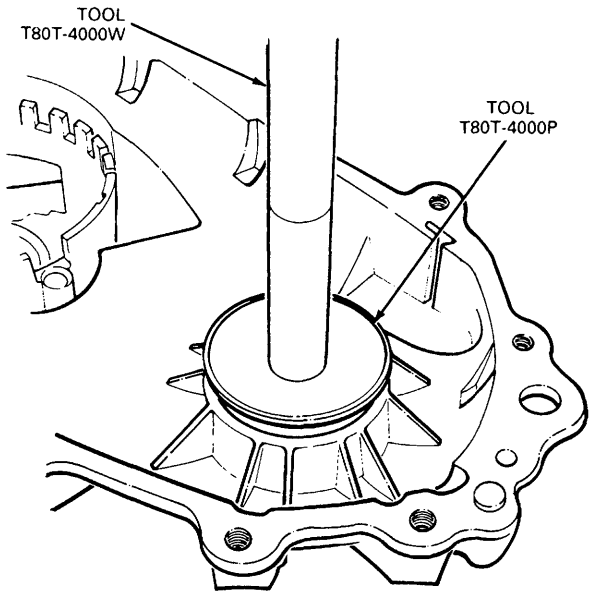


1. Install the input shaft and the front output shaft bearings in the case using appropriate tools. Install the internal snap rings retaining the bearings in the case.



INSTALL INPUT SHAFT BEARING IN CASE C7884-1A

2. Drive the front output shaft seal into the case until it is fully seated against the case using Tool T86T-7034-CH.



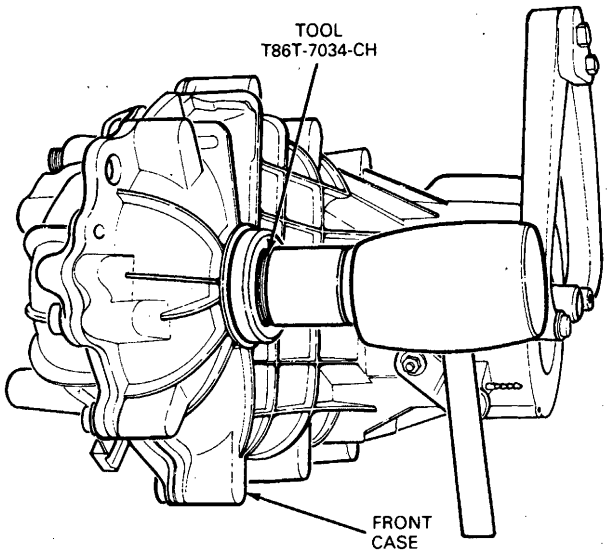
INSTALL FRONT OUTPUT SHAFT BEARING C7885-1A

3. Install the front output shaft through the lower bearing. The front output shaft is held in place in the case by the front output yoke and oil seal slinger assembly. Install the front yoke assembly onto the front output shaft then the rubber seal, flat washer and 30mm locknut. Tighten the yoke locknut to 203-244 N·m (130-180 ft-lb).
4. Press the power take-off drive gear onto the input shaft assembly if it was removed.

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DISASSEMBLY AND ASSEMBLY (Continued)

5. Press the needle bearing and bronze bushing into the input shaft with the appropriate tools.

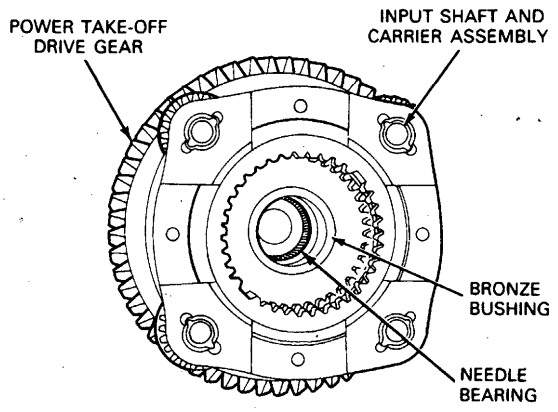


FRONT OUTPUT SHAFT SEAL INSTALLATION

C7886-1A

6. Install the ring gear into the slots in the case and retain it with the large internal snap ring making sure that it is fully seated.
7. Install the input shaft and carrier assembly in the case through the input shaft bearing being careful not to damage the gear teeth when aligning them with the ring gear teeth.
8. While supporting the carrier assembly in position, install a new snap ring on the front side of the input shaft bearing making sure that it is fully seated in the snap ring groove of the input shaft.

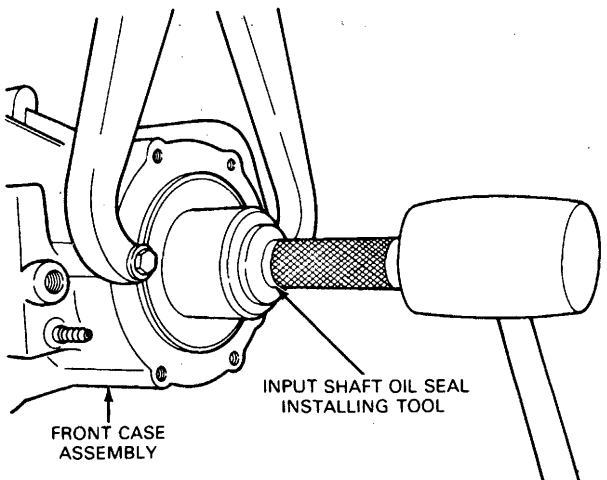
9. Install the upper input shaft oil seal into the case using an appropriate tool until it is fully seated against the case.



FRONT INPUT SHAFT AND CARRIER ASSEMBLY

C7887-1A

10. Install a new shifter shaft seal into the case using an appropriate tool.
11. Assemble the shift cam assembly into the case by sliding the shift shaft and lever assembly through the case and seal into engagement with the shift cam. Secure the shift cam with the retaining clip.



INSTALL FRONT INPUT SHAFT OIL SEAL

C7888-1A

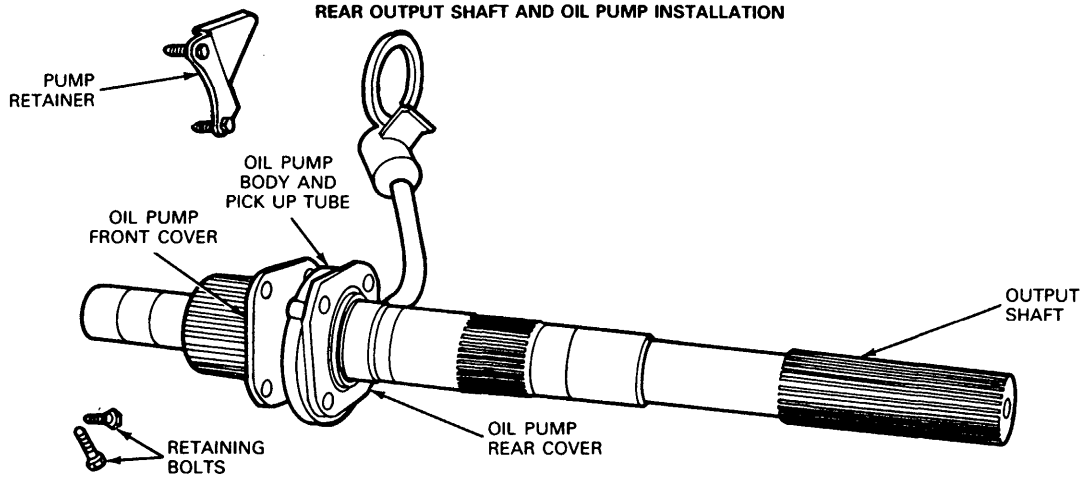
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DISASSEMBLY AND ASSEMBLY (Continued)

12. Install the shift cam assist spring in position in the bushing of the shift cam and in the recess in the case.
13. Assemble the pump and output shaft as follows: Place the oil pump cover with the word TOP facing the front of the front case. Install the two pins (with the flats facing upwards) with the spring between the pins and place the assembly in the oil pump bore in the output shaft. Place the oil pump body and pick up tube over the shaft and make sure that the pins are riding against the inside of the pump body. Place the oil pump rear cover with the words TOP REAR facing the rear of the case. The word TOP on the front cover and the rear cover should be on the same side. Install the pump retainer with the tabs facing the front of the transfer case. Install the four retaining bolts and rotate the output shaft while tightening the bolts to prevent the pump from binding. Tighten the bolts to 4.-4.5 N·m (36-40 in-lb). Lubricate the assembly with automatic transmission fluid.

NOTE: The output shaft must turn freely within the oil pump. If binding occurs, loosen the four bolts and retighten again.

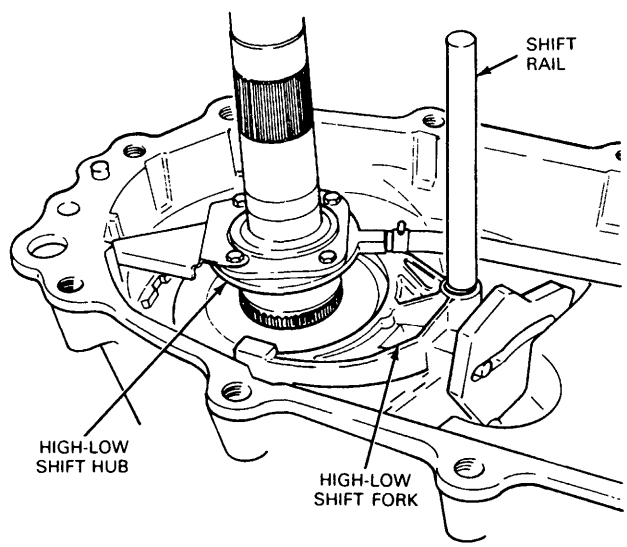
REAR OUTPUT SHAFT AND OIL PUMP INSTALLATION



C7889-2A

14. Install the high low shift hub.

    Install the high low shift fork by engaging it with the shift hub flange and rotating it until the roller is engaged with the lower groove of the cam.
15. Install the shift rail through the high low fork bore and into the rail bore in the case.



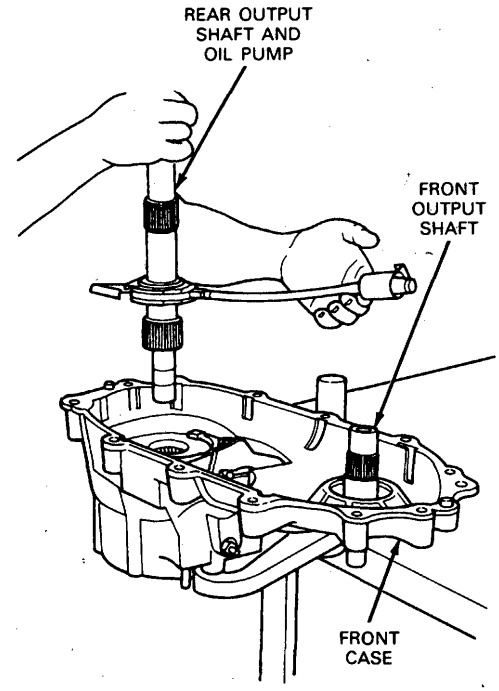
HIGH-LOW SHIFT FORK AND SHIFT RAIL

C7875-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

16. Install the output shaft and oil pump assembly in the input shaft. Make sure that the external splines of the output shaft engage the internal splines of the high low shift hub. Make sure that the oil pump retainer and oil filter leg are in the groove and notch of the front case. Install the collector magnet in the notch in the front case.

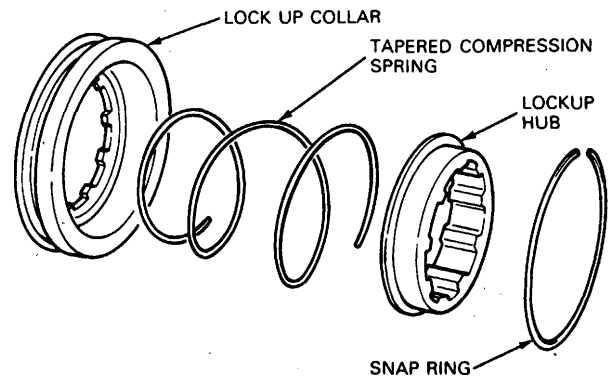


INSTALLATION - REAR OUTPUT SHAFT AND OIL PUMP

C7450-1A

17. Assemble the upper and lower sprockets with the chain and place them as an assembly over the upper and lower output shafts. Install the washer and the snap ring which retain the lower sprocket to the front output shaft.
18. Assemble the 2W-4W lockup assembly by installing the tapered compression spring in the lockup collar with the small end installed first. Place the lockup hub over the spring and compress the spring while installing the internal snap ring which holds the lockup assembly together.

2W/4W LOCK UP COLLAR ASSEMBLY

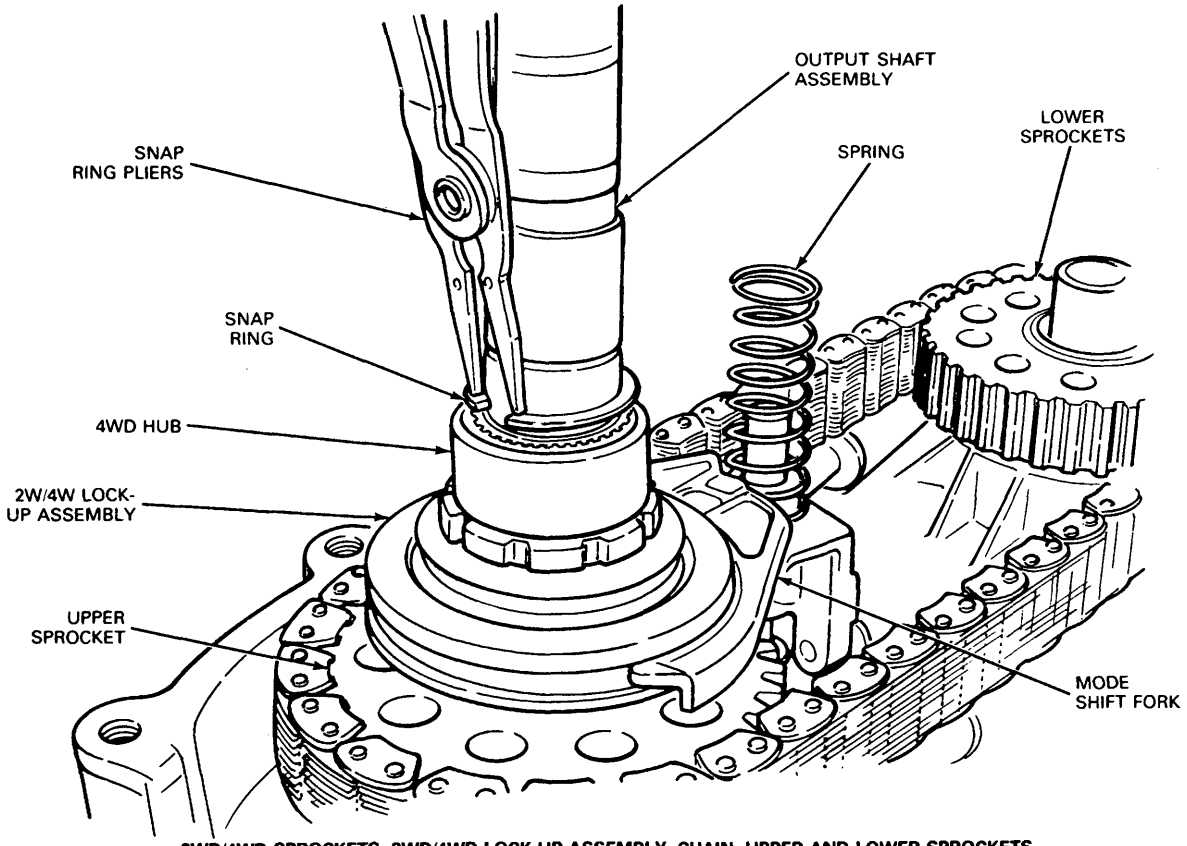


C7874-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

19. Install the lockup assembly and its shift fork over the external splines of the upper sprocket and the shift rail with the long boss of the shift rail facing forward.
20. Assemble the 4WD return spring over the shift rail and against the shift fork.
21. Place the 4WD hub over the external splines of the output shaft and secure with the appropriate snap ring. Make sure that the snap ring is fully seated in the snap ring groove.

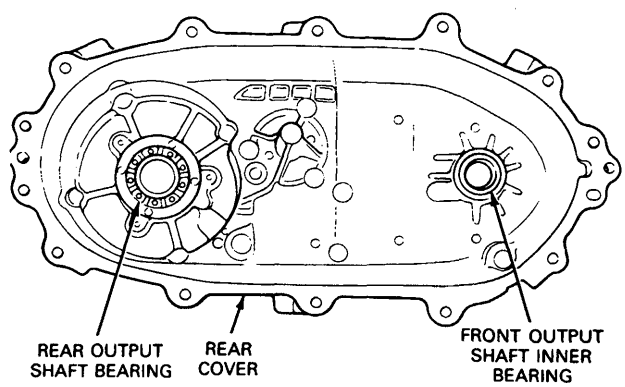


2WD/4WD SPROCKETS, 2WD/4WD LOCK-UP ASSEMBLY, CHAIN, UPPER AND LOWER SPROCKETS

C7872-2A

22. Press the lower output needle bearing in its bore in the rear cover using an appropriate tool.
23. Press the rear output shaft bearing into position in the cover using an appropriate tool. Install bearing snap ring retainer in cover.

REAR COVER - REAR OUTPUT SHAFT BEARING/ FRONT OUTPUT SHAFT INNER BEARING

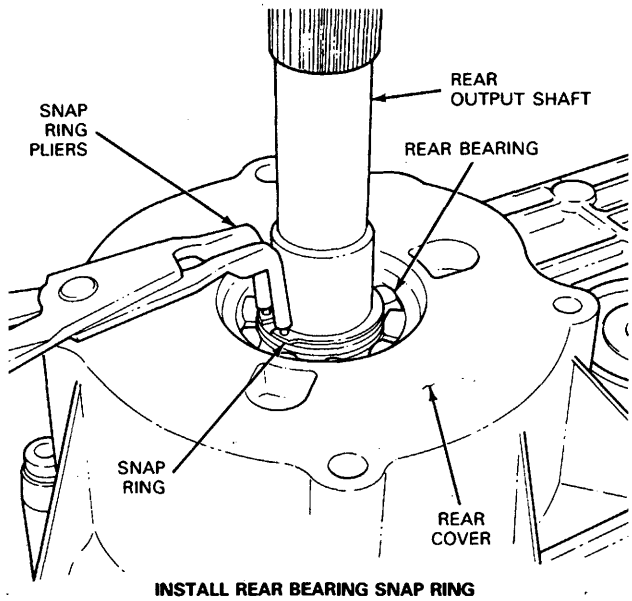


C7871-1A

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DISASSEMBLY AND ASSEMBLY (Continued)

24. Install the rear output shaft oil seal in the bearing retainer using the appropriate tool making sure that it is fully seated.
25. Coat the mating surface of the front case with a bead of non-acidic Silicone Rubber.
26. Place the cover on the case making sure that the lower output shaft, shift shaft and shift rail are aligned. Install and tighten the 12 No. 50-Torx® head case to cover bolts to 30-49 N·m (22-36 ft-lb).
27. Install the rear bearing snap ring on the output shaft making sure that the snap ring is fully seated in the groove of the shaft.

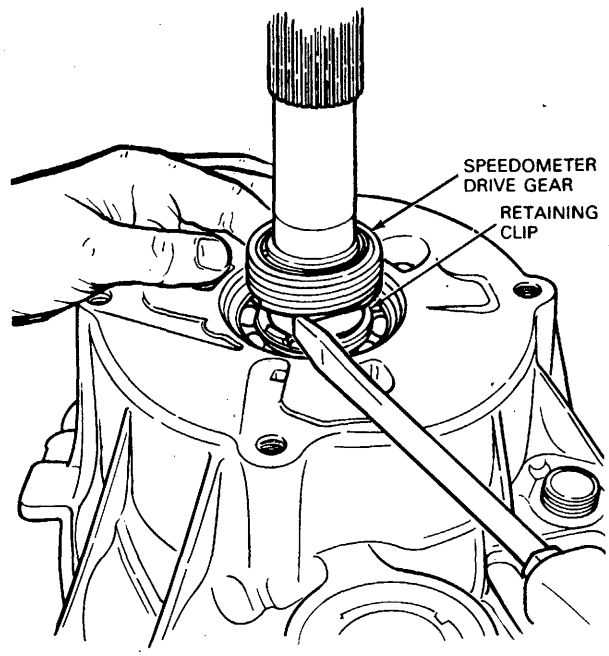


INSTALL REAR BEARING SNAP RING

C7439-1B

28. Place the speedometer drive gear over the shaft with the slot aligned with the hole for the drive ball. The gear should go completely against the snap ring which retains the output shaft. Place the ball in the hole and pull the speedometer gear over the ball. Snap the retaining clip between the snap ring and the speedometer gear.

SPEEDOMETER DRIVE GEAR



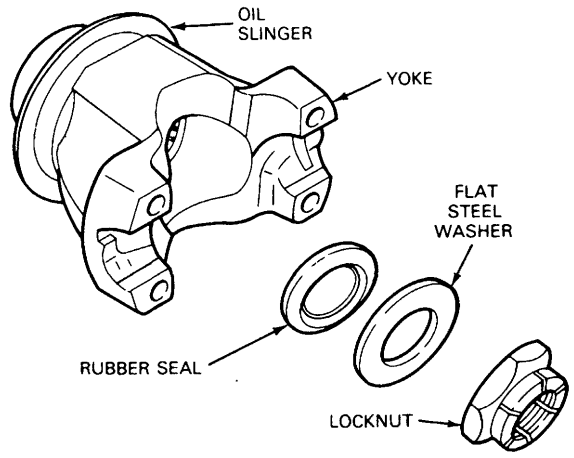
C7870-1A

29. Apply a bead of non-acidic Silicone Sealant to the face or the rear bearing retainer or rear slip yoke extension housing.
30. Place the rear bearing retainer or rear slip yoke extension housing in its position and secure with the 4 Torx® bolts tightend to 30-49 N·m (22-36 ft-lb).
31. On transfer case with slip yoke rear bearing retainer housing remove the extension oil seal using Tool T74P-77248-A and T50T-100-A. Remove the extension housing bushing using Tool T85T-7034-AH. Install a new bushing using Tool T85T-7034-BH and T80T-4000-W. Install a new seal using Tool T61L-7657-B.

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DISASSEMBLY AND ASSEMBLY (Continued)

32. Install the rear output shaft yoke and slinger assembly onto the rear splines of the output shaft. Install the rubber seal, flat steel washer and 30mm locknut on the output shaft and tighten to 203-244 N·m (150-180 ft-lb).
33. Install the drain plug and tighten to 19-30 N·m (14-22 ft-lb).
34. Install the 4WD indicator lamp switch and aluminum washer into the case.
35. Place a 3/8 inch drive ratchet in the fill plug and remove the plug. Fill the transfer case with 64 oz. of Ford Spec ESP-M2C138-CJ transmission fluid, DEXRON®II, XT-2-QDX.
36. Install the fill plug and tighten to 19-30 N·m (14-22 ft-lb).
37. Install the transfer case as described in the Removal and Installation portion of this Section.
38. Start engine, check transfer case for correct operation. Stop engine and check fluid level. Fluid should drip out of "level" hole. If fluid flows out of "level" hole, the oil pump may not be functioning properly.



REAR YOKE INSTALLATION C7890-1A

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 lb.	Universal
D80L-100-A	Blind Hole Puller Set	Universal
D80L-100-T	Blind Hole Puller	Universal 1-1/4" to 1-1/2"
D80L-100-H	Actuator Pin	Use with Blind Hole Puller
TOOL-1175-AC	Seal Remover	Universal — Use with Impact Slide Hammer
T80T-7127-B	Output Bearing Replacer — Front	Borg Warner #1356 Transfer Case
T80T-7127-C	Output Bearing Replacer — Rear	Borg Warner #1356 Transfer Case
T80T-4000-P	Bearing Installer	Borg Warner #1356 Transfer Case
T74P-77248-A	Oil Seal Remover	Borg Warner #1356 Transfer Case
T61L-7657-B	Oil Seal Installer	Borg Warner #1356 Transfer Case
T86L-7034-AH	Extension Housing Bushing Remover	Borg Warner #1356 Transfer Case
T85T-7034-BH	Extension Housing Bushing Installer	Borg Warner #1356 Transfer Case
T80T-4000-W	Bearing Installer	Borg Warner #1356 Transfer Case
T86T-7034-CH	Oil Seal Installer	Borg Warner #1356 Transfer Case
T73T-1202-B	Bearing Installer	Borg Warner #1356 Transfer Case
T73T-1202-A	Bearing Installer	Borg Warner #1356 Transfer Case

CC7858-2A

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SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS — BORG WARNER 1345 TRANSFER CASE

Description	Torque Limits	
	N·m	Ft-Lbs
Case Half Attaching Bolts	48-54	35-40
Four Wheel Drive Indicator Switch	11-16	8-12
Front and Rear Output Yokes to Transfer Case	163-203	120-150
Drain Plug	19-30	14-22
Fill Plug	19-30	14-22
Transfer Case to Transmission Adapter	34-58	25-43
Heat Shield to Transfer Case	54-61	40-45
Skid Plate to Frame	20-27	15-20
Front Driveshaft to Front Output Yoke	11-20	8-15
Rear Driveshaft to Rear Output Yoke — Bolt — Bronco	28-33	20-28
Rear Driveshaft to Rear Output Yoke — Nut — F150-F350 4x4	11-20	8-15

CC7859-2B

ROTUNDA EQUIPMENT

Number	Description
077-00019	Transmission Jack
071-00002	Gasket Compound

CC7406-1B

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SECTION 16-86 Borg-Warner 1345 Transfer Case

SUBJECT	PAGE
DESCRIPTION	16-86-1
DIAGNOSIS AND TESTING	16-86-1
DISASSEMBLY AND ASSEMBLY	
Case	16-86-9
Cover	16-86-8
Planetary Gear Set	16-86-8
Transfer Case	16-86-2
REMOVAL AND INSTALLATION	
Shift Lever	16-86-2
Transfer Case	16-86-1
SPECIFICATIONS	16-86-10
VEHICLE APPLICATION	16-86-1

VEHICLE APPLICATION

Applies to Bronco, F-150, F-250 and F-350 (4x4) Models.

DESCRIPTION

The Borg-Warner 1345 is a two-piece all aluminum part time transfer case (Figs. 1 and 2). The unit is lubricated by a positive displacement oil pump that channels oil flow through drilled holes in the rear output shaft. The pump turns with the rear output shaft and allows towing of the vehicle for extended distances without disconnecting the rear driveshaft.

DIAGNOSIS AND TESTING

Refer to Section 16-10, General Manual Transmission Service, for diagnosis and testing procedures.

REMOVAL AND INSTALLATION

Transfer Case

Refer to Fig. 3.

Removal

1. Raise vehicle on a hoist.
2. Place a drain pan under transfer case, remove drain plug and drain fluid from transfer case.
3. Disconnect four wheel drive indicator switch wire connector at transfer case.
4. If so equipped, remove skid plate from frame.

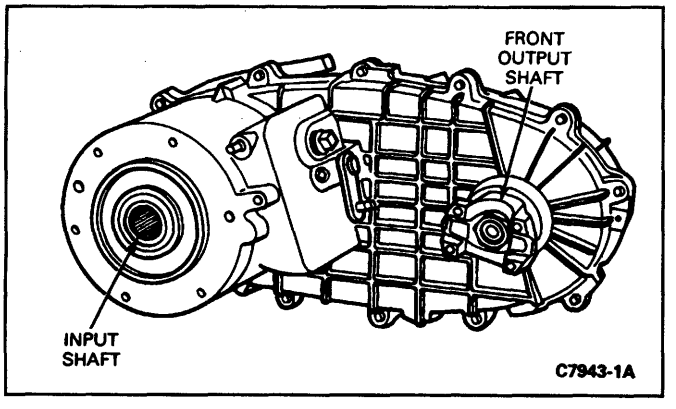


FIG. 1 Borg-Warner 1345 Transfer Case—Front View Case Half

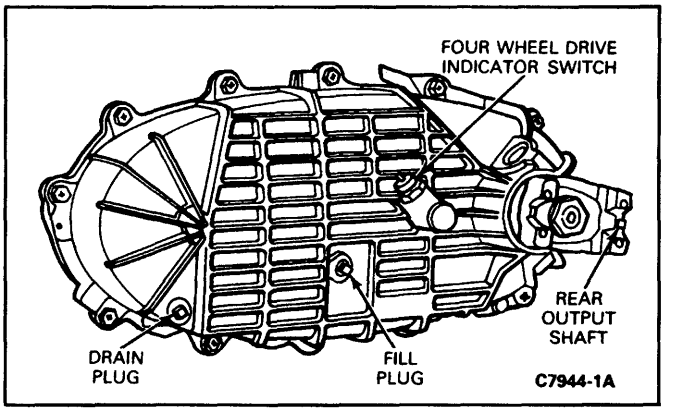


FIG. 2 Borg-Warner 1345 Transfer Case—Rear View Cover Half

5. Disconnect front driveshaft from front output yoke.
6. Disconnect rear driveshaft from rear output shaft yoke.
7. Disconnect speedometer driven gear from transfer case rear bearing retainer.
8. Remove the shift rod from the transfer case control lever and transfer case shift lever.
9. Disconnect vent hose from transfer case.
10. Support transfer case with a transmission jack Rotunda number 077-00019 or equivalent.
11. Remove the bolts retaining transfer case to transmission adapter.
12. Slide transfer case rearward off of the transmission output shaft and lower tranfer case from vehicle and remove gasket between transfer case and adapter.

Installation

1. Place a new gasket between transfer case and adapter.
2. Raise transfer case with transmission jack so transmission output shaft aligns with splined transfer case input shaft. Slide transfer case forward on to transmission output shaft and onto the dowel pin. Install bolts retaining transfer case to adapter. Tighten bolts in the torque sequence shown in View V, Fig. 3.
3. Remove transmission jack from transfer case.

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4. Connect rear driveshaft to rear output shaft yoke. For Bronco tighten bolt to 28-33 N·m (20-28 ft-lb) for F-150—F-350 (4x4) tighten nut to 11-20 N·m (8-15 ft-lb).
5. Attach the shift rod to transfer case shift lever and transfer case control rod.
6. Connect speedometer driven gear to transfer case.
7. Connect four wheel drive indicator switch wire connector at transfer case.
8. Connect front driveshaft to front output yoke. Tighten nut to 11-20 N·m (8-15 ft-lbs).
9. Install skid plate to frame. Tighten nuts and bolts to specification.
10. Install drain plug and tighten to 9-18 N·m (6-14 ft-lbs). Remove filler plug and install 3.1 liters (6.5 pints) of automatic transmission fluid, DEXRON® II, XT-2-QDX (ESP-M2C138-CJ) or equivalent. Install filler plug and tighten to 21-33 N·m (15-25 ft-lbs).
11. Lower vehicle.

Shift Lever

Refer to Fig. 3.

NOTE: Remove the shift ball only if the shift ball, boot or lever is to be replaced. If either the ball, boot or lever is not being replaced, remove the ball, boot and lever as an assembly.

Removal

1. Remove the plastic insert from the shift ball. Warm the ball with a heat gun to 60°-82°C (140°-180°F). Knock the ball off the lever with a block of wood and a hammer, taking care not to damage the finish on the shift lever.
2. Remove the rubber boot and floor pan cover.
3. Disconnect the vent hose from the shift lever.
4. Disconnect the transfer case shift rod from the shift lever.
5. Remove the bolt retaining the shift lever to transfer case. Remove the shift lever and bushings.

Installation

1. Position the shift lever and bushings on the transfer case. Install the bolt and tighten to 95-122 N·m (70-90 ft-lbs).
2. Coat the pivots on the shift lever and transfer case lever with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent. Install the shift rod on the pivots.
3. Connect the vent hose to the shift lever.
4. Install the rubber boot and floor pan cover.
5. Warm the ball with a heat gun to 60°-82°C (140°-180°F) and tap the ball on the lever with a 7/16 inch socket and mallet. Install the plastic shift pattern insert.
6. Check the transfer case for proper shifting and operation.

DISASSEMBLY AND ASSEMBLY

Transfer Case

Refer to Fig. 4.

Disassembly

1. Remove transfer case from vehicle as described in this Section.
2. Drain fluid from case by removing drain plug from rear case half (Fig. 2). Remove the speedometer cover. Replace the filler plug.
3. Remove both output shaft yoke nuts and washers and remove the rear output yoke and the front output yoke.
4. Remove the four-wheel drive indicator switch.
5. Separate the cover from the case by removing the attaching bolts. Pry the case and cover apart by inserting a flat-blade screwdriver or 1/2 inch square drive ratchet or breaker bar in the pry bosses (Fig. 5).
6. Remove the magnetic chip collector from the boss in the bottom of the case half.
7. Slide the shift collar hub off the rear output shaft (Fig. 6).
8. Compress the shift fork spring (Fig. 7) and remove the upper and lower spring retainers from the shaft.
9. As an assembly, lift out from the case the four-wheel drive lockup fork and the lockup shift collar (Fig. 8). Be careful not to lose the nylon wear pads on the lockup fork. Note the location holes on the nylon wear pad and lockup fork.
10. Remove the snap ring from the front output shaft and remove the thrust washer.
11. Grip the chain and both sprockets, (Fig. 9) and lift straight up to remove the drive sprocket, driven sprocket and chain from the output shafts. Remove the thrust washer from the rear output shaft.
12. Lift the front output shaft out from the case.
13. Remove the four oil pump attaching bolts and remove the oil pump rear cover, pickup tube, filter and pump body, two pump pins, pump spring, and oil pump front cover from the rear output shaft (Fig. 10). Disconnect oil pick-up tube from pump body.
14. Remove the snap ring that holds the bearing retainer inside the case. Lift the rear output shaft while tapping on the bearing retainer with a plastic or soft mallet. Lift the rear output shaft and bearing retainer from the case (Fig. 11).

    NOTE: Two dowel pins will fall into the case when the retainer is removed.
15. Remove the rear output shaft from the bearing retainer. If necessary, press the needle bearing assembly out from the bearing retainer.
16. Remove the C-clip that holds the shift cam (Fig. 12) to the shift actuating lever inside the case.
17. Remove the shift lever retaining screw and remove the shift lever from the case.

    NOTE: When removing the lever, the shift cam will disengage from the shift lever shaft and may release the detent ball and spring from the case.
18. As an assembly, remove the planetary gear set, shift rail, shift cam, input shaft and shift forks from the case (Figs. 13 and 14). Be careful not to lose the two nylon wear pads on the shift fork.
19. Remove the spacer washer from the bottom of the case. Remove the bushing.

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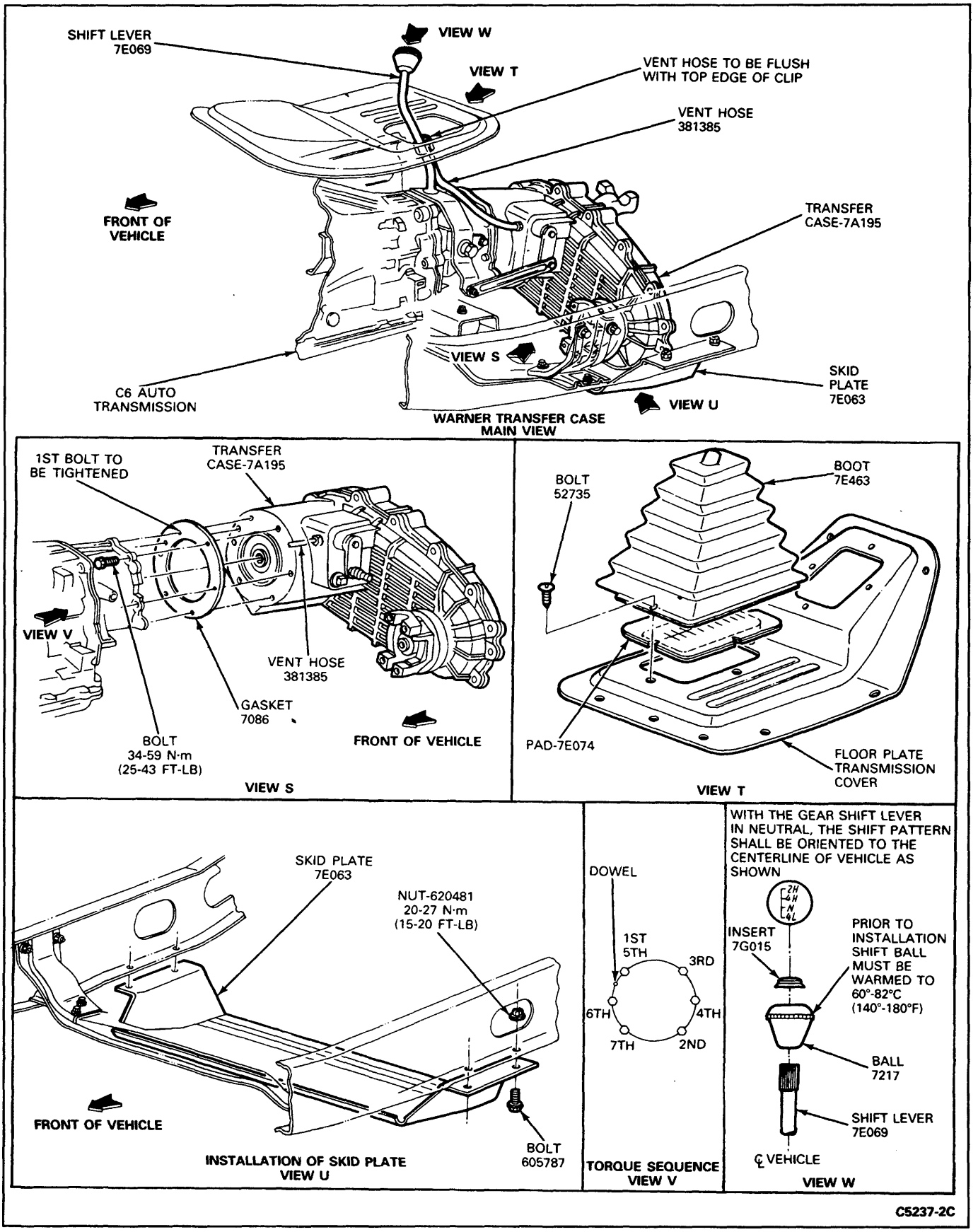


FIG. 3 Borg-Warner 1345 Transfer Case and Skid Plate Installation

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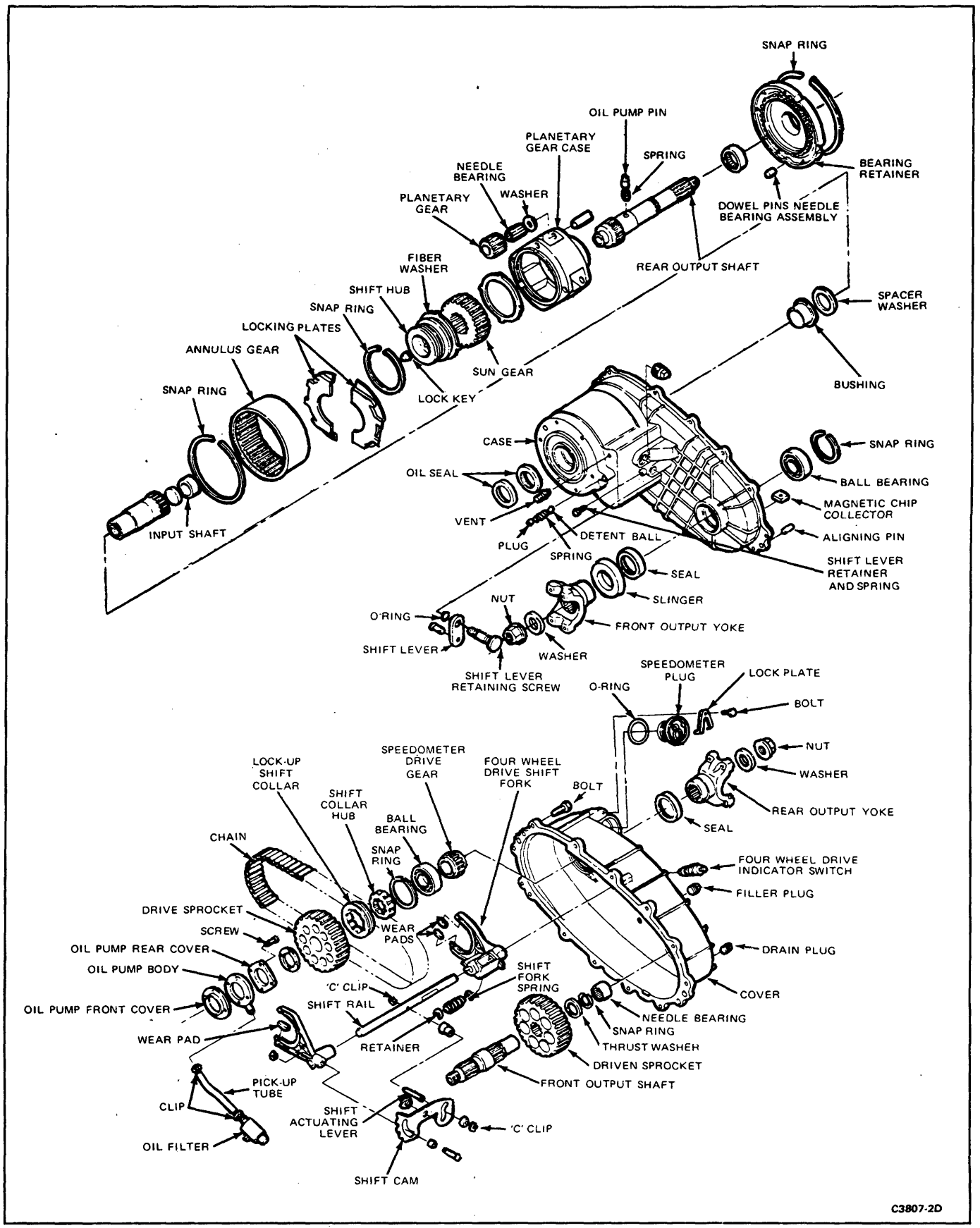


FIG. 4 Borg-Warner 1345 Transfer Case Exploded View

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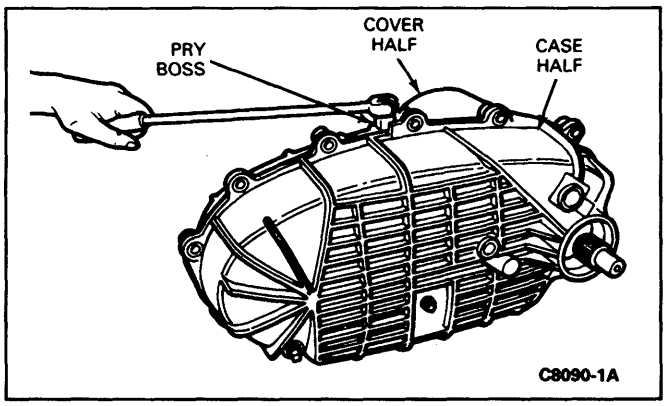


FIG. 5 Separating Case and Cover Halves

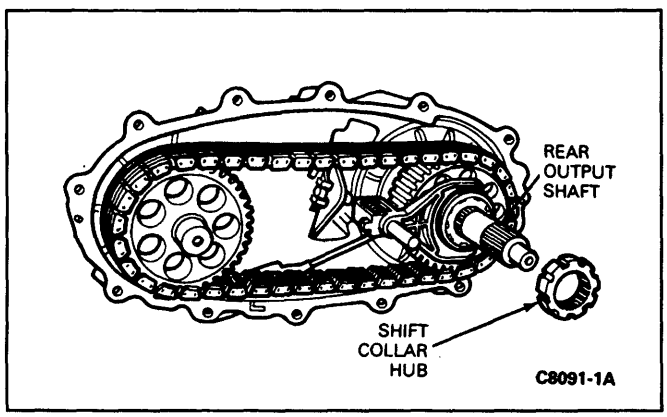


FIG. 6 Removing Shift Collar Hub

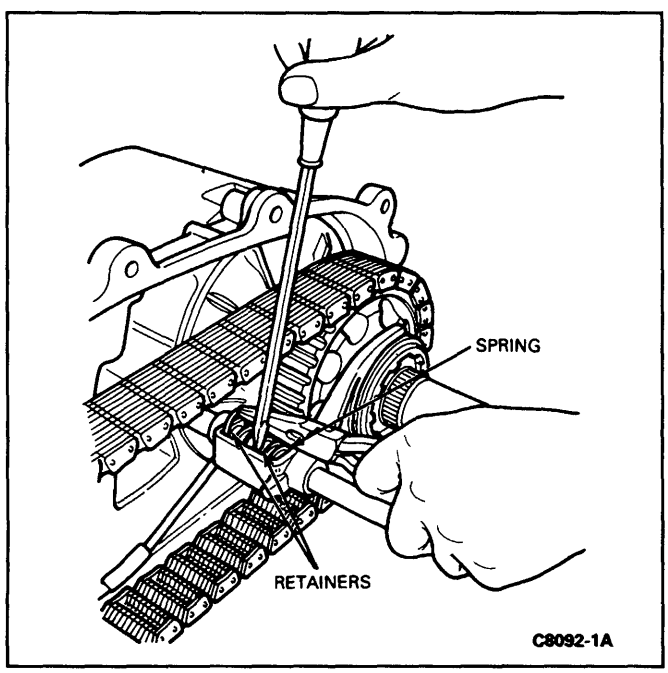


FIG. 7 Removing Spring Retainers

20. With a drift, drive out the plug from the detent spring bore (Fig. 15).

Assembly

Before assembly, lubricate all parts with automatic transmission fluid, DEXRON® II, XT-2-QDX, (ESP-M2C138-CJ) or equivalent.

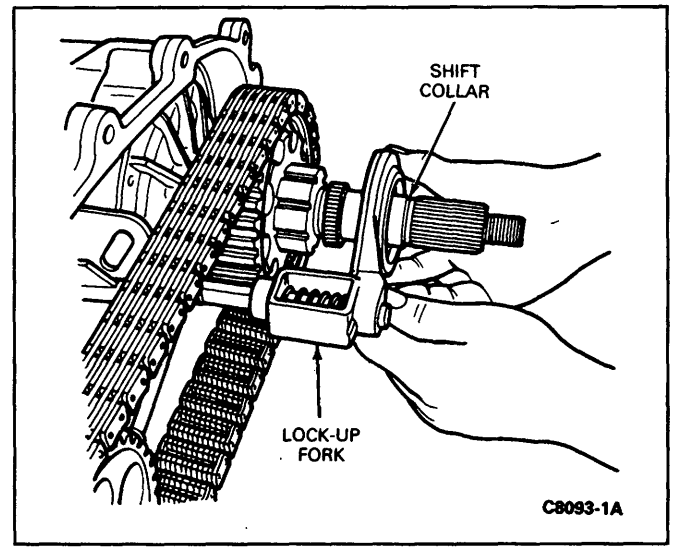


FIG. 8 Removing Lock-up Fork and Shift Collar

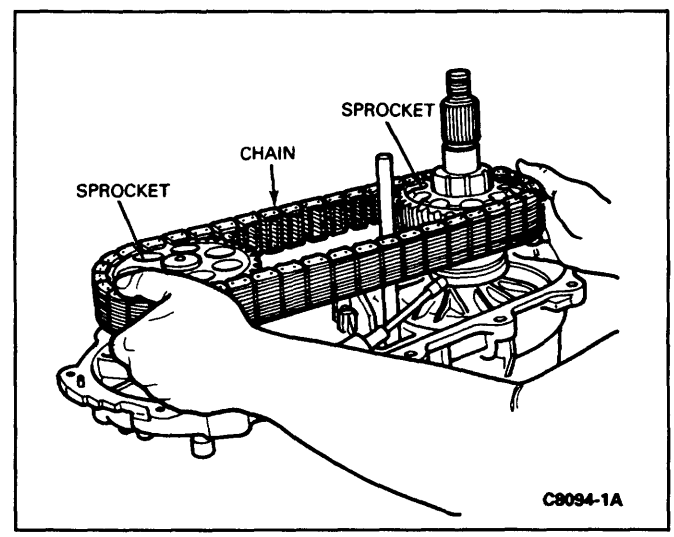


FIG. 9 Removing Sprockets and Chain

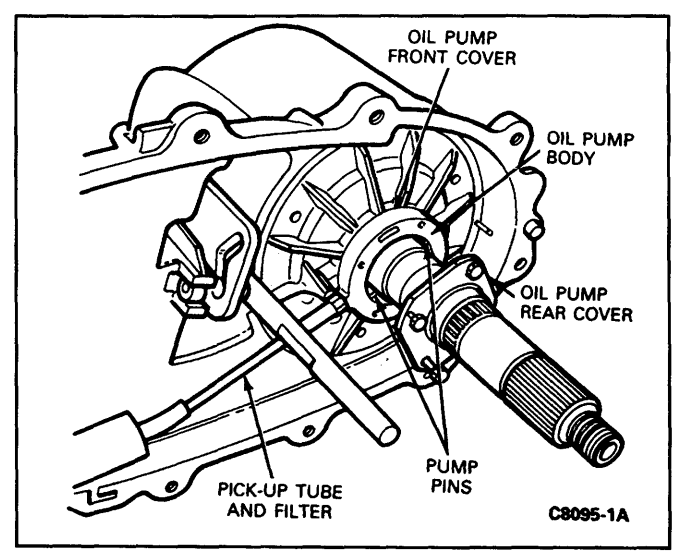


FIG. 10 Removing Oil Pump Assembly

1. Assemble the planetary gear set, shift rail, shift cam, input shaft and shift fork together as a unit

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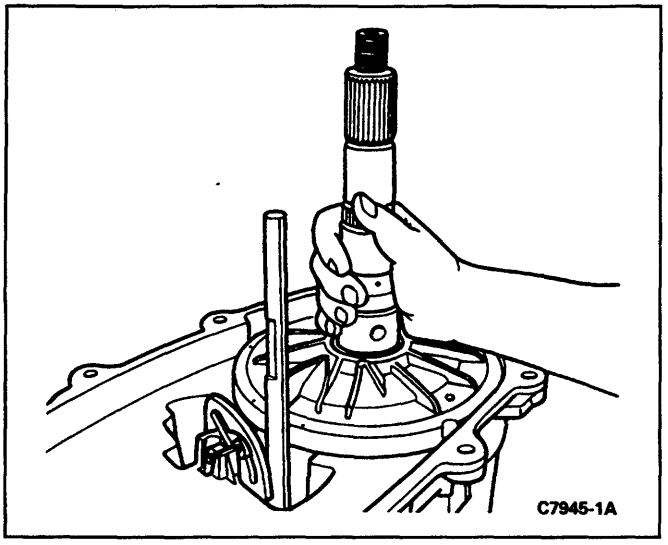


FIG. 11 Removing Rear Output Shaft

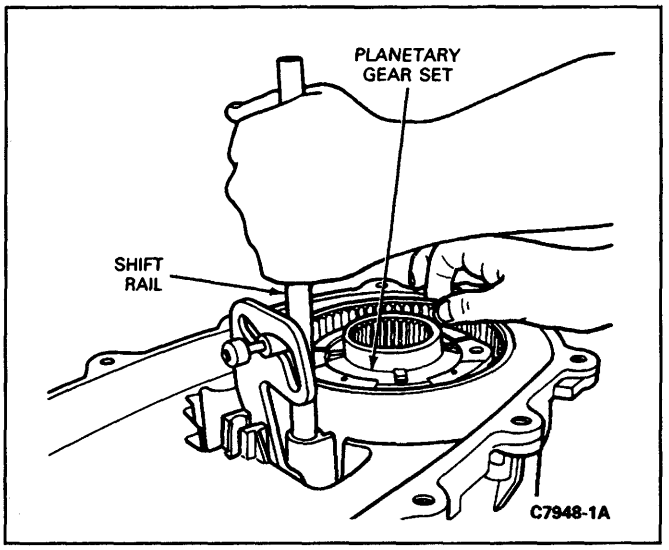


FIG. 13 Removing Shift Rail

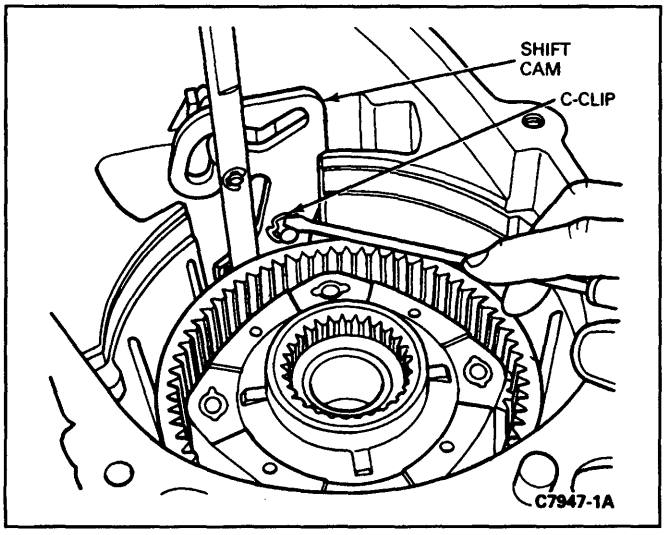


FIG. 12 Removing Shift Cam C-Clip

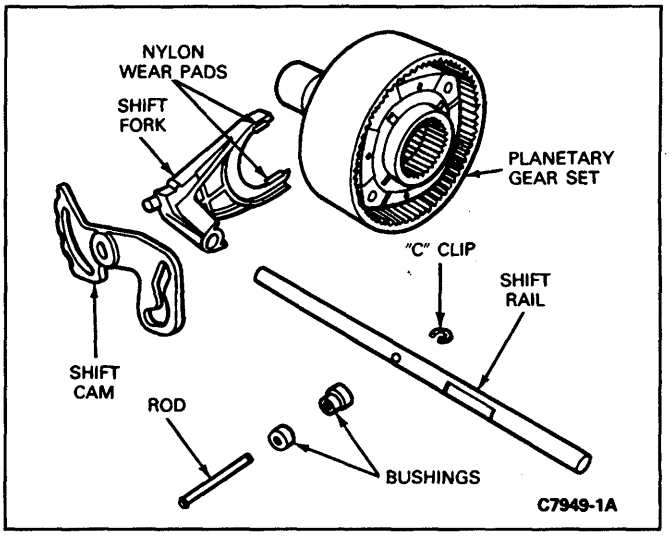


FIG. 14 Shifter Mechanisms

(Fig. 16). Make sure the boss on the shift cam is installed toward the case. Install the spacer washer on the input shaft.

2. Place the rear output shaft in the planetary gear set, making sure the shift cam engages the shift fork actuating pin (Fig. 17).

3. Lay the case on its side. Insert the rear output shaft and planetary gear set into the case. Make sure the spacer washer remains on the input shaft.

4. Install the shift rail into the hole in the case. Install the outer roller bushing into the guide in the case.

5. Remove the rear output shaft and position the shift fork in neutral (Fig. 17).

6. Place the shift control lever shaft through the cam, and install the clip ring. Make sure the shift control lever is pointed downward and is parallel to the front face of the case to be in the neutral position (Fig. 18).

7. Check shift fork and planetary gear engagement. Unit should operate freely without any binding.

8. If removed during disassembly, press new needle bearing into the bearing retainer using Output Bearing Replacer—Rear, T80T-7127-C.

9. Insert output shaft through the bearing retainer from the bottom side outward.

10. Insert the rear output shaft pilot into the input shaft rear bushing. Align the dowel holes and lower the bearing into position.

11. Install dowel pins. Install snap ring that retains the bearing retainer in case.

12. Insert detent ball and spring in detent bore in case half (Fig. 19). Coat the seal plug with RTV sealant or equivalent. Drive plug into case until the lip of the plug is 0.79mm (1/32 inch) below the surface of the case. Peen the case over the plug in two places.

13. Install the oil pump front cover over the output shaft with the flanged side down. The word "Top" must be facing the top of the transfer case as the position the case is installed in the vehicle.

14. Install the oil pump spring and two pump pins with the flat side outward in the hole in the output shaft.

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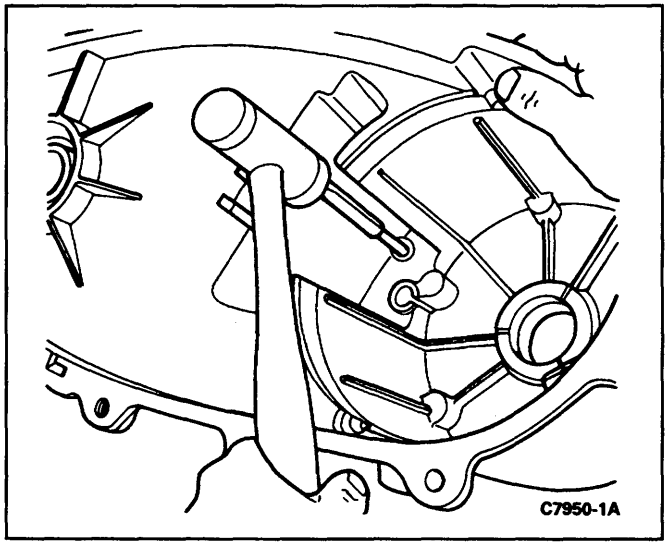


FIG. 15 Removing Detent Ball Plug

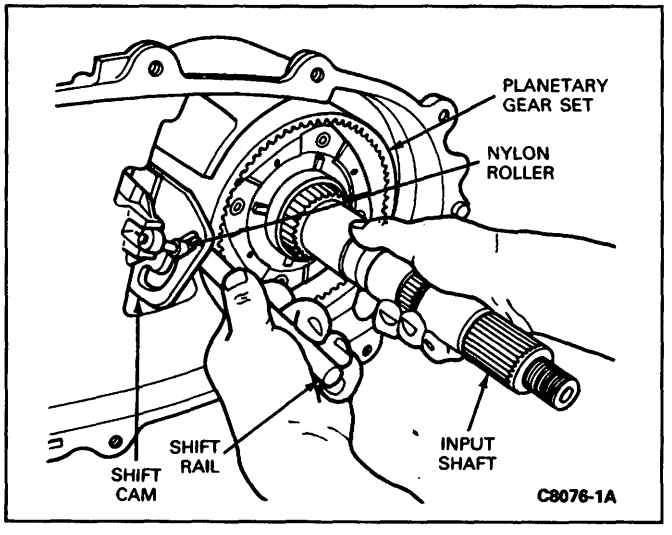


FIG. 16 Installing Planetary Gear Set and Shifter Mechanism

Push in both pins to install the oil pump body, pickup tube and filter. (The 'REAR' markings on the pump body must face upward). Prime the pump with automatic transmission fluid, DEXRON® II, XT-2-QDX (ESP-M2C138-CJ) or equivalent.

15. Place the oil pump rear cover on the output shaft with the flanged side outward. The word "Top Rear" is positioned toward the top of the transfer case in the position the transfer case is installed in the vehicle. Apply Loctite or equivalent to oil pump bolts and install in pump cover. Tighten to 4.0-4.5 N·m (36-40 in-lb) and rotate the pump while tightening.

    NOTE: When the oil pump is correctly installed, it will rotate freely on the output shaft.

16. Install the thrust washer on the rear output shaft next to the oil pump.

17. Install chain on drive sprocket and driven sprocket. Lower the chain and sprockets into position in the case. The driven sprocket is installed over the front output shaft and the drive sprocket is placed on the rear output shaft.

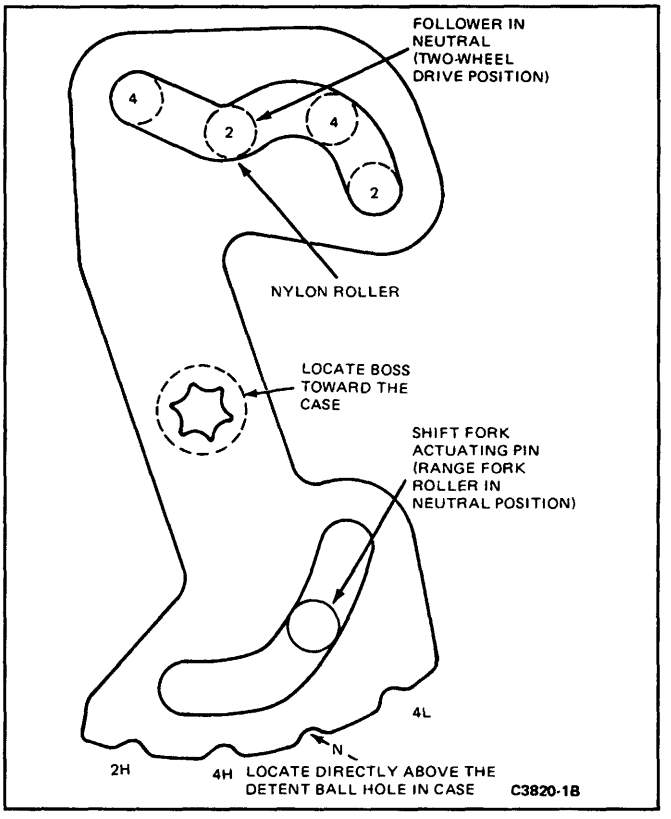


FIG. 17 Correct Shift Cam Engagement

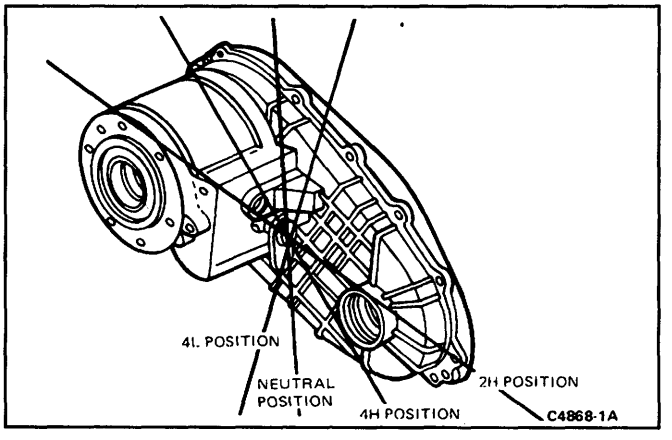


FIG. 18 Correct Shift Lever Installation

18. Assemble the washer and snap ring behind the driven sprocket.

19. Engage the four-wheel drive shift fork on the shift collar. Slide the shift fork over the shift shaft and the shift collar over the rear output shaft. Make sure the nylon wear pads are installed on the shift fork tips and that the necked down part of the shift collar is facing rearward. Note that the location holes in the nylon wear pad and lockup fork are assembled correctly.

20. Push the four-wheel drive shift spring downward and install the upper spring retainer. Push the spring upward and install the lower retainer.

21. Install the shift collar hub on the rear output shaft.

22. Apply a bead of RTV sealant, Silicone Rubber, D6AZ-19562-A (ESB-M4G92-A), or Rotunda Gasket Compound #071-00002, or equivalent on

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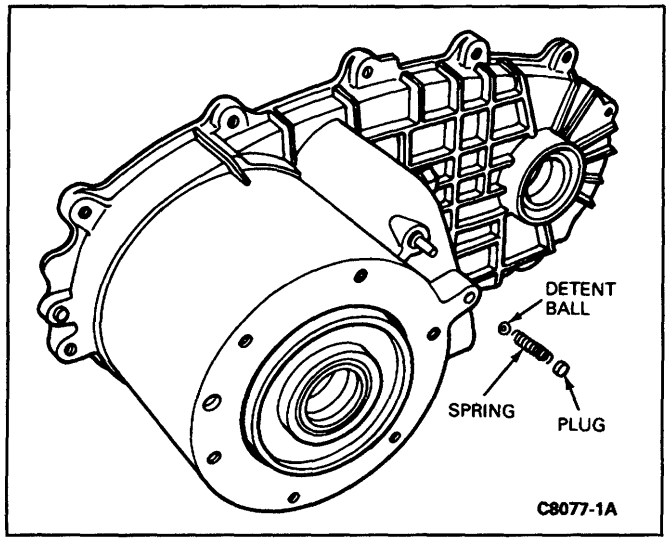


FIG. 19 Installing Detent Ball

the case mounting surface. Lower the cover over the rear output shaft. Align the shift rail to its blind hole in cover. Make sure the front output shaft is fully seated in its support bearing. Install attaching bolts and tighten to 55-61 N·m (40-45 ft. lb). Allow one hour curing time for gasket material prior to operating vehicle.

23. Install the four-wheel drive indicator switch. Tighten to 11-16 N·m (8-12 ft. lbs).
24. Press an oil slinger on the front yoke. Install front and rear output shaft yokes. Install the anti-spill oil seal. Coat the face of the yoke nuts and output shaft threads with Threadlock and Sealer, E0AZ-19554-A (ESE-M4G204-A) (Type II) or equivalent and tighten to 136-176 N·m (100-130 ft. lb). Install the speedometer assembly.
25. Refill transfer case with 3.1 liters (6.5 pints) of automatic transmission fluid, DEXRON® II, XT-2-QDX (ESP-M2C138-CJ), or equivalent. Tighten level and drain plugs to 9-18 N·m (6-14 ft. lb). Tighten fill plug to 21-33 N·m (15-25 ft. lb).
26. Install transfer case in vehicle as described in this Section.
27. Start engine and check transfer case for correct operation. Stop engine and check fluid level. Fluid should drip from level hole. If fluid flows out level hole in a stream, the pump may not be operating properly.

Planetary Gear Set

Disassembly

1. Slide the input shaft rearward out of the planetary gear set (Fig. 20).
2. Remove the snap ring from the annulus gear. Remove the shift hub and planetary gear case from the annulus gear.
3. Unlock the two (2) locking plates (Fig. 21) from the hub. Remove the shift hub snap ring and "T" shaped lock key. Lift the shift hub from the assembly (Fig. 22).
4. Remove the outer fiber washer, sun gear and inner fiber washer (Fig. 22). Rotate inner fiber washer slightly upon removal to allow positioning tabs to clear planetary gears. Replace fiber washers upon assembly.

Assembly

1. Place a new inner fiber washer into the planetary gear housing.
2. Install sun gear.
3. Coat new outer fiber washer with vaseline or equivalent. Install outer washer on hub.
4. Place hub in planetary gear cage and install "T" shape lock key and snap ring.
5. Install ring gear plate, with dished side toward the planetary gear set, on the shift hub.
6. Lower the planetary assembly into the annulus gear. Be sure the tabs on the locking plate engage the annulus gear teeth. Install snap ring.

Cover

Disassembly

1. Remove snap ring retaining the rear output shaft ball bearing assembly in the cover.
2. Turn cover over and remove the rear output shaft seal with T50T-100-A, Slide Hammer, and Tool 1175-AC, seal remover (Fig. 23).
3. Remove speedometer drive gear.
4. Press the rear output shaft ball bearing out from the cover.
5. Remove speedometer gear adapter.
6. Remove front output shaft inner needle bearing from cover with T50T-100-A, Slide Hammer, and D80L-100-T, Collet from D80L-100-A, Blind Hole Puller Set (Fig. 24).

Assembly

1. Press a new needle bearing into the cover using output Bearing Replacer—Front, T80T-7127-B.
2. Press a new ball bearing assembly into the cover. Install snap ring.
3. Turn cover over and install speedometer drive gear.
4. Install new output shaft seal into position.
5. Install speedometer gear adapter.

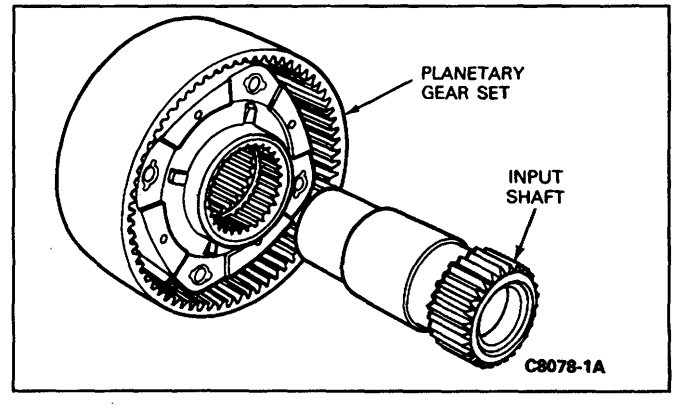


FIG. 20 Removing Input Shaft From Planetary Gear Set

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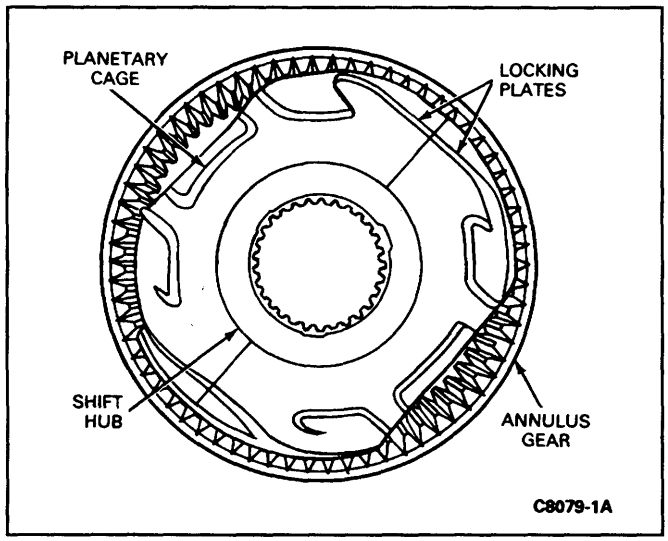


FIG. 21 Lock Plate Removal

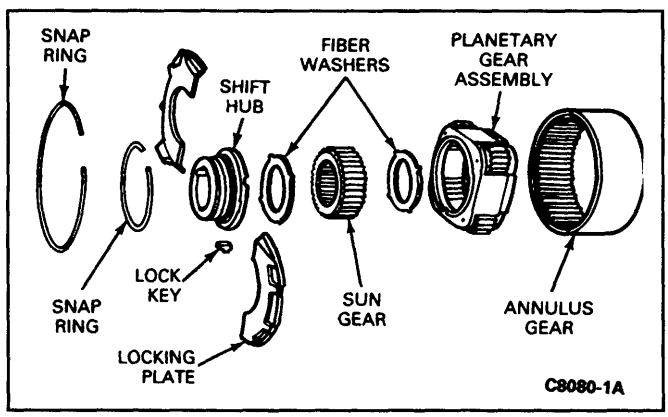


FIG. 22 Planetary Gear Set

Case

Disassembly

1. Remove snap ring retaining front output shaft ball bearing assembly in case.
2. Remove output shaft seal and both input shaft seals.
3. Press the front output shaft bearing and input shaft bushing from the case.

Assembly

1. Press new input shaft bushing into case. Make sure lug is in downward position.
2. Install new output shaft ball bearing. Install snap ring.

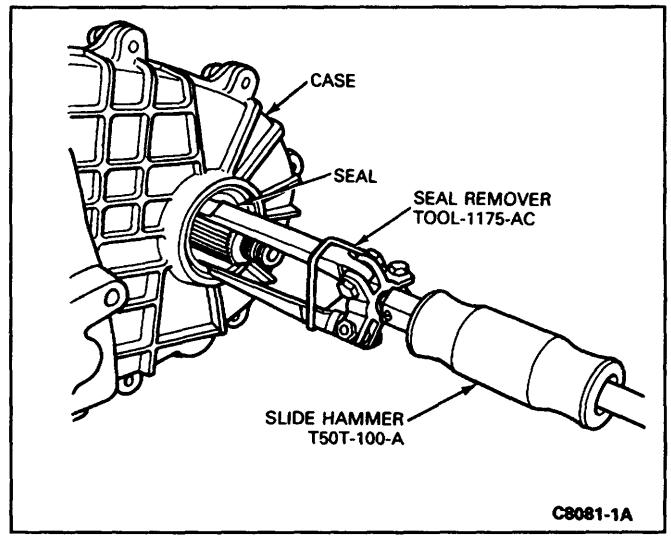


FIG. 23 Removing Front Output Shaft Seal From Case

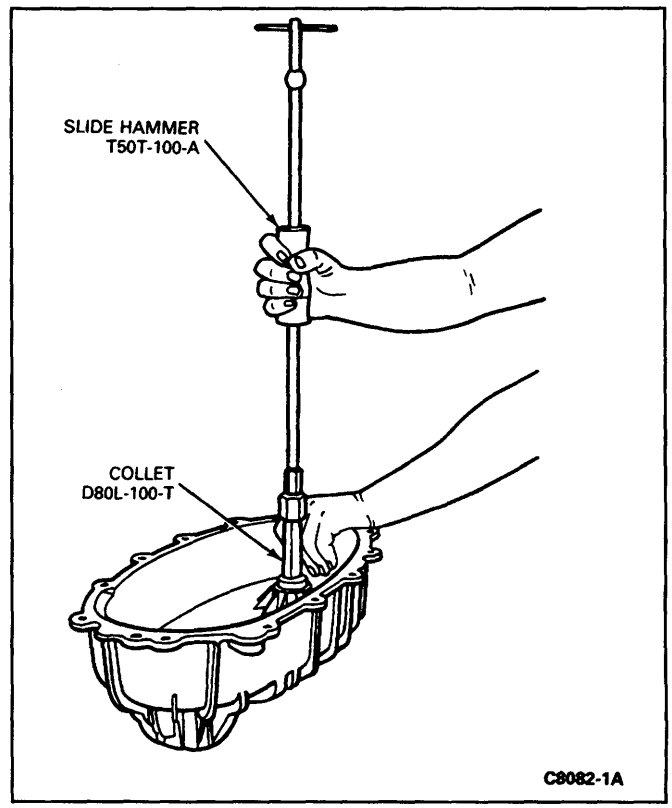


FIG. 24 Removing Needle Bearing

3. Press both input shaft seals into case.
4. Press front output shaft seal into case.

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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description	Application
T50T-100-A	Impact Slide Hammer — 2-1/2 lb.	Universal
D80L-100-A	Blind Hole Puller Set	Universal
D80L-100-T	Blind Hole Puller	Universal 1-1/4" to 1-1/2"
D80L-100-H	Actuator Pin	Use with Blind Hole Puller
TOOL-1175-AC	Seal Remover	Universal — Use with Impact Slide Hammer
T80T-7127-B	Output Bearing Replacer — Front	Borg Warner #1345 Transfer Case
T80T-7127-C	Output Bearing Replacer — Rear	Borg Warner #1345 Transfer Case

CC4011-2C

TORQUE SPECIFICATIONS — BORG WARNER 1345 TRANSFER CASE

Description	Torque Limits	
	N·m	Ft-Lbs
Case Half Attaching Bolts	48-54	35-40
Four Wheel Drive Indicator Switch	34-47	25-35
Front and Rear Output Yokes to Transfer Case	163-203	120-150
Drain Plug	19-30	14-22
Fill Plug	19-30	14-22
Transfer Case to Transmission Adapter	34-58	25-43
Heat Shield to Transfer Case	54-61	40-45
Skid Plate to Frame	20-27	15-20
Front Driveshaft to Front Output Yoke	163-203	120-150
Rear Driveshaft to Rear Output Yoke	163-203	120-150
Rear Driveshaft to Rear Output Yoke-Nut-F150-F350 4x4	11-20	8-15

CC4012-2E

ROTUNDA EQUIPMENT

Number	Description
077-00019	Transmission Jack
071-00002	Gasket Compound

CC7406-1B

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Vacuum Diaphragm C6	17-01-18
SPECIFICATIONS	17-01-36
VEHICLE APPLICATION	17-01-2

VEHICLE APPLICATION

Applies to F-150—F-350, E-150—E-350 and Bronco Trucks Equipped with Automatic Transmission.

GENERAL INFORMATION

All automatic transmissions are equipped with high temperature resistant seals. This includes those seals used on the manual and kickdown levers, the O-rings and oil pan gasket. Under no conditions should older design seals be used on the transmissions, except the regular service replacement oil pan gasket, which is of special leak prevention design. This should still be used.

Transmission Identification

All vehicles are equipped with a Vehicle Safety Certification Label affixed to the left (driver's) side door lock post. Refer to the stamped code in the space marked "Trans." and to Fig. 1 below for proper transmission identification. Refer to Section 10-00, Identification Codes for specific transmission identification coding.

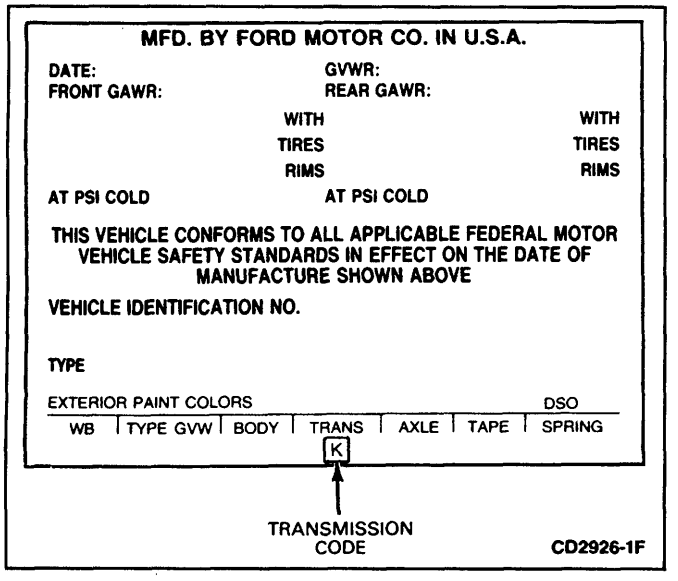


FIG. 1 Typical Vehicle Safety Standard Certification Label—Transmission Identification

DIAGNOSIS AND TESTING

Troubleshooting the automatic transmission is simplified by using the proven methods of diagnosis. One of the most important things to remember is that there is a definite procedure to follow. Do not try to short cut or take it for granted that someone else has done the critical checks or adjustments.

The following procedures are recommended for checking and/or verifying that the various components are adjusted and operating properly. If an Automatic Transmission Tester is used, Rotunda model 014-00737 or equivalent, follow the manufacturer's instructions.

Linkage Check

Accelerator Linkage and Operation

The linkage must be free and must return to idle when released. Refer to Section 24-60—Carburetor Throttle Linkage for accelerator linkage adjustment and to the Engine/Emissions Diagnosis Manual for dashpot adjustment.

Kickdown Linkage (Except AOD)

Check for wide-open carburetor and linkage travel at full throttle. The carburetor full-throttle stop must be contacted by the throttle linkage and there must be a slight amount of movement left in the downshift linkage. Be sure the downshift linkage return spring is connected and the downshift lever returns to a closed position.

For carburetor and EFI system kickdown linkage procedures, refer to Section 24-60, Throttle Linkage.

Throttle Valve Control Cable System Check—AOD

4.9L (300 CID) I-6 and 5.0L EFI Engine Application

Check for free cable and lever travel and return between idle and wide open throttle. Cable must not be loose where it fastens to the throttle body lever.

CAUTION: Do not drive vehicle if cable is broken or disconnected at carburetor.

Damage to friction elements in the transmission may result due to excessive slipping since TV pressure will remain near zero. If it is necessary to drive truck before repairing or resetting cable, disconnect cable at the transmission lever. TV pressure will now be near

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maximum allowing light throttle operation. However, shifts will be delayed and harsh.

Refer to Section 17-20, Automatic Overdrive Transmission for adjustment of automatic overdrive TV cable linkage.

Manual Linkage

This is a CRITICAL adjustment. Be sure the "D" (C6) or Ⓓ detent in the transmission corresponds exactly with the stop in the steering column or console. Hydraulic leakage at the manual valve can cause delay in engagements and/or slipping while operating if the linkage is not correctly adjusted.

Transmission Fluid Level Check

CAUTION: Vehicle should not be driven if fluid level is below the "DO NOT DRIVE" hole.

Transmission—Operating Temperature

The automatic transmission should be checked at an operating temperature of 66° to 77°C (150° to 170°F) (dipstick is hot to the touch). The operating temperature may be obtained by driving 24-32 km (15 to 20 miles) of city-type driving with the outside temperature above 10°C (50°F).

CAUTION: If vehicle has been operated for an extended period at high speed, or in city traffic in hot weather, or vehicle is being used to pull a trailer, to obtain an accurate reading, the fluid has to cool, usually about 30 minutes after engine has been turned off.

Transmission—Room Temperature

If the transmission is not at an operating temperature of 66° to 77°C (150° to 170°F) and it becomes necessary to check the fluid level (such as pre-delivery), the fluid may be checked at room temperature, 21° to 35°C (70° to 95°F) (dipstick cool to touch).

Dipstick Reading

Refer to Fig. 2.

The fluid level on the dipstick should be within the cross hatched area at operating temperature. The fluid level on the dipstick should read between the holes at room temperatures.

Check the fluid as follows:

NOTE: It may be necessary to remove the air inlet tube located directly in the way of access to the dipstick.

1. With the transmission in PARK, engine at idle rpm, foot brakes applied, and vehicle on level surface, move the transmission/selector lever through each range, allowing time in each range to engage transmission. Return to PARK, applying parking brake fully, and block the wheels. Do not turn off the engine during the fluid level check.
2. Clean all dirt from the transmission fluid dipstick cap before removing the dipstick from the filler tube.
3. Pull the dipstick out of the tube, wipe it clean, and push it all the way back into the tube. Be sure it is fully seated.
4. Pull the dipstick out of the filler tube again, and check the fluid level.

IMPORTANT: The fluid level indication on the dipstick will be different at operating temperature and room temperature. For the correct fluid level reading on the dipstick, follow the appropriate instructions stated previously.

Before adding fluid, be sure that the correct type will be used. If in doubt, check the Vehicle Certification Label affixed to the left front door lock face panel or door pillar for the Transmission/Transaxle Code. Also, the fluid is stamped on the dipstick.

CAUTION: Use of a fluid other than specified could result in transmission malfunction and/or failure.

If necessary, add enough fluid through the filler tube to raise the level to the correct position. Do not overfill the transmission, because it will result in foaming, loss of fluid through the vent, and possible transmission malfunction. If overfill occurs, excess must be removed.

5. Install the dipstick, making sure it is fully seated in the tube.

If the transmission fluid level is correctly established at 21° to 35°C (70° to 95°F), it will appear in the cross hatch area on the dipstick when the transmission reaches an operating temperature of 66° to 77°C (150° to 170°F). Do not overfill or underfill.

Overfill can cause the fluid to foam and spill out through the transmission vent resulting in a transmission malfunction.

Underfill can result in transmission loss of engagement or slipping. This condition is most evident in cold weather or when the vehicle is parked or being driven on a hill.

If the transmission fluid level is checked when the fluid is at room temperature, the dipstick could indicate that fluid should be added if the dipstick is misread. If fluid is added at this time, an overfill condition could result when the fluid reaches operating temperatures of 66° to 77°C (150° to 170°F) (dipstick hot to touch).

Refer to the specifications at the end of this Section for automatic transmission fluid requirements and capacities.

Transmission Fluid Condition Check

1. Make the normal fluid check according to the above procedure.
2. Observe color and odor of the fluid. It should be dark reddish not brown or black. A burnt odor can sometimes indicate that there is an overheating condition or clutch disc or band failure.
3. Use an absorbent white facial tissue paper to wipe the dipstick. Examine the stain for evidence of solids (specks of any kind) and for antifreeze signs (gum or varnish on dipstick).

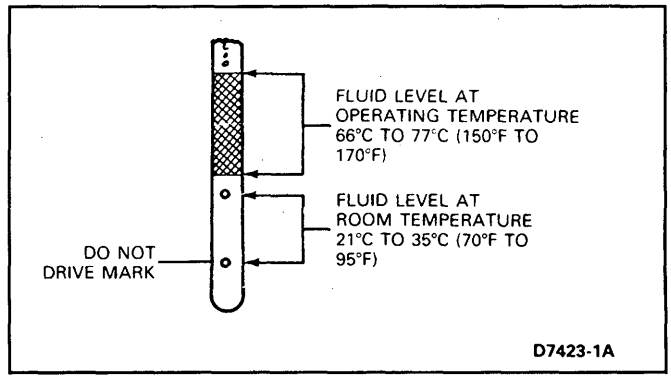


FIG. 2. Dipstick Reading—AOD, C6

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NOTE: Fluid used with the automatic transmission contains a detergent which retains in suspension particles generated during normal transmission use. This characteristic may result in a dark coloring of the fluid and does not by itself indicate malfunction or need for repair.

If specks are present in the oil or there is evidence of antifreeze, the transmission oil pan must be removed for further inspection. If fluid contamination or transmission failure is confirmed by further evidence of coolant or excessive solids in the oil pan, the transmission must be disassembled and completely cleaned and repaired. This includes cleaning the torque converter and transmission cooling system. It would be a waste of time to perform any further checks before cleaning and repairing the transmission.

During disassembly and assembly, all overhaul checks and adjustments of clearances and end play must be made.

High or Low Fluid Level

A fluid level that is too high will cause the fluid to become aerated. Aerated fluid will cause low control pressure, and the aerated fluid may be forced out the vent.

A fluid level that is too low can affect the operation of the transmission. Low level may indicate fluid leaks that could cause transmission damage.

Fluid Level High Before Starting Engine—OK During Normal Check

1. Check for correct operation of drainback valve in stator support.
2. Check pump bushing.
3. Replace or repair pump if required.

Transmission Fluid Cooler Flow Check

The linkage, fluid level and control pressure must be within specifications before performing this flow check.

Remove the transmission dipstick from the filler tube. Place a funnel in the transmission filler tube. Raise the vehicle, remove the cooler return line from its fitting in the case. Attach a hose to the cooler return line and fasten the free end of the hose in the funnel installed in the filler tube.

Start the engine and set idle speed at 1000 rpm with the transmission in neutral.

Observe the fluid flow at the funnel. When the flow is "solid" (air bleeding has been completed), the flow should be liberal. If there is not a liberal flow at 1000 rpm in neutral, low pump capacity, main circuit system leakage, or cooler system restriction is indicated.

Check both metal cooler lines between the transmission and radiator for restrictions. Check for restrictions in the metal or rubber cooler lines to and from the auxiliary cooler, if the vehicle is so equipped. Visually check and physically feel all bends for kinks, especially rubber cooler lines, that would restrict flow and could result in transmission overheating or lack of lubrication.

To separate transmission trouble from cooler system trouble, observe the flow at the transmission case converter-out fitting.

Transmission Fluid Leakage Checks

Check the speedometer cable connection at the transmission. Replace the rubber seal if necessary (if so equipped).

Leakage at the oil pan gasket often can be stopped by tightening the attaching bolts to the proper torque. If necessary, replace the gasket.

Check the fluid filler tube connection at the transmission case. If leakage is found, install a new O-ring. The filler tube brackets should align properly and be attached to the transmission or engine locations.

Check the fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear, or damage. If leakage is found, tighten the fitting, or replace the damaged parts (Fig. 3).

Check the engine coolant in the radiator. If transmission fluid is present in the coolant, the cooler in the radiator is probably leaking.

The cooler can be further checked for leaks by disconnecting the lines from the cooler fittings and applying 345-517 kPa (50-75 psi) air pressure to the fittings. Remove the radiator cap to relieve the pressure build up at the exterior of the oil cooler tank. If the cooler is leaking and/or will not hold pressure, the cooler must be replaced. Cooler replacement is described in the Cooling System Section of Group 27.

If leakage is found at either the downshift control lever shaft or the manual lever shaft, replace either or both seals.

Inspect the pipe plug on the left front side of the transmission case. If the plug shows leakage, tighten the plug to specifications. If leakage continues, replace the plug. On a C6 transmission, inspect the TV pressure plug on the right rear side of the case. On the AOD transmission, inspect the TV pressure plug, forward clutch, pressure plug and direct clutch on the right side of the case and tighten to specification if leakage is evident. If the plug shows leakage, coat the threads with Motorcraft Sealing Compound or equivalent and tighten the plug to specification as listed at the end of the appropriate transmission Section. If leakage continues, replace the plug.

When a converter drain plug leaks, remove the drain plug with a six-point wrench. Coat the threads with Motorcraft Sealing Compound or equivalent and install the plug. Tighten the drain plug to specification as listed

Transmission	Radiator		Transmission		Fluid Line Nut	
	ft-lbs	N-m	ft-lbs	N-m	ft-lbs	N-m
AOD	8-12	11-16	18-23	24-31	12-18	17-24
C6	8-12	11-16	18-23	24-31	12-18	17-24

CD3141-2D

FIG. 3 Cooler Line Fitting Torque Specifications

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at the end of this Section. **Fluid leakage from the converter housing may also be caused by engine oil leaking past the rear main bearing, or from oil galley plugs, or power steering oil leakage from steering system. Be sure to determine the exact cause of the leak before starting repair procedures.**

Oil-soluble aniline or fluorescent dyes premixed at the rate of 1/2 teaspoon of dye powder to 0.23 litre (1/2 pint) of transmission fluid have proved helpful in locating the source of fluid leakage. Such dyes may be used to determine whether an engine oil or transmission fluid leak is present, or if the fluid in the oil cooler leaks into the engine coolant system. A black light must be used with the fluorescent dye solution.

Fluid Leakage in Converter Area

In diagnosing and correcting fluid leaks in the front pump and converter area, use the following procedures to locate the exact cause of the leakage. Leakage at the front of transmission, is evidenced by fluid around the converter housing, may have several sources. By careful observation, it is possible in many instances, to pinpoint the source of the leak before removing the transmission from the vehicle. The paths which the fluid takes to reach the bottom of the converter housing are shown in (Fig. 4).

1. Fluid leaking by the front pump seal lip will tend to move along the drive hub and onto the back of the impeller housing. Except in the case of a total seal failure, fluid leakage by the lip of the seal will be deposited on the inside of the converter housing only, near the outside diameter of the housing.
2. Fluid leakage by the outside diameter of the seal and front pump body will follow the same path which the leaks by the front pump seal follow.
3. Fluid that leaks by a front pump-to-case bolt will be deposited on the inside of the converter housing only. Fluid will not be deposited on the back of the converter.
4. Leakage by the front pump-to-case gasket may cause fluid to be deposited inside the converter housing, or it may seep down between the front of the case and converter housing.
5. Fluid leakage from the converter drain plugs or converter-to-flywheel stud weld will appear at the outside diameter of the converter on the back face of the flywheel, and in the converter housing only near the flywheel.

Engine oil leaks are sometimes improperly diagnosed as transmission front pump seal leaks. The following areas of possible leakage should also be checked to determine if engine oil leakage is causing the problem:

a. Leakage at the rocker arm cover (valley cover) may allow oil to flow over the converter housing or seep down between the converter housing and cylinder block, causing oil to be present in or at the bottom of the converter housing.

b. Oil galley plug leaks will allow oil to flow down the rear face of the block to the bottom of the converter housing.

c. Leakage by the crankshaft seal will work back to the flywheel, and then into the converter housing.

Fluid leakage from other areas, such as the power steering system forward of the transmission, could cause fluid to be present around the converter housing due to blow back or road draft. The following procedures should be used to determine the cause of the leakage before any repairs are made.

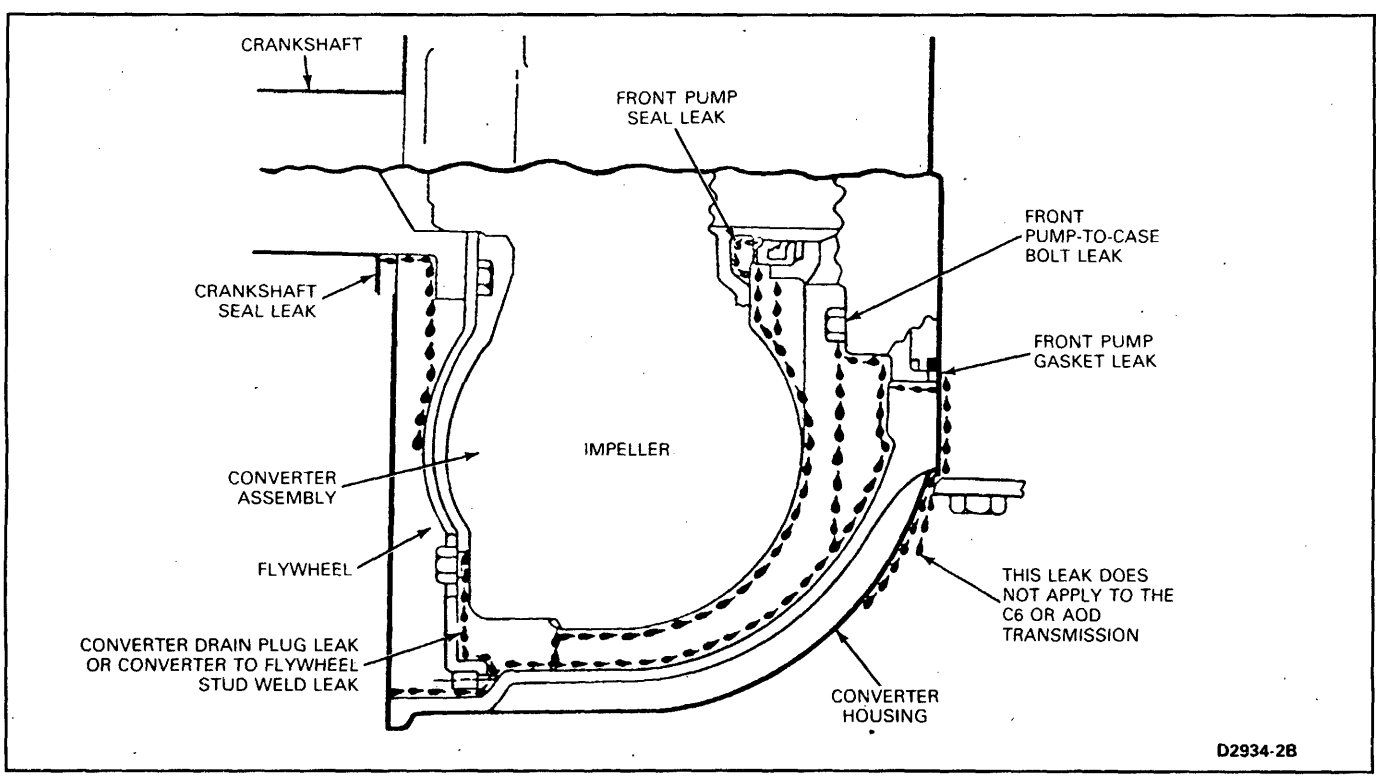


FIG. 4 Converter Leakage—Fluid Path

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a. Remove the transmission dipstick and note the color of the fluid. Original factory-fill fluid is dyed red, to aid in determining if leakage is from the engine or transmission. Unless a considerable amount of makeup fluid has been added or the fluid has been changed, the color should assist in pinpointing the leak. Since road draft may cause leaking power steering fluid to be present on the transmission, this leakage, if present, should be eliminated before checking the transmission for fluid leakage.

b. Remove the converter housing cover. Clean off any fluid from the top and bottom of the converter housing, front of the transmission case, and rear face of the engine and engine oil pan. Clean the converter area by washing with a suitable non-flammable solvent, and blow dry with compressed air.

c. Wash out the converter housing, the front of the flywheel, and the converter drain plugs. The converter housing may be washed out using cleaning solvent and a squirt-type oil can. Blow all washed areas dry with compressed air.

d. Start and run the engine until the transmission reaches its normal operating temperature. Observe the back of the block and top of the converter housing for evidence of fluid leakage. Raise the vehicle on a hoist and run the engine at fast idle, then at engine idle, occasionally shifting to the drive and reverse ranges to increase pressure within the transmission. Observe the front of the flywheel, back of the block (in as far as possible), and inside the converter housing and front of the transmission case. Run the engine until fluid leakage is evident and the probable source of leakage can be determined.

Converter Leakage Check

If welds on the torque converter indicate leakage, remove the converter and make the following check.

Assemble a Rotunda 021-00054 Torque Converter Leak Detector or an equivalent to the converter. Test the converter for leaks following the directions supplied with the detector kit.

Engine Idle Speed Check (With the Throttle Positioner Application)

On vehicles that have curb idle speed adjustment capability, if the idle speed is too low, the engine will run roughly. An idle speed that is too high will cause the vehicle to creep, have harsh engagements and harsh closed-throttle downshifts.

Refer to the ENGINE/EMISSION DIAGNOSIS* manual for curb idle speed adjustment information.

On vehicles equipped with an Exhaust Gas Recirculation (EGR) system, it is important to check the system for proper operation and for a no.restricted or leakage condition.

Control Pressure Test

C6

There are two methods of performing the control pressure test. One is to perform the test using the engine vacuum. The second method is to use a remote vacuum source such as the one provided in the distributor tester or a hand operated vacuum pump.

Engine Vacuum Pressure

When the vacuum diaphragm unit is operating properly and the manual and downshift linkage is adjusted properly, all the transmission shifts (automatic and kickdown) should occur within the road speed limits listed in the Technical Service Bulletin—Special Specifications Issue.

If the shifts do not occur within limits, or the transmission slips during shift point, use the following procedure to determine whether the engine, transmission, linkage, vacuum diaphragm unit or valve body is causing the condition. See Section 17-10 for 7.3L Diesel C6 application for (VRV) Vacuum Regulator Valve.

1. Attach a tachometer to the engine and a vacuum gauge, Rotunda Number 059-00008, or equivalent to the transmission vacuum line at the manifold vacuum port (Fig. 5).
2. Attach a pressure gauge to the control pressure outlet at the transmission (Fig. 6).

   CAUTION: Pressure gauges affect the shift quality of the transmission. Care should be taken NOT to accelerate or decelerate rapidly. Possible transmission failure could result.
3. Firmly apply the parking brake and start the engine.
4. Adjust the engine idle speed to the specified rpm, using the carburetor idle adjustment screw. If the engine idle speed cannot be brought within limits, check the throttle and downshift linkage for a binding condition. If linkage is satisfactory, check for vacuum leaks in the transmission diaphragm unit (Fig. 7) and its connecting tubes and hoses. Check all other vacuum operated units (such as

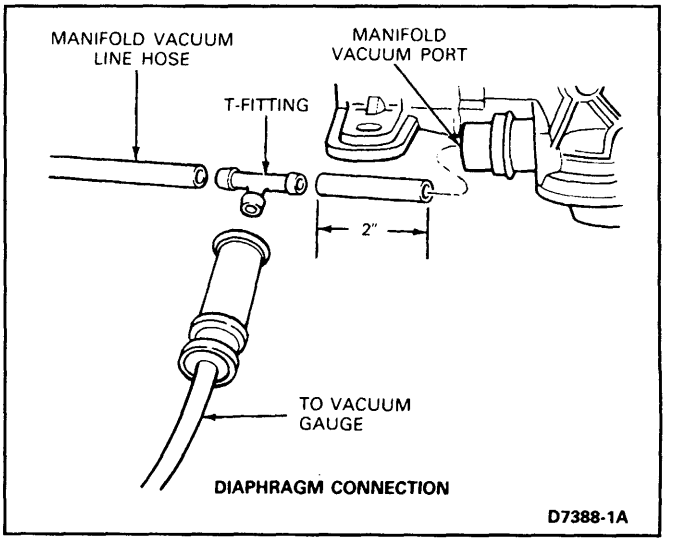


FIG. 5 Typical Vacuum Test Line Connections

*Can be purchased as a separate item.

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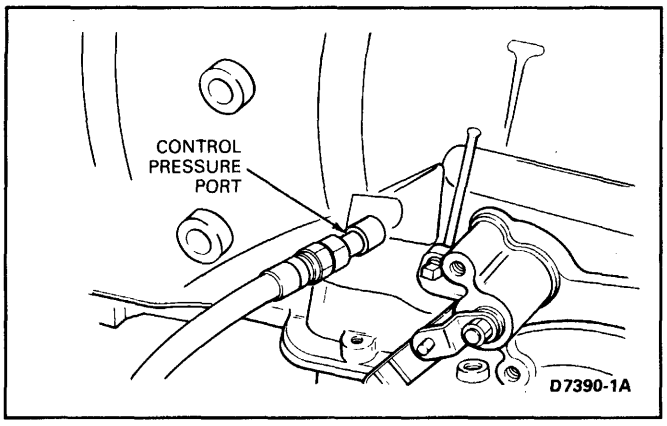


FIG. 6 Control Pressure Connecting Point—C6 Transmissions

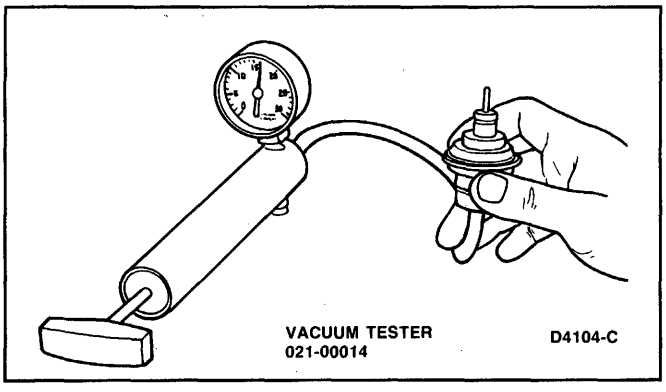


FIG. 7 Testing Transmission Vacuum Unit for Leakage

the power brake) for vacuum leaks. Refer to the appropriate brake Section in Group 12.

Refer to the two control pressure diagnostic guides in Fig. 8 to show what components are inoperative when the control pressure test is not within specifications. Do not proceed with the main diagnosis guide until you have made any repairs, as required, and the control pressure is within specifications as listed in the Technical Service Bulletin—Special Specifications Issue.

Vacuum Pump Method

C6

Disconnect and temporarily plug the vacuum line at the vacuum diaphragm unit. Attach a vacuum pump to the vacuum diaphragm. Apply both the parking and service brakes. Start the engine and vacuum pump. Set the vacuum at 15 inches, read and record the control pressure in all selector positions. Run the engine up to 1000 rpm, and reduce the vacuum to 10 inches. Read and record the control pressure in D, 2 and 1. Keep the engine rpm at 1000 and reduce the vacuum to 1 inch. Read and record the control pressure in D, 1, 2 and R.

Refer to the two control pressure diagnostic guides in Fig. 8 to show what components are inoperative when the control pressure test is not within specifications. Do not proceed with the main diagnosis guide until you have made any repairs, as required, and the control pressure is within specifications as listed in the Technical Service Bulletins—Special Specifications Issue.

Vacuum Supply Test

C6 (See Section 17-10 for 7.3L Diesel C6 Application for (VRV) Vacuum Regulator Valve)

The vacuum supply to the vacuum diaphragm unit and the diaphragm itself must be checked. To check the supply, disconnect the vacuum line at the diaphragm unit and connect it to a vacuum gauge. With the engine idling, the gauge must have a steady acceptable vacuum reading for the altitude at which the test is being performed. If the vacuum reading is low, check for a vacuum leak or poor engine vacuum. If the vacuum reading is OK, rapidly accelerate the engine momentarily. The vacuum reading must drop rapidly at acceleration and return immediately upon release of the accelerator. If the vacuum reading does not change or changes slowly, the transmission vacuum line is plugged, restricted or connected to a reservoir supply. Correct as required.

Vacuum Diaphragm Test—On Vehicle

C6

To check the vacuum diaphragm unit, start the vacuum pump and set the regulator knob so that the vacuum gauge reads 18 inches with the end of the vacuum hose blocked off. Then connect the vacuum hose to the diaphragm unit. If the gauge still reads 18 inches, the vacuum diaphragm unit is not leaking. If the reading does not remain at 18 inches, but drops, the vacuum diaphragm unit is leaking. Replace the vacuum diaphragm unit. Also, if automatic transmission fluid is present in the vacuum side of the diaphragm or in the vacuum hose, the diaphragm is leaking and must be replaced.

Vacuum Diaphragm Test—Off Vehicle

C6

To check the vacuum unit for diaphragm leakage, remove the unit from the transmission. Use a distributor tester equipped with a vacuum pump or Rotunda Vacuum Tester 021-00014 or equivalent (Fig. 7). Set the regulator knob until the vacuum gauge reads 18 inches with the end of the vacuum hose blocked off.

Connect the vacuum hose to the manifold vacuum port as shown in Fig. 7. If the gauge still reads 18 inches, the vacuum unit diaphragm is not leaking. A second leakage check can be made as the hose is removed from the transmission vacuum unit. Hold a finger over the end of the control rod. When the hose is removed, the internal spring of the vacuum unit should push the control rod outward. If the vacuum diaphragm needs replacing, install a new unit that has been released for service. Vacuum diaphragm assembly identification is given at end of this Section.

Control Pressure Test—AOD

Line pressure and throttle pressure on the Automatic Overdrive Transmission is tested in the idle position (zero T.V.) and wide-open-throttle position. Line pressure and throttle pressure specifications can be found in the Technical Service Bulletin—Special Specifications Issue. In each of the two modes the Reverse specifications will be higher than the others.

1. Be sure the T.V. linkage is properly adjusted.
2. Connect a 300 psi gauge to the line pressure port on the case left side just above the control lever

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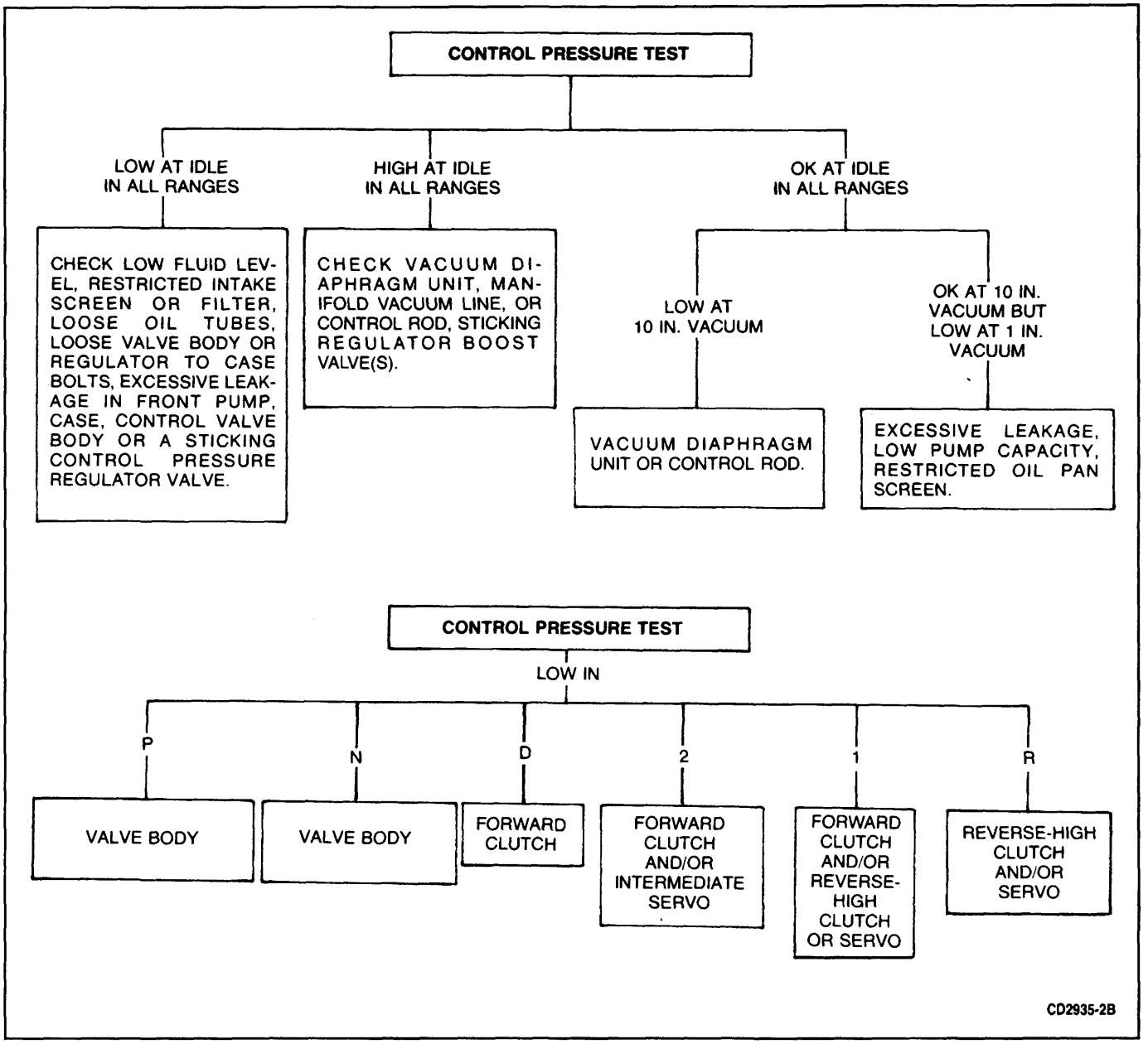


FIG. 8 Control Pressure Test Charts—C6

(Fig. 9). Have sufficient flexible hose to make the gauge accessible while operating the engine.

3. Connect a 0-100 psi pressure gauge to the TV port on the right side of the case (see Fig. 9). Have sufficient flexible Hose to make the gauge accessible while operating the engine.

   CAUTION: Pressure gauges affect the shift quality of the transmission. Care should be taken NOT to accelerate or decelerate rapidly. Possible transmission failure could result.

   NOTE: W.O.T. readings are to be made at full stall. However, be sure to run the engine at fast idle in neutral for cooling between test.

4. Run the engine until it is hot.

   CAUTION: Idle pressure must be read with the throttle off the fast idle cam.

5. Apply the service and parking brakes firmly and shift through all the ranges. Record the line pressure and the throttle pressure and compare it with specifications.

After making the control pressure tests, analyze the results to relate to the conditions in Figs. 10, 11 and 12.

Keep in mind that clutch and servo leakage may or may not show up on the control pressure test. This is because (1) the pump has a high output volume and the leak may not be severe enough to cause a pressure drop; and (2) orifices between the pump and pressure chamber may maintain pressure at the source, even with a leak downstream. Pressure loss caused by a less-than-major leak is more likely to show up at idle than at W.O.T. where the pump is delivering full volume.

Conversely, if you are manipulating the T.V. linkage to simulate W.O.T., but actually testing at idle, the leak is more likely to cause a pressure loss in the W.O.T. position.

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To further isolate leakage in a clutch or servo circuit, it is necessary to remove the oil pan and valve body, and to perform case air pressure tests.

Direct Clutch Pressure Test—(AOD)

The direct clutch pressure test outlined below will diagnose a low pressure condition or leakage in the direct clutch circuit. A difference of 15 psi or more between direct clutch pressure and line pressure (read at the forward clutch pressure tap) will prevent a 3-4 shift.

1. Attach 0-300 psi pressure gauges to the forward clutch pressure tap and to the direct clutch pressure tap (Fig. 9). Gauge accuracy must be capable of distinguishing a 15 psi difference. (If this test is done in conjunction with a control pressure test, pressure gauges will be attached to all pressure taps.) Have sufficient flexible hose to read the gauges in the vehicle.

   CAUTION: Pressure gauges affect the shift quality of the transmission. Care should be taken not to accelerate or decelerate rapidly. Possible transmission failure could result.

2. Drive the vehicle. When pressure is applied to the direct clutch, note the difference between the line pressure read at forward clutch pressure tap and the direct clutch pressure.
3. If the difference in pressures is less than 15 psi, the direct clutch circuit is Ok.
4. If the difference is greater than 15 psi, there could be a leak in the direct clutch pressure circuit. If the difference does exceed 15 psi, the gauges on line pressure and direct clutch pressure can be switched to confirm that gage calibration difference is not the cause.

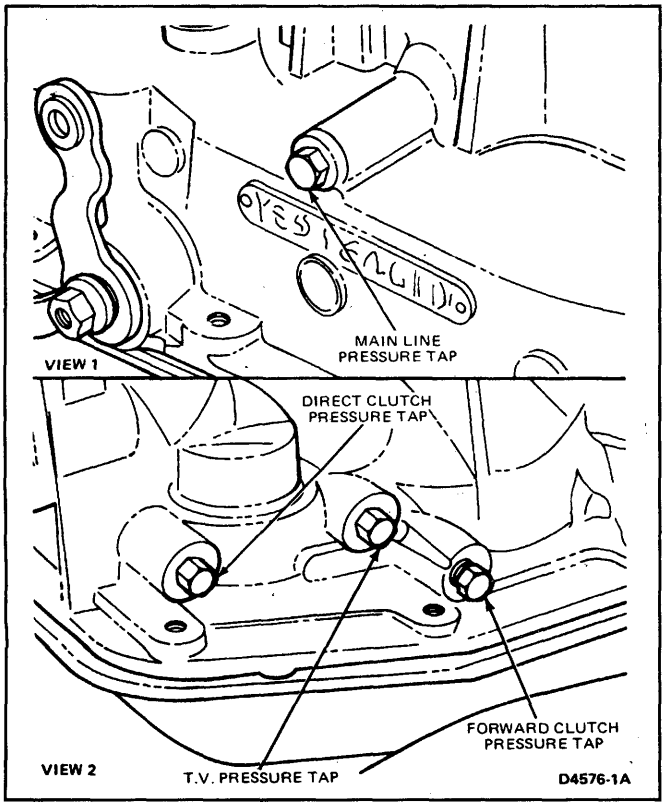


FIG. 9 Control Pressure Connecting Points—AOD

Stall Test

Refer to Fig. 13.

The stall test checks converter clutch operation and installation, the holding ability of the forward clutch, reverse clutch, the low-reverse bands, the planetary one-way clutch and engine performance.

The test should be done only with the engine coolant and transmission fluid at proper levels and at operating temperature, and with the TV linkage set properly.

Apply the service and parking brakes firmly for each stall test.

1. Find the specified stall RPM for the vehicle by referring to the Technical Service Bulletin—Special Specifications Issue. Use a grease pencil to mark the RPM on the dial of a tachometer.
2. Connect the tachometer to the engine.
3. In each of the following ranges for Automatic Overdrive Ⓓ, D, 1, R; for C6,—D, 2, 1, R; press the accelerator to the floor and hold it just long enough to let the engine get to full RPM. While making this test, do not hold the throttle open for more than five seconds at a time.
4. Note the results in each range.
5. After each range, move the selector lever to N (neutral) and run the engine at 1000 RPM for about 15 seconds to cool the converter before making the next test.
6. Refer to Fig. 13 for corrective actions.

IMPORTANT: If the engine speed recorded by the tachometer exceeds the maximum limits given in the Specifications, release the accelerator immediately because clutch or band slippage is indicated.

Governor Check

C6

The governor can be checked at the same time as the Control Pressure Test is performed and in the same manner.

Raise the vehicle with an axle or frame hoist so that the rear wheels are clear of the floor. Disconnect and plug the vacuum line to the vacuum diaphragm unit. Connect the line from the distributor tester if available to the vacuum diaphragm unit. Vacuum pump can be used with an extended vacuum hose to operate from within the vehicle.

CAUTION: Never exceed 96 km (60 mph) speedometer speed.

Place the transmission in D (DRIVE), no load on the engine and apply 10 inches of vacuum to the vacuum diaphragm unit. Increase the speed slowly and watch the speedometer. Check the mph at which the control pressure cutback occurs. It should occur between 16-32 km (10-20 mph).

NOTE: After each test, move the selector to N (neutral) and run the engine at 1000 RPM to cool the transmission.

The governor is good if the cutback occurs within these specifications. If the cutback does not occur within specifications, check shift speeds to verify that it is the governor and not a stuck cutback valve, then repair or replace the governor.

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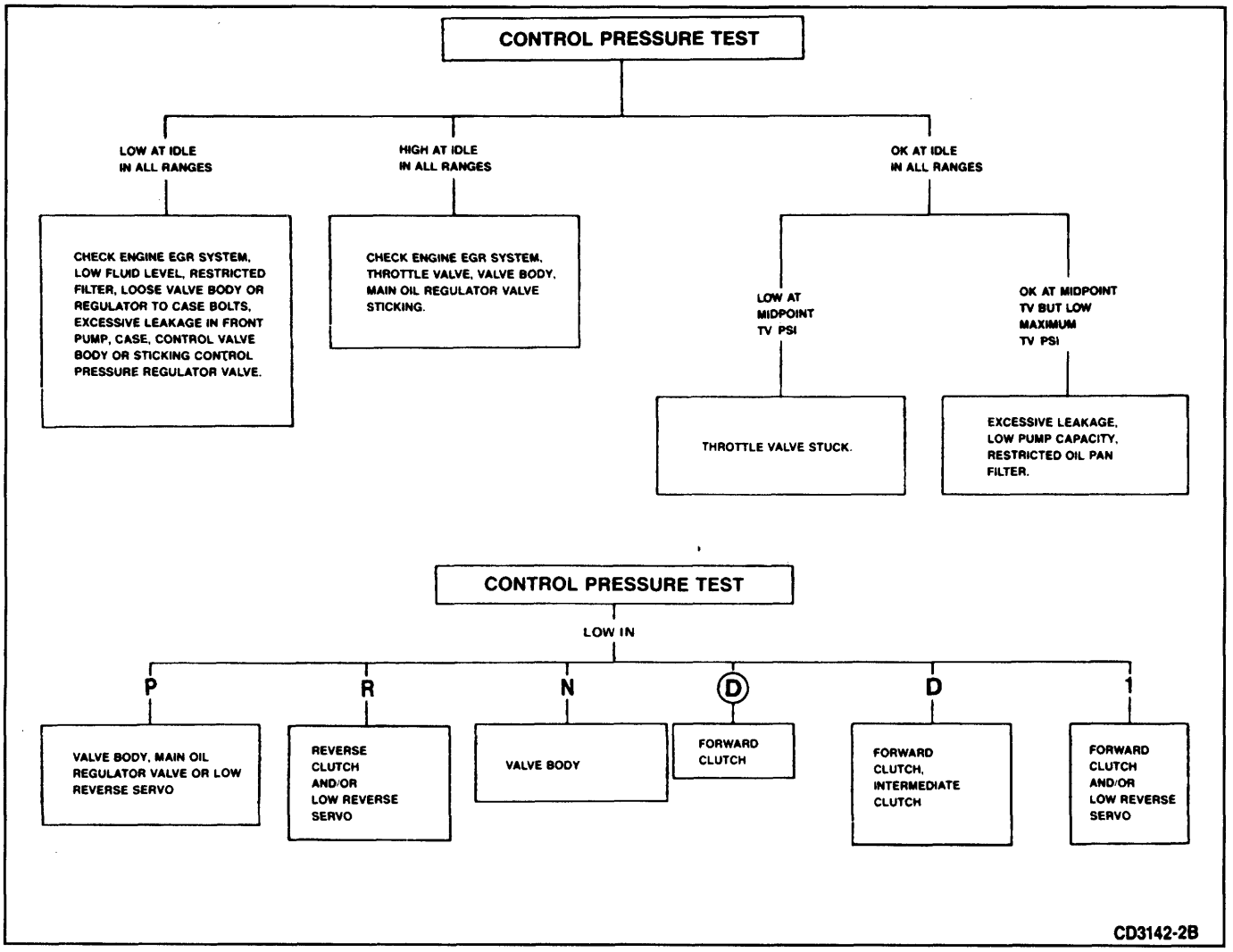


FIG. 10 Control Pressure Test Charts—AOD

AOD

Perform a shift point check. (Road test or in shop). If the shift points are not within specifications, proceed with the following governor check. Accelerate vehicle to 40 km/h (25 mph) then back off throttle completely. The transmission should shift to third gear.

Shift Point Checks

Road Test

C6

This check will determine if the governor pressure and shift control valves are functioning properly.

Check the minimum throttle upshifts in D (DRIVE). The transmission should start in first gear, shift to second, and then shift to third, within the shift points listed in Technical Service Bulletin—Special Specifications Issue.

With the transmission in third gear, depress the accelerator pedal through the detent (to the floor). The transmission should shift from third to second or third to first, depending on the vehicle speed.

Check the closed throttle downshift from third to first by coasting down from about 48 km (30 mph) in third gear. The shift should occur within the limits listed in the Specifications.

When the selector lever is at 2 (SECOND), the transmission can operate only in second gear.

With the transmission in third gear and road speed over 80 km (50 mph) the transmission should shift to second gear when the selector lever is moved from D (DRIVE) to 2 (SECOND) or 1 (FIRST).

The transmission will downshift from second or third to first gear when this same manual shift is made below approximately 48 km (30 mph) with a C6 transmission.

Refer to the band application chart in Fig. 14 to aid in diagnosis of transmission conditions.

In Shop

A shift test can be performed in the shop to check shift valve operation, governor circuits, shift delay pressures, throttle boost and downshift valve action.

Raise the vehicle with an axle or frame hoist so that the rear wheels are clear of the floor. Disconnect and plug the vacuum line to the vacuum diaphragm unit (C6). Connect the line from the distributor tester vacuum pump to the vacuum diaphragm unit.

CAUTION: Never exceed 96 km (60 mph) speedometer speed.

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Control Pressure Test Results:	
Control Pressure Condition	**Possible Causes**
Low in P	Valve body bolts loose, low reverse servo leakage.
Low in R	Reverse clutch leakage, low reverse servo leakage.
Low in N	Valve body bolts loose.
Low in Ⓓ	Forward clutch leakage, overdrive servo leakage, valve body bolts loose.
Low in D	Forward clutch leakage.
Low in 1	Forward clutch leakage, low reverse servo leakage.
Low at idle in all ranges.	Low fluid level, restricted oil filter, loose valve body bolts, pump leakage, case leakage, valve body leakage, excessively low engine idle, fluid too hot, main oil regulator valve sticking.
High at idle in all ranges.	T.V. linkage, valve body (throttle valve or main oil regulator valve sticking).
Okay at idle but low at W.O.T.	Internal leakage, pump leakage, restricted inlet screen, T.V. linkage, valve body (T.V. or T.V. limit valve sticking), main oil regulator valve sticking.

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FIG. 11 Control Pressure Test Results Chart—AOD

T.V. Pressure	Line Pressure	Range	Possible Cause
High at WOT	High at WOT	All	TV limit valve not regulating pressure — repair or replace valve body.
Low at WOT	Low at WOT	All	Throttle valve stuck — repair or replace valve body. TV linkage out of adjustment/damaged/binding — adjust and/or repair as necessary.

CD3143-2B

FIG. 12 TV Pressure and Line Pressure Test Results—AOD

1. To check the shift valves and governor circuits, apply 18 inches of vacuum to the transmission vacuum diaphragm unit. Place the transmission in Drive and make a minimum throttle 1-2 and 2-3 shift. At the shift points you will see the speedometer needle make a momentary surge and feel the driveline bump. If the shift points are within specification, the 1-2 and 2-3 shift valves and governor are OK.

   If the shift points are not within specification, perform a Governor Check to isolate the problem.

   NOTE: After each test, move the selector lever to Neutral, run the engine at 1000 rpm to cool the transmission.

2. To check the shift delay pressures and throttle boost, decrease the vacuum at the vacuum diaphragm to 0-2 inches. Make a 1-2 shift test. If the shift point raises to specification, the throttle boost and shift delay systems are functioning.

3. To check downshift valve action. Leave the vacuum to the vacuum diaphragm at 0-2 inches. Position the downshift linkage in the wide open throttle position (through the detent) and repeat the 1-2 shift test. The speed at the shift point should be higher.

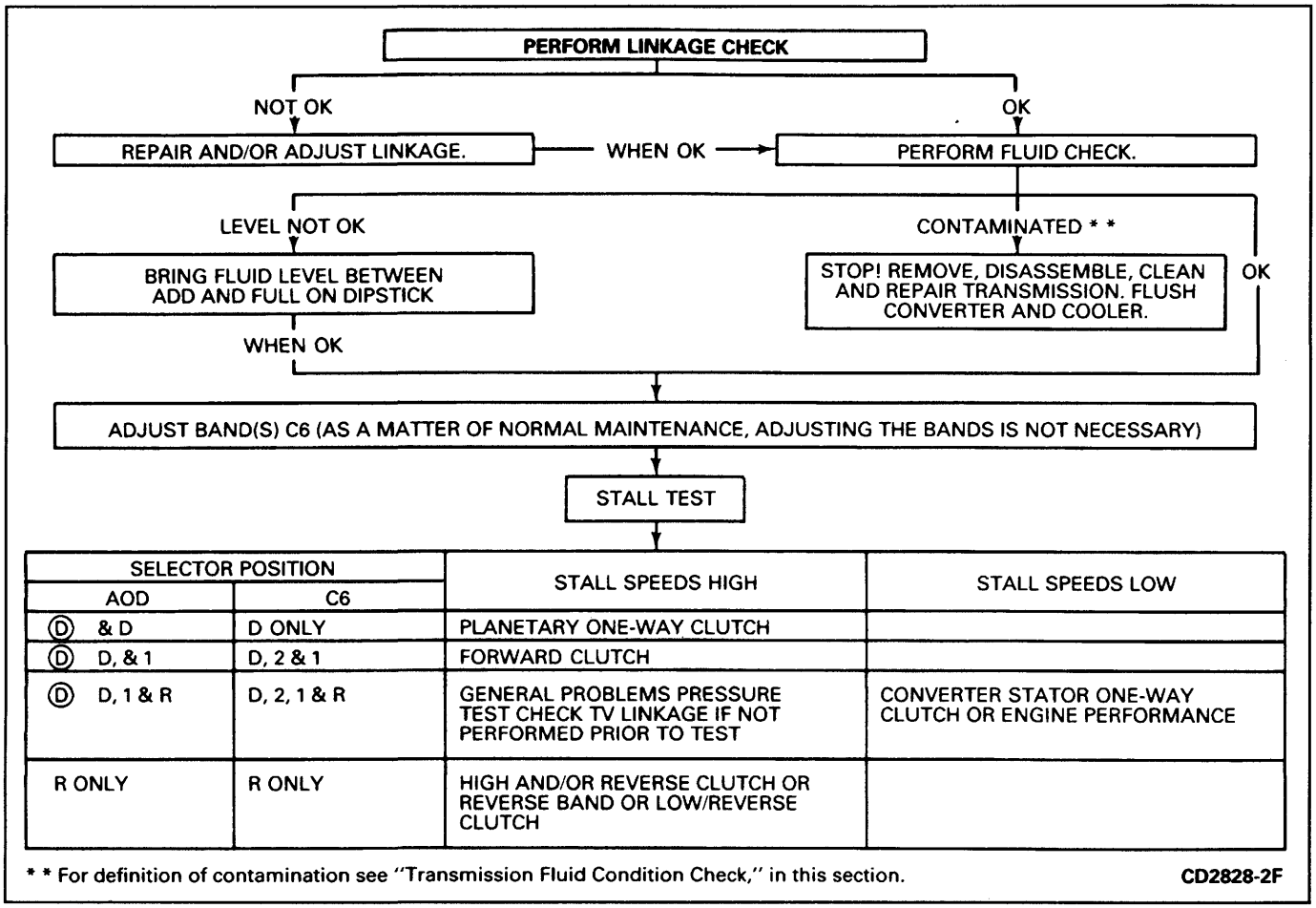
   Shift speed specifications can be found in the Technical Service Bulletin—Special Specifications Issue.

Shift Point Checks AOD

Road Test

This check will determine if the governor pressure and shift control valves are functioning properly. During the shift point check operation, if the transmission does not shift within specifications or certain gear ratios cannot be obtained, refer to the diagnosis wheel or to the symptom analysis Section of this book to resolve the problem.

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SELECTOR POSITION		STALL SPEEDS HIGH	STALL SPEEDS LOW
AOD	C6		
Ⓓ & D	D ONLY	PLANETARY ONE-WAY CLUTCH	
Ⓓ D, & 1	D, 2 & 1	FORWARD CLUTCH	
Ⓓ D, 1 & R	D, 2, 1 & R	GENERAL PROBLEMS PRESSURE TEST CHECK TV LINKAGE IF NOT PERFORMED PRIOR TO TEST	CONVERTER STATOR ONE-WAY CLUTCH OR ENGINE PERFORMANCE
R ONLY	R ONLY	HIGH AND/OR REVERSE CLUTCH OR REVERSE BAND OR LOW/REVERSE CLUTCH	

* * For definition of contamination see "Transmission Fluid Condition Check," in this section. CD2828-2F

FIG. 13 Stall Diagnosis Test

Shift speed specifications can be found in the Technical Service Bulletin—Special Specifications Issue.

Choke on will effect shift points minimum throttle upshifts. Check minimum throttle upshifts in the fourth gear (overdrive). The transmission should start in first gear, shift to second gear then shift to third gear and finally shift to fourth gear, within the shift points specified in the shift speed specifications.

Forced Downshifts:

With the transmission in fourth gear (overdrive) depress the accelerator pedal to the floor. The transmission should downshift to third gear or to second gear, depending on vehicle road speed. Refer to the appropriate shift speed specifications.

Closed Throttle Downshifts

Closed throttle downshifts should be extremely difficult to detect. It may be necessary to attach pressure gauges to the forward and direct clutch pressure taps (Fig. 9) in order to detect 4-3 and 3-2 coast downshifts.

With gauges attached a 4-3 coast (closed throttle) downshift is signified by the application of the forward clutch (the psi reading from the gauge on the forward clutch pressure tap will indicate an increase in pressure from 0 psi to 60 psi). A 3-2 coast downshift is signified by the release of the direct clutch (the psi reading from the gauge on the direct clutch pressure tap will indicate a decrease in pressure from 60 psi to 0 psi). A 2-1 coast downshift should be imperceptible. The coast downshifts should occur within the limits set forth in the shift speed specifications.

When the shift selector is in manual low (1) the transmission will not upshift from first gear.

When the shift selector is moved from either Ⓓ (overdrive) or direct drive (D) ranges to the manual low (1) position, the transmission will downshift into second gear if the vehicle is moving over (approximately) 41 km/h (25 mph) and into first gear if the vehicle is moving less than (approximately) 41 km/h (25 MPH).

The overdrive band is applied when the transmission is in manual second. The low-reverse band is applied when the transmission is in manual first gear.

The automatic overdrive transmission will not shift into fourth gear (overdrive) at wide open throttle.

The Automatic Overdrive Transmission will not make a 4-1 downshift.

When the vehicle road speed drops below approximately 58 km/h (35 mph), the transmission automatically downshifts from Ⓓ (overdrive) into third gear.

In Shop

A shift test can be performed in the shop to check shift valve operation, governor circuits, shift delay pressures, throttle boost and downshift valve action.

Raise the vehicle with an axle or frame hoist so that the rear wheels are clear of the floor.

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C6 AUTOMATIC TRANSMISSION CLUTCH AND BAND APPLICATION SUMMARY

Gear	Holding Members	Front Planetary Gearset			Rear Planetary Gearset		
		Driven	Held	Output	Driven	Held	Output
Manual Low 1	Forward Clutch Low-and-Reverse Clutch	Ring Gear	*Carrier	Sun Gear	Sun Gear	Carrier	Ring Gear
D Low	Forward Clutch One-way Clutch	Ring Gear	*Carrier	Sun Gear	Sun Gear	Carrier	Ring Gear
*The carrier is actually turning with the output shaft, but at a slower speed than the input.							
D Second or 2	Forward Clutch & Band	Ring Gear	Sun Gear	Carrier	EFFECTIVELY IN NEUTRAL		
High	Forward Clutch Reverse-and-High Clutch	Sun Gear Ring Gear	None	Carrier	TURNS AS A UNIT		
Reverse	Reverse-and-High Clutch Low-and-Reverse Clutch	EFFECTIVELY IN NEUTRAL			Sun Gear	Carrier	Ring Gear

AOD AUTOMATIC TRANSMISSION CLUTCH AND BAND APPLICATION SUMMARY

Gear	Intermediate Friction Clutch	Intermediate Roller Clutch	Overdrive Band	Reverse Clutch	Forward Clutch	Planetary (Low) One-Way Clutch	Low and Reverse Band	Direct Clutch
1 Range Low					Applied	Holding	Applied	
O/D and 3 Range Low					Applied	Holding		
Second (Intermediate)	Applied	Holding			Applied	Overruns		
Third (Direct)	Applied	Overruns			Applied	Overruns		Applied
Fourth (Overdrive)	Applied		Applied			Overruns		Applied
Reverse				Applied			Applied	

CD5040-2C

FIG. 14 Band Application Chart

CAUTION: Never exceed 96 km/h (60mph) speedometer speed or rapidly apply the brakes to stop the rear wheels.

To check the shift valves and governor circuits, place the transmission in overdrive and make a minimum throttle 1-2, 2-3 and 3-4 shift test. When the shift occurs, you will see the speedometer needle make a momentary surge and feel the driveline bump. If the shift points are within specification, the 1-2, 2-3 and 3-4 shift valves and governor are OK.

If the shift points are not within specification, perform a Governor Check to isolate the problem.

Place the transmission in manual 2, no load on the engine and apply 10 inches of vacuum to the vacuum diaphragm unit. Increase the speed slowly and watch the speedometer. Check the mph at which the control pressure cutback occurs. It should occur between 16-32 km (10-20 mph).

NOTE: After each test, move the selector lever to N (Neutral) and run the engine at 1000 rpm to cool the transmission.

Decrease the vacuum at the vacuum diaphragm to 0.2 inches. Repeat the check. Control pressure cutback should occur between 48-80 km (30-50 mph).

The governor is good if the cutback occurs within these specifications. If the cutback does not occur within specifications, check shift speeds to verify that it is the governor and not a stuck cutback valve, then repair or replace the governor.

Shift speed specifications can be found in the Technical Service Bulletin—Special Specifications Issue.

Diagnosis Tips AOD Only

Some tips on diagnosing problems with specific components are:

INTERMEDIATE CLUTCH OR ONE-WAY CLUTCH—transmission shifts 1-3 or slips in second gear.

REVERSE CLUTCH—slip or no engagement in R. (Also can be caused by the low-reverse band or servo.)

FORWARD CLUTCH/PLANETARY LOW ONE-WAY CLUTCH—no engagement in forward ranges or slip in forward.

OVERDRIVE BAND OR SERVO—no fourth gear, slip in fourth gear, or no engine braking in second gear in range 1.

DIRECT CLUTCH—slip in third or fourth, or no upshift beyond second.

LOW-REVERSE BAND OR SERVO—no reverse or slip in reverse. Possibly no engine braking in manual low first gear, which would isolate the problem to the band rather than reverse clutch.

Accumulators

Leaking seals on the accumulator pistons can cause their respective clutches to slip. If the 2-3 accumulator seals leak, the symptoms could resemble a direct clutch or forward clutch problem. A leaking 3-4 accumulator will cause a harsh 3-4 upshift.

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T.V. Pressure Low

Another reminder: if the shifts seem soft or mushy, do not make any heavy throttle tests. Check and adjust the T.V. linkage before making a complete road test.

Air Pressure Checks

C6

A NO DRIVE condition can exist, even with correct transmission fluid pressure, because of inoperative clutches or bands. On automatic transmissions, an erratic shift can be caused by a stuck governor valve. The inoperative units can be located through a series of checks by substituting air pressure for fluid pressure to determine the location of the malfunction.

When the selector lever is at 2 (second) a NO DRIVE condition may be caused by an inoperative forward clutch. A NO DRIVE condition at D (drive) may be caused by an inoperative forward clutch or one-way clutch. When there is no drive in 1 (low) the difficulty could be caused by improper functioning of the forward clutch or simultaneous malfunction of the low-reverse band and the one-way clutch. Failure to drive in R (Reverse) could be caused by a malfunction of the reverse-high clutch or low-reverse band or clutch.

When you have a slip problem but don't know whether it is in the valve body or in the hydraulic system beyond the valve body, the air pressure tests can be very valuable.

To make the air pressure checks, loosen the oil pan bolts and lower one edge to drain the transmission fluid. Remove the oil pan and the control valve body assembly. The inoperative clutches or bands can be located by introducing air pressure into the various transmission case passages (Figs. 15 and 16).

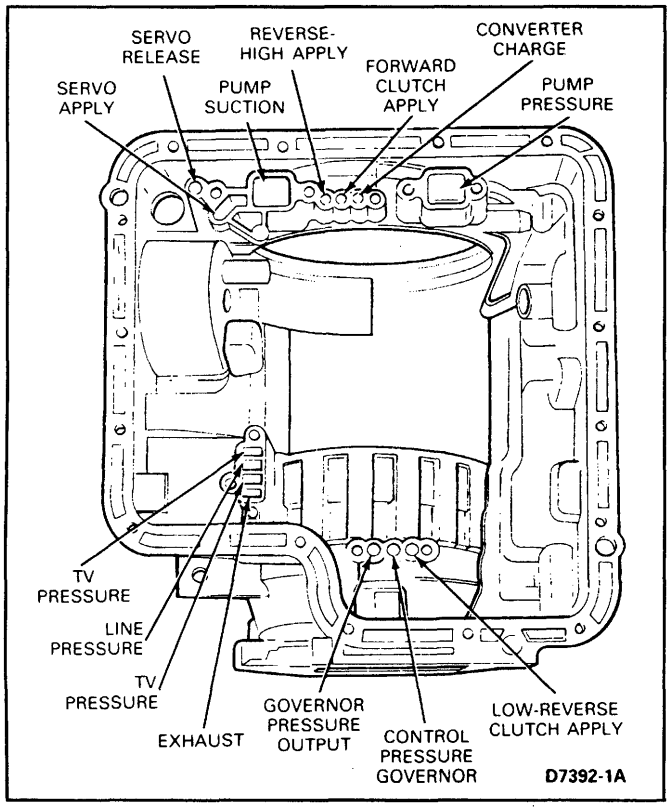


FIG. 15 Case Fluid Passage Hole Identification—C6 Automatic

Forward Clutch

Apply air pressure to the transmission case forward clutch passages (Figs. 15 and 16). A dull thud can be heard when the clutch piston is applied. If no noise is heard, place the finger tips on the input shell and again apply air pressure to the forward or front clutch passage. Movement of the piston can be felt as the clutch is applied.

Governor

Apply air pressure to the control pressure to governor passage (Figs. 15 and 16) and listen for a sharp clicking or whistling noise. The noise indicates governor valve movement.

Reverse-High Clutch

Apply air pressure to the reverse-high clutch (Figs. 15 and 16). A dull thud indicates that the reverse-high or rear clutch piston has moved to the applied position. If no noise is heard, place the finger tips on the clutch drum and again apply air pressure to detect movement of the piston.

Intermediate Servo

Hold the air nozzle in the front servo apply tube or the intermediate servo apply passages (Figs. 15 and 16). Operation of the servo is indicated by a tightening of the front or intermediate band around the drum on C6 transmissions. Continue to apply air pressure to the servo apply tube or passage, and introduce air pressure into the front release tube or the intermediate servo release passage. The front or intermediate servo should release the band against the apply pressure.

Low-Reverse Clutch C6 Only

Apply air pressure to the low-reverse clutch apply passage (Fig. 16). A dull thud should be heard if the clutch is operating properly. If the passages are clear, remove the clutch assemblies, and clean and inspect the malfunctioning clutch to locate the trouble.

Air Pressure Checks AOD

A NO DRIVE condition can exist even with the correct transmission fluid pressure because of inoperative clutches or bands. The inoperative units can be located

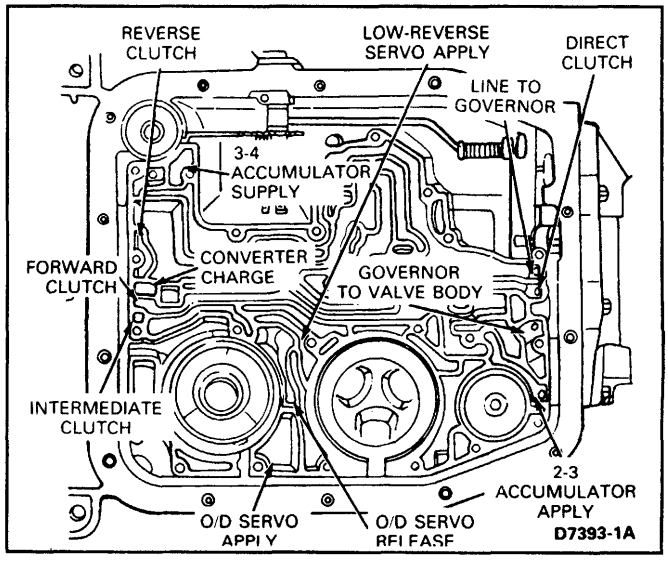


FIG. 16 Air Pressure Checks—Case Apply Passages—Automatic Overdrive Transmission (AOD)

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by substituting air pressure for fluid pressure through a series of passages to determine the location of the malfunction (Fig. 17).

A NO DRIVE condition in Ⓓ (overdrive) may be caused by an inoperative forward clutch or one-way clutch. When there is a NO DRIVE in 1st. (first), the difficulty could be caused by improper functioning of the forward clutch or low-reverse band and the one-way clutch.

Air pressure checks can also isolate slip problems as to whether the source of the problem is in the valve body or in the hydraulic system beyond the valve body.

The passages can be tested adequately with air pressure regulated at 40 psi. However, it may be necessary to use higher air pressure (90 psi) if there is difficulty in hearing the clutches apply.

Use the main control gasket and service Tool T82L-7006-A with T82P-7006-C cap screws (M6 x 16) to seal the case apply passages (Figs. 18 and 19). Tighten the cap screws 9-11 N·m (80-100 in. lb.) (Fig. 20). Apply air to the apply passages in the service tool plate using the air nozzle service tool Tool-7000-DE with the rubber tip Tool-7000-DD or equivalent.

All locations of the case apply passages are stamped on the service tool plate. The transmission case apply holes are illustrated in Fig. 21.

Notes on Air Checks:

If the servos or the accumulators do not operate, disassemble, clean and inspect them to locate the source of the trouble. If air pressure applied to either of the clutch passages fails to operate a clutch or operates both clutches at once, remove and with air pressure, check the fluid passages in the case and front pump to detect obstructions.

Clutches—Reverse Clutch, Forward Clutch, Intermediate Clutch and Direct Clutch

Apply air pressure to the appropriate passage in the service tool (Fig. 18). A dull thud can be heard or felt on the case as the clutch piston is applied (Fig. 21). Movement of the reverse clutch drum may also be detected when the reverse clutch passage is pressure tested (Fig. 21).

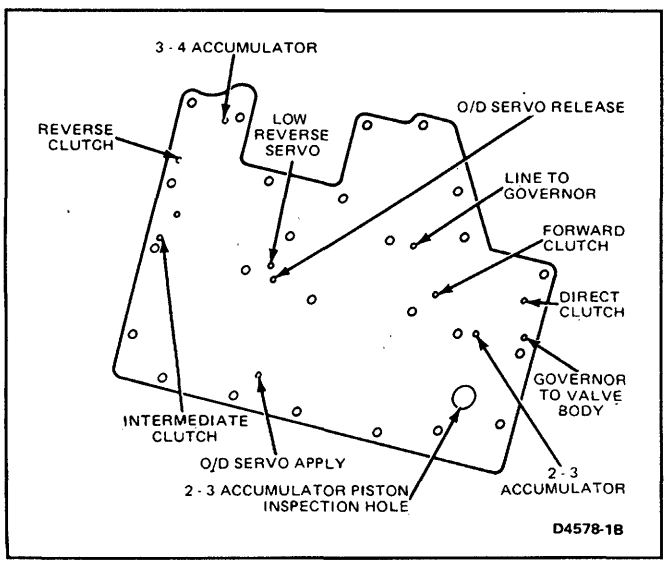


FIG. 17 Air Pressure Check Plate—AOD Transmission Service Tool T82L-7006-A

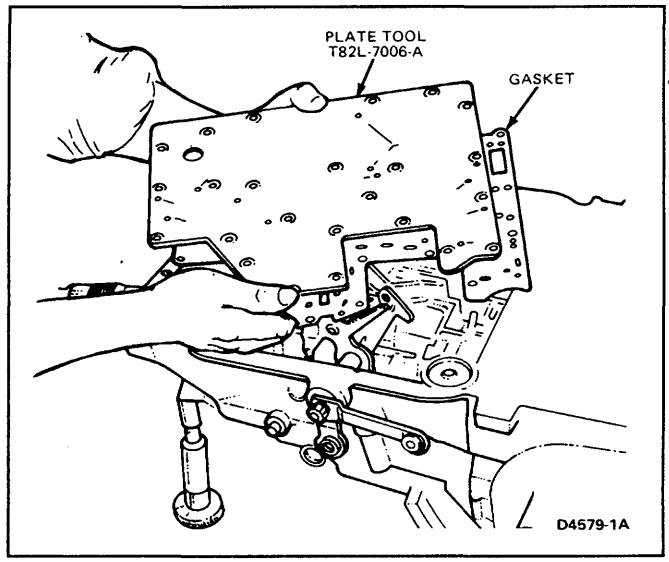


FIG. 18 Installing Air Pressure Plate Service Tool and Main Control Gasket—AOD

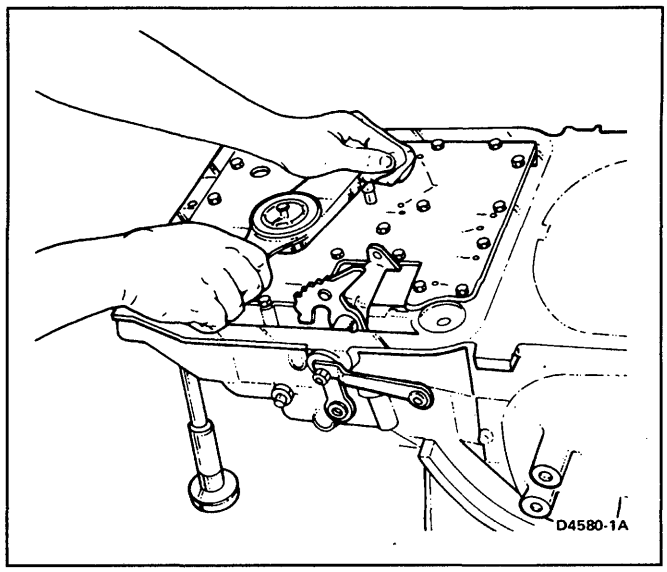


FIG. 19 Tighten T82P-7006-C Cap Screws—AOD

3-4 Accumulator

Apply air pressure to the 3-4 accumulator apply passage. The accumulator piston should unseat (Fig. 22).

2-3 Accumulator

Apply air pressure to the 2-3 accumulator apply passage. The accumulator piston should unseat. This can be detected by inserting a metal rod into the 2-3 piston hole. When the piston unseats the rod will move. Also, a thud can be heard when the piston applies (Fig. 23).

Overdrive Servo

Apply air pressure to the overdrive O/D servo apply passage in the service tool plate. Operation of the band is indicated by the tightening of the band around the reverse clutch drum (Fig. 24). The O/D servo will return to the release position as a result of spring force from the release spring. Also, when the servo returns to the

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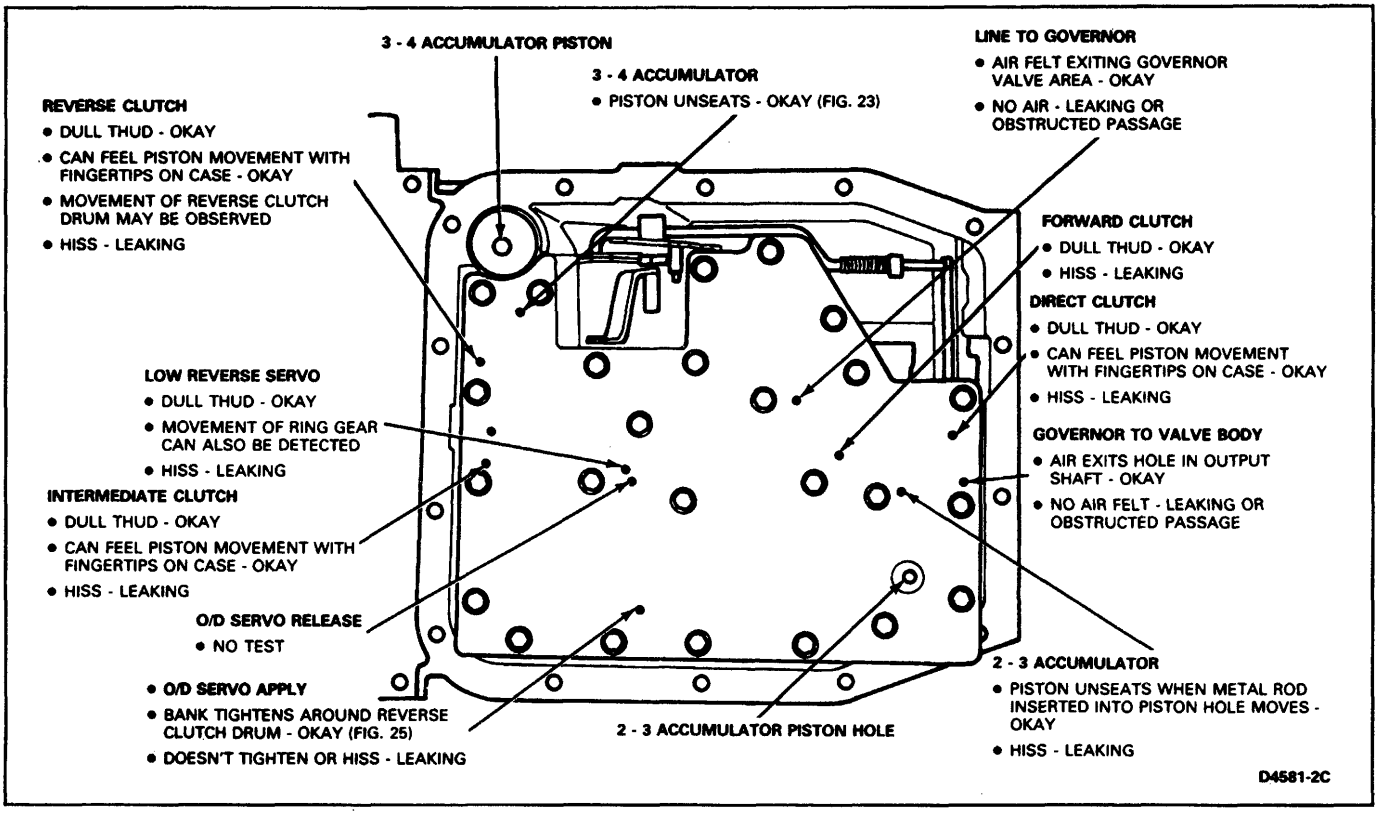


FIG. 20 Air Pressure Test—AOD

release position, a thud can be felt on the O/D servo cover. The band will then relax.

Low-Reverse Servo

Apply air pressure to the low-reverse servo apply passage in the service tool plate. A dull thud can be heard when the low-reverse band tightens around the planetary assembly drum surface. Also, movement of the ring gear can be detected (Fig. 25).

Governor

Apply air pressure to the line to governor passage while holding finger near the governor valve (Fig. 26). If air is felt exiting the valve area, the passage is unobstructed.

To Air pressure check the governor to valve body passage, remove the governor. Apply air pressure to the passage while holding finger over holes in the output shaft (Fig. 27). If air exists in one of the holes, the passage is unobstructed.

Diagnosis Guides

The diagnosis guides in this Section can be used as an aid when diagnosing automatic transmissions.

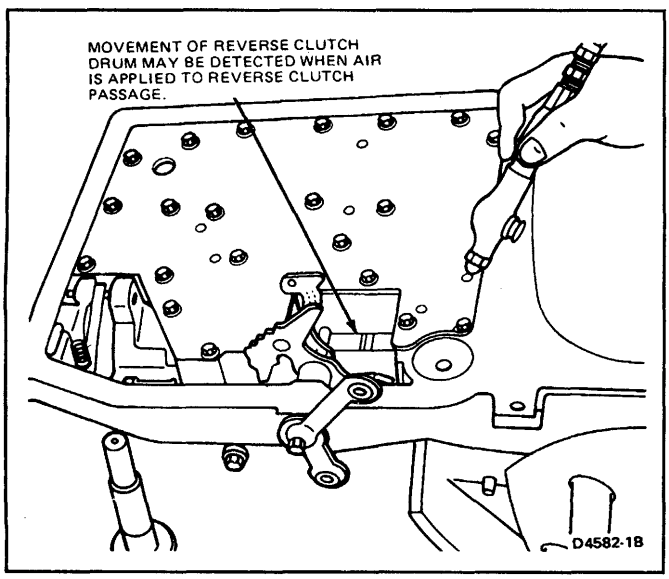


FIG. 21 Air Pressure Test—Reverse Clutch—AOD

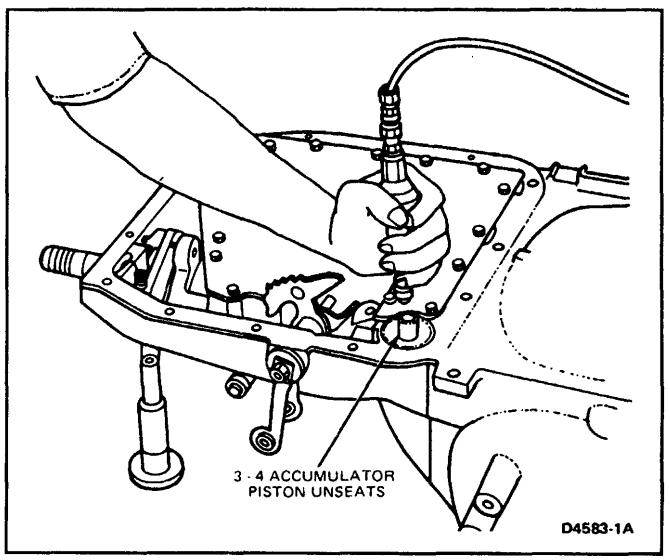


FIG. 22 Air Pressure Test—3-4 Accumulator—AOD

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
Slow initial engagement.	1. Improper fluid level.	1. Perform fluid level check.
	2. Damaged or improperly adjusted linkage.	2. Service or adjust linkage.
	3. Contaminated fluid.	3. Perform fluid condition check.
	4. Improper clutch and band application, or low main control pressure.	4. Perform control pressure test.
Rough initial engagement in either forward or reverse. Rough initial engagement — AOD.	1. Improper fluid level.	1. Perform fluid level check.
	2. High engine idle.	2. Adjust idle to specifications. Check VRV for 7.3L Diesel, C6 applications (Section 17-10).
	3. Automatic choke on (warm temp.).	3. Disengage choke.
	4. Looseness in the driveshaft, U-joints or engine mounts.	4. Service as required.
	5. Improper clutch or band application, or oil control pressure.	5. Perform control pressure test.
	6. Sticking or dirty valve body.	6. Clean, service or replace valve body.
Harsh engagements — (warm engine).	1. Improper fluid level.	1. Perform fluid level check.
	2. TV cable — short.	2. Adjust TV cable.
	3. Engine curb idle too high.	3. Check engine curb idle. Check VRV for 7.3L Diesel, C6 applications (Section 17-10).
	4. Valve body bolts — loose/too tight.	4. Tighten to specification.
	5. Valve body dirty/sticking valves.	5. Determine source of contamination. Service as required.
No/delayed forward engagement (reverse OK).	1. Improper fluid level.	1. Perform fluid level check.
	2. Manual linkage — misadjusted/ damaged.	2. Check and adjust or service as required.
	3. Low main control pressure. (Leakage.) Forward clutch stator support seal rings leaking (#3, #4).	3. Control pressure test, note results.
	4. Forward clutch assembly burnt/ damaged/leaking check ball in cylinder/ leaking piston seal rings.	4. Perform air pressure test.
	5. Valve body bolts — loose/too tight.	5. Tighten to specification.
	6. Valve body dirty/sticking valves.	6. Determine source of contamination. Service as required.
	7. Transmission filter plugged.	7. Replace filter.
	8. Pump damaged/leaking.	8. Visually inspect pump gears. Replace pump if necessary.
No/delayed reverse engagement (forward OK).	1. Improper fluid level.	1. Perform fluid level check.
	2. Manual linkage misadjusted/damaged.	2. Check and adjust or service as required.
	3. Low main control pressure in reverse. Reverse clutch stator support seal rings leaking (#1, #2), (AOD). High reverse clutch OK.	3. Control pressure test.

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DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
No/delayed reverse engagement (forward OK) (continued).	4. Reverse clutch assembly burnt/worn/ leaking check ball in piston/leaking piston seal rings.	4. Perform air pressure test.
	5. Valve body bolts loose/too tight.	5. Tighten to specification.
	6. Valve body dirty/sticking valves.	6. Determine source of contamination. Service as required.
	7. Transmission filter plugged.	7. Replace filter.
	8. Pump damaged.	8. Visually inspect pump gears. Replace if necessary.

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REMOVAL AND INSTALLATION

Vacuum Diaphragm C6

Removal and Installation

1. Disconnect the hose from the vacuum unit.
2. Remove the vacuum unit retaining bracket bolt and bracket (Fig. 29). **Do not pry or bend the bracket.** Pull the vacuum unit from the transmission case.
3. Remove the vacuum unit control rod from transmission case.
4. Install the vacuum unit control rod in transmission case.
5. Push the vacuum unit into the case and secure with the retaining bracket and bolt. Tighten the bolt to 17-21 N·m (12-16 ft-lbs) on C6 transmissions.
6. Install the vacuum unit hose to the diaphragm connector.

Transmission Fluid Drain and Refill

Normal maintenance and lubrication requirements do not necessitate periodic automatic transmission fluid changes.

If a major repair, such as a clutch band, bearing, etc., is required in the transmission, it will have to be removed for service. At this time the converter, transmission cooler and cooler lines must be thoroughly flushed to remove any dirt.

On light trucks equipped with automatic transmissions the following should apply:

When used under continuous or severe conditions, the transmission and the torque converter should be drained and refilled with the specified fluid at intervals directed in the maintenance or owners manual.

Refer to the Truck Performance Specifications Book or the end of this Section for fluid requirements.

NOTE: Fluid level indicator should be used to determine actual fluid requirements. Check fluid level when the transmission is at normal operating temperature. Do not overfill.

Procedures for partial drain and refill, due to in-vehicle repair operation, are as follows:

C6 Transmissions

1. Raise the vehicle on a hoist or jack stands.
2. Place a drain pan under the transmission.

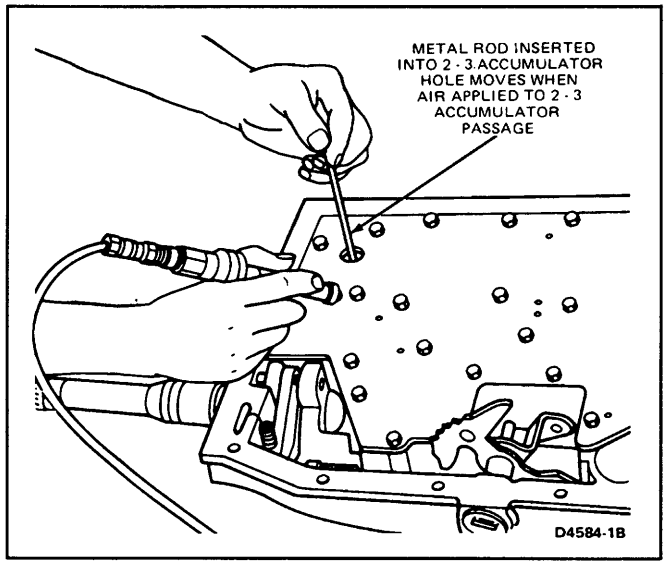


FIG. 23 Air Pressure Test—2-3 Accumulator—AOD

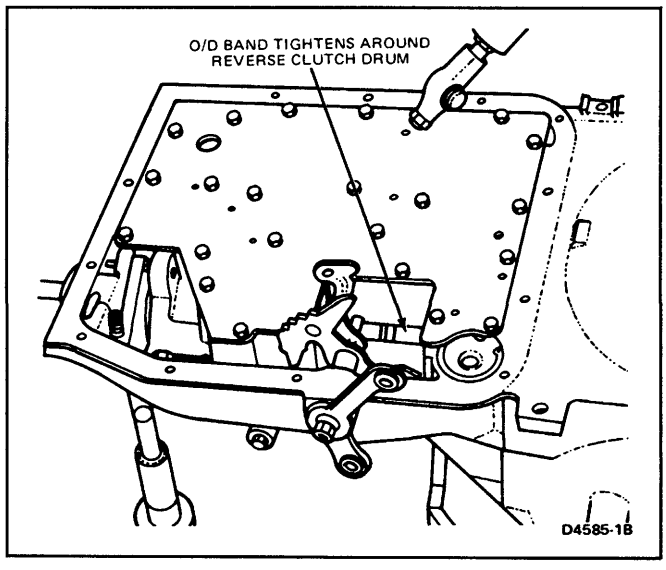


FIG. 24 Air Pressure Test—O/D Servo Apply—AOD

3. Loosen the pan attaching bolts and drain the fluid from the transmission.
4. When fluid has drained to the level of the pan flange, remove the rest of the pan bolts working from the rear and both sides of the pan to allow it to drop and drain slowly.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
No/delayed reverse engagement and/or no engine breaking in manual low (1).	1. Improper fluid level.	1. Perform fluid level check.
	2. TV cable out of adjustment (AOD).	2. Service or adjust TV cable.
	3. Low reverse servo piston seal leaking.	3. Check and replace piston seal.
	4. Low reverse band/servo piston burnt/ worn (AOD).	4. Perform air pressure test.
	5. Planetary low one way clutch damaged.	5. Determine cause of condition. Service as required.
No engine braking in manual second gear.	1. Intermediate band out of adjustment.	1. Adjust intermediate band.
	2. Improper band or clutch application, or oil pressure control system.	2. Perform control pressure test.
	3. Intermediate servo leaking.	3. Perform air pressure test of intermediate servo for leakage. Service as required.
	4. Intermediate one way clutch damaged.	4. Replace.
	5. Polished or glazed band or drum.	5. Service or replace as required.
Forward engagement slips/shudders/ chatters.	1. Improper fluid level.	1. Perform fluid level check.
	2. TV cable misadjusted (long) (AOD).	2. Adjust TV cable.
	3. Manual linkage misadjusted/damaged.	3. Check and adjust or service as required.
	4. Low main control pressure.	4. Control pressure test.
	5. Valve body bolts — loose/too tight.	5. Tighten to specification.
	6. Valve body dirty/sticking valves.	6. Determine source of contamination. Service as required.
	7. Forward clutch piston ball check not seating/leaking.	7. Replace forward clutch cylinder. Service transmission as required.
	8. Forward clutch piston seals cut/worn.	8. Replace seals and service clutch as required.
	9. Forward clutch stator support seal rings #3, #4 leaking (AOD).	9. Replace stator support seal rings.
	10. Low one way clutch (planetary) damaged.	10. Determine cause of condition. Service as required.
Reverse shudder/chatters/slips.	1. Improper fluid level.	1. Perform fluid level check.
	2. Low main control pressure in reverse.	2. Control pressure test.
	3. Low — reverse servo/ leaking.	3. Air pressure test; visually inspect seal rings and piston bore.
	4. Low (planetary) one-way clutch damaged.	4. Determine cause of condition. Service as required.
	5. Reverse clutch drum bushing damaged.	5. Determine cause of condition. Service as required.
	6. Reverse clutch stator support seal rings/ring grooves worn/damaged.	6. Determine cause of condition. Service as required.
	7. Reverse clutch piston seals cut/worn.	7. Determine cause of condition. Service as required.
	8. Reverse band out of adjustment or damaged.	8. AOD has no adjustment. Service as required.
	9. Looseness in the driveshaft, U-joints or engine mounts.	9. Service as required.

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5. When all fluid has drained from the transmission, remove and thoroughly clean the pan and the screen. Discard the pan gasket.
6. Place a new gasket on the pan, and install the pan on the transmission. Tighten the bolts to specifications.
7. Add 4.7 liters (5 quarts) shallow pan, or 5.6 liters (6 quarts) deep pan of fluid to the transmission through the filler tube.
8. Check the fluid level.

AOD Transmissions

1. Raise the vehicle on a hoist or jack stands.
2. Place a drain pan under the transmission.
3. Loosen the pan attaching bolts and drain the fluid from the transmission.
4. When fluid has drained to the level of the pan flange, remove the rest of the pan bolts working from the rear and both sides of the pan to allow it to drop and drain slowly.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
No drive, slips or chatters in first gear in D. All other gears normal. First gear in D or Ⓓ Automatic Overdrive transmission.	1. Damaged or worn planetary one-way clutch.	1. Service or replace one-way clutch.
No drive, slips or chatters in second gear.	1. Intermediate band out of adjustment (C6). 2. Intermediate friction clutch or one-way clutch (AOD). 3. Intermediate clutch piston bleed hole blocked or not positioned at 12 o'clock (AOD). 4. Improper band or clutch application, or control pressure. 5. Damaged or worn intermediate servo piston seals and/or internal leaks. 6. Dirty or sticking valve body. 7. Polished, glazed intermediate band or drum (C6).	1. Adjust intermediate band. 2. Service as required. 3. Clean and install bleed hole at 12 o'clock position. 4. Perform control pressure test. 5. Perform air pressure test. 6. Clean, service or replace valve body. 7. Replace or service as required.
Starts up in 2nd or 3rd.	1. Improper band and/or clutch application, or oil pressure control system. 2. Intermediate clutch pack clearance too tight (AOD). 3. Damaged or worn governor. Sticking governor. 4. Valve body loose. 5. Dirty or sticking valve body. 6. Cross leaks between valve body and case mating surface.	1. Perform control pressure test. 2. Check intermediate clutch pack clearance. 3. Perform governor check. Replace or service governor, clean screen. 4. Tighten to specification. 5. Clean, service or replace valve body. 6. Service or replace valve body and/or case as required.
Shift points incorrect.	1. Improper fluid level. 2. Vacuum line damaged, clogged or leaks (C6). 3. Improper operation of EGR system (C6). 4. TV cable out of adjustment (AOD). 5. Improper speedometer gear installed. 6. Improper clutch or band application, or oil pressure control system. 7. Damaged or worn governor. 8. TV control rod or vacuum diaphragm bent sticking or leaks, (C6). 9. Dirty or sticking valve body. 10. Vacuum regulator valve misadjusted or damaged, (C-6 with 7.3L Diesel).	1. Perform fluid level check. 2. Perform vacuum supply test. Check VRV adjustment on 7.3L Diesel, C6 application. 3. Service or replace as required. 4. Service or adjust TV cable. Check VRV adjustment on 7.3L Diesel, C6 application. 5. Replace gear. 6. Perform shift test and control pressure test. 7. Service or replace governor — clean screen. 8. Replace. 9. Clean, service or replace valve body. 10. Check adjustment and function. Adjust or replace.
All upshifts harsh/delayed or no upshifts.	1. Improper fluid level. 2. AOD Only — TV cable — short. 3. Manual linkage — misadjusted/ damaged. 4. Governor sticking. 5. Main control pressure too high. 6. Valve body bolts — loose/too tight. 7. Valve body dirty/sticking valves.	1. Perform fluid level check. 2. Adjust TV cable. Service as required. 3. Check and adjust or service as required. 4. Perform governor test. Service as required. 5. Control pressure test. Service as required. 6. Tighten to specification. 7. Determine source of contamination. Service as required.

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DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
All upshifts harsh/delayed or no upshifts (continued).	8. Vacuum leak to diaphragm unit (C6).	8. Check vacuum lines to diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests. Check VRV adjustment on 7.3L Diesel, C6 application.
	9. Vacuum regulator valve misadjusted or damaged, (C6 with 7.3L Diesel).	9. Check adjustment and function. Adjust or replace.

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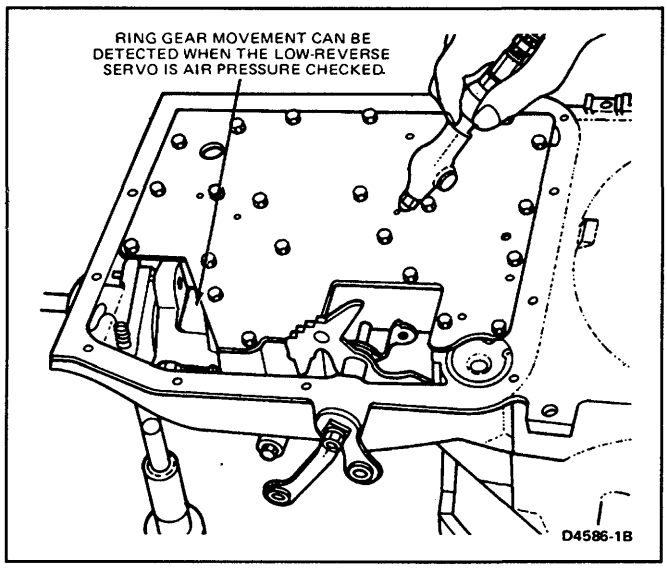


FIG. 25 Air Pressure Test—Low Reverse Servo—AOD

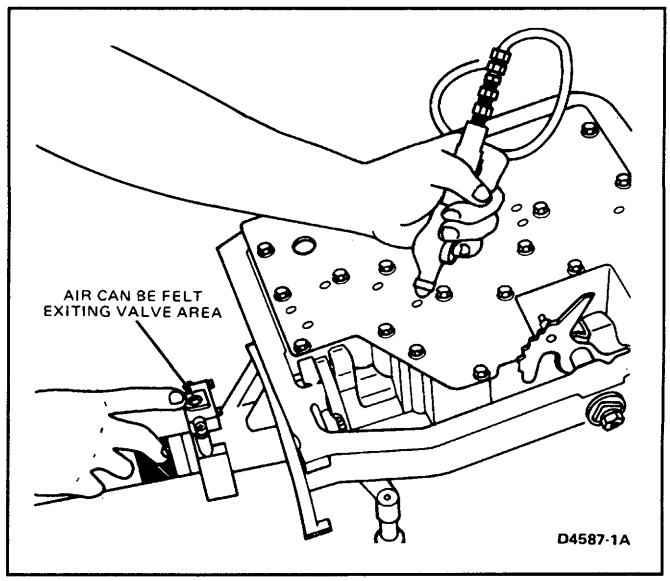


FIG. 26 Air Pressure Test—Line to Governor—AOD

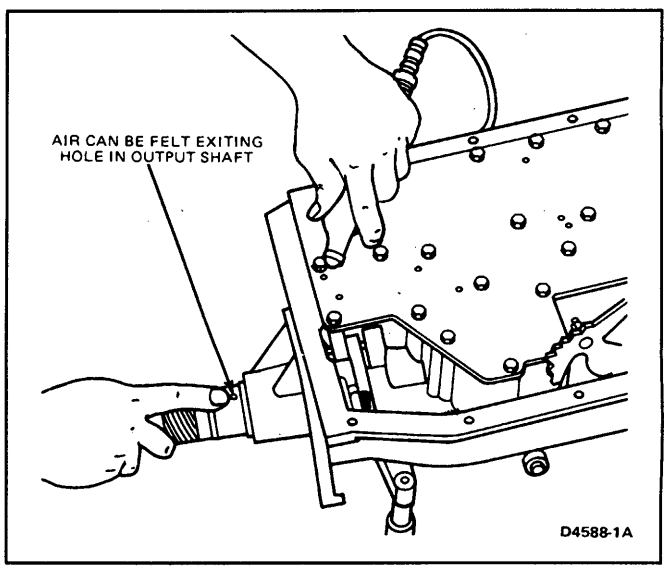


FIG. 27 Air Pressure Test—Governor to Valve Body—AOD

5. When all fluid has drained from the transmission, remove and thoroughly clean the pan. Discard the AOD filter, filter gasket, oil pan gasket and valve body gasket.
6. Install new oil pan gasket, filter and filter gasket on AOD. **Do not reuse the old one.**
7. Place a new gasket on the pan, and install the pan on the transmission. Tighten bolts to specifications.
8. Add 2.8 liters (3 quarts) of fluid to the transmission through the filler tube.
9. Check the fluid level following the checking procedures as described in this Section.

If it is necessary to perform a complete drain and refill, it will be necessary to remove the residual fluid from the torque converter and the cooler lines. To drain the torque converter:

1. Remove the low engine dust cover.
2. Rotate the torque converter until the drain plug comes into view.
3. Remove the drain plug and allow the transmission fluid to drain. Note: It is recommended that this procedure be performed prior to other operations to allow sufficient time for the converter to drain properly.
4. Flush the cooler lines completely.
5. When adding fluid, fill to the capacity required for that transmission.

Fluid Cooler Lines

When fluid leakage is found from the fluid cooler, the cooler must be replaced. Cooler replacement is described in the Cooling System Section of Group 27.

When one or more of the fluid cooler steel tubes must be replaced, each replacement tube must be fabricated from the same size steel tubing as the original line.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
Mushy/early all upshifts/pile up upshifts.	1. TV cable misadjusted (long)/sticking/ damaged (AOD).	1. Adjust TV cable. Service as required. Check VRV for 7.3L Diesel, C6 application.
	2. Low main control pressure.	2. Control pressure test. Note results.
	3. Valve body bolts loose/too tight.	3. Tighten to specification.
	4. Valve body valve or throttle control valve sticking.	4. Determine source of contamination. Service as required.
	5. Governor valve sticking.	5. Perform governor test. Repair as required.
	6. TV control rod too short.	6. Install correct TV control rod.
	7. Vacuum regulator valve misadjusted or damaged. (C6 with 7.3L Diesel.)	7. Check adjustment and function. Adjust or replace.
No 1-2 upshift.	1. Improper fluid level.	1. Perform fluid level check.
	2. For 7.3L Diesel, C6 application — VRV.	2. Check VRV for 7.3L Diesel, C6 application.
	3. Manual linkage — misadjusted/ damaged.	3. Check and adjust or service as required.
	4. Low main control pressure to intermediate friction clutch (AOD).	4. Control pressure test. Note results.
	5. Governor valve sticking. Intermediate band out of adjustment (C6).	5. Perform governor test. Service as required. Adjust intermediate band.
	6. Vacuum diaphragm bent, sticking, leaks.	6. Check diaphragm unit. Service as necessary.
	7. Valve body bolts — loose/too tight.	7. Tighten to specification.
	8. Valve body dirty/sticking valves.	8. Determine source of contamination. Service as required.
	9. Intermediate clutch/band and or servo assembly burnt.	9. Perform air pressure test.
Rough/harsh/delayed 1-2 upshift.	1. Improper fluid level.	1. Perform fluid level check.
	2. Poor engine performance.	2. Tune engine.
	3. For 7.3L Diesel, C6 application — VRV.	3. Check VRV for 7.3L Diesel, C6 application.
	4. Intermediate band out of adjustment (C6).	4. Adjust intermediate band.
	5. Main control pressure too high.	5. Control pressure test. Note results.
	6. Governor valve sticking.	6. Perform governor test. Service as required.
	7. Engine vacuum leak (C6).	7. Check engine vacuum lines. Service as necessary. Check vacuum diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests.
	8. Valve body bolts — loose/too tight.	8. Tighten to specifications.
	9. Valve body dirty/sticking valves.	9. Determine source of contamination. Service as required.
	10. Vacuum regulator valve misadjusted or damaged C6 with 7.3L Diesel.	10. Check adjustment and function. Adjust or replace.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
Mushy/early/soft/slipping 1-2 upshift.	1. Improper fluid level.	1. Perform fluid level check.
	2. Incorrect engine performance.	2. Tune adjust engine idle as required.
	3. For 7.3L Diesel, C6 application — VRV.	3. Check VRV for 7.3L Diesel, C6 application.
	4. Intermediate band out of adjustment (C6)	4. Adjust intermediate band.
	5. Low main control pressure.	5. Control pressure test. Note results.
	6. Valve body bolts loose/too tight.	6. Tighten to specification.
	7. Valve body dirty/sticking valves.	7. Determine source of contamination. Service as required.
	8. Intermediate friction clutch burnt/worn (AOD).	8. Determine cause of condition. Service as required.
	9. Governor valve sticking	9. Perform governor test. Service as required.
	10. Damaged intermediate servo or band.	10. Perform air pressure test. Service as required.
	11. Polished, glazed band or drum (C6).	11. Service or replace as required.
	12. Vacuum regulator valve misadjusted or damaged. (C-6 with 7.3L Diesel.)	12. Check adjustment and function. Adjust or replace.
No 2-3 upshift.	1. Low fluid level.	1. Perform fluid level check.
	2. For 7.3L Diesel, C6 application — VRV.	2. Check VRV for 7.3L Diesel, C6 application.
	3. Low main control pressure to direct clutch.	3. Control pressure test. Note results.
	4. Valve body bolts — loose/too tight.	4. Tighten to specification.
	5. Valve body dirty/sticking valves.	5. Determine source of contamination, then service as required.
	6. Direct clutch (or reverse/high clutch) assembly burnt/worn.	6. Stall test. Determine cause of condition. Service as required.
	7. Converter damper hub/weld broken (AOD).	7. Perform converter damper hub/weld check. Replace torque converter if required.
Harsh/delayed 2-3 upshift.	1. Incorrect engine performance.	1. Check engine tune-up.
	2. Engine vacuum leak (C6).	2. Check engine vacuum lines. Service as necessary. Check vacuum diaphragm unit. Service as necessary. Perform vacuum supply and diaphragm tests. Check VRV for 7.3L Diesel, C6 application.
	3. For 7.3L Diesel, C6 application — VRV.	3. Check VRV for 7.3L Diesel, C6 application.
	4. 2-3 accumulator piston apply passage plugged/omitted (AOD).	4. Remove 2-3 accumulator piston and visually inspect or air test for plugging condition or omission.
	5. 2-3 accumulator piston seals cut/worn (AOD).	5. Replace seals, determine cause of condition. Service as required.
	6. Damaged 2-3 accumulator (AOD).	6. Service as required.

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DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
Harsh/delayed 2-3 upshift (continued).	7. Damaged or worn intermediate servo release and high clutch piston check ball (C6).	7. Air pressure test the intermediate servo apply and release the high clutch piston check ball. Service as required.
	8. Valve body bolts — loose/too tight.	8. Tighten to specification.
	9. Valve body dirty/sticking valves. 2-3 capacity modulator valve (AOD).	9. Determine source of condition. Service as required.
	10. Vacuum diaphragm or TV control rod bent, sticking, leaks.	10. Check diaphragm and rod. Replace as necessary.
	11. Vacuum regulator valve misadjusted or damaged. (C-6 with 7.3L Diesel.)	11. Check adjustment and function. Adjust or replace.

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Using the old tube as a guide, bend the new tube as required. Add the necessary fittings, and install the tube.

After the fittings have been tightened, add fluid as needed, and check for fluid leaks.

CLEANING AND INSPECTION

Transmission

It is important to completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, governor, all clutches, and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service. The cleaning of debris from the direct clutch piston, the forward clutch cylinder, and reverse clutch piston check balls are often omitted. This omission can lead to a repeat servicing of the transmission.

During overhaul inspect all hardware for evidence of overheating. Any overheating will be indicated by heat stained blue surfaces.

Clean the parts with suitable solvent and use moisture-free air to dry off all the parts and clean out fluid passages.

The composition clutch plates, bands and synthetic seals should not be cleaned in a vapor degreaser or with any type of detergent solution. To clean these parts, wipe them off with a lint-free cloth. New clutch plates or bands should be soaked in transmission fluid specified for that transmission type for fifteen minutes before being assembled.

Do not reuse the control valve body to filter gasket or try to clean in solvent and reuse the oil filter on AOD. Upon reassembly of the transmission replace both the valve body to filter gasket and the oil filter on the AOD transmission.

Control Valve Body

1. Clean all parts thoroughly in clean solvent, and blow dry with moisture-free compressed air. **If the valve body-to-screen gasket is removed on a C6 Transmission, the gasket should not be cleaned in a degreaser, solvent or any type of detergent solution. To clean the gasket, wipe it off with a lint-free cloth. For AOD, replace the valve body to filter gasket.**
2. Inspect all valve and plug bores for scores. Check all fluid passages for obstructions. Inspect the check valve for free movement. Inspect all mating surfaces for burrs or distortion. Inspect all plugs and valves for burrs or scores. Use crocus cloth to polish valves and plugs. Avoid rounding the sharp edges of the valves and plugs with the cloth.
3. Inspect all springs for distortion. Check all valves and plugs for free movement in their respective bores. Valves and plugs, when dry, must fall from their own weight in their respective bores.
4. On a C6 transmission, inspect the separator plate screen for obstructions. The screen must be clean and free of foreign material. If contaminated, remove it from separator plate, clean in a suitable solvent, and thoroughly blow clean with compressed air.
5. Roll the manual valve on a flat surface to check for bent condition.

Intermediate Servo

C6

1. Inspect the servo bore for cracks and the servo piston for damage, and the piston bore and the servo piston stem for scores. Check fluid passages for obstructions. Replace damaged seals.
2. Check the servo spring and servo band strut(s) for distortion.
3. Inspect the cover seal and gasket cover sealing surface for damage.

Low-Reverse Servo

AOD

1. Inspect the servo body for cracks and the piston bore for scores.
2. Check the fluid passages for obstructions.
3. Inspect the band and the struts for distortion. Inspect the band ends for cracks.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
Soft/early/mushy 2-3 upshift.	1. For 7.3L Diesel, C6 application — VRV.	1. Check VRV for 7.3L Diesel, C6 application.
	2. Valve body bolts loose/too tight.	2. Tighten to specification.
	3. Valve body dirty/sticking valves.	3. Determine source of contamination. Service as required.
	4. AOD ONLY — Direct clutch assembly or reverse/high clutch/burnt worn.	4. Stall test. Determine cause of condition. Service as required.
	5. Vacuum diaphragm or TV control rod bent, sticking, leaks.	5. Check diaphragm and rod. Replace as necessary.
	6. Vacuum regulator valve misadjusted or damaged. (C-6 with 7.3L Diesel).	6. Check adjustment and function. Adjust or replace.
AOD ONLY — No. 3-4 upshift (stays in 3rd gear).	1. Direct clutch circuit leakage. NOTE: Direct clutch plates burnt will help to confirm leakage in the direct clutch circuit. Replacing only the plates and not finding the cause will result in a repeat repair.	1. Perform Direct Clutch Pressure Test. • Check torque on valve body bolts. Torque not to spec. (loose); can cause leakage. • Check for nicks or porosity in the case passages. (Valve body to case mating surface.) Replace case for the above. • Direct clutch piston check ball leaking. Perform check ball leakage procedure; found in cleaning and inspection portion. Replace piston if leakage confirmed. • Direct clutch piston seal rings (inner and outer) leaking. Replace. • Check the direct clutch output shaft seal rings (#5, #6). They should move freely on the output shaft. Check for metal shaving contamination or burrs between the seal and the output shaft. Replace as necessary. • Check the large seal rings on the output shaft for freedom of movement. Check for contamination such as metal shavings on the output shaft. Replace as necessary. NOTE: The four large seal rings are numbered #7, #8, #9, #10. Seal rings #7, #8 (closest to the output shaft hub) are for the direct clutch. Seal rings #9, #10 (closest to the governor) are for the governor. • Inspect the output shaft feed passages and the cup plug for leakage.
	2. Valve body contamination/sticking valves.	2. Clean the valve body. Check for sticking valves as follows: Overdrive servo regulator valve; 3-4 shift valve; 3-4 TV modulator valve; orifice control valve. If any valves are sticking and they cannot be freed, replace valve body.

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4. Inspect the servo spring for distortion.
5. Inspect the band lining for excessive wear and bonding to the metal band.
6. Replace damaged seals.

Overdrive Servo

AOD

1. Inspect the servo cover for cracks and the piston bore for scores.
2. Check the fluid passages for obstructions.
3. Inspect the band for wear or damage. The apply rod should be securely attached to the piston.
4. Inspect the servo spring for distortion.
5. Inspect the band lining for excessive wear and bonding to the metal band.
6. Replace damaged seals.

Extension Housing

1. Inspect the housing for cracks. Inspect the gasket surface for burrs or warpage.

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DIAGNOSIS — AUTOMATIC TRANSMISSION (Continued)

CONDITION	POSSIBLE CAUSE	RESOLUTION
AOD Only — No. 3-4 upshift (stays in 3rd gear) (continued).	4. Main control gasket distortion.	4. Check to see if main control gasket is blocking an orifice. Replace gasket.
	5. Case being out-of-flat can cause sticking valve.	5. Reduce valve body bolt torque to minimum side of spec. 80 in-lbs.
	6. Governor leakage.	6. Check last two large seal rings on the output shaft (#9, #10). They should move freely. Check for metal shaving contamination or burrs between the seal and output shaft. Replace as necessary. • Check the seal ring bore at the rear of case for scoring. Light scoring is permissible. Deep grooving indicates case wear. Replace case for deep grooving. • Check the governor to output shaft retaining ring to make sure it is properly seated on the output shaft. Repair as necessary. • Check the fit of the governor counterweight on the output shaft. If the fit is sloppy, replace the counterweight.
AOD Only — Harsh/delayed 3-4 upshift.	1. Valve body bolts — loose/too tight.	1. Tighten to specification.
	2. Valve body dirty/sticking valves.	2. Determine source of contamination. Service as required.
	3. Incorrect engine performance.	3. Tune, adjust engine idle as required.
	4. 3-4 accumulator piston seals worn/cut.	4. Determine cause of condition. Service as required.
	5. 3-4 accumulator piston apply passage blocked.	5. Determine cause of condition. Service as required.
Slipping 4th gear (engine flare-up/no 4th gear drive capability).	1. Overdrive circuit leakage or blocked passage. NOTE: Burnt overdrive band will help to confirm leakage in the overdrive circuit. Replacing only the overdrive band without finding the cause will result in a repeat repair.	1. Check valve body bolt torque. Torque not to spec. (loose); can cause leakage. Spec. is 80-100 in-lbs. • Overdrive servo cover O-rings leaking. Replace O-rings. • Overdrive servo piston seal leaking. Replace seal. • Overdrive servo cover cracked/ porous. Coat cover with fluid. Apply air to overdrive servo, apply passage using tool (T80L-77030-B). Observe to see if air bubbles are present on overdrive servo cover. Replace cover if air bubbles are present.
	2. Overdrive servo piston not applying overdrive band/band not applying.	2. Overdrive servo case apply passage blocked. Air pressure test. Replace case if necessary.
	3. Overdrive band mislocated.	3. Overdrive servo piston not seated to the band end seat. Repair. • Overdrive band not seated to anchor pin. Repair.
	4. Converter damper plate and hub fracturing, the weld and/or rivets fatiguing, or the damper springs breaking.	4. Perform converter damper/hub assembly weld check procedure. Use special service tools T83L-7902-A. Replace converter if shaft turns more than two degrees or if there is a grinding noise while applying 50 lbs. ft. torque.
	5. Direct driveshaft splines distorted.	5. Check splines on both ends of the direct driveshaft. Check splines in direct clutch cylinder. Replace direct driveshaft and hardware that splines to it for distortion.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
Erratic shifts.	1. Poor engine performance.	1. Check engine tune-up.
	2. TV cable — binding/sticking (AOD).	2. Inspect throttle linkage. Service as required. Check VRV for 7.3L Diesel, C6 application.
	3. Valve body bolts — loose/too tight.	3. Tighten to specification.
	4. Valve body dirty/sticking valves.	4. Line pressure test, note results. Determine source of contamination. Service as required.
	5. Governor valve stuck.	5. Perform governor test. Service as required.
	6. Output shaft collector body seal rings damaged.	6. Service as required.
Shifts 1-3 in D. (D or Ⓓ range for AOD).	1. Intermediate band out of adjustment (C6).	1. Adjust band.
	2. Intermediate friction clutch burnt/ damaged (AOD).	2. Determine cause of condition. Service as required.
	3. Intermediate one-way clutch damaged (AOD).	3. Determine cause of condition. Replace/ service as required.
	4. Damaged intermediate servo and/or internal leaks (C6).	4. Perform air pressure test. Service front servo and/or internal leaks.
	5. Improper band or clutch application, or oil pressure control system.	5. Perform control pressure test.
	6. Polished, glazed band or drum (C6).	6. Service or replace band or drum.
	7. Dirty or sticking valve body.	7. Clean, service or replace valve body.
	8. Governor valve stuck.	8. Perform governor test. Service as required.
Engine over-speeds on 2-3 shift.	1. Linkage out of adjustment.	1. Service or adjust linkage. Check VRV for 7.3L Diesel, C6 application.
	2. Improper band or clutch application, or oil pressure control system.	2. Perform control pressure test.
	3. Intermediate servo piston seals cut/ leaking.	3. Replace seals. Check for leaks.
	4. Dirty or sticking valve body.	4. Clean, service or replace valve body.
	5. Converter damper/hub brake (AOD).	5. Perform converter damper/hub weld check. Replace converter if necessary.
AOD Only — Shift hunting 3-4, 4-3.	1. Poor engine performance — EGR solenoid defective.	1. Tune-up engine — Replace solenoid.
	2. Manual linkage misadjusted.	2. Check and adjust or service as required.
Rough/shudder 3-1 shift at closed throttle in D. (D range for AOD).	1. Incorrect engine idle or performance.	1. Tune, and adjust engine idle.
	2. Improper linkage adjustment.	2. Service or adjust linkage. Check VRV for 7.3L Diesel, C6 application.
	3. Improper clutch or band application or oil pressure control system.	3. Perform control pressure test.
	4. Improper governor operation.	4. Perform governor test. Service as required.
	5. Dirty or sticking valve body.	5. Clean, service or replace valve body.
AOD Only — Rough or mushy 4-2 or 3-1 shift.	1. Incorrect engine performance.	1. Tune, adjust engine idle as required.
	2. Improper throttle or manual linkage adjustment.	2. Service or adjust linkage.
	3. Improper application of intermediate friction and one way clutch.	3. Service as required.
	4. Dirty or sticking valve body.	4. Clean, service or replace valve body.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
No forced downshifts.	1. Kickdown linkage out of adjustment (C6).	1. Service or adjust linkage.
	2. Damaged internal kickdown linkage (C6).	2. Service internal kickdown linkage.
	3. Damaged, misadjusted (long) TV cable (AOD).	3. Inspect and adjust TV cable.
	4. Improper clutch or band application, or oil pressure control system.	4. Perform control pressure test.
	5. Dirty or sticking governor.	5. Perform governor test. Service or replace governor, clean screen.
	6. Dirty or sticking valve body.	6. Clean, service, or replace valve body.
Engine over-speeds on 3-2 downshift (C5).	1. Linkage out of adjustment.	1. Service or adjust linkage. Check VRV for 7.3L Diesel, C6 application.
	2. Intermediate band out of adjustment.	2. Adjust intermediate band.
	3. Improper band or clutch application, and one way clutch, or oil pressure control system.	3. Perform control pressure test service clutch.
	4. Damaged or worn intermediate servo.	4. Air pressure test check the intermediate servo. Service servo and/ or seals.
	5. Polished, glazed band or drum.	5. Service or replace as required.
	6. Dirty or sticking valve body.	6. Clean, service or replace valve body.
Shift efforts high.	1. Manual shift linkage damaged/ misadjusted.	1. Check and adjust or service as required.
	2. Inner manual lever nut loose.	2. Tighten nut to specification.
	3. Manual lever retainer pin damaged.	3. Adjust linkage and install new pin.
Transmission overheats.	1. Improper fluid level.	1. Perform fluid level check.
	2. Incorrect engine idle, or performance.	2. Tune, or adjust engine idle.
	3. Improper clutch or band application, or oil pressure control system.	3. Perform control pressure test.
	4. Restriction in cooler or lines.	4. Service restriction.
	5. Seized converter one-way clutch.	5. Replace one-way clutch.
	6. Dirty or sticking valve body.	6. Clean, service or replace valve body.
Transmission clunk or squawk during 1-2 or 2-3 shift (AOD).	1. Intermediate clutch piston bleed hole blocked or not positioned at 12 o'clock.	1. Clean piston and install bleed hole at 12 o'clock position.
	2. Anti-clunk spring not positioned.	2. Secure anti-clunk spring.
	3. Converter damper spring broken.	3. Perform converter damper hub weld check.
Transmission leaks.	1. Case breather vent.	1. Check the vent for free breathing. Repair as required.
	2. Leakage at gasket, seals, etc.	2. Remove all traces of lube on exposed surfaces of transmission. Check the vent for free breathing. Operate transmission at normal temperatures and perform fluid leakage check. Service as required.
Poor vehicle acceleration.	1. Poor engine performance.	1. Check engine tune up.
	2. Torque converter one-way clutch locked up.	2. Replace torque converter.
Transmission noisy — valve resonance.	1. Improper fluid level.	1. Perform fluid level check.
	2. Linkage out of adjustment.	2. Service or adjust linkage.
	3. Improper band or clutch application, or oil pressure control system.	3. Perform control pressure test.
NOTE: Gages may aggravate any hydraulic resonance. Remove gage and check for resonance level.	4. Cooler lines grounding.	4. Free up cooler lines.
	5. Dirty or sticking valve body.	5. Clean, service or replace valve body.
	6. Internal leakage or pump cavitation.	6. Service as required.

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DIAGNOSIS — AUTOMATIC TRANSMISSION

CONDITION	POSSIBLE CAUSE	RESOLUTION
AOD only, harsh coasting downshift clunk.	1. Anti-clunk spring not seated properly. 2. TV cable misadjusted (short).	1. Re-position anti-clunk spring properly. 2. Adjust TV cable, repair as required.
AOD only, initial engagement clunk (engine warm). NOTE: Refer also to rough initial engagement.	1. Engine RPM's above specification. 2. TV cable misadjusted. 3. Worn/damaged/loose. A. U-joint (front/rear) B. Slip yoke C. Rear axle D. Rear suspension 4. Excessive transmission end play.	1. Adjust engine RPM's to specification. 2. Adjust TV cable. 3. Service as necessary. 4. Check transmission end play according to shop manual procedure in Section 17-20. Replace selective thrust washer if necessary.
Vehicle will not start.*	1. Misadjusted neutral start switch (C6). 2. Misadjusted ignition switch. 3. Defective ignition switch. 4. Defective neutral start switch.	1. Adjust neutral start switch (C6). 2. Adjust ignition switch. 3. Replace ignition switch. 4. Replace neutral switch.

*For 7.3L Diesel Engines equipped with C6 Transmission, refer to the appropriate portion of Group 28 for additional information.

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2. Inspect the bushing for scores or wear. Replace if required.
3. Inspect the rear seal for hardness, cracks, or wear. If the seal shows wear or deterioration, replace the seal.
4. Inspect the seal counterbore and remove all burrs and scores with crocus cloth.

Governor

1. Inspect the governor valves and bores for scores. Minor scores may be removed from the valves with crocus cloth. Replace the governor if the valves or body is deeply scored.
2. On AOD transmission, inspect the governor screen for obstructions. The screen must be free of foreign material. If contaminated, clean thoroughly in a suitable solvent and blow dry with compressed air.
3. Check for free movement of the valves in the bores. The valves should slide freely of their own weight in the bores when dry. Inspect fluid passages in the valve body and counterweight for obstructions. **All fluid passages must be clean.**
4. Inspect the mating surfaces of the governor body and governor distributor (C6) for burrs and distortion. Mating surfaces must be smooth and flat.
5. Check the mating surface of the governor valve and the counterweight on Automatic Overdrive transmission for burrs or scratches.

Front Pump

1. Inspect the mating surfaces of the pump body and case for burrs.
2. Inspect the drive and driven gear bearing surface for scores and check gear teeth for burrs.
3. Inspect the front pump seal for cuts or nicks, and the pump bushing for scoring.
4. Check the fluid passages for obstructions.
5. If any parts are found damaged or worn, replace the pump as a unit. Minor burrs and scores may be removed with crocus cloth.
6. On a C6 and AOD transmission, check the large seal ring groove of the pump body for damage. Check the gasket mating surface of the pump body for damage.

Reverse-High Clutch—C6—Reverse Clutch—AOD

1. Inspect the drum band surface, the bushing, and thrust surfaces for scores. Minor scores may be removed with crocus cloth. **Badly scored parts must be replaced.**
2. Inspect the clutch piston bore and the piston inner and outer bearing surfaces for scores. Check the air bleed ball valve in the clutch piston for free movement. Check the orifice to make sure it is not plugged.
3. Check the fluid passages for obstructions. All fluid passages must be clean and free of obstructions.
4. Inspect the clutch plates for wear, scoring, and fit on the clutch hub serrations. Replace all plates

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TRANSMISSION NOISY — OTHER THAN VALVE RESONANCE

	TEST STEP	RESULT	ACTION TO TAKE
1	VERIFY NOISE		
	• Check for gear noise to verify if within normal range.	Noise within normal range (OK) ▶	Normal condition.
		Noise not within normal range (OK) ▶	GO to **2**.
2	LINKAGE CHECK		
	• Check linkage for proper adjustment, wear or damage.	(OK) ▶	GO to **3**.
		(OK) ▶	SERVICE, REPLACE and/or ADJUST linkage as required.
3	FLUID CHECK		
	• Check the fluid for proper level and/or contamination. ①	Fluid level between ADD and FULL marks (OK) ▶	GO to **4**.
		Fluid level beneath ADD mark (OK) ▶	ADD specified fluid to bring level between ADD and FULL marks with vehicle at operating temperature. GO to **4**.
		Fluid contaminated (OK) ▶	DISASSEMBLE, CLEAN and SERVICE transmission. FLUSH torque converter and cooler.
4	STALL TEST		
	• Perform the Stall Test as described under Stall Test in the Diagnosis and Testing portion of this section.	Noise stops (OK) ▶	GO to **5**.
		Noise doesn't stop (OK) ▶	EXAMINE torque converter and pump. SERVICE or REPLACE as required. Also CHECK for loose torque converter to flywheel housing bolts or nuts.
5	NOISE CHECK		
	• Run transmission in all gears and check for noise.	Noise doesn't stop in any gear ▶	GO to **6**.
		Noise stops in Low and R only ▶	SERVICE front planetary and/or one-way clutch.
		Noise stops in 2, HIGH and R only ▶	SERVICE rear planetary.
		HIGH only ▶	SERVICE both planetaries.
6	SPEEDOMETER GEAR		
	• Remove the speedometer gear and check for noise.	Noise stops ▶	REPLACE speedometer gear.
		Noise doesn't stop ▶	CHECK extension housing bushing, seal or driveshaft. SERVICE or REPLACE as required.

NOTE: AOD transmission has only one gear set. Gear noise requires the replacement of the planetary carrier assembly.
①For definition of contamination, refer to Transmission Fluid Condition Check in the Diagnosis and Testing portion of this section.

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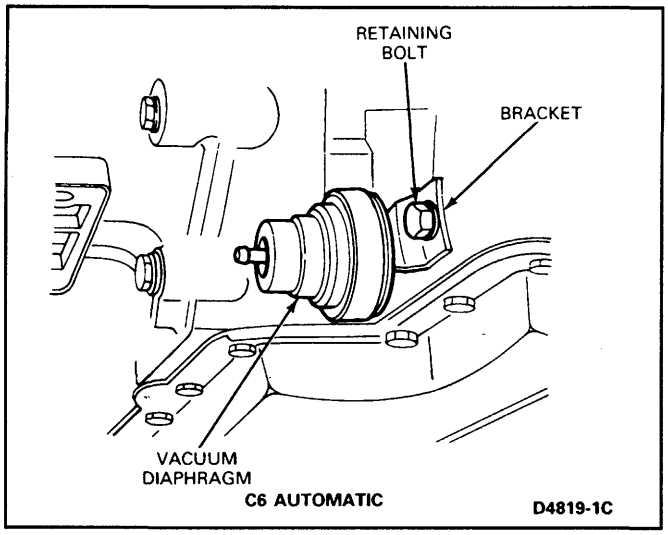


FIG. 28 Vacuum Diaphragm Installed—C-6 Transmission

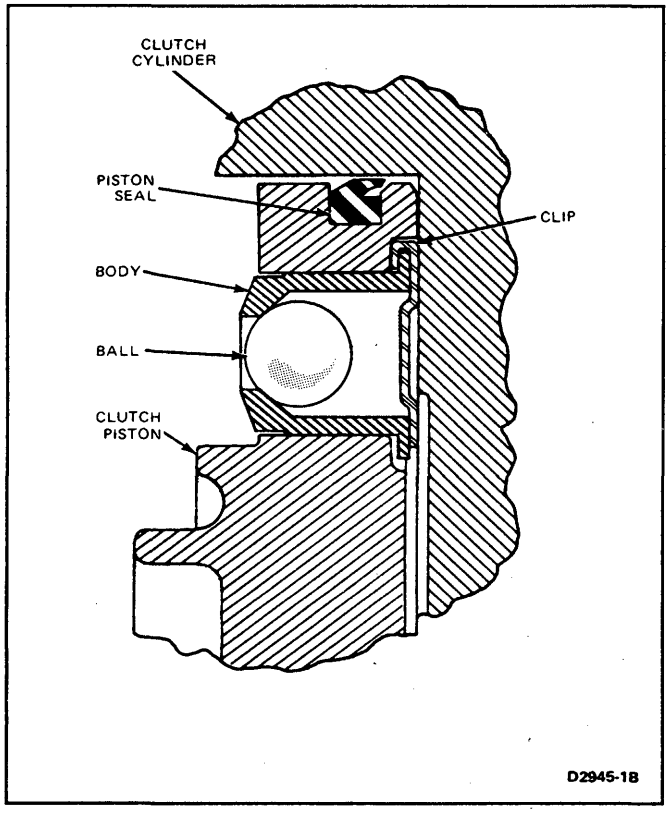


FIG. 29 Clutch Piston Check Ball

that are badly scored, worn, or do not fit freely in the hub serrations.

5. Inspect the clutch pressure plate for scores on the clutch plate bearing surface. Check the clutch release spring(s) for distortion.
6. The clutch piston has a check ball similar to Fig. 29. Inspect the check ball for freedom of movement and proper seating.

Forward Clutch

1. Inspect the clutch cylinder thrust surfaces, piston bore, and clutch plate serrations for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.
2. Check the fluid passage in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary. Inspect the piston check ball for freedom of movement and proper seating (Fig. 29). AOD—Check both check balls in the forward clutch cylinder for freedom of motion.
3. Check the clutch release spring (C6 only) for distortion and cracks. Replace the spring if distorted or cracked.
4. Inspect the composition clutch plates, steel clutch plates, and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored.
5. Check the clutch hub thrust surfaces for scores and the clutch hub splines for wear.
6. Check the splines on the stator support for wear. Inspect the bushing in the stator support for scores. Check the input shaft (C6) for damaged or worn splines. Replace shaft if the splines are excessively worn.

Direct Clutch—AOD

1. Inspect the clutch cylinder thrust surfaces, piston bore, and clutch plate splines for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.
2. Check the fluid passage in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary. Inspect the piston check ball for freedom of movement and proper seating (Fig. 29). Perform the Direct Clutch Piston Check Ball Leakage procedure.
3. Check the clutch release springs and retainer for distortion and cracks. Replace the springs and retainer if distorted or cracked.
4. Inspect the friction clutch plates, steel clutch plates, and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored or polished.
5. Check the clutch plates for flatness and fit on the clutch hub splines. Discard any plate that does not slide freely on the splines or that is not flat.
6. Check the clutch hub thrust surfaces for scores and the clutch hub splines for wear.
7. Check the splines on the direct drive shaft for wear, replace the shaft if the splines are excessively worn.

Direct Clutch Piston Check Ball Leakage Procedure

Direct clutch piston check ball - Inspect the piston check ball for freedom of movement. Improper seating of check ball will cause leakage. Leakage can be detected by turning the piston upside down (flat side of piston facing you) allowing the check ball to seat in the piston. Pour a small quantity of solvent over the check ball. If solvent drips past the check ball, replace the piston.

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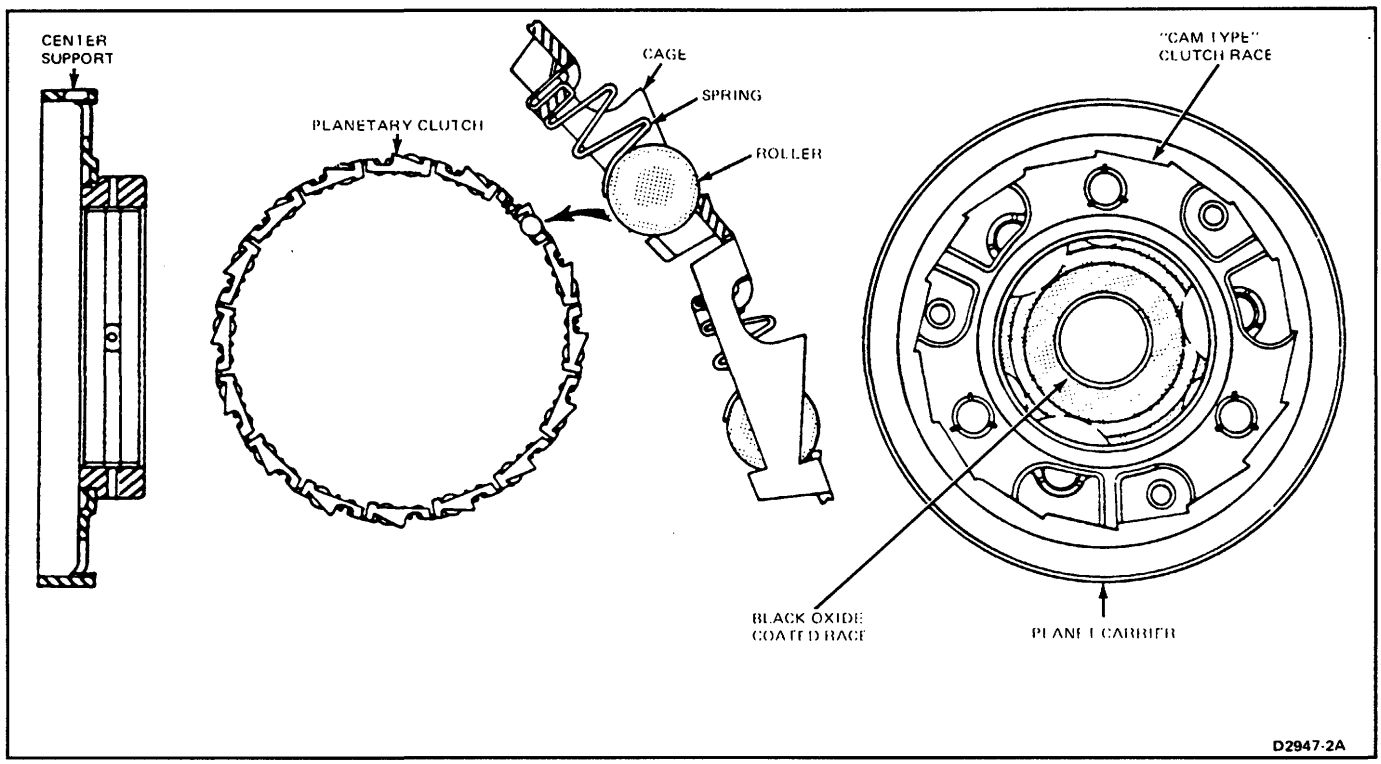


FIG. 30 Roller Type Planetary Clutch, Carrier and Center Support—AOD

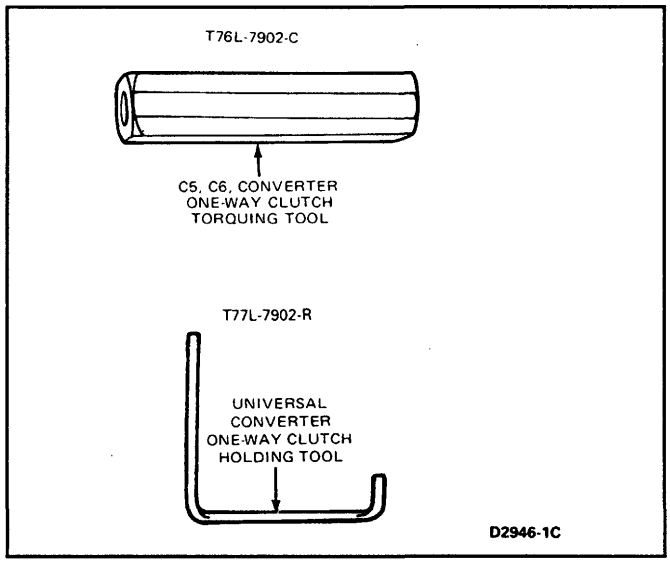


FIG. 31 Converter One Way Clutch Check Tools

Low—Reverse Clutch—C6

1. Inspect the clutch cylinder piston bore and clutch plate serrations for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the case if it is badly scored or damaged.
2. Check the fluid passage in the case for obstructions (Fig. 16). Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary.
3. Check the piston return springs for distortion. Check the piston return spring retainer for flatness.
4. Inspect the composition clutch plates, steel clutch plates and clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored.
5. Check the clutch hub splines.

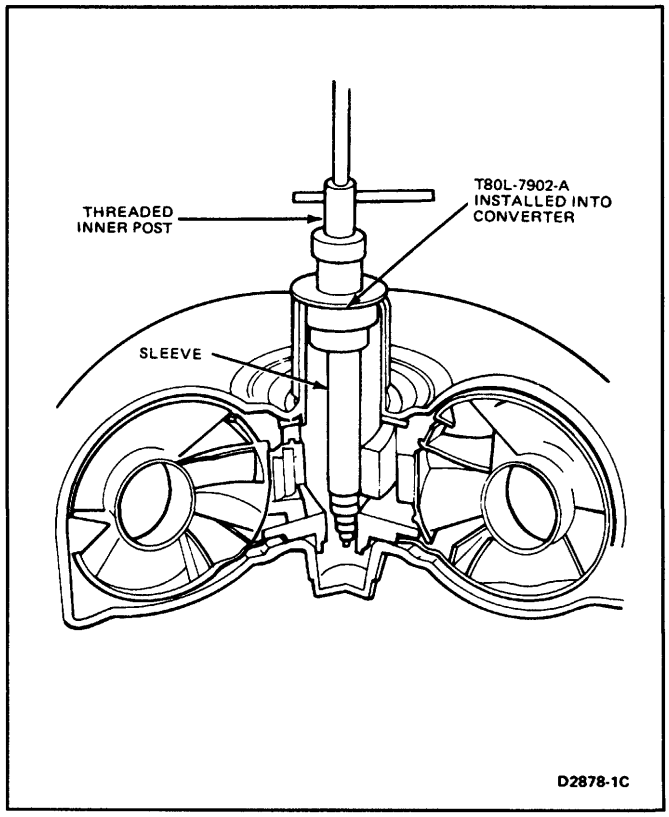


FIG. 32 End Play Checking Tool Installed

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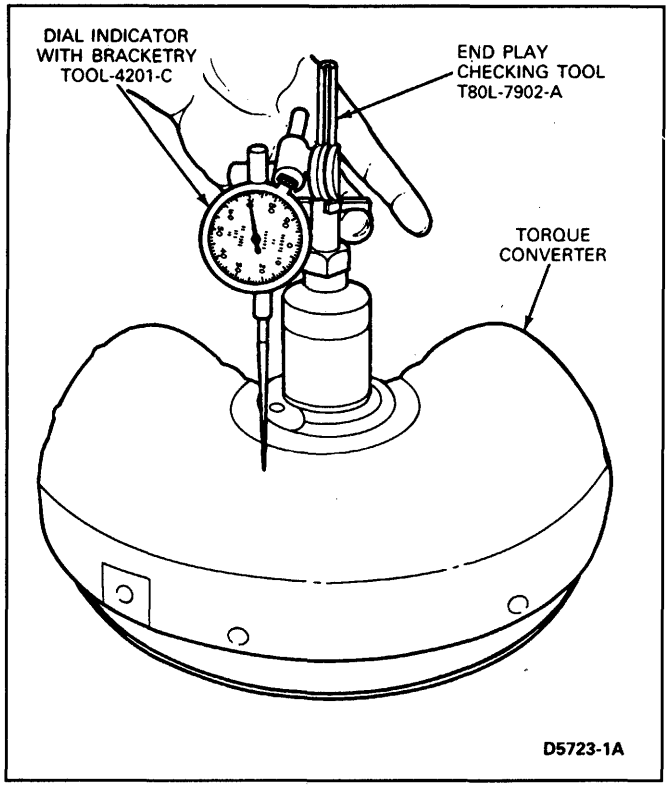


FIG. 33 Checking Stator and Turbine End Play

Intermediate Clutch—AOD

1. Inspect the piston bore in the rear of the pump body for scores or burrs. Minor damage can be repaired with a crocus cloth.

2. Check and clean all fluid passages in the case and pump and the piston. Inspect both lip seals and replace if damaged.

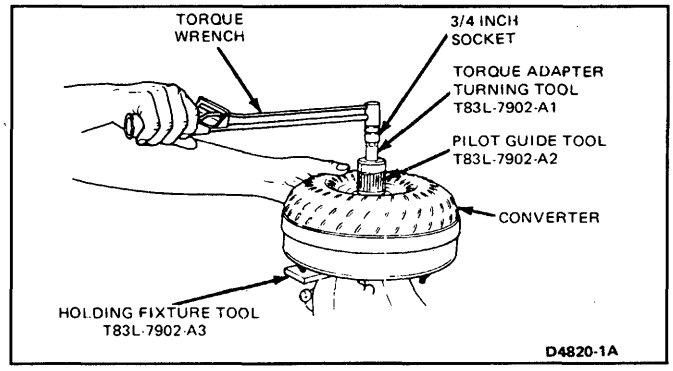


FIG. 35 Converter Damper/Hub Weld Check—AOD

NOTE: Upon reassembly the small drilled hole in the piston must be located toward the top of the transmission (12 o'clock position).

3. Check the springs and spring retainer for damage. Note how the retainer is held to the body with tabs.

4. Inspect composition clutch plates, steel clutch plates and pressure plate. Replace any badly worn or scored parts.

Planetary One-Way Clutch

1. Inspect the intermediate outer and inner races for scores or damaged surface areas where rollers contact the races. If the intermediate one-way clutch inner race on the AOD transmission is damaged, the reverse clutch drum must be replaced.

2. Inspect the rollers and springs for excessive wear or damage.

3. Inspect the spring and roller cage for bent or damaged spring retainers.

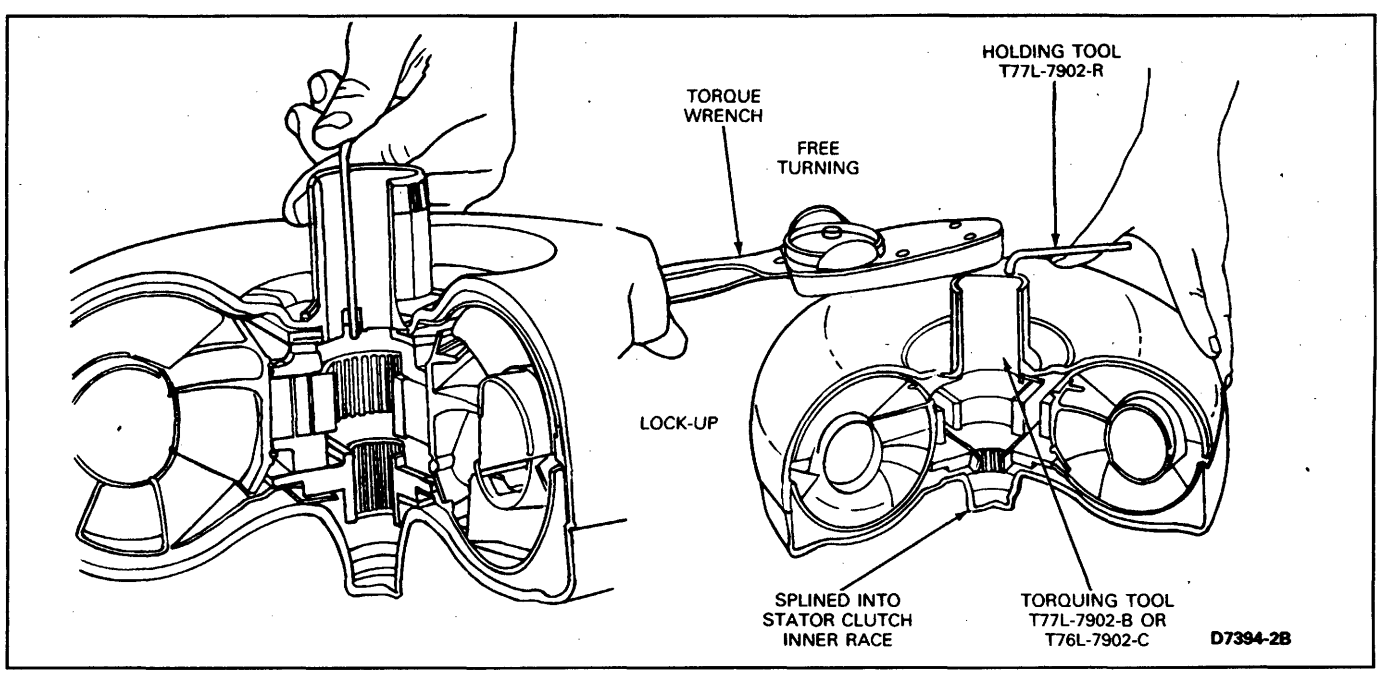


FIG. 34 Checking Converter One-Way Clutch

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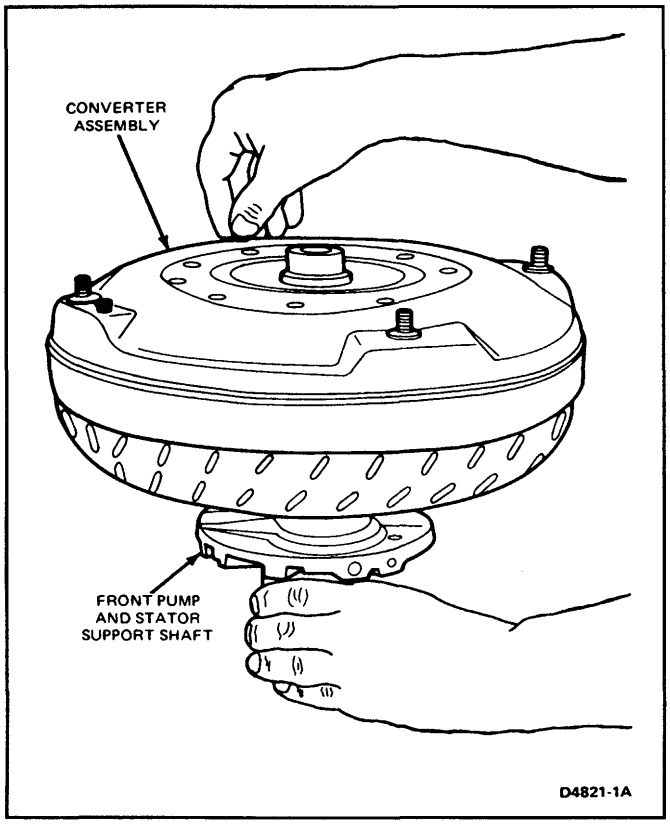


FIG. 36 Stator to Impeller Interference Check

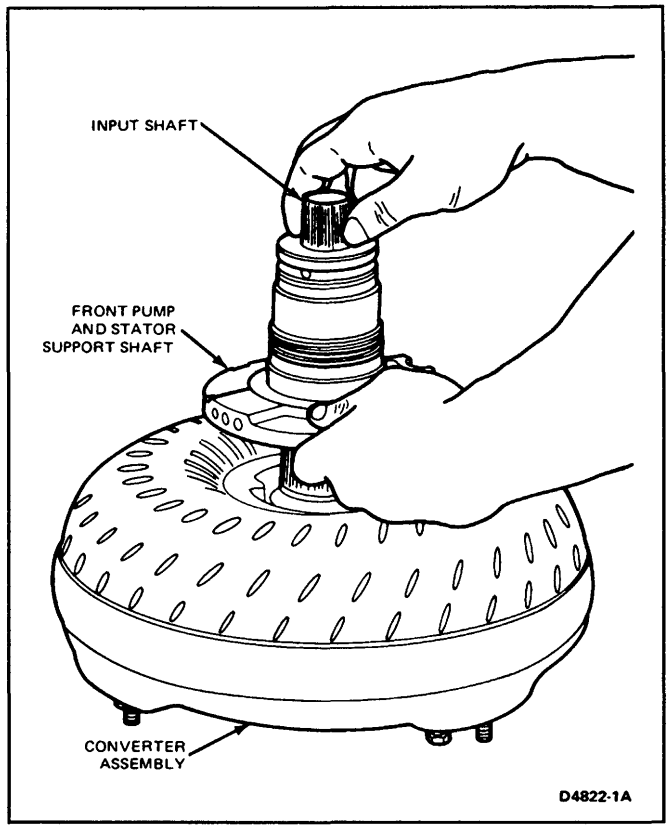


FIG. 37 Stator to Turbine Interference Check—C6 and AOD

Planet Carrier and Center Support (AOD)

1. Inspect the clutch outer race, inner race, band surface, pinion gears, bearings, and thrust washer (Fig. 30) for roughness.
2. Inspect the center support bushing for roughness.
3. Inspect one way clutch, springs, rollers and springs.

Converter and Fluid Cooler

When internal wear or damage has occurred in the transmission, metal particles, clutch plate material, or band material may have been carried into the converter and oil cooler. These contaminants are a major cause of recurring transmission troubles and MUST be removed from the system before the transmission is put back into service.

Whenever a transmission has been disassembled to replace worn or damaged parts or because the valve body sticks from foreign material, the converter and oil cooler MUST be cleaned by using the Rotunda torque Converter Cleaner (model 014-00028) or equivalent. Under NO circumstances should an attempt be made to clean converters by hand agitation with solvent.

Converter End Play and One Way Clutch Check

The Tools T76L-7902-C and T77L-7902-R shown in Fig. 31 are used to check the converter one-way clutch.

End Play Check

1. Insert Tool T80L-7902-A into the converter pump drive hub until it bottoms (Fig. 32).
2. Expand the sleeve in the turbine spline by tightening the threaded inner post, (Fig. 32), until the tool is securely locked into the spline.
3. Attach a dial indicator (with bracketry) TOOL-4201-C to the tool (Fig. 33). Position the indicator button on the converter pump drive hub, and set the dial face at 0 (zero).
4. Lift the tool upward as far as it will go and note the indicator reading. The indicator reading is the total end play which the turbine and stator share. Replace the converter unit if the total end play exceeds the limits. End play specifications are listed at the end in the specifications section of this Section.
5. Loosen the threaded inner post to free the tool, and then remove the tool from the converter.

Converter One-Way Clutch Check

1. Insert the one way clutch holding Tool T77L-7902-R (Fig. 34), in one of the grooves in the stator thrust washer.
2. Insert the one way clutch torquing Tool, (T77L-7902-B) in the converter pump drive hub so as to engage the one way clutch inner race, (Fig. 34).
3. Attach a torque wrench to the one way clutch torquing tool. With the one way clutch holding tool held stationary, turn the torque wrench counterclockwise. The converter one way clutch should lockup and hold a 14 N·m (10 ft-lbs) force. The converter one way clutch should rotate freely in a clockwise direction. Try the clutch for lockup and hold in at least five different locations around the converter.

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4. If the clutch fails to lock up and hold at 14 N·m (10 ft-lbs) torque, replace the converter unit.

Converter Damper/Hub Weld Check—AOD Only

Refer Fig. 35.

1. Position the holding fixture Tool T83L-7902-A3 in a vise and clamp tight.
2. Place the converter on top of the holding fixture aligning the pilot hub and one stud in the appropriate holes.
3. Spline the torque adapter turning Tool T83L-7902-A1 into the converter, making sure the splines engage the damper assembly.
4. Install the pilot guide Tool T83L-7902-A2 over the torque adapter turning tool and onto the impeller hub.
5. HOLD the converter snug to the holding fixture with one hand when applying torque.
6. Turn the shaft clockwise and counterclockwise applying approximately 67 N·m (50 ft-lbs) torque with a 3/4 inch drive socket and torque wrench.
7. The shaft should not turn more than two degrees.
8. If there is a grinding noise and/or if the shaft turns more than two degrees, the converter damper assembly, welds, rivets, or reaction hub are broken. Replace the torque converter.

Stator to Impeller Interference Check

1. Position the front pump assembly on a bench with the spline end of the stator shaft pointing up (Fig. 36).
2. Mount a converter on the pump with the splines on the one-way clutch inner race engaging the mating splines of the stator support. The converter hub will then engage the pump drive gear.
3. Hold the pump stationary and try to rotate the converter counterclockwise. The converter should rotate freely without any signs of interference or scraping within the converter assembly.
4. If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades. In such cases, replace the converter.

Stator to Turbine Interference Check—C6 and AOD Converters

1. Position the converter on the bench front side down.
2. Install a front pump assembly to engage the mating splines of the stator support and stator, and pump drive gear lugs.
3. Install the input shaft, engaging the splines with the turbine hub (Fig. 37).
4. Hold the pump stationary and attempt to rotate the turbine with the input shaft. The turbine should rotate freely in both directions without any signs of interference or scraping noise.
5. If interference exists, the stator front thrust washer may be worn, allowing the stator to hit the turbine. In such cases, the converter must be replaced.

Check the converter crankshaft pilot for nicks or damaged surfaces that could cause interference when installing the converter into the crankshaft. Check the converter front pump drive hub for nicks or sharp edges that would damage the pump seal.

Pinion Carriers

C6 and AOD

Individual parts of the planet carriers are not serviceable.

1. Check the pins and shafts in the planet assemblies for loose fit and/or complete disengagement. Use a new planet assembly if either condition exists. Before installing a planet assembly, the shaft retaining pins should be checked for adequate staking. If necessary, restake the pins before installation. When restaking, the retaining pins must not be driven into the carrier any further than 1.01mm (0.040 inch) below the surface of the carrier.
2. Inspect the pinion gears for damaged or excessively worn teeth.
3. Check for free rotation of the pinion gears.

Stator Support

C6 and AOD

1. Inspect the stator support splines for burrs and wear.
2. Check the oil ring grooves in the stator support for nicks, burrs or damaged edges.
3. Check the front and rear bushings of the stator support for wear or scoring.

Case

Inspect the case for cracks and stripped threads. Inspect the gasket surfaces and mating surfaces for burrs. Check the vent for obstructions, and check all fluid passages for obstructions and leakage (Figs. 15, 16 and 17).

Inspect the case bushing for scores. Check all parking linkage parts for wear or damage.

If a transmission case thread is damaged, service kits may be purchased from local jobbers. To repair a damaged thread, the following procedures should be carefully followed.

1. Drill out the damaged threads **using the same drill size as the thread outside diameter.** For example, use a 5/16 inch drill for a 5/16-18 thread.
2. Select the proper special tap and tap the drilled hole. The tap is marked for the size of the thread being repaired. Thus, the special tap marked 5/16-18 will not cut the same thread as a standard 5/16-18 tap. The tap cuts a thread large enough to accommodate the insert, and after the insert is installed, the original thread size (5/16-18) is restored.
3. Select the proper coil inserting tool. These tools are marked with the thread size being repaired. Place the insert on the tool and adjust the sleeve to the length of the insert being used. Press the insert against the face of the tapped hole. Turn the tool clockwise and wind the insert into the hole until the insert is 1/2 turn below the face.
4. Working through the insert, bend the insert tang straight up and down until it breaks off at the notch.

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5. Improperly installed inserts can be removed with the extractor tool. Place the extractor tool in the insert with the blade resting against the top coil 1/4 to 1/2 turn away from the end of the coil. Tap the tool sharply with a hammer until the blade cuts into the insert. Exert downward pressure on the tool and turn counterclockwise until the insert is removed.

SPECIFICATIONS

VACUUM DIAPHRAGM ASSEMBLY SPECIFICATION

Transmission Type	Diaphragm Type	Diaphragm Part No.	Identification	Throttle Valve Rod #		
				Part No. (7A380)	Length	Identification
C6	HAD	D7AP-7A337-AA	Part No. Stamped	C4AP-A	1.677-1.667	No Color
	SAD	D70P-7A377-BA	1 Green Stripe	D1AP-BA	1.727-1.717	Purple Daub
	SAD	D4TP-7A377-BA	1 Black Stripe	D3AP-DA	1.611-1.601	Yellow Daub
	SAD	D5AP-7A377-AA	1 Purple Stripe	D3AP-EA	1.644-1.634	Blue Daub
				D3AP-FA	1.660-1.650	Green Daub
				D3AP-GA	1.710-1.700	White Daub
				D8AP-AA	1.694-1.684	Brown Daub

Selective fit rods
SAD — Single Area Diaphragm
S-SAD — Super Single Area Diaphragm
HAD — High Altitude Diaphragm

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AUTOMATIC TRANSMISSION REFILL CAPACITY — C6 AND AOD AUTOMATIC TRANSMISSION

Vehicle	Transmission Type	Engine	Approximate Refill Capacity①		
			U.S. Quarts	Imperial Quarts	Liters
E-150 — E-250 — E-350	C6②	4.9L (300 CID) I-6 5.0L (302 CID) V-8 5.8L (351 CID) V-8 7.5L (460 CID) V-8 7.3L Diesel	11-3/4	9.4	11.2
F-150 — F-250 — F-350 (4x2)	C6②	4.9L (300 CID) I-6 5.0L (302 CID) V-8 5.8L (351 CID) V-8 7.5L (460 CID) V-8 7.3L Diesel	11-3/4	9.4	11.2
F-150 — F-250 — F-350 (4x4)	C6②	4.9L (300 CID) I-6 5.0L (302 CID) V-8 5.8L (351 CID) V-8 7.5L (460 CID) V-8 7.3L Diesel	13-1/2	10.8	12.7
Bronco (4x4)	C6②	4.9L (300 CID) I-6 5.0L (302 CID) V-8 5.8L (351 CID) V-8	13-1/2	10.8	12.7
E-150 — E-250 F-150 — F-250 (4x2) (4x4) Bronco (4x4)	AOD③	5.0L (302 CID) V-8 4.9L (300 CID) I-6	12.3	10.2	11.6

①Approximate dry capacity, includes cooler and lines. Fluid level indicator should be used to determine **actual** fluid requirements and fluid specifications. Check level at normal operating temperature. **DO NOT OVERFILL.**

If it is necessary to add or replace fluids, use only fluids which have been certified by the supplier as meeting one of the Ford Motor Company specifications shown below:

②Transmission — Use Automatic Transmission Fluid — Type H, XT-4-H (ESP-M2C166-H) or equivalent.

③AOD transmission — Use Automatic Fluid-Motorcraft MERCON® WSP-M2C185-A

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TORQUE-CONVERTER END-PLAY

Transmission Model	Converter End-Play			
	New or Rebuilt Converter		Used Converter	
	mm	Inch	mm	Inch
C6	0.533 Max.	0.021 Max.	1.01 Max.	0.040 Max.
AOD (Automatic Overdrive)	0.584 Max.	0.023 Max.	1.25 Max.	0.050 Max.

CD2950-2D

STALL SPEED SPECIFICATIONS

Vehicle Application	Engine Disp.	Transmission Type	Converter Size	Stall Speed	
				Min.	Max.
F150/250/350 E150/250/350 Bronco	4.9L	C6	12"	1616	1871
F150/250 E150/250 Bronco	5.0L	C6	12"	1616	1871
F150/250/350 E150/250/350 Bronco	5.8L	C6	12"	1569	1729
F-250/350 E-250/350	7.3L	C6	12"	1715	1966
F-250/350 E-250/350	7.5L	C6	12"	1610	1891
E-Series	4.9L EFI	AOD	12"	2042	2351
F-Series	4.9L EFI	AOD	12"	2042	2351
F-Series/Bronco (4x2, 4x4)	5.0L EFI	AOD	12"	2092	2443
E-Series	5.0L EFI	AOD	12"	2092	2443

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SPECIAL SERVICE TOOLS

Tool Number	Description
Tool-4201-C	Dial Indicator with Bracketry
Tool-7000-DD	Rubber Tip For Air Nozzle
Tool-7000-DE	Air Nozzle Assembly
T82L-7006-A	Air Pressure Check Plate
T82P-7006-C	Cap Screws for Air Pressure Check Plate
T76L-7902-C	Converter Clutch Torquing Tool
T77L-7902-R	Converter Clutch Holding Tool
T77L-7902-B	Converter Clutch Torquing Tool
T80L-7902-A	Torque Converter End Play Checking Tool
T83L-7902-A	Converter Checking Tool Kit
T83L-7902-A1	Torque Adapter Turning Tool
T83L-7902-A2	Pilot Guide
T83L-7902-A3	Holding Fixture
T80L-77030-B	Servo Piston Remover
T83T-7B200-AH	VRV (Vacuum Regulator Valve) Adjustment Gage Block — C6

ROTUNDA EQUIPMENT

Model	Description
014-00028	Torque Converter Cleaner
021-00054	Torque Converter Leak Tester
014-00737	Automatic Transmission Tester
021-00014	Vacuum Tester
059-00008	Vacuum and Pressure Tester

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SECTION 17-02 Shift Control Linkage

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Automatic Transmission Manual Linkage Adjustments	17-02-1
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DIAGNOSIS AND TESTING	17-02-1
REMOVAL AND INSTALLATION	
Manual Shift Linkage Grommet	17-02-1
Neutral Start Switch—AOD	17-02-4
Neutral Start Switch—C6	17-02-2
SPECIFICATIONS	17-02-6
VEHICLE APPLICATION	17-02-1

VEHICLE APPLICATION

Applies to Bronco, F-150—F-250—F-350 (4x2)(4x4) And E-150—E-250—E-350 Trucks Equipped with Automatic Transmissions.

DESCRIPTION AND OPERATION

The transmission shift control linkage transfers the selected transmission operating mode from the selector lever to the transmission. The indicated transmission position on the steering column is transferred to a shift lever on the bottom of the steering column. The shift rod transfers this position through the bell crank assembly to the control rod. The control rod transfers the indicated position to the transmission assembly.

For information on the steering column, refer to Section 13-06, Steering Column-Shift Rod within Tube.

DIAGNOSIS AND TESTING

Refer to Section 17-01, General Automatic Transmission Service for diagnosis and testing procedures.

ADJUSTMENTS

Perform the transmission control linkage adjustments in the order in which they appear in this Section of the manual. Before the linkage is adjusted, the shift lever indicator flag must be checked as detailed in Section 13-06, Steering Column Shift Rod within Tube. Be sure the engine idle speed and anti-stall dashpot are properly adjusted Refer to the Engine/Emissions Diagnosis Manual for the procedure.

Automatic Transmission Manual Linkage Adjustments

1. With the engine stopped and the parking brake applied, place the transmission selector lever at the steering column in the D (DRIVE position) for C6 applications and in the Ⓓ (OVERDRIVE position) for AOD applications, and hold against the D or Ⓓ stop by applying an eight pound weight to the selector lever knob.
2. Loosen the shift rod adjusting nut at point A (Figs. 1-4).
3. Shift the manual lever at the transmission into the D (DRIVE) position or Ⓓ (OVERDRIVE) position, by moving the lever all the way rearward, then forward two detents.
4. With the selector lever and transmission manual lever in the D/Ⓓ position, tighten the nut at point A to 17-24 N·m (12-18 ft-lbs) torque (Figs. 1-4). Use care to prevent motion between the stud and rod.
5. Remove the eight pound weight from the steering column selector lever knob.
6. Operate the shift lever in all positions to make certain that the manual lever at the transmission is in full detent in all gear ranges. Re-adjust the linkage if required.
7. On F-150—F-250—F-350 and Bronco, recheck for correct operation of the automatic transmission selector indicator (PRND21) or (PRNⒹD1). Refer to Section 13-06, Steering Column-Shift Rod within Tube.

Under no circumstances will it be permissible to adjust linkage in any position other than the D position for C6 applications and Ⓓ position for AOD applications.

Neutral Start Switch Adjustment—C6

1. Apply the parking brake.
2. With the automatic transmission linkage properly adjusted, loosen the two switch attaching bolts (Fig. 5).
3. Place the transmission selector lever in neutral. Rotate the switch and insert the gauge pin (No. 43 drill shank end) into the gauge pin holes of the switch. The gauge pin has to be inserted a full 12.303mm (31/64 inch) into the three holes of the switch (Fig. 5).
4. Tighten the two neutral start switch attaching bolts to 6.2-8.4 N·m (55-75 in-lbs). Remove the gauge pin from the switch.
5. Check the operation of the switch. The back-up lamps should come on when the transmission is in reverse. The vehicle should start only with the transmission lever in PARK or NEUTRAL.

REMOVAL AND INSTALLATION

Manual Shift Linkage Grommet

The automatic transmission linkage systems make use of a polyurethane plastic grommet to connect the various rods, levers and adjusting stud. Whenever a rod is disconnected from a grommet type connector, the old grommet must be removed and a new one installed. Remove and install the grommet as follows:

1. Place the lower jaw of the Shift Linkage Installation Tool, T67P-7341-A or equivalent between the lever

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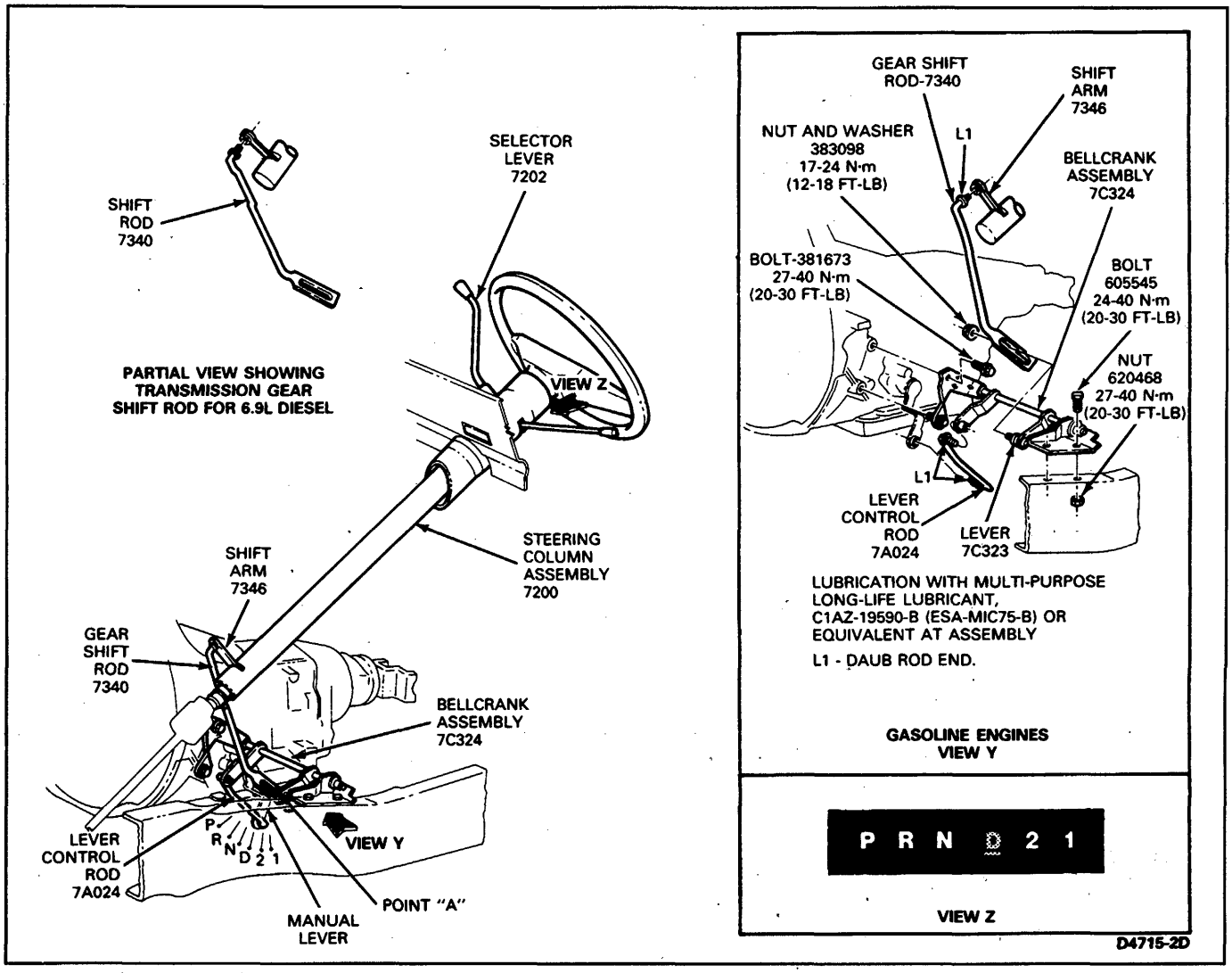


FIG. 1 C6 Automatic Transmission—Shift Linkage Adjustment—F-150—F-250—F-350, Bronco

and the rod (Fig. 6). For areas with limited space, use Shift Linkage Grommet Remover, T84P-7341-A or equivalent for removal of the grommet (Fig. 7). Position the stop pin against the end of the control rod (Fig. 6) and force the rod out of the grommet. Remove the grommet from the lever by cutting off the large shoulder with a sharp knife. **The grommet must be removed from the lever and a new one installed each time the rod is disconnected.**

2. Adjust the stop pin to 12.70mm (1/2 inch) and coat the outside of the grommet with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent. Place a new grommet on the stop pin and force it into the lever hole. Turn the grommet several times to be sure it is properly seated.
3. Readjust the stop pin to the height shown in Fig. 6. The pin height is determined by the length of the rod end which is to be installed into the grommet. If the pin height is not adjusted, the rod may be pushed too far through the grommet causing damage to the grommet retaining lip.

NOTE: Coat ends of rods with D4AZ-19590-A, Linkage Lube or equivalent before installing in new grommet.

4. With the pin height properly adjusted, position the rod on the tool and force the rod into the grommet until the groove in the rod seats on the inner retaining lip of the grommet. For areas with limited space, use Shift Linkage Grommet Replacer, T84P-7341-B or equivalent, for grommet installation (Fig. 7).

Neutral Start Switch—C6

Removal

1. Remove the downshift linkage rod return spring at the low-reverse servo cover.
2. Apply penetrating oil, Rust Penetrant and Inhibitor, D7AZ-19A501-A (ESR-M99C56-A) or equivalent to the outer lever attaching nut to prevent breaking the inner lever shaft. Remove the transmission downshift outer lever attaching nut and lever.
3. Remove the two neutral start switch retaining bolts (Fig. 5).
4. Disconnect the two multiple wire connectors.
5. Remove the switch from the transmission.

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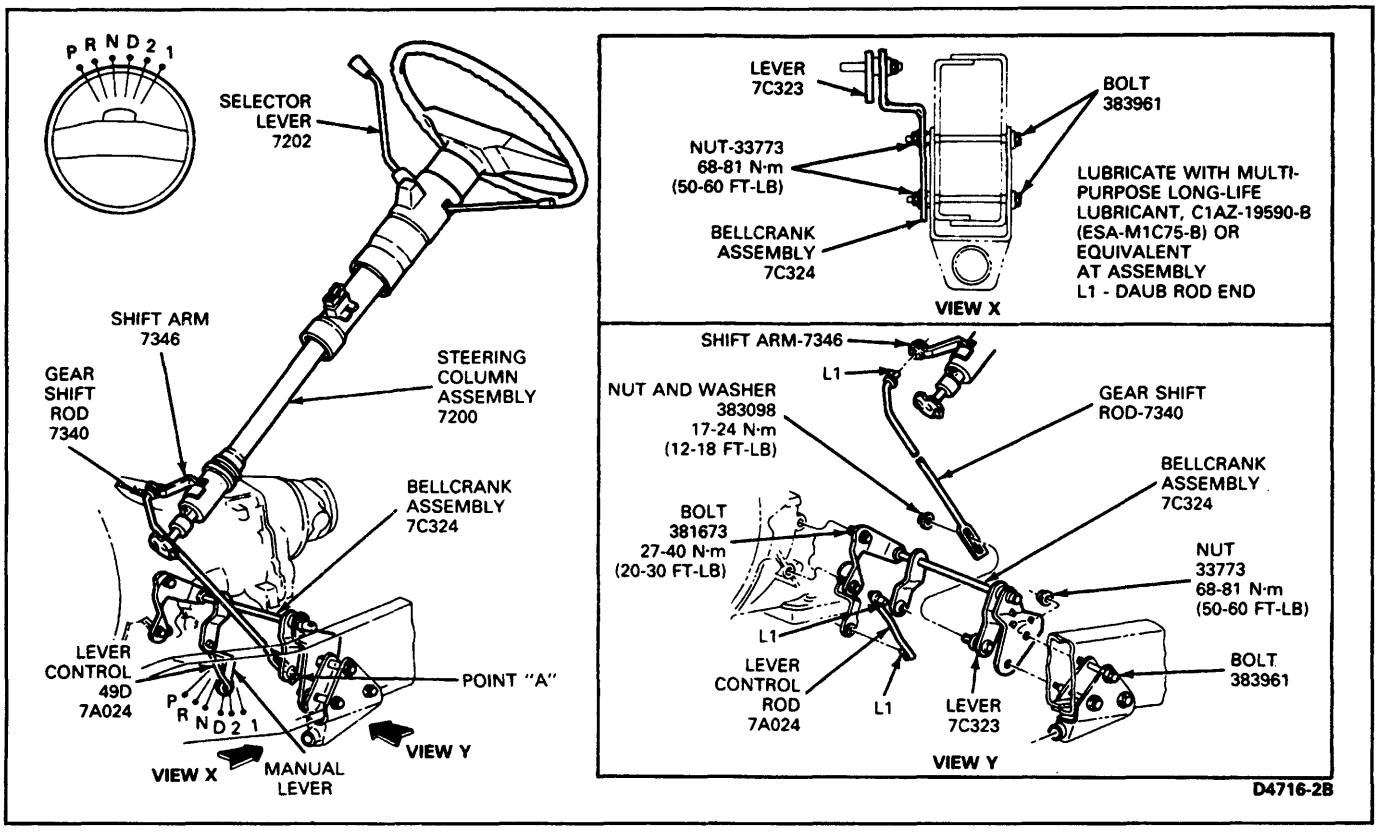


FIG. 2 C6 Automatic Transmission—Shift Linkage Adjustment—E-150—E-250—E-350

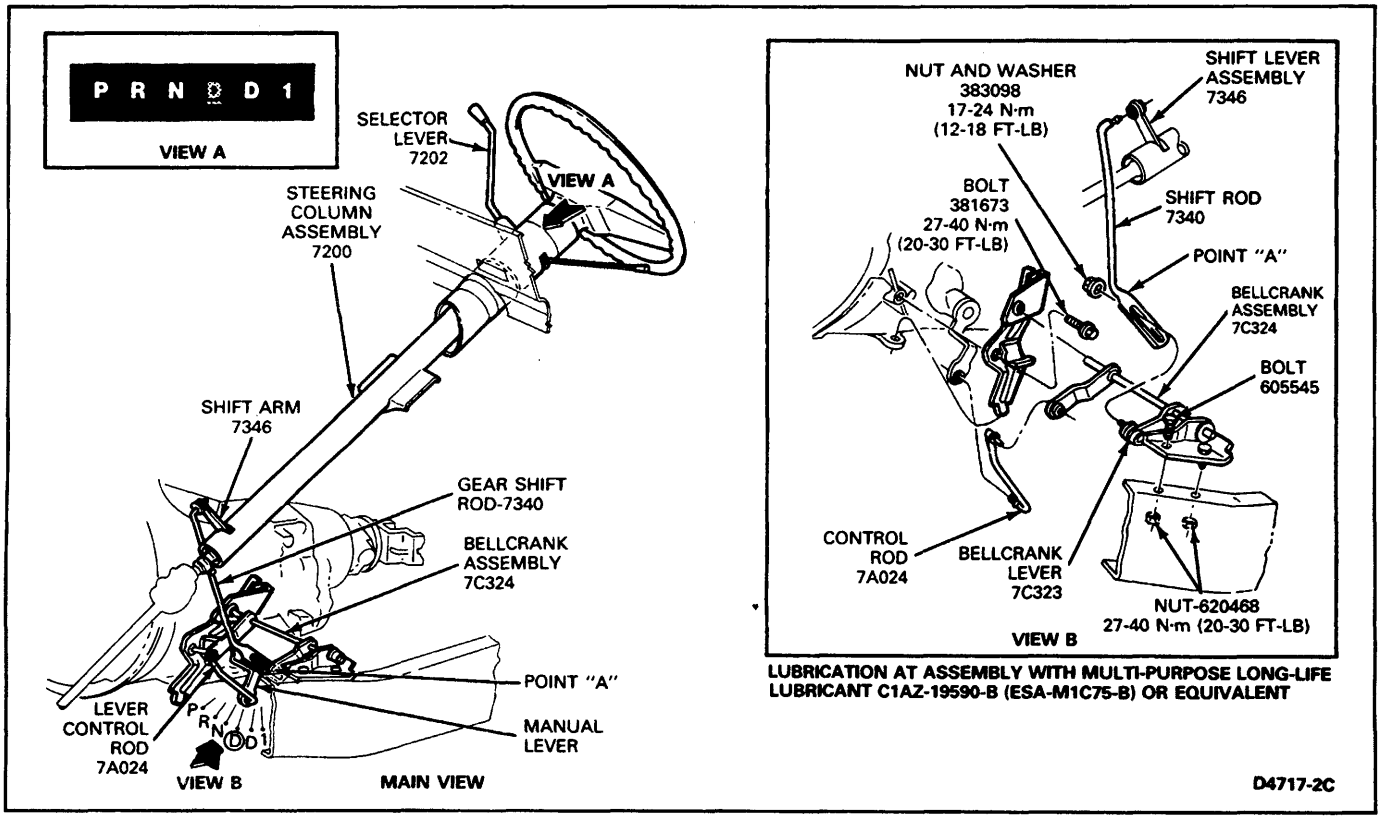


FIG. 3 Shift Linkage—Automatic Overdrive Transmission (AOD)—F-150—F-250 (4x2)

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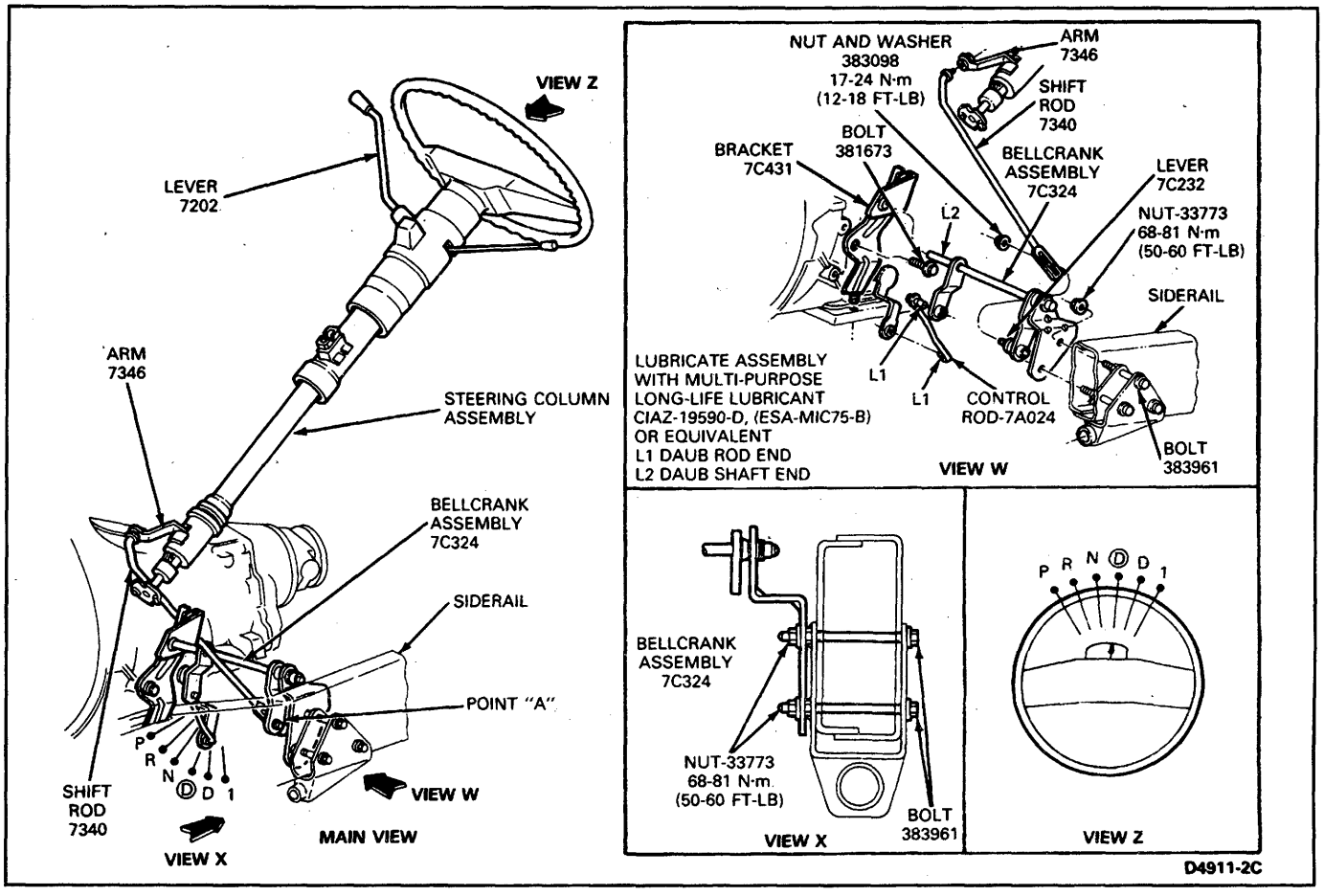


FIG. 4 Shift Linkage Automatic Overdrive Transmission (AOD)—E-150—E-250

Installation

1. Install the switch on the transmission. Install the two retaining bolts.
2. With the transmission manual lever in neutral, check the location of the switch with the gauge pin. Install gauge pin (No. 43 drill) into the three gauge pin holes (Fig. 5).
3. Tighten the switch attaching bolts to 6.3-8.4 N·m (55-75 in-lbs). Remove the gauge pin.
4. Install the outer downshift lever and retaining nut, and tighten the nut. Install the downshift linkage rod return spring between the lever and retaining clip on the low-reverse servo cover.
5. Connect the wire multiple connectors. The red connector has to be inserted into the red connector and the blue connector inserted into the blue connector. Check the operation of the switch installed. The back up lamps should operate only with the transmission selector lever in REVERSE. The vehicle should start only with the transmission selector lever in PARK and NEUTRAL.

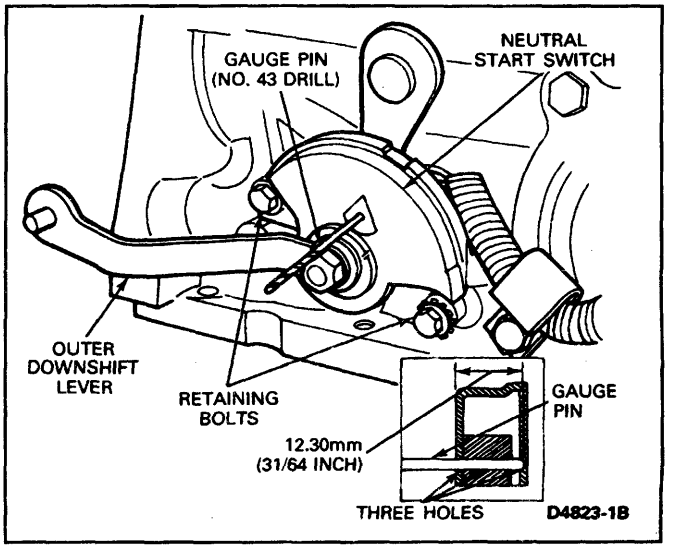


FIG. 5 Neutral Start Switch—C6

Neutral Start Switch—AOD

For neutral start switch removal and installation procedures, refer to Section 17-20, Automatic Overdrive Transmission.

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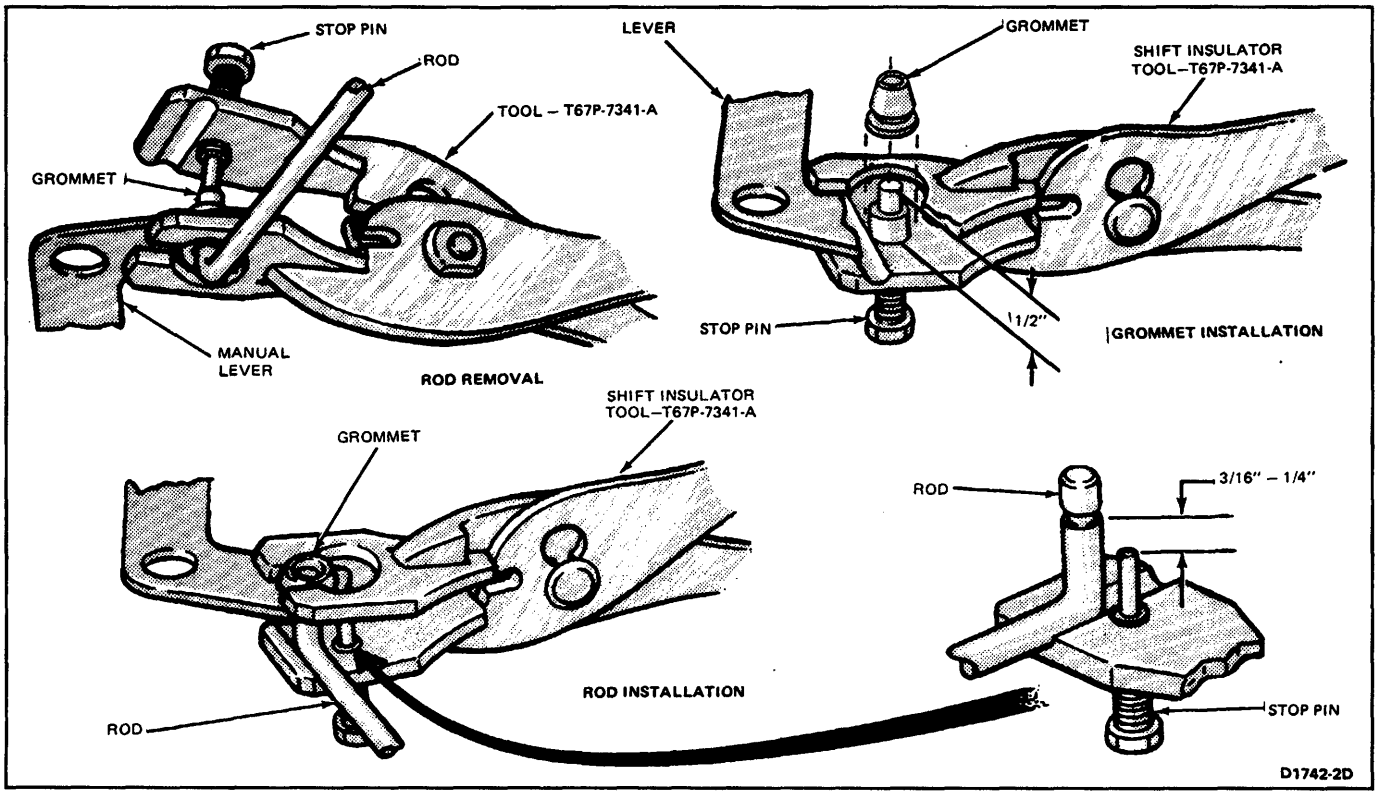


FIG. 6 Removing or Installing Shift Linkage Grommet

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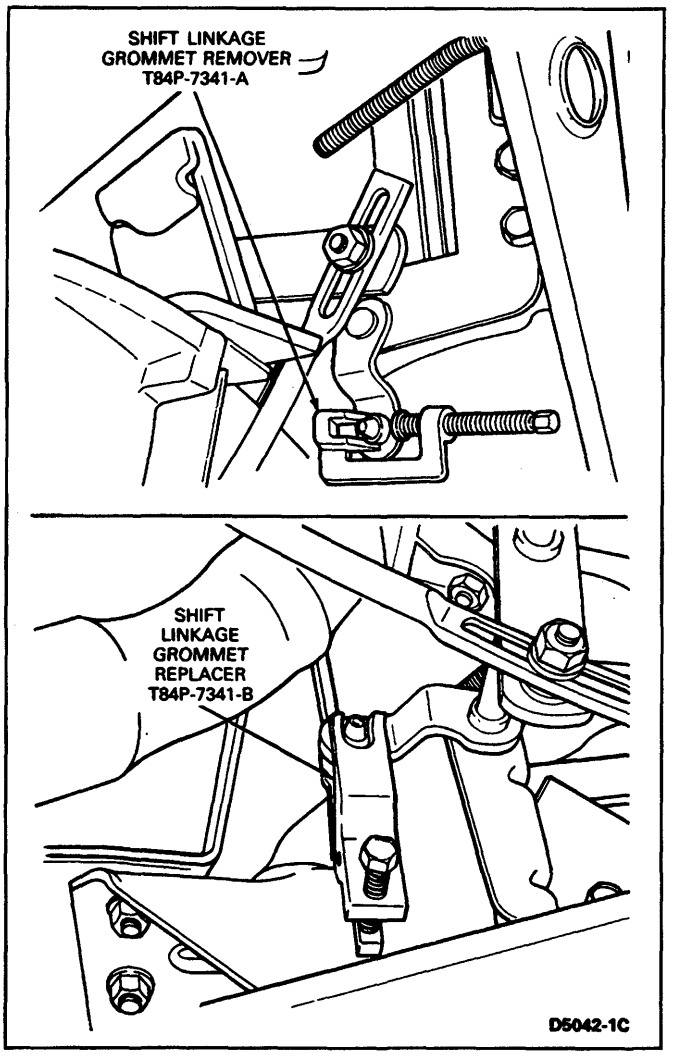


FIG. 7 Removing or Installing Shift Linkage Grommet (Limited Space Situations)

SPECIFICATIONS

TORQUE LIMITS

Description	(in-lbs)	N·m
Neutral Start Switch to Case	55-75	6.3-8.4

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SPECIAL SERVICE TOOLS

Number	Description
T67P-7341-A	Shift Linkage Insulation Tool
T74P-77247-A	Neutral Start Switch Socket Tool
T84P-7341-A	Shift Linkage Grommet Remover
T84P-7341-B	Shift Linkage Grommet Replacer

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VEHICLE APPLICATION

Applies to E-150 Through E-350, F-150 Through F-350 (4x2), (4x4) and Bronco Model Trucks.

DESCRIPTION

C6 Transmission

The C6 transmission is a three speed unit capable of providing automatic upshifts and downshifts through the three forward gear ratios. The transmission is also capable of providing manual selection of first and second gears.

Fig. 1 shows the location of the converter, front pump, clutches, gear train and most of the internal parts used in the C6 transmission. The identification tag (Fig. 2), is attached to the intermediate servo lower front cover bolt. The first line on the tag shows the transmission model prefix and suffix. A number appearing after the suffix indicates that the internal parts in the transmission have been changed after initial production start-up. For example, a PGD-BN model transmission that has been changed internally would read PGD-BN1. Both transmissions are basically the same, but some service parts in the PGN-BN transmission are slightly different than the PGD-BN1 transmission. **Therefore, it is important that the codes on the transmission identification tag be checked when ordering parts or making inquiries about the transmission.**

The hydraulic control system schematic is shown in Fig. 3. The converter housing and the fixed splines which engage the splined outside diameter of the low-reverse clutch steel plates, are both cast integrally into the case.

Only one (intermediate) band is used in the C6 transmission. This along with the forward clutch is used to obtain intermediate gear.

Vacuum Regulator Valve (VRV)

Refer to Fig. 4

The Vacuum Regulator Valve (VRV) is used on E-250—E-350 and F-250—F-350 vehicles equipped with 7.3L diesel engines.

On 7.3L diesel engine trucks equipped with a C-6 automatic transmission a Vacuum Regulator Valve (VRV) is incorporated to provide a vacuum signal which is proportional to the throttle position to the vacuum diaphragm of the transmission. The VRV is necessary to provide a vacuum signal to the C-6 transmission because the diesel engine has no vacuum. The VRV is bolted to the fuel injection pump and is actuated by the throttle lever.

A constant vacuum source is supplied to the VRV by an engine driven vacuum pump which also delivers vacuum to other accessories. The VRV regulates an output vacuum signal to the transmission's vacuum diaphragm which is proportional to the throttle position. As the throttle is opened, the regulated vacuum from the VRV drops.

Should a malfunction occur in the VRV, the valve will cause a 0 vacuum signal to be sent to the diaphragm which will cause delayed and harsh shifts to occur.

Anytime delayed or harsh up-shifts are encountered, the performance of the VRV should be checked prior to performing any transmission repairs. Should the VRV be replaced or the fuel injection pump be removed, the VRV must be adjusted to specifications.

DIAGNOSIS AND TESTING

Refer to Section 17-01, General Automatic Transmission Service.

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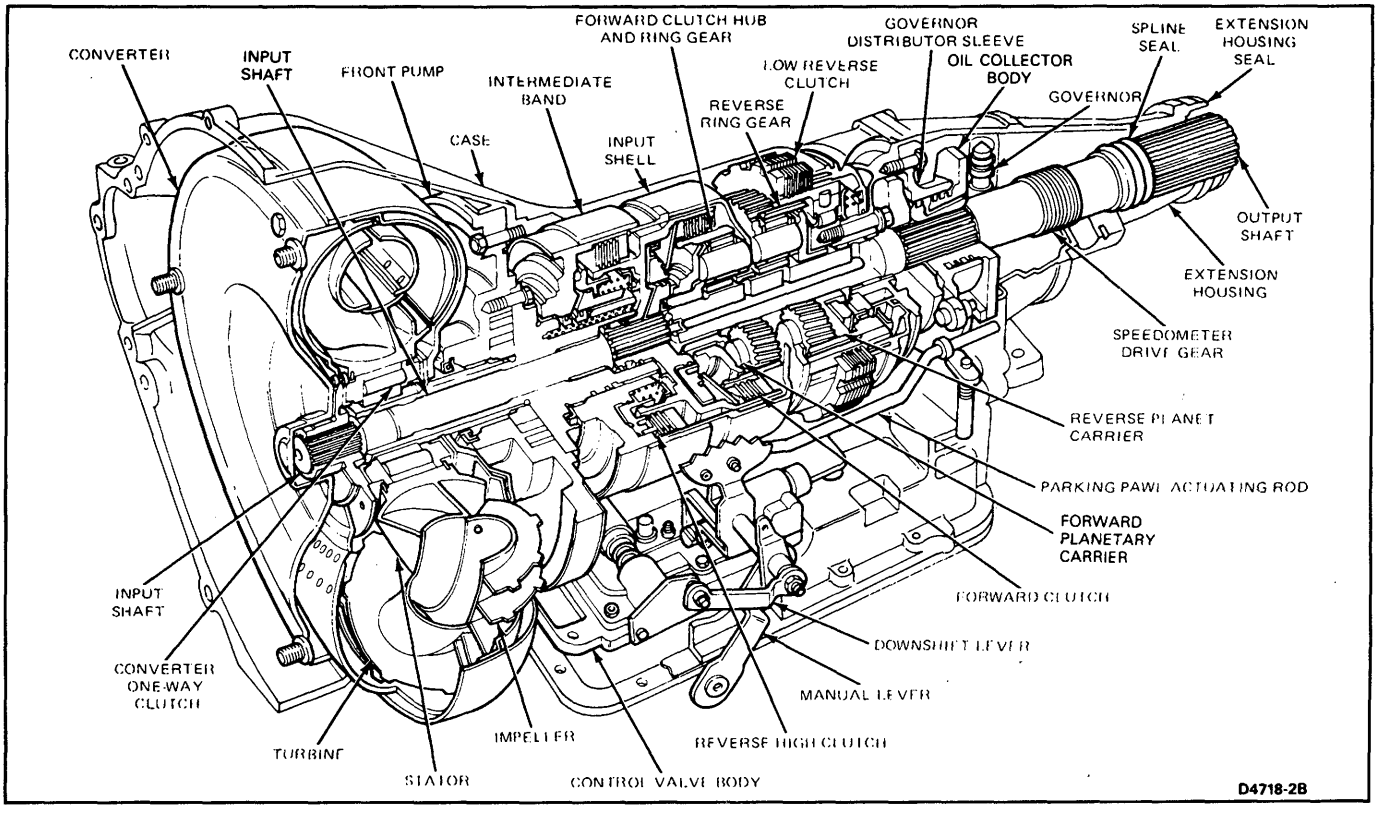


FIG. 1 C6 Automatic Transmission—Sectional

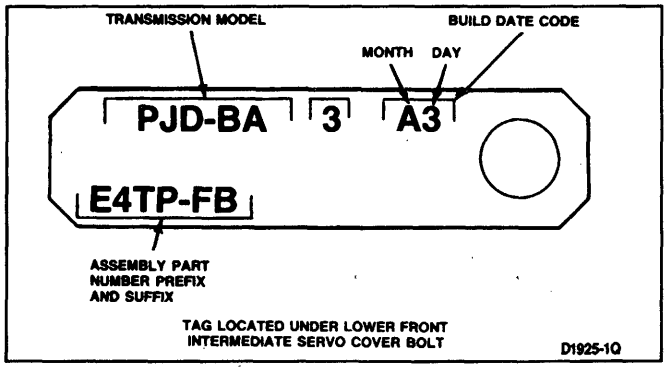


FIG. 2 Identification Tag

ADJUSTMENTS

The only adjustments on the transmission are the intermediate band and the NEUTRAL START switch (and the Vacuum Regulator Valve on vehicles equipped with 7.3L diesel engines).

On vehicles equipped with 7.3L Diesel Engines, the Vacuum Regulator Valve (VRV), which is located on the fuel injector pump must be properly adjusted to regulate vacuum to the transmission vacuum diaphragm.

To prevent damage to the transmission and to assure proper band adjustment, it is essential that the tools and procedures described here are used whenever the band is adjusted.

Intermediate Band Adjustment

1. Raise the vehicle on a hoist or jack stands.
2. Clean all the dirt from the band adjusting screw. Remove and discard locknut.
3. Install a new locknut and tighten the adjusting screw to 14 N·m (10 ft-lbs) torque (Fig. 5).
4. **Back off the adjusting screw exactly 1-1/2 turns.**
5. Hold the adjusting screw from turning and tighten the locknut to 48-61 N·m (35-40 ft-lbs).
6. Lower the vehicle.

Align Neutral Start Switch

1. Apply the parking brake.
2. With the manual linkage properly adjusted, loosen the two switch attaching bolts (Fig. 6).
3. Place the transmission manual lever in NEUTRAL. Rotate the switch and insert the gauge pin (No. 43 drill shank end) into the gauge pin holes of the switch. The gauge pin has to be inserted a full 12.303mm 31/64 inch into the three holes of the switch (Fig. 6).
4. Tighten the two neutral start switch attaching bolts to 6.5-8.0 N·m (55-75 in-lbs). Remove the gauge pin from the switch.
5. Check the operation of the switch. The back up lamps should operate only with the transmission selector lever in **REVERSE.** The vehicle should start only with the transmission selector lever in **PARK** and **NEUTRAL.**

Vacuum Regulator Valve (VRV) Operational Check and Adjustment (Vehicles Equipped with 7.3L Diesel Engine only)

Refer to Fig. 4

To check the VRV for proper operation and to adjust, the engine must not be running (TURNED OFF).

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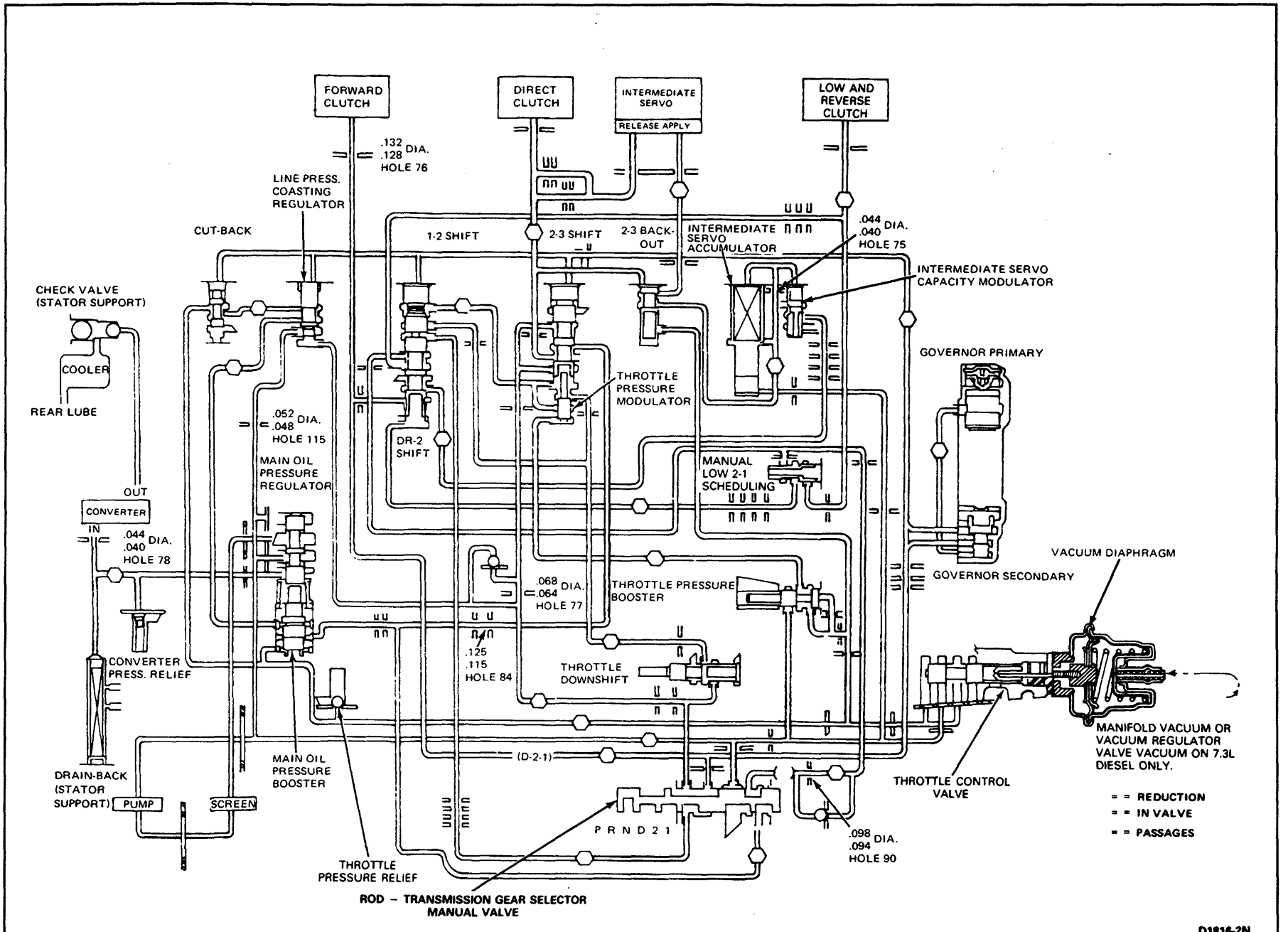


FIG. 3 Hydraulic Control System—C6 Transmission

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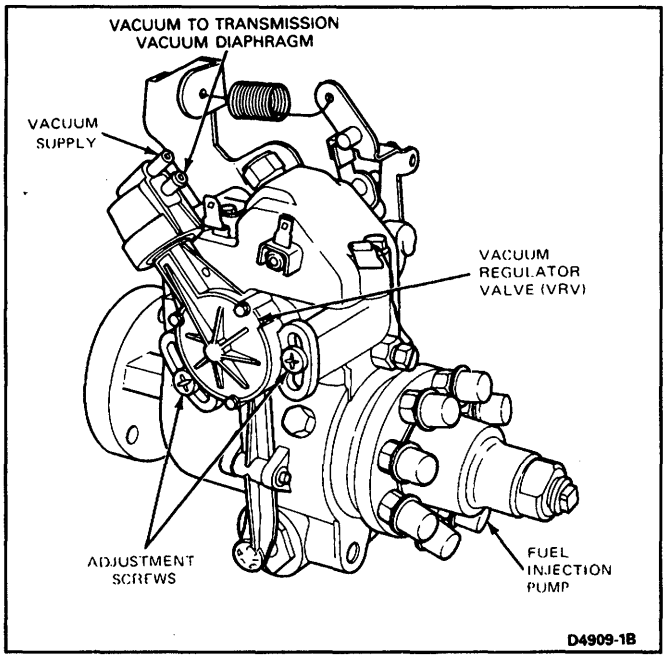


FIG. 4 Vacuum Regulator Valve (VRV)—E-250—E-350, F-250—F-350 with 7.3L Diesel Engine

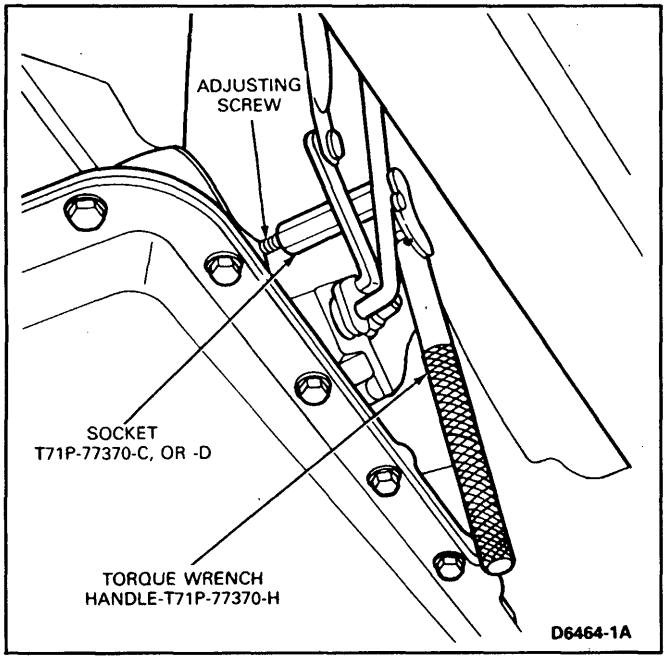


FIG. 5 Adjusting Intermediate Band

1. Disconnect the two port vacuum connector from the VRV located on the left side of the fuel injection pump.
2. Remove the throttle cable from the throttle lever on the right side of the fuel injection pump.
3. Remove the throttle return spring. Install the end of the spring over the throttle lever ball stud and the other end over the throttle cable support bracket.
4. Attach a vacuum pump to the upper port of the VRV (vacuum supply side).
5. Attach a vacuum gauge to the lower port of the VRV, labeled TRANS on the VRV.

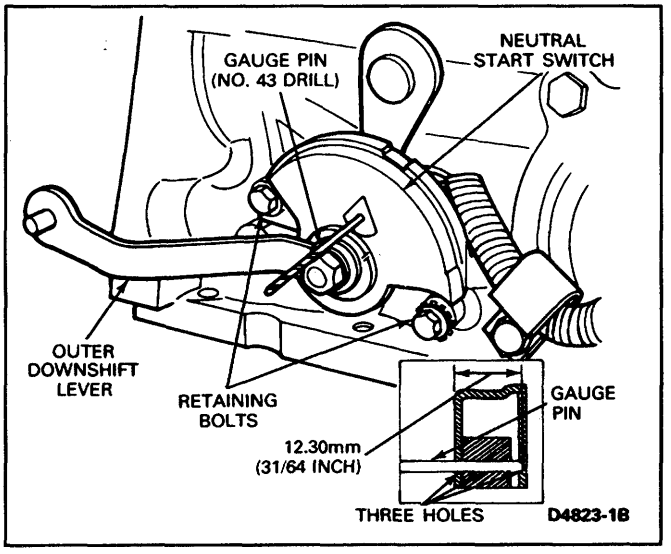


FIG. 6 Neutral Start and Back Up Lamp Switch

6. Apply 20 inches minimum of vacuum to the VRV and maintain. **It will be necessary to continually pump the vacuum up as it bleeds off (this is normal). Cycle the throttle lever 5 times from idle to WOT** with vacuum applied. Insert the gauge block, T83T-7B200-AH (0.515 inch), between the pump boss and the throttle wide-open stop (Fig. 7). The throttle return spring (F-Series), as repositioned in step 3 below, will hold the throttle lever stop against the gauge block (Hold throttle lever open on Econoline by other means). **The vacuum gauge attached to the lower port of the VRV should indicate 6-8 inches of vacuum. If the vacuum reading is not correct, adjust the VRV to achieve a reading of 7 inches (± .5) of vacuum.**
7. To adjust, loosen the two adjustment screws that attach the VRV to the fuel injection pump (Fig. 4). Rotate the VRV until the proper vacuum is obtained. Tighten the two adjusting screws to 8-10.5 N·m (75-90 in-lbs) when the proper vacuum reading is obtained. If the VRV can not be adjusted to obtain the proper vacuum, replace the VRV and repeat procedure from Step 3.
8. Remove the gauge block.
9. Reattach the throttle return spring and throttle cable.
10. Again apply 20 inches of vacuum to the VRV and **while maintaining vacuum, cycle the throttle lever from idle to WOT 5 times.** The vacuum gauge must indicate at least 13 inches (throttle at idle position). If the vacuum gauge indicates less than 13 inches the VRV must be replaced and the new VRV adjusted per the above procedures.
11. After making the check or adjustment, remove the vacuum pump and gauge from the VRV and reattach the vacuum connector.
12. Start engine and check throttle operation and check transmission shifts.

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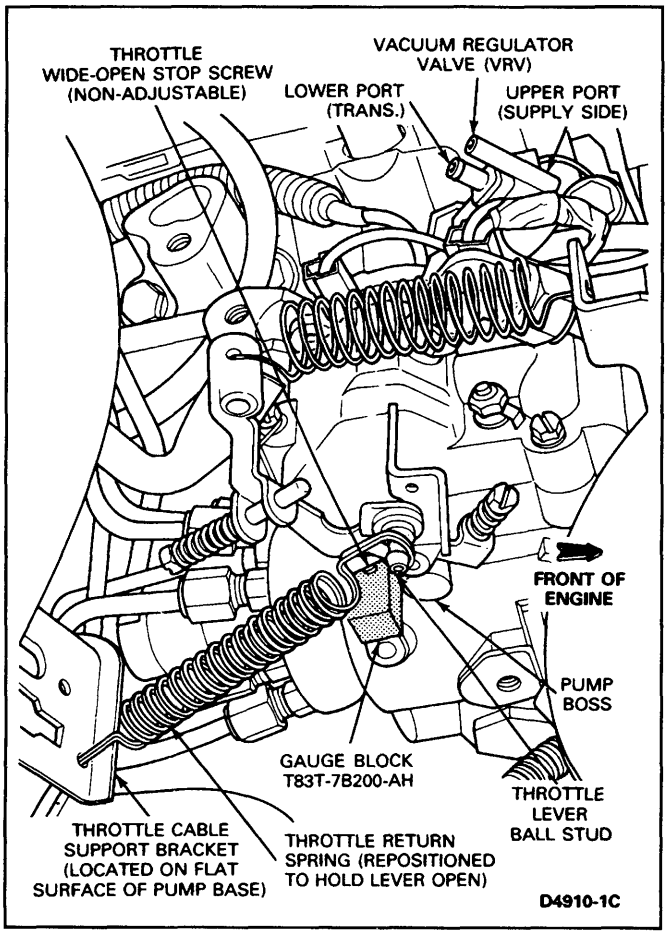


FIG. 7 VRV Gauge Block Installation

REMOVAL AND INSTALLATION

Transmission

F-150—F-250—F-350 and Bronco

Removal

1. Drive the vehicle on a hoist, but do not raise at this time. Disconnect the battery negative cable. Disconnect neutral switch wire at the plug connector.
2. Raise the vehicle on a hoist or stands.
3. Place the drain pan under the transmission fluid pan. Starting at the rear of the pan and working toward the front, loosen the attaching bolts and allow the fluid to drain. Finally remove all of the pan attaching bolts except two at the front, to allow the fluid to further drain. With fluid drained, install two bolts on the rear side of the pan to temporarily hold it in place.
4. Remove the converter drain plug access cover from the lower end of the converter housing.
5. Remove the converter-to-flywheel attaching nuts. Place a wrench on the crankshaft pulley attaching bolt to turn the converter to gain access to the bump switch.
6. With the wrench on the crankshaft pulley attaching bolt, turn the converter to gain access to the converter drain plug. Place a drain pan under the converter to catch the fluid and remove the plug. After the fluid has been drained, re-install the plug.
7. On (4x2) applications disconnect the driveshaft from the rear axle and slide shaft rearward from the transmission. Install a seal installation tool in the extension housing to prevent fluid leakage.
8. Disconnect the speedometer cable from the extension housing.
9. Disconnect the downshift and manual linkage rods or cable controls from the levers at the transmission.
10. Disconnect the oil cooler lines from the transmission.
11. Remove the vacuum hose from the vacuum diaphragm unit. Remove the vacuum line from the retaining clip.
12. Disconnect the cable from the terminal on the starter motor. Remove the three attaching bolts and remove the starter motor.
13. On F-150—F-350 (4x4) and Bronco vehicles, remove the transfer case. Refer to Section 16-80, Borg Warner 13-56 Electronic Shift Transfer Case, 16-81, Borg Warner 13-56 Transfer Case—Manual Shift, or Section 16-86, Borg Warner 1345 Transfer Case.
14. Remove the two engine rear support and insulator assembly-to-attaching bolts (Fig. 8).
15. Remove the two engine rear support and insulator assembly-to-extension housing attaching bolts (Fig. 8).
16. Remove the six bolts securing the No. 2 crossmember to the frame side rails (Fig. 8).
17. Raise the transmission with a transmission jack and remove the crossmember.
18. Secure the transmission to the jack with the safety chain.
19. Remove the converter housing-to-engine attaching bolts.
20. Move the transmission away from the engine. Lower the jack and remove the converter and transmission assembly from under the vehicle.

Installation

1. Tighten the converter drain plug to 11-37 N·m (18-28 ft-lbs).
2. Position the converter on the transmission making sure the converter drive flats are fully engaged in the pump gear.
3. With the converter properly installed, place the transmission on the jack. Secure the transmission to the jack with the chain.
4. Rotate the converter until the studs and drain plug are in alignment with their holes in the flywheel.
5. Move the converter and transmission assembly forward into position, using care not to damage the flywheel and the converter pilot. **The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft. Do not allow converter drive flats to disengage from pump gear.**
6. Install and tighten the converter housing-to-engine attaching bolts to 55-67 N·m (40-50 ft-lbs) on gasoline engines and 67-87 N·m (50-65 ft-lbs) on diesel engines.

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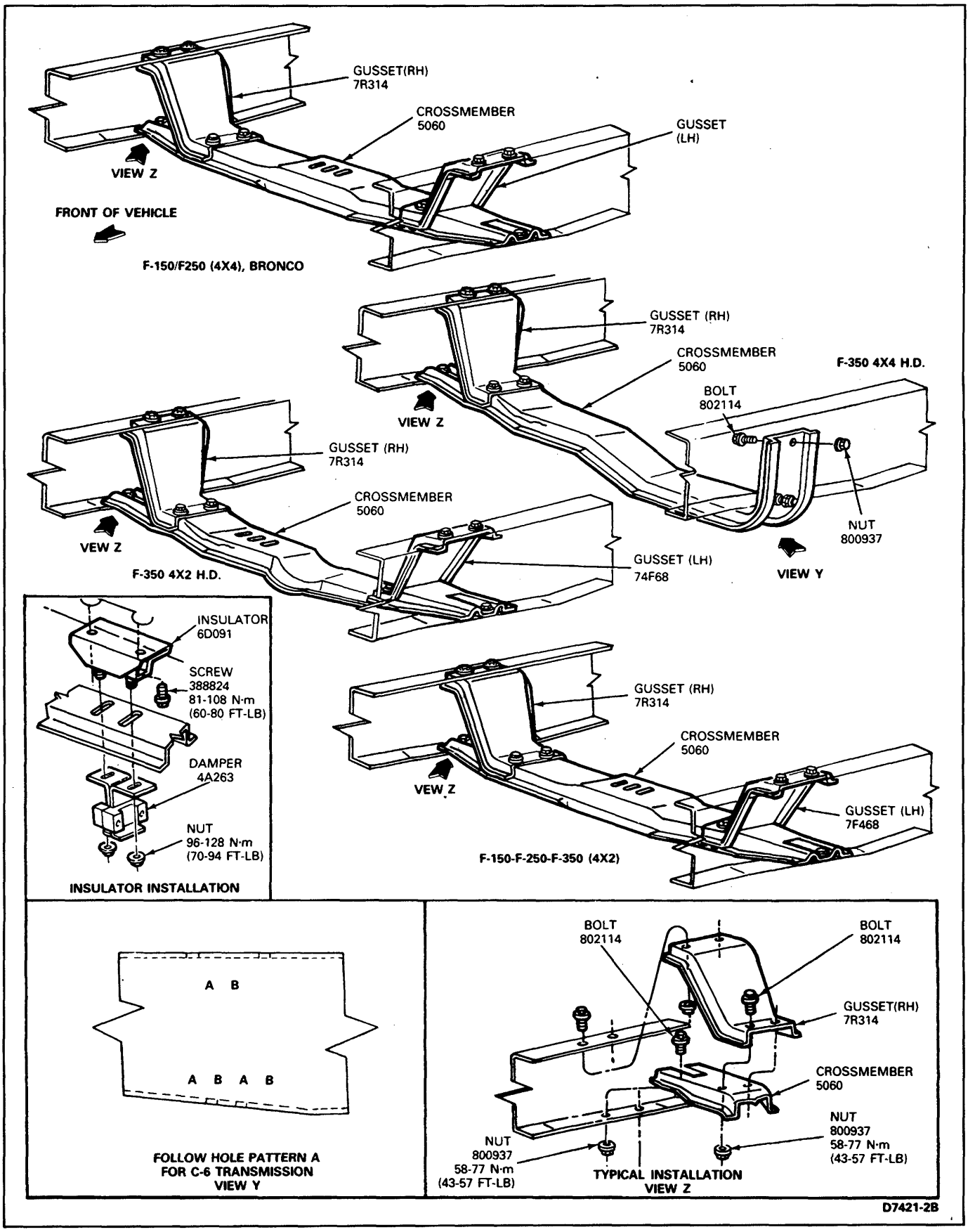


FIG. 8 Crossmember Installation F-150—F-250—F-350 and Bronco

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7. Remove the transmission jack safety chain from around the transmission.
8. Position the No. 2 crossmember to the frame side rails. Install and tighten the attaching bolts to specifications as listed at the end of this Section.
9. Install transfer case on F-150—F-250 (4x4) and Bronco. Refer to Section 16-80, Borg Warner 13-56 Electronic Shift Transfer Case, 16-81, Borg Warner 13-56 Transfer Case—Manual Shift, or Section 16-86, Borg Warner 1345 Transfer Case.
10. Position the engine rear support and insulator assembly above the crossmember. Install the rear support and insulator assembly-to-extension housing mounting bolts and tighten the bolts to specifications as listed at the end of this Section.
11. Lower the transmission and remove the jack.
12. Secure the engine rear support and insulator assembly to the crossmember with the attaching bolts and tighten them to specifications as listed at the end of this Section.
13. Connect the vacuum line to the vacuum diaphragm making sure that the line is in the retaining clip.
14. Connect the oil cooler lines to the transmission.
15. Connect the downshift and manual linkage rods or cable controls to their respective levers on the transmission. Refer to Section 17-02 Shift Control Linkage, Removal and Installation
16. Connect the speedometer cable to the extension housing.
17. Secure the starter motor in place with the attaching bolts. Connect the cable to the terminal on the starter.
18. Install a new O-ring on the lower end of the transmission filler tube and insert the tube in the case.
19. Secure the converter-to-flywheel attaching nuts and tighten them to 28-40 N·m (20-30 ft-lbs).
20. Install the converter housing access cover and secure it with the attaching bolts.
21. Connect the driveshaft.
22. Adjust the shift linkage as required. Refer to Section 17-02, Shift Control Linkage.
23. Connect neutral switch wire to plug connector.
24. Connect the battery negative cable.

Transmission

E-150—E-250—E-350

Removal

1. Disconnect the battery negative cable.
2. Working from inside the vehicle, remove the engine compartment cover.
3. Disconnect the neutral start switch wires at the plug connector.
4. If the vehicle is equipped with a V-8 engine, remove the flexhose from the air cleaner heat tube.
5. Remove the bolt securing the filler tube to the engine.
6. Raise the vehicle on a hoist.
7. Place the drain pan under the transmission fluid pan. Starting at the rear of the pan and working toward the front, loosen the attaching bolts and allow the fluid to drain. Finally remove all of the pan attaching bolts except two at the front, to allow the fluid to further drain. With fluid drained, install two bolts on the rear side of the pan to temporarily hold it in place.
8. Remove the converter drain plug access cover from the lower end of the converter housing.
9. Remove the converter-to-flywheel attaching nuts. Place a wrench on the crankshaft pulley attaching bolt to turn the converter to gain access to the nuts.
10. With the wrench on the crankshaft pulley attaching bolt, turn the converter to gain access to the converter drain plug. Place a drain pan under the converter to catch the fluid. Then, remove the plug. With fluid drained, re-install the plug.
11. Disconnect the driveshaft.
12. Remove fluid filler tube.
13. Disconnect the starter cable at the starter. Remove the starter-to-converter housing attaching bolts and remove the starter.
14. Position an appropriate engine support bar to the frame and engine oil pan flanges.
15. Disconnect the cooler lines from the transmission. Disconnect the vacuum line from the vacuum diaphragm unit. Remove the vacuum line from the retaining clip at the transmission.
16. Remove the speedometer driven gear from the extension housing.
17. Disconnect the manual and downshift linkage rods or cable controls from the transmission control levers.
18. Position a transmission jack to support the transmission. Install the safety chain to hold the transmission.
19. Remove the bolts and nuts securing the rear support and insulator assembly to the crossmember. Remove the six bolts retaining the crossmember to the side rails and remove the two support gussets. Raise the transmission with the jack and remove the crossmember (Fig. 9).
20. Remove the converter housing-to-engine attaching bolts. Lower the jack and remove the converter and transmission assembly from under the vehicle.
21. Remove the converter and mount the transmission in a holding fixture.

Installation

1. Tighten the converter drain plug to specification as listed at the end of this Section.
2. Position the converter on the transmission making sure the converter drive flats are fully engaged in the pump gear.
3. With the converter properly installed, place the transmission on the jack. Secure the transmission to the jack with the safety chain.
4. Rotate the converter until the studs and drain plug are in alignment with their holes in the flywheel.
5. Move the converter and transmission assembly forward into position, using care not to damage the flywheel and the converter pilot.

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The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft. Do not allow converter drive flats to disengage from pump gear.

6. Install the converter housing-to-engine attaching bolts. Tighten the bolts to 55-67 N·m (40-50 ft-lbs) on gasoline engines and 67-87 N·m (50-65 ft-lbs) on diesel engines. Install the converter-to-flywheel attaching nuts. Tighten the nuts to 28-40 N·m (20-30 ft-lbs).
7. Install the crossmember. Install the rear support and insulator assembly-to-crossmember attaching bolts and nuts. Tighten the bolts to specifications as listed at the end of this Section.
8. Remove the safety chain and remove the jack from under the vehicle. Remove the engine support bar.
9. Install a new O-ring on the lower end of the transmission filler tube and insert the tube and dipstick in the case.
10. Connect the vacuum line to the vacuum diaphragm making sure the line is secured in the retaining clip.
11. Connect the cooler lines to the transmission.
12. Install the speedometer driven gear into the extension housing. Tighten the attaching bolt to specifications as listed at the end of this Section.
13. Connect the transmission linkage rods to the transmission control levers. When making transmission control attachments new retaining ring and grommet should always be used (see Removal and Installation in Section 17-02, Shift Control Linkage). Note precautions necessary to prevent grommet damage. Attach the shift rod to the steering column shift lever (refer to Fig. 2, Section 17-02, Shift Control Linkage). Align the flats of the adjusting stud with the flats of the rod slot and insert the stud through the rod. Assemble the adjusting stud nut and washer to a loose fit. Perform a linkage adjustment as outlined in Section 17-02, Shift Control Linkage.
14. Install the converter housing access cover and tighten the attaching bolts to 17-21 N·m (12-16 ft-lbs).
15. Position the starter into the converter housing and install the attaching bolts. Tighten the bolts to 55-67 N·m (40-50 ft-lbs) on gasoline engines and 67-87 N·m (50-65 ft-lbs) on diesel engines. Install the starter cable.
16. Install the driveshaft.
17. Lower the vehicle.
18. On V-8 engines, install the flex hose to the air cleaner heat tube. Install the bolt that retains the filler tube to the cylinder block.
19. Connect the neutral start switch wires at the plug connector.
20. Fill the transmission to the proper level with the specified fluid.
21. Raise the vehicle and check for transmission fluid leakage. Make sure the transmission fluid pan is securely attached. Lower the vehicle and adjust the downshift and manual linkage. Refer to Section 17-02, Shift Control Linkage.
22. Connect the battery negative cable.
23. Install the engine compartment cover.

Control Valve Body

Refer to Fig. 17.

Removal

1. Raise the vehicle on a hoist or jack stands.
2. Place a drain pan under the transmission and loosen the bolts holding the transmission pan to drain the fluid from the transmission.
3. Remove the transmission pan attaching bolts from both sides and the rear to allow the fluid to drain further. Finally, remove the remainder of the attaching bolts. Remove the pan and gasket. Remove and discard the nylon shipping plug from the pan. This plug is used to retain transmission fluid within the transmission during shipment and should be discarded when the oil pan is removed.
4. Remove the valve body attaching bolts and remove the valve body from the case.

Installation

1. Position the valve body to the case making sure that the selector and downshift levers are engaged. Install and tighten the attaching bolts to 11-14 N·m (95-125 in.-lbs).
2. Clean the transmission pan and gasket surfaces thoroughly.
3. Using a new pan gasket, install attaching bolts securing the pan to the transmission case. Tighten the attaching bolts to 10.5-17 N·m (8-12 ft-lbs).
4. Lower the vehicle and fill the transmission to the correct level with the specified fluid.

Intermediate Servo

(Refer to Fig. 10).

Removal

1. Raise the vehicle on a hoist or stands.
2. Remove the bolts that secure the engine rear support to the transmission extension rear support and insulator assembly to the crossmember.
3. Remove the two crossmember-to-frame attaching bolts, and the bolts attaching the gussets to the crossmember if so equipped.
4. Raise the transmission high enough to remove the weight from the crossmember and remove the crossmember.
5. Disconnect the muffler inlet pipe from the exhaust manifolds and allow the pipe to hang.
6. Place a drain pan under the servo. Remove the bolts that attach the servo cover to the transmission case.
7. Remove the cover, piston, spring and gasket from the case, screwing the band adjusting screw inward as the piston is removed. This places enough tension on the band to keep the struts properly engaged in the band end notches while the piston is removed.
8. Apply air pressure to the port in the servo cover to remove the piston and rod.
9. Replace the complete piston and rod assembly if the piston or piston sealing lips are damaged, (Fig. 10).

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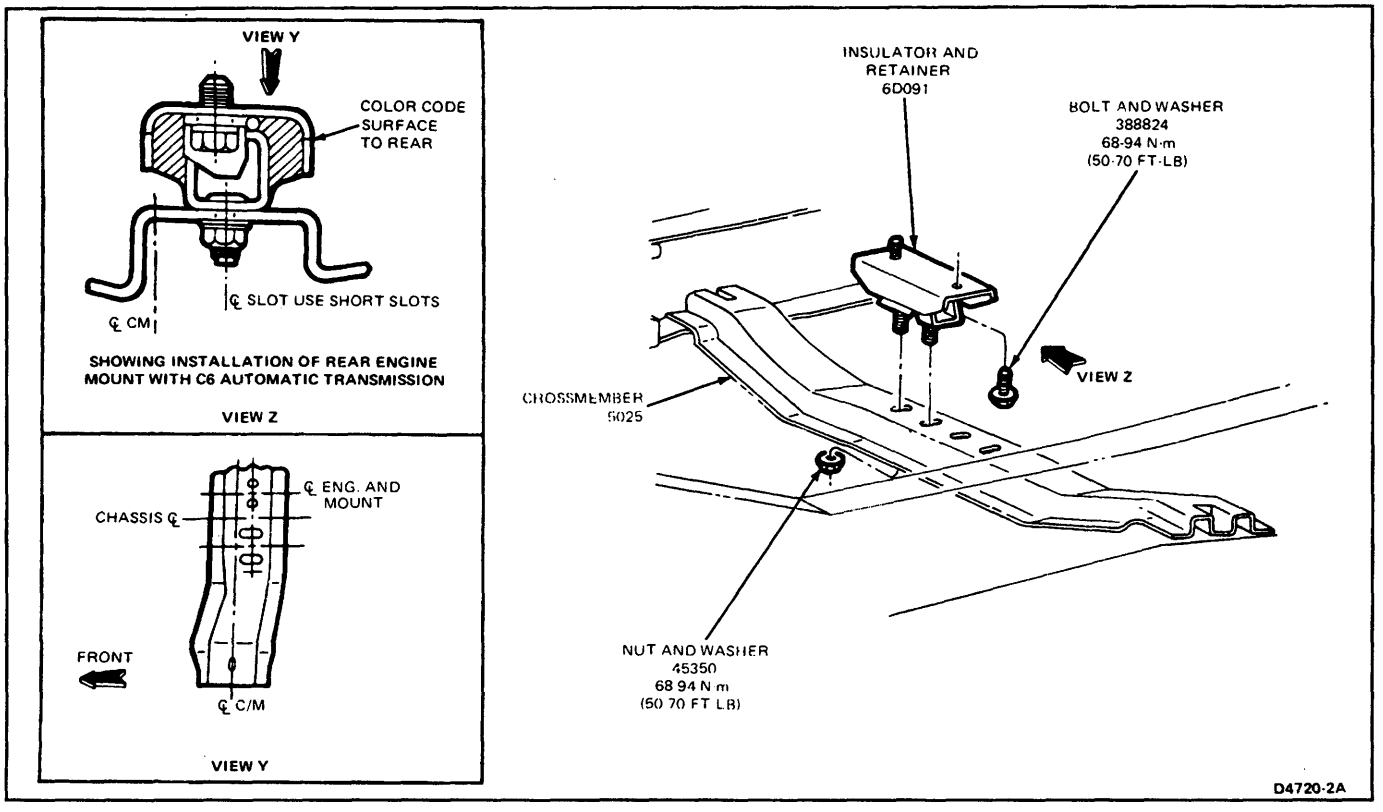


FIG. 9 Crossmember Installation—E-150—E-250—E-350

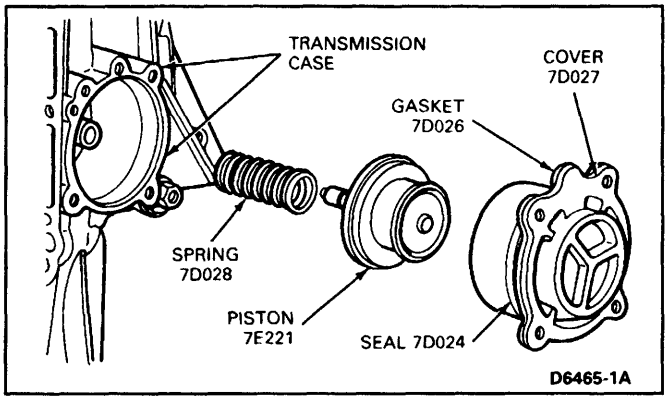


FIG. 10 Intermediate Servo Disassembled—Typical

10. Remove the seal from the cover.

Installation

1. Dip the new seal in transmission fluid.
2. Install a new seal on the cover.
3. Coat new gasket with petroleum jelly, and position on the servo cover.
4. Dip the piston in transmission fluid and install it in the cover.
5. Position the servo spring on the piston rod.
6. Insert the servo piston and cover in the case and secure the cover to the case with the attaching bolts, taking care to back off the band adjusting screw as the cover bolts are tightened 19-27 N·m (14-20 ft·lbs). **Make sure that the service identification tag is in place.**
7. Connect the muffler inlet pipe to the exhaust manifolds.
8. Raise the transmission high enough to install the crossmember. Secure the crossmember to the rear support with the attaching bolts. Lower the transmission as required to install the crossmember to frame and gussets attaching bolts. Tighten the attaching bolts to specifications as listed at the end of this Section.
9. Remove the jack from the transmission. Adjust the band as detailed in the Adjustment portion of this Section.
10. Lower the vehicle and replenish the fluid as required. Refer to Section 17-01 General Automatic Transmission Service.

Extension Housing Bearing or Bushing and Rear Seal

Removal

1. Raise the vehicle and disconnect the driveshaft at the transmission.
2. When only the rear seal needs replacing, carefully remove it with a tapered chisel or the Tools, T50T-100-A and TOOL-1175-AC, shown in Fig. 11. Remove the bushing using Tool T77L-7697-D or equivalent as shown in Fig. 12. **Use the bushing remover carefully so that the spline seal is not damaged.**

Installation

1. When installing a new bushing use the special Tool T77L-7697-C shown in Fig. 13.

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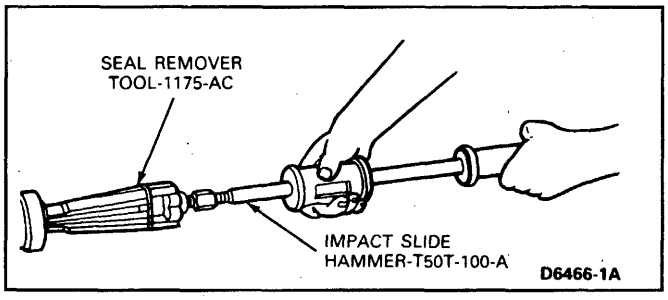


FIG. 11 Removing Extension Housing Seal

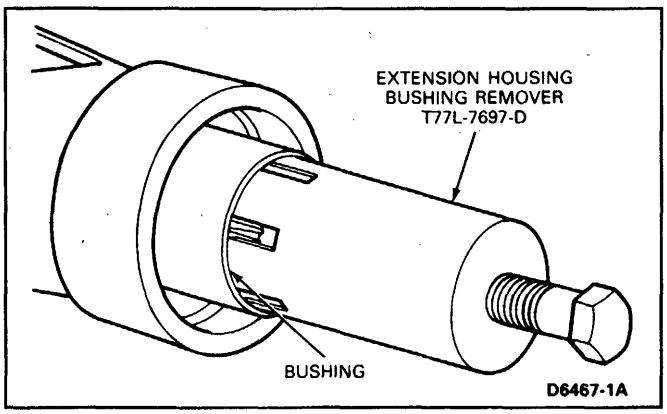


FIG. 12 Removing Extension Housing Bushing

2. Before installing a new seal, inspect the sealing surface of the universal joint yoke for scores. If scores are found, replace the yoke.
3. Inspect the counterbore of the housing for burrs. Remove burrs with crocus cloth.
4. Install the seal into the housing with Tool T61L-7657-B shown in Fig. 14, or an equivalent. The seal should be firmly seated in the bore. Coat the inside diameter of the end of the seal with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or an equivalent lubricant.
5. Coat the front universal joint spline with Multi-Purpose Long-Life Lubricant C1AZ-19590-B (ESA-M1C75-B) or an equivalent lubricant and install the driveshaft.

Extension Housing

Removal

1. Raise the vehicle on a hoist or stands.
2. Disconnect the driveshaft from the rear axle flange and remove it from the transmission. On 4x4 vehicles, remove the transfer case. Refer to Section 16-80, Borg Warner 13-56 Electronic Shift Transfer Case, 16-81 Borg Warner 13-56 Transfer Case-Manual Shift, or 16-86, Borg Warner 1345 Transfer Case.
3. Disconnect the speedometer cable from the extension housing.
4. Remove the engine rear support and insulator assembly-to-extension housing attaching bolts.
5. Place a jack under the transmission and raise it just enough to remove the weight from the engine rear support.

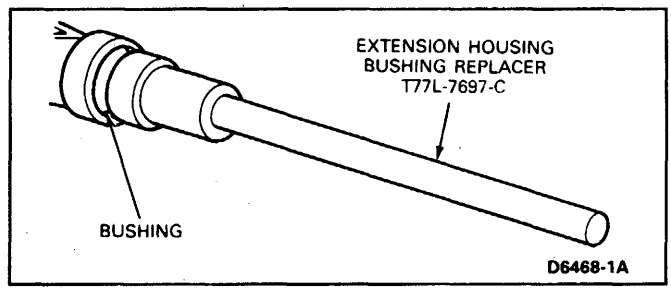


FIG. 13 Installing Extension Housing Bushing

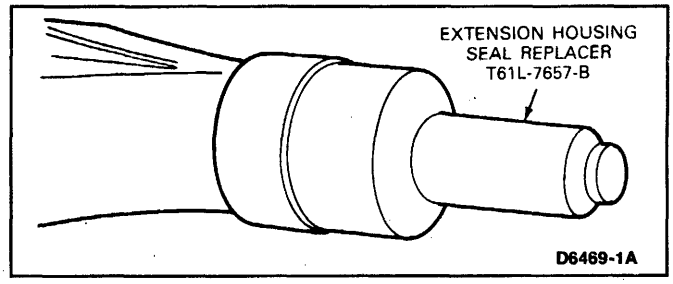


FIG. 14 Installing Extension Housing Seal

6. Remove the bolts that secure the engine rear support to the crossmember and remove the support.
7. Place a drain pan under the rear of the transmission case.
8. Lower the transmission and remove the extension housing attaching bolts. Slide the extension housing off the output shaft and allow the fluid to drain.

Installation

1. Clean the mounting surface on the transmission case and on the extension housing. Position a new gasket on the transmission case.
2. Hold the extension housing in place and secure it with the attaching bolts. Tighten bolts to 34-47 N·m (25-35 ft-lbs).
3. Raise the transmission high enough to position the engine rear support on the crossmember.
4. Secure the support to the crossmember with the attaching bolts and nuts. Tighten the bolts to specification as listed at the end of this Section.
5. Lower the transmission and remove the jack. Install the engine rear support-to-extension housing attaching bolts. Tighten bolts to specification as listed at the end of this Section. On 4x4 vehicles, install the transfer case. Refer to Section 16-80, 16-81 or 16-86.
6. Secure the speedometer cable to the extension housing with the attaching bolt.
7. Install the driveshaft and lower the vehicle to the floor.
8. Fill the transmission to the correct level with the specified fluid.

Governor

Removal

1. Remove the extension housing as outlined in this Section.

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2. Remove the four governor body-to-oil-collector attaching bolts (Fig. 15).
3. Remove the governor from the collector body flange.
4. Refer to the Disassembly and Assembly Section of this Section for Governor repair operations.

Installation

1. Secure the governor (Fig. 15) to the oil collector flange with the attaching bolts. Tighten the bolts to 10.5-13.5 N·m (90-120 in.-lbs).
2. Re-install the extension housing as outlined in this Section.

DISASSEMBLY AND ASSEMBLY

Transmission

Refer to Fig. 38.

Before removing any of the subassemblies, thoroughly clean the outside of the transmission to prevent dirt from entering the mechanical parts.

During the repair of the subassemblies, certain general instructions which apply to all units of the transmission must be followed. Following these instructions will avoid unnecessary repetition.

Handle all transmission parts carefully to avoid nicking or burring the bearing or mating surfaces. Lubricate all internal parts of the transmission with clean automatic transmission fluid before assembly.

Do not use any other lubricants except on gaskets and thrust washers. These may be coated with petroleum jelly to facilitate assembly. Always use new gaskets and seals when assembling a transmission. Refer to Section 17-01, General Automatic Transmission Service for Cleaning and Inspection Procedures.

Tighten all bolts and screws to the recommended torque as outlined in specifications at end of this Section.

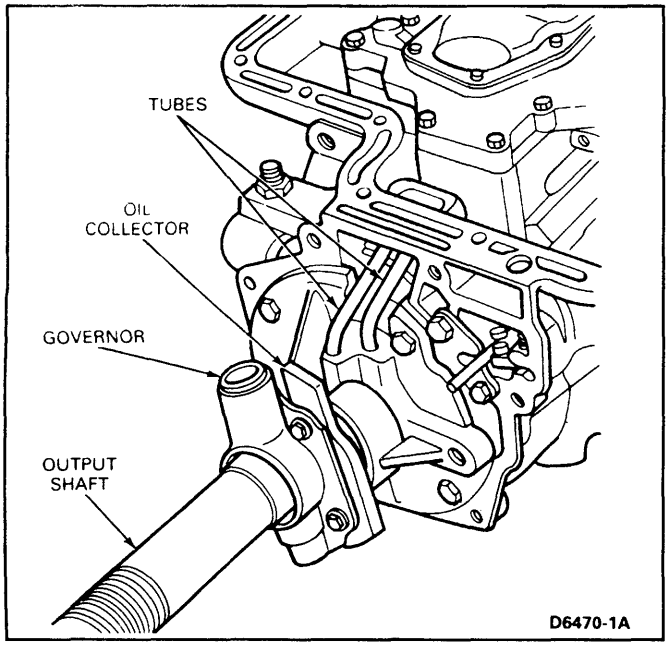


FIG. 15 Governor Installed

Disassembly

1. Remove the converter, and mount the transmission in holding fixture Rotunda Model 014-00106 or equivalent, (Fig. 16).

   NOTE: If equipped, remove and discard the nylon shipping plug from the pan. This plug is used to retain transmission fluid within the transmission during shipping. It should be discarded when the oil pan is removed.
2. Remove the 17 fluid pan attaching bolts. Remove the pan and gasket.
3. Remove the eight valve body attaching bolts. Lift the valve body (Fig. 17) from the transmission case.
4. Attach a dial indicator TOOL-4201-C or equivalent to the front pump as shown in Fig. 18. Install Tool T61L-7657-B in the extension housing to center the output shaft.
5. Pry the gear train to the rear of the case and at the same time, press the input shaft inward until it

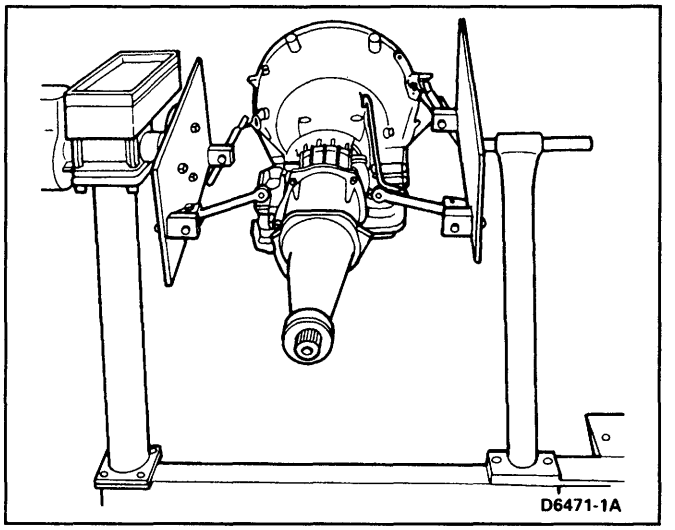


FIG. 16 Transmission Mounted in Holding Fixture

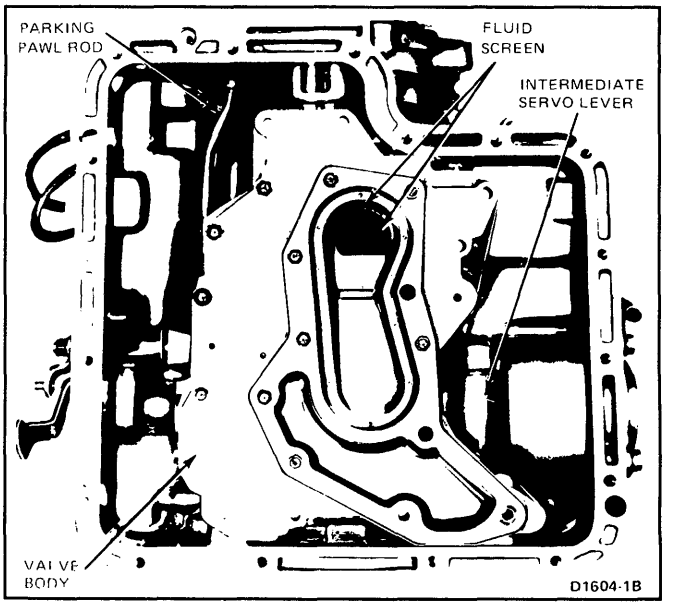


FIG. 17 Transmission With Pan Removed

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bottoms, (Fig. 18). Set the dial indicator to read zero.

6. Pry the gear train forward, (Fig. 18), and note the amount of gear train end play on the dial indicator. Record the end play to facilitate assembling the transmission. Remove the dial indicator from the pump and the tool from the extension housing.
7. Remove the vacuum diaphragm, valve rod and the throttle valve from the bore in the rear of the case. Slip the input shaft out of the front pump.
8. Remove the front pump attaching bolts. Pry the gear train forward as shown in Fig. 19 to remove the pump.

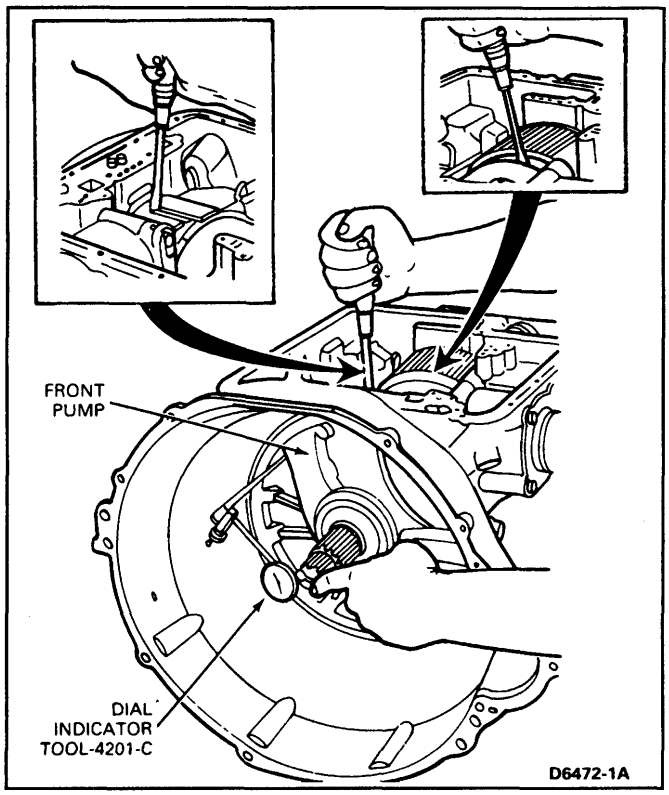


FIG. 18 Checking Gear Train End Play

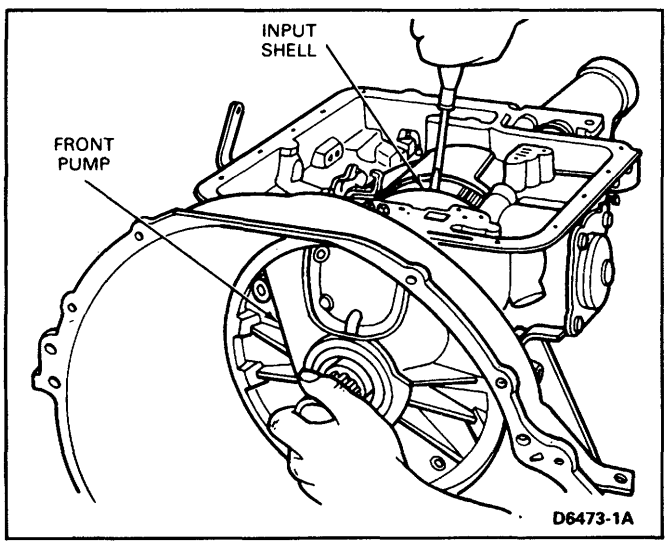


FIG. 19 Removing Front Pump

9. Loosen the band adjustment screw and remove the two struts.
10. Rotate the band 90 degrees counterclockwise to align the ends with the slot in the case (Fig. 20). Slide the band off the reverse-high clutch drum.
11. Remove the forward part of the gear train as an assembly as shown in Fig. 21.
12. Remove the bolts that attach the servo cover to the transmission case.
13. Remove the cover, piston, spring and gasket from the case.
14. Remove the large snap ring that secures the reverse planet carrier in the low-reverse clutch hub. Lift the thrust washers and planet carrier from the drum.
15. Remove the snap ring, (Fig. 22), that secures the reverse ring gear and hub on the output shaft. Slide

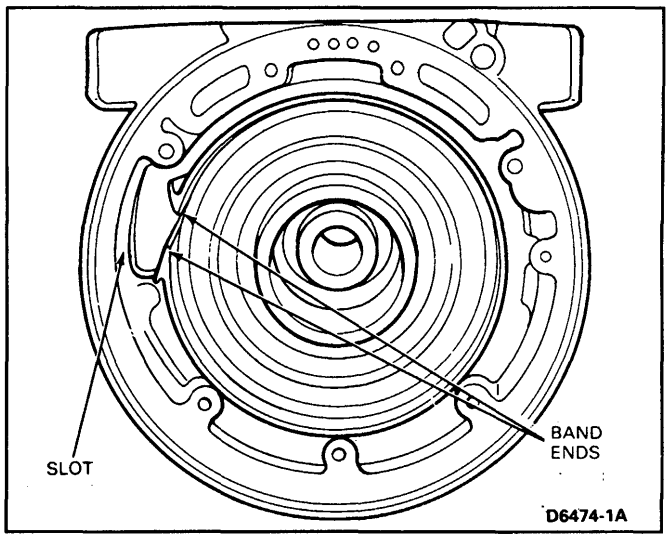


FIG. 20 Removing or Installing Band

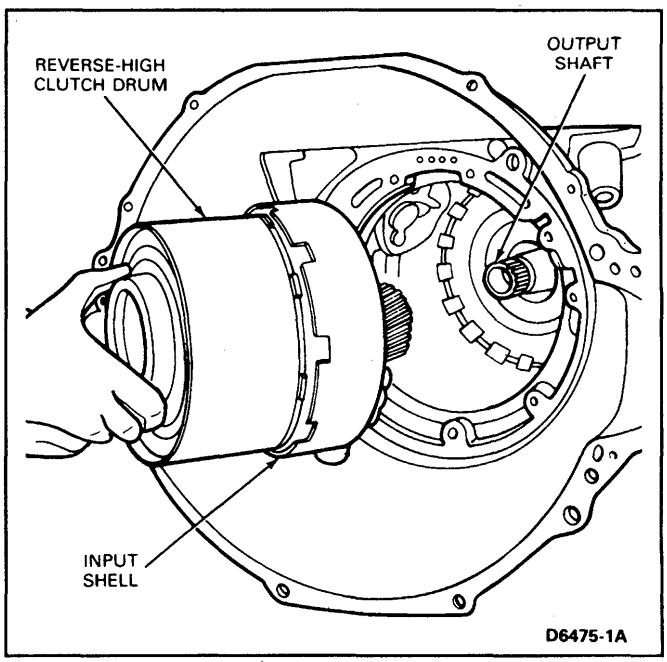


FIG. 21 Removing or Installing Forward Part of Gear Train

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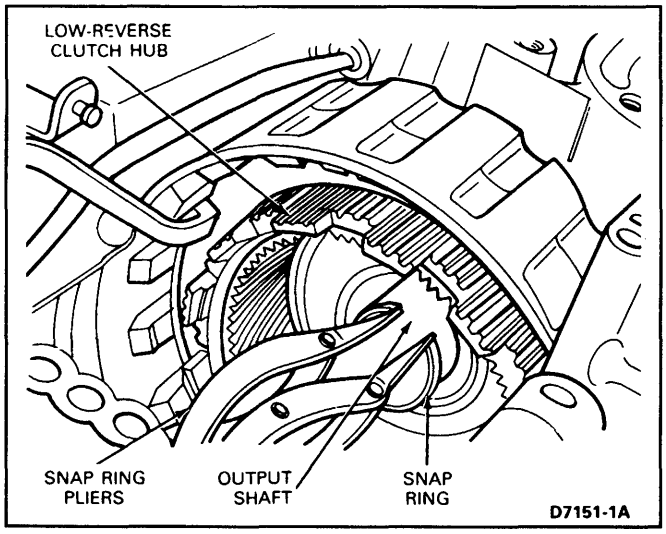


FIG. 22 Removing or Installing Reverse Ring Gear Hub, Snap Ring

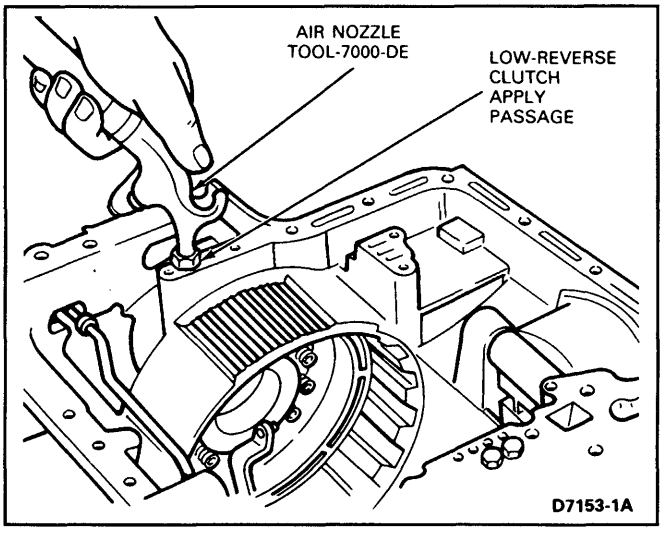


FIG. 23 Removing Low-Reverse Clutch Piston

the ring gear and hub off the shaft. Remove the thrust washer.

16. Rotate the low-reverse clutch hub in a clockwise direction and at the same time, withdraw it from the case.
17. Remove the reverse clutch snap ring from the case, then remove the clutch discs, plates and pressure plate from the case.
18. Remove the extension housing attaching bolts from the case. Remove the extension housing and gasket.
19. Slide the output shaft (with governor and oil collector) assembly from the transmission case.
20. Remove the distributor sleeve attaching bolts and remove the sleeve, parking pawl gear and the thrust washer.

    If the thrust washer is staked in place, use a sharp chisel and cut off the metal from behind the thrust washer. Be sure to clean the rear of the case with air pressure or a suitable solvent to remove any metal particles.
21. Remove the one-way clutch inner race attaching bolts from the rear of the case. Remove the inner race and reverse clutch spring retainer assembly from inside of the case.
22. Remove the low-reverse clutch piston from the case using TOOL-7000-DE or equivalent as shown in Fig. 23.

Assembly

1. Place the transmission case in a holding fixture.
2. Tap the low-reverse piston into place in the case with a clean rubber hammer.
3. Install the low-reverse clutch spring retainer assembly and retainer assembly in the clutch piston.
4. Hold the one-way clutch inner race in position and install the attaching bolts. Tighten bolts to 25-33 N·m (18-25 ft-lbs).
5. Place the transmission case on the bench with the front end facing downward.
6. Position the parking gear thrust washer and the gear on the case (Fig. 31). **Do not re-stake the thrust washer.**
7. Position the collector and tubes in place on the rear of the case. Install the attaching bolts and tighten to 17-21 N·m (12-16 ft-lbs).
8. Install the output shaft, and governor as an assembly.
9. Place a new gasket on the rear of the transmission case. Position the extension housing on the case and install the attaching bolts. Tighten the attaching bolts to 34-47 N·m (25-35 ft-lbs).
10. Place the transmission case in the holding fixture.
11. Coat new gasket with petroleum jelly and position on the servo cover.
12. Position the servo spring on the piston rod.
13. Insert the servo piston rod in the case. Install the servo cover with the attaching bolts, making sure that the identification tag is in place. Tighten the attaching bolts to 19-27 N·m (14-20 ft-lbs).
14. Align the low-reverse clutch hub and one-way clutch with the inner race at the rear of the case. Rotate the low-reverse clutch hub clockwise while applying pressure to seat it on the inner race.
15. Install the low-reverse clutch plates, starting with the wave plate next to the piston and following with steel and friction plates alternately. Retain them with petroleum jelly. If new composition plates are being used, soak them in clean transmission fluid, DEXRON® II - Series D (ESP-M2C166-H, XT-2-QDX, or equivalent), for fifteen minutes before installation. Install the pressure plate and the snap ring. Test the operation of the low-reverse clutch by applying air pressure at the clutch pressure apply hole in the case.
16. Install the reverse planet ring gear thrust washer and the ring gear and hub assembly. Insert the snap ring in the groove on the output shaft.
17. Assemble the front and rear thrust washers onto the reverse planet assembly; retain with petroleum jelly. Insert the assembly into the ring gear and install the snap ring.

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18. Set the reverse-high clutch assembly on the bench, with the front end facing down. Install the thrust washer on the rear end of the reverse-high clutch assembly. Retain the thrust washer with petroleum jelly and insert the splined end of forward clutch into the open end of the reverse-high clutch with splines engaging the direct clutch friction plates (Fig. 38).
19. Install the thrust washers and retain them with petroleum jelly, on the front end of the forward planet ring gear and hub. Insert the ring gear into the forward clutch.
20. Install the thrust washer on the front end of the forward planet assembly. Retain the washer with petroleum jelly and insert the assembly into the ring gear. Install the input shell and sun gear assembly.
21. Install the reverse-high clutch assembly, forward clutch assembly, forward planet assembly and drive input shell, and sun gear as an assembly into the transmission case.
22. Insert the intermediate band into the case around the reverse-high clutch drum. Install the struts and tighten the band adjusting screw sufficiently to retain the band.
23. Place a selective thickness bronze thrust washer on the rear shoulder of the stator support and retain it with petroleum jelly. If the end play was not within specification when checked prior to disassembly, replace the washer with one of proper thickness. Refer to specifications at the end of this Section for selective thrust washer thicknesses.

    Using two 5/16-inch bolts three inches long, make two alignment studs. Cut the heads from the bolts and grind a taper on the cut end. Temporarily install the two studs opposite each other in the mounting holes of the case. Slide a new gasket onto the studs. Position pump on case, being careful not to damage the large seal on the outside diameter of the pump housing, (removing the aligning studs).

    Install six of the seven mounting bolts and tighten to 22-40 N·m (16-30 ft-lbs).
24. Adjust the intermediate band as detailed under Adjustments and install the input shaft with the long splined end inserted into the forward clutch assembly.
25. Install Tool 4201-C or equivalent at the seventh pump mounting bolt (Fig. 18) and check the transmission end play as in steps 4, 5 and 6 of Disassembly. (See specifications at the end of this Section.) Remove the tool.

    Install the seventh pump mounting bolt and tighten to 22-40 N·m (16-30 ft-lbs).
26. Install the main control valve body on the case, making sure that the levers engage the valves properly and tighten the attaching bolts to 11-14 N·m (95-125 in.-lbs). Install the primary throttle valve, rod, and the vacuum diaphragm in the case. Tighten the diaphragm attaching bolt to 17-21 N·m (12-16 ft-lbs).
27. Install a new pan gasket and the pan. Tighten the bolts to 10.5-17 N·m (8-12 ft-lbs).
28. Install the converter assembly.
29. Install the transmission in the vehicle as detailed under Removal and Installation.

Control Valve Body

Disassembly

The valve body-to-screen gasket should not be cleaned in a degreaser solvent or any type of detergent solution when disassembling the main control. To clean the gasket, wipe it off with a lint-free cloth.

1. Remove the nine screws that attach the screen to the lower valve body (Fig. 24) and remove screen and gasket (Fig. 25).
2. Remove the five upper-to-lower valve body and hold-down plate attaching screws. Remove the seven attaching screws from the underside of the lower valve body (Fig. 24).
3. Separate the bodies and remove the separator plate and gasket. **Be careful not to lose the check valves and springs.** Remove and clean the separator plate screen if necessary (Fig. 25).
4. Remove the manual valve retaining pin from the upper valve body (Fig. 26).
5. Slide the manual valve (Fig. 26) out of the valve body.
6. Cover the downshift valve bore with a finger, then working from the underside of the body remove the downshift valve retainer. Remove the spring and downshift valve (Fig. 26).
7. Apply hand pressure on the pressure boost valve sleeve end and remove the sleeve retaining clip from the under side of the body. Slowly release hand pressure and remove the sleeve and the pressure boost valve. Remove the two springs, the spring and the main regulator valve from the bore.
8. Apply pressure on the throttle boost valve retaining plate and remove the two attaching screws. Slowly release the pressure and remove plate, throttle pressure boost valve and spring, and the manual low 2-1 scheduling valve and spring from the body (Fig. 26).
9. Apply pressure on the remaining valve retaining plate and remove the eight attaching screws.
10. Hold the valve body so that the plate is facing upward. Slowly release the pressure and remove the plate.
11. Remove the spring and the intermediate servo modulator valve (Fig. 26) from the valve body.
12. Remove the intermediate servo accumulator valve and springs.
13. Remove the 2-3 back-out valve and spring.
14. Remove the 2-3 shift valve, spring and the throttle modulator valve and spring.
15. Remove the 1-2 shift valve, DR-2 shift valve and the spring from the valve body.
16. Remove the line pressure coasting regulator valve, (Fig. 26) from the body.
17. Remove the cutback control valve to complete the disassembly of the control valve.

Assembly

1. Place the downshift valve and spring in the valve body. Compress the spring and install the retainer from the underside of the body (Fig. 27).

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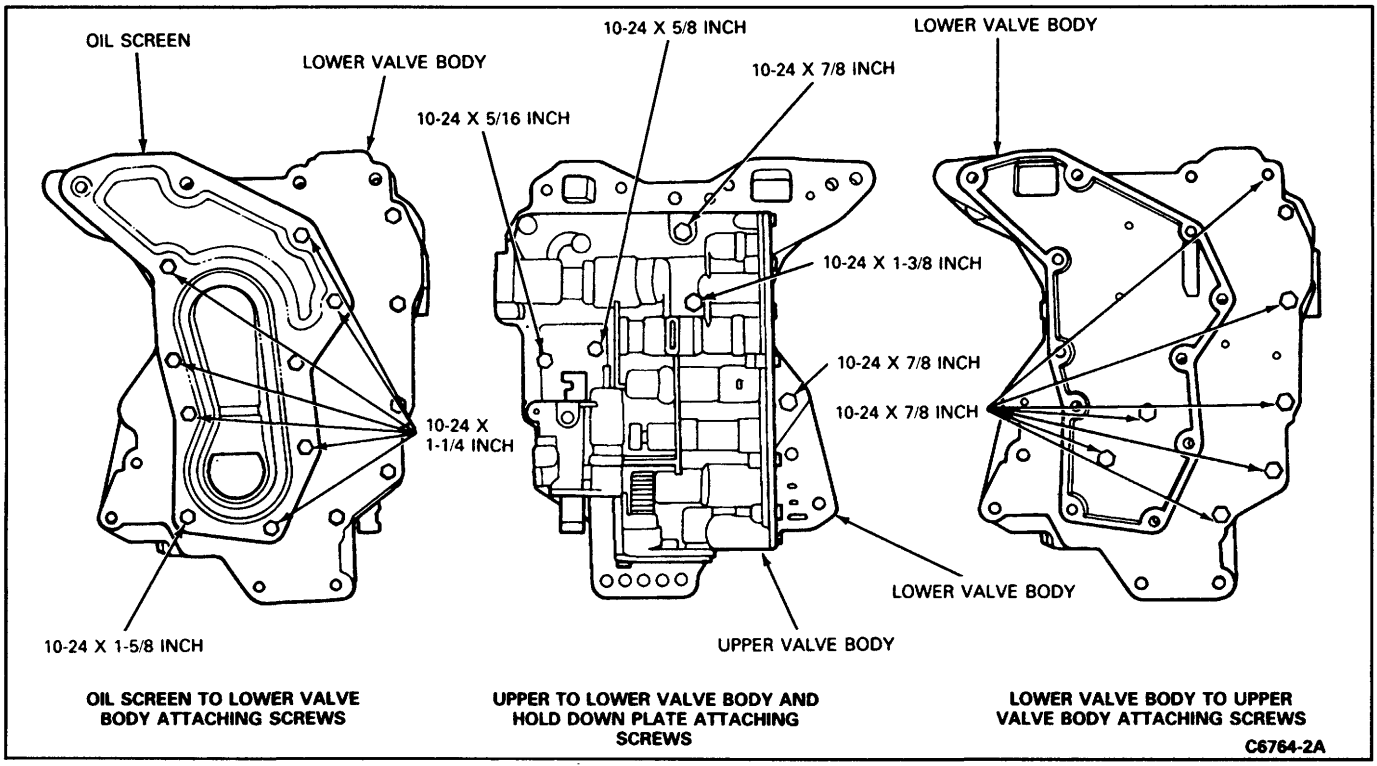


FIG. 24 Control Valve Body and Screen Attaching Screws

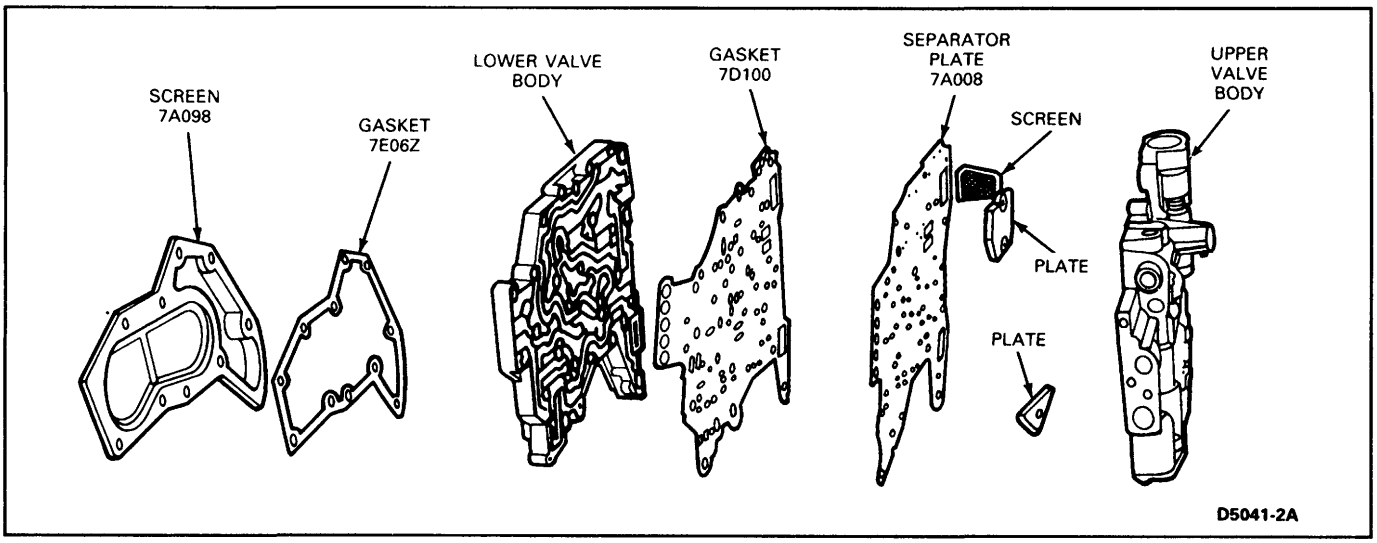


FIG. 25 Upper and Lower Valve Bodies Disassembled

2. Place the valve body on a clean surface with the passage side facing up. Place the converter relief valve spring in its bore (Fig. 27). Coat the converter pressure relief valve with petroleum jelly and place it on top of the spring. Place the 2-3 shift valve check ball in its cavity. Place the throttle pressure relief valve spring in its bore (Fig. 27). Coat the throttle pressure relief valve check ball with petroleum jelly and place it on top of the spring. Place the reverse clutch check ball in its cavity.

3. Install the separator screen in the separator plate if it was previously removed. **Be sure the screen tabs are flush with the separator plate surface.** Carefully position the separator plate and new gasket on the lower valve body. Place the two hold-down plates on the separator plate and install the attaching screws finger tight.

4. Place the lower body and plate assembly on the upper valve body (Fig. 24) and install the attaching screws finger tight.

5. Install the oil screen screws loosely, without the screen, to properly align the upper and lower valve bodies, gasket and separator plate.

6. Tighten the two bolts that are covered by the screen to 5.0-6.2 N·m (40-55 in.-lbs).

7. Remove the oil screen attaching screws and place the gasket and oil screen in position on the lower valve body. Re-install the screen attaching screws (Fig. 24).

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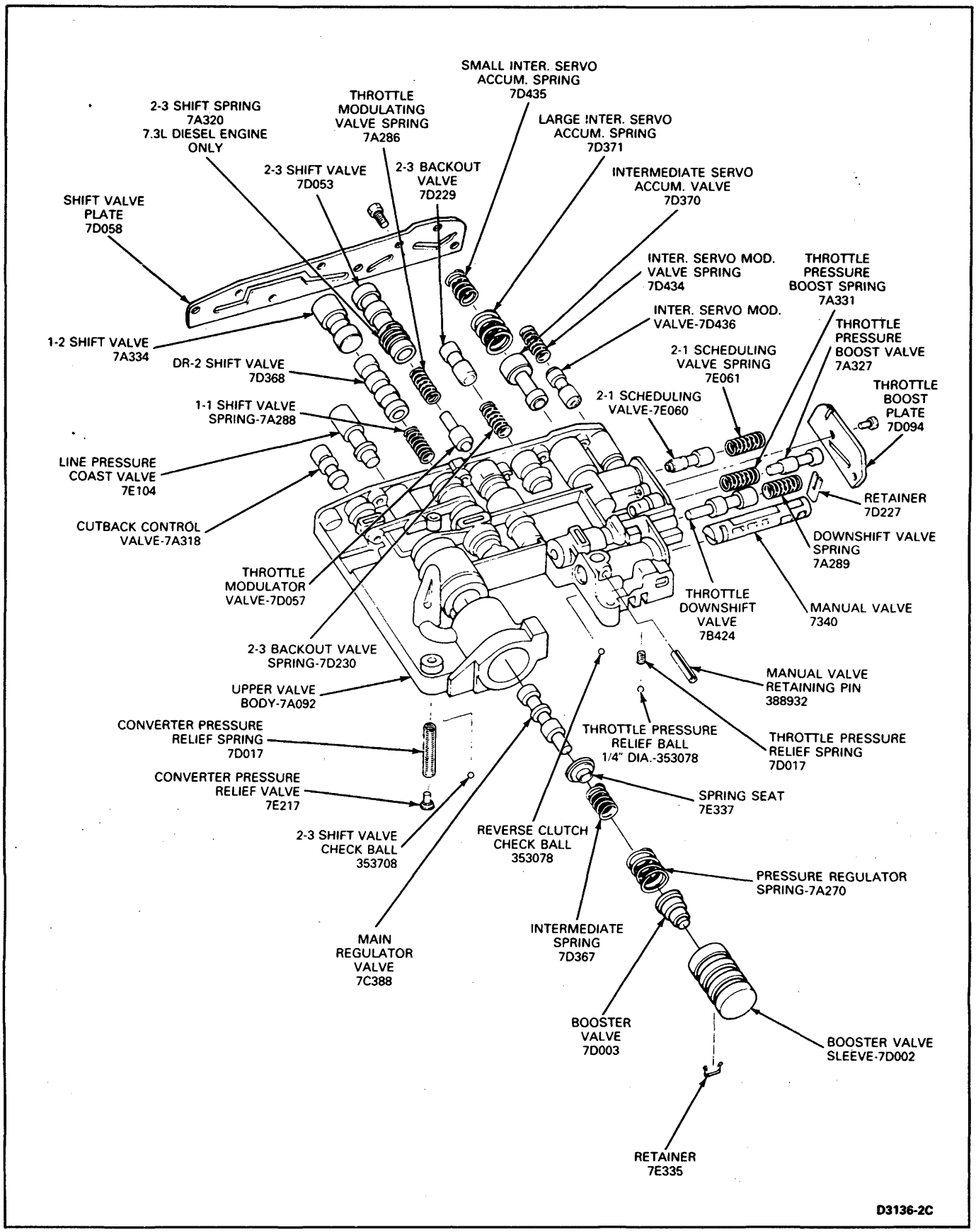


FIG. 26 Upper Valve Body Disassembled

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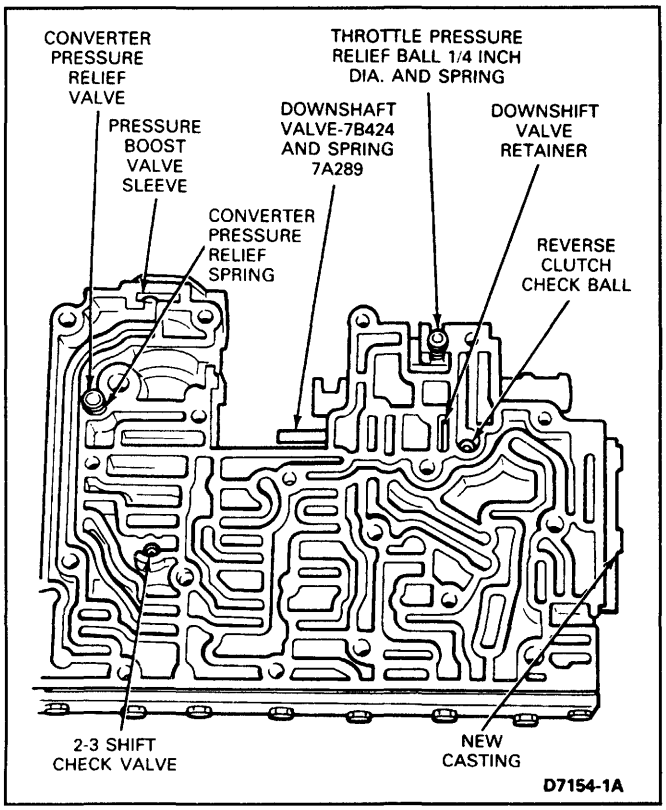


FIG. 27 Downshift Valve and Spring, Converter Pressure Relief Valve, Throttle Pressure Relief Valve Check Ball, and 2-3 Shift Check Valve Locations

8. Tighten all the valve body and screen attaching screws to 5.0-6.2 N·m (40-55 in.-lbs).
9. Place the cutback control valve (Fig. 26) and the line pressure coasting regulator valve in the valve body.
10. Place the one spring, DR-2 shift valve and the 1-2 shift valve in the body.
11. Place the throttle modulator valve and spring and the 2-3 shift valve (and spring on 7.3L Diesel) in the valve body.
12. Place the spring and the 2-3 backout valve in the valve body.
13. Place the two springs and the intermediate servo accumulator valve in the valve body.
14. Place the intermediate servo modulator valve and spring in the body.
15. Carefully place the valve retaining plate on the body and secure it with the eight attaching screws. Tighten the two hex washer head screws to 2.5-5.0 N·m (20-45 in-lbs). Tighten the remaining six screws to 2.5-4.5 N·m (20-40 in-lbs).
16. Place the throttle pressure boost valve and spring in the valve body. Place the manual low 2-1 scheduling valve and spring in the valve body and install the retaining plate. Tighten the attaching screws to 2.5-5.0 N·m (20-45 in.-lbs).
17. Place the spring seat on the stem of the main regulator valve so that the retainer flange is next to the valve shoulder. Place the main regulator valve, spring seat, two springs, pressure boost valve and sleeve in the bore. Apply hand pressure on the end of the pressure boost valve sleeve and install the spring clip retainer in the groove on the under side of the body so that the clip is inserted into the end groove in the sleeve. Be sure that the pressure boost valve sleeve is free in its bore.
18. Place the manual valve in the valve body and install the retaining pin in the body.

Intermediate Servo

(Refer to Fig. 10).

Disassembly

1. Apply air pressure to the port in the servo cover to remove the piston and rod.
2. Replace the complete piston and rod assembly if the piston or piston sealing lips are unserviceable or damaged.
3. Remove the seal and gasket from the cover.

Assembly

1. Dip the new seals in transmission fluid.
2. Install new seal and gasket on the cover.
3. Dip the piston in transmission fluid and install it in the cover.

Governor

Disassembly

1. Remove the governor body attaching bolts and remove the governor.
2. Remove and discard the snap ring that secures the governor oil collector body on the output shaft (Fig. 28) and slide the governor off the front of the shaft.
3. Remove the seal rings from the oil collector body.

Assembly

1. Carefully install new seal rings on the oil collector body.
2. Working from the front end of the output shaft, slide the governor oil collector body into place on the shaft. Install a new snap ring to secure it. Make sure that the snap ring is seated in the groove.
3. Position the governor assembly on the oil collector body (Fig. 28) and secure with the attaching screws. Tighten screws to 10.5-13.5 N·m (90-120 in.-lbs).

Downshift and Manual Linkage

Disassembly

1. Remove the nut and lockwasher that secures the outer downshift lever to the transmission and remove the lever.
2. Slide the inner downshift lever assembly out from the inside of the case (Fig. 29). Remove the seal from the recess in the manual lever shaft.
3. Remove the two bolts retaining the neutral start switch, and remove the switch, (Fig. 6).
4. Remove the C-ring securing the parking pawl actuating rod to the manual lever. Remove the rod from the case.
5. Remove the nut securing the inner manual lever to the shaft. Remove the inner lever from the shaft. Slide the outer lever and shaft from the case.

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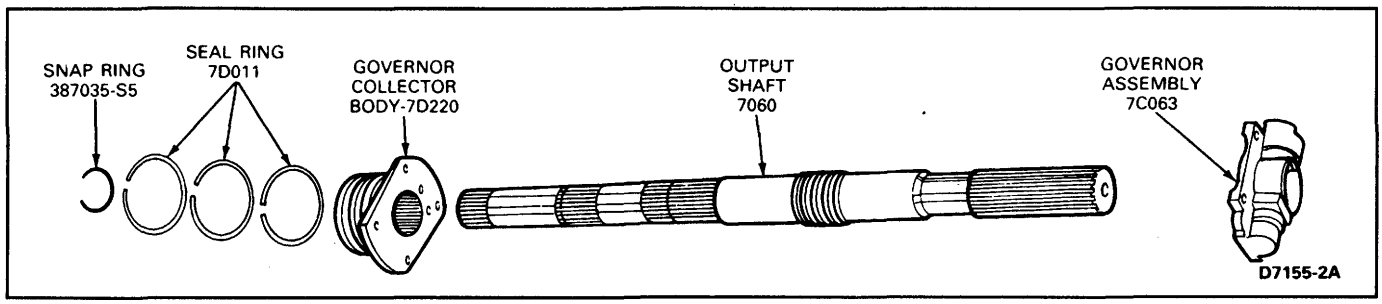


FIG. 28 Output Shaft Disassembled

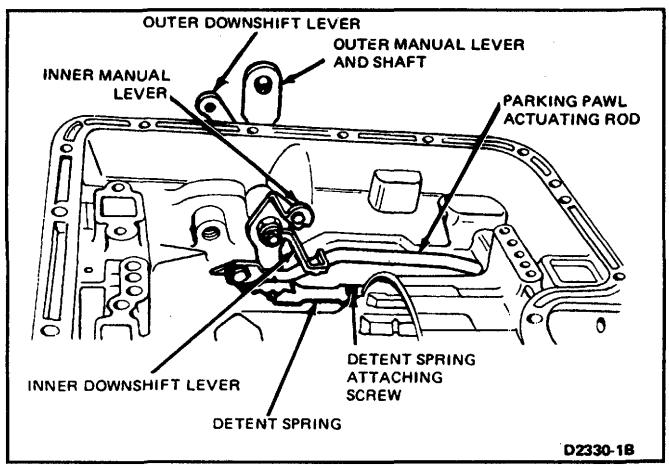


FIG. 29 Downshift and Manual Linkage

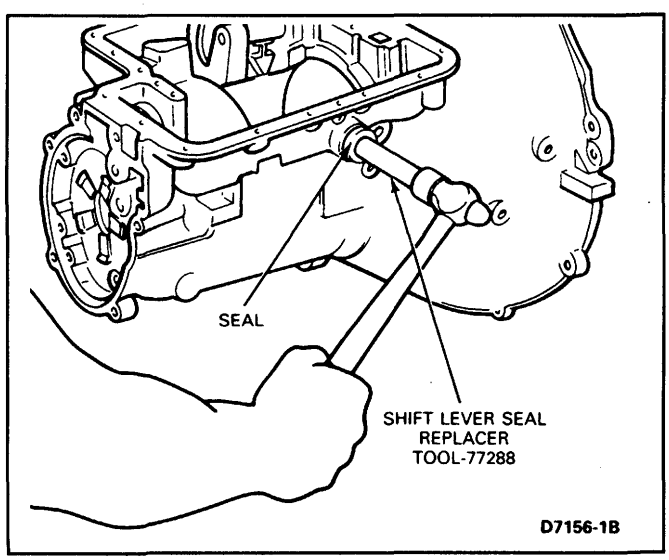


FIG. 30 Installing Manual Lever Seal

6. Remove the seal from the case with Tools T59L-100-B, Slide Hammer and T58L-101-A, Puller Attachment, or equivalents.

Assembly

1. Dip the new seal in transmission fluid and install it in the case using TOOL-77288 or equivalent as shown in Fig. 30.
2. Slide the outer manual lever and shaft in the transmission case.
3. Position the inner lever on the shaft, making sure the leaf spring roller is positioned in the inner manual lever detent. Install the attaching nut. Tighten the nut to 41-54 N·m (30-40 ft-lbs). Install the parking pawl actuating rod and secure it to the inner manual lever with a C-ring.
4. Slide the neutral-start switch on the outer lever shaft and install the bolts in the case.
5. With the transmission manual lever in neutral, rotate the switch and install the gauge pin (No. 43 drill) into the gauge pin hole aligning all three holes (Fig. 6). Tighten the bolts to 6.5-8.0 N·m (55-75 in.-lbs).
6. Install a new downshift lever seal in the recess of the outer lever shaft. Slide the downshift lever and shaft into position.
7. Place the outer downshift lever on the shaft and secure it with a lockwasher and nut. Tighten nut to 17-21 N·m (12-16 ft-lbs).

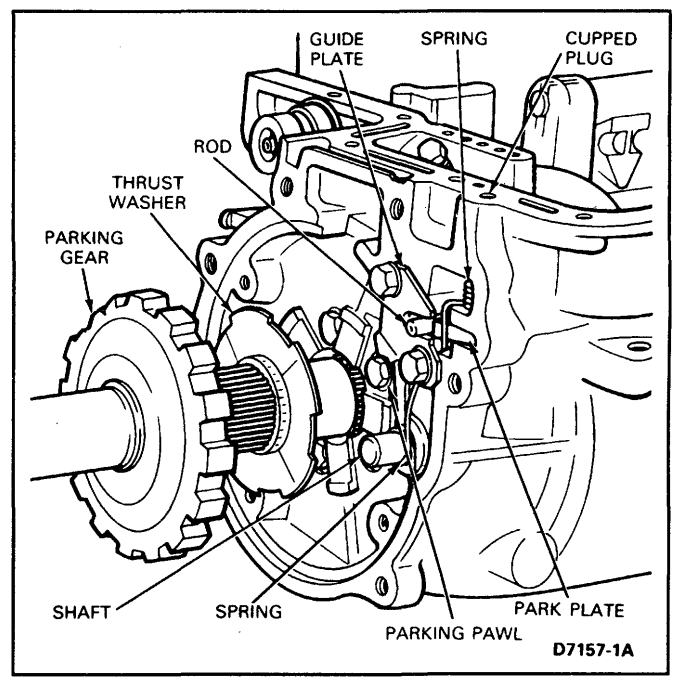


FIG. 31 Parking Pawl Mechanism

Parking Pawl Linkage

Disassembly

1. Remove the bolts securing the parking pawl guide plate to the case (Fig. 31). Remove the plate.
2. Remove the spring, parking pawl and shaft from the case.

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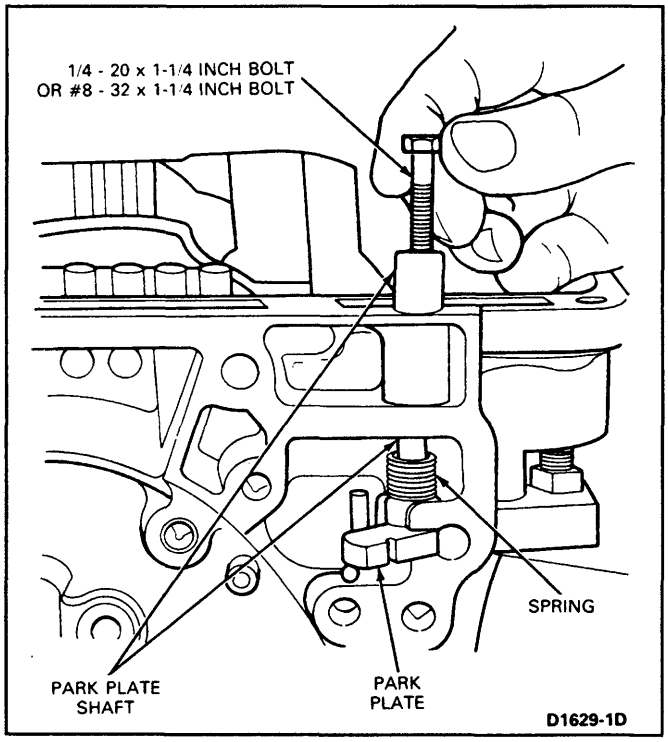


FIG. 32 Removing Park Plate

3. Working from the pan mounting surface, drill a 1/8 inch diameter hole through the center of the cupped plug. Pull the plug from the case with a wire hook.
4. Unhook the end of the spring from the park plate slot to relieve the tension.
5. Thread a 1/4-20 inch or 8-32 x 1-1/4 inch screw (Fig. 32) into the park plate shaft. Pull the shaft from the case with the screw. Remove the spring and park plate.

Assembly

1. Position the spring and park plate in the case and install the shaft. Place the end of the spring into the slot of the park plate.
2. Install a new cupped plug to retain the shaft.
3. Install the parking pawl shaft in the case. Slip the parking pawl and spring into place on the shaft.
4. Position the guide plate on the case, making sure that the actuating rod is seated in the slot of the plate. Secure the plate with two bolts and lockwashers. Tighten bolts to 17-21 N·m (12-16 ft-lbs).

Servo Apply Lever

Disassembly

1. Working from inside of the transmission case, carefully drive on the servo apply lever shaft to remove the cup plug. The shaft (Fig. 33) can be withdrawn from the case by hand.

Assembly

1. Hold the servo apply lever in position and install the new shaft.
2. Using the fabricated tool shown in Fig. 33, drive the cup plug into position in the case. Be sure the plug is flush with the shoulder of the counterbore. The cup plug may be coated with Threadlock and Sealer, EOAZ-19554-A (ESE-M2G204-A) or equivalent, before installation.

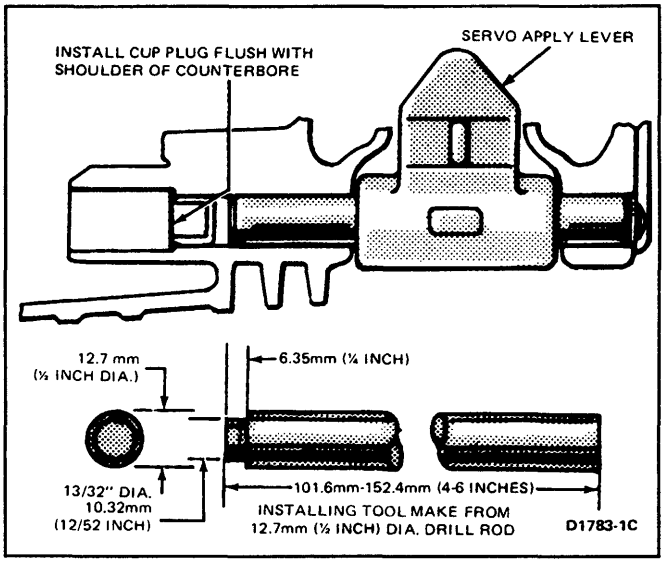


FIG. 33 Servo Apply Lever Installation

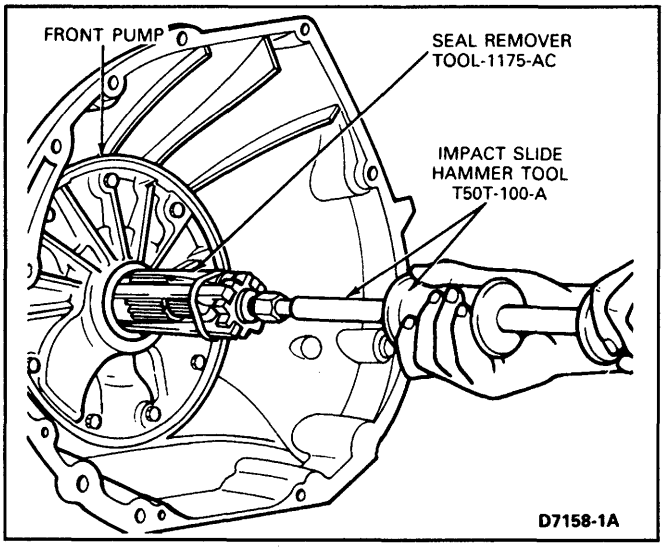


FIG. 34 Removing Front Pump Seal

Front Pump

The front seal can be replaced after the pump has been installed on the transmission using T50T-100-A and TOOL-1175-AC or equivalent for removal, and T87L-77837-AH or equivalent for installation (Figs. 34 and 35).

Disassembly

1. Remove the two seal rings and the selective thrust washer (Fig. 36).
2. Remove the large square-cut seal from the outside diameter of the pump housing.
3. Remove the five bolts that secure the stator support to the pump housing. Lift the support from the housing.
4. Remove the drive and the driven gear from the housing.

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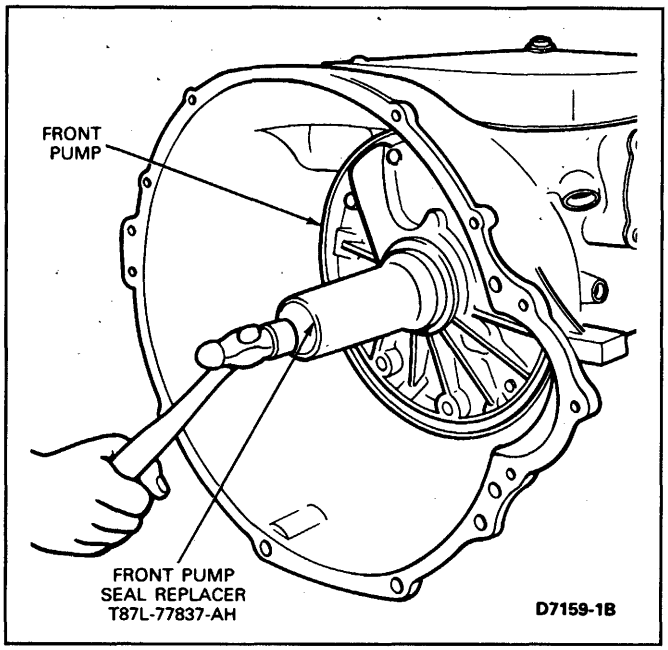


FIG. 35 Installing Front-Pump Seal

5. If the pump housing bushing is worn or damaged, replace it using the handle and Tool T66L-7003-C2 or equivalent shown in Fig. 37.

   Place the new bushing in position, making sure the half moon slot in the bushing is on top and in line with the oil lube hole near the seal bore. Press the bushing in 1.52-2.03mm (0.060-0.080 inch) below the front face of the bushing bore. Use Tool T66L-7003-C2 or equivalent and handle to seat the bushing properly. After assembly, the half moon slot must be in past the lube hole to provide proper lubrication.

Assembly

1. Install the drive and driven gears in the pump housing. **Each gear has either an identification mark or chamfered teeth on one face. The identification mark or the chamfered surface on each gear must be installed toward the front of the pump housing.**
2. Position the stator support in the pump housing and install the five attaching bolts. Tighten bolts to 17-21 N·m (12-16 ft-lbs).
3. Carefully install two new seal rings on the stator support. Make sure that the ends of the rings are engaged to lock them in place. Install a new square-cut seal on the outside diameter of the pump housing.
4. Install the selective thrust washer. **Make sure that the correct thickness selective washer is being used to obtain the specified end play.** Refer to Specifications at end of this Section.
5. Place the pump on the converter, making sure that the drive gear engages the converter hub. Rotate the pump to make sure that the gears rotate freely.

Reverse-High Clutch

Disassembly

1. Separate the drive train as shown in Fig. 38. Remove the pressure plate snap ring as shown in Fig. 39.
2. Remove the pressure plate and the drive and driven (internal and external spline) clutch plates (Fig. 40).
3. Install Clutch Spring Compressor, Tool T65L-77515-A (Fig. 41) on the reverse-high clutch drum. Make sure that the legs clear the snap ring enough to remove it. Remove the snap ring and remove the tool.
4. Remove the spring retainer and the piston return springs.
5. Apply air pressure to the piston apply hole in the clutch hub using TOOL-7000-DE or equivalent (Fig. 42) and remove the piston.
6. Remove the piston outer seal from the piston and the inner seal from the clutch drum (Fig. 40).
7. Remove the front and rear bushings from the clutch drum if they are worn or damaged. To remove the front bushing, use a cape chisel and cut along the bushing seam until the chisel breaks through the bushing wall. Pry the loose ends of the bushing up with an awl and remove the bushing. To remove the rear bushing, use Tool T69L-7D044-A

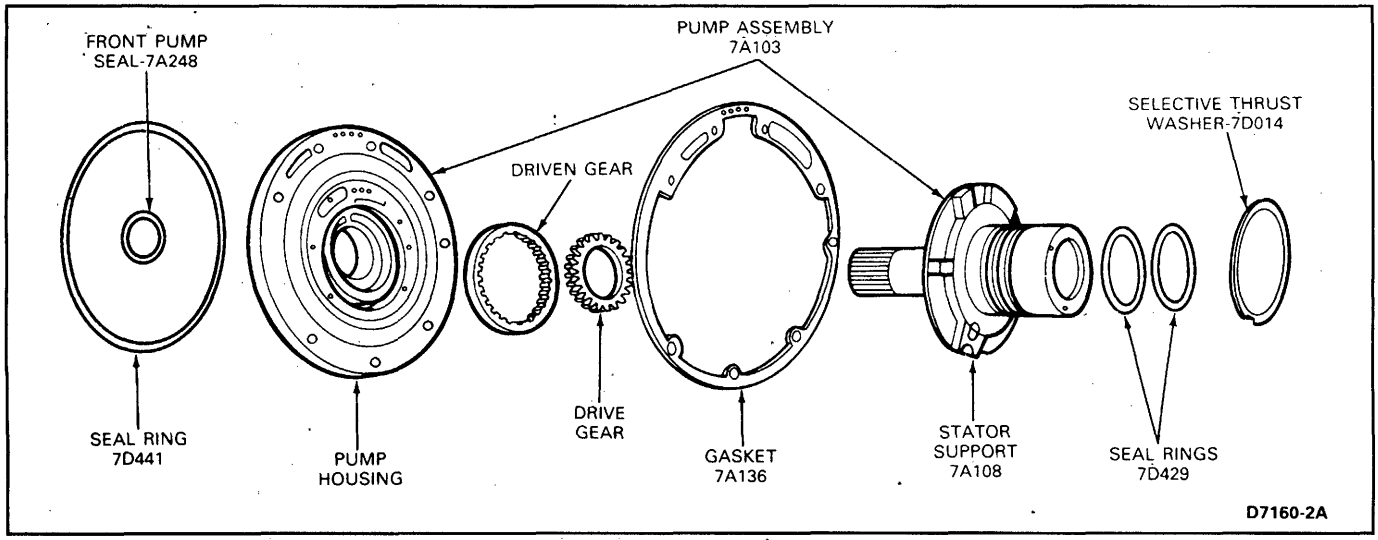


FIG. 36 Front Pump Disassembled

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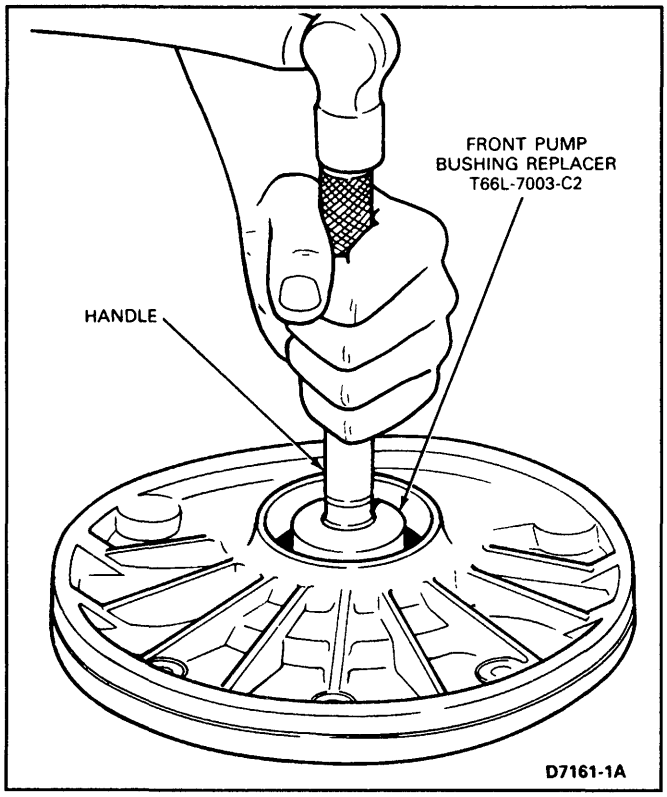


FIG. 37 Replacing Front Pump Housing Bushing

or equivalent shown in Fig. 43, and press the bushing from the drum.

Assembly

1. If the clutch drum bushings were removed, position the drum in a press and press new bushings into the drum with the Tool T69L-7D044-A or equivalent shown in Figs. 43 and 44.
2. Dip the new seals in transmission fluid and install one on the drum and one on the piston.
3. Install the piston in the clutch drum.
4. Position the piston return springs in the piston sockets (Fig. 45). Place the spring retainer on the springs.
5. Install Clutch Spring Compressor, Tool T65L-77515-A (Fig. 41) and compress the springs. Make certain that the spring retainer is centered while compressing the springs. Install the snap ring. **Before releasing the pressure on the tool, make certain that the snap ring is positioned inside of the four snap ring guides on the spring retainer.**
6. Clutch plate usage varies with each model, refer to the specifications at end of this Section for the number of plates required. Dip the clutch plates in clean transmission fluid. Install the clutch plates alternately starting with a steel drive (internal) plate (Fig. 40). When new composition clutch plates are used, soak the plates in automatic transmission fluid, (Spec. ESP-M2C116-H) or equivalent, for 15 minutes before they are assembled.
7. After all clutch plates have been installed, position the pressure plate in the clutch drum. Install the pressure plate (selective) snap ring.
8. With a feeler gauge, check the clearance between the pressure plate and snap ring (Fig. 46).
9. The pressure plate should be held downward as the clearance is checked. The clearance should be 0.558-0.914mm (0.022-0.036 inch). If the clearance is not within specifications, selective thickness snap rings are available in the following thicknesses: 1.42-1.52mm (0.056-0.060 inch), 1.65-1.75mm (0.065-0.069 inch), 1.87-1.98mm (0.074-0.078 inch), 2.10-2.20mm (0.083-0.087 inch), 2.33-2.43mm (0.092-0.096 inch), 2.79-2.89mm (0.110-0.114 inch) and 3.25-3.35mm (0.128-0.132 inch). Install the correct size snap ring and re-check the clearance.

Forward Clutch

Disassembly

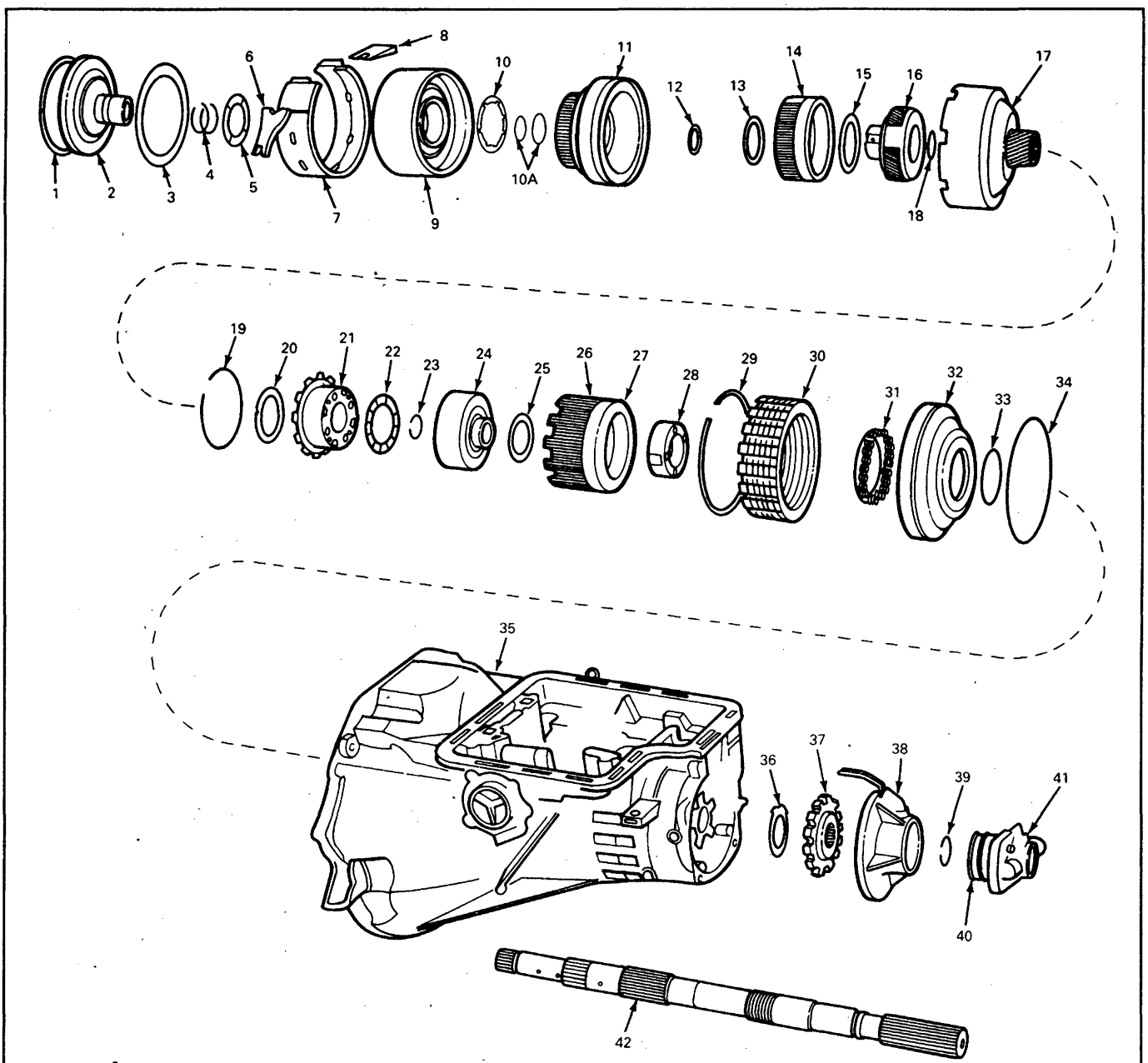
1. Remove the clutch pressure plate snap ring (Fig. 47).
2. Remove the rear pressure plate, the drive and driven plates, wave plate, and the forward pressure plate from the clutch hub (Fig. 48).
3. Remove the snap ring (Fig. 49) that secures the disc spring in the clutch cylinder. Remove the disc spring and steel ring using Tool T65L-77515-A.
4. Apply air pressure to the clutch cylinder using TOOL-7000-DE or equivalent (Fig. 50) to remove the piston.
5. Remove the seal from the piston and the seal from the clutch hub (Fig. 48).

Assembly

1. Dip two new seals in transmission fluid. Install the smaller seal on the clutch hub and the lip seal on the clutch piston.
2. Install the clutch piston and lip seal with Lip Seal Protector, T77L-77548-A, (Fig. 51).
3. Position the installation tool into the forward clutch cylinder, so that the bore of the tool is aligned with the piston bore in the cylinder. Press the piston into the cylinder until it bottoms in the bore. Remove the installation tool.
4. Make sure that the steel pressure ring is in the groove on the piston. **Position the disc spring in the cylinder with the dished face downward.** Install the spring as shown in Fig. 49 so that the pressure ring and spring are in contact. Secure the disc with the retaining snap ring.
5. Install the forward pressure plate with the flat side up and the beveled side downward. Dip the clutch plates in clean transmission fluid (Specification DEXRON® II Series D or equivalent). Next, install the wave plate, then a steel plate and a composition driven plate. Install the remaining plates in this sequence (Fig. 48).

   Refer to the Specification at end of this Section for the number of plates required. The last plate installed will be the rear pressure plate. Install the snap ring and make certain that it seats fully in the groove.
6. With a feeler gauge, check the clearance between the snap ring and the pressure plate (Fig. 52). Downward pressure on the plate should be maintained when making this check. Clearance should be 0.533-1.168mm (0.021-0.046 inch).

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1. FRONT PUMP SEAL RING-7D441
2. FRONT PUMP-7A103
3. GASKET-7A136
4. SEAL RINGS
5. NUMBER 1 THRUST WASHER (SELECTIVE)
6. STRUT INTERMEDIATE BRAKE BAND-7D029
7. INTERMEDIATE BRAKE BAND ASSEMBLY-7D029
8. STRUT INTERMEDIATE BRAKE BAND ANCHOR-7D430
9. REVERSE-HIGH CLUTCH ASSEMBLY
10. NUMBER 2 THRUST WASHER
10A. FORWARD CLUTCH SEAL RINGS
11. FORWARD CLUTCH ASSEMBLY
12. NUMBER 3 THRUST WASHER NEEDLE BEARING
13. NUMBER 4 THRUST WASHER
14. FORWARD PLANET RING AND HUB ASSEMBLY-7D392
15. NUMBER 5 THRUST WASHER
16. FORWARD PLANET ASSEMBLY . 7A298
17. INPUT SHELL-7D064 AND SUN GEAR ASSEMBLY-7D063
18. NUMBER 6 THRUST WASHER NEEDLE BEARING
19. SNAP RING
20. NUMBER 7 THRUST WASHER
21. REVERSE PLANET ASSEMBLY 7D006
22. NUMBER 8 THRUST WASHER
23. REVERSE RING GEAR AND HUB RETAINING RING
24. REVERSE RING GEAR-7A153 AND HUB-7D164
25. NUMBER 9 THRUST WASHER
26. LOW-REVERSE CLUTCH HUB 7B067
27. ONE-WAY CLUTCH-7A089
28. ONE-WAY CLUTCH INNER RACE 7D171
29. SNAP RING
30. LOW-REVERSE CLUTCH PLATES
31. LOW-REVERSE PISTON RETURN SPRING AND RETAINER-7D406
32. LOW-REVERSE PISTON-7D402
33. INNER SEAL
34. OUTER SEAL
35. CASE-7005
36. NUMBER 10 THRUST WASHER
37. PARKING GEAR-7A223
38. GOVERNOR DISTRIBUTOR SLEEVE-7C232
39. SNAP RING
40. GOVERNOR COLLECTOR-7D220
41. GOVERNOR-7C063
42. OUTPUT SHAFT-7060

D3138-2C

FIG. 38 Drive Train Disassembled—Typical

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7. If the clearance is not within specifications, selective snap rings are available in the following thicknesses: 1.42-1.52mm (0.056-0.060 inch), 1.65-1.75mm (0.065-0.069 inch), 1.87-1.98mm (0.074-0.078 inch), 2.10-2.20mm (0.083-0.087 inch), 2.33-2.43mm (0.092-0.096 inch), 2.79-2.89mm (0.110-0.114 inch) and 3.25-3.35mm (0.128-0.132 inch). Insert the correct size snap ring and recheck the clearance.

Input Shell and Sun Gear

Disassembly

1. Remove the rear snap ring from the sun gear as shown in Fig. 53.
2. Remove the thrust washer wear plate from the input shell and sun gear (Fig. 54).
3. Working from inside the input shell remove the sun gear. Remove the snap ring from the gear.

Assembly

1. Install the forward snap ring on the forward end (short end) of the sun gear (Fig. 54). Working from inside the input shell, slide the sun gear and snap ring into place making sure that the longer end is at the rear (Fig. 54).
2. Place the thrust washer wear plate on the sun gear and install the rear snap ring.

Output Shaft Hub and Ring Gear

Disassembly

1. Remove the hub snap ring (Fig. 55) from the ring gear.
2. Lift the hub from the ring gear.

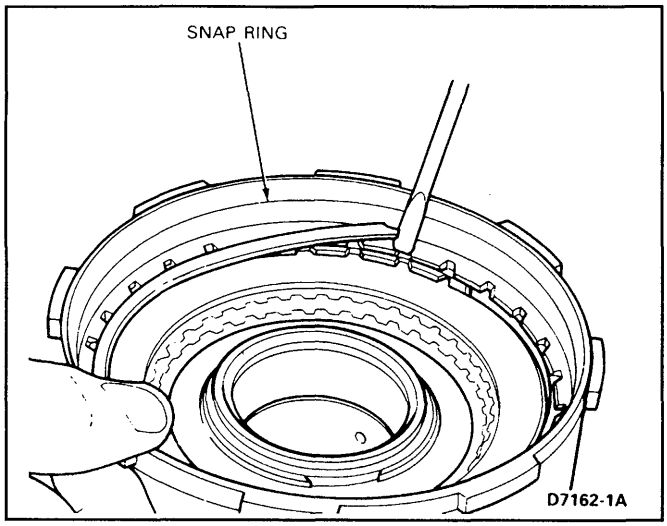


FIG. 39 Removing or Installing Reverse-High Clutch Pressure Plate Snap Ring

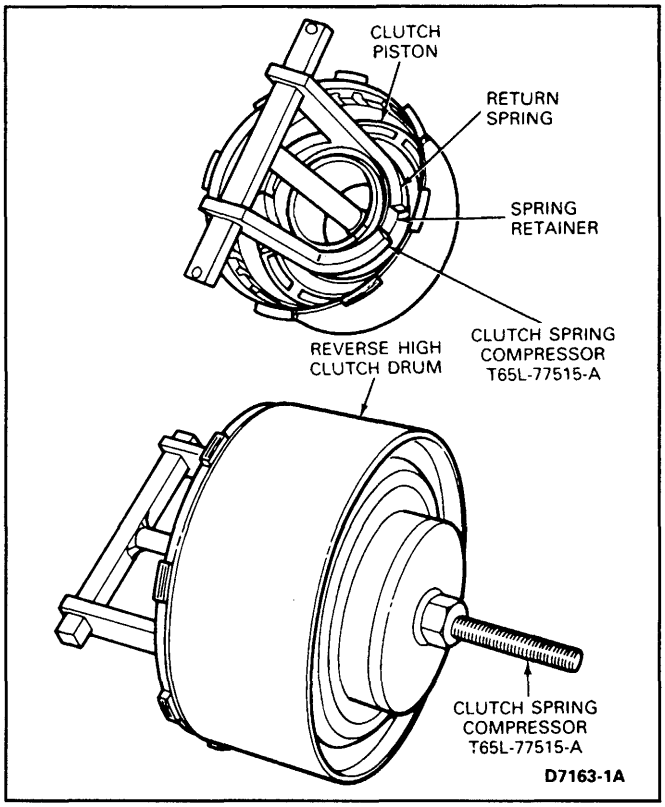


FIG. 41 Removing or Installing Reverse—High Clutch Piston Snap Ring

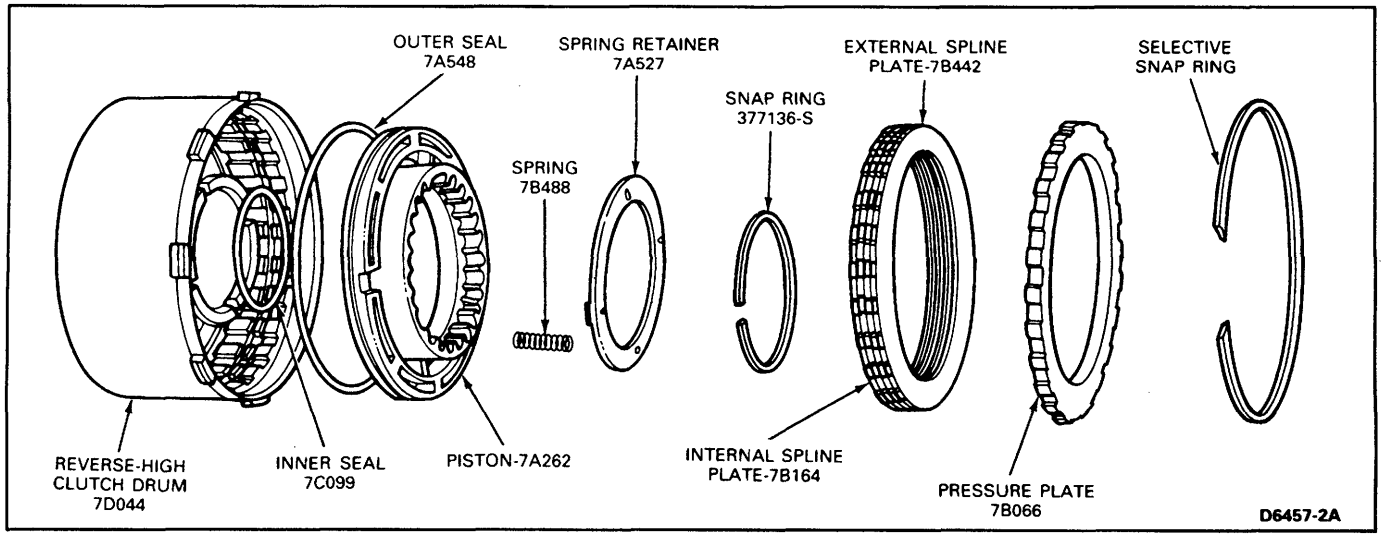


FIG. 40 Reverse-High Clutch Disassembled

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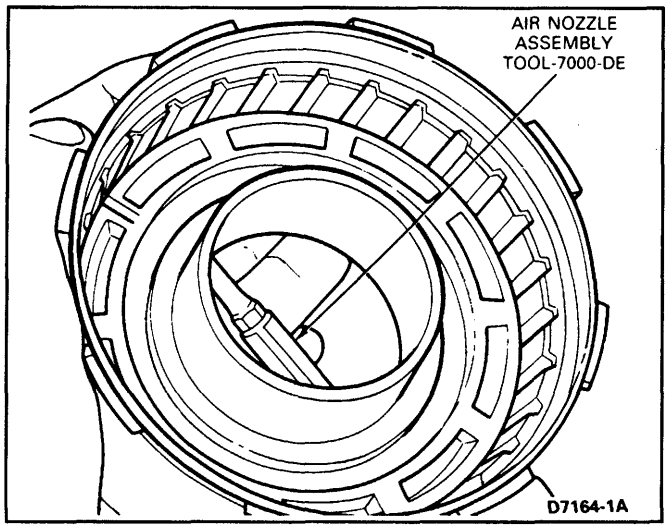


FIG. 42 Removing Reverse-High Clutch Piston

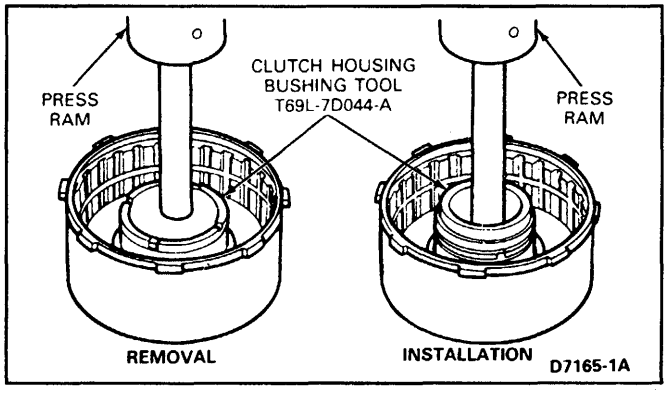


FIG. 43 Replacing Reverse-High Clutch Rear Bushing

Assembly

1. Position the hub in the ring gear.
2. Secure the hub with the snap ring. Make certain that the snap ring is fully engaged with the groove.

One-Way Clutch

Disassembly

1. Remove the snap ring and bushing from the rear of the low-reverse clutch hub (Fig. 56).
2. Remove the rollers from the spring assembly and lift the spring assembly from the hub.
3. Remove the remaining snap ring from the hub.

Assembly

1. Install a snap ring in the forward snap ring groove of the low-reverse clutch hub.
2. Place the low-reverse clutch hub on the bench with the forward end down (Fig. 57).
3. Install the one-way clutch spring assembly on top of the snap ring.
4. Install a roller into each of the spring assembly compartments (Fig. 56).
5. Install the bushing on top of the spring assembly.

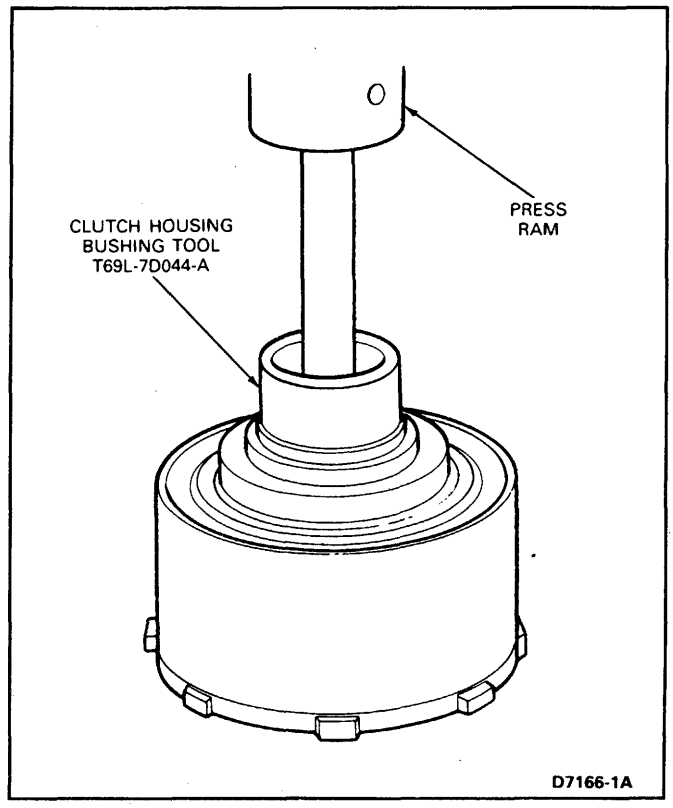


FIG. 44 Installing Reverse-High Clutch Front Bushing

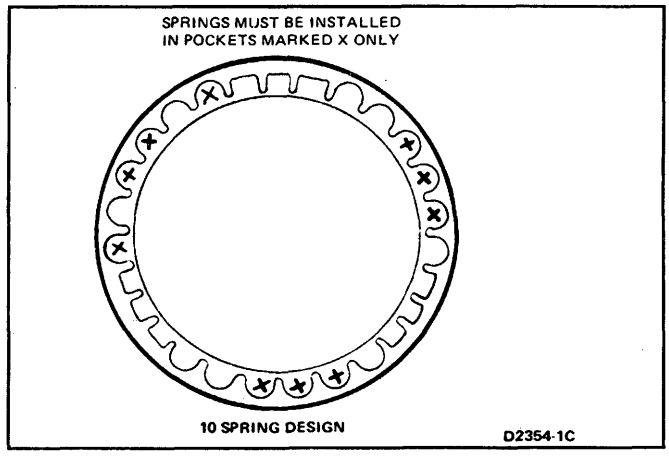


FIG. 45 Reverse-High Clutch Piston Return Spring Locations

6. Install the remaining snap ring at the rear of the low-reverse clutch hub to secure the assembly (Fig. 56).

Low-Reverse Clutch Piston

Disassembly

1. Remove the inner and the outer seal from the low-reverse clutch piston (Fig. 38).

Assembly

1. Dip the two new seals in clean transmission fluid.
2. Install the seals on the piston.

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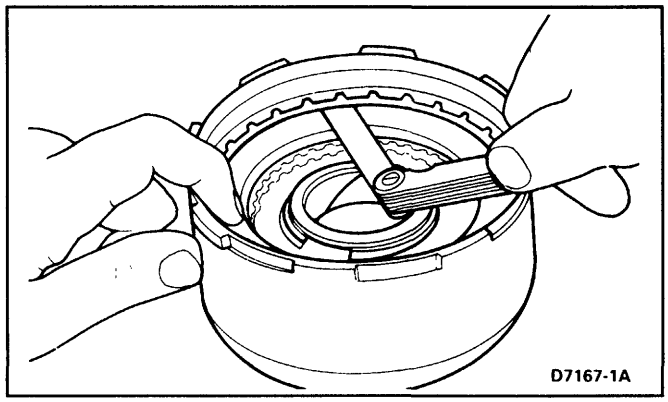


FIG. 46 Checking Reverse-High Clutch Snap Ring Clearance

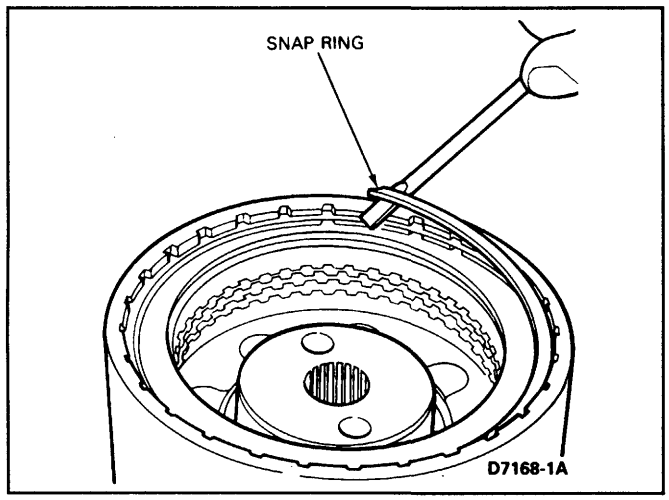


FIG. 47 Removing Forward Clutch Pressure Plate Snap Ring

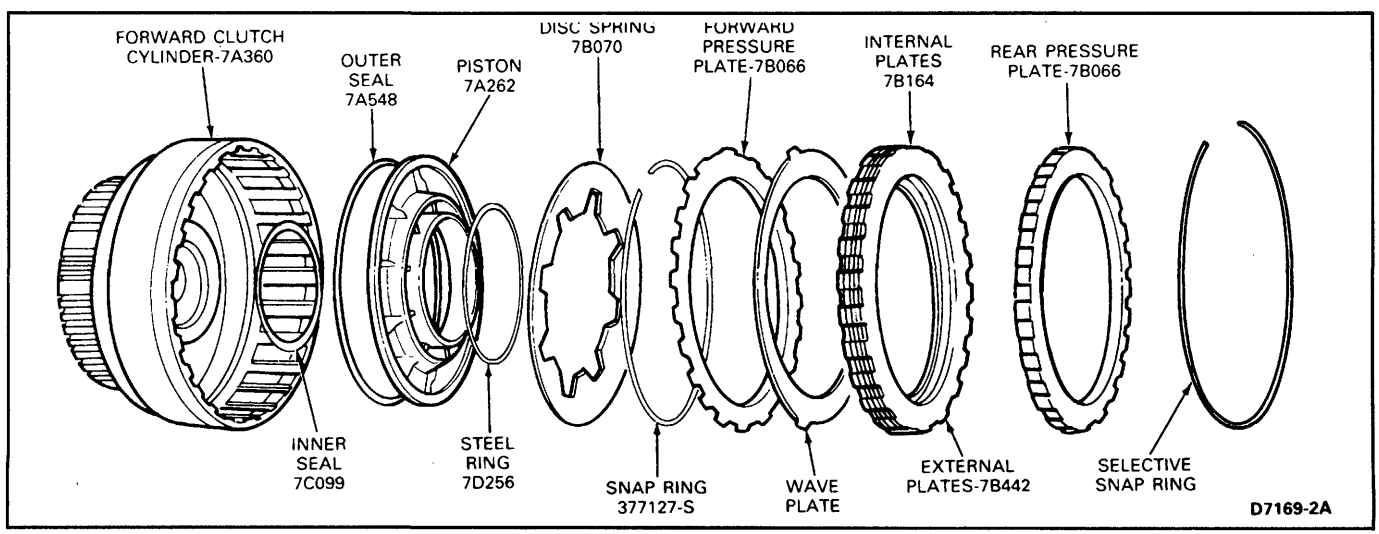


FIG. 48 Forward Clutch Disassembled

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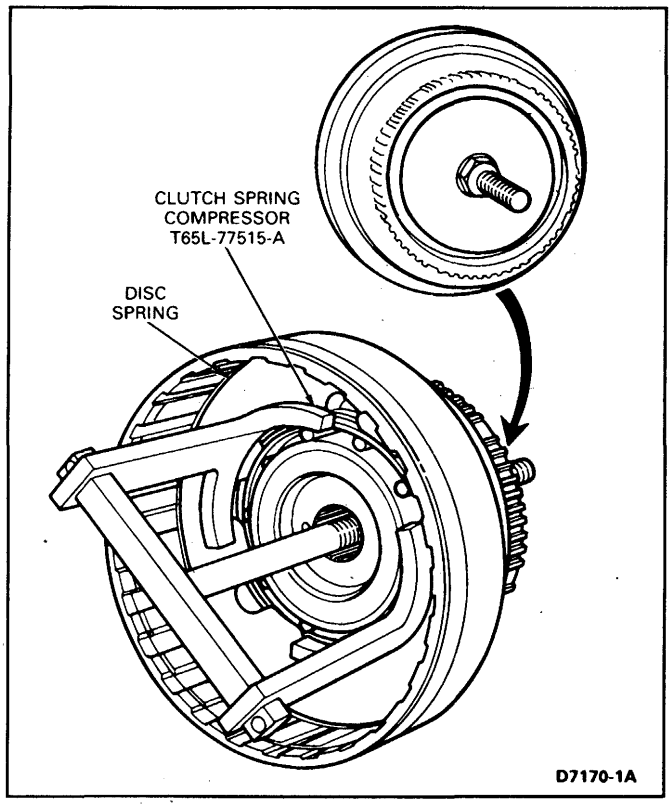


FIG. 49 Removing or Installing Disc Spring

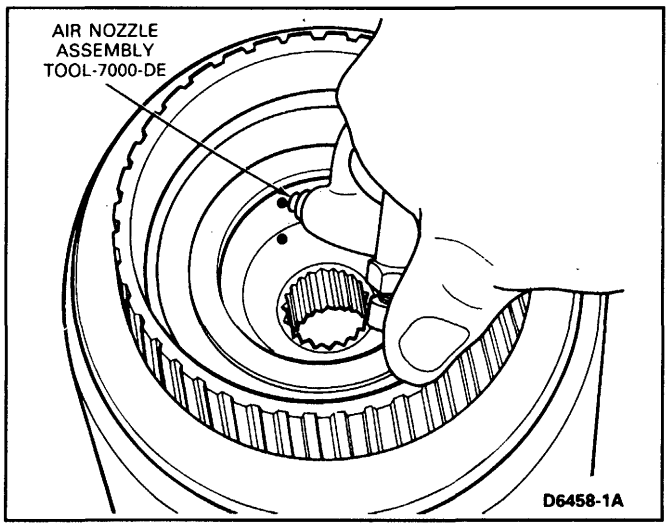


FIG. 50 Removing Forward Clutch Piston

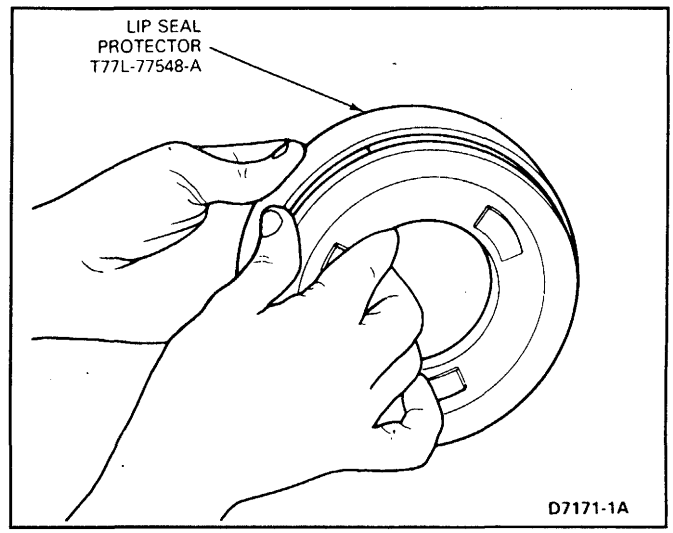


FIG. 51 Installing Forward Clutch Piston and Lip Seal

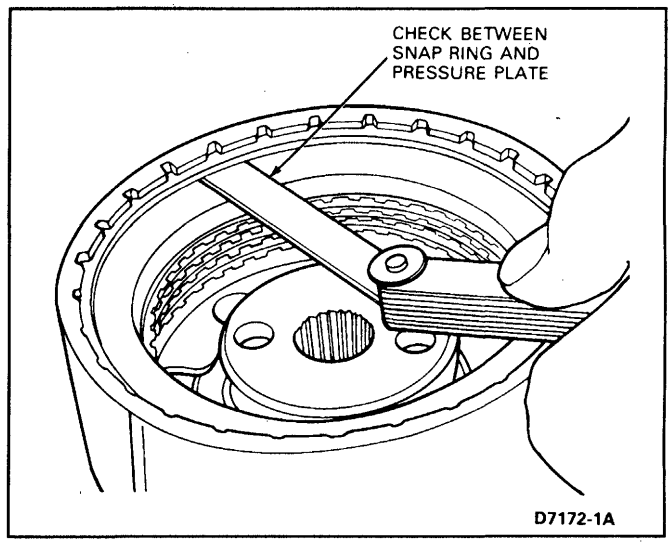


FIG. 52 Checking Forward Clutch Clearance

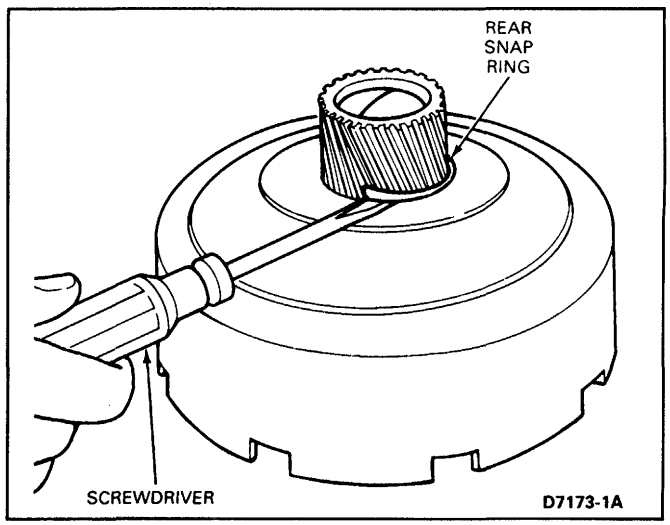


FIG. 53 Removing Sun Gear Snap Ring

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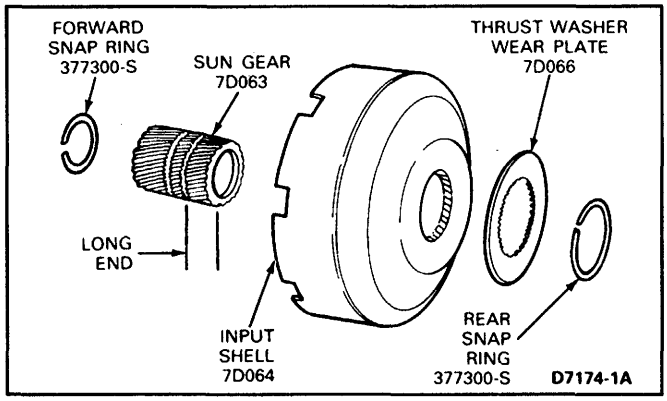


FIG. 54 Input Shell and Sun Gear Disassembled

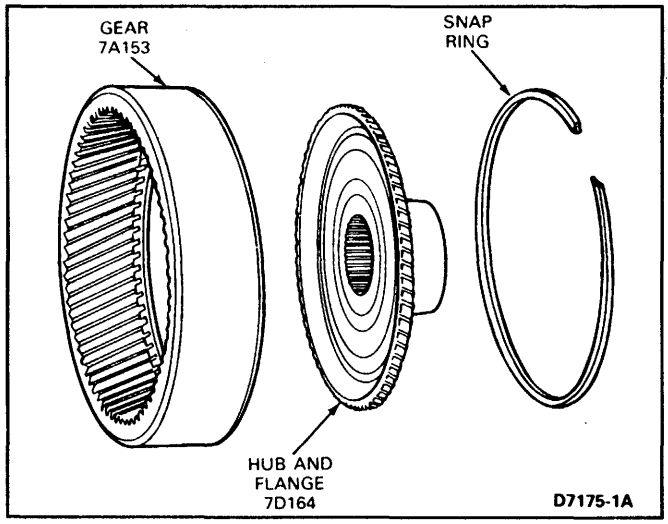


FIG. 55 Output Shaft Hub and Ring Gear

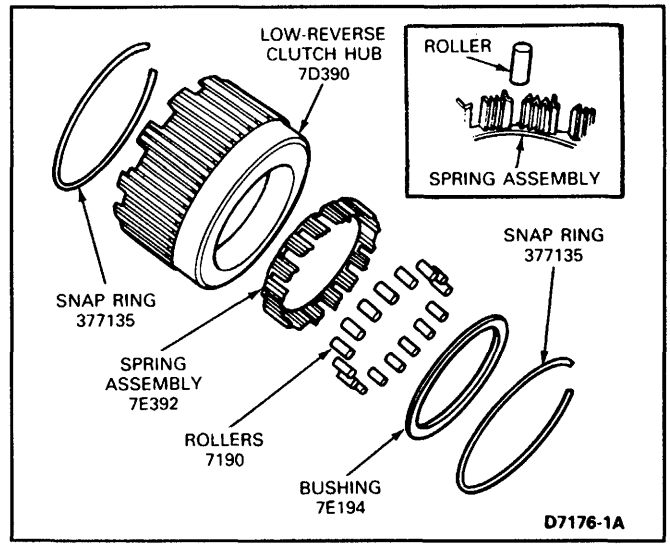


FIG. 56 One-Way Clutch Disassembled

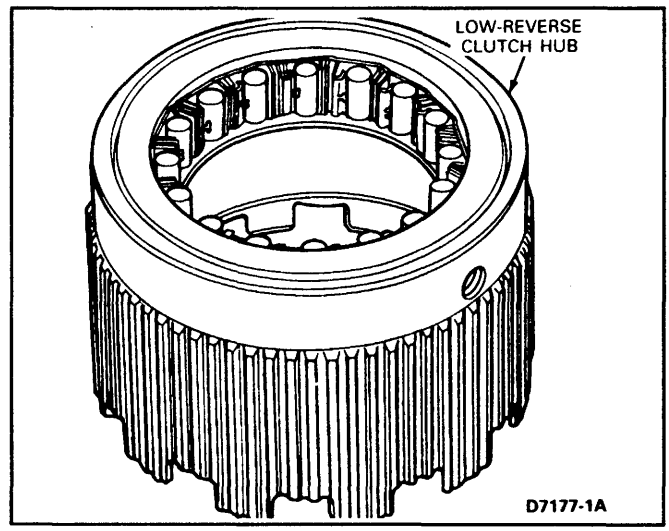


FIG. 57 One-Way Clutch Installed

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SPECIFICATIONS

C6 — TRANSMISSION REFILL CAPACITY

Vehicle	U.S. Quarts	Capacity Imperial Quarts	Liters
F-150 — F-350 (4 x 2), E-150 — E-350	11-3/4	9.4	11.2
F-150 — F-350 (4 x 4), Bronco	13-1/2	10.8	12.7

Use fluid meeting Ford Specification ESP-M2C138-CJ, DEXRON® II, Series D or equivalent.

SELECTIVE THRUST WASHERS (FRONT PUMP SUPPORT)

Identification Color	Thickness	
	MM	Inch
Blue	1.42-1.52	0.056-0.060
Natural (White)	1.85-1.95	0.073-0.077
Red	2.23-2.33	0.088-0.092

TRANSMISSION CLUTCH PLATE USAGE

Transmission Model	Steel	Friction	Clearance	
			MM	Inch
Forward Clutch				
PGD, PJD	4①	4	0.533-1.168	0.021-0.046
High Clutch				
PGD, PJD	3	3	0.558-0.914	0.022-0.036
Reverse Clutch				
PJD	5②	5	—	—
PGD	4②	4	—	—

①Plus a waved plate (7E457) next to inner pressure plate.
②Plus a waved plate next to the piston.

CLUTCH SNAP RINGS

Part Number	Thickness		Forward	High
	MM	Inch		
377434	1.52-1.42	0.060-0.056	X	X
377126	1.75-1.62	0.069-0.064		X
377127	1.98-1.87	0.078-0.074	X	X
377128	2.20-2.10	0.087-0.083		X
377444	2.43-2.33	0.096-0.092	X	X
386841	2.89-2.79	0.114-0.110	X	
386842	3.35-3.25	0.132-0.128	X	

CHECKS AND ADJUSTMENTS

Operation	Specification
Transmission End Play	0.203-1.117 mm. (0.008-0.044 inch) (Selective Thrust Washers Available)
Torque Converter End Play	New or rebuilt 0.533 mm. (0.021 inch) max. Used 1.016 mm. (0.040 inch) max. ①
Intermediate Band Adjustment	Remove and discard locknut. Install new locknut. Adjust screw to 14 N•m (10 ft-lbs) torque, then back off 1-1/2 turns. Hold screw and tighten locknut to 54 N•m (40 ft-lbs)
Forward Clutch Pressure Plate-to-Snap Ring Clearance	0.533-1.168 mm. (0.021-0.046 inch)
VRV to Transmission Vacuum Diaphragm — 7.3L Diesel	6.9 In Hg Vacuum with gauge block in place. See adjustment procedure.

Operation	Specification
Selection Snap Ring Thickness	1.42-1.52 mm. (0.056-0.060 inch) 1.62-1.75 mm. (0.064-0.069 inch) 1.87-1.98 mm. (0.074-0.078 inch) 2.10-2.20 mm. (0.083-0.087 inch) 2.33-2.43 mm. (0.092-0.096 inch) 2.79-2.89 mm. (0.110-0.114) 3.25-3.35 mm. (0.128-0.132 inch)
Reverse-High Clutch Pressure Plate-to-Snap Ring Clearance	0.558-0.914 mm. (0.022-0.036 inch)
Selective Snap Ring Thickness	1.42-1.52 mm. (0.056-0.060 inch) 1.62-1.75 mm. (0.064-0.069 inch) 1.87-1.98 mm. (0.074-0.078 inch) 2.10-2.20 mm. (0.083-0.087 inch) 2.33-2.43 mm. (0.092-0.096 inch)

①To check end play, exert force on checking tool to compress turbine to cover thrust washer wear plate. Set indicator at zero. **CD2845-2H**

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TORQUE LIMITS

Item	(ft-lbs)	N·m	Item	(ft-lbs)	N·m
Converter to Flywheel	20-34	28-45	Converter Drain Plug	8-28	11-37
Front Pump to Transmission Case	16-30	22-40	Manual Valve Inner Lever to Shaft	30-40	41-54
Overrunning Clutch Race to Case	18-25	25-33	Downshift Lever to Shaft	12-16	17-21
Oil Pan to Case	8-12	11-16	Filler Tube to Engine (Econoline-5.0L/5.8L/7.5L)	40-50	54-67
Stator Support to Pump	12-16	17-21	Filler Tube to Engine (Econoline 4.9L)	33-42	44-56
Converter Cover to Converter Housing	12-16	17-21	Filler Tube to Engine (Econoline 6.9L)	24-35	32-47
Guide Plate to Case	12-16	17-21	Transmission to Engine (Diesel Only)	50-65	67-87
Intermediate Servo Cover to Case	14-20	19-27	Transmission to Engine (All Gasoline Engines)	40-50	55-67
Diaphragm Assy. to Case	12-16	17-21	Rear Engine Support to Transmission	60-80	80-107
Distributor Sleeve to Case	12-16	17-21	Plug Case — Throttle Pressure	6-12	8.5-16
Extension Assy. to Transmission Case	25-35	34-47	5/16" Fitting — Cooler Line Connector to Case — Front and Rear (Case Fitting)	18-23	25-32
Plug — Case Front Pump or Line Pressure	6-12	8.5-16			
Pressure Gauge Tap	6-12	8.5-16	5/16" Tube Nut — Cooler Line to Trans. Case Fitting	12-18	17-24
Band Adj. Screw Locknut to Case	35-45	48-61			
	(in-lb)	N·m		(in-lb)	N·m
End Plates to Body	20-45	2.5-5	Reinforcing Right Side Plate to Lower Body	20-45	2.5-5
End Plates to Body	20-40	2.5-4.5	Converter Hsg. Cover to Converter Hsg. (7.5L)	30-60	3.5-6.5
Inner Downshift Lever Stop	20-45	2.5-5	Control Assy. to Case	95-125	11-14
Reinforcement Plate to Body	20-45	2.5-5	Gov. Body to Collector Body	90-120	10.5-13.5
Screen and Lower to Upper Valve Body	40-55	5-6.2	Detent Spring to Case	80-120	9.5-13.5
Shift Valve Plate to Upper Body	20-45	2.5-5	Rear Engine Support to Frame	40-60	5-6.5
Upper to Lower Body	40-55	5-6.2	Neutral Switch to Case	55-75	6.5-8
VRV to Fuel Injector Pump	75-90	8-10.5			

CD4721-2B

CLUTCH AND BAND APPLICATION CHART

	Forward Clutch	One Way Clutch	Low Reverse Clutch	Intermediate Band	Reverse High Clutch
1st Gear — Manual Low	Applied		Applied		
1st Gear — D	Applied	Holding			
2nd Gear — D	Applied			Applied	
3rd Gear — D	Applied				Applied
Reverse (R)			Applied		Applied

CD7744-2A

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SPECIAL SERVICE TOOLS

Number	Description
T50T-100-A	Impact Slide Hammer
T59L-100-B	Impact Slide Hammer
T58L-101-A	Puller Attachment
T57L-500-B	Bench Mounted Holding Fixture
TOOL-1175-AC	Seal Remover
TOOL-4201-C	Dial Indicator With Bracketry
TOOL-7000-DD	Rubber Tip For Air Nozzle
TOOL-7000-DE	Air Nozzle Assembly
T66L-7003-C2	Front Pump Bushing Replacer
T67P-7341-A	Shift Linkage Insulator Tool
T84P-7341-A	Shift Linkage Grommet Remover (In-Vehicle)
T84P-7341-B	Shift Linkage Grommet Remover (In-Vehicle)
T61L-7657-B	Extension Housing Seal Replacer
T77L-7697-C	Extension Housing Bushing Replacer
T77L-7697-D	Extension Housing Bushing Remover
T76L-7902-C	Converter Clutch Torquing Tool
T80L-7902-A	End Play Checking Tool
T77L-7902-A	Converter Clutch Holding Tool
T73P-77060-A	Output Shaft Retainer Pliers
TOOL-77288	Shift Lever Seal Replacer
T71P-77370-A	Band Adjustment Torque Wrench Set
T65L-77515-A	Clutch Spring Compressor
T77L-77548-A	Lip Seal Protector
T87L-77837-AH	Front Pump Seal Replacer
T83T-7B200-AH	VRV Gage Block
T69L-7D044-A	Clutch Housing Bushing Tool

CD3139-1F

ROTUNDA EQUIPMENT

Model No.	Description
014-00106	Engine/Transmission Stand

CD4912-1B

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VEHICLE APPLICATION

Applies to E-150 Through E-250, F-150 Through F-250 (4x2), (4x4) and Bronco Truck Models.

DESCRIPTION

Fig. 1 shows the location of the converter, front pump, clutches, gear train and most of the internal parts used in the Automatic Overdrive Transmission.

The Automatic Overdrive Transmission provides fully automatic operation in either the Ⓓ (overdrive) or D (overdrive lockout) positons. Manual upshifting and downshifting is available through the forward drive positions Ⓓ, D, 1.

NOTE: There is no 2 (second) selector position for an automatic overdrive transmission therefore second gear starts are not available.

Ⓓ (OVERDRIVE) - This is the normal driving position for an Automatic Overdrive Transmission. In this position the transmission starts in first gear and as the vehicle accelerates, automatically upshifts to second and third gear. The upshift to fourth (overdrive) gear will occur as the vehicle approaches the desired highway cruising speed and the driver eases up on the accelerator pedal. The transmission will automatically downshift as vehicle speed decreases.

NOTE: The transmission will not shift into or remain in overdrive gear when the accelerator is pushed to the floor.

The Automatic Overdrive Transmission differs from conventional 3 speed automatic transmissions in that the planetary gear set operates in 4th gear. Some audible perception of planetary action can exist as with any other mechanical device and should be accepted as being commercially quiet unless some abnormal noise is present.

D (OVERDRIVE LOCKOUT) - In this position the transmission operates as in Ⓓ (OVERDRIVE) except that there is no overdrive (fourth) gear. This position may be used when driving up or down mountainous roads to provide better performance and greater engine braking than the overdrive position. The transmission may be shifted from Ⓓ to D or D to Ⓓ at any vehicle speed.

1 (LOW)—This position can be used when maximum engine braking is desired. To help brake the vehicle on hilly roads where D (OVERDRIVE LOCKOUT) does not provide enough braking, shift the selector lever to 1 (LOW). At vehicle speeds above approximately 20 MPH the transmission will shift to second gear, and remain in second gear. When vehicle speed drops below approximately 20 MPH the transmission will downshift to first gear, and remain in first gear. Upshifts from 1 (LOW) can be made by manually shifting to Ⓓ (OVERDRIVE) or D (OVERDRIVE LOCKOUT). When 1 (LOW) is used for starting up, the transmission starts in first gear and stays in first gear.

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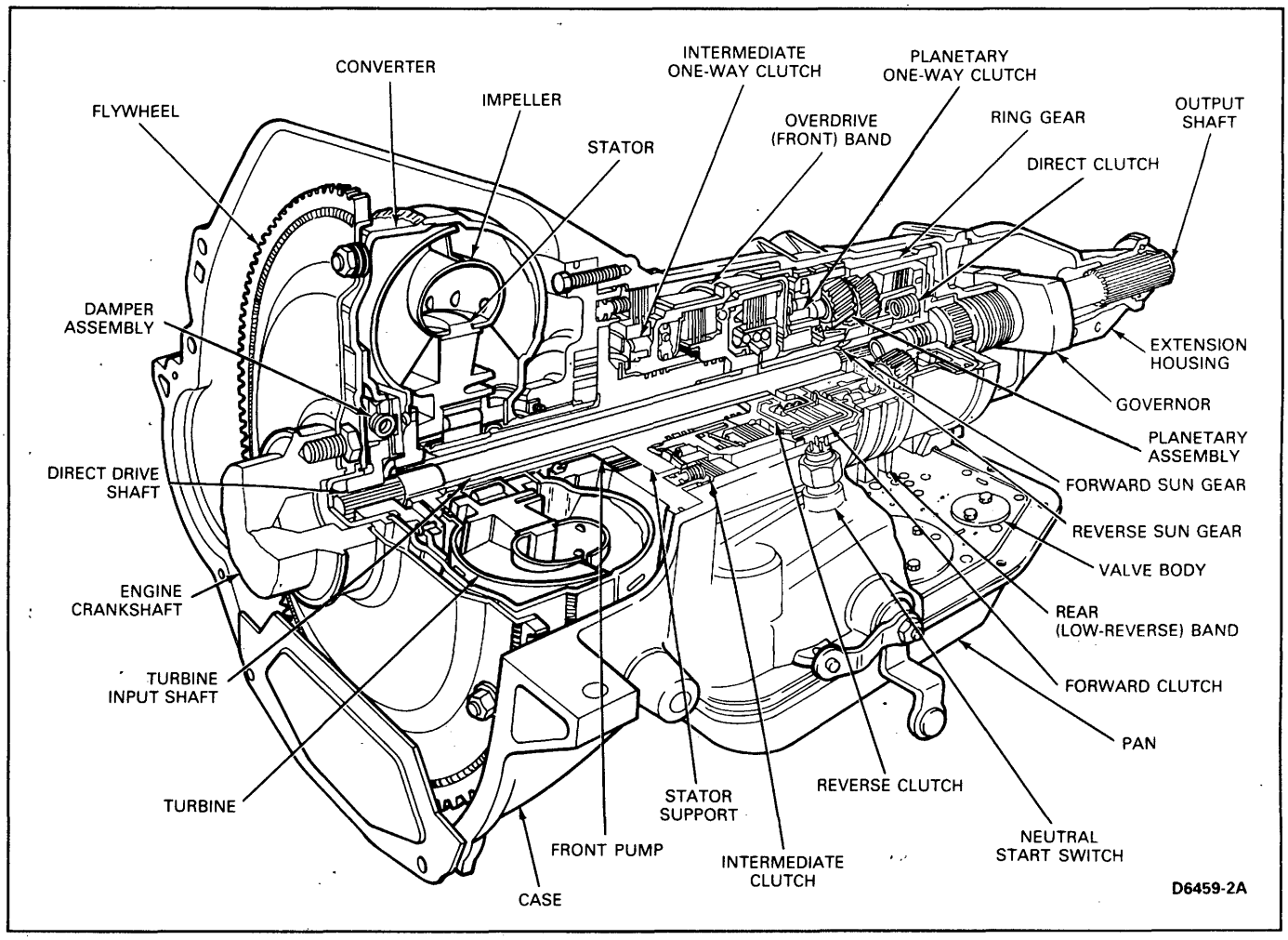


FIG. 1 Automatic Overdrive Transmission

FORCED DOWNSHIFTS—At vehicle speeds from approximately 50 MPH to 20 MPH in Ⓓ (OVERDRIVE) or D (OVERDRIVE LOCKOUT) the transmission will downshift to second gear when the accelerator is pushed to the floor. At vehicle speeds above approximately 50 MPH the transmission will not downshift to second gear. At vehicle speeds below approximately 20 MPH the transmission will downshift to first gear when the accelerator is pushed to the floor. At most vehicle speeds in Ⓓ (OVERDRIVE) the transmission will downshift from fourth gear to third gear when the accelerator is pushed for moderate to heavy acceleration.

DIAGNOSIS AND TESTING

For diagnosis and testing procedures not listed in this Section refer to Section 17-01, General Automatic Transmission Service.

Throttle Valve (TV) Cable System

The AOD Transmission employs a TV (Throttle Valve) Control Cable System on both the 4.9L (300 CID) Electronic Fuel Injected (EFI) engine and the 5.0L (302 CID) Electronic Fuel Injected (EFI) engine (Fig. 2).

The 4.9L engine is available with the F150 and the E150.

The 5.0L EFI engine is available with F150-F250, the E150-E250 and Bronco.

Shift Trouble Diagnosis

TV Control Cable System

Refer to Fig. 2.

A. **Symptoms:** Excessively early and/or soft upshifts with or without slip-bump feel. Slip-bump feel on light throttle shift into and out of 4th gear (3-4 and/or 4-3 shifts). No forced downshift (kick-down) function at appropriate speeds.

Cause: TV control cable set too long.

Remedy: Reset cable per procedure for the TV control cable system.

Cause: Cable is broken or disconnected at the carburetor throttle body.

CAUTION: Do not drive vehicle if cable is broken or disconnected at carburetor throttle body.

Damage to friction elements in transmission may result due to excessive slipping since TV pressure will remain near zero. If it is necessary to drive vehicle before repairing or resetting cable, disconnect cable at the transmission lever. TV pressure will now be near maximum allowing light throttle operation. However, shifts will be delayed and harsh.

Remedy: Replace/reconnect cable and reset per procedure for the TV control cable system.

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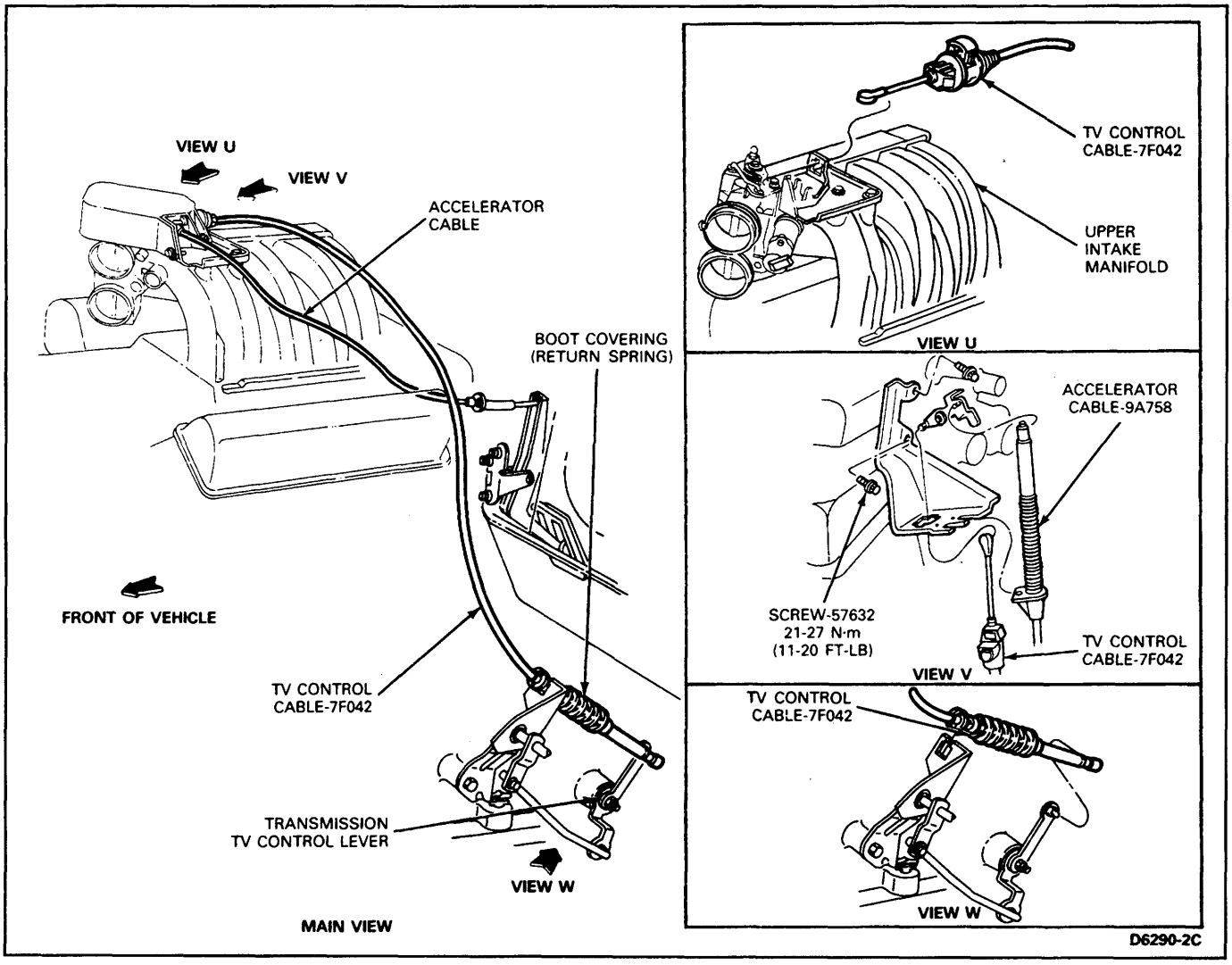


FIG. 2 Typical TV Control Cable System—5.0L (302 CID) EFI Engine Shown

B. **Symptoms:** Shift clunk when throttle is backed off after full or heavy throttle acceleration. Harsh coasting downshifts out of 4th gear (automatic 4-3 shifts in Ⓓ range).

Cause: TV control cable is set too short.

Remedy: Reset cable per procedure for the TV control cable system.

Cause: TV control cable is not locked, locking key is in up position.

Remedy: Set cable per procedure for the TV control cable system.

Cause: Transmission lever does not return to idle (lever to rear as far as possible) although cable is correctly set.

Remedy: Check for binding due to misaligned or damaged cable brackets or damaged cable or return spring (in rubber boot). Check for binding at cable connections at carburetor throttle body or transmission. Pry off cable from the TV lever ball stud and check for free movement of the cable. Lubricate the ball stud with a small amount of Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) lubricant or equivalent and reattach the cable. Check for frozen moisture in cable due to damaged boot. Repair or replace as necessary. Set cable per procedure for the TV control cable system.

Cause: Cable assembly not correctly attached to bracket at either carburetor throttle body or transmission.

Remedy: Determine reason for cable becoming detached. Replace if necessary. Set cable per procedure for the TV control cable system.

C. **Symptoms:** Extremely delayed and harsh upshifts, especially at light to moderate acceleration and harsh idle engagement.

Cause: Cable disconnected at transmission (transmission TV pressure is at maximum).

Remedy: Determine cause for cable becoming disconnected. Repair or replace as necessary. Set cable per procedure for the TV control cable system.

Cause: Transmission lever stays at WOT or part throttle although cable is correctly set.

Remedy: Check for binding conditions as detailed in Part B above. Repair or replace as necessary. Set cable per procedure for the TV control cable system.

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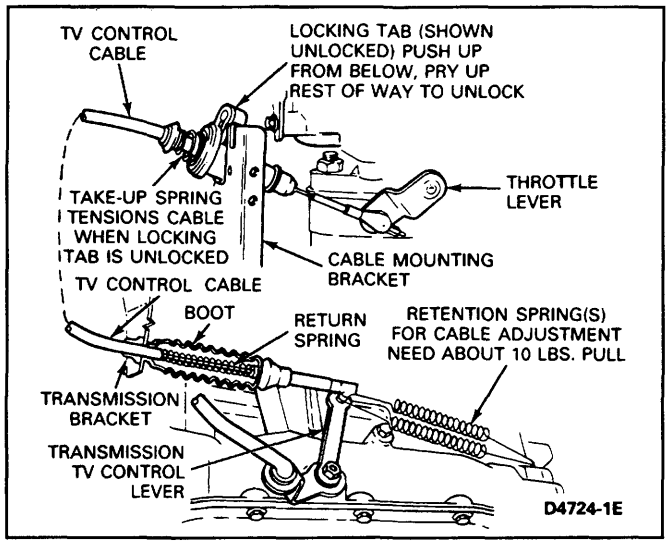


FIG. 3 Typical Throttle Valve (TV) Control Cable Adjustment

ADJUSTMENTS

Throttle Valve (TV) Control Cable Adjustment

Service Adjustment Procedure

Two methods of TV system adjustment are available.

a. TV cable adjustment with engine off.

b. TV control pressure check and adjustment procedure with engine on.

The Throttle Valve (TV) Control Cable System consists of a cable attaching stud on the carburetor or throttle body throttle lever, the TV Control Cable Assembly, the External TV Control Lever on the transmission, and the Cable Mounting Brackets at the carburetor and transmission (Fig. 3). As the carburetor throttle is moved from idle to wide open throttle (WOT), the TV control cable pulls the transmission TV control lever from idle to WOT. Return of the cable and transmission lever towards idle is accomplished by the return spring on the transmission end of the cable assembly. This spring and the end of the cable assembly is protected by a flexible rubber boot. The transmission external TV control lever actuates the internal TV control mechanism which regulates the TV control pressure. The travel of this lever is controlled by stops internal to the transmission.

The TV control cable is set and locked to its proper length during initial assembly by pushing in the locking tab at the carburetor end of the cable assembly. When the tab is unlocked, the cable is released for adjustment. The take-up spring at this end of the cable automatically tensions the cable when released. With the slack taken up and the locking tab pushed in, the take-up spring plays no part in the operation of the system.

Under normal circumstances, it should not be necessary to alter or readjust the initial setting of the TV control cable. Situations requiring readjustment of the TV control cable include maintenance involving the removal and/or replacement of the carburetor, transmission, or TV cable assembly. Readjustment of the TV control cable would also be necessary to correct complaints of poor transmission shift quality.

When the TV control cable is properly set, the transmission TV control lever will be at its internal idle stop (lever to rear as far as it will travel) when the carburetor throttle lever is at its minimum idle stop (anti-diesel stop).

TV Cable Adjustment with Engine Off

IDLE SPEED CONTROL MOTOR (ISC) APPLICATION

Both the 4.9L (300 CID) EFI and 5.0L (302 CID) EFI engines are equipped with an Air By-Pass Idle Speed Control (ISC) System. Idle speed is regulated by by-passing air through the throttle body and does not affect the throttle lever position. Therefore, NO retraction of the Idle Speed Control Plunger is required before adjusting the TV Control Cable.

At WOT, the transmission TV control lever may or may not be at its WOT stop. The wide open throttle position must not be used as a reference point for adjusting the TV control cable.

IDLE SPEED AFFECT ON THE TV CONTROL CABLE

Both the 4.9L (300 CID) EFI and the 5.0L (302 CID) EFI Engines use an air By-Pass ISC that does not affect throttle position. Therefore, idle automatic setting does not affect TV Cable adjustment.

TV Cable Adjustment Procedure—Retention Spring—

4.9L (300 CID) EFI and 5.0L (302 CID) EFI

1. Set parking brake and put selector in "N" (Do not put selector in "P").
2. Remove the protective cover over the cable linkage on the 4.9L (300 CID) and 5.0L (302 CID) engines.
3. Verify that the throttle lever is at the idle stop. If it isn't, check for binding or interference in the throttle system. **Do Not Attempt to Adjust Idle Stop.**
4. Verify that the cable routing is free of sharp bends or pressure points and that the cable operates freely. Lubricate the TV lever ball stud with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent if necessary. Check for damage to cable or rubber boot.
5. Unlock the locking tab at the throttle body end by pushing up from below, and prying up the rest of the way to free the cable (Figs. 4 and 5).
6. A retention spring must be installed on the TV control lever, to hold it in the idle position (as far to rear as the lever will travel) with about ten pounds of force. If a suitable single spring is not available, two V8 TV return springs may be used. Attach retention spring(s) to the transmission TV lever and hook rear end of spring to the transmission case (Fig. 6).
7. With the TV cable locking tab unlocked and the retention spring in place, rotate the transmission outer TV lever 10°-30° and return slowly.
8. Push down on the locking key until flush (Fig. 7).
9. Remove the retention spring(s) from the transmission TV lever.

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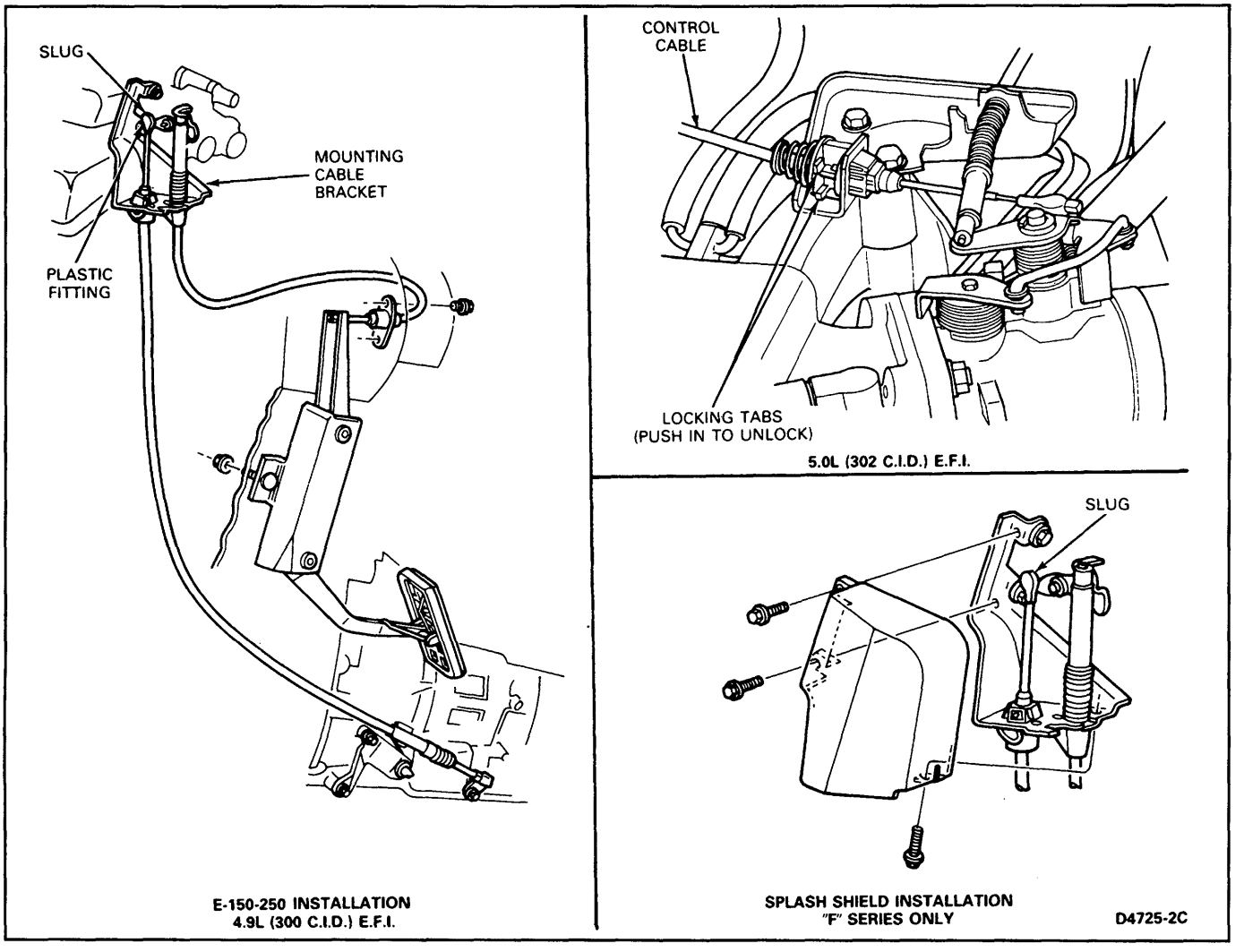


FIG. 4 Unlock Throttle Valve (TV) Control Cable Locking Tab

TV Control Pressure Check and Adjustment with Engine On

NOTE: This procedure requires the use of TV Pressure Gauge with Hose, T86L-70002-A or equivalent. The results of the adjustment procedure depends on the accuracy of the pressure gauge. The pressure gauge should be checked (and recalibrated if necessary) approximately four times a year or when the following occurs:

a. The needle will not return to 0 psi under no pressure.

b. The needle goes past 0 psi (negative side) under no pressure.

c. Bumping or dropping a pressure gauge.

1. Attach TV Pressure Gauge with Hose, T86L-70002-A or equivalent to the TV port on the transmission. On some applications it might be easier to use the TV Pressure Fitting Service Tool No. D80L-77001-A.
2. Remove the protective cover over the cable linkage on the 5.0L (302 C.I.D.) EFI Engine.
3. Insert the tapered end of the Cable TV Control Pressure Gauge Tool, T86L-70332-A between the crimped slug on the end of the cable and the plastic cable fitting that attaches to the throttle lever (Fig. 8). Push in gauge tool, forcing the crimped slug away from the plastic fitting. Make sure gauge tool is pushed in as far as it will go.
4. Operate the engine until normal operating temperature is reached. The transmission fluid temperature should be approximately 100-150°F. Do not make pressure check if transmission fluid is cold or too hot to touch.
5. Set parking brake and place shift selector in N (neutral). With gauge block in place and engine idling in neutral, the TV pressure should be 33 ± 5 psi. For best transmission function, set the TV pressure as close as possible to 33 psi using the following procedure.

   NOTE: Do not check or set TV pressure in P (Park).
6. Unlock the TV Cable Locking Tab at the carburetor (or throttle body). The adjuster preload spring should cause the adjusting slider to move away from the throttle body and the TV pressure should increase.
7. Push on the slider from behind the bracket until the TV pressure is 33 psi. While still holding the slider, push down on locking tab as far as it will go, locking slider in position.

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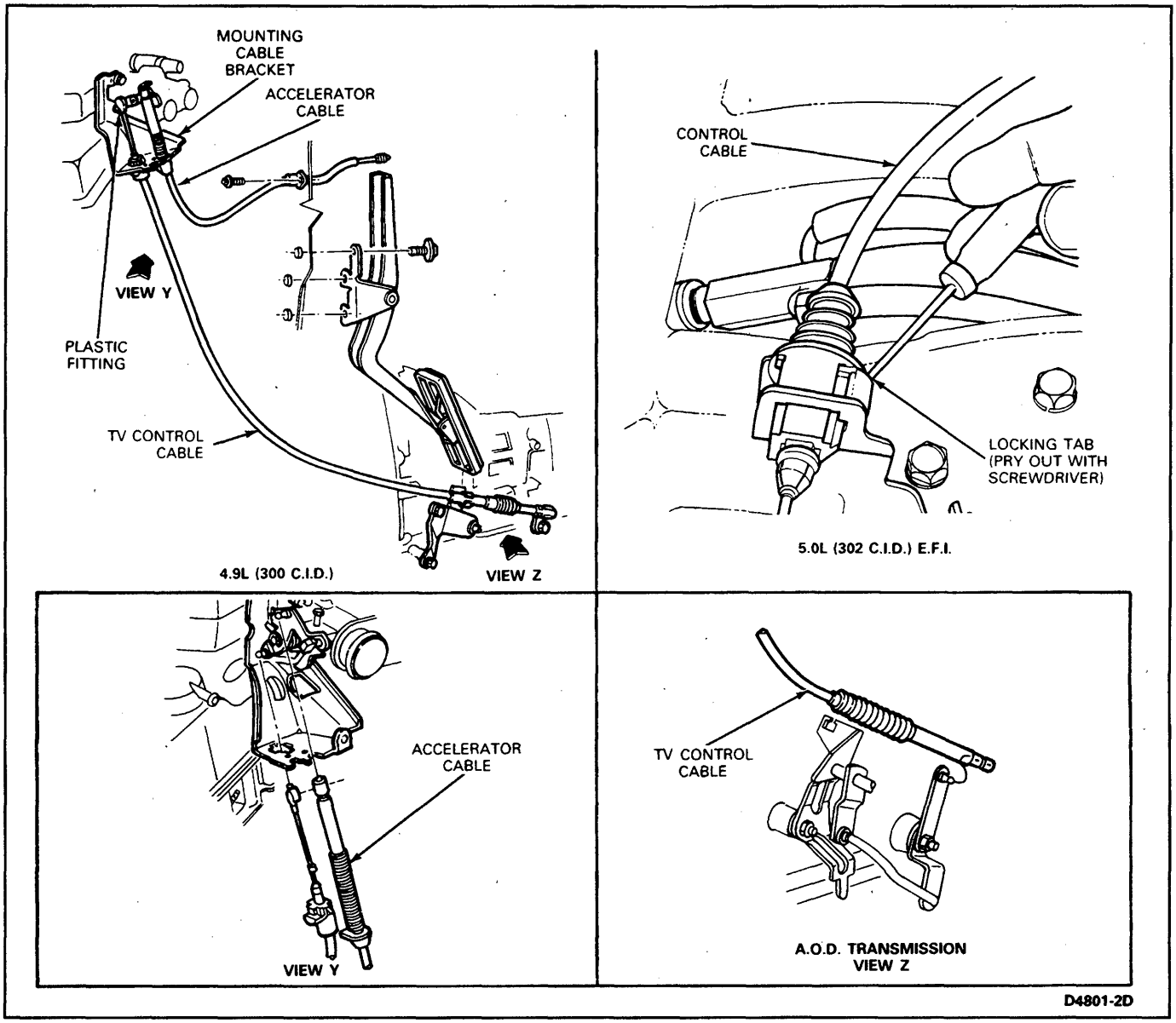


FIG. 5 Prying Up Throttle Valve (TV) Control Cable Locking Tab

8. Remove gauge tool, allowing cable to return to its normal idle position. With the engine still idling in neutral, TV pressure must be at or near zero (less than 5 psi). If not, reinstall gauge tool. Repeat steps 6 and 7 but set the TV pressure to a pressure less than 33 psi but not less than 28 psi. Remove gauge tool and recheck TV pressure to determine if it is at or near zero.

REMOVAL AND INSTALLATION

Transmission

NOTE: Completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, governor, all clutches, and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service. In addition, the cleaning of debris from the direct clutch check ball is often omitted. This omission can lead to a repeat servicing of the transmission. Cleaning and flushing procedures for transmission components, including the direct clutch check ball, can be found in the cleaning and inspection Part of Section 17-01 of this Shop Manual.

NOTE: Do not soak oil filter in solvent cleaner. The filter material could disintergrate. Replace filter if transmission fluid is contaminated.

Removal

1. Disconnect the battery negative cable.
2. Raise the vehicle on a hoist or stands.
3. Place a drain pan under the transmission fluid pan. Starting at the rear of the pan and working toward the front, loosen the attaching bolts and allow the fluid to drain. Finally remove all of the pan attaching bolts except two at the front, to allow the fluid to further drain. With fluid drained, install two bolts on the rear side of the pan to temporarily hold the pan in place.

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4. Remove the converter drain plug access cover from the lower end of the converter housing.
5. Remove the converter-to-flywheel attaching nuts. Place a wrench on the crankshaft pulley attaching bolt to turn the converter to gain access to the nuts.
6. Place a drain pan under the converter to catch the fluid. With the wrench on the crankshaft pulley attaching bolt, turn the converter to gain access to the converter drain plug and remove the plug. After the fluid has been drained, reinstall the plug.
7. Disconnect the driveshaft from the rear axle and slide shaft rearward from the transmission.

   NOTE: To maintain initial driveshaft balance, mark the REAR driveshaft yoke and axle companion flange so they may be installed in their original positions.

   Install a seal installation tool in the extension housing to prevent fluid leakage.

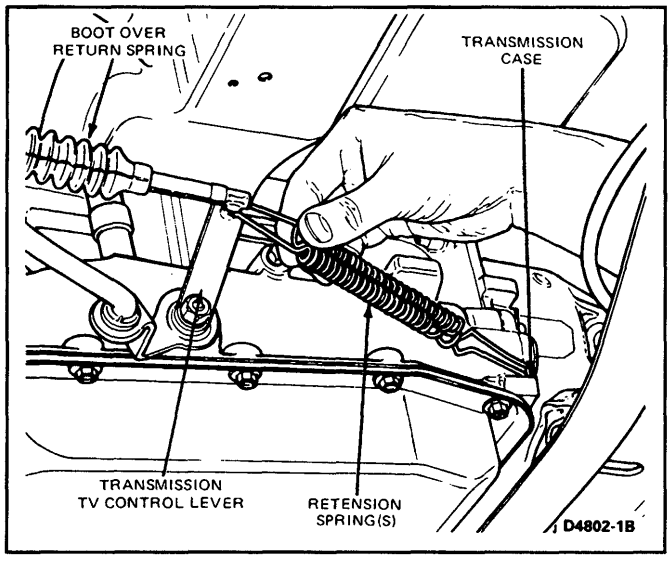


FIG. 6 Transmission TV Lever Retention Spring—4.9L (300 CID) EFI and 5.0L (302 CID) EFI

8. Disconnect the cable from the terminal on the starter motor. Remove the two attaching bolts and remove the starter motor. Disconnect the neutral start switch wires at the plug connector.
9. Remove the rear mount-to-crossmember attaching bolts and the two crossmember-to-frame attaching bolts.
10. Remove the two engine rear support-to-extension housing attaching bolts.
11. Disconnect the TV cable from the transmission TV lever. Disconnect the manual rod from the transmission manual lever at the transmission.
12. Remove the bolt securing the bellcrank bracket to the converter housing.

    On 4x4 applications, remove the transfer case. Refer to the appropriate transfer case section in Group 16.
13. Raise the transmission with a transmission jack to provide clearance to remove the crossmember (Fig. 9). Remove the rear mount from the crossmember and remove the crossmember from the side supports.

    NOTE: The 4x4 application has a deep well oil pan. Use a transmission jack that will allow clearence for the oil pan depth and still provide support for the transmission at the oil pan rail.
14. Lower the transmission to gain access to the oil cooler lines.
15. Disconnect each oil line from the fittings on the transmission.
16. Disconnect the speedometer cable from the extension housing.
17. Remove the bolt that secures the transmission fluid filler tube to the cylinder block. Lift the filler tube and the dipstick from the transmission.
18. Secure the transmission to the jack with the chain.
19. Remove the converter housing-to-cylinder block attaching bolts.
20. Carefully move the transmission and converter assembly away from the engine and, at the same

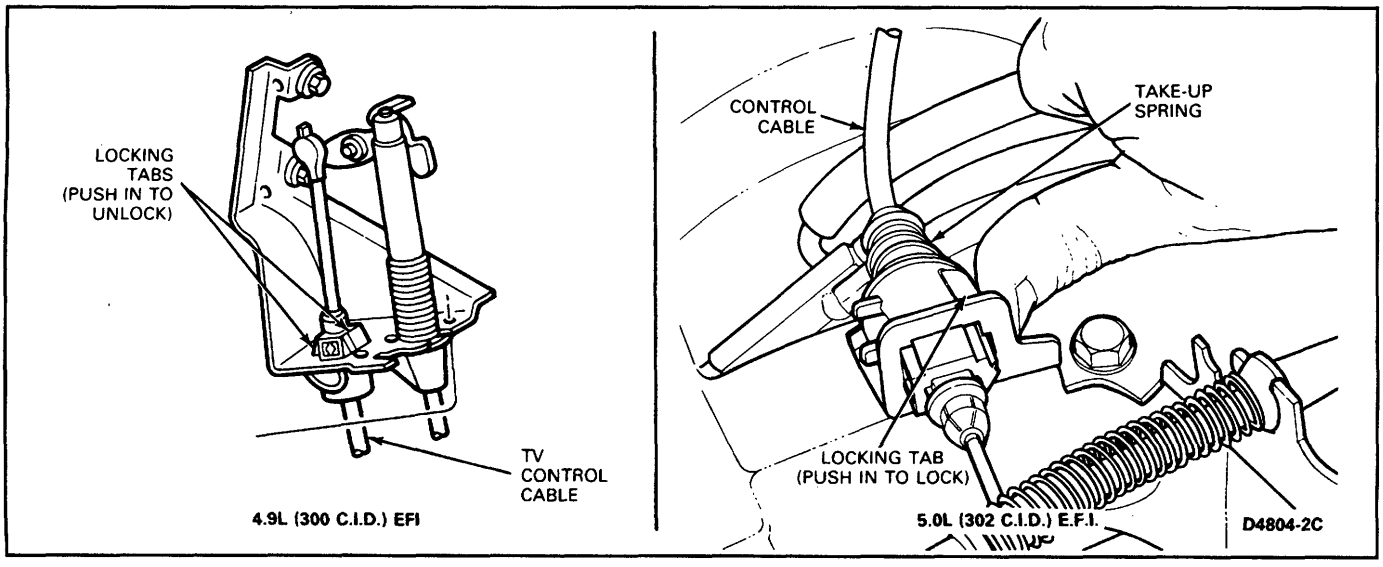


FIG. 7 Throttle Valve (TV) Control Cable Locking Tab Installation—Typical

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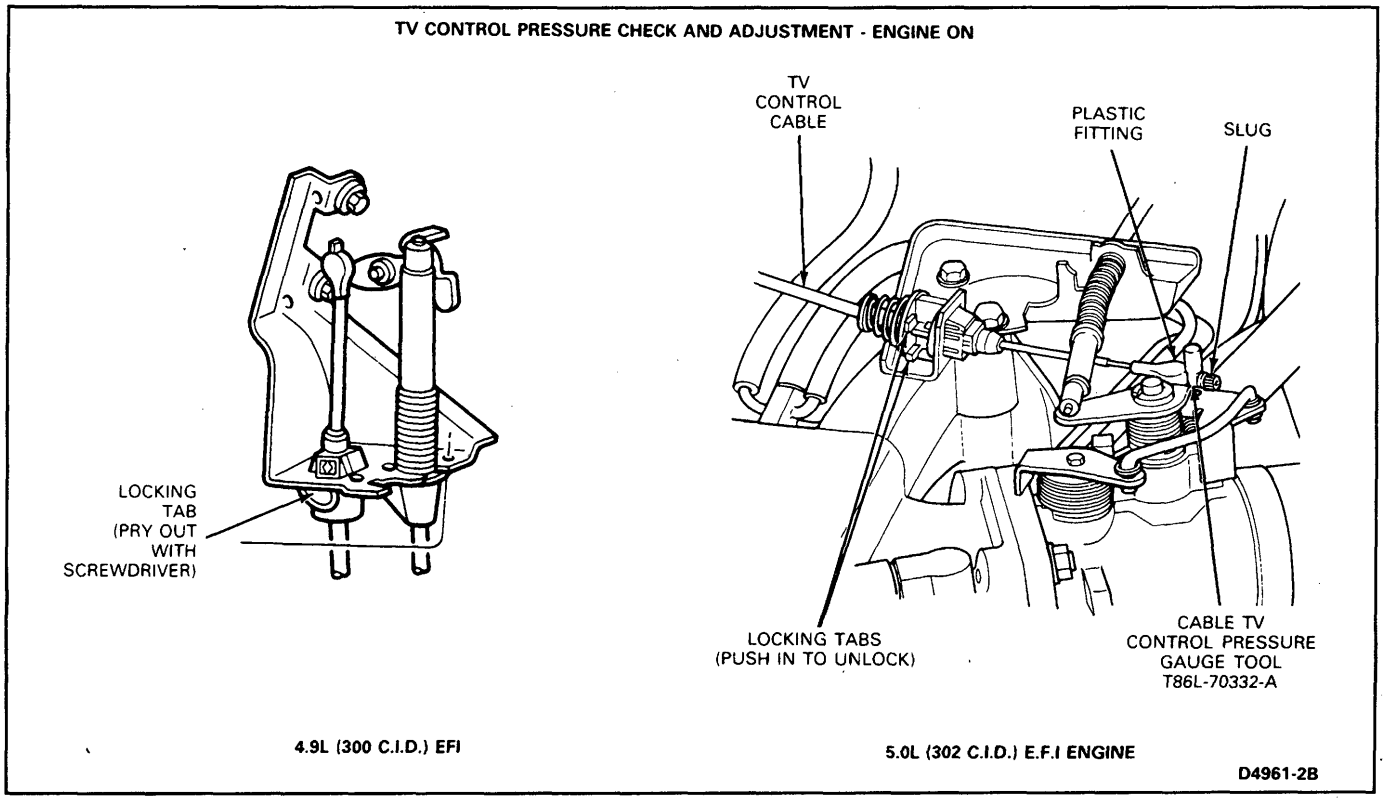


FIG. 8 TV Pressure Check and Adjustment Using Gauge Tool

time, lower the jack to clear the underside of the vehicle.

21. Remove the converter and mount the transmission in a holding fixture.

Transmission

Installation

1. Tighten the converter drain plug to specifications.
2. Position the converter on the transmission, making sure the converter drive flats are fully engaged in the pump gear by rotating the converter.
3. With the converter properly installed, place the transmission on the jack. Secure the transmission to the jack with a chain.
4. Rotate the converter until the studs and drain plug are in alignment with the holes in the flywheel.
5. Move the converter and transmission assembly forward into position, using care not to damage the flywheel and the converter pilot. The converter must rest squarely against the flywheel. This indicates that the converter pilot is not binding in the engine crankshaft.
6. Install and tighten the converter housing-to-engine attaching bolts to specification.
7. Remove the safety chain from around the transmission.
8. Install a new O-ring on the lower end of the transmission filler tube. Insert the tube in the transmission case and secure the tube to the engine with the attaching bolt.
9. Connect the speedometer cable to the extension housing.
10. Connect the oil cooler lines to the right side of transmission case.
11. Secure the engine rear support to the extension housing and tighten the bolts to specification.
12. Position the crossmember on the side supports. Position the rear mount on the crossmember and install the attaching bolt and nut.
13. Install the transfer case. Refer to the appropriate transfer case Section in Group 16. Lower the transmission and remove the jack.
14. Secure the crossmember to the side supports with the attaching bolts and tighten them to specification.
15. Position the bellcrank to the converter housing and install the attaching bolt.
16. Connect the TV cable to the transmission TV lever. Connect the manual linkage rod to the manual lever at the transmission.
17. Secure the converter-to-flywheel attaching nuts and tighten them to specification.
18. Install the converter housing access cover.
19. Secure the starter motor in place with the attaching bolts. Connect the cable to the terminal on the starter. Connect the neutral start switch wires at the plug connector.
20. Install the driveshaft so the index marks on the companion flange and rear yoke are aligned.
21. Adjust the shift linkage as required. Refer to Section 17-02.
22. Adjust throttle linkage per the procedure outlined in the beginning of this Section.
23. Lower the vehicle.

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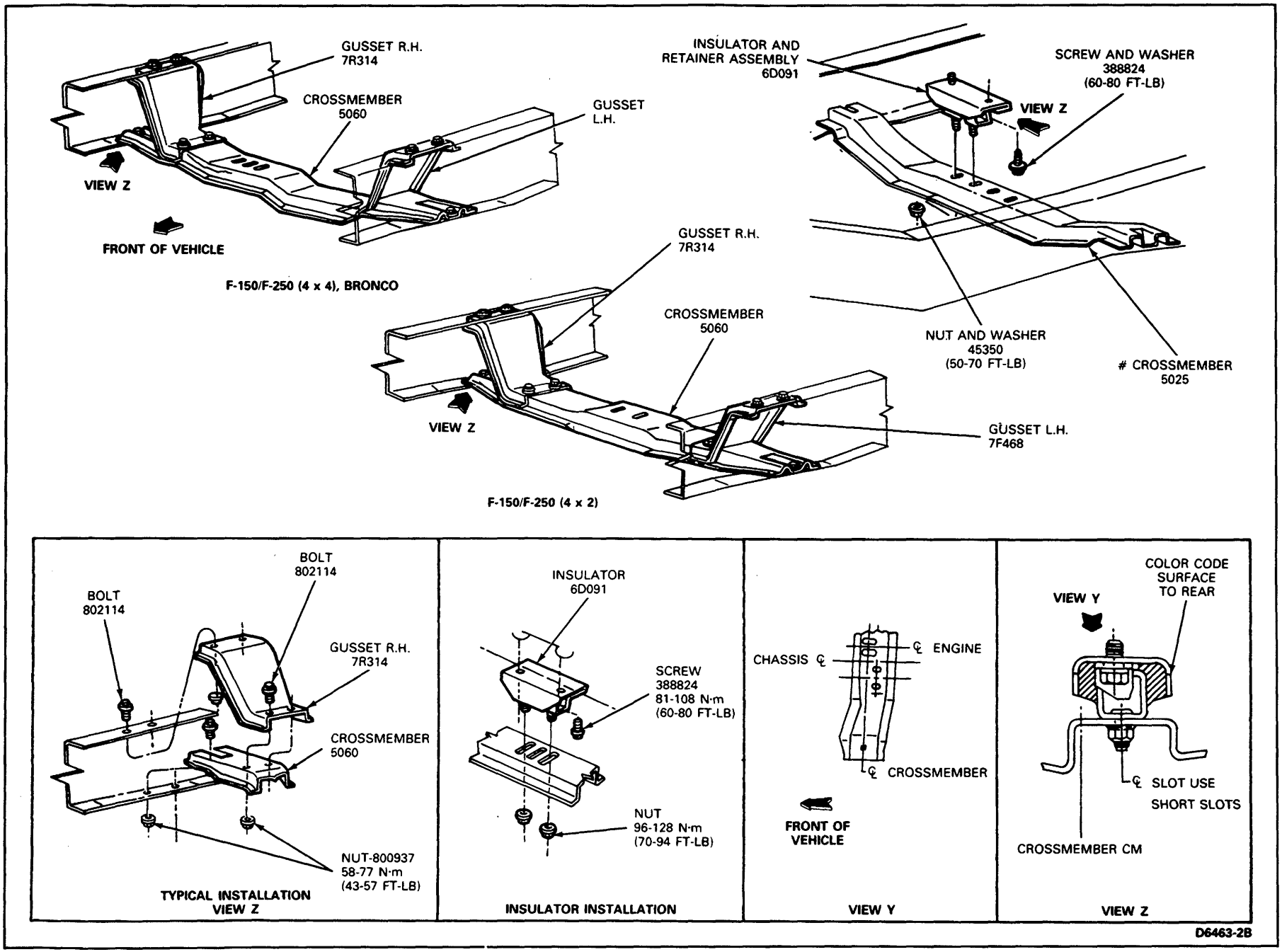


FIG. 9 Crossmember Installation F-150—F-250, E-150—E-350 and Bronco

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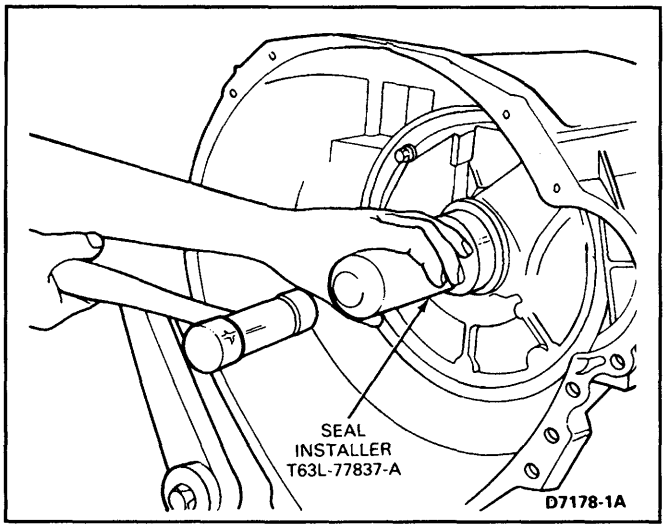


FIG. 10 Front Pump Seal Installation

24. Fill the transmission to the correct level with the specified fluid. Refer to Section 17-01. Connect the battery negative cable. Start the engine and shift the transmission to all ranges, then recheck the fluid level.

Main Control Valve Body

Removal

1. Raise the vehicle on a hoist so the transmission oil pan is accessible.
2. Starting at the rear and working toward the front, loosen the oil pan attaching bolts and drain the fluid from the transmission. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if the fluid is in good condition.
3. Remove the transmission oil pan attaching bolts, pan and gasket. Discard gasket.
4. Remove three dacron filter to valve body attaching bolts and remove the dacron filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the dacron filter (do not clean the filter).
5. Remove the detent spring attaching bolt and spring.
6. Remove the valve body to case attaching bolts (25). Remove the valve body. Discard valve body to case gasket.

Installation

1. Clean and inspect the valve body, as described in Section 17-01 prior to installation.
2. Using valve body guide pins, Tool T80L-77100-A or equivalent, position the valve body and a new gasket to the case, making sure that the inner manual lever and inner TV levers are engaged.
3. Install and tighten (25) valve body-to-case attaching bolts.
4. Install and tighten the detent spring and attaching bolts to specification.
5. Remove the guide pins and install and tighten the remaining two attaching bolts.
6. Load the throttle lever spring against the separator plate.
7. Using three dacron filter attaching bolts install the dacron filter and gasket to the valve body and tighten the attaching bolts to 9-14 N·m (80-120 in-lbs).
8. Clean the transmission oil pan and gasket surfaces thoroughly.
9. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the attaching bolts to 8.0-13.5 N·m (6-10 ft-lbs).
10. Lower the vehicle and fill the transmission to the correct level with the specified fluid. Refer to Section 17-01.
11. Adjust TV cable linkage as outlined in this Section.

Overdrive Servo Assembly

Refer to Fig. 14.

Removal

1. Raise the vehicle on a hoist so the transmission fluid pan is accessible.
2. Starting at the rear and working toward the front, loosen the oil pan attaching bolts and drain the fluid from the transmission. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if the fluid is in good condition.

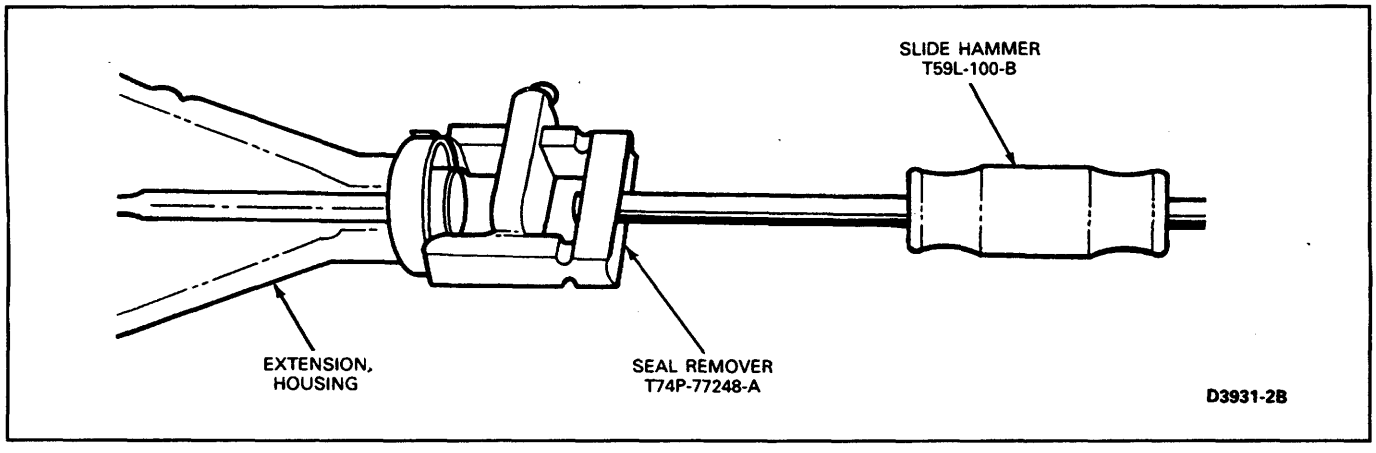


FIG. 11 Removing Extension Housing Seal

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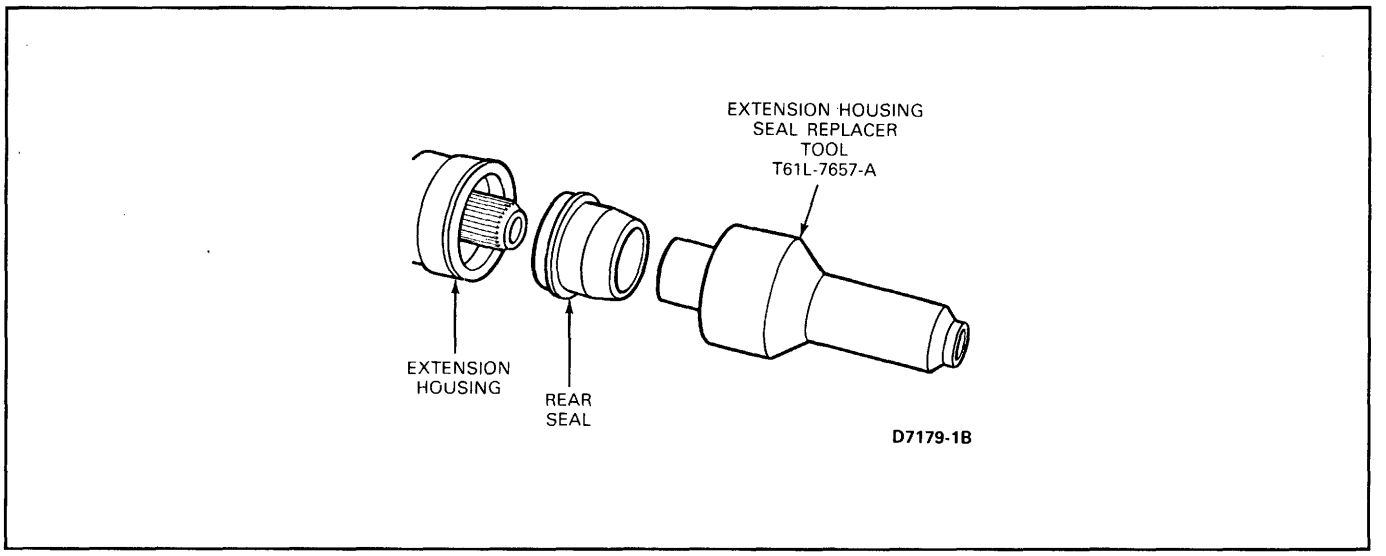


FIG. 12 Installing Extension Housing Seal

3. Remove the transmission fluid pan attaching bolts, pan and gasket. Discard gasket.
4. Remove three dacron filter to valve body attaching bolts and remove the dacron filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the dacron filter. (Do not clean the filter).
5. Remove the detent spring and attaching bolt.
6. Remove the valve body to case attaching bolts (25). Remove the valve body. Discard valve body to case gasket.
7. Depress overdrive servo piston cover with a hammer handle and remove the retaining snap ring.
8. Using Tool T80L-77030-B or equivalent, apply air pressure to the servo piston release passage in order to remove the overdrive servo piston cover and spring. Remove the piston from the cover.
9. Remove the rubber seals from the piston and the cover.

Installation

1. Clean and inspect the servo piston and cover for nicks and/or burrs. Clean and inpsect the servo piston pocket in the case for nicks and burrs also.
2. Install new servo piston and cover seals on the piston and cover, respectively.
3. Lubricate the piston seals with either clean transmission fluid or a petroleum jelly.
4. Install the servo piston into the cover, lubricate the cover seals and the overdrive servo pocket in the case.
5. Assemble the return spring to the servo piston.
6. Install the overdrive piston, cover and spring into the overdrive servo pocket in the case. Make sure the servo rod contacts the band apply pocket while installing. Failure to do so will result in a no 3-4 shift condition.
7. Using the handle of a hammer, depress the overdrive servo sufficiently to gain clear access to the retaining snap ring groove in the case. Install the snap ring.
8. Inspect the outer edge of the overdrive servo pocket for possible nicks and burrs which might have been raised during the removal or installation of the retaining snap ring.
9. Remove nicks and burrs with a "fine honing stone" and clean the expected areas thoroughly. Failure to do so may cause improper seating of the valve body separator plate to the hydraulic passages in the case, and subsequent cross leakage.
10. Clean and inspect the valve body, as described in Section 17-01 prior to installation.
11. Position a new valve body gasket to the separator plate.
12. Install valve body guide Pins, T80L-77100-A or equivalent. Position a new separator plate gasket to the valve body and case, making sure that the inner manual lever and inner TV lever are engaged.
13. Install and tighten the attaching bolts (25) to 9-14 N·m (80-120 in-lbs).
14. Install the detent spring and attaching bolt.
15. Remove the guide Pins T80L-77100-A or equivalent and install and tighten the remaining two valve body-to-case bolts.
16. Position the throttle lever spring against the separator plate.
17. Using three dacron filter attaching bolts, install the dacron filter and gasket to the valve body and tighten attaching bolts to 9-14 N·m (80-120 in-lbs).
18. Clean the transmission oil pan and gasket surfaces thoroughly.
19. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the attaching bolts to 8.0-13.5 N·m (6-10 ft-lbs).
20. Lower the vehicle and fill the transmission to the correct level with the specified fluid. Refer to Section 17-01.
21. Adjust TV cable linkage as outlined in this Section.

Low-Reverse Servo Assembly

Refer to Fig. 14.

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Removal

1. Raise the vehicle on a hoist so the transmission oil pan is accessible.
2. Starting at the rear and working toward the front, loosen the oil pan attaching bolts and drain the fluid from the transmission. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if the fluid is in good condition.
3. Remove the transmission oil pan attaching bolts, pan and gasket. Discard gasket.
4. Remove three dacron filter to valve body attaching bolts and remove the dacron filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the dacron filter (do not clean the filter).
5. Remove the detent spring and attaching bolts.
6. Remove the valve body to case attaching bolts (25). Remove the valve body. Discard valve body to case gasket.
7. Depress the reverse servo piston cover with a hammer handle. Remove the retaining snap ring and piston cover.

   NOTE: Reverse servo piston may spring free from case when cover is removed. Care must be taken to prevent such an occurrence.
8. To remove the reverse servo piston and spring, apply air pressure to the servo piston release passage using Tool T80L-77030-B or equivalent. Cover the servo piston pocket to prevent the piston from falling out the case when air is applied and becoming damaged.

Installation

1. Clean and inspect the servo pocket in the case.
2. Clean the reverse servo piston, cover and return spring. Inspect the piston and cover sealing edges for cuts, burrs or irregular wear pattern. Replace if necessary.
3. Assemble the return spring to the servo piston.
4. Install the reverse servo piston and spring and the servo cover into the case reverse servo pocket.

   NOTE: Make sure that the servo piston is reinstalled with the same rod length as the one which was removed.
5. Using the handle of a hammer, depress the reverse servo piston and cover sufficiently to gain clear access to the retaining snap ring groove in the case. Install the snap ring.
6. Inspect the outer edge of reverse servo pocket for nicks or burrs which might have been raised during the removal or installation of the retaining snap ring.
7. Remove nicks or burrs with a "fine" honing stone and clean the effected surfaces thoroughly. Failure to do so may cause improper seating of the valve body separator plate to the hydraulic passages in the case and subsequent cross leakage.
8. Clean and inspect the valve body, as described in Section 17-01.
9. Position a new valve body gasket to the separator plate.
10. Install valve body guide Pins, Tool T80L-77100-A or equivalent to the case. Position a new separator plate gasket to the valve body and case, making sure that the inner manual lever and inner TV lever are engaged.
11. Install and tighten (25) attaching bolts to 9-11 N·m (80-100 in-lbs).
12. Install and tighten the detent spring and attaching bolt to 9-14 N·m (80-120 in-lbs).
13. Position the throttle lever spring against the separator plate.
14. Remove the guide Pins T80L-77100-A and install and tighten the remaining two valve body attaching bolts.
15. Using three dacron filter attaching bolts install the dacron filter and gasket to the valve body and tighten the attaching bolts to 9-14 N·m (80-120 in-lbs).
16. Clean the transmission oil pan and gasket surfaces thoroughly.
17. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the attaching bolts to 8.0-13.5 N·m (6-10 ft-lbs).
18. Lower the vehicle and fill the transmission to the correct level with the specified fluid. Refer to Section 17-01.
19. Adjust TV cable linkage as outlined in this Section.

3-4 Accumulator Piston

Refer to Fig. 14.

Removal

1. Raise the vehicle on a hoist so the transmission oil pan is accessible.
2. Starting at the rear and working toward the front, loosen the oil pan attaching bolts and drain the fluid from the transmission. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if the fluid is in good condition.
3. Remove the transmission oil pan attaching bolts, pan and gasket. Discard gasket.
4. Remove the dacron filter-to-valve body attaching bolts and remove the dacron filter, grommet and gasket. Discard gasket. If the fluid was contaminated, discard the filter.
5. Remove the detent spring and attaching bolts.
6. Remove the valve body-to-case attaching bolts (25). Remove the valve body. Discard valve body-to-case gasket.
7. To remove the 3-4 accumulator piston, depress the cover and remove the retaining snap ring.
8. Slowly release the tension on the 3-4 accumulator cover, allowing the removal of the piston cover, return spring and piston. (Some models do not use a spring).
9. If necessary, apply air pressure to the hydraulic apply passage using servo release Tool T80L-77030-B or equivalent.
10. Remove the seals from the 3-4 accumulator cover and piston. Inspect seals for possible nicks, cuts or irregular wear patterns, then discard the seals.

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Installation

1. Thoroughly clean and inspect the 3-4 accumulator piston and cover.
2. Install new seals on the 3-4 accumulator piston and cover.
3. Thoroughly clean and inspect the accumulator pocket in the case.
4. Lubricate the rubber cover seal and the cover pocket of case with either clean tranmission fluid or a petroleum jelly.
5. Reinstall the 3-4 accumulator piston (and return spring) into the case. Reinstall the cover.
6. Depress cover into piston pocket sufficiently to allow clear access to the snap ring groove in the inside diameter of the pocket.
7. Install the retaining snap ring.

   IMPORTANT: Cover must then be reseated snug against retaining ring. Inspect the outer edge of the 3-4 accumulator piston pocket for nicks or burrs which might have been raised during the removal of installation of the retaining snap ring. Remove nicks or burrs with a fine honing stone and clean the affected surfaces thoroughly. Failure to do so may cause improper seating of the valve body separator plate to the hydraulic passages in the case and subsequent cross leakage.
8. Clean and inspect the valve body as described in Section 17-01 prior to installation, if necessary.
9. Position a new valve body gasket to the separator plate.
10. Using valve body guide Pins, Tool T80L-77100-A or equivalent, position the valve body to the case with a new gasket, making sure that the inner manual lever and inner TV lever are engaged.
11. Install and tighten (25) valve body-to-case attaching bolts.
12. Install and tighten the detent spring and attaching bolt to specification.
13. Remove the guide Pins (T80L-77100-A or equivalent) and install the two remaining valve body bolts. Tighten to 9-11 N·m (80-100 in-lbs).
14. Position the throttle lever spring against the separator plate.
15. Using three dacron filter attaching bolts install the dacron filter and gasket to the valve body and tighten the attaching bolts to 9-14 N·m (80-120 in-lbs).
16. Clean the transmission oil pan and gasket surfaces thoroughly.
17. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the attaching bolts to 8.0-13.5 N·m (6-10 ft-lbs).
18. Lower the vehicle and fill the transmission to the correct level with the specified fluid.
19. Adjust TV cable as outlined in this Section.

2-3 Accumulator Piston

Refer to Fig. 14.

Removal

1. Raise the vehicle on a hoist so the transmission oil pan is accessible.
2. Starting at the rear and working toward the front loosen the oil pan attaching bolts and drain the fluid from the transmission. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if the fluid is in good condition.
3. Remove the transmission oil pan attaching bolts, pan and gasket. Discard gasket.
4. Remove the three dacron filter-to-valve body attaching bolts and remove the dacron filter, grommet and gasket. Discard gasket. If the fluid is contaminated, discard the dacron filter (do not clean the filter).
5. Remove the detent spring and attaching bolt.
6. Remove the valve body-to-case attaching bolts (25). Remove the valve body. Discard the valve body-to-case gasket.
7. Depress the 2-3 accumulator piston cover. Remove the retaining snap ring, cover and spring.
8. Remove the 2-3 accumulator piston.
9. Remove the seals fron the 2-3 accumulator piston. If the seals have nicks, cuts or irregular wear patterns, then discard the seals.

Installation

1. Clean and inspect the 2-3 accumulator piston. Replace piston if damaged.
2. Clean and inspect the 2-3 accumulator pocket in the case for nicks, burrs or porosity.
3. Install new seals on the 2-3 accumulator piston.
4. Install the 2-3 accumulator piston into the case.
5. Install the return spring and cover.
6. Install the retaining snap ring.
7. Inspect the outer edge of 2-3 accumulator piston pocket for nicks or burrs which might have been raised during the removal or installation of the retaining snap ring.
8. Remove nicks or burrs with a "fine" honing stone and clean the affected surfaces thoroughly. Failure to do so may cause improper seating of the valve body separator plate to the hydraulic passages in the case and subsequent cross leakage.
9. Clean and inspect the valve body, as described in Section 17-01.
10. Position a new valve body to case gasket to the separator plate.
11. Using valve body guide pins, Tool T80L-77100-A or equivalent, position the valve body to the case making sure that the inner manual lever and inner TV lever are engaged. Install and tighten (22) valve body-to-case attaching bolts to 9-11 N·m (80-100 in-lbs).
12. Install and tighten the detent spring and attaching bolt to 9-14 N·m (80-120 in-lbs).
13. Remove the guide Pins T80L-77100-A or equivalent and install and tighten the two remaining valve body attaching bolts.

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14. Position the throttle lever spring against the separator plate.
15. Using three dacron filter attaching bolts install the dacron filter and gasket to the valve body and tighten the attaching bolts to 9-14 N·m (80-120 in-lbs).
16. Clean the transmission oil pan and gasket surfaces thoroughly.
17. Using a new oil pan gasket, secure the pan to the transmission case. Tighten the attaching bolts to 8.0-13.5 N·m (6-10 ft-lbs).
18. Lower the vehicle and fill the transmission to the correct level with the specified fluid. Refer to Section 17-01.
19. Adjust TV cable as outlined in this Section.

Extension Housing Bushing and Rear Seal

Refer to Figs. 14 and 15.

Removal

1. Raise the vehicle and disconnect the driveshaft at the transmission. To maintain initial driveshaft balance, mark the rear driveshaft yoke and companion flange so they may be installed in their original positions.
2. When only the rear seal needs replacing, carefully remove with Tool T74P-77248-A or equivalent as shown in Fig. 11.
3. Remove the bushing as shown (Fig. 71). Use the bushing remover Tool T77L-7697-A or equivalent carefully so that the output shaft spline is not damaged.

Installation

1. When installing a new bushing use special Tool T80L-77034-A or equivalent (Fig. 70).
2. Before installing a new seal, inspect the sealing surface of the universal joint yoke for scores. If scores are found, replace the yoke.
3. Inspect the counterbore of the housing for burrs. Remove burrs with crocus cloth.
4. Install the seal into the housing with Tool T61L-7657-A or equivalent (Fig. 12). The seal should be firmly seated in the bore. Coat the inside diameter of the rubber portion of the seal with Multi-Purpose Long-Life Lubricant, C1AZ-19590-B (ESA-M1C75-B) or equivalent lubricant.

Extension Housing

Removal

1. Raise the vehicle on a hoist or stands.
2. Disconnect the parking brake cable from the equalizer, if so equipped.
3. Disconnect the driveshaft from the rear axle flange and remove from the transmission. To maintain initial driveshaft balance, mark the rear driveshaft yoke and companion flange so they may be installed in their original positions.
4. Disconnect the speedometer cable from the extension housing.
5. Remove the engine rear support-to-extension housing attaching bolts.
6. Place a jack under the transmission and raise just enough to remove the weight from the engine rear support.
7. Remove the bolt that secures the engine rear support to the crossmember and remove the support.
8. Place a drain pan under the rear of the transmission case.
9. Lower the transmission and remove the extension housing attaching bolts. Slide the extension housing off the output shaft and allow the fluid to drain.

NOTE: The extension housing bolts have been coated with a sealant. More break torque may be required to remove these bolts.

10. Remove and discard extension housing gasket.

Installation

1. Clean the mounting surface on the transmission and on the extension housing. Remove any sealant from the bolts and the case bolt holes. Position a new gasket on the transmission. Coat the bolts with Ford Threadlock and Sealant E0AZ-19544-A or Ford Pipe Sealant D8AZ-19554-A Teflon® Tape or equivalent.
2. Hold the extension housing in place and secure with the attaching bolts. Tighten to specified torque.
3. Raise the transmission high enough to position the engine rear support on the crossmember.
4. Secure the support to the crossmember with the attaching bolt and nut. Tighten the bolt to 68-94 N·m (50-70 ft-lbs).
5. Lower the transmission and remove the jack. Install the engine rear support-to-extension housing attaching bolts. Tighten the bolts to 82-108 N·m (60-80 ft-lbs).
6. Secure the speedometer cable to the extension housing with the attaching bolt.
7. Connect the parking brake cable to the equalizer.
8. Install the driveshaft, aligning the index marks, in the transmission and connect shaft to rear axle flange.
9. Lower the vehicle. Fill the transmission to the correct level with the specified fluid. Refer to Section 17-01. Start the engine and shift the transmission through all ranges, then recheck the fluid level.

Governor

Refer to Fig. 24.

Removal

1. Raise the vehicle on a hoist or stands.
2. Disconnect the parking brake cable from the equalizer.
3. Disconnect the driveshaft from the rear axle flange and remove from the transmission. To maintain initial driveshaft balance, mark the rear driveshaft yoke and companion flange so they may be installed in their original position.
4. Disconnect the speedometer cable from the extension housing.

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5. Remove the engine rear support-to-extension housing attaching bolts.
6. Place a jack under the transmission and raise just enough to remove the weight from the engine rear support.
7. Remove the bolt that secures the engine rear support to the crossmember and remove the support.
8. Place a drain pan under the rear of the transmission case.
9. Lower the transmission and remove the extension housing attaching bolts. Slide the extension housing off the output shaft and allow the fluid to drain.
10. Remove and discard the extension housing gasket.

    NOTE: If the governor body only is to be removed, skip Steps 11 and 12.

11. Remove the governor-to-output shaft retaining snap ring.
12. Using a soft-faced hammer, tap the governor assembly off the output shaft. Remove the governor driveball.
13. Remove the governor-to-counterweight attaching screws. Lift the governor from the counterweight.

Installation

1. Lubricate the governor valve parts with clean transmission fluid. Make certain that the valve moves freely in the valve body bore.
2. Position the governor valve body on the counterweight with the cover facing toward the front of the vehicle. Install the two attaching screws, and tighten to 6-7 N·m (50-60 in-lbs).
3. Position the governor drive ball into the pocket of the output shaft.
4. Align the key way in the counterweight to the governor drive ball. Drive the governor assembly onto the output shaft with soft-faced hammer if necessary.
5. Reinstall the governor to output shaft retaining snap ring. Clean the mounting surface on the transmission and on the extension housing. Position a new gasket on the transmission.
6. Raise the transmission high enough to position the engine rear support on the crossmember.
7. Secure the support to the crossmember with the attaching bolt and nut. Tighten the bolt to 68-94 N·m (50-70 ft-lbs).
8. Lower the transmission and remove the jack. Install the engine rear support-to-extension housing attaching bolt. Tighten the bolts to 82-108 N·m (60-80 ft-lbs).
9. Secure the speedometer cable to the extension housing with the attaching bolt.
10. Connect the parking brake cable to the equalizer. Adjust the parking brake as required.
11. Install the driveshaft, after aligning the index marks, in the transmission and connect shaft to rear axle flange.
12. Fill the transmission to the correct level with the specified fluid. Refer to Section 17-01.

Internal and External Shift Linkage

Refer to Fig. 30.

Removal

1. Raise the vehicle on a hoist so that the transmission oil pan is accessible.
2. Apply penetrating oil to the outer throttle lever attaching nut to prevent breaking the inner throttle lever.
3. Grasp the outer throttle lever and hold firmly (Fig. 31). Then remove the outer throttle lever attaching nut and lockwasher. Swing lever and TV rod assembly or cable assembly clear for access path.
4. Carefully disconnect the shift rod at the transmission manual lever using special service Tool T67P-7341-A, T84P-7341-A or equivalent. Refer to Section 17-02.
5. Place a drain pan under the transmission oil pan. Starting at the rear of the pan and working toward the front, loosen the attaching bolts and allow the fluid to drain. Remove all of the attaching bolts except two at the rear to allow the fluid to further drain. It is necessary to use a 1/4 inch drive with a 10mm universal socket for access to remove the oil pan bolts. After all the fluid has drained, remove the two remaining bolts and the fluid pan. If the same fluid is to be used again, filter the fluid through a 100 mesh screen. Reuse the fluid only if it is in good condition.
6. Remove transmission oil filter and gasket.
7. Remove the manual lever detent spring and roller assembly.
8. Remove manual lever retaining pin using a narrow sharp screwdriver—this must be done carefully.
9. Note assembled position of the TV lever torsion spring, then remove the spring.
10. Slide a 5/8 inch box end wrench over the inner manual lever close to the bottom of the lever. Do not allow the wrench to contact the rooster comb area. Using a 21mm wrench (some 13/16 inch wrenches secure the nut better), remove the manual lever attaching nut. Securely hold the inner manual lever with the box end wrench while applying break torque to the manual lever attaching nut.

    NOTE: Note the orientation of the outer manual lever (pointing up or down) before removal.

11. Remove the outer manual lever from the case (Fig. 31).
12. Remove the inner throttle lever and shaft assembly.
13. Remove the inner manual lever and park pawl actuating rod assembly.
14. Disconnect the park pawl actuating rod from the inner manual lever.
15. Remove the manual lever oil seal with a screwdriver, or seal remover Tool T58L-101-B or equivalent (Fig. 32). Discard the oil seal.

Installation

1. Install a new manual lever seal into the case using seal replacer Tool T74P-77498-A or equivalent (Fig. 33).

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2. Check the manual lever, the shaft and the threads for damage.
3. With the manual lever attaching nut on the inner throttle lever and shaft assembly, slide the inner throttle lever through the inner manual lever.
4. Slide the outer manual lever in the case. Make sure the lever is oriented in the proper position (either up or down depending on vehicle application).
5. Allow the inner throttle lever and shaft assembly to slide through the ID bore of the outer manual lever.
6. Snug the manual lever attaching nut against the inner manual lever making sure the flats are properly aligned. Tighten the nut to remove free play, and torque the nut to specification with a crows foot or box type adapter to a torque wrench. The torque can be approximated by tightening the nut to remove free play, then turning the nut an additional 30 degrees. This is equivalent to rotating one point of the nut 1/4 inch.
7. Position TV lever torsion spring on the inner throttle valve shaft and align in notch.
8. Push manual lever all the way into the case. Make sure inner manual lever pin is engaged in manual valve detent slot and inner throttle lever is acting on the TV valve. Neutral start switch plunger must also be riding on cam surface of inner manual lever.
9. Install new manual lever retaining pin in case (light press fit). Pin must be flush to slightly below pan gasket surface.
10. Install the new throttle lever seal in the outer manual lever counterbore with a 13mm thin wall socket, using the end that the ratchet drive would be inserted into, to seat the seal. Install .030 inch to .060 inch below the surface.

    NOTE: Identification numbers on the seal must face outward.
11. Install detent spring. Make sure detent spring roller is centered on rooster comb. Tighten to 9-14 N·m (80-120 in-lbs).
12. Install the throttle valve outer lever (do not push inner throttle valve lever past throttle valve).
13. Install throttle lever lockwasher and attaching nut. Tighten nut to 16-22 N·m (12-16 ft-lbs).
14. Check park function and operation of TV lever and manual lever before further assembly.
15. Connect the shift linkage rod to the manual lever using special service Tool T67P-7341-A, T84P-7341-B or equivalent. Make sure the manual lever is in the same position as adjustment is necessary. Refer to Section 17-02.
16. Install a new oil filter gasket and oil filter. Tighten to 9-14 N·m (80-120 in-lbs).
17. Clean the transmission oil pan and gasket surfaces thoroughly.
18. Reassemble oil pan with a new pan gasket. Tighten bolts to 8.0-13.5 N·m (6-10 ft-lbs). It is necessary to use a 1/4 inch drive with a 10mm universal socket to reinstall the oil pan bolts.
19. Lower vehicle and add three quarts of oil.
20. Check and adjust the TV cable linkage at the throttle body.
21. Start vehicle in park, and with foot on brake, cycle gear selector several times. Recheck fluid level using the procedure in Section 17-01 and add as required. Check for leaks.

Front Pump Seal

Removal and Installation

1. Remove the transmission from the vehicle as described in this Section.
2. Remove the pump seal using seal remover Tool-1175-AC (or equivalent) and slide hammer T59L-100-B (or equivalent).
3. Install the seal using seal installer Tool T63L-77837-A (or equivalent) (Fig. 10).
4. Install the transmission as described in this Section.

Extension Housing Seal

Removal and Installation

1. Remove the driveshaft as described in Section 15-61, Driveshaft Single Type U-joint.
2. Remove the extension housing seal using Slide Hammer T59L-100-B and Seal Remover T74P-77248-A or equivalents (Fig. 11).
3. Install the extension housing seal using seal installer T61L-7657-A or equivalent (Fig. 12).
4. Connect the driveshaft as described in Section 15-61, Driveshaft-Single Type U-joint.

Neutral Start Switch

Transmission Out of Vehicle

Removal And Installation

1. Using the neutral start switch socket, Tool T74P-77247-A (Fig. 13) (or equivalent) remove the switch from the case.
2. Remove the O-ring seal and discard.
3. Install a new seal on the neutral start switch.
4. Install the switch in the case using the neutral start switch socket Tool T74P-77247-A (Fig. 13) (or equivalent). Tighten to 11-15 N·m (8-11 ft-lbs).

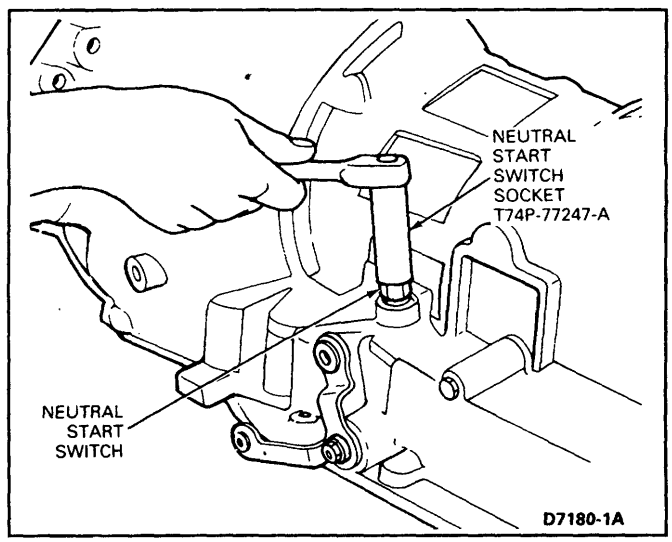


FIG. 13 Removing or Installing Neutral Start Switch

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Transmission in Vehicle

Removal

1. Raise the vehicle on a hoist or stands.
2. Disconnect the neutral start switch electrical harness from the neutral switch. Lift the harness straight up off the switch. **(No lateral movement.)**
3. Using the neutral switch socket Tool T74P-77247-A, remove the neutral start switch and O-ring seal. (Fig. 13).

Installation

1. Install a new O-ring seal on a new neutral start switch.
2. Install the new switch and seal into the case, using the neutral start switch socket Tool T74P-77247-A (Fig. 13). Tighten to 11-15 N·m (8-11 ft-lbs).
3. Connect the neutral switch harness to the new neutral start switch.
4. Lower the vehicle.

DISASSEMBLY AND ASSEMBLY

NOTE: Before beginning the transmission overhaul review the following guidelines. These general rules are provided to emphasize the need for attention to detail and care when servicing an automatic transmission.

1. It is important to completely clean all transmission components, including converter, cooler, cooler lines, main control valve body, governor, all clutches, and all check balls after any transmission servicing that generates contamination. These contaminants are a major cause for recurring transmission troubles and must be removed from the system before the transmission is put back into service.

   In addition, the cleaning of debris from the direct clutch check ball is often omitted. This omission can lead to a repeat servicing of the transmission.

Cleaning and flushing procedures for transmission components, including the direct clutch check ball, can be found in the cleaning and inspection part of Section 17-01 of this Shop Manual.

2. Thorough cleaning of the transmission exterior will reduce the possibility that damaging contaminants might enter the subassemblies during disassembly and assembly.
3. All fasteners must be tightened to the torque indicated in the specifications at the end of this Section.
4. When building-up sub-assemblies each component part should be lubricated with clean transmission fluid. It is also good practice to lubricate the sub-assemblies as they are installed in the case.
5. Needle bearings, thrust washers and seals should be lightly coated with petroleum jelly during sub-assembly build-up or transmission assembly.
6. Many components and surfaces in the transmission are precision machined. Careful handling during disassembly, cleaning, inspection and assembly can prevent unnecessary damage to machined surfaces.
7. When building-up sub-assemblies or assembling the transmission always use new gaskets and seals.
8. The transmission repair area should be kept clean, well organized and supplied with clean lint-free shop cloths.
9. Whenever a seal is removed from a piston, shaft or servo, note the type of seal and when applicable, the direction of the sealing lip.
10. Always use the specified transmission fluid when lubricating seals or other components prior to assembly (refer to Specifications for the proper fluid).

    NOTE: Do not soak oil filter in a solvent cleaner. The filter element could disintergrate. Replace the filter when necessary.

Transmission

Disassembly

Refer to Figs. 14, 15 and 16.

1. Mount the transmission in holding fixture, Tool T57L-500-B or equivalent.

   NOTE: Before removing any of the subassemblies, thoroughly clean the outside of the transmission to prevent dirt from entering the mechanical parts.

   During the repair of the subassemblies, certain general instructions which apply to all units of the transmission must be followed. These instructions are given here to avoid unecessary repetition.

   Handle all transmission parts carefully to avoid nicking or burring the bearing or mating surfaces.

   Lubricate all internal parts of the transmission with transmission fluid before assembly. **DO NOT USE ANY OTHER LUBRICANTS EXCEPT ON GASKETS AND THRUST WASHERS WHICH MAY BE COATED WITH PETROLEUM JELLY TO FACILITATE ASSEMBLY. ALWAYS INSTALL NEW GASKETS WHEN ASSEMBLING PARTS OF THE TRANSMISSIONS.**

   Tighten all bolts and screws to the recommended torque as listed on Specifications in this Section. For detail cleaning and inspection operations, refer to Section 17-01 of this manual.
2. Remove the torque converter by grasping firmly and pulling straight out of the transmission.
3. Remove the 14 oil pan attaching bolts, the oil pan and the pan gasket. Discard the gasket.
4. Remove the three fluid filter attaching bolts (Fig. 17). Remove the filter grommet and gasket. Discard the gasket.
5. Remove the shift linkage detent spring and roller assembly (Fig. 18).
6. Remove the remaining (25) valve body-to-case attaching bolts, the valve body asembly and the valve body gasket.

   NOTE: The (4) front, (1) center and (3) rear attaching bolts are shorter than the others as indicated by a circle (Fig. 91).
7. Push down on the 3-4 accumulator cover (Fig. 19) and remove the retaining ring using a thin-bladed screwdriver.
8. Remove the 3-4 accumulator cover. If the cover sticks in the bore, use Servo Piston Remover, T80L-77030-B (or equivalent) and air pressure to aid removal (Fig. 20).

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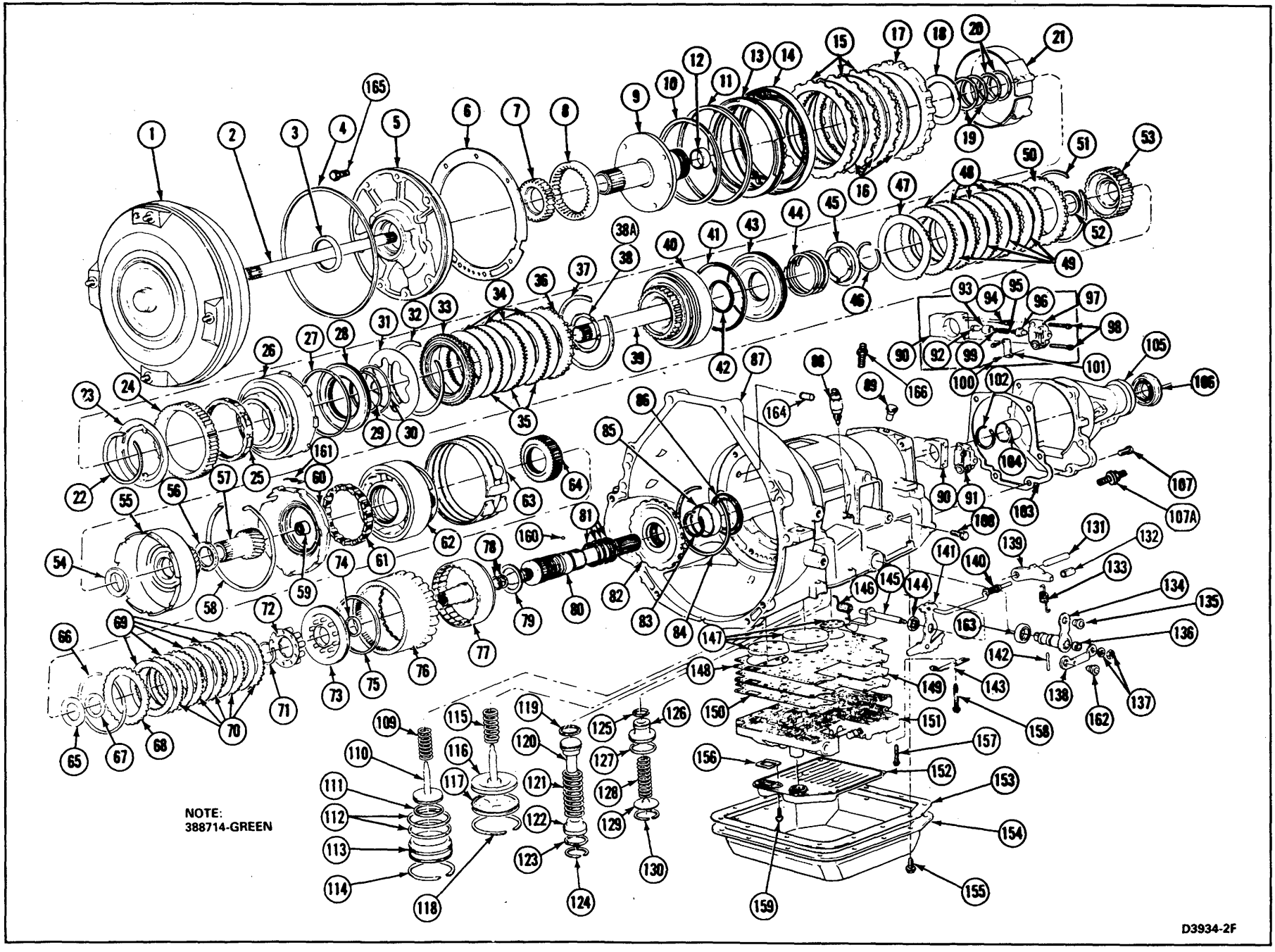


FIG. 14 Automatic Overdrive Transmission—AOD—Exploded View—4x2 Vehicles

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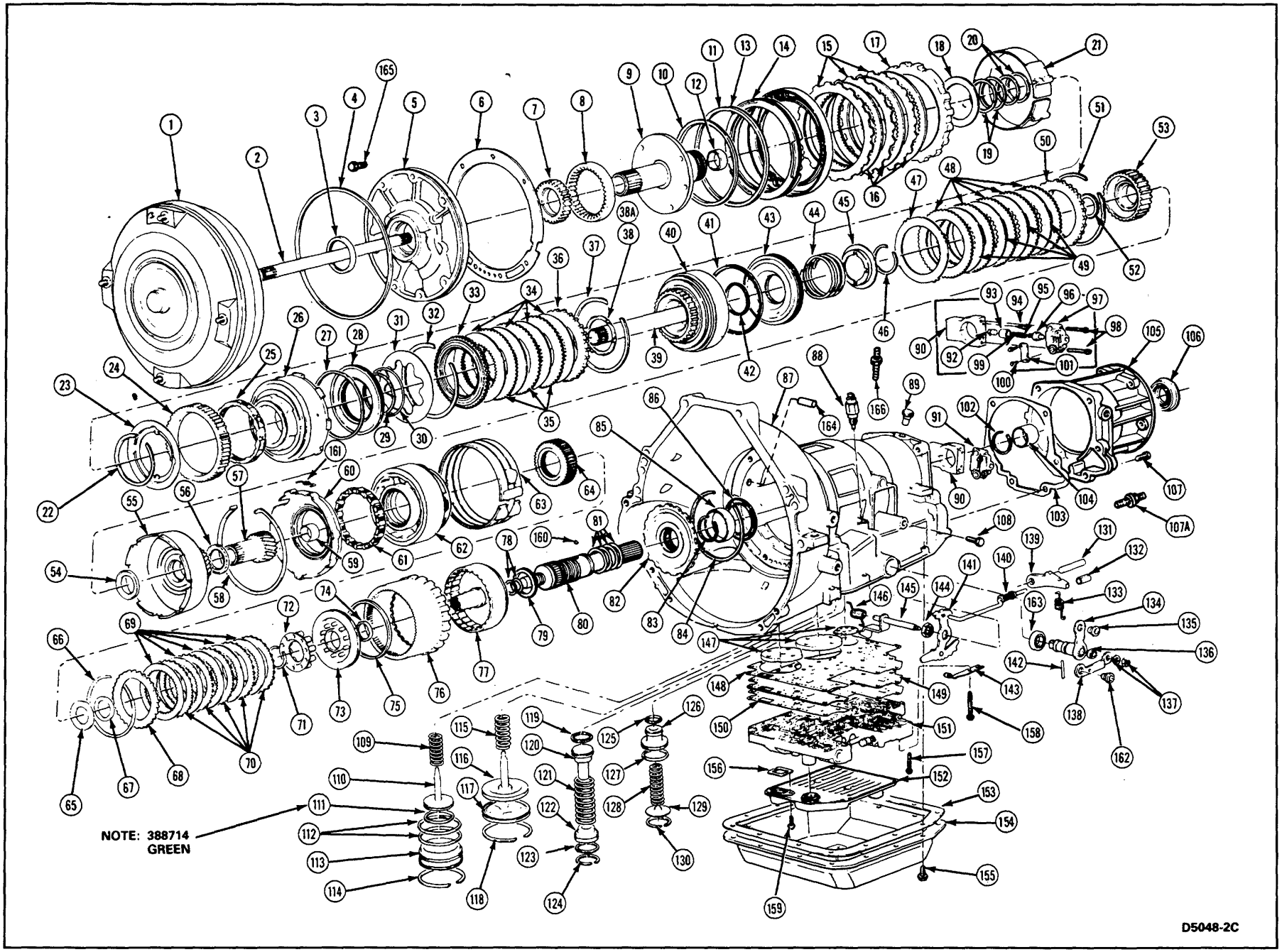


FIG. 15 Automatic Overdrive Transmission—AOD—Exploded View 4x4 Vehicles

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Chart No.	Part No.	Description	Chart No.	Part No.	Description	Chart No.	Part No.	Description	Chart No.	Part No.	Description
1	7902	Torque converter	40	7F207	Forward clutch cylinder & turbine shaft	83	97713	Retaining snap ring (O.P.S. hub to O.P.S.)	124	97626-S	Retaining snap ring (3-4 accum. to case)
2	7F208	Direct drive shaft	41	7F227	Forward clutch piston seal (outer)	84	7C122	Retaining snap ring (O.P.S. hub to ring gear)	125	7F250	2-3 accumulator valve seal (small)
3	7A248	Front pump seal	42	7F228	Forward clutch piston seal (inner)	85	7E110	Rear case bushing	126	7F251	2-3 accumulator valve
4	7D441	Front pump "O" ring	43	7L140	Forward clutch piston	86	7F242	#9 needle bearing (rear case)	127	7F249	2-3 accumulator valve seal (large)
5	7A103	Front pump body	44	7F230	Forward clutch piston return spring	87	7005	Case assy.	128	7F285	2-3 accumulator valve return spring
6	7A136	Front pump gasket	45	7F229	Return spring retainer	88	7A247	Neutral start switch	129	7F252	2-3 accumulator cover
7	7C010	Front pump drive gear	46	388099	Retaining snap ring	89	7034	Vent cap	130	388492	Retaining snap ring (2-3 accum. to case)
8	7C011	Front pump driven gear	47	7E085	Waved Spring	90	7A189	Governor couterweight	131	7D071	Park pawl shaft
9	7A108	Stator support — front pump	48	7B442	Forward clutch external spline steel plate	91	70063	Body assy. — governor	132	7D419	Guide cup
10	7F225	Interm. clutch piston inner lip seal	49	7E311	Forward & reverse clutch internal spline friction plate	92	7A303	Plug governor	133	7D070	Park pawl return spring
11	7F224	Interm. clutch piston outer lip seal	50	7F278	Forward & reverse clutch pressure plate	93	7A304	Sleeve governor	134	7F338	Manual lever
12	7B258	Front pump bushing	51	7D483	Retaining snap ring (selective)	94	7E242	Screen assy. — gov. oil	135	7341	Grommet
13	7E005	Interm. clutch piston	52	7G040	#3 needle bearing (fwd. clutch)	95	7A302	Spring gov. valve	136	7F337	Throttle lever oil seal
14	7F222	Interm. clutch piston return springs & retainer	53	7D051	Forward clutch hub	96	7C054	Valve governor	137	N62004-S51	Attaching nut & lock washer — M8 x 1.25
15	7F220	Interm. clutch external spline steel plates (sel.)	54	7F244	#4 needle bearing	97	7A300	Body governor	138	7F291	Throttle lever (outer)
16	7F219	Interm. clutch internal spline friction plates	55	7A019	Reverse sun gear & drive shell assy.	98	N800273	Bolt (governor body to counterweight)	139	7A441	Park pawl
17	7F226	Interm. clutch pressure plate	56	7F244	#5 needle bearing	99	7A305	Clip — governor spring retainer	140	7A232	Park pawl actuating rod
18	7D014	#1 thrust washer (front pump) selective	57	7A399	Foward sun gear	100	N800274	Bolt (governor cover to governor body)	141	7A115	Manual lever (inner)
19	7F275	Stator support seal rings (rev. clutch) #1 and #2	58	388501	Center support retaining ring	101	7A301	Cover — governor valve body	142	7B210	Roll pin — 1/8 x 0.95 grooved
20	7F276	Stator support seal rings (fwd. clutch) #3 and #4	59	7F209	Forward sun gear precision bushing	102	388104	Retaining snap ring (governor assy. to O.P.S.)	143	7E332	Detent spring
21	7F196	Overdrive band	60	7C363	Center support planetary	103	7086	Extension housing gasket	144	N800287-S51	Attaching nut (manual LVR) — M14 x 1.5 HEX
22	389790-S	Interm. OWC retaining snap	61	7504	Planetary OWC cage spring & roller assy.	104	7A034	Extension housing bushing	145	7F290	Throttle lever (inner)
23	7F262	Interm. OWC retaining plate	62	7A398	Planetary assy.	105	7A039	Extension housing	146	7F292	Throttle torsion spring
24	7F221	Interm. OWC outer race	63	7D095	Reverse band	106	7052	Extension housing seal	147	7F282	Valve body reinforcement plate
25	7F271	Interm. one-way clutch assy.	64	7F236	Direct clutch hub	107	N803747-S100	Bolt (ext. hsg. to case) M6-12.5 x 30 (6 req'd)	148	7C155	Separator plate gasket (upper)
26	7F215	Reverse clutch drum	65	7F243	#7 needle bearing (direct clutch inner)	107A	N803352-S100	Stud (ext. hsg. to case) M8-1.25 x 54 (2 req'd holes 1 and 6)②	149	7A008	Separator plate
27	7D403	Reverse clutch piston seal (outer)	66	388065-6-7-8	Retaining snap ring (selective)	108	376649	Pipe plug — 1/8-27 dry seal	150	7D100	Separator plate gasket (lower)
28	7E079	Reverse clutch piston	67	7F237	Thrust spacer	109	7F201	Overdrive servo piston return spring	151	7A100	Valve body (main control)
29	7D404	Reverse clutch piston seal (inner)	68	7B477	Direct clutch pressure plate	110	7F200	Overdrive servo piston	152	7F003	Filter & Grommet assy. — Oil pan
30	7D256	Thrust ring	69	7E313	Direct clutch internal spline plates	111	See Note	Overdrive servo piston seal	153	7A191	Oil pan gasket
31	7D405	Reverse clutch piston return spring	70	7F238	Direct clutch external spline plates	112	388515-S100	Overdrive servo cover seal rings	154	7A264	Oil pan
32	7D406	Retaining snap ring	71	388104	Retaining snap ring	113	7F204	Overdrive servo cover	155	390233-S2	Bolt (oil pan to case) — M8 x 1.25 x 15 (17 req'd)
33	7B066	Reverse clutch front pressure plate	72	7F235	Return spring & retainer	114	388216	Retaining snap ring (O/D servo to case)	156	7E062	Oil filter gasket
34	7E311	Reverse clutch internal spline friction plate	73	7F254	Direct clutch piston	115	7D031	Reverse servo piston return spring	157	N605775-S	Bolt (valve body to case) — M6-1.0 x 30 (8 req'd)
35	7B442	Reverse clutch external spline steel plate	74	7F234	Direct clutch piston seal (inner)	116	7D030	Reverse servo piston (selective)	158	N606022-S	Bolt (valve body to case) — M6-1.0 x 40 (17 req'd)
36	7F278	Forward and Reverse clutch pressure plate	75	7C000	Direct clutch piston seal (outer)	117	7D281	Reverse servo cover	159	N605772-S	Bolt (screen to valve body) — M6-1.0 x 16 (3 req'd)
37	7D483	Reverse clutch retaining ring (sel.)	76	7A153	Ring gear & park gear	118	388215	Retaining snap ring (rev. servo to case)	160	353351-S	Ball (governor drive)
38	7D076	#2 thrust washer (rev. clutch)①	77	7F283	Direct cylinder	119	7F248	3-4 accumulator valve seal	161	7F277	Spring (anti clunk)
38A	7A166	#2 Needle Bearing (rev. clutch)①	78	7F284	Output shaft small (2) Teflon seal rings (direct clutch) #5 and #6	120	7F287	3-4 accumulator valve	162	7F434	Grommet
39	7F212	Turbine shaft	79	7F240	#8 needle bearing (direct clutch outer)	121	7F288	3-4 accumulator valve return spring	163	7B498	Oil seal assy. Manual lever
			80	7060	Output shaft	122	7F247	3-4 accumulator cover	164	—	Overdrive anchor-pin — not serviced
			81	7F273	Output shaft large (4) steel seal rings #7, #8, #9, #10	123	7F294	3-4 accumulator cover seal	165	N605789-S100	Bolts (front pump to case — 7 req'd)
			82	7D164	Output shaft hub				166	N804799-S100	Connector assy. (cooler line) 5/16 tube x 1/4 external pipe

①Some Applications
②Sealant Coated

CD3935-2F

FIG. 16 Automatic Overdrive Transmission—Nomenclature

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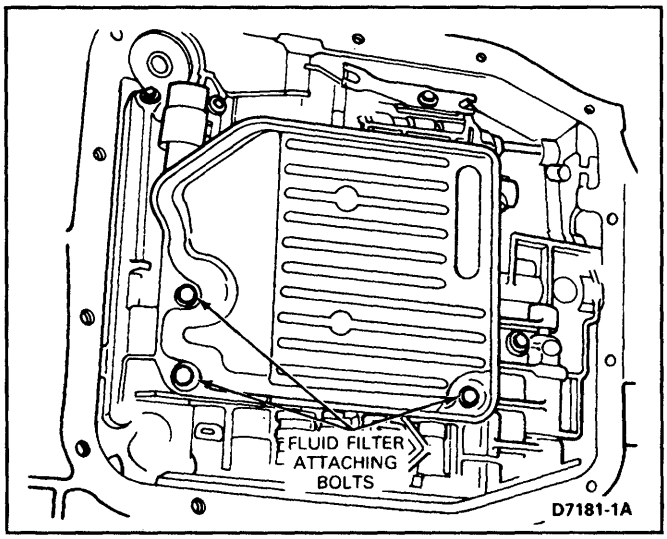


FIG. 17 Fluid Filter

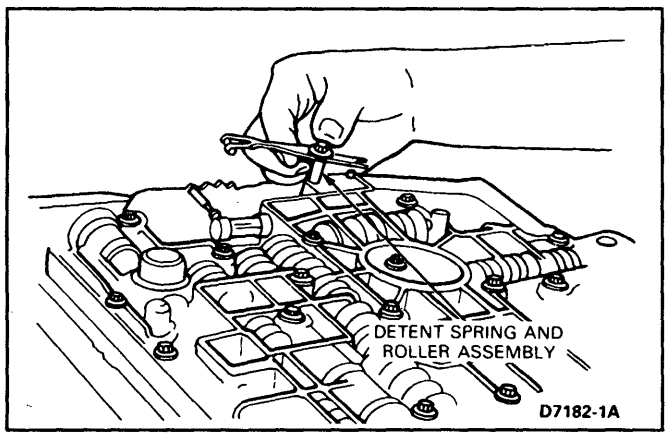


FIG. 18 Removing Shift Spring and Roller Assembly

CAUTION: Make certain a portion of Servo Piston Remover T80L-77030-B (or equivalent) extends over the bore to prevent the cover from flying out of the bore.

9. Remove the 3-4 accumulator piston.

   The piston uses a scarf-cut teflon seal and comes out with very little resistance.

   NOTE: Some models may use a spring. The piston and spring may be different from that shown.

10. Using a wide-bladed screwdriver or wooden dowel, push down on the 2-3 accumulator cover and remove the retaining ring (Fig. 19).

11. Remove the 2-3 accumulator cover and the piston spring.

12. Remove the 2-3 accumulator piston. The piston uses two scarf-cut teflon seals and comes out with very little resistance.

13. Using a hammer handle or wooden dowel, push down on the low-reverse servo cover and remove the snap ring (Fig. 19).

14. Remove the low-reverse servo cover, servo piston and the piston return spring. If necessary, a magnet can be used to lift the piston from the bore.

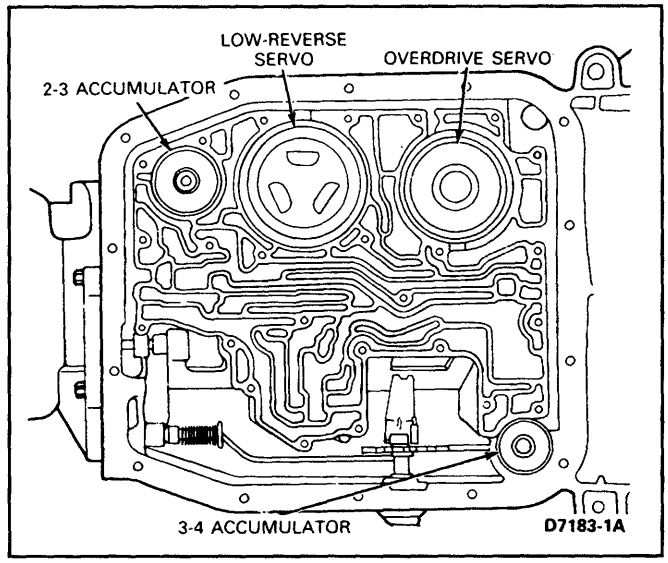


FIG. 19 Accumulator and Servo Locations

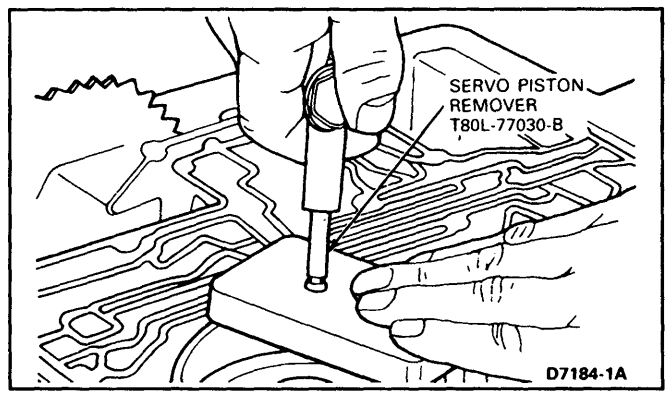


FIG. 20 Removing 3-4 Accumulator Cover

15. Using a hammer handle or wooden dowel, push down on the over-drive servo cover and remove the snap ring (Fig. 19).

16. Remove the overdrive servo cover and piston as a unit. If the cover sticks in the bore, use Servo Piston Remover T80L-77030-B (or equivalent) and air pressure to aid removal (Fig. 20). Remove spring.

    CAUTION: Make certain a portion of Servo Piston Remover T80L-77030-B (or equivalent) extends over the bore to prevent the cover from flying out of the bore.

17. Remove the direct drive shaft (Fig. 21).

18. Remove the (7) pump body attaching bolts.

19. Remove the pump assembly using Slide Hammers T59L-100-B and oil pump remover Adapters T80L-77103-A as shown in Fig. 22.

20. Remove the pump-to-case gasket.

21. Grasp the turbine shaft firmly and pull these components (Refer to Fig. 14) out of the case as an assembly:

    a. Intermediate clutch pack

    b. Intermediate one-way clutch

    c. Reverse clutch

    d. Forward clutch

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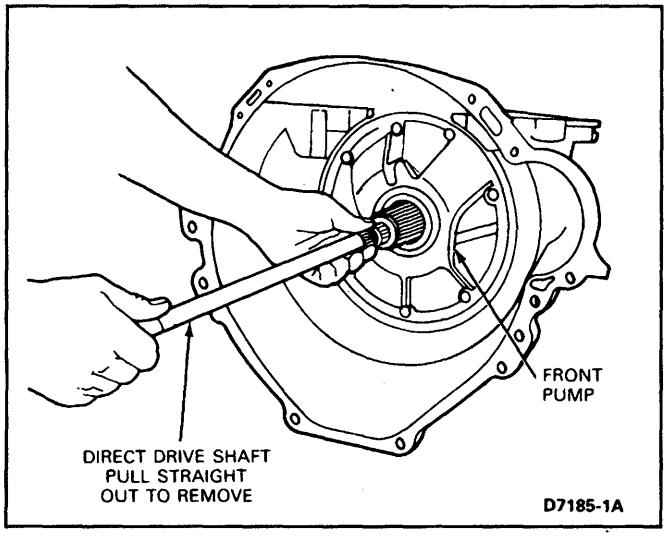


FIG. 21 Removing or Installing Direct Drive Shaft

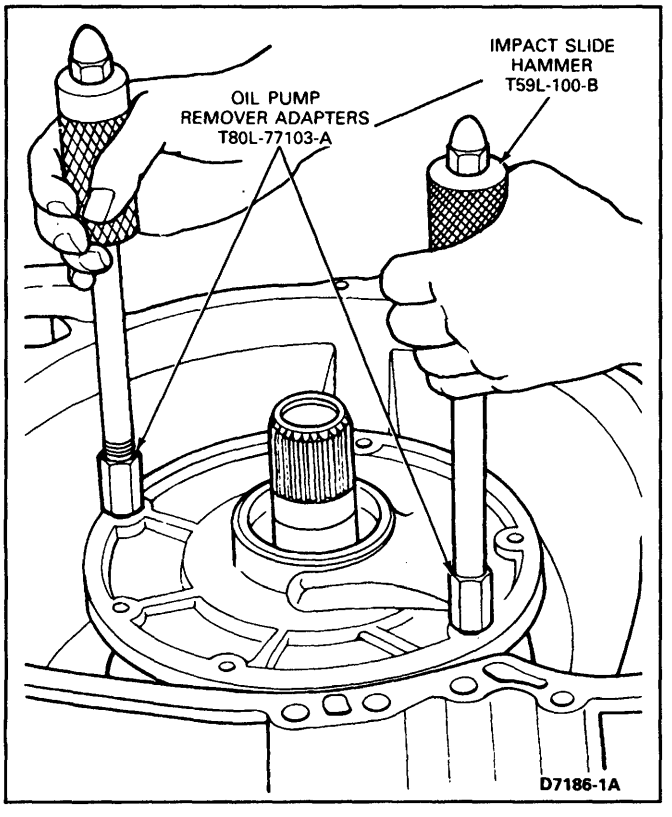


FIG. 22 Removing Front Oil Pump

Use care not to damage the overdrive band friction liner material with the Reverse clutch drive lugs.

22. Disengage the overdrive band from the anchor pins and remove from the case (Fig. 23).
23. Remove the forward clutch hub and the No. 3 needle bearing as an assembly.
24. Remove the forward sun gear, the No. 5 needle bearing, the reverse sun gear and drive shell and the No. 4 needle bearing as an assembly.
25. Remove the center support snap ring.

Note position of tabs for assembly.

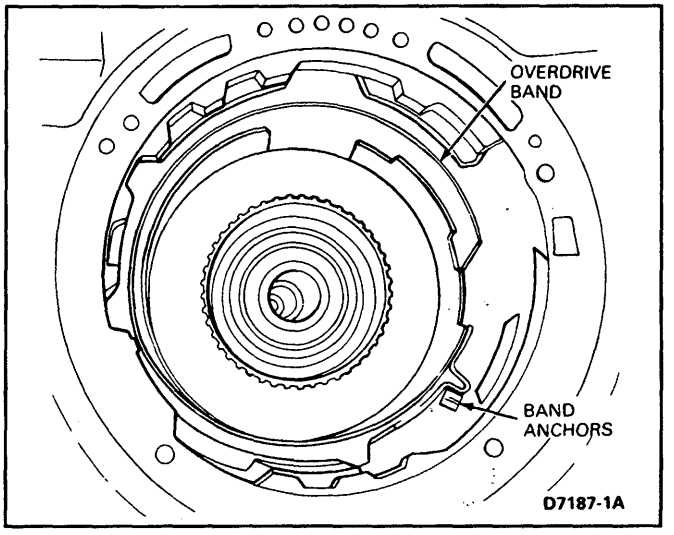


FIG. 23 Removing Overdrive Band

26. Using a screwdriver, pry the anticlunk spring out from between the center support and the case.

Note the location for assembly.

27. Remove the center support and planetary carrier as an assembly.
28. Remove the reverse band.
29. If the direct clutch hub did not come out with the planetary carrier, reach in and lift it out of the direct clutch.
30. Remove the (6) extension housing attaching bolts and the extension housing. Remove and discard the extension housing gasket.

NOTE: The extension housing bolts have been coated with a sealant. More break torque may be required to remove these bolts.

31. Remove the retaining ring and governor assembly (Fig. 24).

NOTE: If the transmission is positioned with the output shaft pointing up, do not allow the shaft assembly to fall through the case when the governor is removed.

32. Remove the governor drive ball from the output shaft. A magnet may be used to aid removal.
33. Remove the output shaft, the ring gear and the direct clutch as an assembly, through the front of the case (Fig. 25).
34. Remove the output shaft No. 9 needle bearing from the rear of the case.
35. Remove the intermediate one-way clutch.
36. Remove the reverse clutch assembly from the forward clutch assembly.

Sub-Assemblies

Governor

Refer to Fig. 26.

Disassembly

1. Remove the screws attaching the counterweight to the governor body.
2. Remove the cover screws and cover.

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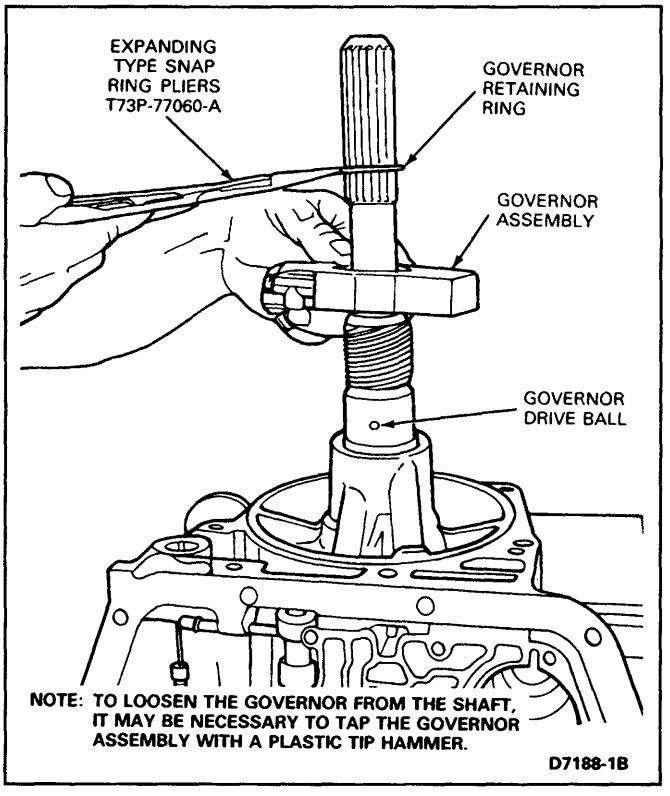


FIG. 24 Removing Governor

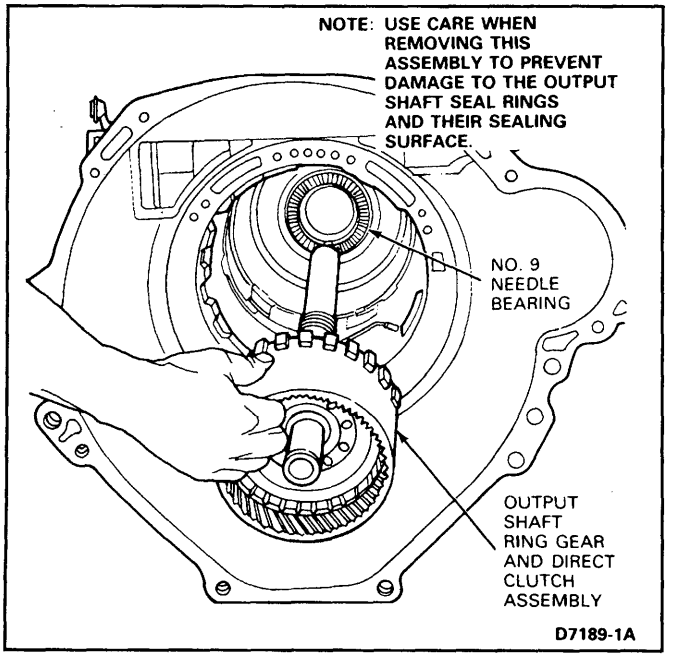


FIG. 25 Remove Output Shaft, Ring Gear and Direct Clutch Assembly

3. Remove the plug, the sleeve, and the valve from the governor body.

Assembly

1. If removed, reinstall the clip and spring on the valve.
2. Install the valve in the governor body.
3. Install the sleeve in the governor body with the points outward.

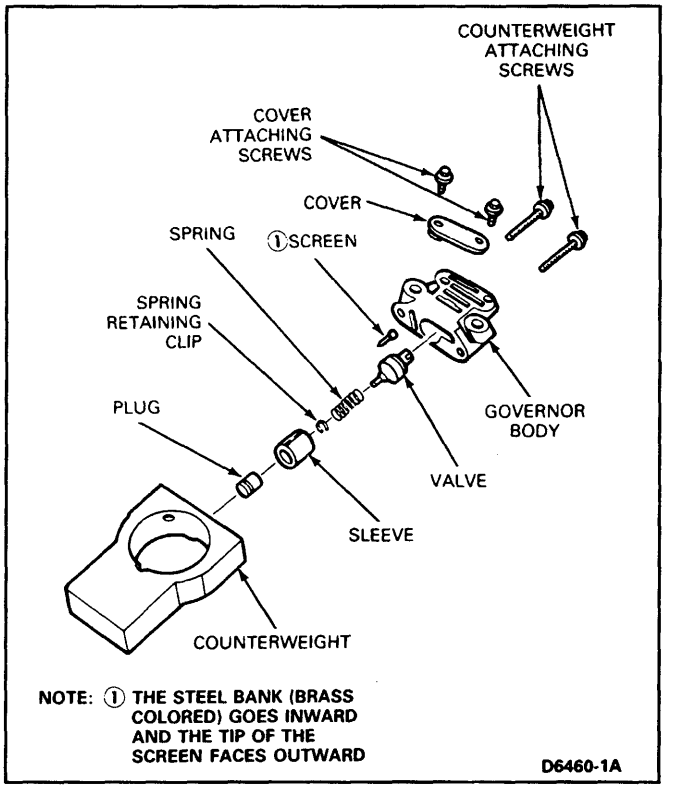


FIG. 26 Governor—Exploded View

4. Install the plug in the sleeve with the knurled face inward.
5. Attach the cover. Tighten the screws to 2.3-3.4 N·m (20-30 in-lbs).
6. Position the governor body to the counterweight and install the screws. Tighten the screws to 6-7 N·m (50-60 in-lbs). The finished face of the body should be flush with the face of the counterweight. (If it is not, the body is installed backwards).

Parking Pawl

Refer to Fig. 27.

Dissassembly

1. Slide the park pawl shaft out the rear of the case and remove the parking pawl.
2. Remove the return spring.

Assembly

1. Hook the squared end of the spring into the notch on the park pawl.
2. Hold pawl and spring in place and hook curved end of spring into the recess in the case.
3. Install the park pawl shaft.

Intermediate One-Way Clutch

Refer to Fig. 28.

Disassembly

1. Using snap ring pliers, remove the clutch retaining ring.
2. Remove the clutch retaining plate.
3. Remove the clutch outer race by lifting on the race while turning counterclockwise.

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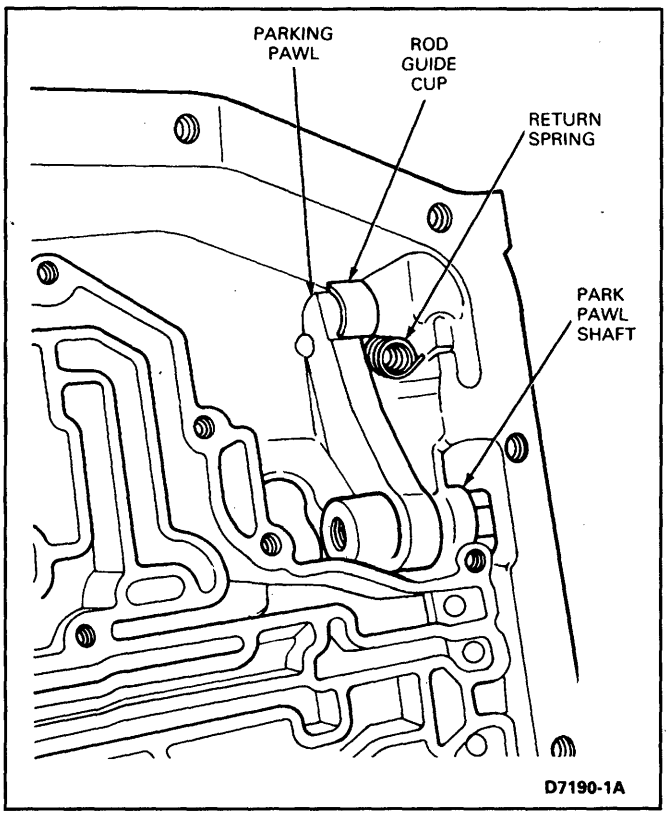


FIG. 27 Parking Pawl

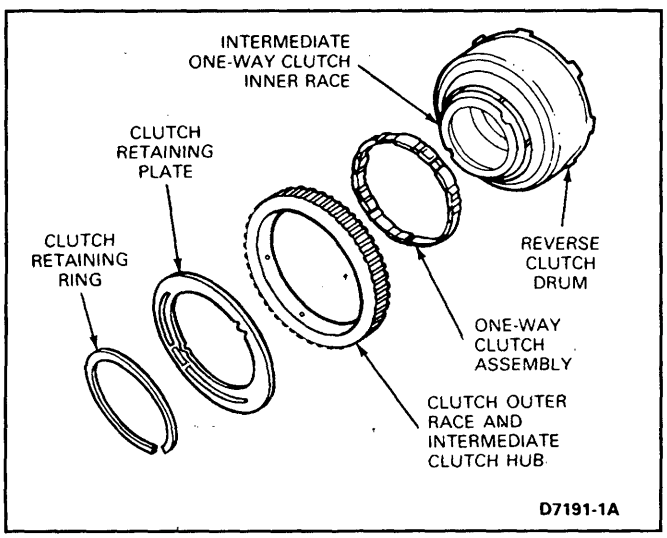


FIG. 28 Intermediate One-Way Clutch-Exploded View

4. Carefully lift the one-way clutch from the inner race.

Assembly

To assemble the intermediate one-way clutch, reverse the disassembly procedure.

Output Shaft

Refer to Fig. 29.

Disassembly

1. Remove the ring retaining the output shaft hub to the ring gear.

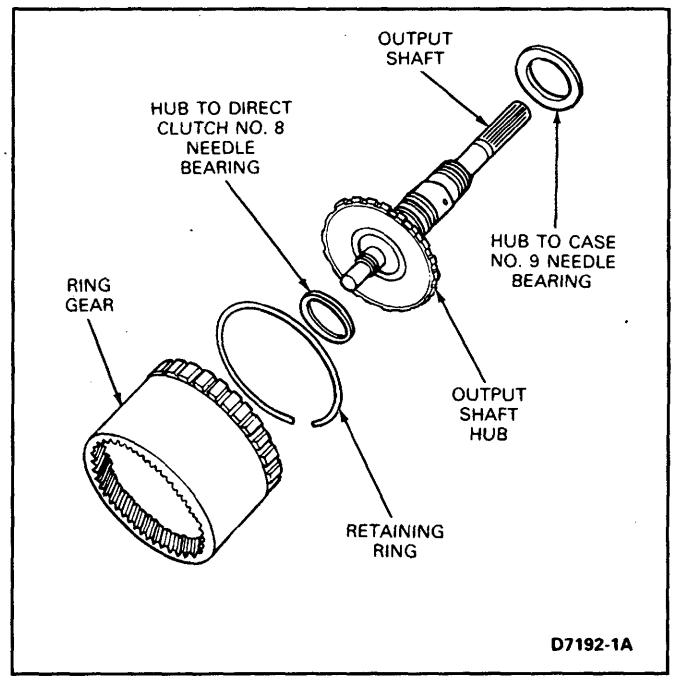


FIG. 29 Output Shaft—Exploded View

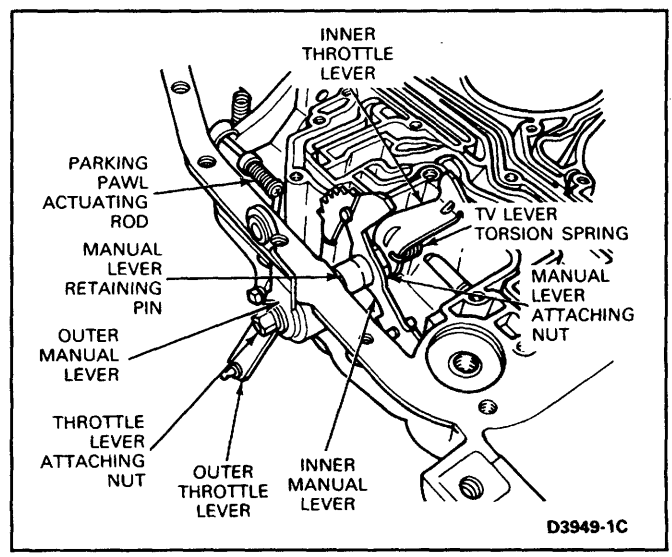


FIG. 30 Manual and Throttle Linkage

2. Separate the output shaft and hub assembly from the ring gear.
3. Remove the direct clutch from the ring gear and the No. 8 needle bearing from the back of the direct clutch.
4. Remove the four output shaft seal rings and the hub-to-output shaft retaining ring. Separate the hub from the output shaft.
5. Remove the two direct clutch seal rings from the outut shaft.

Assembly

To assemble the output shaft, reverse the disassembly procedure.

Manual and Throttle Linkage

Refer to Fig. 30.

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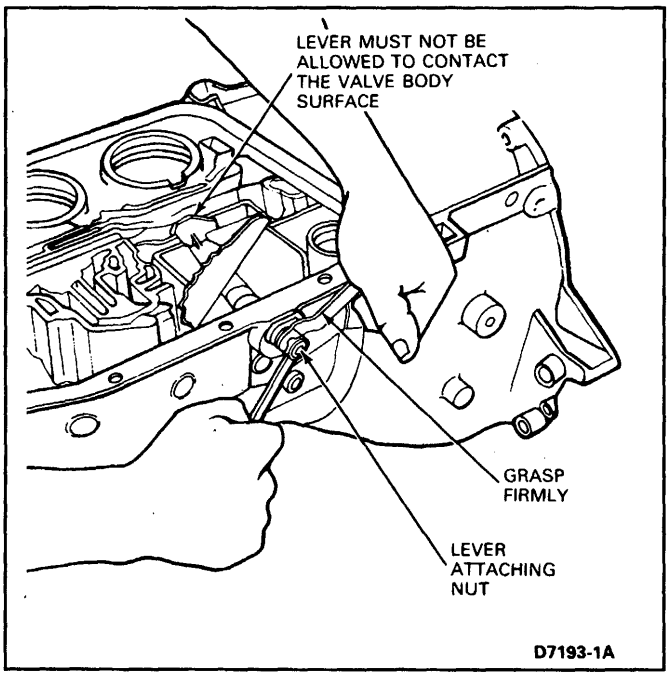


FIG. 31 Removing Outer Throttle Lever

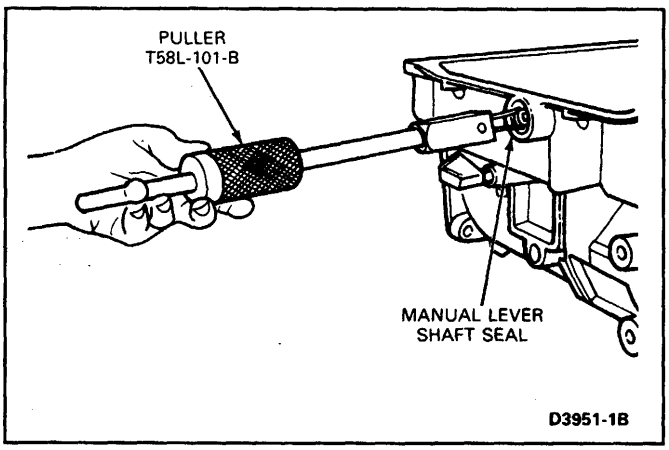


FIG. 32 Removing Manual Lever Shaft Seal

Disassembly

1. Grasp the outer throttle lever firmly and loosen the lever attaching nut (13mm). Remove the attaching nut, the lockwasher, and throttle lever.

   NOTE: The outer throttle lever must be held in the position shown in Fig. 31 to prevent the inner throttle lever from rotating against the machined valve body surface. Failure to observe this precaution could result in damage to the valve body surface.

2. Using a small screw driver or awl, remove the seal from the outer manual lever counterbore.

   Discard seal.

3. Using a pair of diagonal cutters, remove the manual shaft retaining pin from the case.

4. Grip the inner manual lever with an adjustable wrench and loosen the lever attaching nut (20mm). Thread the nut off the shaft and remove the lever.

5. Remove the inner throttle lever and torsion spring.

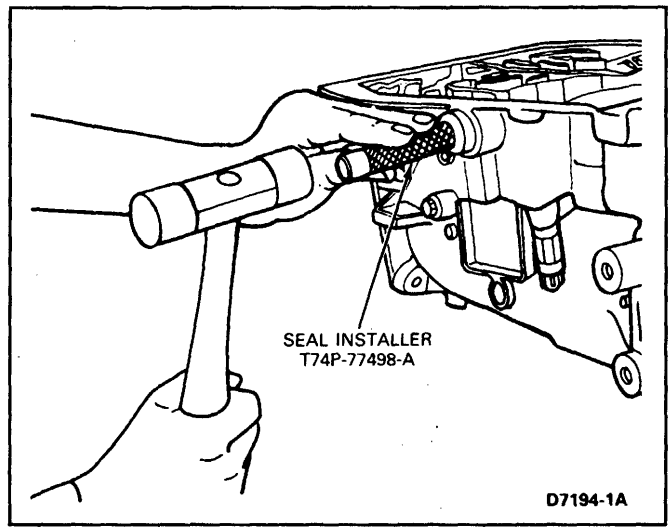


FIG. 33 Installing Manual Lever Seal

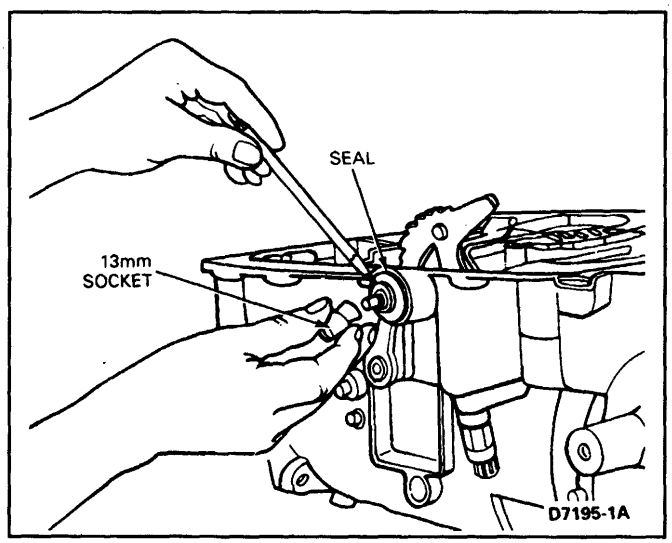


FIG. 34 Installing Outer Throttle Lever Seal

6. Remove the inner manual lever and parking pawl actuating rod as an assembly. After removal, the rod may be disengaged from the lever.

7. Remove the manual lever shaft seal from the case using seal remover Tool T58L-101-B (or equivalent) as shown in Fig. 32.

   Discard seal.

Assembly

To assemble the manual and throttle linkages, reverse the disassembly except for the following:

1. Install a new manual lever seal using Seal Installer T74P-77498-A or equivalent tool as shown in Fig. 33.

2. Before installing the outer throttle lever, install a new seal in the outer manual lever (Fig. 34). A 13mm thin wall socket may be useful, using the end that the ratchet drive would be inserted into, to seat the seal.

   NOTE: The seal identification number must face outward.

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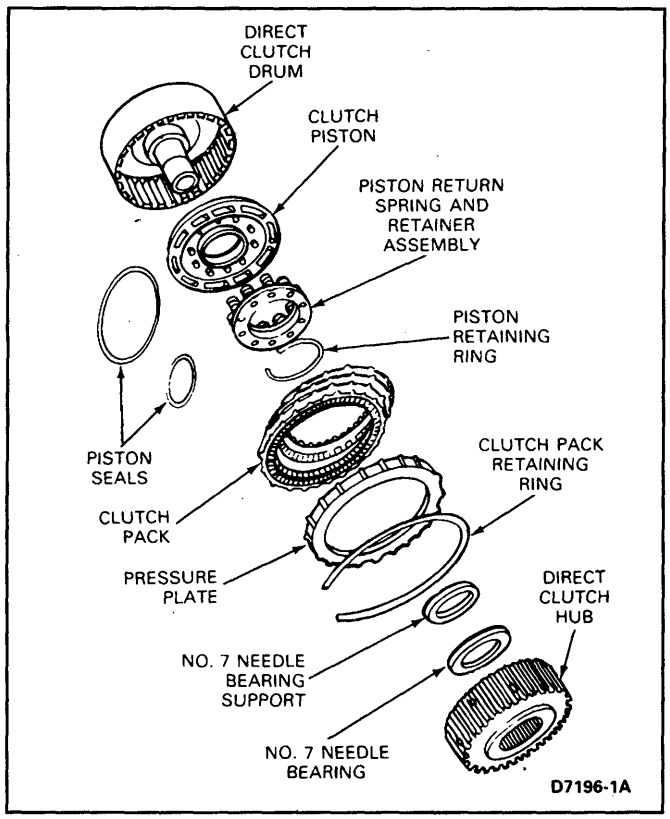


FIG. 35 Direct Clutch—Exploded View

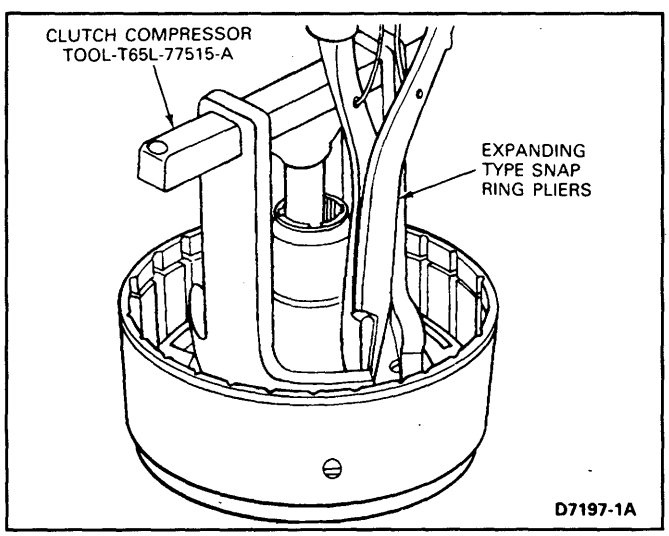


FIG. 36 Removing Direct Clutch Retaining Ring

Direct Clutch

Refer to Fig. 35.

Disassembly

1. Remove the No. 7 direct clutch hub inner needle bearing and bearing support.
2. Remove the clutch pack selective retaining ring.
3. Remove the clutch pack from the drum.
4. Using Clutch Spring Compressor Tool T65L-77515-A (or equivalent), compress the piston return springs and remove the retaining ring (Fig. 36).

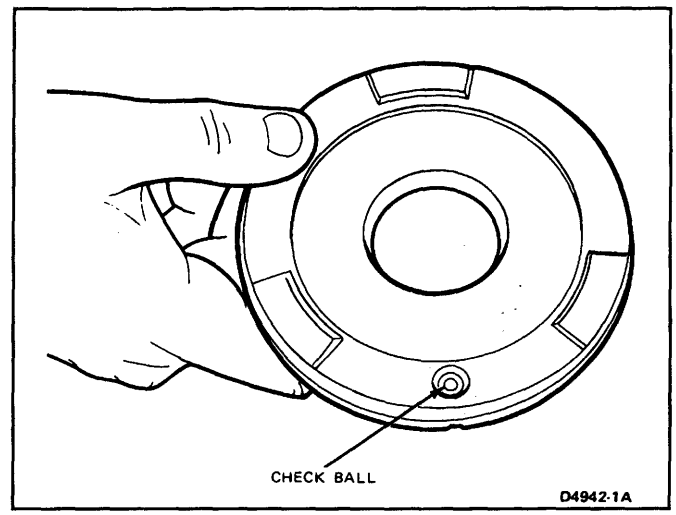


FIG. 37 Direct Clutch Piston

5. Remove the spring retainer assembly and piston from the drum. (Use air pressure, if necessary to remove piston.) Make sure the ball check in piston is free. Note the position and direction of the lip seals and then remove them.
6. Inspect the direct clutch piston check ball (Fig. 37). Perform the direct clutch piston check ball leakage procedure as described in Section 17-01, Automatic Transmission General Service.

Assembly

1. Install a new inner piston seal on the clutch drum hub as follows:
   a. Position Seal Protector T80L-77234-A or equivalent over the clutch drum hub (View A, Fig. 38).
   b. Lubricate the seal and the seal protector with petroleum jelly.
   c. Position the seal over the installer tool with the sealing lip facing down (View B, Fig. 38).
   d. Push the seal down until it snaps off the end of the protector onto the clutch hub.
   e. Remove the seal protector from the clutch hub.
   f. Slide the seal up until it seats in the seal groove.
2. Install a new outer clutch piston seal. Note the direction of the sealing lip before installation. The lip points away from the spring posts.
3. Install the clutch apply piston as follows:
   a. Coat the piston seals, the clutch drum sealing area, and the piston inner seal area with petroleum jelly.
   b. Install the piston in Seal Protector T80L-77254-A (or equivalent) as shown in Fig. 39.
   c. Position the tool in the clutch drum and push the piston to the bottom of the drum using even thumb pressure.
4. Install the piston spring and retainer assembly and retaining ring using compressor Tool T65L-77515-A or equivalent.
5. Install the clutch pack.

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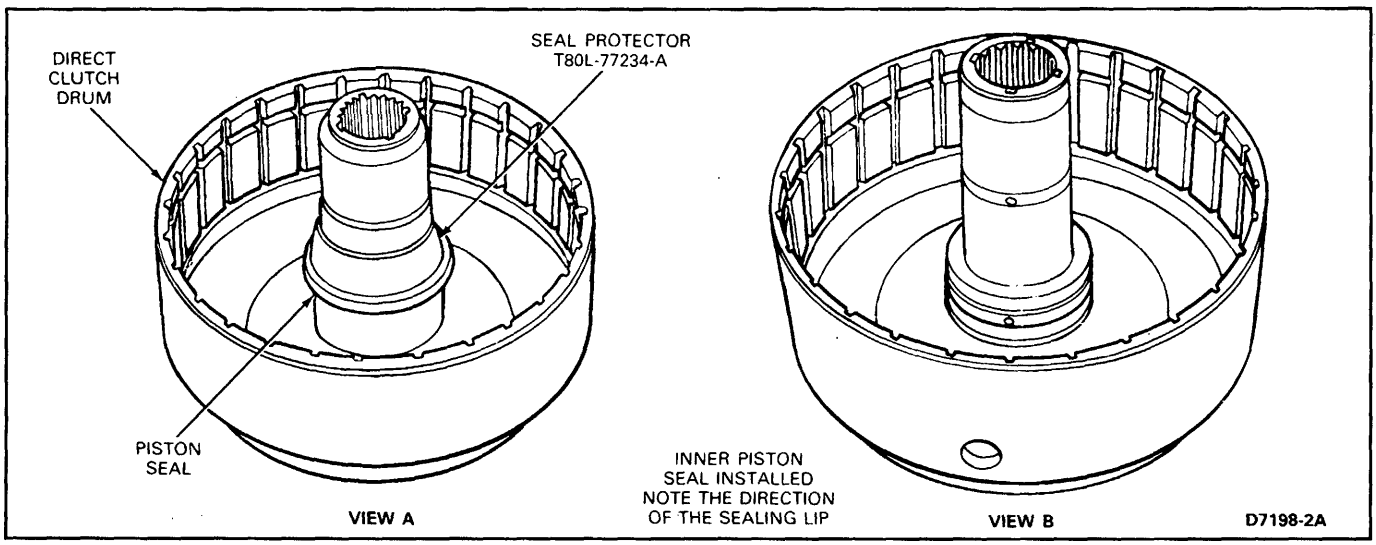


FIG. 38 Inner Piston Seal Installation

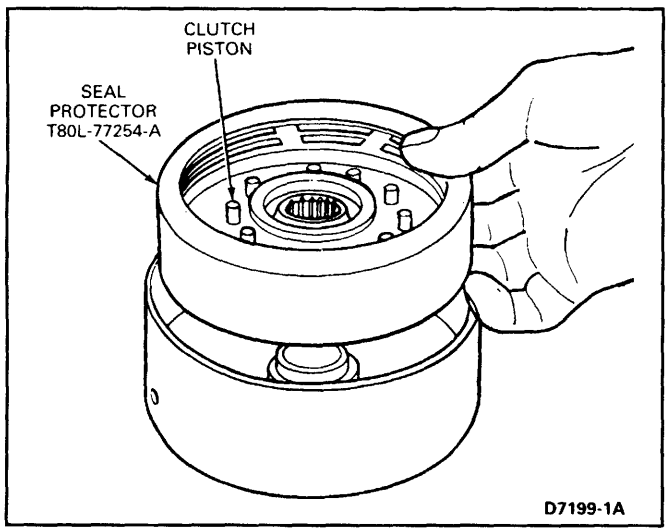


FIG. 39 Clutch Piston Assembly

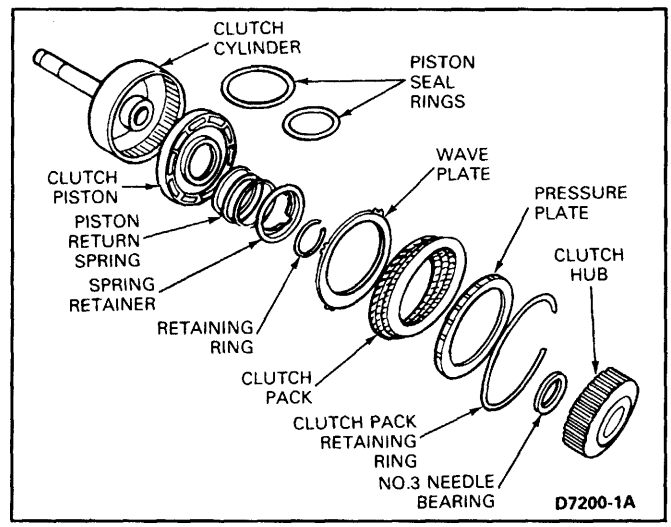


FIG. 40 Forward Clutch—Exploded View

6. Install the clutch pack selective retaining ring and check the clearance between the ring and the pressure plate. The pressure plate should be held downward as the clearance is checked. The clearance should be: 4.9L (300 CID) EFI Engine, and the 5.0L (302 CID) EFI Engine 1.27-1.77mm (0.050-0.067 inch). If the clearance is not within limits, selective snap rings are available in the following thicknesses: 0.050 to 0.054, 0.064 to 0.068, 0.078 to 0.082 and 0.092 to 0.096 inch. Install the correct size snap ring and recheck the clearance.
7. Check the clutch for proper operation using air pressure. The clutch should be heard and felt to apply smoothly and without leakage.

Forward Clutch

Refer to Fig. 40.

Disassembly

1. Remove the clutch hub and No. 3 needle bearing, if not already removed.
2. Remove the clutch pack selective retaining ring.

NOTE: To aid handling, the clutch may set in the extension housing or a 2 inch diameter hole may be cut in the work bench.

3. Remove the clutch pack.
4. Compress the piston return spring using Tool T65L-77515-A and forward clutch adapter Tool T80L-77515-A (or equivalent) (Fig. 41). Remove the retaining ring and spring retainer.
5. Remove the clutch piston.
6. Make sure that the two ball checks in forward clutch cylinder are free.
7. Note the position of the inner and outer piston seals, then remove them.

Assembly

1. Install new seals on the clutch piston. Note the direction of the sealing lip before installation (Fig. 42).
2. Install the clutch piston as follows:
   a. Coat the piston seals and the clutch drum sealing area with petroleum jelly.

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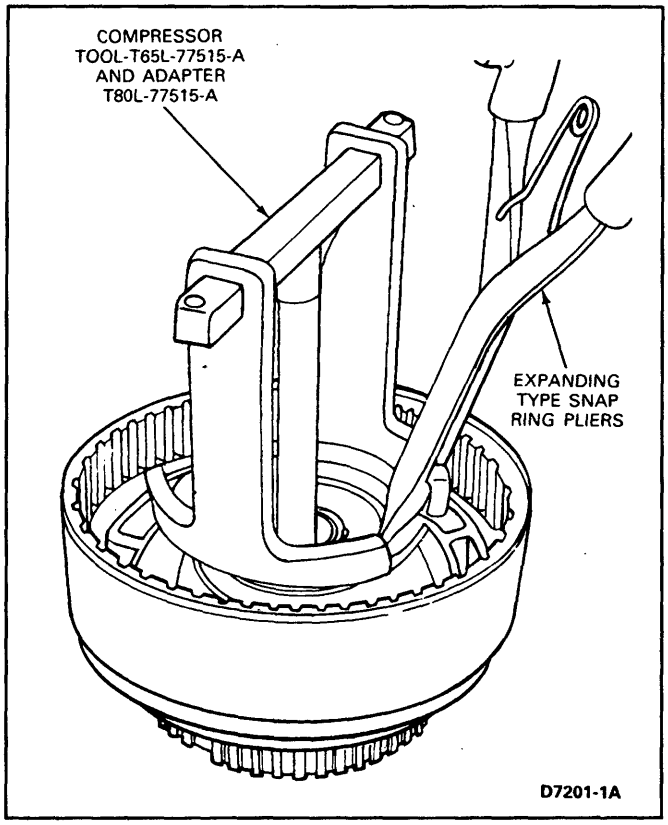


FIG. 41 Removing Forward Clutch Retainer Ring and Spring Retainer

b. Install the inner seal protector, Tool T80L-77140-A or equivalent, over the clutch cylinder hub (Fig. 43).

c. Install the piston in the outer seal protector, Tool T68P-7D158-A or equivalent (Fig. 43).

d. Position the seal protector and piston in the clutch drum. Push the piston to the bottom of the drum using even thumb pressure.

3. Install the piston return spring, the spring retainer and the retaining ring. Compress the piston return spring using compressor Tool T65L-77515-A and forward clutch adapter Tool T80L-77515-A (or equivalent) as shown in Fig. 41.

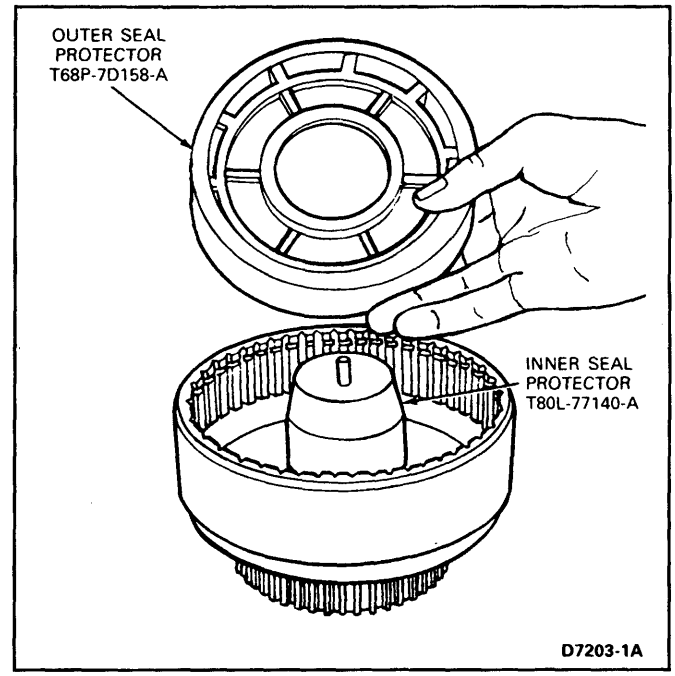


FIG. 43 Clutch Piston Assembly

4. Install the clutch pack. The wave plate must be installed first.

5. Install the clutch pack retaining ring and check the clearance between the ring and the pressure plate. The pressure plate should be held downward as the clearance is checked.

   The clearance should be:

   4.9L (300 CID) EFI and

   5.0L (302 CID) EFI 1.27mm-2.26mm (0.050-0.089 inch)

   If the clearance is not within specifications, selective snap rings are available in the following thicknesses: 0.060 to 0.064, 0.074 to 0.078, 0.088 to 0.092 and 0.102 to 0.106 inch. Install the correct size snap ring and recheck the clearance.

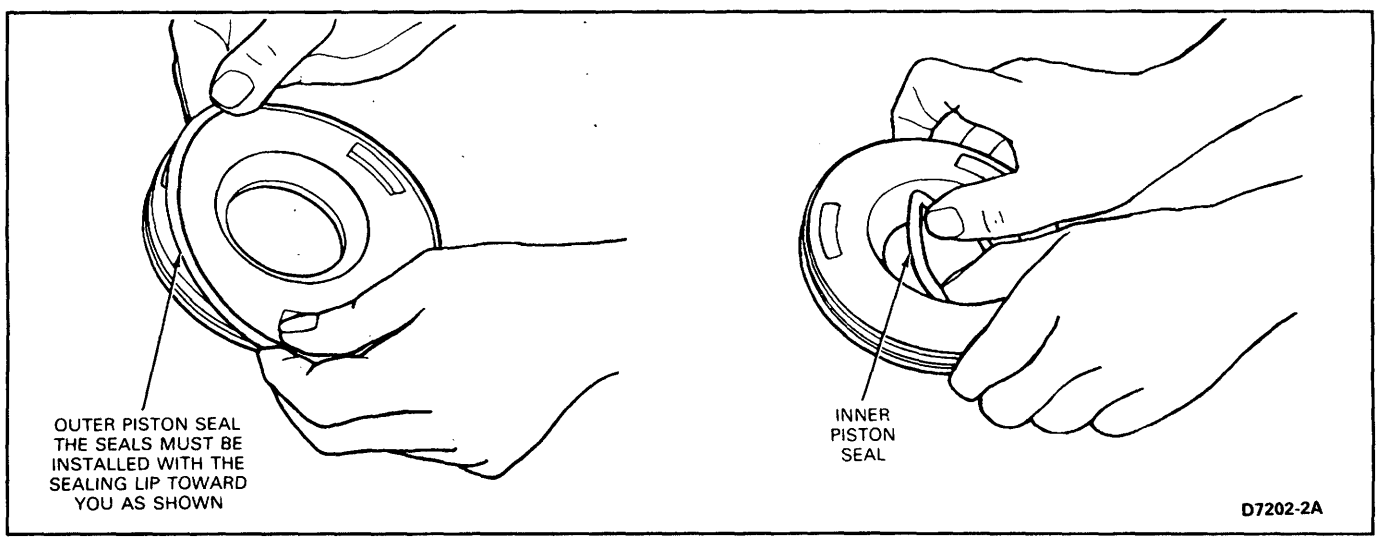


FIG. 42 Clutch Piston Seal Installation

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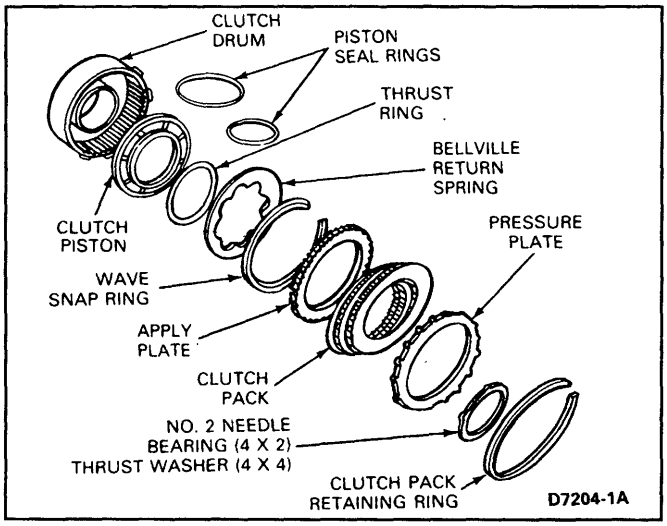


FIG. 44 Reverse Clutch—Exploded View

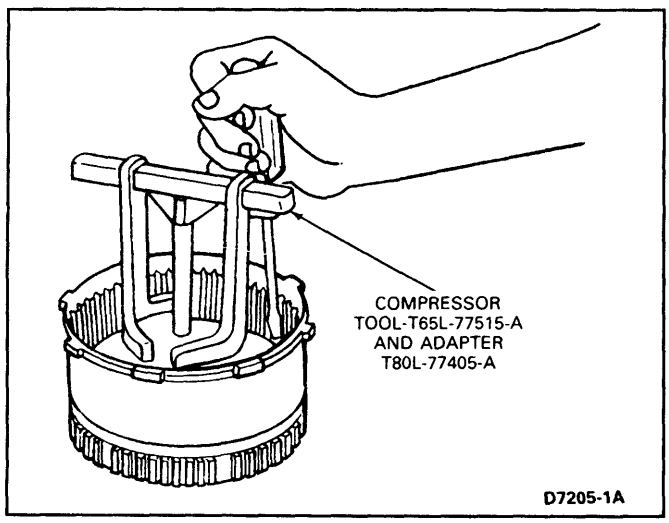


FIG. 45 Removing or Installing Wave Snap Ring

6. Check the clutch for proper operation using air pressure. The clutch should be heard and felt to apply smoothly and without leakage.

Reverse Clutch

Refer to Fig. 44.

Disassembly

1. Remove No. 2 needle bearing (4x2) or No. 2 thrust washer (4x4).

   NOTE: 4x2 applications use a needle bearing. 4x4 applications use a thrust washer.

2. Remove the clutch pack retaining ring.
3. Remove the clutch pack.
4. Remove the wave snap ring using compressor Tool T65L-77515-A and adaptor Tool T80L-77405-A or equivalent (Fig. 45).
5. Remove the piston return spring and the thrust ring.
6. Remove the clutch piston.

   NOTE: To aid removal, apply air pressure to the drum. Block the opposite hole a with finger.

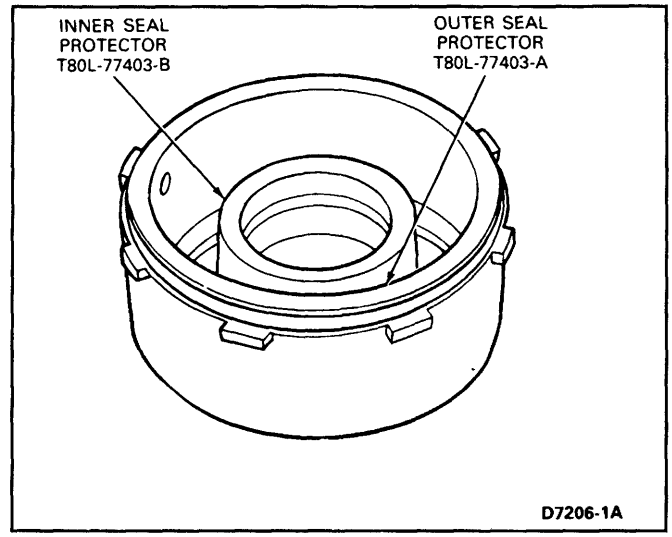


FIG. 46 Installing Clutch Piston

Assembly

1. Install new seals on the clutch piston. Because the seal is square cut, the direction of installation is not important.

   Be sure ball check in piston is free.

2. Install the clutch piston as follows:
   a. Coat the piston seals and clutch drum sealing area with petroleum jelly.
   b. Install inner seal protector, Tool T80L-77403-B and outer Seal Protector T80L-77403-A (or equivalent) in the clutch drum (Fig. 46).
   c. Coat the seal protector tools with petroleum jelly.
   d. Position the piston and push it to the bottom of the drum using even thumb pressure.
   e. Remove the seal protector tools.
3. Install the piston thrust ring and the piston return spring.
4. Install the wave snap ring (with points down) using compressor Tool T65L-77515-A and adaptor Tool T80L-77405-A (or equivalent) (Fig. 41).
5. Install the clutch pack. The apply plate must be installed first. Note that the dished side of the plate must face the piston.
6. Install the clutch pack retaining ring and check the clearance between the ring and the pressure plate. The pressure plate should be held downward as the clearance is checked.

   The clearance should be:

   4.9L (300 CID) EFI and

   5.0L (302 CID) EFI 1.02mm-1.91mm (0.040-0.075 in.)

   If the clearance is not within specifications, selective snap rings are available in the following thicknesses: 0.060 to 0.064, 0.074 to 0.078, 0.088 to 0.092 and 0.102 to 0.106 inch. Insert the correct size snap ring and recheck the clearance.

7. Check the clutch for proper operation using air pressure. The clutch should be heard and felt to apply smoothly and without leakage.

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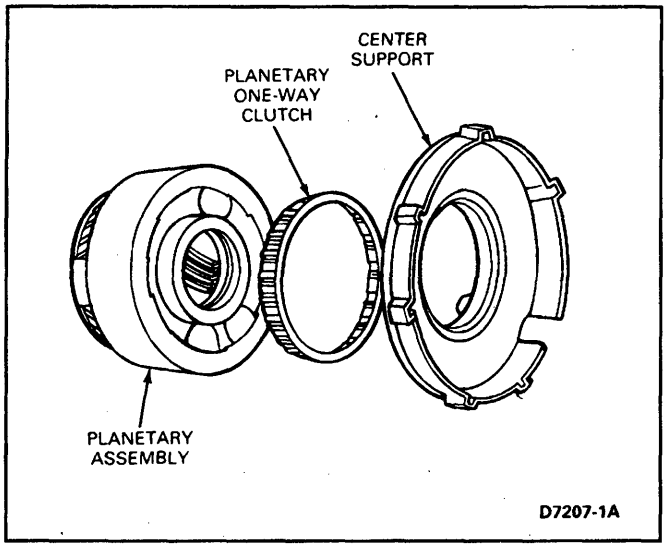


FIG. 47 Center Support and Planetary One-Way Clutch—Exploded View

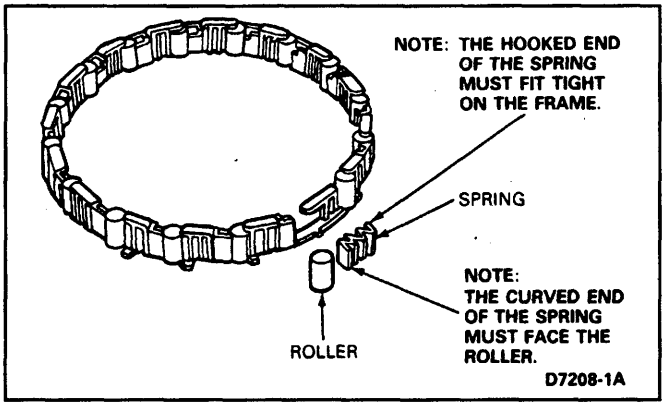


FIG. 48 One-Way Clutch Assembly

8. Install the No. 2 needle bearing (4x2) or thrust washer (4x4).

Center Support and Planetary One-way Clutch

Refer to Fig. 47.

Disassembly

1. Remove the center support from the planetary carrier. Rotate the center support counterclockwise and lift to remove.
2. Carefully remove the planetary one-way clutch from the planetary assembly.

Assembly

1. If necessary, assemble the one-way clutch as shown in Fig. 48.
2. Install the one-way clutch in the planetary carrier.
3. Install the center support into the one-way clutch by rotating the center support counterclockwise.

   Lubricating the clutch races and the clutch assembly with petroleum jelly may aid in assembly.

Sun Gear and Drive Shell

Refer to Fig. 49.

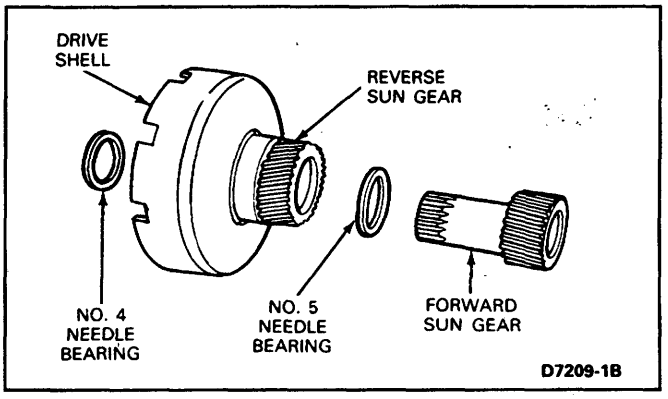


FIG. 49 Sun Gear and Drive Shell—Exploded View

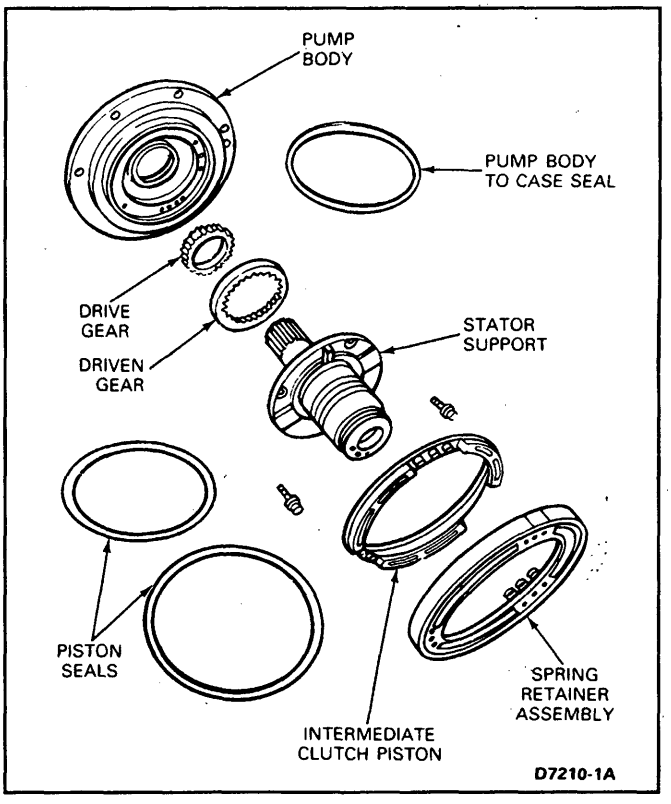


FIG. 50 Pump and Intermediate Clutch Piston—Exploded View

Disassembly

1. Remove the No. 4 needle bearing from the drive shell.
2. Remove the forward sun gear and No. 5 needle bearing from the drive shell.
3. Remove the No. 5 needle bearing from the forward sun gear.

Assembly

The sun gear and drive shell will be assembled as part of the transmission assembly procedure.

Pump and Intermediate Clutch Piston

Refer to Fig. 50.

Disassembly

1. Remove the No. 1 thrust washer (Figs. 14 and 15).

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2. Remove the four pump seal rings (Figs. 14 and 15). The reverse clutch rings are larger than the forward clutch rings.
3. Remove the pump body-to-case seal and discard.
4. Remove the spring retainer assembly by carefully dislodging the tabs (Fig. 51).

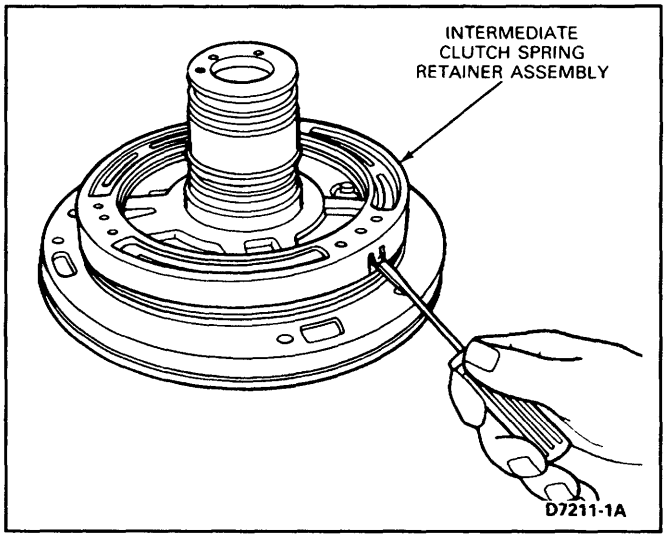


FIG. 51 Removing Spring Retainer

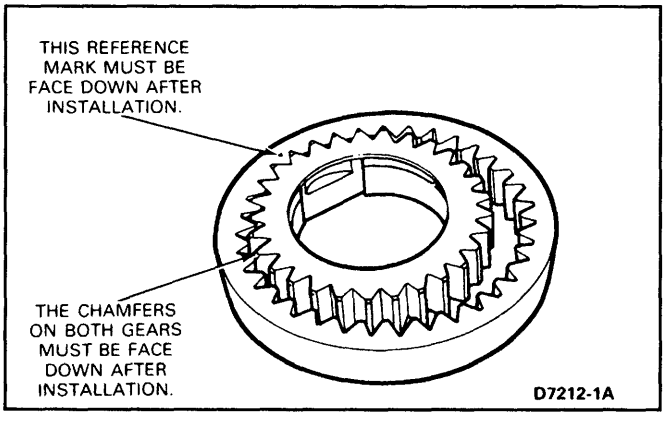


FIG. 52 Drive and Driven Pump Gear—Installation

5. Remove the intermediate clutch piston.
6. Remove the five stator support bolts (10mm) and the stator support.
7. Remove the drive and driven pump gears from the pump body.

Assembly

1. Install the drive and driven pump gears in the pump body as shown in Fig. 52. Chamfers on both gears face into the pump body.
2. Position the stator support and install the bolts. Tighten bolts to 16-22 N·m (12-16 ft-lbs).
3. Install a new pump to case seal.
4. Install new seals on the clutch piston. Note the direction of the sealing lip before installation. The lips point away from the spring posts (Fig. 53).
5. Install the clutch piston as follows:
   a. Coat the piston seals and the pump body sealing area with petroleum jelly.
   b. Install the piston in Seal Protector T80L-77005-A (or equivalent).
   c. Install the piston in the pump body and push to the bottom of the bore by exerting even thumb pressure on the piston.

   IMPORTANT NOTE: The piston bleed hole must be located at 12:00 position (toward top of transmission).
6. Snap the spring retainer assembly into place on the pump body. Use even pressure.
7. Install the pump seal rings.

Accumulators and Servos

Disassembly and Assembly

3-4 Accumulator

Refer to Fig. 54.

Install new seals on the accumulator piston and the piston cover.

NOTE: Some transmissions will be built without a spring. Also, the piston and spring construction may be different from that shown. Be sure the diagonal cuts on the piston seal are aligned properly.

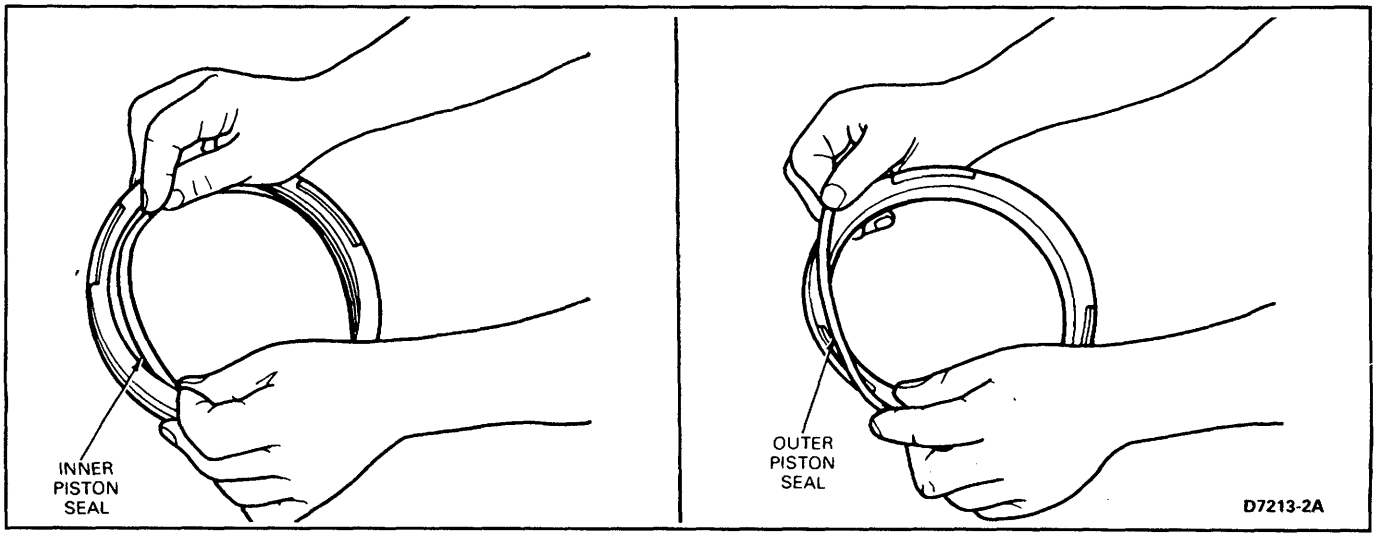


FIG. 53 Piston Seal Installation

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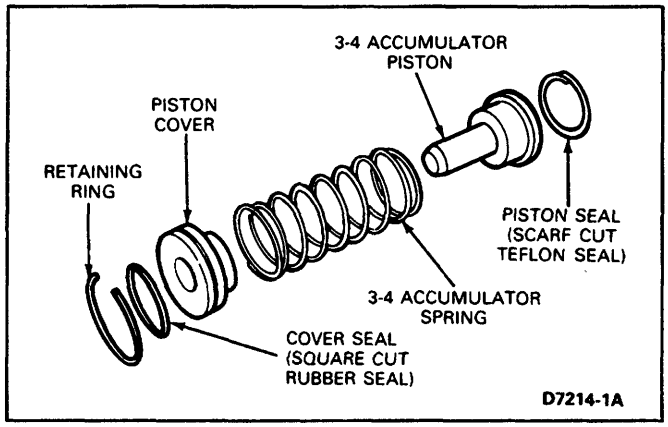


FIG. 54 3-4 Accumulator—Typical

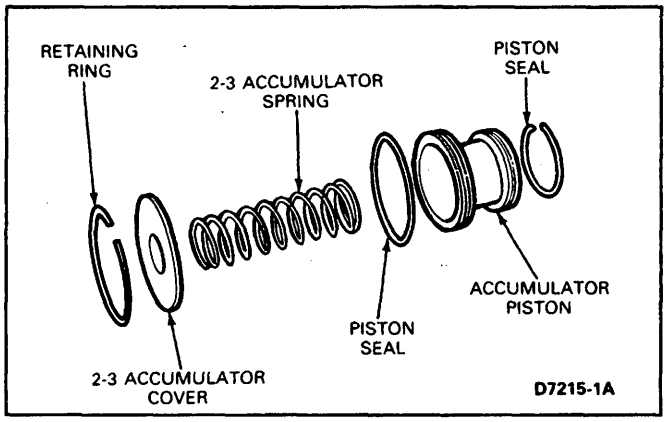


FIG. 55 2-3 Accumulator

2-3 Accumulator

Refer to Fig. 55.

Install new seals on the accumulator piston. Be sure the diagonal cuts are properly aligned.

Low-Reverse Servo

Refer to Fig. 56.

Inspect the sealing edge on both the servo cover and the apply piston. Replace the cover or piston, if necessary.

Overdrive Servo

Refer to Fig. 57.

1. Pull the overdrive servo piston out of the piston cover.
2. Install new seals on the piston and cover.
3. Install the piston in the cover.

Valve Body

Refer to Figs. 58-69.

Disassembly

1. Remove and discard valve body gasket. Loosen and remove (11) bolts (10mm socket) from reinforcement plates and detent spring guide bolt (8mm) from separator plate (Fig. 59). Remove separator plate, reinforcement plates and separator plate gasket (Fig. 60). Discard gasket.
2. Remove the two relief valves and seven check balls from the valve body. Note the location of the orange ball. It is not interchangeable with the (6) black balls (Fig. 61).

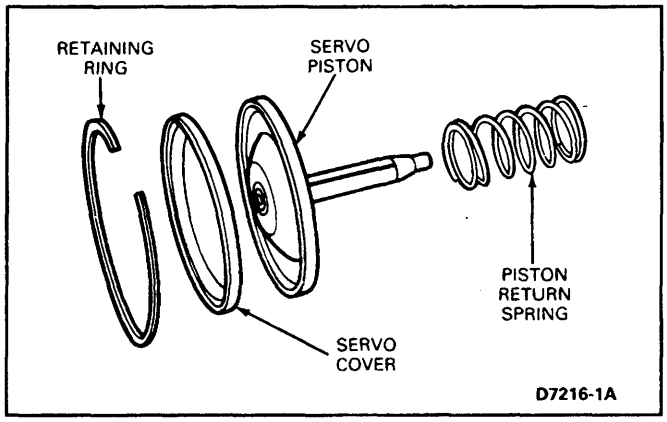


FIG. 56 Low-Reverse Servo—Exploded View

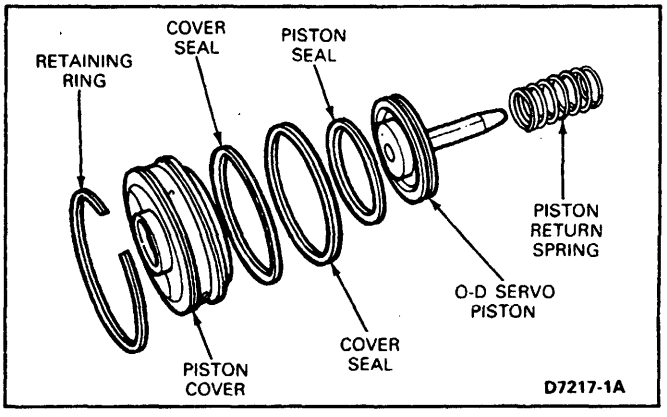


FIG. 57 Overdrive Servo—Exploded View

3. Refer to Figs. 62-66 for identification and location of all valves in the valve body. Figs. 62-65 shows all valves in an exploded view. Fig. 66 shows all valve components assembled in the correct location in the valve body.

   NOTE: Most main control valve body plugs have tapped holes on the outside to accomodate a metric (M4) screw for easier removal of the plugs when cleaning or servicing the valve body. Reinstall the plugs with the tapped holes on the outside.
4. Remove the manual valve from the valve body.
5. With an awl or ice-pick, lift the retaining clip off the throttle sleeve. Press the throttle plunger into the bore and spring pressure will force the throttle sleeve out of the valve body. Position a finger to prevent the valves from flying out of the bore. Remove the throttle sleeve, preload spring, throttle plug, throttle control valve, throttle control spring and throttle plunger.

   NOTE: The chamfered stem of the throttle control valve faces the throttle plunger. The notch in the throttle plug faces the bottom of the sleeve bore.
6. Lift the retaining clip off the 2-3 backout valve with an awl or ice-pick. Remove the bore plug, spring and 2-3 backout valve.
7. Remove the retaining plate from the bore plug of the orifice control valve. Remove the bore plug, orifice control valve and spring. With needle-nose

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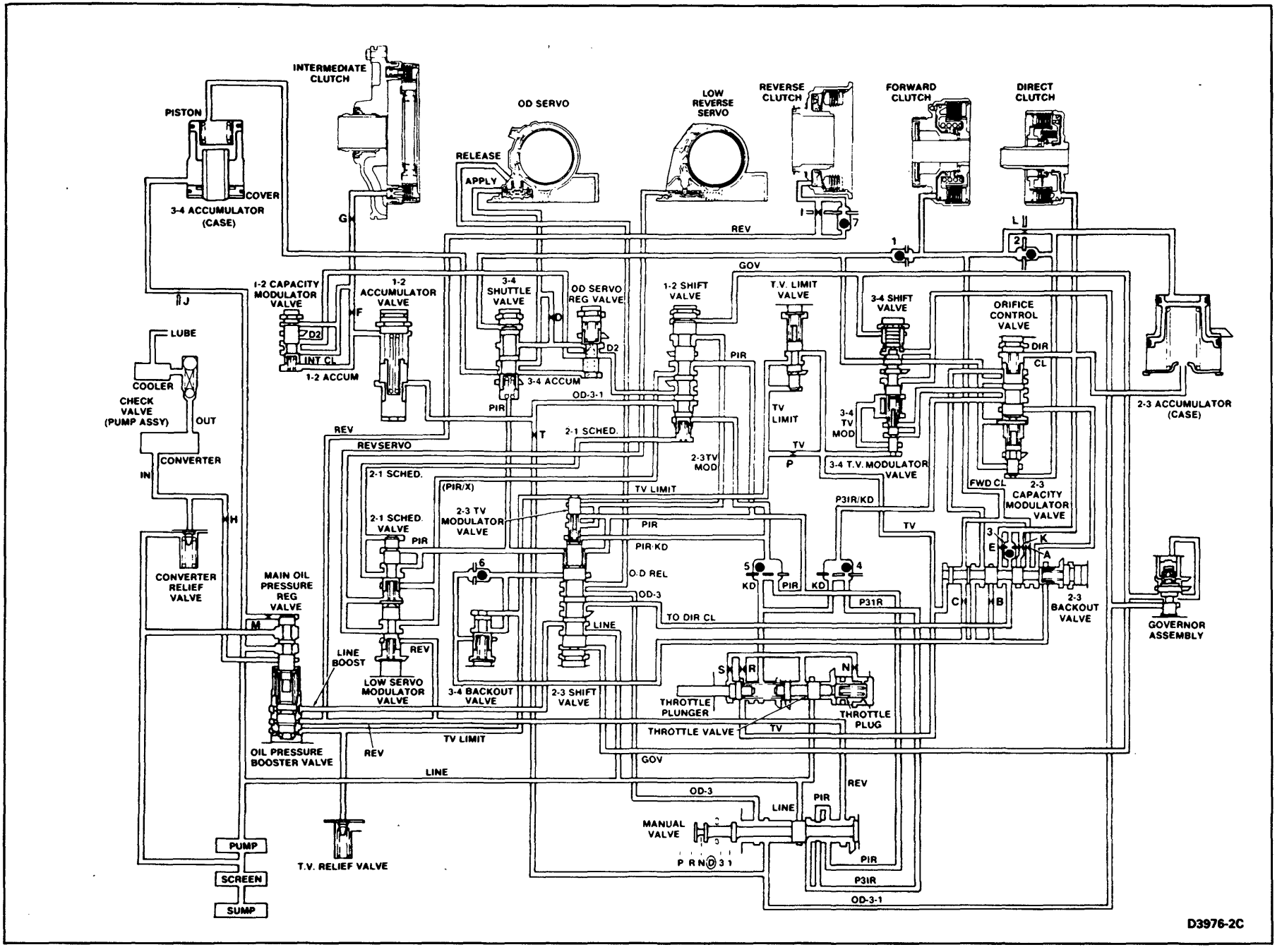


FIG. 58 Valve Body Schematic

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pliers, remove the spring retaining plate that separates the orifice control valve from the 2-3 capacity modulator valve. This retainer plate is longer and thicker than the other four spring retainer plates and must be reinstalled in this slot. Remove the modulator valve spring and 2-3 capacity modulator valve.

8. Lift the retaining clip off the 3-4 shift valve sleeve. Remove the sleeve, plug, 3-4 shift valve, spring, modulator valve spring and 3-4 TV modulator valve.

   NOTE: The notch in the plug faces the bottom of the sleeve bore.

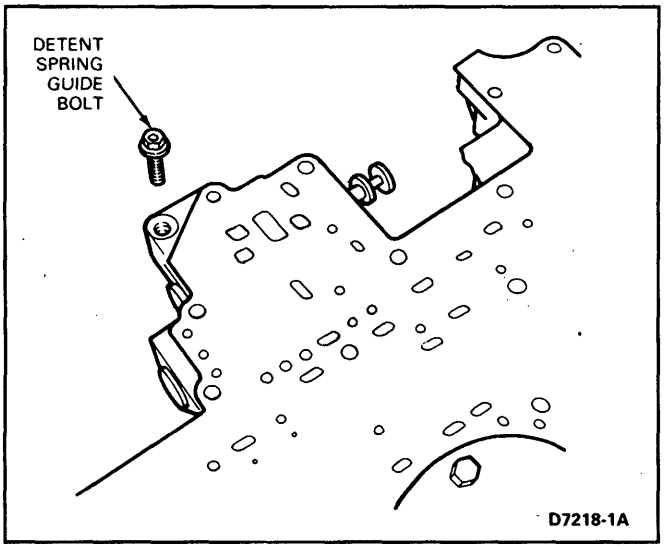


FIG. 59 Removing Detent Spring Guide Bolt

9. With needle-nose pliers, remove the spring retaining plate from the TV limit valve bore. Remove the spring and TV limit valve.
10. Remove the retaining clip from the 1-2 shift valve bore plug. Remove the bore plug, 1-2 shift valve and spring.
11. Remove plug retaining plate from the O.D. servo regulator valve bore plug. Remove the bore plug, spring and O.D. servo regulator valve.
12. Lift the retaining plate off the 3-4 shuttle valve bore plug. Remove the bore plug, 3-4 shuttle valve and spring.
13. With an awl or icepick, lift the retaining clip off the 1-2 accumulator valve bore plug. Remove the bore plug, O-ring seal, spring and 1-2 accumulator valve.

    NOTE: The 1-2 accumulator valve and valve body diameter are not the same for all models.
14. Remove the retaining clip from the 1-2 capacity modulator valve bore plug. Remove the bore plug, 1-2 capacity modulator valve and spring.
15. Remove the retaining clip from the boost sleeve. Remove the boost sleeve, boost valve, main regulator valve spring, boost valve spring, spring seat and main pressure regulator valve.
16. Two spring retainer plates hold and separate the 2-1 scheduling valve and the low servo modulator valve. Remove the outer spring retainer plate and low servo modulator spring and valve from the valve body. Remove the scheduling valve spring and the 2-1 scheduling valve.
17. With needle-nose pliers, remove the spring retainer plate from the 3-4 backout valve bore. Remove the spring and 3-4 backout valve.

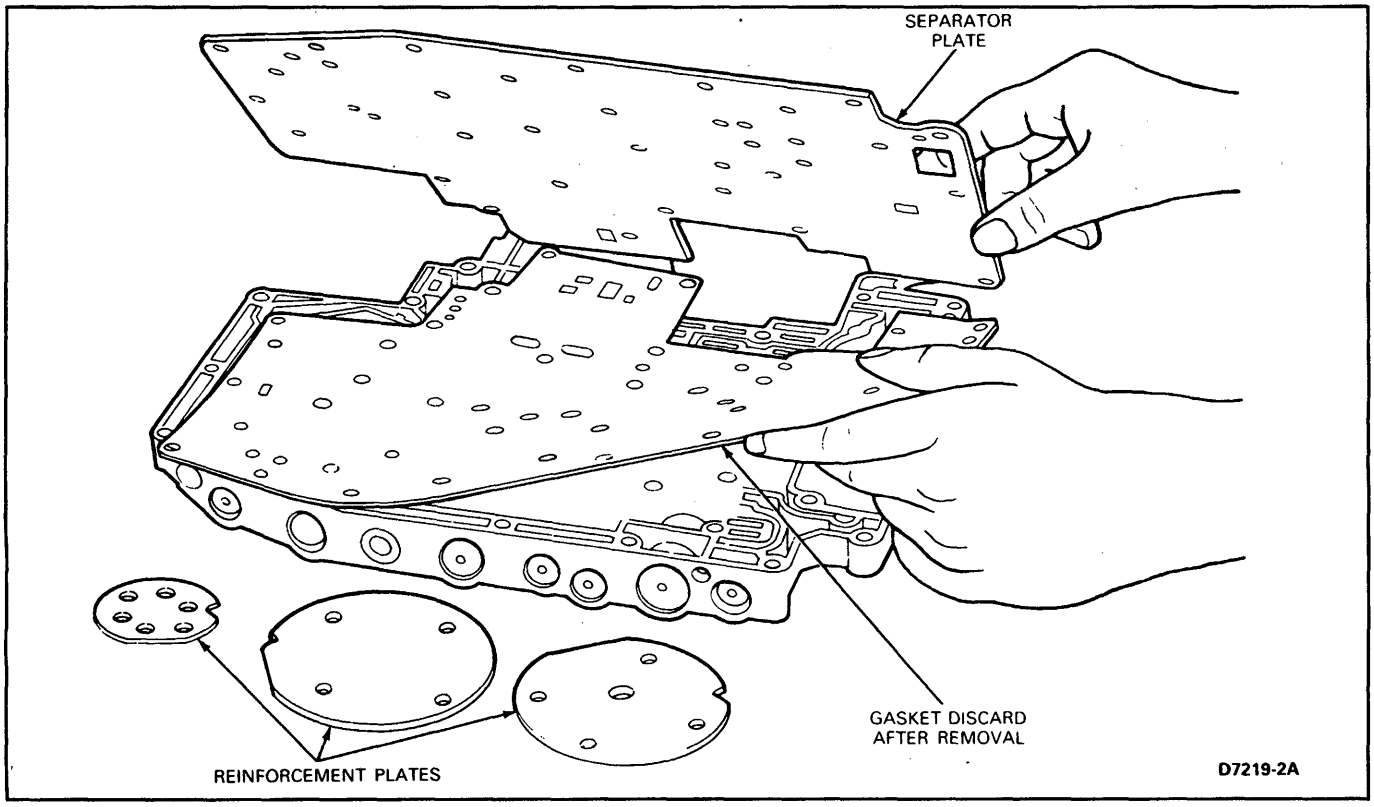


FIG. 60 Removing Separator Plate

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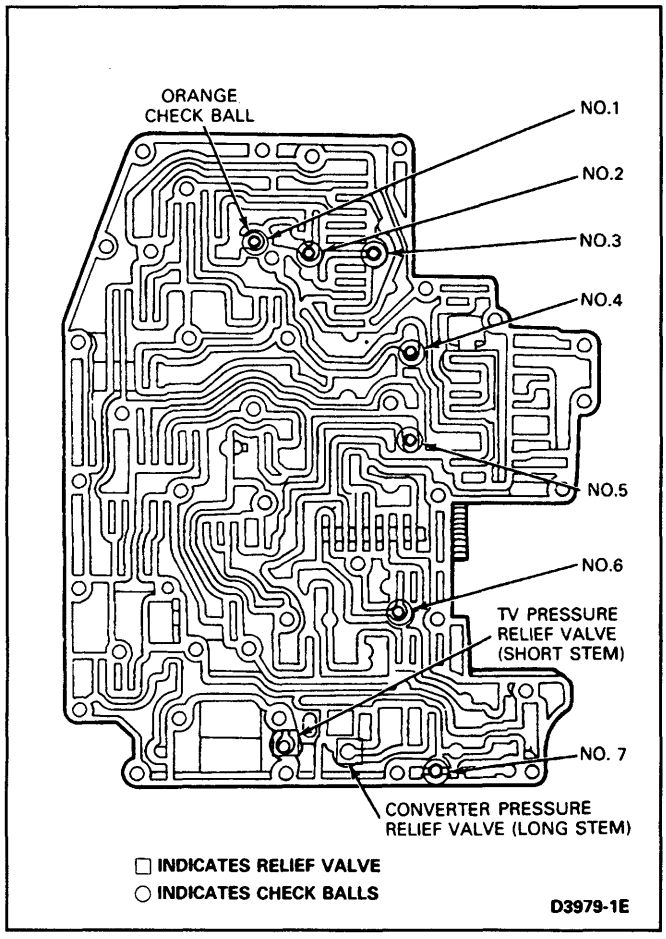


FIG. 61 Relief Valve and Check Ball Location

18. Remove the retaining clip from the 2-3 shift valve bore plug. Remove the bore plug, 2-3 shift valve, the 3-2 control valve, the shift valve spring, modulator valve spring, and 2-3 TV modulator valve.

19. Inspect and clean the valve body as described in Section 17-01, General Automatic Transmission Service, under Control Valve Body—Cleaning and Inspection.

Assembly

Before installing the control valves, lubricate the bores, valves, springs and seals with clean transmission fluid.

Refer to Figs. 62-65 for correct assembly of all valve components. Refer to Fig. 66 for correct location of the valves in the body.

1. Insert the 2-3 TV modulator valve, modulator valve spring, the 3-2 control valve, shift valve spring, and 2-3 shift valve in the valve body. Insert the bore plug and from the underside of the body place the retaining clip in the slot on the bore plug.

2. Install the 3-4 backout valve and spring in the valve body. Insert the spring retainer plate in the proper slot in the valve body.

3. Place the 2-1 scheduling valve and spring in the valve body. Install the spring retainer plate in the bore. Install the low servo modulator valve and spring into the bore in front of the retainer plate that separates the scheduling valve from the modulator valve. Insert the retaining clip into the proper slot in the valve body.

4. Install the main pressure regulator valve, spring seat, boost valve spring, main regulator valve spring, boost valve and boost sleeve. Install the retaining clip on the boost sleeve.

5. Install spring, 1-2 capacity modulator valve, and bore plug in the valve body. Place retaining clip on bore plug.

6. Install the 1-2 accumulator valve, and spring. Install the O-ring in the shallow groove of the bore plug and lubricate the O-ring. Install the bore plug into the bore with the O-ring toward the outside. Install the retaining clip on the bore plug.

   NOTE: The 1-2 accumulator valve and valve body diameters are not the same for all models.

7. Insert the spring, 3-4 shuttle valve, and bore plug in the valve body. Place retaining plate on bore plug.

8. Install the O.D. servo regulator valve, spring and bore plug into bore. Install the bore plug by turning the plate into the slot of the bore plug.

9. Place spring, 1-2 shift valve, and bore plug into valve body. Install retaining clip on bore plug.

10. Insert TV limit valve and spring into valve body bore. Insert spring retainer plate in slot of valve body bore.

11. Install 3-4 TV modulator valve and spring, 3-4 shift valve and spring, plug and sleeve in valve body. Place retaining clip on sleeve. NOTE: The notch in the plug faces the bottom of the sleeve bore.

12. Place 2-3 capacity modulator valve and spring in bore. Install the spring retainer plate that separates the 2-3 capacity modulator valve and orifice control valve.

    NOTE: The spring retainer plate is thicker and longer than the other four retainer plates. Insert orifice control valve and spring, and bore plug in front of retainer plate. Install retaining plate on bore plug.

13. Install 2-3 backout valve, spring and bore plug in valve body. Install retaining clip on bore plug.

14. Install throttle plunger, throttle control spring, and throttle control valve.

    NOTE: The chamfered stem of the throttle control valve faces the throttle plunger.

15. Assemble the preload spring and throttle plug into the throttle sleeve, then load this assembly into the bore. Hold the sleeve into the bore and install the retaining clip from the opposite (unfinished) side of the valve body. NOTE: The notch in the throttle plug faces the bottom of the sleeve bore.

16. Install the manual valve in the valve body bore.

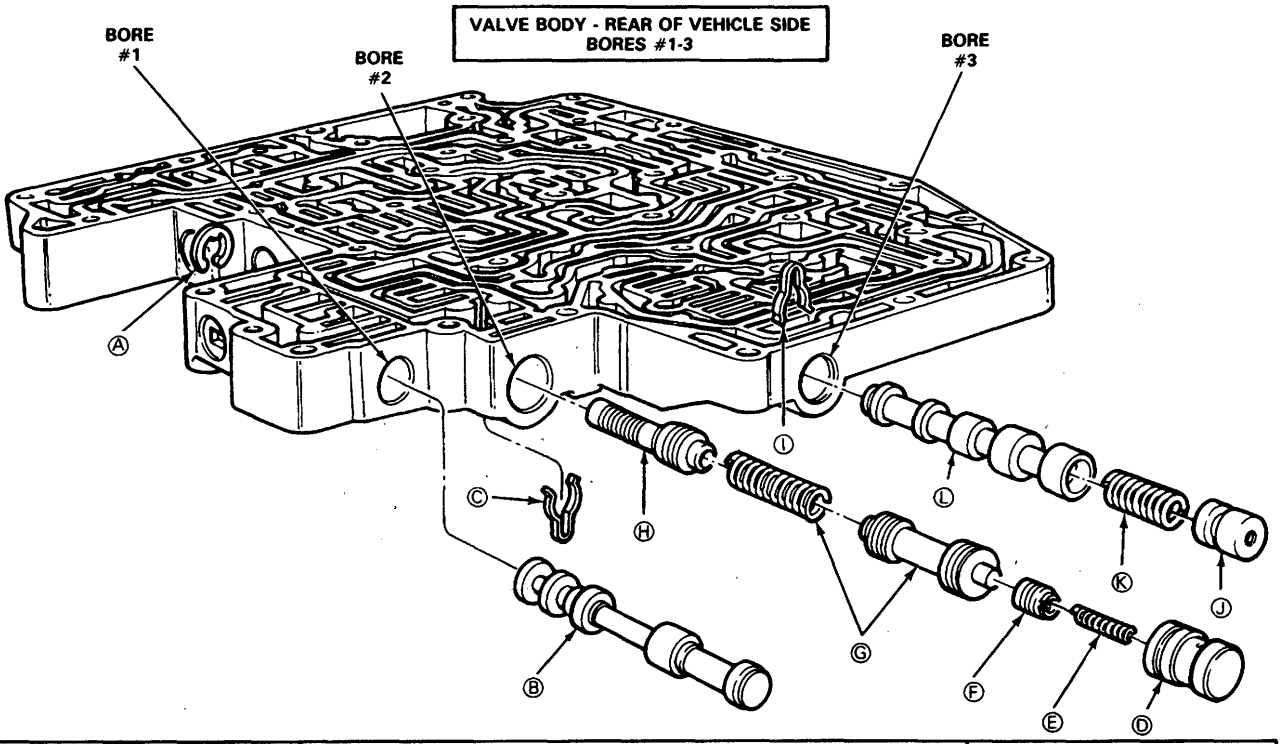
17. Install the valve body check balls (Fig. 61).

    Note the location of the orange ball. This ball is larger than the others and is not interchangeable.

18. Install the pressure relief valves (Figs. 61 and 67).

19. Install Alignment Pins T80L-77100-A (Fig. 67). Note the location of the pins. These two holes are smaller than the other bolt holes to assure proper alignment of gasket and separator plate with valve body. These two holes also align the valve body gasket and valve body assembly with the case.

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Bore #1	Bore #2	Bore #3
Ⓐ Clip	Ⓒ Clip	Ⓘ Clip
Ⓑ Manual Valve	Ⓓ Throttle Sleeve	Ⓙ Bore Plug
	Ⓔ Preload Spring	Ⓚ Spring
	Ⓕ Throttle Plug ①	Ⓛ 2-3 Backout Valve
	Ⓖ Throttle Control Valve and Spring ②	
	Ⓗ Throttle Plunger	

NOTES:

All Bore Plugs have a tapped hole in the center. These plugs must be installed with the tapped hole facing outward. Use a M4 metric screw in the tapped hole for easier plug removal.

① The notch in the throttle plug faces the bottom of the throttle sleeve bore.

② The chamfered stem of the throttle control valve faces the throttle plunger.

D6280-2B

FIG. 62 Valve Body—Exploded View—Bores #1-3

20. Use a new separator plate gasket. Slide the gasket and the separator plate over the two alignment pins. Position the (3) reinforcement plates and loosely install the (11) bolts (Fig. 69). Loosely install the detent spring guide bolt. (Fig. 68, This bolt is the same as the short valve body assembly to case attaching bolts).
21. Starting at the center (large) reinforcement plate and working outward, tighten the eleven 10mm bolts to specification (Fig. 69). Then tighten the 8mm detent spring guide bolt to specification. Remove the alignment pins.

Pump Bushing

Disassembly and Assembly

1. Remove the bushing using Bushing Remover T80L-77268-B or equivalent (Fig. 70).
2. Install the bushing using Bushing Installer T80L-77268-A or equivalent (Fig. 70).

Extension Housing Bushing

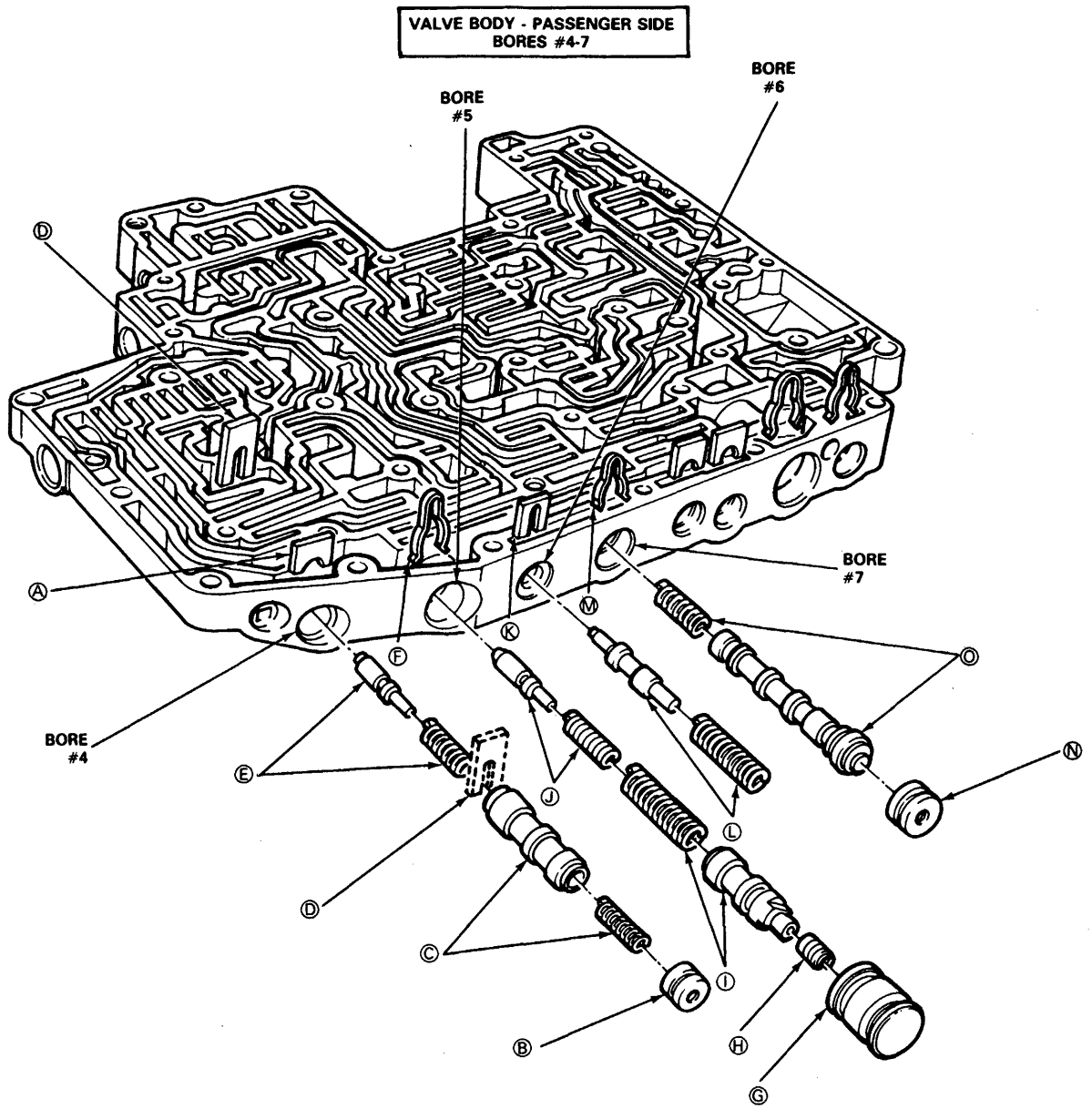
Disassembly

1. Remove the extension housing seal using Slide Hammer T59L-100-B and Seal Remover T74P-77248-A or equivalent (Fig. 11).
2. Remove the extension housing bushing using Bushing Remover T77L-7697-A or equivalent (Fig. 71).

Installation

1. Install the extension housing bushing using Bushing Installer T80L-77034-A or equivalent (Fig. 72).
2. Install the extension housing seal using Seal Installer T61L-7657-A or equivalent (Fig. 12).

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Bore #4	Bore #5	Bore #6	Bore #7
Ⓐ Spring Retainer Plate	Ⓕ Clip	Ⓚ Retainer Plate	Ⓜ Clip
Ⓑ Bore Plug	Ⓖ Sleeve	Ⓛ TV Limit Valve and Spring	Ⓝ Bore Plug
Ⓒ Orifice Control Valve and Spring	Ⓗ Plug ②		Ⓞ 1-2 Shift Valve and Spring
Ⓓ Spring Retainer Plate ①	Ⓘ 3-4 Shift Valve and Spring		
Ⓔ 2-3 Capacity Modulator Valve and Spring	Ⓙ 3-4 TV Modulator Valve and Spring		

NOTES:

All Bore Plugs have a tapped hole in the center. These plugs must be installed with the tapped hole facing outward. Use a M4 metric screw in the tapped hole for easier plug removal.

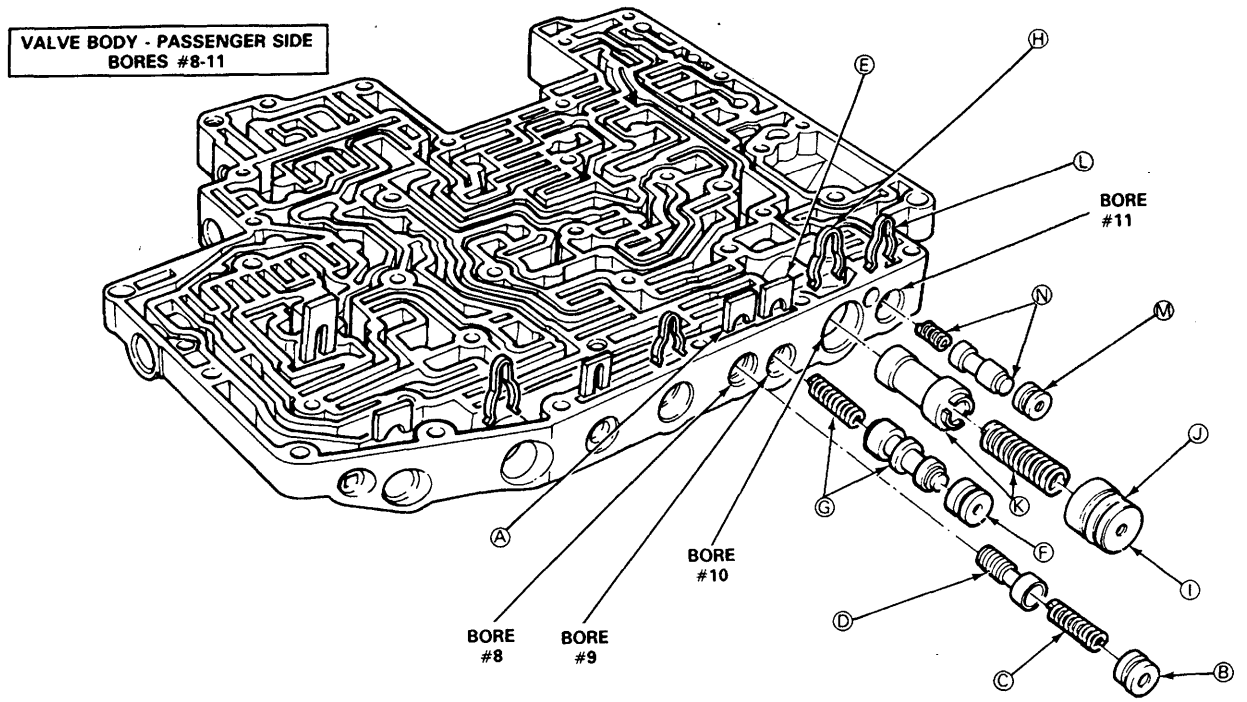
① The 2-3 Capacity Modulator Valve Retainer Plate is thicker and longer than the other plates. It must be installed in this slot.

② The notch in the 3-4 plug faces the bottom of the sleeve bore.

D6281-2B

FIG. 63 Valve Body—Exploded View—Bores #4-7

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Bore #8	Bore #9	Bore #10	Bore #11
(A) Spring Retainer Plate	(E) Retainer Plate	(H) Clip	(L) Clip
(B) Bore Plug	(F) Bore Plug	(I) Bore Plug	(M) Bore Plug
(C) Spring	(G) 3-4 Shuttle Valve and Spring	(J) O-ring Seal (1)	(N) 1-2 Capacity Modulator Valve and Spring
(D) O.D. Servo Regulator Valve		(K) 1-2 Accumulator Valve and Spring (2)	

NOTES:

All Bore Plugs have a tapped hole in the center. These plugs must be installed with the tapped hole facing outward. Use a M4 metric screw in the tapped hole for easier plug removal.

(1) When installing the 1-2 Accumulator Valve Bore Plug into the bore, the O-ring seal must face towards the outside of the valve body.

(2) The 1-2 Accumulator Valve and valve body diameter are not the same for all models.

D6282-2B

FIG. 64 Valve Body—Exploded View—Bores #8-11

Case Bushing

Disassembly and Assembly

To remove the transmission case bushing use Slide Hammer T50T-100-A and Seal Remover TOOL-1175-AC or equivalent (Fig. 73).

1. Position the replacement bushing on Bushing Installer T80L-77110-A or equivalent (Fig. 74) and install in the bushing bore through the front of the case.
2. Thread Slide Hammer T50T-100-A or equivalent into the bushing installer through the back of the case and install the bushing.

Transmission

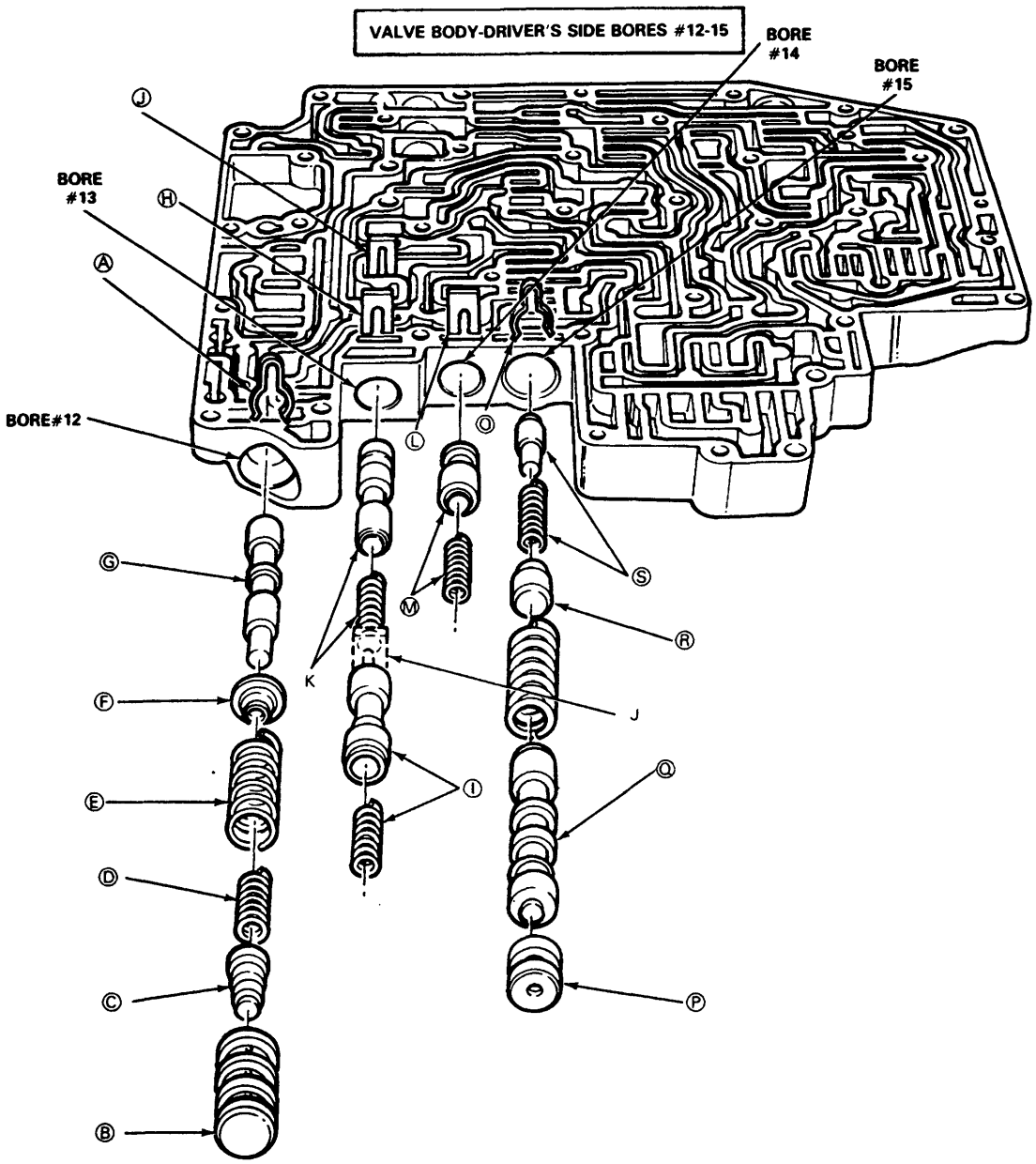
Refer to Figs. 14, 15 and 16.

Assembly

1. Install the No. 9 output shaft needle bearing in the transmission case.
2. Install the bearing support, No. 7 needle bearing and direct clutch hub in the direct clutch.
3. Install the output shaft, the ring gear and the direct clutch as an assembly. This assembly must be assembled as follows:
   a. Assemble output shaft hub to output shaft with retaining ring (seal rings already installed).
   b. Put No. 8 needle bearing in place on rear of direct clutch cylinder.
   c. Slide output shaft into direct clutch cylinder.
   d. Attach output shaft hub to ring gear with retaining ring.
4. Install the governor drive ball, the governor assembly and the governor retaining ring.

   Make sure that the face of the governor body is about flush with the counterweight. The cover and attaching screws must face forward in the case.

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Bore #12	Bore #13	Bore #14	Bore #15
(A) Clip	(H) Spring Retainer Plate	(L) Spring Retainer Plate	(O) Clip
(B) Boost Sleeve	(I) Low Servo Modulator Valve and Spring	(M) 3-4 Back Out Valve and Spring	(P) Bore Plug
(C) Boost Valve	(J) Spring Retainer Plate		(Q) 2-3 Shift Valve and Spring
(D) Boost Valve Spring	(K) 2-1 Scheduling Valve and Spring		(R) 3-2 Control Valve
(E) Main Regulator Valve Spring			(S) 2-3 TV Modulator Valve and Spring
(F) Spring Seat			
(G) Main Pressure Regulator Valve			

NOTES: All Bore Plugs have a tapped hole in the center. These plugs must be installed with the tapped hole facing outward. Use a M4 metric screw in the tapped hole for easier plug removal.

D6283-2C

FIG. 65 Valve Body—Exploded Views—Bores # 12-15

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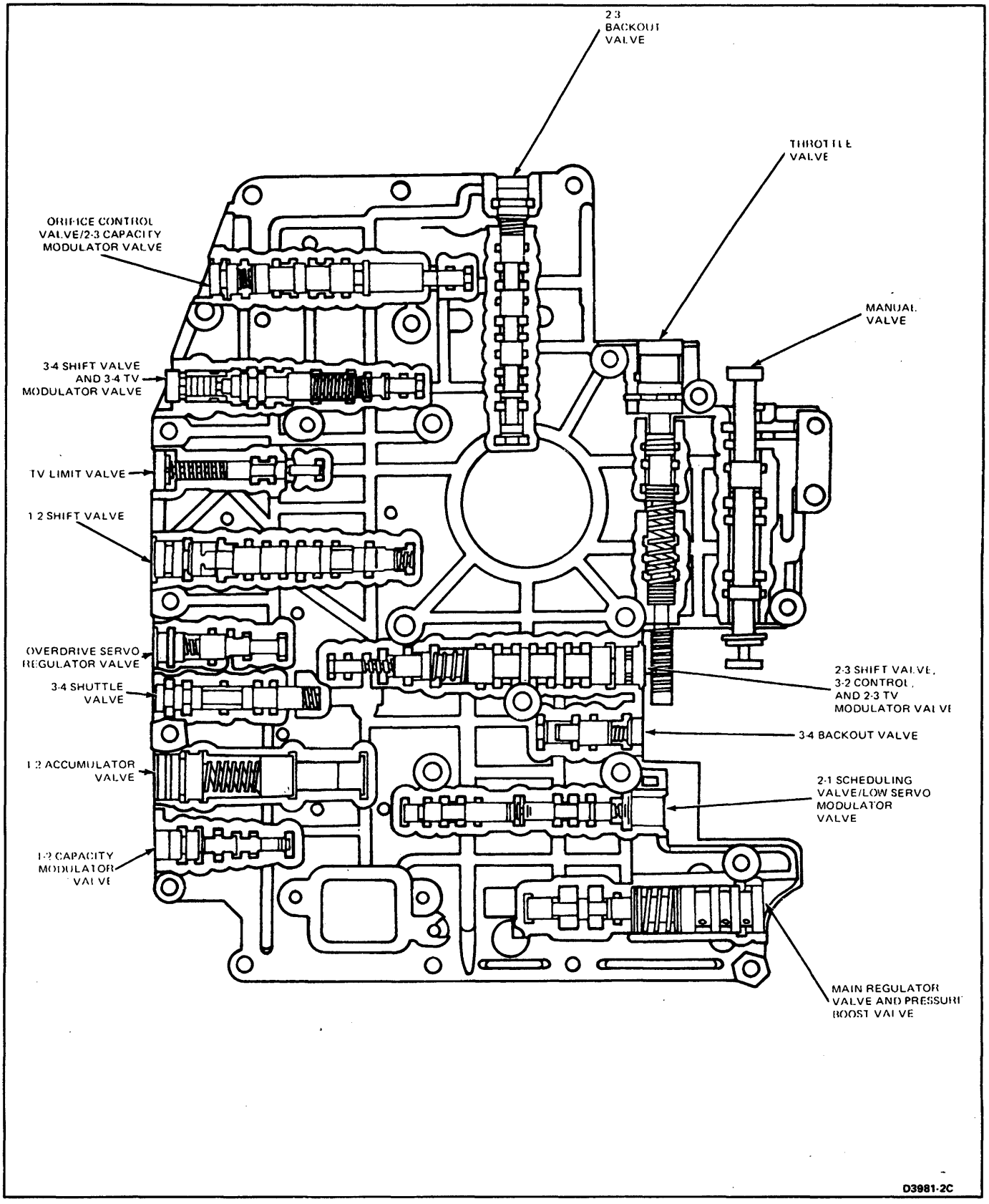


FIG. 66 Valve Locations

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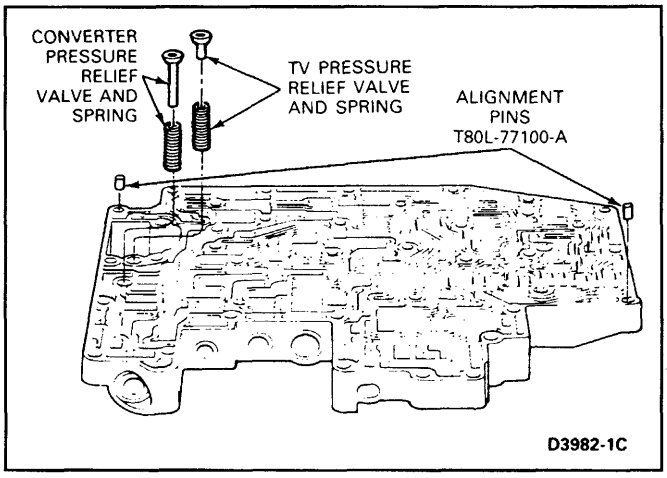


FIG. 67 Installing Pressure Relief Valves

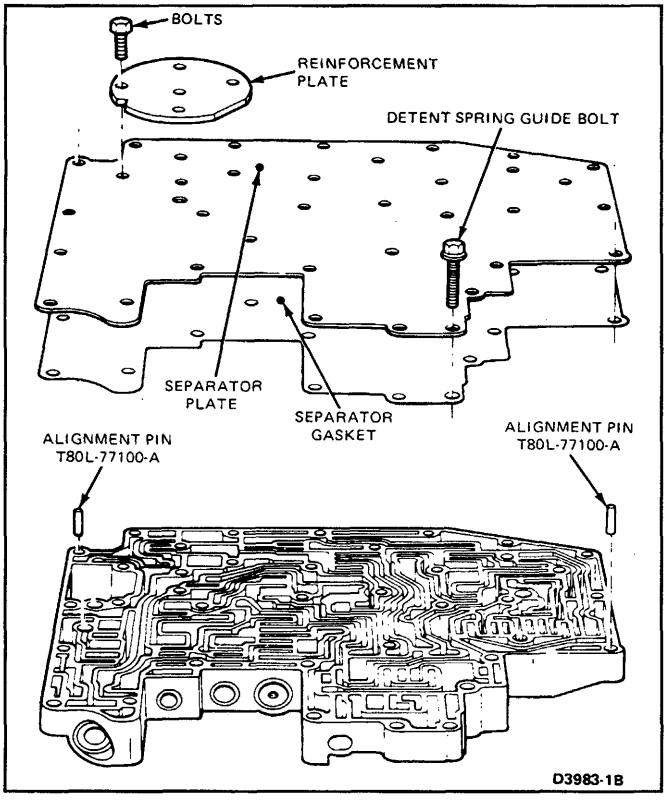


FIG. 68 Separator Plate Installation

5. Install the low-reverse band. Make sure the band is seated on the anchor pins (View A, Fig. 75).

   NOTE: When properly installed, the center of the band anchor can be seen through the servo piston bore (View B, Fig. 75).

6. Install the center support and planetary assembly. Rotate the output shaft, if necessary, to align the planet carrier splines with the direct clutch hub splines.

   NOTE: The planet carrier and center support assembly cannot be installed unless the notch cut in the center support is aligned with the overdrive band anchor pin (Fig. 76).

7. Install the center support anti-clunk spring using a hammer handle or wooden dowel in position shown in Fig. 77.

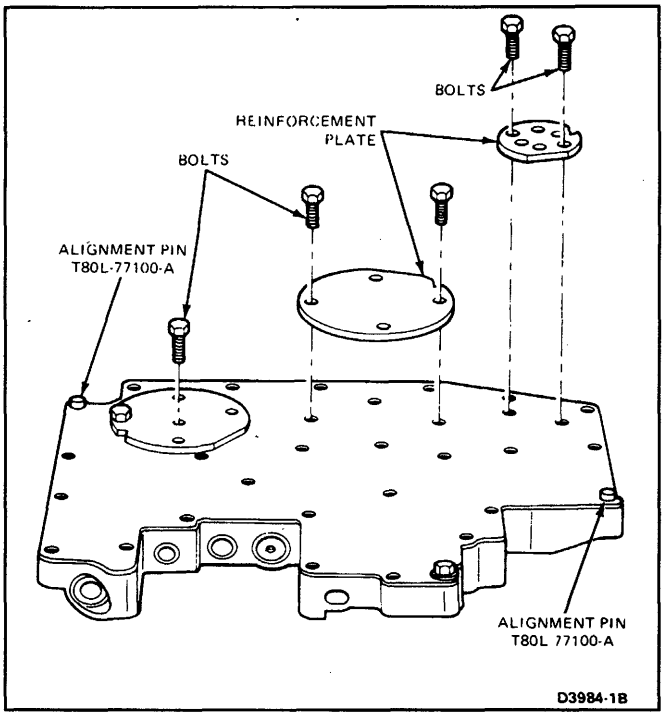


FIG. 69 Reinforcement Plate Installation

8. Install the center support retaining ring in position shown in Fig. 78.

9. To determine the correct length of the servo low-reverse pin proceed as follows:

   a. Install the low-reverse servo piston and return spring. Do not install the piston cover or retaining ring.

   b. Install servo selector Tool T80L-77030-A and tighten the band apply bolt on Tool T80L-77030-A to 5.6 N·m (50 in-lbs) (Fig. 79).

   c. Attach a dial indicator, TOOL-4201-C or equivalent and position the indicator stem on the flat portion of the piston, zero the dial indicator (Fig. 80).

   d. Thread the bolt out of the selector tool until the piston stops against the bottom of the tool.

   e. Read the amount of piston travel on the dial indicator.

      - If the travel is 2.845-6.020mm (0.112-0.237 inch) the piston length is within specification.
      - If the travel is not within specification selective pistons are available in the following lengths:

        I.D.

        1. 2.936—1 groove
        2. 2.989—2 grooves
        3. 3.043—3 grooves

      Length of rod measured from piston surface to end of rod.

      Select the proper rod to bring the servo piston travel within specification.

   f. Remove the servo selection tool and dial indicator.

   g. Install the servo cover and retaining ring.

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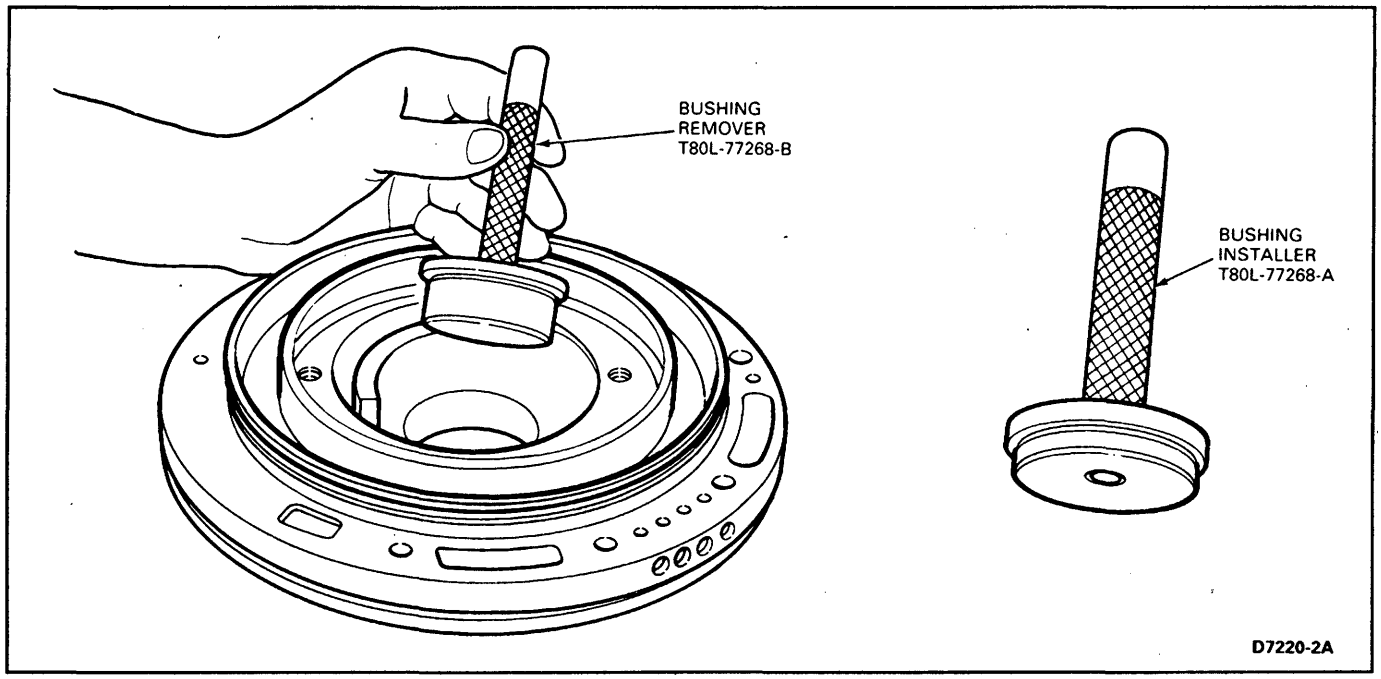


FIG. 70 Pump Bushing Removal and Installation

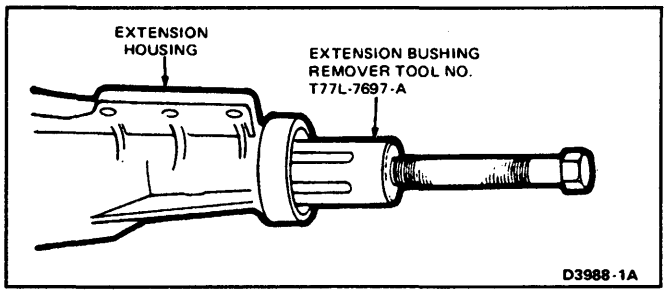


FIG. 71 Removing Extension Housing Bushing

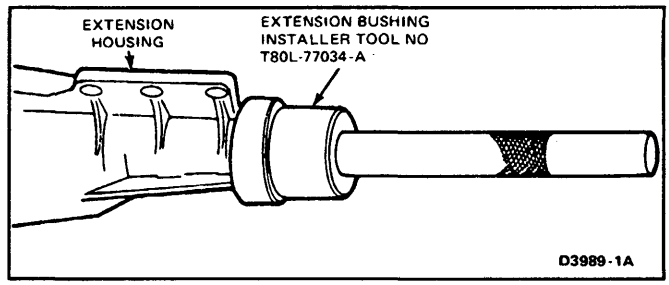


FIG. 72 Installing Extension Housing Bushing

10. Install the reverse clutch on the forward clutch.

    NOTE: Make sure the No. 2 needle bearing (4x2) or No. 2 thrust washer (4x4) is in position.

11. Install the No. 3 needle bearing and forward clutch hub in the forward clutch.
12. Position the No. 4 needle bearing on the forward clutch hub and install the drive shell.
13. Install the No. 5 needle bearing and forward sun gear on the drive shell.
14. Install the drive shell, forward clutch and reverse clutch as an assembly. Rotate the output shaft, as necessary, to aid the engagement of the sun gear with the planetary gears.
15. Install the overdrive band. Make sure the band anchor is properly positioned on the anchor pin as shown in Fig. 81.
16. Install the overdrive servo and retaining snap ring (Fig. 82).
17. With the overdrive servo installed, inspect the piston and band for proper position and engagement. If the band anchor and piston are not properly engaged as shown in Fig. 83, remove the servo and reposition the band as necessary.
18. Install the intermediate clutch pack components in the following order.
    1. The pressure plate
    2. The clutch pack
    3. The selective steel plate
19. Measure the intermediate clutch clearance using a depth micrometer and end-play checking Tool T80L-77003-A or equivalent (Fig. 84). Set the end-play tool across the pump case mounting. Locate the micrometer end-play bar and read depth. The depth at the intermediate clutch separator plate should be 41.5-41.8mm (1.634-1.646 inch) for the 4.9L (300 CID) EFI and 5.0L (302 CID) EFI applications. Check depth again 180 degrees opposite and assure the average depth is within tolerance.

    NOTE: Maintain a downward pressure on the clutch pack while measuring depth.

    If the depth is not within tolerance, the following size selective steel separator plates are available:

    0.071 inch—0.067 inch

    0.081 inch—0.077 inch

    0.091 inch—0.087 inch

    0.101 inch—0.097 inch

    Install the correct plate and recheck the clearance.

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20. Check transmission end-play by locating the depth micrometer on end-play Bar T80L-77003-A (or equivalent) so that depth is measured at the reverse clutch drum thrust face (Fig. 85). Check end-play 180 degrees opposite to determine average depth. The following chart shows the proper selective thrust washer for various depth measurements (Fig. 86).
21. Install the selective washer determined in Step 20 on the Pump as shown in Fig. 87. Use petroleum jelly to hold it in place.
22. Install a pump alignment dowel. The alignment dowel can be fabricated by removing the head from a M8-1.25 bolt. Install the dowel only a few threads in the position shown in Fig. 88.
23. Install a new pump gasket, and "O" ring.
24. Using Slide Hammers T59L-100-B and metric Adaptors T80L-77103-A (or equivalent), lower the pump assembly into the case to the position shown in Fig. 89.
25. Remove the alignment dowel and install the seven pump attaching bolts. Alternately tighten the bolts a few turns at a time to draw the pump into the case. Tighten the attaching bolts to the specified torque.
26. Assemble 3-4 accumulator. Install the piston (and spring, if so equipped). Lubricate the rubber seal on the cover and the top of the bore to help cover installation. Install the cover.

    IMPORTANT NOTE: After assembly, the cover must be fully up and seated against retaining ring to avoid exposing a pressure passage. Use air pressure if necessary to seat cover up against retaining ring.
27. Assemble the 2-3 accumulator.
28. Install valve body alignment Pins T80L-77100-A (or equivalent) in the positions shown (Fig. 90).
29. Install the valve body gasket and the valve body assembly over the pins.

    NOTE: Make sure the manual and throttle levers are properly positioned before installing the valve body attaching bolts.
30. Loosely install (25) valve body attaching bolts. Starting at the center and working outward, tighten the bolts to specification (8mm socket) (Fig. 91, View A).

    NOTE: Two different length bolts are used. The shorter bolts are used at the four front, one center and three rear locations. (Fig. 91, View B).
31. Remove the alignment pins and install bolts (short). Install the detent spring and roller assembly (long bolt). Tighten the bolts to 9-11 N·m (80-100 in-lbs) torque.
32. Position the TV lever torsion spring against the separator plate V notch (Fig. 92). This spring pushes the throttle lever in the direction of wide open throttle.
33. Install the filter grommet, a new filter gasket and the filter on the valve body.

    NOTE: If the fluid was contaminated be sure to use a new filter. Never attempt to clean or reuse a dirty filter.
34. Install the filter attaching bolts (8mm) and tighten to 9-14 N·m (80-120 in-lb) torque.
35. Position a new pan gasket and install the oil pan (10mm socket). Tighten the attaching bolts to the specified torque.
36. Clean the mounting surface on the transmission and on the extension housing. Remove any sealant from the bolts and the case bolt holes. Position a new gasket on the transmission. Coat the bolts with Ford Threadlock and Sealant E0AZ-19544-A or Ford Pipe Sealant D8AZ-19544-A Teflon® Tape or equivalent. Install the extension housing bolts and tighten to 22-27 N·m (16-20 ft-lb).
37. Install the direct driveshaft.
38. Install the torque converter. Make sure the converter is fully seated in the pump.

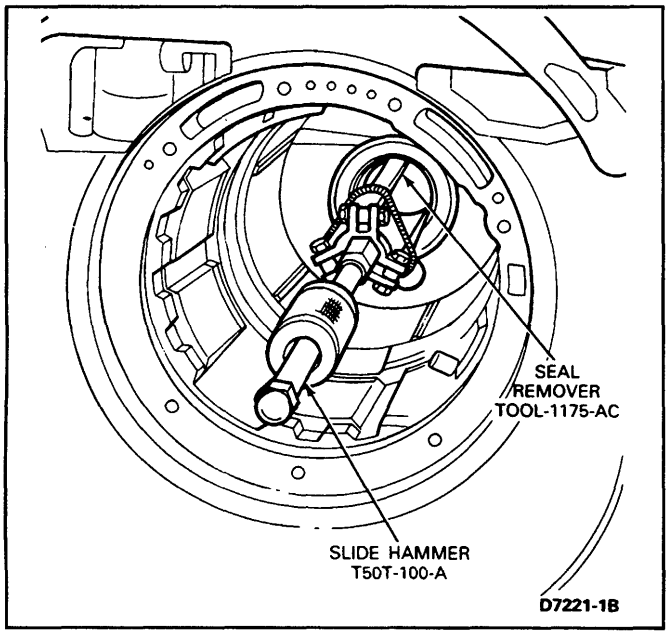


FIG. 73 Case Bushing Removal

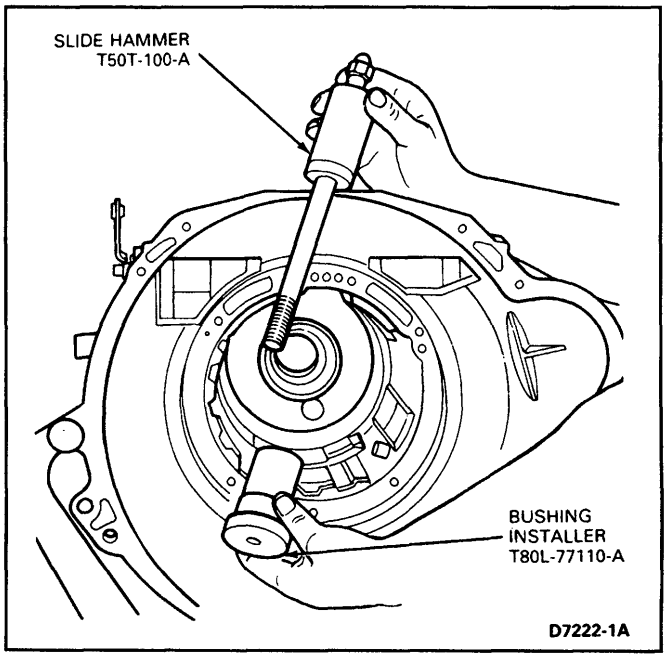


FIG. 74 Case Bushing Installation

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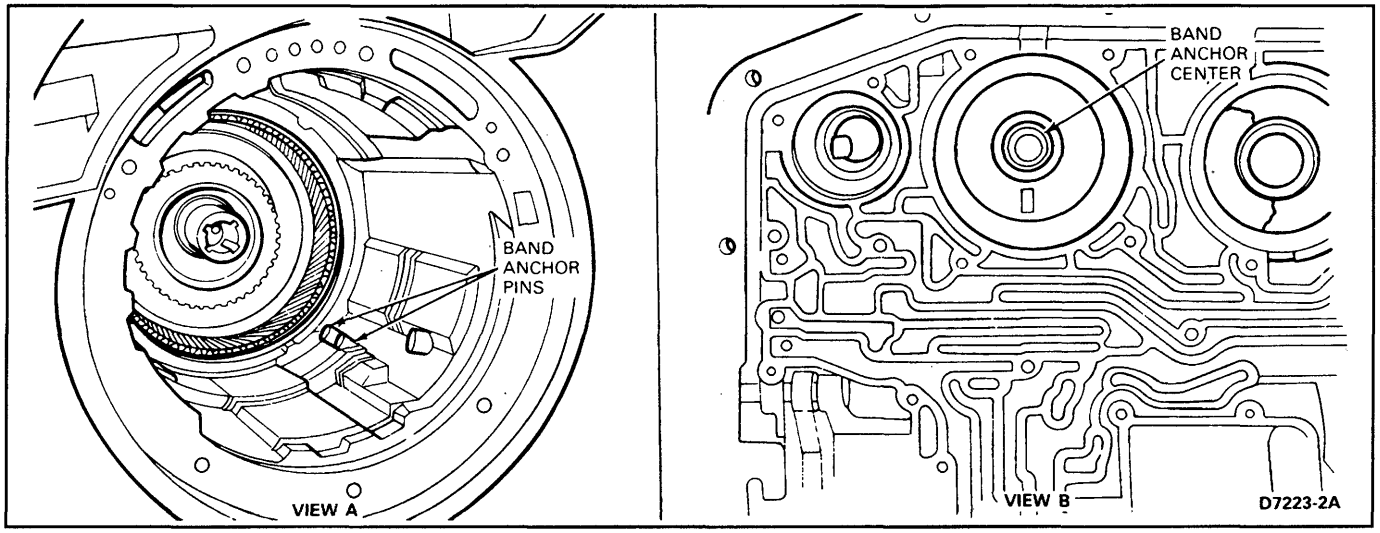


FIG. 75 Low Reverse Band Installation

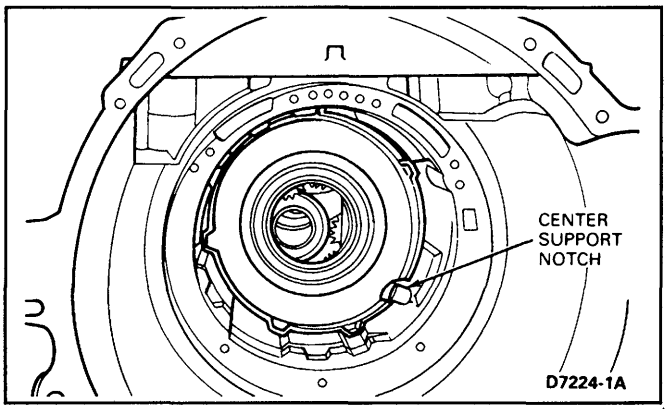


FIG. 76 Center Support and Planetary Assembly

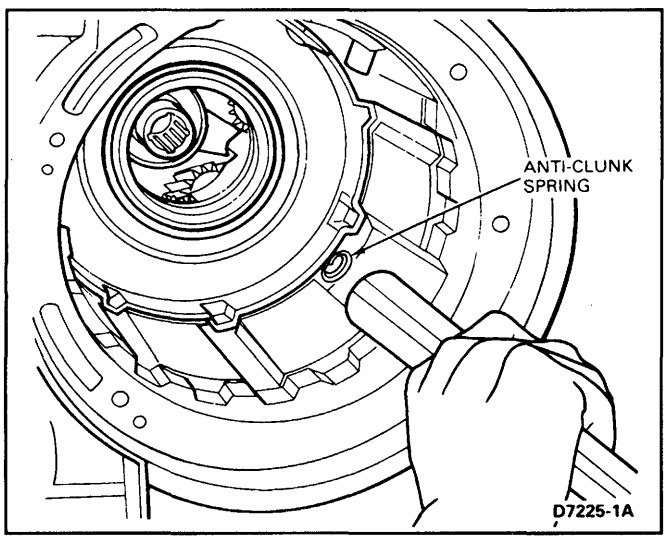


FIG. 77 Installing Anti-Clunk Spring

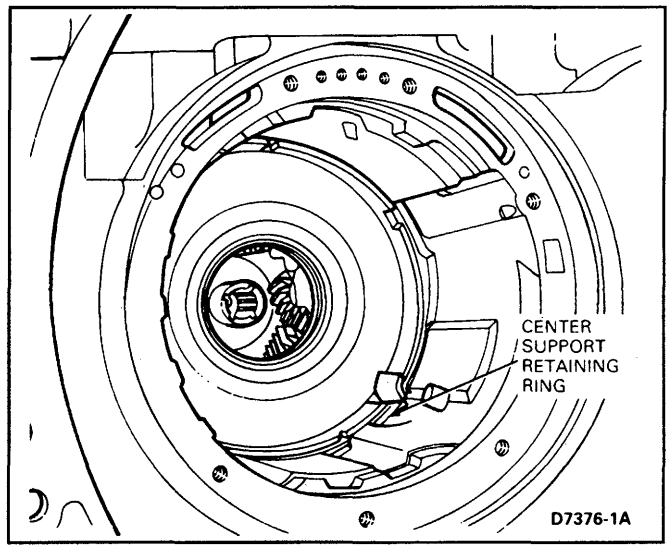


FIG. 78 Installing Center Support Retaining Ring

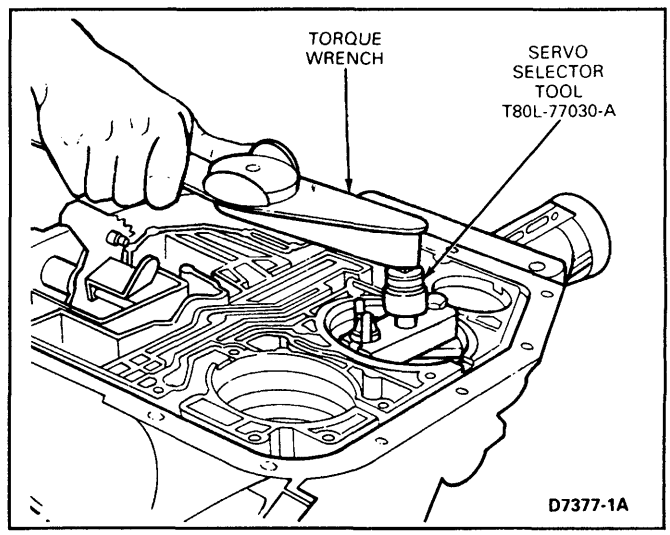


FIG. 79 Installing Servo Selector Tool

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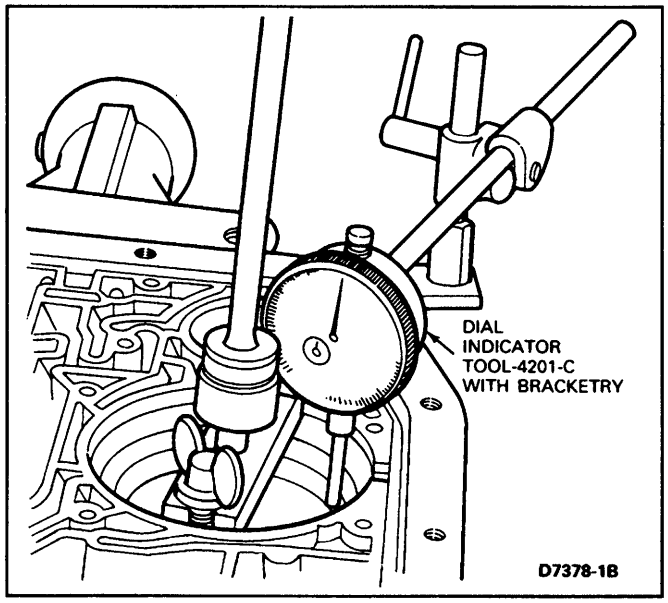


FIG. 80 Checking Pin Length

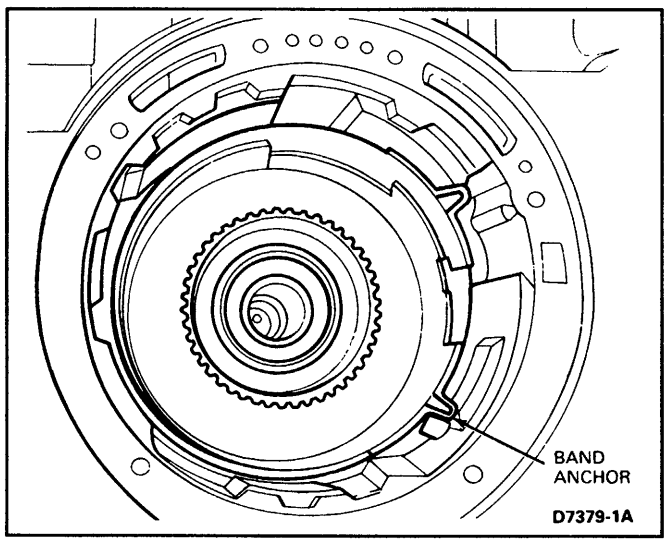


FIG. 81 Overdrive Band Installation

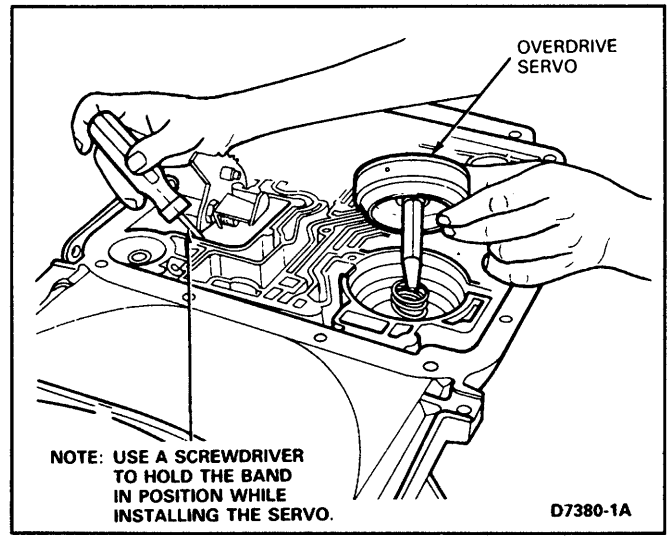


FIG. 82 Installing Overdrive Servo

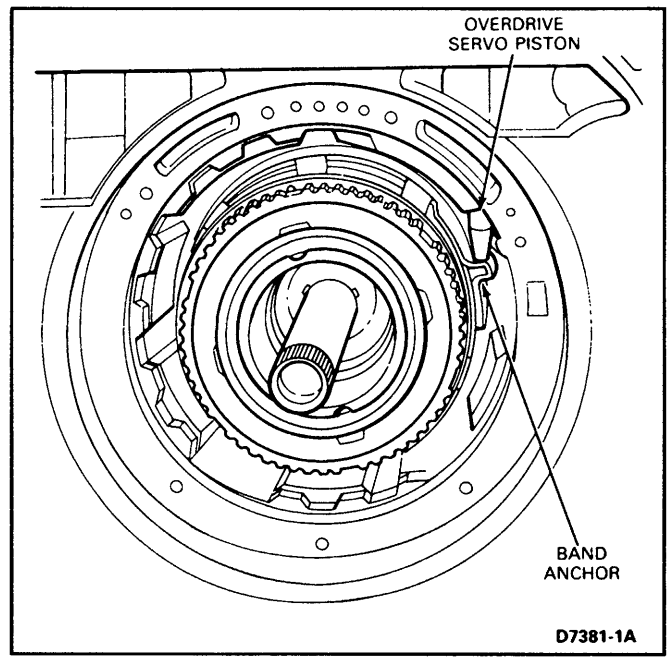


FIG. 83 Overdrive Servo Piston Engagement

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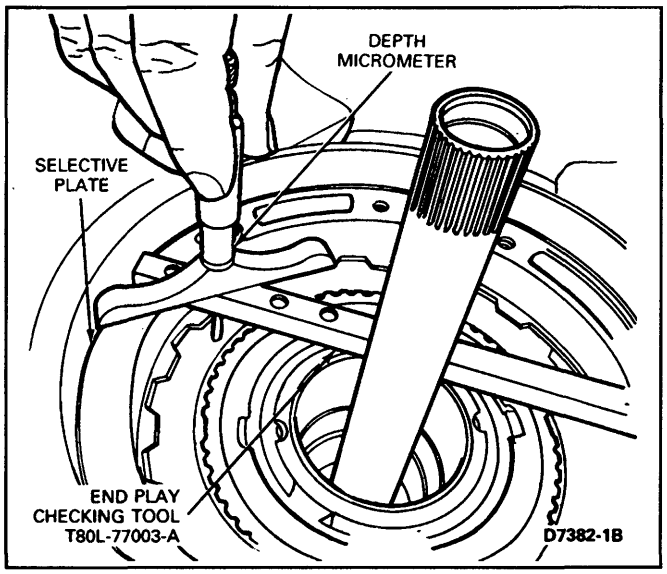


FIG. 84 Measuring Intermediate Clutch Clearance

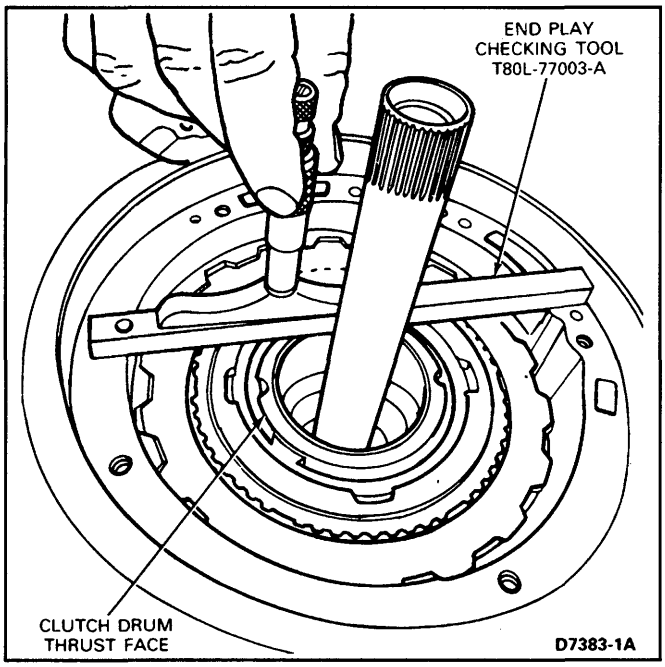


FIG. 85 Checking Transmission End Play

Depth	Washer No.	Washer Size	Washer Color
1.483"-1.500"	1	0.050"-0.054"	Green
1.501"-1.517"	2	0.068"-0.072"	Yellow
1.518"-1.534"	3	0.085"-0.089"	Natural
1.535"-1.551"	4	0.102"-0.106"	Red
1.552"-1.568"	5	0.119"-0.123"	Blue

CD4003-1A

FIG. 86 Selective Thrust Washer Usage

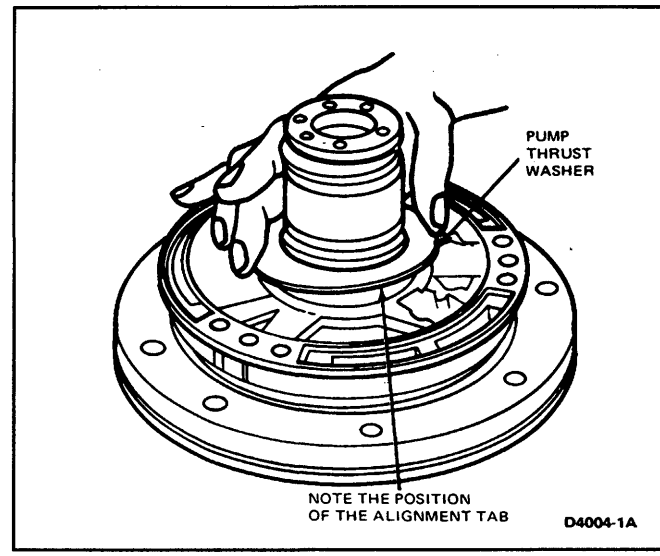


FIG. 87 Installing Selective Washer

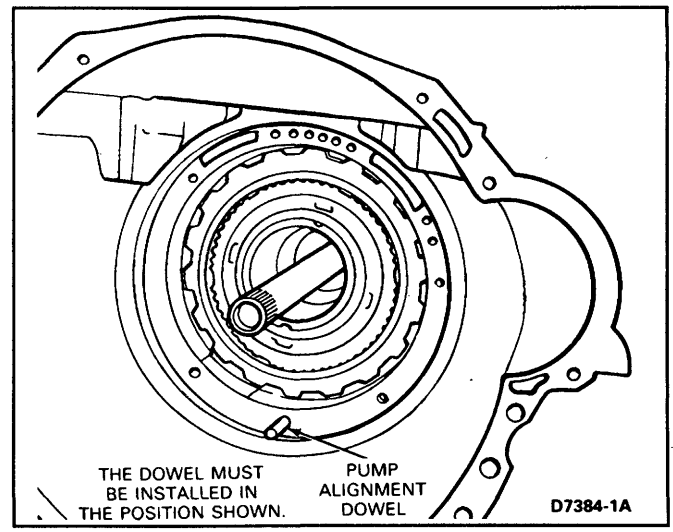


FIG. 88 Installing Pump Alignment Dowel

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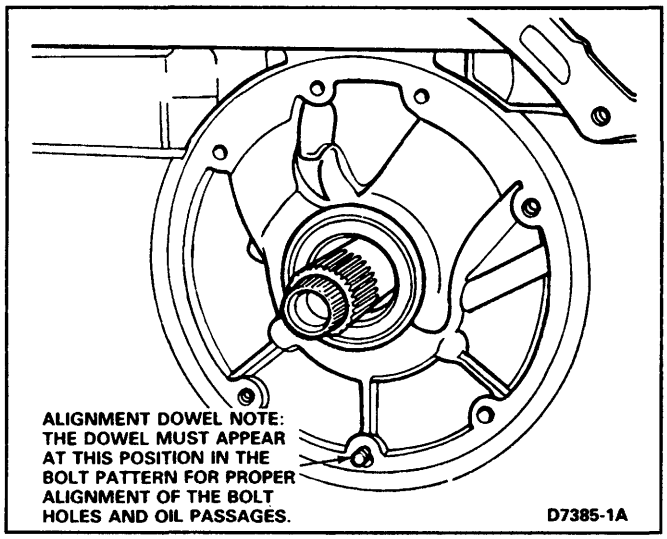


FIG. 89 Correct Front Pump Installation

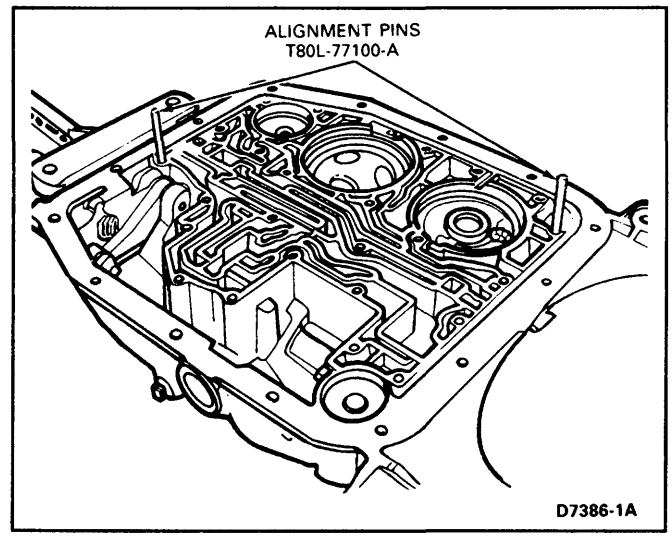


FIG. 90 Installing Valve Body Alignment Pins

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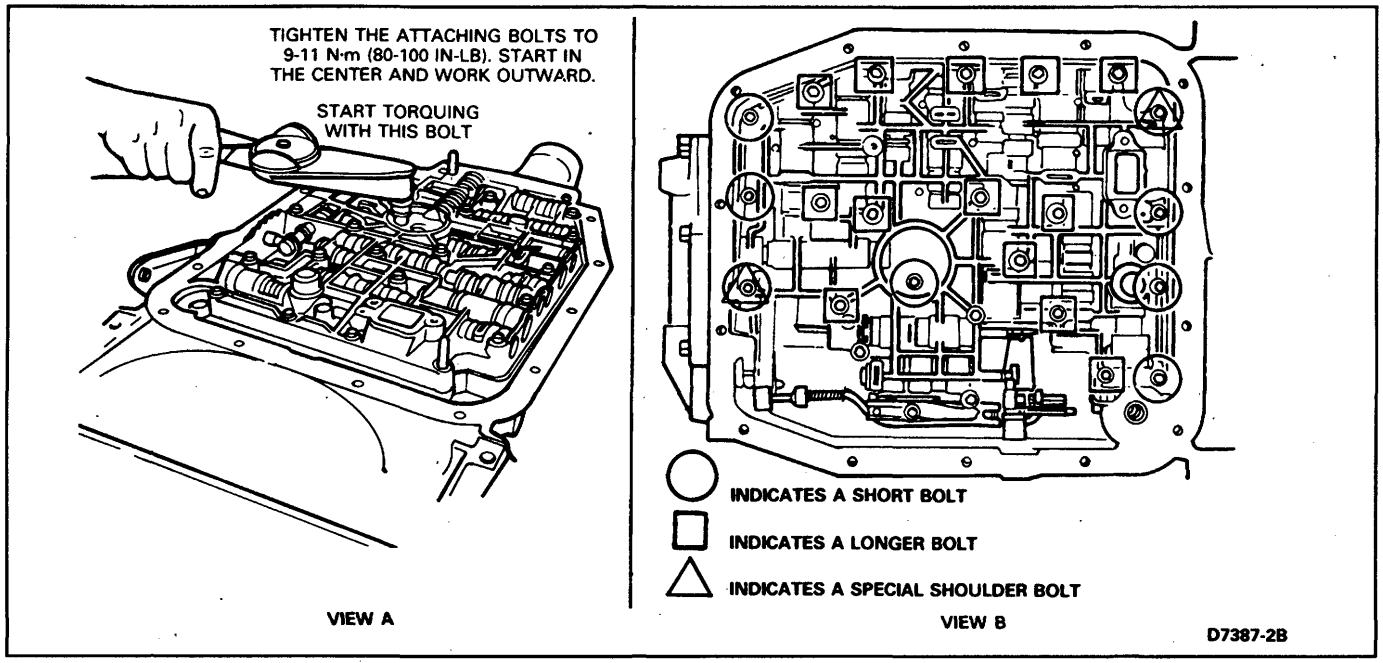


FIG. 91 Valve Body Installation

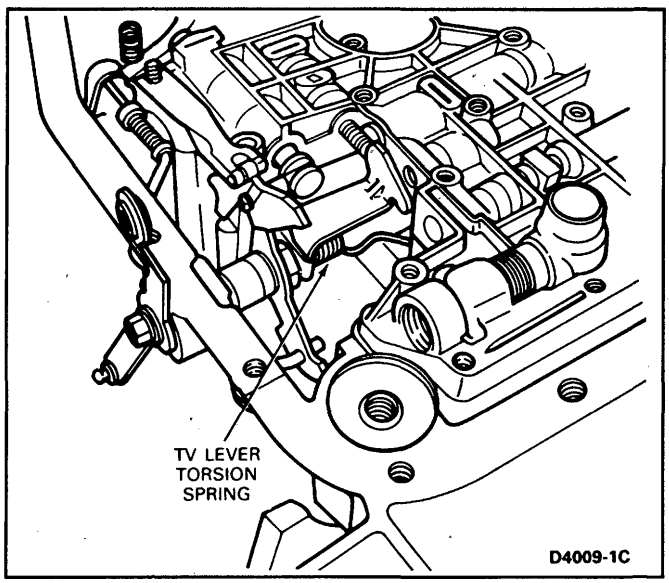


FIG. 92 Torsion Spring Installation

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SPECIFICATIONS

Clutch Pack Plate Usage and Clearance

SPECIFICATIONS
CLUTCH PACK PLATE USAGE AND CLEARANCE

FORWARD CLUTCH

Transmission Model	Steel	Friction	Clearance	Selective Snap Rings-Thickness
Models with 4.9L (300 CID) EFI and 5.0L (302 CID) EFI	5*	5	0.050-0.089	0.060-0.064
				0.074-0.078
				0.088-0.092
				0.102-0.106

*Plus a waved plate (Installed next to piston)

REVERSE CLUTCH

Transmission Model	Steel	Friction	Clearance	Selective Snap Rings-Thickness
Models with 4.9L (300 CID) EFI and 5.0L (302 CID) EFI	3	4	0.040-0.075	0.060-0.064
				0.074-0.078
				0.088-0.092
				0.102-0.106

DIRECT CLUTCH

Transmission Model	Steel	Friction	Clearance	Selective Snap Rings-Thickness
All	5	5	0.050-0.067	0.050-0.054
				0.064-0.068
				0.078-0.082
				0.092-0.096

INTERMEDIATE CLUTCH

Transmission Model	Steel	Friction	Gauge Dim.	Selective Steel Plates-Thickness
All	3	3	1.634-1.646	0.067-0.071
				0.077-0.081
				0.087-0.091
				0.097-0.101

Low-Reverse Servo Piston Travel - 0.108-0.241

Note: Piston travel can be adjusted using one of the selective servo pistons available for service.

SELECTIVE SERVO PISTONS

Rod Length*	I.D.	Rod Length*	I.D.	Rod Length*	I.D.
2.936	1 Groove	2.989	2 Groove	3.043	3 Groove

*Measured from the base of the piston to the end of the rod

Transmission End Play

Note: Transmission end play can be adjusted using one of the selective thrust washers available for service. After measuring the depth, install the required thrust washer.

SELECTIVE THRUST WASHER*

Depth	Thickness	Color Code	Depth	Thickness	Color Code
1.483-1.500	0.050-0.054	Green	1.535-1.551	.102-.106	Red
1.501-1.517	0.068-0.072	Yellow	1.552-1.568	.119-.123	Blue
1.518-1.534	0.085-0.089	Natural			

*The thrust washer is located on the stator support which is attached to the back of the pump housing.

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CLUTCH AND BAND APPLICATION CHART

	Interm. Friction Clutch	Interm. One-Way Clutch	Overdrive Band	Reverse Clutch	Forward Clutch	Planetary One-Way Clutch	Low-Reverse Band	Direct Clutch
1st Gear Manual Low					Applied	Holding	Applied	
2nd Gear Manual Low	Applied	Holding			Applied			
1st Gear - Ⓓ or D					Applied	Holding		
2nd Gear - Ⓓ or D	Applied	Holding			Applied			
3rd Gear - Ⓓ or D	Applied				Applied			Applied
4th Gear - Ⓓ	Applied		Applied					Applied
Reverse (R)				Applied			Applied	

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TORQUE CHART

Application	Torque	Application	Torque
Stator Support to Pump Body	16-22 N•m (12-16 ft-lbs)	Governor Body Cover Plate to Governor Body	2.3-3.4 N•m (20-30 in-lbs)
Front Pump to Case	22-27 N•m (16-20 ft-lbs)	Inner Manual Lever to Shaft	26-37 N•m (19-27 ft-lbs)
Reinforcing Plate to Valve Body	9-14 N•m (80-120 in-lbs)	Outer Throttle Lever to Shaft	16-22 N•m (12-16 ft-lbs)
Separator Plate to Valve Body	9-14 N•m (80-120 in-lbs)	Cooler Connector Line to Case	24-31 N•m (18-23 ft-lbs)
Valve Body to Case	9-11 N•m (80-100 in-lbs)	Converter Plug to Converter	11-38 N•m (8-28 ft-lbs)
Filter to Valve Body	9-14 N•m (80-120 in-lbs)	Neutral Start Switch to Case	11-15 N•m (8-11 ft-lbs)
Oil Pan to Case	8-14 N•m (6-10 ft-lbs)	Pressure Plug to Case	8-16 N•m (6-12 ft-lbs)
Extension to Case	22-27 N•m (16-20 ft-lbs)	Transmission to Engine	55-68 N•m (40-50 ft-lbs)
Governor Body to Counterweight	6-7 N•m (50-60 in-lbs)		

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SPECIAL SERVICE TOOLS

Number	Description
T50T-100-A	Impact Slide Hammer
T59L-100-B	Impact Slide Hammer
T58L-101-B	Shift Shaft Seal Remover
T57L-500-B	Bench Mounted Holding Fixture
TOOL-1175-AC	Front Pump Seal and Rear Case Bushing Remover
TOOL-4201-C	Dial Indicator with Bracketry
T82L-7006-A	Air Pressure Check Plate
T82P-7006-C	Capscrews (M6x16) for use with Air Pressure Check Plate
T67P-7341-A	Shift Linkage Insulator Tool
T84P-7341-A	Grommet Remover
T84P-7341-B	Grommet Replacer
T61L-7657-A	Extension Housing Seal Replacer
T77L-7697-A	Extension Housing Bushing Remover
T83L-7902-A	Converter Checking Tool
TOOL-7000-DE	Air Nozzle
T71P-19703-C	O-Ring Pick
D80L-77001-A	T.V. Pressure Fitting
T80L-77003-A	End Play Gauge Bar
T80L-77005-A	Intermediate Clutch Lip Seal (Inner and Outer)
T80L-77030-A	Servo Piston (Reverse) Selection Tool
T80L-77030-B	Servo Piston Remover (Also Used for Air Pressure Checks)
T80L-77034-A	Extension Housing Bushing Replacer
T73P-77060-A	Snap Ring Plier
T80L-77100-A	Valve Body Guide Pins (2)
T80L-77103-A	Front Pump Adapter Remover (2)
D80L-77001-A	TV Control Pressure Adapter Fitting
T80L-77110-A	Rear Case Bushing Replacer
T80L-77140-A	Forward Clutch Lip Seal Protector (Inner)
T80L-77234-A	Lip Seal Protector (Inner)
T74P-77247-A	Neutral Start Switch Socket
T74P-77248-A	Extension Housing Seal Remover
T80L-77254-A	Lip Seal Protector (Outer)
T80L-77268-A	Front Pump Bushing Replacer
T80L-77268-B	Front Pump Bushing Remover
T80L-77403-A	Reverse Clutch Seal Protector (Outer)
T80L-77403-B	Reverse Clutch Seal Protector (Inner)
T80L-77405-A	Reverse Clutch Spring Compressor Plate
T74P-77498-A	Front Pump and Shift Shaft Seal Replacer
T65L-77515-A	Clutch Spring Compressor
T80L-77515-A	Forward Clutch Spring Compressor Adapter
T68P-7D158-A	Forward Clutch Lip Seal Protector (Outer)
T63L-77837-A	Front Pump Seal Replacer
T86L-70332-A	Cable TV Control Pressure Gauge Tool
T86L-70002-A	TV Pressure Gauge with Hose

CD4805-2F

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AUTOMATIC TRANSMISSION REFILL CAPACITY — AOD AUTOMATIC TRANSMISSION

Vehicle	Transmission Type	Engine	Approximate Refill Capacity*		
			U.S. Quarts	Imperial Quarts	Liters
E-150 — E-250, F-150 — F-250 (4x2) (4x4) Bronco (4x4)	AOD #	5.0L (302 CID) EFI 4.9L (300 CID) EFI	12.3	10.2	11.6

*Approximate dry capacity, includes cooler and lines. Fluid level indicator should be used to determine **actual** fluid requirements and fluid specifications. Check level at normal operating temperature. **DO NOT OVERFILL.**

If it is necessary to add or replace fluids, use only fluids which have been certified by the supplier as meeting one of the Ford Motor Company specifications shown below:

#AOD transmissions — Motorcraft MERCON® WSP-M2C185-A or equivalent. **CD4934-2E**

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NOISE, VIBRATION AND HARSHNESS DIAGNOSIS

GROUP 18

SECTION 18-01 Noise, Vibration and Harshness Diagnosis

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Driveshaft Balancing	18-01-12
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VEHICLE APPLICATION

Applies To All F-150—F-350, E-150—E-350, Bronco and F-Super Duty Truck Models.

DESCRIPTION

Noise

Noise, defined as any unpleasant sound, may be described in a variety of ways such as tapping, whistling, buzzing, humming, clunking, or booming. You can associate these various descriptions of noise with a probable cause. Based on experience, these descriptions will assist in isolating the problem and correcting it. Generally recognizable problem areas are engine, drivetrain, wind and road surface noises. Other less obvious areas that should be considered as noise problem sources are any of the problems that cause the vibrations described in the following Section.

Noise Acceptability

A gear driven unit, especially a drive axle, will produce a certain amount of noise. Some noise is acceptable and may be audible at certain speeds or under various driving conditions: for example, tire noise on a newly paved blacktop road. Such noise is in no way detrimental to the operation of the vehicle and must be considered normal. Similarly, camshaft belt whine, most often associated with new belts used on the smaller engines, will usually go away after belt break-in.

NOTE: It is important that the rear axle noise on vehicles equipped with either a manual or automatic overdrive transmission be evaluated in direct drive rather than overdrive.

Vibration

Vibration, technically, is a high-frequency trembling, shaking or grounding condition, felt or heard, that is

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constant or variable in level and occurs during a portion of the total operating speed range. The types of vibrations that can be felt in the vehicle can be divided into three groups:

1. Vibrations of various unbalanced rotating parts of the vehicle.
2. Resonance vibrations of the body and frame structures caused by rotation of these unbalanced parts.
3. Tip-in moans or resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

These vehicle vibrations can also be subdivided into those that occur at low speeds and those that are most noticeable at higher speeds. Since the dividing line between low and higher speed vibrations is not clear, there will be vibrations that overlap the two ranges.

Typical Low Speed Vibrations (Less than 72 km/h or 45 mph)

- Engine harshness.
- Improper driveline angles.
- Power steering pump disturbances.
- Air conditioner compressor or drive belt vibrations.
- Take-off shudder.
- Brake roughness or harshness.
- Driveline roughness.
- Clutch torsion vibration.
- Exhaust vibration.

Typical High-Speed Vibrations (Above 72 km/h or 45 mph)

- Excessive tire-wheel and drum assembly imbalance.
- Excessive tire and wheel run-out.
- Tire roughness due to high non-uniformity (force variation).
- Companion flange runout or imbalance.
- Driveshaft imbalance noise.
- Rear axle pinion gear pitch line runout.
- Galled, dirty, rusty, worn or improperly lubricated driveline slip yoke splines or U-joint bearings.
- Worn suspension components.

Harshness

Harshness is the term commonly used to describe the ride quality of the vehicle. Hard ride or harshness is usually caused by the tires or suspension system, namely:

- Over-inflated, wrong size or wrong type tire installed on the vehicle.
- Suspension not sufficiently lubricated.
- Worn suspension components.
- Suspension components installed with preload on pivot points, bearings and bushings.
- Units equipped with tires not specified by the manufacturer. (Different brand tires often give different ride qualities to vehicle.)
- Bent or bound-up shock absorbers.
- Heavy-duty components installed on vehicle.
- Improper insulation of body or cab mounting (grounding).

Other vehicle ride motions may be summarized as follows:

- Vehicle Bounce—The vertical motion of a vehicle on its suspension system, front and rear in phase. A low frequency "float," an intermediate frequency "kick."
- Vehicle Pitch—The out-of-phase vertical motion of the front and rear of the vehicle. A flat ride would be considered the opposite of a pitch ride.
- Vehicle Roll—The side-to-side rotation of the vehicle body about the front and rear axles.

DIAGNOSIS AND TESTING

Noise, vibration, and harshness (N.V.H.) usually occurs in four areas: tires, engine accessories, suspension and drive line.

It is important, therefore, that an N.V.H. problem be isolated into its specific area as soon as possible. The easiest and quickest way to do this, is to perform a thorough road test if a visual inspection does not readily pinpoint the problem. After performing the Road Test Check, isolate the probable cause of the condition using the Road Test Diagnosis Chart. Use the appropriate diagnostic procedure chart and/or guide to determine the area of investigation.

N.V.H. Tests and Operations

A gradual appearance of the problem indicates a deterioration of a component, such as tires, U-joints, an accessory drive belt, or a wheel bearing.

A sudden appearance of the problem could indicate a lost wheel balance weight or lost driveshaft balance weight.

NOTE: Information gained from the problem description should never be used in place of facts gained from diagnosis, nor should it be used in an attempted short cut fix. In the long run, time will be saved by adhering to the diagnostic procedures shown in this Section.

Diagnosis

Use the four diagnosis guides in this Section to identify the Noise, Vibration or Harshness condition. When the condition is isolated, refer to the appropriate portion of Testing in this Section.

Testing

Vehicle Vibration Analysis Procedure

1. Initial Checks:
   a. Tire Matching — Tire size and type match.
   b. Inflation Pressure — Correct inflation pressure.
   c. Appearance — Check for wear and condition of tires and wheels.
   d. Rim Centering — Check that tire beads are properly seated.
2. Problem Definition:
   a. Ask customer to explain the problem.
   b. Ride in vehicle and experience the vibration described by owner (with owner if possible). Note speed and suspect wheel position.
3. Tire Runout Check on Vehicle:

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a. Runout okay — Go to dynamic balance check.
a. Excessive runout — Refer to match mounting procedure.
b. High runout still present — Refer to wheel stud runout procedure.
c. Replace high runout wheels or tires when required — Go to dynamic balance check.

4. Dynamic Balance:

Mark a stud bolt and the corresponding position on the rim to ensure that the assembly can be replaced on the vehicle in its original position. Do not remove existing balance weights. If rebalance only requires 1/2 oz. or less on either flange, the problem is not imbalance; proceed to ride test.

If problem is balance, rebalance and continue to ride test.

Never add more than 3 oz. of weight per flange on a passenger car tire. If more weight is required:

a. Spin the assembly on the balancer in static mode.
b. Mark the location and amount of weight required on the sidewall. Do not balance assembly.
c. Remove assembly from the balancer, deflate and rotate tire halfway around (180 degrees) as in matching for runout.
d. Reinflate, replace on balancer and respin a second time in static mode.
e. Mark location and amount of weight required on sidewall.
f. If your two marks are within 4 inches of each other, it is the tire that is the major contributor to imbalance. (The marks followed the tire when it was rotated.) Replace tire.
g. If your two marks are within 4 inches of being opposite each other on the tire, then the wheel is out of balance. Replace wheel.
h. If the two marks are neither opposite nor together, then the assembly can be match mounted for static balance. Refer to match mounting procedure.

5. Ride Test:

a. Problem eliminated — Stop.
a. Vibration is still present check:

Brake drum imbalance
Engine or transmission mounts
Excessive drive shaft runout or imbalance
Improper pinion angle
Faulty universal joints
Worn or damaged wheel bearings
Brake rotor imbalance

High-Speed Shake

This is a low-frequency, high-amplitude, visible vibration felt in floor pan, seats and steering column at speeds above 72 km/h (45 mph), and may be visible in front end sheet metal. The cause is usually found in the wheel/tire/rotor/drum/axle area, arising from imbalance, run-out, bearing play, tire irregularities, etc. Visible sheet metal shake, though usually just another symptom of wheel-and-tire problems, may be indicative of improper tightening or adjustment of sheet metal mounting hardware. This condition, in conjunction with aerodynamic buffeting forces in some vehicles, especially trucks, can be a primary source of shake. If such shake is observed, inspection and tightening of sheet metal mountings may correct the problem.

1. After verifying the shake condition on the road test (at least 10 miles to remove flat spots from nylon cord tires), promptly raise the vehicle on a twin-post hoist or axle jack stands so that the tires do not develop flat spots while cooling off. Inspect tires for extreme wear or damage, or irregularities such as cupping or flat spots (see Fig. 1). If found, check the suspension components for misalignment, abnormal wear, or damage that may have contributed to the tire problems. Correct any suspension problems, and replace the damaged tires.
2. Spin the front wheels by hand (rear wheels on front-wheel-drive models) to check for wheel bearing roughness. Also check for end play. If bearings are loose or rough, adjust or replace and lubricate as necessary. On 4 x 4 models equipped with locking front hubs, unlocking the hubs will free wheels for bearing checks. Without unlockable hubs, removal of the hub cover is necessary to disengage the axle shafts.
3. Spin the non-driving wheels at low speed with a wheel balance spinner, observing for visible wheel/tire run-out. If run-out is evident, proceed to wheel/tire run-out checks, Steps 8 and 9. If run-out is not evident, balance the non-driving wheels and proceed to Step 4. Front wheels on 4 x 4's, if equipped with locking hubs, can be spun with hubs unlocked, or engine-driven with front drive engaged, for run-out checks.
4. With drive train engaged, carefully accelerate the drive wheels until shake is felt. Without road load, the shake may be aggravated, and become extreme at lower speeds than observed in the road test. Accelerate up to the road test speed if necessary to bring out the shake. For 4 x 4's, run the test with front drive both engaged and disengaged, and note any difference. If shake appears, proceed to Step 5. If little or no shake is evident and a front-wheel condition has been found and corrected, repeat the road test to see if the problem still exists. If it does, check wheel/tire run-out (Steps 8 and 9).
5. If shake is evident on the hoist run-up, mark the positions of the drive wheels relative to the axle lugs, remove the wheels, secure the brake drums, if so equipped, by installing all lug nuts, reversed, and repeat the run-up to road speed. If shake is eliminated, the problem is probably wheel imbalance or run-out. Before proceeding to run-out checks, verify that rear axle shaft run-out is within limits (Step 7).
6. If vibration is evident with the rear wheels off, remove the brake drums and repeat the road-speed run-up. If the shake is gone, brake drum imbalance or run-out is indicated, but brake run-out may be caused by axle run-out, which should be checked (Step 7). Check brake drum balance on a bubble-type static balancer, and replace or machine out-of-balance drums. If loss of balance weight is evident, and re-balancing is warranted, refer to brake drum balancing in this Section. If shake persists in the drums-off test, refer to Driveline Vibration in this Section under testing.

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Diagnosis Guides

ROAD TEST DIAGNOSIS

Condition	Possible Source	Refer to (Procedure)
Visible shake in floor pan, seats, steering column and/or front end sheet metal at highway speed, 72 km/h (45 mph) and up.	Wheel/tire/axle imbalance or run-out.	High-Speed Shake.
Vibration felt or heard at highway speed, 72 km/h (45 mph) and up. Evident at steady speed, or under light acceleration or deceleration.	Driveline or drive axle imbalance or run-out. Engine mounts grounded. Exhaust system bound-up.	Driveline Vibration. Tip-In Moan, Step #3. Tip-In Moan, Step #4.
Shudder or rumble on heavy acceleration or deceleration, 0-72 km/h (45 mph).	Incorrect driveline angle(s).	Driveline Angles Check.
Moaning noise, and possible belt vibrations, on light acceleration or deceleration between 40 and 104 km/h (25-65 mph).	Engine or exhaust mounts bound up, powertrain components grounding, or undamped powertrain resonance.	Tip-In Moan.
Engine-rpm-related vibration or noise that disappears in Neutral-Coast drive mode, and appears in standstill engine run-up at specific rpm.	Engine accessory drive or mount not properly adjusted or tightened, not running true, or accessory malfunction.	Engine Accessory Vibration.
Various hums, howls, whines or knocking noises that vary in intensity and pitch with road speed, and may or may not respond to drive mode changes.	Drive axle gear or bearing wear, damage or improper adjustment.	Drive Axle Noise.
Low frequency booming noise or pressure felt in ear drums, which occurs at or just above idle.	Engine or exhaust mounts bound-up.	Idle Boom.

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GENERAL NOISE DIAGNOSTIC PROCEDURE

CONDITION	POSSIBLE SOURCE	
• Noise is the same on drive or coast.	• Road noise • Tire noise • Front wheel bearing noise	• Pinion Bearings • Rear wheel bearings
• Noise changes with type of road surface.	• Road noise	• Tire noise
• Noise tone lowers as vehicle speed is lowered.	• Tire noise • Driveline noise	
• Similar noise is produced with vehicle standing and driving.	• Engine noise	• Transmission noise
• Noise most pronounced on turns.	• Differential side gears and pinion gears	
• Drive noise, coast noise, or float noise.	• Wheel bearings • Ring and pinion gear	• Axle shaft surface finish at bearing bore
• Clunk on acceleration or deceleration.	• Inoperative throttle damper • Excessive differential gear backlash • Excessive ring and pinion gear backlash • Transmission backlash	• Loose engine mounts • Worn driveshaft U-joints • Worn driveshaft slip yoke splines • Loose suspension components • Sticking slip yoke

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7. Remove brake drums, if not already removed, to expose the axle shaft flange. Indicate the flange face lateral run-out (Fig. 2), the drum/rotor pilot radial run-out (Fig. 3), and the lug bolt circle radial run-out (Fig. 4). (Read each lug bolt in turn with a broad-foot indicator as close to the axle flange as possible, being careful not to jar the indicator out of position from one reading to the next. Note the highest and lowest readings.) Compare total indicator readings (T.I.R.'s) with the runout.

   If any run-out value exceeds specification limit, replace the axle shaft or hub. Check for radial play in rear axle bearings, or evidence of roller damage to bearing inner race surfaces on the axle shafts. Replace axle shaft if bearing journal is damaged. Replace bearings if loose or rough.

8. Re-install driving wheels and tires in original positions. Check all wheels for total radial and lateral tire run-out, using Rotunda Gauge 007-00014, or equivalent, as illustrated in Fig. 5. If either is over 1.78mm (.070 inch), check the wheel rim run-out, radial and lateral (Fig. 5). If either exceeds 1.14mm (.045 inch), replace the wheel and re-check run-out. If the rim is within limits, locate and mark the low point of rim radial run-out.

9. If rim run-outs are within limits and total lateral (tire) run-out is over 1.78mm (.070 inch), replace the tire. If total tire **radial** run-out is more than 1.78mm (.070 inch), mark the highest point of the tread, dismount, re-index and remount the tire with the high point aligned with the low point of the wheel. Re-check radial tread run-out, and if still more than 1.78mm (.070 inch), replace the tire and re-check run-outs, re-indexing as necessary to bring radial run-out within limits.

   NOTE: When remounting tires, to assure accurate centering, use plenty of rubber lubricant on rim and tire bead, over-inflate to seat the bead (as recommended by tire manufacturer), then bleed pressure down to pressure noted on specification label.

10. Balance all wheels not previously balanced, using on-vehicle balancing equipment if available. Road test the vehicle. If the problem has not been eliminated, proceed to Step 11.

11. Substitute a known-good set of wheels and tires, and road test. If shake is gone, the problem was probably caused by tire force variation, resulting from non-uniform tire construction. Re-install the original tire/wheel assemblies one-by-one, road testing at each step, until the worn or damaged tire(s) is identified. Replace tire(s) as necessary and retest. If shake persists with substitute wheels, refer to Driveline Vibration in this Section under Testing.

Match Mounting Tires

Match mounting is a technique used to reduce radial or lateral tire runouts on tire and wheel assemblies. Excessive runout is a source of ride complaints and match mounting can be used to minimize the runout. There are two ways to use match mounting: 1. positioning of the tire on the wheel; and 2. positioning the wheel on the hub.

1. Measure the total indicated runout on the center of the tire tread rib, and record it. Mark the tire and rim at the center of the tread rib, and record the reading. Mark the tire at the location of the valve stem for reference.

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DIAGNOSIS GUIDE	
Non-Axle Noises	
• Grille Whistle • Trim Moulding	• Exhaust • Tires
Noise Conditions	
• Gear Howl and Whine — Inspect Gear Set — Check Gear Set Backlash	— Check Ring Gear Run-out — Check Bearing Preload
• Chuckle Noise — Differential Gear Clearance	— Mutilated Gear Teeth
• Knock Noise — Gear Tooth Mutilation — Ring Gear Bolts	— Axle Shaft End Play
• Clunk Noise — Total Axle Backlash — Worn Driveshaft U-joints — Loose or Broken Engine Mounts	— Worn Driveshaft Slip Yoke Splines — Axle Shaft Spline Fit — Inoperative Throttle Damper
• Bearing Noise — Pinion Bearing — Wheel Bearing — Differential Thrust Washer	— Limited-Slip Operation — Click on Engagement
Vibration Conditions	
• Tires • Driveline Angle • Universal Joint	• Axle Shaft • Drive Pinion Stem and Flange • Wheel Nuts
Leakage Conditions	
• Drive Pinion Seal • Drive Pinion Nut • Axle Cover Gasket • Axle Shaft Seals	• Casting Porosity (Holes in Casting) • Weld Leaks • Axle Vent and/or Hose
Inoperative Conditions	
• Broken Axle Shaft • Broken Pinion Stem • Broken Welds	• Wheel Bearing • Axle Lock-Up • Broken End Yoke • Broken U-Joint • Broken Gear Teeth

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2. Break down the tire and remount it 180 degrees on the rim so that the valve stem reference mark is opposite of the valve stem on the wheel.
3. Reinflate the tire and measure the total indicated runout, and again mark the high spot.
4. If the runout is reduced to acceptable guidelines the tire is ready to be put back into service. If the runout is still excessive, one of the following steps must be performed:

- If the high spot is within 4 inches of the first high spot on the tire, and is still outside of guidelines, replace the tire.
- If the high spot is within 4 inches of the first high spot on the wheel, the wheel may be out of tolerance, check the wheel for runout.
- If the high spot is not within 4 inches of either original high spot of the tire and rim, then draw an arrow from the second high spot to the first high spot (in the shortest direction) and rotate the tire on the rim 90 degrees in that direction. This will normally reduce the runout to an acceptable level.

In the majority of cases, the first 180 degrees turn of the tire will either fix the problem or indicate which item to replace.

Tip-In Moan

A moaning noise, possibly accompanied by a felt vibration, under light to medium acceleration between 40-104 km/h (25 and 65 mph), usually indicates a grounding or bound-up condition of power train component or exhaust system mounts. Another

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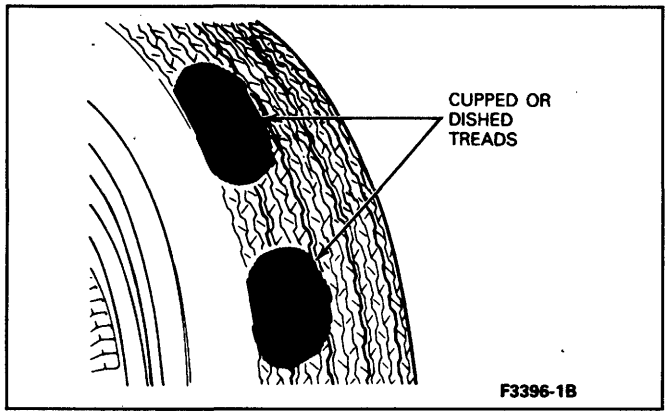


FIG. 1 Worn or Damaged Tires

possible cause is a resonance condition at the natural vibration frequency of the engine. This type of vibration will usually peak at a specific engine speed (RPM) and degree of acceleration (throttle setting) at that speed.

1. Check air cleaner for proper installation of base gasket, lid, element and air inlet duct assembly. If damaged gaskets, or improper duct alignment or tightening of attaching nuts and bolts are evident, correct the condition and road test. If moan persists, proceed to Step 2.
2. To check for powertrain resonance, loosen all converter or clutch housing-to-engine attaching bolts 3/4 turn and road test. Re-tighten bolts after test. If moan persists, proceed to Step 3.
3. Neutralize engine mounts by loosening them (Fig. 6) and, with engine running, shifting transmission from Neutral to Drive and back to Neutral. With manual transmission, load engine by slipping clutch in gear. Re-tighten mounts and road test. If moan persists, proceed to Step 4.
4. Neutralize the exhaust system to relieve strain on mounts which may be sufficiently bound up to transmit vibration as if grounded. First, be sure the system is warmed up to normal operating

Run-out Limits	Flange Face Lateral	Drum/Rotor Pilot Radial	Lug Bolt Circle Radial
Dana Axle	0.13mm (0.005 inch)	0.8mm (0.003 inch)	0.13mm (0.005 inch)
Ford Axle	0.13mm (0.005 inch)	0.10mm (0.004 inch)	0.36mm (0.014 inch)

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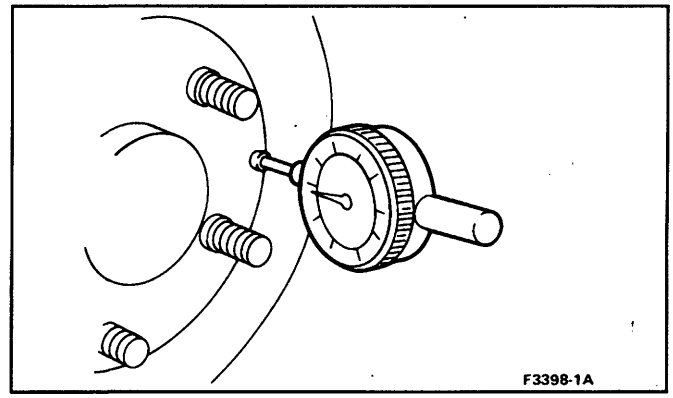


FIG. 2 Flange Face Lateral Run-out

REAR AXLE DIAGNOSIS CHART

CONDITION	POSSIBLE SOURCE	RESOLUTION
• Excessive rear axle noise.	• Differential carrier	• Road test vehicle to assure problem is rear axle noise rather than other system noise. Refer to General Diagnostic Procedure. Service and replace parts as required.
• Loud "clunk" in the driveshaft when shifting from reverse to forward.	• Driveshaft	• Raise vehicle, rotate driveshaft by hand to isolate problem as driveshaft or rear axle problem. Service or replace as required.
	• Rear axle shaft or carrier	• Inspect and service as necessary.
• Limited-slip axle does not work in snow, mud or on ice.	• Differential	• Perform Traction-Lok Differential Operation Check. (Refer to Section 15-01, General Driving Axle and Driveshaft Service.) Service as required.
• On turns, the rear axle has a chattering noise (Limited-slip or Traction-Lok axles only). Slight chatter noise on slow turns after extended highway driving is considered acceptable and has no detrimental effect on the locking axle functions.	• Lubricant	• Road test vehicle. Drive vehicle in tight circles, five clockwise and five counterclockwise. If chatter is still evident, flush, replace lubricant with the required limited-slip lubricant.
	• Differential	• Remove differential, service as required.

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temperature, as thermal expansion could be the cause of a strain problem. Loosen all hanger attachments and flange joints. Reposition the hangers until they hang free and straight (see Fig. 7). Then with engine running, shift transmission from Neutral to Drive and back to Neutral (or load engine with clutch), and re-tighten all hanger clamps and flanges (tighten the manifold to exhaust flange joint last). Verify adequate clearance to prevent grounding at any point in the system. Road test the vehicle and if moan persists, refer to Engine Accessory Vibration in this Section under Testing.

Driveline Vibration

This is a higher-frequency, lower-amplitude vibration than high-speed shake, directly related to road speed, and usually more noticeable at higher road speeds, 72 km/h (45 mph) and up. It is felt in the floor pan or heard as a rumble, hum or boom. It will exist in all drive modes, but may vary somewhat in acceleration, deceleration, float or coast modes. If the vibration is particularly responsive to heavy acceleration or deceleration, especially at lower speeds, driveline angles should be checked. A driveline vibration can usually be duplicated with the axle supported on a hoist or jack stands; through light brake application while accelerating and decelerating, to simulate road load resistance, may be necessary to bring it out.

For driveline vibration diagnosis and testing procedures, refer to Section 15-60, General Driveshaft Service.

Driveline Angle Check

A shuddering feel or audible rumble at speeds up to 72 km/h (45 mph), most pronounced under heavy acceleration or deceleration and reduced or eliminated in float or neutral-coast modes, usually indicates incorrect driveline angle, between driveshaft and rear axle pinion. Another possible cause is poor seating, tight or bound up U-joint trunnion or off-center mounting of U-joints. Driveline angularity is controlled by ride (spring) height, suspension control arm geometry or axle-to-spring shims in leaf spring applications, and center bearing alignment in two-piece shafts (truck). Whether incorrect angle effects are more pronounced under acceleration, or deceleration, depends on whether ride height or pinion angle deviations from specification are plus or minus. The condition usually cannot be duplicated on the hoist because considerable road load torque resistance is required to bring it out.

For driveline angle checking procedures, refer to Section 15-60, General Driveshaft Service.

Engine Accessory Vibration

A noise or vibration that occurs at different road speeds in different gears, but always at the same engine rpm, probably originates in an engine-driven accessory. This type of vibration will disappear in neutral-coast drive mode, and can be duplicated in an engine run-up to the problem speed with the vehicle standing still. It may be caused by a loose, worn or damaged drive belt, a damaged, worn or untrue drive pulley, improperly aligned or tightened accessory mounting brackets or hardware, or worn, damaged, or out-of-true conditions in an accessory itself.

1. Run-up engine to the problem rpm observed in the road test, with vehicle stationary. If vibration is not evident, perform stall test in Drive with brakes locked (or load engine by slipping clutch in gear with manual transmission). If condition appears under load, see Tip-In Moan procedure. If condition appears on no-load test, proceed to Step 2.

   CAUTION: Load tests must be of short duration to minimize torque converter or clutch overheating. If vibration does not appear under load, a more careful road test may suggest driveline vibration as the real problem.

2. With engine stopped, inspect all engine accessory drive belts and pulleys for wear or damage, and check belt tension, using Tool T63L-8620-A or equivalent (Fig. 8). Check all accessory mounting brackets and adjusting hardware for proper alignment and tightness. Replace worn or damaged drive components, correct belt tension and tighten mounting hardware to specification. Start engine and run-up to the problem speed. If vibration or noise persists, proceed to Step 3.

3. With engine idling, visually check all accessory drive belts and pulleys for misalignment, run-out or irregular motion. Replace any pulley with run-out in excess of 3mm (1/8 inch). A belt that is seen to ride up and down in a pulley groove indicates a variable-width condition, either in the belt or in the pulley. If it only happens on one pulley, replace the pulley. Otherwise, replace the belt. When all accessory drives run true at idle, run engine up to the problem speed and look for belt whip. If observed, adjust the belt tension to specification and re-check. If whip persists, replace belt. If no fault is found in the engine accessory drive system, the accessories themselves must be checked. See Step 4.

4. A noisy component can often be identified by probing with a stethoscope-type device while the engine is running at the problem speed. Removing the belt driving the suspect component will usually confirm the identification. If the problem source cannot be pinpointed by probing, a process of elimination is necessary. Remove accessory drive belts one at a time, checking for noise or vibration at the problem speed. When the condition disappears or diminishes, try a new belt on the component thus identified, since the belt construction irregularities may be present which won't show up on inspection. If belt changing doesn't help, repair or replace the noisy component. If the problem is found in the fan/water pump area, re-check for vibration with the fan removed, and if the condition improves, check the fan mounting surfaces for nicks or foreign matter that could cause fan run-out.

   If the source of the condition is not found in the engine accessory system, or corrected by the Tip-In Moan procedures, an imbalance condition in basic components is possible, though unlikely. These include crankshaft, vibration damper, flywheel or flexplate, and clutch or torque converter.

   NOTE: Be sure the vibration condition observed in no-load testing occurs at the same engine speed registered on the tachometer during the road test. All engines have natural vibration frequencies which are evident at no-load, but no problem on the road.

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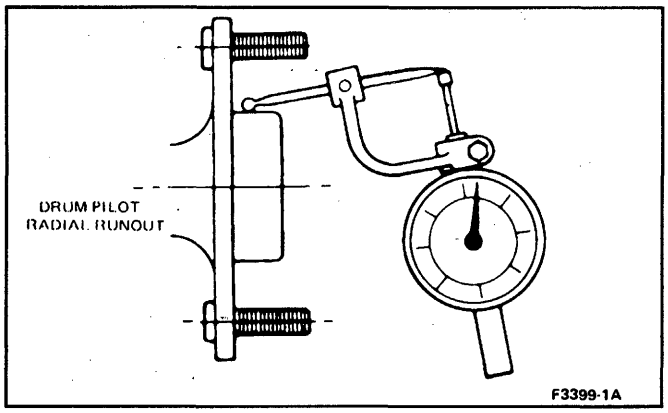


FIG. 3 Drum Pilot Radial Run-out

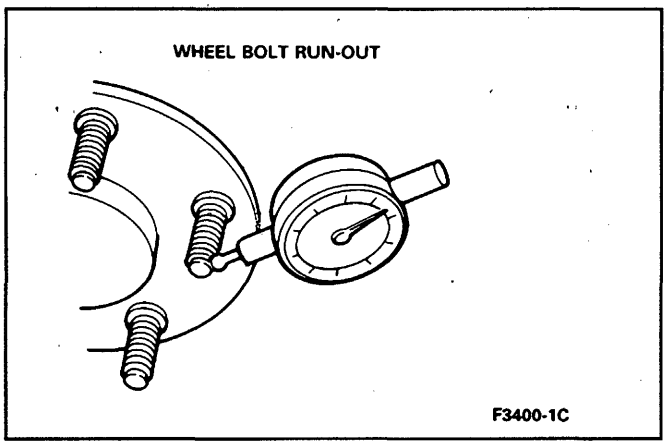


FIG. 4 Wheel Bolt Run-out

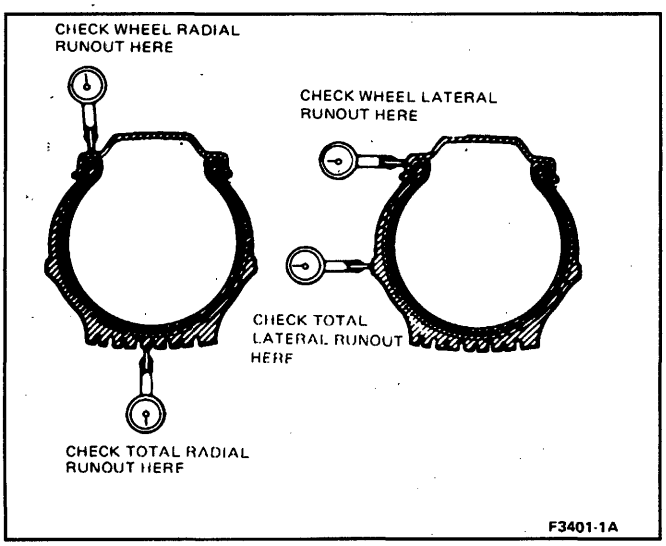


FIG. 5 Radial and Lateral Run-out

Drive Axle Noise

1. **Gear noise** is the typical "howling" or "whining" of the ring gear and pinion due to an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.
2. **Chuckle** is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 64 km/h (40 mph) and usually can be heard all the way to a stop. The frequency varies with the speed of the vehicle.
3. **Knock** is very similar to chuckle; though it may be louder and occurs on acceleration or deceleration. The teardown will disclose what has to be corrected.
4. **Clunk** may be a metallic noise heard when the automatic transmission is engaged in Reverse or Drive, or it may occur when throttle is applied or released. It is caused by backlash somewhere in the driveline; it is "felt" or heard in the axle.

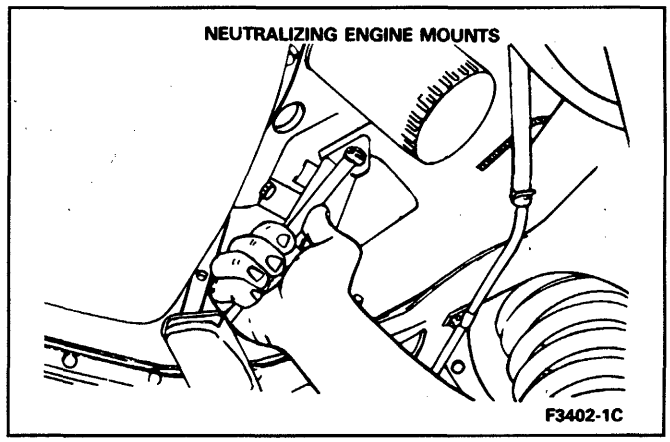


FIG. 6 Neutralizing Engine Mounts

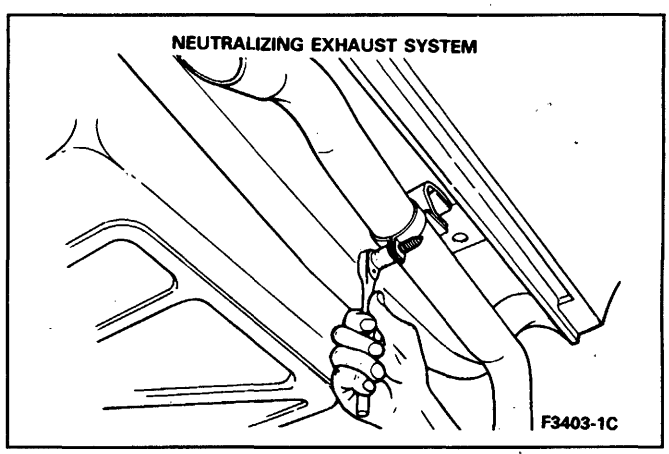


FIG. 7 Neutralizing Exhaust System

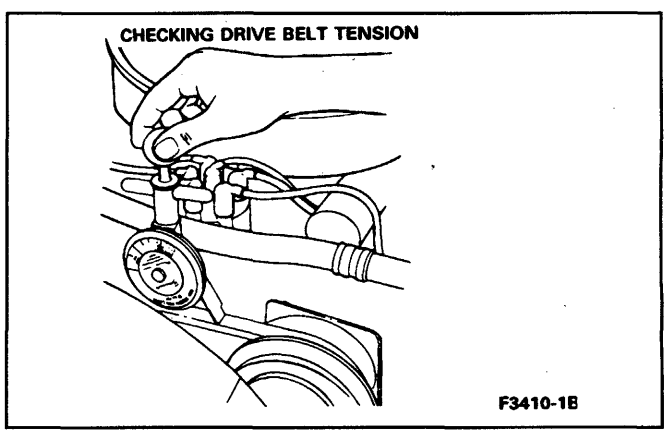


FIG. 8 Checking Drive Belt Tension

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5. **Bearing whine** is a high pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings, which are operating at driveshaft speed. Roller wheel bearings may whine the same way if they run completely dry. Bearing noise occurs at **all driving speeds;** this distinguishes it from gear whine, which usually comes and goes as speed changes.
6. **Bearing rumble** sounds like marbles being tumbled. This condition is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of driveshaft speed.
7. **Chatter on corners** is a condition where the whole rear end vibrates only when the vehicle is moving. The vibration is plainly felt as well as heard. In conventional axles, extra differential thrust washers cause a condition of partial lockup that creates this chatter. Chatter noise on Traction-Lok axles can usually be traced to erratic movement between adjacent clutch components and can sometimes be corrected with a lubricant change and the addition of a friction modifier.
8. **Click at engagement** is a condition on axles of a slight noise, distinct from a "clunk," that happens in Reverse or Drive engagement. Check for the presence of a slinger.
9. **Axle shaft noise** is similar to gear noise and pinion bearing whine. However, axle shaft bearing noise will normally distinguish itself from gear noise by occuring in all driving modes (drive, cruise, coast and float), and will persist with transmission in Neutral while vehicle is moving at problem speed. If upon ride evaluation vehicle displays above noise condition, remove suspect axle shafts, replace wheel seals, and install a new set of axle shafts. Re-evaluate vehicle for noise before removing any internal components.

Non-Axle Noise

There are a few other conditions that can sound just like axle noise and have to be considered in pre-diagnosis. The four most common are exhaust, tires, roof racks and trim mouldings.

1. In certain conditions, the pitch of the exhaust may sound very much like gear whines. At other times, it can be mistaken for a wheel bearing rumble.
2. Tires, especially snow tires, can have a high-pitched tread whine or roar, similar to gear noise. Radial tires, to some degree, have this characteristic. Also, any non-standard tire with an unusual tread construction may emit a roar or whine type noise.
3. Trim and mouldings also can cause whistling or whining noise.

   Therefore, be sure that none of these is the cause of the noise before proceeding with an axle teardown and diagnosis.

Analysis of Gear Noise

Gear Howl and Whine

When disassembling the axle to diagnosis and correct gear noise, it is assumed that the tires, exhaust, and trim items have first been checked as possible causes.

The noises described under "Road Test" usually have specific causes that can be diagnosed by observation as the unit is disassembled. The initial clues are, of course, the type of noise heard on the road test and the driving conditions.

Chuckle

Chuckle that occurs on the driving phase is usually caused by excessive clearance due to differential gear wear; or by a damaged tooth on the coast side of the pinion or ring gear.

Any damage to a gear tooth on the coast side can cause a noise identical to chuckle. Even a very small tooth nick or ridge on the edge of a tooth is enough to cause the noise (Fig. 9).

You can often correct this condition and remove the noise simply by cleaning up the gear tooth nick or ridge with a small grinding wheel.

If either gear is damaged or scored badly, the gear set must be replaced. Also, if there is metal broken loose, the carrier and housing must be cleaned to remove particles that could cause damage later. Any other damaged parts in the axle must be replaced.

To check the gear set, remove as much lubricant as possible from the gears with clean solvent. Wipe the gears dry or blow them dry with compressed air. Look for scored or damaged teeth (Figs. 9 and 10). Also look for cracks or other damage.

If the cleaned up or damaged area is larger than 3.2mm (1/8 inch), it is advisable to replace the gear set.

Knock

Knock, which can occur on all driving phases, has several causes. In most cases, you will discover one of the following conditions:

1. A gear tooth damaged on the drive side is a common cause of the knock. This can usually be corrected by grinding the damaged area.
2. Occasionally, the ring gear bolts will knock against the inside of the carrier casting. The cause may be too little clearance, due to casting flash or bumps. In this case, the carrier can be removed and interference points ground out.

   Another possibility is simply that one or more bolts are slightly backed out. Proper tightening will correct the condition.
3. Knock is also characteristic of excessive end play in the axle shafts. Up to 0.254mm (0.010 inch) is allowed in most axles. However, it may be as high as 1.14mm (0.045 inch); so that knock occurs even in design conditions. The frequency of knock will be less because the axle shaft speed is slower than the driveshaft.

   NOTE: Be sure to measure the end play with a dial indicator, not by feel. A "guesstimate" usually feels like far more end play than there actually is.

   On the 8.8 inch axle, end play is allowable up to 0.762mm (0.030 inch), but can be reduced to 0.127mm (0.005 inch). It is controlled by the C-washer that holds the shaft in the pocket of the side gear (Fig. 11).

   To reduce the clearance, cut a shim in the pattern of the washer and install it behind the washer. Do not reduce the end play to less than 0.127mm (0.005 inch).

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Clunk

Clunk is due to backlash in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, make a check of the total axle backlash as follows:

1. Raise the vehicle on a frame or twin hoist so that the rear wheels are free.
2. Clamp a bar between the axle companion flange and a part of the frame or body so that the flange cannot move.
3. Lock the left rear wheel to keep it from turning.
4. Turn the right wheel slowly until you "feel" it in a drive condition. Hold a chalk marker on the side of the tire 12 inches from the center of the wheel.
5. Turn the wheel the other way until you again feel the drive condition.
6. Measure the length of the chalk mark, which is the total axle backlash. **It should be one inch or less.** If the backlash is within this limit, the clunk will not be eliminated by going into the axle.

Check for these conditions if the backlash is excessive:

1. Elongation of the differential pinion shaft holes in the differential case.
2. Missing differential or side gear washer.
3. Galling or excessive wear of the differential pinion shaft and bore.

   If none of the above conditions shows up, there may be a loose fit of the axle shafts to the side gear splines. You should continue as follows **until the correction is made.**
4. Install new side gears and recheck the backlash.
5. Install two new axle shafts.
6. Replace the axle assembly.

Bearing Noise

Bearing malfunctions normally will be obvious at disassembly (Fig. 12). As noted earlier, pinion bearings make a high pitched, whistling noise, usually at all speeds. However, if there is only one pinion bearing that is malfunctioning, the noise may vary in different driving phases.

Pinion bearings are frequently replaced unnecessarily when correcting gear noise. They should not be replaced unless they are actually scored or damaged, or there is a specific pinion bearing noise. Examine the large end of the rollers for wear. If the original blend radius has worn to a sharp edge, the bearing assembly should be replaced.

Wheel bearings might be mistaken for pinion bearings, so be sure to look at the wheel bearings carefully before tearing down the axle.

Some axle bearings are pressed into the housing, making it more difficult to check them. However, the axle shaft is the inner race for the bearing on semi-float type axles used on vehicles under 8500 lbs. G.V.W. So if the bearing is damaged, the roller surface on the shaft will be damaged as well (Fig. 13). The rollers can run on about the center of the polished surface.

Check Bearing Preload

The absence of differential bearing preload causes noise as driving loads tend to move the gear pattern to the outside (heel) of the ring gear. In fact, if the preload is not set right, it can move out to the edge and score the gears.

Both the pinion bearing and differential bearing preload must be checked to be sure that the pattern will stay in place under load.

Check the pinion bearing preload by putting a N·m (in-lb) torque wrench on the pinion nut and measuring the torque effort it takes to turn the pinion (Fig. 14). Compare the reading with the preload specification for used bearings.

A tip about the pinion bearing preload: The pinion seal will offer a resistance equivalent to (0.5-4.0 in-lbs). If the bearings are preloaded, a reading higher than (0.5-4.0 in-lbs) on the torque wrench scale must be obtained. If not, there is no preload.

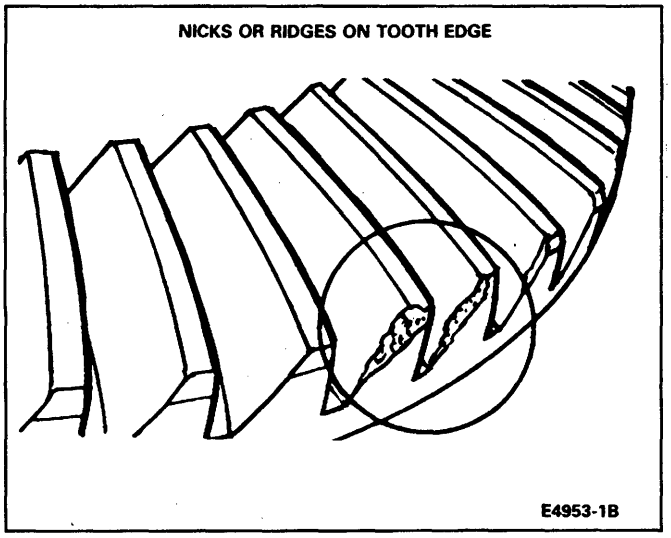


FIG. 9 Damaged Gear Tooth

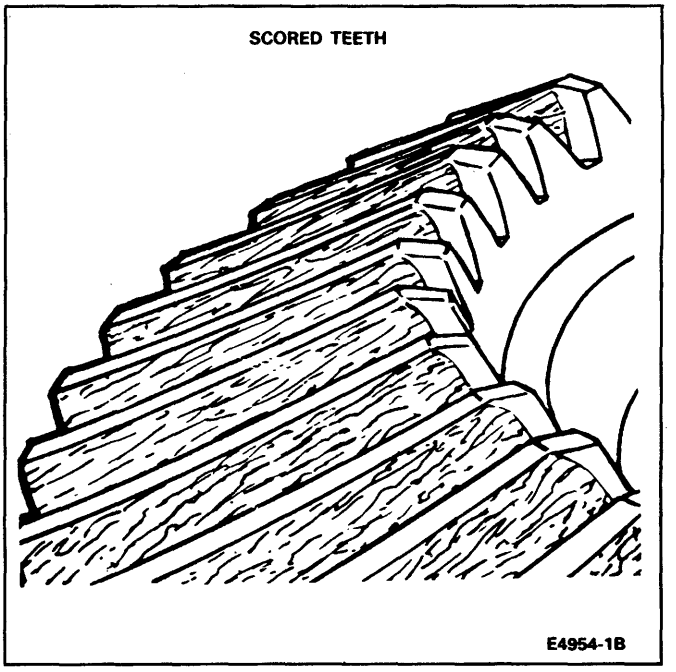


FIG. 10 Scored Gear Set

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Another indication is some threads protruding from in front of the nut. Normally about 2.29-2.54mm (0.090-0.100 inch) of threads protrude if the preload is set properly. If the nut is flush with the end of the stem, chances are the preload was not set. See Pinion Bearing Preload Procedure for resetting the proper preload.

NOTE: The absence of preload here may indicate that the spacer between the pinion bearings is crushed and should be replaced.

ADJUSTMENTS AND SERVICE

Brake Drum Balancing

Rear brake drum imbalance can cause a vibration condition on light trucks that sometimes cannot be compensated for by wheel balancing.

If rear brake drum imbalance is suspected, raise the rear end of the vehicle, taking proper precautions. Remove the rear wheel and tire assembly.

Before testing, install all lug nuts with flat washers on them, to retain the drums to axle flanges. If drums do not have brake weights, run the vehicle up to the speed where vibration occurred during road test.

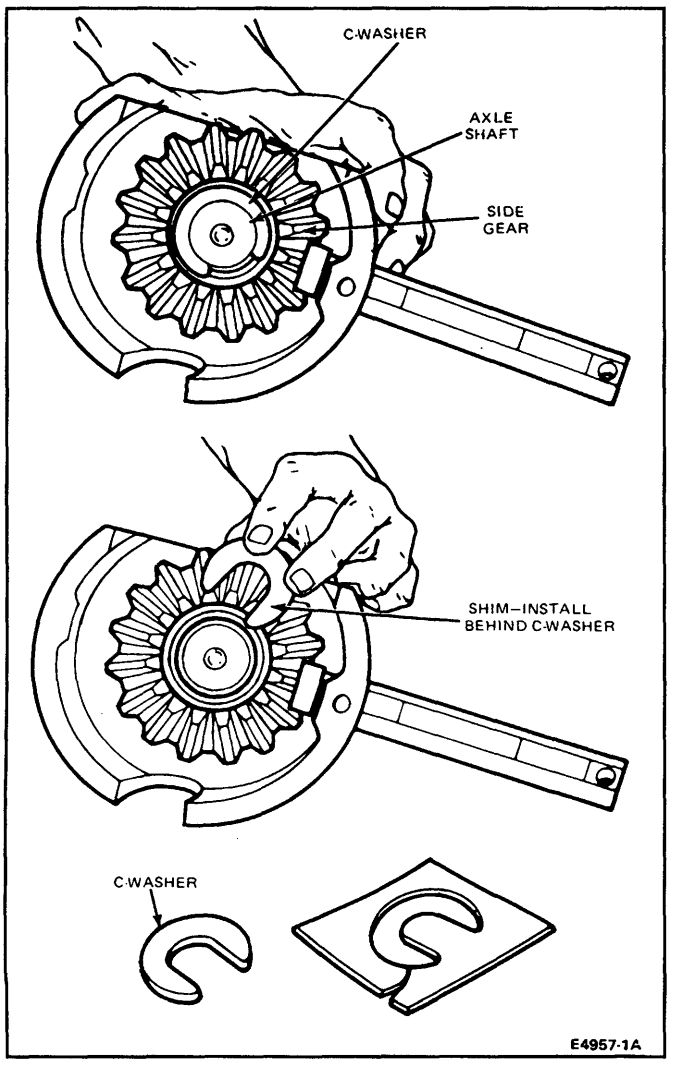


FIG. 11 Integral Axle End Play

If the drums exhibit out-of-balance symptoms, they should be removed from the vehicle and balanced as follows:

1. Position the brake drum on a "bubble-type" balancer and noting the "heavy" side of the drum, place a wheel balance weight on the drum directly opposite the heavy point. Select the appropriate number of weights until the bubble balance indicates a "balanced" condition. Mark the location of the "light" side of the drum, and note the total amount of the balance weight needed to balance the drum.

   NOTE: A drum which already has a balance weight attached, or requires less than 56.6 grams (2 oz.) of weight to balance, is not the prime cause of the vibration.

2. Fabricate a piece of mild steel to fit the curvature of the drum face and equal to the balance weights required to balance the brake drum (an old flywheel ring gear can be cut and used as a balance weight).

   NOTE: A small postal scale may be used for determining the weight of both the balance weights used and the weight of the fabricated drum balance weight needed.

3. Position the drum balance weight on the drum face in the location on the light side of the drum indicated, as shown in Fig. 15. Arc weld (tachweld 6.35mm or 1/4 inch long) the balance weight to the drum face.

   NOTE: Under no condition should any other welding method be used other than arc welding. To prevent drum distortion, do not use a current setting of more than 100 amps.

4. Install the balanced drum on the vehicle.
5. Static balance both rear wheels and tires and install on vehicle.
6. Road test to verify condition.

Driveshaft Balancing

For driveshaft balancing procedures, refer to Section 15-60, General Driveshaft Service.

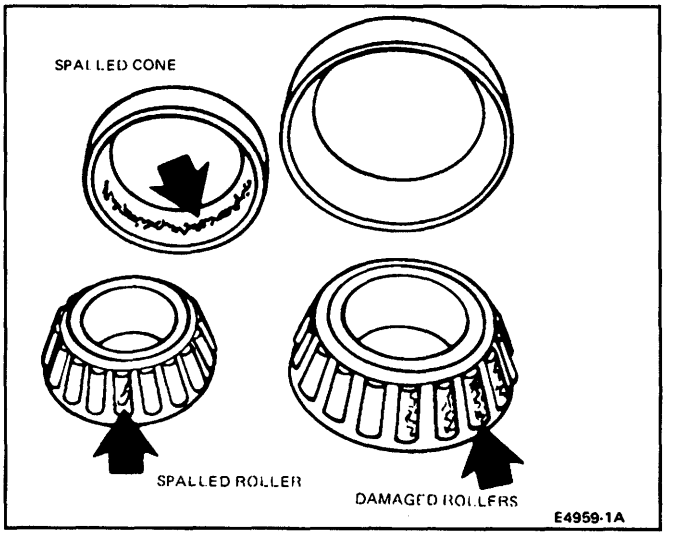


FIG. 12 Typical Bearing Malfunction

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GLOSSARY OF TERMS

Acceleration

1. **Light** —Increase in speed at less than 1/2 throttle.
2. **Heavy** —1/2 to full throttle increase in speed.
3. **WOT** —Wide open throttle.

Ambient Temperature

Surrounding or prevailing temperature. Normally, the temperature in the service area or outdoors, depending on where testing is taking place.

Articulation

Vertical movement of the front driving or rear axle relative to the frame of the vehicle to which they are attached.

Boom

A cycling, rhythmic noise often accompanied by sensation of pressure on the ear drums.

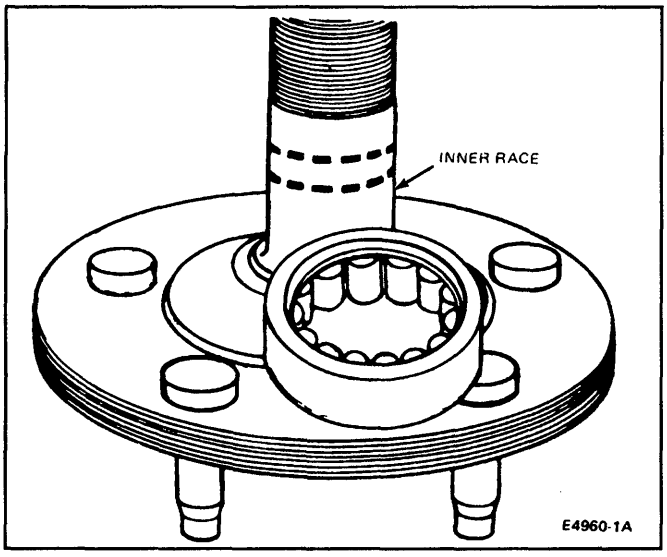


FIG. 13 Semi-Float Axle Wheel Bearing Inner Race

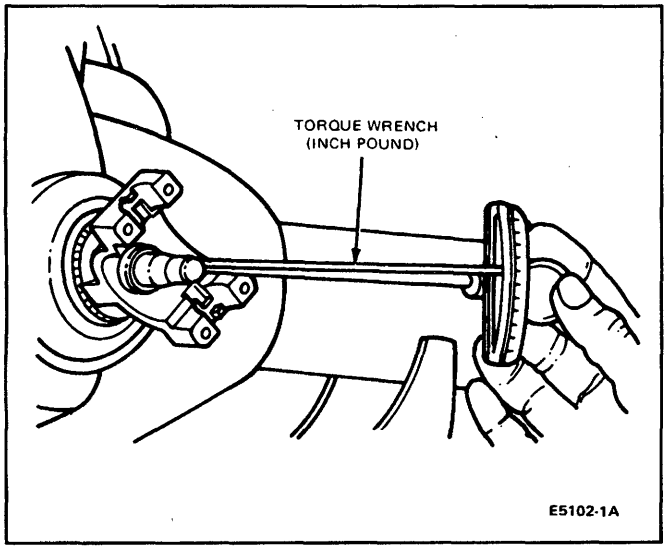


FIG. 14 Checking Pinion Bearing Preload

Bound Up

Refers to a stressed, rubber-mounted component that transmits any NVH which would normally be absorbed by the mount. (See Neutralize.)

Brakes Applied

When vehicle is stationary, service brakes applied with enough force to hold vehicle against acceleration with transmission in gear or drive.

Camber

Angle formed between front wheel spindle axis and horizontal as viewed from in front of the vehicle.

Caster

Angle formed between the kingpin axis and a vertical axis as viewed from the side of the vehicle. Caster is considered positive when the top of the kingpin axis is behind the vertical axis.

Coast/Neutral Coast

Engine/transmission taken out of gear with driveshaft/driveline by placing transmission selector in Neutral or by depressing clutch (manual transmission).

CPS

Cycle Per Second.

Cruise

Steady highway speed, neither accelerating nor decelerating; even pressure on accelerator pedal on level ground.

Controlled Rear Suspension Height

The height at which the components of a particular vehicle should be set when driveline angle measurements are made.

Deceleration

Slowing of vehicle by releasing foot from accelerator at cruise and allowing engine to slow vehicle without application of brakes.

Driveline Angle

Alignment of the transmission output shaft, driveshaft, and rear axle pinion centerline.

Driveshaft (Propeller Shaft/Propshaft)

Rearmost shaft of a driveline which powers the rear axle input shaft (pinion shaft).

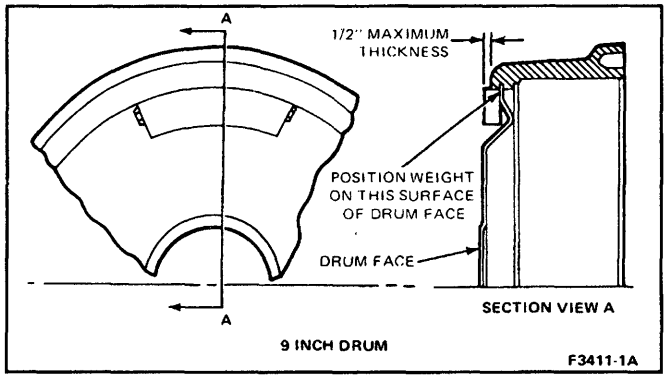


FIG. 15 Brake Drum Balance

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Drivetrain

Includes all power transmitting components from the engine to the wheels, including clutch/torque converter, transmission, transfer case, driveline and front or rear drive axles.

Engine Run-Up Test

Operation of engine through normal RPM range with vehicle sitting still, transmission in Neutral. Used for engine and accessory vibration check.

Engine Misfire

One or more cylinders in the engine fails to fire at the proper time.

Extension Housing Damper

A counterweight attached to an arm on the rear of the transmission extension housing and designed to "soak up" or dampen unwanted driveline or powertrain vibrations.

Engine Imbalance

Some component in the engine which is normally smoothly balanced now causing a perceptible vibration in the vehicle.

Flat Spots (Tires)

Commonly caused by letting vehicle stand while tires cool off. Can be cured by again operating vehicle until tires are warm. Also, regular tire wear patterns in the tire tread resulting from wheel-locked skids.

Float

A cruising drive mode in which throttle setting matches engine speed to road speed, neither accelerating or decelerating.

Gravelly Feel

A grinding or growl in a component, similar to the feel experienced while driving on gravel.

Harshness

A harder than usual behavior of a component, like riding a vehicle with over-inflated tires.

Hz

Hertz (Cycles Per Second).

Imbalance (or Unbalance)

Out of balance; more weight on one side of a rotating component causing shake or vibration.

Inboard

Toward the centerline of the vehicle. (See Outboard.)

Isolate

Separate from the influence of other components.

NVH

Noise, Vibration, Harshness.

Neutralize (Normalize)

To return to unstressed position. Used to describe various mounts and exhaust system hangers (see Bound Up).

Outboard

Toward the outside of the vehicle, rather than toward the centerline (see Inboard).

Pinion Shaft

The input shaft to a driving axle, usually a part of the smaller driving or input gear of a "Ring and Pinion" gear set.

Pumping Feel

A very slow vibration that results in a movement of vehicle components, similar to pumping the service brakes slightly.

Radial/Lateral

Radial is in the plane of rotation, lateral is at 90° to the plane of rotation.

Ring Gear

The large gear, driven by the pinion gear of a "Ring and Pinion" driving axle gear set. Not applicable to transaxle.

Road Test

Operation of vehicle under conditions designed to recreate the problem condition.

Run-out

Out of round or wobble.

Shake

Low frequency vibration, usually results in visual movement of components.

Slip Yoke (Slip Spline)

Driveshaft coupling device (1/2 of a U-Joint) which compensates for changes in shaft length due to articulation of axle; used at one end of driveshaft.

Tire Force Vibration

Tire vibration caused by variations in the construction of the tire, resulting in a vibration when the tire rotates against the pavement. This condition may be present on perfectly round tires because of variations in the inner construction.

Two-Plane Balance

Radial and lateral balance.

Tire Deflection

Bending of the body of the tire during rotation.

T.I.R.

Total Indicator Run-out.

Tip-In Moan

A light moaning noise heard when the vehicle is lightly accelerated, usually between 40-104 km/h (25-65 mph).

Vibration

Regular movement of a component that results in a sound or feel of movement.

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SPECIFICATIONS

SPECIAL SERVICE TOOLS

Number	Description
Tool-4201-C	Dial Indicator with Bracketry
T68P-4602-A	Pinion Angle Level Gauge
T63L-8620-A	Belt Tension Gauge

CF3412-1B

ROTUNDA EQUIPMENT

Number	Description
006-01399	Strobe Light Balancer
007-00014	Radial Run-out Gauge

CF4596-1B

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GROUP

ROADABILITY 19

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VEHICLE APPLICATION

Applies to All F-150—F-350, E-150—E-350, Bronco and F-Super Duty Truck Models.

DESCRIPTION

Roadability describes the vehicle's capability to handle the road. The feel of the road is transmitted to the driver through the suspension, steering, and wheel and tire components.

The following conditions are related to roadability concerns:

- Wander—Wander is the tendency of the vehicle to require steering wheel corrections to maintain a straight path down the road. The vehicle deviates to the left and/or right in a cyclic or random manner when driven on a flat pavement.
- Shimmy—Shimmy is a consistent side-to-side wobble in the steering wheel or the road wheels. The shimmy is usually felt over 64 km/h (40 mph), which is amplified when the tire contacts pot holes or bumps in the road surface.
- Steering Binding (Sticky)—When the steering is binding or sticky, the tendency of the vehicle is not to return to the desired straight ahead direction after any steering wheel input of 20° (1/16 turn of the steering wheel) or more. A vehicle with this condition will require centering of the steering wheel by the driver, after a sharp turn, rather than return by itself due to road force at the tire.
- Groove Feel (Small Angle Returnability)—Groove feel describes the characteristic 'feel' of the steering system during straight ahead highway driving. Small steering deviations from the straight ahead position are counteracted by forces tending to return the steering system and wheel to the centered straight ahead position. A vehicle with poor groove feel may continuously require small steering corrections to maintain a desired straight ahead path.
- Drift/Pull—A drift or pull condition will cause a vehicle to deviate from a straight ahead direction in the absence of any steering input. Drift/pull may be induced by conditions external to the vehicle (i.e., wind, road camber). However, a vehicle related drift/pull, on a flat road, will cause a consistent deviation

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from the straight ahead path and require constant steering input in the opposite direction to counteract the effect.

- Clear Vision Error—When driven on a flat pavement, the vehicle follows a straight line, however, the steering wheel is not level or centered.

DIAGNOSIS AND TESTING

Refer to the diagnosis chart for a diagnosis of conditions, possible causes and resolution. Refer to the diagnosis guide in this Section for a roadability diagnosis procedure.

Steering—Drift/Pull

Drift/pull type conditions may be caused by improper torque and tightening sequence of the steering linkage. BECAUSE THE RUBBER BALL SOCKET LINKAGE TENDS TO RETURN TO ITS INSTALLED POSITION, IT IS IMPERATIVE THAT THE INSTALLATION BE ACCOMPLISHED WITH THE FRONT WHEELS AND THE PITMAN ARM IN THE STRAIGHT AHEAD POSITION, AND THE STUD SEATED IN THE TAPERED HOLE PRIOR TO TIGHTENING THE NUTS. Care should be taken with the installation to prevent a possible drift condition.

To diagnose if a preload in the rubber is causing the drift, the following procedure is recommended:

1. Loosen the studs in the tapered holes at the Pitman arm and the left and right spindles (i.e., disengage the stud from the hole so that it is no longer seated).
2. Hand install the nuts so that the stud is free to turn inside the tapered hole.
3. INSTALL COTTER PINS IN ALL THE STUDS.

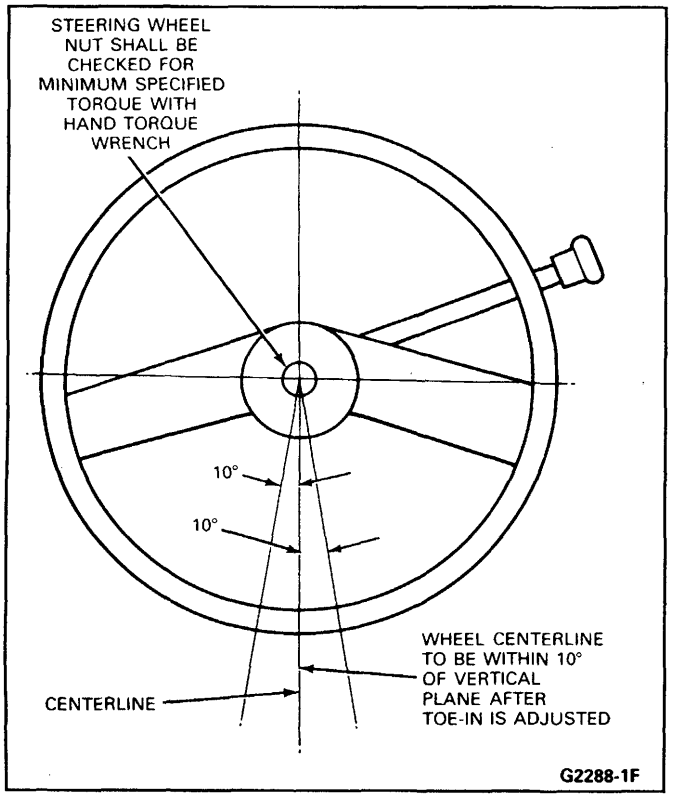


FIG. 1 Acceptable Steering Wheel Installation—Measured From Normal Spoke Angle

4. Drive the vehicle. If it no longer drifts, then it can be assumed that the rubber was causing the drift. If it continues to drift, the condition is NOT being caused by the rubber ball sockets.
5. In either case, do not replace the steering linkage.

Reinstall the linkage as described in the following procedures.

F-150—F-350, F-Super Duty and Bronco

1. Ensure the pitman arm and wheels are in the straight ahead position. (The pitman arm is exactly straight ahead when the clear vision is at 0° except on F-350 4x4 and F-Super Duty).
2. Lock the steering wheel in the straight ahead position and loosely assemble the steering linkage to the Pitman arm and then to the spindles.
3. Being careful not to change the position of the Pitman arm, torque the steering linkage nuts to 88 N·m (65 ft-lbs). The recommended sequence for tightening is: 1) the Pitman arm, 2) the right side spindle and 3) the left side spindle.
4. Install all the cotter pins by advancing the nut to the next castellation.
5. Adjust the toe-in if necessary.

E-150—E-350

1. Ensure that the wheels are in the straight ahead position.
2. Lock the steering wheel in the straight ahead position and loosely assemble the steering linkage to the spindles and the pitman arm.
3. Being careful not to move the wheels from the straight ahead position, tighten the steering linkage nuts to 88 N·m (65 ft-lbs). The recommended tightening sequence is: 1) the right side spindle, 2) the Pitman arm and 3) the left side spindle.
4. Install all the cotter pins by advancing the nut to the next castellation.
5. Adjust the toe-in and reset the clear vision if necessary.

ADJUSTMENTS

Centering Steering Wheel (Clear Vision)

F-150—F-350, F-Super Duty and Bronco

Steering wheel clear vision (Fig. 1) is preset at vehicle assembly prior to toe-adjustment and cannot be adjusted by removing the steering wheel and mis-indexing the steering wheel and steering shaft alignment marks (Fig. 3).

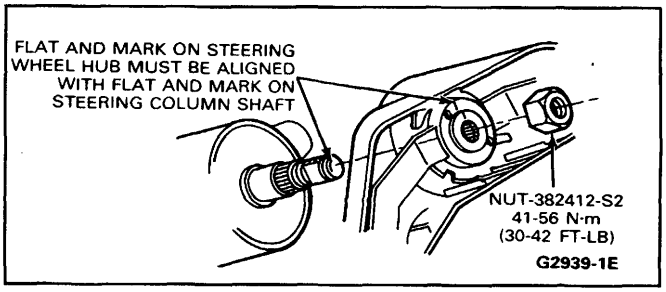


FIG. 2 Steering Wheel Installation Econoline

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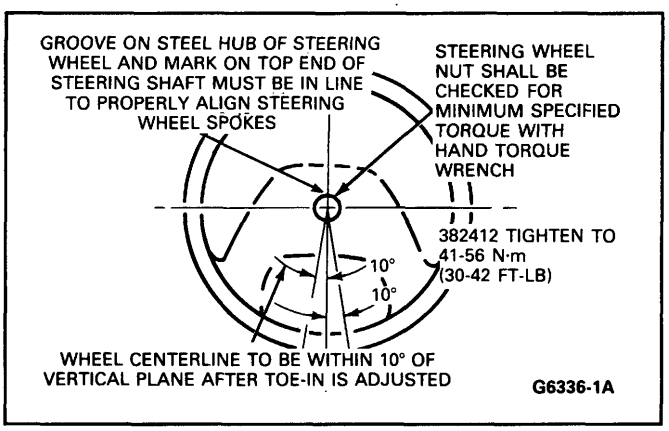


FIG. 3 Steering Wheel Installation—F-Series

NOTE: Whenever original nut is removed, it should be replaced with a new 382412-S2 or 389530-S2 nut and tightened to 41-56 N·m (30-42 ft-lb), or equivalent.

After verification of correct assembly, as noted below, toe must be readjusted to resolve a clear vision complaint. Toe adjustment is similar to passenger car utilizing dual toe adjuster sleeves. The following steering system components should be inspected:

- Steering column U-joint alignment notch is at 12 O'clock when steering wheel is in straight ahead position (refer to Fig. 4).
- Clearances are equal (approx. 4.06mm or 0.16 inch) from both large and small diameter flex coupling pins to intermediate shaft flange cutouts.

If inspection of the above components indicates correct installation of steering components, resolve the clear vision complaint by re-adjusting toe as described in Section 14-01, General Suspension Service.

If inspection of the above components indicate incorrect installation, remove, re-index, or correct any improper installation as suggested in the following procedures:

U-Joint Alignment Notch Is Not At 12 O'Clock When Steering Wheel Straight Ahead (Fig. 4)

1. Remove the two screws from the underside of each steering wheel spoke and lift the horn switch (pad) from the wheel.
2. Check to see that the mark on the steering shaft and the mark on the wheel hub are aligned (Fig. 2).
3. If the marks do not align, remove the wheel and re-install as described in this Section in the Removal and Installation Section.

Final Toe Check

After completing the above checks, center the steering wheel. The front wheels should still be in the straight ahead position and the toe adjusted properly. If required, adjust toe per Section 14-01, General Suspension Service.

E-150—E-250—E-350

1. Set wheels in straight ahead position by driving vehicle a short distance and mark the steering wheel and steering column relationship with a chalk mark.
2. Note the steering wheel position with toe adjusted on E-Series, if off center (spokes in horizontal position) more than plus or minus 10 degrees in a vertical plane (Fig. 1), remove the steering wheel as described in this Section.
3. Install the steering wheel on the steering column so that the steering wheel is within 10 degrees plus or minus from horizontal.
4. Position steering wheel into place with retaining nut.
5. Tighten retaining nut to 41-57 N·m (30-42 ft-lbs).
6. Connect the spade terminal of the horn switch wire to the blade connector, and press the "J" clip ground terminal fully into the threaded hole.
7. Center the horn switch (pad) on the steering wheel, and install the two attaching screws.

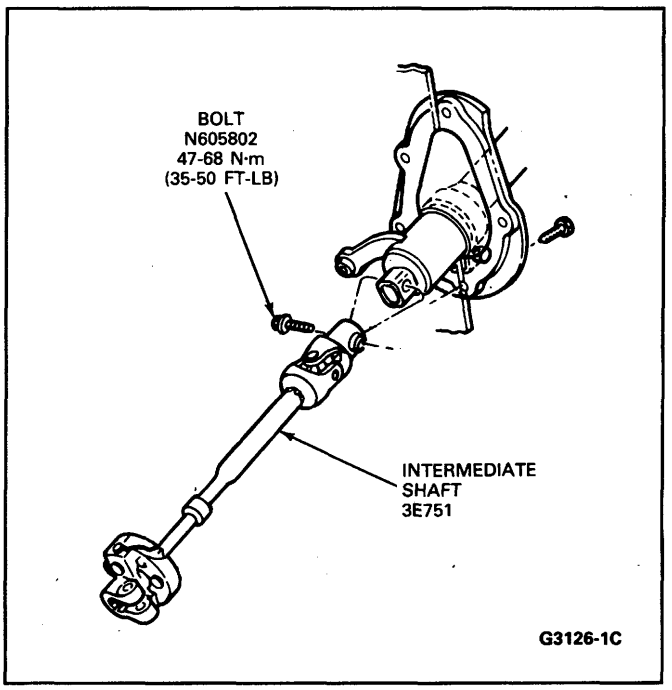


FIG. 4 Steering Column Alignment—Typical

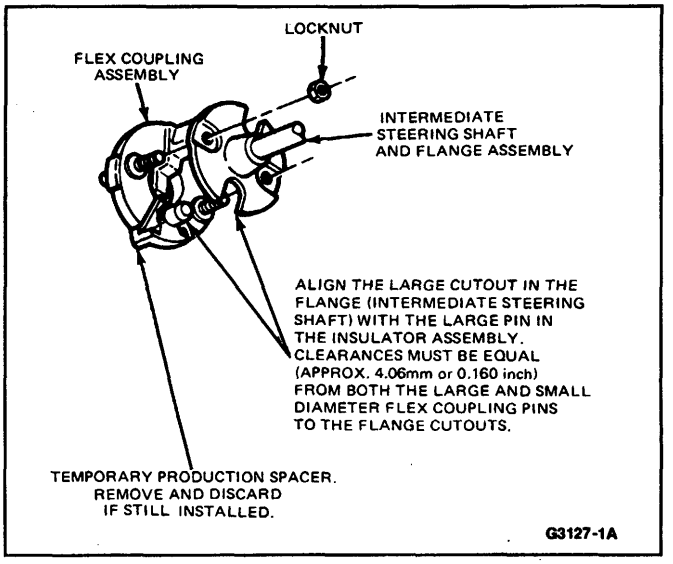


FIG. 5 Flex-Coupling to Intermediate Shaft Alignment E-150—E-250—E-350

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Steering Gear Adjustments

Manual Steering Gear

For mesh load and preload adjustments, refer to Section 13-35, Manual Steering Gear—Recirculating Ball (Koyo) under Adjustments.

Power Steering Gear

For meshload adjustments and rotary valve centering checks, refer to Section 13-41, Integral Power Steering Gear—Ford under Adjustments.

Front Wheel Alignment

For a detailed description of caster, camber and toe adjustment procedures relating to front wheel alignment and specifications, refer to Section 14-01, General Suspension Service.

Caster Split Adjustment

The specified maximum caster split is 1.5 degrees. However, a difference in side-to side caster angles, or split, of more than 3/4 degree may cause some vehicles to drift or pull toward the side with less caster.

Caster may be adjusted using one of three service adjusters to increase the caster angle up to 1-1/2 degrees on either wheel to correct the split. The installation procedure is described in Section 14-01, Suspension Service. Any caster adjustment should result in equal caster between both wheels for a level vehicle either at curb weight or at the loaded condition that the vehicle operates at for most of its use.

NOTE: Several factors influence a vehicle's tendency to drift or pull. These factors are listed under drift/pull in the roadability diagnosis chart in the diagnosis guides portion of this Section. All related possible causes for the drift/pull other than excessive caster split should be verified and resolved as required before caster split correction is attempted.

F-150, F-250, F-350 (4x2)

Caster can be adjusted by replacing the caster/camber adjuster, or slug, found at the upper spindle-to-axle joint. A zero degree adjuster is installed in production. Replacement adjusters can be ordered through service to either increase or decrease caster up to 1-1/2 degrees in 1/2 degree increments. Refer to Section 14-01, General Suspension Service, for description of their use and installation.

F-150, Bronco (4x4)

Caster is not adjustable on F-150 (4x4) and Bronco trucks.

E-150, E-250, E-350

A service kit (Part Number E5TZ-3K064-A) is available which includes complete instructions for increasing caster in increments of 1/2 degree.

F-250—F-350 (4x4) and F-Super Duty

The caster angle on the F-250—F-350 (4x4), and F-Super Duty with a leaf spring type front suspension can be adjusted by inserting a shim between the spring and axle. Shims are available in 0°, 1° and 2° increments. The 0° shim is used to adjust side to side ride height when an angled shim is installed on the opposite side of the front axle.

NOTE: On F-250 (4x4) vehicles equipped with dual axle arm front drive axles, a shim can be installed on one side only to reduce side-to-side caster split. On F-350 (4x4) and F-Super Duty vehicles equipped with Dana Monobeam front drive axles, install a shim on each side of the axle tube. On these vehicles side-to-side caster split cannot be reduced.

1. To adjust caster, raise the vehicle and support the front axles on safety stands.

NOTE: If possible, caster adjustment should always be done on the right front axle to avoid changing front driveshaft alignment.

2. Loosen U-bolt nuts and separate spring from axle. Install caster shims between spring and axle. Position the thin edge of the shim towards the front of the vehicle to increase caster, thin edge to the rear to decrease caster.

NOTE: Caster shims installed on the LH axle will change the front driveshaft angle. If a caster shim is used on the LH axle, driveshaft angles must be checked and conform to specifications in Section 15-60 Driveshaft—Single Type U-Joint. Always attempt to correct side-to-side caster variations by adjusting the RH axle caster.

Tighten U-bolt nuts until all nuts contact cap. Tighten nuts to 142 N·m (105 ft-lbs).

Wheel Bearing Adjustment

For wheel bearing adjustment procedures, refer to the Adjustment portion of Section 11-10, Wheel Hubs and Bearings—Front (except Front Drive) for 4x2 vehicles and Section 11-12, Wheel Hubs and Bearings—Front Wheel Drive for 4x4 vehicles.

INSPECTION

Improper Loading

The vehicle's load capacity is designated by weight, not volume. Thus, with large or heavy loads, you cannot necessarily load the vehicle until all available space is full. Maximum safe vehicle weights (front, rear and total), as well as tire and rim sizes and inflation pressures, are specified for each truck on the Safety Standard Certification Label on the driver's door rear pillar. A sample Safety Standard Certification Label with typical example numbers and an explanation of how this information should be used can be found in Section 10-00, Identification Codes.

NOTE: Do not use the sample numbers on the Safety Standard Certification Label shown. Use the actual numbers that appear on the vehicle.

NOTE: The Vehicle Identification Number is listed on the Safety Standard Certification Label and is the same as the warranty number.

GVWR (Gross Vehicle Weight Rating)—The maximum loaded weight at which the vehicle is to be operated.

GAWR (Gross Axle Weight Rating)—The maximum loaded weight of each axle measured at the ground. These ratings are attainable only with the tires inflated to the specified pressures. The use of selected heavier suspension components (such as after-market installations) does not necessarily increase the GVWR or GAWRs.

NOTE: The vehicle cannot be loaded to both the front and rear GAWR, since the GVWR will be exceeded. In the example, the front GAWR 3020 pounds (1370 kg) plus the rear GAWR 5300 pounds (2404 kg) equals

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Diagnosis Guides

ROADABILITY DIAGNOSIS CHART

CONDITION	POSSIBLE CAUSE	RESOLUTION
Wander	1. Improper loading.	1. Weigh vehicle. Redistribute load.
	2. Improper tire/wheel size.	2. Replace as necessary.
	3. Improper tire pressure.	3. Inflate to specification.
	4. Steering gear not centered.	4. Index steering wheel to column, if required, center steering wheel by adjusting tie rod adjusting sleeve.
	5. Steering gear preload/meshload adjustment off.	5. Measure/adjust preload/meshload.
	6. Incorrect wheel alignment.	6. Align front end.
	7. Excessive spindle rotating torques.	7. Service ball joints or kingpins.
	8. Steering linkage ball studs sloppy or sticky.	8. Inspect and service.
Shimmy	1. Improper wheels/tires.	1. Replace as required.
	2. Incorrect tire pressure.	2. Inflate to specification.
	3. Tire non-uniformity.	3. Check runouts of tires & wheels.
	4. Tire imbalance.	4. Rebalance assemblies static/dynamic.
	5. Weak shock absorber control.	5. Service shocks as required.
	6. Loose wheel bearings.	6. Check & adjust per procedure.
	7. Steering gear preload/meshload low.	7. Check & adjust.
	8. Steering linkage ball stud looseness.	8. Inspect and service.
	9. Loose suspension attachments & components.	9. Inspect all attachments and check bushings for wear.
	10. Worn radius arm bushings.	10. Inspect and replace radius arm bushings if required.
Steering Binding (Sticky) or Poor Groove Feel (Small Angle Returnability)	1. High spindle rotating torque.	1. Inspect & service.
	2. High steering linkage ball stud turning torques.	2. Inspect and service.
	3. Incorrect front wheel toe set (poor groove feel mainly).	3. Measure & reset toe in.
	4. Excessive steering gear preload/meshload.	4. Measure & adjust meshload/preload.
	5. Power steering control valve centering.	5. Inspect & service.
Drift/Pull	1. Improper loading creating caster split. (Side to side).	1. Measure alignment & service as required. Weigh vehicle.
	2. Mismatched tires/wheels.	2. Service as required.
	3. Tire pressure.	3. Inflate to specification.
	4. Tire conicity.	4. Service through tire rotation.
	5. Unequal tire circumferences.	5. Measure & service.
	6. Excessive caster split.	6. Balance caster split.
	7. Improper toe set.	7. Measure and reset toe in.
	8. Front wheel brake drag.	8. Check during alignment inspection.
	9. Power steering control valve centering.	9. Check steering gear valve centering.
	10. Wheel base mismatch.	10. Check per procedure under Inspection portion in this Section.
Clear Vision Error	F-150-F-350, F-Super Duty and Bronco 1. Incorrect toe setting.	1. Set to specification per the appropriate Section in Group 14.
	E-150-E-350 1. Incorrect toe setting.	1. Set to specification per the appropriate Section in Group 14.
	2. Steering wheel incorrectly positioned on steering shaft.	2. Set wheel to specification per this Section.

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ROADABILITY DIAGNOSIS GUIDE

TEST STEP			
1.0	PRELIMINARY INSPECTION		
	After conducting a road test to identify the particular roadability condition, perform the preliminary inspection listed below. Correct any conditions not up to specifications or requirements. ① Check tire pressure. Adjust tire pressure as specified on the Safety Standard Certification Label. ② Check tire/wheel size. All tires must be the same size. Refer to the Safety Standard Certification Label found on the vehicle for the specified sizes. ③ Check the tire wear pattern to identify a possible out-of-alignment condition. ④ Check front tires for radial runout and flat spots. ⑤ Inspect for overloading or improper load distribution. ⑥ Check power steering pump for low fluid or severe aeration. ⑦ Check steering linkage for excessive binding or free play. ⑧ Remove the wheel and tire, and disconnect the steering linkage from the spindle. Rotate the spindle back and forth ten (10) times to verify free movement. Use a dial indicator type torque wrench on the bottom ball stud nut. Rotate the spindle from stop to stop slowly and read the maximum torque to rotate. Rotational torque should not exceed 20 N•m (15 ft-lbs). ⑨ Check spindle end play. Connect linkage and install wheel and tire. ⑩ Inspect components for looseness or damage. ⑪ Road test vehicle to determine possible causal area. Follow test procedure.		
2.0	ROAD TEST	RESULT	ACTION TO TAKE
	• Road test the vehicle (after proper corrections are performed after preliminary inspection) and identify the particular Roadability condition.	Wander Condition ▶	GO to **3.**
		Drift/Pull Condition ▶	GO to **6.**
		Steering Binding — Poor Wheel Return ▶	GO to **5.**
		Lack of "Groove" Feel — Poor Center Feel ▶	GO to **5.**
		Steering or Suspension Shimmy ▶	GO to **4.**

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8320 pounds (3774 kg), which is 520 pounds (236 kg) over the allowable GVWR of 7800 pounds (3538 kg). The excess weight must be removed from the vehicle.

The total weight for the example vehicle (not yours) must not exceed 7800 pounds (3538 kg) with the front tires inflated to 35 psi (241 kPa) cold, and the rear tires inflated to 75 psi (517 kPa) cold. This includes full fuel tank(s), vehicle equipment, and occupants (driver and passengers), as well as the cargo load. **NOTE THAT THE DRIVER AND PASSENGERS ARE PART OF THE VEHICLE LOAD.**

Due to the variety of engines, axles and accessories available on Ford trucks, each vehicle is subject to different maximum load weights. If you suspect that payload is excessive, weigh the vehicle by axle at a highway weigh station or appropriate commercial facility. Weigh the total vehicle, then separately weigh the vehicle at the front and rear wheels. The GVWR and GAWRs should not be exceeded. To assure proper vehicle handling, the load should also be balanced from side to side.

Tire/Wheel Size and Inflation Pressure

Information regarding tires, wheels and recommended inflation pressures for each vehicle as manufactured is included with every vehicle. Vehicles completed by Ford will have the information included on the Safety Standard Certification Label on the driver's door lock pillar. On vehicles completed by a second stage manufacturer, the information will be included on their certification documentation.

All available tire and wheel combinations used in production are listed in the shop manual along with recommended pressures for specific gross vehicle weights. Variance from released configuration can be a source of numerous concerns (ride, wander, shimmy, tire life, speedometer accuracy, etc.).

- Replace non-matching tires.
- Inflate all tires to specification.

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ROADABILITY DIAGNOSIS GUIDE (CONT'D.)

TEST STEP		RESULT	ACTION TO TAKE
3	WANDER		
	Steering Wheel Alignment — Remove the horn pad from steering wheel and check that the notch on the steering column shaft aligns with the steering wheel. Check pot joint alignment per "centering steering wheel" under adjustments.	Steering wheel and steering shaft in alignment (OK) ▶	GO to **3A**.
		Steering wheel or steering shaft not aligned (OK) ▶	ALIGN steering wheel and shaft as described in Centering Steering Wheel under Adjustments in this Section.
3A	WHEEL ALIGNMENT		
	Check the front alignment to be within specifications.	Within specifications (OK) ▶	GO to **3B**.
		Not within specifications (OK) ▶	CORRECT the alignment as described in Wheel Alignment under Adjustments in this Section.
3B	SPINDLE ROTATION		
	Rotate the spindle and check for stiffness, binding or excessive spindle rotational torque. (If not checked during 1.0, preliminary inspection.)	Within specifications (OK) ▶	GO to **3C**.
		Spindle stiff, binding or hard to rotate (OK) ▶	REFER to Spindle Rotational Torque in this Section. If still not OK REMOVE and REPLACE ball joints.
3C	STEERING GEAR CHECK		
	Check the steering gear (manual and power) meshload and preload.	Meshload and/or preload not to specification (OK) ▶	ADJUST meshload and/or preload as described in the appropriate Steering Gear Section in this manual.
4	SHIMMY		
	Check tires for signs of imbalance.	Tires in balance (OK) ▶	GO to **4A**.
		Tires out of balance (OK) ▶	RE-BALANCE tires.
4A	TIRE RUNOUT CHECK		
	Check tire assemblies for excessive runout.	Runout less than 1 mm (.045 inch) (OK) ▶	GO to **4B**.
		Runout greater than 1 mm (.045 inch) (OK) ▶	REFER to Match Mounting Information described under INSPECTION in this Section.
4B	SHOCK ABSORBER CHECK		
	Check shock absorber for signs of leakage. Bounce front of vehicle to check for excessive bouncing.	No leakage or excessive bouncing (OK) ▶	GO to **4C**.
		Shocks leak and/or bounce excessively (OK) ▶	REMOVE and REPLACE shock absorbers.

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ROADABILITY DIAGNOSIS GUIDE (CONT'D.)

TEST STEP		RESULT	ACTION TO TAKE
4C	WHEEL BEARING CHECK		
	Check wheel bearings for looseness, out-of-adjustment, improper lubrication, wear or damage.	Wheel bearings (OK) ▶	GO to **4D**.
		Wheel bearings (OK) ▶	ADJUST, REPAIR, or REPLACE wheel bearings as required.
4D	STEERING GEAR CHECK		
	Check the steering gear (manual and power) meshload and preload.	Meshload and/or preload up to specified level (OK) ▶	GO to **4E**.
		Meshload and/or preload not up to specified level (OK) ▶	ADJUST meshload and/or preload as described in the appropriate Steering Gear Section in this manual.
4E	STEERING LINKAGE CHECK		
	Check the steering linkage for looseness.	Steering linkage (OK) ▶	GO to **4F**.
		Steering linkage loose (OK) ▶	REPLACE steering linkage.
4F	SUSPENSION SYSTEM TORQUES		
	Check for looseness and proper torque with suspension attachments and components.	Suspension system up to specifications (OK) ▶	GO to **4G**.
		Suspension attachments and components loose (OK) ▶	TIGHTEN suspension attachments and components to specification.
4G	RADIUS ARM BUSHINGS		
	Visually inspect the radius arm bushings for wear or damage.	Bushings worn or damaged (OK) ▶	REMOVE and REPLACE bushings.
5	STEERING BINDING OR GROOVE FEEL		
	Remove the horn pad and check the steering wheel alignment. The notch on the steering column shaft must align with the mark on the steering wheel.	Marks in alignment (OK) ▶	GO to **5A**.
		Marks not aligned (OK) ▶	ALIGN steering wheel and shaft as described in Centering Steering Wheel under Adjustments in this Section.

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ROADABILITY DIAGNOSIS GUIDE (CONT'D.)

	TEST STEP	RESULT ▶	ACTION TO TAKE
5A	STEERING GEAR		
	Check steering gear (manual and power) for excessive meshload and/or preload.	Meshload and/or preload at specifications (OK) ▶	GO to **5B**.
		Meshload and/or preload not at specifications (OK) ▶	ADJUST preload and/or meshload as described in the appropriate steering gear section in this manual.
5B	STEERING LINKAGE		
	Check the steering linkage ball studs for stiffness or looseness.	Steering linkage (OK) ▶	GO to **5C**.
		Steering linkage excessively stiff or loose (OK) ▶	REPLACE steering linkage as required.
5C	SPINDLE		
	Check spindle for excessive rotational torque, stiffness, or binding.	Spindle not stiff or binding and rotates with proper torque (OK) ▶	GO to **5D**.
		Spindle rotates with excessive torque, stiff or binding (OK) ▶	REFER to Spindle Rotational Torque in this section, if still not OK, REMOVE and REPLACE ball joints.
5D	TOE SETTING		
	On Groove Feel conditions mainly, check toe setting.	Toe setting to specification (OK) ▶	GO to **5E**.
		Toe setting not at specifications (OK) ▶	ADJUST toe as described in this Section under Front Wheel Alignment in Adjustments.
5E	POWER STEERING CENTERING		
	Check the power steering control valve for centering position.	Power steering control valve not centered properly (OK) ▶	REPLACE power steering control valve.
6	DRIFT/PULL		
	Check tires for conicity (radial tires only).	Tires exhibit no signs of conicity (OK) ▶	GO to **6A**.
		Tires show signs of conicity (OK) ▶	ROTATE tires.

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ROADABILITY DIAGNOSIS GUIDE (CONT'D.)

TEST STEP		RESULT ▶	ACTION TO TAKE
6F	WHEELBASE MISMATCH		
	Check the vehicle for "dog tracking" to discover wheelbase mismatch. Measurements can be taken from both wheel centers with front wheels in straight ahead position.	Wheelbase does not match (OK) ▶	STRAIGHTEN frame as required. Check rear spring usage side-to-side. REPLACE spring if required.
		Wheelbase matches (OK) ▶	GO to **6G**.
6G	RE-VERIFY CASTER SPLIT		
	Check the vehicle caster reading. A vehicle with a 3/4° split may pull.	Caster split is over 3/4° (OK) ▶	REFER to Caster Split adjustment in this Section.

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Tire Non-Uniformity

Tire and Wheel Runout

Excessive radial and lateral runout of a wheel and tire assembly can cause roughness, vibration, wheel tramp, tire wear, and steering wheel tremor.

Before checking runout and to avoid false readings caused by temporary flat spots in the tires, check runout only after the vehicle has been driven.

The extent of runout should be measured with a dial indicator, TOOL-4201-C, or equivalent. All measurements should be made on the vehicle with the tires inflated to recommended inflation pressures and with the front wheel bearings adjusted to specifications.

Tire Runout

Measure radial runout of the tire at the center and outside ribs of the tread face (Fig. 6). Measure lateral runout of the tire just above the buffing rib on the tire sidewall (Fig. 6). Mark the high points of lateral and radial runout for future reference. On tires, radial runout should not exceed 0.070 inch, and lateral runout should not be more than 0.070 inch.

Match Mounting Tires

Match mounting is a technique used to reduce radial or lateral tire runouts on tire and wheel assemblies. Excessive runout is a source of ride complaints and match mounting can be used to minimize the runout. There are two ways to use match mounting: 1. positioning of the tire on the wheel; and 2. positioning the wheel on the hub.

1. Measure the total indicated runout on the center of the tire tread rib, and record it. Mark the tire and rim at the center of the tread rib, and record the reading. Mark the tire at the location of the valve stem for reference.
2. Break down the tire and remount it 180 degrees on the rim so that the valve stem reference mark is opposite of the valve stem on the wheel.
3. Reinflate the tire and measure the total indicated runout, and again mark the high spot.
4. If the runout is reduced to acceptable guidelines the tire is ready to be put back into service. If the runout is still excessive, one of the following steps must be performed:

- If the high spot is within 4 inches of the first high spot on the tire, and is still outside of guidelines, replace the tire.
- If the high spot is within 4 inches of the first high spot on the wheel, the wheel may be out of tolerance, check the wheel for runout.
- If the high spot is not within 4 inches of either original high spot of the tire and rim, then draw an arrow from the second high spot to the first high spot (in the shortest direction) and rotate the tire on the rim 90 degrees in that direction. This will normally reduce the runout to an acceptable level.

In the majority of cases, the first 180 degrees turn of the tire will either fix the problem or indicate which item to replace.

Tire Imbalance

Tire and Wheel Balance

There are two types of wheel and tire balance: static and dynamic.

A static balance is the equal distribution of weight around the wheel. Wheels that are statically unbalanced cause a bouncing action called wheel tramp. This condition will eventually cause uneven tire wear (Fig. 7).

A dynamic balance is the equal distribution of weight on each side of the centerline, so that when the tire spins there is no tendency for the assembly to move from side to side. Wheels that are dynamically unbalanced may cause wheel shimmy (Fig. 8).

Deposits of mud, etc., must be cleaned from the inside of the rim. Stones should be removed from the tread. The tire should be inspected for any damage, then balanced according to Ford specifications.

Off-Vehicle Balancing

When balancing wheels off the vehicle, use a balancer which pilots the wheel by the center hole. If the wheel tramp and vehicle vibration is not corrected by the off-vehicle balance, an on-vehicle balance may be needed. Refer to Section 18-01, Noise, Vibration and Harshness.

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ROADABILITY DIAGNOSIS GUIDE (CONT'D.)

TEST STEP		RESULT ▶	ACTION TO TAKE
6A	TIRE CIRCUMFERENCE		
	Measure and check the circumference of each tire. Tire circumference is usually associated with bias-ply tires and more pronounced on vehicles equipped with limited-slip differentials.	Tire circumference equal (OK) ▶	GO to **6B**.
		Tire circumference unequal (OK) ▶	ROTATE tires. INSTALL the two most evenly matched tires on the rear axle.
6B	CASTER SPLIT		
	Check the vehicle caster reading. Maximum side-to-side variation (split) is 1.5°. **NOTE:** Be sure vehicle loading is balanced "side to side."	Caster within specifications (OK) ▶	GO to **6C**.
		Caster not within specifications (OK) ▶	REFER to Caster Split adjustment in this Section.
6C	TOE SETTING		
	Check that toe is within specifications	Toe setting within specifications (OK) ▶	GO to **6D**.
		Toe settings not within specifications (OK) ▶	RE-ADJUST toe setting to specifications.
6D	FRONT BRAKE DRAG		
	Check the front disc brake systems for brake drag.	No drag in front disc brakes (OK) ▶	GO to **6E**.
		Front brakes drag (OK) ▶	INSPECT brakes for seized calipers or pistons. REPAIR as required.
6E	POWER STEERING CENTERING		
	Check that the power steering control valve is centering.	Steering control valve centering properly (OK) ▶	GO to **6F**.
		Steering control valve not centering properly (OK) ▶	REPLACE power steering gear control valve.

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Tire Conicity

Investigate tire variations. Tires with manufacturing variations cause drift/pull. Problems such as conicity may be encountered with new tires or develop after routine tire rotation or replacement. Conicity is the tendency of a tire to be out-of-round axially as shown in Fig. 9.

Correction Action for the Conicity Issues (for radial tires only)

1. Set all tires to the same air pressure.
2. Exchange front tires, left to right, and right to left. Test drive and evaluate pulling condition.
3. If the pull does not change, the tires are OK. If the pull has been affected, the tires are at fault.
4. Exchange front and rear tires. Test drive and evaluate pulling condition.
5. Substitute spare tire on left front and right front. Test drive after each exchange.
6. Select the best combination of tires noted in Steps 4 and 5.

Tire Circumference Variation

Investigate tire variations. Tires with manufacturing variations cause drift/pull. Problems such as unequal tire circumference may be encountered with new tires or develop after routine tire rotation or replacement.

Corrective Action for Unequal Tire Circumferences (for bias, bias ply, belted tires)

1. Raise the vehicle on a hoist, so all tires are off the ground.
2. Set all tires to the same air pressure, including spare.

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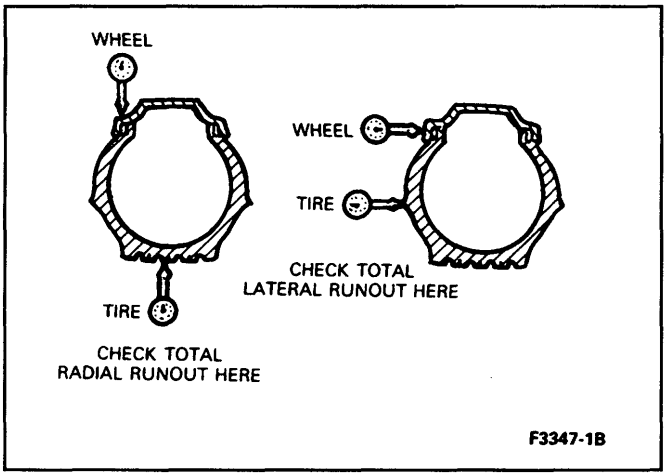


FIG. 6 Radial and Lateral Runout Checks

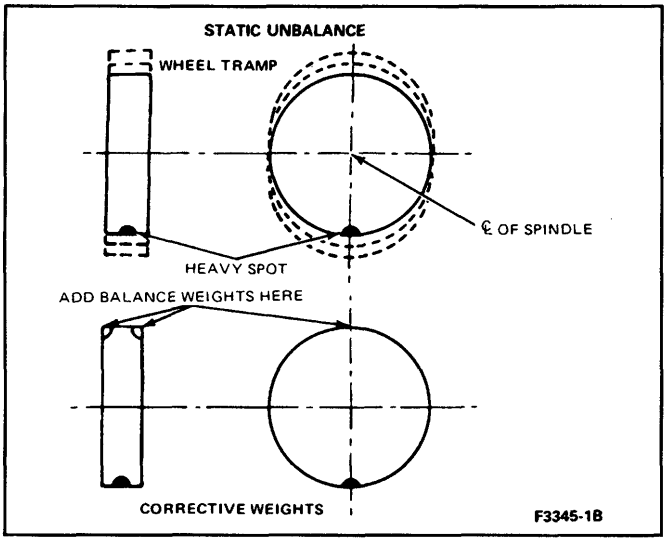


FIG. 7 Static Unbalance

3. Measure the circumference of each tire, checking in the middle of the tread. Record circumference of all tires (vehicle will pull towards the side mounted with the smaller tire).

   NOTE: Circumference is easily checked by using a tape measure. Record the reading and proceed to the next tire.

4. For vehicles with locking rear axles, install the two most evenly matched tires on the rear axle.

   NOTE: If the spare tire is new (no miles on the road), it may change size during break-in and require remeasurement to finalize tire matching.

5. Reset tire pressure to vehicle specification.

Wheelbase Mismatch

Check wheelbase mismatch.

Check wheelbase on the left and right side of the vehicle to verify similar side-to-side wheelbases (wheelbase within 1 inch for every 100 inch of W.B.). Measurements should be taken from wheel centers with front wheels straight ahead. It is very important to ensure front wheels are straight ahead when taking wheel base measurements.

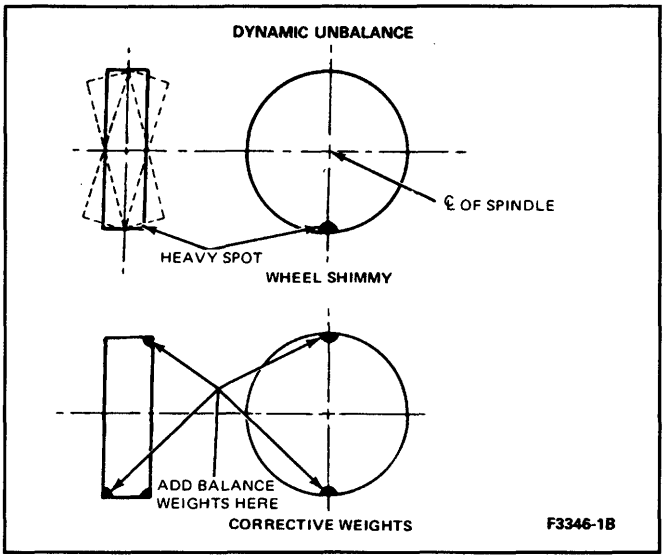


FIG. 8 Dynamic Unbalance

Shock Absorber Checks

The front and rear suspension is equipped with twin tube, low pressure gas shock absorbers. These shocks are of the telescopic double acting type and provide a continuous dampening effect in both compression and rebound modes. The nitrogen gas charge and twin tube constuction provide greater damping efficiency and ride comfort. All shock absorbers are ride tuned for specific vehicle applications.

WARNING: THE LOW PRESSURE GAS SHOCK ABSORBERS ARE CHARGED WITH NITROGEN GAS TO 930 kPa (135 PSI). DO NOT ATTEMPT TO OPEN.

Before replacing a shock absorber, check the action of the shock absorbers as follows:

On-Vehicle Tests

1. Check the shock absorber to be sure it is securely and properly installed. Check the shock absorber insulators for damage and wear. Replace any worn or damaged insulators and tighten attachments to the specified torque (on a shock absorber which incorporated integral insulators, replace the shock absorbers). Tighten shock absorber attachments to the proper Specifications as listed in the Specifications Section of each suspension group.
2. Inspect the shock absorber for evidence of fluid leakage. A light film of fluid is permissible. Be sure any fluid observed is not from sources other than the shock absorber.

   Replace the shock absorber if leakage is severe.
3. Disconnect the lower end of the shock absorber. Extend and compress the shock absorber as fast as possible, using as much travel as possible. Action should become smooth and uniform throughout each stroke. Higher resistance on extension than on compression is a normal condition. Faint swish noises are also normal.
4. If the action is smooth, but the shock absorber is suspected of being weak, follow Step 5.
5. Repeat Step 3 on the mating shock absorber installed on the opposite side of the vehicle, and compare results of both tests. If the action is similar, it is unlikely that either shock absorber is

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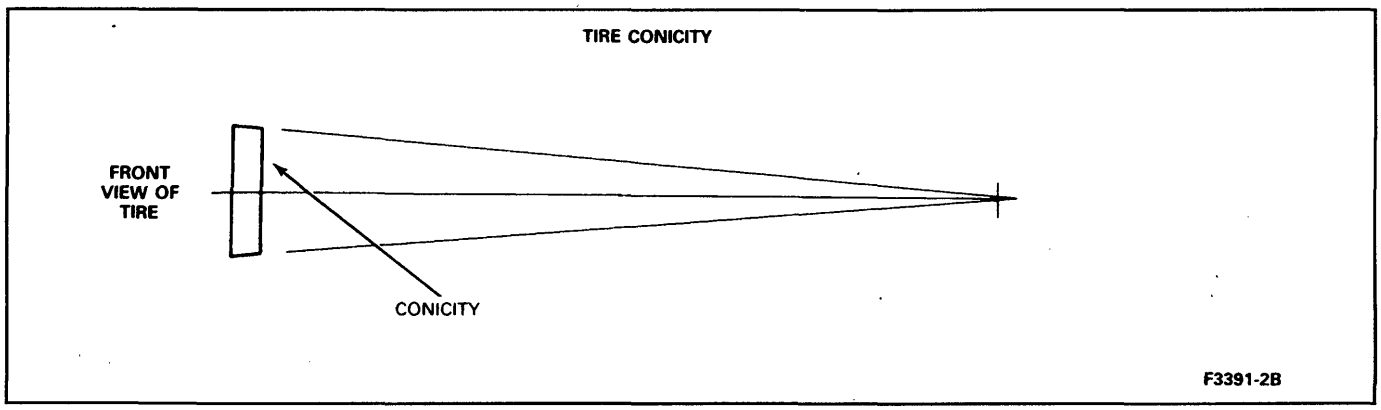


FIG. 9 Tire Conicity

worn or damaged. Reconnect both shock absorbers.

6. If there is a difference between the two, replace the shock absorber having the lower resistance. Ensure that the part number of the replacement is the same as that of the original shock absorber. The replacement shock absorber resistance will appear to be higher than either original, due to initial friction of the rod seal.

Install a new shock absorber if any of the following abnormal conditions are met:

1. If the shock absorber is properly primed in its installed position, and there is a lag or a skip occurring near midstroke of the shaft's reverse travel direction.
2. If there is any seizing during the shaft's full travel, except at either-end of the travel.
3. If upon the shaft's fast, reverse stroke, there is any noise encountered other than a faint swish, such as a clicking sound.
4. If there are excessive fluid leaks.

Spindle Rotating Torque

Twin I-Beam Axle With King Pins

E-150—E-250—E-350

Check spindle turning torques, with the linkage disconnected as follows:

NOTE: Measure spindle turning force at spindle arm to linkage stud hole.

Apply force to end of spindle arm and rotate back and forth quickly ten (10) times. If over twenty (20) lbs. of force is required to rotate the spindle with a push/pull gauge, or if it grabs or sticks during movement, remove the king pin and clean/remove burrs on spindle bushings and pin. Pre-lube spindle bushings and reassemble as shown in Section 14-21, Front Suspension—Twin I-Beam. Pressure lubricate at both grease fittings and recheck rotational force.

Twin I-Beam Axle With Ball Joints

F-150—F-350 (4x2), F-150/F-250/Bronco (4x4)

To check spindle turning efforts, disconnect the steering linkage at the steering knuckle. Rotate the spindle back and forth quickly ten (10) times. Push the spindle at the end of the steering arm with a push-pull gauge at one (1) RPM. Multiply the reading by 0.5 to obtain the spindle turning torque in ft-lbs. Maximum spindle turning torque is 20 N·m (15 ft-lbs) for 4x4's and 13 N·m (10 ft-lbs) for 4x2.

If the spindle rotational torque is below the specification, check the steering gear meshload and steering linkage ball stud turning torques (not applicable to vehicles equipped with rubber ball stud linkage). Refer to Group 13—Steering of this Shop Manual for proper diagnosis and repair.

If the spindle rotational torque is above the specified range for ball joint spindle/knuckle systems, perform the following:

- Rotate the spindle back and forth from stop to stop and check for clearance between the spindle and the axle. Interference between the two surfaces will cause the spindle to bind resulting in high turning efforts.
- If no interference exists, perform the following:

F-150/F-250/Bronco (4x4)

1. Remove the upper ball stud cotter pin and fastener.
2. Use Pitman Arm Puller T64P-3590-F or equivalent with spacer against the end of the stud to break the camber adjuster loose. Leave the nut on the end of the stud if necessary to protect the thread.
3. Measure and record the upper ball joint turning torque as follows:

   Install the castellated nut upside down on the stud and insert the cotter pin. Rotate the stud back and forth quickly ten (10) times.
4. Measure and record the upper ball stud turning torque at 10 RPM using a dial indicator torque wrench. If the torque exceeds 6.7 N·m (60 in-lbs), replace the ball joint as described in Section 14-21, Front Suspension Twin I-Beam of this Shop Manual.
5. Measure and record the lower ball joint turning torque as follows:

   Orientate the front axle shaft U-joint cross between the ball joints such that it is parallel to ball joint studs.

Rotate the spindle back and forth quickly ten (10) times.

Push the spindle at the end of the steering arm with push-pull gauge at 1 RPM. Multiply the reading by six (6) to obtain the lower ball joint turning torque in in-lbs.

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6. If the ball joint torque exceeds 6.7 N·m (60 in-lbs), remove the ball joint as described in Section 14-21, Front Suspension Twin I-Beam of this Shop Manual. Then re-evaluate the torque at 10 RPM using a dial indicator torque wrench. Replace if the turning torque exceeds 4.0 N·m (35 in-lbs). If the torque is within specification, inspect the axle shaft U-joint for binding.
7. If replacement ball joints are required, evaluate the torque of each before installation.

NOTE: If the ball joint torques are within sepcification, high spindle turning efforts are the result of torquing the fasteners out of sequence which preloads the ball joint improperly.

8. Loosen the lower ball joint nut to the end of the stud and strike the spindle near the lower ball joint to break the spindle loose from the stud.

NOTE: The following torque sequence must be followed EXACTLY when securing the spindle.

9. Make sure that the ball joint rubber grease boot is seated at the base of the stud against the socket.
10. Wipe any grease from the studs.
11. Install the steering knuckle and tighten the lower nut to 47 N·m (35 ft-lbs).
12. For all 4x4 vehicles, install the nut and tighten to 136 N·m (100 ft-lbs). Advance the nut to the next castellation and install a new cotter pin.
13. Finish tightening the lower nut to 129-149 N·m (95-110 ft-lbs).
14. The camber adjuster will seat itself into the spindle at a predetermined position during the tightening sequence. DO NOT attempt to adjust this position.
15. Recheck the spindle rotational torque using the push-pull gauge as described above to ensure it does not exceed 34 N·m (25 ft-lbs).

F-150—F-350 (4x2)

1. Measure and record ball joint stud turning torque as follows:
2. Push the spindle at the end of the steering arm with a push-pull gauge at 10 RPMS. Multiply this reading by six (6) to obtain spindle turning torque in in-lbs. Record the reading.
3. Loosen the pinch bolt at the upper ball joint and remove the camber/caster adjuster.
4. Measure the spindle turning torque as described in Step 2 without the camber/caster adjuster. This reading will be lower ball joint stud turning torque.
5. Subtract the lower ball stud torque in Step 4 from the spindle turning torque reading in Step 2. This difference is the upper ball joint stud turning torque.
6. If either ball joint turning torque measurements exceeds 7 N·m (60 in-lbs), replace the ball joint as described in Section 14-21.
7. Measure ball stud turning torque of the replacement ball joint prior to installation. Maximum ball stud turning torque at 10 RPM is 35 in-lbs.

NOTE: If neither ball joint exceeds the stud turning torque specification, high spindle turning efforts is the result of tightening the fasteners out of sequence which preloads the ball joints improperly. Attach the axle and spindle EXACTLY as described below.

8. Wipe any grease from the ball joint studs and ensure the rubber seal is fully seated at the base of the ball stud against the socket.
9. Tighten the lower ball joint fastener to 169 N·m (125 ft-lbs). Advance the castellated nut to install the cotter pin.
10. Install the camber/caster adjuster and tighten the pinch bolt to 75 N·m (55 ft-lbs).
11. Recheck the spindle rotational torque to ensure the maximum 13 N·m (10 ft-lbs) specification is not exceeded.

Attachments and Fasteners

Check the following components with associated brackets, fasteners, and bushings for damage or looseness and service as required:

- Front wheel lug nuts
- Front and rear springs/shocks
- Front/rear suspension components
- Axle and radius arm pivot brackets to frame
- Steering gear to frame
- Pitman arm

Refer to Specifications in the appropriate Shop Manual Section for torque specifications.

Radius Arm Bushing

Check radius arm bushings—worn radius arm bushings can induce shimmy problems. If visual deterioration is apparent, replace per the procedure in the Removal and Installation portion of Section 14-21, Front Suspension—Twin I-Beam, or Section 14-22, Front Suspension—4 Wheel Drive. Ensure plastic spacer is installed between insulator and bracket.

Brake Drag

Inspect brake system for:

- Seized wheel cylinders or calipers.
- Binding/non-releasing brake cables.

SPECIFICATIONS

SPECIAL SERVICE TOOLS

Tool Number	Description
T64P-3590-F	Pitman Arm Puller
T00L-4201-C	Dial Indicator

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GROUP 31 CHARGING SYSTEM

SECTION 31-01 Charging System General Service

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DESCRIPTION AND OPERATION	
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DIAGNOSIS	
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Charging System Check	31-01-12
Isolating the Problem	31-01-12
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Battery Drain Test	31-01-3
Constant Current Drain Test	31-01-3
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VEHICLE APPLICATION	31-01-1

VEHICLE APPLICATION

All Light Truck Models.

DESCRIPTION AND OPERATION

The alternator charging system is a negative ground system, and consists of an alternator, regulator, charge indicator, storage battery, fuse link and associated wiring. Refer to the Electrical Vacuum and Troubleshooting Manual* for schematics and locations of wiring harnesses.

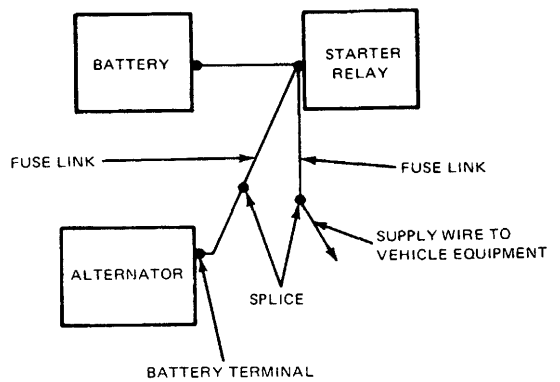
*Can be purchased as a separate item.

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DESCRIPTION AND OPERATION (Continued)

Fuse Link

The fuse link used on the Bronco, E-150—E-350, Club Wagons and F-150—F-350 trucks, is a short length of insulated wire integral with the engine compartment wiring harness. It is several wire gauges smaller than the circuit that it protects and is the color of the circuit being supplied by the fuse link. Service fuse links are green or black depending on usage. All fuse links have a flag moulded on the wire or on the terminal insulator. Color identification of the flag or connector is Red—18 gauge wire, Orange—16 gauge wire, or Green—14 gauge wire. The illustration shows a typical fuse link installation.



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The fuse link is designed to burn out, thus protecting the alternator and wiring when heavy reverse current flows, such as when a booster battery is connected incorrectly, or a short to ground occurs in the wiring harness.

A burned out link may have bare wire ends protruding from the insulation, or expanded or bubbled insulation with illegible identification. If it is hard to determine if the link is burned out, perform a continuity test.

Refer to Section 34-31, Fuses, Circuit Breakers and Fuse Links, for testing procedures for fuse links used in the charging system.

Preliminary Information

Before performing charging or starting system tests on the vehicle, note the complaint such as: slow cranking, battery dead or using an excessive amount of water, top of battery wet, ammeter shows charge at all times or no charge, alternator warning lamp does not come on or never goes out. This information will aid in isolating the part of the system causing the symptom.

Next, visually inspect as follows:

1. Check the fuse link located between the starter relay and the alternator. Replace the fuse link if burned.
2. Check battery posts and battery cable terminals for clean and tight connections. Remove the battery cables (if corroded), clean and install them securely.
3. Check for clean and tight wiring connections at the alternator, regulator and engine.
4. Check the alternator belt tension. Tighten to specification, if necessary. Refer to Section 27-06, Accessory Drive Belts.
5. Discharged maintenance-free batteries could be caused by the following:
   - Glove compartment, hood, courtesy lamps or cargo lamp staying on because of misaligned or malfunctioning switches.
   - Pinched or grounded wire harness.

TESTING

A voltmeter (0 to 20 volt scale), ohmmeter, such as Rotunda Digital Volt Ohm Meter 007-00001, jumper wire and a test lamp (12 volt) are the only tools required to perform an accurate check of the complete charging system. Calibrate meters once a year and stamp the date of calibration on the meter face. It is recommended that this practice be followed by all technicians to maintain their meters at acceptable accuracy.

The tests are divided into On Vehicle and On Bench Test procedures. The On Bench Test procedures are described under the applicable Component Section (31-02, Batteries—31-10, Rear Terminal Alternators, 31-43, Alternator Electronic Regulator).

Troubleshooting or diagnosis is required before actual service can be performed to the electrical system. Even where an obvious fault makes the replacement of a unit necessary, find out why the unit failed. Refer to the Diagnosis Guide in this Section. When a problem is diagnosed correctly, unnecessary service is prevented, the time the vehicle is out of operation will be decreased, and the service performed will be permanent.

On Vehicle Tests

Before performing charging system tests on the vehicle, note the complaint such as: slow cranking, battery dead, top of battery wet, ammeter shows excessive charge at all times or no charge, alternator warning lamp does not come on or never goes out. This information will aid in isolating the part of the system causing the symptom. (Refer to Section 31-02 for battery warnings and cautions.)

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TESTING (Continued)

Visual Inspection

1. Check the fuse link located between the starter relay and the alternator. If burned, determine cause, service system and replace fuse link.
2. The battery must be in proper state of charge (non-maintenance free battery—at least 1.200 specific gravity). Refer to Section 31-02, Batteries. Check the battery posts and battery cable terminals for clean and tight connections. Remove the battery cables (if corroded), clean and install them securely.
3. Check for clean and tight wiring connections at the alternator, regulator and engine.
4. Check the alternator belt tension and tighten to specification, if necessary. Refer to Section 27-06, Accessory Drive Belts.

Fuse Link Continuity Check

1. Make certain that the battery is OK, then turn on the headlamps or any other accessory. If the headlamps or accessory do not operate, the fuse link is probably burned out.
2. On some vehicles there are several fuse links. Use the same procedure as in Step 1 to test the fuse link that protects vehicle equipment.

To test the fuse link that protects the alternator make certain the battery is OK. Then check with a voltmeter for voltage at the BAT terminal of the alternator. No voltage indicates that the fuse link is probably burned out.

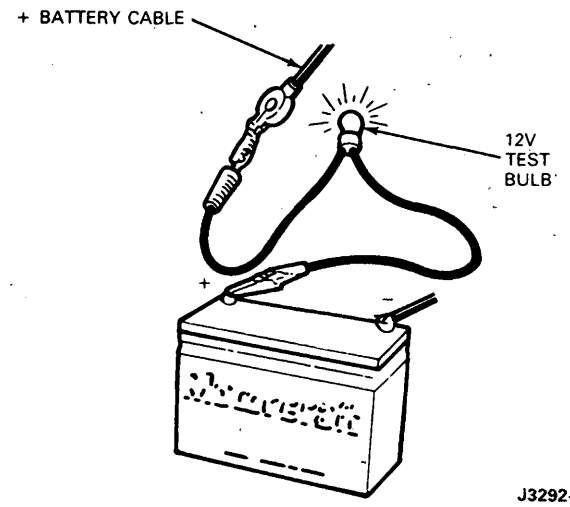
Battery Drain Test

1. Connect a 12-volt test lamp in-series between the battery positive cable clamp and the positive terminal of the battery. Test with all switches OFF. Do not be misled by clock-winding current. Touch cable clamp to terminal to wind clock.
2. If lamp glows, pull fuses, one at a time, and check each circuit for short. Service wiring harnesses or components as required.

Constant Current Drain Test

Use a regular 12-volt test lamp for this test:

1. Ensure all vehicle electrical circuits are turned off. To check for minimum battery charge and/or condition of bulb, connect test lamp across battery terminals. Lamp should light. Disconnect test lamp.
2. Disconnect either positive or negative battery cable. Connect 12-volt test lamp between cable terminal and battery post.



3. If lamp glows, connect terminal to post for five seconds then repeat to ensure results.

Test Conclusions

- Lamp Does Not Glow—No current drain.
- Lamp Does Glow—Check individual circuits to locate cause of current drain. Underhood lamp, glove compartment, cargo lamps, are prime suspects.

Ammeter System Test

Normal Charge Indication

With ignition switch in the OFF position and no electrical load, ammeter should show 0 on center scale.

With ignition in the RUN position (engine running) (fully charged battery), needle deflects towards charge and returns toward center scale in time.

With ignition switch in OFF position and headlamps on, ammeter should show discharge. If the ammeter does not register a discharge, check for loose connections at the ammeter, or an open circuit wire, prior to replacing the gauge.

General Charging System Tests

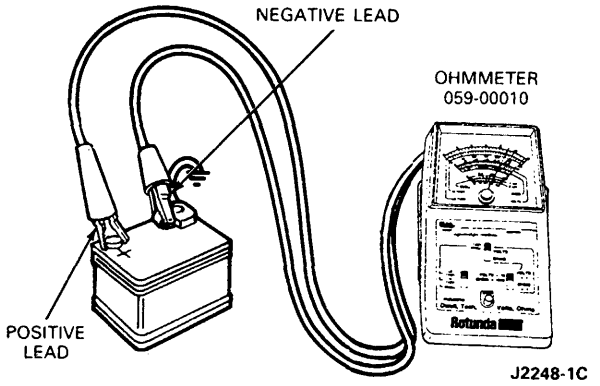
When performing charging system tests turn off all lamps and electrical components. Place the transmission in NEUTRAL and apply the parking brake.

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TESTING (Continued)

Base Voltage Test

1. With ignition in OFF position and no electrical load connect the negative lead of the voltmeter to the negative battery cable clamp.
2. Connect the positive lead of the voltmeter to the positive battery cable clamp.
3. Record the battery voltage reading shown on the voltmeter scale. This reading is called the base voltage.



No Load Test

1. Connect a tachometer to the engine.
2. Start the engine. Increase speed to approximately 1500 RPM. With no other electrical load (foot off brake pedal and doors closed), the voltmeter pointer should move upward (increase), but not more than 2.5 volts above the base voltage.

NOTE: The reading should be taken when the voltmeter pointer stops rising. It may take a few minutes to reach this point. If the voltage increases to proper level, perform Load Test. If the pointer continues to rise, perform the Over Voltage Tests. If the voltage does not rise to proper level, perform Under Voltage Tests.

Load Test

1. With the engine running, turn the heater or air conditioner blower motor on (high speed) and headlamps on high beam.
2. Increase the engine speed to approximately 2000 RPM. The voltmeter should indicate a minimum of 0.5 volt above the base voltage. If not, perform the Under Voltage Test.

If the above tests indicate proper voltage readings, the charging system is operating normally. Proceed to the tests below if one or more of the readings is different than shown above and use a test lamp to check for battery drain.

Over Voltage Tests

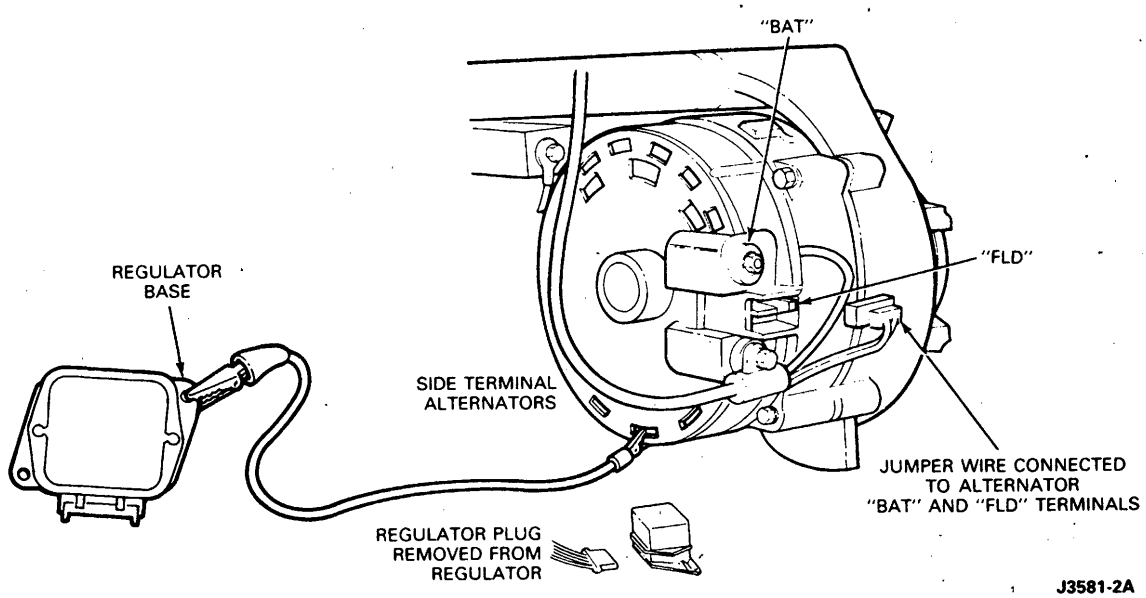
These tests will help determine the cause of the charging system malfunction and will provide the technician with possible solutions to the problem.

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TESTING (Continued)

EVR System

1. If the voltmeter indicated more than 2.5 volts above base voltage in the No Load Test, connect a jumper wire between the regulator base and the alternator frame or housing. Repeat the No Load Test.

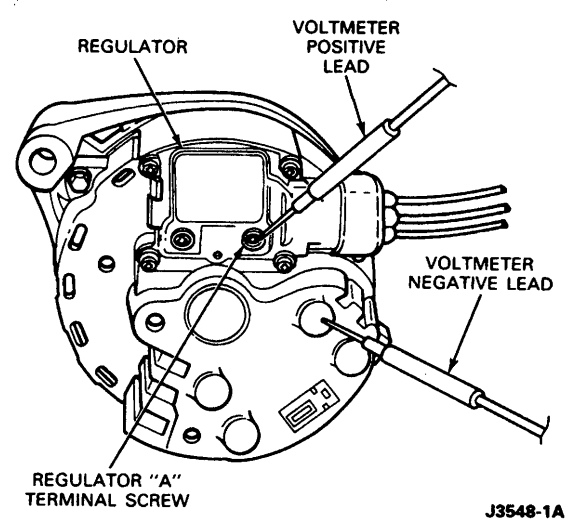


2. If the over voltage condition disappears, check the ground connections on the alternator, regulator, and from the engine to the dash panel and the battery. Clean and tighten the connections securely.
3. If the over voltage condition still exists, disconnect the regulator wiring plug from the regulator and repeat the No Load Test.
4. If the over voltage condition disappears (voltmeter reads base voltage), replace the voltage regulator.
5. If over voltage still exists with the regulator wiring plug disconnected, check for a short between circuits A and F in the wiring harness and service as necessary. Then connect the regulator wiring plug to the regulator.

IAR System

If the voltmeter indicated more than 2.5 volts above base voltage in the No Load Test, follow these procedures:

1. With the ignition in the RUN position (engine not running), connect the voltmeter negative lead to the alternator rear housing. Contact the voltmeter positive lead first to the alternator output connection at the starter solenoid and then to the regulator A screw head.
2. If the voltage difference between the two locations is greater than 0.5 volts, service the A wiring circuit to eliminate the high resistance condition indicated by the excessive voltage drop.
3. If the over voltage condition still exists, check for loose regulator and alternator grounding screws. Tighten loose regulator grounding screws to 1.7-2.8 N·m (15-26 in-lb).



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TESTING (Continued)

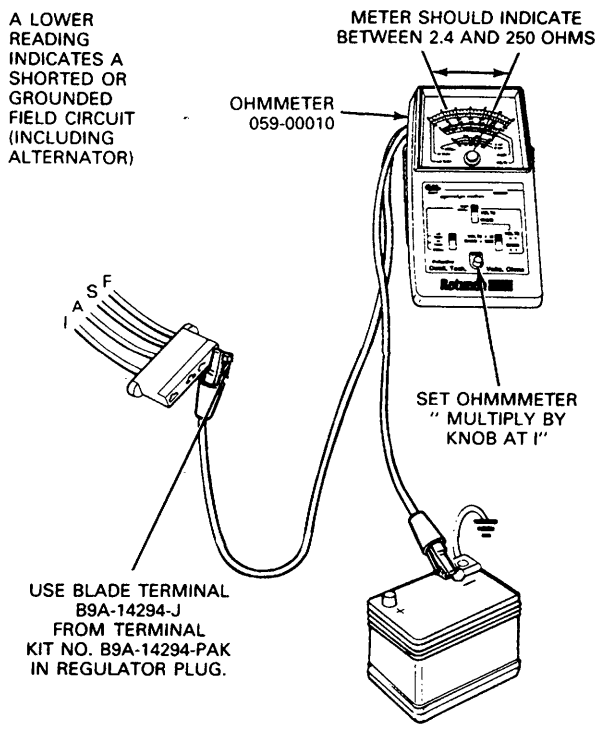
4. If the over voltage condition still exists, connect the voltmeter negative lead to the alternator rear housing. With the ignition OFF, contact the voltmeter positive lead first to the regulator A screw head and then to the regulator F screw head. Different voltage readings at the two screw heads indicate a malfunctioning regulator, grounded brush lead or a grounded rotor coil. Service the entire integral alternator/ regulator assembly.
5. If the same voltage reading (battery voltage) is obtained at both screw heads, in Step 4 and there is no high resistance in the ground or at circuit, replace the regulator.

Under Voltage Tests

EVR System

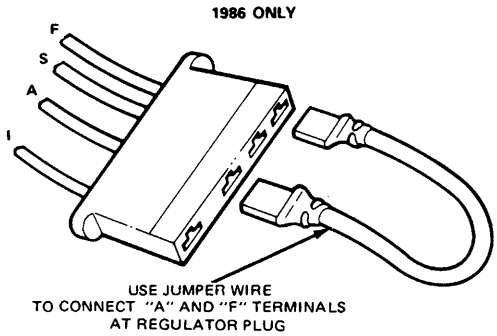
If the voltmeter did not indicate more than 0.5 volts above the base voltage, follow these procedures:

1. Disconnect the wiring plug from the regulator and connect an ohmmeter from the F terminal of the plug to a ground. The meter should read more than 2.4 ohms. If less than 2.4 ohms is indicated, service the grounded field circuit in the wiring harness or the alternator and then repeat the Load Test.



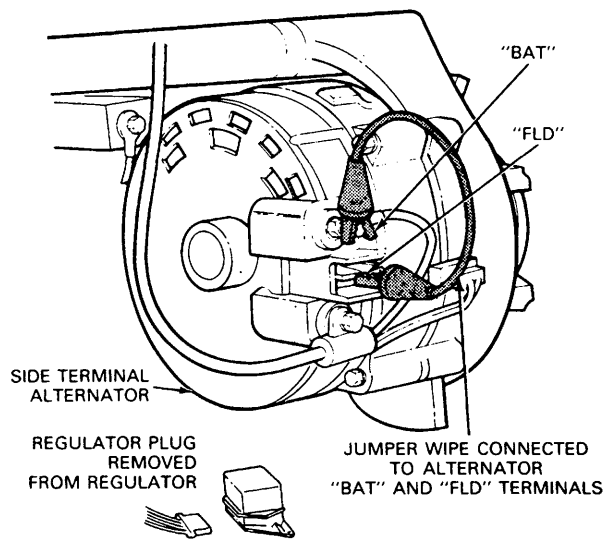
J1633-1J

2. If the ohmmeter indicates more than 2.4 ohms, connect a jumper wire from the A to F terminals of the plug and repeat the Load Test. If the voltmeter now indicates more than 0.5 volts above base voltage, the regulator or wiring is damaged or worn. Perform S and I Circuit Tests and service wiring or regulator as required.



J1635-1B

3. If the voltmeter still indicates a problem of under voltage, remove the jumper wire from the regulator plug and leave the plug disconnected from the regulator. Disconnect the FLD terminal on the alternator and pull back the protective cover from the BAT terminal. Then connect a jumper wire to the FLD and BAT terminals on the alternator and repeat the Load Test.



J3583-1A

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TESTING (Continued)

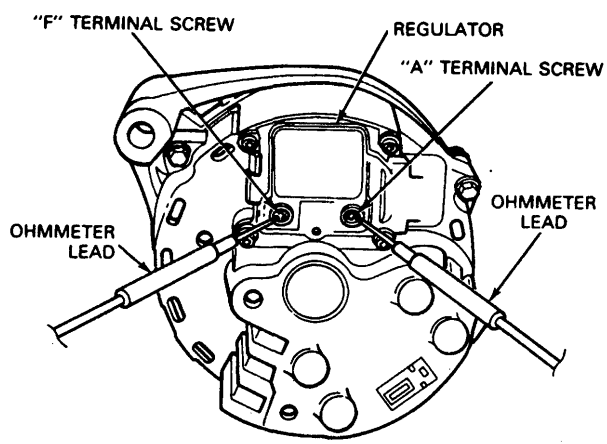
4. If the voltmeter now indicates a 0.5 volt or more increase above the base voltage, perform S and I Circuit Tests and service the wiring or regulator as indicated.
5. If the voltmeter still indicates under voltage, stop the engine and move the positive voltmeter lead to the BAT terminal of the alternator.

   If the voltmeter now indicates base voltage, service the alternator. If the voltmeter indicates zero volts, service the alternator to starter relay wire (Circuit 38).

IAR System

If the voltmeter did not indicate more than 0.5 volts above the base voltage, follow these procedures:

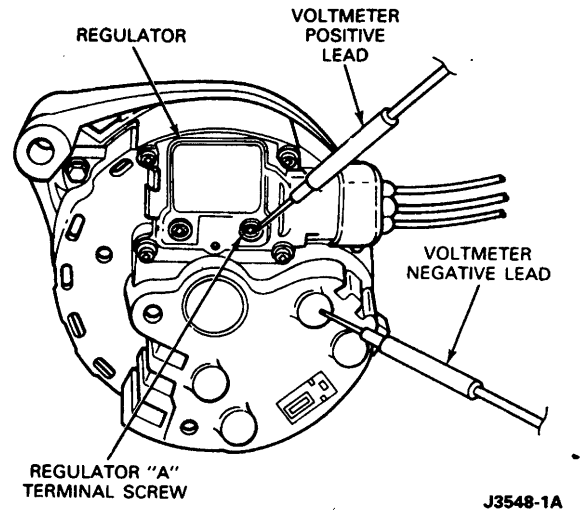
1. Disconnect the wiring plug from the regulator and connect an ohmmeter between the regulator A and F terminal screws. The meter should indicate more than 2.4 ohms. If less than 2.4 ohms is indicated, service the integral alternator/regulator unit for a failed regulator and check the alternator for a shorted rotor or field circuit. Perform the Load Test.



J3549-1A

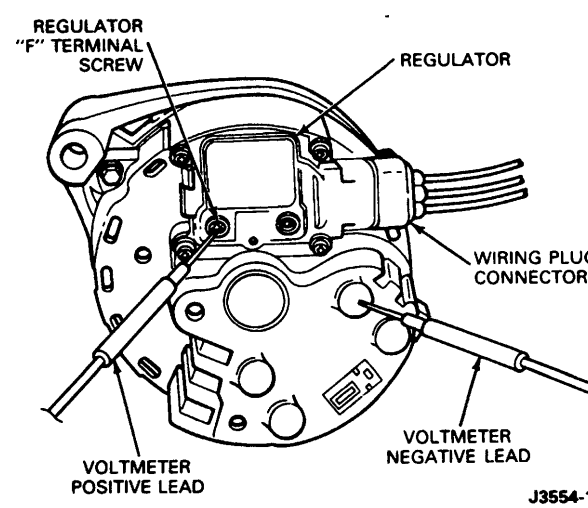
CAUTION: Do not replace the regulator before a shorted rotor coil or field circuit has been serviced. The result could be another damaged regulator.

2. If the above ohmmeter reading is greater than 2.4 ohms, reconnect the regulator wiring plug and connect the voltmeter negative lead to the alternator rear housing. Contact the voltmeter positive lead to the regulator A terminal screw. The meter should indicate battery voltage. If there is no voltage, service the A wiring circuit. Perform the Load Test after servicing.



J3548-1A

3. If voltmeter indicates battery voltage, connect voltmeter ground lead to alternator rear housing. With the ignition switch in OFF position, contact voltmeter positive lead to regulator F terminal screw. The meter should indicate battery voltage. If there is no voltage, service integral alternator/regulator unit for an open field circuit. Perform Load Test after servicing.

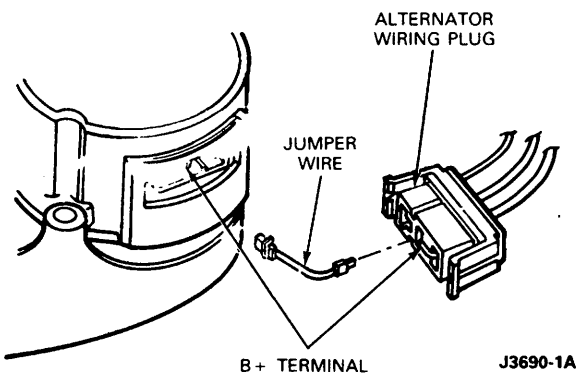


J3554-1A

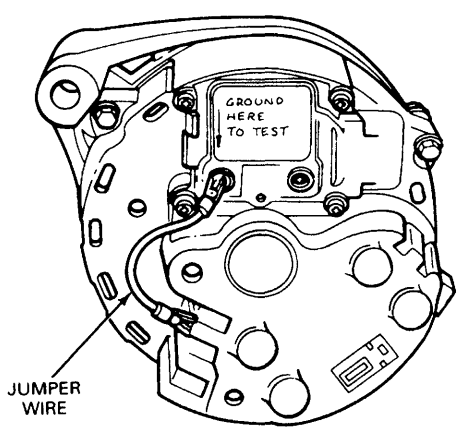
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TESTING (Continued)

4. If voltmeter indicates battery voltage, connect voltmeter negative lead to alternator rear housing. Turn ignition switch to RUN (engine off) and contact voltmeter positive lead to regulator F terminal screw. Refer to illustration under Step 3. The voltmeter should indicate 1.5 volts or less. If more than 1.5 volts is indicated, perform I circuit tests and service I circuit if needed. If I circuit checks normal, replace regulator if needed and perform Load Test.
5. If 1.5 volts or less is indicated, disconnect alternator wiring plug and connect a set of 12-gauge jumper wires between alternator B(+) terminal blades and mating wiring connector terminals. Perform Load Test, but connect voltmeter positive to one of B(+) jumper wire terminals. If voltage rises more than 0.5 volt above base voltage, service alternator-to-starter relay wiring. Repeat Load Test, measuring voltage at battery cable clamps after servicing.



6. If voltage does not rise more than 0.5 volt above base voltage, connect a jumper wire from alternator rear housing to regulator F terminal. Repeat Load Test with voltmeter positive lead connected to one of B(+) jumper wire terminals. If voltage rises more than 0.5 volt, replace regulator.

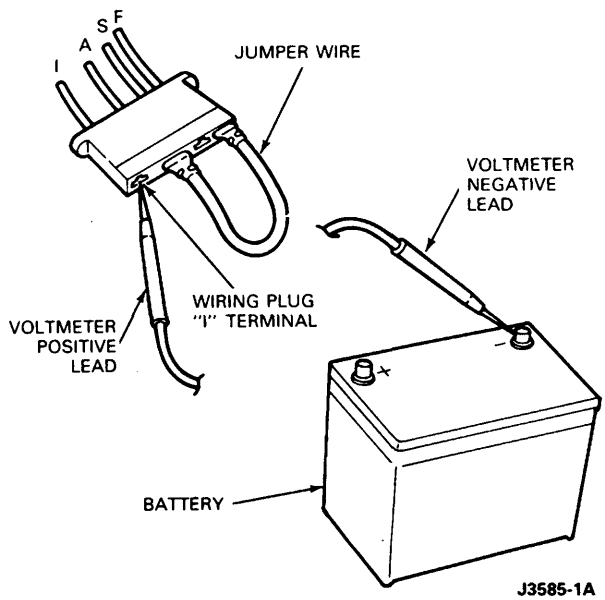


7. If voltage does not rise more than 0.5 volt, service alternator. Refer to illustration under Indicator Lamp System Normal Charge Indication, IAR System.

Regulator S and/or I Circuit Test

EVR System

1. Disconnect the regulator wiring plug and install a jumper wire between the A and F terminals.
2. With the engine idling and the voltmeter negative lead connected to the battery ground terminal, connect the voltmeter positive lead to the S terminal and then to the I terminal of the regulator wiring plug. The voltage of the S circuit should read approximately one-half that of the I circuit. If voltage readings are normal, remove the jumper wire. Replace the regulator and connect the wiring plug. Repeat the Load Test.



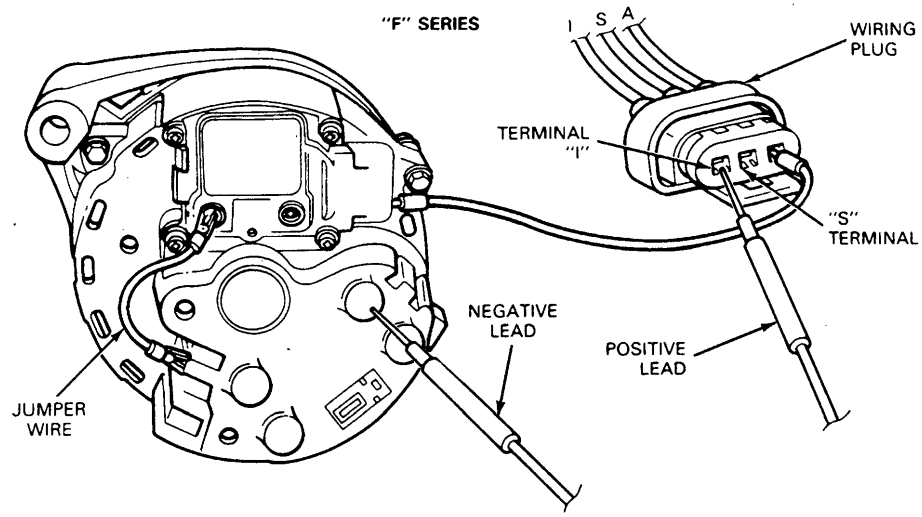
3. If no voltage is present, service the faulty wiring circuit. Connect the voltmeter positive lead to the positive battery terminal.
4. Remove the jumper wire from the regulator wiring plug and connect the wiring plug to the regulator. Repeat the Load Test. Refer to illustration of jumper wire connections in Under Voltage, External Voltage Regulator System.

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TESTING (Continued)

IAR System

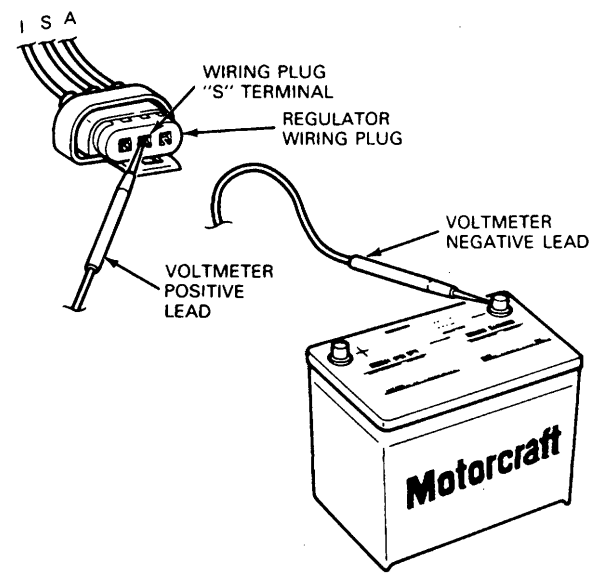
1. Disconnect the wiring plug from the regulator. Connect a jumper wire from the regulator "A" terminal to the wiring plug "A" lead. Add a jumper wire from the regulator "F" screw to the alternator rear housing.



2. With the engine idling and the voltmeter negative lead connected to the battery ground terminal, connect the voltmeter positive lead to the "S" terminal and then to the "I" terminal of the regulator wiring plug. The voltage at the "S" circuit should read approximately one-half that of the "I" circuit. If voltage readings are normal, remove the jumper wires. Replace the regulator and connect the wiring plug to the regulator. Repeat the load test.
3. If no voltage is present, remove the jumper wires and service the faulty wiring circuit or alternator.
4. Connect the voltmeter positive lead to the positive battery terminal. Connect the wiring plug to the regulator. Repeat the load test.

S Circuit with Ammeter

1. Disconnect the regulator wiring plug from the alternator regulator connector. Connect the positive lead of the voltmeter to the "S" terminal and the negative lead to the battery ground terminal voltage should not be indicated with ignition switch off.



2. Turn the ignition switch to RUN position (engine not running). The voltmeter should indicate battery voltage. If the voltage reading is normal, replace the regulator and repeat the load test.
3. If there is no voltage reading, service the S wire lead from the ignition switch to the regulator wiring plug.
4. Connect the positive voltmeter lead to the positive battery cable terminal, connect regulator wiring plug to regulator and repeat the Load Test.

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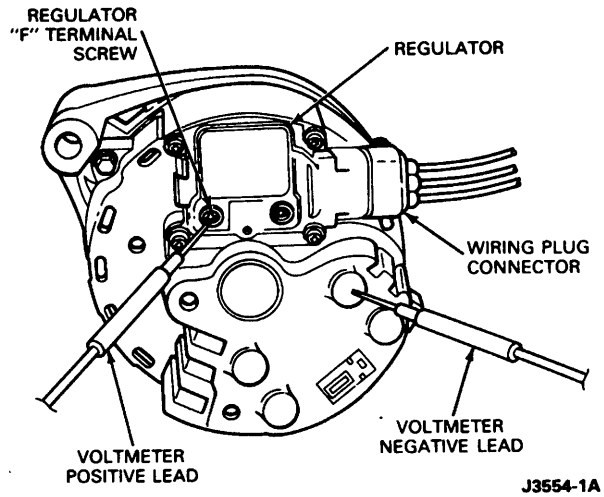
TESTING (Continued)

Field Circuit Drain—Integral Alternator/ Regulator

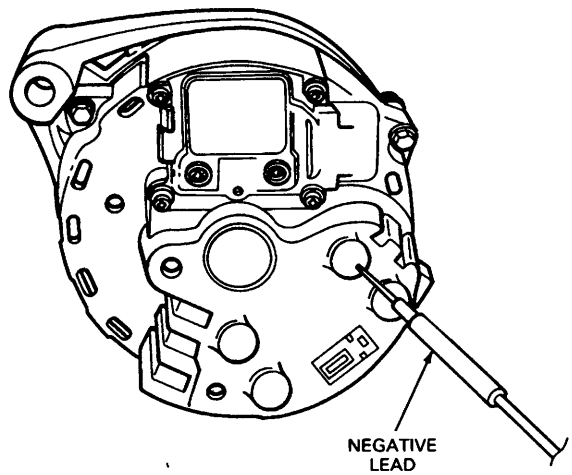
(IAR) System

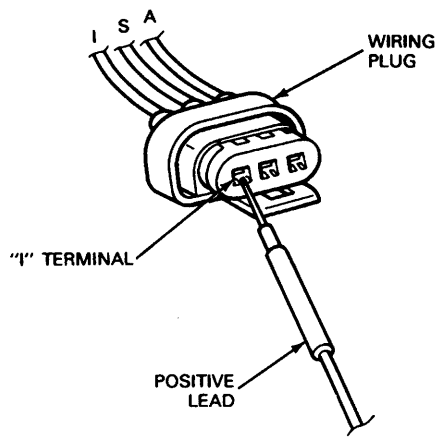
Connect the voltmeter negative lead to the alternator rear housing for all of the following voltage readings:

1. With the ignition switch turned OFF, contact the voltmeter positive lead to the regulator F terminal screw. The meter should indicate battery voltage if the system is operating normally. If less than battery voltage is indicated, proceed to Step 2 to find the cause of the current drain.



2. Disconnect the wiring plug from the regulator and contact the voltmeter positive lead to the wiring plug I terminal. No voltage should be indicated. If voltage is indicated, service the I lead from the ignition switch to identify and eliminate the voltage source.





3. If no voltage was indicated in Step 2, contact the voltmeter positive lead to the wiring plug S terminal. No voltage should be indicated. If no voltage is indicated, replace the regulator.
4. If voltage was indicated in Step 3, disconnect the wiring plug from the alternator rectifier connector. Again, contact the voltmeter positive lead to the regulator wiring plug S terminal. If voltage is ok indicated, service the S lead to the alternator plug to eliminate the voltage source. If no voltage is indicated, replace the alternator rectifier assembly.

Indicator Lamp System

The Integral Alternator Regulator (IAR) has a circuit in the regulator that will indicate a high battery voltage condition. With the IAR system, three conditions can cause the charge indicator lamp to come on during vehicle operation:

1. No alternator output—damaged alternator, regulator or wiring.
2. Overvoltage correlation—shorted alternator rotor, regulator or wiring.

If the system is working normally, the following conditions will be present:

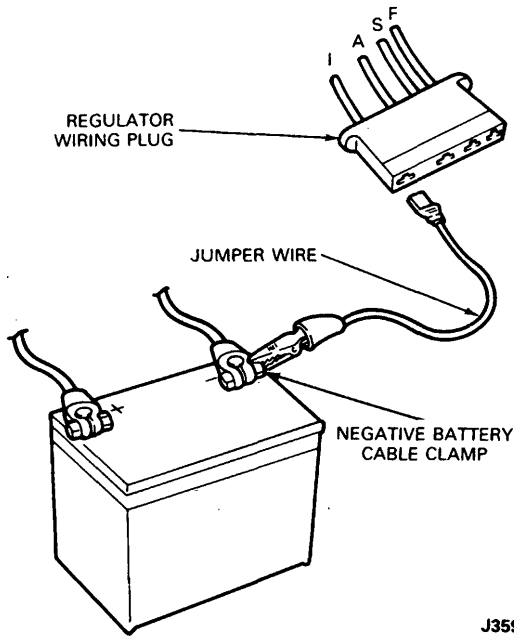
- With ignition switch in OFF position—charge indicator battery symbol lamp is off.
- With ignition switch in RUN position (engine not running)—charge indicator (alternator) lamp is on.
- With ignition switch in RUN position (engine running)—charge indicator (alternator) lamp is off.

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TESTING (Continued)

Electronic Voltage Regulator (EVR) System

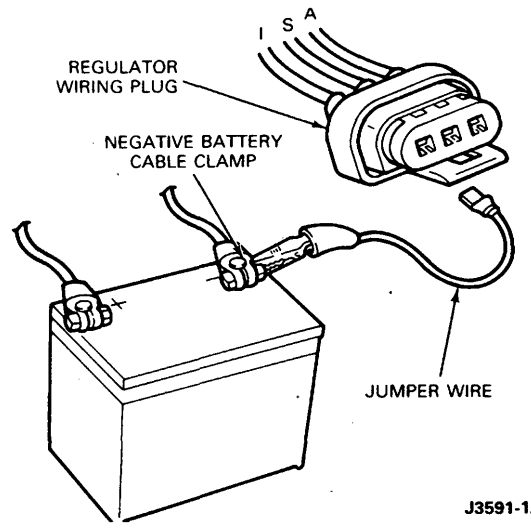
1. If the charge indicator lamp does not come on with the ignition switch in the RUN position (engine not running), check the I circuit (ignition switch to regulator I terminal) for an open circuit or burned out charge indicator lamp. Replace the lamp, if necessary.
2. If the charge indicator lamp does not come on, disconnect the wiring plug connector from the regulator. Connect a jumper wire from the I terminal of the regulator wiring plug to the negative battery post cable clamp.



3. The charge indicator lamp should go on with the ignition key turned to the RUN position.
4. If the charge indicator lamp does not go on, check the bulb for continuity and replace, if necessary.
5. If the bulb is not burned out, an open circuit exists between the ignition switch and the regulator. Check the 500 ohm resistor across the indicator lamp.

Integral Alternator/Regulator (IAR) System

1. If the charge indicator lamp does not come on, disconnect the wiring connector from the regulator.
2. Connect a jumper wire from the wiring connector I terminal to the battery negative post cable clamp.



3. Turn ignition to RUN position with engine off. If indicator lamp does not light, check for presence of bulb socket resistor. If resistor is missing, replace bulb socket. If resistor is present, check for contact of bulb socket leads to the flexible printed circuit. If good, check indicator bulb for continuity and replace bulb if burned out. If bulb checks good, perform regulator I circuit test.
4. If indicator lamp does light, remove jumper wire and reconnect wiring plug to regulator. Connect voltmeter negative lead to battery negative post cable clamp and contact voltmeter positive lead to regulator A terminal screw. Battery voltage should be indicated. If battery voltage is not indicated, service A circuit wiring.
5. If battery voltage is indicated, clean and tighten the ground connections to the engine, alternator and regulator. Tighten loose regulator mounting screws from 1.7 to 2.8 N·m (15-26 in-lb).
6. Turn the ignition switch to RUN position with the engine off. If the indicator lamp still does not light, replace the regulator.

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TESTING (Continued)

Ammeter System

Normal Charge Indication

1. With the ignition switch OFF and no electrical load, the ammeter should show 0 on center scale.
2. With the ignition switch in the RUN position (engine running), (fully charged battery), the needle deflects toward charge and returns toward center scale in time.
3. With the ignition switch in OFF position and the headlamps on, the ammeter should show a discharge. If the ammeter does not register a discharge, check for loose connections at the ammeter or an open circuit wire. Replace the gauge, if necessary.

Charging System Tests

These short simple tests are performed with a volt-ohmmeter, a test lamp and a jumper wire. Follow the procedures carefully. These tests will help you find the cause of a charging problem. Perform these tests only after you have made preliminary inspections and fully charged the battery.

When performing charging system tests turn off all lamps and electrical accessories. Place the transmission in NEUTRAL and apply the parking brake.

CAUTION: Do not make jumper wire connections except as directed. To do so may damage the regulator.

NOTE: Battery posts and cable clamps must be clean and secure to assure accurate meter readings.

DIAGNOSIS

Certain tests outlined in the Sections within this Group are illustrated in pictorial form. Schematic diagrams of the charging systems with either the warning lamp, ammeter (E-150-E-350) or voltmeter F-150-F-350 and Bronco are listed under the appropriate alternator Section 31-10, Rear Terminal Alternator.

Isolating the Problem

Battery, starting system, and lamp systems problems can be caused by poor charging system performance. It is also possible to suspect the charging system because of an overload in another area of the electrical system.

To avoid guesswork, it is necessary to isolate the battery, the charging system, and the electrical circuits to correctly identify the area where the difficulty lies. Check the battery first before any electrical system diagnosis. The battery must be in proper state of charge. The battery must be operating properly before the other areas of the electrical system can perform normally.

Battery Check

Check battery to see if it has the capacity and ability to accept and hold a charge. Refer to Section 31-02, Batteries. If the battery is good, then the charging system should be checked to see that it performs its function of keeping the battery charged.

The battery capacity, specific gravity and cell comparison test (non-maintenance free batteries only) will determine the ability of a battery to accept and hold a charge. If the battery cannot meet the specifications, replace it with a new fully charged battery before further diagnosis of other areas of the electrical system.

If the battery is found to meet the required specifications, it should be fully charged before proceeding with the diagnosis of other electrical system components.

Charging System Check

The General Charging System Test should be performed before testing any of the individual charging system components. The component tests will determine the type of component service to be performed.

The test instruments used in the General Charging System Test are a voltmeter (0-20 or 0-30 volt scale) and an ohmmeter. Special care should be given when using the ohmmeter near "hot" circuits. The component to be checked should be disconnected from the circuit or the battery terminals should be disconnected.

CAUTION: Damage to the component could occur if the circuit is allowed to remain intact. A Charging System Analyzer Rotunda Model 059-00002 or equivalent is available for testing the charging system. Test instructions are provided with the analyzer.

Continue through the Diagnosis Guides until a repair has been made. Then, again test the system to see if the repair has corrected the system problem.

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DIAGNOSIS (Continued)

CHARGING SYSTEM DIAGNOSIS

CONDITION	POSSIBLE CAUSE	RESOLUTION
Battery does not stay charged — engine starts OK	1. Battery	1. Test battery; replace if necessary (2).
	2. Loose or worn alternator belt	2. Adjust or replace belt (1).
	3. Damaged or worn wiring or cables	3. Service as required.
	4. Alternator	4. Test and/or replace components as required (3).
	5. Regulator	5. Test; replace if necessary (4).
	6. Other vehicle electrical systems	6. Check other systems for current draw. Service as required (1).
Alternator noisy	1. Loose or worn alternator belt	1. Adjust tension or replace belt (1).
	2. Bent pulley flanges	2. Replace pulley (3).
	3. Alternator	3. Service or replace alternator (3).
Lamps and/or fuses burn out frequently	1. Damaged or worn wiring	1. Service as required (1).
	2. Alternator regulator	2. Test, service, replace if necessary (4).
	3. Battery	3. Test, replace if necessary.
Charge indicator lamp flickers after engine starts or comes on while vehicle is being driven	1. Loose or worn alternator belt	1. Adjust tension or replace (1).
	2. Alternator	2. Service or replace (3).
	3. Field circuit ground	3. Repair or replace wiring.
	4. Regulator	4. Test, replace if necessary (4).
	5. Lamp circuit wiring and connector	5. Service as required.
	6. Operation at low engine speed (IDLE) and high vehicle electrical loads. (IAR ONLY)	6. Test, replace if necessary (1). (IAR ONLY)
Charge indicator lamp flickers while vehicle is being driven	1. Loose or worn alternator belt	1. Adjust tension, replace belt (1).
	2. Loose or improper wiring connections	2. Service as required (1).
	3. Alternator	3. Service or replace (3).
	4. Regulator	4. Test, replace if necessary.
Charge indicator gauge shows discharge (Ammeter E-Series only) Voltmeter in the red area on F-Series and Bronco	1. Loose or worn alternator belt	1. Adjust tension or replace belt (1).
	2. Damaged or worn wiring (battery to alternator for ground or open)	2. Service or replace wiring.
	3. Field circuit ground	3. Repair or replace wiring.
	4. Alternator	4. Service or replace (3).
	5. Regulator	5. Test, replace if necessary (4).
	6. Charge indicator gauge wiring and connections	6. Service as required (1).
	7. Damaged or worn gauge	7. Replace gauge (1).
	8. Other vehicle electrical system malfunction	8. Service as required.

(1) Refer to test in this Section.
(2) Refer to Battery Section (Section 31-02).
(3) Refer to Appropriate Alternator Section.
(4) Refer to Alternator Electronic Regulator Section (Section 31-43).

CJ2501-2F

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DIAGNOSIS (Continued)

CHARGING SYSTEM TEST — WITH EXTERNAL VOLTAGE REGULATOR (EVR)

TEST STEP		RESULT	ACTION TO TAKE
A1	PRELIMINARY CHECKS		
	Check the following: • Fuse link. • Battery terminals and cable clamps. • Wiring connections at alternator, electronic voltage regulator (EVR) and engine-to-body grounds. • Alternator belt tension.	(OK) ▶ (OK) ▶	GO to **A2**. SERVICE and/or REPLACE as necessary. GO to **A2**.
A2	BASE VOLTAGE AND NO-LOAD TEST		
	• Connect voltmeter to battery posts. Record battery voltage — this is base voltage. • Start engine and run at 1500 RPM with no electrical load. Voltage should increase, but not more than 2.0 volts.	Increased, but not more than 2.0 volts ▶ No increase ▶ Increases more than 2.0 volts ▶	GO to **A3**. GO to **A6**. GO to **A14**.
A3	LOAD TEST		
	• Increases engine speed to 2000 RPM. • Turn heater/A/C blower and headlamps on High. • Voltage should read a minimum of 0.5 volt over base voltage.	Increases .05 volt or more ▶ Increases .05 volt or more, but alternator indicator lamp stays On ▶ Increases less than 0.5 volt ▶	GO to **A4**. GO to **A12**. GO to **A6**.
A4	BATTERY DRAIN TEST — KEY OFF		
	• Perform battery drain test as described in this section.	Battery drain ▶ No battery drain ▶	GO to **A5**. REFER to Section 31-02.
A5	EVR DRAIN TEST		
	• Remove connector from EVR. • Perform battery drain test as described in this section.	Battery drain ▶ No battery drain ▶	CHECK other vehicle circuits for drain. REPLACE EVR.
A6	UNDER VOLTAGE TEST		
	• Disconnect EVR. • Measure resistance between F terminal of EVR harness connector and ground. • Resistance should be more than 3.0 ohms.	Less than 3.0 ohms ▶ More than 3.0 ohms. ▶	SERVICE grounded field circuit. CHECK wiring and alternator. GO to **A2**. GO to **A7**.

CJ3575-2B

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DIAGNOSIS (Continued)

CHARGING SYSTEM TEST — WITH EXTERNAL VOLTAGE REGULATOR (EVR)

TEST STEP		RESULT	ACTION TO TAKE
A7	JUMPER TERMINALS A TO F		
	• Jumper A to F terminal at EVR connector. • Voltage should read a minimum of 0.5 volts over base voltage, with load test conditions in effect.	Less than 0.5 volt ▶	GO to **A8**.
		0.5 volt or more vehicles with alternator warning lamp ▶	GO to **A10**.
		0.5 volt or more vehicles with ammeter ▶	GO to **A11**.
A8	JUMPER BAT TO FLD TERMINALS		
	• Remove jumper from A to F terminals, but leave EVR disconnected. • Jumper BAT to FLD terminals at alternator.	0.5 volt or more ▶	SERVICE faulty or worn A or F circuits. GO to **A2**.
	• Voltage should read a minimum of 0.5 volt over base voltage, with load test conditions in effect.	Less than 0.5 volt ▶	GO to **A9**.
A9	CHECK ALTERNATOR OUTPUT		
	• Stop Engine. • Move voltmeter positive lead to BAT terminal of alternator.	Base voltage ▶	SERVICE or REPLACE alternator. GO to **A2**.
		Zero voltage ▶	SERVICE or REPLACE circuit from alternator to battery. GO to **A2**.
A10	CHECK FOR POWER AT S AND I TERMINALS		
	NOTE: This test is only for vehicles equipped with indicator lamps. • Turn Off all load. • With engine at idle and jumper on terminals A and F, check for power at the S and I terminals at the EVR connector. • Voltage at the S terminal should be approximately 1/2 of voltage at the I terminal.	(OK) ▶	SERVICE faulty S and/or I circuits as necessary. GO to **A2**.
		OK ▶	REPLACE EVR. GO to **A2**.
A11	CHECK FOR POWER TO S TERMINAL		
	NOTE: This test is only for vehicles equipped with ammeters. • Turn Off all load. • Engine Off. • Ignition switch in RUN position. • Check for power to S terminal at EVR harness connector.	(OK) ▶	SERVICE faulty S circuit as necessary. GO to **A2**.
		OK ▶	REPLACE EVR. GO to **A2**.

CJ3576-2B

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DIAGNOSIS (Continued)

CHARGING SYSTEM TEST — WITH EXTERNAL VOLTAGE REGULATOR (EVR)

TEST STEP	RESULT ▶	ACTION TO TAKE
A12 S CIRCUIT TEST • Engine at idle. • Check for power at S terminal on EVR connector. • Voltage should be approximately 1/2 of base voltage at BAT terminal.	(OK) ▶	REPLACE EVR. REPEAT Test Step **A12**.
	No voltage ▶	GO to **A13**.
A13 ALTERNATOR STATOR VOLTAGE TEST • Engine at idle. • Check voltage at alternator S terminal. • Voltage should be approximately 1/2 of base voltage at BAT terminal.	(OK) ▶	SERVICE S circuit between alternator and EVR.
	(OK) ▶	SERVICE or REPLACE alternator. GO to **A12**.
A14 OVER VOLTAGE TEST • Connect jumper between EVR and ground.	Over voltage DOES go away ▶	SERVICE EVR ground GO to **A2**.
	Over voltage DOES NOT go away ▶	GO to **A15**.
A15 DISCONNECT EVR • Disconnect EVR. • Over voltage should go away.	(OK) ▶	REPLACE EVR. GO to **A2**.
	(OK) ▶	SERVICE shorted harness between EVR and alternator. GO to **A2**.

CJ3577-2B

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DIAGNOSIS (Continued)

CHARGING SYSTEM TEST — IAR ALTERNATOR

TEST STEP		RESULT	ACTION TO TAKE
B1	PRELIMINARY CHECKS		
	Peliminary Checks — • Fuse Link • Battery Terminals and Cable Clamps • Wiring and Ground Connections to Alternator Regulator and Engine • Alternator Belt Tension	(OK) ▶ (OK) ▶	GO to **B2**. SERVICE and/or REPLACE as necessary. GO to **B2**.
B2	BASE VOLTAGE AND NO LOAD TEST		
	• Connect voltmeter to battery posts. Read battery voltage — this is base reading • Start engine, run at 1500 rpm with no electrical load. Voltage should increase but not more than 2.0 volts.	Increases, but not more than 2.0 volts ▶ No increase ▶ Increase more than 2.0 volts ▶	GO to **B3**. GO to **B5**. GO to **B12**.
B3	LOAD TEST		
	• Increase engine speed to 2000 rpm. • Turn heater A/C, blower and headlamps on high. • Voltage should read a minimum of 1/2 volt over base voltage.	Increases 1/2 volt or more ▶ Increases less than 1/2 volt ▶	GO to **B4**. GO to **B5**.
B4	BATTERY DRAIN TEST — KEY OFF		
	Problem can still be battery drain. Turn OFF ignition, install test lamp in series with positive battery cable and check to isolate problem circuit.	Battery drain ▶ No battery drain ▶	CHECK vehicle circuits for drain. REFER to Section 31-02.
B5	UNDER VOLTAGE TEST		
	• Disconnect regulator. • Check resistance between regulator A and F terminals. • Resistance should be more than 2.4 ohms.	2.4 ohms or less ▶ More than 2.4 ohms ▶	CHECK alternator for shorted field circuit and service if required. REPLACE regulator — GO to **B2**. GO to **B6**.
B6	A TERMINAL VOLTAGE CHECK		
	• Connect regulator. • Measure A terminal voltage.	No voltage ▶ Battery voltage ▶	SERVICE A circuit wiring. GO to **B7**.

CJ3578-2B

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DIAGNOSIS (Continued)

CHARGING SYSTEM TEST — IAR ALTERNATOR

TEST STEP		RESULT ▶	ACTION TO TAKE
B7	F TERMINAL VOLTAGE CHECK — IGNITION OFF		
	• Measure regulator F terminal voltage with ignition OFF.	No voltage ▶	SERVICE IAR for open or grounded field circuit. GO to **B2**.
		Battery voltage ▶	GO to **B8**.
B8	F TERMINAL VOLTAGE CHECK — IGNITION ON		
	• Turn ignition to RUN position (engine not running). • Measure regulator F terminal voltage.	More than 1.5 volts ▶	GO to **B9**.
		1.5 volts or less ▶	GO to **B10**.
B9	I CIRCUIT TESTS		
	Perform I circuit tests.	(OK) ▶	REPLACE regulator. GO to **B2**.
		(OK) ▶	SERVICE I circuit wiring. GO to **B2**.
B10	JUMPERED LOAD TEST		
	• Disconnect alternator plug. • Connect jumper wires between B+ blades and wiring plug. • Repeat load test measuring voltage to jumper wires from battery negative clamp. • Voltage should rise 1/2 volt or more.	Voltage rise 1/2 volt or more ▶	Service alternator to starter relay wiring. GO to **B2**.
		Voltage rise less than 1/2 volt ▶	GO to **B11**.
B11	LOAD TEST REPEAT — F TERMINAL		
	• Keep B+ jumper wires in place. • Connect another jumper wire from alternator rear housing to regulator F terminal. • Repeat load test measuring voltage at B+ jumper wires. • Voltage should rise 1/2 volt or more.	Voltage rise 1/2 volt or more ▶	REPLACE regulator. GO to **B2**.
		Voltage rise less than 1/2 volt ▶	SERVICE alternator. GO to **B2**.
B12	OVER VOLTAGE TEST		
	• Turn ignition to RUN position (engine not running). • Measure voltage at regulator A terminal and starter solenoid. • Voltage difference should be 1/2 volt or less.	Voltage difference 1/2 volt or less ▶	GO to **B13**.
		Voltage difference more than 1/2 volt ▶	SERVICE A circuit wiring. GO to **B2**.
B13	REGULATOR GROUND CHECK		
	Check for loose regulator ground screws.	(OK) ▶	GO to **B14**.
		(OK) ▶	SERVICE ground screws. GO to **B2**.

CJ3579-2B

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DIAGNOSIS (Continued)

CHARGING SYSTEM TEST — IAR ALTERATOR

TEST STEP	RESULT	ACTION TO TAKE
B14 ENGINE GROUND CHECK		
Check for bad engine ground.	(OK) ▶	GO to **B15**.
	(OK) ▶	SERVICE engine ground. GO to **B2**.
B15 ALTERNATOR GROUND CHECK		
Check alternator ground.	(OK) ▶	GO to **B16**.
	(OK) ▶	SERVICE alternator ground. GO to **B2**.
B16 REPEAT NO LOAD TEST		
• Start engine, run at 1500 rpm with no electrical load. Voltage should increase but not more than 2.0 volts	Increases 2.0 volts or less ▶	GO to **B3**.
	Increases more than 2.0 volts ▶	GO to **B17**.
B17 A AND F VOLTAGE CHECKS		
• Turn ignition OFF. • Measure voltage at regulator A and F terminals. • Terminal voltages should be the same — Battery voltage	Battery voltage ▶	REPLACE regulator. GO to **B2**.
	Different than battery voltage ▶	SERVICE integral assembly for grounded field circuit or bad regulator. GO to **B2**.

CJ3580-2B

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Model Number	Description
Rotunda 059-00002	Charging System Analyzer
Rotunda 007-00001	Digital Volt-Ohmmeter
Rotunda 059-00010	Inductive Dwell-Tach-Volt-Ohm Tester

CJ3293-1B

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SECTION 31-02 Batteries

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REMOVAL AND INSTALLATION	
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TESTING	
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VEHICLE APPLICATION

All Models.

TESTING

Perform battery tests to determine the state of charge and also its capacity or ability to crank an engine. The ultimate result of these tests shows either that the battery is good, needs recharging, or must be replaced.

Prior to battery testing, thoroughly examine the battery for signs of damage.

WARNING: HYDROGEN AND OXYGEN GASES ARE PRODUCED DURING NORMAL BATTERY OPERATION. THIS GAS MIXTURE CAN EXPLODE IF FLAMES, SPARKS OR LIGHTED TOBACCO ARE BROUGHT NEAR THE BATTERY. WHEN CHARGING OR USING A BATTERY IN AN ENCLOSED SPACE, ALWAYS PROVIDE VENTILATION AND SHIELD YOUR EYES.

WARNING: KEEP OUT OF REACH OF CHILDREN. BATTERIES CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES OR CLOTHING. ALSO, SHIELD YOUR EYES WHEN WORKING NEAR THE BATTERY TO PROTECT AGAINST POSSIBLE SPLASHING OF THE ACID SOLUTION. IN CASE OF ACID CONTACT WITH SKIN OR EYES FLUSH IMMEDIATELY WITH WATER FOR A MINIMUM OF FIFTEEN MINUTES AND SEEK PROMPT MEDICAL ATTENTION. IF ACID IS SWALLOWED, CALL A PHYSICIAN IMMEDIATELY.

Battery State of Charge

Maintenance Free Batteries

Check the battery open circuit terminal voltage with a digital voltmeter capable of reading 1/100 of a volt. If open circuit voltage of battery is below 12.4 volts and the battery has passed the capacity test, charge the battery.

Conventional Batteries

Use a hydrometer or Rotunda Battery and Anti-Freeze Tester 021-00046 or equivalent to check the specific gravities of all cells.

In order to obtain an accurate specific gravity reading, it must be corrected to the standard temperature of 26°C (80°F). A correction factor of four points (0.004) is used for each 6°C (10°F) change in temperature. Add four points (0.004) to the indicated reading for each 6°C (10°F) increment above 26°C (80°F) and subtract four points (0.004) for each 6°C (10°F) increment below 26°C (80°F).

If the difference between cells is 50 points (0.050) or more, the battery is not satisfactory for service and should be replaced.

If the difference between cells is less than 50 points (0.050) and one or more cells are less than 1.225, charge the battery for 20 minutes at 35 amps and perform capacity test as outlined. If the battery fails, replace the battery. If it passes, add water if necessary and charge the battery.

If the difference between cells is less than 50 points (0.050) and all cells are above 1.225, perform the capacity test as outlined. If the battery fails, replace the battery. If it passes, return to service.

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TESTING (Continued)

Perform the following tests using Starting and Charging Tester 078-00005 or equivalent.

BATTERY TESTING PROCEDURE

TEST STEP		RESULT	ACTION TO TAKE
A0	VISUAL INSPECTION		
	• Remove negative cable, then positive cable. • Check for dirty or corroded connections.	(OK) ▶	CLEAN terminals and clamps. GO to **A1**.
		OK ▶	GO to **A1**.
A1	LOOSE BATTERY POST		
	• Check for loose battery post.	(OK)	REPLACE battery.
		OK ▶	GO to **A2**.
A2	CRACKED BATTERY COVER		
	• Remove hold-downs and shields. • Check for broken/cracked case or cover.	(OK) ▶	REPLACE Battery.
		OK ▶	GO to **A3**.

CJ2732-2B

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TESTING (Continued)

BATTERY TESTING PROCEDURE

TEST STEP		RESULT	ACTION TO TAKE
A3	BATTERY CAPACITY TEST		
	Use a high rate discharge tester with a variable rate control or a fixed rate tester with meter compensation for different battery electrical sizes. Follow instructions supplied with tester for the battery capacity test.	(OK) ▶	CHARGE battery for 20 minutes at 35 amps. REPEAT Step A3. (If battery fails second check, REPLACE battery.)
	Recommended Discharge Rates **Battery Rating (Ampere-Hrs.)** — **Discharge Rate (Amperes)** 54 Maintenance-Free — 225 71 Maintenance-Free — 235 81 Conventional Batt. — 175 **(Cold Cranking Amps)** 850 — 425 700 — 350 650 — 325 535 — 260 450 — 225	(OK) ▶	GO to **A4**.
	Voltage Readings at 15 seconds For Good Battery (Battery Capacity Test). **Approximate Battery Temperature** — **Minimum Voltage** 21°C (70°F) And Above 9.6 16°C (60°F) 9.5 10°C (50°F) 9.4 4°C (40°F) 9.3 – 1°C (30°F) 9.1 – 7°C (20°F) 8.9 –12°C (10°F) 8.7 –18°C (0°F) 8.5		
A4	VOLTAGE CHECK		
	• Measure open circuit voltage of battery with a digital voltmeter capable of reading 1/100 volt.	OVER 12.4 Volts ▶	Battery OK.
		12.4 Volts or less ▶	CHARGE battery.

CJ2701-2F

Battery Charging

Before recharging a discharged battery, inspect and service the following conditions, if they exist:

1. Loose alternator belt.
2. Pinched or grounded alternator voltage regulator wiring harness.
3. Loose harness connections at the alternator and/or voltage regulator.
4. Loose or corroded connections at battery, starter relay and/or engine ground.
5. Excessive battery drain due to hood, glove compartment and courtesy lamps remaining energized (damaged or misadjusted switch, glove compartment left open, etc.).

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TESTING (Continued)

Maintenance Free and Conventional Batteries

Cold batteries will not readily accept a charge. Therefore, batteries should be allowed to warm up to approximately 5°C (40°F) before charging. This may require 4 to 8 hours at room temperature. Warming time depends upon initial temperature and battery size.

A battery which has been completely discharged may be slow to accept a charge initially. In some cases batteries may not accept a charge at the normal charger setting. When batteries are in this condition, charging can be started by using the dead battery switch on chargers so equipped.

Completely discharged batteries, which have been discharged for a prolonged period of time (over one month) or which have an open circuit voltage of less than two volts, may show no indication of accepting a charge even when the dead battery switch is used. The initial charge rate of batteries in this condition is so low that some charger ammeters will not show any indication of charge for up to 10 minutes.

Determine whether a battery accepts charge as follows: Follow charger manufacturer's instructions for use of dead battery switch. If dead battery switch is the spring-loaded type, it should be held in the ON position for up to three minutes. After releasing dead battery switch and with charger still on, measure battery voltage. If it shows 12 volts or higher, the battery is accepting a charge and is capable of being recharged. However, cold batteries below 5°C (40°F) may require up to two hours of charging before the charge rate is high enough to show on the charger ammeter. All non-damaged batteries can be charged by this procedure. If a battery cannot be charged by this procedure it should be replaced.

Once it has been determined that the battery has begun to accept a charge, it can be charged to a serviceable state or a full state of charge using one of two following methods:

- The **first method** uses the AUTOMATIC setting on chargers so equipped. This setting maintains the charging rate within safe limits by adjusting voltage and current to prevent excessive gassing and spewing of electrolyte. Approximately 2 to 4 hours will be required to charge a completely discharged battery to a serviceable state. If a full state of charge is desired, the charge can be completed by a low current rate of 3 to 5 amps for several additional hours.
- The **second method** uses the MANUAL or constant current setting on the charger. Initially set the charging rate for 30 to 40 amps and maintain this setting for approximately 30 minutes or as long as there is no excessive gassing and electrolyte spewing. If gassing results, the charge rate must be reduced to a level where gassing will stop. Excessive gassing will result in non-replaceable loss of electrolyte, thus shortening battery life.

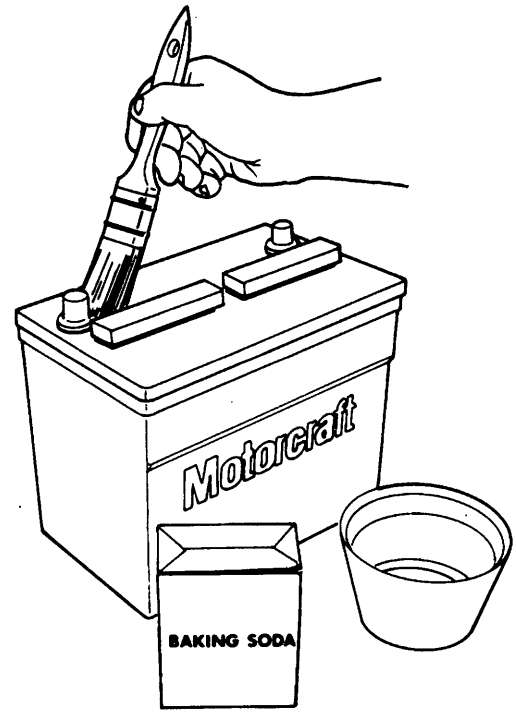
The total charge required will vary with battery size and its initial state of charge. In general, to bring a discharged battery to a serviceable state of charge, current-time input should equal the battery amp-hour capacity. For example: A 45 AH battery will require 15 amps of charge for 3 hours, or 9 amps of charge for 5 hours. Again, if a full state of charge is desired, the charge can be completed by a low constant current of 3 to 5 amps for several hours.

If the battery has failed, or is low in charge, it may be necessary to refer to Diagnosis, Section 31-01, Charging System General Service.

MAINTENANCE

Battery Cleaning

Keeping the battery top clean and dry reduces the need for service and extends battery life. Also, make certain that the cable clamps are tightly fastened to the battery posts. If corrosion is found, disconnect the cables and clean clamps and posts with a wire brush. Neutralize the corrosion with a solution of baking soda and water. After installing cables, apply a small quantity of Multi-Purpose Long-Life Lubricant C1AZ-19590-B or equivalent grease to each battery post to help prevent corrosion.



J3285-1A

Jump Starting

Refer to Section 28-01, Starting System General Service.

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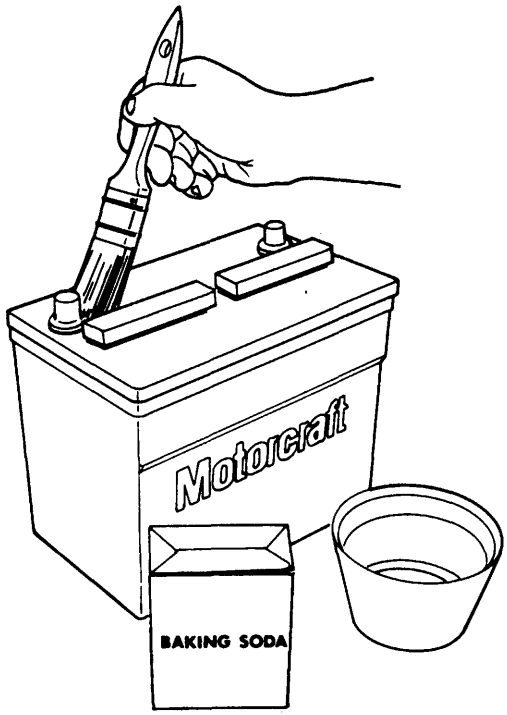
REMOVAL AND INSTALLATION

Battery

Removal

NOTE: The illustrations used in the following procedures show typical battery locations and connections.

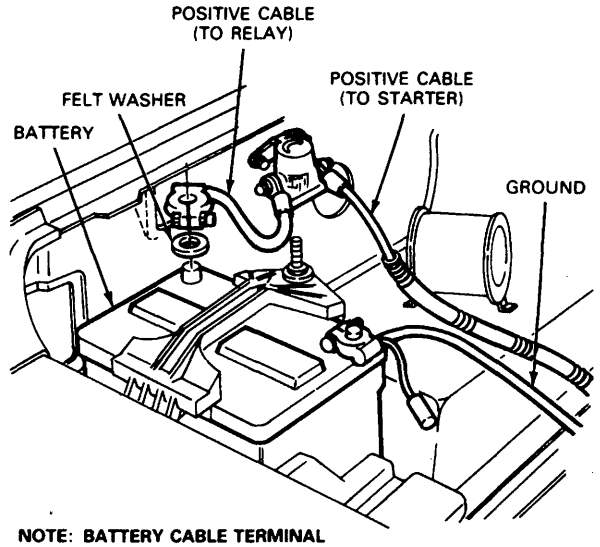
1. Remove battery cables from battery terminals (negative first).
2. Clean cable terminals with an acid neutralizing solution and terminal cleaning brush.



J3285-1A

3. Remove hold-down clamps.
4. Test battery and determine if it should be:
   - Returned to service.
   - Recharged before being returned to service.
   - Replaced with a Motorcraft or equivalent battery.

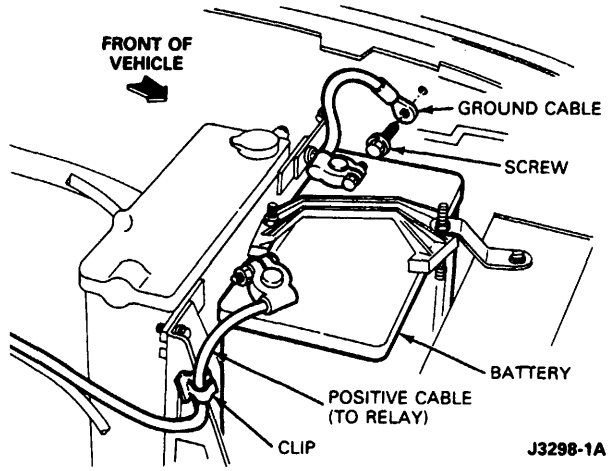
Battery Connections—Standard (R.H.)



NOTE: BATTERY CABLE TERMINAL MAY EXTEND 1/16 INCH OVER TOP OF BATTERY POST

J3297-1A

Battery Connections with Dual Batteries (L.H.)

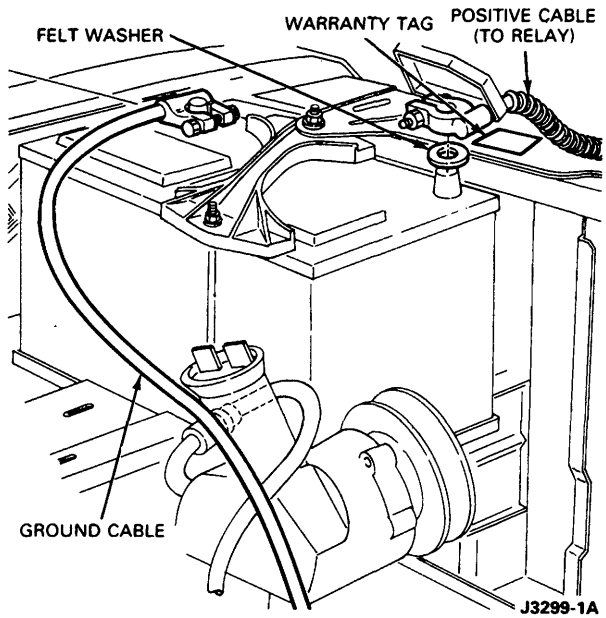


J3298-1A

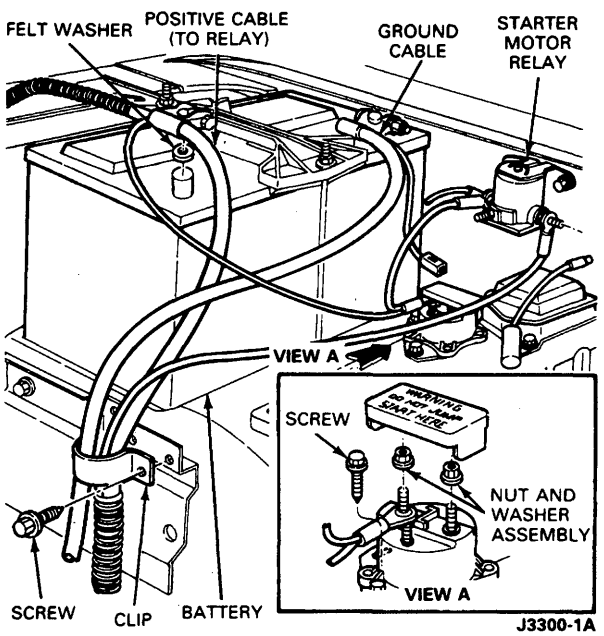
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REMOVAL AND INSTALLATION (Continued)

Battery Connections with 6.9L Diesel Engine (L.H.)

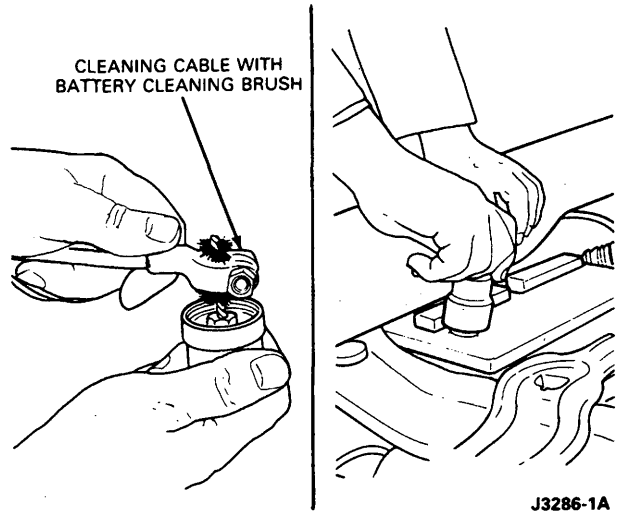


Battery Connections with 6.9L Diesel Engine (R.H.)

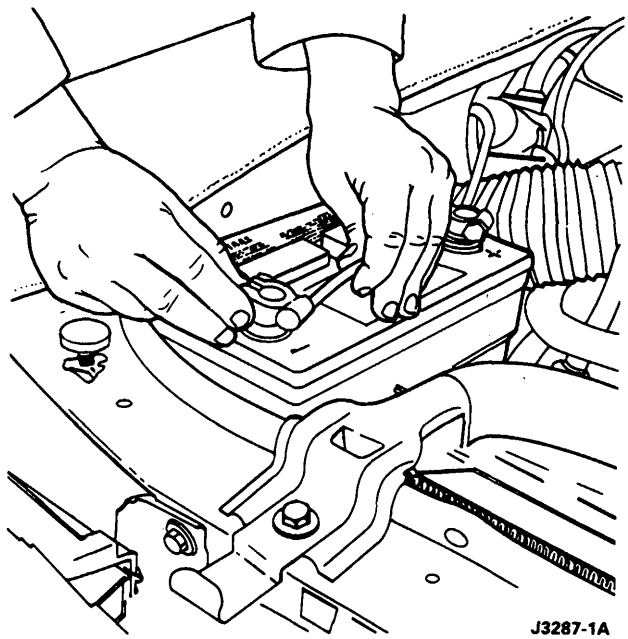


Installation

1. Clean cable terminals and hold-down with a wire brush. Replace all cables or parts that are worn or frayed.



2. Clean battery tray with a wire brush and scraper.
3. Place battery into tray with positive and negative terminals in same position as originally installed battery. Assemble and tighten hold-down hardware to ensure that battery is secure. Do not overtighten.
4. Secure cables (positive first) to proper terminals. **Do not overtighten.** Apply a small quantity of Multi-Purpose Long Life Lubricant C1AZ-19590-B or equivalent to terminals.



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SERVICE

Tools

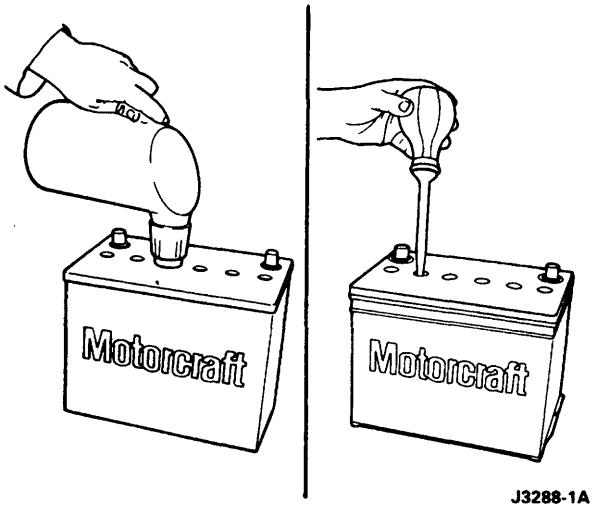
Anyone servicing a battery needs the proper tools. Properly designed tools will help prevent damage to the battery, battery cables and hold-down bracketry. Their use decreases potential hazard to both the technician and the vehicle being serviced.

Tools and equipment manufactured for servicing batteries have parts insulated to help prevent arcing. This feature reduces potential fire hazard should the tool be dropped or otherwise accidentally establish an arc-producing current path.

Battery Filling Devices

Batteries with Removable Vent Caps

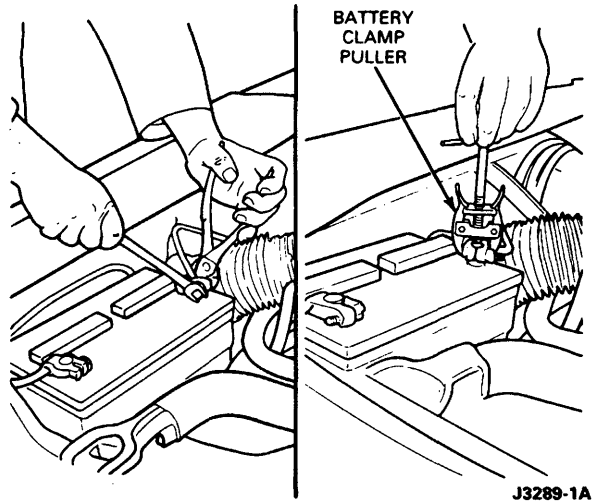
One of the most important on-the-vehicle services is to maintain the correct battery electrolyte level. Two devices are available for this purpose: a self-leveling filler which allows the battery to be filled to a predetermined level automatically, and the syringe type filler.



J3288-1A

Battery Pliers

Battery pliers have jaws specifically designed for gripping cable clamp bolts securely. Exercise care when removing or replacing the cable clamp bolts so that the battery terminal is not subjected to any excessive lateral or twisting forces. Such forces could cause major damage to the internal components of the battery and result in leakage at the terminals.



J3289-1A

Battery Cable Puller

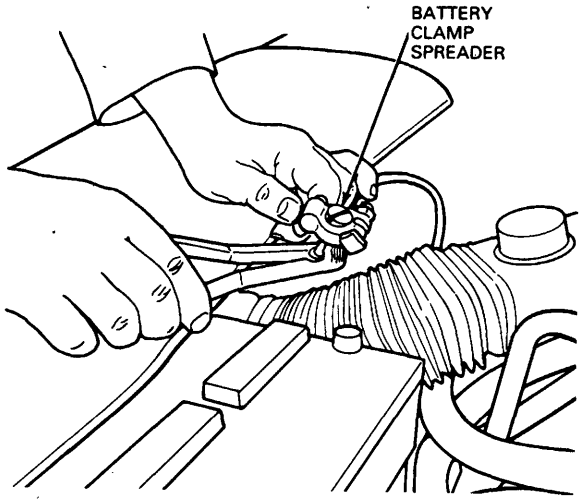
Use a cable puller to remove a cable clamp from the battery terminal. Jaws, gripping the underside of the cable clamp, pull the clamp up by means of pressure exerted against the top of the battery terminal. Proper use of this tool avoids the damaging lateral or twisting forces that result when using a pry bar or pliers to remove the battery clamp. Refer to the illustration shown under Battery Pliers.

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SERVICE (Continued)

Battery Cable Clamp Spreader

The spreader is used to expand the cable clamp after it has been removed from the terminal and the clamp bolt has been loosened. The cable clamp can then be fully and properly installed onto the battery terminal.



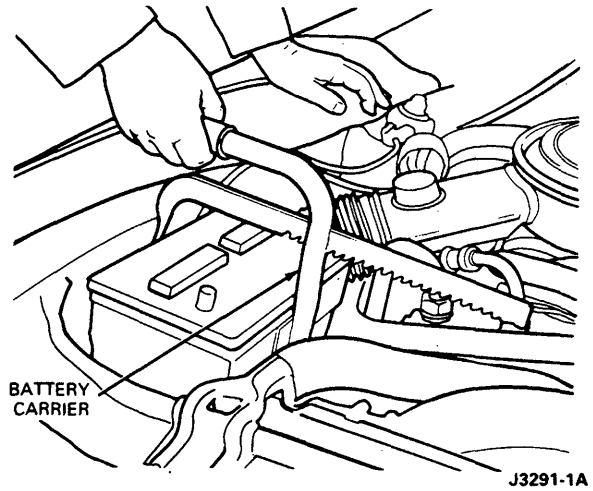
J3290-1A

Terminal Cleaning Brush

The terminal cleaning brush is designed with units to clean both the tapered battery terminal and the mating surface of the cable clamp. Refer to illustration under Battery Installation, Step 1.

Battery Carrier

Use a suitable battery carrier for lifting and transporting the battery. The illustration shows a clamp-type carrier used to grip the sidewalls of the container just below the lip of the cover. The carrier is used on the sidewalls, rather than the endwalls, since the sidewalls have additional strength from the inner cell partitions. This is particularly important with polypropylene-cased batteries. Gripping the flexible endwalls on this type of battery could cause electrolyte to spew from some of the cells, and possibly cause damage to some of the internal components.



J3291-1A

Adding Water

Some batteries have removable vent caps and may occasionally require the addition of water. If the electrolyte level is below the level indicator in any cell, add enough pure water to bring the level up to the indicator. In batteries without level indicator, maintain electrolyte level at 6.3 to 12.7mm (1/4 to 1/2 inch) above the plates. **Never add electrolyte ("battery acid") to the battery.** This could shorten the battery's life.

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Tool Number	Description
078-00005	Starting and Charging Tester
021-00046	Battery and Anti-Freeze Tester

CJ3682-1A

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SECTION 31-17 Alternator—Integral Regulator

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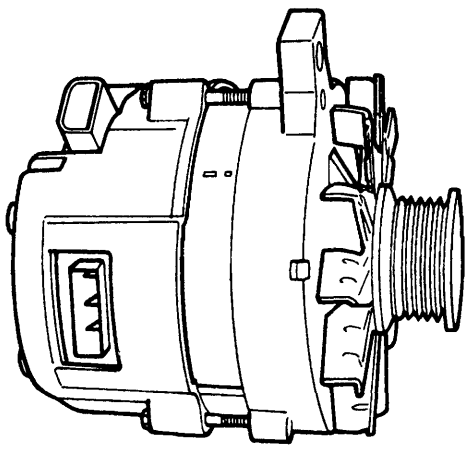
VEHICLE APPLICATION

F-150, F-250, F-350, Bronco, E-150, E-250, E-350 Truck Models.

DESCRIPTION AND OPERATION

The integral alternator/regulator (IAR) is belt-driven from the engine. Field current is supplied from the alternator regulator, mounted on the rear of the alternator, to the rotating field of the alternator through two brushes and two slip rings.

IAR ALTERNATOR



J3170-1A

The alternator produces power in the form of alternating current. The alternating current is rectified to direct current by six diodes. The alternator regulator automatically adjusts the alternator field current to maintain the alternator output voltage within prescribed limits to correctly charge the battery. The alternator is self-current limiting.

If equipped with a warning lamp, the regulator voltage control circuit is turned on when the ignition switch is in RUN and voltage is applied to the regulator I terminal through a resistor in the I circuit. When the ignition switch is in OFF, the control circuit is turned off and no field current flows to the alternator.

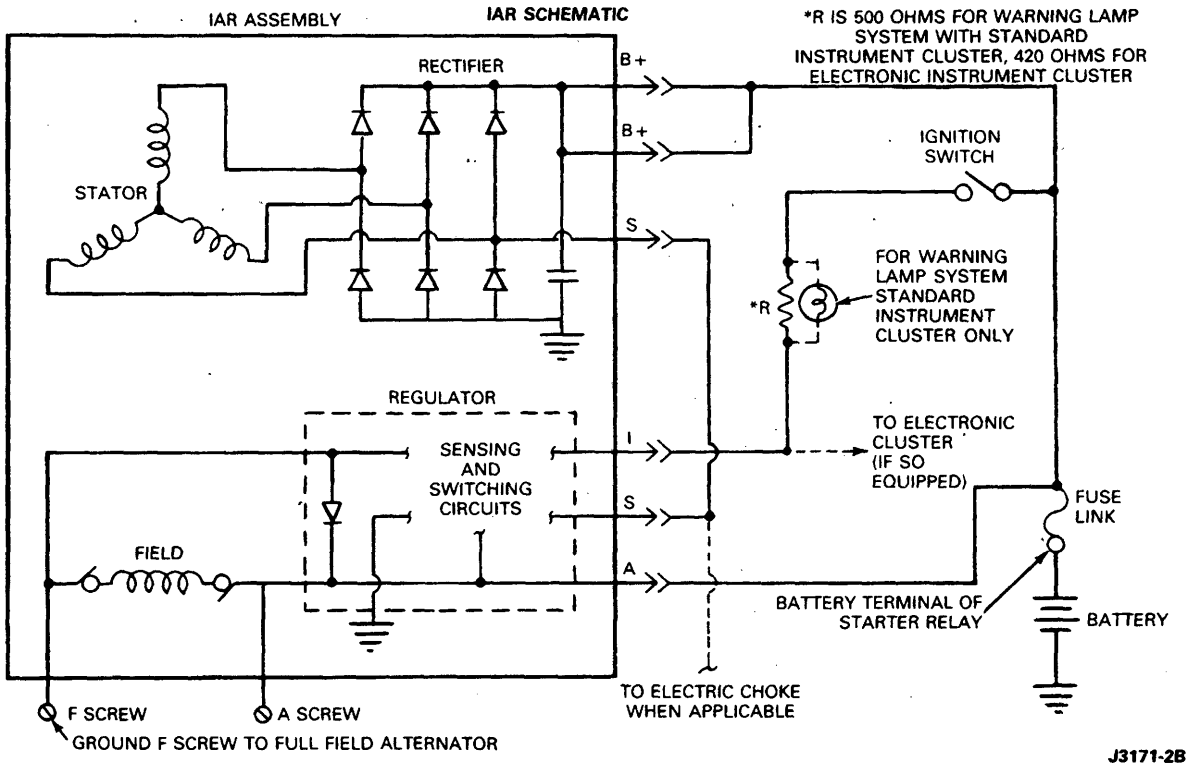
On warning lamp equipped vehicles, the warning lamp is connected across the terminals of a 500 ohm resistor* at the instrument cluster. Current passes through the warning lamp when the ignition switch is in RUN and there is no voltage at terminal S. When voltage at S rises to a preset value, the regulator switching circuits stop the flow of current into terminal I and the lamp turns off.

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DESCRIPTION AND OPERATION (Continued)

System voltage is "sensed" and alternator field current is drawn through terminal A. The regulator switching circuits will turn the warning lamp on, indicating a system fault, if terminal A voltage is excessively high or if the terminal S voltage signal is abnormal.

A fuse link is included in the charging system wiring on all models. The fuse link is used to prevent damage to the wiring harness and alternator if the wiring harness should become grounded, or if a booster battery is connected to the charging system with the wrong polarity.



ADJUSTMENTS

Refer to Section 27-06, Accessory Drive Belt, Service, for drive belt adjustments.

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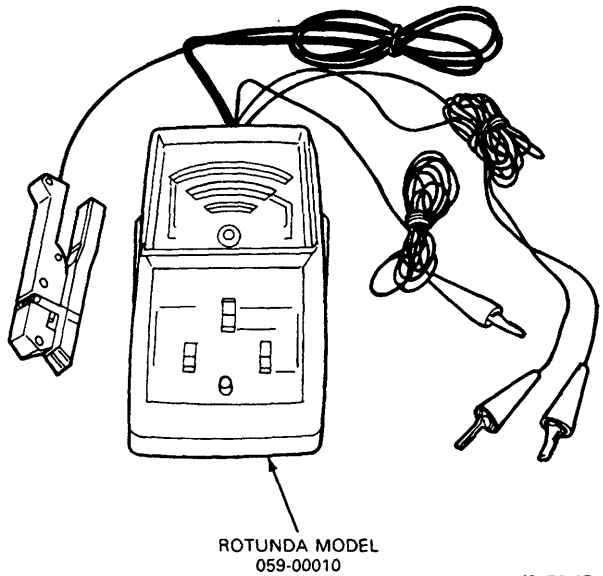
TESTING

Bench Tests

If system diagnosis has isolated a problem in the integral alternator/regulator assembly, remove it from vehicle for bench testing and service or replace. Refer to Removal and Disassembly. In some cases, it may be possible to replace a damaged regulator or brushes without removing the IAR assembly.

The following tests are performed with an analog (needle-type) ohmmeter. Test values shown are referenced to Rotunda Dwell-Tach-Volt-Ohmmeter 059-00010 or equivalent. THESE VALUES MAY BE DIFFERENT FOR OTHER OHMMETERS. If you do not have Rotunda Dwell-Tach-Volt-Ohmmeter 059-00010 or equivalent, use known good parts to establish reference values for your own meter. These values can be written into the spaces provided in the meter reading charts for future reference.

DWELL TACH VOLT-OHMMETER – ROTUNDA 059-00010



J3172-1B

Rectifier and Stator Grounded Tests

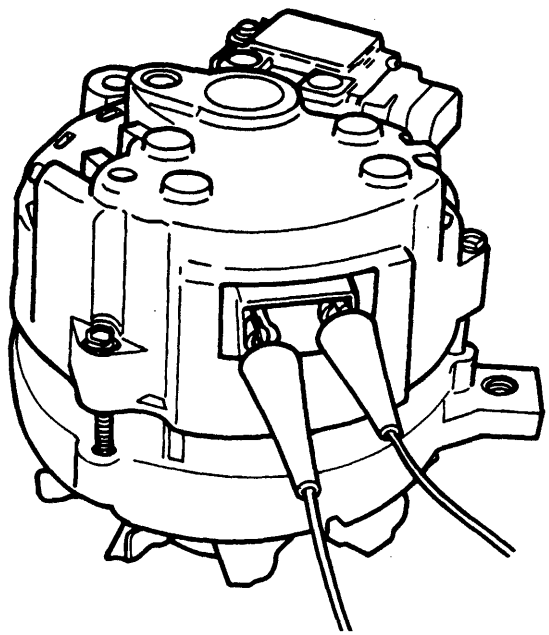
This test is performed with an ohmmeter, Rotunda Dwell-Tach-Volt-Ohmmeter 059-00010 or equivalent. Place the Multiply-By setting at 1 and calibrate the ohmmeter as directed.

NOTE: Text values shown in brackets [ ] ___ are referenced to Rotunda Dwell-Tach-Volt-Ohmmeter 059-00010, and may be different if another tester is used.

CAUTION: Digital meters cannot be used to perform these rectifier tests.

1. Contact one ohmmeter probe of one of the alternator B+ blade terminals and the other probe to the STA blade terminal. Then, reverse the ohmmeter probes and repeat the test. Normally, there will be no needle movement in one direction, indicating the rectifier diodes are being checked in the reverse current direction and are not shorted. A low reading of about [6.5] ___ ohms with the probes reversed indicates that rectifier positive diodes are being checked in the forward current direction. A reading diode or shorted radio suppression capacitor. The radio suppression capacitor is built into the rectifier assembly and is not individually serviceable.

RECTIFIER POSITIVE DIODE TEST



METER READING			
Set meter to Ohms x 1. Make reading in both directions.			
Resistance Measurement		Only Acceptable Reading	
BAT Terminal	to STA Terminal	Model 059-00010	Reference for Another Meter
One probe position		∞	∞
Other probe position		About (6.5) ohms	About ___ ohms

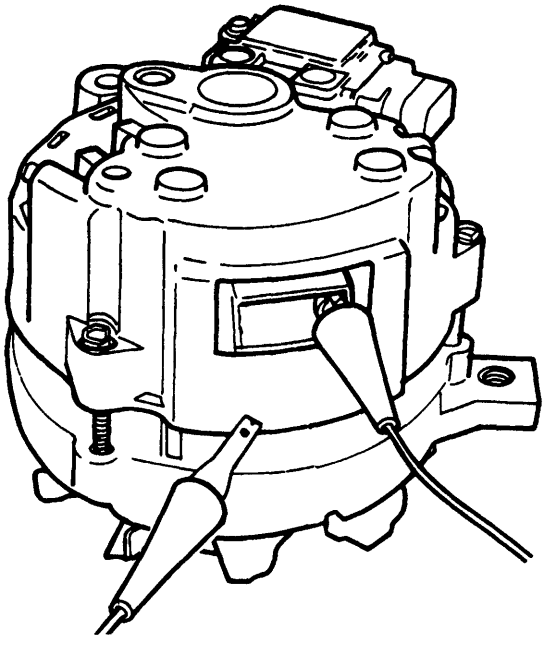
CJ3251-1A

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TESTING (Continued)

2. Perform the same test using the STA blade terminal and alternator rear housing. A reading in both directions indicates either a grounded stator winding, a damaged negative diode, a grounded stator lead wire or a shorted radio suppression capacitor.

RECTIFIER NEGATIVE DIODE AND STATOR GROUNDED TEST



METER READING		
Set meter to Ohms x 1. Make readings in both directions.		
Resistance Measurement	**Only Acceptable Reading**	
GND to STA Terminal	Model 059-00010	Reference for Another Meter
One probe position	∞	∞
Other probe position	About (6.5) ohms	About ___ ohms

CJ3173-1A

3. If there is no needle movement with the probes in one direction and no needle movement or high resistance (significantly over [6.5] ___ ohms) in the opposite direction for Test 1 and 2, a bad connection exists in the rectifier assembly.

Field Open or Short Circuit Test

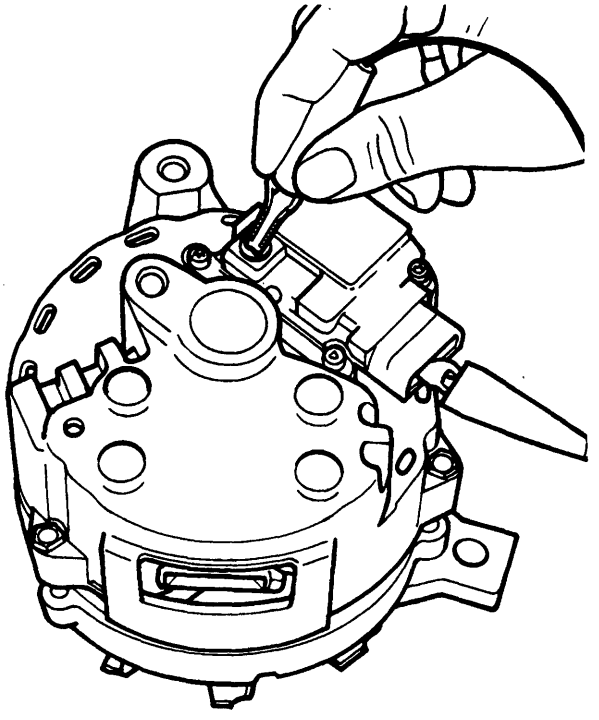
This test is performed with an ohmmeter. Rotunda Dwell-Tach-Volt-Ohmmeter 059-00010 or equivalent.

Place the Multiply-By setting at 1 and calibrate the ohmmeter as directed.

1. Contact the regulator A blade terminal with one probe and the regulator F screw head with the other probe. Spin the alternator pulley.

   Reverse the ohmmeter probes and repeat the test. In one probe direction, the ohmmeter reading should be between 2.2 and 100 ohms (on Rotunda meter) and may fluctuate while the pulley is turning. In the other probe direction, the reading should fluctuate between 2.2 and about [9] ___ ohms.

FIELD OPEN OR SHORT CIRCUIT TEST



METER READING		
Set meter at Ohms x 1. Make readings in both directions. Spin pulley while taking reading.		
Resistance Measurement	**Only Acceptable Reading**	
Regulator A Blade Terminal to Regulator F Screw Head	Tool 059-00010	Reference for Another Meter
One probe position	2.2 to 100 ohms	2.2 to 100 ohms
Other probe position	2.2 to [9] ohms	2.2 to ___ ohms

CJ3175-1A

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TESTING (Continued)

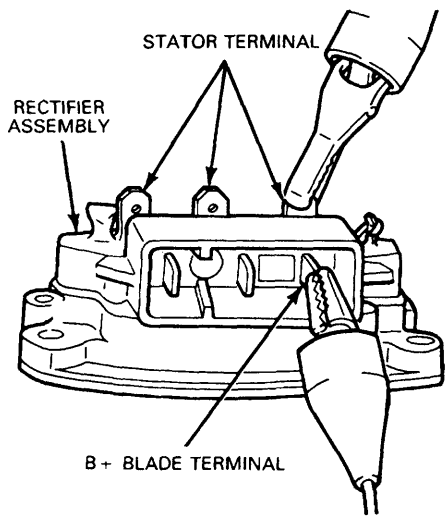
2. An infinite reading (no meter movement) in one direction and approximately [9] ___ ohms in the other, indicates an open brush lead, worn or stuck brushes, a damaged rotor or a loose regulator to brush holder attaching screw.
3. An ohmmeter reading less than [2.2] ___ ohms in both directions indicates a shorted rotor or damaged regulator.
4. An ohmmeter reading significantly over [9] ___ ohms in both directions indicates an inoperative regulator or loose F terminal screw.
5. Contact the alternator rear housing with one ohmmeter probe and touch the other probe to the regulator F terminal. Reverse the probes and repeat the test. The ohmmeter reading should be infinite in one probe direction and approximately [9] ___ ohms in the other. A reading less than infinite in both directions indicates a grounded brush lead or an inoperative regulator. A reading significantly over [9] ___ ohms in both directions indicates an inoperative regulator or a damaged A terminal connection.

Rectifier Assembly Test

Remove the rectifier assembly from the alternator. Place the Rotunda 059-00010 or equivalent, Multiply-By setting at 1 and calibrate the meter as directed.

CAUTION: Digital meters cannot be used to perform these tests.

1. To test the positive diodes, contact one probe to one of the rectifier assembly B+ blade terminals and contact each of the three stator terminals with the other probe. Reverse the probes and repeat the test. All diodes should show a low reading of approximately [7] ___ ohms in one direction and an infinite reading (no needle movement) with the probes reversed. This reading may be checked against a good rectifier if one is available.



METER READING		
Set meter at Ohms x 1. Make readings in both directions to all three phase terminals.		
Resistance Measurement	**Only Acceptable Reading**	
B+ Terminal to Phase Terminal	Tool 059-00010	Reference for Another Meter
One probe direction; each phase terminal	About [7.0] ohms	About ___ ohms
Other probe direction; each phase terminal	∞	∞

CJ3275-1B

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TESTING (Continued)

2. Perform the preceding tests for the negative diodes by contacting the rectifier assembly base plate and the three stator terminals.

Meter Reading		
Set meter at Ohms x 1. Make readings in both directions to all three phase terminals.		
Resistance Measurement	**Only Acceptable Reading**	
Base Plate to Phase Terminal	Tool 059-00010	Reference for Another Meter
One probe direction; each phase terminal	About 7.0 ohms	About ___ ohms
Other probe direction; each phase terminal	∞	∞

CJ3276-1C

3. If the meter readings are not as specified, replace the rectifier assembly.

Radio Suppression Capacitor Open or Short Test

NOTE: This is an open or short circuit test only and does not measure capacitance value. Actual capacitance value should be measured on a capacitance bridge at 1 kHz at a maximum voltage of 350 mV rms.

The radio noise suppression capacitor is built into the rectifier assembly and cannot be serviced by itself. To test the capacitor, place the Rotunda 059-00010 or equivalent, Multiply-By setting at 1000 and zero the meter. Text values shown in brackets [ ] ____ are referenced to Rotunda Model 059-00010 and may be different if another tester is used.

CAUTION: Digital meters cannot be used to perform this capacitor test. The rectifier assembly must be dry.

1. Contact one probe to one of the rectifier assembly B+ blade terminals and contact the other probe to the rectifier assembly base plate. Reverse the probes and repeat the test. One position should give an infinite reading, indicating the reverse current direction through the diodes and the other position should give a reading of about [1000] ____ ohms, indicating the forward current direction. The same reading in both directions indicates an inoperative rectifier assembly.
2. To check the capacitor, contact the probes to the rectifier assembly B+ terminal and base plate in the forward current [1000] ____ ohms reading direction. While observing the meter indicator needle, reverse the probes and again contact them to the rectifier assembly B+ terminal and base plate. The indicator needle should jump slightly (indicating that the ohmmeter batteries are charging the capacitor) and then return to its original position (infinite reading). If the needle does not jump, the capacitor is open. Replace the rectifier assembly.

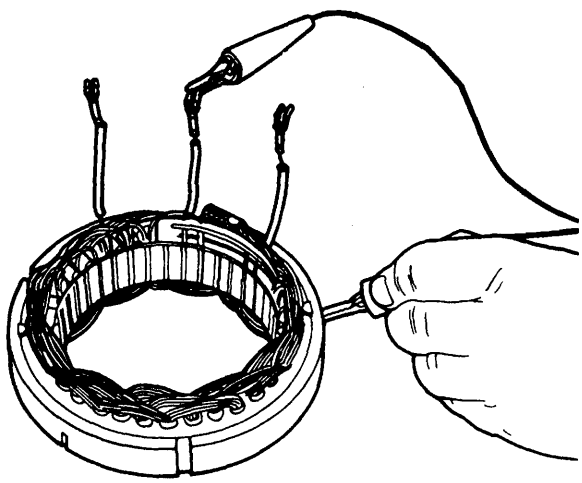
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TESTING (Continued)

Stator Coil Grounded Test

These tests are made to determine if the stator coil is shorted to ground. Remove the stator from the alternator and disconnect it from the rectifier assembly as outlined. Place the ohmmeter Multiply-By setting at 1000.

1. Connect the ohmmeter probes to one of the stator lead terminals and to the stator laminated core. Ensure that the probe makes a good electrical connection with the stator core. The meter should show an infinite reading (no needle movement).
2. If the meter does not indicate an infinite reading (needle moves), the stator winding is grounded to the core and the stator must be replaced.



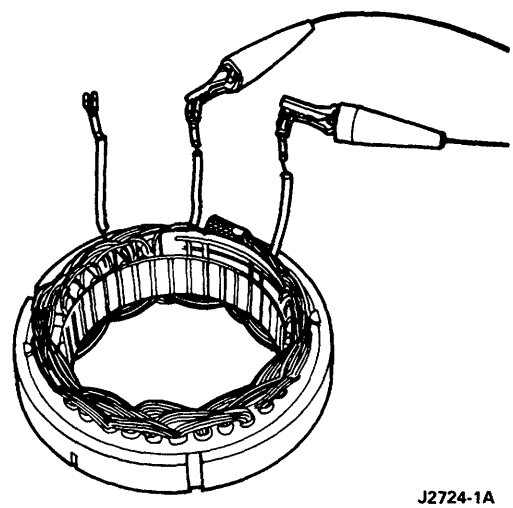
METER READING			
Set meter at Ohms x 1000. Make reading for all stator leads. DO NOT TOUCH LEADS WITH HANDS.			
Resistance Measurement		**Only Acceptable Reading**	
Stator Terminal	to Stator Core	Tool 059-00010	Reference for Another Meter
All stator lead combinations; probe polarity optional		∞	∞

CJ3254-1A

Stator Coil Open Test

This test determines if there is an open stator circuit. Disconnect the stator from the rectifier assembly. Place the ohmmeter Multiply-By setting at 1.

1. Connect one ohmmeter probe to a stator phase lead terminal and touch the other probe to another stator lead terminal. Check the meter reading.
2. Repeat this test with the other two stator lead combinations. If no meter movement occurs (infinite resistance) on a lead paired with either of the other phase leads, that phase is open and the stator must be replaced.



J2724-1A

Meter Reading			
Set meter at Ohms x 1. Make readings for all stator lead combinations.			
Resistance Measurement		**Acceptable reading**	
Stator Terminal	to Stator Terminal	Tool 059-00010	Reference For Another Meter
All lead combinations; Probe polarity optional		Less than 0.5 ohms	Less than 0.5 ohms

CJ3833-1A

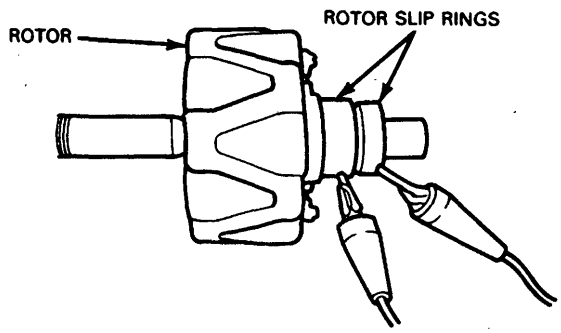
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TESTING (Continued)

Rotor Open or Short Test

Remove the rotor from the alternator. Place the ohmmeter Multiply-By setting at 1 and calibrate the meter as directed.

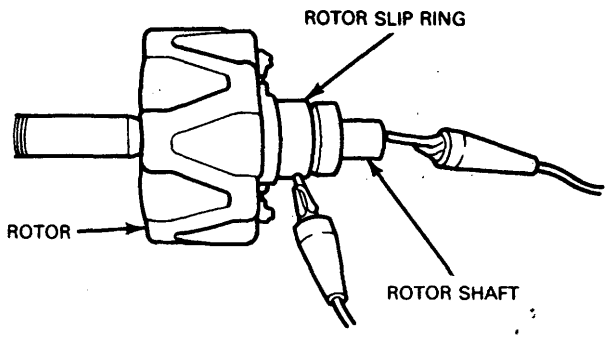
1. Contact each ohmmeter probe to a rotor slip ring. The meter reding should be [2.0-3.9] ____ ohms.
2. A higher reading indicates a damaged slip ring, welded connection or a broken wire. A lower reading indicates a shorted wire or slip ring. Replace the rotor if it is damaged and cannot be serviced.



METER READING		
Set meter at Ohms x 1.		
Resistance Measurement	**Only Acceptable Reading**	
Slip Ring to Slip Ring	Tool 059-00010	Reference for Another Meter
Probe polarity optional	2.0 to 3.9 ohms	2.0 to 3.9 ohms

CJ3279-1A

3. Contact one ohmmeter probe to a slip ring and the other probe to the rotor shaft. The meter reading should be infinite (no needle movement).
4. A reading other than infinite indicates the rotor coil is grounded to the shaft. Replace the rotor if it is grounded and cannot be serviced.



METER READING		
Set meter at Ohms x 1.		
Resistance Measurement	**Only Acceptable Reading**	
Slip Ring to Rotor Shaft	Tool 059-00010	Reference for Another Meter
Either slip ring; probe polarity optional	∞	∞

CJ3280-1A

REMOVAL AND INSTALLATION

WARNING: HYDROGEN AND OXYGEN GASES ARE PRODUCED DURING NORMAL BATTERY OPERATION. THIS GAS MIXTURE CAN EXPLODE IF FLAMES, SPARKS OR LIGHTED TOBACCO ARE BROUGHT NEAR THE BATTERY. WHEN CHARGING OR USING A BATTERY IN AN ENCLOSED SPACE, ALWAYS PROVIDE VENTILATION AND SHIELD YOUR EYES.

WARNING: KEEP BATTERIES OUT OF REACH OF CHILDREN. BATTERIES CONTAIN SULFURIC ACID. AVOID CONTACT WITH SKIN, EYES OR CLOTHING. ALSO, SHIELD YOUR EYES WHEN WORKING NEAR THE BATTERY TO PROTECT AGAINST POSSIBLE SPLASHING OF THE ACID SOLUTION, IN CASE OF ACID CONTACT WITH THE SKIN, EYES OR CLOTHING, FLUSH IMMEDIATELY WITH WATER FOR A MINIMUM OF FIFTEEN MINUTES. IF ACID IS SWALLOWED, DRINK LARGE QUANTITIES OF MILK OR WATER, FOLLOWED BY MILK OF MAGNESIA, A BEATEN EGG, OR VEGETABLE OIL. CALL A PHYSICIAN IMMEDIATELY.

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REMOVAL AND INSTALLATION (Continued)

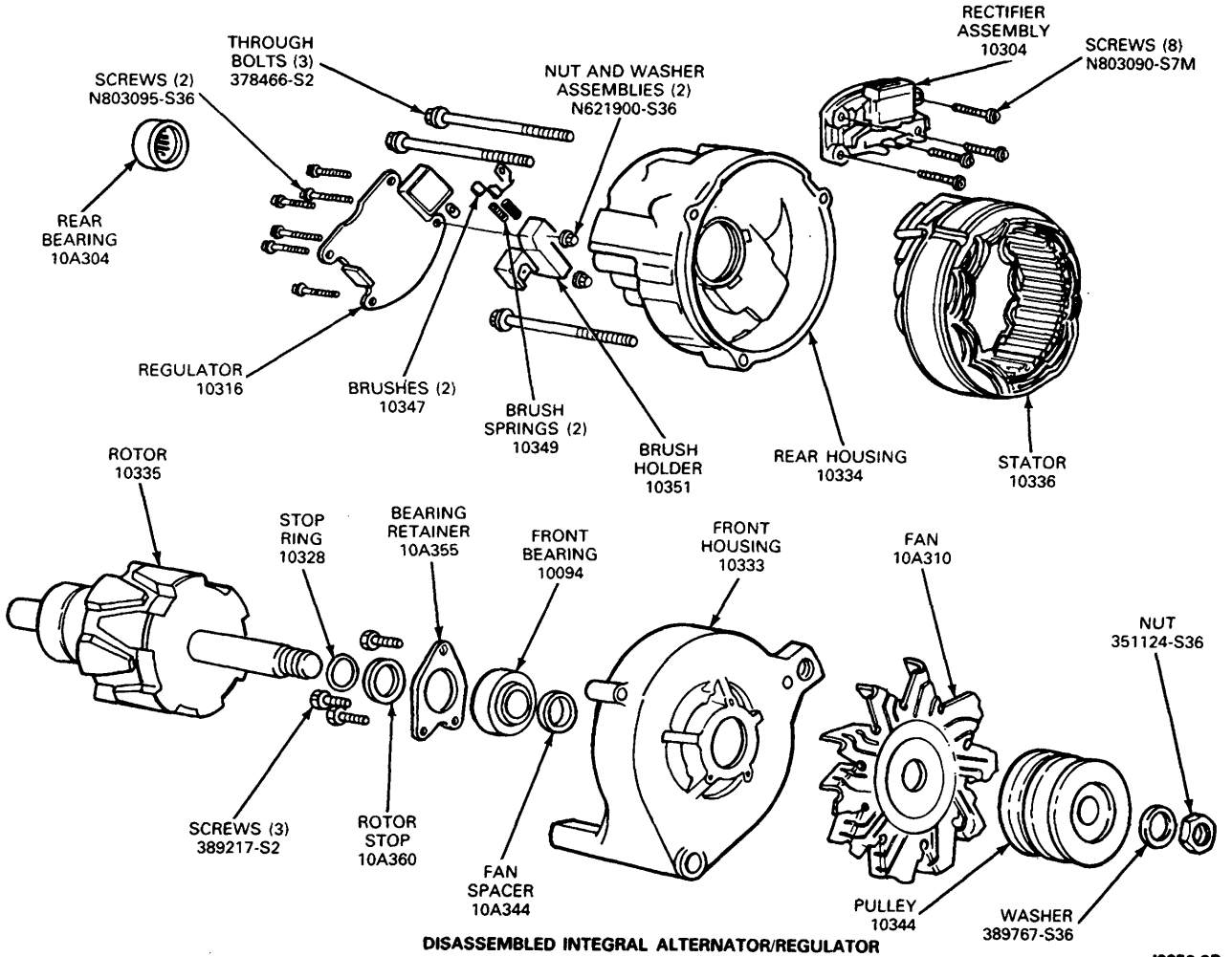
Removal

1. Disconnect battery ground cable.
2. Disconnect the wire harness attachments to the integral alternator/regulator assembly. Pull the two connectors straight out.
3. Loosen the alternator pivot bolt. Remove the adjustment arm bolt from the alternator.
4. Disengage the alternator drive belt from the alternator pulley.
5. Remove the alternator pivot bolt and alternator/regulator assembly.
6. Remove the alternator fan shield, if so equipped.

Installation

1. Position the integral alternator/regulator assembly on the engine.
2. Install the alternator pivot and adjuster arm bolts, but do not tighten the bolts until the belt is tensioned.
3. Install the drive belt over the alternator pulley.
4. Adjust the belt tension and tighten the adjuster and pivot bolts to specification. Check belt tension using Belt Tension Gauge T63L-8620-A or Rotunda Belt Tension Gauge 021-00019 or equivalent. Apply pressure to alternator front housing only when adjusting belt tension. Refer to Section 27-06, Accessory Drive Belts.
5. Connect the wiring harness to the alternator/regulator assembly. Push the two connectors straight in.
6. Attach the alternator fan shield to the alternator, if so equipped.
7. Connect battery ground cable.

NOTE: All of the following Disassembly Steps may not be necessary to perform a particular test or service. Perform only those steps that apply. The following illustration is a disassembled view of the integral alternator/regulator assembly. On alternators with fan shield, remove attaching chip and then remove fan shield.



DISASSEMBLED INTEGRAL ALTERNATOR/REGULATOR

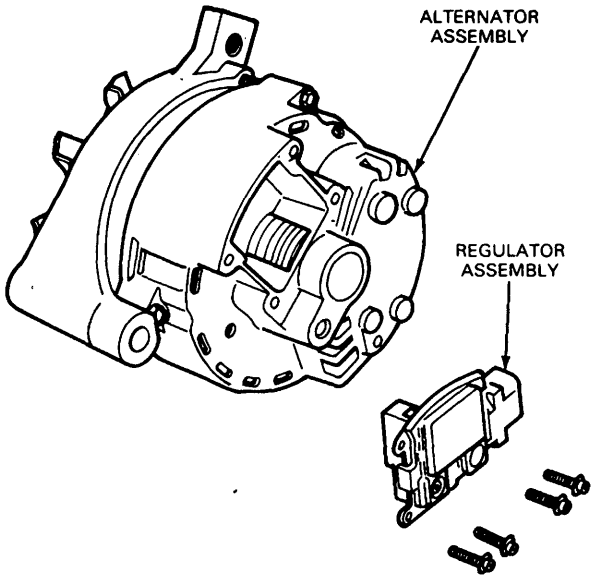
J3256-2B

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REMOVAL AND INSTALLATION (Continued)

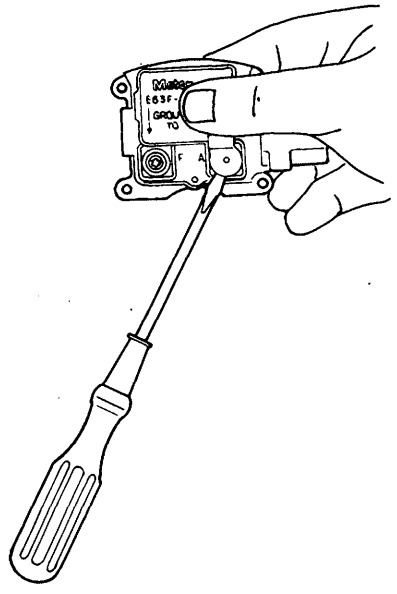
Disassembly

1. Remove the four screws (T20 TORX®-type head) attaching the regulator to the alternator rear housing. Remove the regulator, with brush holder attached, from the alternator.



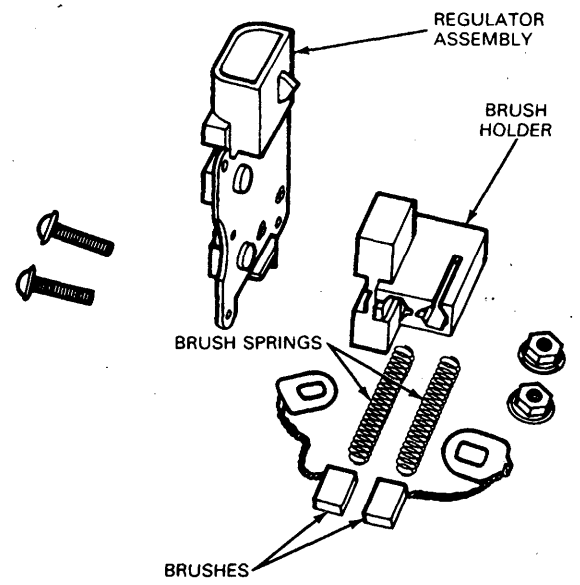
J3257-1A

2. Hold the regulator in one hand and break off the tab covering the "A" screw head with a screwdriver.



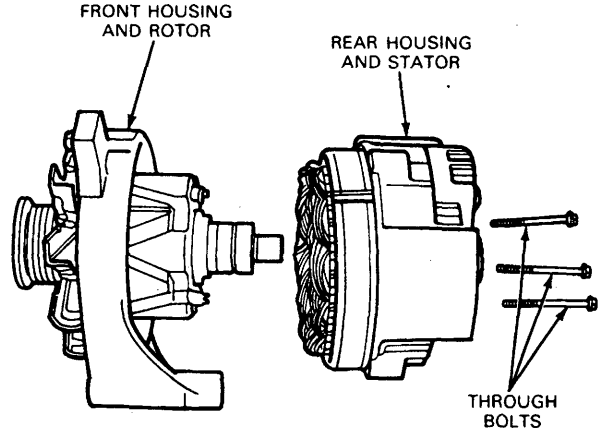
J3832-1A

3. Remove two screws (T20 TORX®-type head) attaching the regulator to the brush holder. Separate the regulator, attaching nuts, brushes and brush springs from the brush holder.



J3258-1B

4. Scribe a line across the end housings and stator laminated core for reference during alternator assembly.
5. Remove the three through bolts.
6. Separate the front housing and rotor assembly from the stator and rear housing. It may be necessary to tap the front housing with a plastic tipped hammer to loosen the front housing from the stator core.

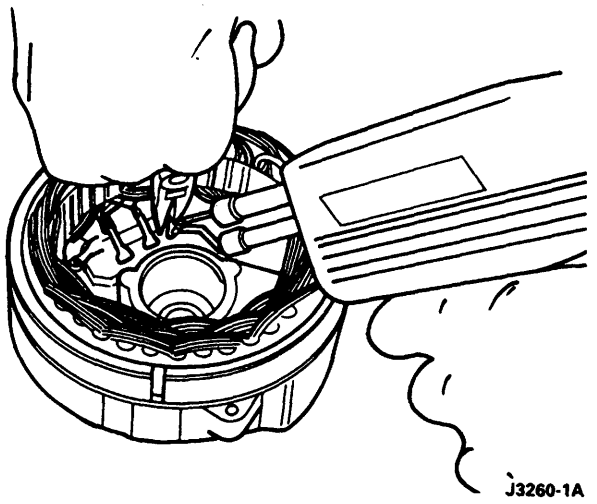


J3259-1A

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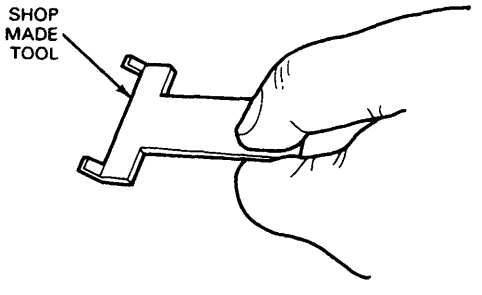
REMOVAL AND INSTALLATION (Continued)

7. Remove the three stator lead terminals from the rectifier. If the terminals are soldered in place, unsolder the connections using a 100-watt soldering iron. Do not allow the soldering iron to overheat the rectifier. Use needlenose pliers to pull the stator lead terminals upward from the rectifier assembly. Separate the stator from the rear housing.

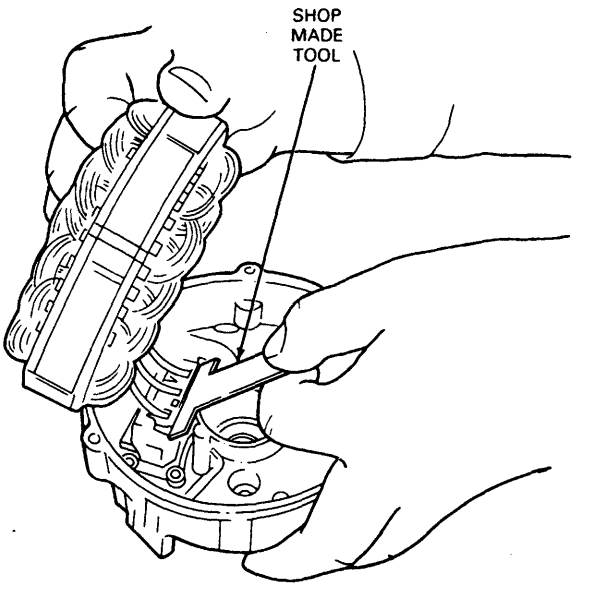


J3260-1A

8. Some alternators are designed with a connector block. In these designs, the terminals are not soldered to the rectifier. Using a shop made tool, carefully pry the connector block straight up to avoid bending the terminals.

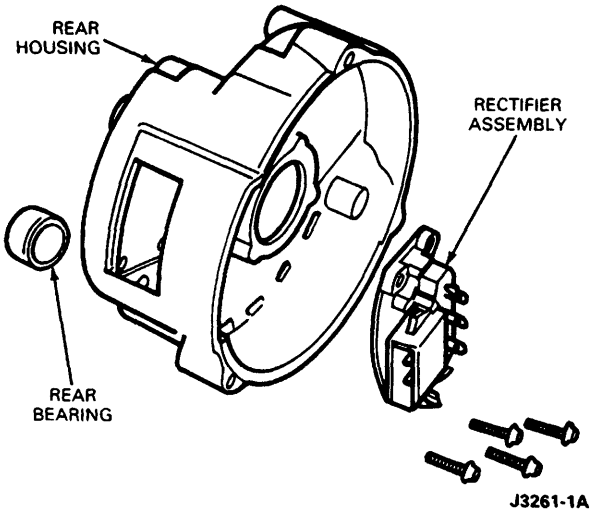


J3836-1A



J3695-1A

9. Remove the four rectifier assembly attaching screws (T20 TORX®-type head). Remove the rectifier assembly from the housing.
10. Using a suitable arbor press, remove the bearing from the rear housing. Support the housing close to the bearing boss to prevent housing damage.

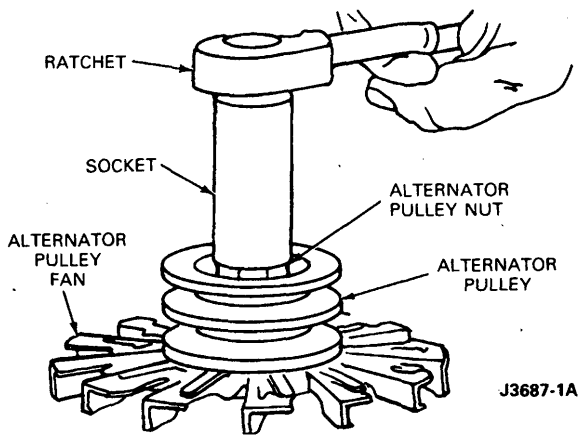


J3261-1A

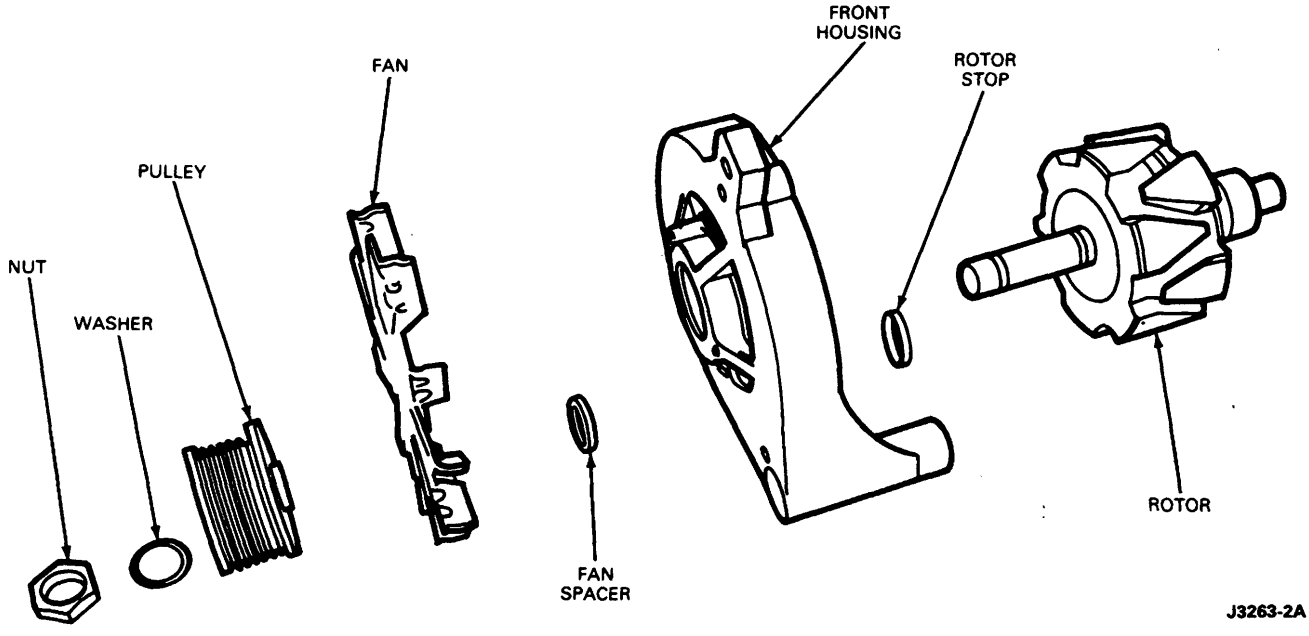
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REMOVAL AND INSTALLATION (Continued)

11. Clamp the rotor in a soft jaw vise.
12. Remove the pulley nut with a socket wrench.



13. Remove the flatwasher, drive pulley, fan and fan spacer from the rotor shaft.
14. Remove the housing from the rotor and remove the rotor from the vise.
15. Remove the front rotor stop from the rotor shaft. Do not remove the stop ring from the rotor shaft unless it is damaged.
16. Remove the screws attaching the bearing retainer to the front housing and remove the retainer.
17. Remove the bearing from the front housing. If the bearing will not slide out, remove it using a suitable arbor press. Support the bearing close to the bearing boss to prevent damage to the housing.



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REMOVAL AND INSTALLATION (Continued)

Cleaning and Inspection

CAUTION: When rebuilding an integral alternator, use only high-temperature bearings. Use of standard parts will result in alternator failure.

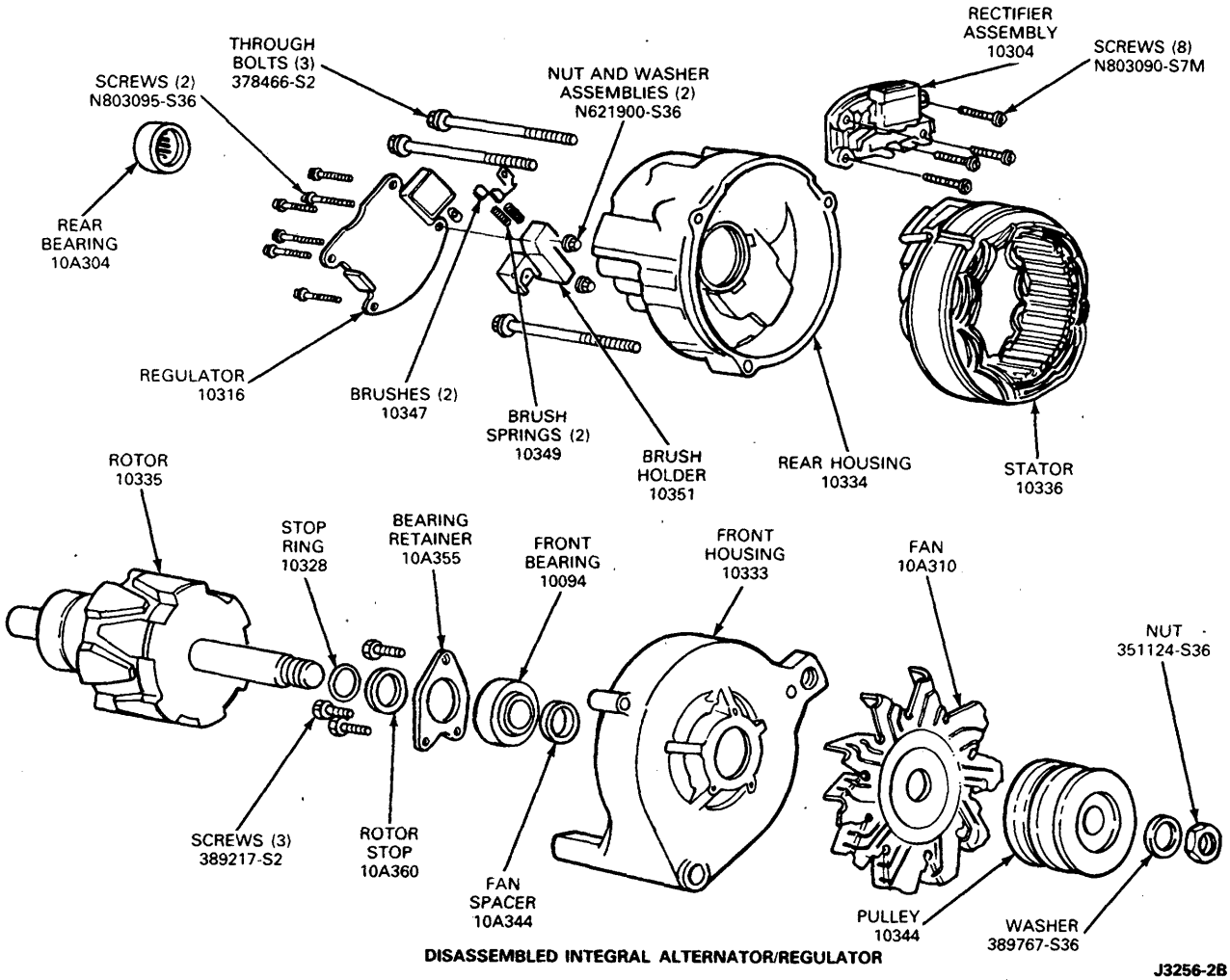
1. Wipe the stator, rotor and front bearing with a clean cloth. Do not clean these parts with solvent.
2. Rotate the front bearing on the drive end of the rotor shaft. Check for any scraping noise, looseness or roughness. Look for excessive lubricant leakage. If any of these conditions exist, replace the bearing.
3. Inspect the rotor shaft rear bearing surface for roughness or severe chatter marks. Replace the rotor assembly if the shaft is not smooth.
4. Place the rear bearing on the slip ring end of the rotor shaft and rotate the bearing. Make the same check for noise, looseness and roughness as was made for the front bearing. Inspect the rollers and cage for damage. Replace the rear bearing if these conditions exist or if the lubricant is lost or contaminated.
5. Check the slip rings for nicks and scratches. These may be removed by turning down the slip rings. Do not go beyond a minimum diameter of 31mm (1.22 inches). If the rings are badly damaged, replace the rotor assembly.
6. Check all wire leads on both the rotor and stator assemblies for loose or broken connections. Check the windings for burned insulation. Replace parts that show signs of burned insulation.
7. Check the pulley and fan for excessive looseness on the rotor shaft and for cracks or other damage. Replace any pulley or fan that is loose, cracked or bent out of shape.
8. Check both the front and rear housings for cracks, particularly in the webbed areas at the mounting ear. Replace a damaged or cracked housing.
9. Wipe the heat transfer grease from the rectifier assembly base and rectifier mounting areas of the rear housing with a clean cloth.
10. Replace the brushes if they are worn shorter than 6.35mm (1/4 inch) from the shunt.

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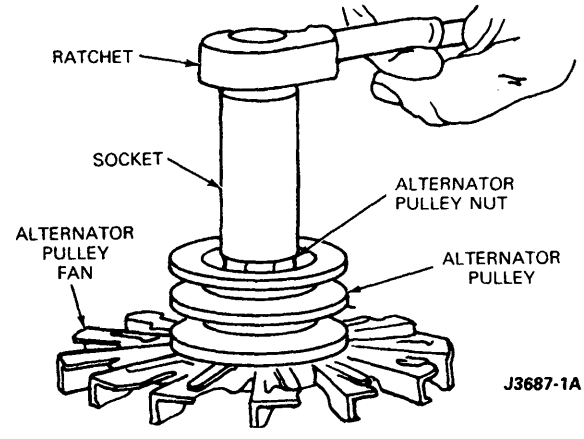
REMOVAL AND INSTALLATION (Continued)

Assembly

Refer to the following illustration for Alternator/ Regulator Assembly.



1. Install the bearing in the front housing. Press on the outer race only.
2. Position the bearing retainer on the front housing and install the attaching screws. Tighten the screws to 2.8-4.8 N·m (24-42 lb-in).
3. If the stop ring was removed from the rotor shaft, install a new ring by sliding it over the end of the shaft and into the groove furthest from the pole piece. Do not open the ring with snap ring pliers as permanent deformation of the ring will result.
4. Install the rotor stop on the rotor shaft with the recessed side against the stop ring.
5. Install the rotor in the front housing and clamp the rotor in a vise equipped with protective jaws.
6. Install the fan spacer, fan, drive pulley, flatwasher and nut on the rotor shaft. Tighten the nut to 82-135 N·m (60-100 lb-ft) with a socket wrench.



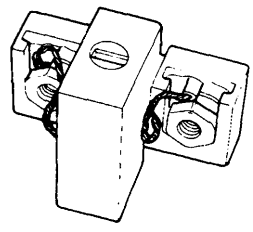
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REMOVAL AND INSTALLATION (Continued)

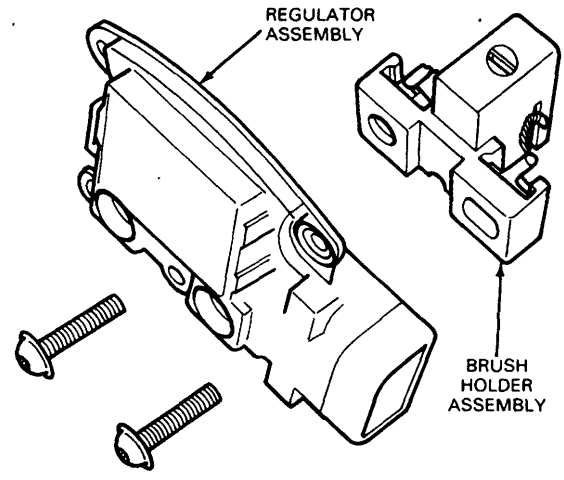
7. Remove the rotor and housing assembly from the vise and check for free rotation of the rotor in the housing.
8. Support the rear housing close to the bearing boss to prevent damage to the housing and install the bearing using a suitable arbor press. Press the bearing into the bore until it is flush with the outside rear surface of the housing.
9. Wipe the rectifier assembly base plate with a clean cloth. Apply a 2.0mm (3/32 inch) wide by 20mm (3/4 inch) long strip of Ford Heat Sink Compound ESF-M99G138-A or equivalent, lengthwise across the rectifier assembly base plate.
10. Wipe the rectifier mounting surface of the rear housing with a clean cloth and seat the rectifier into the recessed mounting area.

CAUTION: The rectifier assembly is cooled by conducting rectifier heat directly into the rear housing. Failure to remove foreign material from the mounting surfaces or failure to apply heat sink compound may cause rectifier overheating.

11. Install the four rectifier assembly attaching screws. Tighten the screws to 2.8-4.0 N·m (25-35 lb-in).
12. Position the stator assembly in the rear housing and align the scribe marks made during disassembly. Push the three stator terminals onto the rectifier blade terminals. Solder securely using resin core electrical solder if the terminals were previously soldered. Work quickly to prevent overheating the rectifier.
13. Wipe the rear end bearing surface of the rotor shaft with a clean, lint-free cloth.
14. Position the rear housing and stator assembly over the rotor and align the scribe marks made during disassembly.
15. Seat the machined portion of the stator core into the stop in both end housings and install the housing through bolts. Tighten the bolts to 4.1-6.7 N·m (35-60 lb-in). Spin the rotor to check for free movement.
16. Position the two nut and washer assemblies into the retaining slots in the brush holder. Tip the holder back slightly so that the nut and washer assemblies fall to the nut side of the slots. Insert the brush terminals past the washers and into the slots.

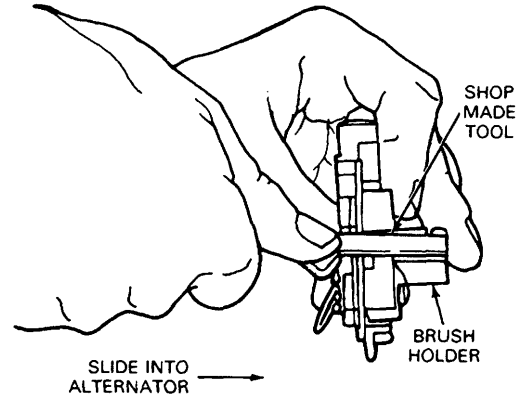


J3265-1A



J3266-1B

17. Wipe the regulator base plate with a clean cloth. Position the regulator against the brush holder and install the regulator to brush holder attaching screws. Tighten the screws to 2.3-3.4 N·m (20-30 lb-in).
18. Cover the head of the A terminal screw head with electrical tape.
19. Place brush springs in brush holder. Locate brushes in brush holder and hold in place with a thin, flat piece of steel (retaining tool). Loop the brush leads toward the brush end of the brush holder.



J3837-1A

20. Wipe the regulator mounting surface of the alternator rear housing with a clean cloth. Position the regulator and brush holder assembly in the alternator rear housing and pull the retaining tool.
21. Install the regulator attaching screws. Tighten the screws to 2.8-4.0 N·m (25-35 lb-in).

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SPECIFICATIONS

Supplier	Rating		Slip-Ring Turning				Brush Length				Pulley Nut	
	Amperes @ 15V	Watts @ 15V	Min. Diameter		Max. Runout		New		Wear Limit			
			MM	Inches	MM	Inches	MM	Inches	MM	Inches	N·m	Lb-Ft
Ford	40A	600W	31	1.22	.013	0.0005	12.19	.480	6.35	.25	82-135	60-100
Ford	40A HE	600W	31	1.22	.013	0.0005	12.19	.480	6.35	.25	82-135	60-100
Ford	60A	900W	31	1.22	.013	0.0005	12.19	.480	6.35	.25	82-135	60-100
Ford	65A	975W	31	1.22	.013	0.0005	12.19	.480	6.35	.25	82-135	60-100
Ford	75A	1125W	31	1.22	.013	0.0005	12.19	.480	6.35	.25	82-135	60-100

CJ3268-2B

Description	N·m	In-Lb
Pulley Nut	81-135	60-100①
Through Bolt	4.1-6.7	35-60
Rectifier Assembly Mounting Screw	2.8-4	25-35
Brush Holder Mounting Screw	2.3-3.4	20-30
Regulator Mounting Screw	2.8-4	25-35
Bearing Retainer Screw	2.8-4.5	24-42

①Ft-Lb

CJ3267-1B

SPECIAL SERVICE TOOLS

Tool Number	Description
T63L-8620-A *or* 021-00019	Belt Tension Gauge
T65P-10300-B	Alternator Pulley Remover

CJ3270-1B

ROTUNDA EQUIPMENT

Model	Description
021-00019	Belt Tension Gauge
059-00010	Dwell-Tach-Volt-Ohmmeter

CJ3281-1B

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SECTION 31-43 Alternator Electronic Regulator

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION		REMOVAL AND INSTALLATION	31-43-3
Ammeter Regulators	31-43-1	SPECIAL SERVICE TOOLS	31-43-3
Application	31-43-3	VEHICLE APPLICATION	31-43-1
Visual Inspections	31-43-3		

VEHICLE APPLICATION

Bronco II.

DESCRIPTION

The electrical charging system incorporates an electronic voltage regulator. These regulators are 100 percent solid-state, consisting of transistors, diodes, and resistors. The working functions are achieved using electronic components arranged in four basic circuit divisions as follows: The output stage, the voltage control stage, the solid-state relay and the field circuit over-current protection stage.

The regulator is calibrated and preset by the manufacturer. No adjustment is required or possible on these units.

Ammeter Regulators

The operating principle for the regulator used in ammeter-equipped vehicles is much the same as the indicator lamp type, with the exception that it does not require a stator voltage input from the alternator.

Solid-state regulators are being used in conjunction with other new components in the charging system and must be properly matched to prevent damage to the regulator or alternator. New components in the charging system are as follows:

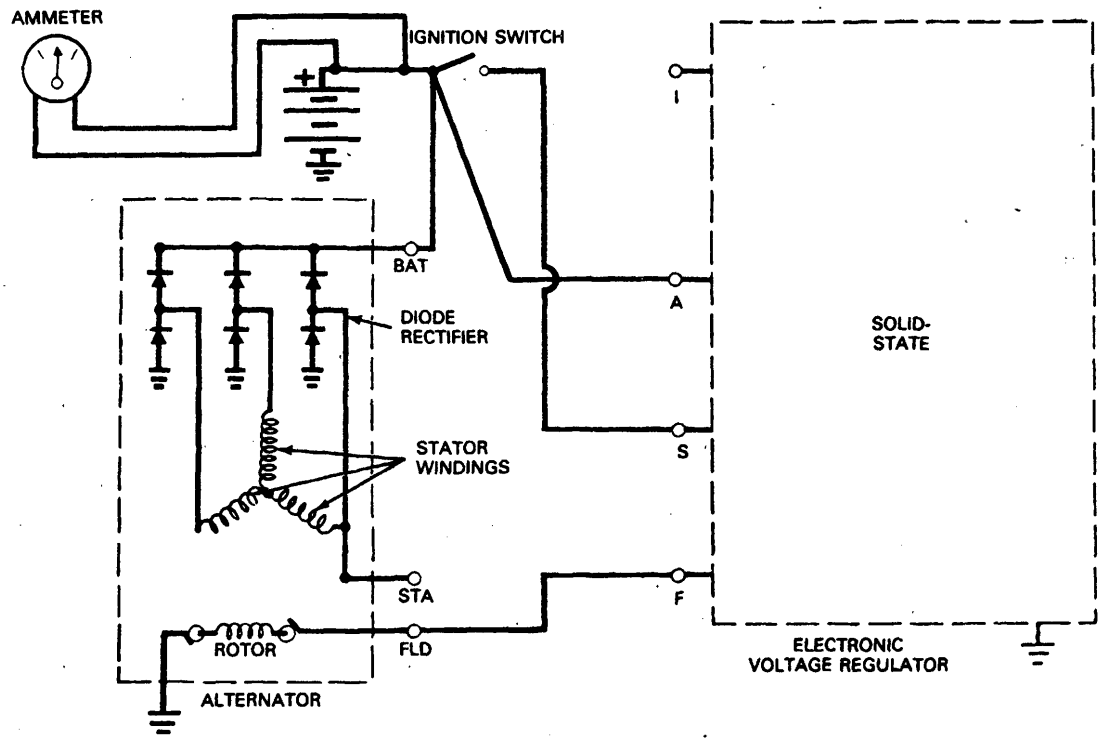
- A new alternator with a higher field current requirement.
- A new warning indicator lamp shunt resistor.
- The alternator-to-regulator wiring harness is changed to incorporate a new regulator connector plug. The new plug is designed so that the connector will not index with the regulator terminals when the wrong regulator is inadvertently installed in the vehicle.

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DESCRIPTION (Continued)

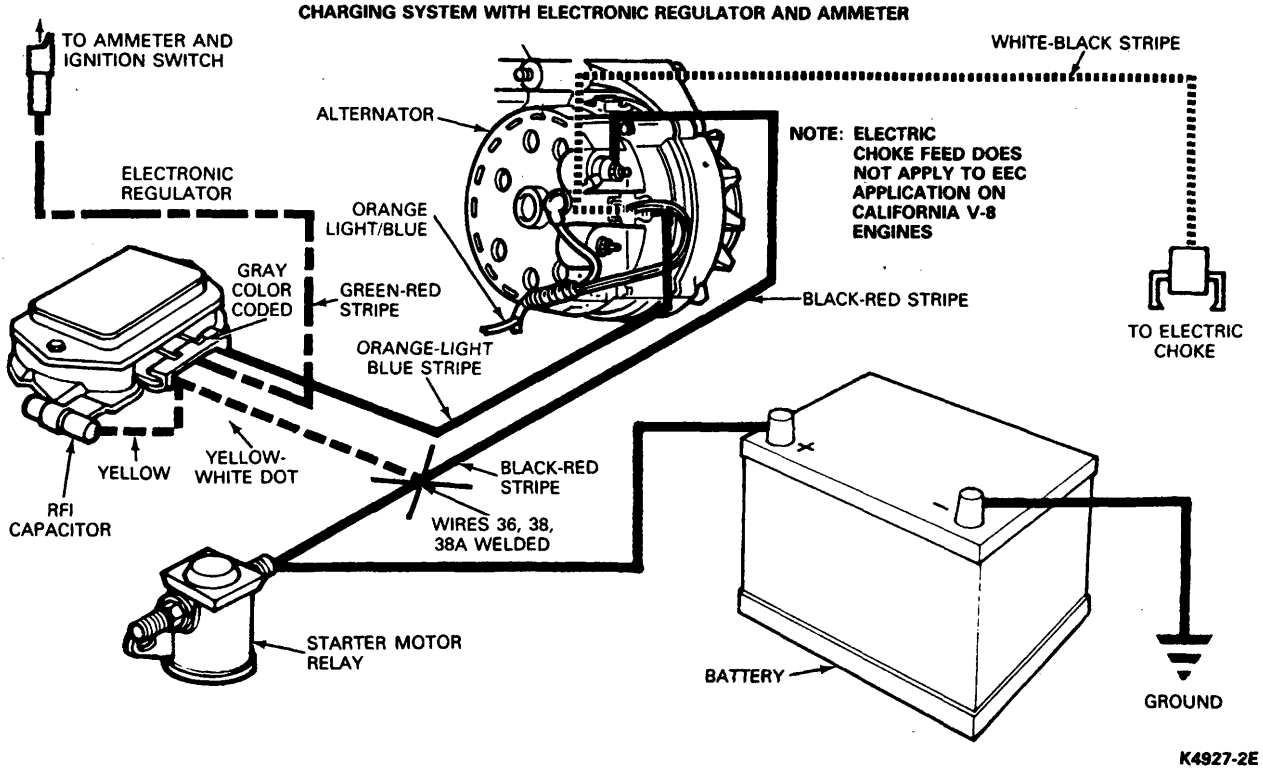
SYSTEM DIAGRAM

CHARGING SYSTEM WITH ELECTRONIC REGULATOR AND AMMETER



SYSTEM COMPONENTS

CHARGING SYSTEM WITH ELECTRONIC REGULATOR AND AMMETER



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DESCRIPTION (Continued)

Application

Whenever the system components are being replaced, the following precautions should be followed so that the charging system will work properly and components will not be damaged.

1. Always use the proper alternator in the system being serviced. Older model alternators, if used in the new system, will have a slightly reduced output. The older model alternator with the 3.8-ohm field will be used as replacement for vehicles with electromechanical and electronic regulators. Only the older model will be serviced.
2. Never use an electromechanical regulator in the new charging system. The connector plug on the new system wiring harness will not index properly with the electromechanical regulator.
3. The production-installed electronic regulators are color coded for proper installation. The gray color coded regulators must be used in ammeter gauge systems. The clear coded regulators are service parts and can be interchanged in either system.
4. The new charging systems use a 500-ohm resistor on the back of the instrument cluster on vehicles with warning indicator lamp. Do not replace this item with the old 15-ohm resistance wire.

Visual Inspections

1. On non-maintenance-free batteries, check battery for proper state of charge (at least 1.200 specific gravity) using Rotunda Battery Tester 041-00002 or equivalent.
2. Check and clean all terminal connections at battery, alternator, and regulator.
3. Check fuse link between starter relay and alternator.
4. Check alternator drive belt for proper tension using Belt Tension Gauges T63L-8620-A, Rotunda 021-00019 or equivalent. Refer to Section 27-06, Accessory Drive Belts.

CAUTION: Always disconnect the connector plug from the regulator before checking alternator output with test probes or a jumper wire.

Always disconnect the connector plug from the regulator before removing the regulator mounting screws. Removing the connector from an ungrounded regulator with the ignition switch in RUN will destroy the regulator.

Be sure to disconnect electric choke wire from stator terminal of alternator when trouble-shooting charging system. Check electric choke wire for a ground condition.

REMOVAL AND INSTALLATION

Electronic Regulator Removal and Installation

1. Disconnect battery ground cable.
2. Remove regulator mounting screws.
3. Disconnect regulator from wiring harness.
4. Connect new regulator to wiring harness.
5. Mount new regulator.
6. Connect battery ground cable.
7. Test the system for proper voltage regulation.

SPECIAL SERVICE TOOLS

SPECIAL SERVICE TOOL

Tool Number	Description
T63L-8620-A	Belt Tension Gauge

CA5760-1E

ROTUNDA TOOLS

Tool	Description
021-00019	Belt Tension Gauge
041-00002	Battery Tester

CJ2569-1B

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GROUP 32 LIGHTING SYSTEM

(13000)

SECTION TITLE	PAGE
TURN SIGNAL AND HAZARD WARNING FLASHERS	32-41-1
HEADLAMP SYSTEM	32-03-1
INTERIOR LAMPS	32-61-1
LIGHTING SYSTEM GENERAL SERVICE	32-01-1
PARKING, REAR AND MARKER LAMPS	32-21-1

SECTION 32-01 Lighting System General Service

SUBJECT	PAGE
DESCRIPTION AND OPERATION	32-01-1
DIAGNOSIS AND TESTING	32-01-1
DIAGNOSIS GUIDES	32-01-1
TESTING GUIDE Headlamp Switch	32-01-5
VEHICLE APPLICATION	32-01-1

VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

The lighting system includes the front headlamps (Section 32-03); the parking, rear, and marker lamps (Section 32-21); the turn signal and hazard flasher (Section 32-41); and the interior lamps (Section 32-61).

DIAGNOSIS AND TESTING

Before performing any lighting system tests, ensure the battery is in a fully charged condition and all battery cable connections are clean and tight.

A visual inspection is an important part of the lighting system test. Check for wires with frayed or damaged insulation, loose connections and proper harness routing. Refer to the Truck Wiring Diagrams Manual.

Any problems found by the visual inspection should be corrected before performing further tests of the lighting system.

For example, a loose ground strap between the engine and body dash panel may cause an intermittent operation of the lamps and gauges. Inspect and tighten, if necessary, the ground strap attaching screws at the back of the engine and the body dash panel. If a No. 10 screw is required, use Part No. 42367-S36 hex washer head tapping screw.

NOTE: Any screws or bolts used for attaching the engine-to-body ground strap must have an "S36" finish (zinc plate plus dichromate dip).

DIAGNOSIS GUIDES

The following Diagnosis Guides provide steps to take when trying to isolate lighting system problems.

Check for burned out bulbs or fuses before proceeding and replace as necessary.

NOTE: All Models use headlamp switch with circuit breaker for headlamps only. All other lamps are on a fuse.

Refer to Testing Guide to verify headlamp switch continuity and condition.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
HEADLAMPS All exterior lamps do not light.	1. Loose wiring connections.	1. Check and secure connections at headlamp switch and dash panel connector.
	2. Open circuit in wiring.	2. Check power to and from headlamp switch. Repair as necessary.
	3. Bad ground.	3. Check ground circuit from bulbs.
	4. Worn or damaged headlamp switch.	4. Verify condition. Replace headlamp switch if necessary.
One headlamp does not work.	1. Loose wiring connections.	1. Secure connections to headlamp and ground.
	2. Sealed beam bulb burned out.	2. Replace sealed beam.
	3. Corroded socket.	3. Repair or replace as required.
All headlamps out — park and taillamps OK.	1. Loose wiring connections.	1. Check and secure connections at dimmer switch and headlamp switch.
	2. Worn or damaged dimmer switch.	2. Check dimmer switch operation. Inspect for corroded connector. Replace as required.
	3. Worn or damaged headlamp switch.	3. Verify condition. Replace headlamp switch if necessary.
	4. Open circuit in wiring or poor ground.	4. Repair as required.
Both low beam or both high beam headlamps do not work.	1. Loose wiring connections.	1. Check and secure connection at dimmer switch and headlamp switch.
	2. Worn or damaged dimmer switch.	2. Check dimmer switch operation. Inspect for corroded connector. Replace as required.
	3. Open circuit in wiring.	3. Repair as required.
TAILLAMPS One taillamp out.	1. Bulb burned out.	1. Replace bulb.
	2. Open wiring or poor ground.	2. Repair as necessary.
	3. Corroded bulb socket.	3. Repair or replace socket.
All taillamps and marker lamps out — headlamps OK.	1. Loose wiring connections.	1. Secure wiring connections where accessible.
	2. Open wiring or poor ground.	2. Check operation of front park and marker lamps. Repair as necessary.
	3. Blown fuse.	3. Replace if blown.
	4. Damaged headlamp switch.	4. Verify condition. Replace headlamp switch if necessary.
STOPLAMPS Stoplamps do not work.	1. Fuse or circuit breaker (C.B.) burned out.	1. Replace fuse or C.B. If fuse or C.B. blows again, check for short circuit. (See Section 34-31.)
	2. Worn or damaged turn signal circuit.	2. Check turn signal operation. Repair as necessary.
	3. Loose wiring connections.	3. Secure connection at stoplamp switch.
	4. Worn or damaged stoplamp switch.	4. Replace stoplamp switch.
	5. Open circuit in wiring.	5. Repair as required.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
STOPLAMPS (Cont'd.) Stoplamps stay on continuously.	1. Damaged stoplamp switch.	1. Disconect wiring connector from switch. If lamp goes out, replace switch.
	2. Internal short circuit in wiring.	2. If lamp stays on, check for internal short circuit. Repair as necessary.
PARKING LAMPS One parking lamp out.	1. Bulb burned out.	1. Replace bulb.
	2. Open wiring or poor ground.	2. Repair as necessary.
	3. Corroded bulb socket.	3. Repair or replace socket.
All parking lamps out.	1. Loose wiring connections.	1. Secure wiring connections.
	2. Open wiring or poor ground.	2. Repair as necessary.
	3. Bulbs burned out.	3. Replace bulbs.
SIDE OR ROOF MARKER LAMPS Side or roof marker lamp does not light.	1. Bulb burned out.	1. Replace bulb.
	2. Open circuit or poor ground.	2. Check socket for corrosion and good ground. Repair as required.
TURN SIGNAL LAMPS All turn signal lamps do not light.	1. Fuse or C.B. burned out.	1. Replace fuse or C.B. If fuse or C.B. blows again, check for short circuit. (See Section 34-31.)
	2. Worn or damaged turn signal flasher.	2. Substitute a known good flasher. Replace if required.
	3. Loose wiring connections.	3. Secure connections where accessible.
	4. Open circuit in wiring or poor ground.	4. Repair as required.
	5. Damaged turn signal switch.	5. Check continuity of switch assembly. Replace turn signal switch and wiring assembly if necessary.
Turn signal lamps light but do not flash.	1. Worn or damaged turn signal flasher.	1. Substitute a known good flasher. Replace if required.
	2. Poor ground.	2. Repair ground.
Front turn signal lamps do not light.	1. Loose wiring connector or open circuit.	1. Repair wiring as required.
Rear turn signal lamps do not light.	1. Loose wiring connector or open circuit.	1. Repair wiring as required.
One turn signal lamp does not light.	1. Bulb burned out.	1. Replace bulb.
	2. Open circuit in wiring or poor ground.	2. Repair as required.

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CONDITION	POSSIBLE CAUSE	RESOLUTION
HAZARD FLASHER LAMPS		
Hazard flasher lamps — do not flash.	1. Fuse or C.B. burned out.	1. Replace fuse or C.B. If fuse or C.B. blows again, check for short circuit. (See Section 34-31.)
	2. Worn or damaged hazard flasher.	2. Substitute a known good flasher. Replace flasher if damaged.
	3. Worn or damaged turn signal operation.	3. Repair turn signal system.
	4. Open circuit in wiring.	4. Repair as required.
	5. Worn or damaged hazard flasher switch.	5. Repair or replace the turn signal switch and wiring assembly which includes the hazard flasher switch.
BACKUP LAMPS		
Backup lamps — one lamp does not function.	1. Bulb burned out.	1. Replace bulb.
	2. Loose wiring connections.	2. Secure connections where accessible.
	3. Open circuit in wiring.	3. Repair as required.
Backup lamps — both lamps do not function.	1. Fuse or C.B. burned out.	1. Replace fuse or C.B. If fuse or C.B. blows again, check for short circuit. (See Section 34-31.)
	2. Backup lamp switch out of adjustment.	2. Adjust switch.
	3. Worn or damaged backup lamp switch.	3. Replace switch.
	4. Loose wiring connections.	4. Secure connections where accessible.
	5. Open wiring or poor ground.	5. Repair as required.
	6. Bulbs burned out.	6. Replace bulb.
INSTRUMENT PANEL LAMP(S)		
Instrument panel lamp does not light.	1. Bulb burned out.	1. Replace bulb.
	2. Fuse burned out.	2. Replace fuse. If fuse blows again, (See Section 34-31).
	3. Open circuit in wiring, rheostat or printed circuit board.	3. Check for a short circuit. Repair as required.
DOME LAMP		
Dome lamp does not come on when door is opened.	1. Connector loose.	1. Secure and/or replace.
	2. Blown fuse.	2. Replace fuse. If fuse blows again, check for short circuit. (See Section 34-31.)
	3. Bulb burned out.	3. Replace bulb.
	4. Open circuit in wiring.	4. Repair as required.
	5. Worn or damaged door jamb switch.	5. Replace door jamb switch.
Dome lamp stays on.	1. Worn or damaged door jamb switch.	1. Replace switch.
	2. Worn or damaged main lighting switch.	2. Replace main lighting switch.
PRND21 LIGHTING		
Poor PRND21 lighting.	1. Burned out bulb.	1. Replace bulb.
	2. Weak bulb.	2. Replace bulb.
	3. Wiring.	3. Check wiring for high resistance. If resistance is high, repair or replace as required.
	4. Worn or damaged dial.	4. Check for total lens illumination. Replace dial if necessary.
	5. Worn or damaged pointer.	5. Check for pointer illumination at all dial positions. Replace pointer if necessary.
	6. Paint overspray.	6. Replace dial.
MAP/DOME LAMP (RPO)		
Map lamp does not come on when switch is actuated.	1. Bulb burned out.	1. Replace bulb.
	2. Blown fuse.	2. Replace fuse.
	3. Open circuit in wiring.	3. Repair as required.
	4. Worn or damaged switch in lamp assembly.	4. Replace lamp assembly.
Map lamp stays on.	1. Worn or damaged switch in lamp assembly.	1. Replace lamp assembly.

CK3899-2F

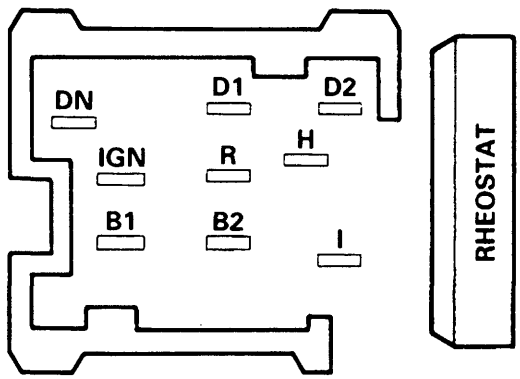
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TESTING GUIDE

Headlamp Switch

The following test provides a continuity check for the headlamp switch to verify switch condition. If the switch fails to show continuity as indicated in the test, replace switch.

HEADLAMP SWITCH — BENCH CHECK CONTINUITY



CONNECTOR 11A646

- Terminal DN — Daytime Illumination
- Terminal IGN — DN Feed
- Terminal B1 — Headlamp Feed
- Terminal B2 — Park/Rear/Instrument Panel Lights Feed
- Terminal D1 — Dome Lamp Feed
- Terminal D2 — To Dome Lamp
- Terminal H — To Headlamps
- Terminal R — To Parking/Rear Lamps
- Terminal I — To Instrument Panel Lamps
- Rheostat — Provides variable resistance between Terminals R and I

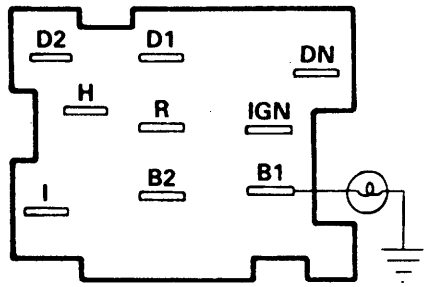
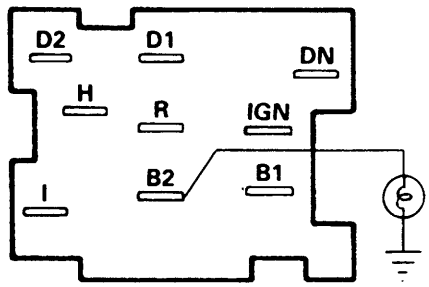
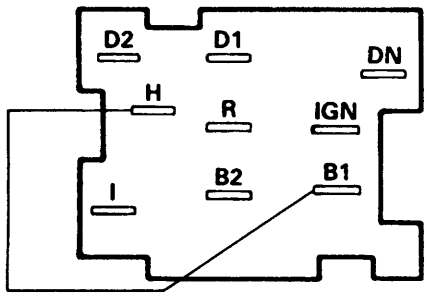
SWITCH POSITION	CIRCUIT CONTINUITY
Daytime Illumination • Ignition Switch ON • Headlamp Switch OFF	Closed Circuit — IGN Terminal to DN Terminal
Parking/Rear Lamps • Headlamp Switch ON — first stop position	Closed Circuit — DN Terminal to I Terminal B2 Terminal to R Terminal
Headlamps • Headlamp Switch ON — second stop position	Closed Circuit — DN Terminal to I Terminal B2 Terminal to R Terminal B1 Terminal to H Terminal
Instrument Panel Illumination • ROTATE Headlamp Switch Knob	Variable Resistance — Between Terminal R and Terminal I

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HEADLAMP SWITCH CONNECTOR CHECKOUT

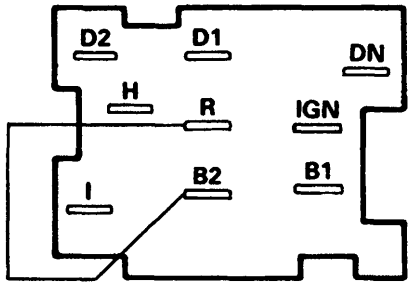
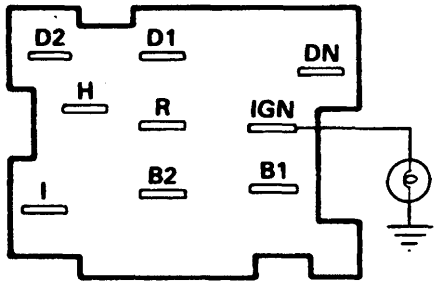
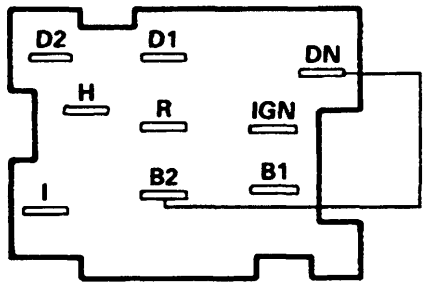
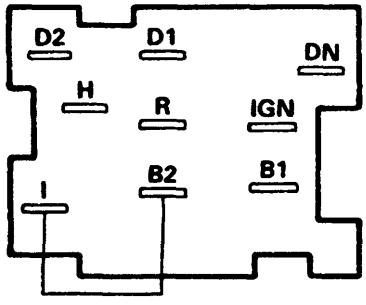
1. Replace burned out bulbs and fuses before proceeding.
2. A 12-volt test lamp and jumper wire will be required.
3. When necessary to trace and/or service the various circuits, refer to the respective vehicle wiring diagrams.
4. Terminal identification used on connector checkout procedure corresponds with actual identification on headlamp switch.
5. Perform checks in sequence as shown.

OPERATION	RESULT
1 Connect a 12-volt test lamp between Terminal B1 and a good ground. 	Test lamp should light. If not, trace circuit back to fuse link and service as necessary.
2 Connect a 12-Volt test lamp between Terminal B2 and a good ground. 	Test lamp should light. If not, trace circuit back to fuse panel and service as necessary.
3 Connect a jumper wire between Terminals B1 and H. 	Headlamps should light. If not, trace Circuit H back to headlamps and service. If circuit is OK, check ground circuit from headlamps to ground.

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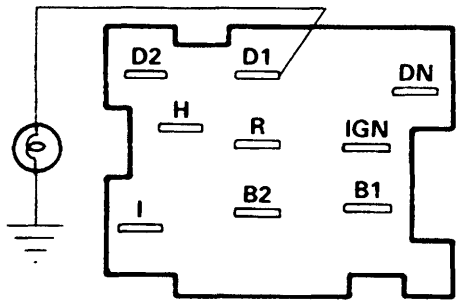
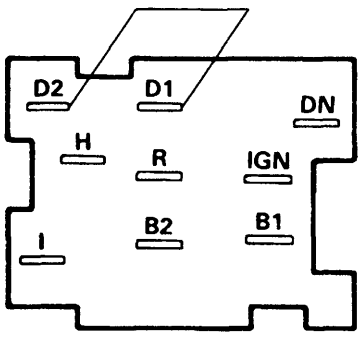
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HEADLAMP SWITCH CONNECTOR CHECKOUT — Continued

OPERATION	RESULT
4 Connect a jumper wire between Terminals B2 and R. 	Parking lamps, rear lamps, and marker lamps should light. If not, trace Circuit R and service as necessary. If Circuit R is OK, check ground circuit from lamps to ground.
5 Connect a 12-volt test lamp between Terminal IGN and a good ground. 	With ignition switch in the RUN position, the test lamp should light. If not, trace circuit back to ignition and service as necessary.
6 Connect a jumper wire between Terminals B2 and DN. 	Liquid crystal display lamps only, should come on, full bright. If lamps do not light, trace Circuit DN back to lamps and service as necessary. If Circuit is OK, check ground circuit from lamps to ground. NOTE: No other instrument panel lamps will light during this test.
7 Connect a jumper wire between Terminals B2 and I. 	Instrument panel illumination lamps only, should come on, full bright. If panel lamps do not light, trace I circuit back to lamps and service as necessary. If circuit is OK, check ground circuit from lamps to ground. NOTE: Liquid crystal displays will not light during this test.

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OPERATION	RESULT
8 Connect a 12-volt test lamp between Terminal D1 and a good ground. 	Test lamp should light. If not, trace circuit back to fuse panel and service as necessary.
9 Connect a jumper wire between Terminals D1 and D2. 	With all vehicle doors closed, dome lamp should light. If not, trace circuit D2 back to dome lamp and service as necessary. If circuit is OK, check ground circuit from dome lamp to ground.

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SECTION 32-03 Headlamp System

SUBJECT	PAGE
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Headlamp Aim	32-03-1
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Headlamps E-150—E-350	32-03-1
Headlamps On Warning Buzzer	32-03-1
REMOVAL AND INSTALLATION	
Dimmer Switch	32-03-3
Headlamp Bulb E-150—E-350	32-03-2
Headlamp Switch	32-03-3
E-150—E-350	32-03-3
F-150—F-350 and Bronco	32-03-3
SPECIAL SERVICE TOOLS	32-03-7
VEHICLE APPLICATION	32-03-1

VEHICLE APPLICATION

All Light Truck Models.

DESCRIPTION AND OPERATION

Headlamps E-150—E-350

Two-type 2B rectangular headlamps are used. The lamps have two filaments each, one for low beam and one for high beam. The filaments are identified by the numeral 2 or 2B molded into the glass lens. Headlamps are controlled by the headlamp switch on the instrument panel and the foot-operated dimmer switch on the floor to the left of the clutch/brake pedal.

Headlamps—F-150—F-350 and Bronco

Two aerodynamically styled headlamps are used. Each lamp uses a halogen bulb. A burned out bulb may be replaced without removing the headlamp. Headlamps are controlled by the headlamp switch on the instrument panel and the foot-operated dimmer switch on the floor to the left of the clutch/brake pedal.

Headlamp Switch

The headlamp switch (Fig. 1) is a combination, three-position switch that controls the circuits to the headlamps, exterior lamps (except stoplamps and turn signal/hazard warning lamps), instrument panel lamps and other interior lamps. A typical headlamp switch is shown in Fig. 1. Circuits are connected to the switch by a molded multiconnector.

The interior lamp circuit is routed through a rheostat on the switch, which is controlled by rotating the switch control knob. This circuit is protected by a fuse in the fuse panel.

NOTE: Refer to Section 32-01, Lighting System General Service, for diagnosis and testing of headlamp switch.

Headlamps On Warning Buzzer

With optional Headlamps On Warning, a seven-terminal buzzer replaces the six-terminal buzzer used with Key Warning. This buzzer allows dual function of the Key Warning and Headlamps On Warning buzzers. The seventh terminal is connected to the taillamp circuit (circuit No. 14); otherwise the circuits are identical. As in Key Warning, when the door is opened, circuit No. 159 is energized and if the headlamp switch is operated, a transistor is turned on to allow completion of the buzzer ground path (circuit No. 57). The buzzer will continue to operate until either the headlamp switch is turned off or the driver's door is closed (Fig. 2). The buzzer is located on the RH side of the instrument panel above the glove compartment on F-150—F-350 and Bronco and to the LH side of the steering column on Econoline.

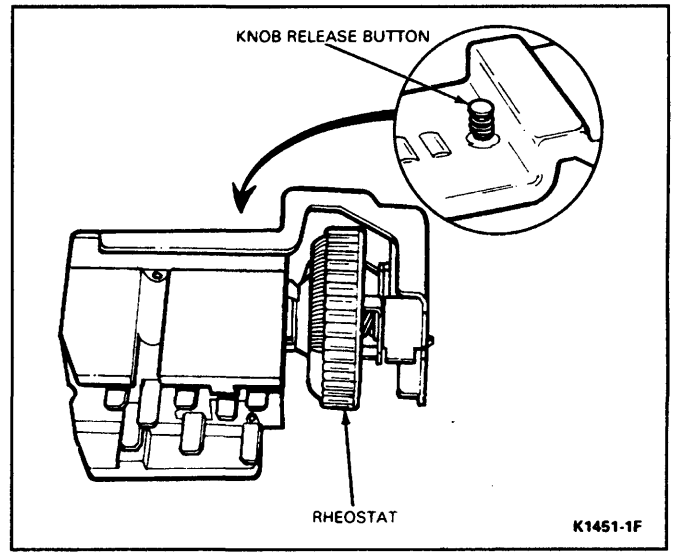


FIG. 1 Typical Headlamp Switch

ADJUSTMENTS

Headlamp Aim

Before making any headlamp adjustments, perform the following preparatory steps:

1. Remove ice or mud from under fenders.
2. Verify that all tires are inflated to recommended pressures.
3. Check springs for sag or broken leaves.
4. Take into consideration faulty wheel alignment or improper tracking of the rear axle.
5. Verify there is no load in the vehicle other than the fuel tank one-half full.
6. Clean lenses and aiming pads.
7. Check for bulb burn-out and proper beam switching.
8. Verify that lamp output is well toward normal new lamp value.

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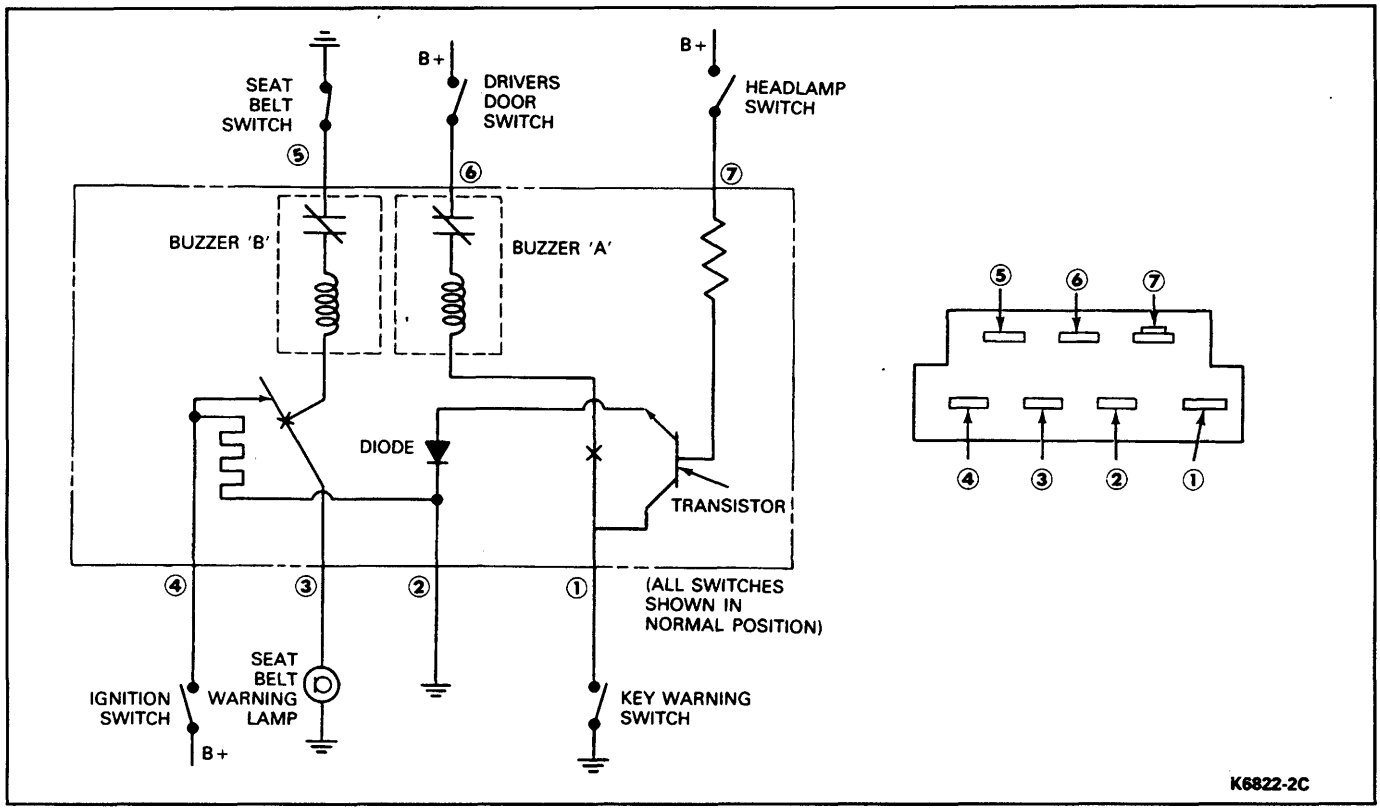


FIG. 2 Lamps-On Warning Buzzer and Wiring Diagram

9. Bounce the vehicle and allow to settle.

Headlamp aim adjustment should be made with the Rotunda Headlamp Aiming Kit 107-00001 or equivalent. Use the latest instructions.

The kit equipment can be calibrated to accommodate a slight slope in the floor, making it usable almost anywhere in the garage.

Each headlamp is adjusted by means of two screws located under the headlamp door or trim ring as shown in Fig. 3.

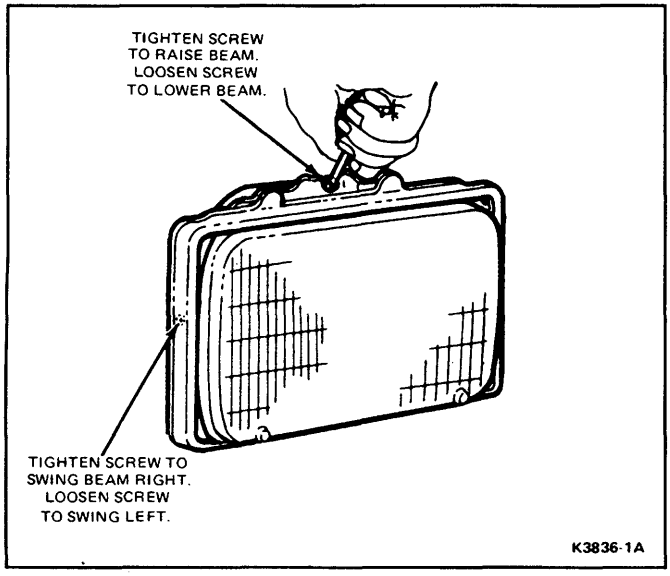


FIG. 3 Headlamp Adjustment Shown Without Headlamp Door or Trim Ring E-150—E-350 Shown F-150—F-350 and Bronco Similar

NOTE: Access doors are provided to allow headlamp adjustment without removing the headlamp door.

Always bring each beam into final position by turning the adjusting screws clockwise so that the headlamp will be held against the tension springs when the operation is completed.

REMOVAL AND INSTALLATION

Headlamp Bulb E-150—E-350

Removal and Installation

1. Remove the headlamp retaining ring screws (Fig. 5), and remove the retaining ring. Do not disturb the adjusting screw settings.
2. Pull the headlamp bulb forward and disconnect the wiring assembly plug from the bulb.
3. Connect the wiring assembly plug to the new bulb. Place the bulb in position, making sure that the locating tabs of the bulb are fitted in the positioning slots.
4. Install the headlamp retaining ring (Fig. 5).
5. Adjust the headlamp aim using the Rotunda Headlamp Aiming Kit 107-00001 or equivalent, if required.

Headlamp Bulb—F-150—F-350 and Bronco

Removal

WARNING—THE HALOGEN HEADLAMP BULB CONTAINS GAS UNDER PRESSURE. THE BULB MAY SHATTER IF THE GLASS ENVELOPE IS SCRATCHED OR THE BULB IS DROPPED. HANDLE BULB CAREFULLY. GRASP BULB ONLY BY ITS PLASTIC BASE. AVOID TOUCHING THE GLASS ENVELOPE. KEEP BULB OUT OF REACH OF

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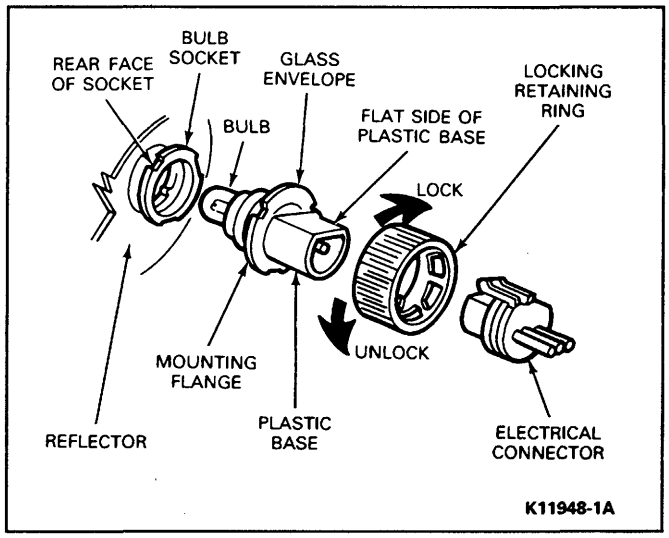


FIG. 4 Bulb Removal and Installation—F-150—F-350 and Bronco

CHILDREN. ENERGIZE THE BULB ONLY WHEN INSTALLED IN THE HEADLAMP.

1. Check that headlamp switch is in OFF position.
2. Lift hood and locate bulb installed in rear of headlamp body (Fig. 4).
3. Remove electrical connector from bulb by grasping wires firmly and snapping connector rearward.
4. Remove bulb retaining ring by rotating counterclockwise (when viewed from rear) about one-eighth turn and sliding ring off plastic base. Keep ring as it may be used again to retain new bulb (Fig. 4).
5. Carefully remove headlamp bulb from socket in reflector by gently pulling straight backward out of socket. Do not rotate bulb during removal.

Installation

1. With flat side of plastic base of bulb facing upward, insert glass envelope of bulb into socket. Turn base slightly to left or right, if necessary, to align grooves in forward part of plastic base with corresponding locating tabs inside socket. When grooves are aligned, push bulb firmly into socket until mounting flange on base contacts rear face of socket.
2. Slip bulb retaining ring over rear of plastic base against mounting flange. Lock ring into socket by rotating ring clockwise. A stop will be felt when retaining ring is fully engaged.
3. Push electrical connector into rear of plastic base until it snaps and locks into position.
4. Turn headlamps on and check for proper operation.

   NOTE: A properly aimed headlamp normally need not be reaimed after installation of this bulb. A burned out bulb should not be removed from the headlamp reflector until just before a replacement bulb is to be installed. Removal of a bulb for an extended period of time may allow contaminants (dust, moisture, smoke) to enter the headlamp body and affect the performance of the headlamp. When servicing the headlamp bulb, energize the bulb only while it is contained within the headlamp body.

Headlamp Switch

F-150—F-350 and Bronco

Removal and Installation

1. Disconnect the battery ground cable.
2. Remove the wiper-washer and headlamp switch knobs. Use a hook tool to release each knob lock tab.
3. Remove the fog lamp switch knob, if so equipped.
4. Remove steering column shroud.
5. Remove the cluster finish panel assembly (Fig. 7).
6. Unscrew the mounting nut. Remove the switch from instrument panel, then remove the wiring connector from the switch (Fig. 8).
7. To install the switch, connect the wiring connector to the headlamp switch, position the switch in the instrument panel and install mounting nut.
8. Install the trim finish panel assembly and column shroud.
9. Install the headlamp switch knob. If so equipped, install the fog lamp switch.
10. Install the wiper-washer control knobs. Connect the battery cable, and check the operation of the headlamp switch.

E-150—E-350

Removal and Installation

1. Disconnect the battery ground cable.
2. Remove the headlamp control knob and shaft by pressing the knob release button on the switch housing (Figs. 1 and 9), with the knob in the full **ON position. Pull the knob and shaft assembly out of the switch. Unscrew the mounting nut or bezel nut. Remove the switch, then remove the wiring connector from the switch (Fig. 9).**
3. To install the switch, connect the wiring connector to the headlamp switch, position the switch in the instrument panel, and install the bezel and mounting nut.
4. Install the knob and shaft assembly by inserting it all the way into the switch until a distinct click is heard. In some instances it may be necessary to rotate the shaft slightly until it engages the switch-contact carrier.
5. Connect the battery ground cable.
6. Test lamps for proper operation.

Dimmer Switch

Removal and Installation—F-150—F-350 and Bronco Shown—E-150—E-350 Similar

Pull the floor mat/carpet back in the area of the switch, and remove the mounting screws (Fig. 10). Disconnect the wire terminal block from the switch.

Install the switch to the floor, and connect the terminal block to the switch. Replace the floor mat. Check dimmer switch operation.

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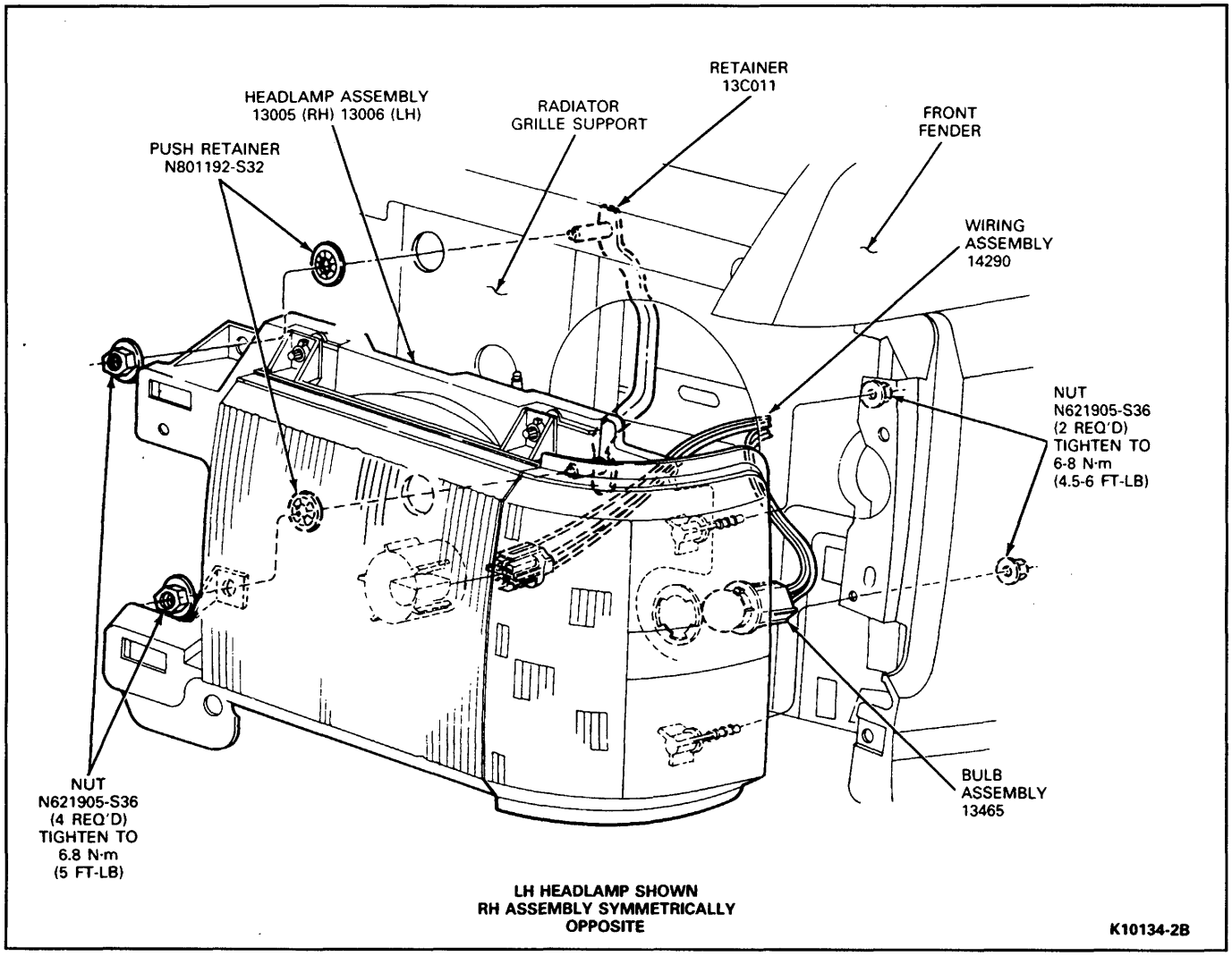


FIG. 5 Square Headlamp—F-150—F-350 and Bronco

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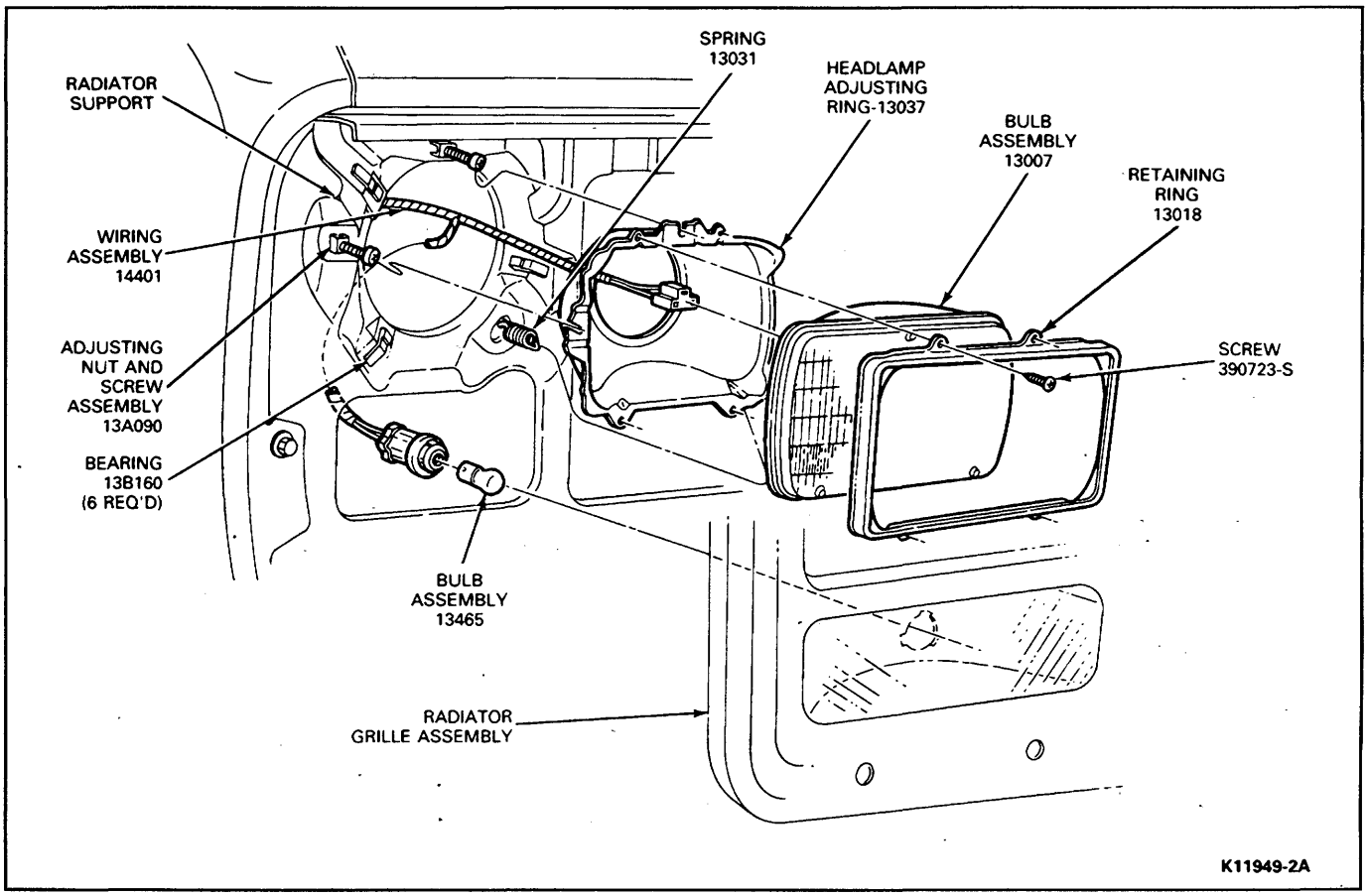


FIG. 6 Square Headlamp—E-150—E-350 Shown

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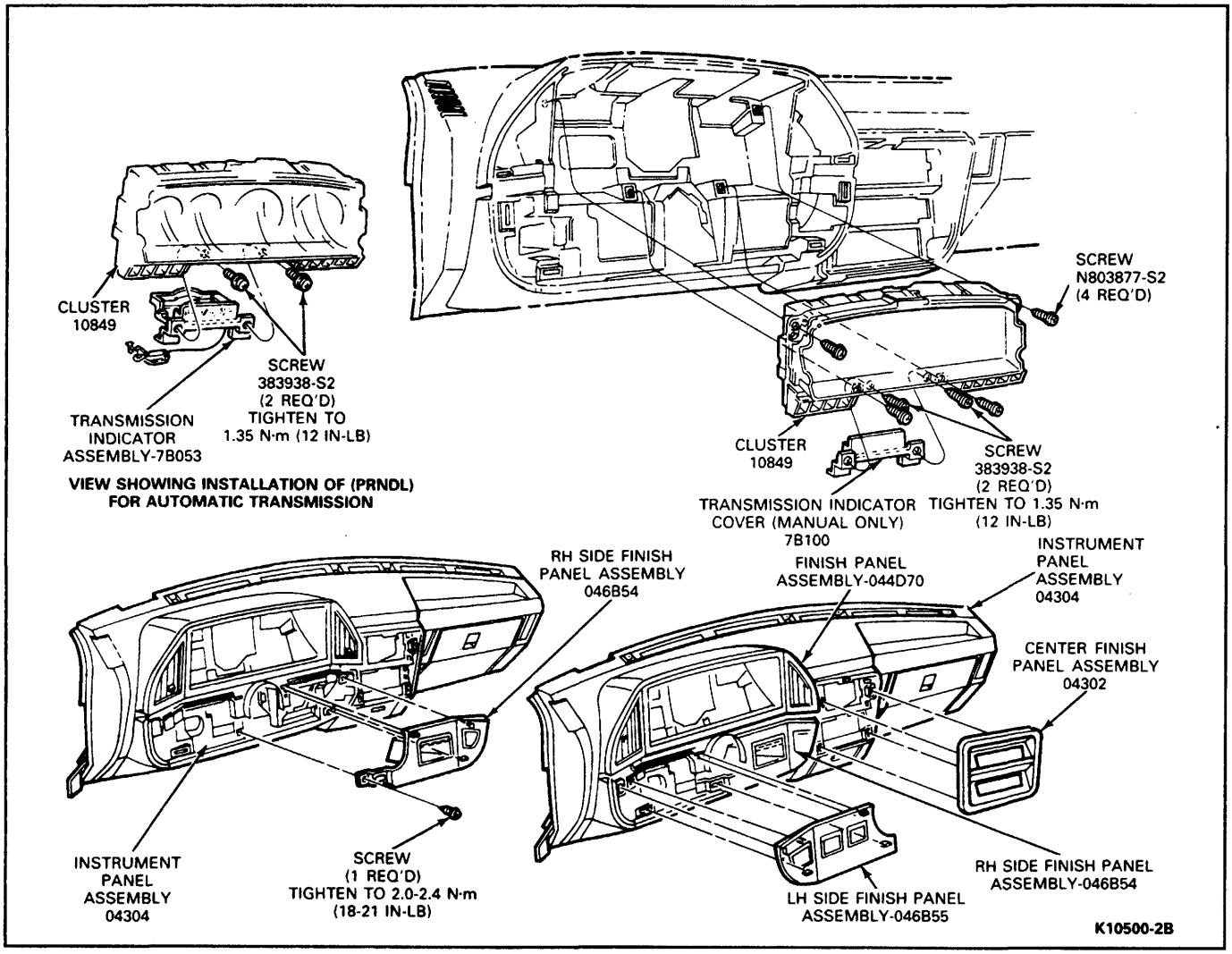


FIG. 7 Instrument Cluster—F-150—F-350 and Bronco

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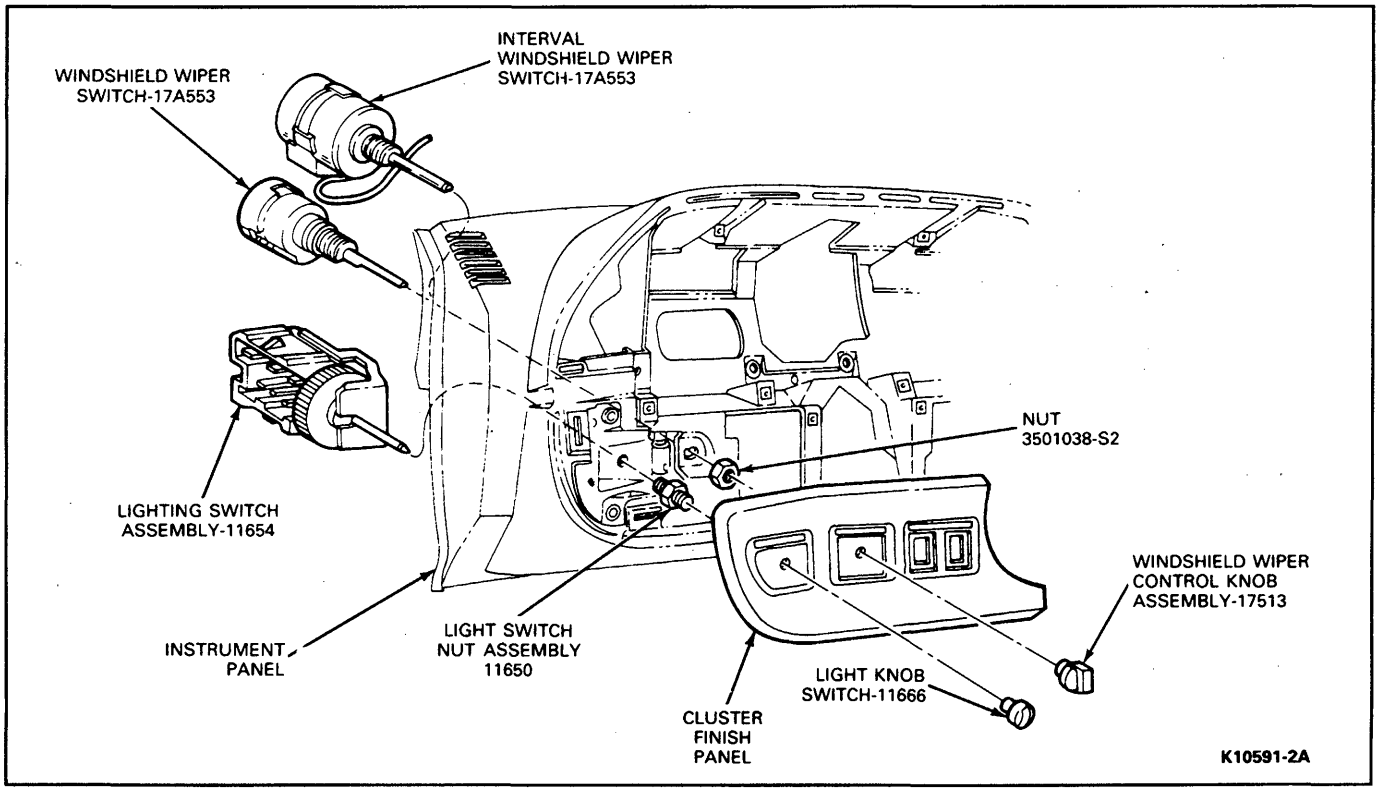


FIG. 8 Headlamp Switch Installation—F-150—F-350 and Bronco

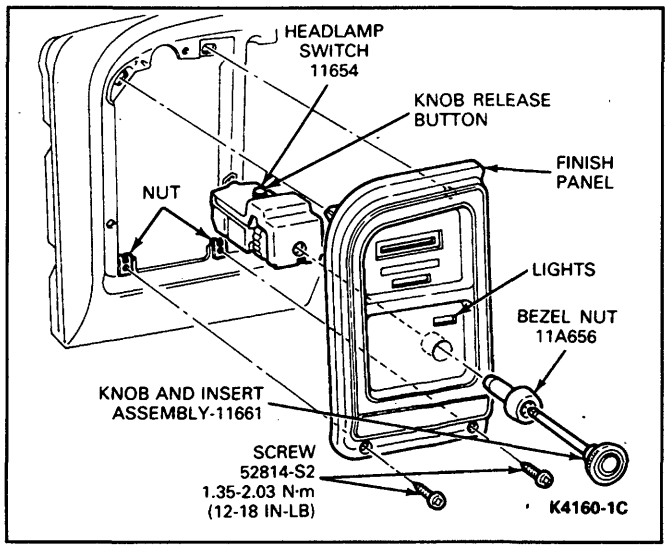


FIG. 9 Headlamp Switch Installation—E-150—E-350

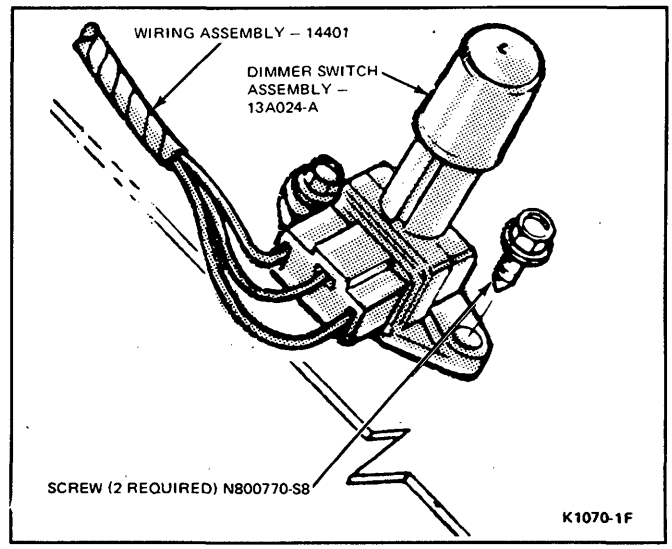


FIG. 10 Headlamp Dimmer Switch

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Model No.	Description
107-00001	Headlamp Aiming Kit

CK6756-1D

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SECTION 32-21 Parking, Rear and Marker Lamps

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F-150 Through F-350 Style Side Pickup, Bronco and E-150—E-350	32-21-1
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E-150—E-350	32-21-2
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Stoplamp Switch	32-21-4
Bronco, E-150—E-350 and F-150 Through F-350	32-21-4
VEHICLE APPLICATION	32-21-1

VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

Stoplamp Switch

E-150—E-350, F-150—F-350, and Bronco

The mechanical stoplamp switch assembly, installed on the pin of the brake pedal arm, straddles the master cylinder push rod, but is not attached directly to the push rod (Fig. 1). The switch assembly moves with the pedal arm when the brake pedal is depressed.

The switch actuating pin is held by spring pressure against the rear end of the push rod. Because of the slight clearance between the eye of the master cylinder push rod and the brake pedal arm pin, the pin and the switch move forward slightly before the push rod moves when the pedal is depressed. This relative movement between the switch and the end of the push rod moves the actuating pin rearward in the switch, closing the switch contacts and completing the circuit to the stoplamps.

When the brake pedal is released, the switch moves rearward in relation to the push rod. The spring in the switch returns the actuating pin to its normal position, opening the switch contacts and interrupting the circuit to the stoplamps.

REMOVAL AND INSTALLATION

Front Side Marker Lamps

E-150—E-350

Removal and Installation

Remove two screws and lamp assembly. Disconnect socket from lamp body (Fig. 2). Replace bulb in socket, if required. Install socket in lamp body and install lamp body to vehicle.

Parking Lamps

F-150—F-350 and Bronco

Removal and Installation

Remove headlamp assembly attaching nuts and retainers (Fig. 3). Pull assembly away from support and disconnect socket from lamp body. Replace bulb. Reverse procedure to install. Tighten attaching nuts to 6-8 N·m (4.5-6 ft-lb).

E-150—E-350

Removal and Installation

If lamp body replacement is required, remove headlamp trim ring and rim. Remove the lamp assembly by removing two mounting screws and/or nuts and disconnecting the socket from the lamp body. Reverse procedure to install.

Rear Lamps

F-150 Through F-350 Style Side Pickup, Bronco and E-150—E-350

Removal and Installation

To replace a bulb in the combination taillamp, stoplamp, reflex and backup lamp, remove the screws that retain the lamp lens assembly to the vehicle and pull lamp lens away from vehicle (Figs. 4 and 5). Turn the socket with the burned out or broken bulb counterclockwise and replace the bulb. Install by turning clockwise into housing. Install lamp lens and retaining screws to vehicle.

NOTE: If lamp body or lens is damaged, replace entire lamp assembly. Lens and body are not serviced separately (Figs. 4 and 5).

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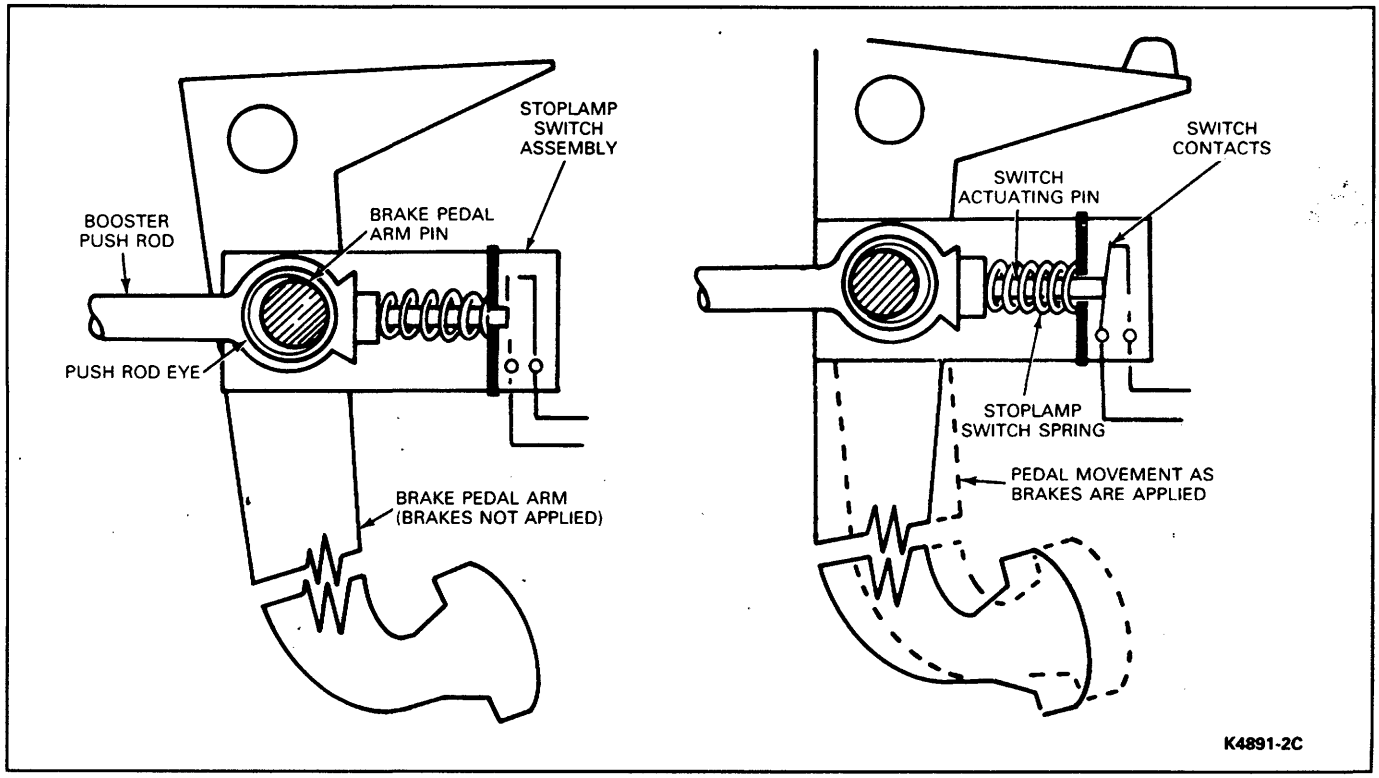


FIG. 1 Stoplamp Switch—F-150 Through F-350 and Bronco, E-150—E-350

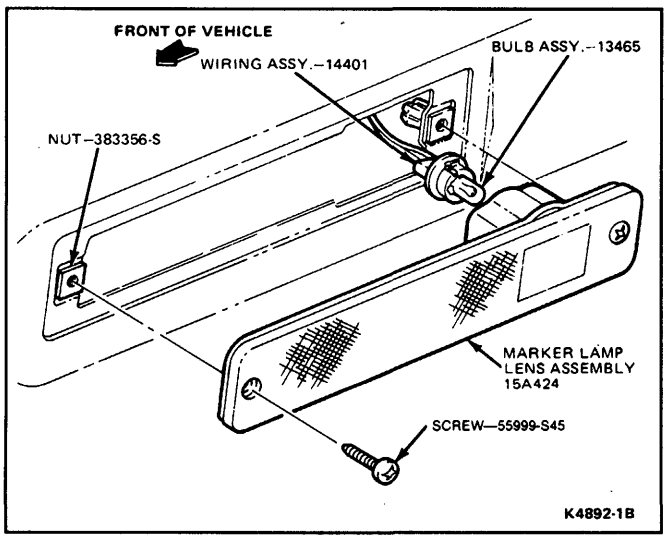


FIG. 2 Parking Lamp and Side Marker Lamp—E-150—E-350

F-150 Through F-350 Flare Side Pickup

Removal and Installation

The bulbs in the rear lamp body can be replaced by removing the lens retaining screws and pulling lens away from vehicle.

To replace the lamp assembly, remove the three nuts from the mounting studs. Disconnect the two connectors (red-black stripe wire and wire with green insulator) inside the frame side rail (Fig. 6). Unhook the wires from the retaining clip and pull the wires out. Insert the studs of the replacement lamp body into the holes of the lamp mounting bracket. Tighten the stud nuts.

Rear Marker Lamps

E-150—E-350

Removal and Installation

Replacement of the bulb, the lamp assembly, or the socket and wiring assembly requires removal of the lamp assembly from the side of the vehicle as shown in Fig. 2. Disengage the bulb socket from the rear of the lamp assembly by turning counterclockwise. With the socket disengaged the lamp bulb can be replaced. If the socket and wiring assembly is to be replaced, disconnect the wiring at the connector and ground screw.

License Plate Lamp

All F-150—F-350 (With Rear Bumper) and Bronco

Bulb

Removal and Installation

To replace the rear license lamp bulb, rotate socket one-quarter turn from backside of lamp (Fig. 7) and remove the bulb. To install, reverse removal procedure.

Lamp Assembly

Removal and Installation

To remove the lamp assembly, push lamp assembly out from behind or pry out from outside (Fig. 7). To install, reverse removal procedure.

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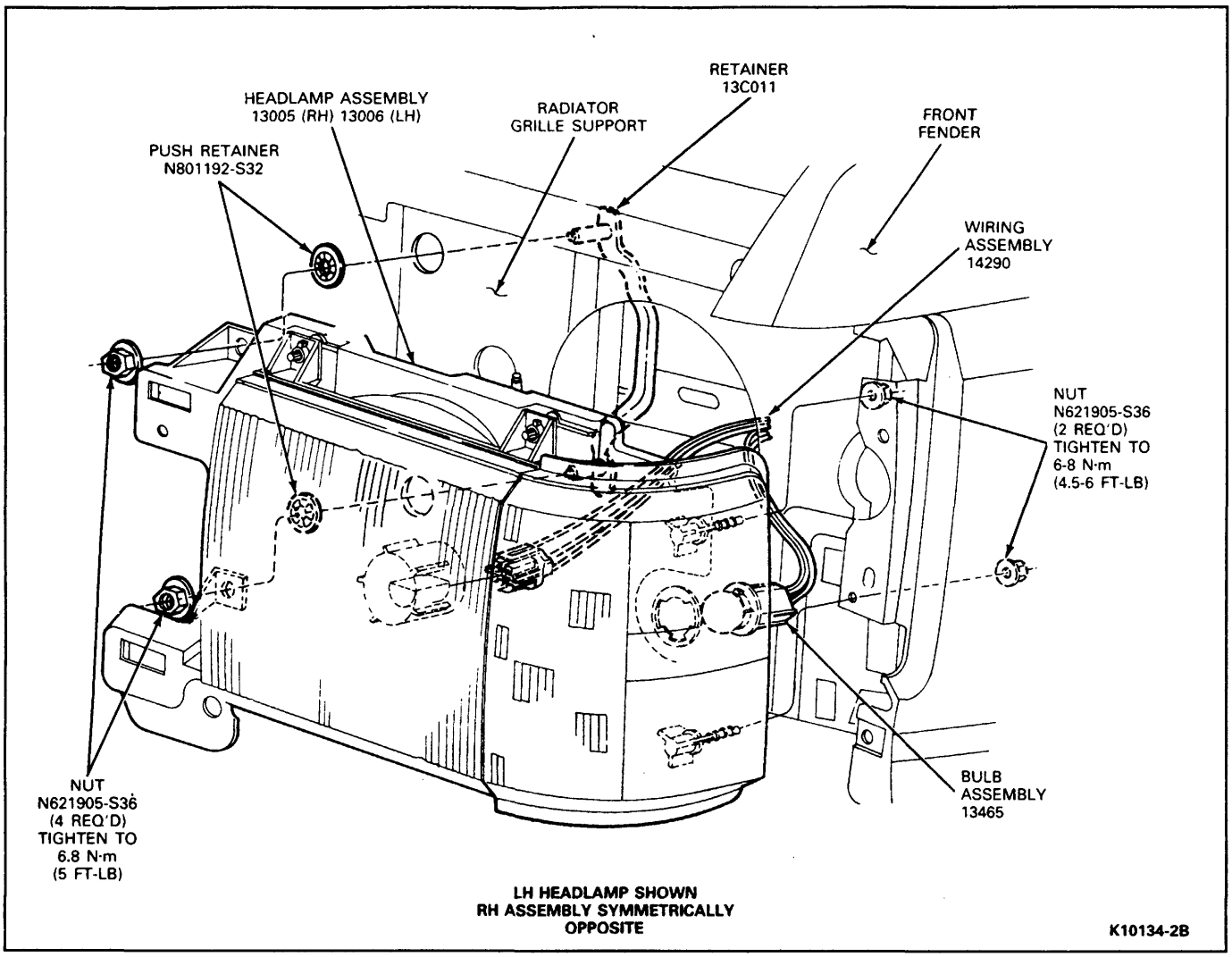


FIG. 3 Parking Lamp—F-150—F-350 and Bronco

All F-150—F-350 (Without Rear Bumper)

Bulb

Style Side Only

Removal and Installation

1. Remove screw retaining rear license lamp cover to assembly.
2. Remove the bulb and replace with a new bulb.
3. Install cover and screw to rear license lamp assembly (Fig. 7).

Lamp Assembly

Removal and Installation

1. Remove two screws that retain the assembly to license bracket.
2. Disconnect wiring connector.
3. To install, connect wiring connector to lamp assembly. Position lamp assembly to license bracket and install the two retaining screws (Fig. 7).

Flare Side Only

Removal and Installation

Refer to Fig. 6

1. Remove two screws that retain the lamp assembly.
2. Remove lamp socket from lamp assembly by rotating socket counterclockwise one-eighth-turn and pull socket from lamp body. Remove bulb by pulling outwards.
3. To install, push bulb into socket.
4. Install lamp and retaining screw.

E-150—E-350

Removal and Installation

To replace the bulb of the E-150—E-350 license plate lamp assembly (Fig. 8) remove the lamp socket from the lamp assembly from inside the LH rear door by twisting counterclockwise. Remove the bulb, install a new bulb and twist the socket into the lamp assembly.

To replace the lamp assembly, remove the three screws accessible from rear door inside opening that retain the assembly to the door. Pull the lamp sockets out of the lamp assembly and remove the assembly from the door. To install, reverse this procedure.

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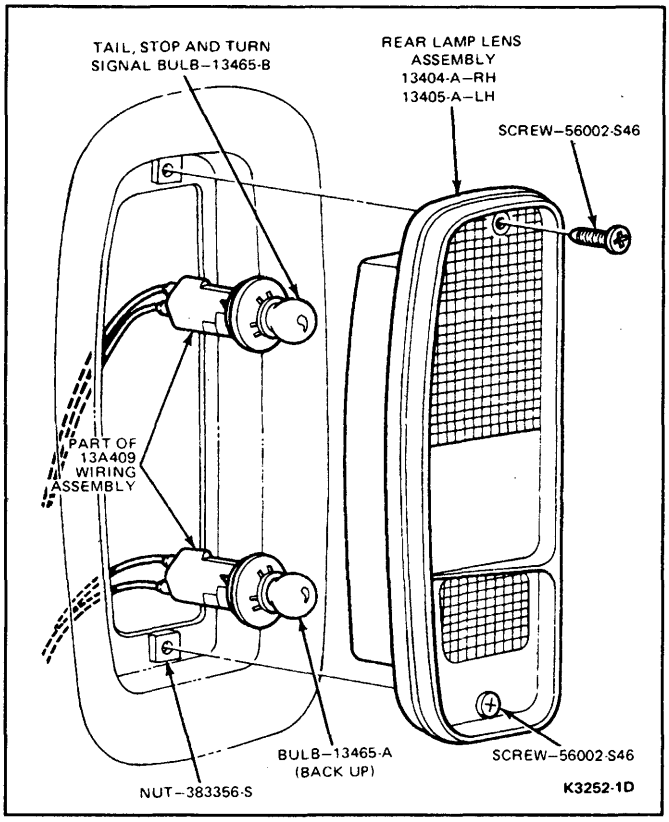


FIG. 4 Rear Lamp—E-150—E-350

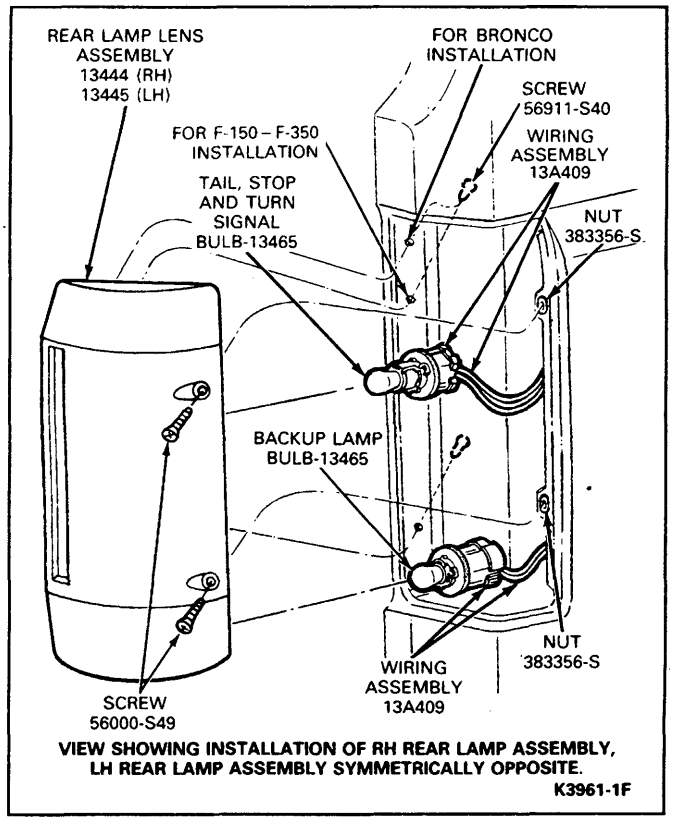


FIG. 5 Rear Lamps—Bronco and F-150—F-350 Styleside

Stoplamp Switch

Bronco, E-150—E-350 and F-150 Through F-350

Removal and Installation

1. Disconnect wire harness connector from switch.

   NOTE: Locking tab must be lifted before connector can be removed.

2. Remove the hairpin retainer. Slide stoplamp switch, push rod, nylon washer and bushing away from the pedal. Remove washer and then the switch by sliding switch up or down (Fig. 9).

   NOTE: Since the switch side plate nearest the brake pedal is slotted, it is not necessary to remove the brake master cylinder push rod and bushing from the brake pedal pin. On vehicles equipped with speed control, the spacer washer is replaced by the dump valve adapter washer assembly.

3. Position switch so that the U-shaped side is nearest the pedal and directly over/under the pin. Then, slide switch up/down trapping the master cylinder push rod and bushing between the switch side plates.

   Push switch and push rod assembly firmly toward brake pedal arm. Assemble outside white plastic washer to pin. Install hairpin retainer to hold entire assembly.

   CAUTION: Do not substitute other types of pin retainers. Use only factory-supplied hairpin retainer.

4. Install connector to the switch (Fig. 9).

5. Check stoplamp switch for proper operation.

   CAUTION: Stoplamp switch wire harness must have sufficient length to travel with switch during full stroke of pedal. If wire length is too short, reroute or repair harness as required.

Backup Lamp Switch

All F-150—F-350 and E-150—E-350 with 5 Speed Manual Overdrive Transmission

The backup lamp switch is mounted on the driver's side of the transmission assembly (Fig. 10 and 11). The switch (C9TZ-15520-C) is not adjustable. To remove the switch, place the transmission selector lever in any position other than REVERSE and disconnect the electrical connector from the switch. Remove the switch from the transmission assembly. Install new switch in reverse order.

Roof Marker Lamps

Removal and Installation

To remove roof marker lamps (Fig. 12), remove two screws securing marker to roof and lift lamp enough to see electrical connector. Tape wiring assembly 15A404 to roof of vehicle and disconnect electrical connector. Remove marker lamp from vehicle.

To install roof marker lamps, position pad over electrical wires and connect electrical connector. Remove tape from wiring assembly. Position marker lamp to roof. Secure with two screws. Tighten screws to 0.90-2.25 N·m (8-20 in-lb).

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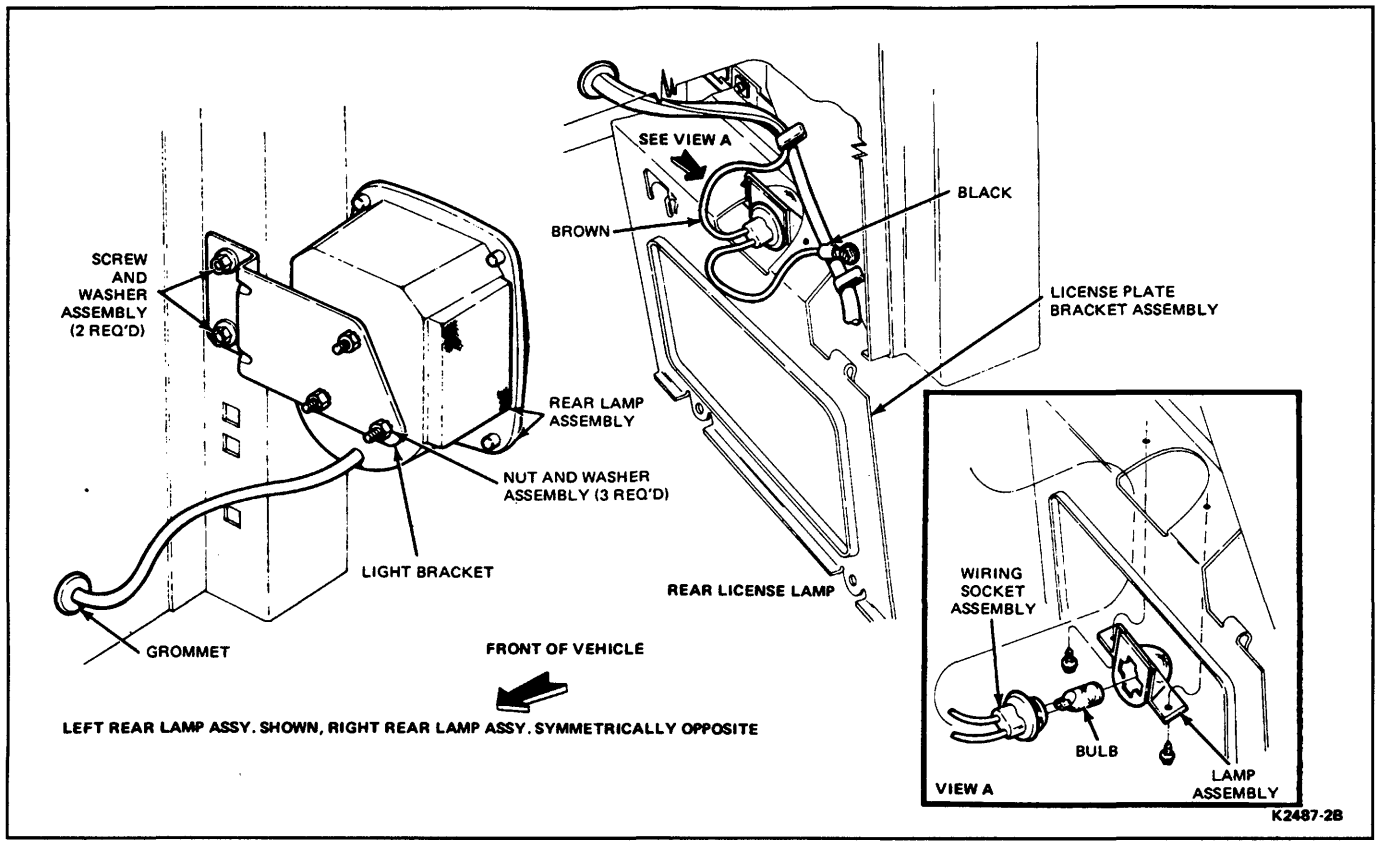
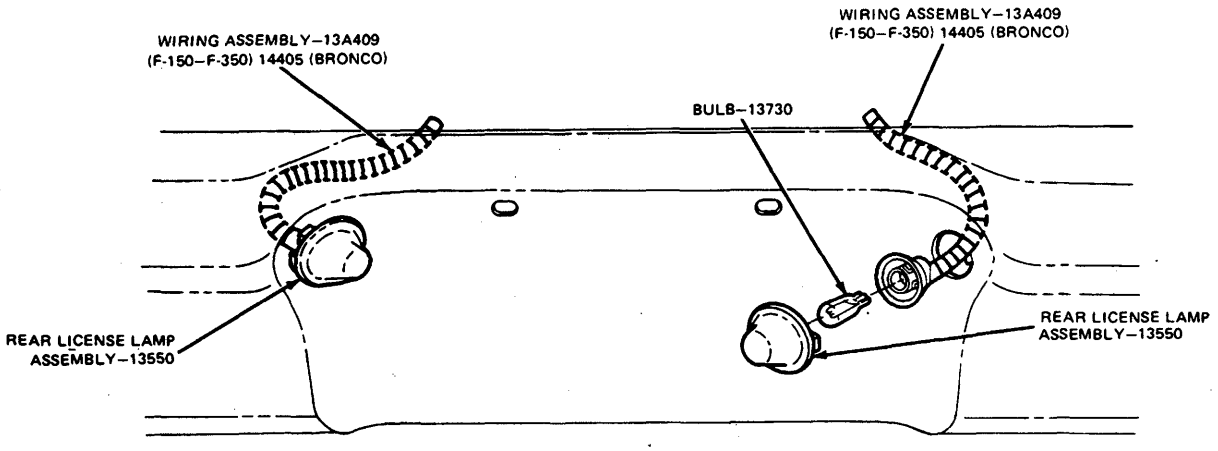
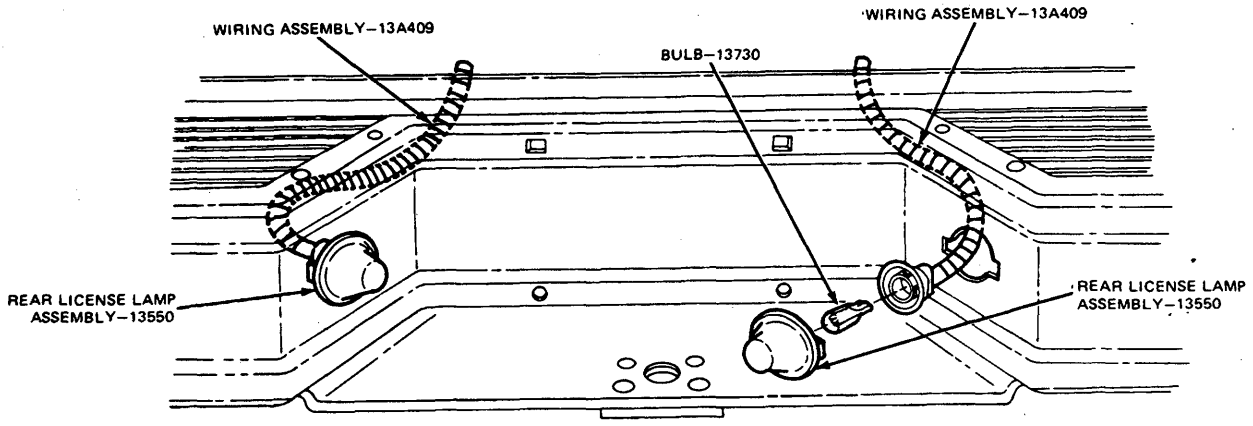


FIG. 6 Rear Side Marker and License Plate Lamps—F-150, and F-250, Flare Side Pick-Up

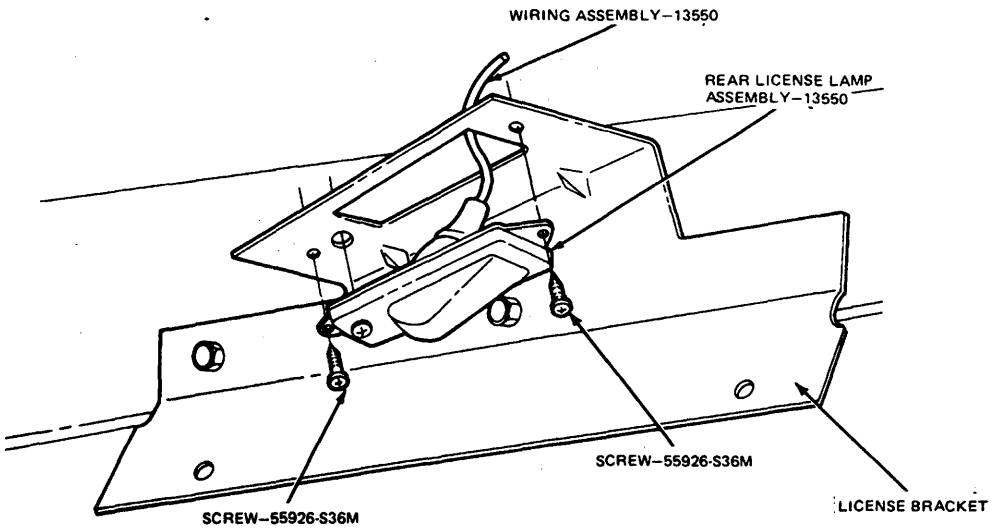
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VIEW SHOWING INSTALLATION OF LICENSE LAMP ASSY. WITH STRAIGHT BUMPER FOR BRONCO



VIEW SHOWING INSTALLATION OF LICENSE LAMP ASSY. WITH STEP-UP BUMPER



F-150–F-350 STYLESIDE WITHOUT BUMPER

K3962-2B

FIG. 7 License Plate Lamp—F-150—F-350 Styleside and Bronco

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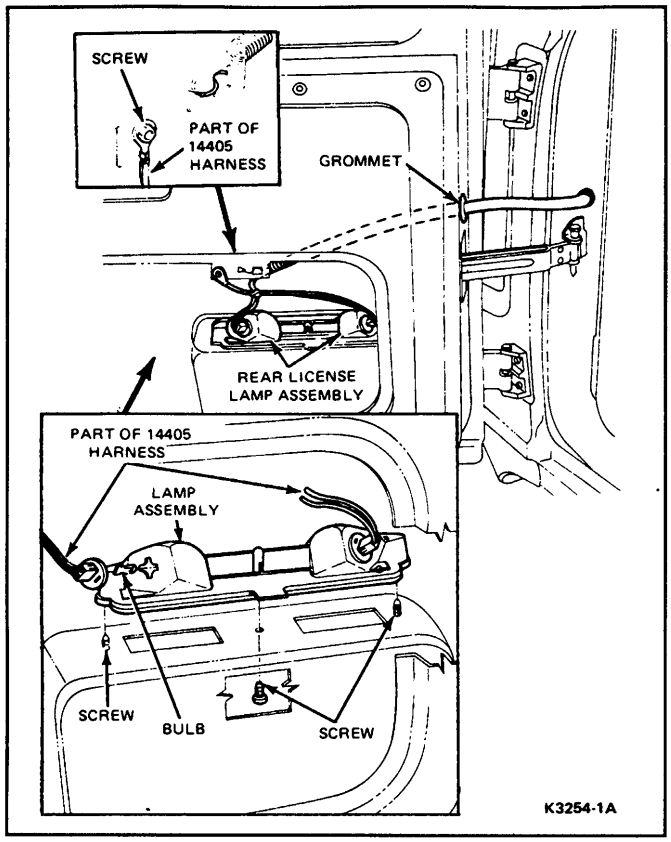


FIG. 8 License Plate Lamp—E-150—E-350

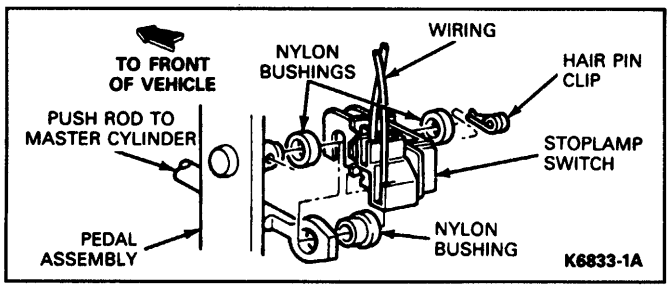


FIG. 9 Stoplamp Switch-Installed—With Power Brakes

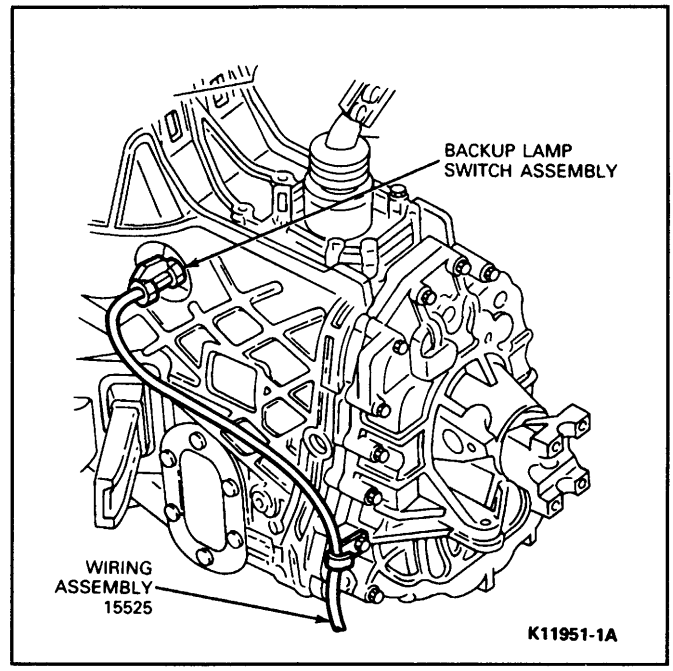


FIG. 10 Backup Lamp Switch—Typical

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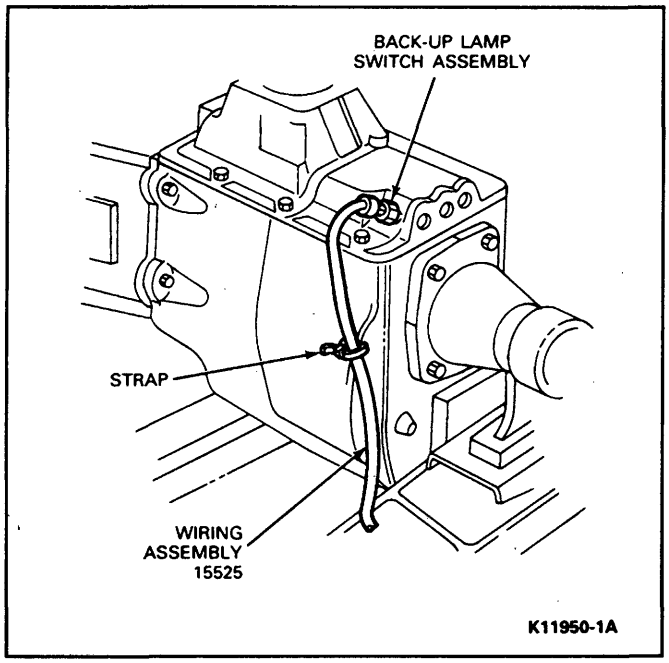


FIG. 11 Backup Lamp Switch-Installed—E-150—E-350

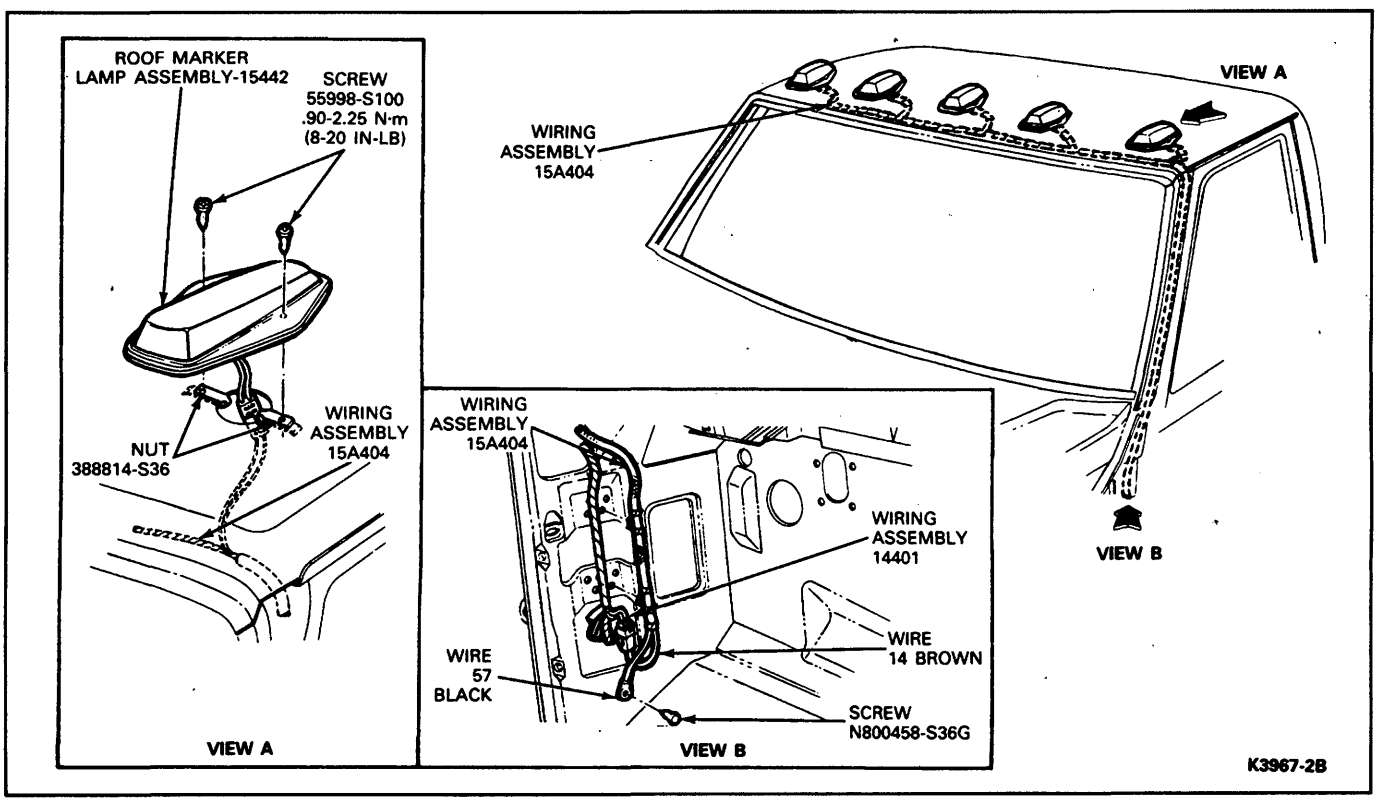


FIG. 12 Roof Marker Lamps—F-150—F-350

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SECTION 32-41 Turn Signal and Hazard Warning Flashers

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Turn Signal/Hazard Warning Flasher Switch	32-41-10
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VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

The turn signal/hazard warning flasher switch is located in the upper steering column hub. The turn signal switch is operated by a lever on the LH side of the hub. The hazard warning flasher switch is located on the RH side of the hub. Two flasher units are used, one for the turn signal circuit and the other for the hazard warning flasher circuit.

On E-150—E-350, the turn signal flasher is attached to the lower reinforcement of the instrument panel on the LH side of the steering column (Fig. 1). The hazard warning flasher is taped to the main wiring assembly in the lower LH corner of the instrument panel (Fig. 1) on E-150—E-350. Both the turn signal flasher and the hazard warning flasher are mounted on the fuse panel on F-150—F-350 and Bronco. The turn signal flasher is mounted on the front of the fuse panel, and the hazard warning flasher is mounted on the rear of the fuse panel (Fig. 2).

To operate the turn signals, the ignition switch must be in the RUN position on the F-150—F-350 and Bronco. The ignition switch must be in either the ACC or RUN position to operate the turn signals on E-150—E-350. The hazard warning system is operated independently of the ignition switch by actuating the hazard warning switch.

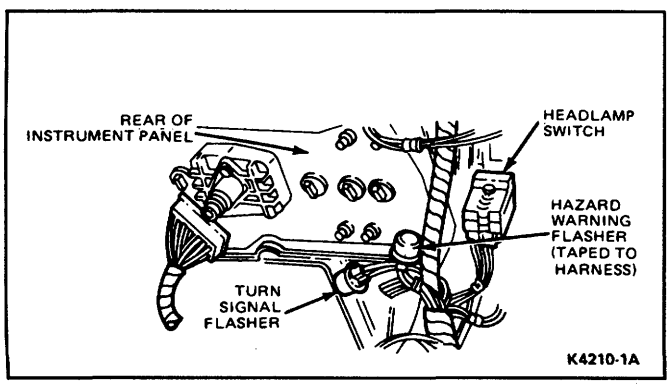


FIG. 1 E-150—E-350 Turn Signal and Hazard Warning Flashers

DIAGNOSIS AND TESTING

Common point diagnosis should be used to isolate or pinpoint the most probable cause of a problem in a multi-load circuit (a circuit with more than one operating component) without making any tests. If one system functions properly but another does not, the problem must be in the part of the circuit unique to the inoperative system. (See Fig. 3).

If more than one circuit does not operate, check for blown fuses. Refer to Section 34-31, Fuses, Circuit Breakers and Fuse Links.

Turn Signal Flasher Power Test

1. Turn ignition switch to RUN position.
2. Connect 12-volt test lamp to a good ground (Fig. 4).
3. For E-150—E-350, contact probe of test lamp to the orange/yellow wire connection at the flasher (Fig. 4). For F-150—F-350, remove flasher from fuse panel and contact probe of test lamp to upper horizontal terminal in fuse panel. If test lamp illuminates, power flow to flasher is good. If test lamp does not illuminate, power is disrupted between flasher and power source. Feed circuit must be repaired.

Turn Signal Switch Power-In Test

1. Turn ignition switch to RUN position.
2. Connect 12-volt test lamp to a good ground (Fig. 5).
3. Contact probe of test lamp to the wire connection at the switch (light blue wire, circuit No. 44) (Fig. 5). If test lamp illuminates, power flow to switch is good. Test lamp should illuminate intermittently due to action of flasher. If test lamp does not illuminate after ten seconds of continuous contact, power flow is disrupted between turn signal flasher and switch. Feed circuit No. 44 (light blue wire) must be repaired, or flasher must be replaced.

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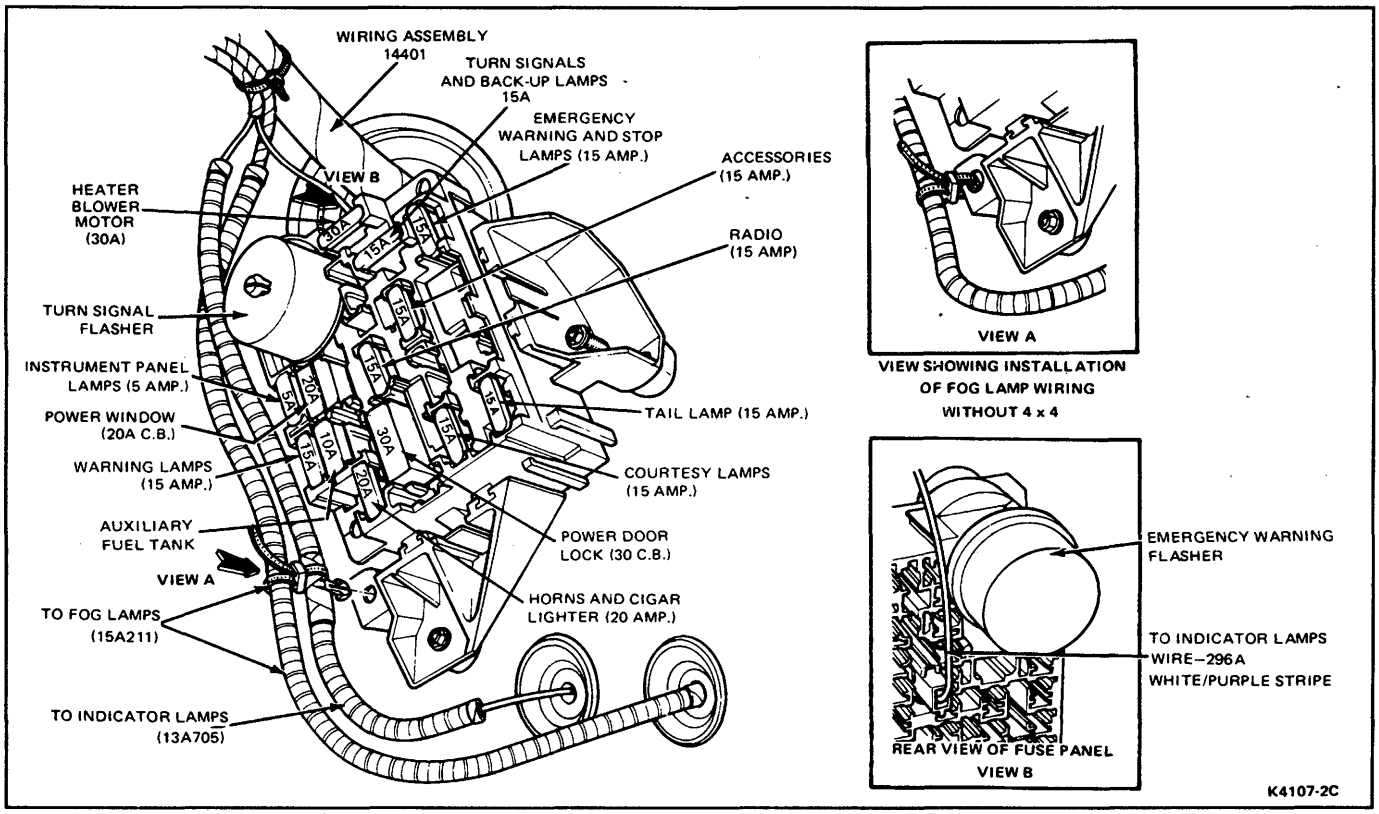


FIG. 2 F-150—F-350 and Bronco Turn Signal and Hazard Warning Flashers

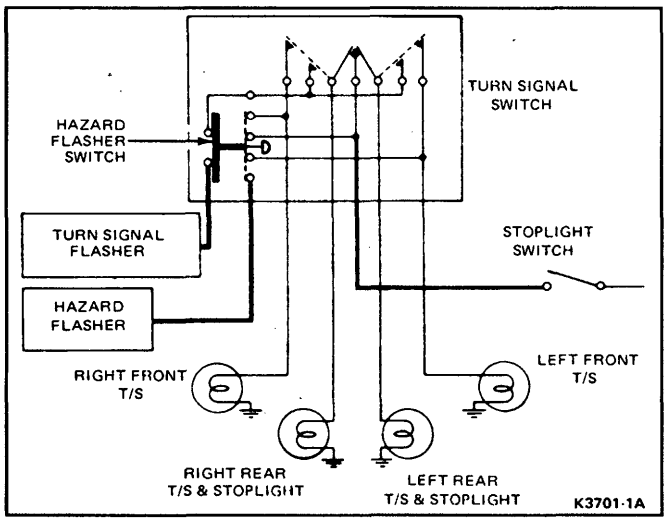


FIG. 3 Circuit Common Points

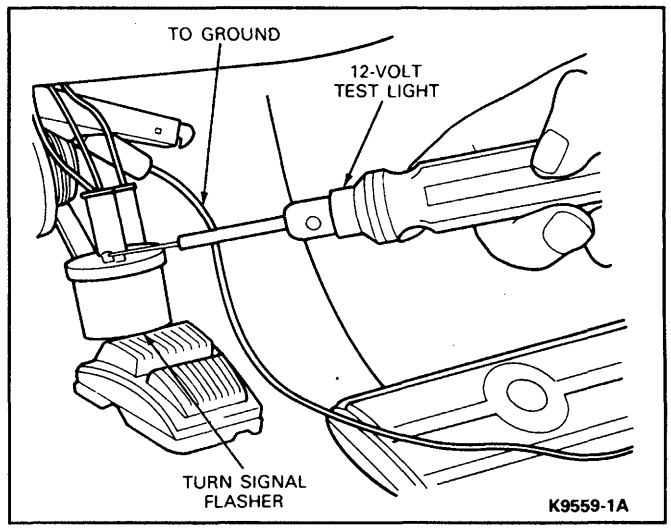


FIG. 4 Turn Signal Flasher Power Test—E-150—E-350

Turn Signal Switch Power-Out Test

1. Turn ignition switch to RUN or ACC position.
2. Position turn signal switch lever to ON position for LH and RH turns as required.
3. Connect 12-volt test lamp to a good ground (Fig. 6).
4. Contact probe of test lamp to the wire connection at the switch (Fig. 6) to check for continuity to the following turn signal lights:

   Left-Front (green wire with white stripe—Circuit No. 3).

   Left-Rear F-150—F-350 (light green wire with orange stripe—Circuit No. 9; E-150—E-350—yellow wire with black stripe—Circuit No. 283).

   Right-Front (white wire with blue stripe—Circuit No. 2).

   Right-Rear F-150—F-350 (orange wire with light blue stripe—Circuit No. 5; E-150—E-350—green wire—Circuit No. 282).

Test lamp should illuminate intermittently, due to action of flasher.

If the continuity through switch is not okay, repair or replace the switch as required.

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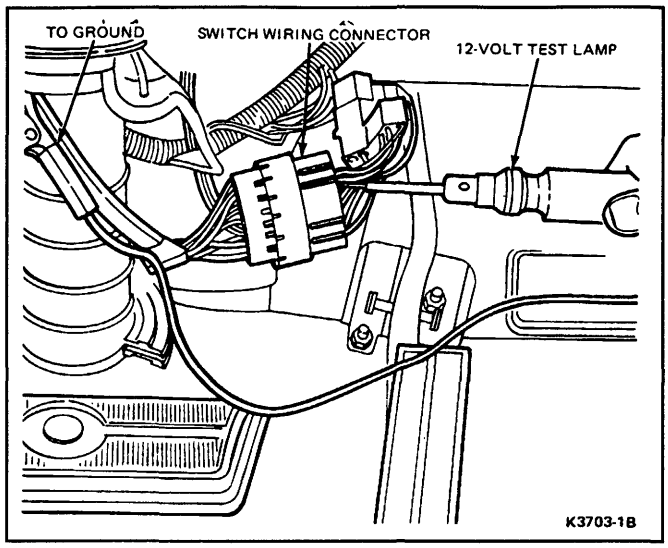


FIG. 5 Turn Signal Switch Power In Test

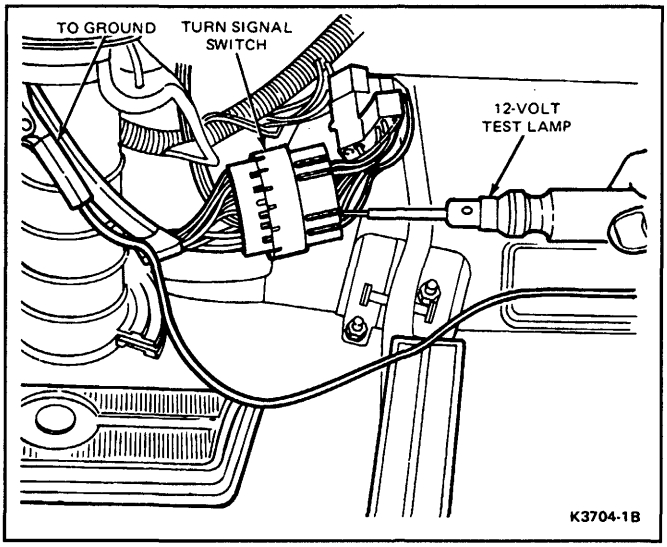


FIG. 6 Turn Signal Switch Power Out Test

It is important to note that the turn signal switch can also be tested by substitution.

Turn Signal Switch Test By Substitution

The turn signal switch can also be checked by plugging a new unit into the main wiring harness (Fig. 7).

Operate the controls to determine if the circuits (including the hazard flasher) function. If not, repair or replace the turn signal switch as necessary.

Bulb Sockets Power Test

1. Turn ignition switch to RUN position.
2. Position turn signal switch lever to ON position for LH or RH turn as required.
3. Connect 12-volt test lamp to a good ground (Fig. 8).
4. Contact probe of test lamp to the wire connection at the bulb socket (Fig. 8) to check for continuity to the following turn signal lamps:

   Left-Front (green wire with white stripe—Circuit No. 3).

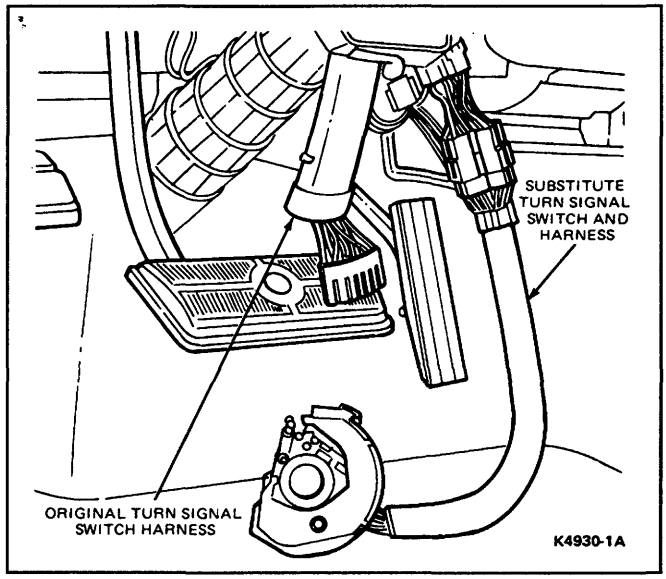


FIG. 7 Signal Switch Test By Substitution

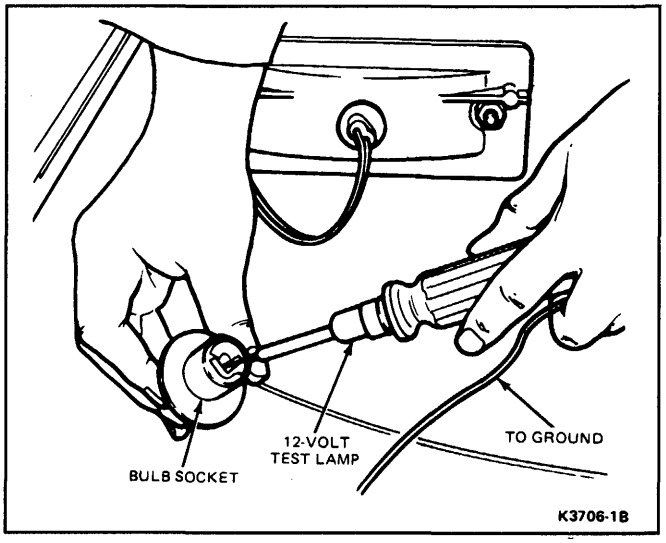


FIG. 8 Bulb Sockets Power Test

   Left-Rear F-150—F-350 (light green wire with orange stripe—Circuit No. 9; E-150—E-350—yellow wire with black stripe—Circuit No. 283).

   Right-Front (white wire with blue stripe—Circuit No. 2).

   Right-Rear F-150—F-350 (orange wire with light blue stripe—Circuit No. 5; E-150—E-350—green wire—Circuit No. 282).

If the continuity to bulb socket is not okay, repair circuit(s) between turn signal switch and lamp sockets.

Bulb Socket Ground Test

1. Turn ignition switch to RUN position.
2. Position turn signal switch lever to ON position for LH or RH turn as required.
3. Connect 12-volt test lamp to ground strap on lamp socket (Fig. 9).
4. Contact probe of test lamp to the wire connection at the lamp socket to check for continuity to ground.

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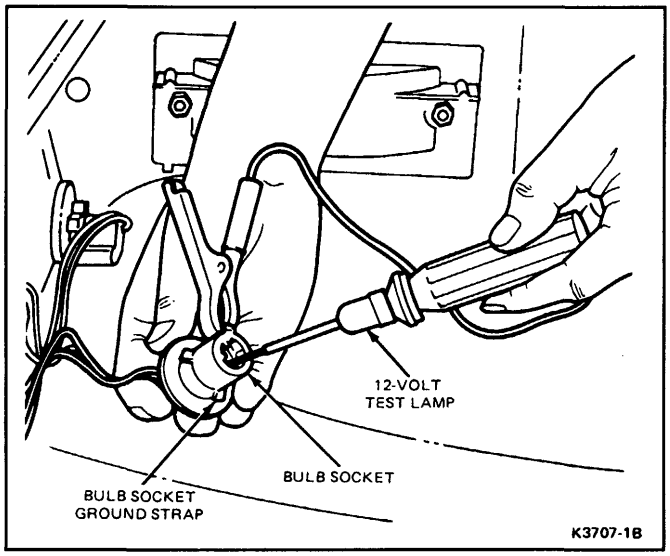


FIG. 9 Bulb Socket Ground Test

If test lamp illuminates, ground is good.

If test lamp does not illuminate, ground circuit is incomplete and must be repaired.

Hazard Warning Flasher Power Test

1. Connect a 12-volt test lamp to a good ground.
2. Contact probe of test lamp to the wire connection at hazard flasher socket (red wire with white—Circuit No. 383). Refer to Figure 10. Hazard warning flasher is taped to windshield wiper/washer wiring behind wiper/washer switch on E-150—E-350. On F-150—F-350 and Bronco the hazard warning flasher is mounted on the fuse panel (Figs. 1 and 2).

   If test lamp illuminates, power flow to hazard warning flasher is good.

   If test lamp does not illuminate, power flow is disrupted between fuse and flasher. Feed circuit (red wire with white stripe—Circuit No. 383) must be repaired.

Hazard Warning Flasher Switch Test In Turn Signal Switch Assembly Power Test

1. Connect a 12-volt test lamp to a good ground (Fig. 11).

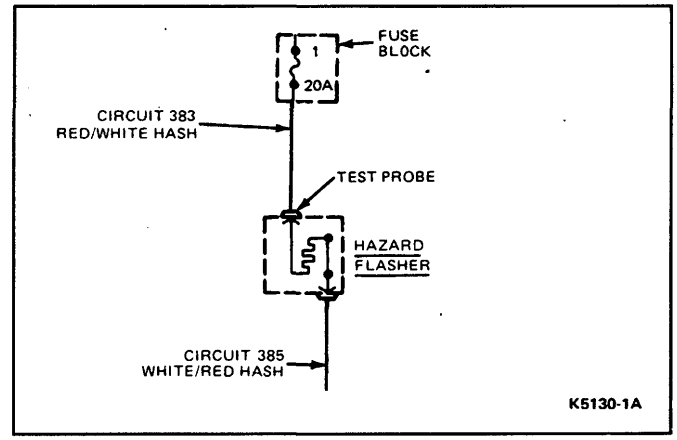


FIG. 10 Hazard Warning Flasher Power Test

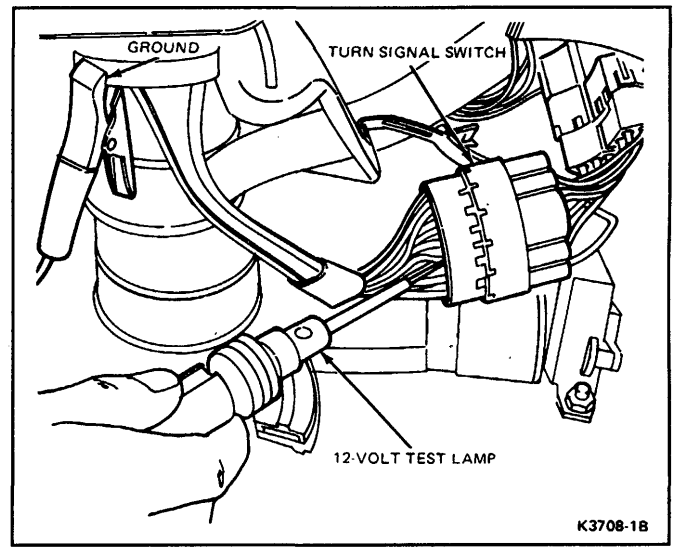


FIG. 11 Hazard Warning Flasher Switch In Turn Signal Switch Assembly Power Test

2. Contact probe of test lamp to the wire connection at the turn signal switch (white wire with red stripe—Circuit No. 385) as shown in Fig. 11.

   If test lamp illuminates, power flow to switch is good.

   If test lamp does not illuminate, power flow is disrupted between the flasher and the switch. Feed circuit (white wire with red stripe—Circuit No. 385), or flasher must be repaired.

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DIAGNOSIS GUIDES

The following Diagnosis Guides can be used with the test procedures described above as an aid when diagnosing the turn signal and hazard warning systems.

TURN SIGNAL LAMPS LIGHT BUT DO NOT FLASH ON BOTH SIDES

TEST STEP		RESULT ▶	ACTION TO TAKE
1.0	VERIFY CONDITION		GO to 1.1.
1.1	DISCONNECT FLASHER		
• Disconnect turn signal flasher. • Turn on signals.		Lamps go out on the side being operated ▶	REPLACE flasher with known good unit. REPEAT test.
		Lamps remain on ▶	CORRECT short in wiring and INSTALL original flasher. REPEAT test.

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TURN SIGNAL LAMPS — ALL LAMPS INOPERATIVE

TEST STEP		RESULT ▶	ACTION TO TAKE
2.0	VERIFY CONDITION		
• Verify the condition making sure hazard warning switch is in the OFF position.		▶	GO to 2.1.
2.1	CHECK FUSE		
• Check operation of a circuit that shares the same fuse — or check fuse.		~~OK~~ ▶	REPLACE fuse. If fuse blows again, CHECK for short circuit(s).
		OK ▶	GO to 2.2.
2.2	CHECK TURN SIGNAL FLASHER		
• Substitute a known good turn signal flasher.		~~OK~~ ▶	GO to 2.3.
		OK ▶	Problem corrected. REPEAT test.
2.3	CHECK POWER TO FLASHER		
• Check for power to the turn signal flasher. F-150 — F-350 and Bronco Circuit No. 298 (P/O). E-150 — E-350 Circuit No. 8 (O/Y).		~~OK~~ ▶	REPAIR feed circuit.
		OK ▶	GO to 2.4.
2.4	CHECK POWER TO SWITCH		
• Check for power to turn signal switch (Lt. Blue wire). Circuit No. 44.		~~OK~~ ▶	REPAIR circuit between turn signal flasher and switch (blue wire). Circuit No. 44.
		OK ▶	GO to 2.5.

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TURN SIGNAL LAMPS — ALL LAMPS INOPERATIVE (Cont'd.)

TEST STEP	RESULT	ACTION TO TAKE
2.5 CHECK TURN SIGNAL SWITCH		
• Connect 12-volt test lamp to a good ground and, with turn signal switch on, check for power out of switch: E-150 — E-350 and F-150 — F-350 LH Front — Circuit No. 3 (GR/W) LH Rear — Circuit No. 283 (Y/BK) RH Front — Circuit No. 2 (W/BK) RH Rear — Circuit No. 282 (GR) Bronco: LH Front — Circuit No. 3 (LG/W) LH Rear — Circuit No. 9 (LG/O) RH Front — Circuit No. 2 (W/LB) RH Rear — Circuit No. 5 (O/LB) **OR**	Switch is (OK) ▶	GO to **2.6.**
• Check the turn signal switch by plugging a new unit into the main wiring harness.	Switch is (OK) ▶	REPAIR or REPLACE turn signal switch.
2.6 CHECK FOR POWER TO SOCKETS		
• Check for power to bulb sockets with turn signal switch on: E-150 — E-350 and F-150 — F-350 LH Front — Circuit No. 3 (GR/W) LH Rear — Circuit No. 283 (Y/BK) RH Front — Circuit No. 2 ((W/BK) RH Rear — Circuit No. 282 (GR)	(OK) ▶	REPAIR circuit(s) between turn signal switch and bulbs.
Bronco: LH Front — Circuit No. 3 (LG/W) LH Rear — Circuit No. 9 (LG/O) RH Front — Circuit No. 2 (W/LB) RH Rear — Circuit No. 5 (O/LB)	(OK) ▶	CHECK all bulbs and assure good ground. REPEAT test.

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TURN SIGNAL LAMPS — ONE OR MORE LAMPS INOPERATIVE

TEST STEP	RESULT	ACTION TO TAKE
3.0 VERIFY THE CONDITION		GO to **3.1**.
3.1 CHECK FOR POWER TO SOCKETS		
• Check for power to bulb socket(s) with turn signal switch on: E-150 — E-350 and F-150 — F-350 LH Front — Circuit No. 3 (GR/W) LH Rear — Circuit No. 283 (Y/BK) RH Front — Circuit No. 2 (W/BK) RH Rear — Circuit No. 282 (GR) Bronco: LH Front — Circuit No. 3 (LG/W) LH Rear — Circuit No. 9 (LG/O) RH Front — Circuit No. 2 (W/LB) RH Rear — Circuit No. 5 (O/LB) NOTE: If one or both of the instrument panel bulbs do not flash, check for power to the bulbs, check the bulb, and/or ground.	⊘K ▶	GO to **3.2**.
	OK ▶	GO to **3.3**.
3.2 CHECK FOR POWER OUT OF SWITCH		
• Connect 12-volt test lamp to a good ground and, with turn signal switch on, check for power out of switch: E-150 — E-350 and F-150 — F-350 LH Front — Circuit No. 3 (GR/W) LH Rear — Circuit No. 283 (Y/BK) RH Front — Circuit No. 2 (W/BK) RH Rear — Circuit No. 282 (GR) Bronco: LH Front — Circuit No. 3 (LG/W) LH Rear — Circuit No. 9 (LG/O) RH Front — Circuit No. 2 (W/LB) RH Rear — Circuit No. 5 (O/LB) **OR**	Switch is ⊘K ▶	REPAIR or REPLACE turn signal switch.
• Check the turn signal switch by plugging a new unit into the main wiring harness.	Switch is OK ▶	REPAIR circuits between switch and bulb socket.
3.3 CHECK FOR GROUND		
• Check for ground to socket.	⊘K ▶	REPAIR socket ground.
	OK ▶	REPLACE bulb.

CK6167-2E

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ONE TURN SIGNAL LAMP DOES NOT LIGHT

TEST STEP		RESULT ▶	ACTION TO TAKE
4.0	VERIFY THE CONDITION		GO to **4.1**.
4.1	CHECK BULB		
	• Check bulb of inoperative turn signal lamp.	OK ▶	REPLACE bulb.
		OK ▶	GO to **4.2**.
4.2	CHECK POWER		
	• Check for power at bulb socket.	OK ▶	REPAIR circuit from socket to turn signal switch.
		OK ▶	SERVICE ground to socket.

CK6751-2A

HAZARD WARNING FLASHER LAMPS DO NOT TURN ON

TEST STEP		RESULT ▶	ACTION TO TAKE
5.0	VERIFY CONDITION		GO to **5.1**.
5.1	CHECK STOPLAMPS		
	• Check stoplamps and turn signal operations.	OK ▶	REFER to turn signal diagnosis to resolve problem and/or SERVICE or REPLACE feed circuit or connections in fuse block or to fuse block.
		OK ▶	GO to **5.2**.
5.2	CHECK CIRCUIT BETWEEN FUSE & FLASHER		
	• Check circuit between fuse and flasher connector, flasher and hazard flasher switch and between hazard flasher switch and bulb feed.	OK ▶	REPAIR circuit wiring as required.
		OK ▶	CHECK hazard flasher switch, or turn signal switch, or turn signal switch assembly. SERVICE or REPLACE as required.

CK6172-2B

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HAZARD WARNING FLASHER LAMPS TURN ON, BUT DO NOT FLASH

TEST STEP		RESULT ▶	ACTION TO TAKE
6.0	VERIFY CONDITION		
			GO to **6.1**.
6.1	CHECK TURN SIGNAL		
	• Check operation of turn signal operation.	(OK) ▶	REFER to turn signal diagnosis to resolve the problem.
		(OK) ▶	GO to **6.2**.
6.2	CHECK POWER TO HAZARD FLASHER		
	• Check for power to the hazard warning flasher. Red wire with white stripe circuit No. 283. • Substitute a known good hazard warning flasher.	(OK) ▶	GO to **6.3**.
		(OK) ▶	Problem corrected.
6.3	CHECK CIRCUIT NO. 385 FOR POWER		
	• Check for power to the hazard warning flasher switch in the turn signal switch assembly. Circuit No. 305 (W/R).	(OK) ▶	SERVICE circuit between hazard warning flasher and switch. Circuit No. 385 (W/R).
		(OK) ▶	GO to **6.4**.
6.4	CHECK FOR POWER OUT OF SWITCH		
	• Connect 12-volt test lamp to a good ground and, with hazard warning flasher switch on, — check for power out of switch: E-150 — E-350 — F-150 — F-350 LH Front — Circuit No. 3 (GR/W) LH Rear — Circuit No. 283 (Y/BK) RH Front — Circuit No. 2 (W/BL) RH Rear — Circuit No. 282 (GR) Bronco: LH Front — Circuit No. 3 (LG/W) LH Rear — Circuit No. 9 (LG/O) RH Front — Circuit No. 2 (W/LB) RH Rear — Circuit No. 5 (O/LB) **OR** Check the hazard warning flasher switch by plugging a new unit into the main wiring harness.	Switch (OK) ▶	SERVICE or REPLACE switch.
		Switch (OK) ▶	SERVICE or REPLACE circuit as required.

CK6173-2F

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REAR HAZARD WARNING FLASHER LAMPS DO NOT LIGHT

TEST STEP		RESULT	ACTION TO TAKE
7.0	VERIFY CONDITION		GO to 7.1.
7.1	CHECK REAR STOPLAMPS		
	• Check rear stoplamps. (Both rear stoplamps should light.)	(OK) ▶	Repair rear stoplamps circuit.
		(OK) ▶	GO to 7.2.
7.2	CHECK TURN SIGNAL LAMPS		
	• Check turn signal lamps. • Check turn signal switch.	Lamps (OK) ▶	Replace switch.
		Switch (OK) ▶	Replace lamp bulbs.

CK6170-2A

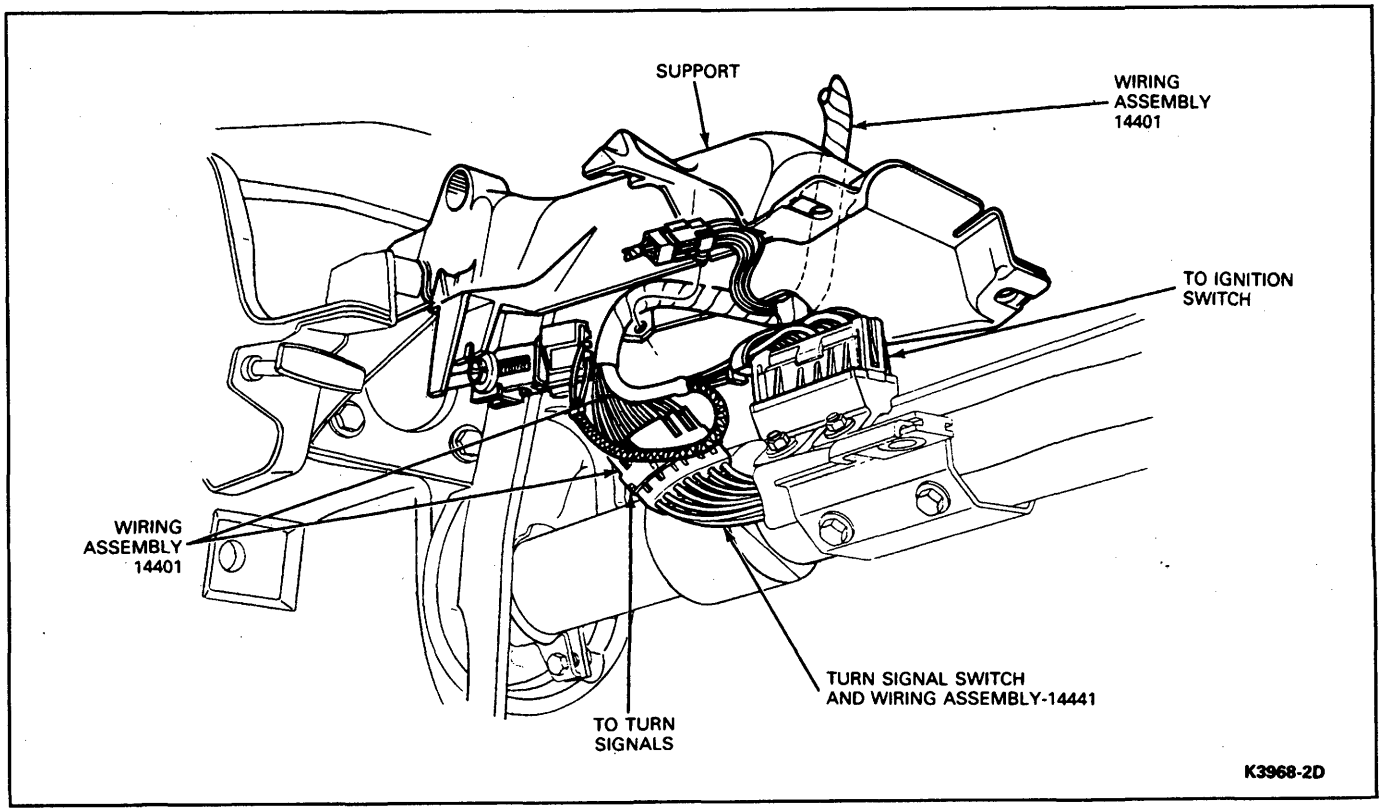


FIG. 12 F-150—F-350, Bronco—Turn Signal Wiring

REMOVAL AND INSTALLATION

Turn Signal/Hazard Warning Flasher Switch

F-150—F-350 and Bronco

Refer to Fig. 12.

Removal

1. Disconnect the battery ground cable.
2. Remove the horn switch.
3. Remove the steering wheel retaining nut. Using Steering Wheel Removal Tool T67L-3600-A or equivalent remove steering wheel from shaft.
4. Remove the turn signal switch lever by unscrewing it from the steering column.
5. Remove the steering column shroud.
6. Disconnect the turn indicator switch wiring connector plug by lifting up on the tabs and separate. Remove the screws that secure the switch assembly to the column.
7. On vehicles with a fixed column, remove the switch assembly from vehicle by lifting it out of the column and guiding the connector plug through the opening in the shift socket.

   Vehicles equipped with tilt columns require removal of the connector plug (Figs. 13 and 14) prior to removing the switch assembly from the column. (The opening in the shift socket provided for the wiring harness is not large enough for the connector to pass through.)

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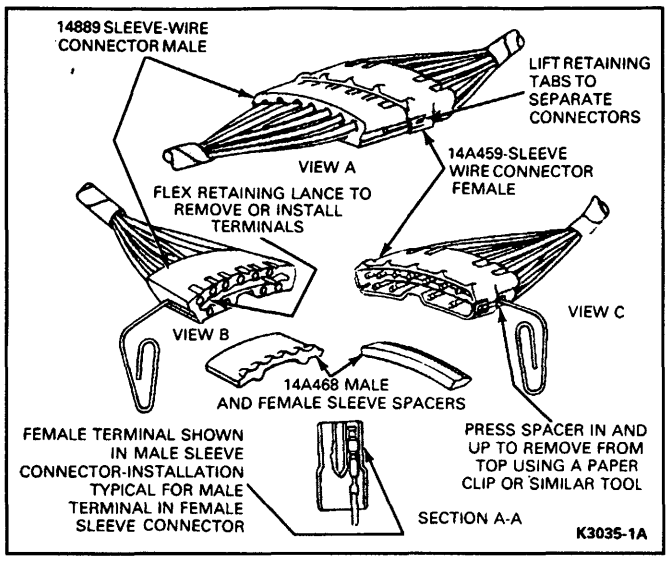


FIG. 13 Wire Connector—Removal

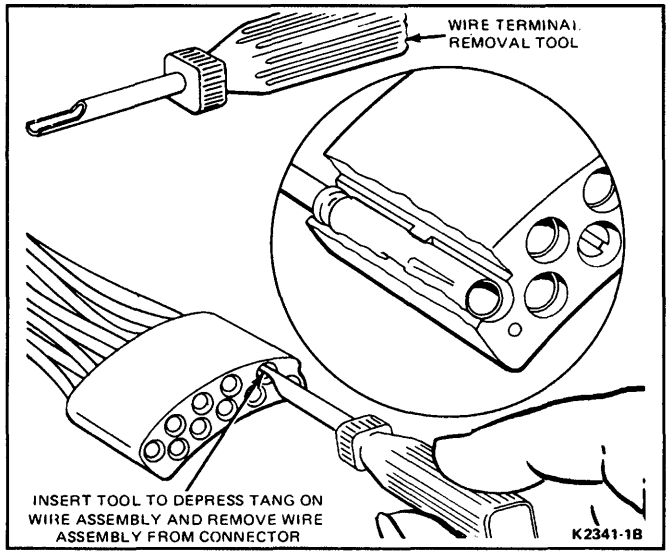


FIG. 14 Wire Terminal Removal—Tilt Only

Installation

1. Guide the turn signal switch wiring harness through the opening provided in the shift socket.
2. Install switch assembly retaining screws to column.
3. Install wires into the steering column connector terminal on vehicles equipped with tilt columns.
4. Plug turn signal switch harness connector into main wiring harness.
5. Install the steering column shroud.
6. Install turn signal lever. Hand tighten the lever (on flat side) to 1.2-2.25 N·m (10-20 in-lb).
7. Install steering wheel and retaining nut. Tighten wheel nut to 41-54 N·m (30-40 ft-lb).
8. Install horn switch.
9. Connect the battery ground cable.

E-150—E-350

Refer to Fig. 15.

Removal

1. Disconnect the battery ground cable.
2. Remove the horn switch.
3. Remove the steering wheel retaining nut. Using Steering Wheel Removal Tool T67L-3600-A or equivalent, remove steering wheel from shaft.
4. Remove the turn signal switch lever by unscrewing it from the steering column.
5. Remove steering column shroud and instrument panel steering column opening cover.
6. Disconnect the turn signal indicator switch wiring connector plug by lifting up on the tabs and separate. Remove the screws that secure the switch assembly to the column.
7. Fixed Column:

   Remove PRNDL lamp assembly from the shift socket on vehicles equipped with an automatic transmission.

   The turn signal switch assembly and PRNDL lamp harness can now be removed from the steering column by lifting out of the column and guiding the connector plug through the openings in the brake and clutch pedal support bracket and the shift socket.

   If the turn signal switch assembly is to be replaced, the connector plug must be disassembled (Figs. 13 and 14) to remove the PRNDL lamp and attaching harness.

   The PRNDL lamp is not serviced with the new turn signal switch assembly and must be reused with replacement turn signal switch assembly.
8. Tilt Column:

   Vehicles equipped with a tilt column require disassembly of the turn signal switch harness plug (Figs. 13 and 14) prior to removal of the switch assembly from the column. (The opening in the shift socket provided for the wiring harness is not large enough for the connector plug to pass through.)

   Vehicles equipped with automatic transmissions also require removal of the PRNDL lamp wire from the turn signal switch harness sheath prior to removal of the switch assembly from the column. The PRNDL lamp harness assembly can remain attached to the column when the turn signal switch is serviced.

   NOTE: The PRNDL lamp used in the tilt automatic transmission column is serviced in the lamp harness assembly. The bulb cannot be serviced separately.

Installation

1. Guide the turn signal switch wire harness through the openings provided in the shift socket and the LH side of the brake and clutch pedal support bracket.
2. On vehicles equipped with an automatic transmission, insert the PRNDL lamp wire into the turn signal switch harness sheath.
3. Install turn signal switch assembly retaining screws.
4. Assemble wires into connector plug on vehicles equipped with tilt column.

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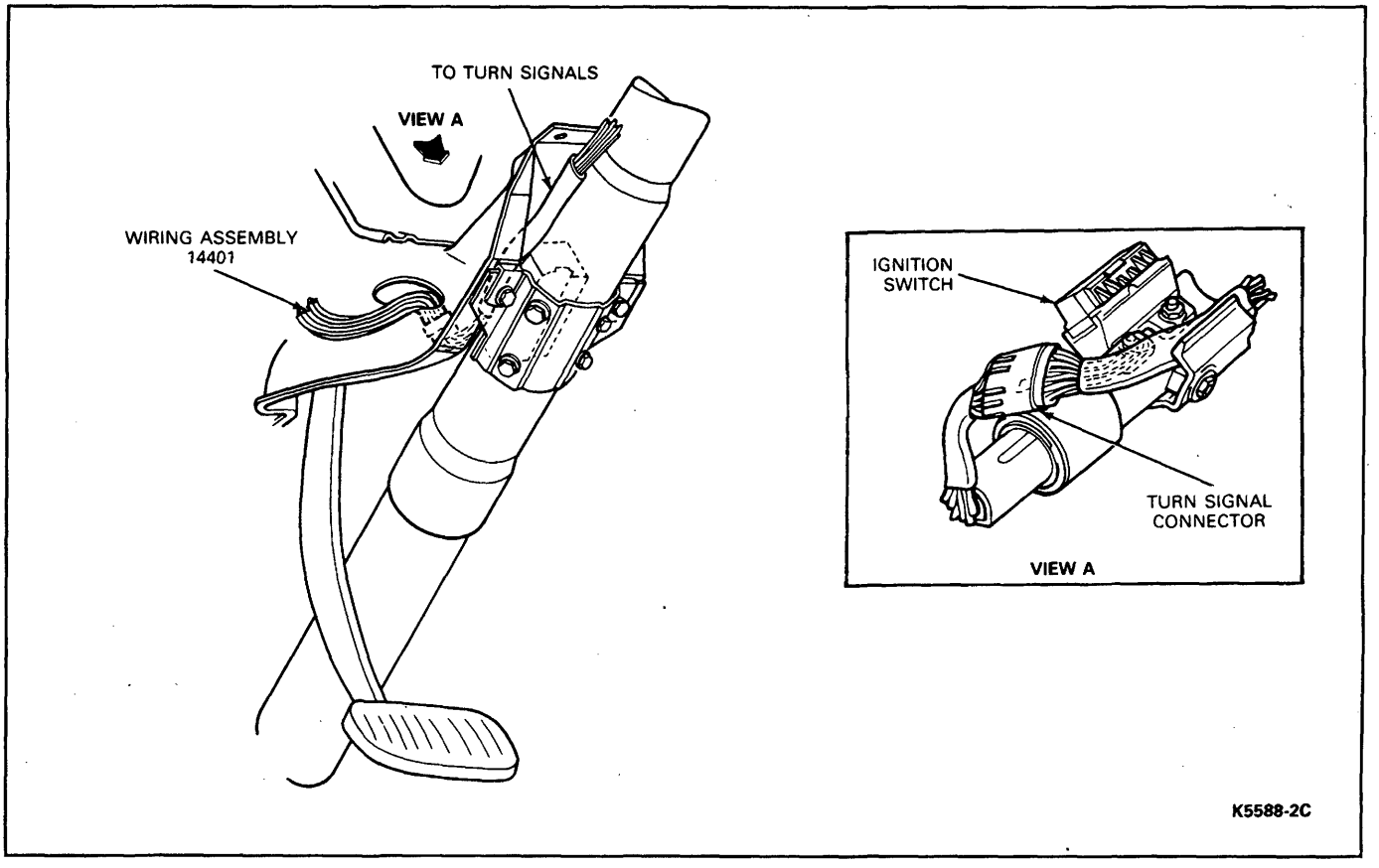


FIG. 15 E-150—E-350—Turn Signal Wiring

NOTE: The color code sequence for this connector does not coincide with the color code of the wires in the harness connector plug. The correct color code sequence is shown in the Wiring Diagram Manual.

5. Plug the switch harness into the main wiring harness. Ensure vinyl sleeve on switch harness covers all harness wires where they pass through the opening in the LH side of the brake and clutch pedal support bracket. If necessary, slide the vinyl sleeve down the switch harness toward the harness connector so that the sleeve protrudes through the opening.
6. Install the turn signal lever. Tighten lever to 1.2-2.25 N·m (10-20 in-lb).
7. Install steering wheel and retaining nut. Tighten wheel nut to 41-54 N·m (30-40 ft-lb).
8. Install horn switch.
9. Install steering column shroud and instrument panel steering column opening cover.
10. Connect battery ground cable.

Flasher Units

Removal and Installation

To remove a flasher unit from F-150-F-350 trucks and Bronco, grasp flasher and pull straight out. To replace flasher, align flasher terminals to fuse panel and push straight in (Fig. 2). For E-150—E-350, twist the flasher unit 90 degrees counterclockwise, remove and disconnect the wiring connector. Install by connecting the connector and inserting the flasher unit into the retaining hole. Twist 90 degrees clockwise (Fig. 1).

When replacing a turn signal flasher unit, ensure the new flasher unit has the same color code and number as the one removed.

NOTE: Do not replace turn signal switch or wiring if:

- Turn signal lamps do not flash on demand with ignition key turned on, and
- Turn signal flasher makes normal pulsing noise, and
- Turn signal lamps prove satisfactory when bench-tested or checked by activating brake stoplamp switch for rear only.

1. Check for power at the turn signal flasher output connector (pulsing noise indicates power is coming into the flasher).
2. If there is **no or very weak power** at the flasher output connector (12-volt test lamp will not light or is dim), **replace the turn signal flasher.**

SPECIAL SERVICE TOOLS

Tool Number	Description
T67L-3600-A	Steering Wheel Removal

CK6196-1B

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SECTION 32-61 Interior Lamps

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VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

Interior Lamps

E-150—E-350

The overhead dome lamp, map-dome lamp, and cargo lamp for E-150—E-350 (Fig. 1) are controlled by the headlamp switch and switches located in the door jams.

The bulbs are energized when the headlamp switch knob is turned fully counterclockwise and also when the door is opened.

Bronco and F-150—F-350

The overhead dome lamp and map-dome lamp are located above the rear window on regular cab F-150—F-350 and is located above the rear of the front seat on Super Cab and Bronco. The bulbs are energized when the headlamp switch knob is turned fully counterclockwise (Figs. 2, 3 and 4).

All models of the F-150 through F-350, Bronco, and Econoline are equipped with door jamb switches which also control the dome lamp (Fig. 5).

The cargo lamp on F-150 through F-350 and Super Cab series is located above the rear window (Fig. 7) and is controlled by the headlamp switch being turned fully counterclockwise.

The cargo lamp and switch for Bronco vehicles is located at the rear left side of the cargo area (Fig. 8).

The engine compartment lamp is located on the bottom center of the hood and is energized when the hood is raised.

The courtesy lamps for the Bronco and F-150 through F-350 are located under the instrument panel on the RH and LH sides (Fig. 6). These lamps are energized by door jamb switches and by turning the headlamp switch fully counterclockwise.

The glove compartment lamp is energized by opening the glove compartment door (Fig. 6).

Dome and Map Lamp Combination—Bronco and F-150—F-350 Super Cabs

The two map lamps are located on each side of the dome lamp housing (Figs. 3 and 4). The map lamps are operated independently of the dome lamp by two switches located at each map lamp housing. The dome lamp is actuated by turning the headlamp switch control knob fully counterclockwise. The dome lamp is also energized by a switch in the pillar when the doors are opened.

Engine Compartment Lamp

E-150—E-250 models may be equipped with an optional engine compartment lamp. The lamp is mounted to the hood in the engine compartment.

REMOVAL AND INSTALLATION

Dome Lamp

Bronco

Carefully pry the dome lamp lens at the corners from the housing (Fig. 3). Remove the two screws retaining the map lamp lens housing to the lamp base and remove the bulbs. To remove the lamp base, remove the four retaining screws. To install, reverse procedure.

F-150—F-350 and E-150—E-350

To replace bulb, snap lens out of lamp body and remove bulb from retainers (Figs. 1 and 2).

To remove lamp body, remove four retaining screws.

To install, position lamp body over screw holes and install four screws. Push on lens to snap into position.

Cargo Lamp

F-150—F-350

To remove the cargo lamp assembly on the F-150 through F-350 Super Cab series trucks, remove the two lens and door retaining screws and remove the lamp assembly (Fig. 8). To install, reverse procedure.

On the E-150—E-350, unsnap the lens, remove the two lamp body attaching screws. Disconnect the wiring assembly and remove the lamp body (Fig. 1). To install, reverse procedure.

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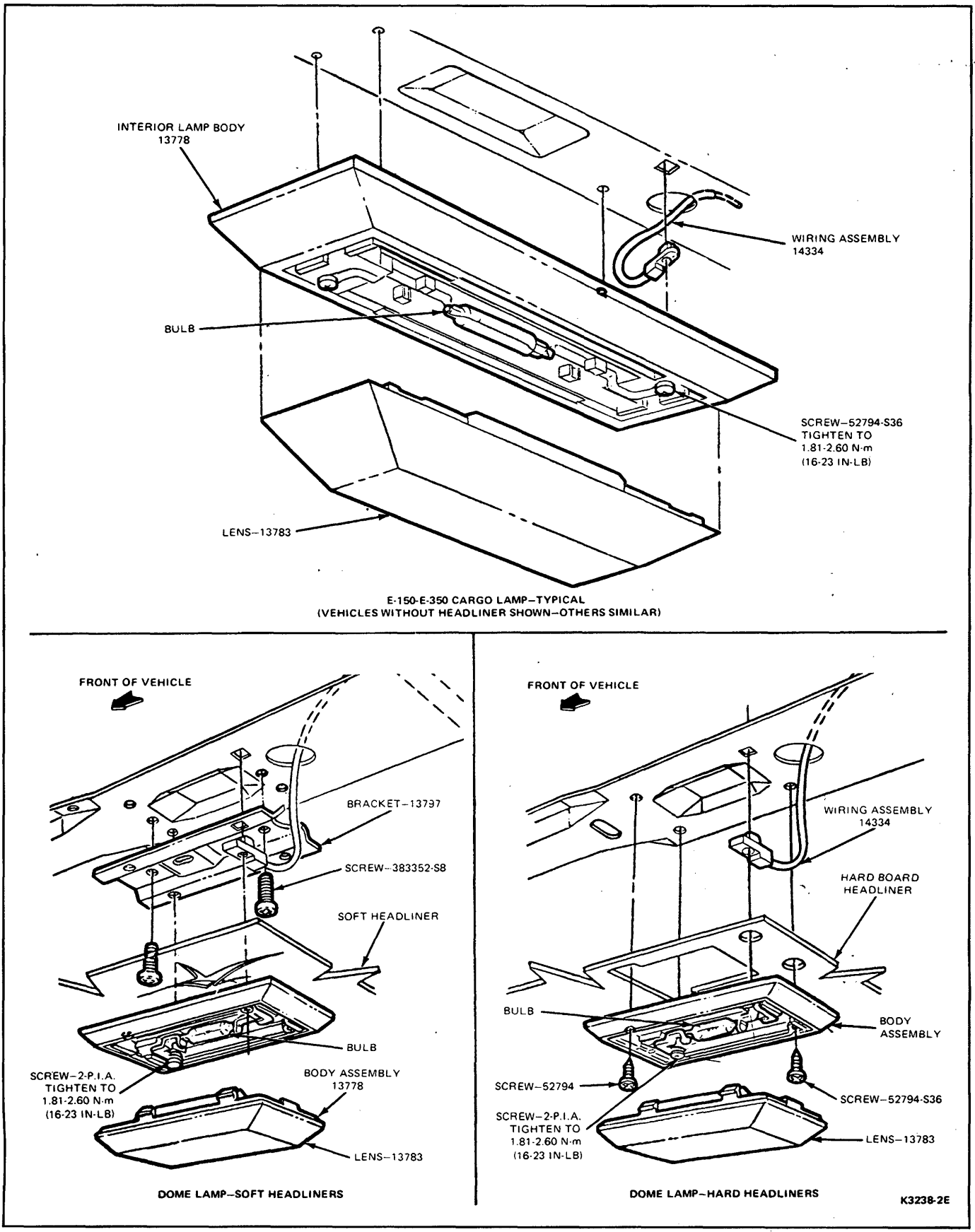


FIG. 1 E-150—E-350 Dome and Cargo Lamp—Typical

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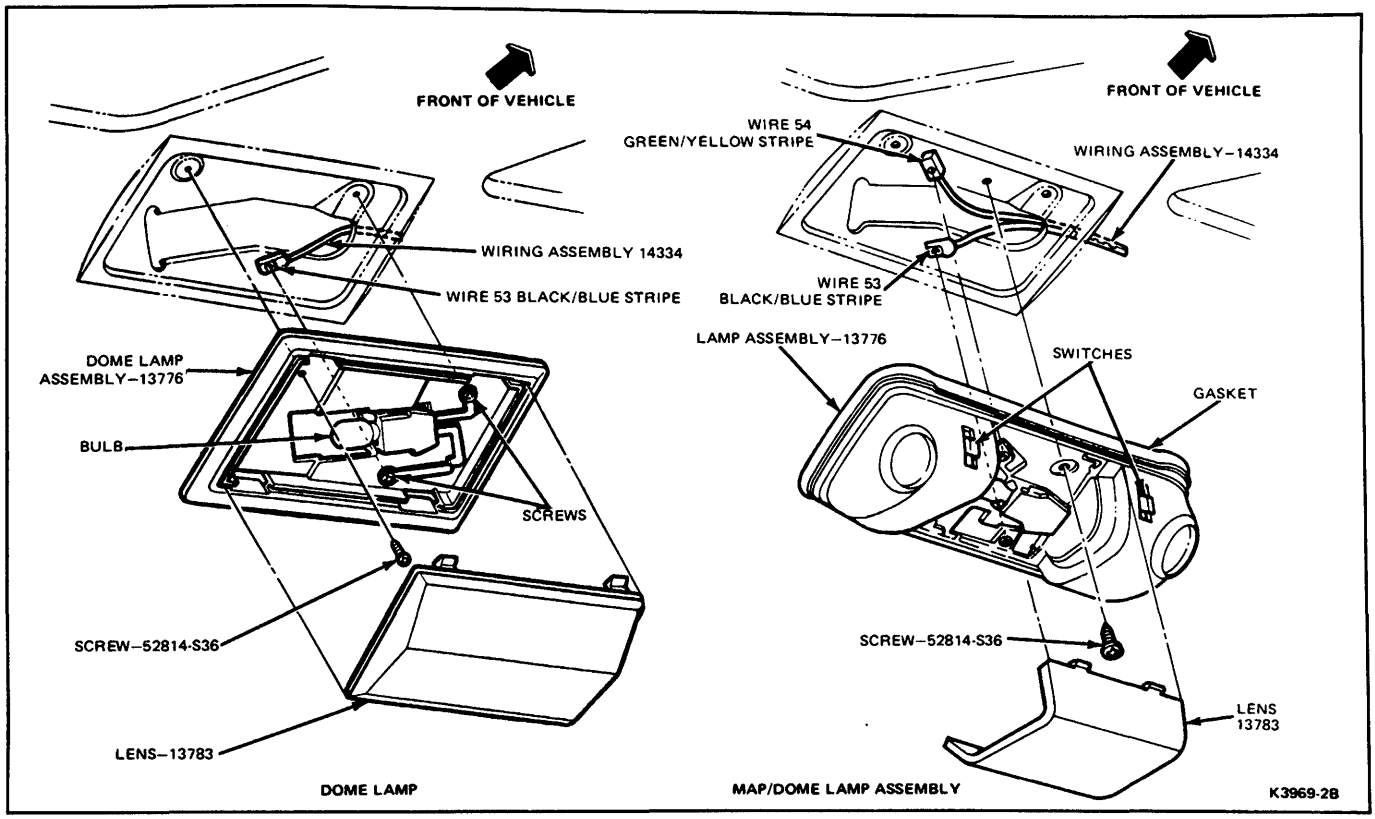


FIG. 2 Map/Dome Lamp—F-150—F-350

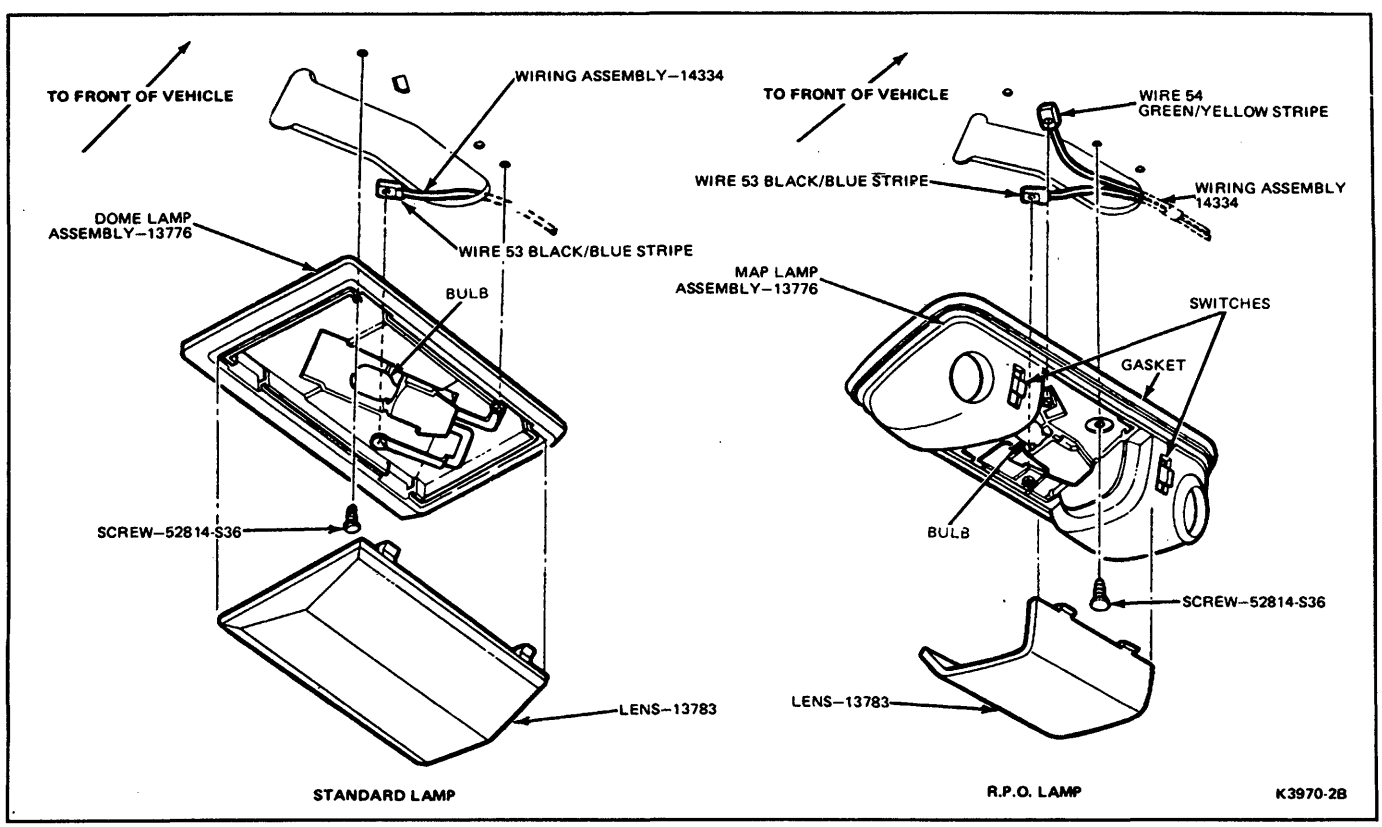


FIG. 3 Map/Dome Lamp—Bronco—Without Headliner Shown

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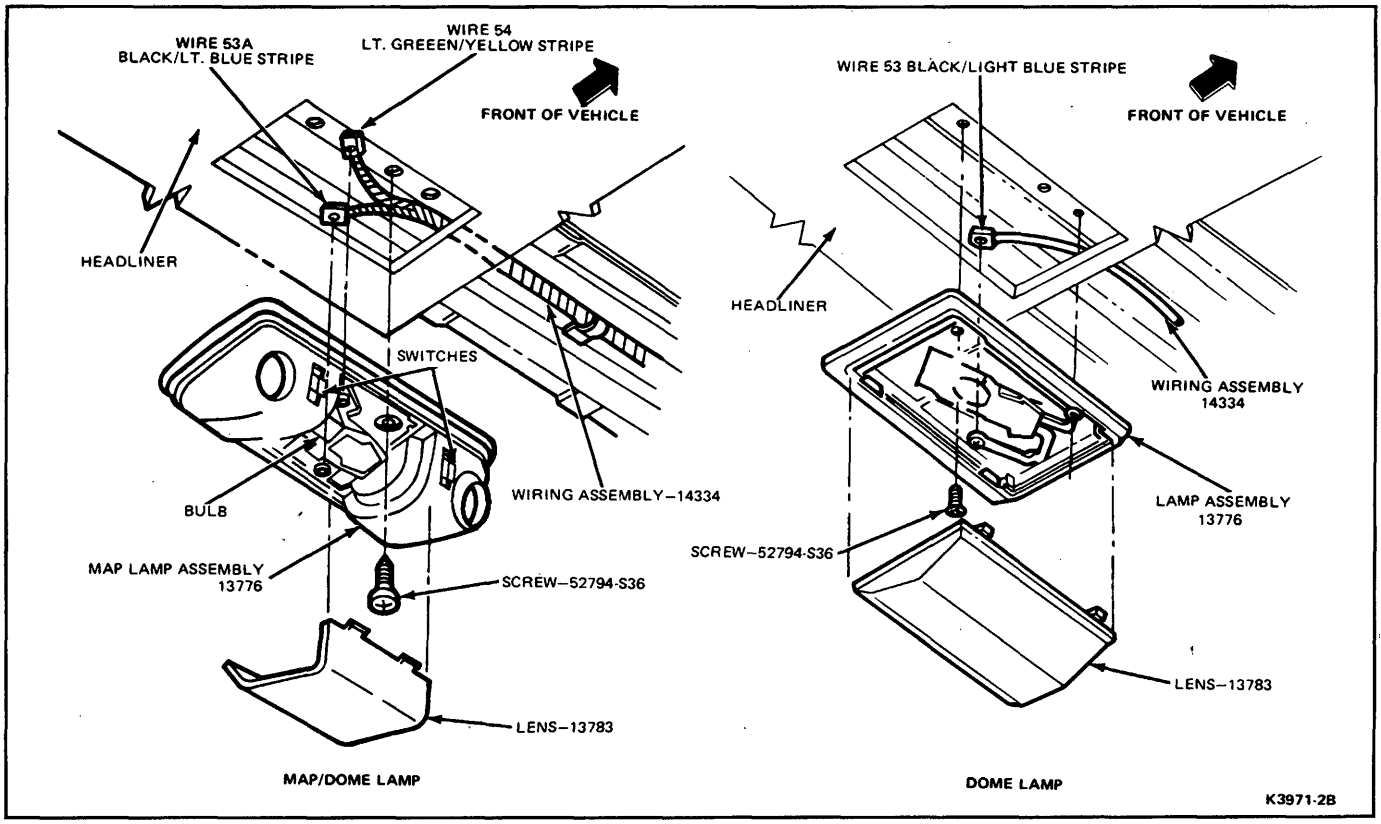


FIG. 4 Map Lamp—F-150—F-350—Super Cab

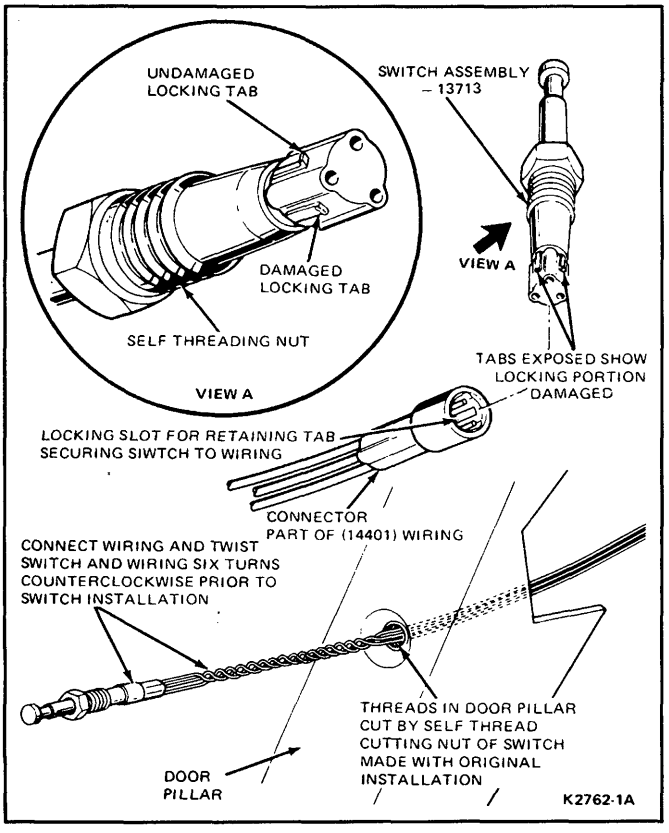


FIG. 5 Courtesy Lamp Switch Installation

Bronco

On Bronco vehicles, carefully unsnap cargo lamp assembly from side of vehicle. Disconnect wiring assembly and remove lamp body (Fig. 8). To install, reverse procedure.

Courtesy Lamp

To remove courtesy lamp on Bronco and F-150 through F-350 vehicles, remove screw securing lamp to bottom of instrument panel. Disconnect electrical connector and remove lamp assembly from vehicle (Fig. 6). To install, reverse procedure.

Courtesy Lamp Switch—Door Jamb

Removal

Unscrew the hex sleeve nut from the pillar. Extract switch and pull the wiring connector off the switch (Figs. 5 and 6).

Retention of courtesy lamp switch to the (14401) wiring connector is by one of three tabs positioned 120 degrees apart on the switch. If, when the switch is disconnected from the wiring connector, the engaged locking tab breaks off, the switch must be rotated 120 degrees to engage a new tab. When all three tabs have been broken, the switch must be replaced (Fig. 5).

Installation

To install the switch in the pillar, pull the wiring connector and wiring through the switch mounting hole in the pillar and connect the switch to the connector (Fig. 5). Then, twist the wiring and switch six turns counterclockwise, push the wiring and connector back through the mounting hole. Screw the switch into the

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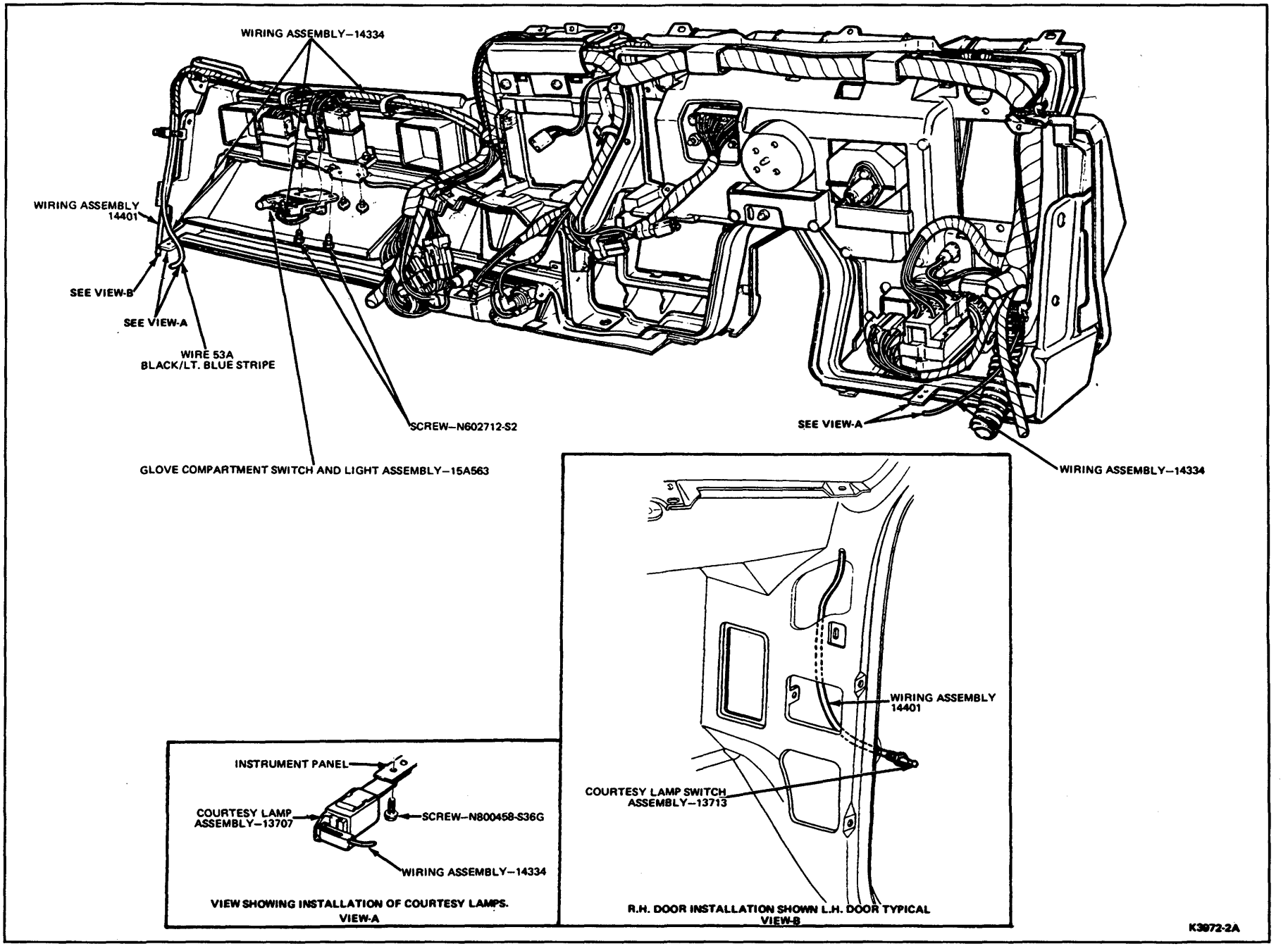


FIG. 6 Bronco and F-150 Through F-350 Courtesy Lamps, Glove Compartment Lamp and Wiring

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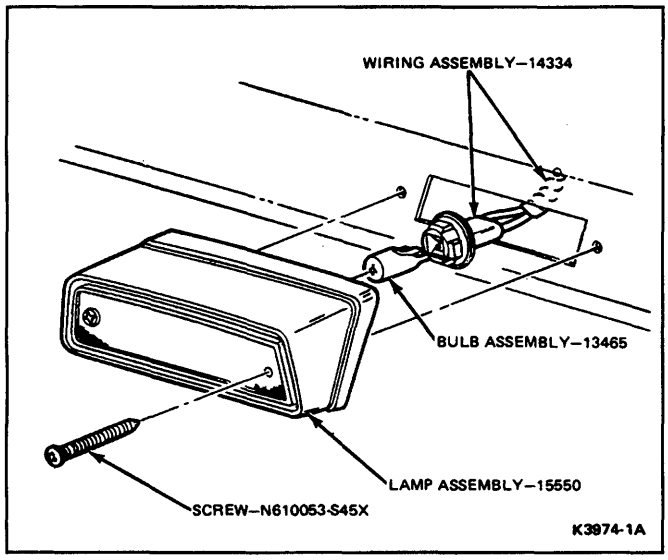


FIG. 7 Cargo Lamp—F-150—F-350 and Super Cab

pillar until it is seated. Close and open the door to ensure the courtesy lamp is operating properly.

Engine Compartment Lamp

E-150—E-250 (Optional)

Bulb replacement requires only removal of the bulb and installation of the new bulb. No lens or door is used on the engine compartment lamp.

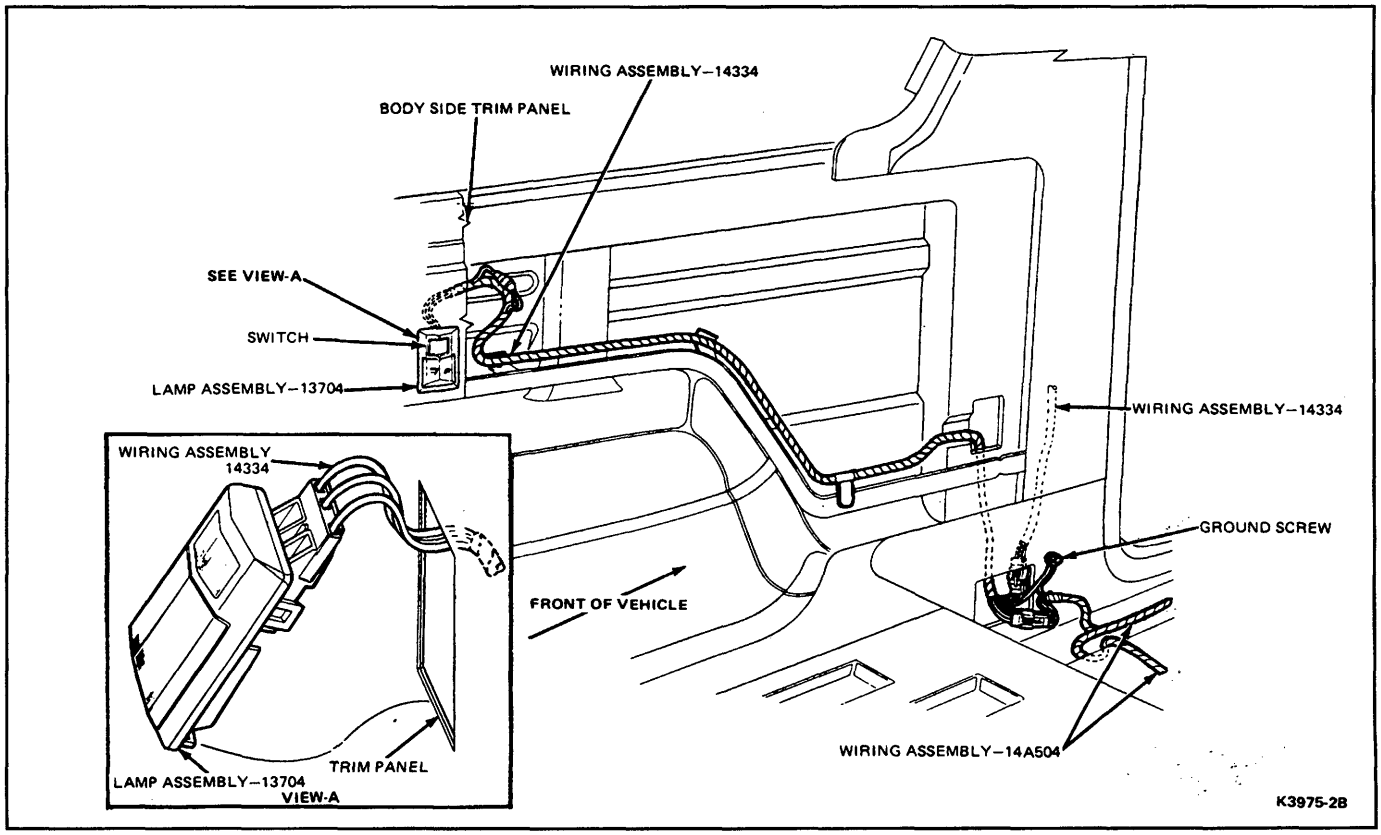


FIG. 8 Cargo Lamp—Bronco

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INSTRUMENTS, CLUSTER AND CONTROLS

GROUP 33

(10000 & 19000)

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VEHICLE APPLICATION

Bronco, F-150 Through F-350 and E-150 Through E-350.

DESCRIPTION AND OPERATION

Speedometer System

The speedometer is connected to the output shaft of the transmission by means of a flexible shaft (core), and a drive gear located inside the transmission. The core drives the speedometer which registers speed in miles per hour (also in kilometers per hour) and also drives an odometer which records distance traveled in miles and tenths of a mile (Figs. 1, 2 and 3). On vehicles equipped with speed control there is a speed sensor attached to the transmission. This is used to sense the revolutions of cable assembly to regulate the speed control (Figs. 2 and 3). Refer to Section 37-01, Speed Control System.

DIAGNOSIS AND TESTING

Speedometer Accuracy Test

To test the odometer accuracy, drive the vehicle over a measured mile. Speedometer accuracy can be checked by comparing the speedometer in question against one known to be accurate, while the two vehicles are moving at th same speed or by timing the vehicle on a measured mile. Refer to the Ford Truck Master Parts Catalog for the proper speedometer gears to use for various rear axle ratio and tire size combinations.

Speedometer

Before removing a speedometer head, if possible, disconnect the cable at the head and insert a short section of cable core in the head. Rotate the section of core to check for any dragging or noise. If the rotation drags, is noisy, or does not turn freely and evenly, replace the speedometer.

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Speedometer Cable and Core

1. Visually inspect the speedometer cable for kinks, cuts, burrs, abrasion or severe bends behind the instrument panel due to the cable being trapped on the brake/clutch pedal support bracket. If evidence of any such damage is observed, replace the speedometer cable.
2. Check the speedometer cable function as follows:
   a. Disconnect the speedometer cable at the speedometer head.
   b. Raise rear wheels, start the engine and check the speedometer core rotation at the meter end.
   c. If the core does not rotate, disconnect the cable from the transmission end.
   d. Twist core. If it will not rotate or is binding, replace the speedometer cable.
   e. Examine the driven gear. A scored, nicked or gouged driven gear is usually indicative of a damaged drive gear on those vehicles that have the driven gear integral with the transmission output shaft. The output shaft should be carefully inspected for imperfections and replaced if necessary. A driven gear with two or three adjoining teeth badly scored is indicative of improper assembly procedure. The gear should be inserted in the transmission while simultaneously turning the drive shaft. This will ensure initial engagement and prevent gear damage. Force should never be used. Whenever a drive gear is replaced, a new driven gear should also be installed regardless of its apparent condition.
   f. Examine the core tip for breaking or fraying. If damaged, replace.

Speed Sensor

Removal

1. Separate the electrical connector to the speed sensor on the transmission and transfer case.
2. Disconnect speedometer cable from speed sensor.
3. Remove retaining screw/nut.
4. Remove speed sensor.
5. Remove drive gear.

Installation

1. Install drive gear on speed sensor as identified in Figs. 1 and 2, View W.
2. Install speed sensor in transmission/transfer case.
3. Install retaining screw/nut.
4. Connect speedometer cable.
5. Connect electrical connector.

DIAGNOSIS GUIDES

If the speedometer is noisy, erratic, inoperative or inaccurate, refer to the following Diagnosis Guides.

REMOVAL AND INSTALLATION

Speedometer Head

F-150 Through F-350, Bronco and E-150—E-350 (Figs. 1, 2 and 3)

Removal

1. Remove instrument cluster. Refer to Section 33-51, Instrument Cluster and Printed Circuit.
2. Remove lens and mask from the cluster. Remove two speedometer attaching screws and remove speedometer cable (Fig. 4).
3. Remove speedometer.

Installation

Position the speedometer to the back plate and install the two attaching screws. Install the mask and lens, then the instrument cluster. If a new speedometer is being installed, examine the square drive hole for sufficient lubrication. If lubrication is needed, apply a 4.8mm (3/16 inch) diameter dab of Silicone Grease per Ford Specification ESF-M1C134-A or equivalent, in the drive hole. Connect speedometer cable as outlined.

Speedometer Cable 17260

Econoline E-150 Through E-350

Removal

1. Raise vehicle on a hoist.
2. Disengage speedometer cable clamp and remove cable assembly from transmission (Fig. 3).

   NOTE: On vehicles equipped with a transmission-mounted speed sensor, remove the speedometer cable by pulling it out of the speed sensor. Do not attempt to remove the spring retainer clip with the speedometer cable in the sensor. To install the speedometer cable, align the core with the sensor and snap cable assembly into the speed sensor.
3. Disengage all remaining cable clips.
4. Push cable and grommet through floorpan opening into cab (Fig. 3).
5. Remove screw holding cable clip to brake and clutch pedal support.
6. Disconnect speedometer cable from speedometer (Fig. 4).

Installation

1. Connect speedometer cable to speedometer head (Fig. 4).
2. Route cable through floorpan opening.
3. Attach cable clip to brake and clutch pedal support.
4. Press grommet into floorpan opening.
5. Raise vehicle on a hoist.
6. Lubricate cable core exposed at transmission ferrule with Speedometer Cable Lubricant D2AZ-19581-A (ESF-M1C160-A) or equivalent.
7. Apply a coating of Ford Polyethylene Grease D0AZ-19584-A (ESR-M1C159-A) or equivalent, to O-ring on ferrule.
8. Lubricate ID and teeth of driven gear with Speedometer Cable Lubricant D2AZ-19581-A

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SPEEDOMETER IS NOISY

TEST STEP		RESULT ▶	ACTION TO TAKE
1.0	DURING CHECKOUT SPEEDOMETER IS NOISY		
1.1	CHECK CONNECTIONS		
	• Check quick connect speedometer head for proper attachment. Make sure cable is connected and nuts are tight and not cross threaded.	All connections are good ▶	GO to **1.2**.
		One or more connections bad ▶	REPAIR or REPLACE bad connection. RECHECK for noise.
1.2	VERIFY CONDITION WITH ENGINE RUNNING IN NEUTRAL		
	• With engine running and vehicle in neutral, check for noise.	Noise is still present ▶	CHECK for other cause of vehicle noise.
		Noise is not present ▶	GO to **1.3**.
1.3	CHECK SENSOR		
	• Check sensor for erratic or noisy operation.	Sensor OK ▶	GO to **1.4**.
		Sensor not OK ▶	REPLACE sensor. RECHECK system for noise.
1.4	CHECK CABLE (IF APPLICABLE)		
	• Check cable for any kinks or bends.	Cable is OK ▶	GO to **1.5**.
		Cable is not OK ▶	If kinks are severe, REPLACE cable. For minor bends, ADJUST cable routing to obtain generous curves and RECHECK for proper connection.
1.5	CHECK CORE		
	• Disconnect cable and check core for kinks, burrs or bent tips.	Core is not OK ▶	REPLACE core. RECHECK system for noise.
		Core is OK ▶	GO to **1.6**.
1.6	LUBRICATE SHAFT END		
	• Put daub of lube on end of shaft.	Noise remains ▶	GO to **1.7**.
		Noise is gone ▶	Condition corrected.
1.7	CHECK GEAR(S)		
	• Check for damaged or worn driven gear(s).	Gear(s) are good ▶	REPLACE speedometer head. RECHECK system.
		Damaged gear(s) ▶	REPLACE gear(s) as required. RECHECK system.

CK5319-2C

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SPEEDOMETER IS ERRATIC OR POINTER WAVERS

TEST STEP	RESULT	ACTION TO TAKE
2.0 DURING CHECKOUT, SPEEDOMETER ACTS ERRATICALLY OR POINTER WAVERS		
2.1 CHECK CONDITIONS • Check quick connect is properly attached at speedometer head. Make sure cable is connected and nuts are tight and not cross-threaded at the speed sensor, if applicable.	All connections are good ▶ One or more connections are bad ▶	GO to **2.2.** REPAIR or REPLACE bad connections. RECHECK for erratic or wavering pointer.
2.2 CHECK CABLE • Check speedometer cable for kinks or bends in the routing. • While cable is disconnected at transmission, check drive tip square for wear.	Cable and drive tip (OK) ▶ (OK) ▶	GO to **2.3.** If kinks are severe, REPLACE cable. For minor bends, ADJUST cable routing to obtain generous curves, and RECHECK for proper connection. If drive tip is worn, REPLACE cable.
2.3 CHECK DRIVEN GEAR • Check driven gear for damage, wear or use of incorrect parts.	(OK) ▶ (OK) ▶	REPLACE driven gear. RECHECK speedometer. GO to **2.4.**
2.4 CHECK CORE • Disconnect cable and check core for kinks, burrs, or bent tips.	(OK) ▶ (OK) ▶	REPLACE core. RECHECK speedometer. GO to **2.5.**
2.5 CHECK CORE (CONTINUED) • Reinstall core and turn by hand to feel for rough or irregular motion.	(OK) ▶ (OK) ▶	REPLACE core. RECHECK speedometer. REPLACE speedometer head. RECHECK speedometer.

CK6786-2C

(ESF-M1C160-A) or equivalent. Install driven gear on ferrule.

9. Assemble driven gear retainer to driven gear with retainer tabs toward gear teeth (Fig. 3).
10. Insert driven gear and cable into transmission. Retain by tightening retaining screw to 2.25-2.82 N·m (20-25 in-lb).
11. Secure cable with clips/clamps at locations indicated by tape on cable.

    NOTE: The speedometer cable routing should avoid sharp bends; the cable should be straight for approximately 203mm (8 inches) from speedometer.
12. Lower vehicle.

Speedometer Cable 17260

F-150 Through F-350 and Bronco

Removal,

1. Raise vehicle on a hoist.
2. Disengage speedometer cable clamp and remove cable assembly from transmission (Figs. 1 and 2).
3. Disengage all remaining cable clips.
4. Remove screw holding cable clip to steering column bracket.

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SPEEDOMETER IS INOPERATIVE

TEST STEP		RESULT ▶	ACTION TO TAKE
3.0	DURING CHECKOUT, SPEEDOMETER IS INOPERATIVE		
3.1	CHECK CONNECTIONS		
	• Check quick connect is properly attached at speedometer head. Make sure cable is connected and nuts are tight and not cross-threaded. • Check drive tip at transmission end of cable to make sure it is properly seated in driven gear. • Check drive gear and driven gear for damage or wear.	All connections are good ▶ One or more connections are bad or drive tip not seated properly ▶	GO to 3.2. REPAIR tighten sensor or REPLACE bad connections. RECHECK to see if speedometer is now operative.
3.2	CHECK ODOMETER		
	• Check operation of odometer.	Odometer is operating ▶ Speedometer pointer operates but odometer does not operate ▶ If both odometer and speedometer pointer fail to operate ▶	REPLACE speedometer head. RECHECK speedometer for operation. REPLACE speedometer head. RECHECK speedometer for operation. GO to 3.3.
3.3	CHECK SPEEDOMETER HEAD		
	• Disconnect cable and check that magnet shaft in speedometer head turns freely by rotating with a short section of cable core.	(OK) ▶ (OK) ▶	REPLACE speedometer head. RECHECK speedometer for operation. GO to 3.4.
3.4	CHECK GEARS		
	• Check cable drive tip at transmission for wear.	Drive gear, drive tip, or driven gear damaged ▶ Drive gear, driven gear, and drive tip okay ▶	REPLACE damaged or worn gear or cable. RECHECK speedometer for operation. GO to 3.5.
3.5	CHECK CABLE		
	• Check speedometer cable for kinks or improper routing.	(OK) ▶ (OK) ▶	REPLACE cable. RECHECK speedometer for operation. GO to 3.6.

CK6787-2C

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SPEEDOMETER IS INOPERATIVE (Continued)

TEST STEP	RESULT	ACTION TO TAKE
3.6 CHECK SPEED SENSOR • Disconnect cable from speed sensor and check that shaft in sensor turns freely.	(OK) ▶	REPLACE speed sensor. RECHECK speedometer for operation.
	(OK) ▶	GO to **3.7**.
3.7 CHECK CORE • With cable disconnected, check core.	Core is damaged ▶	REPLACE core. RECHECK speedometer for operation.
	Core will not turn ▶	REPLACE cable. RECHECK speedometer for operation.

CK6742-2B

5. Push cable and grommet through floorpan opening into cab. (Figs. 1 and 2).
6. Disconnect speedometer cable from speedometer (Fig. 4). Requires cluster removal.

   NOTE: On vehicles equipped with transmission-mounted speed sensor, remove speedometer cable by pulling it out of the speed sensor. Do not attempt to remove the spring retainer clip with the speedometer cable in the sensor. To install the speedometer cable, align the core with the sensor and snap cable assembly into the speed sensor.

Installation

1. Select proper cable for vehicle, engine, and transmission as identified in the Truck Chassis Installation Manual.
2. Route cable through floorpan opening.
3. Connect speedometer cable to speedometer head (Fig. 4).
4. Attach cable clip to steering column bracket.
5. Press grommet into floorpan opening.
6. Raise vehicle on hoist.
7. Lubricate cable core exposed at transmission ferrule with Speedometer Cable Lubricant D2AZ-19581-A (ESF-M1C160-A) or equivalent.
8. Apply a coating of Ford Polyethylene Grease D0AZ-19584-A (ESB-M1C93-A) or equivalent to O-ring on ferrule.
9. Lubricate ID and teeth of driven gear with Speedometer Cable Lubricant D2AZ-19581-A or equivalent, and install driven gear on ferrule.
10. Assemble driven gear retainer to driven gear with retainer tabs toward gear teeth (Figs. 1 and 2).
11. Insert driven gear into transmission. Retain by tightening retaining screw to 2.25-2.82 N·m (20-25 in-lb) on F-150—F-350 and Bronco.
12. Secure cable with clips/clamps at locations indicated by tape on cable.
13. Lower vehicle.

    NOTE: The speedometer cable routing should avoid sharp bends; the cable should be straight for approximately 203mm (8 inches) from speedometer.

Speedometer Core—17262

E-150—E-350, F-150—F-350 and Bronco

Refer to Figs. 1, 2 and 3.

Removal

1. Disconnect speedometer cable (core and casing assembly) from speedometer head.
2. Pull speedometer core out of upper end of casing.
3. If core is broken, raise vehicle on a hoist and remove screw retaining speedometer cable clamp to transmission.
4. Remove conduit and ferrule assembly and driven gear from transmission. Remove driven gear retainer, and remove driven gear and shaft from cable.
5. Remove lower part of core (if it is broken) from lower end of casing.

Installation

1. Position driven gear to casing and install gear retainer. Install driven gear and casing in transmission, and install retaining screw. Lower vehicle.
2. Using Motorcraft Core Repair Kit or equivalent, determine exact length of old core and cut new core so that it is 20.6mm (13/16 inch) shorter than old core. (Do not cut from squared end of core.) Remove any burrs or frayed edges.
3. Install tip on core, making certain to seat core in bottom of tip.
4. Place core and tip in a crimping die. Place die on a solid surface and strike it squarely with a hammer to crimp it.
5. Remove crimping die.

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SPEEDOMETER IS INACCURATE

TEST STEP		RESULT ▶	ACTION TO TAKE
4.0	DURING CHECK-OUT SPEEDOMETER REGISTERS AN INACCURATE READING		
4.1	CHECK CONNECTIONS		
	• Check quick connect is properly attached at speedometer head. Make sure cable is connected and nuts are tight and not cross threaded.	All connections are good ▶	GO to **4.2.**
		One or more of the connections are bad ▶	REPAIR or REPLACE as necessary. RE-CHECK for accuracy.
4.2	CHECK ODOMETER		
	• Check accuracy of odometer. • If odometer is accuarate, calibration of speedometer may be off. Changing the head may correct, but going on to change either gear will make speedometer reading more accurate, but now odometer will not be accurate.	Odometer is accurate ▶	REPLACE speedometer head. RE-CHECK for speedometer accuracy.
		Odometer is inaccurate ▶	GO to **4.3.**
4.3	CHECK DRIVEN GEAR		
	• Check for proper driven gear. • If odometer is accurate, calibration of speedometer may be off. Changing the head may correct but going on to change either gear will make speedometer reading more accurate, but now odometer will not be accurate.	Driven gear improper. ▶	REPLACE gear with correct gear. RE-CHECK for accuracy.
		Proper driven gear ▶	GO to **4.4.**
4.4	CHECK DRIVE GEAR AXLE, TIRES, AND CORRECTOR		
	• Check for proper drive gear, axle, tires and corrector.	Drive gear, axle, tires and corrector are correct. ▶	REPLACE speedometer head. RE-CHECK for accuracy.
		Drive gear, axle, tires or corrector are not correct ▶	REPLACE incorrect component or driven gear. RE-CHECK for accuracy.

CK5323-2B

6. Lubricate core with Speedometer Cable Lubricant D2AZ-19581-A (ESF-M1C160-A) or equivalent (do not over-lubricate). Install core (square end first) into upper end of casing and push it all the way through to transmission. When cable is nearly seated, twist it slightly to make sure that square end is engaged in speedometer driven gear at transmission.
7. Connect cable assembly to speedometer, being sure to eliminate any kinks in housing and shaft. Check operation of speedometer.

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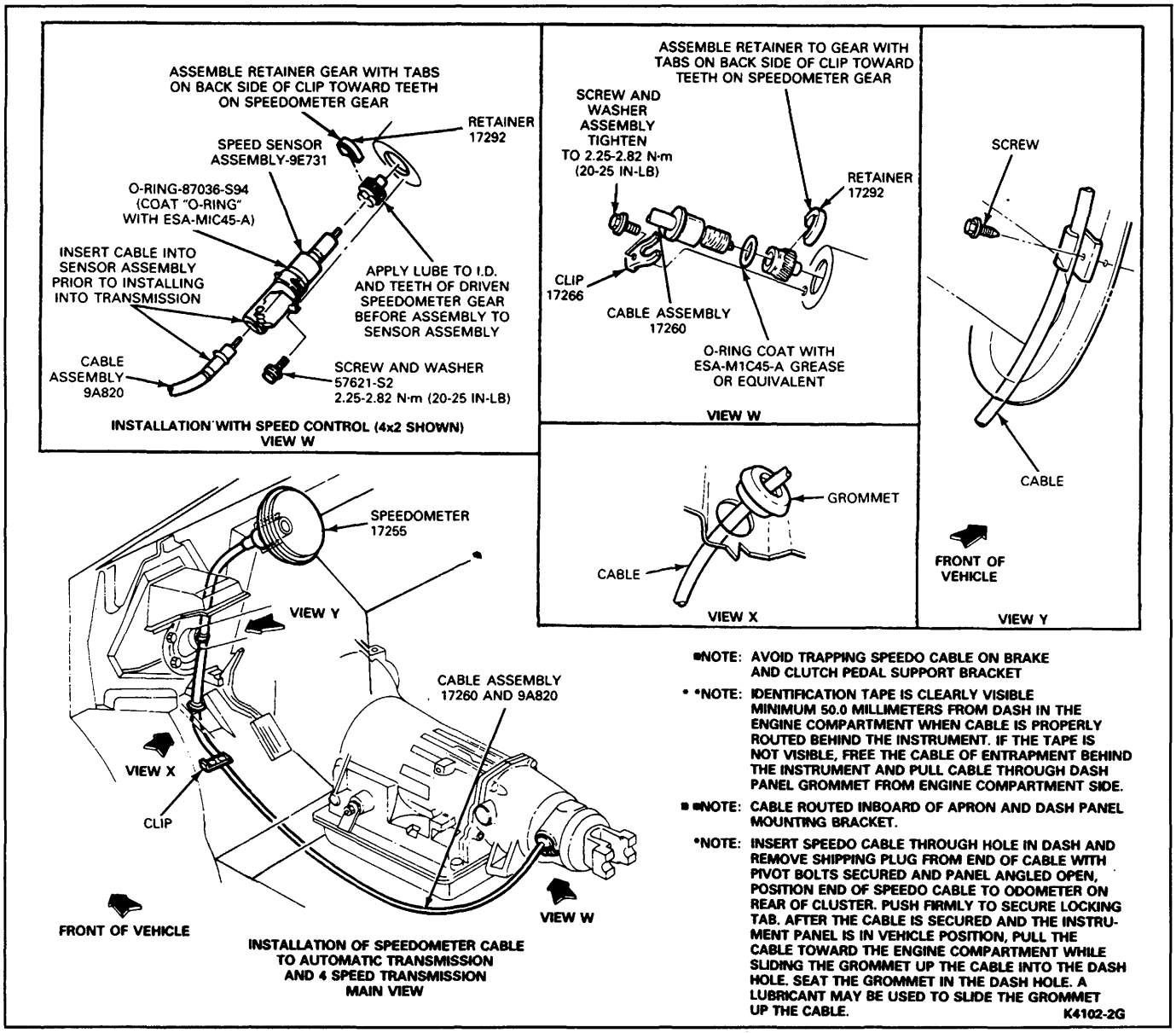


FIG. 1 F-150—F-350 (4x2) Speedometer Cable Installation

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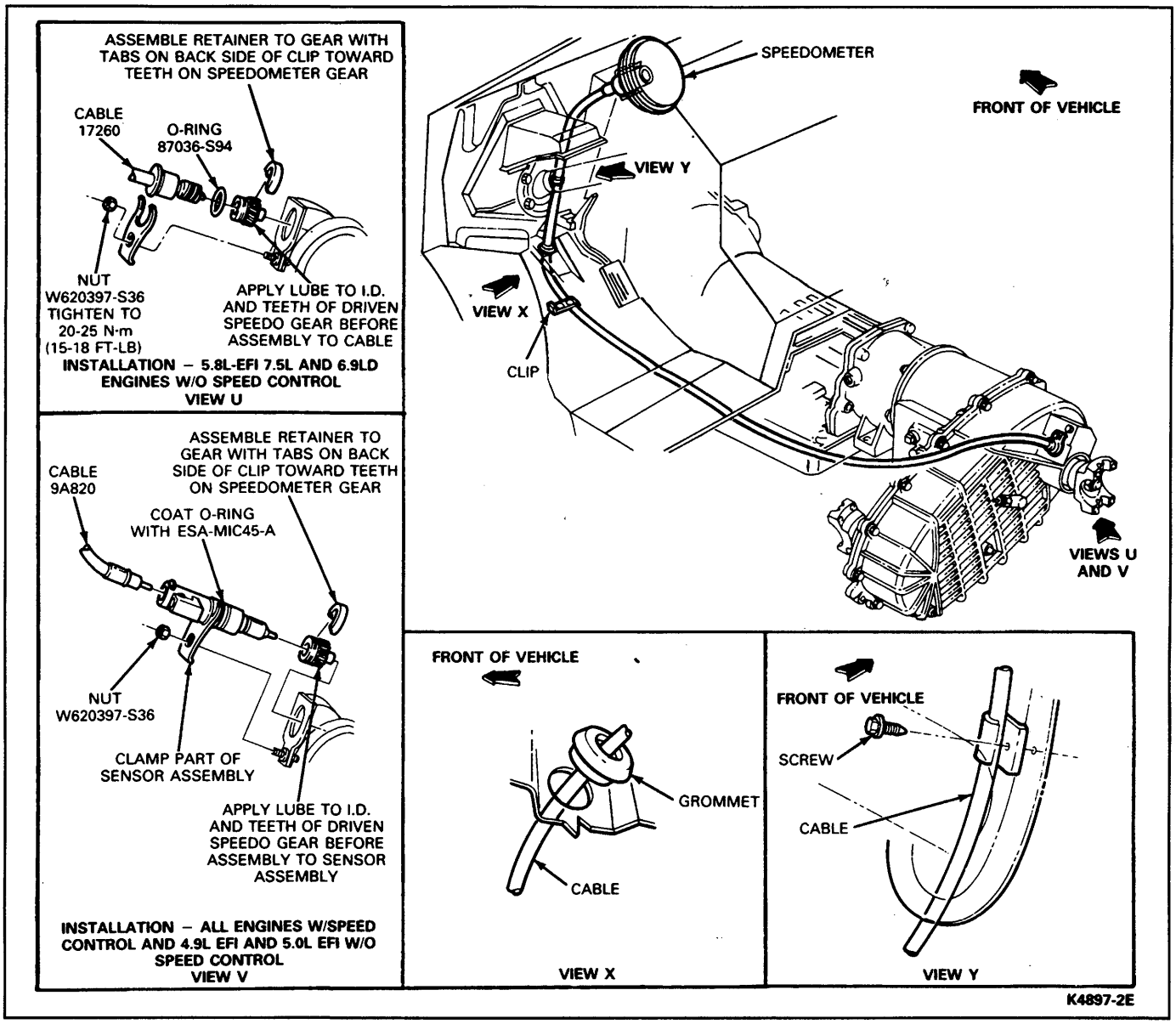


FIG. 2 F-150—F-350 (4X4) and Bronco Speedometer Cable Installation

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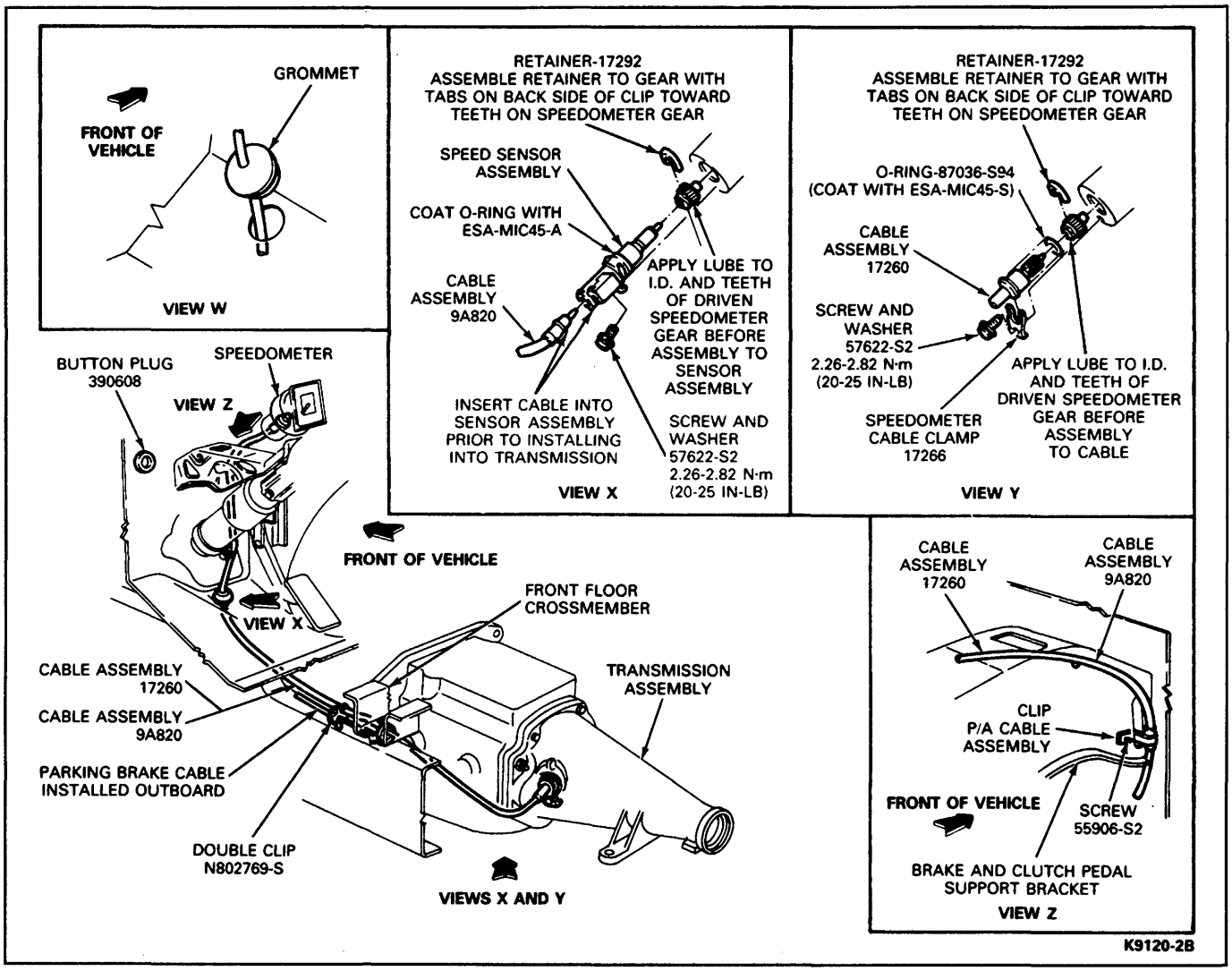


FIG. 3 E-150—E-350—Speedometer Cable Installation

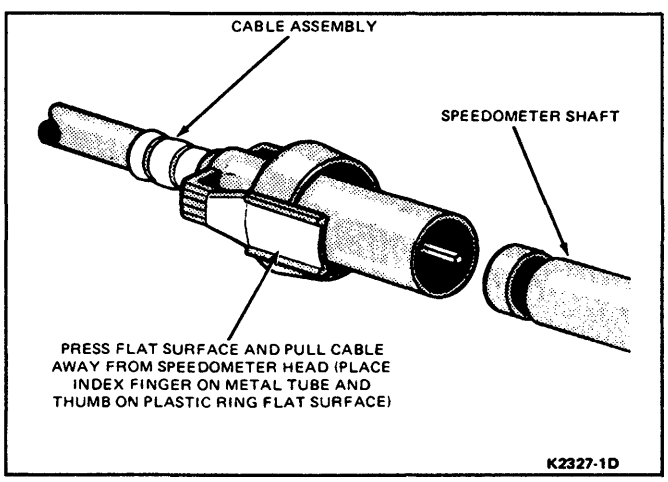


FIG. 4 Speedometer Cable Quick-Connect

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SECTION 33-04 Tachometer

SUBJECT	PAGE
DESCRIPTION AND OPERATION	33-04-1
DIAGNOSIS AND TESTING	33-04-2
REMOVAL AND INSTALLATION	33-04-1
SPECIAL SERVICE TOOLS	33-04-1
VEHICLE APPLICATION	33-04-1

VEHICLE APPLICATION

F-150—F-350 and Bronco.

DESCRIPTION AND OPERATION

The tachometer is an electrically operated instrument which indicates engine speed in revolutions per minute (RPM). It is mounted in the instrument cluster assembly.

The tachometer on F-150—F-350 and Bronco vehicles can be used with either 6-cylinder or 8-cylinder engines. The tachometer terminals "B" (+12 volts), "C" (coil negative), and "G" (ground) are connected when used for 6-cylinder engines. A fourth terminal "8" (8-cylinder ground) is grounded through the wire harness for 8-cylinder engine operation (Fig. 1).

REMOVAL AND INSTALLATION

Removal

1. Disconnect battery ground cable.
2. Remove instrument cluster. Refer to Section 33-51, Instrument Cluster and Printed Circuit.
3. Remove seven screws attaching mask and lens to cluster backplate and remove mask and lens.
4. Remove tachometer by prying tachometer dial away from cluster backplate (tachometer is retained backplate by retaining clips).

Installation

1. Position tachometer cluster backplate, and push into position (making certain the four tachometer pins correctly seat in the cluster backplate clips).
2. Position lens and mask to the cluster backplate and install the seven attaching screws. Install the instrument cluster. Connect battery ground cable and check operation of the tachometer.

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Number	Description
007-00001	Digital Volt Ohmmeter

CK9061-1A

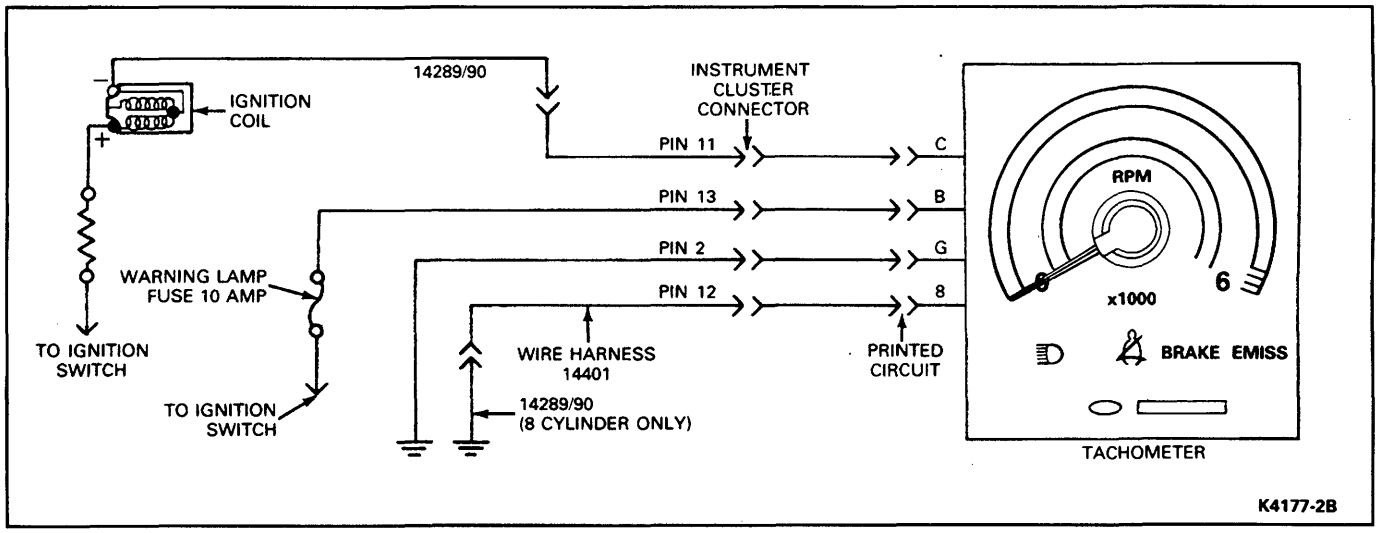
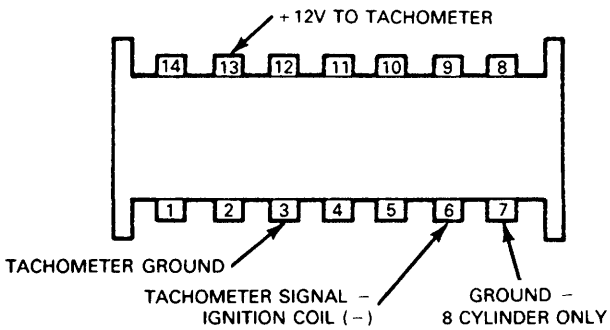


FIG. 1 Tachometer Wiring Diagram

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DIAGNOSIS AND TESTING

INOPERATIVE, ERRATIC, WRONG INDICATION

TEST STEP		RESULT	ACTION TO TAKE
A0	VERIFY CONDITION		
	• Check complaint.	Inoperative ▶	GO tc **A1**.
		Erratic and/or wrong indication ▶	GO to **A2**.
A1	CHECK FUSE		
	• Check fuse.	OK ▶	REPLACE fuse. If fuse blows again, CHECK for short in circuit.
		OK ▶	GO to **A2**.
A2	CHECK WIRING		
	• Check for loose wiring connections in engine compartment or at instrument cluster.	OK ▶	SECURE loose connections.
		OK ▶	GO to **A3**.
A3	MAKE RESISTANCE CHECKS		
	• Remove instrument cluster and make resistance and voltage checks (using Rotunda Digital Volt Ohmmeter 007-00001 or equivalent) at 14401 wiring harness connector as follows:  1. Check pin #3 resistance to chassis ground — should read 1 ohm or less. 2. Check pin #7 resistance to chassis ground — should read 1 ohm or less, if vehicle has 8-cylinder engine. Open circuit if 6-cylinder engine. 3. Check pin #6 resistance to negative terminal of ignition coil should be 1 ohm or less. 4. Connect battery. Turn ignition switch ON. Check for +12V at pin #13. Turn ignition OFF. Disconnect battery.	OK ▶	Condition is not in tachometer. SERVICE wiring.
		OK ▶	GO to **A4**.
A4	CHECK TACHOMETER CONNECTIONS		
	• Check for loose or missing cluster connection clips, or damaged printed circuit.	OK ▶	RESEAT (or replace missing) clips and/or REPLACE printed circuit.
		OK ▶	REPLACE tachometer.

CK6179-2C

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SECTION 33-06 Tachometer 7.3L Diesel

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION AND OPERATION	33-06-1	SPECIAL SERVICE TOOLS	33-06-2
DIAGNOSIS	33-06-1	VEHICLE APPLICATION	33-06-1
REMOVAL AND INSTALLATION	33-06-1		

VEHICLE APPLICATION

F-250 through F-350 and E-250 through E-350 Truck Models with 7.3L Diesel

DESCRIPTION AND OPERATION

The tachometer is an electrically operated instrument which indicates engine speed in revolutions per minute (rpm). It is mounted in the instrument cluster assembly.

The tachometer receives its signal from a variable reluctance sensor (mounted in the injection pump timing gear cover).

REMOVAL AND INSTALLATION

Removal

1. Disconnect the battery ground cable.
2. Remove the instrument cluster. Refer to Section 33-51, Instrument Cluster and Printed Circuit.
3. Remove the six screws attaching the mask and lens to the cluster backplate and remove the mask and lens.
4. Remove the four nuts attaching the tachometer to the cluster backplate and remove the tachometer.

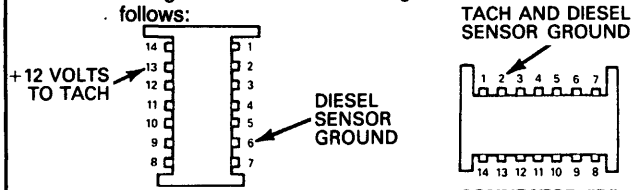
Installation

1. Position the tachometer to the cluster backplate and install the four attaching nuts.
2. Position the lens and mask to the cluster backplate and install the six attaching screws. Install the instrument cluster. Connect the battery ground cable and check the operation of the tachometer.

DIAGNOSIS

INOPERATIVE, ERRATIC, WRONG INDICATION

TEST STEP		RESULT	ACTION TO TAKE
A0	VERIFY CONDITION		
	• Check complaint.	Inoperative	GO to **A1**.
		Erratic and/or wrong indication	GO to **A2**.
A1	CHECK FUSE		
	• Check fuse.	Fuse blown	REPLACE fuse. If fuse blows again, CHECK for short in circuit.
		Fuse is good	GO to **A2**.
A2	CHECK WIRING		
	• Check for loose wiring connections in engine compartment or at instrument cluster.	Loose connections	SECURE loose connections.
		Connections secure	GO to **A3**.
A3	MAKE RESISTANCE CHECKS		
	• Remove instrument cluster and make resistance and voltage checks at 14401 wiring harness connector as follows:	Open or shorted	Condition is not in tachometer. SERVICE wiring.
		Wiring OK	GO to **A4**.

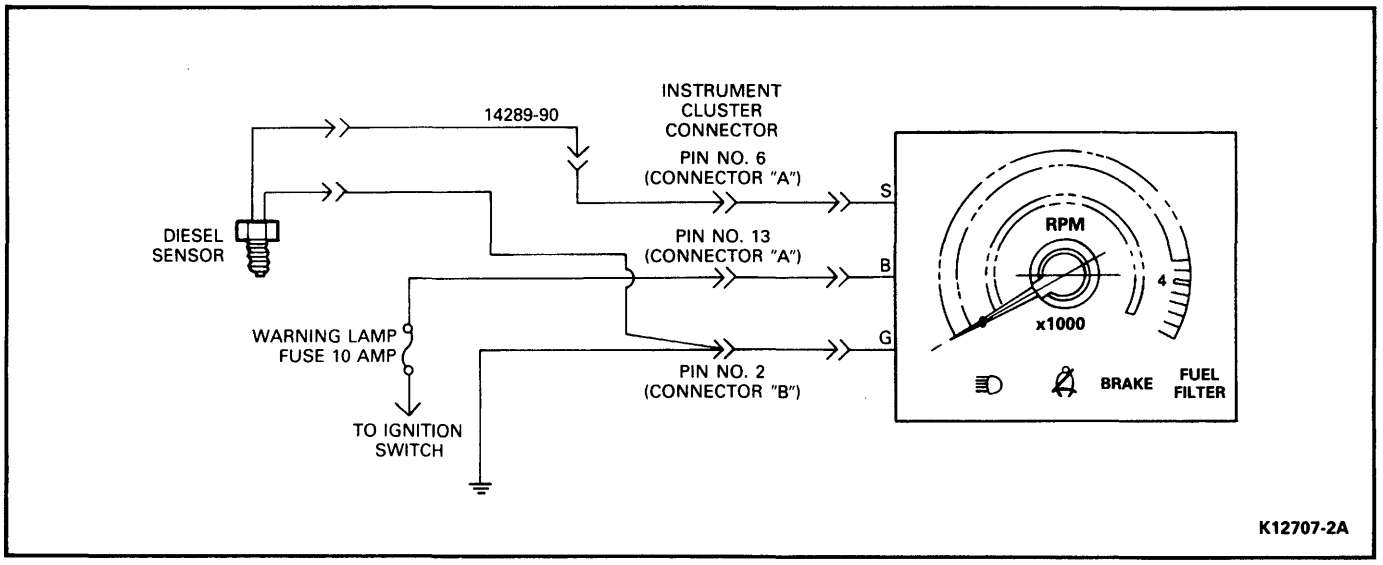


1. Check pin No. 2 (of connector "B") resistance to chassis ground — should read 1 ohm or less.
2. Check pin No. 6 (of connector "A") resistance to corresponding terminal of diesel sensor connector — should be 1 ohm or less.
3. Connect battery. Turn ignition to the RUN position. Check for +12 volts at pin No. 13 (of connector "A"). Turn ignition OFF. Disconnect battery.

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TEST STEP		RESULT	ACTION TO TAKE
A4	CHECK DIESEL SENSOR MOUNTING AND/OR CONNECTOR		
	• Check to see that sensor is not loose in its mounting (in injection pump timing gear cover). Check for loose connection.	Sensor and/or connector loose ▶	TIGHTEN sensor and/or connector.
		Sensor and connector tight ▶	GO to **A5**.
A5	CHECK DIESEL SENSOR FOR DAMAGE		
	• Remove sensor and check for physical damage to sensor face (resulting from contact with timing gear). **NOTE: Checking continuity across the terminals of the diesel sensor will show infinite resistance.**	Sensor damaged ▶	REPLACE sensor.
		Sensor not damaged ▶	GO to **A6**.
A6	CHECK RETENTION CLIPS		
	• Check for loose tachometer retention clips on rear of instrument cluster, or damaged printed circuit.	Clips loose ▶	TIGHTEN clips and/or REPLACE printed circuit.
		Clips tight ▶	REPLACE tachometer.

CK12706-2A



K12707-2A

SPECIAL SERVICE TOOLS

Number	Description
007-00001	Digital Volt Ohmmeter

CK12708-1A

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SECTION 33-10 Charge Indicator—Lamp

SUBJECT	PAGE
DESCRIPTION AND OPERATION	
Charge Indicator Lamp System	33-10-1
F-150—F-350, Bronco	33-10-1
DIAGNOSIS AND TESTING	33-10-2
REMOVAL AND INSTALLATION	
Indicator Lamp	33-10-2
F-150—F-350 and Bronco	33-10-2
VEHICLE APPLICATION	33-10-1

VEHICLE APPLICATION

F-150—F-350 and Bronco.

DESCRIPTION AND OPERATION

Charge Indicator Lamp System

F-150—F-350, Bronco

The battery, alternator, and electronic voltage regulator make up the charging system (Figs. 1 and 2).

With the ignition switch in START or RUN, battery current flows through the alternator indicator lamp which is a resistor/bulb in parallel mounted in a socket in the cluster into the regulator at terminal I, and to ground through the solid-state indicator switch. The electronic control measures a low voltage at regulator terminal A, and closes the field switch. This applies battery voltage to the field through alternator terminal F.

With current in the field and the rotor turning, the alternator stator produces a DC voltage at terminal BAT (to battery) and terminal STA. (Voltage at STA is one-half voltage at BAT.)

A preset voltage at terminal S operates the electronic control to open the indicator switch, which removes ground from the alternator warning indicator.

The alternator output is controlled by the current in the field. The average voltage on the field depends on the percentage of time the field switch is closed. The electronic control closes the field switch when the voltage at A is low, and opens the switch when the voltage at A is high.

The voltage regulator holds the system voltage at approximately 14 volts. The average alternator output is then any required value between zero and full current, depending on conditions sensed by the voltage regulator.

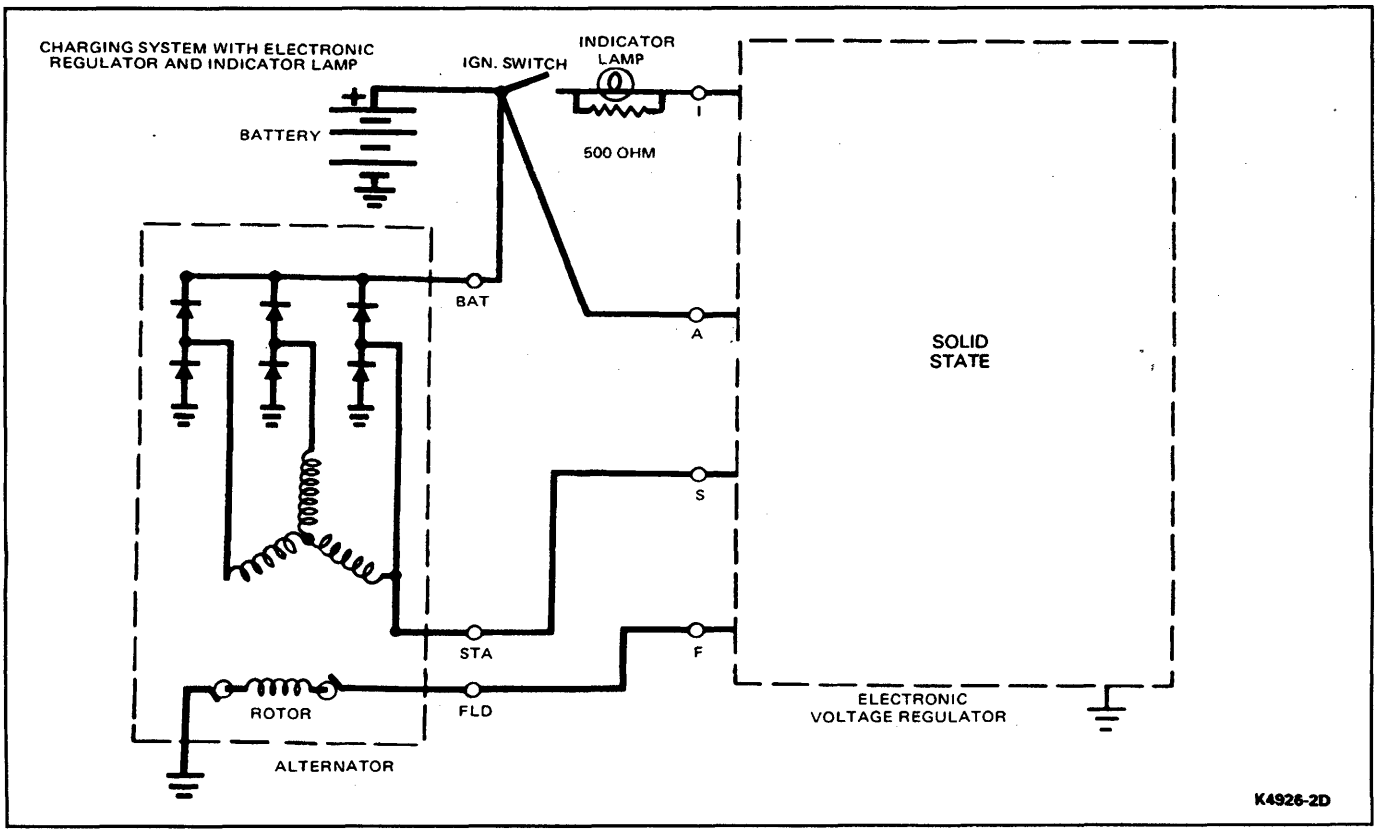


FIG. 1 Charging System Schematic—EVR System

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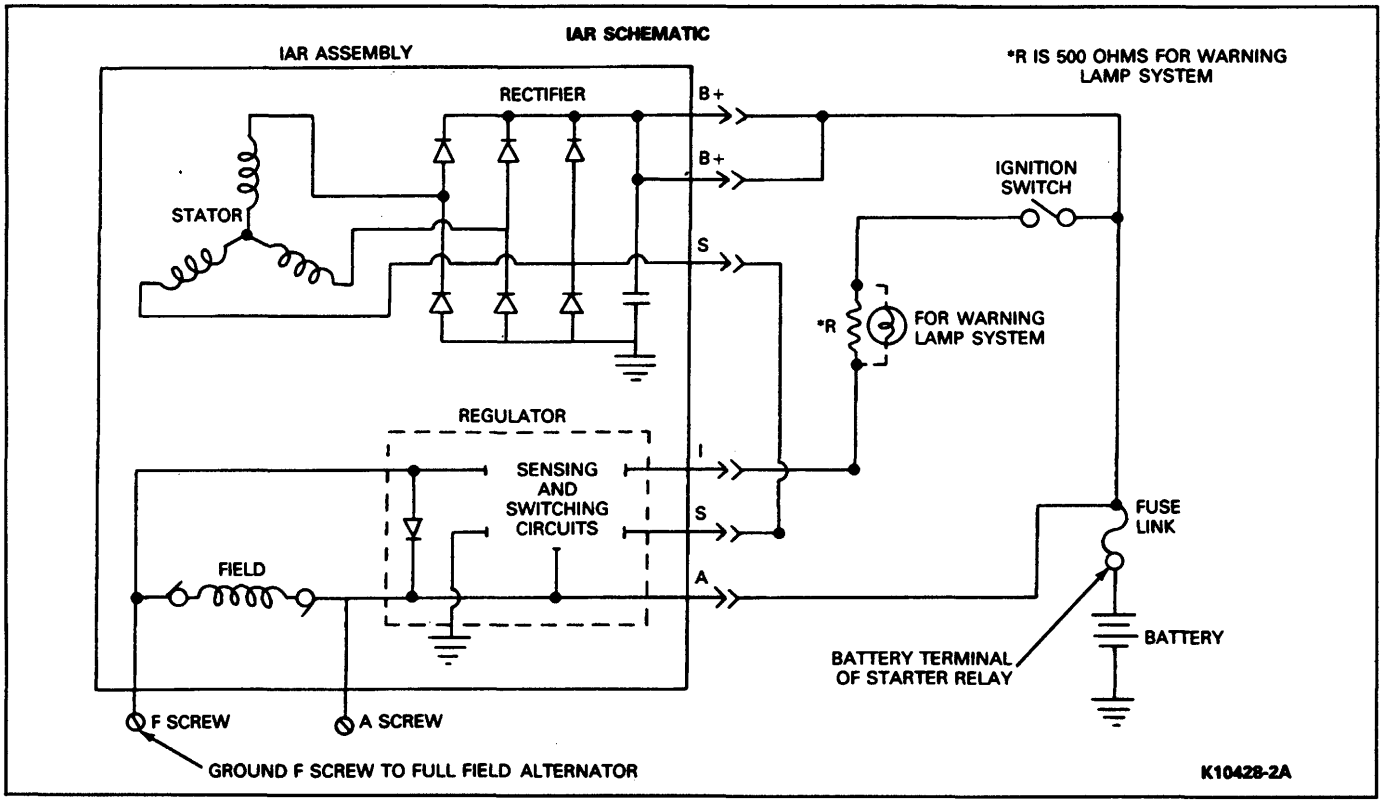


FIG. 2 Charging System Schematic—IAR System

DIAGNOSIS AND TESTING

Refer to Section 31-01, Charging System General Service.

REMOVAL AND INSTALLATION

Indicator Lamp

F-150—F-350 and Bronco

To remove the indicator bulb/resistor socket remove the instrument cluster assembly to gain access to indicator bulb/resistor socket. Refer to Section 33-51, Instrument Cluster and Printed Circuit. Turn the bulb and socket assembly one-quarter turn counterclockwise and remove. To install reverse this procedure.

CAUTION: The use of vinyl cleaners and similar other cleaning agents to clean the vehicle interior and/or instrument cluster lenses has resulted in damage to the instrument cluster lenses. The chemical content of these cleaning agents (O-dichlorobenzene, ethyl alcohol and/or cellosolve), has produced fogging, spotting, stain, or splotches of the lenses, either through over-spray or direct use on the lenses. Therefore, extreme caution should be taken during interior cleanup to prevent over-spray of cleaning agents which contain the chemical contents mentioned from contacting the instrument cluster lenses.

The instrument cluster lenses should be cleaned with Ford Glass Cleaner E4AZ-19C507-A (ESR-M14P5-A) or equivalent commercial cleaning product, using a clean, soft, lint-free cloth. The Ford Glass Cleaner has been especially formulated for cleaning windows in automotive vehicles and is approved for use in cleaning the plastic instrument cluster lenses. Read and carefully follow the directions shown on the container for best results.

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SECTION 33-12 Charge Indicator—Ammeter

SUBJECT	PAGE
DESCRIPTION AND OPERATION	33-12-1
REMOVAL AND INSTALLATION	
E-150—E-350	33-12-1
TESTING	33-12-1
VEHICLE APPLICATION	33-12-1

VEHICLE APPLICATION

E-150—E-350.

DESCRIPTION AND OPERATION

The ammeter is a gauge which senses the direction and rate of flow of electrical current to or from the battery to indicate whether the battery is being charged or discharged. A shunt-type ammeter is used in E-150—E-350 (Figs. 1 and 2).

TESTING

To test the ammeter, turn the headlamps on with engine stopped. The meter pointer should move toward the D or discharge scale. If no movement of the needle is observed, check the battery to circuit breaker wire connections. If the connections are tight, and the meter does not indicate either a charge or a discharge, the meter is inoperative. Check continuity of wires. If OK, replace meter. Jumper wires are not permitted to detect or check operation of charge indicator subsystem.

If the meter pointer moves toward the C or charge scale when the headlamps are turned on, the wire connections at the meter are reversed. Connect the wires to the ammeter correctly after checking first to make sure that the battery is not reversed.

CAUTION: The use of vinyl cleaners and similar other cleaning agents to clean the vehicle interior and/or instrument cluster lenses has resulted in damage to the instrument cluster lenses. The chemical content of these cleaning agents (O-dichlorobenzene, ethyl alcohol and/or cellosolve), has produced fogging, spotting, stain, or splotches of the lenses, either through over-spray or direct use on the lenses. Therefore, extreme caution should be taken during interior cleanup to prevent over-spray of cleaning agents which contain the chemical contents mentioned from contacting the instrument cluster lenses.

The instrument cluster lenses should be cleaned with Ford Glass Cleaner E4AZ-19C507-A (ESR-M14P5-A) or equivalent commercial cleaning product, using a clean, soft, lint-free cloth. The Ford Glass Cleaner has been especially formulated for cleaning windows in automotive vehicles and is approved for use in cleaning the plastic instrument cluster lenses. Read and carefully follow the directions on the container for best results.

REMOVAL AND INSTALLATION

E-150—E-350

Removal

1. Disconnect battery ground cable.

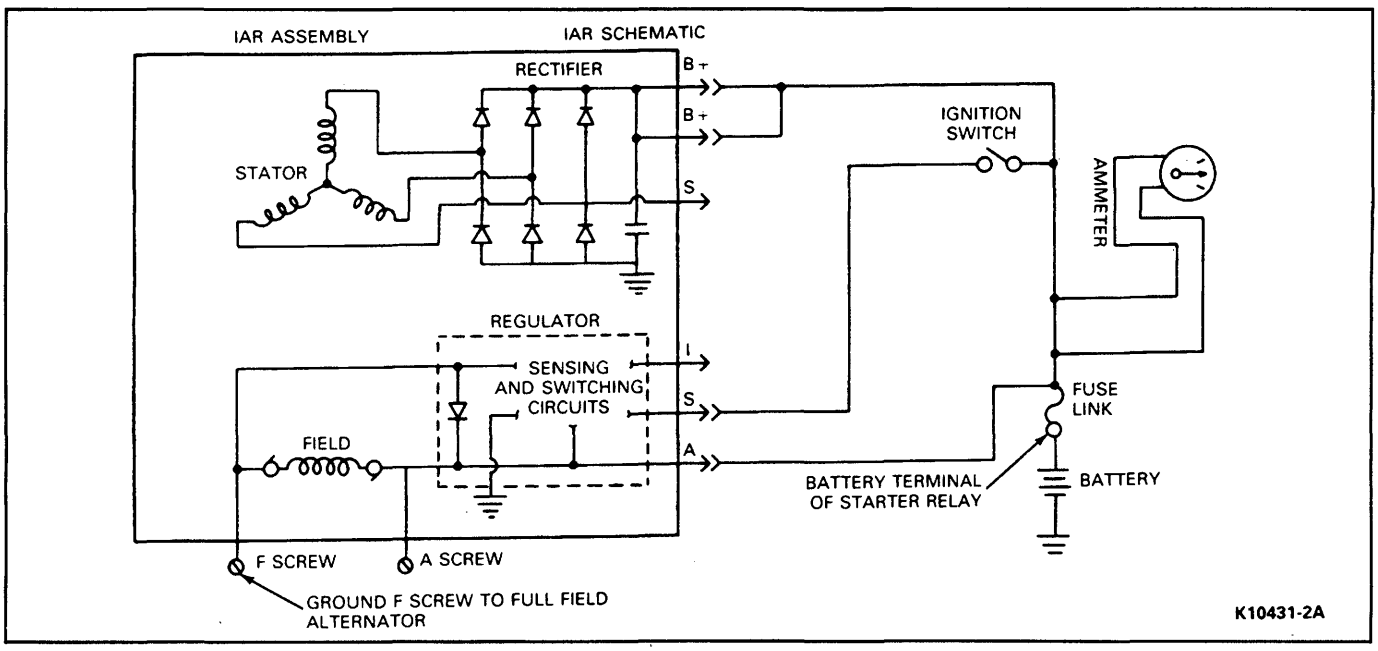


FIG. 1 IAR Ammeter System

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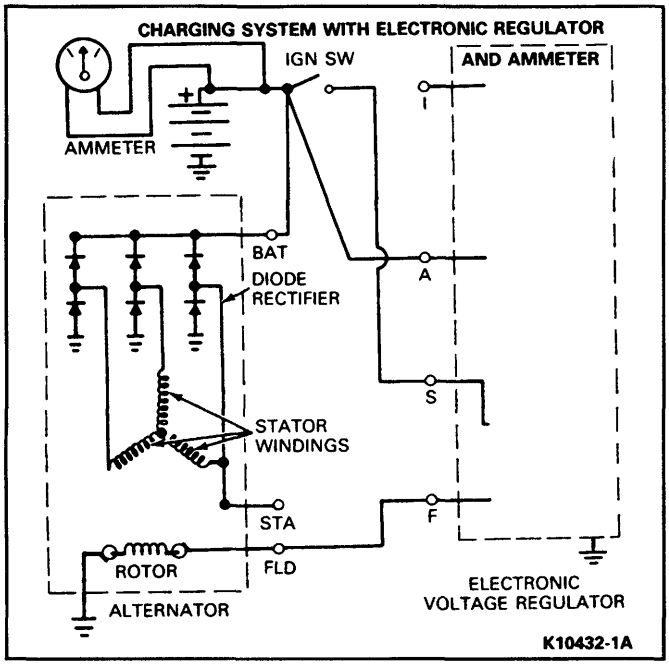


FIG. 2 EVR Ammeter System

2. Remove instrument cluster. Refer to Section 33-51, Instrument Cluster and Printed Circuit.
3. Remove housing, lens and mask from front of cluster by removing six retaining screws.
4. Remove two retaining nuts.
5. Remove ammeter from backplate assembly.

Installation

1. Position ammeter to backplate assembly and install two retaining nuts.
2. Insert the plastic insulator over the gauge terminals, if so equipped.
3. Install mask, lens and housing with six retaining screws.
4. Install the instrument cluster to instrument panel. Refer to Section 33-51, Instrument Cluster and Printed Circuit.
5. Connect battery ground cable. Check operation of the gauge.

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SECTION 33-15 Shift Indicator Lamp

SUBJECT	PAGE
DESCRIPTION	
Top Gear Switch	33-15-1
DIAGNOSIS AND TESTING	33-15-1
REMOVAL AND INSTALLATION	
Shift Indicator Lamp	33-15-1
REMOVAL AND INSTALLATION (Cont'd)	
Top Gear Switch	33-15-1
VEHICLE APPLICATION	33-15-1

VEHICLE APPLICATION

4.9L (300 CID) Engine with Manual Transmission.

DESCRIPTION

The shift indicator lamp system is intended to provide the driver with optimum fuel economy and is controlled by engine speed and manifold vacuum levels. When the engine speed is greater than 900 RPM and engine vacuum is greater than 16.9 kPa (5 in.-Hg.) in part throttle range, the shift indicator lamp comes on, indicating the proper time to upshift. There is a slight delay (approximately 1 second) in the lamp coming on after these conditions are met. The lamp itself is located in the far LH "eyebrow" of the instrument panel on EEC-IV vehicles.

On EEC-IV vehicles, the system is incorporated in the EEC module. There is a top gear switch (mechanical linkage) which prevents the lamp from lighting in top gear. There is also a dimmer relay which reduces the brightness of the lamp when the headlamps are turned on.

Top Gear Switch

The top gear switch is located at the top, RH side of the transmission case. This switch and temperature inhibitors (some are switches and some are purely mechanical devices—depending on the calibration) merely prevent the shift indicator lamp from lighting up when the vehicle is in the top gear.

DIAGNOSIS AND TESTING

For Diagnosis and Testing procedures, refer to Section 17 of the Engine/Emissions Diagnosis.

REMOVAL AND INSTALLATION

Shift Indicator Lamp

Removal

1. Disconnect battery ground cable.
2. Remove instrument panel trim panel.
3. Remove instrument cluster.
4. Remove bulb from shift indicator assembly.

Installation

1. Install bulb into shift indicator assembly.
2. Install instrument cluster.
3. Install instrument panel trim panel.
4. Connect battery ground cable. Test system for correct operation of lamp.

Top Gear Switch

Removal

1. Disconnect battery ground cable.
2. Disconnect electrical connection (pull straight out).
3. Remove bolt from the switch and remove switch.

Installation

1. Install switch and secure with attaching bolt.
2. Connect electrical connector.
3. Connect battery ground cable. Test system for correct operation.

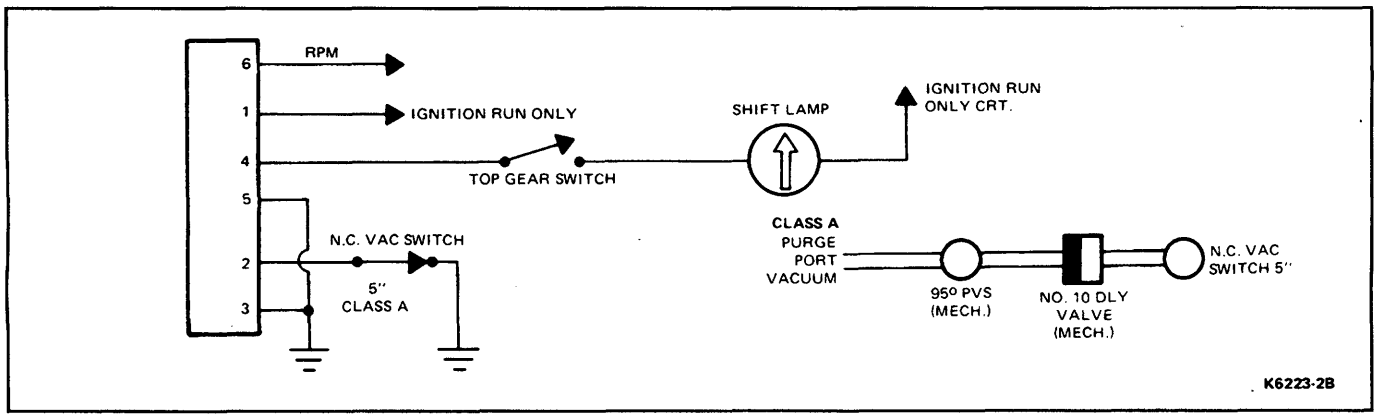


FIG. 1 Shift Indicator Lamp—Wiring Schematic

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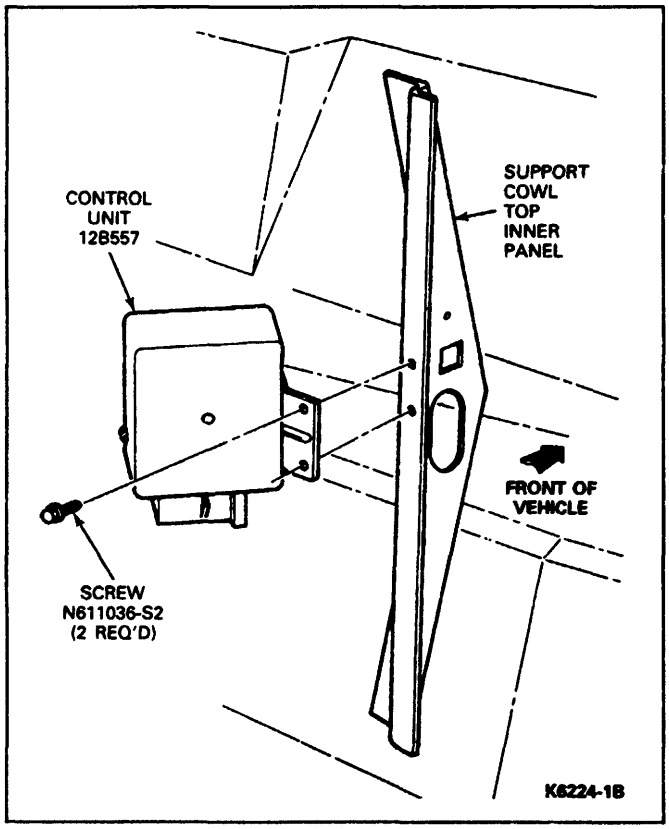


FIG. 2 Installation Control Unit

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SECTION 33-20 Fuel Indicating System

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Fuel Level Indicating System	33-20-1
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VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

Fuel Level Indicating System

All Models

The fuel indicating system is a bimetal-resistance type system for Econoline and a magnetic type system for F-Series. The Econoline system consists of an instrument voltage regulator, fuel indicator (gauge) mounted in the instrument cluster and a sender located in the fuel tank (Fig. 1).

The F-Series system consists of a fuel indicator gauge mounted in the instrument cluster and a sending unit mounted in the fuel tank (Fig. 2).

Instrument Voltage Regulator

Econoline

The instrument voltage regulator (IVR) used with the bi-metal fuel indicator (gauge) controls and maintains an average pulsating voltage of 5.0 volts at the gauge terminals.

Fuel Indicator (Gauge)

The bi-metal (Econoline) fuel indicator gauge pointer is attached to a wire-wound bimetal strip which, when heated by the flow of electrical current controlled by the sender unit, produces the appropriate indication.

The magnetic (F-Series) fuel indicator gauge creates a polarity in the wire windings which, depending on the resistance at the sender, controls the degree of pointer rotation. The magnetic gauge operates on battery voltage (12V).

Fuel Sender

The fuel sender consists of a variable resistor, controlled by the action of an attached float in the fuel tank (Figs. 1 and 2). The variable resistor consists of a screened resistive material on a ceramic substrate. The resistive characteristics of the two types of gauges are shown in Fig. 3.

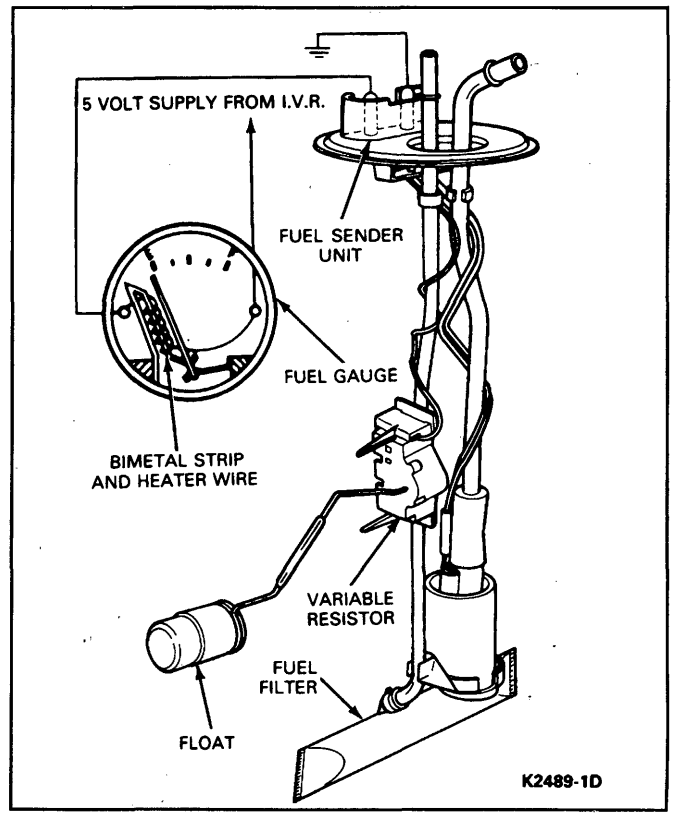


FIG. 1 Fuel Indicating System Using a Bimetal Gauge—Econoline

The fuel sender portion of the fuel sender for the 4.9L EFI, 5.0L EFI, 5.8L EFI and the 7.5L EFI engines

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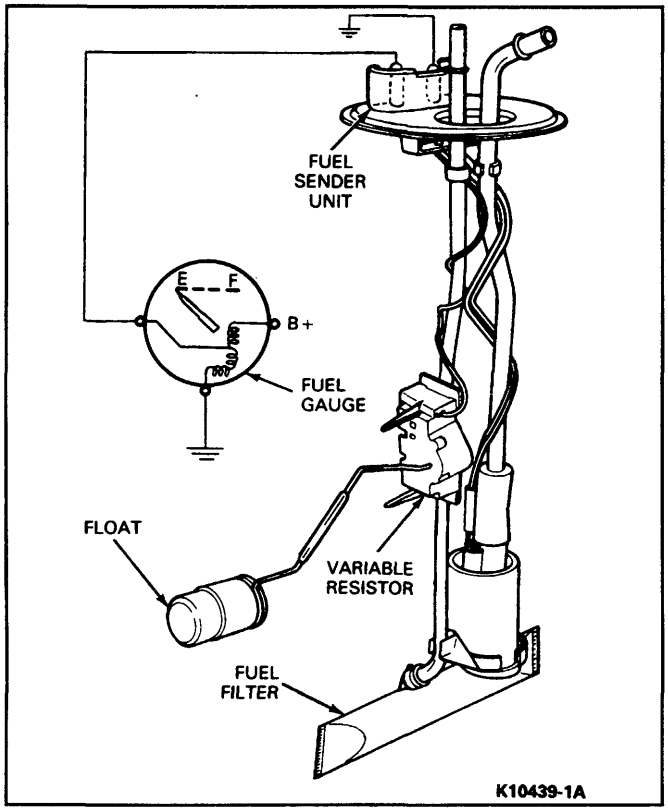


FIG. 2 Fuel Indicating System Using a Magnetic Gauge—F-150-F-350

FUEL SENDER RESISTANCE

Type of Gauge	Full Tank	Empty Tank
Bi-Metal	10 ohms	70 ohms
Magnetic	160 ohms	15 ohms

CK10440-1A

FIG. 3 Fuel Indicating System—Sender Resistance

operates the same as described previously. The sender assembly is unique, in that it has an integral fuel pump (Figs. 4 and 5), and the electrical connector has four pins, two for the sender function and two for the electrical fuel pump.

NOTE: The fuel sender used with the plastic aft-axle tank has only three pins, as the pump and sender share a common ground.

The fuel sender for the 7.3L diesel also operates the same as previously described, except for the following differences. The filter is replaced by an inverted flexible cone-like member. The flexible cone ensures fuel is always being taken from the bottom of the tank. The cone has as part of its assembly a relief-bypass valve (Fig. 6). If the intake becomes obstructed at low temperatures the relief valve opens, allowing fuel to bypass the filter.

The fuel senders used with all engines equipped with EFI, as well as the 7.3L diesel engine have a fuel return port which allows excess fuel delivered to the engine to be returned to the fuel tank.

Fuel Tank Selector Switch

All fuel gage sensing on vehicles with dual tanks (except with 7.3L Diesel engine) passes through the fuel tank selector switch. The circuit diagrams are shown in Figures 7 and 8.

DIAGNOSIS AND TESTING

All Models

Calibration Test (using Rotunda Tester 021-00055)—Econoline

The Rotunda Instrument Gauge System Tester 021-00055 or equivalent (Fig. 9), is used to diagnose problems in all fuel indicating systems using the bimetal fuel indicator gauge and instrument voltage regulator (IVR).

Prior to performing fuel system test, the following tester checks should be made.

1. Set tester switch at IVR CHECK position.
2. Attach tester ground wire to the negative (-) terminal of 12-volt battery and touch one of the tester terminals marked with an arrow to the positive (+) battery terminal.
3. If the IVR check lamp does not come on, return tester for service or replacement.

Test Set-Up

CAUTION: During in-vehicle tests, do not let tester terminal studs designated by arrows come in contact with vehicle ground. The fuel gauge will be shorted to ground, preventing an accurate test and possibly damaging the IVR or gauge. Never apply vehicle voltage across sender, IVR or gauge.

1. Disconnect connector from fuel sender and hook onto the matching terminals on the tester (Fig. 9).
2. Turn vehicle ignition switch to ACC position.

Functional Test

NOTE: The IVR also supplies a common regulated voltage for the temperature gauge indicating system and oil gauge indicating system (when applicable), therefore, the IVR can only be damaged if the other gauges exhibit similar problems (fluctuating movement or high or low indications at the upper calibration band). The IVR has little affect on the lower calibration band of the indicator.

1. Set tester switch to IVR CHECK position.
2. If IVR check lamp flashes on and off, the IVR and wiring are functional. Proceed to calibration check.
3. If IVR check lamp is on steady, check IVR ground screw. If ground screw is secure, replace IVR.
4. If IVR check lamp does not come on, check for open circuit in gauge and/or circuit wiring.

   NOTE: If IVR check lamp does not come on, also check plug-in connector at the instrument cluster printed circuit for proper insertion. A poor tester ground connection, when used with single terminal fuel senders, will prevent the IVR check lamp from coming on. Also check for corroded terminals on the connector at the fuel sender and on the fuel sender-unit terminals.

Calibration Check

With the tester switch in either the HIGH or LOW position, the center line of the gauge pointer should be within, or the pointer edge touching, the "F" or "E" white band of the graphics for the fuel test function as shown on the tester after two minutes (Fig. 9). If the

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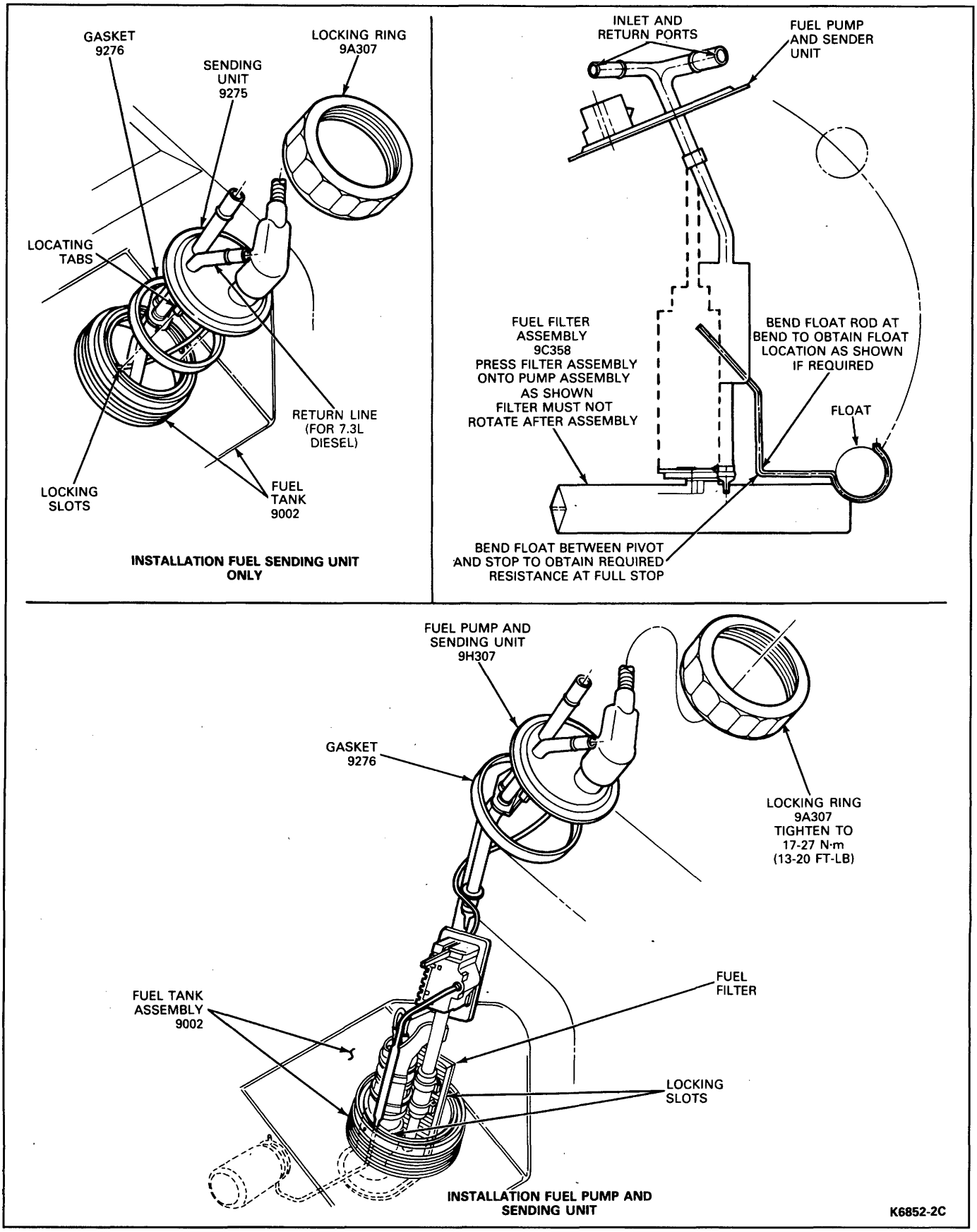


FIG. 4 Fuel Sender With Integral Electric Fuel Pump—F-350 Chassis Cab (Plastic Tank), 4.9L, 5.8L and 7.5L EFI Engines

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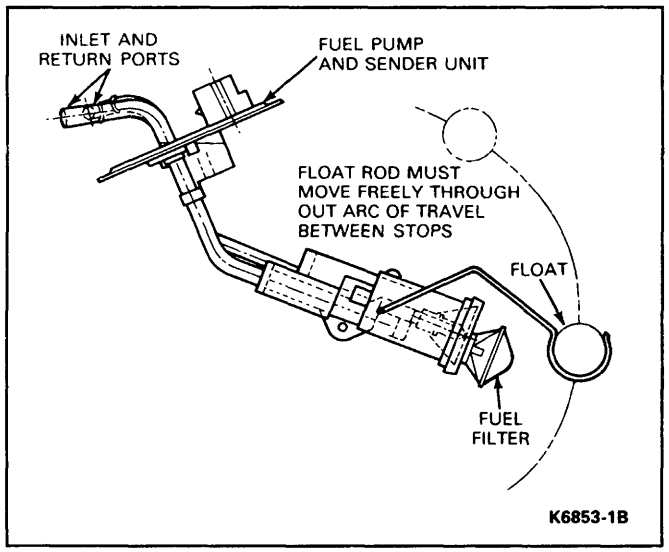


FIG. 5 Fuel Sender—All EFI Equipped Engines with Steel Fuel Tanks

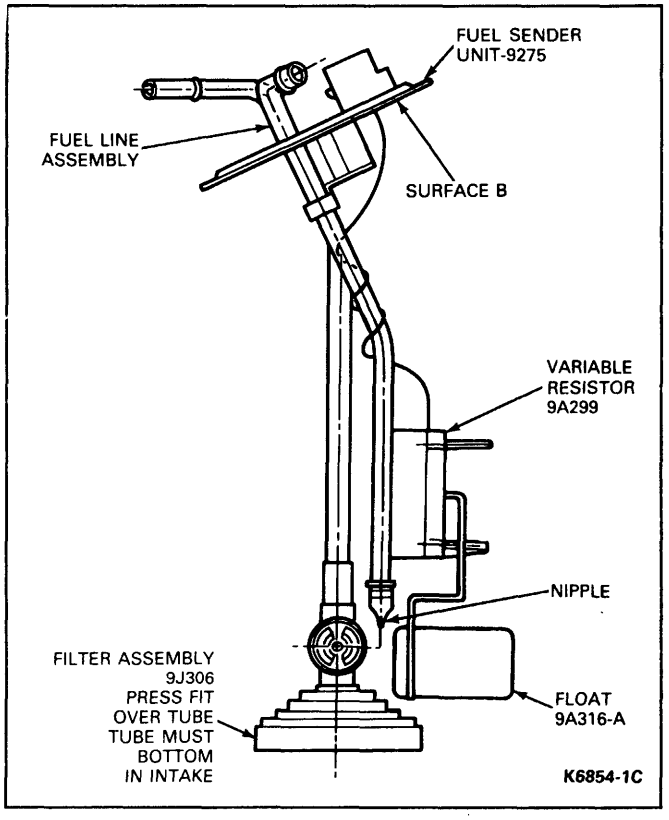


FIG. 6 Fuel Sender—7.3L Diesel Engine

centerline of the pointer registers in the white bands, the fuel indicating system is operating properly and replacement of the fuel sender is necessary. If the pointer center line falls outside the "E" white band, replace the fuel gauge. If the pointer center line falls outside the "F" white band, replace the IVR and retest. If still outside the "F" white band, replace the fuel gauge, install the original IVR and test for calibration.

Calibration Test (Without Tester)—Econoline

If only the fuel gauge is inoperative or appears to be out of calibration, a calibration test can be conducted on the vehicle fuel gauge system. The calibration test checks the fuel gauge and IVR simultaneously (Fig. 10).

- Fuel gauge check without box resistance = 10 ohms and 73 ohms.
- With 10 ohms, pointer should be at or above "F" by approximately two pointer widths.
- With 73 ohms, pointer should be at or below "E" by two pointer widths.

If the gauge pointer does not move and stays below the E mark, check for an open circuit in the wiring assembly, the gauge windings, or the instrument cluster printed circuit. If the gauge pointer moves without any resistor connected, check for a short circuit in the lead to the sender unit. If the gauge reads out of calibration, replace IVR and retest. If still out of calibration, replace the gauge.

Calibration Test (Without Tester)—F-150—F-350

If only the fuel gauge is inoperative or appears to be out of calibration, a calibration test can be conducted on the vehicle fuel gauge system.

- Fuel gauge check without box resistance = 160 ohms and 15 ohms.
- With 145 ohms, pointer should be between the two printed dots at "F" mark on gauge face.
- With 22 ohms, pointer should be between the two printed dots at "E" mark on gauge face.

Fuel Indicator Second Sender Test—F-Series Dual Tanks

On F-Series midship (standard) fuel tank, the fuel sender electrical connector can be disconnected and attached to a second test sender outside the tank. The float can then be manually operated (up and down) while the fuel gauge operation is observed. Proper gauge function indicates a problem with the fuel sender. Improper operation indicates a problem with the gauge or wiring. Refer to Diagnosis and Testing for Fuel Tank Sending Unit diagnosis.

Gauge Bench Test for Open Windings

To test the gauge for open windings, remove the gauge from the vehicle. Connect the gauge to an ohmmeter and read the resistance. Battery positive to sender resistance should be 80 to 90 ohms and sender to ground should be 190 to 200 ohms (Fig. 11). If the ohmmeter reads open or low resistance, replace the gauge.

Fuel Tank Damage

If fuel indicating system components are functioning properly and inaccurate indications continue, check the fuel tank for damage which may have changed the fuel sender mounting angle and/or damaged the fuel sender.

Fuel Selector Valve—Dual Tanks With EFI Engines

The fuel selector valve for EFI equipped vehicles is mechanically operated and uses in-tank pump pressure to control fuel supply and return. Front or rear tank indication is controlled by the selector switch.

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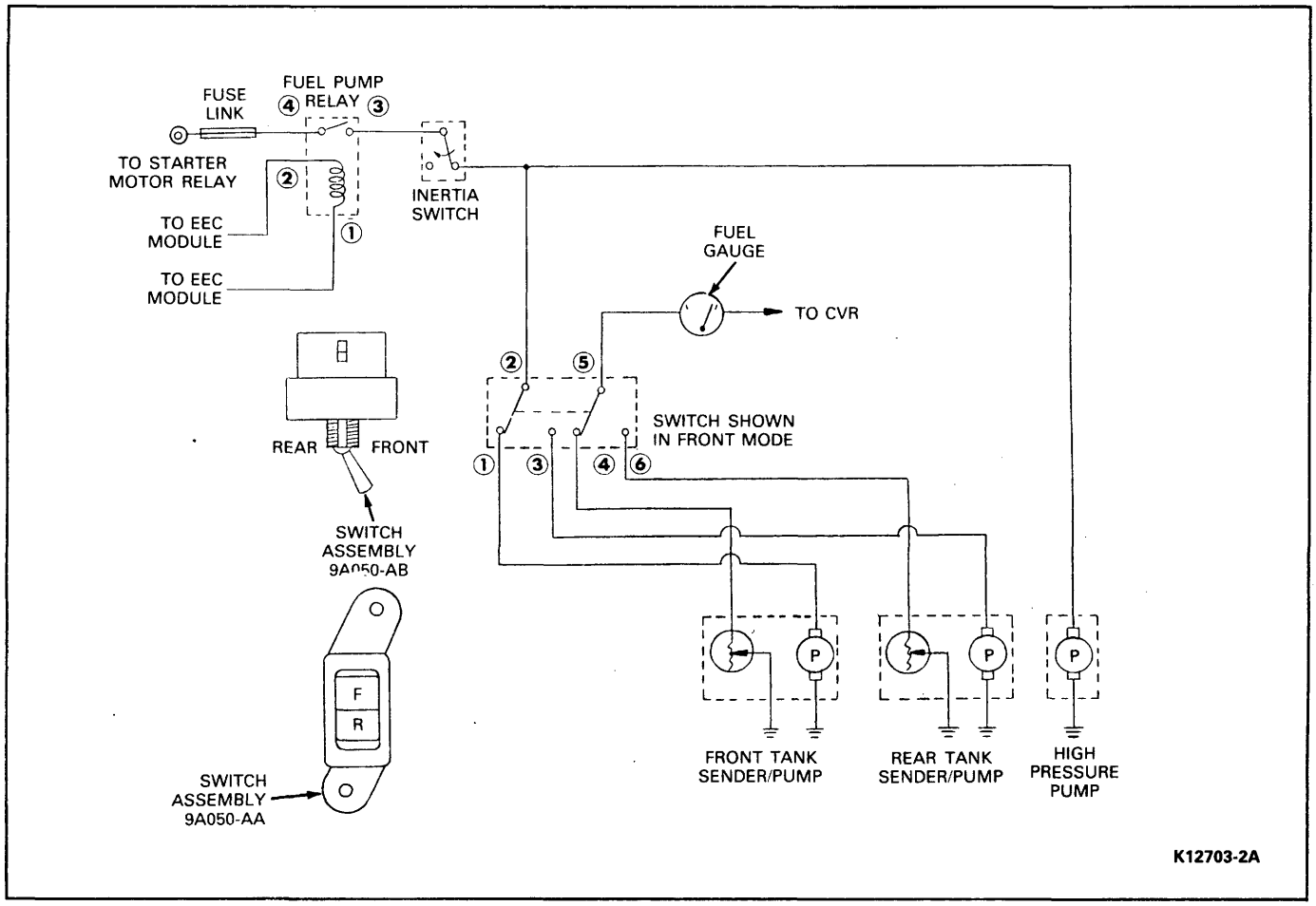


FIG. 7 Fuel Tank Selector Switch Circuit—Except 7.3L Diesel

Fuel Selector Valve—Dual Tanks With Fuel Return Lines (7.3L Diesel only)

The following diagnosis guide is for vehicles equipped with dual tanks and fuel return lines (6-port fuel selector valve). Refer to Fig. 12 for 6-port fuel selector valve connector terminal numbers. Refer to Figs. 13 and 14 for a view of the 6-port fuel selector valve. Make certain that both tanks contain some usable fuel.

Fuel Tank Sending Unit-All Models

Refer to the following guide when diagnosing fuel tank sending unit related problems:

REMOVAL AND INSTALLATION

Sending Units Secured With Metal Locking Ring

Removal and Installation

1. Remove the fuel from the fuel tank until fuel level is below fuel sender mounting hole.

   NOTE: For sending unit removal and installation for E-Series EFI equipped (4.9L, 5.0L, 5.8L, 7.5L) engines refer to Section 24-50, Fuel Tank and Lines and Fuel Evaporative Emission Control System.

2. Disconnect the wiring connector from the fuel system sender.
3. Remove any dirt that has accumulated around the sender so that it will not enter the tank or lines.
4. Loosen the quick connect fittings and disconnect the fuel tank line at the sender.
5. Turn the fuel sender locking ring counterclockwise with Fuel Tank Sender Wrench T74P-9275-A or equivalent. Remove the locking ring, sender and sealing gasket.
6. Clean the fuel sender mounting surface on the fuel tank.
7. Place a new sealing gasket in the groove of the fuel tank. Install the fuel sender into the fuel tank so that the tabs of the sender are positioned into slots of the fuel tank. The sealing gasket must remain in place during and after fuel sender installation (Fig. 15, View A).
8. Holding the fuel sender and sealing gasket in place, install and rotate the locking ring clockwise until the stop is against the retainer ring tab (Fig. 15, View B).
9. Connect the fuel sender wire and the fuel tank line.
10. Refill the tank with the fuel removed. Check for proper fuel gauge operation and for leaks while refilling.

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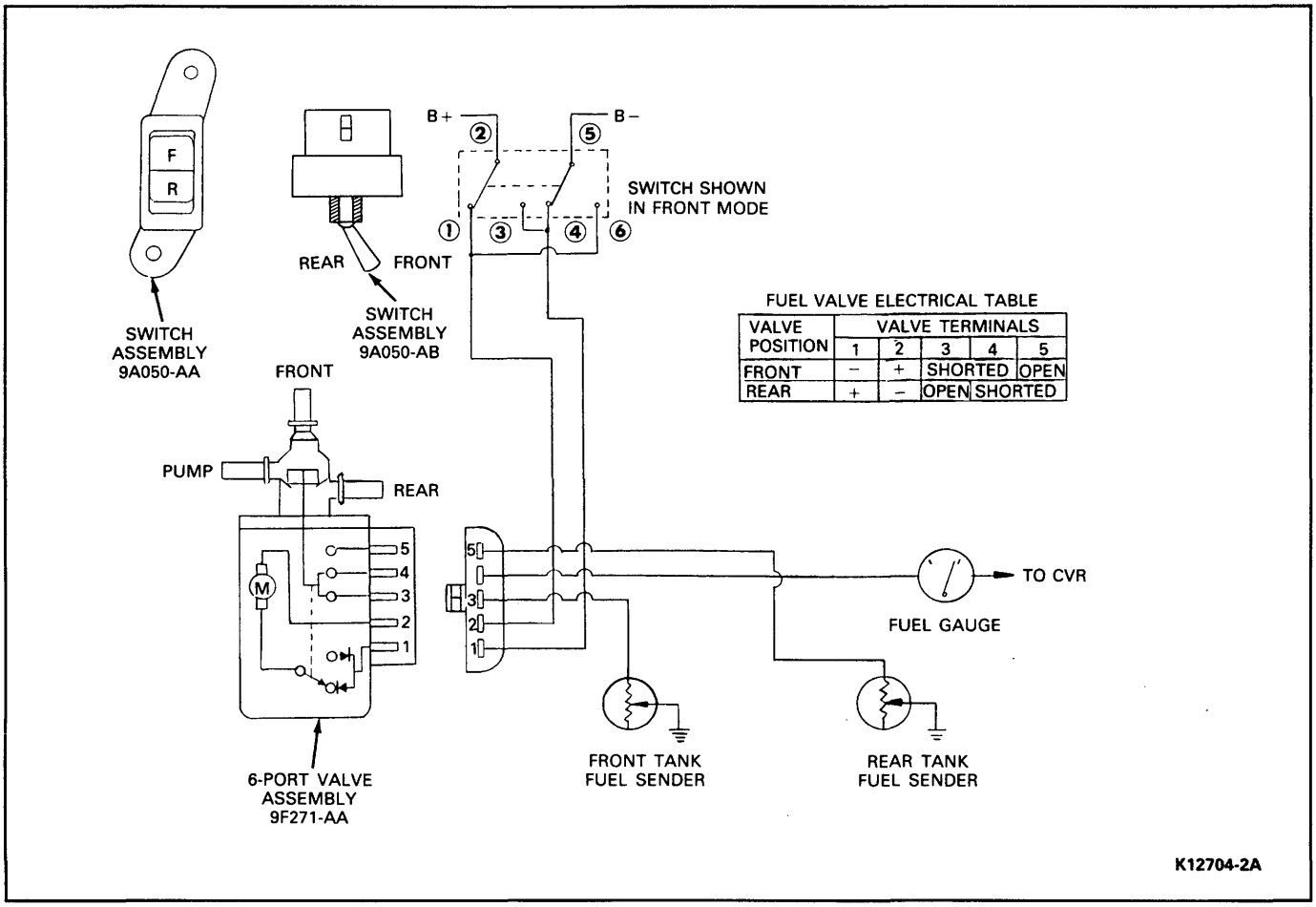


FIG. 8 Fuel Tank Selector Switch Circuit—7.3L Diesel

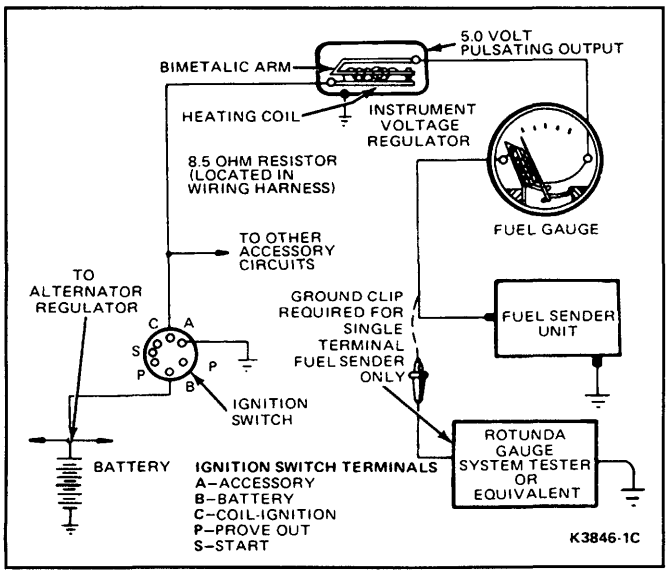


FIG. 9 Fuel Indicating System Test with Rotunda Tester 021-00038 or Equivalent—Econoline

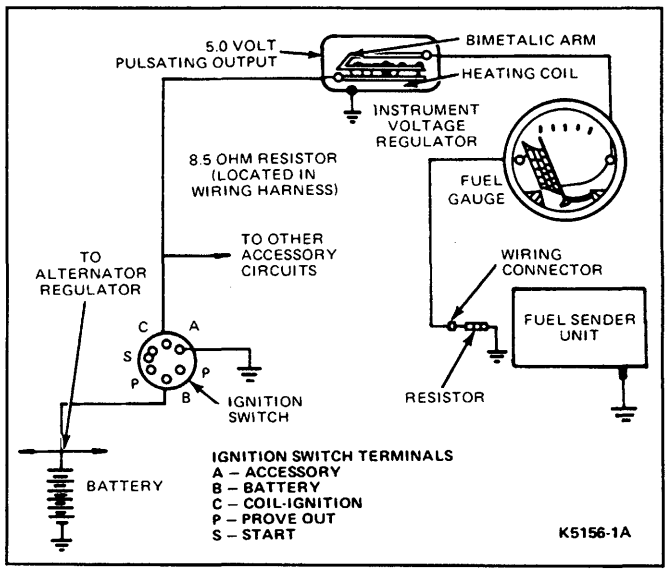


FIG. 10 Fuel Indicating System Test—Using 22 or 73 Ohm Resistor—Econoline

Sending Units Secured With Plastic Locking Ring

Removal and Installation

1. Remove fuel from the fuel tank.
2. Disconnect the wiring connector from the fuel sender.
3. Remove any dirt that has accumulated around the sending unit so that it will not enter the tank or lines.

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4. Loosen the quick-connect fittings and disconnect the fuel line at the sender.
5. Turn the fuel sending locking ring counterclockwise with a band-type oil filter wrench or equivalent. Remove the locking ring fuel sender and sealing gasket (Fig. 16).
6. Clean the fuel gauge sending unit mounting surface at the fuel tank.

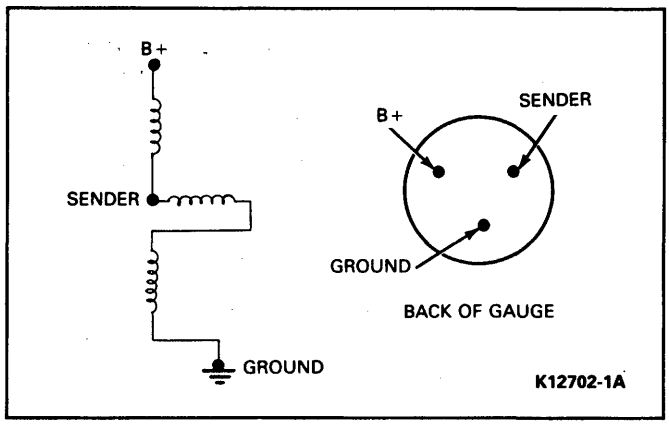


FIG. 11 Fuel Gauge Bench Test Connection Points

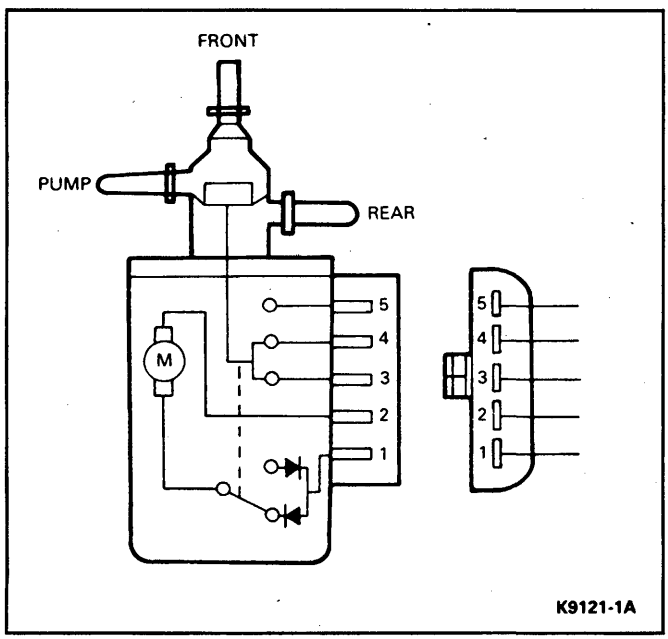


FIG. 12 Fuel Selector Valve—6-Port—Terminal Numbers (7.3L Diesel)

7. Place a new sealing gasket in the groove of the fuel tank. Install the fuel sender into the fuel tank so that the tabs of the sender are positioned into the fuel tank slots. The sealing gasket must remain in place during and after fuel sender installation (Fig. 16).
8. Holding the fuel sender and sealing gasket in place, install and rotate the plastic locking ring clockwise until handtight. Using the service wrench, tighten locking ring to 18-27 N·m (13-20 ft-lb).
9. Connect the wire and the fuel line.
10. Refill the tank with the fuel removed. Check for leaks and proper fuel gauge operation while refilling.

Fuel Gauge

F-150—F-350, Bronco and E-150—E-350

Removal and Installation

1. Disconnect battery ground cable.
2. Remove this instrument cluster. Refer to Section 33-51, Instrument Cluster and Printed Circuit.
3. Remove the lens and mask from the cluster.
4. Remove the two nuts attaching the gauge to the cluster, and remove gauge.

CAUTION: Do not touch gauge pointer.

5. To install, reverse Step 1 through 4. Check gauge operation.

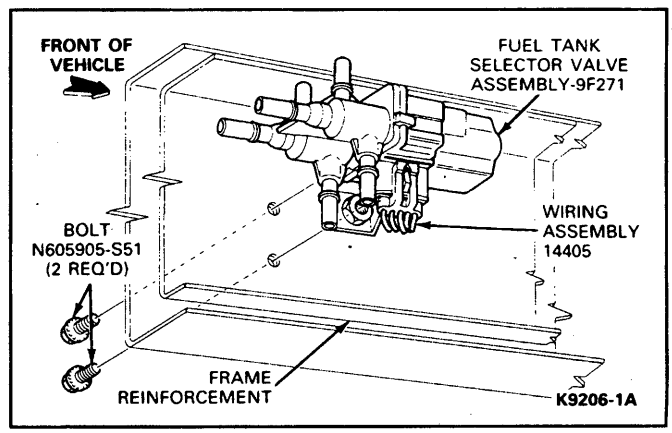


FIG. 13 6-Port Fuel Tank Selector Valve—F-Series (7.3L Diesel)

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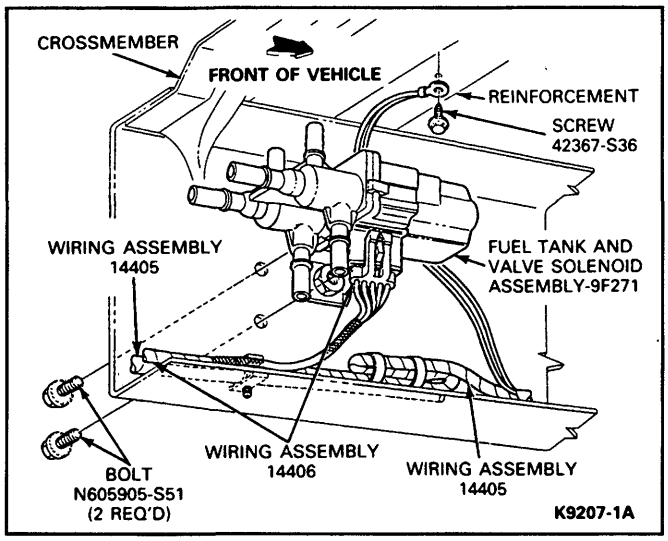


FIG. 14 6-Port Fuel Tank Selector Valve—Econoline (7.3L Diesel)

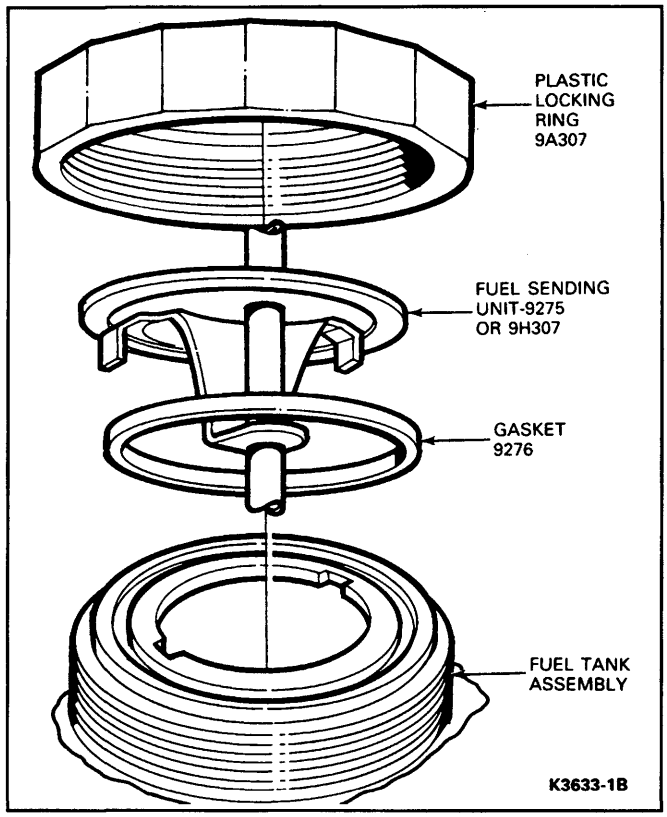


FIG. 16 Fuel Tank Sender Installation (Plastic Locking Ring Type)—F-350 Chassis Cab

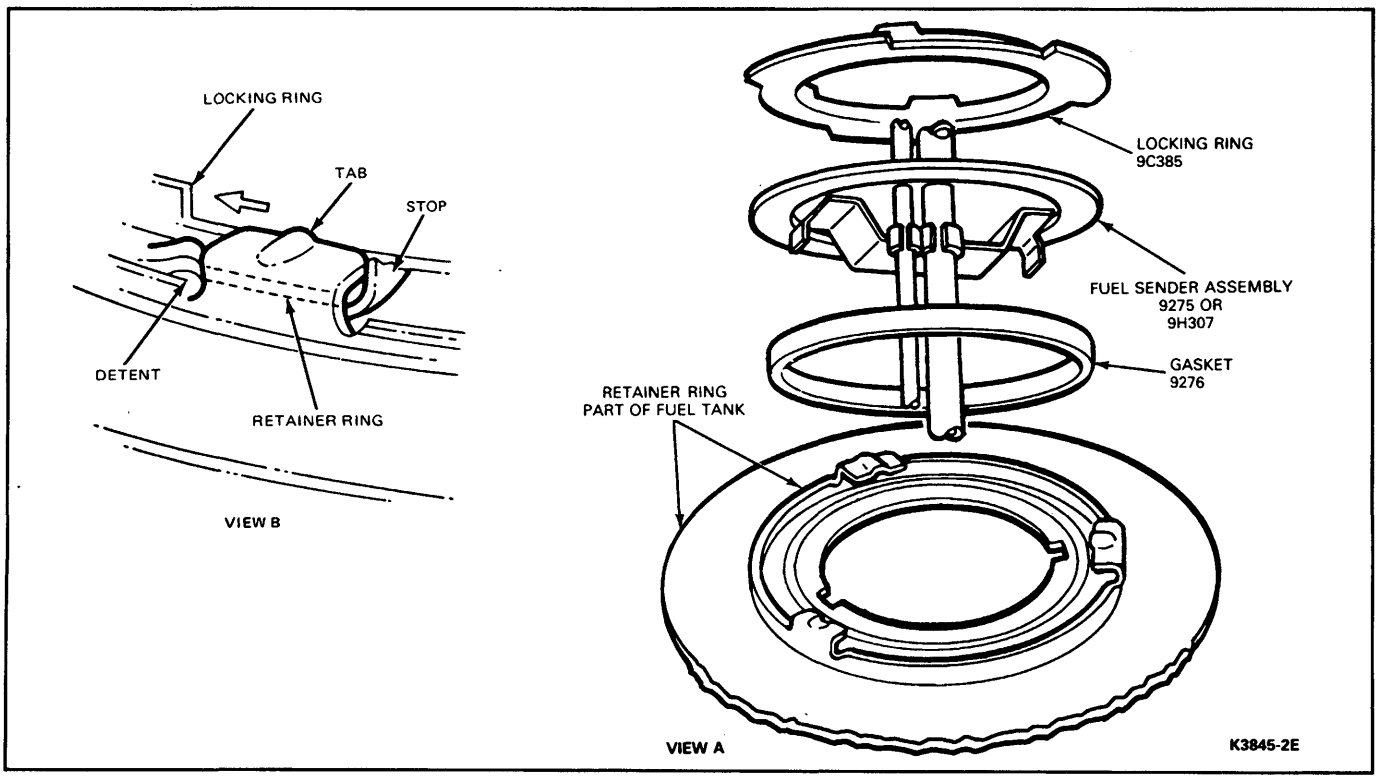


FIG. 15 Fuel Tank Sender Installation (Metal Lock Ring Type)

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CONDITION	POSSIBLE SOURCE	ACTION
Gauge shows full or partial tank when tank is empty.	1. Wrong sender installed.	1. Check part number. Install correct sender.
	2. Sender arm is bent or obstructed.	2. Check sender mounting angle. Bend sender arm gently to correct position.
	3. Improper sender calibration.	3. Test for correct resistance values and replace as needed.
Gauge reads full at all fuel levels.	1. Short circuit in wiring (Econoline). Open circuit (F-Series).	1. Check and repair wiring and/or connectors as necessary.
	2. Sender arm movement obstructed.	2. Check for correct part number and correct angle. Bend sender arm gently away from obstruction or remove obstruction if possible.
Gauge reading fluctuates (erratic). **Note: Some needle movement toward empty during braking, accelerating or cornering is normal.**	1. Loose connection or damaged wiring.	1. Tighten all connections and terminations. Check and repair wiring for shorts or opens.
	2. Wear spot on sender variable resistor.	2. Check sender for smooth electrical resistance change as arm is moved through full range. If resistance readings hesitate or jump, replace sender.
	3. Leaking sender float.	3. Replace float.

CK5823-2C

CONDITION	POSSIBLE SOURCE	ACTION
Fuel gauge shows empty at all levels of fill.	1. Loose or dirty wiring connections or short to ground in wiring.	1. Check wiring connectors and sender terminals. Repair, clean, or tighten as needed.
	2. Leaking sender float.	2. Replace float.
	3. Missing sender float.	3. Install float. Ensure float is securely retained on sender arm.
	4. Open circuit in sender (Econoline). Short circuit (F-Series).	4. Test for correct resistance values and replace if needed.
	5. Sender arm movement obstructed.	5. Reinstall sender properly. Bend arm to correct position if needed.
Fuel gauge will not read full when tank is full.	1. Wrong sender installed.	1. Check part number. Install correct part.
	2. Sender arm movement obstructed.	2. Reinstall sender to correct operation. Bend sender arm slightly away from obstruction or remove obstruction.
	3. Leaking float.	3. Install new float.
	4. Sender or gauge calibration.	4. Test for correct resistance valve and replace if needed.

CK5822-2C

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NO FUEL LEVEL INDICATION — VEHICLES WITH DUAL TANKS (6 PORT FUEL SELECTOR VALVE)

	TEST STEP	RESULT ▶	ACTION TO TAKE
A1	BYPASS TANK SELECTOR VALVE		
	• Disconnect electrical connector from tank selector valve. • Turn ignition to RUN position. • Jumper connector terminals No. 4 and No. 5 for rear tank. • Fuel gauge should indicate fuel level in rear tank. • Jumper connector terminals No. 3 and No. 4 for front tank. • Fuel gauge should indicate fuel level in front tank.	(OK) ▶ (OK) ▶	REPLACE fuel tank selector valve. CHECK for faulty fuel gauge, fuel sender and/or wiring. REPAIR or REPLACE as necessary.

CK6752-2C

SPECIAL SERVICE TOOLS

Tool	Description
T74P-9275-A	Fuel Tank Sender Wrench

CK6222-1C

ROTUNDA EQUIPMENT

Model	Description
021-00055	Instrument Gauge System Tester

CK6351-1E

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SECTION 33-32 Oil Pressure Gauge

SUBJECT	PAGE
DESCRIPTION AND OPERATION	
System Operation	33-32-1
DIAGNOSIS	33-32-1
REMOVAL AND INSTALLATION	
Oil Pressure Gauge	33-32-1
E-150—E-350	33-32-1
F-150 Through F-350 and Bronco	33-32-1
REMOVAL AND INSTALLATION (Cont'd)	
Sending Unit	33-32-1
SPECIAL SERVICE TOOLS	33-32-4
SPECIFICATIONS	33-32-4
VEHICLE APPLICATION	33-32-1

VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

System Operation

Magnetic Gauge System

Refer to Figs. 1 and 2.

The magnetic gauge movement consists of three primary coils, one of which is wound at a 90 degree angle to the other two. The coils form a magnetic field which varies in direction according to the variable resistance of the sender unit which is connected between two of them. A primary magnet, to which a shaft and pointer are attached, rotates to align to this primary field, resulting in pointer position. The bobbin/coil assembly is pressed into a metal housing which has two holes for dial mounting. There is no adjustment, calibration or maintenance required for these gauges.

NOTE: An instrument voltage regulator (IVR) is not required for this system.

REMOVAL AND INSTALLATION

Sending Unit

The oil pressure sending units are mounted in different ways and locations. Fig. 3 is a typical example for gasoline engines. Fig. 4 shows the installation for the 7.3L diesel engine.

To remove the sending unit, disconnect the wire at the unit terminal and unscrew the unit from its mounting. Install the new sending unit and tighten to 11-24 N·m (8-18 ft-lb). Connect the wire to the unit terminal and check the operation of the unit.

CAUTION: Be sure to use electrically conductive water-resistant sealer on the threads of the unit. The pressure switch-type unit used with the indicator lamp system is not interchangeable with the variable resistance-type unit called a sender, which is used with the gauge system. Refer to the Master Parts Catalog for proper parts usage. Installation of the wrong part will result in an inoperative oil pressure indicating system and a damaged sender unit, IVR or gauge.

Oil Pressure Gauge

E-150—E-350

Remove the instrument cluster. Refer to Section 33-51, Instrument Cluster and Printed Circuit. Then remove the housing, mask and lens from the front of the cluster by removing the retaining screws. Remove the oil pressure gauge retaining nuts and remove the gauge. To install, position the oil pressure gauge and install the retaining nuts. Install the mask, lens and housing to the front side of the cluster and install the retaining screws.

F-150 Through F-350 and Bronco

Remove the instrument cluster. Refer to Section 33-51, Instrument Cluster and Printed Circuit. Then, remove the lens and mask from the cluster. Remove the two nuts attaching the gauge to the cluster, and remove the gauge. To install, reverse the removal procedure.

DIAGNOSIS

Refer to the following charts for magnetic gauge diagnosis.

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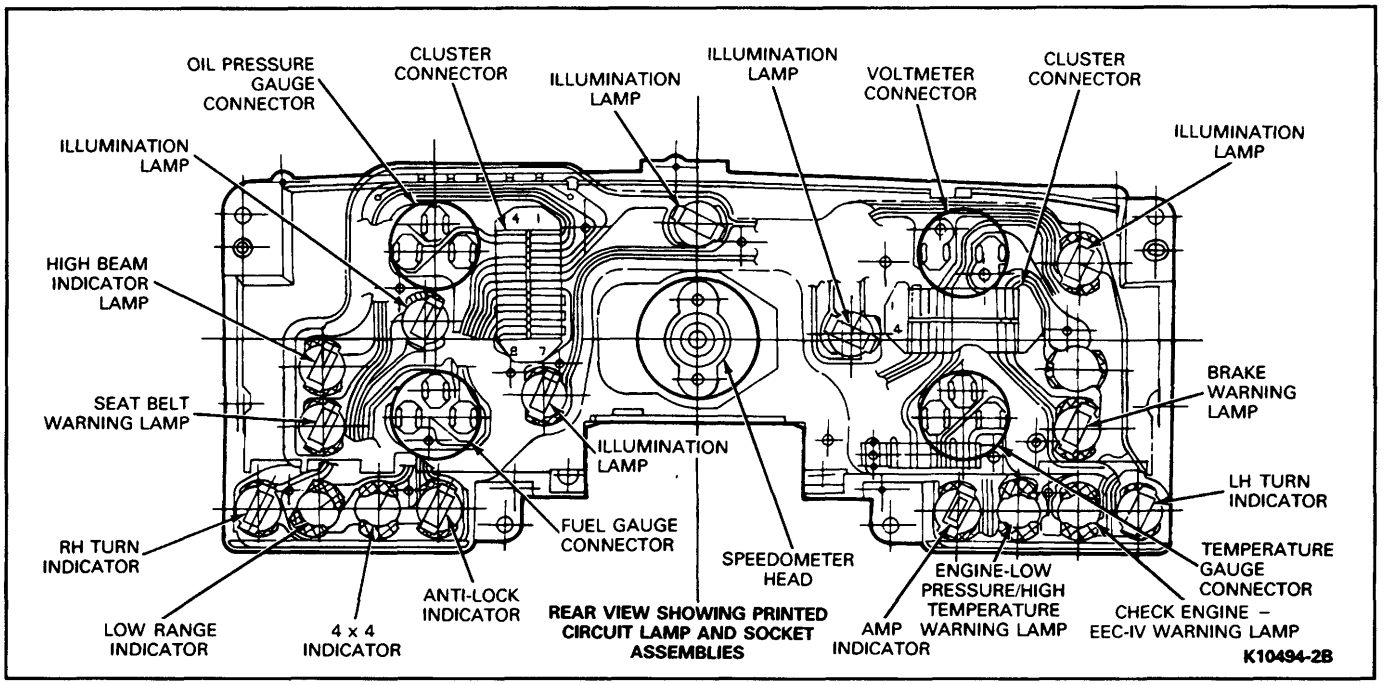


FIG. 1 Oil Pressure Gauge Location

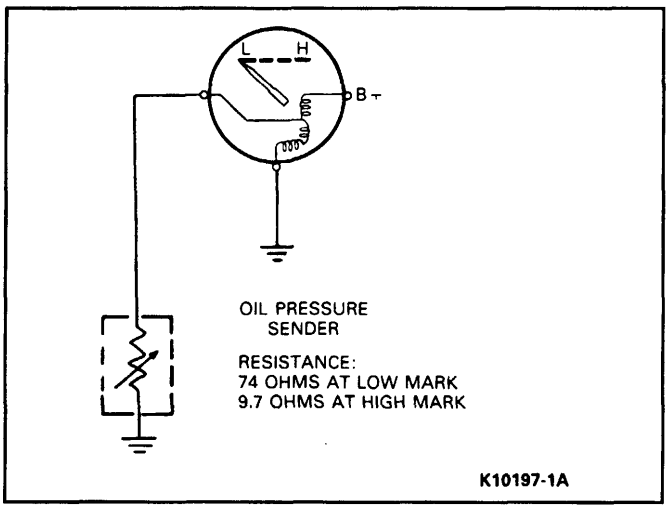


FIG. 2 Oil Pressure Indicating System Schematic

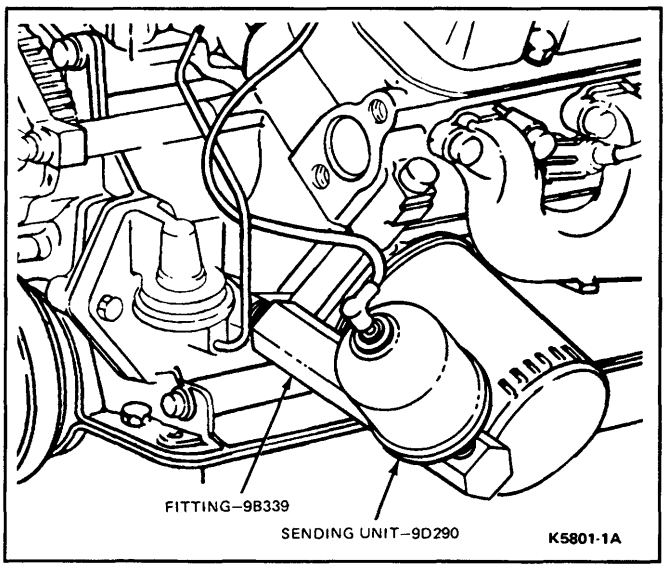


FIG. 3 Typical Oil Pressure Sender Unit 8-Cylinder—5.0L (302 CID) and 5.8L (351 W) Engines Shown

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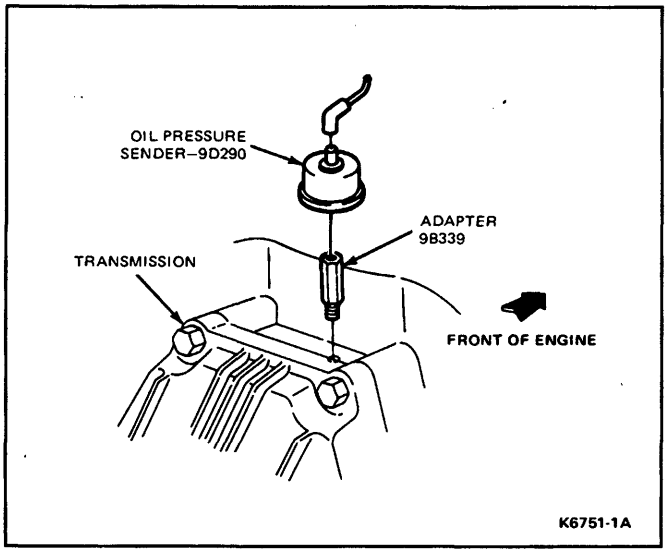


FIG. 4 Oil Pressure Sender Unit—7.3L Diesel Engine

OIL GAUGE INOPERATIVE — POINTER DOES NOT MOVE
PINPOINT TEST A

TEST STEP		RESULT ▶	ACTION TO TAKE
A1	VERIFY CONDITION		
	• Verify Condition.	Gauge pointer does not move ▶	GO to **B2.**
		Gauge pointer moves ▶	GO to **B1.**
A2	CHECK OTHER GAUGES		
	• Check power to cluster. With ignition on, observe other gauges and warning lamps for proper operation. If necessary, use voltmeter or test lamp to verify voltage at B+ terminal of cluster connector.	Other gauges and warning lamps operate correctly; voltage present at cluster ▶	GO to **B1.**
		Other gauges and warning lamps do not operate correctly; no voltage present at cluster ▶	SERVICE power to cluster.

CK10199-2B

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OIL GAUGE INACCURATE
PINPOINT TEST B

TEST STEP		RESULT	ACTION TO TAKE
B1	TEST BOX CHECK		
	• Insert Instrument Gauge, System Tester, Rotunda 021-00055 or equivalent in sender circuit. Disconnect connector at sender and connect tester to cluster side of connector. Set tester to LOW (73 ohms).	Gauge reads L ▶	GO to **B2**.
		Pointer does not move ▶	GO to **B3**.
B2	TEST BOX CHECK		
	• Set tester to HIGH (9.7 ohms).	Gauge reads H ▶	REPLACE sender.
		Gauge does not read H ▶	GO to **B3**.
B3	CHECK SENDER WIRING		
	• Check sender circuit wiring for shorts or open with ohmmeter.	(OK) ▶	REPLACE gauge.
		(OK) ▶	SERVICE wiring.

CK10200-2B

SPECIFICATIONS

ALL GAUGES

Size (Less Terminals)	29mm diameter x 25mm length (1.4 in. diameter x 1 in. length)
Weight (Less Dial and Pointer)	40 grams (1.4 ounces)
Mounting	Flange on Steel Body
Operating Temperature	−30°C to 80°C (−86°F to 176°F)
Pointer Travel	85° (Fuel)
	90° (Temp and Oil)
Electrical Connection	Three Pin Terminals
Operating Voltage	11-16 VDC

CK10426-1A

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Model	Description
021-00055	Instrument Gauge System Tester

CK6351-1E

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SECTION 33-41 Temperature Indicator

SUBJECT	PAGE
DIAGNOSIS AND TESTING	33-41-1
REMOVAL AND INSTALLATION	
Temperature Gauge	33-41-1
Temperature Sending Unit	33-41-1
SPECIAL SERVICE TOOLS	33-41-4
VEHICLE APPLICATION	
Magnetic Gauges	33-41-1

VEHICLE APPLICATION

All Models.

Magnetic Gauges

Fuel, Temperature and Oil Pressure

The magnetic gauge movement consists of three primary coils, one of which is wound at a 90 degree angle to the other two. The coils form a magnetic field which varies in direction according to the variable resistance of the sender unit which is connected between two of them. A primary magnet, to which a shaft and pointer are attached, rotates to align to this primary field, resulting in pointer position. The bobbin/coil assembly is pressed into a metal housing which has two holes for dial mounting. There is no adjustment, calibration or maintenance required for these gauges. Refer to Fig. 1.

NOTE: An instrument voltage regulator (IVR) is not required for this system. Refer to Diagnostic procedure.

REMOVAL AND INSTALLATION

Temperature Sending Unit

Removal and Installation

1. Remove cap from radiator to relieve any pressure and then replace cap. This reduces coolant loss during sender replacement.

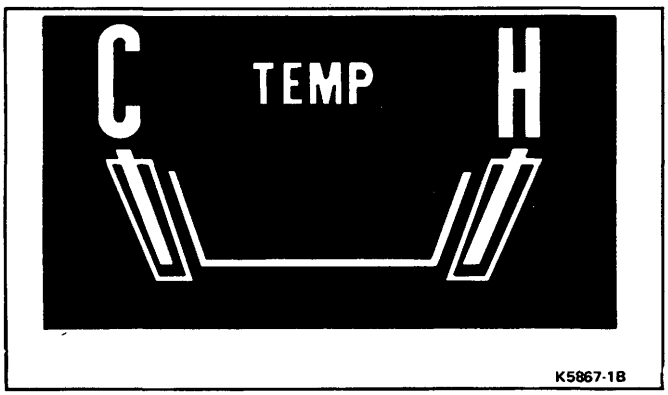


FIG. 1 Coolant Temperature Gauge System (E-Series Shown, Other Models Similar)

2. Disconnect the temperature sending unit wire at the sending unit (Figs. 2 and 3).
3. Prepare the new temperature sending unit for installation by applying Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A, ESR-M18P7-A) or equivalent, or a small amount of electrically conductive sealer to the threads.
4. Remove the temperature sending unit from the cylinder head and immediately install the new temperature sending unit. Tighten to 11-24 N·m (8-18 ft-lb).
5. Connect the wire to the temperature sending unit.
6. Refill cooling system to replace lost coolant.
7. Start the engine and check the sending unit operation.

Temperature Gauge

CAUTION: The use of vinyl cleaners and similar other cleaning agents to clean the vehicle interior and/or instrument cluster lenses has resulted in damage to the instrument cluster lenses. The chemical content of these cleaning agents (O-dichlorobenzene, ethyl alcohol and/or Cellosolve), has produced fogging, spotting, stain, or splotches of the lenses, either through over-spray or direct use on the lenses. Therefore, extreme caution should be taken during interior cleanup to prevent over-spray of cleaning agents which contain the chemical contents mentioned from contacting the instrument cluster lenses.

The instrument cluster lenses should be cleaned with Ford Glass Cleaner E4AZ-19C507-A (ESR-M14P5-A) or equivalent commercial cleaning product, using a clean, soft, lint-free cloth. The Ford Glass Cleaner has been specially formulated for cleaning windows in automotive vehicles and is approved for use in cleaning the plastic instrument cluster lenses. Read and carefully follow the directions shown on the container for best results.

DIAGNOSIS AND TESTING

For diagnosis and testing of the temperature gauge and sending unit, use a test lamp and Rotunda Instrument Gauge System Tester 021-00055 or equivalent. Refer to Figures 4 and 5, and the diagnosis guides for the test schematics and steps to check the gauge and sending unit.

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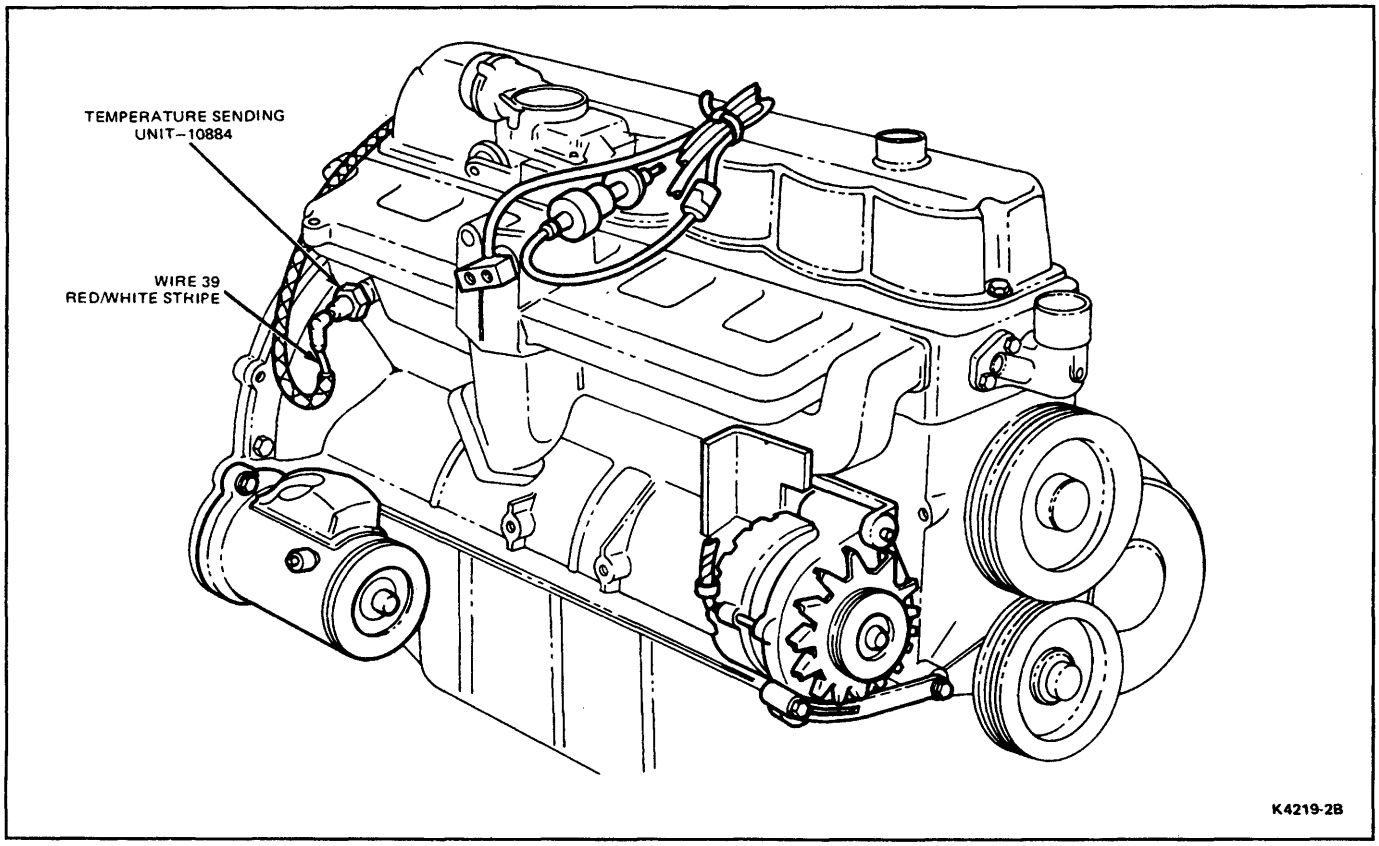


FIG. 2 Temperature Sending Unit—6 Cylinder—E-150—E-350 Shown, F-150—F-350 and Bronco Similar

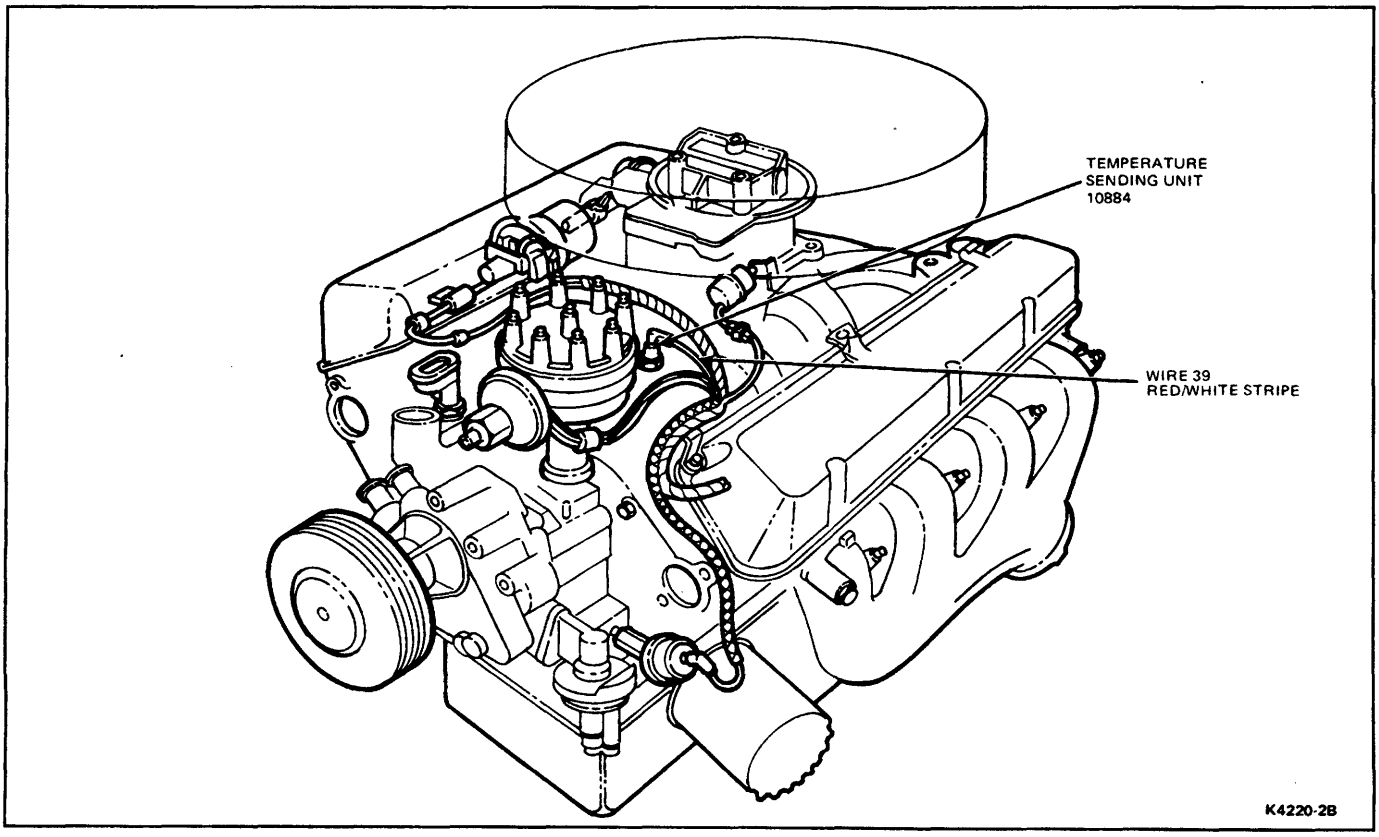


FIG. 3 Temperature Sending Unit—8 Cylinder—E-150—E-350 5.8L (351 C.I.D.) Shown—Other Models and 8 Cylinder Engines Similar

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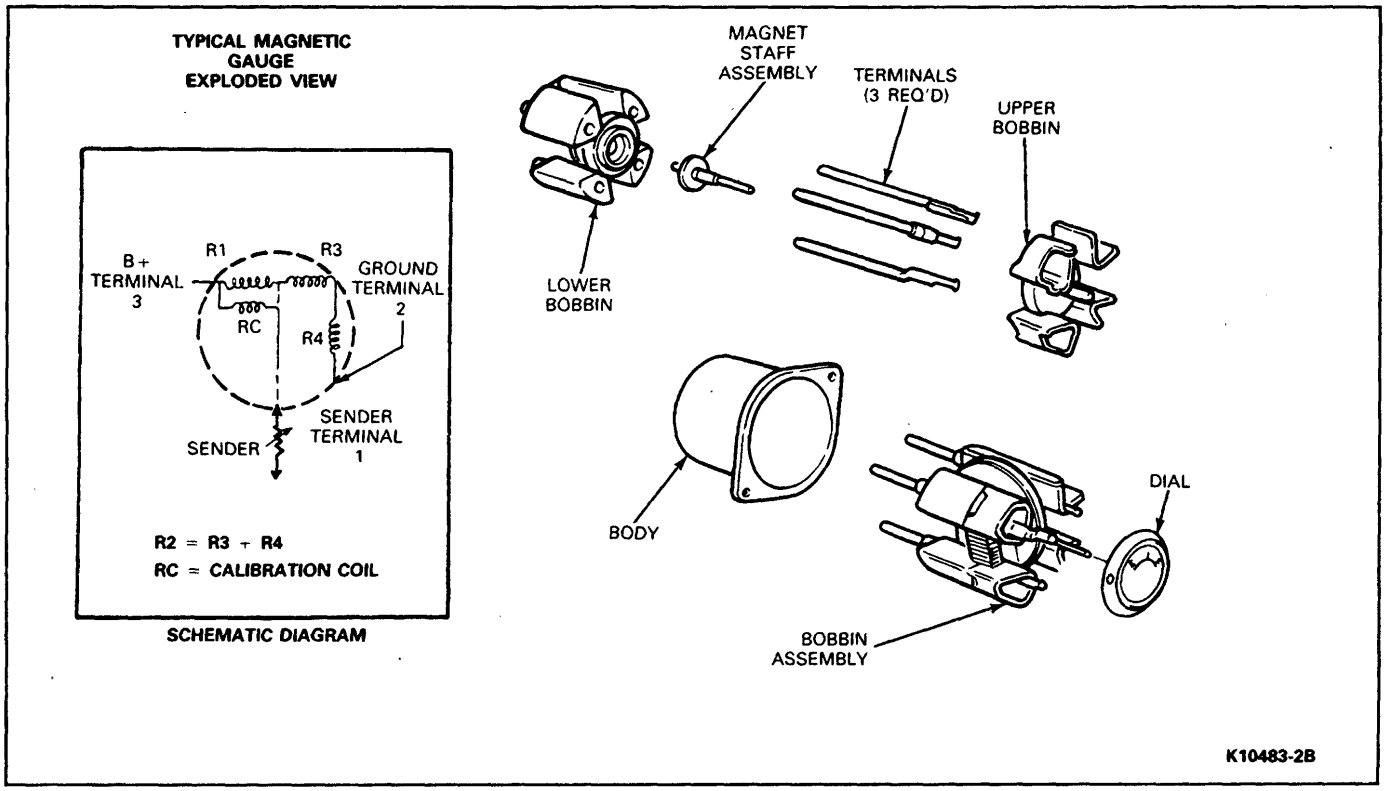


FIG. 4 Typical Magnetic Gauge Exploded View

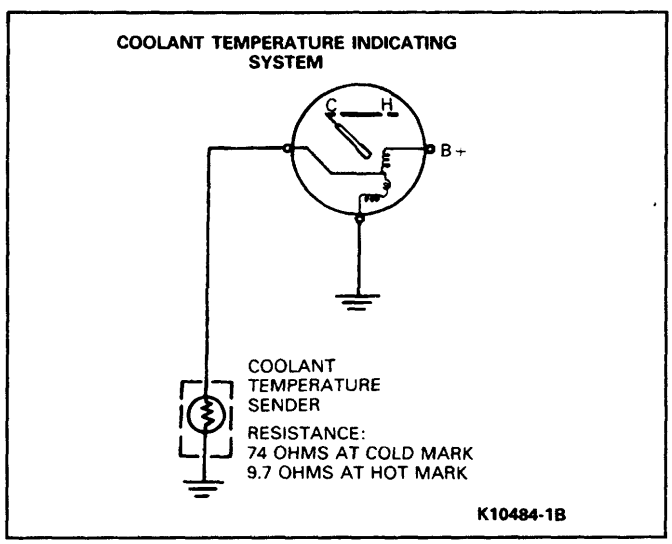


FIG. 5 Coolant Temperature System

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TEMP GAUGE INOPERATIVE — POINTER DOES NOT MOVE
PINPOINT TEST A

TEST STEP		RESULT	ACTION TO TAKE
A1	VERIFY CONDITION		
• Verify Condition.		Gauge pointer does not move	GO to **A2**.
		Gauge pointer moves	GO to **B1**.
A2	CHECK OTHER GAUGES		
• Check power to cluster. With ignition on, observe other gauges and warning lamps for proper operation. If necessary, use voltmeter or test lamp to verify voltage at B+ terminal of cluster connector.		Other gauges and warning lamps operate correctly; voltage present at cluster	GO to **B1**.
		Other gauges and warning lamps do not operate correctly; no voltage present at cluster	SERVICE power to cluster — wiring.

CK10485-2B

TEMP GAUGE INACCURATE
PINPOINT TEST B

TEST STEP		RESULT	ACTION TO TAKE
B1	TEST BOX CHECK		
• Insert Instrument Gauge, System Tester, Rotunda 021-00055 or equivalent in sender circuit. Disconnect connector at sender and connect tester to cluster side of connector. Set tester to LOW (73 ohms).		Gauge reads C	GO to **B2**.
		Pointer does not move	GO to **B3**.
B2	TEST BOX CHECK		
• Set tester to HIGH (9.7 ohms).		Gauge reads H	REPLACE sender.
		Gauge does not read H	GO to **B3**.
B3	CHECK SENDER WIRING		
• Check sender circuit wiring for shorts or open with ohmmeter.		OK	REPLACE gauge.
		OK (crossed out)	SERVICE wiring.

CK10486-2B

ALL GAUGES

Size (Less Terminals)	29 mm diameter x 25 mm length (1.4 in diameter x 1 in length)
Weight (Less Dial and Pointer)	40 grams (1.4 ounces)
Mounting	Flange on Steel Body
Operating Temperature	−30°C to 80°C (−86°F to 176°F)
Pointer Travel	90° (Temp Gauge)
Electrical Connection	Three Pin Terminals
Operating Voltage	11-16 VDC

CK10482-1A

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Model	Description
021-00055	Instrument Gauge System Tester

CK6351-1E

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SECTION 33-51 Instrument Cluster and Printed Circuit

SUBJECT	PAGE
REMOVAL AND INSTALLATION	
Cluster Assembly	33-51-1
E-150—E-350	33-51-1
F-150 Through F-350 and Bronco	33-51-1
Instrument Cluster Illumination and Indicator Bulbs	33-51-6
REMOVAL AND INSTALLATION (Cont'd)	
Instrument Voltage Regulator and Printed Circuit	33-51-3
VEHICLE APPLICATION	33-51-1

VEHICLE APPLICATION

All Light Truck Models.

REMOVAL AND INSTALLATION

CAUTION: The use of vinyl cleaners and similar other cleaning agents to clean the vehicle interior and/or instrument cluster lenses has resulted in damage to the instrument cluster lenses. The chemical content of these cleaning agents (O-dichlorobenzene, ethyl alcohol and/or Cellosolve), has produced fogging, spotting, stain, or splotches of the lenses, either through over-spray or direct use on the lenses. Therefore, extreme caution should be taken during interior cleanup to prevent over-spray of cleaning agents which contain the chemical contents mentioned from contacting the instrument cluster lenses.

The instrument cluster lenses should be cleaned with Ford Glass Cleaner D8AZ-19C507-A (ESR-M14P5-A) or equivalent commercial cleaning product, using a clean, soft, lint-free cloth. The Ford Glass Cleaner has been specially formulated for cleaning windows in automotive vehicles and is approved for use in cleaning the plastic instrument cluster lenses. Read and carefully follow the directions on the container for best results.

Cluster Assembly

Refer to Figs. 1, 2 and 3

E-150—E-350

Removal

1. Disconnect the battery ground cable.
2. Remove two steering column shroud-to-panel retaining screws and remove shroud.
3. Loosen bolts which attach the column to the band C support to provide sufficient clearance for cluster removal. (Required for tilt steering column vehicles only.)
4. Remove seven instrument cluster-to-panel retaining screws (Fig. 1).
5. Position cluster slightly away from the panel for access to the back of the cluster to disconnect the speedometer (Fig. 3).

   If there is not sufficient access to disengage the speedometer cable from the speedometer, it may be necessary to remove the speedometer cable at the transmission and pull cable through cowl, to allow room to reach the speedometer quick disconnect.
6. Disconnect the harness connector plug from the printed circuit and remove the cluster assembly from the instrument panel.

Installation

1. Apply approximately 4.8 mm (3/16-inch) diameter ball of Silicone Dielectric Compound D7AZ-19A331-A (ESE-M1C171-A) or equivalent in the drive hole of the speedometer head.
2. Position the cluster near its opening in the instrument panel.
3. Connect the harness connector plug to the printed circuit board.
4. Connect the speedometer cable (quick disconnect) to the speedometer head (Fig. 3).

   Connect the speedometer cable and housing assembly to the transmission, if removed.
5. Install the seven instrument cluster-to-panel retaining screws and connect the battery ground cable (Fig. 1).
6. Check operation of all gauges, lamps, and signals.
7. Install the steering column. Refer to Section 13-06, Steering Column—Shift Rod Within Tube.
8. Position steering column shroud to instrument panel and install two screws.

F-150 Through F-350 and Bronco

Refer to Figs. 4, 5, 6 and 7

Removal

1. Disconnect the battery ground cable.
2. Remove the wiper-washer knob. Use a hook tool to release each knob lock tab.
3. Remove the knob from the headlamp switch. Remove the fog lamp switch knob, if so equipped.
4. Remove steering column shroud.

   CAUTION: Care must be taken not to damage transmission control selector indicator (PRNDL) cable on vehicles equipped with automatic transmission.
5. On vehicles equipped with automatic transmission, remove loop on indicator cable assembly from retainer pin (Fig. 8). Remove bracket screw from cable bracket and slide bracket out of slot in tube.

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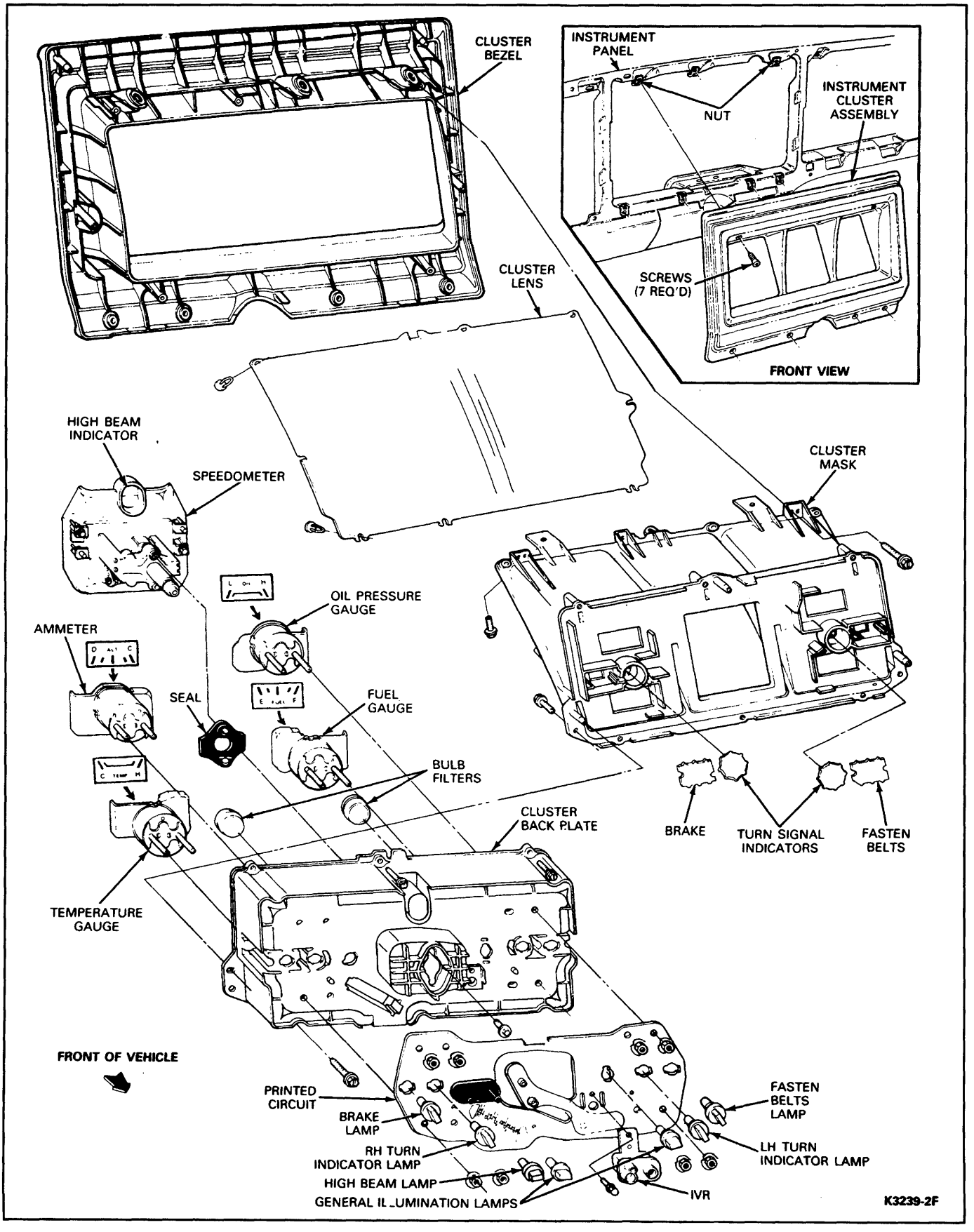


FIG. 1 Instrument Cluster—E-150—E-350

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6. Remove the cluster finish panel assembly. Remove four cluster attaching screws and disconnect the speedometer cable. Also, disconnect wire connectors from the printed circuit and remove the cluster.

Installation

1. Position cluster to opening and connect the two connectors. Connect the speedometer cable. Install the four cluster retaining screws.
2. On vehicles with automatic transmission, place loop on transmission indicator cable assembly over retainer on column.
3. Position the tab on the PRNDL cable bracket into slot on column. Align the PRNDL pointer and attach screw (Fig. 8).
4. With engine off and parking brake applied, place the transmission selector lever at steering column in "D" (DRIVE) (or Ⓓ for automatic overdrive transmissions) position. Hold lever against the "D" (or Ⓓ for AOD transmissions) stop using an approximate 3.6 kg (8 lb) weight attached to the selector lever knob. Use Spring Scale T74P-3504-Y or equivalent.
5. Adjust PRNDL bracket to position the pointer in the adjustment band.
6. Change the transmission lever to PARK position and check the PRNDL pointer. Shift transmission lever to all shift positions (PRND21 or PRNⒹD1) and check the PRNDL pointer position on each transmission shift position, verifying adjustment.
7. Install the trim finish panel assembly and column shroud.
8. Install the headlamp switch knob. If so equipped, install the fog lamp switch.
9. Install the wiper-washer control knobs.
10. Connect the battery cable. Check the operation of all gauges, lamps, signals and PRNDL pointer.

Instrument Voltage Regulator and Printed Circuit

Refer to Figs. 1, 2 and 3.

Removal

1. Remove the instrument cluster assembly from the instrument panel as outlined.
2. Disconnect (snap off) the printed circuit connector buttons from the instrument voltage regulator (Fig. 2).
3. Remove the instrument voltage regulator (one screw).
4. Remove all retaining nuts and light bulbs (and resistor if present), and remove the printed circuit.

Installation

1. When installing the printed circuit, carefully position it to the back of the cluster and engage it to the plastic locating pins.

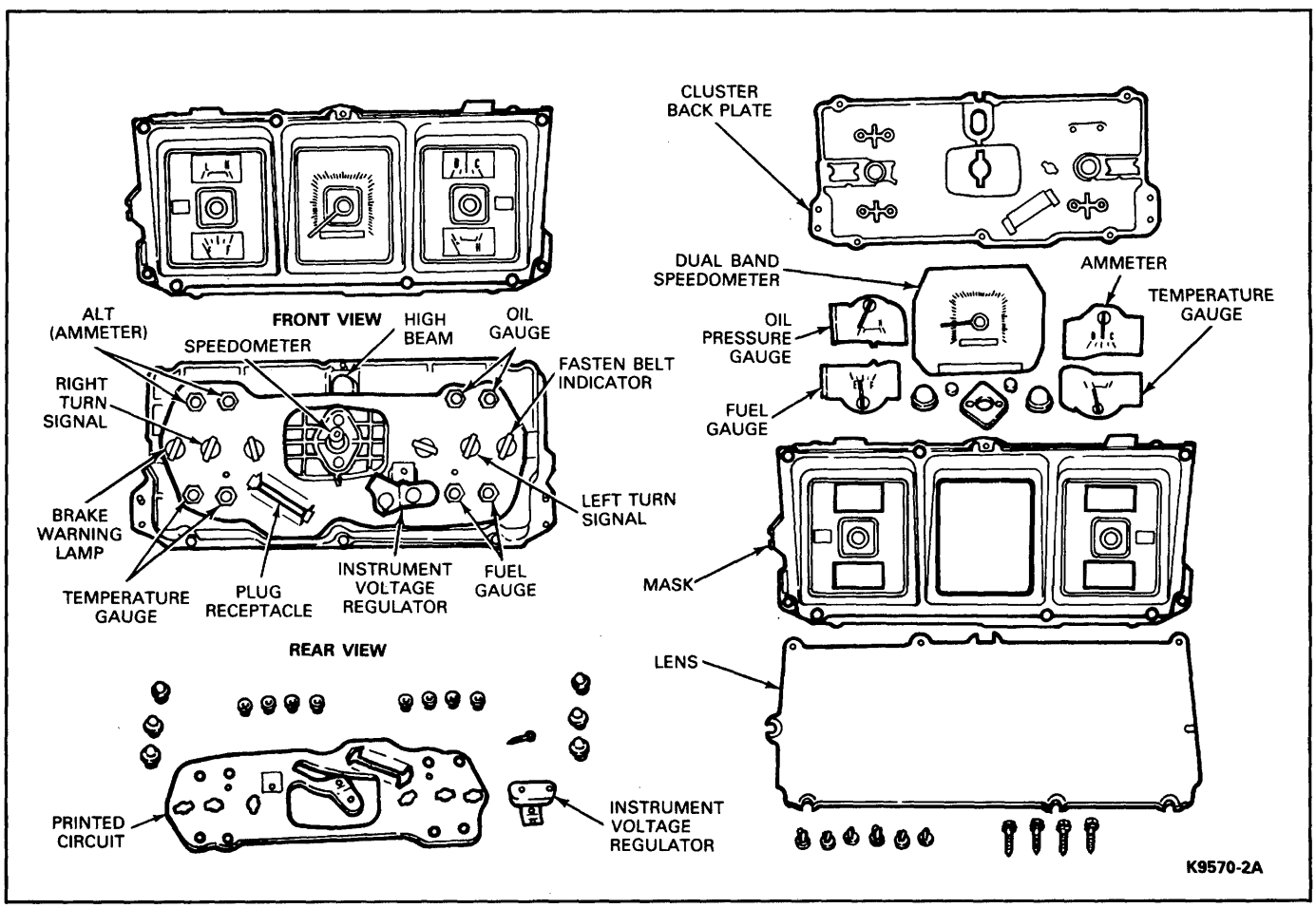


FIG. 2 Instrument Cluster Disassembled—E-150—E-350

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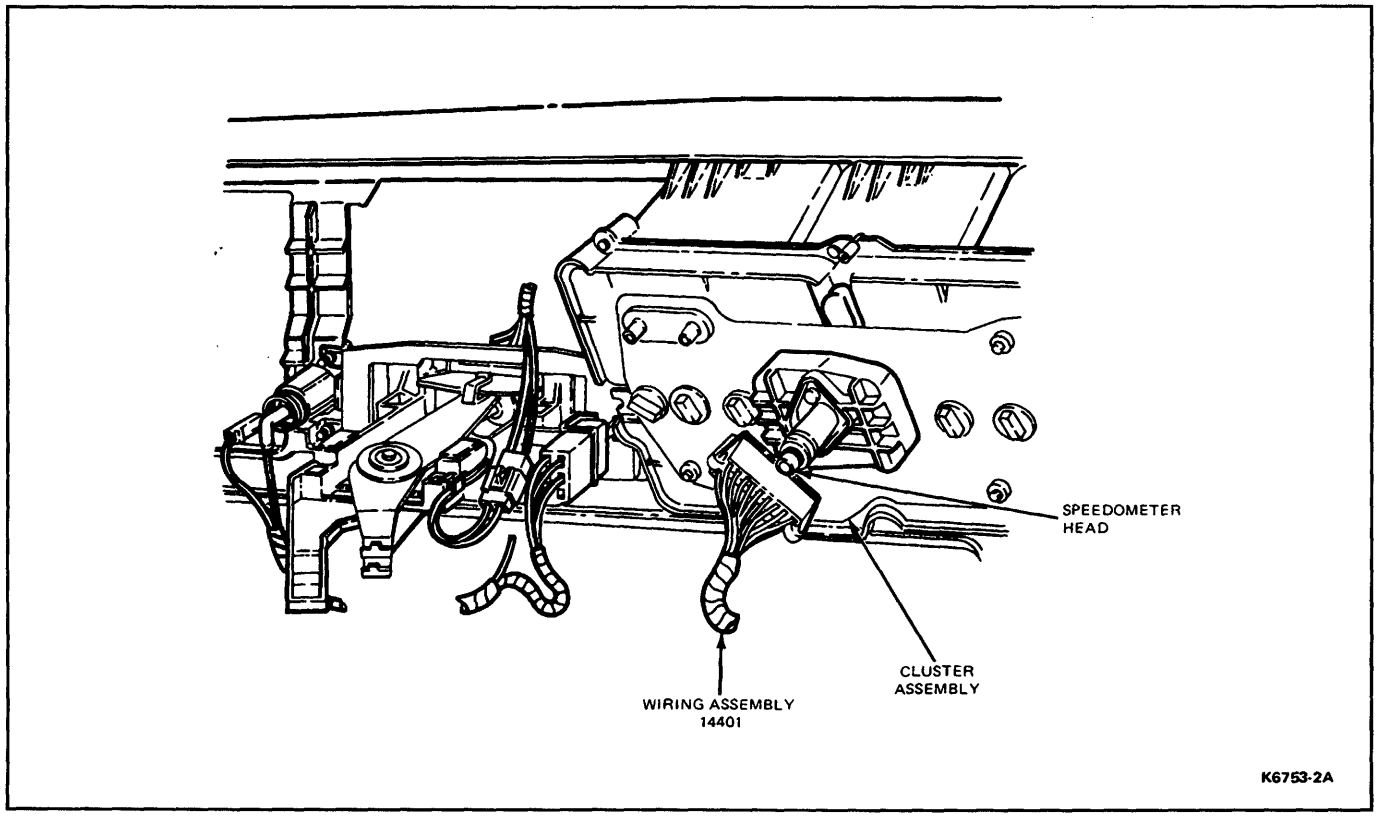


FIG. 3 Instrument Cluster Wiring—E-150—E-350

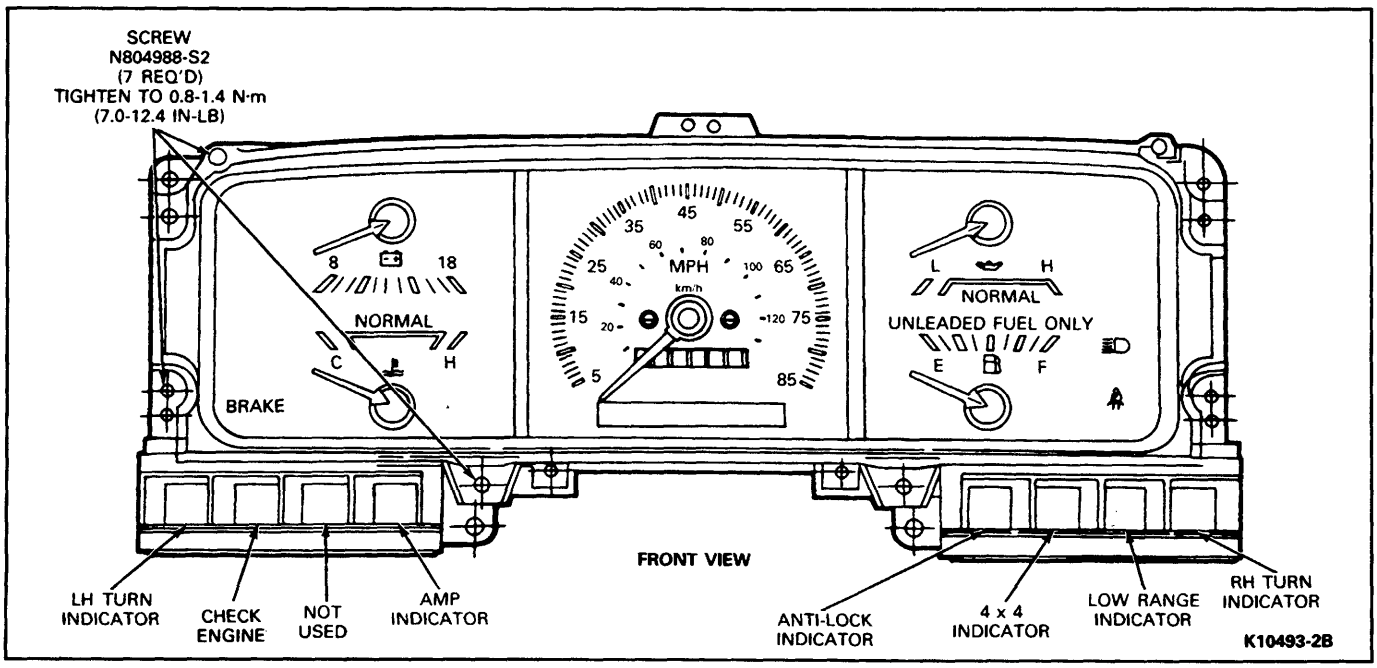


FIG. 4 Instrument Cluster—F-150—F-350 and Bronco (Without Tachometer)

2. Install all retaining nuts, resistor and light bulbs.
3. Install the instrument voltage regulator (one screw).
4. Connect (snap on) the connector buttons to the instrument voltage regulator.
5. Install the cluster assembly as outlined. Check the operation of all gauges, lamps and signals.

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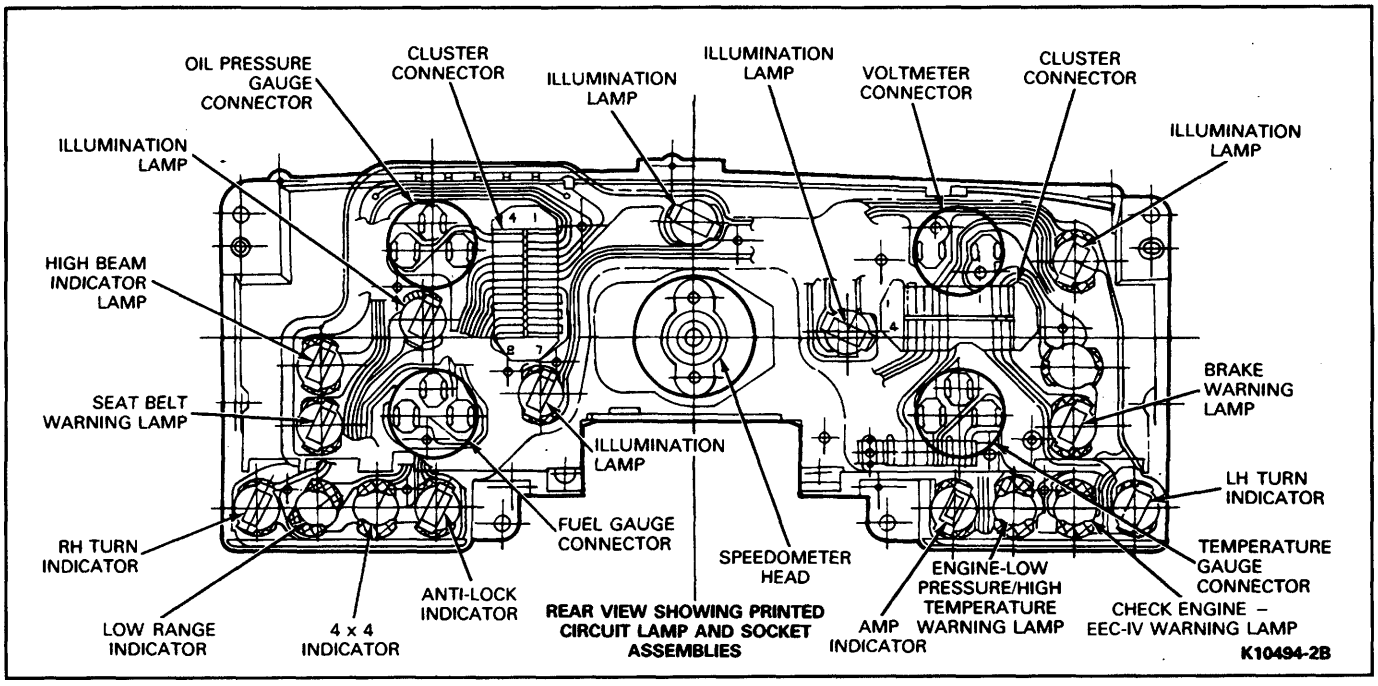


FIG. 5 Instrument Cluster Rear View—F-150—F-350 and Bronco (Without Tachometer)

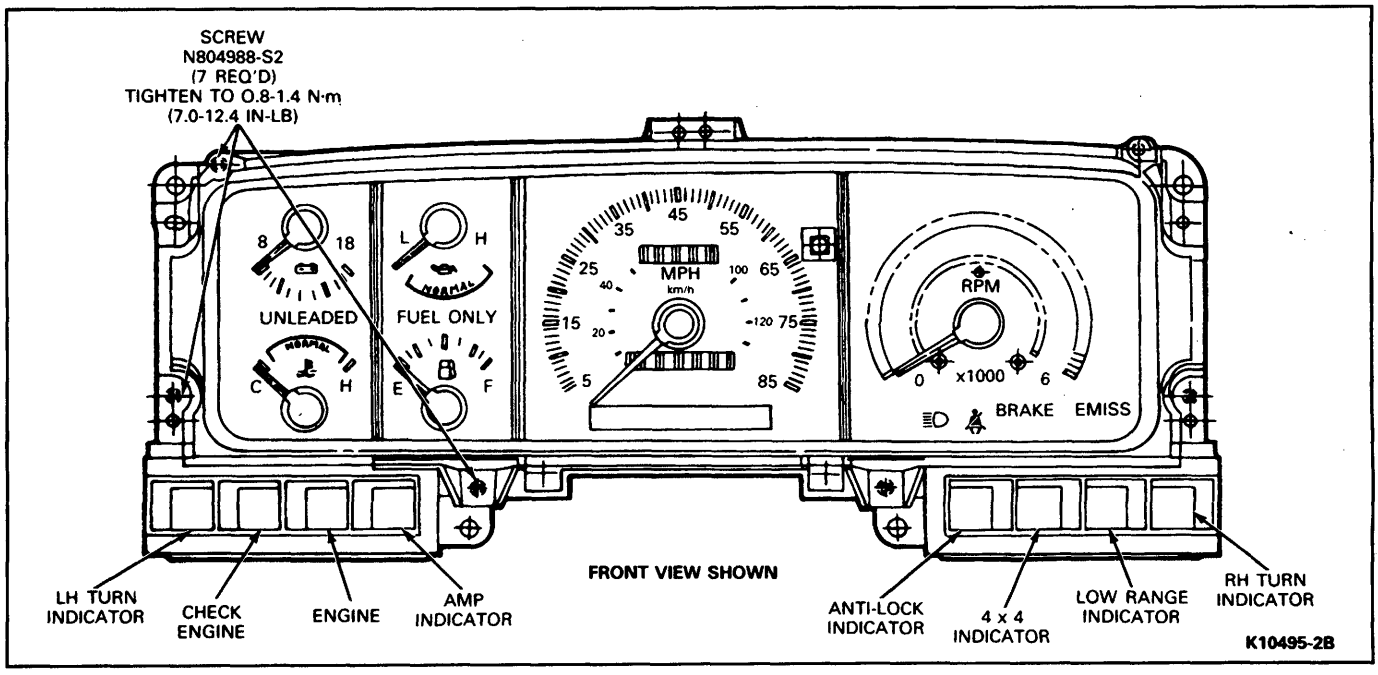


FIG. 6 Instrument Cluster—F-150—F-350 and Bronco (With Tachometer)

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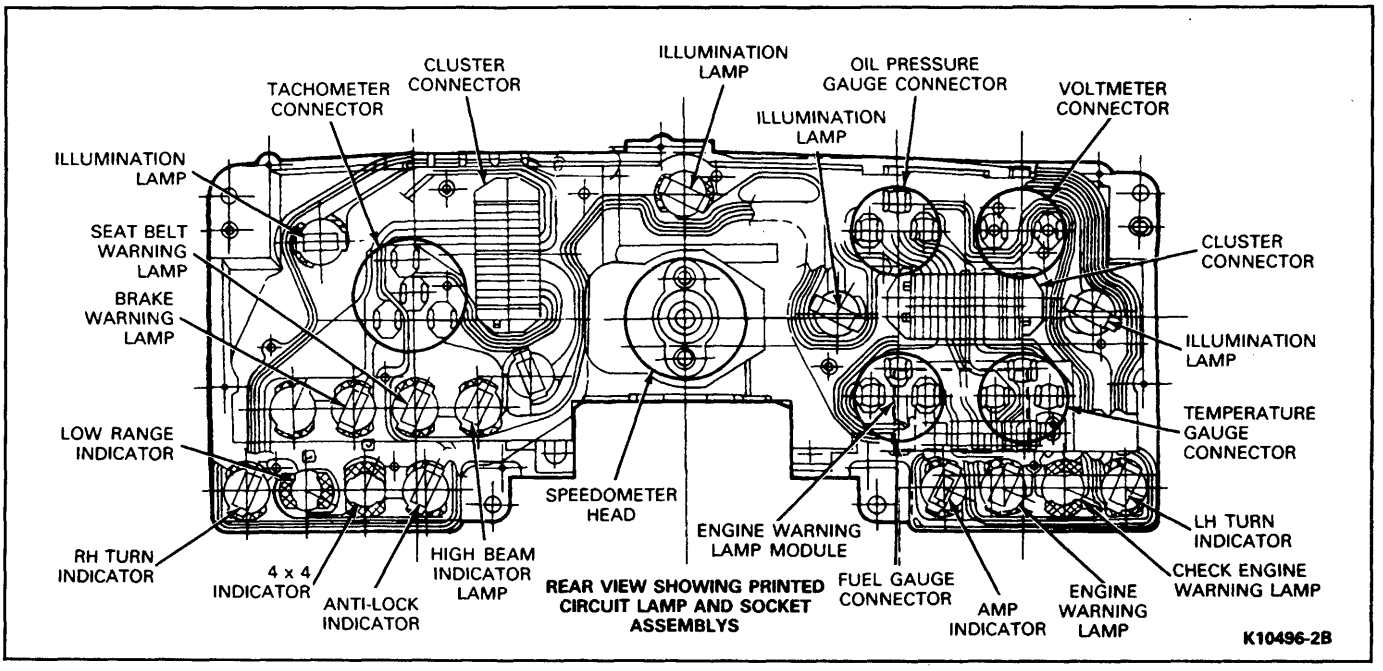


FIG. 7 Instrument Cluster Rear View—F-150—F-350 and Bronco (With Tachometer)

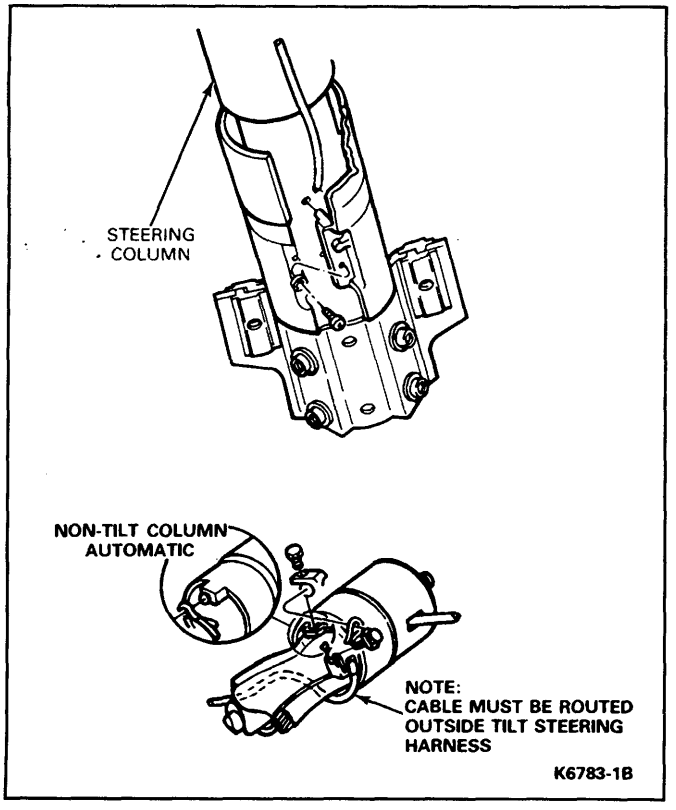


FIG. 8 Automatic Transmission Selector Cable Removal

Instrument Cluster Illumination and Indicator Bulbs —F-150—F-350, Bronco and E-150—E-350

Most cluster illumination and indicator bulbs can be replaced by reaching under the instrument panel. If the bulb cannot be reached from under the panel, access can be gained by removing the instrument cluster as outlined.

SPECIAL SERVICE TOOLS

Number	Description
T74P-3504-Y	Spring Scale

CK9043-1A

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SECTION 33-71 Ignition Switch

SUBJECT	PAGE
ADJUSTMENTS	33-71-2
DESCRIPTION AND OPERATION	33-71-1
DIAGNOSIS AND TESTING	
Electrical Test	33-71-1
DIAGNOSIS AND TESTING (Cont'd)	
Mechanical Test	33-71-1
REMOVAL AND INSTALLATION	33-71-2
VEHICLE APPLICATION	33-71-1

VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

The switch has blade-type terminals that engage with one multiple connector (Fig. 1). The multiple connector is secured to the switch by integral locking fingers.

DIAGNOSIS AND TESTING

NOTE: For an "engine-won't crank" condition with an automatic transmission, determine if the condition exists with the shift lever in both PARK and NEUTRAL positions before performing ignition switch continuity tests. For an "engine-won't crank" condition with a manual transmission, verify that the clutch/starter interlock switches operate properly. If the "no-crank" problem occurs in one shift lever position but not the other, a more probable cause is the neutral start switch located on the transmission.

Electrical Test

Disconnect the ignition switch multiple connector by spreading apart the locking fingers and pulling the plugs from the switch. Test the continuity through the switch following manufacturer's procedures for testing, or connect a self-powered test lamp or ohmmeter between the plug terminals indicated for each switch position in Fig. 2.

NOTE: Accessories that fail to operate with the ignition switch in the RUN position, or that remain on when the ignition switch is turned off, may be the result of a misadjusted ignition switch rather than a malfunctioning ignition switch. Refer to Adjustments.

Mechanical Test

Test the steering column ignition system mechanical operation by rotating the lock cylinder/key through all switch positions. The movement should not stick or bind and should return from the START position back to the RUN position without assistance (spring return). If

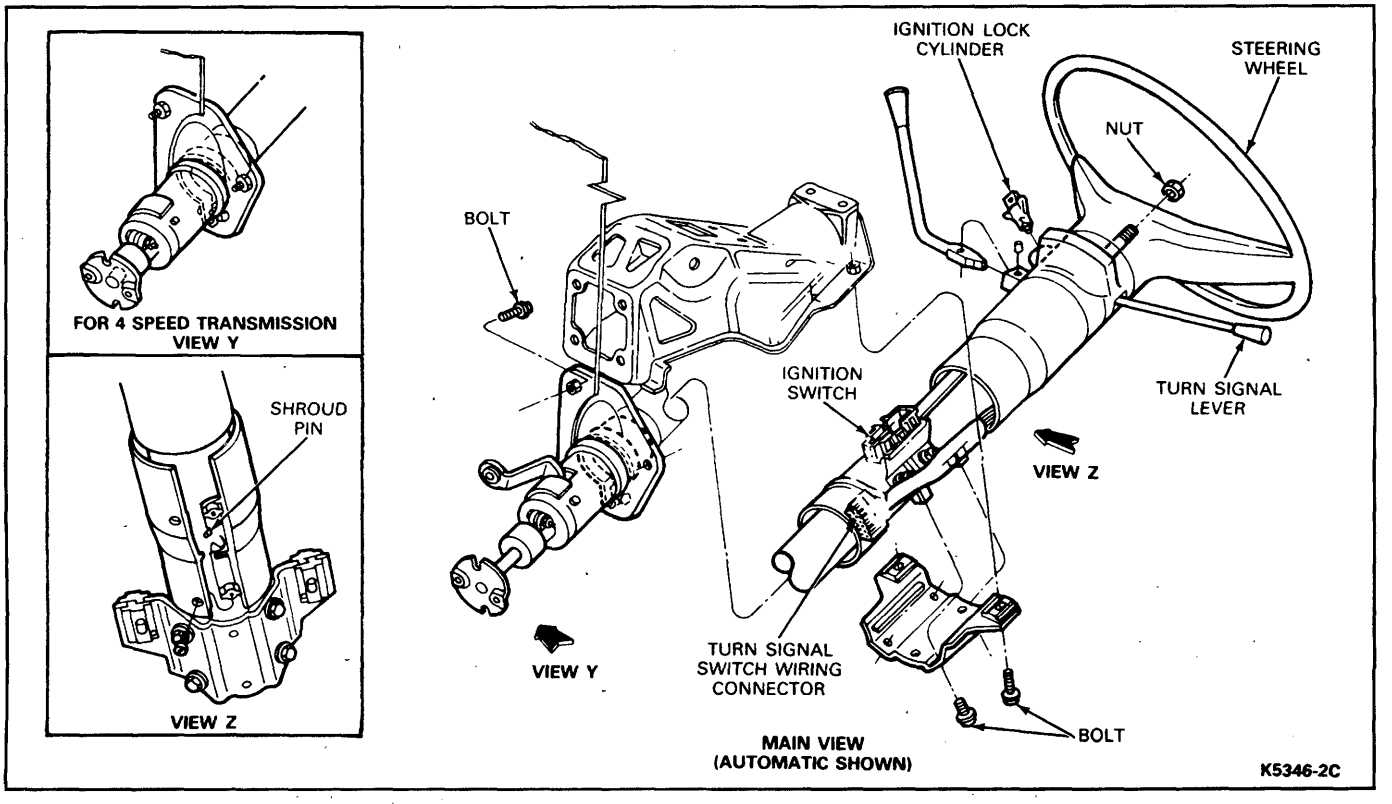


FIG. 1 Blade-Type Connector Ignition Switch

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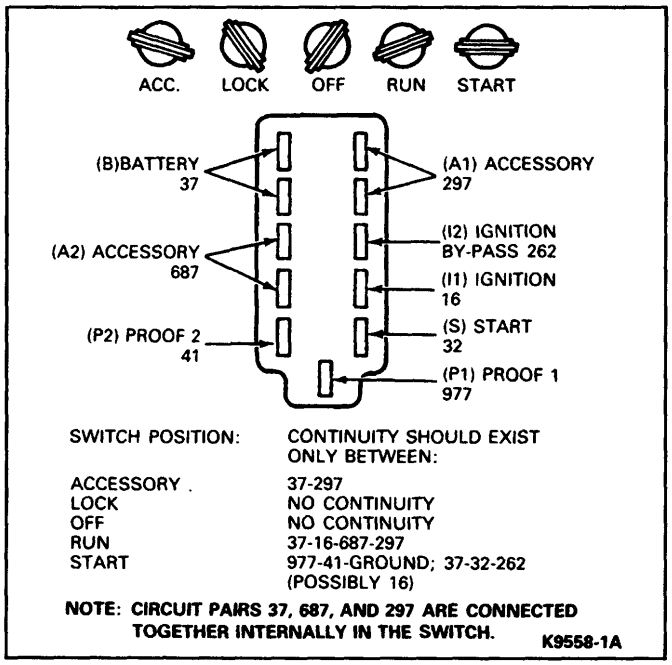


FIG. 2 Blade-Type Connector Ignition Switch Continuity Test

sticking or binding is encountered, check for the following:

- Burrs on the lock cylinder key.
- Insufficient lube on lock cylinder.
- Binding lock cylinder.
- Shroud rubbing against lock cylinder.
- Burrs or foreign material around the rack and pinion actuator in the lock cylinder housing.
- Insufficient lube on actuator.
- Binding ignition switch.
- Binding actuator rod.

NOTE: DO NOT apply lubricant to the inside of the ignition switch.

ADJUSTMENTS

1. Rotate the ignition key back and forth to either side of lock, until a 1.98mm (5/64-inch) drill bit can be inserted through the lockpin hole as far as possible (minimum 9.5mm (3/8 inch)). The lockpin hole is located on the right of the switch next to the steering column tube (Fig. 3).
2. Loosen the two ignition switch mounting nuts.
3. Turn the ignition to LOCK (feel for detent) and remove the ignition key.
4. Move the switch up and down along the column to locate the mid-position of rod lash. Tighten the two ignition switch mounting nuts (top nut first to minimize rod binding) to 4.51-7.34 N·m (40-65 in-lb).
5. Remove the drill bit from the ignition switch lockpin hole.
6. Plug in electrical connector and operate the lock cylinder to ensure the switch is positioned properly.
7. Confirm that all accessories are deactivated with ignition switch in OFF position, and that all accessories are operable in RUN position.

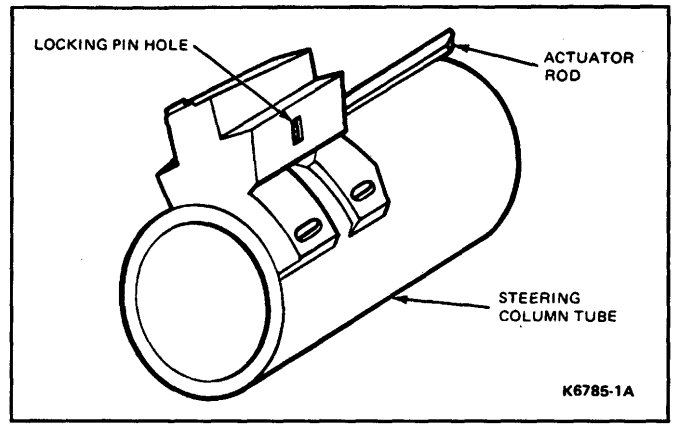


FIG. 3 Locking Pin Hole Location

REMOVAL AND INSTALLATION

Removal

1. Disconnect the battery ground cable.
2. Remove steering column shroud and lower the steering column. Refer to Section 13-06, Steering Column—Shift Rod Within Tube.
3. Disconnect the switch wiring at the multiple plug.
4. Remove the two nuts that retain the switch to the steering column.
5. Lift the switch vertically upward to disengage the actuator rod from the switch and remove switch.

Installation

1. When installing the ignition switch, both the locking mechanism at the top of the column and the switch itself must be in LOCK position for correct adjustment.

   To hold the mechanical parts of the column in LOCK position, move the shift lever into PARK (with automatic transmissions) or REVERSE (with manual transmissions), turn the key to LOCK position, and remove the key. New replacement switches, when received, are already pinned in LOCK position by a metal shipping pin inserted in a locking hole on the side of the switch.
2. Engage the actuator rod in the switch. Must be inserted in the slot of the sliding, black carrier.
3. Position the switch on the column and install the retaining nuts, but do not tighten them.
4. Move the switch up and down along the column to locate the mid-position of rod lash. Tighten the two ignition switch retaining nuts (top nut first to minimize rod binding) to 4.51-7.34 N·m (40-65 in-lb).
5. Remove the lockpin. Connect the battery cable, and check for proper start in PARK or NEUTRAL.

   Also, ensure the start circuit cannot be actuated in the DRIVE and REVERSE position.
6. Raise the steering column into position at instrument panel. Refer to Section 13-06, Steering Column—Shift Rod Within Tube. Install steering column shroud.
7. Confirm that accessories are deactivated with ignition switch in OFF position, and that accessories are operable with switch in RUN position.

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MAIN WIRING HARNESS CIRCUIT PROTECTION AND CONNECTORS

GROUP 34

(14000)

SECTION TITLE	PAGE
CONNECTOR DISENGAGEMENT	34-01-1
FUSES, CIRCUIT BREAKERS AND FUSE LINKS	34-31-1
WIRING LIGHT TRUCK	34-02-1

SECTION 34-01 Connector Disengagement

SUBJECT	PAGE
ALL MODEL APPLICATIONS	34-01-1
VEHICLE APPLICATION	34-01-1

VEHICLE APPLICATION

All Models.

ALL MODEL APPLICATIONS

Connector disengagement procedures are shown in Figs. 1 through 4 and should be used when disconnecting the various types of connectors.

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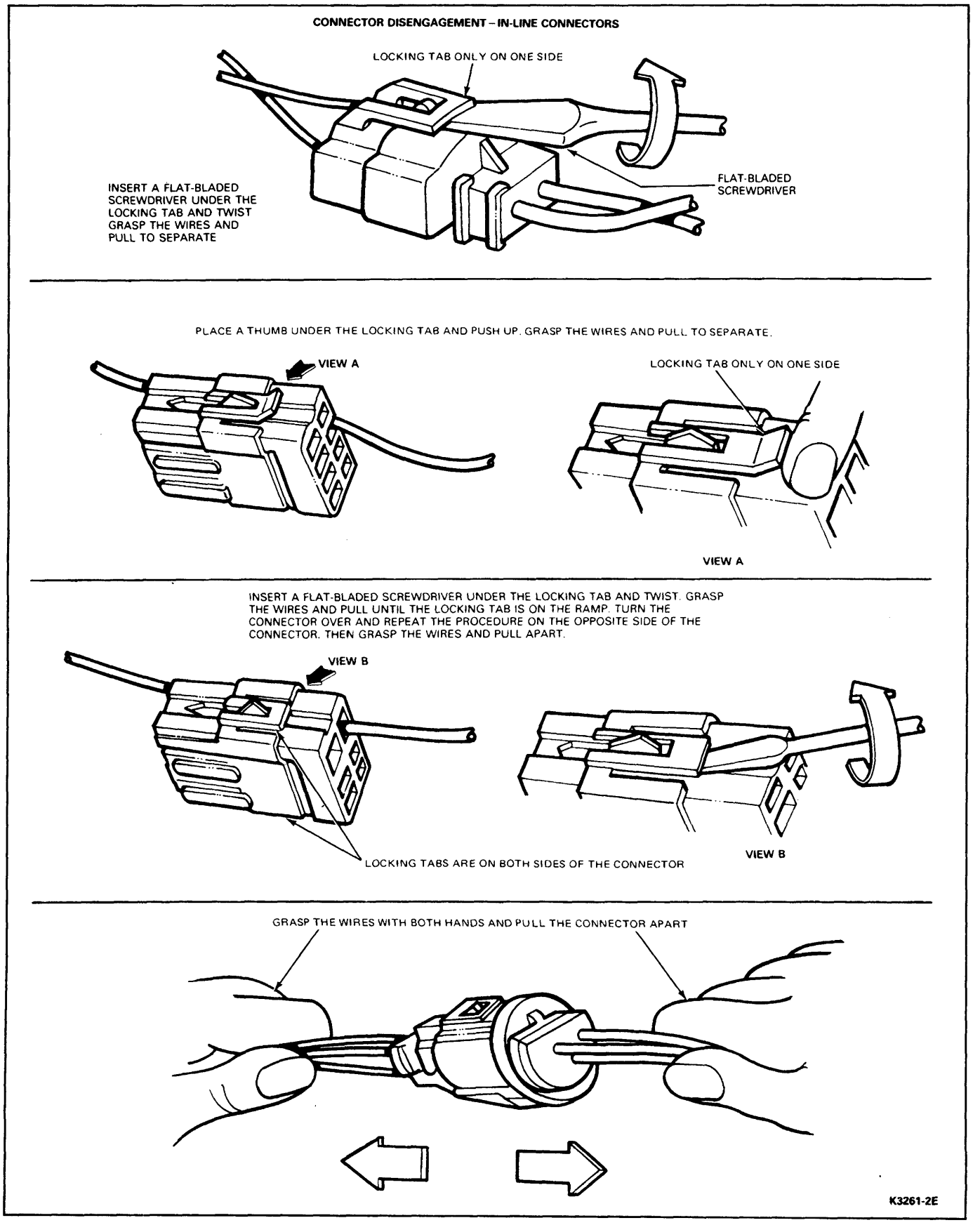


FIG. 1 Connector Disengagement—In-line Connectors

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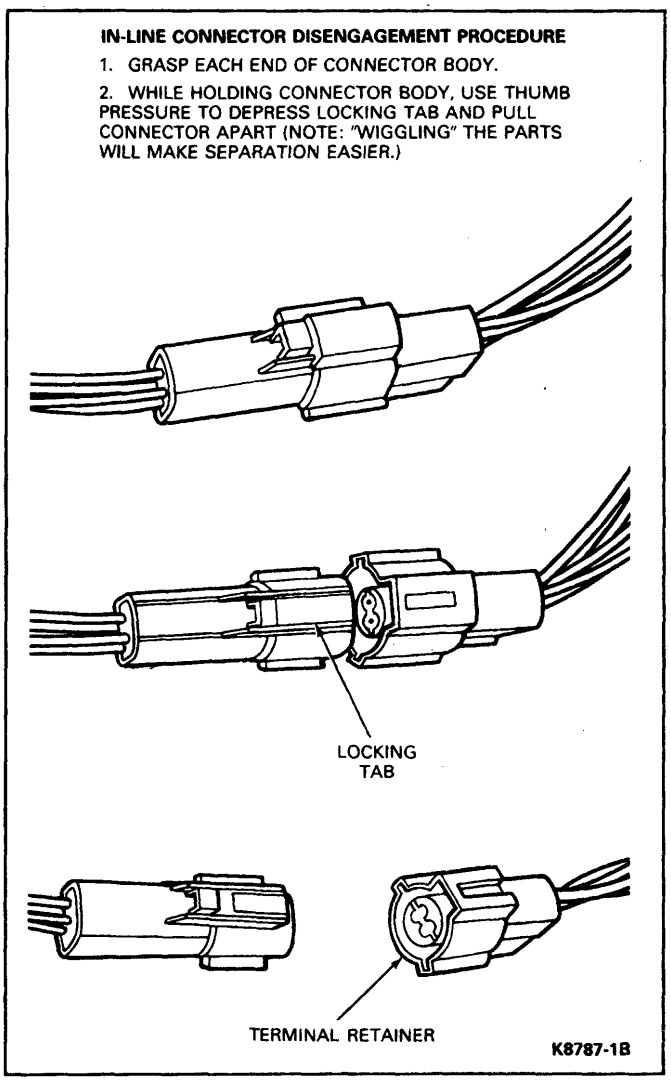


FIG. 2 Connector Disengagement—In-line Connectors (continued)

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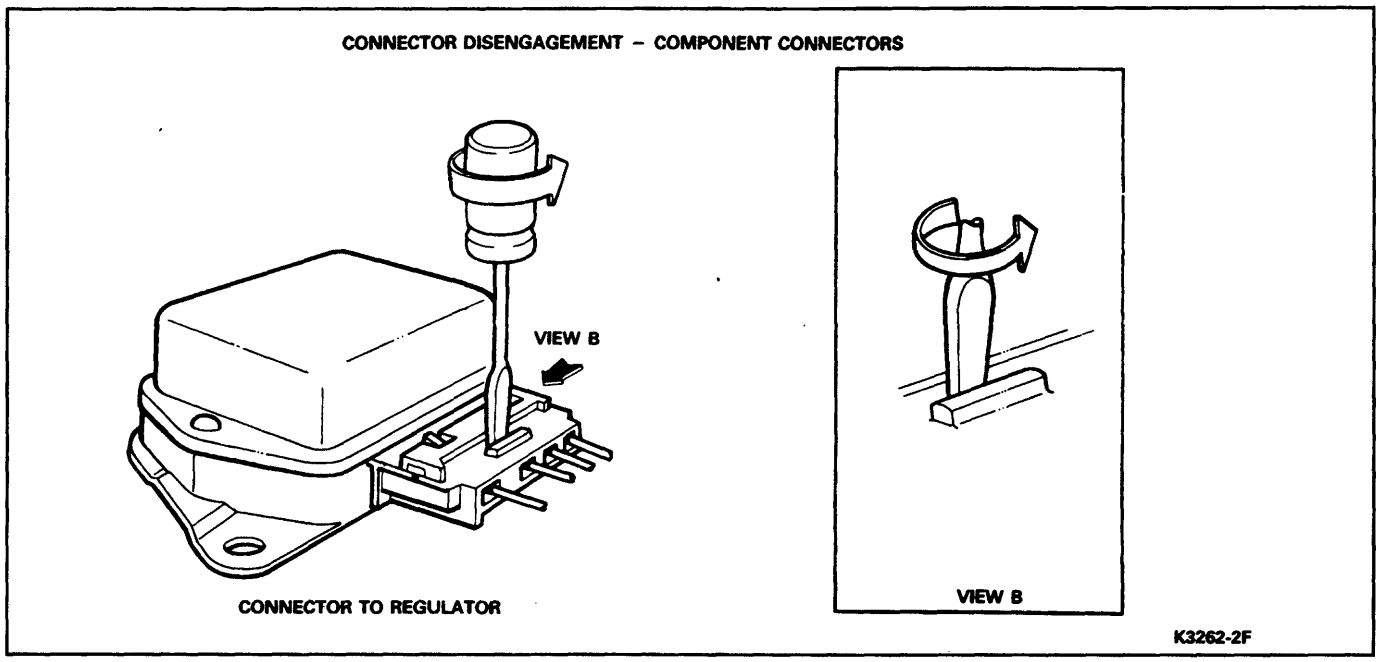


FIG. 3 Connector Disengagement—Component Connectors

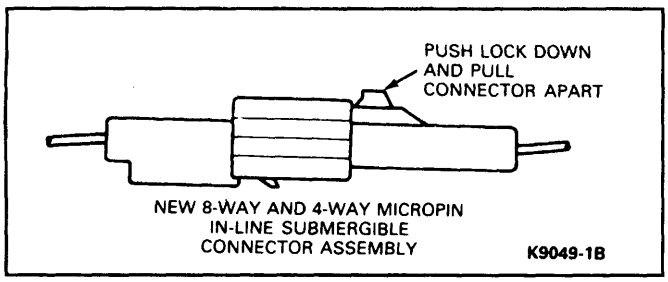


FIG. 4 Connector Disengagement—In-line Submergible Connector

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SECTION 34-02 Wiring Light Truck

SUBJECT	PAGE	SUBJECT	PAGE
REMOVAL AND INSTALLATION	34-02-1	VEHICLE APPLICATION	34-02-1

VEHICLE APPLICATION

E-150 through E-350, F-150 through F-350 and Bronco.

REMOVAL AND INSTALLATION

The illustrations in this Section show the complete wiring harness installation for Light Truck vehicles. Refer to the illustrations for the applicable harness while performing Removal and Installation procedures.

Removal

1. Disconnect battery ground cable.

   NOTE: Refer to Group 45 if it is necessary to remove any trim panels to gain access to the harness.
2. Disconnect all wiring harness connectors.
3. Disengage harness from all locators, straps and/or clips as necessary, including ground wire eyelets. Remove harness from vehicle.

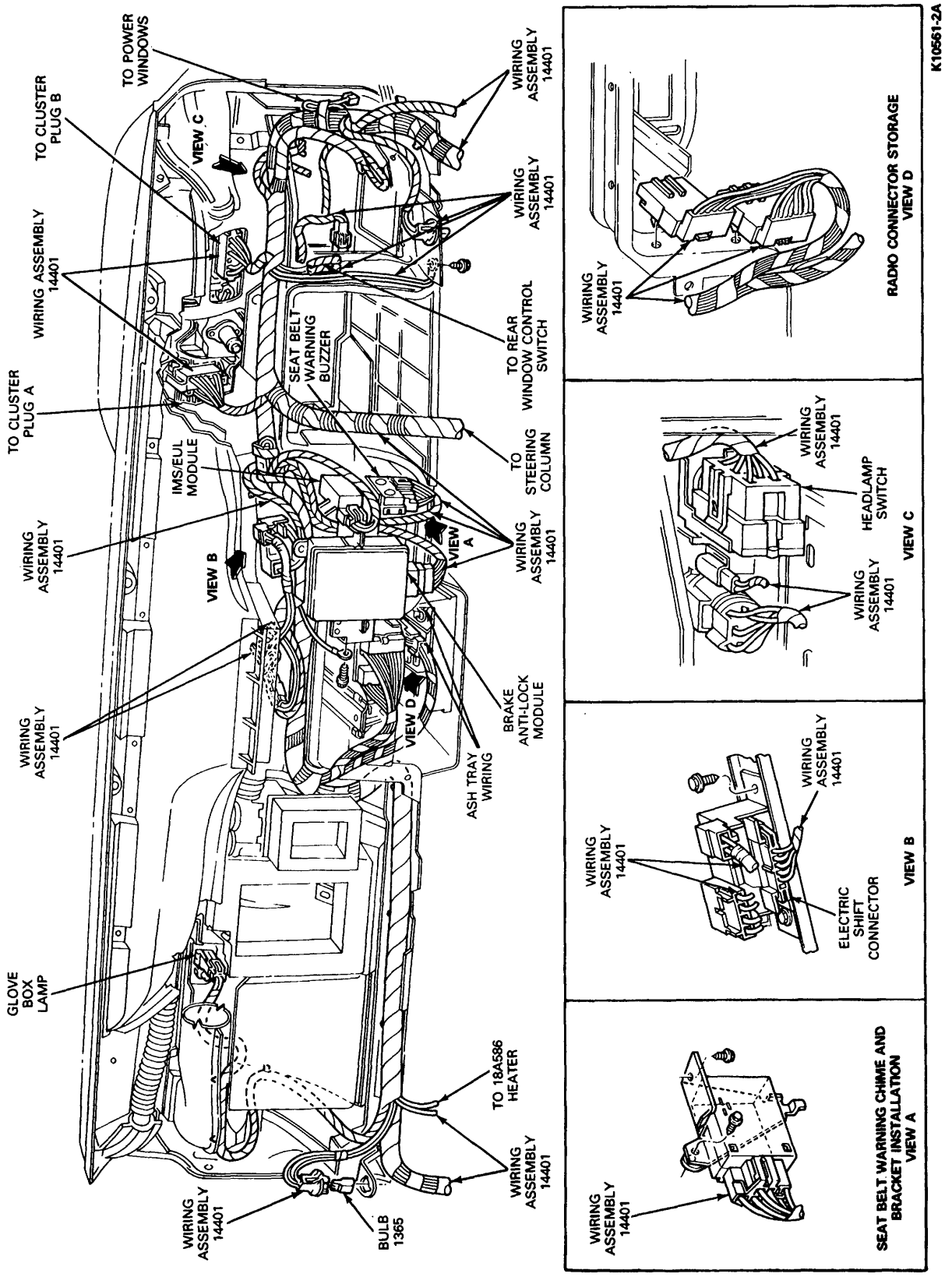
Installation

1. Position harness in vehicle. Ensure that harness is engaged in all locators, straps and/or clips.
2. Connect all harness connectors to components or other harnesses as necessary.
3. Secure ground eyelets to body as necessary.
4. Connect battery ground cable. Check all applicable circuits for proper operation.
5. Install any trim removed during harness removal. Refer to Group 45.

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REMOVAL AND INSTALLATION (Continued)

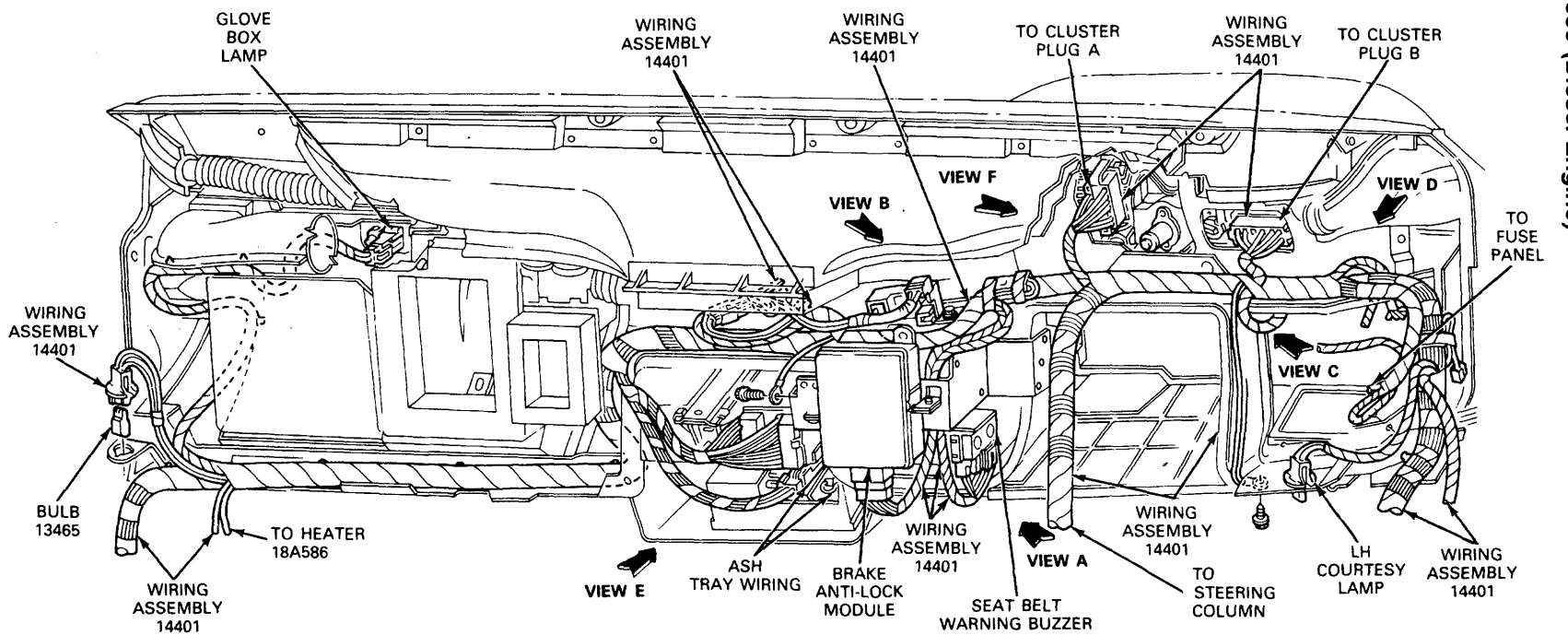
Instrument Panel Wiring Installation—F-150—F-350 and Bronco (Gas Engines)

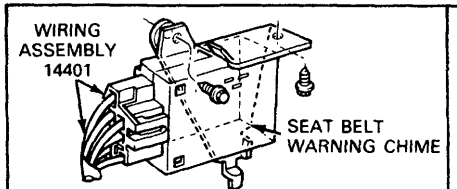


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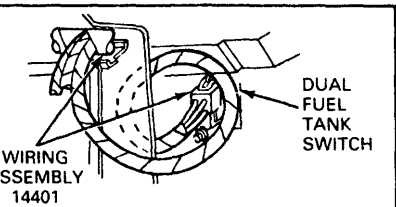
REMOVAL AND INSTALLATION (Continued)

Instrument Panel Wiring Installation—F-150—F-350 (Diesel Engine)

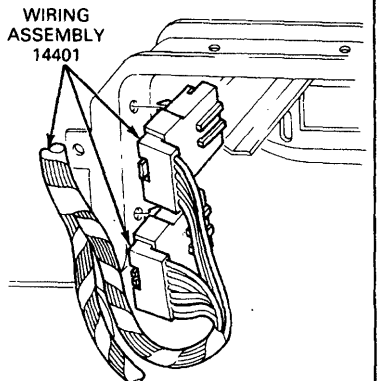




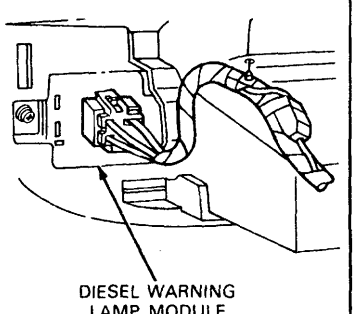
SEAT BELT WARNING CHIME AND BRACKET INSTALLATION VIEW A



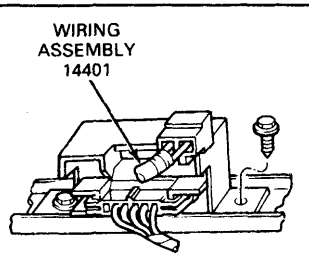
DUAL FUEL TANK WIRING INSTALLATION VIEW C



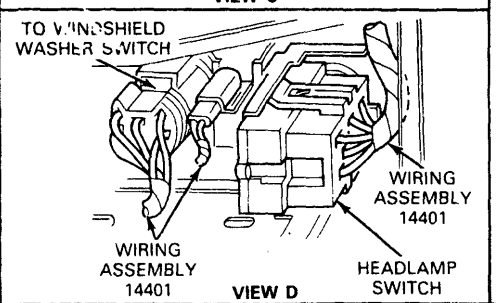
RADIO CONNECTOR STORAGE VIEW E



14401 WIRING ASSEMBLY ROUTING TO DIESEL WARNING LAMP MODULE VIEW F



VIEW B



VIEW D

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REMOVAL AND INSTALLATION (Continued)

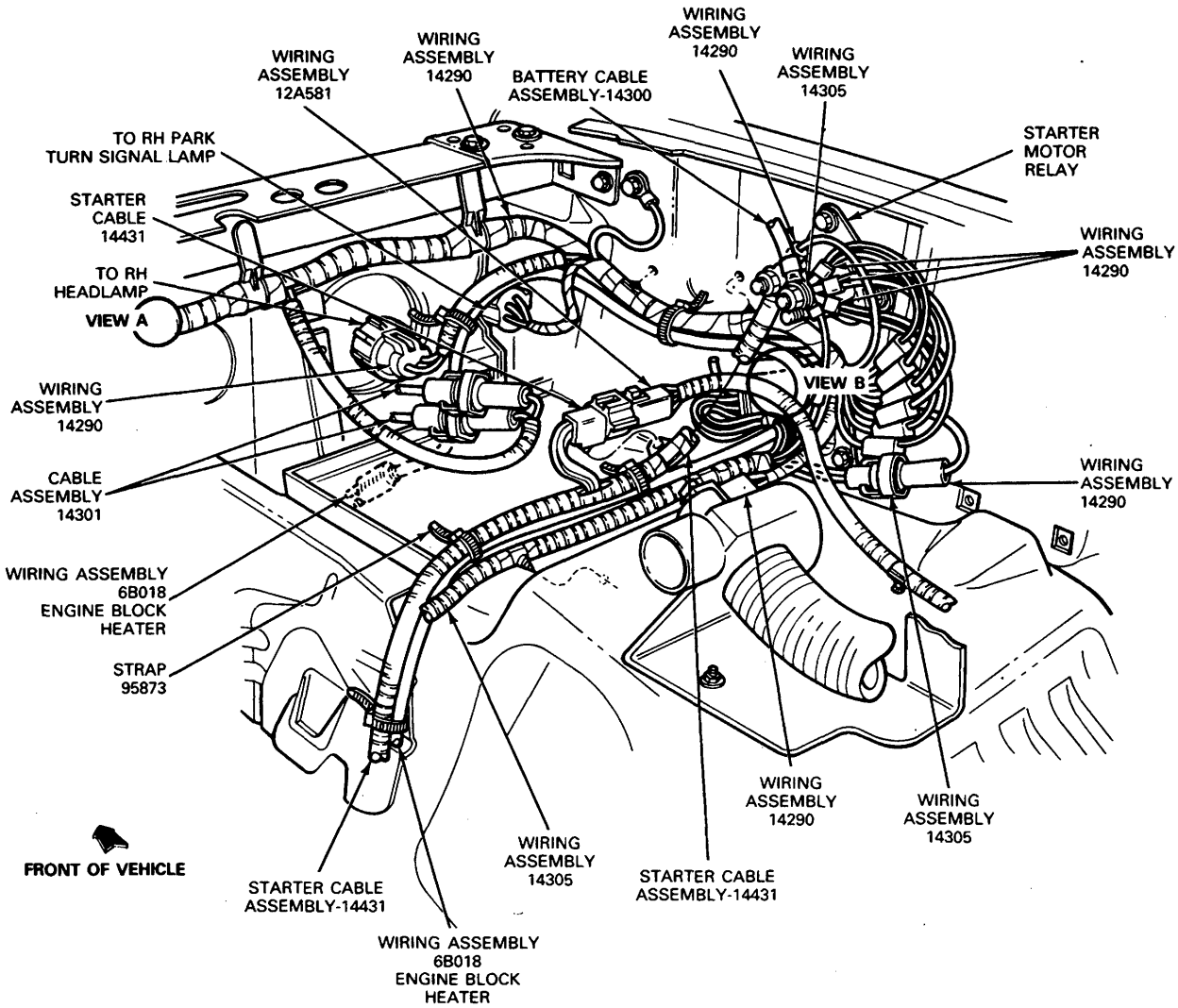
Instrument Panel Wiring Installation—E-Series

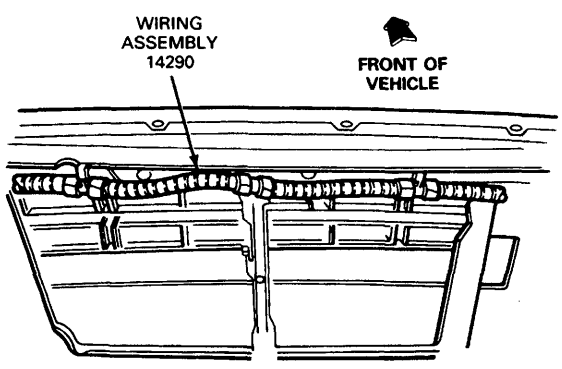
Illustrations not available at time of publication.

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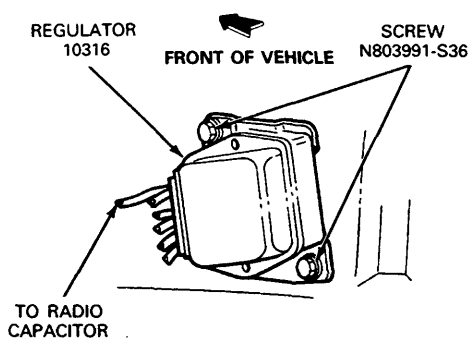
REMOVAL AND INSTALLATION (Continued)

Fender Apron, RH—F-150—F-350 and Bronco with 4.9L, 5.0L and 7.5L EFI Engines





14290 WIRING ASSEMBLY INSTALLATION ON FRONT END RADIATOR SUPPORT VIEW IN CIRCLE A



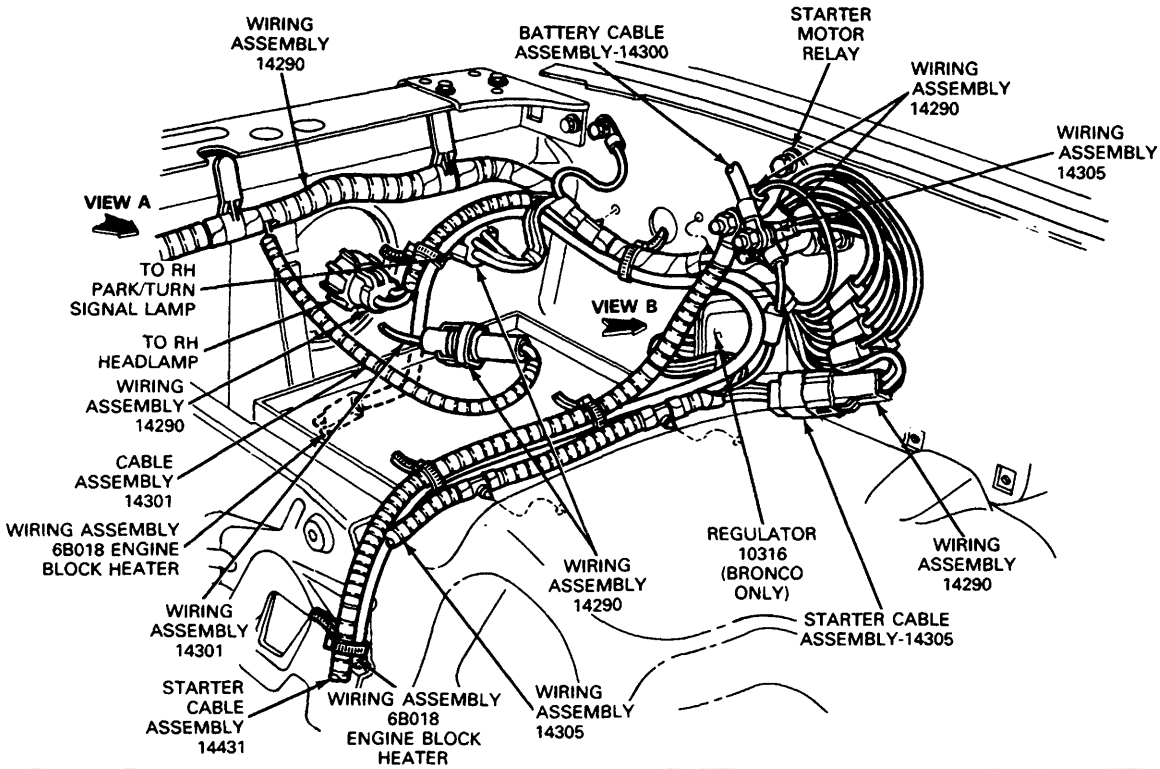
REGULATOR INSTALLATION USED ON BRONCO WITH R.P.O. (GGG) SNOW PLOW OPTION ONLY VIEW IN CIRCLE B

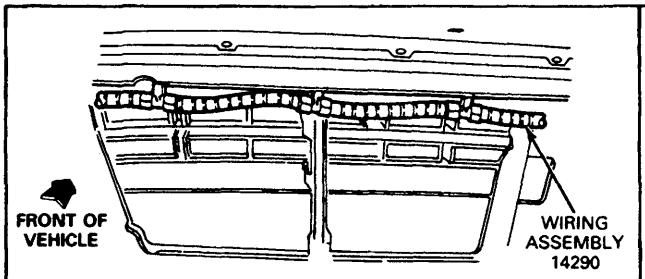
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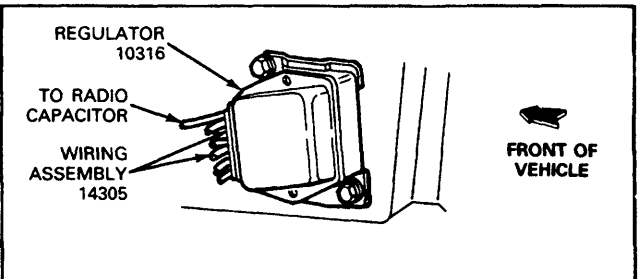
REMOVAL AND INSTALLATION (Continued)

Fender Apron, RH—F-150—F-350 and Bronco with 5.8L EFI Engine





WIRING ASSEMBLY-14290 INSTALLATION ON FRONT END RADIATOR SUPPORT
VIEW A



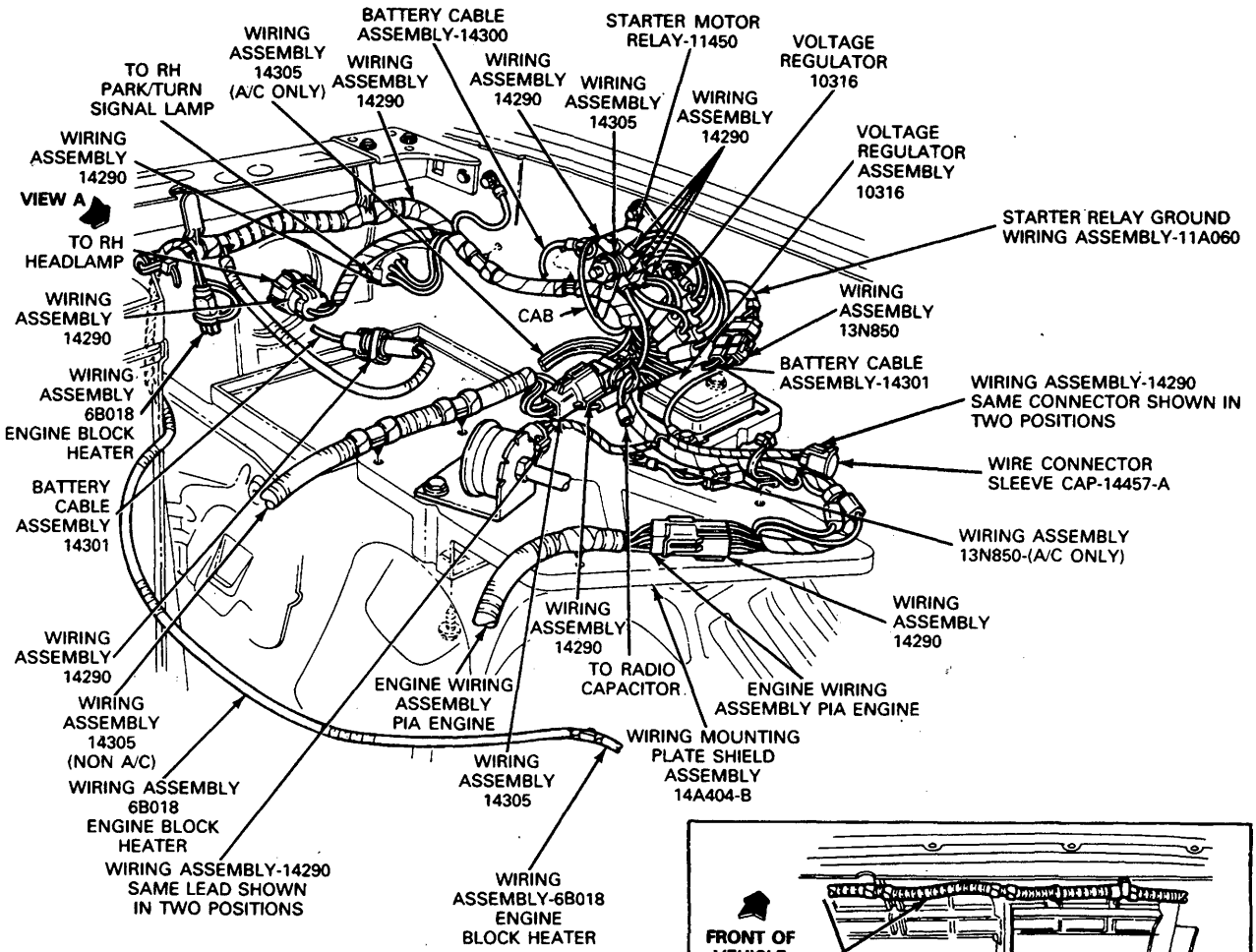
REGULATOR INSTALLATION
BRONCO 5.8L ENGINE WITH R.P.O. (GGG) SNOW PLOW
VIEW B

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REMOVAL AND INSTALLATION (Continued)

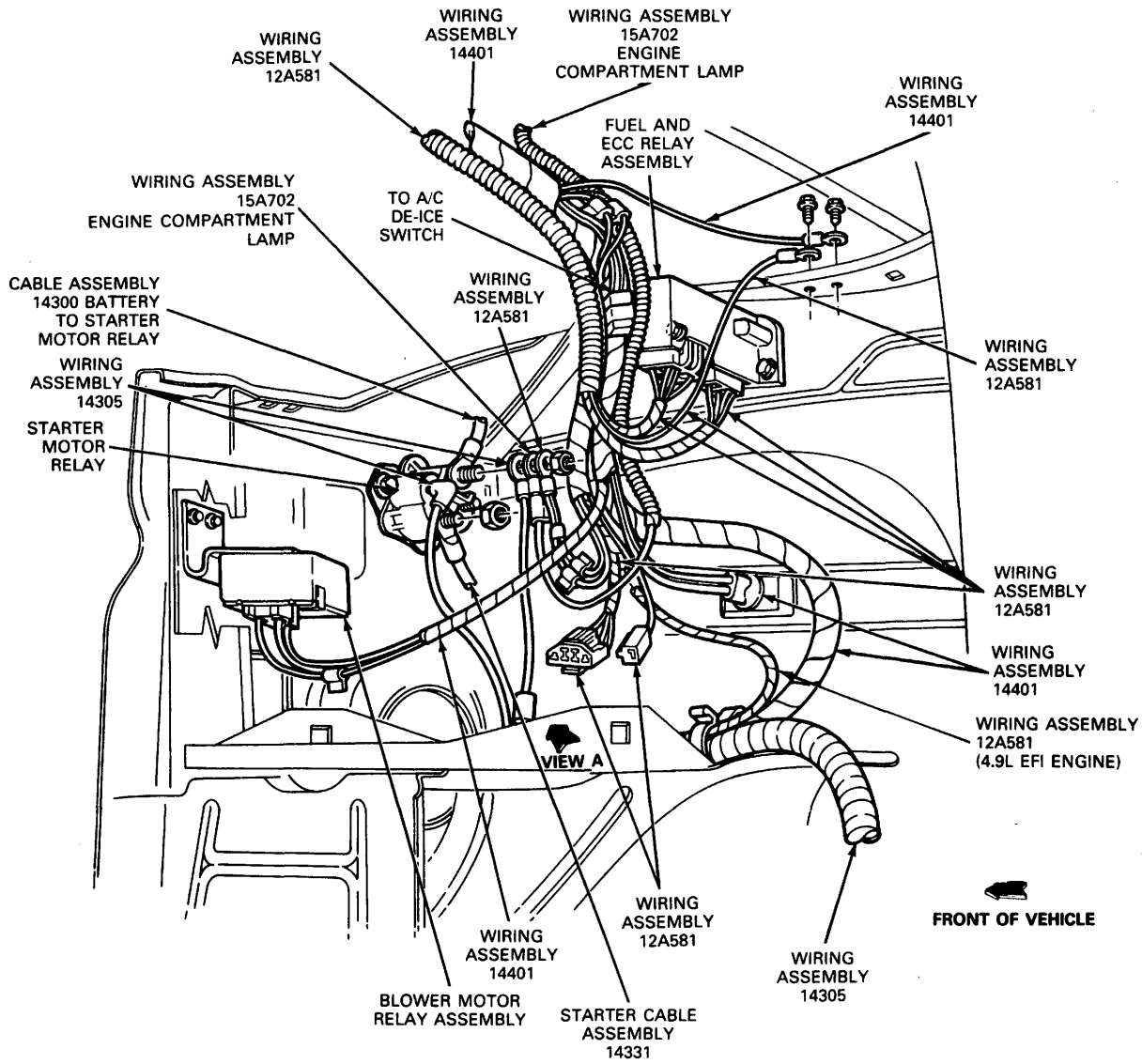
Fender Apron, RH—F-250—F-350 with 7.3L Diesel Engine

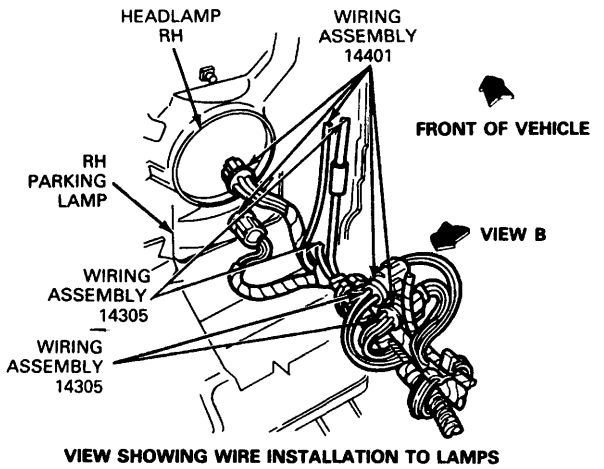


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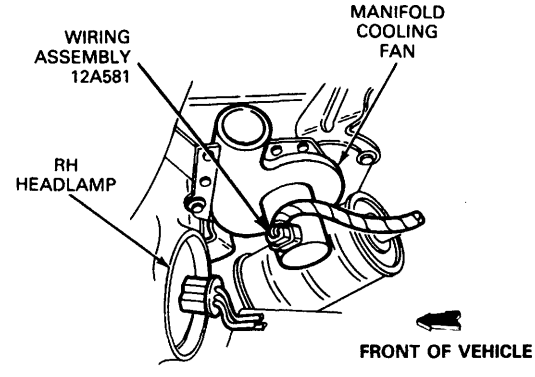
REMOVAL AND INSTALLATION (Continued)

Fender Apron, RH—E-Series with Gasoline Engines





VIEW SHOWING WIRE INSTALLATION TO LAMPS
VIEW A

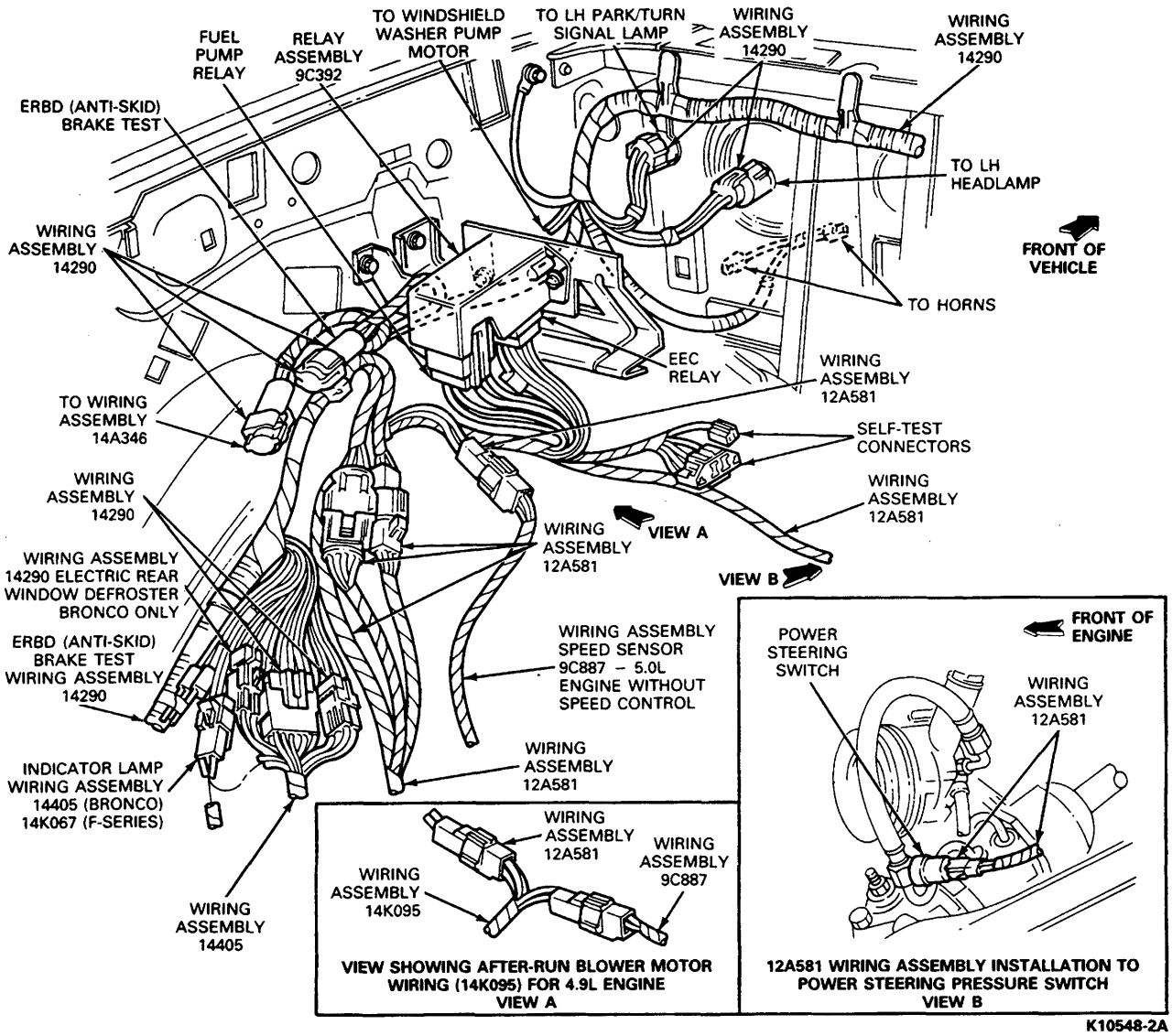


VIEW SHOWING WIRING INSTALLATION TO MANIFOLD COOLING FOR 4.9L EFI ENGINE ONLY
VIEW B

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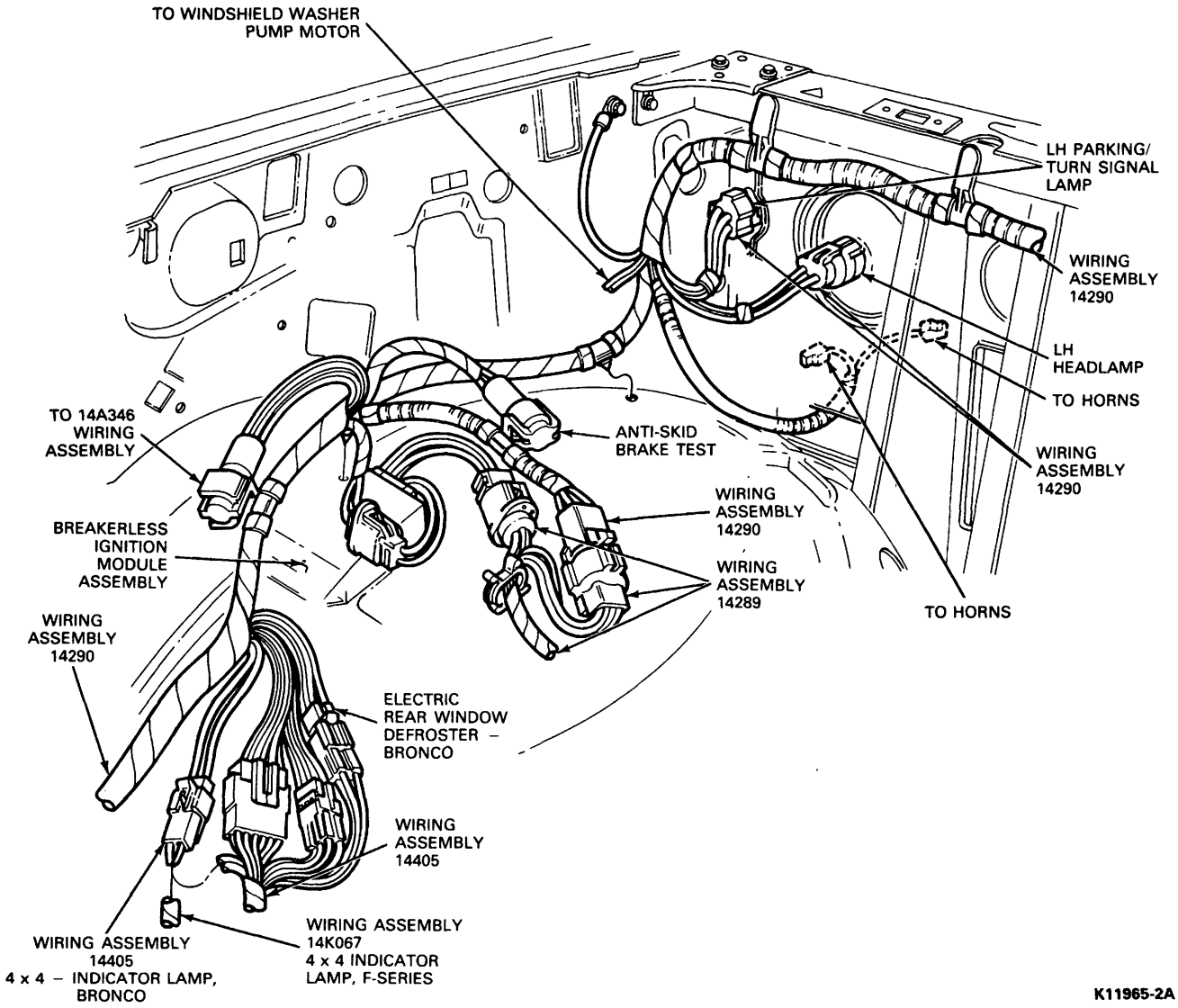
REMOVAL AND INSTALLATION (Continued)



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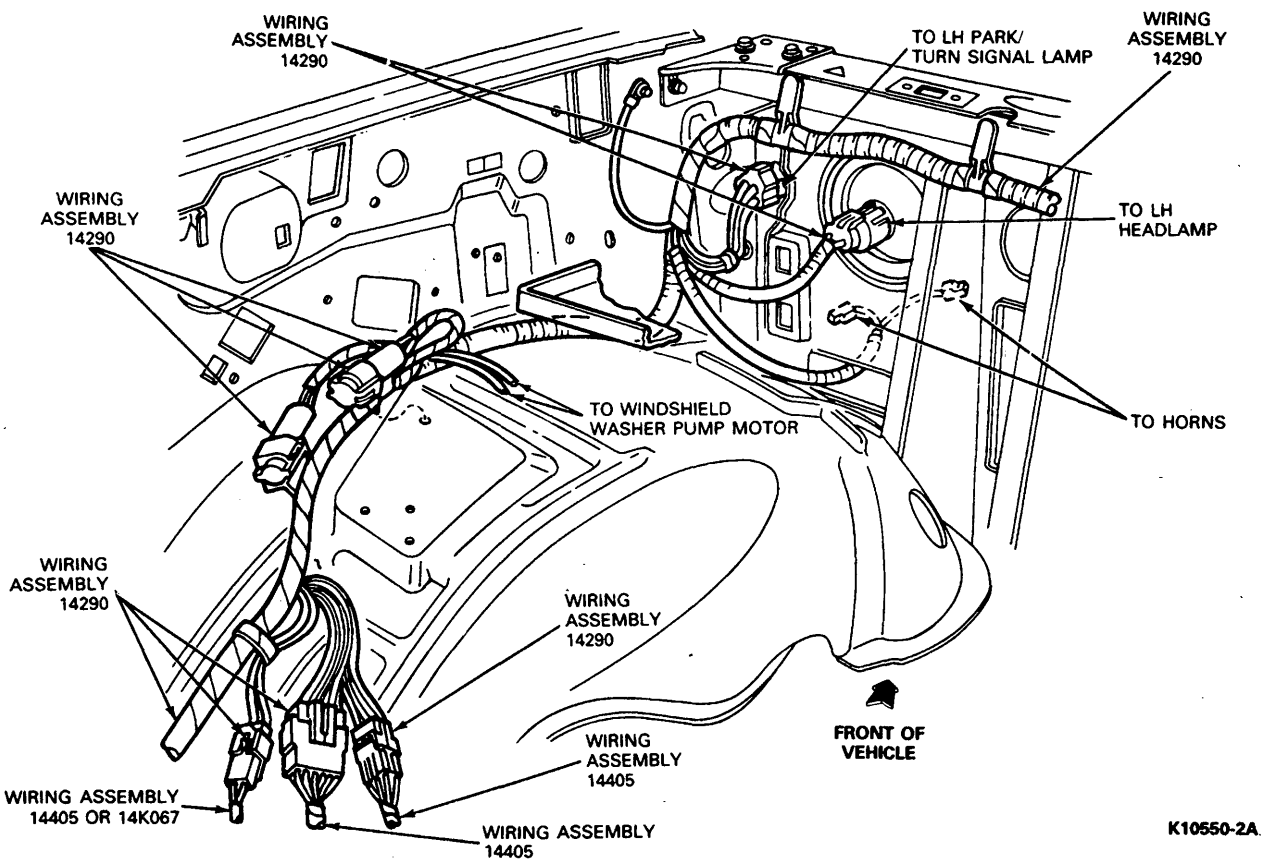
REMOVAL AND INSTALLATION (Continued)

Fender Apron, LH—F-150—F-350 and Bronco with 5.8L (EFI) Engine



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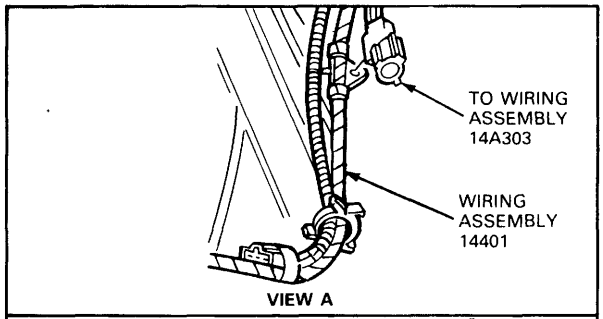
REMOVAL AND INSTALLATION (Continued)



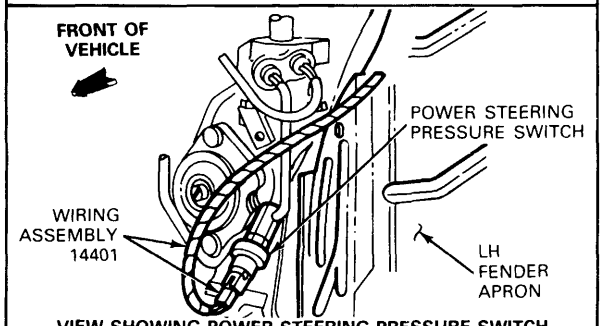
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REMOVAL AND INSTALLATION (Continued)

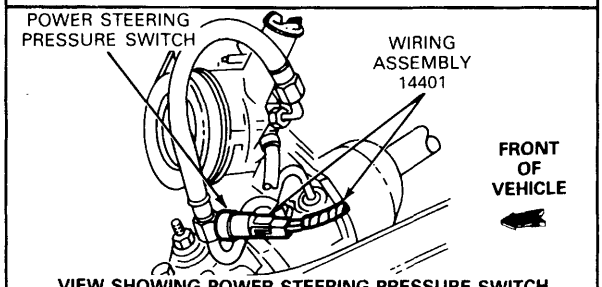
Fender Apron, LH—E-Series with Gasoline Engines



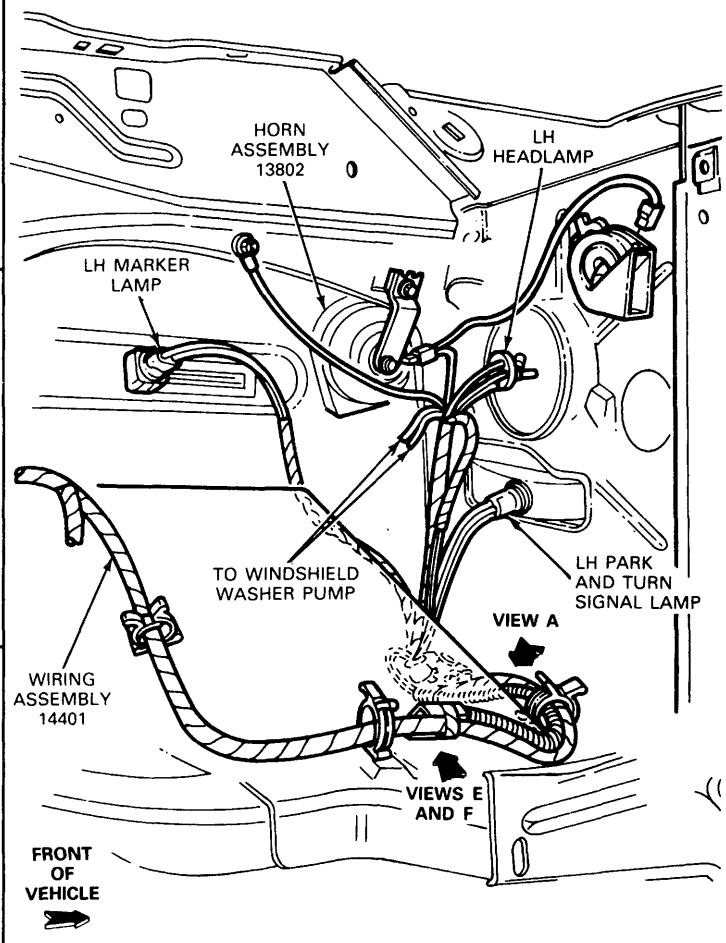
VIEW A



VIEW SHOWING POWER STEERING PRESSURE SWITCH WIRING INSTALLATION FOR 4.9L AUTOMATIC ONLY (EFI) ENGINE
VIEW E



VIEW SHOWING POWER STEERING PRESSURE SWITCH AND WIRING INSTALLATION FOR 5.0L (EFI) ENGINE
VIEW F

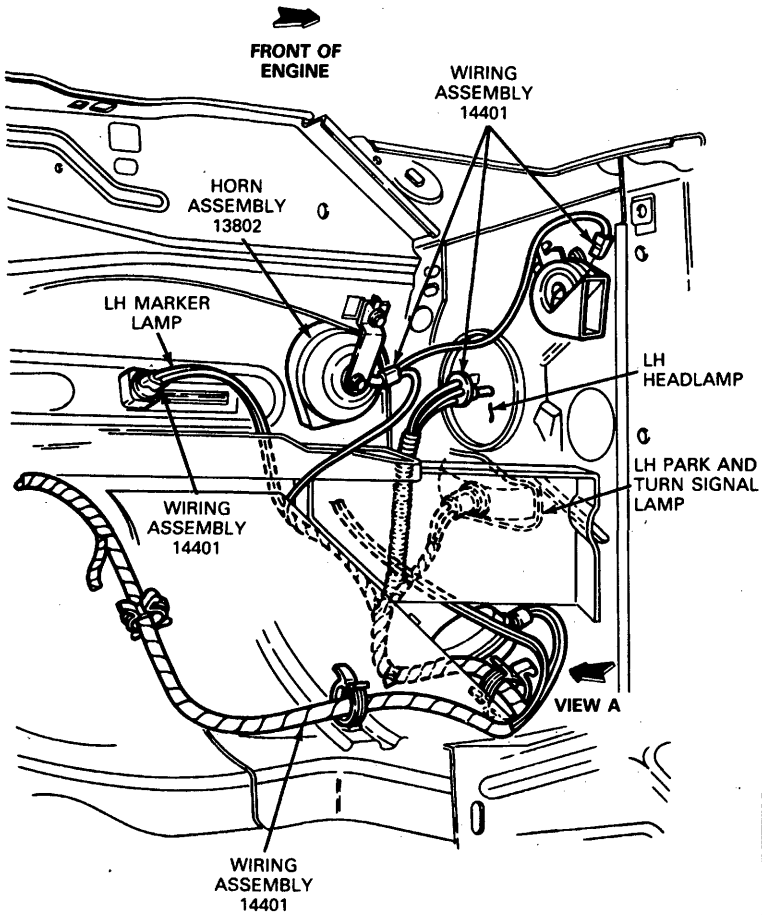


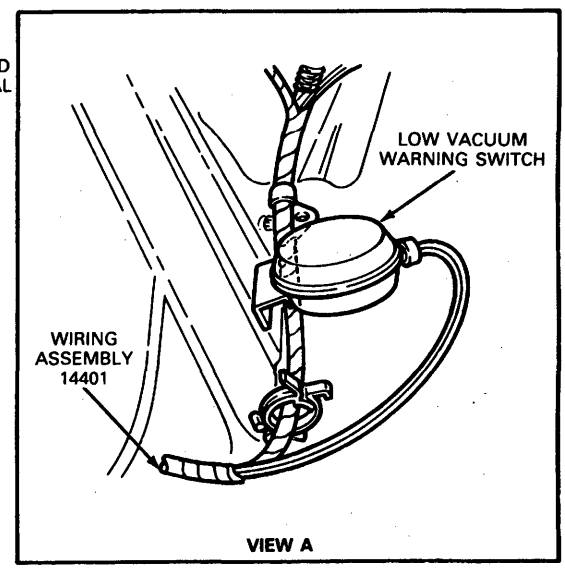
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REMOVAL AND INSTALLATION (Continued)

Fender Apron, LH—E-Series with 7.3L Diesel Engine

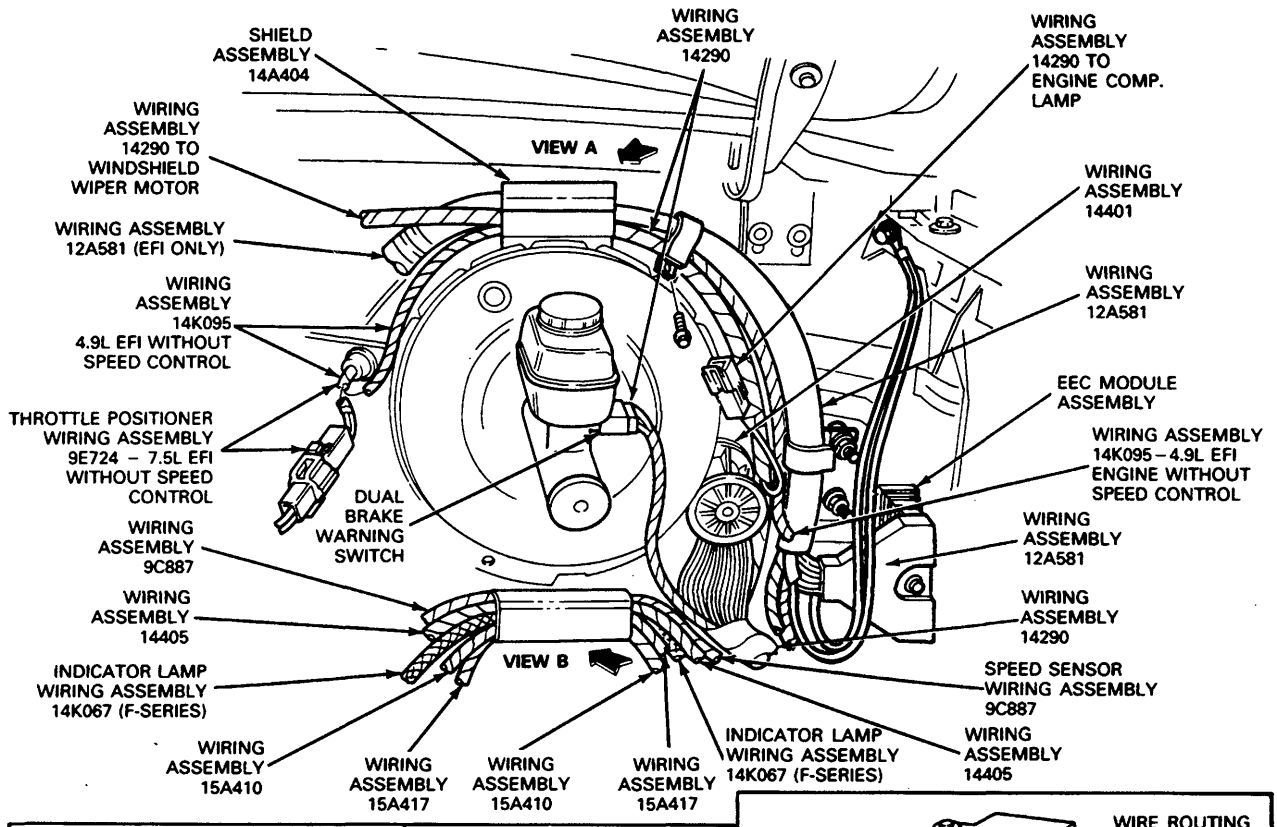


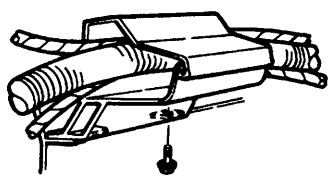


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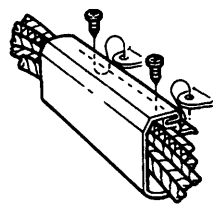
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REMOVAL AND INSTALLATION (Continued)

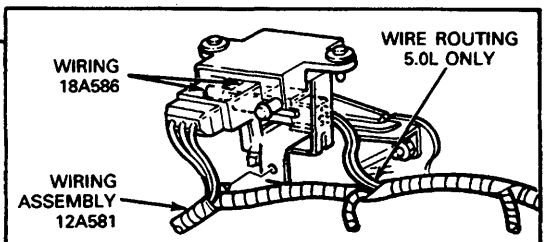




14A404 SHIELD ASSEMBLY INSTALLATION VIEW A



14A163 RETAINER INSTALLATION VIEW B



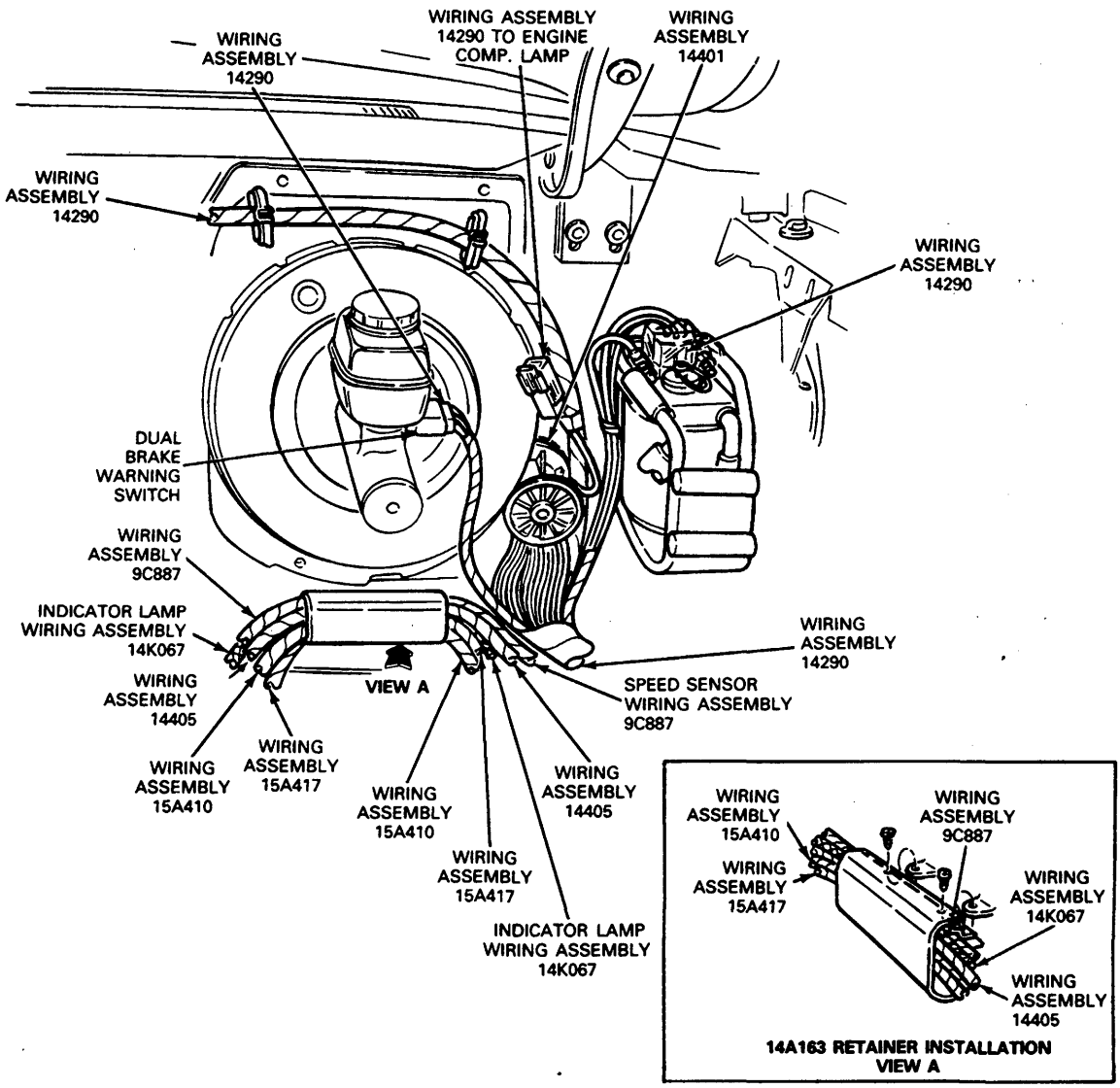
VIEW SHOWING LH DASH PANEL MAP SENSOR WIRING INSTALLATION WITH OR WITHOUT AIR CONDITIONING FOR ALL (EFI) ENGINES ONLY

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REMOVAL AND INSTALLATION (Continued)

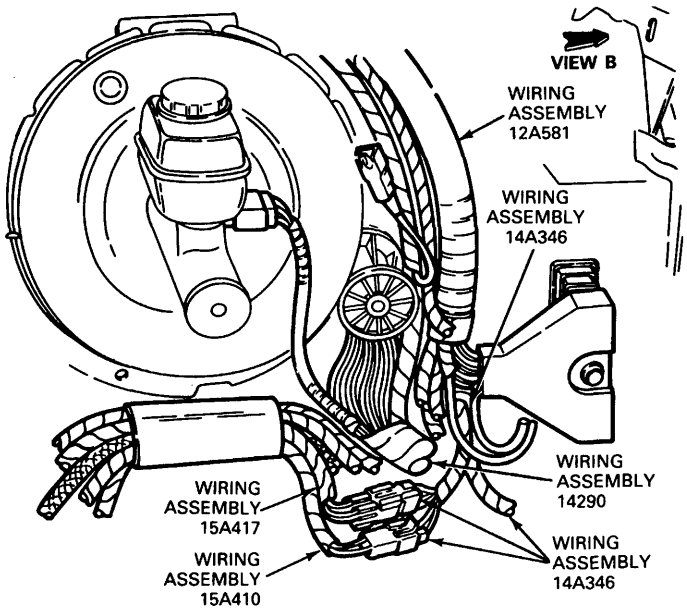
Dash Panel Wiring —F-Series with 7.3L Diesel Engine



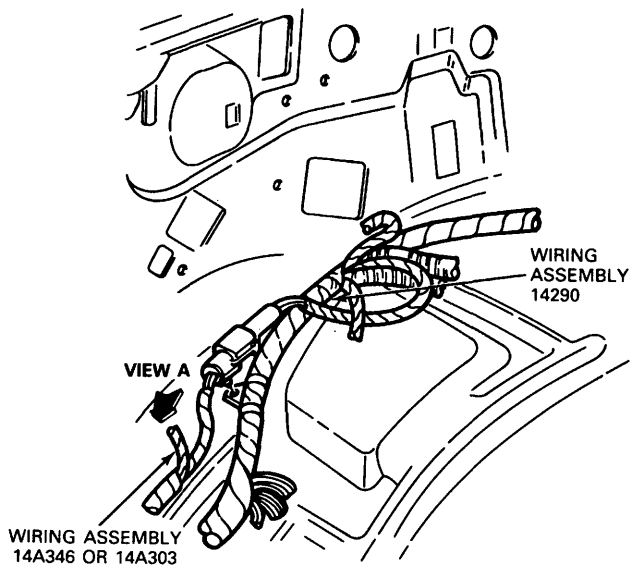
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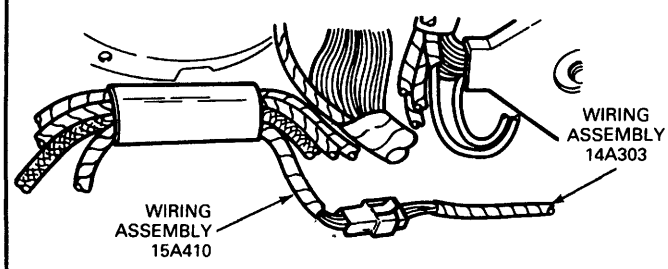
Dash Panel and Relay Wiring—with Trailer Tow Package and/or Dual Rear Wheels



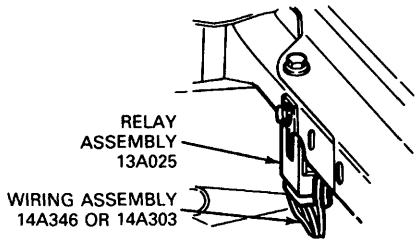
VIEW SHOWING DASH PANEL WIRE ROUTING FOR TRAILER TOW WITH OR WITHOUT DUAL REAR WHEELS



VIEW SHOWING LH FENDER APRON WIRE ROUTING FOR TRAILER TOW AND/OR DUAL REAR WHEELS



VIEW SHOWING DASH PANEL WIRE ROUTING FOR DUAL REAR WHEELS OR CHASSIS CAB WITHOUT TRAILER TOW
VIEW A



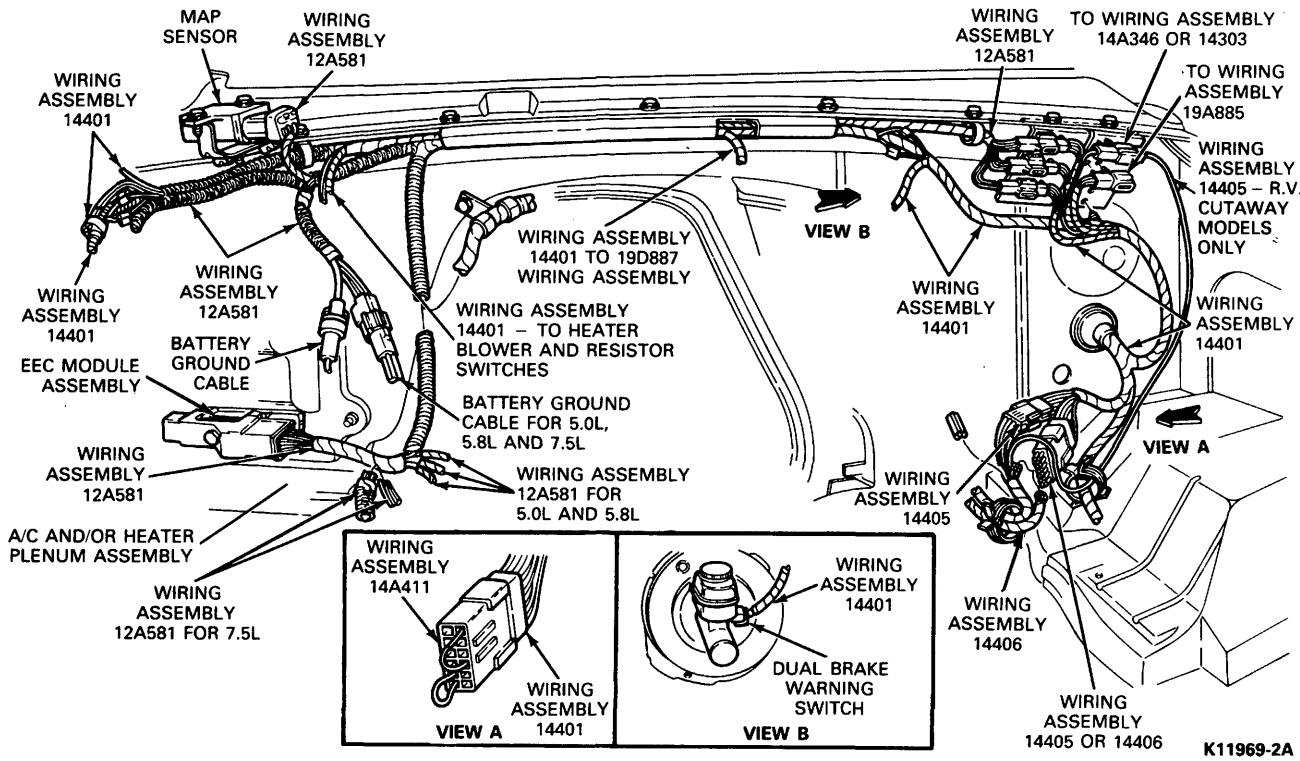
VIEW SHOWING TRAILER TOW AND/OR DUAL REAR WHEEL RELAY INSTALLATION
VIEW B

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REMOVAL AND INSTALLATION (Continued)

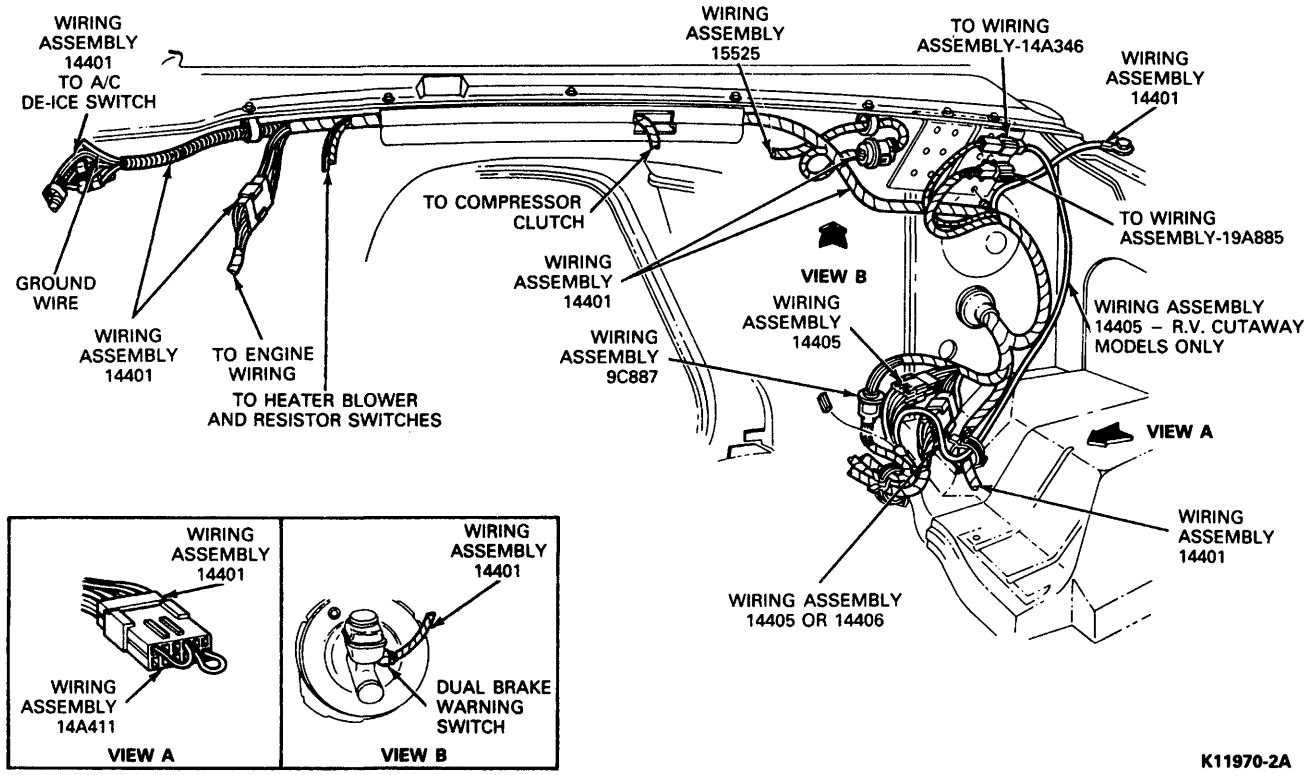
Dash Panel Wiring—E-Series with (EFI) Gasoline Engines



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REMOVAL AND INSTALLATION (Continued)

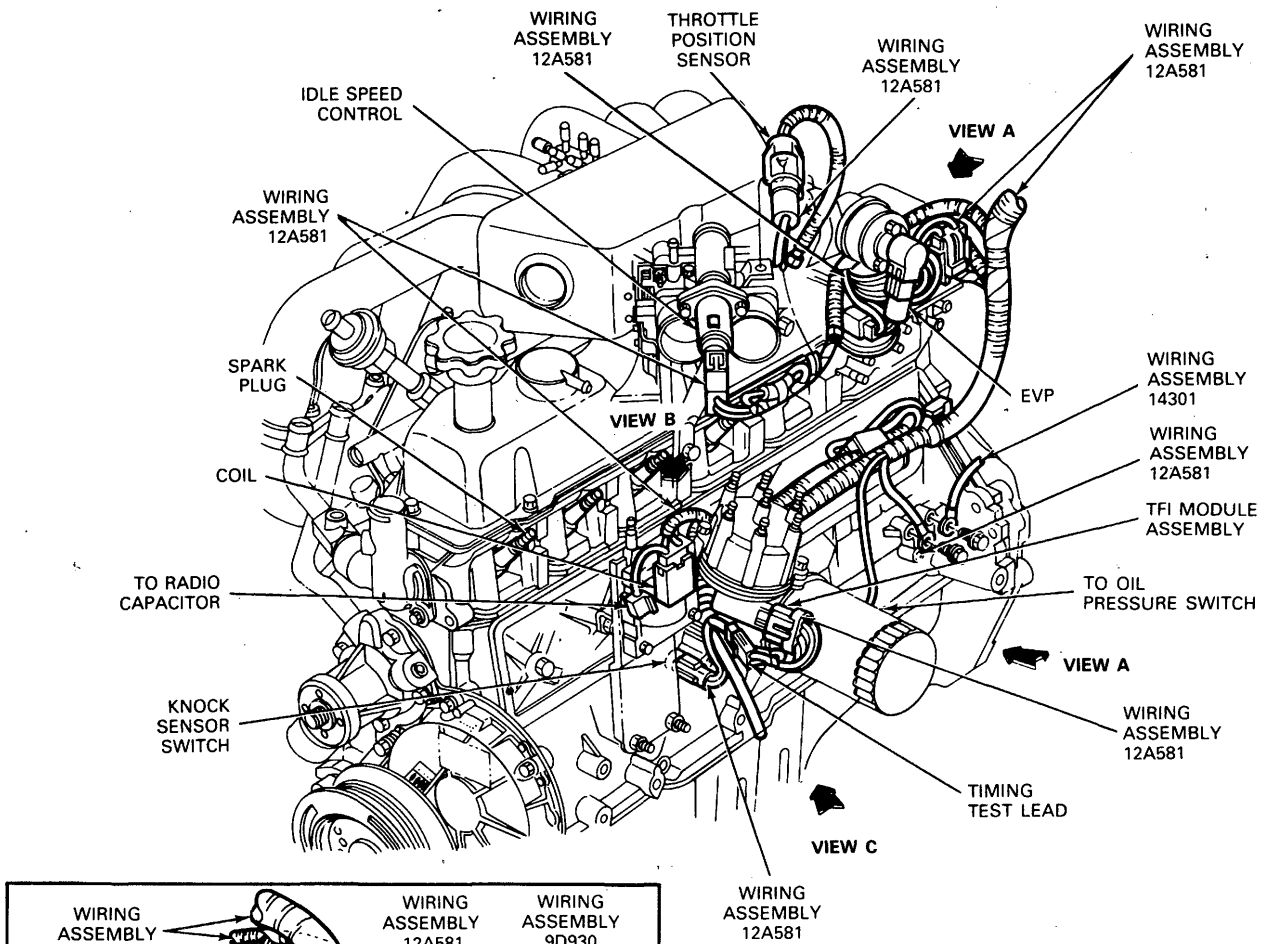
Dash Panel Wiring—E-Series with 7.3L Diesel Engine

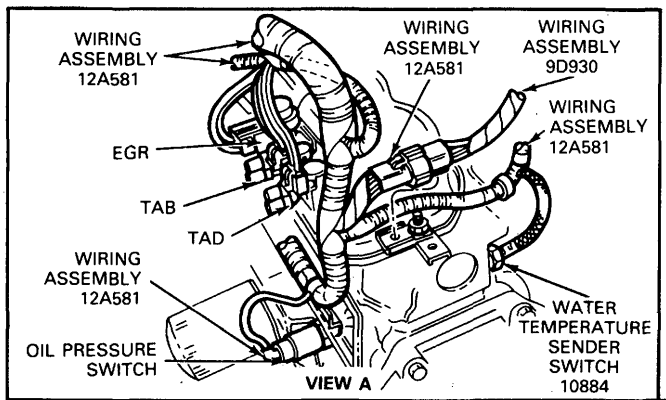


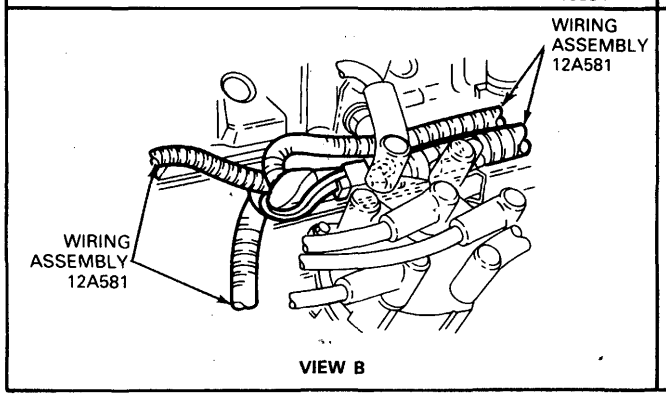
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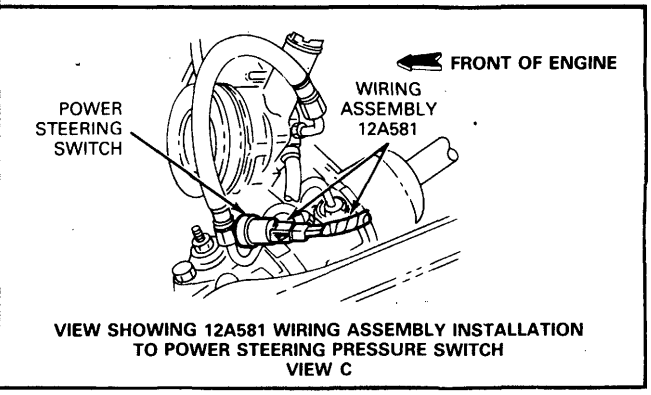
REMOVAL AND INSTALLATION (Continued)

Wiring, Engine—F-Series and Bronco with 4.9L (EFI)—LH Side









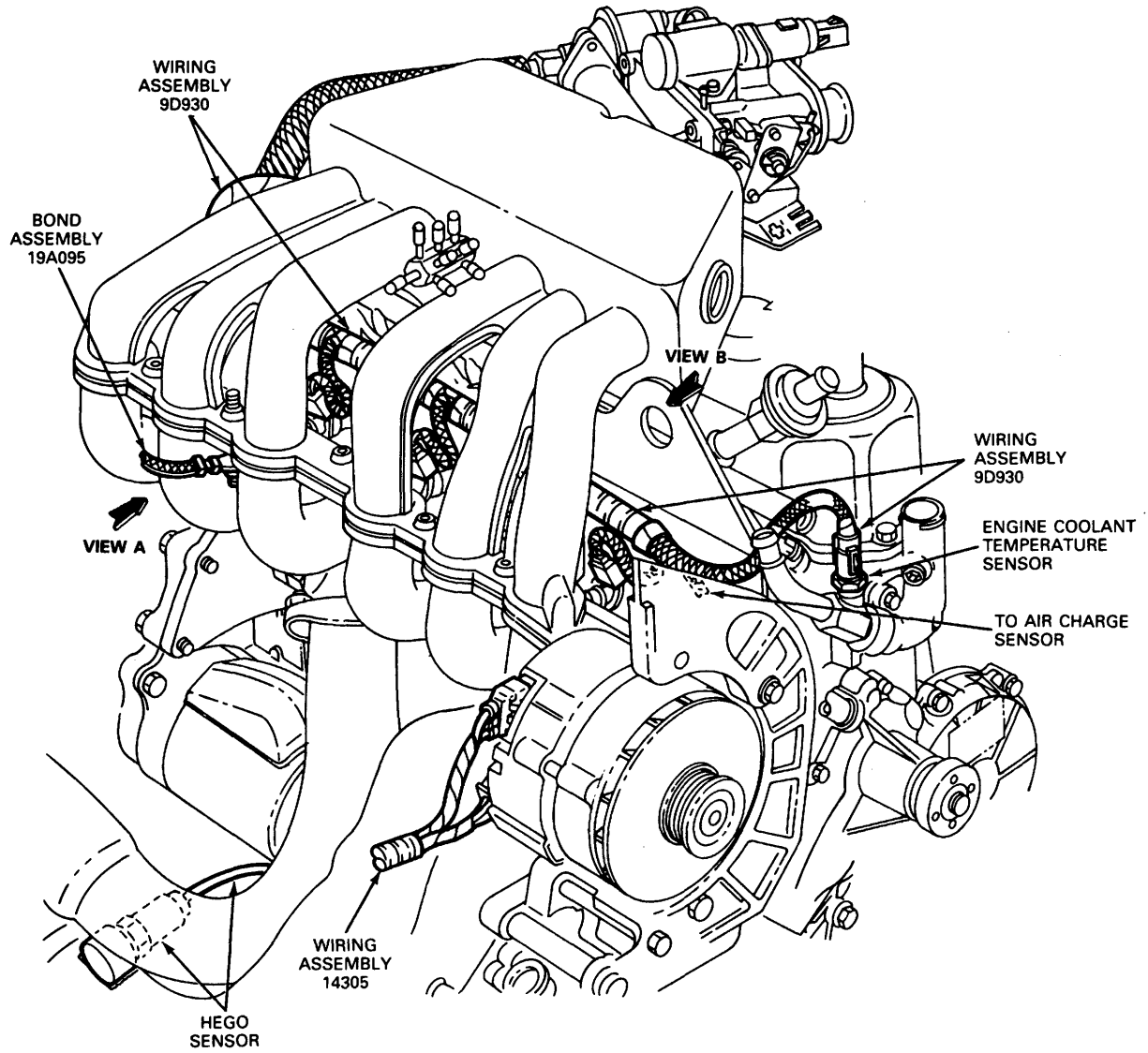
VIEW SHOWING 12A581 WIRING ASSEMBLY INSTALLATION TO POWER STEERING PRESSURE SWITCH
VIEW C

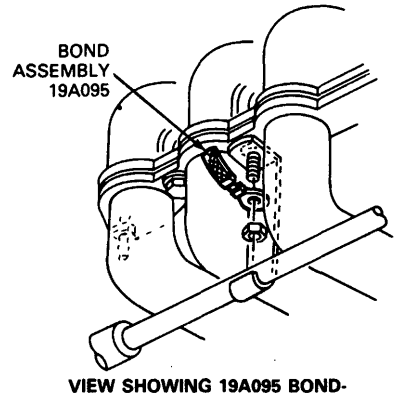
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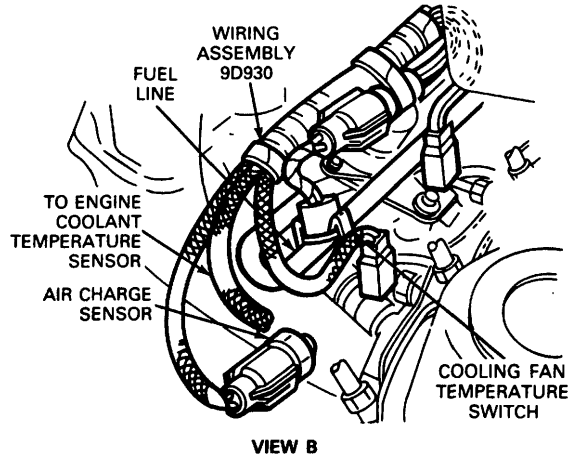
REMOVAL AND INSTALLATION (Continued)

Wiring, Engine—F-Series and Bronco with 4.9L (EFI)—RH Side





VIEW SHOWING 19A095 BOND-ASSEMBLY INSTALLATION FROM UNDER SIDE OF INTAKE MANIFOLD
VIEW A



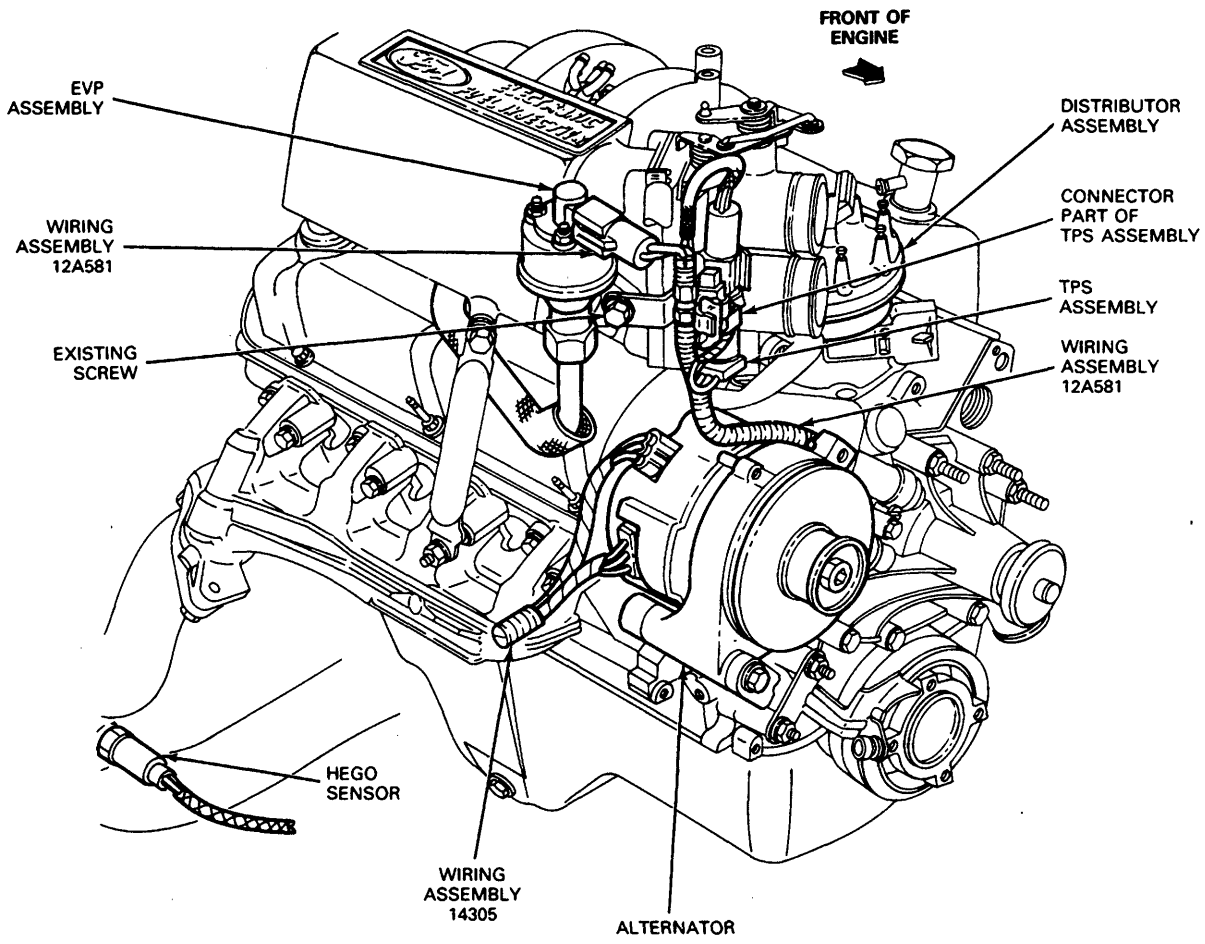
VIEW B

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REMOVAL AND INSTALLATION (Continued)

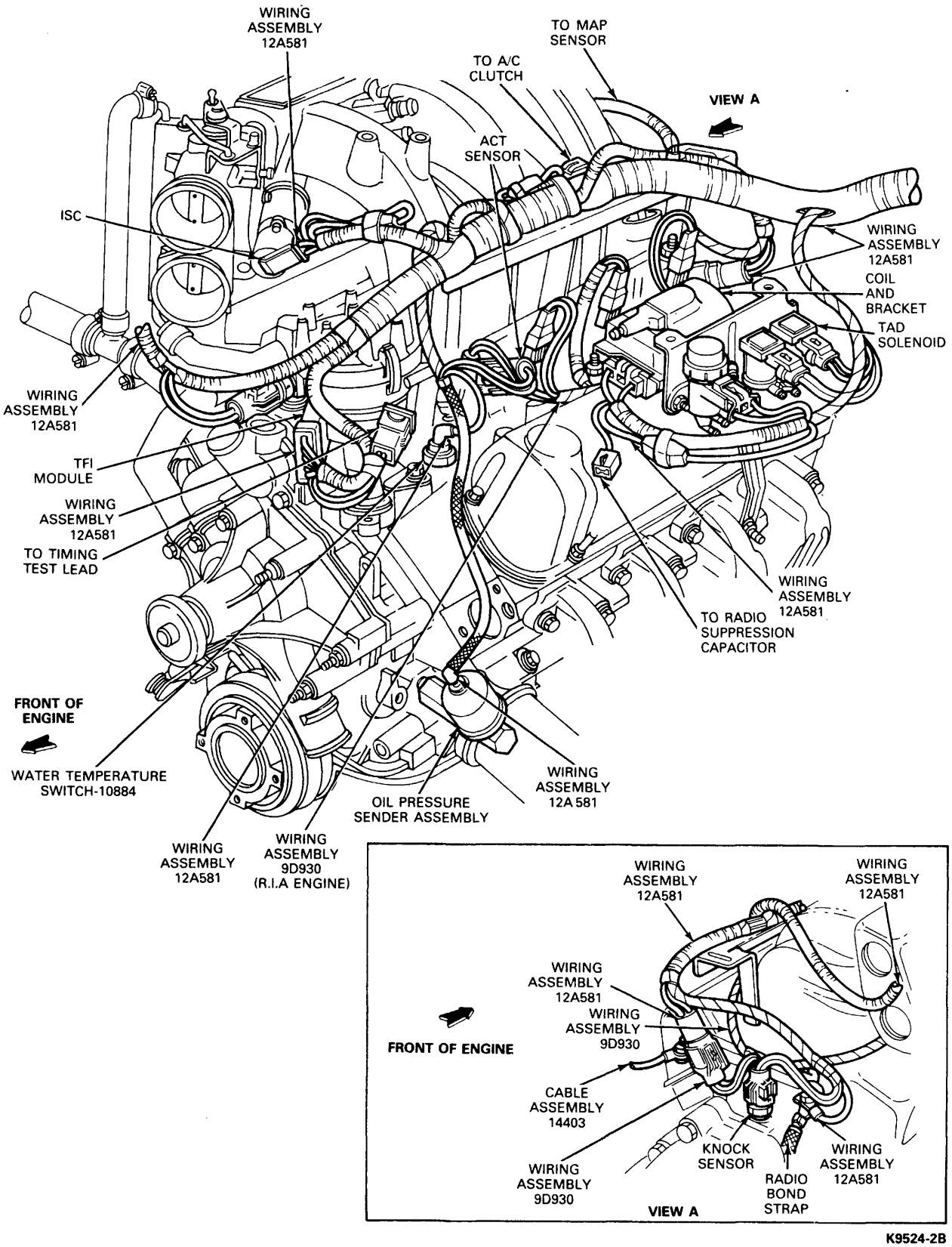
Wiring, Engine—F-Series and Bronco with 5.0L (EFI)—RH Side



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REMOVAL AND INSTALLATION (Continued)

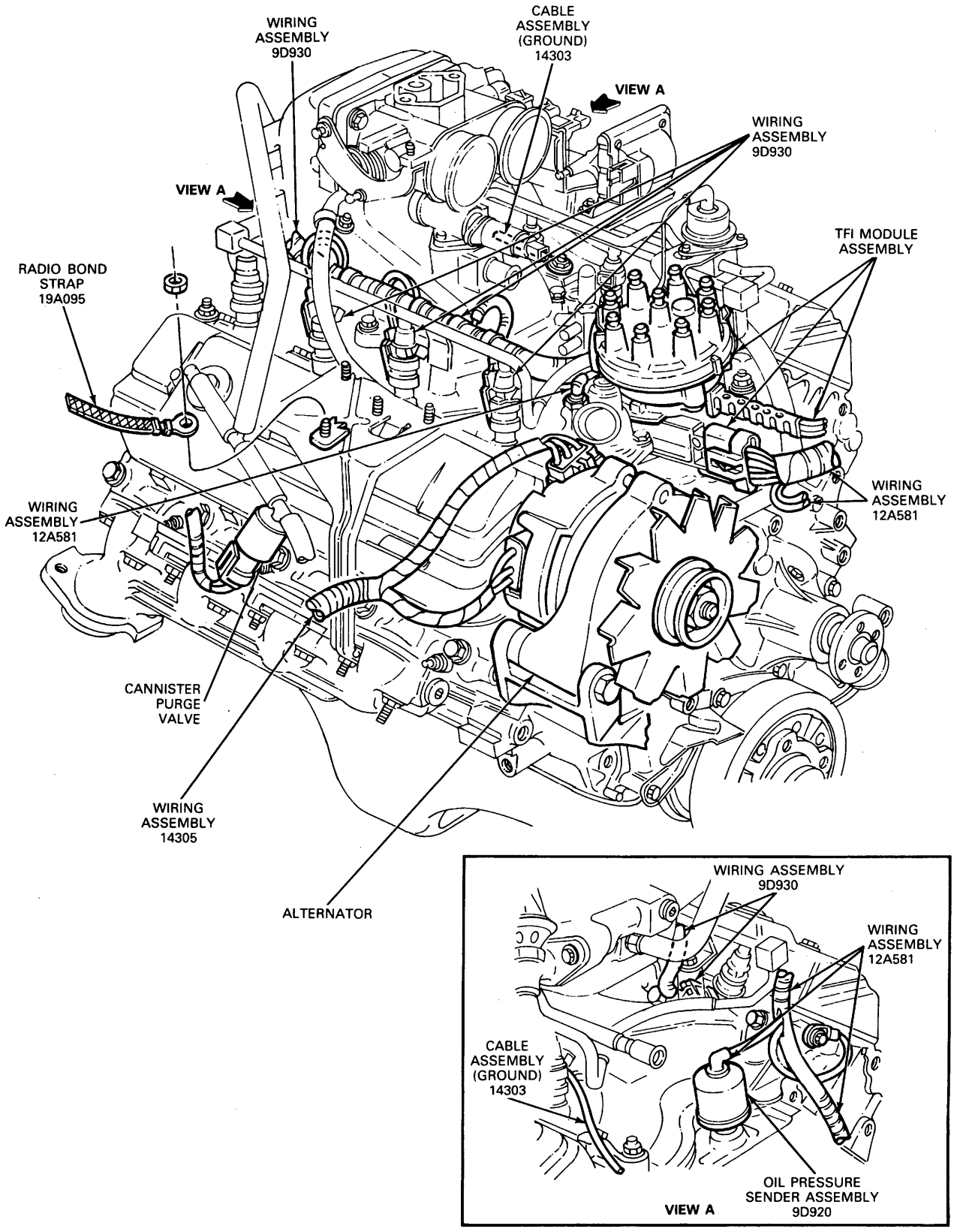
Wiring, Engine—F-Series and Bronco with 5.0L (EFI)—LH Side



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REMOVAL AND INSTALLATION (Continued)

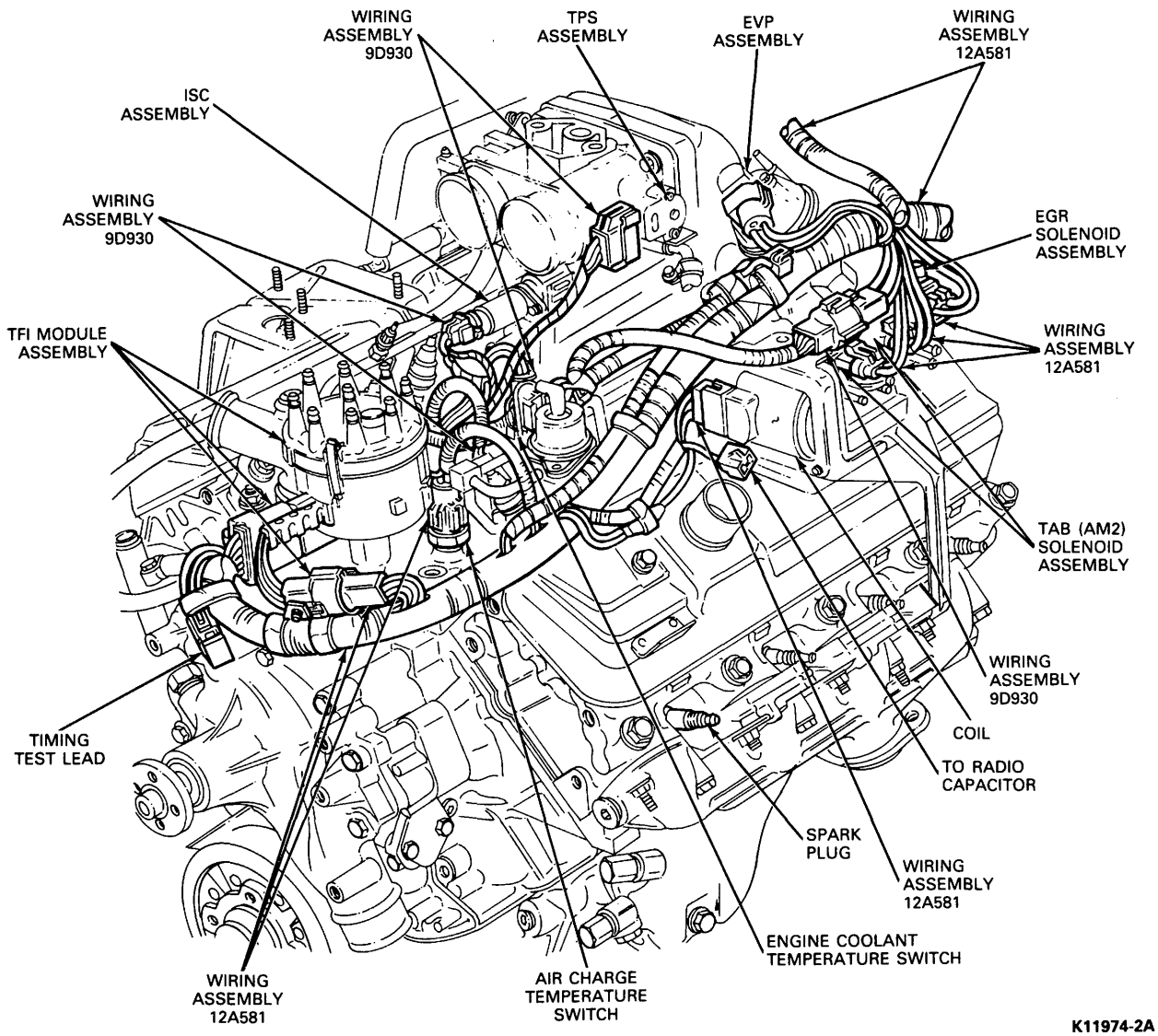
Wiring, Engine—F-250—350 with 7.5L (EFI)—RH Side



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REMOVAL AND INSTALLATION (Continued)

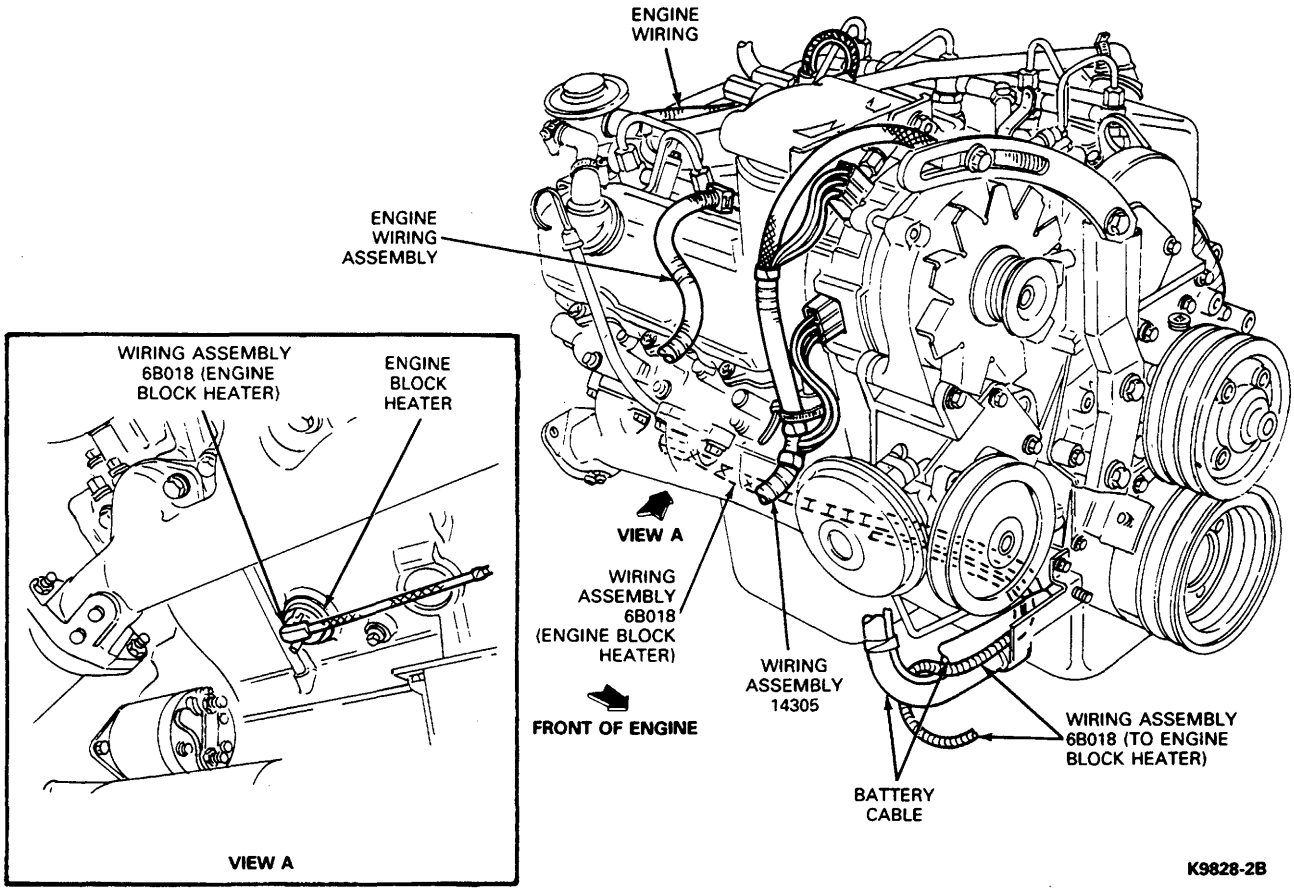
Wiring, Engine—F-250—350 with 7.5L (EFI)—LH Side



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REMOVAL AND INSTALLATION (Continued)

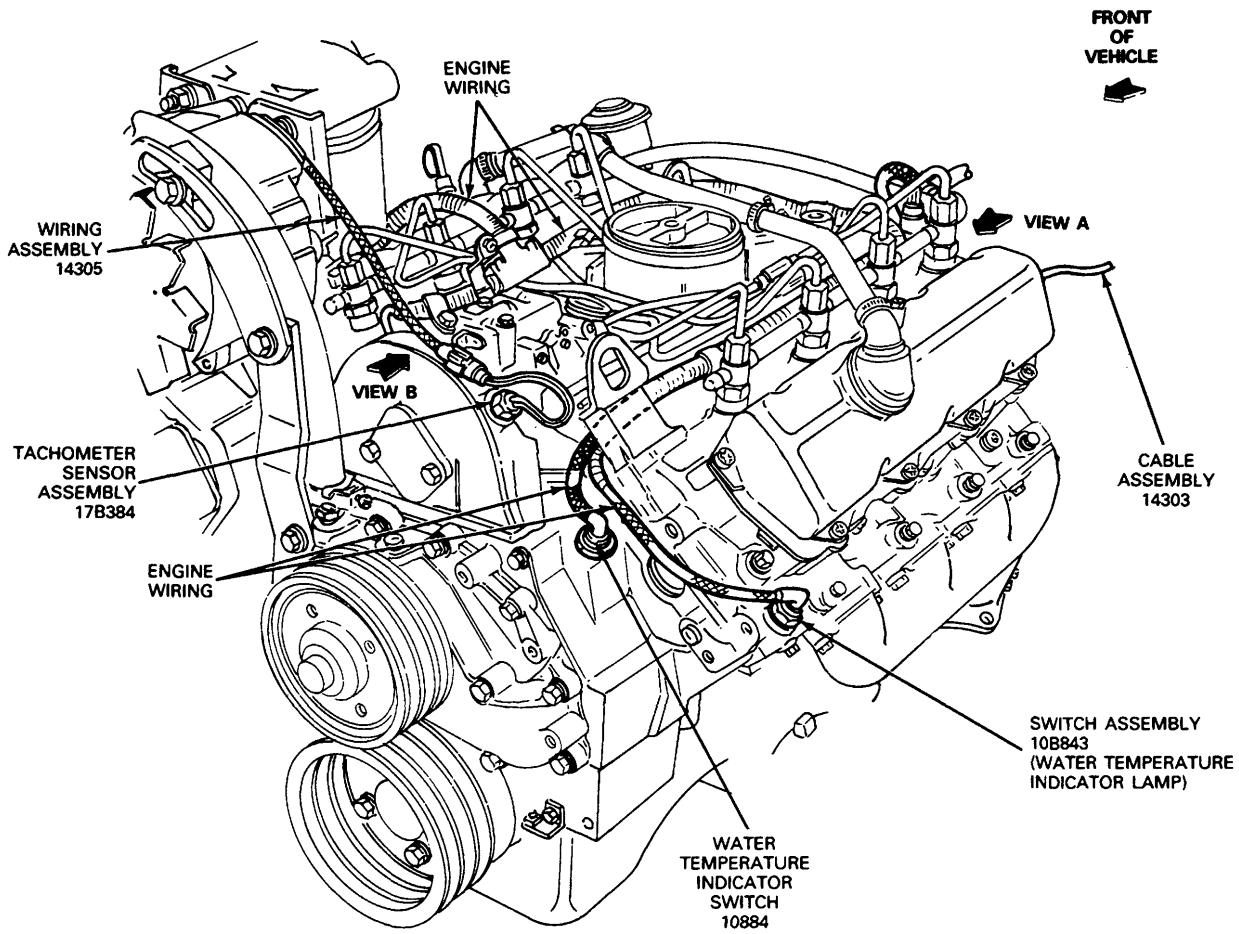
Wiring, Engine—F-250—350 and E-Series with 7.3L Diesel—RH Side

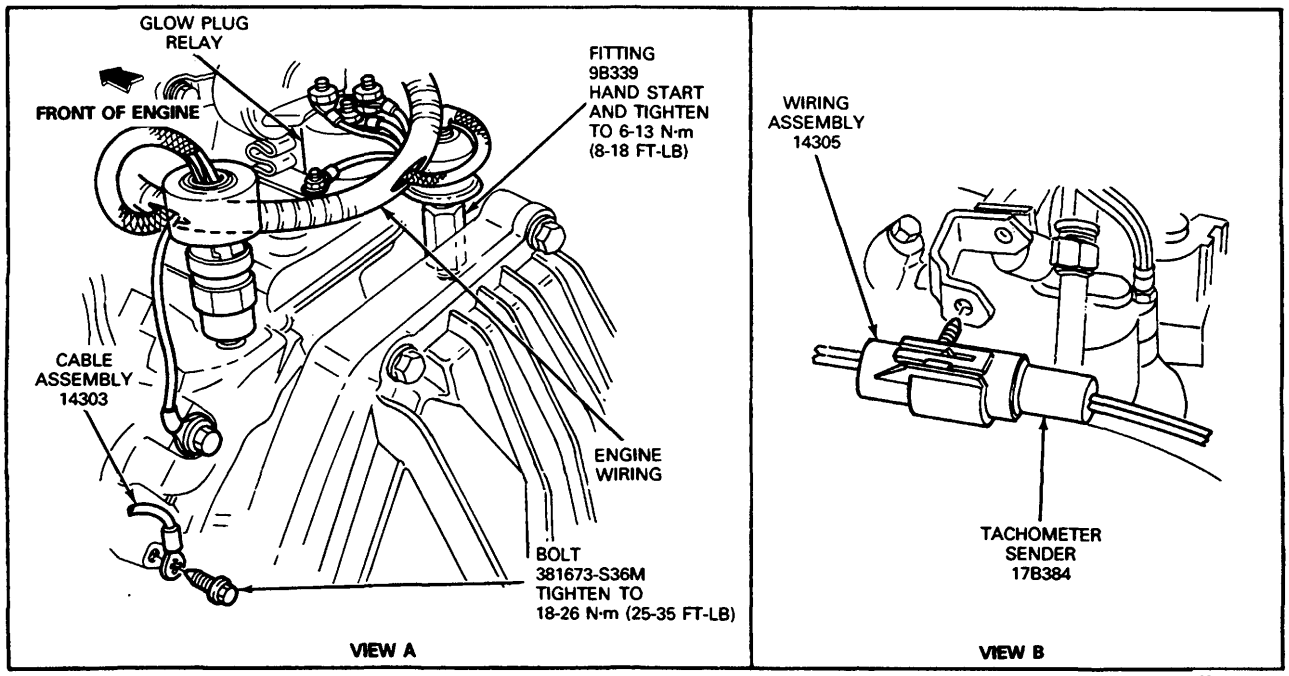


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REMOVAL AND INSTALLATION (Continued)

Wiring, Engine—F-250—350 and E-Series with 7.3L Diesel—LH Side



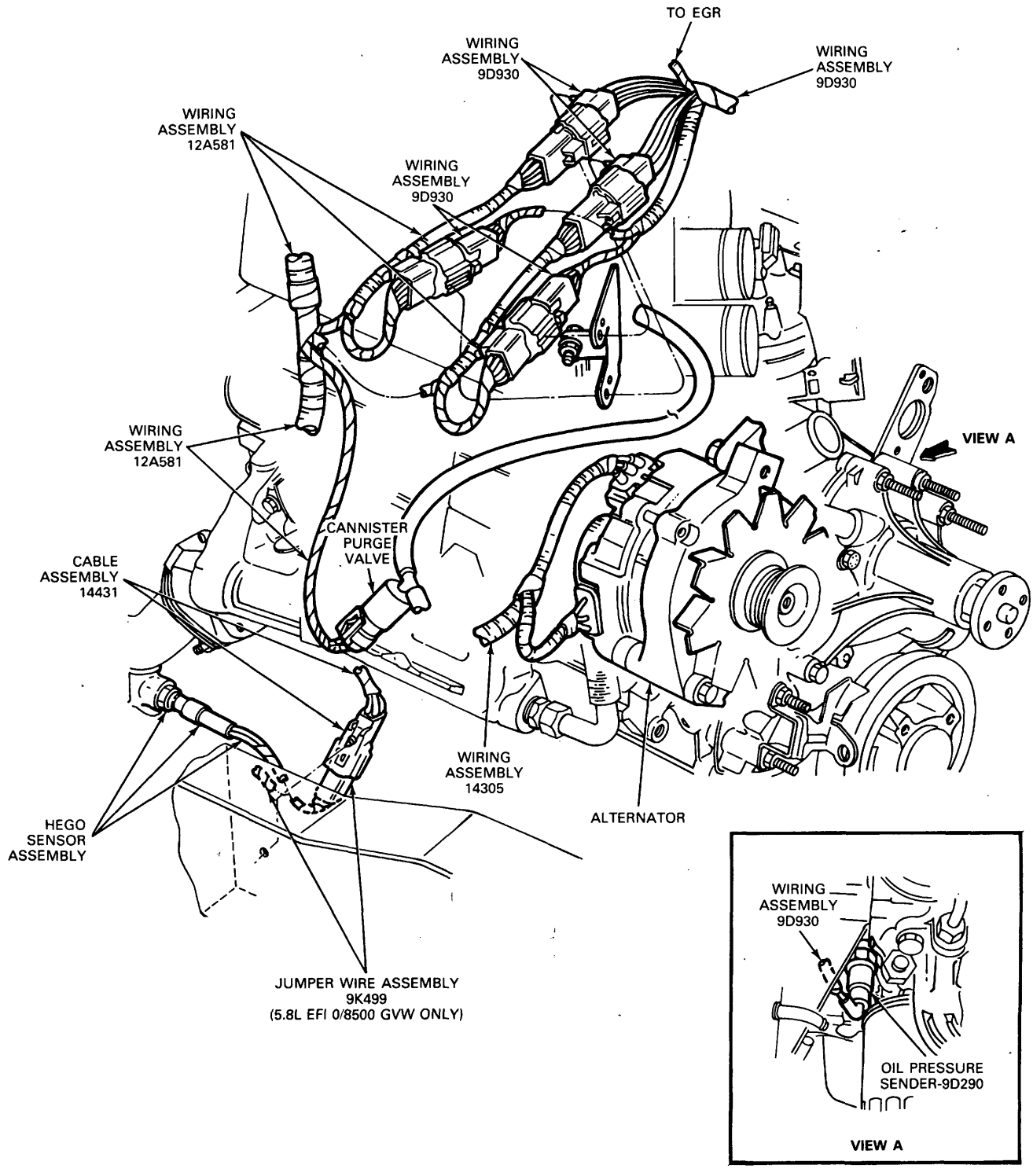


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REMOVAL AND INSTALLATION (Continued)

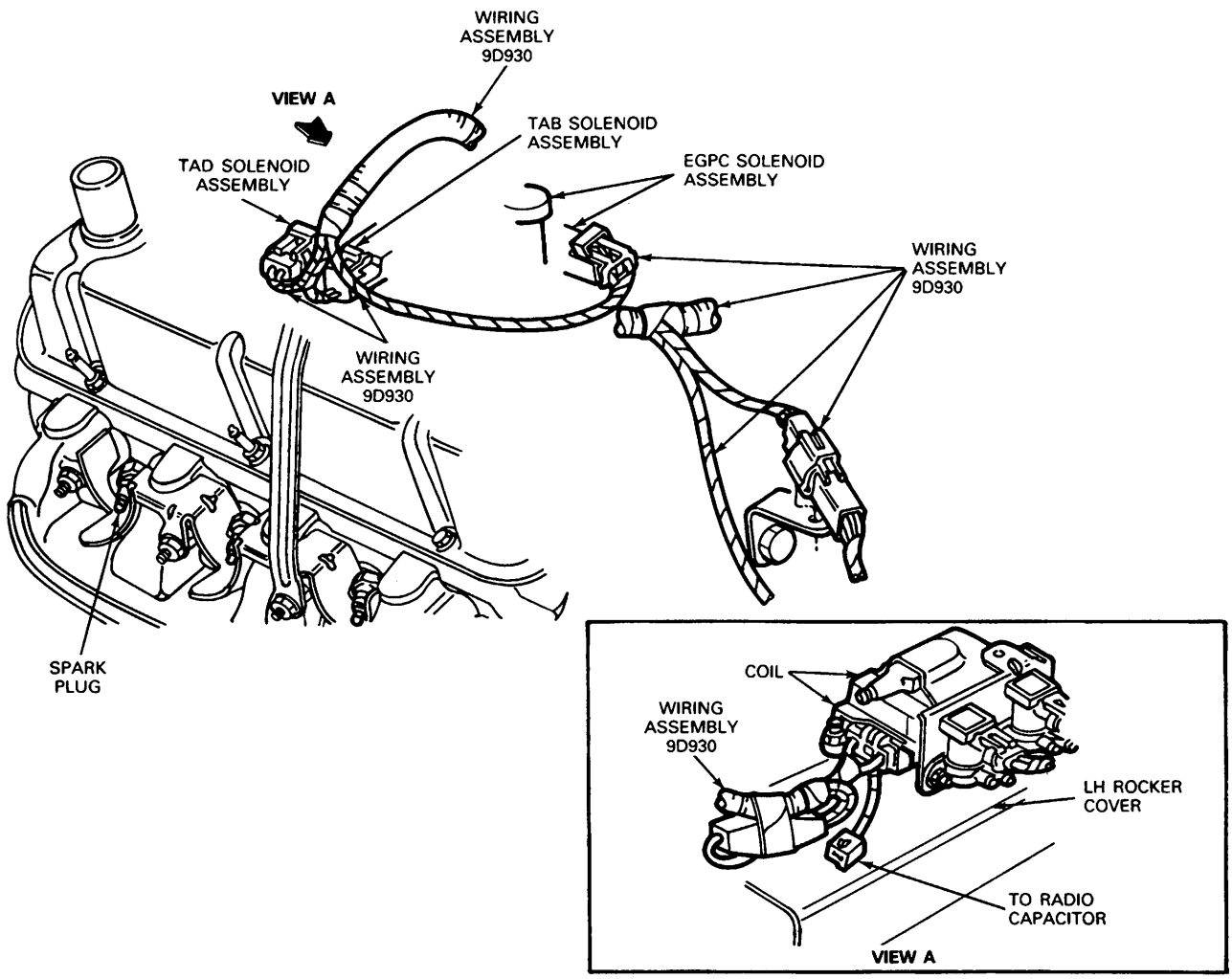
Wiring, Engine—E-Series with 5.0L (EFI) and 5.8L (EFI)—RH Side



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REMOVAL AND INSTALLATION (Continued)

Wiring, Engine—E-Series with 5.0L (EFI) and 5.8L (EFI)—LH Side

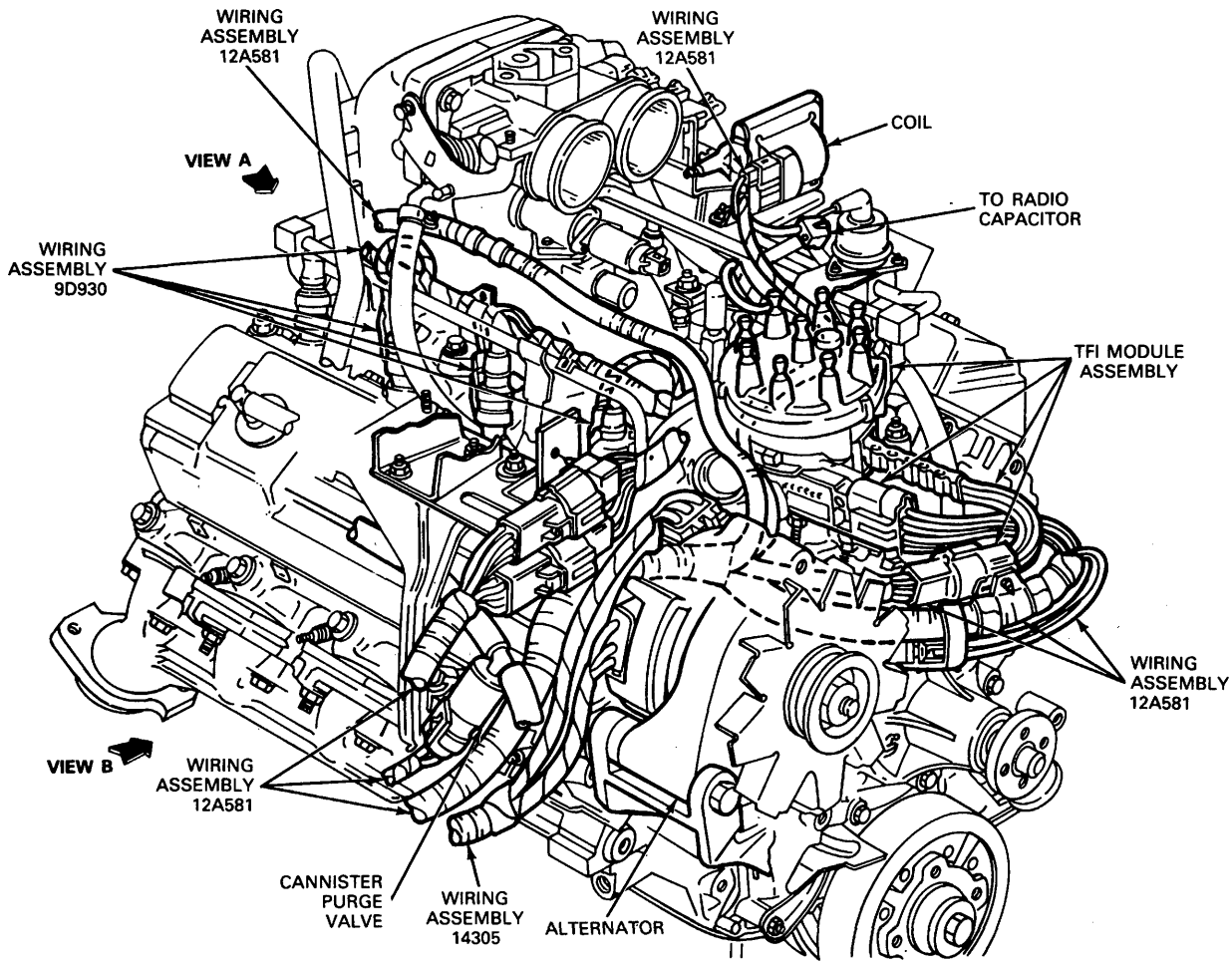


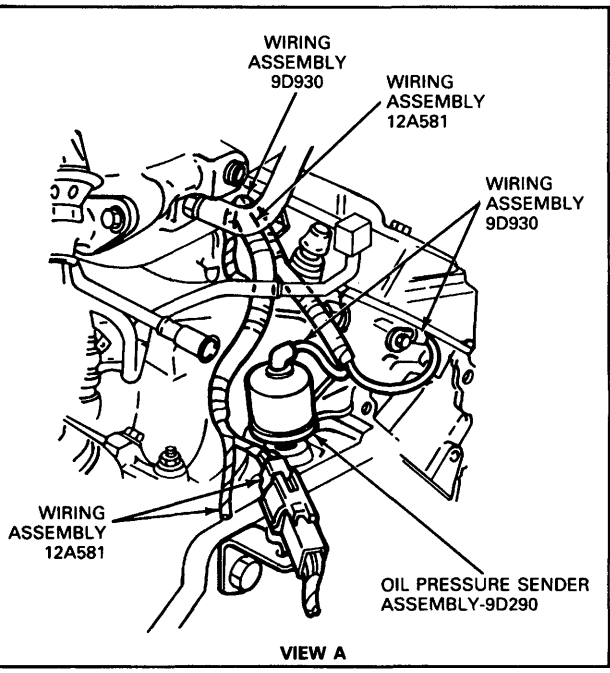
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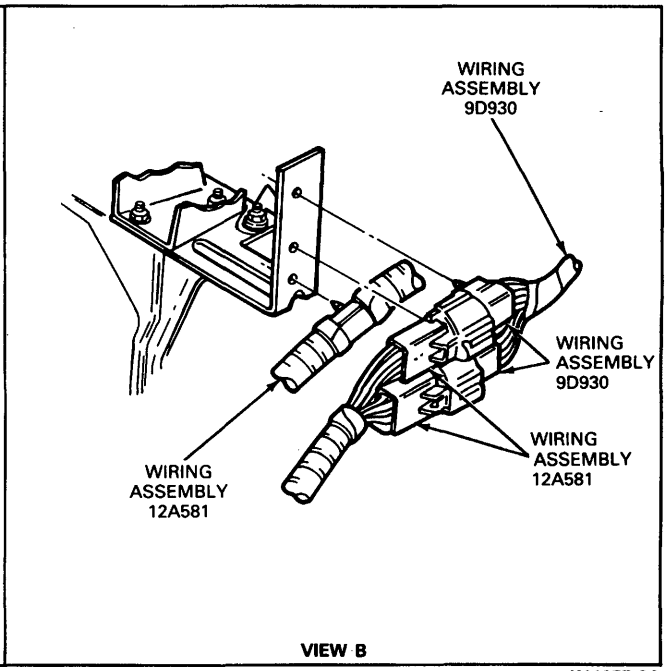
REMOVAL AND INSTALLATION (Continued)

Wiring, Engine—E-Series with 7.5L (EFI)—RH Side





VIEW A



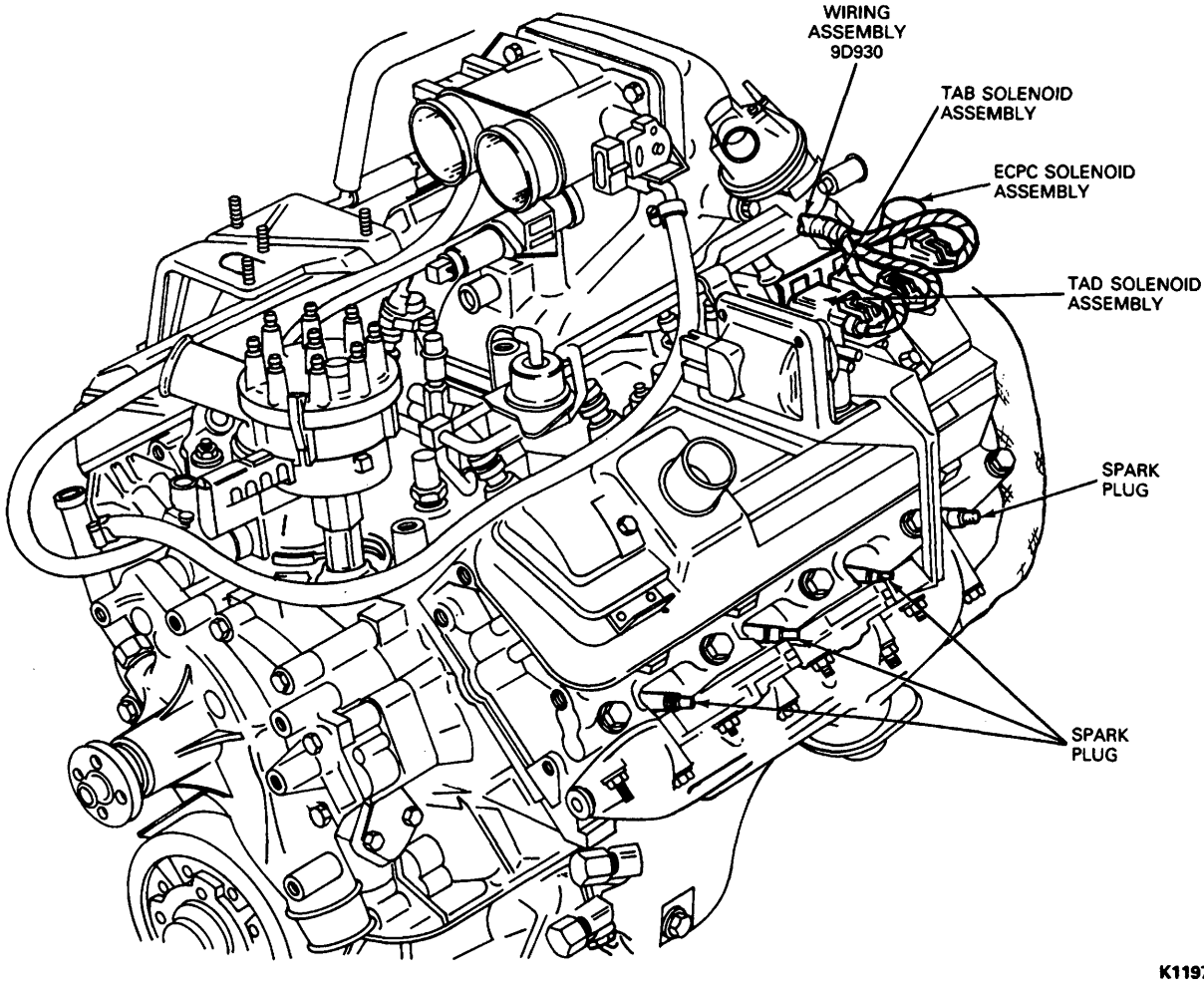
VIEW B

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REMOVAL AND INSTALLATION (Continued)

Wiring, Engine—E-Series with 7.5L (EFI)—LH Side



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SECTION 34-31 Fuses, Circuit Breakers and Fuse Links

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Fuse Panels	34-31-1
DIAGNOSIS AND TESTING	
Fuse Link Continuity Test	34-31-2
DISASSEMBLY AND ASSEMBLY	
Fuse Link	34-31-3
REMOVAL AND INSTALLATION	
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VEHICLE APPLICATION

All Models.

DESCRIPTION

Fuse Panels

Each vehicle has a fuse panel which contains most of the fuses used in the electrical system. The fuse panel for E-150—E-350 is located on a mounting bracket under the instrument panel left of the steering column (Fig. 1). The fuse panels for F-150—F-350 and Bronco are located on the dash panel under the instrument panel left of the steering column (Figs. 2 and 3).

The circuit protection charts in Specifications give the location and values of all the circuits containing fuses or circuit breakers for the various vehicle lines.

Fuse Link

The fuse link is a short length of special, Hypalon (high temperature) insulated wire, integral with the engine compartment wiring harness and should not be confused with standard wire. It is several wire gauges smaller than the circuit which it protects. Under no circumstances should a fuse link replacement repair be made using a length of standard wire cut from bulk stock or from another wiring harness.

The higher melting temperature properties and additional thickness of the Hypalon insulation will

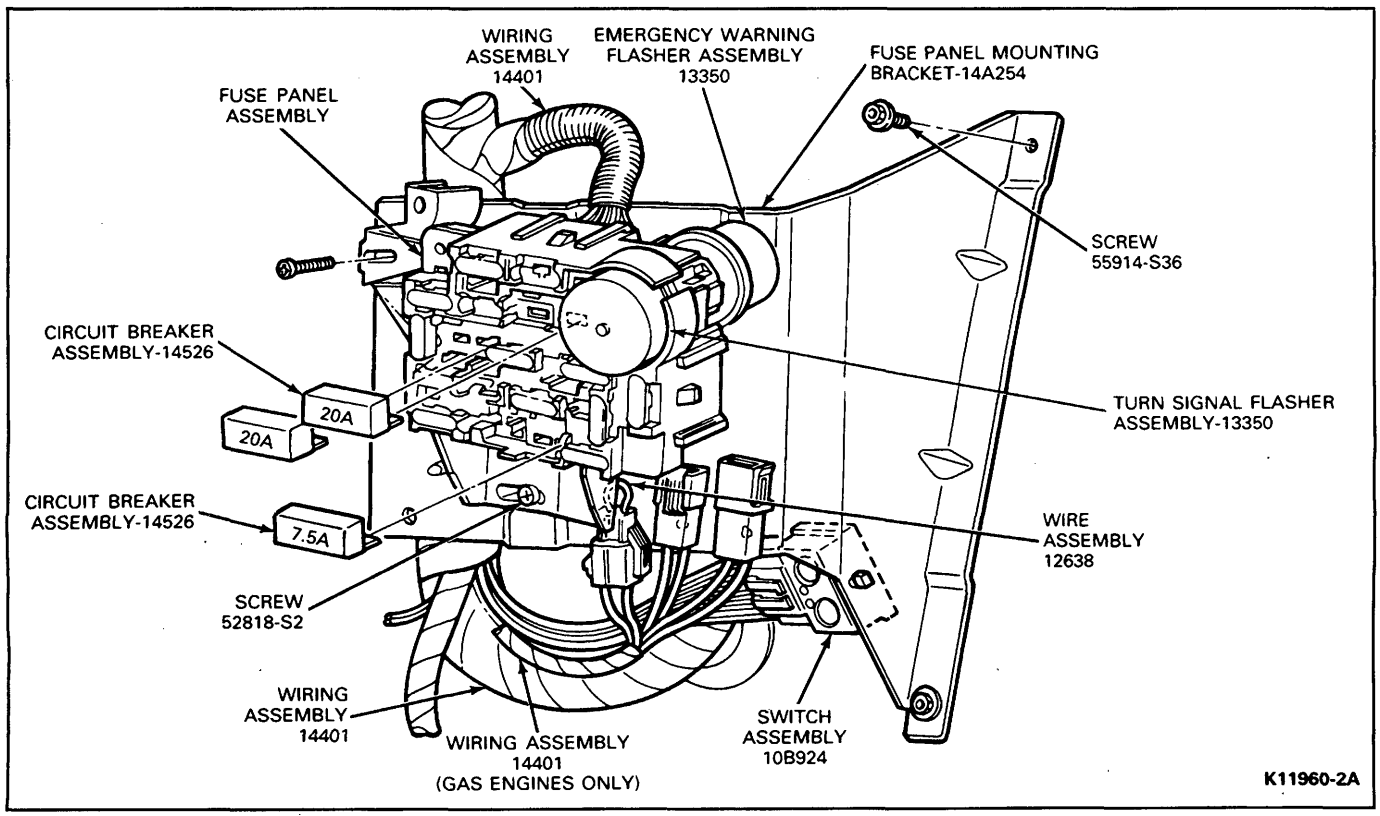


FIG. 1 Fuse Panel—E-150—E-350

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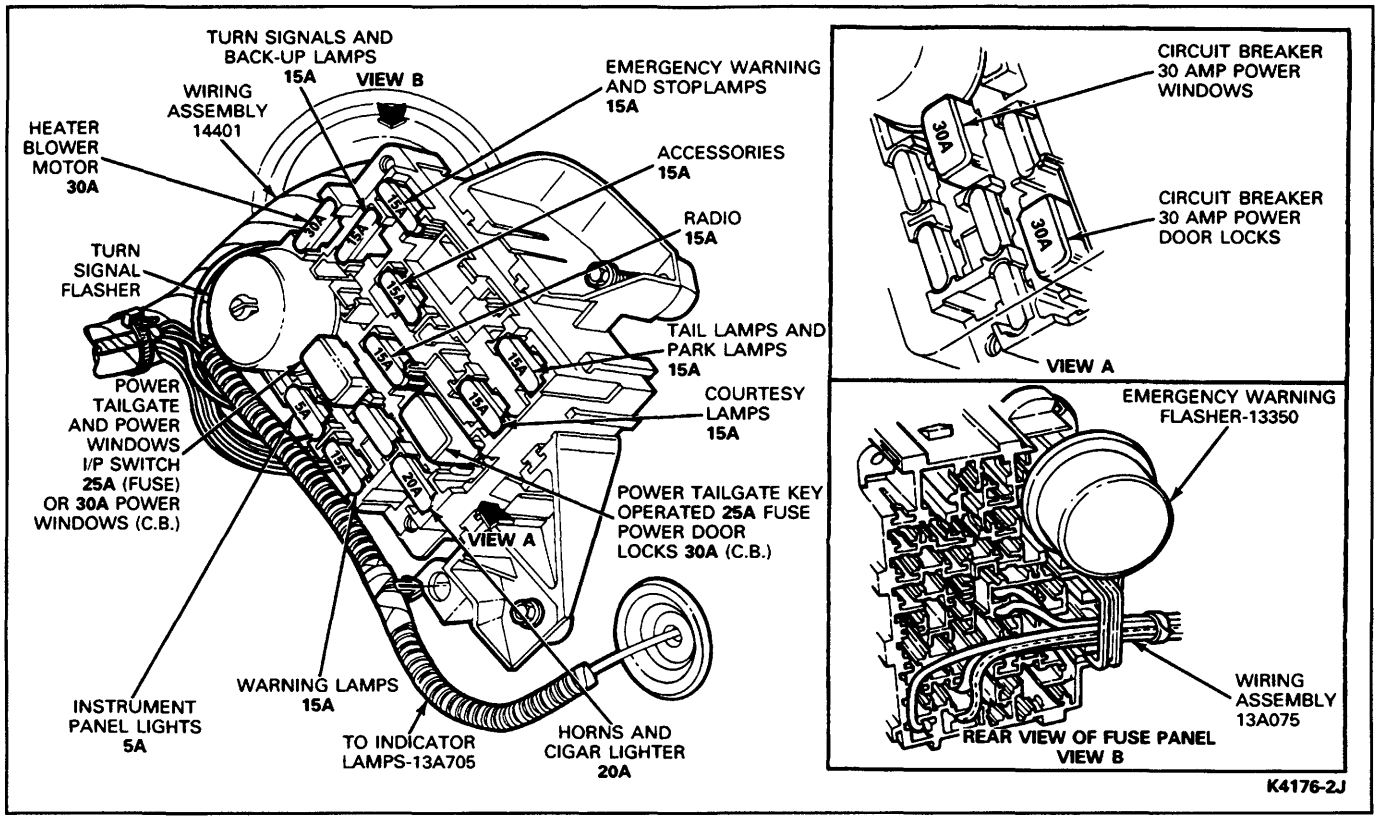


FIG. 2 Fuse Panel—Bronco

usually allow the undersized internal fuse wire to melt and disintegrate within the Hypalon casing with little damage to the high temperature insulation other than discoloration and/or bubbling of the insulation surface. In extreme cases of excessive circuit current the insulation may separate after the fuse wire has disintegrated. However, the bare wire will seldom be exposed. When it becomes difficult to determine if the fuse link is burned open, perform a continuity test. When heavy current flows, such as when a booster battery is connected incorrectly or when a short to ground occurs in the wiring harness, the fuse link burns out and protects the alternator and/or wiring.

Production fuse links have a flag moulded on the wire or on the terminal insulator. Color identification of the flag or connector is Blue-20 Ga. wire, Red-18 Ga. wire, Yellow-17 Ga. wire, Orange-16 Ga. wire, or Green-14 Ga. wire. Fig. 4 shows typical fuse link installations.

DIAGNOSIS AND TESTING

Fuse Link Continuity Test

1. Make certain first that the battery is OK, then turn on the headlamps or any accessory. If the headlamps or an accessory do not operate, a fuse link is probably burned out.
2. Where there are two fuse links (Fig. 4), repeat Step 1 to test the fuse link that protects the vehicle equipment.

   To test the fuse link that protects the alternator, make certain that the battery is OK, then check with a voltmeter or 12-volt test lamp for voltage at the BAT terminal of the alternator. No voltage indicates that the alternator fuse link is probably burned out.

REMOVAL AND INSTALLATION

Fuse Link

Refer to Figs. 5 and 6.

If it becomes necessary to replace a fuse link in a wiring assembly, make sure the replacement fuse link is a duplicate of the one removed with respect to gauge, length and insulation. Original and Ford replacement fuse links have insulation that is flame proof. Do not fabricate a fuse link from ordinary wire because the insulation may not be flameproof.

If a circuit protected by a fusible link becomes inoperative, inspect for a blown fuse link. If the fuse link wire insulation is burned or opened, disconnect the feed wire part of the wiring and cut out the damaged portion as close as possible behind the splice in the harness. If the damaged fuse link is between two splices (weld points in the harness), cut out the damaged portion as close as possible to the weld points.

Two examples are the air conditioner feed and high speed blower motor switch feed circuits, which use special 17 gauge wire fuse links to meet the special protection requirements. These two fuse links are located in the engine compartment, one near the large rubber grommet in the center area of the dash panel, the other near the starter motor relay on the RH fender apron. They are covered with a special vinyl tube shielding which must slide freely between the two welded ends. The shielding is necessary to prevent fumes, oil or fuel from saturating the fuse link area.

When replacing one or both air conditioner fuse links, carefully remove the existing shielding after cutting out the damaged wire. Install the shielding over the new fuse link(s) before crimping the fuse links to the wire ends. Some wiring assemblies have more than one fuse

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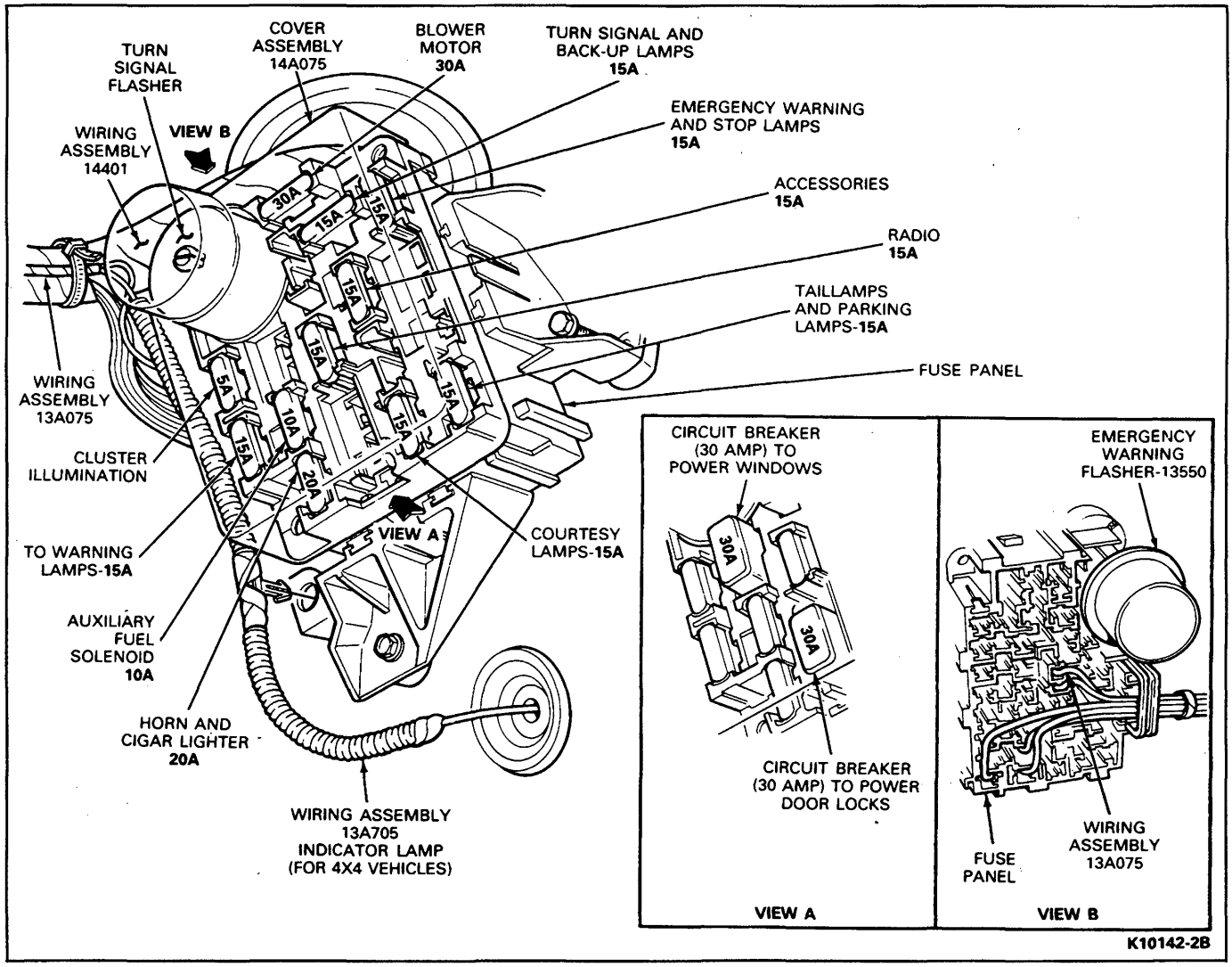


FIG. 3 Fuse Panel—F-150—F-350

link fed from a single, heavy gauge wire in the same location.

To replace the fuse link proceed as follows:

1. Some fuse links shown have an eyelet terminal for a 5/16-inch stud on one end. When the terminal is not required, use one of the fuse links shown in Figs. 5 and 6, with the insulation stripped from both ends.
2. Disconnect the battery ground cable.
3. Disconnect the fuse link and/or fuse link eyelet terminal from the battery terminal of the starter relay. On some vehicle applications, the fuse link is looped outside of the wire harness, behind the point at which the harness is clipped to the RH rocker cover above the starter.
4. Cut the fuse link and the splice(s) from the wire(s) to which it is attached.

   Disconnect the feed wire part of the wiring and cut out the damaged portion as close as possible behind the splice in the harness. If the damaged fuse link is between two splices (weld points in the harness), cut out the damaged portion as close as possible to the weld points.
5. Splice and solder the new fuse link to the wire(s) from which the old link was cut. Use rosin core solder. Wrap the splice(s) completely with Electrical Tape C8AZ-19628-D, F, G, H or equivalent.
6. Securely connect the eyelet terminals (if any) to the battery stud on the starter relay.
7. Install the repaired wiring as before, using existing clips, if provided.
8. Connect the ground cable to the battery.

DISASSEMBLY AND ASSEMBLY

Fuse Link

To service any blown fuse link (Fig. 4) use the following procedure:

1. Determine which circuit is damaged, its location and the cause of the open fuse link. If the damaged fuse link is one of three fed by a common No. 10 or 12 gauge feed wire, determine the specific affected circuit.
2. Disconnect the battery ground cable.
3. Cut the damaged fuse link from the wiring harness and discard it. If the fuse link is one of three circuits

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fed by a single feed wire, cut it out of the harness at each splice end and discard it.

4. Identify and procure the proper fuse link and butt connectors (Figs. 5 and 6) for attaching the fuse link to the harness.
5. To service a two-link group when only one link has blown and other link is not damaged:
   a. Cut out blown link (two places) (Fig. 7).
   b. Position correct eyelet type service fusible link and bare butt connector.
   c. Solder serviced joint and insulate with tape (Fig. 7).
6. To service any fuse link in a 3-link group with one feed:
   a. After cutting the open link out of the harness, cut each of the remaining undamaged fuse links close to the feed wire weld.
   b. Strip approximately 12.7mm (1/2 inch) of insulation from the detached ends of the two good fuse links. Then insert two wire ends into one end of Butt Connector D3AZ-14488-Y or Z, or equivalent (Fig. 6) and carefully push one stripped end of the replacement fuse link into the same end of the butt connector. Crimp all three firmly together.

NOTE: Care must be taken when fitting the three fuse links into the butt connector as the internal diameter is a snug fit for three wires. Make sure to use a Wire Fitting Crimping Tool T67S-17018-A or equivalent. Pliers or side cutters will not apply the proper crimp to retain the wires and withstand a pull test.

   c. After crimping the butt connector to the three fuse links, cut the weld portion from the feed wire and strip approximately 12.7mm (1/2 inch) of insulation from the cut end. Insert the stripped end into the open end of the butt connector and crimp very firmly.
   d. To attach the remaining end of the replacement fuse link, strip approximately 12.7mm (1/2 inch) of insulation from the wire end of the circuit from which the blown fuse link was removed. Firmly crimp Butt Connector D3AZ-14488-Z, or Y or equivalent (Fig. 6) to the stripped wire. Then, insert the end of the replacement link into the other end of the butt connector and crimp firmly.
   e. Using rosin core solder with a consistency of 60 percent tin and 40 percent lead, solder the connectors and the wires at the repairs. Insulate with Electrical Tape C8AZ-19628-D, F, G, H or equivalent (Fig. 6).
7. To replace any fuse link on a single circuit in a harness, cut out the damaged portion, strip approximately 12.7mm (1/2 inch) of insulation from the two wire ends and attach the appropriate replacement fuse link to the stripped wire ends with two proper size butt connectors. Solder the connectors and wires and insulate with tape, as in Step 5.
8. To repair any fuse link which has an eyelet terminal on one end such as the charging circuit (Fig. 6), cut off the open fuse link behind the weld, strip approximately 12.7mm (1/2 inch) of insulation from the cut end and attach the appropriate new eyelet fuse link to the cut stripped wire with an appropriate size butt connector (Fig. 6). Solder the connectors and wires at the repair and insulate with tape, as in Step 5.
9. Connect the negative battery cable to the battery and test the system for proper operation.

NOTE: Do not mistake a resistor wire for a fuse link. The resistor wire is generally longer and has print stating, "Resistor-don't cut or splice."

NOTE: When attaching a single No. 16, 17, 18 or 20 gauge fuse link to a heavy gauge wire, always double the stripped wire end of the fuse link before inserting and crimping it into the butt connector for positive wire retention.

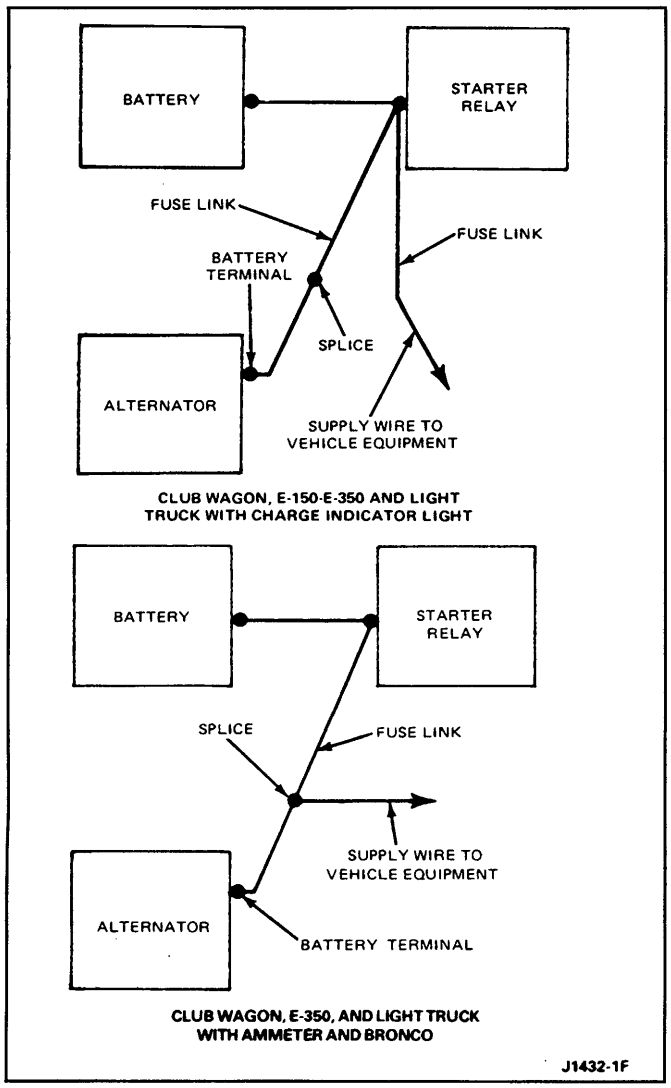
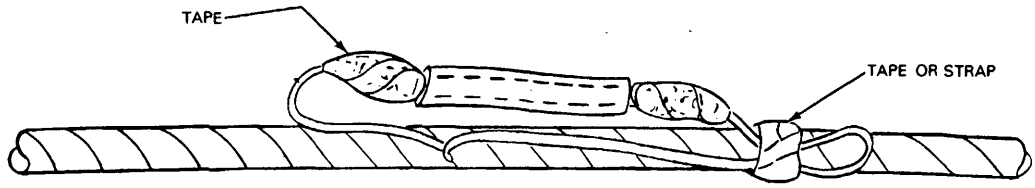


FIG. 4 Fuse Link Installation

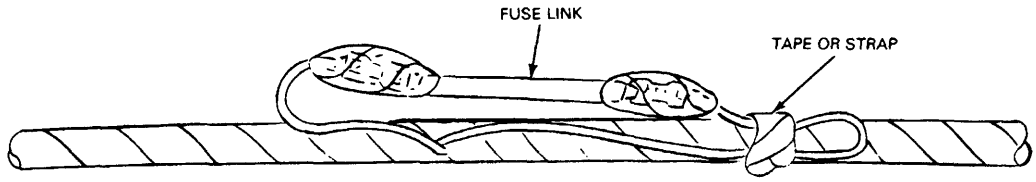
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FUSE LINK AND BUTT CONNECTOR SERVICE PROCEDURES

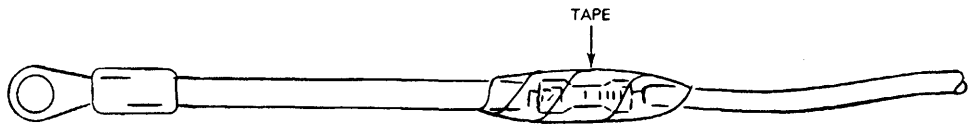
REMOVE EXISTING VINYL TUBE SHIELDING
REINSTALL OVER FUSE LINK BEFORE CRIMPING
FUSE LINK TO WIRE ENDS



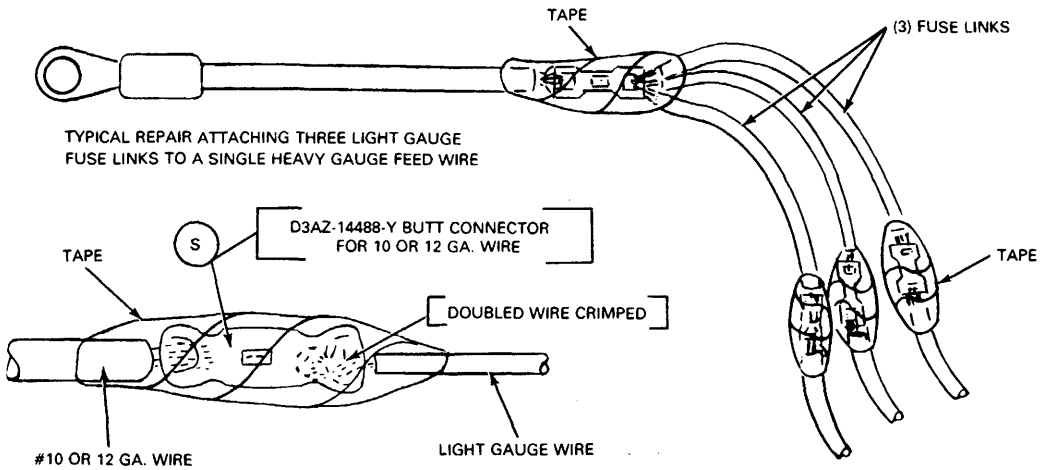
TYPICAL REPAIR USING THE SPECIAL #17 GA. (9.00" LONG-YELLOW) FUSE LINK REQUIRED FOR THE AIR/COND. CIRCUITS (2) #687E AND #261A LOCATED IN THE ENGINE COMPARTMENT

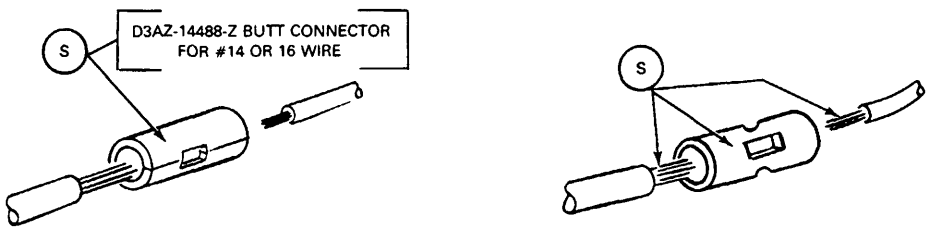


TYPICAL REPAIR FOR ANY IN-LINE FUSE LINK USING THE SPECIFIED GAUGE FUSE LINK FOR THE SPECIFIC CIRCUIT



TYPICAL REPAIR USING THE EYELET TERMINAL FUSE LINK OF THE SPECIFIED GAUGE FOR ATTACHMENT TO A CIRCUIT WIRE END





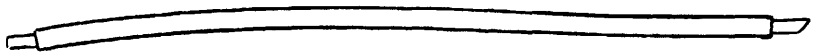
FUSIBLE LINK REPAIR PROCEDURE

J1704-2G

FIG. 5 Fuse Link Repair Procedure

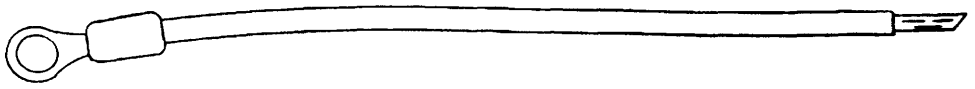
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WIRING ASSEMBLY–FUSE LINK (WITH INSULATION STRIPPED BOTH ENDS)



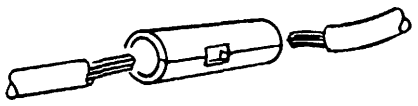
D3AZ–14A526-H	# 14 GA. WIRE - 9.00" ± .50 LENGTH (GREEN INSULATION)
D3AZ–14A526-J	# 16 GA. WIRE - 9.00" ± .50 LENGTH (ORANGE INSULATION) AS REQ'D.
D3AZ–14A526-K	# 17 GA. WIRE - 9.00" ±.50 LENGTH(YELLOW INSULATION) AS REQ'D. (SPECIAL USED WITH AIR CONDITIONING SYSTEM)
D3AZ–14A526-L	# 18 GA. WIRE - 9.00" ± .50 LENGTH (RED INSULATION) AS REQ'D
D3AZ–14A526-M	# 20 GA. WIRE – 9.00" ± .50 LENGTH (BLUE INSULATION) AS REQ'D.

WIRING ASSEMBLY–FUSE LINK (WITH EYELET TERMINAL AND ONE END STRIPPED)



D3AZ–14A526–D	# 14 GA. WIRE - 9.00" ± .50 LENGTH (GREEN INSULATION) AS REQ'D.
D3AZ–14A526-E	# 16 GA. WIRE - 9.00" ± .50 LENGTH (ORANGE INSULATION) AS REQ'D.
D3AZ–14A526-F	# 18 GA. WIRE – 9.00" ± .50 LENGTH (RED INSULATION) AS REQ'D.
D3AZ–14A526-G	# 20 GA. WIRE-9.00 ± .50 LENGTH (BLUE INSULATION) AS REQ'D.

BUTT CONNECTOR –WIRING SPLICE



D3AZ–14488-Y	FOR # 10 AND 12 GA. WIRE (LOAD CIRCUIT) AS REQ'D.
D3AZ–14488-Z	FOR # 14 AND 16 GA. WIRE (LOAD CIRCUIT) AS REQ'D.

J1707-2D

FIG. 6 Fuse Link and Butt Connector Identification

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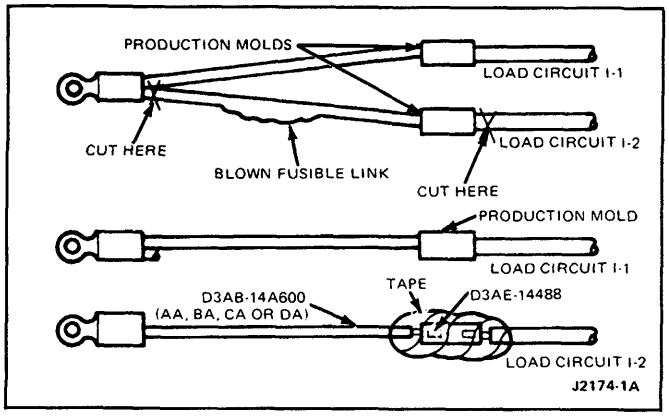
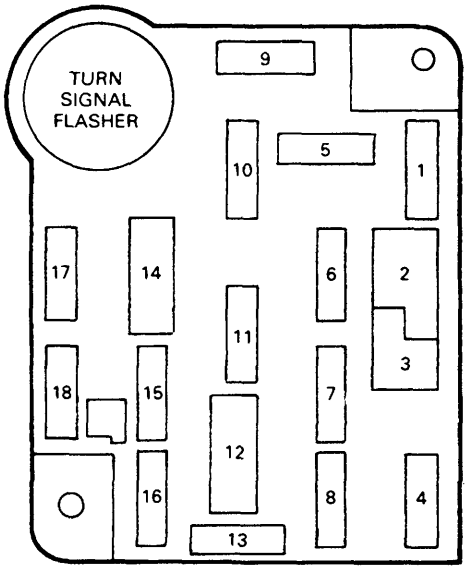


FIG. 7 Fusible Link Service Procedure

SPECIFICATIONS

E-150 — E-350 CIRCUIT PROTECTION FUSE PANEL

Fuse Protection	Amps	Fuse Color	Fuse Panel
1	15	Lt. Blue	Stoplamps, Hazard Flasher, Speed Control
2	7.5 C.B.		Windshield Wiper/Washer, Intermittent Wipers
3	Blank		
4	15	Lt. Blue	Instrument Panel Illumination, Running Lamps, Radio/ Clock Illumination, Heater and A/C Control Illumination
5	15	Lt. Blue	Turn Signal, Back-Up Lamps, Dual Battery Relay Coil
6	20	Yellow	Speed Control, Rear Cargo Lamp, Customer Convenience Plug Located Above Fuse Panel — Hot in RUN or ACCY
7	Blank		
8	15	Lt. Blue	Dome Lamp, Map Lamp, 4.9L Cooling Fan Relay, Radio Memory, Power Door Lock Relays
9	15	Lt. Blue	A/C-Heater Blower Motor Relay Coil, A/C Clutch
10	20	Yellow	Cigar Lighter
11	15	Lt. Blue	Radio and Clock, Premium Sound
12	20 C.B.		Power Door Locks
13	.5	Tan	Instrument Panel Illumination Lamps
14	20		Power Windows
15	Blank		
16	15	Lt. Blue	Horn and Speed Control
17	Blank		
18	15	Lt. Blue	Instrument Panel Warning Lamps, 4.9L Cooling Fan Relay, Warning Buzzer, Fuel Pump



FUSE PANEL DIAGRAM — E-150 — E-350

CK11954-2A

E-150 — E-350 NON-FUSE PANEL CIRCUIT PROTECTION

Circuit Protected	Type of Protection	Location
Ignition Switch and Fuse Panel Feed	16 Gauge Fuse Link	Near A/C Case
Headlamp Switch and Fuse Panel Feed	18 Gauge Fuse Link	Near A/C Case
Hego Sensor	20 Gauge Fuse Link	Near Master Cylinder
Ignition	20 Gauge Fuse Link	Near Master Cylinder
Blower Motor	20 Gauge Fuse Link	R.H. Fender Apron
Fuel Heater Diesel Engine	20 Gauge Fuse Link	R.H. Fender at Dash
Glow Plug Right Bank	14 Gauge Fuse Link	Starter Motor Relay
Glow Plug Left Bank	14 Gauge Fuse Link	Starter Motor Relay
Auxiliary A/C — Heater	18 Gauge Fuse Link	L.H. Fender at Dash

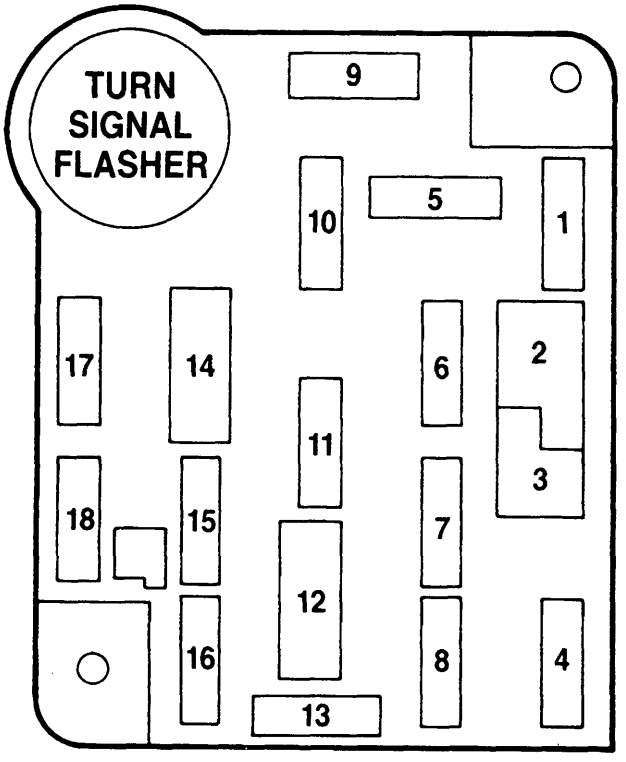
CK11955-2A

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F-150-F-350 AND BRONCO CIRCUIT PROTECTION FUSE PANEL

Fuse Protection	Amps	Fuse Color	Circuits Protected
1	15	Lt. Blue	Hazard warning flasher, stop lamps
2	—	—	Not used
3	—	—	Not used
4	15	Lt. Blue	Tail lamps, parking lamps, marker lamps, license lamps, "Headlamps on" warning buzzer, trailer lamps relay, camper lamps relay,* instrument illumination
5	15	Lt. Blue	Turn signals, back-up lamps
6	15	Lt. Blue	Acc., clock, 4-wheel drive indicator lamp, speed control, auxiliary battery relay, engine solenoids, rear window deice relay**
7	—	—	Not used
8	15	Lt. Blue	Courtesy lamps, cargo lamps, clock, radio memory, engine compartment lamp visibility group**
9	30	Lt. Green	Heater — A/C blower motor
10	—	—	Not used
11	15	Lt. Blue	Radio
11	25	—	Power tailgate**
12	30 C.B	—	Power door locks — electric mirror, power tailgate (Key Switch)**
13	—	—	Not used
14	25 30 C.B.	Natural —	Power tailgate (Instrument Panel Switch)** Power windows
15	10	Red	Fuel tank selector. Not used on Bronco
16	20	Yellow	Horn, cigar lighter
17	5	Tan	Instrument illumination
18	15	Lt. Blue	Warning lamps, seat belt buzzer, carburetor circuits, tachometer, choke heater, upshift indicator lamp

*F-150-F-350 Only
**Bronco Only



FUSE PANEL DIAGRAM — F-150 — F-350 TRUCK AND BRONCO

CK6358-2D

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Flashers	Location
Turn Signal Flasher	Front of fuse panel
Hazard Warning Flasher	Rear of fuse panel behind turn signal flasher

FLASHER/LOCATION CHART

F-150-F-350 AND BRONCO
NON FUSE PANEL CIRCUIT PROTECTION

Circuit Protected	Type of Protection	Location
Headlamp	22 amp C.B.	Integral w/lighting switch
Electric mirror	5 amp fuse (in-line)	On harness near fuse panel
Auxiliary battery	14 gauge fuse link	Near R.H. fender apron and dash panel
Alternator	16 gauge fuse link (for 40 or 60 amp alternators)	Starter motor relay
Alternator	14 gauge fuse link (for 70 amp alternator)	Starter motor relay
Trailer	16 gauge fuse link	Starter motor relay
Trailer	16 gauge fuse link	Starter motor relay
Trailer or auxiliary lamps	18 gauge fuse link	L.H. fender apron
Marker lamps		
Headlamp switch and fuse panel feed	16 gauge fuse link	Near R.H. fender apron and dash panel
Ignition switch and fuse panel feed	14 gauge fuse link (Bronco without ammeter) 16 gauge fuse link (F-150-F-350 without ammeter) 14 gauge fuse link (with ammeter)	Near R.H. fender apron and dash panel
Windshield wiper/washer	C.B.	Integral w/wiper switch
Electronic engine controls	18 gauge fuse link	Starter motor relay
Heated backlite	16 gauge fuse link (Bronco)	L.H. fender apron

CK6379-2D

SPECIAL SERVICE TOOLS

Model	Description
T67S-17018-A	Wire Fitting Crimping Tool

CK9042-1A

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GROUP 35 AUXILIARY EQUIPMENT

SECTION TITLE	PAGE
ANTENNAS	35-11-1
ASH RECEPTACLES AND CIGAR LIGHTER	35-40-1
HORNS	35-80-1
MIRRORS—INSIDE AND OUTSIDE	35-50-1
RADIO AND PREMIUM SOUND SYSTEM	35-01-1
SPEAKERS	35-31-1
WINDSHIELD WASHERS	35-70-1
WINDSHIELD WIPERS—ELECTRIC	35-60-1

SECTION 35-01 Radio and Premium Sound System

SUBJECT	PAGE
DESCRIPTION AND OPERATION	
Chassis Connectors	35-01-1
Operating Instructions	35-01-1
Premium Sound System—Club Wagon	35-01-1
Radio	35-01-1
DIAGNOSIS AND TESTING	
Radio	35-01-2
Radio Reception	35-01-2
DIAGNOSIS GUIDES	35-01-5
REMOVAL AND INSTALLATION	
AM and AM/FM Radio	35-01-4
E-150—E-350	35-01-5
F-150 Through F-350—and Bronco	35-01-4
Premium Sound System Amplifier E-150—E-350	35-01-5
Radio Suppression Equipment	35-01-5
SPECIAL SERVICE TOOLS	35-01-19
VEHICLE APPLICATION	35-01-1

VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

Radio

Refer to Fig. 1.

The electronic AM radio is standard on all models. An electronic AM/FM/MPX and electronic AM/FM/MPX/cassette radio is optional. A premium sound amplifier is included with the AM/FM/cassette radio option on E-Series Club Wagon.

Premium Sound System—Club Wagon

The premium sound system includes AM/FM/cassette premium speakers and a separate power amplifier which increases the sound level and fidelity from the speakers. The premium sound system is on whenever the radio is turned on.

The amplifier is installed in the center instrument panel speaker opening. The premium sound system uses unique wiring to provide separate return wires to each speaker.

Chassis Connectors

The antenna lead-in receptacle is located on the back of the radio at the lower RH corner. The power and speaker leads are located on the back side of the radio at the LH corner.

Operating Instructions

ELECTRONIC AM RADIO (1 through 5)

ELECTROINC AM/FM STEREO RADIO (1 through 11)

ELECTRONIC AM/FM CASSETTE STEREO RADIO (1 through 16)

1. ON/OFF/VOLUME/CLOCK CONTROL—Rotate to turn on radio and increase volume.

   Push to change display mode or push and hold to set time (see clock instructions).

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2. TUNE—Push and quickly release to tune up(+) or down(-) one channel. Push and hold to tune rapidly across the band.
3. FREQUENCY/CLOCK DISPLAY—Indicates station frequency or time (refer to clock instructions).
4. TONE—Single tone control on AM radio. Rotate clockwise to emphasize treble or counterclockwise to emphasize bass.
   - Separate bass/treble controls on AM/FM stereo radios. Rotate control clockwise to increase, or counterclockwise to decrease bass/treble.
5. PUSHBUTTON MEMORY—To store a station, depress memory button and hold 4 seconds (sound will disappear and return). To recall a station, depress memory button and quickly release.
6. SEEK—Seek up or down band to next station.
7. L/D—(Local/Distant) Toggles between local and distant mode. Only displays LOC when in local mode (distant mode not displayed). Local mode is for use in metropolitan areas and allows capture of strong signal stations with seek control.
8. AM—Pushing AM activates AM mode. AM will be displayed. Six AM stations can be stored in memory.
9. FM—Pushing FM activates FM mode. Pushing FM again will toggle between FM1 and FM2. Twelve FM stations can be stored in memory (six in each of FM1 and FM2). FM1 or FM2 will be displayed.
10. BALANCE—Adjusts sound between LH and RH side of vehicle.
11. FADE—Adjusts sound between front and rear of vehicle.

    NOTE: The fader control is not present on some vehicles without rear speakers.
12. DOLBY®—Press when playing tapes recorded using the Dolby® system. Press again to deactivate.
13. REVERSE—Press to change the side of the cassette tape being played.
14. FAST FORWARD—Press to quickly advance the tape being played.
15. FAST REWIND—Press to quickly rewind the tape being played.
16. EJECT—Press to eject cassette.

CLOCK CONTROLS ON ELECTRONIC RADIOS

The electronic radios have a built in clock. The radio display can be in either a clock or radio mode.

When the radio is off the radio display is in the clock mode continuously and time will be indicated.

When the radio is on the display can be in the radio or the clock mode. Pushing the volume control will switch the display mode from clock to radio or radio to clock as desired.

While in the clock mode, activating any of the radio tuning controls (tune, memory, seek) will change the display to radio frequency. After approximately 10 seconds the display will revert back to the clock display.

SETTING THE CLOCK TIME—Push and hold in the radio volume control and use the tune control to set the time.

Pushing on the left side (-) of the tune control sets hours and pushing on the right side (+) sets minutes. Releasing the volume control after setting the time automatically sets the seconds to zero (although seconds are not displayed).

DIAGNOSIS AND TESTING

Radio

A radio tester is designed for in vehicle usage. It rapidly diagnoses radio malfunctions and determines whether the problem is in the radio, antenna, or the speaker. Testing instructions are located on the side of the tester housing.

This radio tester or an equivalent model can save considerable time in servicing all models and makes of radios. Use of the tester eliminates the need for substituting known quality components.

Radio Reception

Antenna Position

If adjustable, adjust the antenna to full height (E-150—E-350).

Tuning

The electronic radio automatically tunes to the center of station frequency.

FM multiplex has a range of about 32 km (20 miles) before reception noises are heard. This means that in problem areas with tall buildings or hills it is necessary to select the strongest possible station.

Experience will dictate which FM stations offer the best reception.

Tone Control

Turn the single tone control on AM radios clockwise to decrease bass (low frequencies) and turn counterclockwise to decrease the treble (high frequencies).

Refer to Operating Instructions for AM-FM radio tone control adjustment procedure.

Interfering Noises

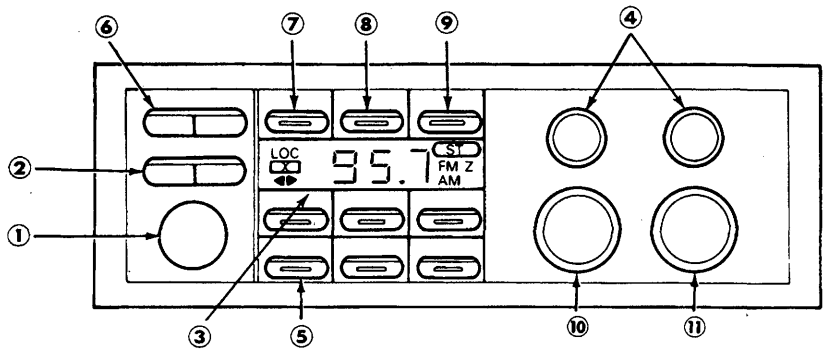
Located within a few feet of the radio is the powerful electrical ignition system. The high voltage of this system produces noisy side effects that can interfere with both the AM and FM stations. Although precautions have been taken to minimize ignition noise, a certain amount can be heard on FM when the station is not quite tuned. Ignition noise from passing vehicles can occasionally be heard if they do not have proper suppression equipment installed. These same vehicles produce interference in television sets. Very little can be done with the radio receiver to protect against this type of external interference.

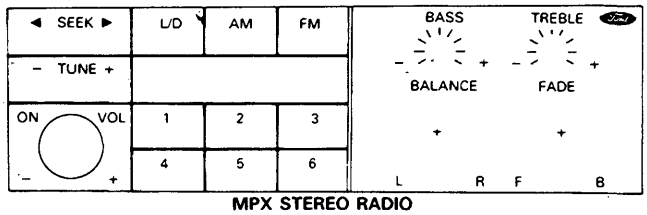
Noise or static may result from many causes. Two of the most common sources of radio noise are listed below.

Ignition Noise:

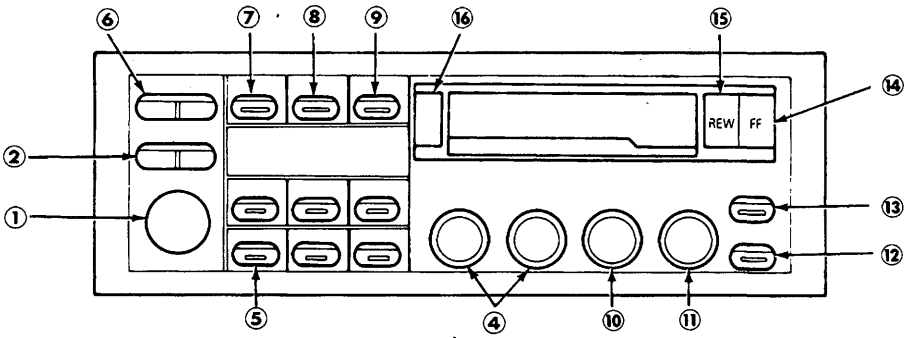
The most effective method of evaluating ignition noise is to compare the radio performance with engine on, versus engine off. If ignition noise is present with engine running:

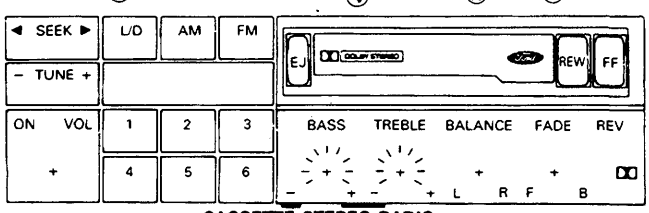
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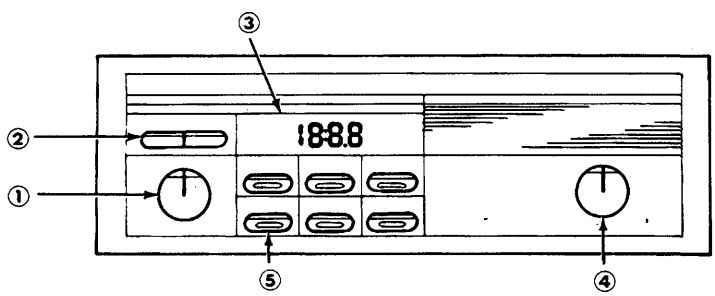


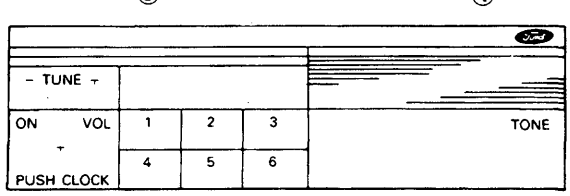
MPX STEREO RADIO





CASSETTE STEREO RADIO
(CASSETTE STEREO WITH EQUALIZER SIMILAR)





AM RADIO

K9050-2C

Fig. 1 Radio Control Functions—Econoline, Bronco, (F-150—F-350 Similar)

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- Check to see that the spark plug wires are the suppressor-type and that the spark plugs are the correct resistor-type.
- Check to see that the carbon center insert in distributor cap is secure.
- Check distributor cap and rotor electrodes for silicone grease as this may cause ignition noise on FM or CB. This noise is characterized by a "motor boat"-type sound on weak to moderate strength stations. The noise can only be eliminated by replacing the distributor cap and rotor with a cap and rotor that does not have grease.

NOTE: Silicone grease must not be removed from cars equipped with electronic engine controls (EEC I, EEC II, EEC III and EEC IV). (Ref. TSB178 and 186; DLR. Coding: Grease, Code: 56.)

Missing or Faulty Noise Suppression Components:

- Noise suppression components may be faulty or missing.
- Check bond strap grounding effectiveness by wedging a large file between metal parts to ensure proper ground, such as between the tailpipe and body, or between the fender and frame, while the radio is playing and the engine is running. Listen for a decrease in the objectionable radio noise. If a reduction in radio noise is noted, first try tightening body and exhaust system clamps and brackets. Then, if necessary, install a new bond strap between the two metal parts to ensure proper ground.

Tape Player will not Accept Cassette, Eats Tape, Plays too Fast or too Slow, etc. (AM and FM Operating Properly)

- Check operation of the tape player by using a known good cassette.
- If the condition is not corrected by the substitution of a known good cassette, the radio chassis must be removed and sent to an authorized service facility for service.

FM Flutter

Flutter can best be described as repeated pops and hissing bursts heard in the speaker during an otherwise good broadcast. Usually this condition exists while traveling in the fringe area of the station. Flutter will become more severe within 40 km (25 miles) or less of the station. The signal loss becomes greater as distance from the station increases. Finally, reception is no longer possible. Flutter may also be noticed near the station because of the "line-of-sight" characteristic of FM radio waves. This condition can happen when a building or large structure is between the radio receiver and the station you are trying to receive. Some of the FM signal "bends" around the building, but certain spots have almost no signal. Some of these signal losses are only a few inches wide and if the vehicle is parked in one of these "dead spots" you will only hear noise from the speaker. As you move out of the shadow of the structure, the station will return to normal. Flutter will not occur on AM.

FM Multi-Path Cancellation

Another effect caused by the "line-of-sight" characteristic is called cancellation. This condition exists when the radio waves are reflected from objects or structures. The noises produced by cancellation are similar to flutter, with the addition of distortion in the program. A more familiar description of cancellation is its similarity to the multiple ghosts and picture jumping that occur on television when a low flying plane passes. The same condition exists in the vehicle, except that the vehicle is moving and the reflecting structure is stationary. The reflected signal cancels the normal signal, causing the antenna to pick up noise and distortion. Cancellation effects are most prominent in metropolitan areas, but can also become quite severe in hilly terrain and depressed roadways.

FM Capture and Overloading

FM capture is an unusual condition that occurs when traveling in the vicinity of a broadcast tower. When tuned to a weak FM station, and passing a broadcast tower, a stronger station is received without changing the displayed frequency. When passing the tower, the station may switch back and forth a few times before returning to the station originally tuned. When several broadcast towers are present (common in metropolitan areas) several stations may overload the receiver resulting in considerable station changing, mixing and distortion. Fortunately this condition is localized and it will not harm the receiver. Some overloading may also be noticed on AM, but usually to a lesser degree.

Receiving FM Multiplex

Because more data is carried in the FM multiplex waves than in the monaural FM broadcasts, flutter, cancellation and capture are even more noticeable. The FM Multiplex noise-free broadcast range is approximately 8 km (5 miles) less than that received with the monaural FM radio. The AM/FM, FM Multiplex radio may never encounter any of these troublesome problems, as they are more prominent in metropolitan areas, hilly terrain and depressed roadways. However, when diagnosing FM Multiplex, it is recommended to accurately tune to the strongest FM Multiplex station.

Stereo Indicator Inoperative or Flickering (AM and FM Reception are OK)

- Verify that the customer is listening to stereo stations.
- A weak or distant signal may cause the stereo indicator to flicker. Tune the radio to a nearby FM stereo station. If reception is good, but the stereo indicator lamp is still intermittent, remove the radio chassis for service.

REMOVAL AND INSTALLATION

AM and AM/FM Radio

F-150 Through F-350—and Bronco

Removal

1. Disconnect the battery ground cable.
2. Remove bezel.
3. Remove screws securing radio mounting bracket to instrument panel and pull out the radio chassis.
4. Disconnect the antenna lead-in cable, speaker wires and radio power wire.

Installation

1. Connect the antenna lead-in cable, speaker wires and feed (power) wires to the radio.

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2. Position the radio in the instrument panel and secure with screws.
3. Position the bezel to the opening, and install.
4. Connect the battery ground cable.
5. Check the radio operation.

E-150—E-350

Removal

1. Disconnect the battery ground cable from the battery.
2. Remove the heater and A/C control knobs.
3. Remove cigar lighter, if so equipped.
4. If equipped with cigar lighter, snap out the name plate (RH side of panel) to gain access to one panel attaching screw and remove the screw.
5. Remove the remaining finish panel attaching screws (five).
6. Being careful not to mar or scratch the instrument panel, insert a screwdriver or similar tool and pry (pop out) the cluster panel at two locations.
7. Remove the front radio-to-instrument panel attaching screws (four) and remove the radio.
8. Disconnect the antenna lead-in cable speaker connectors and radio (power) wire.

Installation

1. Connect the radio antenna lead to the radio and speaker and power wires to the connectors.
2. Position the radio to the instrument panel and install the four attaching screws (front of radio).
3. Position the RH finish panel to the instrument panel (snap-in) and the two retaining clips.
4. Install the finish panel attaching screws and name plate, if removed.
5. Install the cigar lighter assembly if removed.
6. Install the heater and A/C control knobs.
7. Connect the battery ground cable.
8. Check the operation of the antenna.

Premium Sound System Amplifier E-150—E-350

Removal

1. Disconnect amplifier wiring harness connections under RH side of instrument panel.
2. Remove the one screw holding amplifier to bracket.
3. Slide amplifier from under retaining clip and remove.

Installation

1. Insert amplifier under retaining clip and install retaining screw.
2. Connect amplifier wiring connector.
3. Check operation of amplifier.

Radio Suppression Equipment

The radio suppression equipment used on the different models is shown in Figs. 4 through 7. When replacing any radio suppression equipment components, be sure that a good contact is made at all attachments. Remove any paint or dirt from between a condenser and its ground. Tighten all nuts and bolts securely.

Tape Player Performance

If weak or wavering sound is encountered, it is suggested that the player be checked by using a tape of known quality. If the tape cartridge is ruled out as the cause, routine cleaning may restore normal operation.

Periodic Cleaning of Tape Player

Over a period of time, the playback head, capstans and pinch rollers gather an oxide residue from the tape as it passes these components while playing. Oxide accumulation can cause weak or wavering sound and damage to the cassette tape and player.

It is recommended, for best performance, that the player be cleaned every 10 to 12 hours of playing time using a Ford cassette player cleaning cartridge available at your Ford or Lincoln-Mercury dealer. The use of other cleaning cassette products is not recommended, as these could cause damage to your player or cassette tapes.

DIAGNOSIS GUIDES

Use the following guides, along with a radio tester, to diagnose and repair the radio system. Refer to Figs. 2 and 3 when performing Premium Sound system diagnosis. Testing can be performed using Rotunda Volt-Ohm Meter 007-00001 or equivalent.

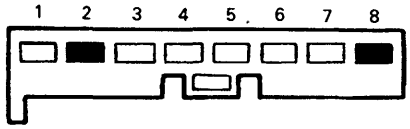
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RADIO HAS WEAK RECEPTION

TEST STEP		RESULT	ACTION TO TAKE
1.0	DURING SYSTEM CHECK RADIO RECEPTION IS WEAK		
1.1	CHECK RADIO RECEPTION		
	• Extend antenna to maximum height (if so equipped) and position vehicle in an open area away from steel buildings.	Good radio reception ▶	Radio operating properly.
	• Check radio reception by counting the number of stations received and compare to the known properly functioning radio system station count.	Poor radio reception ▶	GO to **1.2**.
1.2	CHECK ANTENNA CONNECTIONS		
	• Check antenna connections and clean or tighten as required.	Good radio reception ▶	Radio operating properly.
	• Check radio reception.	Poor radio reception ▶	GO to **1.3**.
1.3	RE-CHECK ANTENNA		
	• Check antenna system using appropriate diagnostic procedures.	Procedure shows antenna needs repair ▶	REPAIR antenna system as required. CHECK operation of radio.
		Procedure shows antenna is (OK) ▶	Have radio chassis repaired by authorized service center.

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RADIO POWER CONNECTORS



ALL RADIOS		
Pin No.	Circuit No.	Function
2, 8	—	Not Connected
7	747	At Output/Sense①
6	694	Radio Ground②
5	484	Display Back Lighting
4	19	Radio Graphics Lighting
3	137	Radio Power (B+)
1	54•	Radio Memory (A+)

①Used with premium sound only
②Not required on Econoline

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RADIO IS INOPERATIVE OR INTERMITTENT

TEST STEP		RESULT ▶	ACTION TO TAKE
2.0	DURING RADIO CHECK, THE RADIO OPERATES INTERMITTENTLY OR IS INOPERATIVE		
2.1	CHECK RADIO OPERATION		
	• Check operation of radio to determine fault.	Radio is inoperative ▶	GO to **2.2.**
		Radio is intermittent ▶	GO to **2.3.**
2.2	CHECK FUSE		
	• Check radio fuse.	Fuse is (OK) ▶	GO to **2.3.**
		Fuse is (OK) ▶	GO to **2.4.**
2.3	CHECK POWER FEED		
	• Check power feed for proper connection.	Connection (OK) ▶	GO to **2.5.**
		Connection (OK) ▶	CONNECT power feed cable correctly. RE-CHECK radio for proper operation.
2.4	REPLACE FUSE		
	• Turn ignition switch and radio to OFF. • Replace fuse. • Turn on ignition switch only. • Recheck fuse.	Fuse (OK) ▶	TURN ignition to OFF. Determine location of powerfeed to radio. REPAIR or REPLACE damaged wiring as required. REPLACE fuse.
		Fuse (OK) ▶	Operate radio and tape player. If fuse fails again have radio chassis serviced by an authorized service center. If fuse is still OK, radio is now operational.
2.5	CHECK POWER TO RADIO		
	• Using a test light or Rotunda Model 007-00001 Digital Volt-Ohmmeter or equivalent, check power to radio.	Radio has power ▶	GO to **2.6.**
		Radio has no power ▶	REPLACE or REPAIR harness as required.
2.6	CHECK GROUND CIRCUIT		
	• Using a DVOM or self-powered test lamp, check continuity of circuit 694.	Continuity in circuit 694 ▶	GO to **2.7.**
		No continuity in circuit 694 ▶	SERVICE ground circuit
2.7	CHECK SPEAKERS		
	• Is problem present on all speakers?	Problem present on all speakers ▶	GO to **2.8.**
		Problem not present on all speakers ▶	GO to **2.9.**

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RADIO IS INOPERATIVE OR INTERMITTENT (Cont'd.)

TEST STEP		RESULT	ACTION TO TAKE
2.8	CHECK ANTENNA		
	• Check antenna system using appropriate diagnostic procedures.	Antenna system (OK) ▶	GO to **2.9**.
		Antenna system (OK) ▶	CONNECT, REPAIR, or REPLACE antenna components as required.
2.9	CHECK RADIO CHASSIS		
	• Check radio chassis using known good speaker connected directly to radio chassis.	Reception (OK) ▶	REPLACE speaker or CONNECT, REPAIR, or REPLACE speaker wiring as required.
		Reception (OK) ▶	Have radio chassis REPAIRED by authorized service center.

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NOISY AM RECEPTION — ENGINE RUNNING, VEHICLE IN OR NOT IN MOTION

TEST STEP		RESULT ▶	ACTION TO TAKE
3.0	DURING CHECK, AM RADIO RECEPTION NOISY WITH ENGINE RUNNING		
3.1	CHECK ANTENNA CONNECTIONS		
	• Check antenna connections including extension cable (if so equipped). Connections must be clean and secure.	Connections are not clean and secure ▶	CLEAN and/or SECURE antenna cable connections as required.
		All connections (OK) ▶	GO to **3.2**.
3.2	CHECK ANTENNA MOUNTING		
	• Check to make sure antenna is securely mounted to body at ground points. Contacts must be clean and metal-to-metal.	Contacts (OK) ▶	CLEAN and/or SECURE ground connections as required.
		Contacts (OK) ▶	GO to **3.3**.
3.3	CHECK SUPPRESSION EQUIPMENT		
	• Check for presence of all required suppression equipment, body grounding strap usage, security, cleanliness and metal-to-metal connections.	Connections are bad and/or suppression equipment not installed ▶	INSTALL or TIGHTEN and/or CLEAN connections as required.
		Connections are and suppression equipment installed correctly (OK) ▶	GO to **3.4**.
3.4	CHECK HOOD BONDING STRAP		
	• Check hood bonding strap for excessive usage, secureness of mounting to sheet metal and contact with hood. Hood bonding strap must scratch hood paint.	Strap (OK) ▶	INSTALL, SECURE, or FORM hood bonding strap as required.
		Strap (OK) ▶	GO to **3.5**.
3.5	CHECK WIRES AND MOUNTING OF VOLTAGE REGULATOR CAPACITOR, IGNITION COIL CAPACITOR		
	• Check the mounting and connecting wires of the voltage regulator capacitor and ignition coil capacitor (if so equipped) for secureness, cleanliness and metal-to-metal contact. IMPORTANT: The capacitor mounting points are used to complete the electrical circuit and must be mounted securely to clean surfaces.	Connections (OK) ▶	CLEAN and/or SECURE connections as required.
		Connections (OK) ▶	GO to **3.6**.
3.6	CHECK OPERATION OF THE VOLTAGE REGULATOR CAPACITOR AND IGNITION COIL CAPACITOR		
	• Check the operation of the voltage regulator capacitor and ignition coil capacitor by replacing with known good components.	Voltage regulator capacitor and/or ignition coil capacitor bad ▶	REPLACE capacitor(s) with known good component(s).
		Capacitor(s) are (OK) ▶	GO to **3.7**.

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NOISY AM RECEPTION — ENGINE RUNNING, VEHICLE IN OR NOT IN MOTION — CONTINUED

TEST STEP		RESULT ▶	ACTION TO TAKE
3.7	CHECK ALTERNATOR		
	• Check alternator by disconnecting wiring harness from voltage regulator.	Noise eliminated ▶	CHECK alternator as directed in Group 31. REPAIR or REPLACE as required.
		Noise still present ▶	GO to **3.8**.
3.8	CHECK SPARK PLUG WIRES		
	• Check spark plug wires for proper routing, grounding and secureness of connections.	Spark plug wires not routed, grounded or secured ▶	REROUTE or REPLACE spark plug wires or SECURE connections as required.
		Spark plug wires (OK) ▶	GO to **3.9**.
3.9	CHECK IGNITION SYSTEM		
	• Check ignition system for proper operation. (Use ignition system analyzer or check for open spark plug wires using ohmmeter.) Also check spark plug for cracked insulators.	Ignition system and/or spark plugs not OK ▶	REPAIR or REPLACE components as required.
		Ignition system and spark plugs OK ▶	GO to **3.10**
3.10	CHECK RADIO CHASSIS MOUNTING		
	• Check all radio chassis mounting points for secureness, cleanliness and metal-to-metal contact.*	Mounting (OK) ▶	CLEAN and/or SECURE as required.
		Mountings (OK) ▶	GO to **3.11**.
3.11	SUBSTITUTE A KNOWN GOOD SPEAKER AND ANTENNA		
	• Substitute a known good speaker, antenna and antenna extension cable (if so equipped). Be sure to ground antenna to an unpainted metal surface.	Noise eliminated ▶	REPAIR or REPLACE antenna, speaker or antenna extension cable.
		Noise not eliminated ▶	GO to **3.12**.
3.12	SUBSTITUTE KNOWN GOOD RADIO		
	• Substitute known good radio.	Noise eliminated ▶	Have radio unit REPAIRED by authorized service center.
		Noise not eliminated ▶	GO to **3.13**.
3.13	REPOSITION ANTENNA, SPEAKER OR RADIO POWER FEED		
	• Check to see if noise can be eliminated by repositioning antenna, speaker or radio power feed wires.	Noise eliminated ▶	REPOSITION permanently by taping.
		Noise not eliminated ▶	GO to **3.14**.
3.14	GROUND VARIOUS PARTS OF TRUCK		
	• Ground various parts of the truck to the frame using a jumper cable. For example: engine, fenders, quarter panel, stone deflectors, air cleaner, body sheet metal.	Noise eliminated ▶	PROVIDE permanent ground where required.

*F-Series/Bronco radios are grounded to the instrument panel through circuit no. 694 with an eyelet near the rear of the radio.

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NOISY FM RECEPTION — ENGINE RUNNING, VEHICLE NOT IN MOTION

TEST STEP		RESULT ▶	ACTION TO TAKE
4.0	DURING CHECK, FM RADIO RECEPTION IS NOISY WHILE VEHICLE IS NOT IN MOTION		
4.1	NOISE IS ONLY ON FM STERO		
	• Check to see if noise is only on FM stereo. Determine if customer concern is due to FM stereo reception limitation. Refer to normal operation description.	Noise only on FM stereo ▶	EXPLAIN and DEMOSTRATE to customer. Inform customer of methods for obtaining best reception.
		Noise is on both FM stereo and FM mono ▶	GO to **4.2**.
4.2	CHECK ANTENNA CABLE CONNECTIONS		
	• Check antenna cable connections including extension cable (if so equipped). Connections must be clean and secure.	Connections ~~OK~~ ▶	CLEAN and/or SECURE as required.
		Connections OK ▶	GO to **4.3**.
4.3	CHECK ANTENNA MOUNTING		
	• Check to ensure antenna is securely mounted to body at mounting nut above antenna; and also, ensure that prongs of grounding collar, at fender underside, are contacting metal. Contact must be clean and metal-to-metal.	Connections ~~OK~~ ▶	CLEAN and/or SECURE as required.
		Connections are OK ▶	GO to **4.4**.
4.4	CHECK DISTRIBUTOR ROTOR		
	• Check for adequate distributor rotor contact spring tension. Height of spring should be 8.9 mm (0.35 in.) from top of rotor (not applicable to recreational vehicles).	Spring tension ~~OK~~ ▶	REPLACE rotor.
		Spring tension OK ▶	GO to **4.5**.
4.5	CHECK DISTRIBUTOR CAP		
	• Check to see if carbon center insert in distributor cap is secure.	Carbon center not secure ▶	REPLACE distributor cap.
		Carbon center OK ▶	GO to **4.6**.
4.6	CHECK SPARK PLUG WIRES		
	Check spark plug wires for proper routing and secureness of connections.	Routing and/or connections ~~OK~~ ▶	REROUTE or SECURE connections as required.
		Routings and connections good ▶	GO to **4.7**.

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NOISY FM RECEPTION — ENGINE RUNNING, VEHICLE NOT IN MOTION — CONTINUED

TEST STEP		RESULT ▶	ACTION TO TAKE
4.7	CHECK IGNITION SYSTEM		
• Check ignition system for proper operation. (Use ignition system analyzer or check for open spark plug wires using ohmmeter). Also check spark plug for cracked insulators.		Ignition system and/or spark plug wires not working properly, and/or spark plug insulators cracked ▶	REPAIR or REPLACE components as required.
		Ignition system, spark plug wires and spark plugs in good condition ▶	GO to **4.8**.
4.8	CHECK RADIO CHASSIS MOUNTING		
• Check all radio chassis mounting points for secureness, cleanliness and metal-to-metal contact.*		Contacts are not secure or clean ▶	CLEAN and/or SECURE as required.
		Contacts are (OK) ▶	GO to **4.9**.
4.9	SUBSTITUTE A GOOD SPEAKER AND ANTENNA		
• Substitute a known good speaker and antenna being sure to ground antenna base to unpainted metal surface.		Noise eliminated ▶	REPAIR or REPLACE antenna or speaker.
		Noise not eliminated ▶	GO to **4.10**.
4.10	SUBSTITUTE EXTENSION CABLE		
• If equipped with antenna extension cable, substitute with a known good cable. (If not equipped with extension cable GO to **4.11**.)		Noise eliminated ▶	REPLACE antenna extension cable.
		Noise not eliminated ▶	GO to **4.11**.
4.11	SUBSTITUTE KNOWN GOOD RADIO		
• Remove radio and substitute with a known good radio.		Noise eliminated ▶	Have radio unit REPAIRED by authorized service center.
		Noise not eliminated ▶	GO to **4.12**.
4.12	REPOSITION ANTENNA, SPEAKER, OR RADIO FEED WIRES		
• Check to see if noise can be eliminated by repositioning antenna, speaker or radio power feed wires.		Noise eliminated ▶	REPOSITION permanently by taping.
		Noise not eliminated ▶	REPLACE distributor cap and rotor with new ungreased cap and rotor.

*F-Series/Bronco radios are grounded to the instrument panel through circuit no. 694 with an eyelet near the rear of the radio.

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NOISY RECEPTION — ENGINE RUNNING, VEHICLE IN MOTION

TEST STEP		RESULT ▶	ACTION TO TAKE
5.0	DURING CHECK, RECEPTION ON RADIO IS NOISY WITH ENGINE RUNNING AND VEHICLE IN MOTION		
5.1	VISUALLY INSPECT CONNECTIONS		
	• Inspect all connections to battery; antenna leads, speaker leads, and radio receiver.*	Connections (OK) ▶	REPAIR or REPLACE wires as necessary.
		Connections (OK) ▶	GO to **5.2**.
5.2	CHECK ANTENNA LEAD IN CABLE		
	• Check for loose antenna lead in cable or loose antenna.	Antenna and/or cable are loose ▶	CONNECT antenna and/ or lead in cable securely.
		Antenna and cable secure ▶	Have radio repaired by a qualified radio technician.

*F-Series/Bronco radios are grounded to the instrument panel through circuit no. 694 with an eyelet near the rear of the radio.

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NOISY RECEPTION — ENGINE NOT RUNNING

TEST STEP		RESULT ▶	ACTION TO TAKE
6.0	DURING CHECK RADIO RECEPTION IS NOISY WHILE ENGINE IS NOT RUNNING		
6.1	VISUALLY CHECK FOR LOOSE CONNECTIONS		
	• Check all connections to battery, antenna leads, speaker lead and radio receiver for proper connection.*	Connections (OK) ▶	REPAIR or REPLACE connections or wires as required.
		Connections (OK) ▶	GO to **6.2**.
6.2	CHECK ANTENNA LEAD IN CABLE		
	• Check all antenna lead-in cables for bent or missing male pins. Also check the female connectors for position of receptacle with respect to the insulator. The receptacle should be visible.	Connectors and/or connections (OK) ▶	REPLACE antenna lead in cables.
		Connections (OK) ▶	Have radio REPAIRED by a qualified radio technician.

*F-Series/Bronco radios are grounded to the instrument panel through circuit no. 694 with an eyelet near the rear of the radio.

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PREMIUM SOUND
NO SOUND FROM ONE OR MORE SPEAKERS, RADIO TURNED ON — PREMIUM SOUND IS OFF

TEST STEP	RESULT ▶	ACTION TO TAKE
A.0 DURING SYSTEM CHECK WITH PREMIUM SOUND OFF AND RADIO TURNED ON THERE IS NO SOUND FROM ONE OR MORE SPEAKERS		
A.1 BYPASS PREMIUM SOUND CIRCUITS • Bypass premium sound control circuits for the inoperative speakers as follows: 1. Disconnect connectors between radio and premium sound amplifier and between speakers and premium sound amplifier. 2. Connect jumper wires from radio to wiring harness for defective speaker. 3. Check connector locations and wiring color codes. • Test radio for sound from speaker(s).	Speaker(s) work ▶ Speaker(s) do not work ▶	GO to **A.2**. GO to **A.3**.
A.2 • Check power and control circuits to amplifier as follows: 1. Connect all connectors of the radio and premium sound system. 2. Turn ignition switch to ACC and turn radio ON. 3. Check for battery voltage at the amplifier on the orange-lt. blue dot wire and on the yellow-black hash wire.	(OK) ▶ (OK) ▶	REPLACE the premium sound amplifier. Vehicle wiring is damaged. FOLLOW standard procedure for diagnosis and service of damage.
A.3 CHECK OPERATION OF SPEAKER AND CHECK SPEAKER WIRING • Check operation of speaker, and vehicle wiring as follows: 1. Connect jumper wire from a radio speaker harness that is working properly to the damaged speaker harness.	Speaker works ▶ Speaker does not work ▶	Radio is damaged. SEND radio to authorized service station for service. Vehicle wiring or speaker is damaged. FOLLOW standard procedure for diagnosis and service of damage.

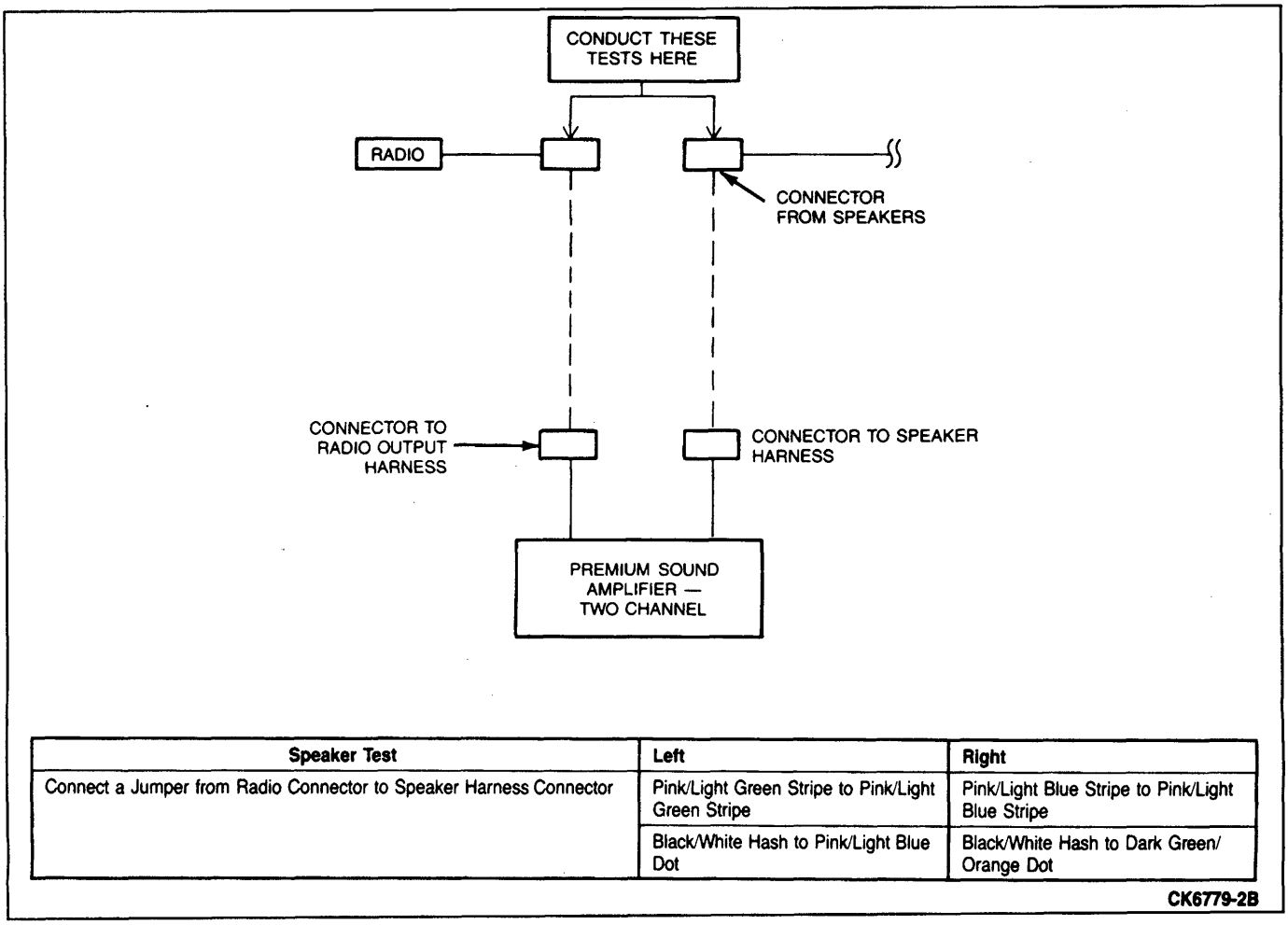
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PREMIUM SOUND SYSTEM
NO PREMIUM SOUND FROM ONE OR MORE PREMIUM SOUND SPEAKERS — PREMIUM SOUND ON
(NORMAL SOUND FROM ALL SPEAKERS WITH PREMIUM SOUND OFF)

TEST STEP	RESULT ▶	ACTION TO TAKE
B.0 DURING CHECK THERE IS NO SOUND FROM ONE OR MORE SPEAKERS WITH PREMIUM SOUND ON (WITH PREMIUM SOUND OFF THERE IS NORMAL SOUND FROM SPEAKERS)		
B.1 VERIFY CONDITION		
• Check for premium sound at each speaker.	Premium sound at all speakers ▶	System OK.
	No premium sound at one or more speakers ▶	REPLACE amplifier

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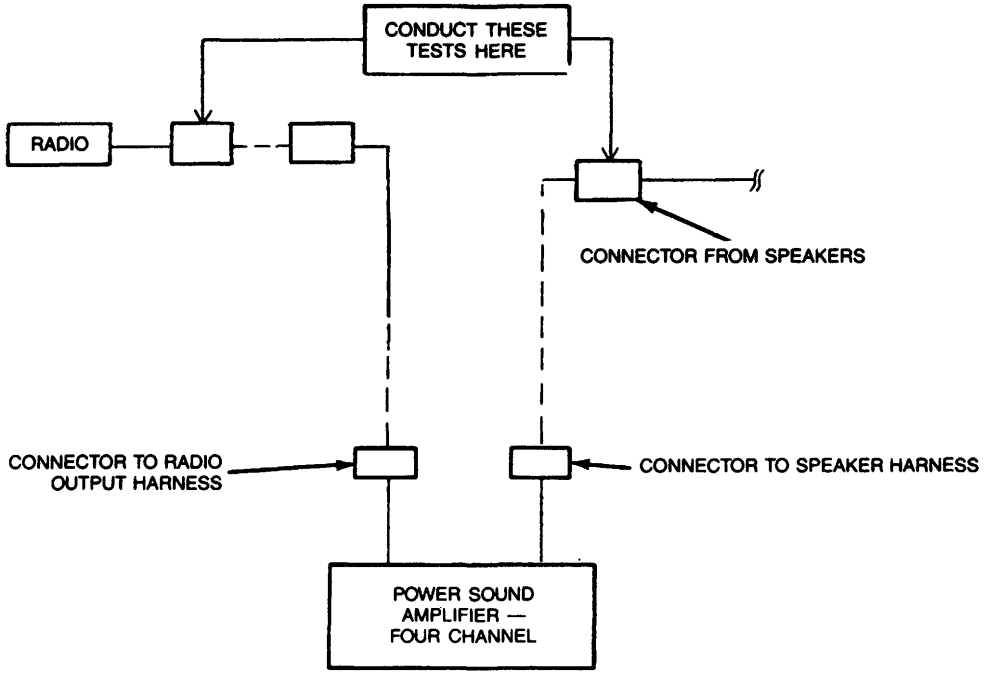


Speaker Test	Left	Right
Connect a Jumper from Radio Connector to Speaker Harness Connector	Pink/Light Green Stripe to Pink/Light Green Stripe	Pink/Light Blue Stripe to Pink/Light Blue Stripe
	Black/White Hash to Pink/Light Blue Dot	Black/White Hash to Dark Green/ Orange Dot

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FIG. 2 Premium Sound By-Passing Test (Two Channel Amplifier)—E-150—E-350

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Speaker Test	Left Front	Right Front	Left Rear	Right Rear
Connect a Jumper from Radio Connector to Speaker Harness Connector	Orange/Light Green Hash to Orange/Light Green Hash	White/Light Green to White/Light Green Hash	Pink/Light Green to Pink/Light Green Stripe	Pink/Light Blue Stripe to Pink/Light Blue Stripe
	Black/White Hash to Light Blue/White Hash	Black/White Hash to Dark Green/Orange Stripe	Black/White Hash to Pink/Light Blue Dot	Black/White Hash to Dark Green/Orange Dot

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FIG. 3 Premium Sound By-Passing Test (Four Channel Amplifier)

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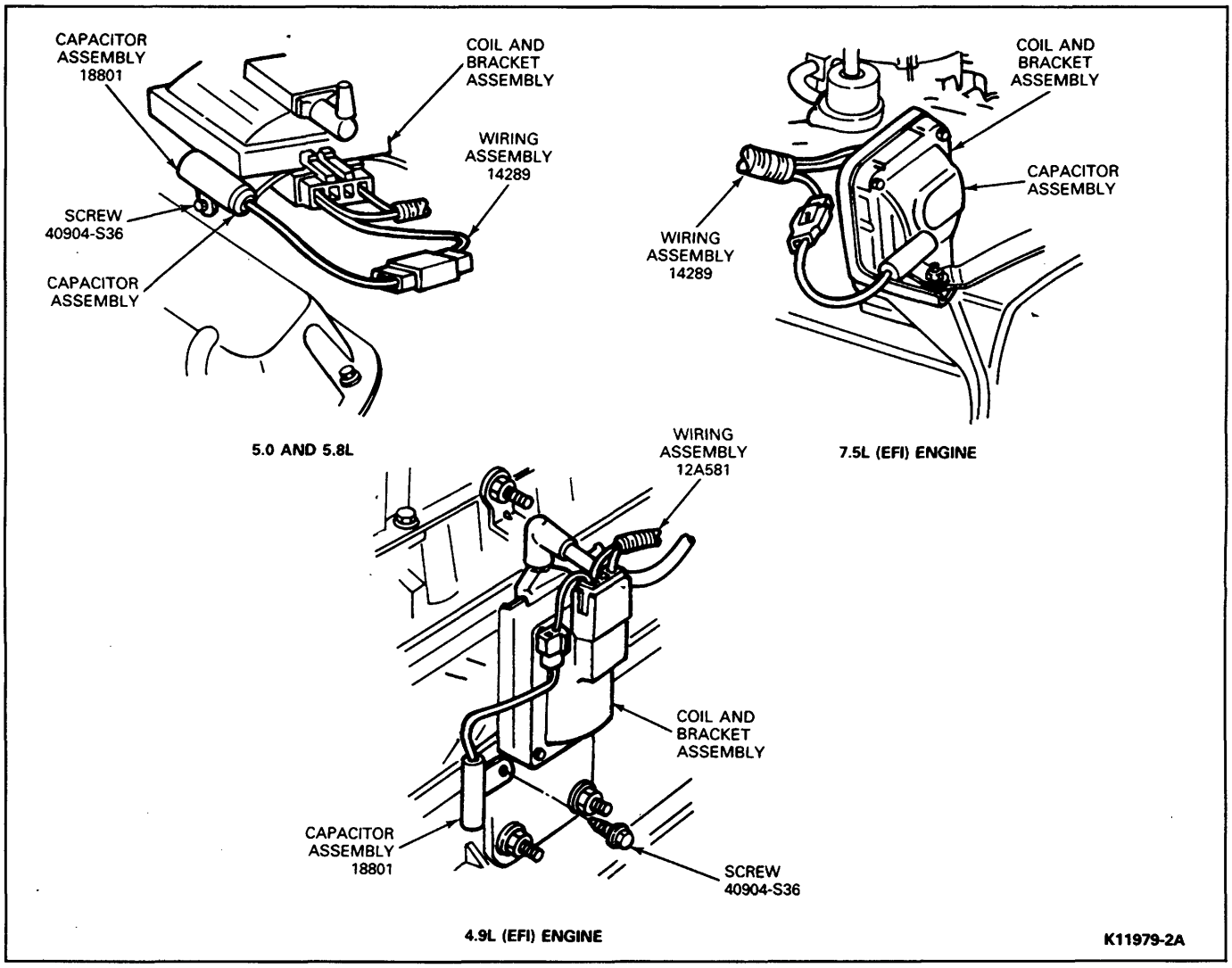


FIG. 4 Radio Suppression Equipment—F-150—F-350—And Bronco

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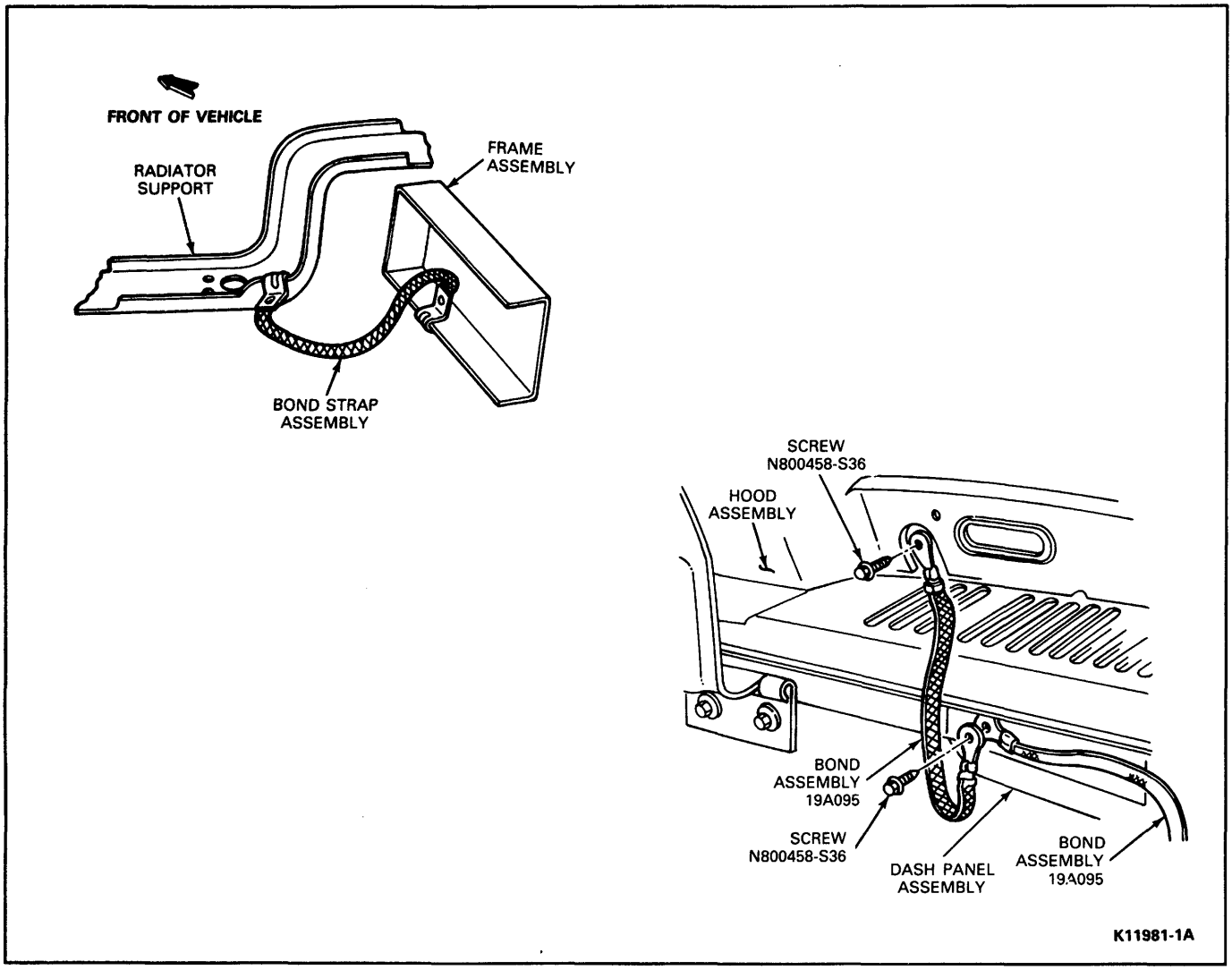


FIG. 5 Radio Bond Strap F-150-F-350 and Bronco

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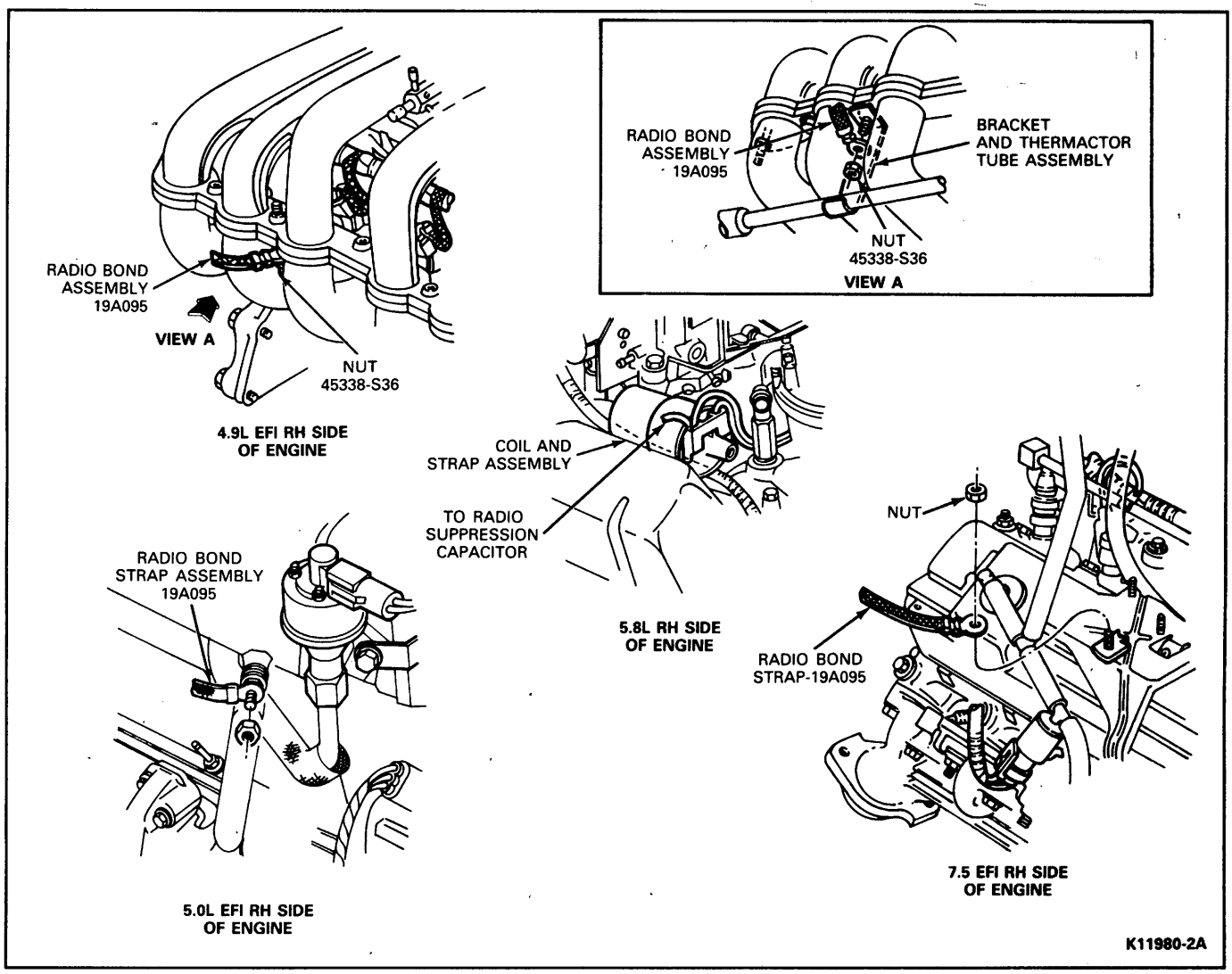


FIG. 6 Radio Suppression Equipment

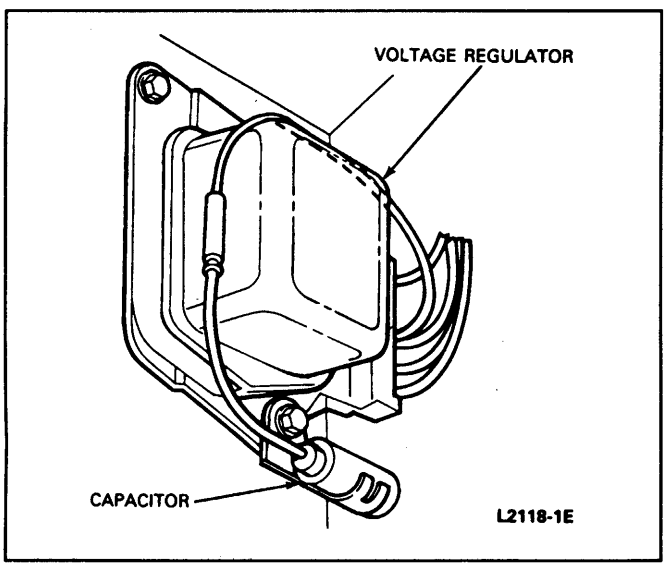


FIG. 7 Radio Suppression Equipment—E-150-E-350

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Number	Description
007-00001	Digital Volt Ohmmeter

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SECTION 35-11 Antennas

SUBJECT	PAGE
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DIAGNOSIS	35-11-1
REMOVAL AND INSTALLATION	
Antenna	35-11-1
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REMOVAL AND INSTALLATION (Cont'd)	
Antenna (Cont'd)	
F-150—F-350 and Bronco	35-11-1
SPECIAL SERVICE TOOLS	35-11-8
VEHICLE APPLICATION	35-11-1

VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

Manual Entertainment Radio Antenna

The manual entertainment radio antenna is not adjustable.

DIAGNOSIS

Poor Reception

- If AM reception is extremely poor and FM reception "spits" or appears to have trouble holding stations, ensure the antenna and antenna connectors are properly mated. If the antenna connectors are properly mated but the reception is still poor, replace the antenna cable.
- If only FM reception is poor, it is unlikely that the antenna is at fault. Remove the radio chassis for service.

NOTE: Many customers do not understand the limitations of FM reception. Refer the customer to the Owner's Guide for information about the limitations of FM radio performance.

REMOVAL AND INSTALLATION

Antenna

F-150—F-350 and Bronco

Removal

The antenna mast in the F-150—F-350 and Bronco is detachable (Fig. 1). To remove the base and cable assembly:

1. Disconnect the antenna lead-in cable from the radio (Fig. 2).
2. Disengage the cable from the retainer at the top of the heater plenum.

   NOTE: It may be necessary to remove the glove compartment to gain access to the antenna lead-in cable.
3. Unsnap the cap from the antenna base and remove the cap.
4. Remove four antenna attaching screws and remove the antenna base, gasket and lead-in cable from the vehicle.

Installation

1. Place the gasket on the cowl panel over the antenna opening (Fig. 1).
2. Insert the antenna lead-in cable into the antenna hole in the cowl until the antenna base is seated on the cowl.
3. Install the four antenna attaching screws.
4. Place the cap in position over the antenna base and snap the cap onto the base.
5. Route the antenna lead-in cable to the retainer at the top of the heater plenum.
6. Connect the antenna lead-in cable to the radio and check the radio operation.

E-150—E-350

Removal

The antenna mast on the E-150—E-350 is detachable (Fig. 3).

1. Remove the cowl top grille panel above the radio.
2. Disconnect the antenna lead-in cable from the radio (Fig. 3).
3. Unsnap the two retaining clips from the antenna cable.
4. Unsnap the stanchion from the antenna base and remove the stanchion.
5. Remove the four antenna attaching screws and remove the base and cable assembly from the vehicle.

Installation

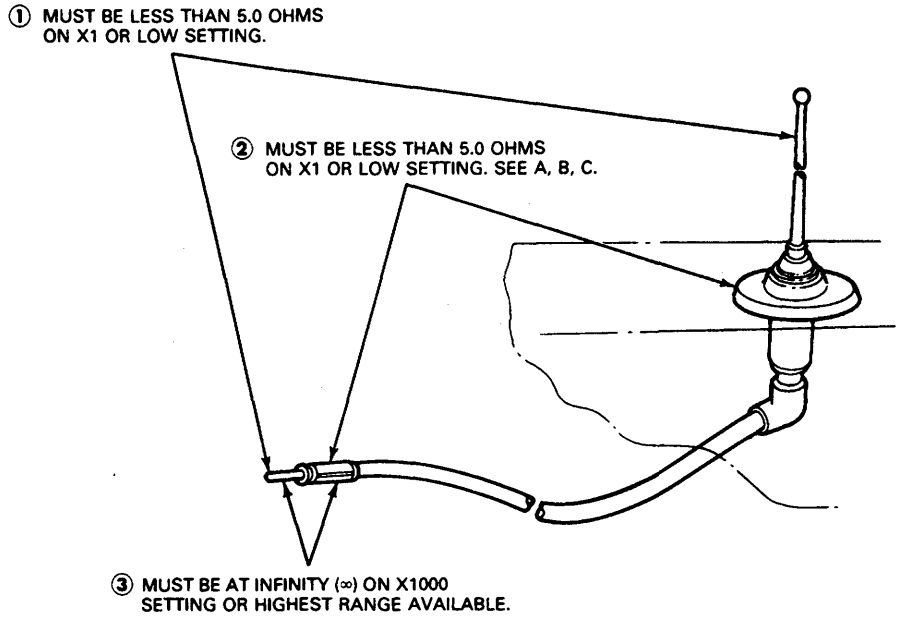
1. Insert the tip of the new antenna cable through the fender opening and thread the antenna cable to the antenna base. Plug the antenna in to the base.
2. Install the four attaching base-to-vehicle screws.
3. Install the stanchion to the antenna base.
4. Inside the vehicle, snap the antenna cable to the two retaining clips, along the cowl top (Fig. 3).
5. Insert the antenna cable through the hole in the dash panel. From inside the vehicle, pull the cable to tightly seat the rubber grommet and seal the cable entry hole.
6. Connect the antenna lead-in cable to the radio and install the cowl top grille panel.

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RADIO ANTENNA TEST (ALL ANTENNA TYPES)

WITH ANTENNA INSTALLED ON VEHICLE AND CABLE UNPLUGGED FROM RADIO, PERFORM THE FOLLOWING RESISTANCE TESTS WITH AN OHMMETER. PROBES MUST CONTACT ANTENNA AT POINTS SPECIFIED BY ARROWHEADS.

ANTENNA TEST NO. 1



RESULTS
IF OHMMETER TESTS ARE SATISFACTORY – THE ANTENNA IS GOOD.

ACTION
IF ANY OHMMETER READING IS UNSATISFACTORY TAKE THE FOLLOWING ACTION:
A. IF ONE PIECE ASSEMBLY, REPLACE THE COMPLETE ANTENNA AND CABLE ASSEMBLY.
B. IF DETACHABLE CABLE AND MAST, PERFORM ANTENNA TEST NO. 2 AND 3.
C. IF MANUAL ANTENNA WITH EXTENSION CABLE, PERFORM ANTENNA TEST NO. 4.

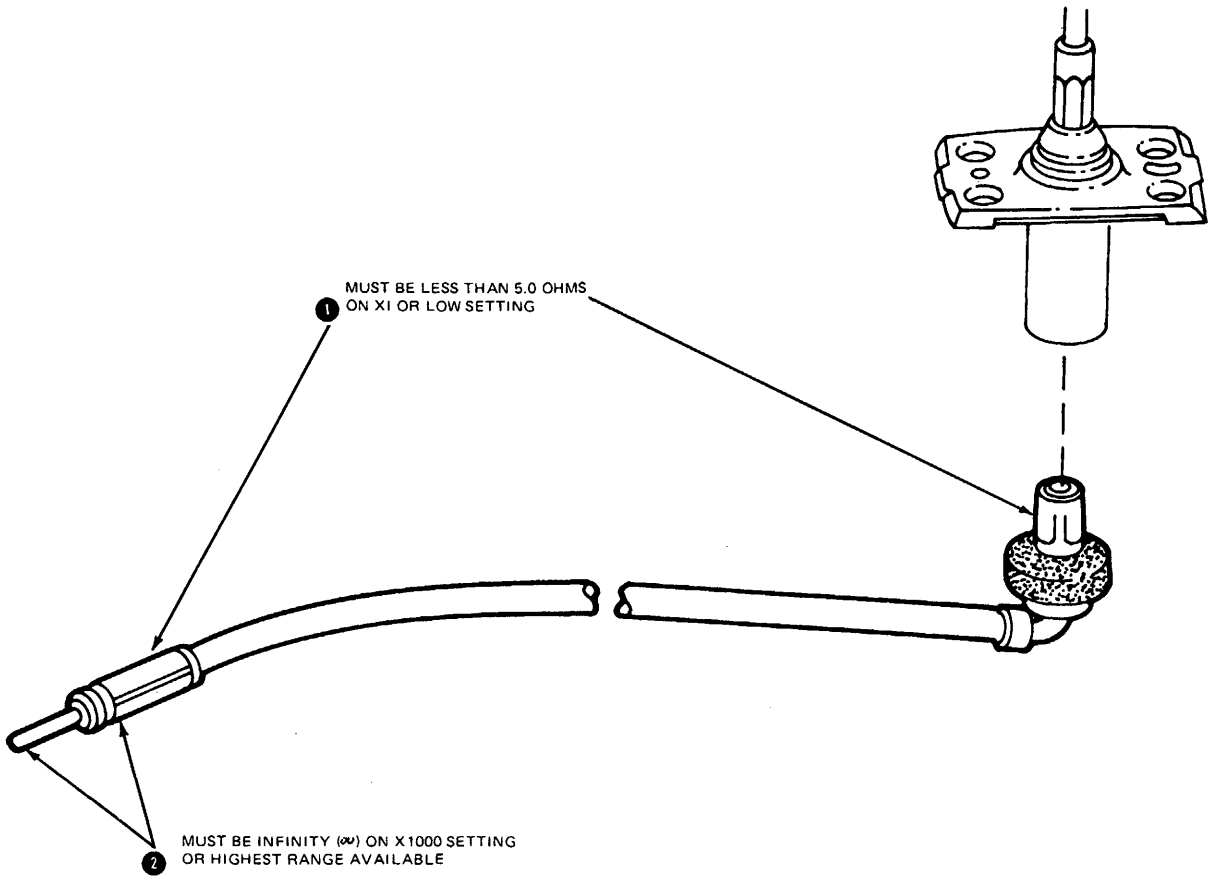
CK8980-2A

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TESTING ANTENNA EQUIPPED WITH DETACHABLE CABLE AND MAST.

WHEN RESULTS IN TEST NO. 1 HAVE BEEN UNSATISFACTORY, DISCONNECT THE ANTENNA MAST AND BASE FROM THE CABLE. PERFORM THE FOLLOWING TESTS:

ANTENNA TEST NO. 2



RESULTS

IF OHMMETER READINGS ARE SATISFACTORY, THE CABLE IS GOOD. PERFORM ANTENNA TEST NO. 3

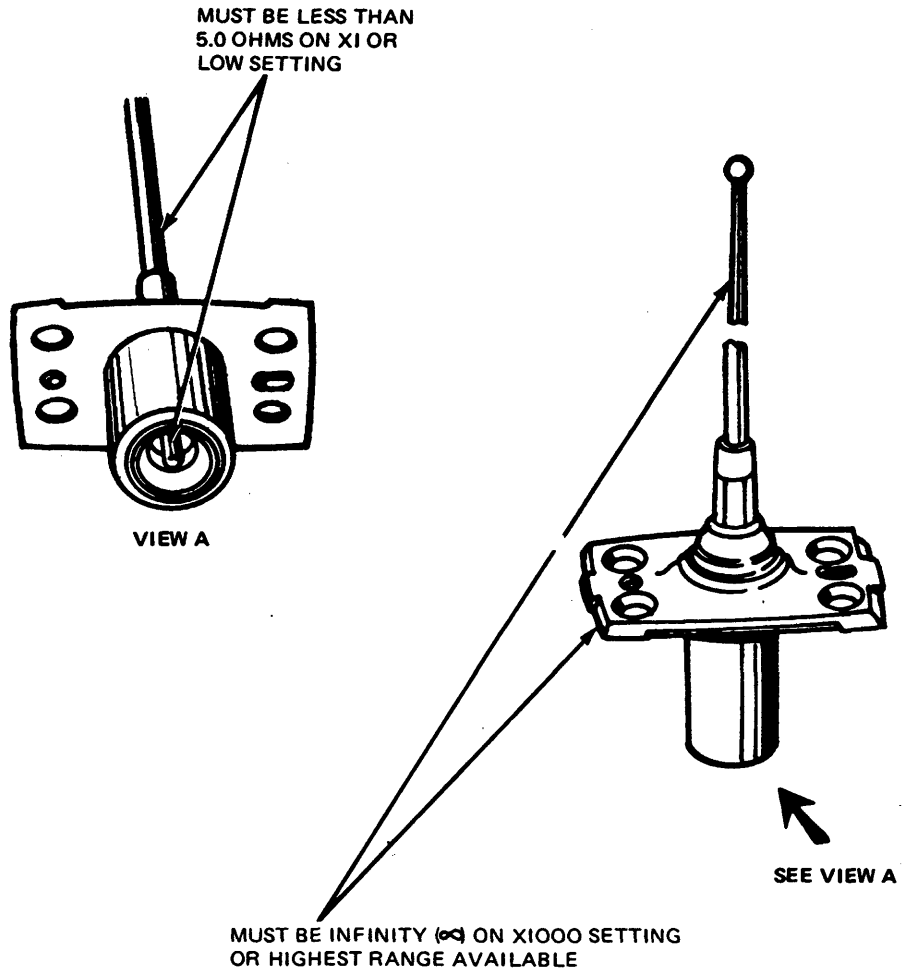
ACTION

IF EITHER READINGS IS UNSATISFACTORY, REPLACE THE CABLE.

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ANTENNA TEST NO.3



RESULTS
IF OHMMETER READINGS ARE SATISFACTORY, ANTENNA MAST AND BASE ARE GOOD, REPLACE CABLE.

ACTION
IF EITHER READING IS UNSATISFACTORY, REPLACE ONLY THE BASE ASSEMBLY, THE MAST SHOULD BE GOOD.

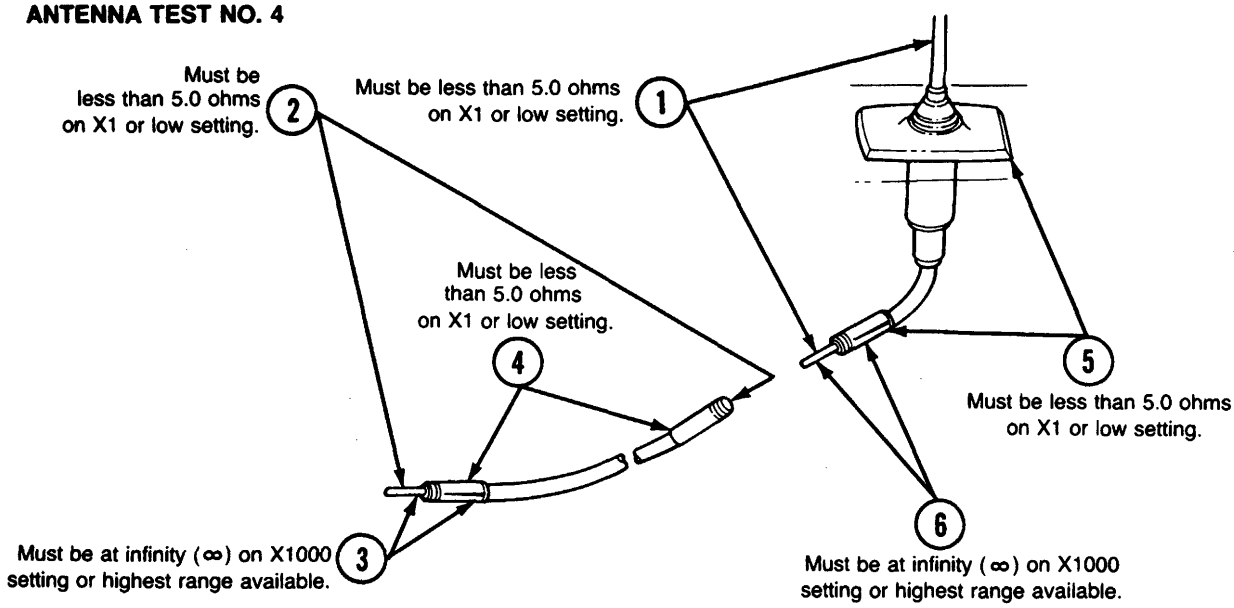
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TESTING ANTENNA WITH EXTENSION CABLE

When results in test No. 2 have been unsatisfactory, disconnect extension cable from main cable. Perform the following tests:

ANTENNA TEST NO. 4



RESULTS

If ohmmeter readings are satisfactory, the extension cable and main antenna cable are good. Perform test No. 3.

ACTION

If either reading on extension cable is unsatisfactory, replace extension cable.
If either reading on main antenna cable is unsatisfactory take the following action:
A. If one piece assembly, replace the complete antenna and main cable assembly.
B. If main cable is detachable, perform antenna test No. 2 and 3.

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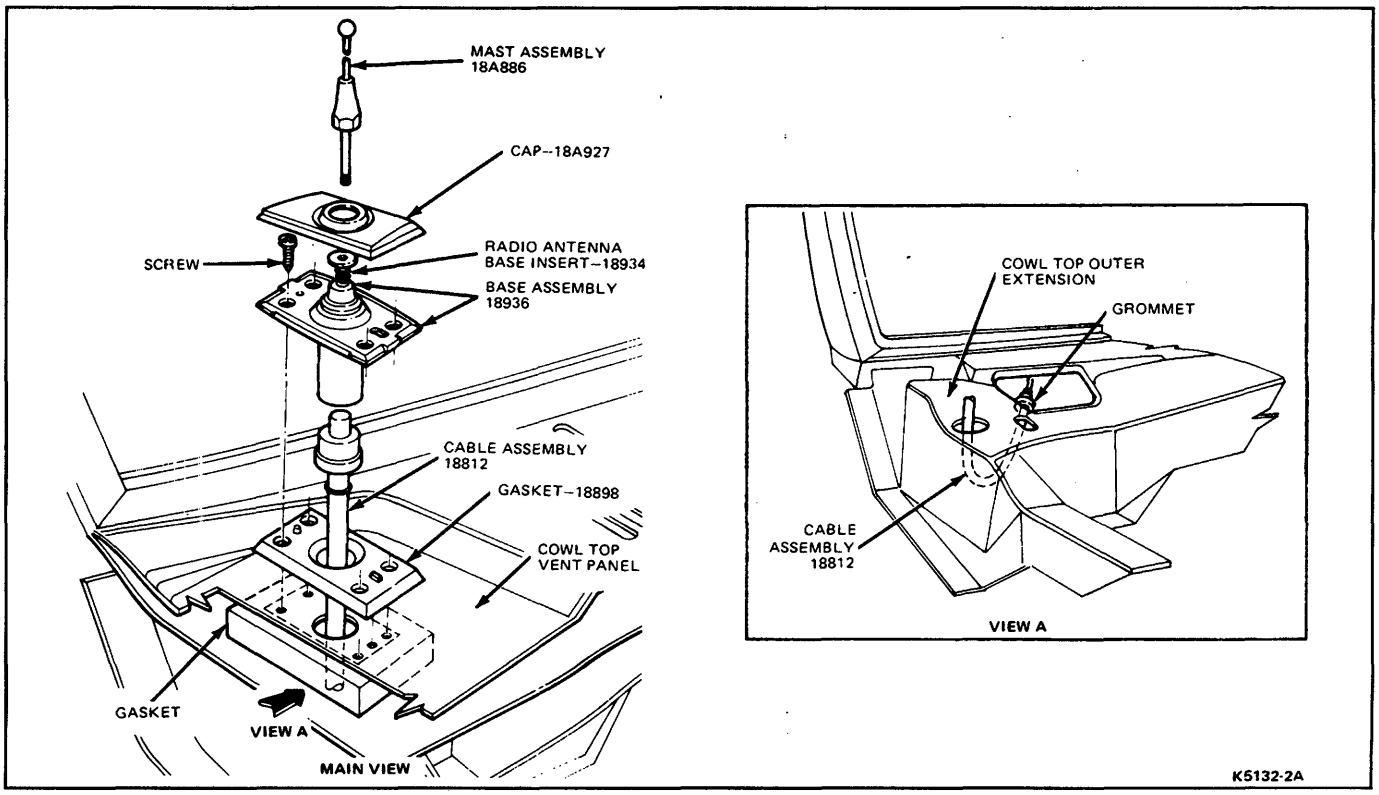


FIG. 1 Entertainment Antenna Installation—F-150 Through F-350 and Bronco

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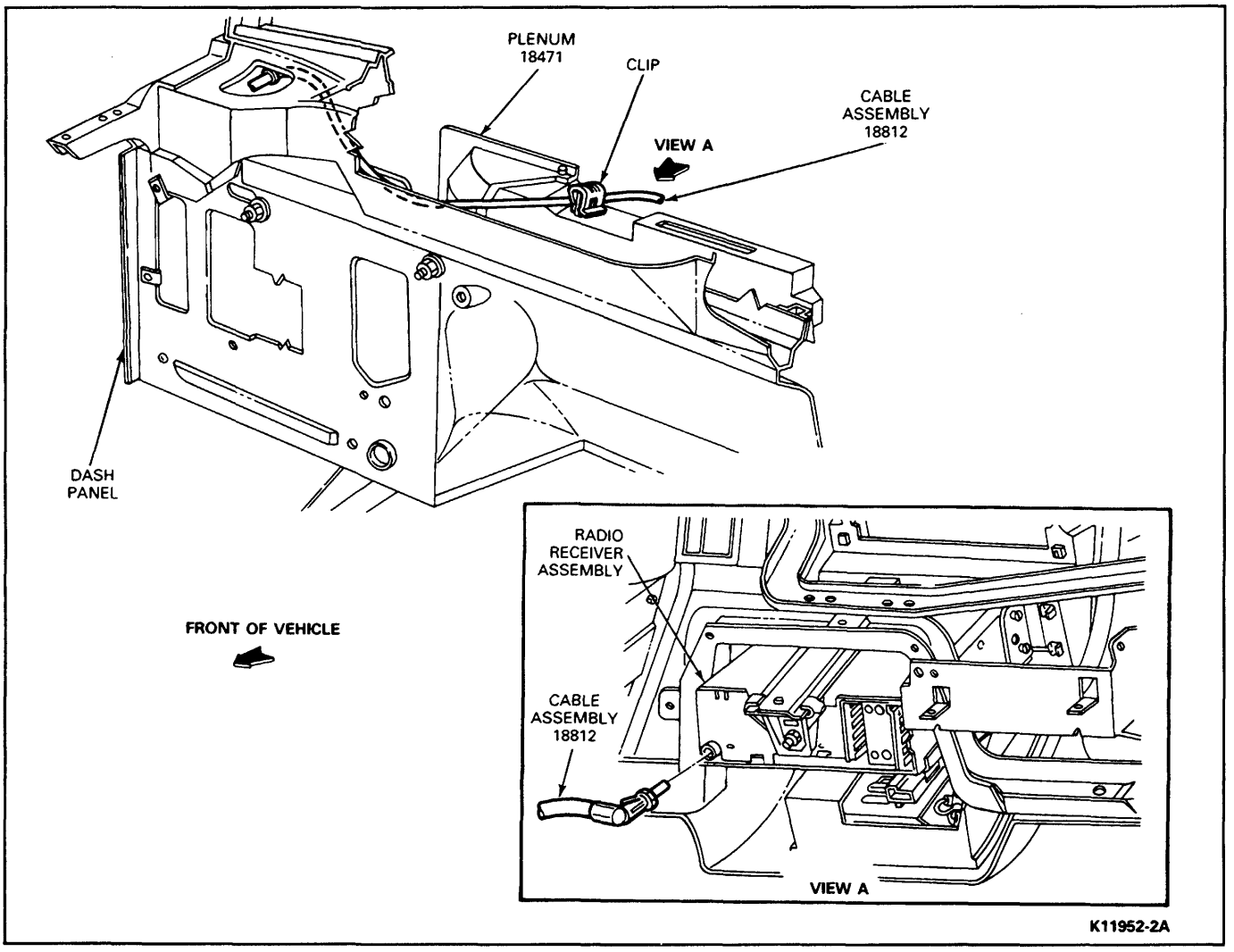


FIG. 2 Entertainment Radio Antenna Cable—F-150 Through F-350 and Bronco

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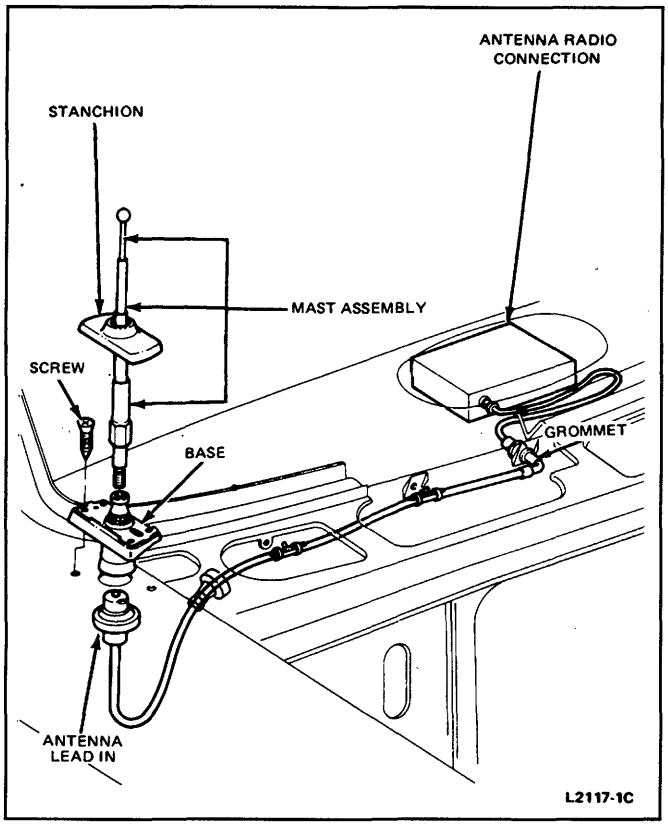


FIG. 3 Antenna Installation—E-150—E-350

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Number	Description
007-00001	Digital Volt Ohmmeter

CK9061-1A

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SECTION 35-31 Speakers

SUBJECT	PAGE
DESCRIPTION	35-31-1
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Door Speakers	35-31-2
Rear Speakers	35-31-1
REMOVAL AND INSTALLATION	
Instrument Panel Speaker	35-31-1
VEHICLE APPLICATION	35-31-1

VEHICLE APPLICATION

All Models.

DESCRIPTION

Econoline vehicles are equipped with a single standard instrument panel speaker with AM radio and two door speakers with stereo radio. F-Series & Bronco are equipped with two door speakers with AM radio. Bronco & Econoline have two additional rear Speakers with stereo radios. All except the instrument panel speaker are premium speakers.

REMOVAL AND INSTALLATION

Instrument Panel Speaker

E-150—E-350

Removal

1. Remove four screws attaching the grille and speaker assembly to the instrument panel (Fig. 1).
2. Disconnect the speaker wires at the radio speaker connector.
3. Remove four nuts and washers and separate the grille from the speaker (entertainment radio only).

Installation

1. Position grille to speaker and install the four washers and nuts.
2. Connect the speaker wires to the radio speaker connector.
3. Position the speaker and grille assembly to the instrument panel. Install four screws and secure.

Rear Speakers

Bronco and E-150—E-350

Removal

1. Remove four screws attaching speaker and grille to the rear trim panel (Figs. 3 and 4).
2. Remove speaker and grille and disconnect the wires at the connector located behind the speaker (Figs. 3 and 4).

CAUTION: Do not operate the radio with the speaker disconnected.

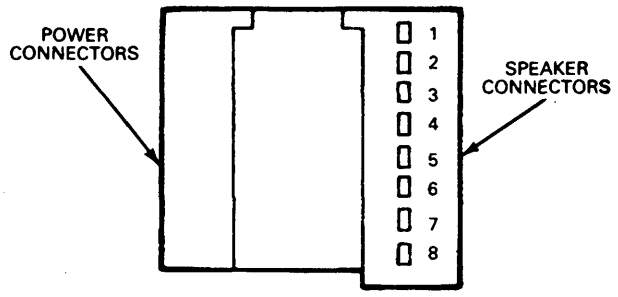
DIAGNOSIS AND TESTING

SPEAKER DIAGNOSTICS
ONE OR MORE SPEAKER DISTORTED, OR INOPERATIVE

TEST STEP		RESULT ▶	ACTION TO TAKE
2.0	DURING CHECK, ONE OR MORE SPEAKERS INOPERATIVE OR DISTORTED		
2.1	SUBSTITUTE SPEAKER		
	• If vehicle is equipped with premium sound proceed to Section 35-01, Radio and Premium Sound for speaker diagnostics.	Sound from speaker (OK) ▶	GO to **2.2**.
	• Unplug radio from speaker wiring harness. Set radio balance and fader controls at their center. Using a speaker of known good quality and the following chart, jumper the pins corresponding to the suspect speaker of the radio connector to the test speaker.	Sound from speaker (OK) ▶	REMOVE radio for service.
2.2	USE JUMPER WIRE ACROSS RADIO CONNECTOR		
	• Unplug the suspect speaker from the wire harness and jumper the appropriate radio connector ring to the speaker (following charts).	Sound from speaker (OK) ▶	CHECK and REPAIR speaker wiring harness for a short or a break in the harness.
		Sound from speaker (OK) ▶	REMOVE and REPLACE speaker.

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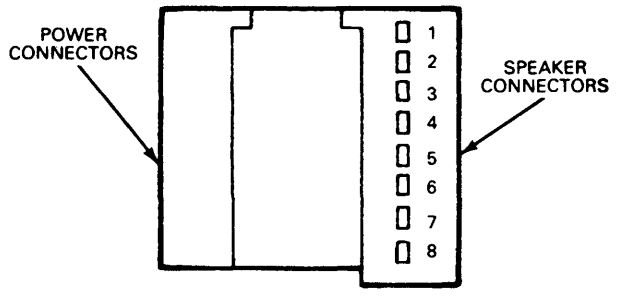
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AM ELECTRONIC RADIO INTEGRAL CONNECTOR — SPEAKERS

Pin	Function
1	Front
2	Common
3	
4	
5	Front
6	Common
7	
8	

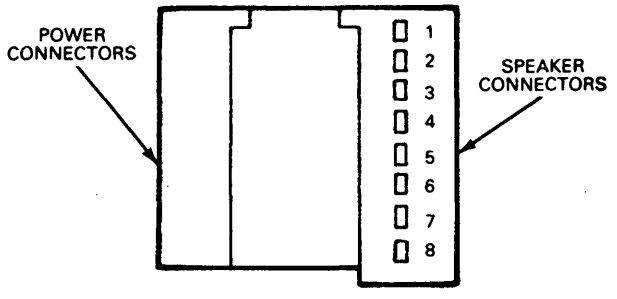
Models: All



AM/FM & AM/FM/CASS — W/O FADER ELECTRONIC RADIO INTEGRAL CONNECTOR — SPEAKERS

Pin	Function
1	Left
2	Common
3	
4	
5	Right
6	Common
7	
8	

Models: F-150/350



AM/FM & AM/FM/CASS — W/FADER ELECTRONIC RADIO INTEGRAL CONNECTOR — SPEAKERS

Pin	Function
1	Left Front
2	Common
3	Left Rear
4	Common
5	Right Front
6	Common
7	Right Rear
8	Common

Models: Bronco
E-150 /350

CK10451-2A

Installation

1. To install, connect wires to connector and position speaker and grille to door trim panel.
2. Install the four attaching screws, and check operation of the speaker (Figs. 3 and 4).

Door Speakers

E-150—E-350

Removal

1. Remove four screws attaching speaker and grille to door trim panel.
2. Remove speaker and grille and disconnect the wires at the connector located behind the speaker. Do not operate the radio with the speaker disconnected (Fig. 3).

Installation

1. To install, connect wires to connector and position speaker and grille to door trim panel.
2. Install the four attaching screws, and check operation of the speakers (Fig. 3).

F-150—F-350 and Bronco

Removal

1. Remove door trim panel.
2. Remove four screws attaching speaker and disconnect wiring (Fig. 2).

NOTE: Do not operate radio with speakers disconnected.

Installation

1. Connect wiring and install speaker. Secure with four screws (Fig. 2).
2. Install door trim panel.

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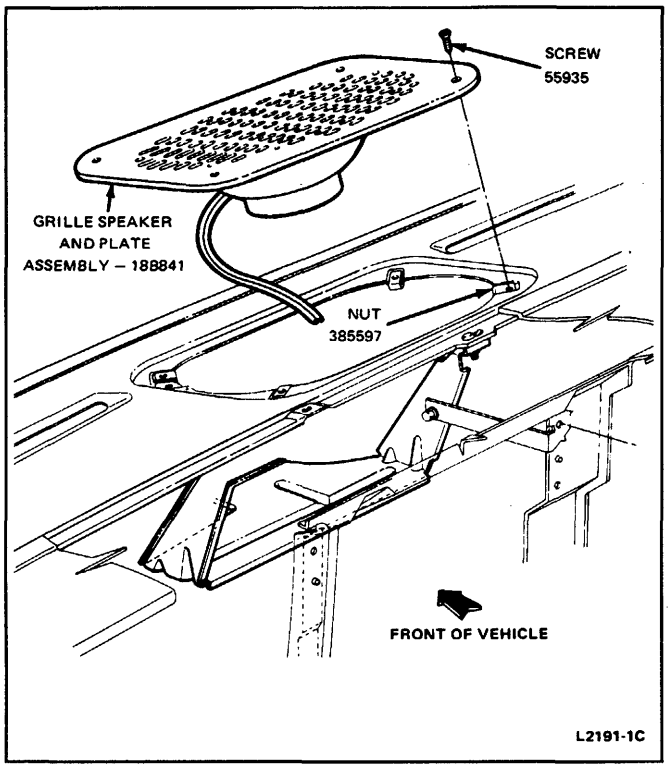


FIG. 1 Speaker Installation—E-150—E-350

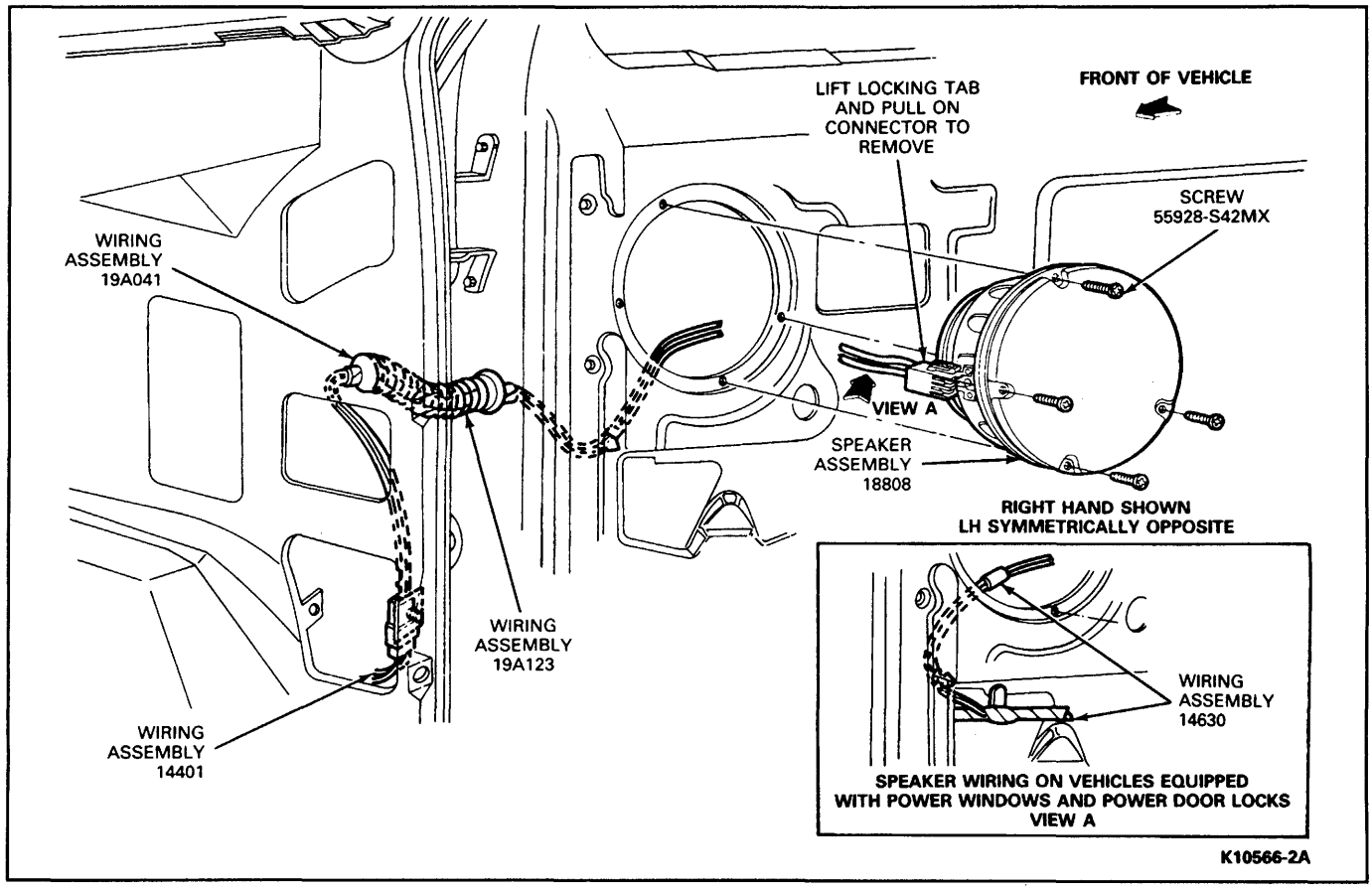


FIG. 2 Door Speakers—F-150—F-350 and Bronco

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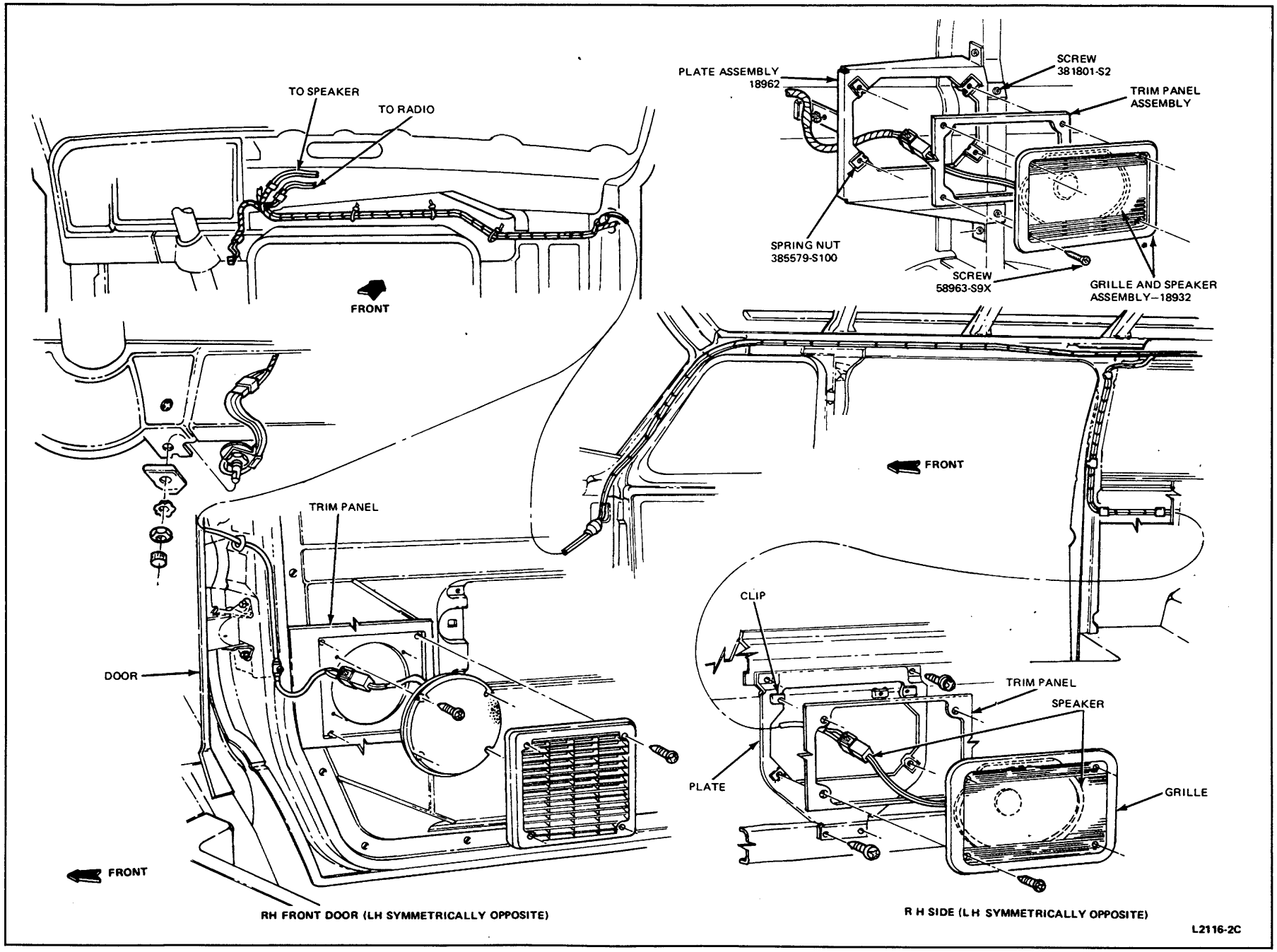


FIG. 3 Door and Rear Speakers—E-150—E-350

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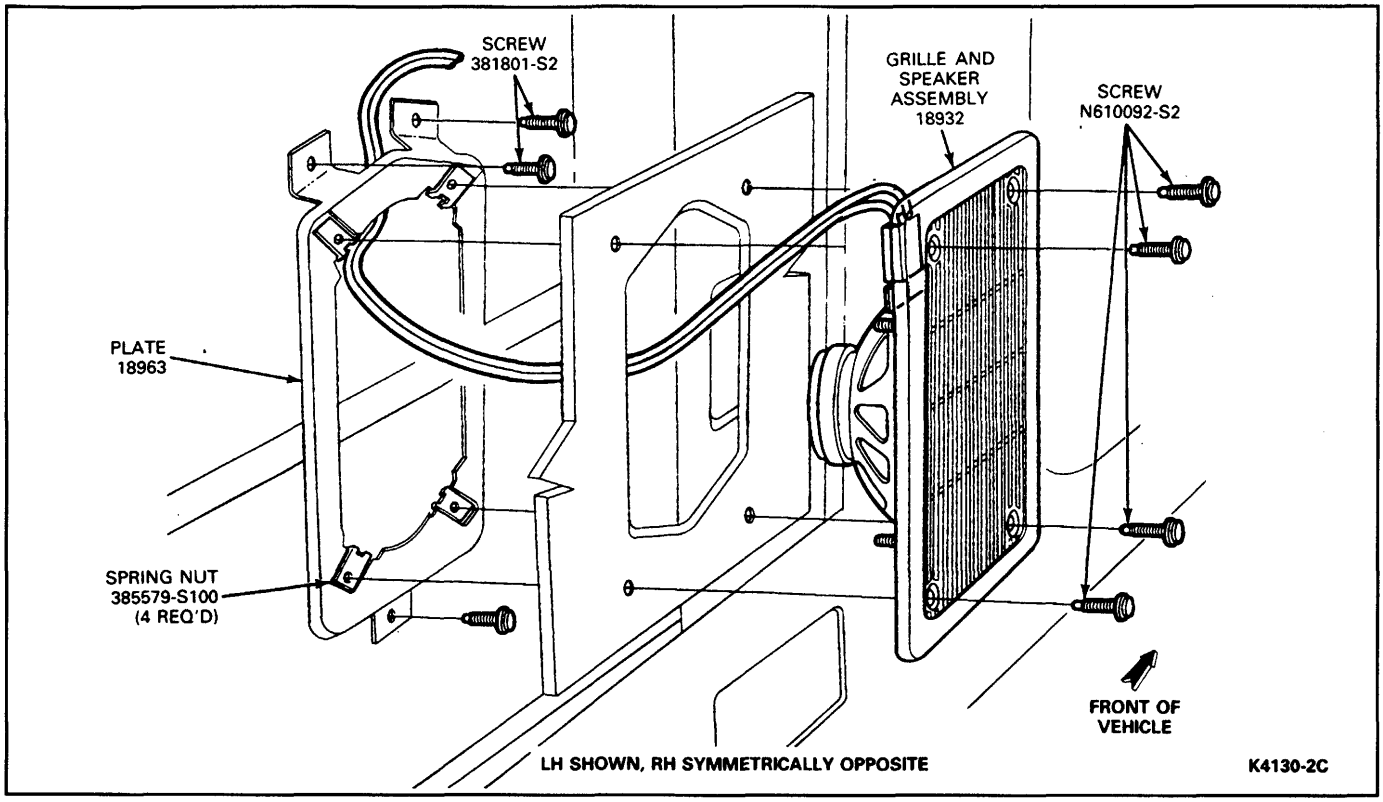


FIG. 4 Rear Speakers—Bronco

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SECTION 35-40 Ash Receptacles and Cigar Lighter

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DIAGNOSIS AND TESTING	
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Ash Receptacles	35-40-1
REMOVAL AND INSTALLATION (Cont'd)	
Cigar Lighters	35-40-1
VEHICLE APPLICATION	35-40-1

VEHICLE APPLICATION

All Models.

DIAGNOSIS AND TESTING

Possible problems associated with the cigar lighter are listed in the following Diagnosis Guide along with possible causes and correction steps.

REMOVAL AND INSTALLATION

Ash Receptacles

Removal

To remove ash receptacle shield assembly, first remove ash receptacle.

1. Remove center finish panel.
2. Remove the two screws that attach the ash receptacle retainer to the instrument panel.
3. Pull the retainer rearward to remove the assembly from the front of the instrument panel.
4. Tip the rear of the retainer down to clear the electrical connector and leg at shield. Remove the assembly from the instrument panel.
5. Disconnect electrical connector.

Installation

1. Connect electrical connector.
2. Position the shield assembly to the opening in the rear side of the instrument panel, lifting the assembly onto the alignment pins.
3. Push shield assembly forward to engage pins on instrument panel.
4. Install the two screws attaching the shield assembly to the instrument panel.
5. Install center finish panel.

NOTE: For the F-150—F-350 and Bronco only, remove the ash receptacle retainer assembly to facilitate cigar lighter removal.

Cigar Lighters

Removal

1. Disconnect the battery ground cable.
2. Open ash receptacle door.
3. Remove the lighter element (Figs. 1 and 2).
4. Depress tongue on detent spring and remove door assembly.
5. Disconnect the push-on connector from the base of the lighter socket (remove the ground when provided).
6. Unscrew the socket and retainer.
7. Remove the socket from the rear of the door assembly and the retainer from the front.

Installation

1. Replace the retainer in the door assembly from the front.
2. Install the socket into the retainer using care not to damage the bimetal contacts.

Diagnosis Guide

CONDITION	POSSIBLE CAUSE	RESOLUTION
Cigar lighter — knob pops out before adequate heating.	1. Cigar lighter element.	1. Substitute another element. Replace if necessary.
	2. Cigar lighter socket.	3. Replace socket.
Cigar lighter — element stays in, will not heat up.	1. Fuse burnt out.	1. Replace fuse. If fuse blows again, check for short circuit.
	2. Open circuit in wiring.	2. Check for power to socket. Repair if necessary.
	3. Cigar lighter element.	3. Substitute another element. Replace if necessary.
	4. Cigar lighter socket.	4. Replace socket.

CL2776-2D

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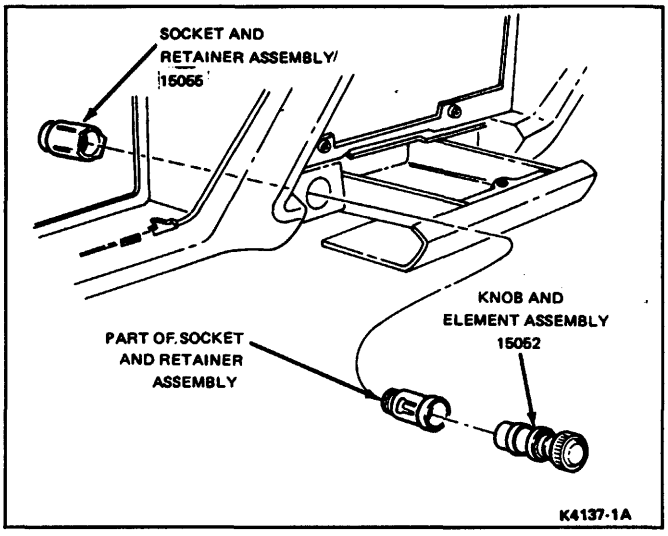


FIG. 1 Cigar Lighter Installation—F-150—F-350 and Bronco

3. Reconnect the push-on connector to the base of the lighter socket (reconnect the ground when provided).
4. Replace door assembly into receptacle shield pivots. Position and rotate upward to close.

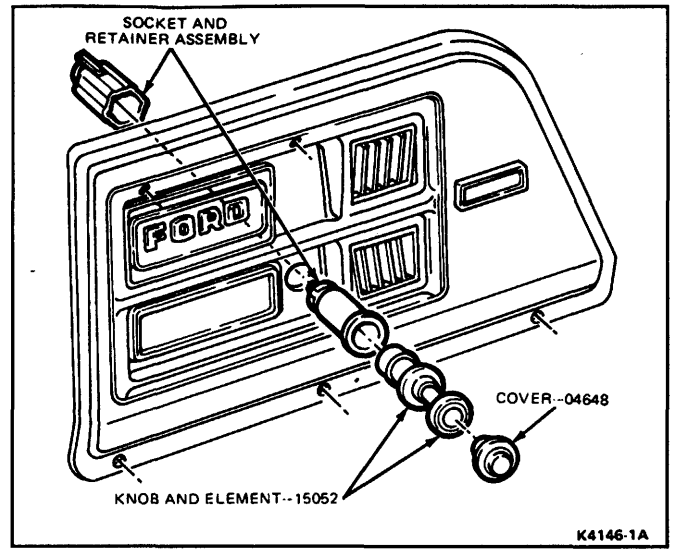


FIG. 2 Cigar Lighter Installation—E-150—E-350

5. Replace the lighter element and reconnect the battery ground cable.
6. Test for proper operation.

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SECTION 35-50 Mirrors—Inside and Outside

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Inside Rearview Mirror	35-50-1
Outside Rearview Mirror	35-50-1
REMOVAL AND INSTALLATION (Cont'd)	
Outside Rearview Mirror (Cont'd)	
Conventional Type	35-50-1
Western Type	35-50-1
VEHICLE APPLICATION	35-50-1

VEHICLE APPLICATION

All Models.

DESCRIPTION

Dual western mirrors are available on all vehicles.

REMOVAL AND INSTALLATION

Inside Rearview Mirror

Removal

1. Loosen the mirror assembly-to-mounting bracket set screw (Fig. 1).
2. Remove the mirror assembly by sliding upward and away from the mounting bracket.
3. If the bracket vinyl pad remains on the windshield, apply low heat from an electric heat gun until the vinyl softens. Then peel the pad off the windshield and discard.

Mounting Bracket Installation

1. Make sure glass, bracket and Rear View Mirror Repair Kit D9AZ-19554-B (ESB-M2G176-A) or equivalent are at least at room temperature (18.3-23.9°C or 65-75°F).
2. Locate and mark the mirror mounting bracket location on the outside surface of the windshield.
3. Thoroughly clean bonding surfaces of glass and bracket to remove old adhesive. Use mild abrasive cleanser on glass and fine sand paper on bracket to lightly roughen surface. Wipe clean with alcohol-moistened cloth.

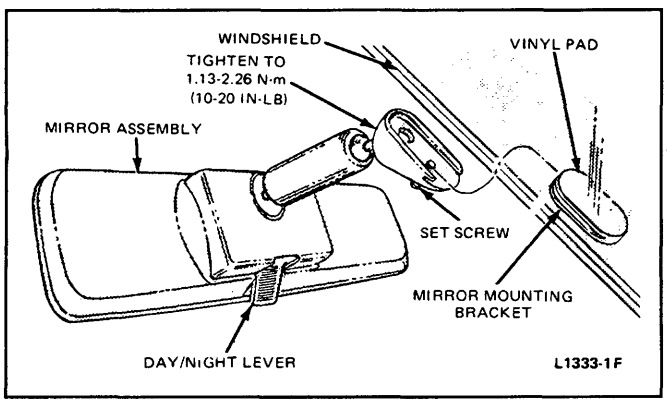


FIG. 1 Inside Rearview Mirror Installation

4. Crush accelerator vial (from Rear View Mirror Repair Kit D9AZ-19554-B or equivalent) and apply accelerator to bonding surface of bracket and windshield. Let dry three minutes.
5. Apply two drops of adhesive from kit D9AZ-19554-B or equivalent to the mounting surface of the bracket. Using a clean toothpick or wooden match, quickly spread the adhesive evenly over the mounting surface of the bracket.
6. Quickly position the mounting bracket on the windshield. The 9.5mm (3/8 inch) circular depression in the bracket must be toward the bottom edge and toward the inside of the cab. Press the bracket against the windshield for approximately one minute.
7. Allow the bond to set for five minutes. Then, remove any excess bonding material from the windshield with an alcohol-dampened cloth.

Installation

1. Attach the mirror to the mounting bracket. Tighten the set screw to 1.13-2.26 N·m (10-20 in-lb).

Outside Rearview Mirror

Conventional Type

The conventional outside rearview mirror is mounted on the door. To remove the mirror, remove the attaching screws and lift off the mirror and gasket (Fig. 2).

Western Type

The dual position outside rearview mirrors are mounted on both doors. The mirrors may be removed from the doors by removing the attaching screws (Fig. 3). Broken mirror glass may be replaced on the mounting bracket using Silicone Rubber D6AZ-19562-A (ESB-M4G92-A and ESE-M4G195-A) or equivalent and following the procedures listed below.

CAUTION: The mirror glass must be installed with the reflective coated side exposed to ensure adequate performance.

1. Break out and discard the larger fragments of the broken mirror glass.
2. Remove the smaller fragments from around the perimeter with a flat-bladed knife.
3. If dust or dirt has accumulated inside the mirror base, wash it and allow it to dry thoroughly before proceeding.
4. Using Ford Silicone Rubber D6AZ-19562-A (ESB-M4G92-A and ESE-M4G195-A) or equivalent,

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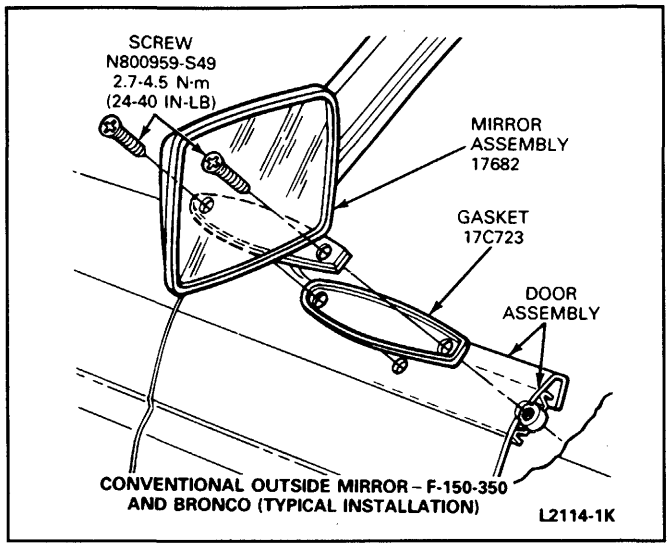


FIG. 2 Conventional Outside Mirrors

apply a 3.2mm (1/8 inch) by 25.4mm (1.00 inch) diameter bead on each of the four upper mounting pads. Apply a continuous 3.2mm (1/8 inch) diameter bead 101.6mm (4.00 inches) long across the two lower center mounting pads on the mirror head.

5. Press the glass firmly into the case **PRIMARY SIDE OUT,** and secure with a rubber band pressing a small pad of styrofoam against the center of the glass. The rubber band should remain in place for a minimum of 24 hours to retain the glass until the silastic is cured.

Broken Mirror Glass Replacement

Removal

1. Remove mirror case from guard arm at upper and lower attachments. (Remove convex mirror if attached.)
2. Remove upper and lower small frame brackets.
3. Remove side frames from gasket and case back.
4. Remove gasket from glass. Discard broken glass and save gasket.

Installation

NOTE: Prior to installing mirror glass, ensure reflective surface is on viewed side of mirror. Touching the glass with the point of a pencil will show a point-to-point image on the reflective surface only.

1. Adhere gasket to glass.
2. Install side frames to gasket and case back.
3. Install upper and lower small frame brackets.
4. Install mirror case to guard arm at upper and lower attachments (install convex mirror if necessary).

Recreation Swing-Out Mirror

The Recreation mirror may be removed from the doors by removing the four retaining screws on E-150—E-350, and five screws on F-150—F-350 (Fig. 4).

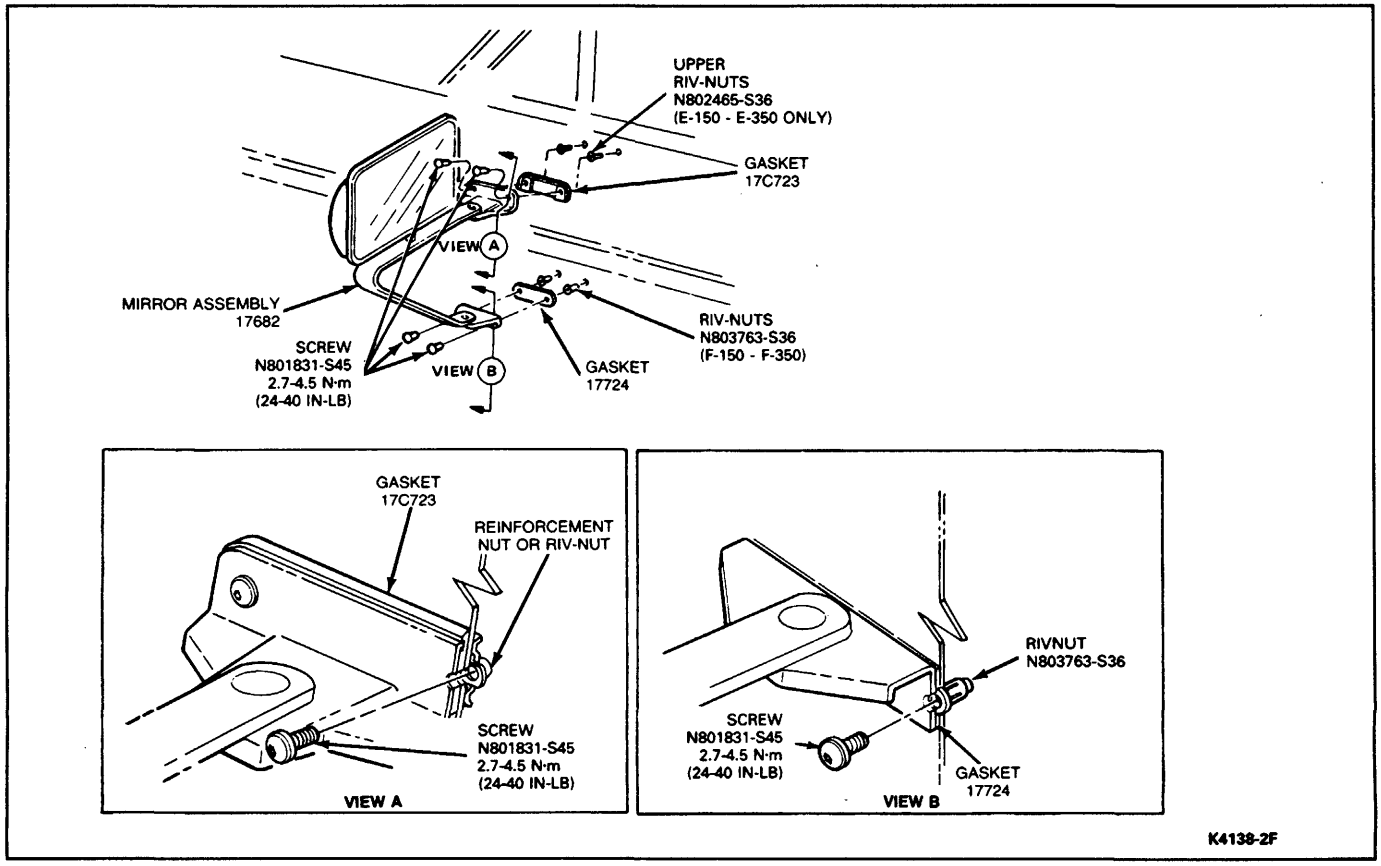


FIG. 3 Western Type Mirror Installations—Mounting Bracket—F-150—F-350 and Bronco Shown, E-150—E-350 Typical

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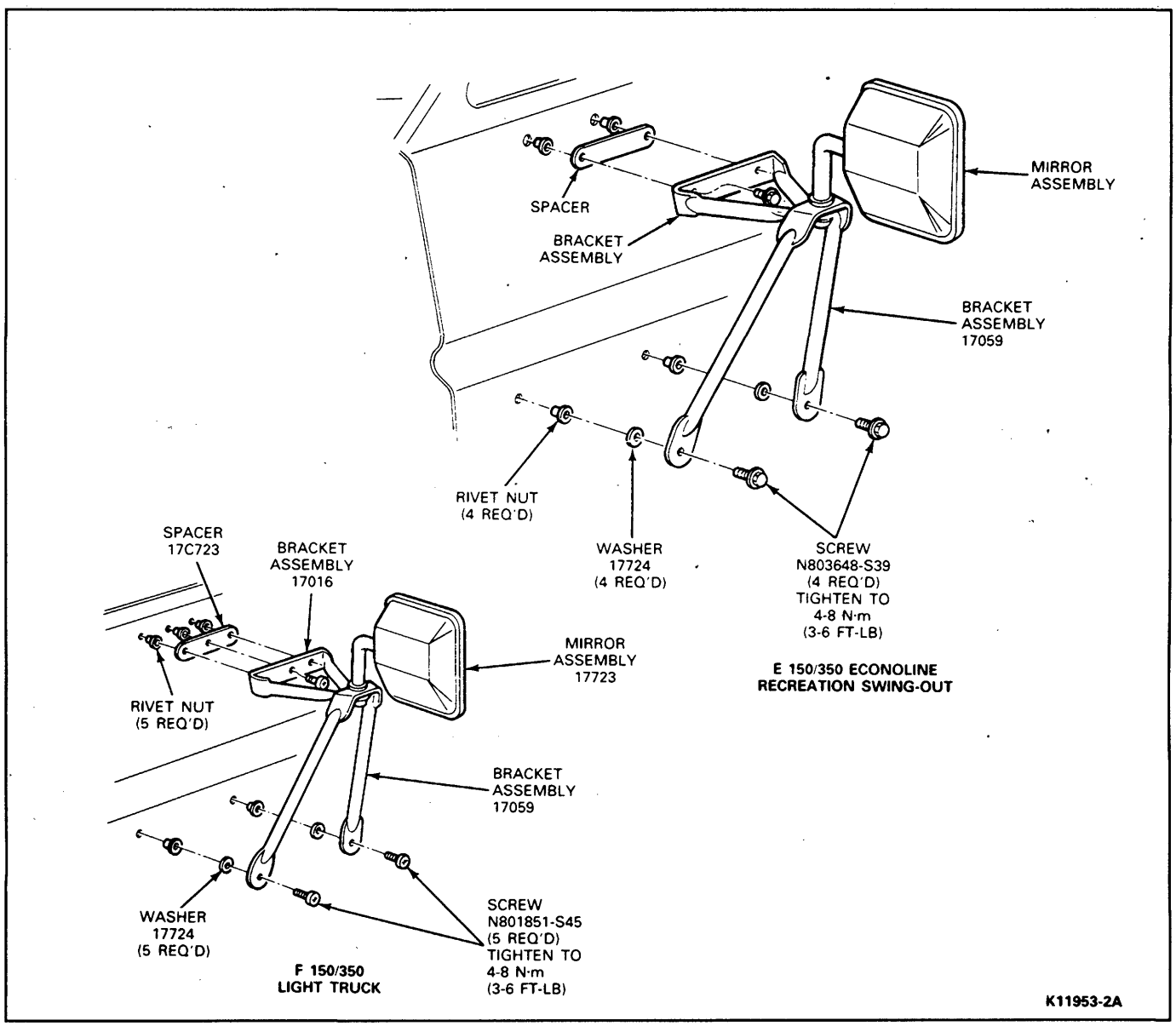


FIG. 4 Removal and Installation—Recreation Swing-Out Mirror—E-150—E-350 and F-150—F-350

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VEHICLE APPLICATION

All Light Truck Models.

DESCRIPTION AND OPERATION

Standard Wipers

Bronco and F-150 Through F-350 (Fig. 1)

The two-speed, permanent magnet, three-brush "E" electric windshield wiper motor has a brush rigging that permits selection of low or high speed. When the control selector is in LOW position, the grounded brush and the white wire brush are used to operate the motor at low speed. When the control selector is in HI position, the grounded brush and the blue/orange wire brush are used. Current bypasses a portion of the armature winding, causing the motor to run faster. When the control selector is moved to the PARK position, the motor will continue at low speed until the PARK switch run contacts open, stopping the motor in the PARK position.

E-150—E-350

(Fig. 2)

The two-speed, permanent magnet, three-brush "B" electric windshield wiper motor has a brush rigging that permits selection of low or high speed. When the control selector is in LOW position, the common (yellow wire) brush and the blue wire brush are used, operating the motor at low speed. When the control selector is in HI position, the common brush and the white/orange wire brush are used. Current bypasses a portion of the armature winding, causing the motor to run faster. When the control selector is moved to the PARK position, the motor will continue at low speed until the park switch run contacts open, stopping the motor in the PARK position.

Interval Wipers

Optional interval wipers are available on E-150—E-350, Bronco and F-150 through F-350 (Figs. 3 and 4).

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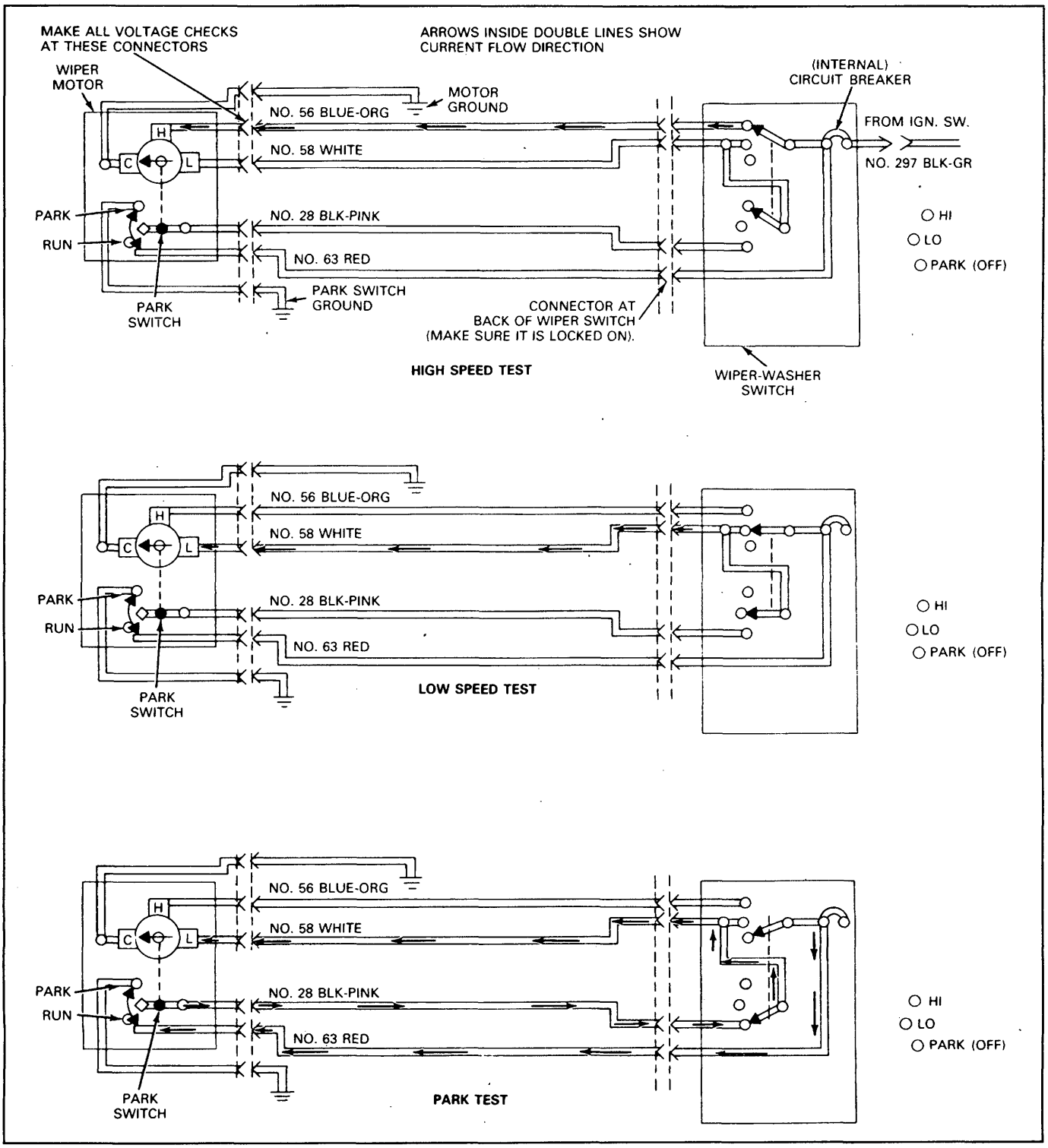


FIG. 1 Standard Windshield Wiper System "E" Motor Tests—Bronco and F-150—F-350

E-150—E-350

The interval operation of the windshield wiper motor is controlled by a variable resistor in the windshield wiper control switch which, in conjunction with the electronic governor, allows a variable pause between wiping cycles (Fig. 4).

For normal operation of the control switch, slide the wiper-washer knob toward the right. The first position (approximately 19mm (3/4 inch) long) is for interval, the second is for low speed and the third is for high speed.

When the control knob is placed at the LH side of the INTERVAL position, the time interval between wiper blade sweeps is at maximum. As the control is moved toward the RH side of the INTERVAL position (before the detent is felt) the time interval between sweeps is reduced.

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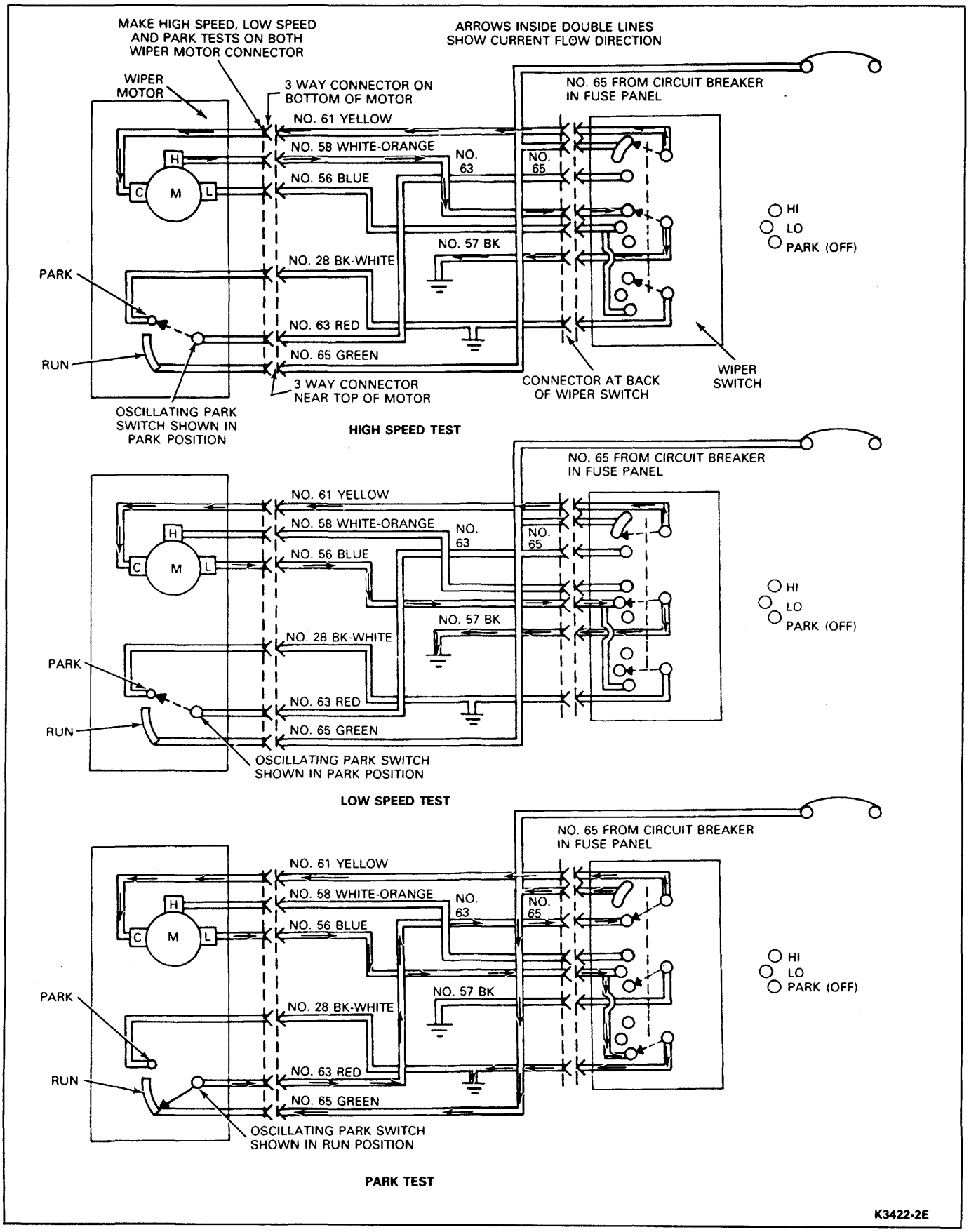


FIG. 2 Standard Windshield Wiper System "B" Motor Tests—E-150—E-350

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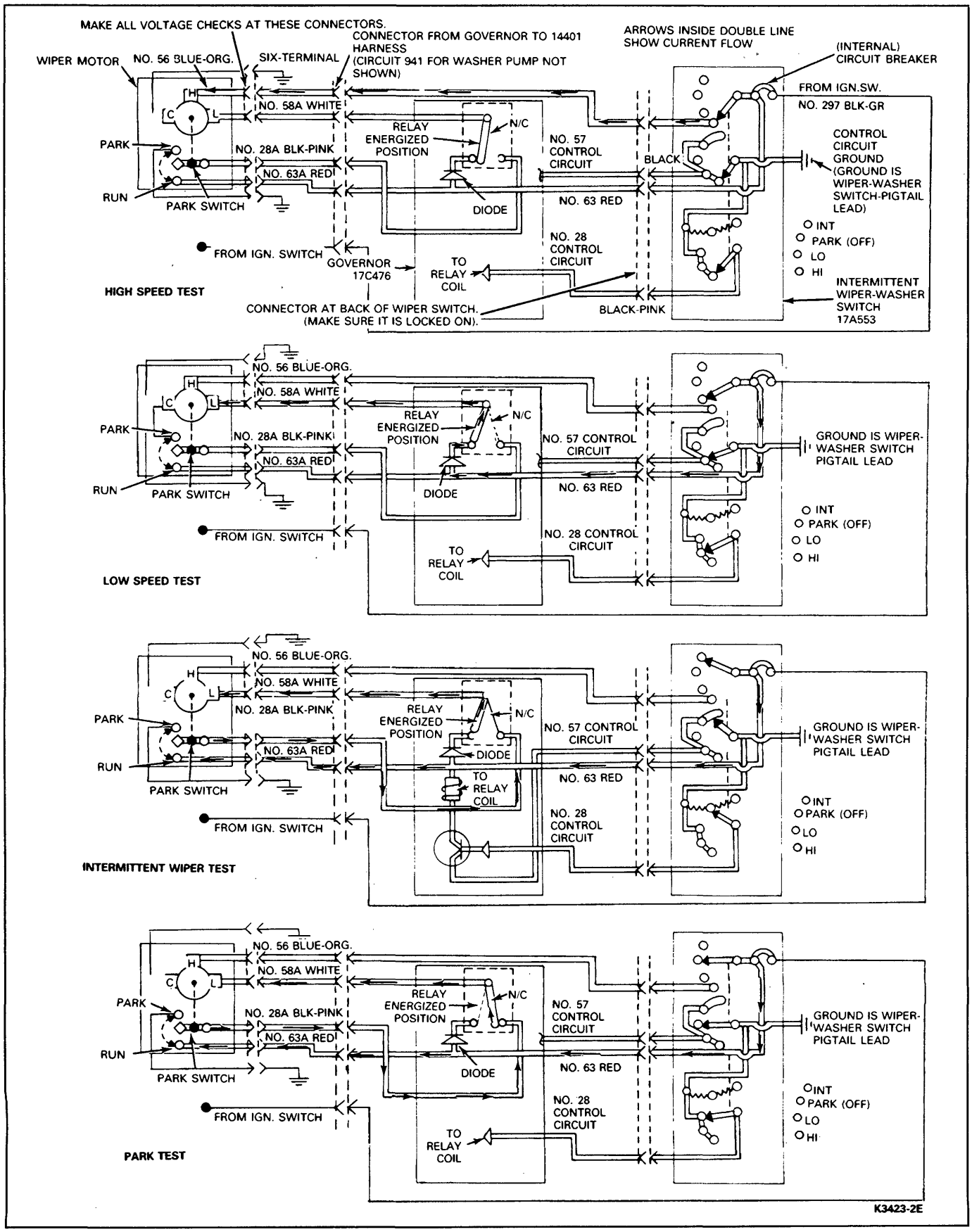


FIG. 3 Interval Windshield Wiper System "E" Motor Test—Bronco and F-150—F-350

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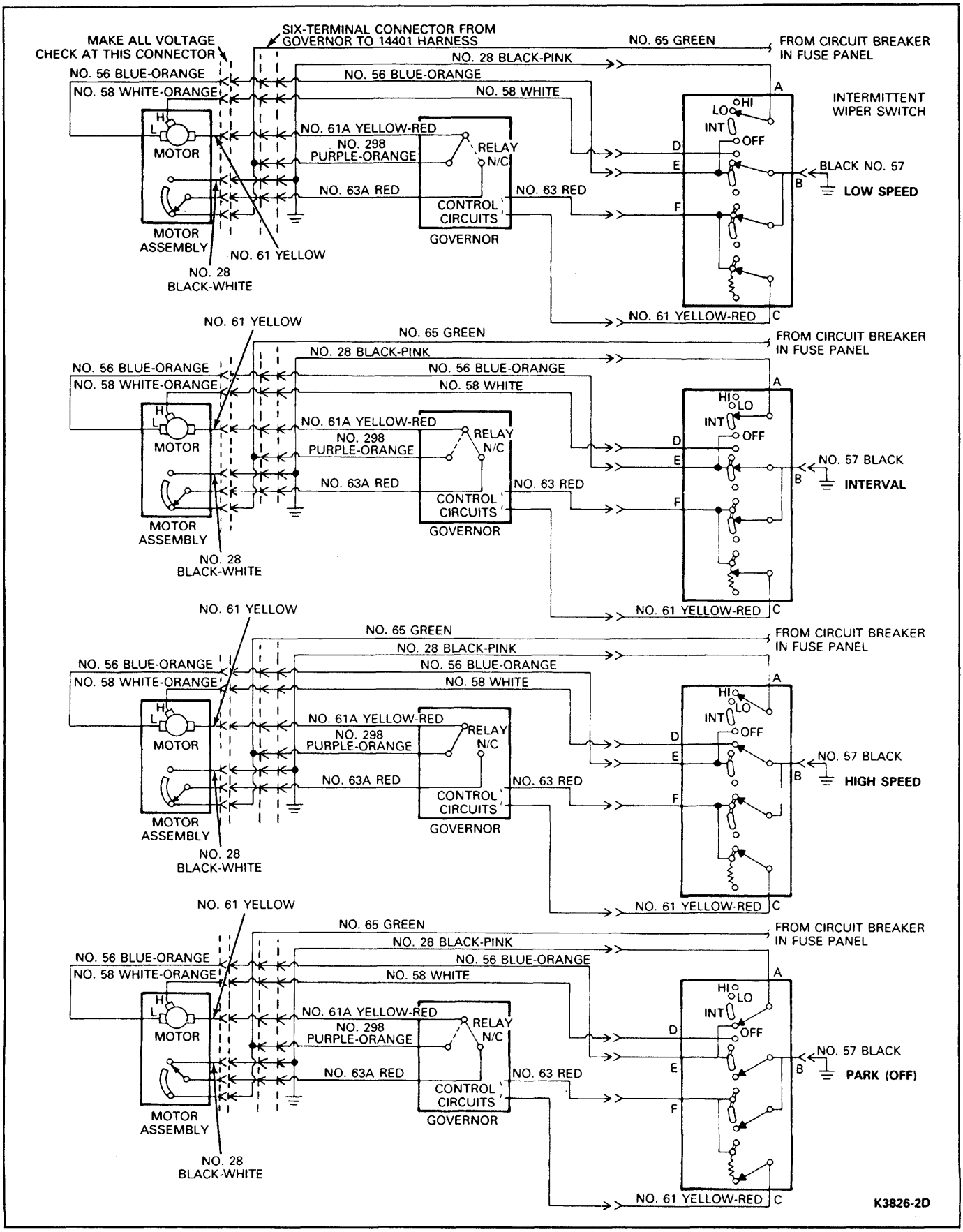


FIG. 4 Interval Windshield Wiper System "B" Motor Tests—E-150—E-350

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NOTE: When the wiper control switch is set on INTERVAL, the first wipe may not occur for up to 12 seconds.

When the detent position is felt as the switch is moved toward the right, the wiper system operates at low speed. The next detent position, on the extreme right, operates the wiper system at high speed.

A variable resistor in the wiper/washer switch controls the amount of current to the electronic pause control. This, in turn, regulates wiper motor operation for the desired time interval.

The governor has a unique feature: Operation of the windshield washers while the switch is in the INTERVAL position electrically overrides the governor. This causes the wipers to operate at low speed.

Normal interval wiper operation resumes when the wash knob is released.

Bronco and F-150 Through F-350

This is a two-speed wiper system with an interval feature (Fig. 4). For normal wiper operation, turn the wiper control knob clockwise to either of two detents (low and high speed).

For interval operation of the wiper switch, rotate the wiper control knob counterclockwise. As the knob is rotated counterclockwise, time interval between wiper blade sweeps increases.

Pushing the switch knob actuates the washer pump only. The control switch must be rotated to LOW or HI for wiping action.

Governor

E-150—E-350, F-150—F-350 and Bronco

The interval wiper system governor is mounted on the lower flange of the instrument panel below the wiper-washer switch.

TESTING

Standard Windshield Wiper System "E" Test Bronco and F-150—F-350

High-Speed Test

With the wiper switch in HI position, current flows from the ignition switch through the wiper switch to the wiper motor high terminal (Fig. 1). To check high-speed operation, turn ignition switch on and place wiper switch in HI position. Check for voltage at the circuit 56 pin (blue/orange wire) at three pin connector. If no voltage is present, check voltage at circuit 297 pin (black/green wire) at the wiper switch. If voltage is present at circuit 297 but not present at circuit 56, replace the wiper switch. If voltage is not present at circuit 297, trace circuit back to determine source of problem. If voltage is present at circuit 56 and motor does not run, ground the motor ground circuit to the body. If motor runs, repair ground. If motor does not run, replace motor.

Low-Speed Test

With the wiper switch in LOW position, current flows from the ignition switch through the wiper switch to the wiper motor low terminal (Fig. 1). To check low-speed operation, turn ignition switch on and place wiper switch in LOW position. Check for voltage at the circuit 58 pin (white wire) at three pin connector. If no voltage is present, check voltage at circuit 297 pin (black/green wire). If voltage is present at circuit 297 but not present at circuit 58, replace the wiper switch. If voltage is not present at circuit 297, trace circuit back to determine source of problem. If voltage is present at circuit 58, and motor does not run, ground motor ground circuit to the body. If motor runs, repair ground. If motor does not run, replace motor.

Park-Operation Test

With the wiper switch off, the wipers will complete one cycle through the wiper motor park switch. Current flows from the ignition switch through the wiper switch to the wiper motor park switch (run) for 9/10th of one cycle (Fig. 1). The low-speed run circuit current flow is from the wiper motor park switch through the wiper switch, to the motor low-speed brush, across the armature, and out a common brush to ground. At the last 1/10th portion of the cycle, the park switch moves from the RUN position to the PARK (ground) position, stopping the motor in the PARK position.

To check the park operation, turn ignition switch on and place wiper switch in the OFF position. Check for voltage at circuits 58 (white wire), 28 (black/pink dot) and 63 (red) pins at the four pin connector (Fig. 6). If voltage is present on all three circuits and wiper blades are in non-park position, ground motor ground circuit to the body. If motor parks, repair motor ground. If motor does not move to PARK position, replace motor. If voltage check shows only voltage at circuit 63 pin, replace wiper motor. If voltage check shows voltage only at circuit 63 and 28 replace wiper switch. If voltage is still not present at circuit 58, trace circuits 28 and 58 back toward wiper switch to determine source of problem.

Standard Windshield Wiper System "B" Test E-150—E-350

High-Speed Test

NOTE: Perform all voltage checks at the wiper motor. If necessary, pierce the blue, white/orange and yellow wires.

With the wiper switch in the HI position, current flows from the ignition switch through the circuit breaker in the fuse panel, through the wiper switch contacts, through circuit 61 (yellow and red) to the wiper motor common brush. From the common brush, the current flows across the motor armature through circuit 58 white to the wiper switch and across the switch contacts to ground. The wiper motor is not grounded (Fig. 2).

To check high-speed operation, place ignition switch in ON position and wiper switch in the HI position. If voltage is present at circuit 61 pin at wiper motor connector and motor does not run, ground circuit 58. If motor runs with circuit 58 grounded, service wiper switch ground circuit or replace wiper switch. If motor does not run with circuit 58 grounded, repair motor. If voltage is present at circuit 65 (green) pin only, replace wiper switch. If no voltage is present at circuit 65 pin, trace circuit 65 to determine the source of problem.

Low-Speed Test

With the wiper switch in LOW position, current flows from ignition switch through circuit breaker in fuse panel, through circuit 61 (yellow) to the wiper motor common brush. From the motor common brush, current flows across the motor armature through circuit 56 (blue) to the wiper switch and across the wiper switch contacts to ground. The motor is not grounded.

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To check low-speed operation, place ignition switch in ON position and wiper switch in LOW position. If voltage is present at circuit 61 pin at wiper motor connector and motor does not run, ground circuit 56. If motor runs with circuit 56 grounded, service wiper switch ground circuit or replace wiper switch. If wiper motor does not run with circuit 56 grounded, service motor. If voltage is present at circuit 65 pin only, replace wiper switch. If no voltage is present at circuit 65 pin, trace problem back to source of current.

Park-Operation Test

A set of contacts attached to circuit 63 inside the wiper motor oscillate between the circuit 65 and ground when the wiper motor is running (Fig. 2). When the wiper switch is turned off to park the wipers, the motor points are kept on the circuit 65 (battery voltage) for 9/10th of one cycle and at ground 1/10th of one cycle. Current flows from circuit 65 (green), through wiper motor park switch points and through the circuit 63 (red) to the wiper switch. From the wiper switch input the current flows across the wiper switch contacts, through circuit 61 circuit (yellow), through the common brush on the wiper motor out the low-speed brush on circuit 56 blue to the wiper switch. From the wiper switch input the current flows through switch contacts out circuit 28 (black/white) to ground.

To check park operation of wiper system, place ignition switch in ON position and wiper switch in OFF position. If wipers do not park, check for voltage at circuits 63 and 61 at wiper motor connector pins. If both pins show voltage, ground circuit 56. If motor parks, repair ground circuit or replace wiper switch. If motor does not run, replace the motor. If voltage is present at circuit 63 but not at circuit 61, replace the wiper switch. If voltage is present at circuit 65 pin but not on circuit 63 pin, service wiper motor park switch. If no voltage is present at circuit 65 pin, trace problem back to source of current.

Interval Windshield Wiper System "E" Motor Test F-150—F-350 and Bronco

Quick Check

If wipers operate in high speed only (and wipers hesitate when going through PARK position), connect jumper wire from windshield wiper switch case to ground. If wipers now work in low speed, repair switch ground. If wipers do not work in low speed with switch case grounded, replace governor.

High-Speed Test

With the wiper switch in the HI position, current flows from the ignition switch through the wiper switch and governor, to the wiper motor, to ground (Fig. 3).

To check high-speed operation, place ignition switch in ON position and wiper switch in HI position. Check for presence of voltage at circuit 56 (blue/orange) pin. If voltage is present and motor does not run, ground motor ground circuit to body. If motor runs, repair motor ground circuit. If motor does not run, replace motor. If voltage is present at 63 pin (red wire) but not at pin 56 (blue/orange), replace the wiper switch. If no voltage is present at pin 63, remove wiper switch connector and check circuit 297 pin (black/green). If voltage is present, replace wiper switch. If not, trace circuit to determine source of problem.

Low-Speed Test

With wiper switch in LOW position, current flows from the ignition switch through the wiper switch and energized relay contacts of the governor, to the wiper motor (Fig. 3).

To check low-speed operation, place ignition switch in ON position and wiper switch in LOW position. Check for presence of voltage at circuit 58 pin. If voltage is present and wiper motor does not run, ground the motor ground circuit to the body. If motor runs, repair motor ground. If motor does not run, replace motor. If voltage is present at circuit 63 pin but not at circuit 58 pin, ground control circuits 57A (black) and 28A (black/pink) at wiper switch connector. If voltage is now present on circuit 58 pin, replace wiper switch. If voltage is not obtained at circuit 58 pin after grounding control circuits at wiper switch, replace governor. If no voltage is present at circuit 63 pin (red) remove the wiper switch connector and check for voltage at circuit 297 pin (black/green). If voltage is present, replace the wiper switch. If not, trace the circuit to determine source of problem.

NOTE: If governor relay is inoperative, wipers will operate in high speed and park only. Wipers will not operate in low and interval modes.

Interval Operation Test

When the wiper switch is placed in the INTERVAL mode, the wiper motor park switch contacts are at ground (assuming wipers started in PARK position), and the relay is energized (Fig. 3). Initially, current flows from the ignition switch through the circuit breaker in the wiper switch, through a diode and energized contacts in the governor, to the wiper motor low speed brush. The motor rotates 1/10th of a cycle. The wiper motor park switch contacts then change from PARK (ground) to RUN (B+). After the contacts change position, the relay in the governor de-energizes. A second current path to the wiper motor is shown by the arrows in Fig. 3. The motor rotates through the remaining 9/10th of one cycle. When the park switch contacts again touch ground (PARK), the motor parks. The governor electronic circuit delays energizing of the relay until the circuit times out. Then the relay energizes and the low-speed interval is repeated. The discharge rate of a capacitor to ground through the wiper switch variable resistor controls the time delay of the system.

Park Operation Test

When the wiper switch is placed in the OFF position, the wipers complete one full cycle through the wiper motor park switch. Current flows from the ignition switch across a circuit breaker in the wiper switch to the wiper motor park switch (run). From the park switch, current flows through the normally closed contacts of the governor relay (de-energized), to the wiper motor low-speed brush, across the armature and out a common brush to ground. This occurs for 9/10th of one cycle. At the last 1/10th of the cycle, the park switch moves from RUN to PARK, stopping the motor in PARK position.

To check park operation, place ignition switch in ON position and move wiper switch from operating mode to OFF position. Check for presence of voltage at circuit 58 pin. If voltage is present and motor does not park, ground the wiper motor ground circuit to the body. If motor parks, repair ground. If motor does not run, replace motor. If voltage is present at circuits 63 and 28 pins but not at circuit 58 pin, replace governor. If there is

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voltage on circuit 63 pin but not on circuit 28 pin, and the motor is not parked, replace the wiper motor. If no voltage is present on circuit 63 pin, remove the wiper switch connector and check for voltage at circuit 297 pin (black/green wire). If voltage is present, replace the wiper switch. If not, trace the circuit to determine source of problem.

NOTE: Before troubleshooting the interval operating mode, the wiper system must be performing properly in LOW and PARK modes. If the wipers run continuously at low speed, or the interval delay is excessive with the ignition switch on and the wiper switch in the INTERVAL position, remove the wiper switch and check continuity and resistence values (Fig. 10). If switch is OK, replace governor; otherwise replace the wiper switch.

Interval Windshield Wiper System "B" Motor Test—E-150—E-350

NOTE: Perform all voltage checks at wiper motor. It may be necessary to pierce the blue, white/orange and yellow wires.

Low-Speed Test

With the wiper switch in the LOW position, the current flow is from the ignition switch through the circuit breaker through circuit 65 (green) to the governor as shown in Fig. 4. Refer to Section 34-31, Fuses, Circuit Breakers and Fuse Links. Placing the wiper switch in the LOW position causes the relay to be energized. This allows current to flow through the energized contacts of the governor and circuit 61 (yellow) to the common brush of the wiper motor. From the motor common brush, the current flows across the motor armature through circuit 56 (blue/orange) to the wiper switch and across the wiper switch contacts to ground.

To check low-speed operation, place the ignition switch in the ON position and wiper switch in LOW position. Check for presence of voltage at circuit 61 pin at the wiper motor connector. If the motor does not run, ground circuit 56. If motor runs with circuit 56 grounded, service wiper switch ground circuit or replace wiper switch. If motor does not run with circuit 56 grounded, replace motor. If voltage is **not** present at circuit 61, and circuit breaker is providing voltage, ground control circuits "F" (red wire) and pin "C" (yellow wire) at the wiper switch. If voltage is not obtained at circuit 61 pin at wiper motor, replace governor. If voltage is obtained at circuit 61 after grounding control circuit in wiper switch, replace wiper switch.

High-Speed Test

With the wiper switch in the HI position, current flows from the ignition switch through the circuit breaker in the fuse panel to the governor (circuit 65—green). The wiper switch grounds the control circuit, causing the relay to be energized. Current flows through the energized contacts of the governor through circuit 61 (yellow) to the common brush of the wiper motor. From the common brush, the current flows across the motor armature through circuit 58 (white/orange) to the wiper switch and through the wiper switch to ground.

To check high-speed operation, use the same procedures outlined for low-speed test except use circuit 58 instead of circuit 56.

Interval Operation Test

Before checking the INTERVAL operating mode, the wiper system must be operating normally in all other modes. Turn the ignition switch on and place the wiper switch in the INTERVAL position. If the wipers are running continuously at low speed or the time delay is excessive, remove the wiper switch and check continuity and resistance values (Fig. 9). If switch is OK, replace governor; otherwise replace wiper switch.

When the wiper switch is placed in the INTERVAL mode, the motor's oscillating park switch contacts are at ground (assuming wipers started in PARK position), and the governor relay is energized. Initially, current flows from the ignition switch (circuit 65—green) through the energized contacts in the governor to the wiper motor's low speed brush (circuit 61—yellow). The motor rotates 1/10th of a cycle. The wiper motor's oscillating park switch contacts then change from PARK (ground) to RUN (battery voltage). After the change in switch contact position, the relay in the governor de-energizes. A second current path to the wiper motor is completed by way of circuit 65 (green), the wiper motor oscillating park switch, circuit 63 (red), the normally closed contacts of the governor, and circuit 61 (yellow). The motor rotates through the remaining 9/10th of one revolution. When the oscillating park switch contacts again touch ground (PARK), the motor parks. The interval windshield wiper governor's electronic circuit delays energizing of the relay until the circuit times out; then the relay energizes and the low-speed interval cycle is repeated. The discharge rate of a capacitor to ground through the wiper switch variable resistor controls the time delay of the system.

Park Operation Test

With the wiper switch in the OFF position, the wipers will complete one cycle through the wiper motor's park switch. Current flows from the ignition switch, across the circuit breaker in the fuse panel, to the wiper motor's oscillating park switch (run). Then, current flows from the park switch through the normally closed governor relay contacts (de-energized) to the motor's common brush, across the motor armature, and out the low-speed brush to ground. This occurs for 9/10th of one cycle. At the last 1/10th of the cycle, the oscillating park switch moves from the RUN position to ground (PARK), stopping the motor in the PARK position.

To check park operation, place the ignition switch in the ON position and move the wiper switch from an operating mode to the OFF position. Check for presence of voltage at circuit 61 (yellow) pin. If voltage is present and the motor does not park, ground circuit 56 (blue). If the motor parks, repair ground circuit or replace wiper switch. If motor does not run, replace motor. If voltage is present at circuits 65 (green) and 63 (red) pins but not at circuit 61 pin, replace the governor. If voltage is present on circuit 65 pin, but not on circuit 63 pin, repair the motor park switch. If no voltage is present on circuit 65 pin, trace circuit back to determine source of problem.

Wiper Motor Current Draw

See Figs. 5 through 10.

CAUTION: Electric wiper motors contain permanent magnets made of ceramic. This is a hard glass-like material that can shatter or crack if the motor receives a severe physical shock. Do not handle any windshield wiper motor abusively when diagnosing wiper operations, because it will damage the magnets and make the motor inoperative. Rough handling of new replacement motors may also damage the magnets.

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Bronco and F-150—F-350

The windshield wiper motor tests can be performed with the wiper motor installed in the vehicle (linkage disconnected), or on the bench.

1. Disconnect positive cable from battery.
2. Disconnect wiper linkage from wiper motor.
3. Disconnect electrical plug to test motor on vehicle.
4. Connect the green lead from the tester to the battery positive post.
5. Connect the positive (red) lead from the tester first to the low-speed connection and then to the high-speed connection at the connector plug. In either case, the current draw should not exceed 3.5 amperes.

E-150—E-350

The windshield Wiper Motor Tests can be performed with the wiper motor installed in the vehicle (linkage disconnected), or on the bench.

The motor terminals are too small to make the necessary test connections without using connector sleeves and wires between the motor terminals and the test equipment as shown in Fig. 7. The connector sleeves (available in Kit No. C4AZ-14294-B or equivalent) should be crimped onto both ends of the wires.

1. Disconnect positive cable from battery.
2. Connect the positive (red) lead from the tester to the center terminal on the motor end plate.
3. Connect the green lead from the tester to the battery positive post (Fig. 7).
4. Connect a jumper wire from the battery negative post to the low-speed terminal on the motor end plate and read the current draw. In either case the current draw should not exceed 3.5 amperes.
5. If the current draw exceeds 3.5 amperes check the output arm for binding or damage before replacing motor.

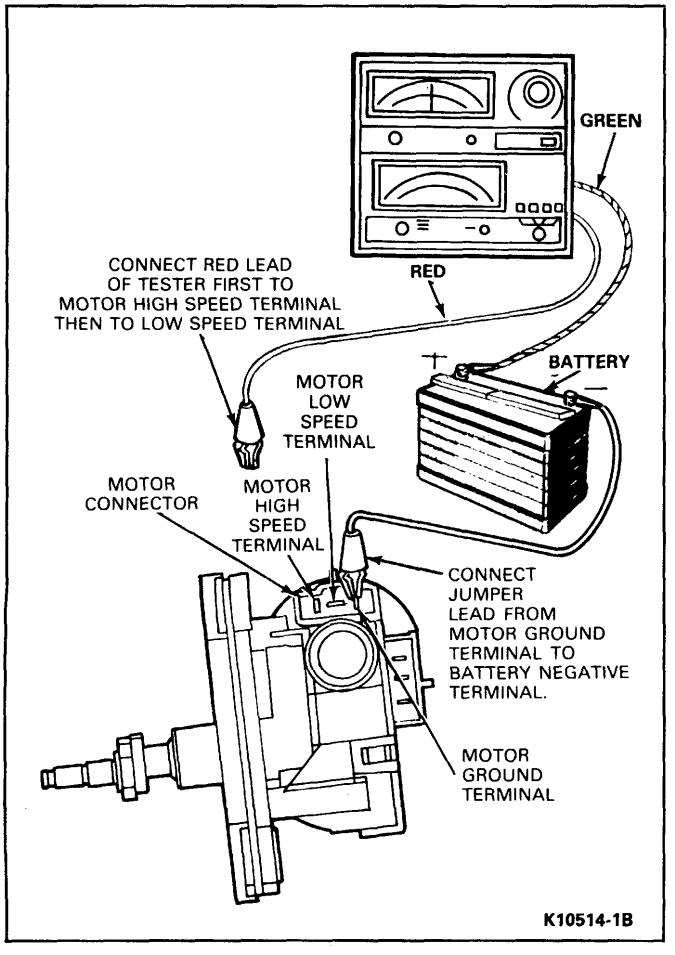


FIG. 5 Wiper Motor Current Draw Test—"E"—F-150—F-350 and Bronco

Circuit Breaker Test—F-150—F-350, Bronco Only

The circuit breaker is rated at 7 amps and is located in the wiper control switch on all rotary switches.

Two separate tests are necessary to check for correct circuit breaker operation when circuit breaker is part of wiper switch (Fig. 8).

Test 1

1. Before connecting the switch to the Rotunda Digital Volt-Ohmmeter 007-00001 or equivalent (Fig. 8), short the tester leads together and adjust the current draw until it equals the circuit breaker rating.
2. Connect the switch to the tester (Fig. 8). Leave the switch connected to the tester for ten minutes. Hold the current reading on the ammeter at the rated current. If the circuit breaker opens during

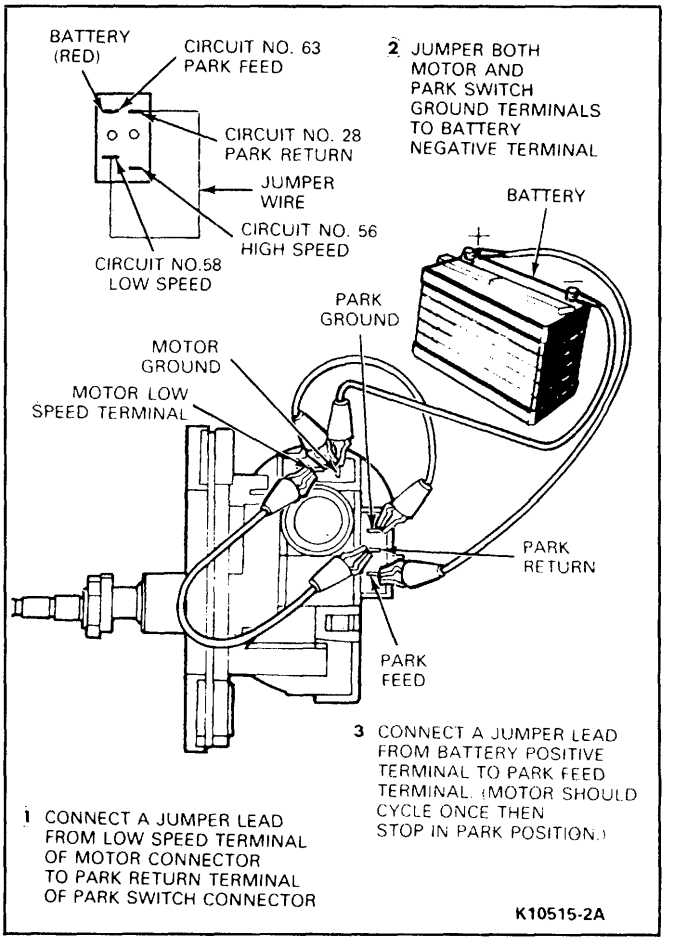


FIG. 6 Park Switch Test—F-150—F-350 and Bronco

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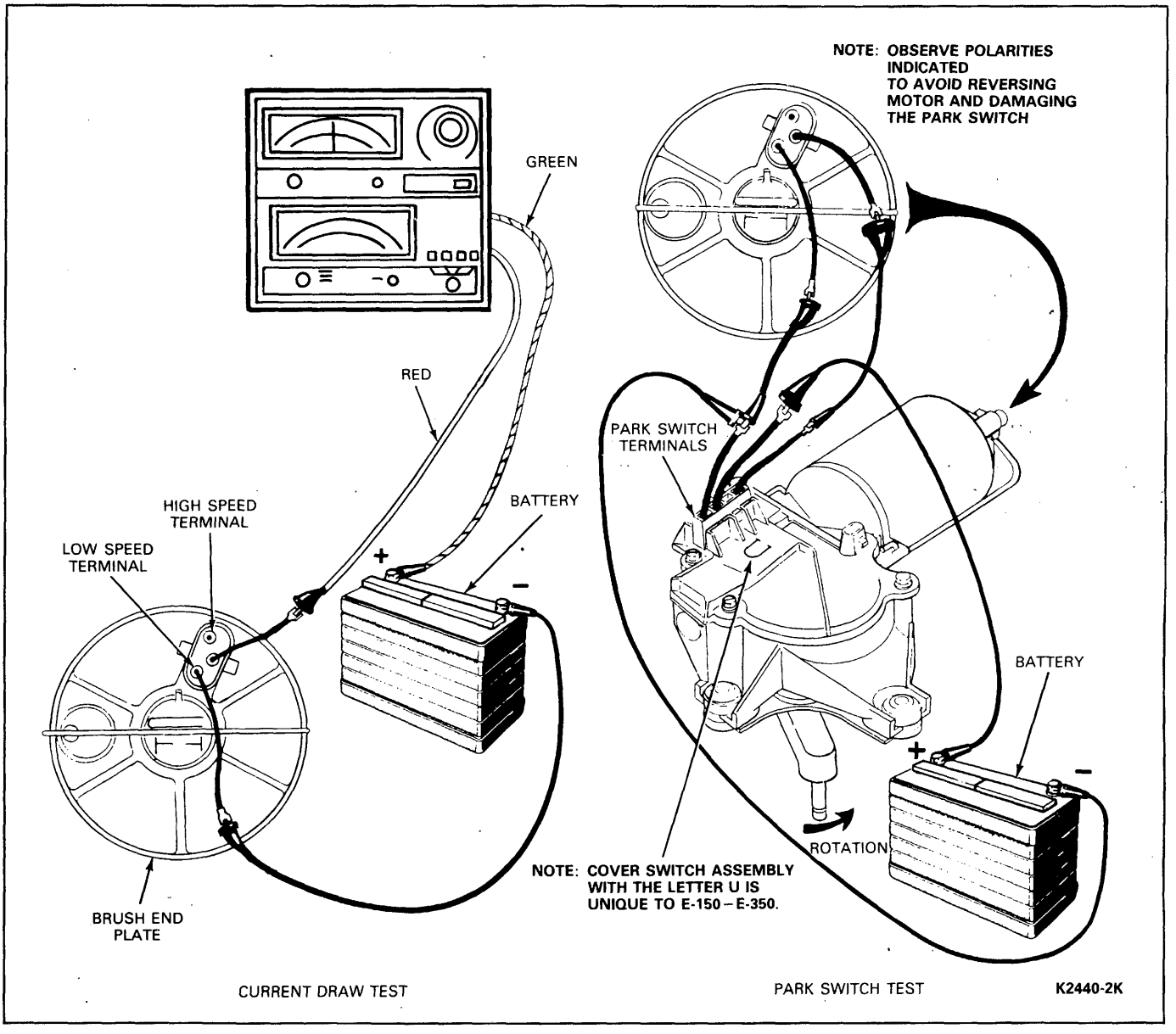


FIG. 7 Wiper Motor Tests—"B"—E-150—E-350

the ten minutes, replace the wiper switch assembly.

Test 2

1. Short the tester leads together and adjust the current draw until it is twice the rated current.
2. Connect the switch. Hold the current reading on the ammeter at twice rated current. The current reading on the ammeter should drop to zero within 20 seconds. If it takes longer than 20 seconds for the circuit breaker to open (current reading drops to zero) replace the wiper switch assembly.

Wiper Switch Continuity Test

Check for continuity between the switch terminals (Figs. 9 and 10). Either a self-powered test lamp or an ohmmeter can be used to test standard two-speed switch. An ohmmeter must be used to test switch used with the interval wiper system.

To detect marginal operation of the switch, rotate or slide the switch control knob while each reading is being taken.

If the switch does not exhibit continuity, or if poor continuity exists in any switch position, replace the switch.

Windshield Wiper Interval Governor Test

If interval operation is unsatisfactory, first check the motor current draw. Then check the control switch and all connecting wires for continuity. If the motor, switch and connecting wires are OK, replace the electronic governor.

DIAGNOSIS GUIDES

Refer to the Diagnosis Guide to isolate problems in the windshield wiper system.

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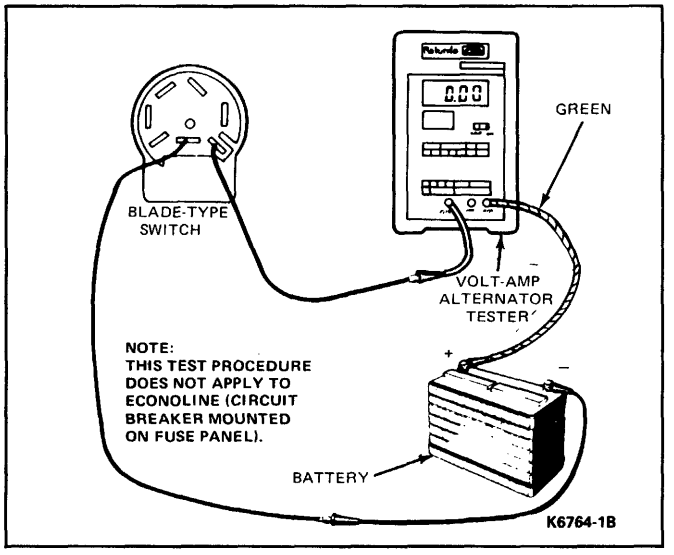
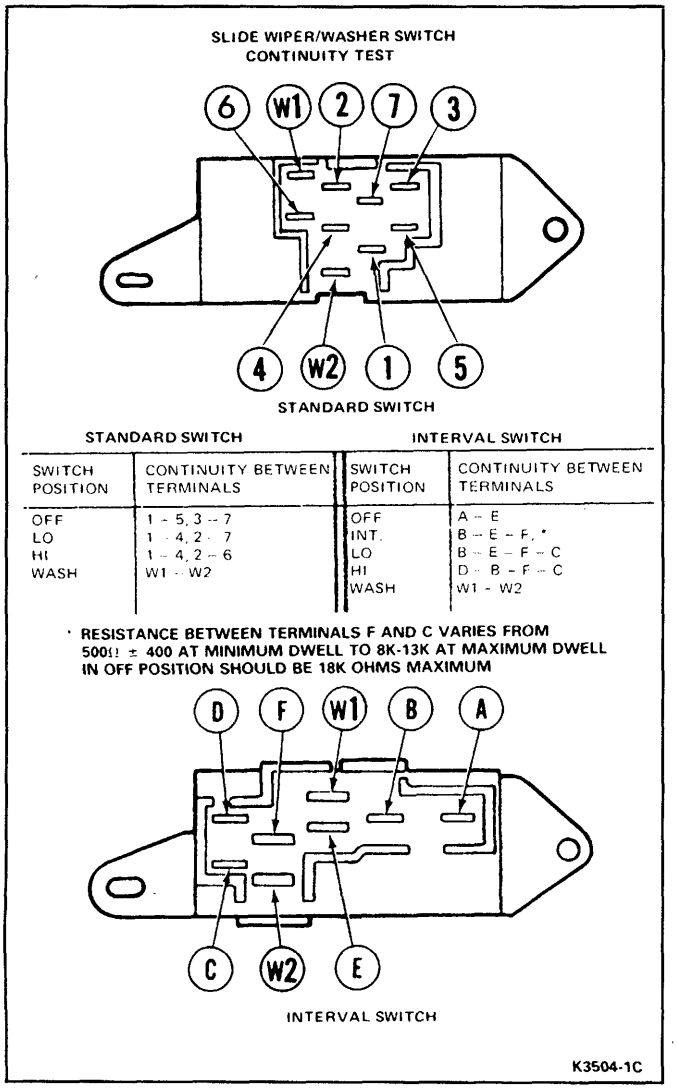


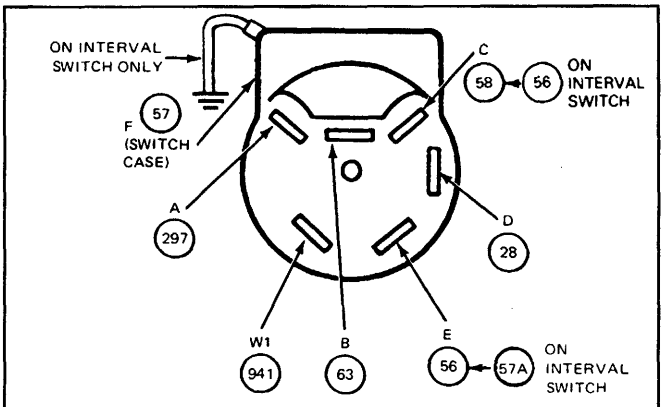
FIG. 8 Circuit Breaker Test



STANDARD SWITCH		INTERVAL SWITCH	
SWITCH POSITION	CONTINUITY BETWEEN TERMINALS	SWITCH POSITION	CONTINUITY BETWEEN TERMINALS
OFF	1 - 5, 3 - 7	OFF	A - E
LO	1 - 4, 2 - 7	INT.	B - E - F, *
HI	1 - 4, 2 - 6	LO	B - E - F - C
WASH	W1 - W2	HI	D - B - F - C
		WASH	W1 - W2

* RESISTANCE BETWEEN TERMINALS F AND C VARIES FROM 500Ω ± 400 AT MINIMUM DWELL TO 8K-13K AT MAXIMUM DWELL IN OFF POSITION SHOULD BE 18K OHMS MAXIMUM

FIG. 9 Wiper Switch Continuity Test—E-150—E-350



INTERVAL SWITCH		2-SPEED SWITCH	
SWITCH POSITION	CONTINUITY BETWEEN TERMINALS	SWITCH POSITION	CONTINUITY BETWEEN TERMINALS
OFF (PARK)	A – B D – E	OFF (PARK)	C – D A – B
LOW	A – B D – E – F	LOW	A – B – C
HIGH	D – E – F A – B – C	HIGH	A – B – E
INTERVAL	A-B, E-F	WASH	A-B-W1
	VARIABLE RESISTANCE BETWEEN D – E 200-1000 OHMS MAX. 5600 – 8400 ohms		
WASH	A-B-W1		

K3025-1D

FIG. 10 Wiper Switch Continuity Test—Bronco and F-150—F-350

ADJUSTMENTS

Arm and Blade Assembly

Remove the arm and blade assemblies from the pivot shafts. Turn on the wiper switch to allow the motor to move the pivot shafts three or four cycles, and then turn off the wiper switch. This will place the pivot shafts in PARK position.

Install the arm and blade assemblies on the pivot shafts to Dimension X as shown in Fig. 11. Dimension X is the distance between the centerline of the blade saddle and the windshield lower moulding or weatherstrip. The value of Dimension X for each vehicle is given in Fig. 11.

REMOVAL AND INSTALLATION

Wiper Motor

F-150—F-350 and Bronco

NOTE: The wiper motor is not serviceable. It must be replaced as a complete assembly.

Removal

1. Disconnect the battery ground cable.
2. Remove both wiper arm and blade assemblies (Fig. 12).
3. Remove the cowl grille attaching screws and lift the cowl grille slightly.
4. Disconnect the washer nozzle hose and remove the cowl grille assembly.
5. Remove the wiper linkage clip from the motor output arm.

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6. Disconnect the wiper motor wiring connector.
7. Remove the wiper motor's three attaching screws and remove the motor.

Installation

1. Install the motor and attach the three attaching screws (Fig. 12). Tighten to 6.7-9.5 N·m (60-83 in-lb).
2. Connect wiper motor wiring connector.
3. Install wiper linkage clip to the motor output arm.
4. Connect the washer nozzle hose and install the cowl assembly and attaching screws.
5. Install both wiper arm assemblies as outlined.
6. Connect battery ground cable.

E-150—E-350

Removal

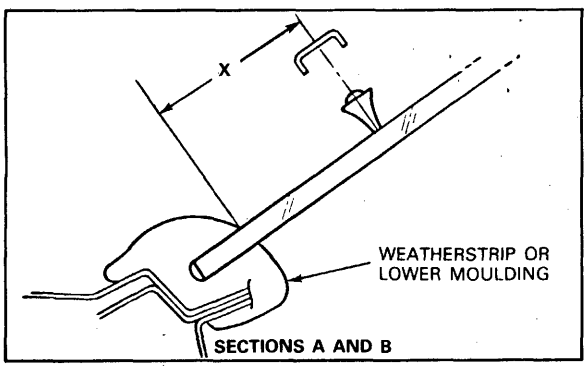
1. Disconnect the battery ground cable. Remove the fuse panel and bracket assembly.
2. Disconnect wiper motor wiring at the motor brush cap and gear box cover (Fig. 13).
3. Remove the wiper arm and blade assemblies from the pivot shaft.
4. Remove the outer air inlet cowl. Remove the clip retaining the motor drive arm to the linkage mounting arm and pivot shaft assembly (Fig. 13).
5. Remove the wiper motor attaching bolts and remove the motor.

Diagnosis Guides

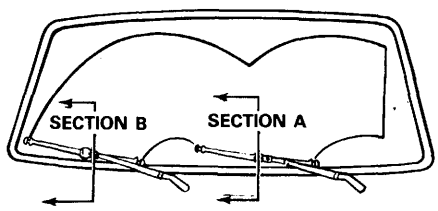
WINDSHIELD WIPERS DO NOT PARK

TEST STEP		RESULT ▶	ACTION TO TAKE
1.0	DURING OPERATION WHEN WINDSHIELD WIPERS ARE TURNED OFF WIPERS DO NOT PARK		
1.1	PERFORM MOTOR PARKING SWITCH TEST		
	• Perform motor parking switch test (as described in this section).	Parking switch test (OK) ▶	REMOVE wiper motor from the vehicle and repair parking switch as required.
		Parking switch test OK ▶	GO to **1.2**.
1.2	CHECK CONTINUITY OF WIPER SWITCH		
	• Perform wiper switch continuity test (as described in this section).	Continuity test (OK) ▶	REPLACE wiper switch.
		Continuity test OK ▶	GO to **1.3**.
1.3	CHECK WIRING		
	• Check wiring between the wiper switch and the motor.	Wiring damaged ▶	REPAIR wiring as required.
		Wiring OK ▶	For interval wiper systems, substitute known good interval windshield wiper governor.

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Vehicle	View	Dimension X in MM (Inches)	
		Ⓐ Driver's Side	Passenger Side Ⓑ
E-150—E-350	1	70-107 (2.75-4.25)	83-120 (3.25-4.75)
F-SERIES, Bronco	1	48-80 (1.90-3.10)	44-76 (1.70-3.0)



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FIG. 11 Wiper Arm and Blade Adjustment to Dimension "X"

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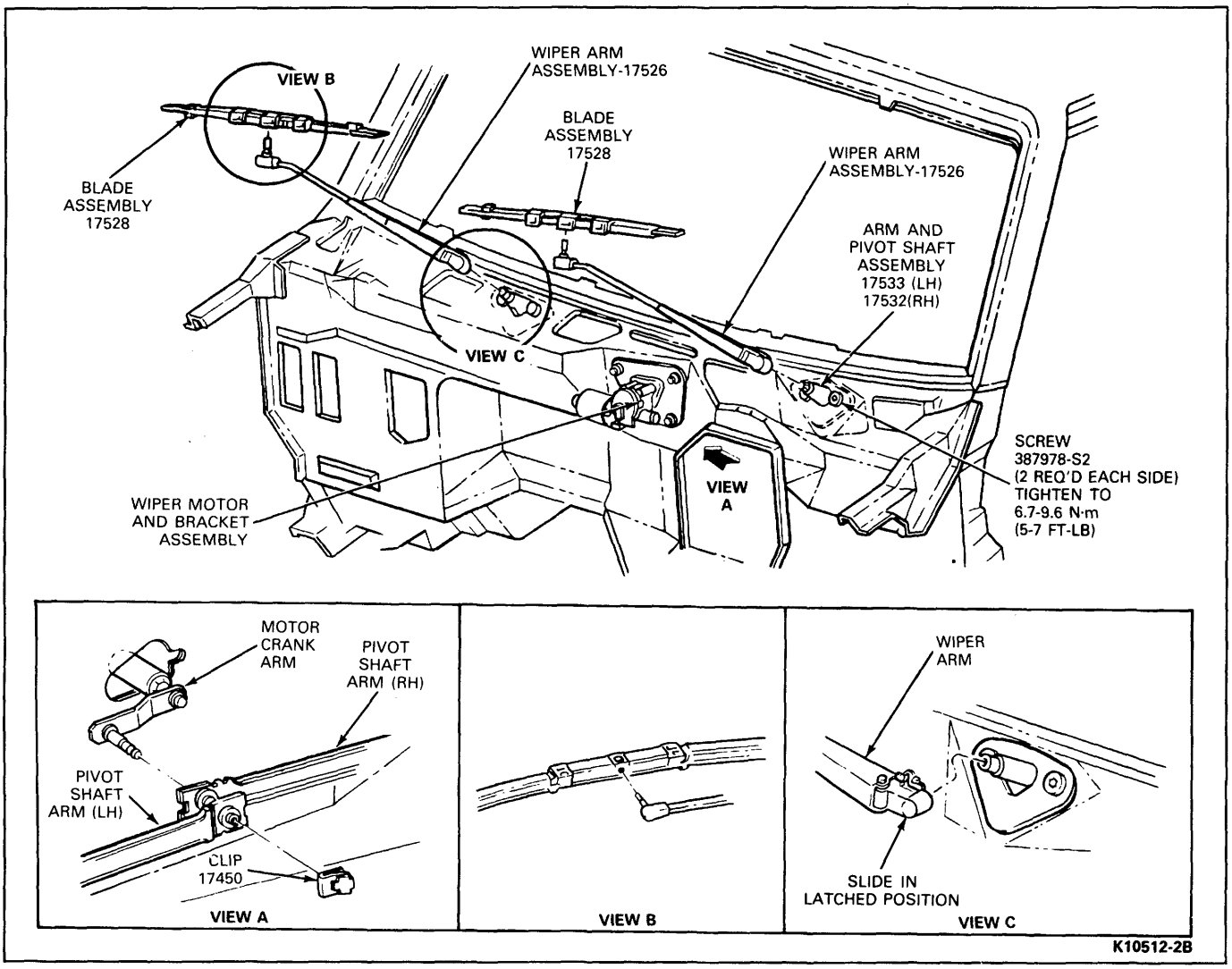


FIG. 12 Windshield Wiper Motor Installation—F-150—F-350 and Bronco

Installation

1. Check the new motor to ensure it is in the PARK position.
2. Install the motor to the inner dash panel. Tighten the attaching bolts 6.7-9.5 N·m (60-85 in-lb).
3. Install the wiper arm and blade assemblies on the pivot shaft as outlined.
4. Connect the linkage mounting arm and pivot shaft assembly to the motor drive arm and install the retaining clip.
5. Install the outer air inlet cowl.
6. Connect the body harness wire plug to the motor (two places). Connect the ground cable to the battery. Install the fuse panel and bracket. Check operation of the wipers.

Wiper Control Switch

NOTE: The switch handle is an integral part of the switch and cannot be removed separately.

F-150—F-350 and Bronco

Removal

1. Disconnect the battery ground cable.
2. Remove the wiper switch knob, bezel nut, and bezel (Fig. 14).
3. Pull out the switch from under the instrument panel. Disconnect the electrical connector from the switch and remove the switch.

Installation

1. Position the switch and connect the electrical connector.
2. Position the switch in the instrument panel and install the bezel, bezel nut, and knob.
3. Connect the battery ground cable and check the operation of the switch

E-150—E-350

Removal

1. Disconnect the battery ground cable.
2. Remove the windshield wiper switch knob.
3. Remove the ignition switch bezel (Fig. 15).
4. Remove the headlamp switch knob and shaft by pulling the switch to headlamp ON position. Then, depress button on top of switch and pull knob and shaft out of headlamp switch.

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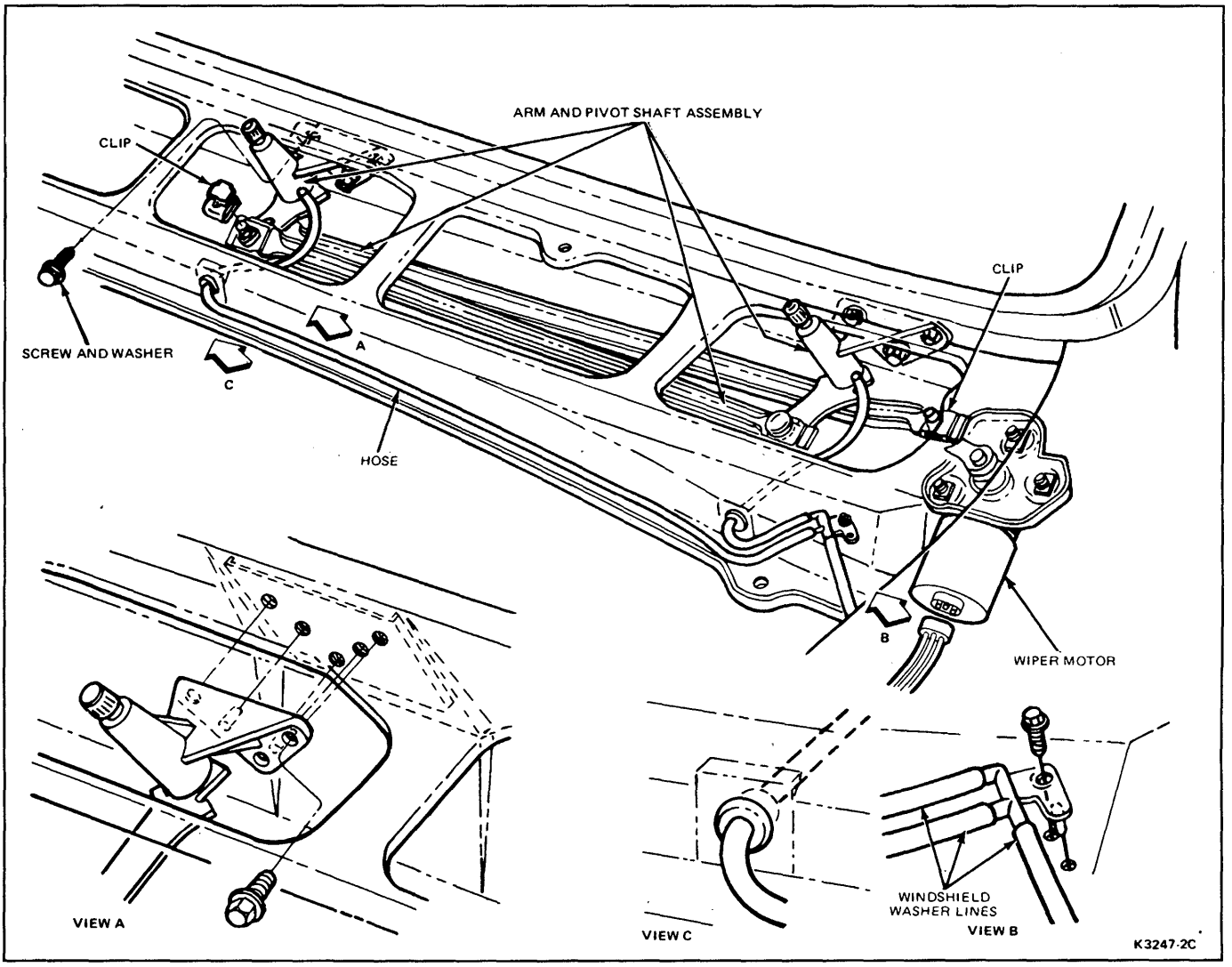


FIG. 13 Windshield Wiper Motor, Linkage, and Pivot Shaft Installation—E-150—E-350

5. Remove two screws at bottom of finish panel. Then, carefully pry the two upper retainers away from the instrument panel assembly.
6. Disconnect the connector from the wiper switch.
7. Remove the wiper switch attaching screws and remove the switch.

Installation

1. Install the wiper switch to the finish panel (two screws).
2. Install the connector to the wiper switch.
3. Position the ignition switch to the finish panel and install the retaining bezel.
4. Position the headlamp switch to the finish panel, install the retaining bezel and snap in the headlamp shaft and knob. Install the wiper switch knob.
5. Position the finish panel to the instrument panel and snap in the upper retaining clips.
6. Install two bottom finish panel retaining screws.
7. Install the battery ground cable. Check operation of the wipers.

Interval Governor

F-150 Through F-350, Bronco and E-150—E-350

Removal and Installation

1. Disconnect the electrical connectors from the governor.
2. Remove the two governor attaching screws (Fig. 16), and remove the governor. On F-150—F-350 and Bronco units equipped with electric rear window, remove the rear window switch assembly to obtain tool clearance to governor RH attaching screw.
3. Position the governor to the instrument panel flange, and install the two attaching screws.
4. Connect the electrical connectors. Check operation of the wiper system.

Arm and Blade Assembly-To-Pivot Shaft

Removal and Installation

Raise the blade end of the arm off of the windshield and move the slide latch (Fig. 17) away from the pivot shaft. This will unlock the wiper arm from the pivot shaft and hold the blade end of the arm off of the glass at the same time. The wiper arm can now be pulled off of the

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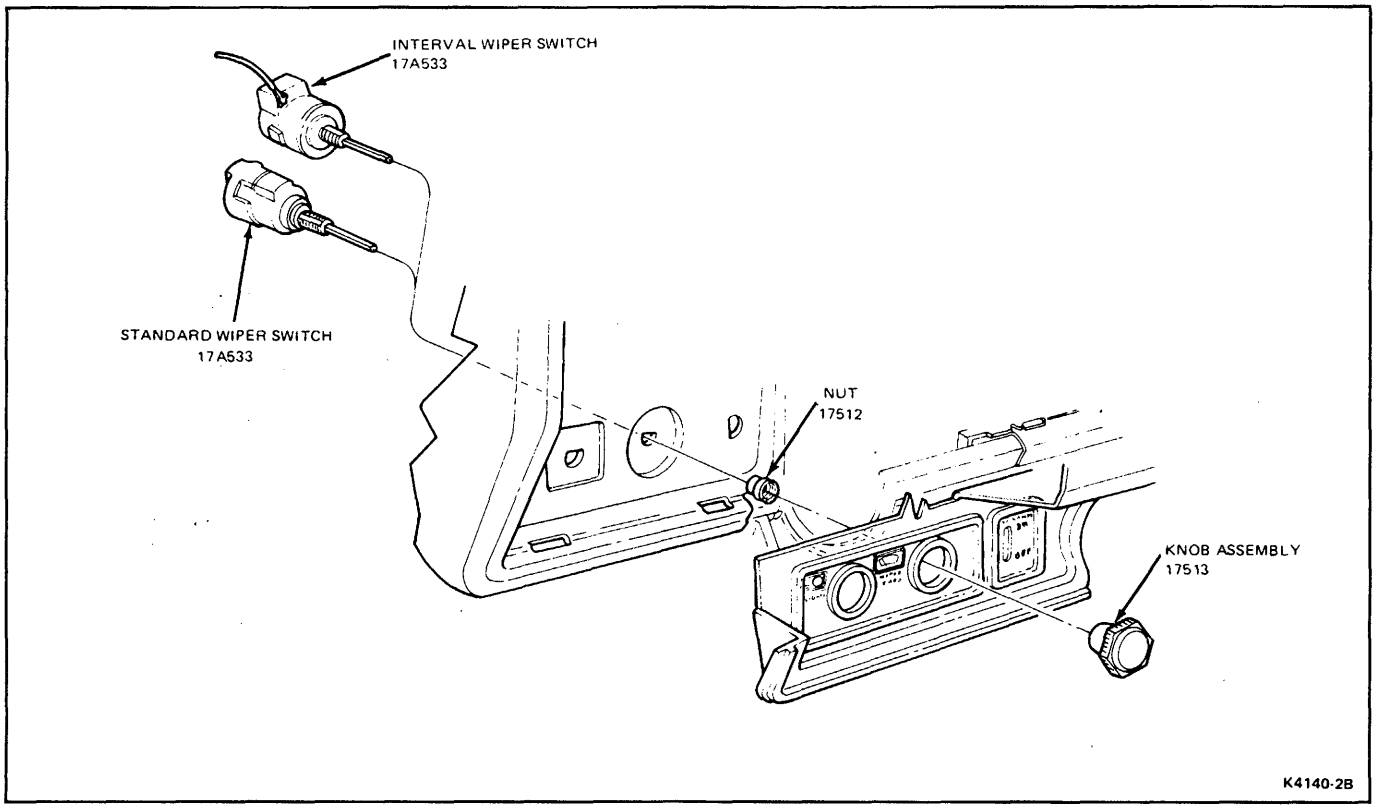


FIG. 14 Wiper Control Switch—F-150—F-350 and Bronco

pivot shaft without the aid of any tools. (Disconnect the washer hose at the wiper arm head on E-150—E-350 only.)

To install, connect the washer hose at the wiper arm head (E-150—E-350 only) and push the main arm head over the pivot shaft. Be sure that the pivot shaft is in PARK position as outlined, and that the blade assembly is correctly positioned (Fig. 11). Hold the main arm head onto the pivot shaft while raising the blade end of the wiper arm and push the slide latch into the lock under the pivot shaft head. Then, lower the blade to the windshield. If the blade does not touch the windshield, the slide latch is not completely in place.

Rubber Element To Wiper Blade

Removal and Installation

The rubber element in all blades can be replaced.

If the arm or blade assembly is bent or distorted, replace the complete blade assembly. Refer to Figs. 18 and 19 for procedures.

Pivot Shaft and Linkage

E-150—E-350

Removal

1. Disconnect the battery ground cable.
2. Remove the wiper blade and arm assembly from the pivot shaft and disconnect the washer hose (Fig. 13).
3. Remove the cowl grille.
4. Remove the clip securing the LH and RH linkage. Remove the clip from the wiper motor arm (Fig. 13).

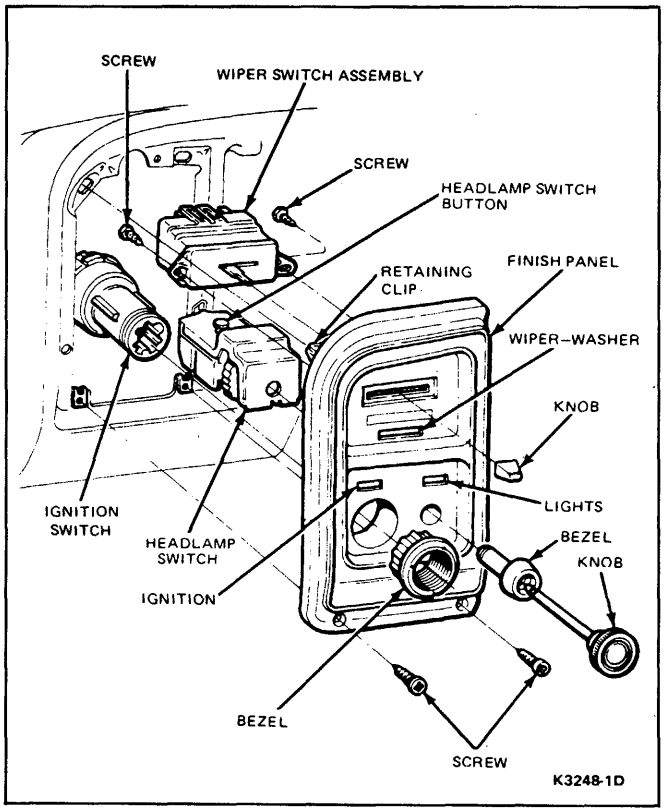


FIG. 15 Windshield Wiper Control Switch Installation—E-150—E-350

5. Remove three pivot body-to-cowl panel screws and remove the arm and pivot shaft assembly.

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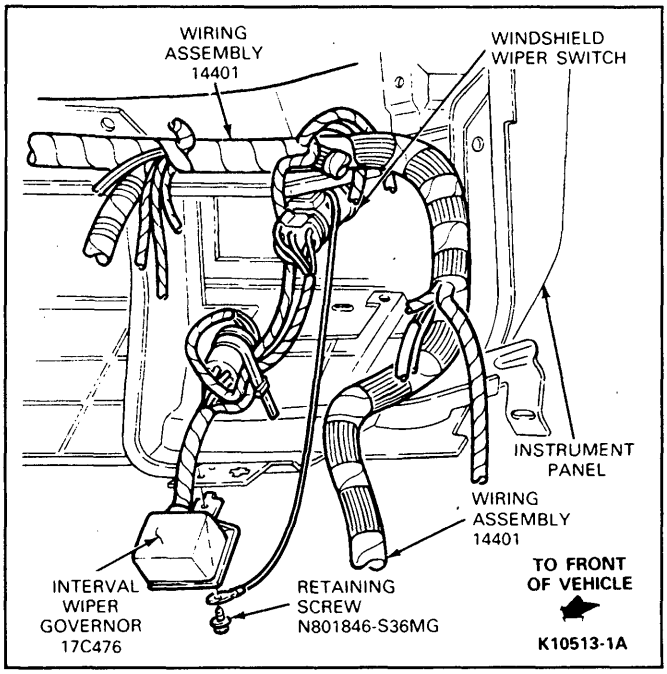


FIG. 16 Windshield Wiper Interval Governor—Typical

Installation

1. Position the arm and pivot shaft assembly to the cowl panel and install the three attaching screws.
2. Install the clip to the LH and RH linkage and the clip linkage to motor arm (Fig. 13).
3. Install the cowl grille and washer hoses to the wiper blade and arm. Install the wiper blade and arm assembly as outlined.
4. Connect the battery ground cable and check the operation and adjustment of the wipers.

F-150—F-350 and Bronco

Refer to Fig. 19.

Removal

1. Disconnect the battery ground cable.
2. Remove both wiper arm assemblies.
3. Remove the cowl grille attaching screws and lift the cowl grille slightly.
4. Disconnect the washer nozzle hose and remove the cowl grille assembly.
5. Remove the wiper linkage clip from the motor output arm and pull the linkage from the output arm (Fig. 18).
6. Remove the pivot body-to-cowl screws and remove the linkage and pivot shaft assembly (three screws on each side). The LH and RH pivots and linkage are independent and can be serviced separately.

Installation

1. Attach the linkage and pivot shaft assembly to cowl with attaching screws.
2. Replace the linkage to the output arm and attach the linkage clip.
3. Connect the washer nozzle hose and cowl grille assembly.
4. Attach cowl grille attaching screws.
5. Replace both wiper arm assemblies as outlined.
6. Connect battery ground cable.

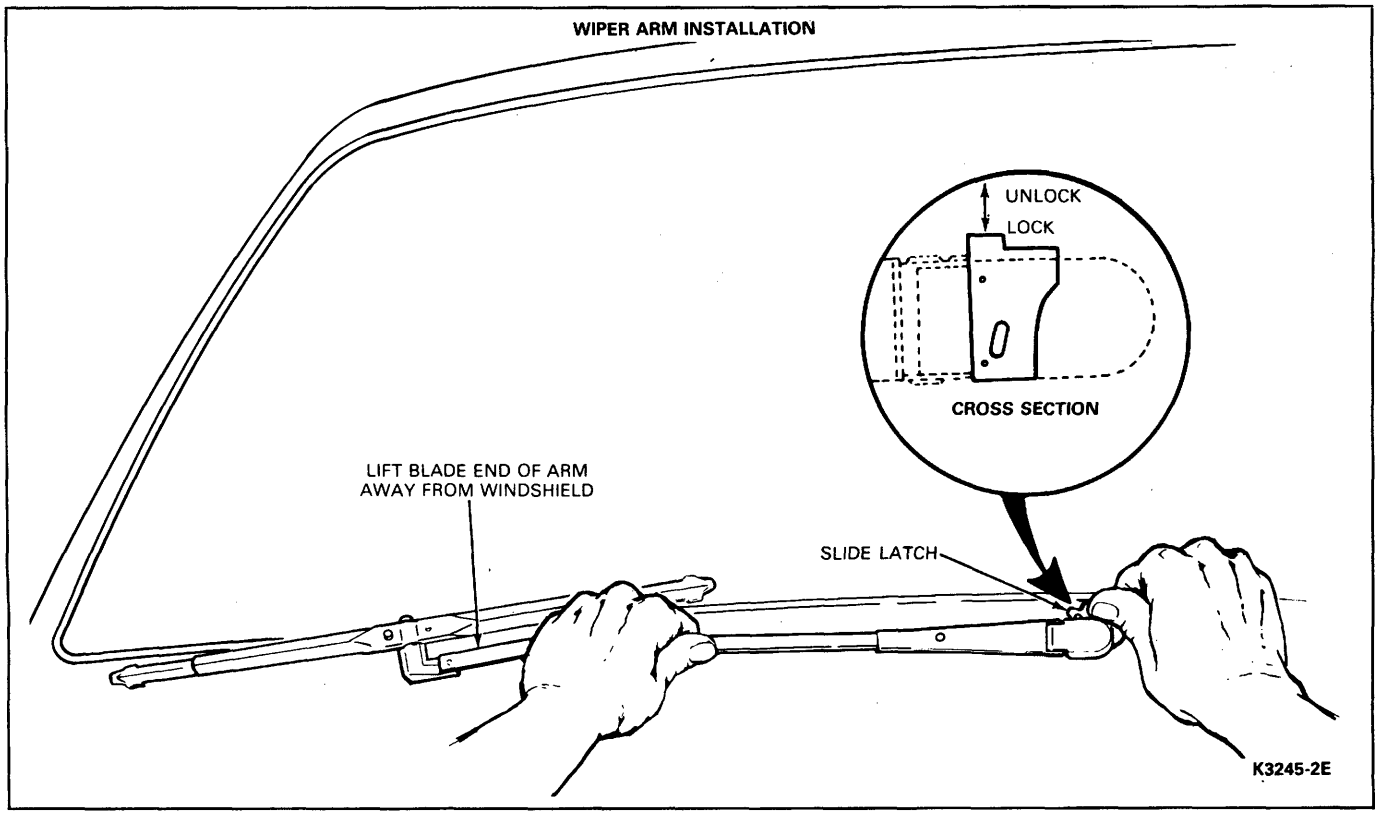


FIG. 17 Wiper Arm Installation—E-150—E-350, F-150—F-350 and Bronco

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DISASSEMBLY AND ASSEMBLY

The wiper motor service parts (except wiper system "E" motor) for F-150—F-350, Bronco and E-150—E-350 are only available in kits of the major subassemblies. The following Removal and Installation procedures apply to the kits.

Cover and Switch Assembly

E-150—E-350

NOTE: The E-150—E-350 switch assembly is identified by the letter "U" stamped on the outside surface with ink.

Remove the four cover retaining screws to remove the assembly. Replace with the appropriate kit. Be sure to assemble the ground strap under the cover screw. On all except E-150—E-350, use the new screws supplied with the kit. Tighten to 1.69-2.82 N·m (15-25 in-lb).

Brush End Plate

E-150—E-350

Carefully observe the original position of the bail retainer and pry it off with a screwdriver. Remove the end plate and plug. Replace it with the appropriate kit (Fig. 20).

NOTE: The E-150—E-350 switch assembly is identified by the letter "U" stamped on the outside surface with ink.

When installing the end plate, use a fine-wire probe through the hub opening to position the brushes on the commutator. Rotate end plate to position the key in the notch and assemble the plug. Install the bail retainer carefully with a screwdriver to avoid overbending.

CLEANING AND INSPECTION

1. Clean all old grease from gear housing. Do not allow any cleaning fluid to contact the armature shaft and output shaft bearings.
2. Wipe all other parts with a clean cloth.

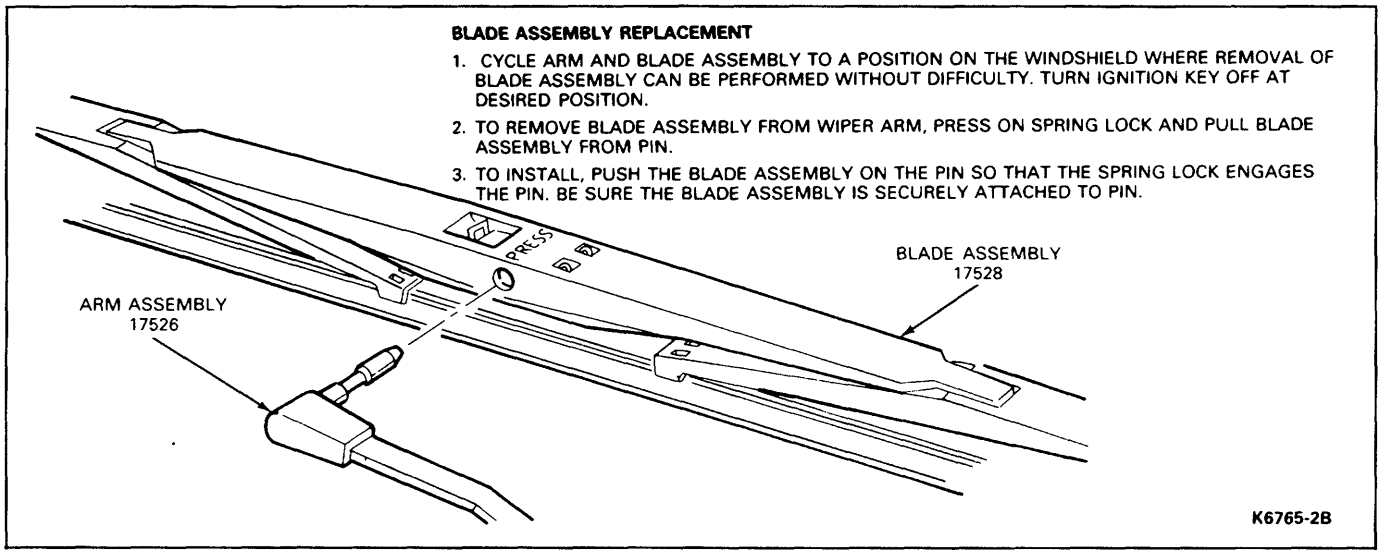


FIG. 18 Tridon Blade and Element Replacement

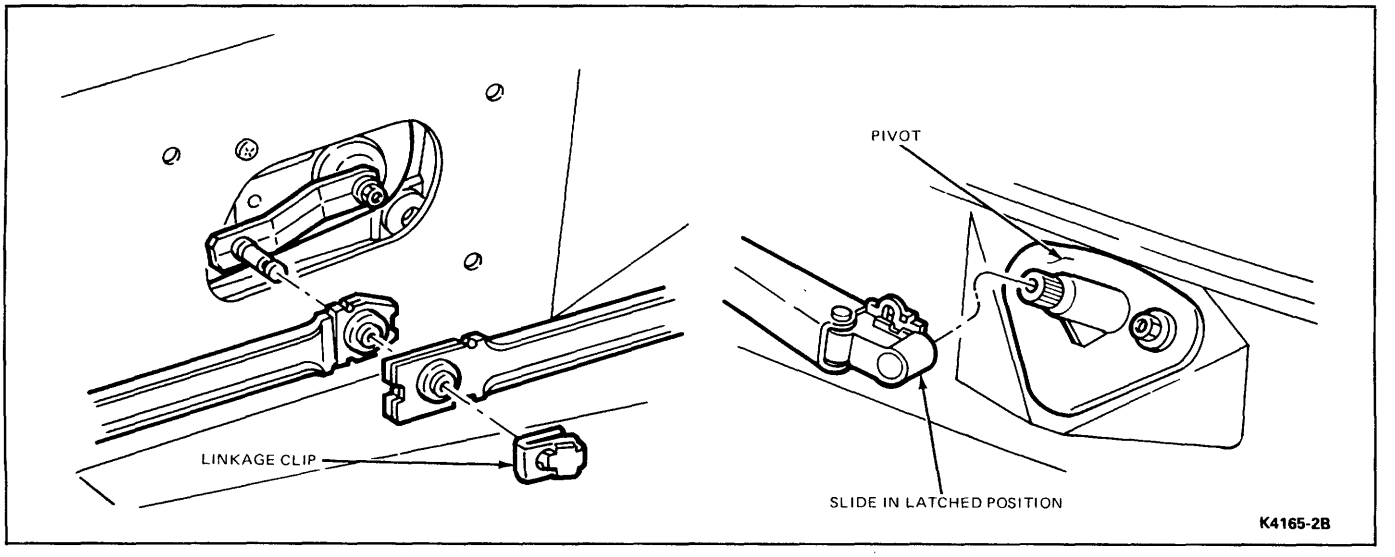


FIG. 19 Linkage and Pivot Shaft Installation—F-150—F-350 and Bronco

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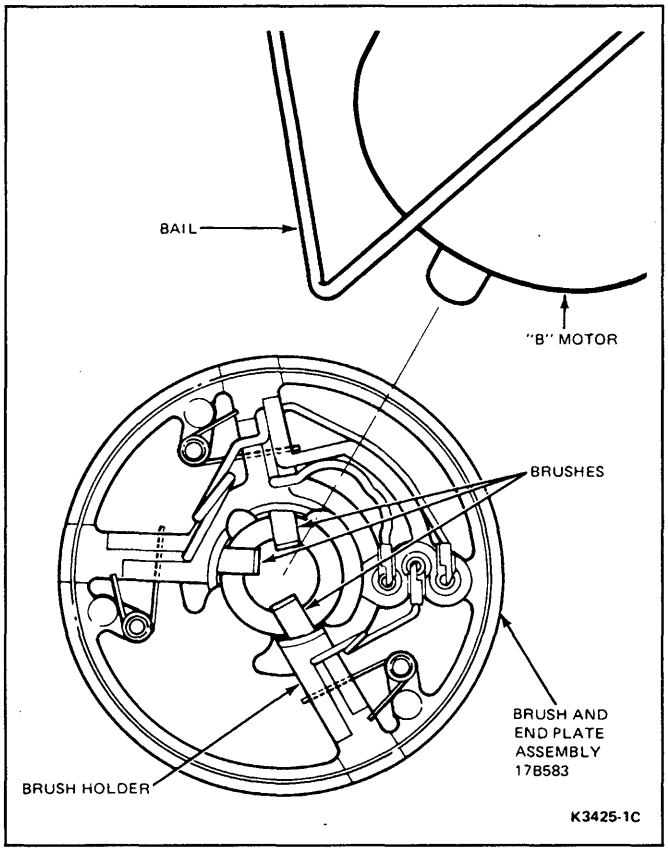


FIG. 20 "B" Motor Brush End Plate Assembly—E-150—E-350

3. Inspect the gear housing for cracks or distortion. Replace a cracked or distorted housing.

4. Check all shafts, bushings, and gears for scored surfaces. Replace damaged parts, and add new ESF-MIC149-A grease or equivalent to the housing and gears.

MAINTENANCE

Windshield Wiper Blades

If the windshield wiper blade assembly is equipped with a yellow or orange plastic sleeve, it is to be removed just prior to delivery of the vehicle to the customer.

To maintain maximum wiper effectiveness after the sleeves are removed, the windshield and wiper blades must be kept clean. Foreign matter on the windshield or wiper blades may cause streaking or chattering or smearing. If blades do not clean properly, with a clean towel, wash the wiper blades and complete windshield area with undiluted Ford Ultra-Clear Windshield Washer Concentrate C9AZ-19550-A or B or equivalent. Wash thoroughly and repetitively until all the foreign matter and contamination is removed. Rinse with water while rubbing with a clean cloth. Lift the blades off the windshield to clean them. For access to hidden blades, turn ignition to ACC position with the wipers on. When wiper blades are approximately vertical, turn ignition off.

If streaking, chattering or smearing persists, repeat the above procedure.

CAUTION: Do not allow wiper blade rubber elements to come in contact with oil, gasoline, kerosene, paint thinner or similar solvents. The elements are damaged by these solvents and must be replaced.

Windshield Wiper Blade Replacement

Wiper blade replacement intervals will vary with the amount of use, type of weather, chemical reaction from road tars or salts and the age of the blades. Be sure that the windshield glass surface is not contaminated with oil, tree sap or other substance which cannot be easily rubbed off.

Generally, if the wiper pattern across the glass is uneven and streaks over clean glass, the blades should be cleaned.

If cracks or breaks are found in the rubber, replace wiper blade, as outlined in this Section.

SPECIFICATIONS

ELECTRIC WINDSHIELD WIPER MOTOR AND SWITCH TEST CURRENT LIMITS

Motor Type	Motor Current* Draw Test	Circuit Breaker/Switch Low Current Pass Test	Circuit Breaker/Switch High Current Pass Test
System "E" — F-Series	3.5 amperes	7 amperes	14 amperes
System "B" — E-Series	3.5 amperes	7.5 amperes	15 amperes

*Motor maximum current when operated without linkage attached.

CK2501-2M

ROTUNDA EQUIPMENT

Number	Description
007-00001	Digital Volt Ohmmeter
059-00003	Electronic Ignition Components Analyzer

CK8982-1A

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SECTION 35-70 Windshield Washers

SUBJECT	PAGE
ADJUSTMENTS	
Washer Nozzle	35-70-3
E-150—E-350	35-70-3
F-150—F-350 and Bronco	35-70-3
DESCRIPTION AND OPERATION	
Washer System—Electric	35-70-1
DIAGNOSIS AND TESTING	
Washer Pump Current Draw Test	35-70-1
Washer Switch	35-70-1
Washer System	35-70-1
DIAGNOSIS GUIDES	35-70-2
REMOVAL AND INSTALLATION	
Jets	35-70-4
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F-150—F-350 and Bronco	35-70-4
Motor, Seal and Impeller Assembly	35-70-3
Windshield Washer Reservoir And Motor Assembly	35-70-3
SPECIAL SERVICE TOOLS	35-70-4
VEHICLE APPLICATION	35-70-1

VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

Washer System—Electric

The electric windshield washer system consists of an instrument panel control switch, integral with the wiper control switch, reservoir and motor assembly, and the necessary hoses, nozzles and attaching parts.

DIAGNOSIS AND TESTING

Washer Pump Current Draw Test

Attach the leads of the Digital Volt-Ohmmeter 007-00001 as shown in Fig. 1. The current draw should not exceed four amps nor be less than 1.7 amps while the washer pump is pumping fluid.

Washer Switch

The windshield washer switch is an integral part of the windshield wiper switch. Refer to Section 35-60, Windshield Wipers for windshield wiper/washer switch testing.

Washer System

Refer to the Diagnosis Guide to isolate problems in the windshield washer system.

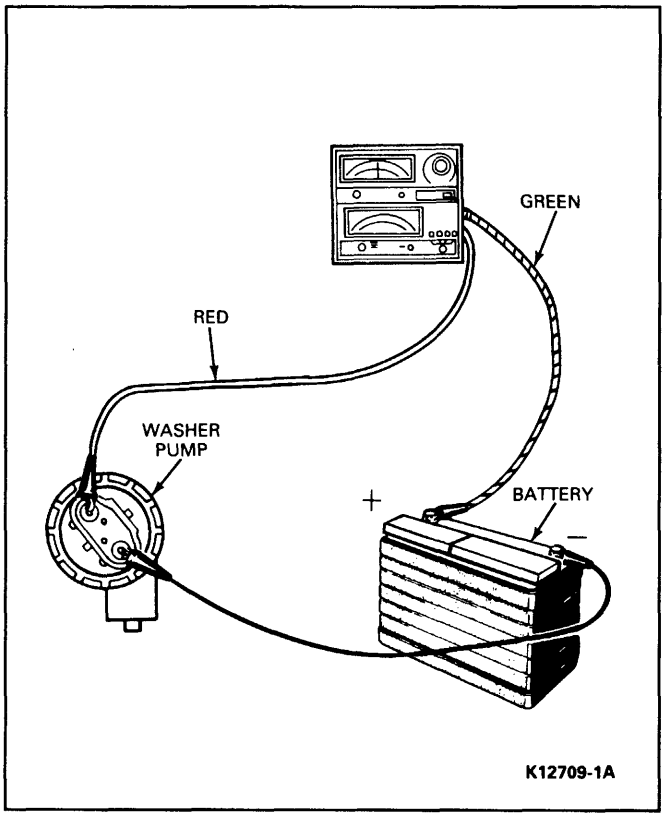


FIG. 1 Washer Pump Current Draw Test

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DIAGNOSIS GUIDES

Use the following guides to isolate problems in the windshield washer system:

WINDSHIELD WASHER DOES NOT WORK

TEST STEP		RESULT	ACTION TO TAKE
1.0	DURING OPERATION WINDSHIELD WASHER DOES NOT WORK		
1.1	CHECK FLUID LEVEL		
	• Check fluid level of washer.	No fluid ▶	FILL washer reservoir and CHECK operation of washers.
		Fluid level (OK) ▶	GO to **1.2.**
1.2	CHECK WIPER OPERATION		
	• Check operation of windshield wiper.	Wipers do not work ▶	GO to **1.3.**
		Wipers do work ▶	GO to **1.4.**
1.3	CHECK HEATER BLOWER AND RADIO		
	• Check operation of heater blower and radio.	Heater blower and radio do not work ▶	GO to **1.5.**
		Heater blower and radio do work ▶	GO to **1.6.**
1.4	CHECK WASHER JET AND HOSE		
	• Inspect washer jet for blockage. • Inspect washer hose for blockage or kinks.	Blocked jet or blocked or kinked hose ▶	CLEAN or REPLACE washer jet or washer hose.
		(OK) ▶	
1.5	CHECK FOR POWER AT IGNITION SWITCH		
	• At accessory terminal check for power at ignition switch.	No power ▶	REPAIR or REPLACE ignition switch.
		Power OK at switch ▶	GO to **2.1.**
1.6	CHECK POWER AT WIPER-WASHER SWITCH		
	• Check for power to wiper-washer switch.	Power ~~(OK)~~ ▶	REPAIR accessory circuit to wiper-washer switch.
		Power (OK) ▶	GO to **1.7.**
1.7	CHECK FOR POWER AT WASHER PUMP		
	• Using a voltmeter, actuate the washer switch and check for power at washer pump.	No power at pump ▶	GO to **1.8.**
		Power at pump ▶	GO to **1.9.**

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WINDSHIELD WASHER DOES NOT WORK (CONT'D.)

TEST STEP	RESULT	ACTION TO TAKE
1.8 CHECK POWER AT PUMP TERMINAL		
• Check for power at pump terminal of washer switch.	Power (OK) ▶	REPAIR or REPLACE washer switch.
	Power (OK) ▶	REPAIR circuit in wiring or connector to pump.
1.9 CHECK GROUND		
• Check ground at pump connector.	Ground (OK) ▶	REPAIR ground.
	Ground (OK) ▶	GO to **2.0**.
2.0 CHECK PUMP OUTLET		
• Inspect washer pump outlet for blockage.	Blocked ▶	REMOVE and CLEAN washer pump.
	(OK) ▶	REPLACE pump.
2.1 CHECK FOR POWER AT ACCESSORY RELAY		
• Check for power to accessory relay, if so equipped, or check wiring to accessories.	No power to relay or wiring damaged ▶	REPAIR circuit between ignition switch and accessory relay, if so equipped, or repair wiring to accessories.
	Power (OK) ▶	REPLACE accessory relay, if so equipped.

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ADJUSTMENTS

Washer Nozzle

F-150—F-350 and Bronco

The washer housing has two adjustable washer nozzles. Insert a small, open safety pin in either nozzle and move the nozzle to the desired spray position.

E-150—E-350

The washer nozzle on the E-150—E-350 is not adjustable.

REMOVAL AND INSTALLATION

Windshield Washer Reservoir And Motor Assembly

To remove the assembly from the vehicle, disconnect the motor electrical connector (use a small screwdrive to unlock tabs) and hose, remove the retaining screws or nuts and lift the assembly from the fender apron (or radiator support or air cleaner bracket) (Fig. 4). Disconnecting the hose will drain the reservoir. The washer reservoir and cover assembly are not serviced separately. The motor retaining ring, seal and pump impeller assembly are serviced separately. **CAUTION: Do not make electrical connection prior to filling reservoir. Do not operate reservoir pump prior to filling reservoir.**

Motor, Seal and Impeller Assembly

1. Remove reservoir assembly from vehicle. Disconnect electrical plug and hose.
2. Using a small-bladed screwdriver, pry out retaining ring (Fig. 2).
3. Using pliers to grip one wall around the electrical terminals (Fig. 3), pull out the motor, seal and impeller assembly. If the impeller and seal come off when the motor is pulled, they can be reassembled. Make certain the reservoir pump chamber is free of foreign material prior to installing the old assembly in the new reservoir.
4. Before installing the assembly, lubricate the outside diameter of the seal (Fig. 2) with a dry lubricant such as powdered graphite. This will prevent the seal from sticking to the wall of the reservoir motor cavity and make assembly easier.
5. Align small projection on the motor end cap with the slot in the reservoir (Fig. 2) and assemble so that the seal seats against the bottom of the motor cavity.
6. Using a 25.4mm (1-inch) socket (preferably 12 point), hand press retaining ring securely against motor end plate.
7. Connect electrical plug and hose and replace the reservoir assembly in the vehicle.
8. Fill the reservoir and operate the washer system.

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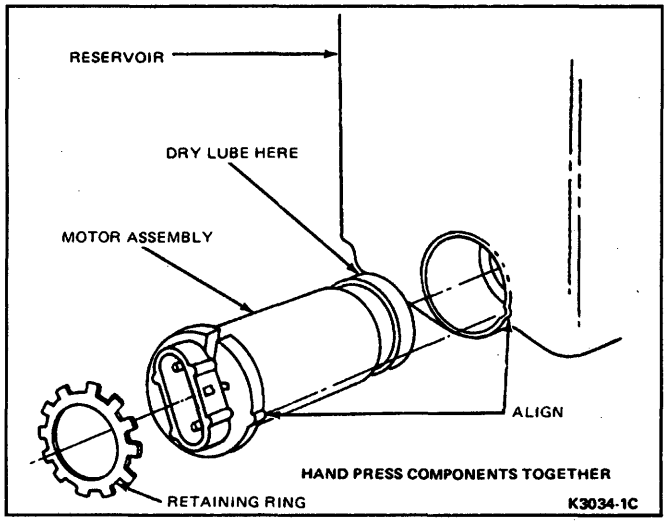


FIG. 2 Windshield Washer Motor Replacement

9. Check for leaks and align the cowl-mounted jets if necessary.

CAUTION: Do not operate pump until fluid is added to the reservoir.

Jets

F-150—F-350 and Bronco

Removal

1. Disconnect the washer nozzle hose using a long-blade screwdriver (Fig. 4).
2. Squeeze the nozzle housing locking tabs and push the nozzle assembly up through the cowl grille.

Installation

Reverse the removal procedure making sure the wiper motor is in PARK and the wiper arm and blade is set to Dimension X, as shown in Section 35-60, Windshield Wipers.

E-150—E-350

Removal and Installation

1. Remove the hose from the upper nozzle and remove the upper arm (Figs. 5 and 6).
2. Remove the nozzle from the wiper arm and disconnect the hose.

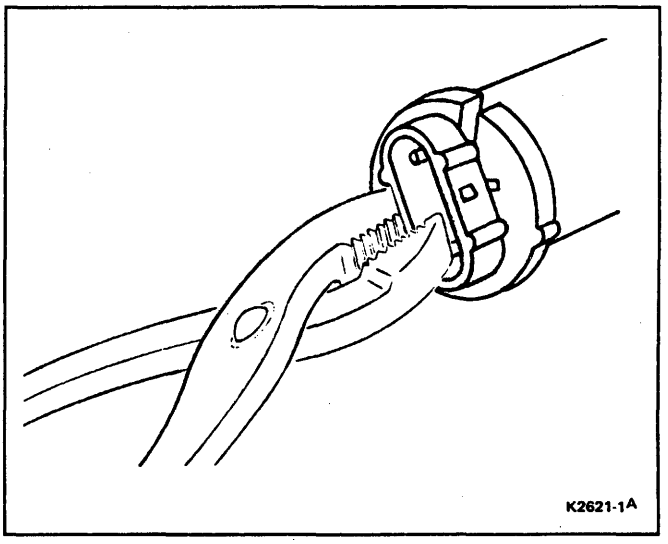


FIG. 3 Disassembling Motor, Seal and Impeller Assembly

3. Remove the windshield washer hose shield by prying the two locking tabs out. Remove the metal and rubber hose assembly.
4. Fish the rubber hose behind the two springs, connect and install the metal hose.
5. Hook the end of the windshield washer hose shield under the lip in the head and pivot into position.
6. Then, lock in position by bending the two locking tabs down.
7. Push the hose onto the nozzle fully and install the nozzle to the arm.
8. Install the wiper arm to the shaft and connect the hose. Refer to Section 35-60 Windshield Wipers-Electric.

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Number	Description
007-00001	Digital Volt-Ohmmeter

CK10195-1A

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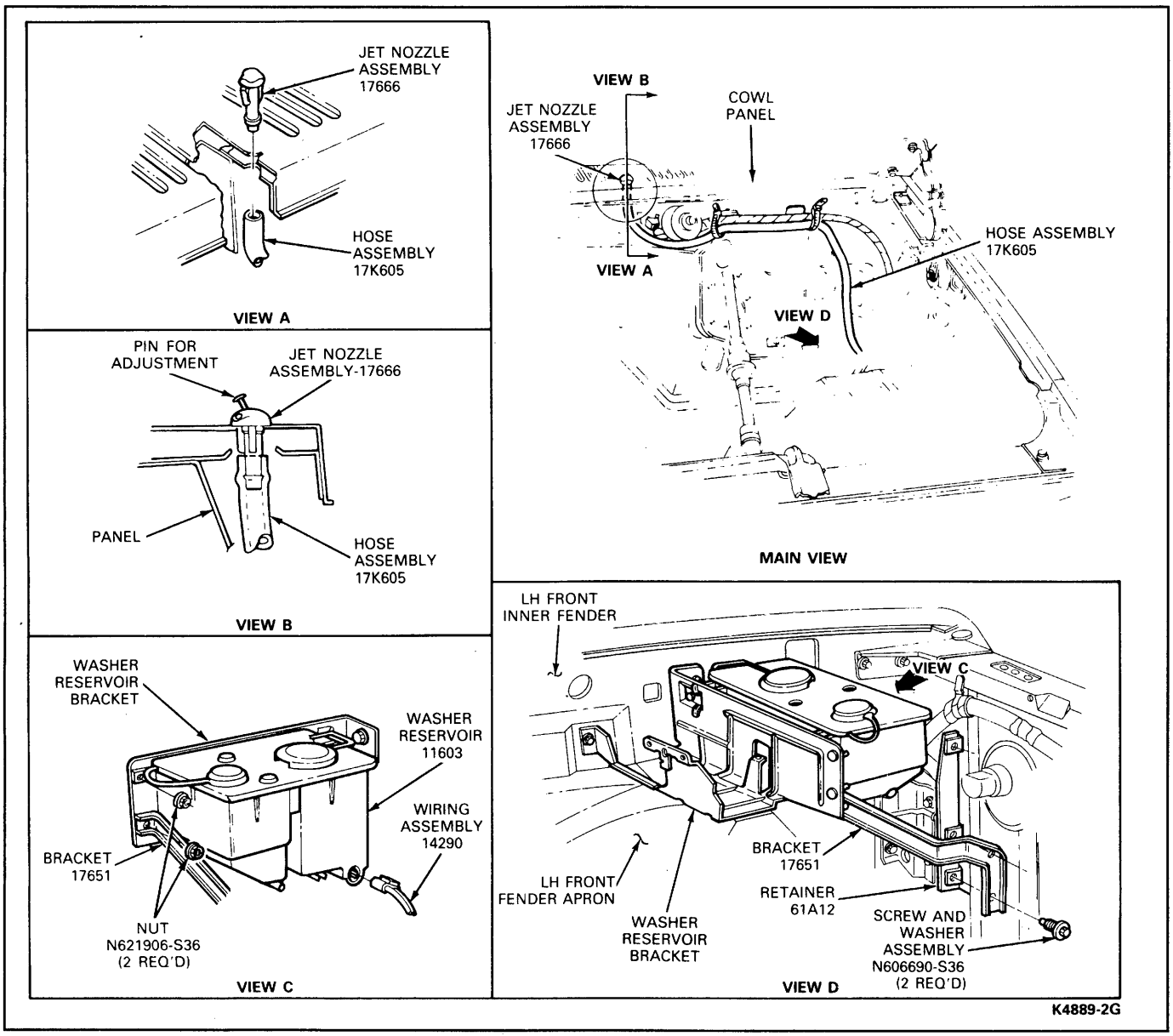


FIG. 4 Washer Pump, Reservoir and Jet Installation—F-150—F-350 and Bronco

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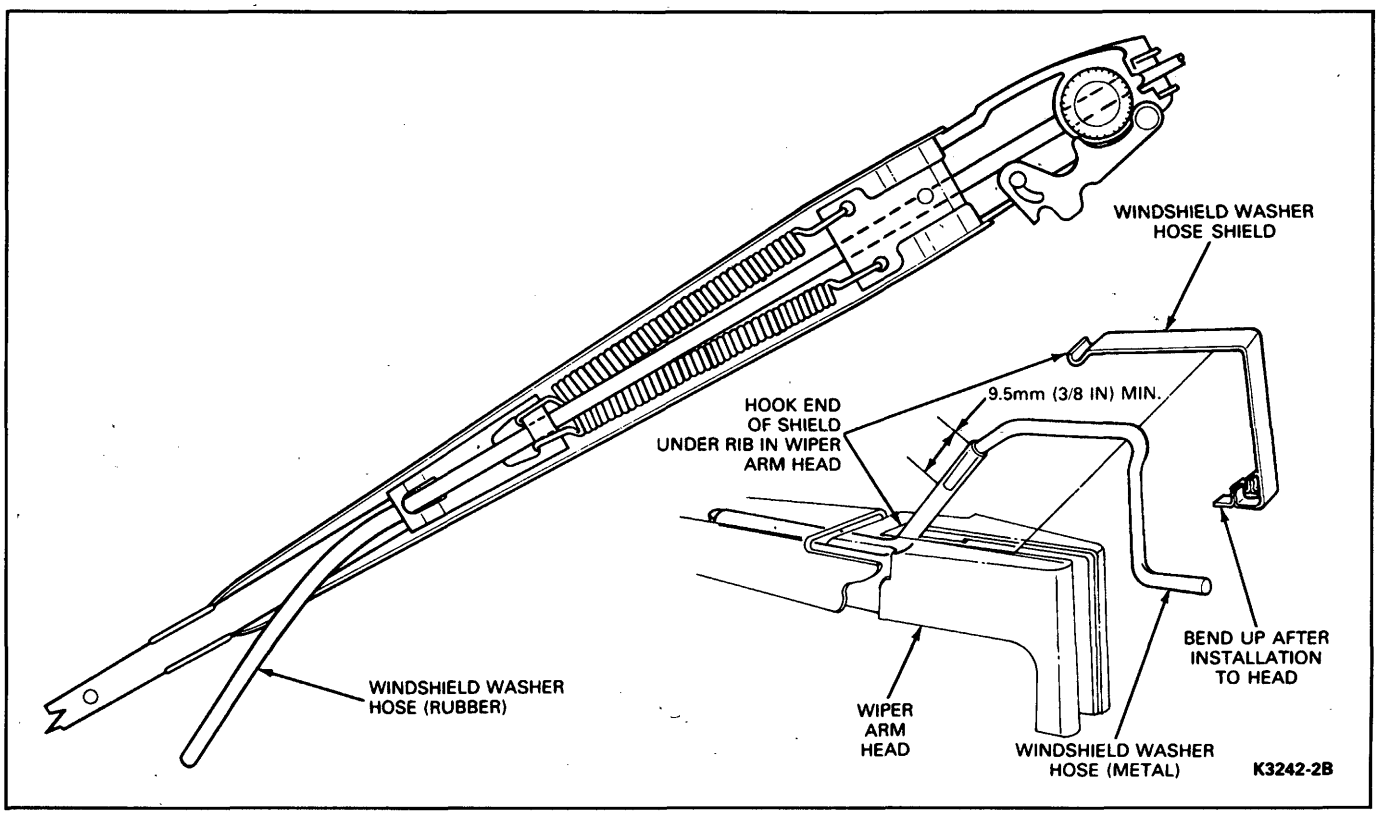


FIG. 5 Windshield Washer Nozzle Installation—E-150—E-350

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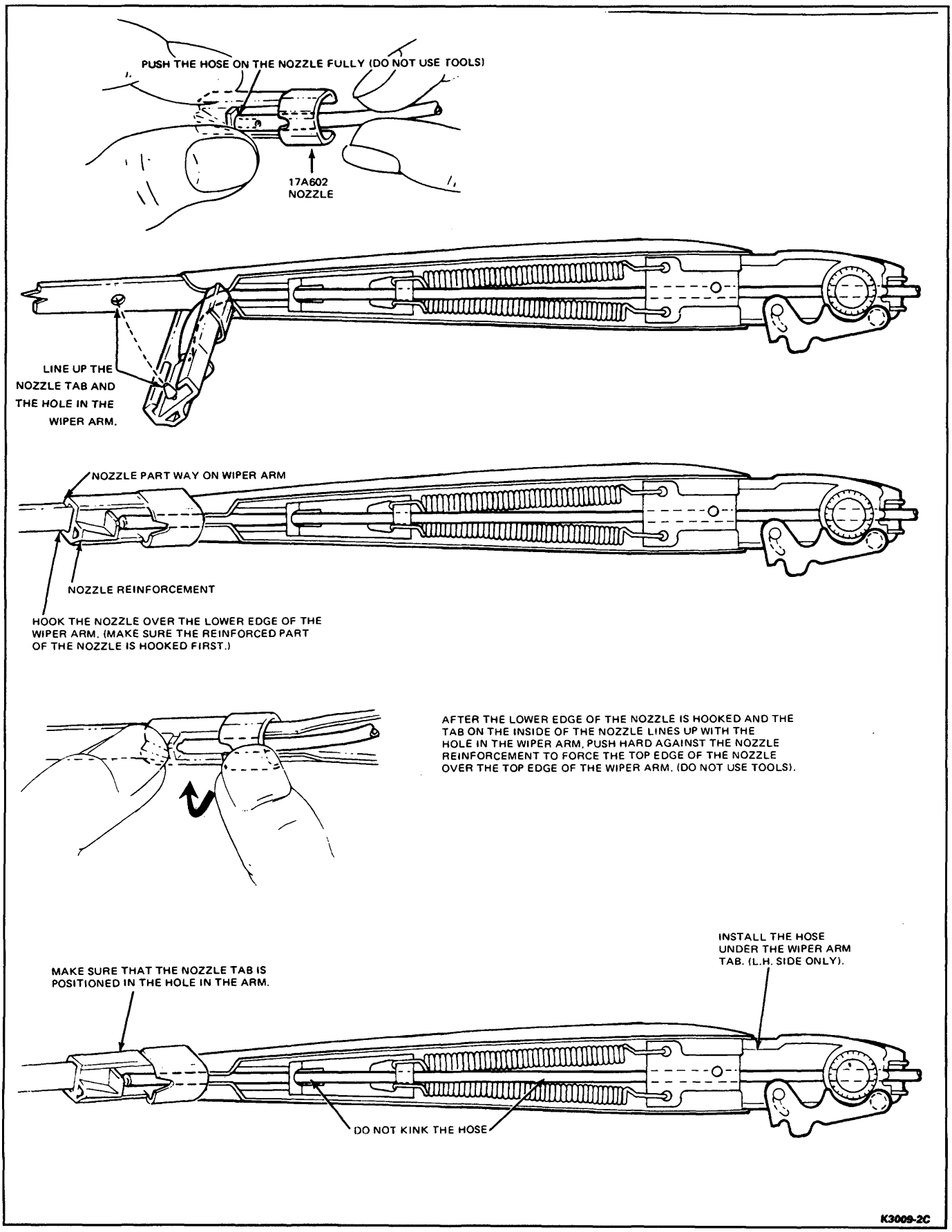


FIG. 6 Windshield Washer Hose Installation—E-150—E-350

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SECTION 35-80 Horns

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Horn Relay	35-80-2
Bronco and F-150—F-350	35-80-2
E-150—E-350	35-80-2

SUBJECT	PAGE
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All Vehicle Lines Circuit Check	35-80-1
With Testing Equipment	35-80-1
Without Test Equipment	35-80-1
VEHICLE APPLICATION	35-80-1

VEHICLE APPLICATION

All Light Truck Models.

DESCRIPTION AND OPERATION

Dual horns are standard on the Bronco, F-150 through F-350, and E-150—E-350. The horn button completes the circuit direct to the horn(s). A horn relay is used on vehicles with speed control.

TESTING

All Vehicle Lines Circuit Check

With Testing Equipment

Verify that the ground connection to the horn is good by checking that the torque on the mounting screw is 17-24 N·m (12-18 ft-lb). Connect a wire from the positive terminal of the battery to the horn. If the horn blows normally, check the horn wiring, if it does not, proceed as follows:

Connect a voltmeter and ammeter to the horn and vehicle battery as shown in Fig. 1. The voltmeter should read battery voltage. If the current reads zero amps, (open circuit), turn the adjusting screw counterclockwise until the meter reads 5.0-5.5 amps. Secure screw by clinching housing extrusions with diagonals or pliers. If the current is greater than 5.5 amps, turn adjusting screw clockwise until the meter reads 5.5 amps. If the horn cannot be adjusted to 5.0-5.5 amps, replace the horn.

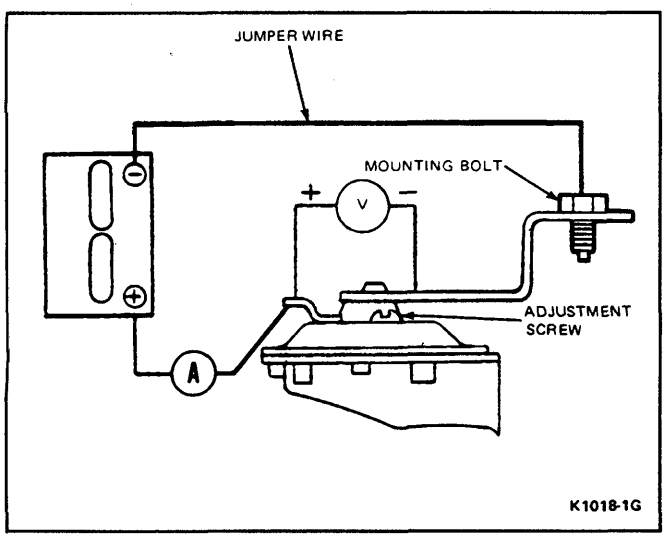


FIG. 1 Horn Current Test—With Test Equipment

Without Test Equipment

Connect a jumper wire from the fastener (bolt) of the horn mounting bracket to the battery ground terminal (Fig. 2). Connect another jumper wire from the horn terminal to the positive (+) terminal of the battery (Fig. 2). If the horn does not sound, and there is no evidence of a spark at the battery terminal, disconnect the jumper wires and turn the adjusting screw counterclockwise 1/4-3/8 turn and secure screw by clinching housing extrusions with diagonals or pliers. If the horn does not sound when the jumper wires are reconnected, replace the horn.

REMOVAL AND INSTALLATION

Electric Horns

Econoline horn assemblies are mounted in the engine compartment. The E-150—E-350 standard low pitch horn is mounted on the LH side of the fender apron reinforcement, next to the battery. The high pitch horn is mounted next to the battery, high on the LH radiator support (Fig. 3).

The Bronco, F-150—F-350 high and low pitch horns are mounted to the LH radiator support (Fig. 3).

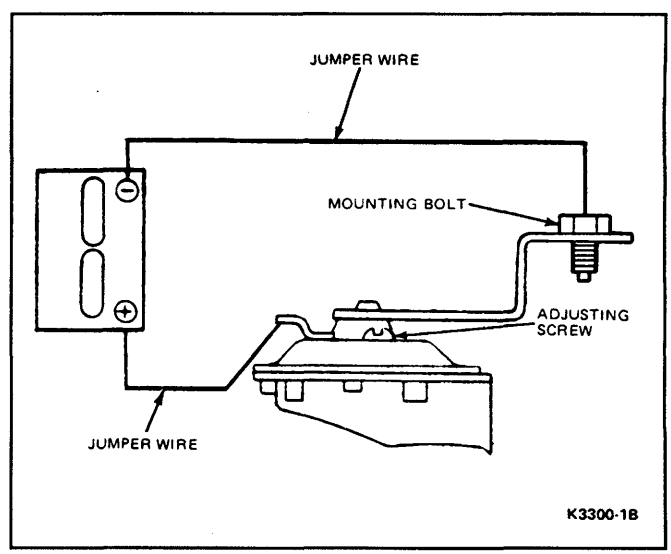


FIG. 2 Horn Current Draw Test—Without Test Equipment

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Disconnect the connector from the horn terminal and remove the mounting bolt. When installing a horn and bracket assembly, tighten the mounting screw to 8-12 N·m (6-9 ft-lb). Install horn wiring connector to horn terminal.

Horn Switch

1. Remove one screw from the underside of each steering wheel spoke, and lift the horn switch assembly (steering wheel pad) from the steering wheel (Fig. 4).
2. Disconnect the horn switch wires by pulling the spade terminal from the blade connector on speed control vehicles only (Fig. 5). Squeeze or pinch the ground wire terminal firmly and pull it out of the hole in the steering wheel. Do not pull the ground terminal out of the threaded hole without squeezing the terminal to relieve retaining spring tension.
3. To install, connect the spade terminals to the blade connector. Press the ground terminal fully into the threaded hole (speed control only) (Fig. 5).
4. Center the horn switch (pad) on the steering wheel. Install the two attaching screws.

Horn Relay

Bronco and F-150—F-350

A horn relay used only on vehicles equipped with speed control. It is located under the instrument panel to the left of the steering column. The relay is mounted on the outboard attaching screw of the speed control amplifier module.

Remove the electrical connector from the horn relay. Remove the retaining screws and remove the relay. Reverse the procedure to install. Test operation of horn(s) after installation of relay.

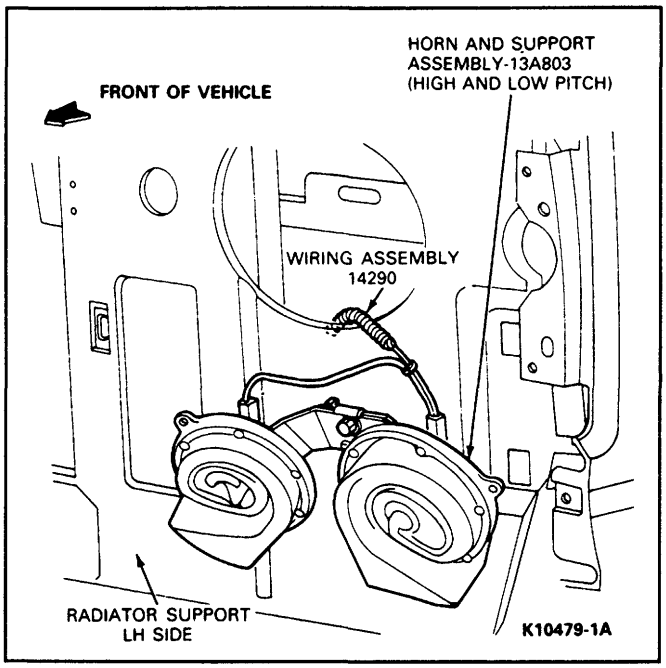


FIG. 3 Horn Installation—F-150—F-350 Bronco

E-150—E-350

The E-150—E-350 horn relay is only used on speed control vehicles. It is located under the instrument panel to the left of the steering column on the fuse panel mounting bracket. To replace the relay, disconnect the electrical connector and remove the retaining screw. Attach the new relay to the instrument panel with the retaining screw. Connect the electrical connector. Test the operation of the horns.

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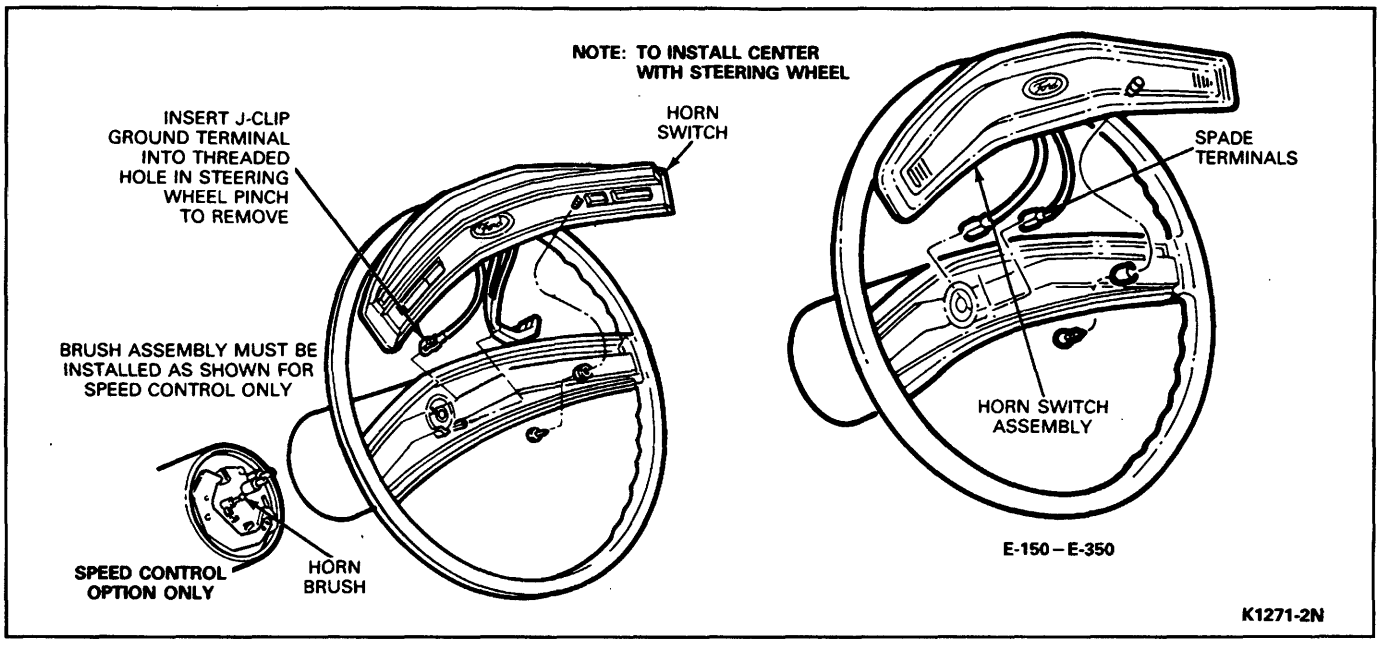


FIG. 4 Horn Contact Button E-150—E-350

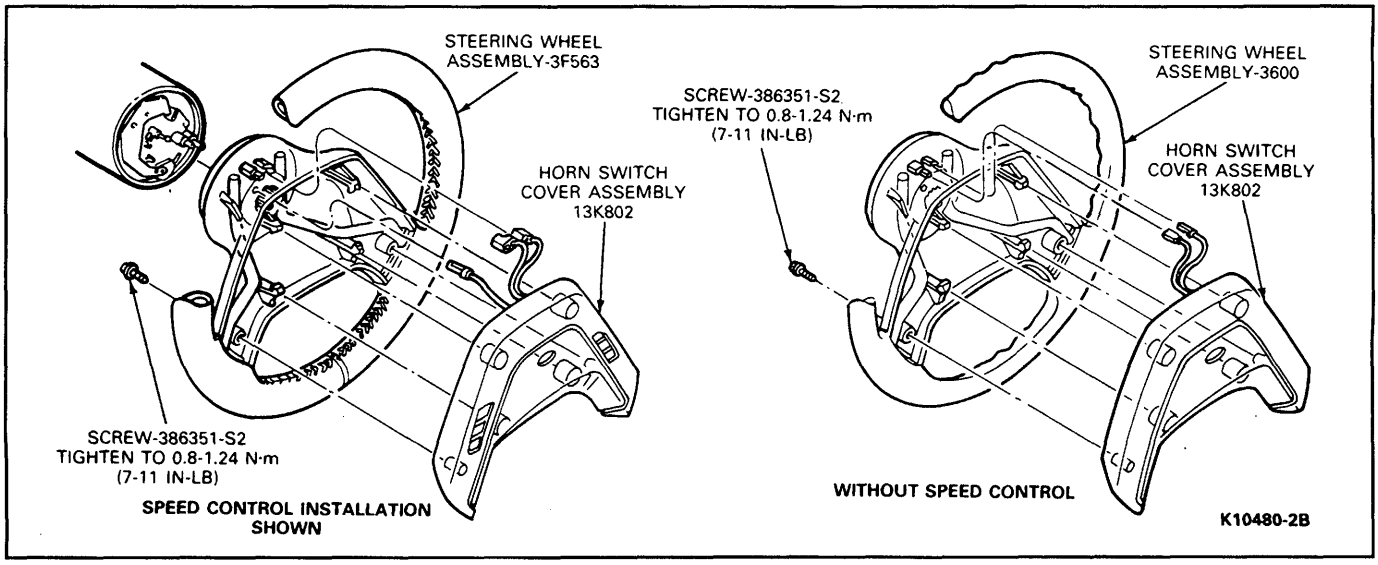


FIG. 5 Horn Switch Cover Assembly F-150—F-350 and Bronco

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SECTION 36-10 Heating System General Service

SUBJECT	PAGE
DESCRIPTION AND OPERATION	
Blower Switch	36-10-1
Heating Systems and Control Doors	36-10-1
Safety Precautions	36-10-1
DIAGNOSIS AND TESTING	
Bleeding Air From Heater Core	36-10-2
Blower Motor Current Draw Test	36-10-1
Blower Motor Voltage Test	36-10-1
Blower Switch Continuity Test	36-10-1
DIAGNOSIS AND TESTING (Cont'd)	
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Open Circuit Test	36-10-2
Visual Check - Blower	36-10-1
SPECIAL SERVICE TOOLS	36-10-5
VEHICLE APPLICATION	36-10-1

VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

Heating Systems and Control Doors

All heater plenum assemblies contain a heater core, through which coolant flows from the engine, and a blower. The air (forced by blower or ram effect) passes through and/or around the heater core and discharges through various outlets.

Several doors determine the amount of air passing through the heater core and the particular outlet(s) through which it discharges. The number of doors used and the manner in which they are actuated differ according to the particular system function. Two control levers (function and temperature) determine location of discharge air and temperature.

Blower Switch

Battery voltage is delivered directly to the blower motor whenever the ignition switch is on. Blower motor speed is controlled by the blower motor resistor through three separate circuits. Various positions of the blower motor switch energize these circuits.

When the blower switch is moved to the blower speed selected, a circuit is completed to ground. Current flow from the battery to the blower motor, blower motor resistor, and blower motor switch operates the blower motor. The different blower motor speeds result from the amount of resistance in each of the circuits. Greater circuit resistance results in slower motor speed.

When the blower switch is moved to the HIGH speed position, a separate circuit is completed. The high speed circuit is completed directly from the blower motor, through the blower switch to ground. This circuit allows full battery voltage, producing maximum blower motor speed.

Safety Precautions

Whenever components in the engine compartment or instrument panel areas are being serviced, the battery ground cable must be disconnected to eliminate the possibility of electrical shorts, burned-up wiring, and fires. Extreme care must be exercised when performing electrical tests where the battery must be connected to operate the system.

Carbon monoxide is colorless, odorless and dangerous. If it is necessary to operate the engine with the vehicle in a closed area such as a garage, always use an exhaust collector to vent the exhaust gasses outside the closed area.

DIAGNOSIS AND TESTING

Various tests checking heater system operations are included below. In addition to these tests, visual inspection of all heater system components and connections, including inspections for air leaks in the body should be made to ensure proper operation.

Visual Check - Blower

Check to see that all blower motor connections are correct including proper ground of the system. Check the resistor connection at heater case and the heater fuse. Also check the connection at the rear of the blower switch located on the control assembly.

Loose Blower Wheel Test

Place the blower switch in HIGH position. If airflow is not evident but the motor can be heard, the blower wheel may not be secured to the motor shaft. Do not replace the blower motor unless the unit fails the current draw test.

Blower Motor Current Draw Test

HEATER SYSTEM

Refer to Section 36-25, Heater System.

Blower Motor Voltage Test

HEATER SYSTEM

Refer to Section 36-25, Heater System.

Blower Switch Continuity Test

Refer to appropriate electrical schematic (Fig. 1). Check for continuity between connected terminals with a self-powered test lamp or an ohmmeter as shown on the schematic. Check terminal continuity at every lever position. The lamp should go on for each connected pair of terminals.

If the ohmmeter moves or the test lamp lights, the circuit is closed. If the ohmmeter moves only slightly,

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the circuit may have high resistance due to a loose connection.

Open Circuit Test

On all electrical circuits, continuity must exist from the source of power (battery), to the unit where the power is used, and back up to the source of power (ground).

An ohmmeter or self-powered test lamp, connected between any two points of a circuit will show whether the circuit is open or continuous.

If the meter does not move or the lamp does not light, the circuit is open.

If the meter movement is slight, high resistance is indicated.

Bleeding Air From Heater Core

Remove the hose at the outlet connection of the heater core (hose leading to the water pump). Allow any trapped air to flow out. When a continuous flow of coolant is obtained, connect the hose to the core. Do not overtighten heater hose clamps.

Heater Core Leak Test

Inspection

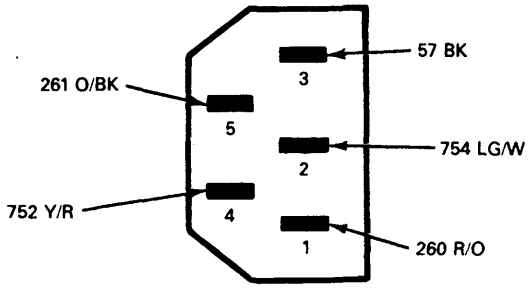
1. Inspect for visible evidence of coolant leakage at the hose to heater core attachments. A coolant leak at the hose could follow the heater core tube to the core and appear as a leak in the heater core.
2. Check the system for loose heater hose clamps. The clamps should be tightened to 1.81-2.49 N·m (16-22 in-lbs).
3. If leakage is found and the hose clamps are tight, check the heater core tubes for distortion. Severe distortion of the tubes could cause leakage at the hose connection.

Pressure Test

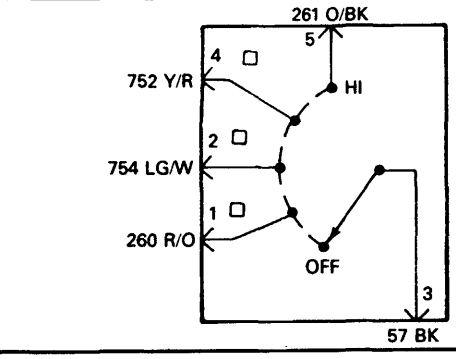
1. Drain the cooling system.
2. Disconnect the heater hoses from the heater core tubes.
3. Install a short piece of heater hose (approximately 100mm or 4 inches long) onto each heater core tube (Fig. 2).
4. Fill the heater core and hoses with water and install Plug (BT-7422-B) and Adapter (BT-7422-A) Fig. 3 from Radiator Pressure Tester 021-00012 or equivalent in the hose ends (Fig. 2). Secure the hoses to the heater core, plug and adapter with hose clamps.
5. Attach Radiator Pressure Tester 021-00012 or equivalent to the adapter (Fig. 4). Close the bleed valve at the base of the gauge and pump 207 kPa (30 psi) of air pressure into the heater core.
6. Observe the pressure gauge for a minimum of three minutes. The pressure should not drop.
7. If the pressure does not drop, no leaks are indicated.
8. If the pressure drops, check the hose connections at the core tubes for leaks. If the hoses do not leak, remove the heater core from the vehicle and test the core as outlined under Bench Test.

Bench Test

1. Drain all coolant from the heater core.



SCHEMATIC



TERMINAL LOCATION ON SWITCH	COMPONENT TESTING PROCEDURE		
	Connect Self-Powered Test Light or Ohmmeter to Terminals	Move Control to Each Position	A Good Switch Will Indicate
	260 R/O (1) and 57 BK (3)	Off	Open Circuit
		Lo	Closed Circuit
		Medium 2	Open Circuit
		Medium 1	Open Circuit
		Hi	Open Circuit
	754 LG/W (2) and 57 BK (3)	Off	Open Circuit
		Lo	Open Circuit
		Medium 2	Closed Circuit
		Medium 1	Open Circuit
		Hi	Open Circuit
	752 Y/R (4) and 57 BK (3)	Off	Open Circuit
		Lo	Open Circuit
		Medium 2	Open Circuit
		Medium 1	Closed Circuit
		Hi	Open Circuit
	261 O/BK (5) and 57 BK (3)	Off	Open Circuit
		Lo	Open Circuit
		Medium 2	Open Circuit
		Medium 1	Open Circuit
		Hi	Closed Circuit

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FIG. 1 Blower Switch Continuity Test

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Diagnosis Guides

CONDITION	POSSIBLE CAUSE	RESOLUTION
Insufficient, erratic, or no heat or defrost.	Low radiator coolant level due to: Coolant leaks.	Check radiator cap pressure. Replace if below minimum pressure. Fill to specified coolant level. Pressure test for engine cooling system and heater system leaks. Service as required.
	Engine overheating.	Remove bugs, leaves, etc. from radiator or condenser fins. Check for: Loose fan belt Sticking thermostat Incorrect ignition timing Water pump impeller damage Restricted cooling system Service as required.
	Loose fan belt.	Replace if cracked or worn and/or adjust belt tension.
	Thermostat.	Check coolant temperature at radiator filler neck. If under 170°F, replace thermostat. See Group 27 for complete testing.
	Plugged or partially plugged heater core.	Clean and backflush engine cooling system and heater core.
	Loose or improperly adjusted control cables.	Adjust to specifications.
	Kinked, clogged, collapsed, soft, swollen, or decomposed engine cooling system or heater system hoses.	Replace damaged hoses and backflush engine cooling system, then heater system, until all particles have been removed.
	Blocked air inlet.	Check cowl air inlet for leaves, foreign material, etc. Remove as required. Check internal blower inlet screen (on vehicles so equipped) for leaves and foreign material.

CK5870-2B

2. Connect the 100mm (four inch) test hoses with plug and adapter to the core tubes. Then, connect Radiator Pressure Tester 021-00012 or equivalent to the adapter (Fig. 5).
3. Apply 207 kPa (30 psi) of air pressure to the heater core with Radiator Pressure Tester 021-00012 or equivalent, and submerge the core in water.
4. If a leak is observed, repair or replace the heater core as necessary.

Heater Core Back-Flushing

All engine cooling system flushing and back-flushing must include a separate back-flushing of the heater or A/C system heater core Separate flushing or back-flushing of the engine cooling system and heater core prevent engine cooling system particles from clogging the heater core tubes and reducing (or eliminating) coolant flow through the heater core.

The heater core must be back-flushed separately from the engine cooling system for proper back-flush water flow direction through the heater core.

The correct heater core back-flushing procedure is as follows:

1. Disconnect the heater core outlet heater hose from the water pump fitting and install a female garden hose-end fitting adapter into the end of the outlet heater hose. Secure with a hose clamp.
2. Connect the female garden hose-end of the outlet heater hose to the male end of a water supply garden hose.
3. Disconnect the heater core inlet heater hose from the engine block fitting. Allow inlet hose to drain onto the ground or into a floor drain.
4. Turn the water supply valve on and off several times so that the surge action will help to dislodge larger stubborn particles from the heater core

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CONDITION	POSSIBLE CAUSE	RESOLUTION
Blower does not operate properly. Check fuse.	Blower motor.	Connect a #10 gauge (or larger diameter) jumper wire directly from the positive battery terminal to the positive lead (orange wire) of the blower motor. If the motor runs, the problem must be external to the motor. If the motor will not run, connect a #10 gauge (or larger diameter) jumper wire from the motor black lead to a good ground. If the motor runs, the trouble is in the ground circuit. On vehicles with ground side switching, check the blower resistor, the blower switch and the harness connections. Service as required. If motor still will not run, the motor is inoperative and should be replaced.
	Blower resistor.	Check continuity of resistors for opens or shorts (self-powered test lamp). Service or replace as required.
	Blower wire harness.	Check for proper installation of harness connector terminal connectors. Check wire-to-terminal continuity. Check continuity of wires in harness for shorts, opens, abrasion, etc. Service as required.
	Blower switch(s).	Check blower switch(s) for proper contact. Replace switch(s) as required.
Too much or too little heat. Air comes out of incorrect outlet for any function control lever position. (Refer to Section 36-25 Standard Heater and Power Ventilation.)	Loose or improperly adjusted control cables.	Adjust as specified.

CK5871-2C

tubes. Allow full water pressure to flow for approximately five minutes.

5. Remove the hose clamp and female garden hose-end adapter from the end of the outlet heater hose. Install the outlet heater hose onto the water pump fitting. Secure with hose clamp.
6. Connect the inlet heater hose onto the engine block fitting. Secure with hose clamp.
7. Fill the cooling system, as described in Section 27-02, Cooling System Service, with the specified coolant mixture of 50/50 Ford Long Life Coolant E2FZ-19549-A (ESE-M97B44-A) and water or equivalent.
8. Test the system for proper heater performance under the specified engine cooling system conditions.

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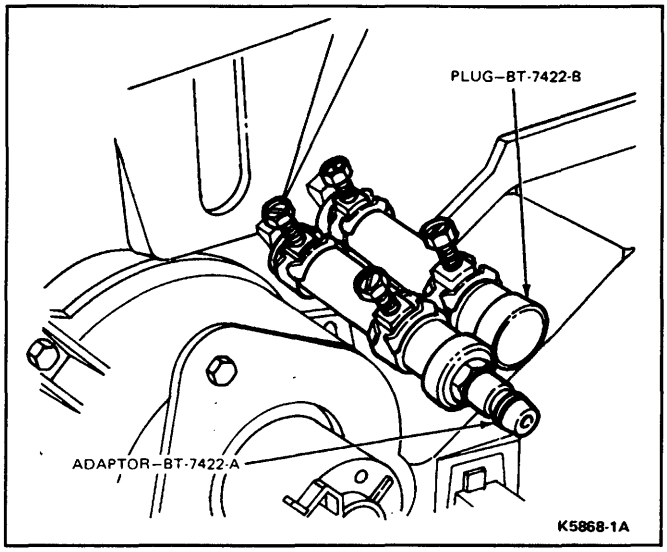


FIG. 2 Heater Hose with Plug and Adapter Installed

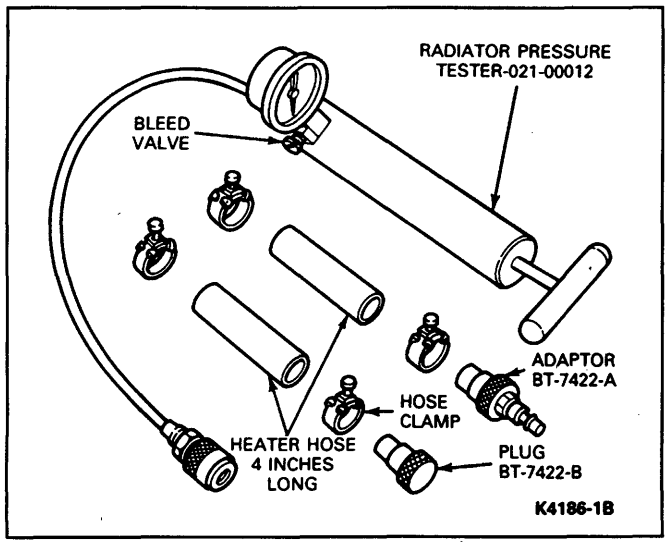


FIG. 3 Radiator Pressure Tester 021-00012 with Heater Hoses and Clamps

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Part Number	Description
021-00012	Radiator Pressure Tester
BT-7422-A	Adapter
BT-7422-B	Plug

CK5589-1D

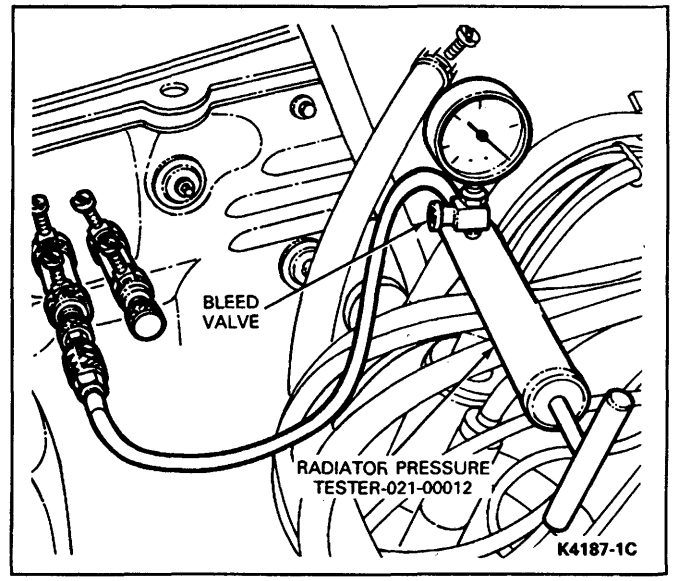


FIG. 4 Radiator Pressure Tester 021-00012 Installed for Pressure Test

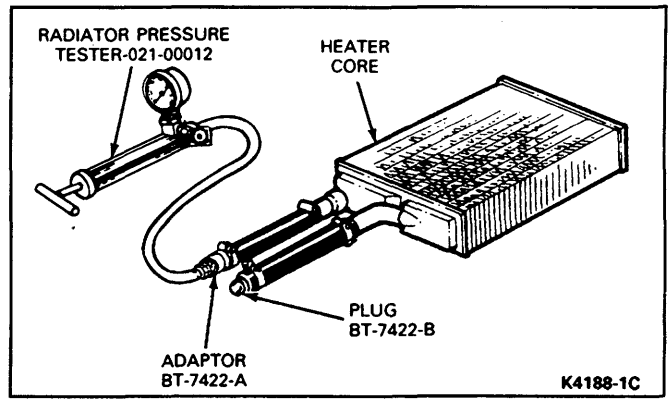


FIG. 5 Heater Core Bench Test

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SECTION 36-23 Hi-Output Heating System

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Center Register Panel Assembly	36-23-11
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VEHICLE APPLICATION

E-150 through E-350 Models.

DESCRIPTION

Heater and Ventilation System

The heater is a blend air type which receives its outside air supply from the cowl inlet. The heater control assembly is located in the instrument panel to the right of the steering column. It includes a blower switch with an OFF position, as well as positions for four operating speeds. The control assembly also includes two levers. One is provided to allow temperature selection between the extremes of COOL and WARM; the other provides for functional selection between OFF, VENT, HEAT, MIX, and DEFROST. Refer to Figure 1.

Ventilation is delivered through the instrument panel registers when the function lever in the control assembly is set in the VENT position. (Fig. 1.) In the VENT position, the outside/recirc door is open to the outside with no vacuum being applied to the door vacuum motor. The air coming in through the cowl is discharged through the panel registers. A small amount of this input is diverted to the floor area. (The A/C compressor will not be operating when the control lever is in the VENT position.)

In the FLOOR position, the outside/recirc. door is open to the outside airflow with no vacuum being applied to the door's motor. Air is discharged through the floor outlets with a small amount going to the defroster nozzles.

In the MIX position, outside air is discharged through the defroster nozzles and the floor outlets.

In the DEFROST position, outside air is discharged through the defrosters with a small amount going to the floor outlets.

In the OFF position, all doors are in the vacuum-applied position with the exception of the PANEL/DEFROST door.

When the temperature control lever in the control assembly is moved between the COOL and WARM positions, a temperature control cable moves the temperature blend door, which directs a portion of the total air input through the heater core. As the percentage of air exposed to the core increases, the air temperature at the outlets to the passenger compartment also increases. Figure 2 illustrates airflow through the system.

MAJOR COMPONENTS

Control Assembly

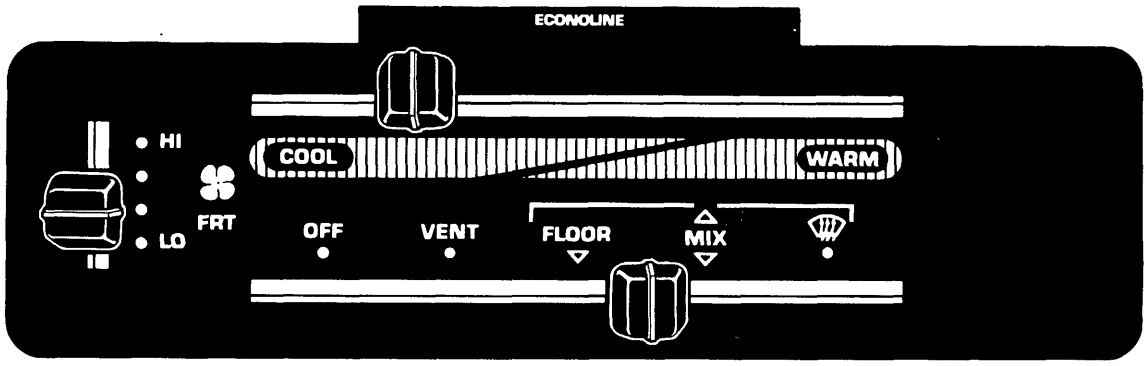
Refer to Fig. 3

When the function selector lever is moved to any of the five positions, the appropriate ports in an eight-port vacuum selector valve are actuated. This valve controls the distribution of vacuum to the motors which operate the following doors:

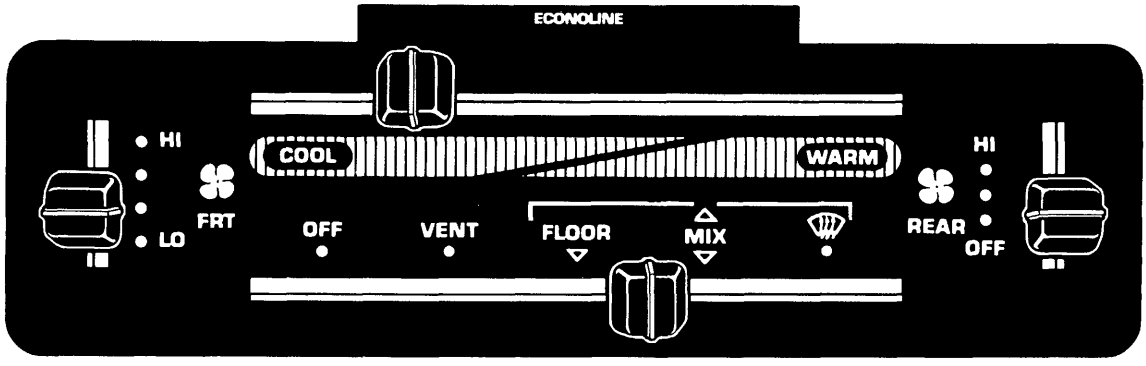
- Outside/Recirc
- Floor/Defrost
- Panel/Defrost

The function selector lever also controls blower operation. When the lever is in the OFF position, the 4-speed blower switch will not operate.

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HEATER ONLY (MAIN SYSTEM)



HEATER ONLY (MAIN & AUXILIARY SYSTEM)

CCL 2980-A

FIG. 1 Typical Heater-Ventilation Control Assembly

Temperature Selector Lever

The temperature selector lever actuates a control cable which operates the temperature blend door. The blower motor will operate at low, medium low, medium high, or high speed, depending upon selection. The function selector lever must be in the OFF position if no blower operation is desired.

Blower Motor Resistor

A resistor with a thermal limiter is mounted in the scroll area of the evaporator (heater) case. It is used in conjunction with the blower motor switch to obtain the desired fan speed. The thermal limiter in the switch assembly serves as a temperature sensitive fuse.

Auxiliary Heater System

Refer to Section 36-70 Side-Mounted Auxiliary A/C and/or Heater Systems for all service procedures.

ADJUSTMENTS

Temperature Control Cable

1. Set temperature selector lever in COOL position.
2. Remove cable from retaining clip on top of evaporator (heater) case. Do not disconnect cable from yellow crank.
3. Rotate yellow crank counterclockwise until temperature blend door seats.
4. Check to be sure the temperature selector lever is in COOL position. Then, install cable housing into its retaining clip by pushing it from the top until it snaps in place.
5. Set blower switch on HIGH. Move temperature lever through its range to verify that cable adjustment is satisfactory. Repeat Steps 1 through 4 if further adjustment is needed.

DIAGNOSIS AND TESTING

Blower Motor Voltage Test

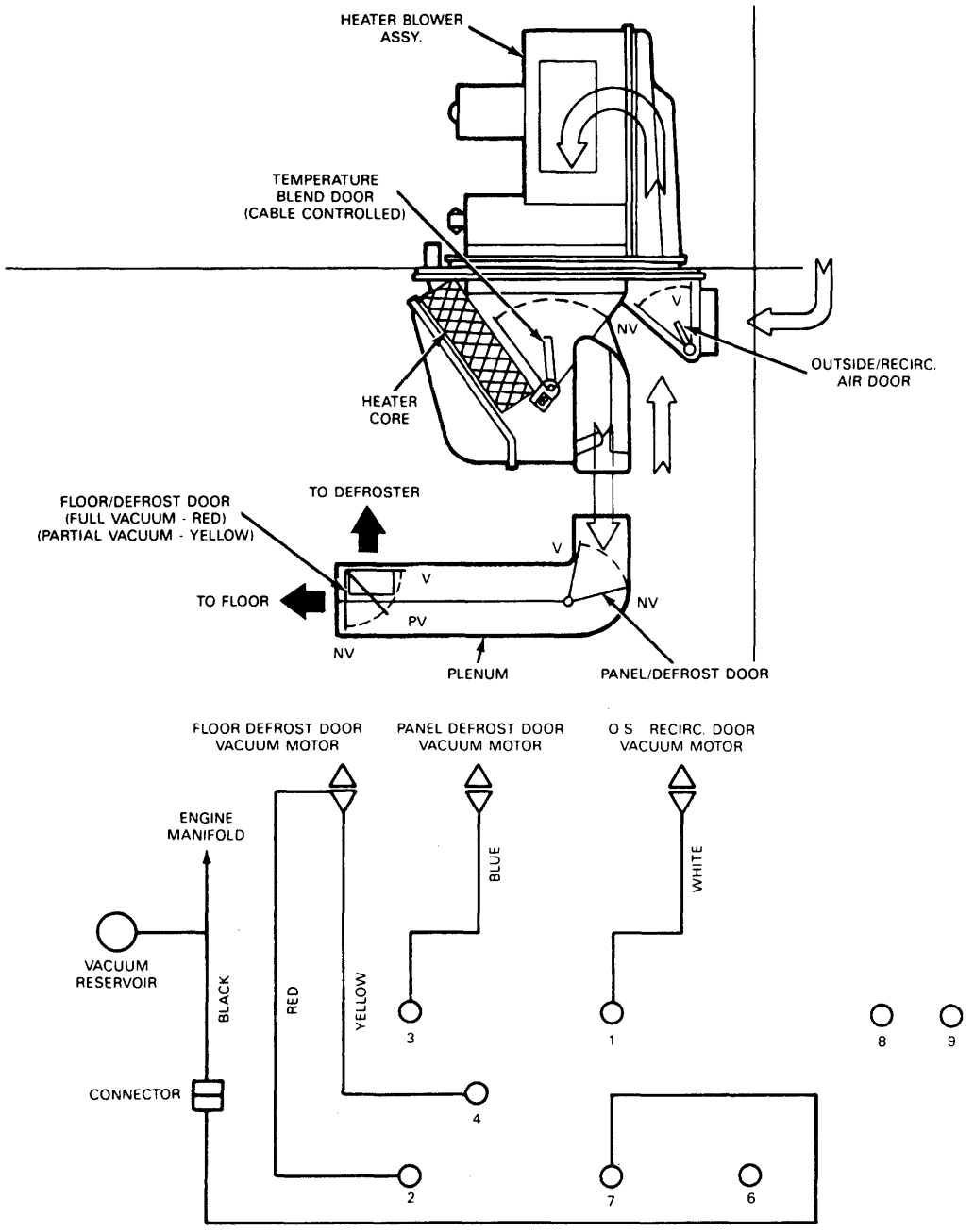
Refer to Figure 4.

The heater system blower motor electrical circuit uses ground side switching. When performing blower motor voltage tests on systems with ground side switching, the voltage reading must be taken across the motor wires.

Test Procedure

1. Place the temperature selector lever in WARM position.
2. Place function selector lever in the FLOOR position.
3. Insert probes of a voltmeter into wire holes of the motors two hardshell connectors and make contact with wire terminals. Measure voltage drop across motor.

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PART NO	FUNCTION	OFF	VENT	HEAT		
				FLOOR	MIX	DEFROST
1	OUTSIDE - RECIRC	V	A	A	A	A
2	FLOOR - DEFROST (FULL)	V	V	V	-	A
3	PANEL - DEFROST	A	V	A	-	A
4	FLOOR - DEFROST (PARTIAL)	V	V	V	PV	A
5	BLANK	-	-	-	-	-
6	SEALED	-	-	-	-	-
7	SOURCE	V	V	V	V	V

CCL 2981-A

FIG. 2 Heater System Airflow

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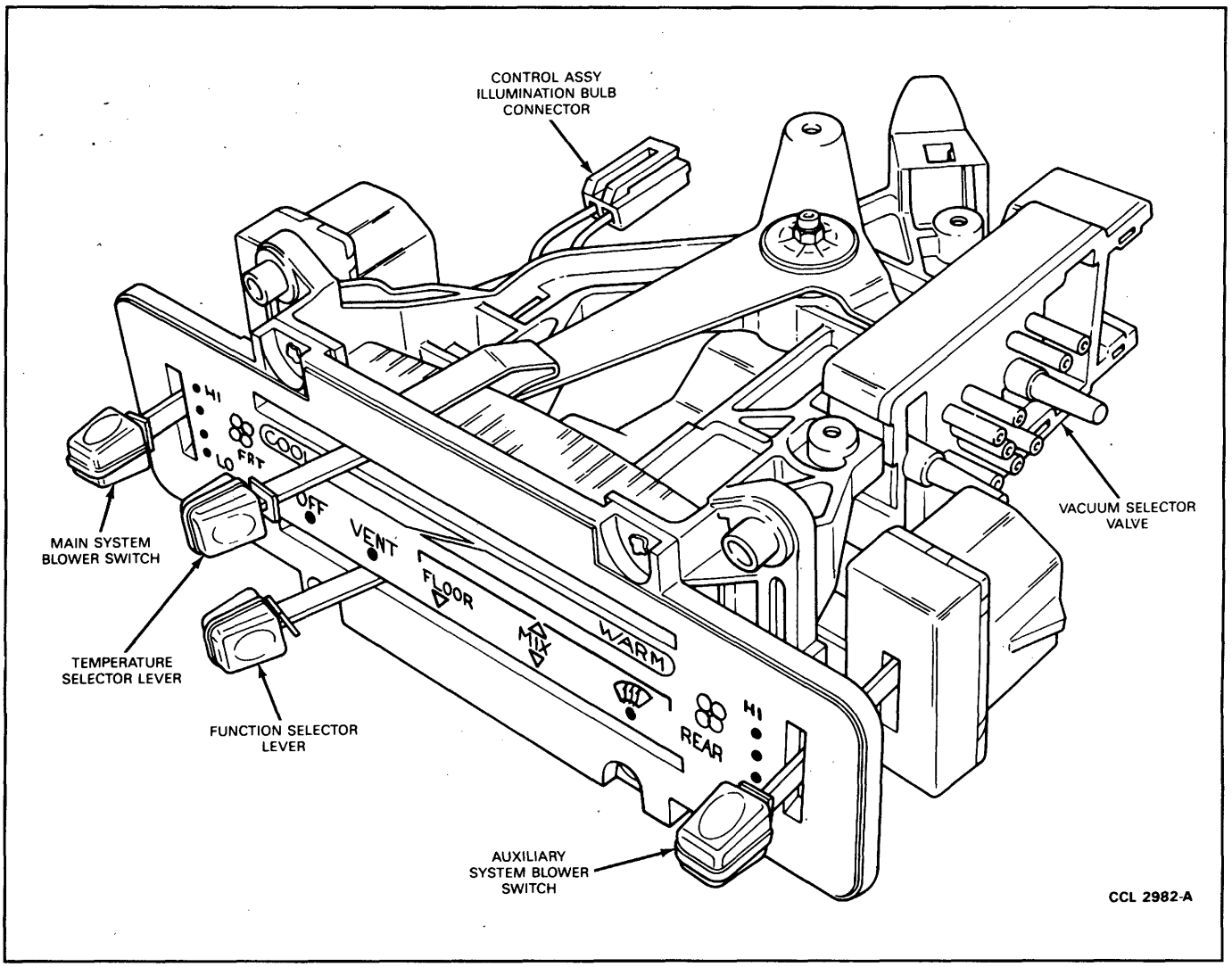


FIG. 3 Control Assembly

4. With engine running (battery voltage approximately 14.2 volts), the voltage reading should be within the specified range for each blower switch position. Refer to blower switch chart of the electrical wiring diagram for specifications.

Blower Motor Current Draw Test

1. Separate blower motor ground (black) wire at blower motor resistor.
2. Connect positive (+) ammeter lead to female spade connector and negative (-) ammeter lead to resistor terminal.
3. Place temperature selector lever in mid-position and the function selector lever in the HEAT position to turn blower on.
4. Turn ignition switch to ON position.
5. With a fully charged battery, blower motor current draw (amps) should be approximately as indicated for each blower speed in blower switch chart of the electrical wiring diagram (Fig. 4).

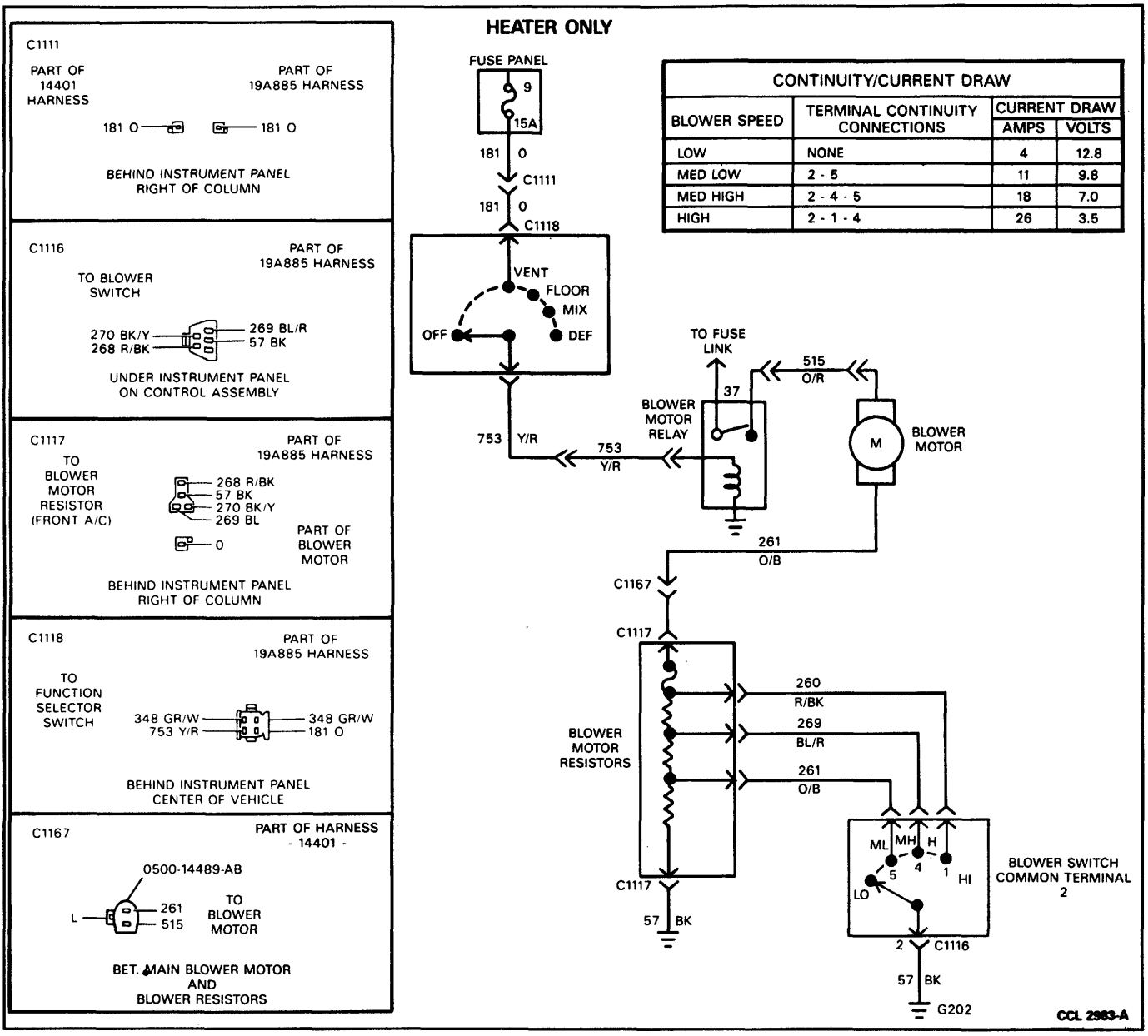
Vacuum System Tests

To test the A/C-heater control system, start the engine and move the function selector lever slowly from one position to another. A momentary hiss should be heard as the function selector lever is moved from one position to another indicating that vacuum is available at the control assembly. A continuous hiss at the control assembly indicates a major leak somewhere in the system. It does not necessarily indicate that the leak is at the control assembly.

If a momentary hiss cannot be heard when the function selector lever is moved from one position to another, check for a kinked, pinched, or disconnected vacuum supply hose (Fig. 2). Also inspect the check valve between the intake manifold and the vacuum reservoir to be sure it is working properly.

If a momentary hiss can be heard when the function selector lever is moved from one position to another, vacuum is available at the control assembly. Then, cycle the function selector through each position with the blower on HI and check the location(s) of the discharge air. The airflow schematic and vacuum control chart shown in Fig. 2 gives the vacuum motors applied for each position of the function and temperature selector levers along with an airflow diagram of the system. The airflow diagram shows the position of each door when vacuum is applied and when there is no vacuum applied. With this chart, airflow for each position of the control assembly can be determined. If a vacuum motor fails to operate, the

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CONTINUITY/CURRENT DRAW			
BLOWER SPEED	TERMINAL CONTINUITY CONNECTIONS	CURRENT DRAW AMPS	CURRENT DRAW VOLTS
LOW	NONE	4	12.8
MED LOW	2 - 5	11	9.8
MED HIGH	2 - 4 - 5	18	7.0
HIGH	2 - 1 - 4	26	3.5

FIG. 4 Heater Electrical Wiring Diagram

inoperative motor can readily be found because airflow will be incorrect.

If a vacuum motor is inoperative, check the operation of the motor with Rotunda Vacuum Tester 021-00014 or equivalent. If the vacuum motor operates properly, the vacuum hose is probably pinched, kinked, disconnected or has a hole (Fig. 2).

REMOVAL AND INSTALLATION

Control Assembly

Removal

1. Remove trim applique.
2. Remove four screws retaining control assembly to mounting bracket. Refer to Figure 3.
3. Carefully pull control assembly from opening in the mounting bracket.
4. Disconnect electrical connectors from blower switch(s), vacuum selector, and illumination bulb.
5. Remove push-on vacuum harness retaining clips from vacuum selector.
6. Disconnect vacuum harness from vacuum selector.
7. Remove temperature control cable from control assembly. Disconnect bullet-type cable retainer from bracket using the Control Cable Removal Tool T83P-18532-AH or equivalent (Fig. 5), or needlenose pliers to compress retaining ears. The cable "S" bend is removed from bottom side of the lever by rotating the cable wire 90 degrees to the lever.

Installation

1. Connect temperature control cable to control assembly (Fig. 5).

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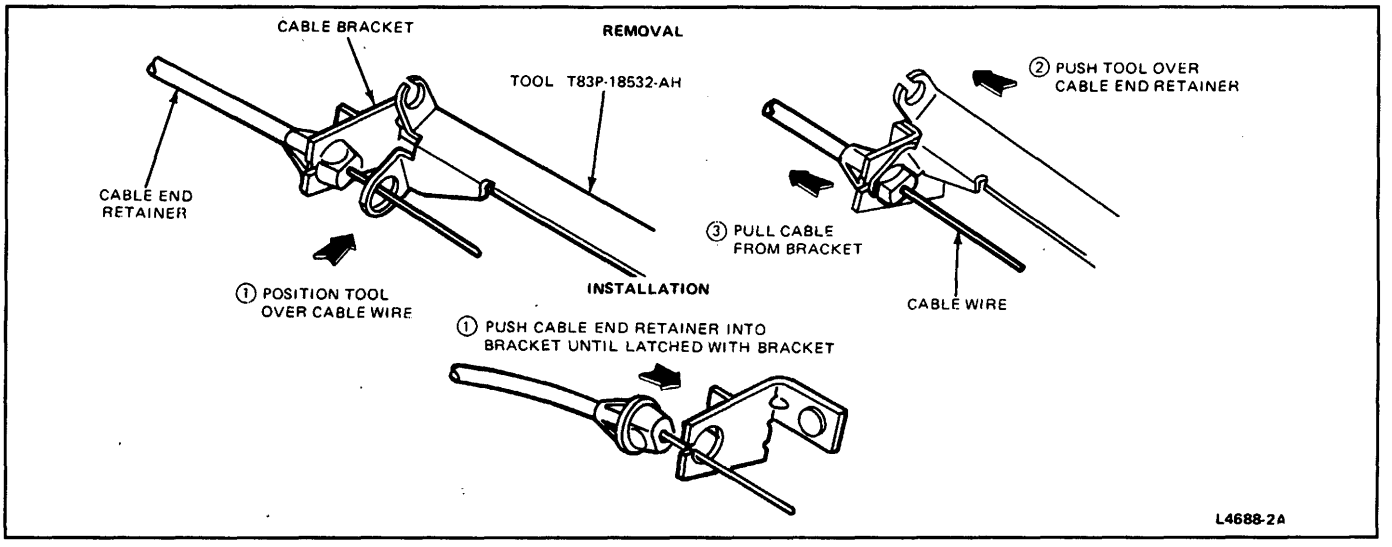


FIG. 5 Temperature Control Cable Removal and Installation

2. Connect vacuum harness to vacuum selector and retain with two push-on clips.
3. Connect electrical connectors to blower switch(s), vacuum selector valve and illumination bulb wire and socket assembly.
4. Carefully position control assembly to mounting bracket and install four retaining screws.
5. Install applique.
6. Adjust the control cable as outlined under Adjustments, Temperature Control Cable.

Blower Switch

Removal

1. Remove knobs from blower switch.
2. Remove trim applique.
3. Remove four screws retaining control assembly mounting bracket to instrument panel.
4. Carefully remove control mounting bracket and control assembly from instrument panel opening.
5. To remove blower switch, disconnect wiring connector from blower switch and remove one screw retaining switch mounting bracket to control assembly.

Installation

1. Position blower switch and bracket on the control assembly and install one retaining screw.
2. Connect wiring connector to blower switch.
3. Position control assembly and bracket in instrument panel and install four retaining screws (Fig. 3).
4. Install trim applique.
5. Install knob on switch.

Vacuum Selector Valve

Removal

1. Remove instrument panel trim panel.
2. Remove four screws retaining control assembly mounting bracket to instrument panel.
3. Carefully remove control mounting bracket and control assembly from instrument panel opening.
4. Disconnect wiring connector from vacuum selector valve.
5. Remove two push-on vacuum harness retainer clips from vacuum selector and disconnect harness from valve.
6. Remove two screws retaining vacuum selector valve to control assembly. Remove vacuum selector valve (Fig. 6).

Installation

1. Position temperature lever at LH side of slot and the function control lever approximately 9.5mm (3/8 inch) from LH side of slot.
2. Position vacuum selector valve onto control assembly, engaging selector lever arms with selector valve. Install two retaining screws.
3. Connect vacuum harness to selector valve and retain with two pushnuts.
4. Connect wiring connector to selector.
5. Position control assembly and bracket in instrument panel. Install four retaining screws.
6. Install trim panel.

Heater Core

Removal

1. Remove inlet and outlet hoses from heater core in the engine compartment. Plug hoses with a suitable 15.87mm (5/8-inch) plug.
2. Remove two screws retaining modesty panel to underside of instrument panel.
3. Remove modesty panel.
4. Remove four screws from heater core cover located on the LH side of the case underneath instrument panel (Fig. 7).
5. Remove heater core cover.
6. Remove screw and retaining bracket at bottom of heater core.
7. Remove heater core and seal from case.

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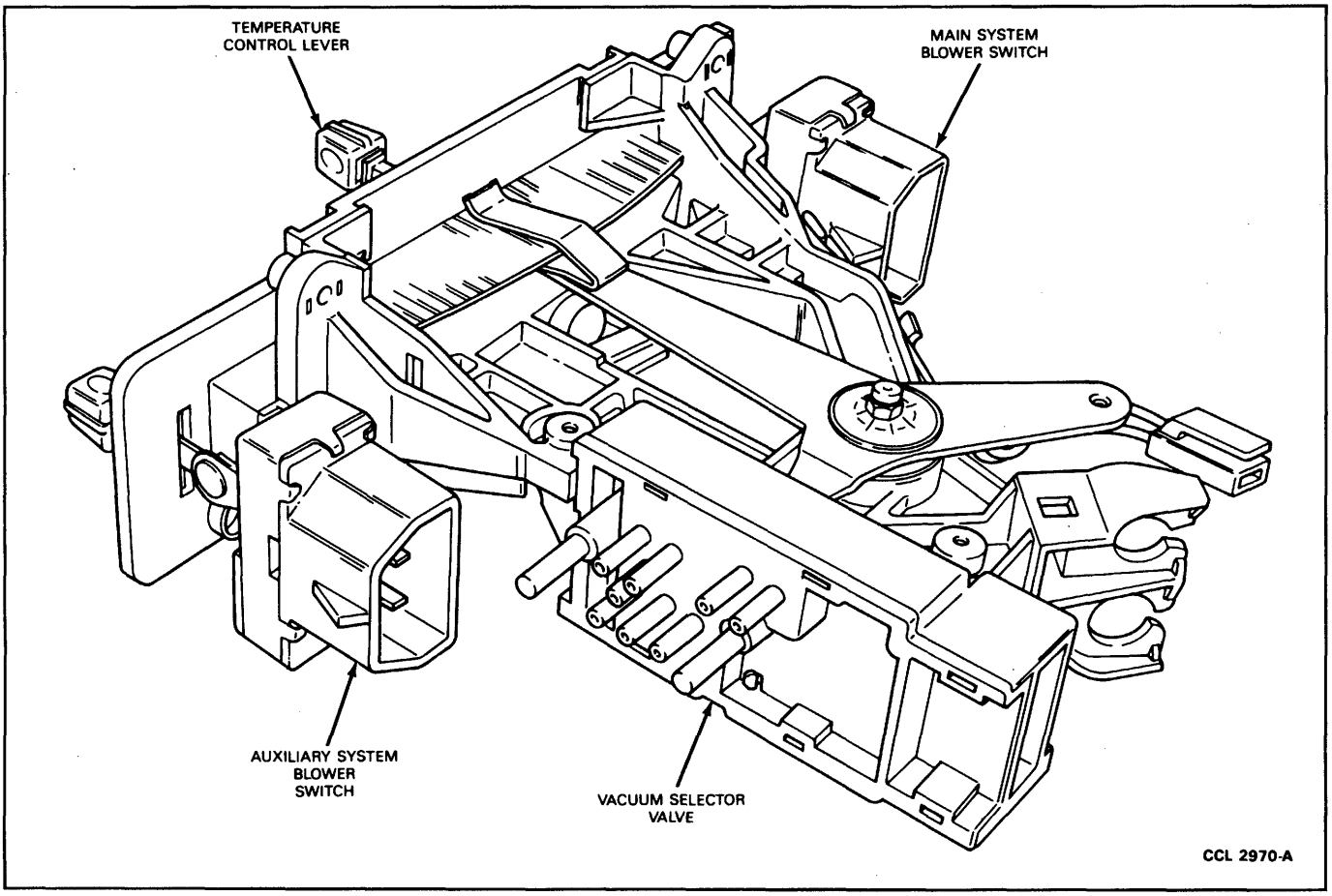


FIG. 6 Vacuum Selector Valve

Installation

1. Position heater core and seal assembly into heater case. Install core retaining bracket and screw.
2. Position heater cover and install four retaining screws.
3. Install modesty panel on instrument panel. Install two retaining screws.
4. Remove plugs from heater hoses.
5. Install heater hoses on heater core using clamps. Fill cooling system to specifications. Refer to Section 27-02, *Cooling System Service*.

Blower Motor and Wheel Assembly

1. Disconnect blower motor wiring connector (Fig. 8).
2. Remove four screws retaining blower motor mounting plate to evaporator case assembly.
3. Remove motor and wheel assembly from evaporator case.
4. If the wheel is to be used on the new motor, install it on motor shaft so that distance from mounting plate to base of wheel is the same as the old motor installation.

Installation

1. When wheel is properly installed on new motor, insert wheel into evaporator case and align locator pins with the holes in the base plate (Fig. 8).
2. Install four retaining screws.
3. Connect electrical wiring connector to blower motor.
4. Check blower motor for proper operation.

Instrument Panel

NOTE: It will be necessary to remove and install the instrument panel to service some components in the heater systems. Refer to Section 45-61, Instrument Panel and Pad.

Air Ducts

To remove the heater outlet LH duct, it is necessary to remove the instrument panel cluster as outlined in Section 33-51, Instrument Cluster and Printed Circuit.

LH Register Duct

Removal

1. Remove retainer attaching LH register duct to center register duct (Fig. 9).
2. Pull LH register duct from center register duct.

Installation

1. Position LH register duct to center register duct and align retainer holes.
2. Install retainer that attaches LH register duct to center register duct.

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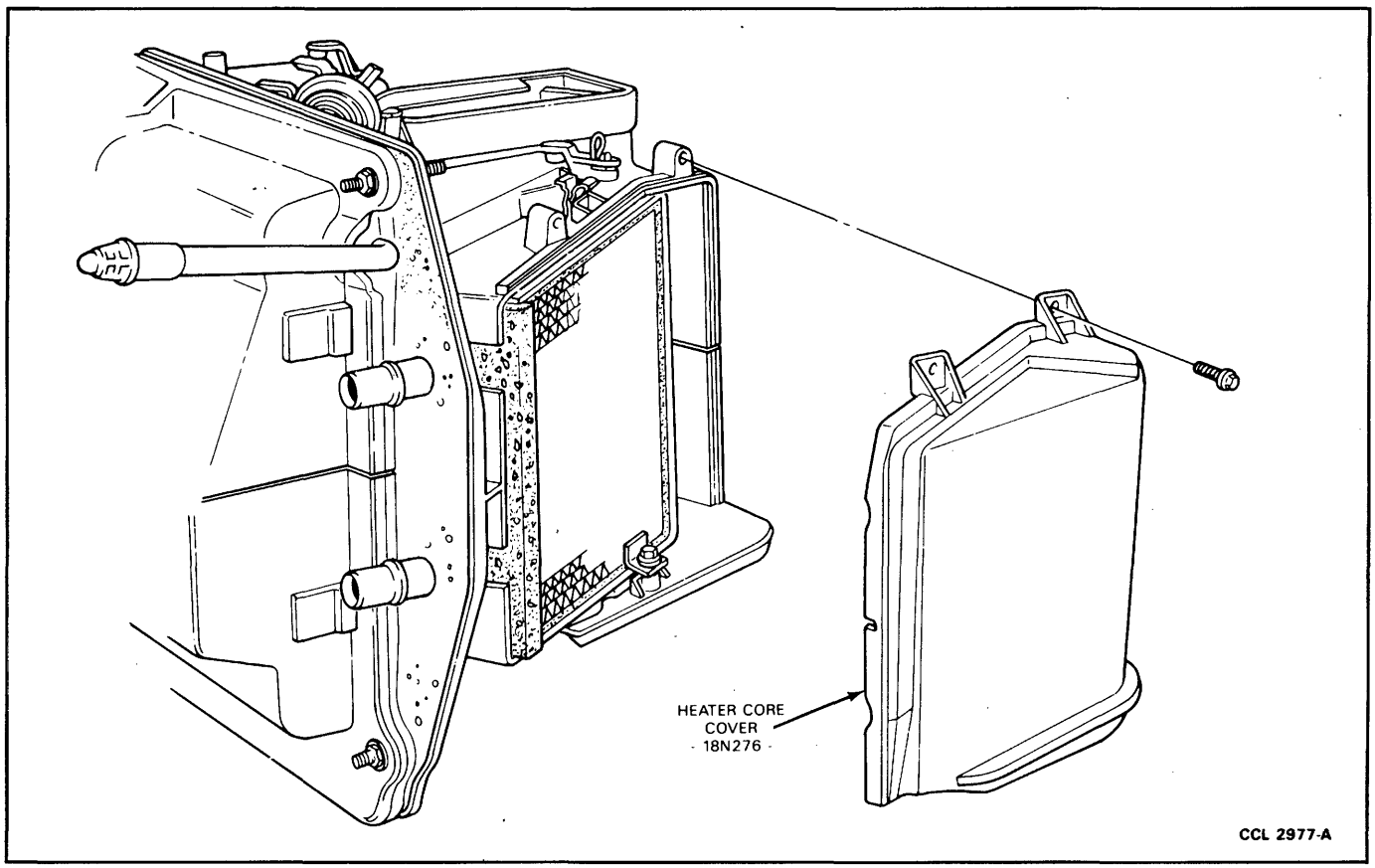


FIG. 7 Heater Core Cover Removal

Center Register Duct

Removal

1. Remove instrument panel. Refer to Section 45-61, Instrument Panel and Pad.
2. Remove LH register duct as outlined.
3. Disengage vacuum harness locator tab from center register duct.
4. Remove one retainer attaching center register duct to plenum.
5. Remove one nut retaining heater air outlet duct, LH heat duct and center register duct support braces to brake pedal support (Fig. 9).
6. Disengage center register duct support brace from clip bolt and remove center register duct.

Installation

1. Position RH end of the center register duct to plenum and support brace at LH end of duct to clip bolt.
2. Install LH heat duct support brace on the clip bolt and install retaining nut.
3. Install retainer attaching center register duct to plenum (Fig. 9).
4. Connect vacuum harness locator tab to center register duct.
5. Install LH register duct as outlined.
6. Install instrument panel. Refer to Section 45-61, Instrument Panel and Pad.

Heater Ducts

Removal

1. Remove instrument panel. Refer to Section 45-61, Instrument Panel and Pad.
2. Remove one nut attaching LH heat duct, floor outlet duct and center register duct support braces to brake pedal support (Fig. 9).
3. Disengage wiring harness locator tabs and vacuum harness locator tab from heater air outlet duct.
4. Remove on retainer attaching LH heat duct to heater air outlet duct and remove LH heat duct.
5. Remove one retainer attaching heat duct to plenum (Fig. 9).
6. Disengage heater air outlet duct support brace from clip bolt on brake pedal support. Remove heater air outlet duct.

Installation

1. Position RH end of heater air outlet duct to plenum and support brace at LH end of duct to the clip bolt on the brake pedal support.
2. Place center register duct support brace on the clip bolt over heat duct brace.
3. Position LH heat duct to the heater air outlet duct and the support brace to the clip bolt.
4. Install nut retaining three support braces to the clip bolt. (Fig. 9).
5. Install one retainer attaching heat duct to plenum and one retainer attaching LH heat duct to heater air outlet duct.

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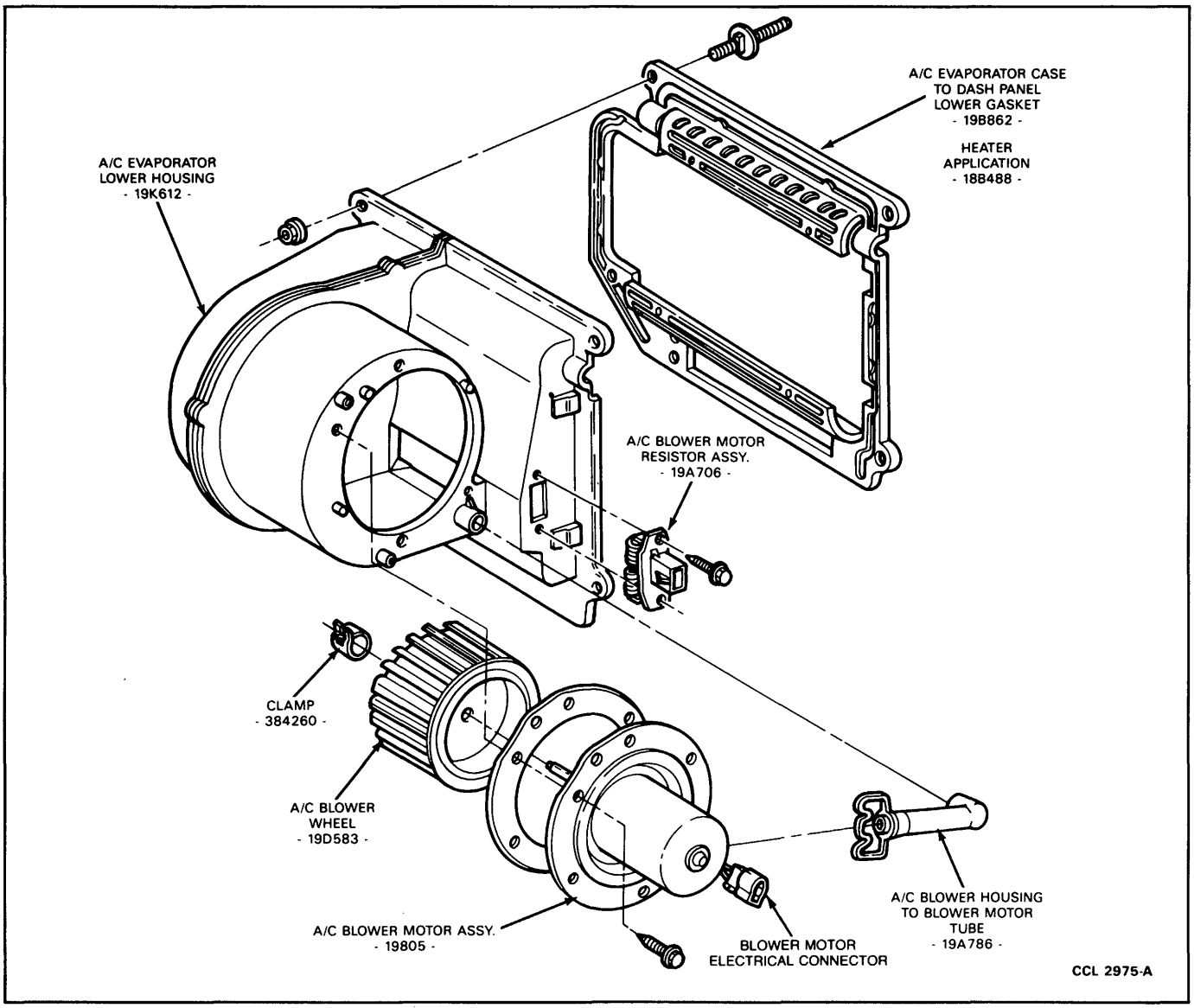


FIG. 8 Blower Motor and Wheel Assembly

6. Install wiring harness and vacuum harness locator tabs in their respective location on the heater air outlet duct.
7. Install instrument panel. Refer to Section 45-61, Instrument Panel and Pad.

Plenum Chamber

The plenum chamber is located under the instrument panel on top of the blower motor housing. For servicing the plenum-chamber, vacuum harness, and plenum doors, it is necessary to remove the instrument panel as outlined in Section 45-61, Instrument Panel and Pad. It is not required to remove the instrument panel to service the vacuum motors attached to the plenum (Fig. 10).

Removal

1. Disconnect vacuum hoses from panel/defrost vacuum motor and floor/defrost vacuum motor.
2. Remove one retainer attaching center register duct to plenum and one retainer attaching heater air outlet duct to the plenum.
3. Separate plenum from evaporator-heater housing, center register duct, and heater air outlet duct and remove plenum.
4. Remove panel/defrost and floor/defrost vacuum motors from plenum.

Installation

1. Install panel/defrost and floor/defrost vacuum motors on plenum (Fig. 11).
2. Position plenum to center register duct, heater air outlet duct and evaporator-heater housing. Ensure clip on plenum is hooked over flange on evaporator-heater housing.
3. Install one retainer attaching center register duct and one retainer attaching heater air outlet duct to plenum. (Fig. 9).
4. Connect blue vacuum hose to top (end) of floor/defrost vacuum motor.
5. Connect yellow vacuum hose to top (end) of panel/defrost vacuum motor and red vacuum hose to side of panel/defrost vacuum motor.

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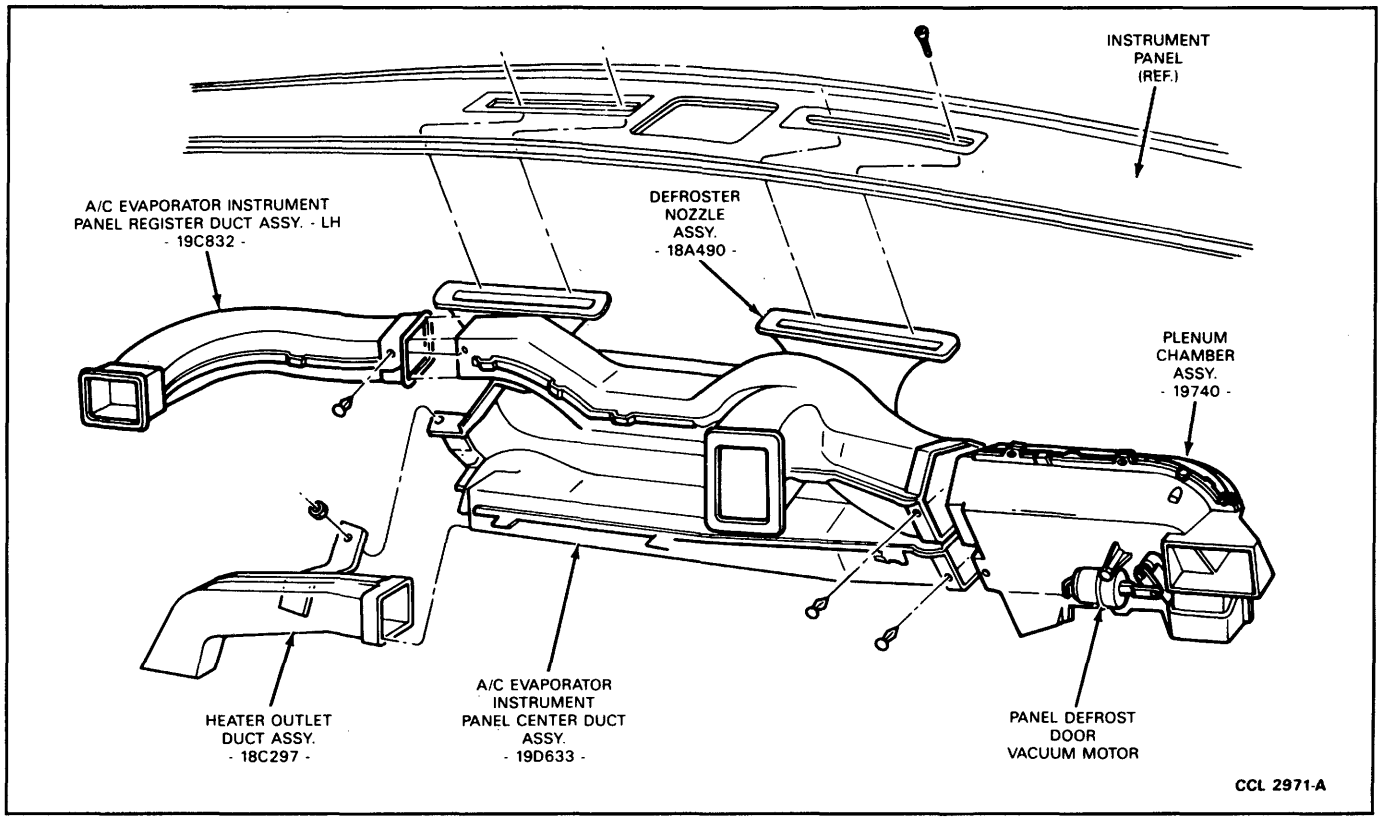


FIG. 9 Heater Duct and Defroster

6. Install instrument panel. Refer to Section 45-61, Instrument Panel and Pad.
7. Check system for proper operation.

Outside-Recirculating Air Door Vacuum Motor

Removal

1. Remove two screws retaining motor to evaporator heater housing (Fig. 12).
2. Carefully pry vacuum motor arm off "rosebud" clip on door crank.
3. Disconnect vacuum hose from outside recirculation vacuum motor. Remove motor.

Installation

1. Snap vacuum motor over "rosebud" clip on door crank.
2. Connect vacuum hose to vacuum motor and position motor to evaporator-heater case.
3. Install two screws retaining vacuum motor.
4. Install a new pushnut (Part No. 383358-S) or equivalent retaining motor arm on door crank arm, if necessary.
5. Check system for proper operation.

Defroster Nozzle

To remove the defroster nozzle it is first necessary to remove the instrument panel. Refer to Section 45-61, Instrument Panel and Pad. Remove heater ducts and register ducts as outlined.

Removal

Refer to Fig. 9.

1. Remove two screws retaining defroster nozzle to each defroster opening near windshield.
2. Pull defroster nozzle from plenum and remove from vehicle.

Installation

1. Position defroster nozzle on plenum and the defroster openings.
2. Install two screws retaining defroster nozzle to each defroster opening.
3. Install register ducts and heater ducts as outlined in this Section.
4. Install instrument panel. Refer to Section 45-61, Instrument Panel and Pad.
5. Check system for proper operation.

Register Louver Assembly

Removal

1. Insert a thin-blade screwdriver under the retaining tab (Fig. 13) and pry tab toward louvers until it clears the hole in register assembly.
2. Pull louver end out from register opening only enough to prevent the louver pivot from going back into pivot hole.
3. Repeat Step 1 for other retaining tab and pull louver assembly from register opening.

Installation

The pivots on each end of some louver assemblies are different diameters and therefore determine the installed position. Other louvers have an arm extending inward on one end of the louver assembly. This end of the louver should be installed in the register assembly at

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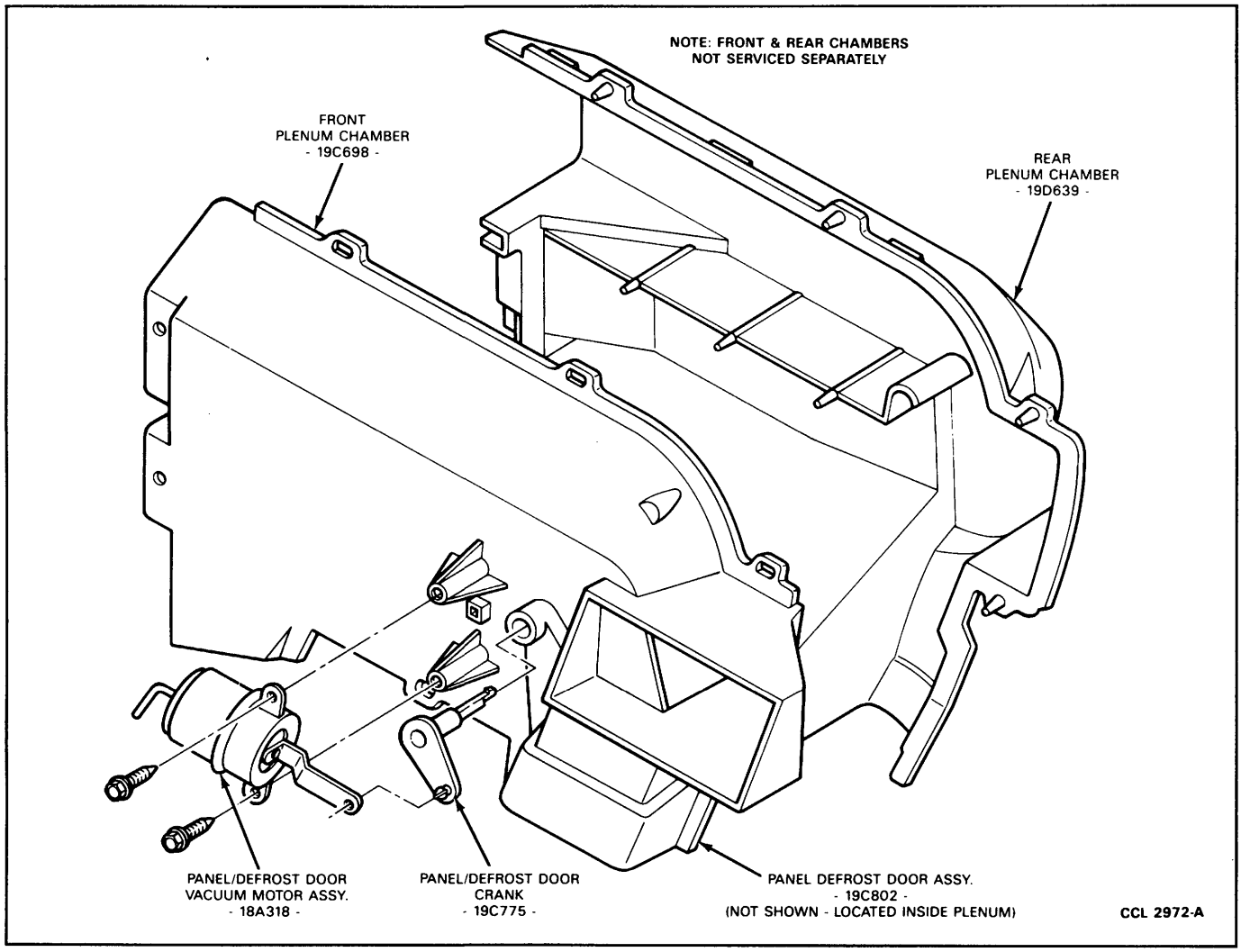


FIG. 10 Plenum Chamber

the same end as the raised boss in the register assembly.

1. Position louver assembly into register opening.
2. Depress retaining tabs and push louver assembly into register opening and engage tabs in pivot holes.

Right Register Assembly

1. Remove louver assembly from register assembly.
2. Using a small-blade screwdriver or similar tool, pry register retaining tabs toward register opening. Push adapter retaining tabs out of the LH and RH sides of register housing. Then, pull register from instrument panel opening and register duct (Fig. 14).

Installation

1. Position register assembly in the instrument panel opening. When louvers move to the right when closing, register installation is correct.
2. While supporting register adapter, push register assembly into instrument panel opening and register duct until register tabs lock into place behind instrument panel opening flanges and into the adapter.

Center Register Panel Assembly

Removal

1. Disconnect battery ground cable.
2. Remove control knobs from radio shafts, if so equipped.
3. Disconnect wire from cigar lighter, if so equipped.
4. Unsnap name plate from its recessed location to the right of the registers, if so equipped.
5. Remove six screws (five without nameplate) retaining register panel assembly to instrument panel (Fig. 15).
6. Pull register panel assembly from instrument panel, unsnapping two clips at the right end of register panel.

Installation

1. Position register panel assembly in the instrument panel and engage two snap clips.
2. Install register panel assembly attaching retaining screws.
3. Install nameplate, if so equipped.
4. Connect wire to cigar lighter, if so equipped.

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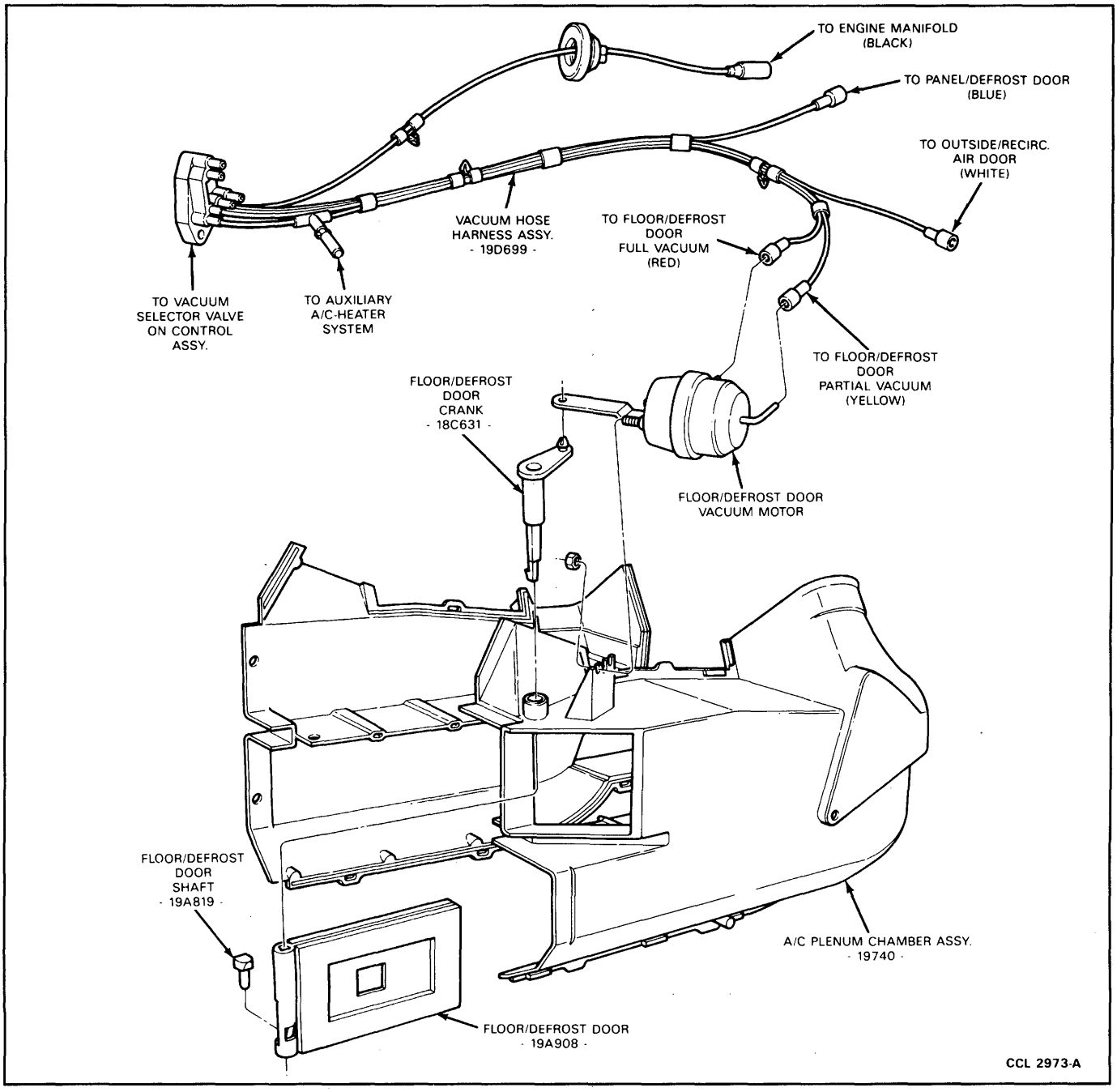


FIG. 11 Typical Vacuum Motor to Plenum Installation and Vacuum Harness Assembly

5. Install control knobs on radio shafts, if so equipped.
6. Connect battery ground cable.

Left Register Assembly

Removal

1. Disconnect battery ground cable.
2. Remove ignition lock cylinder and ignition switch bezel.
3. Remove headlamp switch knob and shaft. Then, remove headlamp switch bezel.
4. Remove knob from windshield wiper switch.
5. Remove two screws retaining left register panel to instrument panel (Fig. 16).
6. Pull register panel assembly away from instrument panel to disengage snap clips at top of register panel.

Installation

1. Position register panel to instrument panel and push to engage snap clips.
2. Install two screws retaining lower edge of register panel to instrument panel.
3. Install headlamp switch bezel, knob and shaft assembly.
4. Install ignition switch bezel and ignition switch lock cylinder.
5. Install windshield wiper switch knob.
6. Connect battery ground cable.

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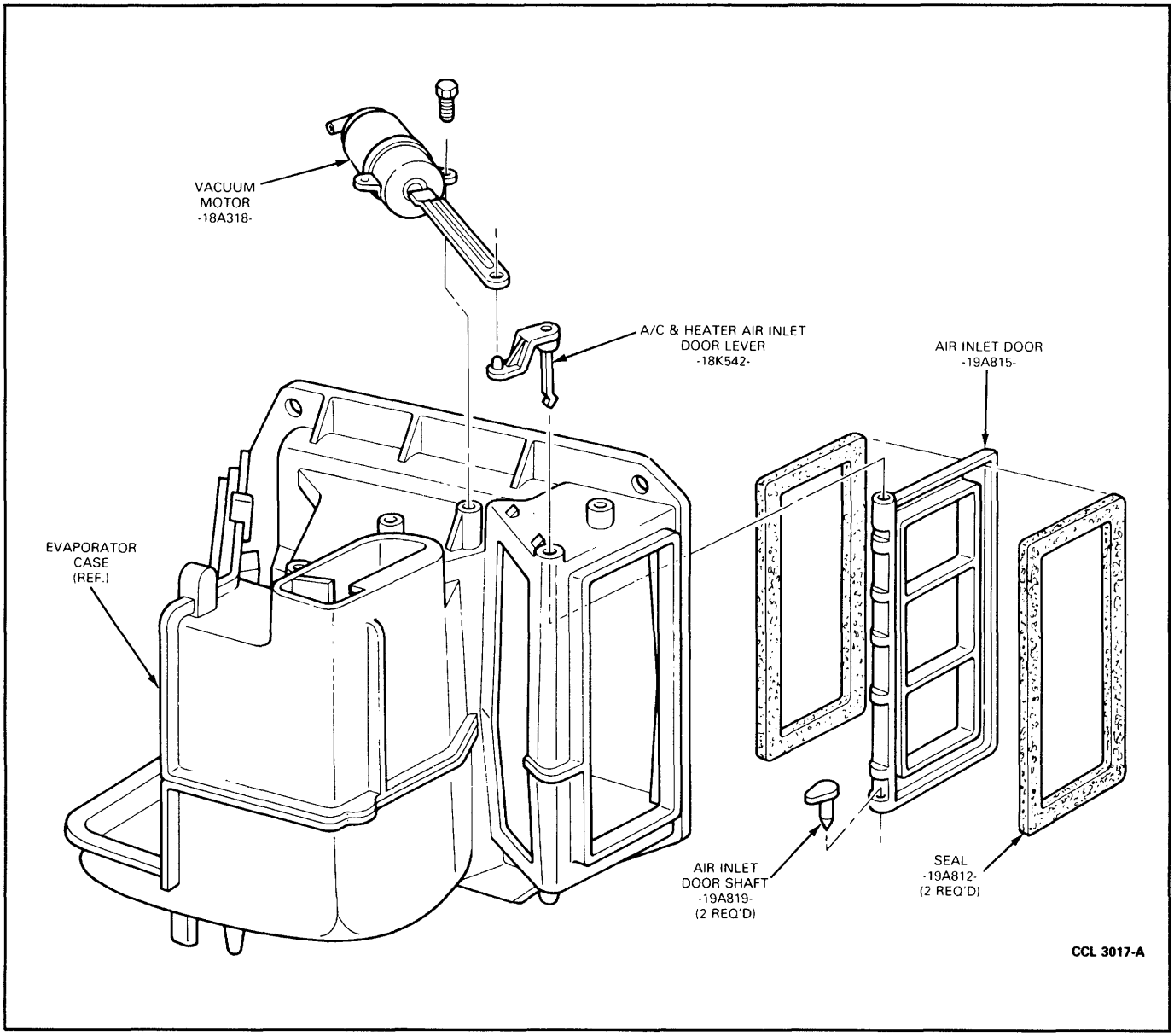


FIG. 12 Outside/Recirc Air Door Vacuum Motor

Heater Blower Assembly

There are five tee shoulder pilot studs which pass through holes in the instrument panel, located around the edges of a large cutout in the panel. This cutout is an opening between the heater blower housing assembly (Part No. 18456) on the engine compartment side of the instrument panel and the A/C evaporator core rear housing assembly (Part No. 19A583) on the passenger compartment side of the panel. Nut and washer assemblies draw the two major components together through their gaskets at the instrument panel.

A disassembled view of the components in the heater blower housing assembly is shown in Figure 17.

The disassembled view illustrates the attaching locations of the blower motor resistor assembly and the blower housing to blower motor tube.

Heater Hose Installation

Figures 18 through 22 illustrate heater hose installations for the 4.9L (300 CID), 5.0L (302 CID), 5.8L (351 CID), 7.5L (460 CID), and 7.3L (445 CID) diesel engines.

Quick Connect/Disconnect Hose Couplings

The quick connect and disconnect tools for hoses having a quick connect coupling are shown in Figure 23.

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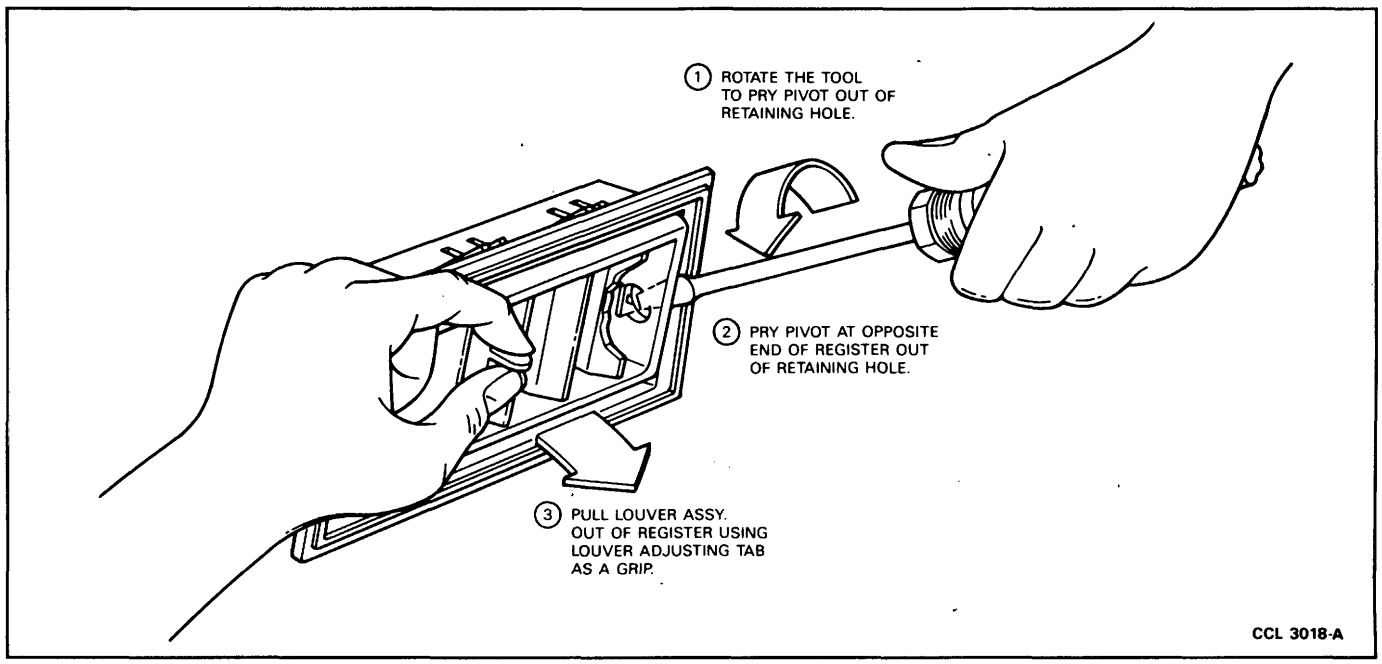


FIG. 13 Louver Removal

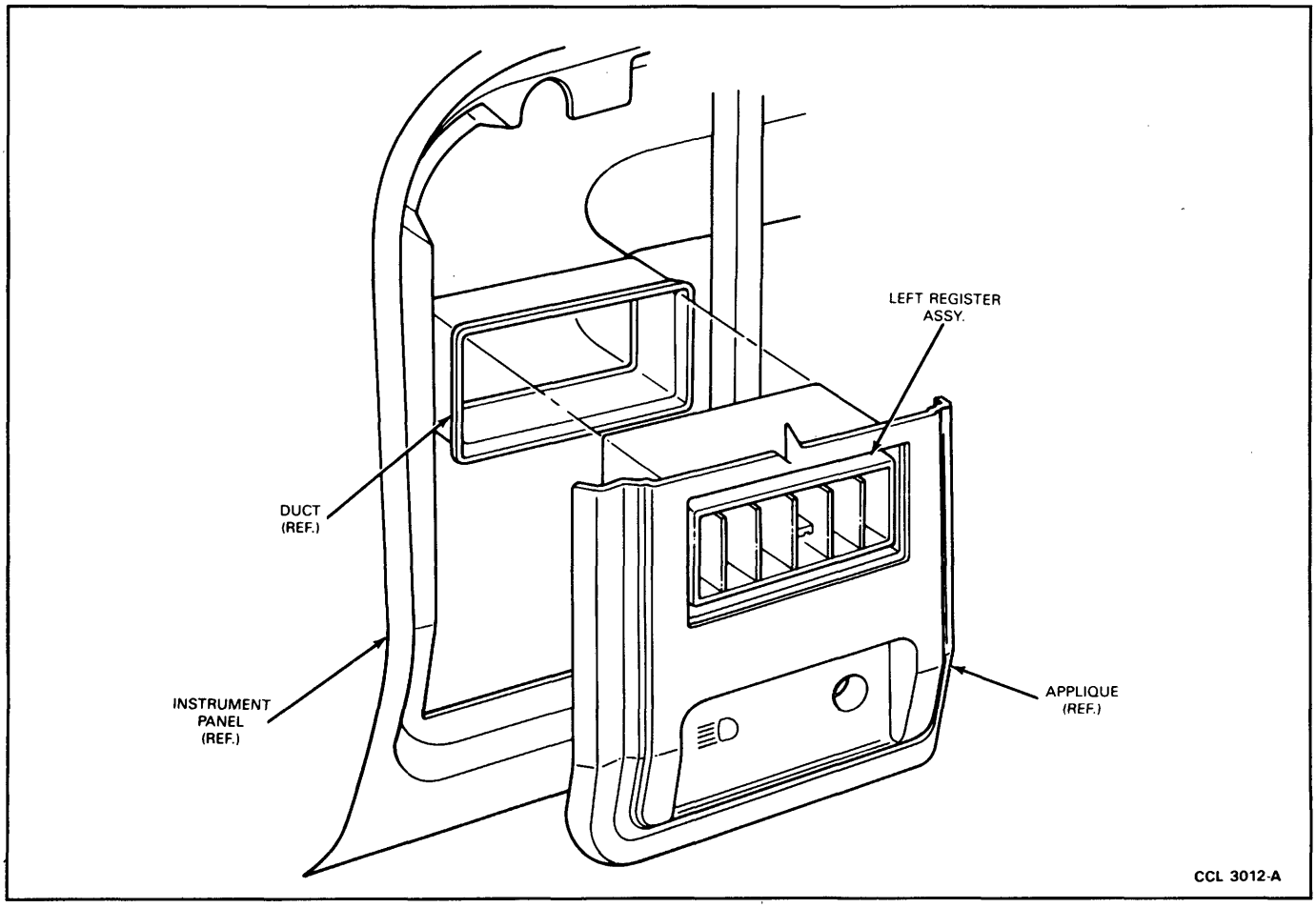


FIG. 14 Right Register Assembly

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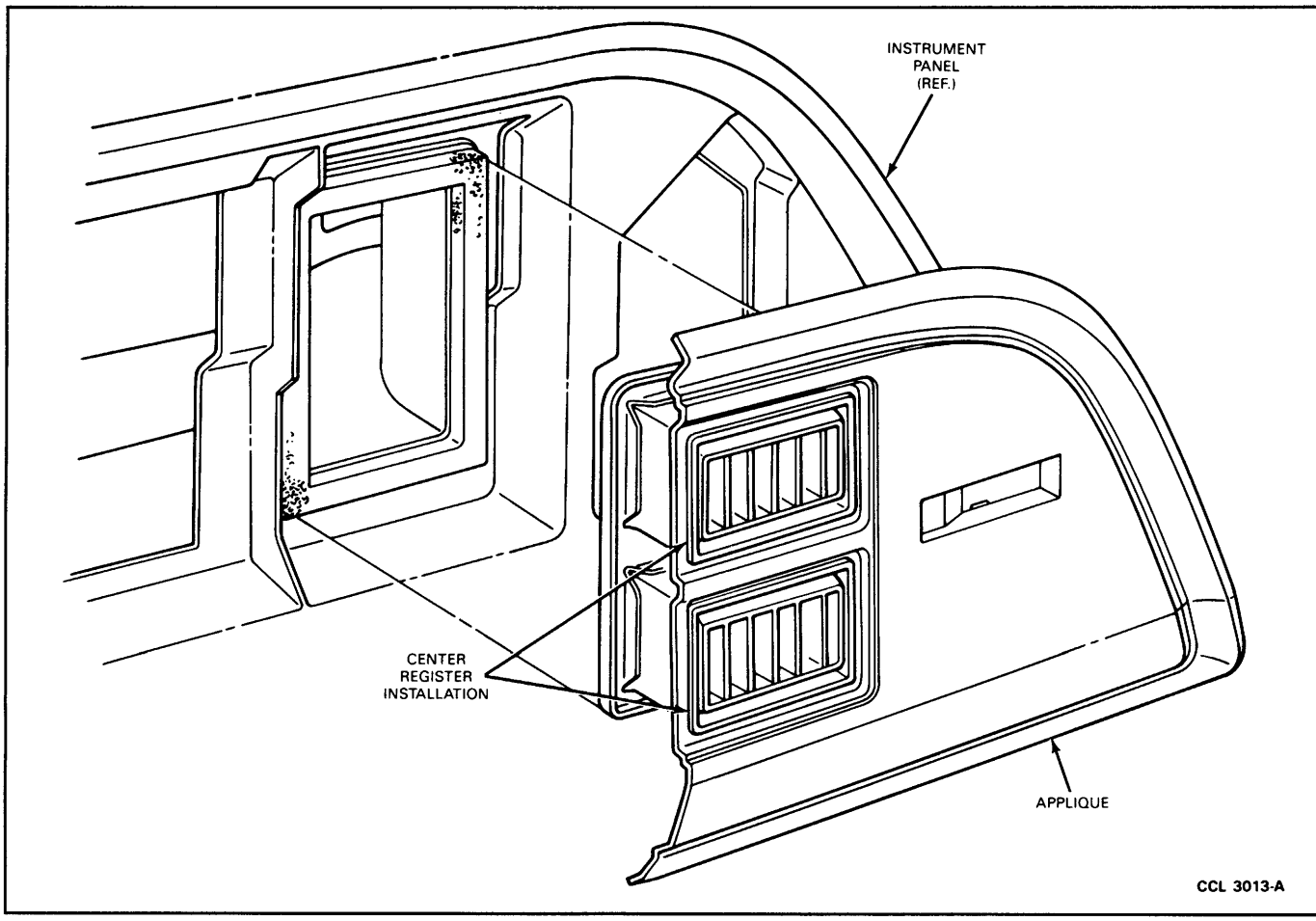


FIG. 15 Center Register Assembly

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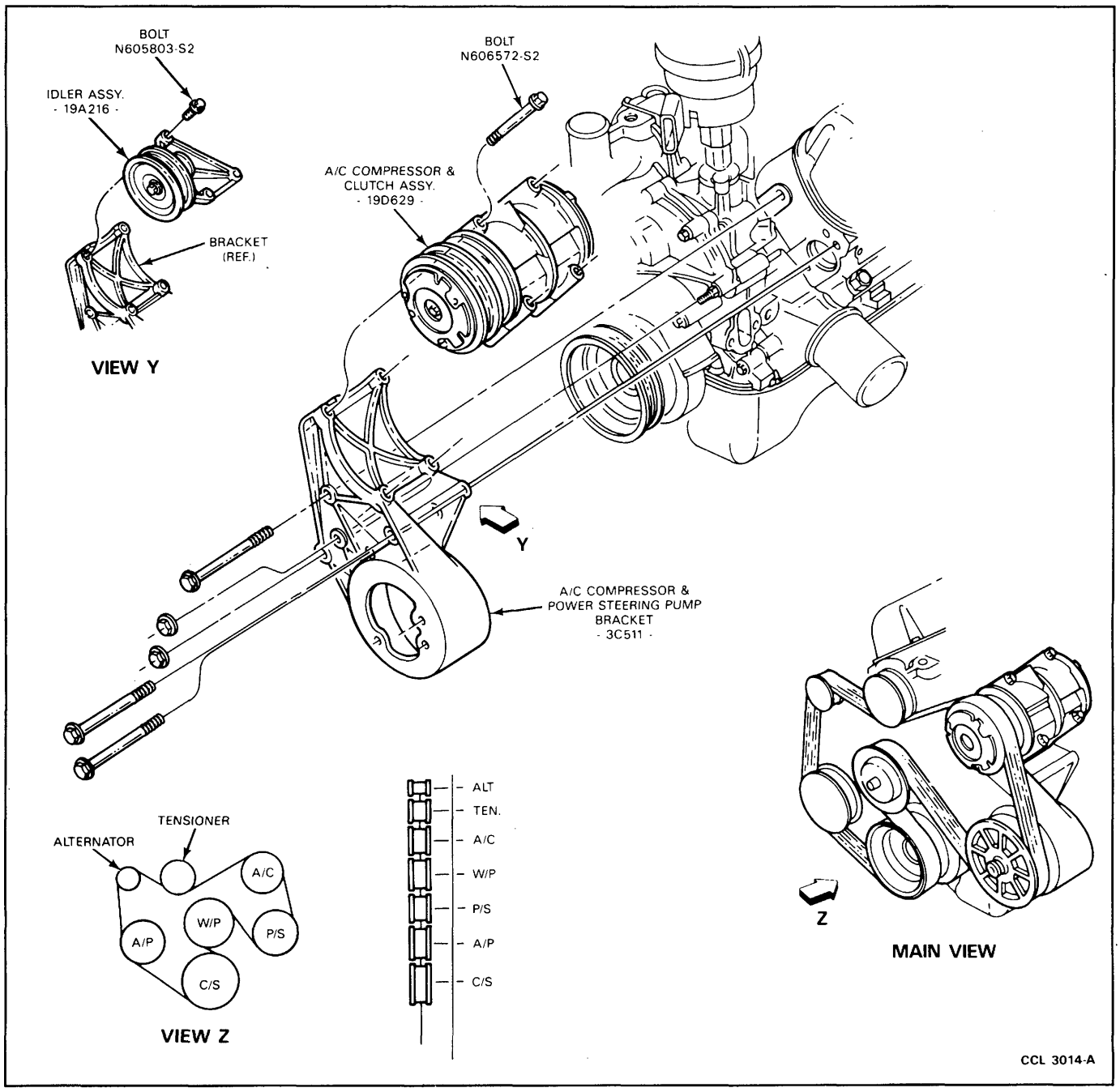


FIG. 16 Left Register Assembly

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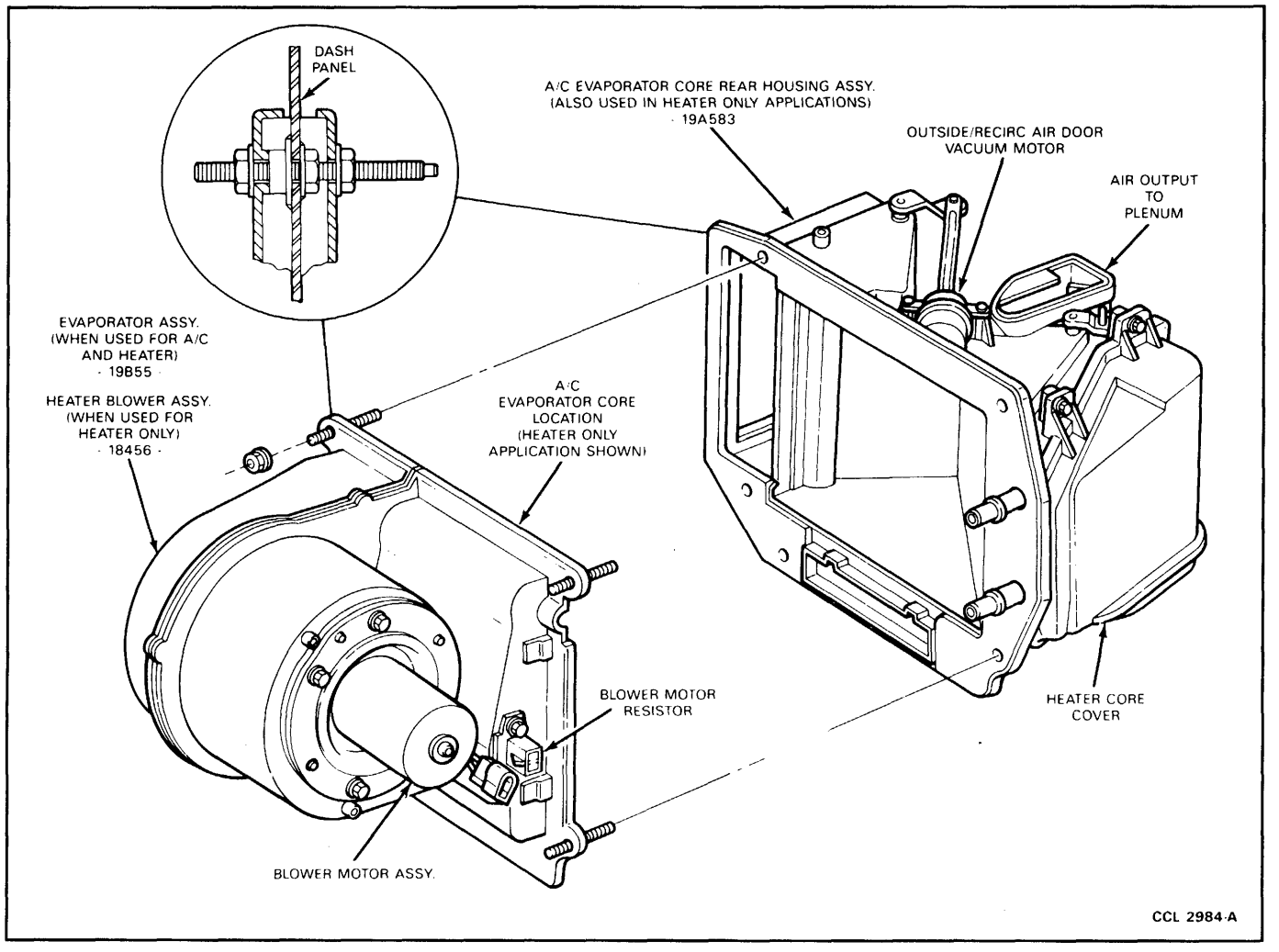


FIG. 17 Heater Blower Housing Assembly

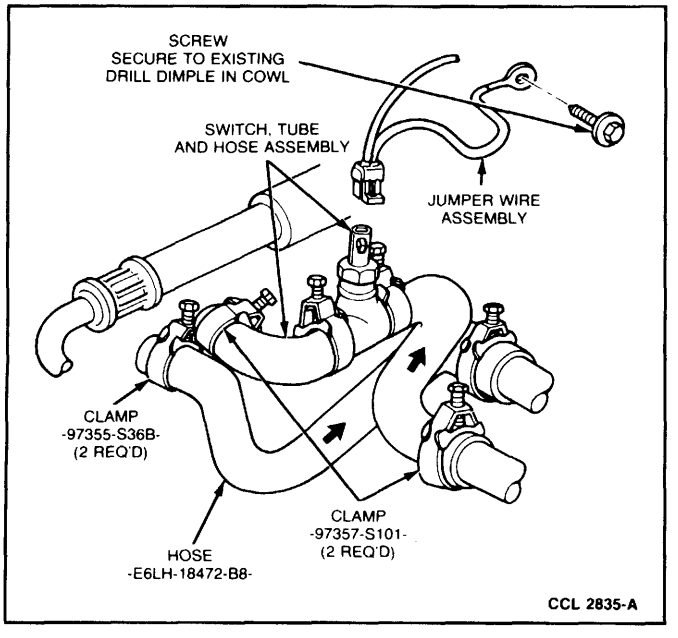


FIG. 18 Heater Hose Installation—4.9L (300 CID - 6-Cylinder) Engine

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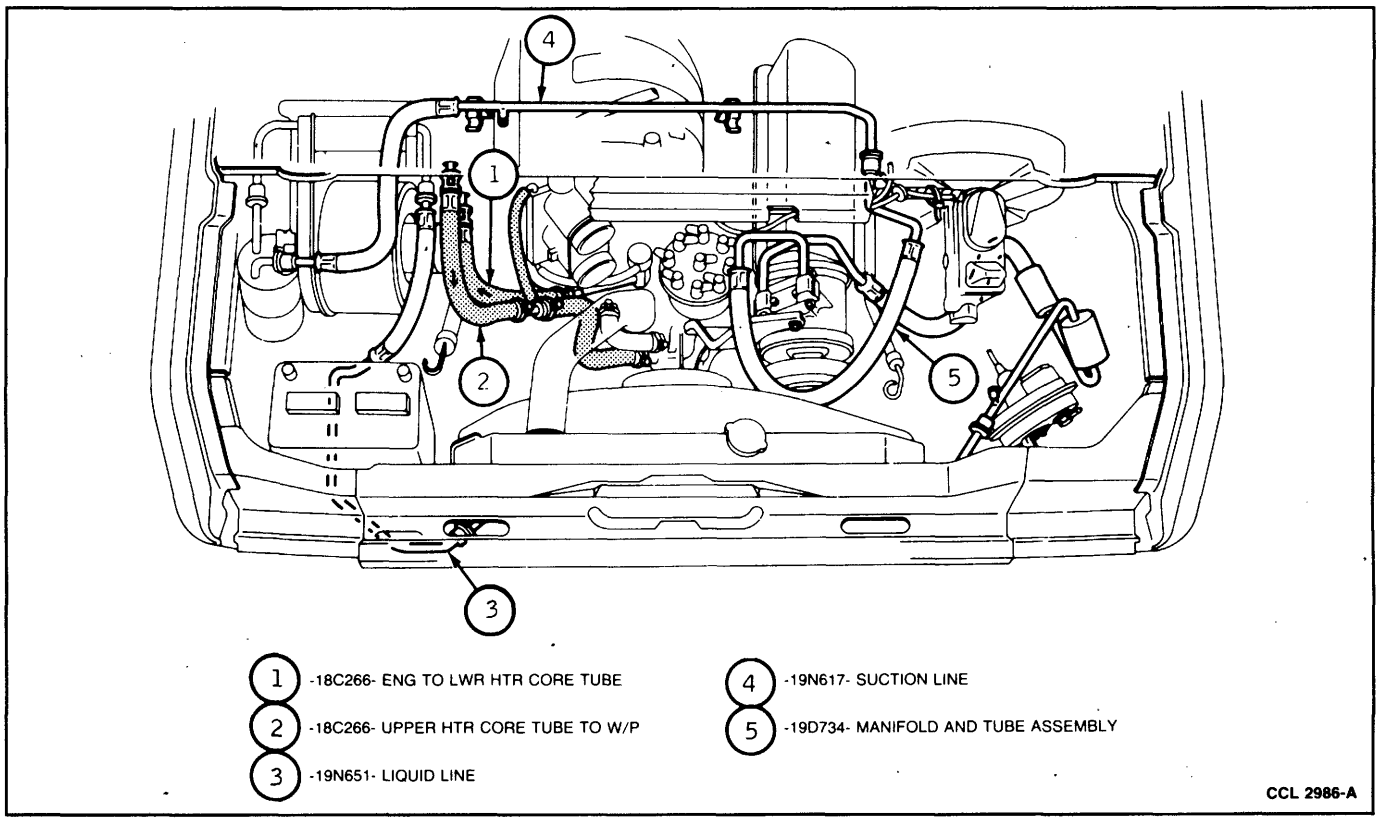


FIG. 19 Heater Hose Installation—5.0L (302 CID) - 8 Cylinder) Engine

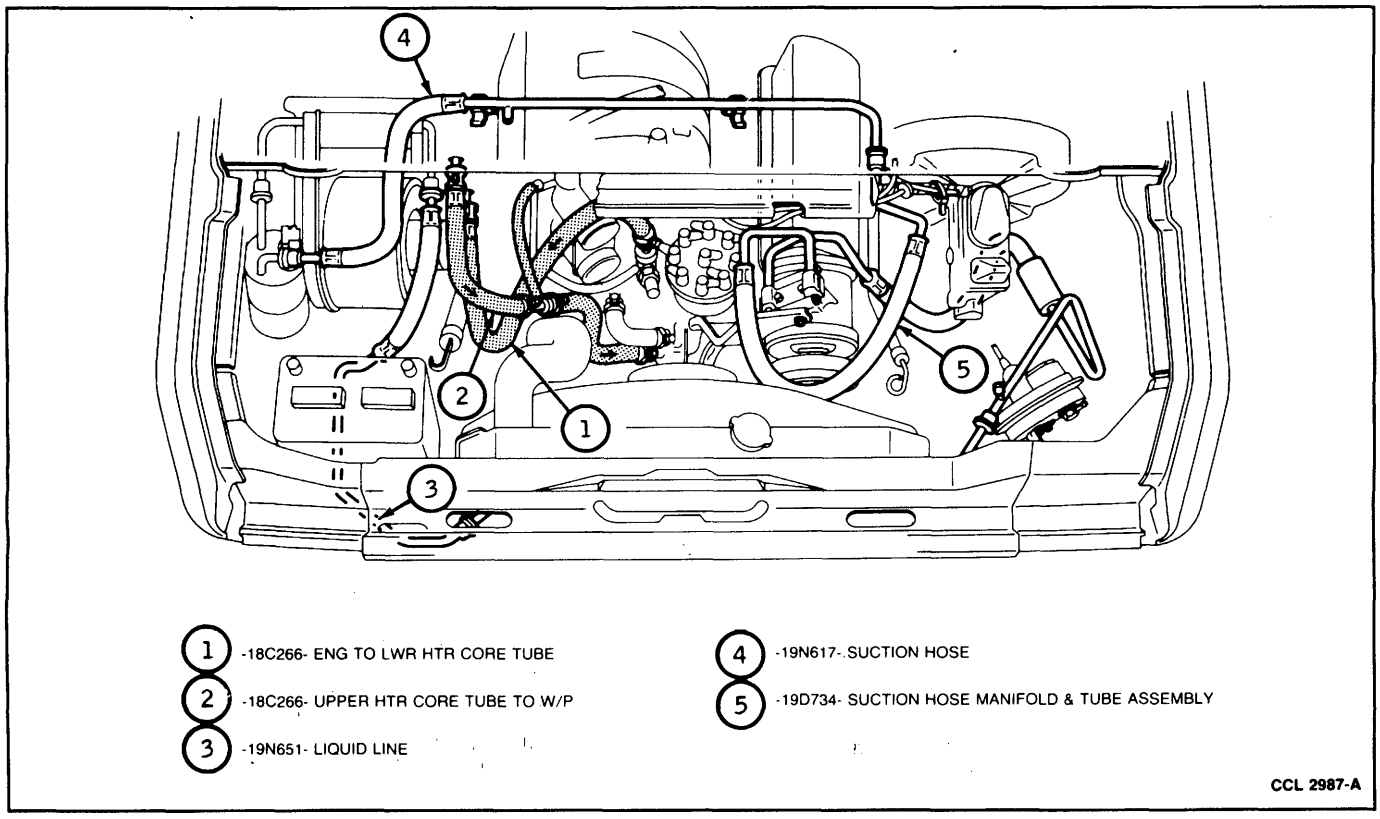
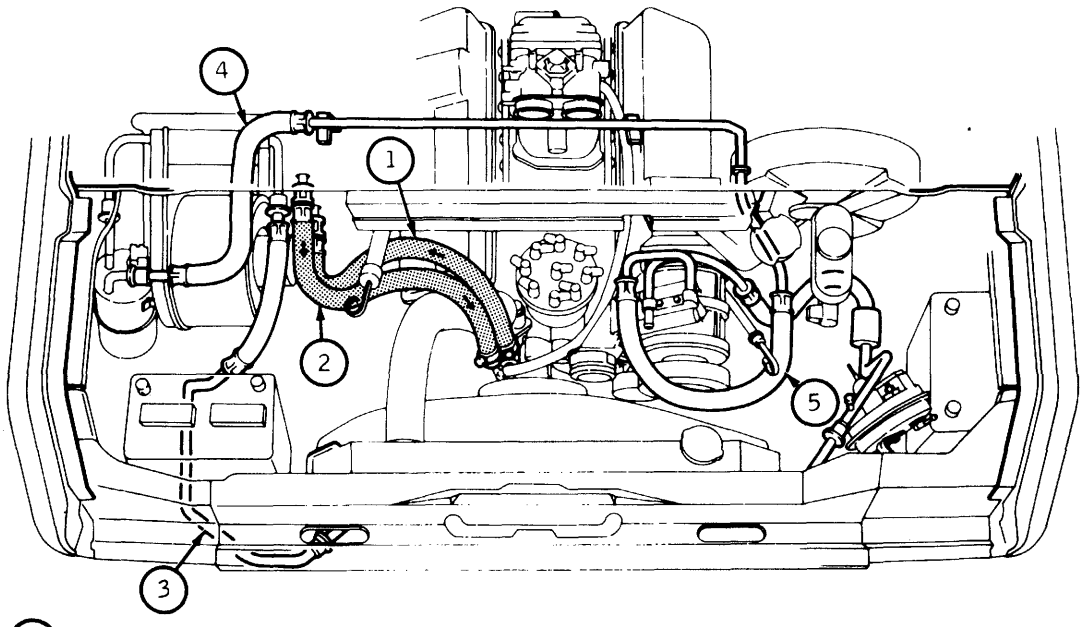


FIG. 20 Heater Hose Installation—5.8L (351 CID) 8-Cylinder) Engine

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1 -18C266- ENG. TO LWR CORE TUBE
2 -18C266- UPPER CORE TUBE TO W/P
3 -19N651- LIQUID LINE
4 -19N617- SUCTION LINE
5 -19D734- MANIFOLD AND TUBE ASSEMBLY

CCL 2988-A

FIG. 21 Heater Hose Installation—7.5L (460 CID) 8-Cylinder

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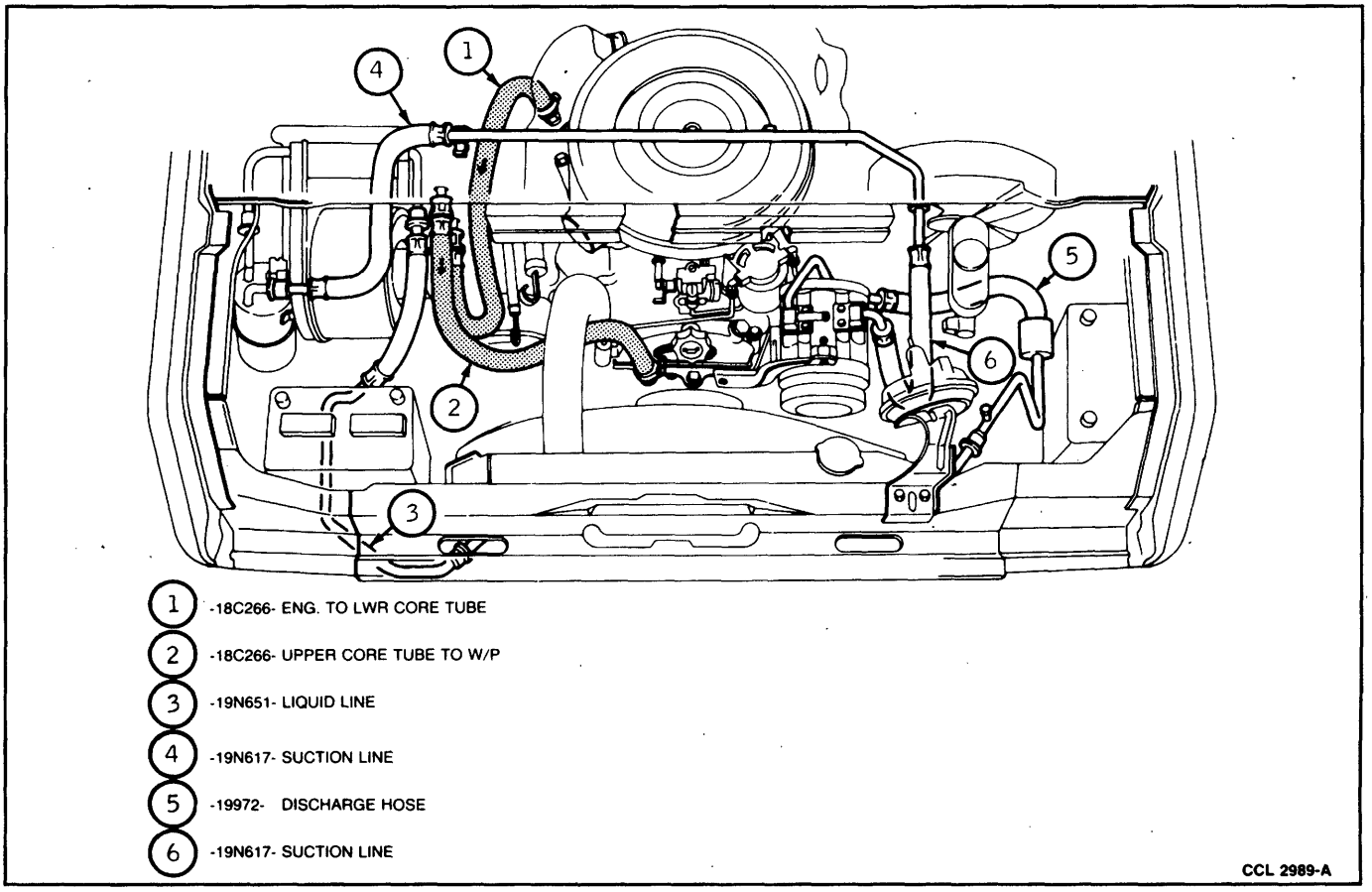


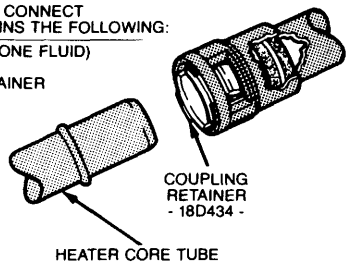
FIG. 22 Heater Hose Installation—7.3L (445 CID) Diesel Engine

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	O-RINGS	SPACER	COMPLETE ASSEMBLY
5/8 IN TO 5/8 IN QUICK CONNECT	390422-S	390420-S	- 18D535 -
3/4 IN TO 3/4 IN QUICK CONNECT	390423-S	390421-S	- 18D535 -

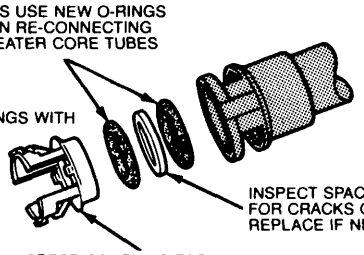
COMPLETE QUICK CONNECT ASSEMBLY CONTAINS THE FOLLOWING:
2 - O-RINGS (SILICONE FLUID)
1 - SPACER
1 - COUPLING RETAINER
1 - HOUSING

SILICONE FLUID
ESF-M99B112-A

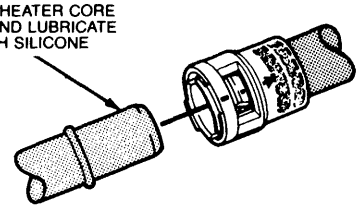


QUICK CONNECT COUPLING - DISCONNECTED

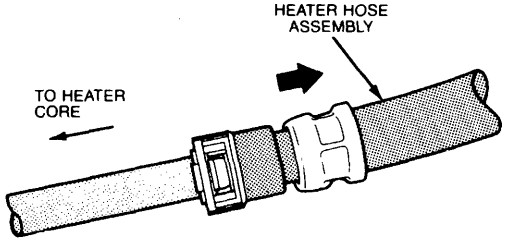
TO CONNECT COUPLING



1



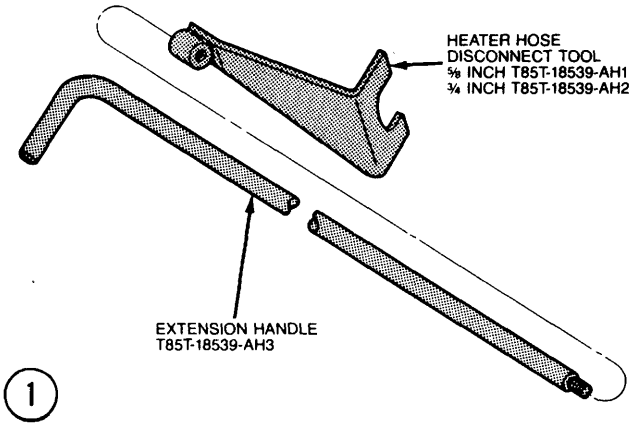
2 ASSEMBLE FITTINGS TOGETHER BY PUSHING TOGETHER — LISTEN FOR COUPLING RETAINER TO SNAP IN PLACE.



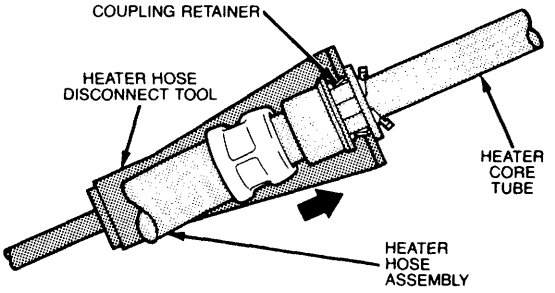
3 TO ENSURE QUICK CONNECT ENGAGEMENT, LIGHTLY PULL ON THE HEATER HOSE ASSEMBLY

TO DISCONNECT COUPLING

CAUTION — ENGINE SHOULD BE OFF BEFORE DISCONNECTING COUPLING

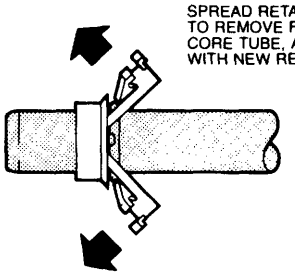


1



PUSH HEATER HOSE ASSEMBLY TOWARDS HEATER CORE TUBE TO ENSURE LOCKING TABS ARE FULLY EXPOSED, THEN PUSH TOOL OVER COUPLING RETAINER WINDOWS TO COMPRESS RETAINER LOCKING TABS — THEN PULL HOSE ASSEMBLY AWAY FROM HEATER CORE TUBE. REMOVE TOOL THEN CONTINUE PULLING HOSE ASSEMBLY AWAY FROM HEATER CORE TUBE.

2 **NOTE:** WHEN COMPRESSING WHITE COUPLING RETAINER, THE TOOL MUST BE PERPENDICULAR AND ON THE HIGHEST POINT OF THE COUPLING RETAINER AS SHOWN ABOVE.



3 WHEN THE QUICK CONNECT COUPLING IS DISCONNECTED — THE WHITE COUPLING RETAINER WILL REMAIN ON THE HEATER CORE TUBE. INSTALL NEW COUPLING RETAINER, SPACER & NEW LUBRICATED O-RINGS INTO QUICK CONNECT ASSEMBLY HOUSING BEFORE RE-INSTALLING HEATER HOSE ASSEMBLY TO HEATER CORE TUBES.

CCL 2443-A

FIG. 23 Heater Hose Quick Connect Coupling Tool

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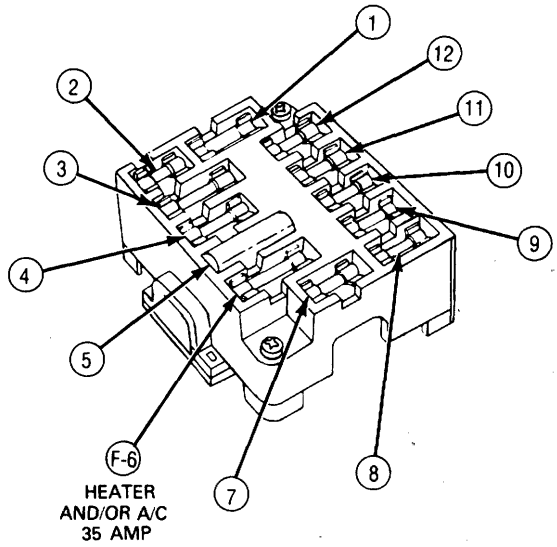
SPECIFICATIONS

ELECTRICAL

System Protection	35 Amp Fuse	
Blower Circuit	in Fuse Panel (F-6)	
Blower Motor Current Draw		
Switch Setting	Amps	Volts
Low	4.0	4.0
Medium Low	7.3	6.0
Medium High	13.8	9.0
High	23.0	12.8
Illumination		
Control Assembly	One ICP-161 Bulb	

TORQUE SPECIFICATIONS

Heater Hose Clamps	13 to 18 lb-in



The fuse panel is located on the dash panel in passenger compartment left of the steering column.

CL3460-2C

SPECIAL SERVICE TOOLS

SPECIAL SERVICE TOOLS

Tool Number	Description
T83P-18532-AH	Heater Control Cable Disconnect Tool
T85T-18539-AH1	5/8-Inch Heater Hose Disconnect Tool
T85T-18539-AH2	3/4-Inch Heater Hose Disconnect Tool
Rotunda Vacuum Tester	021-00014

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VEHICLE APPLICATION

F-150 Through F-350 and Bronco Truck Models.

DESCRIPTION AND OPERATION

The heater-ventilation system is a blend air design and consists of the following major components: the heater blower assembly, plenum, air distribution ducts and registers, control assembly, control cables, vacuum components and defroster nozzle (Figs. 1 and 2).

The heater blower assembly is located in the engine compartment. It houses the blower motor and wheel, the blower resistor, the outside air shutoff door and the door vacuum motor and harness. The plenum is located in the passenger compartment. It contains the heater core, heat-defrost door, temperature blend door, vent-heat door, and the cams/cranks to operate these doors. The defroster nozzle has five outlets. It connects between the plenum and the defroster openings in the instrument panel. The function and temperature control is a two-cable, mechanical-type with a separate vacuum switch for actuating the outside air shutoff door.

Heater-Ventilation System

When the panel outside air lever is moved to the VENT-HEAT position, the heater-ventilation system receives outside air from the cowl top grille for system operation (Figs. 1 and 2). Outside air enters the blower from the cowl air intake and is forced through and/or around the heater core in the plenum. Air is then directed to the floor, to the defroster nozzle, to both the floor and the defroster nozzle, or to the instrument

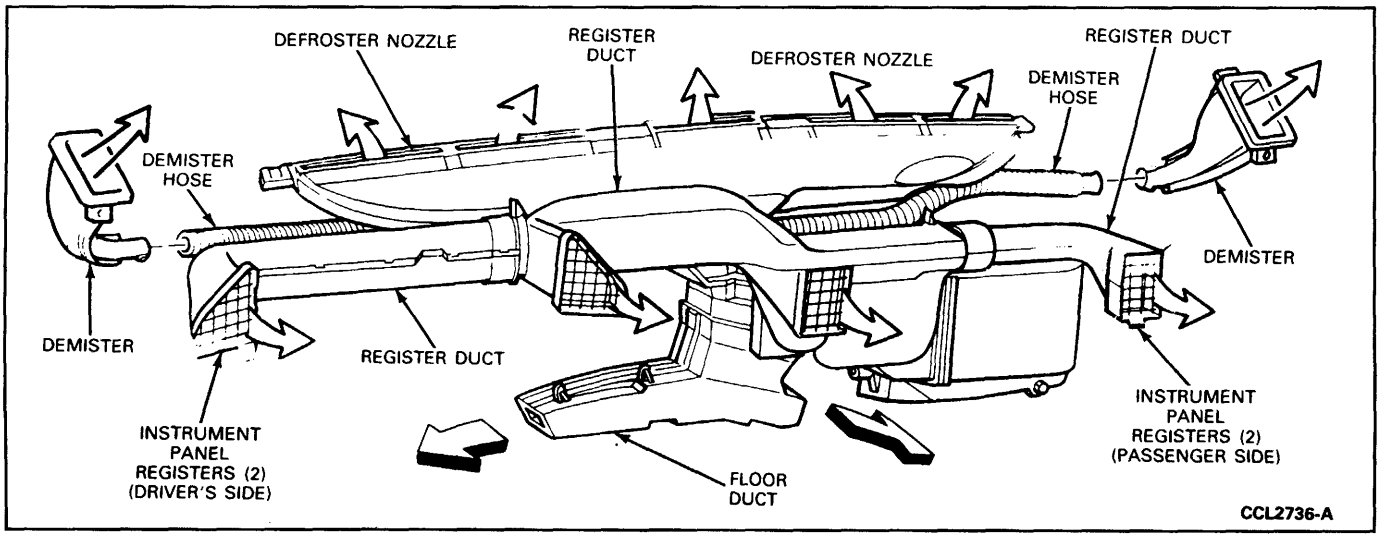


FIG. 1 Heater-Ventilation System and Distribution

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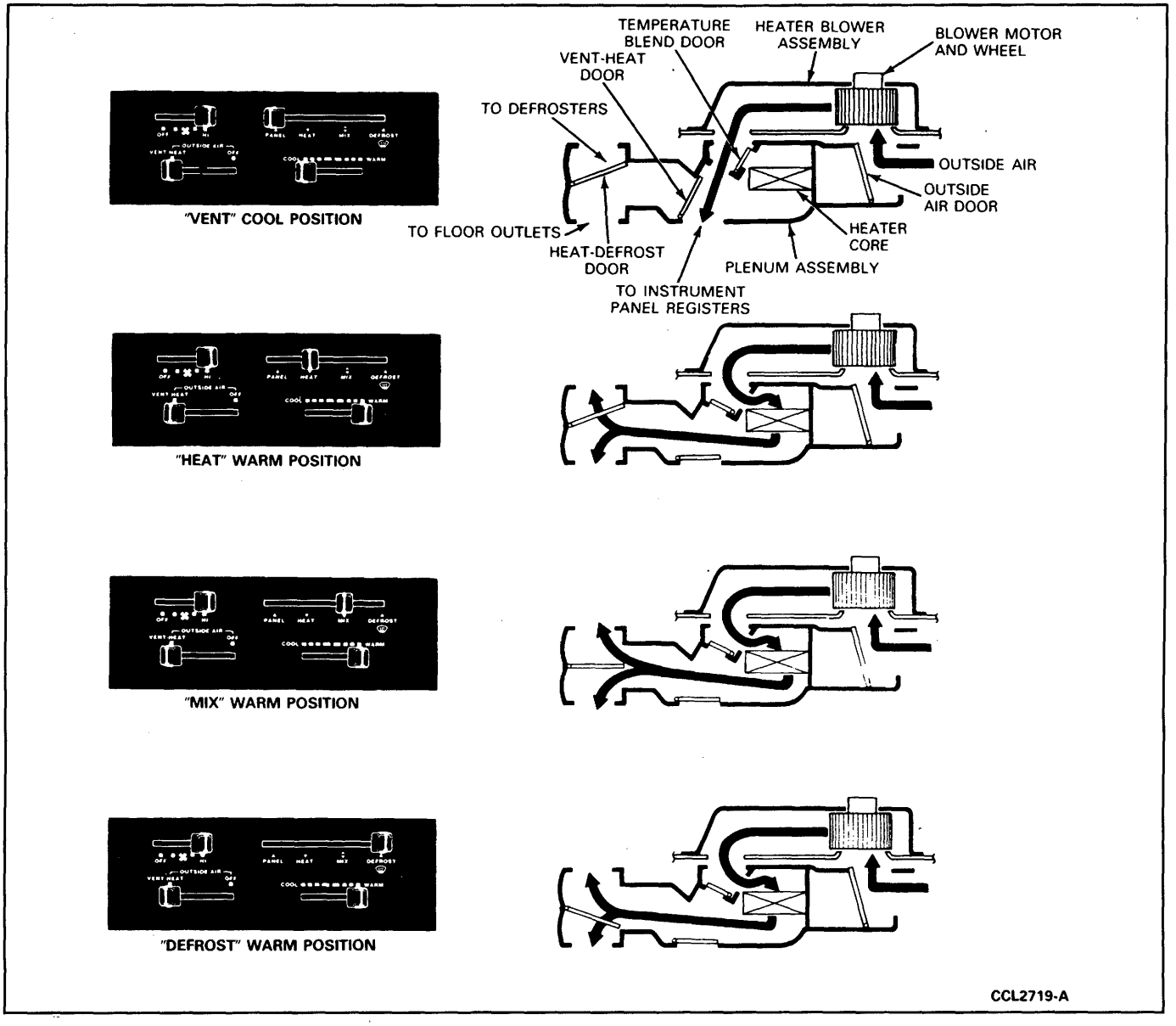


FIG. 2 Heater-Ventilation System Airflow

panel registers, depending upon the position Function selector lever.

Airflow volume is controlled by a blower switch and a resistor assembly to provide four blower operating speeds plus off. Outside airflow can be shut off by moving the outside air lever to OFF and turning the blower switch to OFF.

The system is controlled by manually adjusted cables. These cables connect the control assembly, located in the center of the instrument panel, to cams on the air doors in the plenum. The Function selector lever operates the heat-defrost door and the vent-heat door located in the plenum by means of a cable and cam. The temperature control lever operates the temperature blend door in the plenum by means of a cable and cam.

A outside air lever on the panel control operates a vacuum switch which actuates the outside air shut-off door vacuum motor through a vacuum harness.

Airflow

To start airflow through the system, move the outside air function control lever to VENT-HEAT position and adjust the blower switch to the desired speed. The temperature and direction of airflow can be adjusted to suit comfort by moving the temperature control lever and the function selector lever.

Temperature Control

The temperature blend door is located in the plenum. It directs outside air to flow through the heater core for heating, or to bypass the heater core for ventilation with unheated air. It is controlled by the temperature control lever of the control assembly (Fig. 2).

A cable assembly connects the temperature control lever to a cam which operates the temperature blend door. When the temperature control lever is at the COOL position, the temperature blend door directs outside air to bypass the heater core and it remains unheated. When the temperature control lever is at

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WARM, the temperature blend door directs outside air through the heater core where the air is heated.

Positioning the temperature control lever in any position between COOL and WARM causes the temperature blend door to direct more or less outside air through or around the heater core for whatever proportion of heated or unheated outside air is desired.

The air blends together as it leaves the heater core area of the plenum for distribution.

Air Distribution

Blended (heated and unheated) outside air is directed to the instrument panel registers, the floor outlets or the defroster outlets by the vent-heat door and the heat-defrost door.

A cable assembly, cam, and linkage connects the heat-defrost door to the function selector lever of the control assembly (Fig. 2). When the function function lever is at the PANEL position, the vent-heat door causes air to come out of the instrument panel register (Fig. 2).

When the function selector lever is in the HEAT position, the vent-heat door closes to the registers and airflow is directed to the floor with a small amount of bleed to the defroster. In the MIX position, airflow is divided between floor and defroster. In the DEFROST position, airflow is directed through the defroster nozzle with a small amount of bleed to the floor.

Blower Control

The blower motor is controlled by a five-position switch located on the left side of the control assembly (Fig. 2). The five switch positions are OFF, LOW, MEDIUM LOW, MEDIUM HIGH and HIGH. The four operating speeds are obtained with a resistor assembly (Fig. 3) connected in series with three of the switch operating positions and the ground side of the blower motor.

With the switch at OFF, the blower motor ground circuit is open to stop blower operation (Fig. 3).

With the switch at LOW (position next to OFF), current flow in the motor ground circuit is through three resistor coils to obtain a low motor operating speed.

With the switch at MEDIUM LOW (next position), current flow in the motor ground circuit is through two resistor coils to obtain a medium low motor operating speed.

With the switch at MEDIUM HIGH (position next to HIGH), current flow in the motor ground circuit is through one resistor coil to obtain a medium high motor operating speed.

With the switch at HIGH, current flow in the motor ground circuit bypasses the resistor assembly to obtain the maximum blower operating speed.

CAUTION: The blower switch should not be turned on until the outside air lever has been moved to VENT-HEAT position.

DIAGNOSIS AND TESTING

Blower Motor Voltage Test

1. Place temperature selector lever in mid-range position (halfway between COOL and WARM).
2. Place function control lever in PANEL position (air through registers).
3. Insert probes of Rotunda Digital Volt-Ohm Meter 007-00001 or equivalent into connector at rear of blower motor and make contact with wire terminals. With engine running, measure voltage drop across motor.
4. With engine running (battery voltage approximately 14.2 volts), voltage reading should be within range specified for each blower motor lever position. Refer to Specifications.

Blower Motor Current Draw Test

1. Disconnect blower motor electrical wire harness.
2. Connect an Rotunda Digital Volt-Ohm Meter 007-00001 or equivalent between left (positive) terminal on motor and corresponding terminal of wire harness connector. Set meter to AMPS mode. Connect a jumper wire between right (ground) terminal on motor and corresponding terminal wire harness connector (Fig. 3).
3. Place system temperature control lever in the mid-range position (halfway between COOL and WARM) and function control lever in PANEL position (air through registers).
4. With battery fully charged, start engine and operate blower in all blower speeds. Record current draw for each blower speed.
5. The current draw for each blower speed should be within limits shown in Specifications.
6. Disconnect Digital Volt-Ohm Meter 007-00001 or equivalent and jumper wire. Connect the harness connector to blower motor.
7. Check blower system for proper operation.

ADJUSTMENTS

Function and Temperature Control Cables

To check the function control cable adjustment, set the blower switch to HIGH and move the function control lever to its various positions. Check for airflow at the appropriate outlets (Fig. 2).

If airflow does not occur through outlets selected by the function control lever, the function control cable may be misadjusted or not connected. Refer to Cable Adjustment or Cable Removal and Installation.

To check the temperature control cable adjustment, move the temperature control lever back and forth, checking for the sound of the temperature blend door seating against the stop. If the sound of the door seating is not heard before the lever reaches its limit of travel, the temperature control cable may be misadjusted or not connected. Refer to Cable Adjustment or Cable Removal and Installation.

NOTE: If the function or temperature levers do not move left or right and appear to be locked in place, the adjustment pins may have been inadvertently left in the control cams during assembly.

The function control cam is located on the bottom of the plenum. The pin can easily be seen and removed.

To remove temperature control cam adjustment pin:

1. Disengage glove compartment door by squeezing side with stop and removing pin retaining check strap from opposite side. Allow door to hang free.
2. Working through glove compartment opening and using a mirror for visibility, remove red assembly

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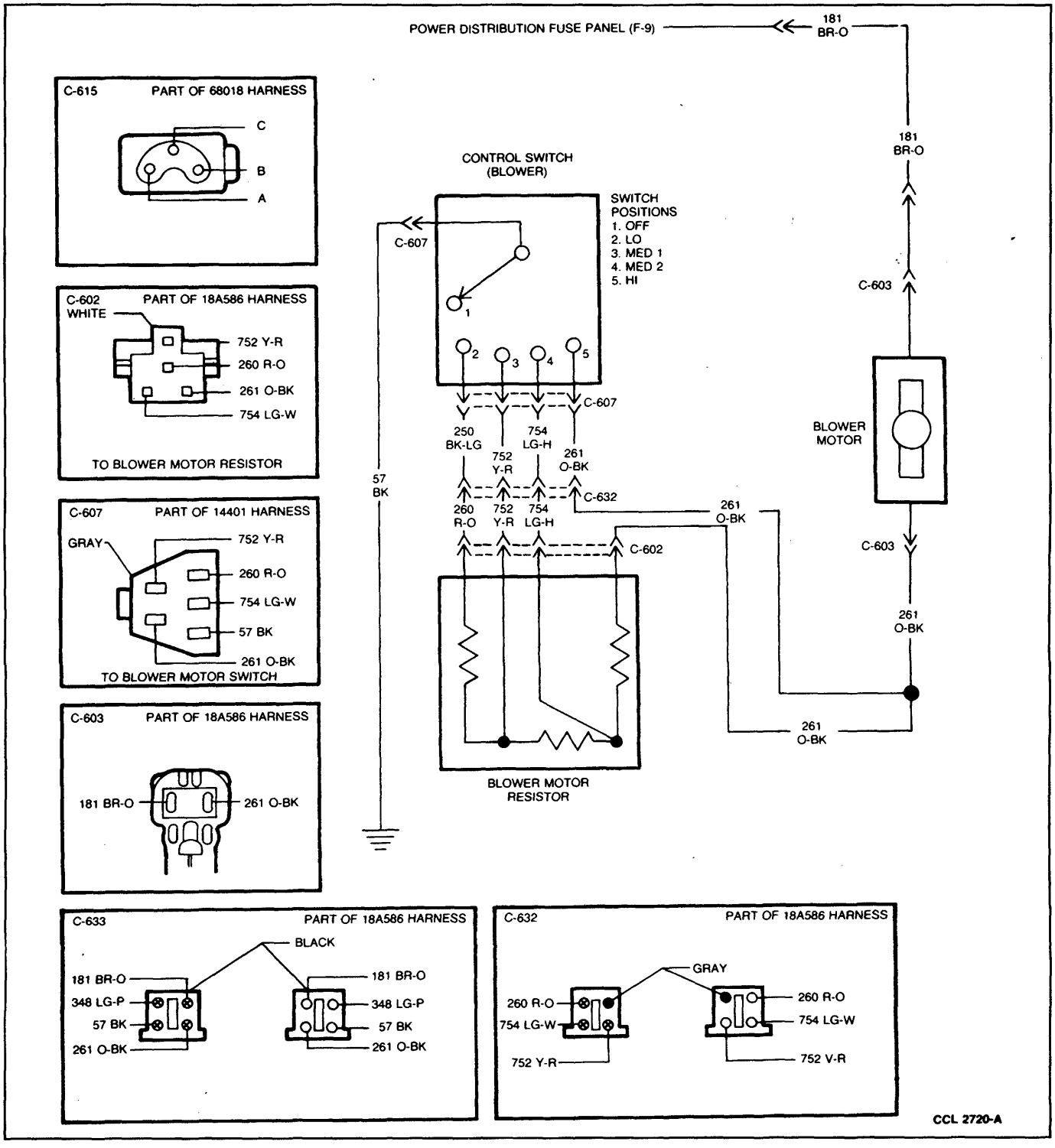


FIG. 3 Heater System Electrical Schematic

pin from control cam with a mechanical fingers tool or a wire with a hook on the end.

3. Check for proper control cable operation.
4. Install glove compartment and door.

Cable Adjustment

The function control cable is located on the bottom of the plenum. The temperature control cable is located on the top of the plenum.

Adjust the function control cable as follows:

1. Remove cable jacket from metal attaching clips on bottom of plenum by depressing clip tab and pulling cable down.

NOTE: Cable end should remain attached to door cam and/or crank arm.

2. Move function lever to DEFROST position and hold firmly.

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3. With cable end attached to function cam, pull on cable jacket until cam travel stops. Install cable into clip by pushing up until it snaps into place (Fig. 4).
4. Run system blower on HIGH and actuate function lever to check for proper adjustment.

Adjust the temperature control cable as follows:

1. Disengage glove compartment door by squeezing side with stop and removing pin retaining check strap from opposite side. Allow door to hang free.
2. Working through glove compartment opening, remove cable jacket from metal attaching clip on top of plenum by depressing clip tab and pulling cable up.

NOTE: Cable end should remain attached to door cam and/or crank arm.

3. Set temperature control lever to COOL and hold firmly.
4. With cable end attached to temperature door cam, push gently on cable jacket to seat blend door (push until resistance is felt). Install cable into clip by pushing cable jacket into clip from top until it snaps into place (Fig. 4).
5. Operate system to check temperature control.

REMOVAL AND INSTALLATION

Control Assembly

Removal

1. Disconnect battery ground cable(s).
2. Pull center finish panel away from instrument panel to expose heater control attaching screws (Fig. 5).
3. Remove four screws attaching control assembly to instrument panel.
4. Pull control assembly through instrument panel opening far enough to allow removal of electrical

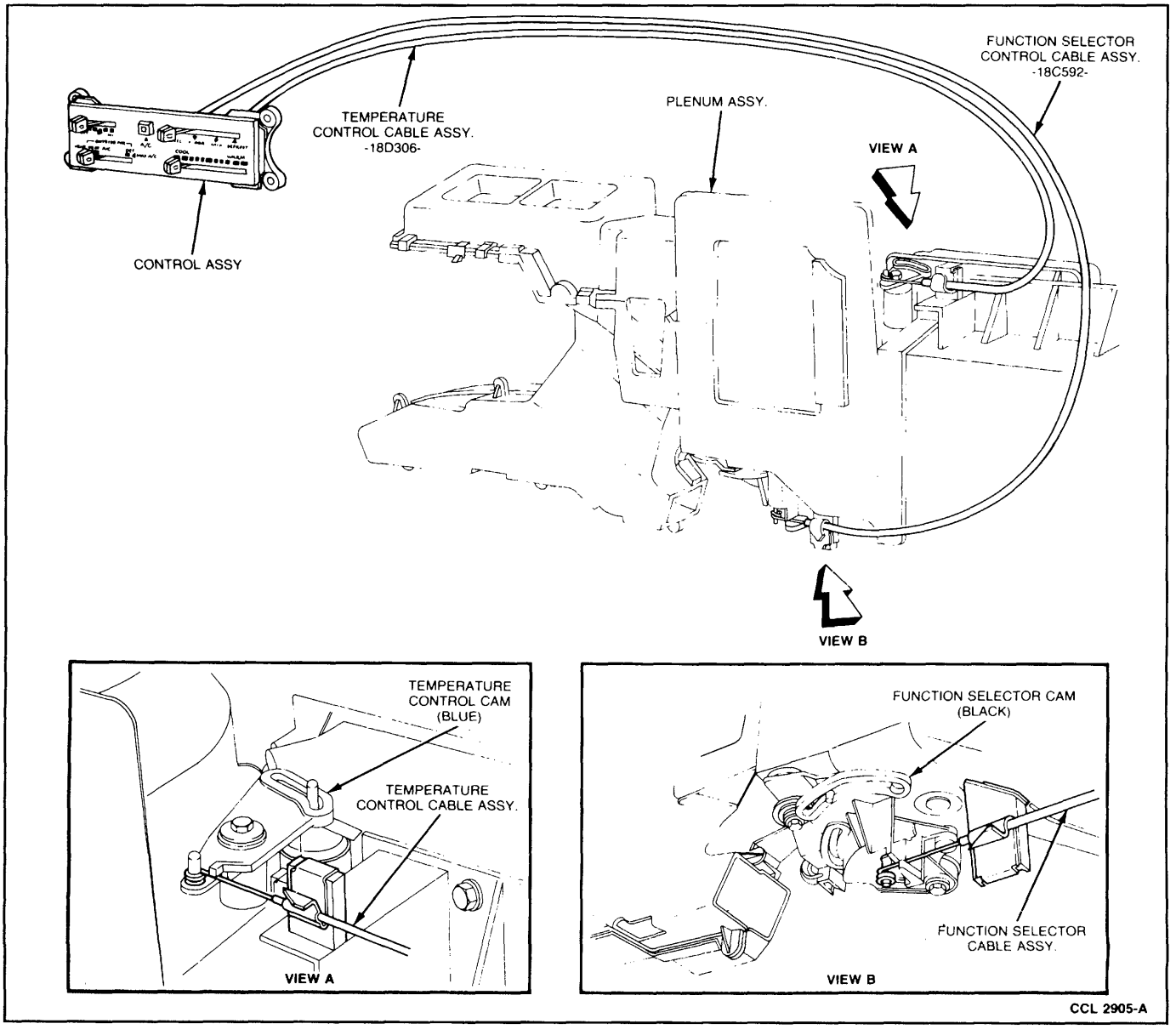


FIG. 4 Control Cable-To-Cam Connection

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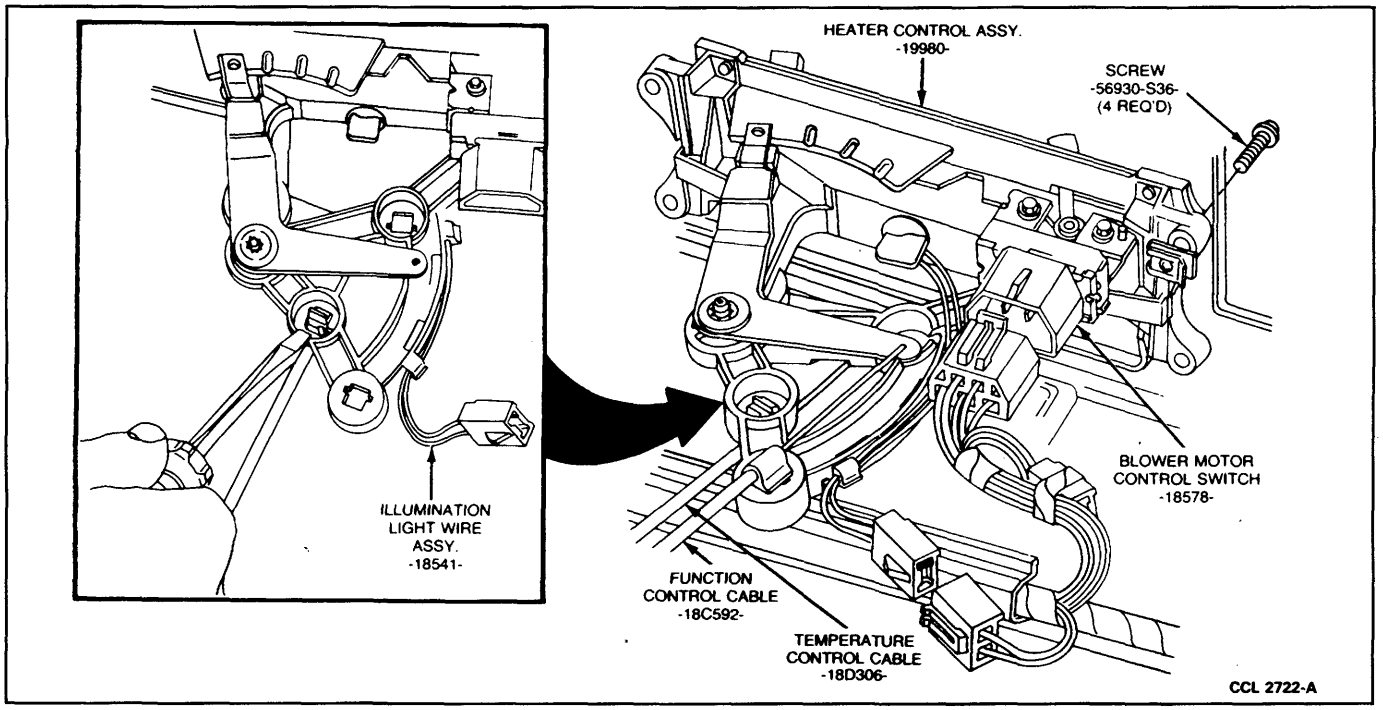


FIG. 5 Heater Control Removal

connectors from blower switch and control illumination lamp.

5. Disconnect vacuum harness from outside air control.
6. Working from bottom of control with a screwdriver or needlenose pliers, carefully release function control cable snap-in flag from control bracket (Fig. 5).
7. Pull enough cable through instrument panel opening to allow cable to be held vertical to control. Then, remove cable from function control lever.
8. Working from top of control with a screwdriver or needlenose pliers, carefully release temperature control snap-in flag (Fig. 5).
9. Rotate control 90 degrees and disconnect temperature control cable from temperature control lever. Move control away from instrument panel.

Installation

1. Pull control cable approximately 203mm (8 inches) through control assembly opening in instrument panel.
2. Hold control assembly up to instrument panel with control face toward floor.
3. Attach temperature cable to temperature control lever. Rotate control back to normal position and snap cable flag into control bracket. Be sure it is firmly in place.
4. Gently bend function control cable down to the control. Attach cable to function control lever and snap cable flag into control assembly bracket.
5. Connect wire harness to blower switch and control illumination lamp. Connect vacuum harness to outside air door control.
6. Position control assembly in instrument panel and install four attaching screws.
7. Snap finish panel into place. Be sure it is seated firmly.
8. Connect battery cable(s).
9. Check system for proper operation.

Blower Switch

Removal

1. Disconnect battery ground cable(s).
2. Remove control assembly instrument panel as outlined. Do not detach cables.
3. Remove knobs from blower switch by placing a small screwdriver between knob spring retainer and face of control assembly. Apply pressure to knob spring retainer by pulling on screwdriver and pull knob from switch.
4. Pull control assembly through instrument panel opening far enough to allow removal of blower switch electrical connector.
5. Remove electrical connector from switch by lifting snap-lock retainer with a screwdriver and pulling on the connector.
6. Remove two hex-head screws attaching blower switch to control assembly bracket. Remove switch (Fig. 6).

Installation

1. Position switch bracket to top of control assembly, making sure locating pin is inserted into small hole of switch bracket.
2. Install two screws attaching blower switch to control assembly (Fig. 6). Install blower switch knob.
3. Connect electrical connector to blower switch.

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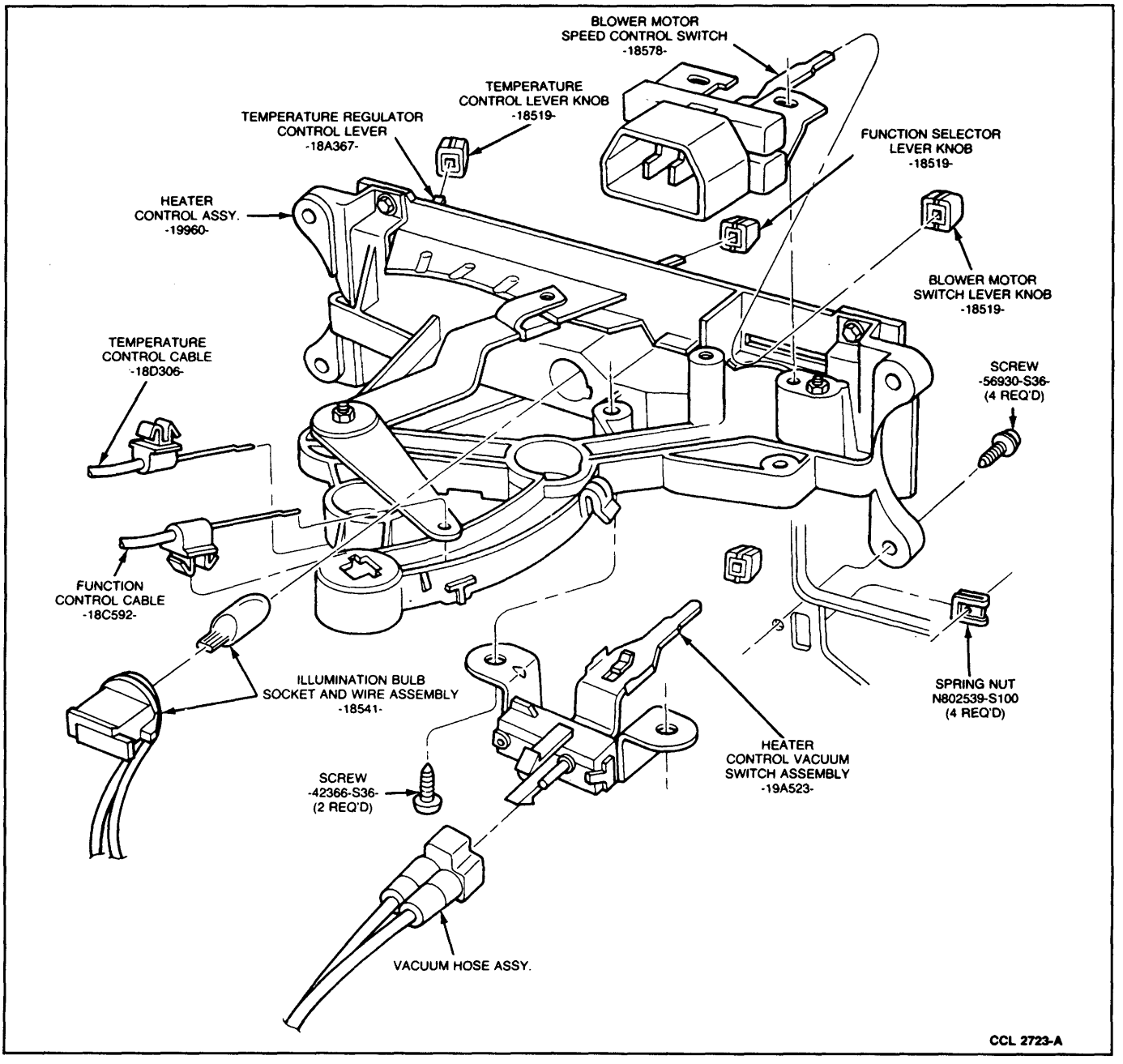


FIG. 6 Control Assembly-Disassembled

4. Position control assembly in instrument panel opening. Install four attaching screws (Fig. 5).
5. Install control assembly as outlined.
6. Connect battery ground cable(s).
7. Operate blower switch and check for proper blower motor operation.

Vacuum Switch

Removal

1. Disconnect battery ground cable(s).
2. Remove control assembly from instrument panel as outlined. Do not detach cables.
3. Remove knob from vacuum switch by placing a small screwdriver between knob & spring retainer and face of control assembly. Apply pressure to knob spring retainer by pulling on screwdriver and pull knob from switch.
4. Turn control assembly over and depress retaining clips in vacuum harness connector. Remove vacuum harness from switch.
5. Remove two hex-head screws attaching switch to control assembly bracket. Remove switch (Fig. 7).

Installation

1. Position vacuum switch against underside of control assembly.
2. Align holes and install two hex-head screws securing switch to control assembly.
3. Connect the vacuum harness connector to vacuum switch. Ensure locking tabs are engaged.
4. Install vacuum switch knob.

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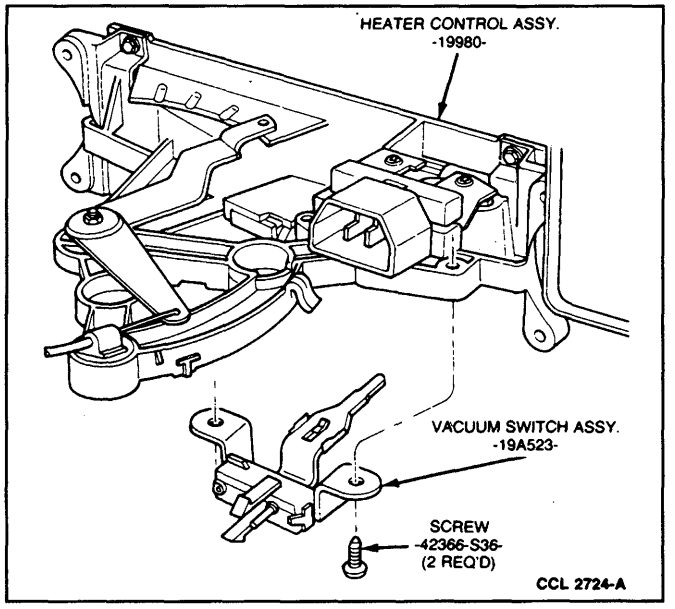


FIG. 7 Vacuum Switch Removal

5. Position control assembly in instrument panel opening. Install four attaching screws (Fig. 5).
6. Install control assembly as outlined.
7. Connect battery ground cable(s) and start engine to create vacuum.
8. Operate vacuum switch and check for proper operation of outside air door.

Control Cables

Removal

1. Removal the control assembly from instrument panel as outlined.
2. Disengage glove compartment by squeezing side with stop and removing pin retaining check strap from outside. Allow glove compartment to hang free.
3. Working through glove compartment, remove temperature control cable housing from clip on top of plenum by depressing clip tab and pulling cable up.
4. Remove function control cable housing from clip on underside of plenum by depressing clip tab and pulling cable down.
5. Working from bottom of control using a screwdriver or needlenose pliers, carefully release function control cable snap-in flag from center bracket (Fig. 5).
6. Pull slack in function control cable wire through the control opening. Turn wire 90 degrees vertical to control assembly and disconnect cable wire from function control lever.
7. Working from top of control with a screwdriver or needlenose pliers, carefully release temperature control cable snap-in flag.
8. Rotate control assembly face 90 degrees down. Disconnect temperature control cable and move control assembly away from instrument panel.
9. Disconnect temperature control cable from cam on top on plenum and function control cable from cam on underside of plenum.
10. Pull cables away from instrument panel through control assembly opening.

Installation

1. Feed wire loop ends of cables through control assembly opening in instrument panel.
2. Attach wire loop end of cable to appropriate cam assembly on top or underside of plenum. Ensure wire loop coils are up and that cable is routed under cable hold-down on cam assembly.
3. Hold control assembly with top of control toward steering wheel. Attach temperature control cable to temperature control lever. Snap flag into bottom of control assembly bracket.
4. Rotate control back to normal position and install function control cable by engaging cable wire into function control lever and snapping flag into top of control assembly bracket.
5. Position control assembly close to opening in instrument panel. Working through opening, route cables so they do not have kinks or sharp bends between control assembly and cams on plenum.
6. Adjust cables as outlined.
7. Actuate each lever and check for proper cable adjustment. Adjust if necessary.
8. Connect wire and vacuum harness to control assembly.
9. Install control assembly in instrument panel using four attaching screws.
10. Check system for proper operation.
11. Complete installation of control assembly and glove compartment as outlined.

Heater Function Control Cam

Removal

1. Remove screw holding function control cam in place on plenum and move cam away from plenum.
2. Move cam as necessary, to disconnect function control cable and remove cam from vehicle.

Installation

1. Connect function control cable to function cam. Ensure cable is routed under cable retainer in cam.
2. Position control cam on plenum and install retaining screw.
3. Check operation of cam for each heater function. Adjust control cable, if necessary.

Temperature Control Cam

Removal

1. Disengage glove compartment door by squeezing side with stop and removing pin retaining check strap from opposite side. Allow door to hang free.
2. Working through glove compartment opening, remove temperature control cam retaining screw and lift cam away from plenum.
3. Move cam as necessary, to disconnect temperature control cable and remove cam from vehicle.

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Installation

1. Connect temperature control cable to temperature control cam. Ensure cable is routed under cable retainer on cam.
2. Position temperature control cam on top of plenum and install retaining screw.
3. Check operation of cam for a full range of temperature control. Adjust temperature control cable, as necessary.

Defrost Door Control Arm

Removal

1. Remove function control cable cam.
2. Remove retaining screw from defrost door control arm.
3. Disconnect control arm from defrost door link and remove the arm from vehicle.

Installation

1. Position defrost door control arm on plenum and install retaining screw.
2. Connect defrost door link to control arms.
3. Install function control cable arms.
4. Operate control to check for proper defroster operation. Adjust function control cable, as necessary.

Instrument Panel

Removal

1. Disconnect battery ground cable(s).
2. Remove steering column cover from bottom of instrument panel by releasing four quick-operating pins (quarter turn to release).
3. Remove four screws located along top front edge of instrument panel.
4. Remove bolt from instrument panel end of instrument panel-to-dash panel bracket.
5. Remove one screw from bottom corner at each end of instrument panel.
6. Disconnect speedometer cable.
7. Disconnect hard wheel connector located at lower LH side behind instrument panel.
8. Remove radio antenna wire from clip attached to defroster nozzle, if so equipped.
9. Disconnect function and temperature control cables at plenum.
10. Pull instrument panel away from dash panel.

Installation

1. Position instrument panel to dash panel.
2. Connect function and temperature cables at plenum as outlined.
3. Install radio antenna wire into clip attached to defroster nozzle, if so equipped.
4. Connect hard shell connector located at lower LH side behind instrument panel.
5. Connect speedometer cable.
6. Install one screw in bottom corner at each end of instrument panel.
7. Install bolt into instrument panel end of instrument panel-to-dash panel brace.
8. Install four screws located along top front edge of instrument panel.
9. Position steering column corner on bottom of instrument panel and engage four quick-operating pins (one-quarter turn to engage).
10. Connect battery ground cable(s).
11. Check all systems for proper operation.

Defroster Nozzle

Removal

1. Loosen instrument panel and pull it back far enough to gain access to defroster nozzle screws.
2. Remove four screws attaching defroster nozzle to underside of instrument panel (Fig. 8).
3. Remove screw attaching defroster nozzle inlet to center duct.
4. Remove radio antenna clips on rear side of defroster nozzle, if so equipped.
5. Pull defroster nozzle rearward, clearing mounting tabs. Lift defroster nozzle out.

Installation

1. Position defroster nozzle in underside of instrument panel and install four retaining screws.
2. Install instrument panel as outlined.
3. Install defroster inlet retaining screw.

Demister Nozzles and Hoses

Removal and Installation

1. Remove instrument panel, as outlined.
2. Remove two nuts attaching RH and LH demister nozzles to instrument panel (opposite corners of panel). Disconnect flexible hose which slides over input end of nozzle (Fig. 9).
3. A connector which slides over a slip joint opening in the center duct receives the opposite end of two demister hoses. The hose to left demister nozzle slides over a neck on upper surface of connector; hose on right demister nozzle slides over a neck on onboard surface of connector. To disconnect a hose, pull it off connector and/or demister nozzle.
4. To install nozzles, hoses, and/or connector, install two attaching screws into each nozzle. Then, slide all removed demister hoses over attaching locations as necessary.
5. Install instrument panel, as outlined.

Floor Duct

Removal and Installation

1. Remove attaching screw on side of floor duct (to plenum).
2. Disengage floor duct from plenum. Remove floor duct.
3. To install, position floor duct onto plenum by engaging lug inside duct to mating part on plenum. Tilt duct into place and secure with screw.

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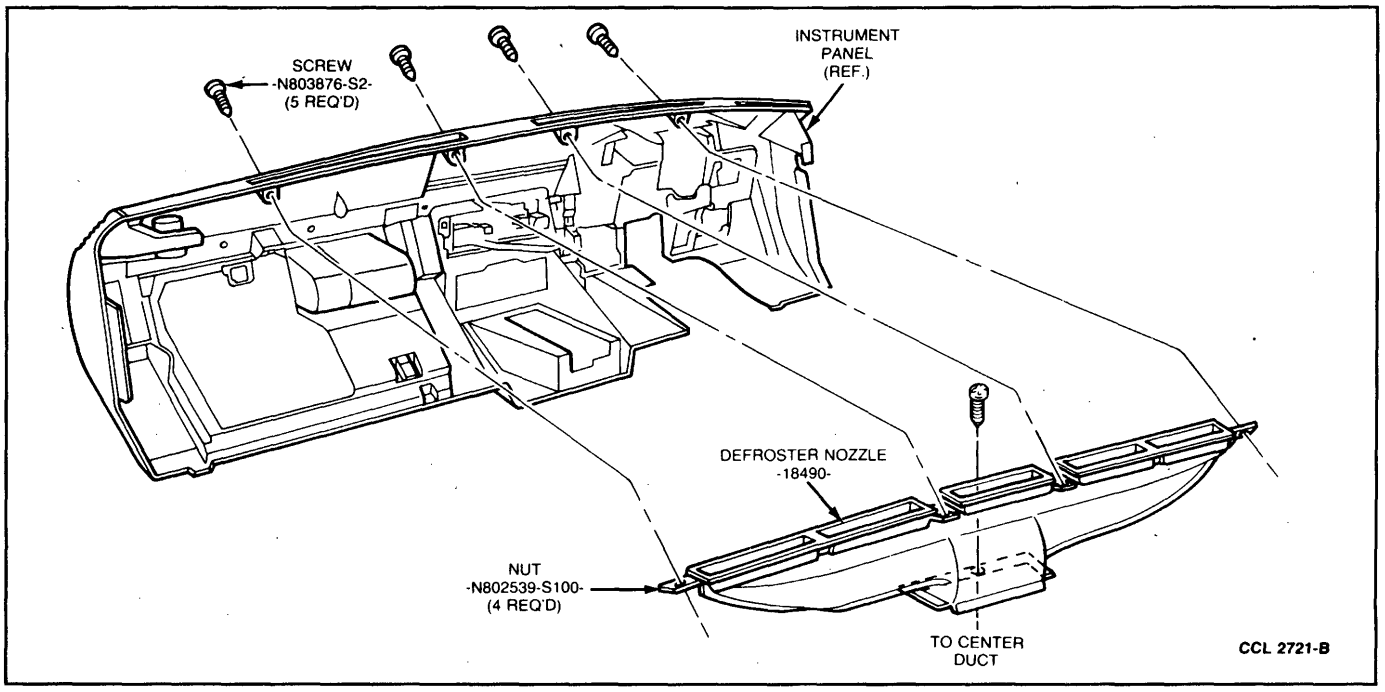


FIG. 8 Defroster Nozzle

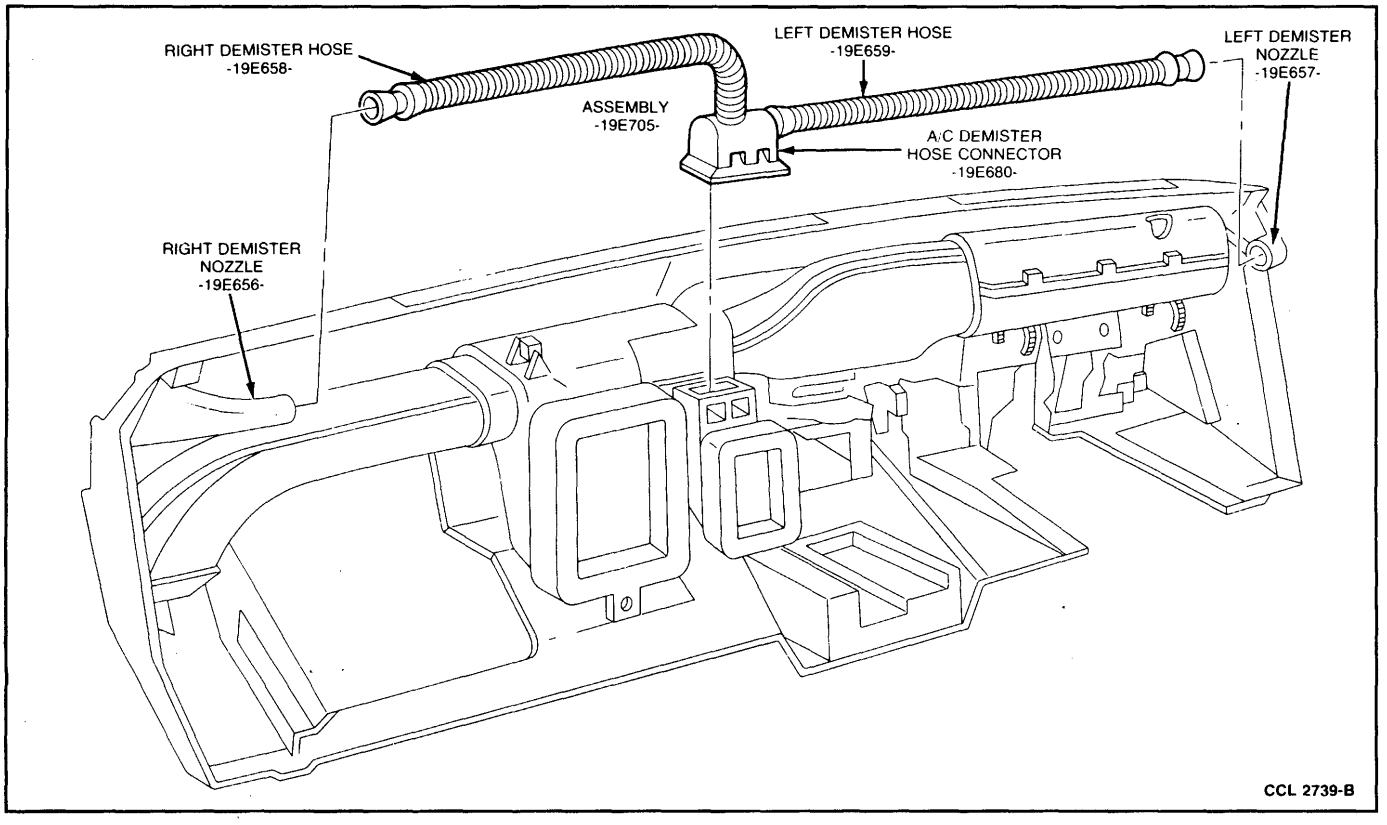


FIG. 9 Demister Nozzles and Hoses

Heater Blower Assembly

Removal

1. Disconnect battery ground cable(s).
2. In passenger compartment, remove nut from bottom of plenum assembly just to right of heater core access cover.
3. In engine compartment, remove electrical connector from blower motor by pushing on connector tab and pulling connector off motor. Remove connector from blower motor resistor.
4. Remove bolt from heater blower assembly (upper RH side of engine compartment).

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5. Remove three nuts from heater blower assembly (Fig. 10).
6. Pull heater blower assembly away from dash panel.

Installation

1. Position heater blower assembly to dash panel in engine compartment, taking care to align blower assembly to existing studs.
2. Install three nuts retaining heater blower assembly.
3. Install bolt to heater blower assembly (upper RH side of engine compartment).
4. Install electrical connectors to blower motor and resistor.
5. In passenger compartment, install nut to stud at bottom center of plenum assembly.
6. Connect battery ground cable(s). Check system for proper operation.

Heater Plenum Assembly

Removal

1. Loosen all instrument panel retaining screws as outlined. Move instrument panel rearward to gain access to plenum assembly.
2. Remove glove compartment liner.
3. Remove one screw attaching floor air distribution duct to plenum. Disengage tabs and remove duct.
4. Remove two nuts retaining LH end of plenum to dash panel (Fig. 11).
5. Remove one screw retaining LH end of plenum to dash panel (Fig. 11).
6. Disconnect function cable from plenum cable bracket. Disconnect cable self-adjusting clip from floor-defrost crank arm.
6. Pull heater case forward to disengage three heater case studs from dash panel.
7. Lower plenum from under instrument panel.

NOTE: On some vehicles, it may be necessary to remove the instrument panel lower RH attaching screw and the screws attaching the two braces to the lower center area of the instrument panel.

Installation

1. Position plenum to dash panel. Install one screw to attach the LH end of plenum to dash panel.
2. Position heater case to dash panel, making sure heater case studs are inserted through holes in dash panel and plenum flange.

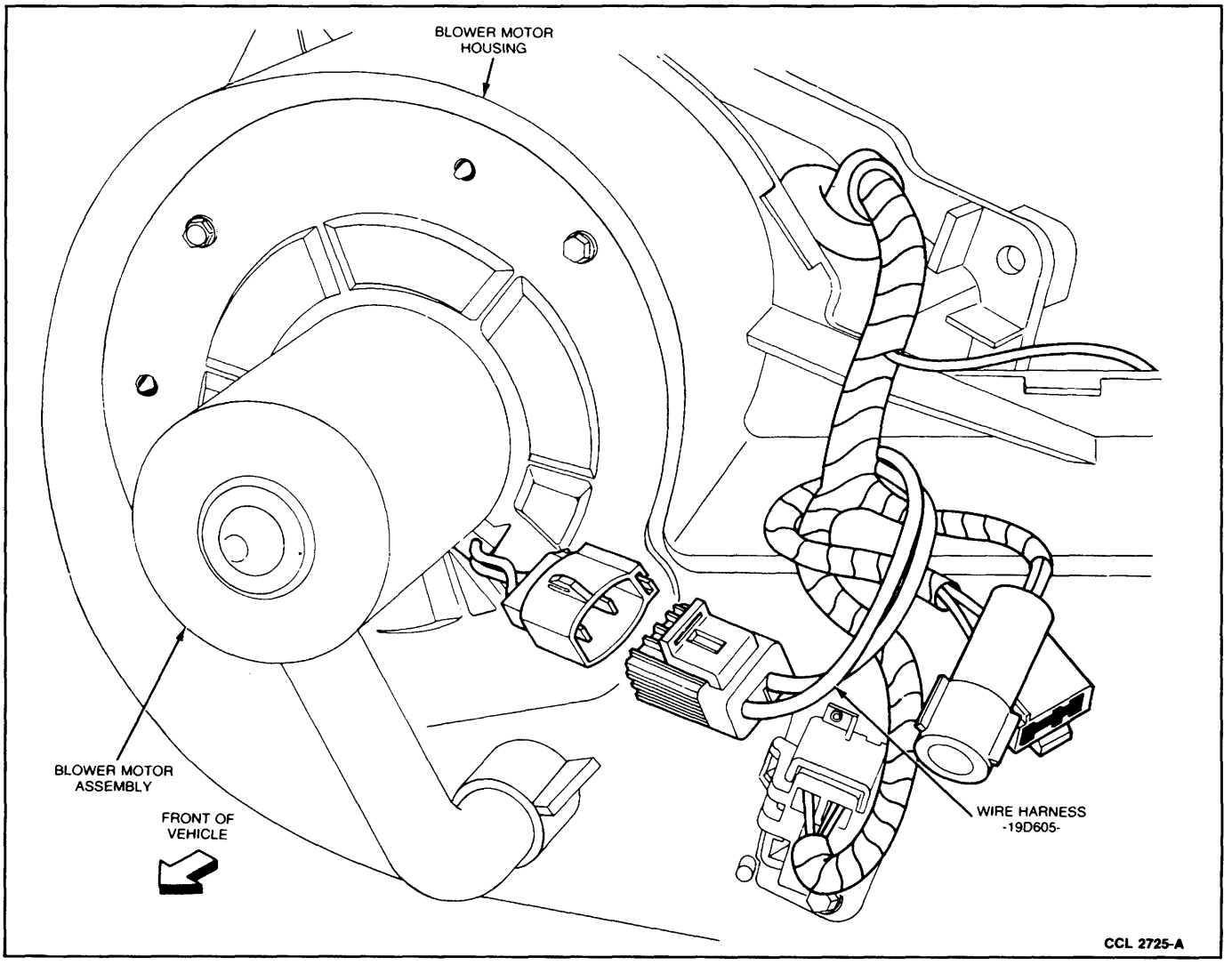


FIG. 10 Blower Motor Wire Harness Removal

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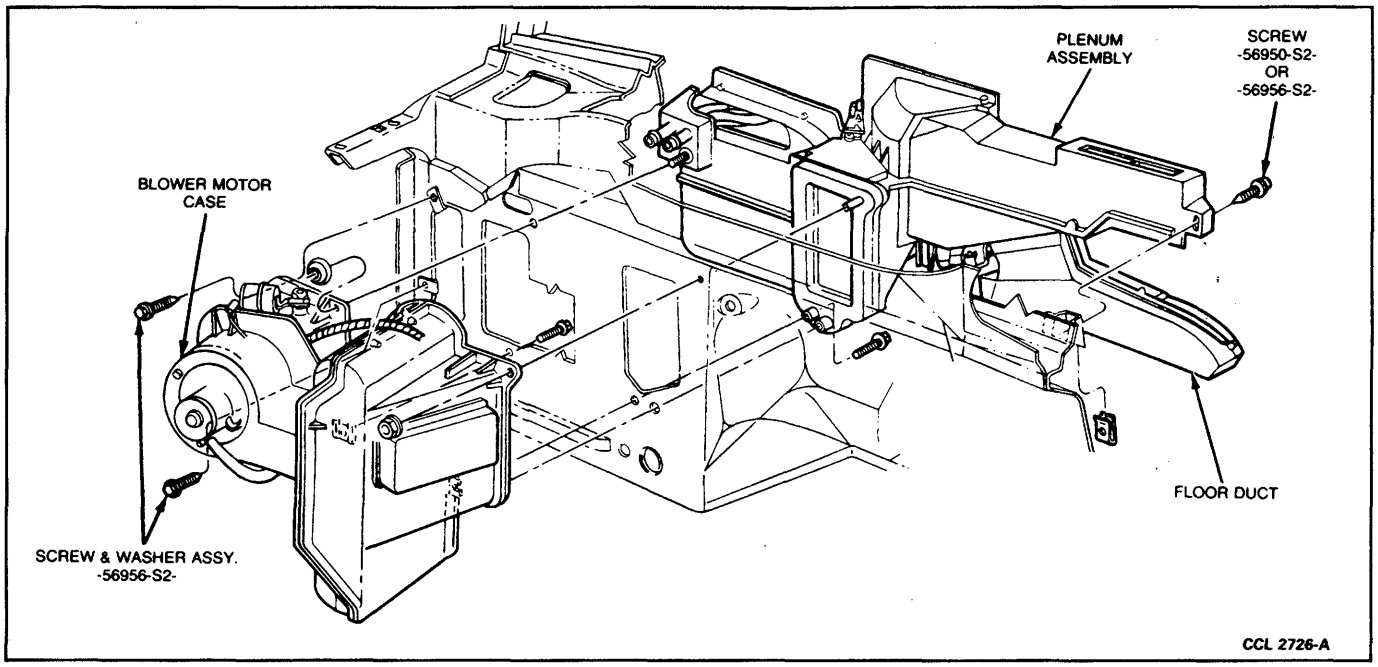


FIG. 11 Heater Blower Motor Case and Plenum Assemblies Removal

3. Position instrument panel and install retaining screws.
4. Snap function control cable onto cable mounting bracket of plenum.
5. Install floor air distribution duct (one screw).
6. Adjust function control cable as outlined.
7. Install glove compartment liner.
8. Check system for proper operation.

Heater Plenum Doors

Replacement

If there is a problem with the doors in the plenum or with the heater case mounting studs, replace the plenum as outlined.

Outside Air Door, Vacuum Motor or Door Crank

Removal

1. Disconnect blower motor connector and remove blower motor.
2. If only the vacuum motor is to be removed, disconnect the two screws which attach the motor to the upper surface of the outside door duct.
3. Pry the motor and arm assembly upward at the arm end to free it from its mounting peg. A retaining flange which is an integral part of the crank, peg, and flange component may partially obstruct the motor arm in its upward movement along the peg. If this retaining flange should break off when forcing the motor arm upward, a 3/16 inch spring nut (383358-S) must be used to retain the motor arm when the same or replacement motor is installed (Fig. 12, View B).
4. Look through blower motor opening in case and use a screwdriver to depress snap-on door crank, while pulling up on door shaft to release crank from door (Fig. 13).
5. Remove door through blower motor opening.

Installation

1. Insert door through blower motor opening. Seat bottom door pivot first, then swing top door pivot into place.
2. Hold door in full outside air position (swing to full in-board position) and snap in crank (Fig. 12).
3. Align the hole in the vacuum motor arm with peg door crank.
4. Slide the arm downward over the peg and along the inner surface of the retaining flange with the arm seats below the base of the flange surface.

NOTE: If the flange has been broken off install the spring nut as described in Step 2 of the Removal procedure.

5. Install blower motor in housing and connect blower motor electrical harness.

Heater Core

Removal

1. Allow engine to cool down. Following all safety precautions (refer to Section 27-02, Cooling System Service) and using a thick cloth, turn radiator cap slowly to first stop. Step back while pressure is released. When pressure has been released, tighten radiator cap on radiator.
2. Disconnect heater hoses from heater core tubes and plug hoses.
3. In passenger compartment, remove seven screws attaching heater core access cover to plenum assembly. Remove access cover (Fig. 14).

Installation

1. Position heater core and seal in plenum assembly.
2. Install heater core access cover to plenum assembly and secure with seven screws.

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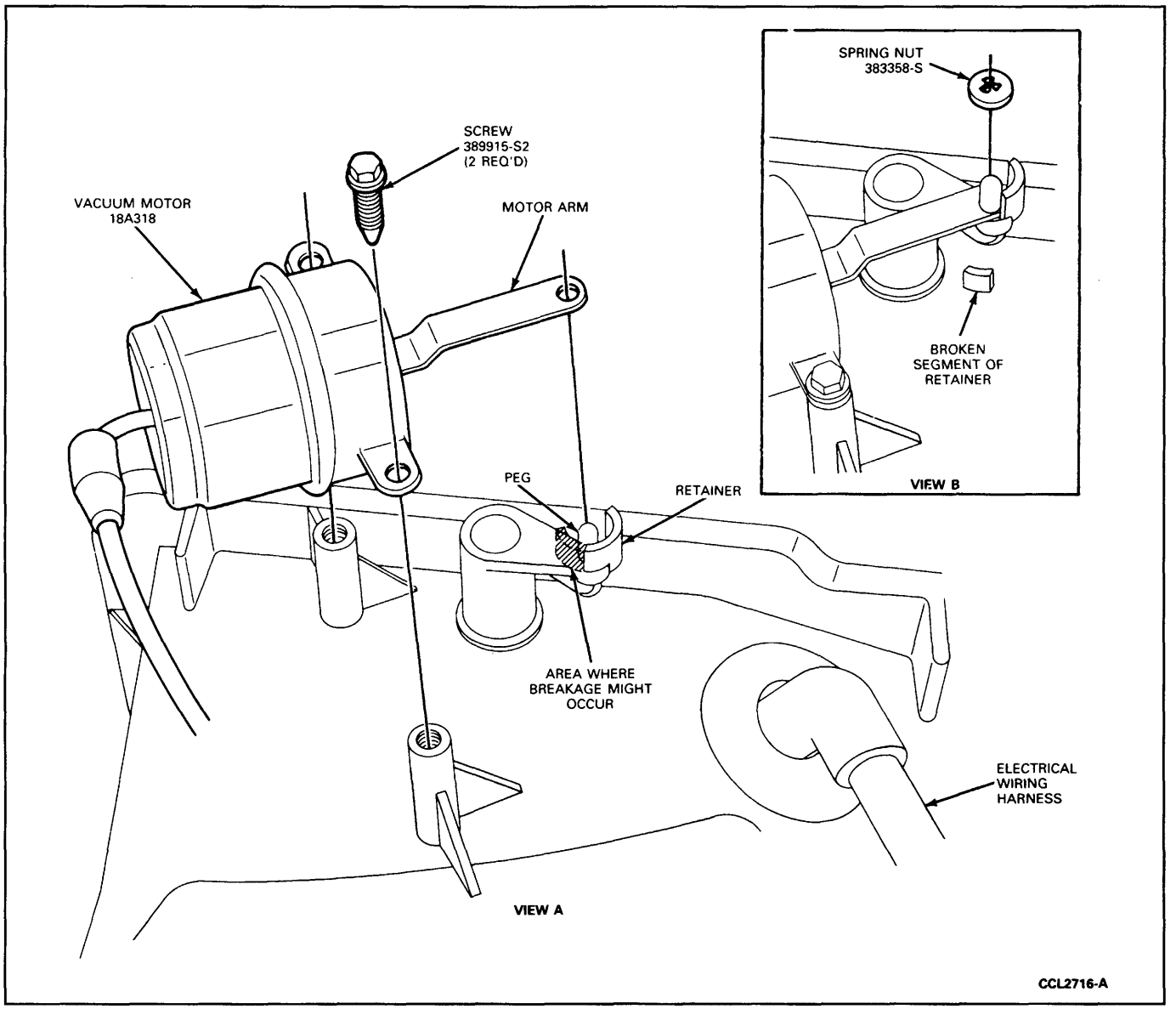


FIG. 12 Outside Air Door Removal

3. Install heater hoses to heater core tubes at dash panel in engine compartment. Do not overtighten hose clamps.
4. Check coolant level and add coolant as required. Refer to Section 27-02, Cooling System Service.
5. Check system for proper operation and coolant leaks.

Blower Motor and/or Wheel

Removal

1. Disconnect battery ground cable(s).
2. On California vehicles, remove emission module forward of blower motor.
3. Disconnect wire harness connector from blower motor by pushing down on connector tabs and pulling connector off motor (Fig. 10).
4. Disconnect blower motor cooling tube at blower motor.
5. Remove four screws attaching blower motor and wheel to heater blower assembly.
6. Holding cooling tube aside, pull blower motor and wheel from heater blower assembly and remove from vehicle (Fig. 15).
7. Remove blower wheel hub clamp from motor shaft. Then, pull blower wheel from motor shaft.

Installation

1. Install blower wheel onto blower motor shaft.
2. Install hub clamp as shown.
3. Holding cooling tube aside, position blower motor and wheel to heater blower assembly and install three attaching screws.
4. Connect blower motor cooling tube at blower motor.
5. Connect wire harness connector at blower motor (push on).
6. On California vehicles, install emission module forward of blower motor.

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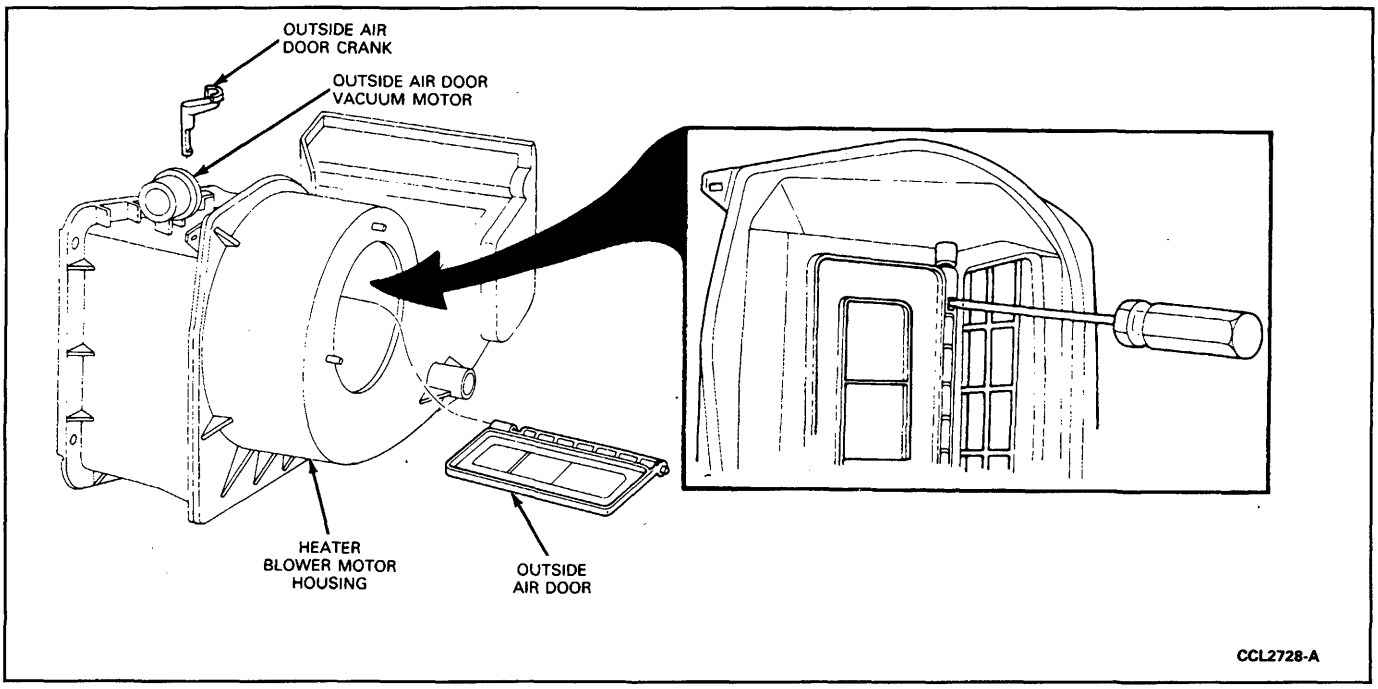


FIG. 13 Removing Outside Air Door Crank

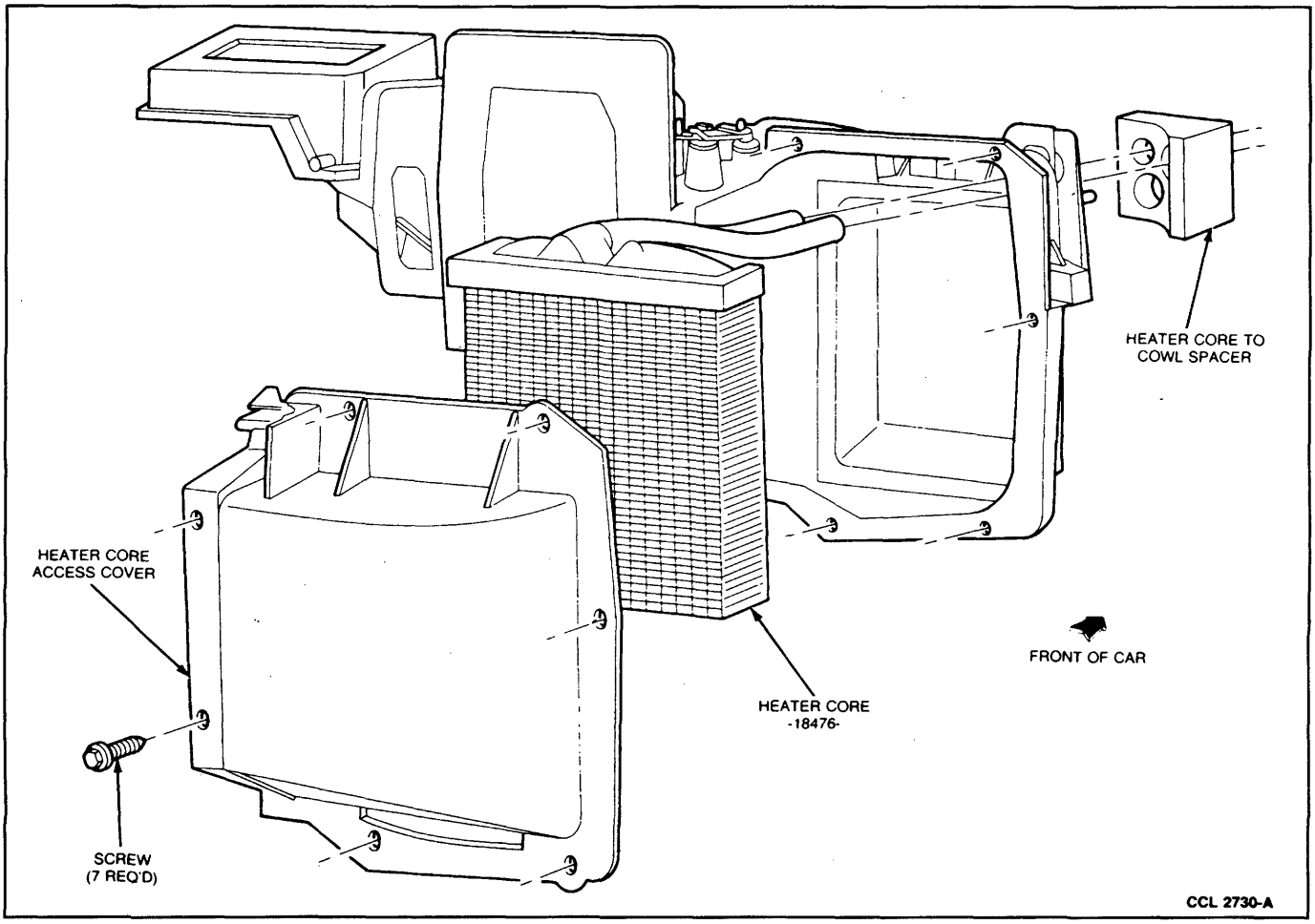


FIG. 14 Heater Core Removal

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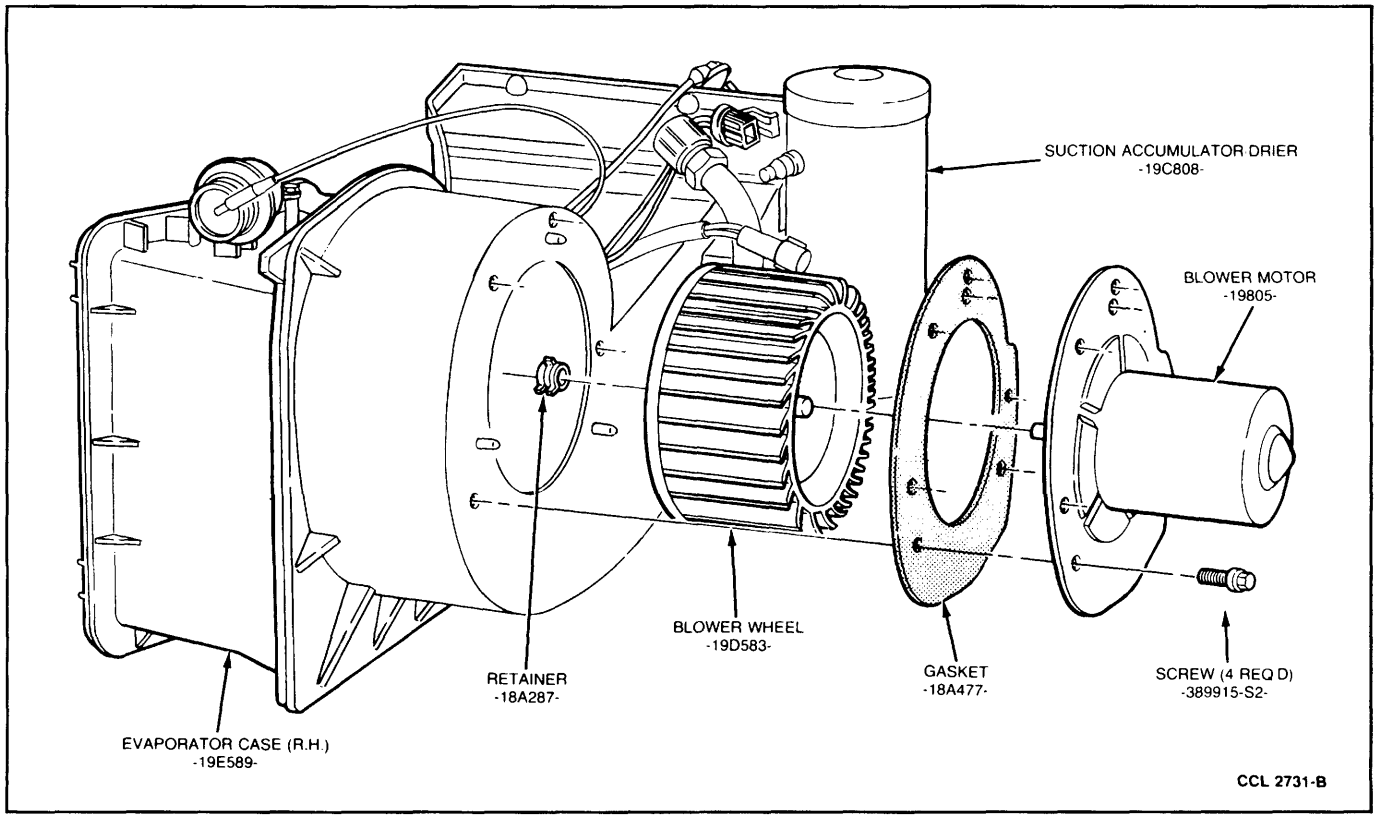


FIG. 15 Blower Motor and Wheel Assembly

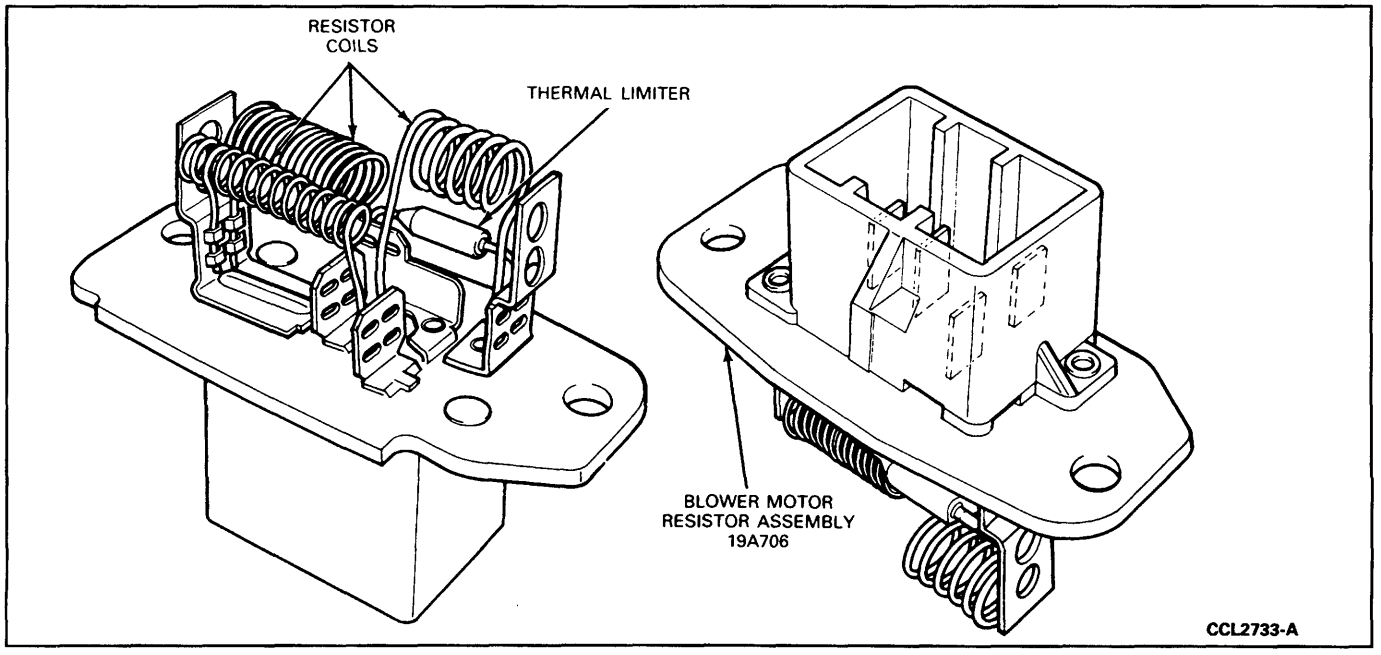


FIG. 16 Blower Motor Resistor Removal

7. Connect battery ground cable. Check system for proper operation.

Blower Motor Resistor

The blower motor resistor assembly is located on the heater blower assembly in the engine compartment (Fig. 17).

Removal

1. Disconnect wire connector from blower motor resistor.
2. Remove two resistor assembly attaching screws and lift resistor from heater blower assembly.

Installation

1. Position resistor assembly on heater blower assembly.

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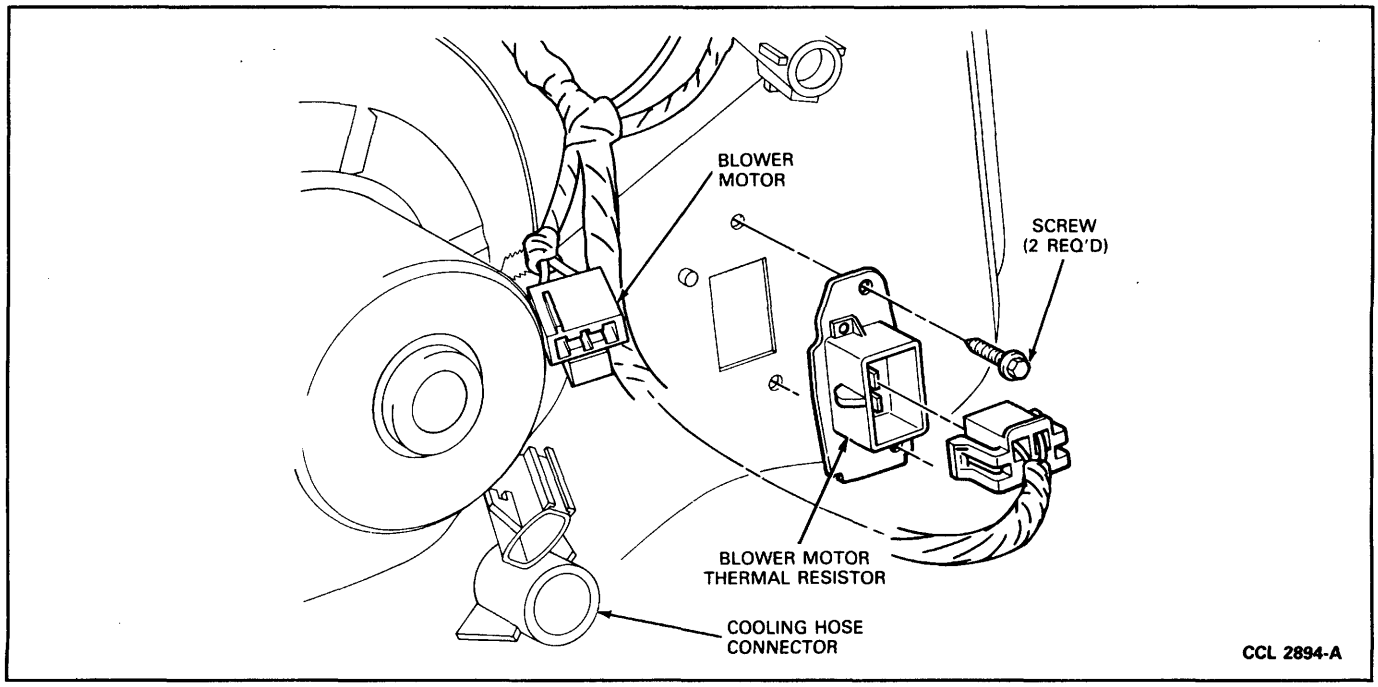


FIG. 17 Blower Motor Resistor Removal

2. Install two resistor attaching screws and tighten securely.
3. Connect wire connector to resistor terminals.
4. Check blower for proper operation in all blower speeds.

Heater Hoses

Removal and Installation

1. Drain coolant from cooling system.
2. Loosen hose clamps and remove hoses from vehicle (Figs. 18 through 22).
3. Cut a new length of heater hose to dimension of removed heater hose.

NOTE: The 4.9L engine is equipped with formed hoses. Therefore, bulk heater hose cannot be used.

4. Route heater hose(s) as shown (Figs. 18 through 22).
5. Connect heater hose to fittings. Tighten clamps to 1.8-2.5 N·m (16-22 in-lb).
6. Fill and bleed cooling system. Refer to Section 27-02, Cooling System Service.
7. Check for coolant leaks and proper operation of system.

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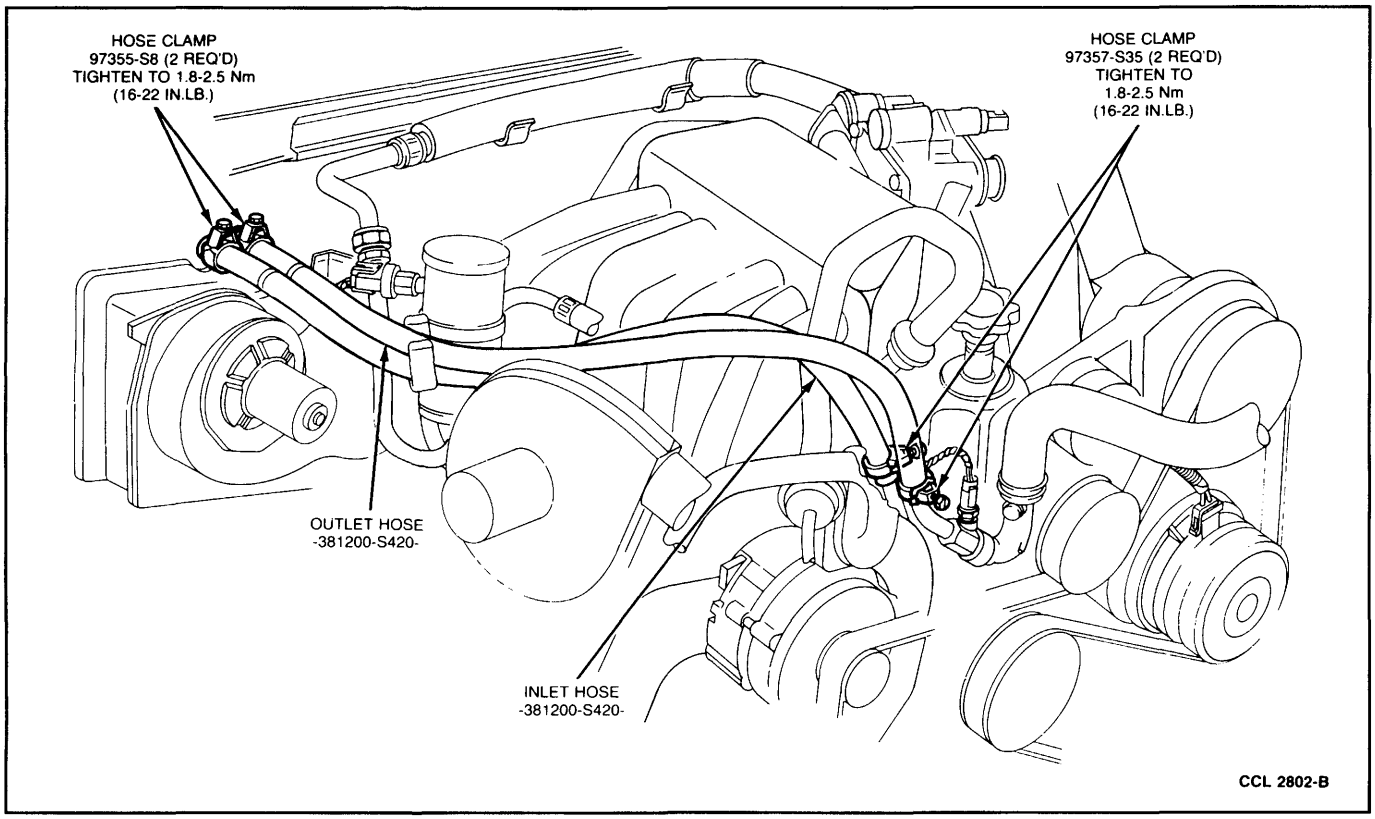


FIG. 18 Heater Hose Routings—4.9L (300 CID) EFI Engine

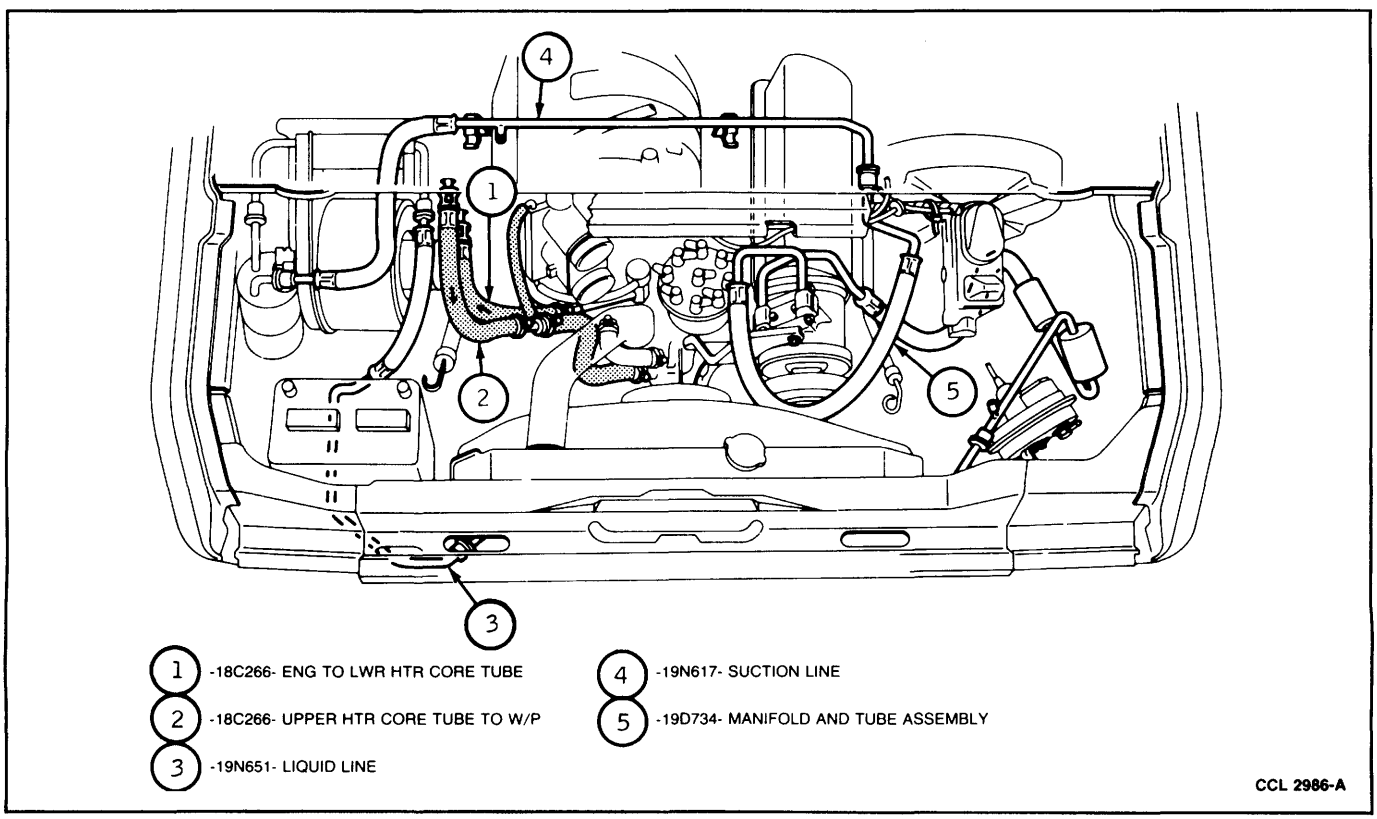


FIG. 19 Heater Hose Routings—5.0L (302 CID) EFI Engine

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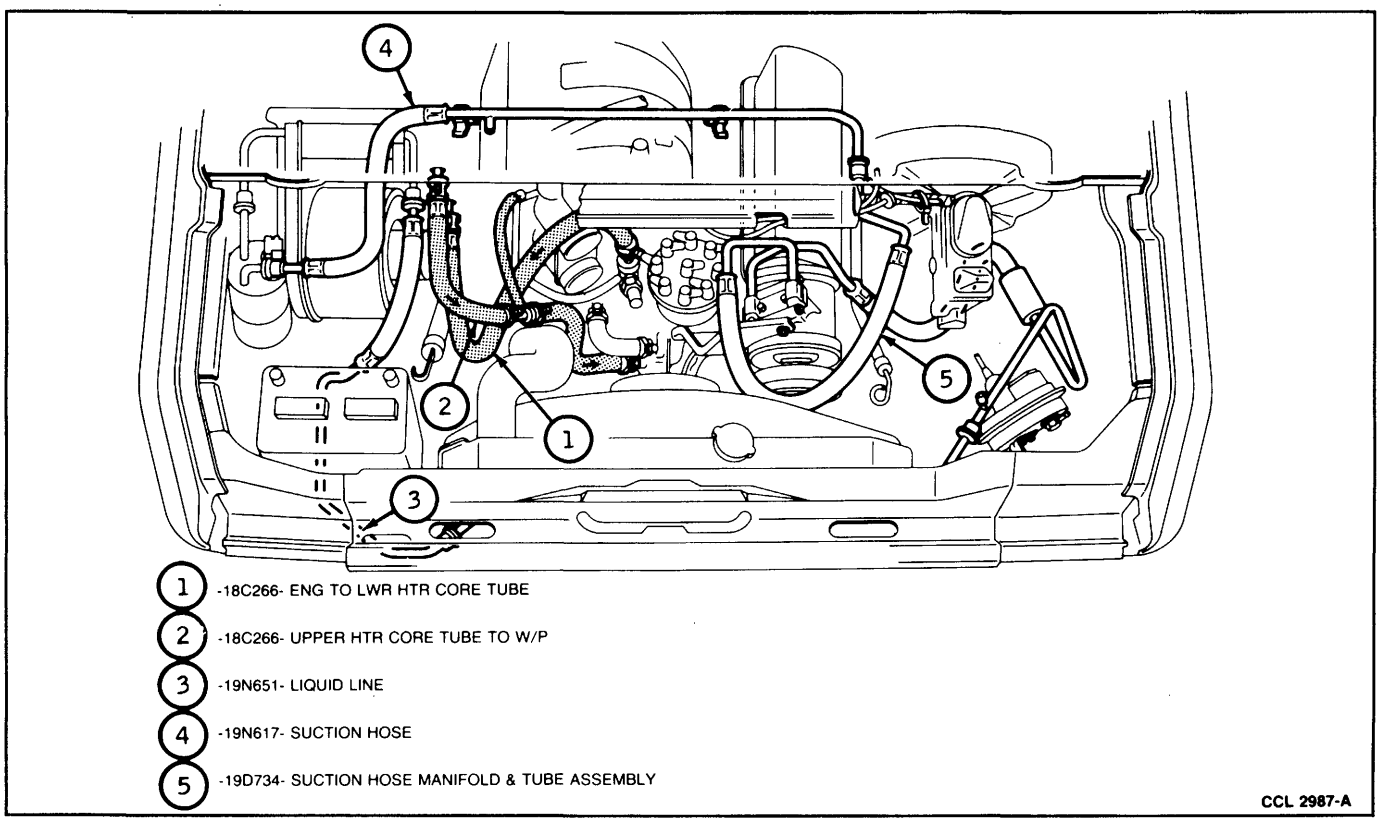


FIG. 20 Heater Hose Routings—5.8L (351 CID) EFI V-8 Engine

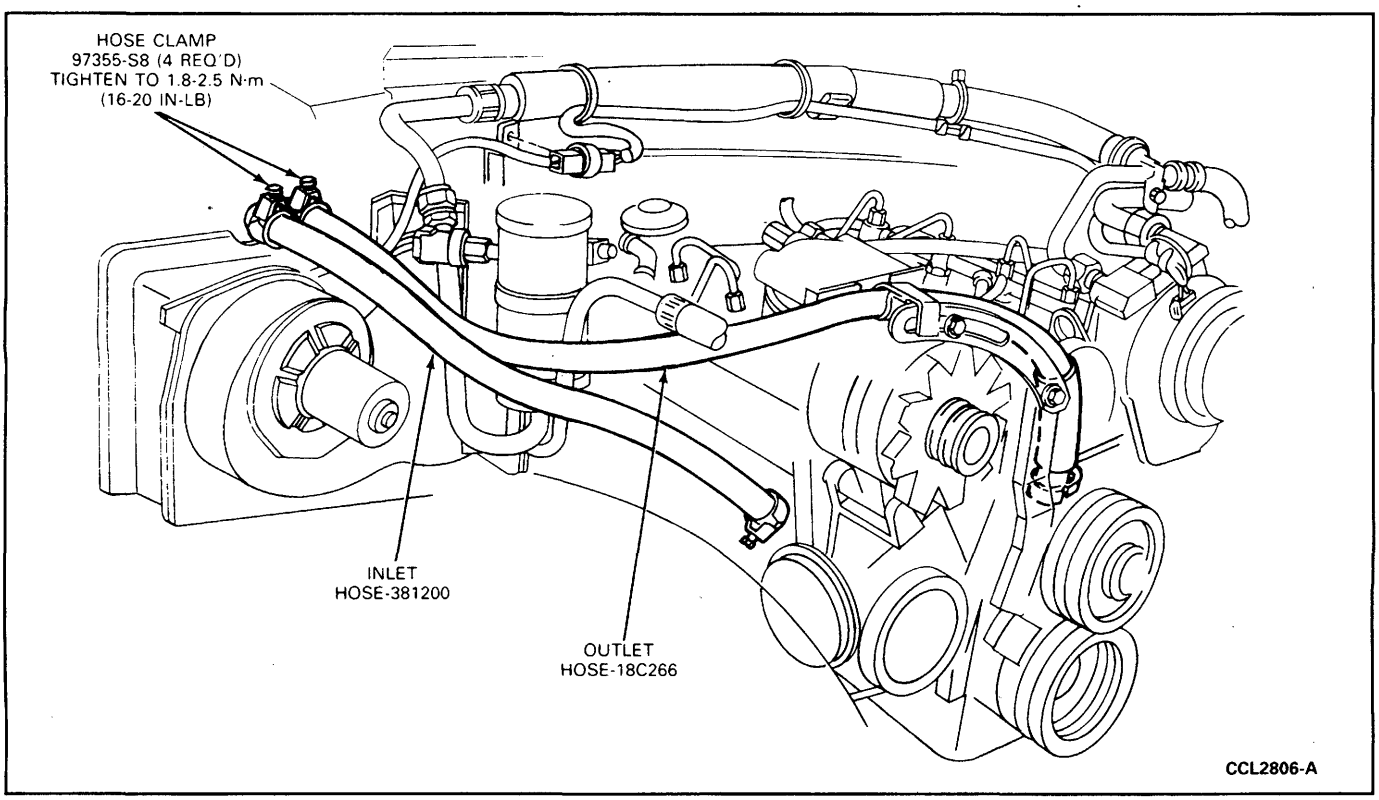


FIG. 21 Heater Hose Routings—7.3L (447 CID) Diesel Engine

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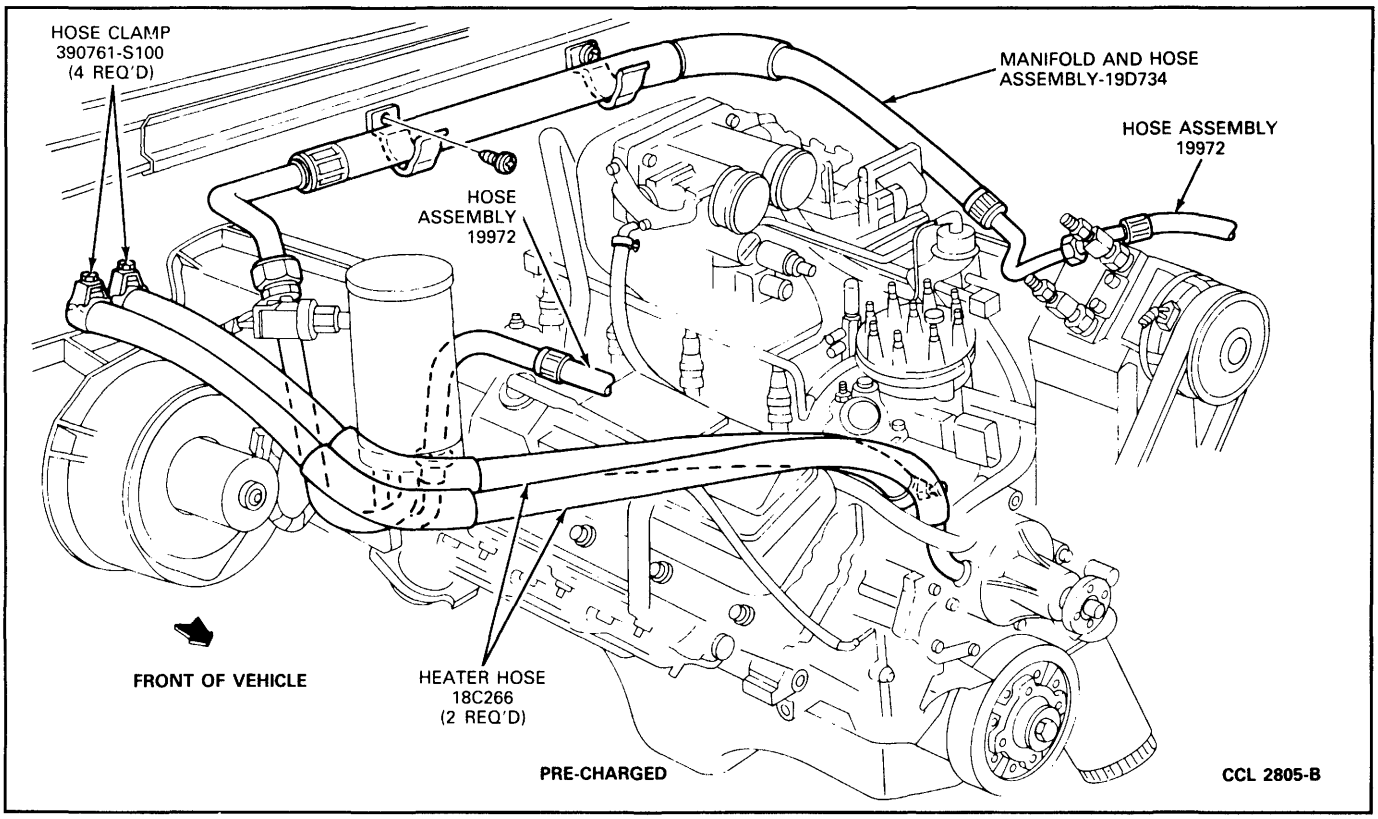


FIG. 22 Heater Hose Routings—7.5L (460 CID) V-8 Engine

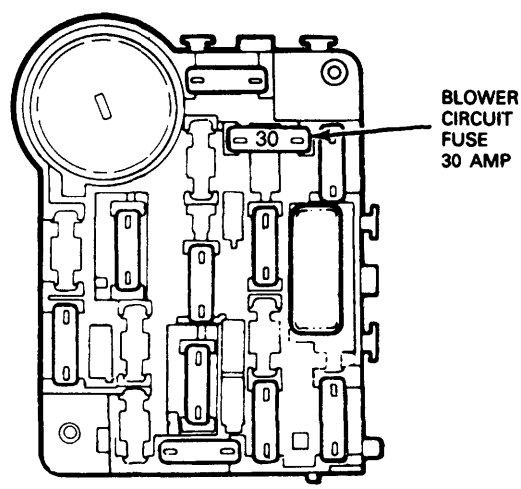
SPECIFICATIONS

ELECTRICAL

System Protection	30 Amp Mini-Fuse (Light Green)		
Blower Circuit	in Panel F-14 (D9ZB-14A094-GA)		
Blower Motor Current Draw			
Switch Setting		Amps	Volts
Off		0	0
Low		4	5
Medium		6	8
High		9	12
Illumination			
Control Assembly	One ICP-161 Bulb		

TORQUE SPECIFICATIONS

Heater Hose Clamps	1.46-2.03 N•m (13-18 In-Lb)



The fuse panel is located on the dash panel in passenger compartment left of steering column. CL3513-2C

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Number	Description
007-00001	Digital Volt-Ohm Meter

CN6078-1A

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VEHICLE APPLICATION

All Light Truck Models.

DESCRIPTION AND OPERATION

This Section gives the basic principles and service procedures that apply to all Ford Light Truck air conditioning systems. Each of the following Sections (beginning with Section 36-61) covers only those procedures that are peculiar to the indicated vehicle system. **Reference both to this Section and to the Section covering the pertinent vehicle line is necessary for complete coverage of any given system.**

Basic Principles

Air conditioning is the cooling or refrigeration of the air in the passenger compartment. Refrigeration is accomplished by making practical use of three laws of nature. These laws of nature and their practical application are outlined in the following paragraphs. Basic A/C systems are shown in Fig. 1.

Heat Transfer

If two substances of different temperature are placed near each other, the heat in the warmer substance will always travel to the colder substance until both are of equal temperature. For example, a cake of ice in an ice box does not communicate its coldness to the bottle of milk standing nearby. Rather, the heat in the warm milk automatically flows into the ice.

To determine the amount of heat that transfers from one substance to another, science uses the British Thermal Unit or BTU. One BTU is the amount of heat required to raise the temperature of one pound of water 0.55°C (1°F). For example, to raise the temperature of one pound of water from 0°C to 100°C (32°F to 212°F), one BTU of heat must be added for 0.55°C (1°F) rise in temperature or a total of 180 BTUs of heat. Conversely, in order to lower the temperature of one pound of water from 100°C to 0°C (212°F to 32°F), 180 BTUs of heat must be removed from the water.

Latent Heat of Vaporization

When a liquid boils (changes to a gas) it absorbs heat without raising the temperature of the resulting gas. When the gas condenses (changes back to a liquid), it gives off heat without lowering the temperature of the resulting liquid.

For example, place one pound of water at 0°C (32°F) in a container over a flame. With each BTU of heat that the water absorbs from the flame, its temperature rises 0.55°C (1°F). Thus, after it has absorbed 180 BTUs of heat, the water reaches a temperature of 100°C (212°F). Even though the flame continues to give its heat to the water, the temperature of the water remains at 100°C (212°F). The water, however, starts to boil or change from the liquid to the gaseous state. It continues to boil until the water has passed off into the atmosphere as vapor. If this vapor were checked with a thermometer, it also would show a temperature of 100°C (212°F). In other words, there was a rise of only 100°C (212°F) (from 0°C to 100°C or 32°F to 212°F) in the water and vapor temperature even though the flame applied many more than 180 BTUs of heat. In this case, the heat is absorbed by the liquid in the process of boiling and disappears in the vapor. If the vapor were brought in contact with cool air, the hidden heat would flow into the cooler air as the vapor condensed back to water. Scientists refer to this natural law as the latent (hidden) heat of vaporization.

Water has a latent heat of vaporization of 970 BTUs and a boiling point of 100°C (212°F). This means that one pound of water at 100°C (212°F), will absorb 970 BTUs of heat in changing to vapor at 100°C (212°F). Conversely, the vapor will give off 970 BTUs of heat in condensing back to water to 100°C (212°F).

This tremendous heat transfer, occurring when a liquid boils or a vapor condenses, forms the basic principle of all conventional refrigeration systems.

For a liquid to be a refrigerant, it must also have a low boiling point. That is, the temperature at which it boils must be lower than the substance to be cooled.

Refrigerant-12 is the liquid most commonly used in automotive air conditioning systems because in an open container it boils at -5.7°C (-21.7°F). It is a liquid that boils or vaporizes well below passenger compartment temperatures and, in vaporizing, will absorb tremendous amounts of heat without getting any warmer itself.

Air Conditioner Components

Suction Accumulator/Drier

The suction accumulator/drier is mounted on the side of the evaporator core and attaches directly to the

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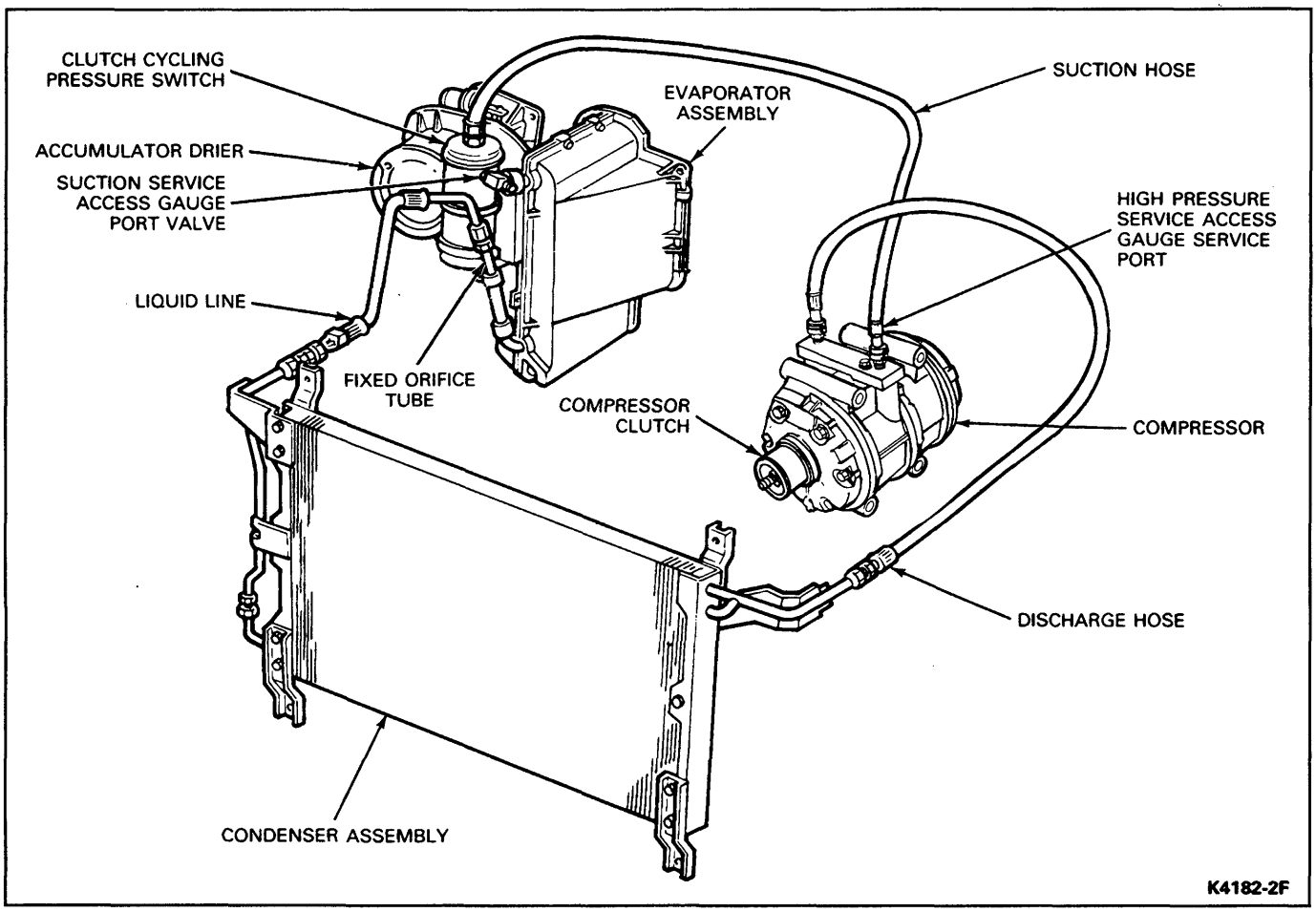


FIG. 1 A/C Basic Fixed Orifice Refrigerant System

evaporator outlet tube (Fig. 1). A suction service access gauge port valve is mounted on the inlet fitting of the suction accumulator/drier for F-Series. It is located on suction line for E-Series. Its purpose is to provide service access to the suction side of the refrigerant system for pressure readings and system diagnosis. It also may be used for liquid charging the system when required. An inverted liquid diverter cup is internally mounted on top of the refrigerant vapor return tube, in the center of the suction accumulator/drier, to prevent the heavier, oil-laden liquid refrigerant from going directly into the compressor suction line. Upon entering the inlet of the suction accumulator/drier, heavier, oil-laden refrigerant contacts the liquid diverter cup, which serves as an umbrella, and drips down onto the bottom of the housing. A small diameter oil bleed hole, approximately 1.1mm ± 0.06mm (0.0445 inch ± 0.0025 inch) above the bottom of the housing, allows the accumulated heavier liquid refrigerant and oil mixture to re-enter the compressor suction line at a controlled rate. As the heavier liquid refrigerant and oil mixture pass through the small diameter liquid bleed hole, it has a second opportunity to revaporize and recirculate through the compressor without causing compressor damage due to slugging. A fine mesh screened filter fits tightly around the bottom of the vapor return tube to filter out refrigerant system contaminate particles and prevent them from plugging the oil bleed hole.

A desiccant bag is mounted inside the suction accumulator/drier tank assembly to absorb any moisture which may be in the refrigerant system.

Another fitting, on the suction accumulator/drier, is used to mount the clutch cycling pressure switch. It has a long-travel Schrader-type valve stem core installed in the fitting opening to prevent refrigerant loss when the clutch cycling pressure switch is removed.

Evaporator Core

The evaporator core is a multi-pass plate/fin aluminum core. The liquid line connects to the bottom of the core and the suction (low pressure) line connects to the top of the core. The liquid line tube is fitted with a fixed orifice to control refrigerant flow. This orifice can be removed from the evaporator core tube for replacement if it becomes necessary. However, a special tool is necessary to prevent breakage of the orifice.

Expansion Valve—E-150—E-350 Auxiliary Unit

The expansion valve meters refrigerant into the evaporator according to cooling requirements. The restrictive effect of the expansion valve, while limiting the refrigerant flow to the evaporator, results in the reduced evaporator pressure.

The expansion valve consists of the valve and a temperature-sensing capillary tube and bulb. The valve is connected to the inlet tube of the evaporator and the sensing bulb is clamped to the outlet tube of the evaporator.

The expansion valve is opened and closed by opposing pressures on either side of the diaphragm. The temperature-sensing bulb which is clamped to the

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evaporator outlet tube usually contains Refrigerant-12. As evaporator outlet temperature rises, the Refrigerant-12 expands and exerts pressure against the diaphragm to open the valve further and admit more refrigerant into the evaporator for increased cooling. As evaporator outlet temperature fails, the pressure against the diaphragm is decreased. Inlet pressure on the opposite side of the diaphragm then starts closing the valve. The valve tends to seek a position to control the Refrigerant-12 flow to maintain near maximum cooling from the evaporator.

Fixed Orifice Tube

The fixed orifice tube is a restriction between the high and low pressure refrigerant and meters the flow of liquid refrigerant into the evaporator core.

The fixed orifice tube is located in the evaporator inlet tube and has filter screens on the inlet and outlet ends of the tube body. The filter screens act as strainers for the liquid refrigerant flowing through the fixed orifice opening. O-rings on the tube body prevent the high pressure liquid refrigerant from bypassing the orifice. Adjustment or repairs cannot be made to the fixed orifice tube assembly and it must be replaced as a unit. F-Series and Bronco vehicles use a 0.062-inch orifice tube color coded **red** and the Econoline main system use a 0.057-inch orifice tube color coded **orange**.

A/C Compressor and Clutch

The refrigerant system uses a Ford-built swash-plate designed six-cylinder compressor designated the FS-6 (Fig. 1). The compressor is mounted on the side of the engine and is driven with a belt. Belt tension adjustment is obtained by means of an automatic tensioner (gasoline engines) or by moving the compressor braces away from the engine (diesel engines).

High Pressure Relief Valve

Under extreme pressure conditions, the high pressure relief valve will momentarily open, allowing refrigerant vapor to escape. This relieves excessive pressure that might damage the compressor. The valve closes as soon as pressure is lower than the relief setting. This prevents loss of the complete refrigerant charge. The high pressure relief valve is located in the discharge manifold at the top of the compressor (Fig. 1).

Condenser

Refer to Fig. 1.

The air conditioning condenser is located in front of the radiator. The condenser receives compressed (therefore heated) refrigerant gas from the compressor.

As the hot refrigerant gas flows through the condenser, it is cooled by air passing over the fins. The cooled, compressed refrigerant gas condenses to liquid refrigerant which flows directly to the evaporator through the fixed orifice tube in the evaporator inlet.

Spring Lock Coupling

The spring lock coupling is a refrigerant line coupling held together by a garter spring inside a circular cage. When the coupling is connected, the flared end of the female fitting slips behind the garter spring inside the cage of the male fitting. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage.

Two O-rings are used to seal between the two components of the coupling. These O-rings are made of special material and **must** be replaced with an O-ring made of the same material. The O-rings normally used in refrigerant system connections are not the same material and should not be used with the spring lock coupling. Use only the O-rings listed in the Master Parts Catalog for the spring lock coupling.

A plastic indicator ring is used on spring lock couplings to indicate, during vehicle assembly, that the coupling is connected. Once the coupling is connected, the indicator ring is no longer necessary but will remain captive by the coupling near the cage opening.

After the coupling has been cleaned, install new O-rings lubricated with clean refrigerant oil. Connect the coupling together by pushing with a slight twisting motion. When the coupling is connected a distinct click or snap should be heard or felt, indicating positive engagement. If possible, visually inspect the cage to ensure that the flared end of the female fitting is fully behind the garter spring. Otherwise, push and pull on the fitting to verify engagement.

Clutch Cycling Pressure Switch

The clutch cycling pressure switch is mounted on a Schrader valve-type fitting on the accumulator/drier assembly. A valve depressor, located inside the threaded end of the pressure switch, depresses the Schrader valve stem as the switch is mounted and allows the suction pressure inside the accumulator/drier housing to control the switch operation. The electrical switch contacts are normally open when the suction pressure is at or below 169 kPa (24.5 psi); they will close when the suction pressure rises to approximately 293 kPa (43.5 psi) or above. Lower ambient temperatures (below 9°C or 48°F), during cold weather seasons, will also open the clutch cycling pressure switch contacts due to the pressure/temperature relationship of the refrigerant in the system. The electrical switch contacts control the electrical circuit to the compressor's magnetic clutch coil. When the switch contacts are closed, the clutch coil is energized and the A/C clutch is engaged to drive the compressor. When the switch contacts are open, the compressor's magnet clutch coil is deenergized, the A/C clutch is disengaged and the compressor does not operate. The clutch cycling pressure switch, when functioning properly, will control the evaporator core pressure at a point where the plate/fin surface temperature will be maintained slightly above freezing which prevents evaporator icing and the blockage of airflow.

Manual Valves

Some F-150—F-350 and Bronco vehicles are equipped with manual valves at the compressor similar to manual service valves. These valves do not have service ports and are used only to isolate the compressor (Fig. 2).

Service Access Gauge Port Valves

These valves are similar to a tire valve (Figs. 4 and 5). The service valve in the high pressure line (from compressor to condenser) allows access to the high pressure side of the system for attaching a service hose and pressure gauge. The service valve in the low pressure line (from evaporator to compressor) allows access to the low pressure side of the system for attaching a service hose and pressure gauge. High pressure service valve adapters are shown in Fig. 5. An additional low pressure gauge port valve adapted to the accumulator is available for attaching a service hose or

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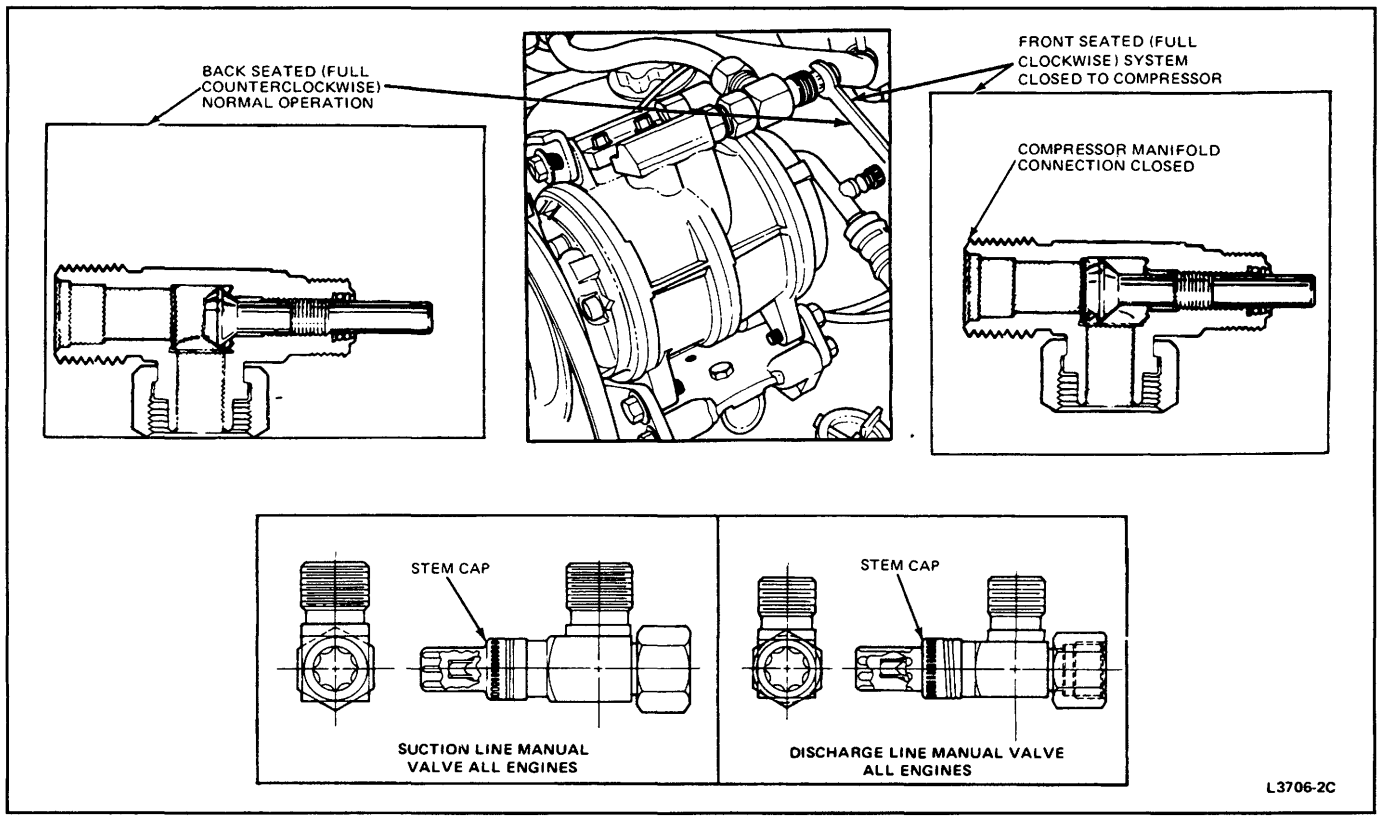


FIG. 2 Manual Valve Positions—F-150—F-350 and Bronco

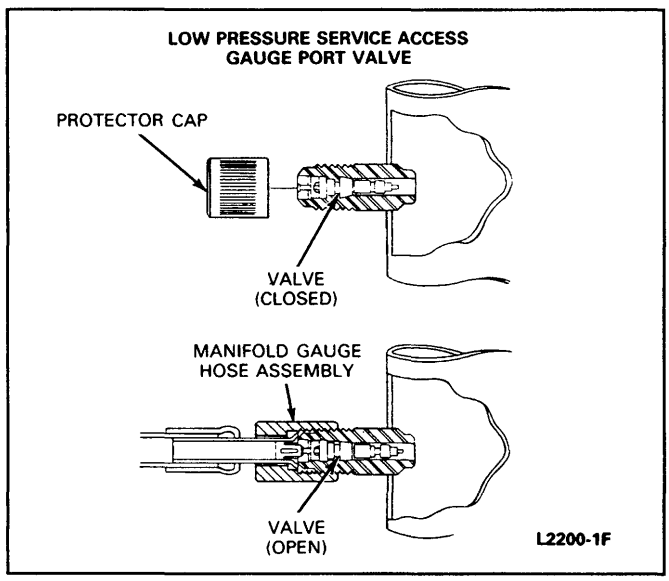


FIG. 3 Low Pressure Gauge Port Valve

pressure gauge. Refer to Tee Adapter Tool procedure as outlined in this Section.

DIAGNOSIS AND TESTING

Diagnosis is more than following a series of interrelated steps to find the solution to a specific condition. It is a way of looking for systems that are not functioning properly and finding out why. Also, it is knowing how the system should work, and whether it is working correctly.

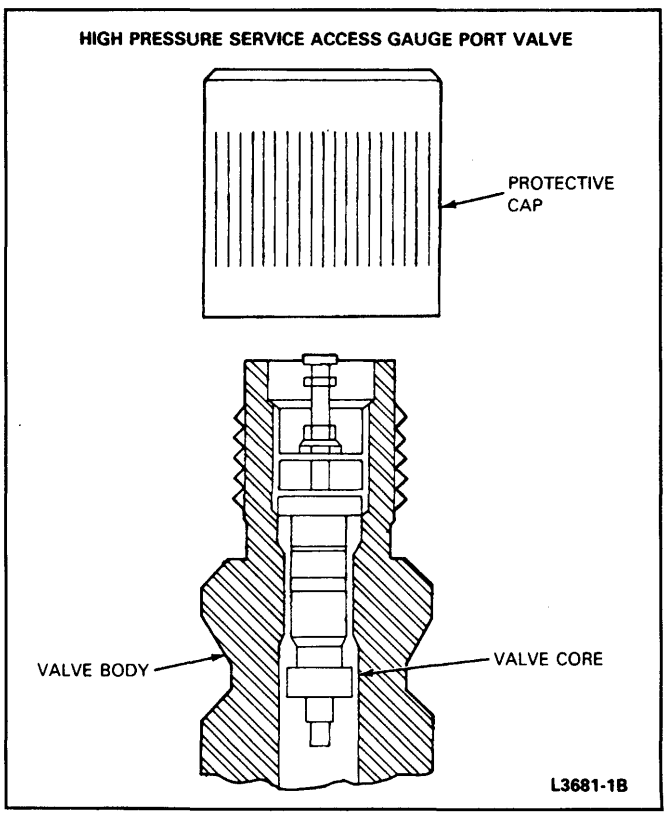


FIG. 4 High Pressure Gauge Port Valve

Know the System

Know how the parts go together and how the system operates, as well as its limits and what happens when

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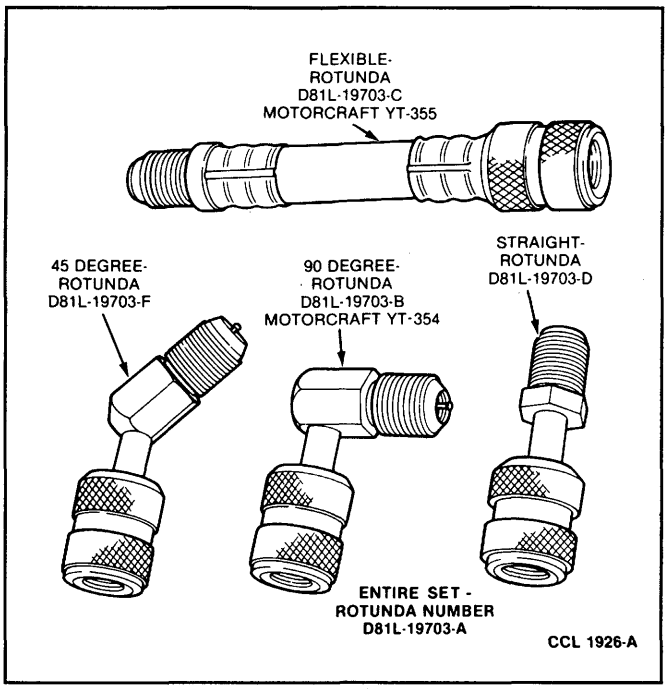


FIG. 5 High Pressure Gauge Port Valve Adapters

something goes wrong. This may require checking the system against a known good system.

Know the History of the System

Know how old the system is and its service history, which might relate to the present condition. A clue in these areas may save time.

Know the History of the Condition

Find out if the condition started suddenly or gradually, or whether it was related to some other occurrence like an accident or another component that was replaced. Knowing how the condition was discovered may be an important clue to the cause.

Know the Probability of Certain Conditions Developing

Most conditions are caused by simple things rather than by complex ones, and they occur in a fairly predictable pattern. Electrical problem conditions usually occur at connections rather than in components. An engine "no start" is more likely to be caused by a loose wire or a component out of adjustment than a sheared-off camshaft. To avoid spending unnecessary diagnosis time, do not eliminate certain failures unless sure that these failures are impossible. Also, although a part may be new, it is no guarantee that the part is functioning properly.

Safety Precautions

The refrigerant used in the air conditioning system is Refrigerant-12. Refrigerant-12 is non-explosive, non-flammable, noncorrosive, has practically no odor, and is heavier than air. Although it is classified as a safe refrigerant, certain precautions must be observed to protect the parts involved and the person who is working on the unit.

CAUTION: Use only Refrigerant-12. Do not use refrigerant that is canned for pressure-operated accessories (such as boat air horns). This type is not pure Refrigerant-12 and will cause a malfunction.

WARNING: AVOID CONTACT OF LIQUID REFRIGERANT-12 WITH SKIN AND EYES. AT NORMAL ATMOSPHERIC PRESSURES AND TEMPERATURES, REFRIGERANT-12 EVAPORATES SO QUICKLY THAT IT HAS THE TENDENCY TO FREEZE ANYTHING IT CONTACTS. SHOULD LIQUID REFRIGERANT COME IN CONTACT WITH THE EYES, IMMEDIATELY WASH WITH A FEW DROPS OF MINERAL OIL FOLLOWED BY A WEAK BORIC ACID SOLUTION. CONTACT A PHYSICIAN IMMEDIATELY.

WARNING: ALWAYS WEAR SAFETY GOGGLES WHEN SERVICING ANY PART OF THE REFRIGERANT SYSTEM. REFRIGERANT-12 IS ALWAYS UNDER PRESSURE. BECAUSE THE SYSTEM IS TIGHTLY SEALED, HEAT APPLIED TO ANY PART OF THE SYSTEM WILL CAUSE EXCESSIVE PRESSURE BUILDUP. TO AVOID A DANGEROUS EXPLOSION, NEVER WELD, USE A BLOW TORCH, SOLDER, STEAM CLEAN, BAKE BODY FINISHES OR USE AN EXCESSIVE AMOUNT OF HEAT ON OR IN THE IMMEDIATE AREA OF ANY PART OF THE AIR COOLING SYSTEM OR REFRIGERANT SUPPLY TANK, WHILE CLOSED TO ATMOSPHERE, WHETHER FILLED WITH REFRIGERANT OR NOT.

WARNING: LIQUID REFRIGERANT EVAPORATES RAPIDLY, DISPLACING AIR WHERE THE REFRIGERANT IS RELEASED. TO PREVENT POSSIBLE SUFFOCATION IN ENCLOSED AREAS, DISCHARGE THE REFRIGERANT FROM AN AIR COOLING SYSTEM INTO THE GARAGE EXHAUST COLLECTOR. MAINTAIN GOOD VENTILATION SURROUNDING THE WORK AREA.

WARNING: ALTHOUGH REFRIGERANT-12 GAS, UNDER NORMAL CONDITIONS, IS NON-POISONOUS, THE DISCHARGE OR REFRIGERANT GAS NEAR AN OPEN FLAME CAN PRODUCE A VERY POISONOUS GAS. IT IS GENERATED WHEN THE FLAME-TYPE LEAK DETECTOR IS USED. AVOID INHALING FUMES FROM THE LEAK DETECTOR. MAKE CERTAIN THAT REFRIGERANT-12 IS STORED AND INSTALLED IN ACCORDANCE WITH ALL STATE AND LOCAL ORDINANCES.

CAUTION: When admitting Refrigerant-12 gas into the cooling unit, keep the tank in an upright position. If the tank is on its side or upside down, liquid Refrigerant-12 will enter the system and damage the compressor.

Service Precautions

Observe the following service precautions.

1. Never open or loosen a connection before discharging the system.
2. When loosening a connection, if any residual pressure is evident, allow it to leak off before opening the fitting.
3. Evacuate a system which has been opened to replace a component or one which has discharged through leakage before charging.
4. Seal open fittings with a cap or plug immediately after disconnecting a component from the system.
5. Clean the outside of the fittings thoroughly before disconnecting a component from the system.

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6. Do not remove the sealing caps from a replacement component until ready to install.
7. Refrigerant oil will absorb moisture from the atmosphere if left uncapped. Do not open an oil container until ready to use and install the cap immediately after using. Store the oil only in a clean, moisture-free container.
8. Install a new seal ring before connecting an open fitting. Coat the fitting and seal with refrigerant oil before connecting.
9. When installing a refrigerant line, avoid sharp bends. Position the line away from the exhaust or any sharp edges which may chafe the line.
10. Tighten fittings only to specifications. The copper and aluminum fittings used in the refrigeration system will not tolerate over tightening.
11. When disconnecting a fitting, use a wrench on both halves of the fitting to prevent twisting of the refrigerant lines or tubes.
12. Do not open a refrigerant system or uncap a replacement component unless it is as close as possible to room temperature. This will prevent condensation from forming inside a component which is cooler than the surrounding air.
13. Keep service tools and the work area clean to avoid contamination of a refrigerant system.

System Visual Inspection

It is possible to detect problem causes by a careful visual inspection of the A/C refrigerant system. This includes broken belts, obstructed condenser air passages, a loose clutch, loose or broken mounting brackets, disconnected or broken wires and many refrigerant leaks.

A refrigerant leak will usually appear as an oily residue at the leakage point in the system. The oily residue soon picks up dust or dirt particles from the surrounding air and appears greasy. Through time, this will build up and appear to be a heavy dirt-impregnated grease.

Most common leaks are caused by damaged or missing O-ring seals at the various hose and component connections. When these O-rings are replaced, lubricate the new O-rings with refrigerant oil. Be careful to keep shop towel lint from contaminating the internal surfaces of the connection. Leakage may occur at a spring lock coupling if the wrong O-rings are used at the coupling. Use **only** the O-rings listed in the Ford Master Parts Catalog for the spring lock coupling.

If the system contains no refrigerant or is extremely low on refrigerant, the clutch will engage for compressor operation. A rapid cycling compressor clutch is usually an indication that the system is low on refrigerant. Also, clutch cycling will normally not occur when the engine is operating at curb idle speed.

Tee Adapter Tool

A Tee Type Service Adapter tool D87P-19703-A or equivalent may be used to diagnose the low pressure side of the refrigerant system. The tool is shown installed in Fig. 6.

1. Disconnect electrical connector at clutch cycling pressure switch and remove switch from switch fitting.

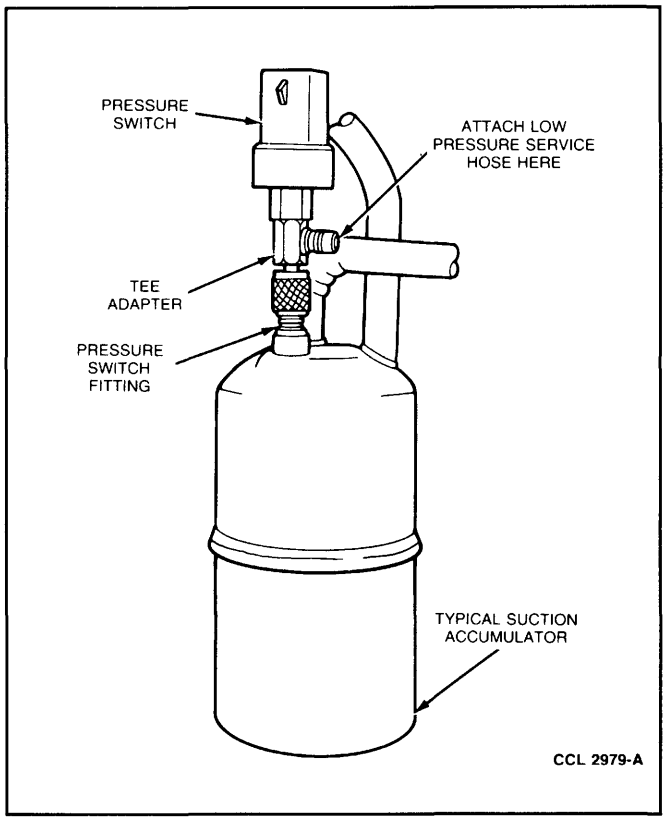


FIG. 6 Tee Adapter Tool Installation

2. Install a new clutch cycling pressure switch and O-ring on adapter tool (Fig. 6), and plan to leave it on adapter as a permanent part of tool. Lubricate O-ring before installation.
3. Install tee adapter tool on clutch cycling pressure switch fitting and tighten it securely.
4. Connect low pressure hose of manifold gauge set to side fitting of Tee Adapter tool.
5. Connect electrical connector to clutch cycling pressure switch on Tee Adapter tool.

With the Adapter Tool installed in this manner, the refrigerant system can be operated under normal conditions with clutch cycling pressure switch control and evaporator (suction) pressure may be observed. This provides a more accurate low pressure reading than can be obtained from a low pressure gauge port located in the suction line or near the compressor.

After completing the repair, disconnect the manifold gauge set from the Adapter Tool. Disconnect the electrical connector from the clutch cycling pressure switch on the tool and remove the tool from the pressure switch fitting. Install the removed clutch cycling pressure switch and connect the electrical connector.

ADJUSTMENTS

Discharge the System

Discharge the refrigerant from the system before replacing any part of the system (except the compressor vehicles with manual valves). On vehicles with manual valves, make sure valves are back-seated.

1. Remove caps from high and low pressure service gauge port valves in high and low pressure lines.

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2. Turn both manifold gauge valves fully clockwise to close gauge set to center outlet hoses.
3. If gauge set hoses do not have service valve actuating pins, install Straight Adapter T71P-19703-S and Curved Adapter T71P-19703-R or equivalent on manifold gauge low pressure hose. Install a special adapter coupler on high pressure hose.
4. Connect high and low pressure gauge hoses with adapters to respective high and low pressure service gauge port valves.
5. Place open end of center hose in a garage exhaust outlet.
6. Slowly de-pressurize refrigeration system by opening low pressure gauge valve a slight amount and allowing refrigerant to discharge slowly from system.
7. After system is nearly discharged, open high pressure gauge valve very slowly to avoid losing an excessive amount of refrigerant oil. Allow any refrigerant remaining in compressor and high pressure line to discharge.

Evacuating the System

1. Discharge refrigerant system as outlined.
2. Be certain manifold gauge set is connected as follows:
   a. Low pressure hose connected to low pressure service gauge port on top center of the accumulator/drier assembly.
   b. High pressure hose to high pressure gauge port on compressor discharge line at condenser connection. An adapter is necessary at this service gauge port.
   c. Connect manifold gauge set center hose to a vacuum pump.
3. Open manifold gauge set valves and start vacuum pump.
4. Evacuate system with vacuum pump until low pressure gauge reads at least 84 kPa (25 in. Hg) (vacuum) and as close to 101 kPa (30 in. Hg) as possible. Continue vacuum pump operation for 15 minutes. If part of system has been replaced, continue vacuum pump operation for an additional 20-30 minutes.
5. When evacuation of system is complete, close manifold gauge set valves and turn vacuum pump off.
6. Observe low side gauge to ensure system holds vacuum for 5 minutes. If vacuum is held for 5 minutes, proceed to charging the system. If vacuum is not held for 5 minutes, leak test system, repair leak(s) and again evacuate system.

Charging the System

1. With manifold gauge set valve closed to center hose, disconnect vacuum pump from manifold gauge set.
2. Connect center hose of manifold gauge set to a refrigerant drum.

WARNING: USE ONLY A SAFETY TYPE DISPENSING VALVE. THE REFRIGERANT CANS ARE UNDER PRESSURE AND COULD CAUSE PERSONAL INJURY IF NOT PROPERLY HANDLED.

3. Loosen center hose at manifold gauge set and open refrigerant drum valve. Allow refrigerant to escape to purge air and moisture from center hose. Then, tighten center hose connection at manifold gauge set.
4. Disconnect wire harness snap-lock connector from clutch cycling pressure switch and install a jumper wire across two terminals of connector.
5. Open manifold gauge set low side valve to allow refrigerant to enter system. Keep refrigerant can in an upright position if vehicle low pressure service gauge port is not on suction accumulator/drier or suction accumulator fitting.
6. When no more refrigerant is being drawn into system, start engine, move blower switch to HI and move Function selector lever to MAX A/C.

Continue to add refrigerant to system until specified weight of Refrigerant-12 is in system. Then, close manifold gauge set low pressure valve and refrigerant supply valve.

7. Remove jumper wire from clutch cycling pressure switch snap-lock connector and connect connector to pressure switch.
8. Operate system until the pressures stabilize to verify normal operation and system pressures.
9. In high ambient temperatures, it may be necessary to operate a high volume fan positioned to blow air through radiator and condenser to aid in cooling the engine and prevent excessive refrigerant system pressures.
10. When charging is completed and system operating pressures are normal, disconnect manifold gauge set from vehicle. Install protective caps on service gauge port valves.

Isolating the Compressor

This procedure can be performed only on F-150—F-350 and Bronco models with manual valves and is used to replace the compressor without losing the refrigerant charge. The compressor on E-150—E-350 and F-150—F-350 without manual valves cannot be isolated from the system.

To isolate the compressor equipped with manual valves from the system, turn both the high and the low pressure manual valves to the extreme clockwise (front-seat) position. Loosen the nut on the high pressure manual valve connection to the compressor manifold and allow the gas to escape until the compressor is relieved of refrigerant pressure.

Loosen the connection a small amount only, and do not remove it until the pressure is completely relieved.

To connect the compressor back into the system, make sure the manual valve connections to the compressor are tight and back-seat the low pressure manual valve. Then, loosen the high pressure valve connection to the compressor manifold just enough to allow the system refrigerant to purge the compressor. Tighten the high pressure manual valve at the compressor manifold and back-seat the high pressure manual valve.

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Purging the Refrigerant System to Remove Air and Moisture Vapor

The triple evacuation procedure should be employed when there are definite indications of moisture in the system. This procedure is effective in removing small amounts of moisture from the refrigerant system. However, if the system is contaminated with a large quantity of water, complete system flushing will be required.

The principle of the three evacuations is simple. The first pull-down removes approximately 90 percent of the air and moisture vapors.

The first purge with new, dry Refrigerant-12 mixes with the remaining 10 percent.

With the next evacuation, this mixture will be drawn out so that only approximately one percent of the initial air and moisture vapors remain.

The second purge with new, dry Refrigerant-12 will mix with this one percent, and the third evacuation will finish the job by drawing out practically all the remaining vapors.

But, if any water was present in the system at the start of this procedure, most of it will still be there, because a short period of vacuum is not long enough to boil and vaporize the water. The Refrigerant-12 purges, in passing over the liquid, will absorb only a relatively small amount of water.

This procedure is effective only when no water is in the system. It should not be used if there is any indication of water in the system.

Cleaning a Badly Contaminated Refrigerant System

A refrigerant system can become badly contaminated for a number of reasons.

- The compressor may have failed due to damage or wear.
- The compressor may have been run for some time with a bad leak or any opening in the system.
- The system may have been damaged by a collision and left open for a long time.
- The system may not have been cleaned properly after a previous failure.
- The system may have been operated for a time with water or moisture in it.
- Clutch cycle rate is fast.
- Clutch ON time is short.
- Clutch OFF time is short.

The evaporator bore is causing the problem. Airflow is restricted, indicating leaves or debris entering through the cowl air inlet and plugging the core.

This condition can also be detected by checking the center register discharge temperature. An abnormally low temperature indicates air is spending more time in the evaporator and is very cold when discharged, although the volume is not enough to cool the car properly.

Additional cause components are listed at the bottom of the chart (Fig. 12) for poor compressor operation or a damaged compressor condition.

These diagnosis charts provide the most direct and sure way to determine the cause of any problem in a poorly performing refrigerant system.

After servicing and correcting a refrigerant system problem, take additional pressure readings and observe the clutch cycle rate while meeting the conditional requirements (Fig. 11) to be sure the problem has been corrected.

In ambient temperatures above 38°C (100°F), the compressor clutch will not normally cycle off (Figs. 10 and 11) and in many instances, the clutch will not cycle off when temperatures are above 32°C (90°F).

Another type of leak may appear at the internal Schrader-type A/C charging valve core in the service gauge port valve fittings. If tightening the valve core does not stop the leak, replace it with a new A/C charging valve core (part number 19D701) or equivalent.

Missing service gauge port valve caps (19D702 or equivalent) can also cause a refrigerant leak. If this important primary seal (the valve cap) is missing, dirt will enter the area of the A/C charging valve core. When the service hose is attached, the valve compressor in the end of the service hose forces the dirt into the valve seat area and the dirt will destroy the sealing surface of the A/C charging valve core. When a service gauge port valve cap is missing, clean the protected area of the A/C charging valve core and install a new 19D702 service gauge port valve cap.

CAUTION: Service gauge port valve caps must be installed finger-tight. If tightened with pliers, the sealing surface of the service gauge port valve may be damaged.

Proper Use of Manual Valves

In the back-seated position (Fig. 2), the low pressure valve is open between the suction side of the compressor and the evaporator, and the high pressure valve is open between the discharge side of the compressor and the condenser. This is the normal operating position.

In the front-seated position (Fig. 2), the low pressure valve cuts off the suction side of the compressor from the evaporator, and the high pressure valve cuts off the discharge side of the compressor from the condenser.

Mini-Tube Vacuum Hose

Service

1. Measure the length of the damaged area of the mini-tube vacuum hose.
2. Cut a piece of standard 3mm (1/8-inch) ID vacuum hose approximately 25mm (1-inch) longer than the damaged area of the mini-tube vacuum hose.
3. Cut off the mini-tube vacuum hose on each side of the damaged area.
4. Dip the mini-tube hose ends in Tetra Hydro Furan (THF) or Methyl Ethyl Ketone (MEK). This solvent will seal the mini-tube in the vacuum hose.
5. Insert the ends of the mini-tube vacuum hose (Fig. 7) approximately 9mm (3/8-inch) into the ends of the standard 3mm (1/8-inch) service vacuum hose section.
6. Shake the service joint after assembly to make sure the solvent is dispersed and the vacuum line is not plugged.

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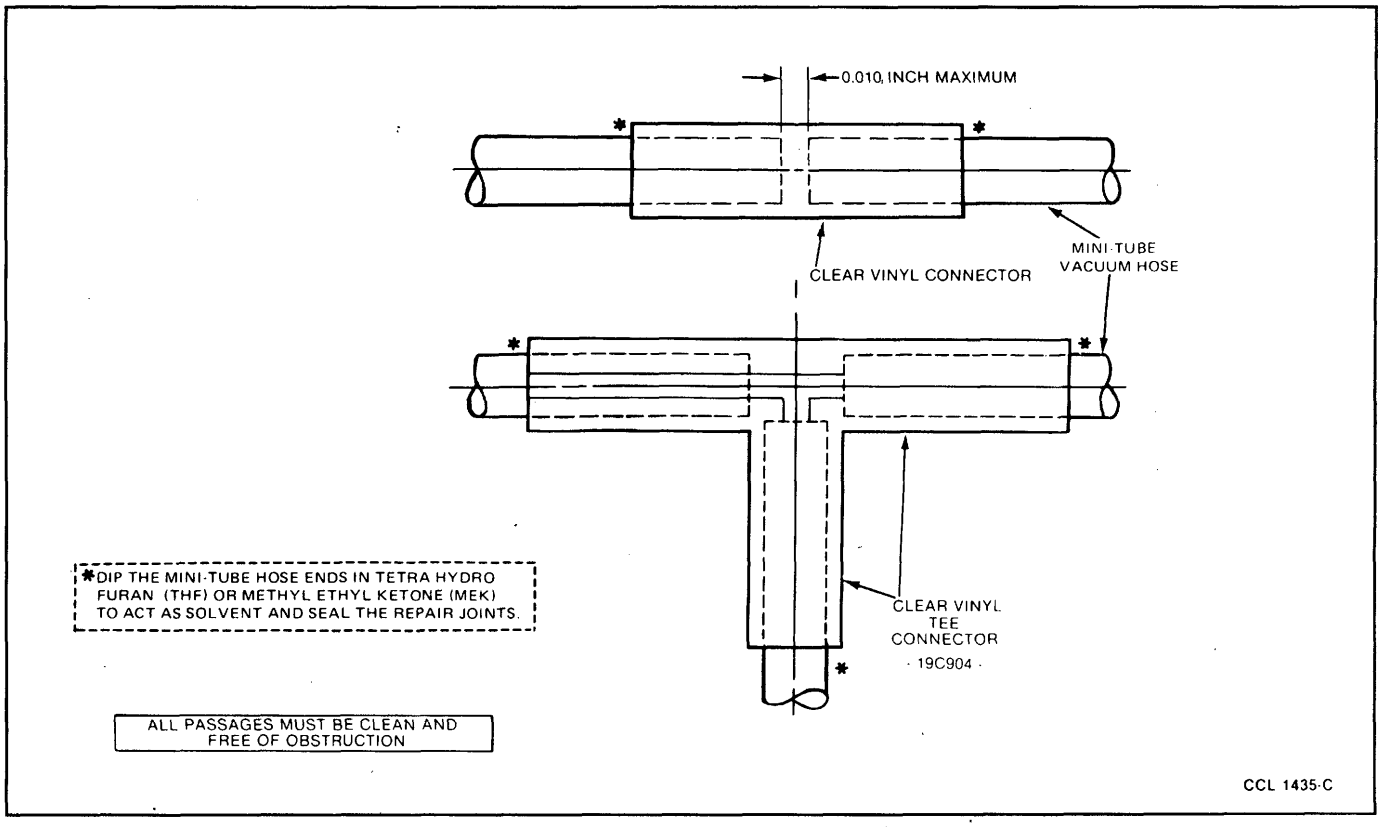


FIG. 7 Mini-Tube Vacuum Hose Service

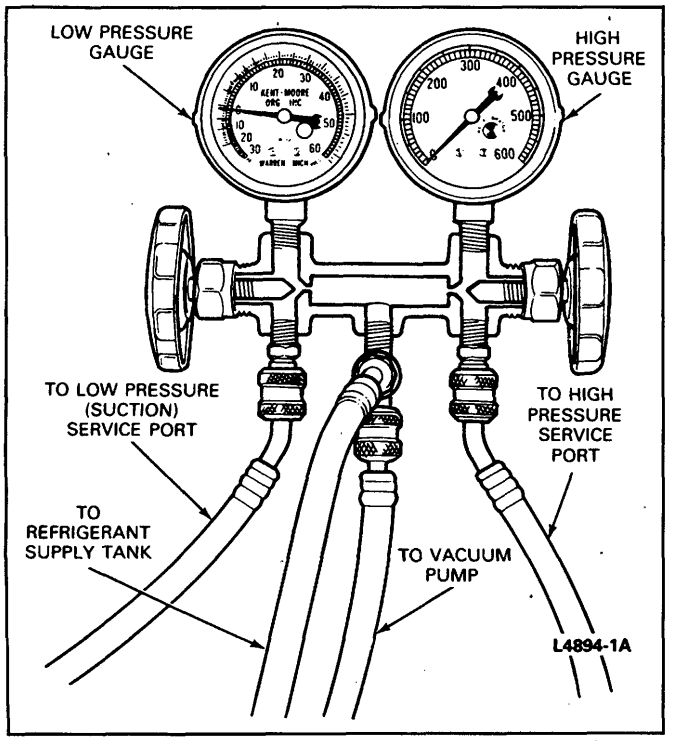


FIG. 8 Manifold Gauge Set

7. Test the system for a vacuum leak in the service area.

Attaching the Manifold Gauge Set

When performing any of the various tests, test equipment must be connected to the refrigerant system. If charge station-type equipment is used, follow the instructions of the manufacturer.

To attach a manifold gauge set (Fig. 8) (part of Rotunda Manifold Gauge Set 063-00010 or equivalent) to the service access gauge port valves, proceed as follows:

1. Turn both manifold gauge set valves fully clockwise to close high and low pressure hoses at gauge.
2. Remove caps from high and low pressure service (Schrader) access gauge port valves in high and low pressure lines (Figs. 3 and 4).
3. If refrigerant hoses do not have valve depressing pins in them, install Straight Adapter T71P-19703-S or Curved Adapter T71P-19703-R or equivalents (containing valve depressing pins) on manifold gauge set low and high pressure hoses.
4. Connect high and low pressure refrigerant hoses with depressing pins or adapters containing depressing pins to respective high and low pressure service access gauge port valves. The special adapter shown in Fig. 5 must be used on high pressure service access gauge port valve.
5. Connect hoses attached to manifold center fitting to refrigerant supply tank and vacuum pump valves.

Checking For Leaks

Attach the manifold gauge set (Fig. 8). Leave both manifold gauge set valves at the maximum clockwise position. Both gauges should show approximately 414-551 kPa (60-80 psi) at 23.9°C (75°F) with the engine not running. If very little or no pressure is indicated, leave the vacuum pump valve closed, open the Refrigerant-12

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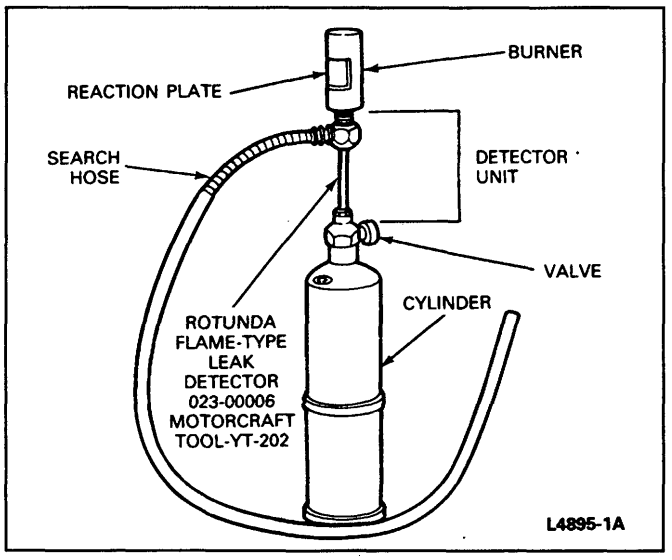


FIG. 9 Flame-Type Leak Detector

tank valve, and turn the low pressure (suction) manifold gauge set valve to the counterclockwise position. This opens the system to tank pressure. Check all connections, and the compressor head gasket, oil filter plug, and the shaft seal for leaks using a flame-type leak detector or Rotunda Flame-Type Detector 023-00006 (Motorcraft YT-202) or equivalent (Fig. 9).

NOTE: Use compressed air to blow off excessive oil from the shaft seal area to reduce the possibility of an erroneous detection of freon retained in the refrigerant oil.

Flame-Type Leak Detector

Avoid inhaling the fumes from the leak detector. Follow the directions with the leak detector.

The smaller the flame on the flame-type detector the more sensitive it is to leaks. Therefore, to ensure accurate leak indication, keep the flame as small as possible. The copper element must be red hot. If it is burned, always replace the element. Hold the open end of the hose below each suspected leak point for two or three seconds. The flame will normally be almost colorless. The slightest leak will be indicated by a bright green blue color to the flame. Be sure to check the manifold gauge set and hoses for leaks as well as the rest of the system.

If the surrounding air is contaminated with refrigerant gas, the leak detector will indicate this gas all the time. Good ventilation is necessary to prevent this situation. A fan, even in a well ventilated area, is very helpful in removing small traces of refrigerant vapor.

Refrigerant System

To diagnose a problem in the refrigerant system, note the system pressure (shown by the manifold gauges) and the clutch cycle rate. Then compare readings to the charts shown in Figs. 10 and 11.

- The system pressures are low (compressor suction) and high (compressor discharge).
- A clutch cycle is the time the clutch is engaged plus the time it is disengaged (time on plus time off).
- Clutch cycle times are the lengths of time (in seconds) that the clutch is on or off.

To achieve accurate diagnosis results in the least amount of time use the following procedure and refer to Figs. 10 and 11.

NOTE: The test conditions specified at the top of each of the charts must be met to obtain accurate test results.

1. Connect a manifold gauge set to the system.
2. When system has stabilized, record high and low pressures as shown by manifold gauges.
3. Determine clutch cycle rate per minute (clutch ON time plus OFF time is a cycle).
4. Record clutch OFF time in seconds.
5. Record clutch ON time in seconds.
6. Note center register discharge temperature.
7. Determine and record ambient temperature.
8. Compare test readings and appropriate chart (Figs. 10 and 11).
   - Plot a vertical line for recorded ambient temperature from scale at bottom of each chart to top of chart.
   - Plot a horizontal line for other test readings from scale at LH side of appropriate chart.

If the point where the two lines cross on each chart falls within the dark band, the system is operating normally. If the lines cross outside the dark band on one or more of the charts, there is a problem and the specific cause must be determined. Refer to the Refrigerant System and Clutch Cycle Timing Evaluation chart (Fig. 12). NOTE: The following five system operating conditions are indicated by where the lines cross on the chart:

- System high (discharge)—pressure is high, low or normal.
- System low (suction)—pressure is high, low or normal.
- Clutch cycle rate is fast, slow or clutch runs continuously.
- Clutch ON time is long or short.
- Clutch OFF time is long or short.

Match these conditions to the conditions shown in the five columns toward the left in the System Pressure and Clutch Cycle Timing Evaluation chart (Fig. 12). All five system conditions will be indicated on one line. The most likely component or components causing the problem are listed in the RH column.

Example:

- High (discharge)—pressure is low.
- Low (suction)—pressure is normal.
- Clutch cycle rate is very fast.
- Clutch ON time is very short.
- Clutch OFF time is very short.

In this example, the problem is caused by the clutch cycling pressure switch. The clutch cycling range is too close. Replace the switch and recheck the system.

Example

- High (discharge)—pressure is normal to low.
- Low (suction)—pressure is normal.

A badly contaminated system contains water, carbon and other decomposition products. Where such a

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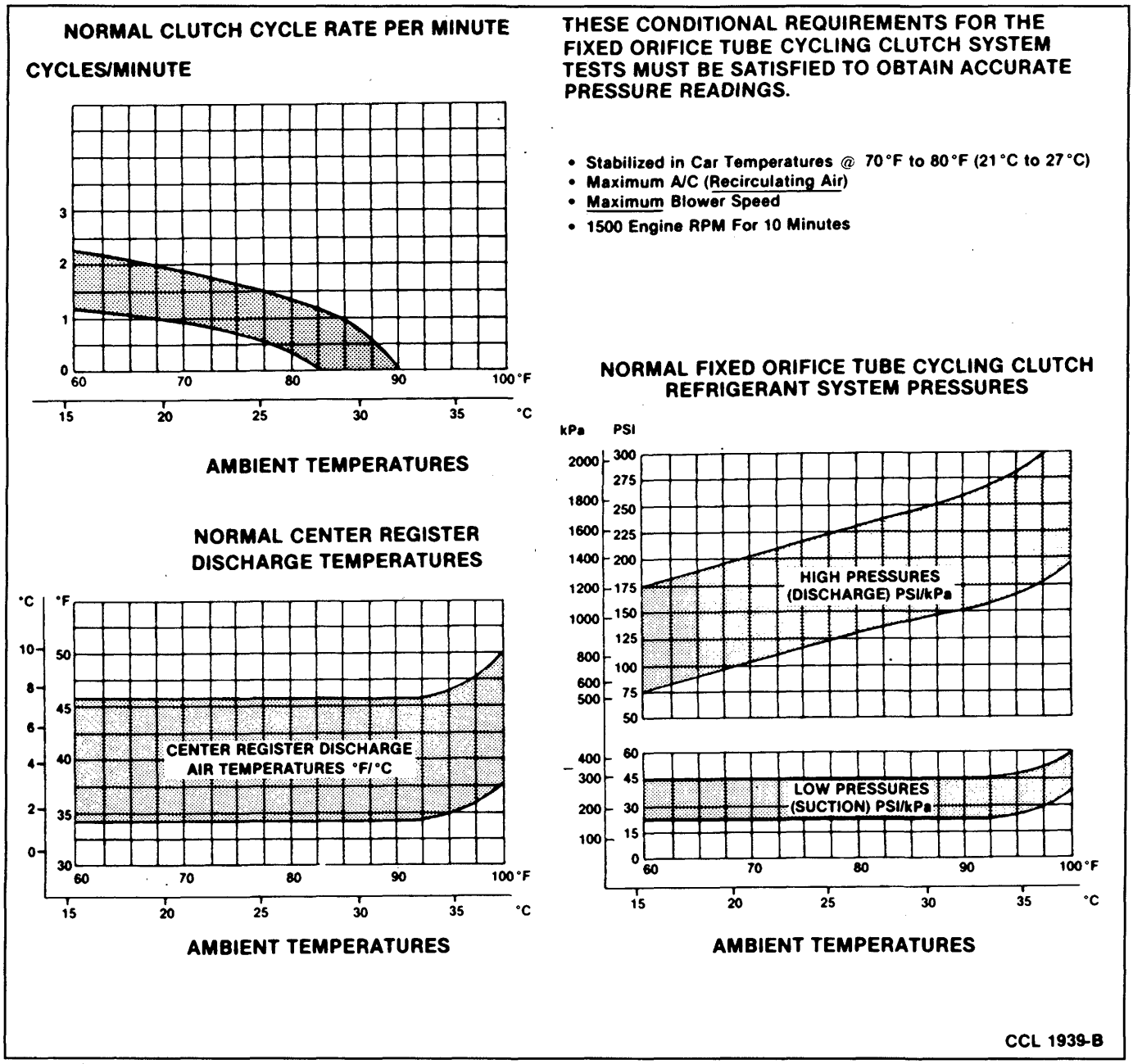


FIG. 10 Normal Fixed Orifice Tube Cycling Clutch Refrigerant System Pressure/Temperature Relationships

condition exists, the system must be flushed with a special flushing agent using equipment designed especially for this purpose. Follow the suggestions and procedures outlined to ensure a proper cleaning job.

Flushing Agents

To be suitable as a flushing agent, a refrigerant must remain in the liquid state during the flushing operation, in order to wash the inside surfaces of the system components. Refrigerant vapor will not remove contaminant particles. They must be flushed with a liquid. Some refrigerants are better suited for this purpose than others. Refer to Fig. 13.

The chart (Fig. 13) shows the pressure/temperature relationship and the vaporization/temperature relationship for four refrigerants. Neither Refrigerant-12 nor Refrigerant-114 is suitable for flushing a system because of low vaporization (boiling) points (-5.78°C (21.6°F) for Refrigerant-12 and 3.55°C (38.4°F) for Refrigerant-114). Both these refrigerants would be difficult to use and would not do a good job because of their tendency to vaporize rather than remain in the liquid state, especially in high ambient temperatures.

The other two refrigerants listed in the chart (Refrigerant-11 and Refrigerant-113) are much better suited for use with special flushing equipment. Both have rather high vaporization points (23.4°C (74.7°F) for Refrigerant-11 and 47°C (117.6°F) for Refrigerant-113). Also, both refrigerants have low closed container pressures. This reduces the danger of an accidental system discharge because of a ruptured hose or fitting. Flushing Refrigerant-113 is recommended. Both Refrigerant-11 and Refrigerant-113 require a propellant or pump-type flushing equipment because of their low closed container pressures. Refrigerant-12 can be used as a propellant with either flushing refrigerant.

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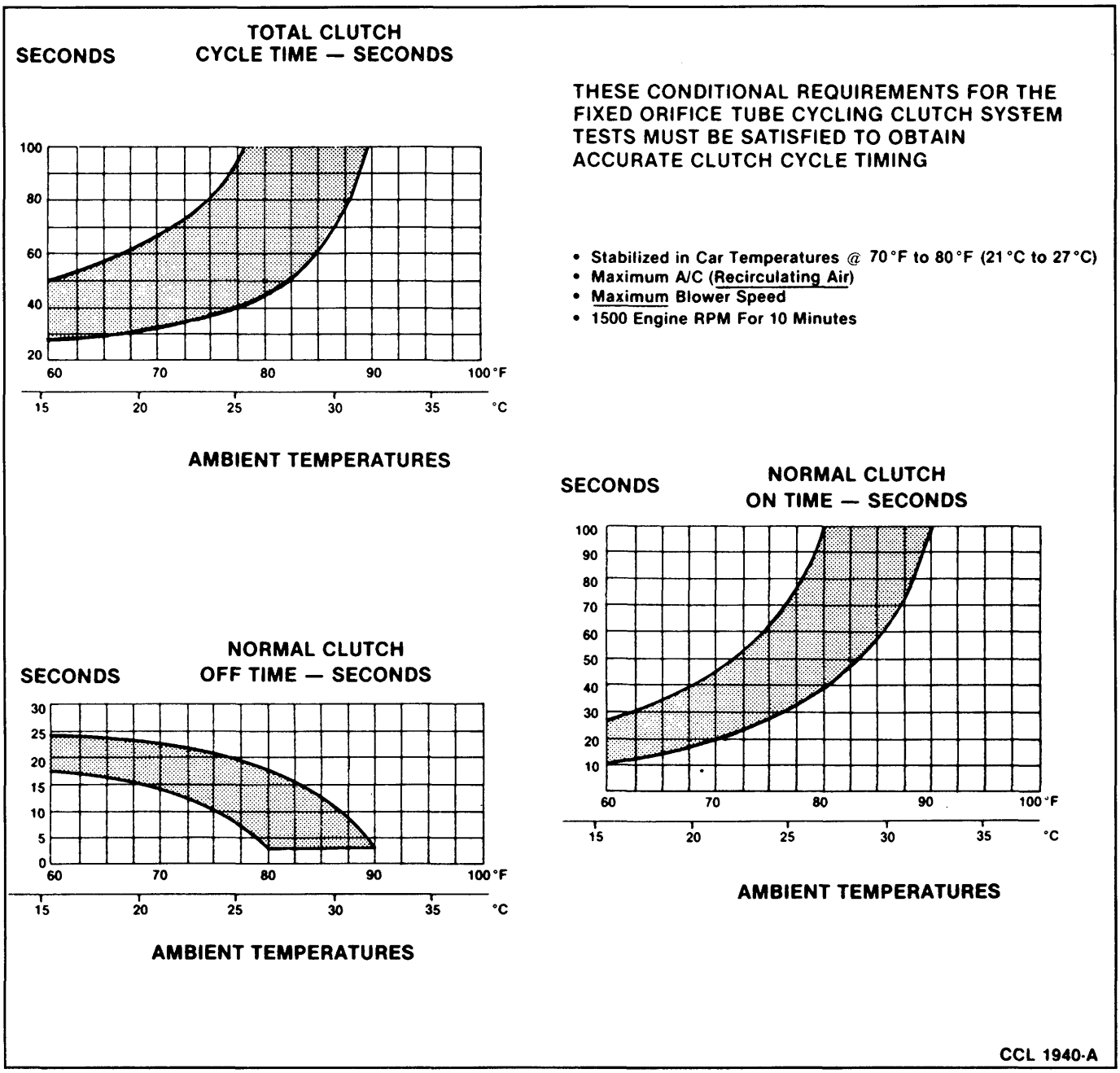


FIG. 11 Normal Clutch Cycle Rates and Times—Fixed Orifice Tube System

Refrigerant-11 is available in pressurized containers. Although not recommended for regular use, it might become necessary if special flushing equipment is not available. Handle with care as it is more toxic than the other refrigerants.

CAUTION: Use extreme care and follow all safety precautions related to the use of refrigerants when flushing a system.

Special Flushing Equipment

Special refrigerant system flushing equipment is available from a number of air conditioning equipment manufacturers and usually comes in kit form.

The kit consists of a cylinder for the flushing agent, a nozzle to introduce the flushing agent into the system and a connecting hose (Fig. 14).

Another type of equipment which must be connected into the system allows for the continuous circulation of the flushing agent through the system with the contaminants being trapped by an external filter/drier. If equipment other than a refrigerant system flushing kit is used, follow the manufacturer's instructions and safety precautions carefully.

System Cleaning and Flushing

1. Check hose connections at flushing cylinder outlet and flushing nozzle to be sure they are tight.
2. Ensure flushing cylinder is filled with approximately 0.47L (1 pint) of Refrigerant-113. Ensure valve assembly in top of cylinder is tightened securely.
3. Connect a can of Refrigerant-12 to Schrader valve at top of charging cylinder. A refrigerant hose and a special safety-type refrigerants dispensing valve,

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REFRIGERANT SYSTEM PRESSURE AND CLUTCH CYCLE TIMING EVALUATION CHART FOR FIXED ORIFICE TUBE CYCLING CLUTCH SYSTEMS

NOTE: System test requirements must be met to obtain accurate test readings for evaluation. Refer to the normal refrigerant system pressure/temperature and the normal clutch cycle ratio and times charts.

High (Discharge) Pressure	Low (Suction) Pressure	Clutch Cycle Time			Component — Causes
		Rate	On	Off	
High	High	Continuous Run			Condenser — Inadequate Airflow
High	Normal to High				Engine Overheating
Normal to High	Normal				Air in Refrigerant Refrigerant Overcharge (a) Humidity or Ambient Temp Very High (b)
Normal	High				Fixed Orifice Tube — Missing O Rings Leaking/Missing
Normal	High	Slow	Long	Long	Clutch Cycling Switch — High Cut In
Normal	Normal	Slow or No Cycle	Long or Continuous	Normal or No Cycle	Moisture in Refrigerant System Excessive Refrigerant Oil
		Fast	Short	Short	Clutch Cycling Switch — Low Cut In or High Cut Out
Normal	Low	Slow	Long	Long	Clutch Cycling Switch — Low Cut Out
Normal to Low	High	Continuous Run			Compressor — Low Performance
Normal to Low	Normal to High				A/C Suction Line — Partially Restricted or Plugged (c)
Normal to Low	Normal	Fast	Short	Normal	Evaporator — Restricted Airflow
			Short to Very Short	Normal to Long	Condenser fixed orifice Tube or A/C Liquid Line — Partically Restricted or Plugged
			Short to Very Short	Short to Very Short	Low Refrigerant Charge
			Short to Very Short	Long	Evaporator Core — Partially Restricted or Plugged
Normal to Low	Low	Continuous Run			A/C Suction Line — Partially Restricted or Plugged (d) Clutch Cycling Switch — Sticking Closed
Low	Normal	Very Fast	Very Short	Very Short	Clutch Cycling Switch — Cycling Range Too Close
Erratic Operation or Compressor Not Running		—	—	—	Clutch Cycling Switch — Dirty Contacts or Sticking Open Poor Connection at A/C Clutch Connector or Clutch Cycling Switch Connector A/C Electrical Circuit Erratic — See A/C Electrical Circuit Wiring Diagram

Additional Possible Cause Components Associated with Inadequate Compressor Operation

- Compressor Drive Belt — Loose
- Compressor Clutch — Slipping
- Clutch Coil Open — Shorted or Loose Mounting
- Control Assembly Switch — Dirty Contacts or Sticking Open
- Clutch Wiring Circuit — High Resistance Open or Blown Fuse

Additional Possible Cause Components Associated with a Damaged Compressor

- Compressor Clutch — Seized
- Clutch Cycling Switch — Sticking Closed
- Suction Accumulator Drier — Refrigerant Oil Bleed Hole Plugged
- Refrigerant Leaks

(a) Compressor may make noise on initial run. This is slugging condition caused by excessive liquid refrigerant.
(b) Compressor clutch may not cycle in ambient temperatures above 80°F depending on humidity conditions.
(c) Low pressure reading will be normal to high if pressure is taken at accumulator and if restriction is downstream of service access valve.
(d) Low pressure reading will be low if pressure is taken near the compressor and restriction is upstream of service access valve.

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FIG. 12 Refrigerant System and Clutch Cycle Rate and Timing Evaluation—Fixed Orifice Tube Systems

such as Small Can Adapter 023-00009 (Motorcraft YT-280) or equivalent, are required for connecting small can to cylinder. Ensure valve on can is closed (full clockwise) when connections are made. Ensure all connections are tight.

4. Connect a gauge manifold and discharge the system. Disconnect gauge manifold.
5. Remove compressor from vehicle for cleaning and service or replacement, as required. If compressor is cleaned and serviced, add specified amount of refrigerant oil prior to installing it in vehicle. Place protective caps on compressor inlet and outlet connections and install it on mounting brackets in vehicle. If compressor is replaced, adjust oil level.

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Refrigerant	Vaporizes @ °F	Approximate Closed Container Pressure @					Adaptability
		60°F	70°F	80°F	90°F	100°F	
R-12	−21.6°F	57 PSI	70 PSI	84 PSI	100 PSI	117 PSI	Self Propelling
F-114	38.4°F	8 PSI	13 PSI	19 PSI	25 PSI	32 PSI	
F-11	74.7°F	8 in Hg	3 in Hg	1 PSI	5 PSI	9 PSI	Pump Required*
F-113	117.6°F	22 in Hg	19 in Hg	16 in Hg	13 in Hg	8 in Hg	

*F-11 is also available in pressurized containers. This makes it suitable for usage when special flushing equipment is not available. However, it is more toxic than R-12 and F-114.

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FIG. 13 Refrigerant Flushing Information Chart

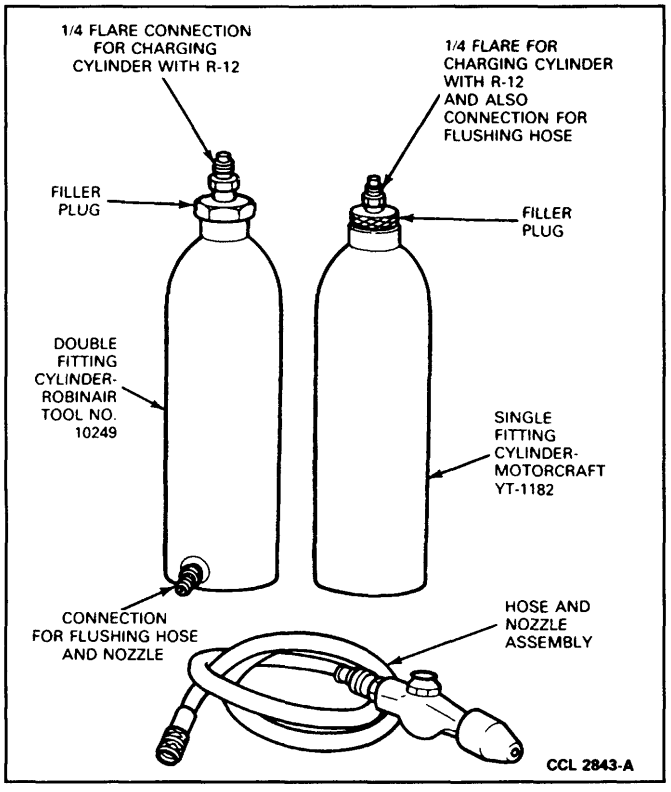


FIG. 14 Refrigerant System Flushing Kit

Refer to Section 36-39. Install the shipping caps on compressor connections. Install new compressor on mounting brackets in vehicle.

6. For E-150—E-350 vehicles:
   a. Remove expansion valve. Clean it with a small charge of Refrigerant R-113. Blow Refrigerant-113 out with a small charge of Refrigerant-12. When it is installed, use a new O-ring seal dipped in clean refrigerant oil.
   b. Remove receiver-drier from the condenser.
   c. Place a suitable container under removed discharge hose compressor manifold end. Back-flush the condenser and discharge hose from receiver-drier connection with a suitable flushing agent. Observe all safety precautions.
   d. Attach a short piece of hose to liquid line connection at receiver-drier and place end of hose in a suitable container to hold flushing agent.
   e. If vehicle has an auxiliary air conditioner, disconnect auxiliary liquid line from front system liquid line, and cap opening in front system line.
   f. Flush front system liquid line from expansion valve end with a suitable flushing solvent. Observe all safety precautions.
   g. If vehicle is equipped with an auxiliary air conditioner, disconnect auxiliary unit suction hose from front unit suction hose at spring lock coupling. Cover male fitting of spring lock coupling with a suitable plastic cap.
   h. Place a suitable container under removed suction hose compressor manifold end. Then, flush evaporator core and suction line from expansion valve connection with a suitable flushing agent.
   i. Remove plastic cap from auxiliary unit suction line take-off and again flush suction line auxiliary system take-off hose.
   j. If vehicle is equipped with an auxiliary air conditioner, remove expansion valve from auxiliary evaporator core and liquid line. Clean expansion valve as outlined in Step a.
   k. Place a suitable container under engine end of auxiliary liquid line. Flush auxiliary liquid line from expansion valve end with a suitable flushing agent.
   l. Attach a piece of hose to auxiliary unit evaporator core inlet and place end of hose in a suitable container. Flush suction hose and evaporator core with a suitable flushing agent. Observe all safety precautions.
   m. Purge all system components with nitrogen or liquid Refrigerant-12.
   n. Assemble all connections using new O-rings lubricated with clean refrigerant oil. Use only specified O-rings on spring lock couplings.
   o. Install a new receiver-drier using new O-rings lubricated with clean refrigerant oil. Tighten fittings to specifications using a backup wrench to prevent component damage.
7. For F-150—F-350 and Bronco vehicles, remove suction accumulator/drier and discard. Install a new one and connect it to the evaporator. Do not connect it to suction line from compressor, but ensure protective cap is in place on suction line connection.
8. Remove fixed orifice tube. If a new tube is available, replace contaminated one. Otherwise, wash it carefully in flushing refrigerant or mineral spirits and blow it dry. If it does not show signs of damage or deterioration, it may be reused. Be sure

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to use new O-rings dipped in clean refrigerant oil. Install a protective cap on evaporative inlet line, as soon as orifice tube is in place. The liquid line will be connected later.

9. Back-flush the condenser and liquid line as follows:
   a. Remove two O-rings from condenser inlet tube spring lock coupling.
   b. Remove discharge hose from condenser and clamp a piece of heater hose (1/2 inch ID) to the condenser inlet line. Be sure hose is long enough to insert free end into a suitable waste container to catch the flushing refrigerant.
   c. Move flushing equipment into position and open valve on can of Refrigerant-12 (fully counterclockwise).
   d. Back-flush condenser and liquid line by introducing flushing refrigerant into supported end of liquid line with flushing nozzle. Hold nozzle firmly against open end of liquid line.
   e. After liquid line and condenser have been flushed, lay charging cylinder on its side so that Refrigerant-12 will not force more flushing refrigerant into liquid line. Press nozzle firmly to liquid line and admit Refrigerant-12 to force all flushing refrigerant from liquid line and condenser.
   f. Remove 1/2-inch hose and clamp from condenser inlet connection.
   g. Stand flushing cylinder upright and flush compressor discharge line. Secure it so flushing refrigerant goes into waste container.
   h. Close dispensing valve at Refrigerant-12 can (fully clockwise). If there is any flushing refrigerant in cylinder, it may be left there until next flushing job. Put flushing kit and Refrigerant-12 can in a suitable storage location.
   i. Install new lubricated O-rings on spring lock coupling male fittings on both the condenser inlet and liquid lines. Assemble the couplings.
10. Connect all refrigerant lines. Connections should be cleaned and new O-rings used. Lubricate new O-rings with clean refrigerant oil. Any moisture in the evaporator will be removed during system evacuation.
11. Connect a charging station or manifold gauge set and charge the system with 0.45kg (1 pound) of Refrigerant-12 (do not evacuate the system until after it has been leak tested).
12. Leak test all connections and components with a flame-type or electronic leak detector. If no leaks are found, go to Step 13. If a leak(s) is found, service as necessary, recheck the system, and then go to Step 13.
13. Evacuate and charge the system with the specified amount of Refrigerant-12. Operate the system to be sure it is cooling properly.

Flushing The System With Special Flushing Equipment

Special Refrigerant System flushing Equipment is available from various air conditioning equipment manufacturers. This equipment provides a faster method of cleaning the major refrigerant system components without removing them from the vehicle. All restrictive components, however, such as the fixed orifice tube, the suction accumulator/drier, the expansion valve and the receiver/drier must be removed. A temporary replacement for the removed suction accumulator/drier or receiver/drier can be made by using tubing such as neoprene or plastic garden hose. This allows for the continuous circulation of a refrigerant system flushing agent so that all system contaminants can be washed out of the major refrigerant system components and hose assemblies, to be trapped in an external filter/drier assembly.

CAUTION: Always check to be sure the flushing refrigerant is compatible with the hose material being used. Some hose materials may dissolve, swell or become brittle when used with certain refrigerants.

The Safety Precautions should be observed at all times. If the components are flushed with a refrigerant other than R-12, it is necessary to remove the excess flushing refrigerant by blowing out with refrigerant-12 or with Nitrogen. If Nitrogen is used, a pressure regulator should be installed on the Nitrogen supply tank to reduce the extremely high Nitrogen Supply Pressure.

When cleaning a contaminated refrigerant system using the continuous circulation method, follow the method as recommended by the manufacturer of the special flushing equipment.

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Insufficient or No A/C Cooling Fixed Orifice Tube Cycling Clutch System

TEST STEP	RESULT ▶	ACTION TO TAKE
A1 VERIFY CONDITION		
• Verify the condition.	System cooling properly ▶	Instruct driver on how to use system.
	System not cooling properly ▶	GO to **A2**.
A2 CHECK A/C CLUTCH		
• Does the A/C compressor clutch engage?	Yes ▶	GO to **A3**.
	No ▶	REFER to compressor clutch, circuit diagnosis.
A3 CHECK UNDER HOOD		
Under-hood check for: • Loose, missing or damaged compressor drive belt. • Loose or disconnected A/C clutch or clutch cycling pressure switch wires or connectors. • Disconnected resistor assembly. • Loose vacuum lines or misadjusted control cables. In-car check for: • Blown fuse/proper blower motor operation. • Vacuum motors/temperature door movement — full travel. • Control electrical and vacuum connections.	OK but still not cooling ▶	GO to **A5**.
	Not OK ▶	REPAIR and GO to **A4**.
A4 CHECK SYSTEM OPERATION		
• Check system operation.	System cooling OK ▶	Condition corrected, GO to **A1**.
	System not cooling OK ▶	GO to **A5**.

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Insufficient or No A/C Cooling Fixed Orifice Tube Cycling Clutch System (Continued)

TEST STEP	RESULT ▶	ACTION TO TAKE
A5 CHECK PRESSURE/CLUTCH CYCLE RATE		
• Use refrigerant system pressure/clutch cycle rate and timing evaluation charts. 1. Hook up manifold gauge set. 2. Set function lever at MAX A/C. 3. Set blower switch on HIGH. 4. Set temp lever full cold. 5. Close doors and windows. 6. Use a thermometer to check temperature at center discharge register. Record outside temperature. 7. Run engine at approximately 1500 RPM with compressor clutch engaged. 8. Stabilize with above conditions for 10-15 minutes. • Check compressor clutch OFF/ON; time with watch. See charts for normal clutch cycle and timing rates.	Compressor cycles very rapidly ▶ Compressor runs continuously (Normal operation in ambient temp above 26.6° (80°F) depending on humidity conditions) ▶ Compressor cycles slow ▶	GO to **A6**. GO to **A7**. GO to **A6**.
A6 CHECK EVAPORATOR TUBES TEMP.		
• Bypass clutch cycling pressure switch with jumper wire. Compressor on continuously. • Hand feel evaporator inlet and outlet tubes.	Outlet tube same temperature (Approximately −2.2°C- −4.4°C or 28°F-40°F) or slightly colder than inlet tube (after fixed orifice) ▶ Inlet tube warm or (after fixed orifice) colder than outlet tube ▶	REPLACE expansion valve. GO to **A7**. GO to **A8**.

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TEST STEP	RESULT ▶	ACTION TO TAKE
A7 CHECK PRESSURES		
Check system pressures. • Compare readings with normal system pressure ranges.	Clutch cycles within limits ▶	System OK. GO to **A1**.
	Compressor runs continuously (normal operation in ambient temperature above 26.6°C (80°F) depending on humidity conditions). ▶	GO to **A9**.
	Compressor cycles high or low: ON above 358 kPa (52 psi) OFF below 144 kPa (21 psi) ▶	REPLACE expansion valve.
	▶	System OK, GO to **A1**.
	▶	Not OK. GO to **A8**.
A8 CHECK FOR LEAKS		
Leak check system.	Leak found ▶	Repair, discharge, evacuate and charge system.
	▶	System OK, GO to **A1**.
	No leak found ▶	Low refrigerant charge or moisture in system. Discharge, evacuate and charge system. System OK.

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Insufficient or No A/C Cooling Fixed Orifice Tube Cycling Clutch System (Continued)

TEST STEP		RESULT	ACTION TO TAKE
A9	CHECK CLUTCH CYCLING OFF		
Disconnect blower motor wire and check for clutch cycling off at 144 kPa (21 psi) (suction pressure).		Clutch cycles off at 144 kPa (21 psi) ▶	RECONNECT blower motor wire.
		▶	System OK, GO to **A1**.
		Pressure falls below 144 kPa (21 psi) ▶	REPLACE expansion valve.
		▶	System OK, GO to **A1**.

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COMPRESSOR CLUTCH CIRCUIT DIAGNOSIS

TEST STEP		RESULT ▶	ACTION TO TAKE
A1	CHECK SYSTEM OPERATION		
	• Turn blower switch On. • Depress A/C push-button. • Turn ignition switch to Run position. • Compressor clutch should engage.	Clutch operates ▶	System OK.
		Clutch does not operate ▶	GO to **A2**.
A2	CHECK FOR VOLTAGE		
	• Check for voltage at circuit wire at the clutch cycling pressure switch connector or A/C control switch (E-150 — E-350).	Voltage present ▶	GO to **A3**.
		No voltage ▶	GO to **A9**.
A3	BY-PASS PRESSURE SWITCH		
	• Disconnect connector at clutch cycling pressure switch or control switch (E-150 — E-350). • Jumper connector pins or control switch. • Clutch should engage.	(OK) ▶	GO to **A4**.
		Not OK (OK) ▶	GO to **A5**.
A4	CHECK SYSTEM PRESSURE		
	• Connect manifold gauge set and check system pressure.	Pressure above 55 psi ▶	REPLACE clutch cycling pressure switch. GO to **A1**.
		Pressure below 55 psi (ambient temperature above 50°F) ▶	CHECK refrigerant system for leaks. REPAIR and CHARGE system as necessary GO to **A1**.
A5	CHECK VOLTAGE AT CLUTCH		
	• Check for voltage at clutch field coil.	Voltage present ▶	GO to **A8**.
		No voltage ▶	GO to **A7**.
A6	CHECK CLUTCH GROUND		
	• Jumper ground terminal of clutch field coil to ground. • Clutch should engage.	(OK) ▶	SERVICE open in ground wire. GO to **A1**.
		(OK) ▶	REPLACE clutch field coil. GO to **A1**.
A7	CHECK FUSE		
	• Check Fuse 17 in fuse panel for continuity.	(OK) ▶	GO to **A8**.
		(OK) ▶	CHECK for short. SERVICE as necessary. REPLACE fuse. GO to **A1**.

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COMPRESSOR CLUTCH CIRCUIT DIAGNOSIS — Continued

TEST STEP		RESULT ▶	ACTION TO TAKE
A8	CHECK A/C CONTROLS		
	• Move Function selector lever to DEFROST position. • Check for voltage at circuit wire at the clutch cycling pressure switch connector.	Voltage present ▶ No voltage ▶	GO to **A10**. GO to **A9**.
A9	CHECK CIRCUIT 294		
	• Remove connector from A/C push-button switch. • Check for voltage at circuit.	Voltage present ▶ No voltage ▶	GO to **A10**. CHECK for open in Circuit 294. SERVICE as necessary. GO to **A1**.
A10	CHECK A/C CONTROLS		
	• Check A/C push button switch and Function switch for continuity. **NOTE: A/C push-button switch must be depressed. Function switch must be in DEFROST position.**	Continuity through Function switch only ▶ Continuity through A/C pushbutton switch only ▶ Continuity through both switches ▶	REPLACE A/C pushbutton switch. GO to **A1**. REPLACE Function switch. GO to **A1**. CHECK for open in circuit between control assembly and clutch cycling pressure switch. SERVICE as necessary. GO to **A1**.

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SPECIFICATIONS

Rotunda Equipment	Model	Motorcraft
Flame Type Leak Detector	023-00006	YT-202
Dial Thermometer	023-00007	YT-227
Small Can Adapter	023-00009	YT-280
Manifold Gauge Set	063-00010	YT-201

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REFRIGERANT CAPACITIES (REFRIGERANT-12)

Vehicle	Capacity (Pounds)
F-150 — F-350 and Bronco	3.00 + .25-0
E-150 — E-350	3-1/2 + .25-0 Front A/C Only
E-150 — E-350	4-1/4 + .25-0 Front and Auxiliary A/C

REFRIGERANT SPECIFICATION

Type	Specification	Part No.
Refrigerant-12 (R-12) Dichlorodifluoromethane CCL^2F^2	ESA-M17B2-A or equivalent	D3AZ-19B519-A or equivalent

SPECIAL SERVICE TOOLS

Description	Number	Motorcraft
Belt Tension Gauge	T63L-8620-A	YT-371
Straight Adapter	T71P-19703-S	—
Curved Adapter	T71P-19703-R	—
Back Flushing Adapter — E-150 — E-350, F-150 — F-350, Bronco	T83P-19703-B	YT-1123
Service Port Adapter	D81L-19703-A	—
Orifice Tube Remover and Installer	D80L-19990-A	YT-1008
Broken Orifice Tube Extractor	D80L-19990-B	YT-1009
Flexible Adapter	D81L-19703-C	YT-355
Straight Adapter	D81L-19703-D	YT-357
90 Degree Adapter	D81L-19703-B	YT-354
45 Degree Adapter	D81L-19703-E	YT-927
Spring Lock Coupling Tool 3/8 Inch	T81P-19623-G1	—
1/2 Inch	T81P-19623-G2	—
5/8 Inch	T83P-19623-C	—
3/4 Inch	T85L-19623-A	—
Tee Adapter	D87P-19703-A	①

①Also available from: Four Seasons P.N. 59655 and Robinair P.N. 40387.

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VEHICLE APPLICATION

E-150 Through E-350, F-150 Through F-350 and Bronco Truck Models.

DESCRIPTION AND OPERATION

Two different versions of the FS-6 compressor are used. The familiar radial mount FS-6 (Fig. 1) is used on the 7.3L diesel engine and the tangential mount (Fig. 2) is used on all gasoline engines.

The compressor mainshaft is driven by a belt from the engine crankshaft pulley. Three double-acting pistons, positioned axially around the compressor shaft, operate in a front and rear cylinder assembly. The pistons are actuated by a swash plate that is pressed on the compressor shaft. The swash plate changes the rotating action of the shaft to provide a reciprocating driving force to each of the three pistons. This driving force is applied, through shoes and balls, to the midpoint of each of the double ended pistons.

Reed-type suction and discharge valves are mounted in valve plates between the cylinder assembly and the head at each end of the compressor.

The heads are connected with each other by gas tight passageways which direct refrigerant gas to a common output.

A magnetic clutch is used to drive the compressor shaft. When voltage is applied to the clutch field coil, the clutch plate and hub assembly (which is solidly coupled to the compressor shaft) is drawn by magnetic force toward the pulley which rotates freely on the compressor front head casting. The magnetic force locks the clutch plate and hub assembly and the pulley together as one unit. The compressor shaft then turns with the pulley. When voltage is removed from the clutch field coil, springs in the clutch plate and hub assembly move the clutch plate away from the pulley and the clutch plate and hub assembly and the compressor shaft cease to rotate.

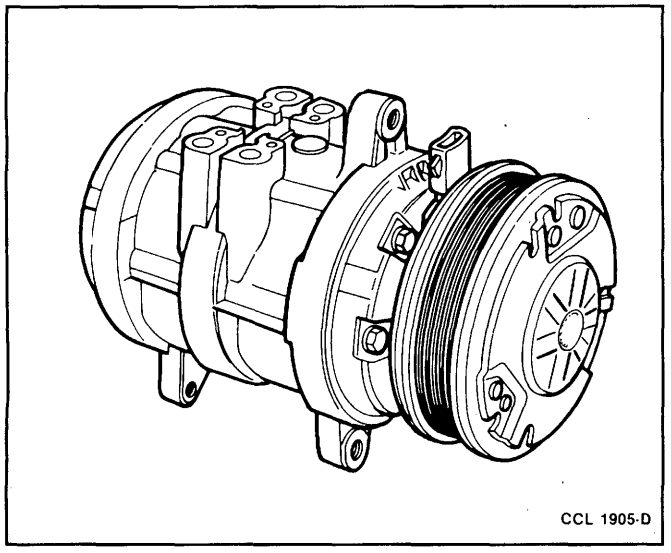


FIG. 1 FS-6 Compressor-Radial Mount

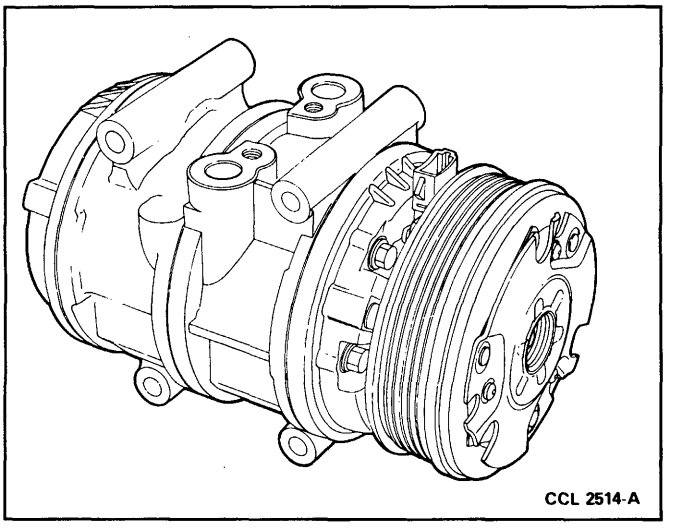


FIG. 2 FS-6 Compressor-Tangential Mount

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MAINTENANCE

Adding Refrigerant Oil

The FS-6 compressor uses a 500 viscosity refrigerant oil (Part No. C9AZ-19557-B or Motorcraft Part No. YN-2 or equivalent). An oil charge of 300ml (10 fluid ounces) is required in a new system. It is important that only the specified type and quantity of refrigerant oil be used in the compressor. If there is a surplus of oil in the system, too much oil will circulate with the refrigerant reducing the cooling capacity of the system. Too little oil will result in poor lubrication of the compressor.

When it is necessary to replace a component of the refrigerant system, the procedures given here must be followed to assure that the total oil charge in the system is correct after the new part is installed. When the compressor is operated, oil gradually leaves the compressor and is circulated through the system with the refrigerant. Eventually a balanced condition is reached in which a certain amount of oil is retained in the compressor and a certain amount is continually circulated. If a component of the system is removed after the system has been operated, some oil will go with it. To maintain the original total oil charge, it is necessary to compensate for this by replacing the oil in the new replacement part.

The procedures for replacing oil are as follows:

During Compressor Replacement

A new service replacement FS-6 compressor contains 300ml (10 fluid ounces) of the specified refrigerant oil. Prior to installing the replacement compressor, drain four fluid ounces of refrigerant oil from the compressor. This will maintain the total system oil charge within the specified limits.

NOTE: The suction accumutor/drier and orifice tube should also be replaced whenever the compressor is replaced.

During Component Replacement

When replacing other components of the air conditioning refrigerant system, measured quantities of 500 viscosity refrigerant oil should be added to the component to assure that the total oil charge in the system is correct before the system is operated.

Clean refrigerant oil should be added to the replacement components as follows:

- EVAPORATOR CORE: Add 90ml (3 fluid ounces)
- CONDENSER: Add 30ml (1 fluid ounce)
- ACCUMULATOR: Drain the oil from the removed accumulator/drier. Add the same amount plus one fluid ounce of clean refrigerant oil to the new accumulator.

Clean refrigerant oil should be poured directly into the replacement component.

If any other components, such as valves or hoses are replaced, no additional refrigerant oil is necessary unless a hose bursts with a fully charged system. Then, depending on the situation, the addition of some refrigerant oil may be necessary.

TESTING

Compressor Manifold Leak Test

1. Tighten the manifold retaining bolts to 18-23 N·m (13-17 ft-lb).
2. Leak test the manifold O-ring seals.
3. If no leaks are found during the leak test, the manifold O-ring seals are good.
4. If a leak is found at the manifold and the manifold bolts are tightened to 28-33 N·m (20-25 ft-lb), install new manifold O-ring seals and repeat the leak test procedure.

Compressor External Leak Test

1. Disconnect the refrigerant lines and/or manifolds from the compressor. Install the Pressure Test Fittings T81P-19623-F on the compressor manifolds or Pressure Test Plates D85L-19703-A or T86P-19703-A or equivalents on the compressor (Figs. 3, 4 and 5).
2. Remove the clutch assembly including field coil from the compressor.
3. Connect the high and low pressure lines of a manifold gauge set to the corresponding fittings on the manifold pressure test fittings (Figs. 3, 4 and 5).
4. Attach the center hose of the manifold gauge set to a refrigerant drum standing in an upright position.
5. Open the low pressure gauge valve, the high pressure gauge valve, and the valve on the refrigerant drum to allow the refrigerant vapor to flow into the compressor.
6. Using a leak detector, check for leaks at the compressor rear head seal, compressor front head seal, the compressor shaft seal, the center joint seal and around the compressor cylinder bolt heads. After checking, turn off the manifold gauge valves.
7. If an external leak is found at either head, either manifold or at the shaft seal, repair as necessary. If an external leak is found at the center joint of the compressor body, install a new compressor assembly.
8. If a refrigerant leak is found at a cylinder bolt, remove the bolt and inspect the underside of the bolt head and the sealing surface around the bolt hole in the head for any damage. Replace the cylinder bolt if damage is found on the underside of the bolt head. Replace the compressor front head if damaged around the bolt hole.

   If no damage is found to either the bolt head or the bolt hole sealing surface, install a new bolt and tighten the bolt approximately 3-4 N·m (2-3 ft-lb) tighter than the specified torque. Leak test the compressor as outlined.

   If the cylinder bolt still leaks around the bolt head, install a new front cylinder head and leak test as outlined.
9. Disconnect the manifold gauge hoses from the Pressure Test Fittings and install the clutch assembly including field coil as outlined.

Compressor Rotating Torque Check

The rotational torque of a used compressor should be checked if excessive compressor drag is suspected.

1. Discharge the refrigerant system following the recommended service procedures. Observe all safety precautions.
2. Remove the compressor from the vehicle.

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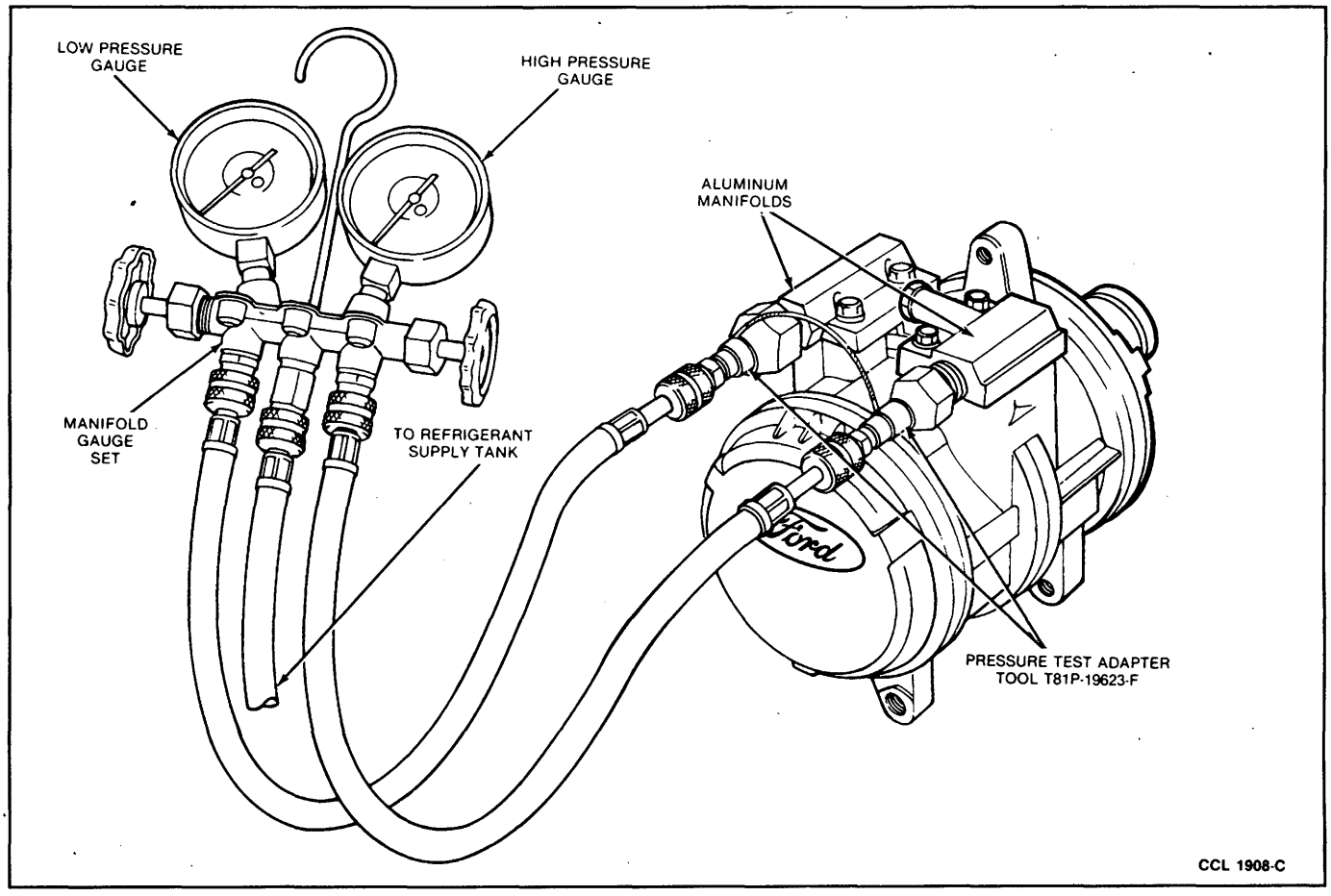


FIG. 3 Testing Compressor for External Leaks—Radial Mount FS-6

3. Rotate the compressor shaft and note the torque required for one complete rotation. Observe the torque while rotating the compressor-shaft, not the starting torque.
4. If the rotational torque exceeds specification, replace the compressor assembly.
5. if the rotational torque is less than the specified rotational torque, excessive drag does not exist in the compressor. Install the compressor. Then, leak test, evacuate and charge the system.
6. Check the system for proper operation.

REMOVAL AND INSTALLATION

On some vehicles, the compressor manifolds are brazed steel and are an integral part of the hose assembly. On other vehicles, the manifolds are made of extruded aluminum and are attached to the hose assembly with a threaded (tube-O) fitting.

NOTE: Two different O-rings are used on compressor manifolds and they are not interchangeable. One O-ring is black and the other is red. Either O-ring must be replaced with the same type and color O-ring. Some vehicles may have black O-rings on one manifold and red O-rings on the other manifold.

Suction or Discharge Aluminum Manifold

Removal

1. Discharge the refrigerant from the system following the recommended procedures. Disconnect the refrigerant lines from the manifolds and remove the compressor from the vehicle. Place the compressor on a clean bench.
2. Remove the two bolts attaching the manifold to the compressor, and remove the manifold and O-rings (Fig. 6).
3. When replacing the discharge manifold, remove and re-use the pressure relief valve from the discharge manifold.

Installation

1. Lubricate the new O-rings with clean refrigerant oil and position them in the O-ring grooves of the manifold.
2. Apply Loctite sealer compound to the threads of the new manifold attaching bolts.
3. Position the manifold with O-rings to the compressor and install the two attaching bolts. Tighten the bolts to Specification.
4. Install the compressor in the vehicle following the recommended procedure.
5. Leak test, evacute and charge the system following the recommended procedures. Observe all safety precautions.

Integral Brazed Manifolds

Removal

1. Discharge the refrigerant from the system following the recommended service procedures.

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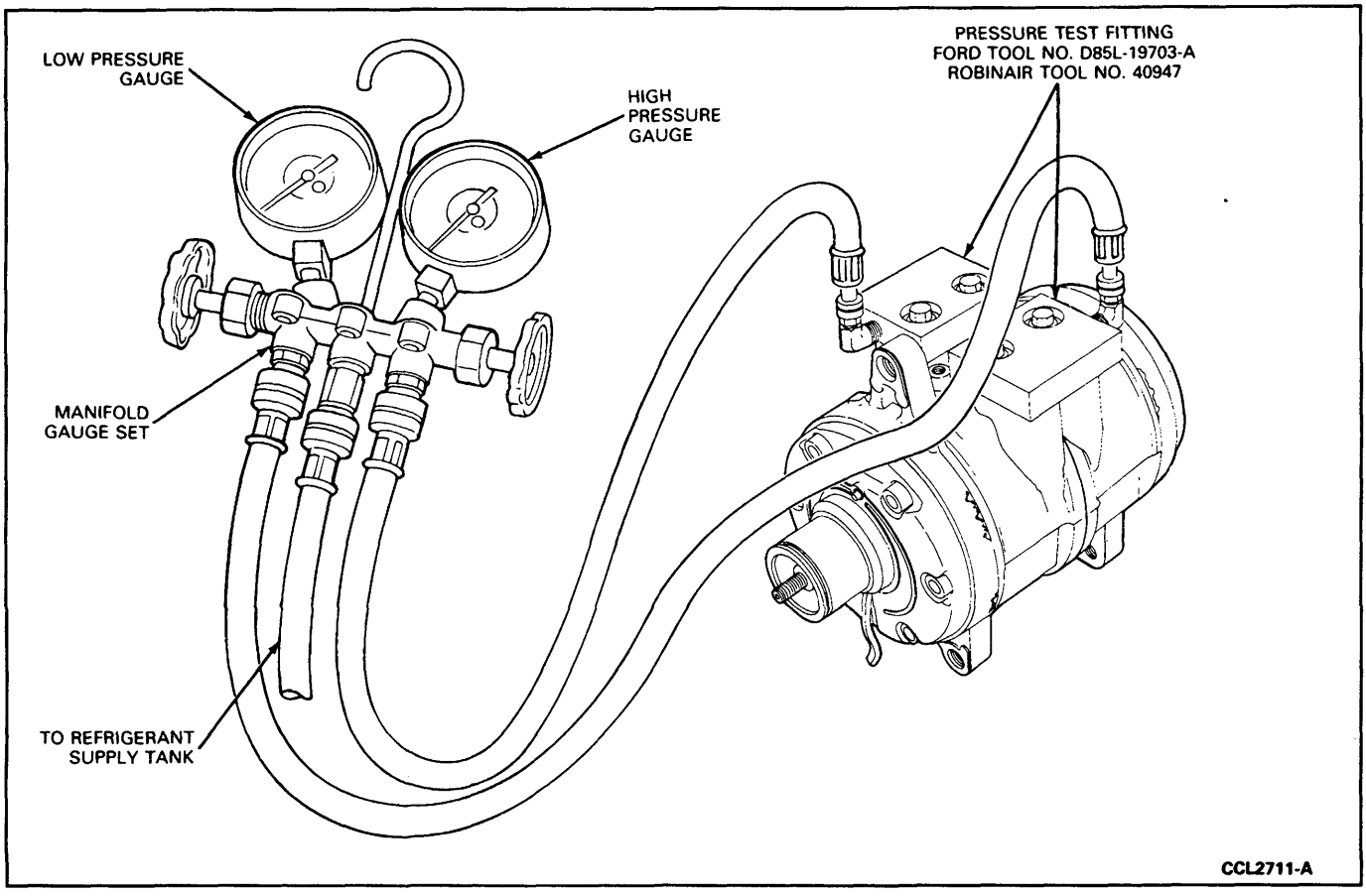


FIG. 4 Testing Compressor for External Leaks—Radial Mount FS-6

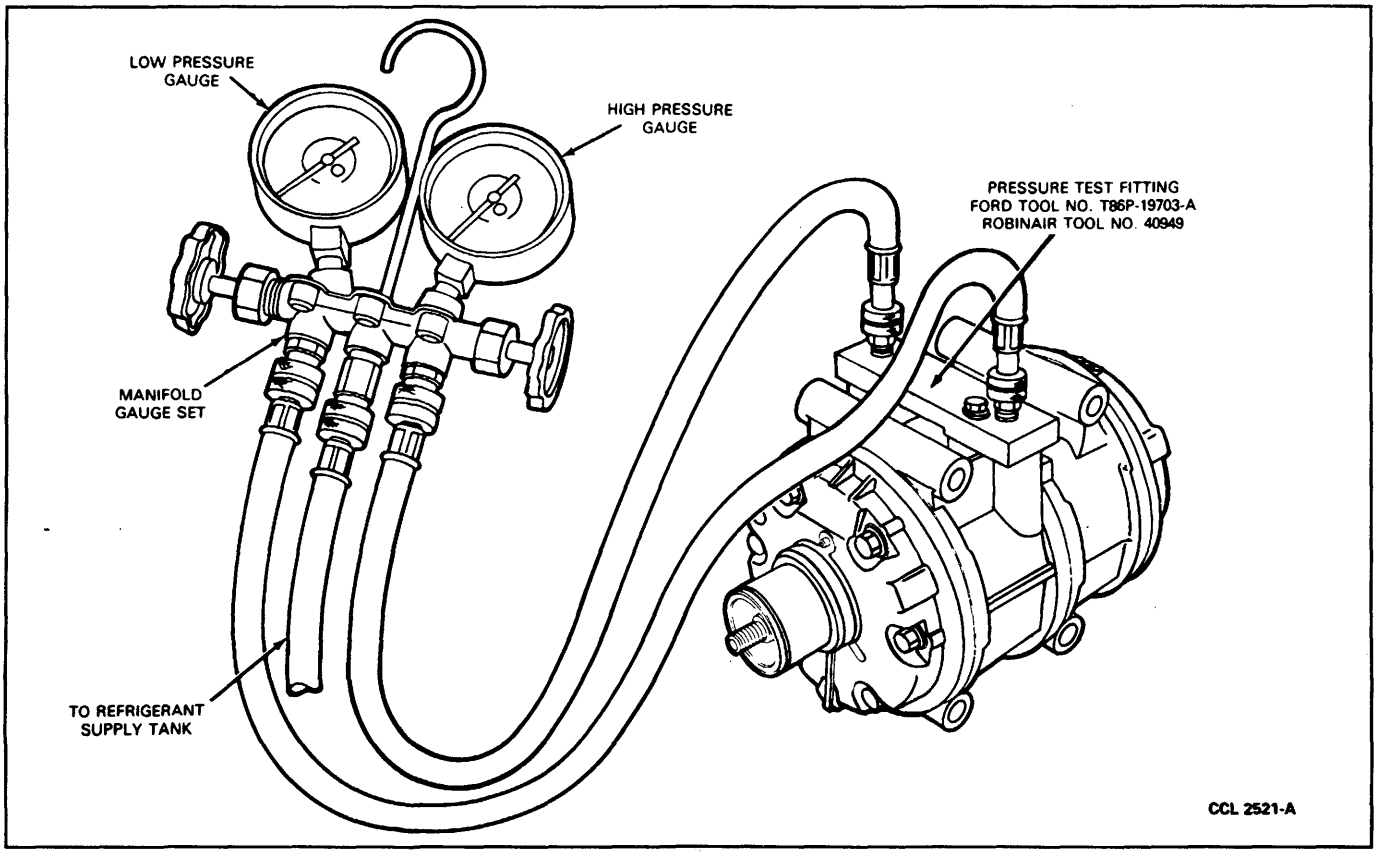


FIG. 5 Testing Compressor for External Leaks—Tangetal Tangetal Mount, FS-6 Compressor

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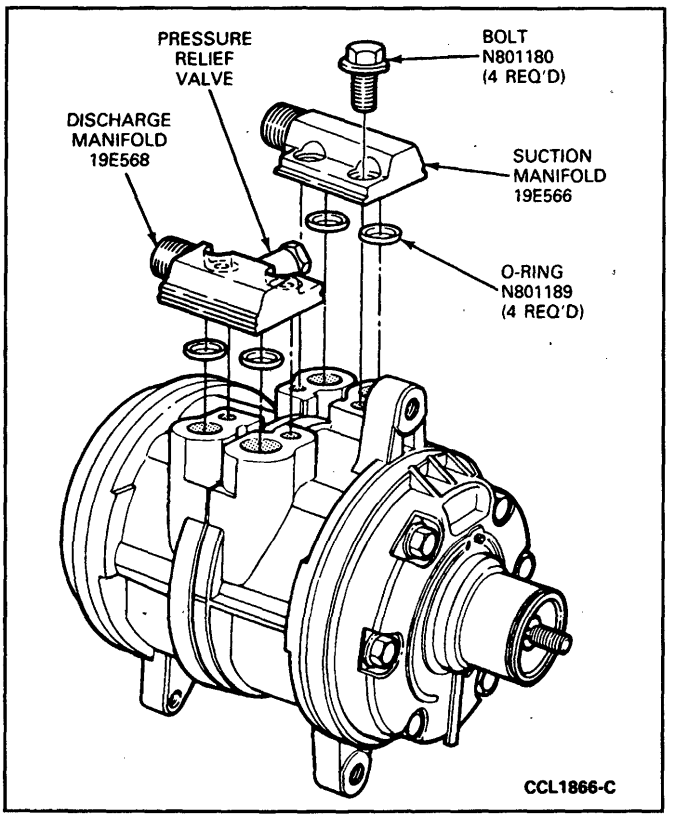


FIG. 6 Aluminum Suction and Discharge Manifolds—Installation

2. Remove the two bolts attaching the manifold to the compressor and separate the manifold with attached hose from the compressor.
3. Remove the O-rings from the manifold.

Installation

1. Lubricate the new O-rings with clean refrigerant oil and position them in the O-ring grooves of the manifold.
2. Apply Loctite sealant to the threads of the manifold attaching bolts.
3. Position the manifold with O-rings to the compressor and install the two attaching bolts. Tighten the bolts to specification. Do not use air tools.

   NOTE: When replacing a compressor use the original manifold bolts from the old compressor to attach the manifold to the new compressor. Do not use the shipping cap bolts.
4. Connect the other end of the manifold and hose assembly as necessary.
5. Leak test, evacuate and charge the system following the recommended procedures. Observe all safety precautions.

Clutch Hub and Pulley

Removal

1. Remove the clutch hub retaining nut. Use Spanner Wrench T81P-19623-MH, or equivalent if necessary.
2. Remove the clutch hub and shims from the compressor shaft with Hub Driven Plate Remover (Fig. 9). Hold the tool with a one inch wrench and tighten the bolt with a 12.7mm (1/2 inch) wrench to pull the hub from the compressor shaft.
3. Remove the clutch pulley retaining snap ring (Fig. 10).
4. Pull the pulley and bearing assembly from the compressor. If the pulley and bearing assembly cannot be removed by hand, use Shaft Protector T80L-19703-G and Pulley Puller D81P-19703-B or equivalents to remove the pulley (Fig. 11).

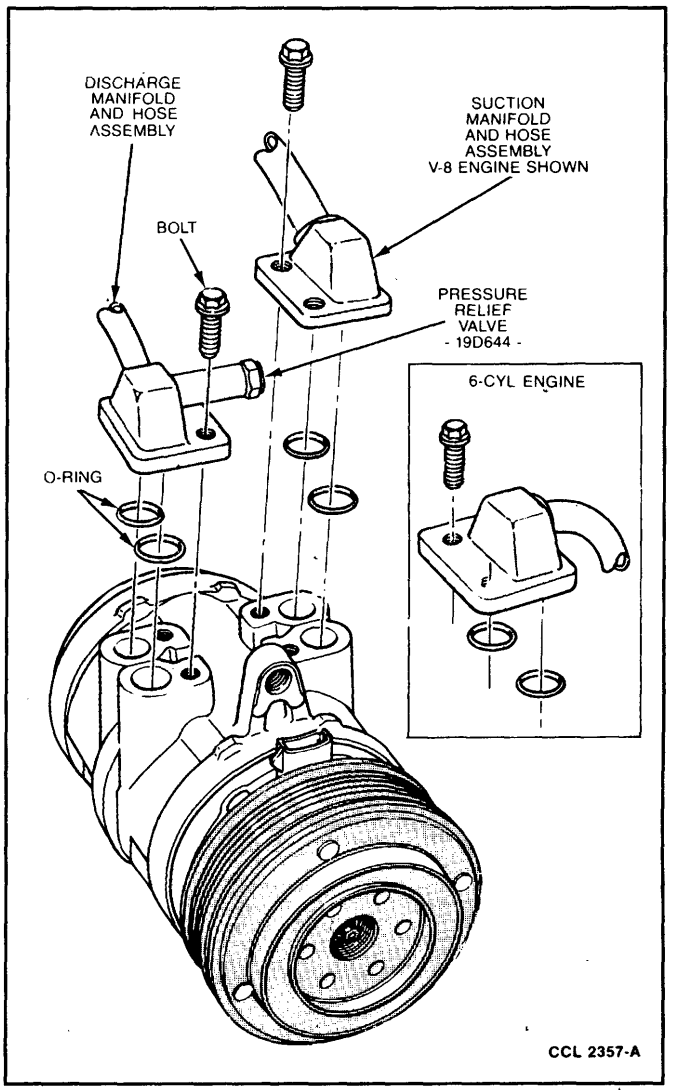


FIG. 7 Brazed Steel Manifolds—Installation

Installation

1. Clean the pulley bearing surface of the compressor head to remove any dirt or corrosion.
2. Install the pulley and bearing on the compressor. The bearing is a slip fit on the compressor head and, if properly aligned, should slip on the compressor head. If difficulty is encountered installing the pulley, gently tap the pulley on the compressor using Pulley Replacer and Bearing Remover T80L-19703-J or equivalent, (Fig. 12). Be sure the pulley bearing is aligned with the compressor head.
3. Install the pulley retaining snap ring with the bevel side of the snap ring out.
4. Install the clutch hub on the compressor shaft using the two thickest shims of the shim pack

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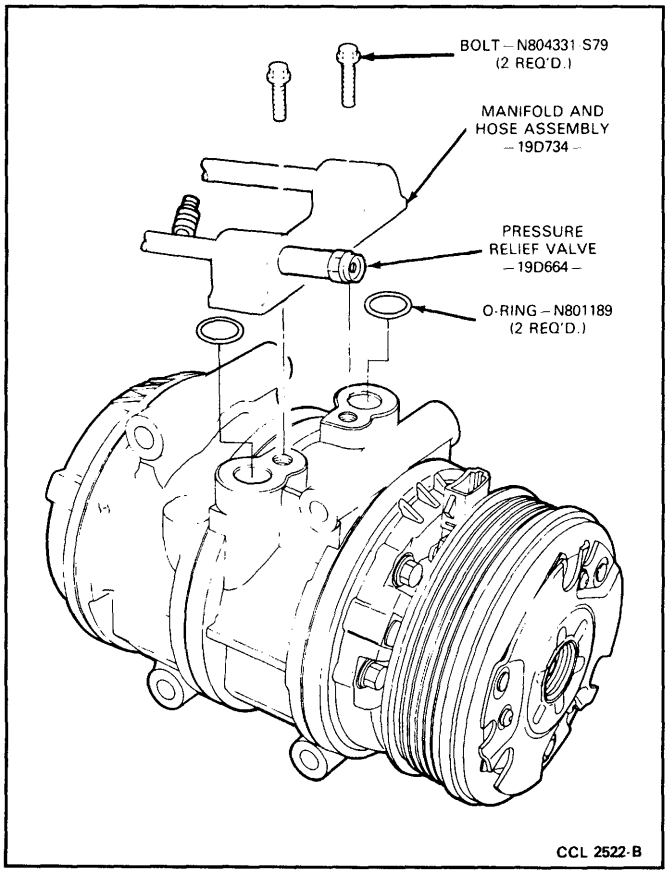


FIG. 8 Single Port Manifolds—Installation

between the clutch hub and the end of the compressor shaft. Be sure the shaft key is aligned with the keyway in the clutch hub. Use Hub Driven Plate Replacer T80L-19703-F or equivalent to press the hub on the compressor shaft as necessary (Fig. 13). Do not attempt to drive the hub on the compressor shaft as damage to the compressor will result. Use only the specified tool if the hub will not easily slide on the compressor shaft.

5. Install the hub retaining nut on the compressor shaft and tighten the nut to specification as listed at the end of this Section. Do not use air tools.
6. Check the air gap between the hub and the mating pulley surface in three locations equally spaced around the pulley (Fig. 14). Record the air gap readings.
7. Rotate the compressor pulley one-half turn (180 degrees) and again check the air gap in three equally spaced locations. The smallest air gap must be within the specified limits for the air gap. Add or remove shims between the hub and the compressor shaft as necessary until the smallest air gap is within specification.

Clutch Field Coil

Removal

1. Remove the clutch hub and pulley following the procedure given.
2. Remove the snap ring retaining the clutch field coil on the front of the compressor.
3. Pull the field coil from the front of the compressor.

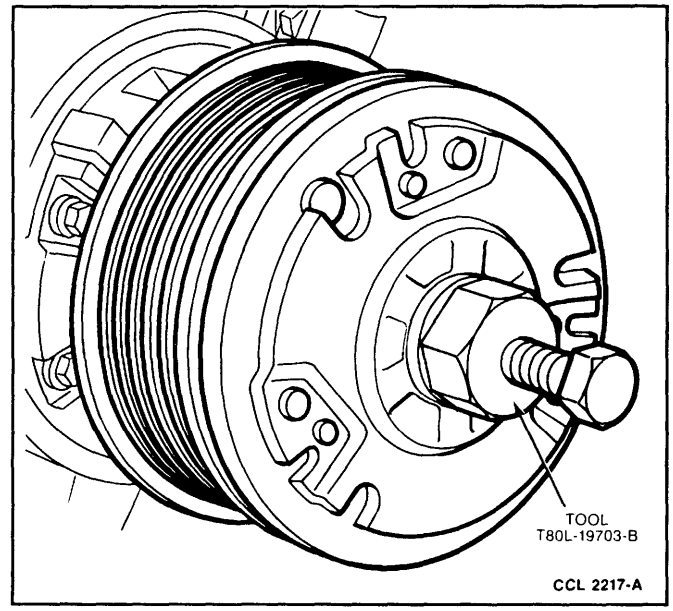


FIG. 9 Removing Clutch Hub

Installation

1. Position the clutch field coil to the compressor, engaging the locator pin on the compressor head with the hole in the clutch field coil.
2. Install the snap ring to retain the clutch field coil on the compressor with the bevel side of the snap ring out.
3. Install the pulley and hub on the compressor following the procedure given. Do not use air tools.

Pulley Bearing

Removal

1. Remove the clutch hub and pulley from the compressor.
2. Position the largest opening of Clutch Pulley Support T80L-19703-E or equivalent over the hub of the pulley to support the pulley. Then, drive the bearing from the pulley with Pulley Replacer and Bearing Remover T80L-19703-J or equivalent as shown in Fig. 15.

Installation

1. Place the clutch pulley friction face on the small opening of Clutch Pulley Support T80L-19703-E or equivalent as shown in Fig. 16.
2. Place the grease retainer in the clutch bearing opening (Fig. 10). Then, position the new bearing to the clutch bearing bore and install the bearing in the bore until seated with Clutch Pulley Bearing Replacer T80L-19703-C or equivalent (Fig. 16). Be sure the bearing is aligned with the bearing bore.
3. Stake the bearing in the bearing bore with a blunt drift three equally spaced places around the bearing. Do not use the same locations used to retain the removed bearing.
4. Install the pulley and hub on the compressor following the procedure for clutch hub and pulley installation.

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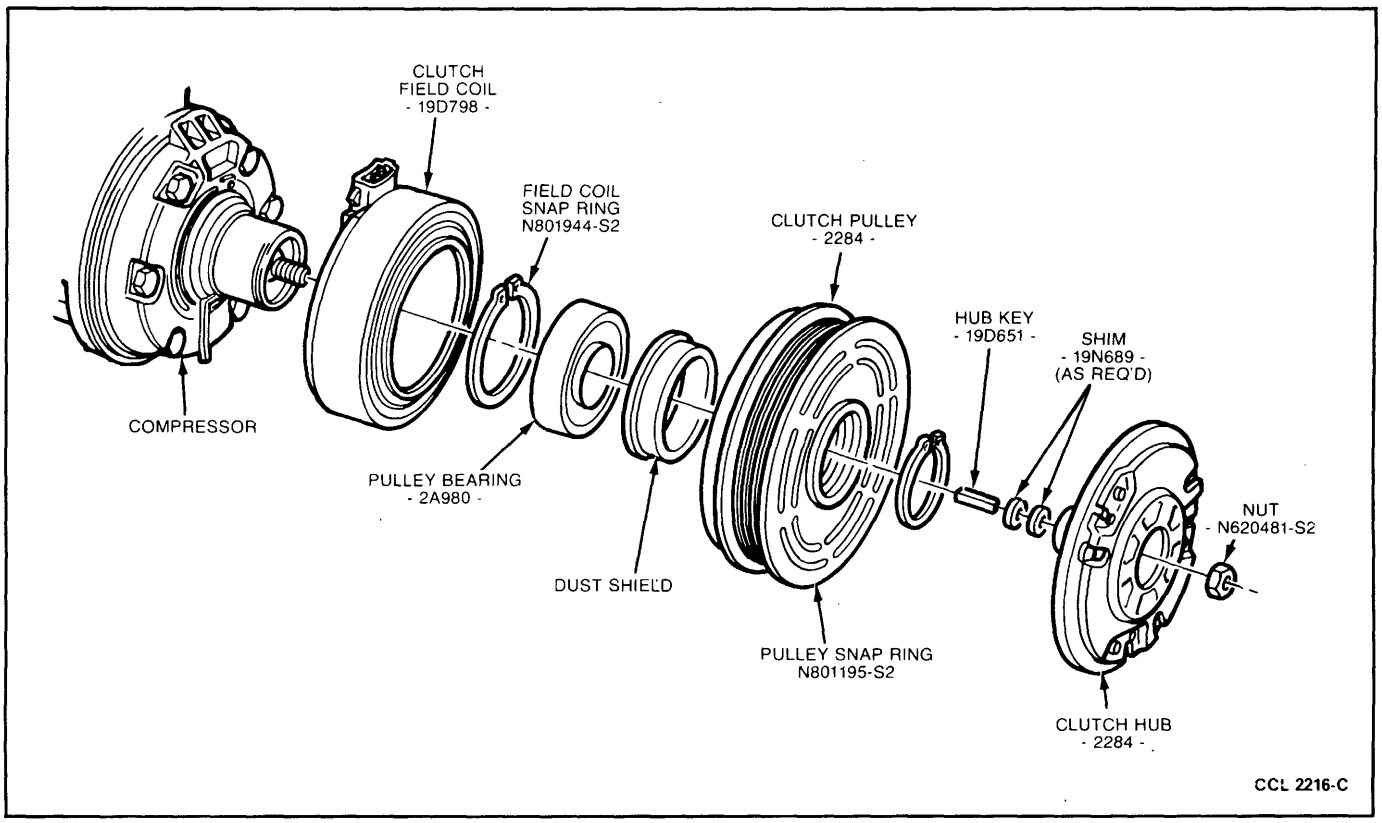


FIG. 10 Ford Clutch Disassembled

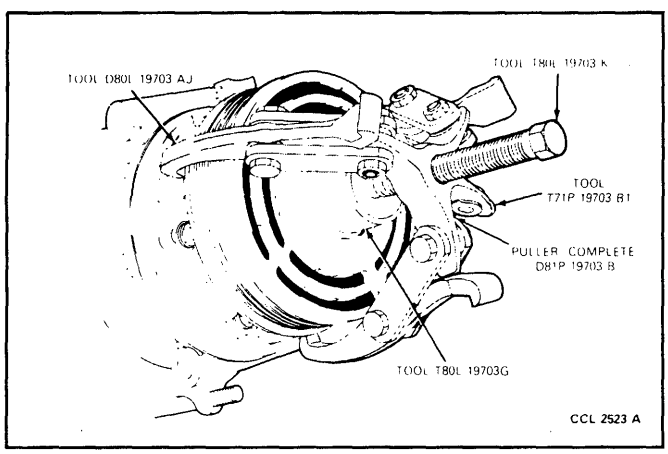


FIG. 11 Removing Clutch Pulley

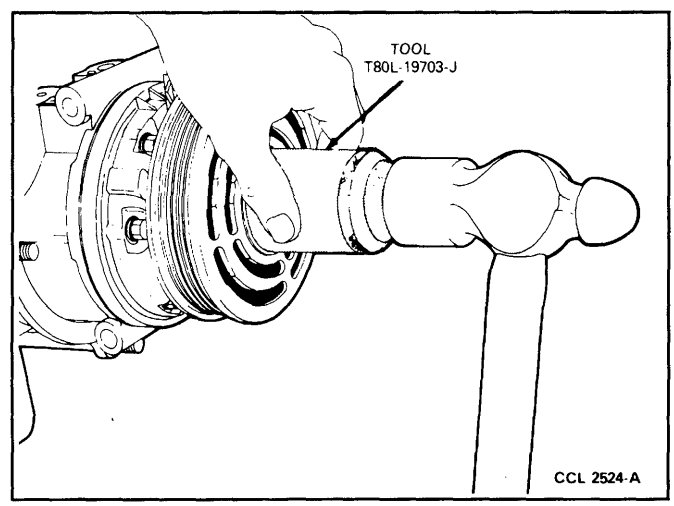


FIG. 12 Installing Clutch Pulley

MAJOR REPAIR OPERATIONS

Shaft Seal and/or Front Head Gasket and O-Ring

Removal

1. Remove the clutch assembly following the procedure given for Clutch Field Coil Removal.
2. Invert the compressor and pour the refrigerant oil from the compressor suction manifold opening.
3. Install Housing Clamp T81P-19623-D or equivalent, on the compressor to retain the cylinder assembly and the rear head in position (Fig. 17). Then clamp the tool in a vise.
4. Remove the key from the compressor shaft with Compressor Key Remover T81P-19623-NH or equivalent (Fig. 18).
5. Remove the six cylinder bolts from the compressor using a 10mm (3/8 inch) socket. Then, pull the front head from the compressor. The valve plate assembly, inlet reed, shaft seal and cylinder gasket normally will come off with the head assembly.

   NOTE: Use extreme care not to damage any sealing surfaces.
6. Carefully lift the inlet reed valve from the head assembly.

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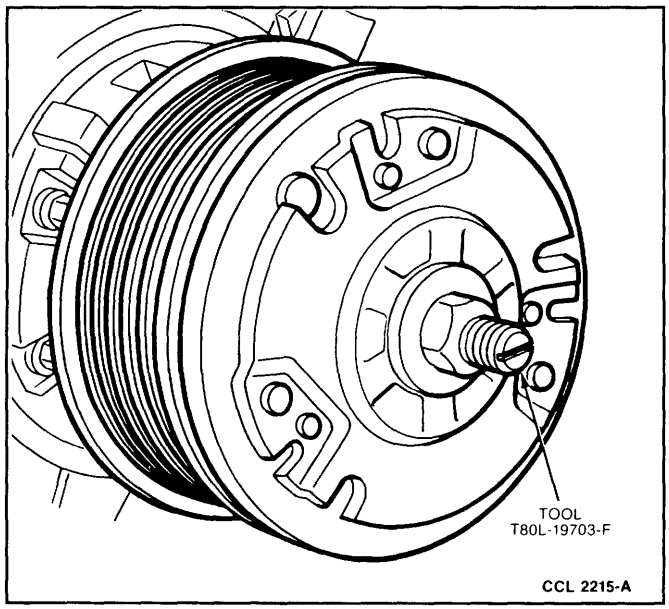


FIG. 13 Installing Clutch Hub

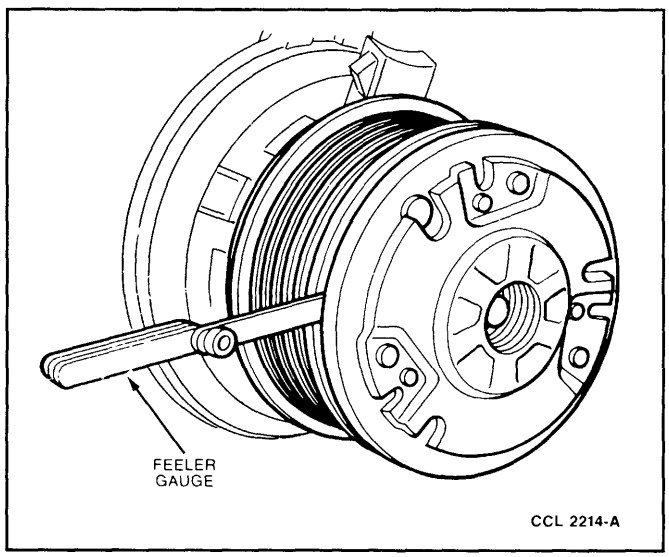


FIG. 14 Checking Clutch Air Gap

7. Remove the front valve plate assembly and gasket from the front head with Valve Plate Remover T81P-19623-B or equivalent, (Fig. 19).

8. Carefully remove the gasket from the valve plate assembly using care not to damage the surface of the valve plate assembly.

9. Remove the two dowel pins from the front head or compressor housing.

10. Remove the shaft seal assembly from the head.

11. Place the head on a piece of clean corrugated cardboard and remove the seal seat assembly from the head with Shaft Seal Seat Remover T81P-19623-OH or equivalent, (Fig. 20).

12. Clean the front head, valve plate assembly and inlet reed with clean cleaning solvent. Dry the parts with compressed air.

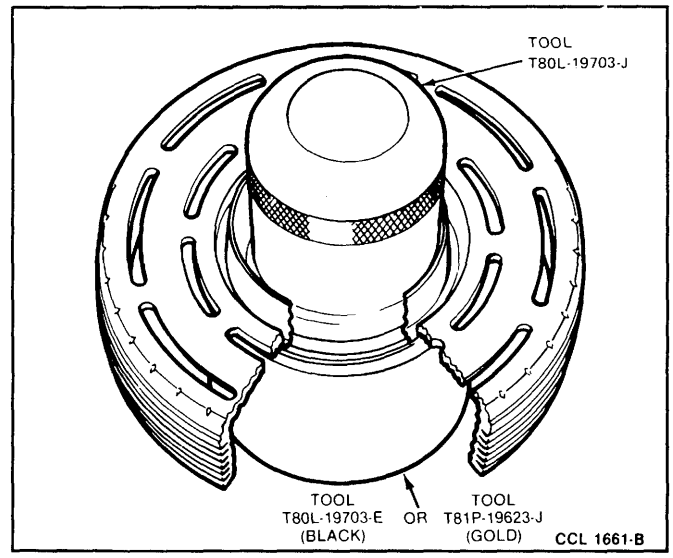


FIG. 15 Removing Clutch Pulley Bearing

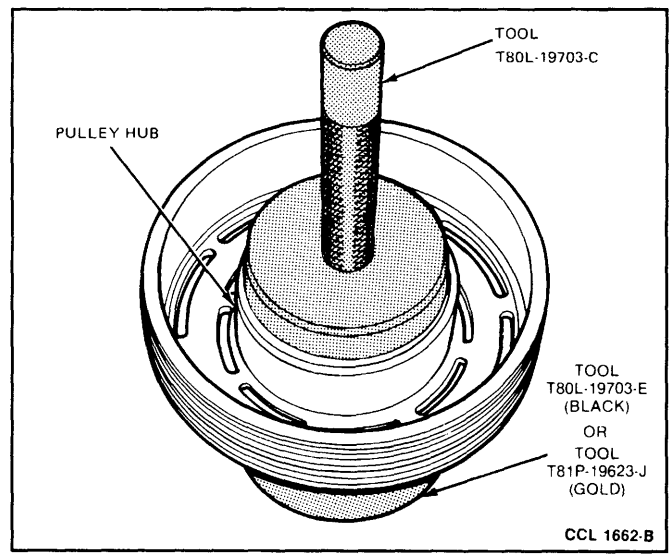


FIG. 16 Installing Clutch Pulley Bearing

Installation

1. Inspect the inlet reed, valve plate assembly and the front head for damage. Replace any damaged parts.

2. Install the two dowel pins in the dowel pin holes of the cylinder assembly.

3. Lubricate the inlet reed with a light coating of clean refrigerant oil. Then, position the inlet reed to the cylinder assembly aligning the holes in the inlet reed with the dowel pins.

4. Assemble the valve plate assembly to the cylinder assembly aligning the dowel pin holes with the dowel pins.

5. Assemble a new cylinder gasket to the head side of the valve plate assembly aligning the dowel pin holes with the dowel pins (Fig. 21).

6. Carefully remove the shaft seal and seal seat from the protective package. Do not cut the transparent protective cover, but peel it from the backing to expose the seal and seat.

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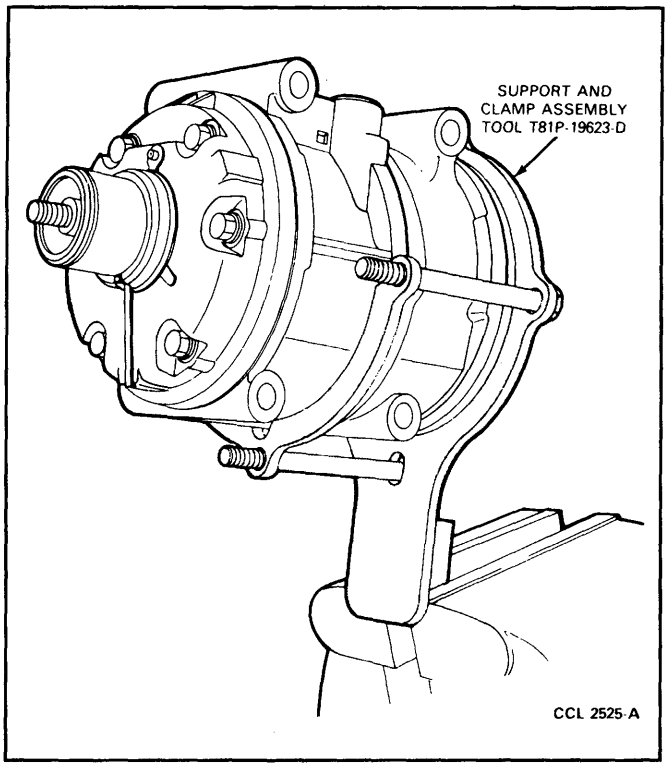


FIG. 17 Compressor Support and Clamp Assembly

NOTE: Do not touch the sealing surfaces of the shaft seal or seal seat.

7. Lubricate the new shaft seal seat with clean refrigerant oil and install the seat in the front head. Use Shaft Seal Seat Remover T81P-19623-C or equivalent positioned to the seal seat as shown (Fig. 22) to install the seat in the head. The latest designs of the FS-6 seal seat do not have the groove on the seal side, but have a raised seal surface (Fig. 22). Position tool to the seal seat so that the raised seal surface is covered and protected by the tool during installation.

   NOTE: Do not touch the seal surface of the seal seat.

8. Lubricate the new shaft seal with clean refrigerant oil and assemble the seal to the compressor with the sealing surface toward the end of the shaft. Engage the internal flats of the seal with the two flats notched into the shaft.

   NOTE: Avoid handling the carbon sealing surface of the seal assembly to prevent damaging the surface.

9. Install a new O-ring in the O-ring groove of the front head. (Fig. 21).

10. Position the front head to the cylinder assembly aligning the dowel pin holes in the head with the dowel pins. Install six bolts and tighten to the specification listed at the end of this Section in a diagonally opposite sequence. Do not use air tools.

12. Install the key in the slot of the compressor shaft.

13. Install the clutch assembly on the compressor following the procedure given for Clutch Field Coil Installation. Do not use air tools.

14. Install 180ml (6 fluid ounces) of clean refrigerant oil in the compressor through the suction ports. It may be necessary to rotate the compressor shaft to draw all the oil into the compressor.

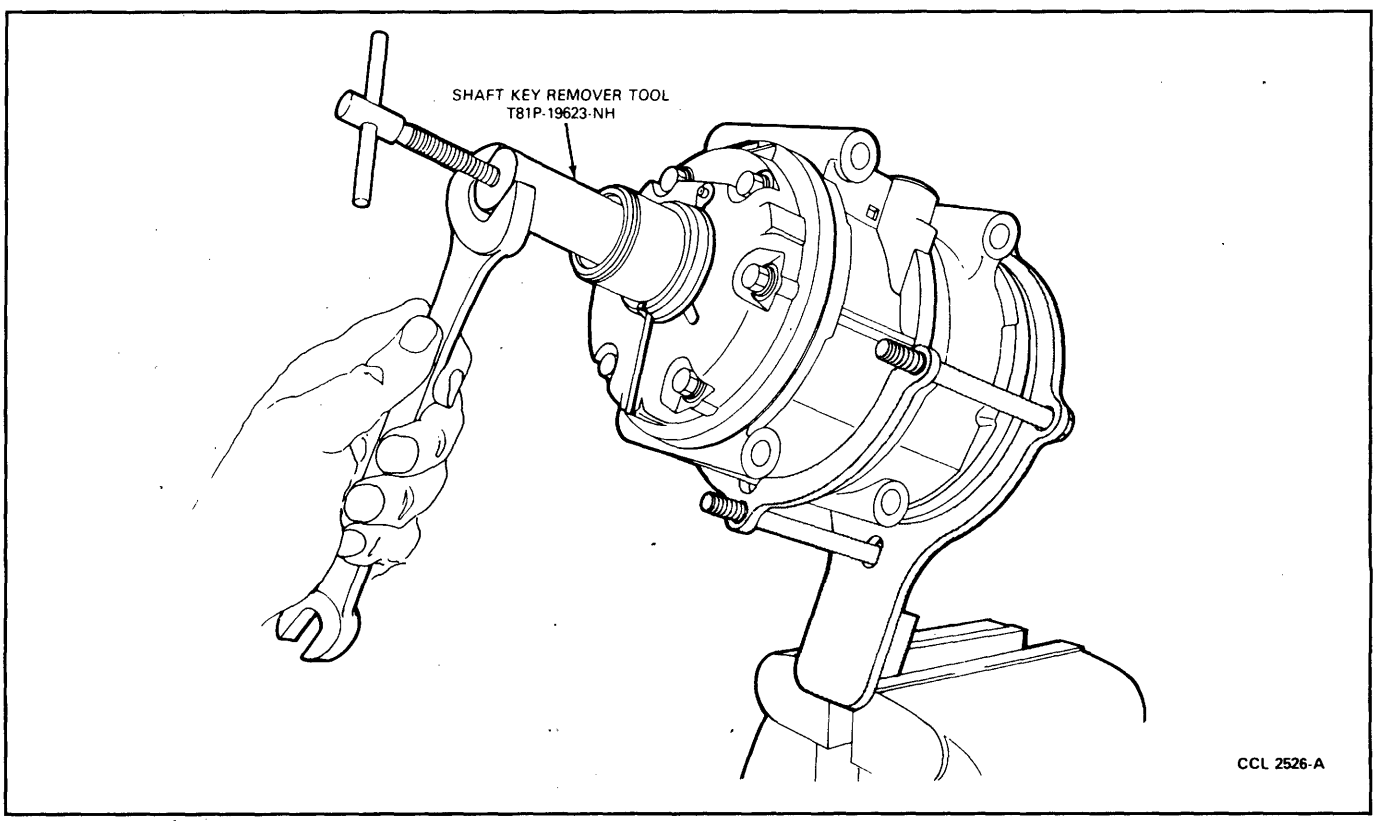


FIG. 18 Removal of Compressor Key

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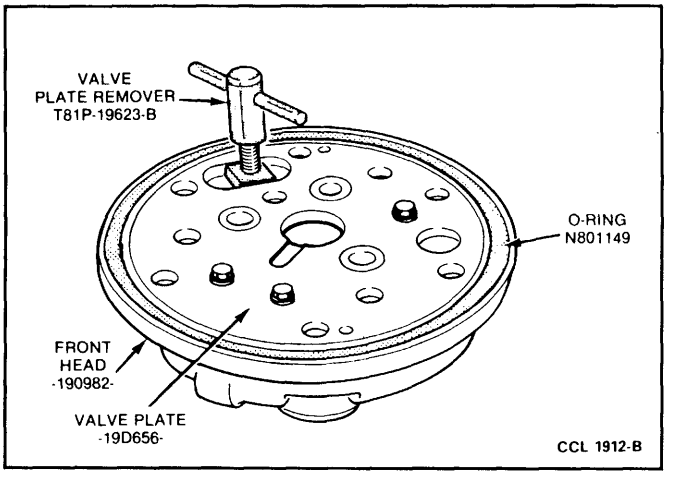


FIG. 19 Valve Plate Removal

Rear Head Gasket and O-Ring

Removal

1. Remove the clutch assembly from the compressor following the procedure given for Clutch Field Coil Removal.
2. Invert the compressor and pour the refrigerant oil from the suction manifold opening.
3. Install Housing Clamp T81P-19623-D or equivalent, on the front of the compressor to retain the cylinder assembly and the front head in position (Fig. 23). Then, clamp the tool in a vise.
4. Hold the rear head and remove the six cylinder bolts from the cylinder assembly.
5. Separate the rear head assembly from the cylinder assembly and remove the O-ring from the head.
6. Remove the two dowel pins.
7. Remove the inlet reed from the rear head and valve plate assembly.
8. Remove the valve plate assembly from the rear head with Valve Plate Remover T81P-19623-B or equivalent, (Fig. 19).
9. Carefully remove the cylinder gasket from the head and/or valve plate assembly.
10. Wash the rear head, valve plate assembly and inlet reed with clean cleaning solvent and dry with compressed air.

Installation

1. Install the two dowel pins in the dowel pin holes of the rear head.
2. Install the cylinder gasket on the head taking care to align the dowel pin holes with the dowel pins.
11. Leak test the compressor following the procedure given under TESTING.
3. Install the valve plate assembly on the cylinder head aligning the dowel pin holes with the dowel pins (Fig. 24).
4. Lubricate the inlet reed with clean refrigerant oil. Then, install the inlet reed on the valve plate aligning the dowel pin holes with the dowel pins.
5. Install a new O-ring gasket into the O-ring groove of the rear head.

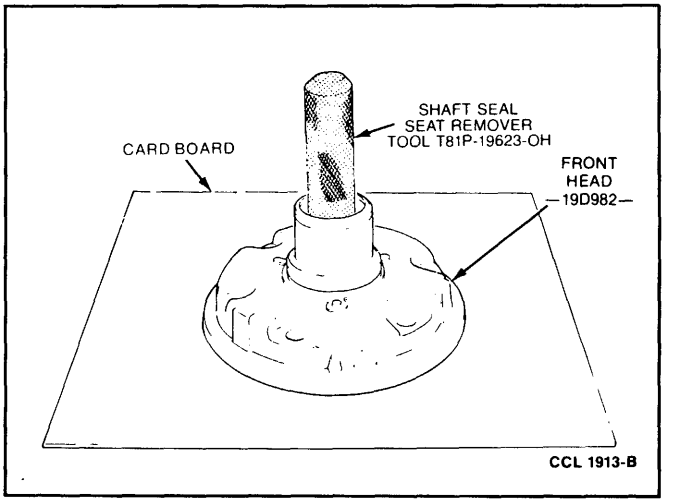


FIG. 20 Removing the Shaft Seal Seat Assembly

6. Position the rear head to the cylinder assembly and align the dowel pins with the dowel pin holes.
7. Hold the rear head in place and install the six cylinder bolts and tighten them to specification as listed at the end of this Section in a diagonally opposite sequence. Do not use air tools.
8. Remove the compressor from the support and clamp assembly (Housing Clamp T81P-19623-D).
9. Leak test the compressor following the procedure given under TESTING.
10. Install the clutch assembly on the compressor following the procedure for Clutch Field Coil Installation.
11. Install 180ml (6 fluid ounces) of clean refrigerant oil in the compressor.

Valve Plates and Inlet Reeds

1. Remove the clutch assembly from the compressor following the procedure given for Clutch Field Coil Removal.
2. Invert the compressor and pour the refrigerant oil from the suction manifold opening.
3. Install Housing Clamp T81P-19623-D or equivalent, on the compressor to retain the front head and the cylinder assembly assembled together (Fig. 23). Then, clamp the tool in a vise.
4. Remove the six through-bolts from the compressor using a 10mm (3/8 inch) wrench. Then, remove the rear head from the compressor. The valve plate assembly inlet reed and the cylinder gasket will normally be removed with the rear head.
5. Remove the O-ring and the inlet reed from the rear head.
6. Remove the valve plate assembly from the rear head with Valve Plate Remover T81P-19623-B or equivalent, (Fig. 19). Use care not to lose the two dowel pins.
7. Clean the rear head with clean cleaning solvent. Dry the head with compressed air.
8. Install the two dowel pins in the dowel pin holes of the cylinder assembly (Fig. 24).
9. Position the inlet reed (lightly lubricated with refrigerant oil) to the cylinder assembly aligning the dowel pin holes with the dowel pins.

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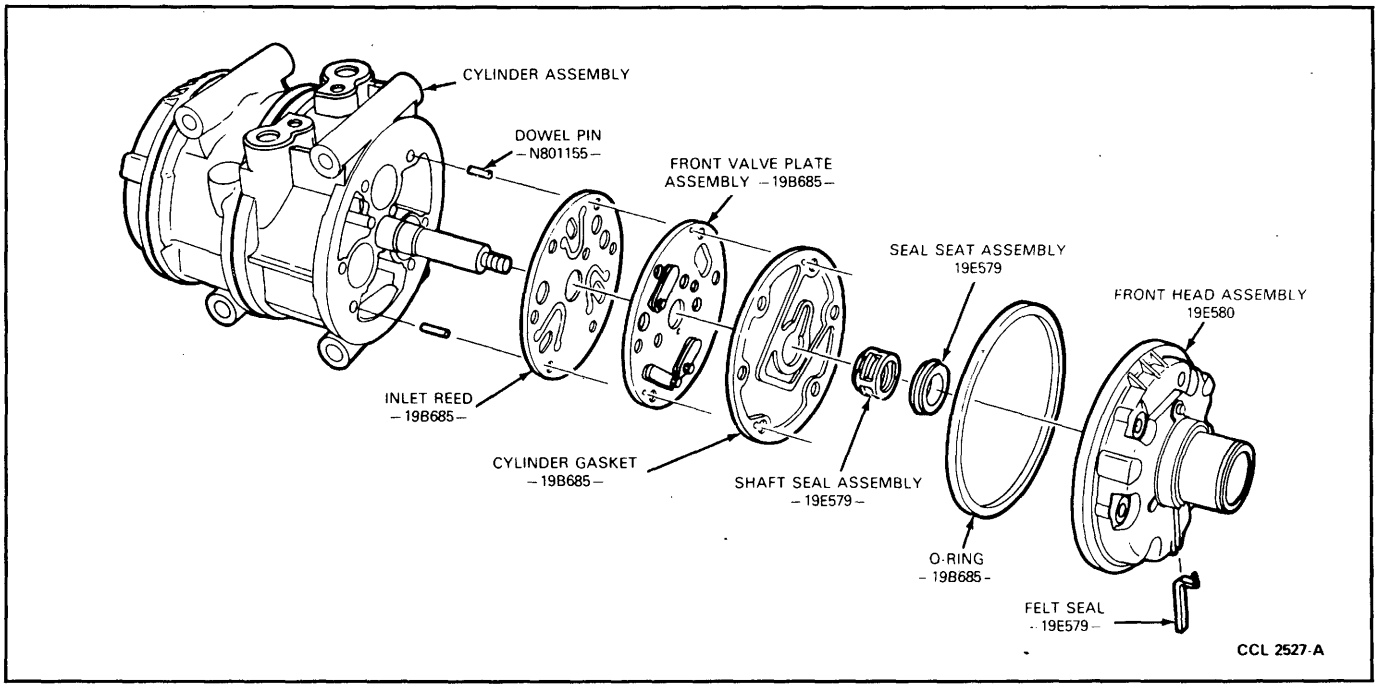


FIG. 21 Front Head and Valve Plate Disassembled

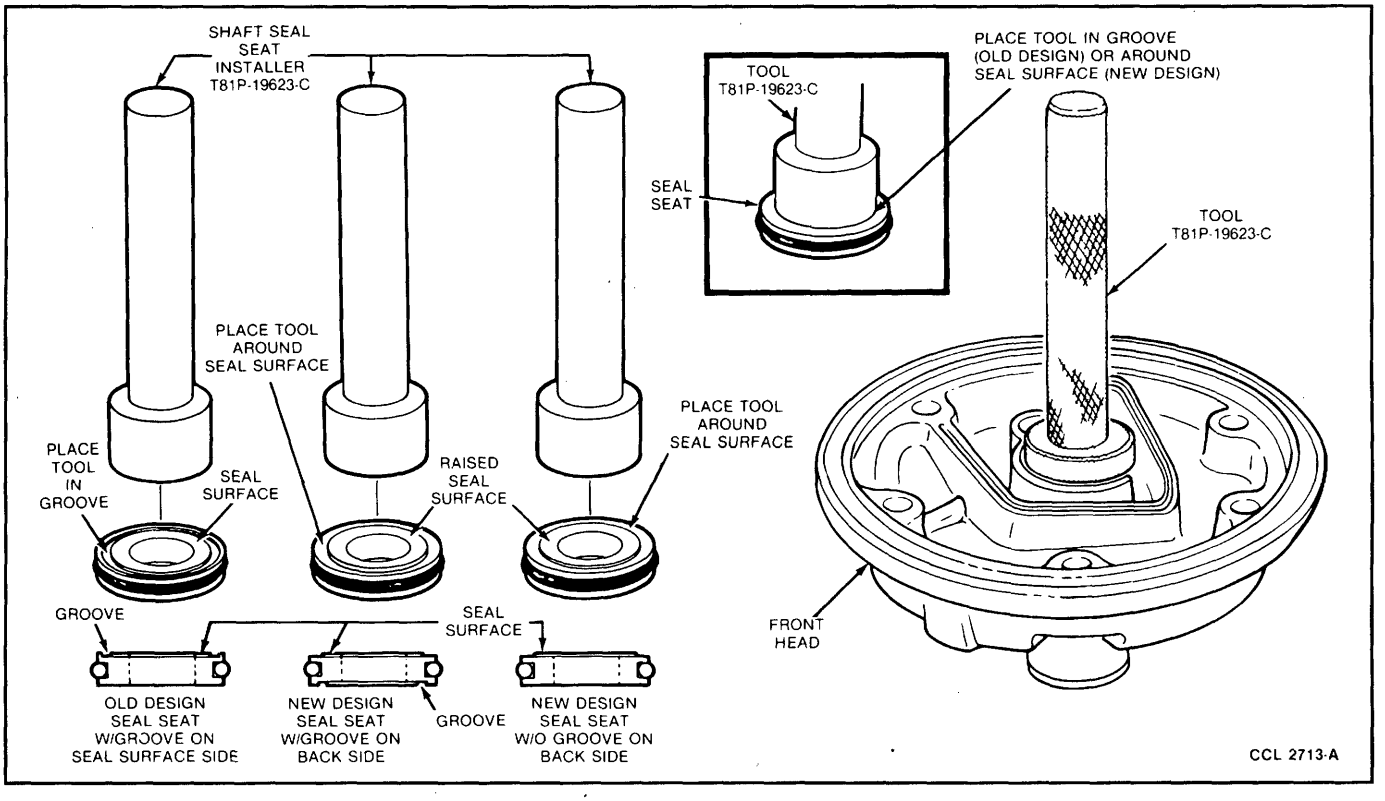


FIG. 22 Installing the Shaft Seal Seat Assembly

10. Position the valve plate assembly to the inlet reed and align the dowel pin holes with the dowel pins.
11. Install the cylinder gasket over the valve plate assembly aligning the dowel pin holes with the dowel pins.
12. Install a new O-ring into the O-ring groove of the rear head. Then, position the rear head to the cylinder assembly aligning the dowel pin holes in the head with the dowel pins.
13. Hold the rear head against the cylinder assembly and install two through bolts into opposite holes to hold the rear head in place. Tighten the two bolts just snug.
14. Remove the clamp and support (Housing Clamp T81P-19623-D) from the front half of the compressor and install the tool to clamp the rear head to the cylinder assembly (Fig. 17).

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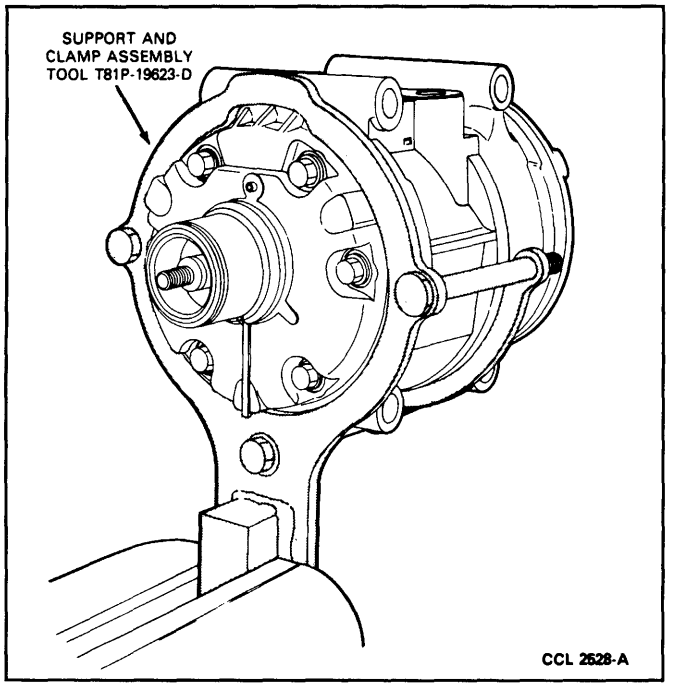


FIG. 23 Compressor Clamped for Rear Head Removal

15. Remove the key from the compressor shaft with Compressor Key Remover T81P-19623-NH or equivalent (Fig. 18).
16. Remove the two through bolts from the compressor.
17. Pull the front head from the compressor assembly. The valve plate assembly, inlet reed and shaft seal assembly will come off with the front head (Fig. 21).
18. Remove the O-ring and the inlet reed from the front head.
19. Remove the valve plate assembly from the front head with Valve Plate Remover T81P-19623-B or equivalent, (Fig. 19).
20. Remove the two dowel pins, the shaft seal and the felt seal from the front head.
21. Place the front head on a piece of clean corrugated cardboard and remove the seal seat assembly from the front head with Shaft Seal Seat Remover T81P-19623-OH or equivalent, (Fig. 20).
22. Clean the front head with clean cleaning solvent and dry with compressed air.
23. Install the two dowel pins in the dowel pin holes of the cylinder assembly.
24. Lubricate the inlet reed with a light coating of clean refrigerant oil. Then, position the inlet reed to the cylinder assembly aligning the dowel pin holes of the inlet reed with the dowel pins.
25. Assemble the valve plate assembly to the cylinder assembly aligning the dowel pin holes with the dowel pins.
26. Assemble the cylinder gasket to the valve plate assembly aligning the dowel pin holes with the dowel pins.
27. Carefully remove the shaft seal and seal seat from the protective package. Do not cut the transparent protective cover, but peel it from the backing to expose the seal and seat.

    NOTE: Do not touch the sealing surfaces of the shaft seal or seal seat.
28. Lubricate the new shaft seal seat with clean refrigerant oil and install the seat in the front head. Use Shaft Seal Seat Installer T81P-19623-C positioned to the seal seat as shown (Fig. 22) to install the seat in the head. The latest designs of the FS-6 seal seat do not have the groove on the seal side, but have a raised seal surface (Fig. 22). Position the tool to the seal seat so that raised seal surface is covered and protected by the tool during installation. Be sure the shaft seal seat is seated against the recess in the front head.
29. Lubricate the shaft seal with clean refrigerant oil and assemble the seal on the compressor shaft with the sealing surface toward the end of the

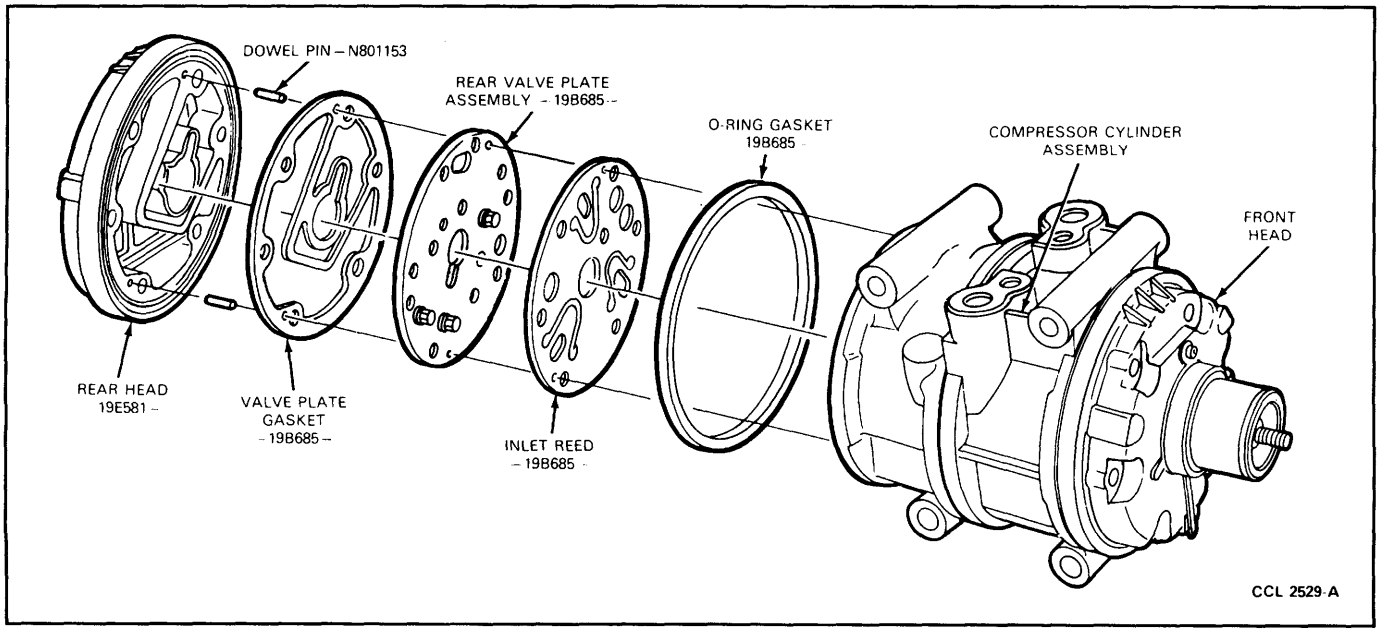


FIG. 24 Rear Head and Valve Plate Disassembled

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shaft. Engage the internal flats of the seal with the two flats notched into the shaft.

NOTE: Avoid handling the carbon sealing surface of the seal assembly to prevent damaging the surface.

30. Install a new O-ring in the O-ring groove of the front head.
31. Position the front head to the cylinder assembly aligning the dowel pin holes in the head with the dowel pins. Install the six through bolts and tighten them to the specification listed at the end of this Section in a diagonally opposite sequence. Do not use air tools.
32. Install the key in the slot of the compressor shaft and the felt seal in the shaft bore of the head.
33. Leak test the compressor following the procedure given under TESTING.
34. Install the clutch assembly on the compressor following the procedure given for Clutch Field Coil Installation.
35. Install 180ml (6 fluid ounces) of clean refrigerant oil in the compressor through the suction ports. It may be necessary to rotate the compressor shaft to draw all the oil into the compressor.

Head Replacement

If it is necessary to replace the front or rear head, follow the service procedure for replacing the head gasket.

SPECIFICATIONS

TYPE — Swash Plate — Three double acting pistons — Axial Type	
DISPLACEMENT	10.4 CID
CYLINDER BORE (DIA.)	1.4 inch
STROKE	1.2 inch
ROTATION	Clockwise
ROTATION TORQUE(Maximum-Manifold Removed)	10 N•m — 7 FT. LBS.

REFRIGERANT OIL

Type (Ford Spec)	ESA-M2C31-A — 500 Viscosity
Capacity (New)	300 ml (10 Fluid Ounces)
Part Number	C9AZ-19577-B Motorcraft YN2

DRIVE BELT TENSION — NEWTONS (LBS.)

Belt Type	New N (lbs)	Used Minimum N (lbs)	Used Reset Limits N (lbs)
6 Rib	623-756 (140-170)	400 (90)	623-712 (140-160)
15/32 Inch Standard V-Belt	534-712 (120-160)	289 (65)	400-534 (90-120)

MAGNETIC CLUTCH

Air Gap Between Pulley and Hub	0.021-0.036 inch
Current Draw	4.67 Amps @ 12.8 volts
Run-Out (Maximum) Pulley	0.02 inch — Radial or Axial

TORQUE LIMITS

Hose Manifold to Compressor	24-34 N•m (18-25 ft-lbs)
Clutch Hub Nut	13-20 N•m (10-14 ft-lbs)
Compressor Cylinder Bolts	24.5-26.5 N•m (18-19 ft-lbs)
(Max. to Correct Freon Leak)	34 N•m (25 ft-lbs)
Suction Hose to Manifold	28-36 N•m (21-27 ft-lbs)
Discharge Hose to Manifold	20-27 N•m (15-20 ft-lbs)

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SPECIAL SERVICE TOOLS — Ford FS-6 Compressor

Rotunda Tool Number	Motorcraft Tool No.	Robinair Tool No.	Draf Tool No.	Description
T81P-19623-D	YT-1067	18015	1067	Support & Clamp Assembly
T81P-19623-MH	YT-499	10546	499	Spanner Wrench
T81P-19623-NH	YT-1062	18005	1062	Shaft Key Remover
T81P-19623-OH	YT-1060	40495	—	Shaft Seal Seat Remover
T81P-19623-B	YT-1069	10967	1069	Valve Plate Remover
T81P-19623-C	YT-1061	40945	1061	Shaft Seal Seat Installer
T80L-19703-E	YT-1064	18010	1064	Clutch Pulley Support (Ford & Warner Clutch)
D80L-19703-AJ	YT-1058	40679	1058	Pulley Puller Jaws
D81P-19703-B	—	10501	—	Complete Pulley Puller
T71P-19703-B1	YT-457	40710	457	Pulley Puller Hub
T80L-19703-B	YT-1011	10884	1011	Hub Remover
T80L-19703-C	YT-1059	40930	1059	Pulley Bearing Replacer
T80L-19703-F	YT-1052	18020	1052	Hub Installer
T80L-19703-G	YT-1012	41358	1012	Compressor Shaft Protector
T80L-19703-J	YT-1059	40938	1059	Pulley Replacer
T80L-19703-K	YT-451	40568	451	Pulley Puller Center Bolt
T81P-19623-F	YT-1066	40941/40942	1066	Pressure Test Fittings Radial Mount Only
D85L-19703-A	—	40947	—	Pressure Test Adapter — 2 Req'd Radial Mount Only
T86P-19703-A	—	40949	—	Pressure Test Adapter Tangential Mount Only

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VEHICLE APPLICATION

F-150 Through F-350—Bronco And Truck Models.

DESCRIPTION

Most of the major components of the manual A/C-Heater system used in the F-150 through F-350 and Bronco vehicles are identified in Fig. 1.

Refer to Fig. 1 for part names and locations. Details regarding the physical and functional characteristics of the components will follow.

As preliminary information, the system is equipped with:

- A plate-fin evaporator core and attached suction accumulator/drier
- A fixed orifice tube for control of refrigerant flow
- A clutch cycling pressure switch

Two Schrader-type service access gauge port valves are used in the manual A/C-Heater system. The high pressure valve is located near the condenser in the discharge line and has a quick disconnect-type valve body. This requires a special high pressure service access valve adapter to connect a manifold gauge set or a charging station to the valve. The other service access gauge port valve is located on the inlet of the suction accumulator and is used to measure evaporator pressure. in addition to the Schrader-type valves, some vehicles have valves at the compressor similar to the manual service valves used on past models. These valves do not have service ports and can be used only to service the compressor.

The evaporator case is attached to the engine side of the dash panel. It contains the:

- Evaporator core
- Accumulator/drier
- Blower motor and wheel
- Blower resistor
- Outside air/recirc door and its vacuum motor
- Vacuum reservoir
- Vacuum/wiring harness assemblies

The suction accumulator/drier is clamped to the evaporator case with its inlet tube connected to the evaporator outlet tube. The A/C clutch cycling pressure switch is installed in a fitting on the side of the accumulator/drier. The inlet tube to the evaporator core houses the fixed orifice tube.

The plenum is located in the passenger compartment. It contains the:

- Heat/defrost door
- Temperature blend door
- Vent/heat door
- Cams/crank which operate the doors
- Heater core

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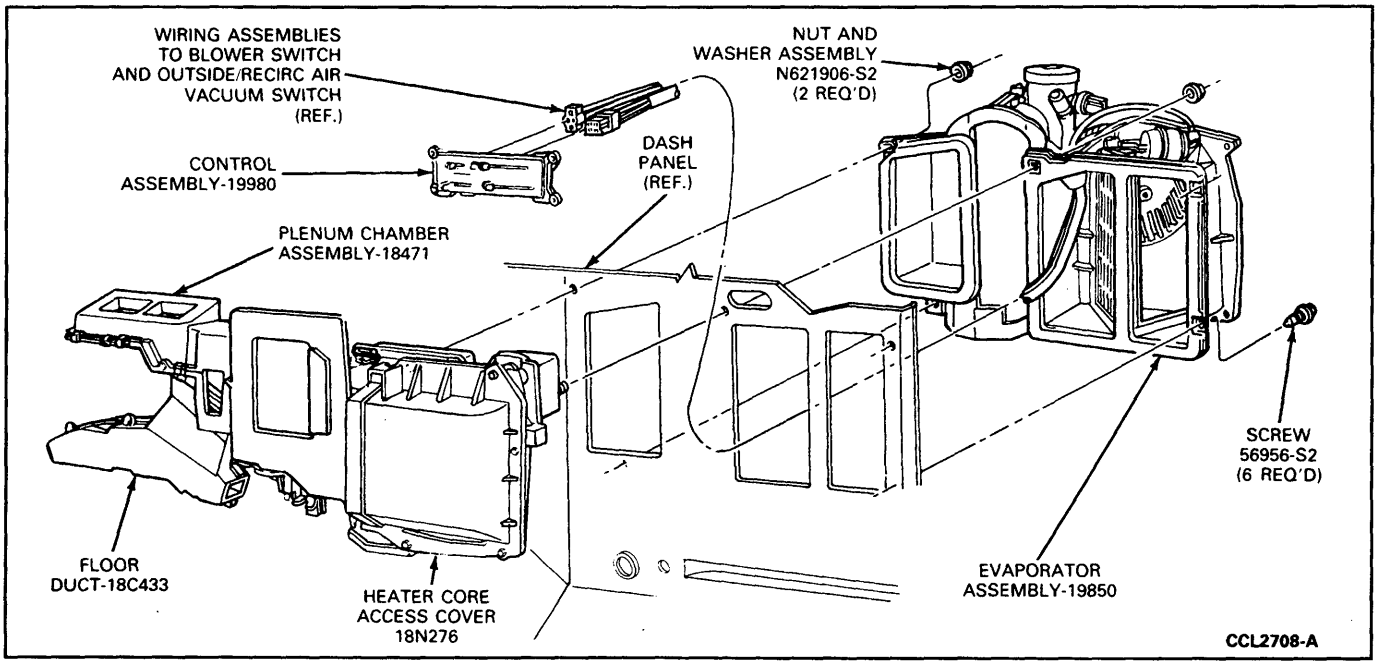


FIG. 1 Manual A/C-Heater System (F-150—F-350, Bronco)

The defroster nozzle has five outlets and connects between the plenum and the defrost outlet on the instrument panel. The control is a two-cable mechanical type (function and temperature). A separate vacuum switch is provided to actuate the outside air shutoff door.

The control assembly contains four levers, one of which functions as a blower switch. The control also contains an A/C ON-OFF pushbutton switch to control A/C operation. The A/C ON-OFF pushbutton switch is part of the blower switch and will not close for A/C operation unless the blower switch is on.

OPERATION

Airflow

During system operation, outside air is drawn into the system by a blower motor and wheel from the cowl air intake when the air door lever is in the VENT-HEAT-A/C position. When the air door lever is in the MAX-A/C position, airflow is drawn from inside the vehicle through the recirculating air door opening. The air is then forced by the blower through the evaporator core and, depending upon the setting of the temperature lever, is forced by the blower through and/or around the heater core into the plenum. Air is then directed to the floor and/or defrost nozzles or the instrument panel registers, depending on the position of the function selector lever.

Figs. 2 and 3 illustrate airflow through the system when control levers are moved from position-to-position.

Airflow volume through the system is controlled by a lever-operated, five-position blower switch. The blower switch, used with a resistor assembly, provides four blower speeds to control airflow through the system. The blower can be shut off by moving the lever to the OFF position.

Refrigerant Flow

Fig. 4 shows a basic refrigerant circuit representing refrigerant changes as it passes through a cycle from compressor output to compressor input.

The illustration identifies four states in which refrigerant will exist in a closed circuit: (1) High pressure vapor, (2) High pressure liquid, (3) Low pressure liquid, and (4) Low pressure vapor. Beginning with compressor output, refrigerant moves as a high pressure vapor to the condenser. As it passes through the condenser, the vapor condenses into a liquid.

In the course of this condensation process, the refrigerant gives up heat. This heat exchange does not alter the temperature of the refrigerant. Thus, the refrigerant continues its flow through the circuit as a high temperature, high pressure liquid.

The restriction called out in the illustration in F-150—F-350 and Bronco applications is a fixed orifice tube which contains a 1.575mm (0.062 inch) orifice. When the refrigerant passes through this tube, it changes from a high to low pressure liquid, with a corresponding drop in temperature.

The refrigerant, upon leaving the orifice tube, is drawn through the circuit by compressor suction. Thus, it enters the evaporator as a low pressure/low temperature liquid.

The cooling of the evaporator core creates a temperature differential between the core and the ambient air in the evaporator case. As a result of this difference, heat is absorbed from the air. Simultaneously, humidity is extracted from the air and drained out the surface under the vehicle. Again, the absorption of BTUs does not affect refrigerant temperature.

Refrigerant flow, after leaving the evaporator, continues through the suction accumulator/drier where water is absorbed into a desiccant bag and the more heavily oil-laden refrigerant is further vaporized as it is dispelled into the inlet line to the compressors.

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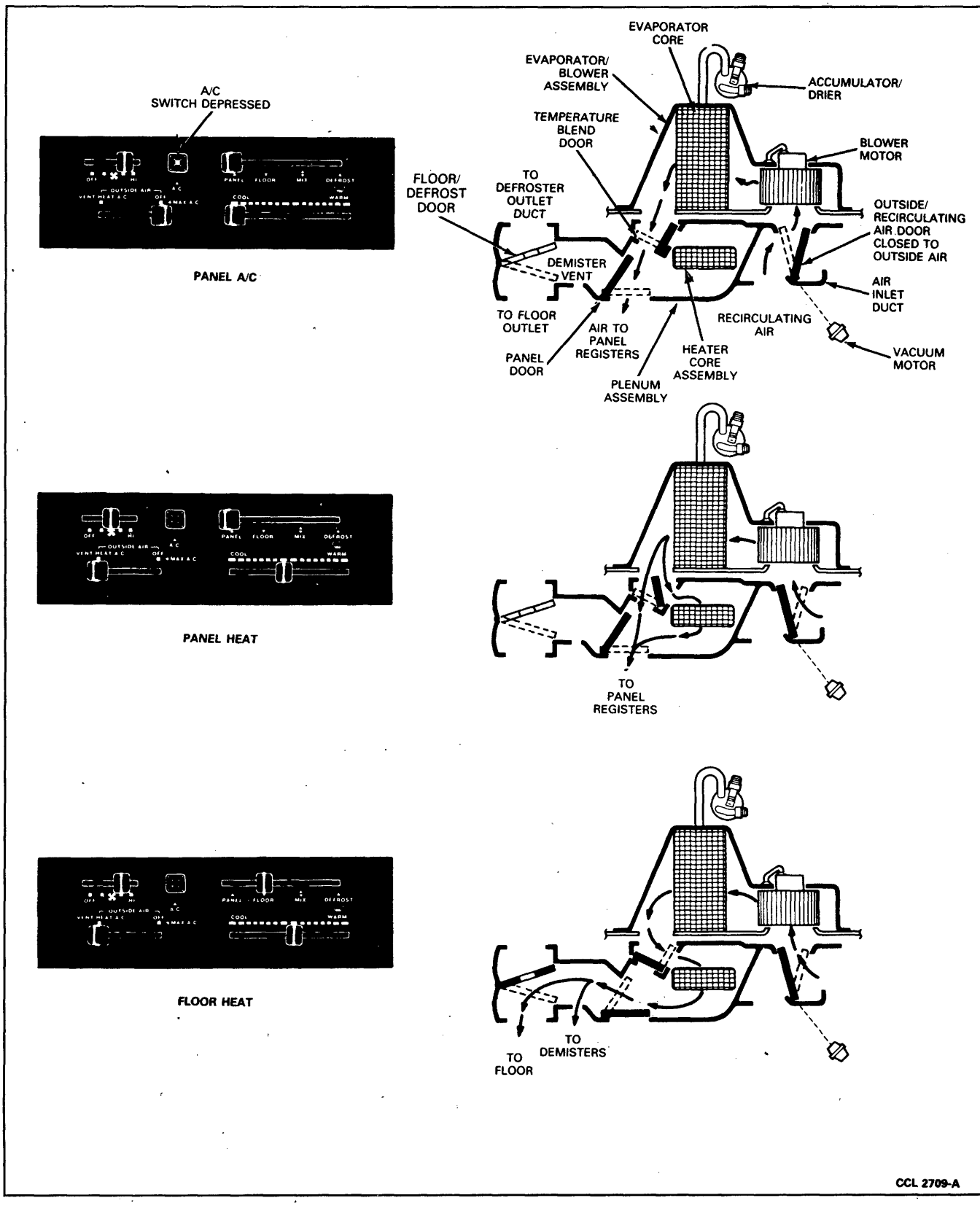


FIG. 2 Manual A/C-Heater Airflow Schematic (A/C, Panel Heat, Floor Heat)

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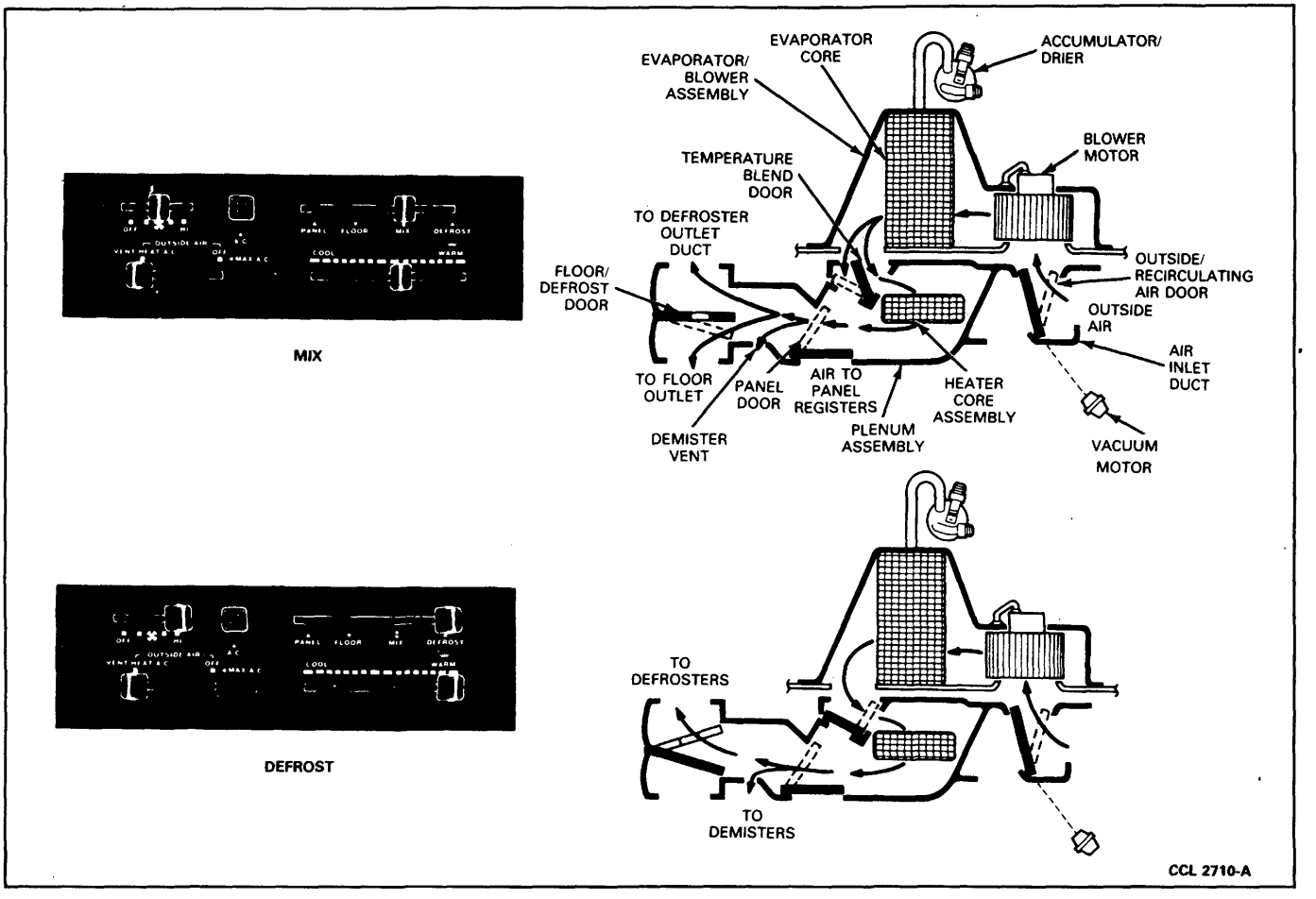


FIG. 3 Manual A/C-Heater Airflow Schematic (Mix, Defrost)

The cooled, dehumidified air in the evaporator case is pushed by the blower through the case and out through ducting to the registers in the instrument panel.

Extending this basic coverage of a refrigerant circuit, the following traces refrigerant flow through actual circuit components.

When the A/C system is not on, refrigerant system pressures are equalized on both the high and low sides of the refrigerant system. In both cases, the refrigerant is in a vapor state.

When the A/C ON-OFF pushbutton is pushed to ON, the A/C compressor magnetic clutch field coil is energized and the clutch plate is pulled into contact with the clutch pulley. The clutch plate and hub assembly then rotates the compressor shaft.

When the compressor shaft is rotated, the double ended pistons move backward and forward in their respective cylinder bores. As each piston is moved backward in its cylinder bore, the pressure in the cylinder suddenly reduces to a pressure (or vacuum) considerably lower than the refrigerant vapor pressure on the suction side of the refrigerant system. The higher refrigerant system vapor pressure overcomes the suction reed valve spring pressure, forcing itself through the reed valve and into the lower pressure (or vacuum) area inside the compressor cylinder. The spring pressure on the reed valve closes the valve when the refrigerant system suction vapor pressure and the compressor cylinder vapor pressure are equalized.

As each piston is forced into its respective cylinder bore, the refrigerant vapors from the suction side of the refrigerant system are compressed into a decreasingly smaller area, thus increasing the refrigerant vapor pressure and also raising the refrigerant vapor temperature. The higher refrigerant vapor pressure now assists in sealing the suction reed valve closed and also opens the discharge (high pressure) reed valve as the cylinder pressure exceeds the higher pressure side of the refrigerant system. When the compressed higher pressure and temperature refrigerant vapor is discharged into the high pressure side of the refrigerant system, the discharge reed valve spring pressure and the high side refrigerant pressure closes and seals the reed valve, thus preventing the discharge pressure from re-entering the compressor cylinder. The compressor's refrigerant vapor compression cycle begins again as the pistons are again pulled from their respective compressor cylinder bores by the rotating compressor shaft.

The high pressure and high temperature compressor discharge refrigerant vapor is released into the top of the condenser assembly, via the compressor's discharge hose. The condenser, being close to ambient temperature, causes the refrigerant vapor to condense into a liquid when heat is removed from the refrigerant vapor by ambient air passing over the condenser fins and tubing.

Liquid refrigerant from the condenser outlet enters the high pressure liquid line and then the inlet side of the fixed orifice tube located in the evaporator inlet

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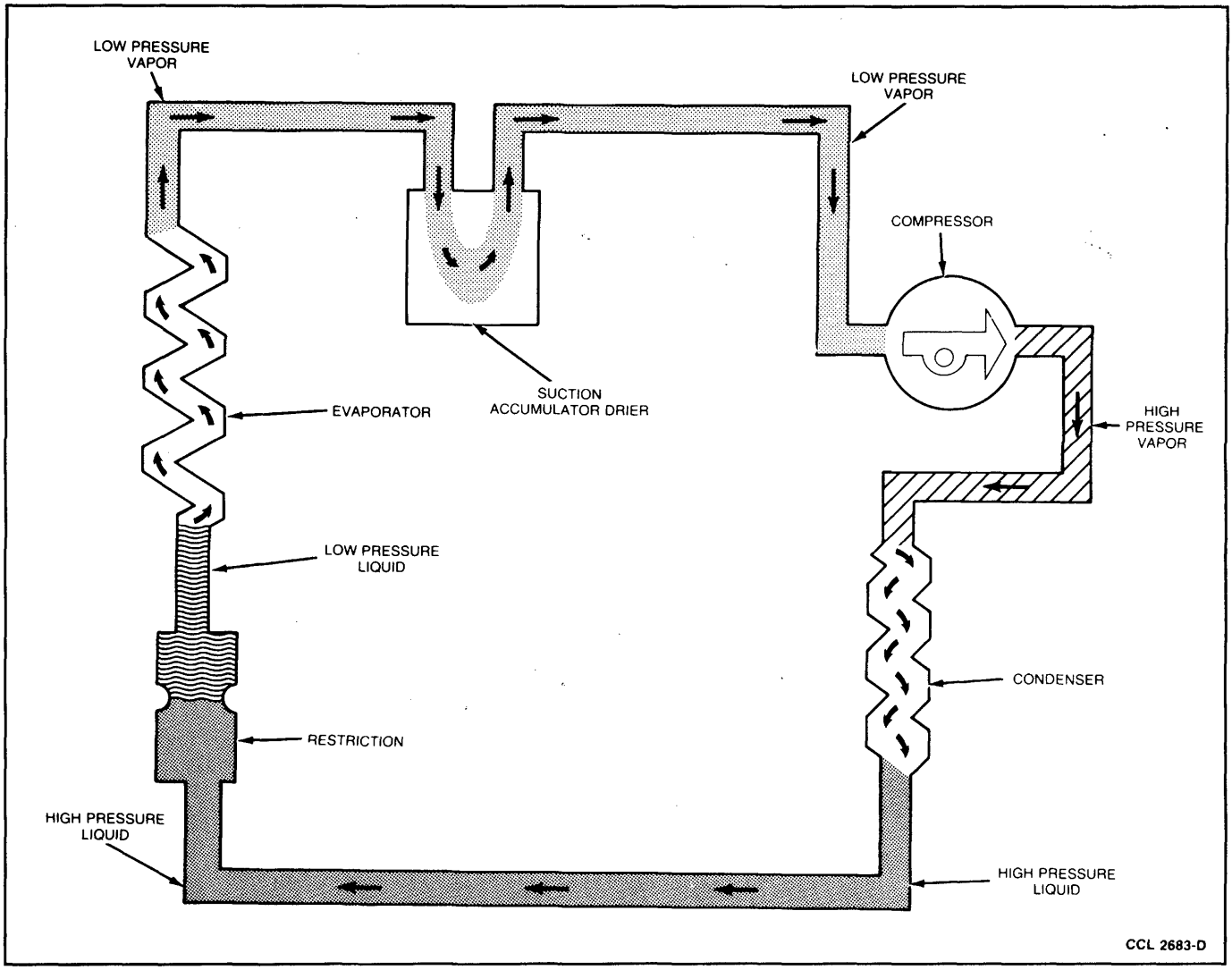


FIG. 4 Refrigerant Cycle

tube. The inlet filter screen of the fixed orifice tube assembly removes coarse contaminant particulates, which may be present in the liquid refrigerant, before the liquid refrigerant enters the calibrated opening of the fixed orifice tube. The outlet end of the orifice tube assembly has a fine mesh filter with four open side slots in the body of the tube assembly, upstream from the filter. This filter removes fine contaminants and allows some of the refrigerant to exit through the non-filtered side slots. The side slots and filter act as a refrigerant flow noise suppressor.

Evaporator pressure is reduced as a result of A/C compressor suction. As the evaporator pressure is lowered and the liquid line pressure increases, the liquid refrigerant passes through the fixed orifice tube and enters the evaporator at a low pressure and as a cold liquid. As airflow passes over the plate-fin sections of the evaporator core, the refrigerant inside absorbs the heat and changes into a vapor.

Compressor suction draws the vaporized refrigerant and oil mixture into the suction accumulator/drier where the heavier, oil-laden vapors fall to the bottom and the lighter vapors and oil mixture continue their path to the compressor via the top of the vapor return tube. A desiccant bag, located inside the suction accumulator/drier, absorbs and retains moisture which may be circulating in the refrigerant system. The heavier, oil-laden refrigerant also returns to the compressor through a small liquid bleed hole near the bottom of the vapor return tube. The liquid bleed hole provides a controlled second opportunity for the accumulated refrigerant and oil mixture to revaporize as it passes through the opening to re-enter into the main vapor flow path to the suction side of the compressor.

Summary

Airflow—Air can be distributed through the instrument panel registers, the floor outlets, and the defroster outlets depending upon the position of the function selector lever. Airflow to the side window demisters occurs in all control assembly lever settings except PANEL.

Function Control—When the function selector lever is in the PANEL position, air flows out of the panel registers. Moving the function lever to the FLOOR position directs airflow to the floor outlets with a slight bleed to the defroster outlets. The MIX position splits the air between the floor outlets and the defroster outlets, and DEFROST position directs airflow to the defroster outlets with a slight bleed to the floor outlets (Fig. 5).

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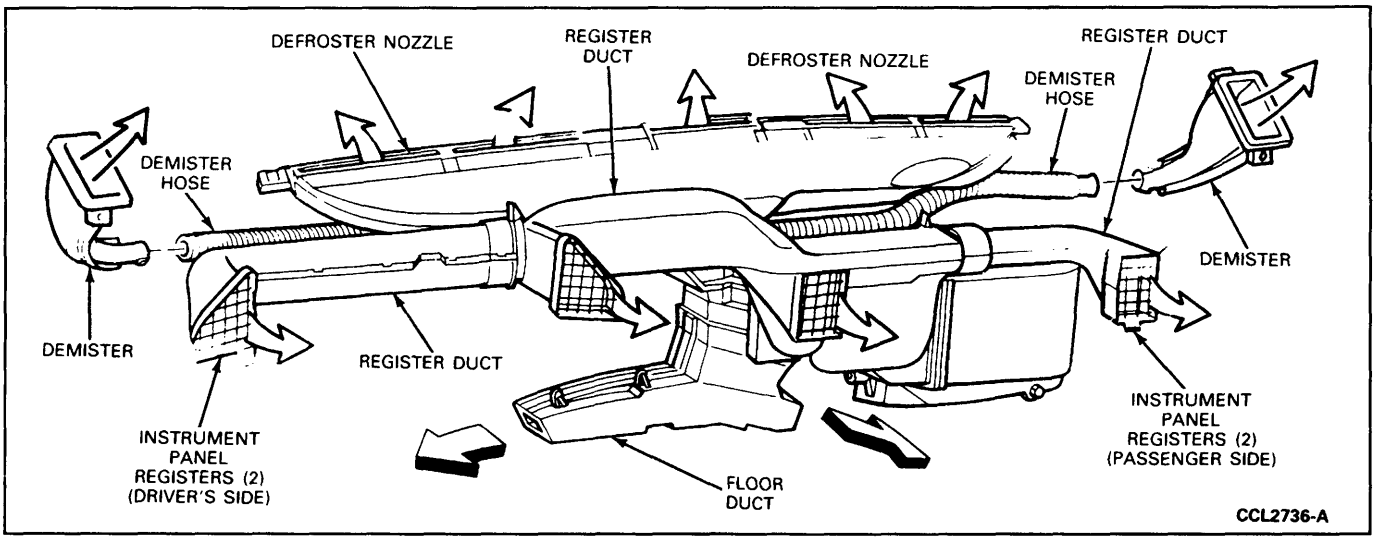


FIG. 5 Airflow Into Passenger Compartment

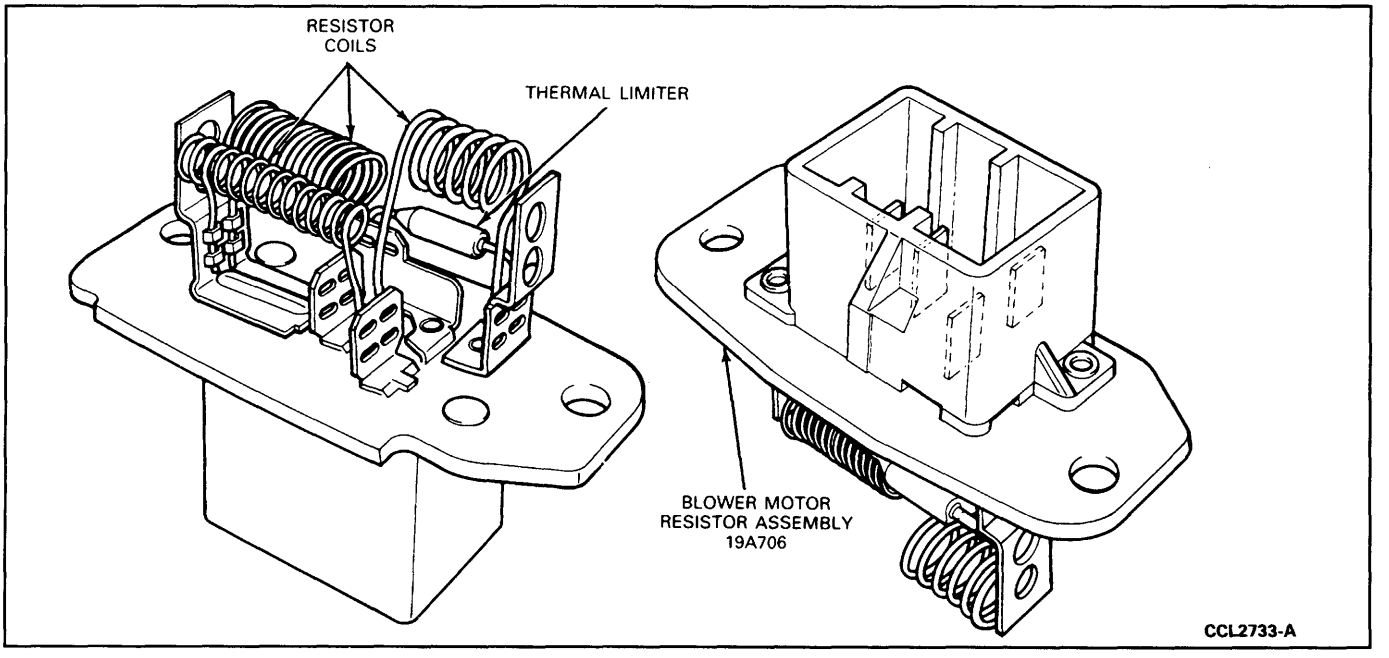


FIG. 6 Blower Motor Resistor

The outside air door lever actuates a vacuum switch which controls the movement of the door. A vacuum harness running between the switch and a vacuum motor transmits the power needed to position the door for the admission of outside air or the admission of inside air for recirculation through the evaporator case and into the passenger compartment.

In the VENT-HEAT-A/C position, outside air is drawn into the system by the blower. In the OFF/MAX A/C position, the recirc door is positioned so that outside air cannot pass into the evaporator case.

Temperature Control—Temperature is controlled by a cable-operated air blend door in the plenum assembly. When the temperature control lever is in the COOL (extreme LH) position, all air is directed around the heater core.

When the temperature control lever is moved to the WARM (extreme RH) position, all air is directed through the heater core. When the temperature control lever is between COOL and WARM (between extreme LH and extreme RH), air is directed through and around the heater core in proportion to the position of the temperature control lever between the extremes of its travel.

Blower Control—Blower speeds are controlled by a five-position blower switch and a resistor assembly located in the evaporator case upstream from the evaporator core (Fig. 6).

The switch is used to select low, two intermediate, or high blower speed settings. The blower is turned off by the blower speed selector lever when it is in the OFF position.

A/C System Control—The A/C system is turned on and off by a two-position pushbutton switch located next to the blower switch (Fig. 2). When the A/C button is pushed to ON and latched, electrical current flows through the pressure switch to the compressor clutch coil; the clutch engages and the A/C system is on. Also,

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a lamp in the pushbutton lights up. When the button is pushed again and disengages, current is stopped to the compressor clutch coil and the A/C system is off.

System Components

Evaporator Case Assembly

The evaporator case assembly is attached to the engine side of the dash panel.

The case is a two-piece molded construction, one piece of which forms a cover over the evaporator core. An integral vacuum reservoir is part of the cover housing. This reservoir and the vacuum motor, which operates the outside/recirc air door, are linked through a check valve to a hose that supplies engine vacuum.

The blower housing is an integral part of the evaporator case. It houses the blower motor and wheel assembly which attaches to the case through a mounting flange on the blower motor.

The blower motor resistor assembly is attached to the case with its thermal elements extending into the air stream inside the evaporator case. The suction accumulator/drier is attached to the evaporator core by a support bracket.

Plenum Assembly

Refer to Fig. 7.

The plenum assembly is mounted to the dash panel in the passenger compartment. It contains the heater core, temperature blend door, panel door and the floor/defrost door. The temperature blend door is cable-controlled through a cam located on top of the plenum (Fig. 23). The panel and floor/defrost doors are both controlled through one cam assembly, located on the bottom of the plenum.

The heater core is located in the plenum behind the heater core cover. The cover allows the core to be removed without removing the plenum.

Defroster Nozzle

The defroster nozzle attaches to the instrument panel with four screws and one screw to the center air duct. It

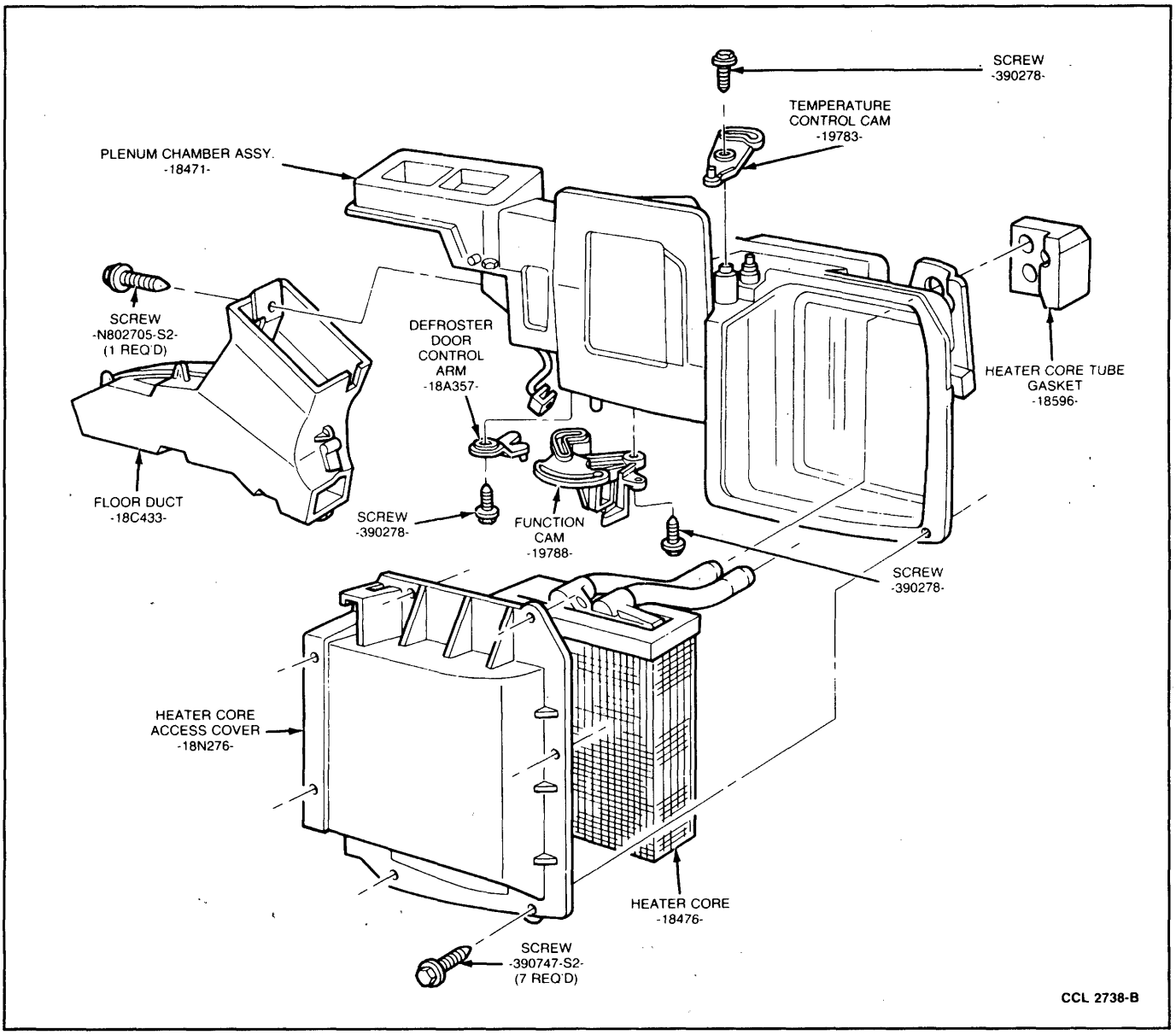


FIG. 7 Plenum Assembly

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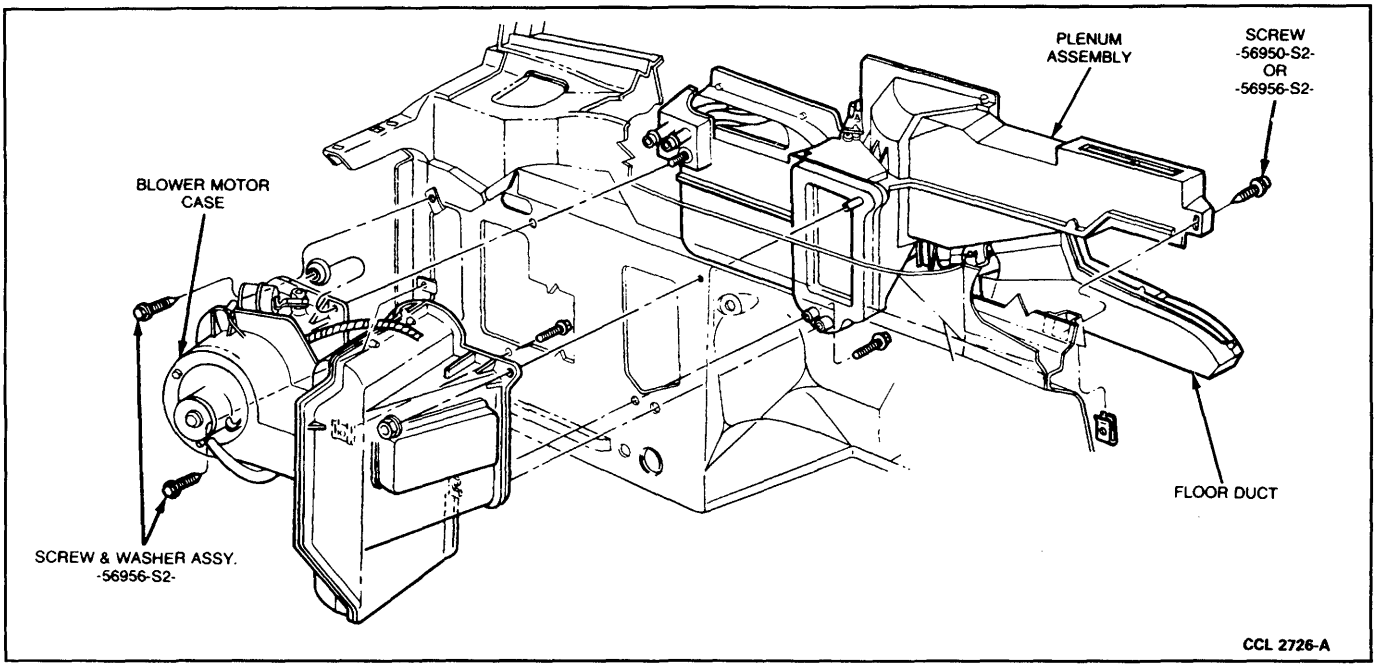


FIG. 8 Case and Plenum Assembly Installation

directs air onto the windshield through five slotted openings in the upper, forward portion of the panel (Fig. 9).

Demister Nozzles and Hoses

Fig. 10 illustrates the parts which make up the side window demister system. A separate nozzle attaches to a register which is molded into each end of the instrument panel. A separate hose leads from each nozzle to a connector attached to the center air duct.

Register Ducts

The register ducts are three one-piece molded parts which attach to the underside of the instrument panel (Fig. 11).

The ducts feed four registers in the instrument panel. A triangular-shaped register is located on each side of the instrument cluster (Fig. 12) and one of two rectangular registers is located at the immediate right of the heater-A/C control assembly. The other rectangular register is located near the RH edge of the instrument panel.

Outside Air/Recirculation Air Door

The outside air/recirculation air door is located in the evaporator case assembly (Fig. 13). It is operated by a vacuum motor in response to movement of the outside air control lever.

When the lever is in the VENT-HEAT-A/C position, the door is open to admit outside air; when the lever is in the OFF/MAX A/C position, the door is moved by vacuum to shut off outside air and open the passageway so that inside air can be recirculated through the system.

Control Assembly

The control assembly is installed in the center of the instrument panel (Fig. 14).

It includes the control head with two cable operating levers: one for selecting function and the other for selecting temperature. A third lever is provided to select outside or recirc air by means of applying or removing vacuum. A fourth lever moves electrical switch contacts so that they establish continuity for one of five available blower switch positions between OFF and HI speed.

Electrical System

The electrical system consists of the blower motor, blower speed switch, blower resistor with a thermal limiter, pressure switch, magnetic clutch and the fuse and wiring to complete the circuits (Fig. 15).

The blower motor is installed in the blower housing which is part of the evaporator case. The motor is connected to the electrical circuit with one hardshell connector located near the motor.

The blower speed switch is installed on the control assembly and, with the blower resistor, provides the selection of four blower operating speeds. This switch turns the blower off when the lever is moved fully to the left to the OFF position.

The blower motor resistor is installed in the evaporator case between the blower motor and the evaporator core.

The resistor assembly also contains a thermal limiter which is used as a temperature-protecting fuse. The thermal limiter is located a preset distance from the resistor coils (Fig. 6). If the temperature of the thermal limiter reaches approximately 121°C (250°F), the limiter contacts will open, interrupting the blower motor circuit for all blower speeds except high speed. The thermal limiter will not reset and the resistor assembly must be replaced if the thermal limiter opens.

The pressure switch is located on the side of the suction accumulator and controls the compressor clutch cycling. When the evaporator pressure increases to approximately 276-324 kPa (40-47 psi), the switch closes. When the pressure drops below approximately 169 kPa ±10 kPa (24.5 psi ±1.5 psi), the switch opens to stop compressor operation. In ambient temperatures below approximately 7.2°C (45°F), the pressure switch

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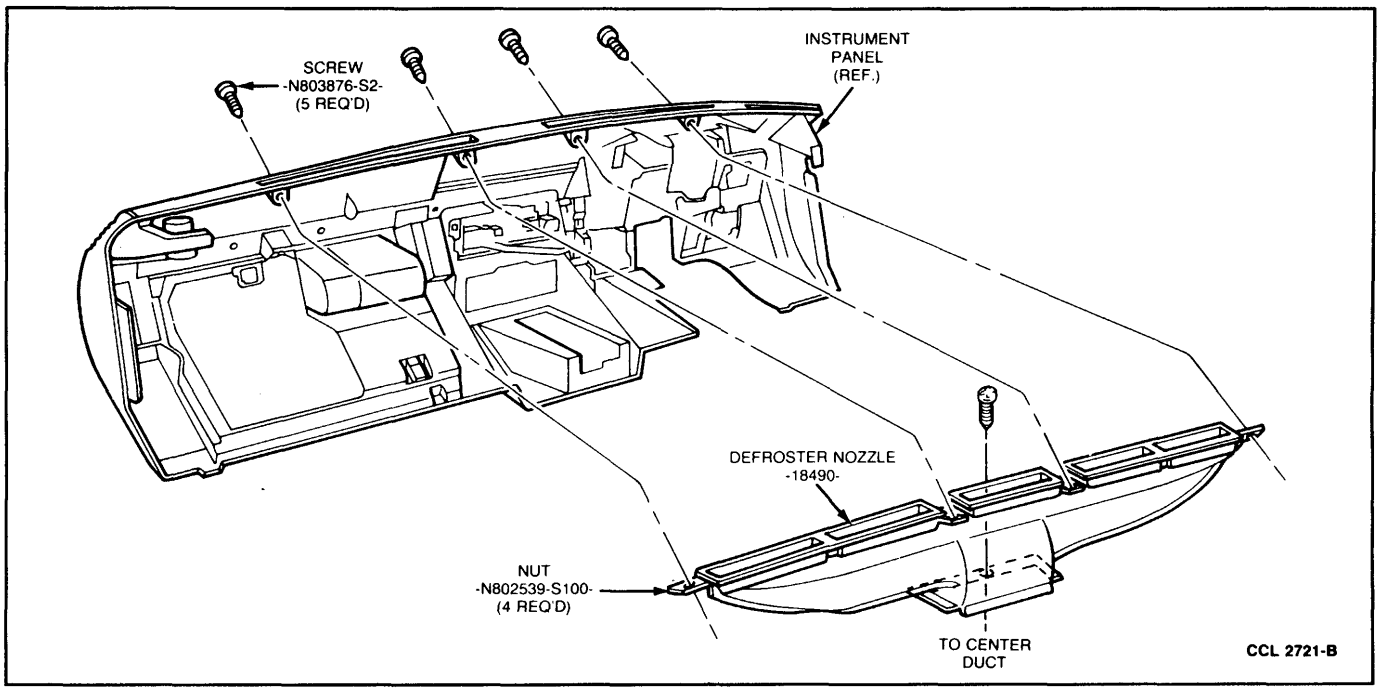


FIG. 9 Defroster Nozzle

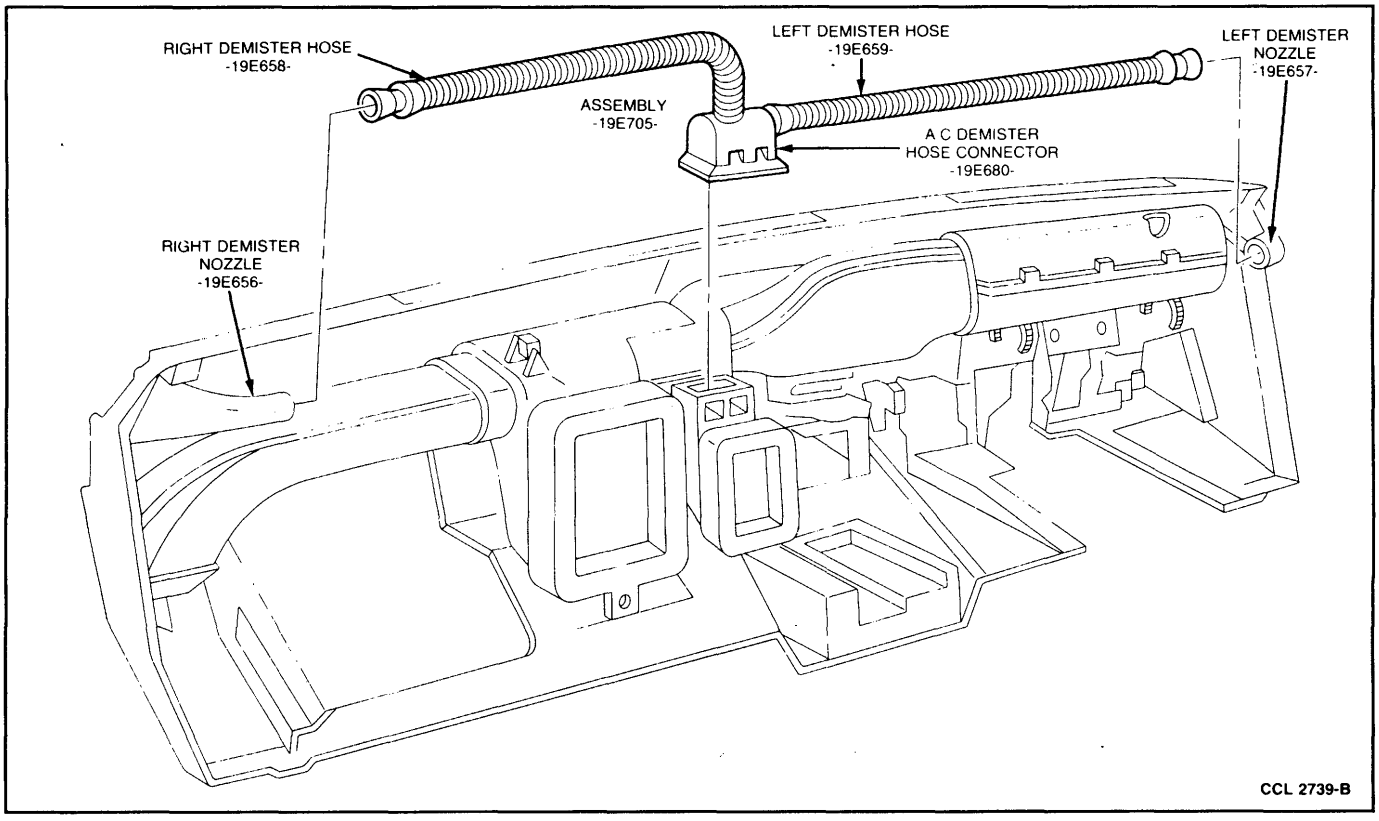


FIG. 10 Demister Nozzles and Hoses

will not allow compressor operation because of low system pressures.

Vacuum System

Only the outside/recirc air door is vacuum operated. Beginning at the control assembly, the outside air control lever may be moved between two positions. At the extreme left, the lever has been set in the VENT-HEAT-A/C position, and vacuum is not being applied to the motor. Therefore, the recirc air door is closed. When the lever is moved to the extreme right, the vacuum motor moves the door to close off the flow of outside air and open the doorway in the duct to allow the flow of air inside the vehicle to recirculate through the system and into the passenger compartment.

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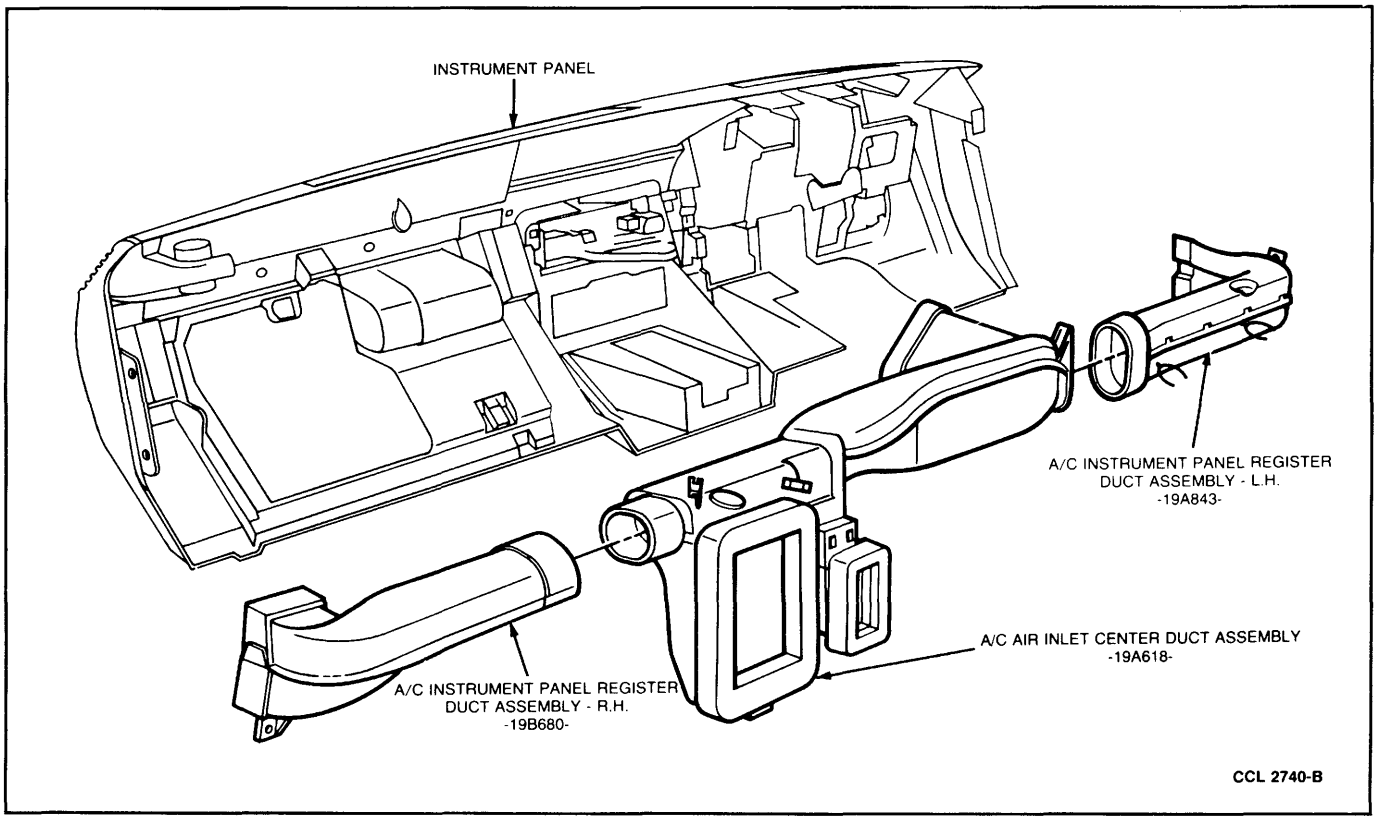


FIG. 11 Instrument Panel Register Duct

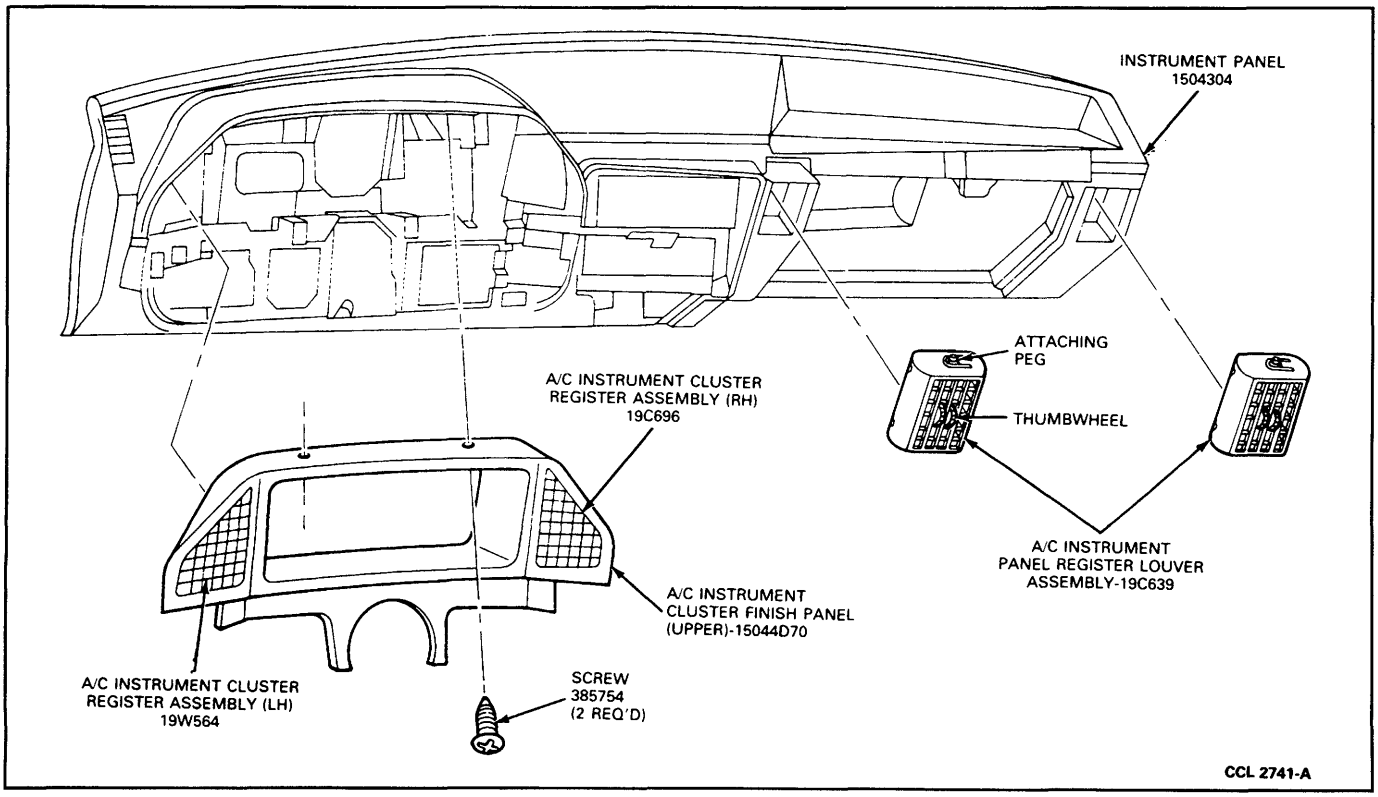


FIG. 12 Instrument Panel Registers

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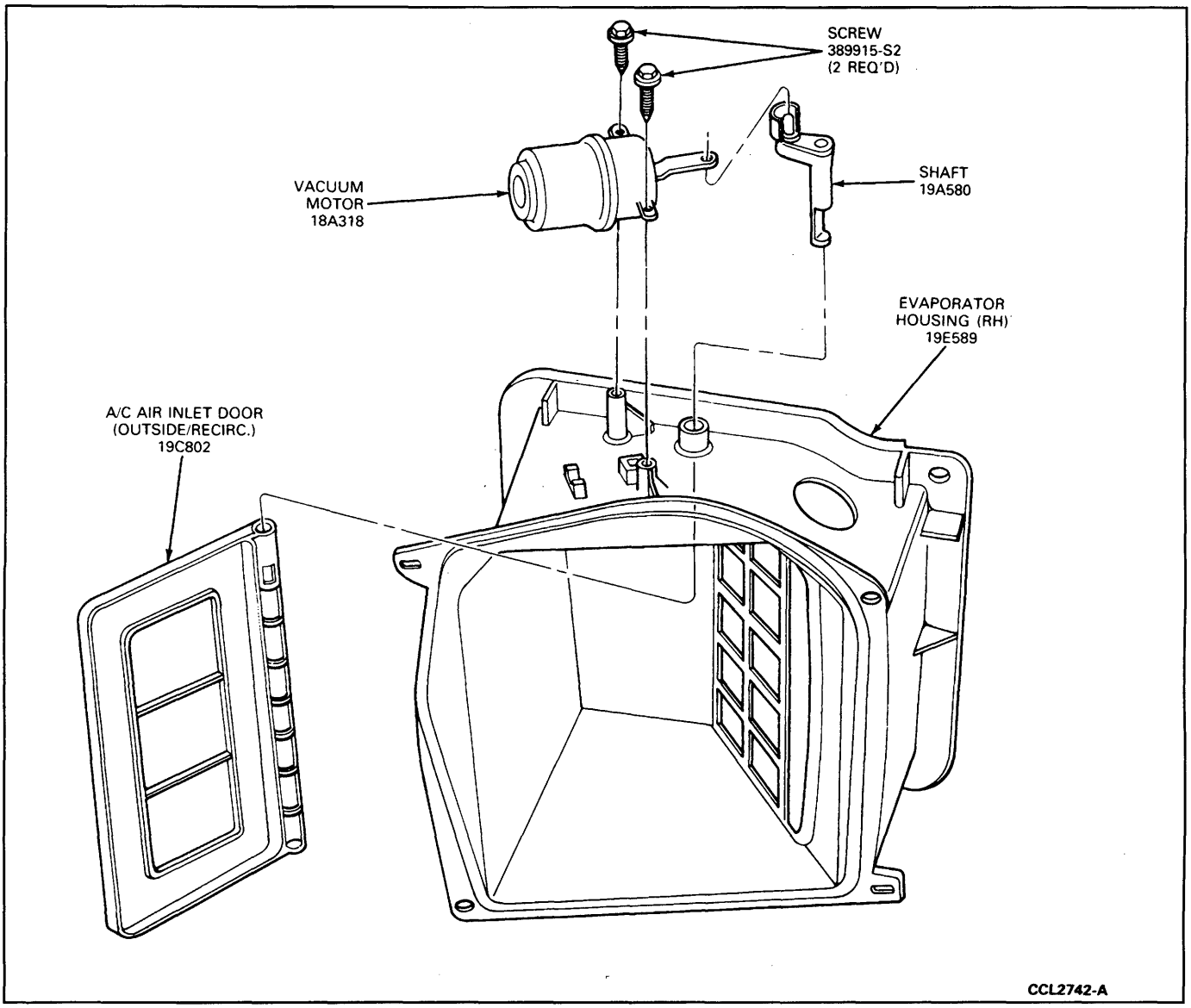


FIG. 13 Outside Air/Recirc Air Control and Vacuum Motor

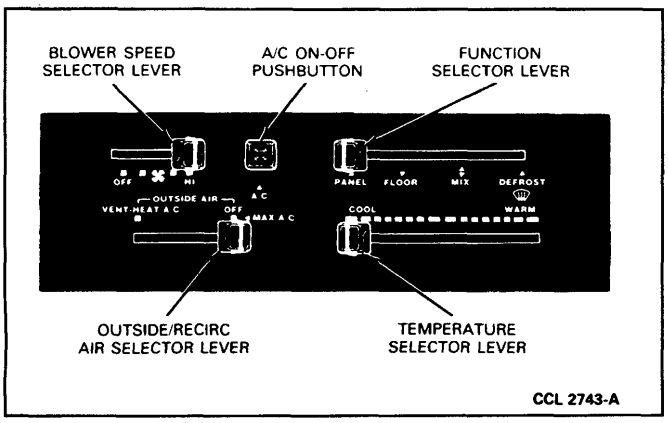


FIG. 14 Control Assembly (Front View)

In addition to indicating that outside air control is OFF, control assembly graphics indicate that the lever, when moved to the extreme right, is also in a position for MAX A/C performance. The other three levers in the control assembly will respond to their setting. For maximum cooling, the temperature lever should be set to the extreme left; the function lever should be in the PANEL position; and the blower should be set for a desired rate of airflow but not set in the OFF position.

Even though the outside air lever is off and the A/C switch is on, the function and temperature levers, being manually controlled, may be set to modify the temperature of the air and the path through which the air flows. Another characteristic of the MAX A/C setting is the increased noise level of the blower. Blower speed does not change when the outside air/recirc door is moved to either of its two positions. The difference in noise level is that an open recirc door exposes the passenger compartment directly to the noise. When insulated against the noise with the recirc passageway closed, the blower speed appears to be less.

The control lever operates a vacuum valve (Fig. 16) which is attached to the backside of the control assembly by two screws.

Two hoses extend from the valve to a tee. A large hose connected to the base of the tee supplies engine vacuum. Two hoses leave the tee. One supplies

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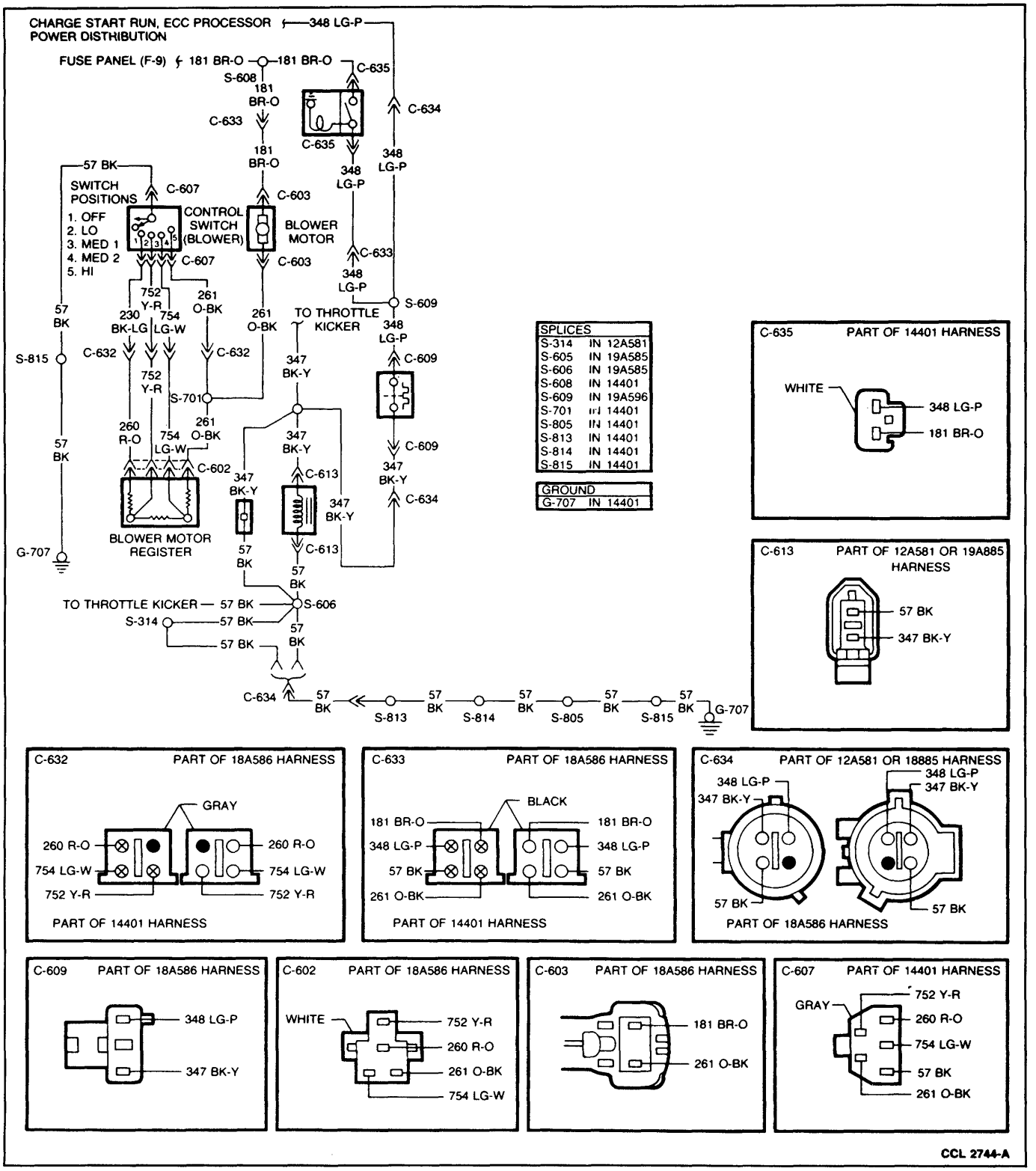


FIG. 15 Manual A/C-Heater Electrical System Wiring Diagram

vacuum to a reservoir which is an integral part of the molded case; the other supplies to the outside/recirc air door vacuum motor. Each end of each hose slides onto the nipple of the vacuum port to which it attaches.

Refrigerant System

The manual A/C-heater refrigerant system uses a six-cylinder swash plate compressor, a condenser, an evaporator core with a fixed orifice in the evaporator inlet tube, a suction accumulator with an integral drier, a pressure switch, Schrader-type service access gauge port valves, and the necessary refrigerant lines.

A/C Compressor and Clutch Assembly

The A/C compressor is the six-cylinder swash-plate type and is installed in a horizontal position on the LH

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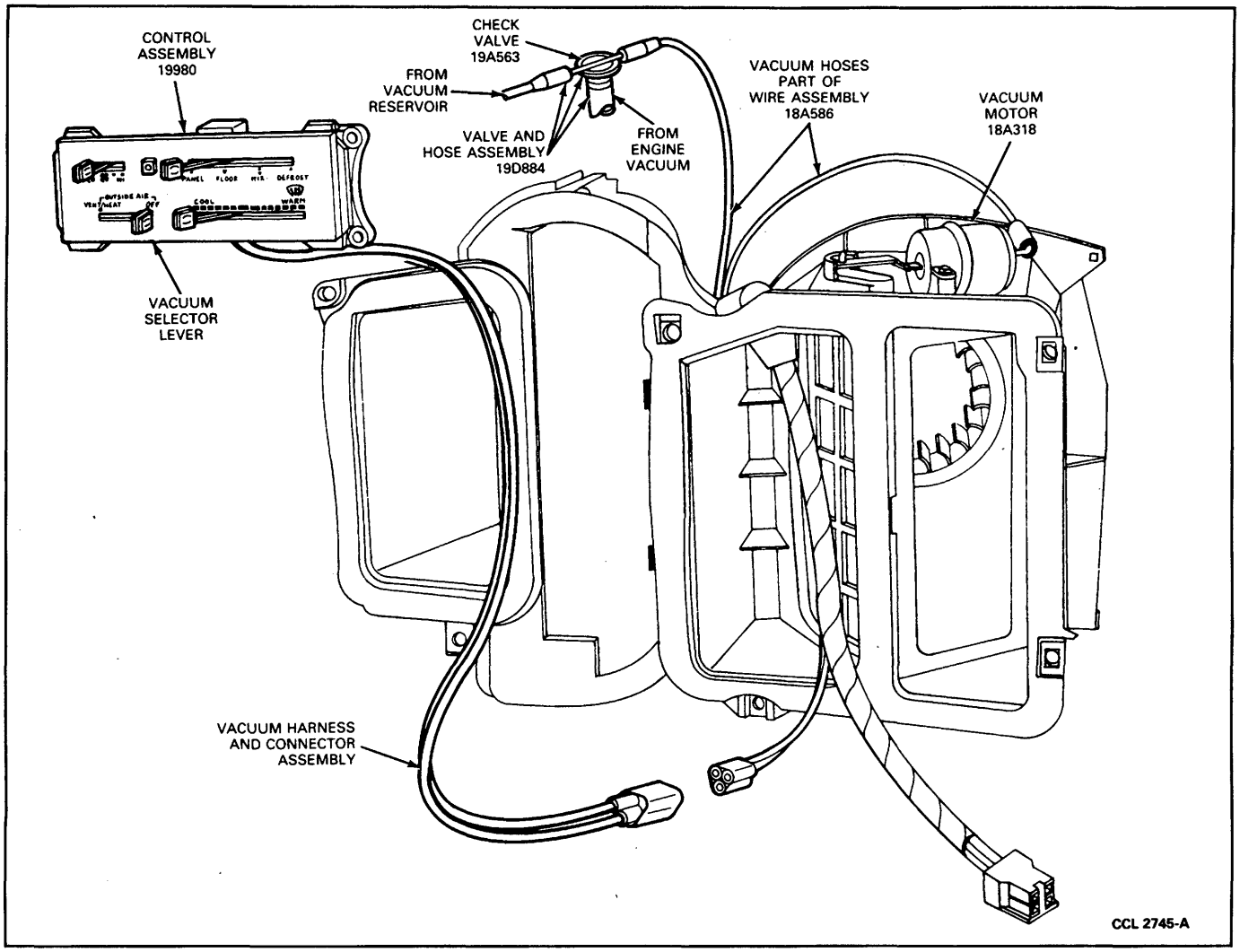


FIG. 16 Vacuum Valve and Hoses

side of the engine compartment (Fig. 5). It is driven by the front end accessory drive VEE belt. Belt tension adjustment is obtained by means of an automatic tensioner (on gasoline engines or by moving the compressor and braces on 7.3L diesel engines).

Pressure Relief Valve

A pressure relief valve is installed on the compressor discharge manifold to relieve excess high pressure buildups (310 kPa or 450 psi and above) and prevent damage to the compressor and other A/C components.

Condenser Assembly

The condenser assembly is attached to the radiator support in front at the radiator with two mounting brackets at the top and bottom of the condenser (Fig. 17). The top mounting brackets attach to the rear side of the radiator support and the lower brackets attach to the front side of the radiator support.

Evaporator Core

The evaporator core is a "flooded type" (plate-fin) core similar to passenger car cores (Fig. 18). The liquid line connects to the bottom of the core and the suction accumulator/drier assembly connects to the top of the core.

Fixed Orifice Tube

The evaporator inlet tube is fitted with a fixed orifice to control refrigerant flow. This orifice tube can be removed from the evaporator core inlet tube for placement if it becomes necessary. However, Orifice Tube Remover and Installer T83L-19990-A (Motorcraft YT-1008) or equivalent (Fig. 19) is necessary to prevent breakage when removing the tube.

The fixed orifice tube assembly is a restriction between the high and low pressure refrigerant and meters the flow of liquid refrigerant into the evaporator core. The diameter of the orifice within the orifice tube is 1.575mm (0.062 inch). The orifice tube can be identified by the RED body color with a white outlet tip.

The fixed orifice tube is located in the evaporator inlet tube and has filter screens on the inlet and outlet ends of the tube body. The filter screens act as strainers for the liquid refrigerant flowing through the fixed orifice opening. O-rings on the tube body prevent the high pressure liquid refrigerant from bypassing the orifice. Adjustment or repairs cannot be made to the fixed orifice tube assembly and it must be replaced as a unit.

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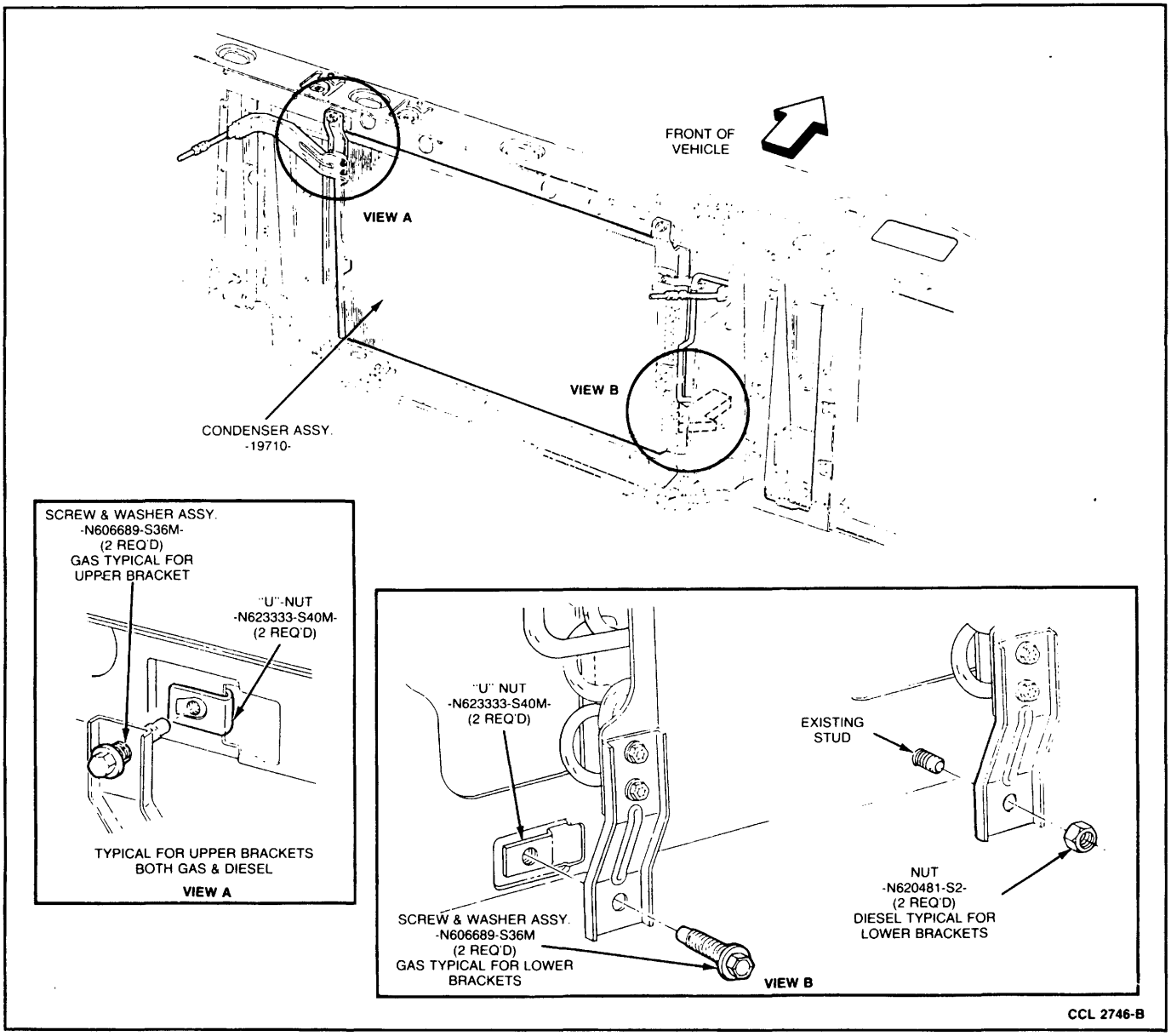


FIG. 17 Condenser Assembly

Suction Accumulator/Drier

The suction accumulator/drier (Fig. 18) is mounted inside the evaporator case and attaches directly to the evaporator outlet tube.

Refrigerant enters the accumulator/drier canister through the inlet tube and the heavier, oil-laden refrigerant falls to the bottom of the canister (Fig. 20). A small diameter oil bleed hole is located in the side of the outlet tube near the bottom of the canister. This bleed hole is covered with a filter screen and allows a small amount of the heavier liquid refrigerant and oil mixture to re-enter the suction line at a controlled rate. When the heavier liquid refrigerant and oil mixture enters the compressor suction line, it has a second opportunity to vaporize and circulate through the compressor without causing damage to the compressor due to refrigerant slugging.

A desiccant bag is mounted inside the suction accumulator/drier canister to absorb any moisture which may be in the refrigerant system.

A fitting located on the top or side of the canister is used to attach the clutch cycling pressure switch. A long-travel Schrader-type valve stem core is installed in the fitting opening to prevent refrigerant loss when the clutch cycling pressure switch is removed.

If it is necessary to check the suction accumulator/drier for excessive refrigerant oil, the oil must be poured from the accumulator through the pressure switch fitting when the Schrader valve stem is removed.

Replacement Guidelines

Replace Accumulator/Drier when:

- The suction accumulator/drier is restricted, plugged or perforated.
- The system has been left open for more than 24 hours (system completely discharged).
- There is evidence of moisture in the system (i.e., internal corrosion of metal lines or dark thick refrigerant oil).

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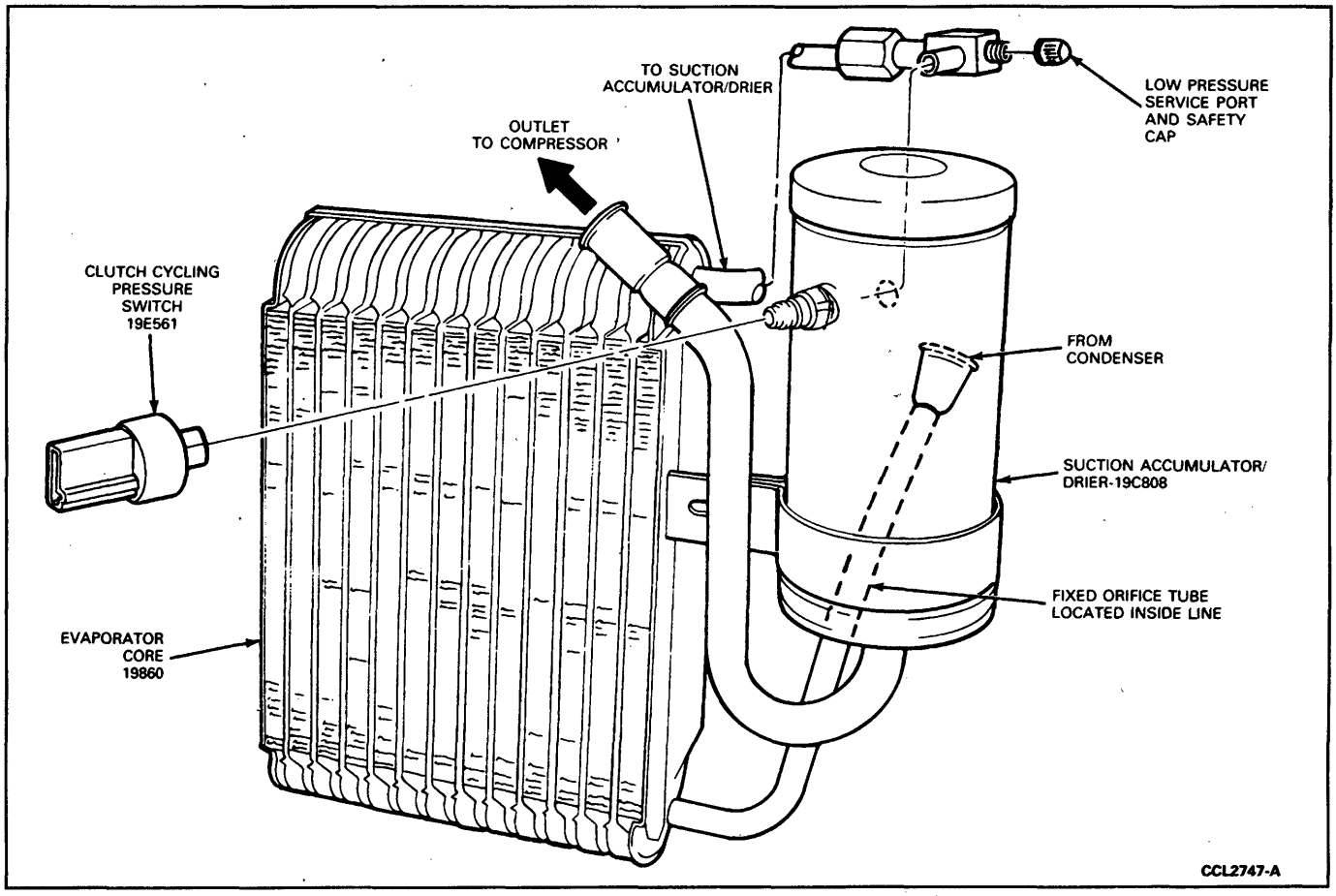


FIG. 18 Evaporator Core and Suction Accumulator/Drier

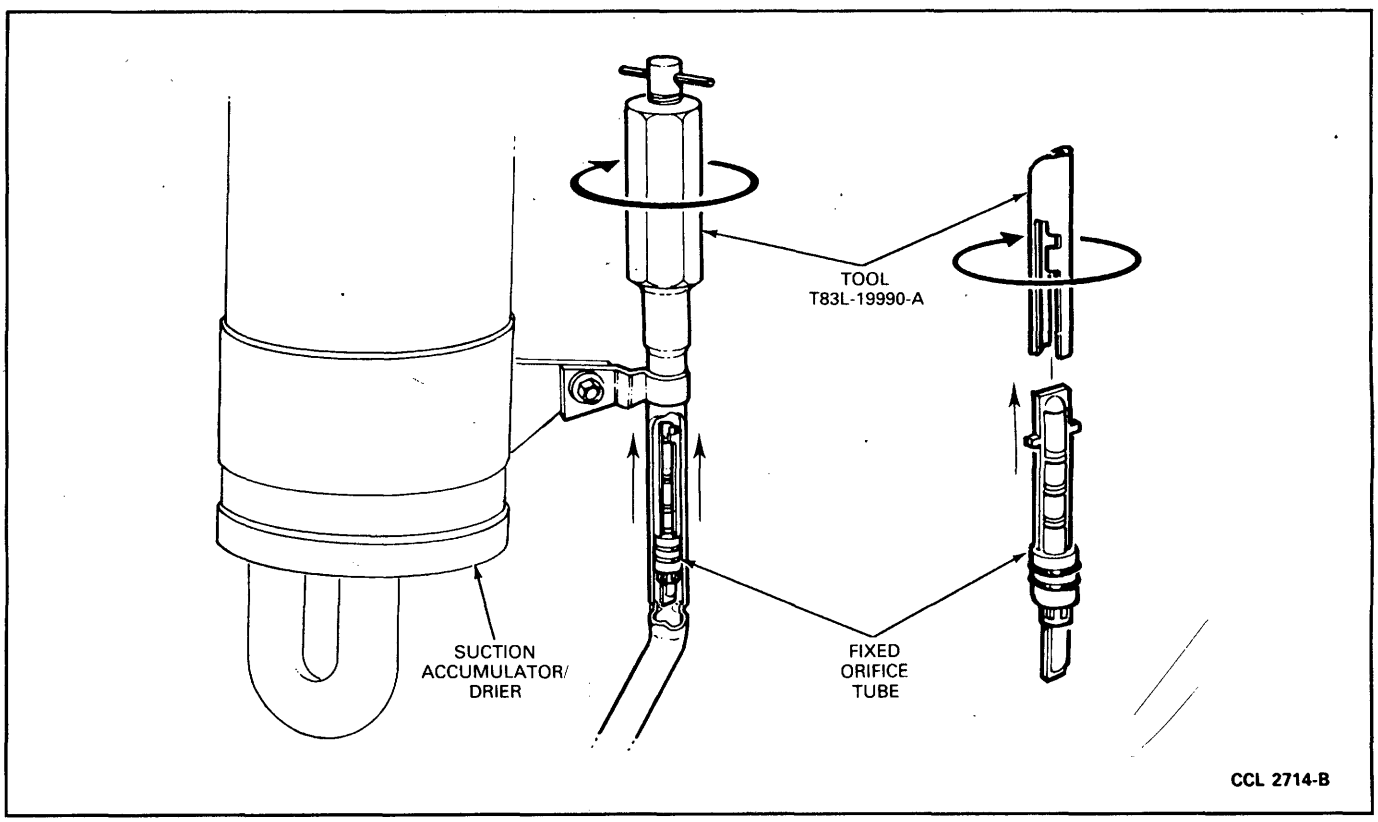


FIG. 19 Removal of Fixed Orifice Tube

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- A component such as a condenser, evaporator, refrigerant line or a seized compressor is replaced. (Flush system and replace orifice tube when replacing a seized or damaged compressor.)

Do not replace Accumulator/Drier every time if:

- There is a partial loss of refrigerant charge.
- A dent is found in the outer shell of the suction accumulator/drier.

Clutch Cycling Pressure Switch

The clutch cycling pressure switch (Fig. 20) is mounted on a Schrader valve-type fitting on the side of the suction accumulator/drier assembly. A valve depressor, located inside the threaded end of the pressure switch, presses in on the Schrader valve stem as the switch is mounted and allows the suction pressure inside the accumulator/drier housing to activate the switch. The electrical switch contacts are normally open when the suction pressure is at or below 179 kPa (26 psi); they will close, activating the compressor clutch, when the suction pressure rises to approximately 310 kPa (45 psi) or above. Lower ambient temperatures (below approximately 7°C or 45°F) during cold weather seasons will also open the clutch cycling pressure switch contacts, because of the pressure/temperature relationship of the refrigerant in the system. The electrical switch contacts control the electrical circuit to the compressor's magnetic clutch coil. When the switch contacts are closed, the clutch coil is energized and the A/C clutch is engaged to drive the compressor. When the switch contacts are open, the compressor's magnetic clutch coil is de-energized, the A/C clutch is disengaged and the compressor does not operate. The clutch cycling pressure switch, when functioning properly, will control the evaporator core pressure at a point where the plate-fin surface temperature will be maintained slightly above freezing which prevents evaporator icing and the blockage of airflow.

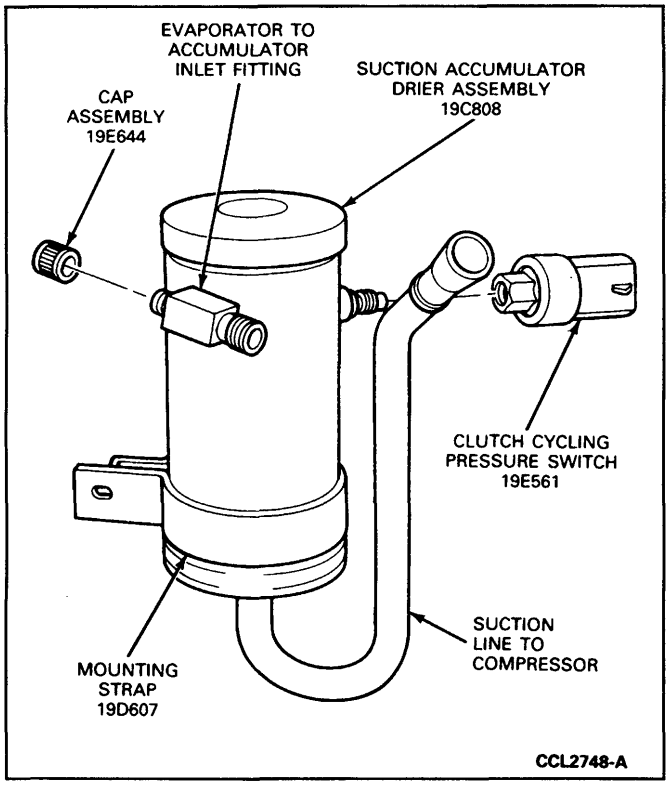


FIG. 20 Suction Accumulator/Drier—Cutaway View

Service Access Gauge Port Valves

Two service access gauge port valves are used in the refrigerant system. The high pressure (discharge) valve is located in the discharge line near the condenser (Fig. 21). This service access gauge port valve requires High Pressure Service Port Adapter Set D81L-19703-A (Motorcraft YT-354 or 355) or equivalent (Fig. 22) to connect a manifold gauge set or charging station to it. The other service access gauge port valve is located on the side of the suction accumulator (Fig. 21), and is used to measure evaporator pressure. An additional Low Pressure Gauge Port Valve adapted to the accumulator is available for attaching a service hose and pressure gauge. See Tee Adapter Tool Installation in Section 36-30.

Manual Valves

Some vehicles are equipped with manual valves at the compressor similar to manual service valves. These

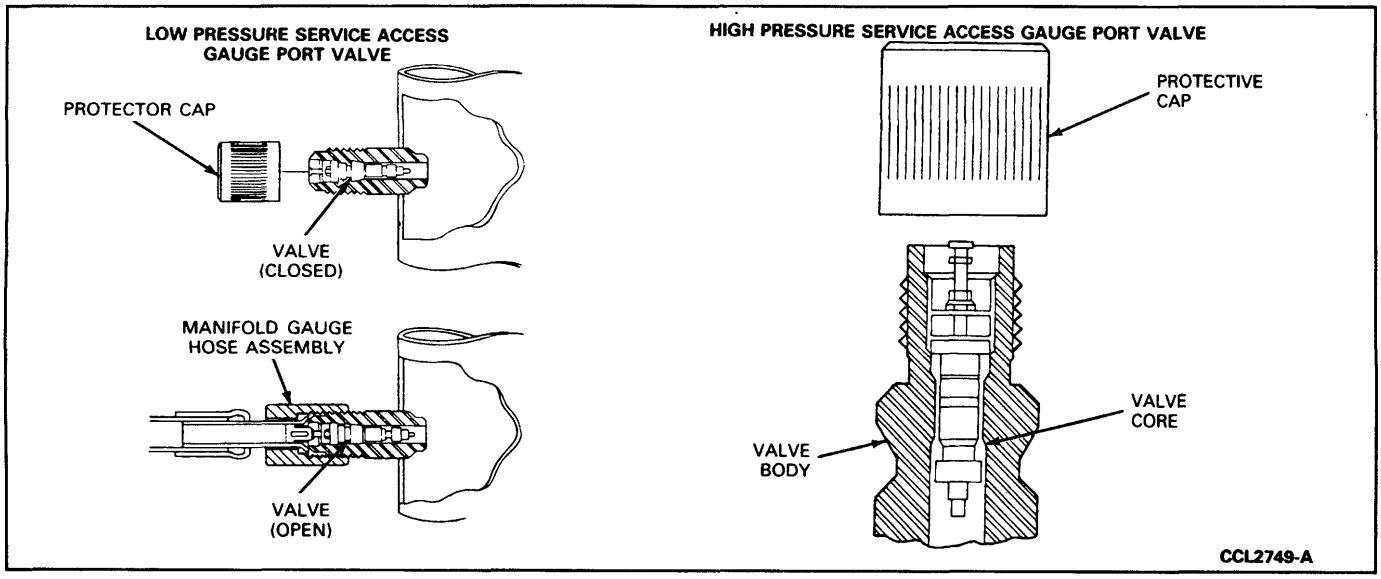


FIG. 21 Service Access Gauge Port Valves

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valves do not have service ports and are used to isolate the compressor.

Refrigerant Lines

Two types of refrigerant lines are used with the manual A/C-Heater system. One type has manual valves (without integral service ports) at the compressor and a self-sealing coupling at the liquid line connection of the condenser. These refrigerant lines are used on A/C systems that are pre-charged at the time of manufacture.

The other type of refrigerant lines do not have manual valves or the self-sealing coupling. These lines are used on A/C systems that are charged with refrigerant at vehicle assembly. This is the only type of refrigerant line that will be available for service.

The compressor discharge line has a Schrader-type service access gauge port valve located near the compressor. This is the high pressure service port. A High Pressure Service Port Adapter Set D81L-19703-A (Motorcraft YT-354 or 355) or equivalent is necessary to connect a manifold gauge set or a charging station to this service port.

DIAGNOSIS AND TESTING

For instructions and illustration covering diagnosis and testing of the heater and A/C systems used on current F-Series and Bronco vehicles, refer to Sections 36-10 and 36-30.

- Heating system coverage includes the following:
  - —Blower motor current draw test
  - —Blower motor voltage test
  - —Blower switch continuity test
  - —Heater core leak testing
  - —Loose blower wheel test
  - —Open circuit test

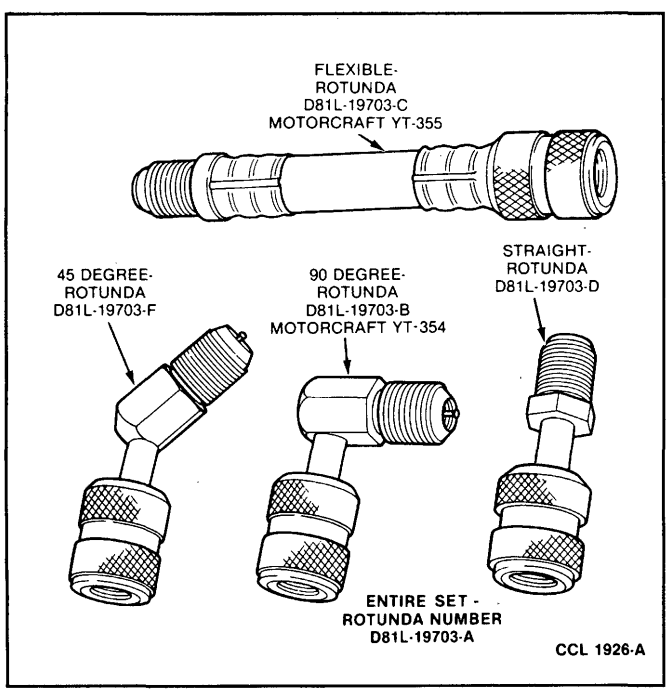


FIG. 22 Service Access Gauge Port Valve Adapters

Procedures are also provided for bleeding air from the heater core, visually checking the blower, and backflushing the heater core.

- A/C system coverage includes the following:
  - —A/C performance testing
  - —Magnetic clutch test
  - —Pressure switch test

Procedures are also provided for leak testing, making visual inspections, and using a manifold gauge set.

ADJUSTMENTS

Function and Temperature Control Cables

To check the function control cable adjustment, turn the blower to HIGH and move the function control lever to its various positions. Check for airflow at the appropriate outlets (Fig. 2).

If this condition is not met, the function control cable may be misadjusted or not connected. Refer to Cable Adjustment or Cable Removal and Installation.

To check the temperature control cable adjustment, move the temperature control lever back and forth, checking for the sound of the temperature blend door seating against the stop. If the sound of the door seating is not heard before the lever reaches its limit of travel, the temperature control cable may be misadjusted or not connected. Refer to Cable Adjustment or Cable Removal and Installation.

NOTE: If the function or temperature levers do not move left or right and appear to be locked in place, the adjustment pins may have been inadvertently left in the control cams during assembly.

The function control cam is on the bottom of the plenum. The pin can easily be seen and removed.

To remove temperature control cam adjustment pin:

1. Disengage glove compartment door by squeezing side with stop and removing pin holding check strap from opposite side. Allow door to hang free.
2. Working through glove compartment opening, remove red assembly pin from control cam with a mechanical fingers tool or a wire with a hook on the end.
3. Check for proper control cable operation.
4. Install glove compartment and door.

Cable Adjustment

The function control cable is on the bottom of the plenum and the temperature cable is on the top of the plenum.

To adjust the function control cable:

1. Remove cable jacket from metal attaching clips on bottom of plenum by depressing clip tab and pulling cable down.

NOTE: Cable end should remain attached to door cam and/or crank arm.

2. Move function lever to DEFROST position and hold firmly.
3. With cable end attached to function cam, pull on cable jacket until cam travel stops. Install cable into clip by pushing up until it snaps into place (Fig. 23).

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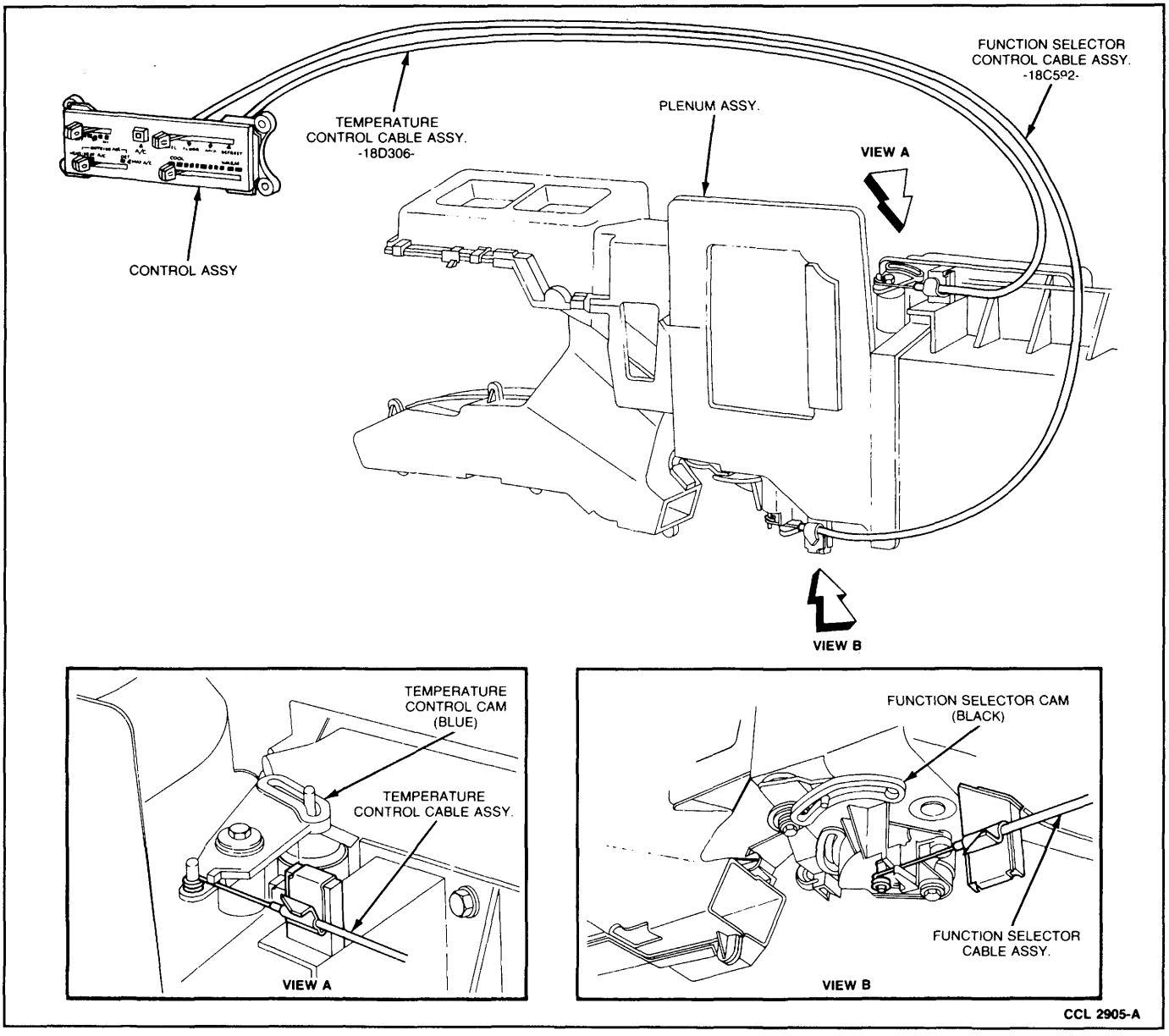


FIG. 23 Control Cable-To-Cam Connection

4. Run system blower on HIGH and actuate function lever to check for proper adjustment.

To adjust the temperature control cable, proceed as follows:

1. Disengage glove compartment as outlined. Allow door to hang free.
2. Working through glove compartment opening, remove cable jacket from metal attaching clip on top of plenum by depressing clip tab and pulling cable up.

NOTE: Cable end should remain attached to door cam and/or crank arm.

3. Set temperature control lever to COOL and hold firmly.
4. With cable end attached to temperature door cam, push gently on cable jacket to seat blend door (push until resistance is felt). Install cable into clip by pushing cable jacket into clip from top until it snaps into place (Fig. 23).
5. Operate system to check temperature control.

Compressor Drive Belt Tension

For compressor drive belt adjustment procedures, refer to Section 27-06, Accessory Drive Belt Service.

REMOVAL AND INSTALLATION

Control Assembly

Removal

1. Disconnect battery ground cable(s).
2. Pull center finish panel away from instrument panel to expose heater control attaching screws (Fig. 27).
3. Remove four screws attaching control assembly to instrument panel.
4. Pull control assembly through instrument panel opening far enough to allow removal of electrical connectors from blower switch and control lamp.

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5. Disconnect vacuum harness from outside air control.
6. Working from bottom of control with a screwdriver or needlenose pliers, carefully release function control cable snap-in flag from control bracket (Fig. 27).
7. Pull enough cable through instrument panel opening to allow cable to be held vertical to control. Then, remove cable from function control lever.
8. Working from top of control with a screwdriver or needlenose pliers, carefully release temperature control snap-in flag (Fig. 27).
9. Rotate control 90 degrees and disconnect temperature control cable from temperature control lever. Move control away from instrument panel.

Installation

1. Pull control cable approximately 203mm (8 inches) through control assembly opening in instrument panel.
2. Hold control assembly up to instrument panel with control face toward floor.
3. Attach temperature cable to temperature control lever. Rotate control back to normal position and snap cable flag into control bracket. Be sure it is firmly in place.
4. Gently bend function control cable down to the control. Attach cable to function control lever and snap cable flag into control assembly bracket.
5. Connect wire harness to blower switch and control illumination lamp. Connect vacuum harness to outside air door control.
6. Position control assembly in instrument panel and install four attaching screws.
7. Snap finish panel into place. Be sure it is seated firmly.
8. Connect battery cable(s).
9. Check system for proper operation.

Blower Speed Switch

Removal

Refer to Fig. 24.

1. Carefully pry instrument panel center finish panel out of its four lower retaining slots. Then, rotate panel out of upper slot.
2. Remove control assembly from instrument panel, as outlined.
3. Remove knob from blower switch by placing a small screwdriver between knob spring retainer and control assembly. Then, pull on screwdriver, applying pressure on spring retainer and pull knob from switch.
4. Remove four control assembly attaching screws.
5. Move control assembly away from instrument panel opening and disconnect wire connector from switch.
6. Remove two screws attaching switch to top of control assembly, and remove switch.

Installation

1. Position switch on control assembly and install two attaching screws.
2. Connect wire connector to switch.
3. Position control assembly in instrument panel and attach it with four screws.
4. Install blower switch lever knob with spring retainer pushed into place.
5. Slide instrument panel center finish panel upper retainer into slot in the instrument panel. Press remaining four retainers into mating slots in the panel.
6. Check blower switch for proper blower motor operation.

Vacuum Selector Valve

Removal

1. Remove control assembly as outlined.
2. Remove outside air selector lever knob.
3. Disconnect vacuum hose from valve.
4. Remove two screws attaching vacuum selector valve to control assembly and remove selector valve (Fig. 24).

Installation

1. Position vacuum selector valve to control assembly.
2. Install two vacuum selector valve attaching screws.
3. Attach vacuum hose to valve.
4. Move function selector valve from one side of control assembly slot to other side. Ensure lower actuating arm of control assembly moves freely.
5. Install control assembly as outlined.
6. Attach outside air selector lever knob.
7. Check system for proper operation in all function positions.
8. Install center finish panel.

Temperature Control Cable

Removal

1. Working through glove compartment opening, remove temperature cable from attaching clip on core cover.
2. Disconnect cable pigtail from temperature cam.
3. Remove instrument panel center finish panel by carefully prying it out of four retaining slots in instrument panel. Then, rotate panel slightly upward to slide top retainer out slot in panel.
4. Remove four control assembly attaching screws.
5. Move control assembly away from instrument panel and disengage cable snap-in flag retainer from the control.
6. Rotate control approximately 180 degrees to disengage temperature cable from arm.
7. Pull temperature cable out through control assembly opening.

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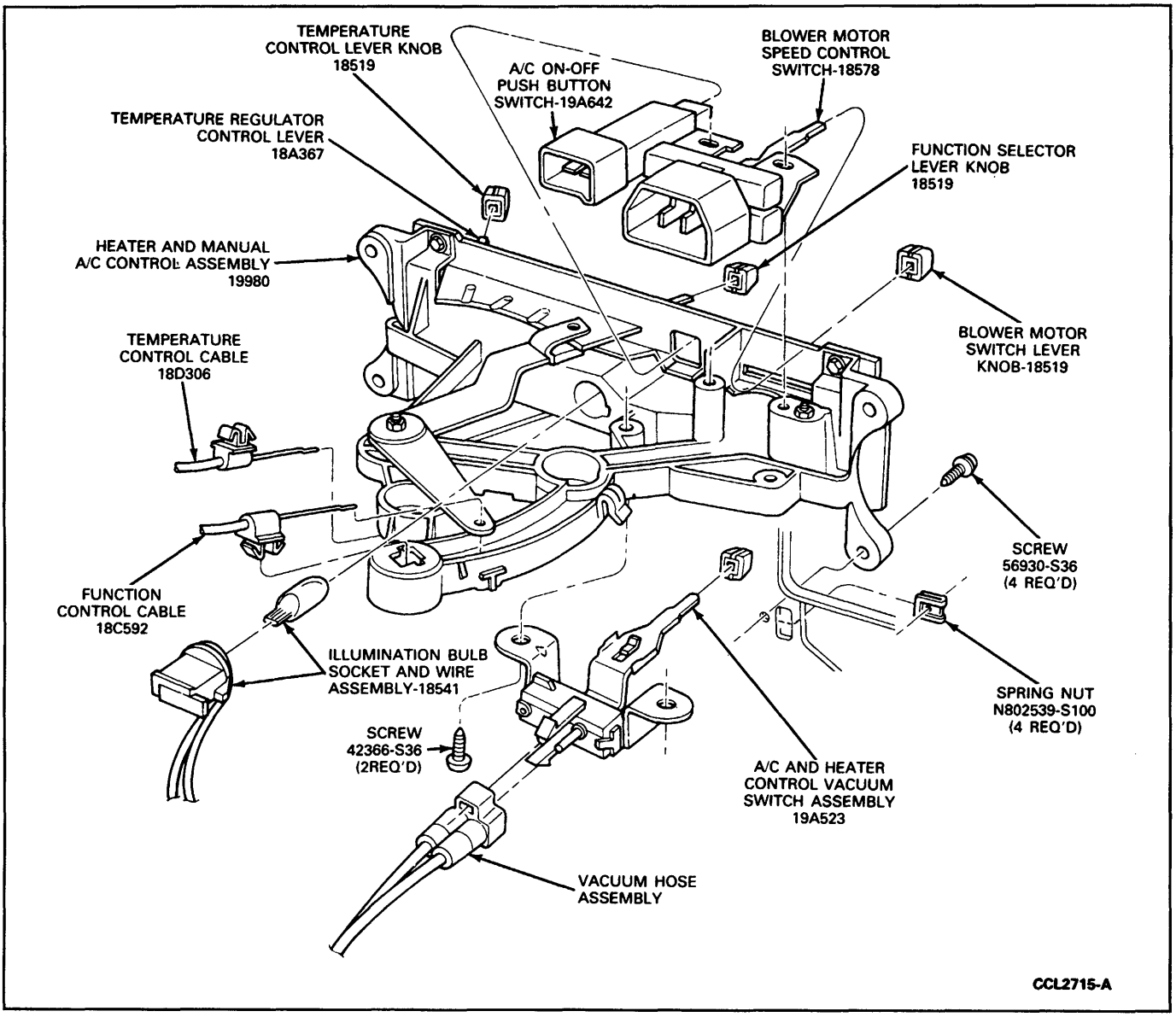


FIG. 24 Manual A/C-Heater Control Assembly Removal (Disassembled View)

Installation

1. Install temperature cable end into control lever. Then, press snap-in flag into cutout in control lever frame.
2. Position control assembly in panel opening and simultaneously feed pigtail end of cable through plenum until it can be reached through glove compartment opening.
3. Install pigtail over pin on cam and secure cable to its clip on core cover.
4. Move control assembly away from instrument panel. Attach end of cable to lever and snap-in flag retainer to cutout in control assembly.
5. Install control assembly.
6. Check cable travel and adjust, if necessary, as outlined.
7. Install instrument panel center finish panel.
8. Install glove compartment.

Instrument Panel

Removal

1. Disconnect battery ground cable.
2. Working beneath instrument panel, remove nut and washer assembly attaching panel to brake and clutch pedal support (Fig. 25).
3. Remove bolt attaching instrument panel to panel dash brace.
4. Remove four quick operating quarter turn pins securing instrument panel steering column opening cover assembly to underside of instrument panel. Remove cover.
5. Remove screw and washer assembly, located in lower outer corner on each side of instrument panel, securing panel to cowl side panel.
6. Disconnect connectors from main wiring harness (14401) to: (1) the blower ON-OFF switch and lever assembly, (2) to A/C control switch and

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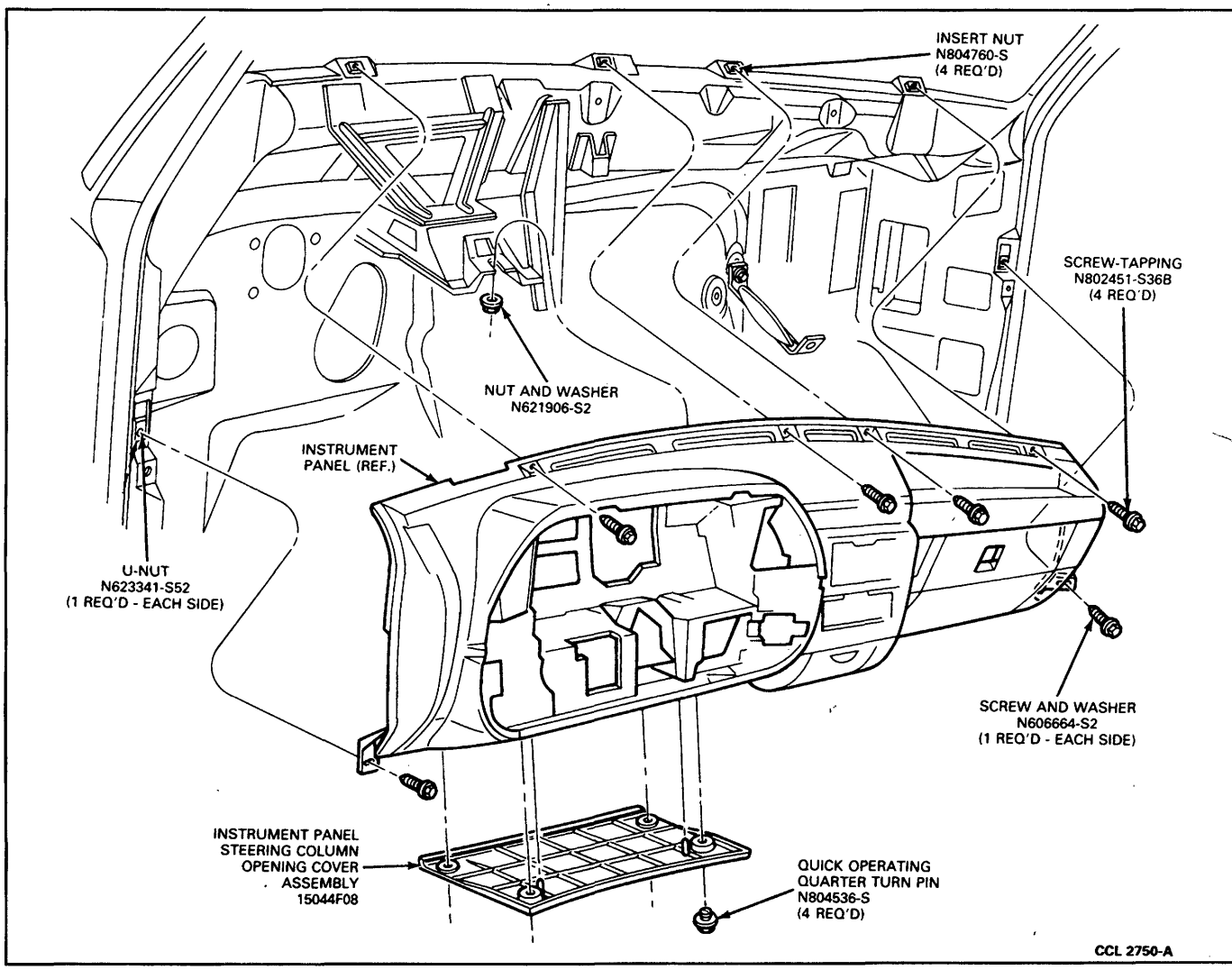


FIG. 25 Instrument Panel

pushbutton assembly, and (3) the control assembly illumination bulb.

7. Disconnect hoses from vacuum valve which is operated by the outside air control lever.
8. Disconnect function and temperature control cables from control assembly as outlined.
9. Remove tapping screws securing upper, leading edge of instrument panel to top of dash panel at four locations.
10. Lift instrument panel assembly upward and over steering column and wheel.

Installation

1. Position instrument panel so that four holes near forward edge of panel align with mating holes near upper edge of dash panel.

NOTE: The self-tapping screws used to attach the panel at these four locations turn into insert nuts in the dash panel. If any of these nuts (part number 804670-S) are damaged, they should be replaced.

2. Connect function and temperature control cables to respective levers in control assembly as outlined.
3. Connect vacuum hoses to vacuum valve in control assembly.
4. Connect wiring connector for blower ON-OFF switch, A/C control switch, and control assembly illumination bulb.
5. Attach lower, outer corners of instrument panel to cowl side panel.
6. Install instrument panel steering column opening cover on instrument panel.
7. Install bolt attaching instrument panel to dash panel brace.
8. Install nut and washer assembly attaching instrument panel to brake and clutch pedal support.
9. Connect battery ground cable.

Instrument Cluster Opening Finish Panels and Center Finish Panel

There are four finish panels which attach to the instrument panel (Fig. 26). They are:

- An instrument cluster opening upper finish panel assembly.

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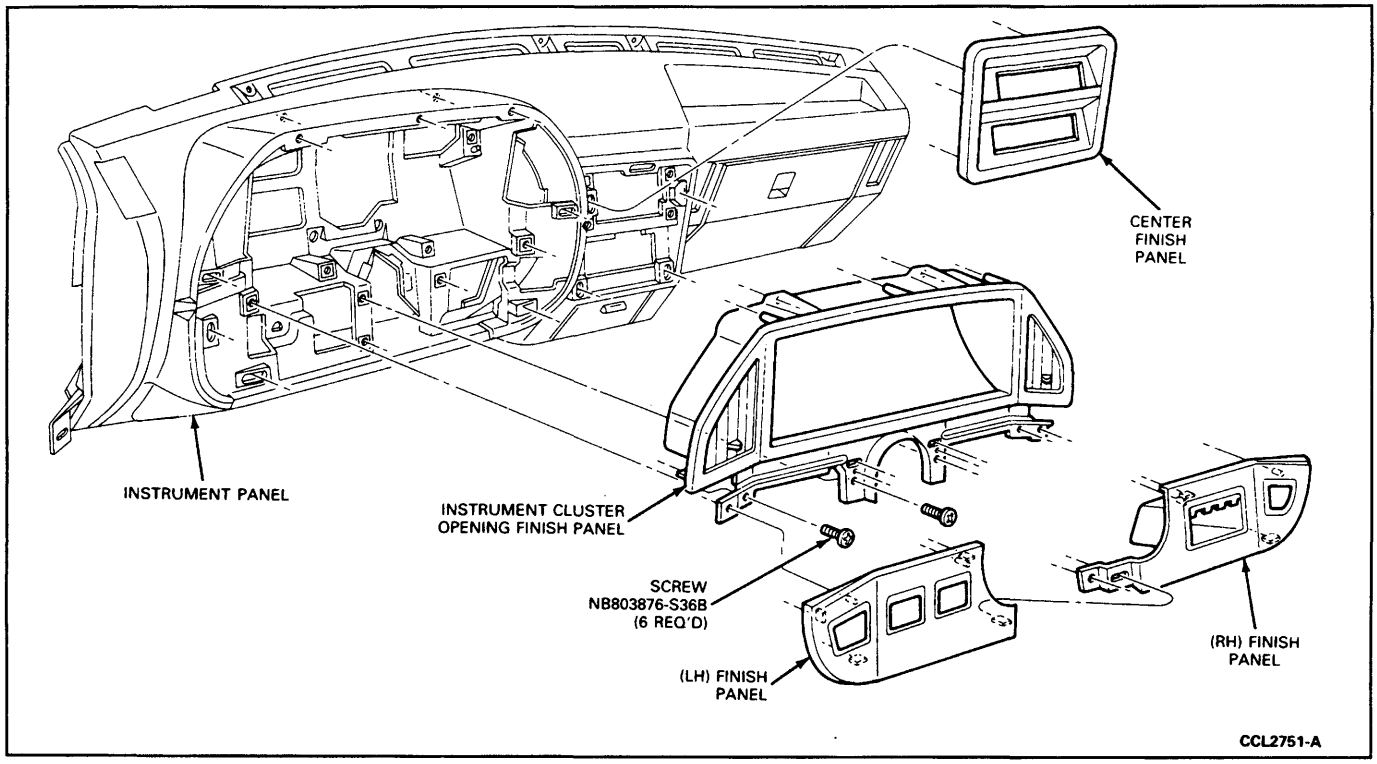


FIG. 26 Instrument Panel Finish Panels

- An instrument cluster finish panel assembly which attaches on the RH side of the steering column opening.
- An instrument cluster finish panel assembly which attaches on the LH side of the steering column opening.
- An instrument center finish panel assembly.

Cluster Opening Finish Panels

Removal

1. Remove six screws attaching upper cluster opening finish panel to instrument panel.
2. Pull panel rearward to release two mounting tabs on forward side of finish panel from retaining slots in instrument panel.
3. Remove finish panel.
4. Disconnect one screw securing RH lower finish panel to instrument panel.
5. Pull finish panel rearward to release locating pin and two tangs from respective hole and slots in instrument panel.
6. Remove finish panel.
7. Pull rearward on LH finish panel to release it from two locating pin holes and four slots in the instrument panel which match with attaching tang locations on finish panel.
8. Remove finish panel.

Installation

1. If all three finish panels have been removed, begin installation with upper cluster opening finish panel. Install six attaching screws.
2. Install RH finish panel by aligning it with locating pin hole and two attaching slots. Press finish panel into engagement with instrument panel.
3. Install one attaching screw for RH finish panel.
4. Install LH finish panel by aligning two pins and four attaching tangs with mating holes and slots in instrument panel. Press finish panel into engagement with instrument panel.

Center Finish Panel

Removal and Installation

The center finish panel attaches with tangs on the underside of the finish panel to slots in the instrument panel. To remove the finish panel, pull it rearward to disengage the tangs from the slots. To install, align the tangs with the slots and press them into engagement.

Defroster Nozzle

Removal

1. Remove instrument panel as outlined.
2. Remove defroster nozzle from underside of instrument panel by removing four attaching screws at top of instrument panel and one at defroster air inlet (Fig. 9).

Installation

1. Position defroster nozzle in underside of instrument panel and install four retaining screws.
2. Install instrument panel as outlined.

Demister Nozzles and Hoses

Removal and Installation

1. Remove instrument panel as outlined.

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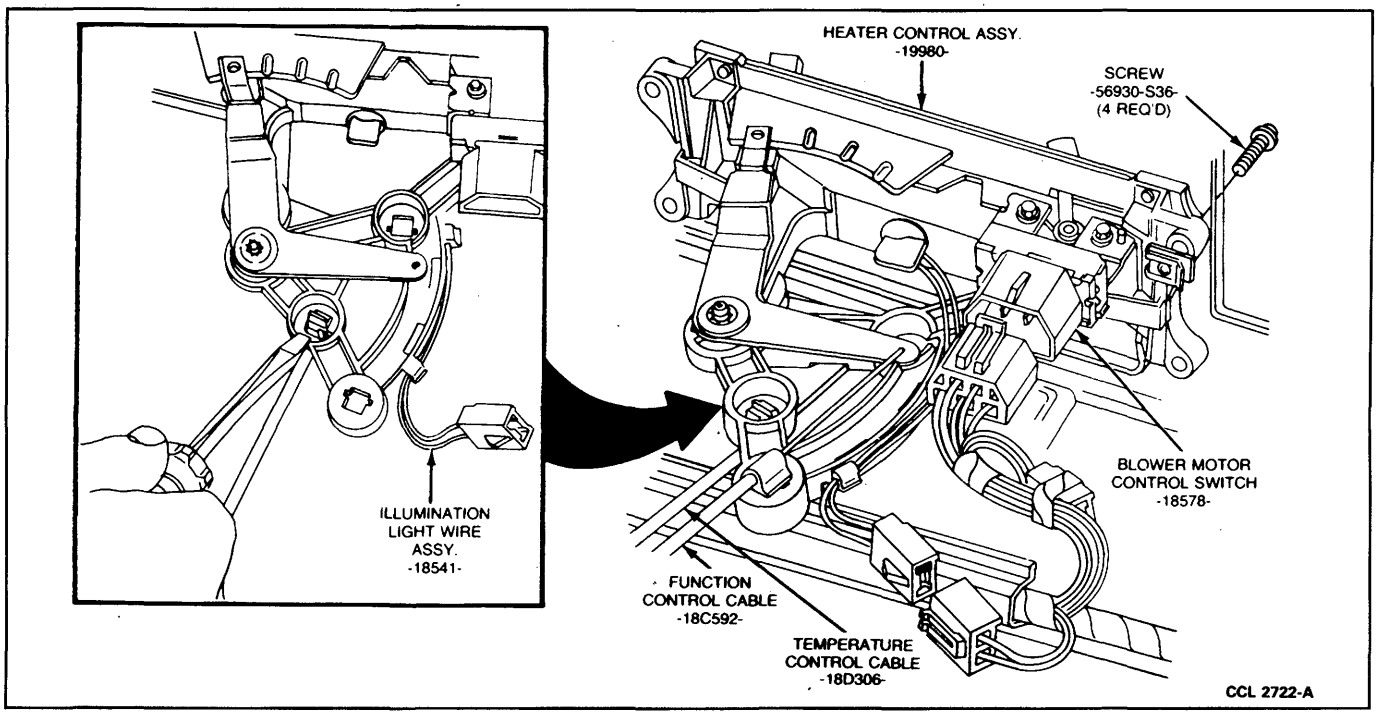


FIG. 27 Control Assembly Removal

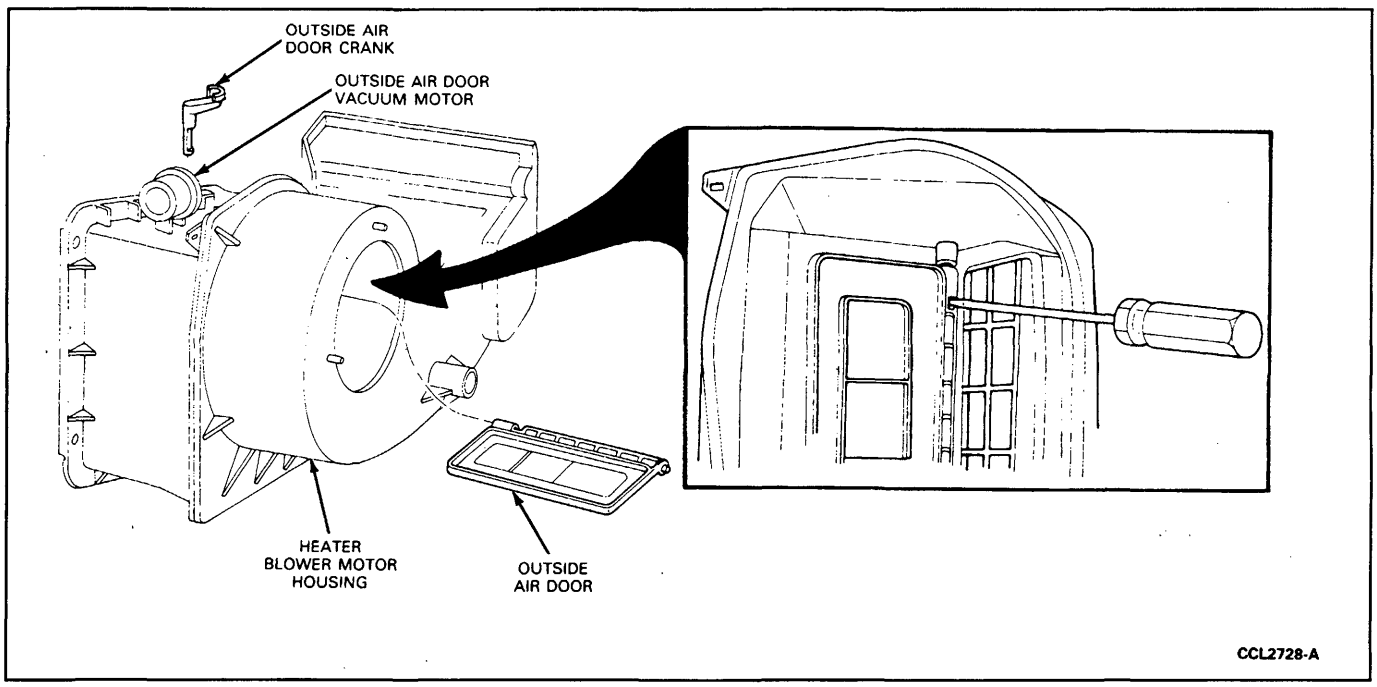


FIG. 28 Removing Outside Air Door Crank

2. Two attaching nuts secure RH and LH demister nozzle to instrument panel in opposite corners of panel. To remove either of these nozzles, remove two nuts and detach flexible hose which slides over input end of nozzle (Fig. 29).

3. A connector which slides over a slip joint opening on the center duct receives opposite ends of two demister hoses. The RH demister nozzle hose slides over a neck on upper surface of connector; LH demister nozzle hose slides over a neck on inboard surface of connector. To disconnect a hose, pull it off connector and/or demister nozzle.

4. To install nozzles, hoses, and/or connector, install two attaching nuts for each nozzle and slide demister hoses over attaching location on applicable hose(s).

5. Install instrument panel as outlined.

Plenum

Removal

1. Disconnect ground from battery negative terminal.

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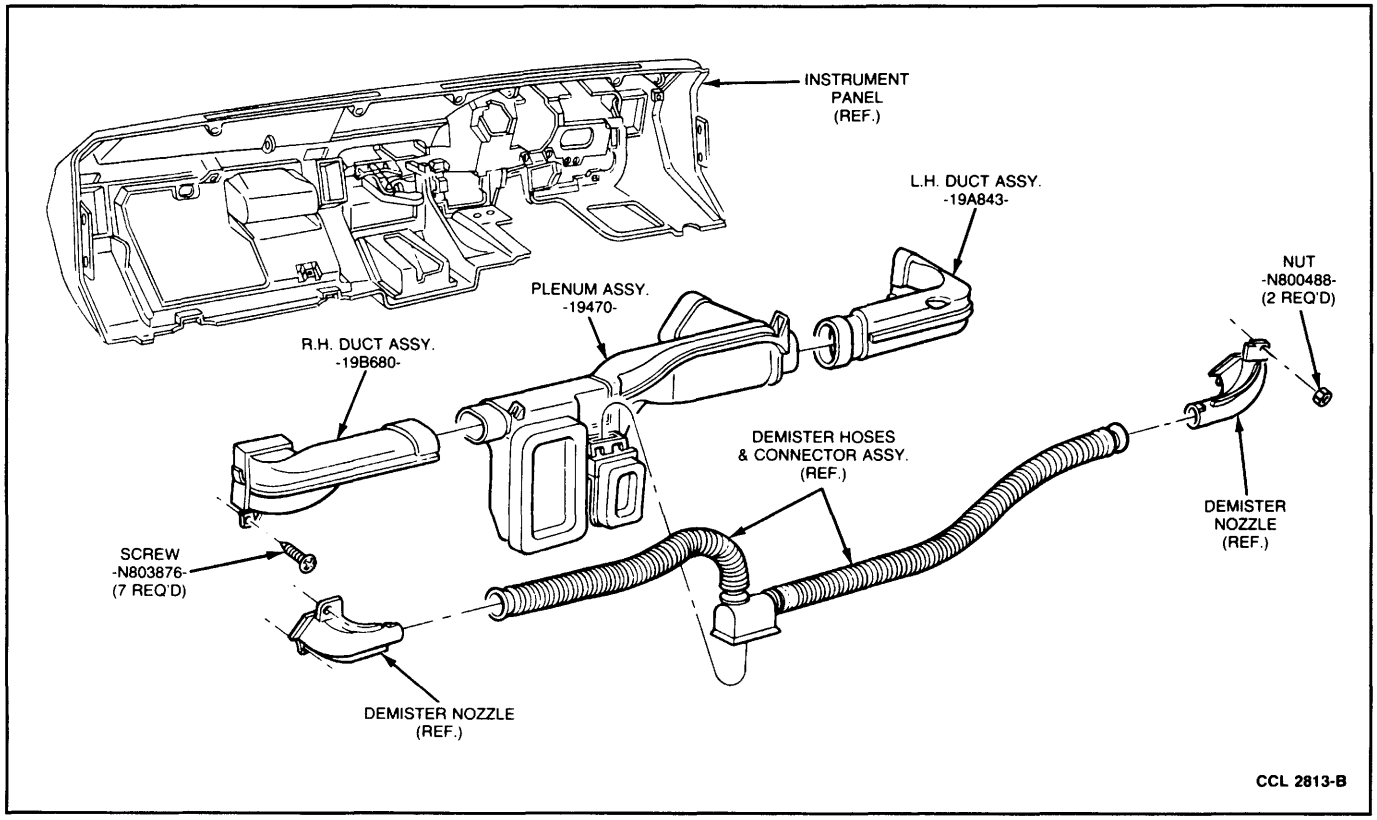


FIG. 29 Register Duct Removal

2. Disconnect instrument panel assembly from dash brace, brake and clutch pedal support, and dash panel as outlined.
3. Remove heater core hoses from heater core tubes. Plug hoses with suitable plugs (15.87mm or 5/8 inch).
4. Remove one screw attaching LH end of plenum to dash panel.
5. Remove one screw attaching lower center area of plenum to dash panel.
6. Remove two nuts attaching evaporator case and plenum to dash panel.
7. Pull evaporator assembly away from dash panel pad and check for presence of an assembly aid washer. If one was used in production, cut and remove it from stud with side cutters and discard washer.
8. Place a protective cover over steering column and allow column to support detached instrument panel assembly.
9. Disconnect function and temperature cables and vacuum hose.
10. Disconnect wires from RH door courtesy lamp switch, if so equipped.
11. Disconnect antenna lead-in cable from attaching clip on plenum, if so equipped.
12. With instrument panel resting on steering column, pivot RH side rearward to provide any clearance needed to remove plenum. Disconnect any wires or cables which interfere with plenum removal.
13. Disconnect temperature door cable from plenum and remove plenum from vehicle.

Installation

1. Position plenum to dash panel and, working in the engine compartment, install two nuts to attach plenum and evaporator case to dash panel.
2. Connect function control cable.
3. Position instrument panel to dash panel. Connect all electrical connectors, vacuum lines, control cables, and hoses that were disconnected during removal.
4. Install one screw to attach each corner of instrument panel to cowl.
5. Connect temperature control cable to plenum.
6. Connect antenna cable to clip on plenum.
7. Connect courtesy lamp wires to RH door switch.
8. Complete installation of instrument panel assembly as outlined.
9. Install one screw to attach the plenum in lower, center area.
10. Install one screw to attach LH end of plenum to dash panel.
11. Remove the plugs and attach heater hoses to heater core tubes. Tighten hose clamps to 1.4-2.0 N·m (12-18 in-lb).
12. Connect ground cable to battery negative terminal.
13. Check system for proper operation.

Floor Duct

Removal and Installation

1. Remove two screws attaching floor duct to plenum. Remove floor duct (Fig. 34).

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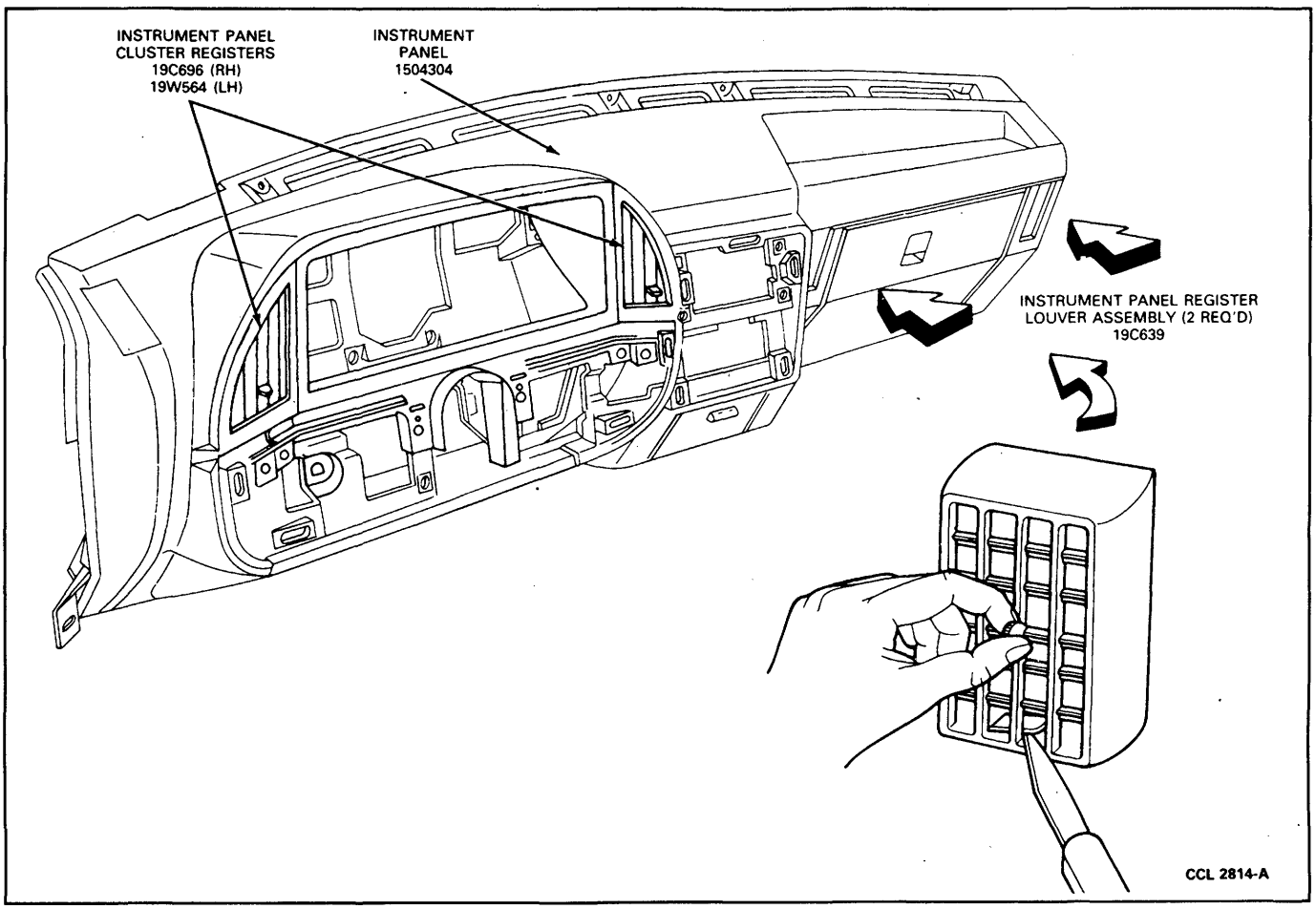


FIG. 30 Instrument Panel Register Louver Removal—Passenger Side

2. To install, position duct to plenum and install two attaching screws.

Heater Core

Removal

1. Disconnect heater hoses from heater core tubes and plug hoses with suitable 15.87mm (5/8 inch) plugs.
2. Remove glove compartment.
3. Disconnect temperature and function cables.
4. Remove seven screws attaching heater core cover to plenum and remove cover.
5. Remove heater core from plenum taking care not to spill coolant from core.

Installation

1. Install heater core in plenum.
2. Install seven heater core cover screws.
3. Install glove compartment.
4. Connect heater hoses to heater core. Tighten the hose clamps to 1.4-2.0 N·m (12-18 in-lb).
5. Fill and bleed cooling system. Refer to Section 27-02.
6. Check system for proper operation and for coolant leaks.

Register Ducts

Removal

1. Disconnect ground cable from battery negative terminal.
2. Remove instrument panel as outlined.
3. Rotate instrument panel rearward as far as necessary to permit removal of register ducts from panel.
4. Remove defroster nozzle.
5. Remove register duct attaching screws. Remove the duct (Fig. 29).

Installation

1. Position register ducts in instrument panel and install the attaching screws (Fig. 29).
2. Install defroster nozzle.
3. Rotate instrument panel forward and install as outlined.
4. Connect battery ground cable.

Register Louver Assembly

Passenger Side

Removal

1. Insert tool with thin blade under retaining tab (Fig. 30). Pry retaining tab toward louvers until retaining tab pivot clears hole in register opening.

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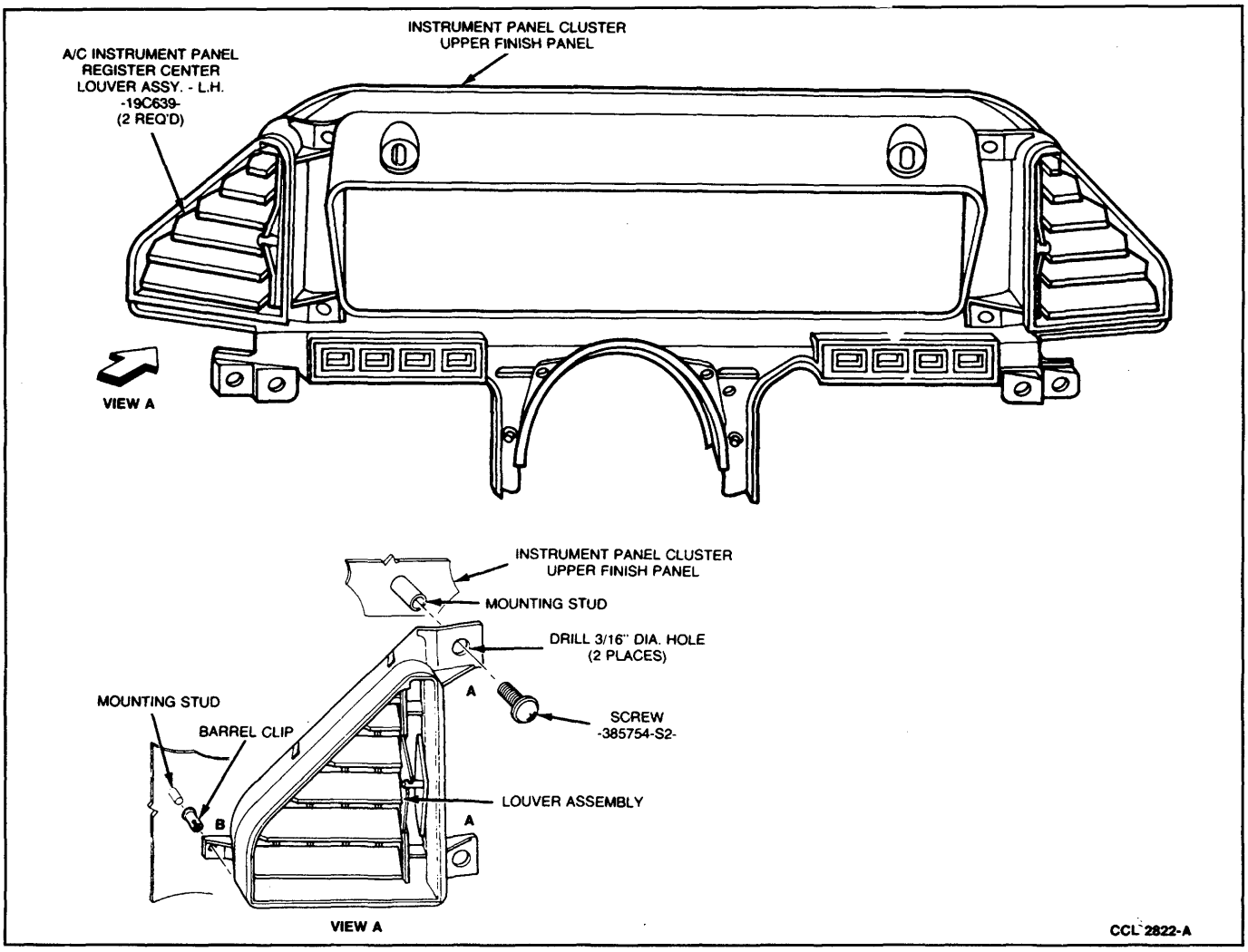


FIG. 31 Removal of Registers from Instrument Cluster Upper Finish Panel

2. Pull register louver assembly end out from housing only enough to prevent pivot from going back into pivot hole.
3. Repeat Step 1 for other retaining tab and pull register louver assembly from register opening.

Installation

NOTE: The pivots on each end of the register louver assembly are different diameters and therefore determine the installed position of the register louver assembly.

1. Position register louver assembly into opening with largest diameter pivot near largest pivot hole.
2. Depress retaining tabs and push register louver assembly into register opening. Then, engage retainer tab pivots in pivot holes.

Register Louver Assembly (Driver's Side Only)

Removal and Installation

1. Remove the right and left instrument panel cluster finish panels located on each side of the steering column.
2. Remove the instrument panel cluster opening upper finish panel.

NOTE: Procedures for Steps 1 and 2 have been provided earlier in this section of the manual under Instrument Panel.

3. Refer to Fig. 31.
4. If both louvers are being replaced, remove the staked-over finish panel material from the two stud locations on the backside of each panel which are called out as Point "A".
5. Remove the barrel clip from the stud located at the lower, outer corner of each register called out as Point "B".
6. Remove the louvers.
7. To install replacement louvers, drill a 3/16 inch diameter hole through the mounting studs from which staking was removed.
8. Seat the register tabs with barrel clips onto the studs at points B. Align the two inboard tabs with the new holes drilled in the bosses (Points A). Secure the assemblies with a No. 8-12x1/2 inch Type P Washer Head Screw (Part No. 385754) at two places (Points A) each louver, if both are being serviced.
9. Install the upper and two lower finish panels.

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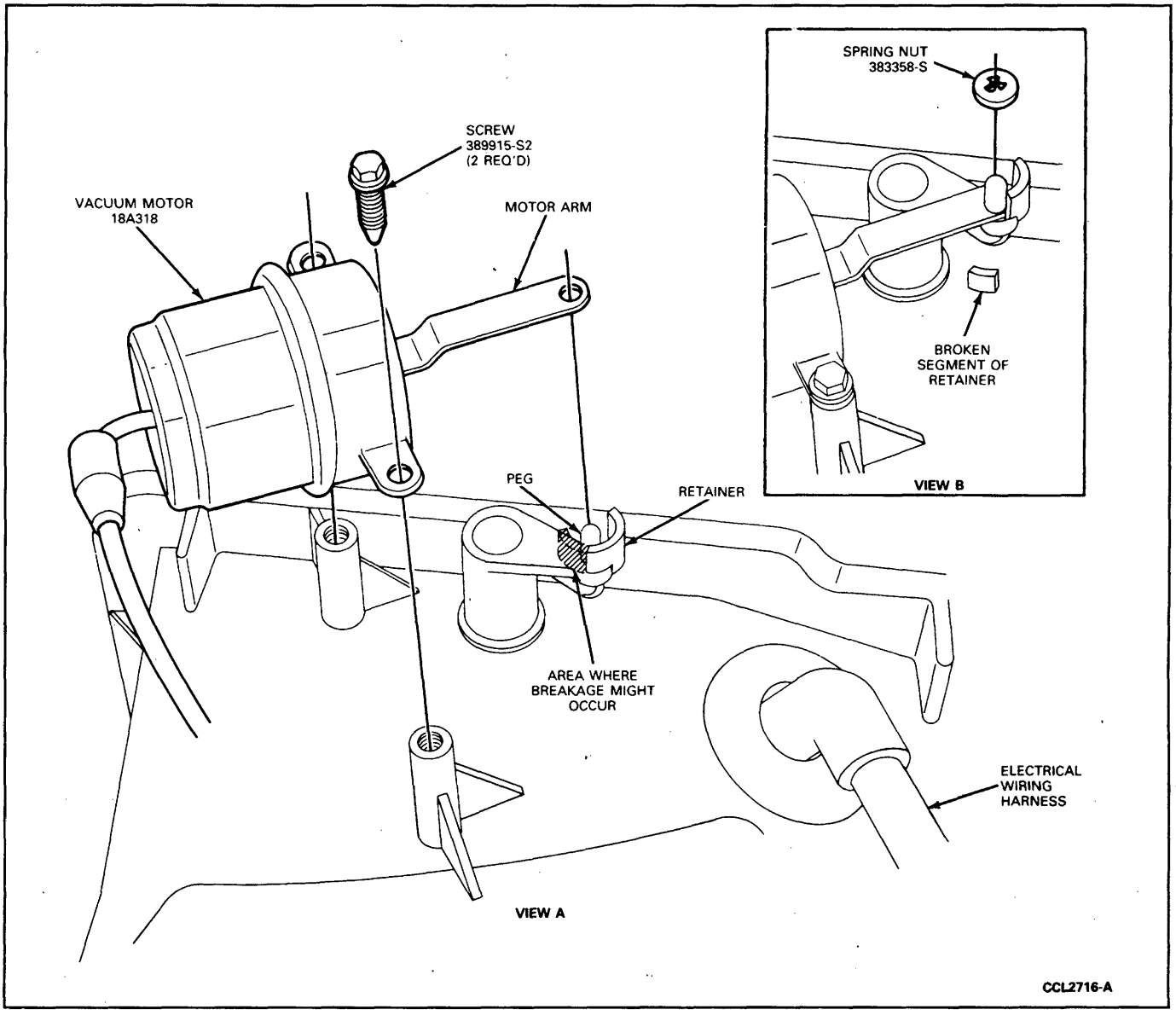


FIG. 32 Outside/Recirc Air Door Removal

Outside/Recirc Air Door, Vacuum Motor or Door Crank

Removal

1. Disconnect blower motor connector from harness.
2. Disconnect blower motor cooling tube.
3. Remove four screws attaching blower motor and wheel assembly to evaporator case.
4. Remove blower motor and wheel assembly.
5. Remove two screws with attaching vacuum motor through lugs to mounting bosses on top of outside/recirc air duct.
6. Disconnect vacuum line at vacuum motor.
7. Pry motor crank arm upward along mounting peg and retaining flange (Fig. 32, View A).

NOTE: If the retaining flange breaks off during disassembly, a 3/16 inch spring nut (part number 383358-S) must be installed over the mounting peg when the arm is being assembled over the peg (Fig. 32, View B).

8. Place door in recirc position.
9. Reaching through blower motor opening, use a screwdriver to depress portion of crank arm which extends below slotted opening in integral part of door mold which functions as a hinge (Fig. 28). Pull upward on crank until it frees upper end of door.
10. Lift upward on door to raise integral lower hinge pin out of hole in mounting boss. Then, remove door through blower motor opening.

Installation

1. Insert door through blower motor opening.
2. Position bottom, inner corner of the door so that lower mounting pin seats in hole in mounting boss.
3. Pivot top, inner corner of door so that hinge portion comes into alignment with crank hole in case.
4. Position door in recirc position.

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5. With vacuum motor attached to the crank, insert crank through duct and into door.
6. Insert the vacuum motor onto square mounting pin; then, attach motor assembly to duct with a screw through each of its two mounting lugs.
7. Attach blower motor and wheel assembly to evaporator with four screws.
8. Connect electrical connector.
9. Install blower motor cooling tube.

NOTE: Refer to Step 7 in the removal procedure if the crank arm retaining flange was broken.

Panel and Floor/Defrost Doors

If either the panel or floor/defrost door should become damaged or inoperative, the complete plenum must be replaced. There are no provisions for servicing either of these doors.

Evaporator Case

Removal

1. Discharge refrigerant system following the recommended service procedures. Refer to Section 36-30. Observe all safety precautions.
2. Disconnect vacuum supply hose at dash panel. Position check valve away from evaporator case.
3. Disconnect liquid line from evaporator core using a spring lock coupling removal tool (Fig. 33).
4. Disconnect suction line from accumulator. Cap all open refrigerant lines to prevent entrance of dirt and moisture.
5. Disconnect heater hoses from heater core and plug hoses with suitable 15.87mm (5/8 inch) plugs.
6. Working in passenger compartment, remove two screws or nuts attaching bottom of evaporator case to dash panel (Fig. 34). One screw also attaches lower edge of plenum to dash panel.
7. Unplug vacuum harness and two wiring connectors to wiring assembly (14401) located near RH end of plenum harness coming from recirc duct opening back into opening.
8. Remove two screws attaching RH side of recirc duct to dash panel (Fig. 34).
9. Remove two retaining nuts attaching evaporator case and recirc duct to dash panel (Fig. 34).
10. Pull evaporator case and recirc duct forward and remove it from vehicle.

Installation

1. Position recirc duct and evaporator case to dash panel. Install two retaining nuts along top edge of assembly (Fig. 34).
2. Install two screws along RH side of recirc duct (Fig. 34).
3. Working in passenger compartment, install top screws to attach bottom of evaporator case to dash panel (Fig. 34).
4. Connect vacuum harness from recirc duct opening to the dash panel.
5. Using a new O-ring lubricated with clean refrigerant oil, connect liquid line to evaporator core. Tighten connection to 21-27 N·m (15-20 ft-lb) using two wrenches.
6. Using a new O-ring lubricated with clean refrigerant oil, connect suction line to accumulator. Tighten connection to 34-44 N·m (28-33 ft-lb) using two wrenches.
7. Connect heater hoses to heater core. Tighten clamps only to 1.4-2.0 N·m (12-18 in-lb).
8. Connect vacuum harness and two wiring connectors to wiring assembly (14401) under instrument panel.
9. Fill and bleed cooling system. Refer to Section 27-02.
10. Leak test, evacuate and charge system following recommended procedures. Observe all safety precautions.
11. Check system for proper operation.
12. Refer to Section 36-30 for Evaporator Leak Test.

Evaporator Core

Removal

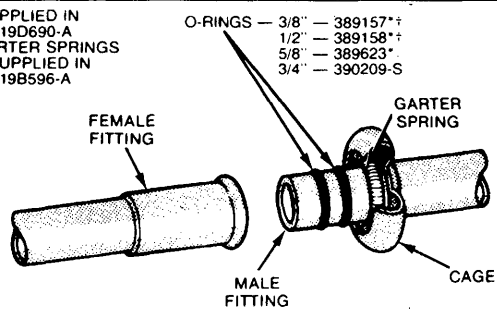
1. Discharge refrigerant system following recommended service procedures. Observe all safety precautions.
2. Disconnect electrical connector from pressure switch on side of suction accumulator.
3. Remove pressure switch from accumulator.
4. Disconnect suction hose from suction accumulator. Use a backup wrench to loosen fitting. Cap suction hose to prevent entry of dirt and excess moisture.
5. Using two wrenches, disconnect liquid line from evaporator core. Cap liquid line to prevent entry of dirt and excess moisture.
6. Working in passenger compartment, remove one screw attaching bottom of plenum to dash panel (Fig. 34).
7. Working under hood, remove one nut retaining upper LH corner of evaporator case to dash panel.
8. Remove six screws attaching LH evaporator housing to evaporator case.
9. Remove spring clip holding LH side of housing cover plate and LH evaporator housing together at dash panel.
10. Remove LH evaporator housing from evaporator case.
11. Remove evaporator core and suction accumulator from evaporator case.

Installation

1. Transfer suction accumulator support straps and spring nuts to the evaporator core.
2. Position evaporator housing to evaporator case. Install six screws to attach housing to one evaporator case along flange.
3. Install one spring clip to retain housing cover plate to LH edge of LH evaporator housing.
4. Install one nut to retain upper LH corner of housing to dash panel.
5. In passenger compartment, install one screw to attach lower edge of the plenum and bottom of the evaporator case to dash panel.

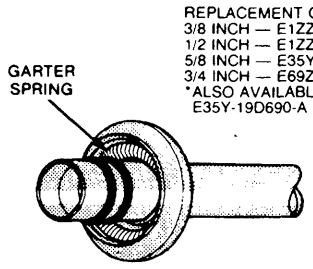
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*ALSO SUPPLIED IN KIT E35Y-19D690-A WITH GARTER SPRINGS
† ALSO SUPPLIED IN KIT E1ZZ-19B596-A



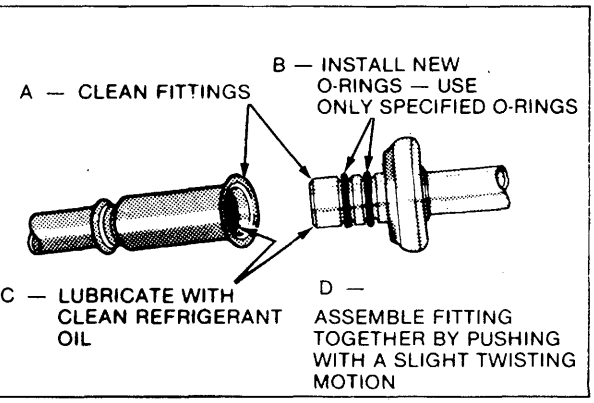
SPRING LOCK COUPLING DISCONNECTED

TO CONNECT COUPLING

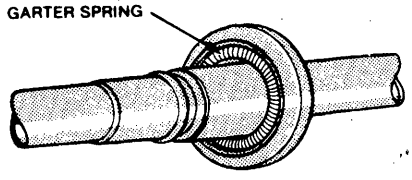


REPLACEMENT GARTER SPRINGS
3/8 INCH — E1ZZ-19E576-A*
1/2 INCH — E1ZZ-19E576-B*
5/8 INCH — E35Y-19E576-A*
3/4 INCH — E69Z-19E576-A
*ALSO AVAILABLE IN E35Y-19D690-A KIT WITH O-RINGS

1. CHECK FOR MISSING OR DAMAGED GARTER SPRING — REMOVE DAMAGED SPRING WITH SMALL HOOKED WIRE — INSTALL NEW SPRING IF DAMAGED OR MISSING.



2.

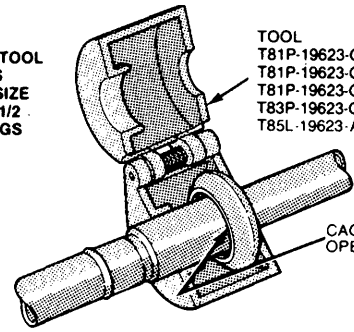


3. TO ENSURE COUPLING ENGAGEMENT, VISUALLY CHECK TO BE SURE GARTER SPRING IS OVER FLARED END OF FEMALE FITTING.

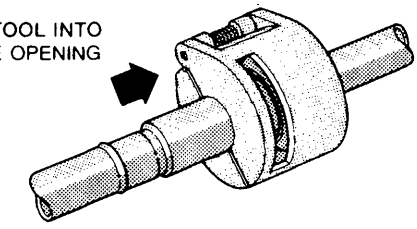
TO DISCONNECT COUPLING

CAUTION — DISCHARGE SYSTEM BEFORE DISCONNECTING COUPLING

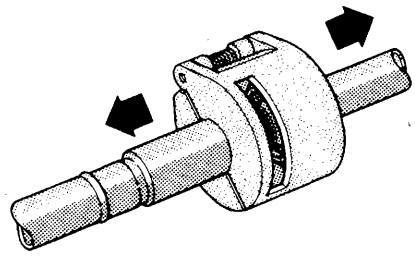
NOTE: EACH END OF TOOL T81P-19623-G IS A DIFFERENT SIZE TO FIT 3/8 and 1/2 INCH COUPLINGS



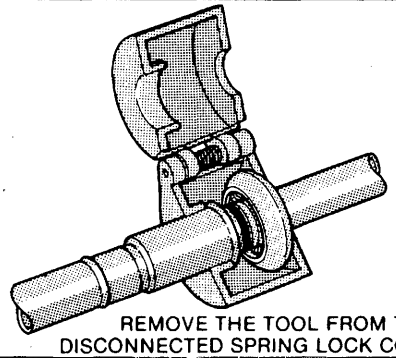
1. FIT TOOL TO COUPLING SO THAT TOOL CAN ENTER CAGE OPENING TO RELEASE THE GARTER SPRING.



2. PUSH THE TOOL INTO THE CAGE OPENING TO RELEASE THE FEMALE FITTING FROM THE GARTER SPRING.



3. PULL THE COUPLING MALE AND FEMALE FITTINGS APART.



4. REMOVE THE TOOL FROM THE DISCONNECTED SPRING LOCK COUPLING.

CCL 1925-E

FIG. 33 Spring Lock Coupling Tools

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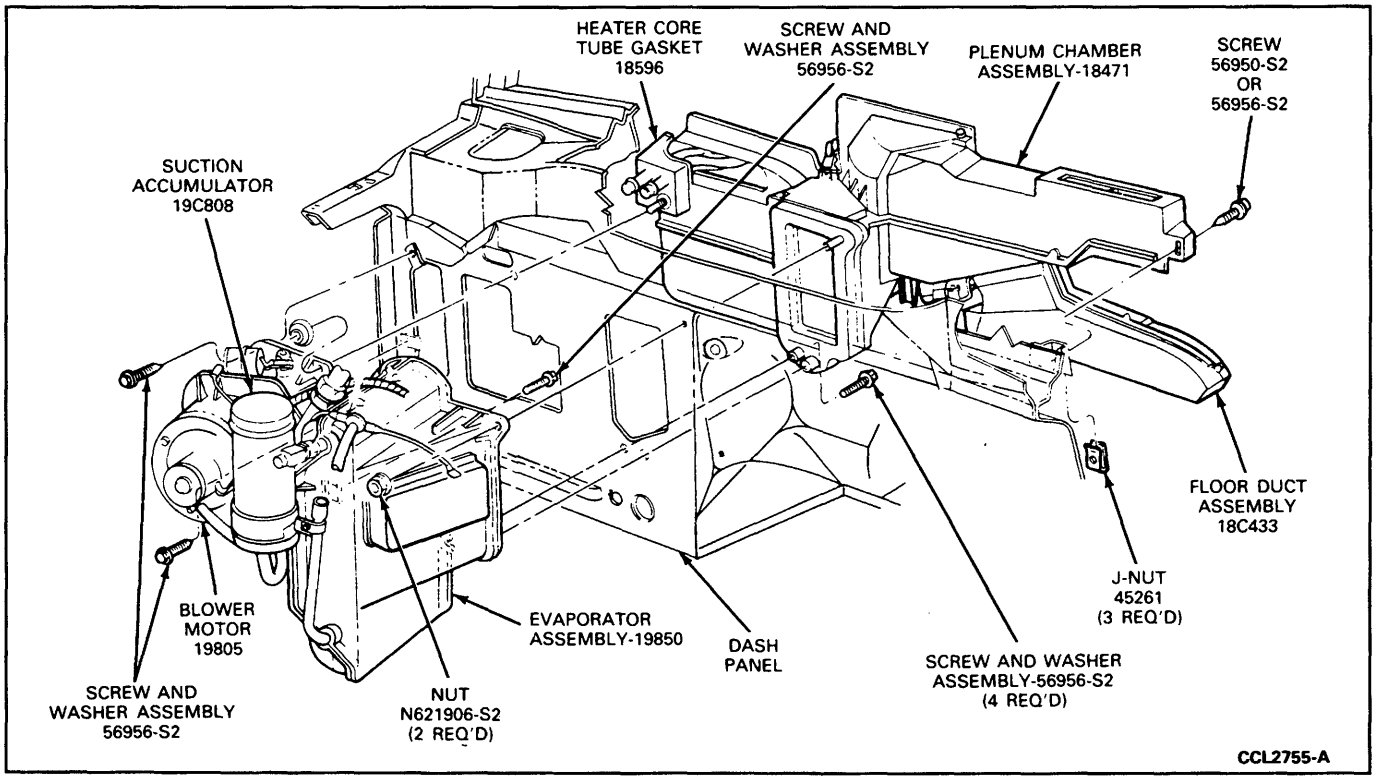


FIG. 34 Evaporator and Plenum Assembly Removal

6. Remove cap from evaporator core liquid line connection and install a new fixed orifice tube in the evaporator core tube as outlined.
7. Using a new O-ring lubricated with clean refrigerant oil, connect liquid line to evaporator core. Tighten connection to 21-27 N·m (15-20 ft-lb) using two wrenches.
8. Add 88.7ml (3 ounces) of clean refrigerant oil to a new suction accumulator to compensate for oil lost in evaporator core replacement.
9. Using a new O-ring lubricated with clean refrigerant oil, connect suction accumulator to evaporator core.
10. Install suction accumulator support straps (two screws). Tighten accumulator-to-evaporator core fitting to 21-27 N·m (15-20 ft-lb). Use a backup wrench on accumulator to prevent component damage.
11. Using a new O-ring lubricated with clean refrigerant oil, connect suction hose to suction accumulator. Use a backup wrench to prevent component damage.
12. Using a new O-ring lubricated with clean refrigerant oil, install pressure switch on suction accumulator nipple.
13. Connect electrical connector to pressure switch.
14. Leak test, evacuate and charge system following recommended procedures. Observe all safety precautions.
15. Check system for proper operation.

Blower Motor Resistor

Removal and Installation

1. Disconnect wire connector from resistor assembly (Fig. 6).
2. Remove two screws attaching resistor assembly to evaporator case and remove resistor.
3. To install, apply a bead of sealer D9AZ-19560-A or equivalent around the resistor mounting board.
4. Position resistor to opening in evaporator case, and install two attaching screws.
5. Connect wire connector to resistor assembly.
6. Check blower motor for proper operation in all blower speeds.

Blower Motor and/or Wheel

Removal

1. Disconnect motor connector.
2. Disconnect blower motor air cooling tube from motor.
3. Remove four blower motor mounting plate attaching screws and remove motor and wheel assembly from blower housing.
4. Remove hub clamp spring from blower wheel hub and remove blower wheel from motor shaft.

Installation

1. Position blower wheel on blower motor shaft. Then, install a new hub clamp spring on blower hub. NOTE: The hub clamp spring (Part No. 384260-S32) is included with a new blower wheel, but not with blower motor.

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2. Install a new motor mounting seal on blower motor flange.
3. Position blower motor and wheel assembly in blower housing and install four attaching screws.
4. Cement blower motor air tube on nipple of blower housing with Liquid Butyl Sealer D9AZ-19554-A or equivalent.
5. Connect blower motor connector.
6. Check blower motor for proper operation.

Fixed Orifice Tube

The fixed orifice tube is constructed with a plastic body, two screens, and a small brass tube down the center of the orifice body (Fig. 35). Two O-rings are around the orifice tube body to seal against leakage.

CAUTION: DO NOT attempt to remove the fixed orifice tube with pliers or to twist or rotate the orifice tube in the evaporator core tube. To do so will break the fixed orifice tube body in the evaporator core tube. USE ONLY the recommended tool following the recommended service procedures.

Removal

1. Discharge refrigerant from A/C system following recommended service procedures. Observe all safety precautions.
2. Disconnect liquid line from evaporator core using specified spring lock coupling tool. Cap liquid line to prevent entrance of dirt and excessive moisture.
3. Pour a small amount of clean refrigerant oil into evaporator core inlet tube to lubricate tube and orifice O-rings during removal of fixed orifice tube from evaporator core tube.
4. Engage the Orifice Tube Remover and Installer T83L-19990-A (Motorcraft YT-1008) or equivalent with the two tangs on the fixed orifice tube (Fig. 35).

CAUTION: Do not twist or rotate the fixed orifice tube in the evaporator core tube as it may break off in the evaporator core tube.

5. Hold T-handle of Orifice Tube Remover and Installer T83L-19990-A (Motorcraft YT-1008) or equivalent to keep it from turning, and run nut on tool down against evaporator core tube until orifice is pulled from tube.
6. If fixed orifice tube breaks in evaporator core tube, it must be removed from tube with Orifice Tube Extractor T83L-19990-B (Motorcraft YT-1009) or equivalent.
7. To remove a broken orifice tube, insert screw end of Orifice Tube Extractor T83L-19990-B (Motorcraft YT-1009) or equivalent into evaporator core tube. Thread screw end of tool into brass tube in center of fixed orifice tube. Pull fixed orifice tube from evaporator core tube.
8. If only brass center tube is removed during Step 7, insert screw end of the Orifice Tube Extractor T83L-19990-B (Motorcraft YT-1009) or equivalent into evaporator core tube and screw end of tool into fixed orifice tube body. Pull fixed orifice tube body from evaporator core tube.

Installation

1. Lubricate O-rings on fixed orifice tube body liberally with clean refrigerant oil.
2. Place fixed orifice tube in Orifice Tube Remover and Installer T83L-19990-A (Motorcraft YT-1008)

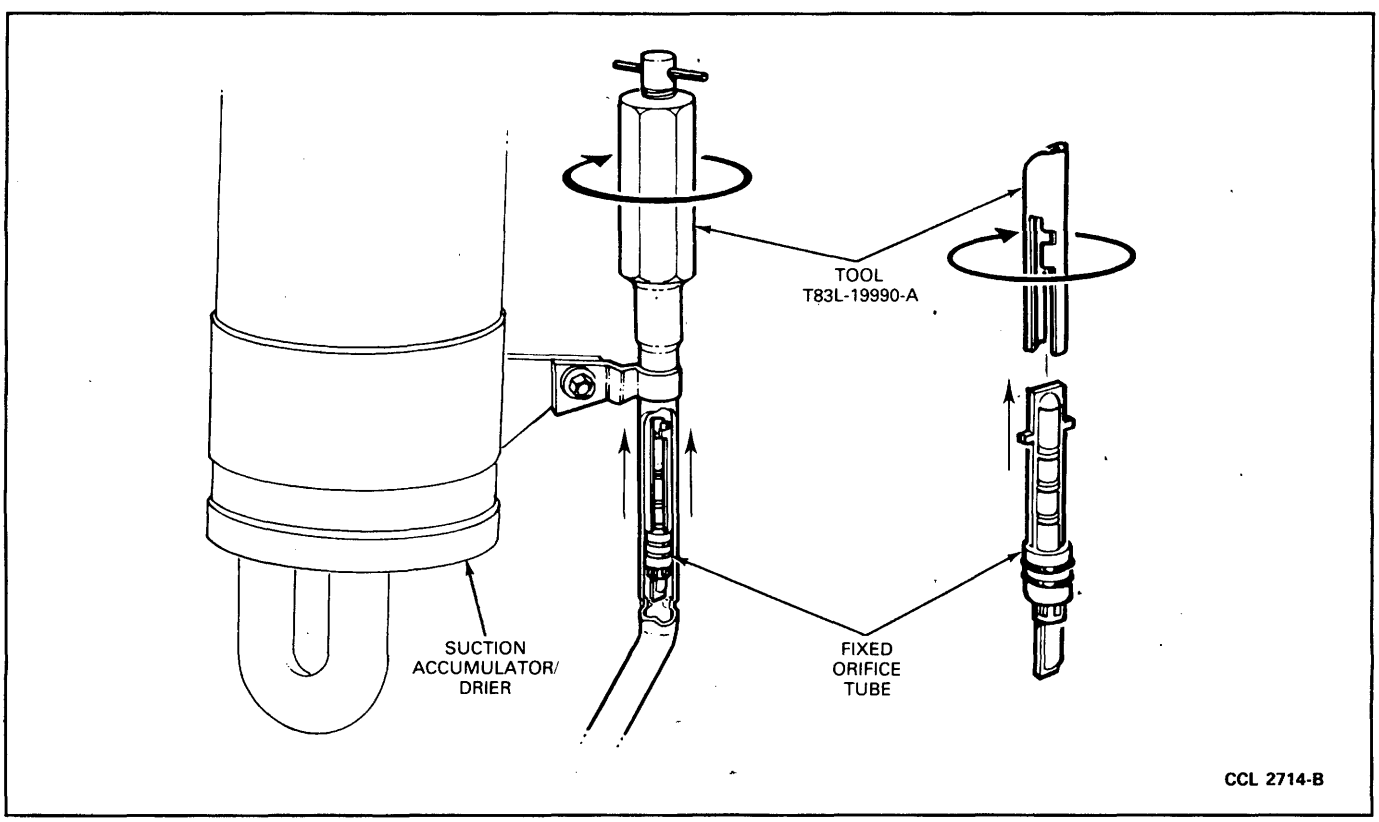


FIG. 35 Removal of Fixed Orifice Tube

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or equivalent, and insert fixed orifice tube into evaporator core tube until orifice is seated at stop.

3. Remove Orifice Tube Remover and Installer T83L-19990-A or equivalent from fixed orifice tube.
4. Using a new O-ring lubricated with clean refrigerant oil, connect liquid line to evaporator core tube. Tighten fitting to specifications using a backup wrench.
5. Leak test, evacuate and charge system following recommended service procedures. Observe all safety precautions.
6. Check system for proper operation.

Suction/Accumulator/Drier

Removal

1. Discharge refrigerant from A/C system following recommended service procedures. Observe all safety precautions.
2. Disconnect electrical connector from pressure switch (Fig. 20).
3. Remove pressure switch by unscrewing it from suction accumulator (Fig. 20).
4. Disconnect suction hose from suction accumulator/drier. Use two wrenches to prevent component damage. Cap suction hose to prevent entrance of dirt and moisture.
5. Loosen fitting connecting suction accumulator/drier to evaporator core. Use two wrenches to prevent component damage.
6. Remove two screws attaching suction accumulator/drier strap to evaporator case and clip to evaporator core inlet tube.

Installation

1. Using a new O-ring lubricated with clean refrigerant oil, connect suction accumulator/drier to evaporator core tube. Tighten connection finger-tight.

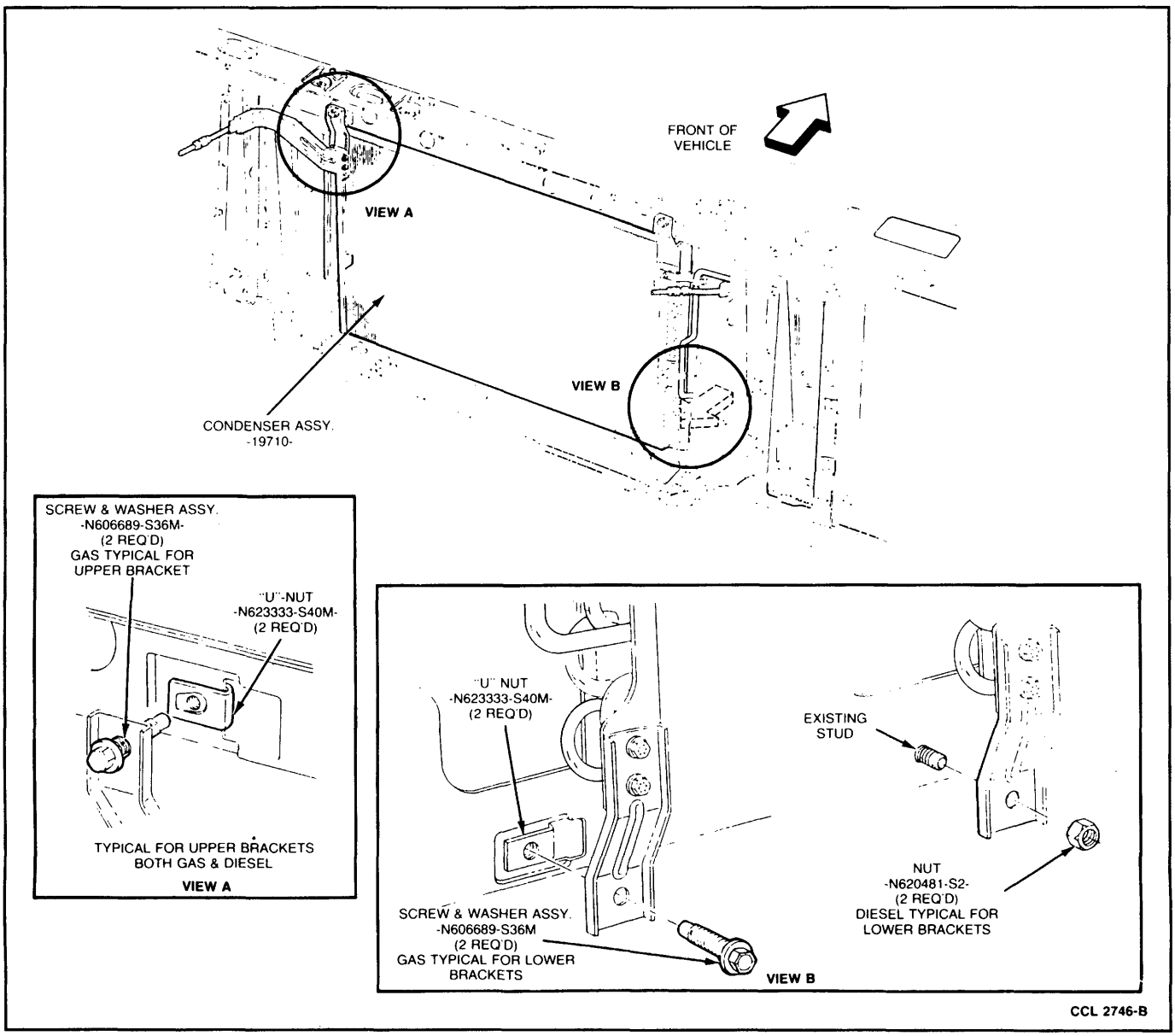


FIG. 36 Condenser Assembly

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2. Position strap on suction accumulator/drier to evaporator case and clip to evaporator core inlet tube. Align strap and clip with mounting bracket and install two attaching screws. Loosen connection of accumulator/drier to evaporator core if it is necessary to re-position accumulator/drier to install strap attaching screws.
3. Tighten suction accumulator/drier-to-evaporator core fitting to specification using two wrenches.
4. Using a new O-ring lubricated with clean refrigerant oil, connect suction hose to accumulator/drier. Use two wrenches and tighten connection to specification.
5. Install a new O-ring lubricated with clean refrigerant oil on pressure switch nipple of suction accumulator/drier. Install pressure switch. Tighten switch to 7-13 N·m (5-10 ft-lb) if switch has metal base and hand tighten only if switch has plastic base.
6. Connect electrical connector to pressure switch.
7. Leak test, evacuate and charge system following the recommended service procedures. Observe all safety precautions.
8. Check system for proper operation.

Clutch Cycling Pressure Switch

Removal

1. Disconnect wire connector from pressure switch.
2. Unscrew pressure switch from suction accumulator (Fig. 20).

NOTE: Do not vent refrigerant charge.

Installation

1. Install a new O-ring lubricated with clean refrigerant oil on accumulator nipple (Fig. 20).
2. Screw pressure switch on accumulator nipple hand tight only.
3. Connect wire connector to pressure switch.
4. Check system for proper operation.

Condenser

Removal

1. Discharge refrigerant from system following recommended service procedures. Observe all safety precautions.
2. Disconnect liquid line from condenser. Cap liquid line to prevent entrance of dirt and moisture.

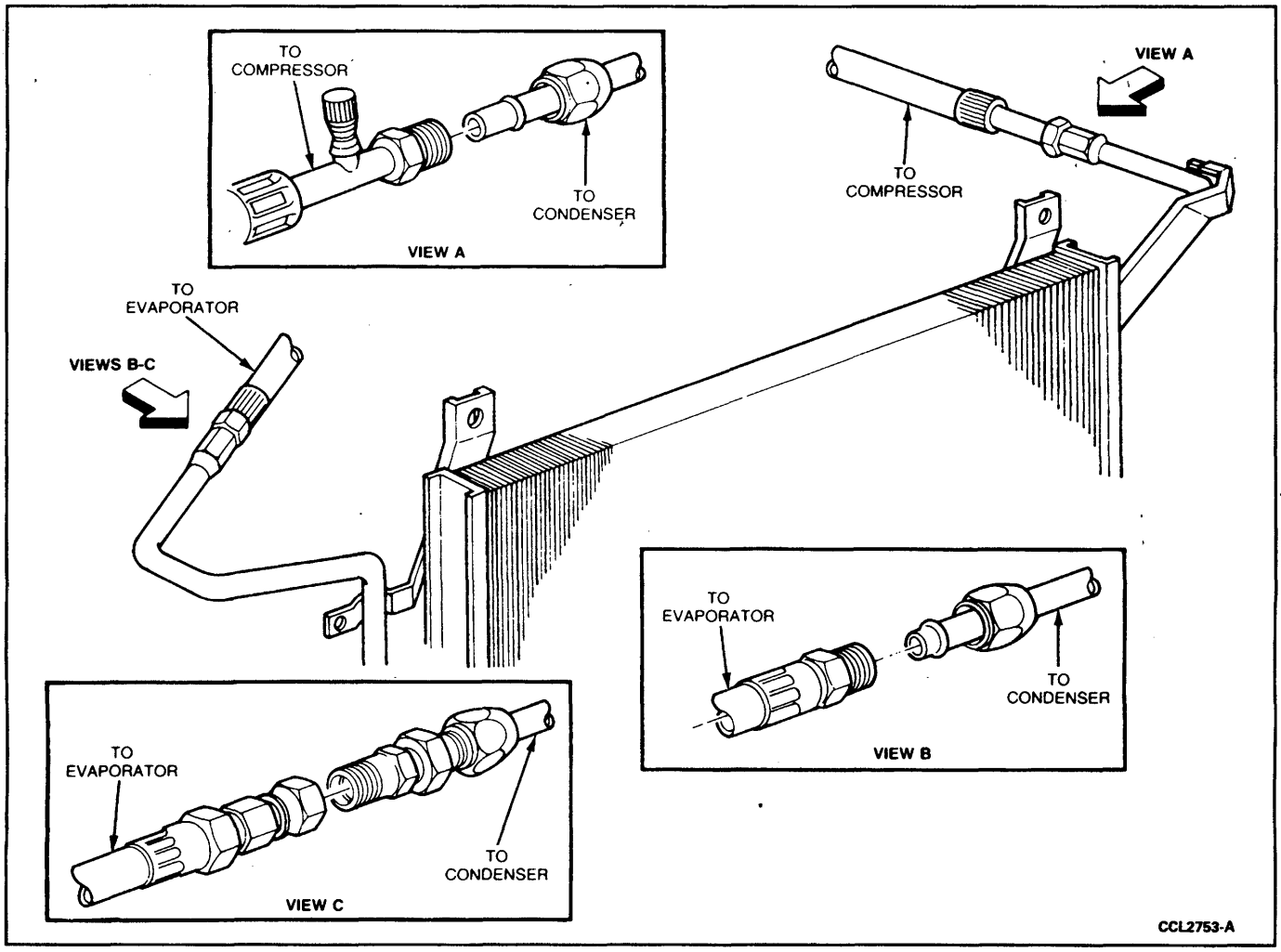


FIG. 37 Liquid Line-to-Condenser Installation

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3. Disconnect compressor discharge line from condenser. Cap discharge line to prevent entrance of dirt and moisture.
4. Partially drain radiator and disconnect upper hose from radiator.
5. Working under vehicle, remove two screws attaching two condenser lower mounting brackets to front radiator support (Fig. 36).
6. Remove bolts from radiator upper retaining brackets.
7. Tilt top of radiator rearward and remove two screws attaching two condenser upper mounting brackets to rear side of radiator support.
8. Lift condenser from vehicle.

Installation

1. Position condenser to vehicle with lower mounting brackets on front side of radiator support and upper brackets on rear side (Fig. 36).
2. Install four screws attaching four mounting brackets to radiator support. Tighten screws to 13.6 N·m (10-14 ft-lb).
3. Move radiator into correct installed position and install bolts to upper retaining brackets.
4. Connect radiator upper hose to radiator and fill cooling system to specified level.
5. Using a new O-ring lubricated with clean refrigerant oil, connect compressor discharge line to condenser. Tighten connection to 21-27 N·m (15-20 ft-lb).
6. If liquid line has a self-sealing coupling (used on vehicles with manual valves at compressor), remove self-sealing coupling half from old condenser and install it on new condenser. Use a new O-ring lubricated with clean refrigerant oil. Then, connect liquid line to condenser at self-sealing coupling and tighten connection to 9 N·m (7 ft-lb).
7. If liquid line does not use a self-sealing coupling (Fig. 37), (vehicles without manual valves at compressor), connect liquid line to condenser using a new O-ring lubricated with clean refrigerant oil. Tighten connection to 21-27 N·m (15-20 ft-lb).
8. Leak test, evacuate and charge system following recommended service procedures. Observe all safety precautions.
9. Check system for proper operation.
10. Refer to Section 36-30, Condenser Leak Test.

Refrigerant Lines

Figures 38 through 42 illustrate refrigerant line routing for each engine released for 1988 F-Series and Bronco vehicles. A typical procedure for removing and installing the lines is as follows:

1. Discharge refrigerant from system following recommended procedure. Observe all safety precautions.
2. Disconnect and remove refrigerant line using a wrench on each side of fitting.
3. If spring lock couplings are used, disconnect couplings as shown in Fig. 33. Use Spring Lock Coupling T81P-19623-G and/or T83P-19623-C or equivalent to disconnect the 12.7mm (1/2-inch) and the 15.87mm (5/8-inch) coupling.
4. Route new refrigerant line (with protective caps installed).

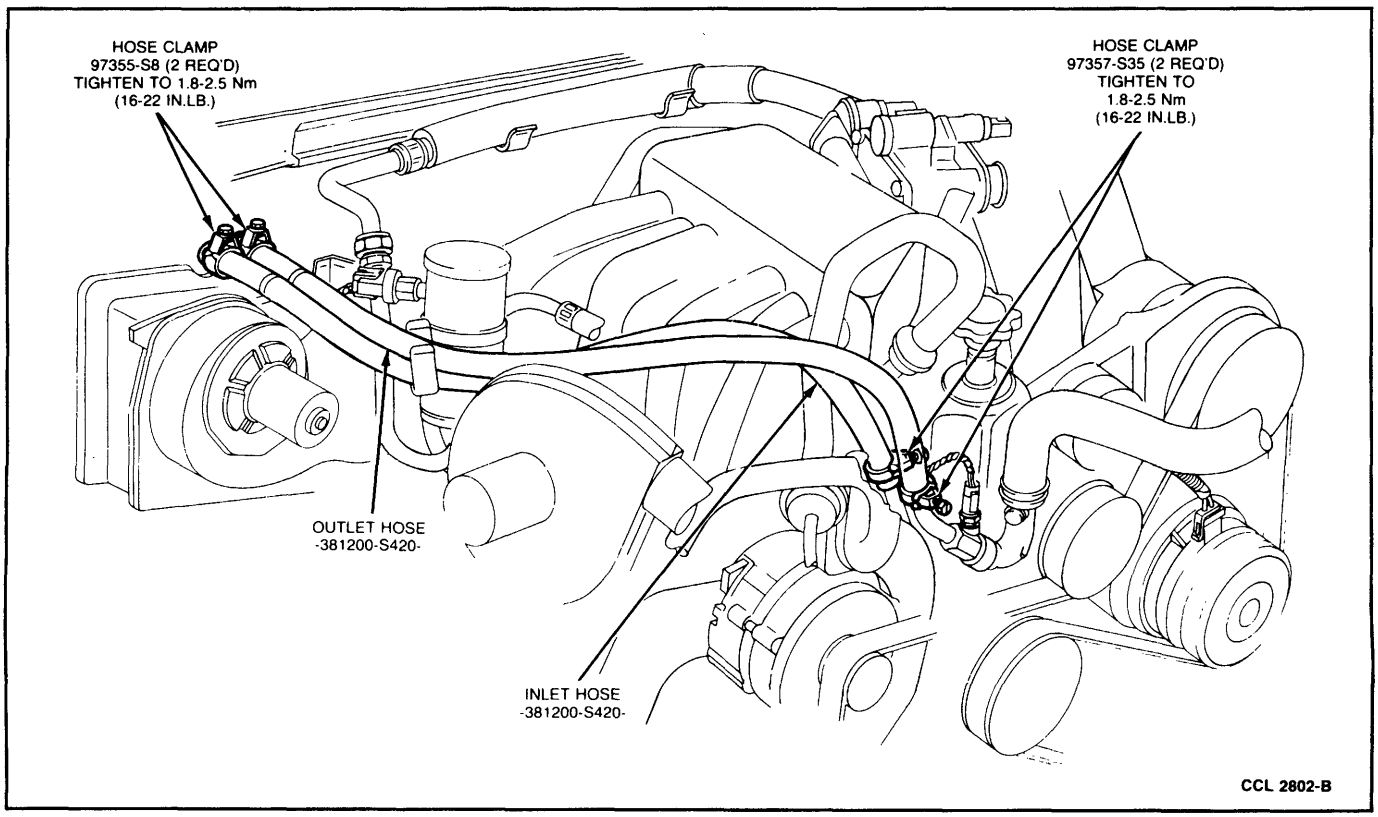


FIG. 38 Refrigerant Line Routing—4.9L (300 CID) EFI Engine

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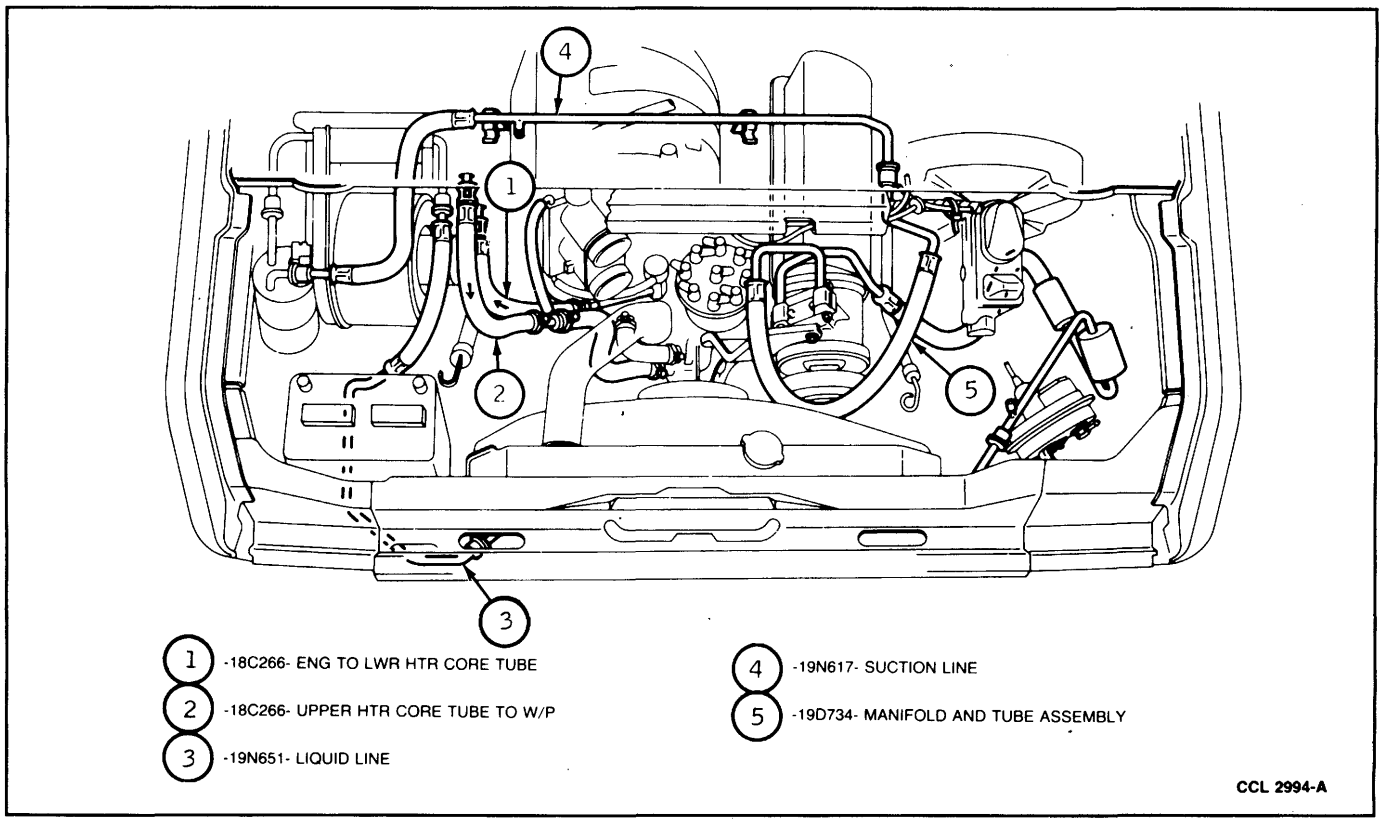


FIG. 39 Refrigerant Line Routing—5.0L (302 CID) EFI Engine

5. When replacing a liquid line, remove entire self-sealing coupling (Fig. 37) from condenser and discard coupling (vehicles with manual valves at compressor).
6. Connect refrigerant line into system using new O-rings lubricated with clean refrigerant oil. Tighten connections to 9 N·m (7 ft-lb) (self-sealing coupling) and 21-27 N·m (15-20 ft-lb) (non self-sealing coupling), using a backup wrench to prevent component damage.
7. Connect spring lock couplings as shown in Fig. 33. Use only specified O-rings.
8. Leak test, evacuate and charge refrigerant system following recommended procedures and safety precautions. Then, check system for proper operation.

Heater Hoses

Refer to Section 36-25 for details regarding the servicing of heater hoses on F-150—F-350 and Bronco vehicles.

1. Drain coolant from cooling system.
2. Loosen clamps and remove heater hose(s) from vehicle.
3. Cut a new length of heater hose to dimension of removed heater hose(s).
4. Route heater hose(s).
5. Connect heater hose to fittings and tighten clamps to 1.8-2.5 N·m (16-22 in-lb). DO NOT over-tighten hose clamps.
6. Fill and bleed cooling system. Refer to Section 27-02.
7. Check for coolant leaks and for proper operation of system.

Cross References

Compressor

Refer to Section 36-30 for compressor removal and installation procedures.

Compressor Clutch

Refer to Section 36-37 for compressor clutch removal and installation procedures.

Compressor Clutch Field Coil

Refer to Section 36-37 for compressor clutch field coil removal and installation procedures.

COMPRESSOR

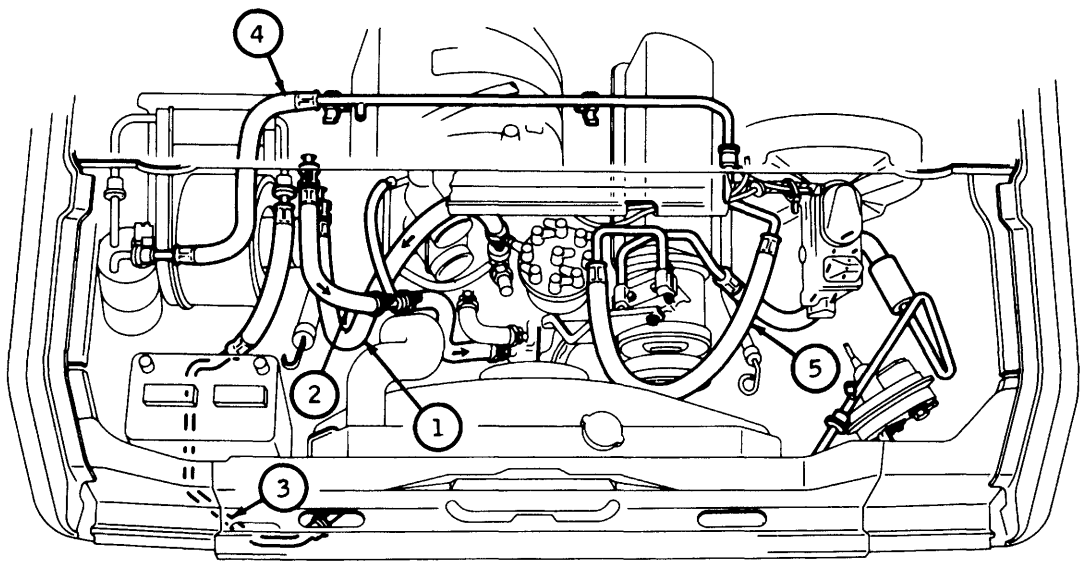
F-Series and Bronco vehicles will be equipped with one of the five engines specified for standard or optional applications. These engines are identified in the following chart.

Displacement (Liters)	Fuel System
4.9L	EFI
5.0L	EFI
5.8L	EFI
7.3L	Diesel
7.5L	EFI

CL5723-1A

Figures 43 through 46 illustrates the compressor installation for each of the engines in the chart.

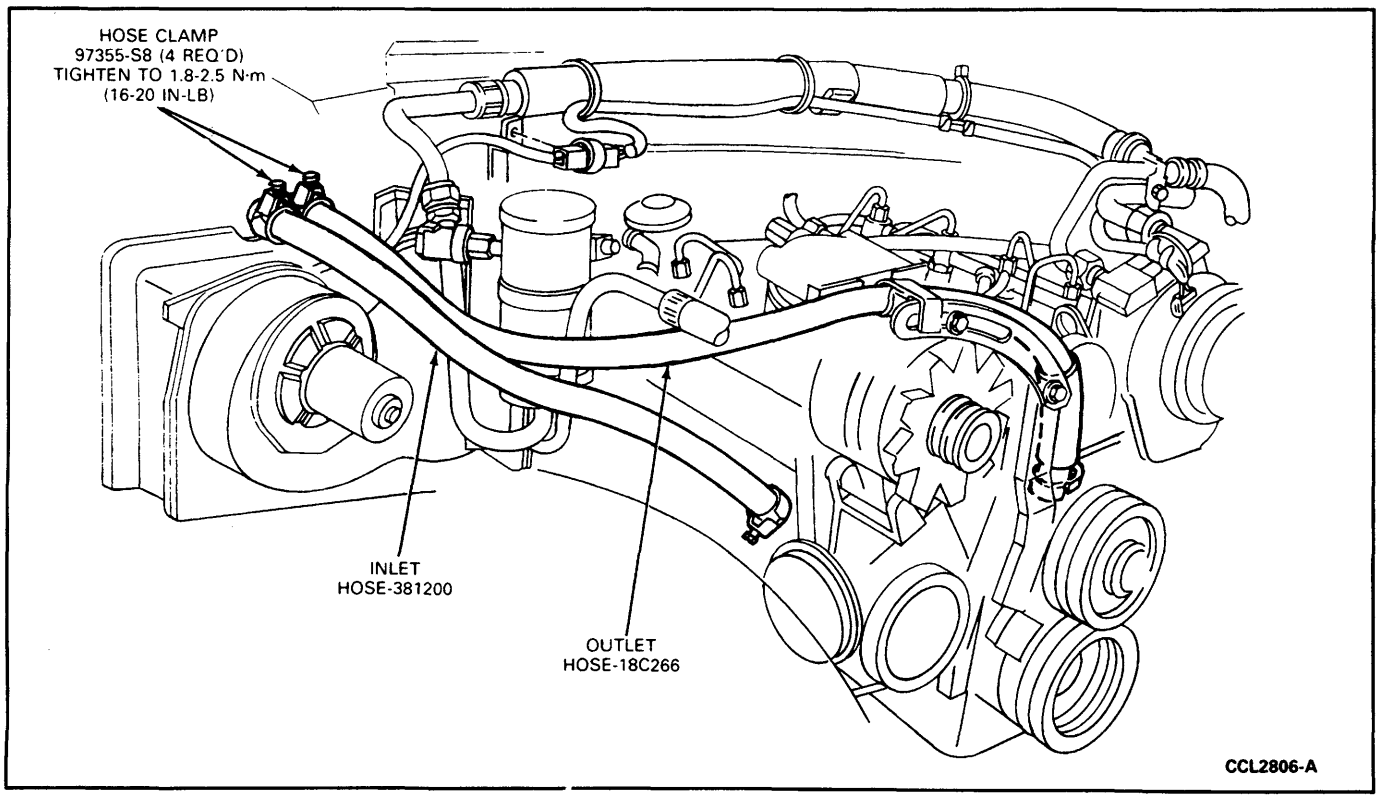
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1 -18C266- ENG TO LWR HTR CORE TUBE
2 -18C266- UPPER HTR CORE TUBE TO W/P
3 -19N651- LIQUID LINE
4 -19N617- SUCTION HOSE
5 -19D734- SUCTION HOSE MANIFOLD & TUBE ASSEMBLY

CCL 2995-A

FIG. 40 Refrigerant Line Routing—5.8L (351 CID) EFI Engine



CCL2806-A

FIG. 41 Refrigerant Line Routing—7.3L (447 CID) Diesel Engine

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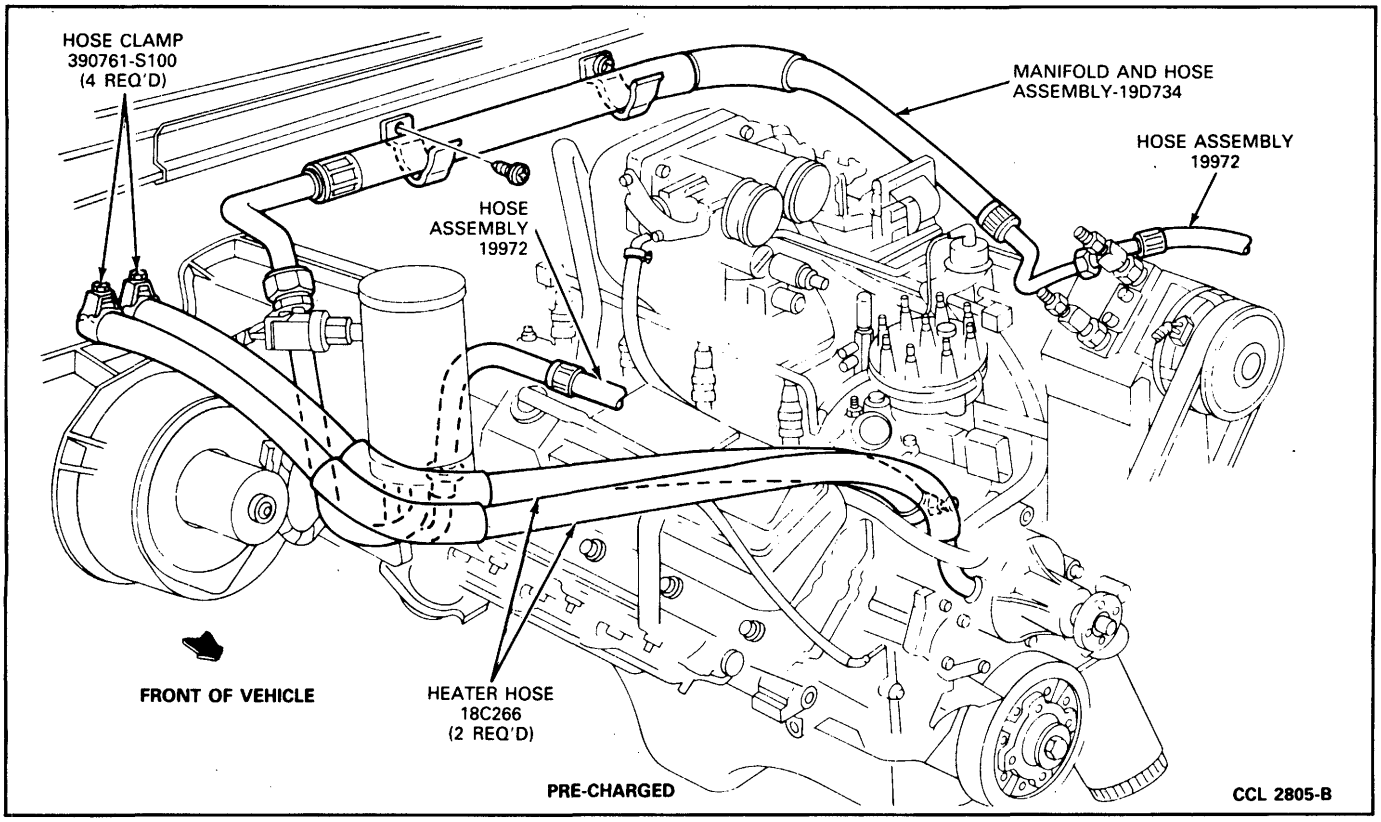


FIG. 42 Refrigerant Line Routing—7.5L (460 CID) EFI Engine

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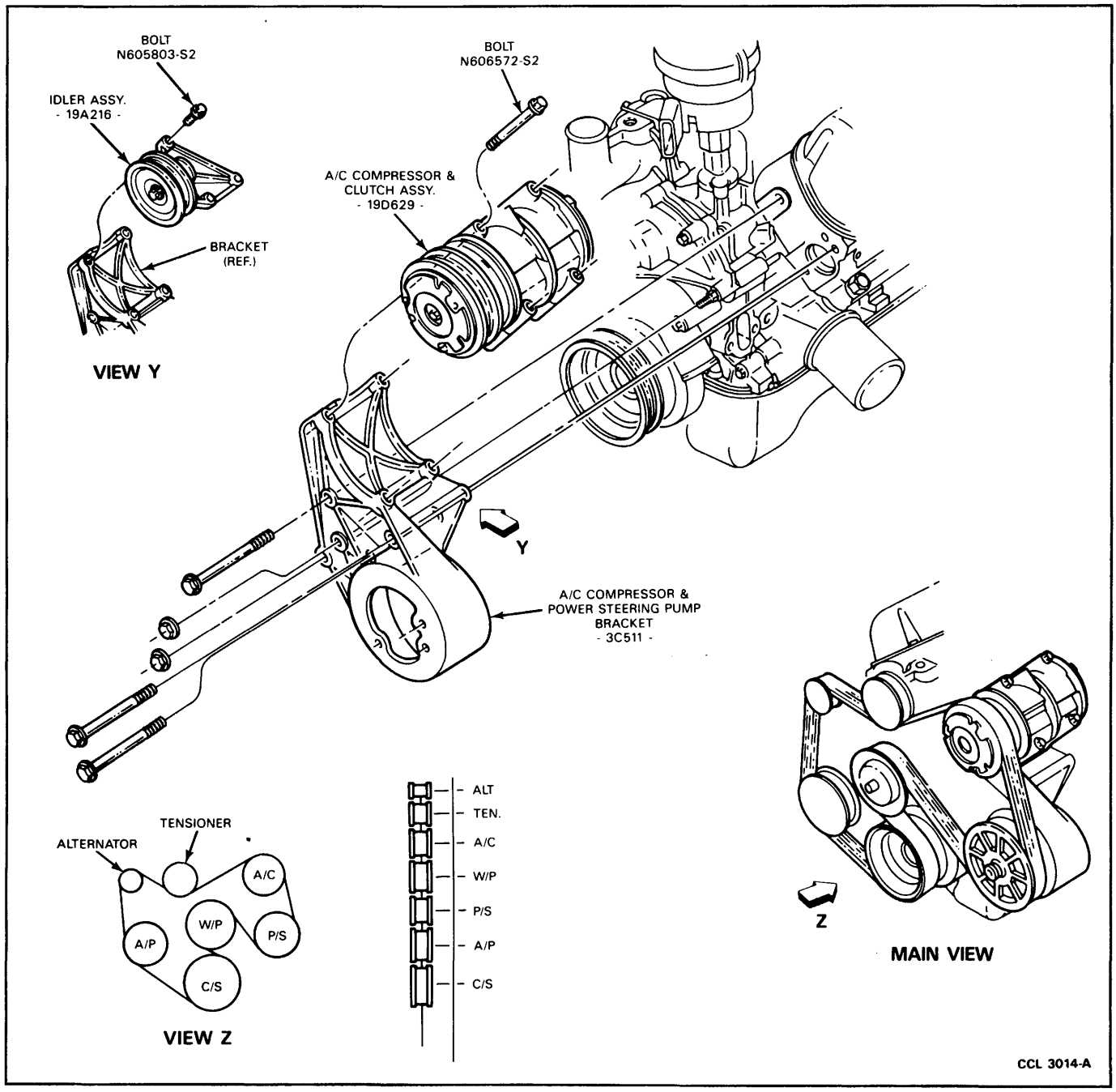


FIG. 43 5.0L and 5.8L EFI Engines

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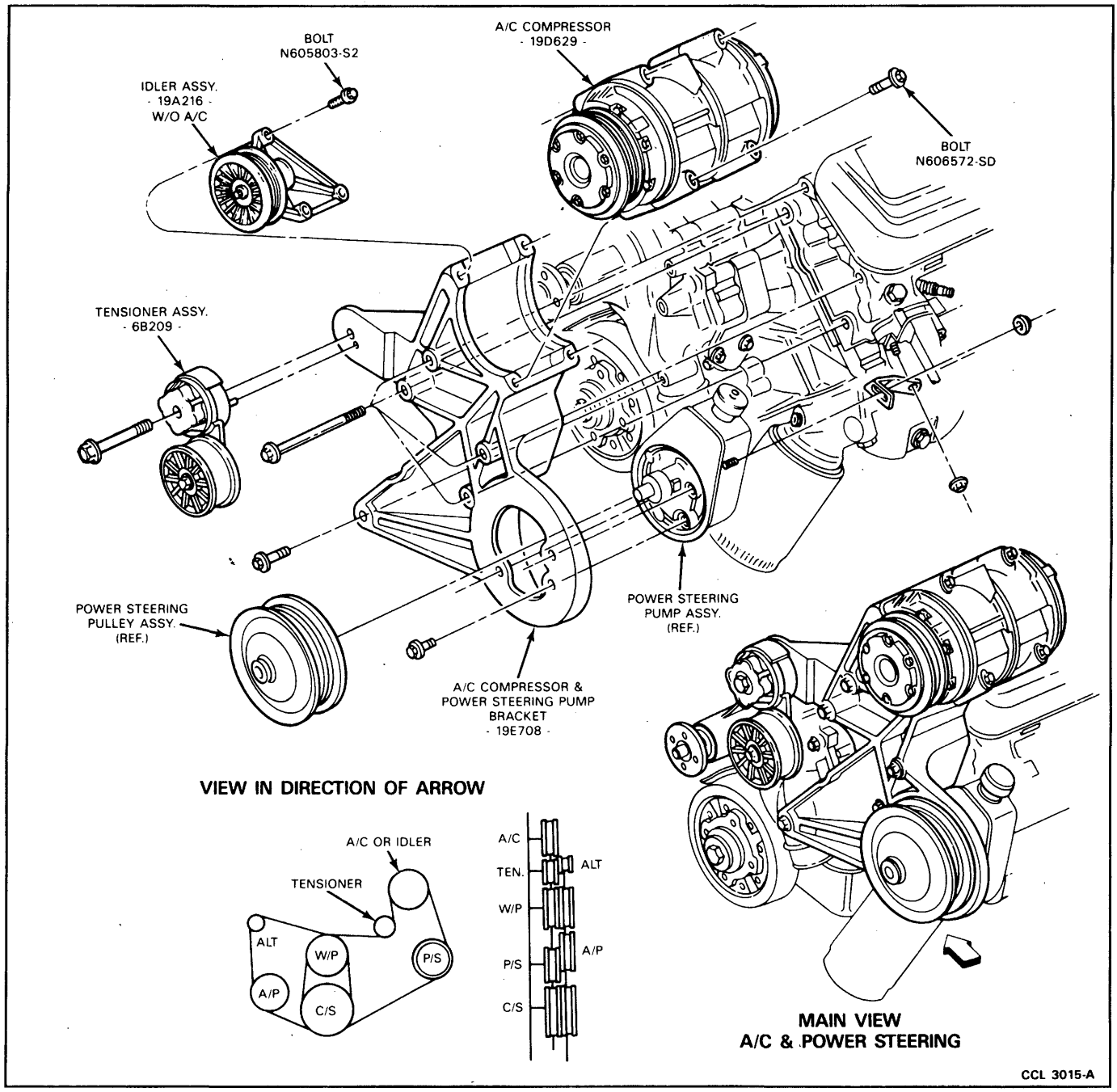


FIG. 44 7.5L EFI Engine

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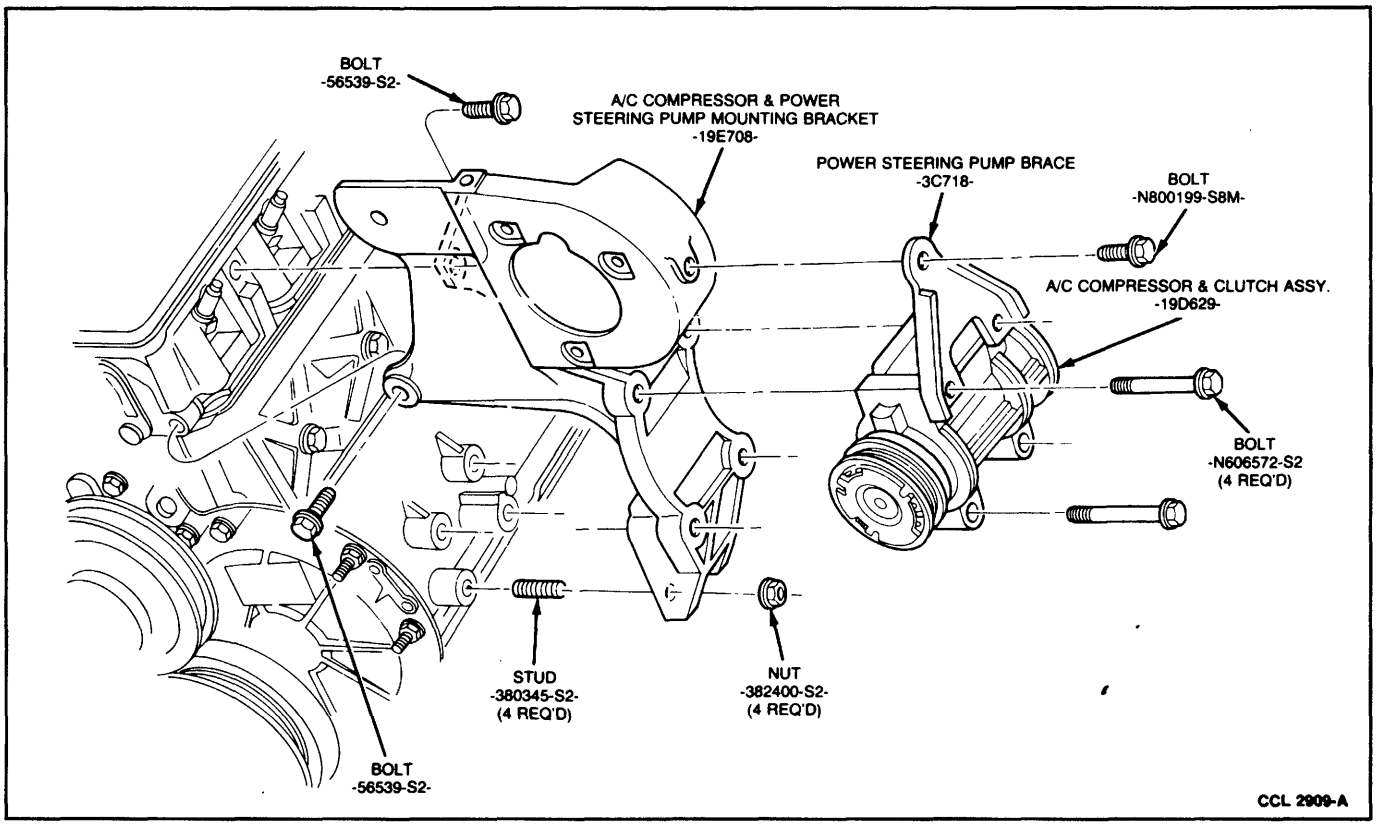


FIG. 45 4.9L EFI Engine

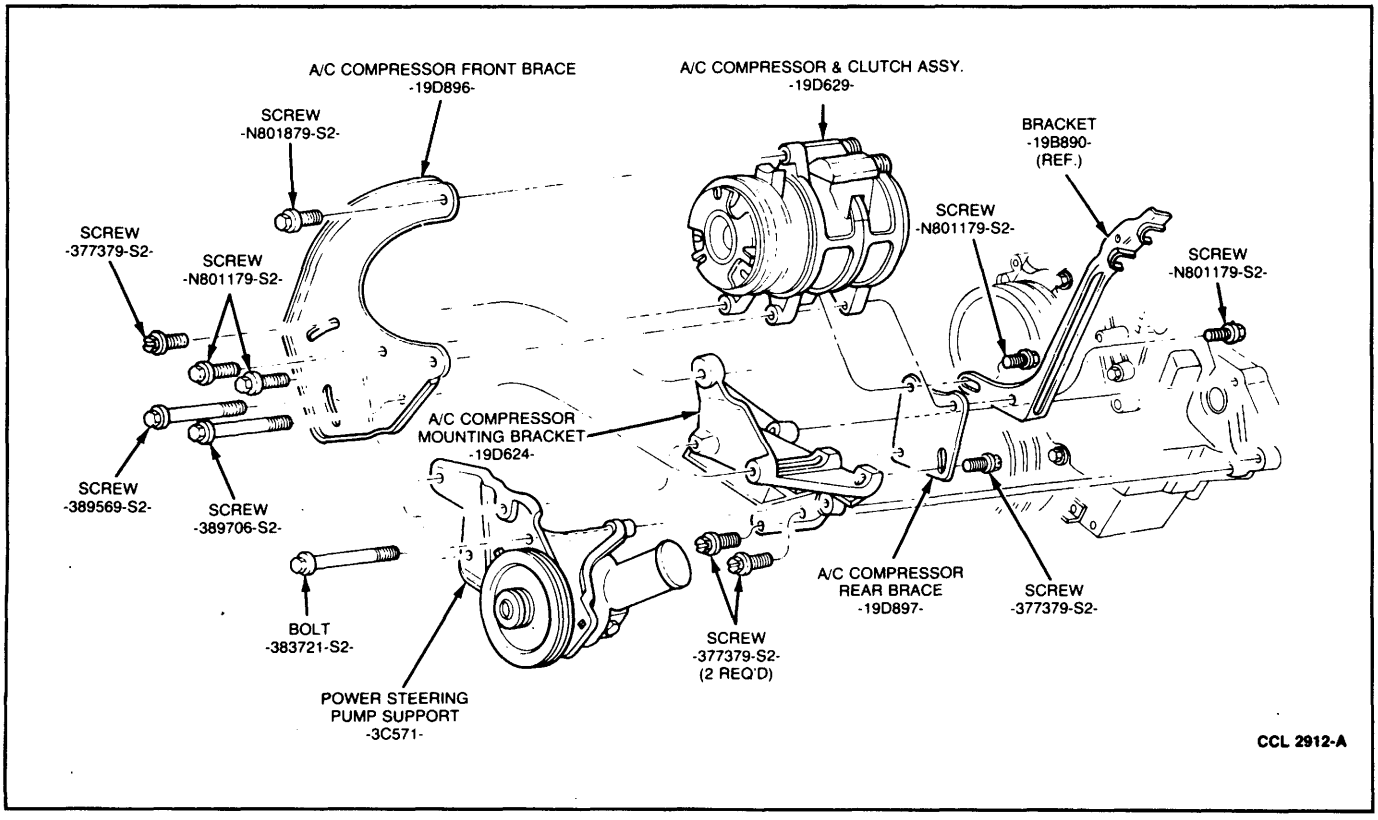


FIG. 46 7.3L Diesel Engine

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SPECIFICATIONS

ELECTRICAL

Protective Device		30 Amp. Fuse (Lt. Green) F-15 Thermal Limiter in Blower Resistor Circuit (Integral with Resistor)	
Blower Motor Current Draw (Amps and Voltage)	**Blower Speed**	**Amps**	**Volts**
	Low	6.0	5.0
	Med. Low	8.0	7.0
	Med. High	15.0	10.0
	High	25.0	12.8
Magnetic Clutch Current Draw — Approximately 4.57 Amps @ 12.8 Volts			
Illumination Control Assembly		One ICP-161 Bulb	

REFRIGERANT

System Protection Pressure Switch	Close Maximum 47 psi Open Minimum 23 psi
High Pressure Relief Valve (Located on Compressor Discharge Manifold)	3103kPa (450 psi)
Maximum Capacity	3-1/4 Lbs. (1.47 kg) 52 Oz. (1474 g)
Type Refrigerant 12 (R-12) ESA-M17B2-A	Dichlorodifluoromethane CCL^2F^2 Ford D4AZ-198519-A Motorcraft YN-1A 14 Oz. Can YN-7 30 Lb. Container
Fixed Orifice Tube	0.062 inch (Color Code-Red)

CL5334-1C

SPECIAL SERVICE TOOLS

SPECIAL SERVICE TOOLS

Tool	Description	Motorcraft
T63L-8620-A	Belt Tension Gauge	YT-371
D81L-19703-A	High Pressure Service Port Adapter Set	YT-354
T83P-18532-AH	Control Cable Remover	YT-1246
T83L-19990-A	Orifice Tube Remover and Installer	YT-1008
T83L-19990-B	Orifice Tube Extractor	YT-1009

CL4356-2D

ROTUNDA EQUIPMENT

Tool	Description	Motorcraft
023-00006	Flame-Type Leak Detector	YT-202
023-00007	Dial Thermometer	YT-227
023-00009	Small Can Adapter	YT-229
055-00015	Electronic Leak Detector	YT-288
021-00014	Hand Operated Vacuum Pump Tester	YT-335

CL4357-2C

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SECTION 36-65 Air Conditioning System

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Vacuum System	36-65-5
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Compressor Clutch and Field Coil	36-65-33
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VEHICLE APPLICATION

E-150 through E-350 models.

DESCRIPTION

This Section covers the controls and components of the manually operated A/C-heater system. Section 36-30, Air Conditioning System General Service, provides information and service procedures regarding refrigerants. Depending on the service operation being performed, reference to both of these sections in the manual may be necessary.

The air conditioner used in the E-150—E-350 is a combination air conditioning and heating system referred to as a blend air design. The system, excluding the plenum and ducts, consists of a two-piece A/C-heater assembly. Both pieces assemble to each other and to the dash panel on the RH side of the vehicle. One part extends into the engine compartment and the other is in the passenger compartment under the instrument panel. The plenum and ducts to the registers and defrosters are located behind the instrument panel. Refer to Figure 1.

The control assembly is located in the instrument panel at the right of the steering column. Four registers in the instrument panel direct airflow into the passenger compartment. The louvers in the registers can be adjusted to direct airflow upward, downward, to the right or to the left. They can also be set in a closed position which will block nearly all airflow.

Control Assembly

Function Selector Lever

The function selector lever actuates an eight-port vacuum selector that controls vacuum motors at the floor/defrost, panel/defrost, and outside/recirc air doors. The function selector lever also controls the blower switch OFF-ON operation and activates the A/C clutch circuit in the A/C position (Fig. 7).

In either A/C position (MAX or NORM), compressor operation is dependent upon the clutch cycling pressure switch (Fig. 2).

The cutout pressure is approximately 169 kPa (24.5 psi). Cut-in pressure is approximately 300 kPa (43.5 psi).

Temperature Selector Lever

The temperature selector lever actuates a control cable which operates the temperature blend door (Fig. 7).

Blower Control Switches

A four-speed blower control switch with a range between LO and HI is located at the LH side of the control assembly. To completely stop blower operation, it is necessary to move the function selector lever to its OFF position. If the vehicle is equipped with auxiliary air, a second blower control switch will be included. This switch is installed near the right end of the control. It provides three blower speeds plus an OFF position.

Blower Motor Resistor

The blower motor resistor assembly attaches to the evaporator case in the area near the dash panel and heater core tubes (Fig. 3).

Evaporator Assembly

Refer to Figures 4, 5 and 6 for evaporator assembly illustrations.

The heater core and blend air door are housed in the evaporator core rear housing. The blower motor and wheel, blower motor resistor, and evaporator core are located in the evaporator assembly.

When servicing any of these components it is not necessary to loosen or remove the instrument panel.

The suction accumulator/drier and with its component clutch cycling switch attach to the evaporator case.

Fixed Orifice Tube

The fixed orifice tube regulates the flow of refrigerant into the evaporator. It is the dividing point in the refrigerant system between high and low pressure. Refer to Figure 17.

Econoline vehicles are equipped with an orifice tube that is color-coded orange. It is also identified as an

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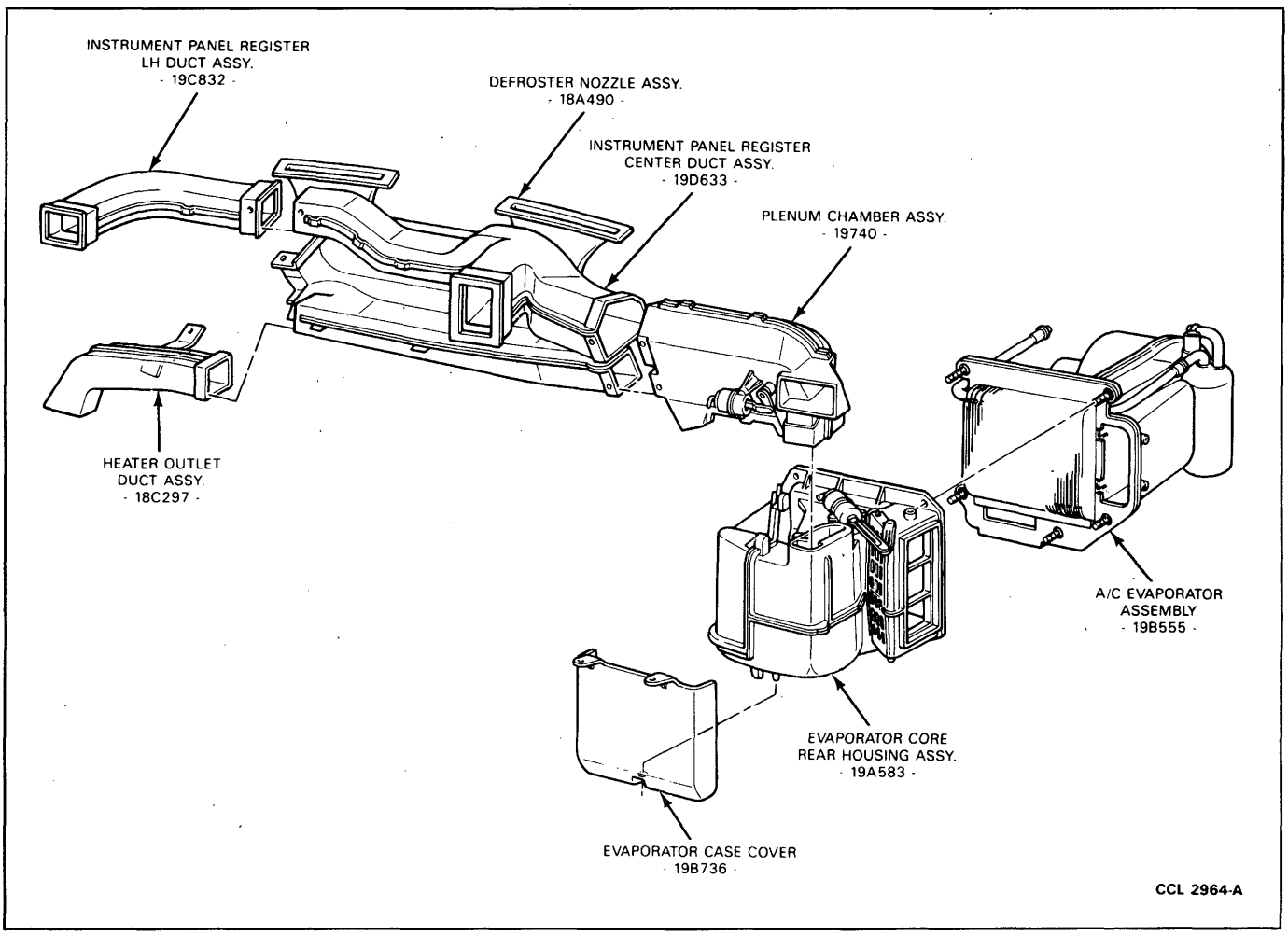


FIG. 1 Manual A/C—Heater System

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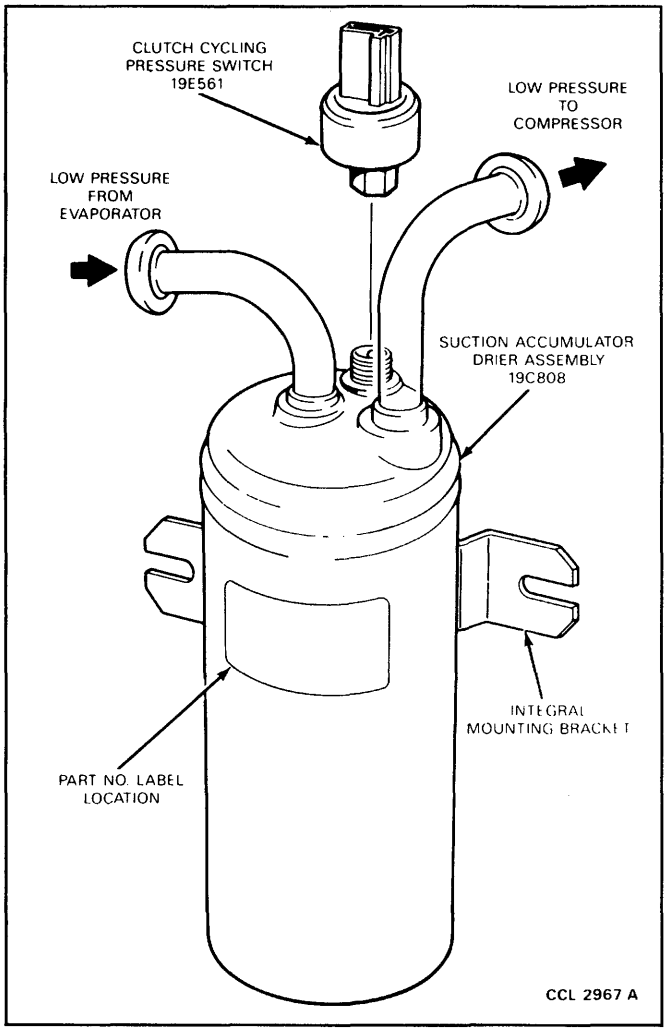


FIG. 2 Suction Accumulator/Drier

0.057-inch tube. This dimension is the inside diameter of the short brass tube which protrudes inside the transparent surface of the orifice tube assembly.

Suction Accumulator/Drier

Refrigerant enters the accumulator/drier canister through the inlet tube and the heavier oil-laden refrigerant falls to the bottom of the canister (Fig. 2). A small diameter bleed hole is located in the side of the outlet tube near the bottom of the canister. This bleed hole is covered with a filter and allows a small amount of the heavier liquid refrigerant and oil mixture to re-enter the suction line at a controlled rate. When the heavier liquid refrigerant and oil mixture enters the compressor suction line, it has a second opportunity to vaporize and circulate through the compressor without causing damage to the compressor due to refrigerant slugging.

A desiccant bag is mounted inside the suction accumulator/drier canister to absorb any moisture which may be in the refrigerant system.

A fitting located on the top of the canister is used to attach the clutch cycling pressure switch. A long travel Schrader-type valve stem core is installed in the fitting opening to prevent refrigerant loss when the clutch cycling pressure switch is removed.

OPERATION

Refer to Figure 8

There are several control levers and switches which are involved in the operation of an Econoline climate control system. They are as follows:

- Function Selector Lever
- Temperature Selector Lever
- Blower Control Switch

The control assembly illustrated in Figure 8 shows where the levers and switches are located.

The main blower is turned on whenever the function selector lever is not in the OFF position. The A/C compressor clutch is actuated whenever the function selector lever is in the MAX or NORM A/C position. Cycling of the compressor is then controlled by a clutch cycling pressure switch on the suction accumulator/drier. This drier attaches to the side portion of the evaporator case which extends into the engine compartment.

Other positions, VENT, FLOOR, MIX or DEFROST may be selected by moving the function selector lever to the appropriate detent. This actuates a vacuum selector valve which is part of the control assembly. Vacuum lines from this valve lead to vacuum motors which operate all doors in the system except the cable-controlled temperature air door.

Air is drawn into the system by the blower motor and wheel through the outside-recirc door opening. The air is then blown through the evaporator core and then the heater core (when the temperature lever is moved toward the WARM position). When the cable operated temperature blend door is in the maximum COOL position, the air bypasses the heater core. When the temperature lever is moved to the right, away from the maximum COOL position, a small percentage of air passes through the heater core where it is warmed, and then mixed with the cool air before it is discharged through the registers.

With the function selector lever in the OFF position, the outside-recirc door is in the recirculated air position. It is closed to outside air and no air passes through the system. The blower motor is off.

In the MAX A/C, the outside-recirc air door is in the recirculated air position. All of the air discharges through the panel registers except for a small amount of floor bleed. The compressor operates in the function lever setting.

In the NORM A/C position the outside-recirc air door is open to the outside (no vacuum) and outside air is discharged through the panel register with a small amount of floor bleed. The compressor operates in this lever setting.

In the VENT position the outside-recirc air door is open to the outside (no vacuum), and outside air is discharged through the panel registers except for a small amount of floor bleed. The compressor does not operate in this control lever setting.

In the FLOOR position, the outside-recirc air door is open to outside air (no vacuum). Air is discharged through the floor outlets plus a small amount of defroster bleed is directed to the windshield.

In the MIX position air is discharged through both defroster and floor outlets.

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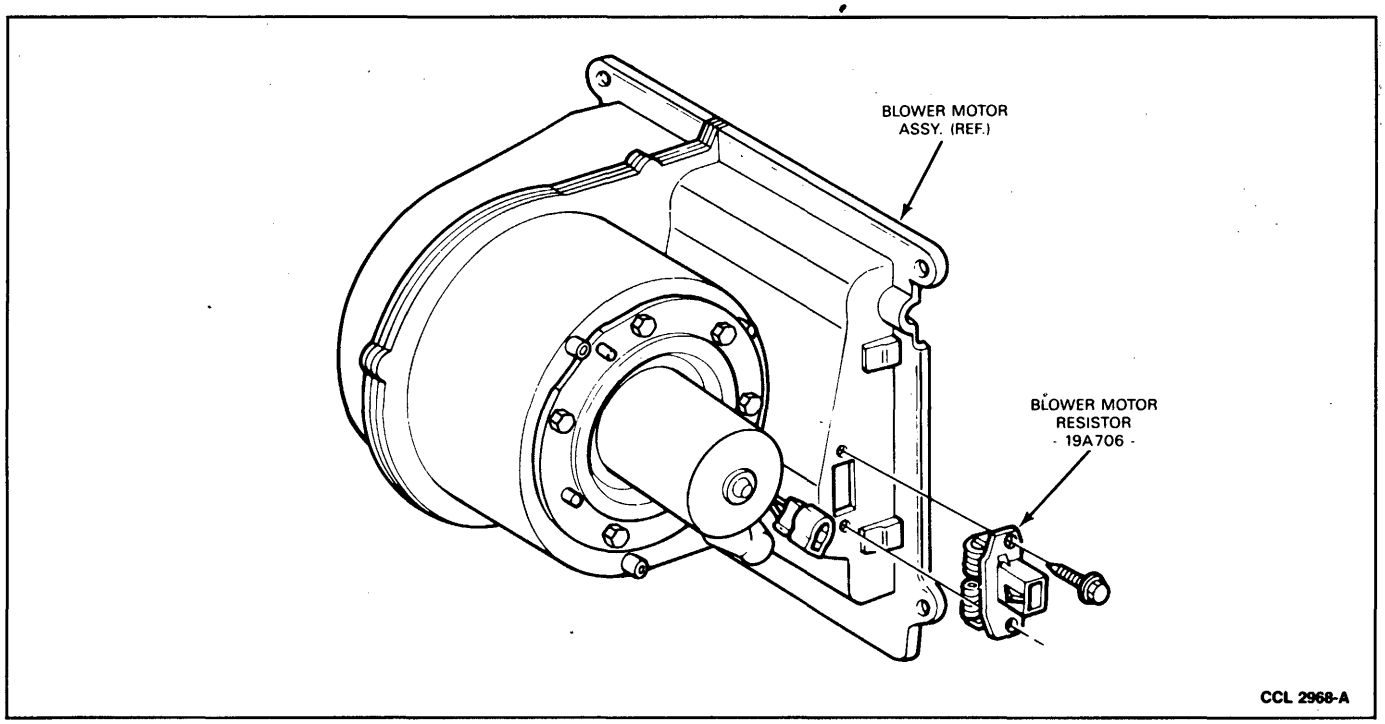


FIG. 3 Blower Motor Resistor

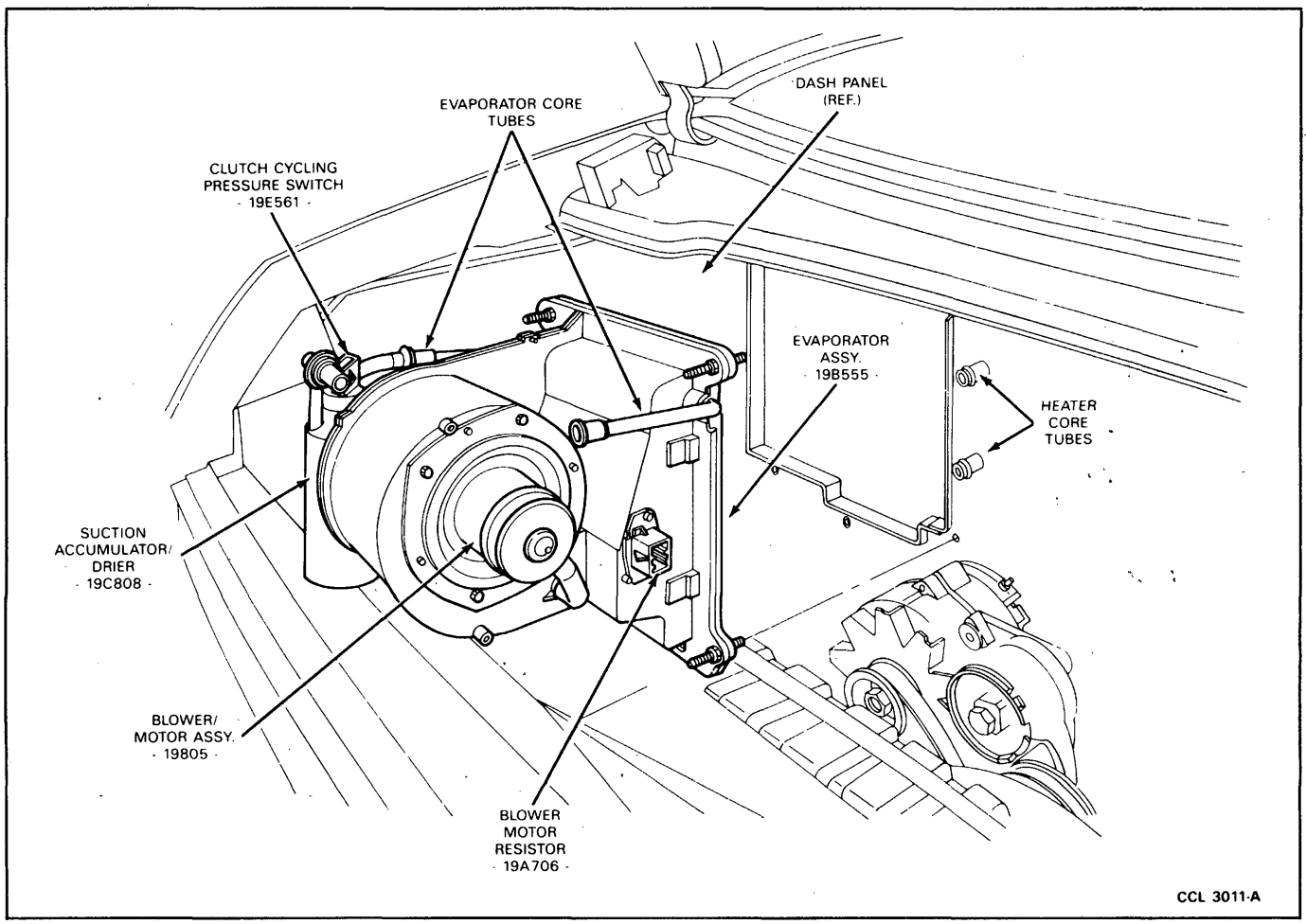


FIG. 4 Evaporator Assembly—Installation

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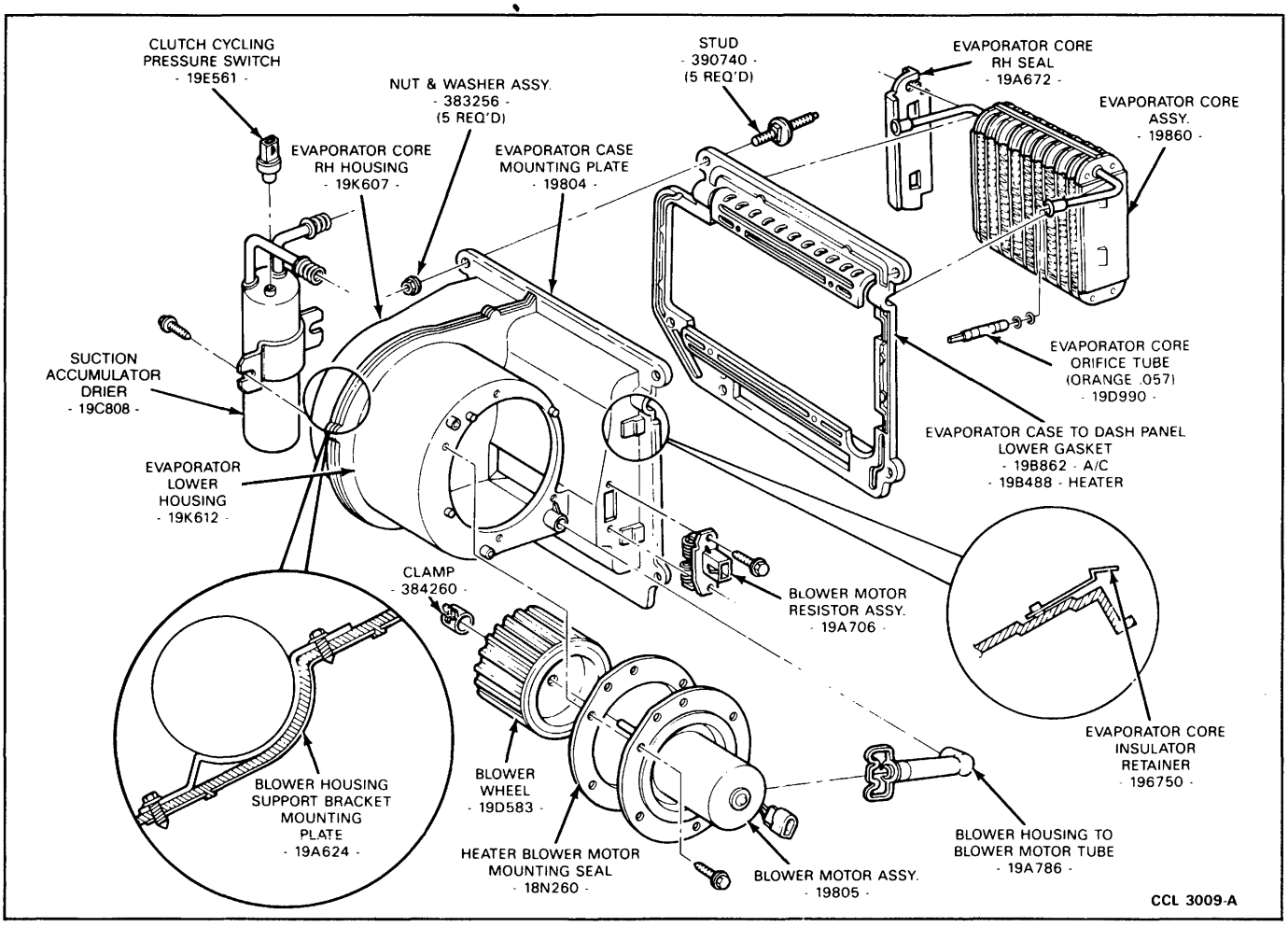


FIG. 5 Evaporator Assembly—Disassembled View

In the DEFROST position the air is discharged through the defrosters to the windshield. There is also a small amount of floor bleed. The compressor operates in this control setting to help dehumidify the air.

Vacuum System

Figure 9 illustrates the vacuum circuit which controls the movement of three of the four doors in the system. These doors are:

- Outside-Recirc Air Door
- Panel/Defrost Door
- Floor/Defrost Door

The temperature control door (blend air door) is cable controlled.

Refrigerant Flow

Figure 10 is a simplified illustration of refrigerant flow through an A/C circuit.

The boiling or condensing temperature of a refrigerant increases or decreases according to the pressure exerted on it.

In the E-150—-E-350 air conditioning system, liquid refrigerant (R-12) is delivered under high pressure from the condenser to the orifice tube located in the evaporator inlet tube. When the refrigerant passes through the orifice tube, its pressure drops and its temperature reverts to its boiling point (-21.6° -29.8°F).

As the refrigerant flows through the evaporator coils, warm passenger compartment air, or outside air, passes over the **outside surface** of the coils. As it boils, the colder R-12 absorbs heat from the air and thus cools the passenger compartment. The heat from the air is absorbed by the boiling refrigerant which is converted to a gas. The refrigeration cycle is now under way. To complete the cycle, the following remains to be done:

1. Dispose of the heat in the gas.
2. Convert the gas back to liquid for re-use.
3. Return the liquid to the starting point in the refrigerant cycle.

The compressor pumps the gas and liquid out of the evaporator into the suction line to the accumulator/drier which stores any liquid which may have entered the system. The drier then allows gas only to return to the compressor. The compressor forces the gaseous refrigerant under high pressure and temperature into the condenser which is located in the outside air stream at the front of the vehicle. The temperature of the gas entering the condenser is higher than that of the outside air. As the heat transfers from the hot gas to the cooler air, the R-12 condenses back to a liquid. The liquid under high pressure now returns to the orifice tube in the evaporative inlet line to repeat its flow cycle.

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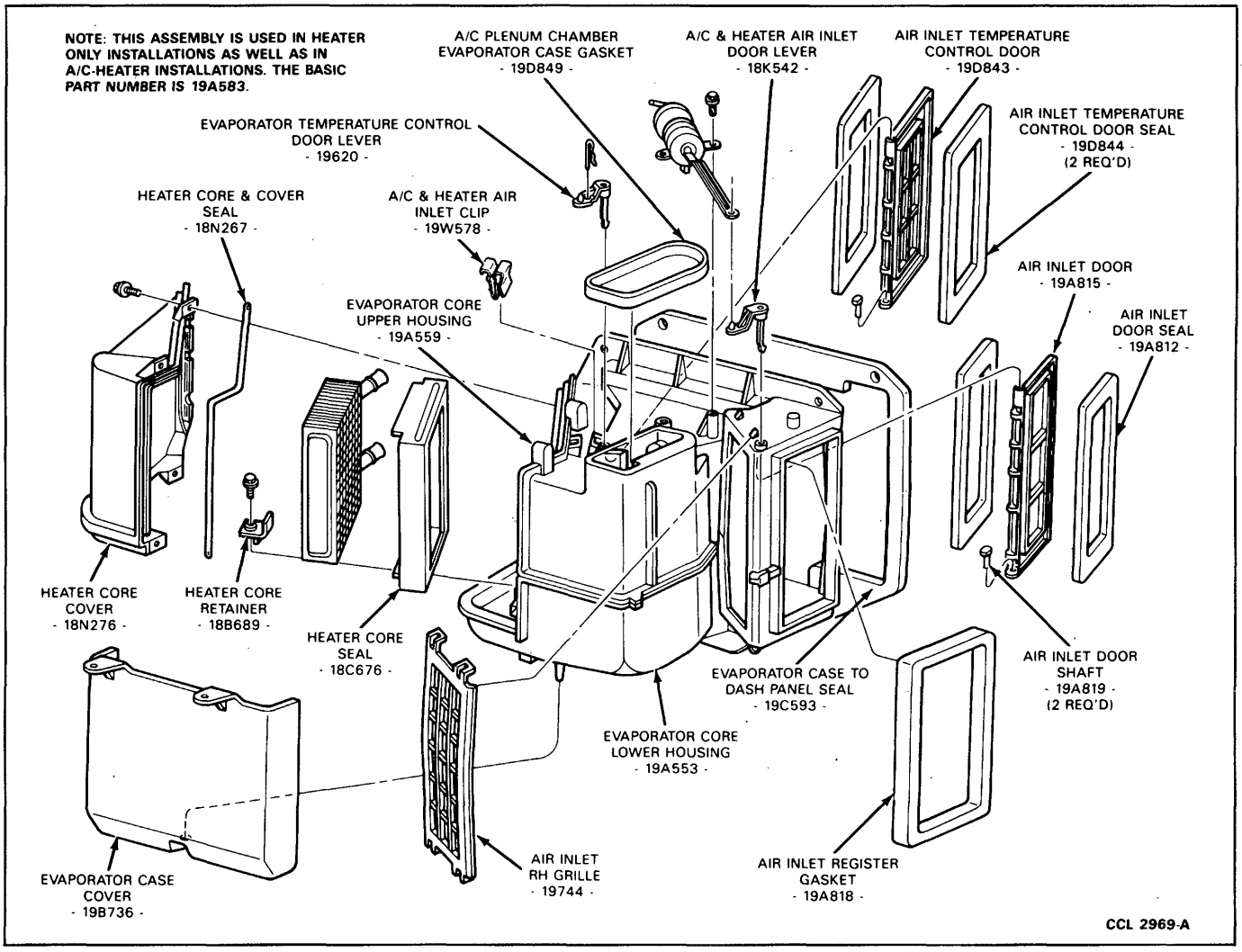


FIG. 6 Evaporator Core Rear Housing Assembly—Disassembly View

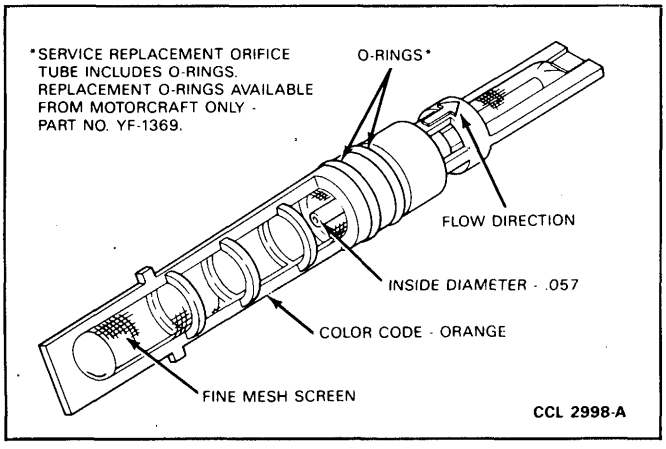


FIG. 7 Fixed Orifice Tube

Spring Lock Couplings

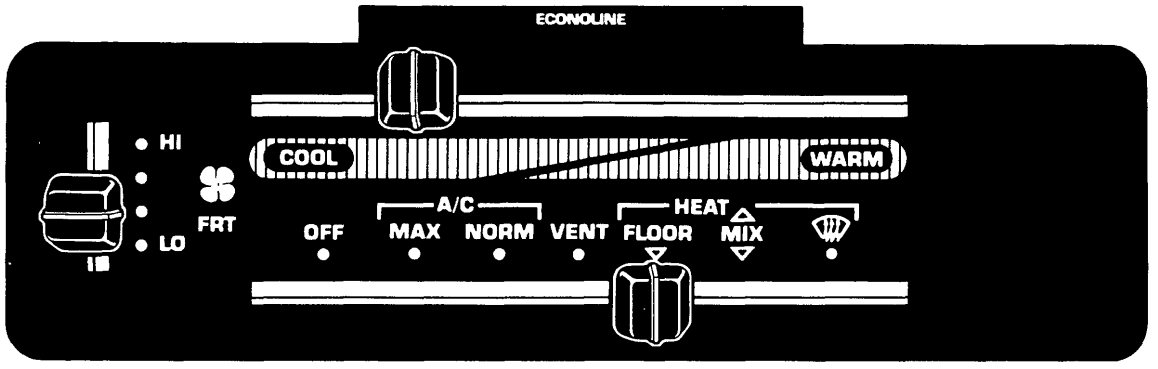
The spring lock coupling is a refrigerant line coupling held together by a garter spring inside a circular cage. When the coupling is connected, the flared end of the female fitting slips behind the garter spring inside the cage of the male fitting. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage (Fig. 11).

Two O-rings are used to seal between the two halves of the coupling. These O-rings are made of a special material and must be replaced with an O-ring made of the same material. The O-rings normally used in the refrigerant system connections are not the same material and should not be used with the spring lock coupling. Use only the O-rings listed in the master parts catalog for the spring lock coupling. It is available in E35Y-19D690-A Kit.

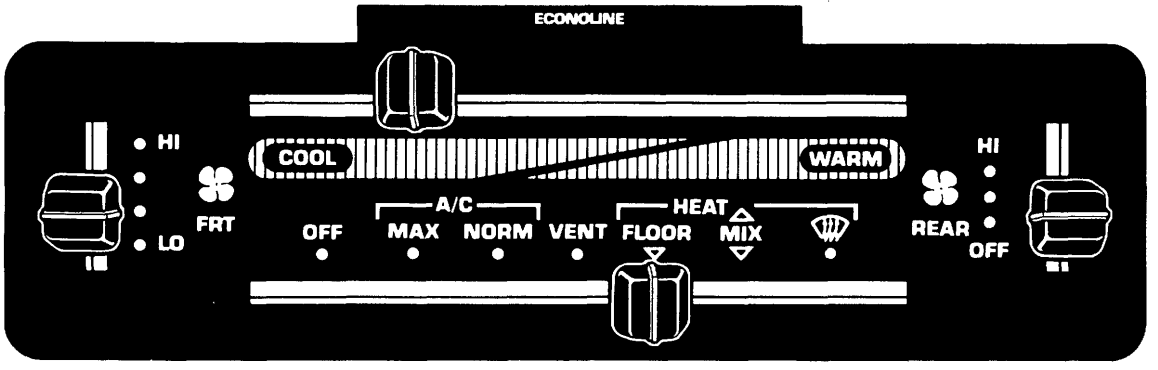
A plastic indicator ring is used on spring lock couplings to indicate, during vehicle assembly, that the coupling is connected. Once the coupling is connected, the indicator ring is no longer necessary but will remain captive by the coupling near the cage opening.

The indicator ring may also be used during repair operations to indicate connection of the coupling. After a coupling has been cleaned and new O-rings have been installed and lubricated with clean refrigerant oil, insert the tabs of the indicator ring into the cage opening. Then, connect the coupling by pushing it together with a slight twisting motion. When the coupling is connected, the indicator ring will snap out of the cage opening but will remain captured on the coupling by the refrigerant line.

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HEATER & A/C (MAIN SYSTEM)



HEATER & A/C (MAIN & AUXILIARY SYSTEM)

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FIG. 8 Control Assembly

Side Mounted Auxiliary and/or Air Conditioning System

Refer to Section 36-70 for information pertaining to the E-150—-E-350 Side Mounted Auxiliary Heater and/or Air Conditioning System.

DIAGNOSIS AND TESTING

Blower Motor Voltage Test

The manual A/C-heater system blower motor electrical circuit uses ground side switching. When performing blower motor voltage tests on systems with ground side switching, the voltage reading must be taken across the motor wires.

Test Procedure

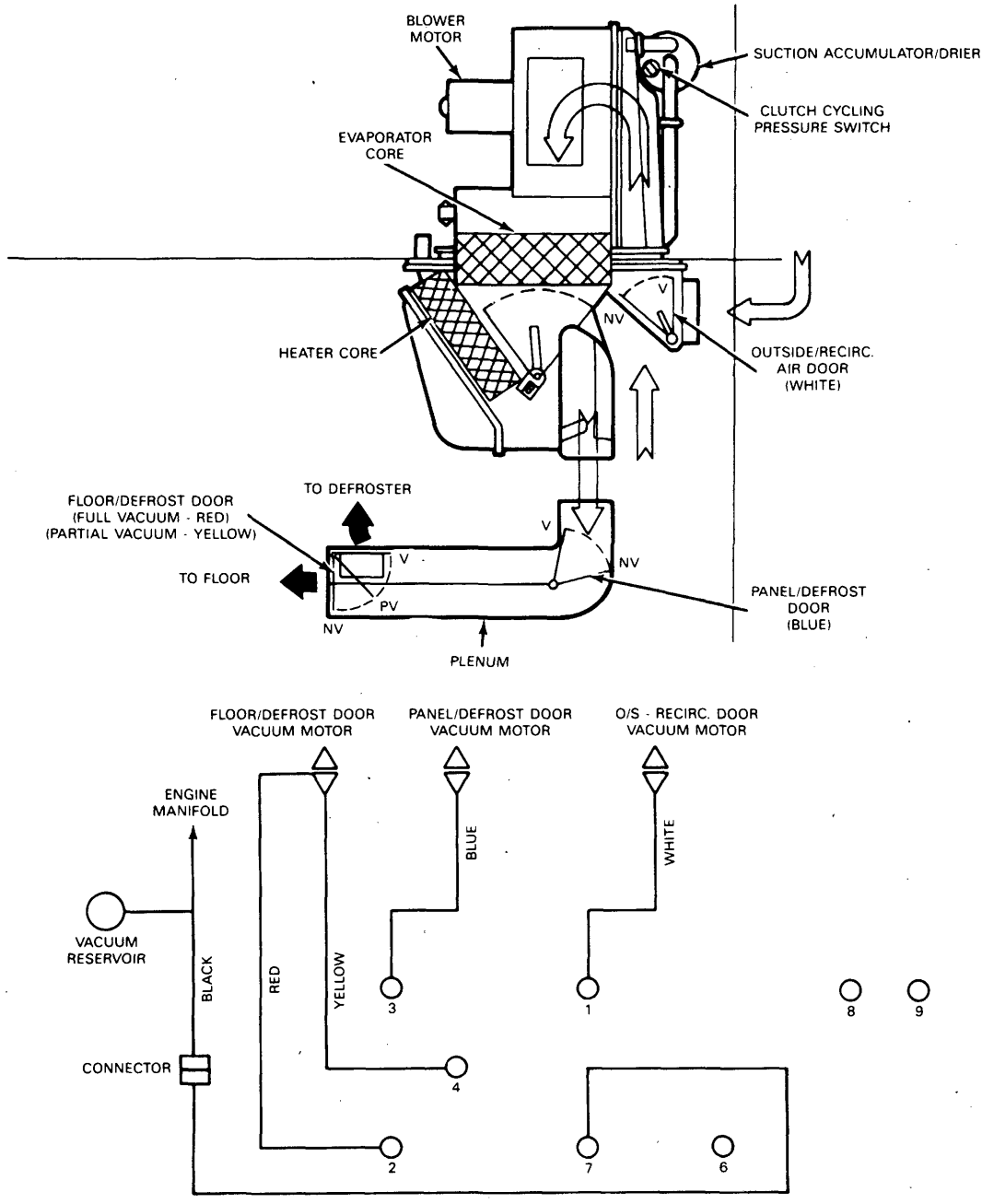
1. Place the temperature selector lever in the WARM position.
2. Place the function selector lever in the FLOOR position.
3. Insert the probes of a voltmeter into the wire holes of the motors two hardshell connectors and make contact with the wire terminals. Measure the voltage drop across motor.
4. With the engine running (battery voltage of approximately 14.2 volts), the voltage reading should be within specified range for each blower switch position as indicated in the blower switch chart of the electrical wiring diagram (Fig. 12).

Blower Motor Current Draw Test

1. Separate the blower motor ground (black) wire at the blower motor resistor.
2. Connect the positive (+) ammeter lead to the female spade connector and the negative (-) ammeter lead to the resistor terminal.
3. Place the temperature selector lever in the mid-position and the function selector lever in the HEAT position to turn the blower on.
4. Turn the ignition switch to the RUN position.
5. With a fully charged battery, the blower motor current draw (amps) should be approximately as indicated for each blower speed in the blower switch chart of the electrical wiring diagram (Fig. 12).

Heat can be transferred from a comparatively cooler passenger compartment to the hot outside air because of the difference between the refrigerant pressure in the evaporator and the pressure in the condenser. At the evaporator, the orifice tube reduces the pressure and thereby reduces the boiling point below the temperature of the passenger compartment. Thus, heat transfers from the passenger compartment to the boiling refrigerant. In the condenser, the compressor raises the

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PART NO	FUNCTION	OFF	A/C		VENT	HEAT		
			MAX	NORM		FLOOR	MIX	DEFROST
1	OUTSIDE - RECIRC	V	V	A	A	A	A	A
2	FLOOR - DEFROST (FULL)	V	V	V	V	V	-	A
3	PANEL - DEFROST	A	V	V	V	A	-	A
4	FLOOR - DEFROST (PARTIAL)	V	V	V	V	V	PV	A
5	BLANK	-	-	-	-	-	-	-
6	SEALED	-	-	-	-	-	-	-
7	SOURCE	V	V	V	V	V	V	V

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FIG. 9 Vacuum Circuit

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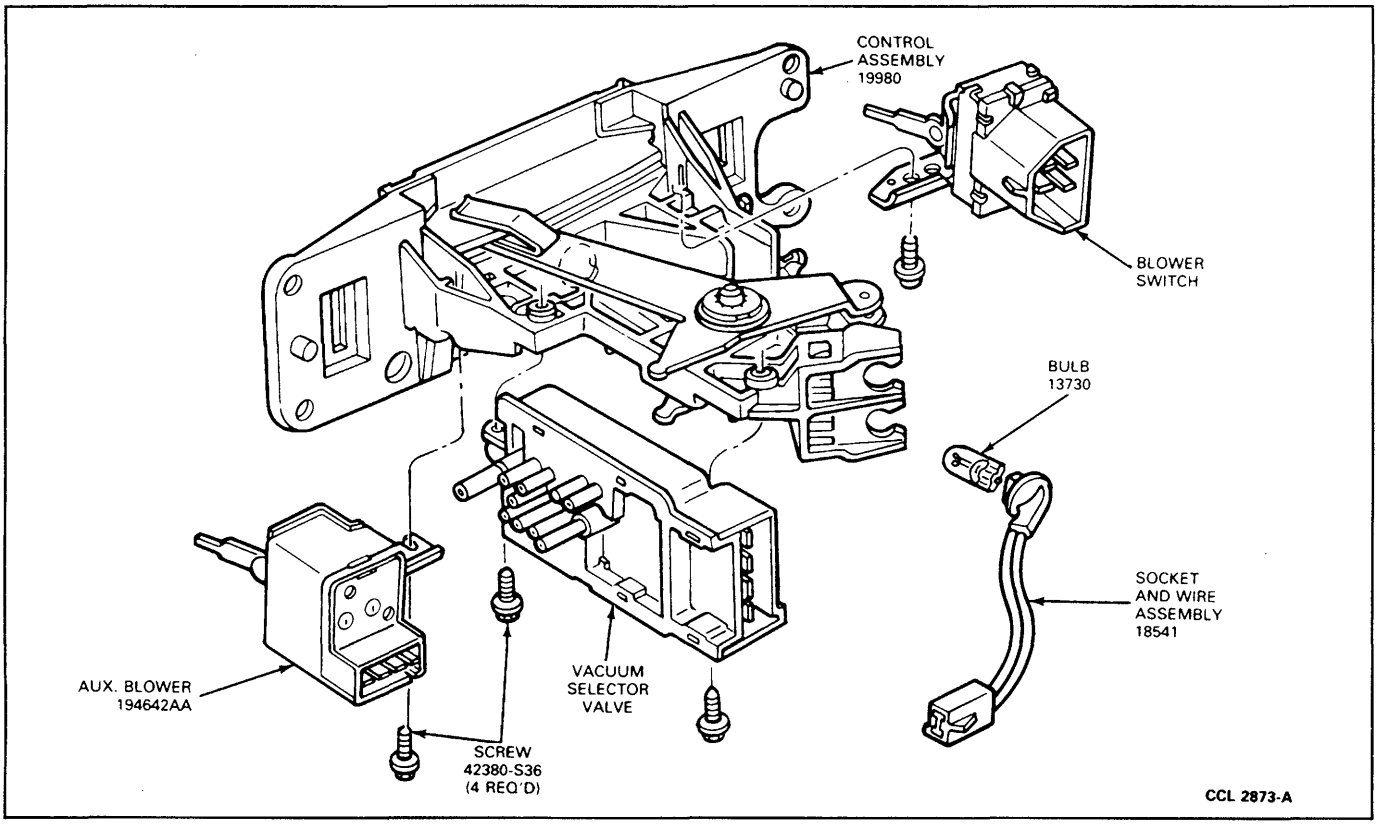


FIG. 10 Refrigerant Cycle

condensation point above the temperature of an outside air. Thus, the heat transfers from the condensing refrigerant to the outside air. The orifice tube and the compressor simply create pressure conditions that permit the laws of thermodynamics to provide the desired cooling effects.

Vacuum System Tests

To test the A/C-heater control system, start the engine and move the function selector lever slowly from one position to another. A momentary hiss should be heard as the function selector lever is moved from one position to another indicating that vacuum is available at the control assembly. A continuous hiss at the control assembly indicates a major leak somewhere in the system. It does not necessarily indicate that the leak is at the control assembly (Fig. 9).

If a momentary hiss cannot be heard when the function selector lever is moved from one position to another, check for a kinked, pinched or disconnected vacuum supply hose (Fig. 9). Also inspect the check valve between the intake manifold and the vacuum reservoir to be sure it is working properly.

If a momentary hiss can be heard when the function selector lever is moved from one position to another, vacuum is available at the control assembly. Then, cycle the function selector through each position with the blower on HI and check the location(s) of the discharge air. The airflow schematic and vacuum control chart shown in Fig. 9 indicates which vacuum motors are applied for each position of the function selector lever along with an airflow diagram of the system. The airflow diagram shows the position of each door when vacuum is applied and when there is no vacuum applied. With this chart, airflow for each position of the control assembly can be determined. If a vacuum motor fails to operate, the inoperative motor can readily be found because the airflow will be incorrect.

If a vacuum motor is inoperative, check the operation of the motor with Rotunda Vacuum Tester 021-00014 or equivalent. If the vacuum motor operates properly, the vacuum hose is probably pinched, kinked, disconnected or has a hole in it (Fig. 9).

Refrigerant System

Diagnosis of refrigerant system performance must be done by analyzing the high and low pressure readings in the system. Compare the pressure readings to the chart shown in Fig. 13 to determine if the system pressures are normal. The conditional requirements for the refrigerant system tests must be satisfied to obtain accurate pressure readings.

NOTE: If conditional requirements are not satisfied, a normal system may appear to be functioning improperly. If they cannot be satisfied, pressure readings although inaccurate may be used to help determine the cause of a system problem.

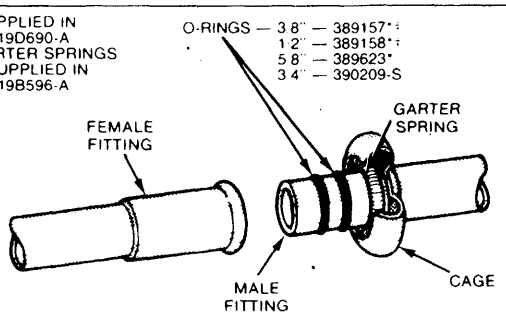
Compare the pressure results with the conditions described in the pressure evaluation chart shown in Fig. 14.

Once the problem is corrected, take additional pressure readings while meeting the conditional requirements for the pressure tests to be sure that the problem has been corrected.

The low-pressure service access standard gauge port is located on the suction line under the center of the cowl. A special Service Access Adapter D81L-19703-A or Motorcraft Tools YT-354 or 355 are necessary to

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*ALSO SUPPLIED IN KIT E35Y-19D690-A WITH GARTER SPRINGS
‡ ALSO SUPPLIED IN KIT E1ZZ-19B596-A

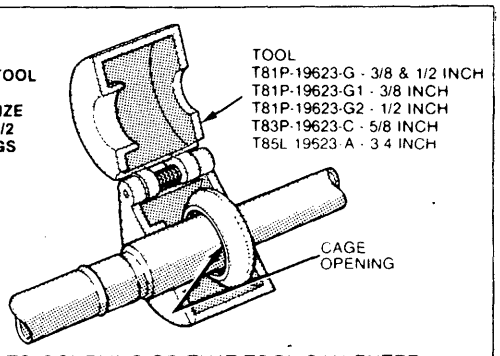


SPRING LOCK COUPLING DISCONNECTED

TO DISCONNECT COUPLING

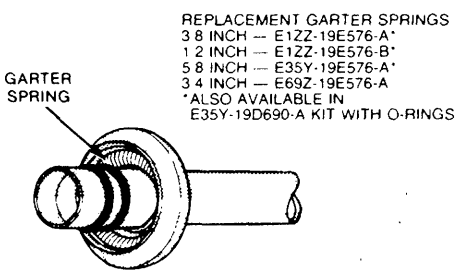
CAUTION — DISCHARGE SYSTEM BEFORE DISCONNECTING COUPLING

NOTE: EACH END OF TOOL T81P-19623-G IS A DIFFERENT SIZE TO FIT 3/8 and 1/2 INCH COUPLINGS

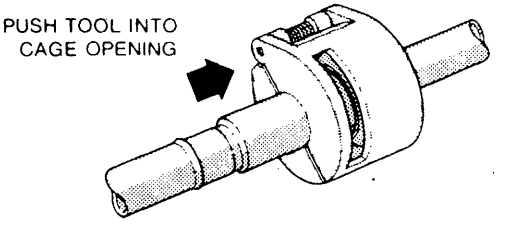


1. FIT TOOL TO COUPLING SO THAT TOOL CAN ENTER CAGE OPENING TO RELEASE THE GARTER SPRING.

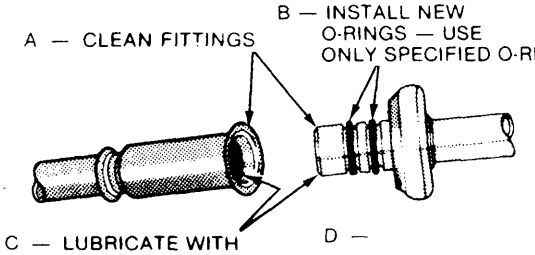
TO CONNECT COUPLING



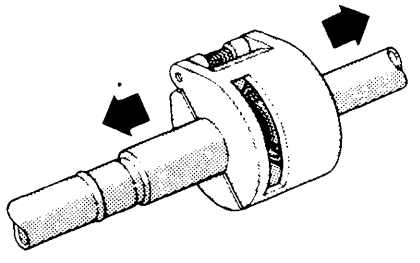
1. CHECK FOR MISSING OR DAMAGED GARTER SPRING — REMOVE DAMAGED SPRING WITH SMALL HOOKED WIRE — INSTALL NEW SPRING IF DAMAGED OR MISSING.



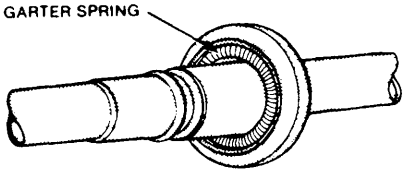
2. PUSH THE TOOL INTO THE CAGE OPENING TO RELEASE THE FEMALE FITTING FROM THE GARTER SPRING.



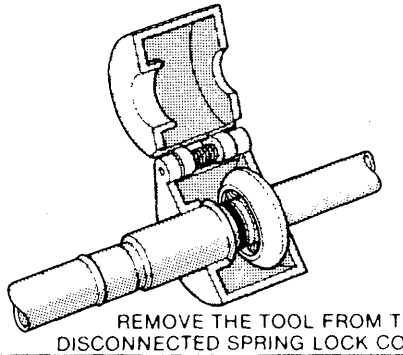
2. (see figure)



3. PULL THE COUPLING MALE AND FEMALE FITTINGS APART.



3. TO ENSURE COUPLING ENGAGEMENT, VISUALLY CHECK TO BE SURE GARTER SPRING IS OVER FLARED END OF FEMALE FITTING.

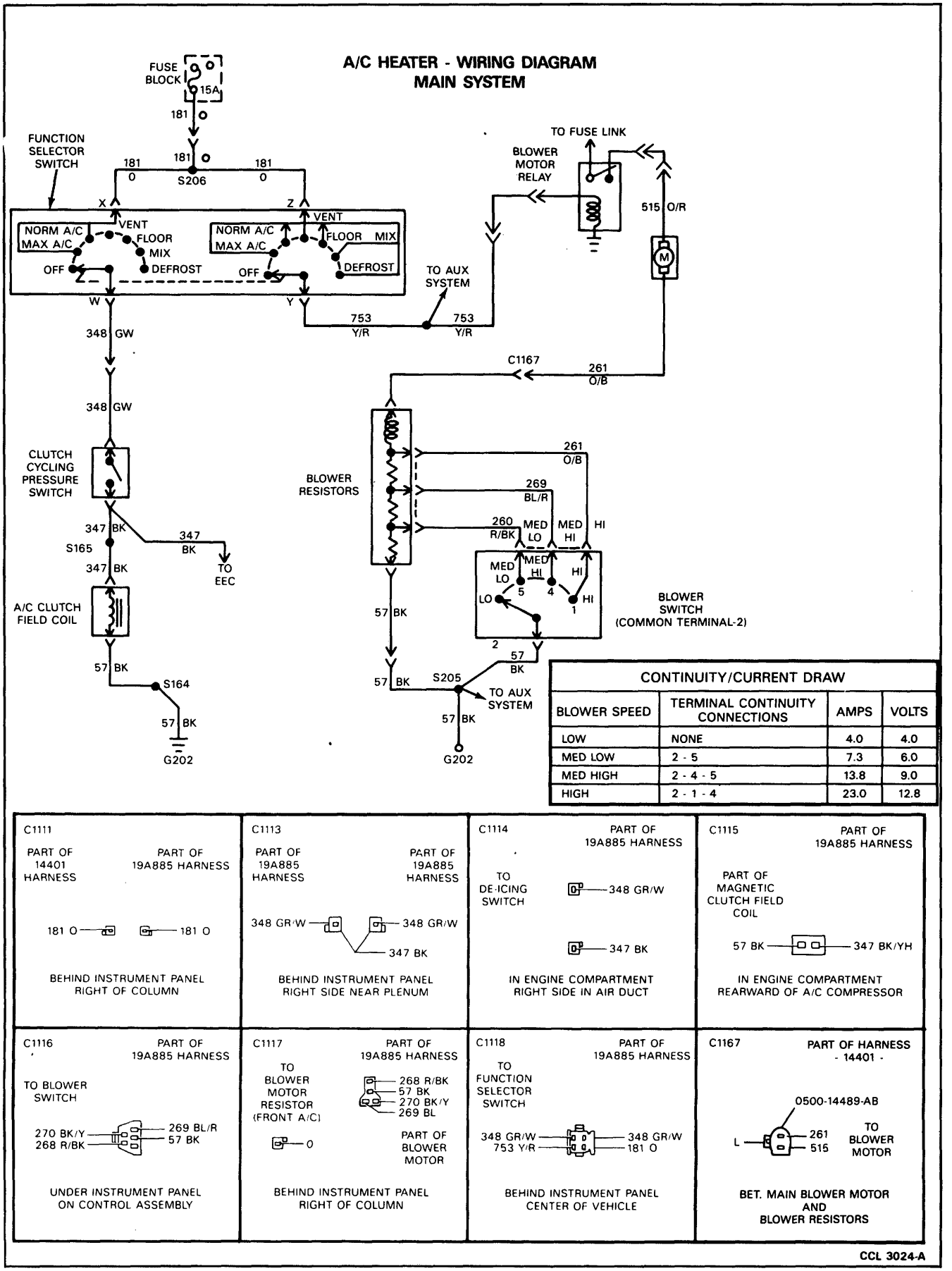


4. REMOVE THE TOOL FROM THE DISCONNECTED SPRING LOCK COUPLING.

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FIG. 11 Spring Lock Coupling

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CONTINUITY/CURRENT DRAW			
BLOWER SPEED	TERMINAL CONTINUITY CONNECTIONS	AMPS	VOLTS
LOW	NONE	4.0	4.0
MED LOW	2 - 5	7.3	6.0
MED HIGH	2 - 4 - 5	13.8	9.0
HIGH	2 - 1 - 4	23.0	12.8

FIG. 12 Manual A/C Heater Wiring Diagram

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THESE CONDITIONAL REQUIREMENTS FOR THE CYCLING CLUTCH SYSTEM TESTS MUST BE SATISFIED TO OBTAIN ACCURATE PRESSURE READINGS.

- Stabilized Pressures
- Stabilized in Car Temperatures at 70 to 80 F (21 to 27 C)
- Maximum A/C (Recirculating Air)
- Maximum Blower Speed
- 1500 Engine RPM
- Compressor Clutch Engaged

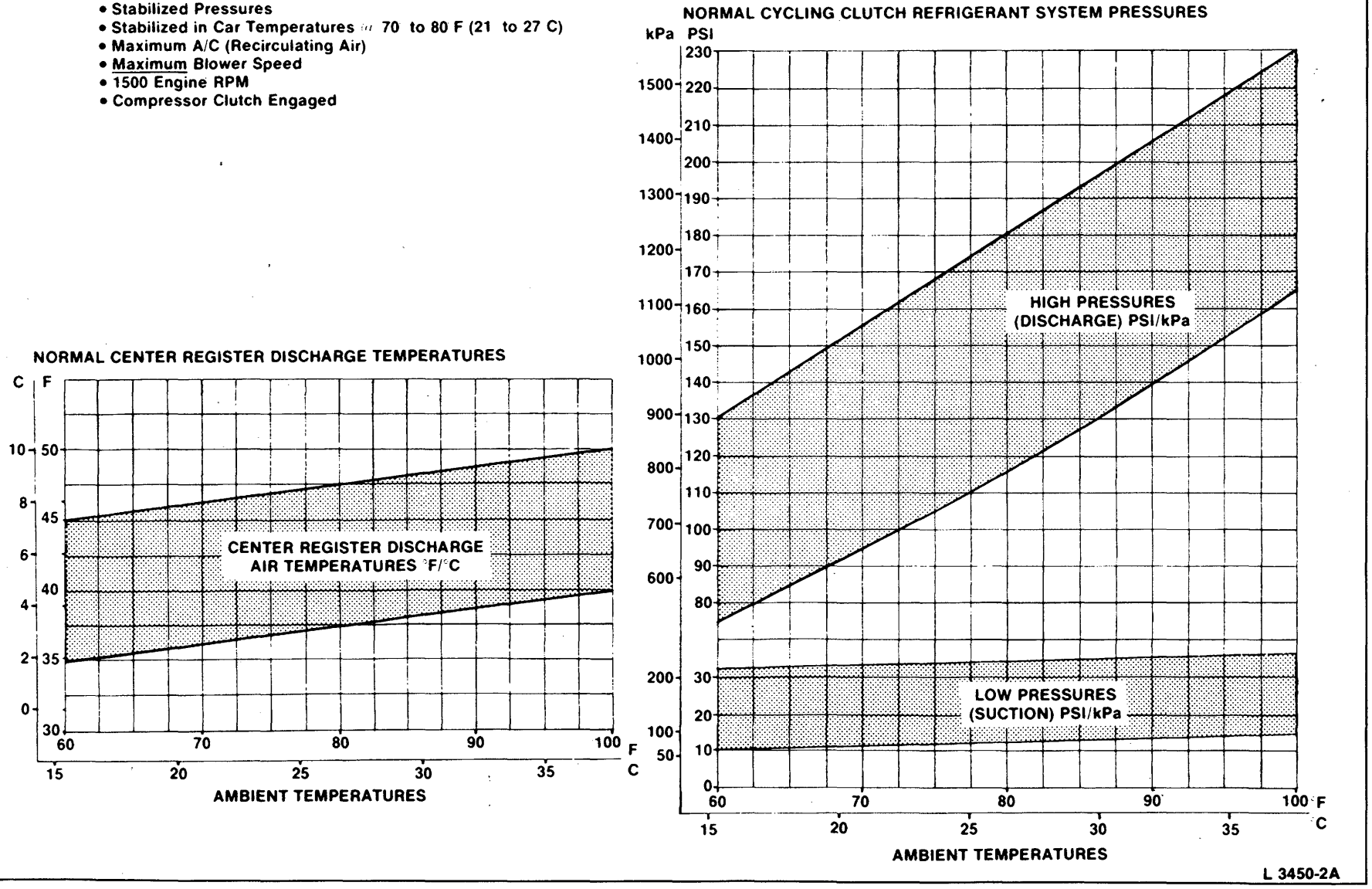


FIG. 13 Normal Clutch Cycling Pressure/Temperature Relationship

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REFRIGERANT SYSTEM PRESSURE AND CLUTCH CYCLE TIMING EVALUATION CHART FOR FIXED ORIFICE TUBE CYCLING CLUTCH SYSTEMS

NOTE: System test requirements must be met to obtain accurate test readings for evaluation. Refer to the normal refrigerant system pressure/temperature and the normal clutch cycle ratio and times charts.

High (Discharge) Pressure	Low (Suction) Pressure	Clutch Cycle Time			Component — Causes
		Rate	On	Off	
High	High	Continuous Run			Condenser — Inadequate Airflow
High	Normal to High				Engine Overheating
Normal to High	Normal				Air in Refrigerant Refrigerant Overcharge (a) Humidity or Ambient Temp Very High (b)
Normal	High				Fixed Orifice Tube — Missing O Rings Leaking/Missing
Normal	High	Slow	Long	Long	Clutch Cycling Switch — High Cut In
Normal	Normal	Slow or No Cycle	Long or Continuous	Normal or No Cycle	Moisture in Refrigerant System Excessive Refrigerant Oil
		Fast	Short	Short	Clutch Cycling Switch — Low Cut In or High Cut Out
Normal	Low	Slow	Long	Long	Clutch Cycling Switch — Low Cut Out
Normal to Low	High	Continuous Run			Compressor — Low Performance
Normal to Low	Normal to High				A/C Suction Line — Partially Restricted or Plugged (c)
Normal to Low	Normal	Fast	Short	Normal	Evaporator — Restricted Airflow
			Short to Very Short	Normal to Long	Condenser fixed orifice Tube or A/C Liquid Line — Partically Restricted or Plugged
			Short to Very Short	Short to Very Short	Low Refrigerant Charge
			Short to Very Short	Long	Evaporator Core — Partially Restricted or Plugged
Normal to Low	Low	Continuous Run			A/C Suction Line — Partially Restricted or Plugged (d) Clutch Cycling Switch — Sticking Closed
Low	Normal	Very Fast	Very Short	Very Short	Clutch Cycling Switch — Cycling Range Too Close
Erratic Operation or Compressor Not Running		—	—	—	Clutch Cycling Switch — Dirty Contacts or Sticking Open Poor Connection at A/C Clutch Connector or Clutch Cycling Switch Connector A/C Electrical Circuit Erratic — See A/C Electrical Circuit Wiring Diagram

Additional Possible Cause Components Associated with Inadequate Compressor Operation

- Compressor Drive Belt — Loose
- Compressor Clutch — Slipping
- Clutch Coil Open — Shorted or Loose Mounting
- Control Assembly Switch — Dirty Contacts or Sticking Open
- Clutch Wiring Circuit — High Resistance Open or Blown Fuse

Additional Possible Cause Components Associated with a Damaged Compressor

- Compressor Clutch — Seized
- Clutch Cycling Switch — Sticking Closed
- Suction Accumulator Drier — Refrigerant Oil Bleed Hole Plugged
- Refrigerant Leaks

(a) Compressor may make noise on initial run. This is slugging condition caused by excessive liquid refrigerant.
(b) Compressor clutch may not cycle in ambient temperatures above 80°F depending on humidity conditions.
(c) Low pressure reading will be normal to high if pressure is taken at accumulator and if restriction is downstream of service access valve.
(d) Low pressure reading will be low if pressure is taken near the compressor and restriction is upstream of service access valve.

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FIG. 14 Refrigerant System Pressure Evaluation Chart

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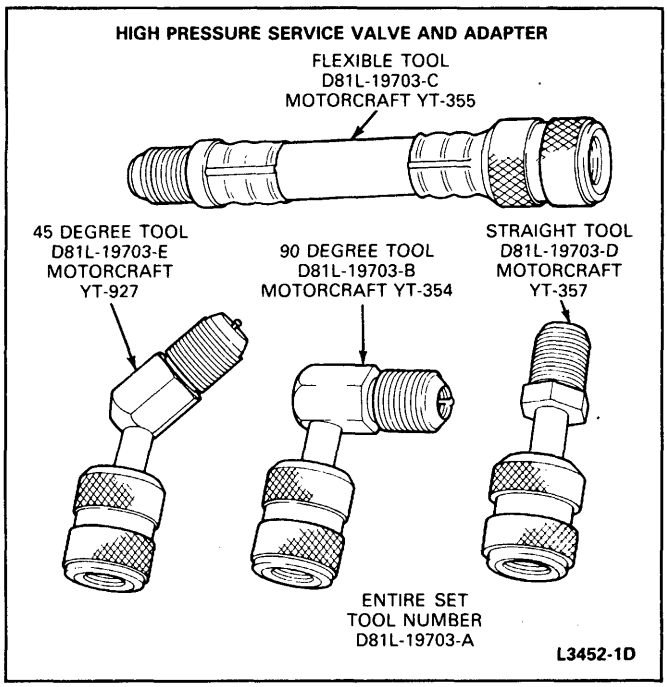


FIG. 15 High Pressure Service Access Gauge Port Valve

connect a manifold gauge set to the high pressure service access gauge port valve (Fig. 15). The adapters contain a Schrader-type valve core to prevent accidental discharge of refrigerant if the service hose is inadvertently disconnected from the adapter. Refer to Section 36-30, Air Conditioning-General Service for details regarding refrigerant system service and for procedures describing the use of the Special Tee Adapter Tool D87P-19703-A.

NOTE: Whenever a refrigerant line is replaced, or service for a major component requires the opening of the system to the atmosphere the suction accumulator/drier must be replaced.

Excess Moisture

One of the characteristics of an air conditioner is that it will remove moisture from air passing through the cooled evaporator core. This moisture (condensate) then runs off the evaporator core and is drained from the evaporator case. In some instances, leaves or other foreign material plug the drain and sometimes mechanical conditions such as a damaged or kinked drain tube prevent the condensate from draining from the evaporator case. If either of these conditions exist, condensate may drip from the evaporator case or be blown from the instrument panel registers. This cause of insufficient evaporator case drainage or leads can best be eliminated by performing the inspections and correction procedures as follows.

Inspection

1. Inspect the vehicle dash panel for missing grommets plugs or seals. Also, inspect for correct sealing of the evaporator case-to-dash panel retaining nuts to correct a seal leak between the evaporator case and the dash panel.
2. Inspect for possible air leaks around the heater lines at the evaporator case and around the electrical connector at the bottom of the evaporator case. Seal any leaks around the refrigerant lines with insulating Tape Motorcraft YZ-1, or Caulking Cord D6AZ-19560-A, or equivalent.

ADJUSTMENTS

Temperature Control Cable

1. Set the temperature control lever in the COOL position.
2. Remove the cable from the retaining clip on top of the evaporator-heater core. Leave the cable attached to the yellow crank.
3. Rotate the yellow crank counterclockwise until the temperature blend door seats.
4. Check again to be sure that the temperature lever is in the COOL position. Then, install the cable housing in its retaining clip by pushing it from the top until it snaps into place.
5. Turn the blower switch to its HI position and move the temperature lever through its range of travel to check for proper cable adjustment. Readjust if necessary.

REMOVAL AND INSTALLATION

Control Assembly

Removal

1. Remove trim applique.
2. Remove four screws retaining control assembly to mounting bracket (Fig. 16).
3. Carefully pull control assembly from opening in mounting bracket.
4. Disconnect electrical wiring connector from blower switch, vacuum selector, and illumination bulb.
5. Remove push-on vacuum harness retaining clips from vacuum selector.
6. Disconnect vacuum harness from vacuum selector.
7. Remove temperature control cable from control assembly. Disconnect bullet-type cable retainer from the bracket using the Control Cable Removal Tool T83P-18532-AH (Fig. 17) or needlenose pliers to compress the retaining ears. Both cable "S" bends are removed from the bottom side of the levers by rotating cable wire 90 degrees to the lever.

Installation

1. Connect temperature and function control cables to the control assembly (Fig. 17).
2. Connect vacuum harness to vacuum selector and retain it with two push-on clips.
3. Connect electrical wiring connector to blower switch(s), vacuum selector valve and illumination bulb wire and socket assembly.
4. Carefully position the control assembly on its mounting bracket and install attaching screws.
5. Install applique.
6. Adjust control cable as described previously.

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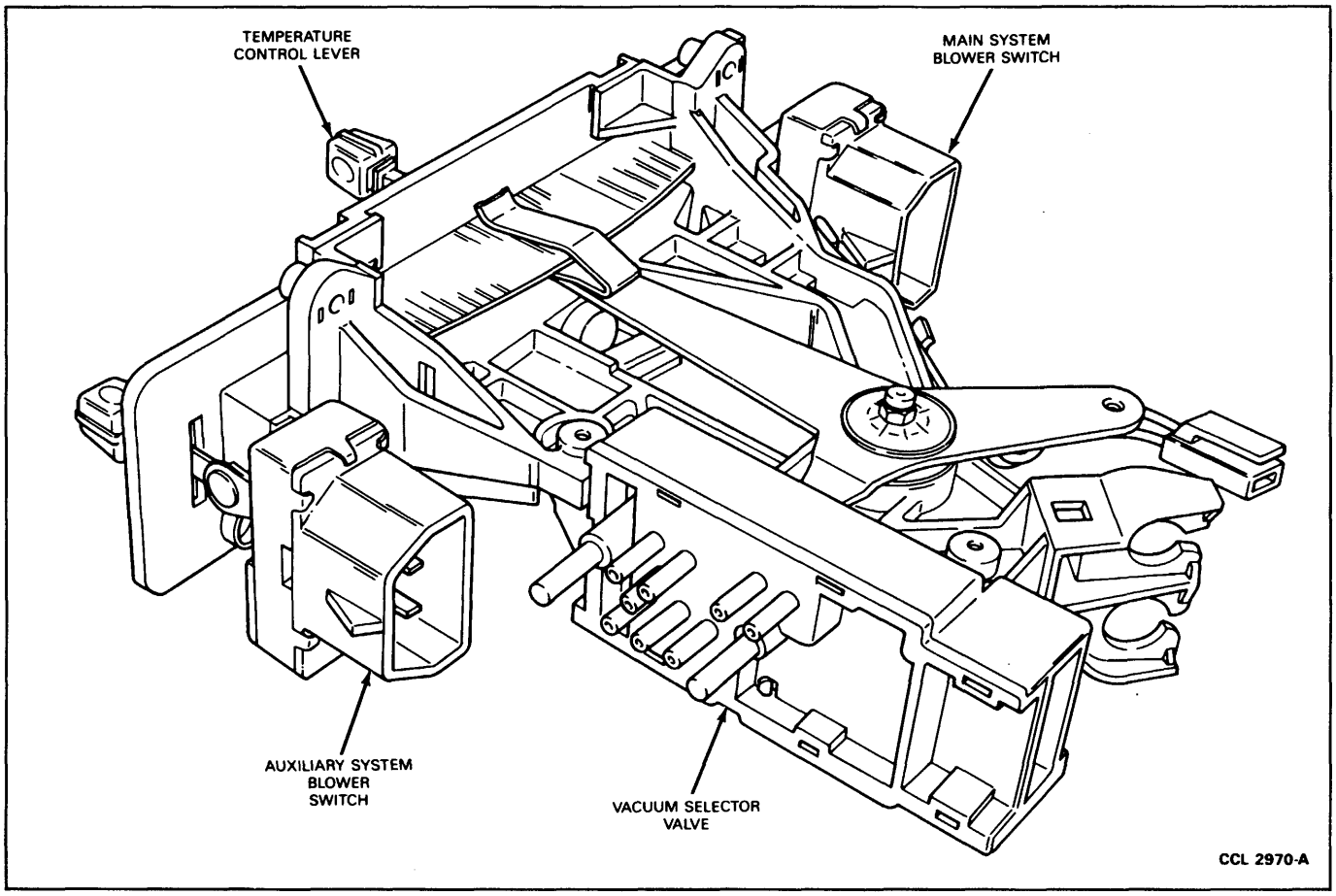


FIG. 16 Control Assembly

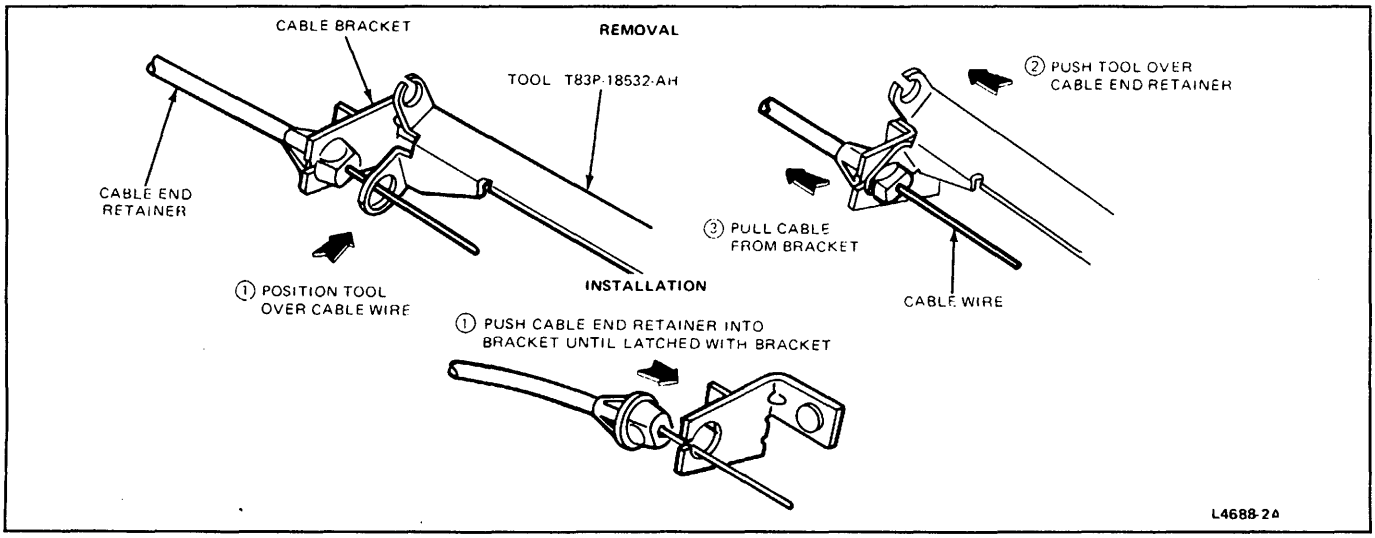


FIG. 17 Control Lever Cable Removal and Installation

Blower Switch

Removal

1. Remove the knob(s) from blower switch (Fig. 8).
2. Remove trim applique.
3. Remove four screws retaining control assembly mounting bracket to instrument panel.
4. Carefully remove the mounting bracket and control assembly from opening in instrument panel.
5. To remove blower switch, disconnect the wire harness connector from blower switch and remove switch mounting bracket from control assembly (one screw).

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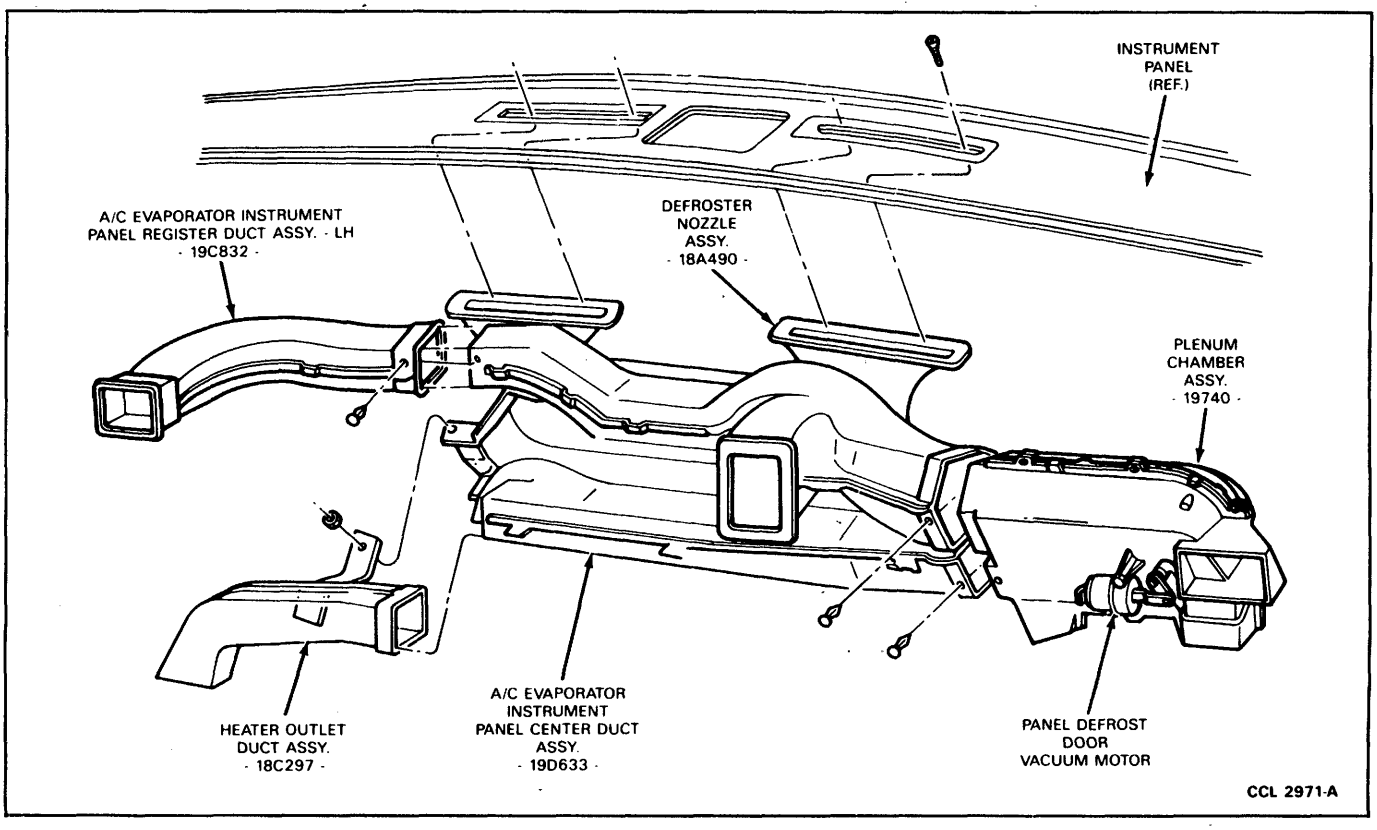


FIG. 18 A/C—Heater Ducts and Defroster Nozzle

Installation

1. Position blower switch and bracket on control assembly and secure with one screw.
2. Connect wiring harness to blower switch.
3. Position control assembly and bracket in instrument panel and secure it with four retaining screws.
4. Install trim applique.
5. Install knob(s) on switch.

Vacuum Selector Valve

Removal

1. Remove instrument panel trim panel.
2. Remove four screws retaining control assembly mounting bracket to instrument panel.
3. Carefully remove mounting bracket and control assembly from opening in instrument panel.
4. Disconnect wire harness connector from vacuum selector valve.
5. Remove two push-on vacuum harness retainer clips from vacuum selector and disconnect harness from valve.
6. Remove two screws retaining vacuum selector valve to control assembly (Fig. 16).

Installation

1. Position temperature lever at LH side of slot and function selector lever approximately 9.5mm (3/8 inch) from LH side of slot.
2. Position vacuum selector valve on control assembly, engaging selector lever arms with selector valve. Install two retaining screws.
3. Connect vacuum harness to selector valve and install two pushnuts.
4. Connect wire harness connector to selector.
5. Position control assembly and bracket in instrument panel and install four retaining screws.
6. Install instrument panel trim panel.

Instrument Panel

Removal and installation of several components and assemblies described in this Section require the removal and installation of the instrument panel. For instructions and illustrations, refer to Section 45-61, Instrument Panel and Pad.

Defroster Nozzle

To remove the defroster nozzle, it is first necessary to remove the instrument panel, heater ducts and register ducts. Refer to Figure 18 for heater and register duct illustrations. Refer to Section 45-61, Instrument Panel and Pad for instrument panel removal and installation.

Removal

1. Remove two screws retaining defroster nozzle to each defroster opening near the windshield.
2. Pull defroster nozzle from plenum and remove it from vehicle.

Installation

1. Position defroster nozzle on plenum and align it with defroster openings.

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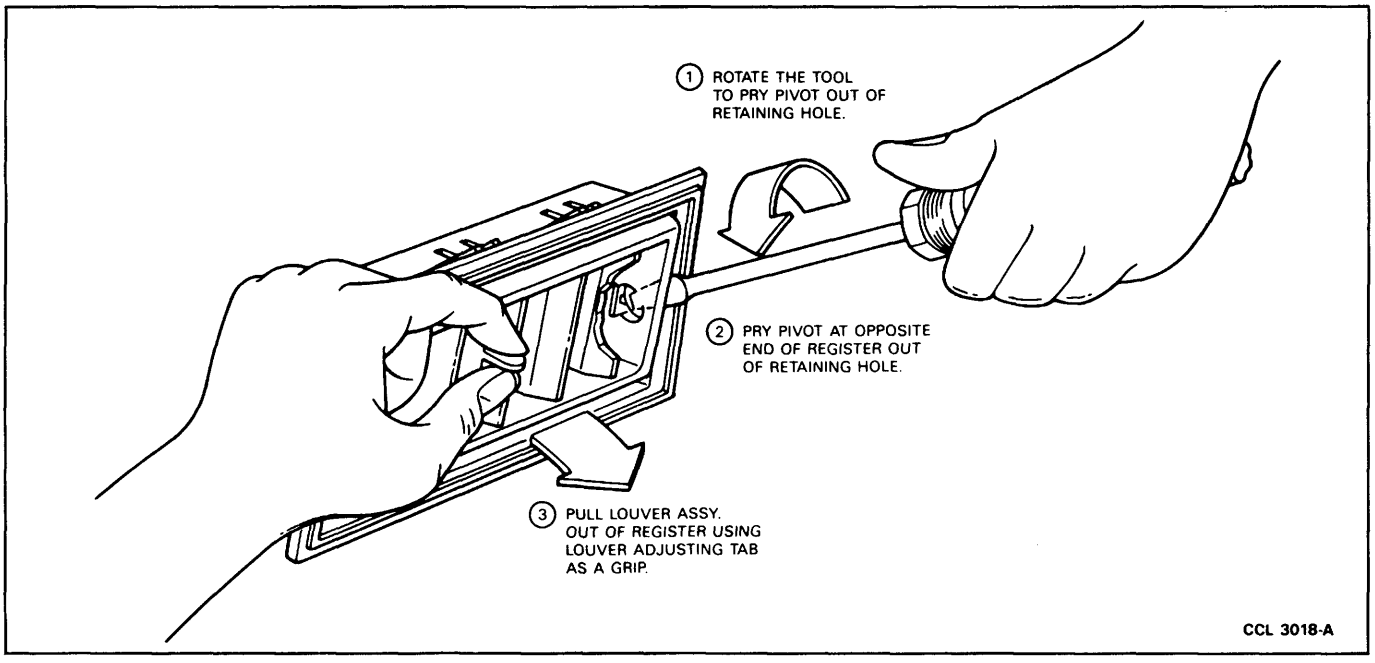


FIG. 19 Register Louver Removal

2. Install two screws retaining defroster nozzle to each defroster opening.
3. Install register ducts and heater ducts following procedures described in this Section.
4. Install instrument panel. Refer to Section 45-61, Instrument Panel and Pad.
5. Check system for proper operation.

Register Louver Assembly

Removal

1. Insert a thin-blade screwdriver under retaining tab (Fig. 19) and pry retaining tab toward louvers until retaining tab clears hole in register assembly.
2. Pull louver end out from register opening only enough to prevent louver pivot from going back into the pivot hole.
3. Repeat Step 1 for the other retaining tab and pull louver assembly from register opening.

Installation

The pivots on each end of some louver assemblies are different diameters and therefore determine the installed position. Other louvers have an arm extending inward on one end of the louver assembly. This end of the louver should be installed in the register assembly at the same end as the raised boss in the register assembly.

1. Position louver assembly into register opening.
2. Depress retaining tabs and push louver assembly into register opening and engage retaining tabs in pivot holes.

Registers

Refer to Figures 20, 21 and 22.

Right Register Assembly

Removal

1. Remove louver assembly from register assembly.
2. Using a small-blade screwdriver or an awl, pry the register assembly retaining tabs toward the register opening. Push the adapter retaining tabs out of the LH and RH sides of the register housing. Then, pull the register from the instrument panel opening and the register duct (Fig. 20).

Installation

1. Position the register assembly into instrument panel opening. The correctly instailed position is when the louvers are moved to the right to close.
2. While supporting the register adapter, push the register assembly into the instrument panel opening and the register duct until the register tabs lock into place behind the instrument panel opening flange and into the adapter.

Center Register Panel Assembly

1. Disconnect battery ground cable.
2. Remove control knobs from radio shafts, if so equipped.
3. Disconnect wire from cigar lighter, if so equipped.
4. Unsnap name plate from its recessed location at the right of registers, if so equipped.
5. Remove six screws (five without nameplate) retaining register panel assembly to instrument panel (Fig. 21).
6. Pull register panel assembly from instrument panel, unsnapping two clips at the right end of register panel.

Installation

1. Position register panel assembly to instrument panel and engage two snap clips.
2. Install register panel assembly attaching screws.
3. Install nameplate, if so equipped.
4. Connect wire to the cigar lighter, if so equipped.

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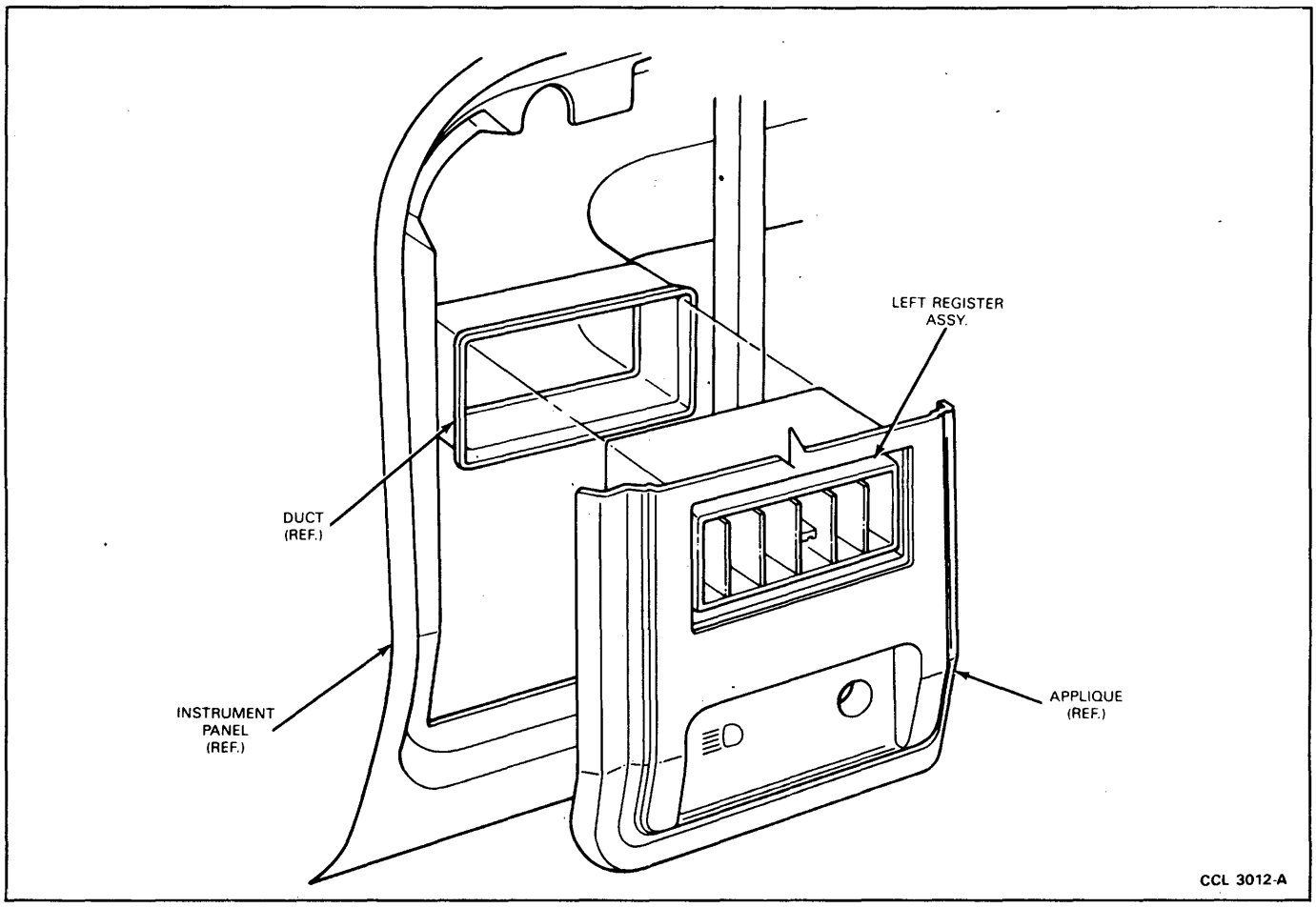


FIG. 20 Right Register Assembly

5. Install control knobs on radio shafts, if so equipped.
6. Connect battery ground cable.

Left Register Panel Assembly

Removal

1. Disconnect battery ground cable.
2. Remove ignition lock cylinder and ignition switch bezel.
3. Remove headlamp switch knob and shaft. Then, remove headlamp switch bezel.
4. Remove knob from windshield wiper switch.
5. Remove two screws retaining LH register panel to the instrument panel (Fig. 22).
6. Pull register panel assembly away from instrument panel to disengage snap clips at top of register panel.

Installation

1. Position register panel in instrument panel and push it to engage snap clips.
2. Install two screws retaining lower edge of register panel to instrument panel.
3. Install headlamp switch bezel and knob and shaft assembly.
4. Install ignition switch bezel and ignition switch lock cylinder.
5. Install windshield wiper switch knob.
6. Connect battery ground cable.

Air Ducts

Remove instrument panel. Refer to Section 45-61, Instrument Panel and Pad. Refer to Fig. 18 for an illustration of the A/C-heater air ducts.

Left Register Duct

Removal

1. Remove retainer attaching LH register duct to center register duct (Fig. 18).
2. Pull LH register duct from center register duct.

Installation

1. Position LH register duct to center register duct and align retainer holes.
2. Install retainer to attach LH register duct to center register duct.

Center Register Duct

Removal

1. Remove LH register duct.
2. Disengage vacuum harness locator tab from center register duct.
3. Remove one retainer attaching center register duct to plenum.

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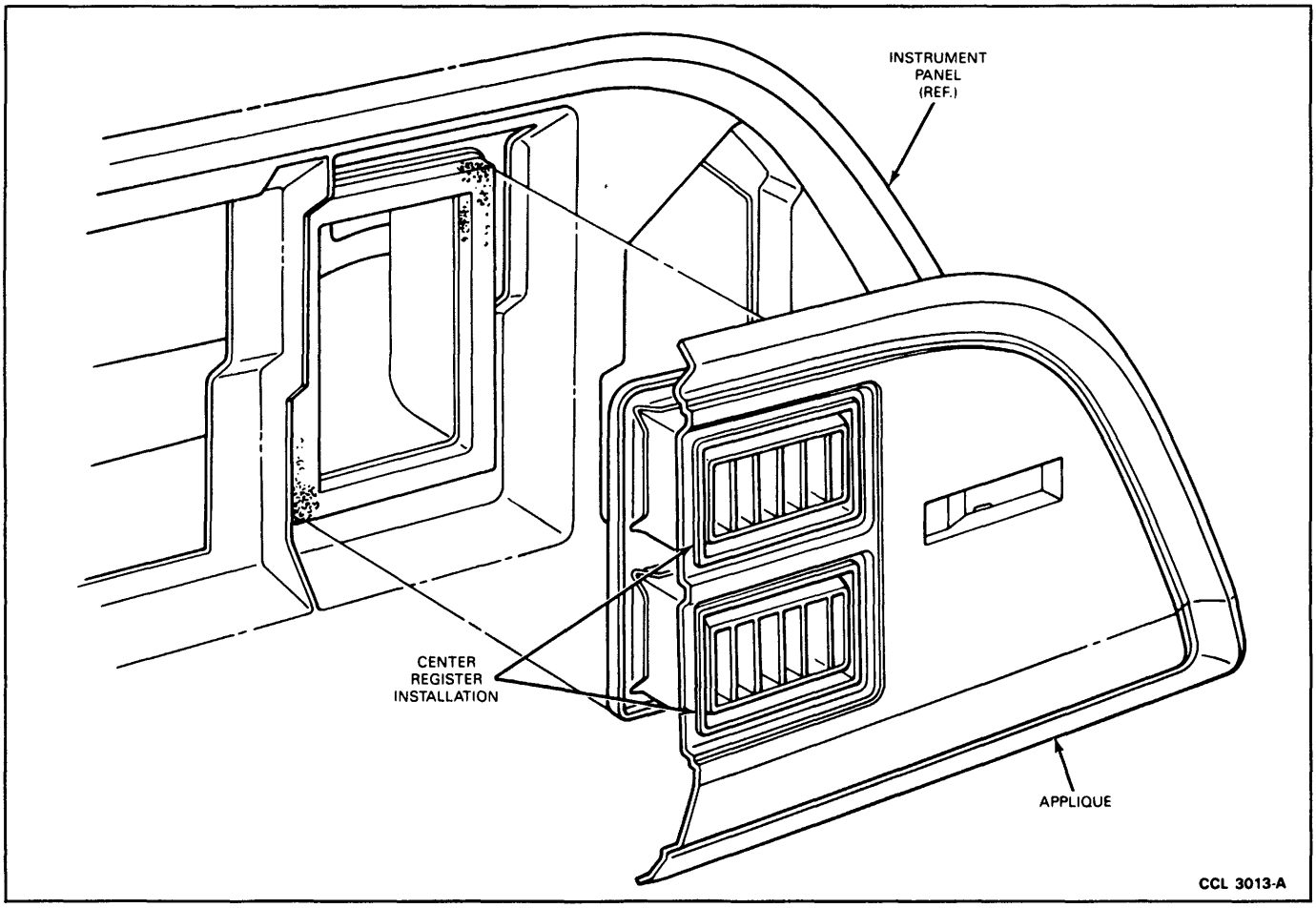


FIG. 21 Center Register Assembly

4. Remove one nut retaining heater air outlet duct, LH heat duct and center register duct support braces to brake pedal support (Fig. 18).
5. Disengage center register duct support brace from clip bolt and remove the center register duct.

Installation

1. Position the RH end of center register duct to plenum and support brace at LH end of duct to clip bolt.
2. Install LH heat duct support brace on clip bolt and install retaining nut.
3. Install retainer to attach center register duct to plenum (Fig. 18).
4. Connect vacuum harness locator tab to center register duct.
5. Install LH register duct.

Heater Duct

Removal

1. Remove one nut retaining LH heat duct, floor outlet duct and center register duct support braces to brake pedal support braces to brake pedal support.
2. Disengage the wiring harness locator tabs and vacuum harness locator tab from heater air outlet duct.
3. Remove one retainer attaching LH heat duct to heater air outlet duct and remove LH heat duct.
4. Remove one retainer attaching heat duct to plenum (Fig. 18).
5. Disengage heater air outlet duct support brace from clip bolt on brake pedal support and remove heater air outlet duct.

Installation

1. Position RH end of heater air outlet duct to plenum and support brace at the LH end of the duct to clip bolt on brake pedal support.
2. Place center register duct support brace on clip bolt over heat duct brace.
3. Position LH heat duct to heater air outlet duct and support brace to clip bolt.
4. Install nut that retains three support braces to clip bolt (Fig. 18).
5. Install one retainer to attach heat duct to plenum and one retainer to attach LH heat duct to heater air outlet duct.
6. Install wiring harness and vacuum harness locator tabs in their respective locations on the heater air outlet duct.
7. Install instrument panel following the procedure in Section 45-61, Instrument Panel and Pad after all air ducts are installed.

Plenum Chamber

The plenum chamber is located under the instrument panel on top of the blower motor housing. For servicing

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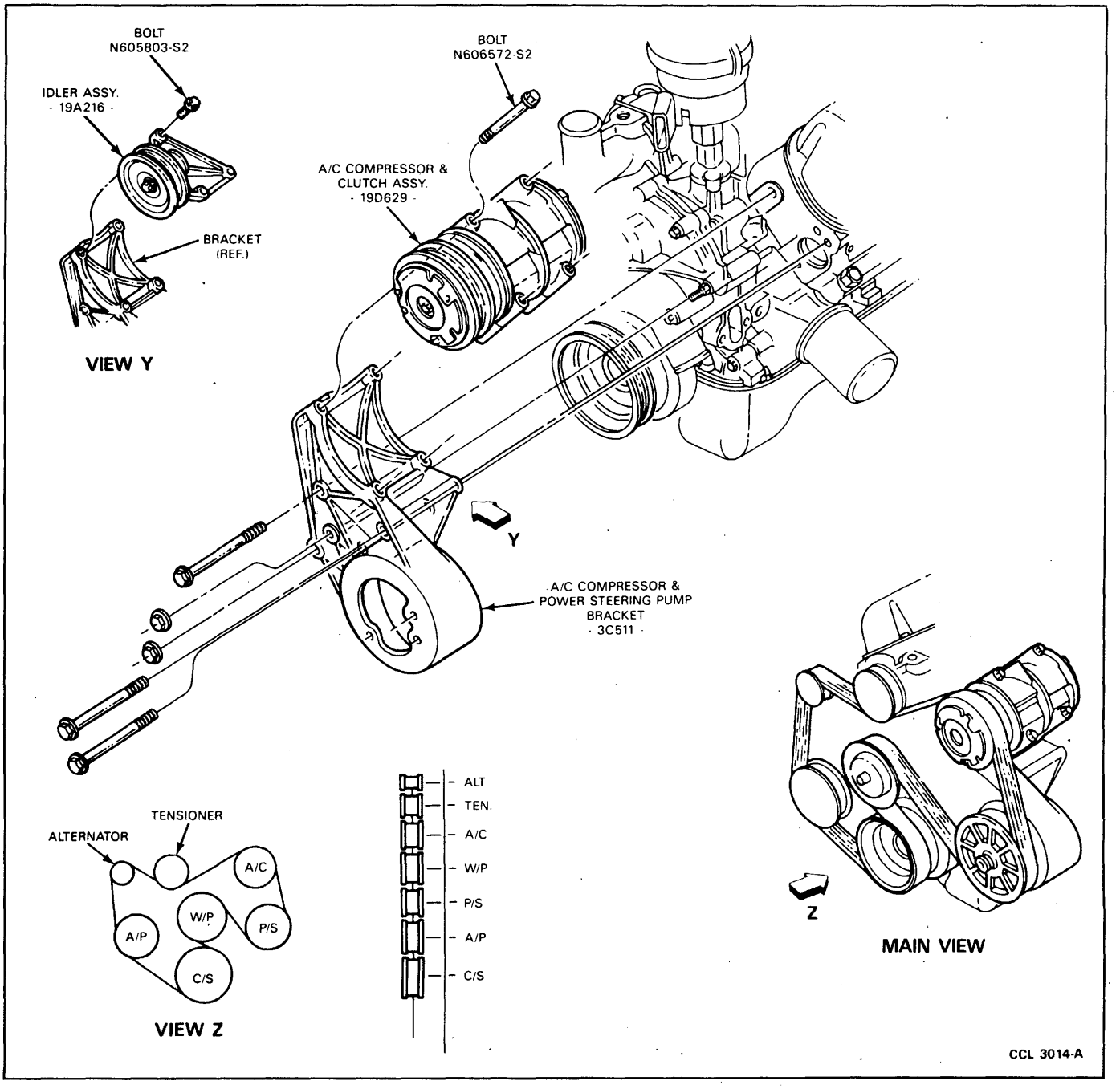


FIG. 22 Left Register Assembly

the plenum-chamber, vacuum harness, and plenum doors, it is necessary to remove the instrument panel. It is not required to remove the instrument panel to service the vacuum motors attached to the plenum (Fig. 23).

Removal

1. Disconnect the vacuum hoses from the heat-defrost vacuum motor and the A/C-heat vacuum motor.
2. Remove one retainer attaching the center register duct to plenum and one retainer attaching heater air outlet duct to plenum.
3. Separate plenum from evaporator-heater housing, center register duct, and heater air outlet duct and remove plenum.

Installation

1. Install heat-defrost and A/C-heat door vacuum motors on plenum (Fig. 23).
2. Position plenum to center register duct, heater air outlet duct and evaporator-heater housing. Ensure clip on plenum is hooked over flange on evaporator-heater housing.
3. Install one retainer to attach center register duct and one retainer to attach heater air outlet duct to plenum.
4. Connect the blue vacuum hose to the top (end) of the A/C-heat door vacuum motor.
5. Connect the yellow vacuum hose to the top (end) of the heat-defrost door vacuum motor. Connect

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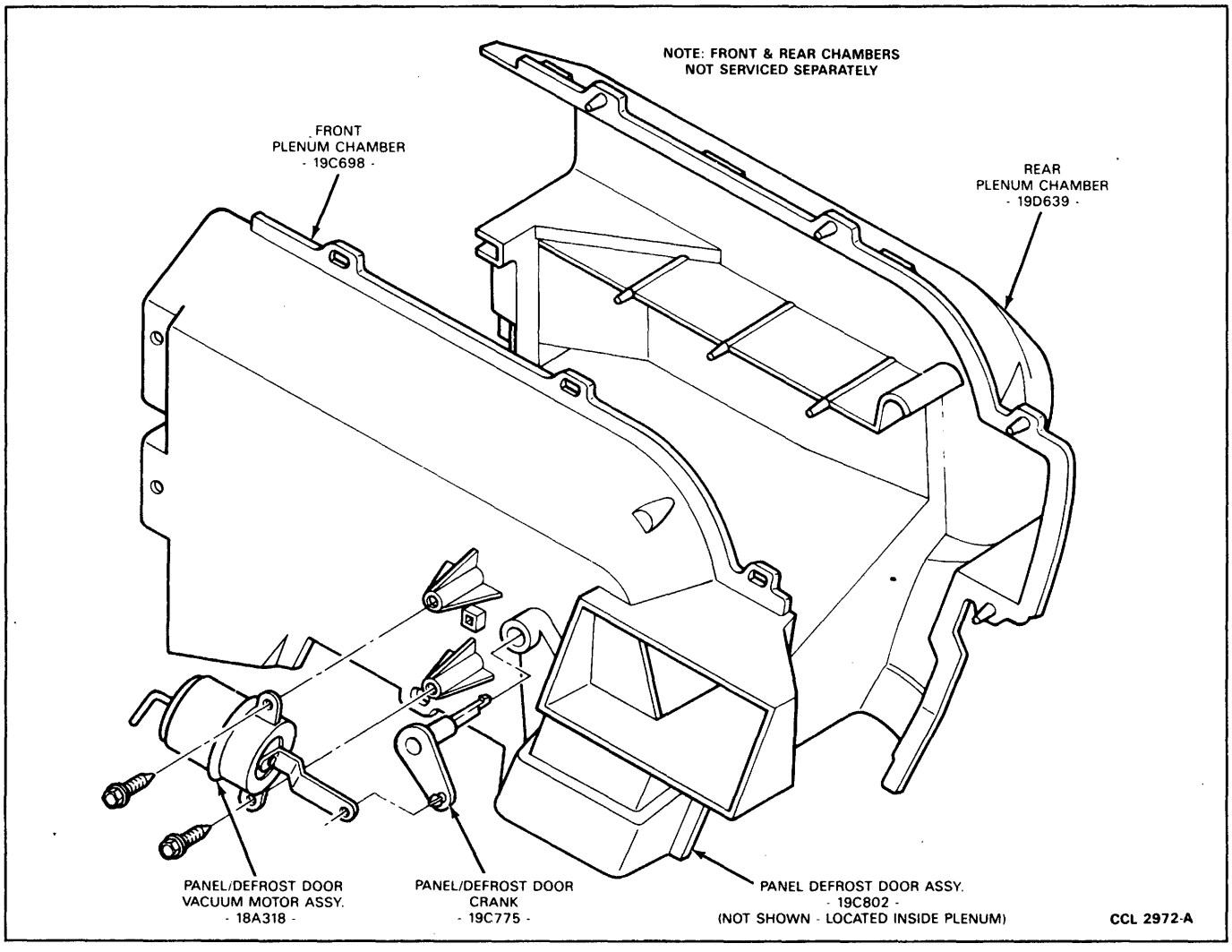


FIG. 23 Plenum Chamber

the red vacuum hose to the side of the heat-defrost door vacuum motor.

6. Install the instrument panel. Refer to Section 45-61, Instrument Panel and Pad.
7. Check system for proper operation.

Outside/Recirculating Air Door Vacuum Motor

On Evaporator Case

Removal

1. Remove two screws retaining motor to evaporator-heater housing.
2. Carefully pry vacuum motor arm off rosebud clip on door crank.
3. Disconnect the vacuum hose from outside-recirc vacuum motor and remove motor and bracket.

Installation

1. Snap the vacuum motor arm over the rosebud clip on the crank.
2. Connect vacuum hose to vacuum motor and position the motor and bracket to the evaporator-heater case.
3. Install the two screws retaining vacuum motor.
4. If necessary, install a new pushnut (Part No. 383358-S) or equivalent to retain motor arm on door crank arm.
5. Check system for proper operation.

Vacuum Motors

On Plenum

Remove and install vacuum motors as shown in Fig. 25. The illustration also relates the vacuum harness to each vacuum motor.

Clutch Cycling Pressure Switch

The clutch cycling pressure switch is attached to the suction accumulator/drier located in the engine compartment (Fig. 26). In the A/C position, the pressure switch senses pressure in the drier and electrically controls the cycling of the clutch assembly to prevent the core from freezing the condensation which occurs. If allowed to build up, the ice would block airflow. The cut-in pressure of the compressor clutch is approximately 43.5 lbs (clutch is operative) and the cut-out pressure is approximately 24.5 lbs (clutch is inoperative).

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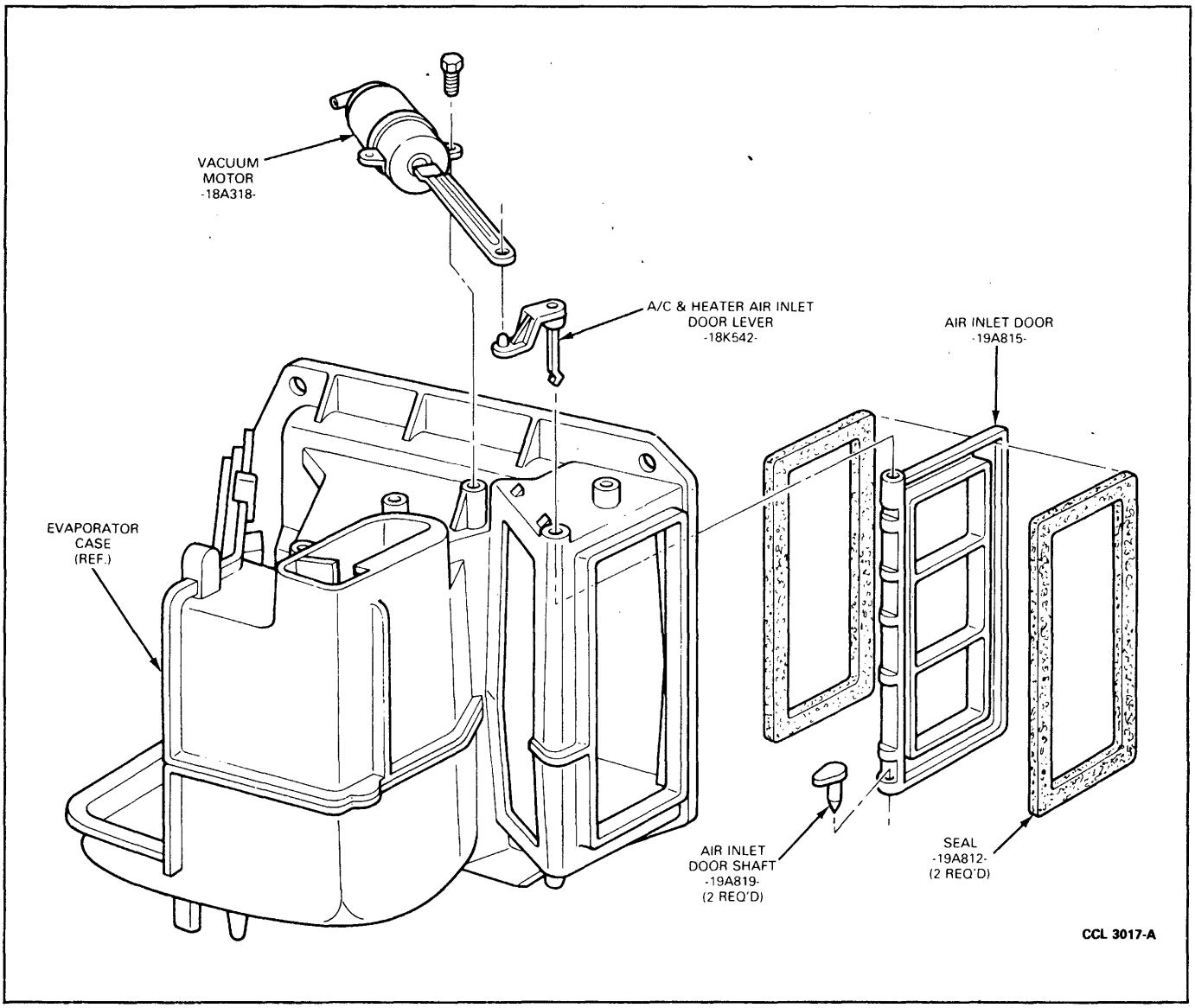


FIG. 24 Outside/Recirc Air Door Vacuum Motor and Vacuum Harness Assembly

Removal

1. Remove electrical connector from switch. Unscrew pressure switch from top of suction accumulator/ drier.

Installation

1. Lubricate O-ring which is installed over switch threads. Use refrigerant oil.
2. Screw pressure switch onto top of suction accumulator/drier. Do not exceed specified torque limits. Tighten to 7-13 N·m (5-10 ft-lb). Install electrical connector.

Blower Motor and Wheel Assembly

Removal

1. Disconnect blower motor electrical connector (Fig. 27).
2. Remove four screws retaining blower motor mounting plate to the evaporator case assembly.
3. Remove motor and wheel assembly from evaporator case.
4. If old wheel is to be used on new motor, position it on the motor shaft so that distance from mounting to base of wheel is same as previous installation.

Installation

1. When wheel is properly installed on new motor, insert assembly into evaporator case and align locator pins with holes in base plate.
2. Install four mounting screws retaining motor mounting base plate.
3. Connect the electrical connector.
4. Check blower motor for proper operation.

Resistor Assembly

Removal and Installation

1. Disconnect electrical connector from resistor located on the evaporator case in the engine compartment. Refer to Figure 28.
2. Remove two screws from old resistor on front face of A/C blower evaporator-heater cover and remove resistor.

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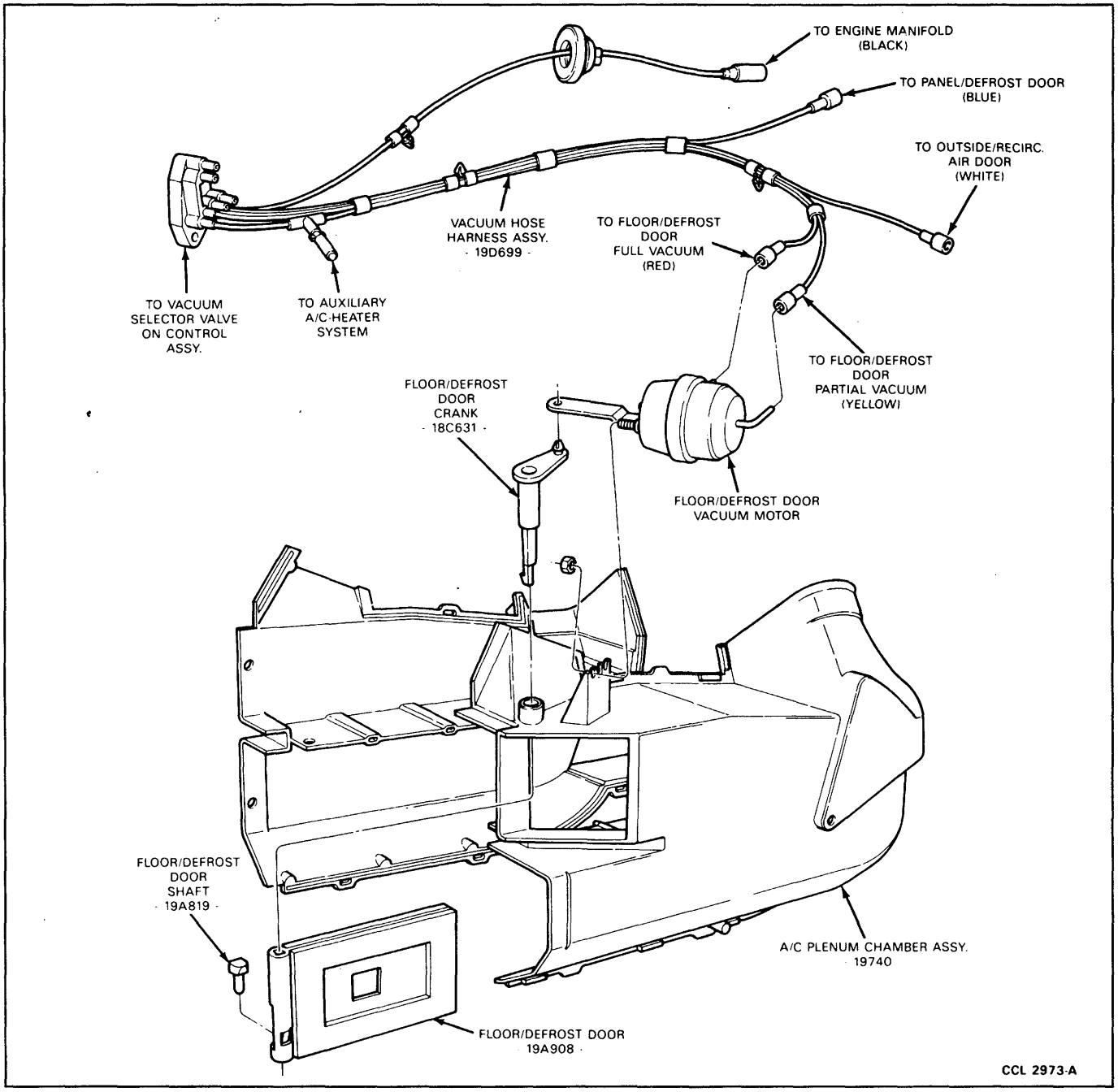


FIG. 25 Typical Vacuum Motor to Plenum Installation and Harness Assembly

3. Install new resistor to evaporator-heater cover with two screws and connect electrical connector.

Heater Core and Seal Assembly

Removal

1. Remove inlet and outlet hoses from heater core in engine compartment. Plug hoses with a 15.875mm (5/8-inch) diameter plug.
2. Remove two screws retaining modesty panel to underside of instrument panel. Remove panel.
3. Remove the four screws from heater core cover located on the LH side of case underneath instrument panel (Fig. 29). Remove cover.
4. Remove screw and retaining bracket at bottom of heater core.
5. Remove heater core and seal from case (Fig. 30).

Installation

1. Position heater core and seal assembly and install core retaining brackets and screws.
2. Remove plugs from hoses.
3. Install inlet and outlet hoses to heater core.
4. Position heater cover and install four retaining screws.
5. Attach modesty panel to instrument panel with two retaining screws.

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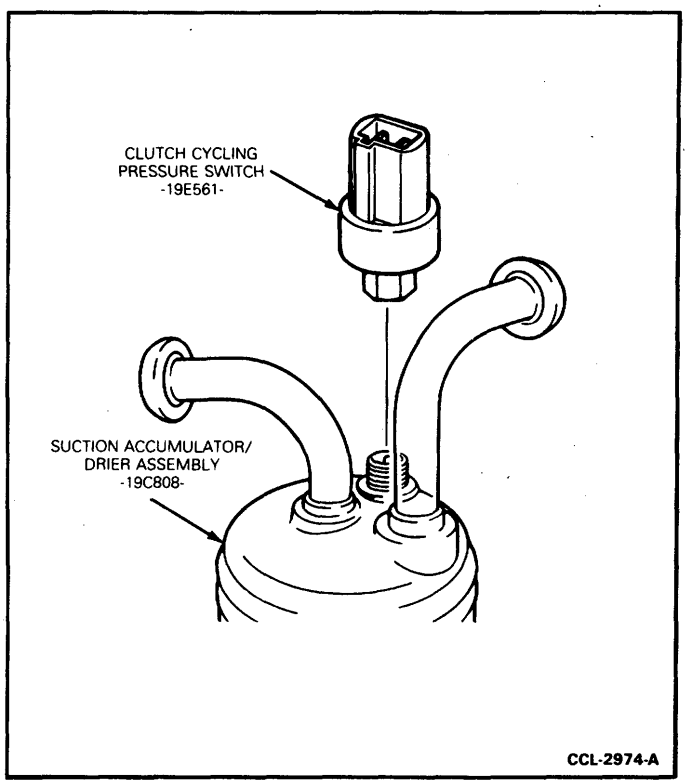


FIG. 26 Clutch Cycling Pressure Switch

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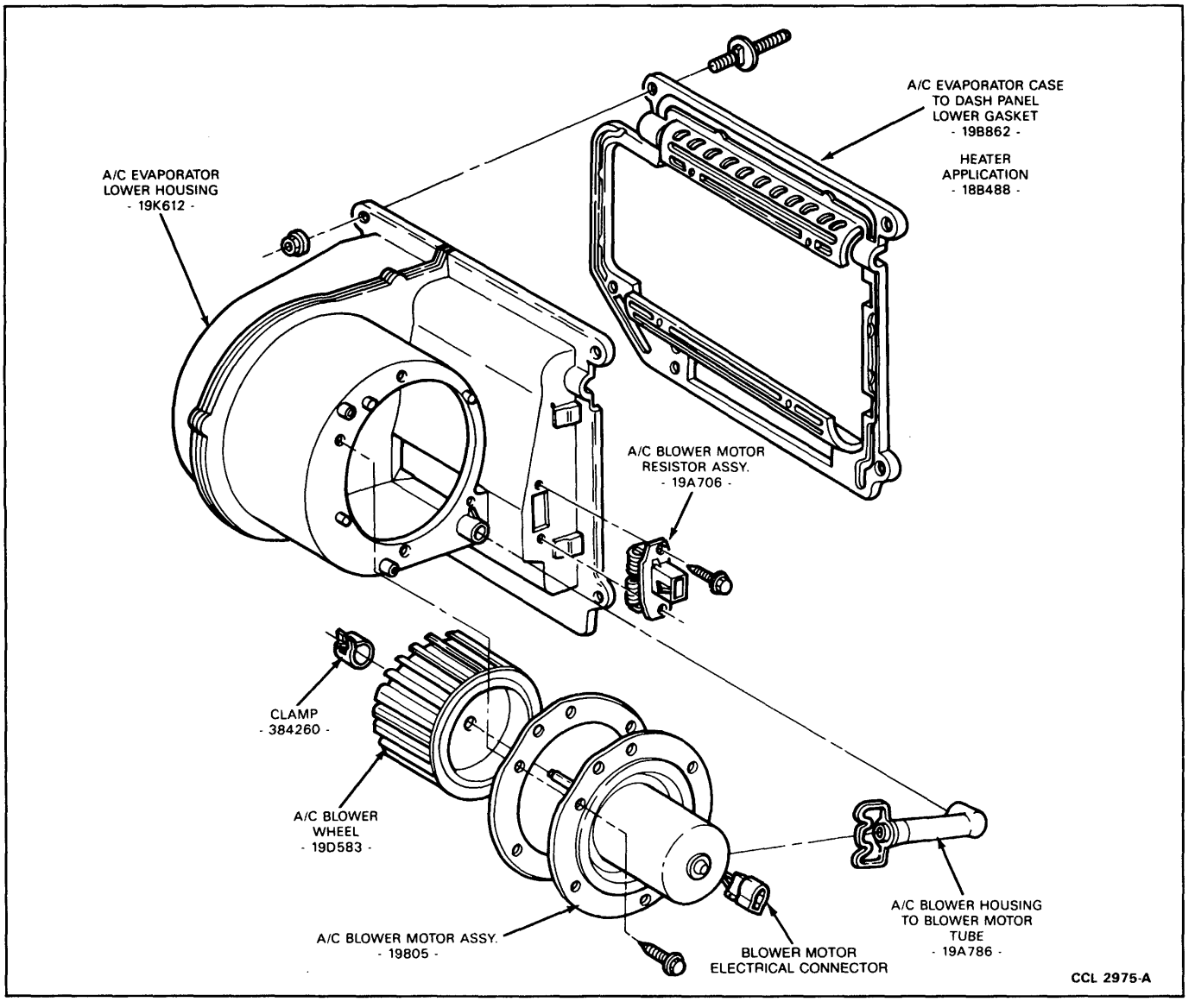


FIG. 27 Blower Motor and Wheel Assembly

Evaporator Core

Removal

1. Disconnect electrical connector from resistor on evaporator case and from pressure switch on accumulator.
2. Disconnect battery cables and remove battery.
3. Disconnect EEC-IV harness.
4. Remove heater hoses from heater core and plug hoses with suitable 15.875mm (5/8-inch) plugs.
5. Discharge refrigerant from system observing all safety precautions.
6. Disconnect suction line from accumulator/drier and liquid line from evaporator core.
7. Remove five nuts retaining evaporator assembly to dash and remove evaporator assembly (Fig. 31).
8. Remove two screws retaining accumulator/drier to case.
9. Disconnect accumulator from evaporator case.
10. Remove evaporator core and seal assembly by pulling back retaining tab in housing.

Installation

When installing the evaporator core and seal assembly, make sure all new O-ring seals are used and positioned properly in their respective location.

CAUTION: Use care not to damage or bend fins when handling evaporator core.

1. Position evaporator core and seal assembly on the evaporator assembly and snap it into the four retaining tabs.
2. Install accumulator/drier on evaporator core.
3. Install two screws which retain the accumulator to case.
4. Position evaporator assembly against the dash and secure with five nuts (Fig. 31).
5. Connect suction line to accumulator/drier and liquid line to evaporator core.
6. Connect EEC-IV harness.

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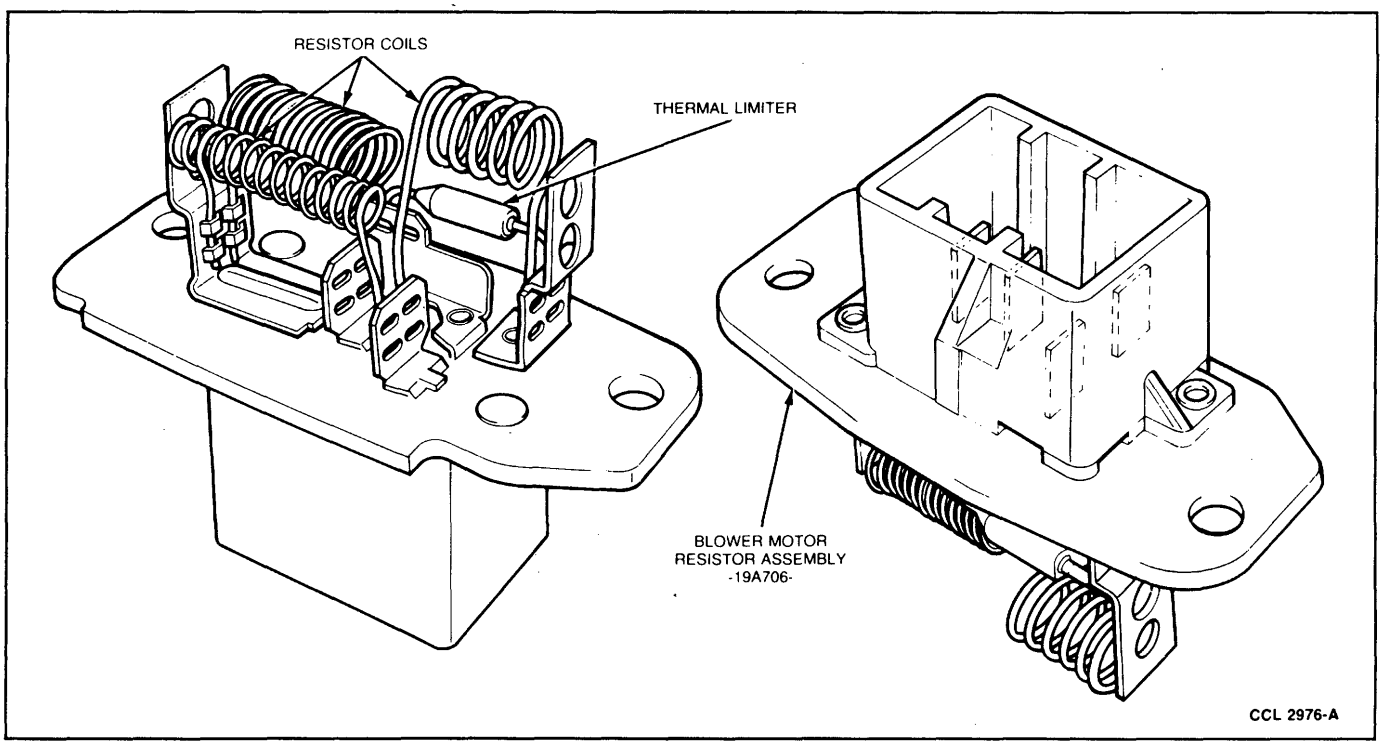


FIG. 28 Blower Motor Resistor Assembly

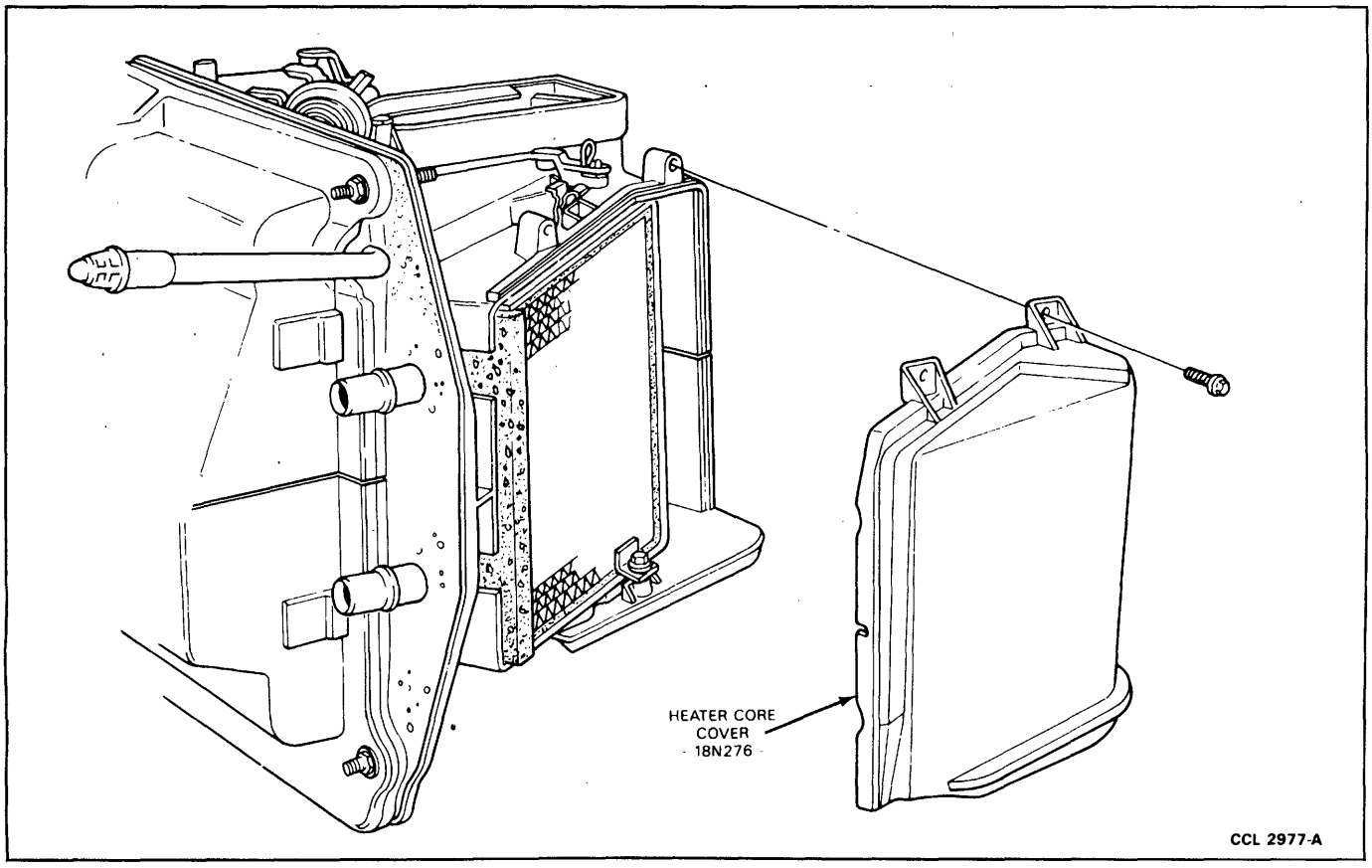


FIG. 29 Heater Core Cover Removal

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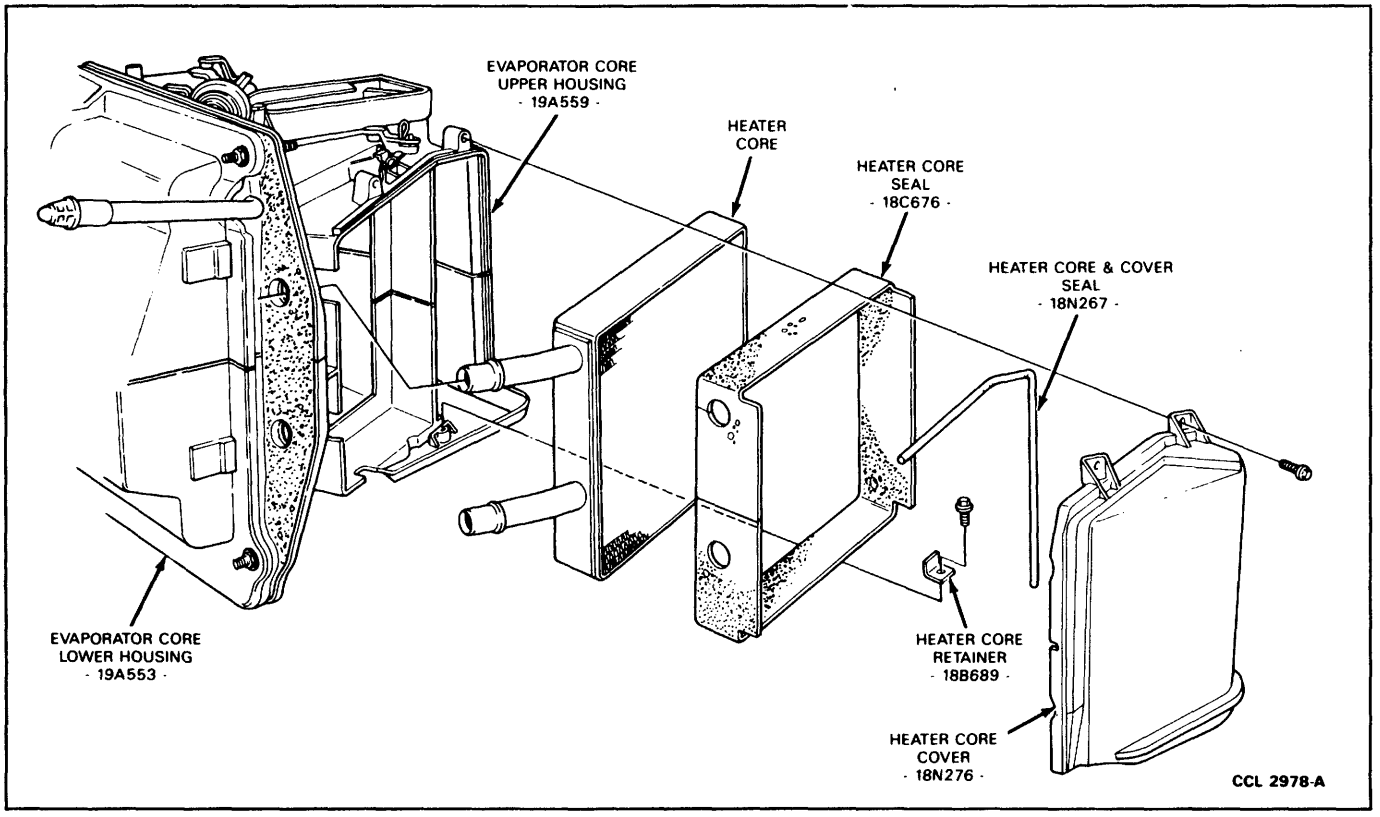


FIG. 30 Heater Core and Seal Removal

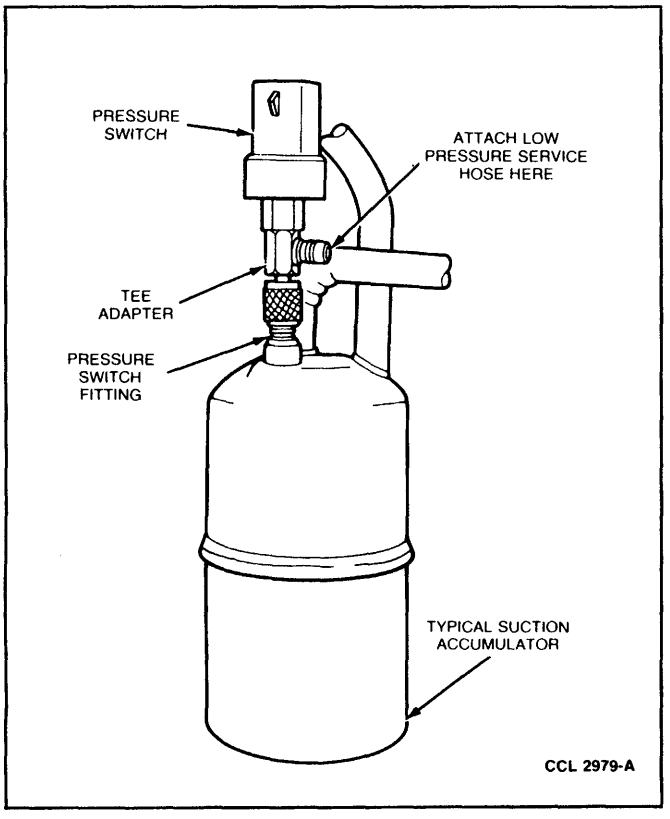


FIG. 31 Evaporator Core Assembly

7. Install battery and connect battery cables.
8. Install connectors to resistor and pressure switch.
9. Remove plugs from hoses.
10. Connect heater hoses to heater core.
11. Refill cooling system with coolant.
12. Charge A/C system and check it for leaks.

Fixed Orifice Tube

The fixed orifice tube is constructed with a plastic body, two screens and a small brass tube down the center of the orifice body. Two O-rings are around the orifice tube body to seal against leakage around the body (Fig. 32).

CAUTION: Do not attempt to remove the fixed orifice tube with pliers or by twisting tube. To do so will break the fixed orifice tube body in the evaporator core tube. Use only the recommended tool and follow the recommended service procedures.

Removal

1. Discharge refrigerant from A/C system. **Observe all safety precautions.**
2. Disconnect liquid line from evaporator core. Cap liquid line to prevent entry of dirt and excessive moisture.
3. Squirt a small amount of clean refrigerant oil into evaporator core inlet tube to lubricate tube and orifice O-rings during removal of the fixed orifice tube from evaporator core tube.
4. Engage Fixed Orifice Tube Installer T83L-19990-A (Motorcraft YT-1008) or equivalent with the two tangs on the fixed orifice tube (Fig. 32).

   CAUTION: Do not twist or rotate the fixed tube in the evaporator core tube as it may break off the evaporator core tube.

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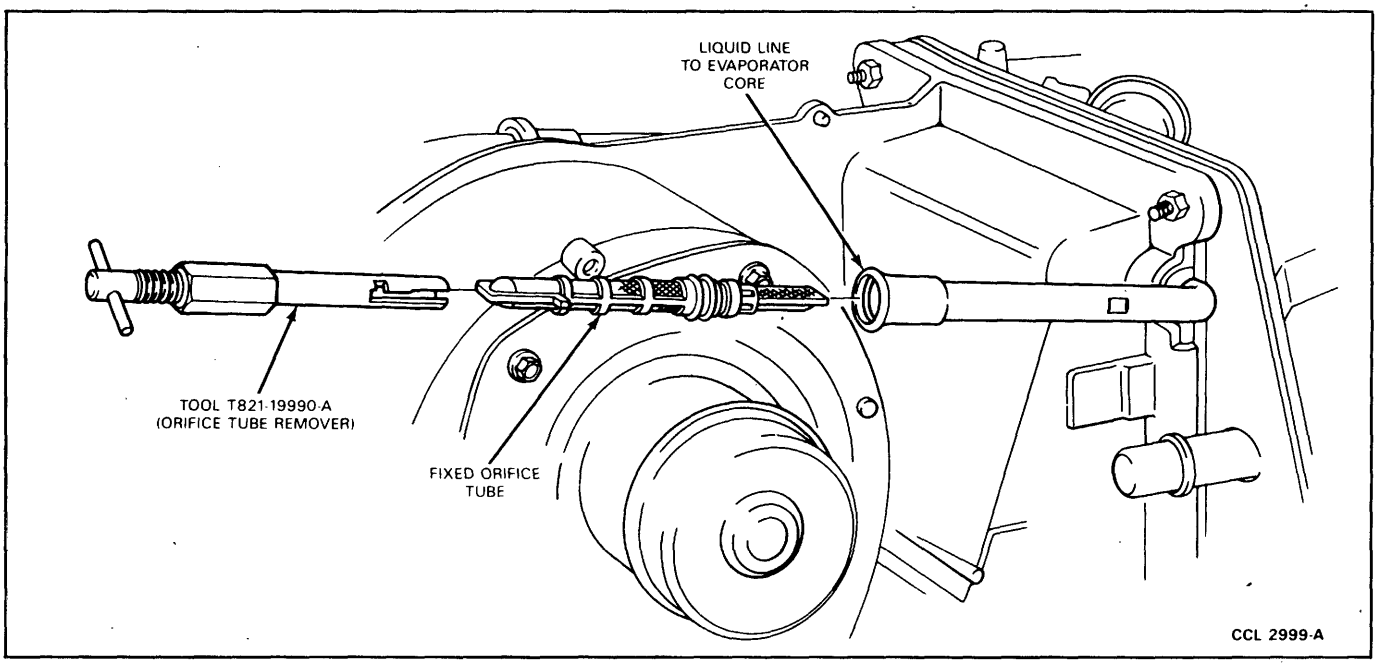


FIG. 32 Fixed Orifice Tube Removal

5. Hold the T-handle of Broken Orifice Tube Extractor T83L-19990-B or Motorcraft YT-1009 equivalent to keep it from turning and run the nut on tool down against evaporator core tube until the orifice is pulled from tube.
6. If the fixed orifice tube breaks in the evaporator core tube, it must be removed from the tube with Broken Orifice Tube Extractor T83L-19990-B or Motorcraft YT-1009.
7. To remove a broken orifice tube, insert screw end of extractor, Tool YT-1009, into evaporator core tube and thread screw end of tool into brass tube in center of fixed orifice tube. Then, pull fixed orifice tube from evaporator core tube.
8. If only the brass center tube is removed during Step 7, insert the screw end of Tool YT-1009 into evaporator core tube and screw end of tool into fixed orifice tube body. Then, pull fixed orifice tube body from the evaporator core tube.

Installation

1. Lubricate O-rings on fixed orifice tube body liberally with clean refrigerant oil.
2. Place fixed orifice tube in Fixed Orifice Tube Remover/Replacer T83L-19990-A or equivalent, and insert fixed orifice tube into evaporator core tube until orifice is seated at the stop (Fig. 32).
3. Remove tool from fixed orifice tube.
4. After checking liquid line for a missing or damaged spring lock coupling garter spring and replacing or repairing, as necessary, install two new specified O-rings lubricated with clean refrigerant oil into spring lock coupling male fitting. Insert male fitting into inlet tube until spring lock is fully engaged.
5. Leak test, evacuate and charge system. **Observe all safety precautions.**
6. Check system for proper operation.

Condenser Assembly

The condenser assembly is mounted forward of the radiator on the radiator support (Fig. 33).

Removal

1. Discharge refrigerant from system following recommended procedures. Observe all safety precautions.
2. Disconnect compressor discharge line and liquid line from condenser using the spring-lock coupling tool. Refer to Fig. 11. Cap refrigerant lines to prevent entry of excessive moisture and dirt.
3. Remove two screws retaining hood latch to radiator support and position hood latch out of way.
4. Remove nine screws retaining top edge of radiator grille to radiator support.
5. Remove one screw retaining center area of grille to grille center support.
6. Remove one screw retaining grille center support to radiator support.
7. Working under vehicle, reposition splash shield and remove two condenser lower retaining nuts (Fig. 33).
8. Remove two bolts retaining the top of condenser to radiator upper support (Fig. 33).
9. Remove four bolts retaining each end of radiator upper support to radiator side supports.
10. Carefully pull top edge of grille forward and remove radiator upper support.
11. Lift condenser from vehicle.

Installation

1. If the condenser if to be replaced, add one fluid ounce of clean refrigerant oil to the condenser.
2. Position condenser to vehicle and install two condenser lower retaining nuts.

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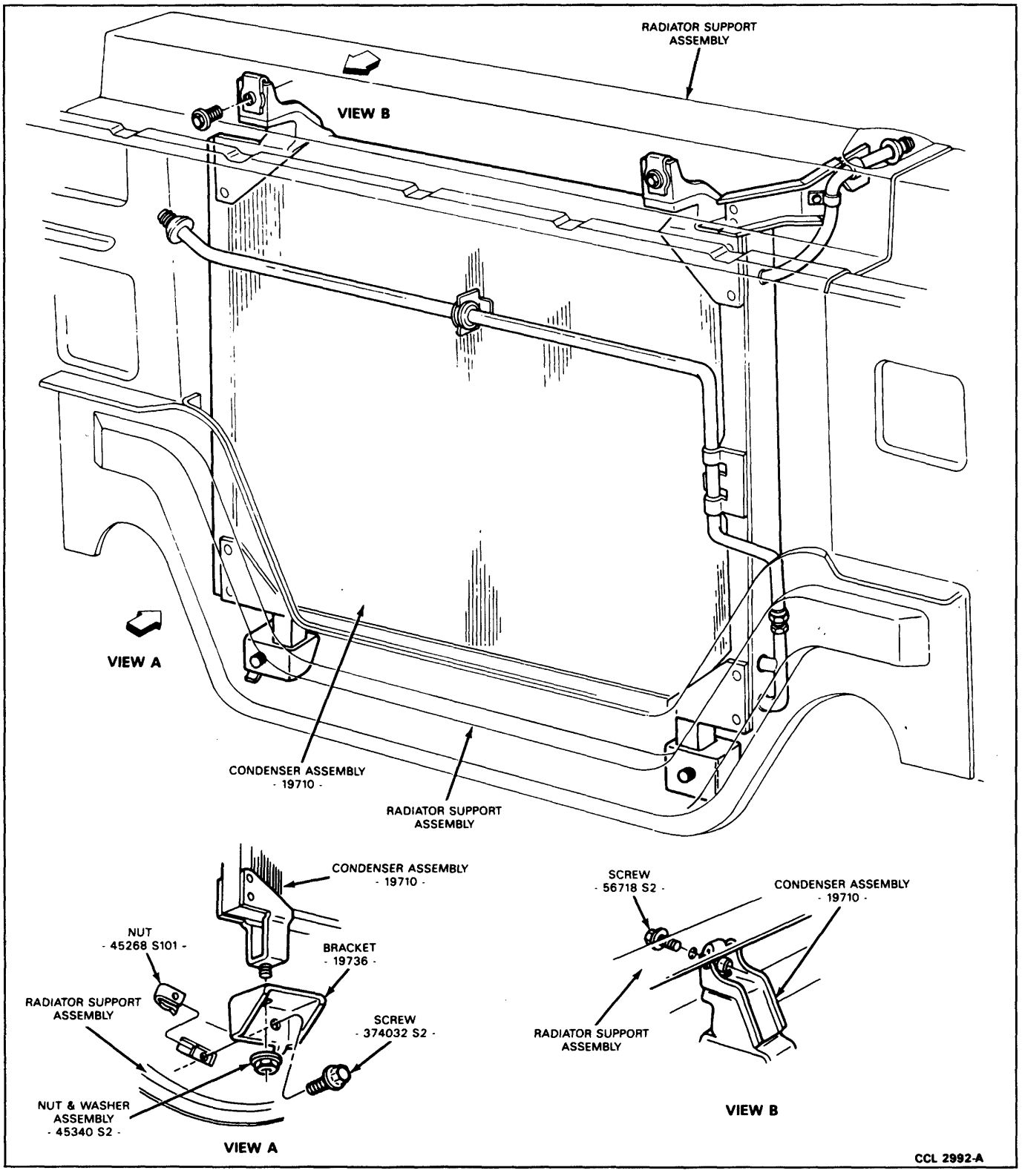


FIG. 33 Condenser Assembly Installation

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3. Position radiator upper support to vehicle using care not to damage radiator grille.
4. Install four bolts retaining each end of radiator upper supports to side supports.
5. Install two bolts retaining top end of condenser to radiator upper support.
6. Install one screw retaining grille center support to radiator support.
7. Install nine screws retaining top edge of grille.
8. Install one screw retaining center area of grille to grille center support.
9. Connect compressor discharge line and liquid line to condenser. Use new O-rings lubricated with clean refrigerant oil.

   NOTE: Service parts are available for O-rings and garter springs.
10. Install hood latch and adjust latch.
11. Leak test, evacuate and charge system. **Observe all safety precautions.**
12. Check system for proper operation.

Suction Accumulator/Drier

Refer to Figure 34.

Replace the accumulator/drier when:

- The accumulator/drier is restricted, plugged or perforated.
- The system has been left open for more than 24 hours (system completely discharged).
- There is evidence of moisture in the system (i.e. internal corrosion of metal lines or the refrigerant oil is thick and dark).
- A component such as a condenser, evaporator refrigerant line, or a seized compressor is replaced. Flush system and replace orifice tube when replacing a seized or damaged compressor.
- There is more than five ounces of compressor oil in it, indicating that the bleed hole is clogged. (Be sure to make this check if the compressor is replaced for lack of performance or seizure).

Do not replace the accumulator/drier every time:

- There is a loss of refrigerant charge.
- A component (except as described above) is changed.
- A dent is found in the outer shell of the accumulator/drier.

Removal

1. Discharge refrigerant from A/C system. **Observe all safety precautions.**
2. Disconnect electrical connector from pressure switch.
3. Remove pressure switch by unscrewing it from suction accumulator.
4. Disconnect suction line from suction accumulator/drier using Spring Lock Coupling Tool (Fig. 11).
5. Remove two mounting screws retaining bracket for the accumulator/drier. Using the Spring Lock Coupling Tool (Fig. 11), disconnect accumulator/drier from evaporator outlet tube and remove accumulator/drier. Cap all open refrigerant connections to prevent entry of dirt and moisture.

Installation

1. After checking male fitting on accumulator/drier for a missing or damaged spring lock coupling garter spring and replacing, ore repairing as necessary, install two new specified O-rings lubricated with clean refrigerant oil into the spring lock coupling male fitting. Insert male fitting into evaporator outlet tube until spring lock is fully engaged (Fig. 11).
2. Install two mounting screws on the bracket for the accumulator/drier. Tighten screws to 1.7 N·m (15 in-lb) minimum.
3. After checking suction line for missing or damaged spring lock coupling garter spring and replacing as necessary, install two new specified O-rings lubricated with clean refrigerant oil into spring lock coupling male fitting. Insert male fitting into accumulator/drier until spring lock is fully engaged.
4. Use a new O-ring lubricated with clean refrigerant oil on pressure switch nipple of suction accumulator/drier. Install pressure switch and tighten to 7-13 N·m (5-10 ft-lb) if switch has metal base, and hand-tight only if switch has plastic base.

Compressor Assembly

4.9L (300 CID) Engines

Removal

1. Discharge refrigerant from system following recommended service procedures and safety precautions in Section 36-30, Air Conditioning General Service.
2. Disconnect wire connector from clutch field coil connector.
3. Remove retaining bolts from compressor manifolds and remove refrigerant lines. Plug refrigerant lines and compressor ports to prevent entrance of dirt and moisture.
4. Remove hex-head screw retaining compressor adjusting arm to mounting bracket (Fig. 35).
5. Remove four screws retaining front and rear braces to mounting bracket support. Remove compressor with front and rear braces attached.
6. Remove front and rear braces from compressor (two screws each).

Installation

1. If a new service replacement compressor is being installed, remove shipping plates and pour 120ml (four fluid ounces) of refrigerant oil into the compressor through compressor ports.
2. Transfer clutch components to new compressor. Refer to Section 36-37 FS-6 Compressor and Clutch. Be sure to follow recommended procedures using tools specified.
3. Install front and rear braces on compressor. Tighten retaining screws to specification. Refer to Figure 35.
4. Position compressor braces on mounting bracket support and install four retaining screws.

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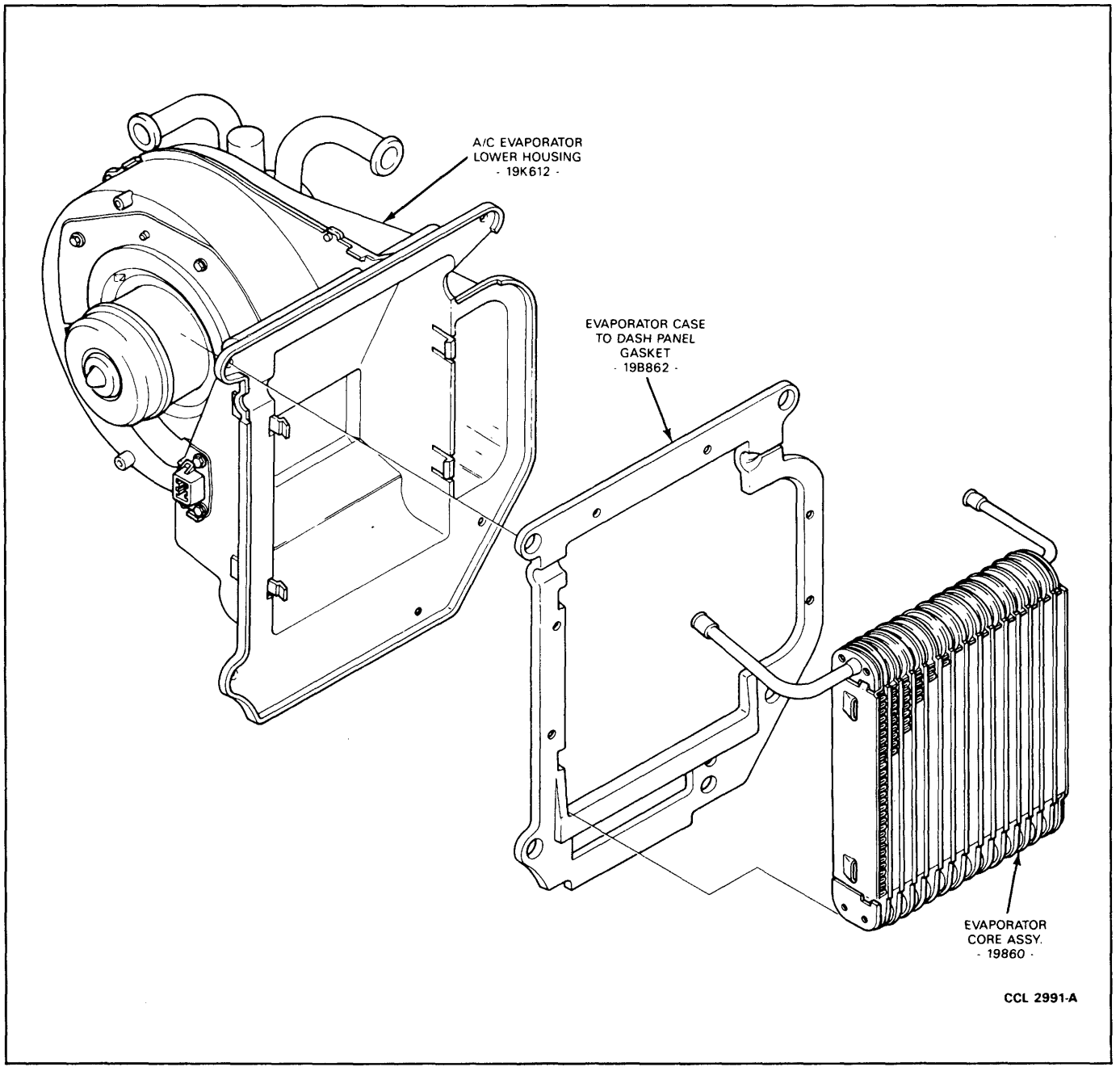


FIG. 34 Suction Accumulator/Drier

5. Install but do not tighten, hex-head screw attaching compressor adjusting arm to mounting bracket.
6. Install drive belt and adjust to specification as described in Section 27-06, Accessory Drive Belt.
7. Tighten four compressor screws and braces to mounting bracket support retaining screws and hex-head screw to specification.
8. Position compressor manifolds over compressor ports and start attaching bolts. Tighten bolts to 17-23 N·m (13-17 ft-lb).

   CAUTION: Be sure bolts are not cross-threaded before tightening. Do not over-tighten bolts or the aluminum threads may become stripped.

   Use new O-rings lubricated with clean refrigerant oil.
9. Connect clutch wires to clutch field coil.
10. Leak test, evacuate and charge system, then check for proper operation.

V-8 Gasoline Engines

Refer to Figures 36 and 37.

Removal

1. Discharge refrigerant from system following recommended service procedures and safety precautions in Section 36-30, Air Conditioning General Service.
2. Disconnect wire connector from clutch field coil connector.

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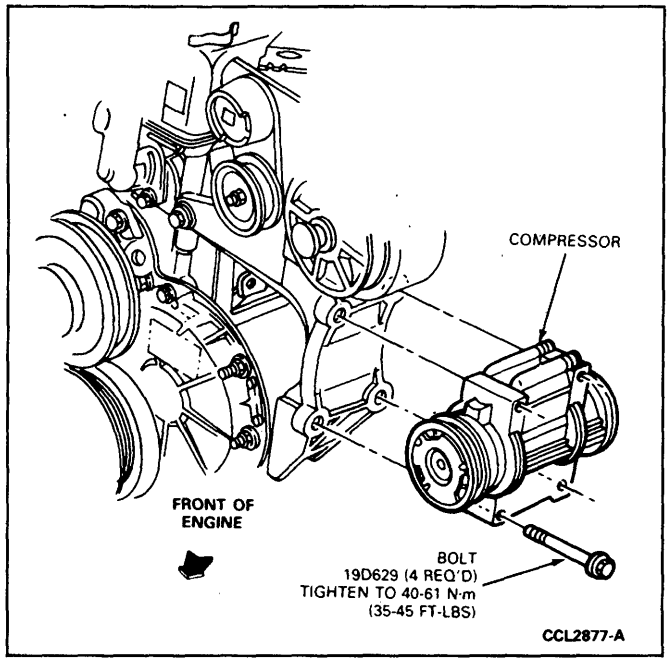


FIG. 35 Compressor Installation—4.9L (300 CID) Engine

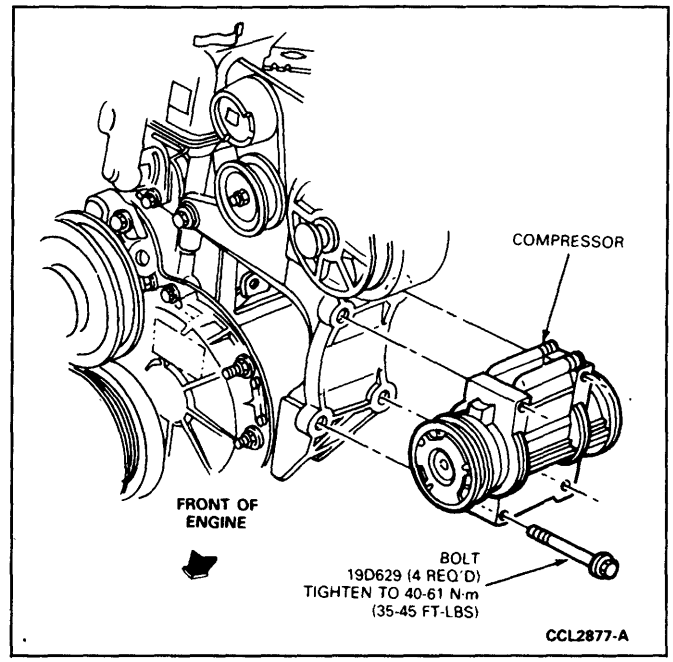


FIG. 36 Compressor Assembly Installation—4.9L (300CID) Engine

3. Remove retaining bolts from compressor manifolds and remove refrigerant lines. Plug refrigerant lines and compressor ports to prevent entrance of dirt and moisture.
4. Remove bolts retaining compressor to brackets and remove compressor.

Installation

1. If a new service replacement compressor is being installed, remove shipping plugs and pour 120ml (four fluid ounces) of refrigerant oil into compressor.
2. Transfer clutch components to new compressor. Refer to Section 36-37, FS-6 Compressor and Clutch.
3. Position compressor on its mounting brackets and install five retaining bolts. Tighten to specifications. Refer to Figures 36 and 37.
4. Install drive belt and adjust as described in Section 27-06, Accessory Drive Belt Service.
5. Position compressor manifolds over compressor ports and start the retaining bolts. Tighten bolts to 17-23 N·m (13-17 ft-lb).

   CAUTION: Be sure bolts are not cross-threaded before tightening. Do not over tighten bolts or the aluminum threads may become stripped.

   Use new O-rings lubricated with clean refrigerant oil.
6. Connect clutch field coil connector.
7. Leak test, evacuate and charge system as described in Section 36-30, Air Conditioning General Service.
8. Check compressor for proper operation.

7.3L Diesel Engine

Removal

1. Discharge refrigerant from system following recommended service procedures and safety precautions in Section 36-30, Air Conditioning General Service.
2. Disconnect connector from clutch field coil.
3. Remove retaining bolts from compressor manifolds and remove refrigerant lines. Plug refrigerant lines and compressor ports to prevent entrance of dirt and moisture.
4. Loosen pivot bolt and adjusting bolts.
5. Remove drive belt from compressor pulley and position out of the way.
6. Remove five bolts retaining compressor to brackets and remove compressor from vehicle.

Installation

1. If a new service replacement compressor is being installed, remove shipping plates and pour 120ml (four fluid ounces) of refrigerant oil from compressor through compressor ports.
2. Transfer clutch components to new compressor. Refer to Section 36-37, FS-6 Compressor and Clutch.
3. Position compressor to mounting brackets.
4. Install retaining bolts.
5. Position compressor manifolds over compressor ports and start retaining bolts. Tighten bolts to 17-23 N·m (13-17 ft-lb).

   CAUTION: Be sure the bolts are not cross-threaded before tightening. Do not over tighten the bolts or the aluminum threads may become stripped.
6. Connect clutch coil electrical connector.

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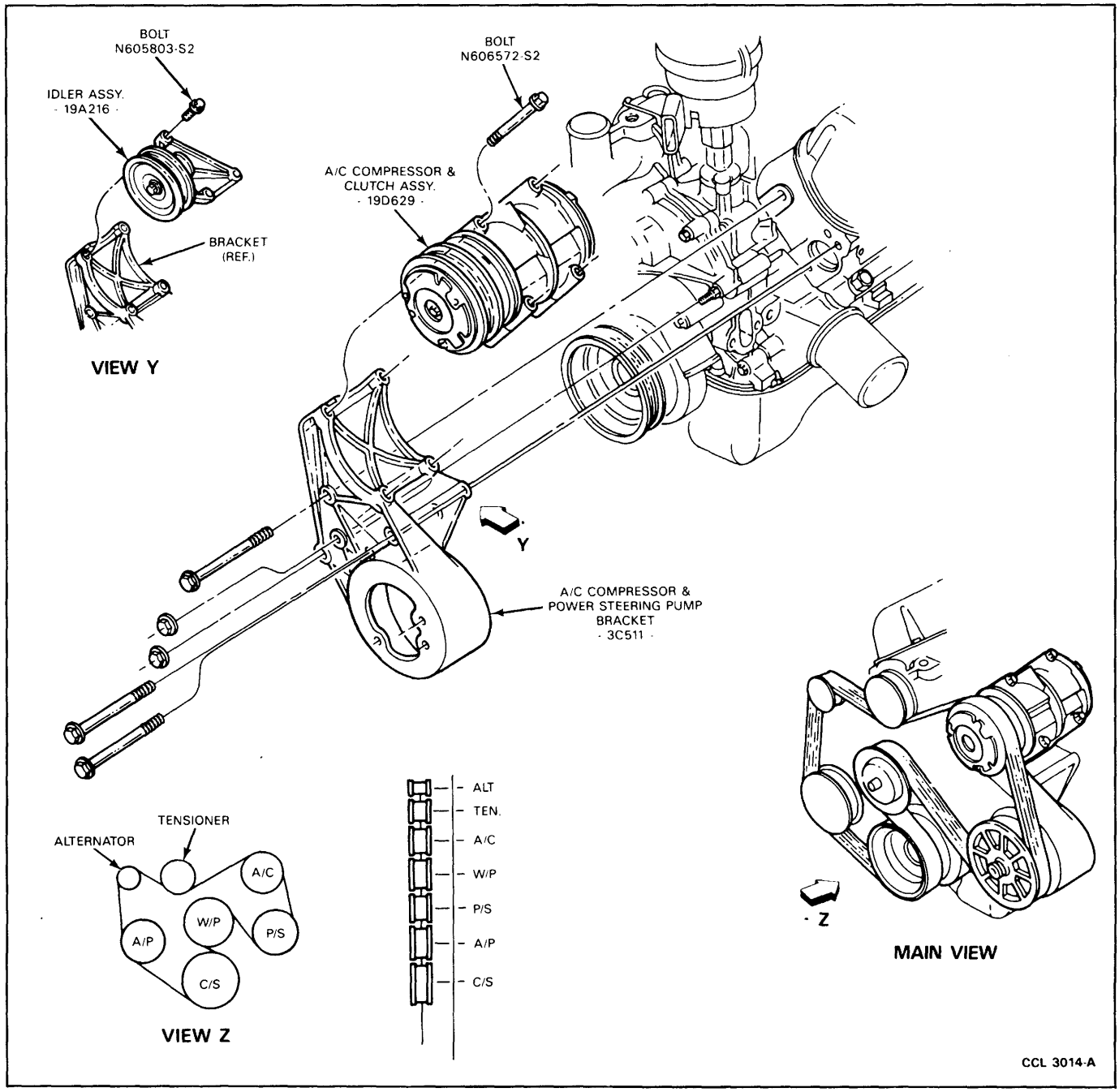


FIG. 37 Compressor Assembly Installation—5.0L (302 CID) and 5.8L (351 CID) Engines

7. Install drive belt on compressor drive pulley and adjust belt tension to specification. Refer to Section 27-06, Accessory Drive Belt Service.
8. Leak test, evacuate and charge system. Refer to Section 36-30, Air Conditioning General Service.
9. Check compressor for proper operation.
10. Remove fender cover and close hood.

Compressor Clutch and Field Coil

Refer to Section 36-37, FS-6 Compressor and Clutch.

Heater Hose and A/C Line Routing

Figures 39 through 43 illustrate heater hose and A/C line routing for the 4.9L (300 CID), 5.0L (302 CID), 5.8L (351 CID), 7.5L (460 CID) gasoline engines and 7.3L (447 CID) diesel engine.

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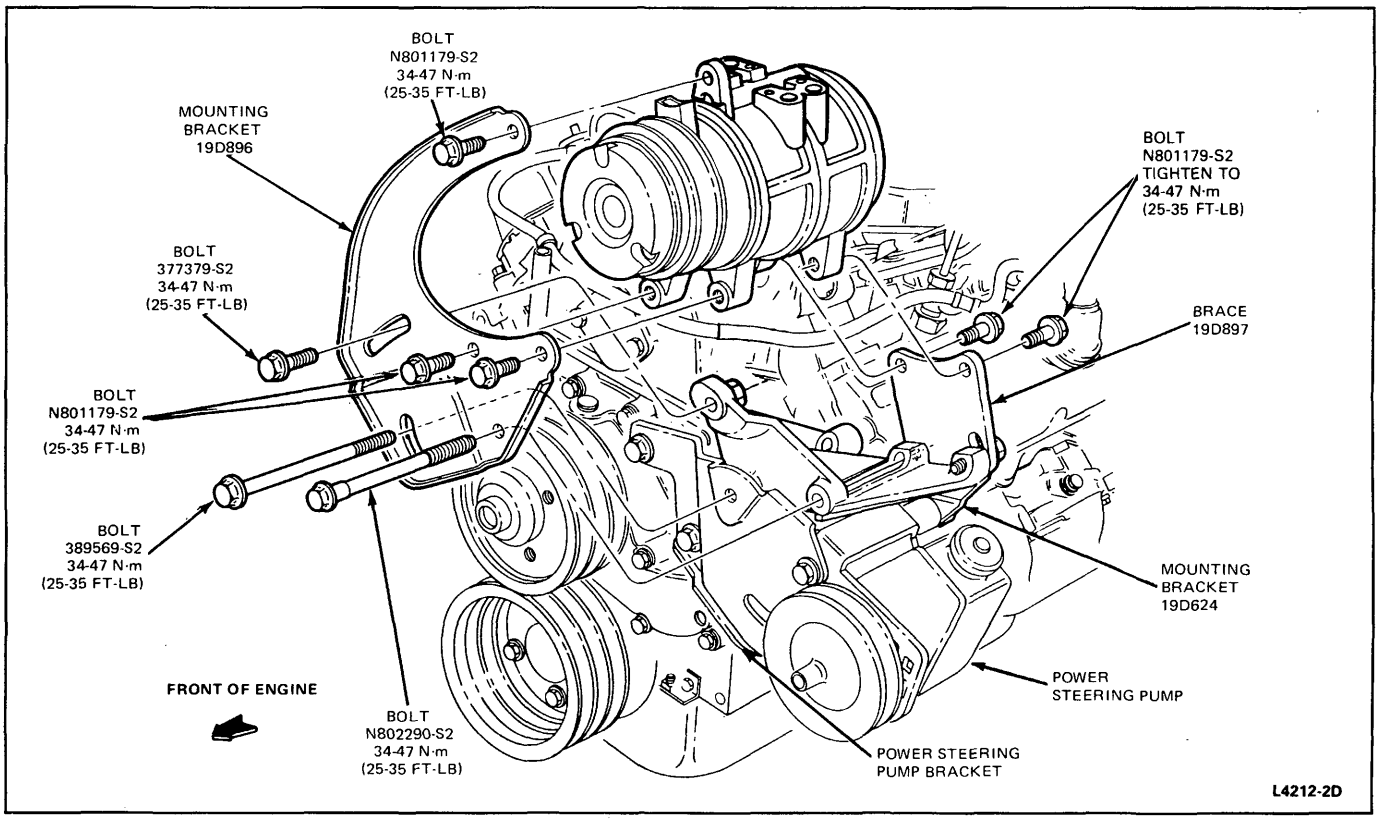


FIG. 38 Compressor Assembly Installation—7.3L Diesel Engine

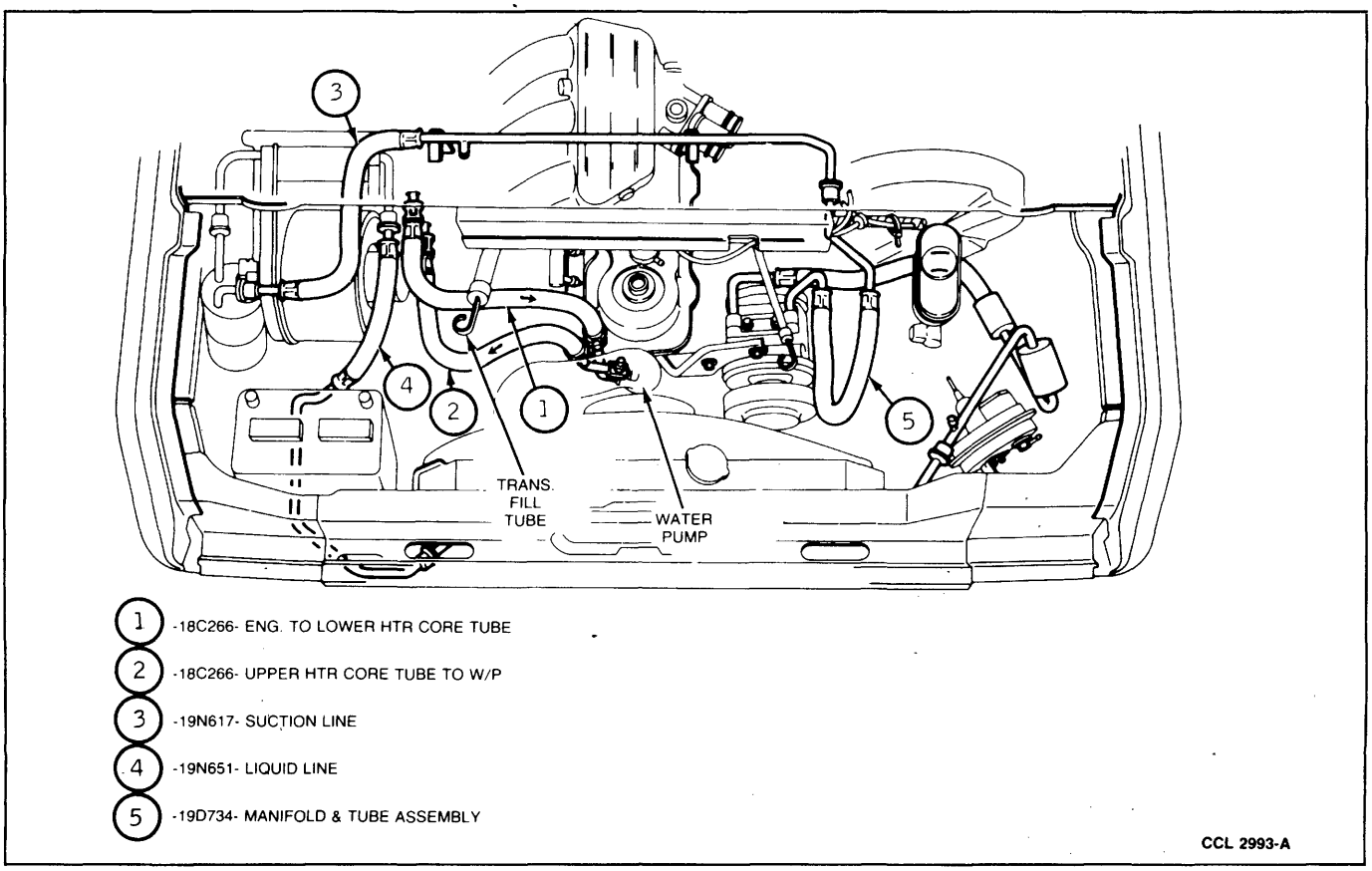


FIG. 39 Heater Hose and A/C Line Routing—4.9L (300 CID) Engine

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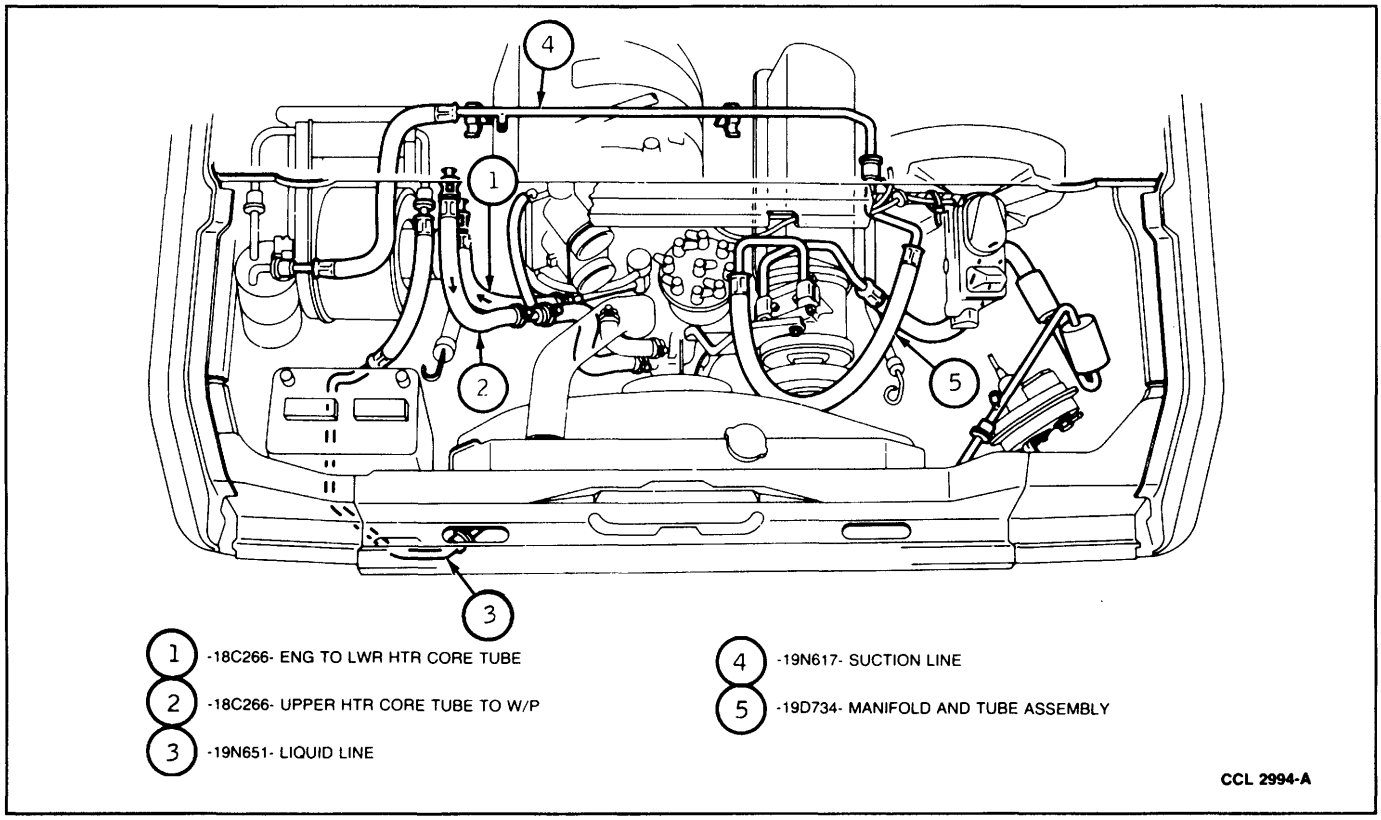


FIG. 40 Heater Hose and A/C Line Routing—5.0L (302 CID) Engine

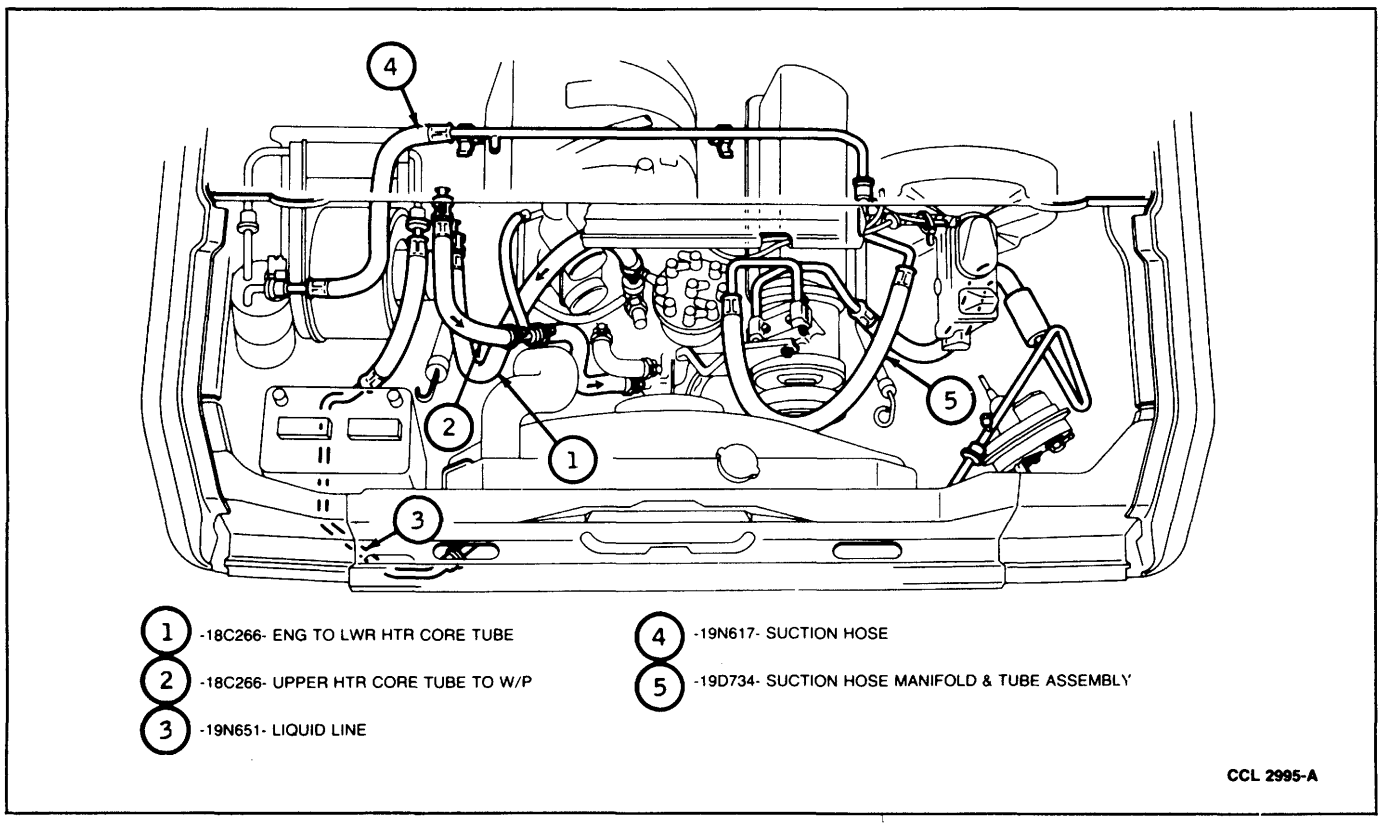


FIG. 41 Heater Hose and A/C Line Routing—5.8L (351 CID) Engine

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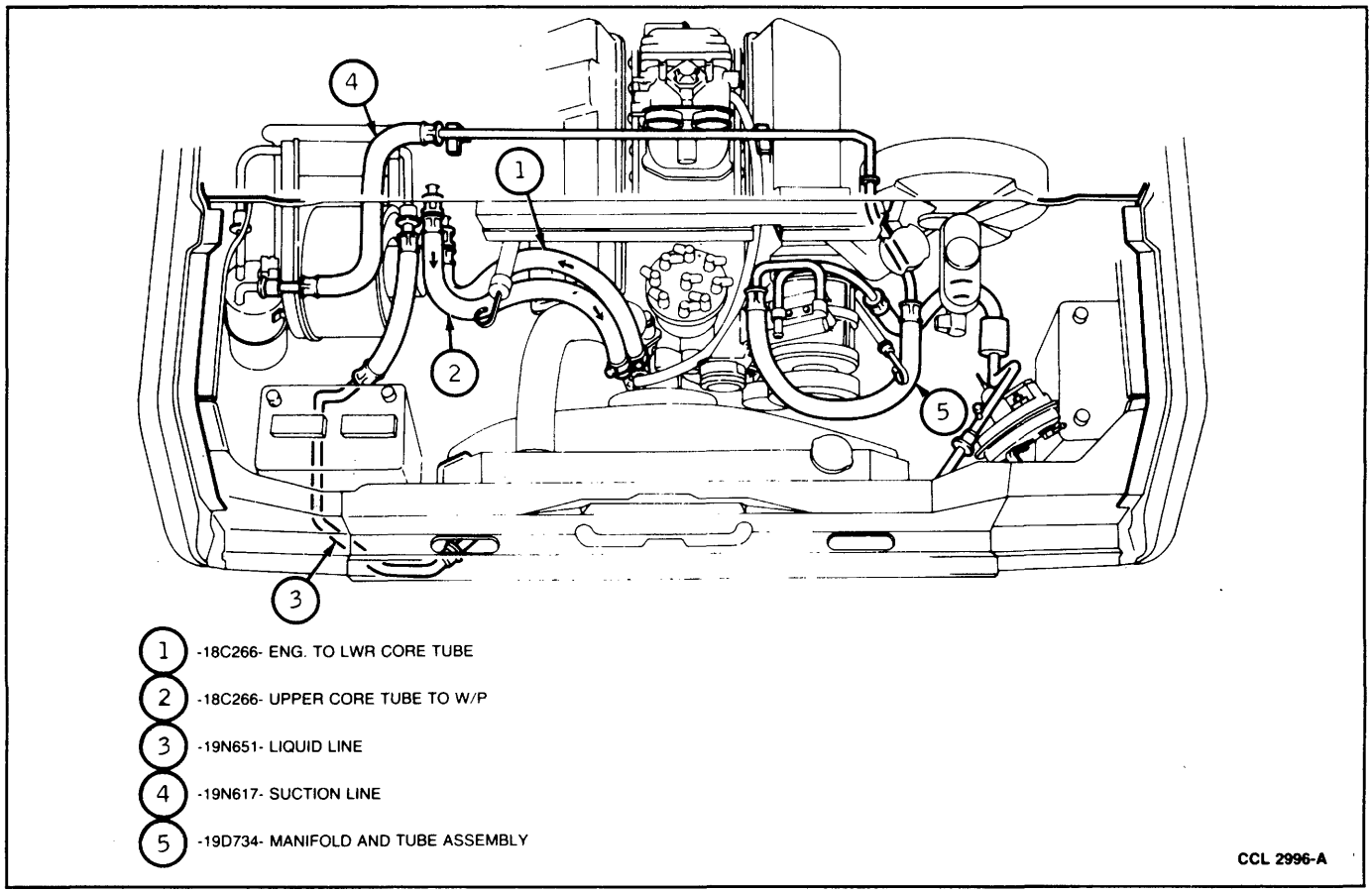
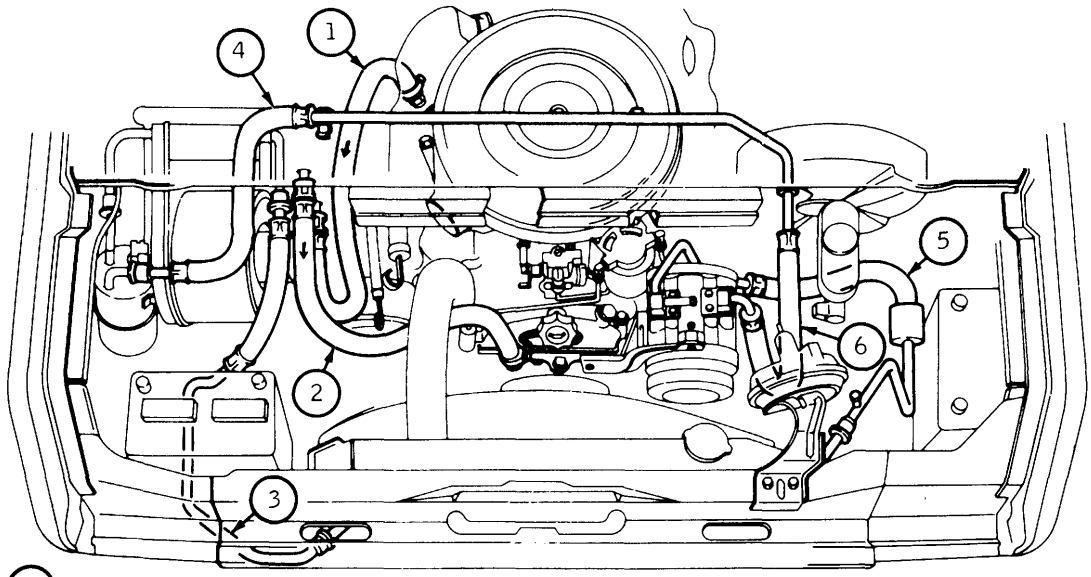


FIG. 42 Heater Hose and A/C Line Routing—7.5L (480 CID) Engine

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1 -18C266- ENG. TO LWR CORE TUBE
2 -18C266- UPPER CORE TUBE TO W/P
3 -19N651- LIQUID LINE
4 -19N617- SUCTION LINE
5 -19972- DISCHARGE HOSE
6 -19N617- SUCTION LINE

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FIG. 43 Heater Hose and A/C Line Routing—7.3L (447 CID) Diesel Engine

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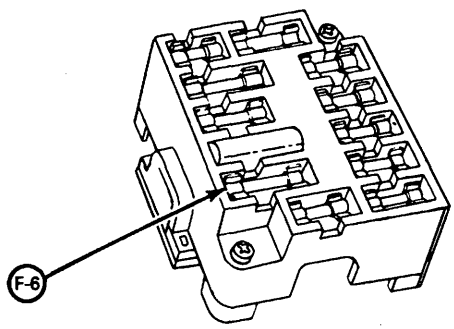
SPECIFICATIONS

ELECTRICAL

Protective Device	35 Amp. Fuse (F-6) in Fuse Panel Thermal Limiter in Blower Resistor Circuit (Integral with Resistor)		
Blower Motor Current Draw (Amps and Voltage)	**Blower Speed**	**Amps**	**Volts**
	Low	6.0	5
	Med. Low	8.0	7
	Med. High	15.0	10
	High	25.0	12.8
Magnetic Clutch Current Draw — Approximately 3.75 Amps @		12.8 Volts.	
Illumination Control Assembly		One ICP-161 Bulb	

REFRIGERANT

Cycling Clutch Control De-Icing Switch	Close	42°F
	Open	28°F
System Protection		
High Pressure Relief Valve	Opens 3103kPa (450 psi)	
Capacity (Front System Only)	3-1/2 Lbs. Plus 1/4 Lb. Minus 0 56 Oz. Plus 4 Oz. Minus 0 1.588 Kg. Plus .113 Kg. Minus O	
(Front and Auxiliary System)	4-1/4 Lbs. Plus 1/4 Lb. Minus 0 68 Oz. Plus 4 Oz. Minus 0 1.928 Kg. Plus .113 Kg. Minus 0	
Type Refrigerant 12 (R-12) ESA-M17B2A	Dichlorodifluoromethane CCL^2F^2 Ford D4AZ-19B519-A Motorcraft YN1-A 14 Oz. Can YN-7 30 Lb: Container	



The fuse panel is located on the dash panel in passenger compartment left of steering column.

SPECIAL SERVICE TOOLS

Description	Number	Motorcraft
Belt Tension Gage	T63L-8620-A	YT-371
Heater Control Cable Disconnect Tool	T83P-18532-AH	—
Spring Lock Coupling Tool — 1/2 inch	T81P-19623-G2	—
5/8 inch	T83P-19623-C	
3/8 inch	T81P-19623-G1	
3/4 inch	T85L-19623-A	
Service Access Adapter	D81L-19703-A	YT-354
ROTUNDA EQUIPMENT		
Description	**Number**	**Motorcraft**
Flame Type Leak Detector	023-00006	YT-202
Dial Thermometer	023-00007	YT-227
Small Can Adapter	023-00009	YT-229
Safety Shield Goggles	023-00010	YT-204
Electronic Leak Detector	055-00007	YT-288
Manifold Gauge Set	063-00010	YT-201
Vacuum Tester	021-00014	—

TORQUE LIMITS

Description	Torque		
	Ft-Lb	**In-Lb**	**N-m**
Suction Hose to Evaporator Core	30-35		41-47
Liquid Line to Expansion Valve	10-15		14-20
Heater Hose Clamps		12-18	1.35-2.03
Condenser to Mounting Bracket	12-18		17-24
Condenser Mounting Bracket to Radiator Support	12-18		17-24
Compressor to Bracket	20-32		28-43
Compressor Bracket to Support to Engine (4.9L)	45-65		62-88
Compressor Adjusting Bracket to Support Bracket (4.9L)	30-45		41-61
Compressor Bracket to Engine (8-Cylinder)	45-65		62-88
Idler Pulley to Bracket (8-Cylinder)	30-45		41-61
Compressor Brace to Engine	30-45		41-61
Compressor Brace to Compressor	20-32		28-43
Evaporator Case to Dash Panel		30-40	3.38-4.51
Plenum to Evaporator Case		12-17	1.35-1.92
Temperature Cable To Bracket at Evaporator Case		17-22	1.92-2.48
To Control Assembly		10-15	1.12-1.69
Defroster Nozzle to Instrument Panel Opening		9-15	1.02-1.69
Control Assembly to Support Bracket		10-15	1.12-1.69
Control Support Bracket to Instrument Panel		17-22	1.92-2.48

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SECTION 36-70 Side-Mounted Auxiliary A/C and/or Heater Systems

SUBJECT	PAGE
DESCRIPTION	
Auxiliary A/C-Heater Cover Assembly	36-70-4
Control Assembly	36-70-1
Expansion Valve	36-70-3
Function Selector Lever	36-70-1
Registers	36-70-4
DIAGNOSIS AND TESTING	
Blower Motor Current Draw Test	36-70-4
Blower Motor Voltage Test	36-70-4
Refrigerant System	36-70-6
Test Procedure	36-70-4
Vacuum System Tests	36-70-6
REMOVAL AND INSTALLATION	
Auxiliary Duct and Trim Panel Assembly	36-70-6
Auxiliary Duct Assembly	36-70-6
Auxiliary Evaporator Core Assembly	36-70-13
Auxiliary Heater and/or Air	36-70-7
Auxiliary Heater and/or Air Conditioner Cover	36-70-6
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Expansion Valve	36-70-13
Refrigerant Lines and Heater Hoses	36-70-14
Resistor Assembly	36-70-7
Super Club Wagon	36-70-6
SPECIFICATIONS	36-70-24
VEHICLE APPLICATION	36-70-1

VEHICLE APPLICATION

E-150 through E-350.

DESCRIPTION

An auxiliary climate control system is available as an option that can be used in combination with some of the main climate control system. The chart in Fig. 1 lists the main and auxiliary system applications.

The auxiliary system is available as a combination air conditioning and heating system if the main system has the same combination. Fig. 2 illustrates the components of a typical auxiliary air conditioning and heating system.

The interior components of the system are mounted on the LH side of the vehicle, between the side windows and floorpan and rearward of the driver's seat. All components, including the blower motor and wheel, resistor, wiring grommet and seal, A/C core and seal, heater core and seal, and expansion valve, are serviceable from the inside of the vehicle.

BODY STYLE	HEATER		A/C HEATER	
	BASE SYS.	AUX. SYS. (1)	BASE SYS.	AUX. SYS. (1)
REG. CARGO VAN	X	X	X	X
SUPER CARGO VAN	X	X	X	X
REG. WINDOW VAN	X	X	X	X
SUPER WINDOW VAN	X	X	X	X
REG. CLUB WAGON	X	X	X	(2)
SUPER CLUB WAGON	X	X	X	(2)

NOTES:

(1) NOT AVAILABLE ON VEHICLES WITH A 124" WHEELBASE WITH P205 TIRES

(2) NOT AVAILABLE ON CLUB WAGONS WITH BASE TRIM

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FIG. 1 Main and Auxiliary Climate Control System Application

To remove any of the components, it is necessary to remove the auxiliary A/C-heater cover assembly and the first bench seat on vehicles so equipped. To service the heater and/or air conditioner as an assembly, it is also necessary to remove the LH side window garnish moulding and loosen the forward portion of the auxiliary duct assembly. The duct assembly is attached to the side of the body with ten screws.

Control Assembly

Fig. 3 illustrates a control assembly installed in a vehicle with both manual and auxiliary A/C-heat. From the location of the control in the instrument panel, the driver and front seat passenger have access to the function and temperature levers in the main system, as well as to the separate switches that control blower motor speeds in the main and auxiliary units.

The auxiliary blower switch provides four operating speeds (HIGH, MEDIUM HIGH, MEDIUM LOW, and LOW) plus an OFF position. This switch is located near the light edge of the control assembly. The auxiliary blower switch will not function in any of its operating positions unless the function selector lever in the main system is in a position other than the OFF position.

Function Selector Lever

In addition to using the thumbwheel louver control in the four (of five) rearward auxiliary duct registers, the rear seat passengers can adjust airflow with a 3-position function selector lever. Refer to Fig. 4.

As shown a door operated by the lever can be set fully forward to direct all airflow to the four rear duct registers. (The forward duct register is located ahead of the function lever. As a result, it is not affected by lever position.) With the door in the middle position, airflow is directed in approximately equal quantities to the duct register and floor outlets. With the door in the fully rearward position all air is directed through the floor outlets.

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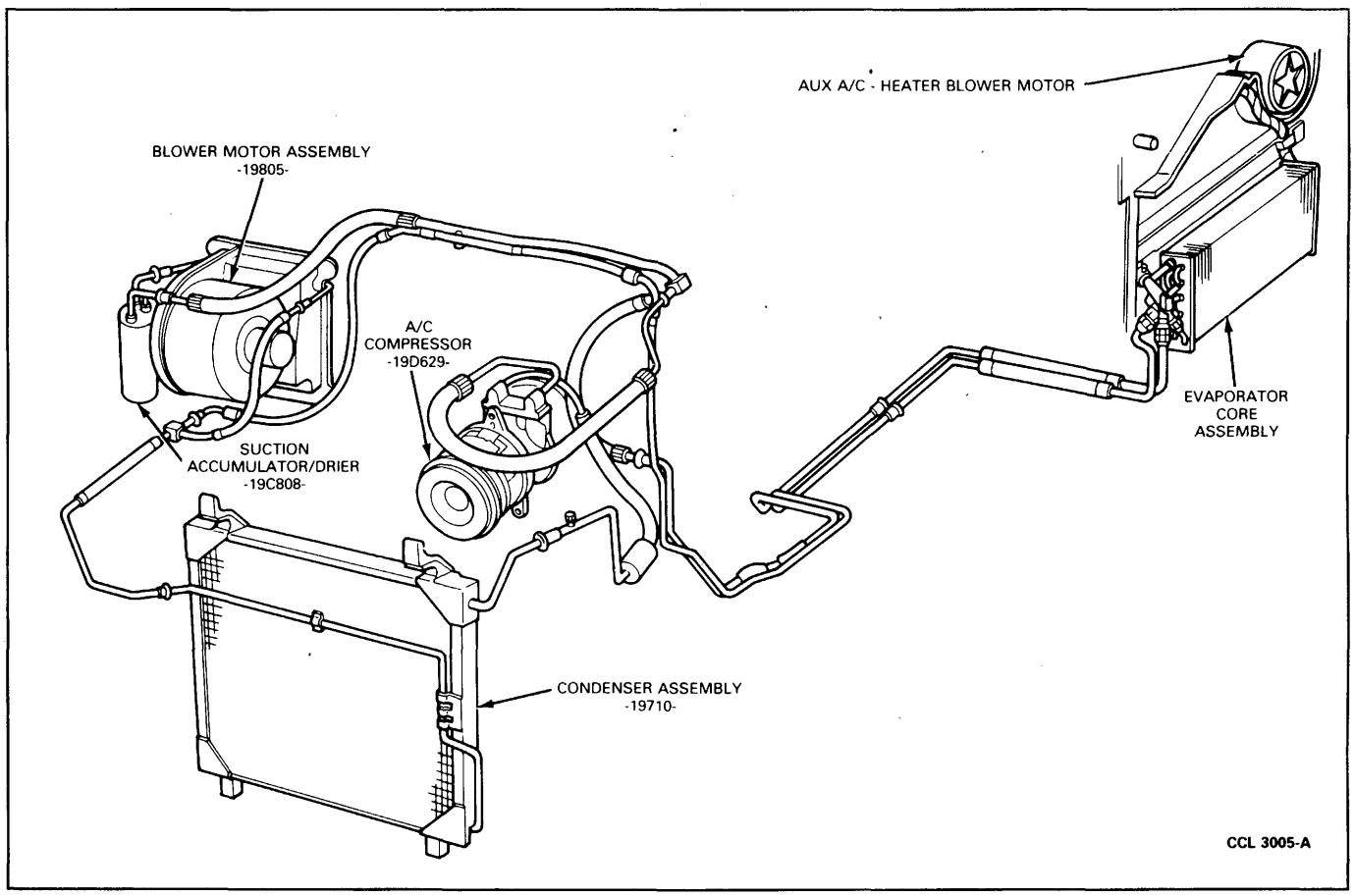
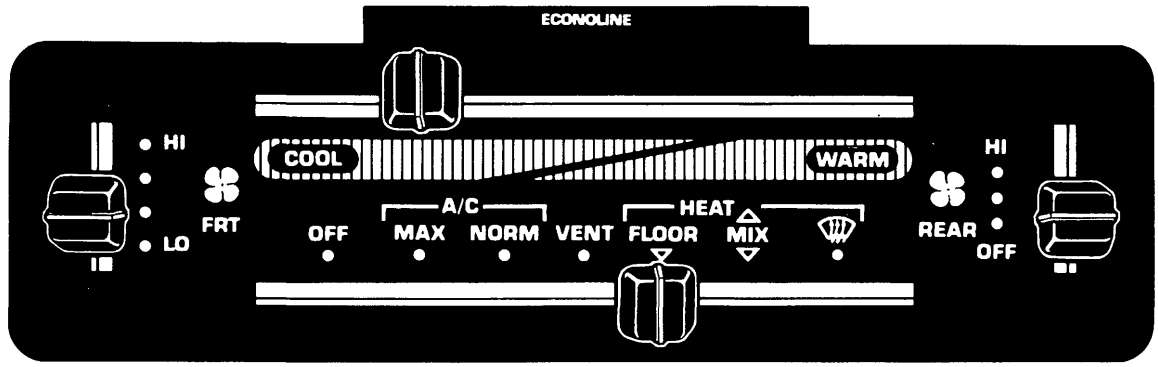


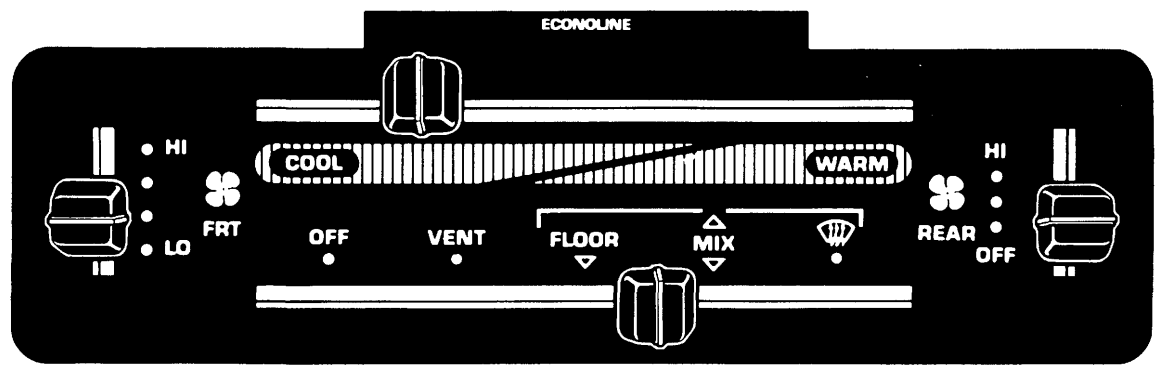
FIG. 2 Typical Auxiliary A/C-Heater System

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FRONT VIEW OF A/C - HEATER CONTROL ASSEMBLY
WITH MAIN & AUXILIARY BLOWER SWITCHES

FUNCTION LEVER POSITION	AIR DISCHARGED TO PASSENGER COMPARTMENT	
	MAIN SYSTEM (1)	AUXILIARY SYSTEM (2)
OFF	INACTIVE - NO BLOWER OPERATION	INACTIVE - NO BLOWER OPERATION
MAX A/C	RECIRCULATED AIR TO INSTRUMENT PANEL REGISTERS	RECIRCULATED AIR THROUGH AUXILIARY DUCTS
NORM A/C	OUTSIDE AIR TO INSTRUMENT PANEL REGISTERS	
VENT		
FLOOR	OUTSIDE AIR TO FLOOR OUTLETS WITH BLEED TO DEFROSTERS	
MIX	OUTSIDE AIR TO FLOOR OUTLETS AND DEFROSTERS	
DEFROST	OUTSIDE AIR TO DEFROSTERS	
NOTES	(1) TEMPERATURE BLEND DOOR POSITION WILL DETERMINE AIR TEMPERATURE IN ALL FUNCTION SELECTOR LEVER POSITIONS.	(2) DIRECTION OF AIRFLOW TO REGISTERS, FLOOR OUTLETS OR BOTH DEPENDS UPON POSITION OF AUXILIARY SYSTEM 3-POSITION FUNCTION SELECTOR LEVER.



FRONT VIEW OF HEATER ONLY CONTROL ASSEMBLY
WITH MAIN & AUXILIARY BLOWER SWITCHES

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FIG. 3 A/C-Heater Control Assembly

Expansion Valve

The expansion valve automatically regulates the flow of refrigerant into the evaporator, and is the dividing point in the system between high and low pressure refrigerant. Refer to Fig. 5.

The temperature sensing bulb, clamped to the suction (outlet) tube on the evaporator, measures the temperature of the refrigerant in the suction tube and transmits the temperature variation to the expansion valve. This temperature variation regulates the refrigerant (R-12) flow to the core. When the bulb senses a high temperature, the valve opens and floods refrigerant through the evaporator core. When the bulb senses a low temperature, the valve starts closing to shut off the refrigerant to the evaporator core.

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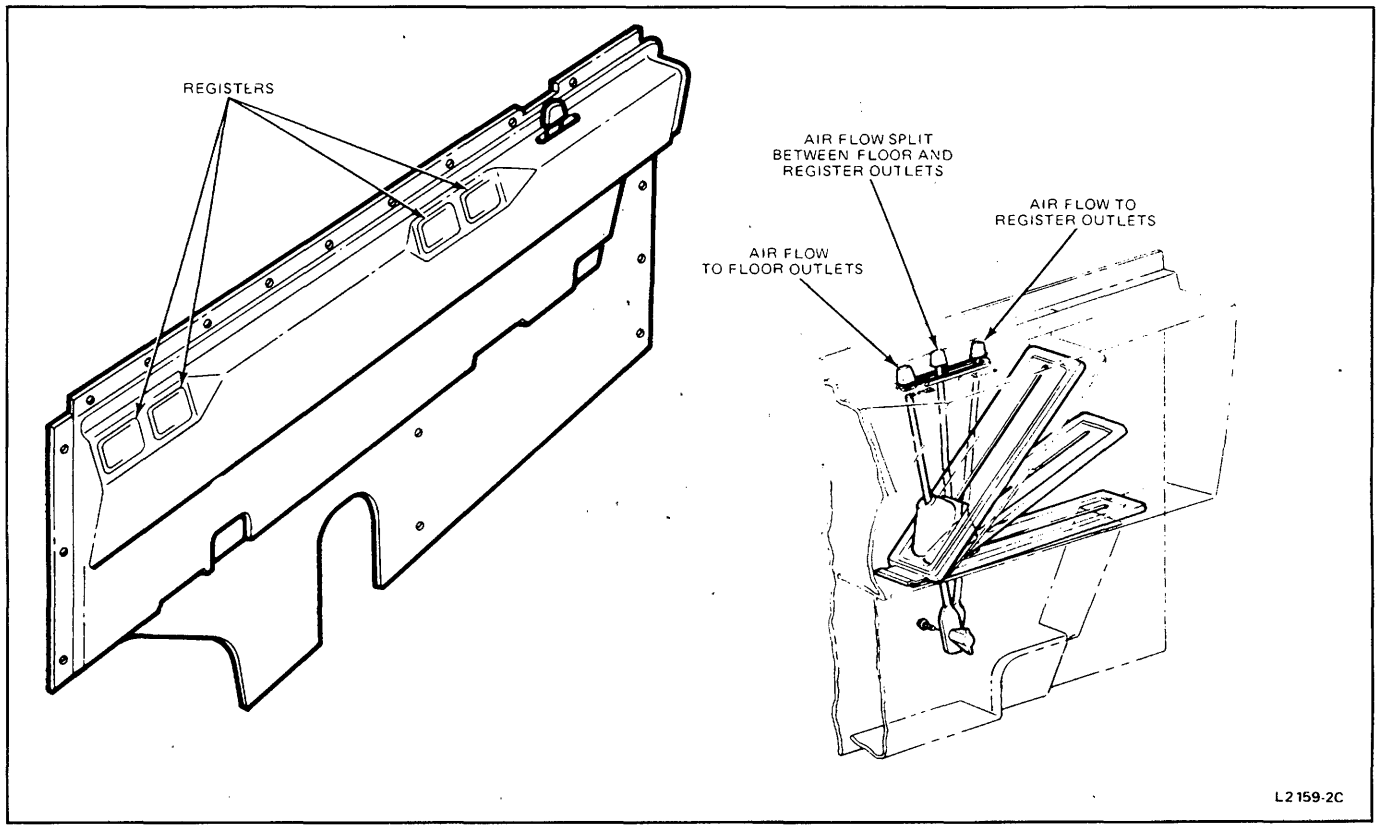


FIG. 4 Auxiliary A/C-Heater Function Selector Lever

Auxiliary A/C-Heater Cover Assembly

The cover assembly is attached to the body with sixteen screws on both van and club wagon vehicles. On vehicles so equipped, the first bench seat must be removed to service the cover assembly. The auxiliary duct assembly must be installed prior to installing the cover assembly. Refer to Fig. 6.

On vehicles not equipped with an auxiliary A/C-heater duct assembly, a register assembly is attached to the discharge opening as shown in Fig. 7.

To remove the auxiliary A/C-heater duct it is necessary to remove the cover assembly, LH body side window garnish moulding, and the first two bench seats on vehicles so equipped. The duct assembly is attached to the body by fifteen screws on club wagon vehicles, seven screws on van vehicles and four screws on Super Wagon vehicles.

To access the function selector lever and door for service, it is necessary to remove the auxiliary duct assembly from the vehicle, and the duct outer panel from the duct inner panel.

Registers

The five register assemblies can be adjusted to direct air as desired (Fig. 8). The register louvers can be closed to block most of the airflow. The forward register assembly can be rotated to totally block the airflow. To remove the register, pry on the end pivot with a thin blade to separate the pivot from the pivot hole and pull the barrel assembly from the register housing. The pivot ends of the barrels may have different sizes to control register position when installed.

DIAGNOSIS AND TESTING

Blower Motor Voltage Test

All auxiliary system blower motor electrical circuits use ground side switching to control the blower motor speed. When performing blower motor voltage tests on a system using ground side switching, the voltage reading must be taken at the ground side of the motor (between the motor and the resistor assembly, otherwise the voltage reading will be battery voltage.

Test Procedure

1. Insert probes of voltmeter into wire holes of blower motor hardshell connectors and make contact with wire terminals.
2. Measure voltage drop across motor.
3. With engine running (battery voltage approximately 14.2 volts), the voltage reading should be within the range specified for each switch position (Figs. 9 and 11). Connectors for the heater and/or A/C system are shown in Figs. 10 and 12.

Blower Motor Current Draw Test

1. Separate the blower motor ground (black) wire from blower motor resistor.
2. Connect positive (+) ammeter lead to female spade connector on motor wire, and negative (-) ammeter lead to blower motor resistor.
3. With a fully charged battery, operate blower in each switch position and record current draw (amps). The current draw for each switch position should approximate the values shown in the charts in Figs. 9 and 11.

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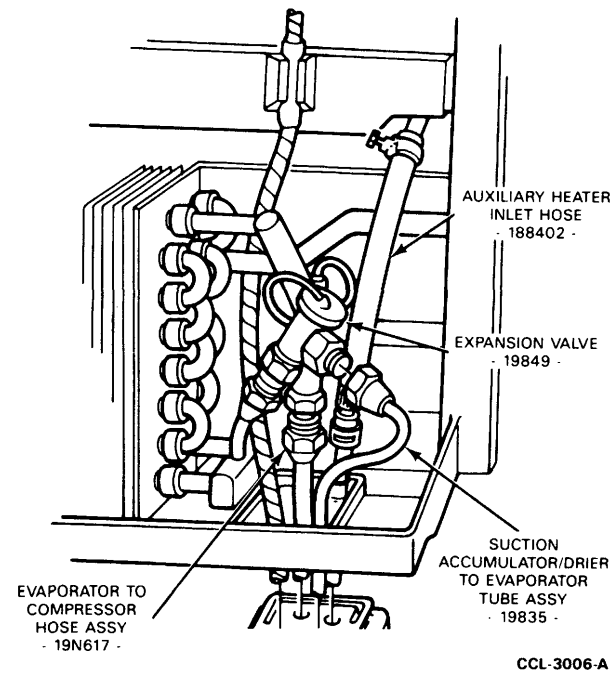


FIG. 5 Expansion Valve

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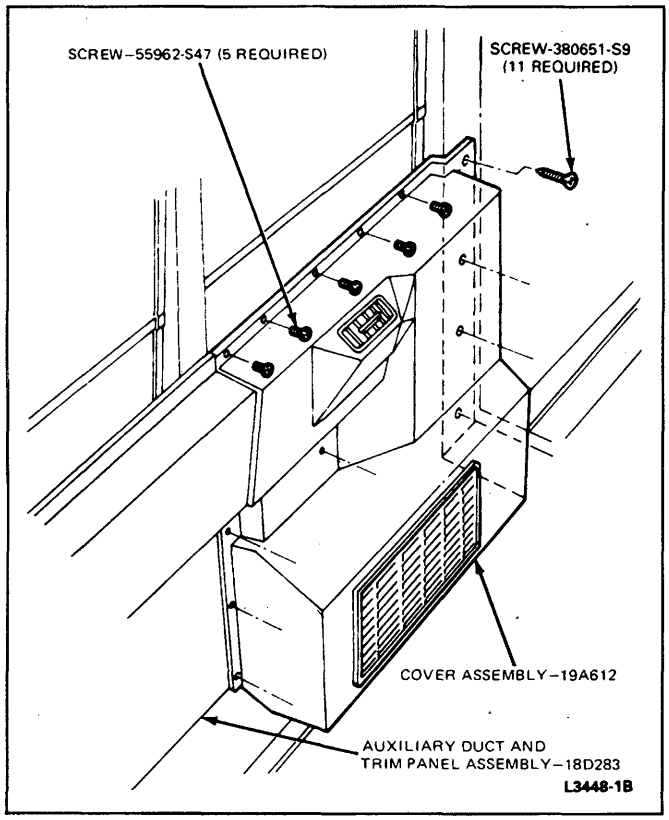


FIG. 6 Auxiliary System Cover—Removal and Installation

Vacuum System Tests

Vacuum is used to control water valve operation. Refer to Section 36-65 E-150—E-350 Air Conditioning System for vacuum system test procedure.

Refrigerant System

Refer to the refrigerant system tests in Section 36-65 E-150—E-350 Air Conditioning System for refrigerant system diagnosis.

REMOVAL AND INSTALLATION

Auxiliary Heater and/or Air Conditioner Cover Assembly

Removal and Installation

1. Remove first bench seat, if so equipped.
2. Remove auxiliary heater and/or air conditioner cover assembly attaching screws and remove cover (Fig. 6).
3. To install, position cover assembly to body side panel and install attaching screws.
4. Install bench seat, if removed. Tighten retaining bolts 34-61 N·m (25-45 ft-lb).

Auxiliary Duct and Trim Panel Assembly

The installation of the auxiliary duct and trim panel assembly is shown in Fig. 13. The auxiliary heater and/or air conditioner cover assembly must be removed before removing the auxiliary duct and trim panel assembly.

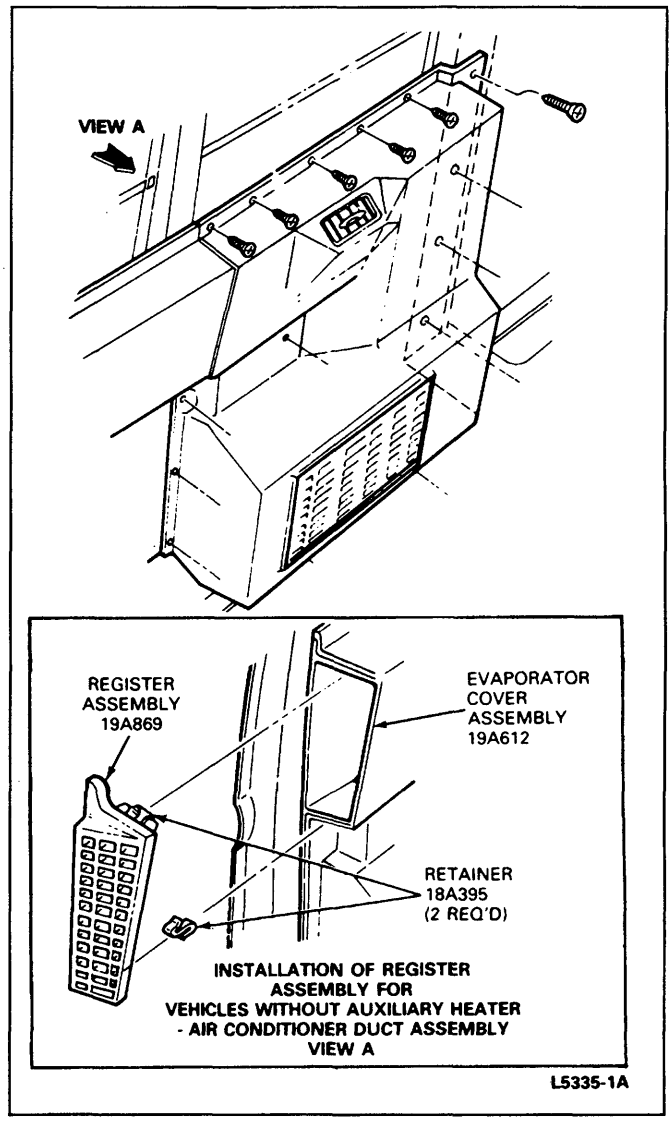


FIG. 7 Register Assembly—Removal and Installation

Auxiliary Duct Assembly

Super Club Wagon

To service the auxiliary duct assembly, the auxiliary heater and/or air conditioner cover assembly (Fig. 6), the auxiliary duct and trim panel assembly (Fig. 13) and the rear trim panel must be removed. Refer to Fig. 14 for installation of the auxiliary duct assembly.

Auxiliary Heater Core and Seal Assembly

Removal

1. Remove first bench seat, if so equipped.
2. Remove auxiliary heater and/or air conditioner cover attaching screws (Fig. 6), and remove cover.
3. Remove and discard strap retaining heater core in auxiliary system case.
4. Remove heater hoses from auxiliary heater core (two clamps), and plug hoses with suitable 15.875mm (5/8-inch) plugs.
5. Disengage wire assembly from heater core seal.
6. Slide the heater core and seal assembly out of housing slot. Refer Fig. 15.

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Installation

1. Position wire assembly to one side and slide heater core and seal assembly into housing slot.
2. Remove plugs from heater hose.
3. Install heater hoses on heater core tubes (two clamps).
4. Fill cooling system to specification and check for coolant leaks. Refer to Section 27-02 for cooling system service procedures.
5. Install a new strap to retain heater core in case assembly.
6. Install auxiliary heater and/or air conditioner cover (Fig. 6).
7. Install bench seat, if so equipped. Tighten retaining bolts to 34-61 N·m (25-45 ft-lb).

Resistor Assembly

Removal

1. Remove first bench seat, if so equipped.
2. Remove auxiliary heater and/or air conditioner cover retaining screws and remove cover (fig. 6).
3. Disconnect wiring connectors from resistor assembly (Fig. 15).
4. Remove two resistor retaining screws and remove resistor assembly.

Installation

1. Position resistor to housing and install two retaining screws.
2. Connect wiring connectors to resistor assembly (Fig. 15).
3. Hold auxiliary unit cover in place and check operation of blower at each blower speed. **DO NOT** touch resistor during or after operation of blower motor.
4. Install auxiliary heater and/or air conditioner cover (Fig. 6).
5. Install bench seat, if so equipped. Tighten retaining bolts to 34-61 N·m (25-45 ft-lb).

Auxiliary Heater and/or Air Conditioner Assembly

Removal

1. Discharge refrigerant from A/C system if an auxiliary A/C is installed.
2. Remove first bench seat, if so equipped.
3. Remove auxiliary heater and/or air conditioner cover retaining screws and remove cover (Fig. 6).
4. Disconnect heater hoses from heater core tubes and plug hoses with suitable 15.875mm (5/8-inch) plugs. Plug heater core tubes to prevent coolant spill during removal.
5. Using a backup wrench to prevent component damage, disconnect liquid line from expansion valve, and suction line from evaporator core (if equipped with auxiliary A/C).
6. Cap lines and fittings to prevent entrance of dirt and moisture into refrigerant system.

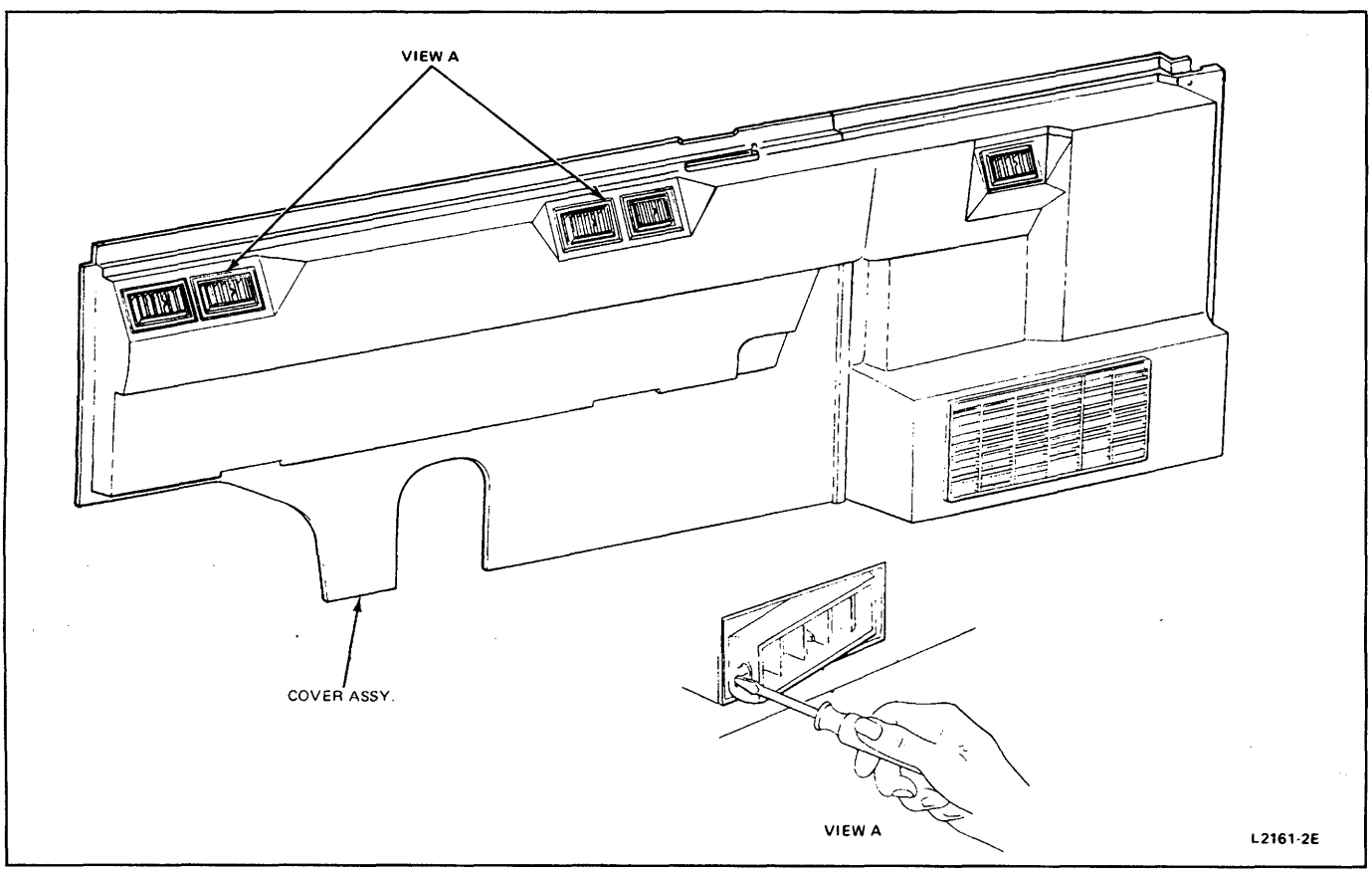
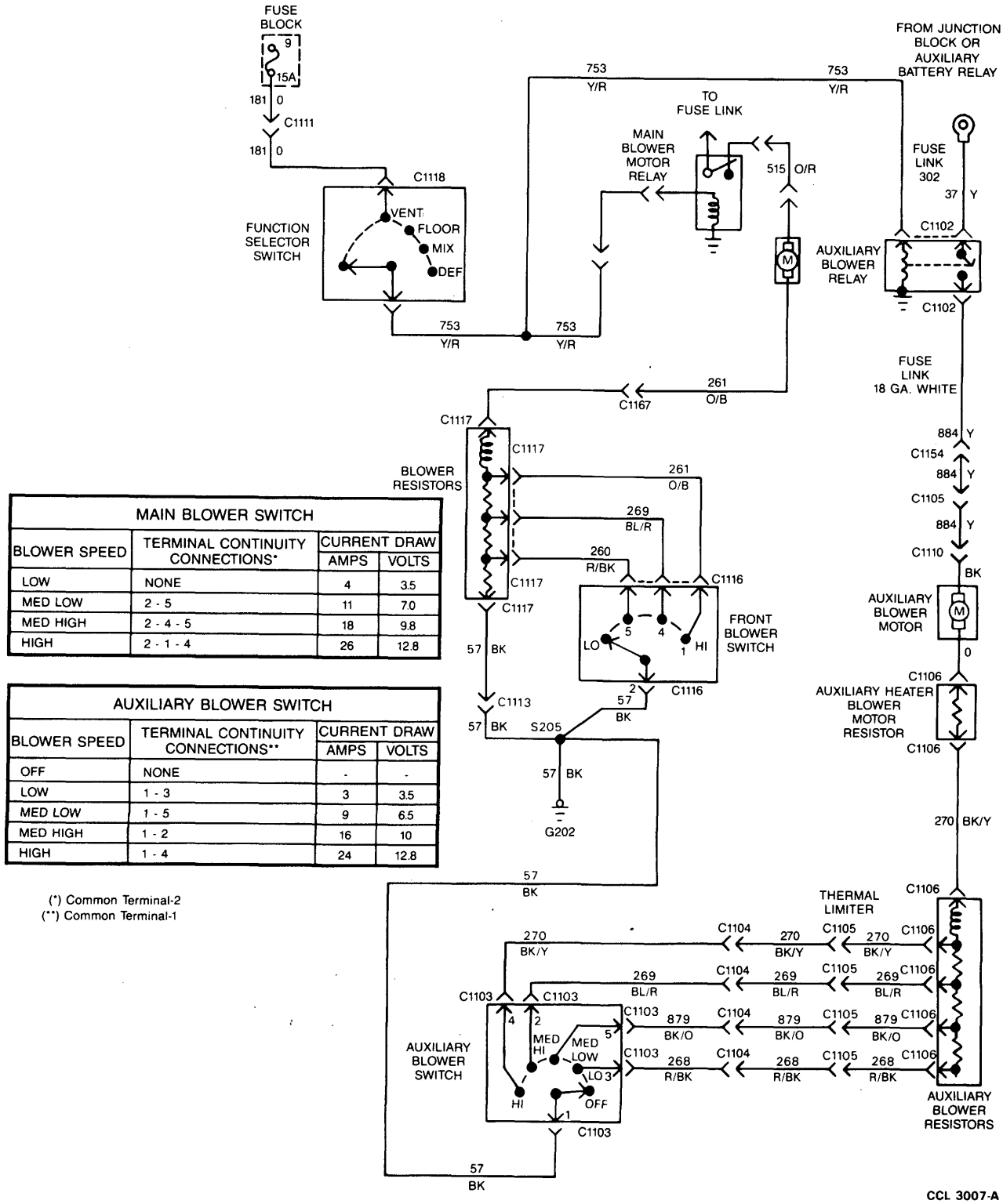


FIG. 8 Registers

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HEATER WIRING DIAGRAM
MAIN AND AUXILARY SYSTEMS



MAIN BLOWER SWITCH			
BLOWER SPEED	TERMINAL CONTINUITY CONNECTIONS*	CURRENT DRAW AMPS	CURRENT DRAW VOLTS
LOW	NONE	4	3.5
MED LOW	2 - 5	11	7.0
MED HIGH	2 - 4 - 5	18	9.8
HIGH	2 - 1 - 4	26	12.8

AUXILIARY BLOWER SWITCH			
BLOWER SPEED	TERMINAL CONTINUITY CONNECTIONS**	CURRENT DRAW AMPS	CURRENT DRAW VOLTS
OFF	NONE	-	-
LOW	1 - 3	3	3.5
MED LOW	1 - 5	9	6.5
MED HIGH	1 - 2	16	10
HIGH	1 - 4	24	12.8

(*) Common Terminal-2
(**) Common Terminal-1

FIG. 9 Main and Auxiliary Blower Wiring Diagram

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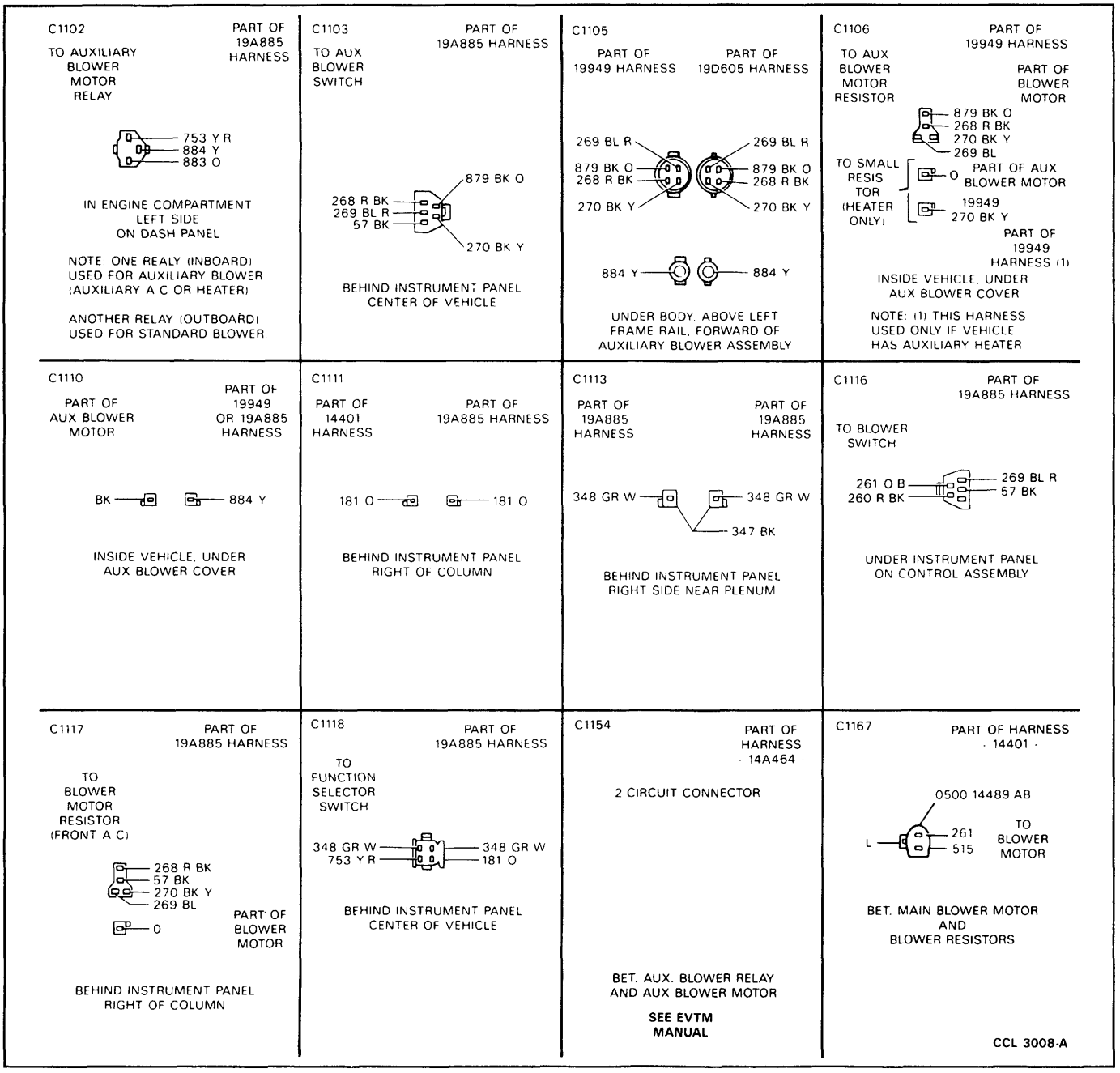


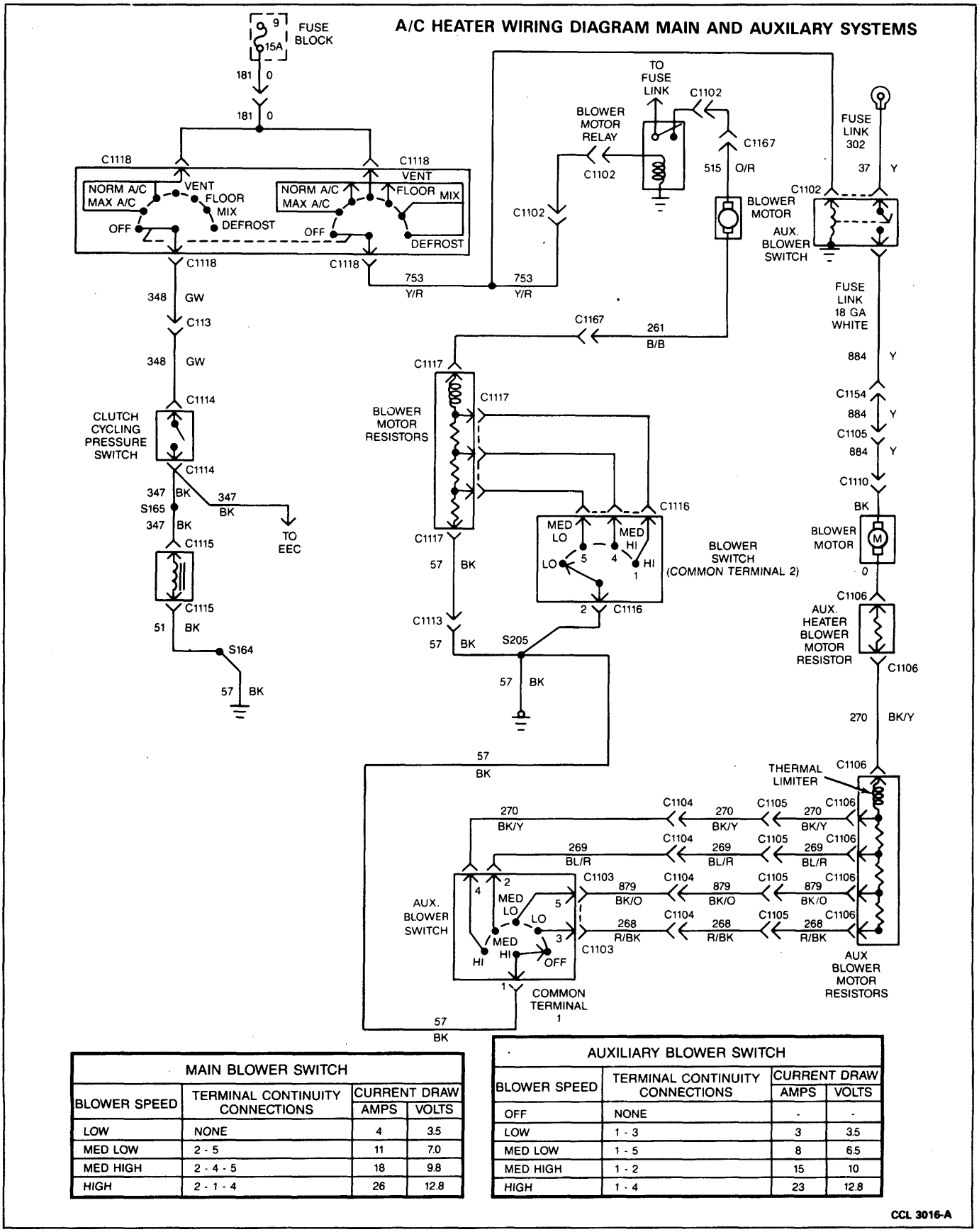
FIG. 10 Main and Auxiliary Blower Wiring Connectors

7. Working under vehicle, disconnect blower motor wires at connectors and disengage wiring harness from retaining strap.
8. Remove case assembly retaining screws (Fig. 16). Then, lift case assembly, disengage wiring harness grommet from floor seal, and remove case assembly from vehicle.

Installation

1. Ensure that all seals are in place on bottom of case assembly. Place case assembly near installed position and route wire harness through floor seal. Seat harness grommet in floor seal.
2. Position case assembly over floor seal, refrigerant lines and heater hoses, and to body side.
3. Install case assembly attaching screws (Fig. 16).
4. Working under vehicle, route blower motor wires through support strap and connect wires at harness connectors.
5. Remove plugs from heater hoses.
6. Connect heater hoses to heater core, if equipped with an auxiliary heater. Tighten hose clamps only to 14-20 N·m (12-18 in-lb).
7. If equipped with an auxiliary air conditioner, remove caps from refrigerant lines. Then, connect refrigerant lines to expansion valve and evaporator core. Use new O-rings lubricated with clean refrigerant oil. Tighten all fittings using a backup wrench to prevent component damage.
8. Fill cooling system to specification and check for coolant leaks (if equipped with an auxiliary heater). Refer to Section 27-02, Cooling System Service.

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MAIN BLOWER SWITCH			
BLOWER SPEED	TERMINAL CONTINUITY CONNECTIONS	CURRENT DRAW	
		AMPS	VOLTS
LOW	NONE	4	3.5
MED LOW	2 - 5	11	7.0
MED HIGH	2 - 4 - 5	18	9.8
HIGH	2 - 1 - 4	26	12.8

AUXILIARY BLOWER SWITCH			
BLOWER SPEED	TERMINAL CONTINUITY CONNECTIONS	CURRENT DRAW	
		AMPS	VOLTS
OFF	NONE	-	-
LOW	1 - 3	3	3.5
MED LOW	1 - 5	8	6.5
MED HIGH	1 - 2	15	10
HIGH	1 - 4	23	12.8

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FIG. 11 A/C-Heater Main and Auxiliary Blower Wiring Diagram

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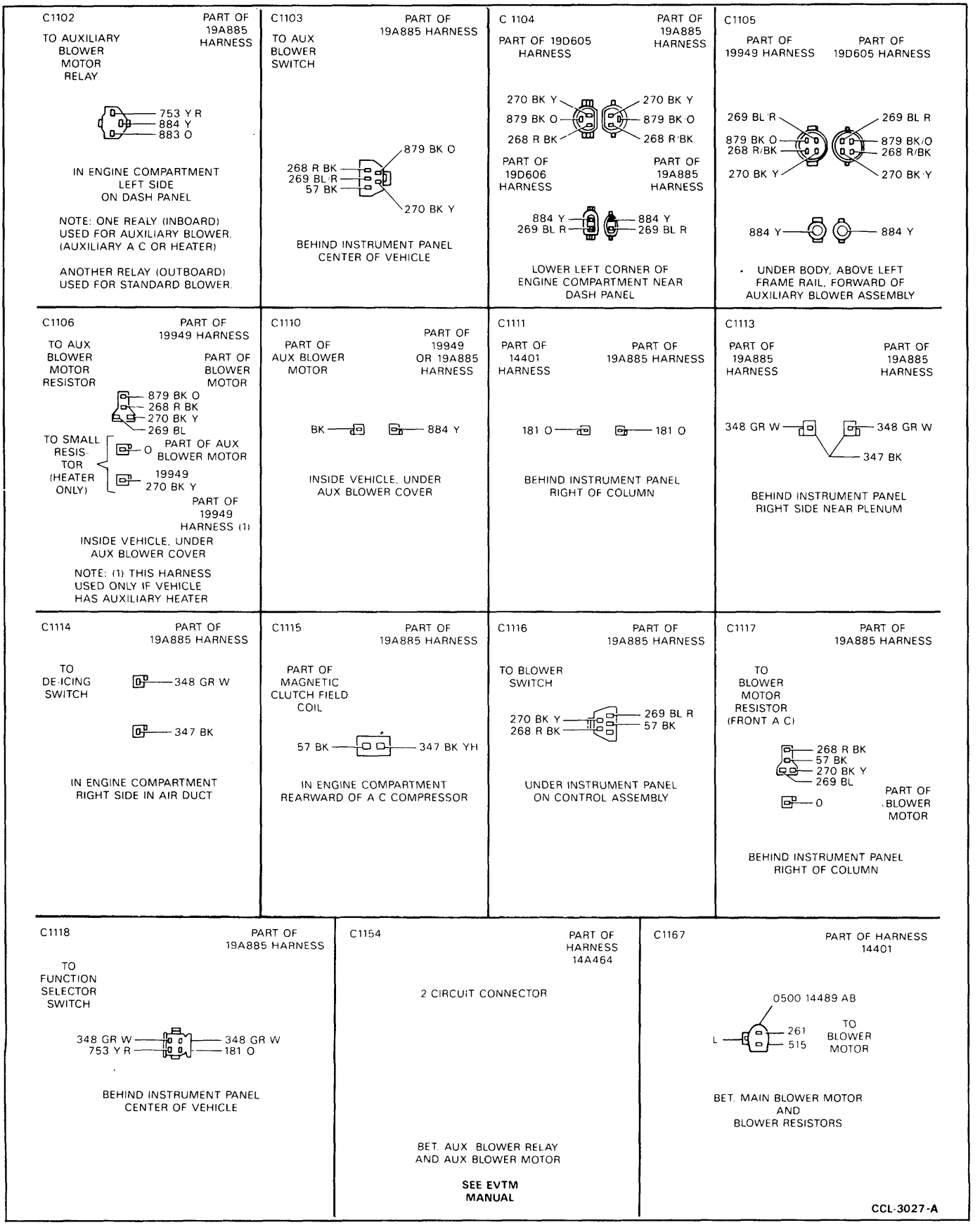


FIG. 12 A/C-Heater Main and Auxiliary Blower Wiring Connectors

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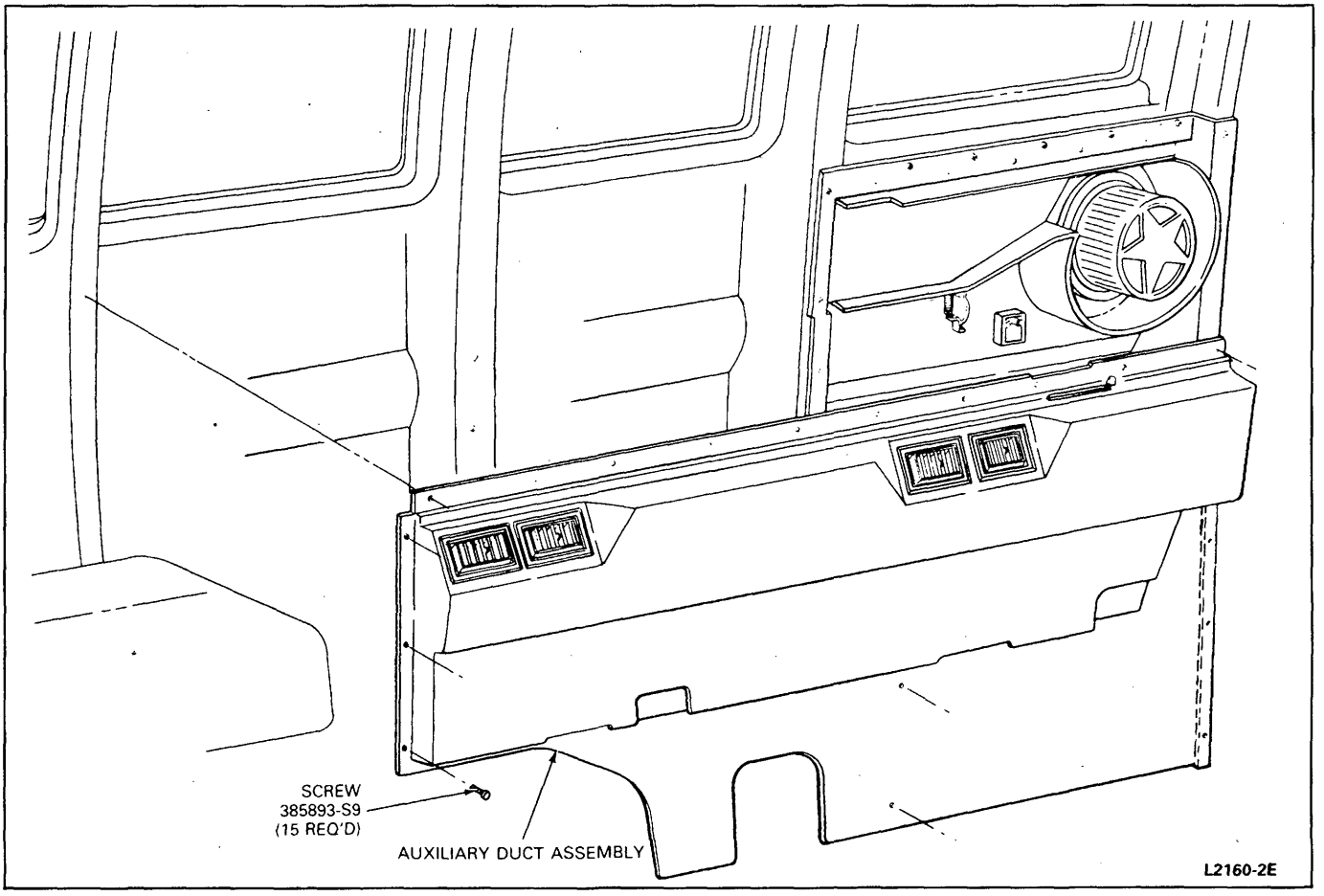


FIG. 13 Auxiliary Duct and Trim Panel Assembly

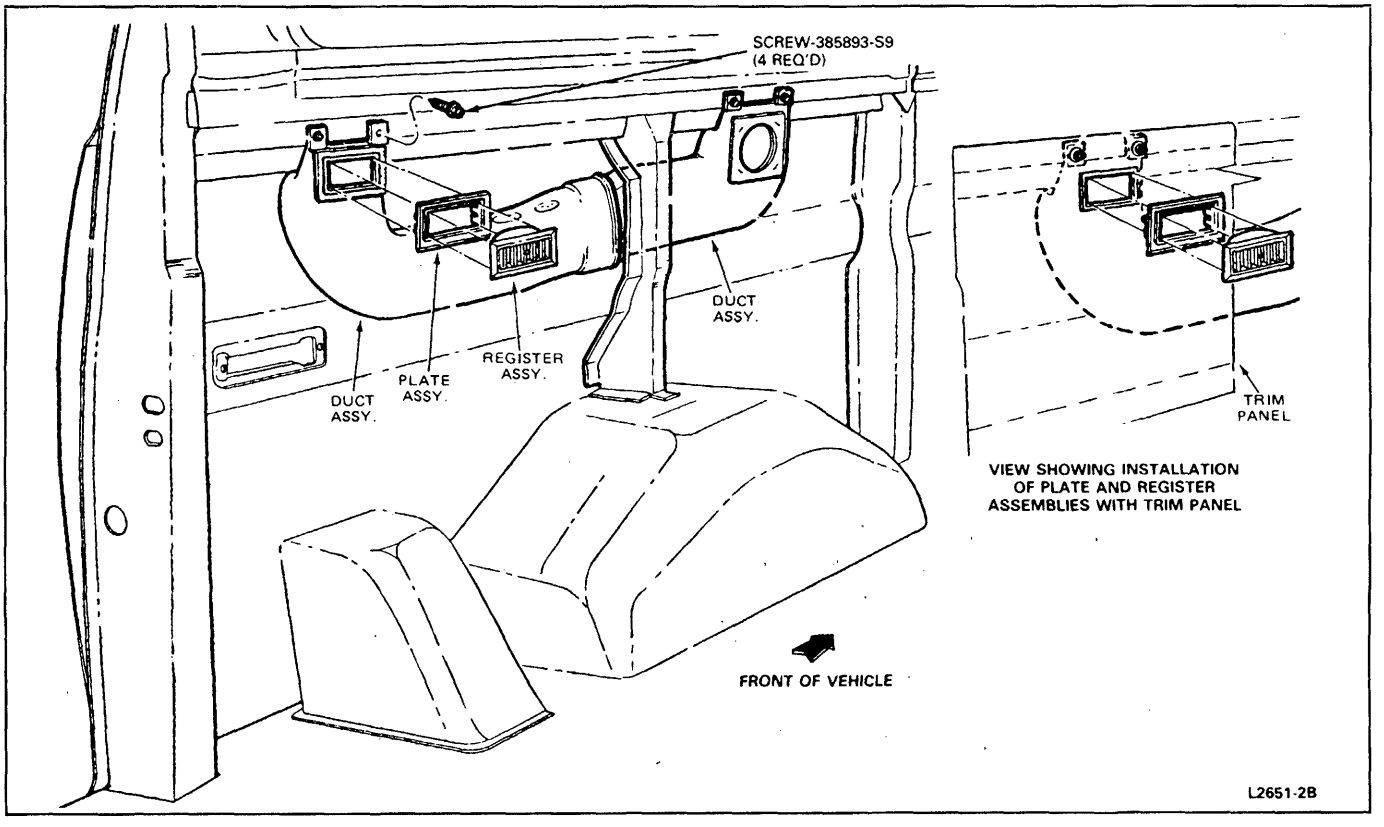


FIG. 14 Super Club Wagon Auxiliary Duct Assembly

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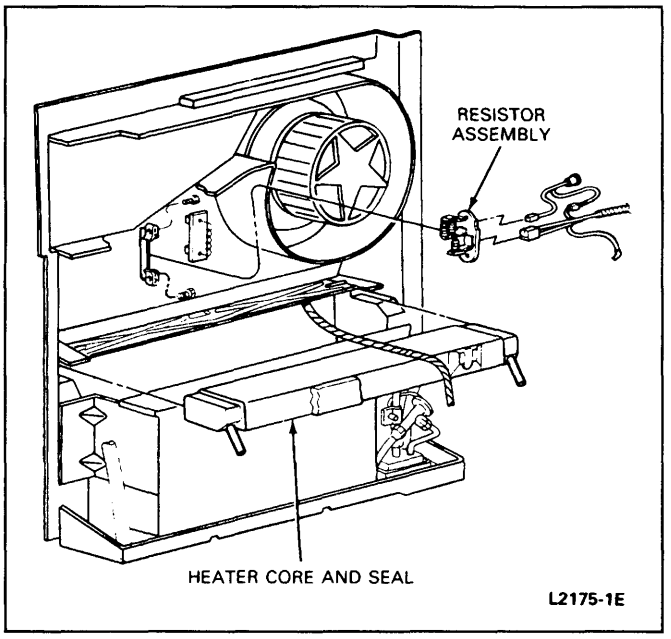


FIG. 15 Heater Core and Resistor

9. Leak-test, evacuate and charge refrigerant system following recommended procedures, if equipped with auxiliary A/C.
10. Install auxiliary heater and/or air conditioner cover assembly (Fig. 5).
11. Install bench seat, if so equipped. Tighten retaining bolts to 34-61 N·m (25-45 ft-lb).

Auxiliary Evaporator Core Assembly

Removal

NOTE: Whenever a refrigerant line, expansion valve or evaporator core in the auxiliary system is replaced, it will be necessary to replace the suction accummulator drier in the main system.

1. Remove first bench seat, if so equipped.
2. Remove auxiliary heater and/or air conditioner cover assembly retaining screws and remove cover assembly (Fig. 6).
3. Discharge the refrigerant system following recommended service procedures. Observe all safety precautions.
4. Using backup wrenches to prevent component damage, disconnect suction line from evaporator core and liquid line from expansion valve. Cap all open refrigerant line connections to prevent entrance of dirt and moisture.
5. Disconnect heater hoses (if equipped with an auxiliary heater) from auxiliary heater core and plug hoses with suitable 15.875mm (5/8-inch) plugs.
6. Remove four screws retaining evaporator core and mounting bracket to auxiliary case assembly (Fig. 17).
7. Remove evaporator core, expansion valve and core mounting plate from case assembly (Fig. 17).
8. If evaporator core is to be replaced, remove expansion valve and mounting plate from evaporator core.

Installation

1. Connect expansion valve to evaporator core inlet tube using a new O-ring lubricated with clean refrigerant oil. Tighten connection to 21-27 N·m (15-20 ft-lb) using a backup wrench to prevent component damage.
2. Clamp the expansion valve capiliary bulb to evaporator core outlet tube making sure bulb makes good contact with outlet tube. Clean both surfaces. Wrap capiliary bulb and outlet tube with insulating tape, Motorcraft YZ-1 or equivalent.
3. Wrap ends of evaporator core with insulating tape.
4. Attach mounting plate to expansion valve end of evaporator core with two screws.
5. Carefully position evaporator core to case and refrigerant lines. Use new O-rings lubricated with clean refrigerant oil at refrigerant line connections.
6. Tighten refrigerant line connections; suction line to evaporator core 41-47 N·m (30-35 ft-lb), liquid line to expansion valve 14-20 N·m (10-15 ft-lb). Use a backup wrench to prevent component damage.
7. Install four screws that retain evaporator core mounting brackets to evaporator case.
8. Remove plugs from heater hoses.
9. Connect heater hoses to heater core. Tighten hose clamps to 14-20 N·m (12-18 in-lb). DO NOT overtighten hose clamps.
10. Fill radiator to specified level with coolant. Refer to Section 27-02, Cooling System Service.
11. Leak-test, evacuate and charge the refrigerant system following recommended service procedures. Observe all safety precautions.
12. Install auxiliary heater and/or air conditioner cover assembly (Fig. 6).
13. Install bench seat, if so equipped. Tighten retaining bolts 34-61 N·m (25-45 ft-lb).

Expansion Valve

Removal

1. Remove first bench seat, if so equipped.
2. Remove auxiliary heater and/or air conditioner cover assembly (Fig. 6).
3. Discharge refrigerant system following recommended procedures. Observe all safety precautions.
4. Disconnect liquid line from expansion valve (Fig. 16). Use a backup wrench to prevent entrance of dirt and moisture.
5. Remove insulating tape from evaporator core outlet tube. Then, remove clamp and expansion valve capiliary bulb from outlet tube of evaporator core.
6. Using a backup wrench, remove expansion valve from evaporator core inlet tube. Cap inlet tube if it will be open to atmosphere more than 15 minutes.

Installation

1. Connect expansion valve to evaporator core inlet tube using a new O-ring lubricated with clean refrigerant oil. Tighten connecttion only fingertight at this time.

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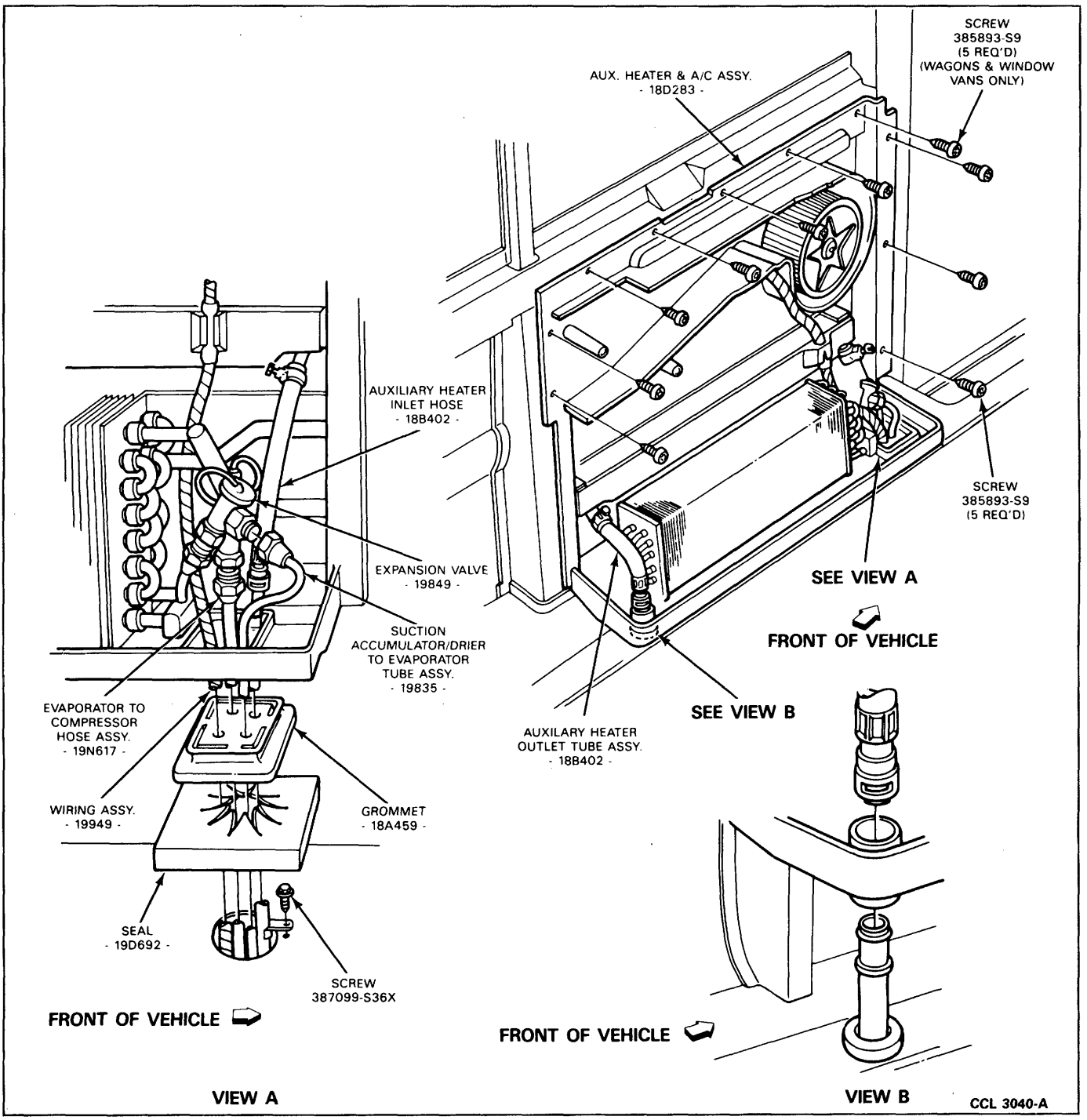


FIG. 16 Auxiliary A/C-Heater Assembly

2. Connect liquid line to expansion valve using a new O-ring lubricated with clean refrigerant oil.
3. Using two wrenches, tighten liquid line to expansion valve fitting to 14-20 N·m (10-15 ft-lb). Tighten expansion valve to evaporator core fitting to 21-27 N·m (15-20 ft-lb).
4. Clamp expansion valve capiliary tube bulb to evaporator core outlet tube. Clean both surfaces. Bulb must make good contact with outlet tube.
5. Wrap evaporator core outlet tube and capiliary tube bulb with insulating tape.
6. Leak-test, evacuate and charge refrigerant system following recommended procedures. Observe all safety precautions.
7. Install auxiliary heater and/or air conditioner cover assembly (Fig. 6).
8. Install first bench seat, if so equipped.

Refrigerant Lines and Heater Hoses

The refrigerant line and heater hose routings for front and auxiliary systems are shown in Figs. 18 through 25.

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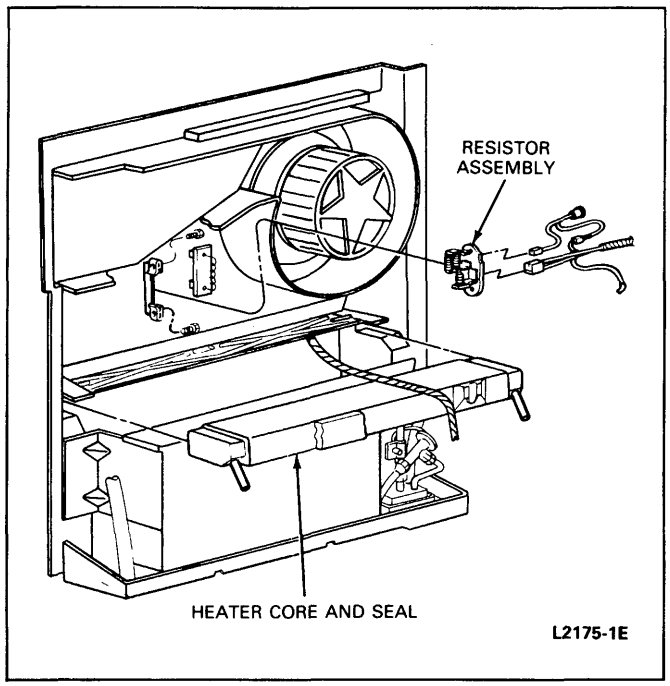


FIG. 17 Evaporator Core Installation

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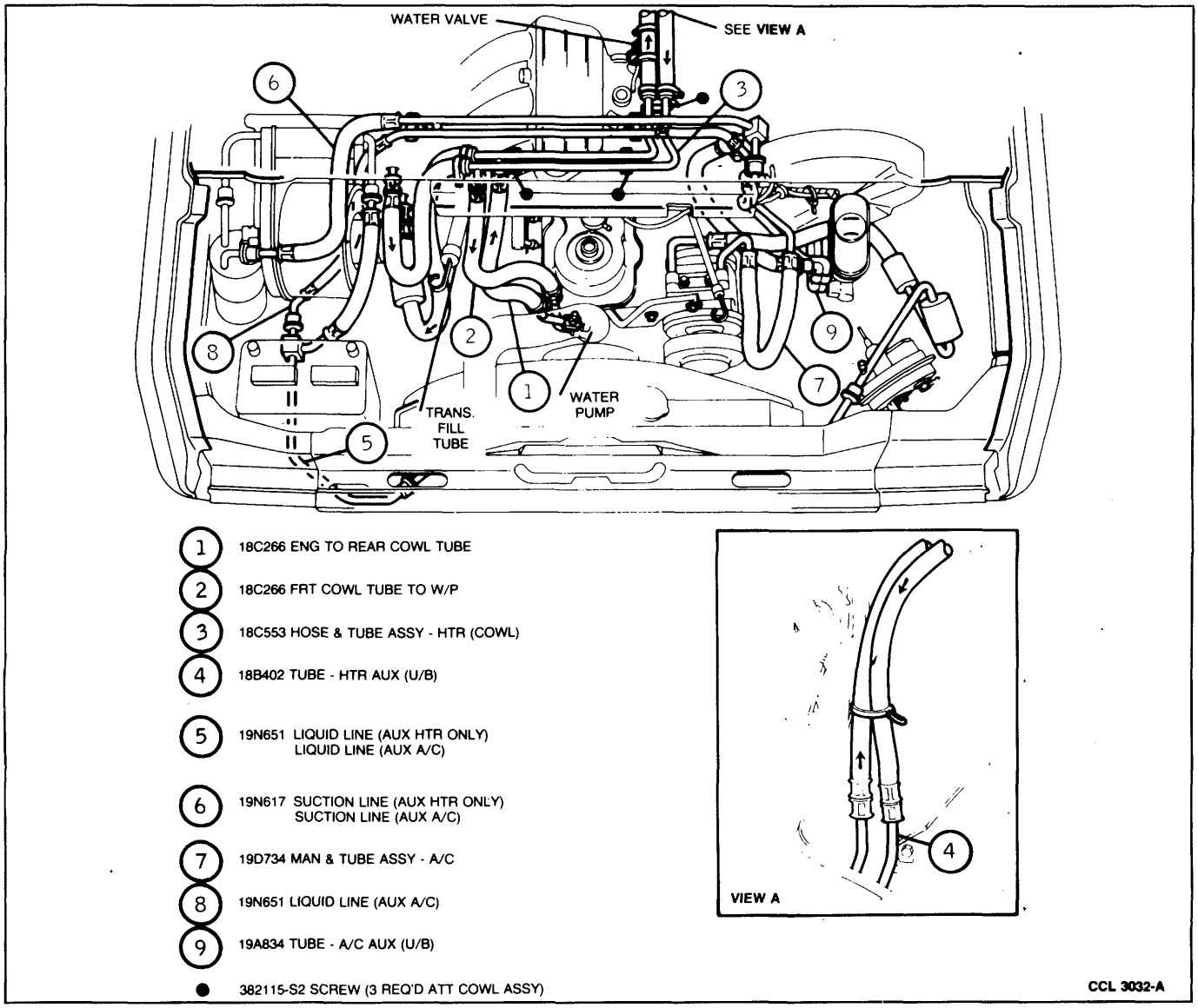
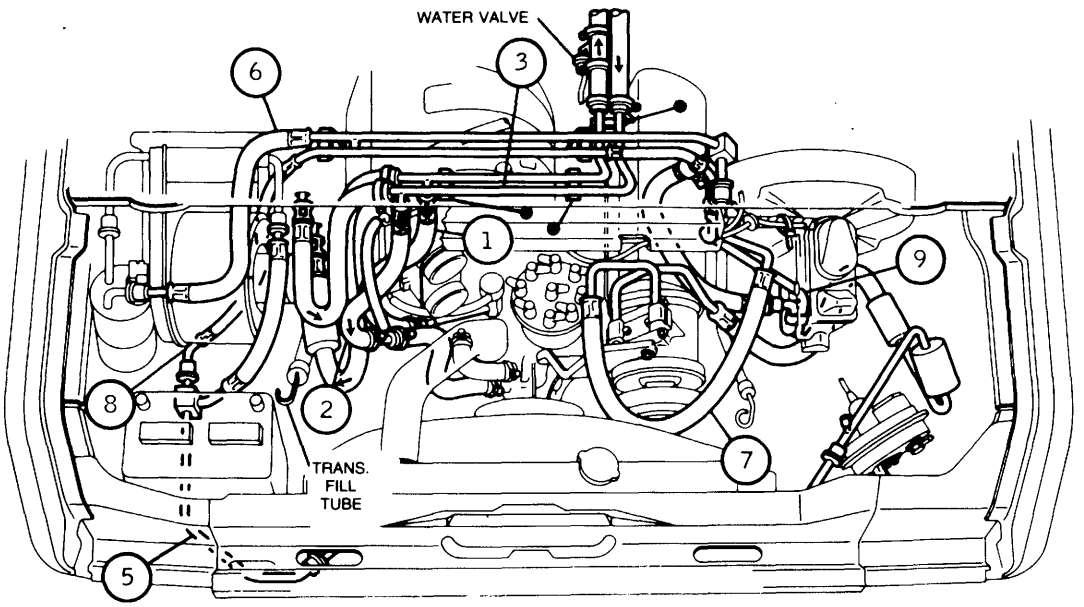
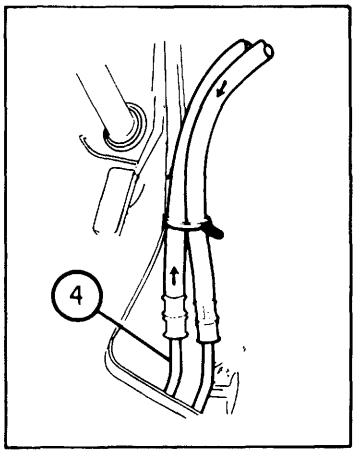


FIG. 18 Main and Auxiliary A/C-Heater System-Lines and Hoses-Engine Compartment-4.9L (300CID) Engine

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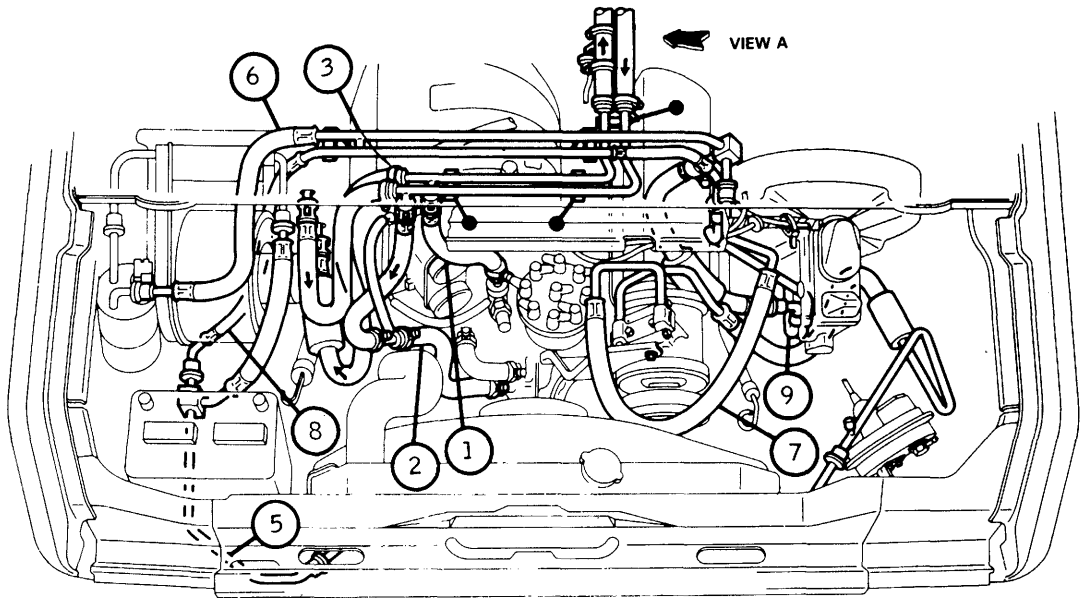


1 18C266 ENG TO LWR HTR CORE
2 18C266 UPPER HTR CORE TO W/P
3 18C553 HOSE TUBE ASSY - HTR (COWL)
4 18B402 TUBE-HTR AUX (U/B)
5 19N651 LIQUID LINE (AUX HTR ONLY) (AUX A/C)
6 19N617 SUCTION LINE (AUX HTR ONLY) (AUX A/C)
7 19D734 MANIFOLD & TUBE ASSEMBLY
8 19N651 LIQUID LINE (AUX A/C)
9 19A834 TUBE - A/C AUX (U/B)
● 382115-S2 SCREW (3 REQ'D ATT COWL ASSY)
✱ ENGINE RELEASE

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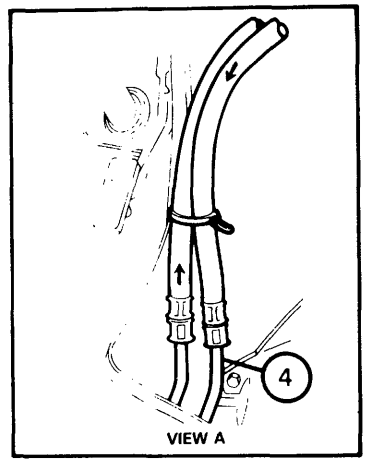
FIG. 19 Main and Auxiliary A/C-Heater System-Lines and Hoses-Engine Compartment -5.0L (302 CID) Engine

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1. 18C266 ENG TO REAR COWL TUBE
2. 18C266 FRONT COWL TUBE TO W/P
3. 18C553 HOSE TUBE ASSY - HTR (COWL)
4. 18B402 TUBE - HTR (U/B)
5. 19N651 LIQUID LINE (AUX HTR ONLY)
   LIQUID LINE (AUX A/C)
6. 19N617 SUCTION LINE (AUX HTR ONLY)
   SUCTION LINE (AUX A/C)
7. 19D734 MANIFOLD AND TUBE ASSY
8. 19N651 LIQUID LINE (AUX A/C)
9. 19A834 TUBE - A/C AUX (U/B)

● 382115-S2 SCREW (3 REQ'D ATT COWL ASSY)



CCL 3034-A

FIG. 20 Main and Auxiliary A/C-Heater System-Lines and Hoses-Engine Compartment 5.8L (351 CID) Engine

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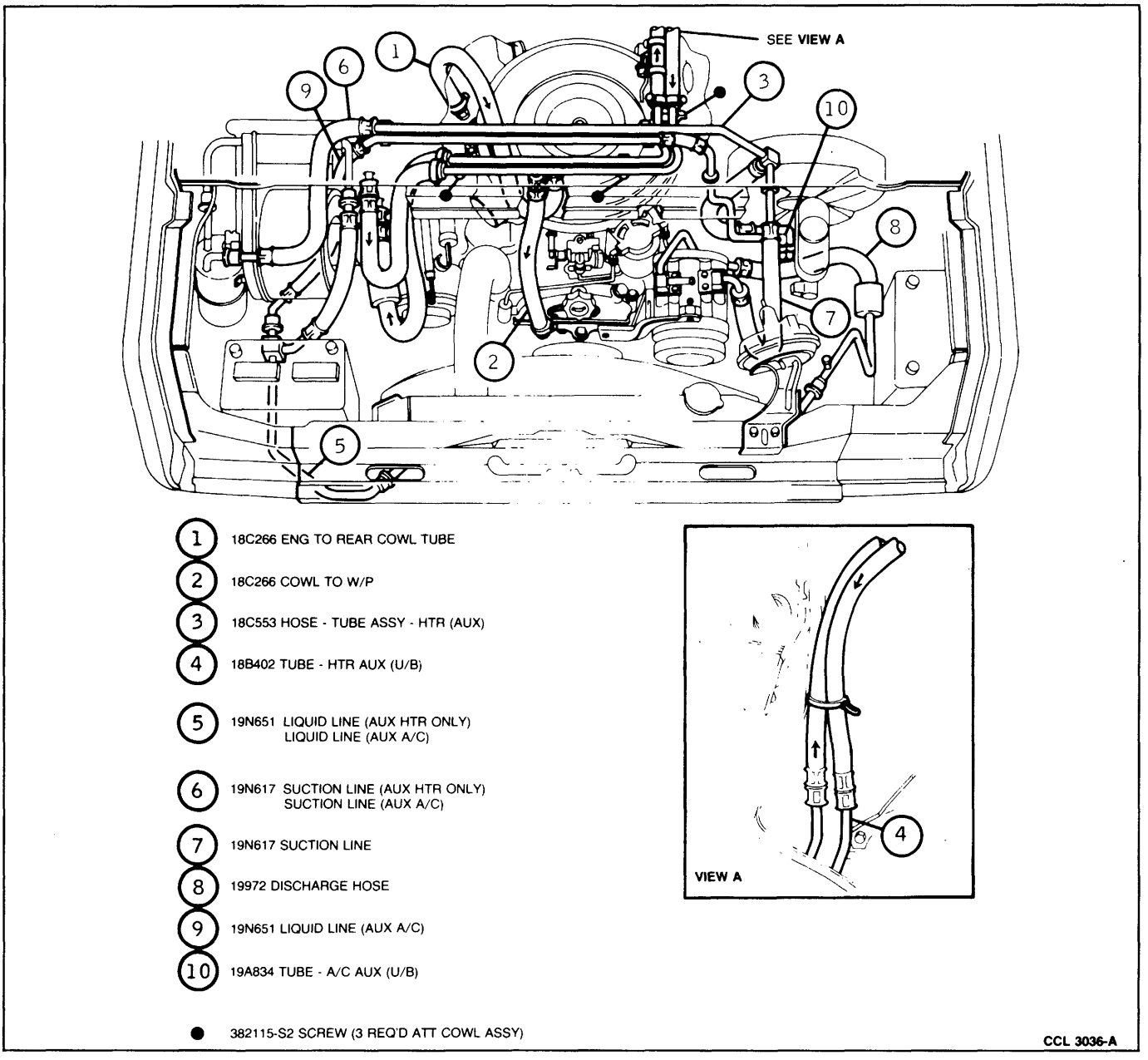
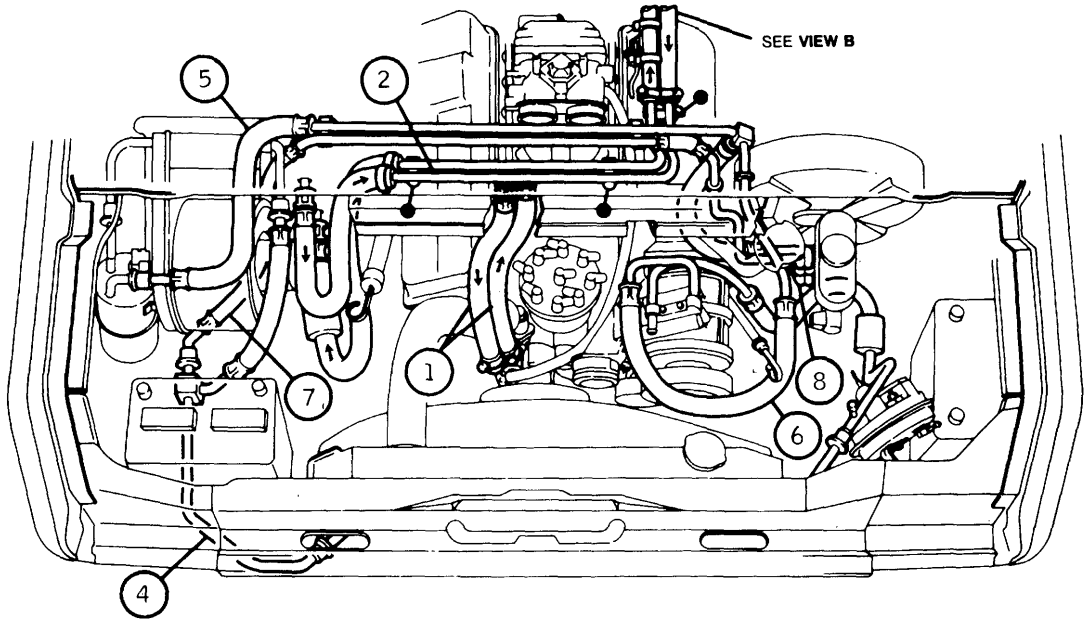


FIG. 21 Main and Auxiliary A/C-Heater System-Lines and Hoses-Engine Compartment 7.3L Diesel Engine

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1 18C266 (2 REQD)

2 18C553 HOSE & TUBE ASSY - HTR (COWL)

3 18B402 TUBE-HTR AUX (U/B)

4 19N651 (AUX MTR ONLY)
(AUX A/C)

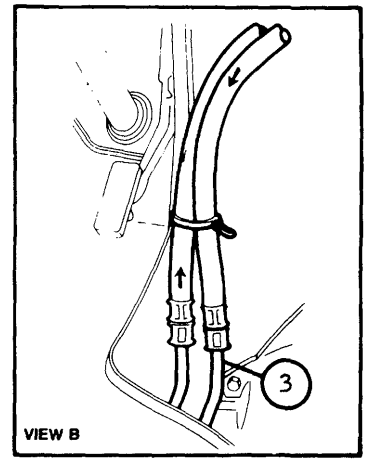
5 19N617 (AUX HTR ONLY)
(AUX A/C)

6 19D734 MANIFOLD & TUBE ASSEMBLY

7 19N651 LIQUID LINE (AUX)

8 19A834 TUBE - A/C AUX (U/B)

● 382115-S2 SCREW (3 REQ'D ATT COWL ASSY)



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FIG. 22 Main and Auxiliary A/C-Heater System-Lines and Hoses-Engine Compartment-7.5L (460 CID) Engine

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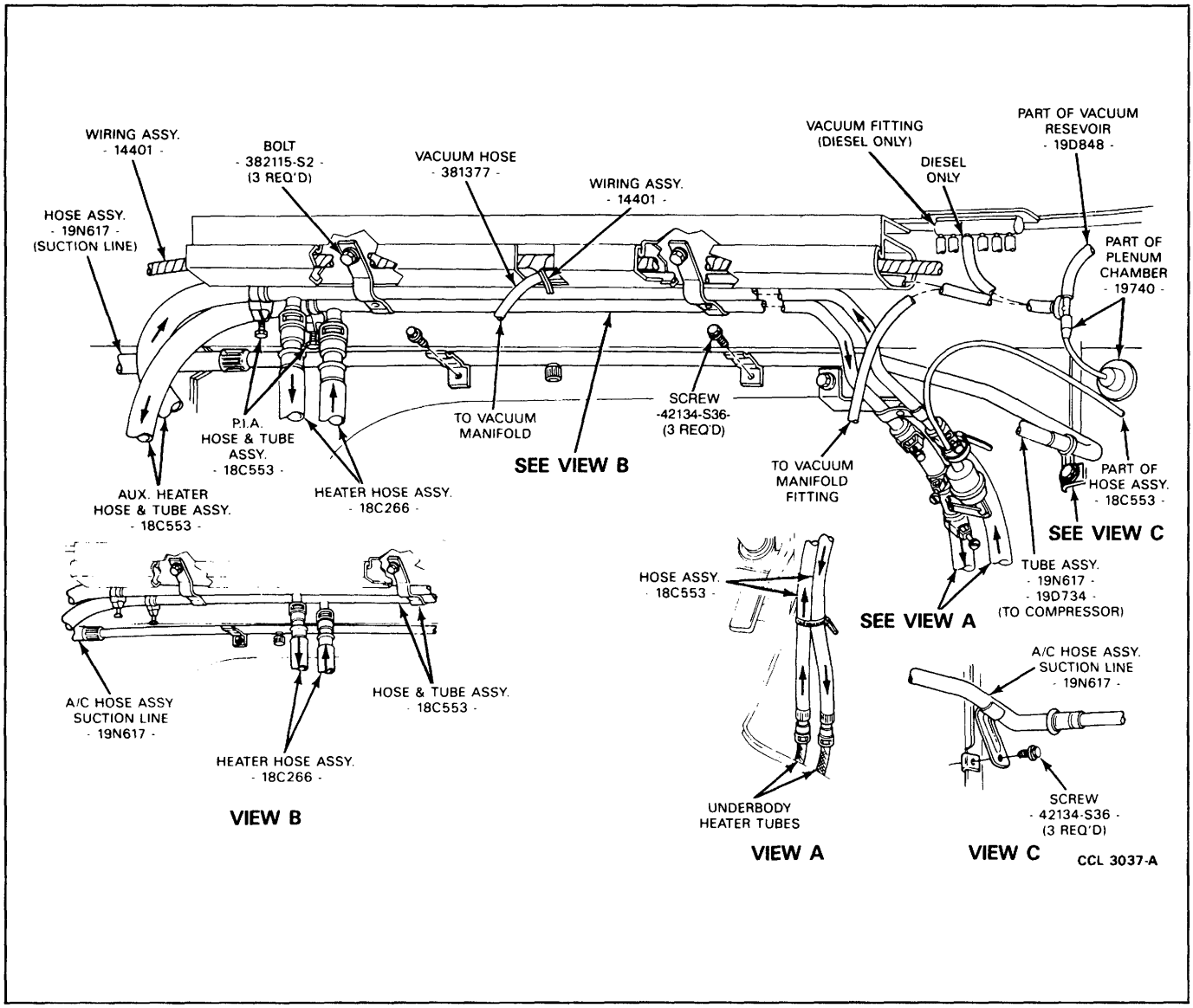


FIG. 23 Typical Hose and Tube Routing and Connections at Dash Panel-Main A/C-Heater and Auxiliary Heater Systems

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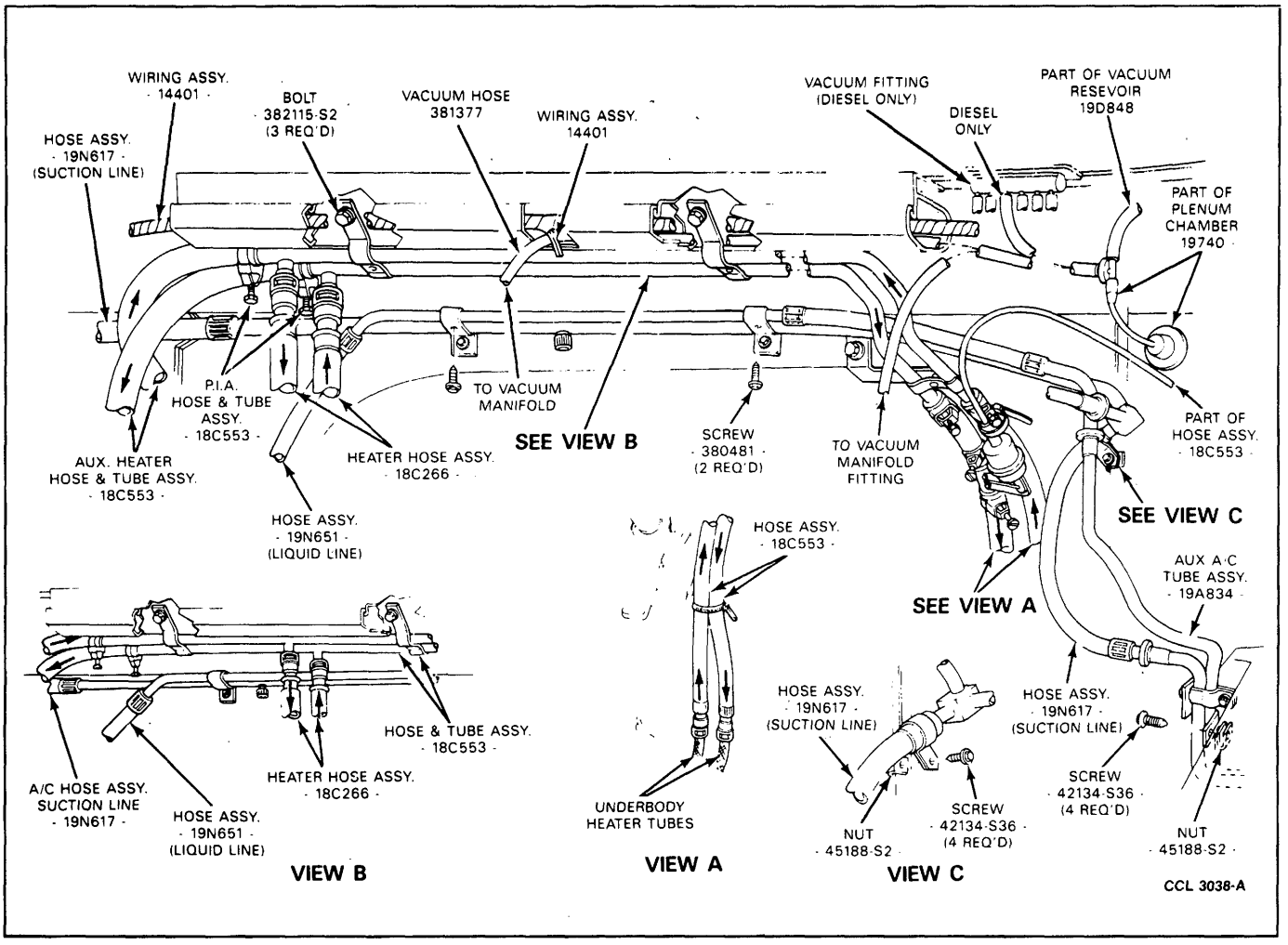


FIG. 24 Typical Hose and Tube Routing and Connections at Dash Panel-Main and Auxiliary A/C and Heater Systems

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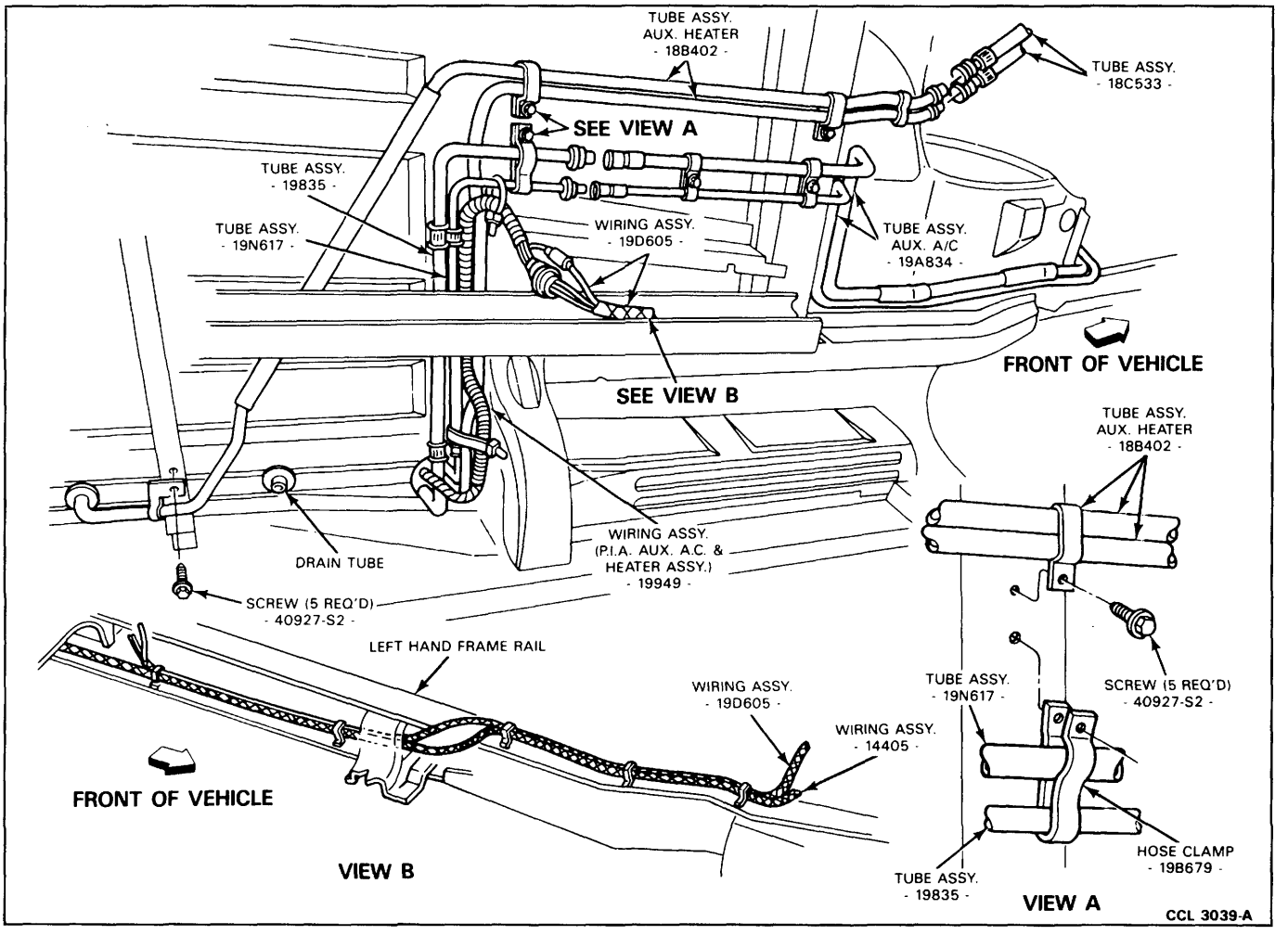


FIG. 25 Typical Underbody Routing of A/C-Heater Hoses and Tubes Between Main and Auxiliary Systems

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SPECIFICATIONS

ELECTRICAL

System Protection			
Main System	15 Amp. Fuse (F-9) in Fuse Panel		
Auxiliary System	Fuse Link (Orange) Connected to Starter Relay or Dual Battery Relay		
Blower Motor	**Blower Speed**	**Amps.**	**Volts**
Current Draw			
Auxiliary System	Low	4.0	4.0
	Med. Low	7.3	6.0
	Med. High	13.8	9.0
	High	23.0	12.8
Clutch Cycling Pressure Switch — Main System Expansion Valve — Auxiliary System			
Illumination Control Assembly	One 1CP — 161 Bulb		

REFRIGERANT (A/C ONLY)

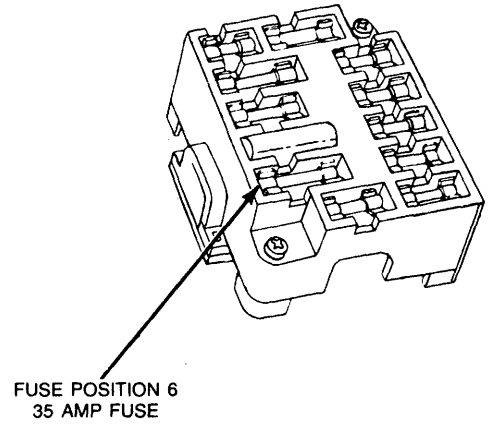
Cycling Clutch Control De-Icing Switch	Common with Main A/C System
System Protection High Pressure Relief Valve	Common with Main A/C System
Capacity Main (Front) System Only	3½ Lbs. Plus ¼ Lb. Minus 0 56 Oz. Plus 4 Oz. Minus 0 1.588 Kg. Plug 0.113 Kg. Minus 0
Main (Front) System and Auxiliary System	4½ Lbs. Plus ¼ Lb. Minus 0 68 Oz. Plus 4 Oz. Minus 0 1.928 Kg. Plus 0.113 Kg. Minus 0
Type Refrigerant 12 (R-12) Ford Spec. Motorcraft Part Number 30 Lb. Container	Dichlorodifluoromethane CCl_2F_2 ESA-M17B2A YN-7

TORQUE SPECIFICATIONS

Description	Torque N•m	Torque Ft-Lbs
Expansion Valve to Evaporator Core	21-27	15-20
Liquid Line to Expansion Valve	14-20	10-15
Suction Line to Evaporator Core	41-47	30-35

COMPRESSOR

6-Cylinder	Common with Main A/C System



CL3447-2F

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GROUP

SPEED CONTROL 37

(19000)

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VEHICLE APPLICATION

E-150 through E-350, F-150 through F-350 and Bronco.

DESCRIPTION AND OPERATION

Speed Control E-150—E-350, F-150—F-350 and Bronco

The speed control system is comprised of the OFF-ON switch and the SET-ACCL, CST, RSM (ACCEL, COAST, RESUME on Econoline) switches, a servo (throttle actuator) assembly, a speed sensor, a clutch position sensing switch (manual transmissions), an amplifier assembly and the necessary wires, linkage, and vacuum dump valve vacuum hose to connect the components. The 7.3L diesel engine incorporates a vacuum reservoir with an integrated check valve. The switches are located in the horn pad assembly (Figs. 1 and 2). The amplifier assembly is located under the instrument panel (Figs. 3, 4 and 5). The servo assembly (throttle actuator) is attached as shown in Figs. 9 through 15. The speed control sensor is located on the LH side of the transmission. To operate the speed control system the engine must be running and the vehicle speed over 48 Km/h (30 mph). Manifold vacuum is constantly supplied when the engine is running. When the ON/OFF switch in the steering wheel is momentarily actuated to the **ON position the system is made ready to accept a set speed signal.** When the vehicle has been accelerated and stabilized at a speed over 48 Km/h (30 mph) and the **ON switch engaged, the operator may momentarily depress and release the**

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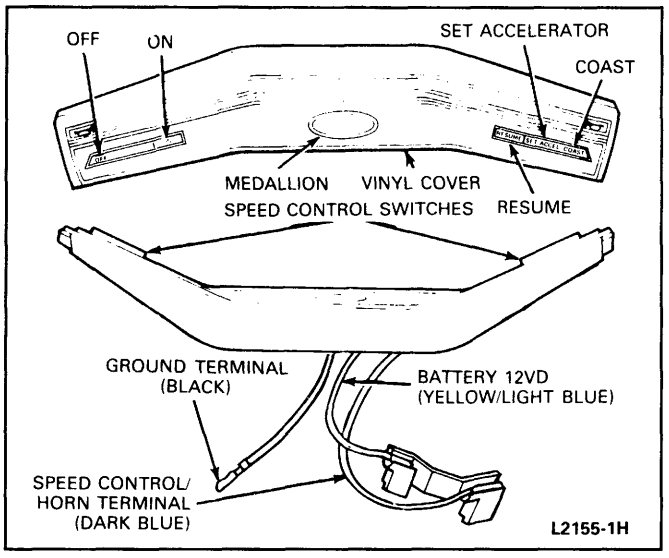


FIG. 1 Control Switch Installation E-150—E-350

SET/ACCL (ACCEL on Econoline) button. This speed will be maintained until a new speed is set by the operator, the brake pedal is depressed, the clutch pedal is depressed, the hazard lights are activated or the system or vehicle is turned off.

Decreasing Set Speed

The set speed may be reduced by applying the brake and then resetting the speed using the preceding method or by depressing the COAST/CST switch. When the vehicle has slowed to the desired speed the COAST/CST switch is released and the new speed is set automatically. If the vehicle speed is reduced below 48 Km/h (30 mph), the operator must manually increase the speed up to 48 Km/h (30 mph) and reset the system.

Increasing Set Speed

The vehicle set speed may be increased at any time by depressing the accelerator until the higher speed is reached and stabilized, then depressing and releasing the SET/ACCEL, ACCL button.

Speed may also be increased by depressing the SET/ACCEL, ACCL switch button, (at speeds over 48 Km/h (30 mph)), and holding it in that position. When the desired speed is attained and the button is released, that new set speed will be maintained.

Resume Feature

When the speed control system is deactivated by depressing the brake pedal or clutch pedal or activating the hazard light. The set speed prior to deactivation may be reestablished by momentarily depressing the RESUME/RSM switch. The resume feature is deactivated with the OFF switch, or if the vehicle speed has dropped below 48 Km/h (30 mph). In addition, when the ignition is turned to OFF, the speed control memory is erased and the RESUME/RSM feature will not function.

Vacuum Dump Valve

The vacuum dump valve provides a backup safety feature in the new system. Normally, when the brake pedal is depressed an electrical signal from the stoplamp switch to the amplifier will return the system to the stand-by mode. In addition, the vacuum dump valve will mechanically release the vacuum in the servo while

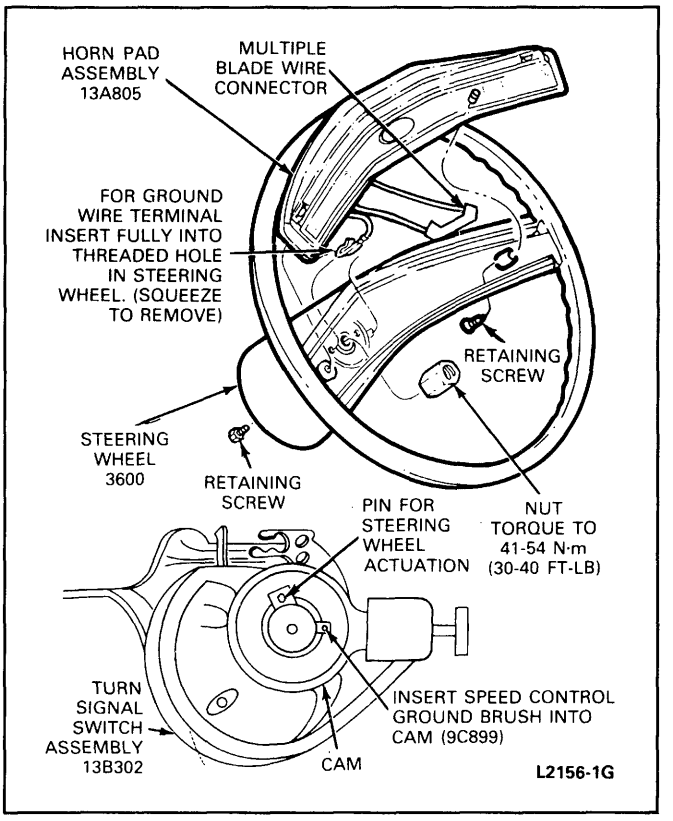


FIG. 2 Horn and Speed Control Switch and Wiring Installation E-150—E-350

the brake pedal is depressed, thus releasing the throttle independently of the amplifier control.

Vacuum Reservoir Assembly (7.3L Diesel Engine)

The vacuum reservoir assembly is provided to supply vacuum to the servo during peak demand. The reservoir is located on the RH apron on Econoline (Fig. 13) and on the LH apron near the servo on F-Series (Fig. 17). A check valve is integrated with the reservoir to prevent reverse vacuum flow. There are two 7.9mm (5/16-inch) diameter vacuum ports on the reservoir. The "VAC" port is connected by a 7.9mm (5/16-inch) I.D. vacuum hose to the vacuum source distribution port. The other port is connected by an identical vacuum hose to the speed control servo vacuum source port adjacent to the 6-way electrical connector.

Ground Brush

The speed control ground brush assembly provides an electrical ground path between the steering wheel hub and the turn signal switch when inserted into the turn signal cancelling cam (Fig. 4).

DIAGNOSIS AND TESTING

Speed control system tests should be performed using the Rotunda Speed Control Tester 007-00013 or equivalent. If the Rotunda Speed Control Tester 007-00013 is not available, use the following procedures.

NOTE: Diagnosis charts are provided at the end of this Section to assist in locating speed control system problems.

Visual Inspection

A visual inspection is an important part of the system test. When performing a visual inspection, check all

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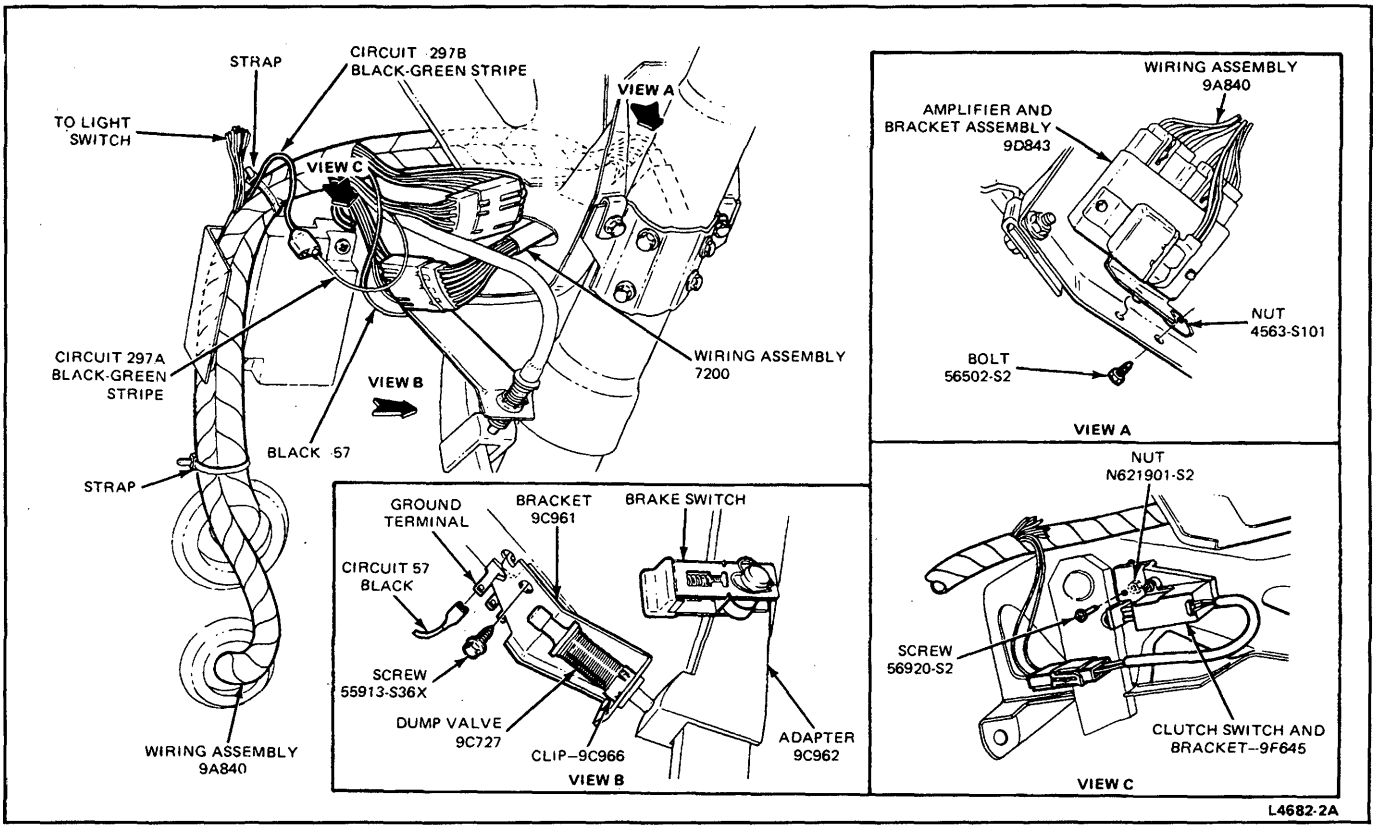


FIG. 3 Speed Control Amplifier and Wiring Installation—E-150—E-350

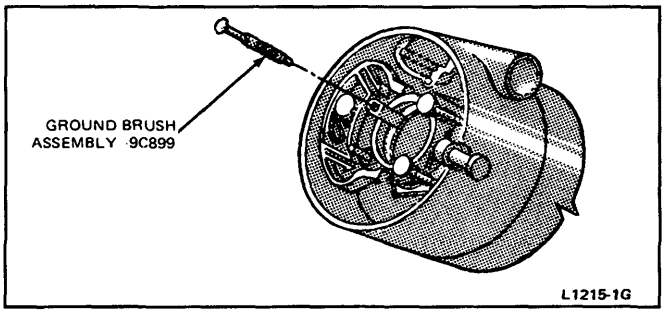


FIG. 4 Ground Brush Installation

items for abnormal conditions such as frayed wires and damaged servo vacuum hoses. For the speed control system to function properly, it is necessary that the speedometer cables be properly routed and securely attached to the components. All vacuum hoses must be securely attached and routed with no sharp bends or kinks. The servo (throttle actuator) and throttle linkage should operate freely and smoothly. **The bead chain, if so equipped, should have no more than 3.18mm (1/8 inch) free play with the throttle set to hot idle position. The actuator cable, if so equipped, should be adjusted as tight as possible without opening the throttle plate or increasing the idle speed. Electrical connections must be complete and tight. The wiring harness must be properly routed. Look for frayed wiring insulation or evidence of shorts.** Any problems revealed by the visual inspection should be corrected before further tests of the speed control system are made.

Control Switches Test

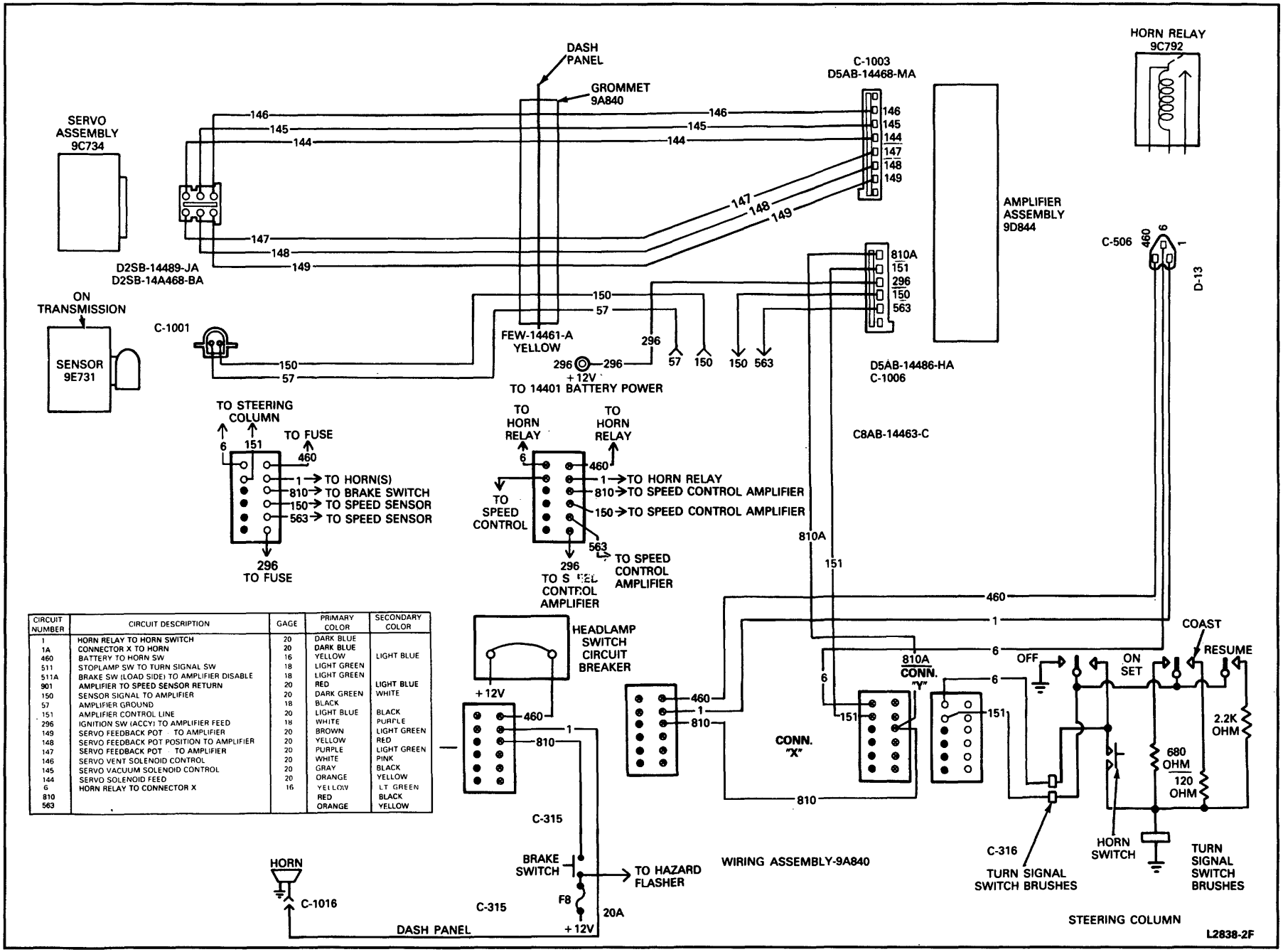
Disconnect the 6-way connector at the amplifier from the steering column control switches (Fig. 3). Then, check the lead (light blue-black -151) from the control switches as follows:

NOTE: F-150—F-350 Bronco switches are marked SET/ACCL and CST/RSM.

1. Check for battery voltage at the lead (light blue-black) when the ON switch is depressed. Battery voltage should be available at the lead (light blue-black) coming from the control switches. (Refer to the wiring diagram, Figs. 5 through 8.)

2. Connect an ohmmeter such as Rotunda Digital Volt-Ohm-Meter 007-00001 or an equivalent between the light blue-black wire (151) and ground. Check the wire for continuity to ground (0-1 ohm) when the OFF switch is depressed. If a resistance higher than 1 ohm is found, the wiring, slip rings, the copper brushes in the turn signal switch, or the switch is at fault, or the steering column is not properly grounded. To check for proper ground, connect an ohmmeter between any good electrical ground point on the body sheet metal and the steering column upper flange. Scrape away paint in a non-visible spot if necessary for good contact. The resistance should be less than 1/2 ohm. Rotate the steering wheel back and forth and check flexible coupling for resistance of less than 1 ohm. If resistance higher than 3 ohms is noted, clean the horn brush contacts and the ground brush (verify that the ground brush is installed). A resistance of less than 1 ohm must be obtained before performing the remaining tests.

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CIRCUIT NUMBER	CIRCUIT DESCRIPTION	GAGE	PRIMARY COLOR	SECONDARY COLOR
1	HORN RELAY TO HORN SWITCH	20	DARK BLUE	
1A	CONNECTOR X TO HORN	20	DARK BLUE	
460	BATTERY TO HORN SW	16	YELLOW	LIGHT BLUE
511	STOPLAMP SW TO TURN SIGNAL SW	18	LIGHT GREEN	
511A	BRAKE SW (LOAD SIDE) TO AMPLIFIER DISABLE	18	LIGHT GREEN	
901	AMPLIFIER TO SPEED SENSOR RETURN	20	RED	LIGHT BLUE
150	SENSOR SIGNAL TO AMPLIFIER	20	DARK GREEN	WHITE
57	AMPLIFIER GROUND	18	BLACK	
151	AMPLIFIER CONTROL LINE	20	LIGHT BLUE	BLACK
296	IGNITION SW (ACCY) TO AMPLIFIER FEED	18	WHITE	PURPLE
149	SERVO FEEDBACK POT TO AMPLIFIER	20	BROWN	LIGHT GREEN
148	SERVO FEEDBACK POT POSITION TO AMPLIFIER	20	YELLOW	RED
147	SERVO FEEDBACK POT TO AMPLIFIER	20	PURPLE	LIGHT GREEN
146	SERVO VENT SOLENOID CONTROL	20	WHITE	PINK
145	SERVO VACUUM SOLENOID CONTROL	20	GRAY	BLACK
144	SERVO SOLENOID FEED	20	ORANGE	YELLOW
6	HORN RELAY TO CONNECTOR X	16	YELLOW	LT GREEN
810			RED	BLACK
563			ORANGE	YELLOW

FIG. 5 Wiring Diagram—E-150—E-350

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CIRCUIT NUMBER	CIRCUIT DESCRIPTION	GAGE	PRIMARY COLOR	SECONDARY COLOR
1	HORN RELAY TO HORN SWITCH	20	DARK BLUE	
1A	CONNECTOR X TO HORN	20	DARK BLUE	
460	BATTERY TO HORN SW	16	YELLOW	LIGHT BLUE
511	STOPLAMP SW TO TURN SIGNAL SW	18	LIGHT GREEN	
511A	BRAKE SW (LOAD SIDE) TO AMPLIFIER DISABLE	18	LIGHT GREEN	
901	AMPLIFIER TO SPEED SENSOR RETURN	20	RED	LIGHT BLUE
150	SENSOR SIGNAL TO AMPLIFIER	20	DARK GREEN	WHITE
57	AMPLIFIER GROUND	18	BLACK	
151	AMPLIFIER CONTROL LINE	20	LIGHT BLUE	BLACK
296	IGNITION SW (ACCY) TO AMPLIFIER FEED	18	WHITE	PURPLE
149	SERVO FEEDBACK POT TO AMPLIFIER	20	BROWN	LIGHT GREEN
148	SERVO FEEDBACK POT POSITION TO AMPLIFIER	20	YELLOW	RED
147	SERVO FEEDBACK POT – TO AMPLIFIER	20	PURPLE	LIGHT GREEN
146	SERVO VENT SOLENOID CONTROL	20	WHITE	PINK
145	SERVO VACUUM SOLENOID CONTROL	20	GRAY	BLACK
144	SERVO SOLENOID FEED	20	ORANGE	YELLOW
6	HORN RELAY TO CONNECTOR X	16	YELLOW	LT. GREEN

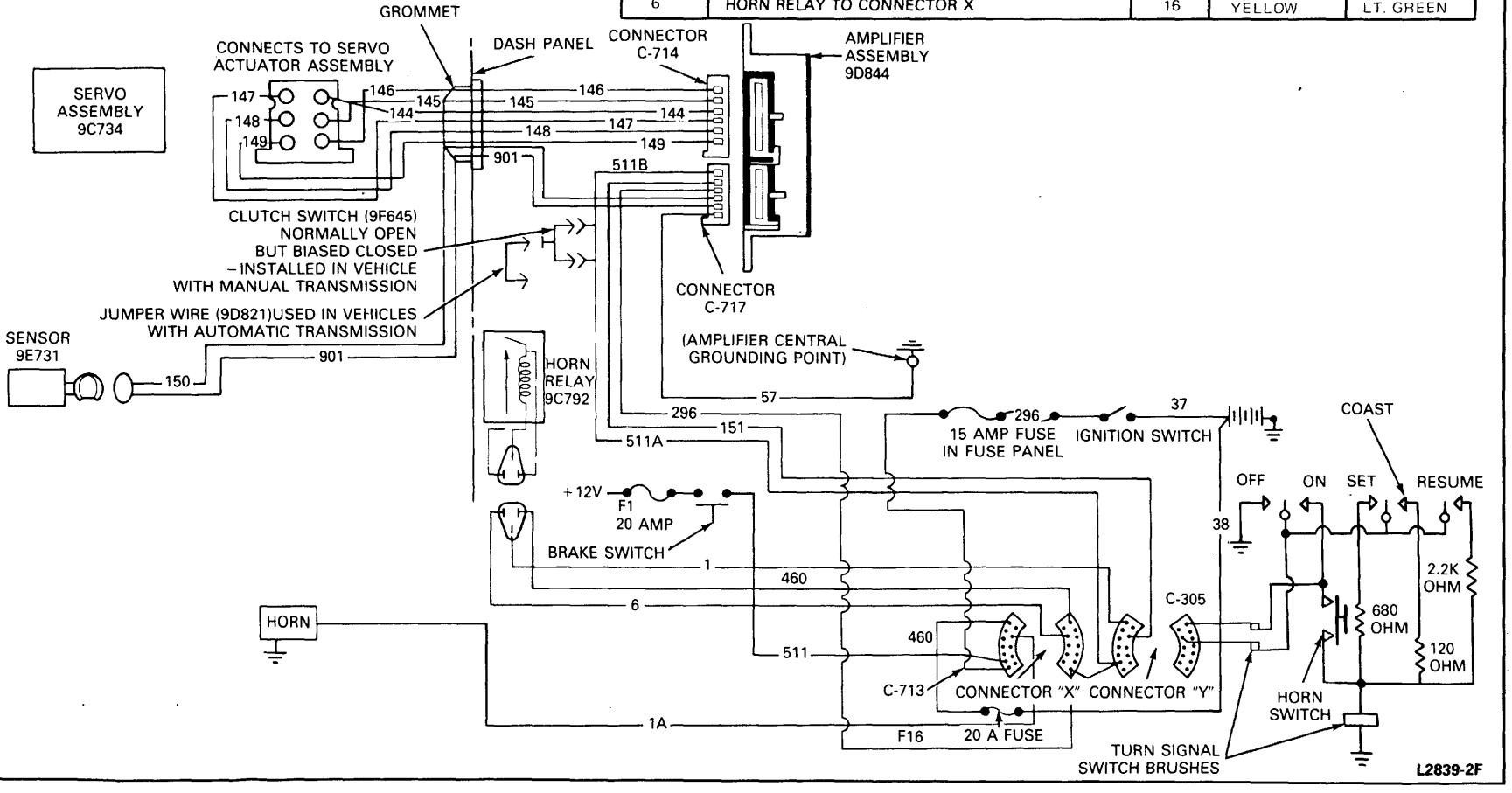


FIG. 6 Wiring Diagram—F-150—F-350 and Bronco

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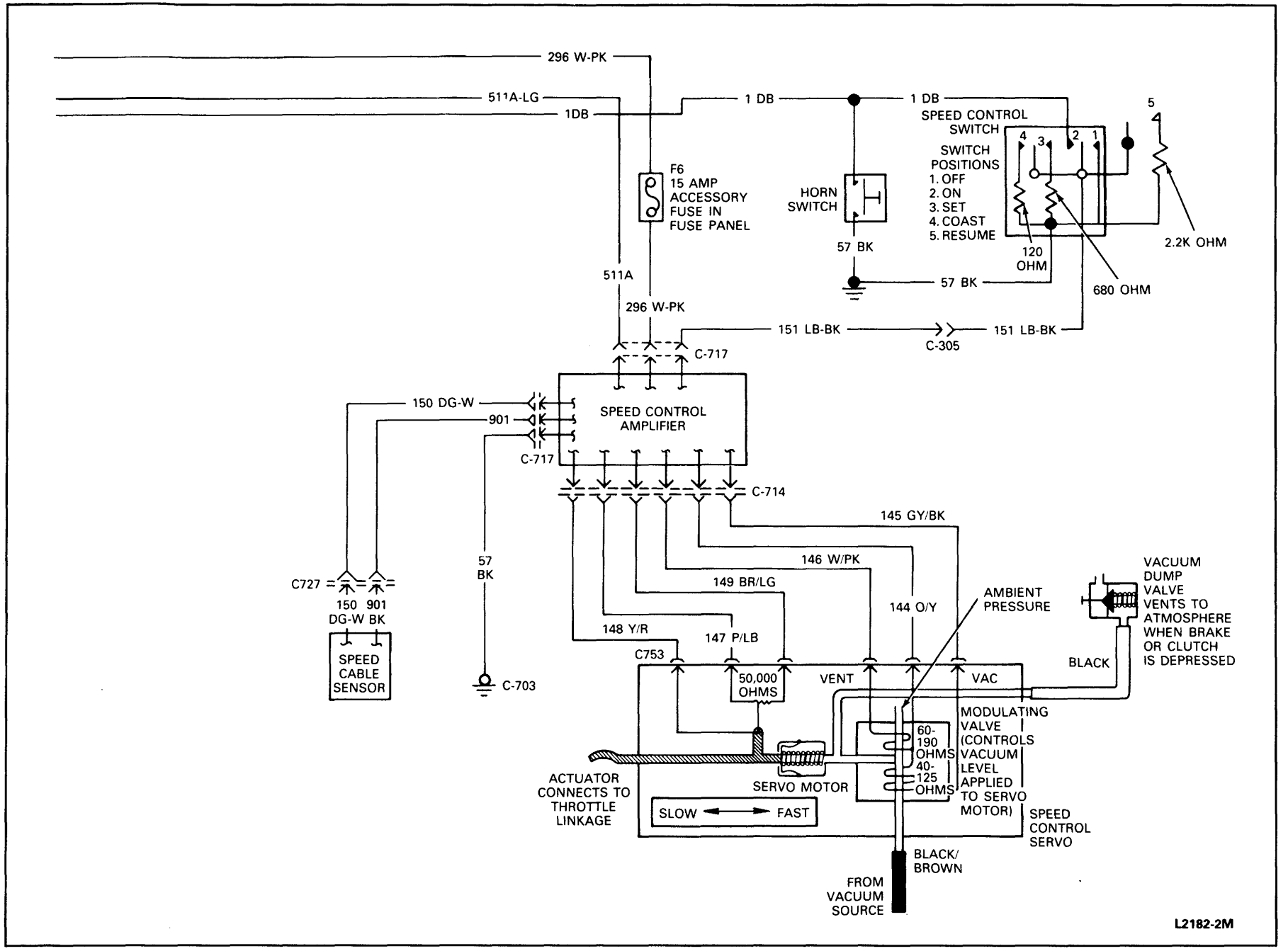


FIG. 7 Main Wiring Diagram—F-150—F-350 and Bronco

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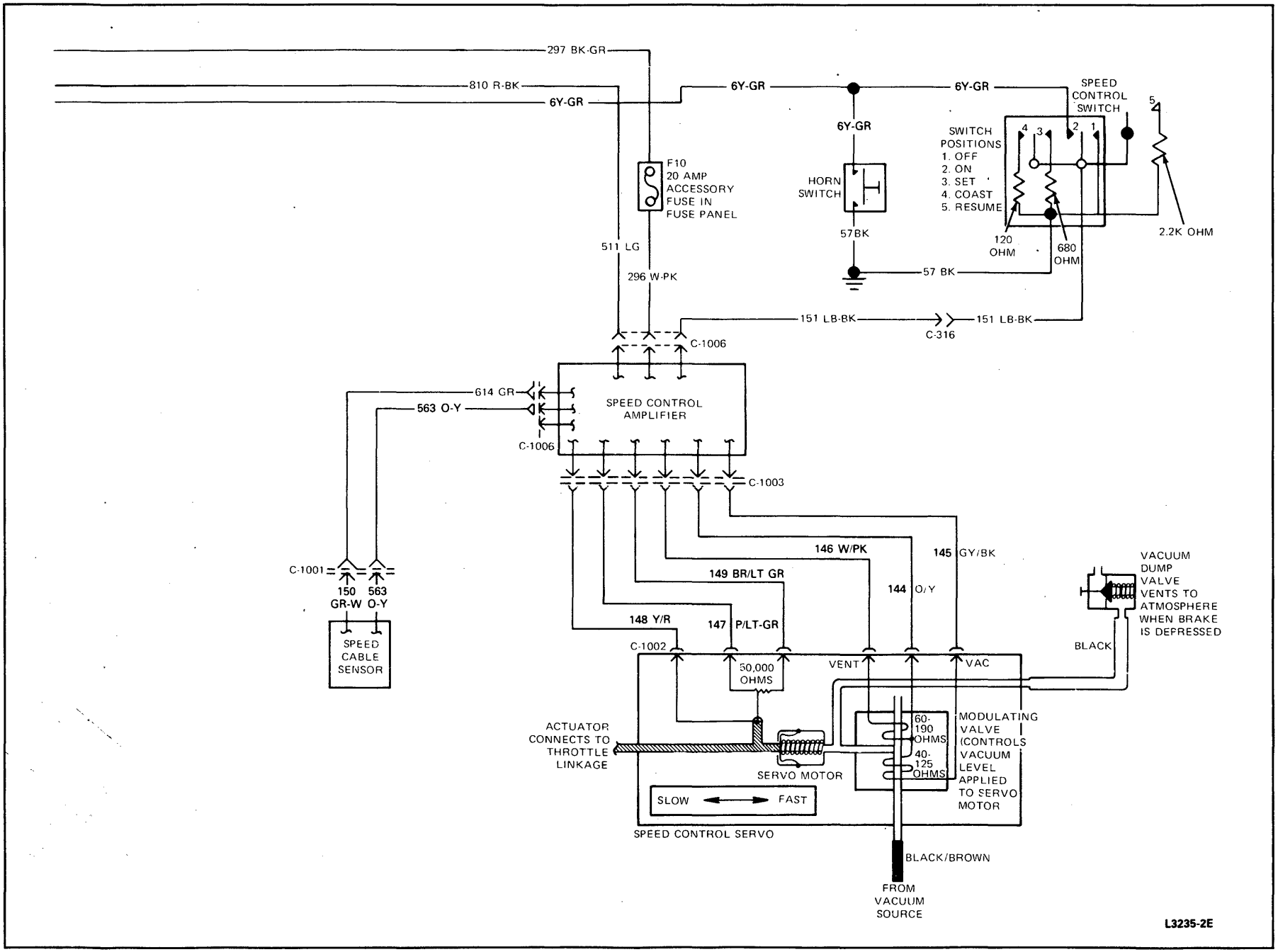


FIG. 8 Main Wiring Diagram—E-150—E-350

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3. With an ohmmeter connected between the light blue-black wire (151) and ground, depress and hold the SET/ACCEL/ACCL switch. A reading of approximately 680 ohms should be indicated on the ohmmeter.
4. With an ohmmeter connected between the light blue-black wire (151) and ground, depress and hold the COAST/CST switch. A reading of approximately 120 ohms should be indicated on the ohmmeter.
5. With an ohmmeter connected between the light blue-black wire (151) and ground, depress and hold the RESUME/RSM switch. A reading of 2200 ohms should be indicated on the ohmmeter.

Speed Sensor Test

Disconnect the 6-way connector (C-1006 on E-150—E-350 and C-717 on F-150—F-350, Bronco) at the amplifier assembly (Fig. 3), and connect an ohmmeter between the wire connector terminals (Dark Green-614 and Black -57 on E-150—E-350 and Dark Green—White Stripe-150 and Black -57A on F-150 through F-350 and Bronco) at the speed sensor end. A reading of approximately 200 ohms should be obtained. A reading of zero ohms indicates a shorted coil or wiring harness and a maximum reading indicates an open coil or wiring harness. Replace the sensor in either case.

If the ohmmeter records 200 ohms and the speedometer operates properly within needle waver, the speed sensor is probably good. A speed sensor of known good quality can also be substituted for the existing sensor to check for proper operation.

Servo Assembly Test

Disconnect the cable from the throttle body, if so equipped (Figs. 10, 11, 12 and 15). Separate connector C-714 at the amplifier. Connect an ohmmeter between the orange-yellow wire 144 and gray-black wire 145 at the 8-way connector. A resistance of approximately 40 to 125 ohms should be obtained. Connect the ohmmeter between the orange-yellow 144 and white-pink wire 146. A resistance of approximately 60 to 90 ohms should be obtained. Reconnect the cable, if so equipped, to the throttle body and properly adjust as described in Figs. 9, 10 and 11.

Start the engine, and verify servo vacuum from engine exceeds 2.5 inches Hg (1.22 psi). With the servo disconnected from the amplifier, connect the orange-yellow lead (wire 144) of the servo to the battery positive terminal. Connect the white-pink lead (wire 146) of the servo to ground, and momentarily touch the gray-black lead (wire 145) of the servo to ground. The servo throttle actuator should tighten the actuator cable and open the throttle. The throttle should hold in that position or slowly release the tension. When the white-pink wire is removed from ground, the servo should release actuator cable tension immediately. Replace the servo if it fails any part of the preceding test.

CAUTION: If the orange-yellow lead is shorted to either the white pink or gray-black leads, it may be necessary to replace the amplifier.

Amplifier Test

Do not use a test lamp to perform the following tests as excessive current draw will damage electronic components inside the amplifier. **Use only a voltmeter of 5,000 ohm/volt rating or higher.**

Do not substitute a new amplifier for the old amplifier until the actuator coils have been tested. Refer to the Servo Assembly (Throttle Actuator Test).

ON Circuit Test

Turn the ignition switch on and connect a voltmeter such as Rotunda Digital Volt-Ohm-Meter 007-00001 or an equivalent between ground and the wire lead (151) (light blue-black) at the amplifier connector (C-717 on F-150—F-350, Bronco and C-1006 on E-150—E-350). The voltmeter should read 12 volts when the ON switch on the steering wheel is depressed and held. If voltage is not available check the horn relay circuit and control switch test. Release the ON button; the voltmeter should read approximately 7.8 volts, indicating the ON circuit is engaged. If the voltage does not remain, check for bad connector 151 or ground contacts to amplifier, fuse and/or circuit breaker and/or hang in a known good amplifier and check for a good ON circuit.

OFF Circuit Test

With the ignition on and the voltmeter connected between ground and the light blue-black wire (151), depress the OFF switch on the steering wheel. Voltage on the blue wire should drop to zero indicating the ON circuit is de-energized. If the voltage does not drop to zero, perform the control switch test. If the switches check OK, hang in a known good amplifier and check the OFF circuit as above.

Set-Accelerate Circuit Test

With the ignition on and the voltmeter connected between ground and the light blue-black wire (151), depress the ON switch, then hold SET/ACCEL/ACCL button on steering wheel. Voltmeter should indicate approximately 4.5 volts. Rotate the steering wheel back and forth and watch the voltmeter for fluctuations. If the voltage varies more than 0.5 volt, perform the control switch test.

Coast Circuit Test

With the ignition on and the voltmeter connected between ground and the light blue-black wire (151), depress the ON switch, then hold the COAST/CST button on steering wheel. Voltmeter should indicate approximatel 1.5 volts. If all the functions check OK, perform the servo check and sensor test and hang in a known good amplifier.

Resume Circuit Test

With the ignition on and the voltmeter connected between the light blue-black mark wire in the six-way connector and ground, depress and hold the RESUME/RSM button on the steering wheel. The voltmeter should read approximately 6.5 volts.

If all the circuits check OK, perform the servo assembly test and hang in a known good amplifier.

Simulated Road Test

CAUTION: When performing this simulated road test, the rear wheels of the vehicle must be raised clear of the floor. Block the front wheels securely and use only a suitable lifting device (such as a garage-type hoist) and support the rear axle with one jack stand on each side. Never attempt to use the vehicle bumper jack for tests of this type.

1. Start the engine.
2. Shift the transmission to DRIVE.

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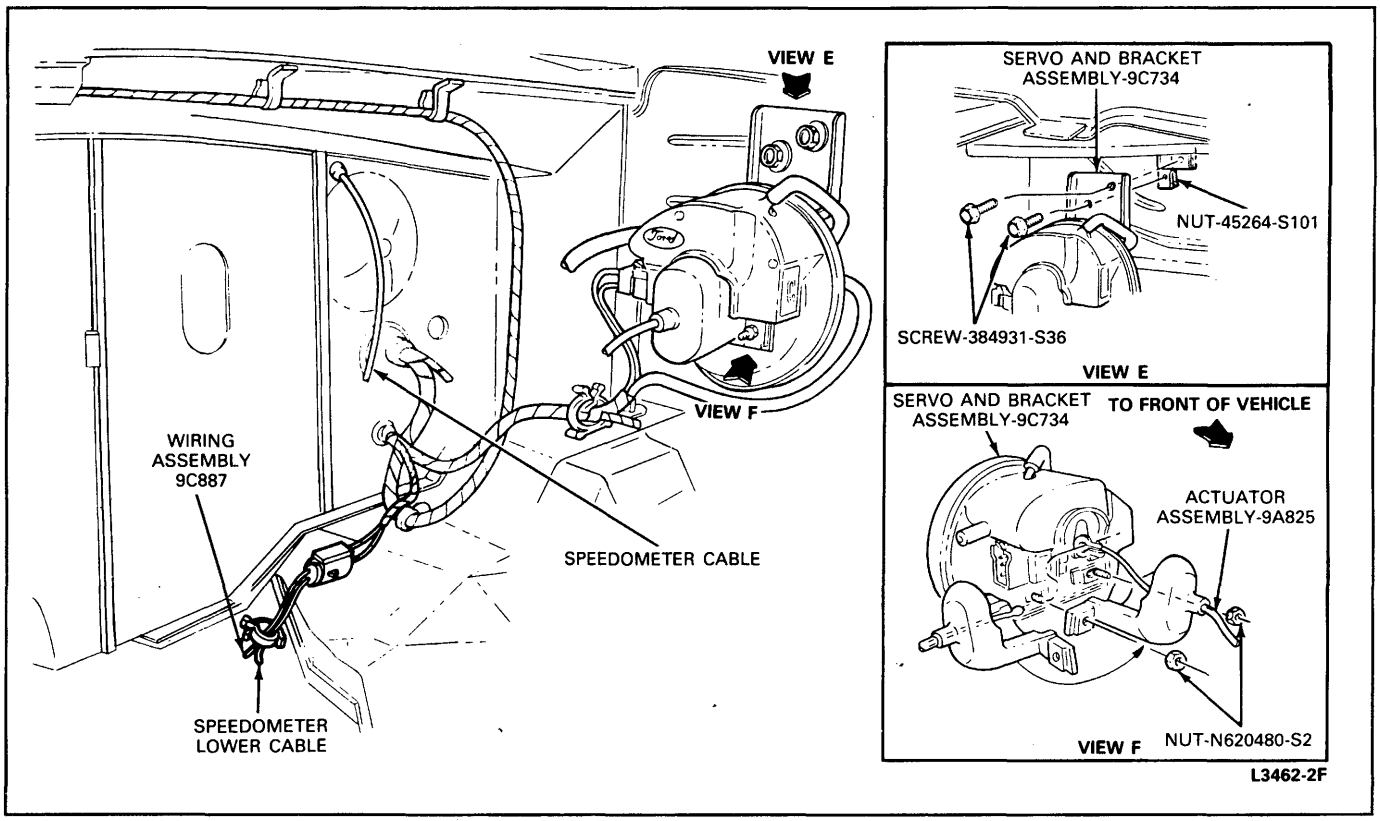


FIG. 9 Servo and Bracket Installation—E-150—E-350—4.9L (300 CID) w/o Dual Batteries (Cont'd.)

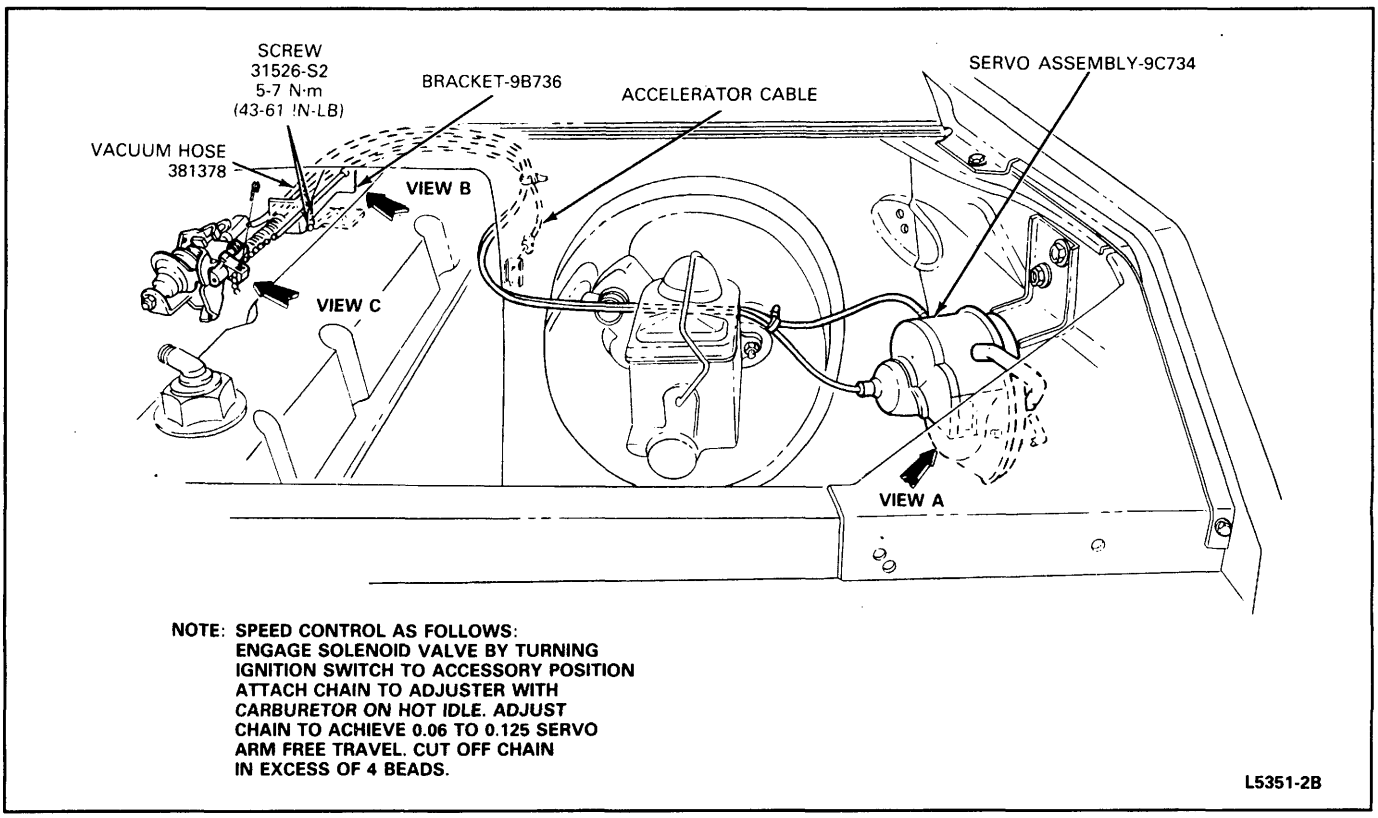


FIG. 10 Servo and Bracket Installation—E-150—E-350—V-8 Gasoline Engines w/o Dual Batteries

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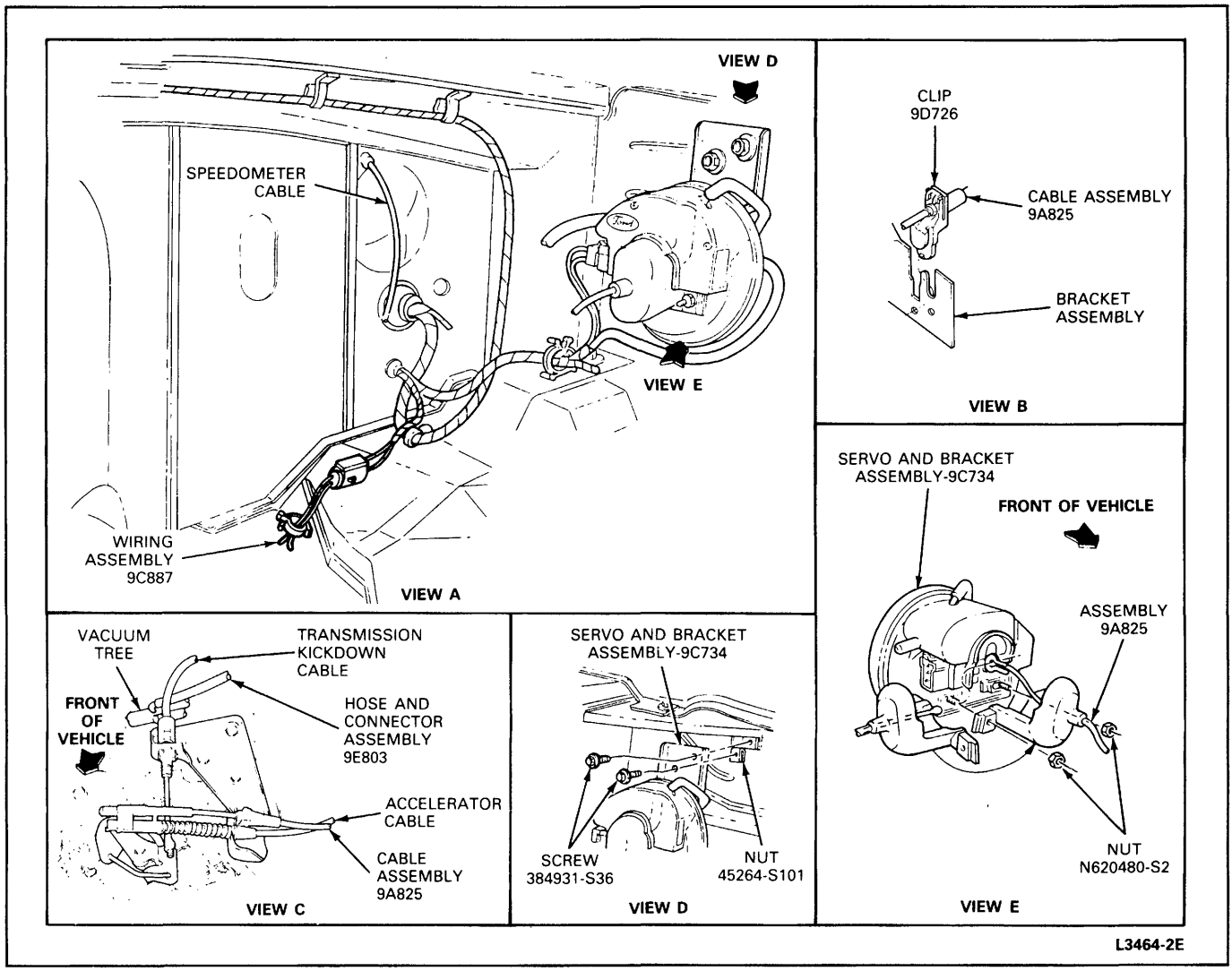


FIG. 10A Servo and Bracket Installation—E-150—E-350—V-8 Gasoline Engines w/o Dual Batteries (Cont'd.)

3. Turn on the speed control.

WARNING: IF ANY TIME DURING THE FOLLOWING STEPS THE SYSTEM SHOULD APPEAR TO GO OUT OF CONTROL AND OVERSPEED, BE PREPARED TO TURN THE SYSTEM OFF AT ONCE WITH THE OFF SWITCH OR THE IGNITION SWITCH.

4. Accelerate in highest gear (manual transmissions) and hold at 56 Km/h (35 mph).
5. Press and release the SET speed button. Hold foot pressure very lightly on accelerator pedal. Normally the speed will continue at 56 Km/h (35 mph) for a short period of time and then gradually start surging because the engine is not loaded.
6. Press the OFF button. The engine should drop back to idle. Stop the rear wheels with the brake.
7. Press ON button, accelerate and hold the speed at 56 Km/h (35 mph).
8. Press and hold the SET/ACCEL/ACCL button. Slowly remove the foot from the accelerator. The engine speed should gradually increase.
9. When the speed reaches 80 Km/h (50 mph), release the SET/ACCEL/ACCL button. The vehicle should maintain 80 Km/h (50 mph) for a short time before the surging begins.
10. Press the COAST/CST button and hold. The engine should idle. Slow the rear wheels to 56 Km/h (35 mph).
11. Release the COAST/CST button. Speed should set in. Surging should soon start.
12. Press the brake pedal. The system should shut off, the engine should slow to idle and the wheels should stop.
13. Set the speed at 80 Km/h (50 mph). Brake to 56 Km/h (35 mph) and maintain 56 Km/h (35 mph) with the accelerator. Depress and release the RESUME/RSM button. The speed should return to 80 Km/h (50 mph).

When performing these tests keep the vehicle speeds within reasonably low limits. If the system does not perform as normally expected, make note of the malfunction.

Road Test

1. Start the engine. Perform speed control system road test in high gear with manual transmission or DRIVE with automatic transmission vehicles.
2. Turn on the speed control.

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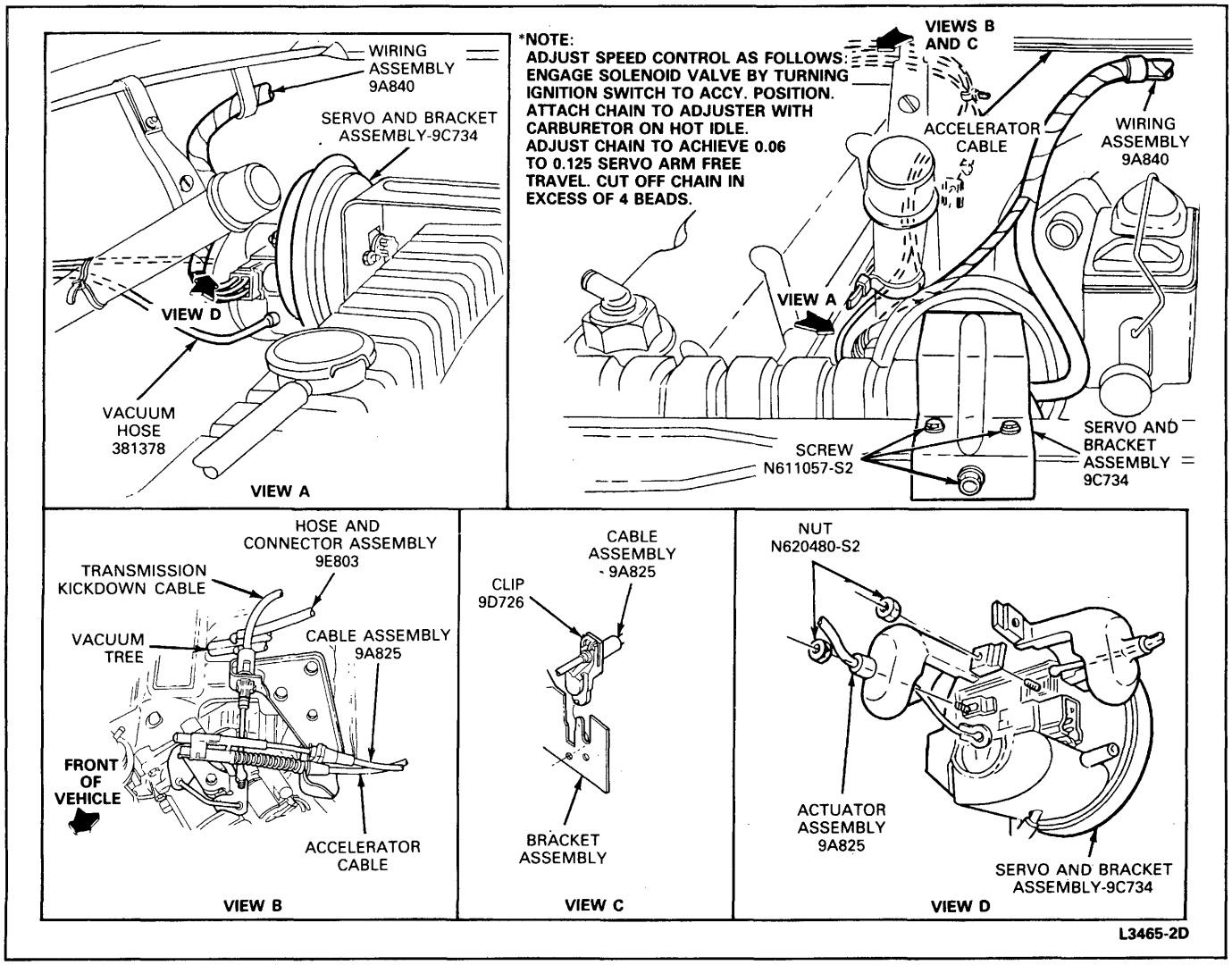


FIG. 11 Servo and Bracket Installation—E-150—E-350—V-8 Gasoline Engines w/Dual Batteries and All Chassis Cab Models with Speed Control

WARNING: IF ANY TIME DURING THE FOLLOWING STEPS THE SYSTEM SHOULD APPEAR TO GO OUT OF CONTROL AND OVERSPEED, TURN THE SYSTEM OFF AT ONCE WITH THE OFF SWITCH OR THE IGNITION SWITCH.

3. Accelerate and hold at 56 Km/h (35 mph).
4. Press and release the set-speed button. Hold foot pressure very lightly on accelerator pedal. Normally the speed will continue at 56 Km/h (35 mph).
5. Press the OFF button (Figs. 1 and 2). The engine should decelerate.
6. Press ON button, accelerate and hold the speed at 56 Km/h (35 mph).
7. Press and hold the SET/ACCEL/ACCL button. Slowly remove foot from the accelerator. The engine speed should gradually increase.
8. When the speed reaches 80 Km/h (50 mph), release the set-speed button.
9. Press the COAST/CST button and hold. The engine should decelerate and slow to 56 Km/h (35 mph).
10. Release the COAST/CST button. Speed should set in.
11. Press the brake pedal. The system should shut off causing the engine to idle.
12. Set the speed at 80 Km/h (50 mph). Brake to 56 Km/h (35 mph) and maintain 56 Km/h (35 mph) with the accelerator. Depress and release the RESUME/RSM button. The speed should return to 80 Km/h (50 mph).

When performing these tests, keep the vehicle speeds within reasonably low limits. If the system does not perform as normally expected, make note of the malfunction.

Supply Circuit

Blow the horn. This test will determine that there is power in the horn circuit to the steering wheel.

Brake Stoplamp Switch and Circuit Test

To be performed when brake application will not disconnect the speed control. On manual transmission vehicles, verify that clutch switch is correct, as outlined, before performing the following.

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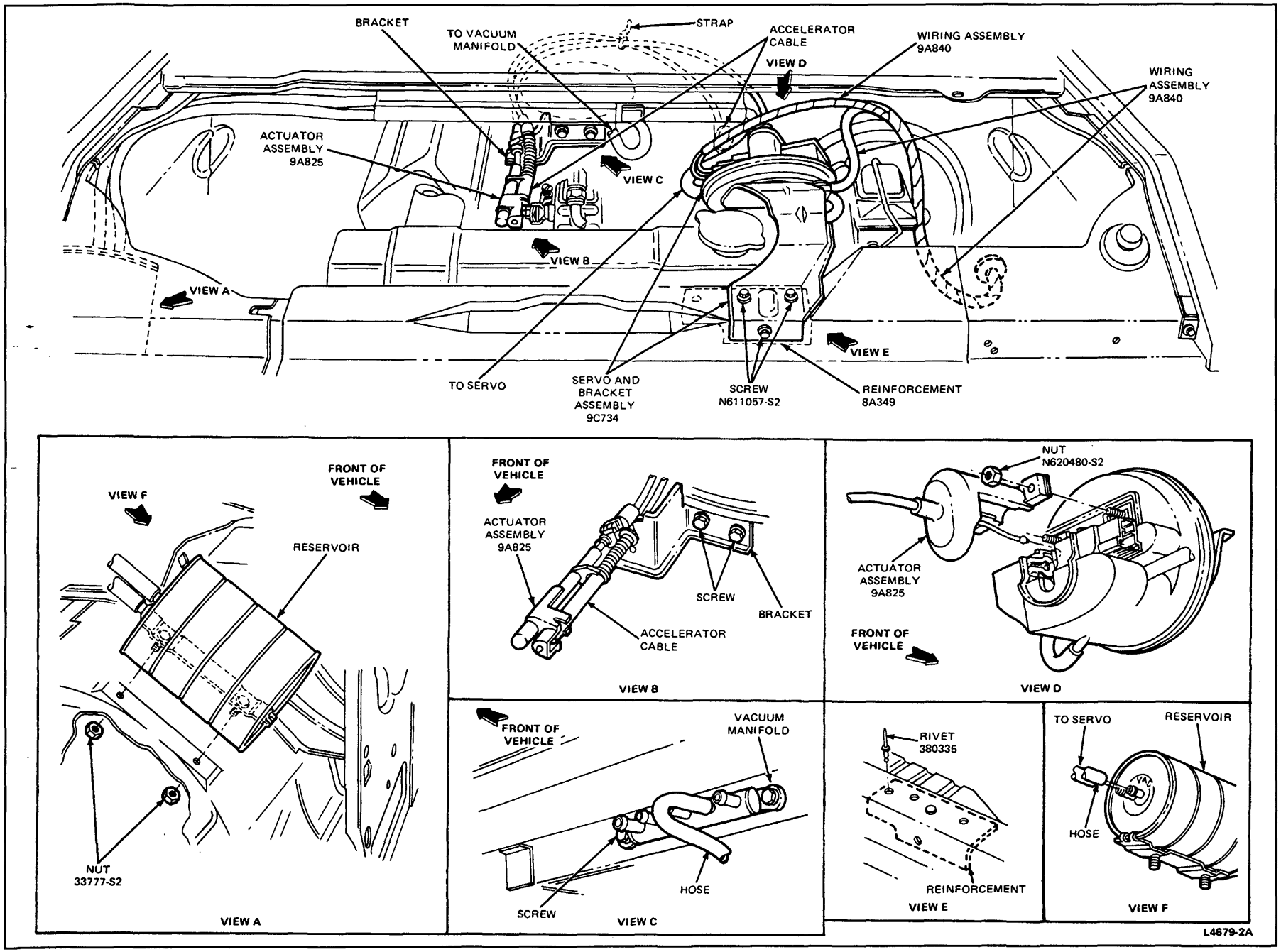


FIG. 12 Servo and Bracket Installation—E-250—E-350 with 7.3L Diesel Engine

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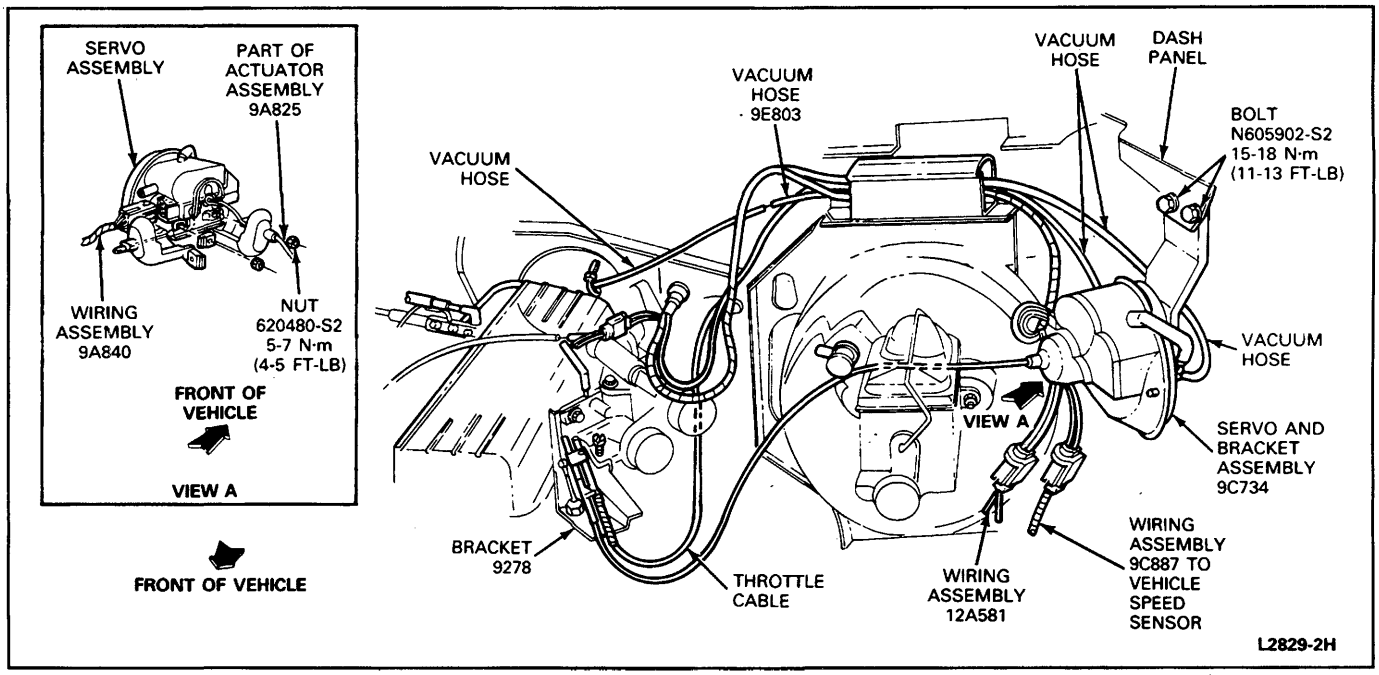


FIG. 13 Servo and Bracket Installation—F-150—F-350 and Bronco 4.9L (300 CID) Engine

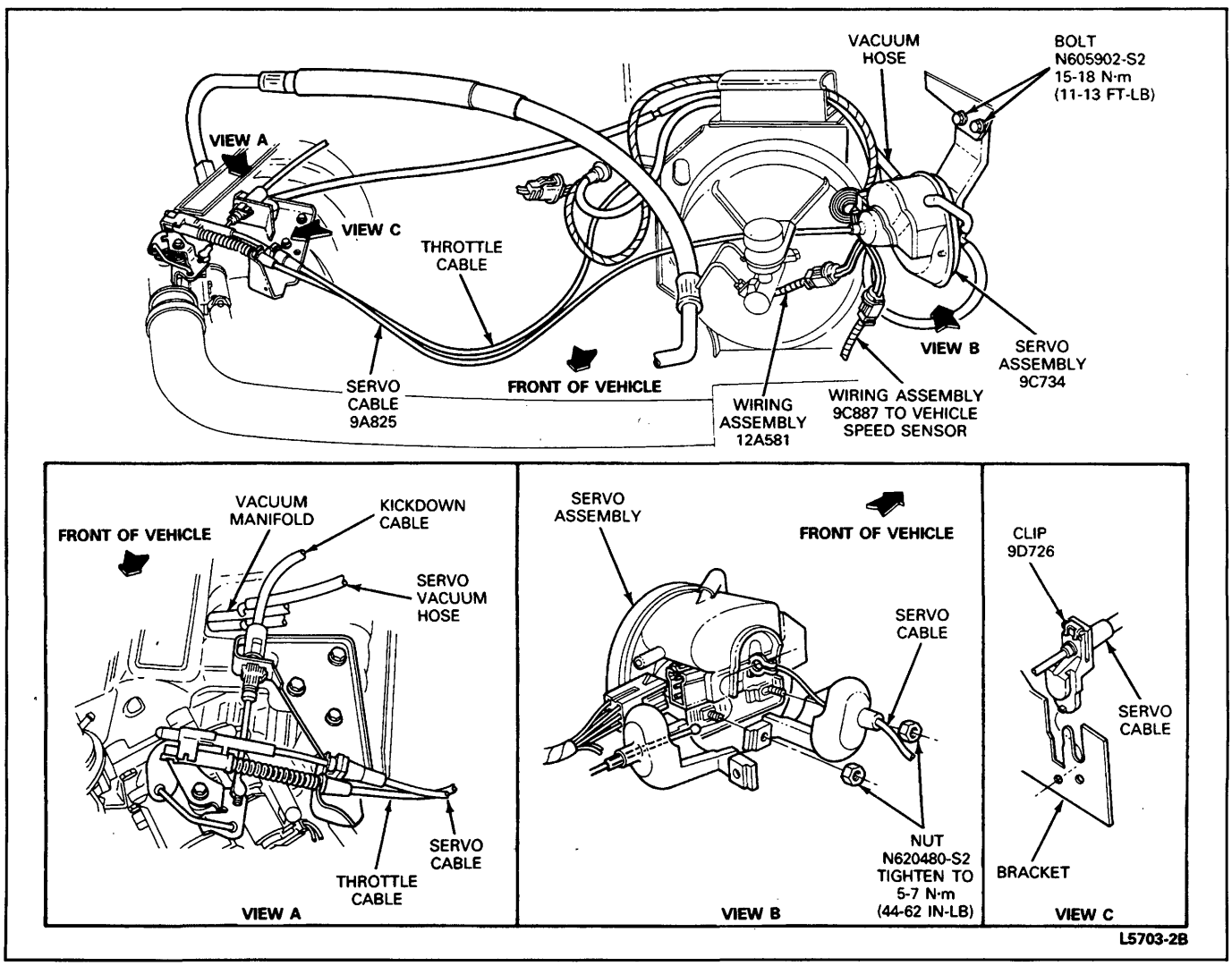


FIG. 14 Servo and Bracket Installation F-150—F-350 and Bronco 5.0L EFI (302 CID) Engine

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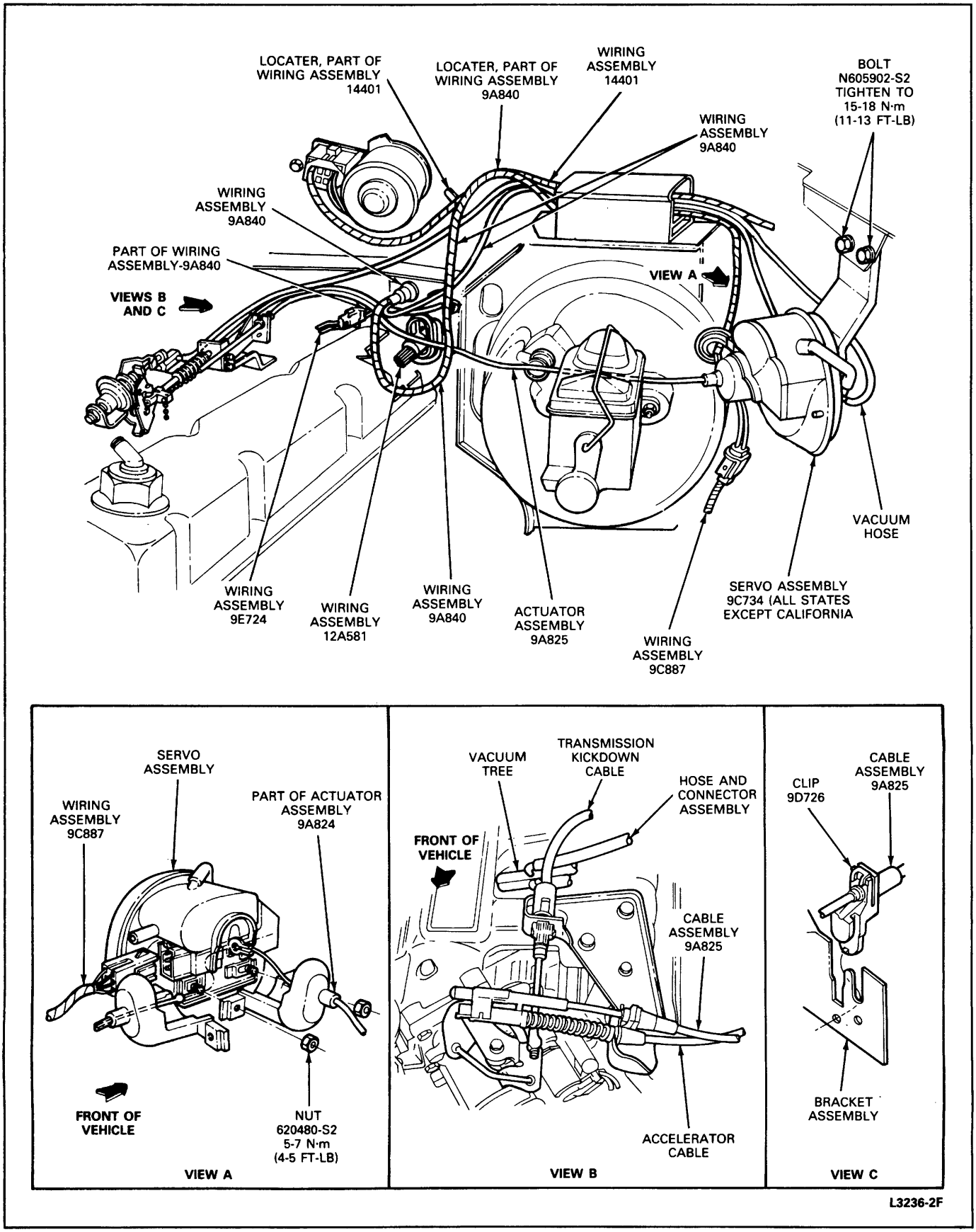


FIG. 15 Servo and Bracket Installation—F-150—F-350 and Bronco—5.8L and 7.5L V-8 Gasoline Engines

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1. Check for stoplamp operation with a maximum brake pedal effort of 26.7N (6 lb). If more than 26.7N (6 lb) effort is required, check the brake pedal actuation and stoplamp switch. Also, check for a burned out brake bulb. Repair or replace as required.
2. If stoplamps work properly, check the battery voltage on the white-purple stripe lead 296 at the amplifier connector (Figs. 7 and 8). Depress the brake pedal until the stoplamps are lit. Check voltage on the red-black stripe lead 810 (E-150—E-350) or on the light green wire (511A) (F-150—F-350 and Bronco) at the same connector. The voltage difference between leads 296 and 810 (Econoline) or 511A (F-Series, Bronco), must not exceed 1.5 volts. The high resistance must be found and corrected in the stoplamp circuit.
3. If the stoplamps do not work, the stoplamp switch, supply circuit, fuses or bulbs must be checked.

Vacuum Dump Valve Test

The vacuum dump valve releases the vacuum in the servo assembly whenever the brake pedal is depressed. It should be checked whenever brake application does not disconnect the speed control. The dump valve should be pushed sufficiently forward in the retainer clip so that no more than 3.2mm (1/8 inch) of the white (black on Econoline) plunger is showing when the brake pedal is in the released position (Fig. 16).

Disconnect the vacuum hose from the dump valve to the servo at the servo. Connect a hand vacuum pump to the hose, and pump up a vacuum. If a vacuum cannot be obtained, the hose or the dump valve leaks and should be replaced or adjusted. Step on the brake pedal. The vacuum should be released. If it is not, adjust as described below:

1. Move the valve forward in the retaining clip (Fig. 3, View B) with the valve plunger contacting the brake pedal adapter and the pedal in the released position until 3.2mm (1/8 inch) or less of the plunger shows.
2. Ensure brake pedal is against the stop in the release position after adjustment.

If vacuum still does not release, replace vacuum dump valve.

Vacuum Reservoir Test

To test the vacuum reservoir and check valve for vacuum leakage, proceed as follows:

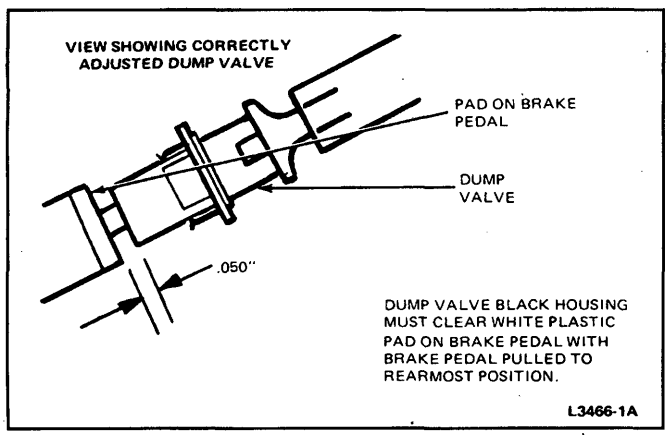


FIG. 16 Dump Valve Adjustment

1. Locate vacuum reservoir on LH apron (Fig. 17). Disconnect vacuum hose at the servo and connect hose to a vacuum gauge with a minimum range of 0-85 kPa (0-25 inches Hg).
2. Start the engine and observe that the vacuum level exceeds 67.4 kPa (20 in. Hg) [77.5 kPa (23 in. Hg) is nominal.] If not, check for leaky vacuum source hose or damaged vacuum pump.
3. Turn off the engine after the vacuum level has stabilized above 67.4 kPa (20 in. Hg). The vacuum level should remain essentially constant and after 24 hours should still exceed 50.5 kPa (15 in. Hg).
4. If the vacuum level can not be maintained, the reservoir should be replaced.

Horn Relay Circuit Test—E-150—E-350, F-150—F-350 and Bronco

1. Locate horn relay wire connector on the wiring diagram (Figs. 5 and 6).

   NOTE: Connectors remain connected for the following tests.
2. Locate yellow-light blue wire (460) (Figs. 5 and 6).
3. Using voltmeter, measure for battery voltage (approximately 12V) on the pin side of the connector to ground.
4. Locate yellow-light green stripe wire (6) (E-150—E-350) or dark blue (1) (F-150—F-350 and Bronco) (Figs. 5 and 6).
5. Using voltmeter, measure for battery voltage (approximately +12V) on socket side of connector.
6. With voltmeter still connected to socket lead in Step 5, depress horn switch. Voltmeter should read zero. Horn should sound.
7. If voltmeter reading remains at +12V when horn switch is depressed, horn switch or steering column wiring has an open circuit.
8. Before continuing, prove out horn relay by momentarily grounding circuit (1) (F150-F350 and Bronco) or circuit 6 (E150-E350) to body electrical ground or body sheet metal and the horn should sound. This test bypasses horn switch.
9. With circuit from Step 8 grounded, if the horn still does not sound, check for approximately +12V on the dark blue wire (1) (E-150—E-350) or yellow—light green wire (6) (F-150—F-350 and Bronco) when relay operates.
10. If voltage is present at circuit from Step 9 when the relay is operated, an open circuit is present between the horn relay connector and the horn.
11. If the relay does not operate with +12V on circuit (460) and circuit from Step 8 grounded, replace the relay.

    NOTE: The horn and/or speed control may operate intermittently if the ground brush is missing (Figs. 2 and 4).

Clutch Switch Test—F-150—F-350, E-150—E-350 and Bronco

(Manual Transmission Vehicles Only)

The speed control system is designed to disengage when the clutch pedal is depressed. This is accomplished via a clutch disable switch.

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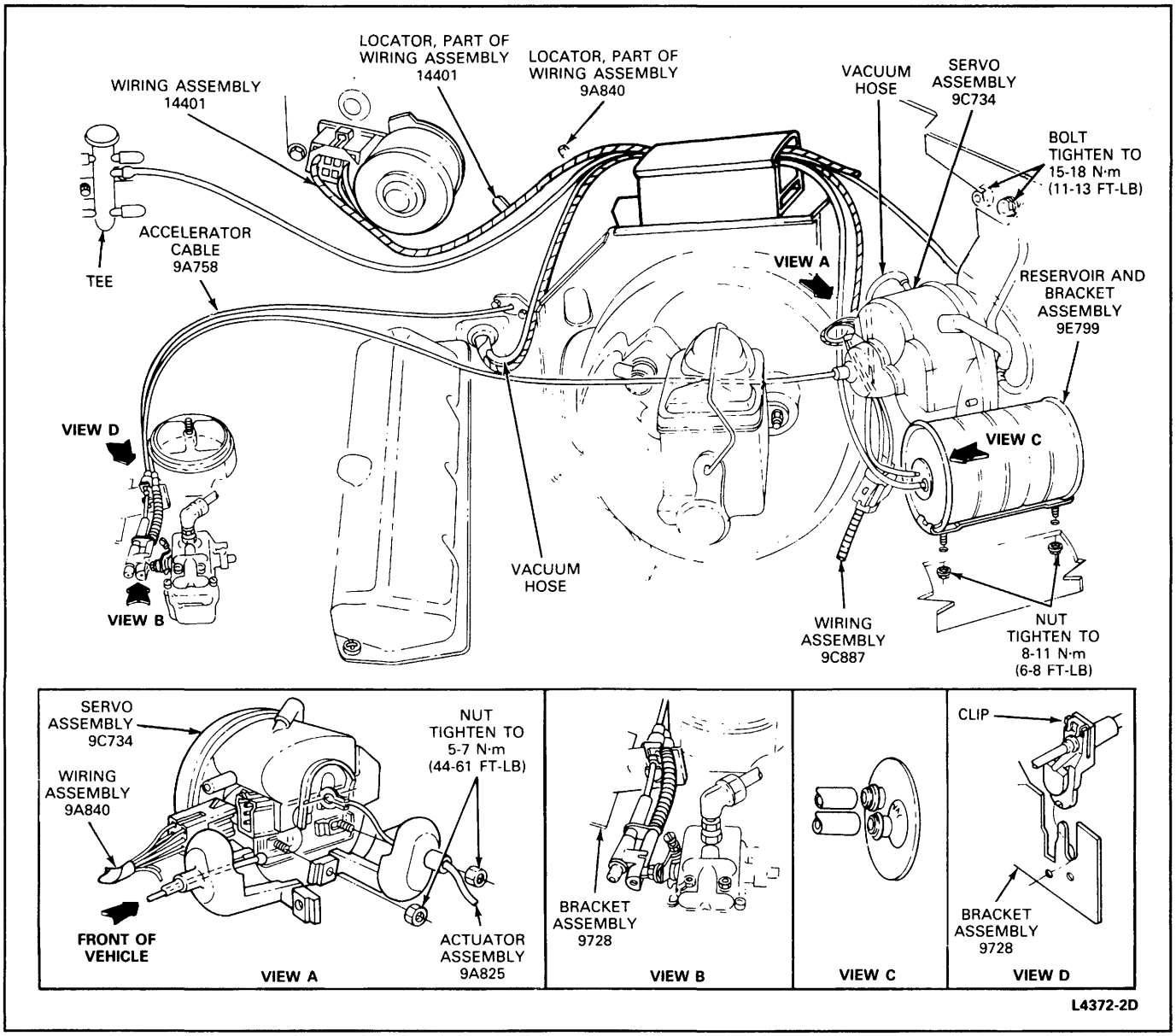


FIG. 17 Servo and Bracket Installation—F-250—F-350 w/7.3L Diesel Engine

The disengage function operates by opening the 511 circuit (F150-F350 and Bronco) or the 810 circuit (E150-E350) between the speed control module and the stoplamps. This prevents engine overspeed when the clutch is depressed and the speed control is engaged.

The switch is a plastic plunger type mounted to the brake and clutch pedal support on the side near the driver's door. It is actuated by the clutch pedal arm.

NOTE: The switch functions magnetically through a reed switch. Do not use magnetized tools near this switch.

If the switch is open when the clutch pedal is released, the speed control will not operate. This must be corrected before making other tests.

CAUTION: Do not use a test lamp to perform the following tests because a lamp cannot properly indicate condition of switch. Use only a voltmeter of 5,000 ohm/volt rating or higher.

To check the switch, disconnect the switch pigtail connector from the speed control harness connector and connect an ohmmeter to the two-switch connector terminals. With the clutch pedal in the full up (released) position the resistance should be less than 5 ohms. With the clutch pedal depressed (switch plunger extended) the circuit should be open.

Automatic Transmission

Vehicles equipped with automatic transmissions use a shorting plug instead of a clutch switch.

Diagnosis Guides

The speed control system diagnosis guides in this Section can be used to determine and isolate speed control problems.

Speed Decreases—On Steep Grades Or Under Heavy Loads

Verify that a complaint regarding a decrease in speed during high inclines or under heavy-load conditions is not caused by a powertrain limitation. To verify, conduct a road test. Set the speed at about 88.5 Km/h (55 mph)

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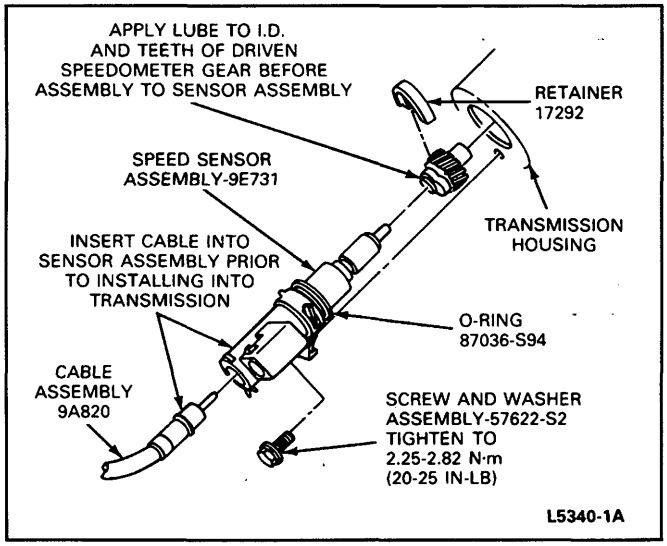


FIG. 18 Speed Sensor Installation—E-150—E-350

and proceed up a steep grade. When the speed decreases 6.4 to 9.7 Km/h (4 to 6 mph), manually accelerate the vehicle. Verify that the vehicle can maintain the SET speed **without** causing transmission kickdown (a transmission down-shift is acceptable with the overdrive transmissions). If SET speed **can** be maintained manually, a problem exists with the speed control system (e.g., bead chain needs adjustment, vacuum leak or vacuum source not connected to the 7.9mm (5/16 inch) port, a damaged servo or amplifier, etc). If SET speed **cannot** be maintained without a transmission kickdown, the speed control system is normal and the powertrain capacity is the limiting factor.

NOTE: When the vehicle speed decreases about 16.1 Km/h (10 mph) below the SET speed, the speed control system will, by design, cancel control (similar to the cancellation that occurs when the stoplamps are activated). The servo requires a 8.5 kPa (2.5 inch Hg) minimum vacuum source for normal operation.

ADJUSTMENTS

Linkage Adjustment—Actuator Cable

Refer to Figs. 12 and 17.

1. Snap the molded speed control actuator cable retainer over the accelerator cable end fitting attached to the throttle ball stud.
2. Remove the adjuster retainer clip, if installed, from the adjuster mounting tab.
3. Insert the speed control actuator cable adjuster mounting tab in the slot provided in the accelerator cable support bracket.
4. Pull cable through adjuster until a slight tension is felt **without** opening the throttle plate or increasing idle rpm.
5. Insert adjuster retainer clip slowly until engagement is felt and then push downward until it locks in position.

Vacuum Dump Valve Adjustment

Refer to Vacuum Dump Valve Test.

REMOVAL AND INSTALLATION

Control Switches

Removal

1. Remove the two retaining screws holding the horn pad assembly to the steering wheel (Fig. 2).
2. Lift up the pad assembly to expose the horn and speed control wire terminals. Disconnect and remove the horn pad assembly.

Installation

Attach the wires to the steering wheel hub and the horn pad assembly to the steering wheel with the two retaining screws (Fig. 2).

NOTE: Do not replace individual switch of horn pad assembly.

Speed Sensor

Removal

1. Separate the electrical connector to speed sensor on the transmission.
2. Disconnect speedometer cable from speed sensor (Figs. 13, 14, 15 and 18).
3. Remove retaining bolt.
4. Remove the speed sensor.
5. Remove drive gear.

Installation

1. Install drive gear on speed sensor. Refer to Section 33-02, Speedometer.
2. Install speed sensor in transmission.
3. Connect speedometer cable.
4. Connect the electrical connector.

Amplifier Assembly

Removal

1. Disconnect the connectors at the amplifier (Fig. 3).
2. Remove the attaching screws or nuts that fasten the amplifier bracket to the vehicle.
3. Remove the amplifier assembly and mounting bracket from the vehicle.
4. Remove the amplifier assembly from the mounting bracket.

Installation

1. Install the amplifier on the mounting bracket.
2. Connect the connectors to the amplifier (Fig. 3).
3. Attach the amplifier assembly and mounting bracket to the vehicle with the attaching screws or nuts.
4. Road test and check the system for proper operation.

Servo Assembly (Throttle Actuator)

Removal

1. Disconnect the wiring harness connectors under the hood at the servo assembly (Figs. 9 through 17).
2. Disconnect the adjuster from accelerator cable and disconnect the vacuum hose at the servo Y.

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SPEED CONTROL DOES NOT WORK

	TEST STEP	RESULT ▶	ACTION TO TAKE
A0	VERIFY THE CONDITION		GO to **A1**.
A1	CHECK CONNECTIONS		
	• Check all electrical and vacuum connections.	(OK) ▶	GO to **A2**.
		(OK) ▶	SERVICE or REPLACE as required.
A2	CHECK BRAKE LAMP		
	• Press brake pedal. • Check to see that brake lamp is operating.	(OK) ▶	GO to **A3** if manual transmission. If automatic transmission GO to **A4**.
		(OK) ▶	SERVICE brake lamp circuit.
A3	CHECK CLUTCH SWITCH (MANUAL TRANSMISSION)		
	• Check clutch switch for proper operation.	(OK) ▶	GO to **A4**.
		(OK) ▶	SERVICE as required.
A4	CHECK THROTTLE ACTUATOR		
	• Check throttle actuator bead chain (or cable).	(OK) ▶	GO to **A5**.
		(OK) ▶	SERVICE as required.
A5	CHECK LINKAGE OPERATION		
	• Check the throttle linkage for proper operation.	(OK) ▶	GO to **A6**.
		(OK) ▶	SERVICE as required.
A6	CHECK VACUUM		
	• Check vacuum at servo. NOTE: 2.5 inches of Hg (1.22 psi) is minimum vacuum for normal servo operation. The vacuum source hose is attached to the 7.9mm (5/16 inch), vacuum fitting port or the vacuum reservoir "VAC" port with the 7.3L diesel engine. The servo vacuum source hose is connected to the unmarked vacuum reservoir port.	(OK) ▶	GO to **A8**.
		(OK) ▶	GO to **A7**.
A7	CHECK DUMP VALVE		
	• Check vacuum dump valve.	(OK) ▶	SERVICE or REPLACE vacuum hose as required.
		(OK) ▶	SERVICE or ADJUST as required.

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SPEED CONTROL DOES NOT WORK (Continued)

TEST STEP		RESULT	ACTION TO TAKE
A8	PERFORM CONTROL SWITCHES AND CIRCUIT TESTS		
• Perform control switches and circuit tests as described in this Section.		(OK) ▶	GO to **A9**.
		(OK) ▶	SERVICE circuit or REPLACE horn pad assembly as required.
A9	PERFORM SERVO TESTS		
• Perform servo tests as described in this Section.		(OK) ▶	GO to **A10**.
		(OK) ▶	REPLACE actuator.
A10	PERFORM SENSOR TEST		
• Perform sensor test as described in this Section.		(OK) ▶	GO to **A11**.
		(OK) ▶	REPLACE sensor.
A11	PERFORM AMPLIFIER TEST		
• Perform amplifier test as described in this Section (Substitution)		Problem corrected ▶	INSTALL a new amplifier.
		Problem not corrected ▶	EXAMINE all connectors carefully for proper contact. REPAIR as required. REMOVE substitute amplifier.

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3. Remove the screw attaching the actuator cable to the retaining bracket.
4. Remove the pins and nuts retaining the servo assembly to the mounting bracket and remove the servo assembly.

Installation

1. Position the servo assembly to the bracket and install the retaining nuts. Connect the vacuum hose.
2. Attach the actuating cable to the retaining bracket.
3. Connect the adjuster to the accelerator cable.
4. Connect the wiring harness connectors under the hood at the servo assembly.

Actuator Cable

For removal and installation refer to Servo Assembly. Remove the actuator cable from the servo assembly (Figs. 9 through 18). Reverse the procedure for installation.

Vacuum Dump Valve

Removal

1. Remove the vacuum hose from the valve and remove the bracket mounting screw (Fig. 3, View B). On F-Series or Bronco vehicles the dump valve can be replaced without removing the bracket.
2. Remove the valve and bracket assembly.
3. Remove the valve from the bracket.

Installation

1. Install the valve to the bracket.
2. Install the bracket mounting screw.
3. Connect the vacuum hose.
4. Adjust dump valve.

Vacuum Reservoir—7.3L Diesel Engine

Refer to Figs. 12 and 17.

Removal

1. Disconnect both vacuum hoses from the two ports located on the reservoir.
2. Remove the two nuts retaining the reservoir from the underside of the LH apron and remove the reservoir.

Installation

1. Position the reservoir to the LH apron. Secure with two nuts and tighten.
2. Connect the two vacuum hoses to the reservoir.

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SPEED CONTROL OPERATION IS INTERMITTENT

TEST STEP		RESULT ▶	ACTION TO TAKE
B0	VERIFY THE CONDITION		
	• Note carefully when intermittent action occurs.		GO to **B1**.
B1	INSPECT VISUALLY		
	• Perform visual inspection test.	If intermittant action occurs while cruising ▶	GO to **B2**.
		If intermittent action occurs while using control buttons or turning steering wheel ▶	GO to **B4**.
B2	CHECK VACUUM TO SERVO		
	• Check vacuum supply to servo.	(OK) ▶	GO to **B3**.
	NOTE: 2.5 inches of Hg (1.22 psi) is minimum vacuum for normal servo operation. The vacuum source hose is attached to the 7.9 mm (5/16 inch) engine vacuum-fitting port or the vacuum reservoir "VAC" port with the 6.9L diesel engine.	(OK) ▶	SERVICE vacuum supply.
B3	PERFORM SERVO ASSEMBLY TEST		
	• Perform servo assembly test. Lightly tap servo body while making test.	(OK) ▶	SUBSTITUTE known good amplifier if OK — properly INSTALL amplifier.
		(OK) ▶	REPLACE servo assembly.
B4	PERFORM CONTROL SWITCHES AND CIRCUIT TESTS		
	• Perform control switches and circuit tests as described in this Section.	(OK) ▶	SUBSTITUTE known good amplifier if OK — properly INSTALL amplifier.
		(OK) ▶	REPAIR circuits, REPLACE horn pad assembly. CLEAN or SERVICE three copper brushes and steering wheel ring.

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NOTE: Be certain when connecting the vacuum hoses that hoses are connected to the proper vacuum outlet at the reservoir.

Ground Brush

Removal

1. Remove the steering wheel for access. Refer to Section 13-06, Steering Column-Shift Rod Within Tube.
2. Snap the brush assembly out of the turn signal switch.

Installation

1. Install the ground brush in the turn signal switch. (If the turn signal switch was lifted off the column when removing the ground brush, install the turn signal switch.)
2. Install the steering wheel horn pad assembly and the steering wheel (Fig. 2). Refer to Section 13-06, Steering Column-Shift Rod Within Tube for steering wheel installation.

Clutch Deactivator Switch (Manual Transmission Only)

1. Remove nut and bolt attaching switch to bracket.
2. Disconnect switch connector.
3. Reverse Steps 1 and 2 for installation.

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SPEED CONTROL OPERATES BUT DOES NOT ACCELERATE OR COAST DOWN PROPERLY

	TEST STEP	RESULT ▶	ACTION TO TAKE
C0	PERFORM VISUAL INSPECTION TEST		
	• Visually inspect system.	(OK) ▶	GO to **C1**.
		(OK) ▶	SERVICE or REPLACE affected circuit.
C1	PERFORM CONTROL SWITCHES AND CIRCUIT TESTS		
	• Perform control switches and circuit tests as described in this Section.	(OK) ▶	GO to **C2**.
		(OK) ▶	SERVICE circuits or REPLACE horn pad assembly.
C2	PERFORM SERVO ASSEMBLY TEST		
	• Perform servo assembly test as described in this Section.	(OK) ▶	SUBSTITUTE known good amplifier if OK, REPLACE amplifier.
		(OK) ▶	REPLACE servo assembly.

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SPEED CONTINUOUSLY CHANGES UP AND DOWN

TEST STEP		RESULT	ACTION TO TAKE
D0	VERIFY CONDITION		GO to **D1**.
D1	CHECK THROTTLE ACTUATOR		
	• Check throttle actuator for proper operation and adjustment.	OK ▶	GO to **D2**.
		OK ▶	SERVICE or ADJUST as required.
D2	CONTINUITY CHECK		
	• Check continuity of circuits 147, 148 and 149 on F-150 — F-350 and Bronco. Check continuity of circuits 735, 827 and 828 on E-150 — E-350.	OK ▶	GO to **D3**.
		OK ▶	REPAIR or REPLACE wiring as necessary.
D3	TEST SERVO		
	• Perform servo test as described in this Section.	OK ▶	GO to **D4**.
		OK ▶	REPLACE as required.
D4	CHECK SPEEDOMETER CABLES		
	• Check speedometer cables for proper routing, no sharp bends or binding.	OK ▶	GO to **D5**.
		OK ▶	SERVICE as required.
D5	CHECK SENSOR		
	• Check sensor for free operation. At 30 mph, the output voltage is constant in the range 2.5-4.9 V.R.MS with a 4K ohms resistance load coil resistance is 200 ohms.	OK ▶	GO to **D6**.
		OK ▶	REPLACE sensor.
D6	TEST SENSOR		
	• Perform sensor test as described in this Section.	OK ▶	GO to **D7**.
		OK ▶	REPLACE speed sensor.
D7	CHECK DUMP VALVE		
	• Check vacuum dump valve.	OK ▶	GO to **D8**.
		OK ▶	SERVICE or ADJUST as required.
D8	TEST AMPLIFIER		
	• Perform amplifier test as described in this Section.	Corrects problem ▶	REPLACE amplifier.
		Does not correct problem ▶	CHECK circuit connections for good contacts. SERVICE as required.

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SPEED CONTROL DOES NOT DISENGAGE WHEN BRAKES ARE APPLIED

	TEST STEP	RESULT ▶	ACTION TO TAKE
E0	VERIFY THE CONDITION		GO to **E1**.
E1	CHECK STOPLAMPS		
	• Apply brakes and observe stop lamps.	(OK) ▶	GO to **E2**.
		(OK) ▶	SERVICE stoplamp circuit as required. VERIFY fuses are not open. GO to **E2**.
E2	CHECK DUMP VALVE		
	• Check vacuum dump valve.	(OK) ▶	GO to **E3**.
		(OK) ▶	ADJUST or SERVICE as required.
E3	CHECK SERVO		
	• Check servo operation and throttle linkage.	(OK) ▶	GO to **E4**.
		(OK) ▶	REPLACE servo.
E4	TEST AMPLIFIER		
	• Perfrom amplifier test as described in this Section.	Corrects problem ▶	REPLACE amplifier.
		Does not correct problem ▶	CHECK contacts of green connector. SERVICE as required.

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SPEED WILL NOT SET IN SYSTEM

TEST STEP		RESULT ▶	ACTION TO TAKE
F0	VERIFY THE CONDITION		GO to **F1**.
F1	CHECK THROTTLE ACTUATOR		
	• Check throttle actuator for proper operation and adjustment.	(OK) ▶	GO to **F2**.
		(OK) ▶	ADJUST or SERVICE as required.
F2	CHECK CONNECTIONS		
	• Check system circuit connections.	(OK) ▶	GO to **F3**.
		(OK) ▶	SERVICE as required.
F3	CHECK CONTROL SWITCH		
	• Check control switch circuit.	(OK) ▶	GO to **F4**.
		(OK) ▶	SERVICE switch circuit as required.
F4	CHECK DUMP VALVE		
	• Check vacuum dump valve.	(OK) ▶	GO to **F5** for manual transmission, **F6** for automatic transmission.
		(OK) ▶	ADJUST or SERVICE as required.
F5	CHECK CLUTCH SWITCH		
	• Check clutch switch.	(OK) ▶	GO to **F6**.
		(OK) ▶	SERVICE switch as required.
F6	CHECK STOPLAMPS		
	• Check stoplamps, switch and circuit.	(OK) ▶	GO to **F7.**
		(OK) ▶	SERVICE lamps and circuit as required.
F7	CHECK SERVO		
	• Check servo for proper operation.	(OK) ▶	GO to **F8.**
		(OK) ▶	REPLACE servo.
F8	CHECK SENSOR		
	• Check speed control sensor.	(OK) ▶	CHECK amplifier, REPLACE as required.
		(OK) ▶	REPLACE sensor.

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SPEED CONTROL SYSTEM DOES NOT DISENGAGE WHEN CLUTCH PEDAL IS DEPRESSED (MANUAL TRANSMISSION ONLY)

TEST STEP		RESULT ▶	ACTION TO TAKE
G0	VERIFY		
	• Verify system disengages when stoplamp switch is activated.	(OK) ▶	SERVICE or REPLACE wire assembly 9A840 as required.
	• Check clutch switch operation.	(OK) ▶	SERVICE or REPLACE as required.

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SPEED GRADUALLY INCREASES OR DECREASES AFTER SPEED IS SET

TEST STEP		RESULT ▶	ACTION TO TAKE
H0	VERIFY*		
	• Verify that engine is properly tuned.	(OK) ▶	GO to **H1**.
	• Check accelerator action and head chain adjustment.	(OK) ▶	ADJUST or CORRECT as required.
H1	CHECK DUMP VALVE		
	• Check vacuum dump valve.	(OK) ▶	GO to **H2.**
		(OK) ▶	ADJUST or SERVICE as required.
H2	TEST SERVO		
	• Perform servo test.	(OK) ▶	PERFORM amplifier test. REPLACE if required.
		(OK) ▶	REPLACE servo.

*Perform "Speed Decreases — On Steep Grades or Under Heavy Loads" test in this Section.

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SPEED CONTROL OPERATES BUT DOES NOT RESUME ACCELERATE OR COAST DOWN PROPERLY

TEST STEP		RESULT ▶	ACTION TO TAKE
J0	VERIFY THE CONDITION		GO to **J1**.
J1	CHECK FOLLOWING SWITCHES AND CIRCUITS		
	• Check the SET-ACCEL switch, Coast switch, RESUME switch and slip ring circuits and brush contacts.	(OK) ▶	GO to **J2**.
		(OK) ▶	SERVICE the circuit as required.
J2	TEST SERVO		
	• Perform servo test.	(OK) ▶	GO to **J3**.
		(OK) ▶	REPLACE servo.
J3	TEST AMPLIFIER		
	• Perform amplifier test as described in this Section.	Corrects problem. ▶	REPLACE amplifier.
		Does not correct problem. ▶	CHECK circuit connections for proper contact. SERVICE as required.

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SPECIFICATIONS

ROTUNDA EQUIPMENT

Model	Description
007-00013	Speed Control Tester
007-00001	Digital Volt-Ohmmeter

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GROUP

SEATS 41

(70000)

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VEHICLE APPLICATION

All E-150—E-350, F-150—F-350 and Bronco and Crew Cab Model.

DESCRIPTION

The captain's chair on E-Series and Club Wagon mounts on a swivel pedestal attached to the vehicle floor. The bench seat on F-Series and Bronco mounts on two seat tracks attached to the vehicle floor.

The bucket seats on E-Series, F-Series and Bronco mount on two seat tracks. The seat tracks mount on a fixed pedestal (E-150—E-350) or to the vehicle floor (F-150—F-350 and Bronco).

The captain's chair (LH) on F-Series Super Cab and Bronco mounts to a seat track assembly attached to the vehicle floor. The F-Series Super Cab and Bronco captain's chair (RH) mounts to a flip mechanism without tracks.

ADJUSTMENTS

Captain's Chair

The captain's chair on Econolines can be adjusted for either forward facing or rearward facing. However, the chair is intended to be locked in the forward facing direction when the vehicle is in motion.

To rotate the seat, actuate the handle rearward to unlatch the seat and rotate (Fig. 1). The seat automatically latches in either the forward or rearward facing positions. The seat may be more firmly locked in the latch position against slight movements by sliding the lock handle forward.

The bench and bucket seat adjustment lever is located at the LH front of the seat cushion. Pulling the lever to the left releases the lock mechanism, permitting fore and aft seat adjustment. Releasing the lever will lock the seat in the new position.

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Latch Band

Captain's Chair

Captain's chairs exhibiting side-to-side movement while latched in the forward facing position may be serviced by adjusting latch band as follows:

1. Rotate the swivel pedestal (Lear Siegler design) as follows:
   - Driver's seat - adjust the outboard armrest to the down position.
   - Passenger seat - adjust the outboard armrest to the up position.
   - Adjust the seat back to the full upright position.
   - Adjust the seat tracks to the mid position.
   - Slide the swivel pedestal's actuator lever rearward. Rotate the seat and pedestal sufficiently to ensure that the latch pawl will not engage the pedestal tube slot when the actuator lever is released. Then, release the lever (Fig. 2, View A).
2. Tighten the latch band adjusting bolt until all play is removed from support-to-pedestal mount. A good indicator is that the latch pawl will not engage in the slot in the tube when the swivel pedestal is rotated to the forward facing position (Fig. 2, View A).
3. Rotate the seat and pedestal assembly to the forward facing position, ensuring that the latch pawl aligns with the slot in the tube.
4. Slowly loosen the latch band adjusting bolt until the latch pawl "snaps" into the slot in the tube (Fig. 2, View B). Check support-to-pedestal mount to ensure that no play is present.
5. Actuate the swivel pedestal's release lever and rotate the seat and pedestal assembly. Then, release the actuator lever and rotate the seat and pedestal assembly to the forward facing position. The latch pawl should "snap" into the slot. Check the latch pawl for full engagement in the slot. Refer to Fig. 2, View B.

REMOVAL AND INSTALLATION

CAUTION: Use care when handling seat and track assembly. Dropping assembly or sitting on seat when not secured in vehicle could result in damaged components.

Bench Seat

F-150—F-350 and Bronco

Refer to Fig. 3.

Removal

1. Remove the seat track-to-floorpan retaining screws (two on each side) and lift the seat and track assembly out of the vehicle.

Installation

1. Apply Caulking Cord D6AZ-19560-A or equivalent around seat track assembly attaching bolt locations on floorpan.
2. Position the seat and track assembly in the vehicle and secure it to the floorpan with the retaining screws. Tighten the screws to 25-44 N·m (19-32 ft-lb).

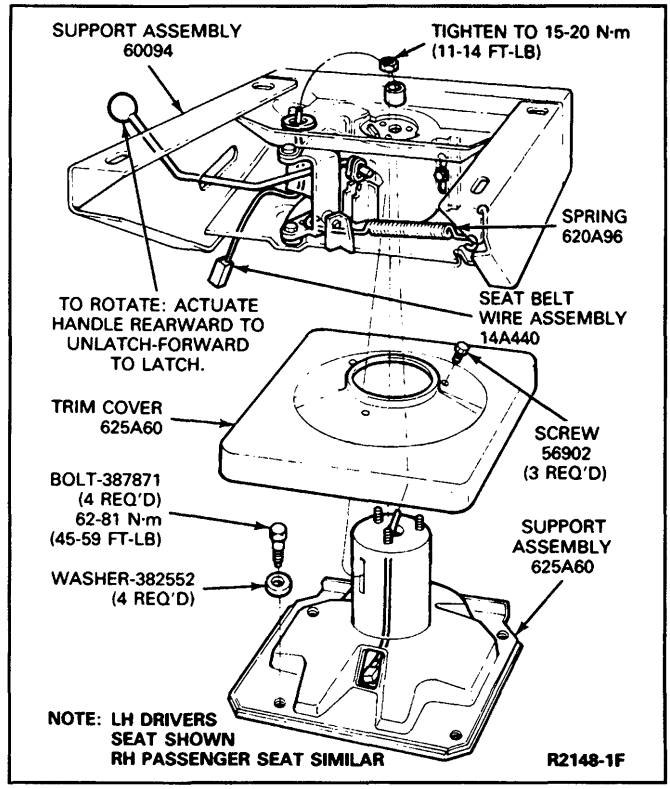


FIG. 1 Swivel Pedestal—Captain's Chair—E-150—E-350 and Club Wagon

3. Install the seat track bolt plastic cover using the attachment screw.

Bucket Seats

E-150—E-350—Driver and Passenger

Refer to Fig. 4.

Removal

1. Remove nut and washer assemblies securing seat and track assembly to support assembly (four).
2. Remove seat and track assembly from vehicle.
3. Remove four support-to-floorpan retaining bolts and washers (two on each side) and lift the support assembly out of the vehicle.

Installation

1. Position seat and track assembly on support assembly.
2. Install nut and washer assemblies securing seat and seat track to support assembly. Tighten nuts to 10-23 N·m (8-17 ft-lb).
3. Apply Caulking Cord D6AZ-19560-A or equivalent around support assembly attaching bolt locations on floorpan.
4. Position the support assembly in the vehicle and secure it to the floorpan with the retaining bolts and washers. Tighten the support assembly-to-floorpan screws to 61-81 N·m (45-59 ft-lb).

F-150—F-350 Super Cab and Bronco—Driver's Seat

Removal

Refer to Fig. 5.

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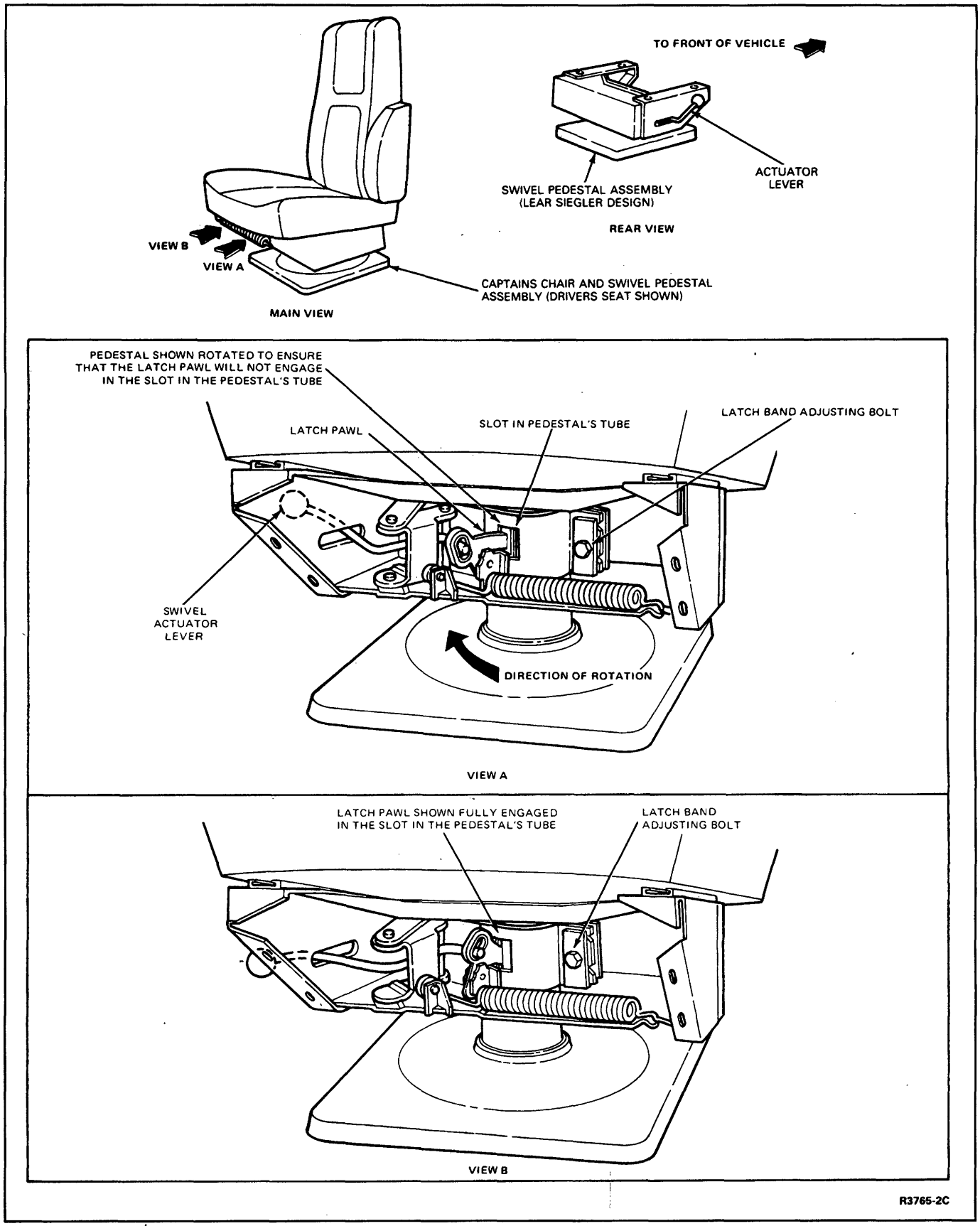


FIG. 2 Swivel Pedestal Assembly Latch Band Adjustment—E-150—E-350 and Club Wagon

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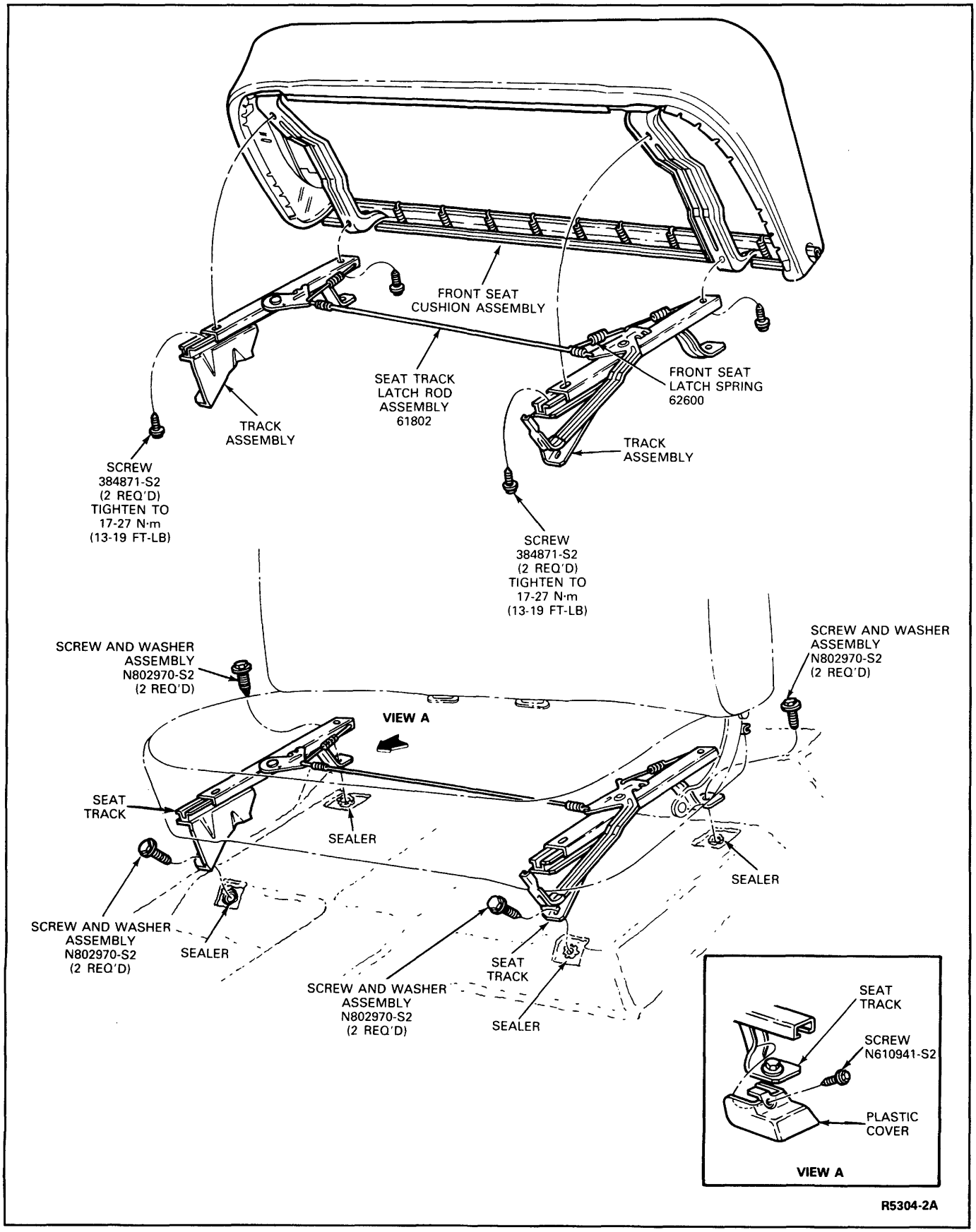


FIG. 3 Bench Seat and Track Installation—F-150—F-350, Bronco and Crew Cab

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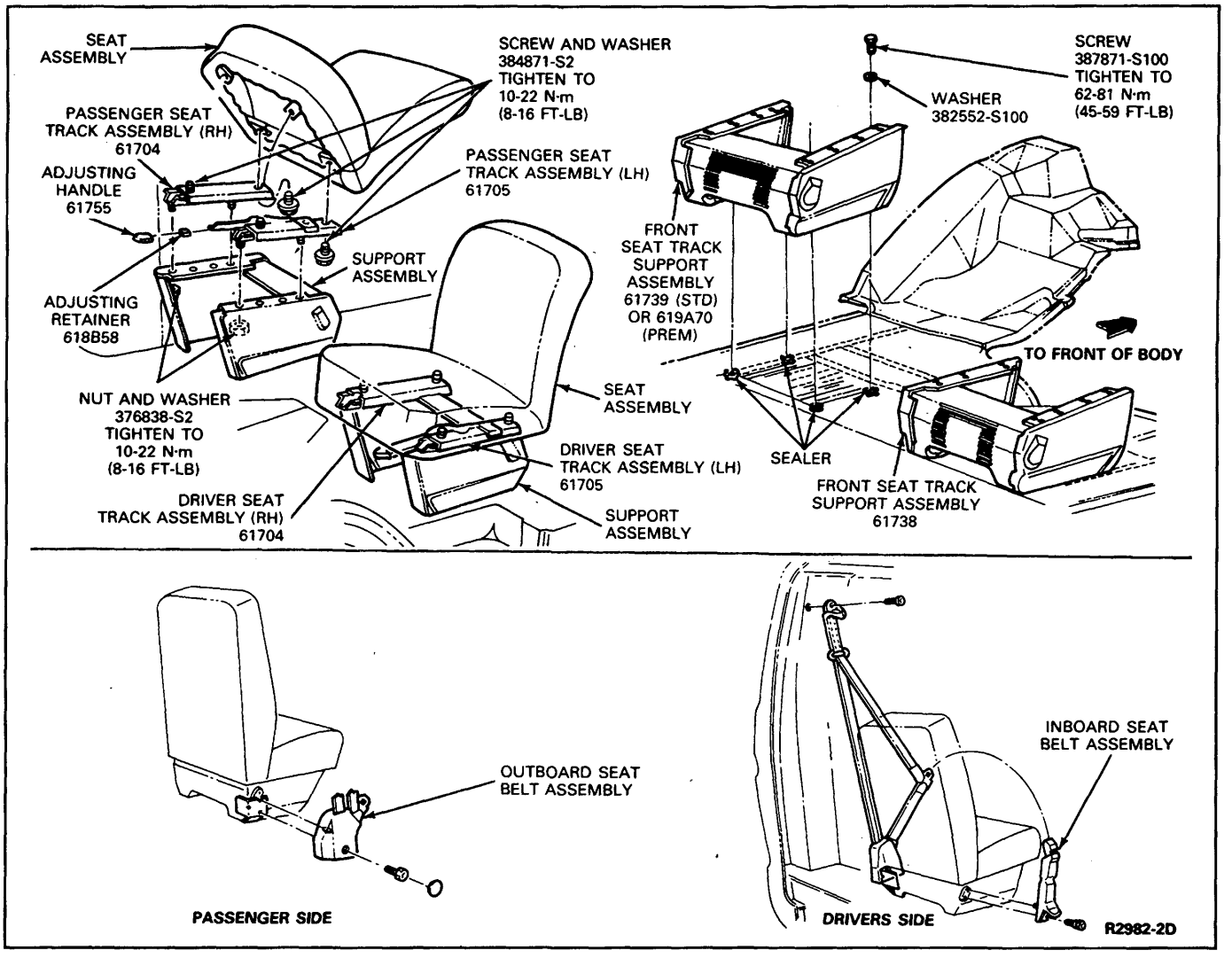


FIG. 4 Bucket Seat and Track Installation—E-150—E-350

1. Remove support assembly-to-floor bolts and lift the seat and track assembly from vehicle.

Installation

1. Apply Caulking Cord D6AZ-19560-A or equivalent under the seat track assembly.
2. Position seat and track assembly on the floor and secure bolts. Apply sealer around support assembly attaching bolt locations on floorpan (Fig. 5). Tighten bolts to 25-44 N·m (19-32 ft-lb).

F-150—F-350 Super Cab and Bronco—Passenger seat—Bucket/Captain's Chair

Removal

1. Remove the two front bolts retaining the passenger seat and support assembly to the floorpan (Fig. 5).
2. Move the seat release lever rearward, causing the seat to "pop-up" and fold forward. Then remove the two rear bolts used to retain the seat and support assembly to the floorpan (Fig. 5).
3. Disengage one end of the passenger seat support stop cable (Fig. 6).
4. Move the seat and support assembly rearward until the seat back clears the instrument panel when folded forward. Then, fold the seat full forward and disengage the ends of the three assist springs from their retainers (Fig. 7).
5. Return the seat back to an upright position, then push the seat back down firmly until the seat is latched. Remove the seat and support assembly from the vehicle and place it on a clean, flat work surface.

WARNING: TO ENSURE THE SAFETY OF THE TECHNICIAN, IT IS CRUCIAL THAT THE ENDS OF THE THREE PASSENGER SEAT SUPPORT ASSIST SPRINGS BE DISENGAGED FROM THEIR RETAINERS BEFORE THE SEAT AND SUPPORT ASSEMBLY IS REMOVED FROM THE VEHICLE.

Installation

1. Disengage ends of the passener seat support assembly assist springs from their retainers. Position the seat and support assembly in the vehicle far enough rearward of the seat support-to-floor attaching holes to enable the seat back to clear the instrument panel when folded forward.

WARNING: TO ENSURE THE SAFETY OF THE TECHNICIAN, IT IS CRUCIAL THAT THE THREE PASSENGER SEAT SUPPORT ASSIST SPRINGS BE DISENGAGED FROM THEIR RETAINERS BEFORE

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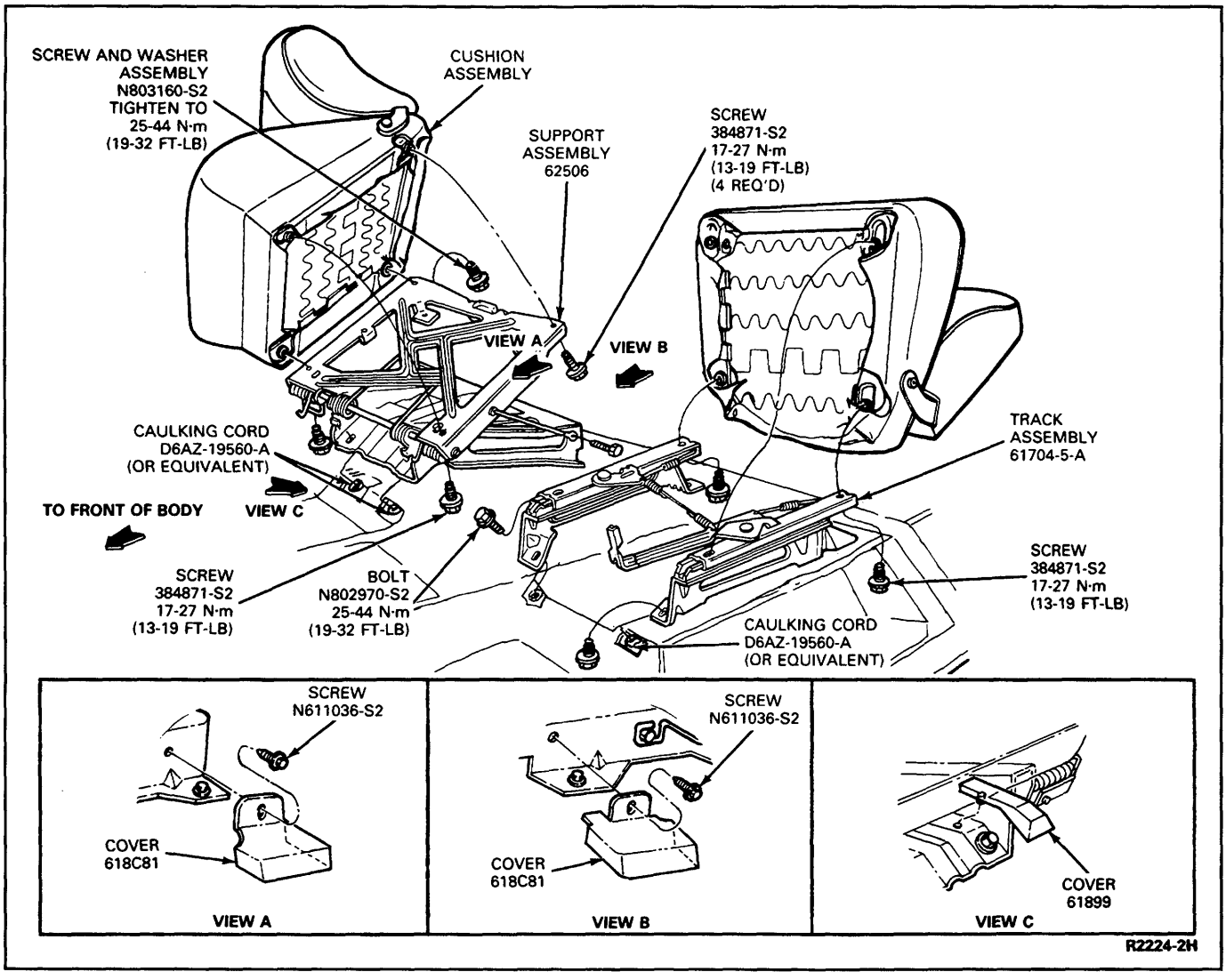


FIG. 5 F-150—F-350 Super Cab and Bronco Bucket Seat Installation

THE SEAT AND SUPPORT ASSEMBLY IS INSTALLED IN THE VEHICLE.

2. Unlatch the seat support assembly. Then, fold the seat forward.
3. Install the ends of the assist springs into their retainers (Fig. 7).
4. Return the seat to an upright position. Then, push the seat back down firmly until the seat support assembly is latched. Apply Caulking Cord D6AZ-19560-A or equivalent around floorpan attaching holes.
5. Position the seat and support assembly over the floorpan attaching holes. Then, install the two front attaching bolts but DO NOT tighten (Fig. 5).
6. Install the end of the passenger seat support stop cable (Fig. 6).
7. Operate the seat support release lever, causing the seat to "pop-up" and fold forward. Then, install the two rear seat support-to-floorpan attaching bolts. Tighten the four attaching bolts to 25-44 N·m (19-32 ft-lb).
8. Move the seat to an upright position, then push the seat back down firmly until the seat support assembly is latched.
9. Check the seat support assembly for proper operation.

WARNING: TO ENSURE THE SEAT SUPPORT ASSEMBLY IS IN AN UNLATCHED POSITION, A MEASURED DISTANCE OF 102MM 4 INCHES) OR MORE IS REQUIRED BETWEEN THE BUMPER AND THE LOWER SUPPORT AS SHOWN IN FIG. 8.

NOTE: For captain's chair applications perform the following:

10. Operate the seat support release lever rearward. Ensure the seat back adjuster permits the seat back to fold forward at approximately the same time the seat support assembly unlatches and "pops-up." In the event the seat assembly and/or the seat back does not release properly, it will be necessary to adjust the release cable by moving the slotted cable retainer fore-or-aft as required (Fig. 7).

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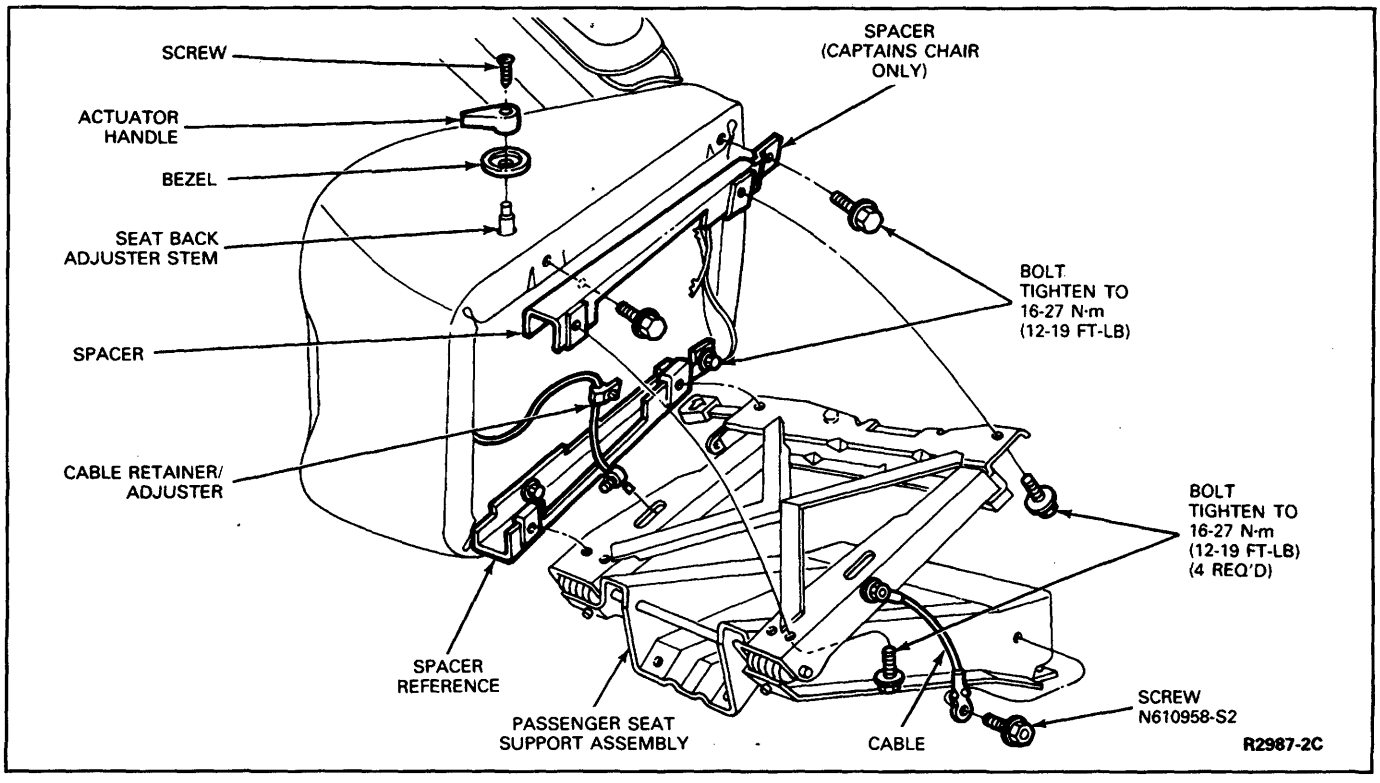


FIG. 6 Bronco Bucket Seat Installation—Passenger

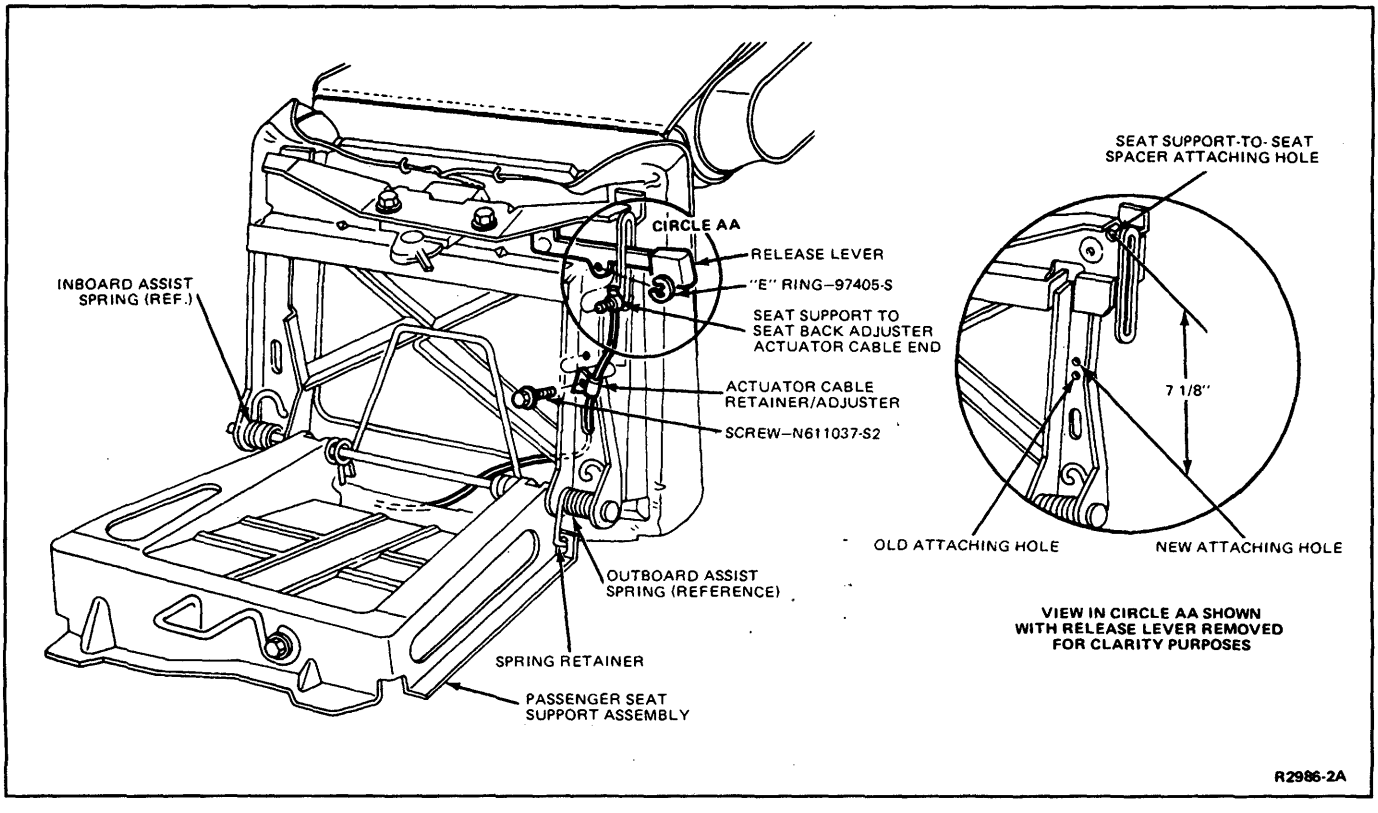


FIG. 7 Bronco Bucket Seat Assist Springs Installation

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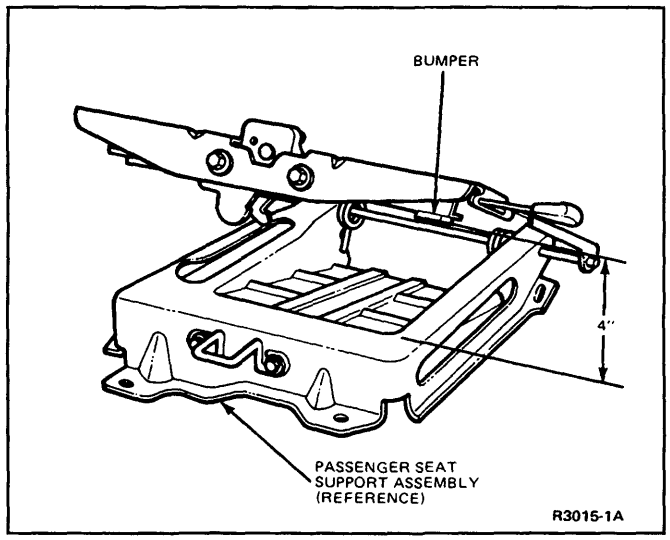


FIG. 8 Passenger Seat Assembly—F-150—F-350 and Bronco Captain's Chair

Captain's Chairs

F-150—F-350 Super Cab and Bronco—Drivers Seat (LH)

Refer to Fig. 9.

Removal

1. Remove and retain four seat track-to-floor bolts.
2. Remove the seat and seat track assembly from vehicle.

Installation

1. Apply Caulking Cord D6AZ-19560-A or equivalent around attaching screw locations on floorpan.
2. Position the seat and seat track assembly in the vehicle.
3. Install four bolts securing seat tracks-to-floor. Tighten bolts to 25-44 N·m (19-32 ft-lb).

E-150—E-350 and Club Wagon, Driver and Passenger Seats With Fixed Support or Swivel Pedestal

Refer to Fig. 10.

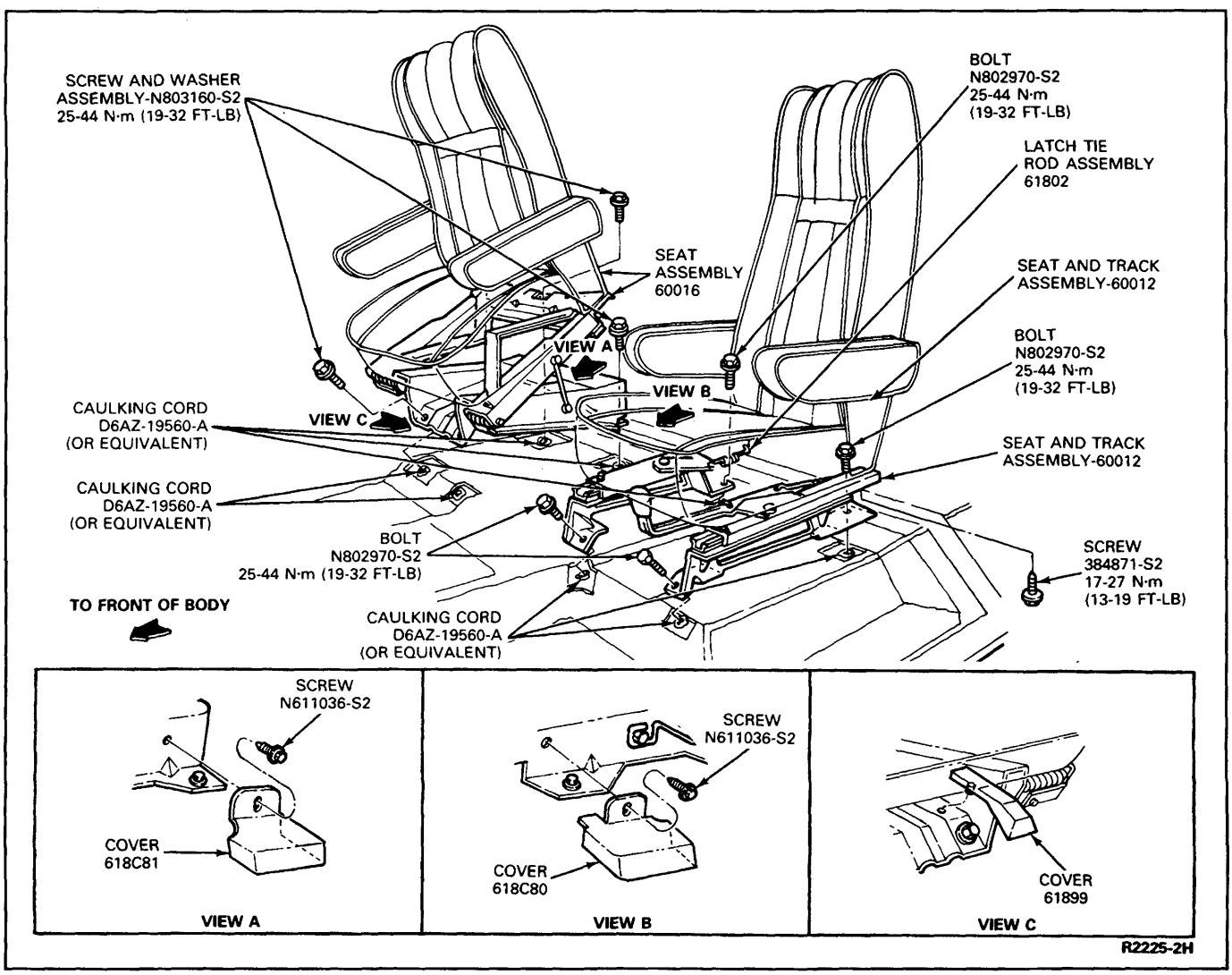


FIG. 9 Bronco and F-150—F-350 Super Cab Captain's Chairs

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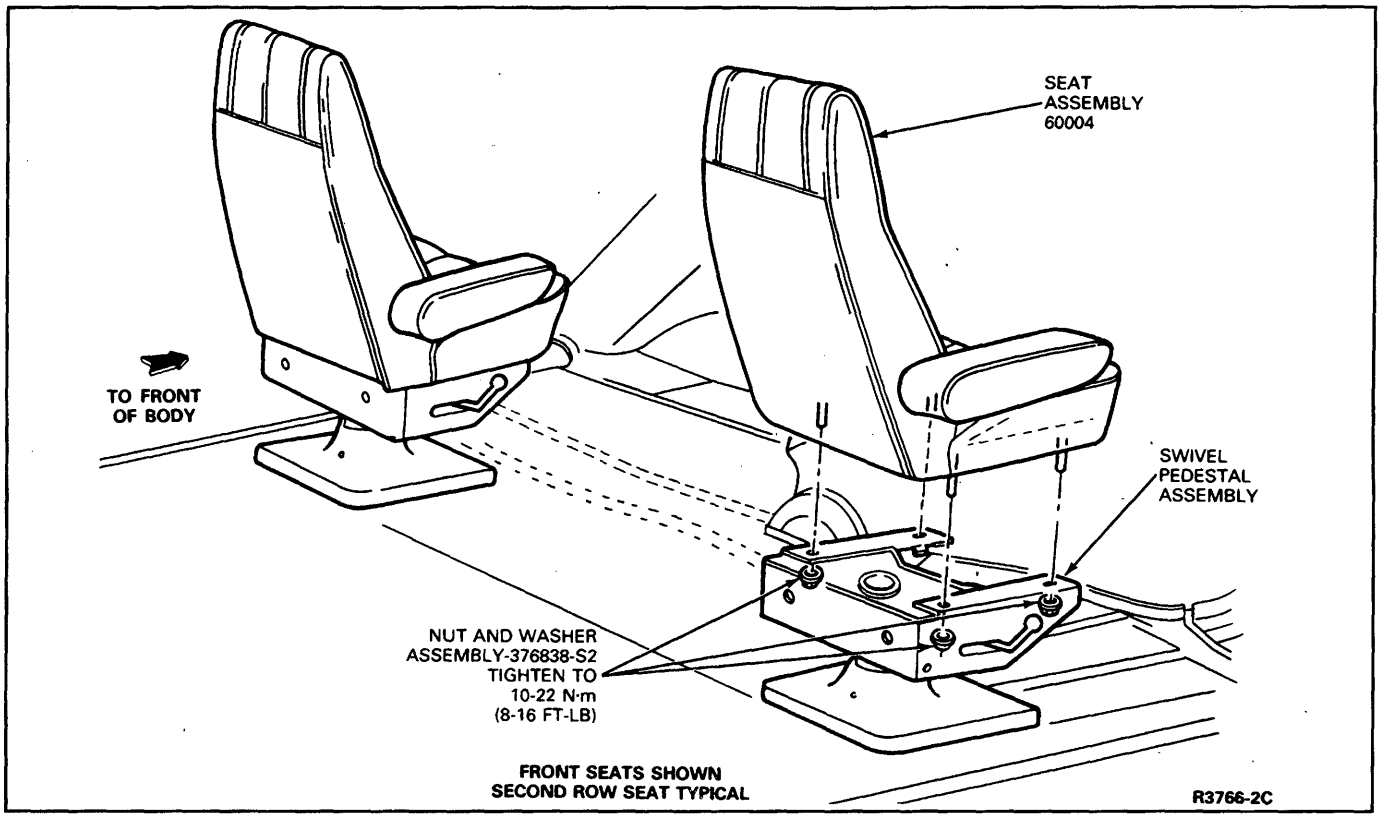


FIG. 10 E-150—E-350 Captain's Chair Seat Support—Swivel Pedestal Shown, Fixed Support Typical

Removal

1. Remove the four nut and washer assemblies (two each side) securing seat and seat track to fixed support or swivel pedestal.
2. Remove seat and track assembly from vehicle.
3. On vehicles with fixed support, remove four bolt and washer assemblies retaining support to vehicle floor. Remove fixed support from vehicle.
4. On vehicles with swivel pedestal, remove three screws retaining trim cover to pedestal and remove cover, and remove four bolt and washer assemblies retaining swivel pedestal to vehicle floor. Remove swivel pedestal from vehicle.

Installation

1. Apply Caulking Cord D6AZ-19560-A or equivalent around fixed support or swivel pedestal attaching bolt location on floorpan.
2. To install fixed support. Position support on floorpan and install four bolt and washer assemblies. Tighten to 61-81 N·m (45-59 ft-lb).
3. To install swivel pedestal, position pedestal on floorpan, lift up trim cover and install four bolt and washer assemblies. Tighten to 61-81 N·m (45-59 ft-lb).
4. Install trim cover on base of pedestal and install three retaining screws.
5. Install seat and seat track assembly on fixed support or swivel pedestal.
6. Install four nut and washer assemblies. Tighten to 10-22 N·m (8-16 ft-lb).

Seat Tracks

CAUTION: Use care when handling seat and track assembly. Dropping assembly or sitting on seat when not secured in vehicle may result in damaged components.

Bench Seat—F-150—F-350 and Bronco

Refer to Fig. 3.

Removal

1. Remove the bench seat as outlined.
2. Disconnect the small tension spring from the LH seat track and the tie rod.
3. Disconnect the seat track latch tie rod from the latches on the seat tracks (Fig. 3).
4. Remove the seat track-to-seat cushion screws and remove the tracks from the cushion.
5. If the seat is being replaced, proceed to Step 1 of Installation.

Installation

1. Lubricate the seat track assemblies using Ford Polyethylene Grease D7AZ-19584-A or equivalent. Assemble the seat tracks to the cushion assembly (Fig. 3). Install the track-to-cushion screws and tighten to 17-27 N·m (13-19 ft-lb).
2. Connect the tie rod to the latch on each seat track.
3. Connect the small tension spring to the LH seat track and the tie rod.
4. Install seat and track assembly into the vehicle as outlined.

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Bucket Seats—E-150—E-350 Driver and Passenger

Removal

Refer to Fig. 4.

This procedure applies to both front seats.

1. Remove four seat track-to-support nuts and washers and lift the seat and track assembly from its support as outlined (Fig. 4).
2. Remove the track-to-seat screws and separate the seat from the track.
3. If only the seat is being replaced, proceed to Step 1 of Installation. If only the track is being replaced, remove the plastic handle and retainer from the handle lever. Remove the small spring from latch side track. Transfer all these parts to the replacement track.

Installation

1. Position the track assembly to the seat and secure it with the attaching screws. Tighten screws to 10-22 N·m (8-16 ft-lb).
2. Position the seat and track assembly on the support assembly and secure it with the attaching nuts and washers as outlined.

Bucket Seat—F-150—F-350 Super Cab and Bronco—Driver's Seat

Removal

Refer to Fig. 5.

1. Remove four seat track-to-floor bolts and lift the seat and track assembly from the vehicle as outlined.
2. Disconnect and remove seat track latch tie rod assembly from the latches on the seat tracks.
3. Remove track-to-seat screws and separate seat from track.
4. If only seat is being replaced, proceed to Step 1 of Installation. If only track is being replaced, remove plastic handle and metal retainer from handle lever. Remove spring from each track. Transfer all these parts to replacement tracks.

Installation

1. Position the track assembly to the seat and secure with attaching screws. Tighten screws to 17-27 N·m (13-19 ft-lb).
2. Install the latch tie rod to the latches on both seat tracks.
3. Apply Caulking Cord D6AZ-19560-A or equivalent around the seat track attaching bolt locations on floorpan. Install seat and track assembly into the vehicle as outlined.

Bucket Seat—Bronco—Passenger Seat

Removal

1. Remove seat assembly as outlined.
2. Remove the four bolts retaining seat assembly to the seat support.

Installation

1. Install seat assembly to support and secure with four bolts. Tighten bolts to 17-27 N·m (13-19 ft-lb).
2. Install seat and support assembly into vehicle as outlined.

Captain's Chair—F-150—F-350 Super Cab and Bronco—Driver Seat

Refer to Fig. 9.

Removal

1. Remove seat and seat track assembly as outlined.
2. Disconnect and remove seat track latch tie rod assembly from the latches on the seat tracks.
3. Remove four seat track-to-seat screws and separate seat from track.
4. If only seat is being replaced, proceed to Step 1 of Installation. If only track is being replaced, remove handle assembly and retainer from lever. Remove spring from each track. Transfer all these parts to replacement tracks.

Installation

1. Position the track assembly to the seat and secure with four attaching screws. Tighten screws to 17-27 N·m (13-19 ft-lb).
2. Install the latch tie rod to the latch on both seat tracks.
3. Apply sealer to track attaching bolt locations. Position the seat and track assembly in the vehicle as outlined.

Captain's Chair—F-150—F-350 Super Cab and Bronco—Passenger Seat

Removal

1. Remove the seat and support assembly as outlined.
2. Remove four bolts securing the support assembly to seat (Fig. 6).

Installation

1. Position seat to the support assembly and secure with four bolts. Tighten bolts to 16-27 N·m (12-19 ft-lb).
2. Install seat and support into vehicle as outlined.

Captain's Chairs E-150—E-350 and Club Wagon, Driver and Passenger

Seat—Fixed Support and Swivel Pedestal

Removal

Refer to Fig. 10.

1. Remove the seat and track assembly from its support as outlined.
2. Remove the four track-to-seat screws and separate the seat from the track.
3. If only the seat is being replaced, proceed to Step 1 of Installation. If only the track is being replaced, remove the plastic handle and retainer from the lever. Remove the latch spring from the latch side track. Transfer all these parts to the replacement track.

Installation

Refer to Figs. 4 and 10.

1. Position the track assembly to the seat and secure with the four attaching screws. Tighten screws to 10-22 N·m (8-16 ft-lb).

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2. Position seat and track assembly on the support and secure it with four attaching nuts and washers as outlined. Tighten nuts to 10-22 N·m (8-16 ft-lb).

Front Seat Back Adjuster (Recliner) Actuator Cable

Captain's Chair—F-150—F-350 Super Cab and Bronco—Passenger Seat

Refer to Fig. 11.

Removal

1. Remove the seat and track assembly as outlined.
2. Move the seat support release handle rearward and fold the seat fully forward.
3. Remove the screw retaining the seat back adjuster actuator cable to the seat support. Then, remove the E-ring retaining the cable end to the release lever and remove the cable end (Fig. 7).
4. Remove four bolts retaining the seat support assembly to the seat spacers (Fig. 6).
5. On the recliner actuator side of the seat, remove two bolts securing the spacer to the seat cushion frame and remove the spacer.
6. Remove the seat back recliner actuator handle and bezel.
7. Remove the seat cushion trim cover hog rings. Roll back the trim cover as required to gain access to the seat back adjuster (Fig. 12).
8. Carefully peel the seat cushion pad away from the cushion frame. Then, remove the two screws retaining the seat back actuator cable to the cushion frame (Fig. 12).
9. Temporarily install the seat back adjuster actuator handle. Then, operate the seat back actuator handle, allowing the seat back to fold forward.

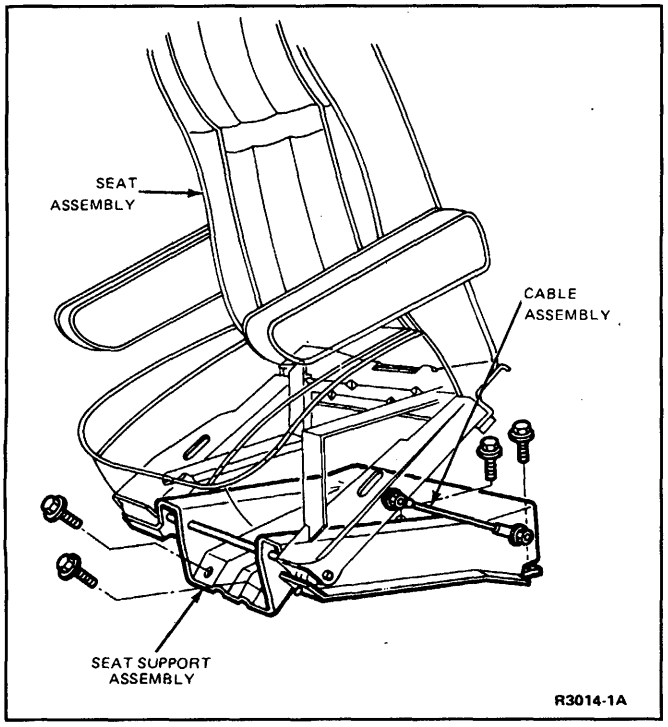


FIG. 11 F-150—F-350 Super Cab and Bronco Passenger Seat Removal—Captain's Chair

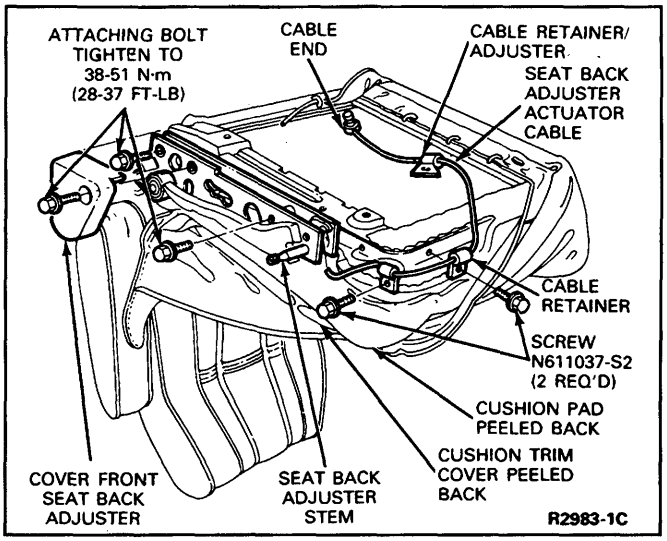


FIG. 12 Captain's Chairs—F-150—F-350 Super Cab and Bronco—Passenger Seat

NOTE: In the event the seat back does not fold forward of its normal upright position when the seat back adjuster actuator handle is operated, trigger the seat back adjuster mechanism as shown in Fig. 13.

WARNING: TO PREVENT INJURY TO THE TECHNICIAN, BEFORE REMOVING THE SEAT BACK AND ADJUSTER ASSEMBLY FROM THE SEAT CUSHION ASSEMBLY, THE SEAT BACK MUST BE FULLY FORWARD OF ITS NORMAL UPRIGHT POSITION.

10. Remove the clip retaining the seat back to the seat cushion frame at the seat back pivot.
11. Remove the three bolts retaining the seat back adjuster to the seat cushion frame. Then, to prevent damage to the cushion trim cover, carefully remove the seat back and adjuster assembly from the seat cushion. Place the seat back on a clean surface (Fig. 12).
12. From the back side of the adjuster assembly, remove E-ring used to retain the end of the **short** cable to the adjuster assembly and remove the cable end (Fig. Item A1). Next, rotate the adjuster actuator handle to expose E-ring Item A-3. Then, remove and retain E-ring Item A-3 used to retain the end of the **long** cable to the adjuster assembly as shown in Fig. 14. Then, remove the cable end and cable.

NOTE: If short seat back adjuster actuator cable requires replacement, perform Removal Steps 1 through 7 inclusive. Do not remove E-ring item A3. Instead, remove E-ring item A2, and remove worn cable.

Installation

1. Install the replacement cable **(long)** and the one end of the short cable using E-rings. Install the new cable and E-rings (A1 and A2) if removed.
2. Remove the recliner actuator handle.
3. Install the seat back and adjuster assembly to the seat cushion frame (three bolts). Tighten the bolts to 38-51 N·m (29-37 ft-lb) (Fig. 12).
4. Install seat back pivot pin.
5. Secure the seat back adjuster actuator cable to the seat cushion (Fig. 12).

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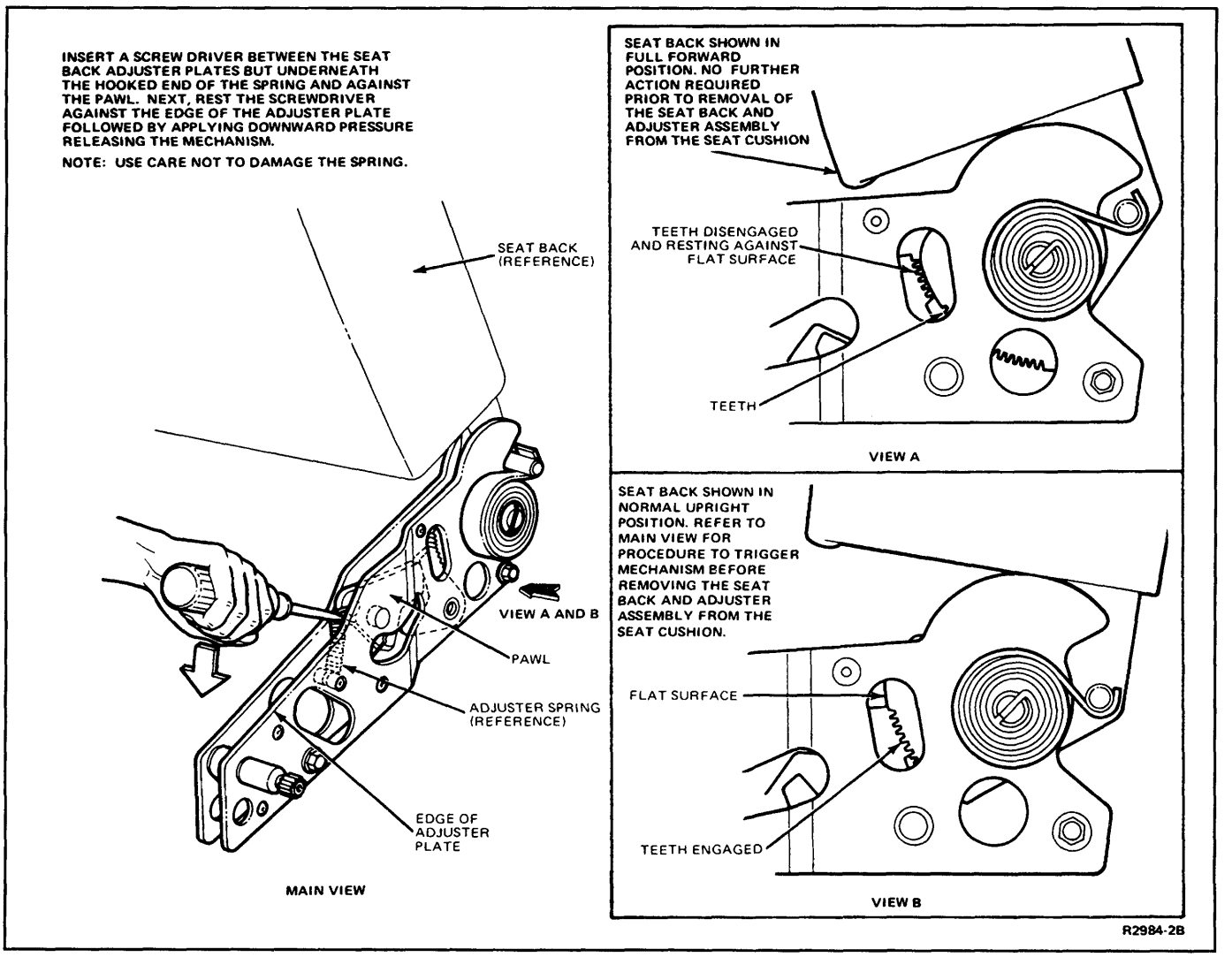


FIG. 13 Seat Back Adjuster—F-150—F-350 Super Cab and Bronco, E-150—E-350

6. Reposition and secure the cushion trim cover.
7. Install the seat spacer to the seat cushion frame. Tighten the bolts to 16-27 N·m (12-19 ft-lb) (Fig. 6).
8. Install the seat back adjuster bezel and actuator handle.

   NOTE: The replacement of the seat support to seat back adjuster actuator cable (long) may require the drilling of a new attaching hole in the support assembly. Measure from the center of the seat support-to-seat spacer attaching hole to the center of the actuator cable attaching hole. If the distance is 180.9mm (7 1/8 inches) no rework is required. If not, drill a 9/64 inch diameter hole at the location shown in Fig. 7.
9. Install the support assembly to the seat spacers using the four previously removed bolts. Tighten the bolts to 16-27 N·m (12-19 ft-lb).
10. Install the end of the seat back release actuator cable into the actuator handle. Then, install the E-ring (Fig. 7).
11. Secure the actuator cable to the support assembly (Fig. 7).
12. Position the seat in an upright position. Then, push the seat back down firmly until the seat support assembly is latched.
13. Install seat into vehicle as outlined.

F-150—F-350 Super Cab and Bronco—Driver Seat E-150—E-350 Driver and Passenger Seat

Removal

Refer to Fig. 13.

1. Remove seat and track assembly as outlined.
2. Remove four bolts retaining the seat tracks to the seat assembly. Then, remove the seat tracks. Remove two bolts retaining the seat spacer to the cushion frame, if so equipped.
3. Remove the seat back recliner actuator handle and bezel.
4. Remove the seat cushion trim cover hog rings and roll back the trim cover as required to gain access to the seat back adjuster.
5. Carefully peel the seat cushion pad away from the cushion frame.
6. Temporarily install the seat back adjuster actuator handle. Then, operate the seat back actuator

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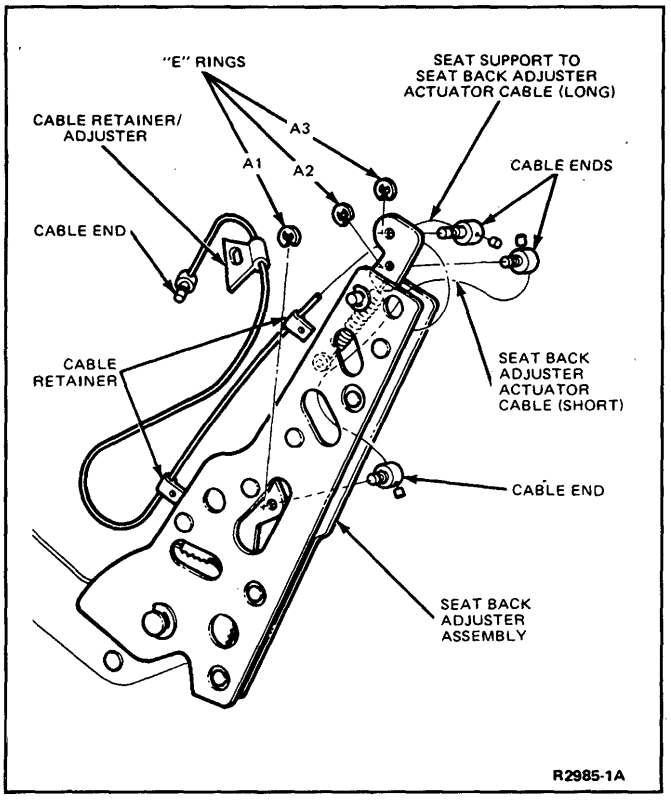


FIG. 14 Seat Back Adjuster Assembly—F-150—F-350 Super Cab and Bronco—Passenger Seat

handle, allowing the seat back to fold forward of its normal upright position.

NOTE: If the seat back does not fold forward of its normal upright position when the seat back adjuster actuator handle is operated, trigger the seat back adjuster mechanism as shown in Fig. 13.

WARNING: TO PREVENT INJURY TO THE TECHNICIAN, BEFORE REMOVING THE SEAT BACK AND ADJUSTER ASSEMBLY FROM THE SEAT CUSHION ASSEMBLY, THE SEAT BACK MUST BE FULLY FORWARD OF ITS NORMAL UPRIGHT POSITION.

7. Remove clip retaining the seat back to the seat cushion frame at the seat back pivot.
8. Remove bolts retaining the seat back adjuster to the seat cushion frame (Fig. 12). Then, to prevent damage to the cushion trim cover, carefully remove the seat back and adjuster assembly from the seat cushion. Place the seat back on a clean surface.
9. From the back side of the adjuster assembly, remove E-ring Item A-1 (Fig. 14) retaining the end of the short cable to the adjuster assembly. Remove the cable end (Fig. 14). Next, rotate the adjuster actuator handle to expose E-ring Item A-2 (Fig. 14). Remove E-ring Item A-2 securing the end of the cable to the adjuster assembly as shown in Fig. 14. Then, remove the cable end.
10. Remove worn cable.
11. Remove the recliner actuator handle.

Installation

1. Install the seat back and adjuster assembly to the seat cushion frame attaching bolts. Tighten the bolts to 38-51 N·m (29-37 ft-lb).
2. Install the seat back pivot pin.
3. Reposition and secure the cushion trim cover.
4. Install the seat spacer to the seat cushion frame using the two previously removed attaching bolts, if so equipped. Tighten the bolts to 16-27 N·m (12-19 ft-lb).
5. Install the seat back adjuster bezel and actuator handle.
6. Install the support assembly to the seat spacers using the four previously removed bolts. Tighten the bolts to 16-27 N·m (12-19 ft-lb).
7. Install the seat tracks to the seat cushion. Tighten the bolts to 10-22 N·m (8-16 ft-lb).
8. Install the seat and track assembly as outlined.

Seat Support Assembly Assist Springs

F-150—F-350 Super Cab and Bronco—Passenger Bucket/Captain's Chairs

Removal

1. Remove seat from vehicle as outlined.
2. Move the seat support release handle rearward and fold the seat fully forward.
3. Remove the cotter pin and flat washer used to retain the pivot rod to the seat support assembly. Then, remove the pivot rod (Fig. 15).
4. Discard the worn or damaged assist spring.

Installation

1. Install the replacement assist spring. Insert the pivot rod through the springs. Add flat washer and secure with cotter pin.
2. Assemble the support assembly but do not install the ends of the assist springs into their retaining slots.

   NOTE: Under no circumstances should the inner (center) assist spring be reworked or omitted from the support assembly. If the center assist spring was reworked or is missing, obtain and install one E0TB-9864812-AB spring.
3. Move the seat into an upright position. Then, push the seat back down firmly until the seat support assembly is latched.
4. Position and install seat into vehicle as outlined.

Seat Support

E-150—E-350

Removal

1. Remove the seat belt assembly. Refer to Section 41-50, Seat and Shoulder Belts.
2. Remove the four bolts and washers retaining the seat and support assembly to the floorpan.

Installation

1. Install the seat and support assembly in the vehicle. Tighten the attaching bolts to 67-81 N·m (50-59 ft-lb).
2. Install the seat belts. Tighten the bolts as outlined in Section 41-50, Seat and Shoulder Belts.

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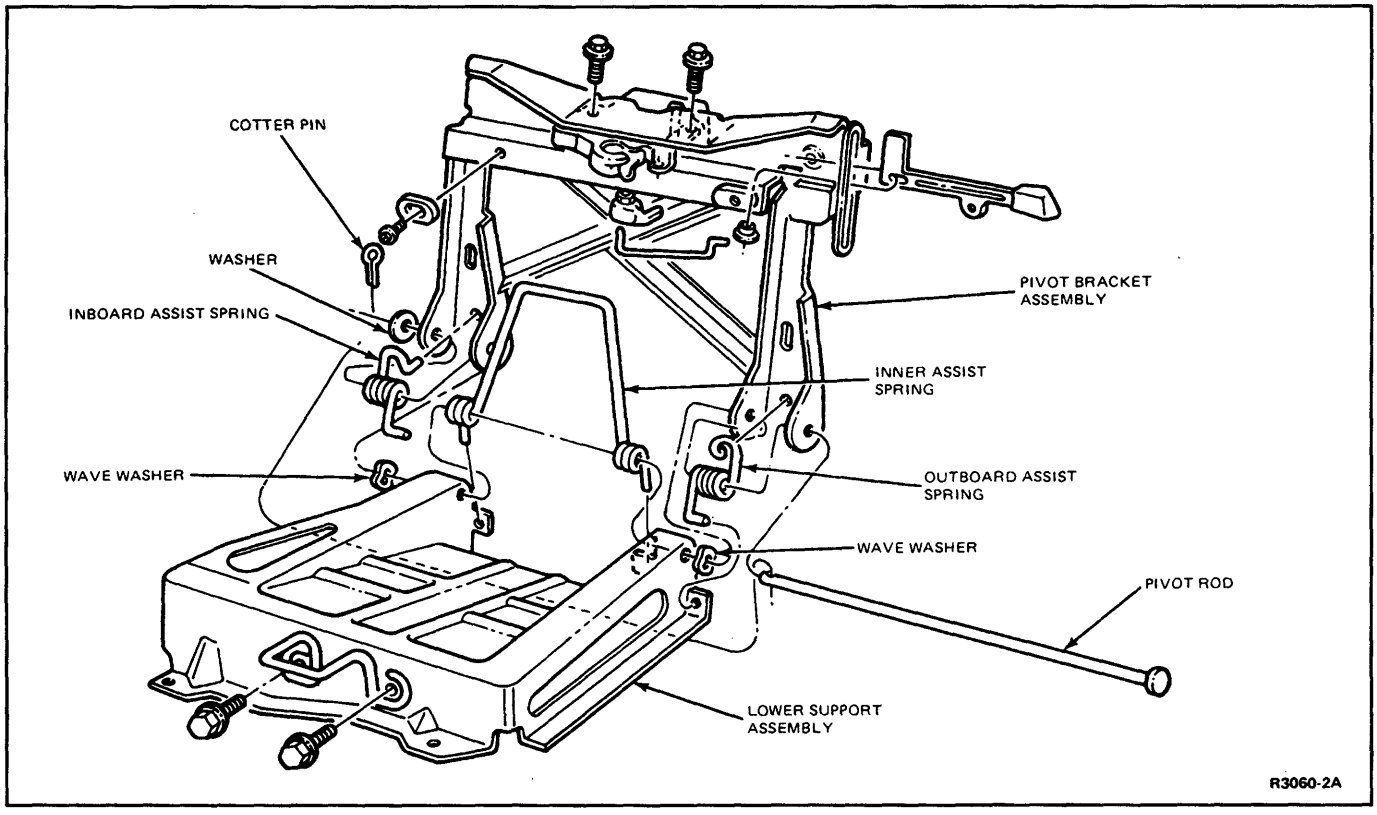


FIG. 15 Seat Support Assist Springs

Fixed Support, Swivel Pedestal

E-150—E-350—Driver and Passenger Seat

Refer to Fig. 1 for Swivel Pedestal and Fig. 4 for Fixed Support

Removal

1. Remove three screws securing trim cover to the base (Swivel Pedestal only). Lift trim cover.
2. Remove four base-to-floorpan bolt and washer assemblies.
3. Lift the support (pedestal) assembly out of the vehicle.

Installation

1. Position the support (pedestal) assembly on the floor.
2. Apply sealer under the base, over the holes, and install four bolts and washer assemblies. Tighten the bolts to 62-81 N·m (46-59 ft-lb).
3. Position the trim cover in place and secure it with three screws (Swivel Pedestal only).

Seat Back Adjuster (Recliner) Captain's Chair—Driver and Passenger—F-150—F-350 Super Cab, Bronco and E-150—E-350

Removal

1. Remove the seat assembly from the vehicle as outlined.
2. Remove the seat support/seat tracks from the seat as outlined.
3. Carefully peel back the inboard armrest trim cover until the armrest-to-seat back attaching bolt is exposed (Fig. 16). Remove the bolt and place the armrest on a clean protected surface.
4. Remove the recliner actuator handle and bezel from the seat cushion (Fig. 16).
5. Remove the clip retaining the seat back to the seat cushion frame at the outboard pivot (Fig. 16, view A).
6. Remove the hog rings along the bottom of the seat back trim cover (Fig. 17).
7. Carefully peel up the seat back trim cover until the two bolts retaining the seat back to the recliner are exposed (Fig. 18).
8. Temporarily install the seat back recliner actuator handle. Then, operate the seat back actuator handle, allowing the seat back to fold forward of its normal upright position.

NOTE: In the event the seat back does not fold forward of its normal upright position when the seat back adjuster actuator handle is operated, trigger the seat back adjuster mechanism as shown in Fig. 13.

WARNING: TO PREVENT INJURY TO THE TECHNICIAN, BEFORE REMOVING THE SEAT BACK ASSEMBLY FROM THE SEAT CUSHION ASSEMBLY, THE SEAT BACK MUST BE FULLY FORWARD OF ITS NORMAL UPRIGHT POSITION.

9. Remove the clip retaining the seat back to the seat cushion frame at the seat back pivot.
10. After removing the two bolts retaining the seat back to the recliner assembly, lift the seat back off of the seat cushion and place it on a clean, protected surface.
11. Remove the hog rings and cushion trim cover as required to gain access to the three bolts retaining

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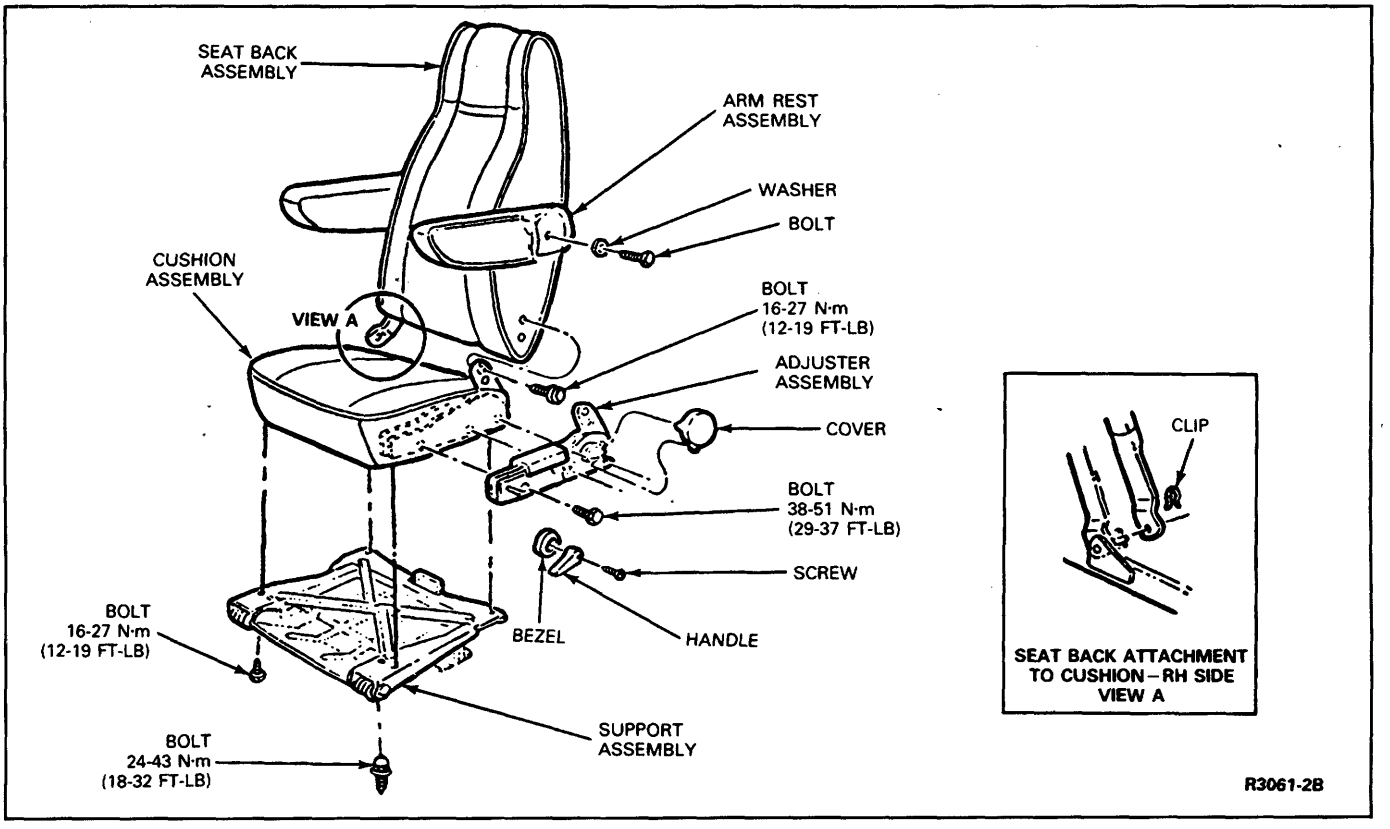


FIG. 16 Arm Rest and Pivot Retaining Clip

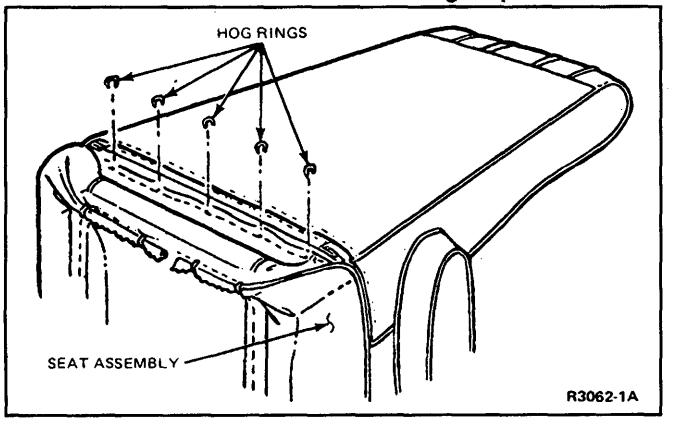


FIG. 17 Seat Back Trim Hog Rings

the recliner assembly to the seat cushion frame (Figs. 19 and 20).

12. Remove the three recliner assembly-to-seat cushion frame attaching bolts.
13. Remove replacement recliner assembly.

Installation

1. Install the recliner assembly-to-the seat cushion frame.
2. Install the three recliner assembly-to-seat cushion frame attaching bolts (Fig. 20).
3. Install the cushion trim cover to the seat cushion frame using new hog rings (Fig. 19).
4. Position the seat back on the recliner assembly and install the retaining bolts (Fig. 18).
5. Install the seat back to seat cushion frame using retaining clip on inboard seat back pivot (Fig. 16).

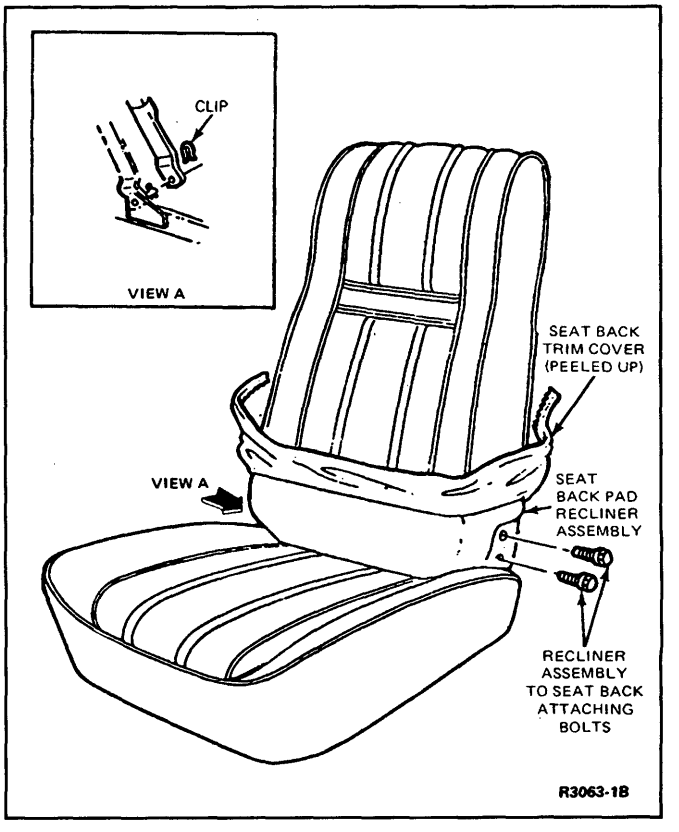


FIG. 18 Seat Back Retaining Bolts

6. Move the seat back to the upright position.
7. Install the seat back trim cover using new hog rings (Fig. 17).

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8. Install the seat back-to-seat cushion frame outboard pivot retaining clip (Fig. 16).
9. Install the recliner actuator handle and bezel on the seat cushion (Fig. 16).
10. Position the inboard armrest and install the retaining bolt. Install the armrest cover (Fig. 16).
11. Install the seat support/seat tracks as outlined.
12. Install the seat assembly as outlined.

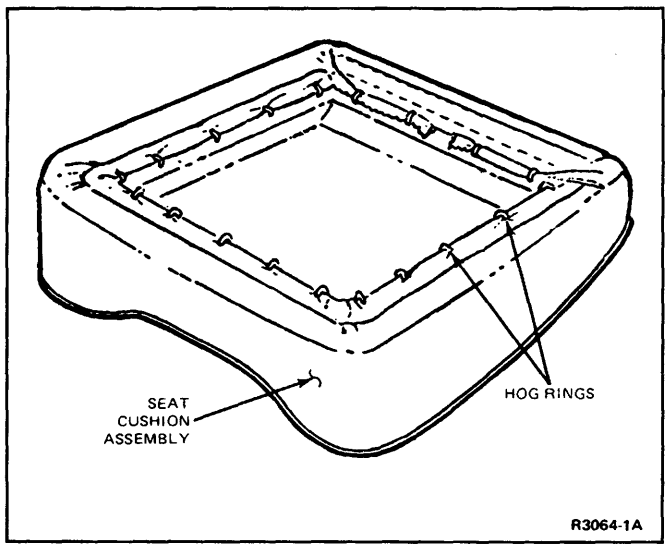


FIG. 19 Seat Cushion Hog Rings

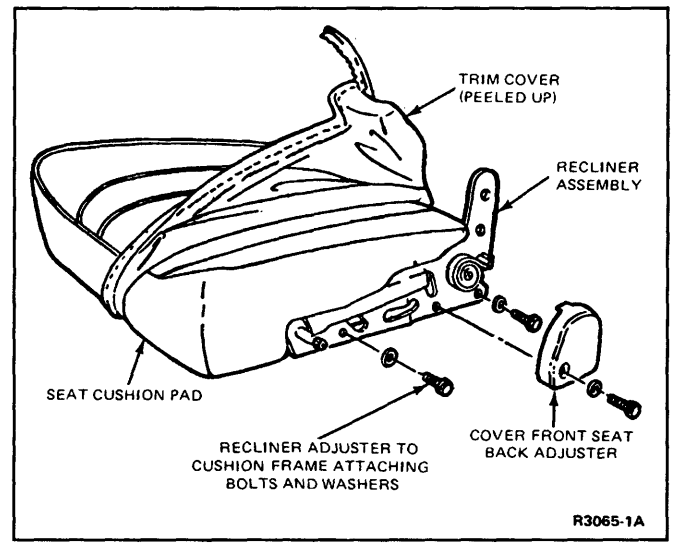


FIG. 20 Recliner Assembly

SPECIFICATIONS

SEAT TRACK — MANUAL — TORQUE N·m (FT-LB)

Vehicle	Seat Track-to-Cushion		Seat Track-to-Floor Pan or Support			Support-to-Floor	
	Bench	Bucket	Captains	Bench	Bucket	Captains	Bucket
Econoline	—	10-22 (8-16)	10-22 (8-16)	—	10-22 (8-16)	61-81 (45-59)	61-81 (45-59)
F-Series & Bronco	17-27 (13-19)	17-27 (13-19)	25-44 (19-32)	25-44 (19-32)	25-44 (19-32)	61-81 (45-59)	—

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SECTION 41-14 Conventional Rear Seats

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VEHICLE APPLICATION

E-150—E-350 And F-Series Crew Cab.

DESCRIPTION

On E-series, the 3-Passenger Quick Release Rear Seat is held to the floor by the engagement of the rear retainer with the rear striker and the engagement of a latch rod hook with the front striker. The Quick Release facilitates removal of the rear seat.

REMOVAL AND INSTALLATION

Quick Release Seat—3-Passenger—E-150—E-350

Removal

1. Lift and rotate the seat latch handles (RH and LH) rearward, causing the seat to move rearward and disengage the floor strikers (Fig. 1).
2. Lift the latch rod hook end (RH and LH) out of the locking holes in the front floor strikers.
3. Remove the seat assembly from the vehicle.
4. If floor strikers are to be removed:

   Remove striker attaching bolts and washers. Apply a bead of Ford Caulking Cord D6AZ-19560-A or equivalent to the floorpan side of the washers. Install the bolts and washers into the floor and tighten the seat striker bolts to 14-27 N·m (10-20 ft-lb).

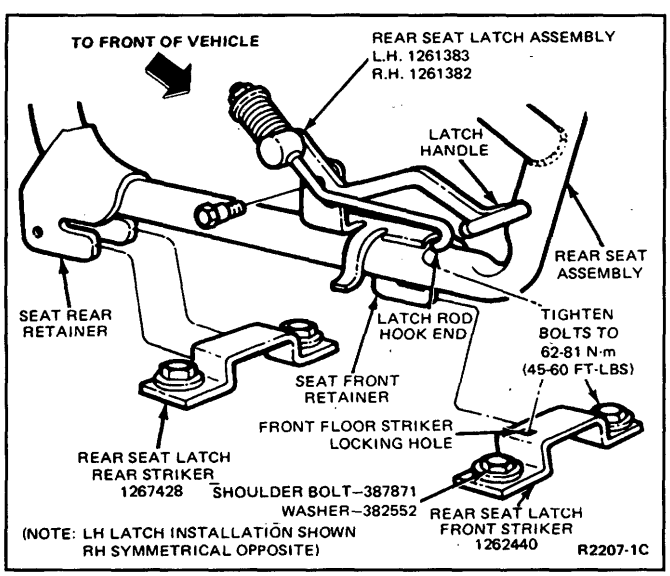


FIG. 1 Optional Quick Disconnect for 3-Passenger Rear Seat E-150—E-350

Installation

1. If floor strikers were removed, install strikers, bolts and washers. Tighten the bolts to 62-81 N·m (45-60 ft-lb). The front strikers have holes to be positioned inboard for latch engagement.
2. Lift the seat assembly into the vehicle and align the retainers to the rear edge of the floor strikers (Fig. 1).
3. Engage the hook end of the latch rods (RH and LH) into the front floor striker locking hole.
4. Rotate the latch handles (RH and LH) forward, causing the seat assembly to slide forward into engagement with the floor strikers. Continue latch handle rotation until the bottom of the handle contacts the top surface of the front floor strikers.

   NOTE: In Club Wagons with eight passenger seating, the bench seat with automatic locking seat belt retractors at the outboard positions must be installed in the first bench seat position.

   WARNING: KEEP STRIKER AREA FREE OF FOREIGN OBJECTS THAT WOULD PREVENT FRONT AND REAR RETAINERS FROM PROPERLY ENGAGING THE STRIKERS. NEVER ATTEMPT TO ADJUST THE SEAT LATCH WHILE THE VEHICLE IS IN MOTION. PRIOR TO OCCUPYING THE SEAT, CHECK TO SEE THAT THE HOOK END OF THE LATCH RODS AND HANDLES ARE LATCHED SECURELY TO THE STRIKERS TO ENSURE PROPER SEAT RETENTION.

Rear Compartment Seat and Seat Belt—Four Passenger Seat—E-150—E-350

To remove a rear compartment seat and floor attaching seat belts, remove each bolt and lock washer (Figs. 2 and 3). Remove the seat and belts. Apply a bead of putty-like waterproof sealer, such as Ford Caulking Cord D6AZ-19560-A or equivalent, to the floorpan side of the washers. Install the bolts and washers in the floor. Tighten the seat bolts to 34-61 N·m (25-45 ft-lb) and the seat belt bolts to 14-29 N·m (10-22 ft-lb).

To install the seat and belts, use the same sealing procedure. Tighten the seat mounting bolts to 62-81

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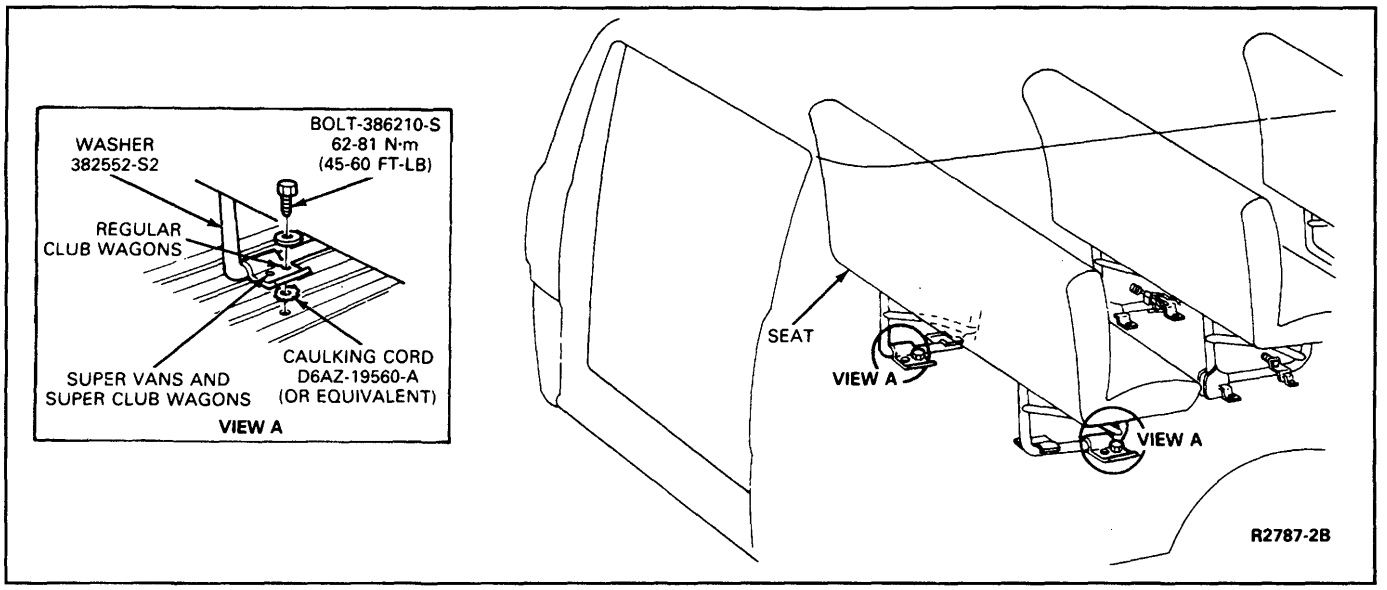


FIG. 2 Rear Four Passenger Seat—Fourth Row—E-150—E-350 (12-passenger)

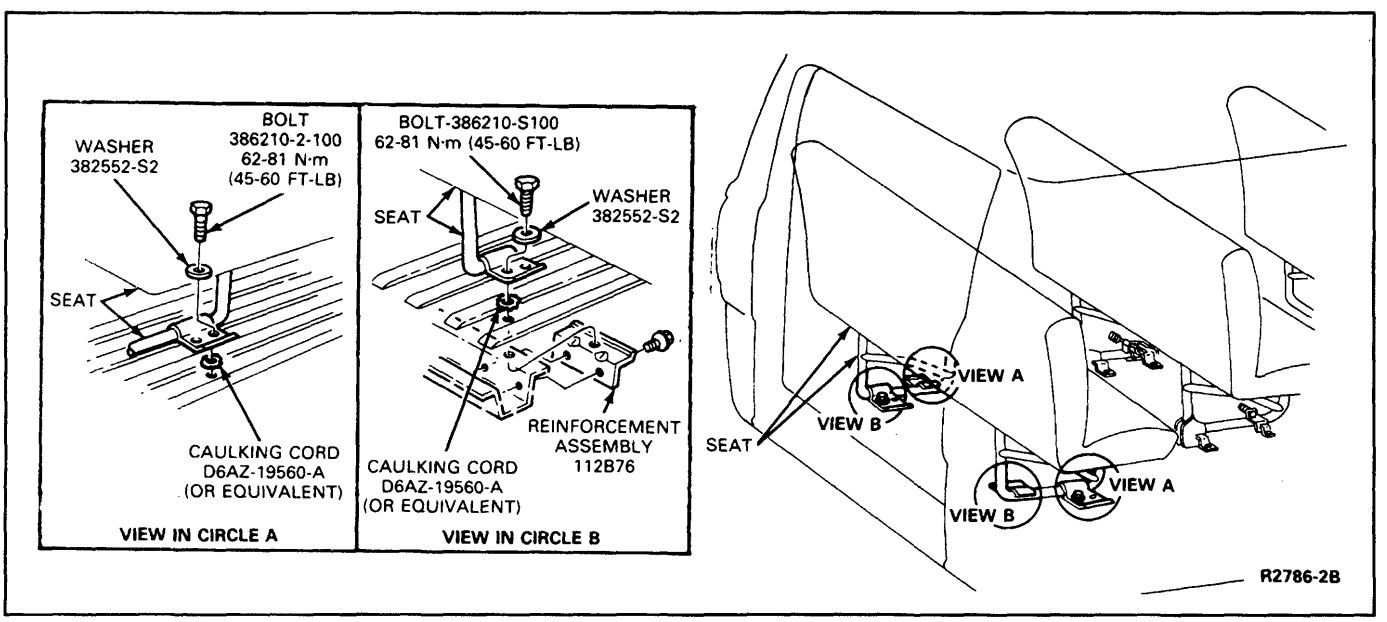


FIG. 3 Rear Four Passenger Seat—Fifth Row—E-150—E-350 (15-passenger)

N·m (45-60 ft-lb) and seat belt mounting bolts to 30-43 N·m (22-32 ft-lb).

NOTE: In Club Wagons with eight passenger seating, the bench seat with automatic locking retractors at the outboard positions must be installed in the first bench seat position.

Rear Bench Seat

F-350 Crew Cab

Removal

1. Remove the seat track-to-floorpan retaining screws (two on each side) and lift the seat and track assembly out of the vehicle (Fig. 4).

Installation

1. Apply Caulking Cord D6AZ-19560-A or equivalent under seat track assembly.
2. Lift the seat and track assembly into the cab and secure it to the floorpan with the retaining screws. Tighten the screws to 25-44 N·m (18-32 ft-lb).

Seat Tracks

Rear Bench Seat F-350 Crew Cab

Removal

1. Remove the bench seat as outlined.
2. Disconnect the small tension spring from the LH seat track and the tie rod.
3. Disconnect the seat track latch tie rod from the latches on the seat tracks (Fig. 4).
4. Remove the seat track-to-seat cushion screws and remove the tracks from the cushion.

CAUTION: Use care when handling a seat and track assembly. Dropping assembly or sitting

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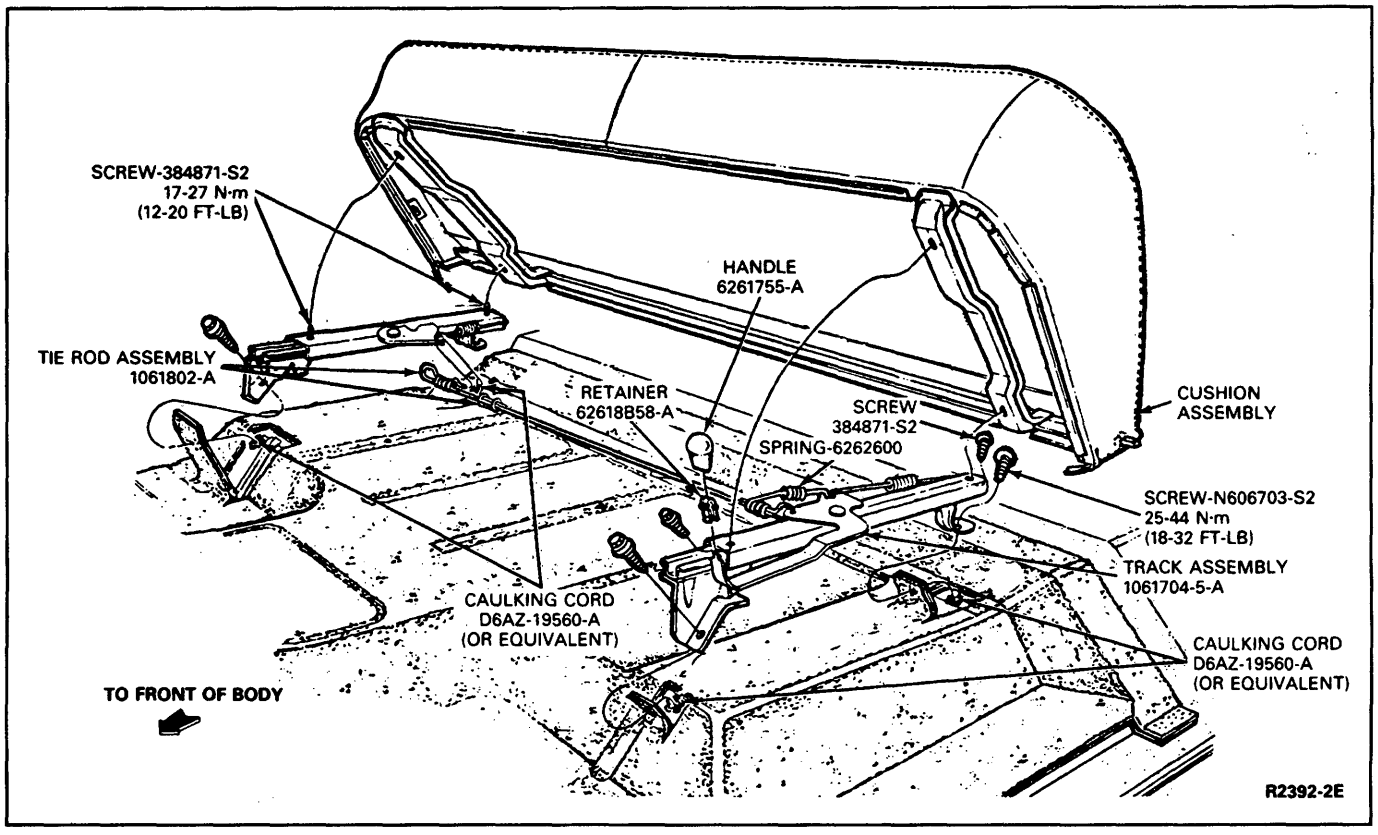


FIG. 4 Rear Bench Seat and Track Installation—F-350 Crew Cab

on seat when not secured in vehicle may damage seat track components.

Installation

1. Lubricate the seat track assemblies using Ford Polyethylene Grease D7AZ-19584-A or equivalent. Assemble the seat tracks to the cushion assembly (Fig. 4). Install the track-to-cushion screws and tighten to 17-27 N·m (12-20 ft-lb).
2. Connect the tie rod to the latch on each seat track.
3. Connect the small tension spring to the LH seat track and the tie rod.
4. Install seat and track assembly as outlined.

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SECTION 41-20 Folding Rear Seats

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VEHICLE APPLICATION

F-150 Through F-350 with Super Cab, Bronco and E-150 Through E-350.

DESCRIPTION AND OPERATION

Super Cab

Super Cab models have optional folding side-mounted rear seats which are designed to fold upward against the side of the cab for storage (Fig. 1). A forward-facing folding rear seat which converts to a load floor is optional with F-150 and F-350 Super Cab models (Fig. 2). The back of the seat is held in an upright position by a latch mounted on the inside rear of the cab (Fig. 3). The bottom of the seat pivots to lie flat against supporting bumpers (Fig. 4).

Bronco

The Bronco has an optional fold-down rear seat (Fig. 5). A seat back latch on the lower RH side of the rear seat is lifted to unlock the seat back. The seat back is folded to the cushion with an additional seat back lever. A cushion latch located at the center rear of the cushion is lifted to unlock the cushion from the floor-mounted striker. The cushion folds forward to provide a flat storage area.

E-150—E-350

E-150 through E-350 models have an optional rear seat/bed (Fig. 6). A latch is provided to convert the seat to a bed.

ADJUSTMENTS

E-150—E-350 Seat/Bed Tie Rod

If the seat/bed latch fails to release, turn the adjusting turnbuckle clockwise to shorten the rod travel (Fig. 6). If the seat fails to lock in the bed position, turn the adjusting turnbuckle counterclockwise to lengthen the rod travel.

E-150—E-350 Seat/Bed Center Latch

If the seat/bed center latch does not return to the locked position after operation of seat/bed, move latch adjusting spring toward the center of the seat/bed (Fig. 6).

E-150—E-350 Seat/Bed Operation

If the seat/bed operation becomes difficult, loosen four cushion attaching bolts and allow seat/bed to shift (Fig. 6). Tighten attaching nuts. Check operation effort. Tighten upper seat back attachment to 11-21 N·m (8-16 ft-lb).

REMOVAL AND INSTALLATION

E-150—E-350 Seat/Bed

Front Cushion and Armrest Assembly

Removal

1. Detach rear latch wire from the front latch (Fig. 6).
2. Remove four nuts attaching seat cushion to frame assembly.
3. Remove seat cushion from frame assembly.

Installation

1. Position seat cushion to frame assembly (Fig. 6).
2. Secure cushion to frame assembly with four nuts. Tighten nuts to 17-27 N·m (12-20 ft-lb).
3. Attach rear latch wire to front latch.

Seat Back

Removal

1. Remove seat cushion as outlined.
2. Remove four bolts and nuts attaching the seat back to the frame assembly (Fig. 6).
3. Remove seat back from the frame assembly.

Installation

1. Position seat back to the frame assembly (Fig. 6).
2. Install attaching screws and tighten to 11-21 N·m (8-16 ft-lb).

   NOTE: Cross tighten attaching screws to ensure proper seat/bed operation.
3. Install seat cushion as outlined.

Rear Deck

Removal

1. Loosen wing nuts on each side of rear deck (Fig. 6).
2. Slide rear deck off the frame assembly.

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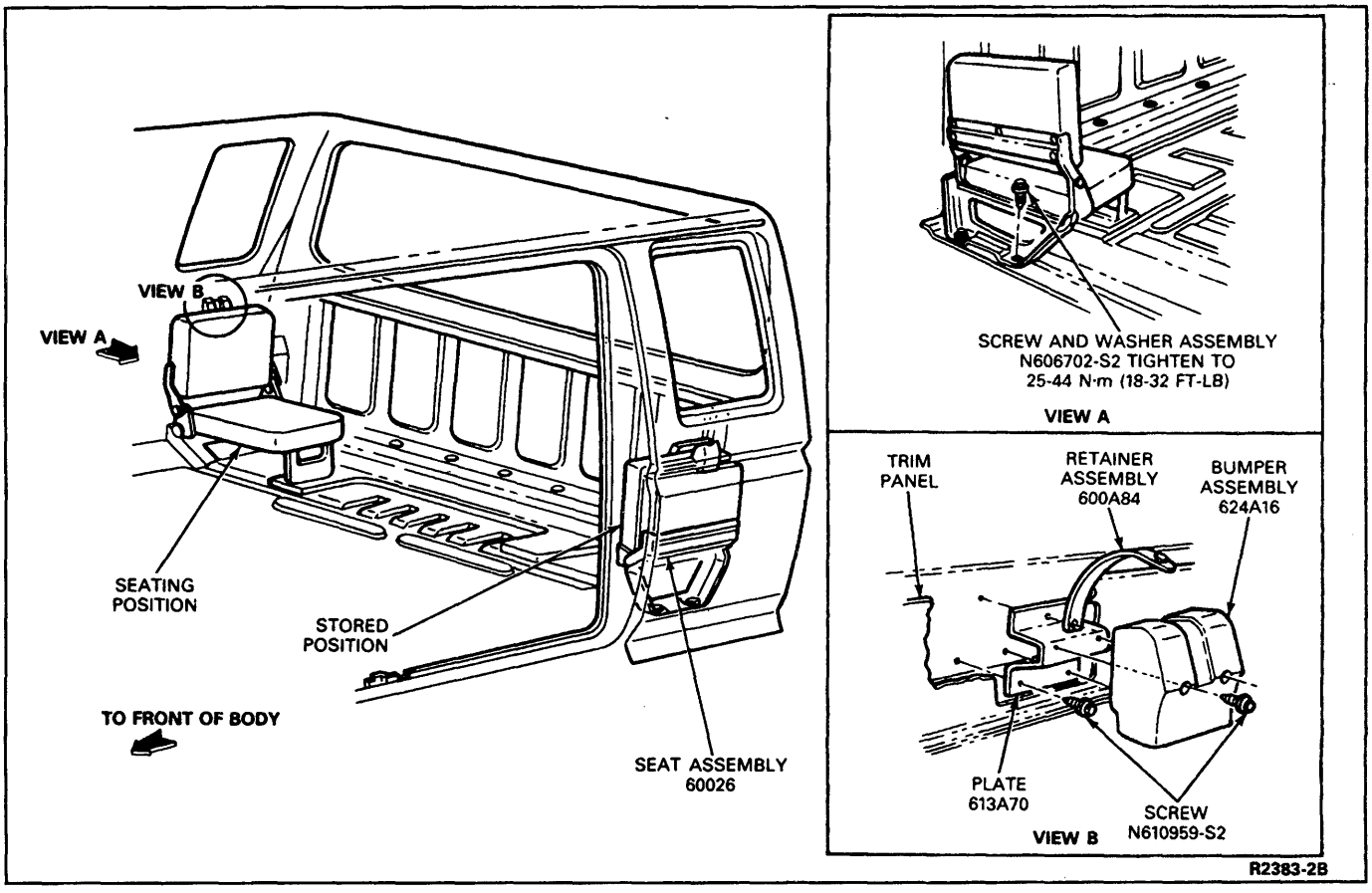


FIG. 1 Side-Mounted Folding Rear Seats—F-150—F-350 Super Cab

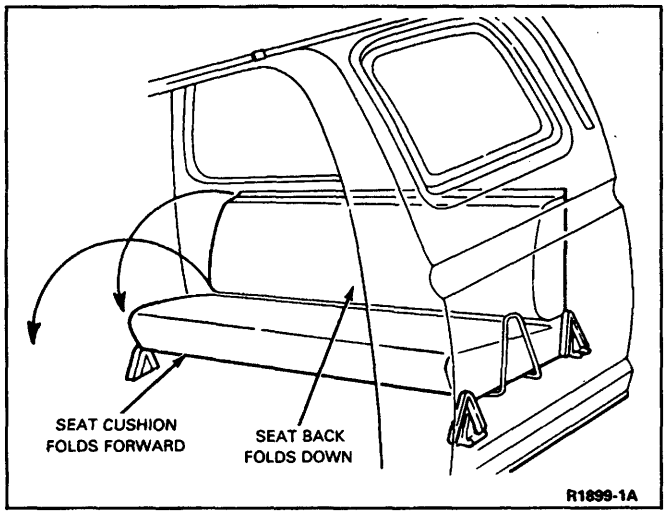


FIG. 2 Forward-Facing Folding Rear Seat—F-150—F-350 Super Cab

Installation

1. Slide rear deck into place on frame assembly (Fig. 6).
2. Secure with wing nut on each side.

Seat/Bed Assembly

Removal

1. Remove rear deck from assembly as outlined.
2. Remove the seat belts. Refer to Section 41-50, Seat and Shoulder Belts.
3. Remove four bolts attaching seat/bed to floor (Fig. 6).
4. Remove seat/bed assembly from vehicle through the rear door.

Installation

1. Position seat/bed assembly on floor.
2. Secure with attaching bolts. Tighten attaching bolts to 62-81 N·m (45-60 ft-lb).
3. Install the seat belts. Tighten the attaching bolts to 30-43 N·m (22-32 ft-lb).
4. Install rear deck as outlined.

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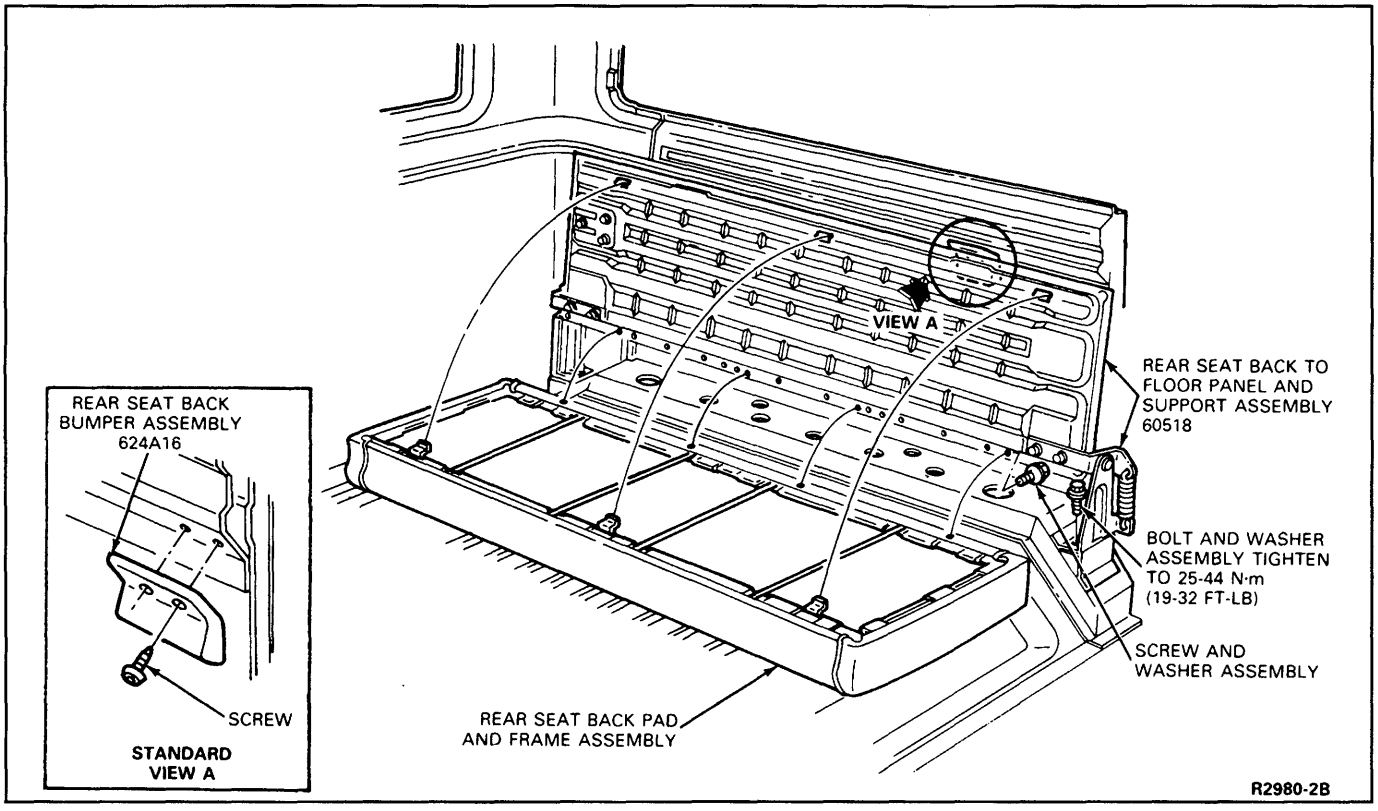


FIG. 3 Forward-Facing Rear Seat Back Installation—F-150—F-350 Super Cab

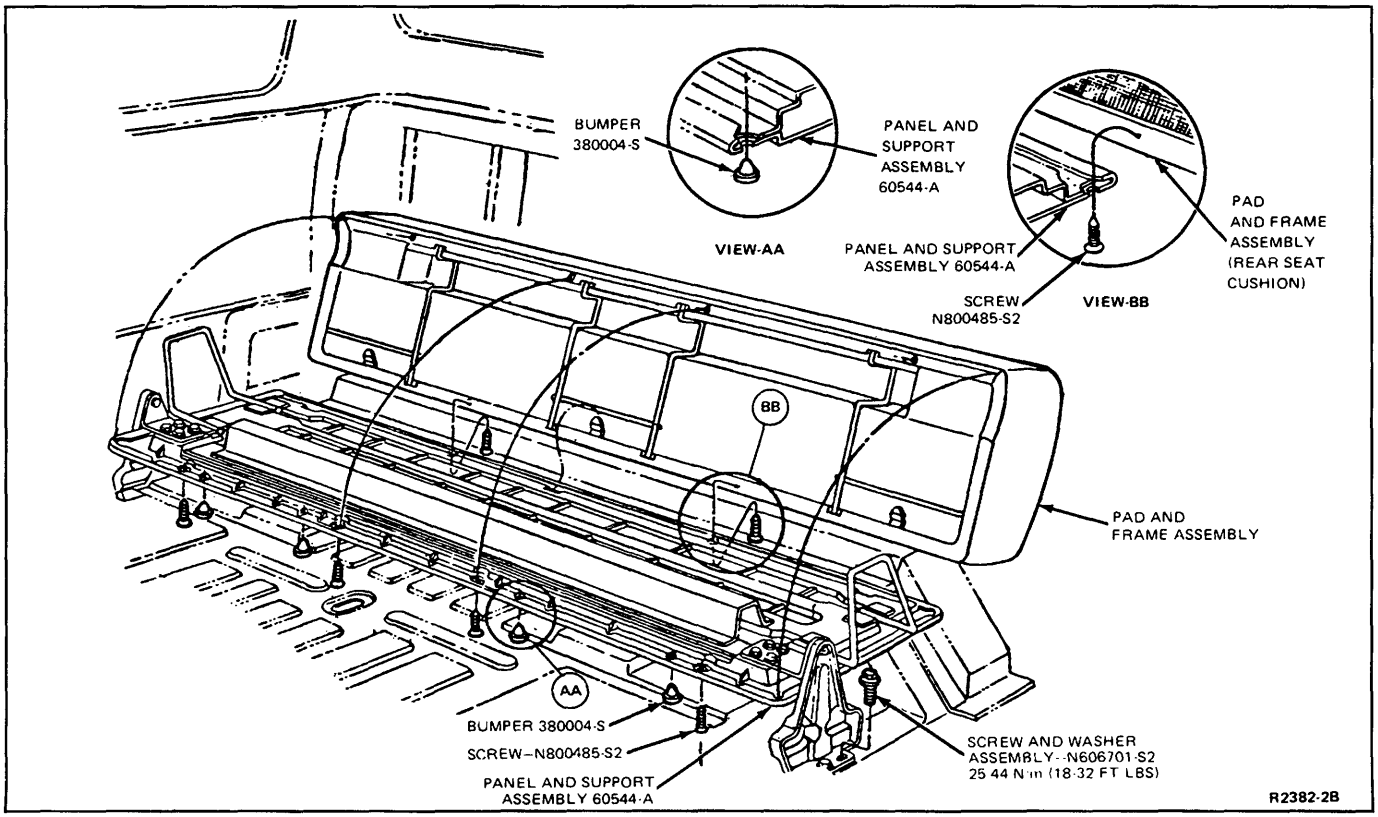


FIG. 4 Forward-Facing Rear Seat Cushion Installation—F-150—F-350 Super Cab

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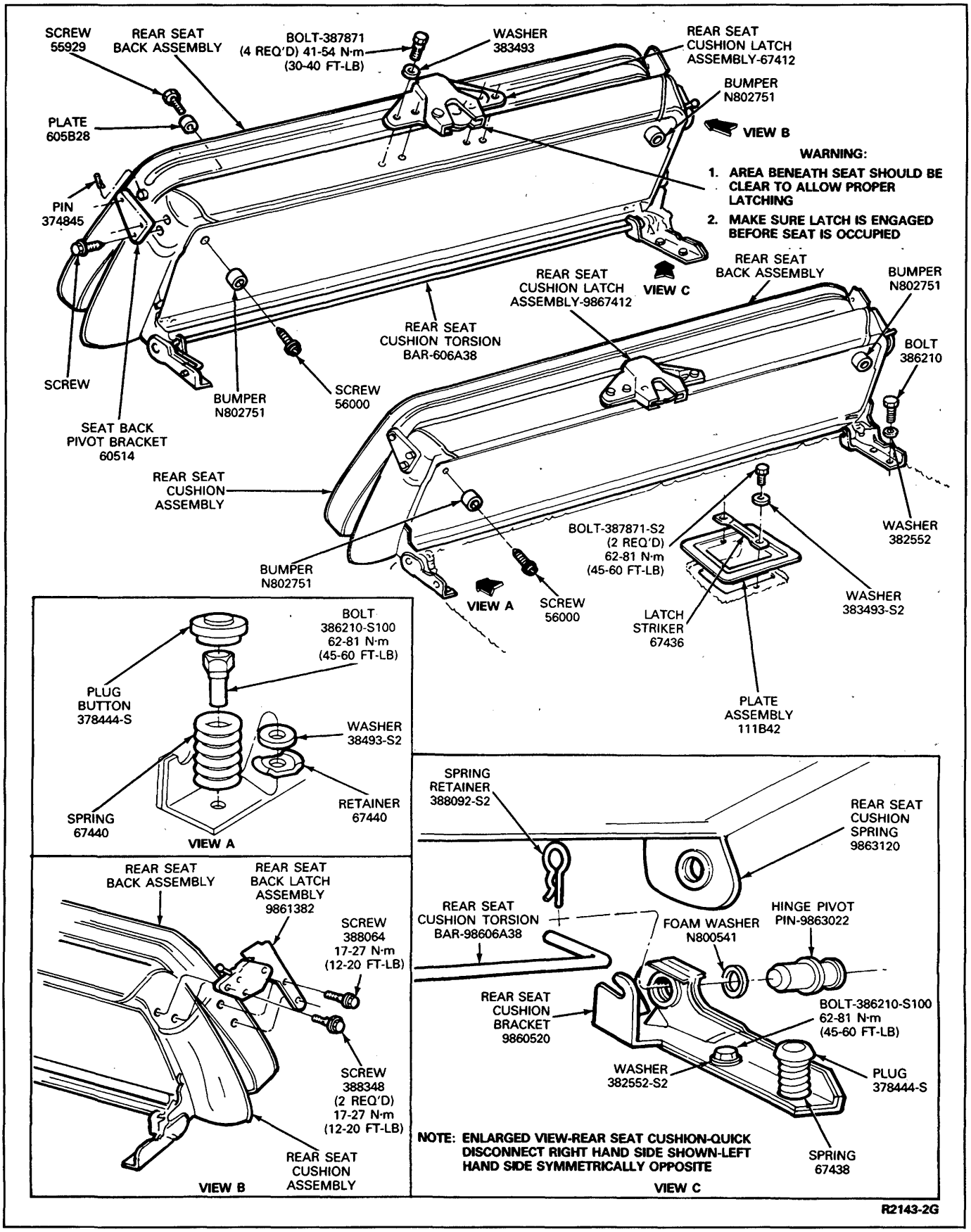


FIG. 5 Rear Fold Down Seat—Bronco

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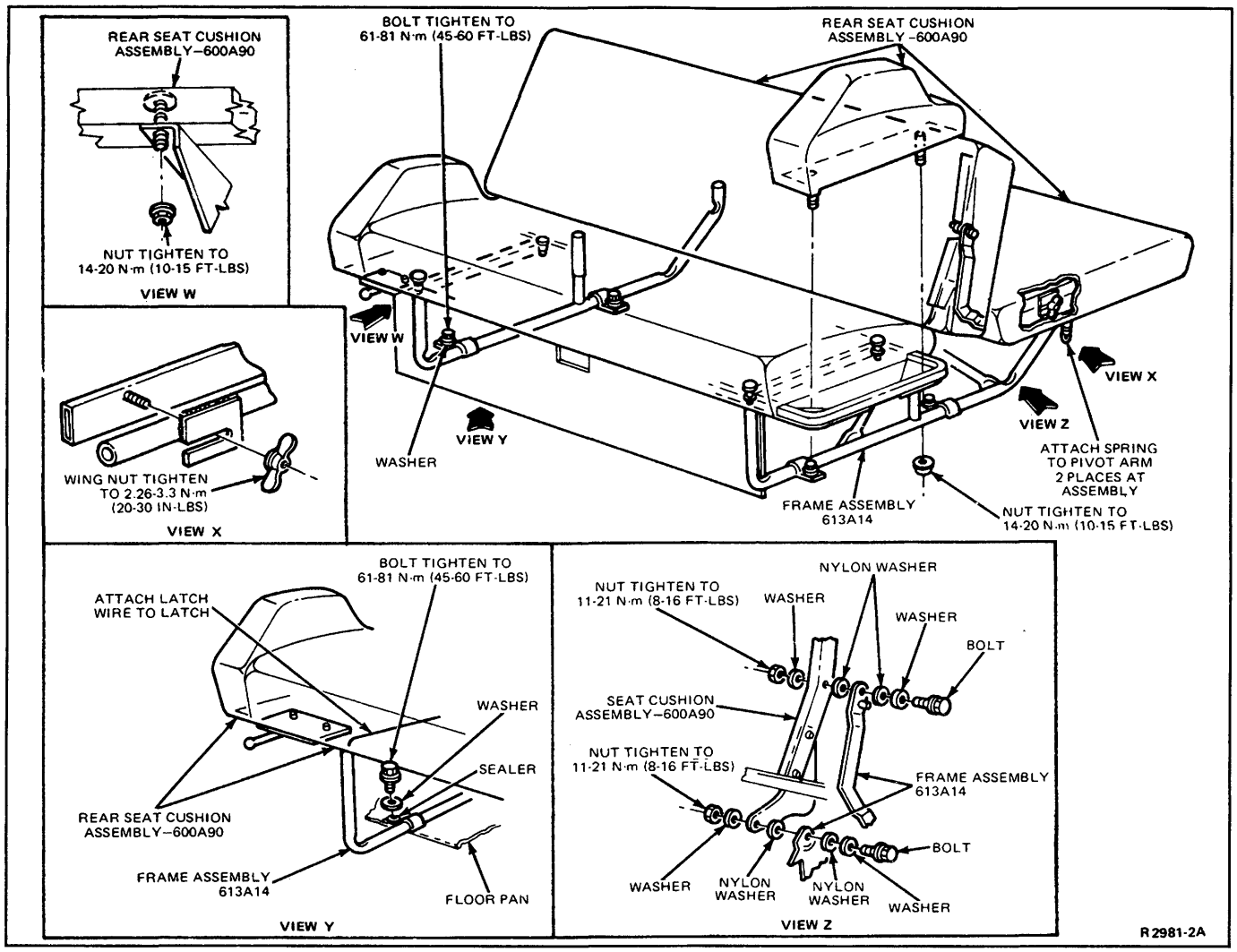


FIG. 6 Rear Seat/Bed—E-150—E-350

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SECTION 41-25 Seat Back Latch

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VEHICLE APPLICATION

Bronco And F-150 Through F-350.

DESCRIPTION AND OPERATION

All folding seats (except Bronco passenger seat on models with bucket seats) have a latch designed to hold the seat back in the normal position. The Bronco bucket seat back does not fold forward on the passenger side. For rear seat passenger entry and exit and to gain access to the storage compartment (F-150—F-350 Super Cab, F-350 Crew Cab and Bronco with full bench seat), a handle on the side of the seat back releases the seat latch.

If the seat back will not latch in position or the latch mechanism will not unlock, it may be necessary to remove the side shield and/or remove the seat back trim cover far enough to inspect the latch mechanism. Then, replace any parts to put the latch system in proper working order (Figs. 1, 2 and 3).

For information on the seat back latch used with forward-facing rear seat option (Super Cab only), refer to Section 41-20 Folding Rear Seats.

REMOVAL AND INSTALLATION

Bronco—Bucket Seat

Removal

Driver and Passenger

1. Remove seats from tracks or support assembly. Refer to Section 41-01, Front Seats.
2. Remove the seat back shield and/or trim cover as required to gain access to the following parts.

Driver's Side

1. Remove screw retaining handle assembly to pin (Fig. 1, View B). Remove pin, disengage spring from frame assembly.
2. To remove handle assembly, remove two screws that hold it to the frame assembly.
3. To remove striker, remove two screws retaining striker to seat (Fig. 1).

Passenger Side

1. To remove retainer, remove the attachment screw to the bracket and the nut and bolt attaching the retainer to the seat back frame (Fig. 1, View A).
2. To remove the bracket, remove the three screws that attach it to the seat cushion and retainer (Fig. 1).

Installation

Driver's Side

1. Install striker assembly to seat and tighten screws to 13-24 N·m (9-18 ft-lb).
2. Position handle and secure with two screws.
3. Position pawl and engage the spring. Insert pin through frame assembly and pawl (Fig. 1).
4. Install screw to handle and pin.

Passenger Side

1. Install bracket to seat cushion and tighten screws to 13-24 N·m (9-18 ft-lb).
2. Position retainer in seat back, insert bolt and attach nut. Tighten nut to 17-27 N·m (12-20 ft-lb).
3. Attach retainer to bracket by installing screw and tightening to 13-24 N·m (9-18 ft-lb).

Driver and Passenger

1. Install seat back trim cover and/or side shield. Refer to Section 41-60, Seat Trim.
2. Position and install seat to mounting tracks or support assembly. Refer to Section 41-01, Front Seats.

F-150—F-350 Bench Seat Latch

Removal

1. Remove attaching screws and trim shield from lower side of seat back (both sides) (Fig. 3).
2. Remove two bolts attaching latch to seat back.

Installation

1. Install two attaching bolts. Ensure that springs (one each side) rest against the bottom of the seat back and are hooked over the pawls on each end of the latch. Tighten upper bolt to 25-37 N·m (18-28 ft-lb) and the lower bolt to 25-34 N·m (18-32 ft-lb).
2. Install trim cover using cover attaching screw (Fig. 3).

Bronco and F-150—F-350 Super Cab Bench Seat Latch

Removal

1. Remove bolt and washer attaching seat back to cushion and remove back from vehicle (Fig. 2).

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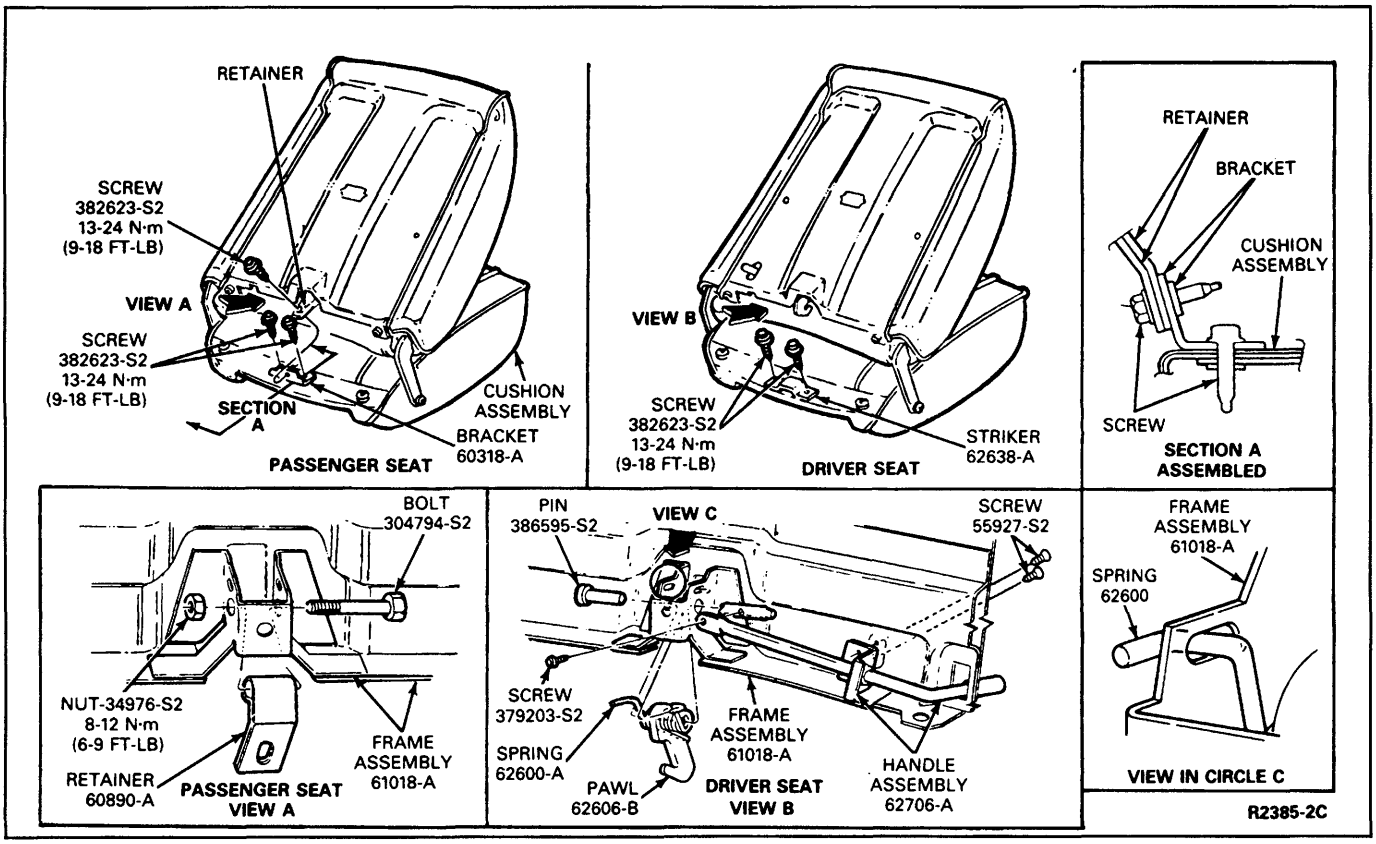


FIG. 1 Bucket Seat Back Latch Installation—Bronco

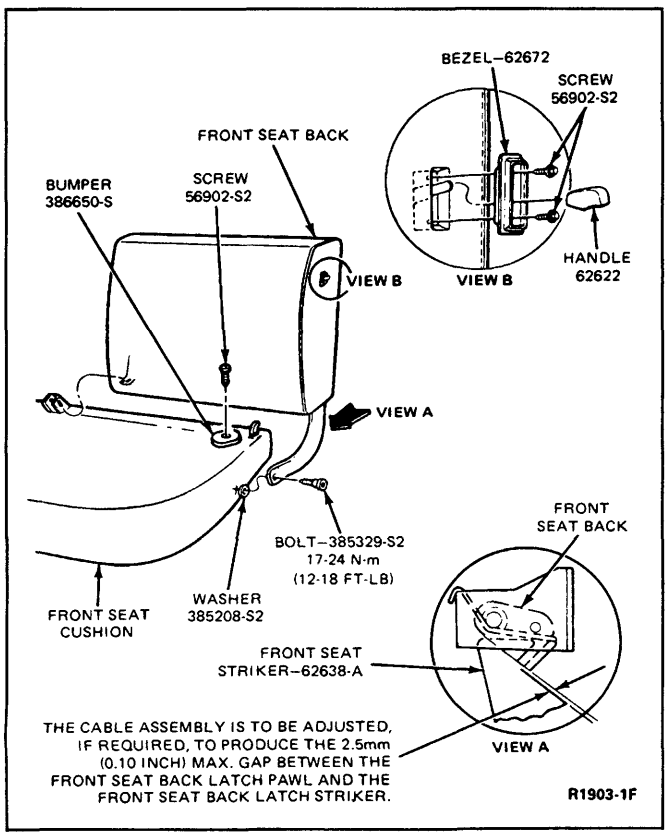


FIG. 2 Front Seat Back Latch Installation—Bronco and F-150—F-350 Super Cab Models

2. Untrim back to gain access to latch mechanism. Refer to Section 41-60, Seat Trim.
3. To remove the rod assembly connecting the unlatching lever to the latch pawl, remove two screws and bundling strap. Unhook rod from lever and pawl.
4. To remove the latch pawl, disconnect the rod from the pawl. Cut and remove the pawl pivot pin and disconnect spring from seat back frame.

Installation

1. To install latch pawl, insert a new pivot pin through holes in seat back and pawl. Flatten end of pin to retain it in the seat frame and hook end of spring onto seat frame. Insert end of latch rod through hole in pawl.
2. To install the latch rod, push attachment screws through holes in attaching tabs on rod and install to seat frame. Insert ends of rod into proper holes in the lever and pawl.
3. Install untrimmed seat back frame to cushion and adjust gap between pawl and striker by rotating center portion of the rod assembly. The gap between the pawl and striker must be 1.27-1.77mm (0.05-0.07 inch). Remove seat frame from cushion and retrim.
4. Install trimmed seat back to cushion by inserting attaching bolt through hole at end of the arm sticking out of the trimmed back. Slide washer over the end of the bolt, slide back onto inboard pivot pin and drive attachment bolt. Tighten bolt to 25-43 N·m (18-32 ft-lb). Check gap and adjust if necessary.

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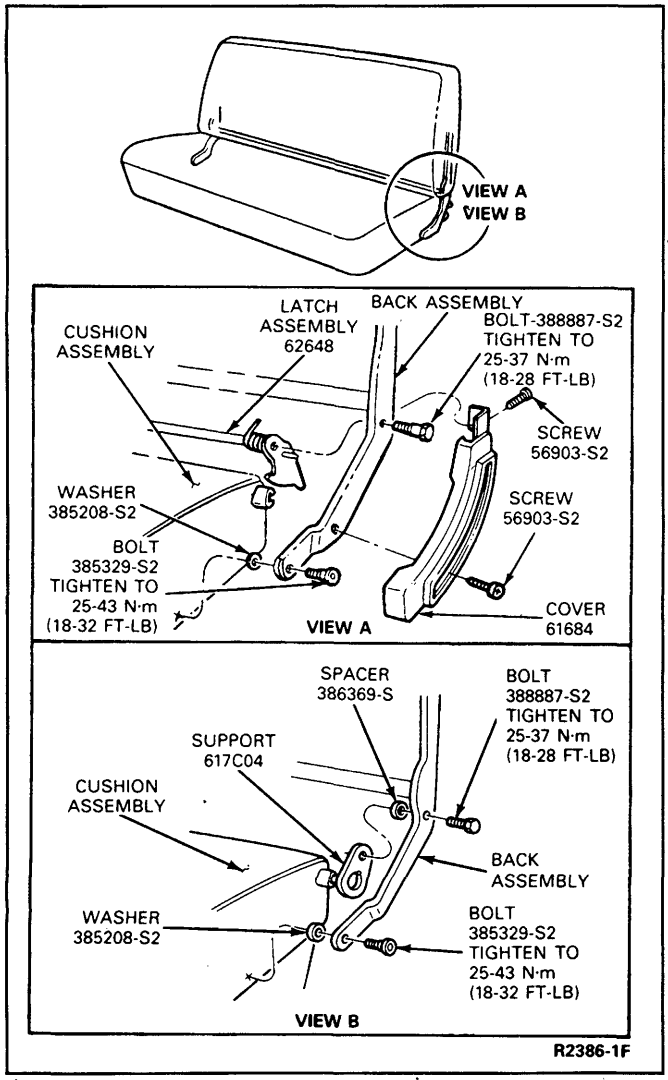


FIG. 3 Front Seat Back Latch Installation—F-150—F-350 Conventional Cab Bench Seat

Striker

Removal

1. Dump seat back forward.
2. Untrim rear corner of seat cushion.
3. Remove two attaching bolts and striker from seat cushion (Fig. 1).

Installation

1. Install two attaching bolts and tighten to 17-27 N·m (12-20 ft-lb).
2. Retrim rear corner of seat cushion.
3. Adjust gap between pawl and striker by reaching up inside trimmed back and rotating latch rod adjustment until gap is 1.27-1.77mm (0.05-0.07 inch).

F-350 Crew Cab Rear Seat Latch

Removal

1. Remove two bolts attaching latch to seat back (Fig. 4).

Installation

1. Install two attaching bolts. Ensure that springs (one each side) rest against the bottom of the seat back and are hooked over the pawls on each end of the latch. Tighten bolts to 25-43 N·m (18-32 ft-lb).

CLEANING/MAINTENANCE

The inertia latch assemblies are factory-installed in their proper locations, and maintenance is not required. Proper function of the latch in emergency situations requires that the seat back be in its full rearward, normal position and against the rearward stops in the latch assembly. Therefore, the area behind the seat must be kept clear at all times to allow full rearward travel of the seat back.

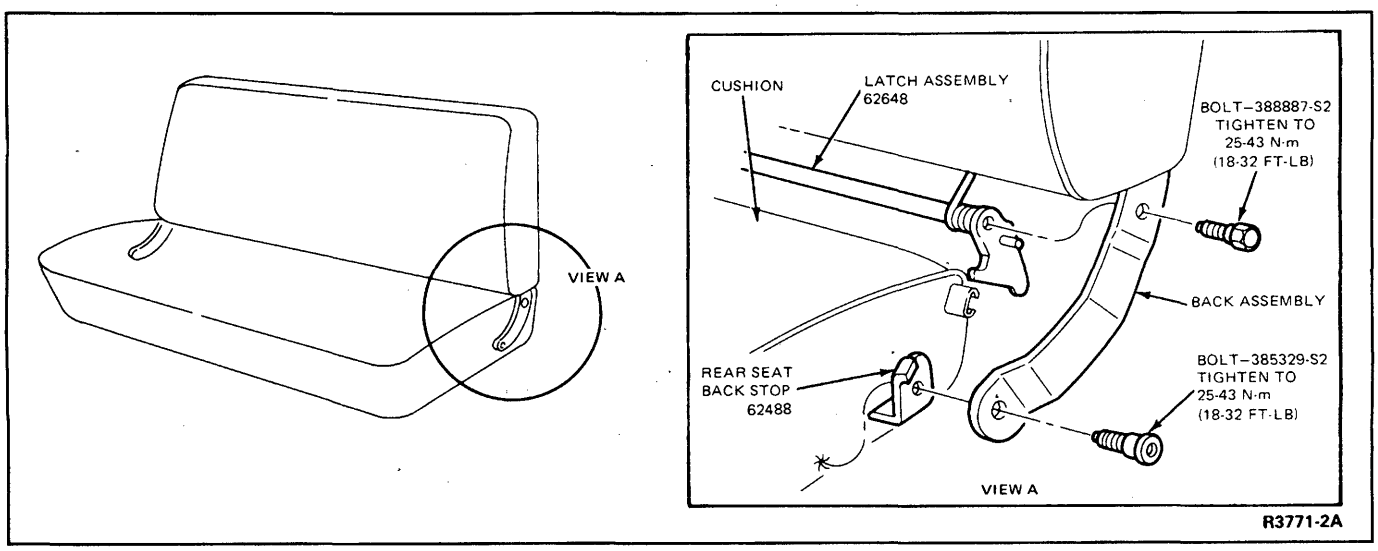


FIG. 4 Rear Seat Back Latch Installation—F-350 Crew Cab

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SECTION 41-50 Seat and Shoulder Belts

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VEHICLE APPLICATION

All Models.

DESCRIPTION AND OPERATION

The seat belts and shoulder belts are factory-installed in their proper locations. If the seat belts or shoulder belts are removed for any reason, they should be installed as shown in Figs. 1 through 10. Sealer should be placed around all seat belt anchor bolt holes in the floorpan. Tighten the anchor bolts to 30-43 N·m (22-32 ft-lb).

Belt assemblies must be installed in matched sets as received and **must not be interchanged between vehicle models.**

If a component portion (buckle portion, retractor portion, etc.) of a seat belt or shoulder belt assembly is nonfunctional or damaged, the entire assembly (buckle, tongue and shoulder harness portions) must be replaced. The replacement assembly must be installed as a matched set and the identification labels on all portions must bear exactly the same code, date of manufacture and manufacturer's name. **Under no circumstances are seat belt or shoulder belt components to be replaced as individual components.**

Seat Belt Extension Assembly

A seat belt assembly that is too short when fully extended over the lap of a stocky vehicle occupant, can be lengthened approximately 203mm (8 inches) with a seat belt extension assembly which can be obtained through local Ford Dealers. The seat belt extension assembly is only available with black webbing and standard buckle and must be of the same manufacture as the belt system to which it is attached.

Occupant Restraint System

The continuous loop system can be identified by the movable tongue on the front outboard lap/shoulder belt and only one retractor. (This is a combination lap/shoulder belt retractor.)

Seat Belt Warning System

Continuous loop system units incorporate a buzzer and lamp warning system. The seat belt warning lamp will illuminate for approximately eight seconds after the ignition switch is turned to the RUN position, regardless of seat belt usage. The seat belt warning buzzer is grounded by a switch in the LH inboard buckle, on the continuous loop and the dual spool systems. The seat belt warning buzzer will sound for approximately eight seconds unless the driver's belt is used.

Continuous Loop System Description

The occupant restraint system for front outboard passengers is a continuous loop system (Figs. 1 through 5). The outboard combination lap and shoulder belt use a common sliding tongue. To secure the belts, the tongue is inserted into the inboard buckle.

On F-150—F-350, Bronco, the webbing for the lap belt is anchored near the inboard side of the sill **without a retractor.** On E-150—E-350, it is attached to the seat pedestal.

The shoulder harness retractor is designed to let the webbing freely move in or out at all times, except during vehicle maximum deceleration, when it is automatically locked by a mechanically actuated inertia sensor.

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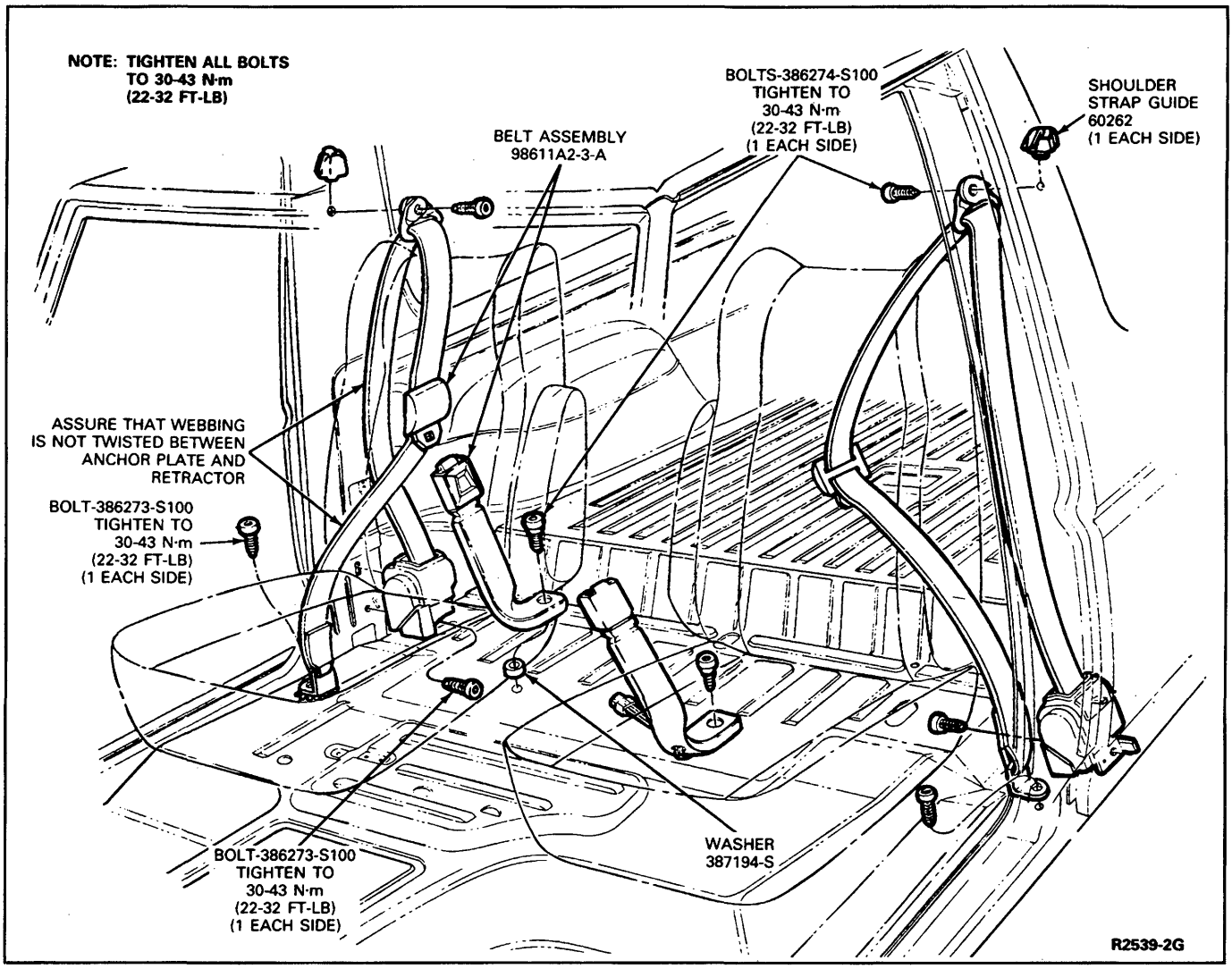


FIG. 1 Seat Belt Installation—Bronco Front Bucket Seat

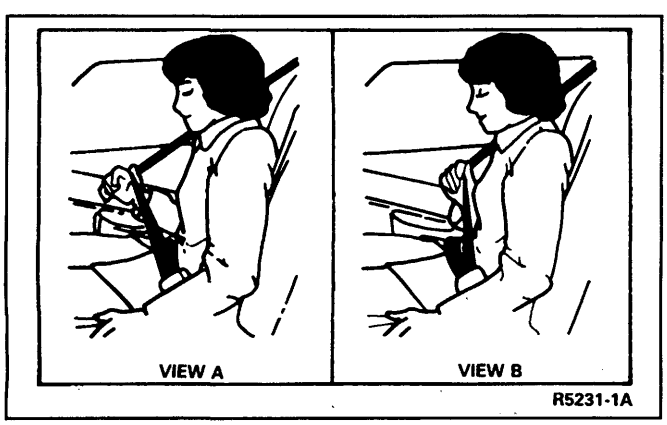


FIG. 2 Seat Belt Adjustment

On bench seat installations, the inboard belt with the buckle passes through the seat before being anchored to the floor, and directly to a fixed anchorage on the floor on bucket seat installations (except E-150—E-350). Attaching the tongue and buckle secures the occupant with both lower and upper restraints. This tongue and buckle attachment can be accomplished by a single continuous movement.

After entering the vehicle, adjust the front seat to obtain the best position for driving comfort and visibility. Then, use the following procedure for fastening belts:

Pull up on the shoulder portion of the belt to tighten the lap portion to a snug fit. Be sure the belt is as low on your hips as possible. If the shoulder belt is uncomfortably tight, a comfort regulator is provided in the shoulder belt retractor to reduce belt pressure against your chest. The shoulder belt can be adjusted much like a window shade to maintain a small amount of slack in the belt. The adjacent door must be closed to use this comfort regulator feature.

Adjustment Procedure

To set the comfort regulator, the shoulder belt initially should be positioned snug against the chest. If the belt is not snug, the comfort regulator may already be engaged. Disengagement is accomplished by the following procedure:

1. Pull the shoulder belt outward 10-13 cm (4-5 inches), then release it and allow belt to fully retract. Repeat procedure if belt is not snug to the chest (Fig. 2, View A).
2. Now the belt tension may be adjusted by pulling down slightly on the shoulder belt and releasing.

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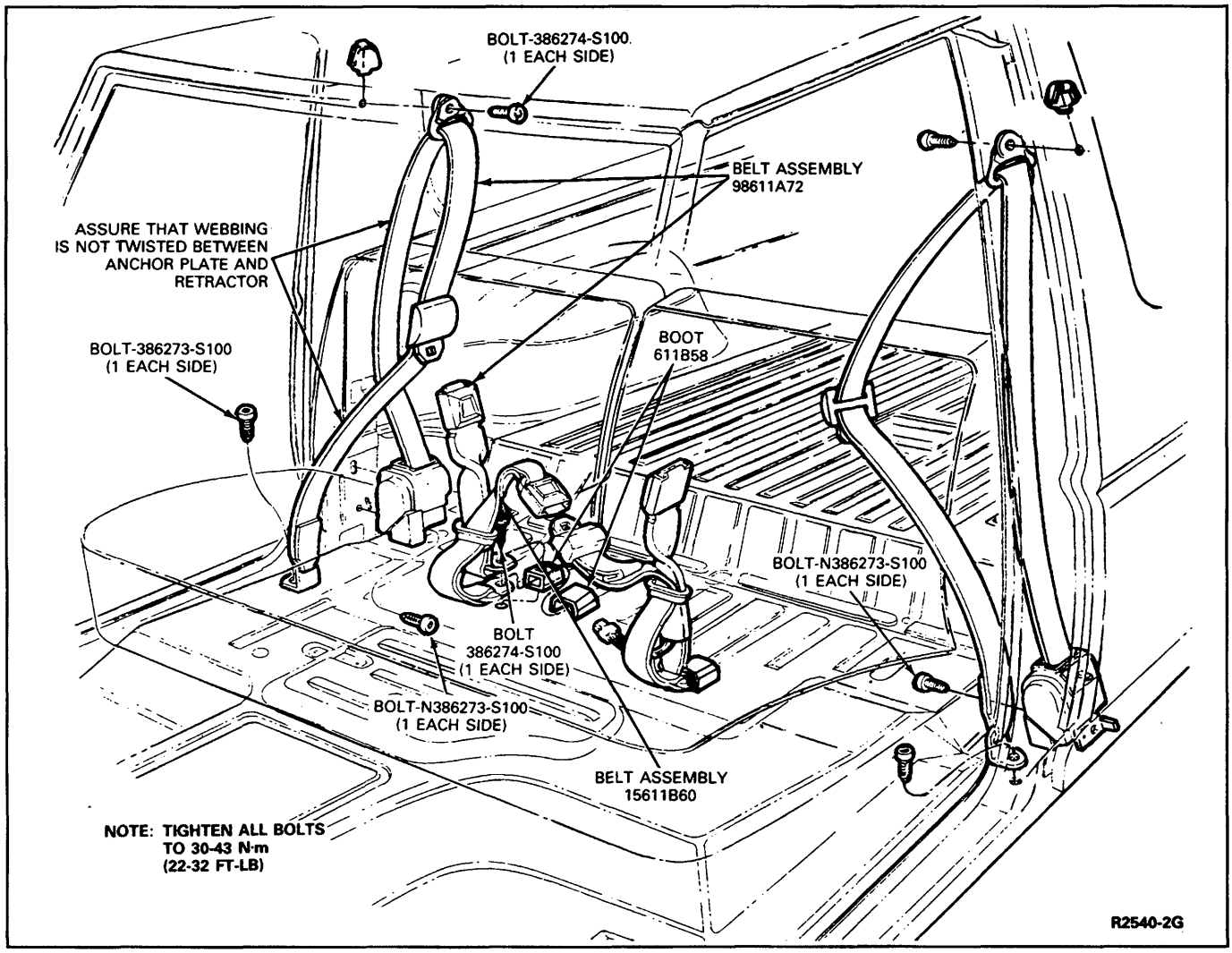


FIG. 3 Seat Belt Installation—Bronco Front Bench Seat

The least amount of slack needed to relieve tension, but not more than 3.8 cm (1-1/2 inch) should be pulled out when using the comfort regulator system (Fig. 2, View B).

If the desired setting is not achieved or excess slack develops as you change seat position, repeat the above procedure.

When the door is opened, the comfort regulator releases automatically, permitting the lap-shoulder belt to retract. After unbuckling the belt it is recommended that you guide the tongue during retraction to prevent it from striking you or the vehicle.

Two-Point Lap Belt Operation—Non-Retractor

(All E-150—E-350 Rear Seats Except Captain's Chairs and Second Row Bench With Retractors)

To lengthen the belt, tip the tongue at a right angle to the belt, and pull the tongue until the ends can be joined over the lap.

To fasten the belt, insert the tongue into the open end of the buckle until a snap is heard. To shorten the belt, pull on the loose end of the webbing. **The belt should be snug across the hips, NEVER ACROSS THE WAIST.**

Two-Point Lap Operation—Retractor

(F-150—F-350 Super Cab and Bronco Rear Seats and E-150—E-350 Second Row Captain's Chairs and Second Row Bench with Retractors)

The webbing for the lap belt extends from a retractor that automatically locks when the belt is worn (Figs. 8, 9 and 10). This lock prevents the belt from being pulled out further but allows the belt to retract and thus maintains a snug fit around the user for optimum safety.

Center Lap Belts

The center seat belts do not have retractors (Figs. 3, 4 and 5). To lengthen the belt, tip the tongue at a right angle to the belt, and pull the tongue until the ends can be joined over the lap.

To fasten the belt, insert the tongue into the open end of the buckle until a snap is heard. To shorten the belt, pull on the loose end of the webbing. **The belt should be snug across the hips, NEVER ACROSS THE WAIST.**

Unfastening Seat Belts

Push the release button in the buckle and allow the front and rear outboard belts to retract to the fully stowed position.

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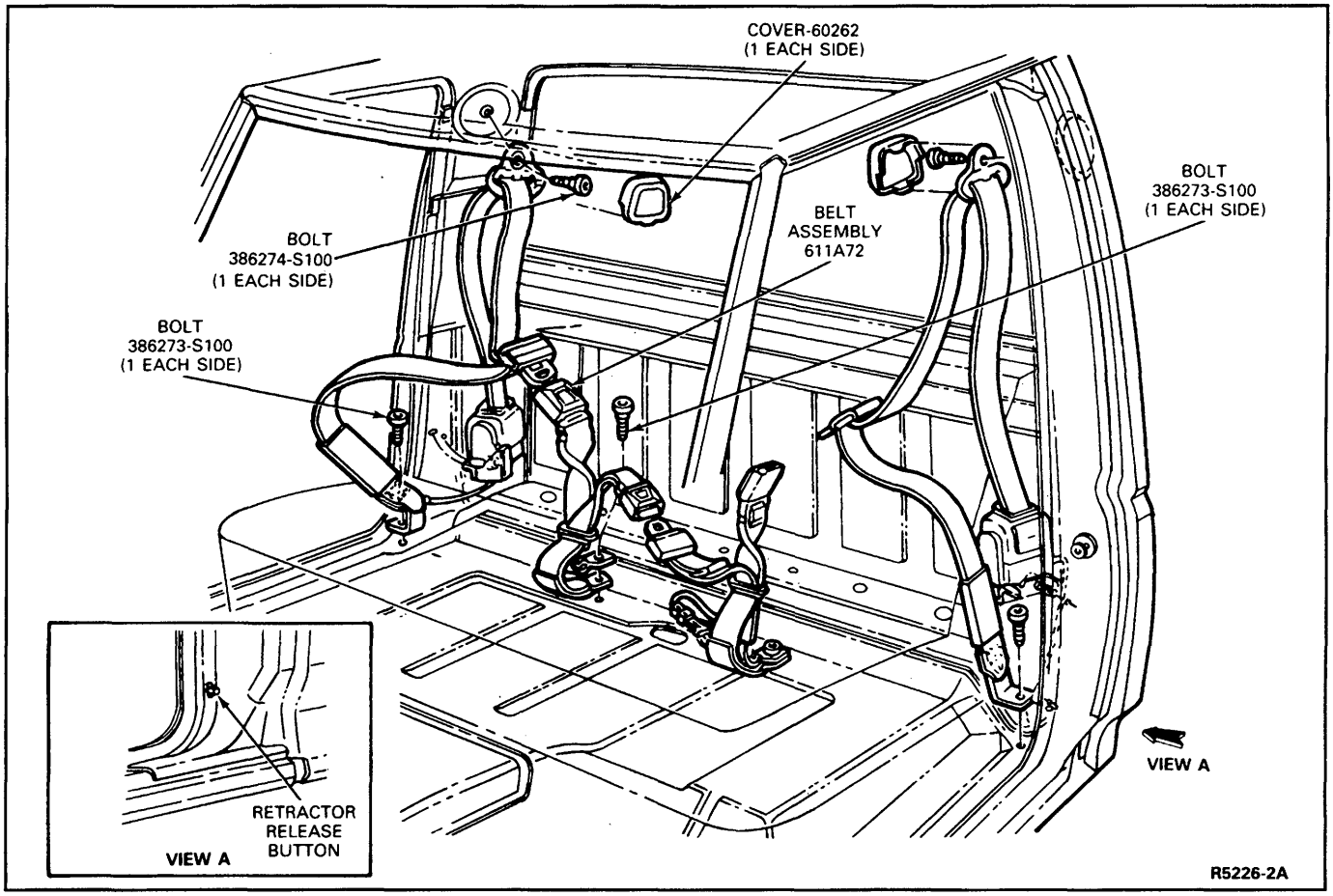


FIG. 4 Front Seat Belt Installation—F-150—F-350 Regular Cab Shown, F-350 Crew Cab Similar

ADJUSTMENTS

Rear Belts

(Super Cab, Crew Cab and Bronco E-150—E-350 Captain's Chair, Second Row Bench Except 12-15-Passenger)

To fasten the rear belts, pull the belt out of the retractor with a steady motion and insert it into the buckle until a snap is heard and a latch is felt (Figs. 5 and 7.) **Adjust the lap belt snugly across the hips, NEVER ACROSS THE WAIST, by allowing the slack to return to the retractor.**

Seat Belt Maintenance

Seat belt assemblies are maintenance-free; however, they should be periodically inspected to ensure that they have not become damaged and that they remain in proper operating condition.

Jammed Lap Belt Retractor Two-Point Systems

If the lap belt retractor is jammed by allowing the belt to retract while twisted, webbing can be freed with this procedure:

1. Use both hands to tighten the webbing on the spool by pulling on the belt.
2. Push the webbing into the retractor until the belt is completely retracted. Repeat Step 1 if necessary.
3. Pull the belt out of the retractor as far as it will go and inspect the webbing for foreign material or twisting. Remove the foreign matter or untwist the belt and let the webbing retract.
4. Sit in the seat, pull out the lap belt, and buckle up. Do this about five times to ensure the belt retractor operates properly.

TESTING

Webbing Cannot be Pulled from Lap Belt Retractor

1. From the fully stowed position, pull webbing out of the lap belt retractor.
2. If OK, withdraw lap belt webbing and buckle up while sitting in seat. Repeat five times to ensure proper operation. If not OK, replace the seat belt assembly.

Lap Belt Retractor Does Not Lock

1. Withdraw a minimum of 457.2mm (18 inches) of webbing from lap belt retractor and check for lock-up. (Retractor must lock up after 457.2mm (18 inches) of webbing withdrawal.) Return 50.8mm (2 inches) into retractor and pull out.
2. If not OK, replace the seat belt assembly. Withdraw lap belt webbing and buckle up while sitting in seat. Repeat five times, to ensure proper operation. If not OK, replace the seat belt assembly.

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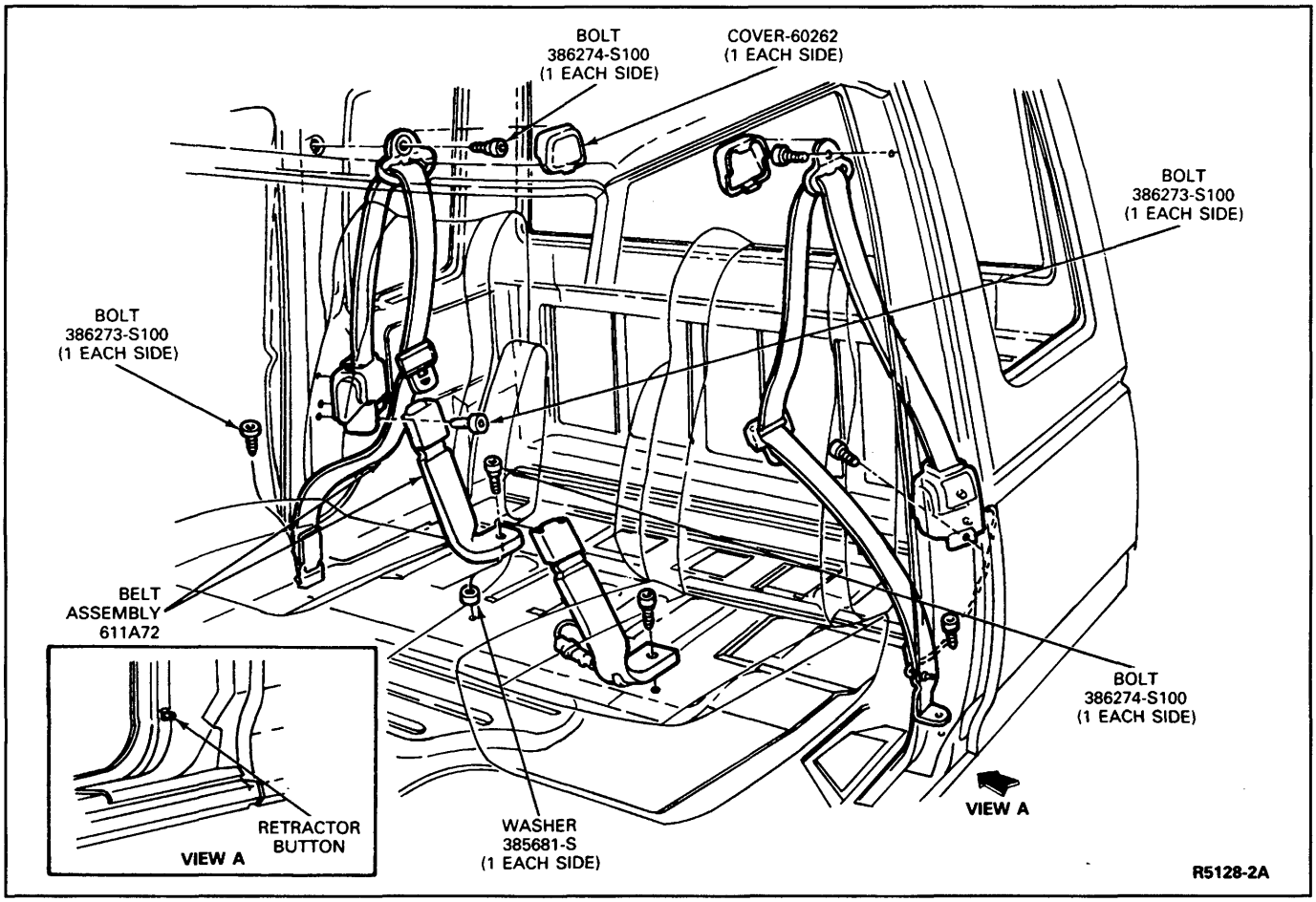


FIG. 5 Front Seat Belt Installation—F-Series Super Cab With Captain's Chair

REMOVAL AND INSTALLATION

Seat Belts

Removal and Installation

Use Seat Belt Bolt Bit T77L-2100-A or equivalent to remove or install all seat belt assembly anchor bolts. Upon installation, tighten the anchor bolts to 30-43 N·m (22-32 ft-lb).

Bronco—Front Bucket Seats

Removal and Installation

Remove the shoulder belt retractor cover. Remove the shoulder belt retractor anchor bolt and the floor anchor bolt. Remove affected seat belt assembly from the vehicle (Fig. 1).

The buckle end of the front seat belt can be removed by removing the seat belt anchor bolt from the floor. Driver's buckle contains an electrical switch, which must be disconnected before removing the anchor bolt.

On rear seat positions, remove any affected seat belt assemblies by removing the seat belt anchor bolts from the seat frame (Fig. 6).

Reverse the above procedure for installing the replacement seat belt assemblies in the vehicle as shown in Fig. 1. Check for sealer around each removed floor anchor bolt holes. Add Ford Caulking Cord D6AZ-19560-A or equivalent sealer, if necessary.

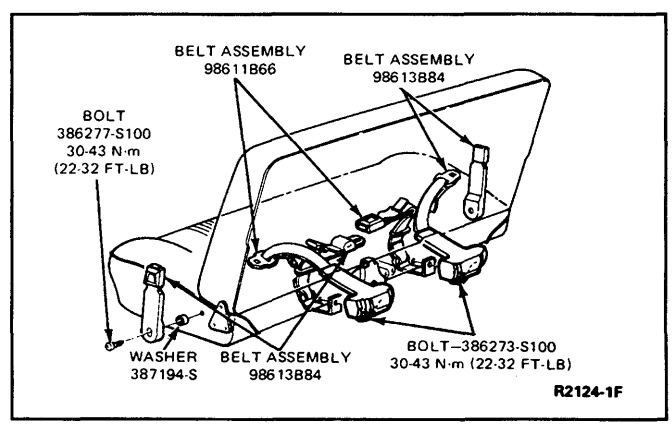


FIG. 6 Seat Belt Installation—Bronco Rear Seat

Bronco-Front Bench Seat (Fig. 3)

Removal and Installation

Remove the shoulder belt retractor cover and lift from floor anchor. Remove the shoulder belt retractor anchor bolt and the floor anchor bolt. Remove affected seat belt assembly from the vehicle (Fig. 3).

Remove the buckle end of the front bench seat belt by removing the anchor bolt at the floor. The driver's side buckle contains an electrical connector which must be disconnected before removing the anchor bolt.

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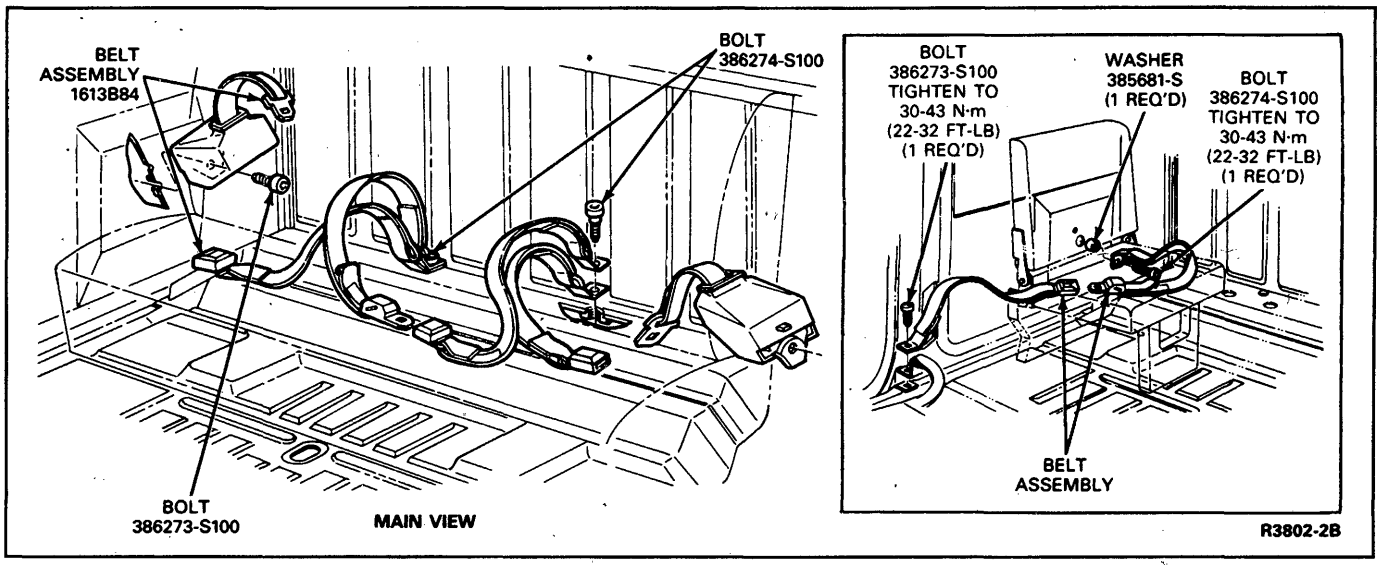


FIG. 7 Rear Seat Belt Installation—F-Series Super Cab

Install by connecting the electrical connector (driver's side only) and securing with the anchor bolt. Install cover.

Reverse the above procedure for installing the replacement seat belt assemblies in the vehicle as shown in Fig. 3. Check for sealer around each removed floor anchor bolt hole. Add Ford Caulking Cord D6AZ-19560-A or equivalent sealer, if necessary.

F-150—F-350 Regular Cab

Removal and Installation

On front seat outboard positions only: Remove the shoulder belt retractor cover. Remove the shoulder belt retractor anchor bolt and the lap belt bolt. Remove affected seat belt assembly from the vehicle.

The buckle end of the front seat belt and the center seating position belts can be removed by removing the seat belt anchor bolt from the floor. Driver's buckle contains an electrical switch. Disconnect switch before removing the anchor bolt.

Reverse the above procedure for installing the replacement seat belt assemblies in the vehicle as shown in Fig. 5. Check for sealer around each removed floor anchor bolt holes. Add Ford Caulking Cord D6AZ-19560-A or equivalent sealer, if necessary.

E-150—E-350 and F-350 Crew Cab—(Figs. 4 and 8)

Removal and Installation

Remove any affected seat belt assemblies by removing the seat belt anchor bolts from under or on the outboard side of the seat. NOTE: Remove the seat assembly for access to the LH seat belt outboard attaching bolt.

Fourth Seat and Seat/Bed—Remove any affected seat belt assemblies by removing the seat belt attaching bolts from the rear floor.

Note location of steel and rubber washers so they can be correctly replaced.

Reverse the above procedure for installing the replacement seat belt assemblies in the vehicle, and position as shown in Figs. 4 and 8. Check for sealer around each removed floor anchor bolt holes. Add Ford Caulking Cord D6AZ-19560-A or equivalent sealer, if necessary.

F-150—F-350 Super Cab

Removal and Installation

(Refer to Fig. 7)

On front seat outboard positions only: Lift the cover from the D-ring attachment and remove the rear seat area trim panel from over the shoulder belt retractor. Remove the shoulder belt retractor anchor bolt, the D-ring attaching bolt. Remove the affected seat belt assembly from the vehicle.

The buckle end of the front seat belt can be removed by lifting the cover and removing the seat belt anchor bolt. Driver's buckle contains an electrical switch. Disconnect before removing the anchor bolt.

Rear seat and front center seating positions: Remove any affected seat belt assemblies by removing the seat belt anchor bolts from the rear floor.

Reverse the above procedure for installing the replacement seat belt assemblies in the vehicle as shown in Figs. 5 and 7. Check for sealer around each removed floor anchor bolt holes and add Ford Caulking Cord D6AZ-19560-A or equivalent sealer, if necessary.

MAJOR REPAIR OPERATIONS

Seat and Shoulder Belts

The seat belts and shoulder belts are factory-installed in their proper locations. If the belts are removed for any reason, they should be installed as shown in Figs. 1 through 10. Apply Ford Caulking Cord D6AZ-19560-A or equivalent sealer around all seat belt anchor bolt holes in the floorpan. Tighten the anchor bolts to 30-43 N·m (22-32 ft-lb).

Seat Belt with No Anchor Plate Thread Damage

1. Remove the damaged bolt for the anchor reinforcement and discard.
2. Install a new bolt with the same part number as indicated under Specifications. Tighten to 30-43 N·m (22-32 ft-lb).

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Seat and Shoulder Harness Belt with Damaged Anchor Plate Threads

1. Remove the broken or stripped bolt and discard.
2. Drill out the internal threads in the seat belt anchor plate with a 27/64-inch drill.
3. Re-thread the anchor plate with a 1/2-13 tap (seat belt).
4. Blow out the chips.
5. Install the attachment parts in the sequence shown. Refer to applicable illustration (Figs. 1 through 10). Tighten the replacement bolt to 30-43 N·m (22-32 ft-lb). Original parts are to be replaced with the repair parts indicated in the seat belt parts replacement guides. Refer to Specifications. Unless specified in the guides, use original parts.
6. When repairing a multiple belt and attachment, install nut 382599-S100 to the bolt in the tunnel area from the underside of the floorpan. Tighten to 30-43 N·m (22-32 ft-lb).

Seat Belt Procedure After an Accident

All seat belt assemblies must be replaced after a collision, provided either:

1. The seat belt was in use at the time of the accident, or
2. The seat belt was damaged by the accident (bent retractor, torn webbing, etc.), or
3. The seat belt attaching area(s) was damaged by the accident.

Before installing the new seat belt assembly, the seat belt attaching areas must be inspected for damage and distortion. If the attaching points are damaged and distorted, the sheet metal must be reworked back to its original shape and structural integrity.

Install the new seat belt(s). Then perform Functional Test Procedure as outlined.

Damaged Anchor Plate Threads Functional Test Procedure

Determine the type(s) of seat belt assembly(s) that have been replaced. Then, functionally test the new seat belt assembly using the appropriate procedure.

Lap Belt Retractor Test—(Two-Point System)

Grasp the new seat belt tongue and pull the webbing out of the retractor until the manufacturer's label is exposed. Return approximately 127mm (5 inches) of webbing into the retractor and pull. If the retractor locks, the belt assembly is functioning properly. If the retractor does not lock or the webbing cannot be pulled from the retractor far enough to expose the manufacturer's identification label, rework the sheet metal surface in the seat belt retractor attaching area until the retractor will function properly.

NOTE: If the retractor of a new seat belt assembly has been bolted into a damaged or distorted mounting area, the new retractor could be warped and may not function. If this is the case, reshape the sheet metal and install another new complete seat belt assembly.

Continuous Loop Shoulder/Lap Belt Test—(System with Movable Tongue and One Retractor)

1. Driver will buckle up and proceed to a safe test area. If the RH passenger seat belt must be tested, a passenger should be buckled into the RH seat. (The passenger belt may be tested utilizing a driver only, providing the driver has the ability to grasp the RH shoulder belt and extend it approximately 660.4mm (26 inches) with no compromise to safe driving.) This method applies to the 8.05 km/h (5 mph) test only.

   NOTE: The RH shoulder belt is not extended fully to preclude the possibility of a false feeling (full extension vs. lock-up).
2. After reaching a safe area to perform sudden stops, the driver will attain a speed of approximately 8 km/h (5 mph). The driver should inform the passenger, if applicable, that he is preparing to make a severe brake application. At this time, both driver and rider should grasp their respective shoulder harness and prepare to lean slightly forward at the moment the brake application is made.
3. The driver will make a maximum brake application (approximately 9.7m/sec^2 (32 ft/sec)^2) without tire skid. (The maximum brake application should be on dry concrete or equivalent hard road surface. Never on a wet or gravel road.) The driver and passenger should lean forward slightly into the shoulder harness. At this instant, the belts should lock up without webbing payout.

   WARNING: THE DRIVER AND PASSENGER SHOULD BE PREPARED TO BRACE THEMSELVES IN THE EVENT THE SEAT BELT RETRACTOR DOES NOT LOCK.
4. If there is a lock-up of both shoulder straps, the seat belt assemblies are functioning properly. Should either or both retractors fail to lock up at the 8.05 km/h (5 mph) speed, the test should be repeated at a constant 24.14 km/h (15 mph). (This test must be performed with a RH passenger if the RH belt is to be tested.)
5. If either or both shoulder belts do not lock up at the 24.14 km/h (15 mph) test, the vehicle is to be returned for repair of the malfunctioning seat belts. Remove the retractor and rework the sheet metal in the retractor's mounting surface. Install the retractor assembly and test the seat belt assembly(s) as previously stated.

   WARNING: IF THE RETRACTOR OF A NEW SEAT BELT ASSEMBLY HAS BEEN BOLTED INTO A DAMAGED OR DISTORTED MOUNTING AREA, THE NEW RETRACTOR COULD BE WARPED AND MAY NOT FUNCTION. IF THIS IS THE CASE, RESHAPE THE SHEET METAL AND INSTALL ANOTHER NEW COMPLETE SEAT BELT ASSEMBLY.

CLEANING PROCEDURE

Refer to Section 45-01 Interior Trim, General Service.

DIAGNOSIS

The following Diagnosis Guides provide information to isolate malfunctions in the seat belt warning system used on three-point and continuous loop seat belt systems.

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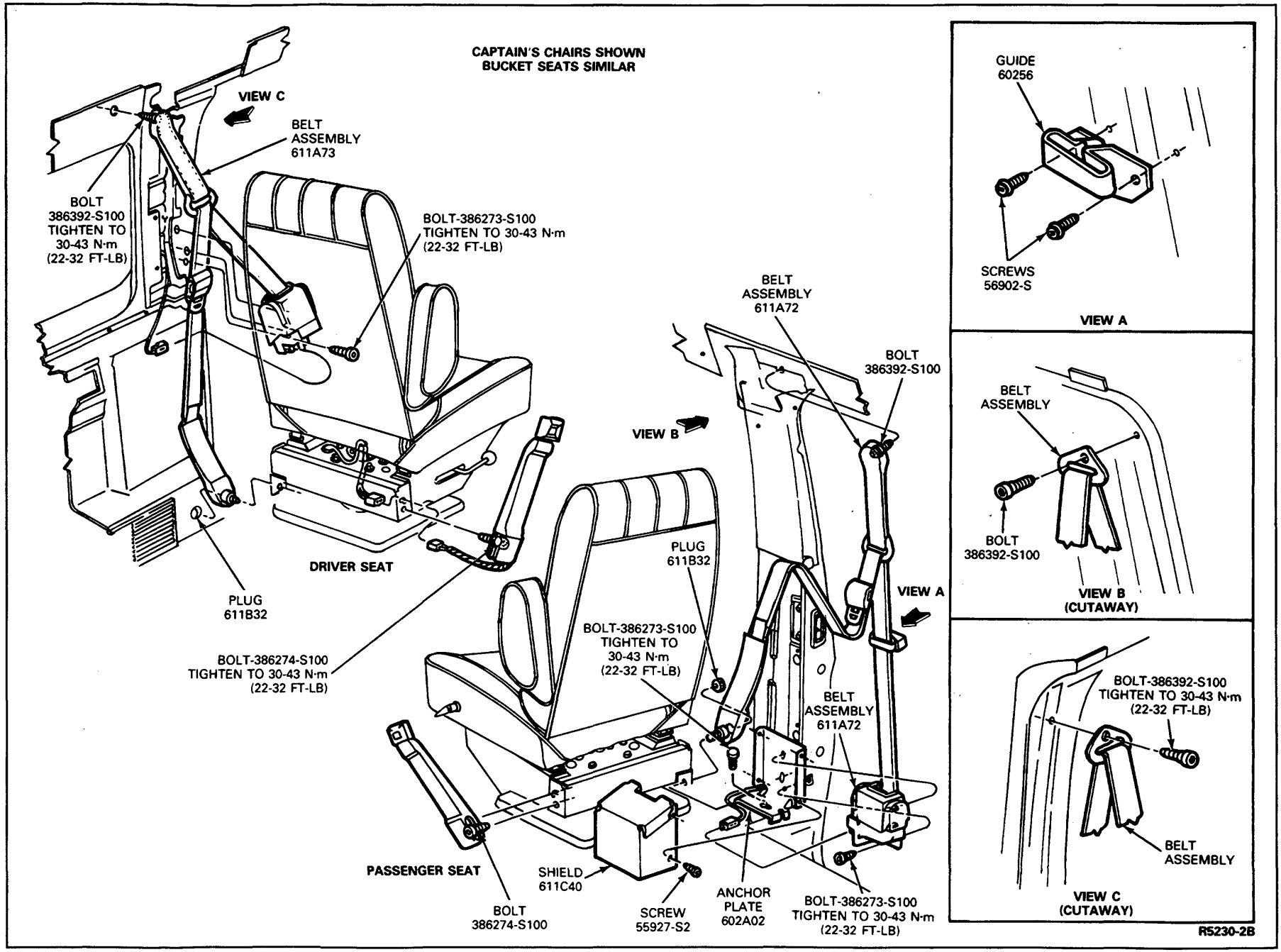


FIG. 8 Front Seat Belt Installation—E-150—E-350 Captain's Chairs

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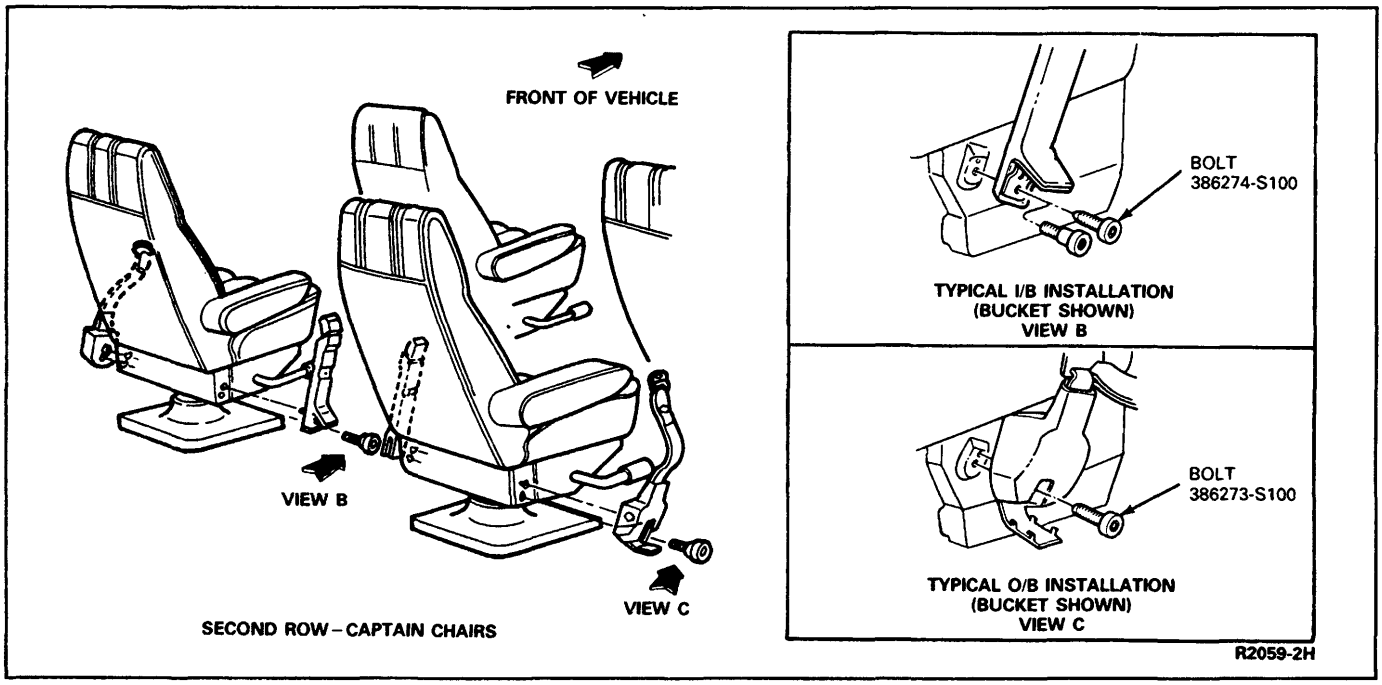


FIG. 9 Rear Seat Belt Installation—E-150—E-350—Captain's Chair

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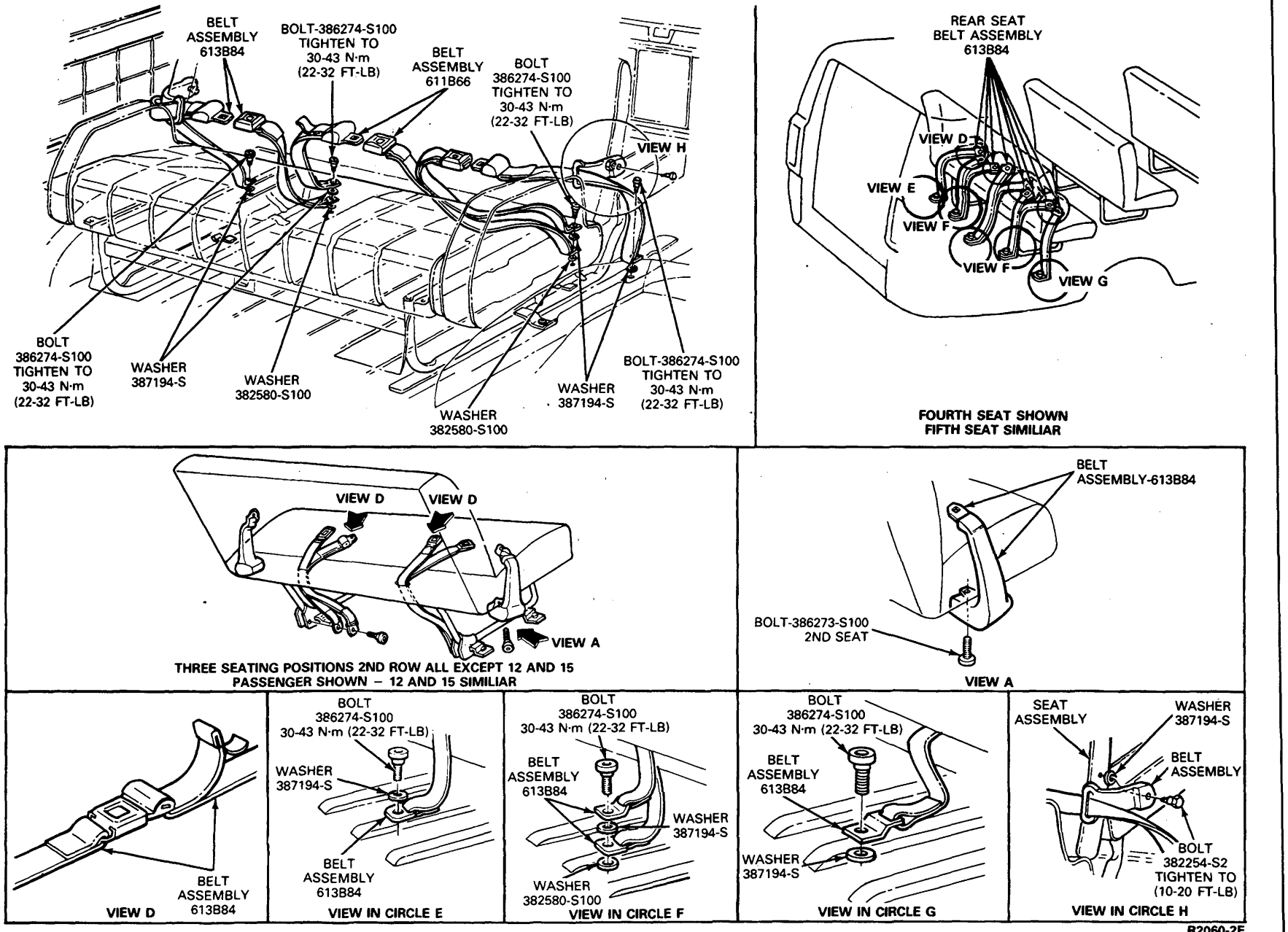


FIG. 10 Second, Third, Fourth and Fifth Row Seat Belt Installation—E-150—E-350

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SEAT BELT WARNING SYSTEM

TEST STEP		RESULT ▶	ACTION TO TAKE
1.0	DURING SYSTEM CHECK — SEAT BELT BUZZER DOES NOT OPERATE (SEAT BELT LAMP OPERATING PROPERLY)		
1.1	CHECK CIRCUIT		
• Remove connector from thermal timer buzzer. • Using a continuity lamp to verify vehicle ground with driver's tongue and buckle disengaged.		Circuit not okay ▶	TRACE circuit to driver's buckle switch and REPAIR as necessary. CHECK for shorted or trapped wires.

CK5316-2D

SEAT BELT WARNING SYSTEM

TEST STEP		RESULT ▶	ACTION TO TAKE
2.0	DURING SYSTEM CHECK — SEAT BELT WARNING LAMP DOES NOT GO OUT SHORTLY AFTER ENGINE IS STARTED (BUZZER/CHIME OPERATES PROPERLY)		
2.1	CHECK CIRCUIT		
• Remove connector from thermal timer buzzer/chime. Lamp should go out.		Lamp goes out ▶	GO to **2.2**.
		Lamp does not go out ▶	TRACE circuit from the thermal timer buzzer/chime connector to the bulb. REPAIR as necessary.
2.2	REPLACE THERMAL TIMER BUZZER		
• Replace thermal timer buzzer/chime with known good part. Lamp and buzzer/chime should operate properly.		Lamp and buzzer/chime operate properly ▶	System functional.
		Lamp and buzzer/chime not operational ▶	RECHECK proper circuit input to thermal timer buzzer/chime. Inputs are ignition, ground, lamp and driver's buckle switch. Check and repair any crossed wires.

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SEAT BELT WARNING SYSTEM

	TEST STEP	RESULT ▶	ACTION TO TAKE
3.0	DURING SYSTEM CHECK — SEAT BELT AND/OR BUZZER/CHIME DO NOT OPERATE		
3.1	CHECK FUSE		
	• Check warning lamp fuse.	Fuse bad ▶	REPLACE fuse. If fuse blows again CHECK for short circuit.
		Fuse is good ▶	GO to **3.2**.
3.2	CHECK IGNITION FEED CIRCUIT, AND SEAT BELT LAMP CIRCUIT		
	• Locate and remove connector tor thermal timer buzzer/chime. • Turn ignition key to "RUN" position. • Using a jumper wire, jump between ignition feed terminal circuit No. 640 red/yellow hash on F-150 — F-350 and Bronco, circuit No. 584 green/blue stripe on E-150 — E-350 and seat belt lamp circuit No. 450 dark green/light green stripe F-150 — F-350 and Bronco, circuit No. 670 pink on E-150 — E-350, seat belt lamp should light.	Seat belt lamp lights ▶	REPLACE thermal timer buzzer with known good unit. If lamp and buzzer operate properly, system is functional.
		Seat belt lamp does not light ▶	GO to **3.3**.
3.3	CHECK BULB		
	• Remove bulb and check continuity of bulb.	Bulb not good ▶	REPLACE bulb.
		Bulb is good ▶	GO to **3.4**.
3.4	CHECK CONTINUITY OF BULB WIRE		
	• Check continuity of wire from thermal timer to bulb.	Wiring okay ▶	GO to **3.5**.
		Wiring not okay ▶	REPAIR open circuit in wire between timer and bulb.
3.5	CHECK GROUND		
	• Check for vehicle ground at bulb.	Vehicle ground okay ▶	REPLACE thermal timer buzzer/chime with known good unit. RECHECK system.
		Vehicle ground not okay ▶	REPAIR vehicle at bulb. TRACE circuit back to junction and REPAIR.

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SPECIFICATIONS

PARTS REPLACEMENT CHART — SEAT AND SHOULDER BELT WITH DAMAGED WELD NUT ANCHOR PLATE THREADS

Original Parts — Seat Belt			Replacement Parts — Seat Belt		
Part No.	①Code Letter	Part Name	Part No.	①Code Letter	Part Name
386273-S100	IA	Bolt — 7/16-20 x 1.38 Pan Head Tapping	383531-S36	X	Bolt — 1/2-13 x 1.38 Pan Locking
386274-S100	IB	Bolt — 7/16-20 x 1.75 Pan Head Tapping (.50 Shoulder)	383753-S36	Y	Bolt — 1/2-13 x 1.75 Pan Locking (.50 Shoulder)
382629-S100	—	Washer — .463/.443 I.D. Plate (1.80 Dia. .190 Thick)	382552-S100	—	Washer — 1/2 Flat (1.30 Dia. .190 Thick)
382583-S100	—	Washer — 1/2 Serrated (.18 Thick)	382533-S100	—	Washer — 1/2 Flat (.25 Thick)
386272-S100	IF	Bolt — 7/16-20 x .88 Pan Head Tapping	383437-S36	W	Bolt — 1/2 x 13 Pan Locking
386276-S100	IL	Bolt — 7/16-20 x 1.75 Pan Shoulder Tapping (.75 Shoulder)	383754-S36	Z	Bolt — 1/2-13 x 2.25 Pan Locking (.88 Shoulder)
386277-S100	IK	Bolt — 7/16-20 x 1.38 Pan Shoulder Tapping (.50 Shoulder)	385709-S	T	Bolt — 1/2-13 x 1.38 Pan Head Shoulder Locking
382580-S100	—	Washer — 7/16			
386392-S100	D IG	Bolt — 3/8-16 x 1.50 Pan Head Tapping 7/16-20 x 2.15			
384966-S100	V	Bolt — 7/16-20 x 1.75 Pan Head Tapping			

①Identification letter on top of bolt head or face of spacer.
NOTE: Bolt Torque Must be Maintained at 30-43 N•m (22-32 ft-lbs) **CR3104-2A**

SPECIAL SERVICE TOOLS

Number	Description
T77L-2100-A	Seat Belt Bolt Bit

CR2388-1C

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SECTION 41-60 Seat Trim

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Seat Cushion Cover—Bench Seat	41-60-1
Bronco, F-150—F-350 and E-150—E-350	41-60-1
VEHICLE APPLICATION	41-60-1

VEHICLE APPLICATION

All Models.

DESCRIPTION

Seat Trim

The following seat trim removal and installation procedures generally apply to all truck lines. If some of the steps do not apply to the particular vehicle being serviced, proceed to the next step and review the appropriate illustration shown.

Unless otherwise noted, the illustrations shown in this Section are **typical of all bucket and bench seat assemblies.** Refer to Figs. 1 through 15.

Seat trim replacement requires removal and installation of seat components such as seat assemblies, track assemblies and seat belts. Refer to the applicable Section in Group 41 for these procedures.

REMOVAL AND INSTALLATION

NOTE: Repairs to seat cushions or seat backs are performed out of the vehicle and are usually for replacement of torn, worn or burned seat covers. In a few instances, the pads may be damaged and require replacement.

When installing a new seat or back cover assembly, refer to Figs. 1 through 15 for the location of listing wires, hog rings, anti-squeak pads, and seat pad stack-up.

Seat Cushion and Back Cover—Bucket Seat

Removal and Installation

Bronco, F-Series and E-150—E-350

1. Remove the seat belt retainer loop, if so equipped (one screw). Remove the seat and track assembly if the cushion cover is to be replaced. Refer to the appropriate Section in Group 41.
2. Remove the seat tracks from the seat.
3. Remove the seat back assembly and the seat cushion stops.
4. Remove the hog rings retaining the seat cushion cover to the frame. Remove cover.
5. Remove the back cushion stops and the seat back release handle.
6. Remove the seat back panel assembly (retained with clips).
7. Remove the hog rings retaining the seat back cover to the frame. Remove cover.
8. Transfer the bolster wires to the cover listings.
9. Position the seat cushion cover to the seat. Install hog rings as shown. Install the seat cushion stops.
10. Position the seat back assembly. Install hog rings.
11. Install the seat back stops, release handle and rear seat back panel assembly. Then, install the seat back to the seat cushion assembly.
12. Install the seat tracks to the seat cushion and tighten to specifications. Refer to Sections 41-01, Front Seats; 41-14, Conventional Rear Seats and 41-20, Folding Rear Seats.
13. Install the seat assembly into the vehicle. Tighten to specifications. Refer to Sections 41-01, Front Seats; 41-14 Conventional Rear Seats and 41-20, Folding Rear Seats. Install the seat belt retainer loop, if so equipped (one screw).

Seat Cushion Cover—Bench Seat

Bronco, F-150—F-350 and E-150—E-350

1. Remove the seat and track assembly from the vehicle. Refer to Sections 41-01, Front Seats; 41-14, Conventional Rear Seats and 41-20, Folding Rear Seats.
2. Remove the seat back assembly from the seat cushion (Figs. 7, 8, 10, 11, 13, 14 and 15).
3. Cut the hog rings retaining the cushion cover to the frame assembly. Remove cover.
4. If the padding is being replaced, cut the hog rings attaching the padding to the spring assembly and remove the padding.
5. Position the new pad to the seat back assembly. Fasten pad in place with hog rings.
6. Transfer the listing wires from the old cover to the listings in the new cover.
7. Position the cover over the spring assembly. Fasten cover with hog rings.
8. Install the seat back to the seat cushion.
9. Install the seat and track assembly into the vehicle. Tighten attaching screws and washers to specifications. Refer to Sections 41-01, Front

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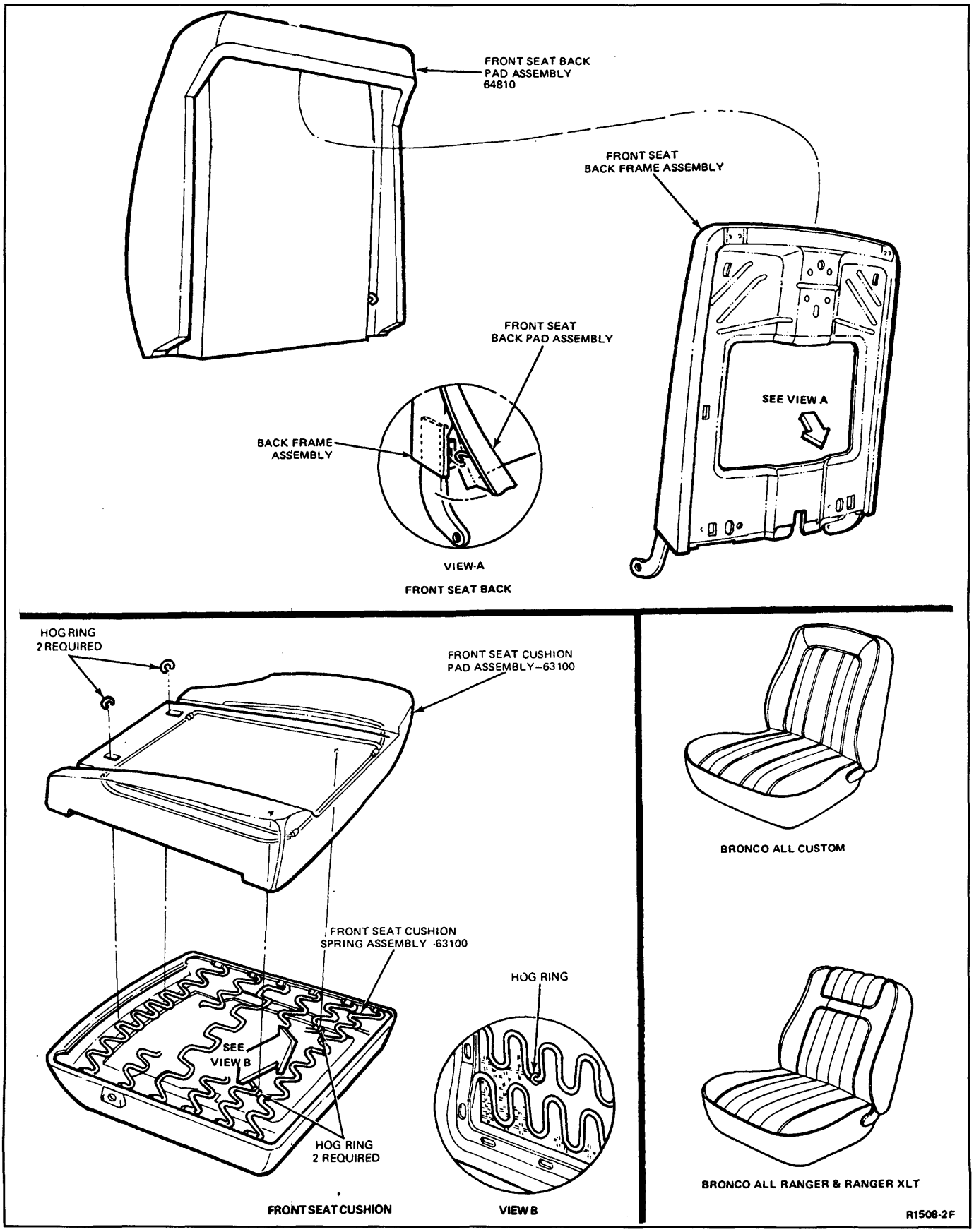


FIG. 1 Front Seat Cushion and Back Cover Installation Bronco-Bucket Seat

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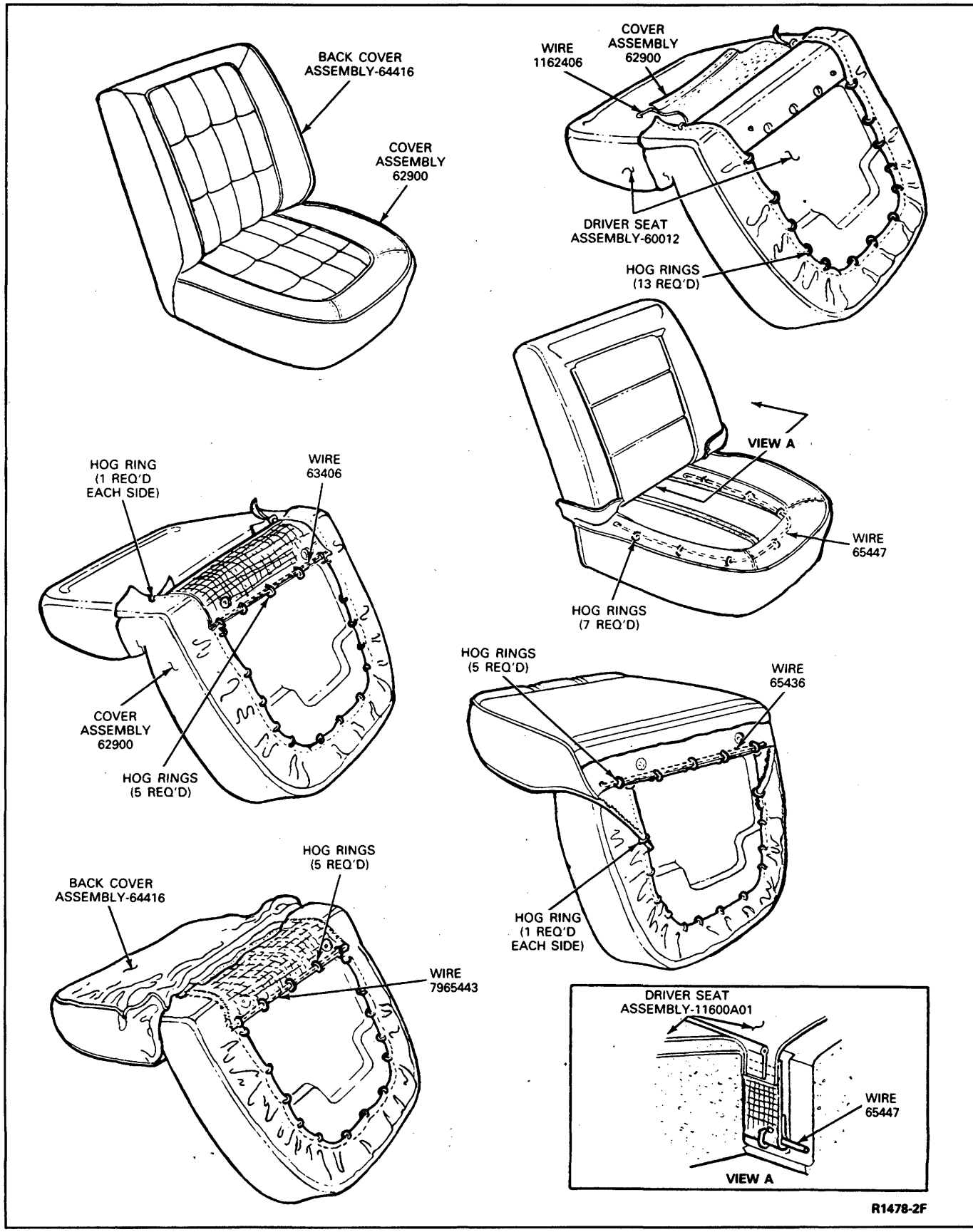


FIG. 2 Front Seat Assemblies—E-150—E-350

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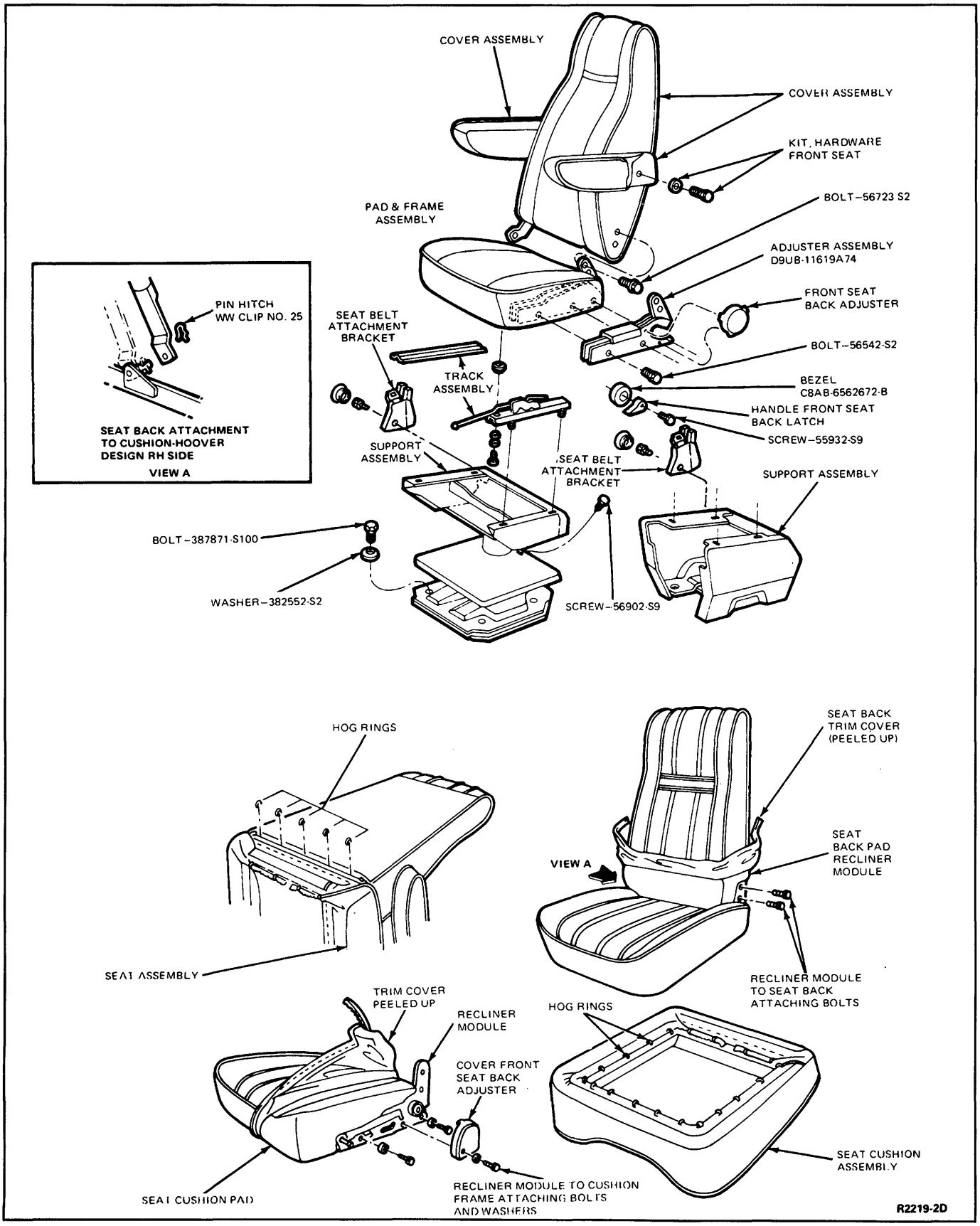


FIG. 3 Captains Chair—Reclining Seat Back/Stationary Supports, Pad and Cover—E-150—E-350

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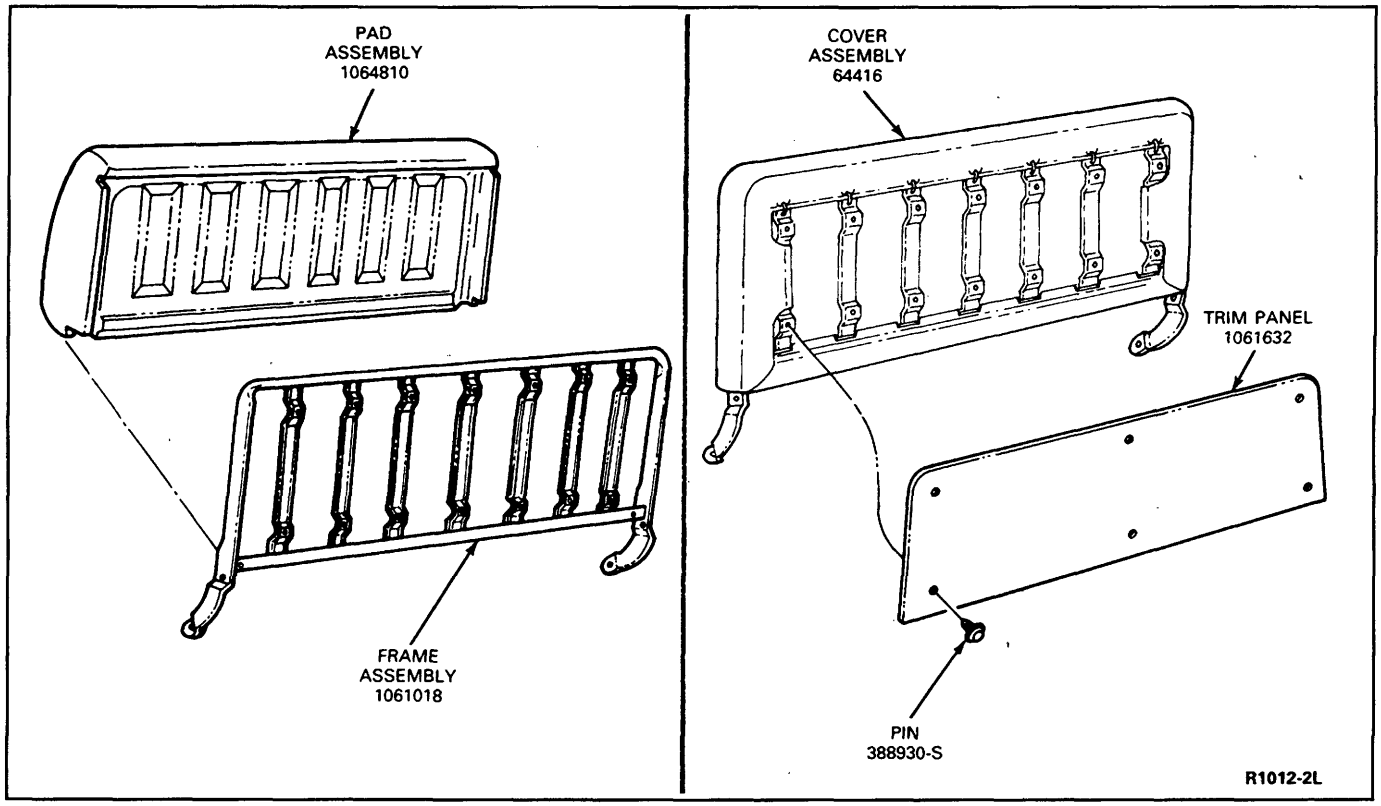


FIG. 4 Seat Back Cover Installation—F-Series

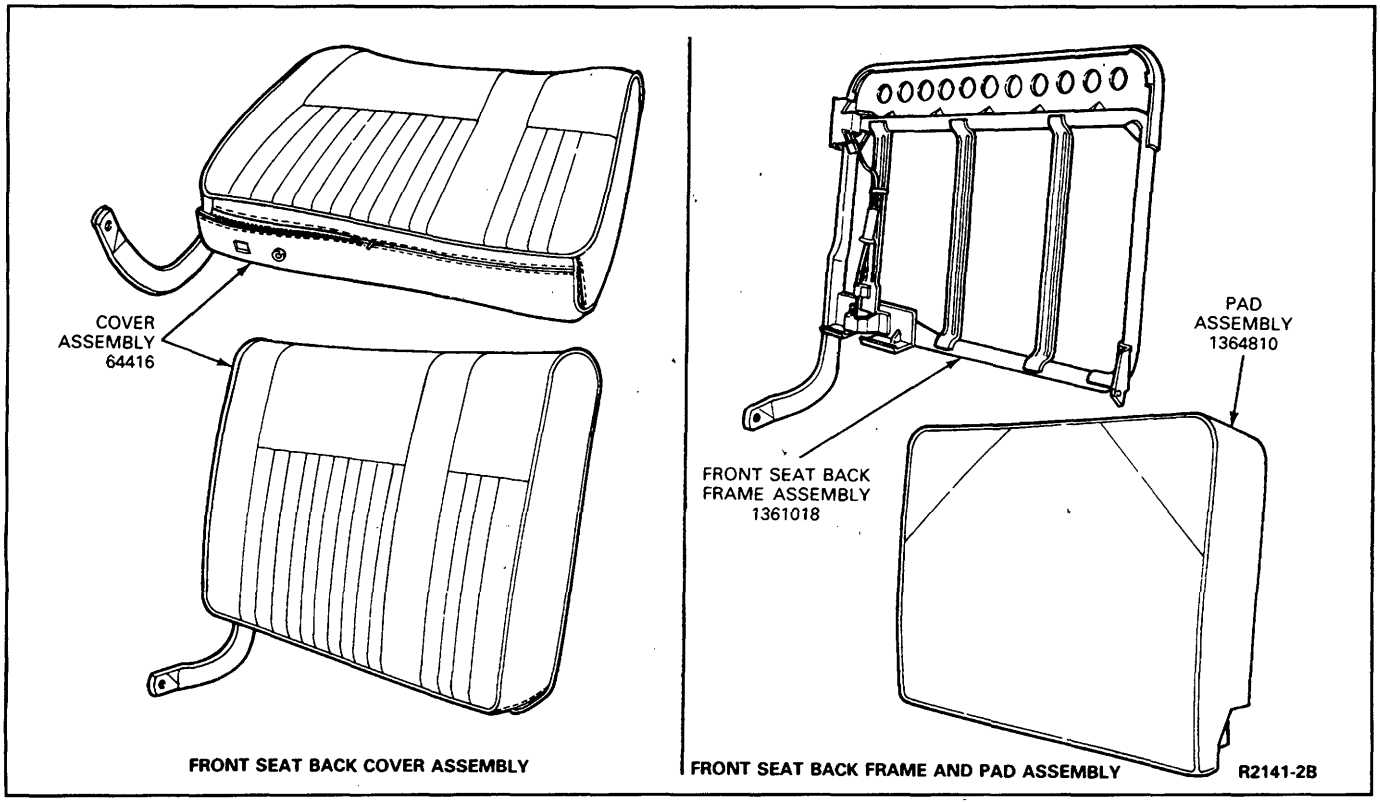


FIG. 5 Front Seat Back Frame, Pad and Cover—F-Series, Super Cab and Bronco

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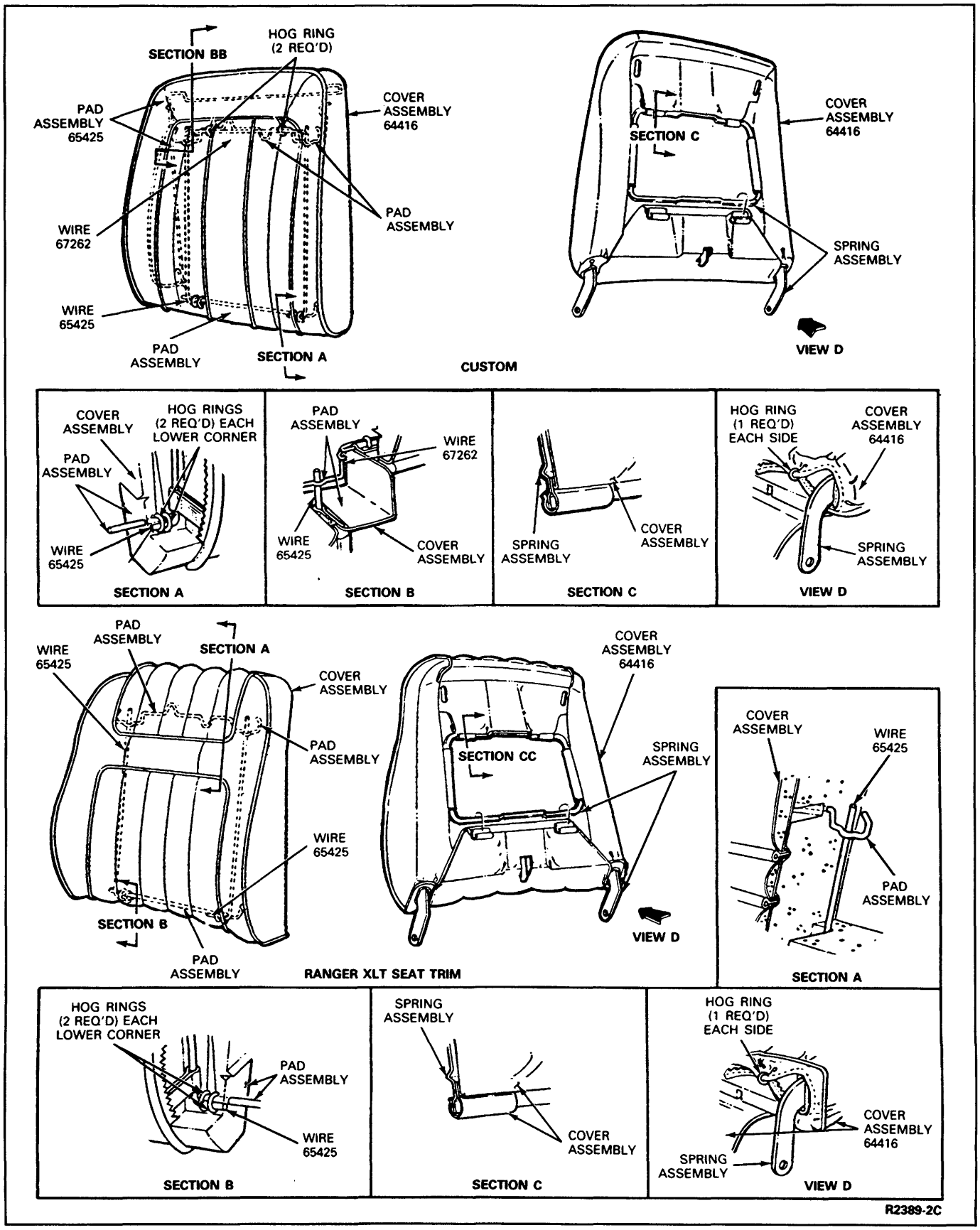


FIG. 6 Front Seat Back Cover Assembly—Bucket Seat

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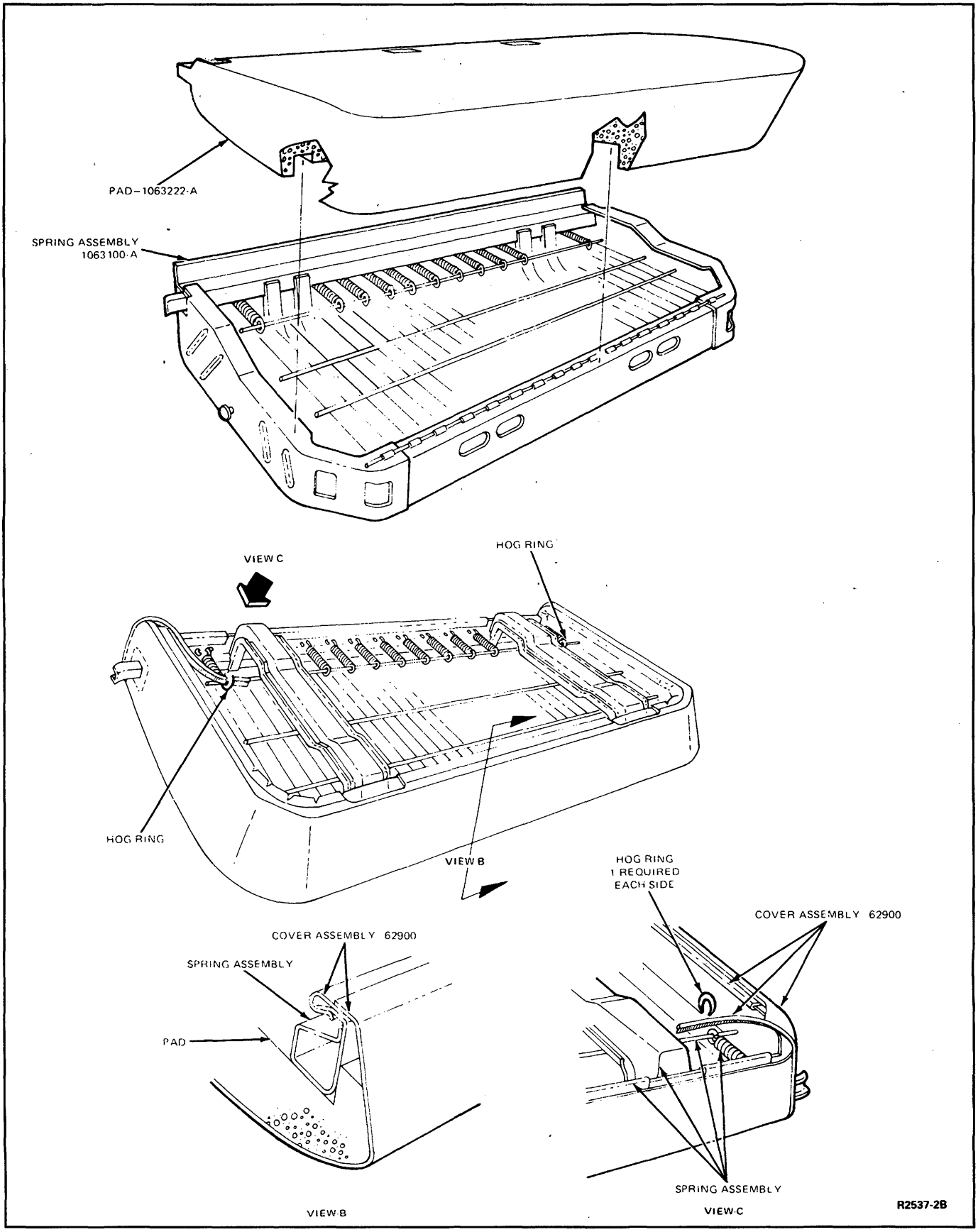


FIG. 7 Front Seat Cushion Cover Installation—F-Series, Conventional Cab

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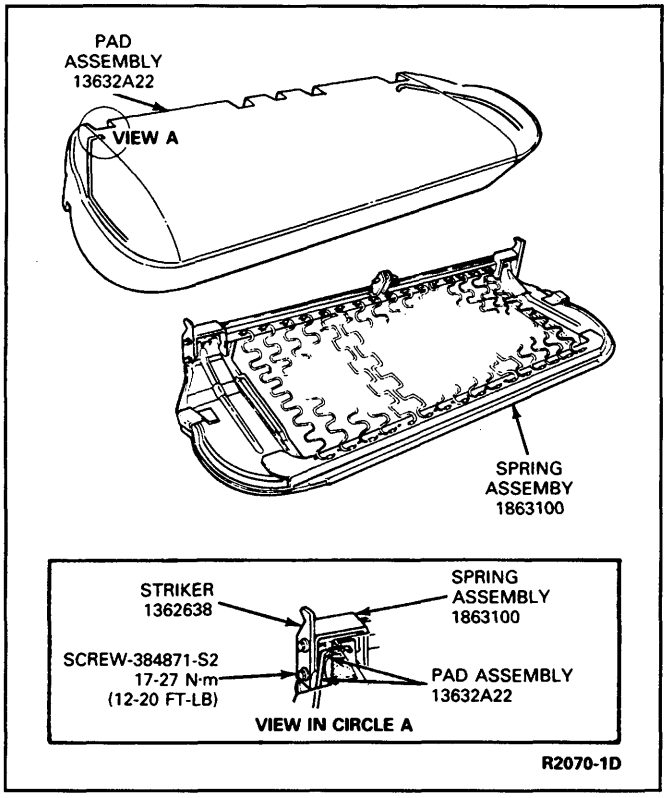


FIG. 8 Front Seat Cushion Cover Installation—F-Series Super Cab

Seats; 41-14, Conventional Rear Seats and 41-20 Folding Rear Seats.

Seat Back Cover—Bench Seat

Bronco, F-150—F-350 and E-150—E-350

1. Remove the seat back-to-cushion mounting bolts and washers. Separate the back from the cushion and lift the seat back out of the vehicle.
2. Cut the hog rings attaching the cover to the seat back or cushion spring assembly (Figs. 13, 14 and 15). Remove the seat back cover.
3. Remove plastic retainers and front seat back trim panel.
4. Transfer the listing wires from the old cover to the listings in the new cover.
5. Position the new cover over the padding. Pull cover tight, and fasten the cover to the spring assembly with hog rings.
6. Install front seat back trim panel.
7. Install the seat back to the seat cushion assembly.

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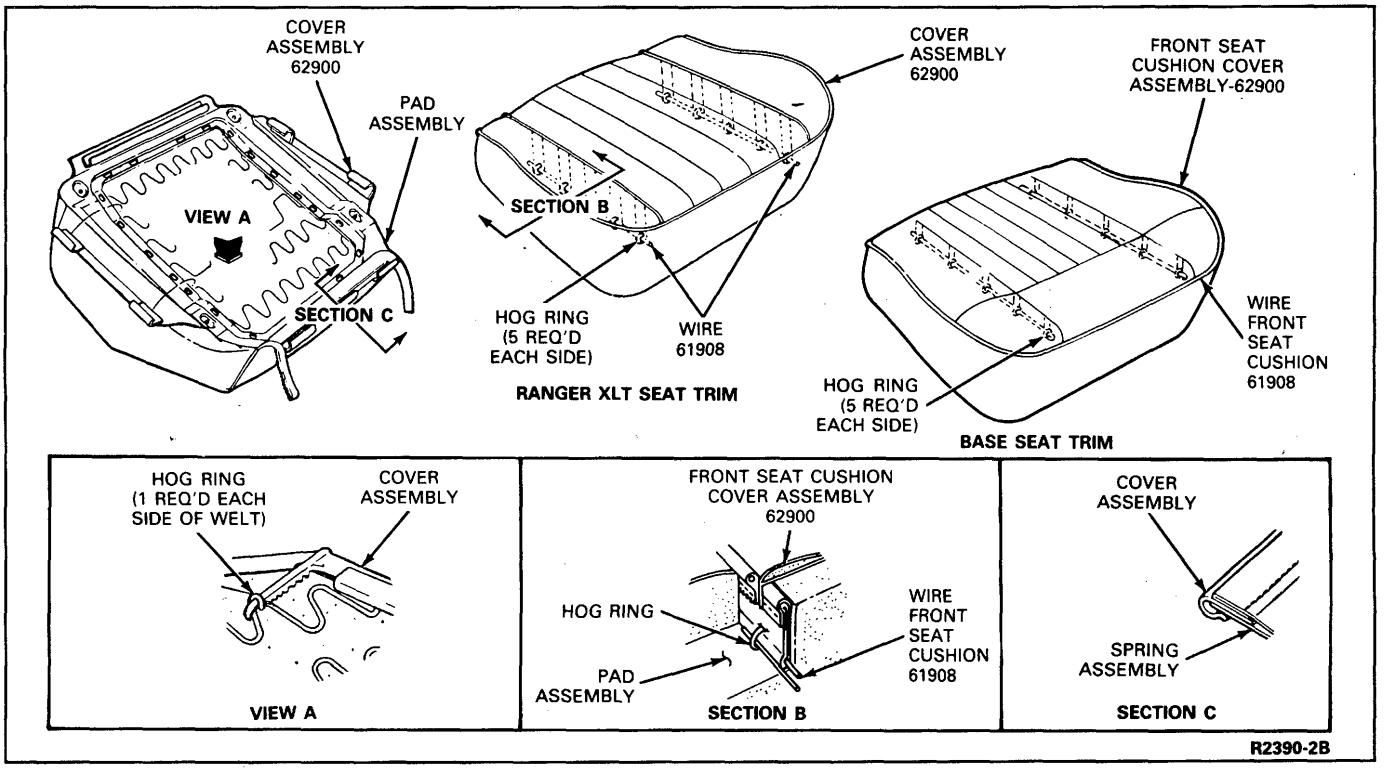


FIG. 9 Front Seat Cushion Cover Installation—Bronco Bucket Seat

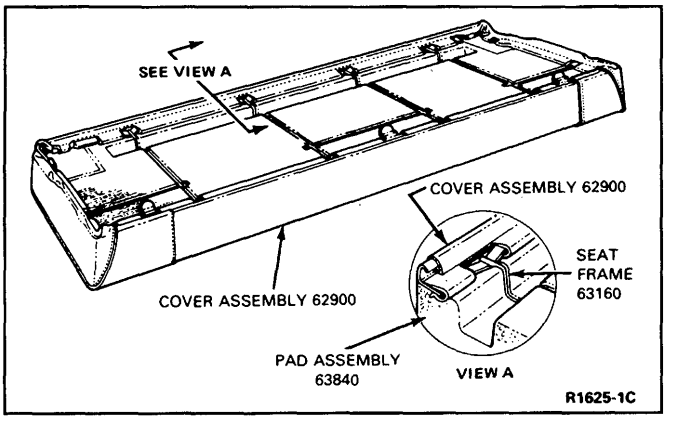


FIG. 10 Rear Seat Installation—F-Series Super Cab

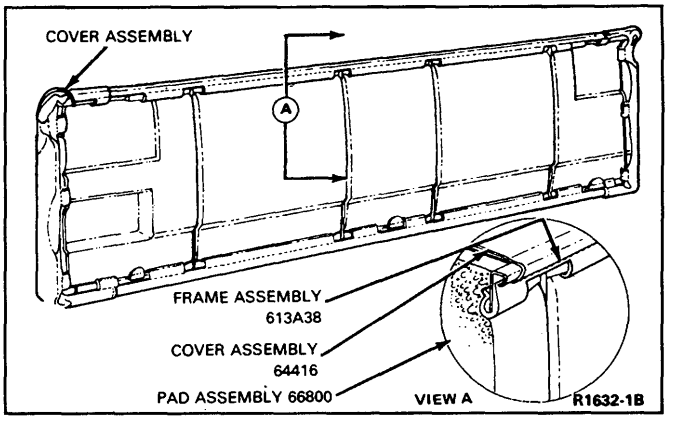


FIG. 11 Rear Seat Back Cover Installation—F-Series Super Cab

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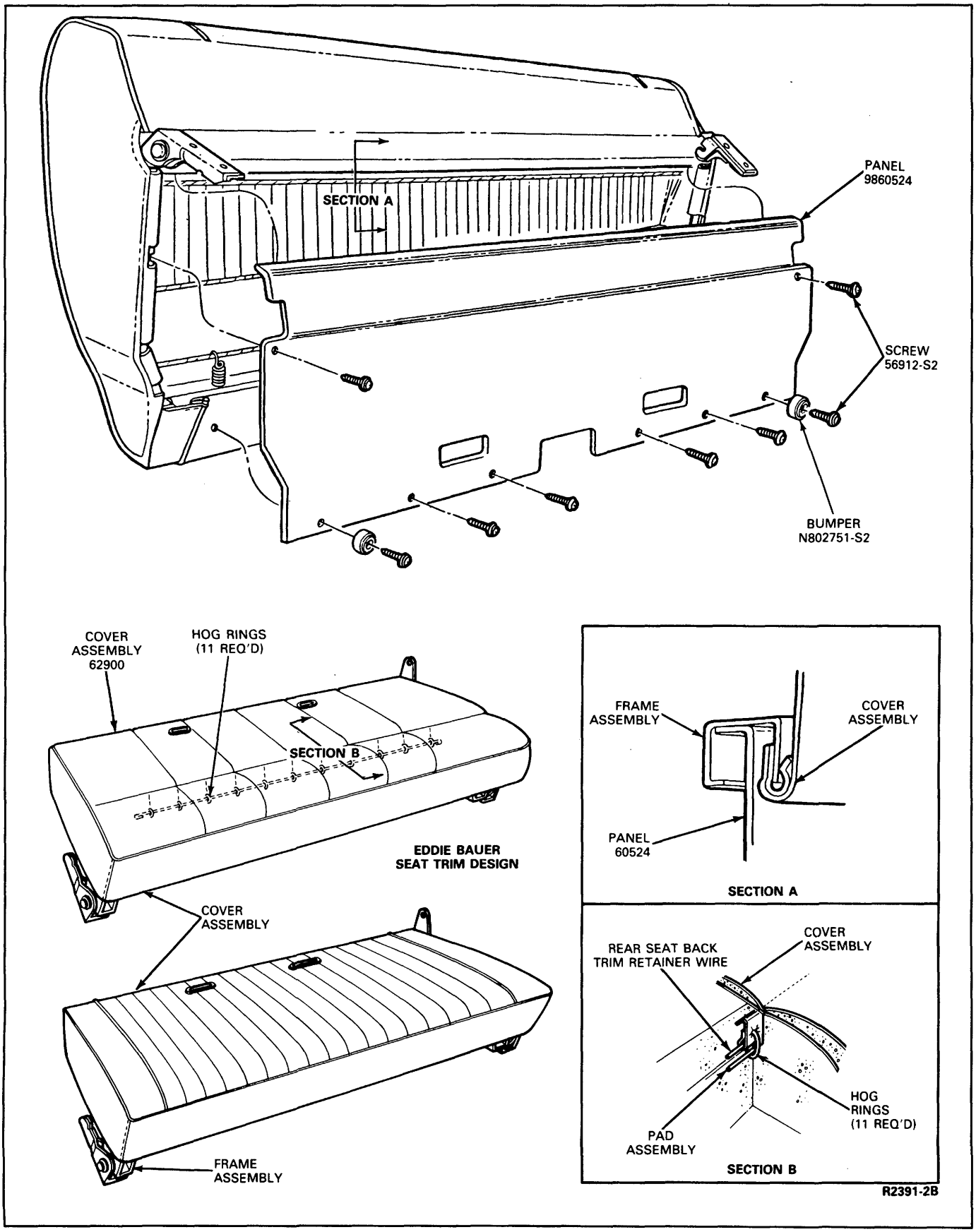


FIG. 12 Rear Folding Seat—Bronco

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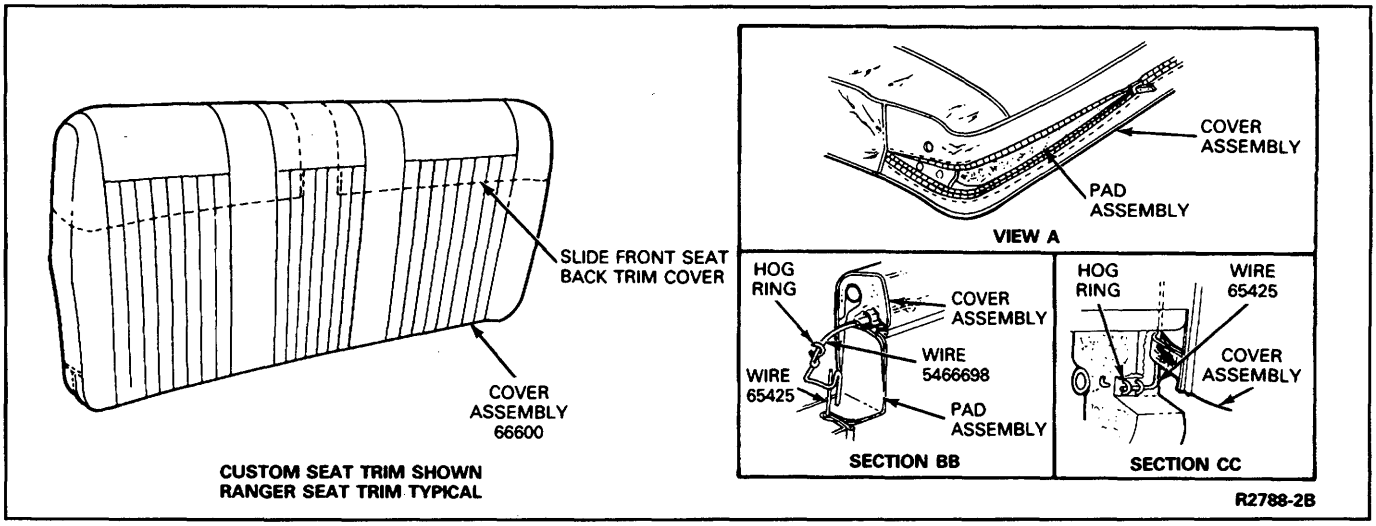


FIG. 13 Rear Seat Back Cover Assembly—Bronco

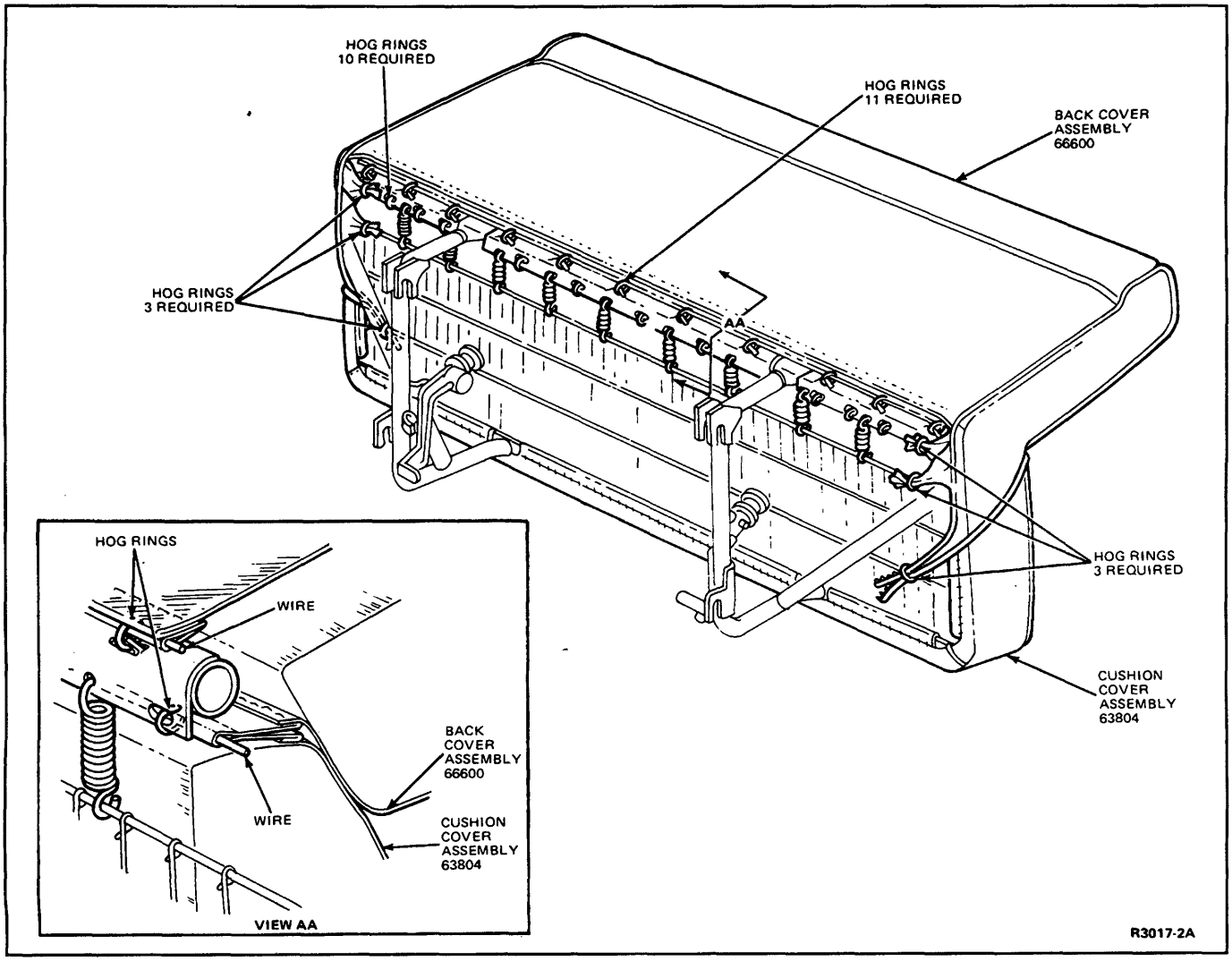


FIG. 14 Rear Seat Cover Assemblies—E-150—E-350 (Three Passenger Seats)

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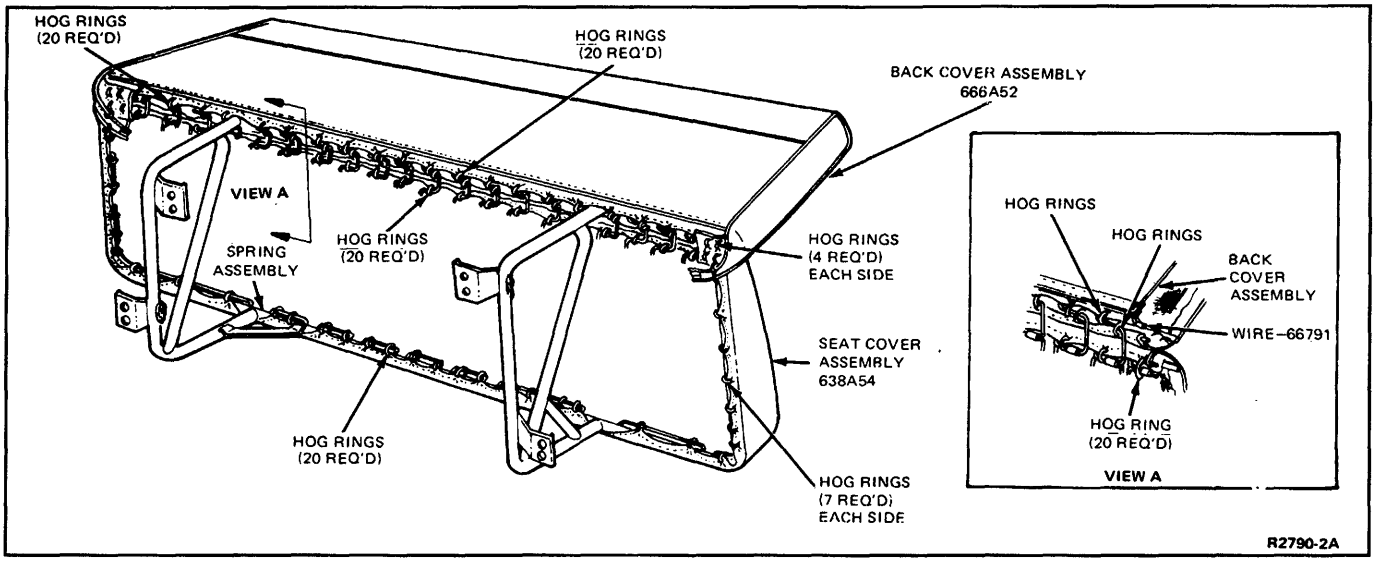


FIG. 15 Rear Seat Cover Assemblies—E-150—E-350 (Four Passenger Seats)

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WINDOW GLASS AND MECHANISMS

GROUP 42

(70000)

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TAILGATE WINDOW MECHANISMS	42-35-1
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SECTION 42-01 Window Glass and Mechanisms General Service

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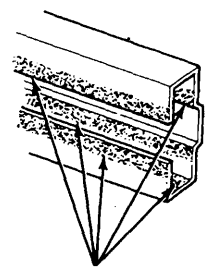
VEHICLE APPLICATION

All Models.

LUBRICATION

Window Mechanism

The door window mechanism should be properly lubricated to provide ease of operation. The window glass mechanism should be lubricated whenever the glass channel or window regulator is removed, or excessive effort is required to operate the windows. To lubricate a door window mechanism, apply an even coating of Lithium Complex Polymer Additive Grease ESB-M1C208-1A or equivalent to the window regulator rollers, shafts and the entire length of the roller guides as illustrated by the shaded areas in Fig. 1.



NOTE: APPLY AN EVEN COATING OF LUBRICANT ESB-MIC208-1A OR EQUIVALENT TO ALL WINDOW REGULATOR ROLLERS, SHAFTS AND THE ENTIRE LENGTH OF ROLLER GUIDES AS ILLUSTRATED BY THE SHADED AREA.

N6024-1C

FIG. 1 Window Mechanism Lubrication

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SECTION 42-04 Front Door Window Glass and Mechanisms

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VEHICLE APPLICATION

All Models.

ADJUSTMENTS

Window Mechanism

E-150—E-350, F150-F350

1. Remove the trim panel from the door, if so equipped.
2. Remove the watershield from the door.
3. Loosen the front division bar lower attaching screw and the rear run retainer lower attaching screw (Figs. 1 and 2).
4. Lower the window glass until the top edge of the glass is approximately 101mm (4 inches) above the belt line (Figs. 1 and 2).
5. Tighten the screws (Figs. 1 and 2) and check the operation of the window mechanism.
6. Install the trim panel and watershield on the door.

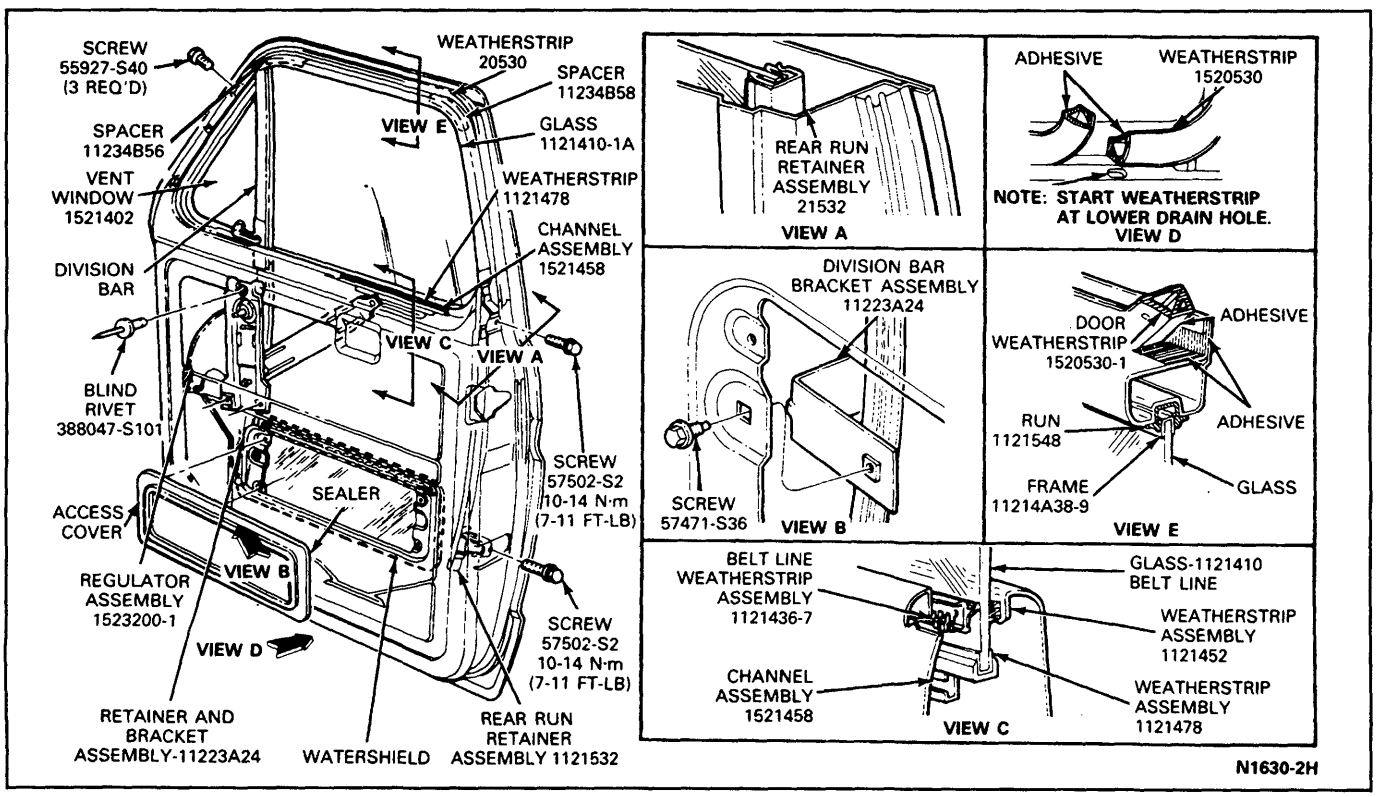


FIG. 1 Front Door Window Glass Adjustment—E-150—E-350

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REMOVAL AND INSTALLATION

Front Door Glass

E-150—E-350

Removal

1. Remove the door trim panel.
2. Remove three screws attaching the vent window assembly to the upper leading edge of the door (Fig. 1).
3. Remove one screw attaching the front run division bar bracket to the door (Fig. 1, View B).
4. Lower door glass to DOWN position.
5. Pull rear run down and out of the run slot along the top of the glass opening.
6. Tilt the vent window and division bar assembly rearward. Then, remove the vent window and division bar from the door.
7. Unsnap and remove belt weatherstrip.
8. Rotate the front edge of the glass downward, and lift the glass and channel assembly from the door, sliding the glass channel off the regulator arm roller.
9. Remove the glass channel from the glass using Glass and Channel Removal Tool 2900 or equivalent (Fig. 3).

Installation

1. Install the glass channel onto the glass using Glass and Channel Removal Tool 2900 or equivalent (Fig. 3).

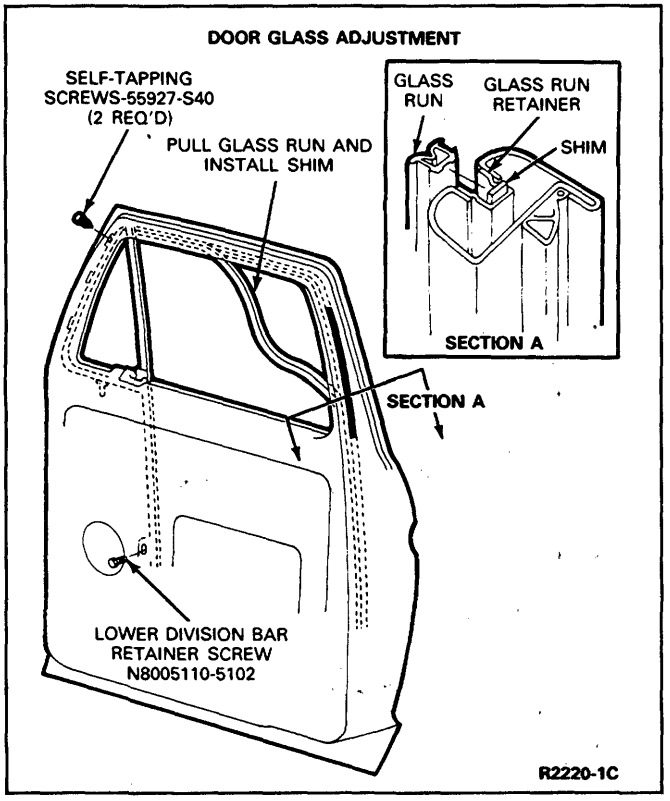


Fig. 2 Door Glass Adjustment—F-150—F-350 and Bronco

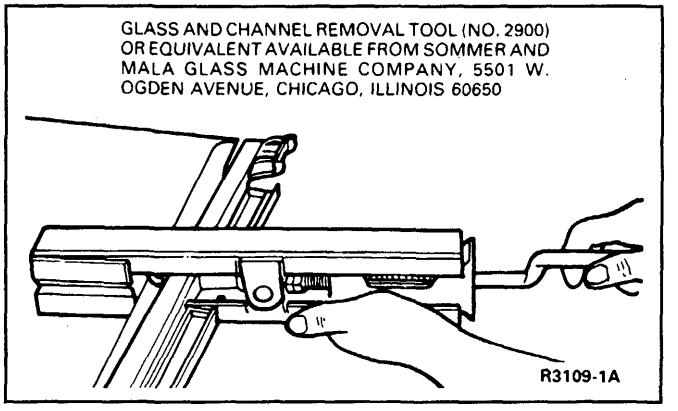


FIG. 3 Glass Channel Replacement

2. Lubricate the window mechanism. Refer to Section 42-01, Window Glass and Mechanisms—General Service.
3. Position the glass and channel assembly into the door, inserting the regulator arm roller into the glass channel.
4. Position the vent window and division bar into the door.
5. Position the rear run retainer into the door, and install the attaching screw.
6. Position the glass and channel assembly into the front division bar, and the rear run. Then, place the vent window assembly into position in the door, and install the three vent frame attaching screws.
7. Insert the front run in the division bar.
8. Install the screw attaching division bar bracket to the door.
9. Adjust the window glass as outlined.
10. Install the door trim panel, if so equipped.

Bronco and F-150—F-350

Removal

1. Remove the door trim panel.
2. Remove the screw from the front division bar (Fig. 4, View E).
3. Remove two vent window assembly attaching screws from the front edge of the door (Fig. 4, Views B and C).
4. Lower the door glass and pull the glass run out of the run retainer near the vent window division bar enough to allow removal of the vent window assembly.
5. Tilt the vent window and division bar assembly toward the rear of the door and remove the vent window from the door.
6. Rotate the front edge of the glass downward and lift the glass from the door.
7. Remove the glass from the glass channel using Glass and Channel Removal Tool 2900 or equivalent (Fig. 3).

Installation

1. Install the glass in the glass channel using Glass and Channel Removal Tool 2900 or equivalent (Fig. 3).

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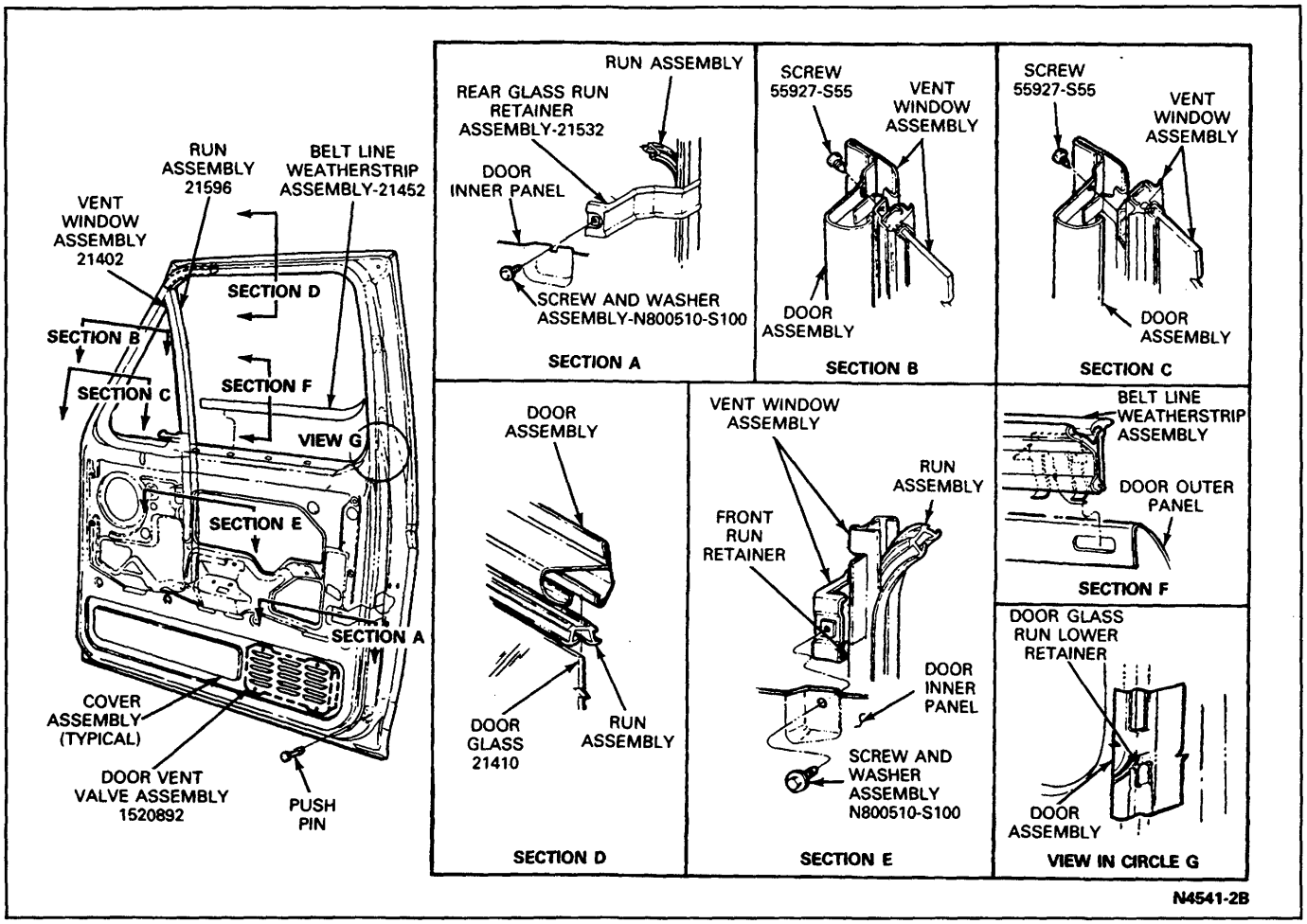


FIG. 4 Door Glass and Vent Window Installation—Bronco and F-150—F-350 Truck

2. Position the glass and channel assembly into the door, inserting the regulator arm roller into the slot of the glass channel (Fig. 5, View A).
3. Position the vent window and division bar into the door and insert the front edge of the glass into the division bar (front) run.
4. Install the two vent window attaching screws at the forward edge of the door (Fig. 4, Views B and C).
5. Insert the glass run into the run retainer near the division bar (Fig. 4, View E).
6. Install the screw at the front run retainer (Fig. 4, View E). Adjust as outlined.
7. Check the operation of the window and install the door trim panel.

Door Glass Belt Weatherstrip

E-150—E-350

Removal

1. Remove the trim panel from the door inner panel.
2. Lower glass to full down position.
3. Unsnap and remove the belt line weatherstrip(s) from the door (Fig. 1).

Installation

1. Position the weatherstrip to the door and snap into place.
2. Install the trim panel onto the door inner panel.

Window Regulator

E-150—E-350, F-150—F-350 and Bronco

Removal

1. Remove door trim panel and access cover, if so equipped.
2. Support glass in the full up position.
3. Remove center pin from regulator attaching rivets with drift punch. Then, drill head from each rivet using a 6.35mm (1/4-inch) drill and remove rivet. Be careful not to damage sheet metal holes during drilling (Fig. 5).
4. Disengage regulator arm from glass bracket and remove regulator.

Installation

1. Position regulator in door and insert arm into glass bracket channel (Fig. 5).
2. Position regulator to inner panel and install rivets using Rotunda Hydraulic Rivet Gun 107-00600 or equivalent to attach regulator to inner panel. A 1/4 inch -20 x 1/2 inch screw and washer assembly and a 1/4 inch -20 nut and washer assembly may be used in place of the rivets if rivets are not available (equivalent metric retainers may also be used).

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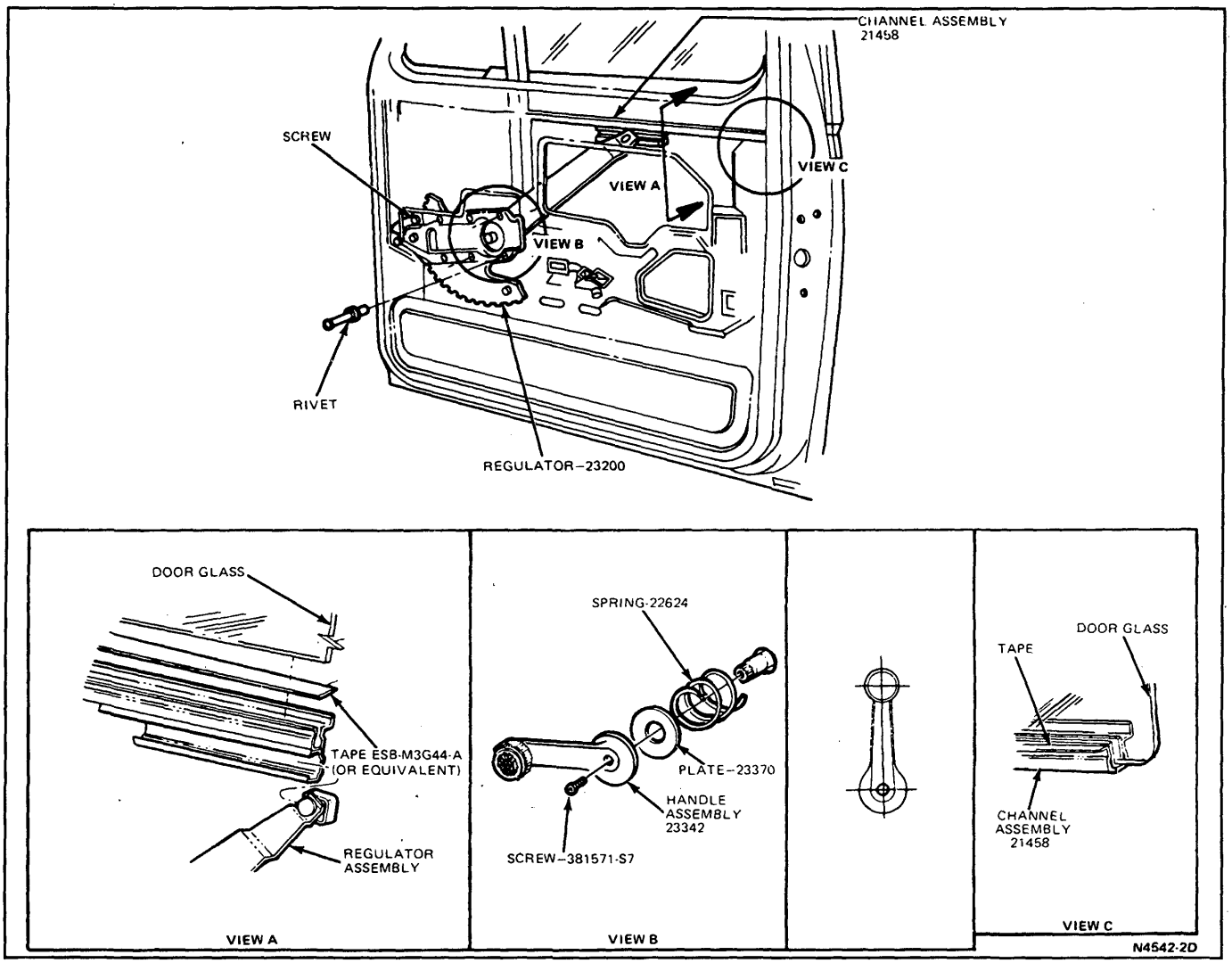


FIG. 5 Window Regulator—Removal and Replacement—F-150—F-350 and Bronco Shown—E-150—E-350 Similar

3. Check operation of window mechanism and install door trim panel.

Power Window Regulator Motor F-150—F-350 and Bronco

Refer to Section 42-08, Power Windows for removal and installation procedures.

SPECIAL SERVICE TOOLS

Tool Number	Description
2900	Glass and Channel Removal Tool

CN6016-1A

ROTUNDA EQUIPMENT

Model	Description
107-00600	Hydraulic Rivet Gun

CN5976-1B

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VEHICLE APPLICATION

All F-150—F-350, E-150—E-350 and Bronco Models.

TESTING

Power Window Switch Tests

Multiple Switch For E-150—E-350 Econoline Only

Test Procedure

Testing of the power window multiple switch should be performed with the switch removed from the vehicle. Use a self-powered test lamp or a Rotunda 007-00001, Digital Volt-Ohm Meter, or equivalent.

1. Clip one test lead probe on pin No. 6 (Fig. 1) which is grounded.
2. With both switches in the neutral position, pins No. 1 through 4 should have continuity to pin No. 6.
3. Push both window switches upward (toward window when in installed position). Both pins No. 1 and 3 should have no continuity to pin No. 6.
4. Push both window switches downward (away from window when in installed position). Both pins No. 2 and 4 should have no continuity to pin No. 6.
5. Remove the test lead from pin No. 6 and connect to pin No. 5 (hot feed pin). With both switches in the neutral position, pin No. 5 should have continuity only with itself.
6. Push both window switches upward (toward the window when in installed position). Both pins No. 1 and 3 should have continuity to pin No. 5.
7. Push both window switches downward (away from the window when in installed position). Both pins No. 2 and 4 should have continuity to pin No. 5.
8. If any one switch does not test as stated, replace the complete switch assembly.

Single Switch—E-150—E-350

Test Procedure

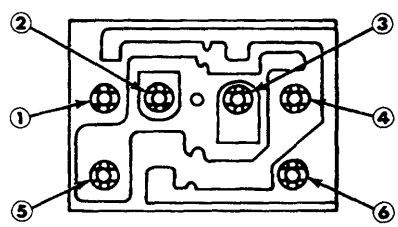
1. Use a self-powered test lamp or an ohmmeter, to test the power window switch.

CONNECT ONE SIDE OF AN AMMETER SELF-POWERED OR TEST LAMP TO TERMINAL NO. 5 (BATTERY TERMINAL) AND THE OTHER SIDE TO THE TERMINALS SHOWN BELOW.

WINDOW SWITCH POSITION	CONTINUITY BETWEEN TERMINALS
NEUTRAL	NO. 5
RIGHT FRONT — UP	NO. 3
RIGHT FRONT — DOWN	NO. 4
LEFT FRONT — UP	NO. 1
LEFT FRONT — DOWN	NO. 2

CONNECT ONE SIDE OF AN OHMMETER SELF-POWERED OR TEST LAMP TO TERMINAL NO. 6 (GROUND TERMINAL) AND THE OTHER SIDE TO THE TERMINALS SHOWN BELOW.

WINDOW SWITCH POSITION	CONTINUITY BETWEEN TERMINALS
NEUTRAL	NOS. 1, 2, 3, 4
RIGHT FRONT — UP	NOS. 1, 2 AND 4
RIGHT FRONT — DOWN	NOS. 1, 2 AND 3
LEFT FRONT — UP	NOS. 2, 3 AND 4
LEFT FRONT — DOWN	NOS. 1, 3 AND 4

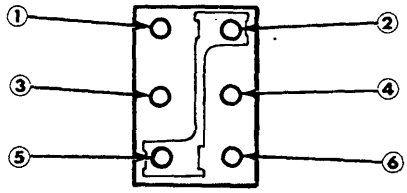


1. LEFT FRONT "UP" TERMINAL
2. LEFT FRONT "DOWN" TERMINAL
3. RIGHT FRONT "UP" TERMINAL
4. RIGHT FRONT "DOWN" TERMINAL
5. HOT FEED WHEN IGNITION SWITCH IS "ON"
6. GROUND TERMINAL

N5031-2E

FIG. 1 Power Window Multiple Switch Pin Connections and Locations—E-150—E-350

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SINGLE POWER WINDOW SWITCH TEST

① POWER FEED, OR GROUND FROM DRIVERS SWITCH (ALLOWS OPERATION OF INDIVIDUAL WINDOWS FROM LEFT FRONT DOOR)
② HOT FEED FOR SINGLE SWITCH (BUS BAR TO PIN NO. 5)
③ MOTOR TERMINAL – UP
④ MOTOR TERMINAL – DOWN
⑤ HOT FEED
⑥ POWER FEED, OR GROUND FROM DRIVERS SWITCH (ALLOWS OPERATION OF INDIVIDUAL WINDOWS FROM LEFT FRONT DOOR)

N5032-1C

FIG. 2 Power Window Single Switch Pin Locations—E150—E-350

2. With the switch in the neutral position, there should be continuity between terminals 1 and 3, 2 and 5, and 4 and 6 (Fig. 2).
3. With the toggle switch pushed downward, there should be continuity between terminals 2, 4 and 5, and 1 and 3. Terminal 6 should be disconnected from any other terminal.
4. With the toggle switch pushed upward, there should be continuity between terminals 2, 3 and 5, and 4 and 6. Terminal 1 should be disconnected from any other terminal.
5. If the switch does not test as stated, replace the switch.

Window Switch—F-150—F-350 and Bronco

Test Procedure

NOTE: The switch should be oriented so that the raised portion of the switch knob is to the right and you are looking at the five terminals.

1. Use a self-powered test lamp or an ohmmeter to test the power window switch (Fig. 3).
2. With the switch in the neutral position, there should be continuity between terminals 1 & 2 and terminals 3 & 4. Terminal 5 should be disconnected from all other terminals.
3. When the raised portion of the switch rocker knob is pushed (to close the windows), there should be continuity between terminals 1 & 5 and terminals 3 & 4. Terminal 2 should be disconnected from all other terminals.
4. When the depressed portion of the switch rocker knob is pushed (to open the windows), there should be continuity between terminals 1 & 2 and terminals 4 & 5. Terminal 3 should be disconnected from all other terminals.
5. If the switch assembly does not test as stated, replace the switch.

Instrument Panel-Mounted Tailgate Switch—Bronco

1. Use a self-powered test lamp, or an ohmmeter to test the power tailgate switch (Fig. 4).

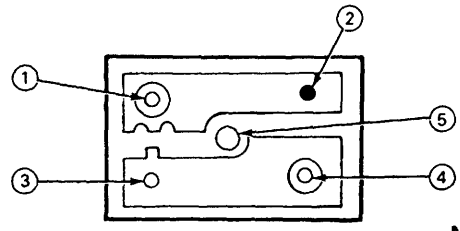


FIG. 3 Power Window Switch Pin Locations—F-150-F-350 and Bronco

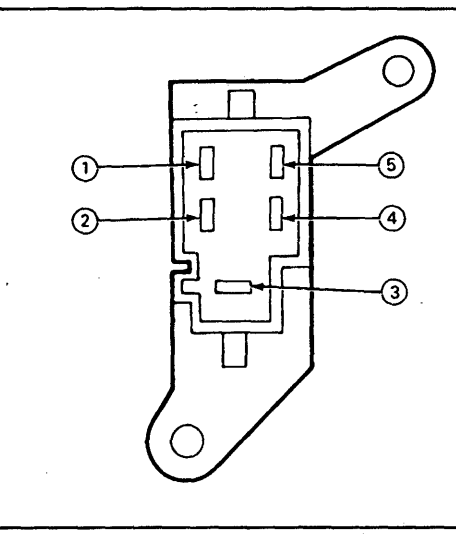


FIG. 4 Tailgate Switch Terminal Locations—Bronco

2. With the switch in the neutral position, there should be continuity between terminals 1 & 2 and terminals 3 & 4. Terminal 5 should be disconnected from all other terminals.
3. When the switch rocker knob is pushed up (to close the tailgate window), there should be continuity between terminals 1 & 2 and terminals 4 & 5. Terminal 3 should be disconnected from all other terminals.
4. When the switch rocker knob is pushed down (to open the tailgate window), there should be continuity between terminals 2 & 5 and terminals 3 & 4. Terminal 1 should be disconnected from all other terminals.
5. If the switch does not test as stated, replace the switch.

Power Window Motor Test

To test the current draw of a power window motor, remove the door trim panel. Refer to Section 45-03, Door Trim Panels.

Test Procedure

1. Disconnect the motor lead.
2. Disconnect the regulator mechanism from the motor.
3. Supply power to motor lead connector with an ammeter in series (Figs. 5 and 6).
4. Operate the motor and observe the current draw. The current draw for the no-load test should not exceed four amps and should not fluctuate.

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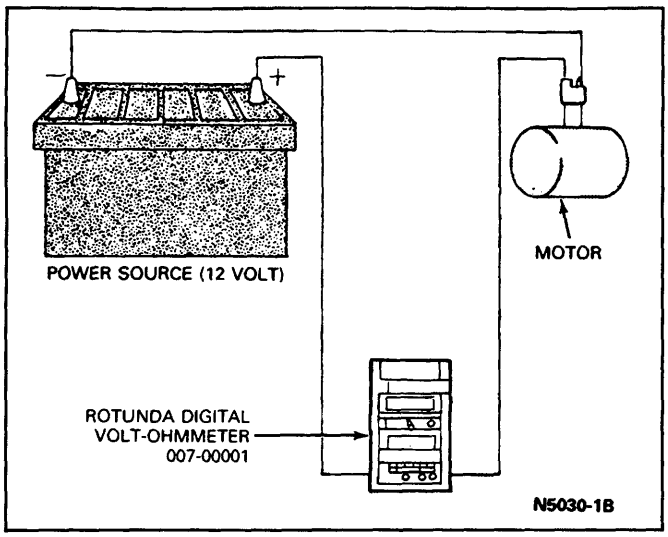


FIG. 5 Power Window Motor Current Draw Test—Permanent Magnet-Type

Reversal of the motor wire connections will reverse the direction of motor rotation. Replace the motor if the current draw exceeds four amps.

REMOVAL AND INSTALLATION

Power Window Switch E-150—E-350

Removal and Installation

1. To remove the power window switch, remove the bezel retaining screw (Fig. 7). Then, lift the bottom of the bezel from the door trim panel and remove the switch and bezel assembly.
2. Remove the wiring connector retaining screw from the back of the bezel. Then, using a thin-bladed screwdriver, carefully pry the switch from the connector.
3. To install, reverse Steps 1 and 2.

Power Window Switch F-150—F-350 and Bronco

Removal and Installation

Refer to Fig. 8.

The power window switches are located on the front door trim panels.

Removal

1. Insert a small, thin-bladed screwdriver into spring tab slots (located at front & rear of switch housing) and apply pressure to make the switch housing assembly pop out.
2. Remove three connector attaching screws from switch housing.
3. The switch is held in place by the electrical contact pins. To remove switch, carefully pry switch from connector with a small screwdriver.

Installation

1. Position switch to connector and press firmly into place.

   NOTE: The switch is keyed to the connector and can only be installed one way.

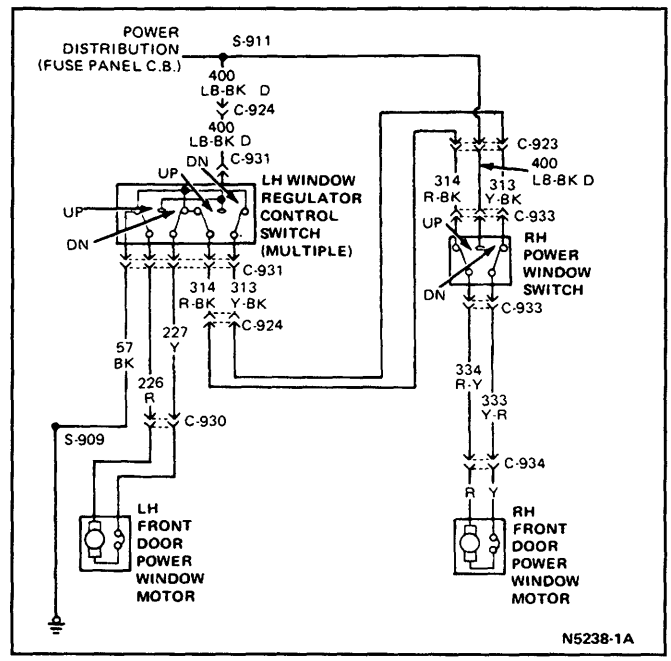


FIG. 6 Power Windows—Electric Schematic—E-150—E-350

2. Install connector to the switch housing using three attaching screws.
3. Position switch housing to door trim panel and press firmly into place.

Instrument Panel-Mounted Tailgate Switch—Bronco

Removal and Installation

The tailgate switch is located in the lower left finish panel on the instrument panel.

Removal

1. Remove headlamp switch knob and windshield wiper switch knob by releasing knob retaining clips and pulling knobs from their switch shafts.
2. Using a thin-bladed screwdriver (on a small putty knife) carefully pry off lower left finish panel by starting at upper left corner of finish panel and working counterclockwise around perimeter of finish panel.

NOTE: The finish panel is held in place by four retaining clips on the instrument panel, holding four plastic fingers on the finish panel. Care should be taken not to break the four plastic fingers when prying the finish panel off.

3. Remove two switch retaining screws and remove switch from finish panel.
4. Separate switch assembly from wiring harness by grasping wiring harness in one hand (close to the switch), switch in the other hand and pulling them apart.

Installation

1. Position wiring connector to switch and push them firmly together.
2. Position switch to finish panel and install two retaining screws.

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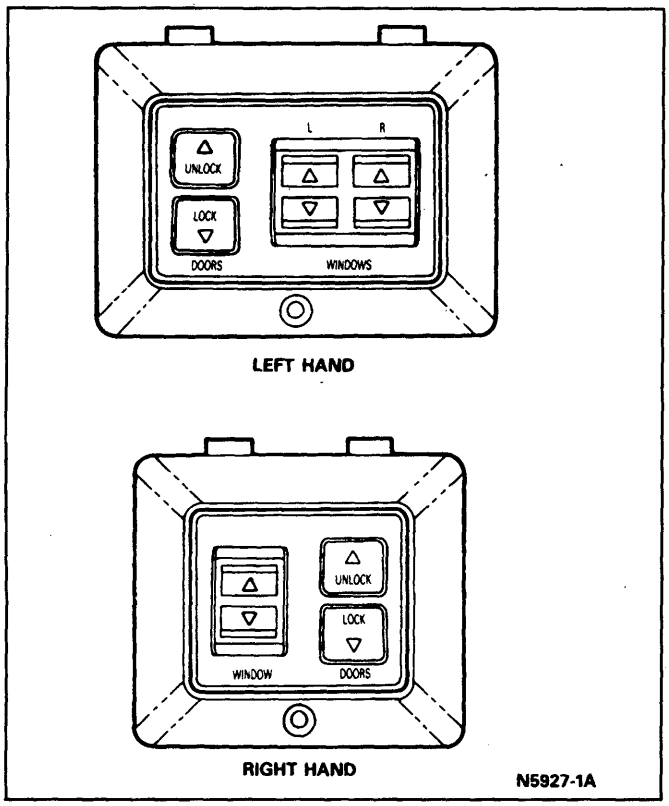


FIG. 7 Power Window Switches—E-150—E-350

3. Position finish panel to instrument panel taking care to align four plastic fingers with four retaining clips and press firmly into place.
4. Reinstall headlamp switch knob and windshield wiper switch knob.

Power Window Switch Connector Wire

Removal and Installation

If replacement of the switch connector or a wire leading to the connector is necessary, the wire(s) can be removed from the connector without disassembling the connector.

To remove a wire from the connector, insert a needle-like tool in the edge of the pin hole (Fig. 9), and bend the terminal in. Then, pull the wire and terminal from the connector. To install the terminal in the connector, open the terminal and insert it into the wire hole.

Power Window Motor

Removal

1. Disconnect the battery ground cable.
2. Remove the door trim panel.
3. Disconnect power window motor wire from wire harness connector (Fig. 10).
4. Check inside the door to ensure electrical wires are not in line with holes to be drilled in the door inner panel. Using a 12.7mm (1/2-inch) diameter drill bit, drill two holes in the door inner panel at the drill dimples located opposite the two unexposed motor drive retainer screws (Fig. 10).
5. Remove the three motor mount retainer screws using two drilled holes and existing larger hole access to screw heads (Fig. 10).
6. Push the motor toward the outside sheet metal to disengage the motor and drive from the regulator gear. After the motor and drive are disengaged, prop the window in full UP position.
7. Remove the motor and drive from inside the door.

Installation

1. Install a new motor and drive assembly (Fig. 10). Tighten motor retaining screws to 5.6-9.6 N·m (50-85 in-lb).
2. Install two pieces of Pressure-Sensitive Waterproof Tape D6AZ-19627-A or equivalent body tape (1 inch square) over drilled holes.
3. Connect power window motor wiring. Connect battery ground cable.
4. Remove glass prop and check window operation.
5. Ensure door drain holes are open.
6. Install trim panel.

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Number	Description
007-00001	Digital Volt-Ohm Meter

CN6078-1A

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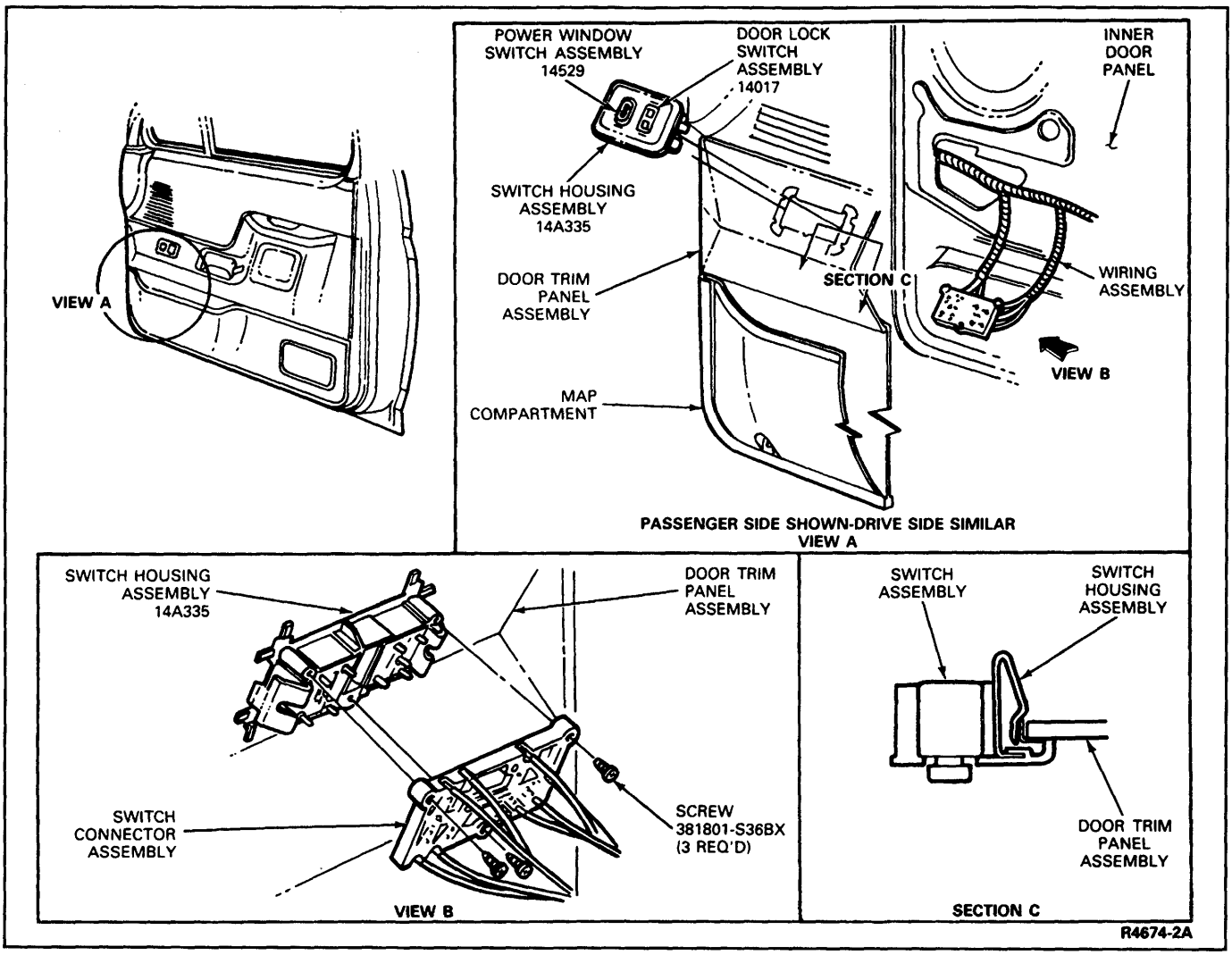


FIG. 8 RH Power Window Switch—F-150, F-250, F-350, Bronco

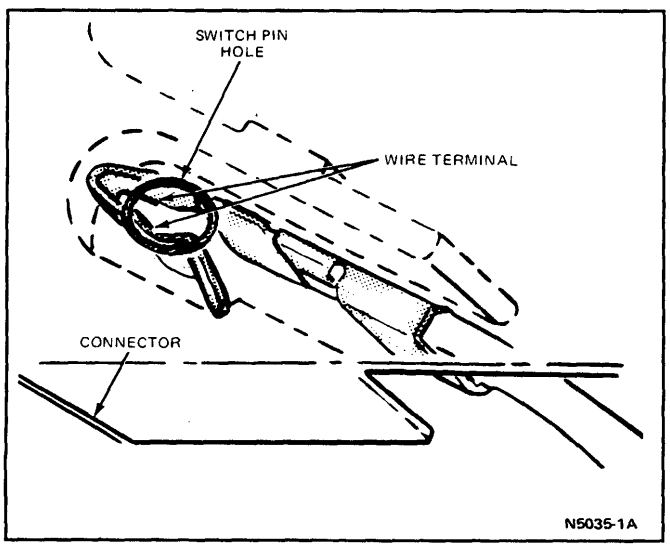


FIG. 9 Power Window Switch Connector Wire Terminal Removal

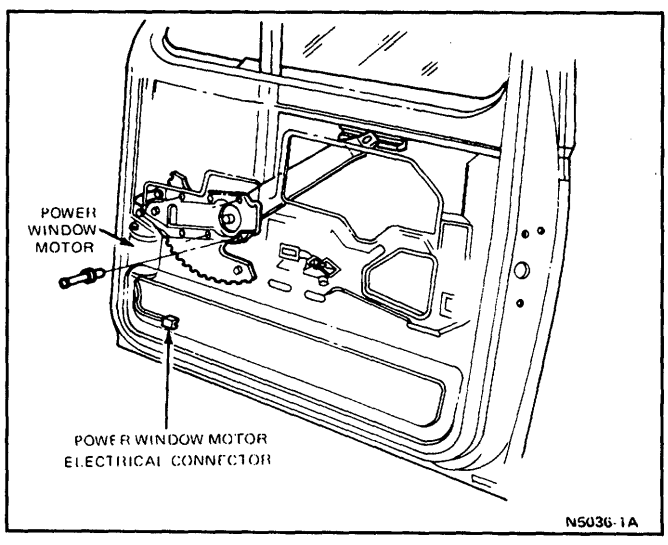


FIG. 10 Power Window Installation

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SECTION 42-15 Vent Window Mechanism

SUBJECT	PAGE
REMOVAL AND INSTALLATION	
Vent Window Assembly and/or Weatherstrip	42-15-1
Bronco and F-150—F-350	42-15-2
E-150—E-350	42-15-1
REMOVAL AND INSTALLATION (Cont'd)	
Vent Window Glass	42-15-1
All Models	42-15-1
SPECIAL SERVICE TOOLS	42-15-3
VEHICLE APPLICATION	42-15-1

VEHICLE APPLICATION

All Models.

REMOVAL AND INSTALLATION

Vent Window Glass

All Models

Removal

1. Open the vent window.
2. Push the glass from the glass frame using Glass and Channel Removal Tool 2900 or equivalent (Fig. 1).
3. Clean the glass frame of tape and sealer.

Installation

1. Apply sealer to the glass frame.
2. Install the glass and new tape in the glass frame using Glass and Channel Removal Tool 2900 or equivalent (Fig. 1).
3. Trim the excess edges of the tape around the glass frame and clean the glass and surrounding area.

Vent Window Assembly and/or Weatherstrip

E-150—E-350

Removal

1. Remove the trim panel from the door inner panel. Refer to Section 45-03, Door Trim Panels.

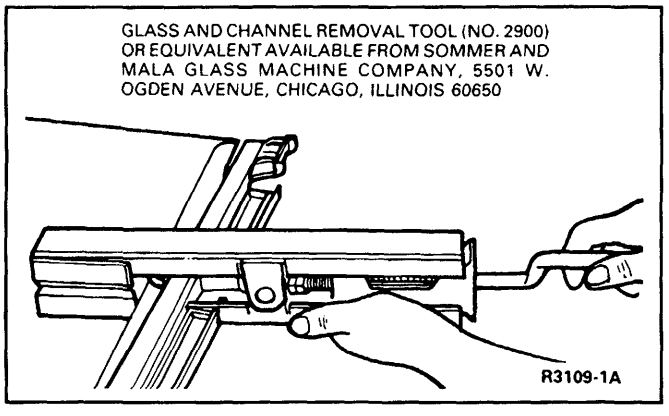


FIG. 1 Vent Glass Replacement

2. Remove three screws attaching the vent window assembly to the upper leading edge of the door (Fig. 2).
3. Remove one screw attaching the division bar bracket to the door (Fig. 2, View B).
4. Lower door glass to the down position.
5. Pull the front run out of the division bar.
6. Tilt the vent window and division bar assembly rearward. Then, remove the vent window and division bar from the door.
7. Remove two screws attaching the vent window upper pivot to the vent window frame.
8. Remove the nut, spring, spacer and bushing from the vent window lower pivot. Then, separate the vent window glass and frame from the vent window frame.
9. To remove the weatherstrip, remove two screws from the top of the vent window frame. Then, straighten the weatherstrip retaining tabs and remove the weatherstrip.

Installation

1. Position the weatherstrip to the vent frame.
2. Position the vent window upper pivot to the glass frame pivot and vent frame. Install the two attaching screws.
3. Position the glass frame to the vent frame and install spacer, bushing, spring and nut on the vent window lower pivot. Adjust the spring tension to hold the vent window in any position at highway speeds.
4. Position the vent window and division bar in the door.
5. Position the glass and channel assembly in the front division bar. Then, place the vent window assembly into position in the door. Install three screws attaching the vent frame to the upper leading edge of the door.
6. Insert the rear run into the slot along the top edge of the window opening.
7. Install the screw attaching the division bar bracket to the door.
8. Adjust the window glass runs.
9. Install the trim panel on the door inner panel. Refer to Section 45-03, Door Trim Panels.

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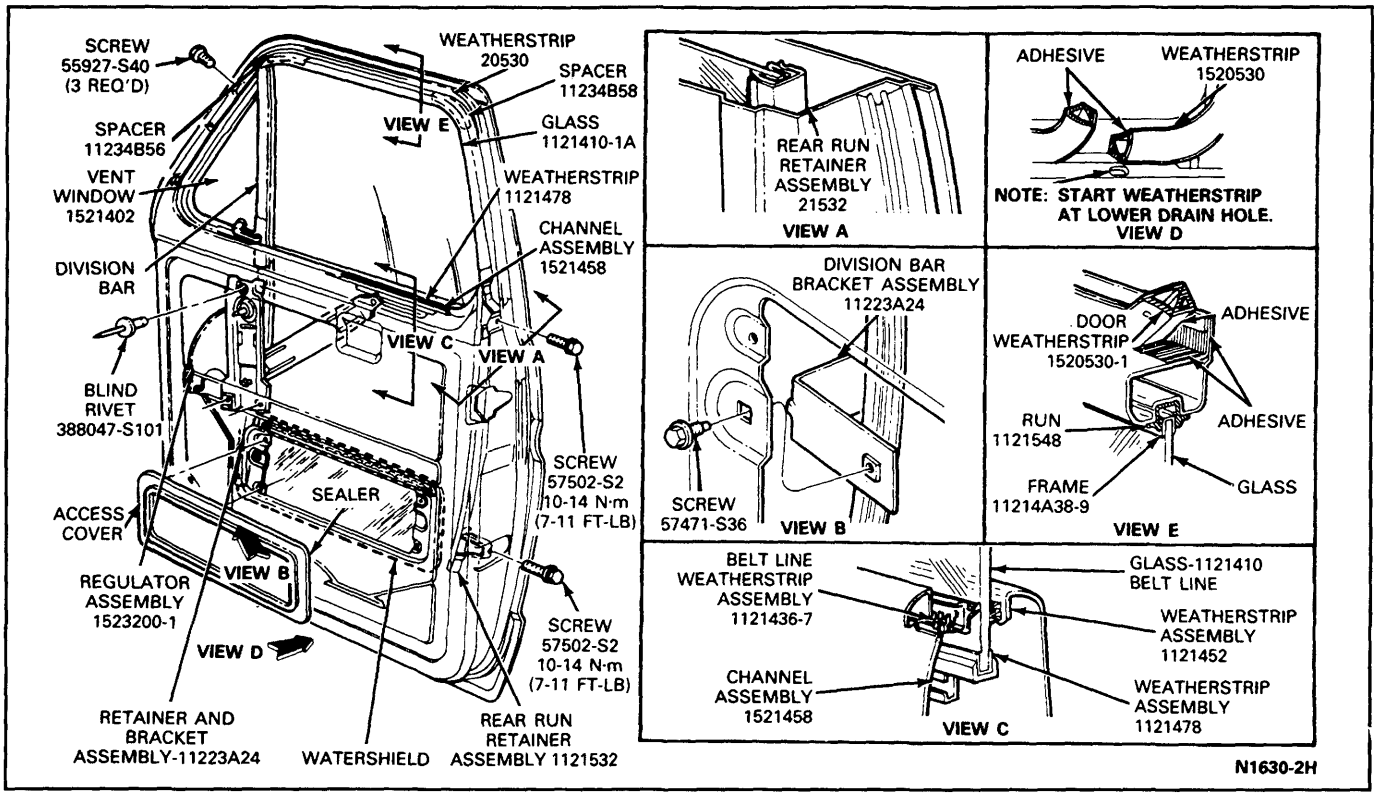


FIG. 2 Front Door Window Glass—E-150—E-350

Bronco and F-150—F-350

Removal

1. Remove the door trim panel retaining screws and remove the door trim panel.
2. Remove the screw retaining the division bar to the door inner panel (Fig. 3, Section A).
3. Remove the two screws attaching the vent assembly to the leading edge of the door.
4. Lower the door glass to full down position.
5. Pull the glass run part way out of the door run retainer in the division bar area (Section D).
6. Tilt the vent window and division bar assembly toward the rear of the door and remove the vent window assembly from the door.
7. Remove two vent upper pivot-to-vent frame screws.
8. Remove the retaining nut and tension spring from the vent window lower pivot.
9. Separate the vent glass retainer and the pivot stops from the vent frame and weatherstrip assembly.

Installation

1. Position the vent glass retainer assembly with the pivot stops into the vent window frame and weatherstrip assembly.
2. Install the two upper pivot-to-frame retaining screws.
3. Install the pivot tension spring and retaining nut. Adjust spring tension so that the vent will stay open at highway speeds.
4. Position the run assembly in the vent window assembly.
5. Position the vent window and division bar assembly into the door and to the glass edge. Ensure front door window spacer (Fig. 3, View E) is in place.
6. Install the vent window frame to leading edge of door window frame with two retaining screws.
7. Install the division bar screw (adjust the run for proper door window operation).
8. Install the door trim panel.

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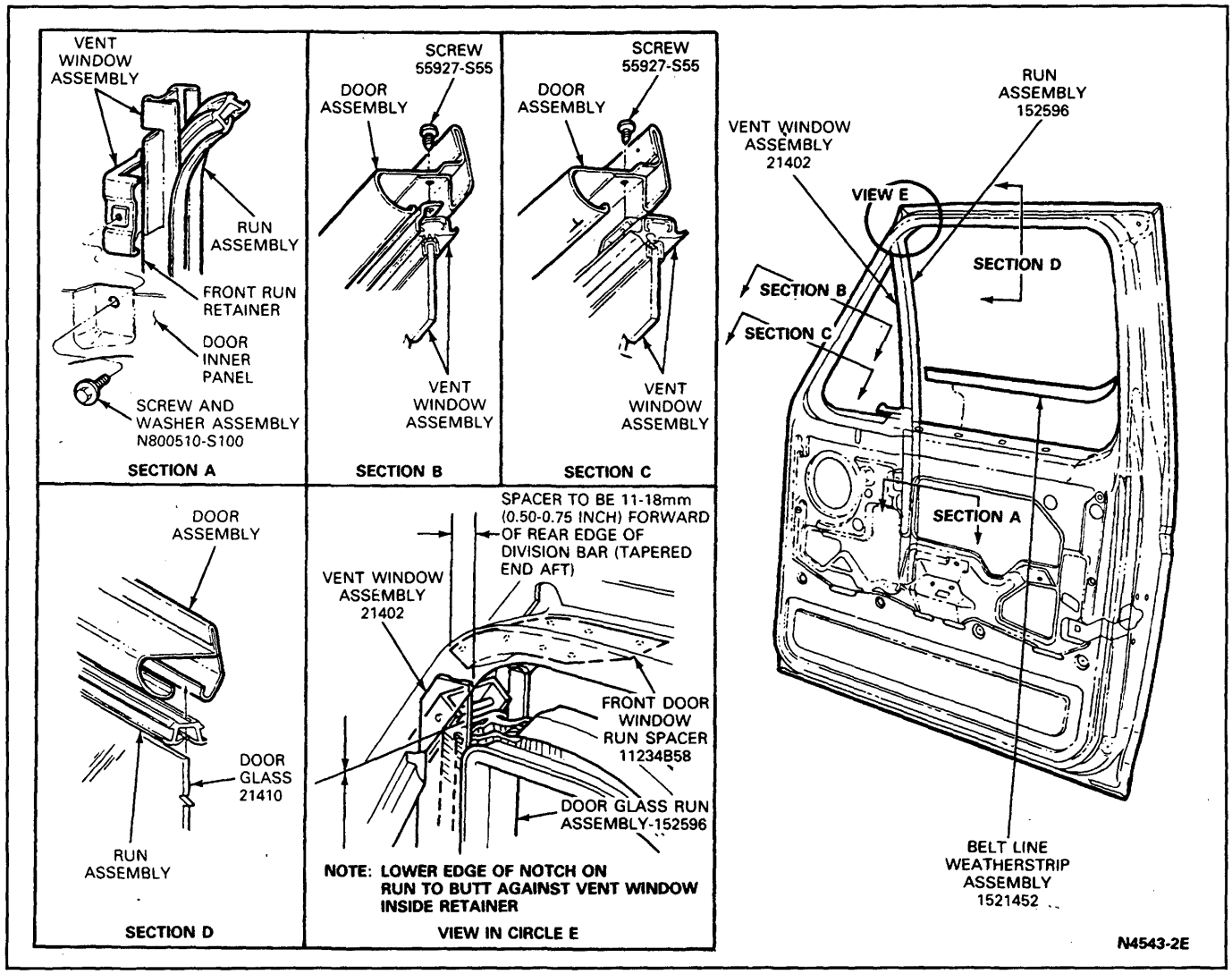


FIG. 3 Front Door Window Glass—F-Series and Bronco

SPECIAL SERVICE TOOLS

Tool Number	Description
2900	Glass and Channel Removal Tool

CN6016-1A

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SECTION 42-25 Pivot Type Rear Door and Side Window

SUBJECT	PAGE
REMOVAL AND INSTALLATION	
Movable Glass—Door and Body Side—(Back Doors Typical)	42-25-1
E-150—E-350 and Club Wagon	42-25-1
REMOVAL AND INSTALLATION (Cont'd)	
Movable Glass Weatherstrip	42-25-1
E-150—E-350 and Club Wagon	42-25-1
VEHICLE APPLICATION	42-25-1

VEHICLE APPLICATION

E-150 Through E-350.

REMOVAL AND INSTALLATION

Movable Glass—Door and Body Side—(Back Doors Typical)

E-150—E-350 and Club Wagon

Removal

1. Remove the trim panel, if so equipped, from the door. It is not necessary to remove the LH body side trim panel unless the plate on the body is to be removed.
2. Remove screws attaching the latch assembly and the latch anchor to the door or side inner panel. It is necessary to catch the loose tapping plate when removing the handle screws on the door flip windows (Figs. 1 and 2).
3. Remove glass and latch assembly by rotating it out to disengage the hinge.
4. To remove the hinge from the door or body, remove the four screws.

Installation

1. Center the hinge to the body. Tighten the four screws to 0.9-2.25 N·m (8-20 in-lb).
2. Engage the glass and latch assembly into the hinge. Rotate the hinge to a closed position.
3. Position the latch plate to the door or side inner panel. Position the latch anchor inside the door and install the attaching screws. The latch anchor is attached to the body side inner panel when equipped with garnish mouldings (Figs. 1 and 2). Tighten the screws to 3-8 N·m (2-6 ft-lb).
4. Install the door trim panel, if so equipped.

Movable Glass Weatherstrip

E-150—E-350 and Club Wagon

Removal and Installation

1. To remove weatherstrip open the window and pull the weatherstrip from the window opening.
2. Apply Weatherstrip Adhesive C0A2-19552-A or equivalent to both sides of the window opening flange around the entire perimeter of the opening.
3. Install the weatherstrip onto the window opening flange as shown in Figs. 1 and 2.
4. Apply Ford Silicone Lubricant D7AZ-19553-A or equivalent to outside surface of weatherstrip along entire top and 10 cm (4 inches) on each side at top.

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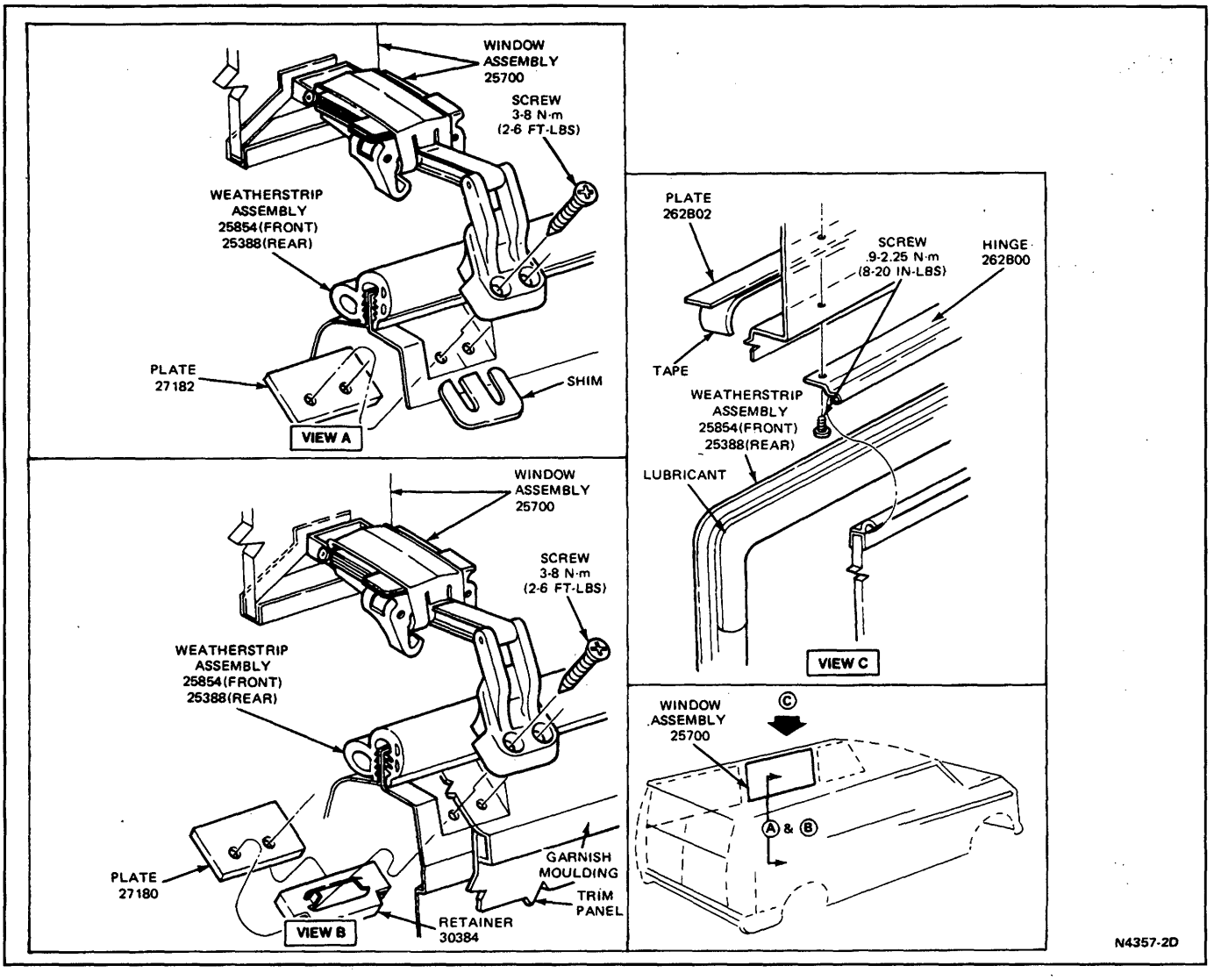


FIG. 1 Body Side Pivot Windows—E-150—E-350, Club Wagon

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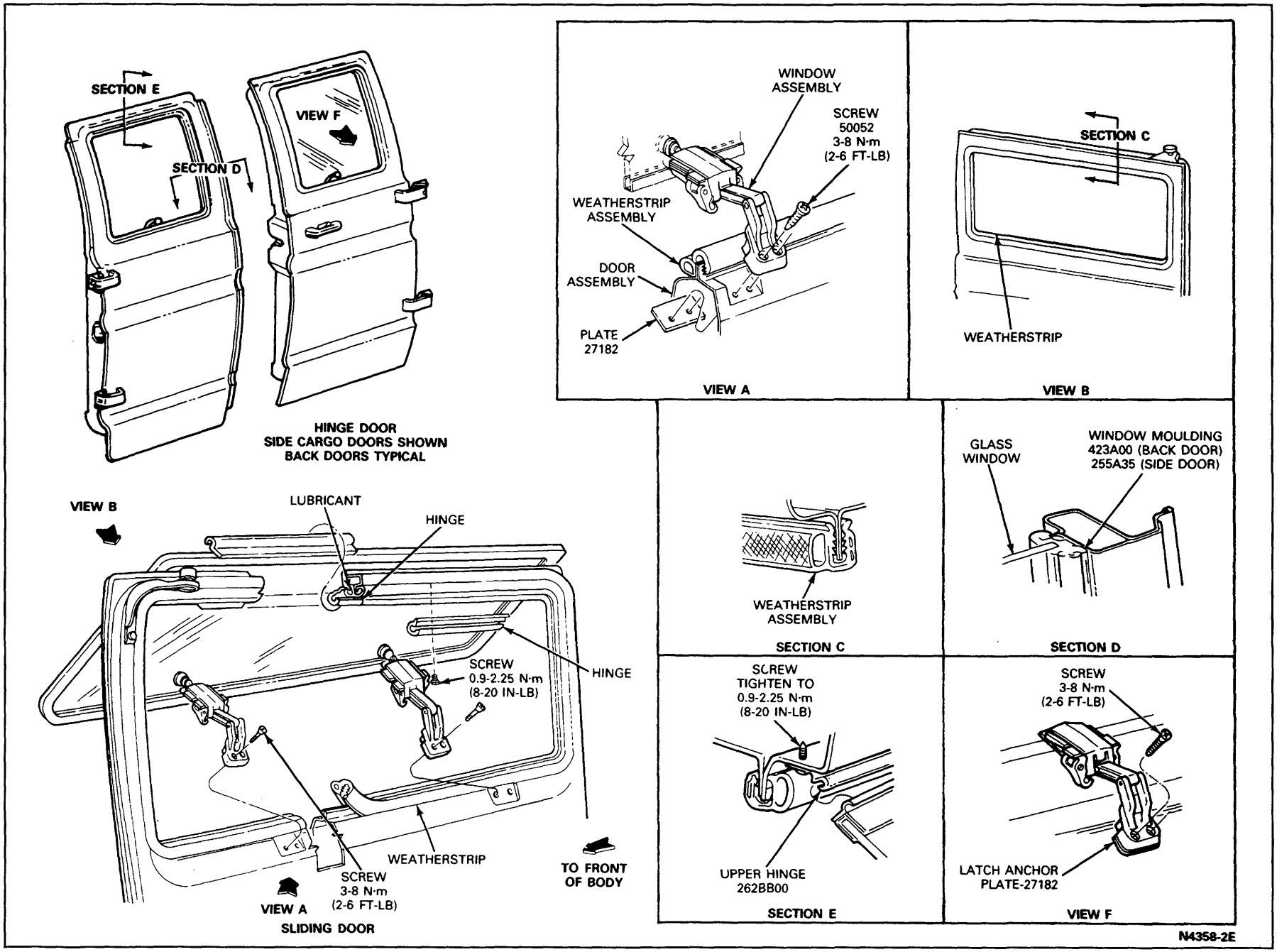


FIG. 2 Sliding Door Pivot Windows—E-150—E-350, Club Wagon

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SECTION 42-30 Rear Door Window Glass and Mechanisms

SUBJECT	PAGE
REMOVAL AND INSTALLATION	
Fixed Windows	42-30-1
VEHICLE APPLICATION	42-30-1

VEHICLE APPLICATION

Crew Cab Only.

REMOVAL AND INSTALLATION

Fixed Windows

Removal

1. Remove the door latch trim cup, armrest and window regulator handle. Remove door trim panel. Refer to Section 45-03, Door Trim Panels.
2. Remove one screw at top of door and one screw on door inner panel retaining division bar to door (Figs. 1 and 2).
3. With movable window in the down position, remove division bar by pulling it toward rear of vehicle and lifting up, while twisting bar so that the bracket clears the window glass opening and the weatherstrip slides off.
4. Raise movable window half way up, slide the regulator out of the window glass channel, and remove the window from the window opening.
5. Pull fixed window and weatherstrip towards rear of vehicle as an assembly and remove.

Installation

1. Install weatherstrip to fixed window (Fig. 3).
2. Position fixed window and weatherstrip as an assembly into the window opening, align in channels, and slide towards front of vehicle until it is firmly seated.
3. Install the movable window into the window opening and while supporting window in half open position, slide window regulator into window glass channel.
4. Install division bar into the window opening.
5. Install movable window weatherstrip into division bar and onto top of movable window.
6. Align movable window into division bar run. Install one screw at top of door and one bolt to front of door to retain division (Figs. 1 and 2) bar. Tighten to specifications.
7. Cycle window and check for looseness or binding. Adjust channel as necessary by loosening rear window run retaining bolt and moving rear window run forward or rearward. Tighten rear window run screw securely as specified.
8. Install door trim panel. Refer to Section 45-03, Door Trim Panels.
9. Install the armrest with two bolts and the door latch trim cup with one screw.
10. Install the window regulator handle with one screw.

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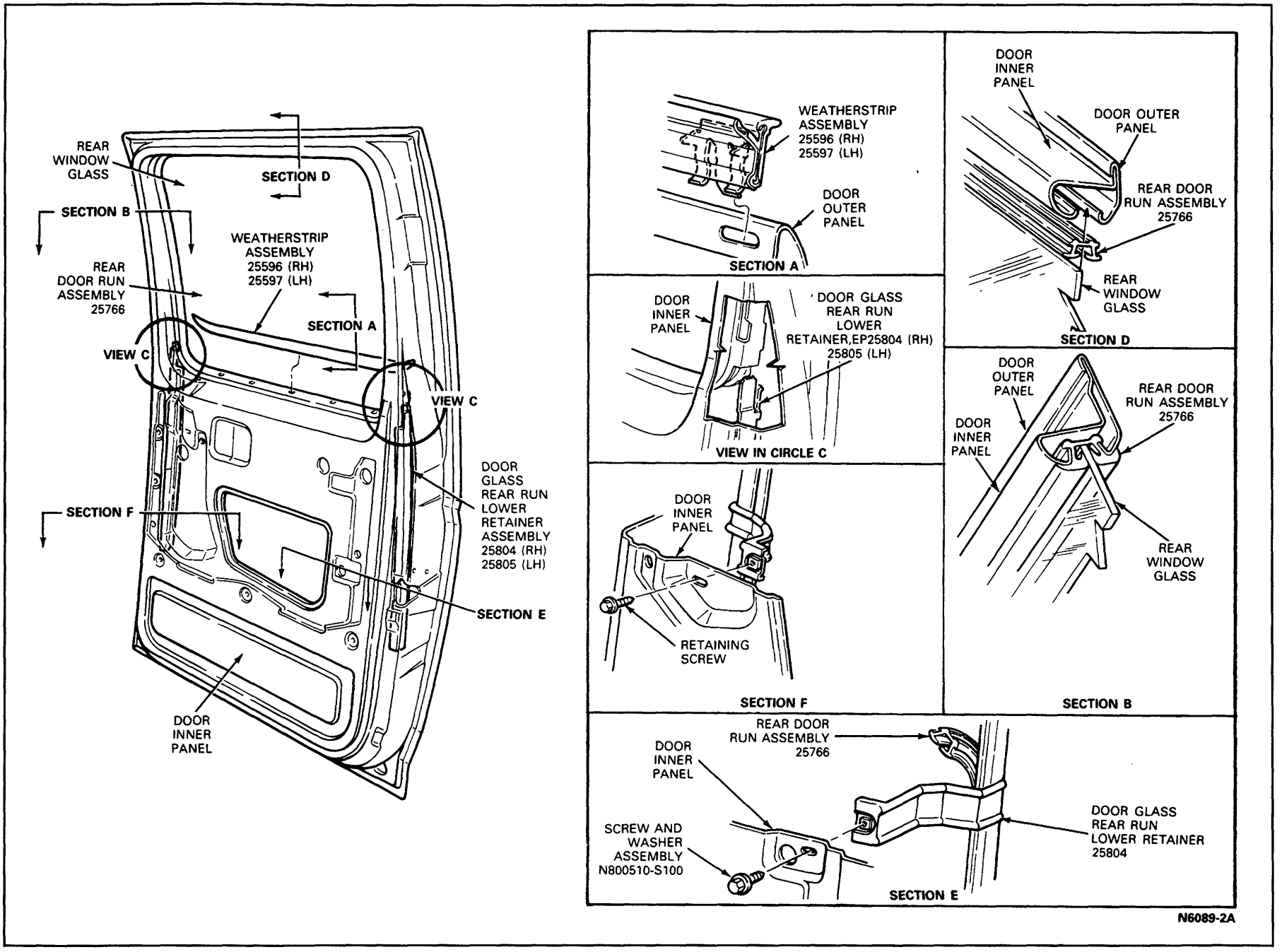


FIG. 1 Crew Cab Rear Door Window, Weatherstrips and Retainers

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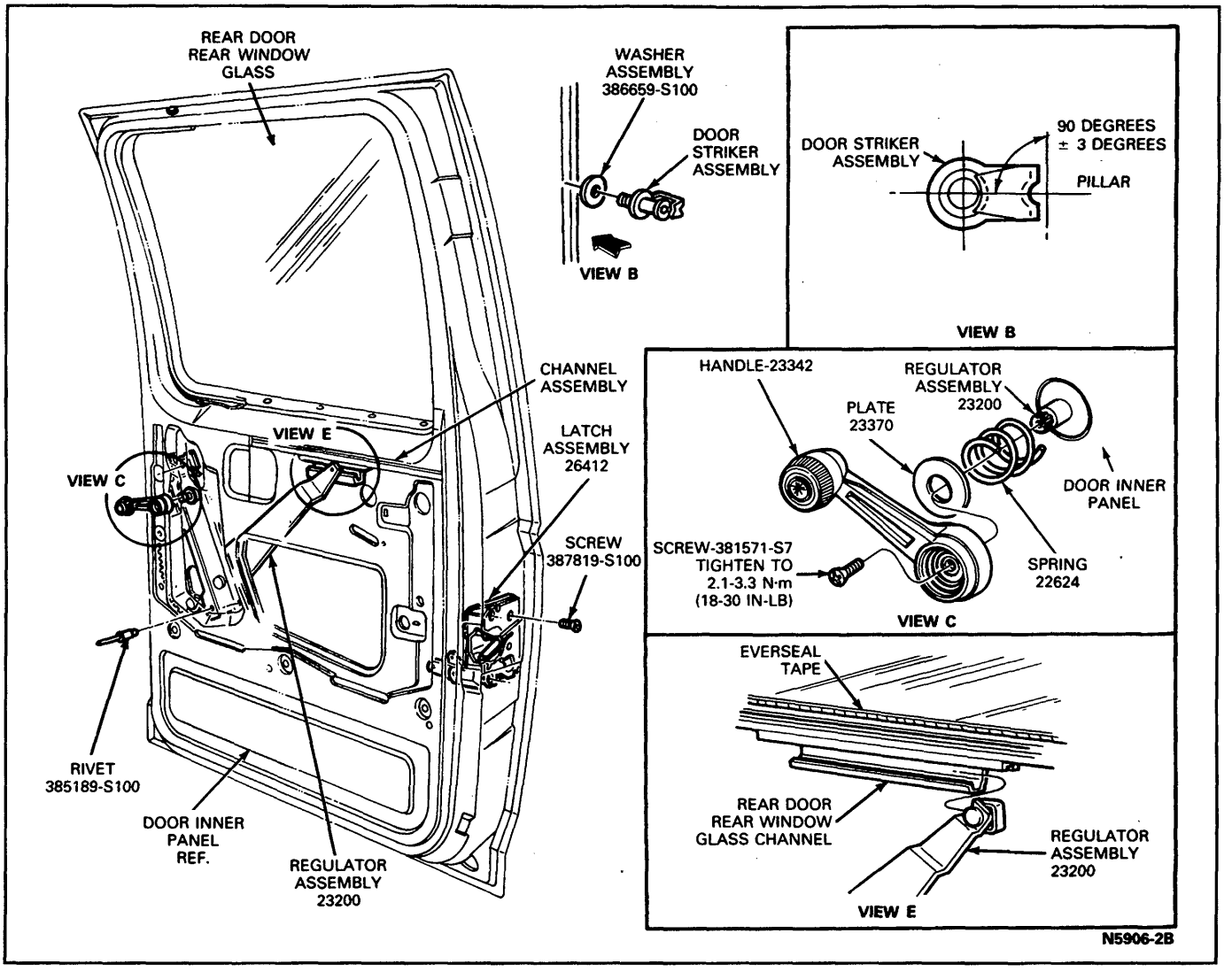


FIG. 2 Crew Cab Rear Door Window Mechanisms

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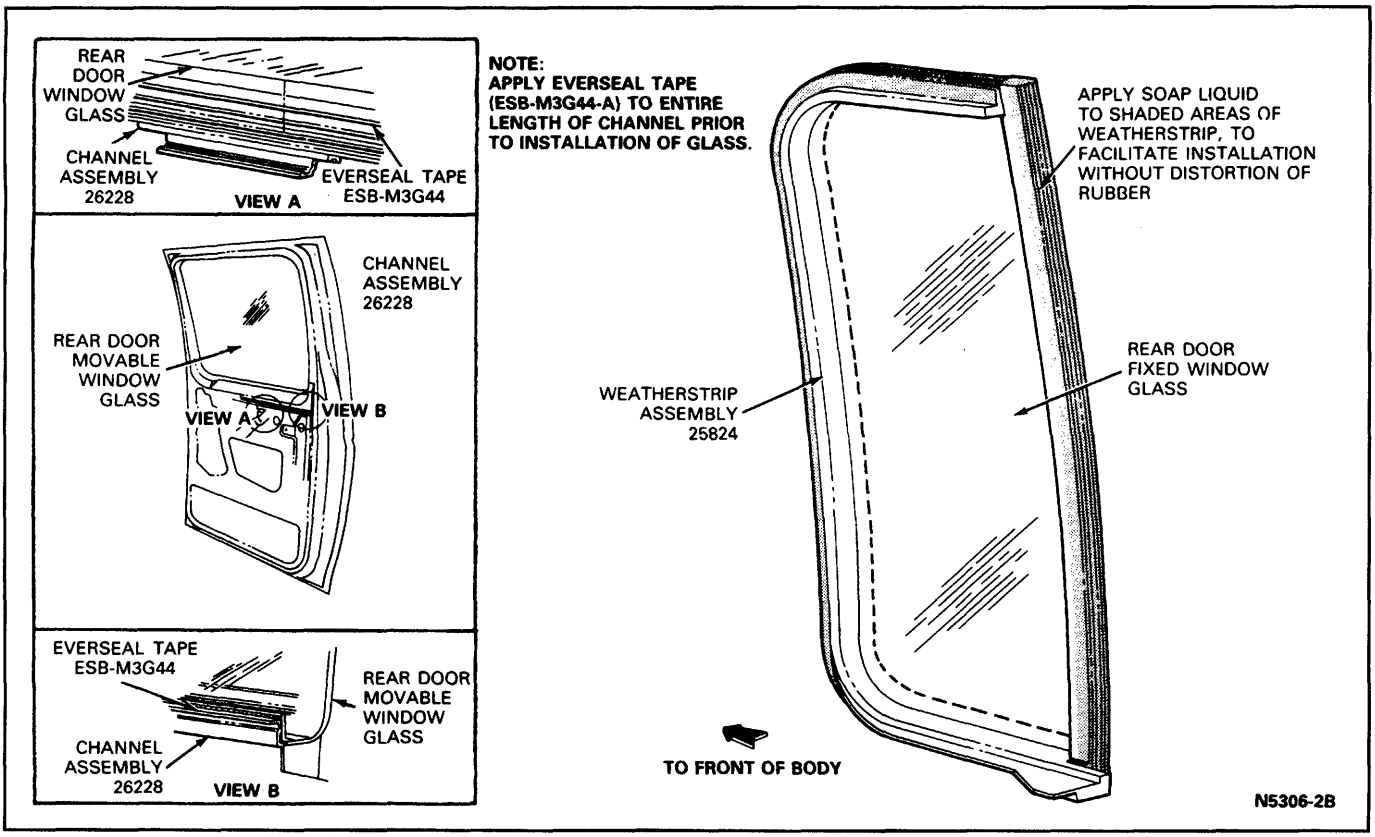


FIG. 3 Crew Cab Rear Door Window Glass

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SECTION 42-35 Tailgate Window Mechanisms

SUBJECT	PAGE
ADJUSTMENTS	
Tailgate Glass	42-35-2
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REMOVAL AND INSTALLATION	
Glass	42-35-2
Lock Cylinder	42-35-5
Tailgate Window Regulator Electric Motor	42-35-4
REMOVAL AND INSTALLATION (Cont'd)	
Tailgate Window Regulator Switch	42-35-4
Window Regulator	42-35-5
TESTING	
Tailgate Window Motor Test	42-35-1
Tailgate Window Switch Tests (Instrument Panel Mounted)	42-35-1
VEHICLE APPLICATION	42-35-1

VEHICLE APPLICATION

Bronco.

DESCRIPTION

The tailgate window regulator is electrically operated by either the key switch located on the tailgate or the switch located on the instrument panel (Fig. 1).

TESTING

Tailgate Window Motor Test

To test the current draw of a power window motor, remove the tailgate trim panel. Refer to Section 45-03, Door Trim Panels.

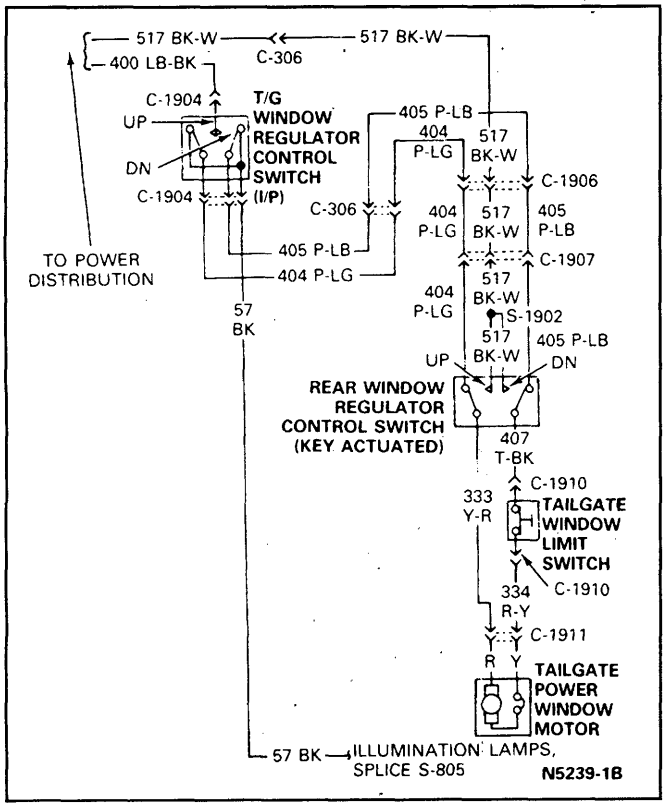


FIG. 1 Tailgate Power Window Electrical Schematic

Test Procedure

1. Disconnect the motor lead.
2. Supply power to motor lead connector with an ammeter in series as shown in Fig. 2.
3. Operate the motor and observe the current draw. The current draw for the no-load test should not exceed four amps and should not fluctuate. Reversal of the motor wire connections will reverse the direction of motor rotation. Replace the motor if the current draw exceeds four amps.

WARNING: COUNTERBALANCE SPRING IS UNDER TENSION! BEFORE REMOVING THE MOTOR TO TEST THE NO-LOAD CURRENT, USE THE CONTROL SWITCH TO MOVE THE REGULATOR UP, THUS REDUCING SPRING TENSION. THEN, LOCK/CLAMP THE SECTOR GEARS SECURELY.

Tailgate Window Switch Tests (Instrument Panel Mounted)

Refer to Fig. 3.

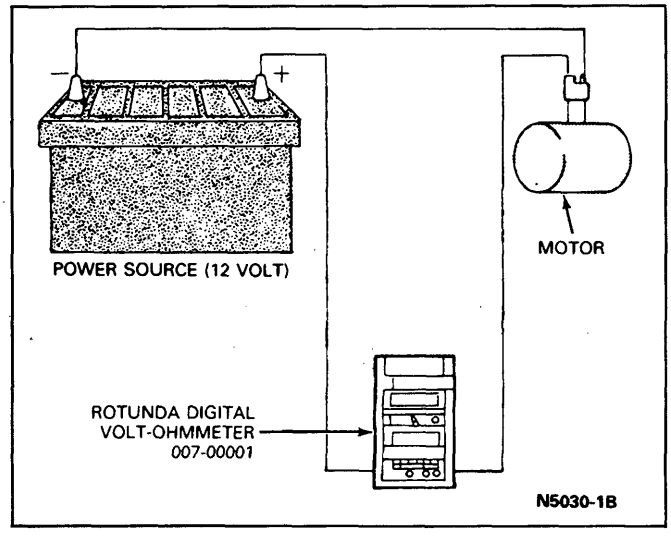


FIG. 2 Power Window Motor Current Draw Test—Permanent Magnet Type Motor

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Test Procedure

Testing of the tailgate-mounted window switch can be performed with the switch installed in the vehicle. Use a self-powered test lamp or an ohmmeter.

1. With the switch in the neutral position, there should be continuity between terminals 1, 2 and 3.
2. With the key rotated clockwise (window UP) there should be continuity between terminals 1 and 5, and 2 and 4.
3. With the key rotated counterclockwise (window DOWN) there should be continuity between terminals 2 and 5, and 3 and 4.
4. If the switch does not test as stated, replace the switch.

ADJUSTMENTS

Tailgate Glass

Fore-and-aft adjustments can be made after opening the tailgate by loosening the back window side glass run attaching screws (2 per side) (Fig. 4). Adjust the glass as required and tighten the attaching screws to 9-14 N·m (6-11 ft-lb) (Fig. 4).

REMOVAL AND INSTALLATION

Glass

Removal

1. Open tailgate.
2. Remove inside cover access panel (10 screws) (Fig. 4).
3. Remove inside cover watershield.
4. Remove inside cover panel support (1 screw) (Fig. 4).
5. Cut templates from template sheet. Position template for center punching holes on tailgate inner panel (Figs. 5 and 6).

   NOTE: Refer to local authorized Ford dealer to receive template. The templates shown in this manual are not actual size.

   NOTE: Prior to center punching holes, the technician can eye the center punch with glass bracket retainer nuts to ensure hole location is directly aligned.
6. Cover glass with protective cover prior to drilling four holes in tailgate inner panel.
7. Using a 16mm (5/8-inch) diameter hole saw, drill four holes in tailgate inner panel at four template hole locations (Fig. 7).
8. Clean drillings from area.
9. Using each drilled access hole, remove the four glass bracket retainer rivets.
10. Using undersize 8mm (5/16-inch) drift punch, remove glass bracket C-channel from glass and glass bracket to separate tailgate glass (Fig. 7).
11. Remove protective cover and drillings.
12. Reaching through tailgate panel access holes, grasp glass bottom edge cutouts and slide glass to half-open position.
13. If tailgate has heated glass option, disconnect two terminals (driver side).
14. Slide glass from tailgate assembly.

Installation

1. Slide glass midway into tailgate assembly.
2. Connect heated glass wires, if so equipped.
3. Install glass bracket C-channels onto the regulator arm slide guides.
4. Position tailgate glass over glass bracket C-channel studs and install four rivets.
5. Lower glass to connect heated glass wiring terminals.

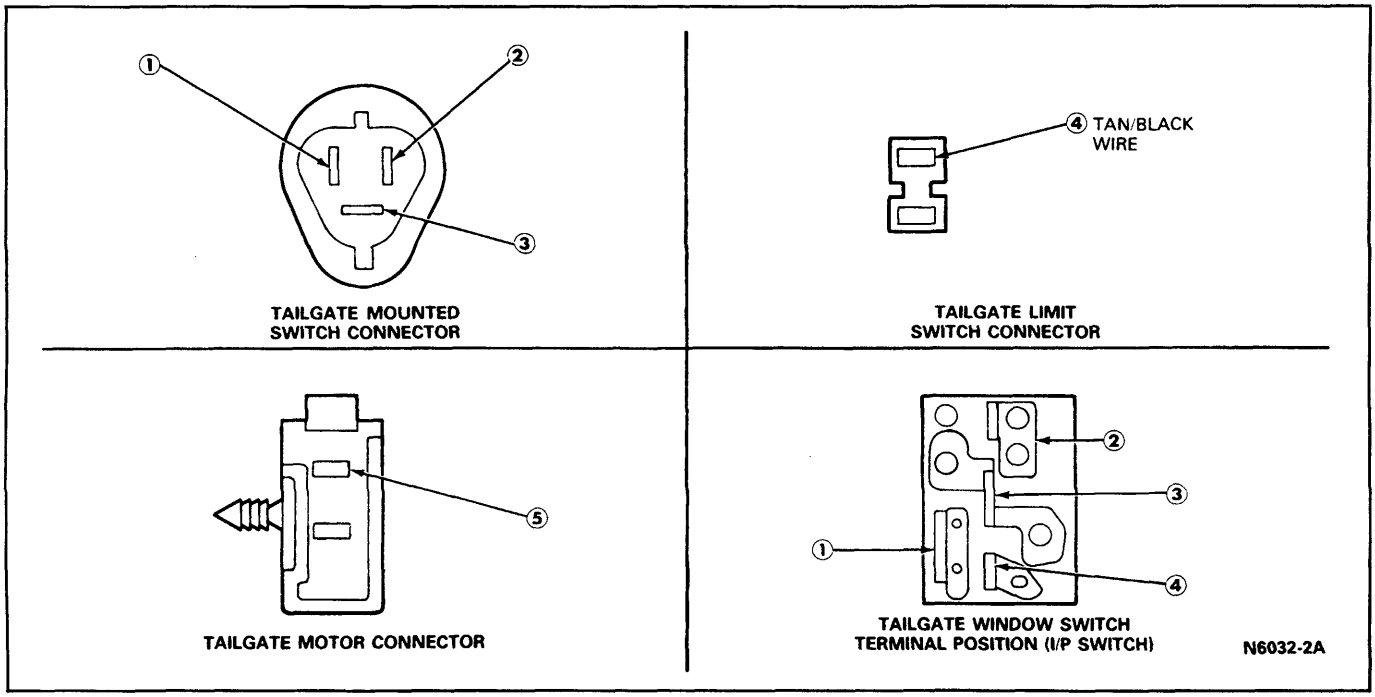


FIG. 3 Tailgate Window Terminal Position

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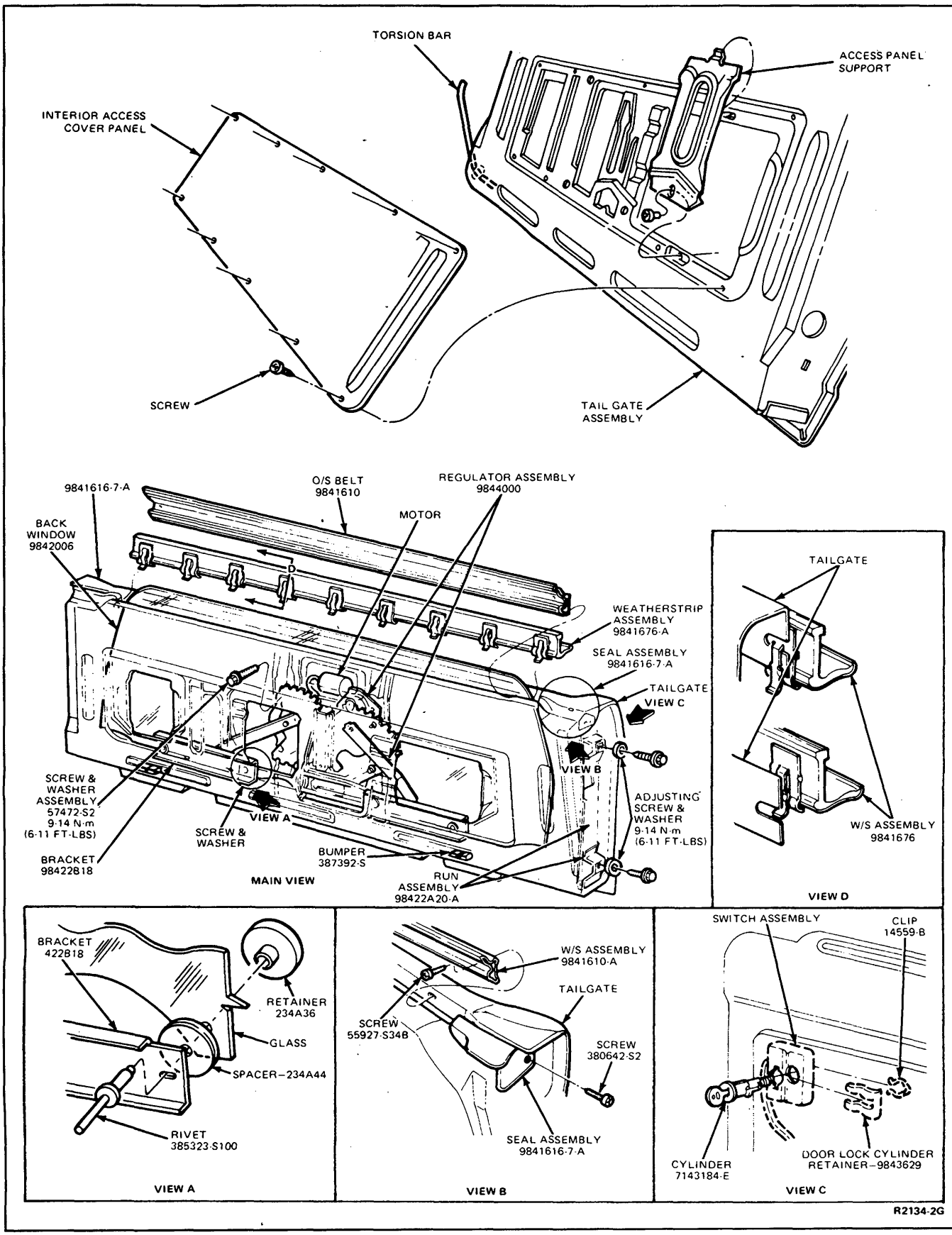


FIG. 4 Tailgate Window Mechanism and Belt Weatherstrips—Bronco

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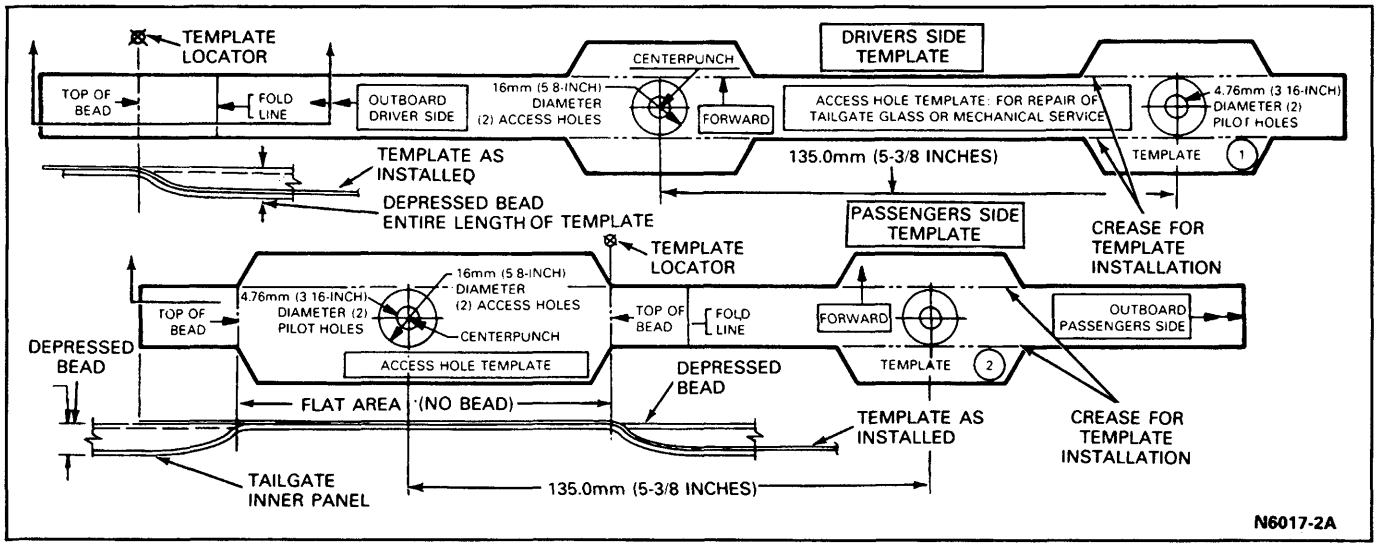


FIG. 5 Tailgate Template

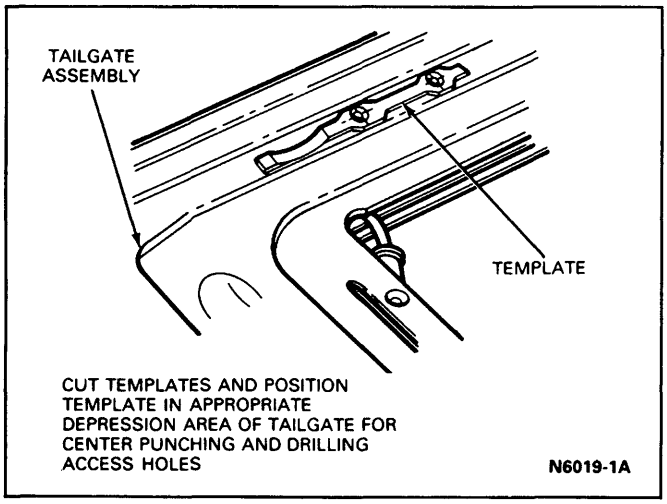


FIG. 6 Tailgate Template Placement

6. Close tailgate and cycle glass to ensure smooth operation.
7. Open tailgate and apply body color touch-up paint to drilled hole surfaces.
8. Install inside cover panel support (1 screw).
9. Install watershield.
10. Install ten inside cover access panel screws.
11. Install four 5/8-inch diameter rubber plugs (376966-S) in four drilled holes.
12. Close door and cycle tailgate to ensure proper function.

Tailgate Window Regulator Switch (Instrument Panel Mounted)

Removal and Installation

1. Remove climate control head from instrument panel.
2. Disconnect switch wiring connector.

   NOTE: At this point the switch can be tested.
3. Remove switch knob by depressing the retaining clip that holds the knob to the switch shaft.
4. Remove the switch retaining screw and remove the switch from the climate control head.
5. To install, reverse Steps 1 through 4.

Tailgate Window Regulator Switch (Tailgate Mounted)

Removal

1. Remove interior access cover panel.
2. Raise glass. If glass cannot be raised, remove glass as outlined.
3. Disconnect wiring harness.
4. Detach switch from lock cylinder by removing clip and remove from tailgate (Fig. 4).

Installation

1. Install switch on lock cylinder and install clip (Fig. 4).
2. Connect wiring harness.
3. Check operation of switch.
4. Install interior access cover panel.

Tailgate Window Regulator Electric Motor

Removal

Refer to Window Regulator Removal.

1. Raise glass to full up position. If glass cannot be raised, remove glass as outlined.
2. Disconnect motor wiring harness (Fig. 4).

WARNING: COUNTERBALANCE SPRING IS UNDER TENSION! TO PREVENT INJURY FROM SUDDEN MOVEMENT OF REGULATOR COMPONENTS, CLAMP/LOCK GEAR SECTORS TO ALLOW SAFE MOTOR REMOVAL.

3. Detach and remove electric motor from tailgate.

Installation

1. Position electric motor in tailgate and secure to regulator (Fig. 4).
2. Connect wiring harness.
3. Check operation of electric motor.

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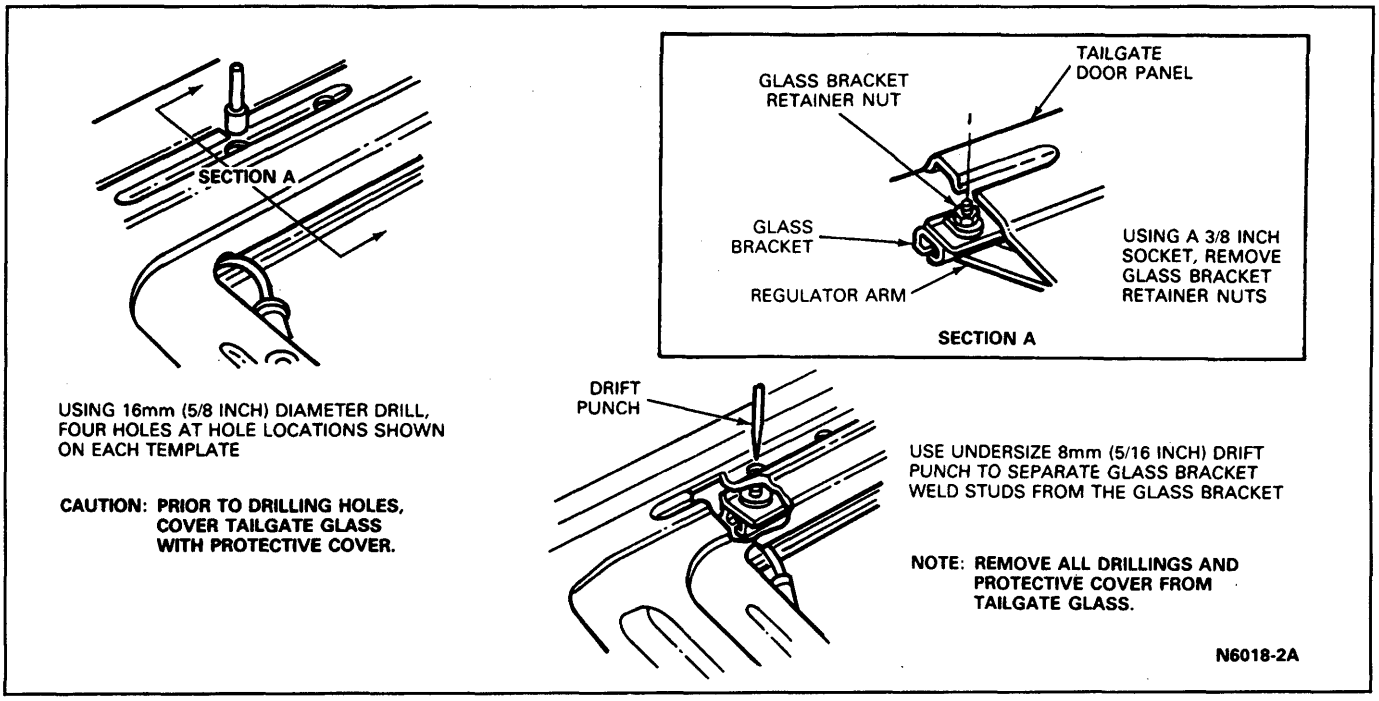


FIG. 7 Bracket Removal, Tailgate Glass

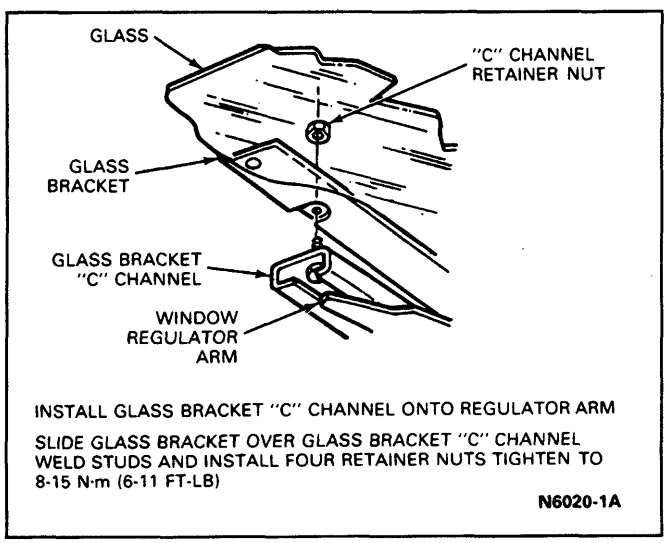


FIG. 8 Bracket Installation, Tailgate Glass

4. Install interior access cover.

Window Regulator

Removal

1. Lower tailgate and remove interior access cover panel (10 screws). If tailgate will not lower because glass will not go full down, manually depress safety lockout rod (located in bottom center of tailgate).
2. Raise glass using jumper to motor (or manually close L.H. tailgate latche) (Refer to Fig. 1). If the glass will not go up, glass must be removed as outlined.
3. Remove regulator attaching screw and washer assemblies.
4. Remove regulator.

Installation

1. Position regulator in tailgate and secure with four screw and washer assemblies (Fig. 4). Tighten to 9-14 N·m (6-11 ft-lb).
2. Install glass as outlined.
3. Check operation of regulator.
4. Install interior access cover panel.

Lock Cylinder

Removal

1. Remove interior access cover panel.
2. Raise glass. If glass cannot be raised, remove glass as outlined.
3. Remove lock cylinder retainer (Fig. 4).
4. Disengage lock cylinder from switch and remove from tailgate.

Installation

1. Position lock cylinder to tailgate and engage in switch.
2. Secure lock cylinder with retainer.
3. Check operation of lock cylinder and switch.
4. Install interior access cover panel.

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GROUP 43 STATIONARY WINDOW GLASS

(70000)

SECTION TITLE	PAGE
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STATIONARY GLASS—WEATHERSTRIP TYPE SEAL	43-01-1

SECTION 43-01 Stationary Glass—Weatherstrip Type Seal

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VEHICLE APPLICATION	43-01-1

VEHICLE APPLICATION

E-150—E-350, F-150—F-350 and Bronco.

REMOVAL AND INSTALLATION

Back Window

F-150—F-350

An assistant outside the vehicle is necessary when removing or replacing the glass.

Removal

Refer to Fig. 1.

1. From the interior of the vehicle, pull down the weatherstrip. Push the back window glass and weatherstrip out of the window opening from inside the cab while an assistant grasps the window from outside the cab.
2. Remove the weatherstrip from the glass. Clean all sealer from the weatherstrip and/or glass, if either is to be reused.
3. Clean all sealer from the back window opening.

Installation

1. Install the outside moulding, if so equipped. Position the weatherstrip to the back window glass.
2. Install a draw cord all around the weatherstrip in the flange crevice (Fig. 2), allowing the cord to overlap at the bottom center of the glass. Coat the weatherstrip mounting surface with Rubber Lubricant D9AZ-19583-A or equivalent.
3. Apply Liquid Butyl Sealer C9AZ-19554-B or equivalent to the back window opening as shown in Fig. 1.
4. Position the glass and weatherstrip to the window opening. With an assistant applying hand pressure from outside the cab, pull (from inside) the weatherstrip lip over the window opening flange with the draw cord. Pull the weatherstrip over the lower flange, pulling one end of the cord at a time. Then, pull the weatherstrip over the side flanges and upper flange.
5. Clean the glass and the area around the window to remove all excess sealer.
6. Test for water leaks.

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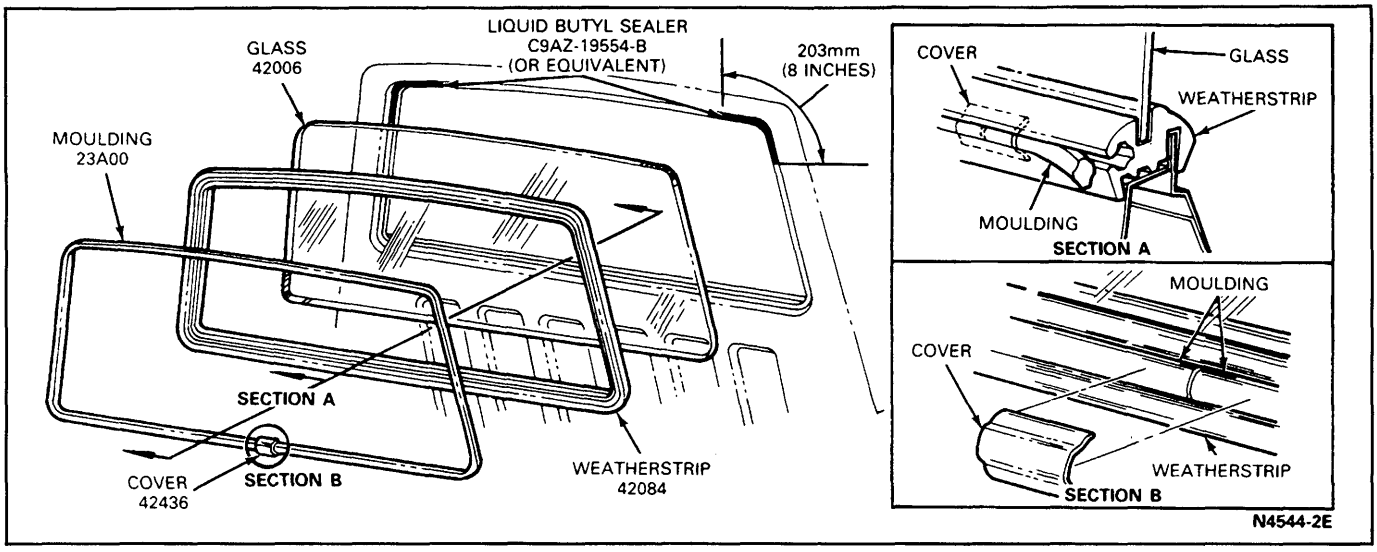


FIG. 1 Stationary Back Window Installation—F-150—F-350

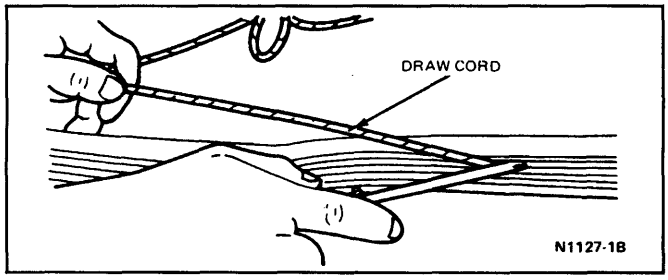


FIG. 2 Draw Cord Installation—Typical

Rear Side Window Glass

Refer to Fig. 3.

Bronco

An assistant outside the vehicle is necessary when removing or replacing the glass.

Removal

1. Working from inside, start at one corner and work across the top of the glass, pulling the weatherstrip down and pushing the glass and weatherstrip outward until the assistant can grasp the glass and lift it from the glass opening.
2. Remove the weatherstrip from the glass (Fig. 3).

Installation

1. Clean the weatherstrip with cleaning solvent to remove all old sealer and cement.
2. Clean the glass opening flange. Check the flange for wavy areas, and repair as necessary.
3. Apply Liquid Butyl Sealer C9AZ-19554-B or equivalent in the glass crevice of the weatherstrip. Install it on the glass.
4. Apply a bead of Liquid Butyl Sealer C9AZ-19554-B or equivalent between the secondary sealing fins of the weatherstrip (Fig. 3).
5. Install a draw cord all around the weatherstrip in the flange crevice (Fig. 2). Let the draw cord overlap at the bottom center approximately 457mm (18 inches) and tape the ends of the draw cord to the inside of the glass. Apply Rubber Lubricant D9AZ-19583-A or equivalent to the weatherstrip lip.
6. Have an assistant position the window assembly in the window opening and apply hand pressure on the glass from the outside. From the inside, draw the lip of the weatherstrip over the window opening lower flange with a draw cord. Alternate from side to side, moving approximately 305mm (12 inches) at a time, until the window is in place.
7. Water test the installation for leaks, and seal with additional Liquid Butyl Sealer C9AZ-19554-B or equivalent, if necessary.

Quarter Window

F-150—F-350 Super Cab

Removal

1. Remove interior rear quarter trim panel. Refer to Section 45-11, Quarter Trim Panels.
2. Remove nuts securing moulding assembly (Fig. 4).
3. Remove window assembly and seal.

Installation

1. Position window assembly and seal to vehicle.
2. Install nuts securing moulding assembly (Fig. 4).
3. Install interior rear quarter trim panel. Refer to Section 45-11, Quarter Trim Panels.
4. Test for water leaks.

Body Side and Rear Window Glass

E-150—E-350

Removal and Installation

NOTE: Mouldings can be installed on the bench prior to window installation.

1. Loosen the weatherstrip around the inside and outside of the window opening (Fig. 5).
2. From the inside of the vehicle, push the glass and weatherstrip from the window opening.
3. Remove the weatherstrip from the glass.
4. Clean the weatherstrip and body opening to remove all old sealer.

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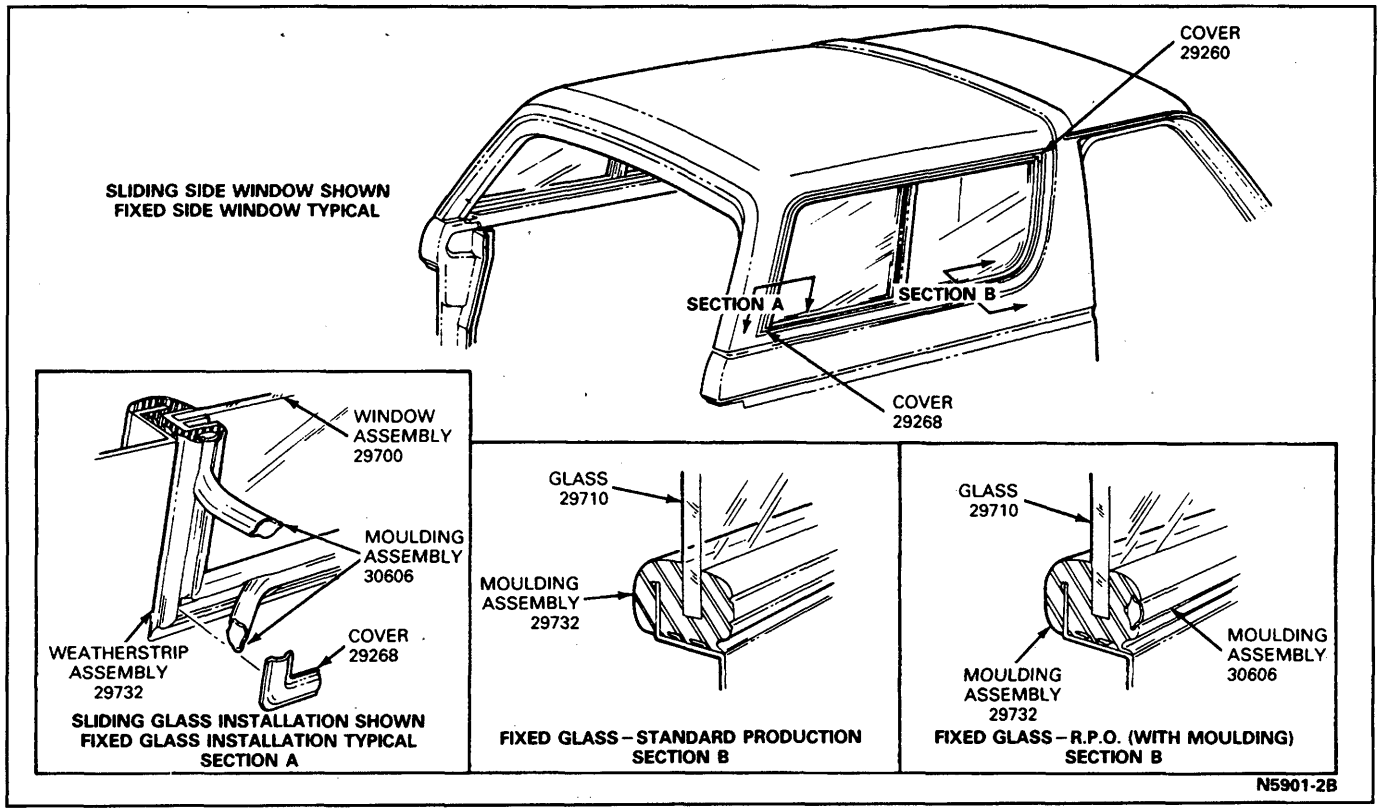


FIG. 3 Rear Side Window Installation—Bronco

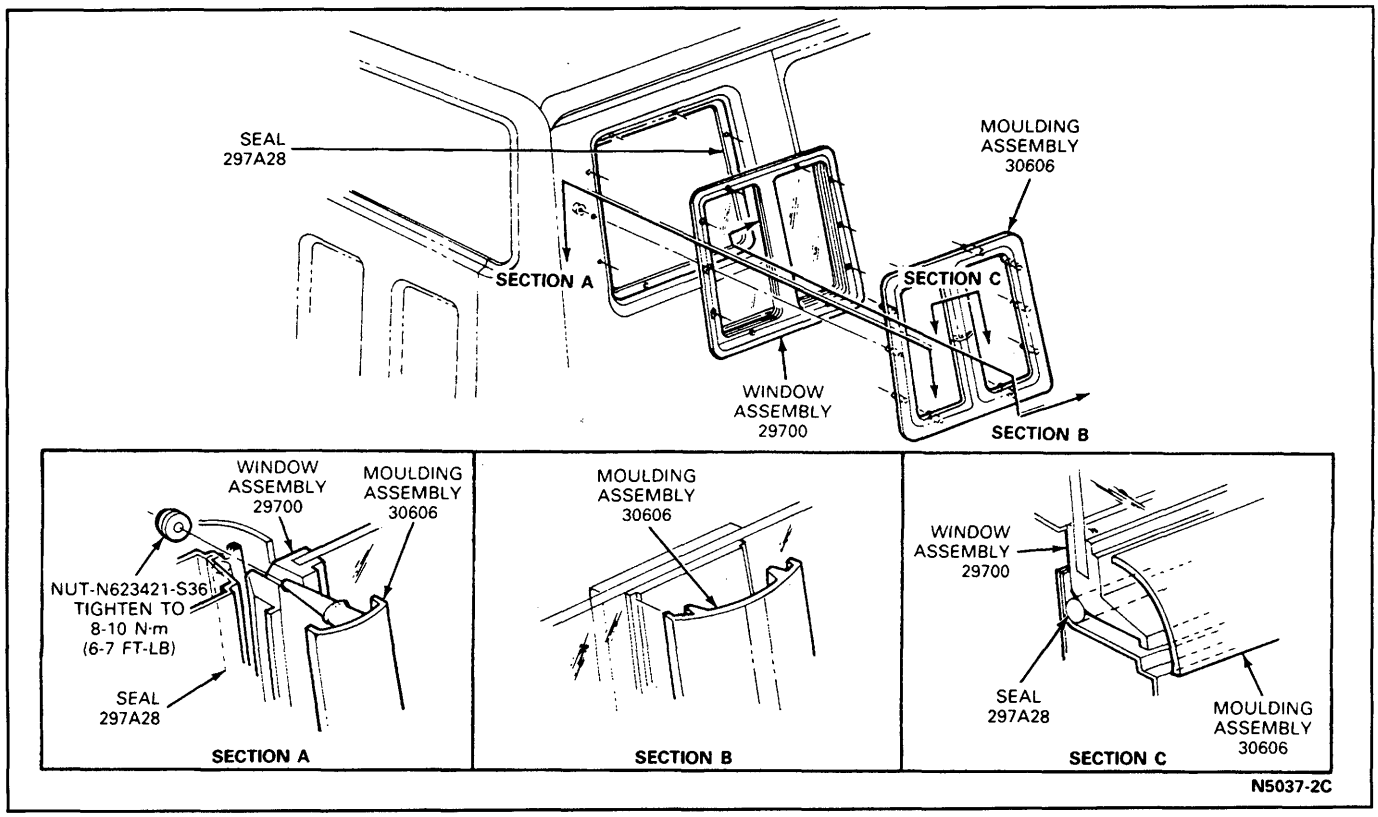


FIG. 4 Quarter Window Installation—F-150—F-350 Super Cab

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5. Apply Liquid Butyl Sealer C9AZ-19554-B or equivalent in the glass groove of the weatherstrip (Fig. 5).
6. Apply Liquid Butyl Sealer C9AZ-19554-B or equivalent around the entire perimeter of the window opening.
7. Position the weatherstrip to the window glass with butt joint along bottom edge of glass at center of window opening. Install a draw cord in the pinch weld opening of the weatherstrip (Fig. 2). Overlap the cord approximately 457mm (18 inches) at the lower center of the glass and tape the ends of the cord to the inside of the glass.
8. Position the window glass and weatherstrip to the body opening.
9. With an assistant applying hand pressure from the outside, pull the draw cord to pull the lip of the weatherstrip over the window opening flange. Draw the weatherstrip over the lower flange, each side flange, and then over the upper flange. Alternate from side to side, moving approximately 305mm (12 inches) at a time, until the window is in place.
10. Clean the glass, weatherstrip, and surrounding area to remove all excess sealer.
11. Test for water leaks.

Movable Back Window

F-150—F-350

Removal

1. From the interior of the vehicle, pull down the weatherstrip lip along the window opening. Push the back window frame and weatherstrip out of the window opening from inside the cab (Fig. 6).
2. Remove the weatherstrip from the window frame and place the movable windows in the open position.
3. From the top of the window frame, remove the screw retaining each division bar. Also, remove the two screws retaining the anchor plate in the window track and remove the plate.
4. Spread the window frame and work the movable glass out of its track. Remove it from the frame.
5. If the stationary glass is to be replaced, remove the division bar lower retaining screw and remove the division bar.
6. Spread the window frame just enough to permit the stationary glass to be worked out of the frame.

Installation

1. If the stationary glass is to be replaced, apply Silicone Lubricant C0AZ-19553-A or equivalent to the window weatherstrip and track. Spread the frame slightly and slide the glass into place, in the frame. Do not allow the weatherstrip to bunch.
2. Position the division bar in the frame and install the lower retaining screw.
3. Spread the frame slightly and install the movable glass in its track.
4. Position the anchor plate in the window track and install the two retaining screws.
5. Install the division bar upper retaining screws.
6. Position the weatherstrip to the window frame.
7. Install a draw cord all around the weatherstrip in the flange crevice (Fig. 2), allowing the cord to overlap at the bottom center of the glass.

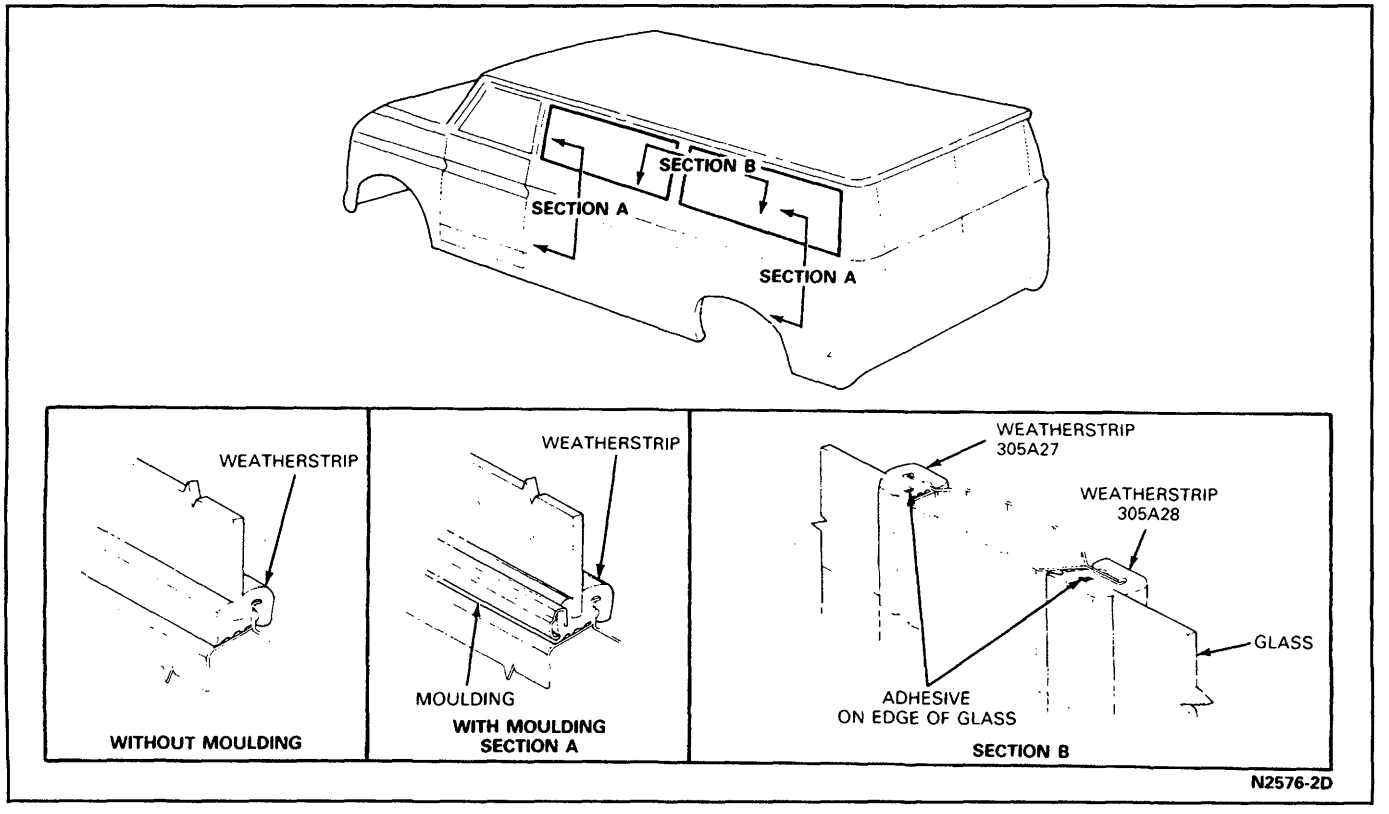


FIG. 5 Body Side and Rear Stationary Window Installation—E-150—E-350

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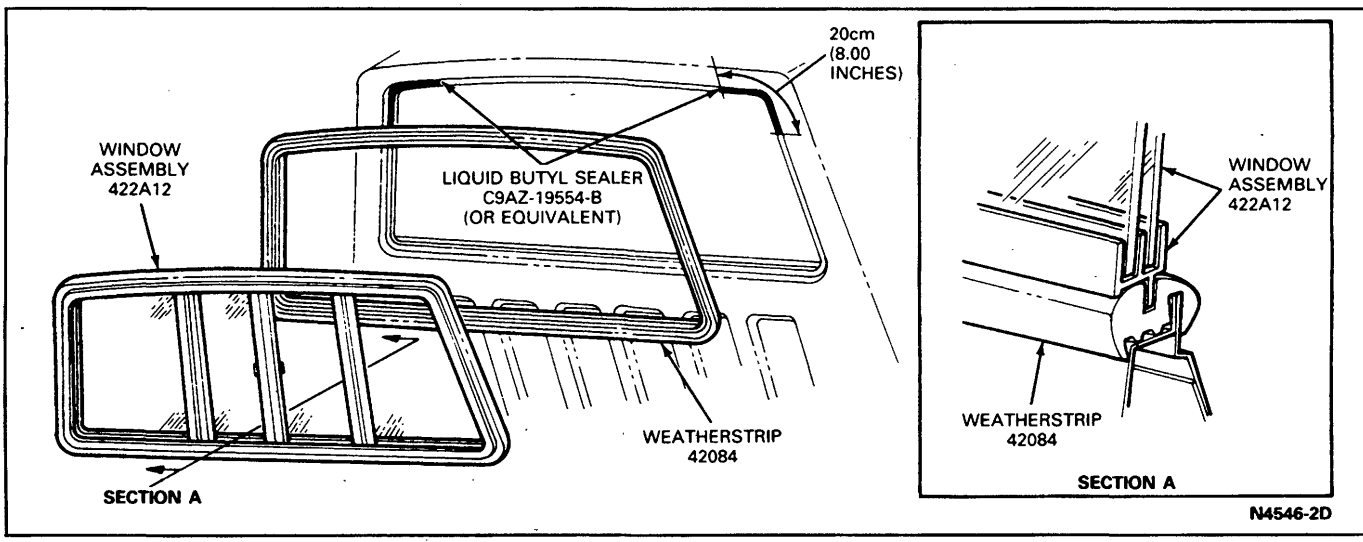


FIG. 6 Movable Back Window—F-150—F-350

8. Apply 203mm (8 inches) of Liquid Butyl Sealer C9AZ-19554-B or equivalent between the two secondary sealing fins centered on each upper corner as shown in Fig. 6.
9. Position the glass and weatherstrip to the window opening. With an assistant applying hand pressure from outside the cab, pull the weatherstrip lip over the window opening flange with a draw cord. Pull the weatherstrip over the lower flange, pulling one end of the cord at a time. Then, pull the seal over the side flanges and upper flange.

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SECTION 43-11 Stationary Glass—Butyl—Type Seal

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(Procedure No. 2)	43-11-2
Side Window	43-11-5
F-150—F-350 Super Cab	43-11-5
REMOVAL AND INSTALLATION (Cont'd)	
Side Window (Cont'd)	
Sealing Leaks	43-11-5
Windshield	43-11-1
VEHICLE APPLICATION	43-11-1

VEHICLE APPLICATION

E-150—E-350, F-150—F-350 and Bronco.

DESCRIPTION

There are two applicable procedures for installation of glass with butyl-type seal.

Procedure No. 1 should be used with Windshield and Backlight Seal Kit D9AZ-19562-B or equivalent, packaged with 8mm (5/16-inch) diameter butyl (round type). DO NOT use this kit if adhesion of existing butyl-to-pinch weld flange is unreliable, as indicated by a surface which is not smooth and free of excessive skips, bumps and contamination.

Procedure No. 2 should be used with Windshield and Backlight Seal Kit D9AZ-19562-A or equivalent, packaged with "I" beam-type butyl, where complete replacement of existing butyl is necessary.

REMOVAL AND INSTALLATION

Windshield

(Procedure No. 1)

Removal

1. Remove the windshield wiper arms and blades.
2. Remove the windshield exterior mouldings (Figs. 1 through 5).
3. With Electric Knife T70P-42006-A or equivalent, insert the blade under the edge of the glass (Fig. 6).
4. Cut the butyl seal as close to the inside surface of the glass as possible.
5. To cut the butyl at corners of the windshield, move the handle of the tool as close to the corner of the windshield as possible. Then, rotate the blade downward to cut the corner butyl seal.
6. Remove the glass from the vehicle using Glass Holding Tool D81T-33610-H or equivalent (Figs. 6, 7 and 8).
7. Temporarily position the replacement glass in the windshield opening using spacers to prevent glass-to-metal contact.
8. Adjust glass side-to-side to the best glass-to-A-pillar weld flange overlap position.
9. Adjust the lower spacers, if necessary, for proper positioning at the top. A minimum of 4.8mm (3/16-inch) butyl tape-to-glass contact is required around the perimeter to ensure proper retention and a waterproof seal. Mark this location on the outside surface of the glass and a corresponding surface of the glass opening.
10. Remove the glass. Clean the inside surface and edge thoroughly.

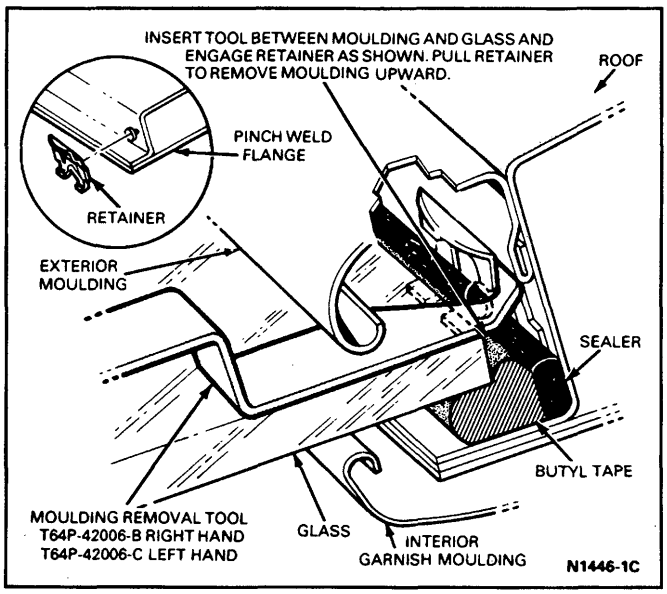


FIG. 1 Windshield Moulding Removal Tool—Typical

Installation

1. Start at the side of the glass opposite the original butyl splice and place the 8mm (5/16-inch) diameter butyl furnished in the kit on top of and in a position that ensures the 4.8mm (3/16-inch) minimum contact with the glass on the existing butyl remaining on the pinch weld flange (Fig. 9).

   NOTE: Do not allow the new butyl to overhang the edge of the existing butyl. Do not stretch the butyl or bridge the corners of the windshield opening.
2. Carefully splice the two loose ends of the new butyl. The cut line of the splice must taper downward toward the outboard side of the vehicle.
3. Apply the primer (furnished in the kit) around the perimeter of the cleaned inside surface and the edge of the glass in the area that will contact the butyl seal. Allow the primer to dry a minimum of five minutes before installing the glass.

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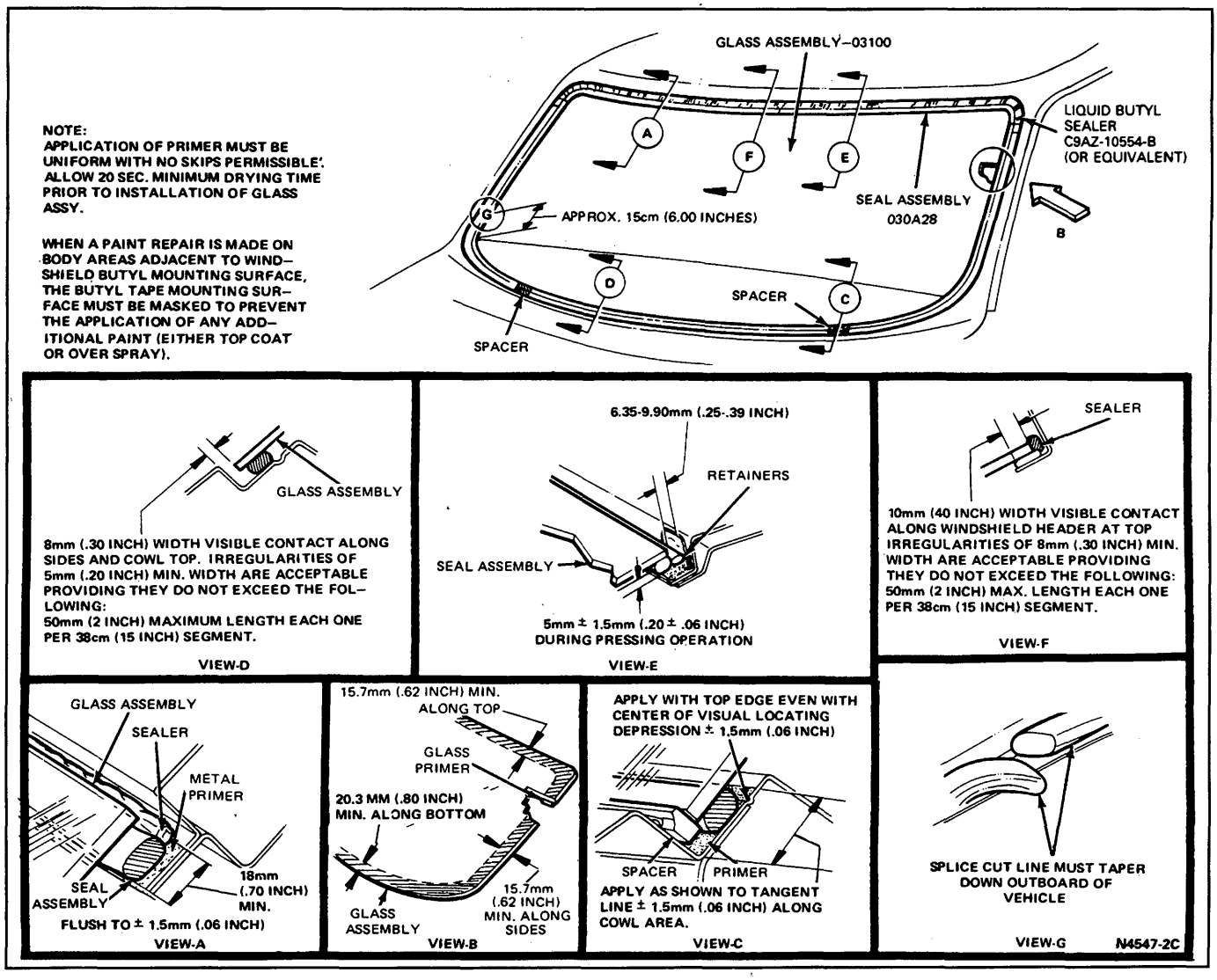


FIG. 2 Windshield Sealers—E-150—E-350

4. Place the glass in the opening, aligning the crayon marks.
5. Firmly press the glass against the butyl with hand pressure or weights (approximately 113 kg (250 lb)). Verify the 4.8mm (3/16-inch) contact between glass and butyl is achieved. A dull spot indicates an area where the butyl is not contacting the glass surface. Additional pressure should seal such areas.
6. From outside the vehicle, apply Liquid Butyl Sealer C9AZ-19554-B or equivalent around the entire edge of the glass.
7. Remove any excess primer from the inside surface of the glass with a razor blade. Wipe the glass with a clean cloth dampened with naphtha.

CAUTION: Do not use razor blade to clean primer from heated rear windows. Use of razor blades, steel wool, or abrasive powders will damage the grid wires.

8. When the liquid sealer has skinned-over (approximately 10 minutes), water test the installation. If necessary, repair any leaks with additional liquid sealer.
9. Install the mouldings and wiper arms and blades.
10. Clean the glass and surrounding areas.

(Procedure No. 2)

Removal

Use the following procedure if adhesion of existing butyl is unreliable:

1. Remove the windshield wiper arms and blades.
2. Remove the windshield exterior mouldings (Figs. 1 through 5). Refer to Group 47—Body Shell, Exterior Trim, Frame and Underbody. On vehicles with heated rear windows, disconnect heating wires before proceeding with glass removal.
3. With Electric Knife T70P-42006-A or equivalent, insert the blade under the edge of the glass (Fig. 6).
4. Cut the butyl seal as close to the inside surface of the glass as possible.
5. To cut the butyl at corners of the windshield, move the handle of the tool as close to the corner of the windshield as possible. Then, rotate the blade downward to cut the corner butyl seal.

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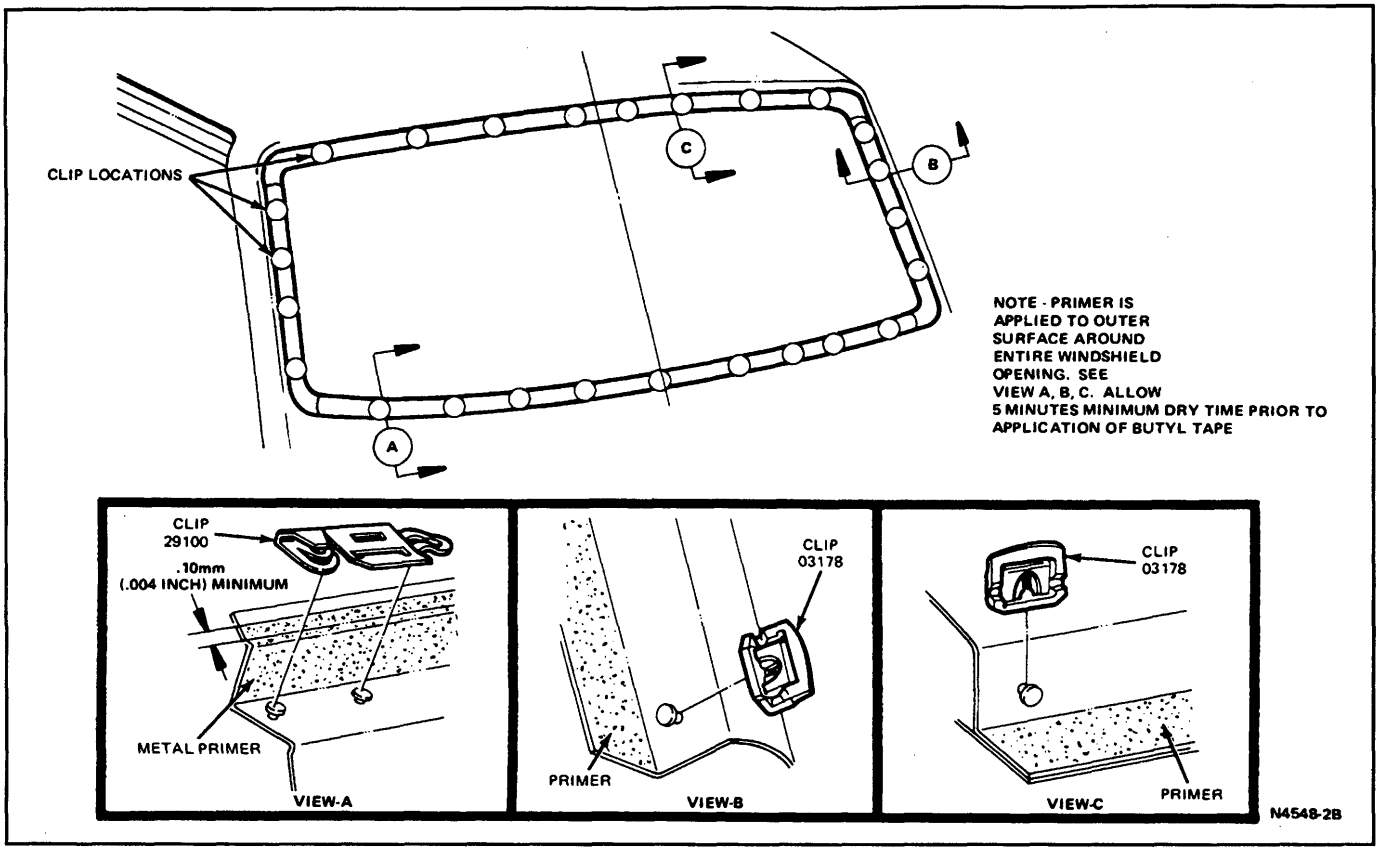


FIG. 3 Windshield Sealers—F-150—F-350 and Bronco

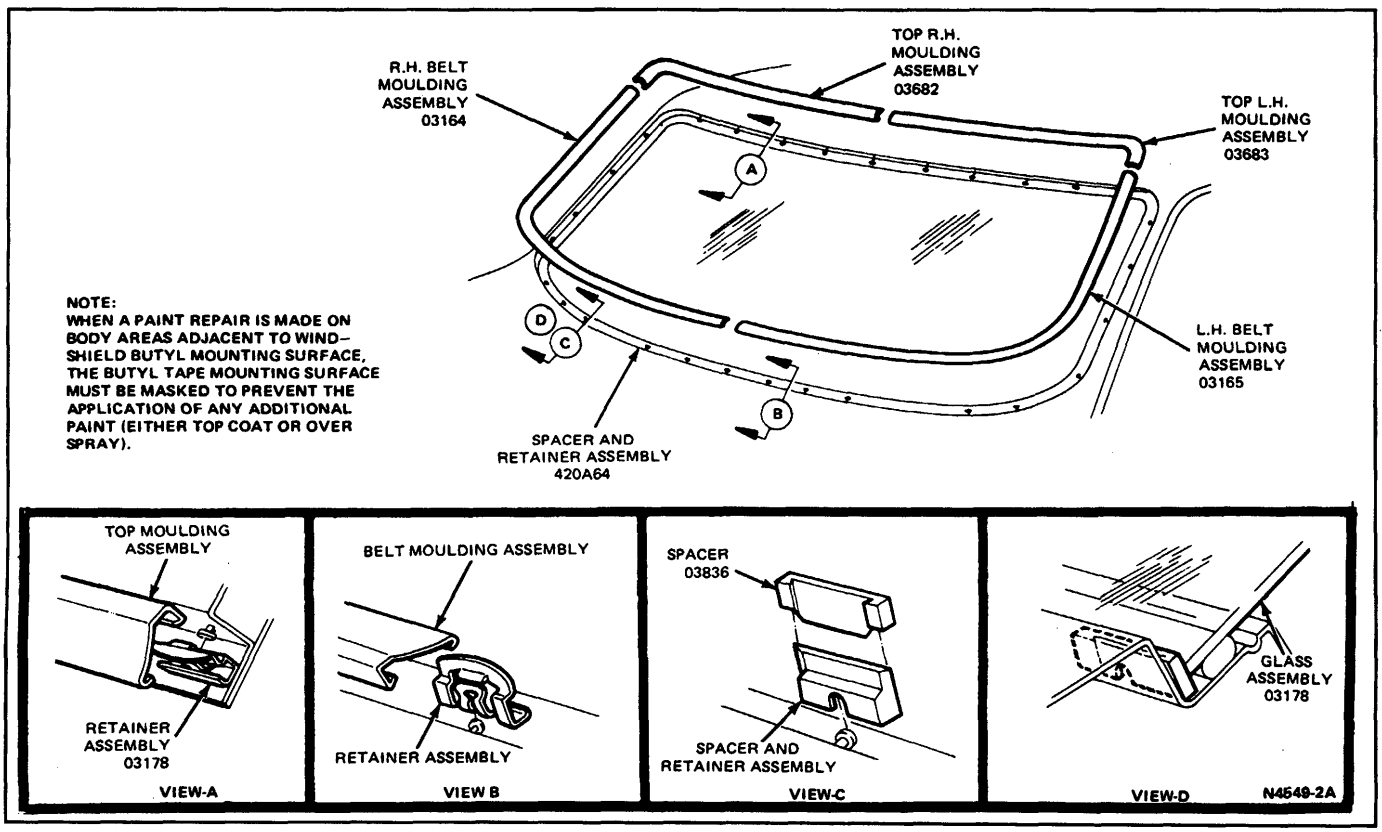


FIG. 4 Windshield Clips and Mouldings—E-150—E-350

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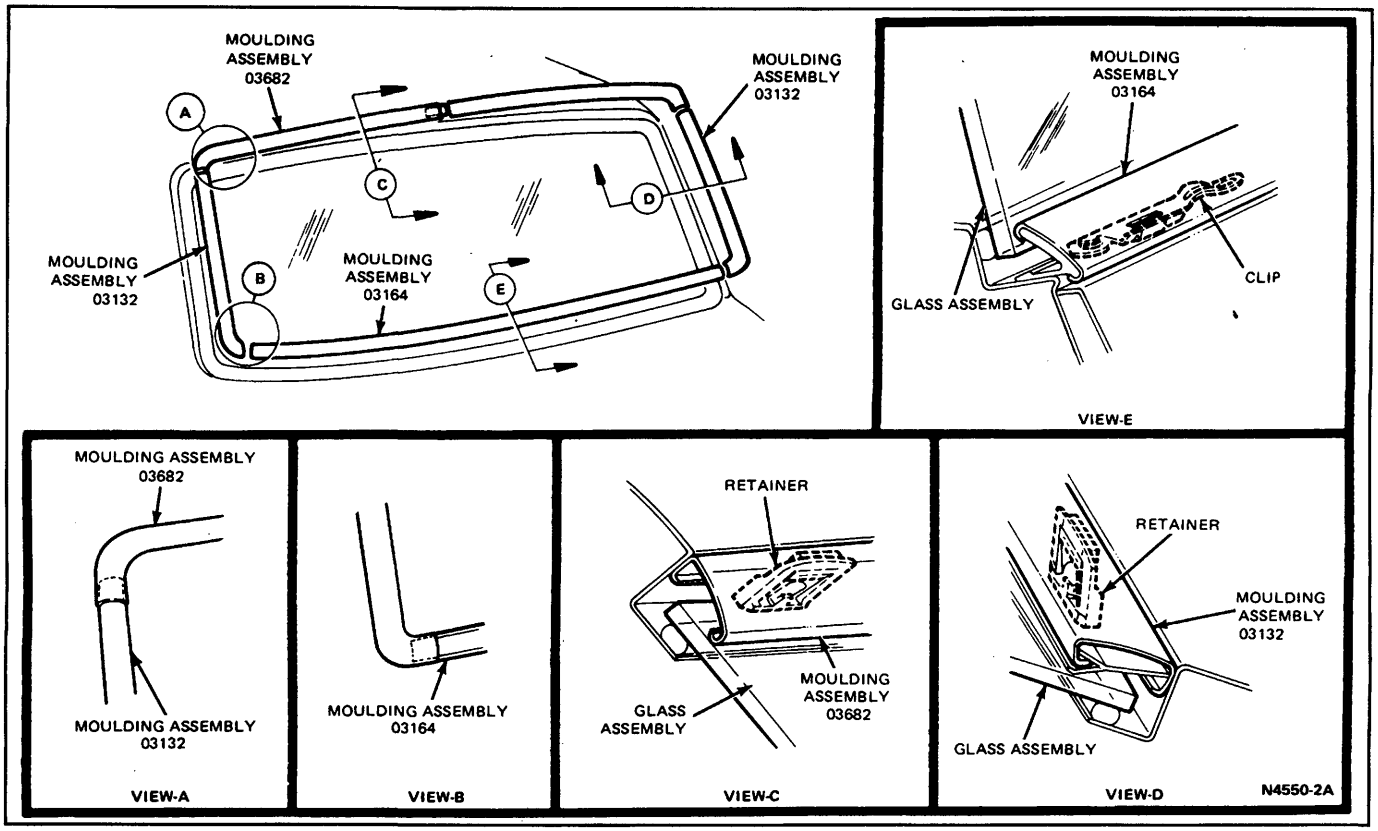


FIG. 5 Windshield Exterior Mouldings—F-150—F-350 and Bronco

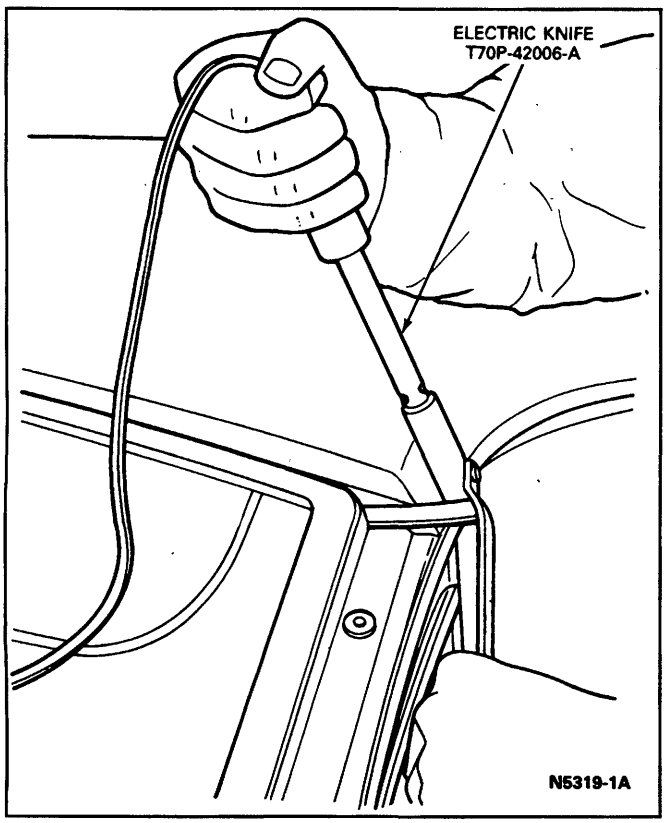


FIG. 6 Removing Butyl-Type Seal—Typical

6. Remove the glass from the vehicle using Glass Holding Tool D81T-33610-H or equivalent (Figs. 6, 7, and 8).
7. Clean all remaining butyl from the pinch weld flange.
8. Inspect flange carefully for sheel metal deficiencies, and the sealing surface of the pinch weld flange for chipped or missing paint. Repair as necessary. Pinch weld flange must be primed with Metal Primer ESB-2C171-AB or equivalent before applying butyl tape.

Installation

1. Starting at the midpoint on A-pillar, apply the butyl tape around the opening as shown in Fig. 10, View B.
2. Cut the butyl at the required length on a 45-degree angle and carefully splice the two loose ends. The splice cut line must taper down and toward the outboard side of the vehicle (Fig. 10, View A).
3. Apply the glass primer (furnished in the kit) around the perimeter of the cleaned inside surface and the edge of the glass in the area that will contact the butyl seal.
4. Allow the primer to dry a minimum of five minutes before installing the glass.
5. Place the glass in the opening, aligning the crayon marks.
6. Firmly press the glass against the butyl with hand pressure or weights (approximately 113 kg (250 lb)). Ensure 4.8mm (3/16-inch) contact on A-pillar, 9.5mm (3/8-inch) contact on header and cowl between glass and butyl is achieved. A dull spot indicates an area where the butyl is not contacting the glass surface. Additional pressure should seal such areas.
7. From outside the vehicle, apply Liquid Butyl Sealer C9AZ-19554-B or equivalent around the entire edge of the glass.

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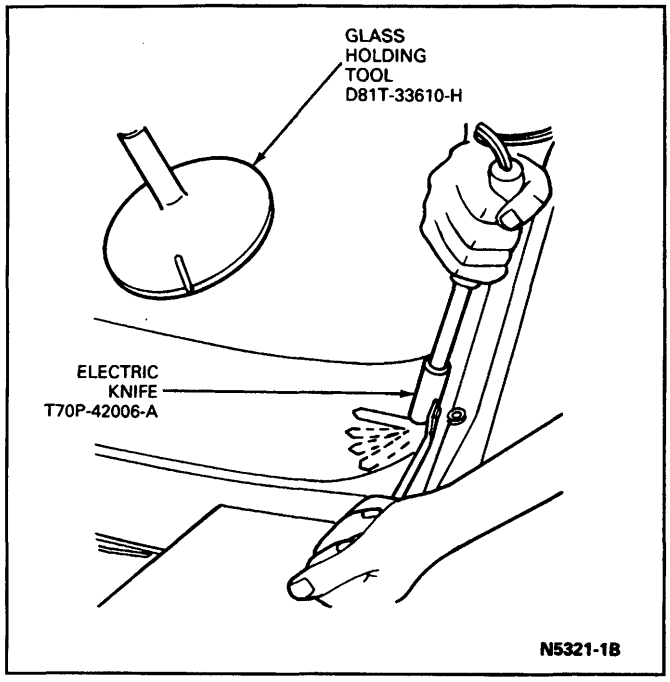


FIG. 7 Cutting Corner Seal—Typical

8. Remove any excess primer from the inside surface of the glass with a razor blade. Wipe glass with a clean cloth dampened with naphtha.
9. When the liquid butyl has skinned-over (approximately 10 minutes), water test the installation. If necessary, repair any leaks with additional liquid sealer.
10. Install the exterior mouldings and wiper arms and blades.
11. Clean the glass and surrounding area.

Side Window

F-150—F-350 Super Cab

Refer to Fig. 11.

Removal

1. Remove interior trim around window.
2. Remove 10 self-threading nuts from inside the window assembly and remove the moulding assembly.
3. Remove the glass assembly by pushing with enough pressure to separate the butyl seal.
4. Clean the old seal from the body recess and from the glass assembly. All traces of the old sealing material must be removed.
5. Inspect for sheet metal deficiencies. Check the sealing surface of the flange for chipped or missing paint. Repair as necessary.

Installation

1. Apply new Butyl Tape D9AZ-19562-B or equivalent around the outer perimeter of the body recess.
2. Press window assembly into place. Use enough pressure to seat the glass firmly in the sealing material, but avoid damaging or distorting window assembly.
3. Install moulding assembly.
4. Install 10 self-threading nuts and run up snug. Do not overtighten.

Sealing Leaks

If water or dust enters the window, follow Steps 1 and 2 of Side Window Removal. Run a bead of clear Silicone Rubber D6AZ-19562-A or equivalent around the entire perimeter of the glass. Immediately install the moulding assembly and nuts, and tighten. Then, carefully wipe away any visible silicone seal. Use a clean cloth, changing the wiping surface often. Make sure to remove all silicone seal from the sheet metal and moulding assembly. This must be done within three minutes of running the bead around the glass.

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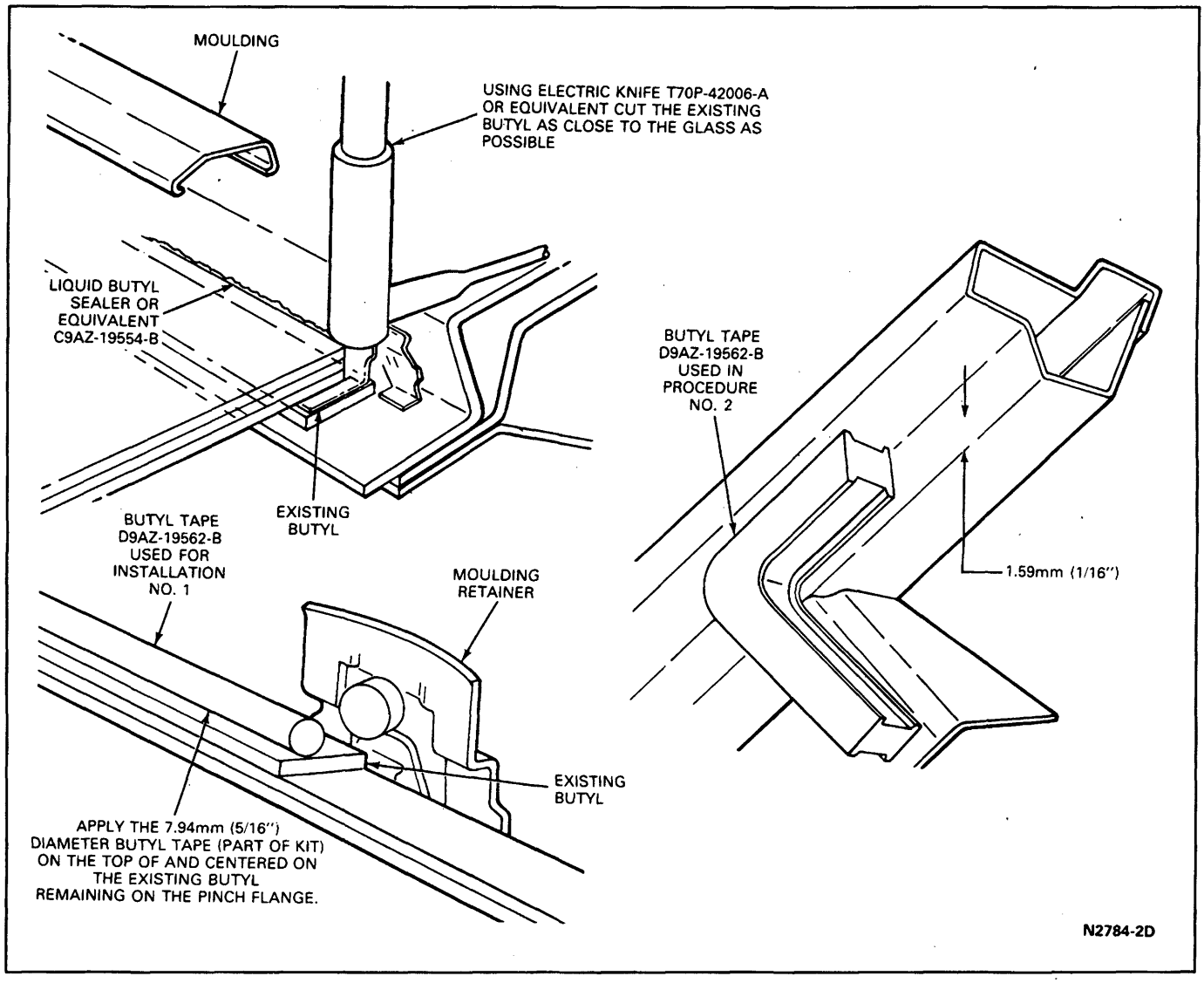


FIG. 8 Tape Installation

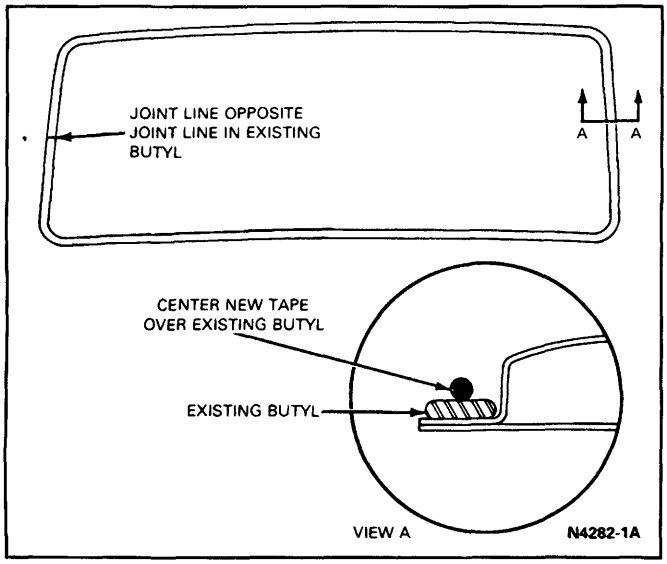


FIG. 9 Procedure No. 1—Butyl Tape Installation

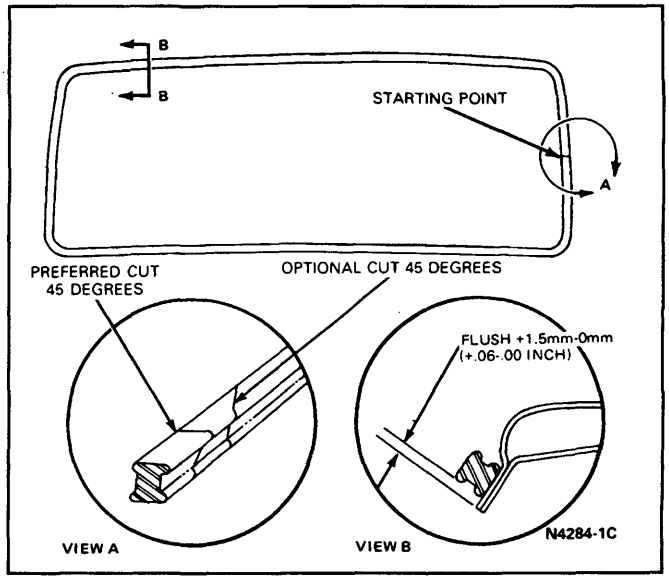


FIG. 10 Procedure No. 2—Single Row Butyl Tape Replacement

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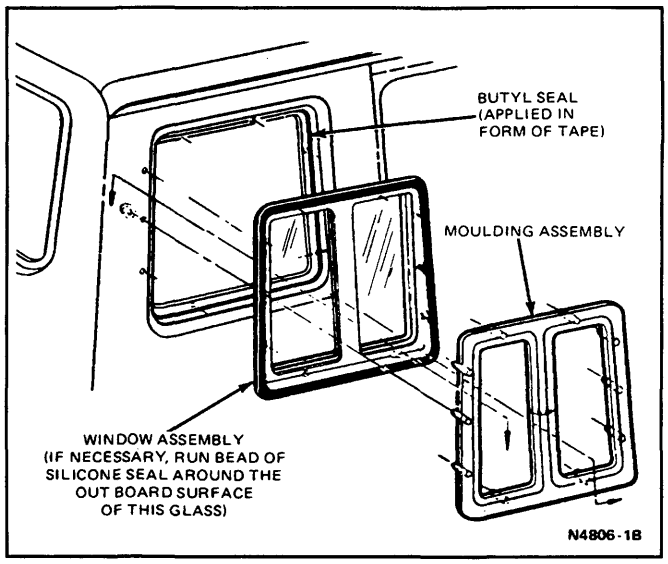


FIG. 11 F-150—F-350 Super Cab Side Window Installation

SPECIAL SERVICE TOOLS

Tool Number	Description
T64P-42006-B	Moulding Removal Tool
T64P-42006-C	Moulding Removal Tool
T70P-42006-A	Electric Knife
T70P-42006-AA	Replacement Knife Blades
D81T-33610-H	Glass Holding Tool

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GROUP 44 DOORS, HOOD AND TAILGATE

(16000 & 17000)

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VEHICLE APPLICATION

All Light Truck Models.

DESCRIPTION

Door and Window Weatherstrip Lubricant

CAUTION: Silicone Lubricant is not recommended on any door or door weatherstrips since it will soften all painted surfaces that contact the weatherstrip. If a lubricant is required, a soapy solution is acceptable.

Door, Hood and Tailgate Hinges—Lubricant

Use Polyethylene Grease D7AZ-19584-A or equivalent to lubricate door hinges. Apply an even coat to all movable hinge surfaces as outlined in the maintenance schedules or when a binding or squeaking condition occurs (Fig. 1).

Lock Cylinder Lubricant

Apply Lock Lubricant D8AZ-19587-A or equivalent to prevent sticking or binding of all key lock cylinders.

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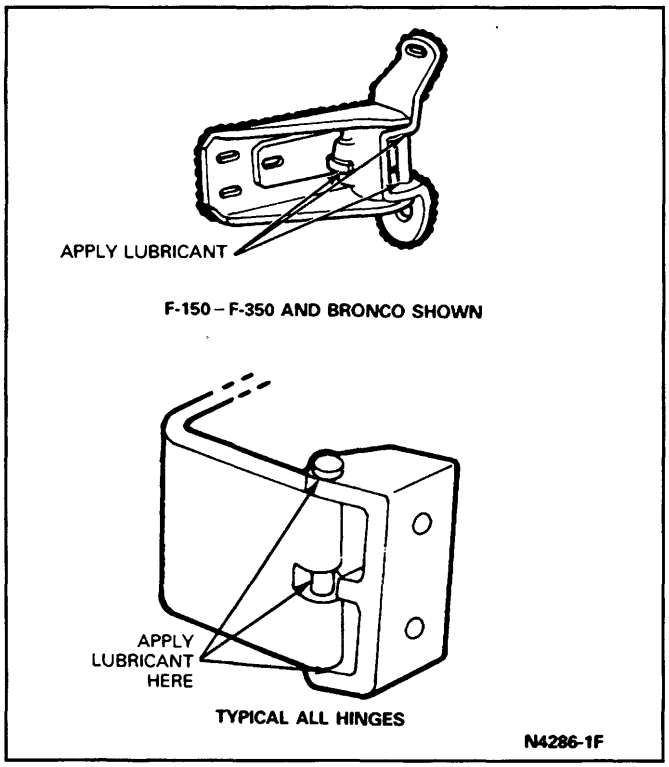


FIG. 1 Door Hinge Lubrication—Typical

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SECTION 44-06 Doors, Hinges, Checks and Weatherstrips

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VEHICLE APPLICATION

All Light Truck Models.

ADJUSTMENTS

Front Door Alignment

CAUTION: Do not cover up a poor alignment with a latch striker adjustment.

E-150—E-350

The door hinges provide sufficient adjustment to correct most door misalignment conditions. The holes of the hinge and/or hinge attaching points are enlarged or elongated to provide for hinge and door alignment (Fig. 1).

Front Door

1. Determine which hinge bolts must be loosened to move the door in the desired direction (Fig. 1).
2. Loosen the hinge bolts just enough to permit movement of the door with a padded pry bar.
3. Move the door the distance estimated to obtain the desired fit. Tighten the hinge bolts and check the door fit to ensure there is no bind or interference with the adjacent panel.
4. Repeat the operation until the desired fit is obtained. Then, check the striker plate alignment for proper door closing. Refer to Section 44-11, Door Latches and Locks.

Bronco and F-150—F-350

1. Refer to Figs. 2 and 3, to determine which hinge bolts must be loosened to move the door in the desired direction.
2. Loosen the hinge bolts just enough to permit movement of the door with a padded pry bar.
3. Move the door the distance estimated to obtain the desired fit. Tighten the hinge bolts and check the door fit to ensure there is no bind or interference with the adjacent panel.
4. Repeat the operation until the desired fit is obtained. Check the striker plate alignment for proper door closing.

Hinged—Side Cargo and Back Door Alignment

E-150—E-350

The door hinge attachment to the door and body provide a means for adjusting the doors in the body opening. Up or down and in or out adjustment is provided by enlarged holes at the hinge-to-door attachment (Fig. 4). Side-to-side movement of the doors is provided by horizontally elongated holes at the hinge-to-body attachment (Fig. 4).

The cargo doors should be adjusted to obtain a proper fit. After the doors have been adjusted, tighten the hinge attaching bolts securely, and adjust the latch mechanisms, if required.

REMOVAL AND INSTALLATION

Doors

Removal and Installation

1. Remove all usable hardware, trim, and glass parts. Refer to Sections 45-03, Door Trim Panels; 42-04, Front Door Window Glass and Mechanisms; 42-25, Pivot-Type Rear Door and Side Window; and 42-15, Vent Window Mechanisms.
2. Remove the upper and lower hinge access hole cover plates, if so equipped. Mark the location of the hinge on the door and body.
3. Remove the door-to-lower hinge retaining bolts (Figs. 1 through 4).
4. Support the door, and remove the door-to-upper hinge retaining bolts. Slide the door off the hinges (Figs. 1 through 4).
5. If a hinge is to be replaced, remove the hinge-to-pillar bolts, and remove the hinge.
6. Cement the door weatherstrip in proper position on the door using Weatherstrip Adhesive C0AZ-19552-A or equivalent. Include the belt seals.

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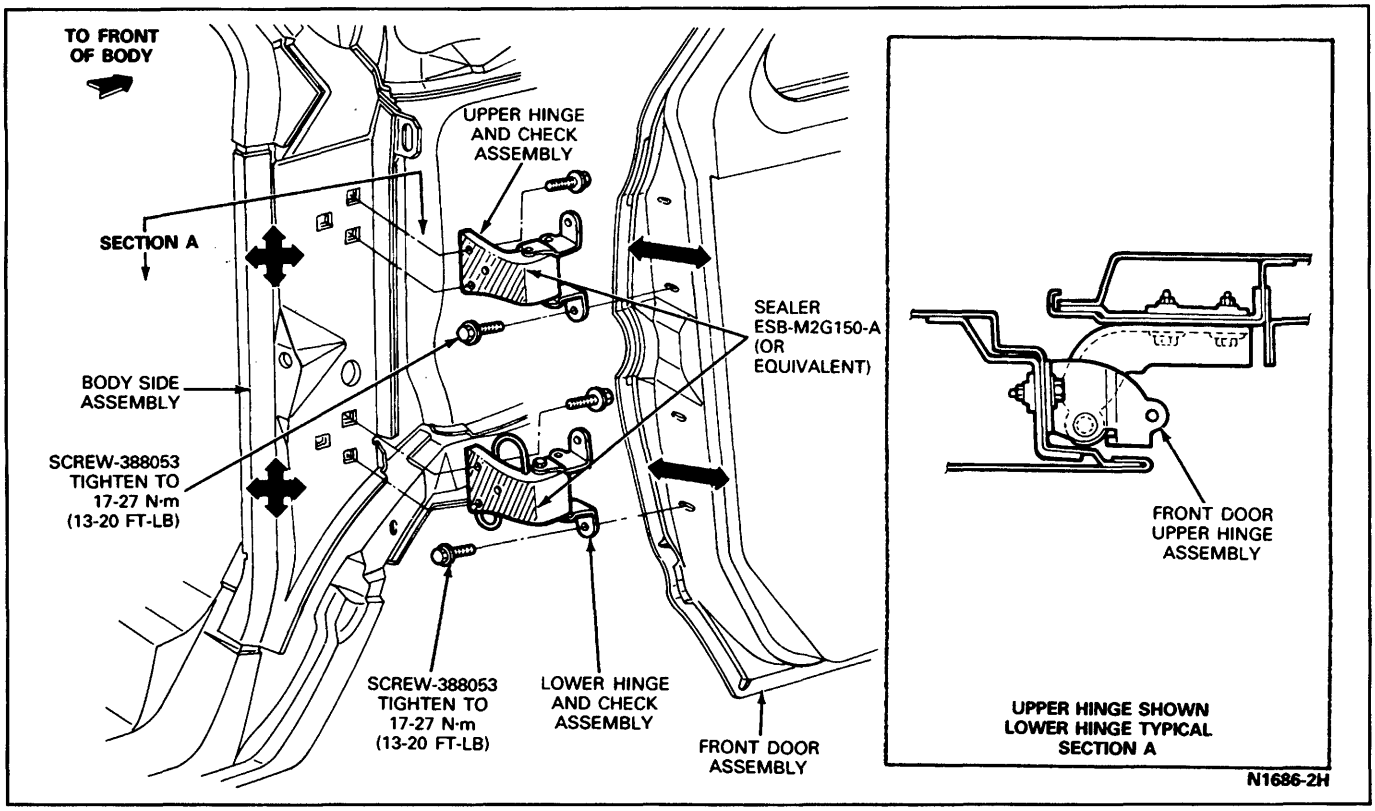


FIG. 1 Front Door Hinge Adjustment—E-150—E-350

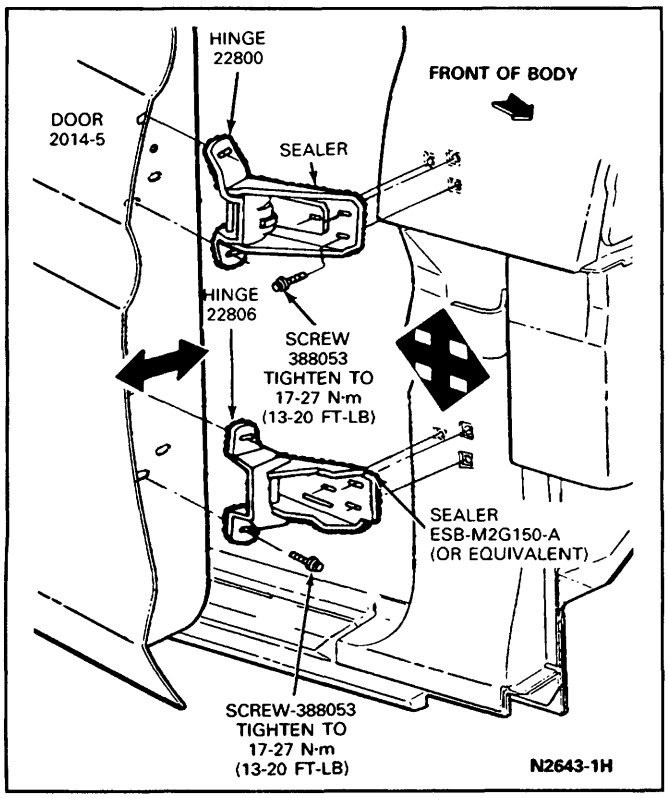


FIG. 2 Door Hinge Adjustment—Bronco and F-150—F-350

7. If a hinge has been removed, install the hinge in the pillar in approximately the same position as the removed hinge.

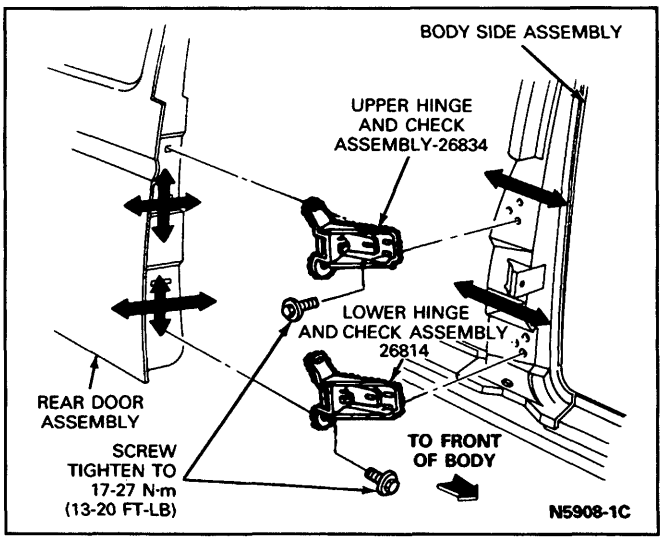


FIG. 3 Rear Door Hinge Adjustment—F-350 Crew Cab

8. Position the door on the hinges, and install the retaining bolts snug (Figs. 1 through 4).
9. Install the lock mechanism. Refer to Section 44-11, Door Latches and Locks. Install the glass mechanism, glass, and vent window assembly. Make all necessary adjustments as these assemblies are installed. Refer to Sections 45-03, Door Trim Panels; 42-04, Front Door Window Glass and Mechanisms; 42-25, Pivot-Type Rear Door and Side Window and 42-15, Vent Window Mechanisms.
10. Adjust the door and tighten all hinge bolts securely. To provide a good weatherstrip seal, the upper

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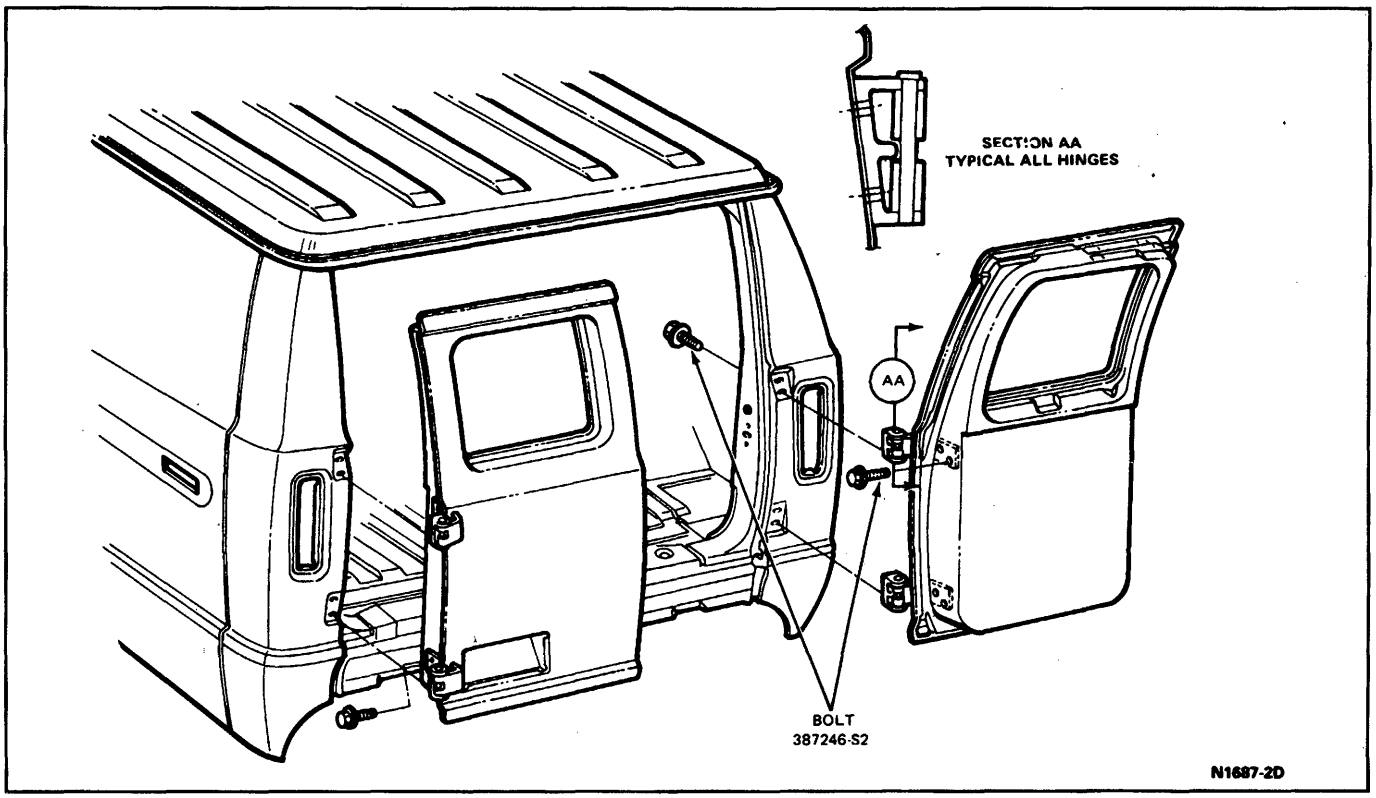


FIG. 4 Hinged Side Cargo and Back Door Alignment—E-150—E-350

front edge of the door must be 4.8mm (3/16 inch) inboard of the upper part of the pillar from the belt line to a point near the top of the door. This adjustment is made by adjusting the upper striker of the RH door inboard 4.8mm (3/16 inch) (Figs. 1 through 4).

11. If the truck is so equipped, install the watershield. The top edge should be cemented to the inside surface of the inner panel.
12. Install the hinge access hole cover plates. Install door access hole cover plate.

Door Hinge

Bronco, F-150—F-350 and E-150—E-350

Removal and Installation

1. Support the door.
2. Mark the location of the hinge on the door and body.
3. Remove the hinge-to-body attaching bolts (Figs. 1 through 4).
4. Remove the hinge-to-door attaching bolts and remove the hinge.
5. Position the new hinge to the door and body, and install the attaching bolts.
6. Adjust the door and hinges. Remove the support.

Door Weatherstrips

E-150—E-350

Removal and Installation

Refer to Figs. 5 through 8.

1. Remove the weatherstrip.
2. Clean all old weatherstrip adhesive and apply new Weatherstrip Adhesive C0AZ-19552-A or equivalent to the door and retaining flanges.
3. Apply Weatherstrip Adhesive C0AZ-19552-A or equivalent to the weatherstrip.
4. Install the weatherstrip.
5. Cut the weatherstrip 3.2mm (1/8 inch) long. Cover the ends with Weatherstrip Adhesive C0AZ-19552-A or equivalent, and butt the ends together.

F-150—F-350 and Bronco

Removal and Installation

1. Remove weatherstrip by pulling from body flange.
2. Install weatherstrip by pushing onto flange around entire door opening (Figs. 9 and 10).
3. Use a roller to seat the weatherstrip on the flange.
4. Trim the weatherstrip to proper length.
5. Butt the ends of the weatherstrip at the bottom of the door opening.
6. An adhesive-backed weatherstrip is also applied to the upper door (Fig. 9).

A secondary weatherstrip is also used on the door of XLT and Lariat models (Fig. 9). Remove the weatherstrip and clean all old weatherstrip adhesive from the door. Replacement weatherstrip has paper backed adhesive on the attachment surface. Peel off paper backing and apply seal to the door inner panel Fig. 9.

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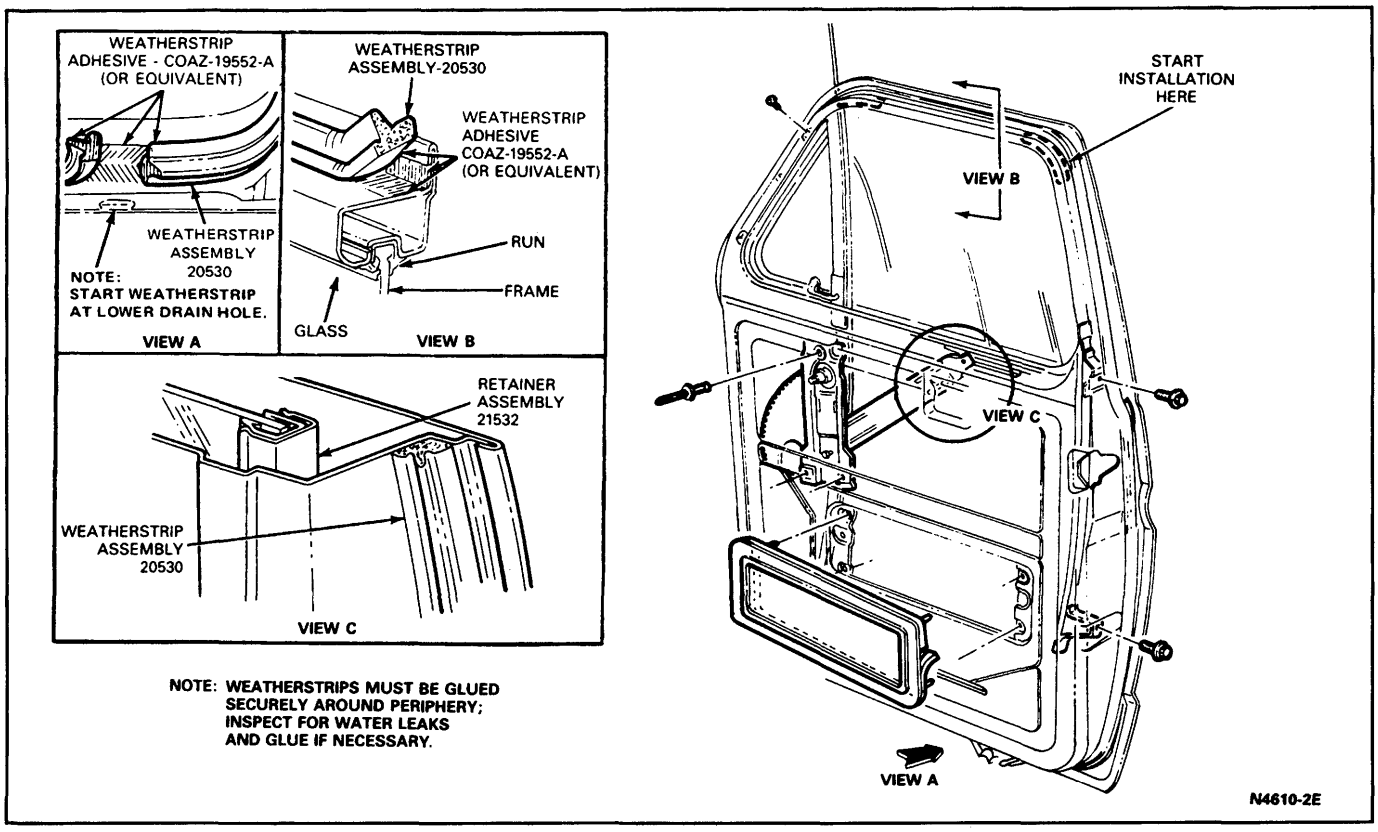


FIG. 5 Front Door Weatherstrip—E-150—E-350

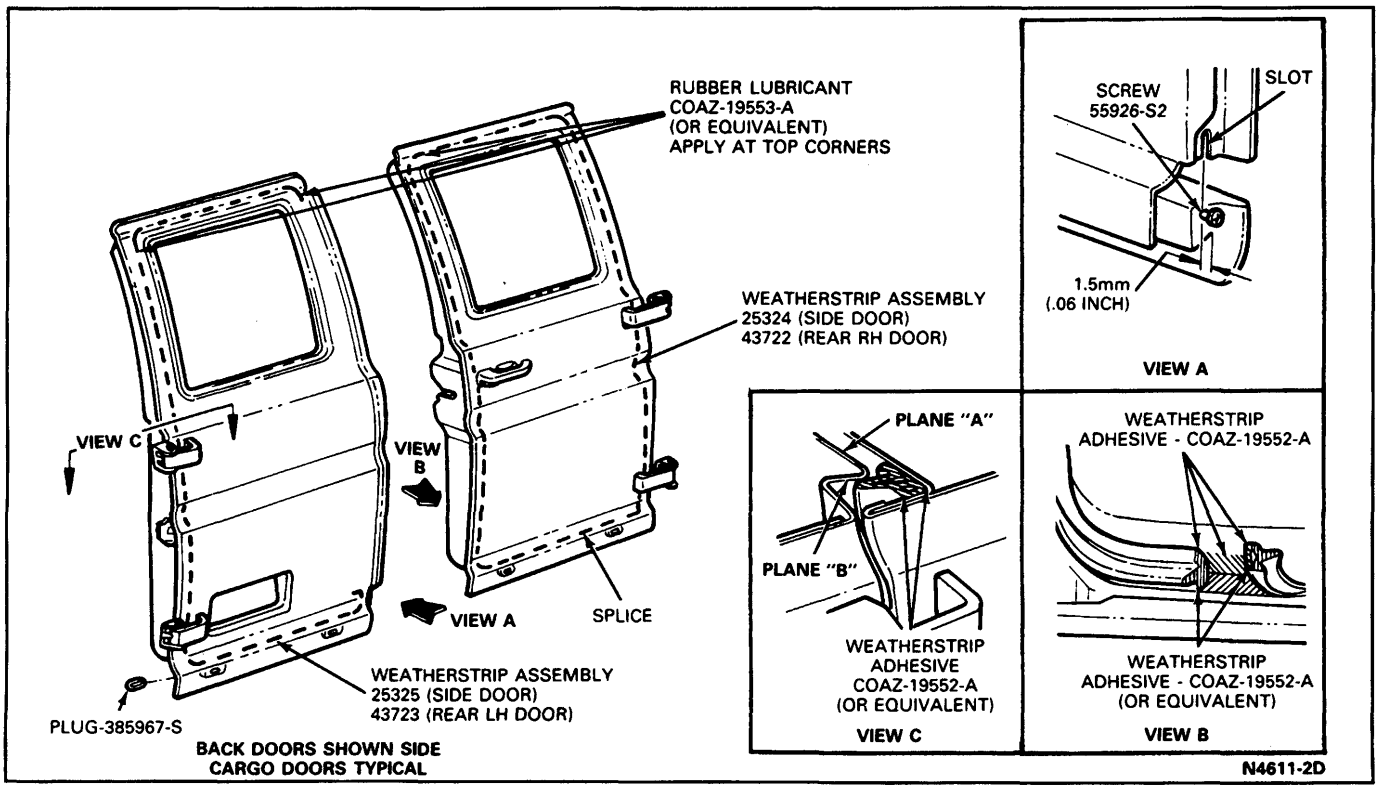


FIG. 6 Side Cargo and Back Doors Weatherstrip—E-150—E-350

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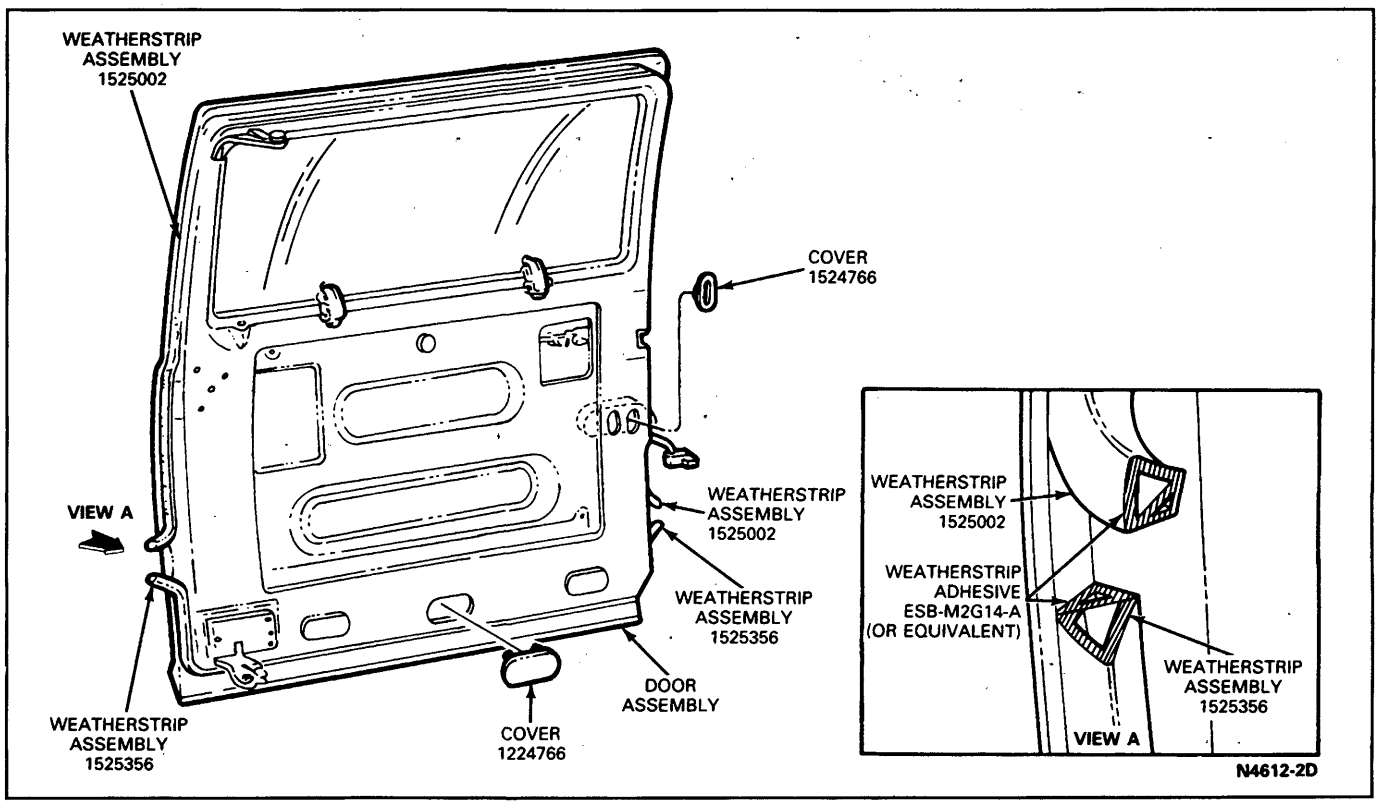


FIG. 7 Sliding Door Weatherstrip—E-150—E-350

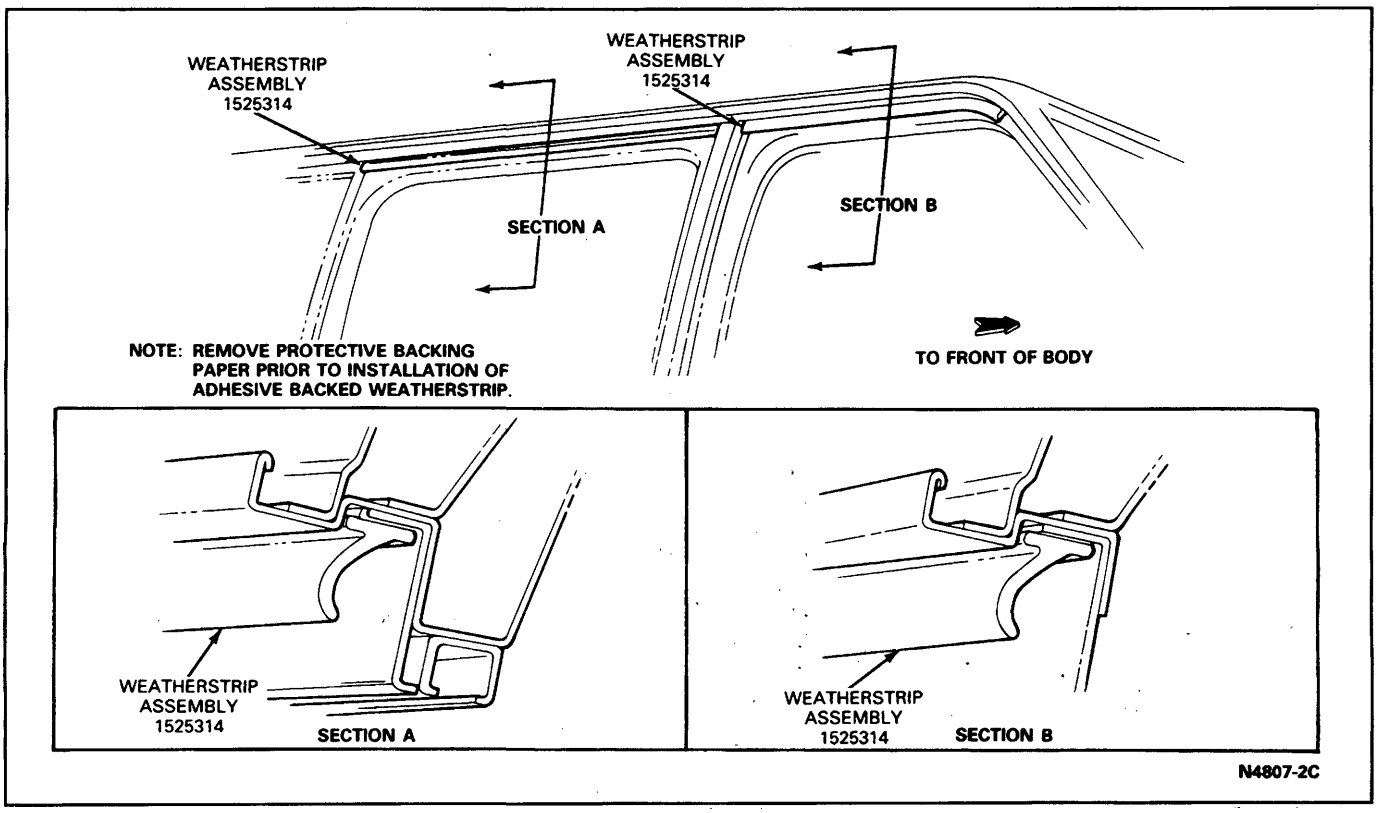


FIG. 8 Body Side Door Opening Weatherstrips—E-150—E-350

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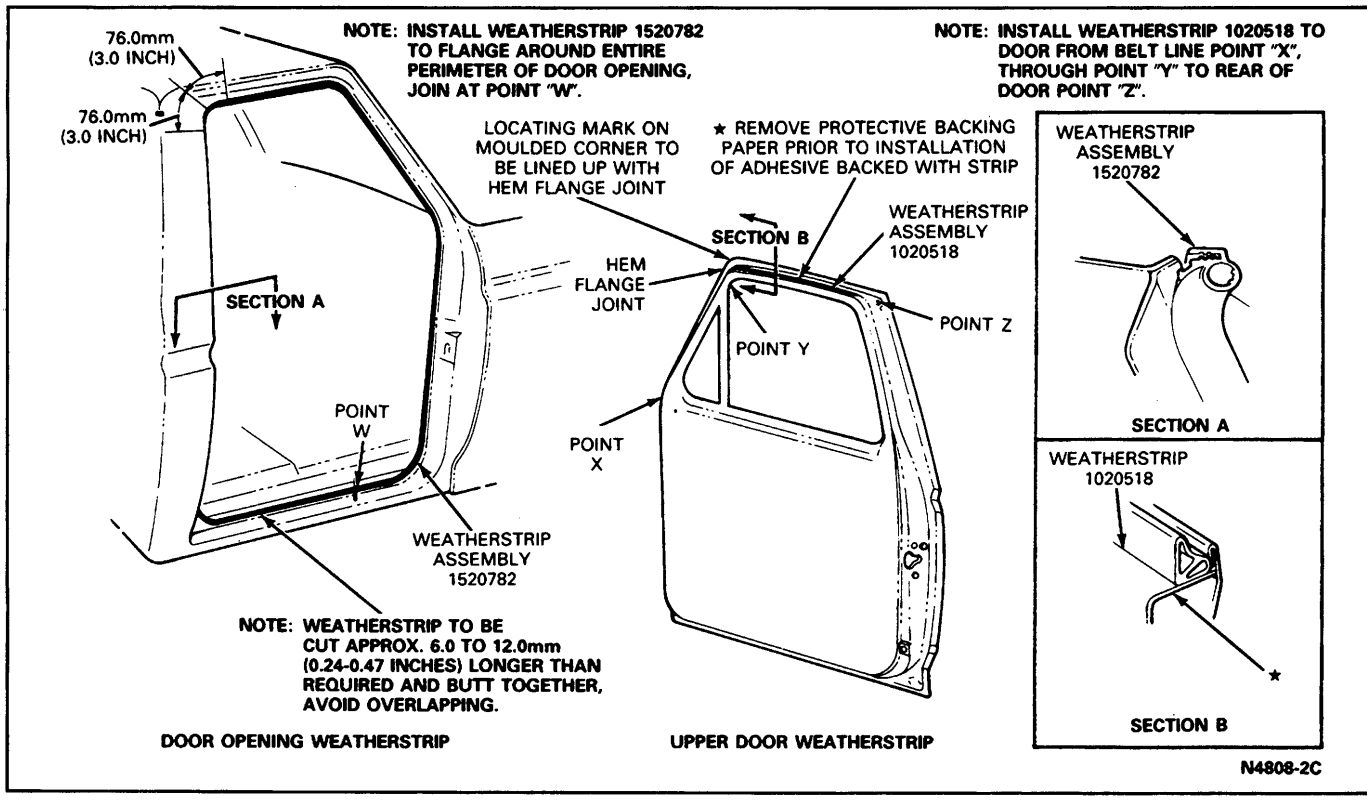


FIG. 9 Door Opening and Upper Door Weatherstrips—F-150—F-350 and Bronco

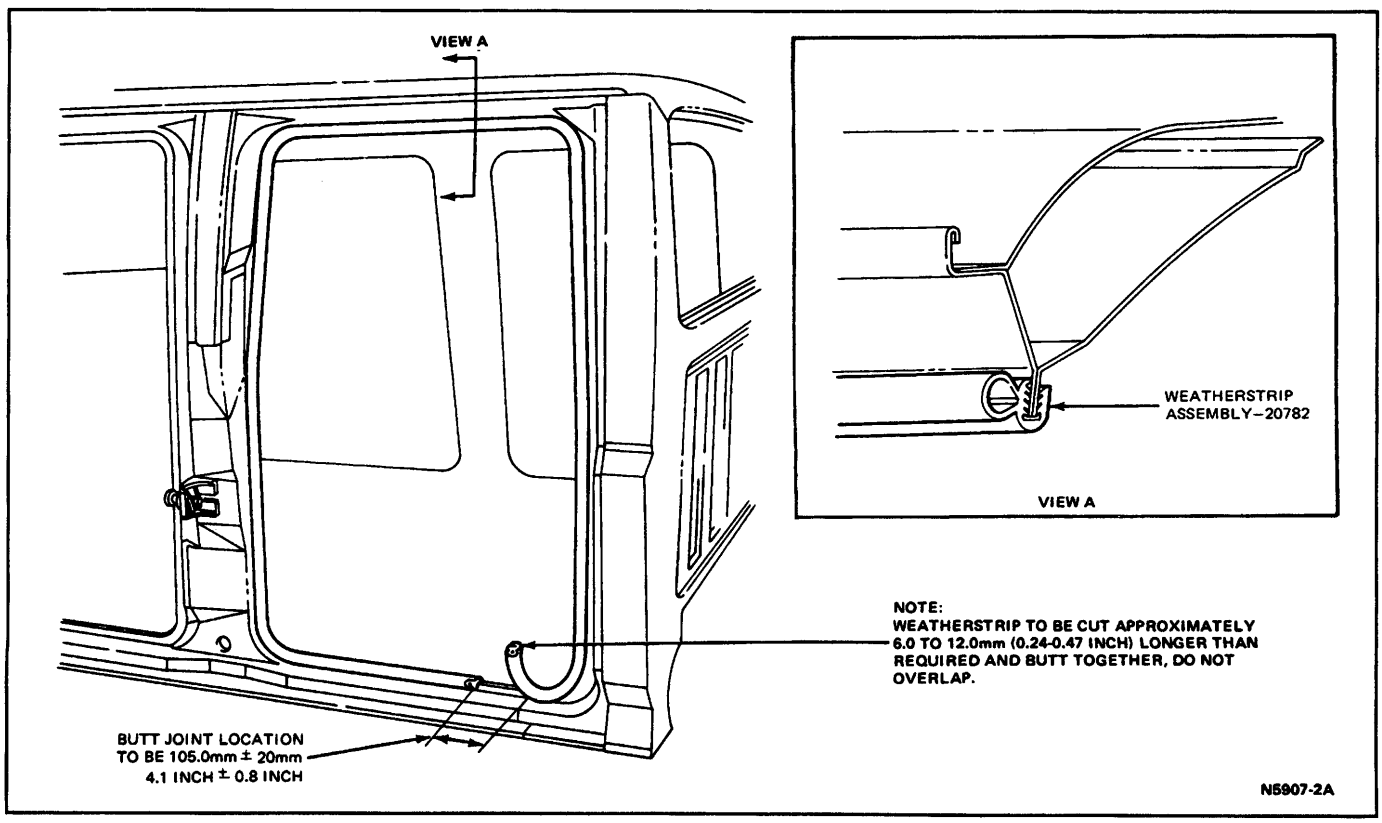


FIG. 10 Rear Door Weatherstrip—F-350 Crew Cab

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VEHICLE APPLICATION

E-150 Through E-350.

DESCRIPTION AND OPERATION

The door is operated by rotating the inside or outside handle (inside-rearward or outside-downward) to release the latch and by sliding the door rearward to the full open position. When the door has been pushed fully rearward, the hold-open check will activate and prevent the door from inadvertently closing. There are no intermediate hold-open positions. To close the door, the inside or outside handle must be activated (inside-forward or outside-upward) to release the door from the check position.

If the door is slammed with sufficient force, the latch will engage the striker in the primary position and the door panel will become flush with the body panel. A door slammed with less force may allow the rear latch (Fig.1) to engage the rear striker (Fig. 2) in the secondary position. In this event, the door may be placed in the primary or fully-latched position by rotating the inside or outside handle (inside - forward, outside - upward) until a click is heard.

The door can be locked by pushing down on the lock knob and closing the door, or by pushing down the lock knob after door is closed.

ADJUSTMENTS

In or Out

Front Upper

To adjust the upper edge of the door, loosen the upper roller retaining nut and move the roller in or out to obtain a flush fit with the body sheet metal at the top edge of the door (Fig. 1, View D).

Front Lower

Support the door assembly so that **no up or down** movement can be made to the door when performing the in or out adjustment.

To adjust the lower front edge of the door, loosen the retaining screws on the guide assembly and move the guide assembly **forward** to obtain a snug fit to the body, and **rearward** to move it away from the body, at the B-pillar post (Fig. 1, View E).

Rear—Upper and Lower

To move rear edge of door in or out, open door and loosen and adjust rear latch striker as required (Fig. 2, View A). Tighten striker.

Up or Down

Front

To move the front edge of the door up or down, loosen the three lower guide attaching screws (Fig. 1, View E). Then, rotate the guide at the lower attaching screw to obtain the desired door **up or down** position.

Loosen the upper roller bracket assembly attaching screws. Adjust the bracket so that the bottom edge of the roller assembly is approximately 1.58mm (1/16 inch) from the bottom flange of the upper track (Fig. 2, View B).

Hinge Assembly

To move the rear edge of door up or down, remove the rear hinge assembly mounting bolt covers. Then, loosen the four rear hinge assembly mounting bolts and move hinge assembly up or down until the hinge pin is observed to be horizontal and the roller properly sitting on the center track (Fig. 1, View C). Tighten the mounting screws. Open door and check striker-to-rear latch alignment. Adjust the rear latch striker up or down as required (Fig. 2, View A). Tighten striker. Close the door slowly. Ensure the rear latch striker clears the inboard tang on the latch pawl.

Striker—Rear Latch

To adjust the rear edge of the door in or out, mark the location of the rear striker, loosen and move the striker in or out to obtain a flush fit with the body sheet metal. Tighten striker (Fig. 3, View B).

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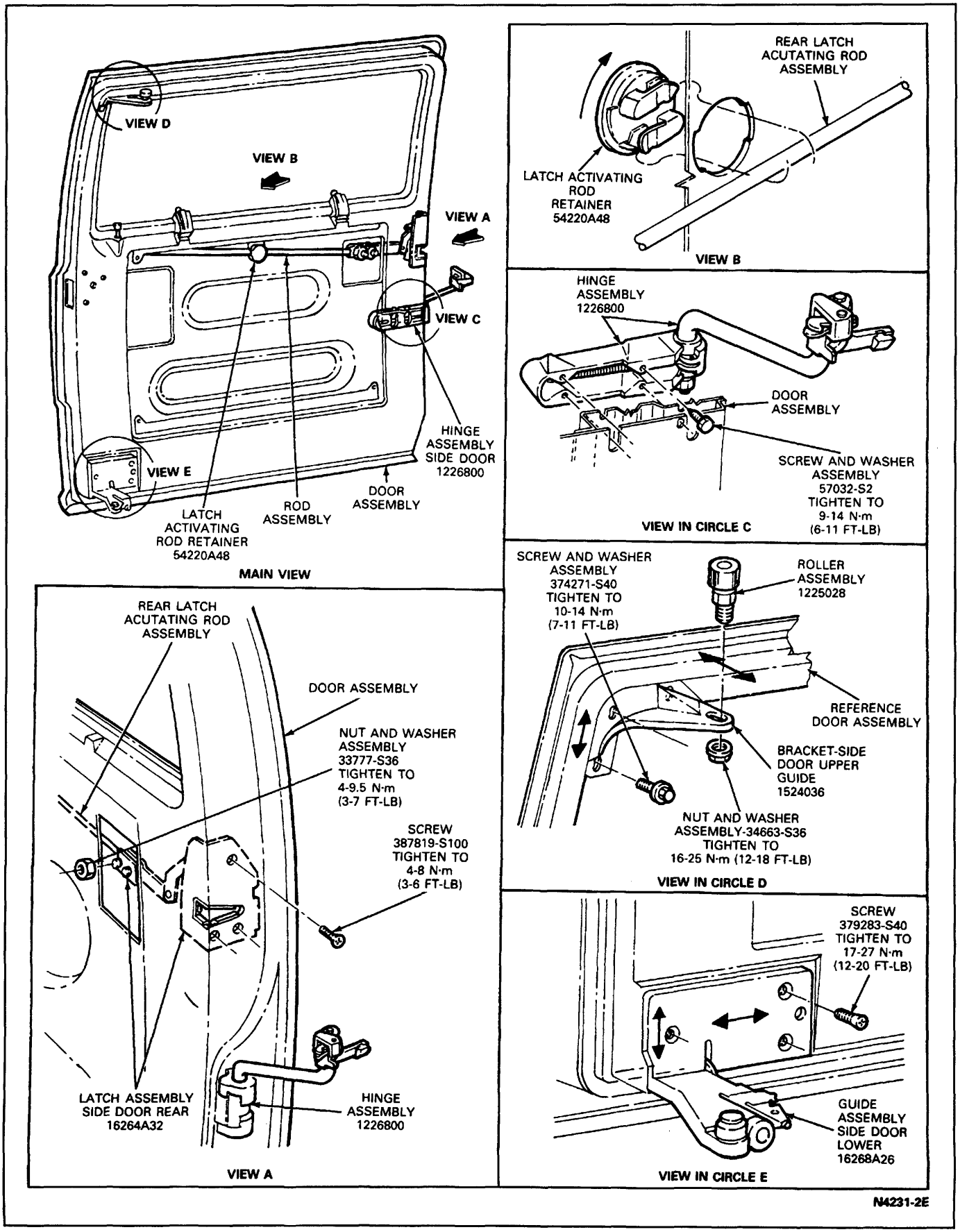


FIG. 1 Sliding Door Adjustments—In or Out or Up or Down

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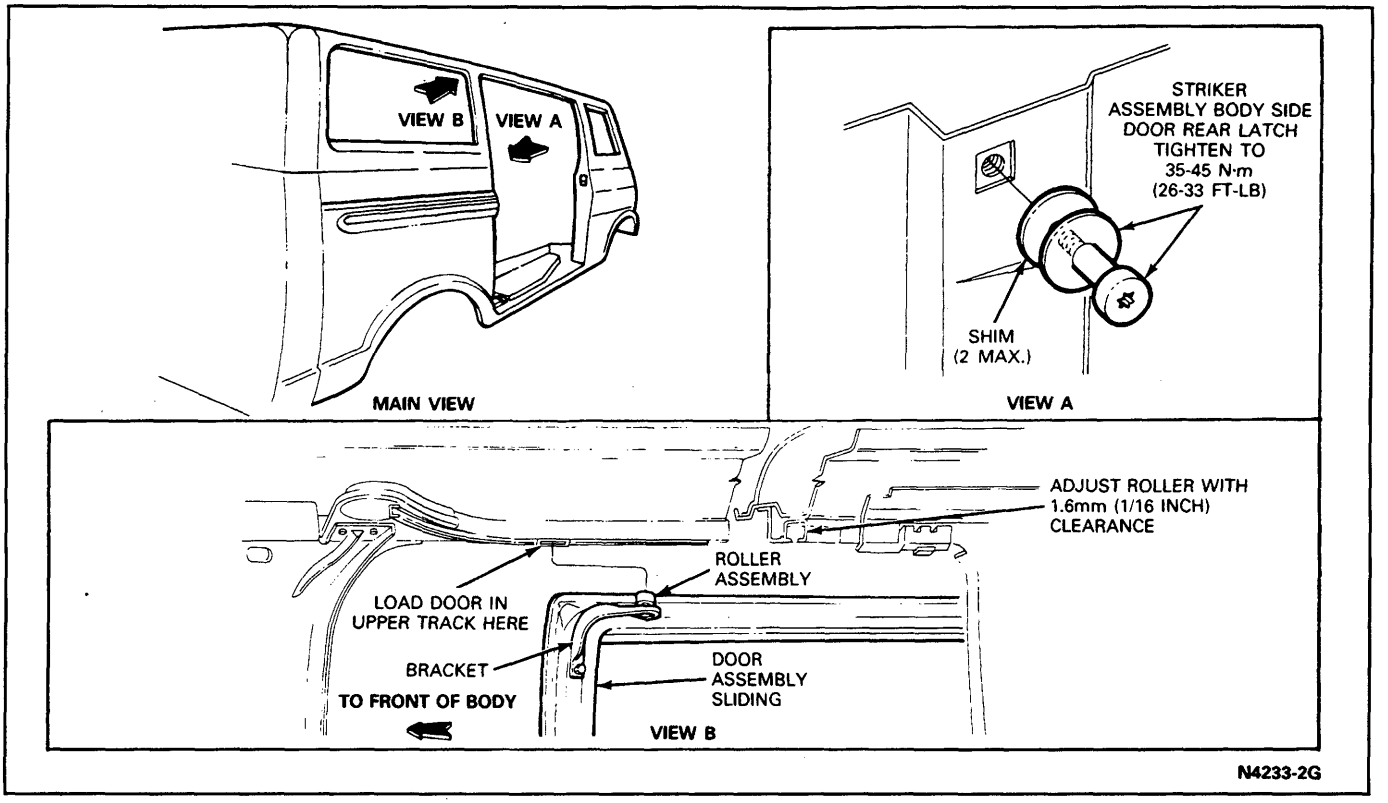


FIG. 2 Sliding Door—Guides and Rollers

Fore and Aft

Center Hinge Check and Front Striker

To gain access to the hinge check, remove the two screws retaining the center track shield (Fig. 3, View B and View E). On the regular 3505mm (138-inch) wheel base van the rear side marker lamp must be removed to gain access to the center track rear attaching screws. Refer to Section 32-21, Parking, Rear and Marker Lamps. Remove center track shield by pushing it forward, clearing it from the slot position. It can now be removed by pulling it away from the body.

Loosen the hinge check screws (Fig. 3, View A). These bolts must be kept loose when making the fore-and-aft adjustment. Then remove the B-pillar post trim panel (nine screws). Loosen the two striker bolts and remove the striker (Fig. 3, View C). Then, install the front striker and shim as necessary to obtain the proper fit and operation of the front latch assembly. Close door with front and rear fully latched. Adjust the door check so it is fully engaged with the hinge lever hook and the check bumper is firmly depressed against the hinge casting (ensure check latching face is vertical). Tighten check screws.

Lower Check

The lower check holds the sliding door assembly in the full open position (Fig. 3, View D).

No adjustment is required for this component.

REMOVAL AND INSTALLATION

NOTE: Due to the conversion from single 90 degree Rod to double 90 degree Rod, it may be necessary to remove more parts than the instructions indicate. This action will allow more maneuverability of the Rod and ease the Removal Process.

Upper Bracket and Roller Assembly

Removal and Installation

1. Remove the upper garnish moulding. Open and support the door.
2. Mark the location of the upper bracket assembly to the door (Fig. 2).
3. Remove the screws retaining the bracket and roller assembly. Remove the assembly from the door, through the opening at the back of the upper track.
4. If a new bracket is being installed, transfer the roller assembly to the new bracket.
5. Position the bracket and roller assembly to the door. Install the three retaining screws (Figs. 1 and 2).
6. Adjust door as necessary to obtain proper fit, as outlined.

Lower Guide Assembly

Removal and Installation

1. Open and support the door.
2. Remove the lower guide check screws and remove the check.
3. Slide the door forward on the support to gain access to the lower guide attaching screws.
4. Mark the location of the lower guide bracket to the door (Fig. 1, View E), and remove the guide attaching screws. **To gain access to the stop actuating rod retainer assembly (Fig. 4, View A), rotate the guide assembly 90 degrees.** Then, disconnect the stop actuating rod from the stop and remove the guide assembly.

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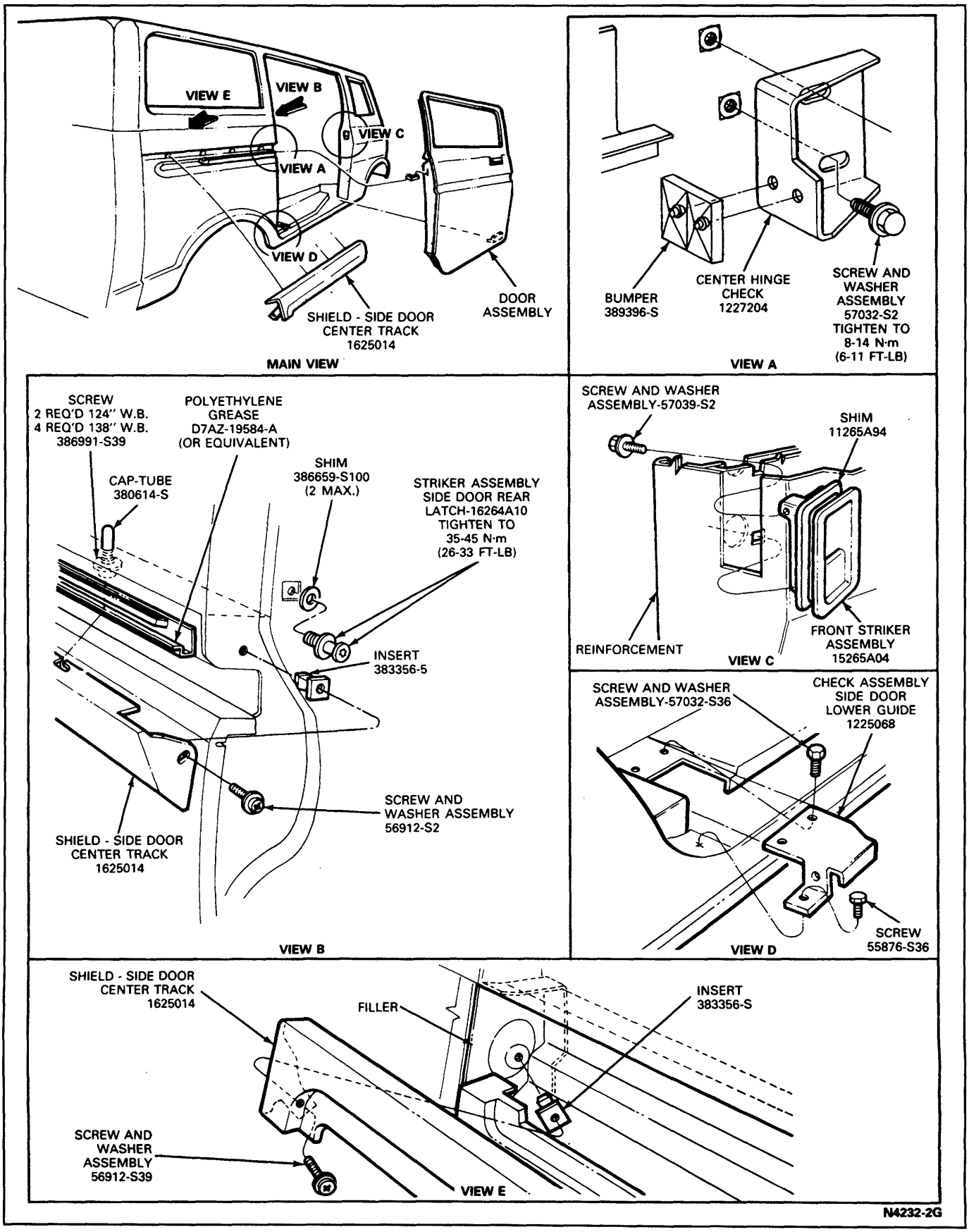


FIG. 3 Sliding Door Adjustments—Fore and Aft

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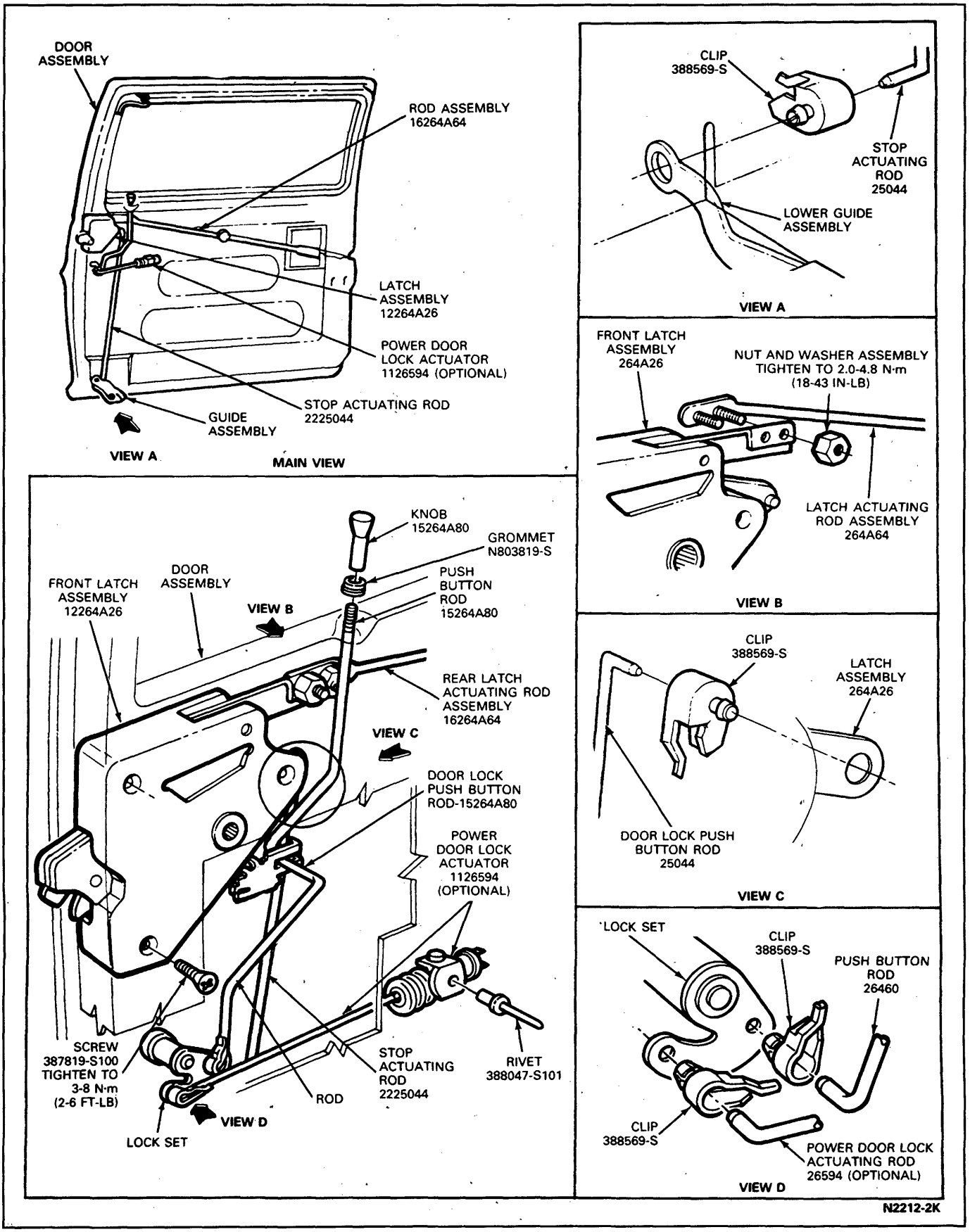


FIG. 4 Sliding Door—Latch and Rods—E-150—E-350

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5. Connect the rod to the new lower guide stop arm and secure the retainer.
6. Position the guide assembly to the door and install the retaining screws.
7. Rotate the inside door handle forward to ensure proper releasing action of the stop.

Door Latch—Front

Removal and Installation

1. Remove door trim panel. Refer to Section 45-03, Door Trim Panels. Also, remove inside handle attaching screw and inside handle and escutcheon (Fig. 5).
2. Remove outside door handle retainer. Slide outside door handle and shaft as an assembly out of the latch. DO NOT REMOVE THE OUTSIDE DOOR HANDLE SCREW
3. Remove the sleeve attaching screws and remove the sleeve from the latch.
4. Remove the rear latch actuating rod assembly from the rear latch (Fig. 1, View A).
5. Remove the door lock pushbutton rod from the lock cylinder and disengage it from the latch lever arm (Fig. 4, Views C and D, and Main View).
6. Remove the stop actuating rod from the front latch (Fig. 4, Main View).
7. Remove the three front latch retaining screws and disconnect the rear latch actuating rod from the latch.
8. Remove the front latch assembly through the access hole in the door.
9. Position the new latch assembly in the access hole opening and connect the rear latch actuating rod to the front latch.
10. Position the latch to the door and install the three retaining screws.
11. Connect the stop actuating rod to the front latch fork in the lock.
12. Position the pushbutton lock rod through the latch lever and connect the lock rod to the lock cylinder.
13. Position the sleeve to the latch assembly and install the retaining screws (Fig. 5).
14. Insert the outside handle assembly into the latch and install the handle retaining clip.
15. Connect the rear latch actuating rod to the rear latch assembly (Fig. 5, Main View). **The front latch must be in the full latched position and the rear latch must be in the secondary position before connecting the rear latch actuating rod to the rear latch assembly. Do not push or pull on the rod to make the hookup. Align the attaching holes by rotating the adjuster on the rear latch actuating rod.**
16. Check for proper latching operation before installing the door trim panel, escutcheon and inside door handle.

Door Latch—Rear

Removal and Installation

1. Remove the door trim panel. Refer to Section 45-03, Door Trim Panels.

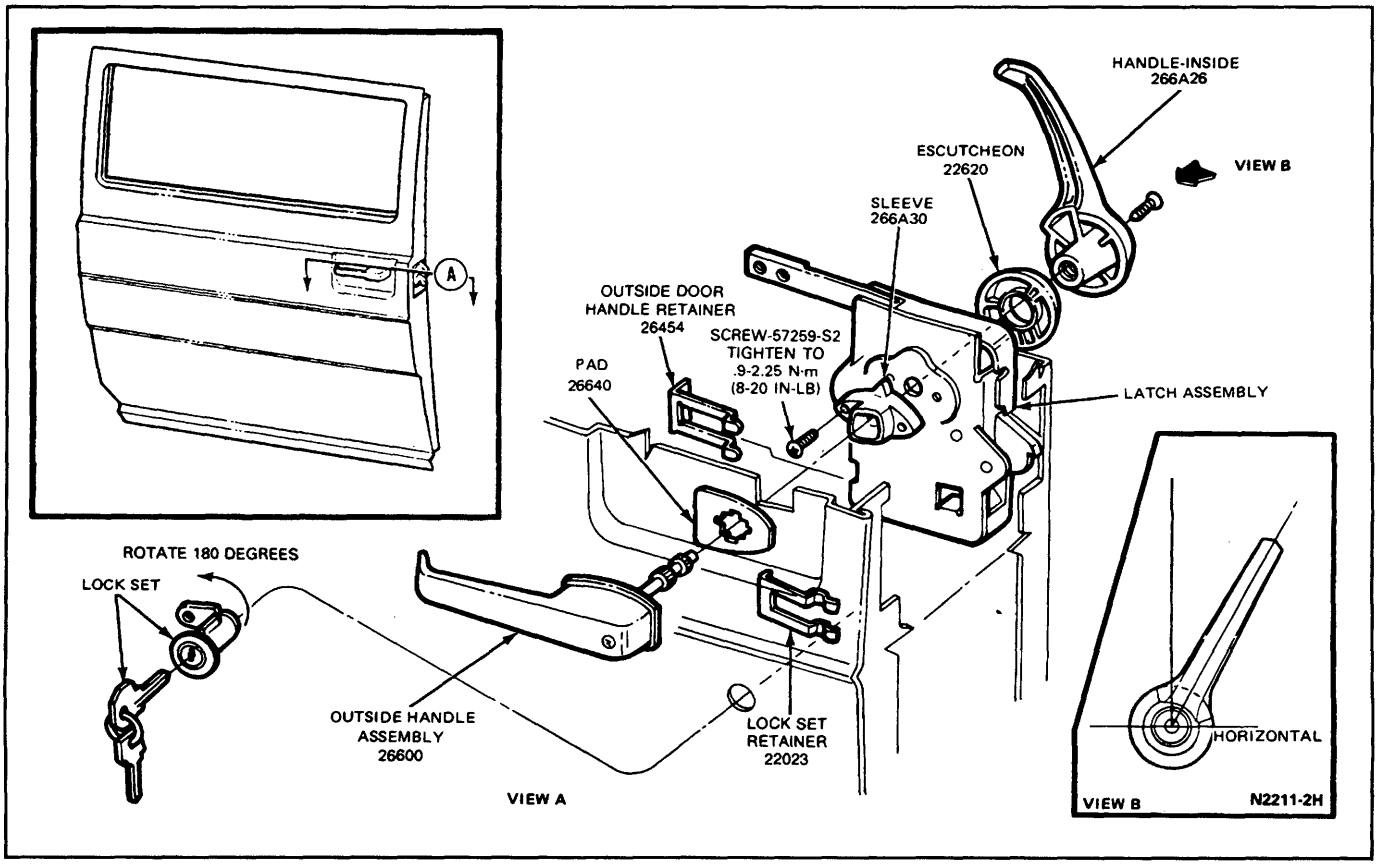


FIG. 5 Sliding Door—Lock and Latch—E-150—E-350

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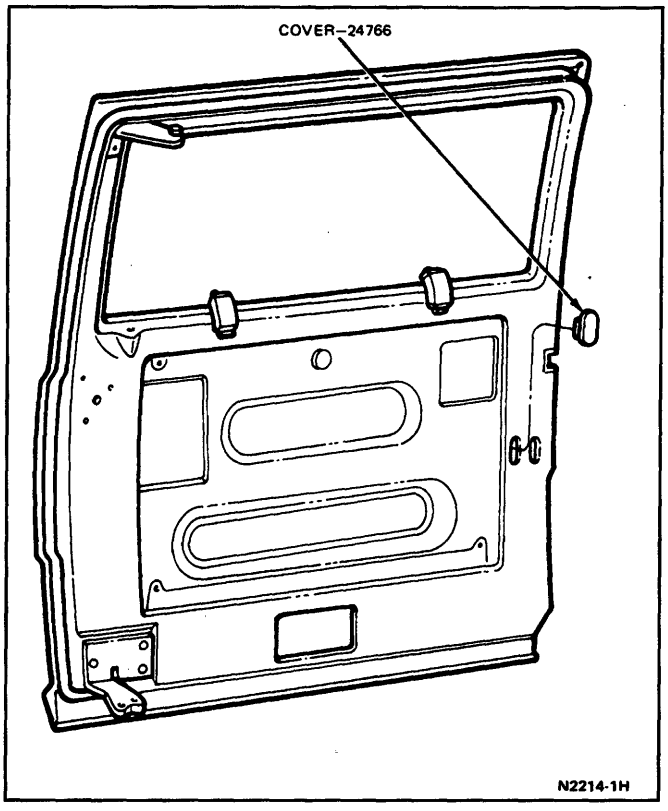


FIG. 6 Sliding Door—Access Hole Covers—E-150—E-350

2. Disconnect the actuating rod and retainer from the rear door latch arm (Fig. 1, View A).
3. Remove the three latch retaining screws and remove the latch from the door.
4. Position the new latch assembly into the door and install the three retaining screws.
5. Connect the actuating rod and retainer to the door latch arm. **The front latch must be in the full latched position and the rear latch must be in the secondary position before connecting the actuating rod and retainer to the door latch arm. Do not push or pull on the rod to make the hook-up. Align the attaching holes by rotating the adjuster on the front latch actuating rod.**
6. Check the latch operation and then, install the door trim panel. Refer to Adjustments if necessary.

Door Hinge Assembly

Removal and Installation

1. Open and support the door assembly.
2. Remove the center track shield as outlined (Fig. 3, View B).
3. Remove the door trim panel and/or access hole covers, if so equipped (Fig. 6). Refer to Section 45-03, Door Trim Panels.
4. Mark the position of the hinge assembly to the door (Figs. 1 and 7).
5. Slide the hinge assembly to a position in line with the loading notches located in the center track. Remove the door from the track.
6. Install the new hinge assembly through the loading notches in the center track. Position the hinge to the door.
7. Install the hinge retaining screws and check the operation of the door.
8. Then, install the trim panel and/or access hole covers. Refer to Section 45-03, Door Trim Panels.
9. Install the center track shield.

Weatherstrips

Refer to Section 44-06, Door Hinges, Checks and Weatherstrips.

Striker—Front Latch

Removal and Installation

1. Remove nine B-pillar trim panel screws.
2. Remove two striker bolts and transfer the shim(s) to the new striker (Fig. 3, View C).
3. Position the striker and install the two attaching bolts (snug). Adjust as necessary.
4. Install the B-pillar trim panel (nine screws).

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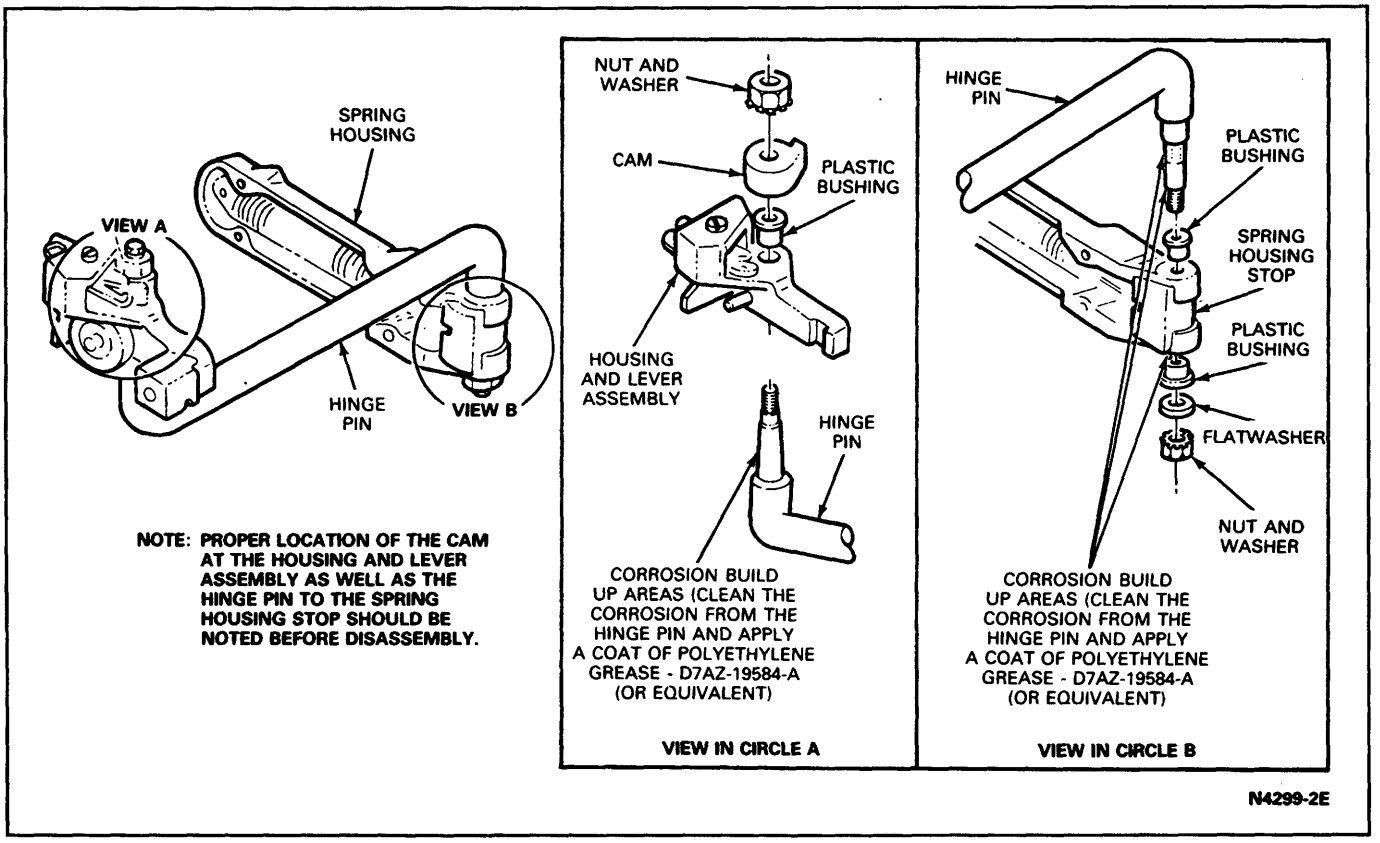


FIG. 7 Hinge Disassembled

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SECTION 44-11 Door Latches and Locks

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VEHICLE APPLICATION

All Models.

ADJUSTMENTS

Latch Striker Adjustment

CAUTION: Do not cover up a poor door alignment with a latch striker adjustment.

Front Doors

Use Torx Drive Bit Set D79P-2100-T or equivalent where required to loosen or tighten striker.

The striker pin can be adjusted laterally and vertically as well as fore and aft. The latch striker should not be adjusted to correct door sag. The latch striker should be shimmed to get the clearance shown in Fig. 1 between the latch striker and the latch. To check this clearance:

1. Clean the latch jaws and the striker area.
2. Apply a thin layer of dark grease such as Multi-Purpose Long-Life Lubricant C1AZ-19590-B or equivalent to the latch striker.
3. As the door is closed and opened, a measurable pattern will result.
4. Move the striker assembly laterally to provide a flush fit with the door and body. Do not use more than two shims.
5. Tighten the striker to 33-45 N·m (24-33 ft-lb).

Rear Doors E-150—E-350

The back door latch strikers are adjusted inboard or outboard to obtain a flush fit of the doors with the body. To adjust the striker(s), loosen the two attaching screws and move the striker(s) as necessary to obtain the proper door fit. Tighten the two attaching screws. The striker should be shimmed to get the required clearance (Fig. 7, Views B And C). **Do not use more than two shims.**

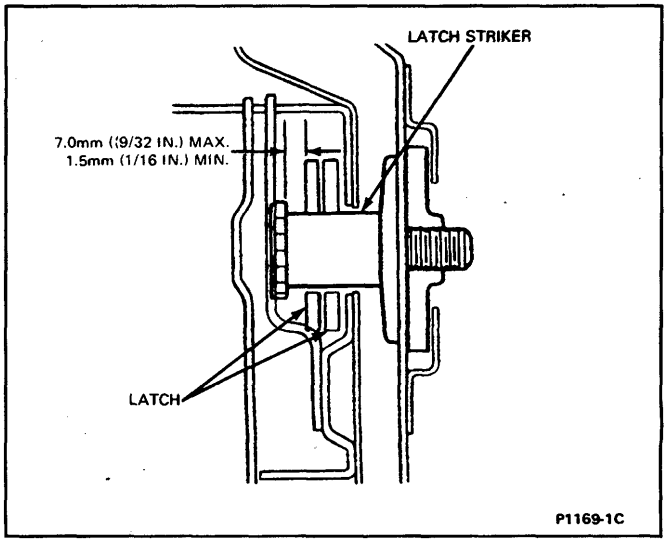


FIG. 1 Latch Striker Adjustment—Typical Bronco, F-150—F-350 and E-150—E-350

Rear Side Door (E-150—E-350 with Side Hinged Doors)

The rear side door latches (upper and lower) can be adjusted inboard or outboard to obtain a flush fit of the door with the body. To adjust the latch assemblies, loosen the two attaching screws and move the assemblies as necessary to obtain the proper door fit. Tighten the two attaching screws (Fig. 5).

REMOVAL AND INSTALLATION

Note: Due to the conversion from single 90 degree Rod to double 90 degree Rod, it may be necessary to remove more parts than the instructions indicate. This action will allow more maneuverability of the Rod and ease the removal process.

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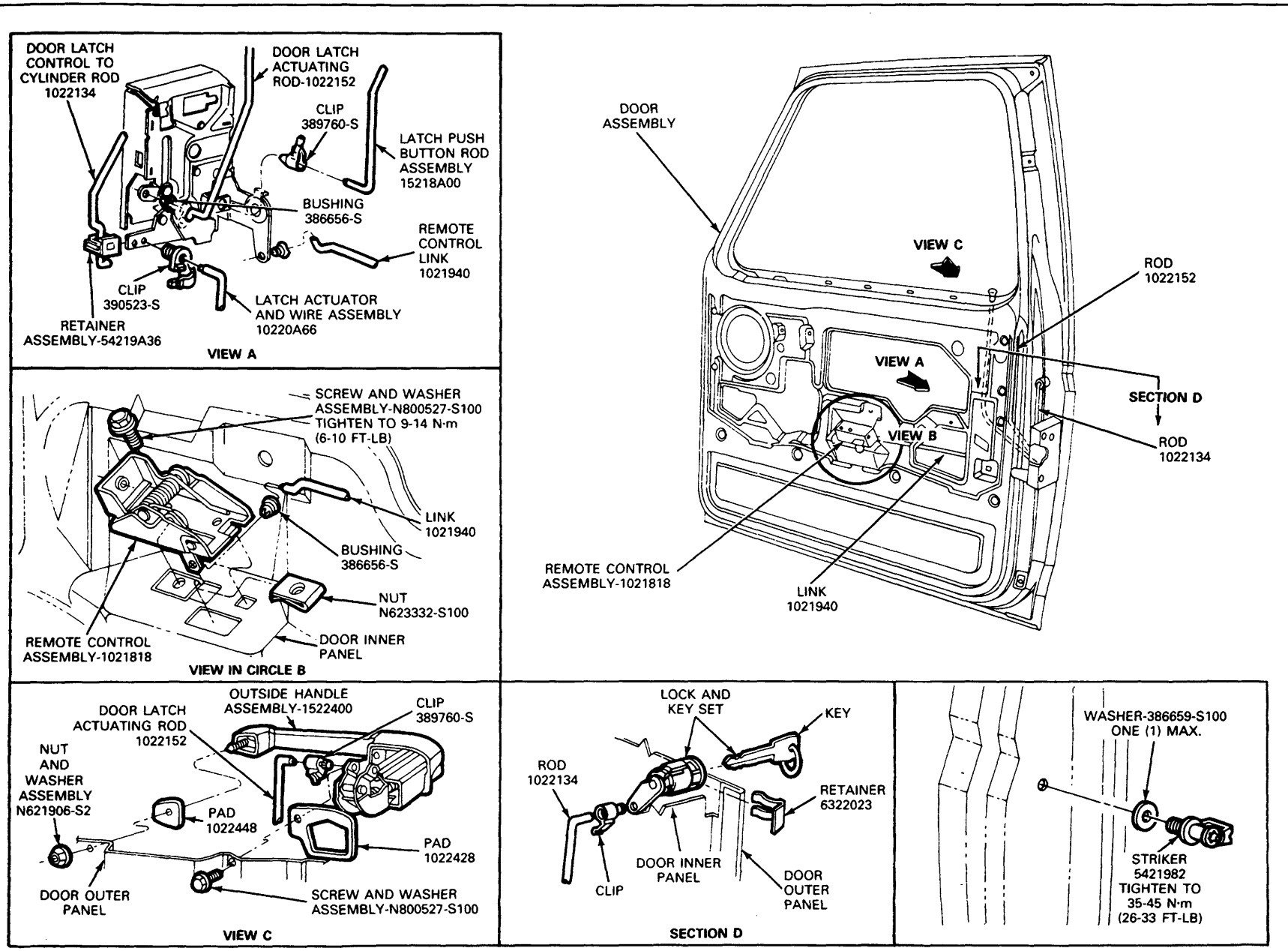


FIG. 2 Door Latch Installation—Bronco and F-150—F-350

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Front Door Latch

Bronco and F-Series

Removal

1. Remove the trim panel and watershield from the door. Refer to Section 45-03, Door Trim Panels.
2. Disconnect rods from handle and lock cylinder if necessary, and from remote control assembly (Fig. 2).
3. Remove the latch assembly attaching screws and remove the latch from the door.

Installation

1. Install the rod retaining clips in the new latch assembly. Rods should be attached to latch before latch installation.
2. Position the latch in the door and install the latch attaching screws.
3. Connect the rods to the handle, lock cylinder and remote control. Check the operation of the latch.
4. Install the watershield and trim panel on the door. Refer to Section 45-03, Door Trim Panels.

E-150—E-350

Removal

1. Remove the door inside handle. If equipped with door trim panels, remove the inside handle cup and window regulator handle. If equipped with power door locks, refer to Section 44-16, Power Door Locks.
2. Remove the access cover plate or door trim panel and the watershield. Refer to Section 45-03, Door Trim Panels.
3. Remove the door glass rear run. Refer to Section 42-04, Front Door Window Glass and Mechanisms.
4. Disconnect rods from handles and lock cylinder.
5. Remove the three screws attaching the latch to the door and remove latch assembly.

Installation

1. Connect the control rods and link to the door latch (Fig. 3, View A).
2. Position the door latch to the door and install the three attaching screws.
3. Install the door glass rear run.
4. Install the watershield and door trim panel or access cover plate. Refer to Section 45-03, Door Trim Panels.
5. Install the door inside handle cup (if equipped with trim panel), inside handle, and window regulator handle.

Front Side Cargo Door Latch

E-150—E-350 with Hinged Side Doors

Removal

1. Remove the door access cover or trim panel and watershield, if so equipped. Refer to Section 45-03, Door Trim Panels.
2. Remove the two nuts attaching the door inside handle and remove handle (Fig. 4).
3. Remove the three remote control bracket attaching screws. Disconnect the remote control link. Remove the remote control and bracket as an assembly.
4. Unscrew and remove the door lock pushbutton knob (Fig. 4).
5. Disconnect the pushbutton rod from the door latch.
6. Disconnect the door outside handle rod from the outside handle (Fig. 4).
7. Remove the three latch attaching screws and remove latch from door.

Installation

1. Transfer the rods and bushings to the new latch assembly if the latch assembly is to be replaced.
2. Position the latch in the door and insert the pushbutton rod through the pushbutton hole. Install the three latch attaching screws. Tighten the three screws 4-8 N·m (3-6 ft-lb).
3. Connect the outside handle rod to the door outside handle.
4. Connect the pushbutton rod to the door latch.
5. Connect the link to the remote control. Position the remote control and bracket to the door inner panel and install the attaching screws.
6. Install the door inside handle and the lock pushbutton.
7. Install the watershield and trim panel or access cover, if so equipped. Refer to Section 45-03, Door Trim Panels.

Rear Door Latch—F-350 Crew Cab

Removal

1. Remove the trim panel and watershield from the door. Refer to Section 45-03, Door Trim Panels.
2. Disconnect rods from handle and lock cylinder if necessary, and from remote control assembly (Fig. 5, View A).
3. Remove the latch assembly attaching screws and remove the latch from the door.

Installation

1. Install the rod retaining clips in the new latch assembly. Rods should be attached to latch before latch installation.
2. Position the latch in the door and install the latch attaching screws.
3. Connect the rods to the handle, lock cylinder and remote control. Check the operation of the latch.
4. Install the watershield and trim panel on the door. Refer to Section 45-03, Door Trim Panels.

Rear Side Cargo Door Latch

E-150—E-350 with Hinged Side Doors

Removal

1. Remove the inside handle from the remote control shaft.
2. Disconnect the lower latch rod from the remote control (Fig. 6, View A).

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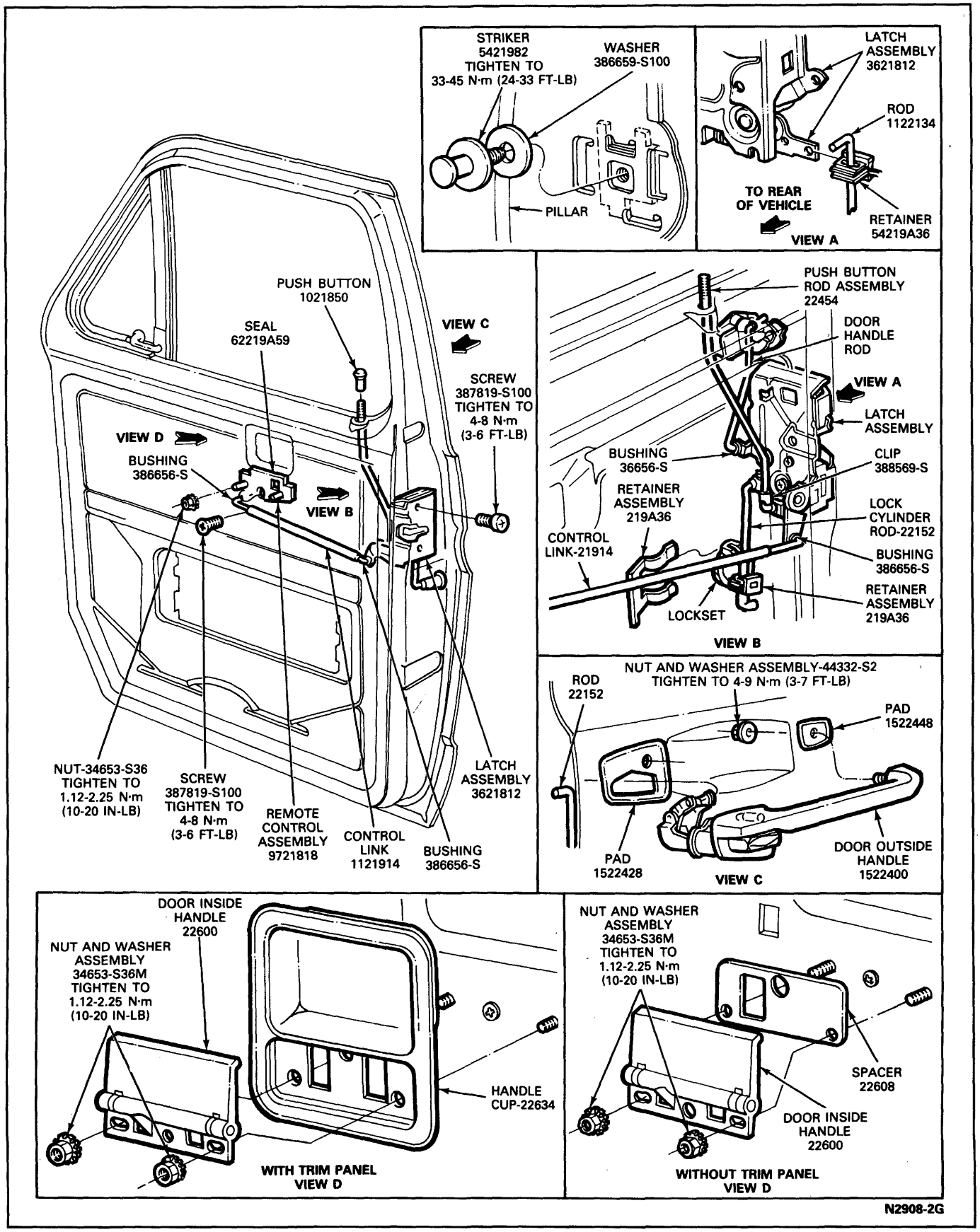
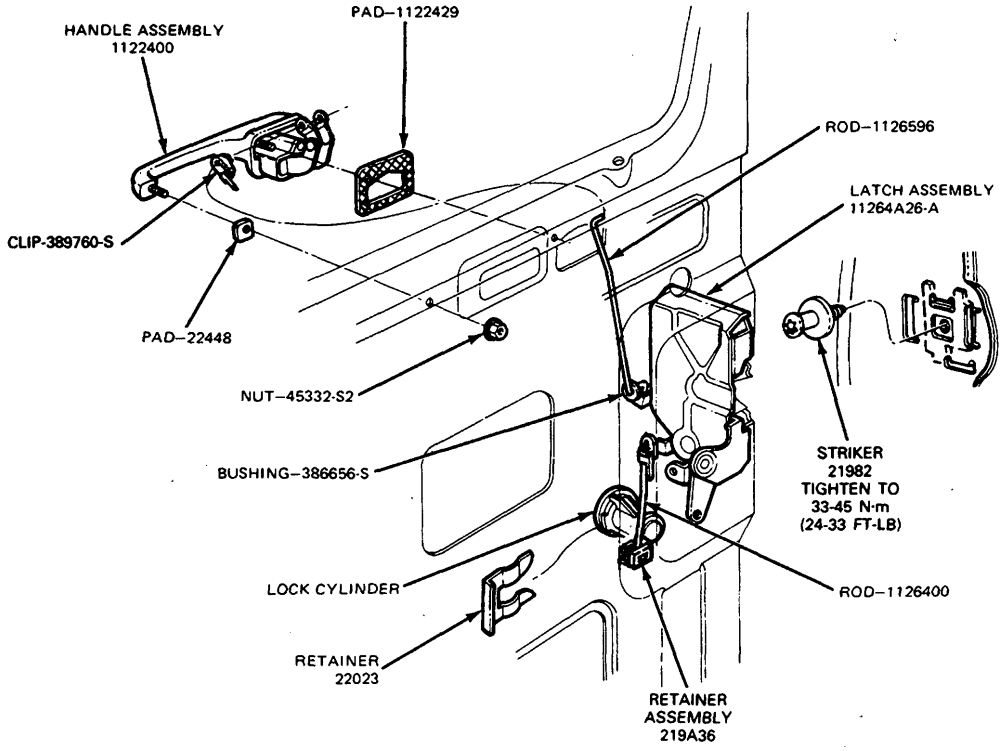
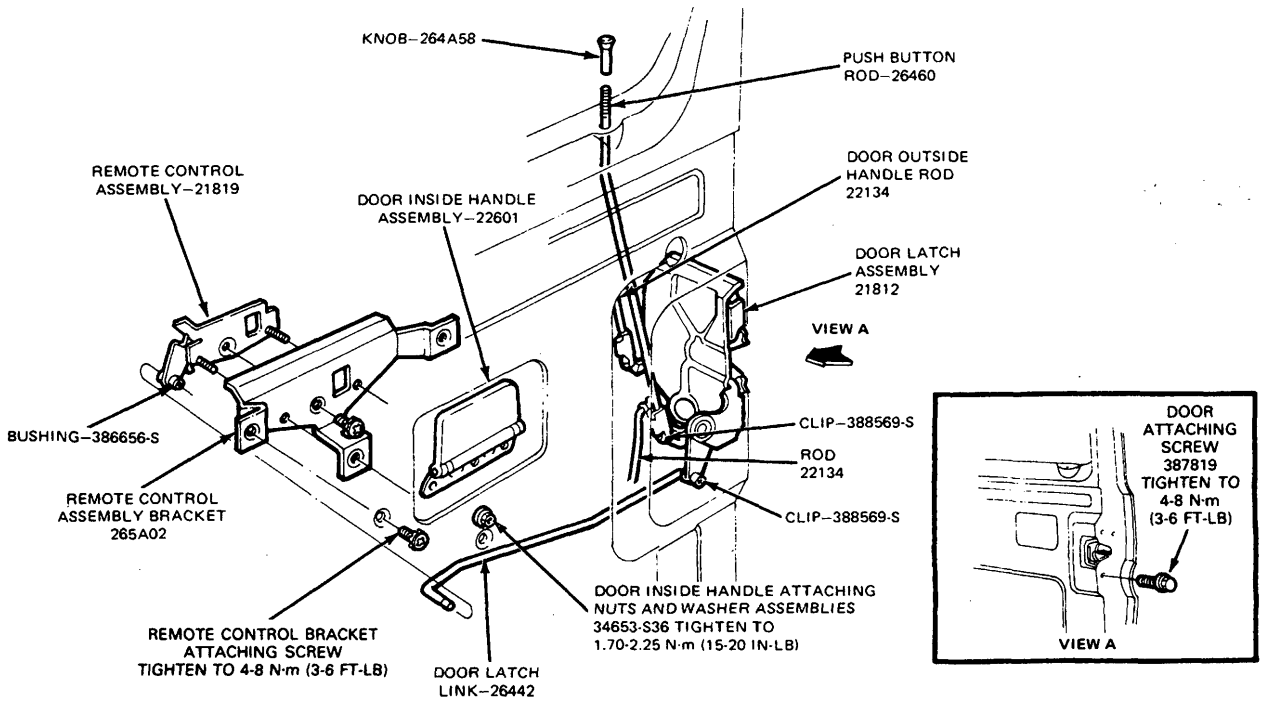


FIG. 3 Front Door Latch and Remote Control Installation—E-150—E-350 w/o Power Door Locks

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OUTSIDE HANDLE INSTALLATION



INSIDE HANDLE INSTALLATION

N1625-2H

FIG. 4 Front Side Cargo Door Latch Installation—E-150—E-350

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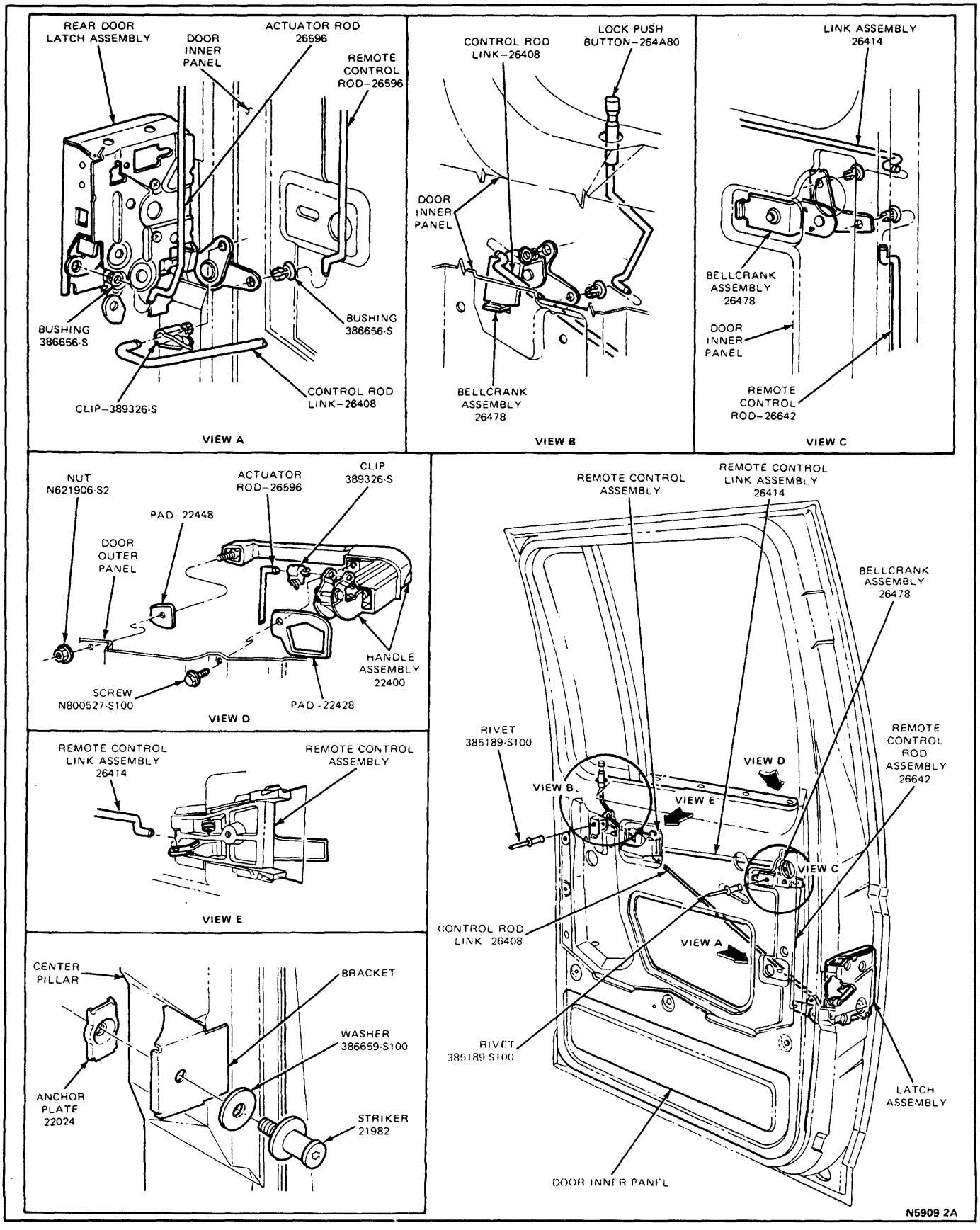


FIG. 5 Rear Door Latch and Remote Control Installation—F-350 Crew Cab

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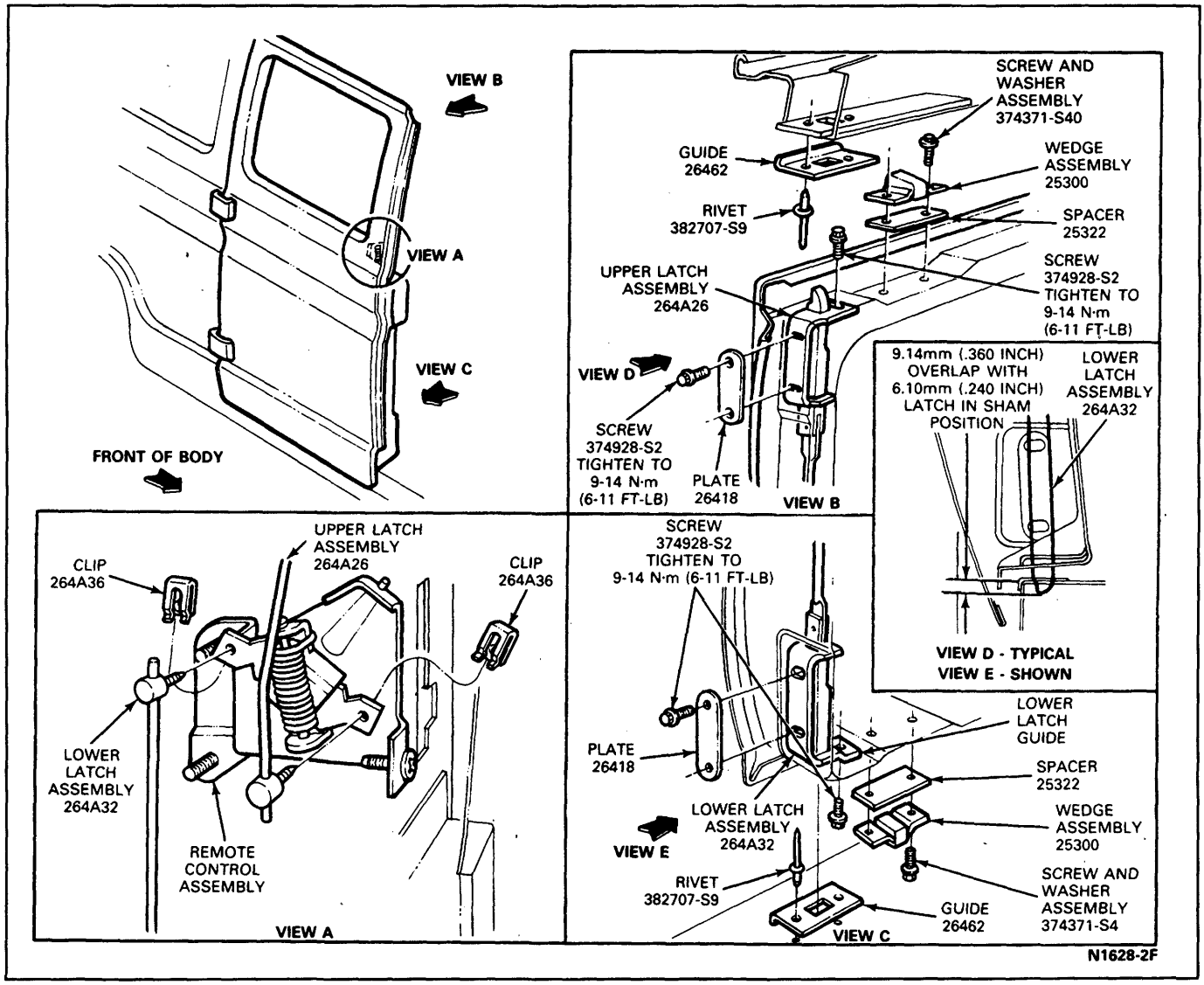


FIG. 6 Rear Side Cargo Door Latch Installation—E-150—E-350

3. Remove three screws attaching the lower latch guide to the bottom of the door (Fig. 6, View C). Remove the lower latch assembly from the door.
4. Remove three screws attaching the remote control to the door (Fig. 7, View A).
5. Remove three screws attaching the upper latch guide to the top of the door (Fig. 6, View B). Remove the upper latch assembly and remote control from the door.
6. Disconnect the upper latch assembly from the remote control.

Installation

1. Assemble the upper latch assembly to the remote control (Fig. 6, View B).
2. Position the upper latch assembly and remote control to the door. Install three screws attaching the upper latch guide to the top of the door.
3. Position the lower latch assembly in the door and connect the lower latch rod to the remote control (Fig. 6, View C).
4. Install three screws attaching the lower latch guide to the door.
5. Install three screws attaching the remote control to the door (Fig. 7, View A).
6. Install the inside handle on the remote control shaft.
7. Adjust the door for a snug fit against the weatherstrip. This is done by loosening the latch guide attaching screws and moving the latch assembly inboard or outboard as required. Then, tighten the latch guide attaching screws.

Right Rear Door Latch

E-150—E-350

Removal

1. Remove the door trim panel and watershield, if so equipped. Refer to Section 45-03, Door Trim Panels.
2. To remove the upper latch, remove the three screws attaching the upper latch to the door (Fig. 8, View B).
3. Disengage the lock rod clip, remove the latch rod from the upper latch, and remove the upper latch from the door.

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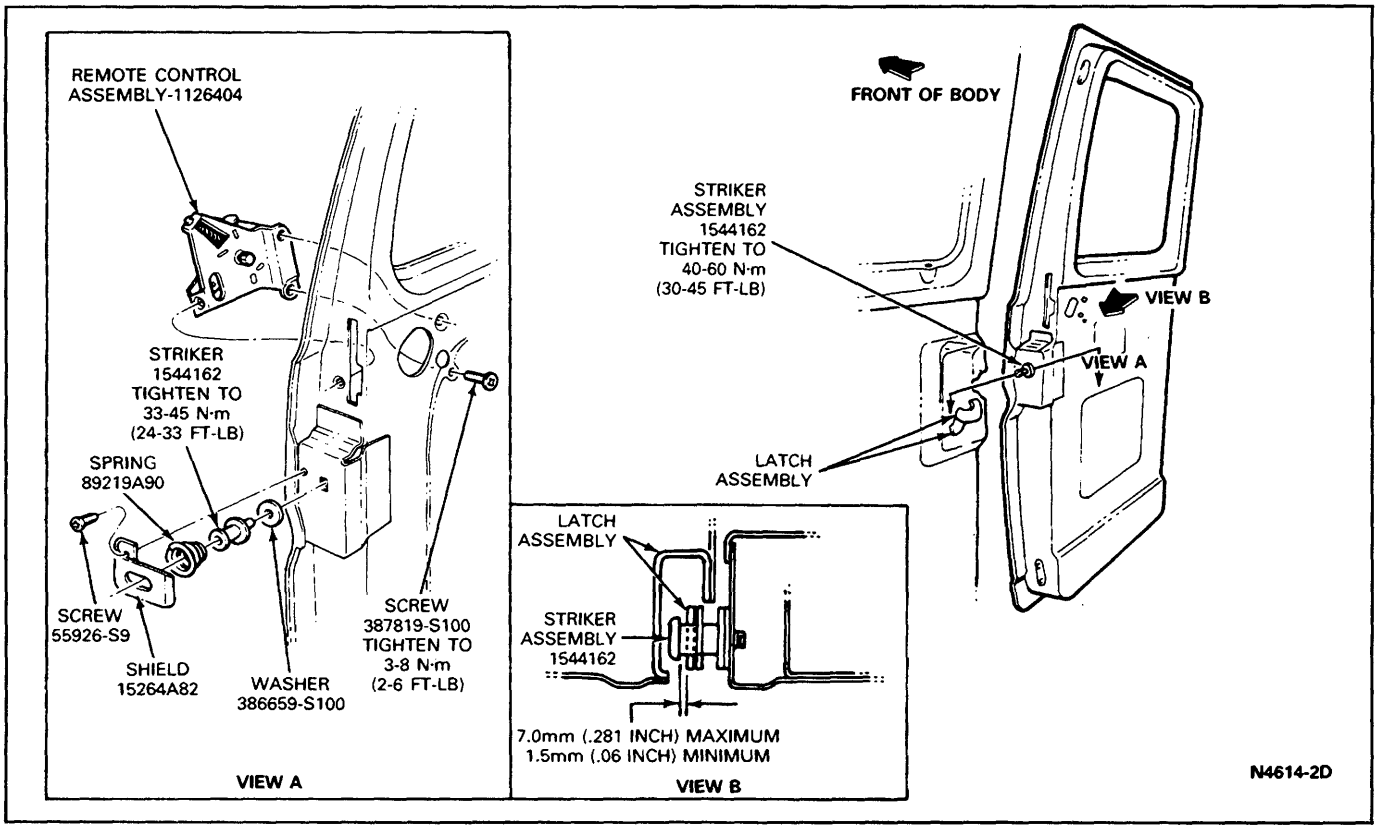


FIG. 7 Rear Side and Left Rear Door Remote Control Door Latch and Striker—E-150—E-350

4. To remove the lower latch, remove the four latch attaching screws and disengage the latch rod from the latch. Remove the latch from the door (Fig. 8, View C).

Installation

1. To install the lower latch, connect the latch rod and bushing to the latch. Position the latch to the door and install the four attaching screws.
2. To install the upper latch, position the latch to the door and install the three attaching screws.
3. Connect the latch rod clip and rod to the latch (Fig. 8).
4. Check the operation of the latches and adjust the strikers, if necessary. Refer to Latch Striker Adjustments.
5. Install the watershield and door trim panel, if so equipped. Refer to Section 45-03, Door Trim Panels.

Left Rear Door Latch

E-150—E-350

Removal and Installation

1. Remove the door trim panel and watershield, if so equipped.
2. Remove the four latch attaching screws and remove the latch from the door (Fig. 9).
3. Position the latch to the door and install the four attaching screws.
4. Install the watershield and door trim panel, if so equipped. Refer to Section 45-03, Door Trim Panels.

Remote Control Assembly—Front Door

F-Series and Bronco

Removal and Installation

1. Remove the door trim panel and watershield. Refer to Section 45-03, Door Trim Panels.
2. Remove the screws attaching the remote control to the door inner panel, and remove the remote control.
3. Disconnect the latch remote control link from the remote control (Fig. 2, View A).
4. Transfer the rod clip to the new remote control, if the remote control is to be replaced.
5. Position the remote control to the door inner panel and connect the link to the remote control.
6. Install the remote control attaching screw.
7. Check the remote control and latch operation.
8. Install the watershield and door trim panel. Refer to Section 45-03, Door Trim Panels.

E-150—E-350

Removal and Installation

1. Remove the door inside handle, inside handle cup (if so equipped) and window regulator handle.
2. Remove the access cover plate and watershield from the door inner panel.
3. Remove the screw attaching the remote control to the door inner panel (Fig. 3).
4. Disengage the link from the remote control and remove the remote control from the door.

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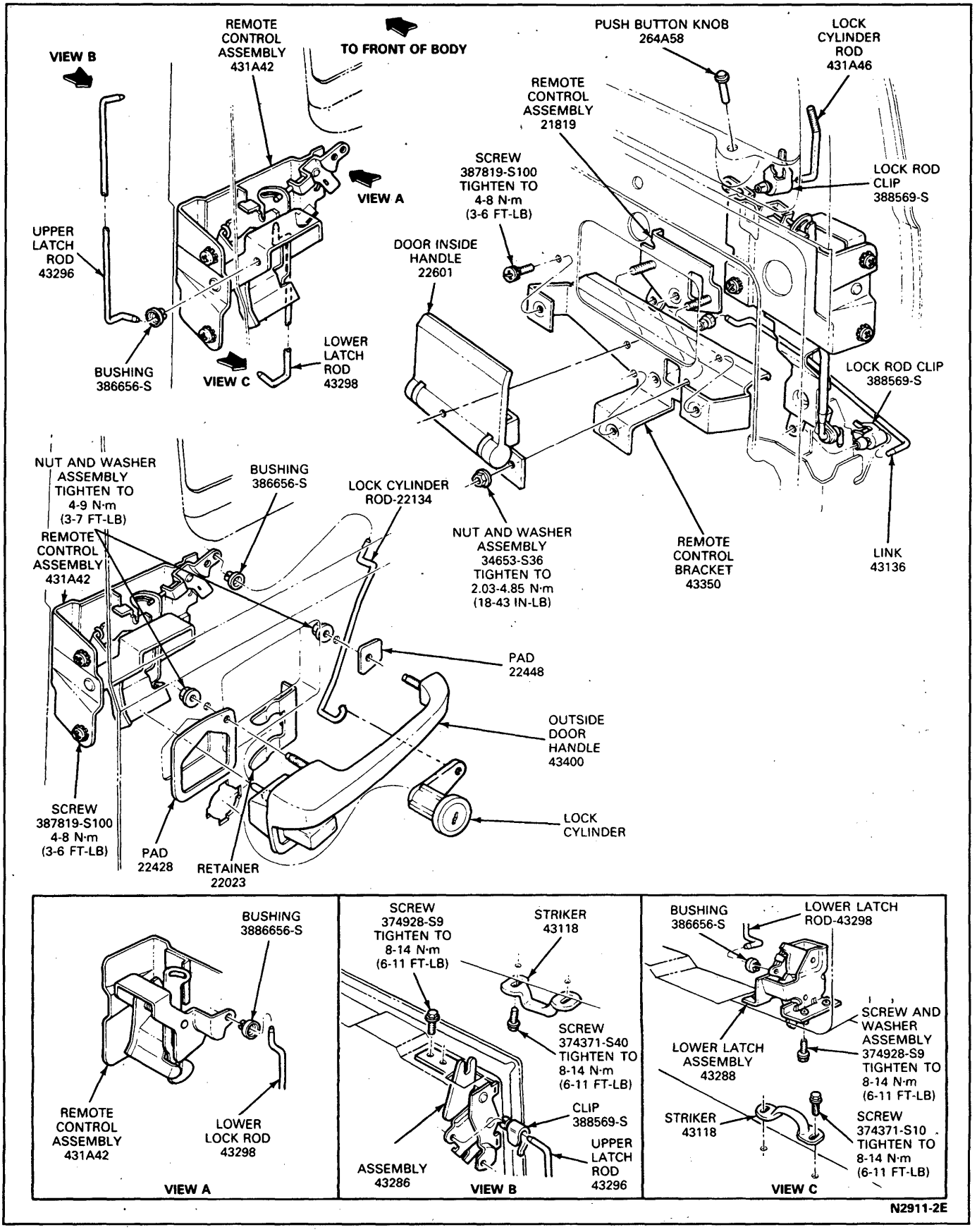


FIG. 8 Right Rear Door Latch and Remote Control Installation—E-150—E-350

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5. Transfer the bushing to the new remote control.
6. Connect the link to the remote control. Install the remote control to the door inner panel with the attaching screws.
7. Install the watershield and access cover plate.
8. Install the window regulator handle, inside handle cup (if so equipped), and door inside handle.

Remote Control Assembly—F-350 Crew Cab Rear Door

Removal

1. Remove the two screws retaining armrest to door inside panel. Remove the screw retaining window regulator handle to door.
2. Remove inside door handle trim cup.
3. Remove door trim panel and watershield, if so equipped. Refer to Section 45-03, Door Trim Panels.
4. Push tabs on remote control assembly together and slide assembly forward (Fig. 5, View E).
5. Disconnect link rod from remote control assembly by rotating remote control clockwise. Remove remote control assembly from door.

Installation

1. Install link rod to remote control assembly.
2. Slide remote control assembly into slot in door inner panel until retaining tabs are engaged.
3. Install door trim panel and watershield, if so equipped. Refer to Section 45-03, Door Trim Panels.
4. Install door handle trim cup with one screw. Install window regulator handle with one screw.
5. Install armrest with two screws.

Remote Control Assembly—Right Rear Door

E-150—E-350 (Without Door Inside Handle)

Removal

1. Remove the door trim panel and watershield, if so equipped. Refer to Section 45-03, Door Trim Panels.
2. Disconnect the lock cylinder rod from the lock cylinder (Fig. 8).
3. Remove the three screws attaching the remote control assembly to the door (Fig. 8).
4. Disconnect the upper latch rod from the upper latch (Fig. 8, View B). Disconnect the upper latch rod from the remote control assembly.
5. Disconnect the lower latch rod from the remote control assembly, and remove the assembly from the door.

Installation

1. Transfer the lock cylinder rod and rod bushings to the new remote control assembly.
2. Position the remote control assembly into the door and connect the lower latch rod to the assembly.
3. Connect upper latch rod to remote control assembly and to the upper latch (Fig. 8, View B).
4. Position remote control assembly to door inner panel and install three attaching screws.

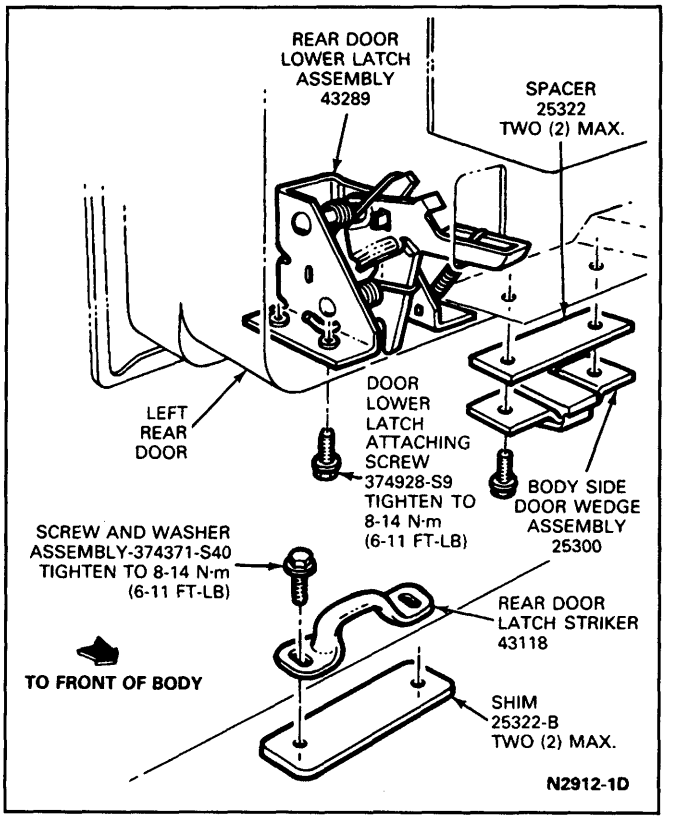


FIG. 9 Left Rear Door Latch—E-150—E-350

5. Connect the lock cylinder rod to the lock cylinder (Fig. 8).
6. Install the watershield and door trim panel, if so equipped. Refer to Section 45-03, Door Trim Panels.

E-150—E-350 (With Door Inside Handle)

Removal

1. Remove the two nuts retaining the door inside handle to the handle remote control and remove the handle.
2. Remove the door trim panel and watershield, if so equipped. Refer to Section 45-03, Door Trim Panels.
3. Disconnect the door handle remote control link from the remote control (Fig. 8).
4. Remove the three screws attaching the door handle remote control bracket to the door inner panel. Remove the door handle remote control, bracket, and link from the door.
5. Unscrew and remove the door lock pushbutton (Fig. 8).
6. Disconnect the lock cylinder rod from the lock cylinder.
7. Remove the three screws attaching the remote control assembly to the door (Fig. 8).
8. Disconnect the upper latch rod from the upper latch (Fig. 8). Disconnect the upper latch rod from the remote control assembly.
9. Disconnect the lower latch rod from the remote control assembly and remove the assembly from the door.

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Installation

1. Transfer the door lock push rod, lock cylinder rod, and rod bushings to the new remote control assembly.
2. Position the remote control assembly into the door, and connect the lower latch rod to the assembly.
3. Connect the upper latch rod to the remote control assembly and upper latch (Fig. 8).
4. Place the remote control assembly in position and insert the door lock pushbutton rod through the pushbutton hole (Fig. 8). Install the three remote control assembly attaching screws.
5. Connect the lock cylinder rod to the lock cylinder (Fig. 8).
6. Screw the door lock pushbutton on the pushbutton rod.
7. Position the door inside handle remote control and bracket to the door inner panel. Install the three attaching screws (Fig. 8).
8. Connect the inside handle remote control link to the remote control assembly.
9. Install the watershield and door trim panel, if so equipped. Refer to Section 45-03, Door Trim Panels.
10. Install the door inside handle.

Lock Cylinder

Removal and Installation

When a lock cylinder is replaced, both door lock cylinders should be replaced in a set. This will eliminate carrying an extra key which will fit only one lock. If a key is to be replaced, the new key code number is stamped on a metal tag attached to the key.

1. Roll the window to the up position.
2. Remove the access hole cover and/or trim panel and pull away the watershield, if so equipped.
3. Disconnect the lock actuating rod from the lock control link clip.
4. Slide the lock cylinder retainer away from the lock cylinder (Figs. 2, 3, 4 and 8).
5. Remove the lock cylinder.
6. Insert the lock cylinder in the door and connect the lock cylinder retainer.
7. Connect the lock actuating rod to the lock control link clip.
8. Install the watershield. Using Rubber Cement 8A-19552-B or equivalent, cement the top and/or side edges of the watershield to the inner surface of the inner panel.
9. Install the access hole cover and/or trim panel. Refer to Section 45-03, Door Trim Panels.

Door Inside Handle

F-150—F-350 and Bronco (except F-350 Crew Cab Rear Door)

Removal and Installation

To remove the door inside handle, remove one screw and remove the handle. To install, position handle on shaft and secure with set screw.

F-350 Crew Cab—Rear Door

The door inside handle is an integral part of the remote control assembly. Refer to Crew Cab Rear Door Remote Control Removal and Installation.

E-150—E-350

Removal and Installation

The door inside handle is attached to the remote control with two nut and washer assemblies (Fig. 3). Remove the nut and washer assemblies to remove the inside handle. An inside handle cup is used on E-150—E-350 models with door trim panels. The cup can be removed by pulling it off the remote control studs.

Door Outside Handle

Bronco, F-150—F-350 and E-150—E-350

Removal and Installation

1. Remove the trim panel and watershield from the door. Refer to Section 45-03, Door Trim Panels.
2. Disconnect the latch actuating rod from the handle link connector (Fig. 2).
3. Remove two nuts retaining outside handle (one nut and one screw for Bronco and F-150—F-350).
4. Remove handle and pads from door.
5. Attach actuator rod and pads to new handle.
6. Install two retaining nuts (one nut and one screw for Bronco and F-150—F-350).
7. Install door trim panel and watershield. Refer to Section 45-03, Door Trim Panels.
8. Check operation.

Front Side and Right Rear Cargo Doors—Outside Handles

E-150—E-350

Removal and Installation

1. Remove the door trim panel and watershield, if so equipped. Refer to Section 45-03, Door Trim Panels.
2. Remove the two nut and washer assemblies attaching the outside handle to the door (Fig. 8).
3. Remove the outside handle and pads from the door.
4. Position the pads and outside handle to the door and install the two screw and washer assemblies.
5. Install the watershield and door trim panel, if so equipped. Refer to Section 45-03, Door Trim Panels.

SPECIFICATIONS

SPECIAL SERVICE TOOL

Tool No.	Description
D79P-2100-T	"Torx" Drive Bit Set

CN5260-1B

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SECTION 44-16 Power Door Locks

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REMOVAL AND INSTALLATION (Cont'd)	
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Switch	44-16-3
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VEHICLE APPLICATION

All Light Truck Models.

DESCRIPTION AND OPERATION

E-150—E-350

The power door lock control system uses electric switches controlled by push buttons mounted on the front door trim panels. Relays direct current to the door lock actuator motors to lock or unlock the doors.

To lock the doors, push firmly on either front door LOCK push button. Sliding cargo door and rear doors must be closed for contact buttons to function. To unlock the doors from inside the vehicle, push the UNLOCK button on the door trim panel-mounted switches.

The key will not lock or unlock all doors at the same time from outside the vehicle. The key inserted into the door lock can only be used to lock or unlock each individual door.

The power door lock control system includes contact buttons at the side cargo door and key-locked rear door. The contact buttons provide an electrical link for the operation of the lock actuator motors in the remote doors.

If electrical connections to the contact buttons are reversed, the door(s) will lock when the switch is moved to UNLOCK and open when the switch is moved to LOCK.

Two power contact buttons are installed in the B-pillar, the D-pillar, the side doors and rear door (Fig. 1).

The power contact buttons only transmit electrical power to the lock actuators when the two pairs of buttons are in good contact.

Power door locks are available on the following models:

- Cutaway models, power locks on driver and passenger doors.
- Vans and Club Wagons, power locks on all doors. All doors can be locked or unlocked by pushing on either driver or passenger lock button but not the side or rear door button.

F-150—F-350 and Bronco

Refer to Fig. 7.

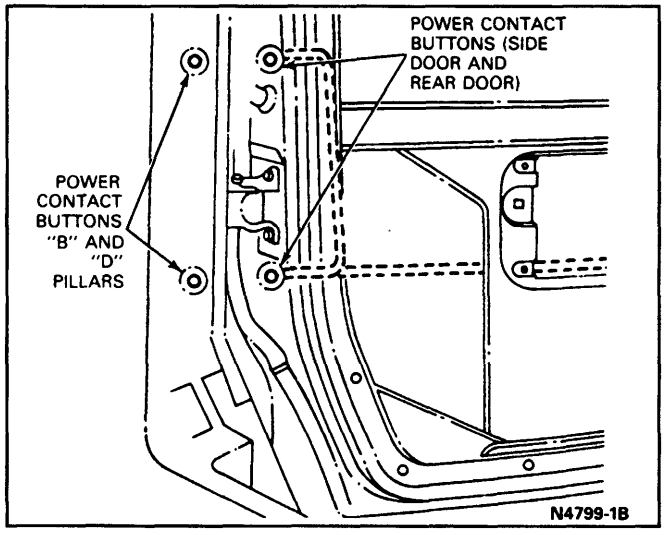


FIG. 1 Power Contact Buttons

The power door lock control system uses electric rocker-type switches located in the door trim panel.

Push the door lock switch to lock or unlock the door as desired.

The key inserted into the door lock can only be used to lock or unlock each individual door, from outside the vehicle.

DIAGNOSIS AND TESTING

Refer to the Diagnosis Guide for power door lock diagnosis.

TESTING

Motor

Apply 12 volts directly to one terminal of the motor's (actuator) connector and ground the other terminal (Figs. 2, 3 and 4). The motor (actuator) should finish its travel in less than one second. Reverse the polarity for opposite travel.

Using a Rotunda Model 007-00001 Digital Volt-Ohm Meter or equivalent, the motor current draw (stall test), should not exceed 6.2 amps. Reverse the power and ground leads to the connector and re-test.

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Diagnosis Guides

CONDITION	POSSIBLE CAUSE	RESOLUTION
All door locks do not work.	1. Malfunctioning circuit breaker.	1. Check circuit breaker. Replace if necessary. Refer to "Fuses & Circuit Breakers", Section 34-31 for location.
	2. Open or shorted circuit.	2. Check wiring and connections between circuit breaker and door lock switches. Service if necessary.
	3. Malfunctioning switch.	3. Test switch. Refer to Testing in this Section. Replace if necessary.
	4. Open ground circuit.	4. Check ground circuit from LH switch. Repair if necessary.
Locks do not work in below freezing weather.	Frozen door latch or linkage.	Bring vehicle into heated garage to allow lock system to thaw. Verify that all locks now work. Using Silicone Lubricant D7AZ-19584-A or equivalent, spray into latch opening and manually cycle ten times. It may be necessary to remove door trim panel to lubricate entire latch and linkage system.
All locks work from one switch only.	1. Open or shorted circuit.	1. Check wiring and connections between circuit breaker and inoperative switch. Service if necessary.
	2. Malfunctioning switch.	2. Test switch. Refer to Testing in this Section. Replace if necessary.
Door locks operate one way only.	Open ground circuit.	Check ground circuit from LH switch. Service if necessary.
Locks work intermittently.	1. Loose connections.	1. Check connectors. Tighten if necessary.
	2. Poor ground at LH switch.	2. Check ground circuit from left hand switch. Service if necessary.
	3. Malfunctioning switch.	3. Test switch. Refer to Testing in this Section. Replace if necessary.
One door lock does not work.	1. Latch or linkage binding.	1. Using Silicone Lubricant D7AZ-19584-A or equivalent, spray into latch opening and manually cycle ten times. Check for interference around night latch and all linkage.
	2. Open or shorted circuit.	2. Check for voltage at actuator connector, operating switch in both positions. Service circuit if necessary.
	3. Malfunctioning actuator.	3. Test actuator. Refer to Testing in this Section. Replace if necessary.
Door locks work with engine running only.	1. Low charge in battery.	1. Test battery. Refer to Section 31-02, Batteries. Charge if necessary.
	2. Loose or corroded connections.	2. Check wiring and connections. Service if necessary.
	3. Latch or linkage binding.	3. Using Silicone Lubricant D7AZ-19584-A or equivalent, spray into latch opening and manually cycle ten times. Check for interference around night latch and all linkage.

CN5302-2C

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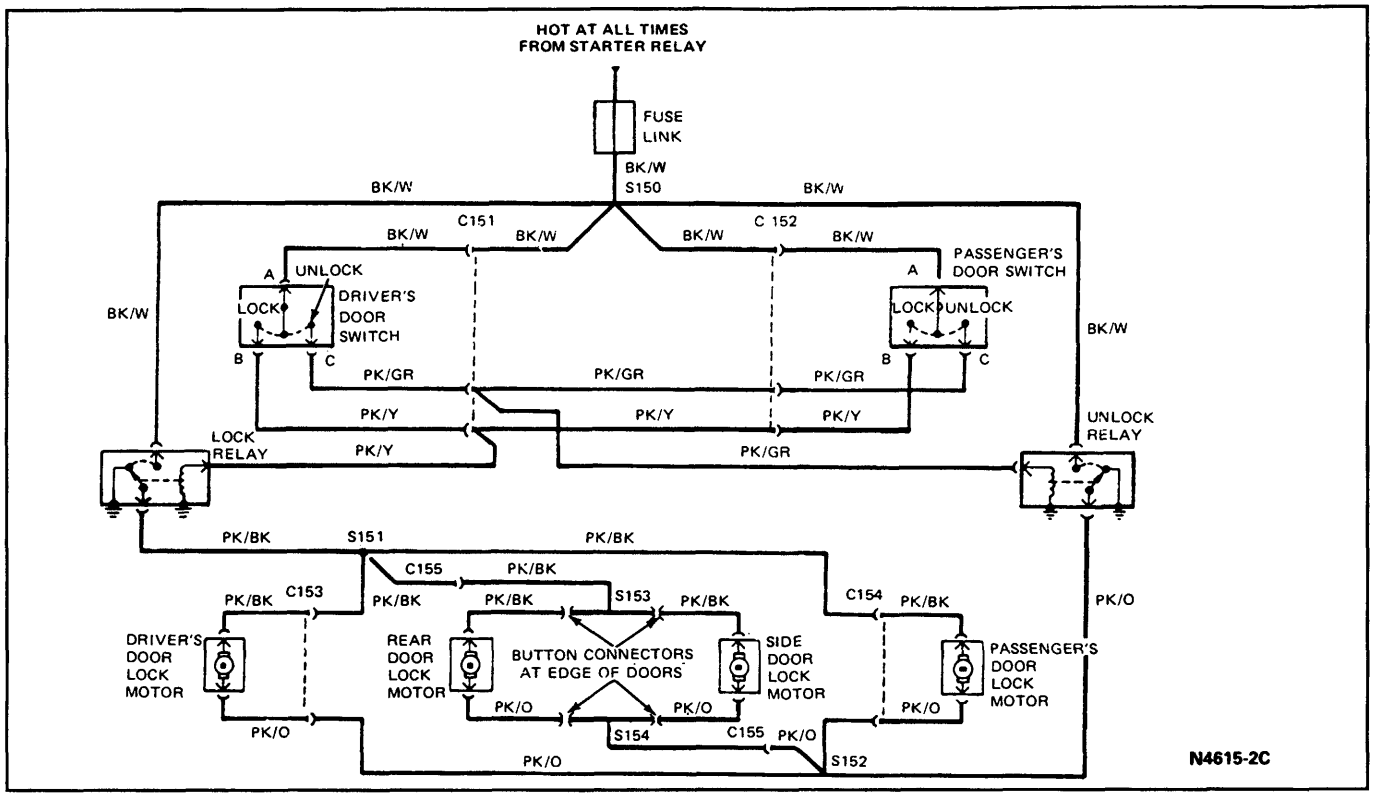


FIG. 2 Power Door Lock Electrical Schematic—E-150—E-350 Shown

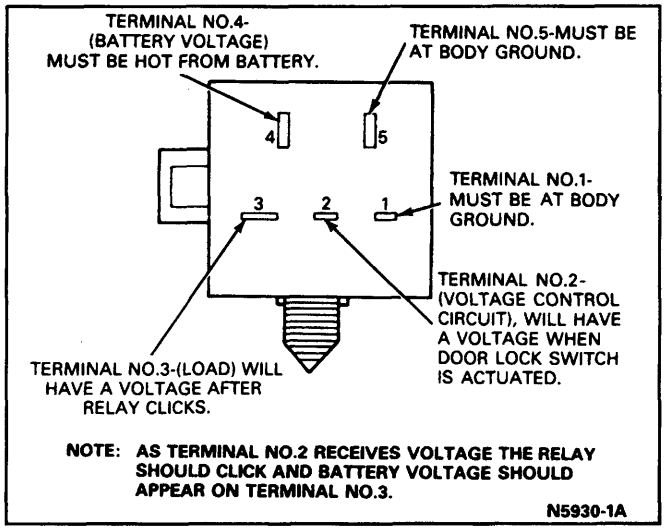


FIG. 3 Door Lock Relay Assembly Terminals—E-150—E-350

Switch

E-150—E-350

Using a self-powered test lamp, there should be **no continuity** between any terminals with the switch in its normal position.

Continuity should exist between terminals A and B with the switch held in the down (LOCK) position and between terminals A and C with the switch held in the up (UNLOCK) position (Figs. 2 and 5).

F-150—F-350 and Bronco

Procedures for testing the power door lock switch is the same as for the single power window switch. Refer to Section 42-08, Power Windows.

There is no relay test. Power is supplied directly to the door lock motor through the switch located in the door trim panel.

REMOVAL AND INSTALLATION

NOTE: Due to the conversion from single 90 degree Rod to double 90 degree Rod, it may be necessary to remove more parts than the instructions indicate. This action will allow more maneuverability of the Rod and ease the Removal Process.

Electric Door Lock Actuator Motor

E-150—E-350, F-150—F-350 and Bronco

Removal

1. Remove door trim panel. Refer to Section 45-03, Door Trim Panels.
2. Disconnect the actuator motor (Figs. 6 and 7) link from the door latch.
3. Remove actuator motor and swivel bracket assembly from the door by drilling out the retaining pop rivet.
4. Disconnect the wire harness plug at the motor connector (Figs. 6 and 8).

Installation

1. Connect wire harness plug at actuator motor connector (Figs. 6 and 8).
2. Install door lock actuator motor in door with pop rivet (Figs. 6 and 7).

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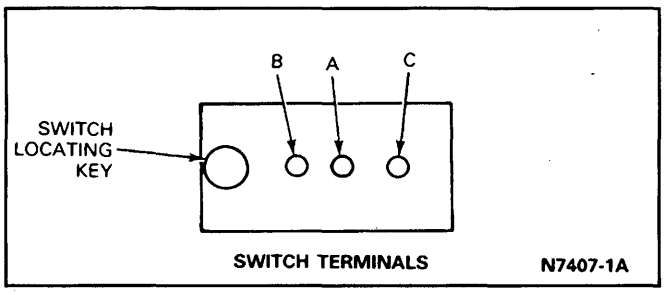


FIG. 4 Door Lock Switch

NOTE: Pop rivet must retain the actuator bracket securely. A loose bracket will affect actuator function by causing a loss of travel, or by causing binding or rattle.

3. Connect actuator motor link to the door latch.
4. Check operation for correct function.
5. Install door trim panel.

NOTE: Old motor bracket must be replaced with new bracket which is supplied with replacement actuator motor assembly.

Door Lock Control Switch

Refer to Fig. 6.

E-150—E-350

Removal and Installation

The power door lock switches are located on the front door trim panels. To replace a switch, remove the bezel retaining screw. Then, lift the bottom of the bezel from the door trim panel and remove the switch and bezel assembly.

Remove the wiring connector retaining screw from the back of the bezel. Using a thin-bladed screwdriver, carefully pry the switch from the connector.

To install the switch, reverse the removal procedure.

F-150—F-350 and Bronco

The power door lock switches are located on the front door trim panels.

Removal

1. Insert a small, thin-bladed screwdriver into the spring tab slots (located at the front and rear of the switch housing) and apply pressure to make the switch housing assembly pop out.
2. Remove the three connector attaching screws from the switch housing.
3. The switch is held in place by the electrical contact pins. To remove the switch, carefully pry the switch from the connector with a small screwdriver.

Installation

1. Position the switch to the connector and press firmly into place.

NOTE: The switch is keyed to the connector and can only be installed one way.

2. Install the connector to the switch housing using the three attaching screws.
3. Position the switch housing to the door trim panel and press firmly into place.

Door Lock Relay

Refer to Fig. 9.

E-150—E-350

Removal and Installation

To remove the door lock relay from the LH dash panel brace, insert a small screwdriver to pop free. Disconnect the relay from the wiring assembly by separating the locking fingers and remove the relay.

CAUTION: Carefully spread retaining legs to prevent breakage.

To assemble the wiring connector to the relay, press firmly on the locking fingers until they latch behind the locking clamps on the connector. Snap the relay assembly locator pin into hole on brace.

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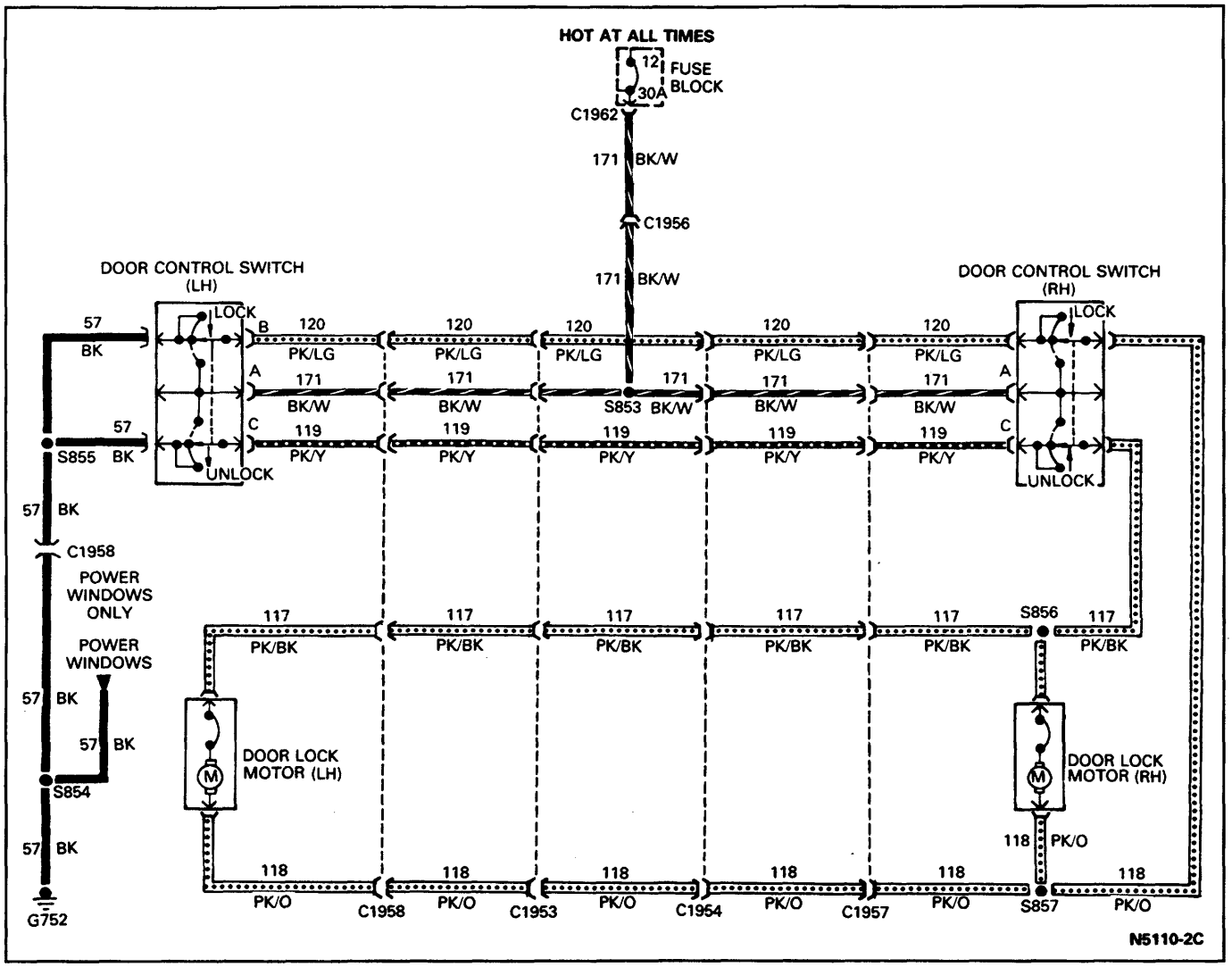


FIG. 5 Power Door Lock Electrical Schematic—F-150—F-350 and Bronco

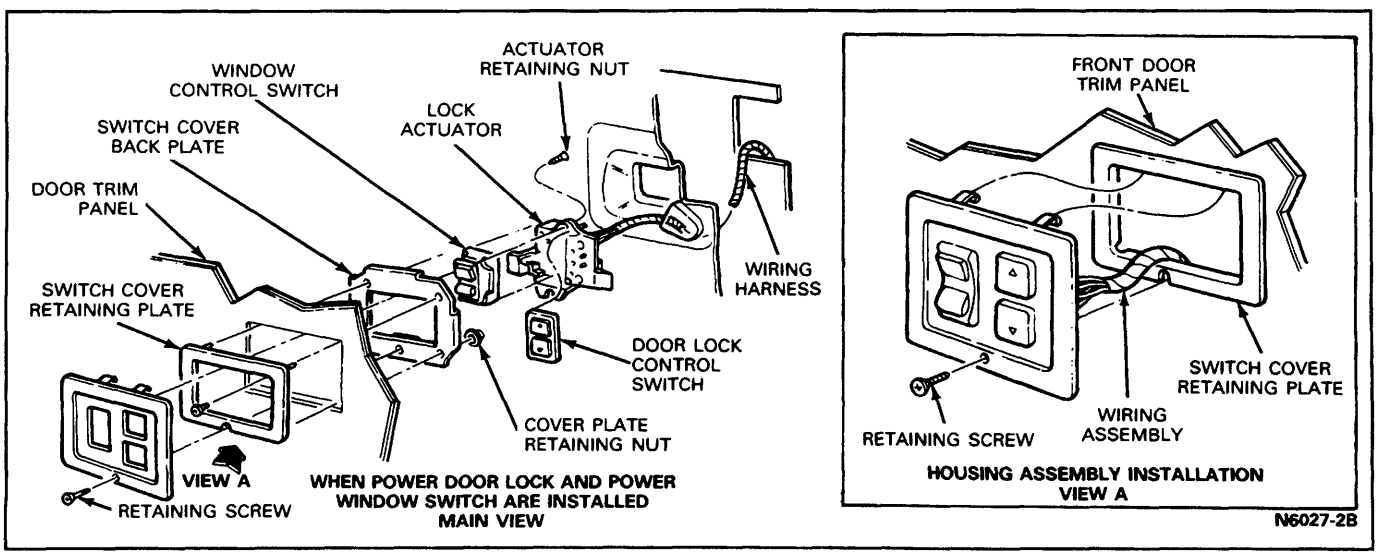


FIG. 6 Door Lock Control Switch—E150—E-350

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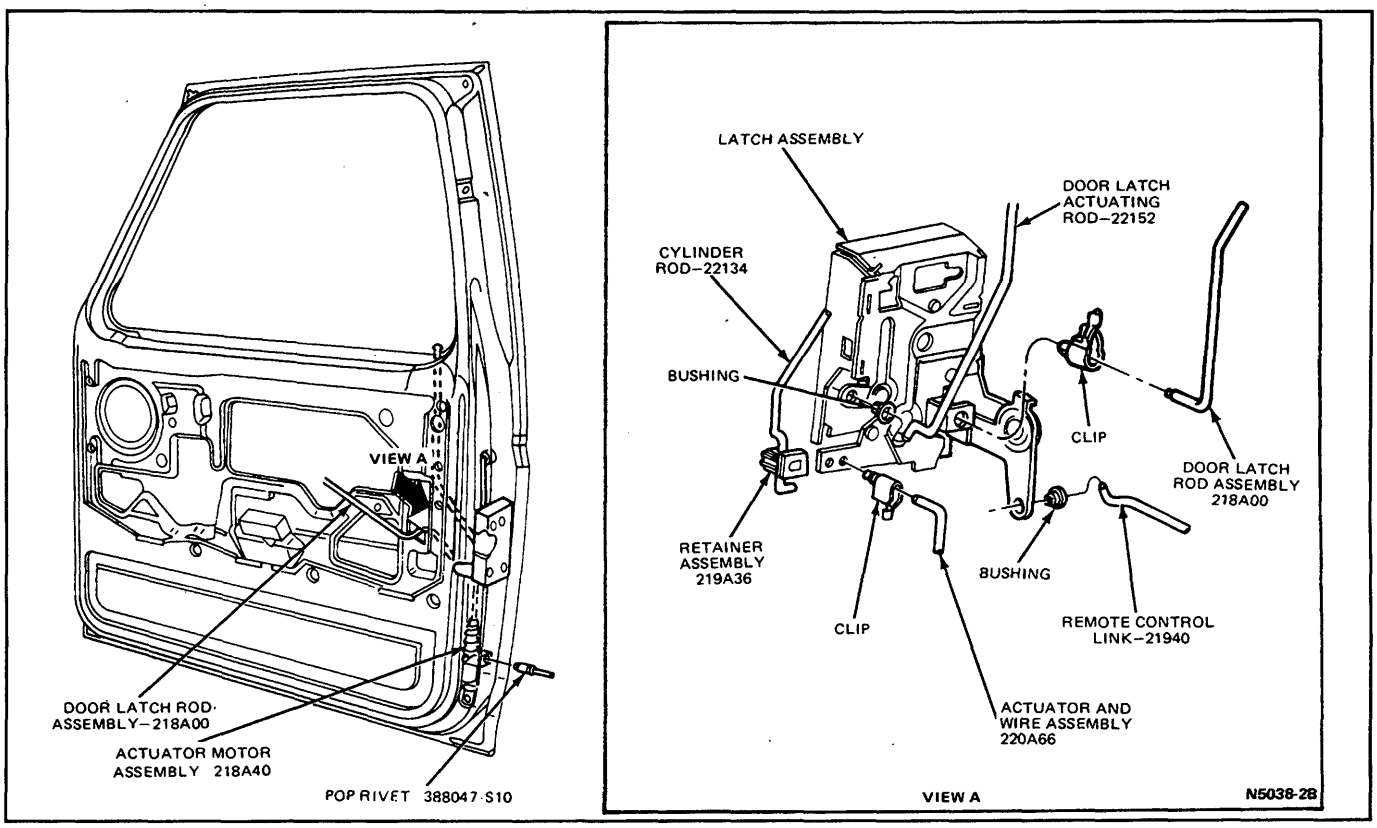


FIG. 7 Electric Door Lock Installation—F-150—F-350 and Bronco

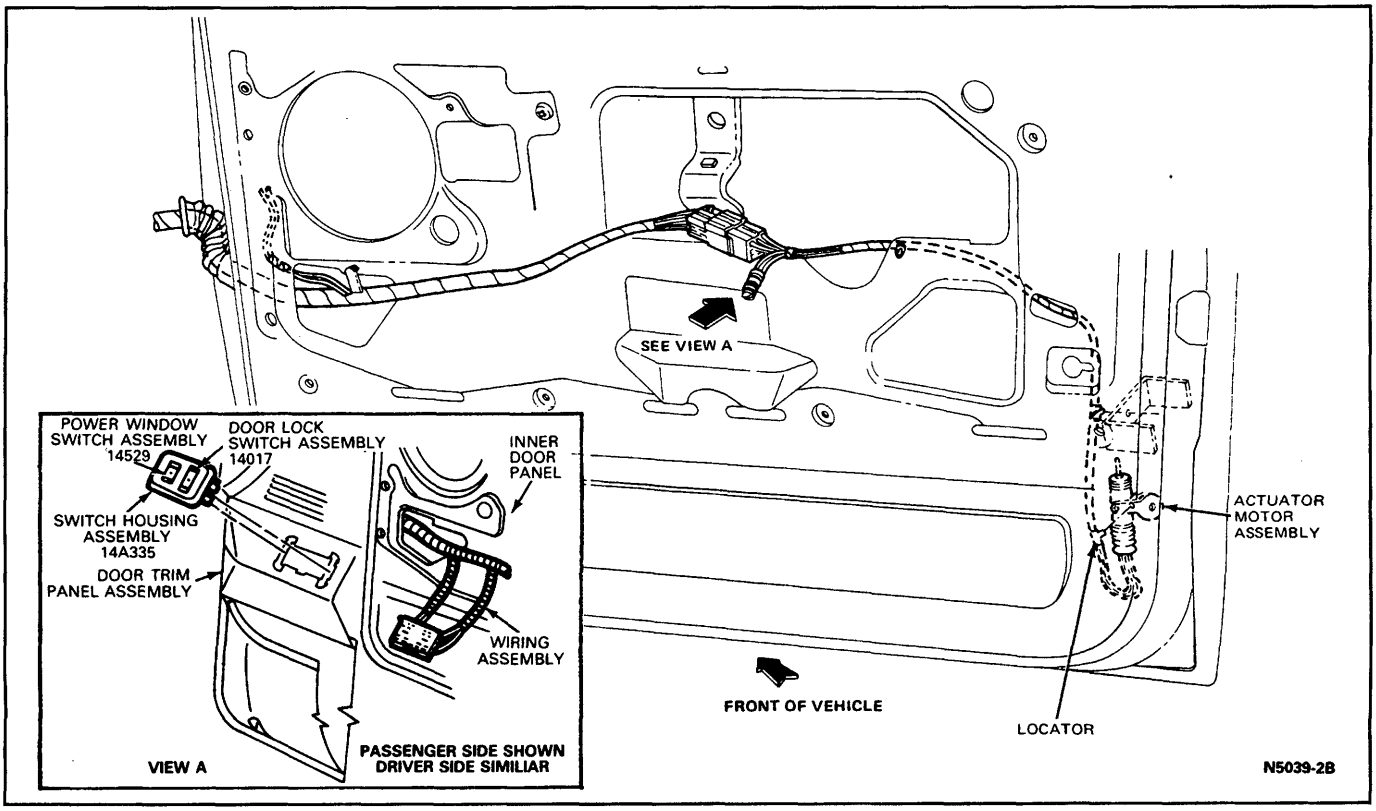


FIG. 8 Electric Door Lock Actuator Motor and Control Switch Wiring—F-150—F-350 and Bronco

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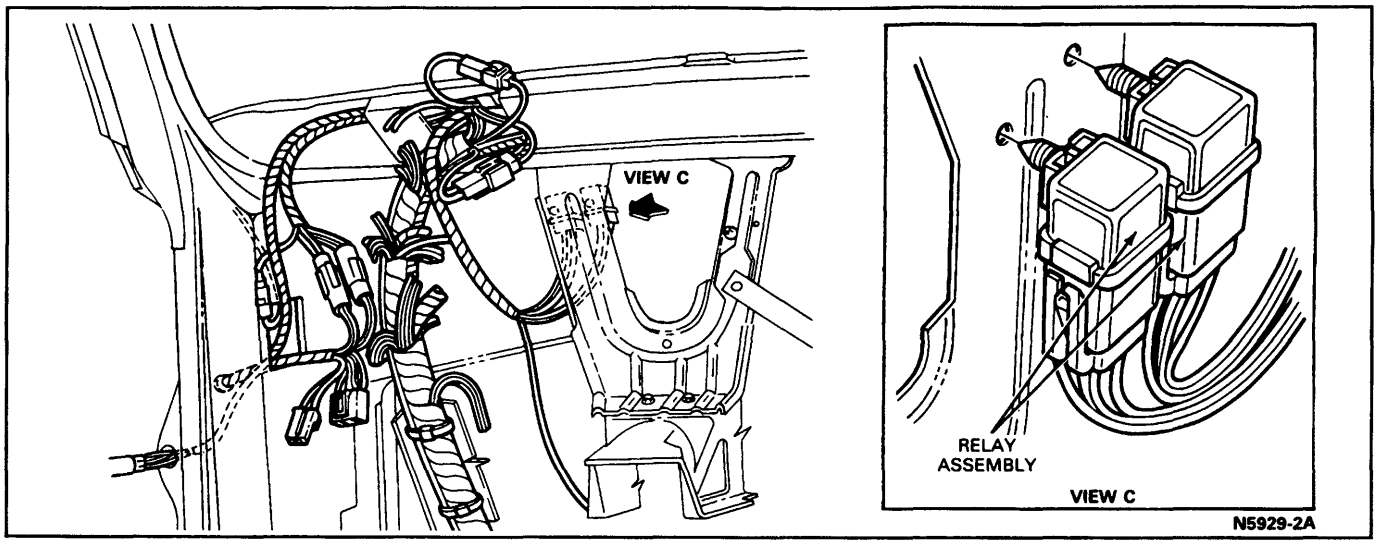


FIG. 9 Door Lock Relay Assembly Removal—E-150—E-350

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Number	Description
007-00001	Digital Volt-Ohm Meter

CN6078-1A

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SECTION 44-21 Hood and Hinges

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VEHICLE APPLICATION	44-21-1

VEHICLE APPLICATION

Bronco, E-150—E-350 And F-150—F-350.

ADJUSTMENTS

F-150—F-350 and Bronco

1. Open the hood and mark the hinge and latch assembly locations.
2. Loosen the hinge-to-fender inner attaching screws until they are snug (Fig. 1).

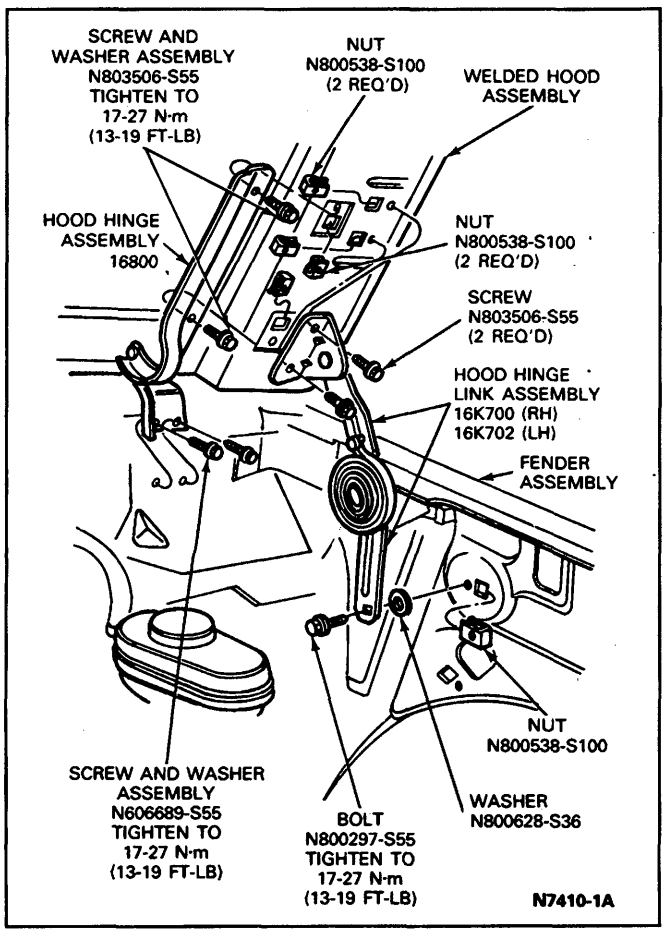


FIG. 1 Hood, Hinge Installation—Bronco and F-150 and F-350

3. Adjust the hinge up or down or rotate as required to obtain a flush fit between the hood and the top of the cowl panel. Then, tighten the hinge-to-fender inner attaching screws.
4. Loosen the two hood latch assembly attaching screws (Fig. 1, View A).
5. Loosen the hinge-to-hood attaching bolts until they are snug. Move the hood forward or rearward and from side to side as required for a proper hood fit. Then, tighten the hinge-to-hood attaching screws. Move the latch from side to side as required to center the latch with the hood striker. Tighten the hood latch attaching screws.
6. Lubricate each hood hinge at all pivot points with Polyethylene Grease D7AZ-19584-A or equivalent. Check the functional operation of the hinges by opening and closing the hood several times to ensure alignment is correct and the lubricant has effectively worked into the pivot points.

E-150—E-350 and Club Wagon

The hood can be adjusted fore and aft and up and down to obtain the proper clearance. To adjust the hood, loosen the hood-to-hinge attachments (fore-or-aft adjustment) or the hinge-to-cowl attachments (up-or-down adjustment) until they are snug. Then, position the hood as required, and tighten the attachments (Fig. 2). After the hood has been adjusted, check the hood latch adjustment. Adjust the hood latch if required. Refer to Section 44-31, Hood Latch.

REMOVAL AND INSTALLATION

Hood

Removal and Installation

F-150—F-350 and Bronco

1. Remove the two link assembly bolts.
2. Remove the hood hinge bolts. With an assistant, lift the hood off the hinges.
3. If the hood is to be replaced, transfer the hood latch components and ornaments to the new hood.
4. With the aid of an assistant, position the hood on the hinges and install the hinge bolts snug.
5. Install link assembly to hood with two bolts.
6. Adjust the hood for a proper fit by shifting the hood on the hinges. Tighten the hinge bolts (Fig. 1).

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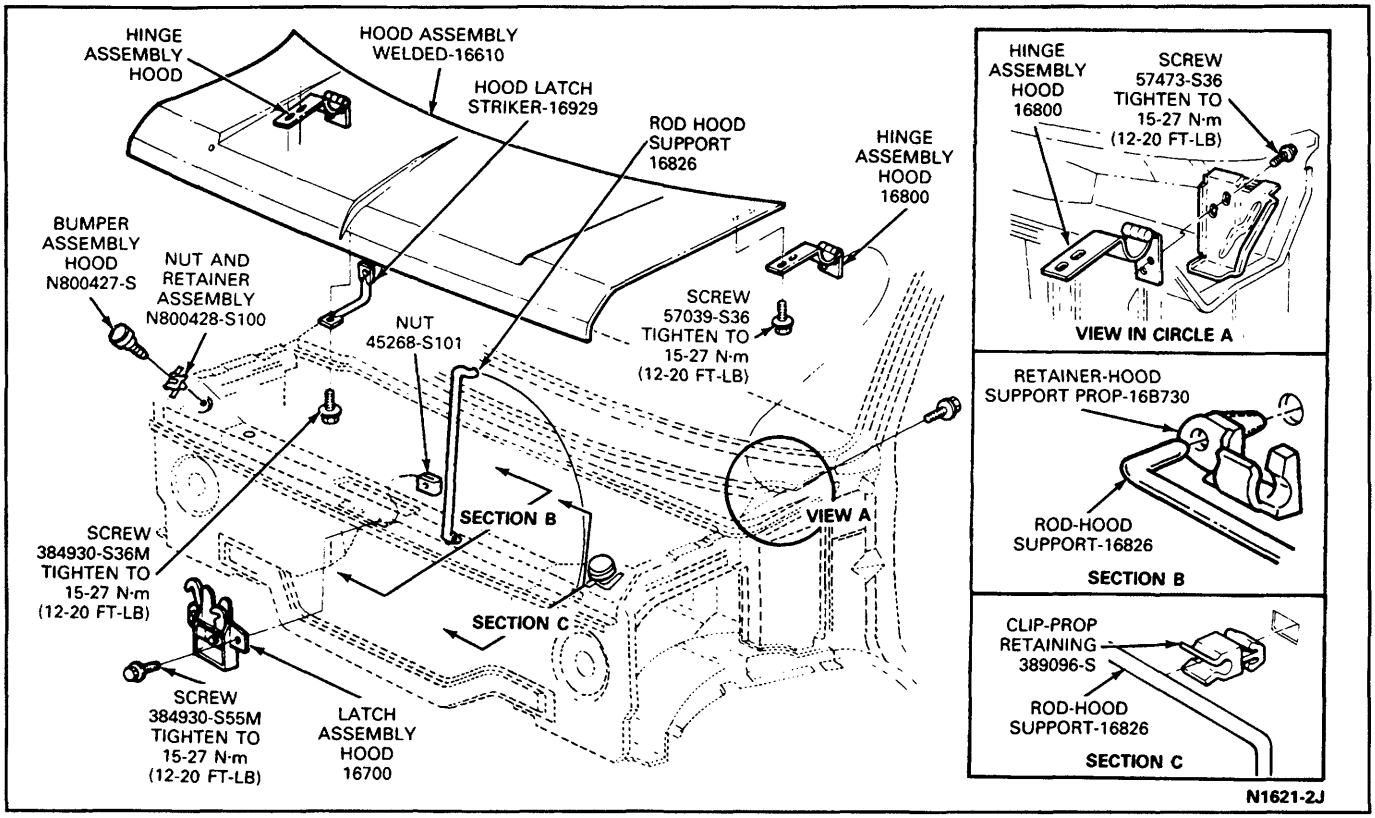


FIG. 2 E-150—E-350 Hood Installation—Steel

7. Adjust the hood latch for proper alignment. Refer to Section 44-31, Hood Latch.

E-150—E-350

Removal

1. Open the hood. Retain in the open position (Fig. 2).
2. Cover the cowl area to prevent paint damage.
3. Remove screws or nuts attaching each hood hinge to the hood and remove the hood from the vehicle.
4. Remove the hood lock striker from the hood.

Installation

1. Position the hood to the hood hinges and install the attaching screws or nuts.
2. Adjust the hood as outlined. Tighten the hood-to-hinge attaching screws or nuts.
3. Install the hood lock striker on the hood and adjust the hood latch if required.

NOTE: The fiberglass hood outside surface can be repaired if the damage is minor (scratches, dents). Normal fiberglass repair procedures should be followed. Refer to Section 46-51, Fiberglass Rear Roof. Under no circumstances should any repairs be made to the inside surface of the hood.

Hood Hinge

F-150—F-350 and Bronco

Refer to Fig. 1.

Removal

1. Open the hood. Retain in the open position with a suitable prop.
2. Mark the locations of the hinges.
3. Remove four screws attaching each hinge assembly to the hood and remove the hood from the vehicle. Do not allow the hood to slide down as damage to the cowl top may result.
4. Remove the hinge attaching bolts and remove the hinge from the vehicle.

Installation

1. Position the new hinges to the vehicle and install the attaching bolts snug.
2. Position the hood to the hinges and install the four attaching screws snug.
3. Remove the prop supporting the hood in the open position.
4. Close the hood and adjust as outlined.

E-150—E-350

Removal

1. Open the hood. Retain in the open position.
2. Cover the cowl area to prevent paint damage.
3. Remove hinge-to-body attachments (Fig. 2) and remove hood.
4. Remove hinge-to-hood attachments and remove the hinge.

Installation

1. Position the hinge to the hood and install the attaching screws snug.
2. Position the hinge to the body and install the attaching screws snug.
3. Adjust the hood as outlined. Tighten the hinge attaching screws.
4. Remove the protective cover and close the hood.

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SECTION 44-31 Hood Latch

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VEHICLE APPLICATION	44-31-1

VEHICLE APPLICATION

Bronco, E-150 Through E-350, F-150 Through F-350.

ADJUSTMENTS

Hood Latch Adjustment

F-150—F-350, E-150 Through E-350, and Bronco

Before adjusting the hood latch, ensure the hood is properly aligned. Refer to Section 44-21, Hood and Hinges. The hood latch can be moved from side to side and up and down to obtain a snug hood fit (Figs. 1 and 2).

1. Loosen the hood latch attaching screws just enough to move the latch.
2. Move the latch until it is aligned with the hood latch striker. Then, tighten the latch attaching screws.
3. Check the hood latch to ensure it makes full engagement with the hood latch striker. If the hood latch does not make full engagement with the hood latch striker, loosen the hood latch attaching screws and reposition the latch to obtain full engagement. Then, tighten the attaching screws.
4. Lubricate the latch handle pivot, catch pawls and spring with Polyethylene Grease D7AZ-19584-A or equivalent. Check the functional operation of the latch mechanism by opening and closing the hood several times to ensure alignment is correct. Ensure lubricant has effectively worked into the pivot points and bearing surfaces.

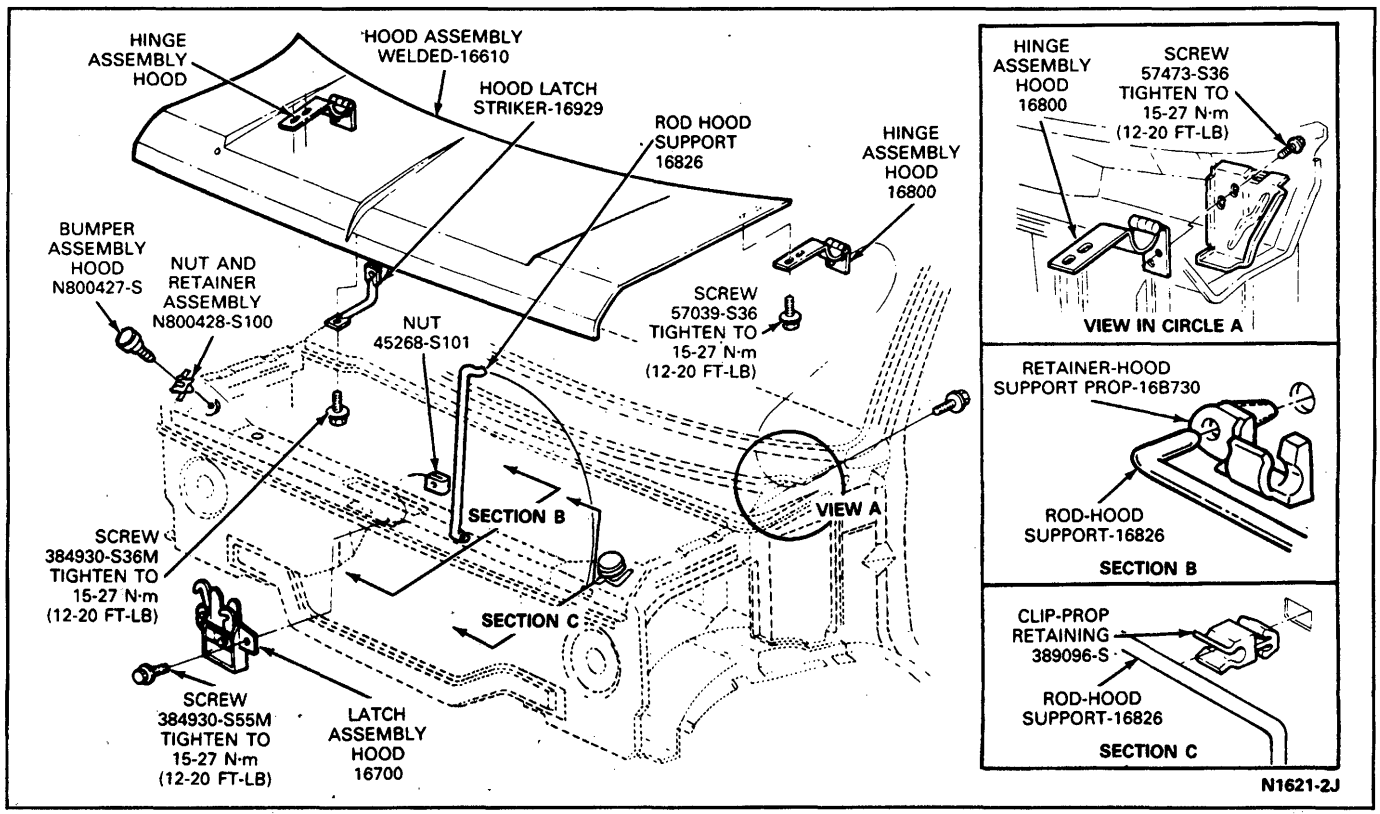


FIG. 1 Hood Latch Adjustment—E-150—E-350

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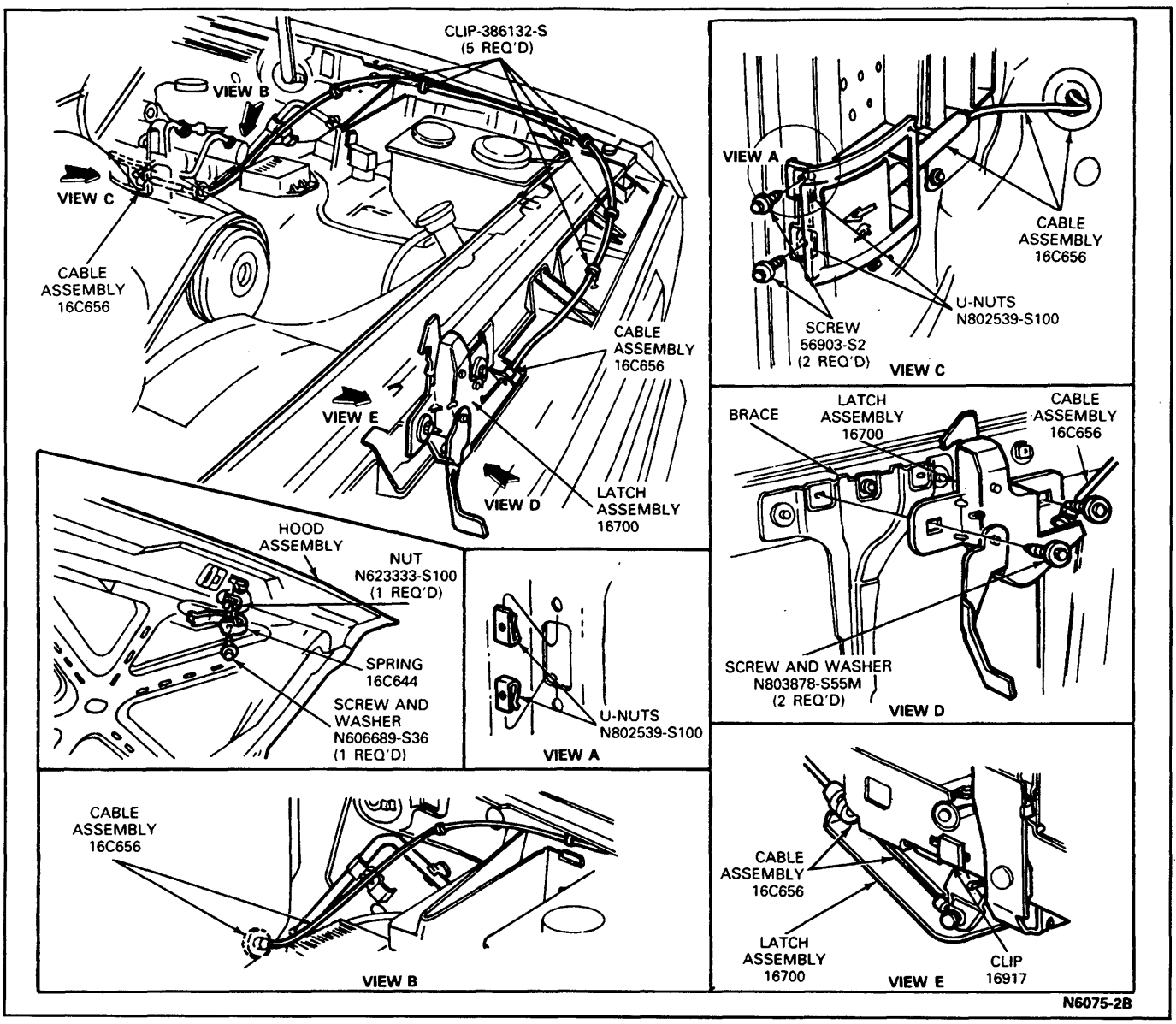


FIG. 2 Hood Latch Remote Control Cable and Lock—F-150—F-350 and Bronco

Hood Latch—Remote Control Cable

E-150 Through E-350, F-150—F-350, and Bronco

The remote control-operated hood latch is adjusted the same as the non-remote latch.

The release cable and handle is routed as shown in Figs. 2 and 3.

REMOVAL AND INSTALLATION

Hood Latch

Removal and Installation

F-150—F-350, E-150 Through E-350, and Bronco

Mark location of hood latch prior to removal to aid in positioning of new latch when installed.

1. If so equipped, remove the hood latch cable plate screw, the cable plate, cable clip and cable from the hood latch (Figs. 2 and 3).
2. Remove the hood latch attaching screws and remove the latch assembly (Figs. 1, 2 and 3).
3. Position the latch assembly and install the attaching screws snug, but do not tighten.
4. Install the hood release cable, cable clip, hood latch cable plate and cable plate screw.
5. Adjust the latch assembly for positive engagement with the hood latch striker. Tighten the latch attaching screws.
6. Lubricate the latch handle pivot, catch pawls and spring with Polyethylene Grease D7AZ-19584-A or equivalent. Check the functional operation of the latch mechanism by opening and closing the hood several times to ensure alignment is correct. Ensure lubricant has effectively worked into the pivot points and bearing surfaces.

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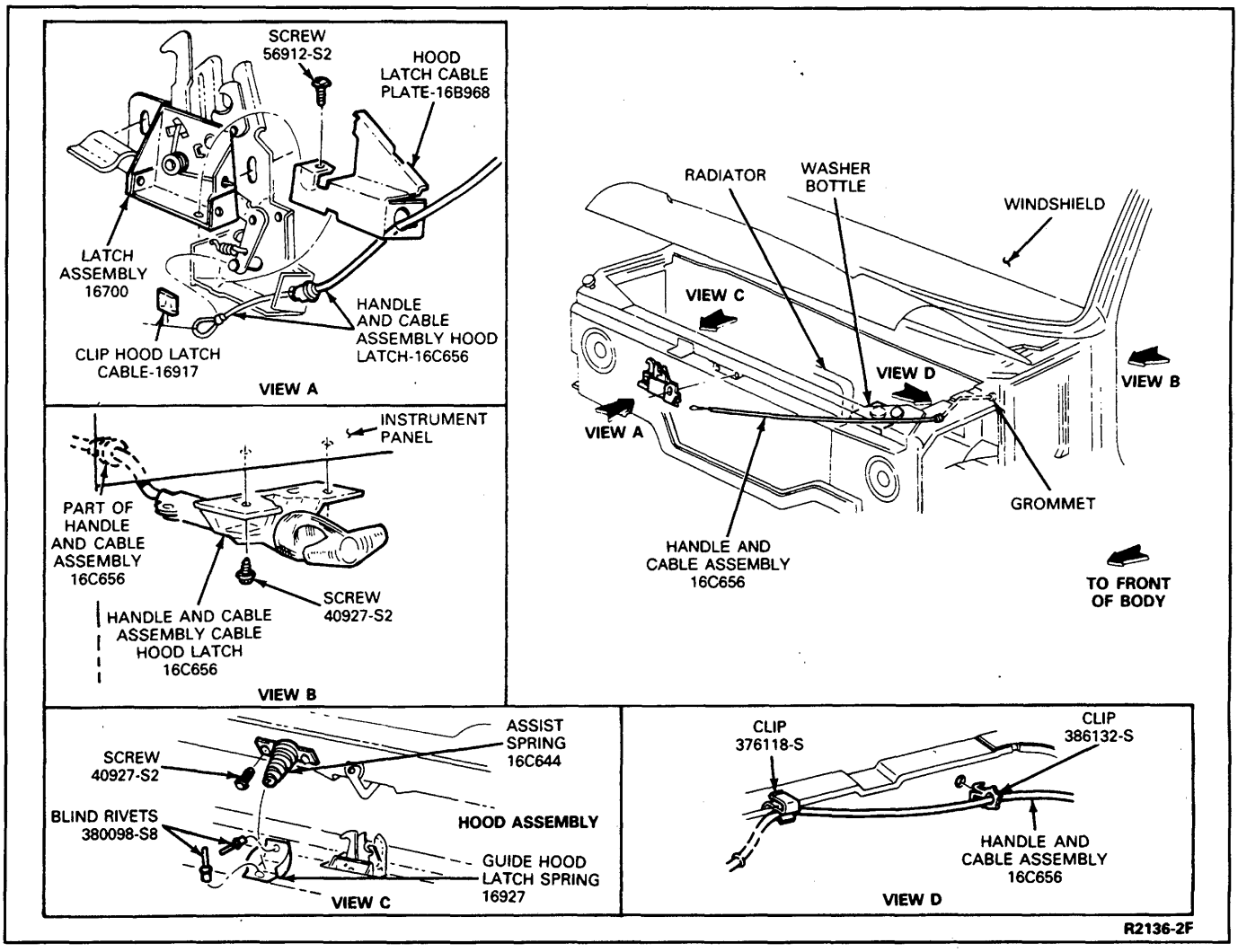


FIG. 3 Hood Latch Remote Control Cable and Lock—E-150 Through E-350

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SECTION 44-86 Tailgate

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VEHICLE APPLICATION

F-150—F-350 And Bronco.

REMOVAL AND INSTALLATION

NOTE: Due to the conversion from single 90 degree Rod to double 90 degree Rod, it may be necessary to remove more parts than the instructions indicate. This action will allow more maneuverability of the Rod and ease the Removal Process.

Tailgate Latch and Support Cable

F-150—F-350 Pickup

Removal and Installation

1. Remove 10 retaining screws from tailgate inside panel access opening cover to tailgate assembly and remove.
2. Disconnect two tailgate latch release links from tailgate latch control assembly.
3. Remove two screws retaining tailgate latch assembly to the panel assembly. Remove latch assembly (both sides) by sliding out the link.
4. Remove link from latch assembly.
5. Remove support cable from latch assembly by removing screw retaining support cable to latch and remove cable.
6. Prior to installation take out the slack in the links and latches by gently pulling the link to the center of the tailgate. Close plastic clip over the closest thread of the link.
7. To install, reverse Steps 1 through 5.

Handle and Control Assembly

Removal and Installation

1. Remove tailgate inside panel access opening cover.
2. Disconnect two tailgate latch release links from tailgate latch control assembly.
3. Remove two nut and washer assemblies retaining handle and control assembly to tailgate outside panel assembly and remove handle and control assembly.
4. Prior to installation take out the slack in the links and latches by gently pulling the link to the center of the tailgate. Close plastic clip over the closest thread of the link.
5. To install, reverse Steps 1 through 3.

Tailgate

F-150—F-350 Pickup

Removal and Installation

Remove the tailgate support strap at the pillar T-head pivot. Lift off the tailgate at RH hinge; then pull off the LH hinge. If a new tailgate is being installed, transfer all mouldings, latches, hinges, brackets, links, clips and washers to the new tailgate.

Bronco

Removal

1. Unlatch the tailgate handle (Fig. 2) and lower the tailgate. Disconnect the LH and RH cable assemblies at the tailgate (Fig. 3, View B).
2. Disconnect the tailgate window motor wire at the connector. Pull the lead wire from the tailgate body rail.
3. Support the tailgate and remove the torsion bar retainer from the body (Fig. 3, View B).
4. Remove the three screw and washer assemblies that secure the LH and RH hinge assemblies (Fig. 3, View B) to the body.
5. Remove the tailgate from the vehicle.

Installation

1. Position the tailgate to the body and support.
2. Secure the hinge assemblies to the tailgate.
3. Attach the torsion bar retainer over the torsion bar.
4. Connect the tailgate window motor wire.
5. Secure the cable assemblies at the tailgate. Remove support and check tailgate operation.

Tailgate Latch Release Handle and Lock Release Control Assemblies

Bronco

Removal

1. Lower the tailgate and remove the inner access cover (Fig. 2).

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2. Remove two screws attaching the handle assembly to the tailgate (Fig. 2).
3. Remove the rod from the clip retaining the handle rod to the lock control.
4. Remove the handle and rod assembly.
5. Disconnect the latch release links and the latch control rod (Fig. 2, View A).
6. Disconnect the electrical connector from the interlock switch (Fig. 2, View A).
7. Remove three screw and washer assemblies that retain the lock control to the tailgate.
8. Remove the lock control from the tailgate.

Installation

1. Position the lock control into the tailgate. Install three screw and washer assemblies and tighten to 9-14 N·m (6-11 ft-lb).
2. Connect the electrical connector.
3. Position the latch control rod and install the clip.
4. Position the latch release links and install the clips.
5. Position handle and rod assembly to the tailgate. Connect the rod to the lock control and install clip.
6. Secure two screws retaining the handle assembly to the tailgate.
7. Install the inner access cover.

Tailgate Weatherstrip

Bronco

Removal and Installation

Refer to Section 44-92, Tailgate Weatherstrip for tailgate weatherstrip removal and installation procedures.

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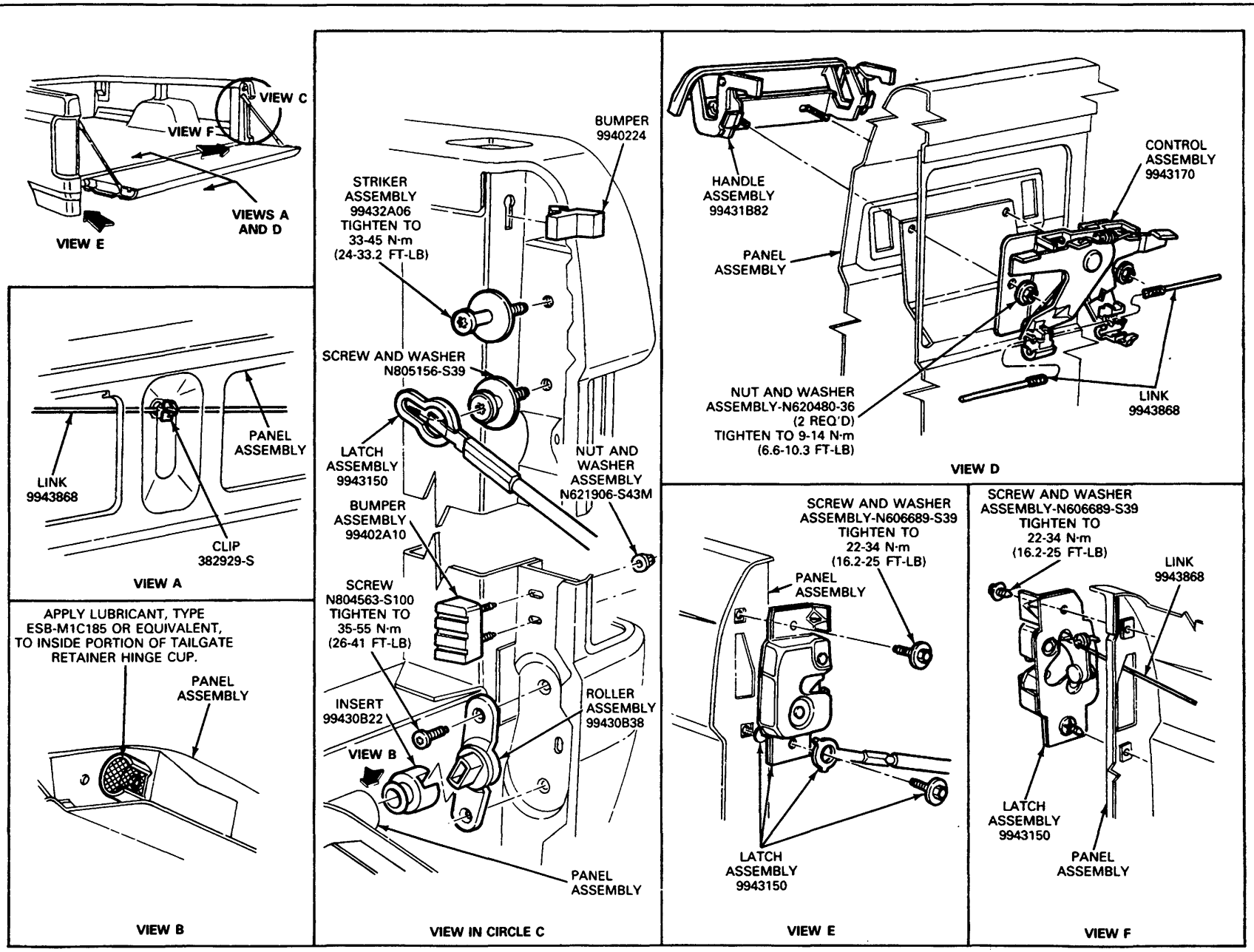


Fig. 1 Tailgate Installation—Styleside Pick-Up

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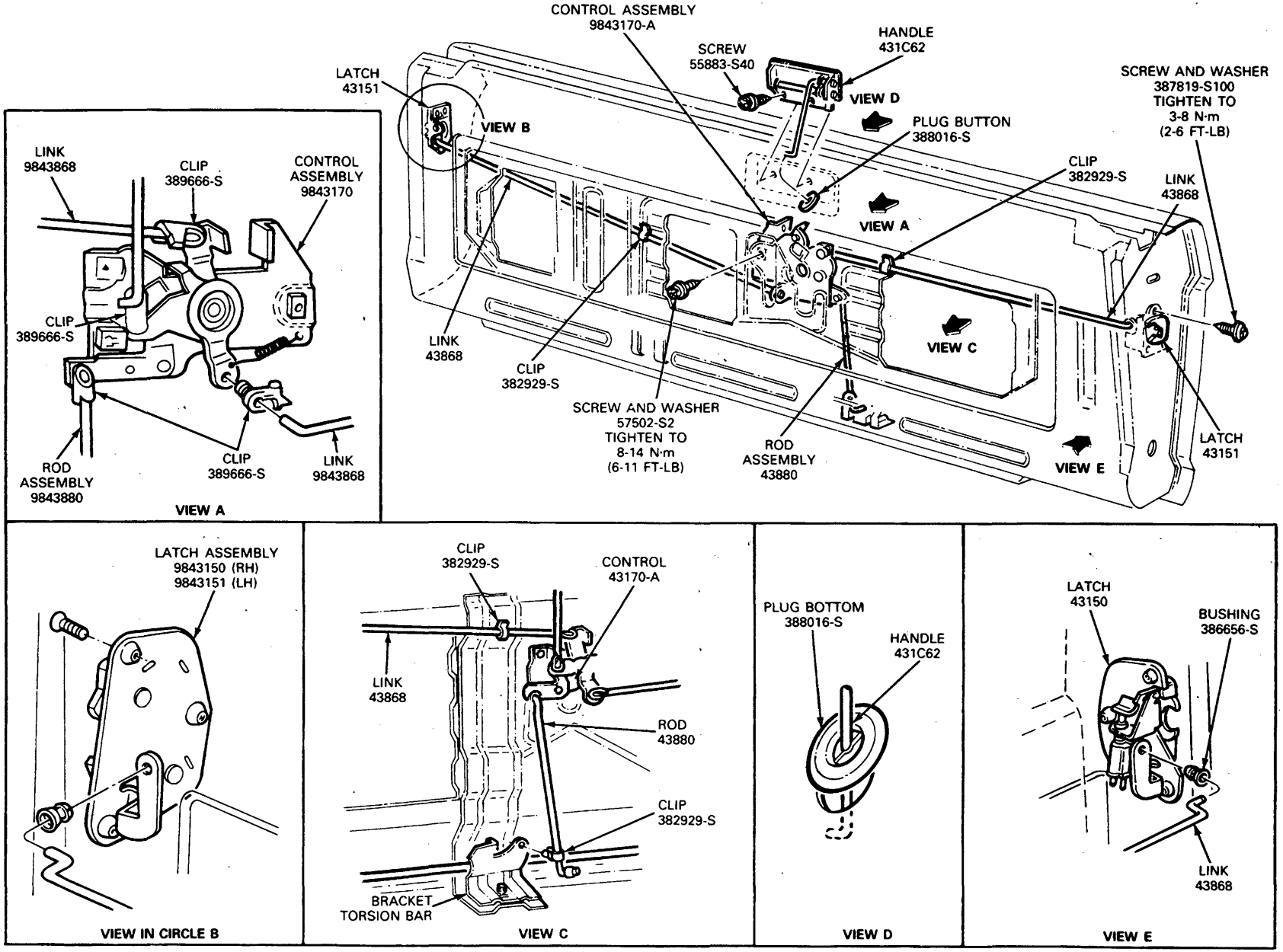


FIG. 2 Tailgate Latch Release and Lock Control—Bronco

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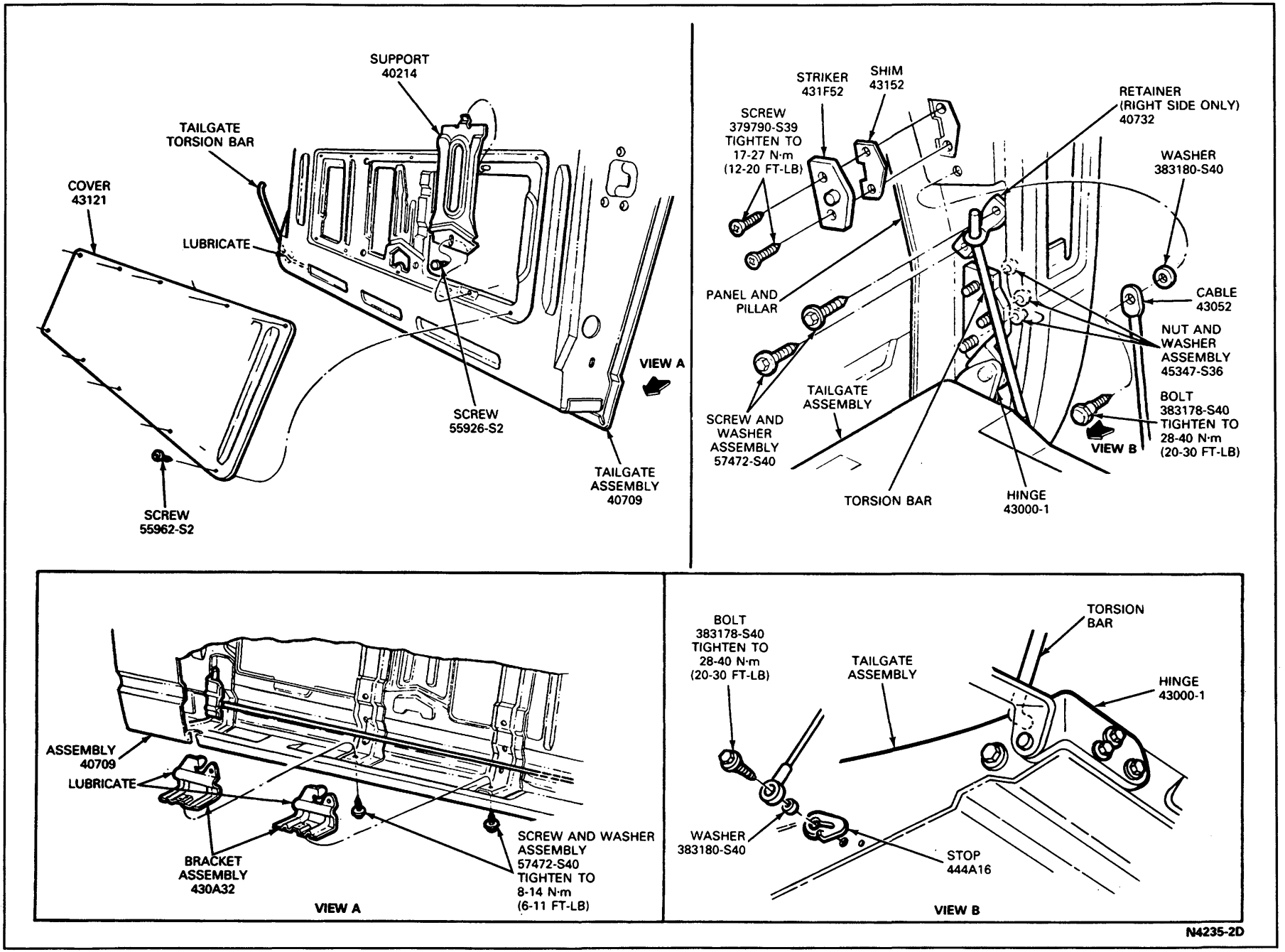


FIG. 3 Tailgate Installation—Bronco

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SECTION 44-92 Tailgate Weatherstrip

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REMOVAL AND INSTALLATION	
Tailgate Weatherstrip Assembly	44-92-1

SUBJECT	PAGE
VEHICLE APPLICATION	44-92-1

VEHICLE APPLICATION

All Models.

REMOVAL AND INSTALLATION

Tailgate Weatherstrip Assembly

Removal

1. Lower the tailgate.
2. Remove the screws attaching the tailgate weatherstrip and weatherstrip retainer to the body (Fig. 1).
3. Remove weatherstrip and retainer from the body.

Installation

1. Position the weatherstrip to the body and install the upper attaching screws.
2. Secure the right and left weatherstrip attaching screws to the body sill and push the weatherstrip onto the body pillar flange.
3. Position the lower weatherstrip retainer to the body and attach with eleven screws.

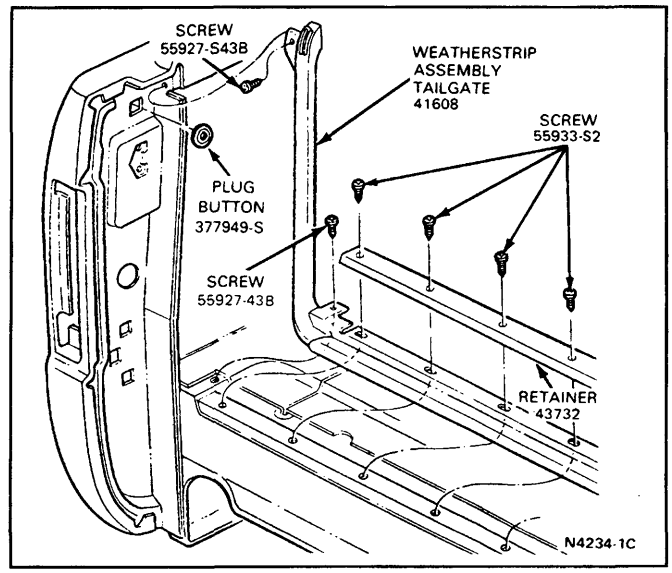


FIG. 1 Tailgate Opening Weatherstrips—Bronco

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GROUP 45 INTERIOR TRIM

(70000)

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CARPETS AND FLOOR MATS	45-26-1
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SECTION 45-01 Interior Trim—General Service

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Cleaning Simulated Woodgrain or Plastic Interior	45-01-2
Fabrics	45-01-1
VEHICLE APPLICATION	45-01-1

VEHICLE APPLICATION

All Models.

CLEANING PROCEDURE

Fabrics

The following procedure is recommended for the removal of spots and stains encountered in service. It is important that proper cleaning techniques and cleaning agents be used to prevent the stain from setting, or alteration of the color and/or flame-resistant properties of the fabric.

1. Remove excess staining material from fabric by scraping or wiping with a clean cloth (blot if stain is wet).
2. Identify the staining material if possible.
3. Clean the fabric as outlined in the following Methods "A", "B", or "C".

CAUTION: Test all cleaners in a small hidden area of the fabric prior to use. If fabric color or texture is adversely affected by a particular cleaner do not use.

METHOD "A" (SPOT CLEANING) Stains such as grease, oil, tar, water spots, crayon and lipstick.

NOTE: Using other than recommended cleaners or procedures may adversely affect fabric flammability, appearance or durability.

1. Spray stain with Ford Spot Lifter E2AZ-19526-A or equivalent from a distance of 203-254mm or (8-10 inches) as directed on the instructions furnished with the can.
2. Allow the Spot Lifter to dry completely, forming a white powder on the surface of the fabric.
3. Brush and vacuum the white powder from the surface of the fabric.
4. If the soiled spot is not removed from the fabric, repeat Steps 1, 2 and 3 as necessary.

CAUTION: Use care during application of the spot lifter to avoid contact with vinyl trim.

METHOD "B" (GENERAL CLEANING) Stains such as grease, oil, tar, adhesive, crayon and lipstick.

1. If the stain is still visible after performing spot cleaning procedure (Method "A"), blot the soiled area with a clean cotton cloth saturated with Ford Spot Remover B7A-19521-A or equivalent.
2. Rub in a circular motion while continuously exposing clean portion of cloth.

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3. Gradually widen area of application onto edges of design, pleat, or biscuit.
4. Repeat Steps 1, 2 and 3 as necessary.
5. Wipe cleaned area with clean, damp cloth to remove any residual cleaner.

METHOD "C" (GENERAL CLEANING) Stains such as dirt, dry soil, food, pop and coffee.

1. Apply "Rosenthal" multi-purpose rug and upholstery cleaner with a clean brush or sponge as directed in the label instructions.
2. Rub in a circular motion until stain is removed.
3. Gradually widen area of application to edges of design, pleat, or biscuit.
4. Repeat Steps 1, 2 and 3 as necessary.
5. Rub cleaned area with a damp cloth to absorb residual cleaner.
6. Allow to dry at room temperature.

NOTE: Spot cleaning described in Method "A" will be sufficient on fabrics which are not excessively soiled. However, to maintain a uniform appearance of the seat material in the event of severe soil and stain, the entire seat or insert will have to be cleaned to prevent a "ring" condition.

Cleaning Simulated Woodgrain or Plastic Interior Trim

Clean soiled or stained surfaces with Ford Multi-Purpose Cleaner B8A-19523-A or equivalent, diluted in accordance with label instructions. Apply cleaner with a soft cloth. Remove mild abrasions (key marks, etc.) on woodgrains surfaces with Ford Custom Silicone Gloss B7A-19530-A, Ford Custom Auto Wax B4A-19534-A, or equivalent.

Cleaning Leather or Vinyl Interior Trim

Clean vinyl or leather interior trim with Ford Leather and Vinyl Cleaner E0AZ-19521-A or equivalent by following instructions on the label.

Cleaning Lap-Shoulder Safety Belt Webbing

Clean the belt webbing with any mild soap solution recommended for cleaning upholstery or carpets; follow the instructions provided with the soap.

CAUTION: Do not bleach or re-dye the webbing. Bleaching or dyeing the webbing can reduce both belt effectiveness and occupant safety.

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SECTION 45-03 Door Trim Panels

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E-150—E-350 and Club Wagon	45-03-2
E-150—E-350 Cargo Van	45-03-2
SPECIAL SERVICE TOOLS	45-03-8
VEHICLE APPLICATION	45-03-1

VEHICLE APPLICATION

All Light Truck Models.

REMOVAL AND INSTALLATION

Door-Trim Panel

Bronco and F-150—F-350

Removal

1. Remove the screw(s) retaining the armrest area of the trim panel to the door inner panel (Figs. 1 and 2).
2. Remove the screw retaining the door inside handle and remove the handle (Fig. 3). Refer to Section 44-06, Doors, Hinges, Checks and Weatherstrips.
3. Remove the screw retaining the door window regulator handle and remove the handle and washer, if so equipped (Fig. 3).

   NOTE: On units with power windows, remove the power window switch housing (Fig. 4). Refer to Section 42-08, Power Windows.
4. Remove the door lock control, if so equipped (Fig. 5).

   NOTE: On units with power door locks, remove the power door lock switch housing. Refer to Section 44-16, Power Door Locks.
5. Remove the switch housing for the power rear view outside mirror, if so equipped. Refer to Section 35-50, Mirrors—Inside and Outside.
6. Using the Trim Pad Removing Tool from Rotunda Moulding/Trim Kit 107-00401 or equivalent, carefully pry the trim panel away from the door inner panel and remove the trim panel.

   NOTE: At no time should the trim panel be used to remove push pins from the inner panel holes.

Installation

1. Replace any bent, damaged or missing push pins on the door trim panel. Position the trim panel to the door inner panel, locating push pins in the countersunk holes. Firmly push the trim panel at the push pin locations to seat each push pin into the holes in the door inner panel.
2. Install the switch housing for the power rearview outside mirror, if so equipped.
3. Install the door lock control, if so equipped.

NOTE: On units with power door locks, install power door lock switch housing.

4. Position door window regulator handle to door and install retaining screw.

NOTE: On units with power windows, install power window switch housing.

5. Install inside door handle and retaining screw.
6. Position trim panel armrest area to door panel and install retaining screws(s).

E-150—E-350

Removal

1. Remove the armrest retaining screws and remove the armrest from the door inner panel (Fig. 5).
2. Remove the two nuts from the inside door handle and remove the handle and trim cup. Refer to Group 44.
3. If the vehicle is equipped with a stereo radio, remove four screws retaining the speaker grille and remove the grille.
4. Remove the window regulator handle retaining screw. Remove the handle and washer.
5. Using the Trim Pad Removing Tool from Rotunda Moulding/Trim Kit 107-00401 or equivalent, carefully pry trim panel away from door inner panel and remove trim panel.

NOTE: At no time should the trim panel be used to remove the push pins from the inner panel holes.

Installation

1. Replace any bent, damaged or missing push pins on the door trim panel. Position the trim panel to the door inner panel, locating the push pins in the countersunk holes. Firmly push the trim panel at the push pin locations to seat each push pin into the holes in the door inner panel.
2. Position the inside door handle and trim cup to the door and install the retaining nuts.

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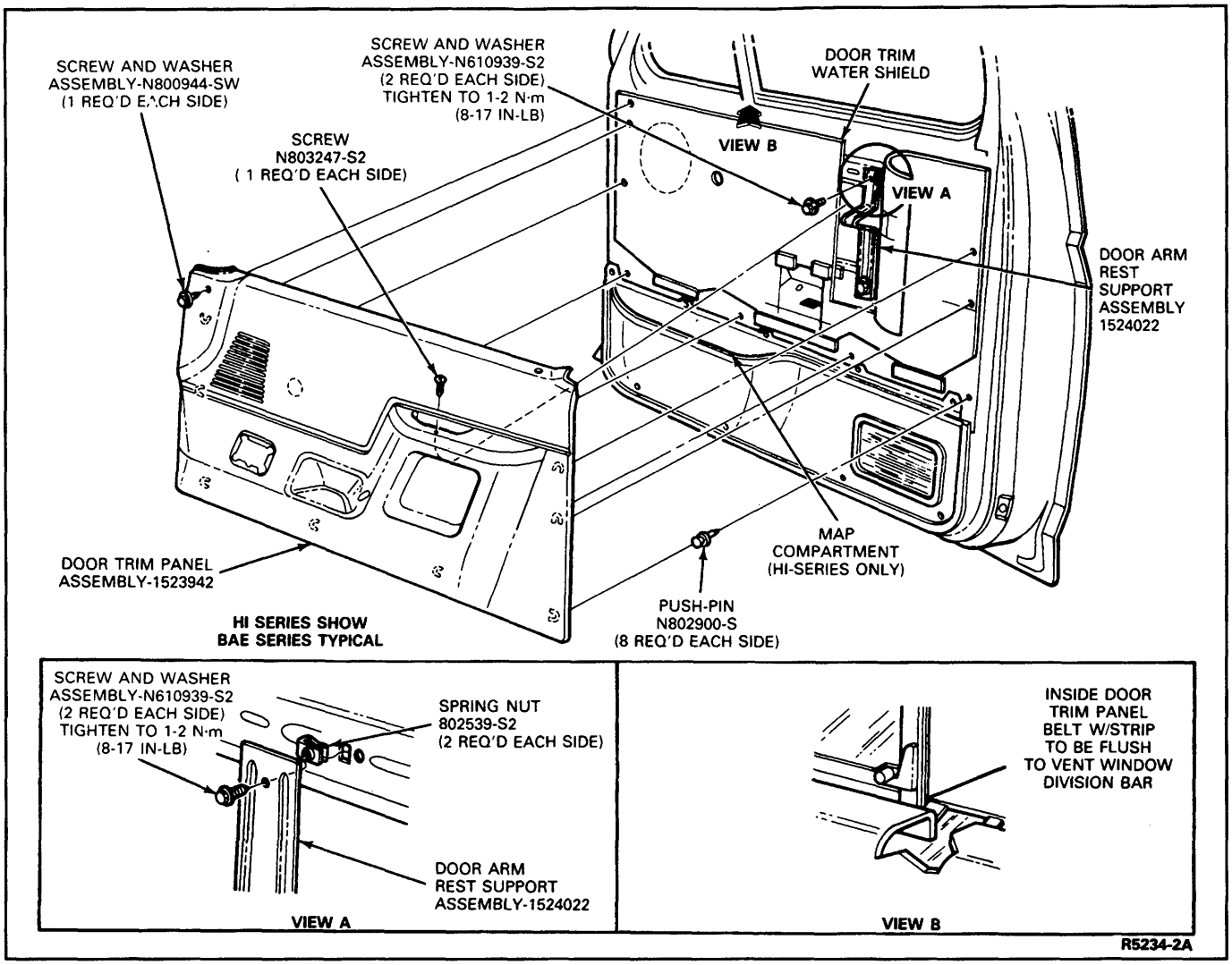


FIG. 1 Bronco and F-150—F-350 Truck Door Trim Panel Installation

3. If the vehicle is equipped with stereo radio, position the speaker grille and install the retaining screws.
4. Position the window regulator handle and washer to the window regulator and install retaining screw.
5. Install the armrest to the door inner panel.

Sliding Door Trim Panel

E-150—E-350 Cargo Van

Remove the sliding door trim panel retaining screws and remove the panel (Fig. 6). Position replacement panel to door assembly and install retaining screws.

E-150—E-350 and Club Wagon

Removal

1. Carefully pry the two pull strap end caps off with a small screwdriver.
2. Remove the pull strap retaining screws and pull strap. The pull strap screws remain attached to the pull strap.
3. Disengage the door trim panel push pins individually from the attaching holes in the door inner panel using the Trim Pad Removing Tool from Rotunda Moulding/Trim Kit 107-00401 or equivalent (Fig. 7).

NOTE: At no time should the trim panel be used to pull the push pins from the inner panel holes.

Installation

1. Replace any bent, damaged or missing push pins on the trim panel. Position the trim panel to the door inner panel. Position the push pins in the countersunk holes. Firmly push the trim panel at the push pin locations to seat each push pin into the holes in the door inner panel.
2. Position the pull strap onto the inner panel and tighten the retaining screws.
3. Snap the two end caps into the pull strap assembly.

Side and Rear Door Trim Panel

Refer to Figs. 8 and 9.

E-150—E-350 Side Hinged Door Trim Panels

Remove retaining screws and trim panel (Fig. 8). Replace any bent, damaged or missing trim clips on the panel. Position replacement trim panel to door assembly and install retaining screws.

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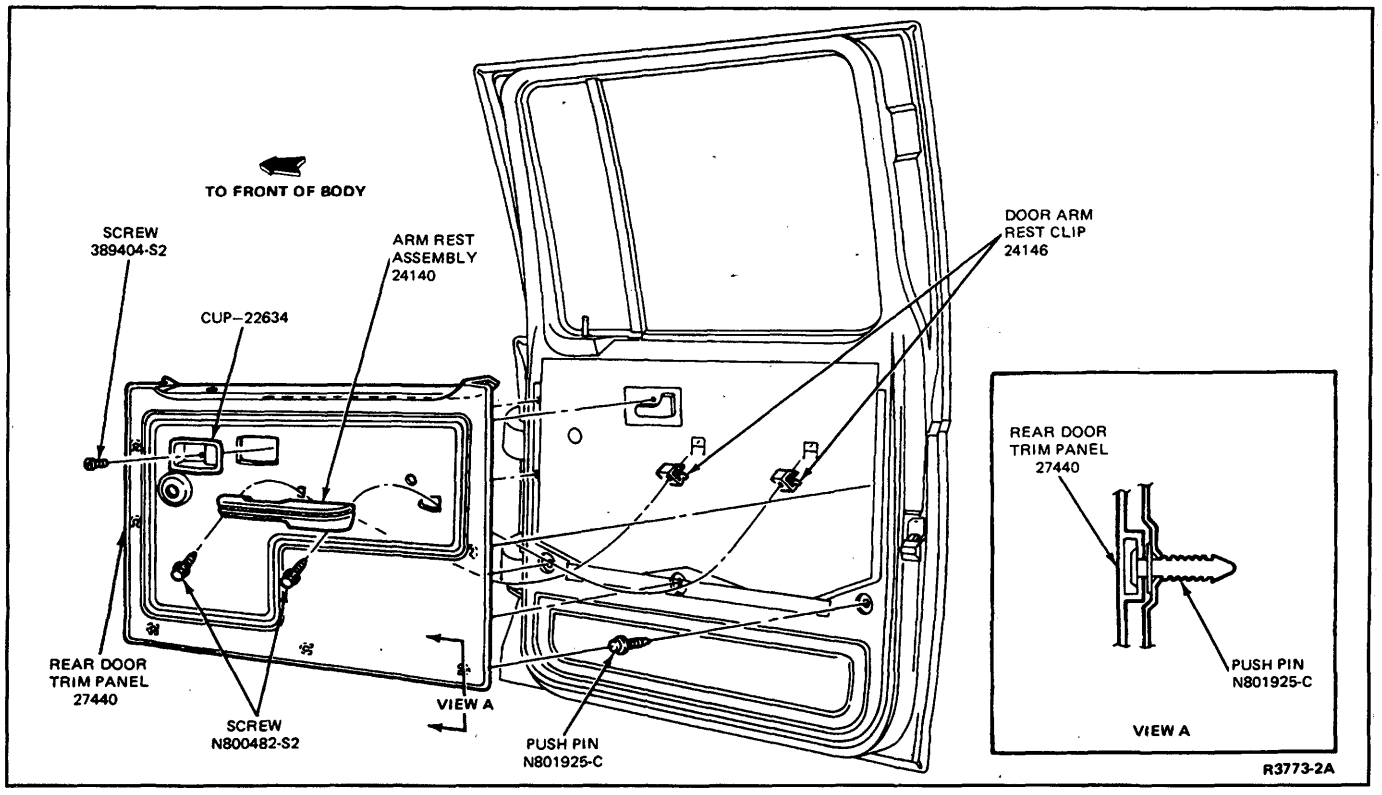


FIG. 2 F-350 Crew Cab Rear Door Trim Panel Installation

E-150—E-350—Cargo Van Hinged Door Panels—Rear

Remove retaining screws and panel from door (Fig. 9). Position replacement panel to door assembly and install retaining screws.

E-150—E-350 Cargo Vans and Wagons Rear Door Trim Panels

Removal

Remove the door trim panel push pins individually from the inner door panel using the Trim Pad Removing Tool from Moulding/Trim Kit 107-00401 or equivalent (Fig. 10).

NOTE: At no time should the trim panel be used to pull the push pins from the inner panel holes.

Installation

Replace any bent, damaged or missing push pins on the panel. Position the trim panel to the door inner panel and locate the push pins into the countersunk holes (Fig. 10). Firmly push the trim panel at the push pin locations to seat each push pin into the holes in the door inner panel.

E-150—E-350 Super Vans Rear Door Trim Panels

Remove retaining screws and trim panel (Fig. 10). Position replacement trim panel to door assembly and install retaining screws.

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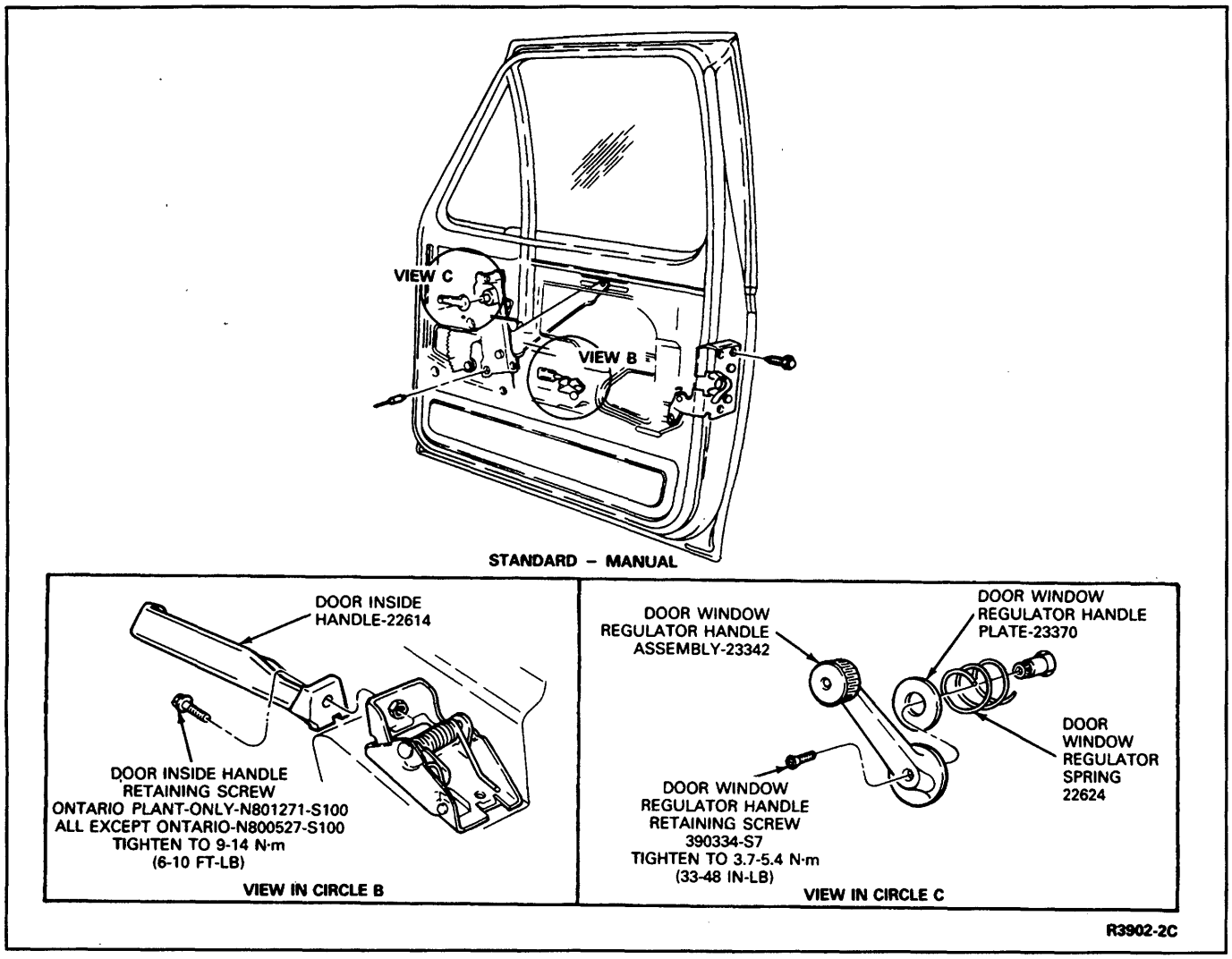


FIG. 3 Door Window Regulator and Inside Handle—F-Series, Bronco

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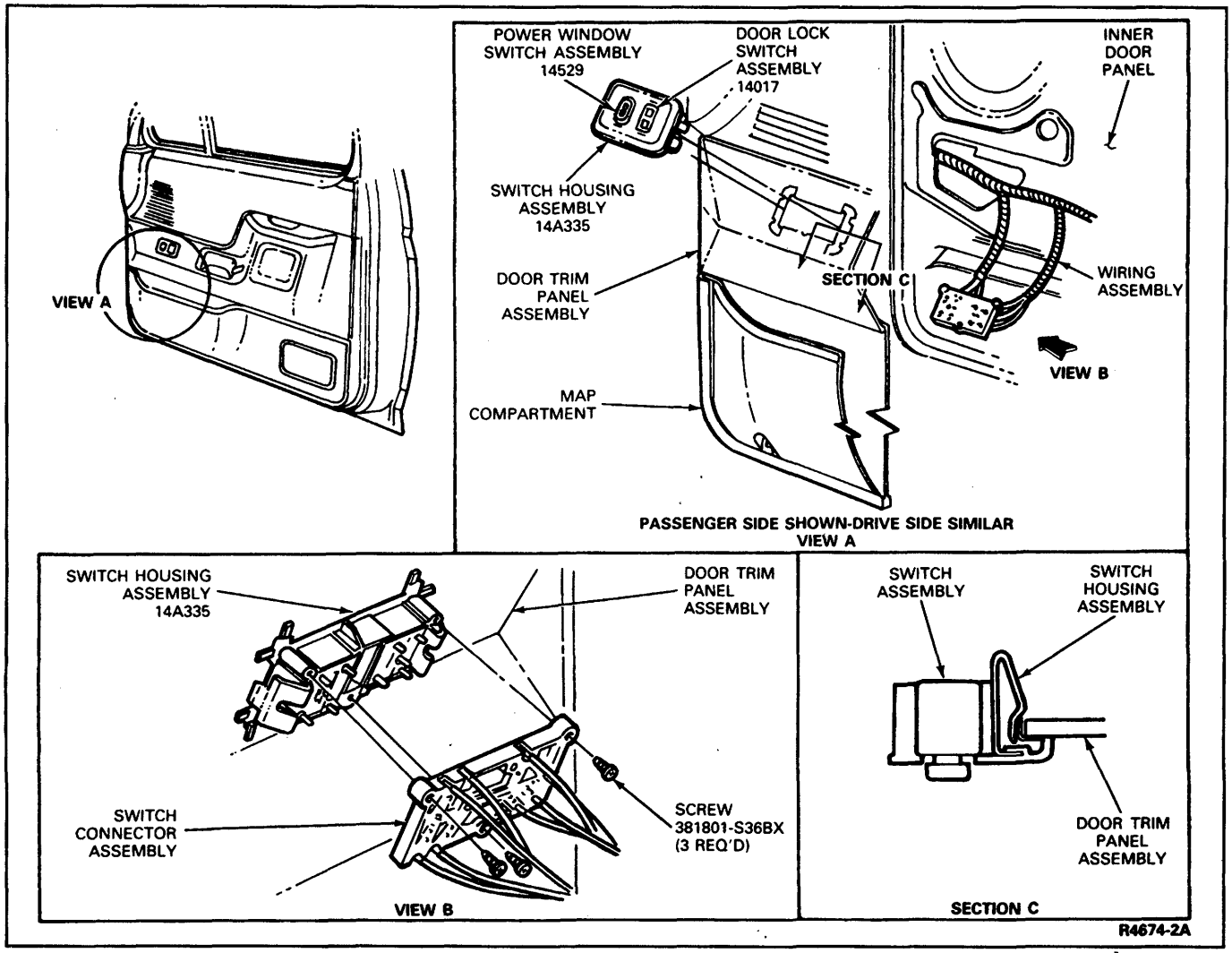


FIG. 4 Power Window and Power Door Lock Switch—F-Series, Bronco

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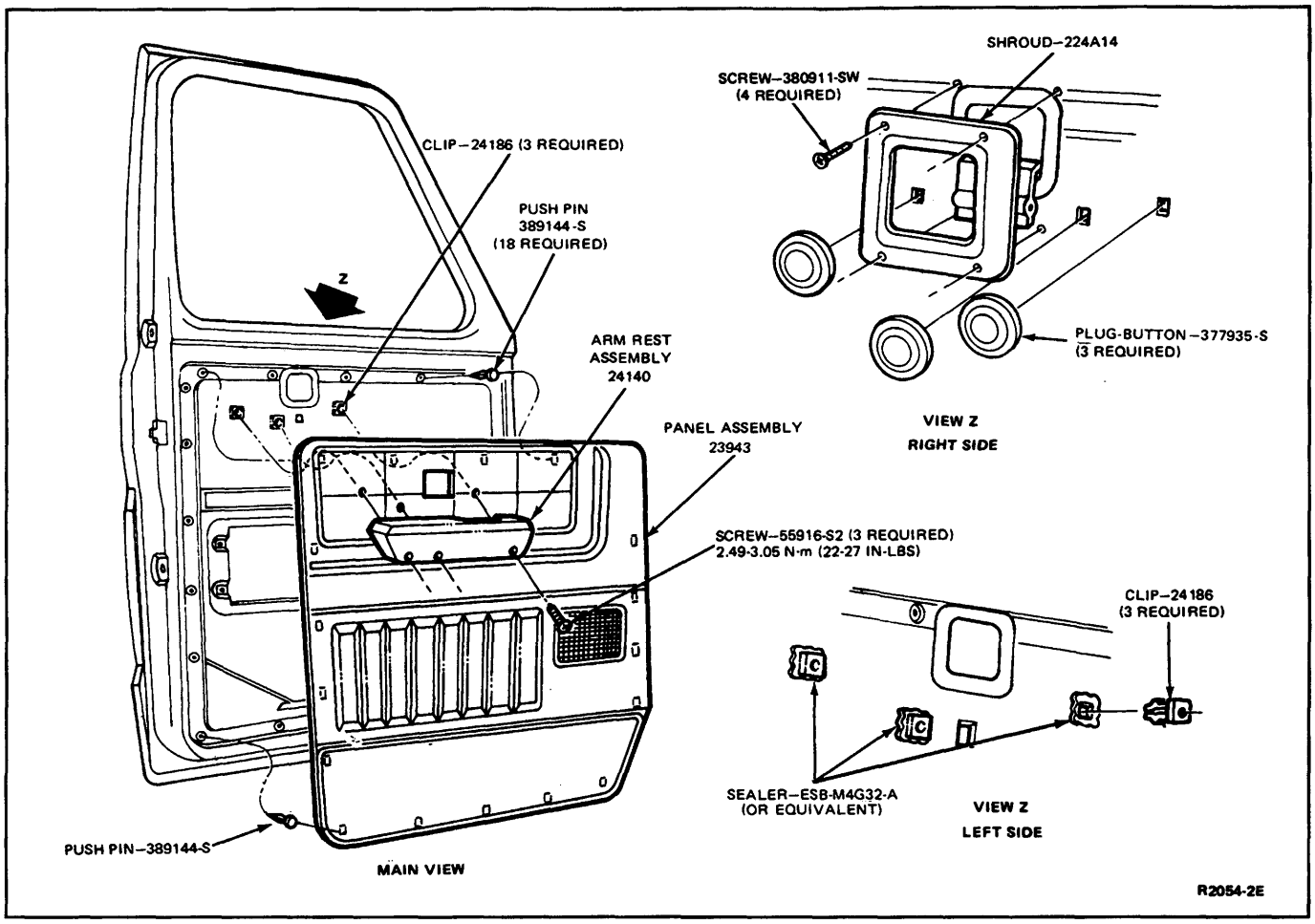


FIG. 5 E-150—E-350 Door Trim Panel Installation

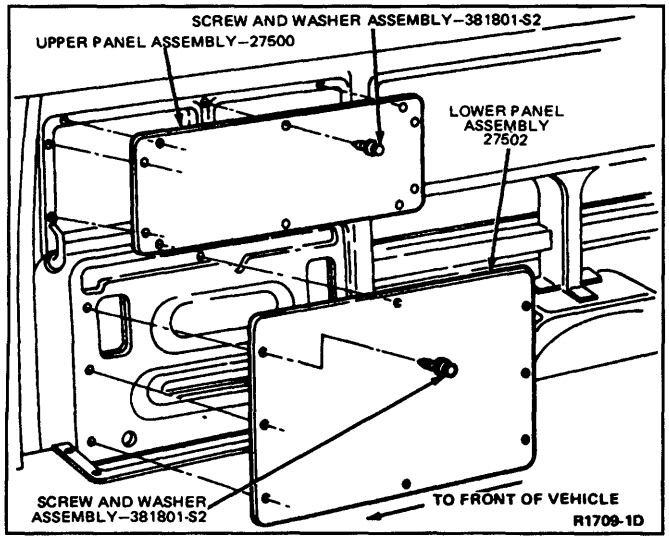


FIG. 6 Sliding Cargo Door—Trim Panel—E-150—E-350

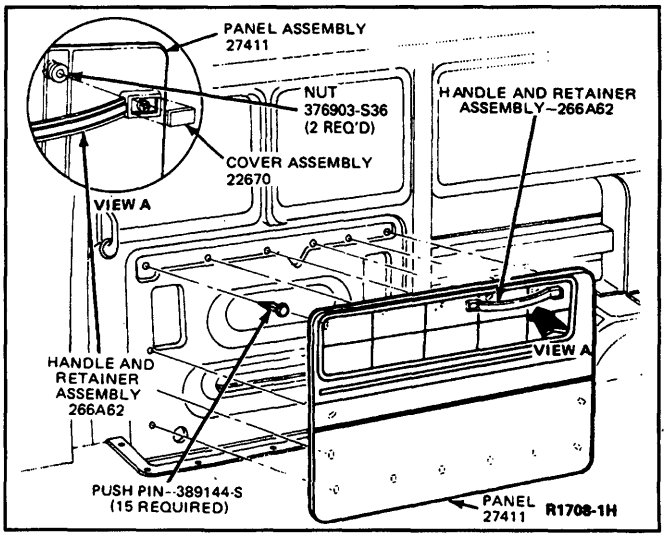


FIG. 7 Sliding Cargo Door—Trim Panel—E-150—E-350

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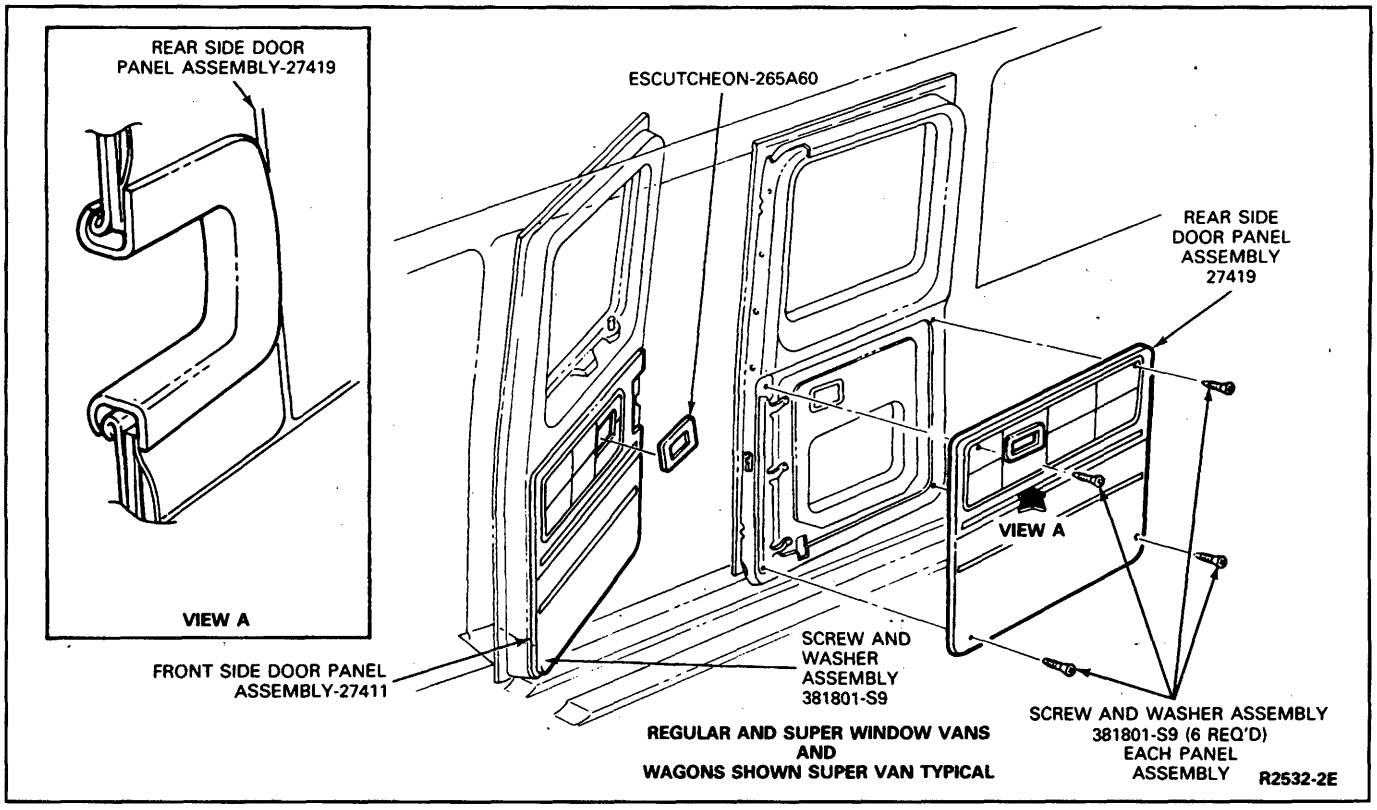


FIG. 8 Side Hinged Door Trim Panel—E-150—E-350

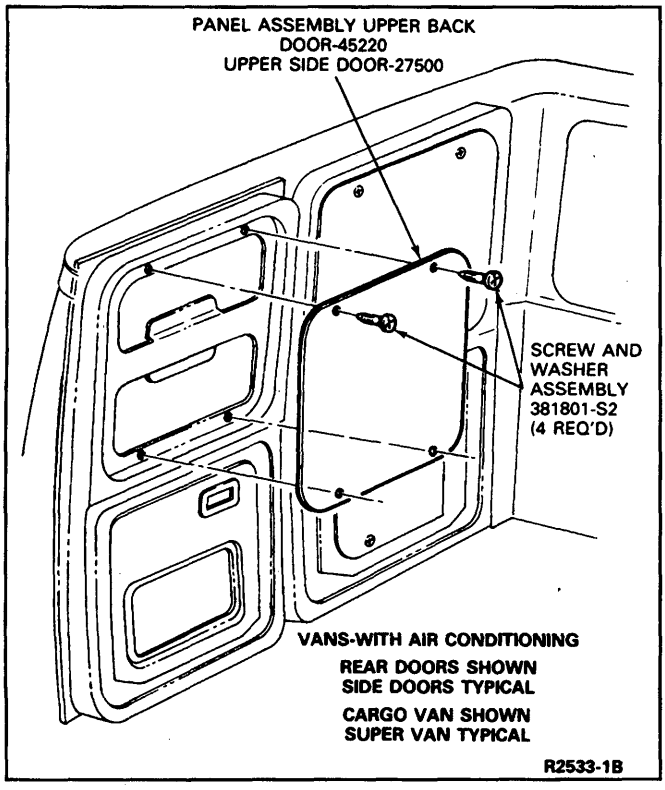


FIG. 9 Cargo Van Hinged Door Panel—Rear

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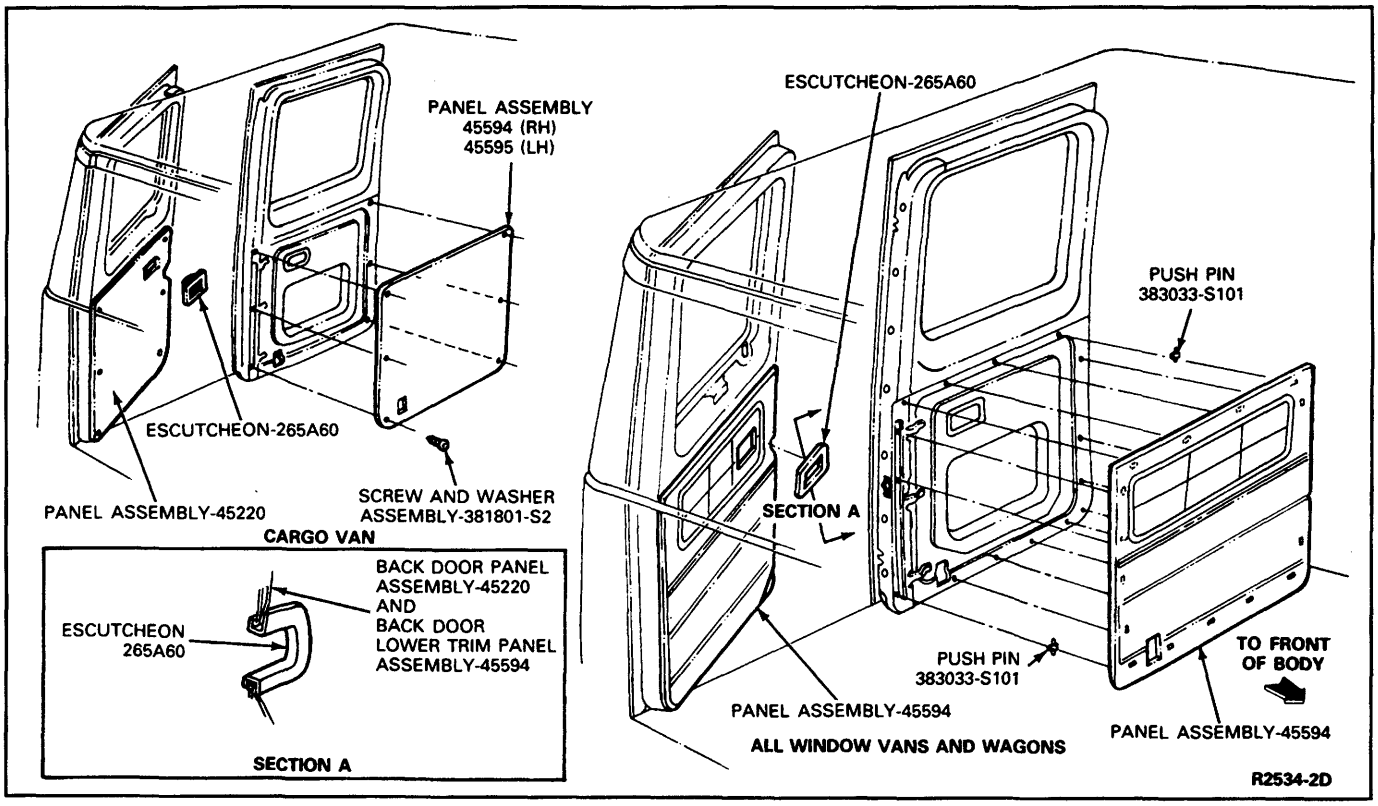


FIG. 10 Rear Door Trim Panel—E-150—E-350 Cargo Vans and Wagons

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Model	Description
107-00401	Molding/Trim Kit

CR4673-1A

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SECTION 45-11 Interior Trim Panels

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Side Trim Panels (Cont'd)	
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VEHICLE APPLICATION	45-11-1

VEHICLE APPLICATION

E-150 Through E-350, F-150 Through F-350 and Bronco.

REMOVAL AND INSTALLATION

Since all interior trim panels are retained to the body panels with screws and/or metal strips, the removal and installation procedures are obvious. Trim panels and retainers are shown in Figs. 1 through 24. Access to some of these panels, however, requires prior removal of other parts. Applicable removal procedures are outlined as follows:

Quarter Trim Panel

E-150—E-350

Refer to Figs. 1 through 16.

Before removing the LH side trim panel, adjust the driver's seat forward.

Before removing the RH side trim panel, remove the right seat assembly from the vehicle. Refer to Group 41.

Side Trim Panels

Front Trim Panel, LH Side—Remove the first bench seat and window garnish moulding. Refer to Group 41.

Right Trim Panel, RH side—Remove the two rear bench seats, the spare tire, and window garnish moulding. Refer to Group 41.

Rear Trim Panel, LH side—Remove the two rear bench seats and window garnish moulding. Refer to Group 41.

F-150—F-350

Refer to Figs. 17, 18, 19 and 20 for removal and installation of trim panels.

Bronco

Refer to Figs. 20 through 24 for removal and installation of trim panels.

NOTE: When removing panels retained by push pins use the Trim Pad Removing Tool from Rotunda Moulding/Trim Kit 107-00401 or equivalent to carefully pry trim panel from inner panel. Replace any bent, damaged or missing push pins.

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Model	Description
107-00401	Molding/Trim Kit

CR4673-1A

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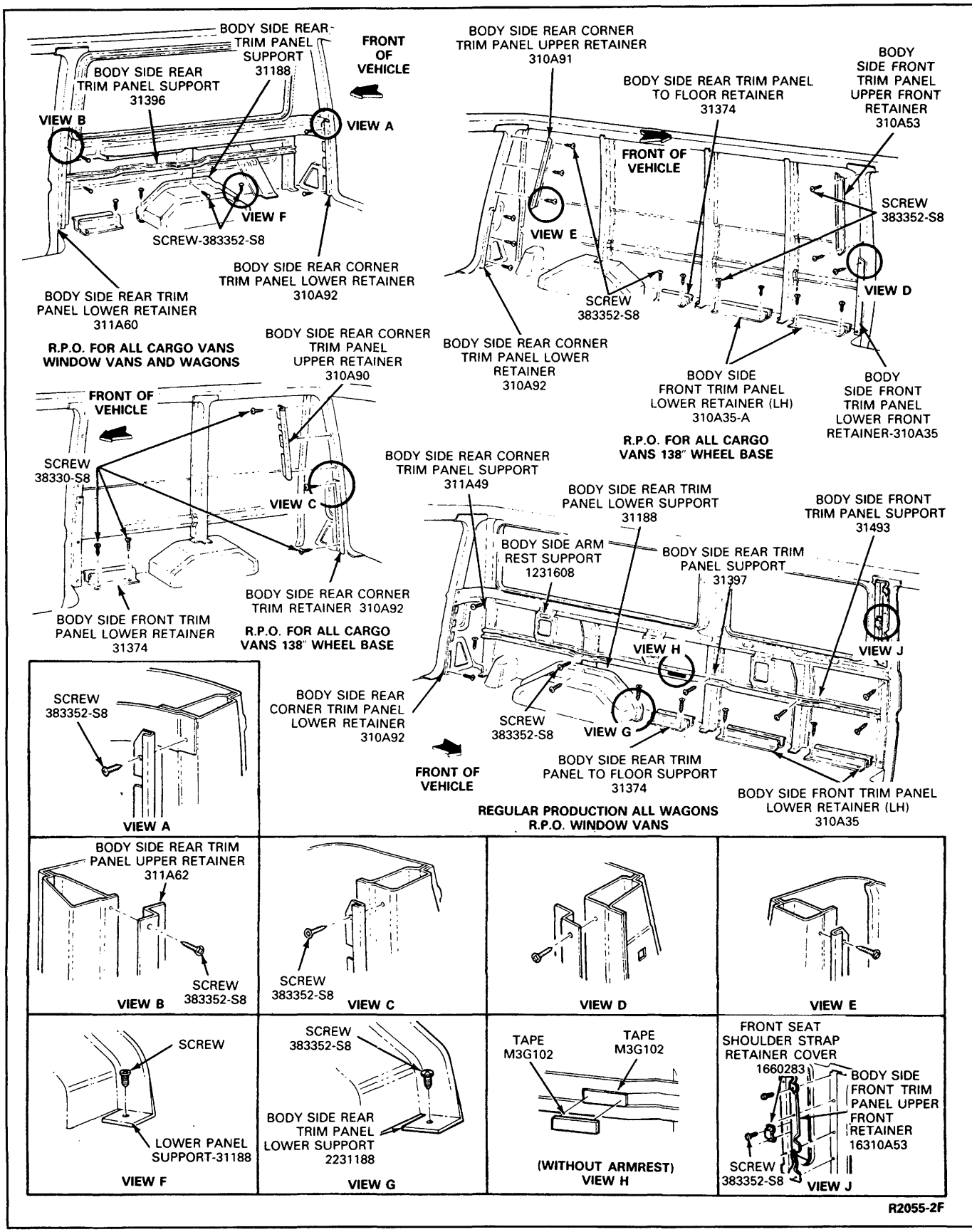


FIG. 1 Trim Panel Retainers and Supporters—E-150—E-350 and Club Wagon—138-Inch W.B.

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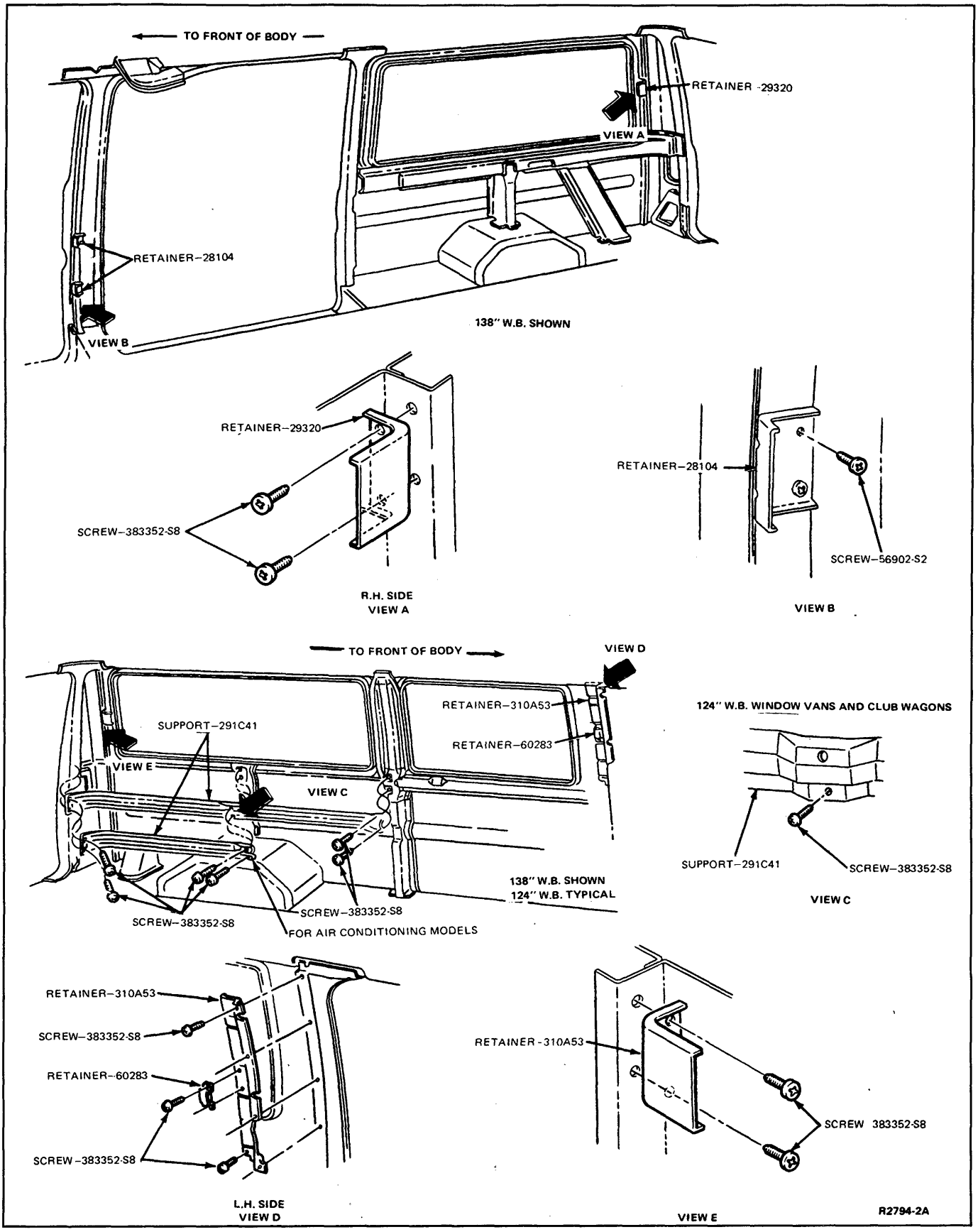


FIG. 2 Interior Moulding Supports—E-150—E-350

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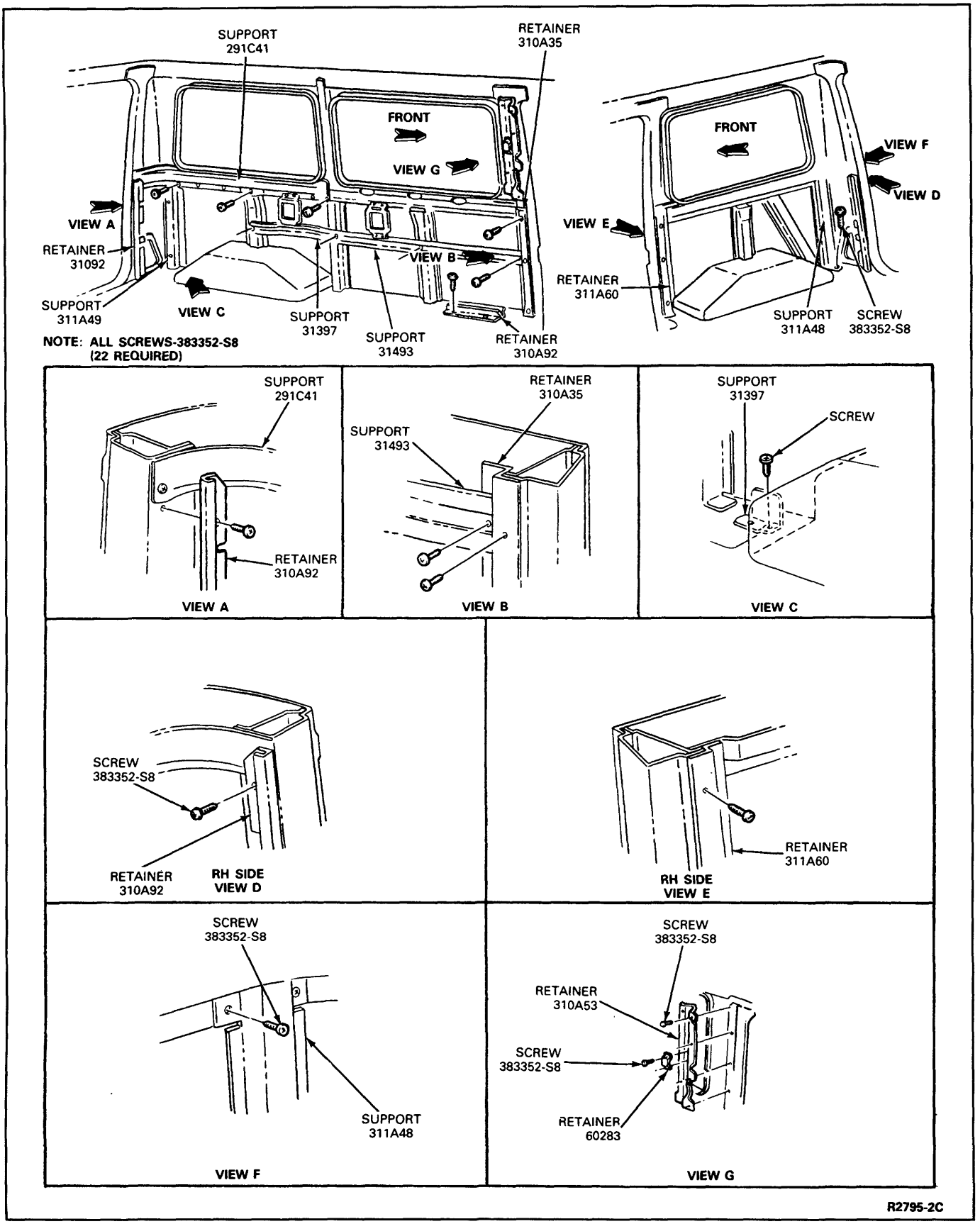


FIG. 3 Trim Panel Retainer and Supports—E-150—E-350—124 Inch W.B.

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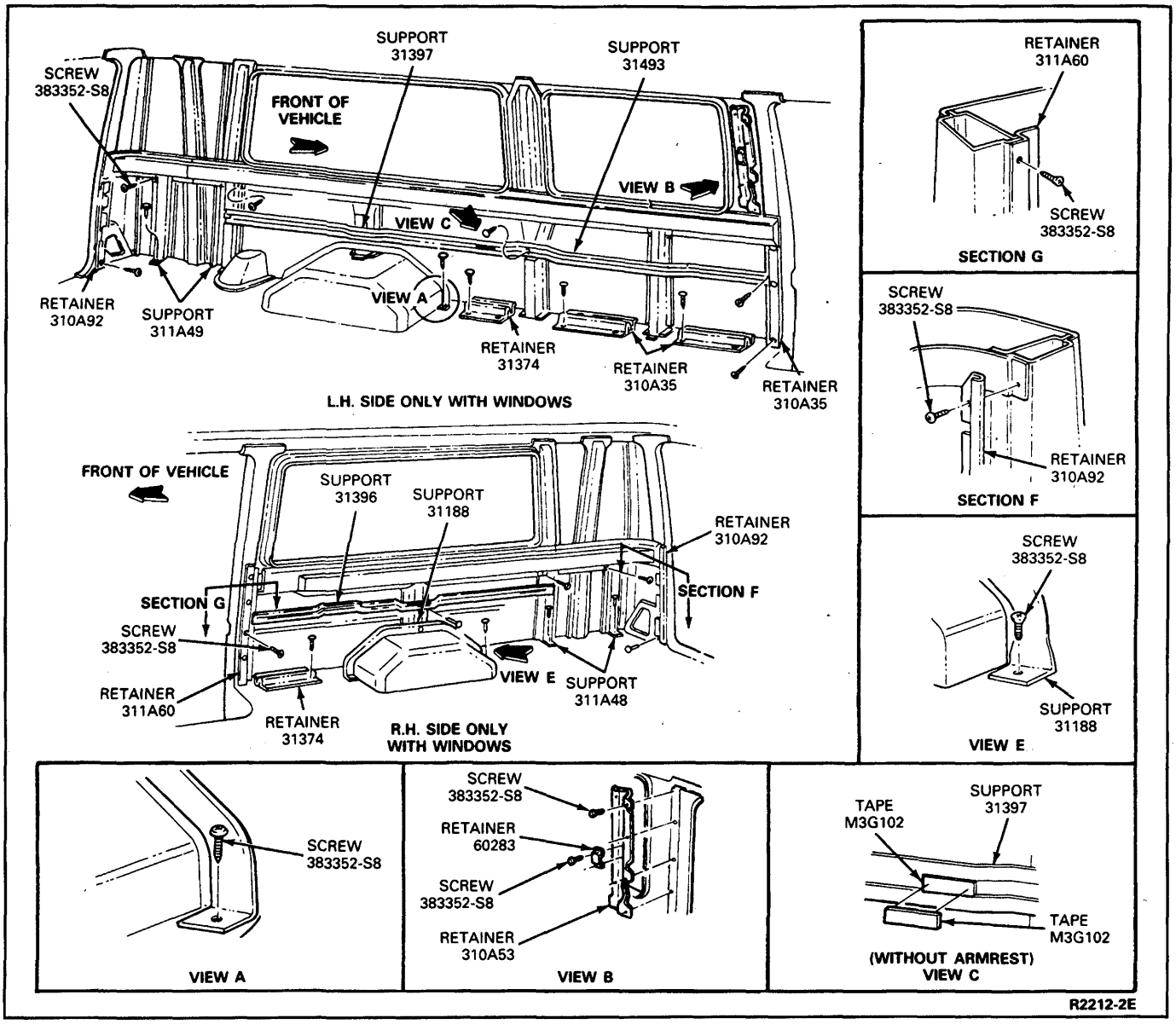


FIG. 4 Trim Panel Retainers and Supports—E-150—E-350 Super Wagon

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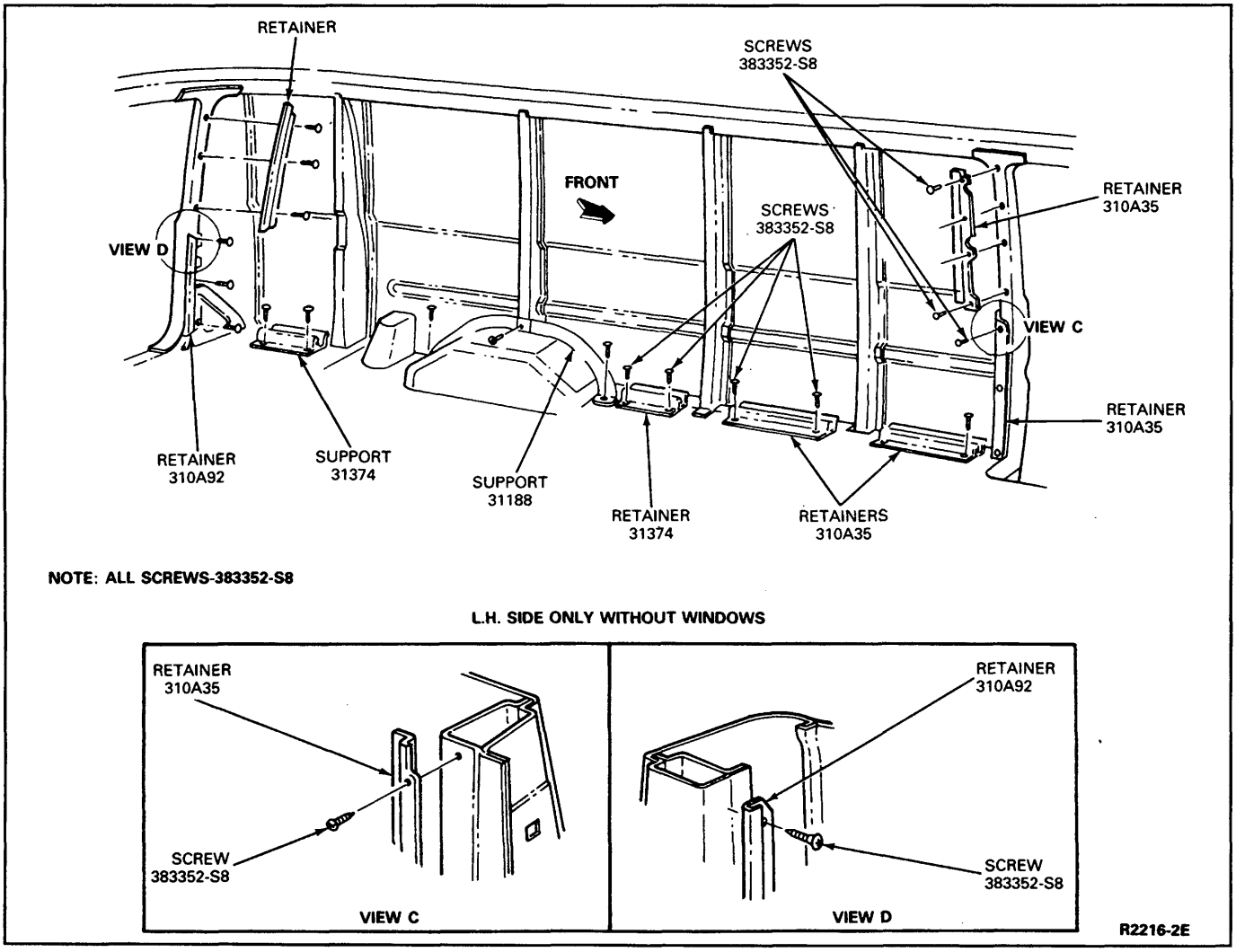


FIG. 5 Trim Panel Retainers and Supports—E-150—E-350 Super Van

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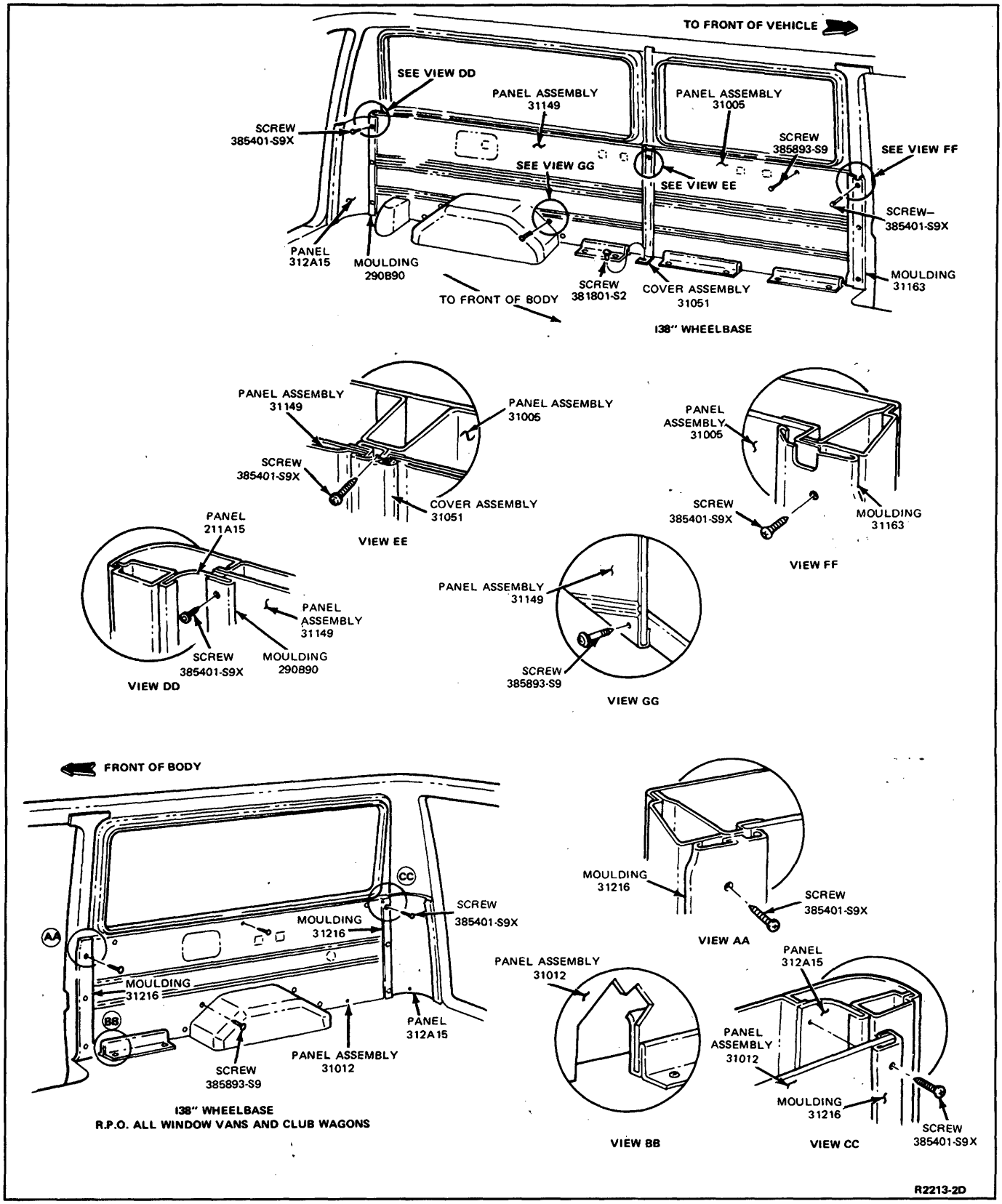


FIG. 6 Trim Panel and Mouldings—E-150—E-350

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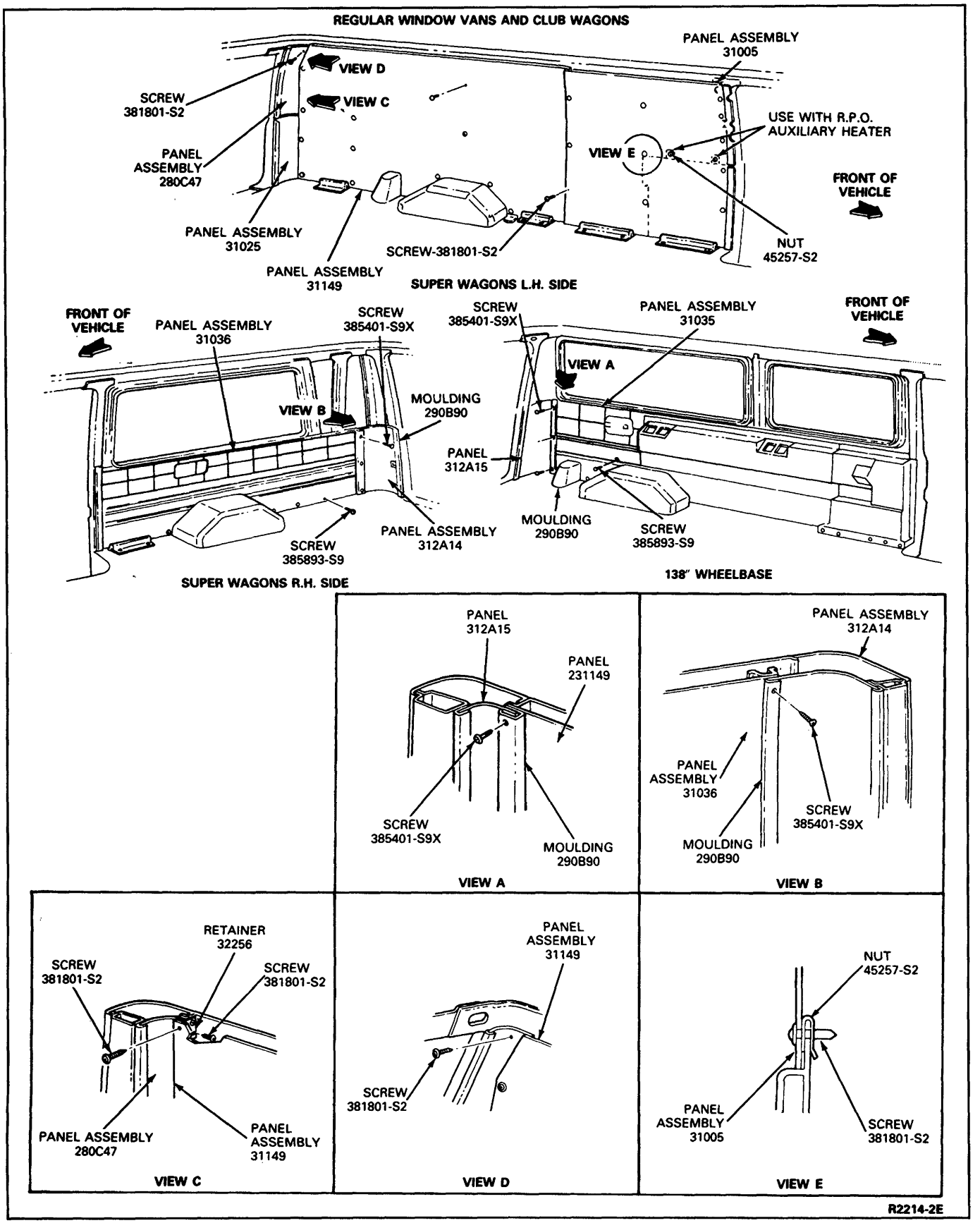


FIG. 7 Trim Panels—E-150—E-350

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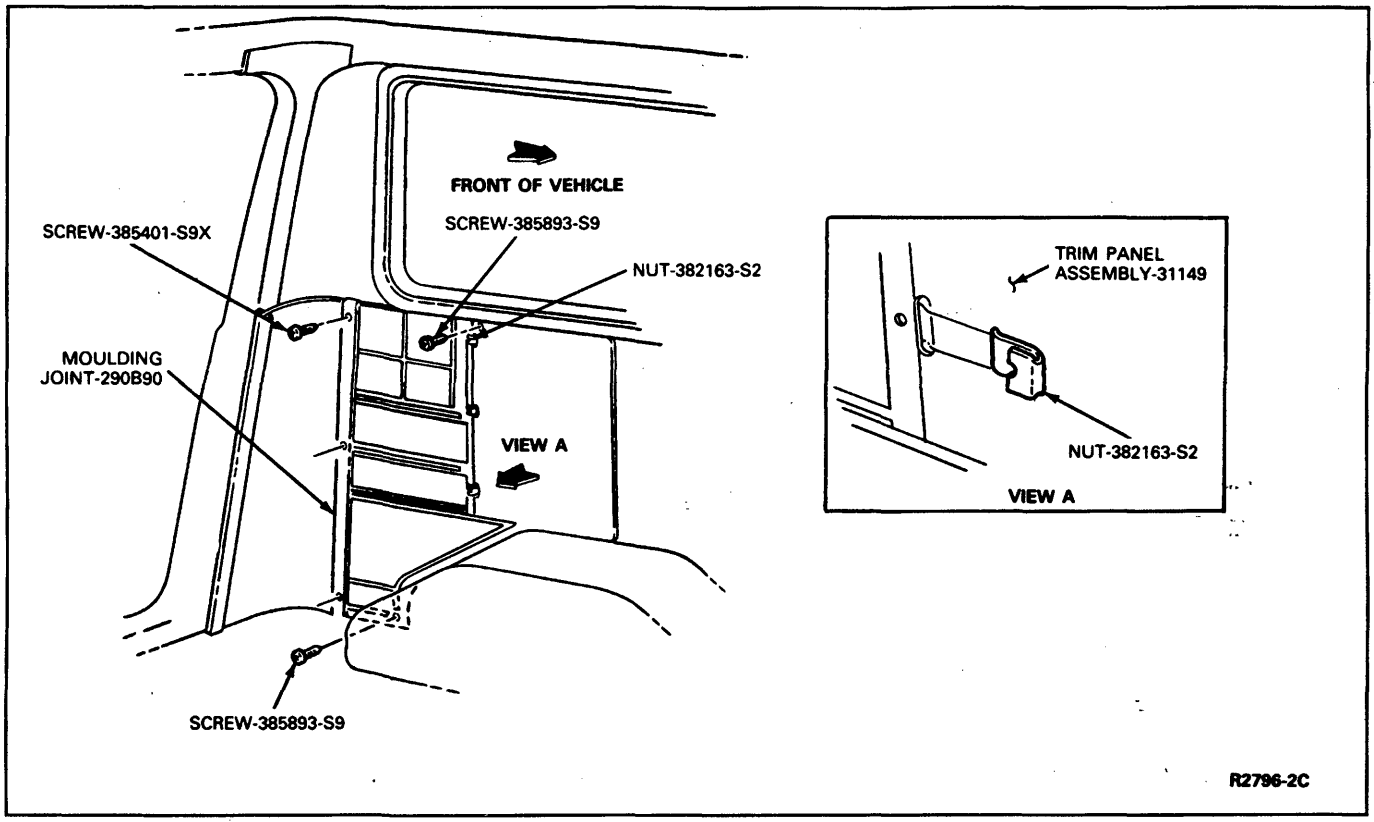


FIG. 8 Rear Trim Panel—E-150—E-350—124-Inch W.B.

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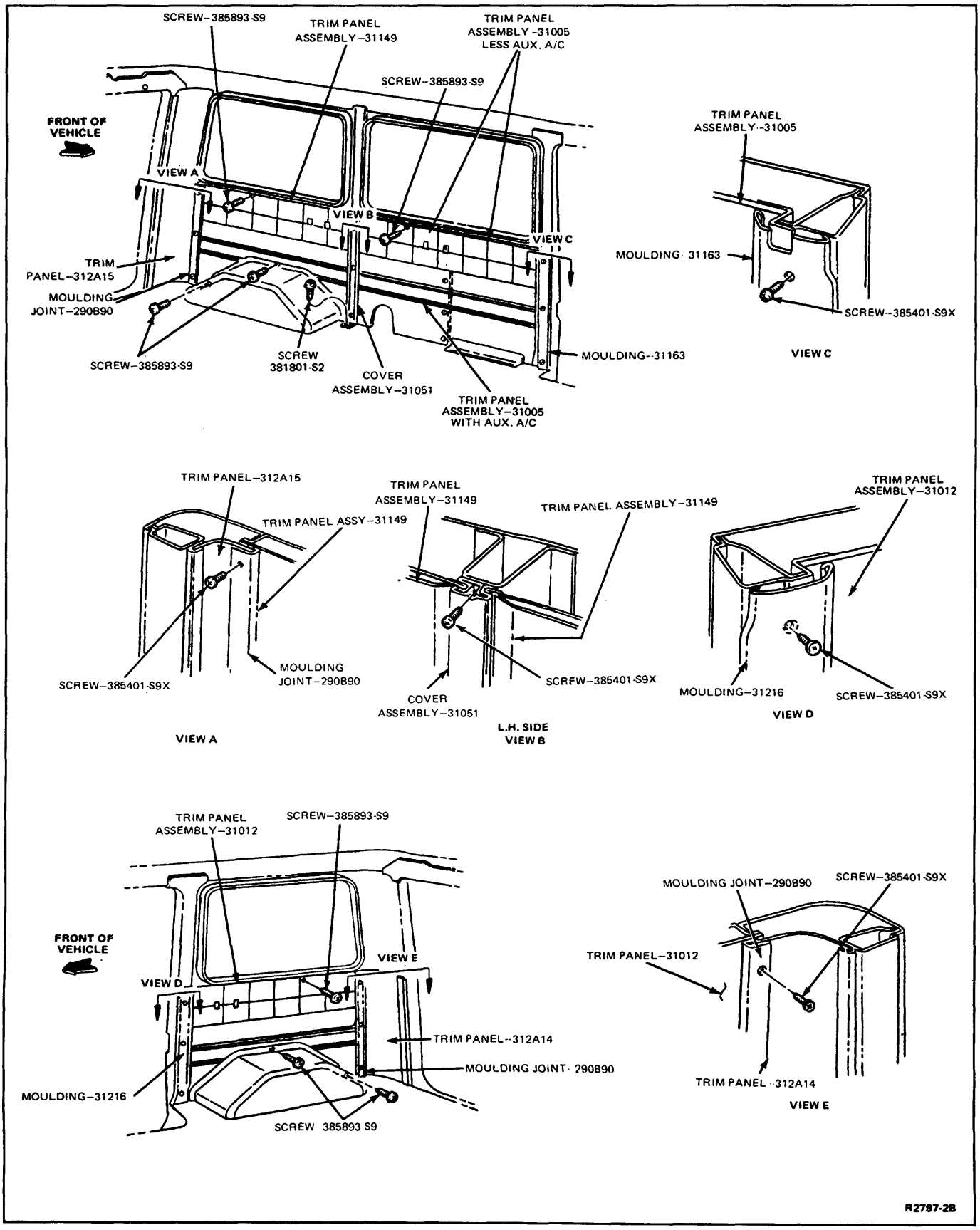


FIG. 9 Trim Panels—E-150—E-350 Window Vans and Wagons—124-Inch W.B.

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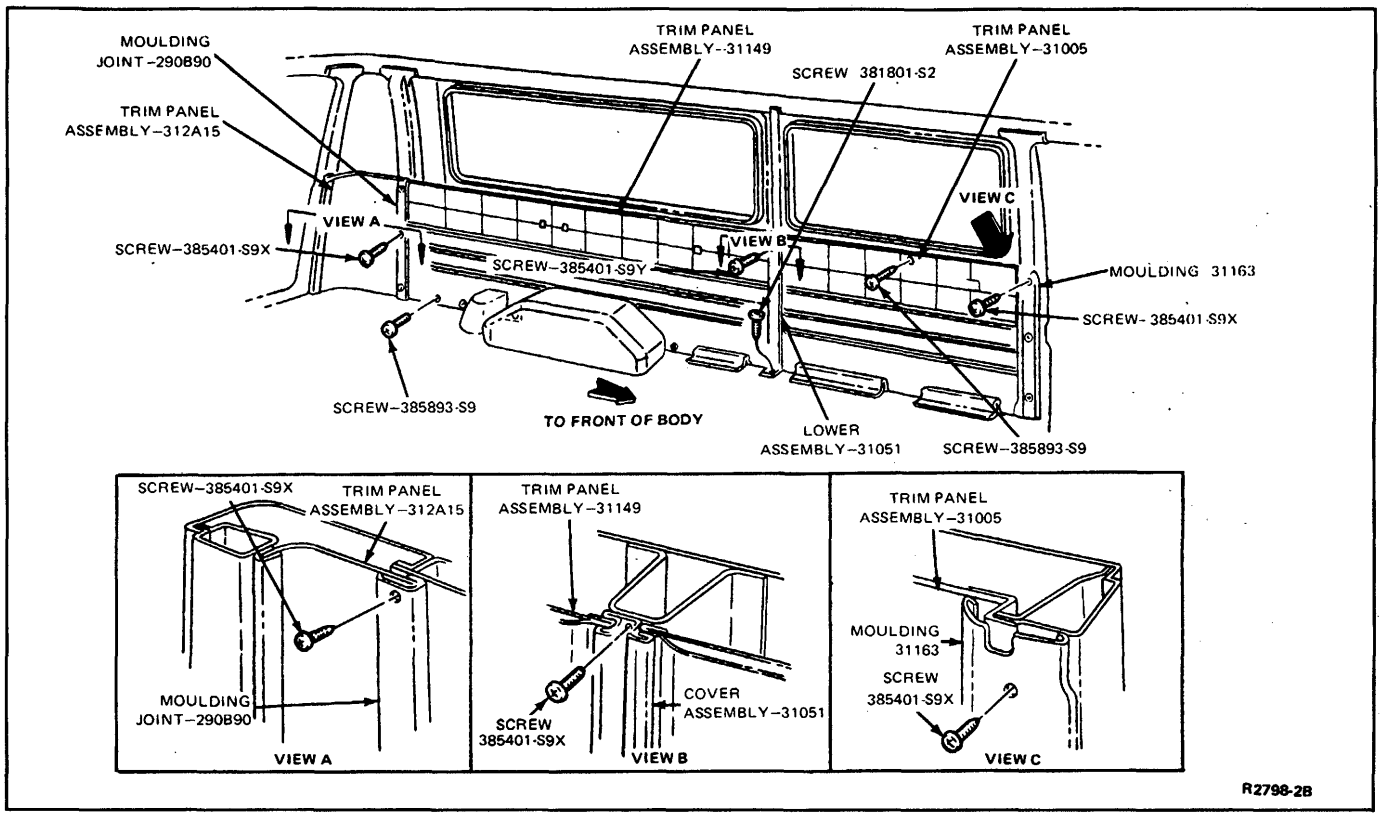


FIG. 10 Super Wagon Trim Panels—E-150—E-350 (L.H Side Shown, R.H. Side Similar)

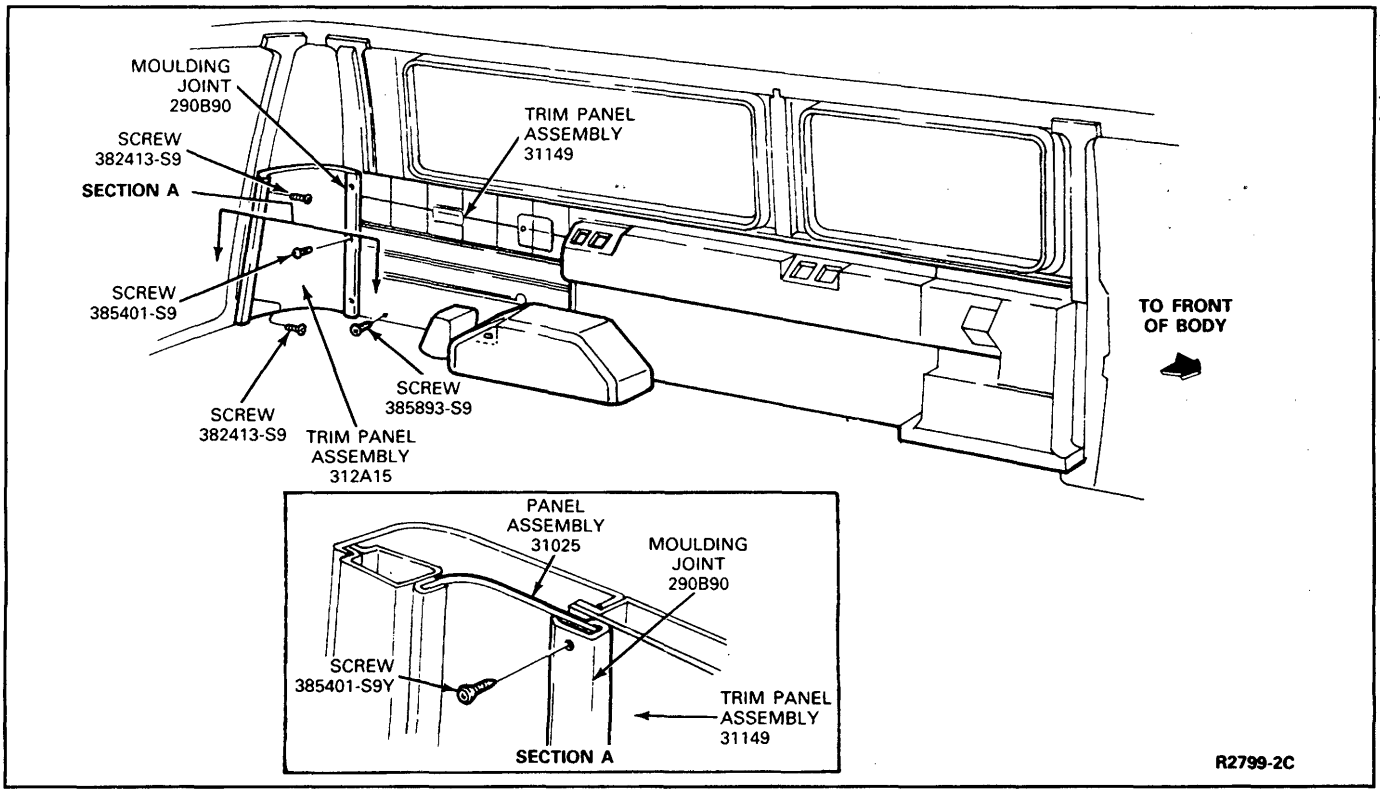


FIG. 11 Super Wagon (w/A/C) Trim Panels—E-150—E-350 (L.H. Side Shown)

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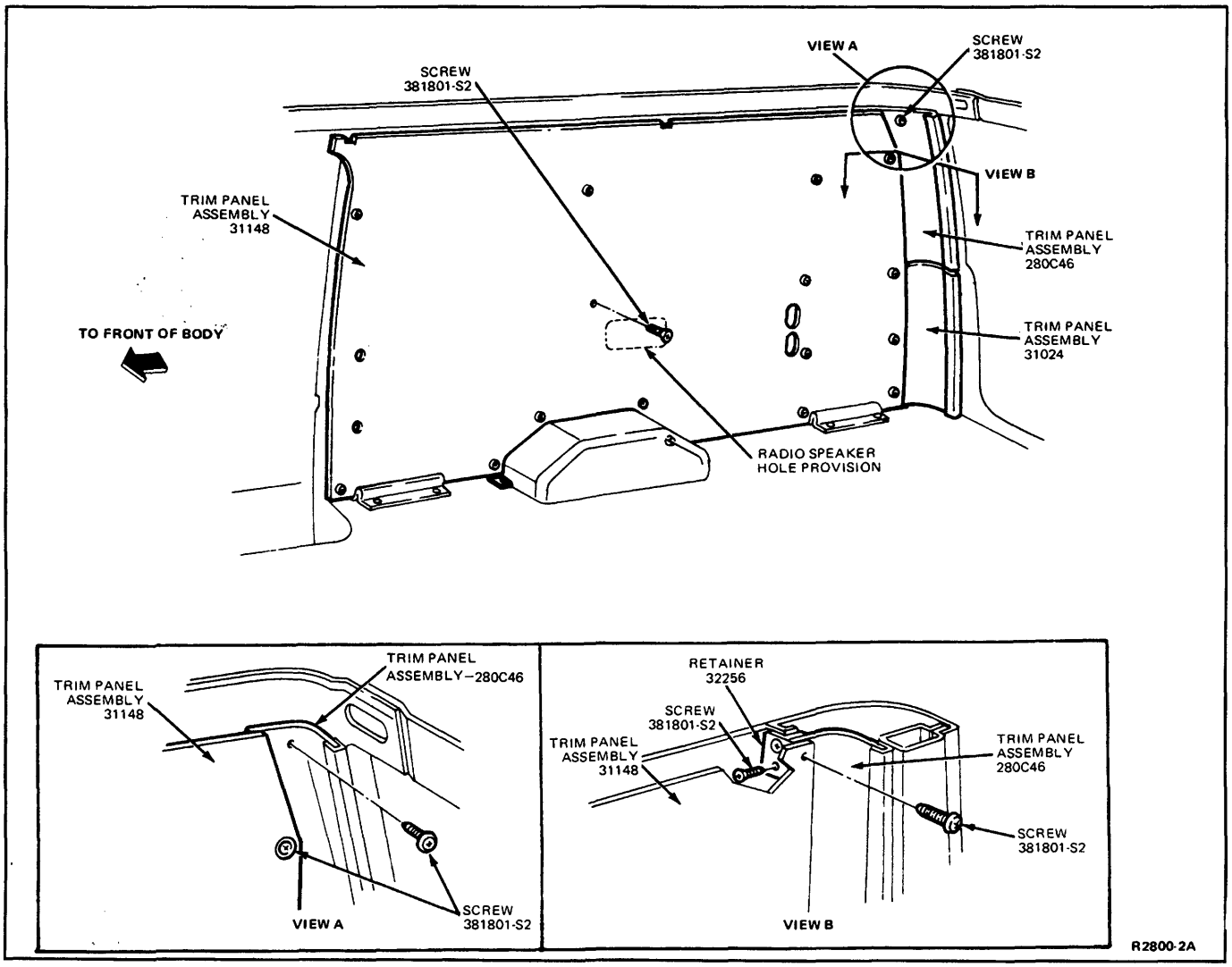


FIG. 12 Super Van Trim Panels—E-150—E-350

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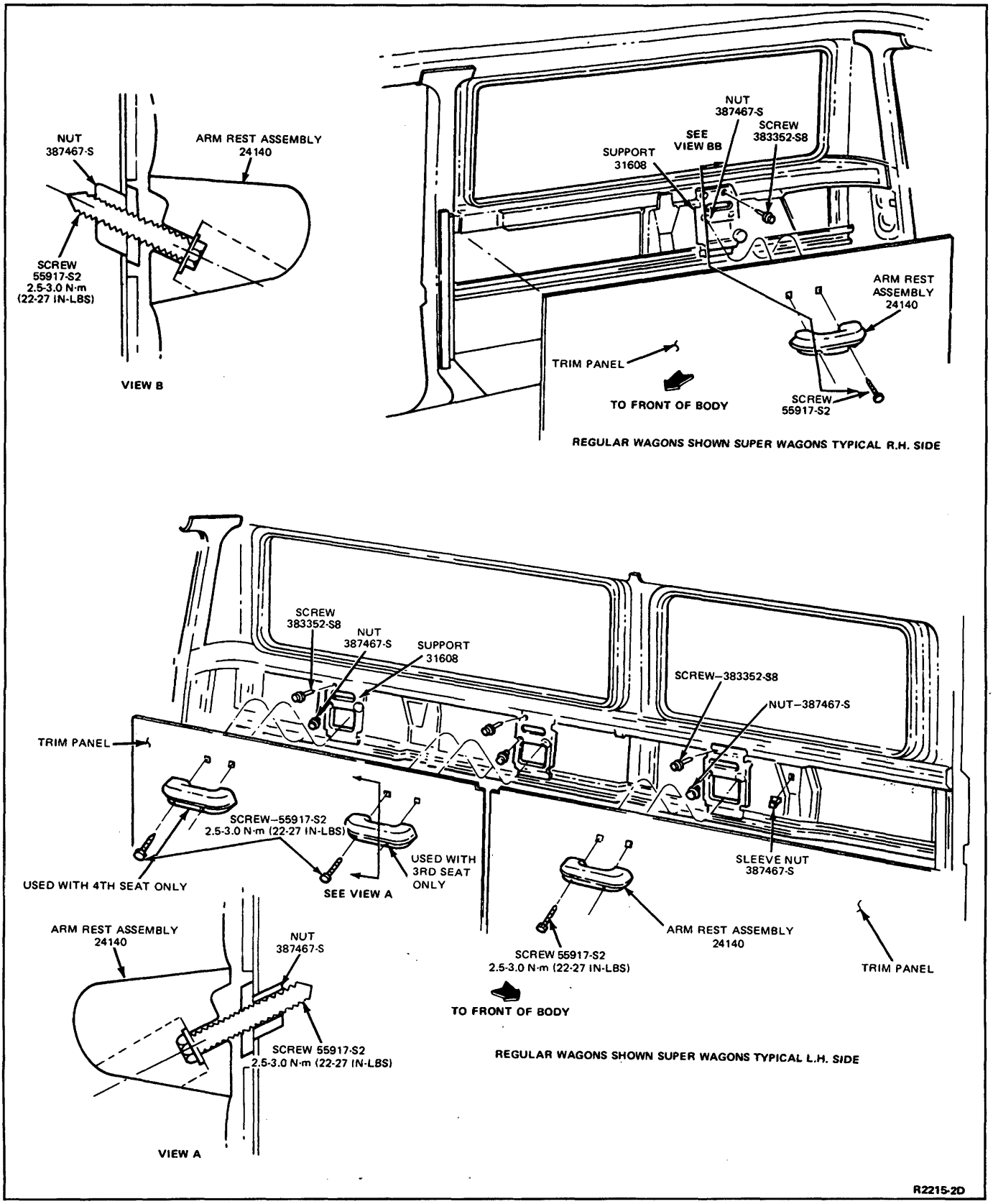


FIG. 13 Quarter Trim Armrest—E-150—E-350

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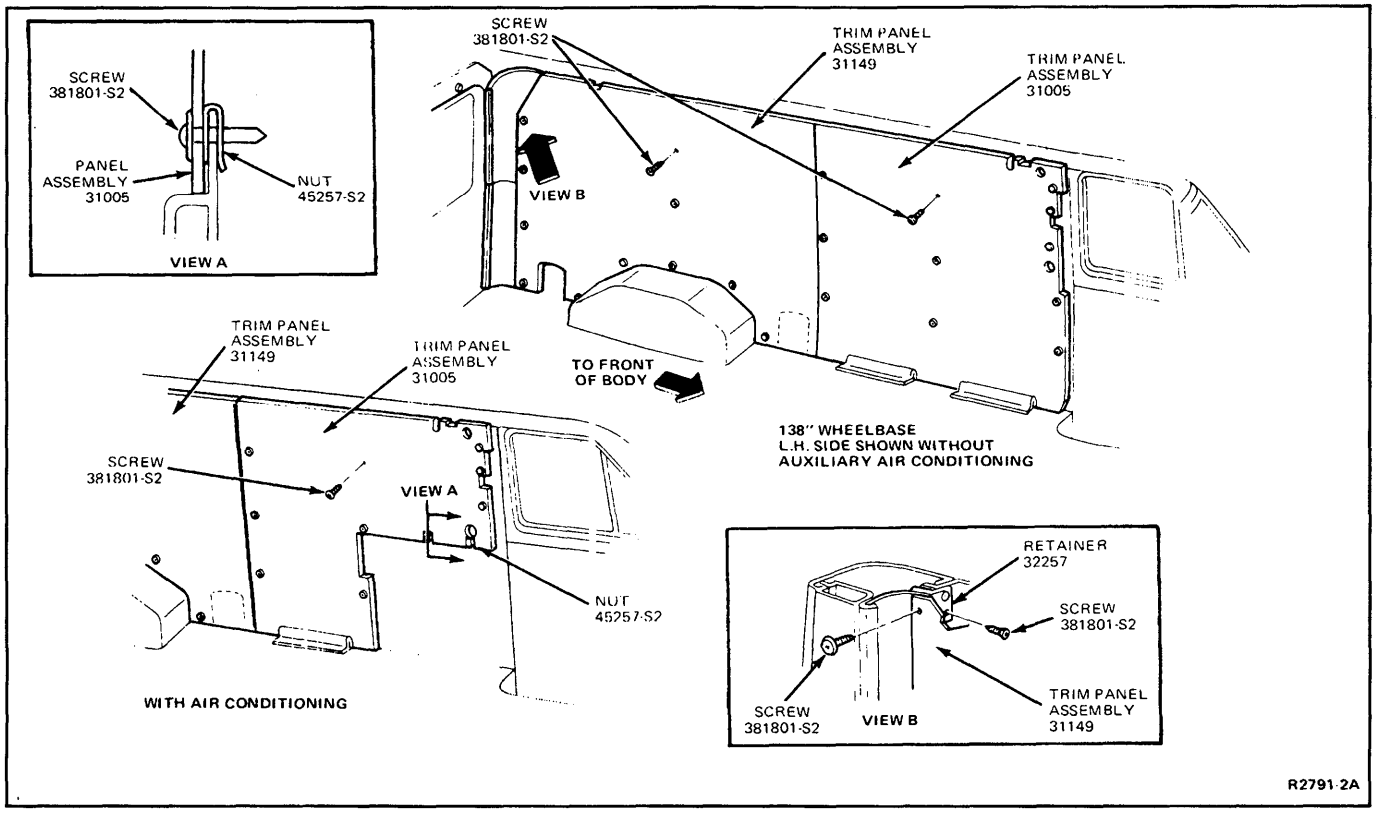


FIG. 14 Body Side Trim Panels—E-150—E-350 Vans (L.H. Side Shown, R.H. Side Similar)

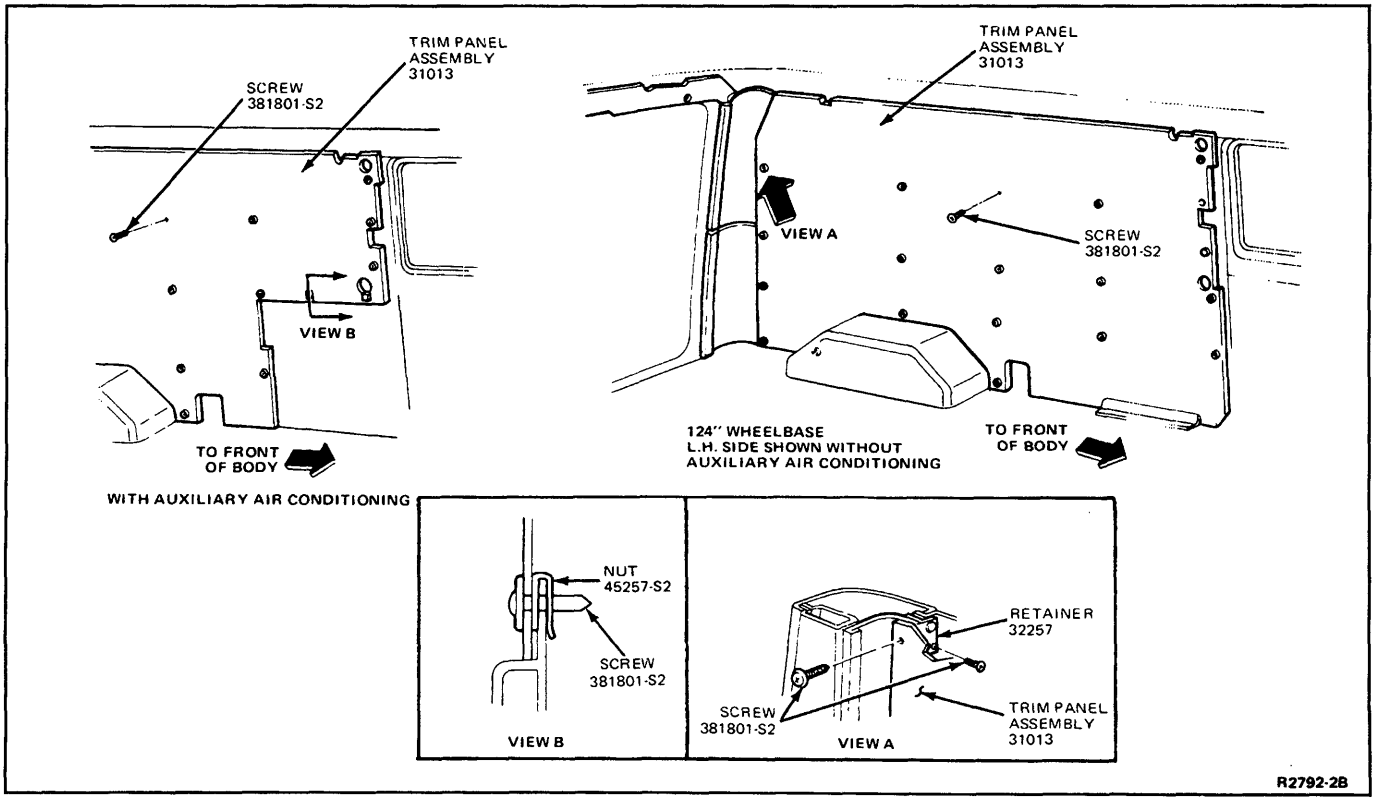


FIG. 15 L.H. Side Rear Trim Panels—E-150—E-350 Vans

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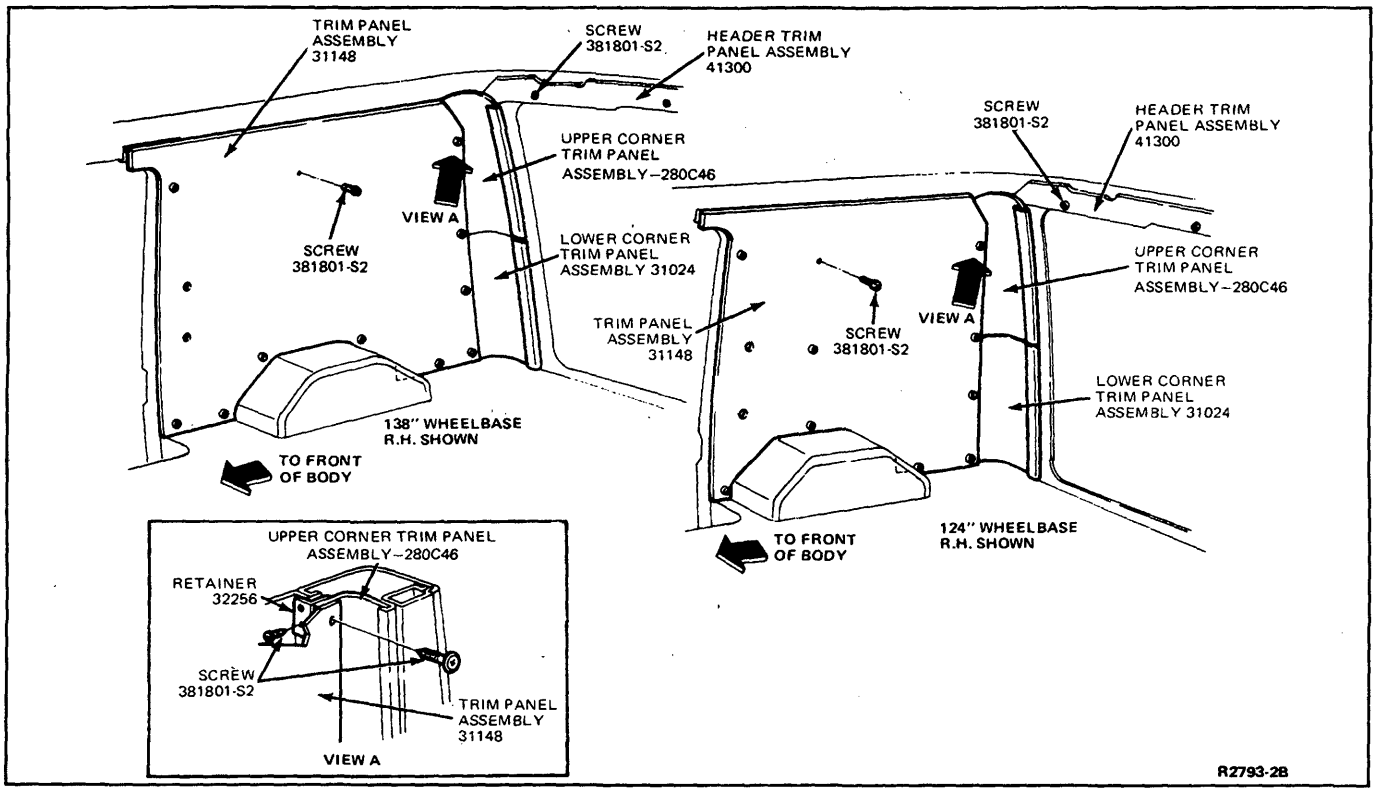


FIG. 16 R.H. Side Rear Trim Panels—E-150—E-350 Vans

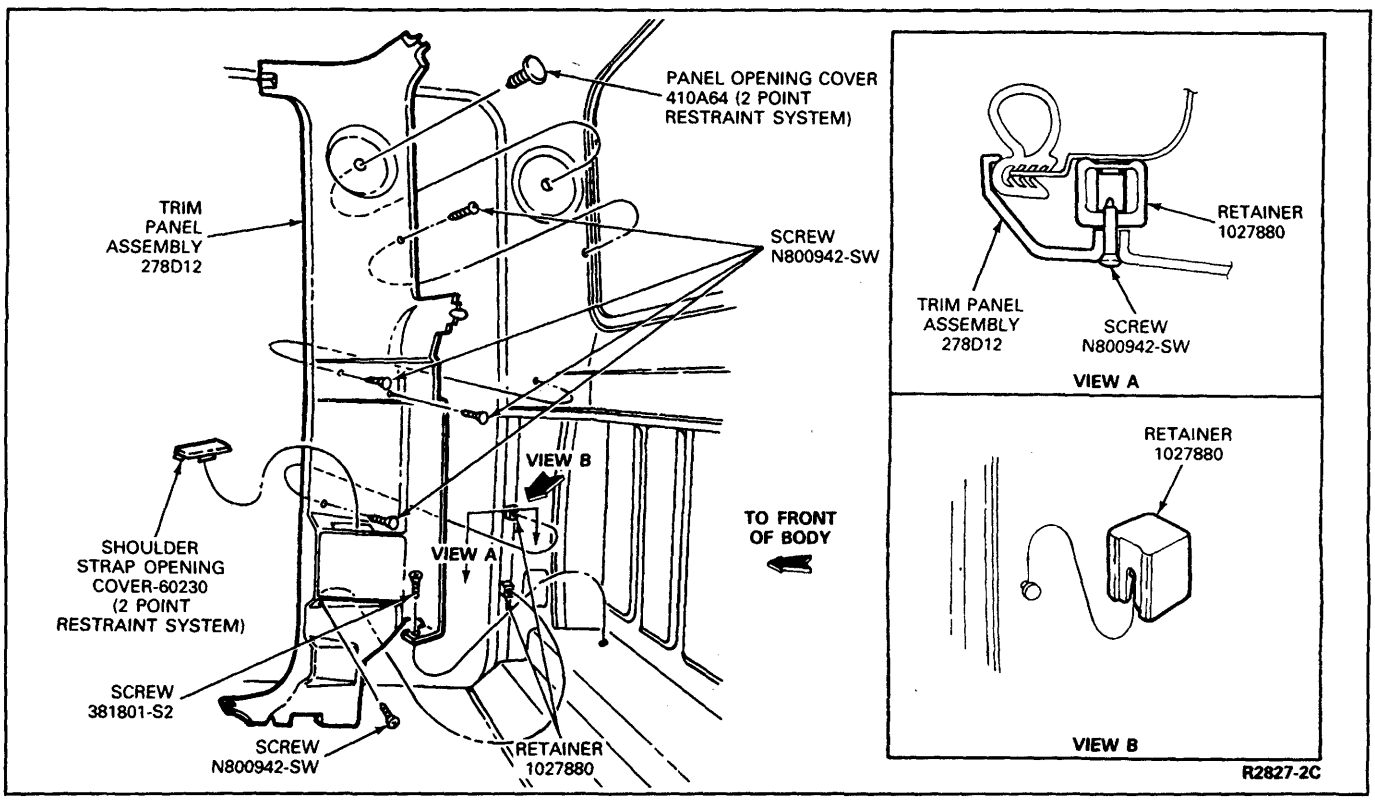


FIG. 17 F-250—F-350 Over 8500 G.V.W. Rear Corner Trim Panels—Regular Cab Shown, Crew Cab Typical

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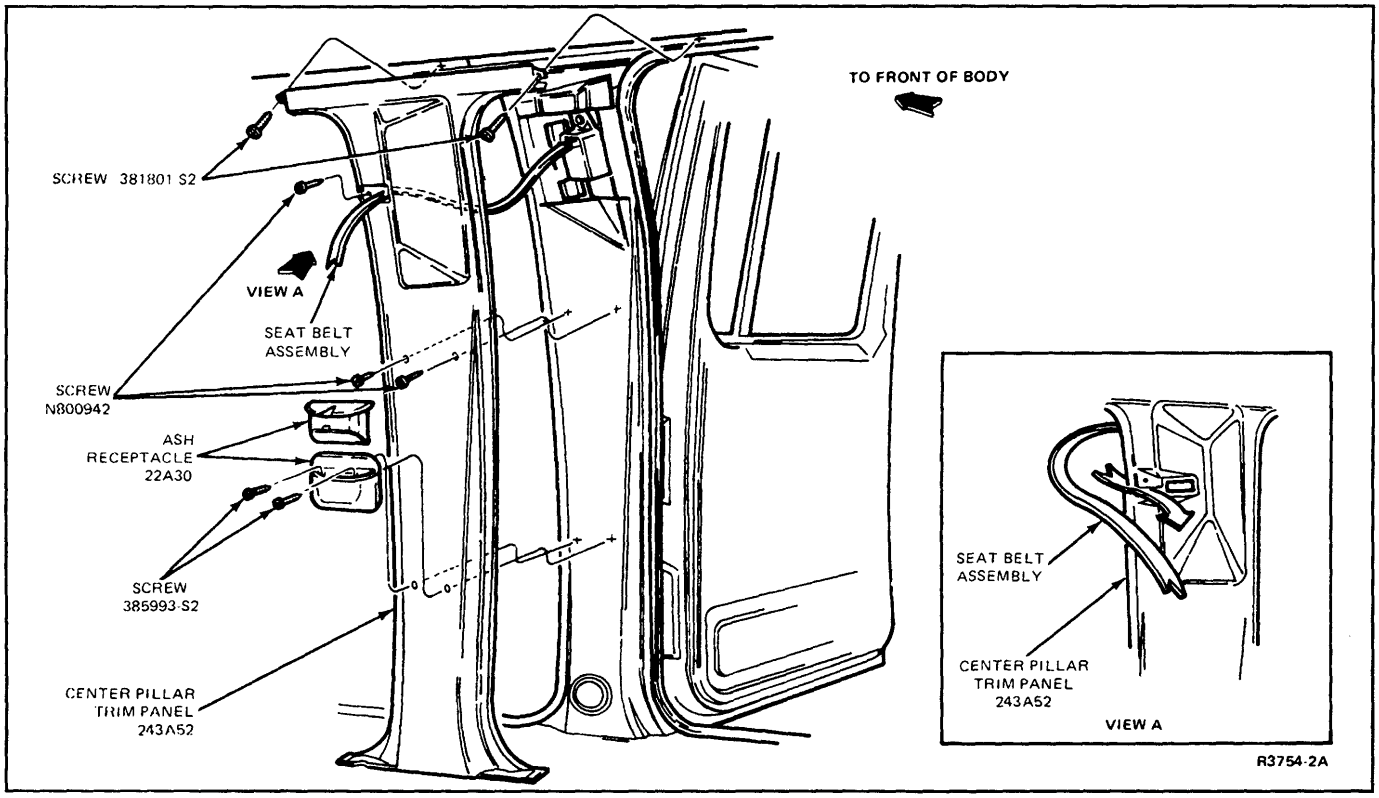


FIG. 18 F-350 Crew Cab Center Pillar Trim Panel

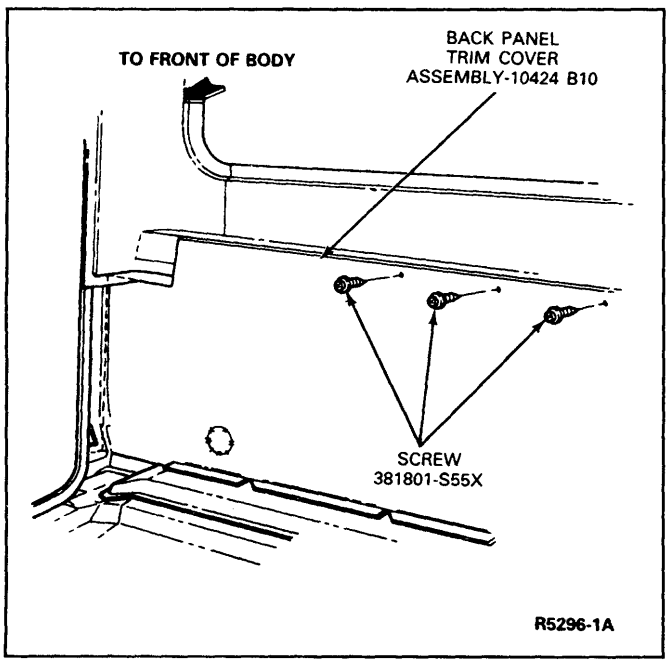


FIG. 19 Back Panel Trim Cover Assembly

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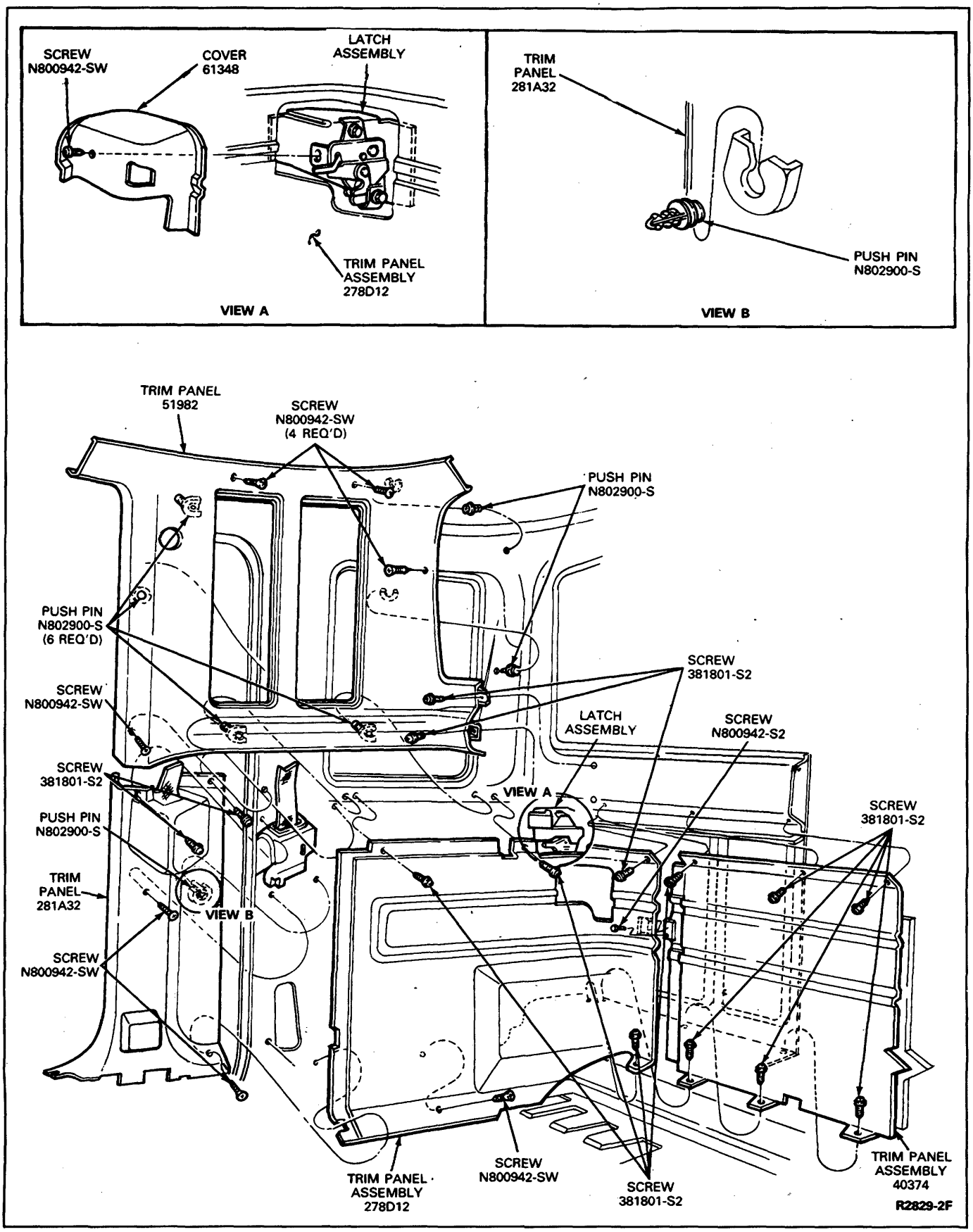


FIG. 20 F-150—F-350 Super Cab Body Trim Panels

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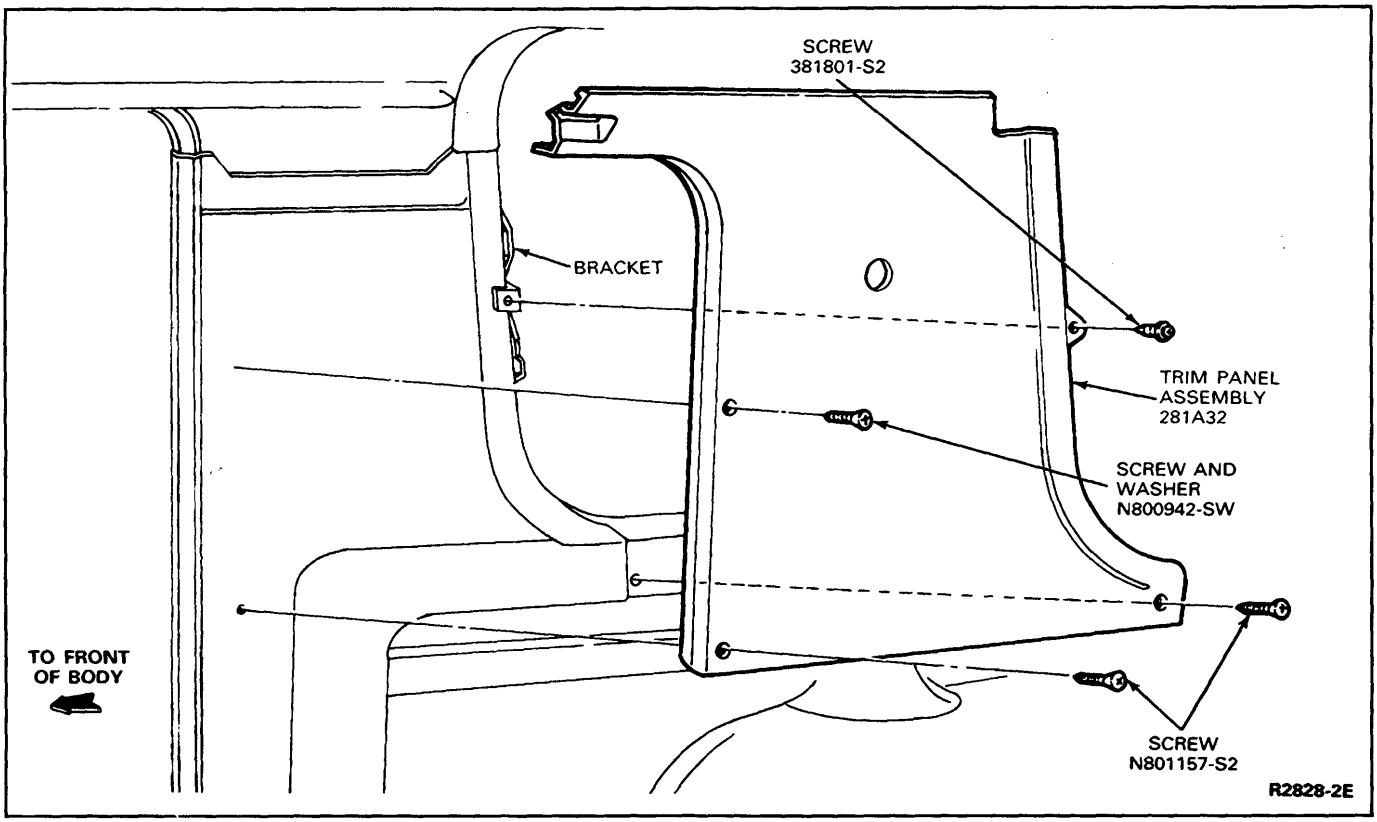


FIG. 21 R.P.O. Bronco Body Trim Panels

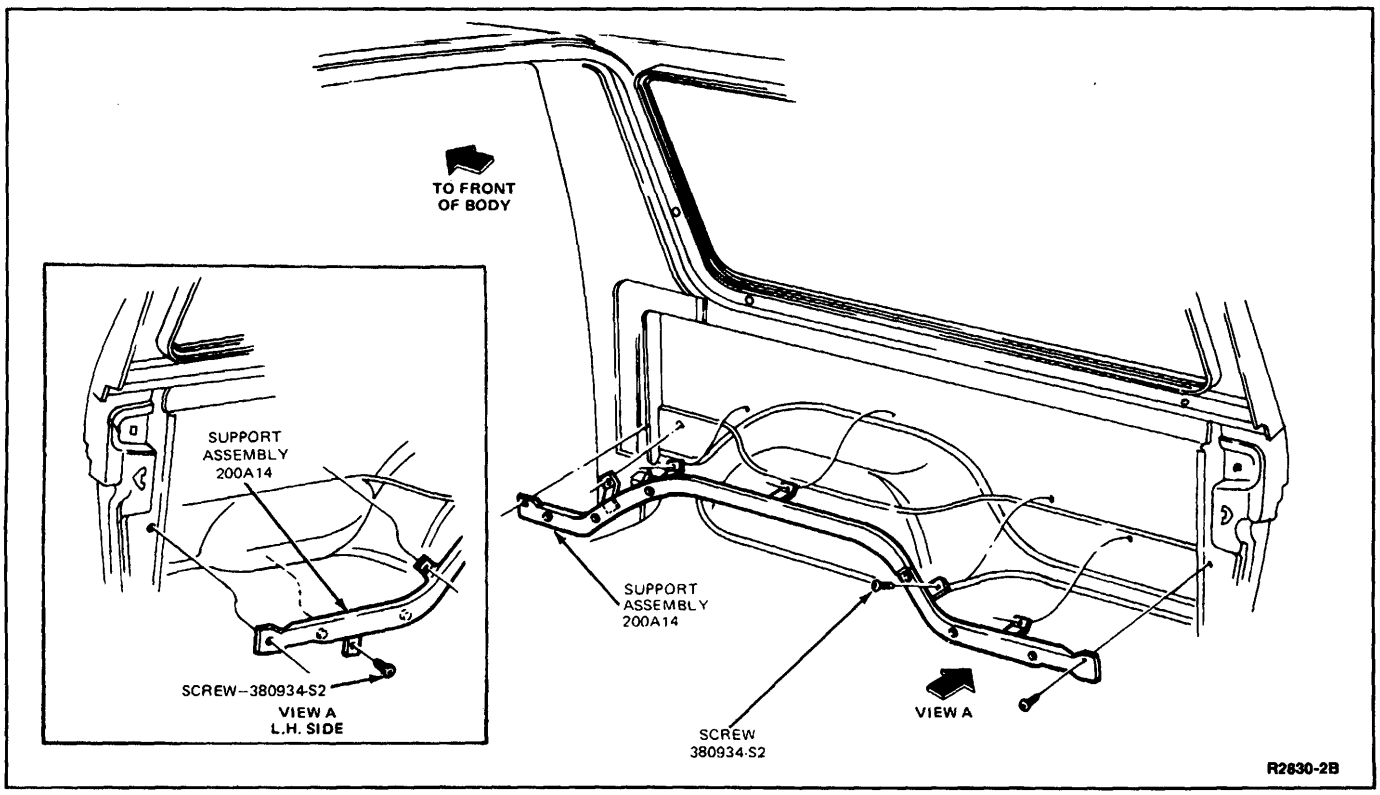


FIG. 22 Bronco Body Side Trim Panel Support

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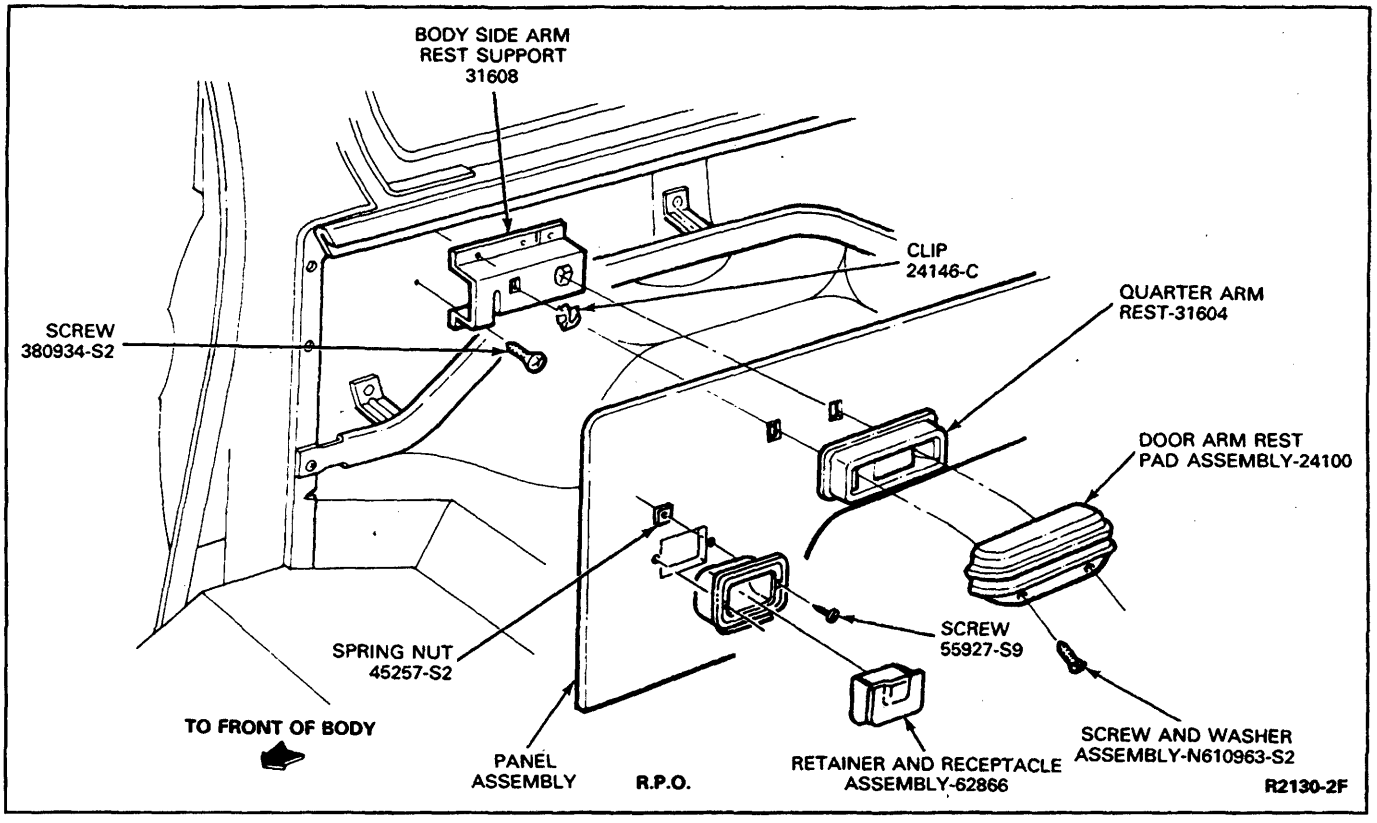


FIG. 23 R.P.O. Body Side Trim Armrest and Ash Receptacle—Bronco

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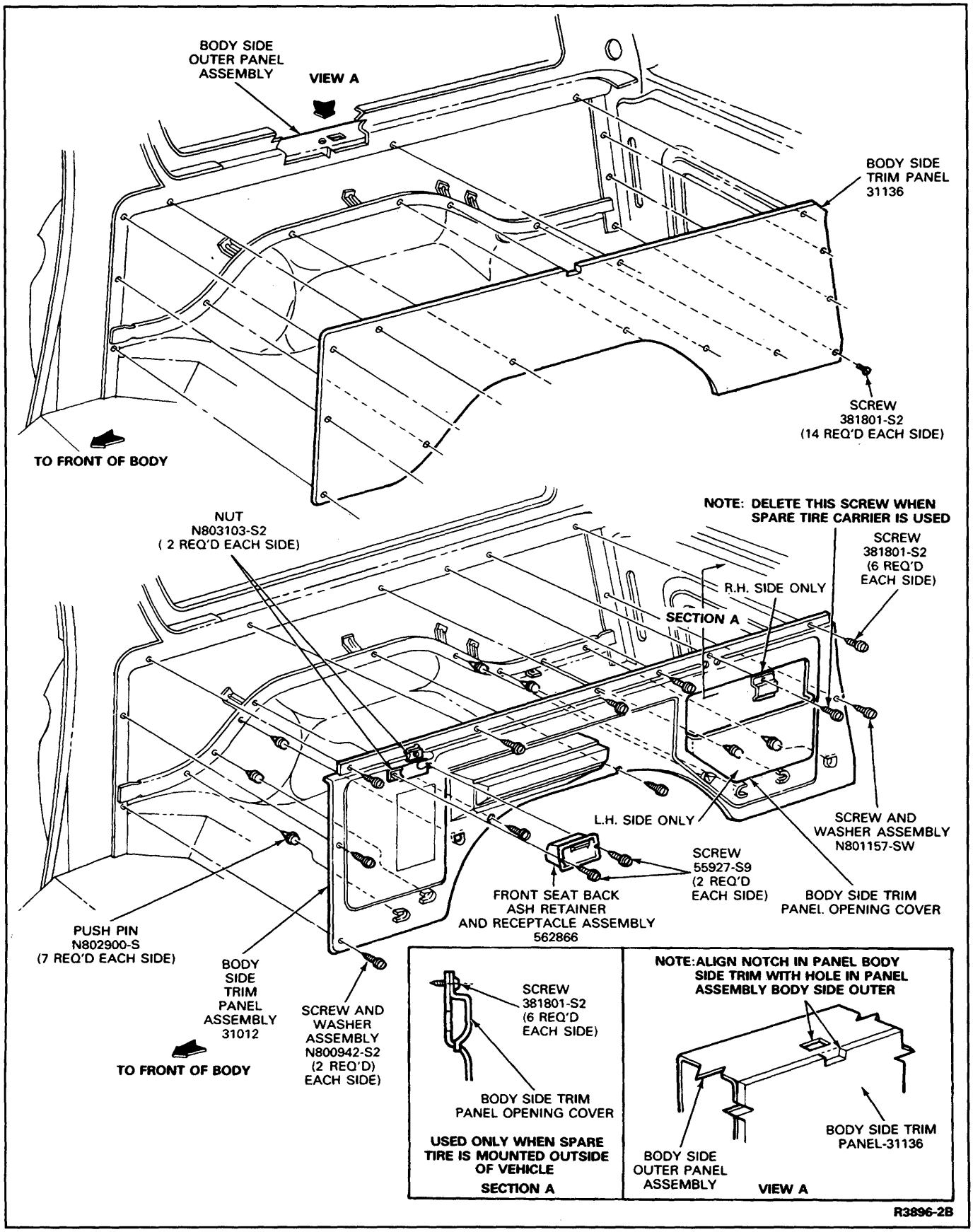


FIG. 24 Body Side Trim Panels—Bronco

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SECTION 45-16 Mouldings

SUBJECT	PAGE	SUBJECT	PAGE
REMOVAL AND INSTALLATION	45-16-1	VEHICLE APPLICATION	45-16-1

VEHICLE APPLICATION

All Models.

REMOVAL AND INSTALLATION

The installation of the plastic and steel interior mouldings are shown in Figs. 1 through 10. In most instances, one moulding overlaps another moulding. If this condition is found, it will be necessary to loosen or remove the overlapping moulding before removal of the desired moulding.

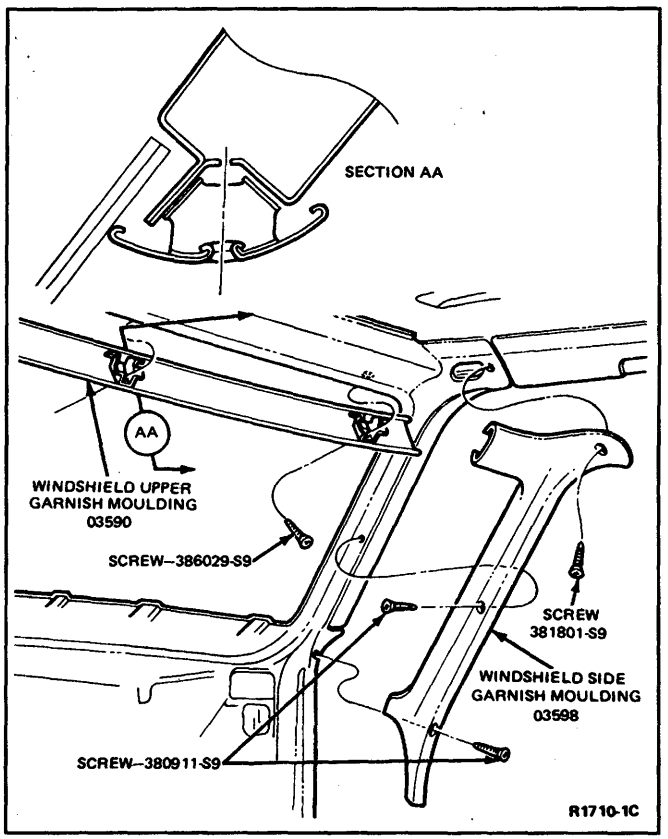


FIG. 1 Interior Plastic Mouldings—E-150 through E-350

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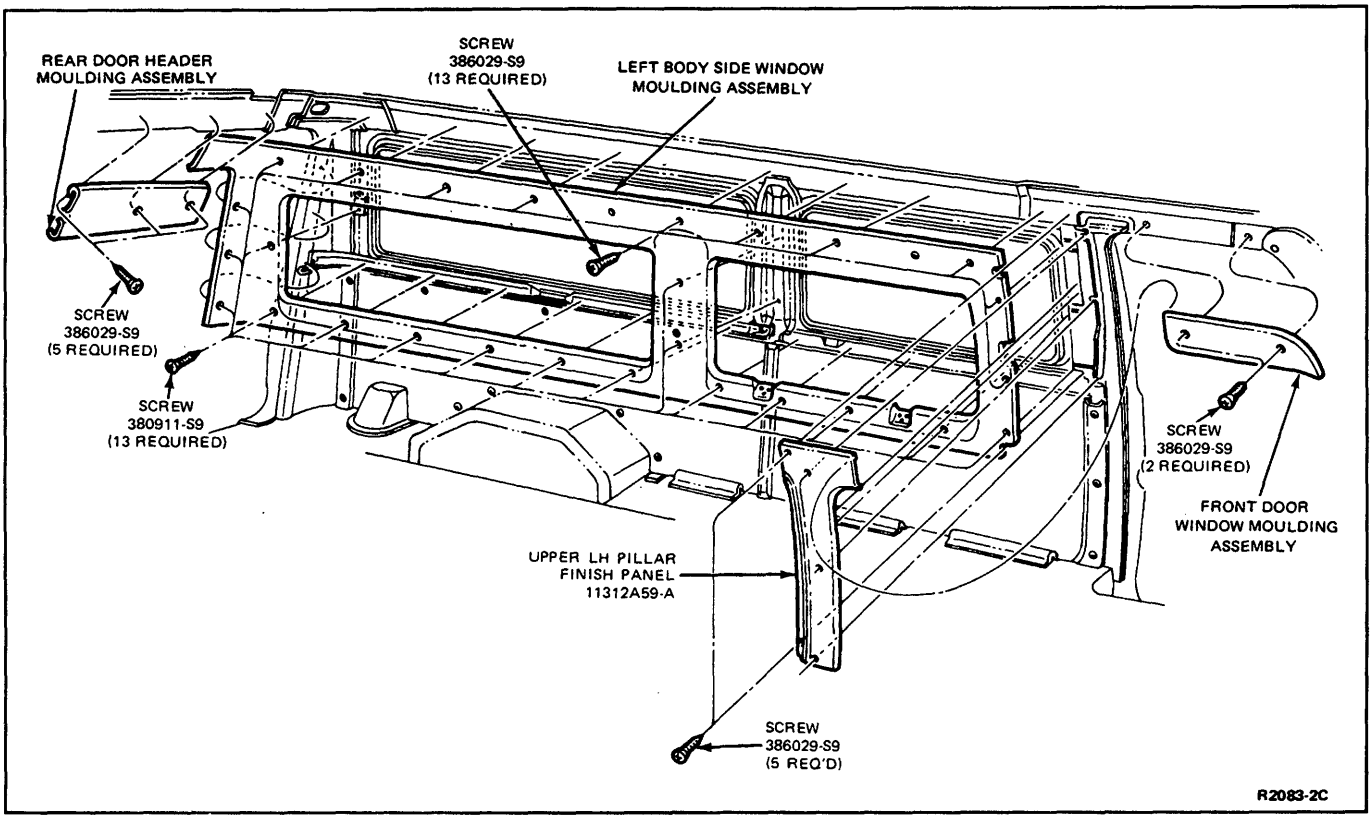


FIG. 2 Left Side Interior Mouldings—138 Inch W.B. Similar—E-150—E-350

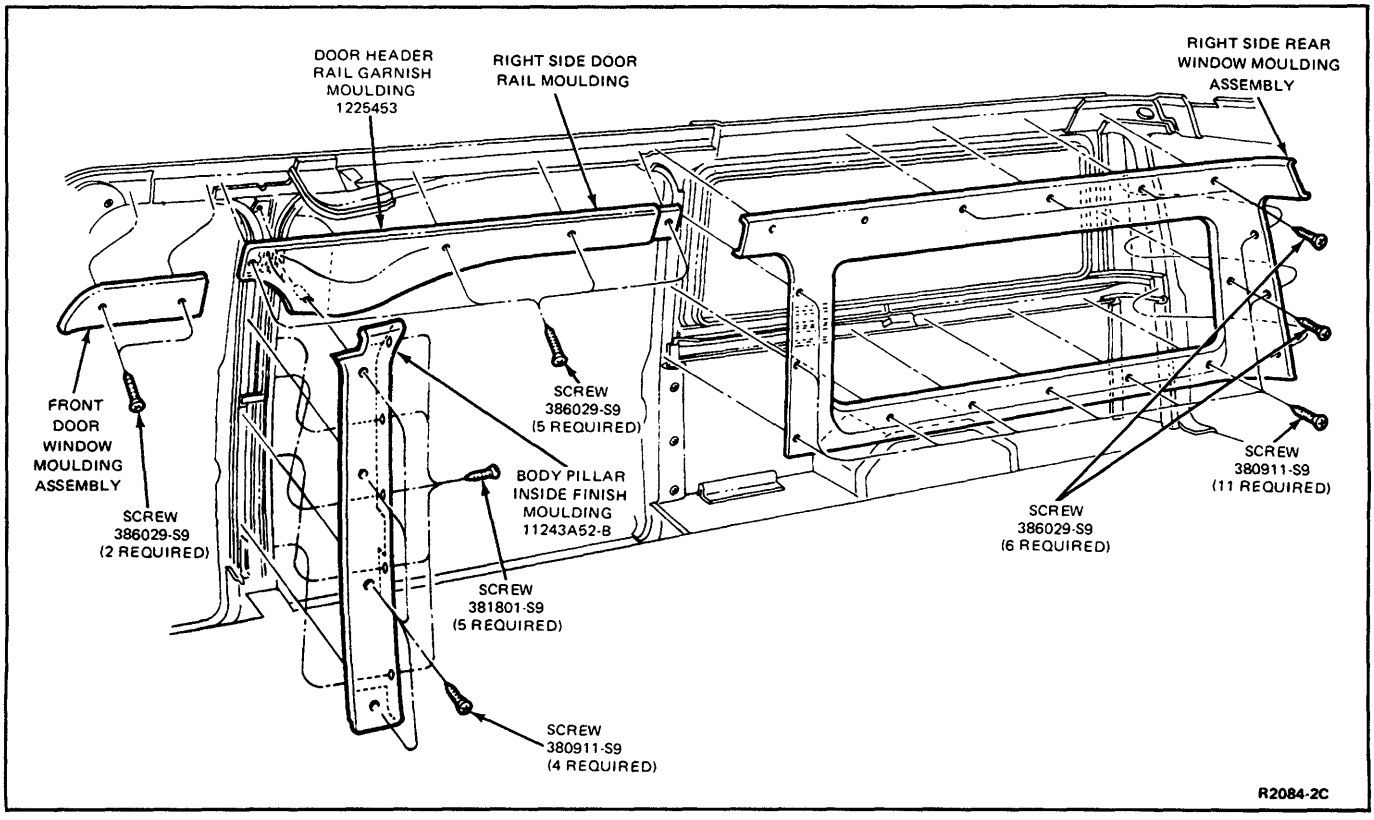


FIG. 3 Right Side Interior Mouldings—138 Inch W.B.—E-150—E-350

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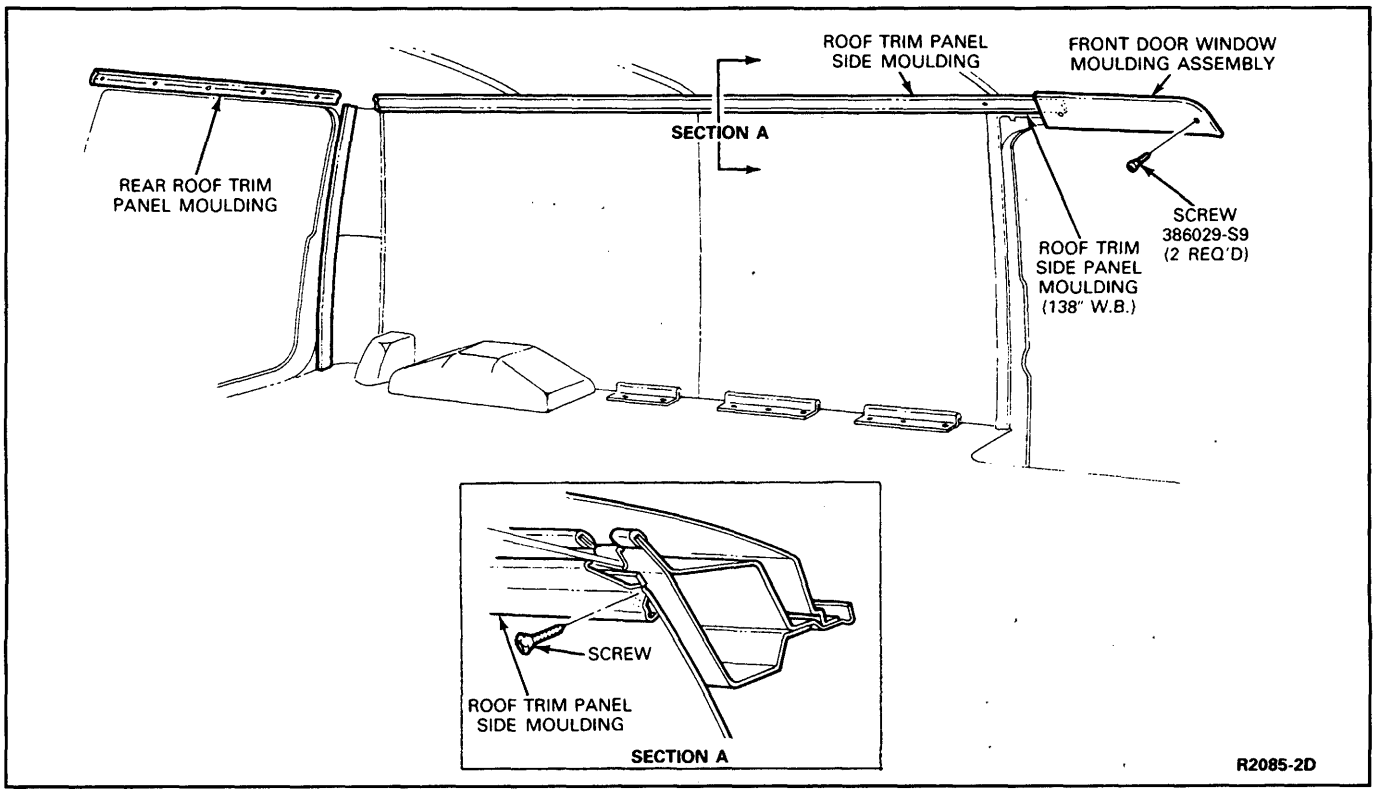


FIG. 4 Right Side Interior Mouldings—Optional 124 and 138 Inch W.B.—Left Side Similar—E-150—E-350

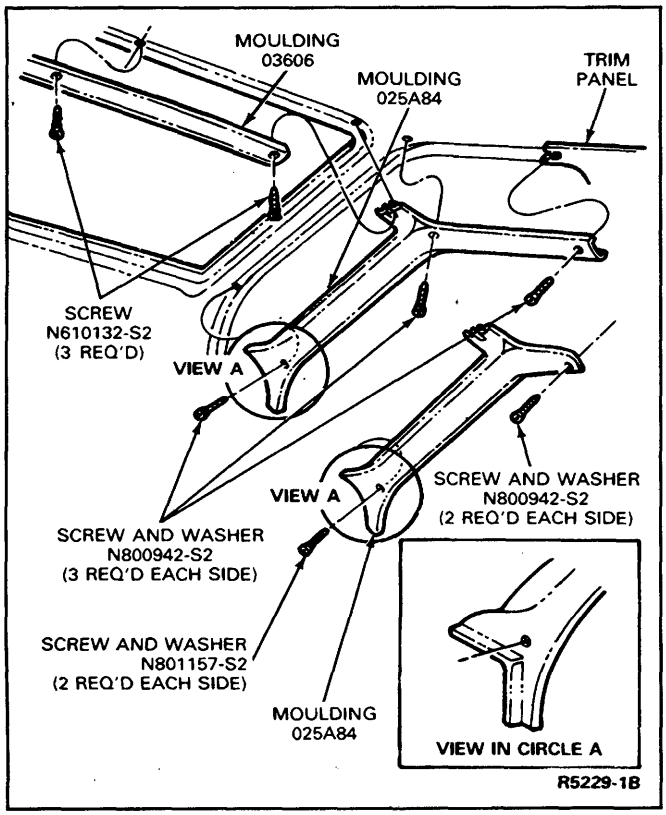


FIG. 5 Window Interior Garnish Mouldings—F-150—F-350, F-350 Crew Cab and Bronco

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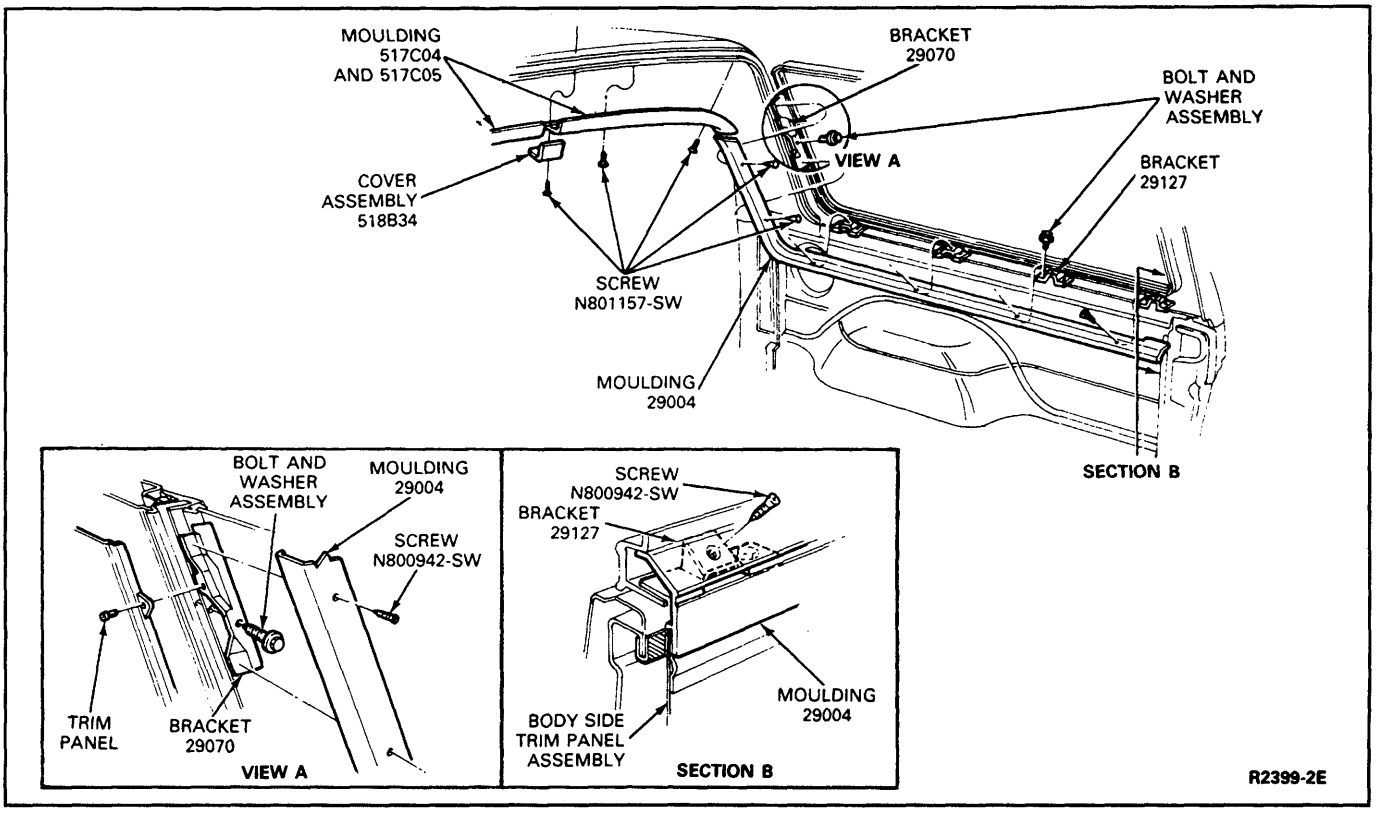


FIG. 6 Body Side and Roof Rear Garnish Mouldings—Bronco

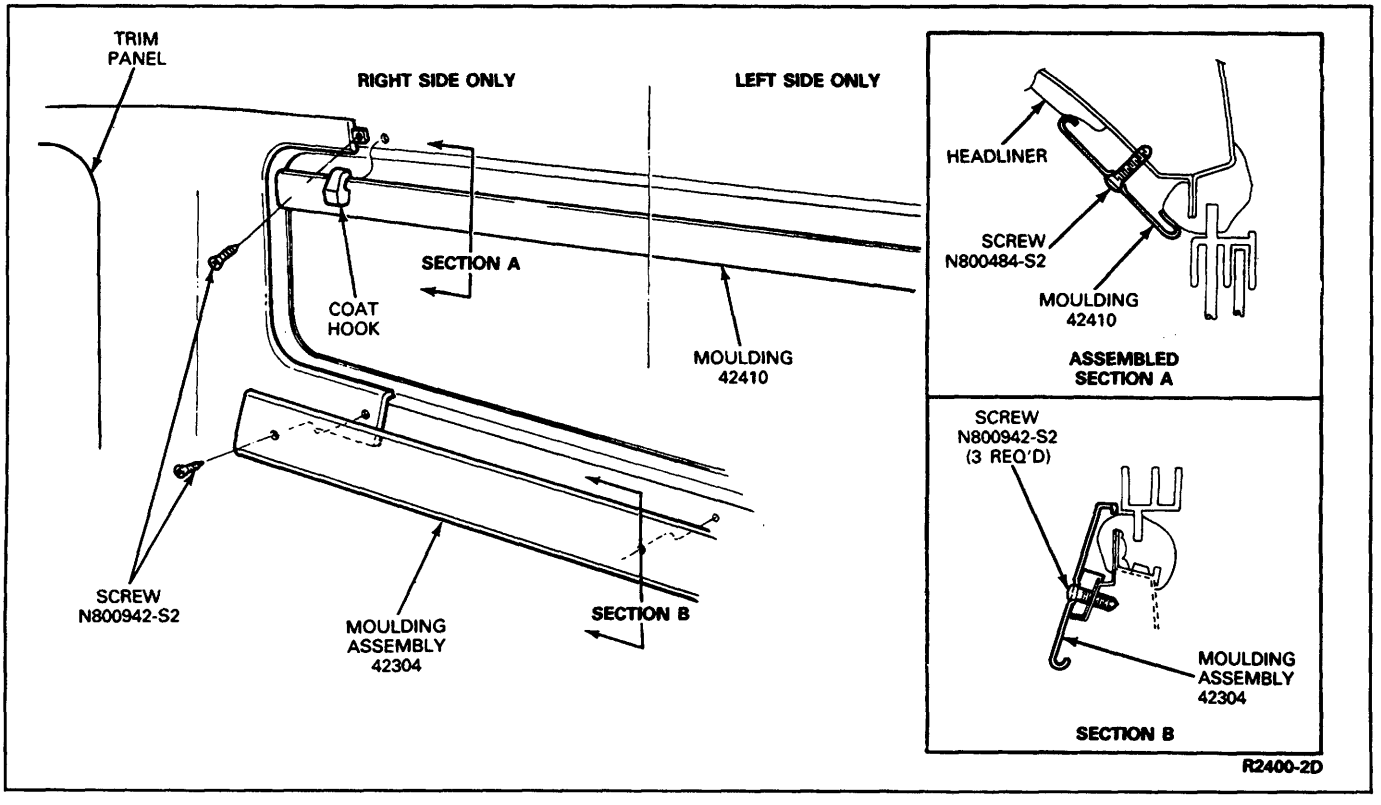


FIG. 7 Back Window Garnish Moulding—Hi Series—F-150—F-350

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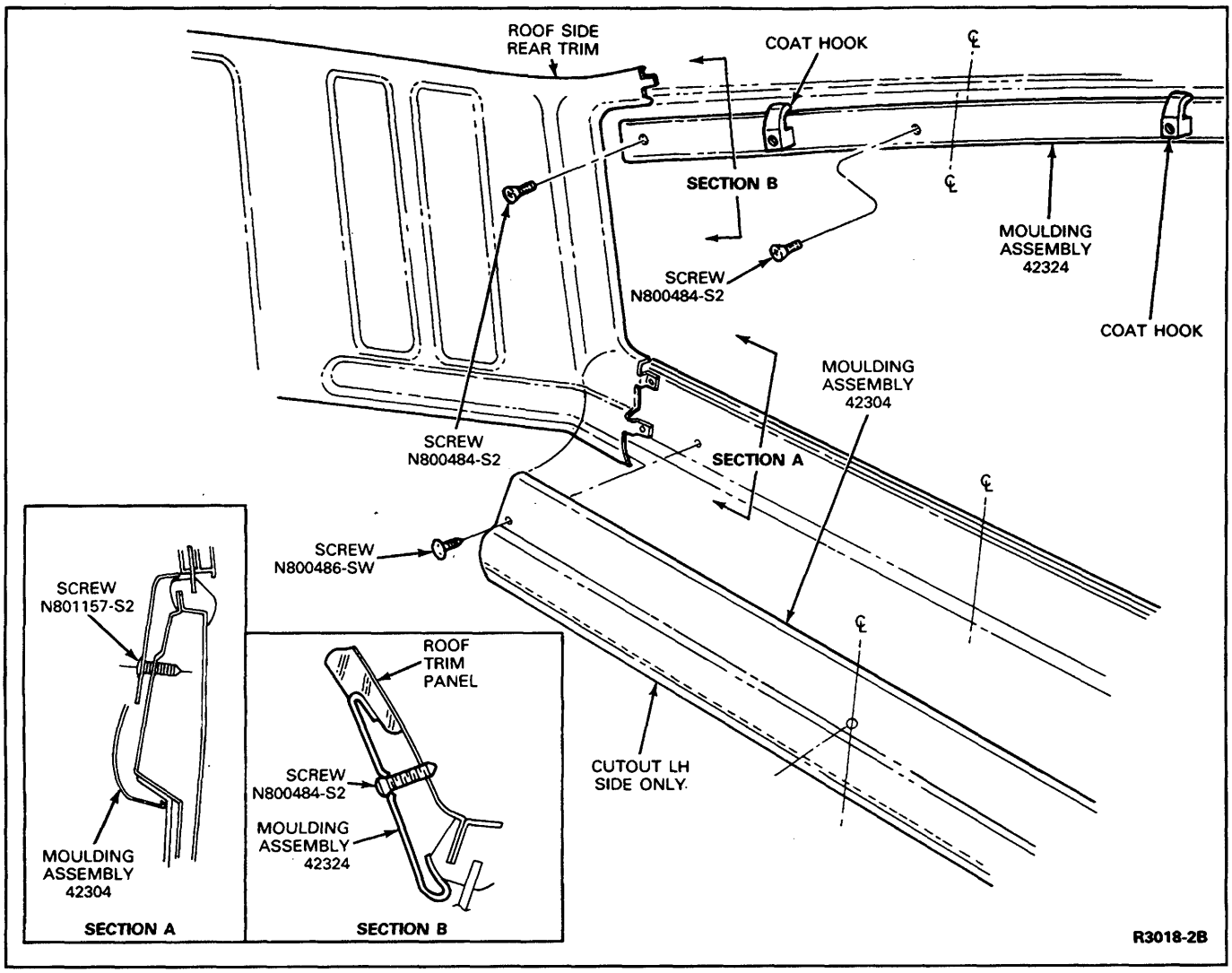


FIG. 8 Back Window Garnish Moulding—Super Cab—F-150—F-350

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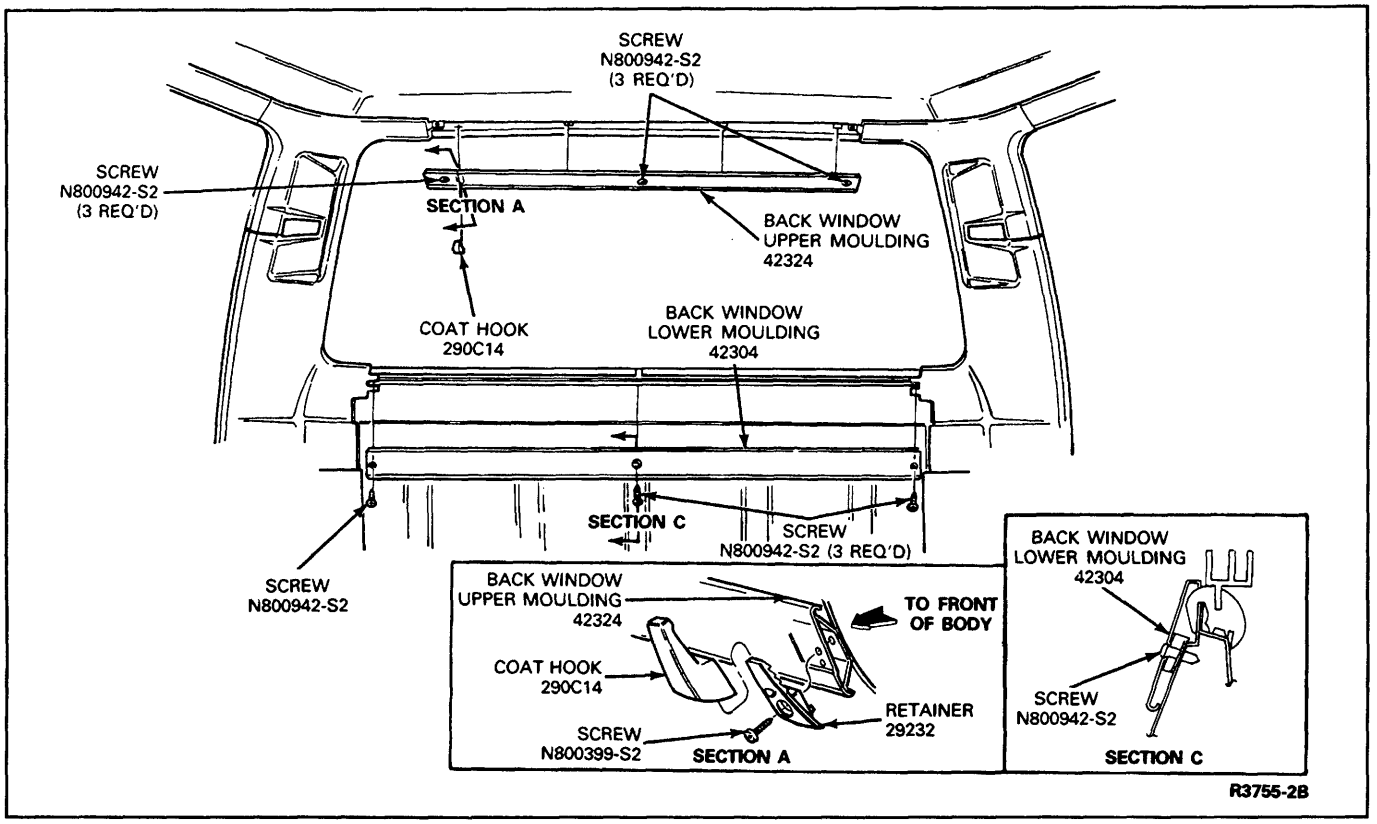


FIG. 9 Back Window Moulding and Coat Hook—F-350 Crew Cab

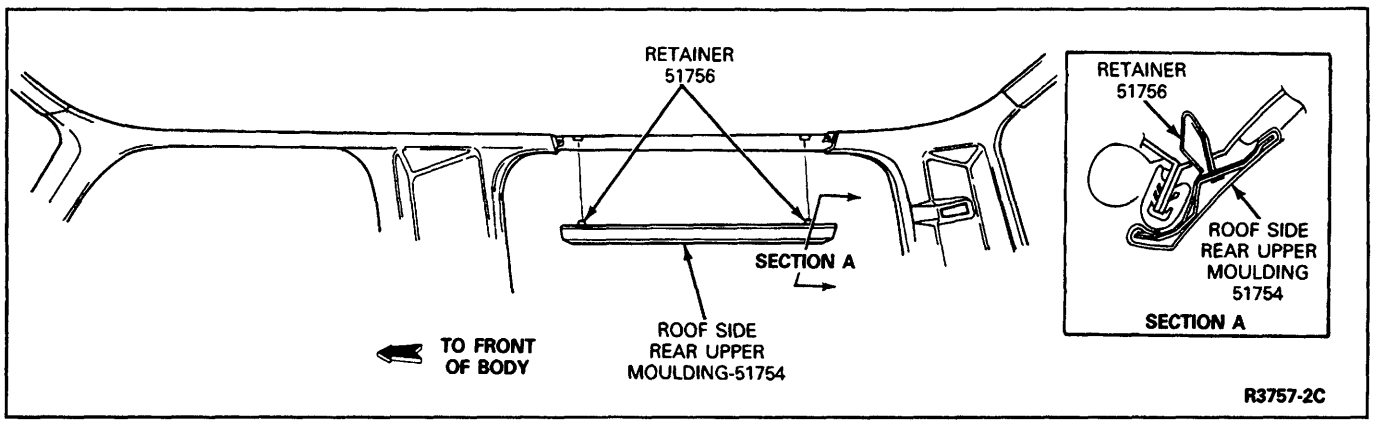


FIG. 10 Roof Side Moulding—F-350 Crew Cab

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SECTION 45-26 Carpets and Floor Mats

SUBJECT	PAGE
CLEANING AND INSPECTION	
Dirt, Dry Soil, Food, Pop and Coffee	45-26-2
General Stain Cleaning	45-26-2
Spot Cleaning Stains	45-26-2
REMOVAL AND INSTALLATION	
Floor Carpet/Mat	45-26-1
VEHICLE APPLICATION	45-26-1

VEHICLE APPLICATION

All Light Truck Models.

REMOVAL AND INSTALLATION

Floor Carpet/Mat

Removal

E-150—E-350, F-150—F-350 and Bronco

1. Remove the seat(s). Refer to Section 41-01, Front Seats.
2. Grasp the carpet or mat surrounding edge beneath the convoluted floor shifter boot and pull it outward and upward away from the boot (Fig. 1).
3. Remove the floor console. Refer to Section 45-31, Console Assembly.
4. Remove the screws retaining the RH and LH cowl side trim panels (Fig. 2).
5. Remove all carpet or mat retaining screws (Figs. 3 through 7).
6. Remove the screws retaining the RH and LH door sill scuff plates and remove the scuff plates (Figs. 8 and 9). Remove cowl side trim panels.
7. Remove the carpet or mat.

Installation

1. Using the old carpet as a template, cut the hole for the shifter, if required.
2. Position carpet or mat to vehicle (Figs. 3 through 7).
3. Position cowl side trim panels (RH and LH) and install screws to secure (Fig. 2).
4. Position RH and LH door sill scuff plates to vehicle. Install screws to secure (Figs. 8 and 9).
5. Install all carpet or mat retaining screws.
6. Install the console. Refer to Section 45-31, Console Assembly.

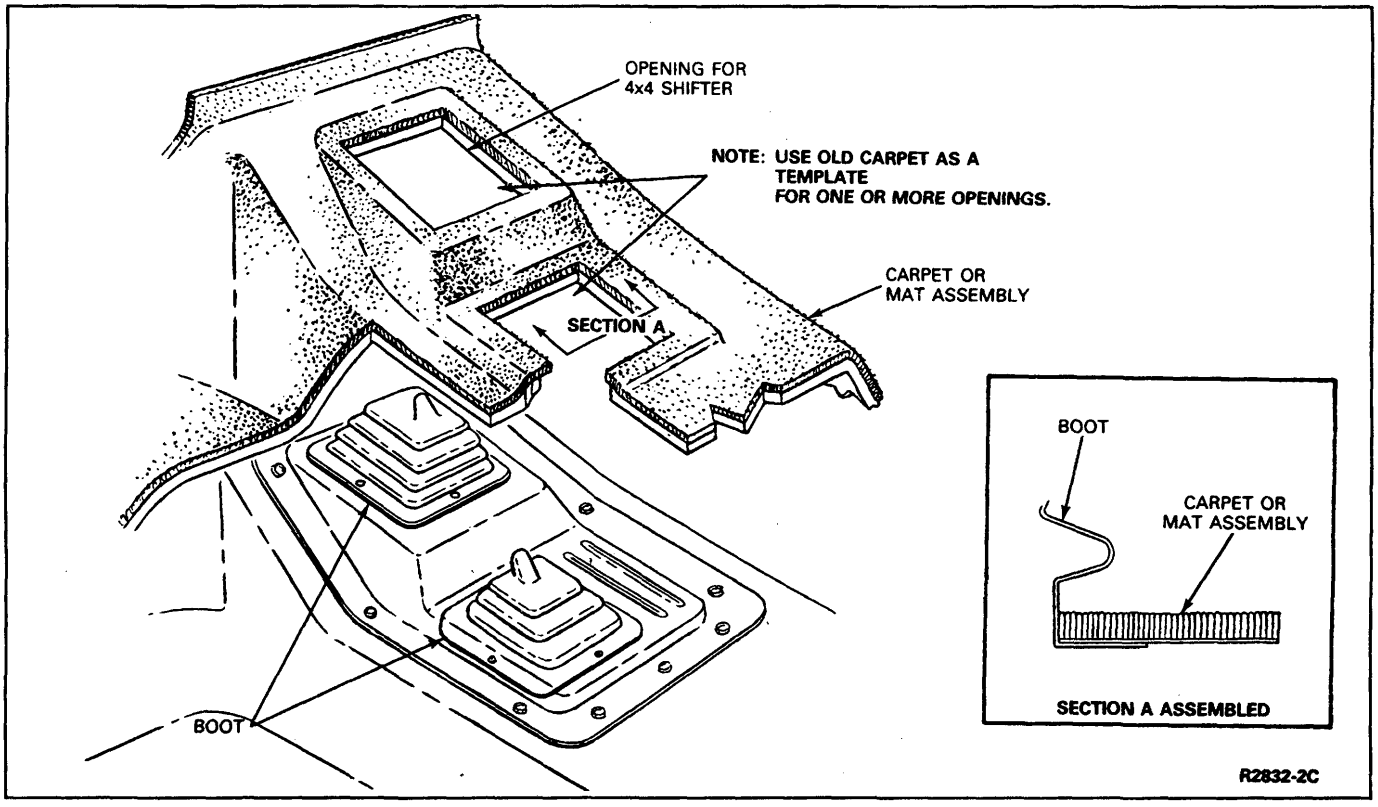


FIG. 1 Floor Carpet Center Retainers—F-150—F-350 and Bronco

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7. Install carpet or mat under floor shifter boot (Fig. 1, View A).
8. Install the seats. Refer to Section 41-01, Front Seats.

Floor Carpet/Mat

Removal and Installation

E-150—E-350

1. Remove the seat(s). Refer to Section 41-01, Front Seats.
2. Remove the floor shifter carpet retainer (Fig. 10).
3. Repeat E-150—E-350, F-150—F-350 and Bronco Removal Steps 4 through 7 (Figs. 11 through 19).
4. To install, reverse Steps 1, 2 and 3.

CLEANING AND INSPECTION

The following procedure is recommended for the removal of spots and stains encountered in service. It is important that proper cleaning techniques and cleaning agents be used to prevent the stain setting of affecting the color and/or flame resistant properties of the fabric.

1. Remove excess staining material from fabric by scraping or wiping with a clean cloth.
2. Identify the staining material if possible.
3. Clean the fabric as outlined in the following Steps.

Spot Cleaning Stains

Grease, Oil, Tar, Water Spots, Crayon and Lipstick

1. Spray stain with Spot Lifter C9AZ-19526-A or equivalent from a distance of 204-254 N·m (8-10 inches) as directed per the instructions furnished with the can.
2. Allow the Spot Lifter to dry completely forming a white powder on the surface of the fabric.
3. Brush and vacuum the white powder from the surface of the fabric.
4. If the soiled spot is not removed from the fabric, repeat Steps 1, 2 and 3 as necessary.

General Stain Cleaning

Grease, Oil, Tar, Adhesive, Crayon and Lipstick

1. If the stain is still visible after the spot cleaning procedure, blot the soiled area with a clean cotton cloth saturated with the trichloroethane Spot Remover (Part No. B7A-19521-A) or equivalent.
2. Rub in a circular motion while continuously exposing clean portion of cloth.
3. Gradually widen area of application onto edges of design, pleat, or biscuit.
4. Repeat Steps No. 1, 2 and 3 as necessary.
5. Wipe cleaned area with clean damp cloth to remove any residual cleaner.

Dirt, Dry Soil, Food, Pop and Coffee

1. Apply Rosenthal's 8 to 1 Shampoo, or Bissell's Upholstery Shampoo for Home and Auto, or an equivalent with a clean brush or sponge as directed on the instructions furnished with the container.
2. Rub in a circular manner until stain is removed.
3. Gradually widen area of application to edges of design, pleat, or biscuit.
4. Repeat Steps 1, 2 and 3 as necessary.
5. Rub cleaned area with a damp cloth to absorb residual cleaner.
6. Allow to dry at room temperature.

NOTE: Spot cleaning as described under Spot Cleaning Stains above will be sufficient on fabrics which are not excessively soiled. However, to maintain a uniform appearance of the seat material in the event of severe soil and stain, the entire seat or insert will have to be cleaned to prevent a "ring" condition.

It is advisable to clean all fabric material immediately upon detection of soilage.

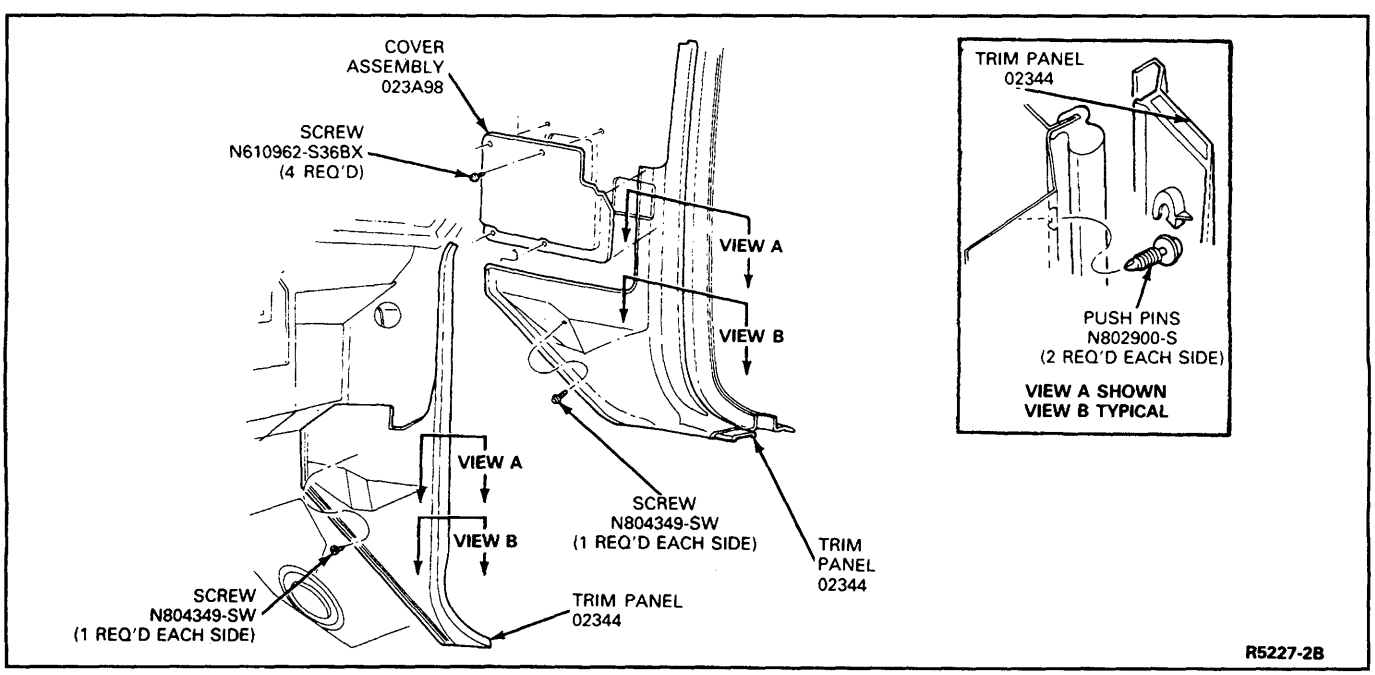


FIG. 2 Cowl Side Trim Panels—F-150—F-350 and Bronco

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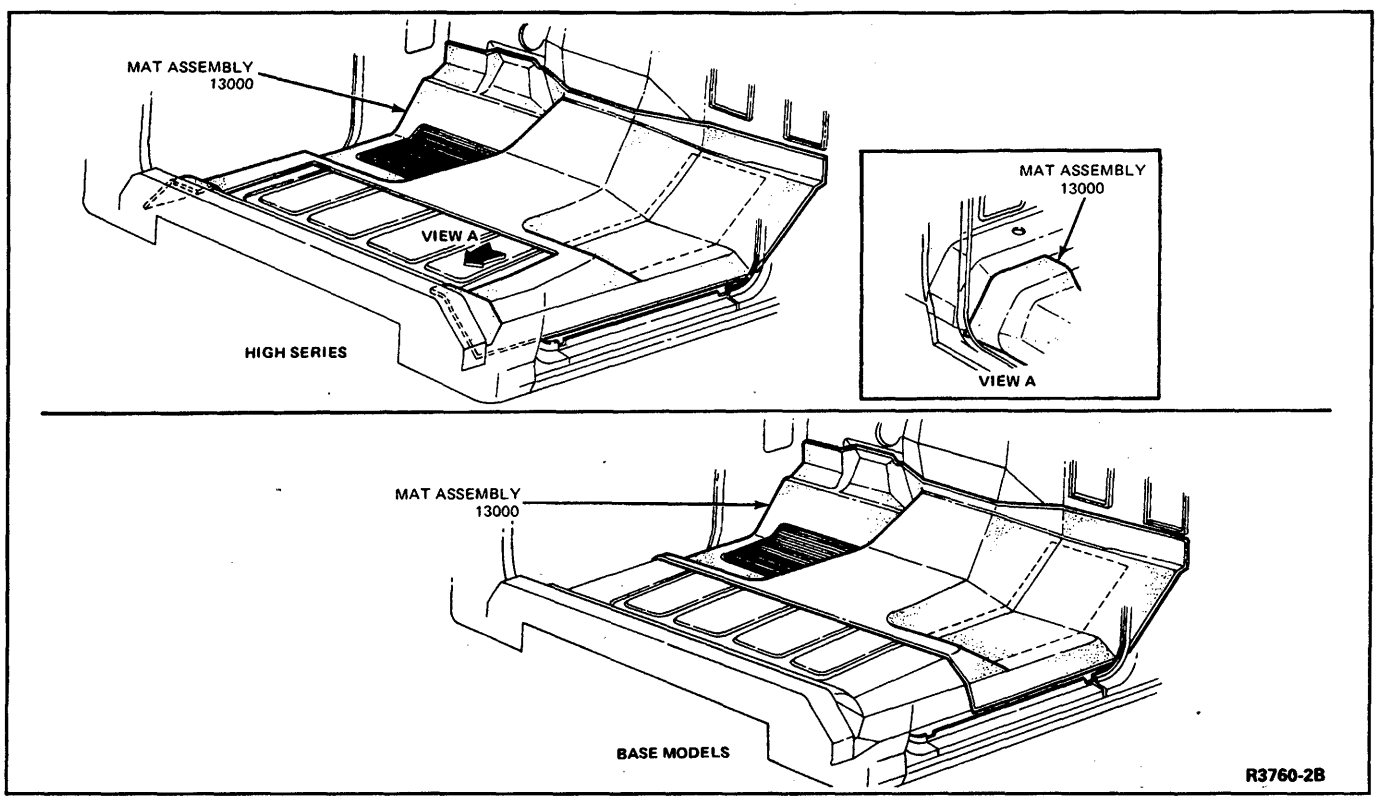


FIG. 3 Floor Mats—F-150—F-350 Regular Cab

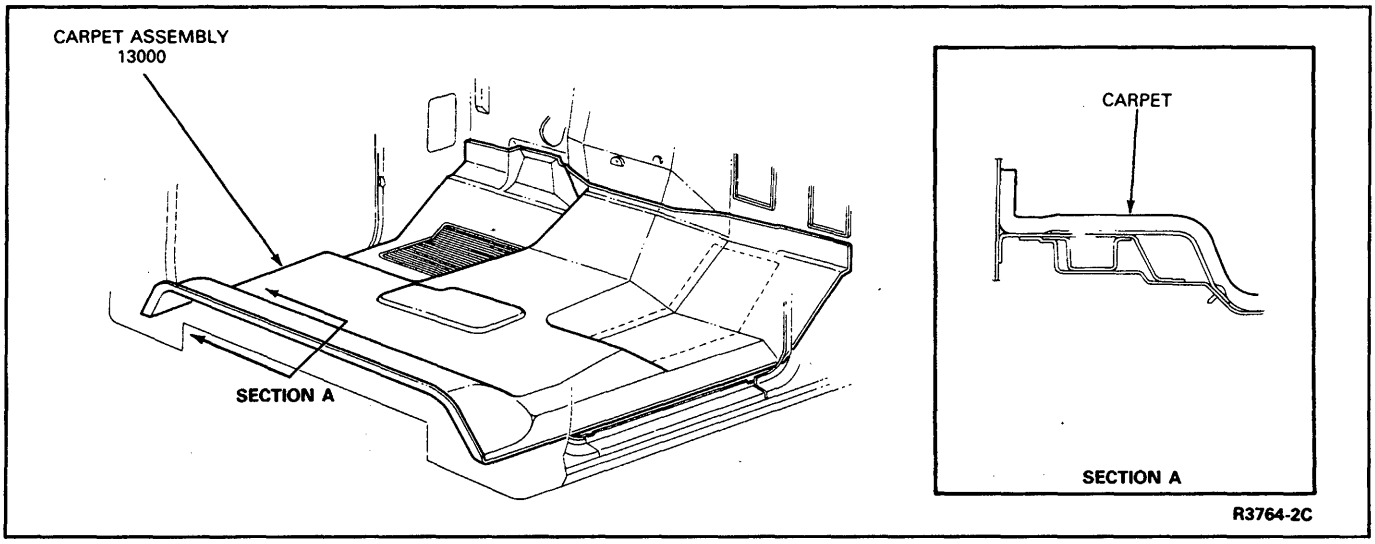


FIG. 4 Floor Carpet—F-150—F-350 Regular Cab

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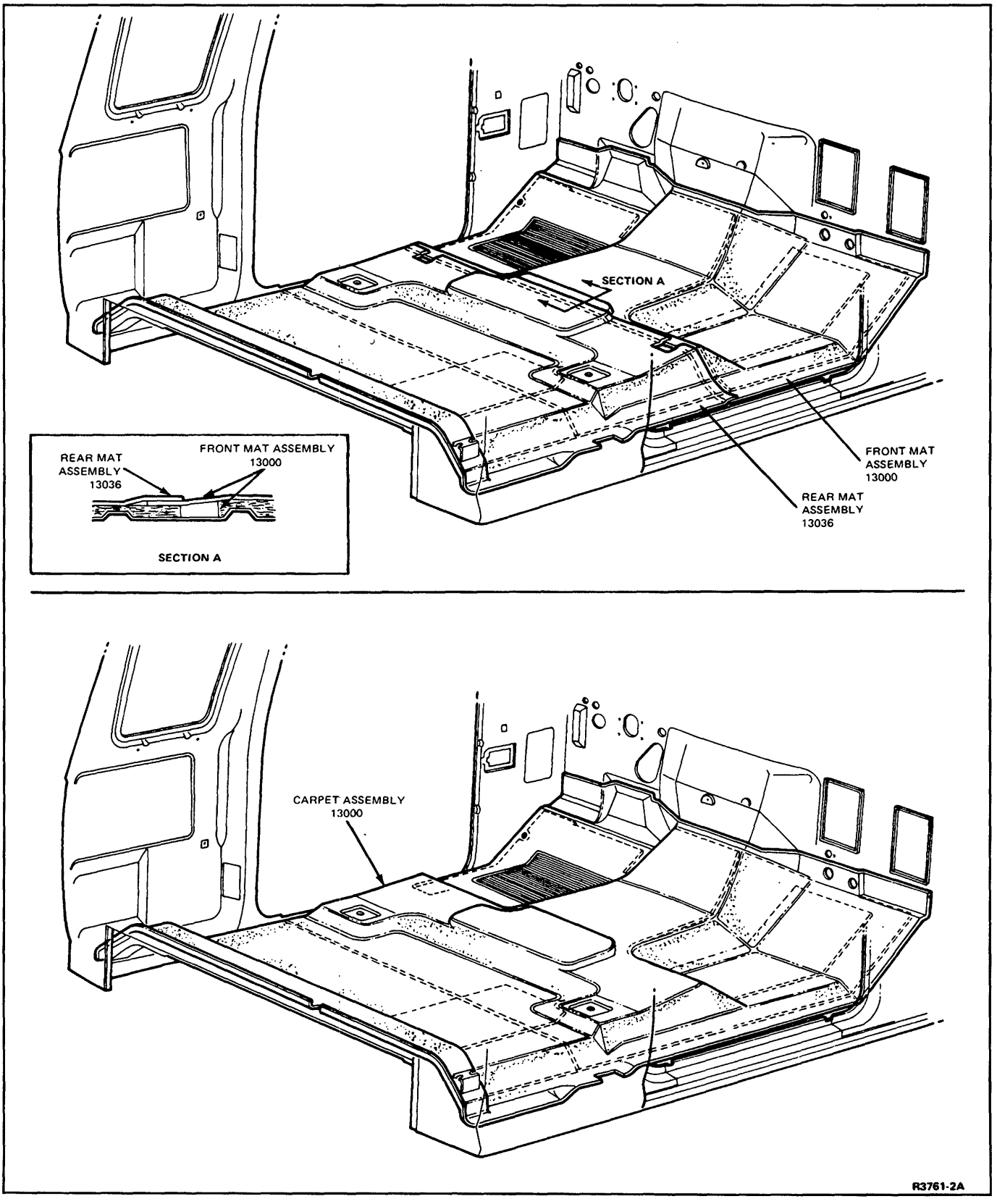


FIG. 5 Floor Mat and Carpet—F-Series Super Cab

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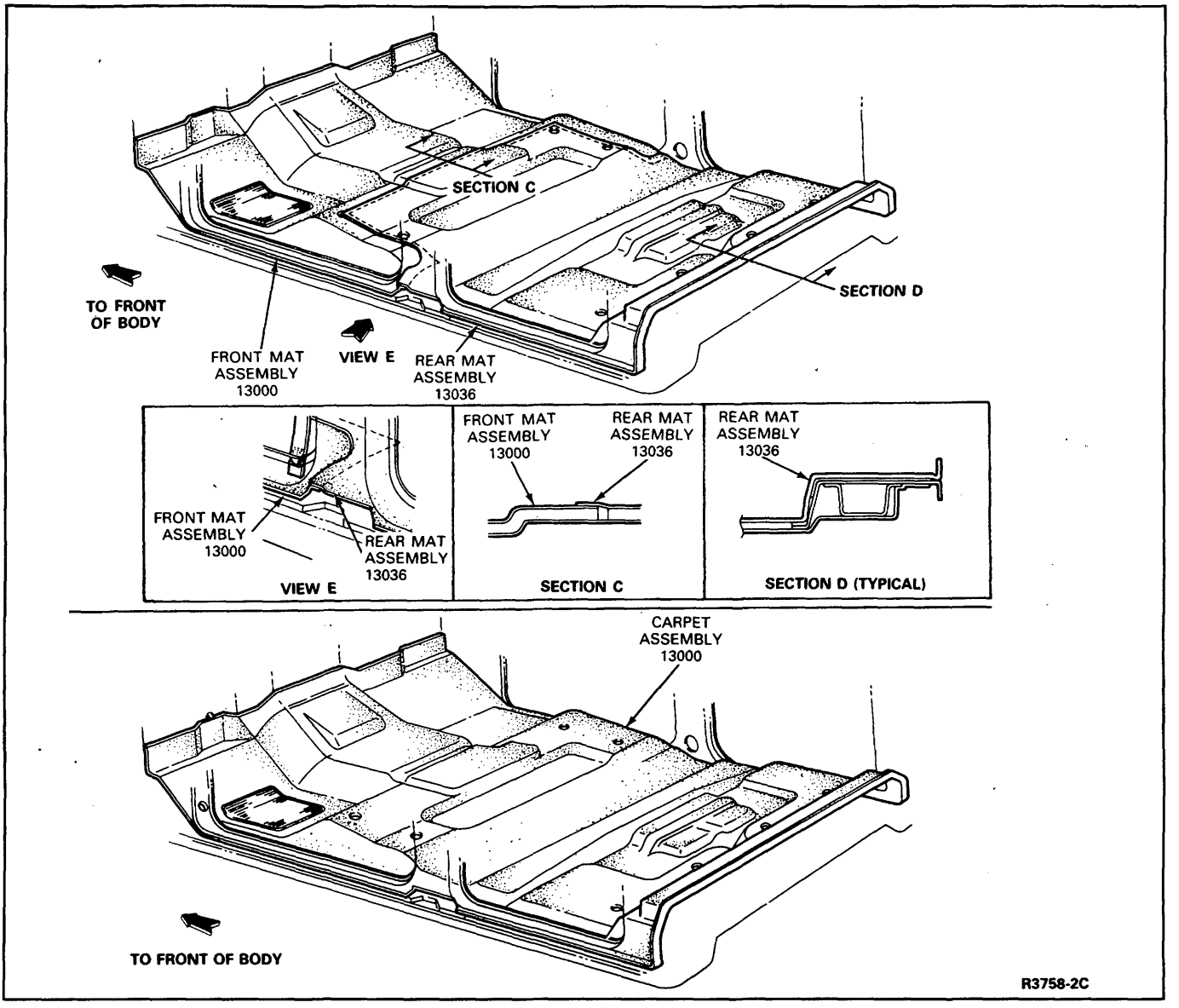


FIG. 6 Floor Mat and Carpet—F-350 Crew Cab

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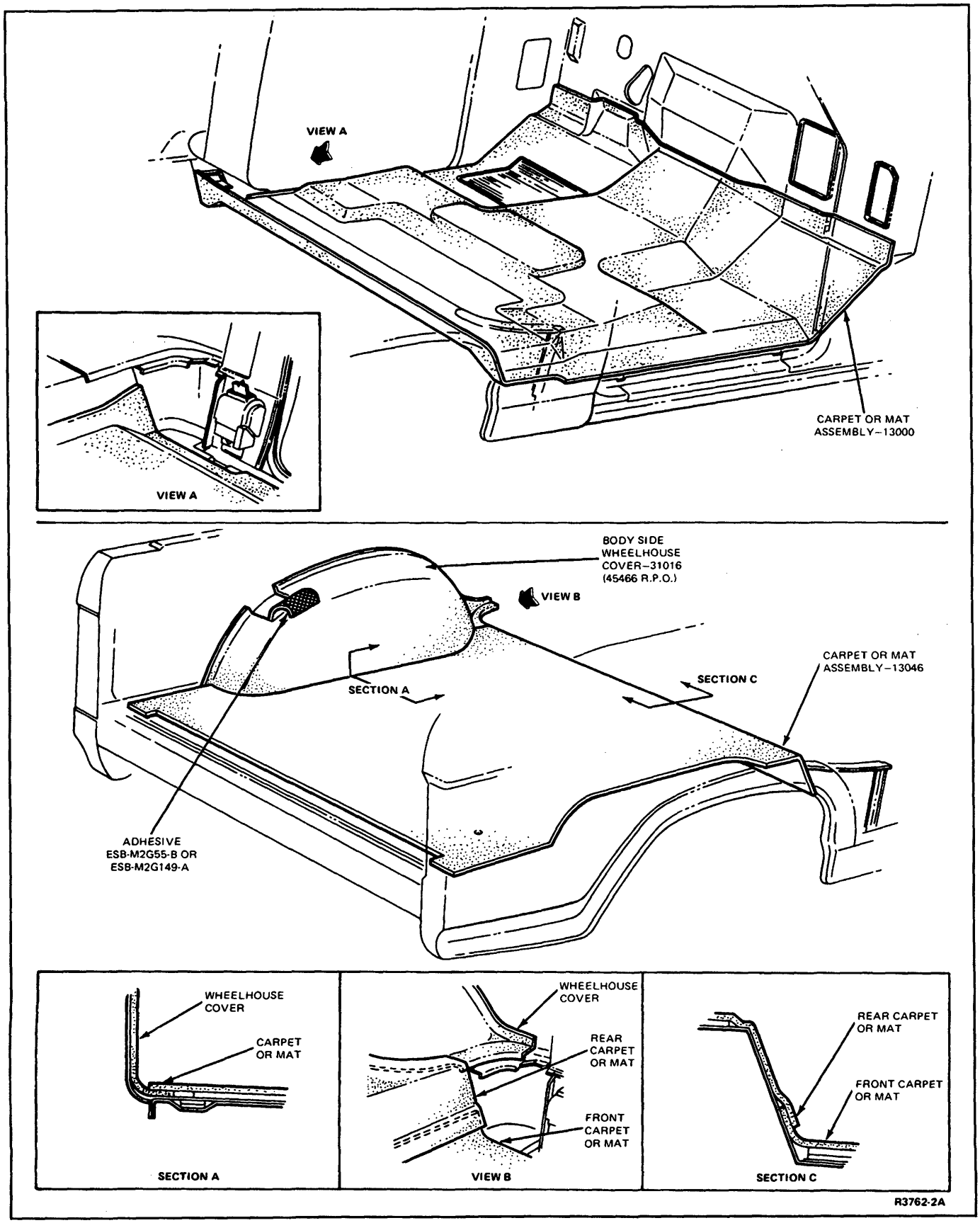


FIG. 7 Floor Mat and Carpet—Bronco

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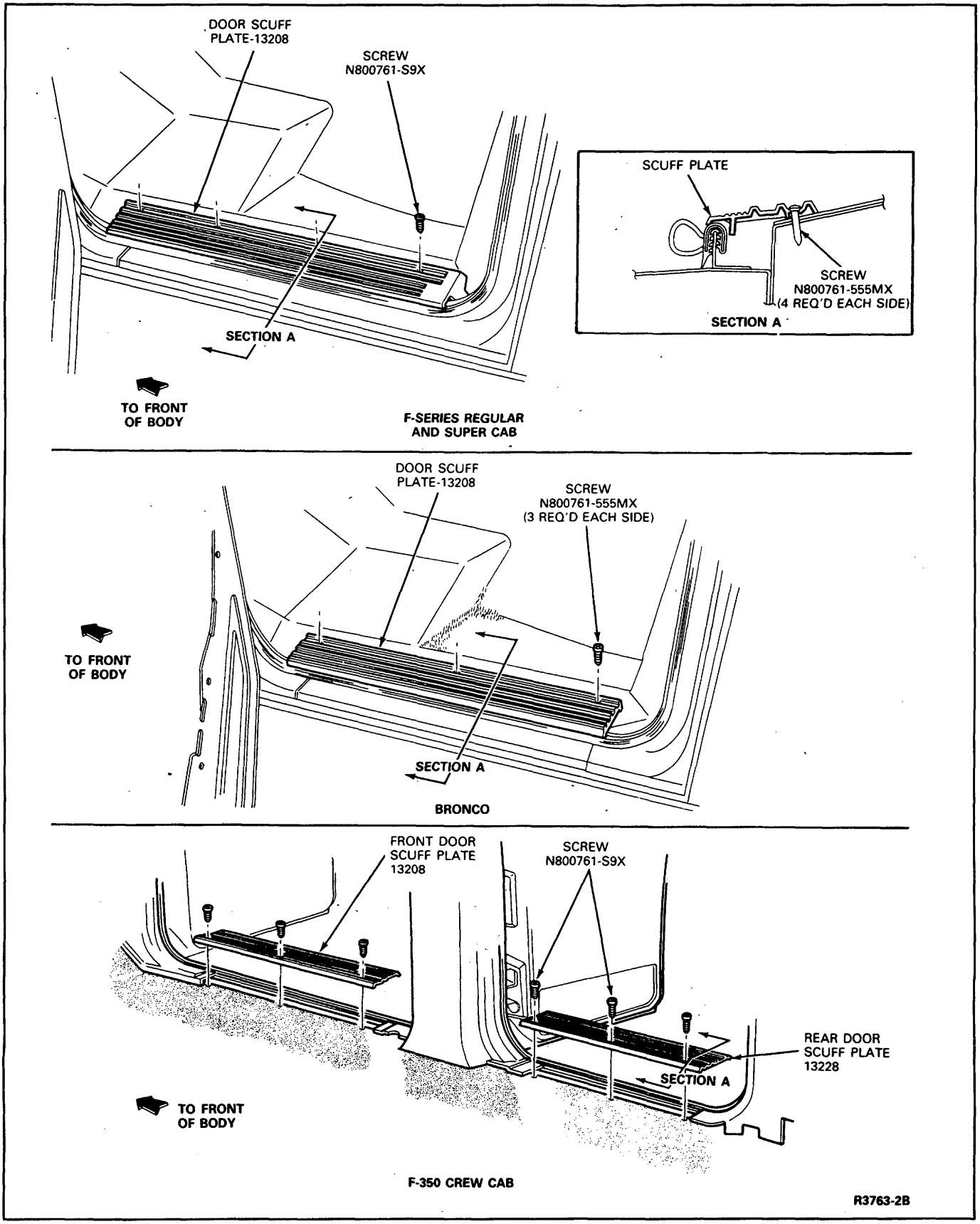


FIG. 8 Door Scuff Plates—F-150—F-350 and Bronco

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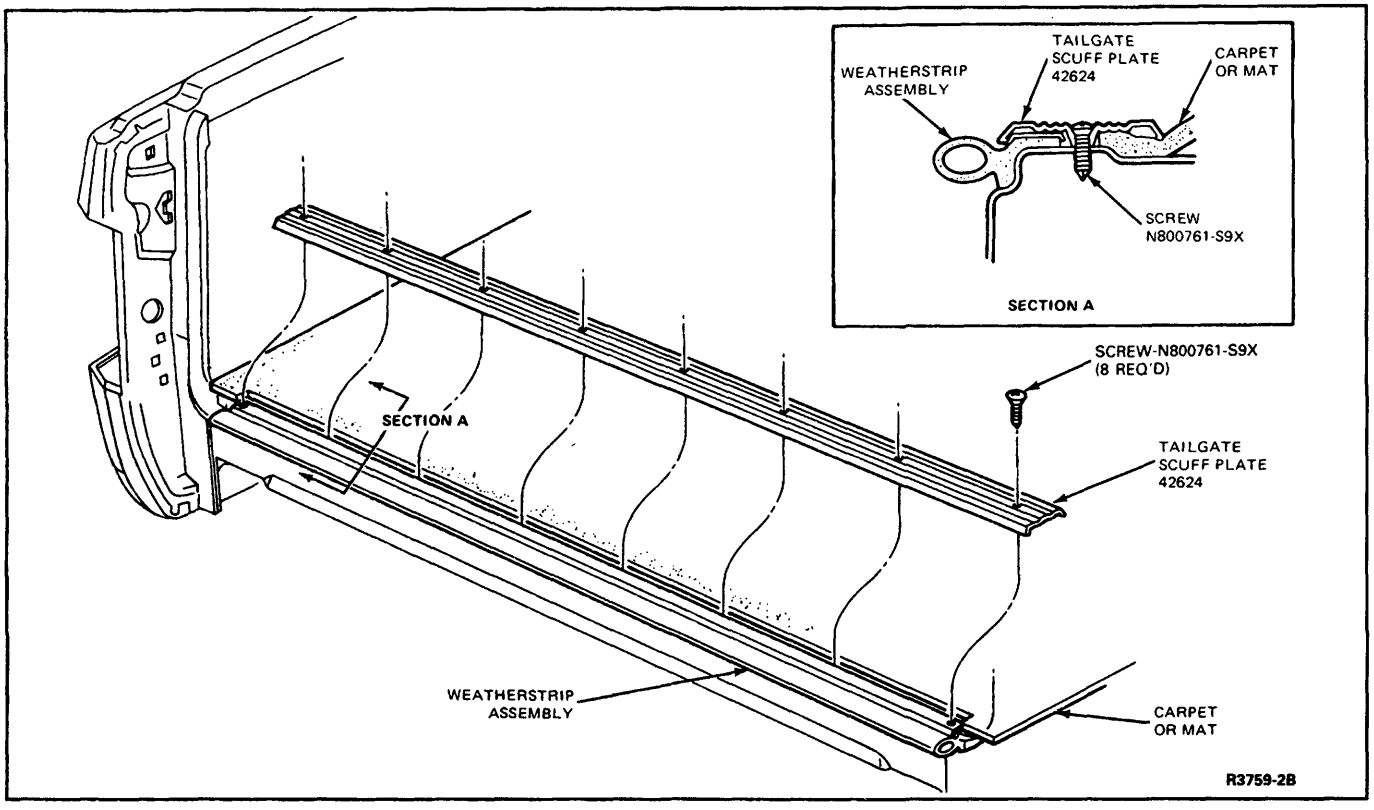


FIG. 9 Tailgate Scuff Plate—Bronco

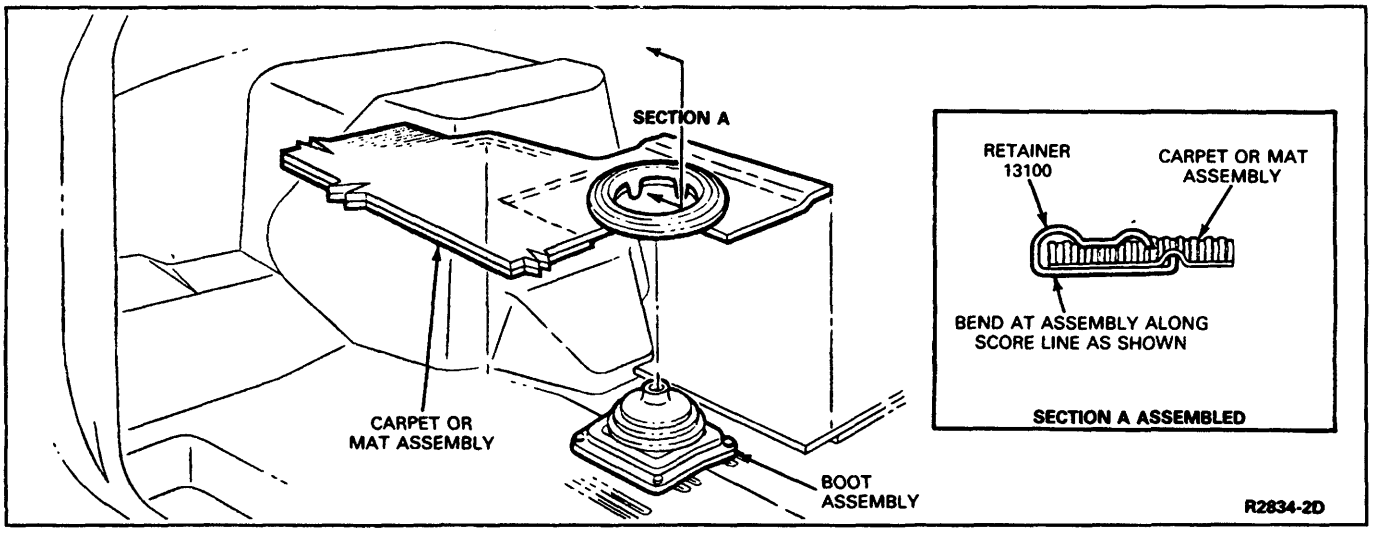


FIG. 10 Floor Carpet Center Retainers—E-150—E-350

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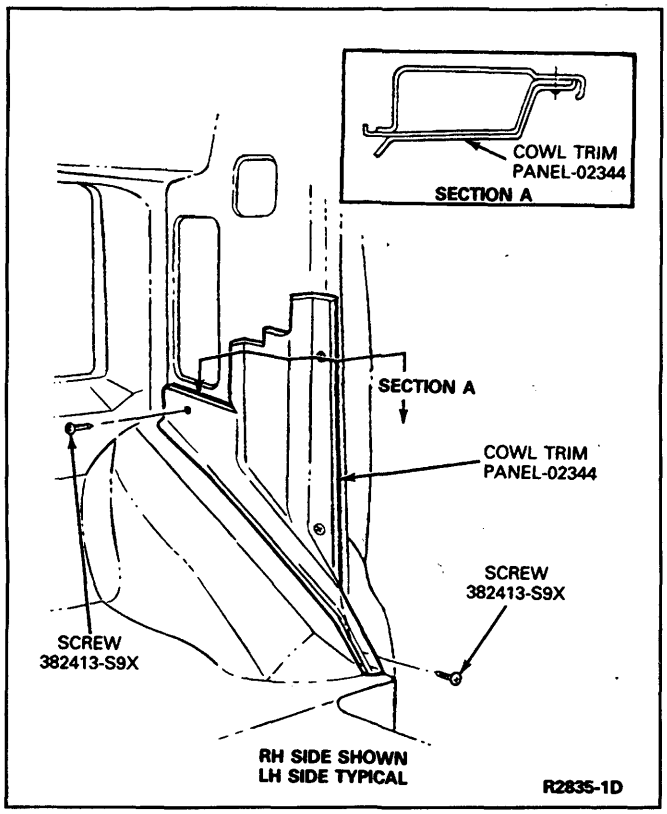


FIG. 11 Cowl Side Trim Panels—E-150—E-350

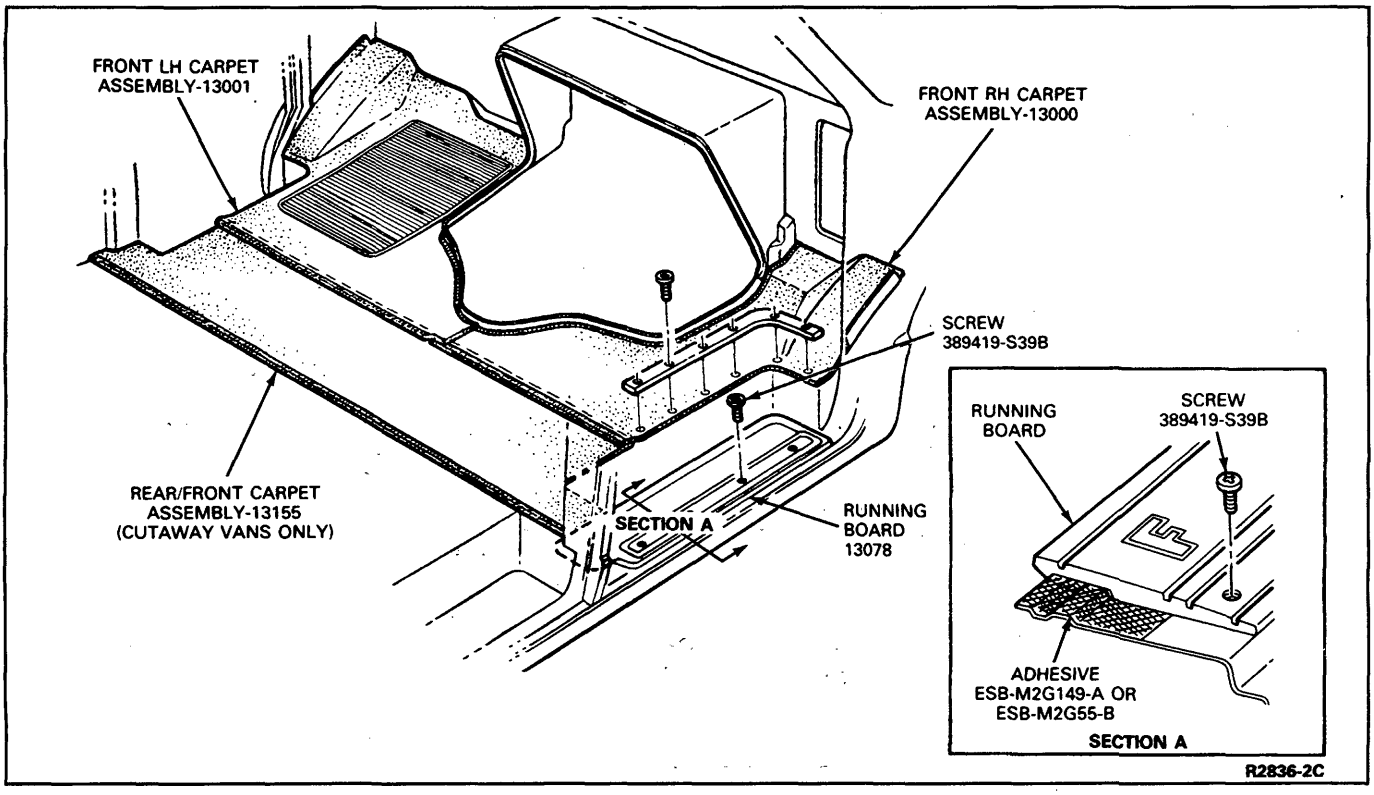


FIG. 12 Front Floor Carpets—E-150—E-350

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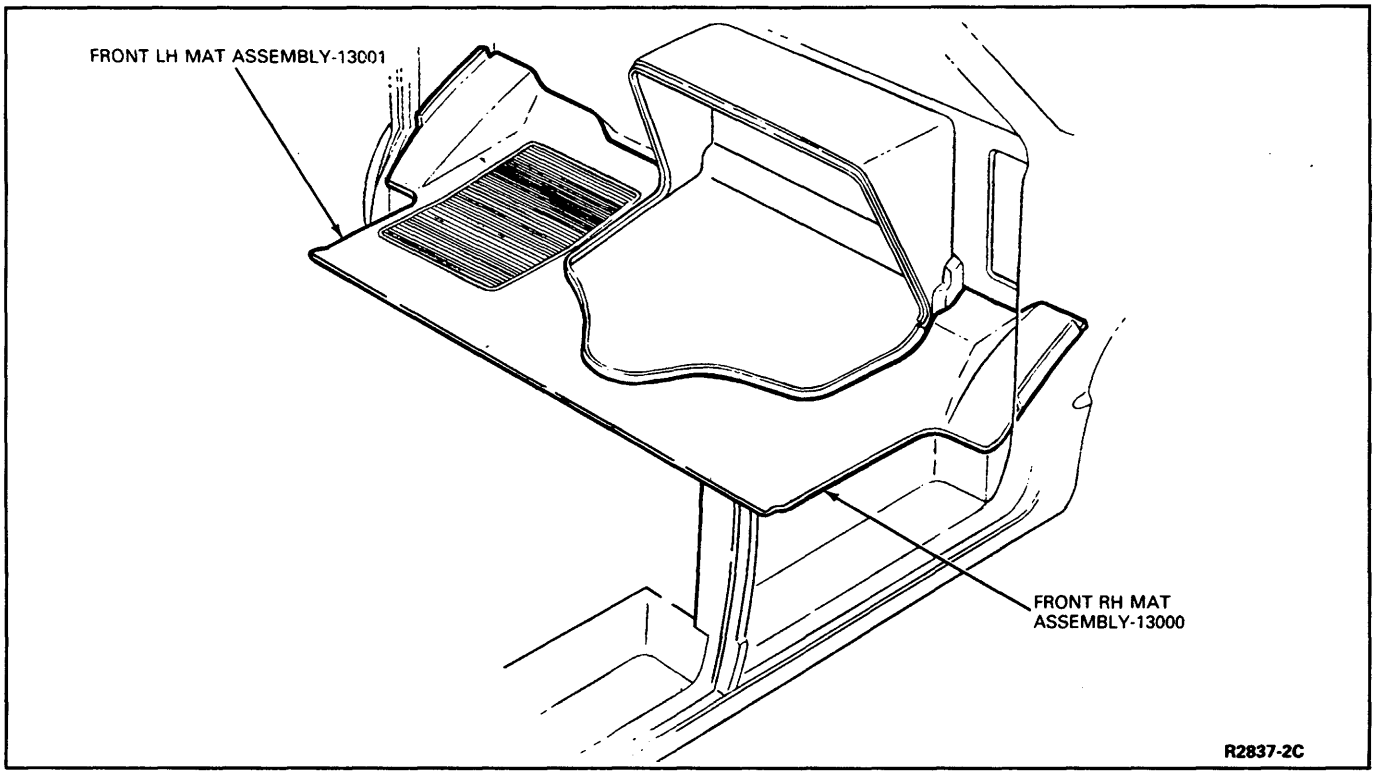


FIG. 13 Front Floor Mats—E-150—E-350

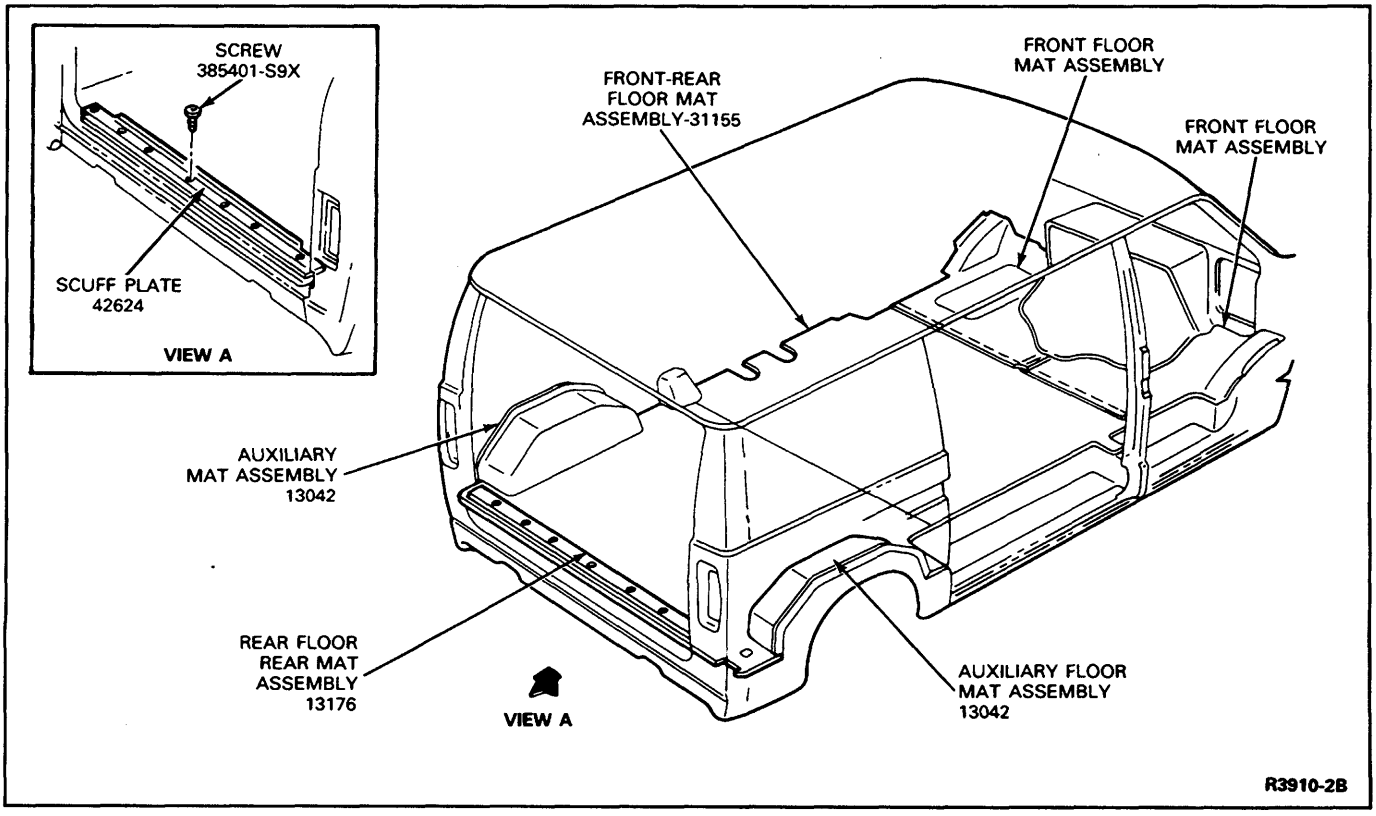


FIG. 14 Rear Floor Mats—E-150—E-350—124-Inch W.B.

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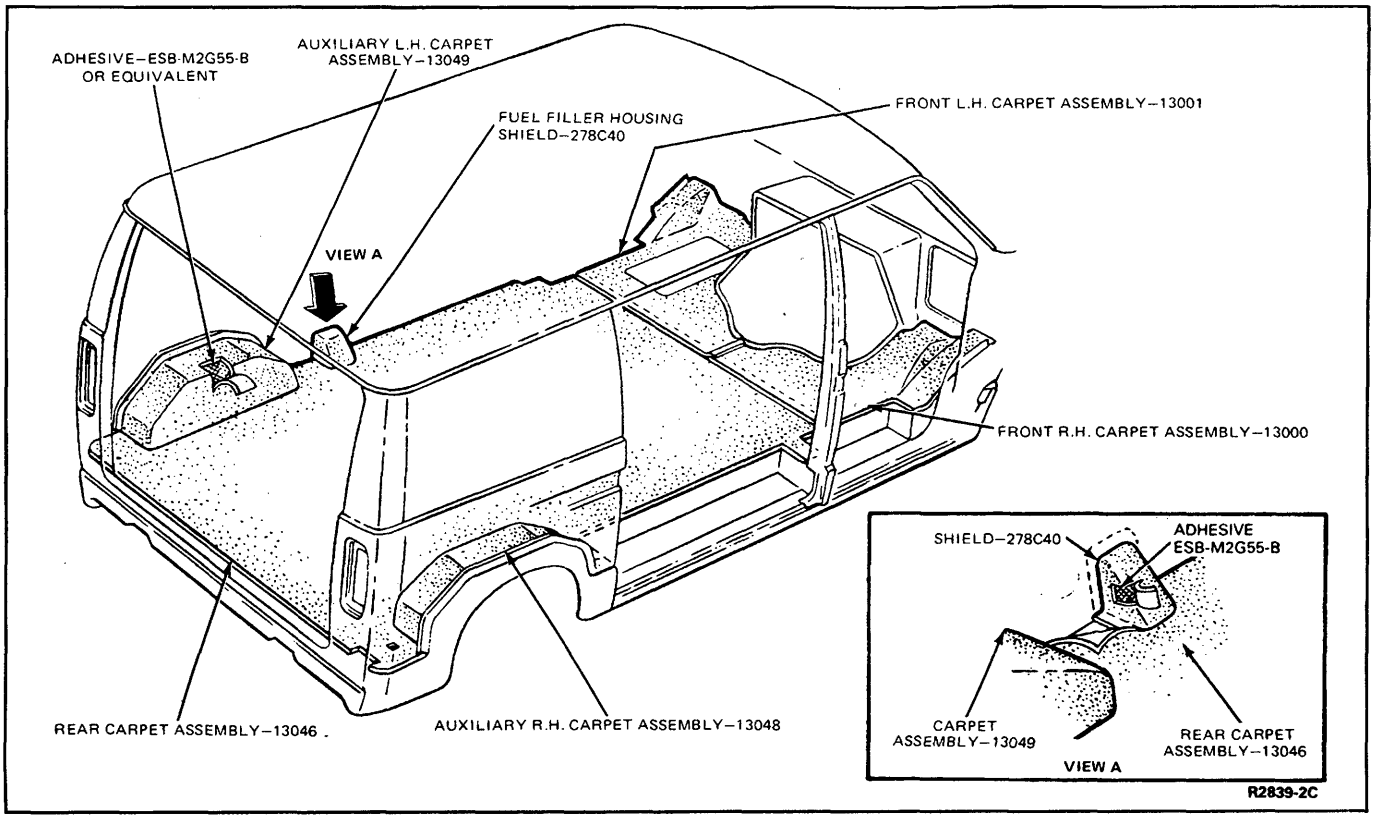


FIG. 15 Rear Floor Carpets—E-150—E-350—124-Inch W.B.

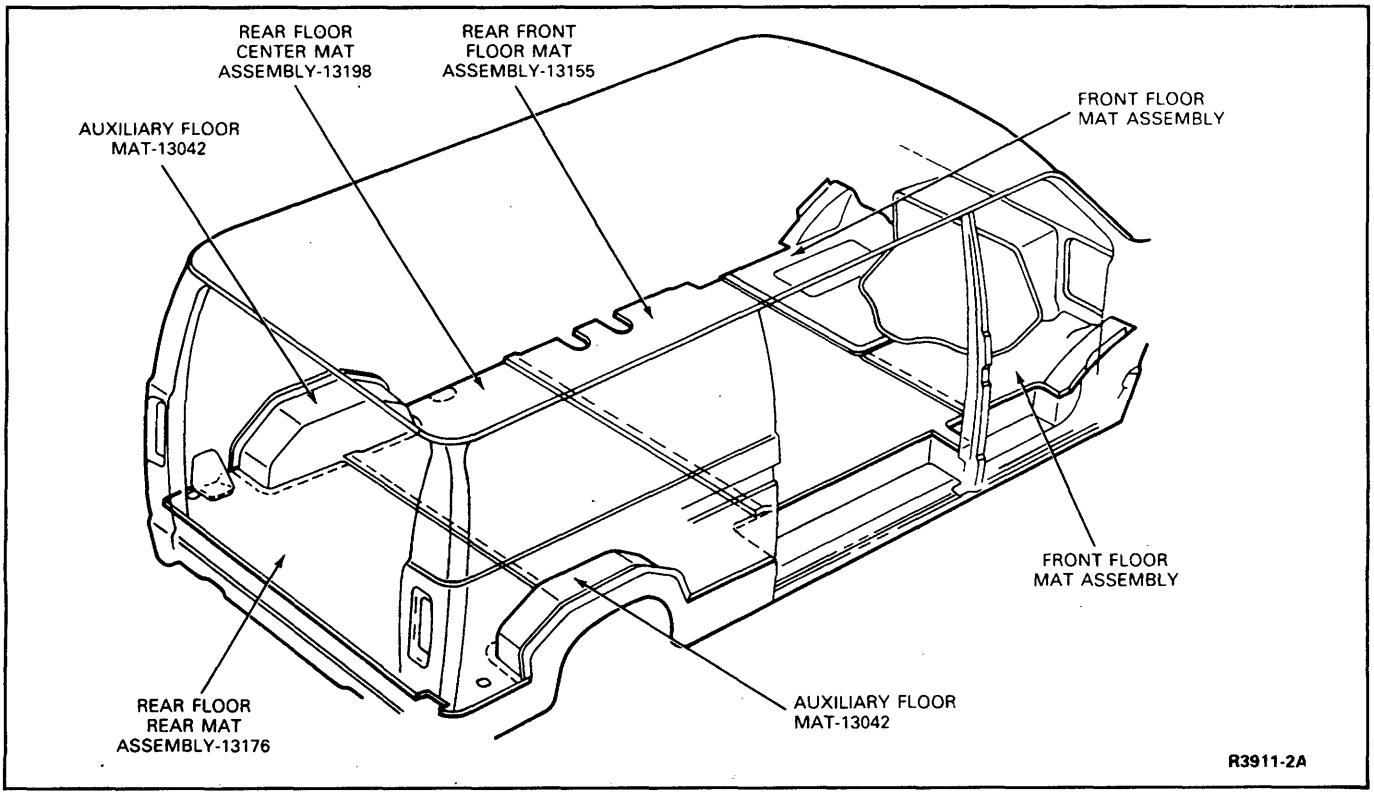


FIG. 16 Rear Floor Mats—E-150—E-350—138-Inch W.B.

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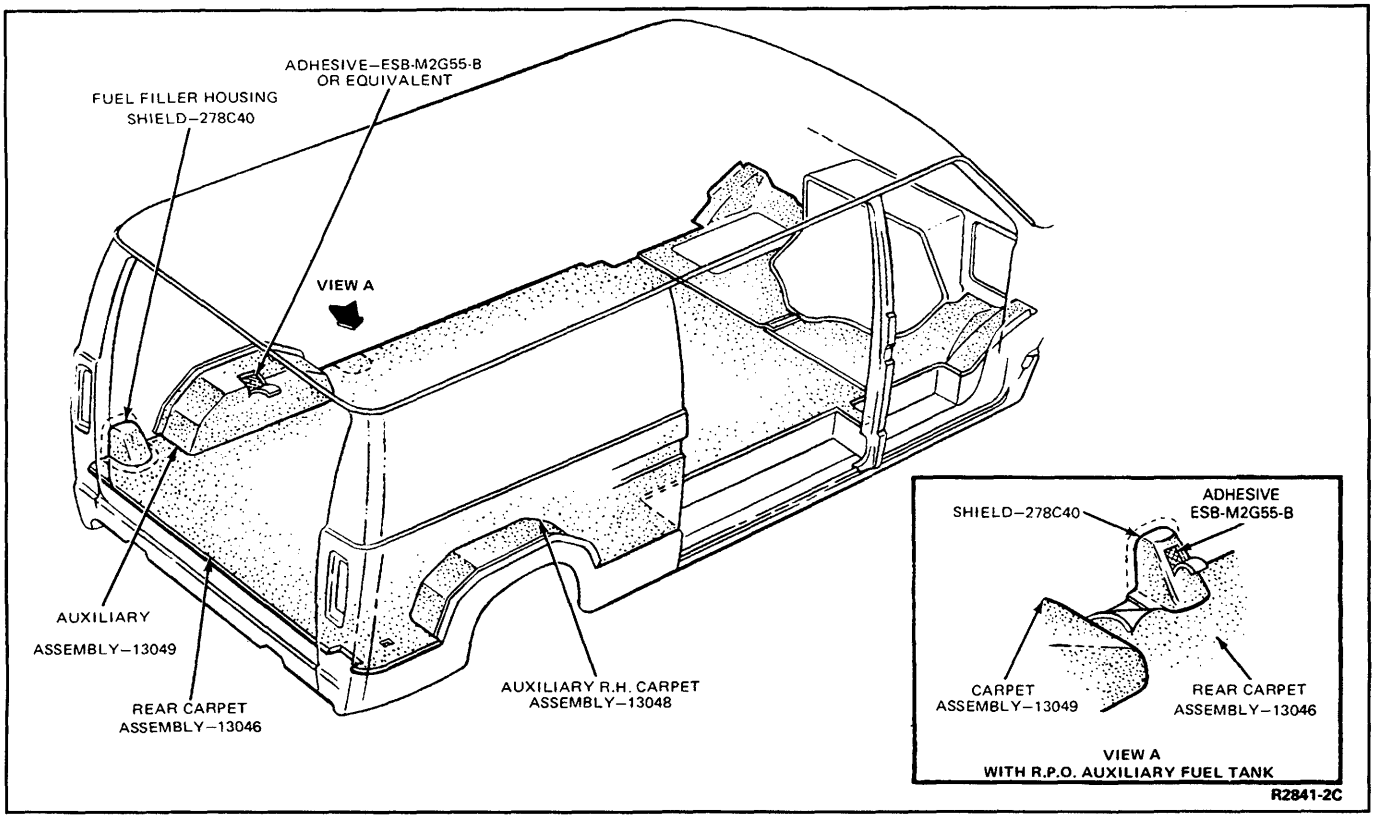


FIG. 17 Rear Floor Carpets—E-150—E-350—138-Inch W.B.

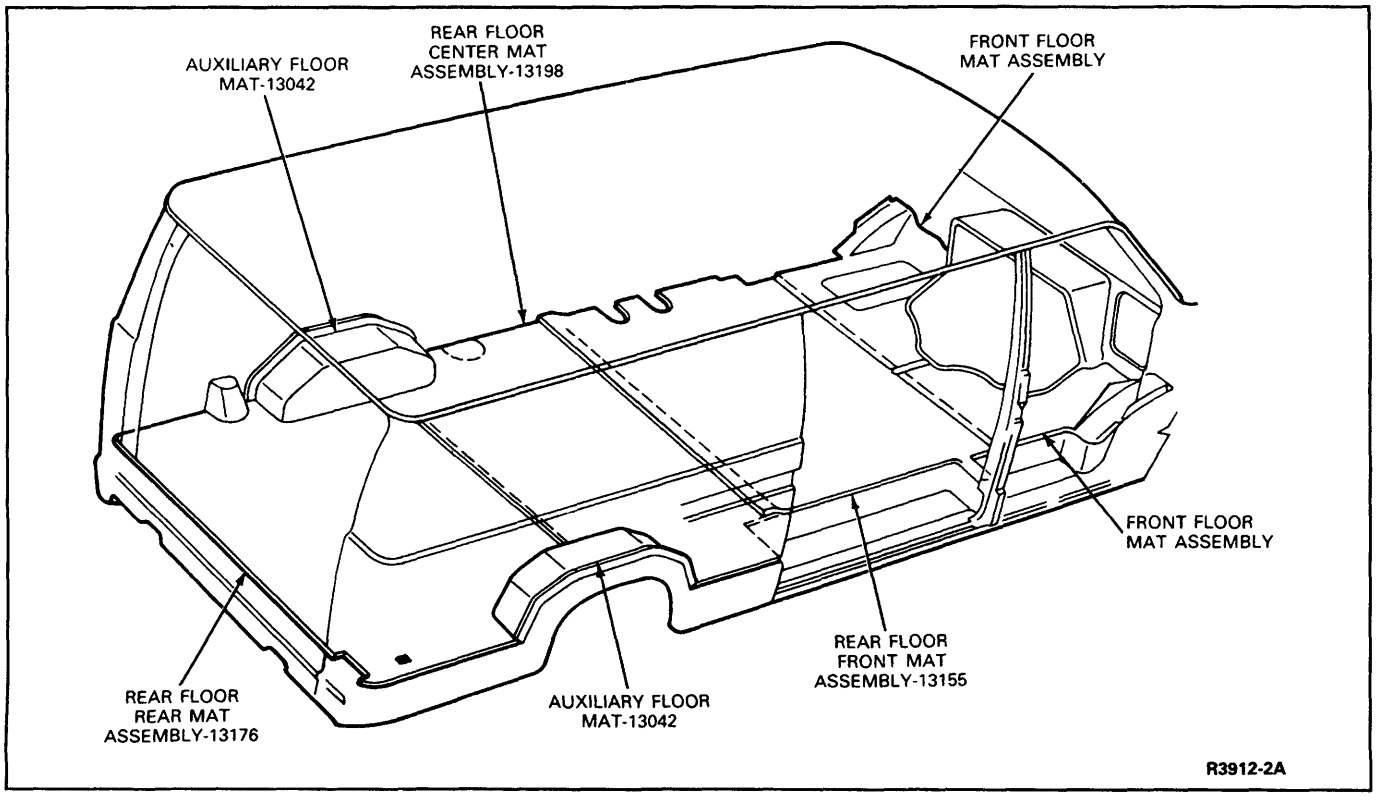


FIG. 18 Rear Floor Mats—E-150—E-350 Super Vans and Wagons

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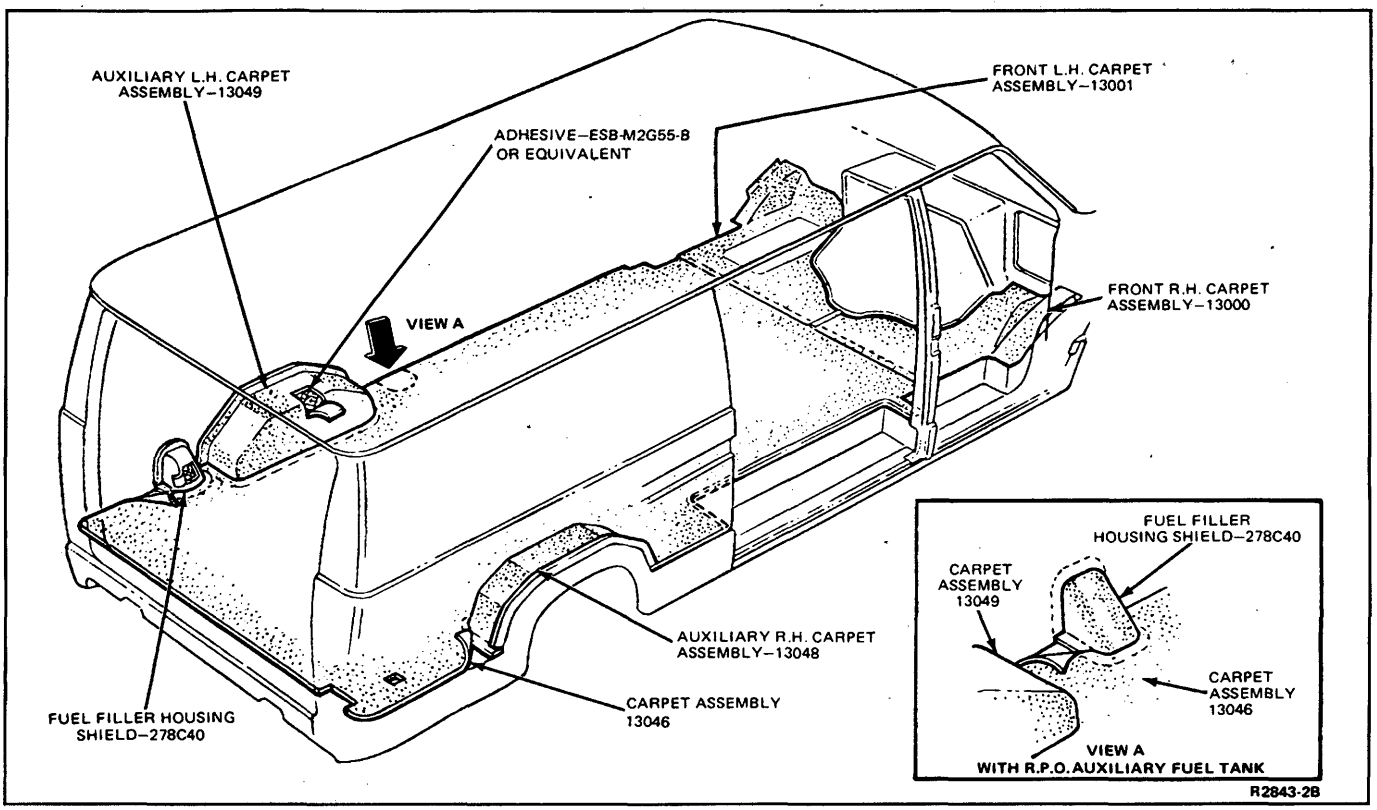


FIG. 19 Rear Floor Carpets—E-150—E-350 Super Vans and Wagons

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SECTION 45-31 Console Assembly

SUBJECT	PAGE	SUBJECT	PAGE
REMOVAL AND INSTALLATION	45-31-1	VEHICLE APPLICATION	45-31-1

VEHICLE APPLICATION

F-150 (Super Cab) And Bronco.

REMOVAL AND INSTALLATION

Removal

1. Remove the bolts from the base of the console panel (Fig. 1).
2. Remove the console.

Installation

1. Position console to floor of vehicle (Fig. 1).
2. Secure with bolts.

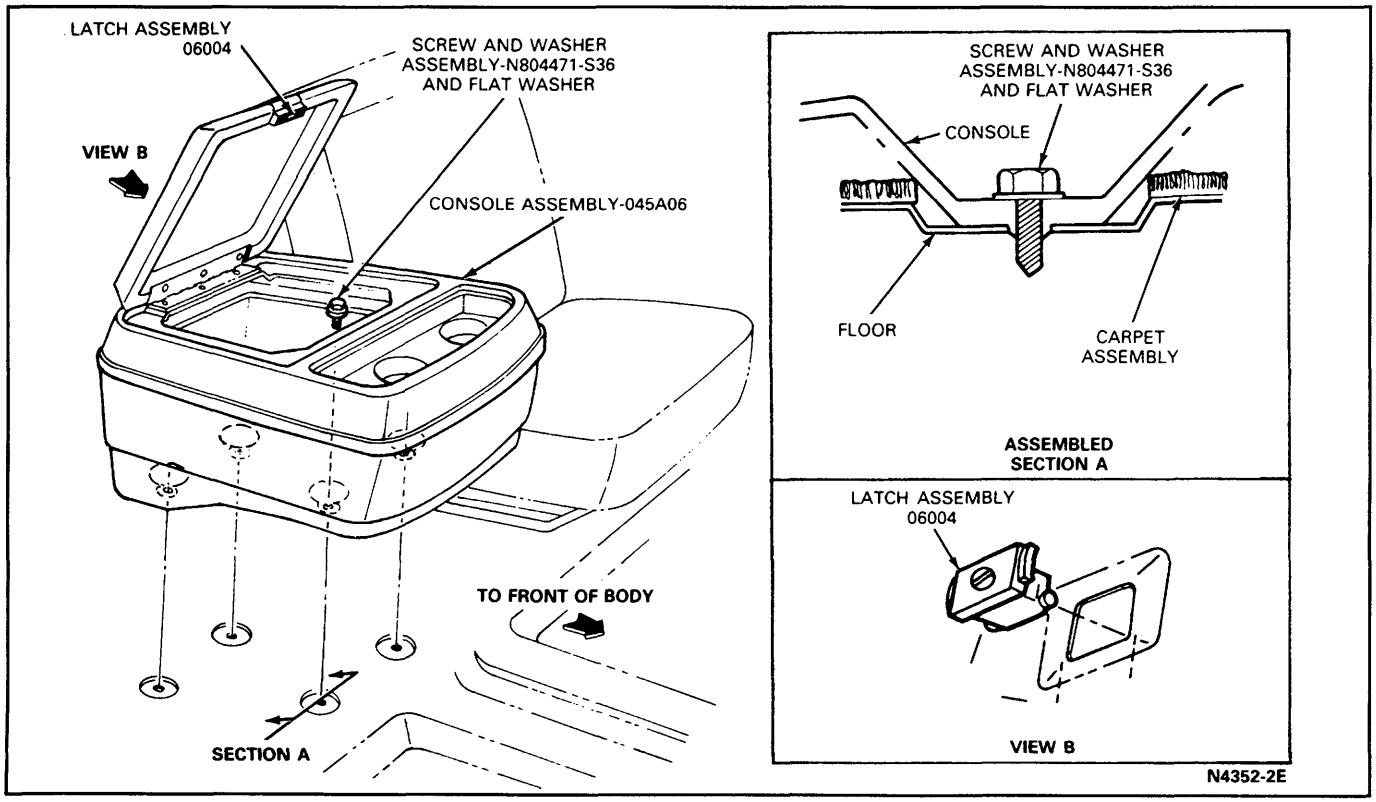


FIG. 1 Console Assembly—Removal and Installation

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SECTION 45-41 Headlining

SUBJECT	PAGE
REMOVAL AND INSTALLATION	
Cut and Score Headlining	45-41-2
Bronco	45-41-2
F-150—F-350	45-41-2
Cut and Sew Headlining	45-41-1
E-150—E-350	45-41-1
REMOVAL AND INSTALLATION (Cont'd)	
Front Hard Headlining	45-41-1
E-150—E-350	45-41-1
Full Length Hard Headlining	45-41-1
E-150—E-350	45-41-1
VEHICLE APPLICATION	45-41-1

VEHICLE APPLICATION

All Models.

REMOVAL AND INSTALLATION

Front Hard Headlining

E-150—E-350

Removal

1. Remove the sun visor retaining screws and center retainer clip remove the sun visors (Fig. 1).
2. Remove side garnish moulding, if so equipped. Refer to Section 45-16, Mouldings.
3. Remove front dome lamp. Refer to Section 32-61, Interior Lamps.
4. Remove the six retaining screws from the rear of the trim panel.
5. Remove the centerline retaining screw (Fig. 2).
6. Slide the trim panel rearward out of the windshield header retaining strip (Fig. 2, View C).

Installation

1. Slide the trim panel forward into the windshield header retaining strip (Fig. 2, View C).
2. Install the centerline retaining screw (Fig. 2).
3. Install the six retaining screws at the rear of the trim panel.
4. Install the front dome lamp. Refer to Section 32-61, Interior Lamps.
5. Install the side garnish mouldings, if so equipped.
6. Install the sun visors (Fig. 1).

Full Length Hard Headlining

E-150—E-350

Removal

1. Remove all garnish mouldings from the perimeter of the headliner (Figs. 3 and 4). Refer to Section 45-16, Mouldings.
2. Remove the front and rear dome lamps. Refer to Section 32-61, Interior Lamps.
3. Remove the metal end caps from the plastic trim panel retainers. Unsnap the plastic trim panel retainers from the metal supports.
4. Remove trim panel retaining screw located on the centerline of the vehicle (Fig. 2).
5. Bow each trim panel section downward at the center of the vehicle and remove the trim panel from the retainers.

Installation

1. Position the trim panel to the retainers by bowing the trim panel.
2. Install the trim panel retaining screw located on the centerline of the vehicle (Fig. 2).
3. Snap the plastic trim panel retainers to the metal supports. Install the metal end caps to the plastic trim panel retainers.
4. Install the front and rear dome lamps. Refer to Section 32-61, Interior Lamps.
5. Install all garnish mouldings to the perimeter of the headliner (Fig. 3). Refer to Section 45-16, Mouldings.

Cut and Sew Headlining

E-150—E-350

Removal

1. Remove sun visor(s) (Fig. 1).
2. Remove windshield garnish and all side mouldings from headlining. Refer to Section 45-16, Mouldings.
3. Unhook headlining from retainer tabs (Figs. 5, 6 and 7).
4. Remove front and rear dome lamps. Refer to Section 32-61, Interior Lamps.
5. Pull headlining loose from all cemented areas.
6. Disengage all support rods from holes in LH and RH roof rails (Figs. 8 and 9).
7. Remove headlining from center retaining clips and remove from vehicle.

Installation

1. Unpackage the new headlining and lay it out on a flat surface.
2. Trim the listings (or "pockets") on the new headlining to the approximate length of those on the old one. Remove the support rods from the old headlining. Install them in the same relative rod listings of the new headlining.

Roof headlining support rods are color coded at each end. When ordering new rods,

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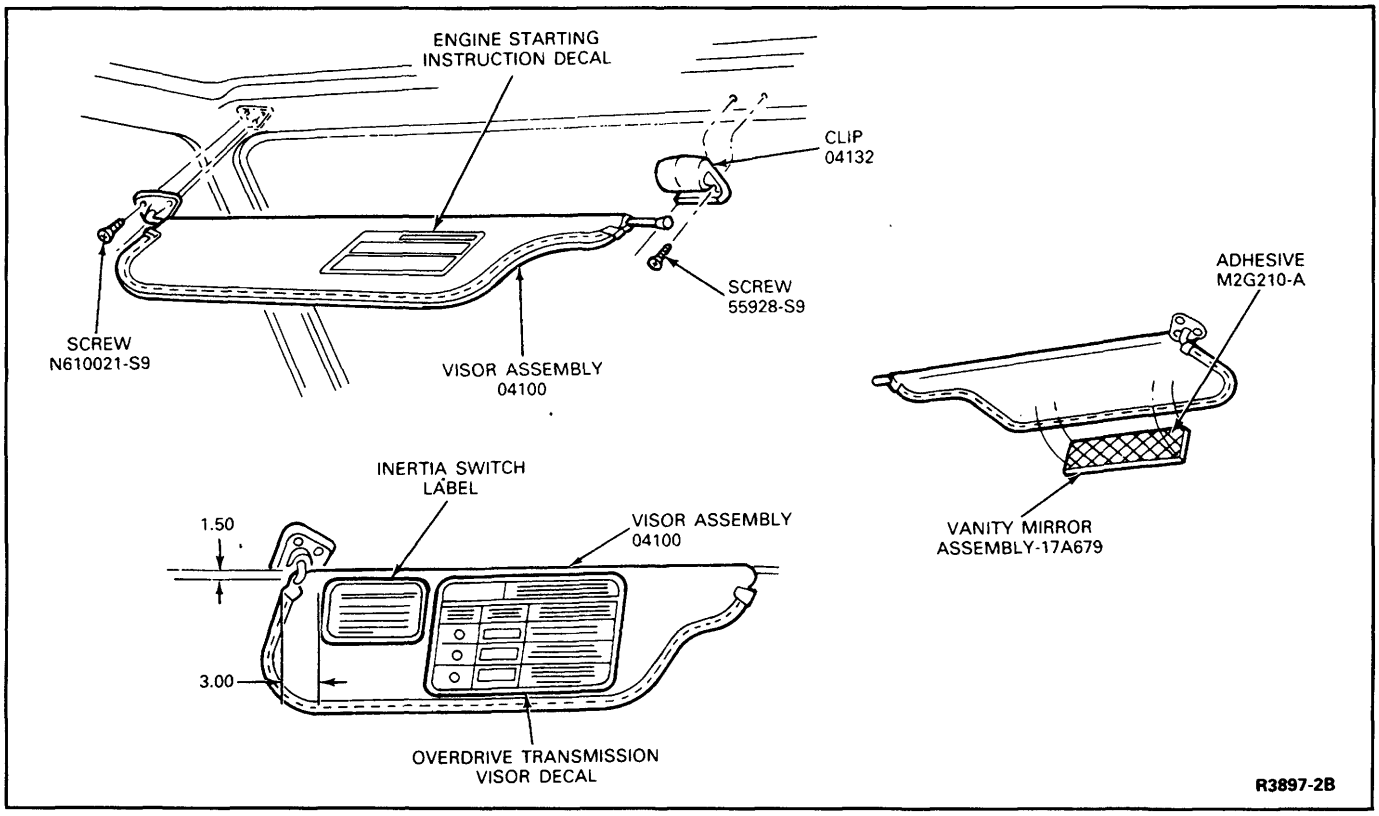


FIG. 1 Sun Visors—E-150—E-350

be sure to note the color at each end of the rod.

3. Position the headlining in the vehicle.
4. Insert support rods into holes in RH and LH roof rails (Figs. 8 and 9).
5. Snap headlining into center retaining clips.
6. Starting from center to outboard side, stretch headlining to back roof line and hook headlining on retainer.
7. Repeat Step 6, stretching to the sides.
8. Cement the headlining at points marked (Fig. 5).
9. Trim excess material.
10. Install windshield garnish and all side mouldings.
11. Install the sun visor(s) (Fig. 1).
12. Install front and rear dome lamps.

Cut and Score Headlining

Bronco

Removal

1. Remove the three screws retaining each sun visor to the roof and remove the sun visors (Fig. 10).
2. Remove the screws retaining the garnish mouldings and remove the mouldings.
3. Remove the two drive pins retaining the headliner to the roof structure. Remove the headliner (Fig. 11).

Installation

1. Position the headliner to the roof and install two drive pins to retain the headliner.
2. Position garnish mouldings and install retaining screws.
3. Position sun visors to headliner and install retaining screws.

F-150—F-350

Removal

1. Remove both sun visors and retainer clips (Fig. 10).
2. Remove the windshield upper garnish moulding. Refer to Section 45-61, Mouldings.
3. Remove the roof side inner front mouldings (Figs. 12, 13 and 14).
4. Loosen the windshield side mouldings.
5. Remove the rear window upper moulding.
6. Loosen the pillar moulding on both sides.
7. Remove the dome lamp lens.
8. Remove the dome lamp assembly. Refer to Section 32-61, Interior Lamps.
9. Remove the roof trim panel.

Installation

1. Preshape new headliner along score marks to approximately same shape as old headliner.
2. Position the headliner to roof.
3. Install the dome lamp assembly. Refer to Section 32-61, Interior Lamps.
4. Install the visors.
5. Install the garnish and tighten mouldings (Figs. 12, 13 and 14).

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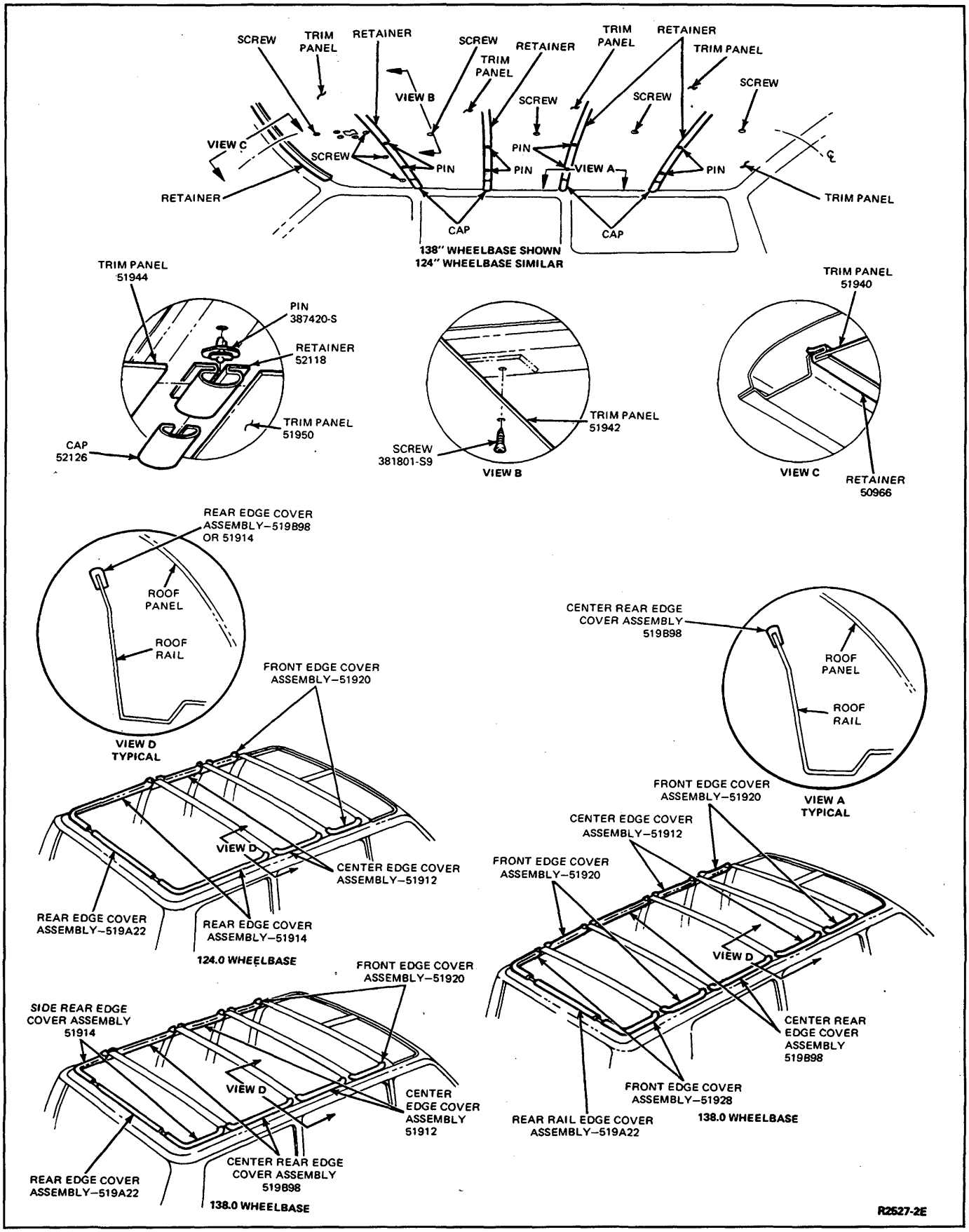


FIG. 2 Roof Trim Panels—E-150—E-350—124 inch and 138 inch Wheel Base Shown—Others Typical

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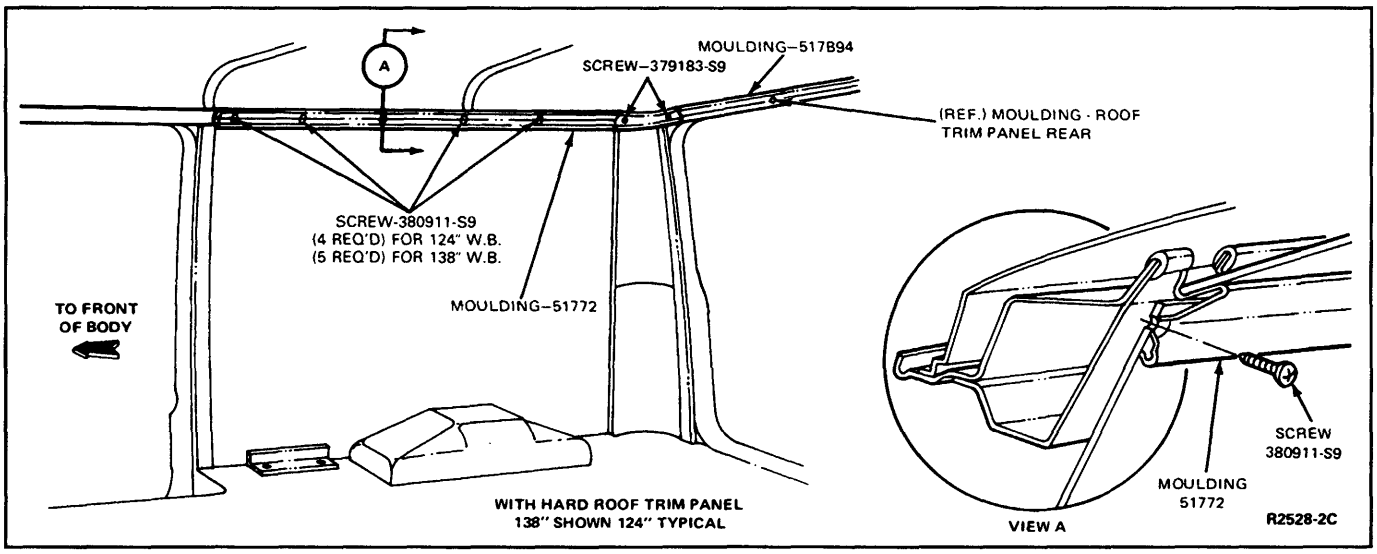


FIG. 3 Interior Roof Mouldings—E-150—E-350—Hard Roof Trim Panels

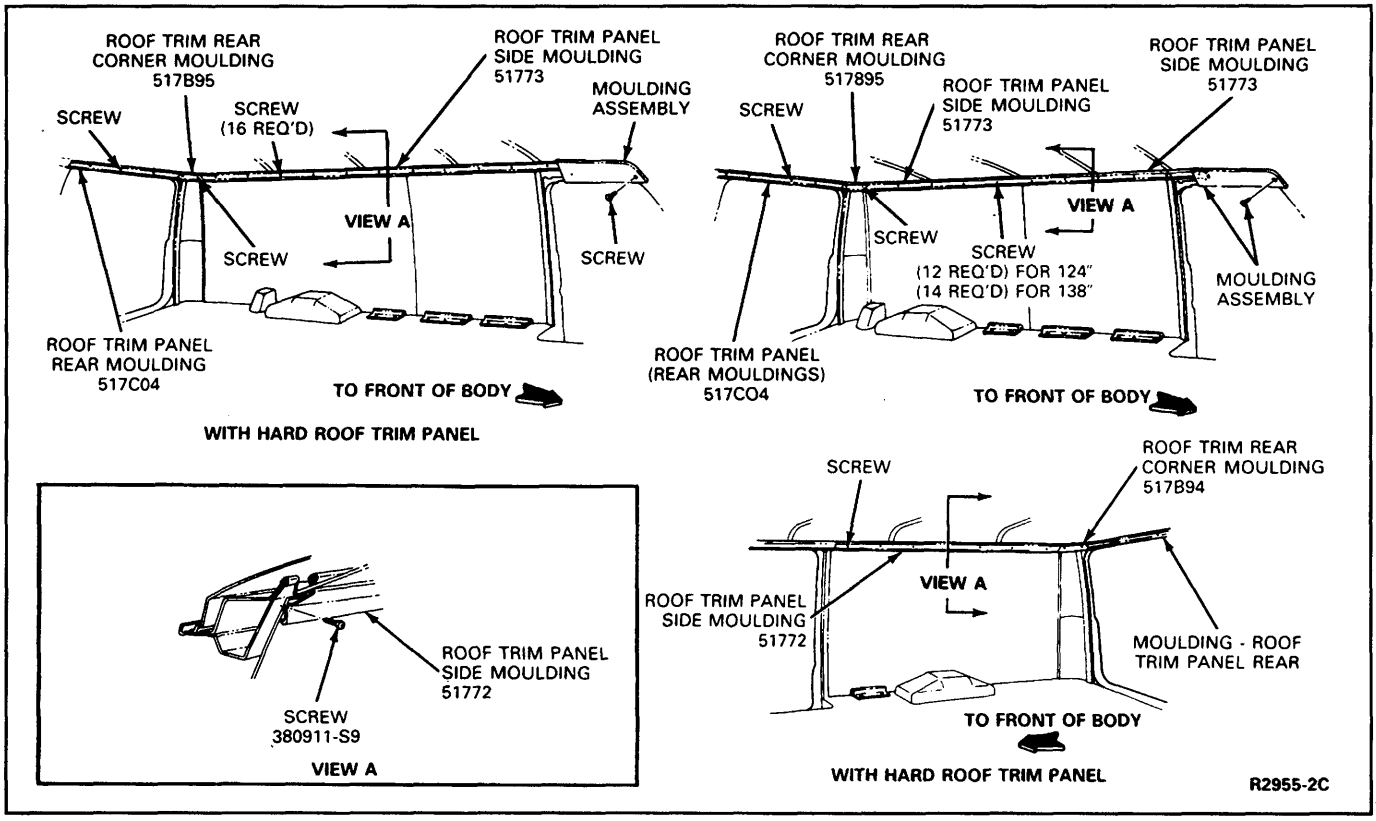


FIG. 4 Interior Roof Trim Panels—Captain's Chateau Package-E-150—E-350

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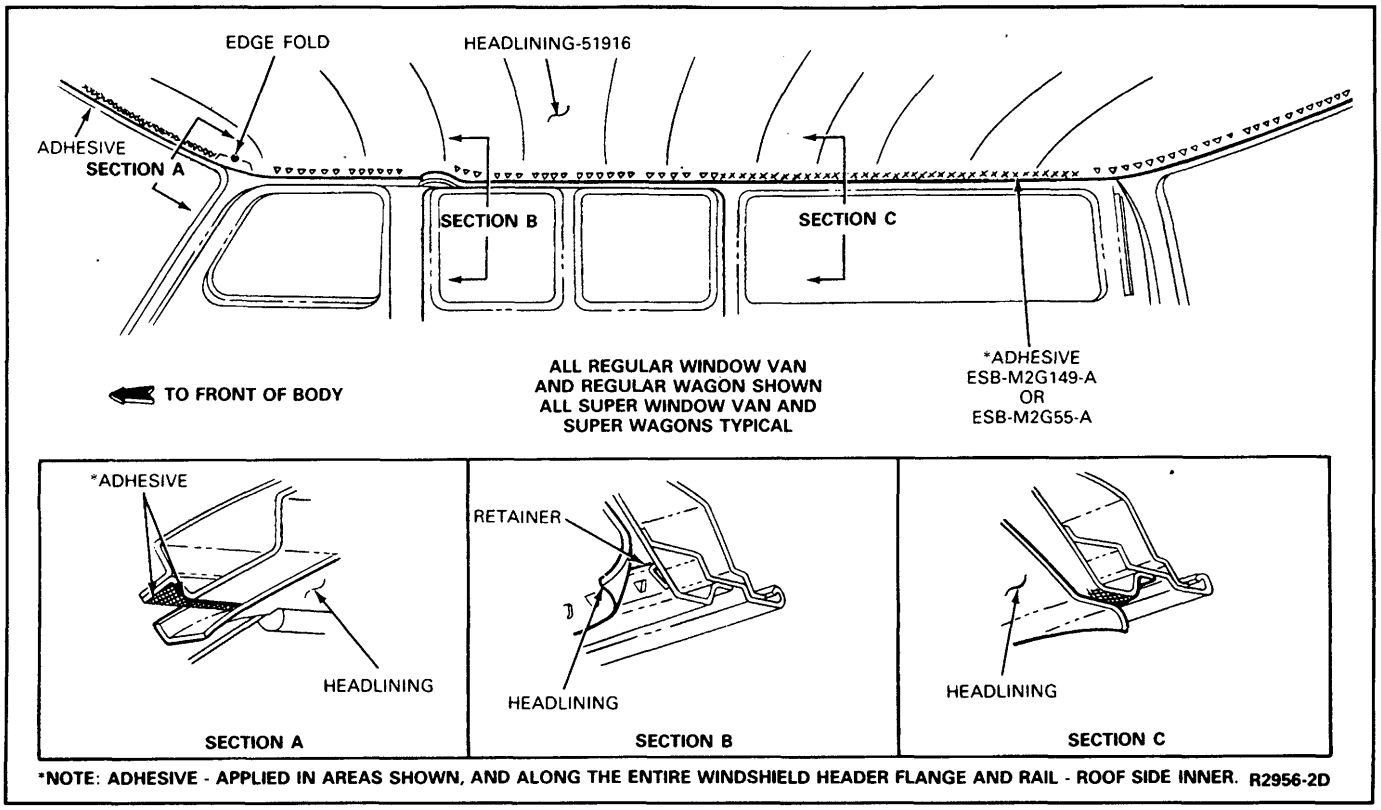


FIG. 5 R.P.O. Headlining Assembly—E-150—E-350

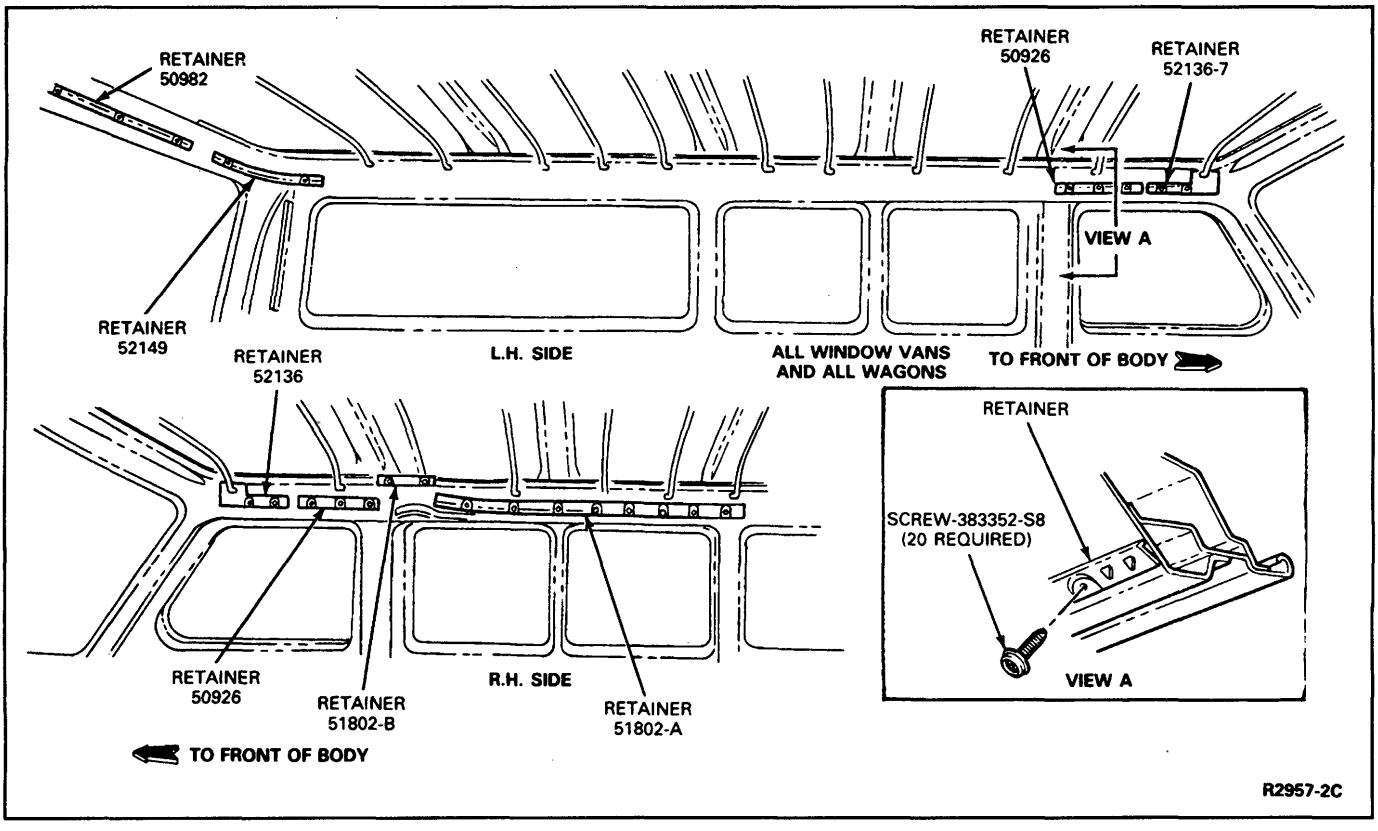


FIG. 6 R.P.O. Headlining Retainers—E-150—E-350 Sliding Door

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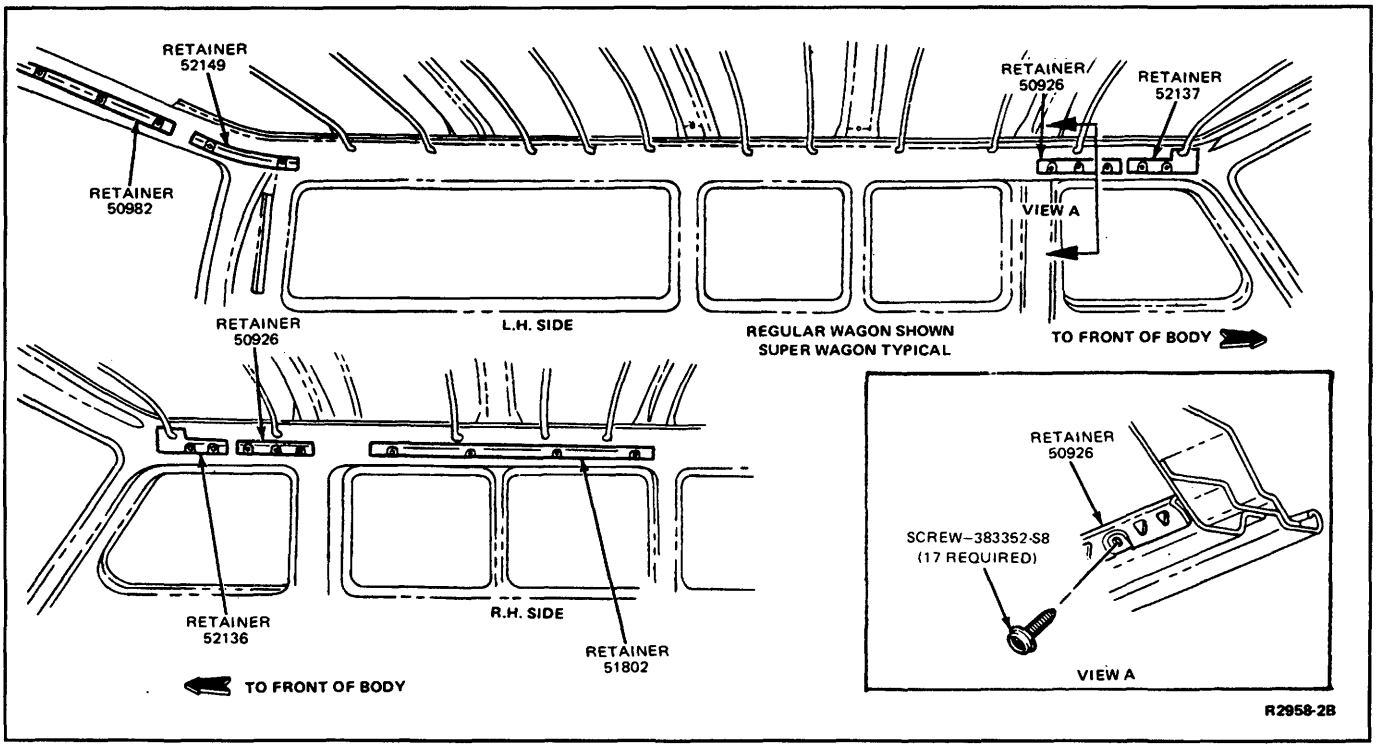


FIG. 7 R.P.O. Headlining Retainers—E-150—E-350 Hinged Door

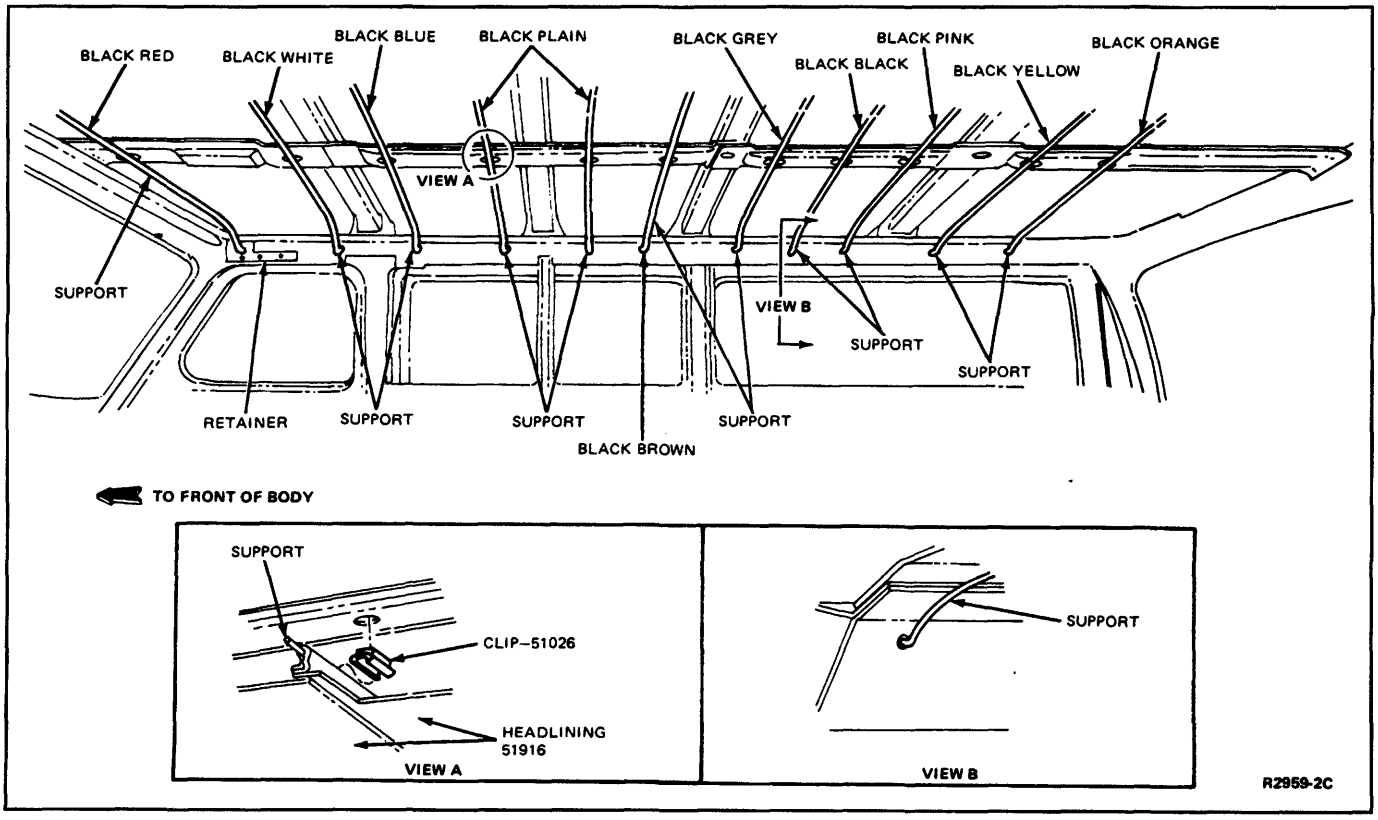


FIG. 8 R.P.O. Headlining Supports—E-150—E-350 138 inch W.B.

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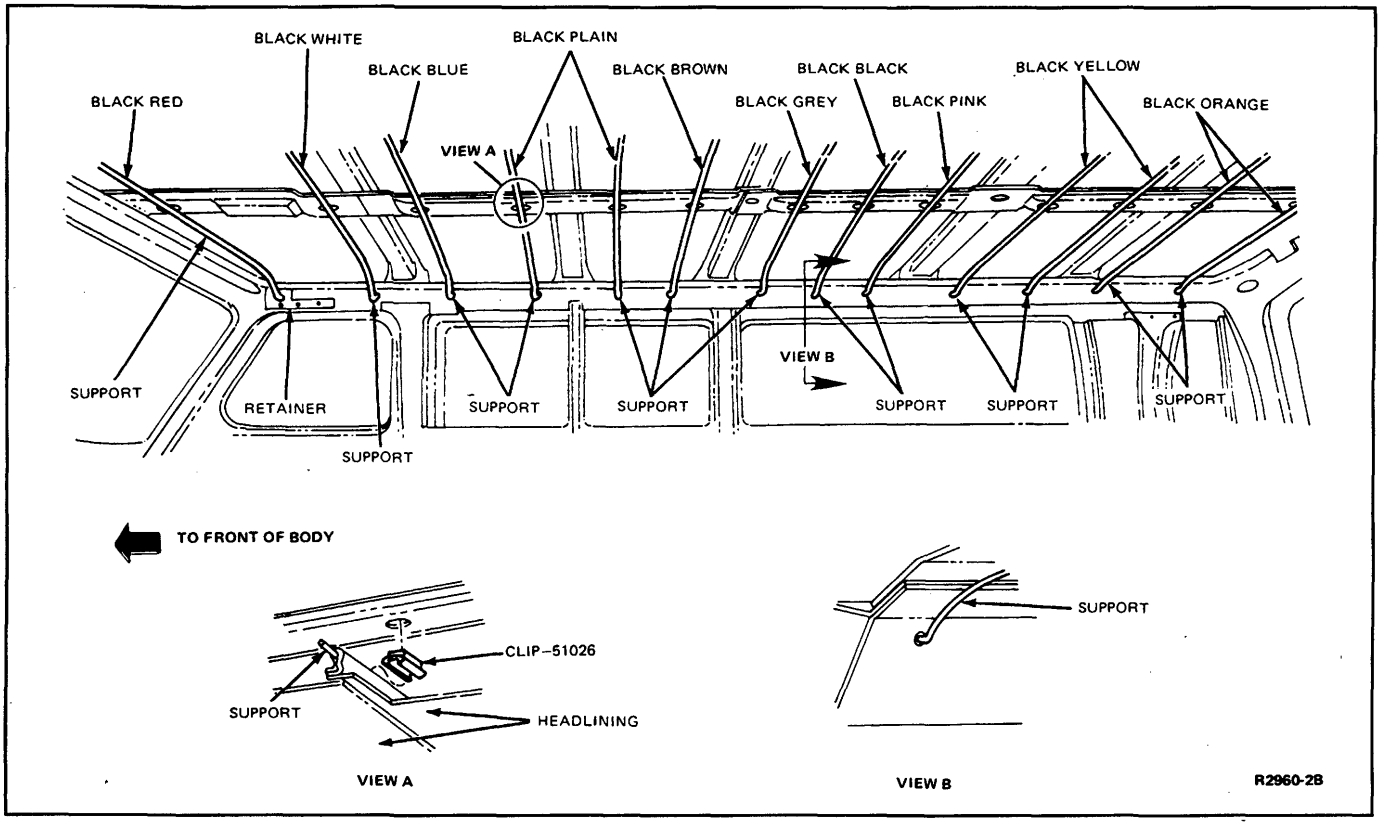


FIG. 9 R.P.O. Headlining Supports—E-150—E-350 Super Van and Super Wagon—138 Inch W.B.

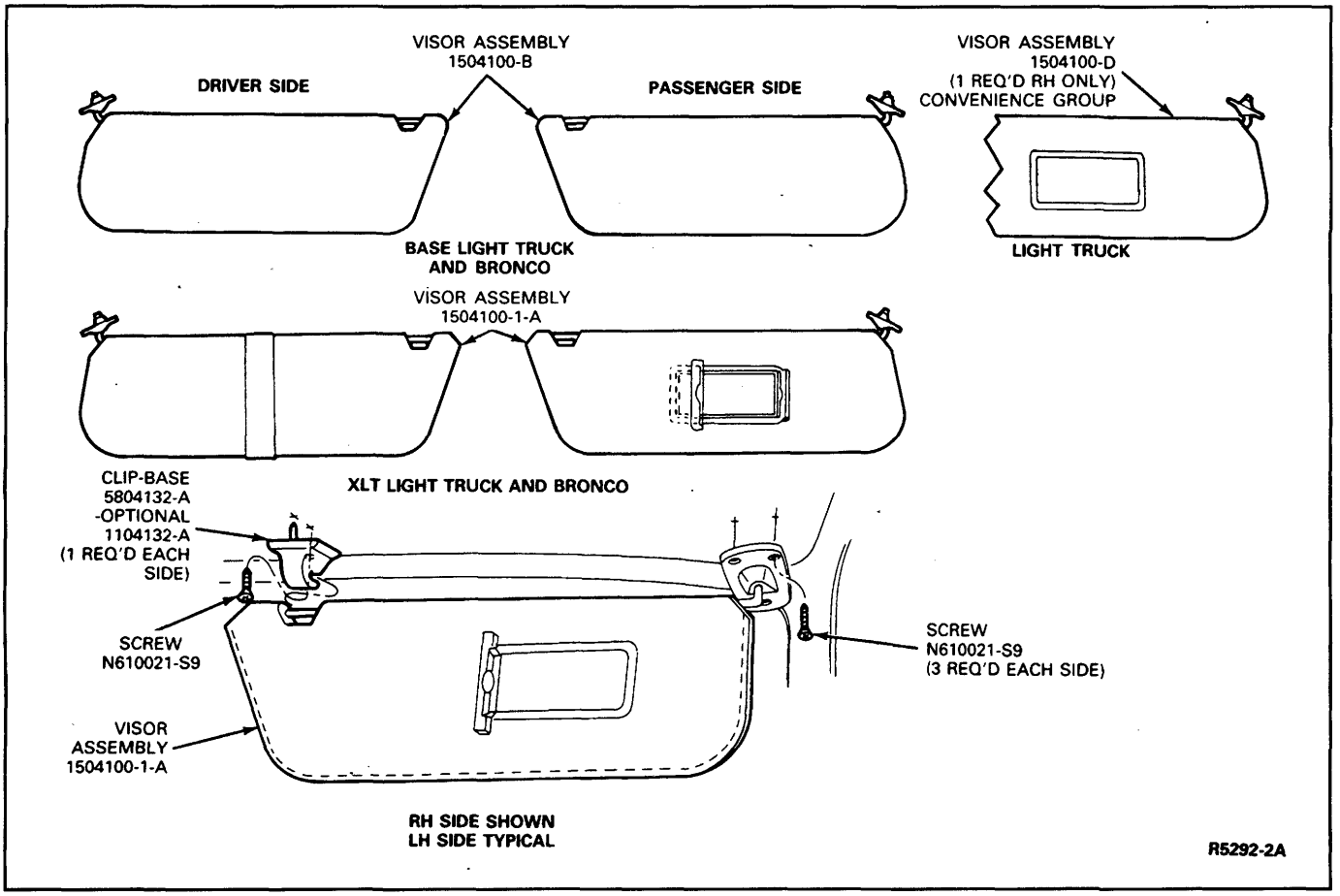


FIG. 10 Sun Visors—F-150—F-350 and Bronco

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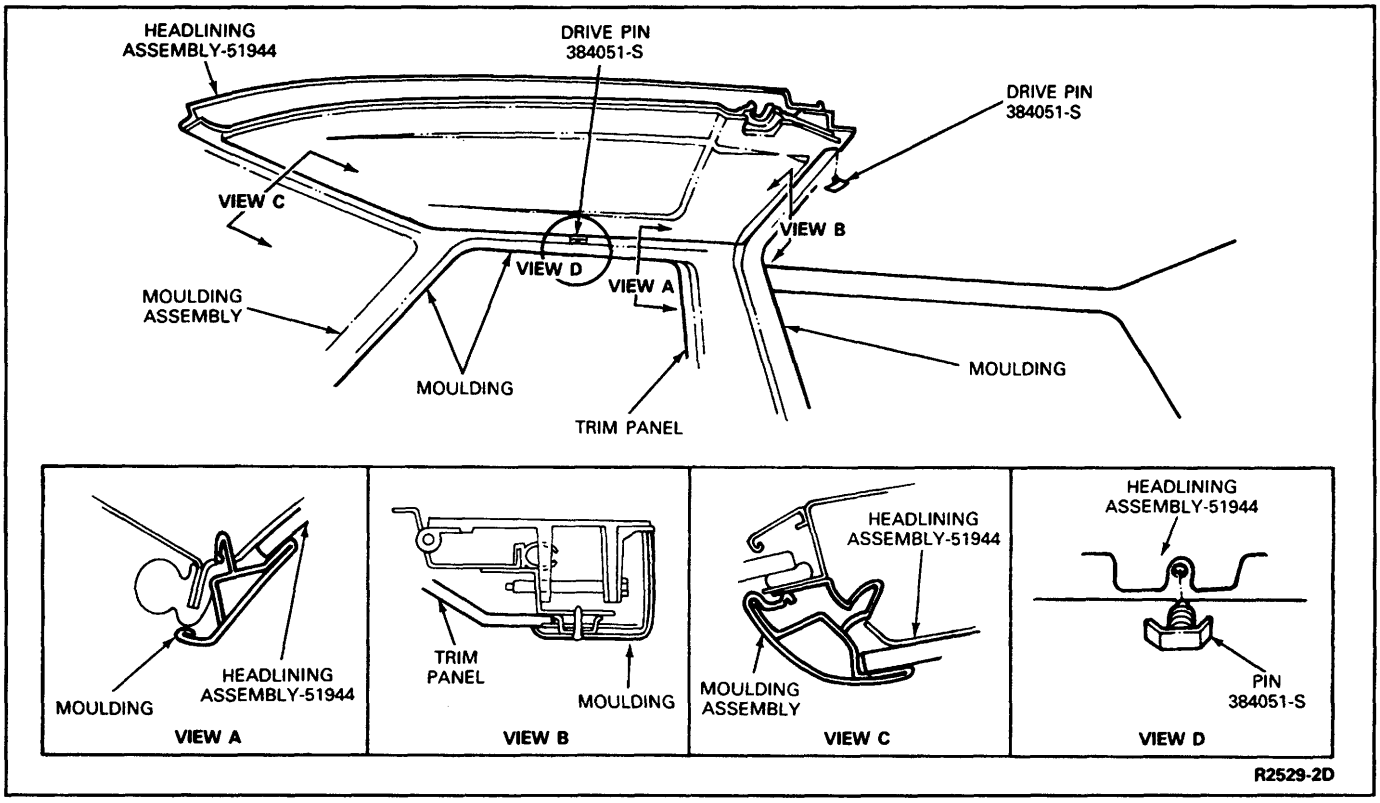


FIG. 11 Roof Trim Panel Installation Bronco

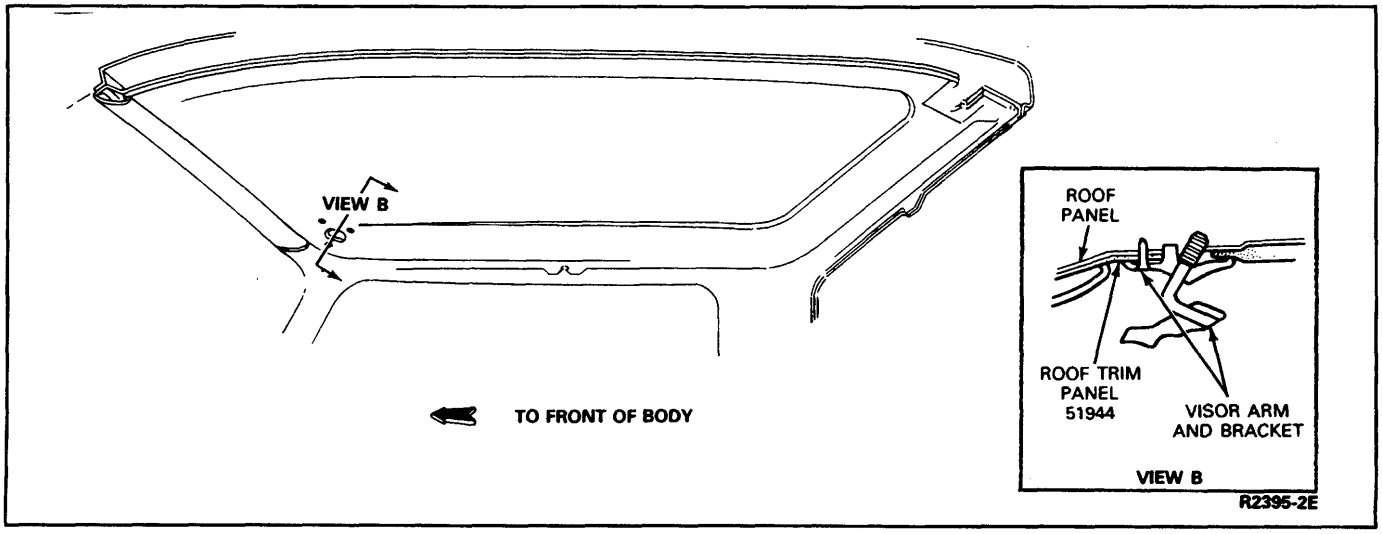


FIG. 12 Roof Headlining Assembly—F-150—F-350

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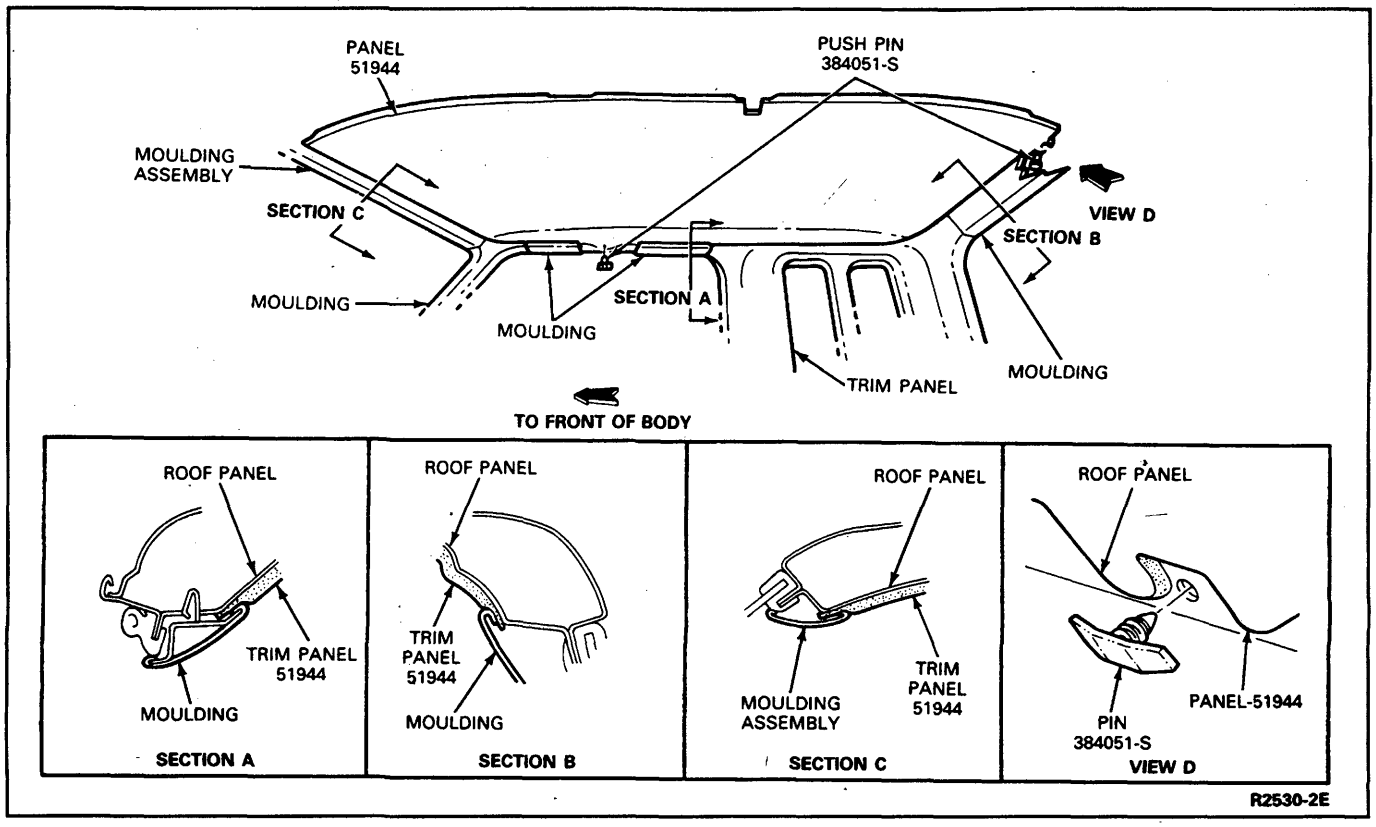


FIG. 13 Roof Trim Panel Installation—F-150—F-350 Super Cab

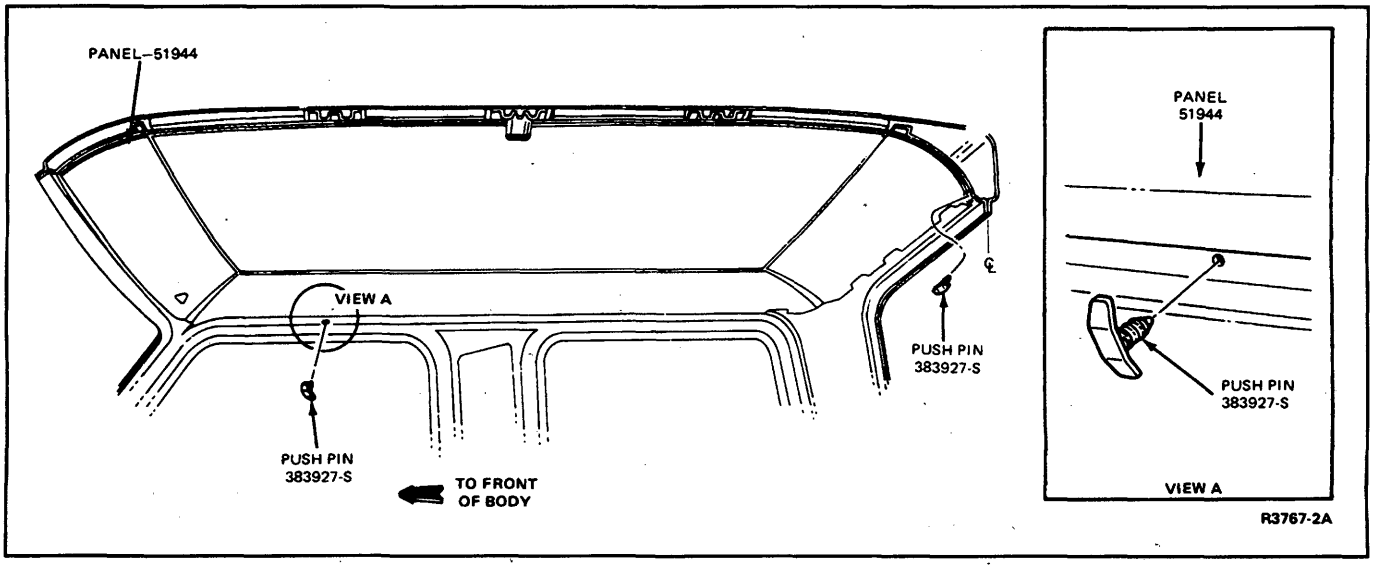


FIG. 14 Roof Trim Panel Installation—F-350 Crew Cab

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SECTION 45-61 Instrument Panel and Pad

SUBJECT	PAGE
REMOVAL AND INSTALLATION	
E-150—E-350 and Club Wagon	45-61-1
Instrument Panel	45-61-2
VEHICLE APPLICATION	45-61-1

VEHICLE APPLICATION

All Models.

REMOVAL AND INSTALLATION

E-150—E-350 and Club Wagon

Instrument Panel Pad

Removal

1. Remove the battery ground cable.
2. Remove headlamp switch bezel, knob and shaft assembly.
3. Remove two screws at bottom of LH finish panel and pull rearward to disengage friction cups (Fig. 1). Disconnect wiring connectors and remove panel.
4. Remove four screws at bottom of instrument cluster finish panel and three screws at top of panel. Pull rearward and disconnect cluster wiring connectors, speedometer and remove instrument cluster (Fig. 2).
5. Remove three screws at bottom of RH finish panel and two screws at top of panel, over radio. Pull rearward to disengage friction clips (Fig. 3).
6. Disconnect cigar lighter wiring, if so equipped.
7. Remove radio, if so equipped.
8. Remove A/C register grille from RH end of instrument panel pad.
9. Reach under panel through openings made by removal of panels and remove eleven pad attaching nuts (Fig. 4). Remove pad.

NOTE: To remove the RH nuts it is necessary to approach from the underside of the instrument panel with an extension tool.

Installation

1. Position instrument panel pad in place. Install retaining nuts and tighten to 2.03-3.39 N·m (18-30 in-lb).
2. Install A/C grille vents.
3. Install radio, if so equipped.
4. Position RH finish panel in place, connect cigar lighter wiring and install two upper screws and three lower screws.
5. Connect wiring connectors and speedometer cable to instrument cluster and position instrument cluster in place. Install three top retaining screws and four bottom retaining screws.

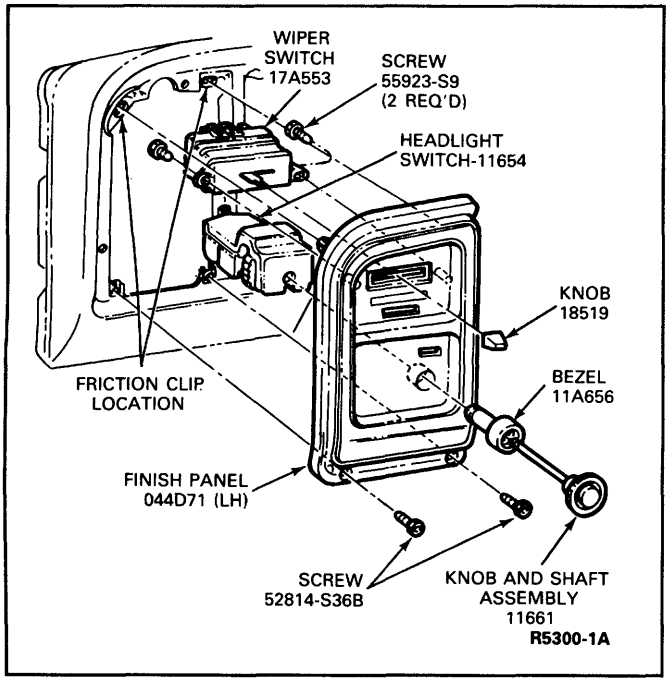


FIG. 1 Instrument Panel Installation LH Side—E-150-350

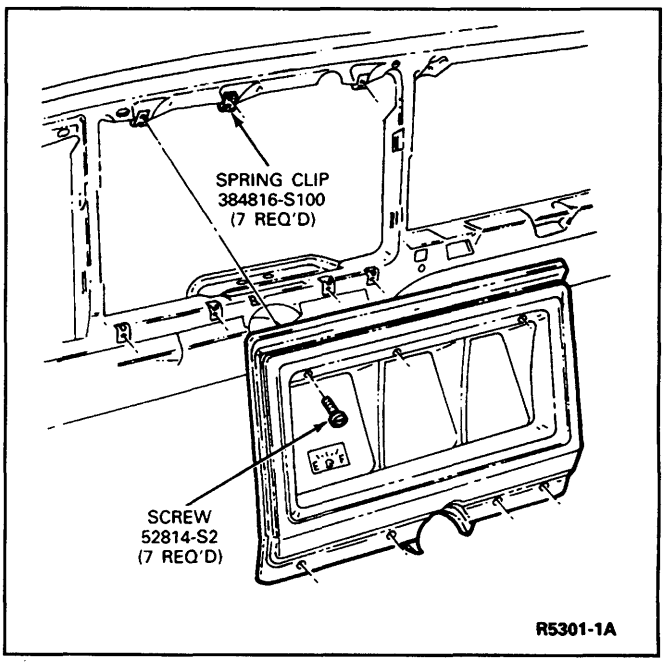


FIG. 2 Instrument Cluster Installation

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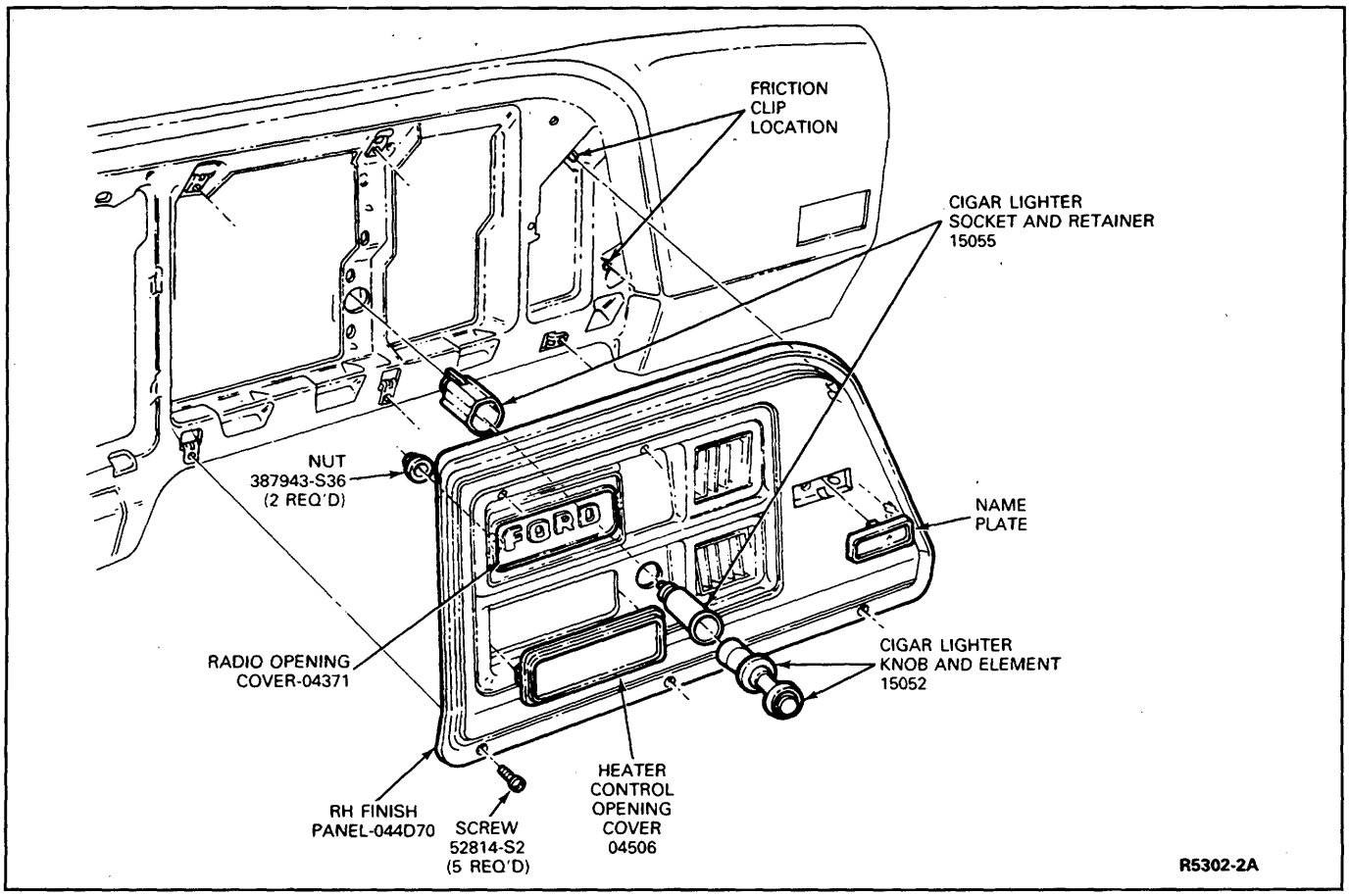


FIG. 3 Instrument Panel Installation RH Side—E-150-350

6. Connect wiring connectors to LH finish panel. Position panel in place, and install two bottom retaining screws.
7. Install headlamp switch bezel, knob and shaft assembly.
8. Connect battery ground cable.

Instrument Panel

Removal

1. Disconnect battery ground cable.
2. Remove steering wheel. Refer to Section 13-06, Steering Column—Shift Rod Within Tube.
3. Remove instruments, clusters and controls. Refer to Group 33.
4. Remove heater/air conditioning control. Refer to Section 36-65, E-150 through E-350 Air Conditioning System.
5. Disconnect and remove cigar lighter.
6. If so equipped, remove radio and instrument panel mounted speaker. Refer to Section 35-01, Radios and Premium Sound System and Section 35-31, Speakers.
7. Remove 11 nuts securing pad to instrument panel (Fig. 4) and remove pad. Use care to prevent damage to pad.
8. Remove steering column cover.
9. Remove instrument panel upper moulding.
10. Remove two screw and washer assemblies securing instrument panel to brake and clutch pedal support bracket assembly.
11. Remove screw and washer assembly securing the instrument panel at lower support bracket.
12. While supporting the instrument panel, remove two side attaching screw and washer assemblies. Carefully remove instrument panel from vehicles.

Installation

1. Carefully position instrument panel in vehicle and secure with two side attaching screw and washer assemblies tightened to 15-28 N·m (11-21 ft-lb) (Fig. 4).
2. Secure instrument panel to supports with three screw and washer assemblies tightened to 17-27 N·m (12-20 ft-lb).
3. Install instrument panel upper moulding. Tighten screws to 14-20 N·m (10-15 in-lb).
4. Install steering column cover. Tighten screws to 14-20 N·m (10-15 in-lb).
5. Install instrument panel pad. Tighten nuts to 11-27 N·m (8-20 in-lb).
6. Install all auxiliary equipment and controls removed during removal procedure.
7. Install instruments, clusters and controls. Refer to Group 33.
8. Install steering wheel. Refer to Section 13-06, Steering Column—Shift Rod Within Tube.
9. Connect battery ground cable.

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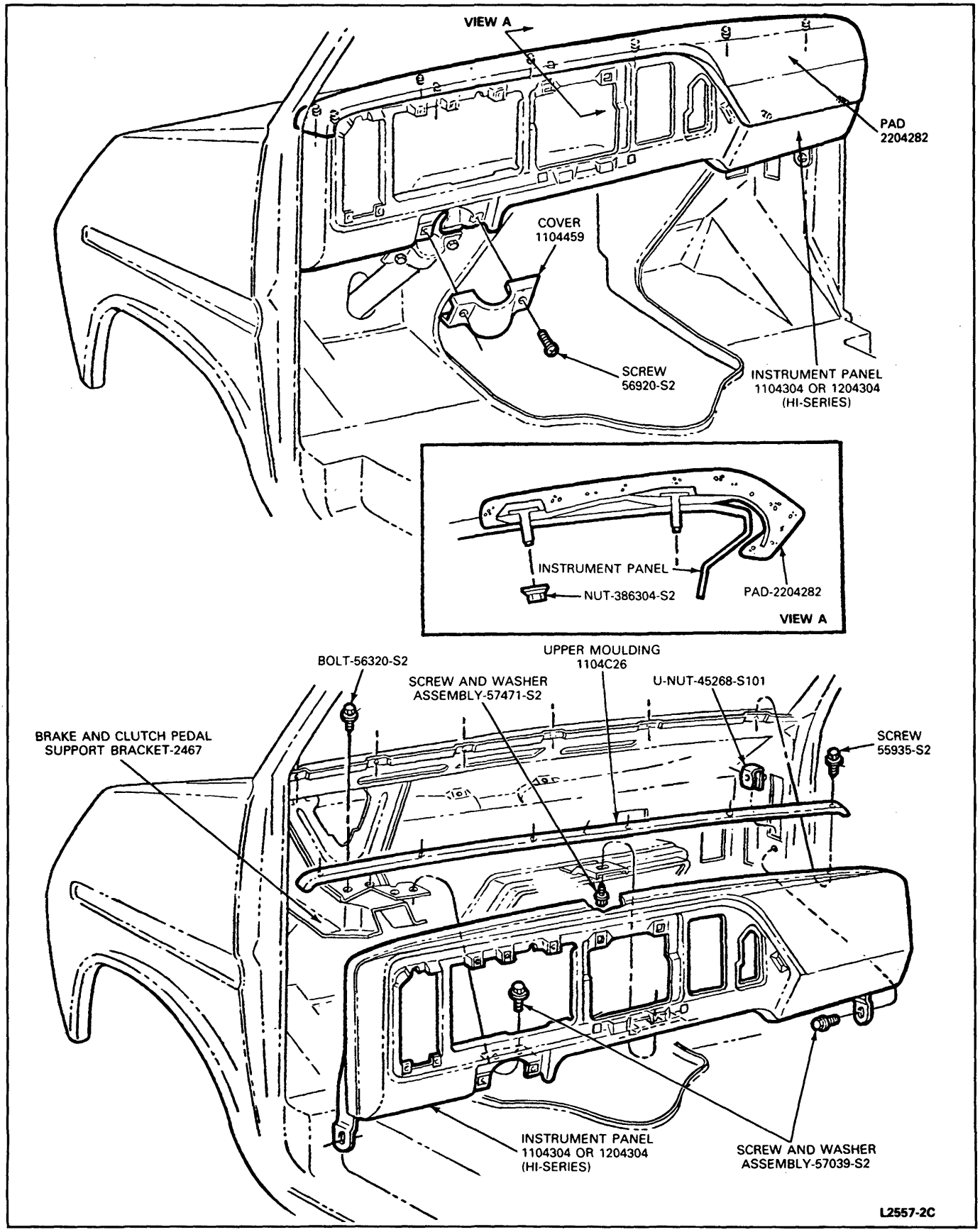


FIG. 4 Instrument Panel Installation—E-150—E-350 and Club Wagon

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TOPS AND EXTERIOR FINISHES

GROUP 46

(70000)

SECTION TITLE	PAGE	SECTION TITLE	PAGE
FIBERGLASS REAR ROOF	46-51-1	TAPE STRIPING	46-30-1

SECTION 46-30 Tape Striping

SUBJECT	PAGE	SUBJECT	PAGE
DESCRIPTION	46-30-1	SPECIFICATIONS	46-30-3
REMOVAL AND INSTALLATION	46-30-1	VEHICLE APPLICATION	46-30-1
REPAIR	46-30-1		

VEHICLE APPLICATION

All Models.

DESCRIPTION

Tape stripes are made from a tough, durable, weather-resistant, solid vinyl with a pressure-sensitive adhesive back. The pressure-sensitive adhesive back is protected by a liner paper which is easily peeled away during installation. During shipment and storage, the face is protected with an easy release pre-mask paper.

REPAIR

Repair small nicks or scratches using touch-up paints mixed to blend with the affected area.

Repair blisters or air bubbles by piercing them with a sharp needle or pin at one end. Work the trapped air out through the pin hole with the thumb moving toward the pin hole (Fig. 1) and press the tape stripe firmly against the panel. It may be necessary to preheat the panel slightly to soften the adhesive. Heat also may be used to remove small wrinkles or irregularities. If bunching occurs around curves, spread bunching over as large an area as possible, then remove wrinkles.

REMOVAL AND INSTALLATION

Removal

1. Clean repair surfaces, adjacent panels, and openings as required.

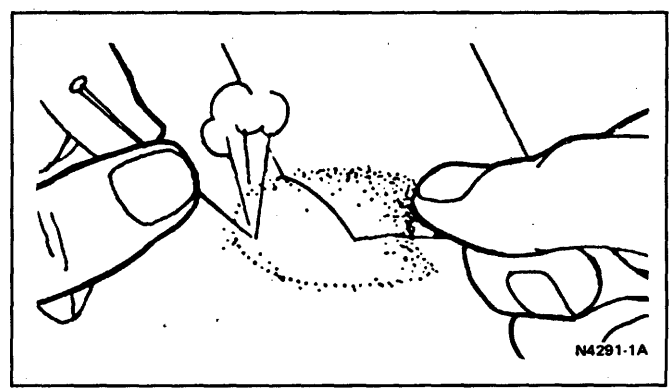


FIG. 1 Removing Entrapped Air

2. Remove any parts overlapping tape stripe from affected panel(s).
3. Remove tape stripe by starting at one edge and peeling it from painted surface. Apply heat to tape stripe to facilitate removal.

   NOTE: Removal can also be assisted by using 3M® Woodgrain and Stripe Remover 08907 or equivalent. Avoid using pointed or sharp tools as they may damage the painted surface.
4. Remove adhesive from painted surfaces using a cloth saturated with 3M® Adhesive Remover 08908 or equivalent. Then, scrape with a squeegee.

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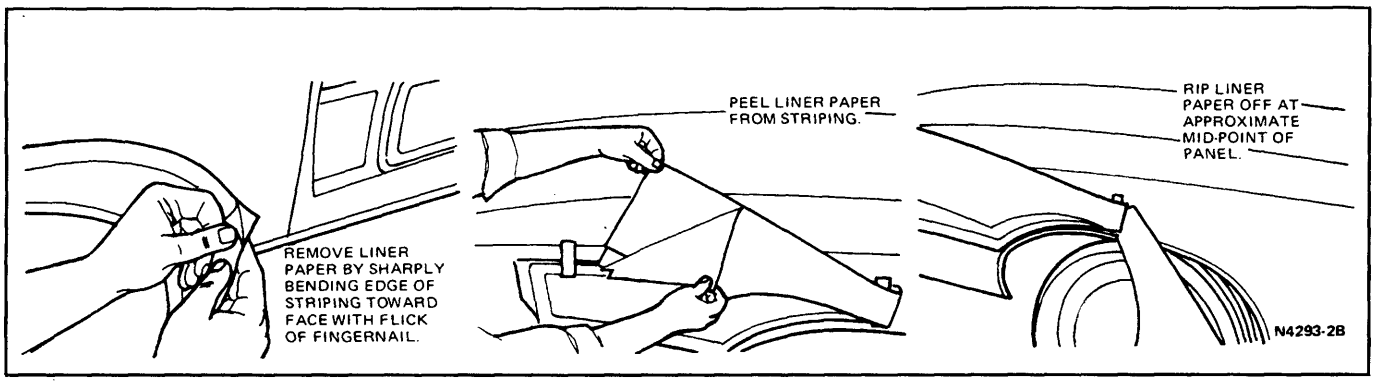


FIG. 2 Removing Liner Paper from Tape Stripe

NOTE: Exercise care when using solvents to avoid possible damage to painted surfaces. To determine if solvent is harmful to body paint, test it on a hidden area of the vehicle.

5. Rinse thoroughly with clean water and/or solvent as required.

Installation—Dry Method (Small or Thin Stripes)

1. Clean painted surface (including wrap-around flanges on door openings) with Silicone and Wax Remover DL60-3271-A or equivalent. Wipe surface with a clean cloth and allow to dry.

   NOTE: Freshly painted surfaces must be thoroughly dry. Residual solvents in fresh paint may cause tape stripe to blister.

2. Position carrier edge or locating darts on tape stripe to body opening character lines on vehicle. Leading edge of tape stripe has a 2.5mm (1/10-inch) tape and liner extension. The rear edge has no extention. This will help determine which edge is forward and which edge is rearward. Using masking tape, tape striping into place. Use particular care when matching tape stripe to character lines.

NOTE: If tape stripe overlaps occur, ensure forward piece overlaps rear piece.

3. Remove liner paper from stripe at the approximate mid-point panel, and tear off liner paper (Fig. 2).
4. Stretch striping into desired location but away from the sheet metal. Using squeegee (piastic), start from center of panel and press striping into position moving toward the end of the panel (Fig. 3).

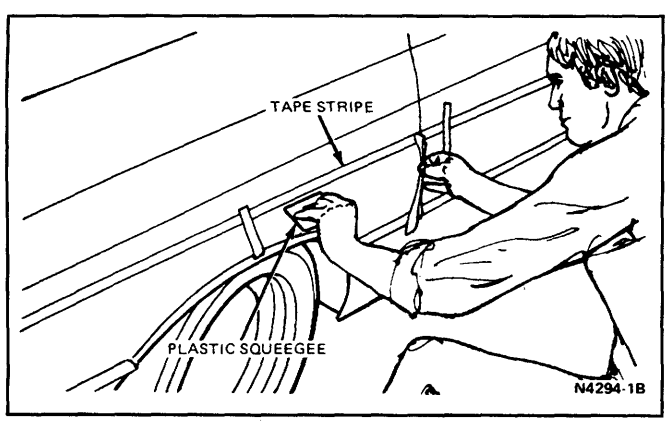


FIG. 3 Installing Tape Stripe with Squeegee

CAUTION: Do not use hands or fingers to smooth out the striping. Use of hands will result in creases and air bubbles in striping.

5. Peel off the remainder of liner paper and press striping into position using plastic squeegee.

NOTE: A 3M® SA-3 Low Friction Sleeve or equivalent should be placed over squeegee when installing large letters to prevent stretching and distortion of applique.

6. Remove pre-mask by pulling at 180-degree angle (knuckles against body panel) away from stripe (Fig. 4). After removal of pre-mask, inspect for bubbles. Remove bubbles as outlined.
7. Mold recessed areas into place using Rotunda Heat Gun 107-00301 or equivalent and a soft, clean cloth (Fig. 5).

Installation—Wet Method (Large Areas—Decal)

1. Mix a teaspoon of standard dish washing detergent in four liters (one gallon) of water. Fill a spray bottle with the solution.
2. Remove liner paper from tape stripe as outlined in Step 3 of Dry Method Installation, or as required.
3. Wet pressure-sensitive side of tape stripe and panel to be striped with detergent solution.
4. Position tape stripe on vehicle as outlined in Step 2 of Dry Method Installation.
5. Using squeegee and firm overlapping pressure, begin from center of tape stripe and squeegee toward the sides and then toward the front (Fig. 3). The tape stripe can be easily lifted and reapplied if air bubbles are present.

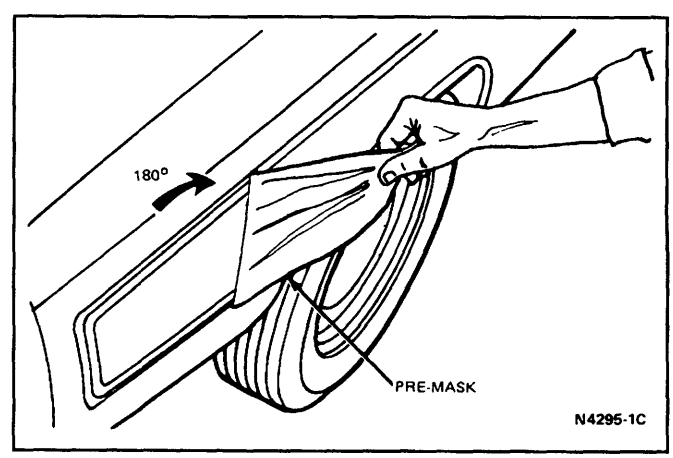


FIG. 4 Removing Pre-Mask Paper

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6. After the tape stripe is fully installed and squeegeed, remove pre-mask (Fig. 4). An assistant can be very helpful in removing pre-mask from large areas. Wetting pre-mask on large decals may facilitate removal.
7. Use Rotunda Heat Gun 107-00301 or equivalent as in Dry Method Installation, to mold decal into recessed areas and dry moisture as required. (Fig. 5).

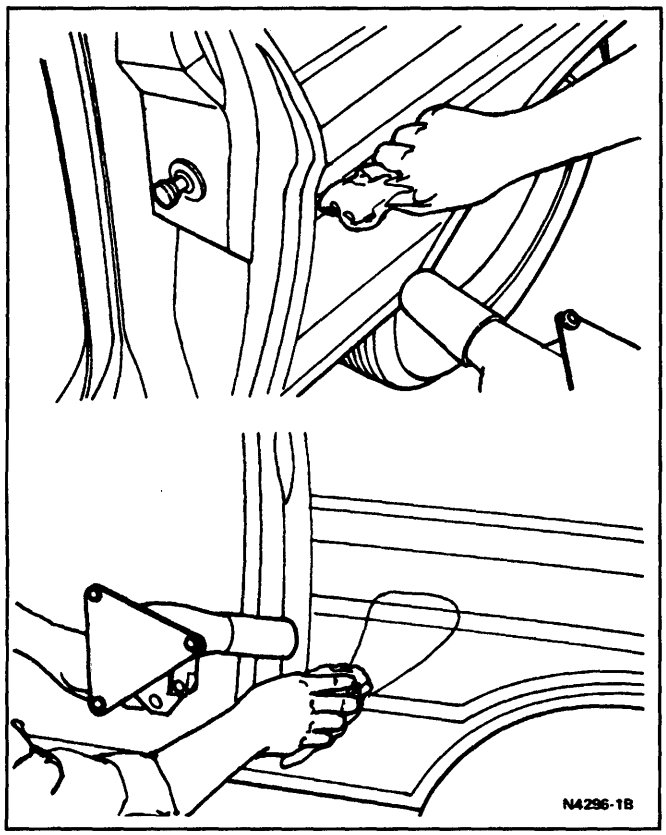


FIG. 5 Molding Striping into Recessed Area

SPECIFICATIONS

ROTUNDA EQUIPMENT

107-00301	Heat Gun

CR5236-1A

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VEHICLE APPLICATION

Bronco Only.

REMOVAL AND INSTALLATION

Weatherstrip Replacement on Roof

To repair or replace the weatherstrips, remove the roof panel assembly as outlined. Rest the roof in an upside down position on the floor, then proceed to service the weatherstrips as shown in Fig. 1.

Stationary Side Window

When removing or replacing the glass, an assistant must be employed to work outside the vehicle.

Removal

1. Working from inside, start at one corner and work across the top of the glass, pulling the weatherstrip down and pushing the glass and weatherstrip outward until the assistant can grasp the glass and lift it from the glass opening.
2. Remove mouldings, if so equipped.
3. Remove the weatherstrip from the glass (Fig. 2).

Installation

1. Clean the weatherstrip with a suitable solvent to remove all old sealer and cement.
2. Clean the glass opening flange. Check the flange for wavy areas, and repair as necessary.
3. Apply Liquid Butyl Sealer C9AZ-19554-B (ESB-M4G162-A) or equivalent in the glass crevice of the weatherstrip and install it onto the glass.
4. Replace mouldings.
5. Run a bead of sealer around the opening flange and in the inner flange crevice of the weatherstrip.
6. Install a draw cord all around the weatherstrip in the flange crevice. Let the draw cords overlap in both mitered corners. Apply soapy water or equivalent to the weatherstrip lip (Fig. 3).
7. Have an assistant position the window assembly in the window opening and apply hand pressure on the glass. From the inside, draw the lip of the weatherstrip over the window opening lower flange with a draw cord. Start at both mitered corners using both cords at same time. Alternate from side to side, moving approximately 305mm (12 inches) at a time, until the window is in place.
8. Water test the installation for leaks, and apply with additional sealer if necessary.

Fiberglass Roof Repair

Surface Preparation

1. Clean the affected area with a Silicone and Wax Remover and inspect the area closely to determine the exact extent of the damage.
2. Using a burr bit on a power drill, form a V-groove the length of the scratch or gouge. The sides of the "V" should be angled no more than 45 degrees.

   NOTE: Exercise care to avoid cutting all the way through the laminate during routing operations.
3. Remove all flaky edges and feather the painted surface back approximately 13mm (1/2 inch) beyond the damaged area by hand-sanding or power-sanding with 360-grit sandpaper.
4. Clean the repair area with dry, oil-free, high-velocity compressed air.

Fiberglass Laminate Repair

1. Following the instructions in the fiberglass repair kit, mix enough filler material on a clean hard surface to re-establish the laminate surface.
2. Just prior to application of the filler material, preheat the repair area using a 375-watt lamp placed 254mm (10 inches) from the repair surface until it is hot to the touch.
3. Using a plastic squeegee, spatula or putty knife, apply and spread the filler material into the repair area, rolling it into the depression and over the surface to avoid excessive air entrapment. Apply sufficient filler material so that the applied repair surface is at least 1.6mm (1/16 inch) above the adjacent laminate surface.
4. Let the filler set up until it is firm to the touch. Then, re-establish the original contour by filing off the excess, leaving the filler level slightly higher than that of the original surface.
5. Pre-shrink the filler, using a Rotunda Heat Gun 107-00301 or heat lamp. A minimum temperature of 48.9°C (120°F) is required for shrinkage.

   NOTE: Keep the heat source at least 305mm (12 inches) away from the repair area.
6. Power-sand the filler with 360-grit sandpaper until it is smooth and even with the original surface. If the

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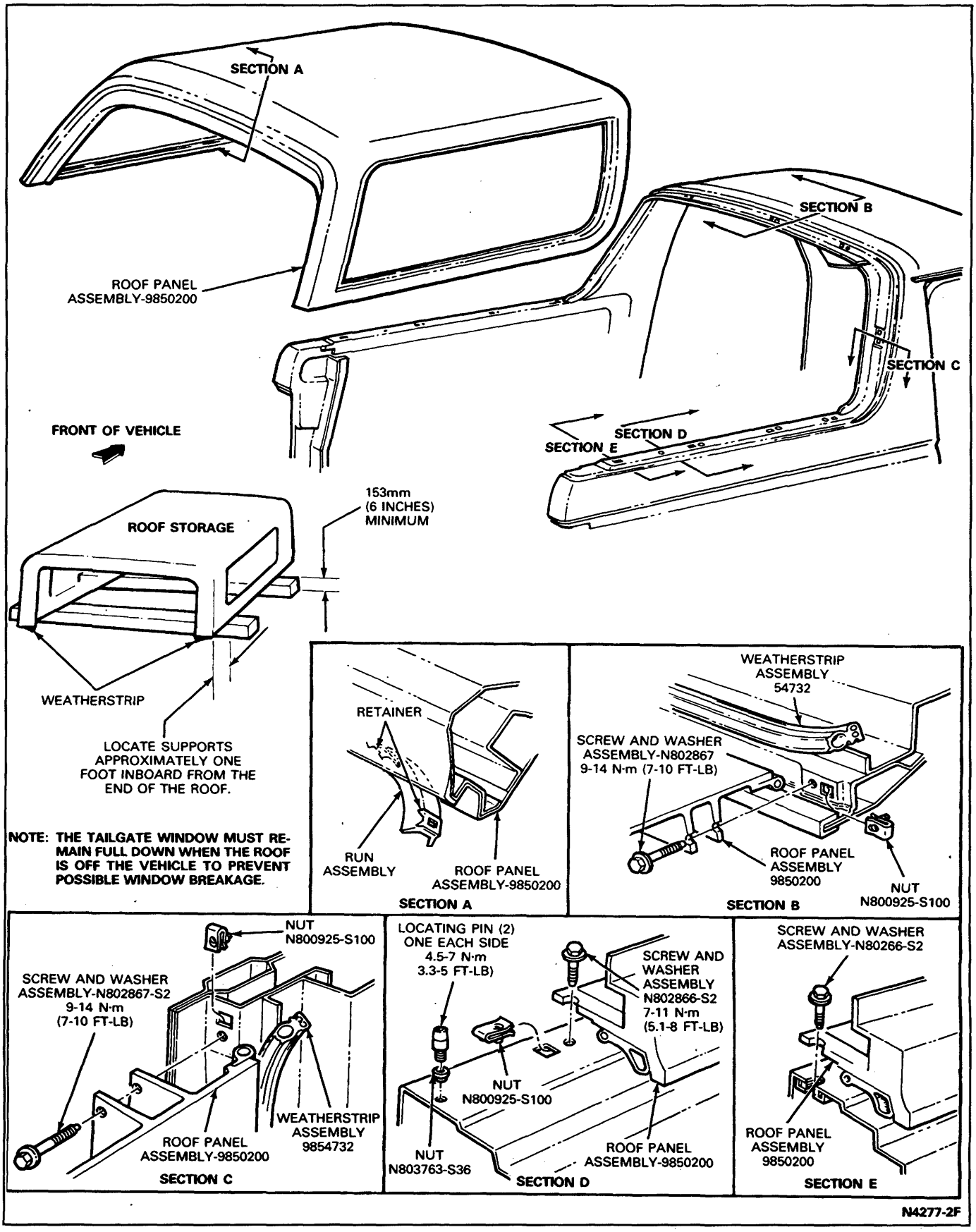


FIG. 1 Fiberglass Roof Removal and Installation

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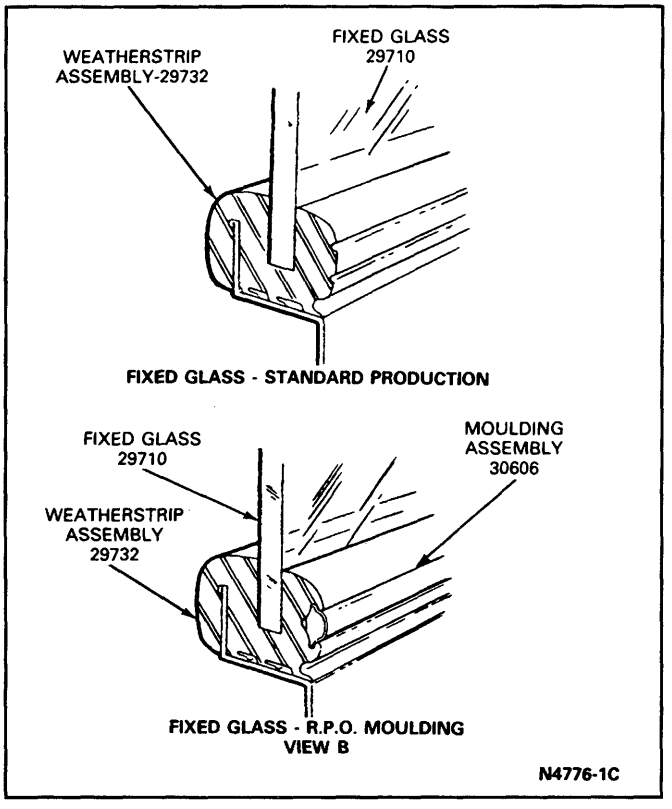


FIG. 2 Window Removal and Replacement

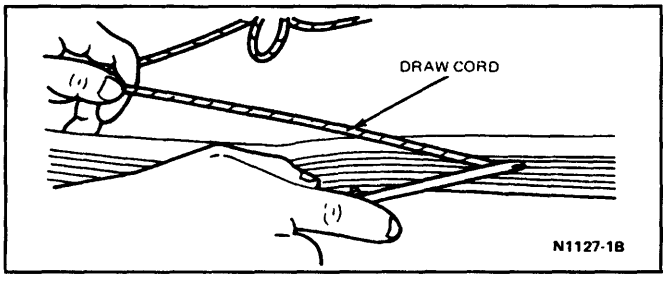


FIG. 3 Draw Cord Installed—Typical

filler surface exhibits fine pinholes, apply a thin coat of glaze wipe or equivalent. If the filler is pockmarked, do not use the glaze wipe. Instead, apply another layer of filler, repeating Steps 1 through 6.

7. Finish by sanding with a sanding block and 400-grit sandpaper.
8. Clean the repair area with dry, oil-free, high-velocity compressed air.
9. Repair the paint (Spatter Texture Coat) using the appropriate painting procedure.

Fiberglass Roof

Removal

1. Lower the tailgate window to the full down position.
2. Lower tailgate.
3. On F-Series Bronco, only remove the lower trim moulding attaching screws and the plastic trim mouldings. Scribe the location of the moulding attaching brackets on the fiberglass roof's surface and number each bracket as it is removed for reference during installation.
4. Remove all the roof attaching bolts and moulding attaching brackets (Fig. 1).
5. Carefully lift the roof off the vehicle to prevent tearing or separating the weatherstrip from the fiberglass roof. The roof weighs 264 kg (120 lb).
6. Remove the two fiberglass roof locating pins (Fig. 1).

   NOTE: The tailgate window must always remain in the full down position when the roof is off the vehicle to prevent possible window breakage.

Installation

1. Install the two fiberglass roof locating pins (Fig. 1). Ensure the tailgate window is in the full down position. Ensure that the tailgate is down.
2. Carefully place the roof on the vehicle, lining up the two locating pins.
3. Loosely install all moulding attaching brackets and roof attaching bolts, ensure that the brackets are located in their original positions.
4. Install the upper roof fasteners (Fig. 1). Install remaining roof fasteners (Fig. 1). Fasteners should be tightened enough to compress weatherstrip without distorting roof.
5. Install the plastic trim mouldings and attaching screws. Using caution not to crack the mouldings, tighten the screws securely.

Fiberglass Roof Storage

To prevent permanent deformation to the portion of the belt weatherstrip extending below the lower edge at the rear of the fiberglass roof, store the removed roof right side up on a level surface at least 152mm (6 inches) above the ground (Fig. 1).

Trim Moulding Storage (High Series Bronco Only)

In order to protect the plastic trim mouldings from damage during storage, it is recommended they be placed inside the removed fiberglass roof.

Tailgate Glass Care

When operating the vehicle in an extremely dusty environment, the tailgate glass should be cleaned periodically with Ford Glass Cleaner E4AZ-19C507-A (ESR-M14P5-A) or equivalent to prevent buildup of surface dust. This will ensure the best possible performance and the greatest number of years of trouble-free service.

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

107-00301	Heat Gun

CR5236-1A

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BODY SHELL, EXTERIOR TRIM, FRAME AND UNDERBODY

GROUP 47

(70000)

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VEHICLE APPLICATION

All Models.

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GENERAL INFORMATION

Type Of Sealers and Application

Since many sealers are used in vehicle assembly, the following all-purpose sealers have been selected for service use. The method and points of application are shown in each applicable group.

Caulking Cord—D6AZ-19560-A, or Equivalent

This sealer has a plastic base with a filler, is heavy bodied and is commonly known as perma-gum. It is used on spotweld holes, around mounting clips, and between two surfaces not sealed by a gasket. Apply the sealer with a putty knife.

NOTE: Meets Ford Specification ESB-M4G32-A.

Rubber Cement—8A-19552-B, or Equivalent

This quick-drying, strong, adhesive cement is designed to cement weatherstripping to doors, bodies, cowl ventilators, and the surrounding metal. Windows and windshields that are set in rubber can be effectively sealed against leakage by flowing cement into affected areas.

Clean all grease, dirt, and old sealer from the surfaces to be cemented. Wash the surfaces thoroughly with a cloth moistened with a suitable commercial cleaner. For best results, apply a medium coat of cement to both surfaces, allow it to dry until tacky, and then press both surfaces firmly together.

NOTE: Meets Ford Specification ESR-M11P16-A.

Liquid Butyl Sealer—C9AZ-19554-B (Black) or Equivalent

This sealer does not run, is fast drying, and remains semi-elastic. The sealer can be used for seam sealing in such areas as the floorpan, wheelhouse, dash panel, running board, door openings and drip rails. It can also be used to seal outside moulding clip holes, and for windshield and back window installation.

NOTE: Meets Ford Specification ESB-M4G162-A.

DIAGNOSIS AND TESTING

Dust and Water Leaks

Remember, the forward motion of the vehicle creates a slight vacuum within the body, particularly if a window or ventilator is partially open. Any unsealed crevice or small opening in the lower section of the body will permit air to be drawn into the body. If dust is present in the air, it will follow.

Under certain conditions, water can enter the body at any point where dirt or dust can enter. Any consideration of water leakage must take into account all points covered under dust leaks.

To determine the exact location of a dust leak, remove the following trim from the cab: the cowl trim panel, the kick pads, and the floor mats.

Removal of the trim will reveal the location of most leaks. Seal these leaks, and road test the vehicle on a dusty road to ensure all leaks are sealed. The entrance of dust is usually indicated by a pointed shaft of dust or silt at the point of entrance. After the road test, check for indications of a dust pattern around the door openings, cowl panel, and cowl side panel.

Sometimes leaks can be located by putting bright lights under the vehicle with the above components removed, and checking the interior of the body at joints and weld lines. The light will show through where leaks exist.

Floorpan Plugs and Grommets

Many plugs and grommets are used in the floorpan and dash panel. The floorpan plugs seal the various body bolt access holes.

If any plugs are missing or damaged, a dust or water leak may result. Such leakage may also occur around grommets used on the dash panel. When dust or water leaks are evident, these plugs and grommets should be checked for proper installation.

Drain Holes

Drain holes are located on the underside of each door along the weld line of the inner and outer panels. If these holes become clogged with mud or road tars, water will collect inside the panels and rust the sheet metal from the inside. A sound of sloshing water in a door is an indication of this condition.

Check the drain holes regularly. Clean the drain holes of dirt and foreign material with a punch or screwdriver.

Wind Noise

Air entering or exiting the vehicle through small openings in the body can result in wind noise. Sources of wind noise are detected by driving the vehicle at highway speeds in four different directions. Listen for sources of wind noise with all windows closed, radio off, heater and air conditioner blower motor turned off and ventilation ducts open. A stethoscope can be used to pinpoint the source of the noise.

Most wind noise-producing leaks will occur at the door and window seals or at sheet metal joints in the door or the door opening in the body.

Seal all leaks with RTV sealant and foam tape or by positioning or replacing the seals. Road test the vehicle to ensure all leaks have been adequately sealed.

An alternate method of verifying corrective actions involves the use of Rotunda Ultrasonic Leak Detector 029-00001 or equivalent. After identifying the leak point through a drive evaluation, obtain a meter reading by using the leak detector. A check with the leak detector after repairing the leak will verify the effectiveness of the corrective action. A final test drive may still be advisable to ensure that other objectionable leaks, not noticed because of a major leak, do not exist.

Rattle Elimination

Most rattles are caused by loose foreign objects such as nuts, screws, bolts or small pieces of body deadener in the door wells, pillars, and quarter panels. Door wells can be checked by carefully striking the underside of the door with a rubber mallet. The impact made by the mallet will indicate if loose objects are in the door well.

All bolts and screws should be tightened periodically. In the event that tightening the bolts and screws located on such assemblies as the doors does not eliminate the rattles, the trouble is probably caused by **misalignment.** If this is the case, follow the adjustment and alignment procedures for these assemblies.

Rattles and squeaks are sometimes caused by weatherstripping and anti-squeak material that has slipped out of position. Apply additional cement or other

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adhesive, and install the material in the proper location to eliminate this difficulty.

ADJUSTMENTS

Checking Body For Misalignment

To align or square up a body, take two opposite diagonal measurements between pillars. Use a measuring tram for these measurements. Take the measurements between reference points such as crease lines or weld joints which are diagonally opposite each other on the two pillars being measured. Since all measurements should be made from the bare metal, remove all interior trim from the checking points.

In some cases, it is difficult to obtain proper body alignment when repairing a body that is damaged on both sides. In these cases, horizontal and vertical measurements can be taken from a body of the same body style. Once these basic dimensions are taken and established on the damaged body, alignment can be made by diagonal measurements taken from points on the two pillars.

Do not attempt to correct any serious misalignment with one jacking operation. This is particularly true if other sections of the body also require aligning. Align each section proportionately until the proper dimensions are obtained.

Door openings are checked in the same manner as the body. Horizontal, vertical, and diagonal checking points are established on all four sides of the door opening that is being measured.

Frame Inspection

Frame misalignment is the result of damaged or loose frame components.

Before checking frame alignment, inspect the frame for damage and loose parts. Inspect all frame members for cracks, twists, or bends. Check all welded connections for cracks. Inspect all rivets, bolts, and body support brackets for looseness. Make all necessary repairs or replacements.

Diagonal or X Frame Checking Method

Frame alignment can be checked without removing the body from the frame by using the diagonal or X checking method.

This method should be used to identify misalignment prior to any attempt to straighten a frame.

1. Place the vehicle on a clean level floor and set the parking brake.
2. Select at least four points along one frame side member and transfer these points to the floor with a plumb bob. If desired, paper can be taped on the floor along both sides of the vehicle below the frame. Mark the points on the floor as accurately as possible.
3. Locate the corresponding points along the opposite frame side member and transfer these points to the floor in the same manner.
4. Move the vehicle away from the marks on the floor, and measure diagonally between all points on the floor. Both measurements should be equal within 6.35mm (1/4 inch).
5. Measure between corresponding points parallel to the frame side members. These measurements should be within 3.18mm (1/8 inch) of each other.

The squareness of the frame side member web to the floor at the spring hangers and at the steering gear mounting location should be within 1.59mm (1/16 inch). The squareness of the frame side member web to the floor at all other points should be within 3.18mm (1/8 inch). The web and flange should be square at all other points within 3.18mm (1/8 inch).

Any point on one side member should be within 3.18mm (1/8 inch) ahead, behind, above, or below the corresponding point on the opposite side member. The frame side member should not be bowed more than 3.18mm (1/8 inch) for each 2540mm (100 inches) of frame length. The overall width of the frame should not vary more than 3.18mm (1/8 inch).

NOTE: An alternate method of checking frame alignment is to use a frame gauge.

REPAIR OPERATIONS

Frame Repair

Drilling Precautions

Do not drill holes in the frame flanges, since this tends to reduce the frame strength.

If a hole must be drilled in the frame, insure that it meets all the following requirements:

1. The hole is located in the upper half of the frame.
2. The edge of the drilled hole and the edge of the nearest hole are at least 25mm (1 inch) apart.
3. The edge of the drilled hole is at least 25mm (1 inch) from the edge of the flange.
4. The drilled hole is not adjacent to any other existing frame brackets or components.

Welding Precautions

Disconnect the negative battery ground cable before using electric welding equipment.

All frame welding **must** be done with electric welding equipment, and the heat should be kept in a small area to prevent change in hardness of the metal. **Do not use gas welding equipment. A double reinforcement must be added to frames where heat or weld is applied to the area to be repaired. The welds are to run lengthwise along the reinforcement when a reinforcement is to be welded to a side member.**

Frame Straightening

Frame misalignment can be corrected by straightening the out-of-line parts or by replacing the crossmembers, braces, or brackets if they are badly damaged.

Straightening should be attempted on frames that fail to meet specifications of the diagonal checking method or where damage is visually apparent.

However, to prevent internal stresses in the metal, frame straightening should be limited to parts which are not severely bent. **If heat is needed to straighten a frame member, keep the temperature below 649°C (1200°F) (a dull red glow). Excessive heat may weaken the metal in the frame members and cause permanent damage.**

Frame Reinforcing

After a bent frame member has been straightened, inspect the member closely for cracks. If any cracks

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show, the frame member should be reinforced or replaced.

Reinforcements should be made from angle of flat stock of the same material and thickness as the frame member being reinforced, and should extend a minimum of 152.40mm (6 inches) to either side of the crack. Ideally, the reinforcement should be cut from the corresponding area of a similar frame.

Weld Attachment

The following procedure must be adhered to if it is deemed necessary to weld reinforcements to the frame and to ensure quality repair.

The crack should be prepared before welding the reinforcement to the cracked frame member by wire brushing the area around the crack to remove the paint, grease, mud, etc. to completely expose the crack and assure good weld adhesion. To stop the crack from spreading, drill a 6.35mm (1/4-inch) hole at a point 12mm (0.50 inch) beyond the root of the crack. Grind out the full length of the crack to the hole to form a V-shaped slot with the base of the "V" contacting the reinforcement. The base of the "V" should have at least 1.52mm (.06 inch) opening to insure weld penetration to the reinforcement when welding the crack. Drill clearance holes in the reinforcements, to clear rivet heads and bolt heads or nuts where necessary.

In the event that repair is required to more than one frame surface (i.e., a flange crack which extends into the web) two pieces of flat stock (one for each surface) should be utilized and welded together where they join (Fig. 1). The web reinforcement should be a minimum 76.20mm (3.0 inch) high and have 63.50mm (2.5 inch) radius at each of the two corners.

Completely clean the frame surface under and around the reinforcements. Clamp the reinforcements securely to the frame prior to welding. Weld the reinforcement all around after welding the crack "V" to the reinforcement (Fig. 1). The flange edge weld should be ground smooth after all pit holes have been filled by the weld.

If a damaged, bolted on frame bracket is to be replaced, the new bolts, washers, and nuts should be of the same specifications and bolt torques as the original parts.

In cases where it is necessary to remove rivets, replace them with Grade 8 nuts, bolts and washers of the next larger size (i.e., for 3/8 diameter rivets use 7/16-inch bolts, for 7/16 diameter rivets use 1/2-inch bolts). This requires line drilling of the holes to the same diameter as the new bolt (i.e., either 0.437 diameter or 0.500 diameter).

Frame Member Replacement

If a damaged frame member is to be replaced, new bolts, Grade 8 fasteners, and rivets required for replacement of parts should be of the same specifications as the original bolts or rivets. In cases where it is necessary to substitute a bolt for a rivet, use the next larger size bolt.

Fiberglass Repair

Safety Precautions

Always use rubber gloves or the special hand cream supplied with epoxy resin repair kits. **REMOVE ANY RESIN FROM HANDS AS SOON AS POSSIBLE AND**

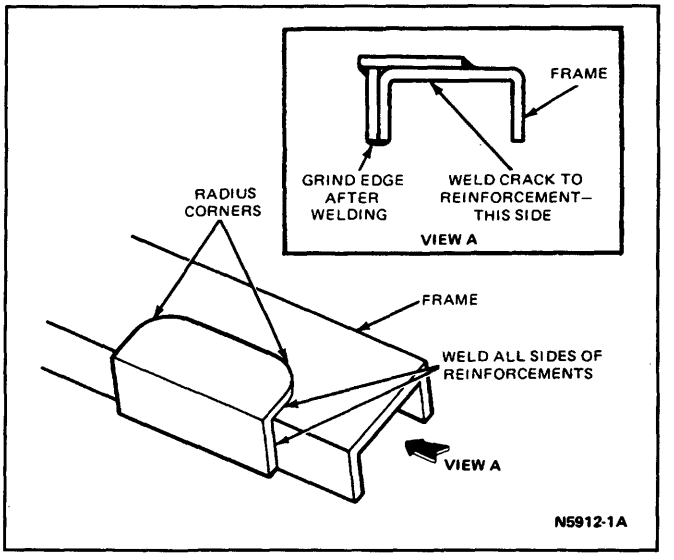


FIG. 1 Weld Attachment of Frame Reinforcement—Two Frame Surfaces

PARTICULARLY BEFORE THE MIXTURE STARTS TO GEL. Any resin that adheres to the hands may be removed with lacquer thinner followed by a thorough washing with soap and water.

Use a respirator when grinding the fiberglass surface and use a vacuum attachment when operating a belt sander.

Always work in a well ventilated area in order to avoid possible toxic fumes that may result from using resin mixtures. Exercise care so as not to get any resin on clothing.

Keep all materials, utensils and the work area clean and dry as resin repairs involve chemical reactions. Any dirt, foreign material or moisture may upset the chemical reaction and result in an unsatisfactory repair.

Repair Procedure

Grind or sand away all loose or broken material at the damaged area. Scuff sand the surface approximately 25.4mm (1 inch) around the area to provide a good bonding surface. Ensure the surface to be repaired is clean, dry, oil and paint free.

For cracks, form a shallow V-shape along the crack with a file or grinder. Fill the area with a good quality polyester or epoxy body repair compound. Follow the manufacturer's directions with regard to mixing procedures. Allow the compound to harden and then sand smooth. If the surface is not level or smooth, use an additional filling and sand to a final smooth finish.

For larger broken areas use fiberglass cloth (five layers) impregnated with the resin, to cover the area. Overlap the damaged portion by 25.4-50.8mm (1-2 inches). When the material has hardened, file or grind and sand smooth. If low spots exist, fill them with resin mixture to which short fibers cut from the fiberglass cloth have been added. Add enough on the cloth to form a putty-like resin mixture.

Painting

After the desired repaired surface has been obtained, prime and paint the surface in the normal manner.

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CLEANING AND MAINTENANCE

Chrome and Bright Metal Care

Many parts of the vehicle, such as the bumpers and body hardware, are chrome-plated or anodized aluminum. These finishes are susceptible to corrosion due to salt air near coastlines (or salt spray during winter), factory smoke and other conditions found in today's cities. When such conditions exist, frequent washing and the use of Ford Bright Metal Cleaner 8A-19522 or equivalent wax or polish is recommended.

Do not use steel wool, abrasive-type cleaners or strong detergents containing highly alkaline or caustic agents on chrome plated or anodized aluminum parts. These methods or cleaners may damage the protective coating and cause discoloration and/or paint deterioration.

Vinyl Insert Moulding Care

Rinse the vinyl to remove loose dirt and grime. Exceptionally dirty areas should be pre-cleaned with Ford Triple Clean E0AZ-19526-A or Ford Multi-Purpose Cleaner B8A-19523-A diluted to proper concentration per label directions or mild soap solution. Next, apply Ford Vinyl Hardtop Cleaner E3AZ-19F535-A or equivalent following label directions.

Commercial hot waxes applied at automatic car washes have been known to affect cleanability of vinyl material.

CAUTION—To avoid damage to the vinyl insert mouldings, use only an approved Ford cleaner, or equivalent. The use of stiff bristle brushes or abrasive material or cleaners must be avoided.

Bumpers and Trim

The bumpers and trim on the vehicle requires no special care. Periodic cleaning will preserve the beauty and life of these finishes. Wash with clear water or if the parts are very dirty, use Multi-Purpose Cleaner B8A-19523-A or an equivalent compound. Using a clean soft cloth or a sponge and water, rinse and wipe the parts dry. Ford Bright Metal Cleaner 8A-19522 or equivalent may be used sparingly to remove rust or salt corrosion from chrome plated parts. Do not scour aluminum- or chrome-finished parts with steel wool or polish them with products containing abrasives. A coating of wax will provide excellent protection for all bright metal parts.

Body Maintenance

Regular body maintenance preserves the vehicle's appearance and reduces the cost of maintenance during the life of the vehicle. The following steps are suggested as a guide for regular body maintenance:

1. Vacuum the interior thoroughly and wash the vehicle.
2. Check all openings for water leaks, and seal where necessary.
3. Inspect loose weatherstrips for width of channel. Crimp as required to ensure retention to body flange.
4. Replace all door and tailgate weatherstrips which are unfit for service.
5. Replace all cracked, fogged, or chipped glass.
6. Align the hood and doors if necessary.
7. Inspect the windshield wiper blades and replace them if necessary.
8. Tighten the sill plate and garnish moulding screws.
9. Clean the seats, door trim panels, and headlining.
10. Touch up or paint chipped or scratched areas.
11. Periodically clean drain holes located on the underside of each rocker panel, quarter panel, and door.

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Number	Description
029-00001	Ultrasonic Leak Detector

CN6031-1B

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VEHICLE APPLICATION

F-150 Through F-350 and Bronco Truck Models.

REMOVAL AND INSTALLATION

Radiator Grille

Refer to Fig. 1.

Removal

1. Remove two expansion screws retaining grille assembly to headlamp housings.
2. Carefully push in on bottom of four moulded snap-in retainers to disengage from headlamp housings. Remove grille assembly from vehicle.

Installation

1. Carefully position radiator grille to headlamp housings making sure moulded snap-in fasteners are aligned with slots in headlamp housings.
2. Using hand-pressure, push corners of grille inward until snap-in barbs of moulded fasteners engage in headlamp housings.
3. Insert plastic expansion screw nuts into grille and headlamp housings. Push expansion screws into plastic nuts until screws are fully seated.

Front Fender

Removal

1. Clean all dirt from the fender attaching screws, bolts and nuts.
2. Remove headlamp assemblies from the vehicle as outlined in Section 32-03, Headlamp System.
3. Remove the screws attaching the front of the fender to the radiator support at upper and lower locations.
4. Remove one screw attaching the rear lower end of the fender to the lower corner of the cab (Fig. 2).

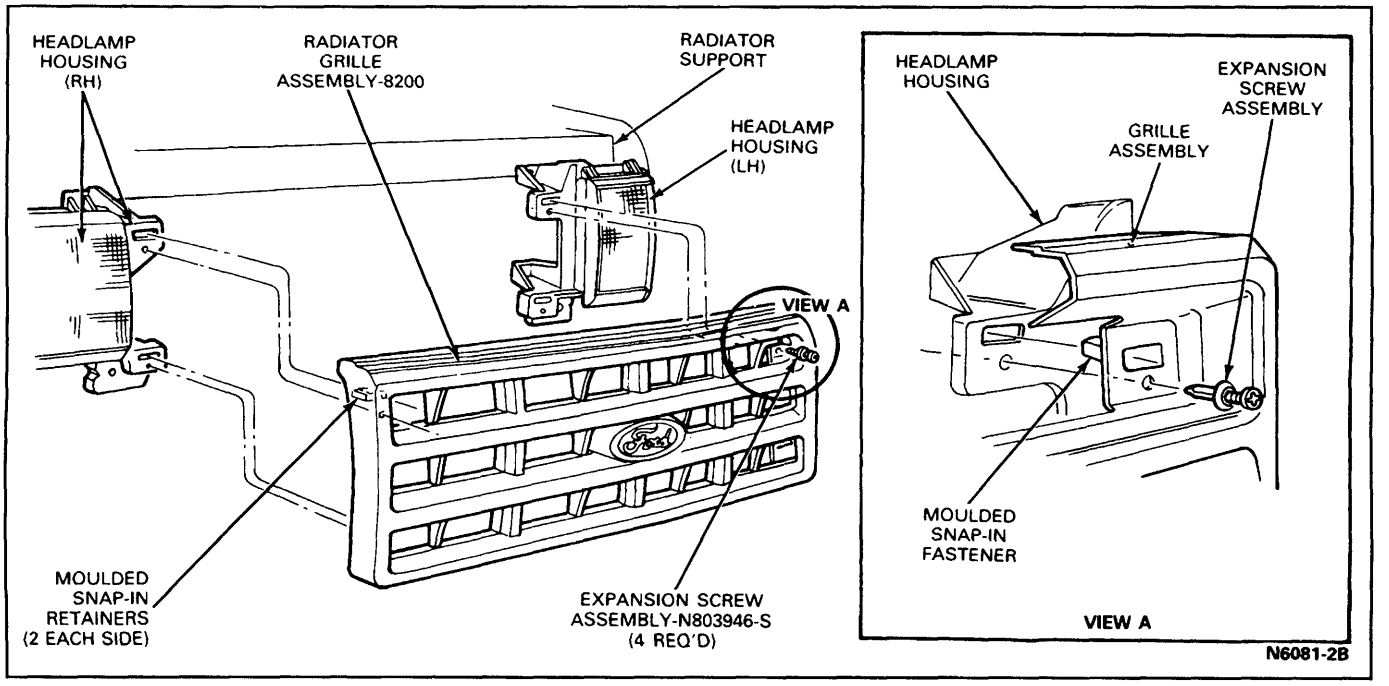


FIG. 1 Radiator Grille—Bronco and F-150—F-350

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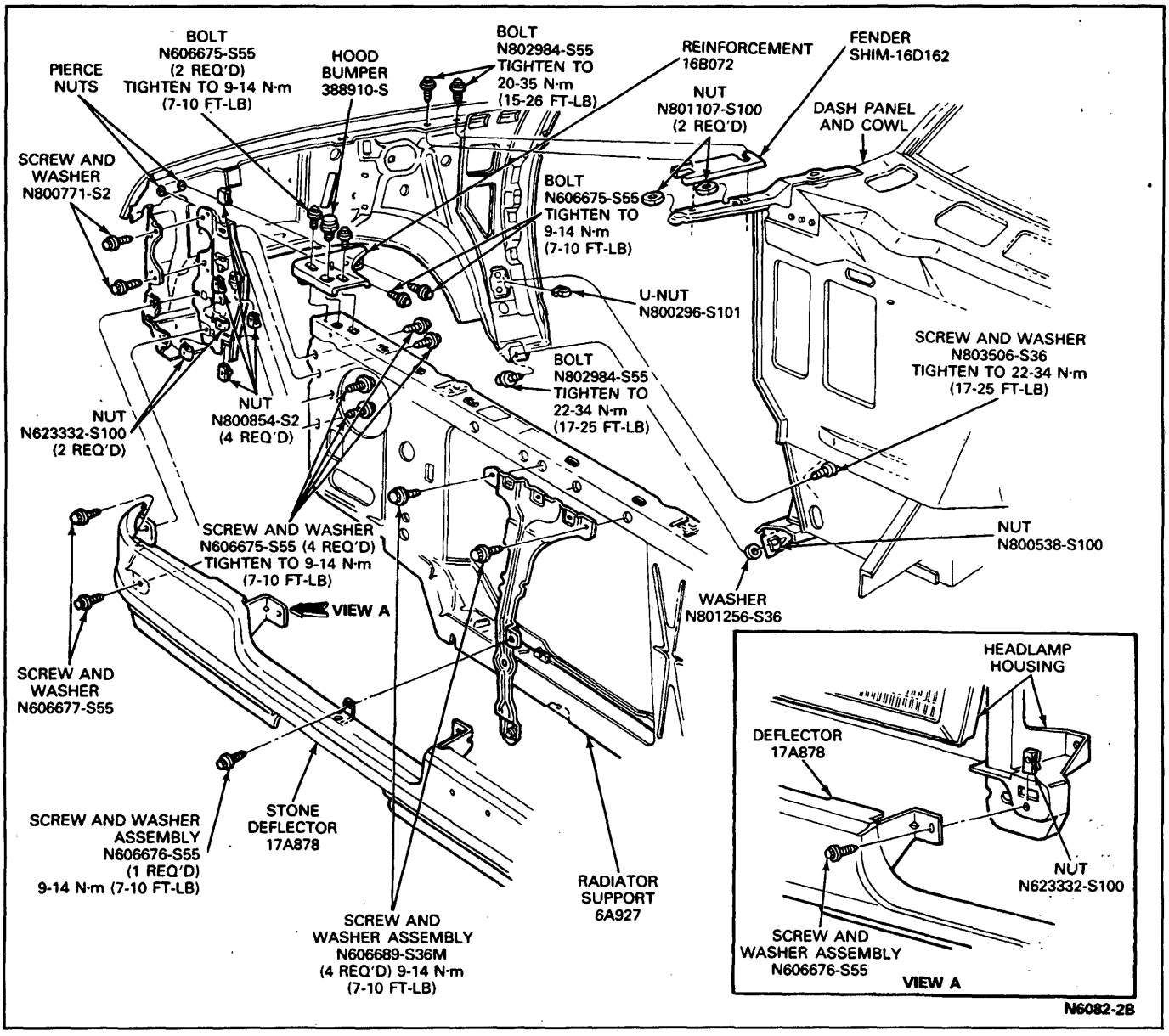


FIG. 2 Front Fender Installation Right Side—F-150—F-350 and Bronco

5. Remove one screw from inside the cab attaching the rear lower end of the fender to the cowl.
6. Remove the screws attaching the top edge of the fender at the rear, to the cowl extension.
7. Remove screws around wheel opening attaching the fender apron (Fig. 3).
8. Remove the bolts along top of apron that attach to fender.
9. Remove bolts attaching battery tray to fender (RH only) and bolts attaching auxiliary battery tray or tool box (both R.P.O.) (LH only).
10. Remove hood latch cable from LH fender and main wiring harness from RH fender.
11. Remove the screw attaching the hood prop spring to the fender and remove fender.

Installation

1. Position the nuts and retainers on the fender.
2. Apply sealer to the upper edge of the apron.
3. Position the fender to the apron and loosely install the screws.
4. Loosely install one screw from the inside of the cab, attaching the rear lower end of the fender to the cowl.
5. Loosely install a screw, attaching the rear lower end of the fender to the lower corner of the cab.
6. Loosely install the screws, attaching the front of the fender to the radiator support.
7. Adjust the fender position and tighten all mounting screws.
8. Install the hood prop spring to the fender.
9. Install headlamp assemblies as outlined in Section 32-03, Headlamp System.

Rear Fender

F-350, with Dual Wheels

Refer to Fig. 4.

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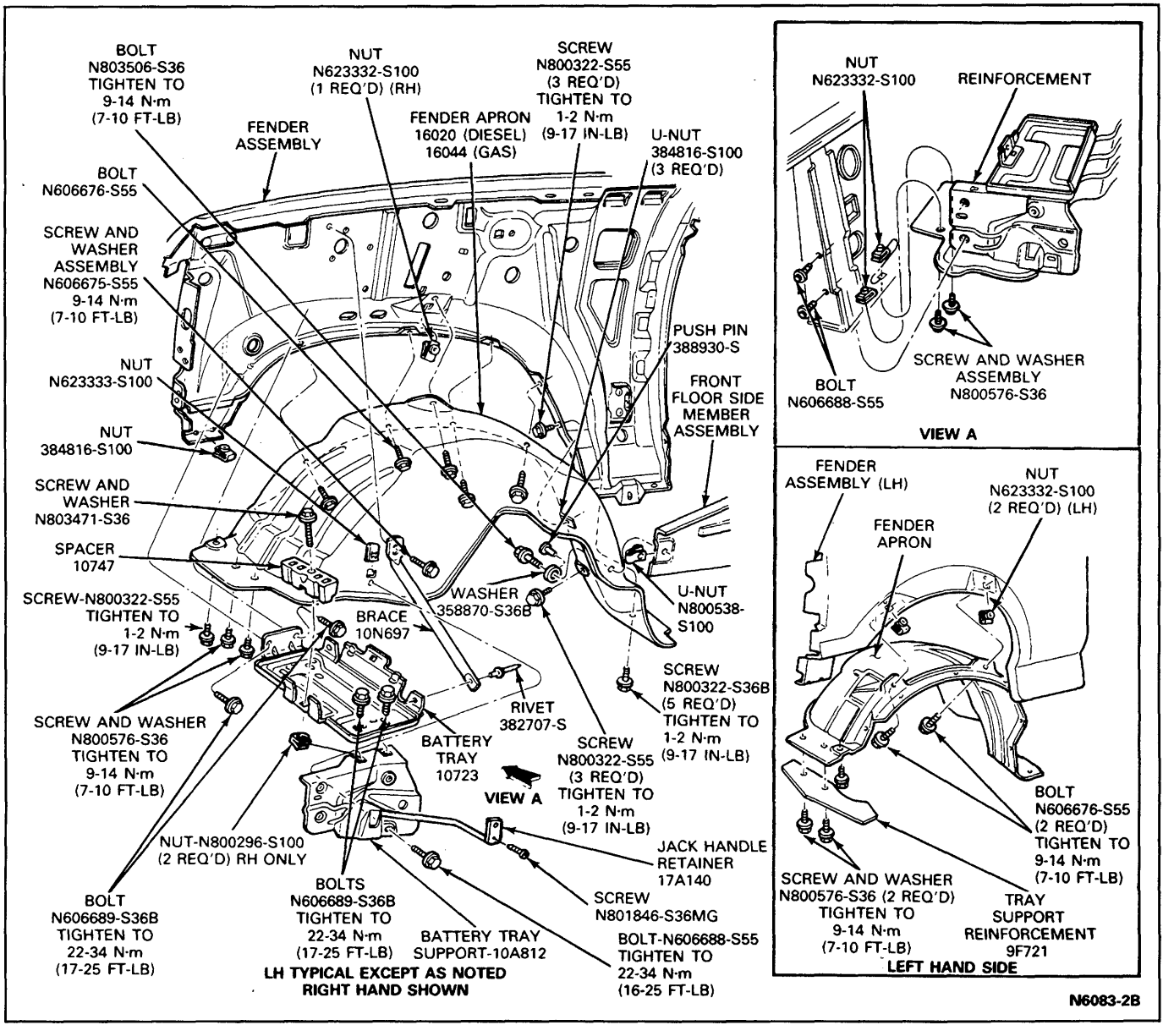


FIG. 3 Fender Apron Installation, Right Side—F-150—F-350 and Bronco

Removal and Installation

1. Remove two upper and one lower splash shield-to-fender attaching nuts and bolts (Fig. 4).
2. Remove front and rear fender brace attaching bolts.
3. Remove 11 fender-to-body attaching bolts.
4. Support fender and remove two (one each upper corner) fender-to-body retaining nuts. Remove fender.
5. To install, reverse Steps 1 through 4. Tighten all attaching nuts and bolts to specifications (Fig. 4).

Front Bumper

The front bumper installation for all light truck models is shown in Fig. 5.

Removal

1. Remove nuts retaining bumper brackets to frame rails.
2. Remove screws from brackets and remove bumper and brackets from vehicle.
3. If bumper is to be replaced by a new one, transfer bumper brackets to new bumper.

Installation

1. Position bumper and brackets to frame rails.
2. Install bracket-to-frame retaining bolts and tighten nuts.

Exterior Mouldings

Removal and Installation

Before removing the exterior mouldings, determine the type of retainer used if it is necessary to remove an interior trim panel (Figs. 6 through 9). Super Cab models use conventional exterior mouldings except in the area of the cab extension. If a weld stud is distorted or broken off, it should be replaced with a drill point screw (379560-S101).

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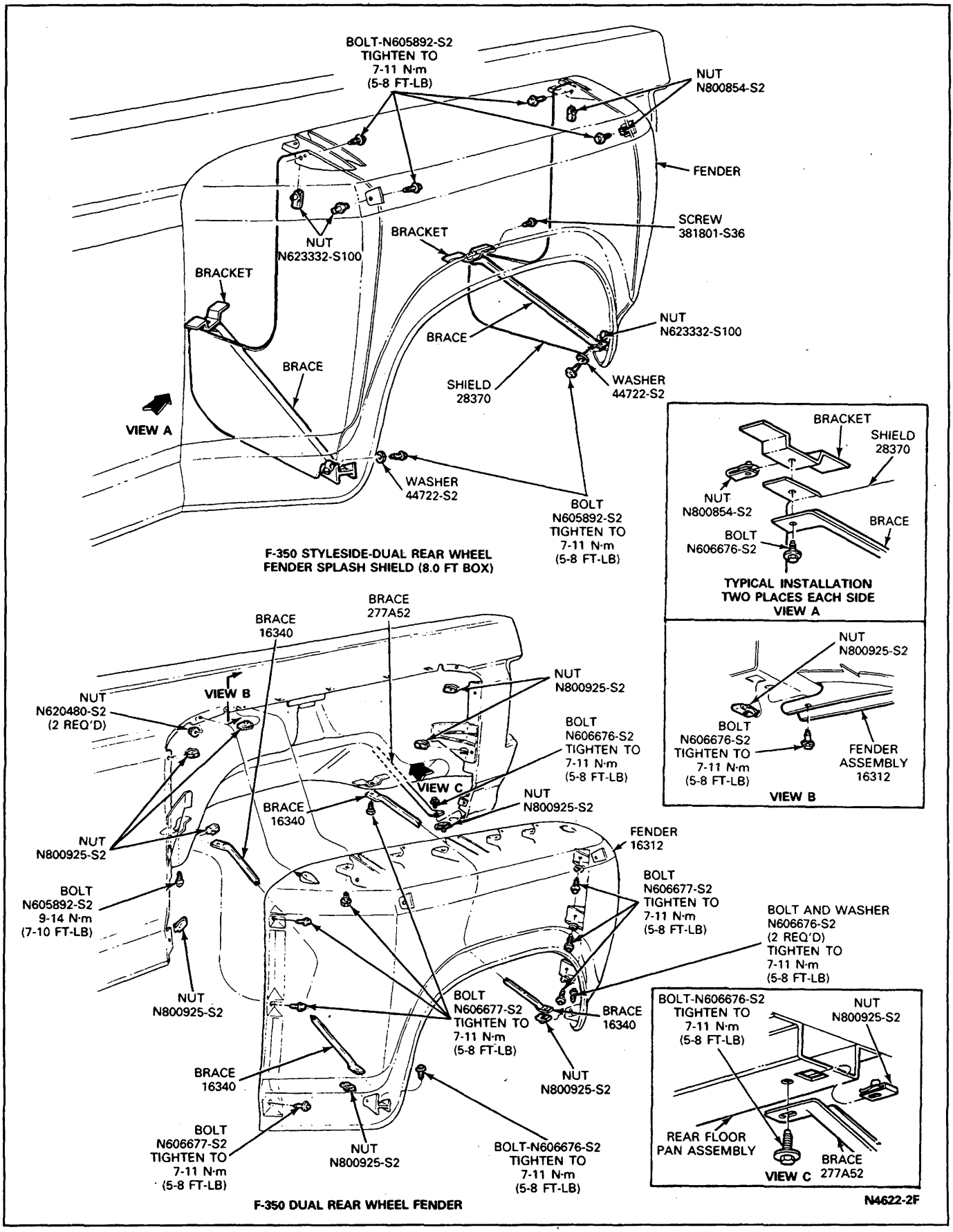


FIG. 4 Dual Wheel Rear Fender—F-350

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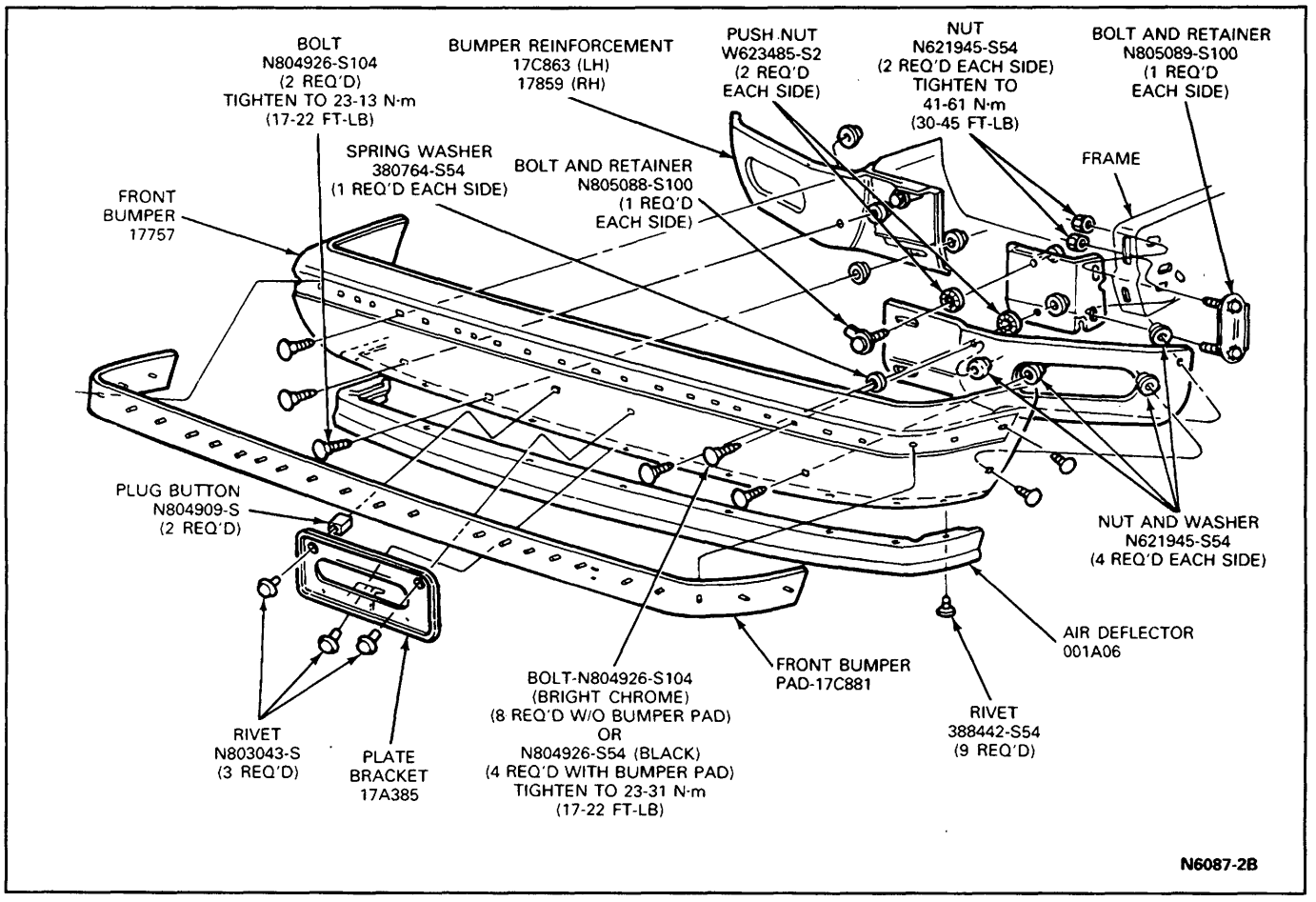


FIG. 5 Bumper Installation—F-150—F-350 and Bronco

Body Mounts

F-150—F-350—Regular, Super Cab and Superduty

The body mounts for F-150—F-350—regular and super cab are shown in Fig. 10.

Bronco

The body mounts for Bronco are shown in Fig. 11.

Spare Tire Carrier

Under Frame—F-150—F-350, F-350 Chassis Cab and Superduty

The spare tire is stowed at the rear of the truck under the frame (standard location).

CAUTION: Due to possible air seepage at the tire rim or valve, the spare tire may lose air and become loose in the carrier. Therefore, check the spare tire at least twice a month for proper inflation. Any evidence of tire movement under hand pressure or foot kicking indicates that the spare tire requires air. Correct the cause for leakage and then inflate the tire to the pressure recommended on the Safety Compliance Certification Label for original equipment tires located on door pillar—LH side.

NOTE: The tire valve stem is on the top side of the tire to reduce the possibility of accidental valve stem air leakage through contact with mud, brush, snow, ice, or some other obstruction.

WARNING: TO AVOID POSSIBLE INJURY DO NOT PLACE ANY PART OF THE BODY UNDER THE CHANNEL WITH MOUNTED SPARE TIRE DURING ITS REMOVAL OR INSTALLATION.

Removal

1. Insert the tang of the lug nut wrench through the spare tire retaining eyebolt eye and turn the bolt until the tire is sufficiently loose from the upper retaining support (Figs. 12, 13 and 14). To avoid a sudden drop off of the tire do not turn the end of the eyebolt out of the retaining nut.
2. Align the eye of the eyebolt with the channel slot.
3. While holding the nut end of the wrench parallel to the ground, insert the tang of the wrench into the channel assembly tube. Lift up on the wrench and at the same time pull the eyebolt toward the tube and push on the wrench to pass the eyebolt shoulder through the channel keyhole.
4. Lower the spare tire assembly. Swing the channel to the rear of the vehicle and remove the wrench from the tube.
5. With the channel assembly end on the ground, remove the wheel retainer from the center bolt. If necessary insert the tang of the wrench through the retainer handle to provide additional leverage to loosen the retainer from the center bolt.
6. Remove the spare tire from the channel assembly.

Installation

1. To replace the spare tire under the frame, center the tire on the channel assembly (Figs. 12, 13 and

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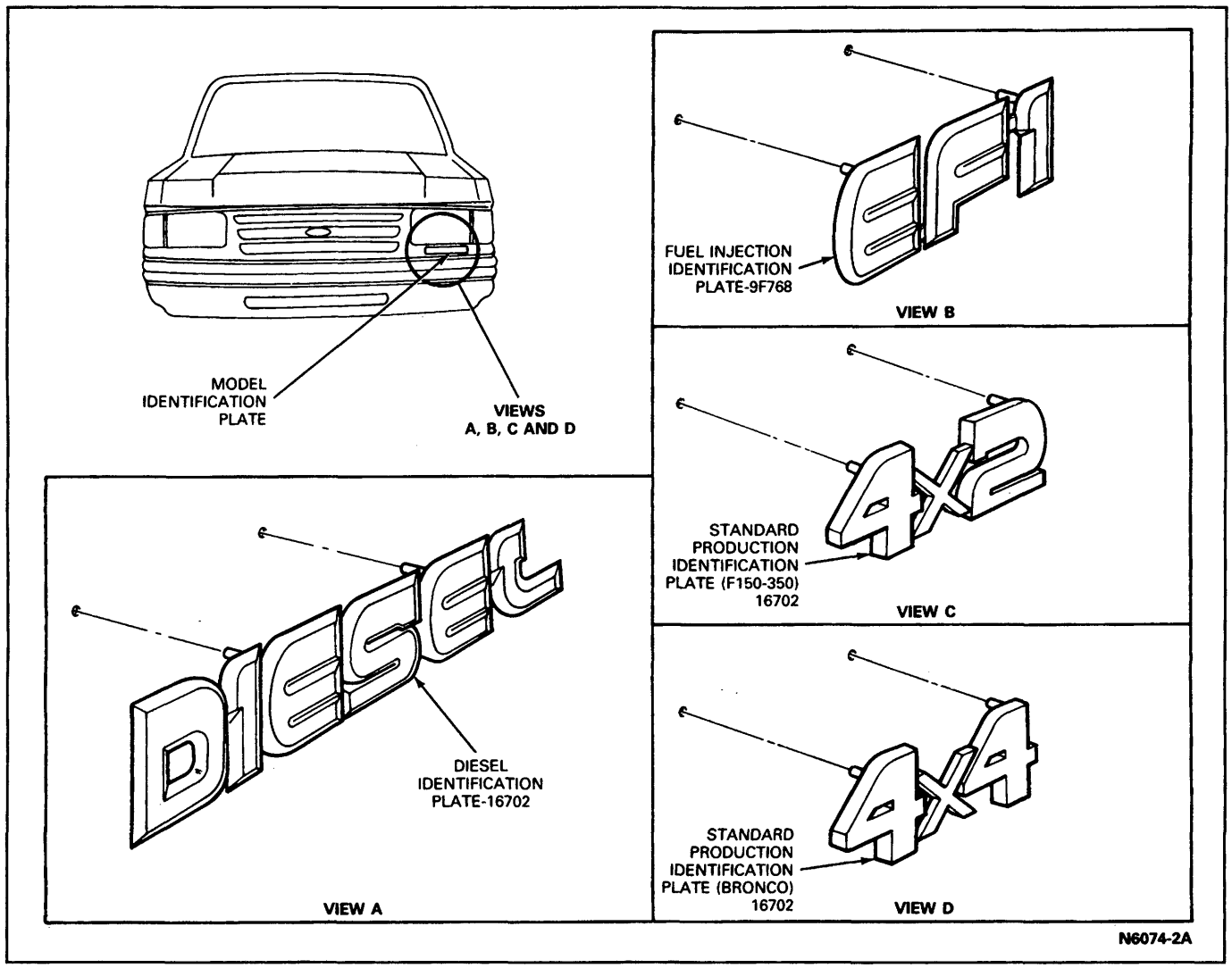


FIG. 6 Exterior Ornamentation, Front Identification Plates—F-150—F-350, Bronco

14). Shift the tire as necessary until it is balanced on the channel. Install and always tighten the retainer on the center bolt until the wheel is tight to the channel.

2. Install the tang of the lug nut wrench into the channel assembly tube and swing the channel under the eyebolt.
3. Lift the channel and insert the shoulder of the eyebolt through the keyhole. Shift the channel and eyebolt until the shoulder of the eyebolt is pushed all the way into the slot.
4. Insert the tang of the wrench into the eyebolt and always tighten the eyebolt until the tire cannot be moved by hand pressure. Adjustment of the driver side channel ball end bolt is not required when installing original equipment size wheel and tire.
5. Refer to the View Y in Figs. 12, 13 and 14 for proper position of the eyebolt after it has been tightened to secure the spare tire in stowage position.

CAUTION: This eyebolt position is SPECIFIED to prevent possible channel separation and/or possible tire loss when the spare tire is loose in the channel. Tire looseness is caused by air leakage or by insufficient tightening of the eyebolt when installing the spare tire (flat or inflated).

Spare Wheel Only—F-150—F-350

When the wheel only (without tire) is ordered, it is located at the rear of the truck under the frame. A wood spacer is installed for shipment of the wheel only and must be removed when installing the tire (Figs. 12, 13 and 14).

After installing the wheel and tire in the carrying position, adjust the driver side channel ball and bolt and the eyebolt as necessary until the tire cannot be moved by hand pressure. Then tighten both bolts an additional 2 to 5 turns.

GT Bar—Pickup Box Mounted

The roll bar is painted gloss black and normal painting procedure can be used when a repair is required.

Removal

1. Remove nuts and bolts that secure GT bar to the front panel of the pickup box (Fig. 15).
2. From the underside of the vehicle, remove nuts that secure GT bar and braces to the floor of the pickup box.

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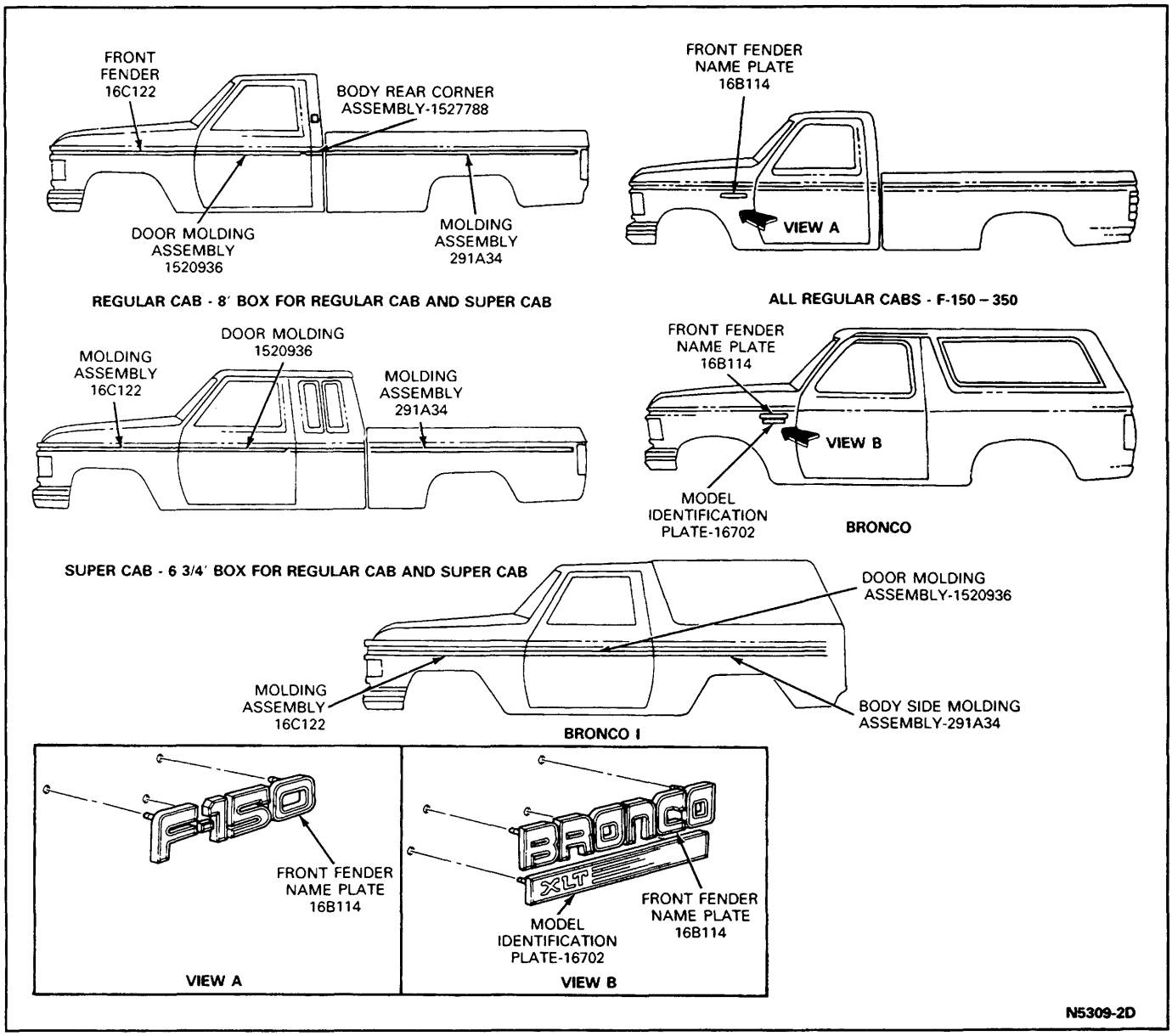


FIG. 7 Exterior Ornamentation, Body Side Mouldings with Tu-Tone Paint Only—F-150—F-350, Bronco

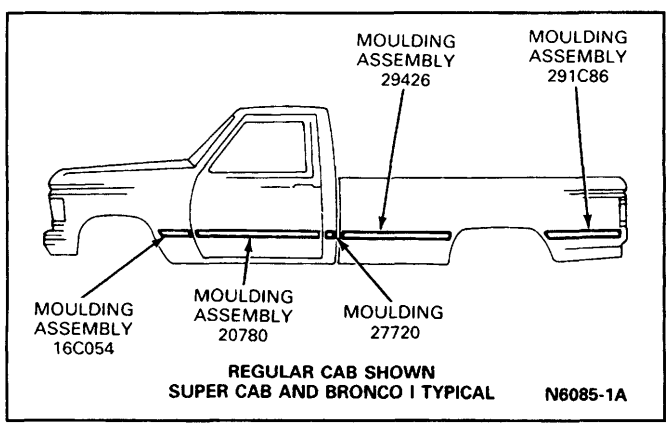


FIG. 8 Exterior Ornamentation, Wheel Lip and Body Side Moulding—F-150—F-350 Shown, Bronco Similar

3. Lift and remove complete GT bar and brace assembly from vehicle.

   NOTE: When replacing any one section of the GT bar, it is only necessary to remove the attaching nuts and bolts that secure that particular section to the vehicle

Installation

1. Position the GT bar and brace assembly to the vehicle and secure with nuts and bolts shown in Fig. 16.

2. Tighten all attaching nuts to 17-27 N·m (12-20 ft-lb).

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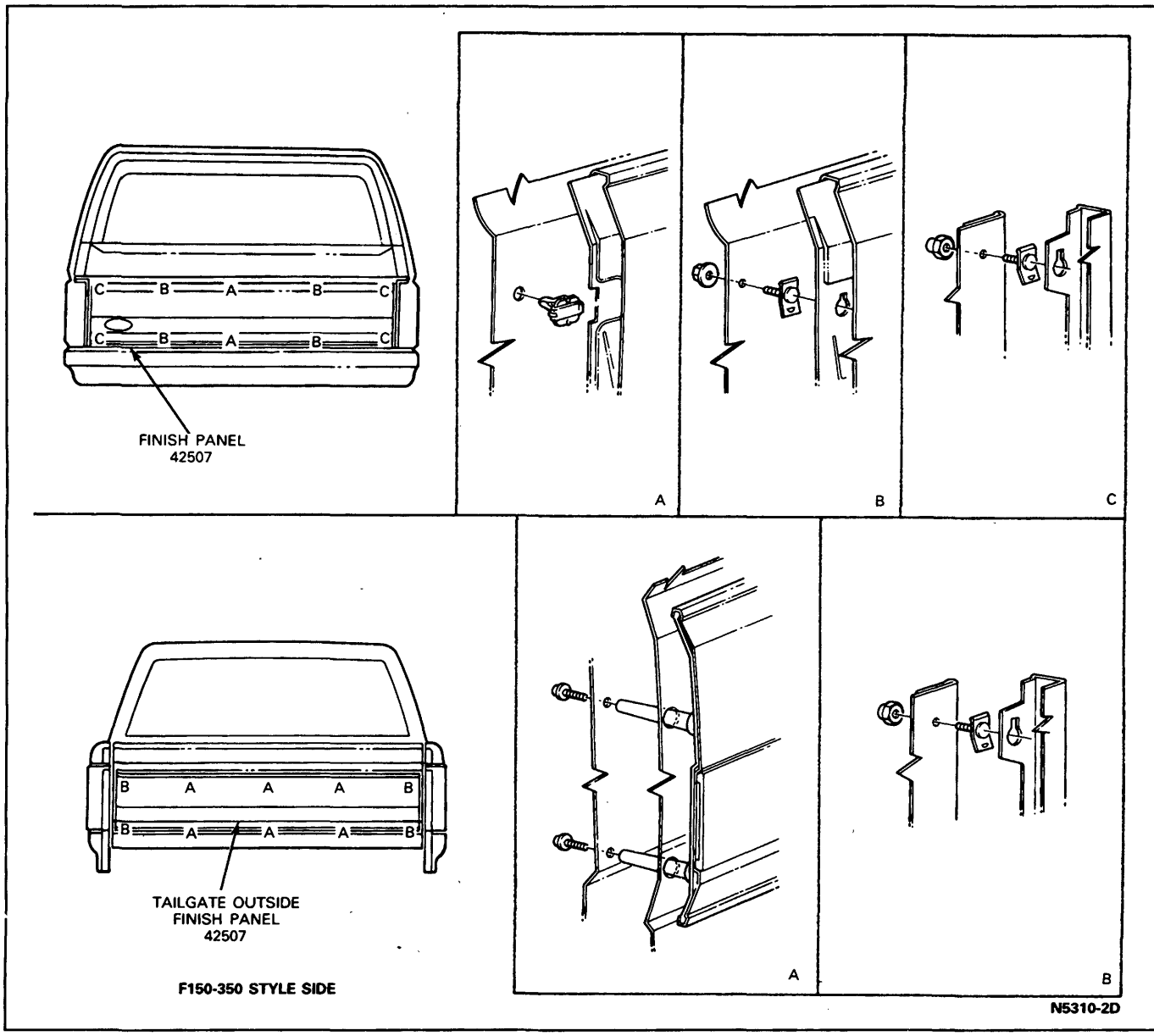


FIG. 9 Exterior Ornamention and Tailgate Mouldings—Bronco, F-150—F-350

Swing-Away (Bronco)

Removal and Installation

For swing-away spare wheel carrier removal and installation refer to Fig. 16.

Inside Spare Wheel Carrier (Bronco)

Removal and Installation

For inside spare wheel carrier removal and installation refer to Fig. 17.

Rear Bumper

Removal and Installation

The rear bumper installation for all models is shown in Fig. 18. To remove the bumper, remove the bumper bracket-to-frame attaching bolts and remove the bumper and brackets. Then, remove the brackets from the bumper. To install the bumper, install the brackets on the bumper. Position bumper to the frame and install bumper bracket-to-frame bolts.

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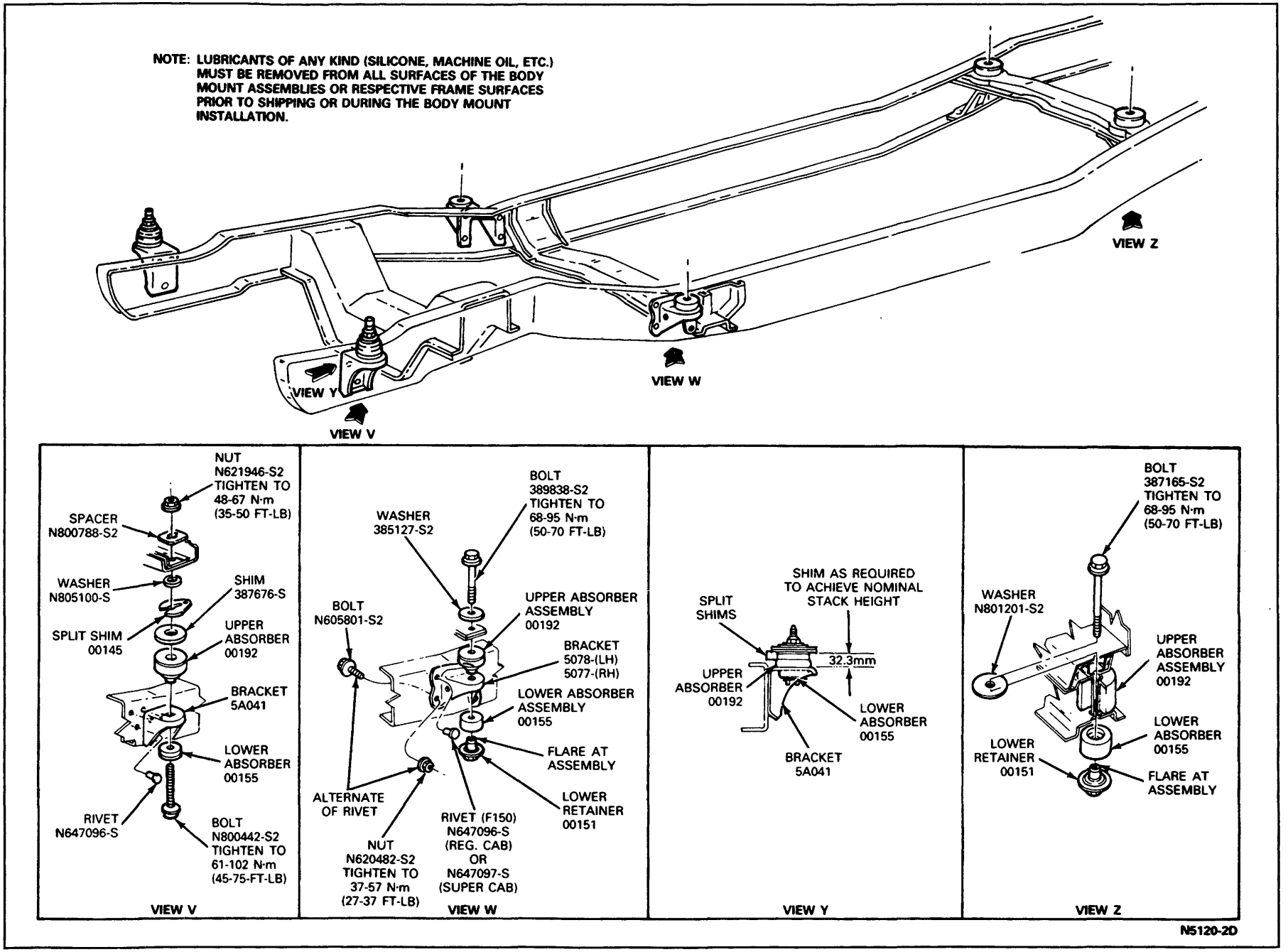


FIG. 10 Body Mounts—F-150—F-350, Superduty

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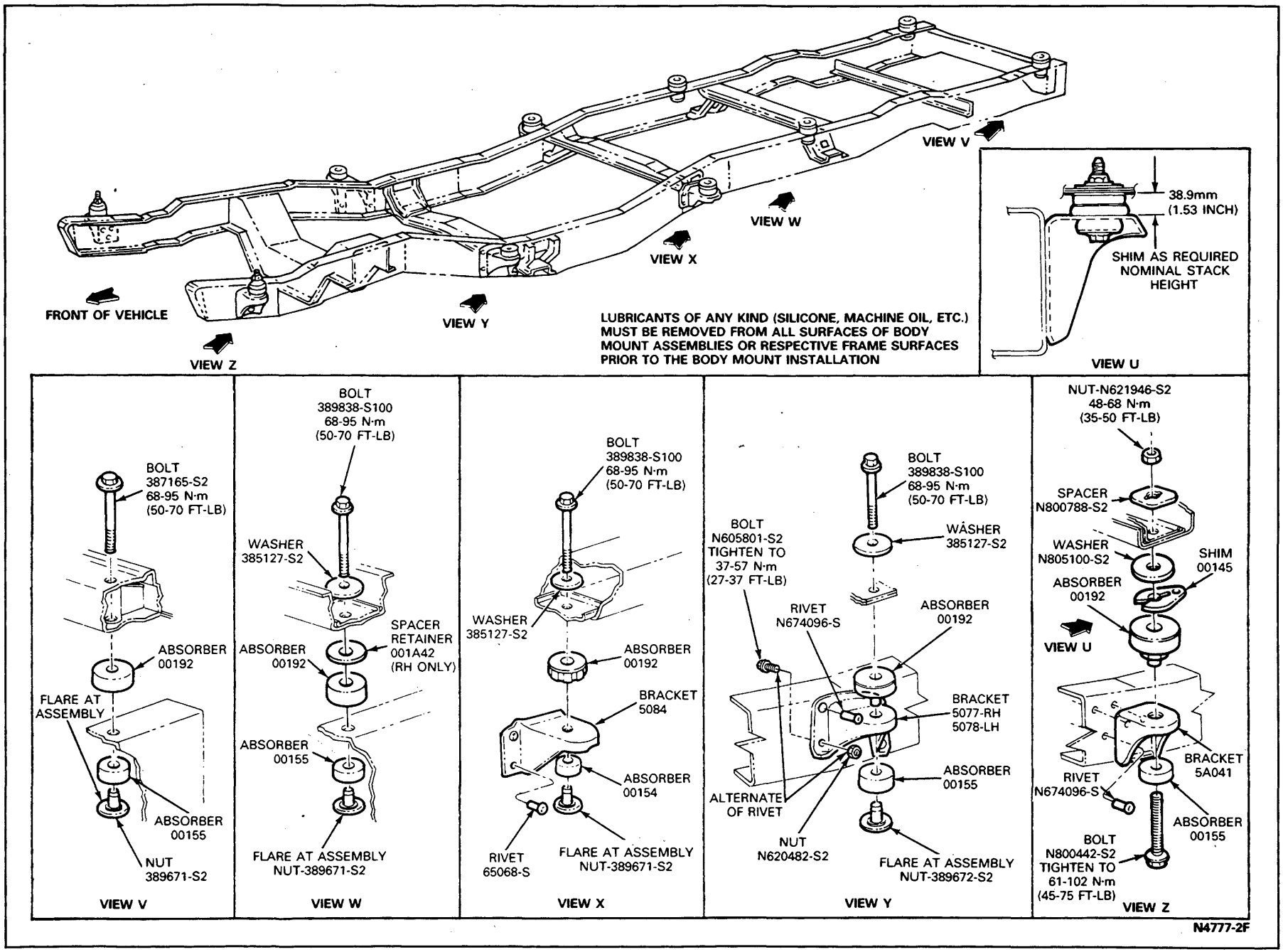


FIG. 11 Body Mounts—Bronco

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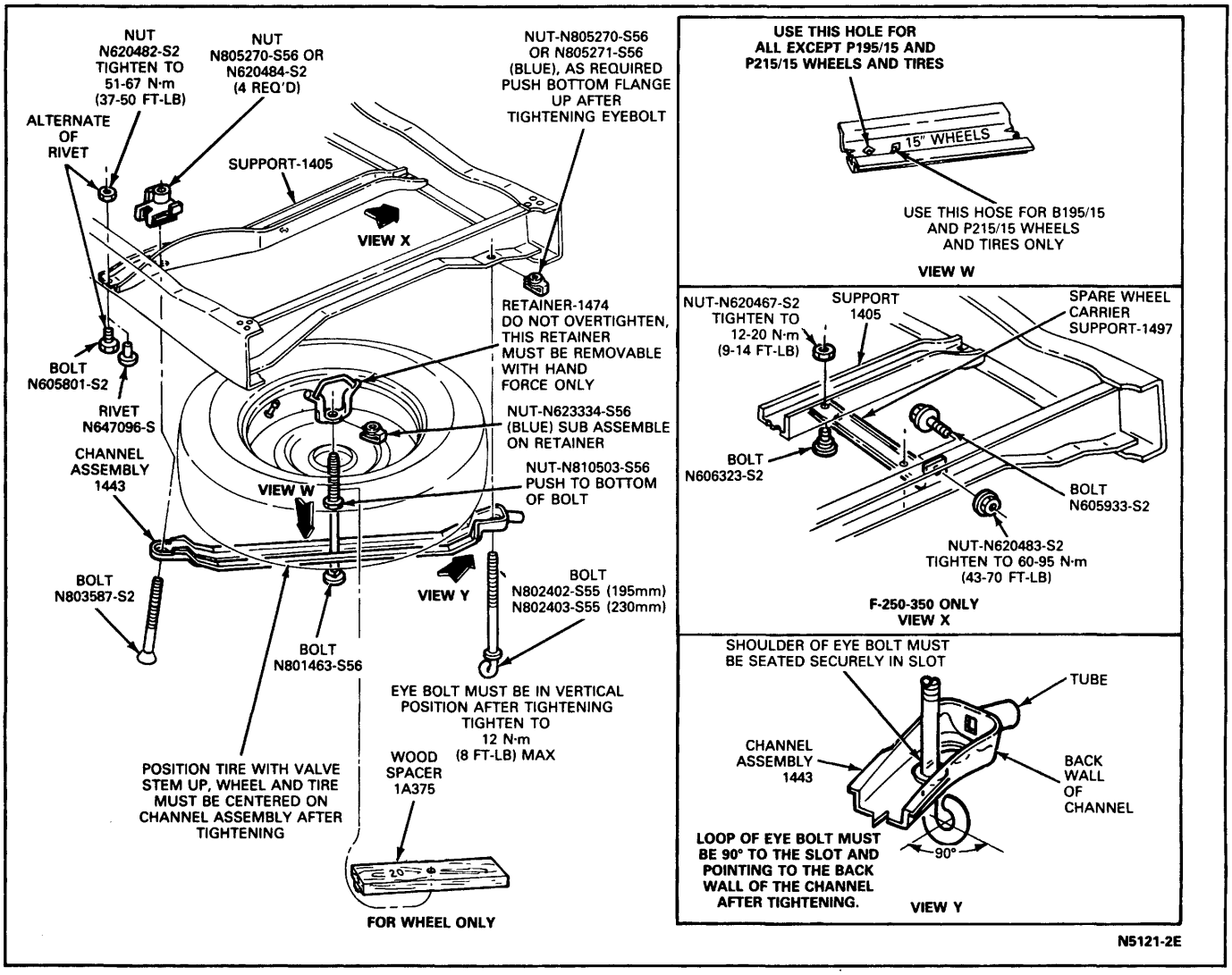


FIG. 12 Spare Tire Carrier—F-150—F-350 Without Aft Axle Tank

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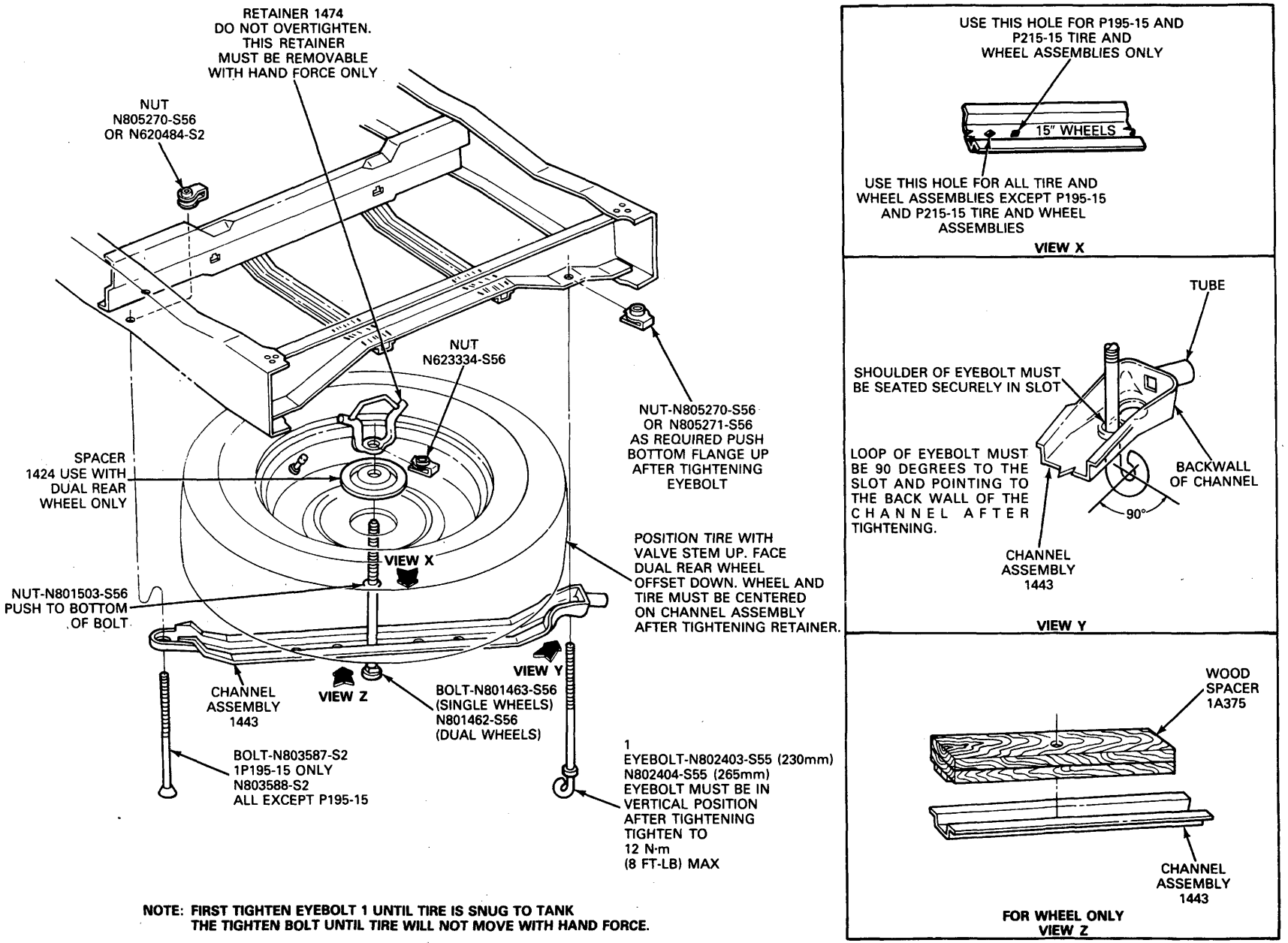


FIG. 13 Spare Tire Carrier—F-150, F-250—F-350 With Aft Axle Tank

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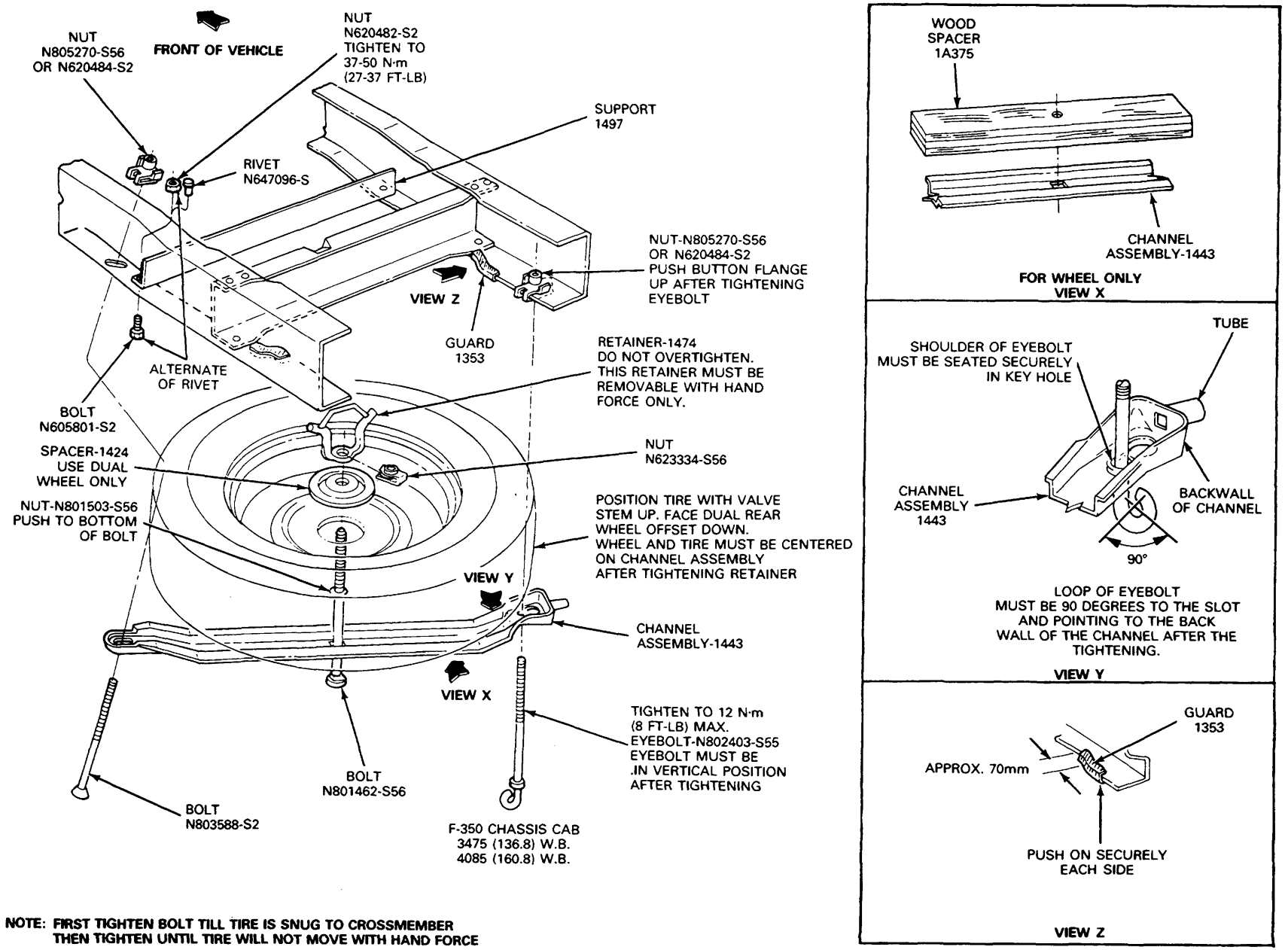


FIG. 14 Under Frame Spare Tire Carrier—F-350 Chassis Cab, Superduty

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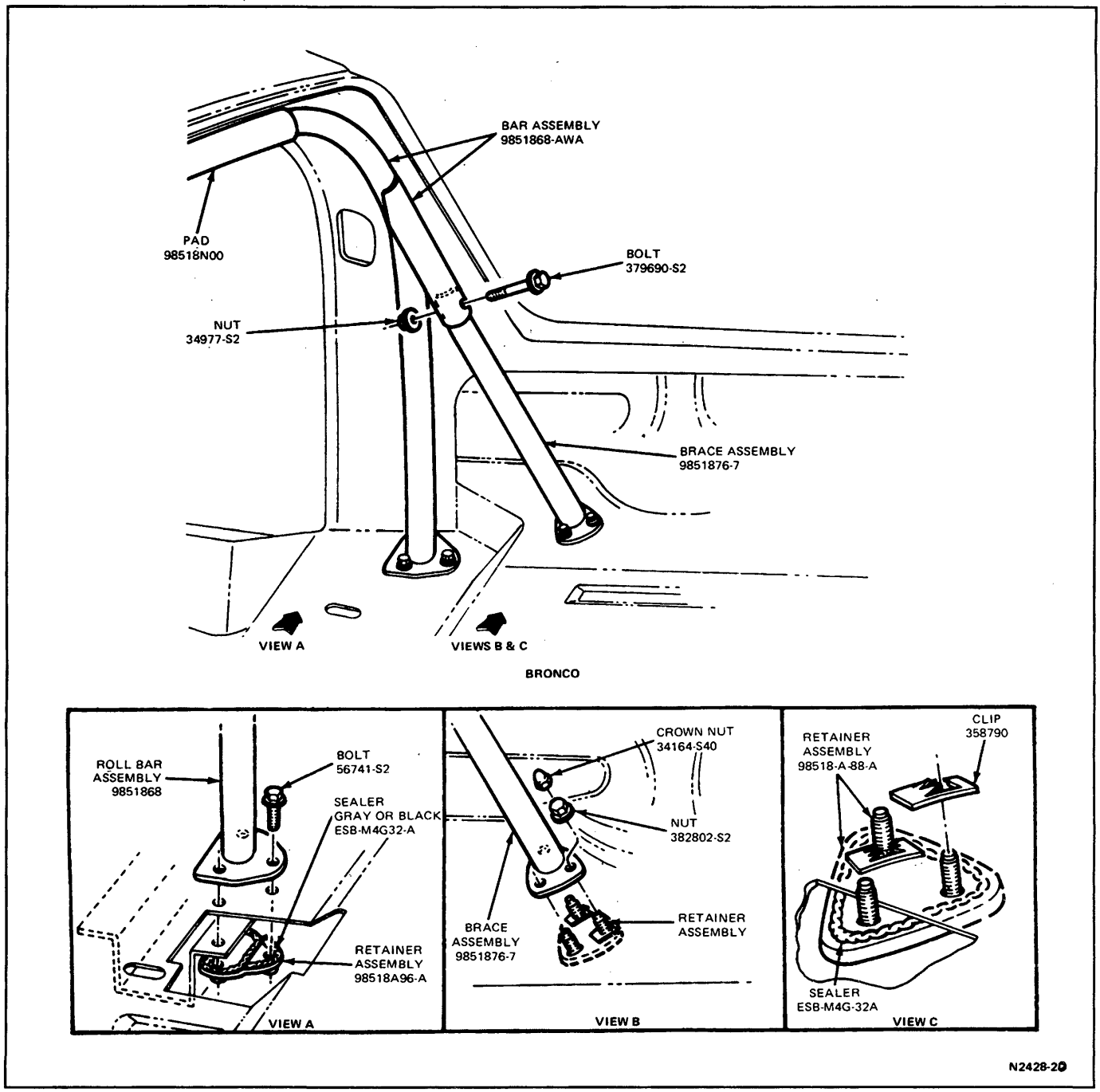


FIG. 15 GT Bar-Pickup Box Mounted—Bronco and F-150—F-350

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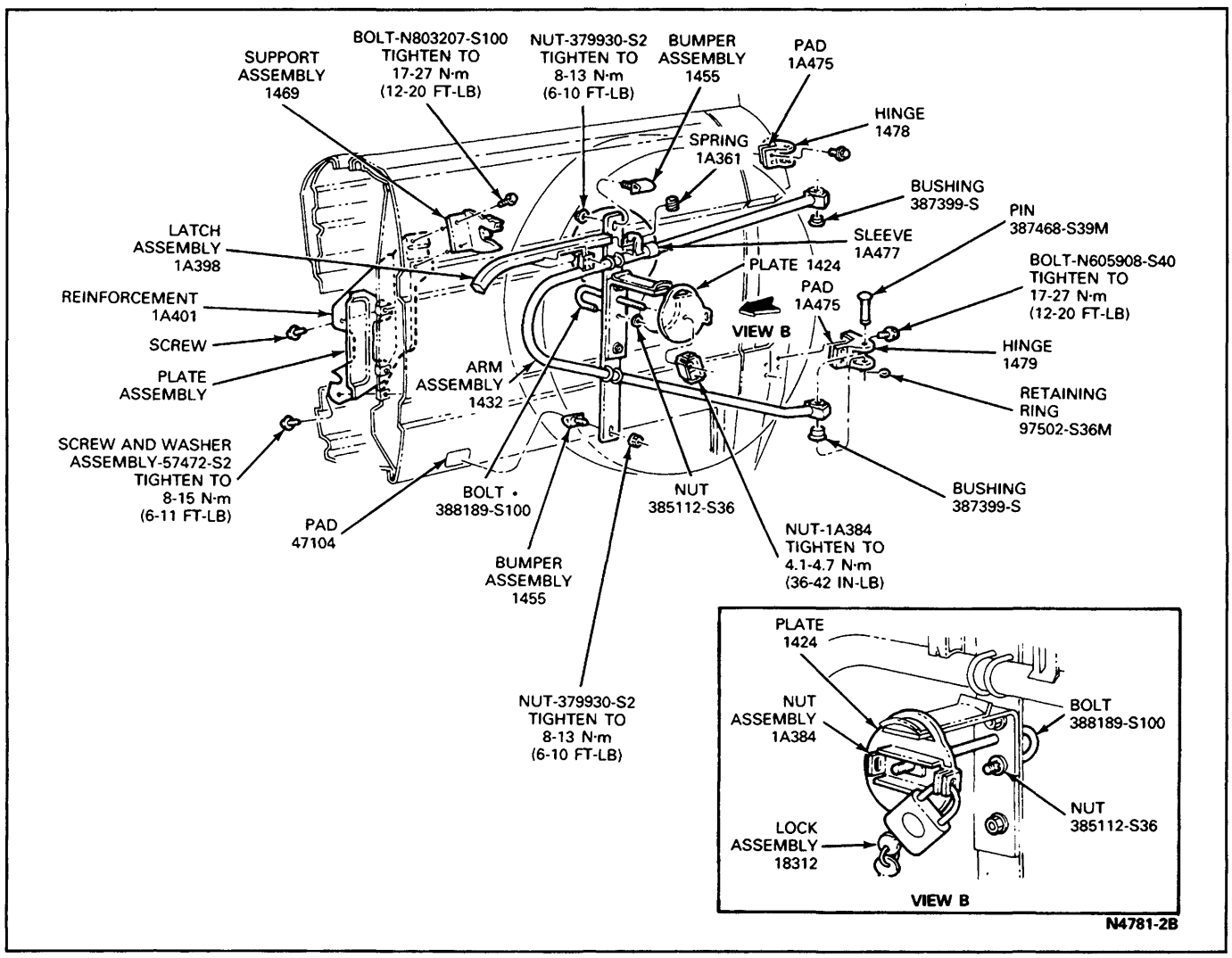


FIG. 16 Swing-Away Spare Wheel Carrier—Bronco

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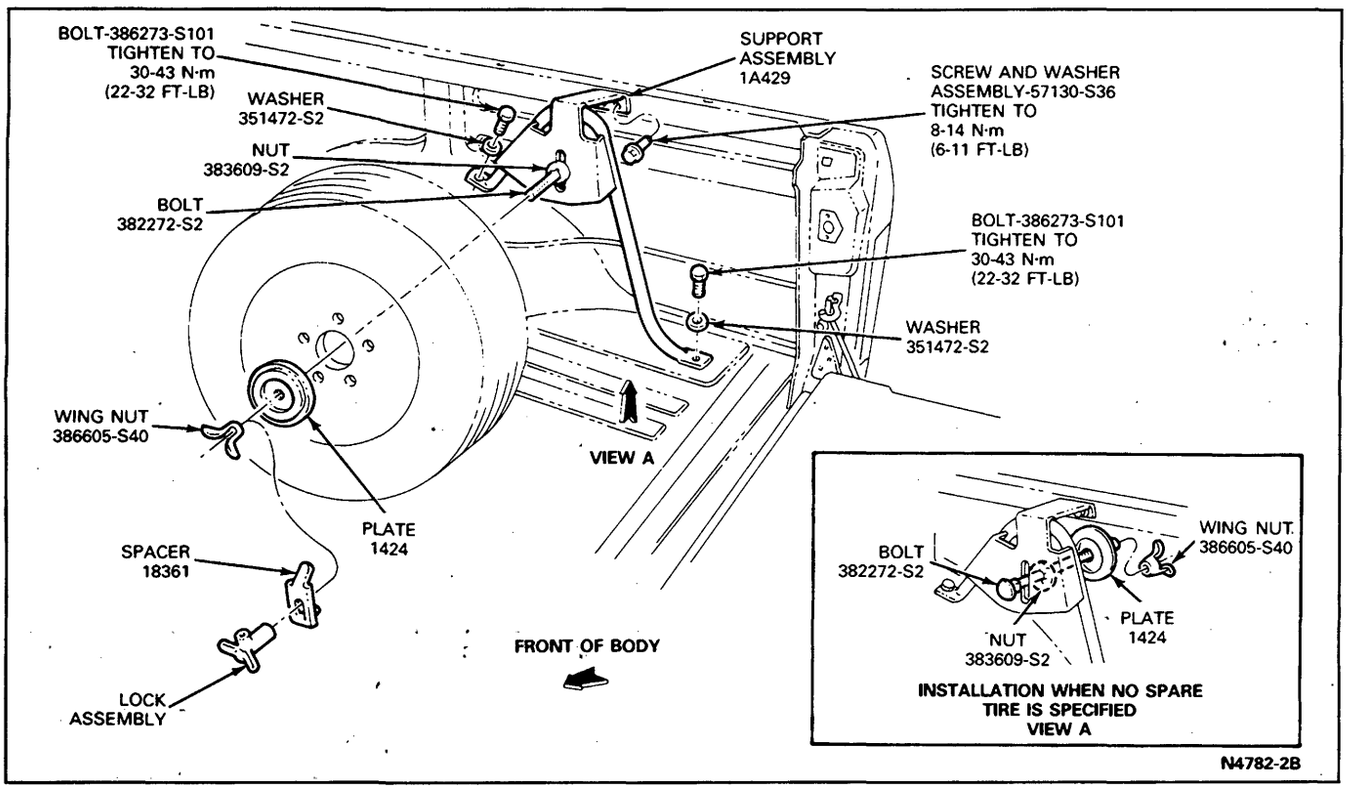


FIG. 17 Inside Spare Wheel Carrier—Bronco

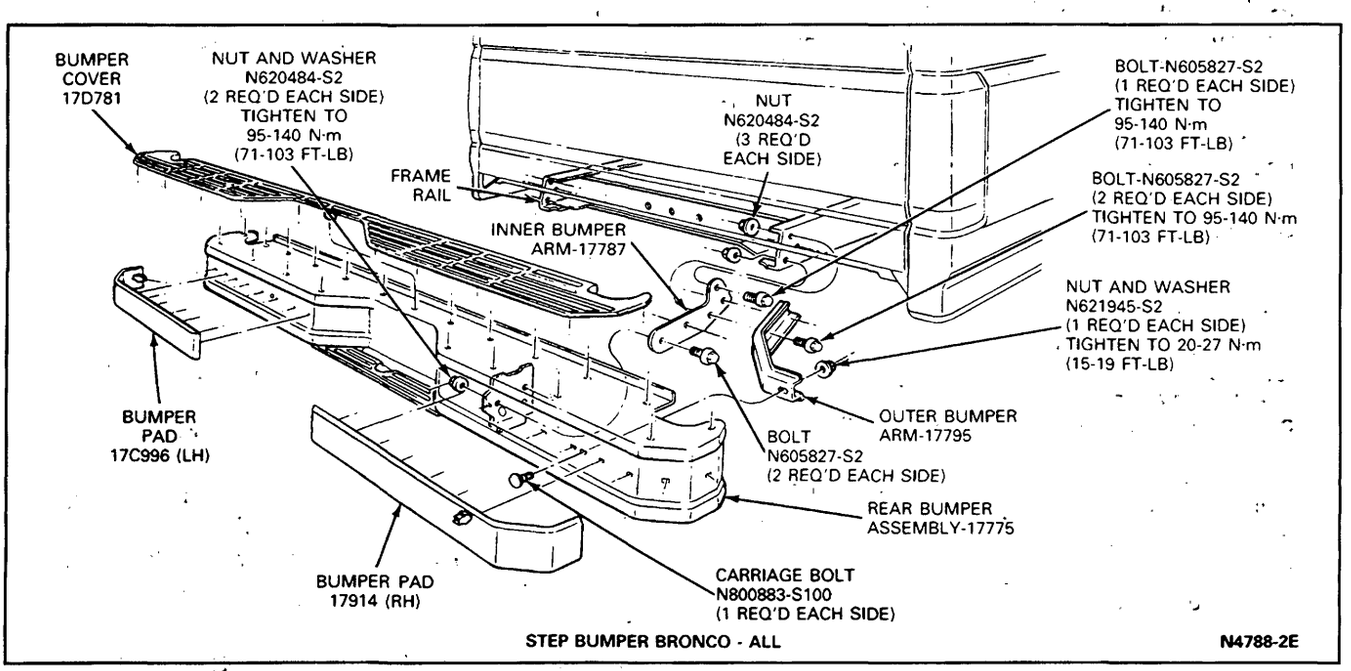


FIG. 18 Rear Bumper

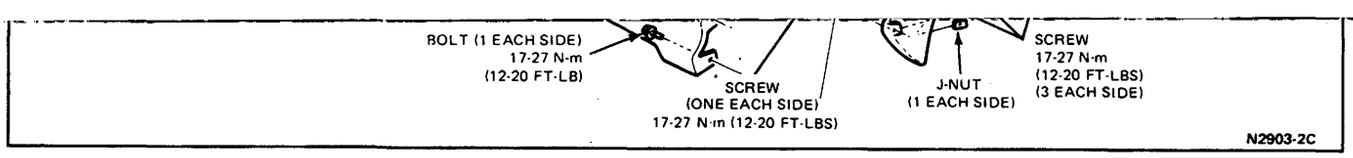


FIG. 2 Front Fender Installation

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Rear Bumper	47-52-3

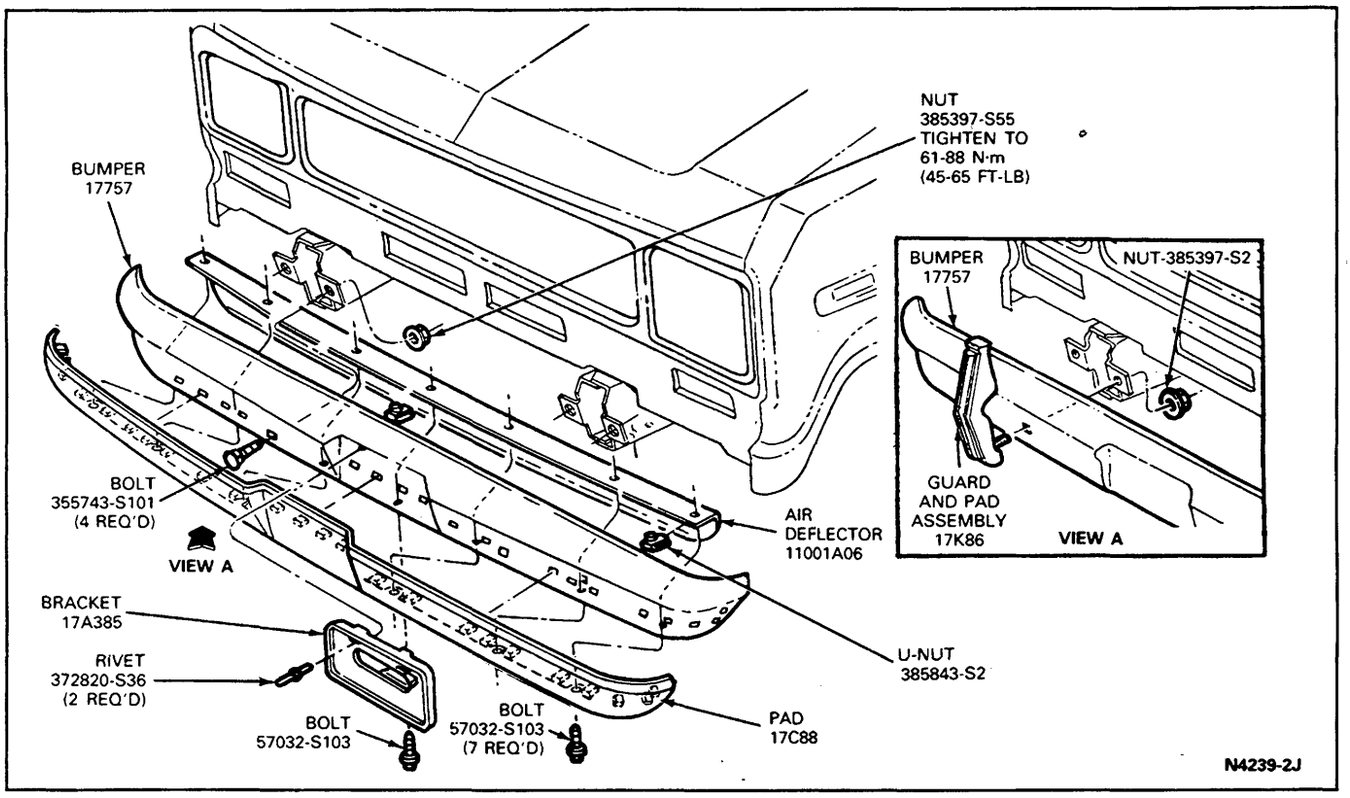


FIG. 3 Front Bumper and Bumper Guards

2. Remove four bolts and nuts retaining the bumper. Carefully remove bumper.

Installation

1. Loosely fit the four bolts and nuts retaining the bumper. Ensure proper bumper position and body-to-bumper clearance.
2. Tighten attaching nuts to 61-88 N·m (45-65 ft-lb).
3. Install bumper pad and license plate bracket as outlined.

Front Bumper Pad

Removal

1. Remove license plate bracket as outlined.
2. Using a pair of pliers, carefully compress the plastic bumper pad retaining barbs. Access the bumper pad retaining barbs from the inner surface of the bumper.
3. Pull each portion of the pad free of the bumper as it is released. Remove pad.

Installation

1. Align the center of the bumper pad with the center of the bumper and press this small area into place.
2. Stretch the pad and work the pad barbs into place. Work from the center out, switching from left of center to right of center, as the pad is gradually stretched from the center to the outer edges of the bumper. If necessary, use a small rubber hammer to tap each barb into place in its rectangular slot in the bumper.
3. If the barbs are damaged and can not be securely fastened to bumper, replace pad.
4. Install license plate bracket as outlined.

License Plate Bracket (Front)

Removal

1. To remove bracket, drill out the two rivets retaining the top of the bracket to the bumper.
2. Remove the lower center bolt at the base of the bracket. Remove bracket.

Installation

1. Install two new rivets through the top edge of the bracket.
2. Install the lower center bolt at the base of the bracket.

Rear Bumper

Removal

1. Remove bumper pad as outlined.
2. Remove four nuts and bolts attaching the bumper to the support brackets (Fig. 4).
3. Remove bumper.

Installation

1. Position bumper on support brackets and loosely install the four nuts and bolts. Ensure proper bumper position and body-to-bumper clearance.
2. Tighten attaching nuts to 27-41 N·m (20-30 ft-lb).
3. Install bumper pad as outlined in this Section.

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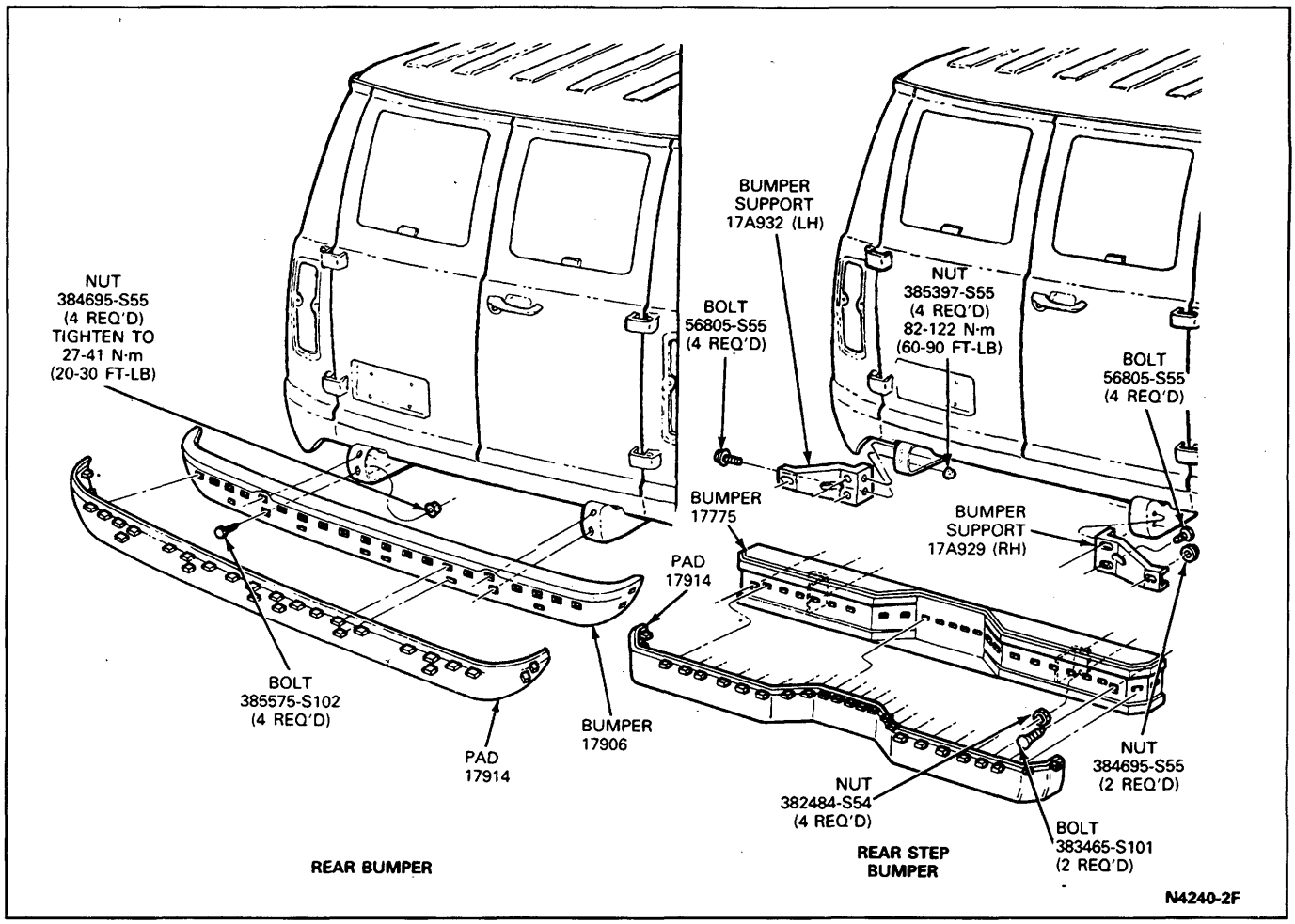


FIG. 4 Rear Bumper

Rear Bumper Pad

Removal

1. Using a pair of pliers, carefully compress the plastic bumper pad retaining barbs. Access the bumper pad retaining barbs from the inner surface of the bumper.
2. Pull each portion of the pad free of the bumper as it is released. Remove pad.

Installation

1. Find the center of the bumper pad and mark it with a piece of chalk.
2. Find the center of the bumper and align it with the center of the pad.
3. Press a small area at the center of the pad into place.
4. Stretch the pad and work the pad barbs into place. Work from the center out, switching from left of center to right of center, as the pad is gradually stretched from the center of the outer edges of the bumper. If necessary, use a small rubber hammer to tap each pad barb into place in its rectangular slot in the bumper.

Rear Step Bumper

Removal

1. Remove bumper pad from bumper as outlined.
2. Remove six nuts and bolts securing the bumper to the bumper bracket.
3. Remove bumper. If required, remove four bolts that secure brackets to frame. Remove brackets.

Installation

1. If necessary, install brackets and tighten four attaching nuts and bolts to 82-122 N·m (60-90 ft-lb).
2. Position bumper on support brackets and loosely attach the six nuts and bolts. Ensure proper bumper position and body-to-bumper clearance.
3. Tighten attaching nuts securely.
4. Install bumper pad as outlined.

Rear Step Bumper Pad

Removal

1. Using a pair of pliers, carefully compress the plastic bumper pad retaining barbs. Access the bumper pad retaining barbs from the inner surface of the bumper.
2. Pull each portion of the pad free of the bumper as it is released. Remove pad.

Installation

1. Align the center of the bumper pad with the center of the bumper and press this small area into place.

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2. Stretch the pad and work the pad barbs into place. Work from the center out, switching from left of center to right of center, as the pad is gradually stretched from the center to the outer edges of the bumper. If necessary, use a small rubber hammer to tap each barb into place in its rectangular slot in the bumper.
3. If the barbs are damaged and can not be securely fastened to bumper, replace pad.

Exterior Mouldings

Removal and Installation

Before removing the exterior mouldings, determine by the type of retainer used if it is necessary to remove an interior trim panel (Figs. 5 through 9). If a weld stud is distorted or broken off, it should be replaced with screw (379560-S101).

Body Mounts

Removal and Installation

The E-150—E-350 body mounts are shown in Figs. 10, 11 and 12.

Body Sealer

For sealer types and application procedures refer to Section 47-01, Body Shell, Exterior Trim, Frame and Underbody—General. For test procedure for locating dust and water leaks refer to Diagnosis and Testing in Section 47-01, Body Shell, Exterior Trim, Frame and Underbody—General.

Frame Dimensions

For E-150—E-350 frame checking and repair procedures refer to Section 47-01, Body Shell, Exterior Trim, Frame and Underbody—General.

Spare Tire Carrier

Removal and Installation

The various spare tire carrier installations are shown in Figs. 13 through 15.

Inside Mounting

On inside installations, remove the standard retaining nut or optional locknut to remove tire from mounting (Figs. 13 and 14).

CAUTION: When installing the spare tire under the rear seat on 12-passenger Club Wagons, Club Wagons with optional seat/bed, and 15-passenger Super Wagons, position the tire with the valve stem downward to prevent removal of the lock by deflating the tire. Then, install the spacer and lock assembly as shown.

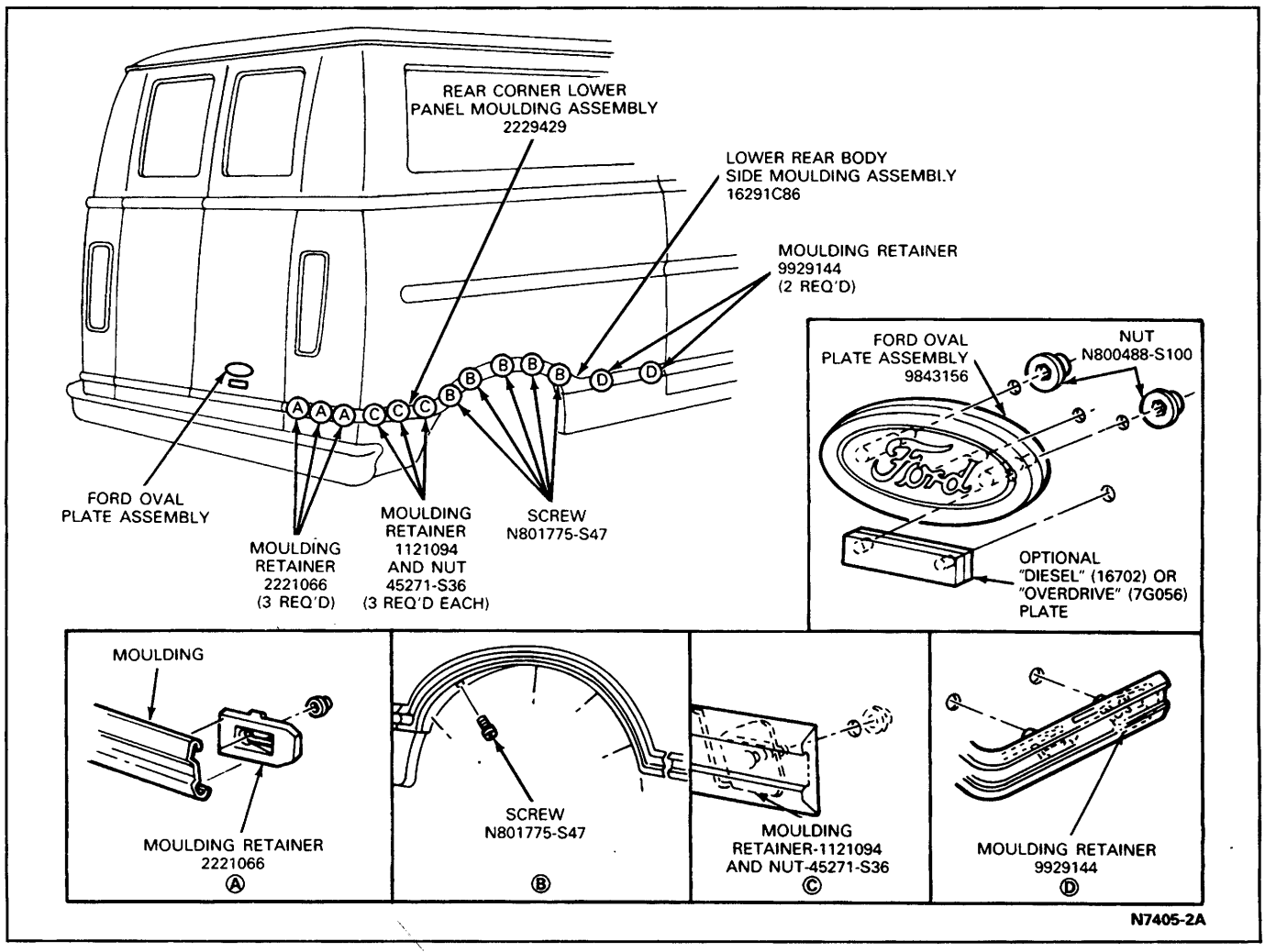


FIG. 5 Exterior Side and Rear Mouldings

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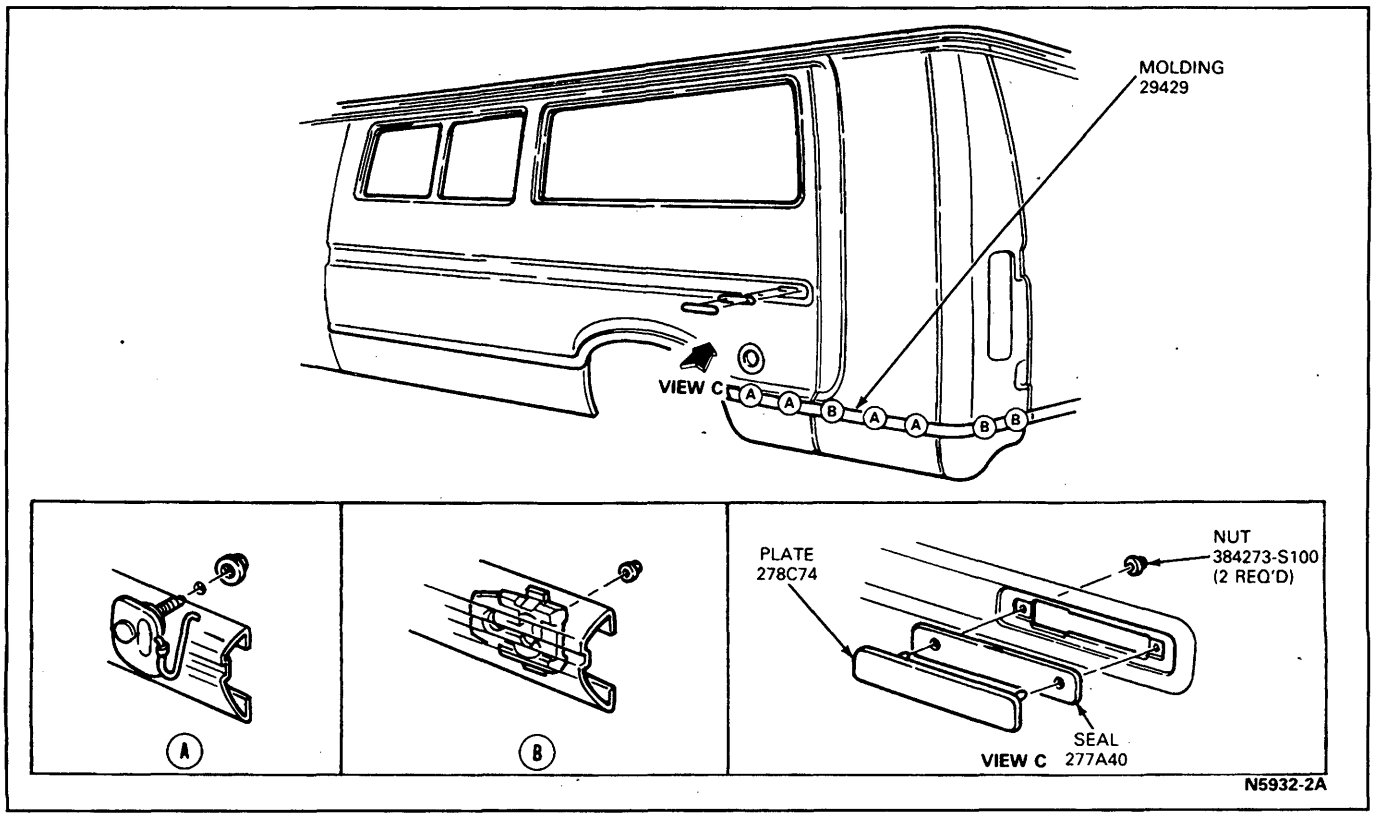


FIG. 6 Rear Corner Moulding—Super Van

Outside Mounting

E-150—E-150

Removal and Installation

The outside-mounted spare tire is equipped with a tire cover.

To remove, grasp the edge of the cover behind the top of the tire. Slide the cover rearward over the top of the tire, then downward.

To install, position the cover with the drainage eyelet at the bottom, over the edge of the tire. Slide the cover upward, wrapping it around the edge of the tire until the cover is completely fitted.

NOTE: The spare tire cover is designed to fit snugly around the tire. When properly installed, the cover seam will be centered on the face of the tire.

To remove the tire from the carrier, follow the instructions below.

1. Remove the padlock (Fig. 15).
2. Remove the retaining nut assembly.

   NOTE: If the retaining nut is very tight, insert the "chisel point" of the lug wrench in one of the slots in either end of the retaining nut and turn the nut counterclockwise.
3. Remove the retaining disc, then slide the tire outward and lift off of the carrier.

When installing the spare tire, be sure to tighten the retaining nut securely before installing the lock. This will help prevent spare tire vibration or noise.

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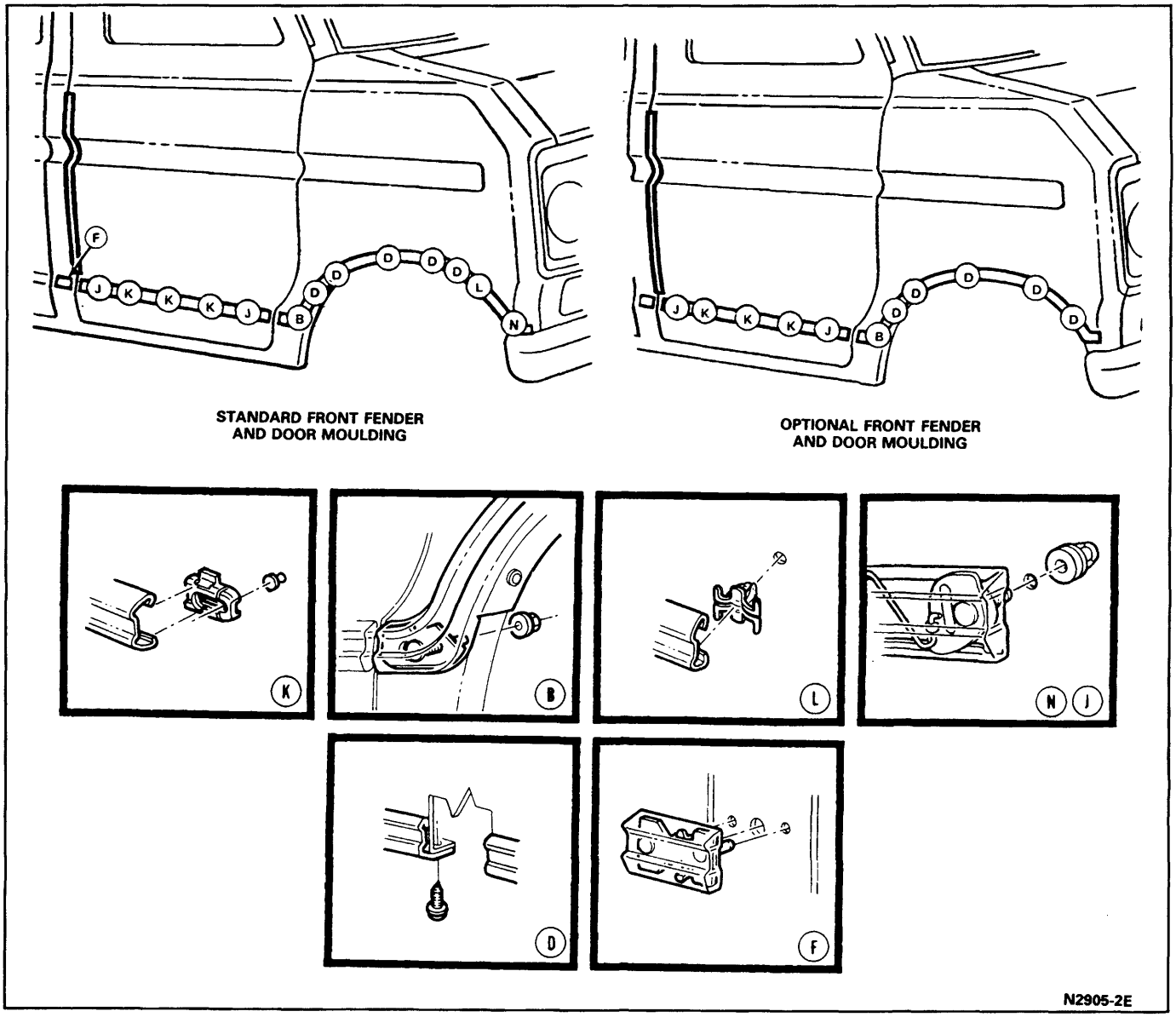


FIG. 7 Exterior Front Fender and Door Mouldings

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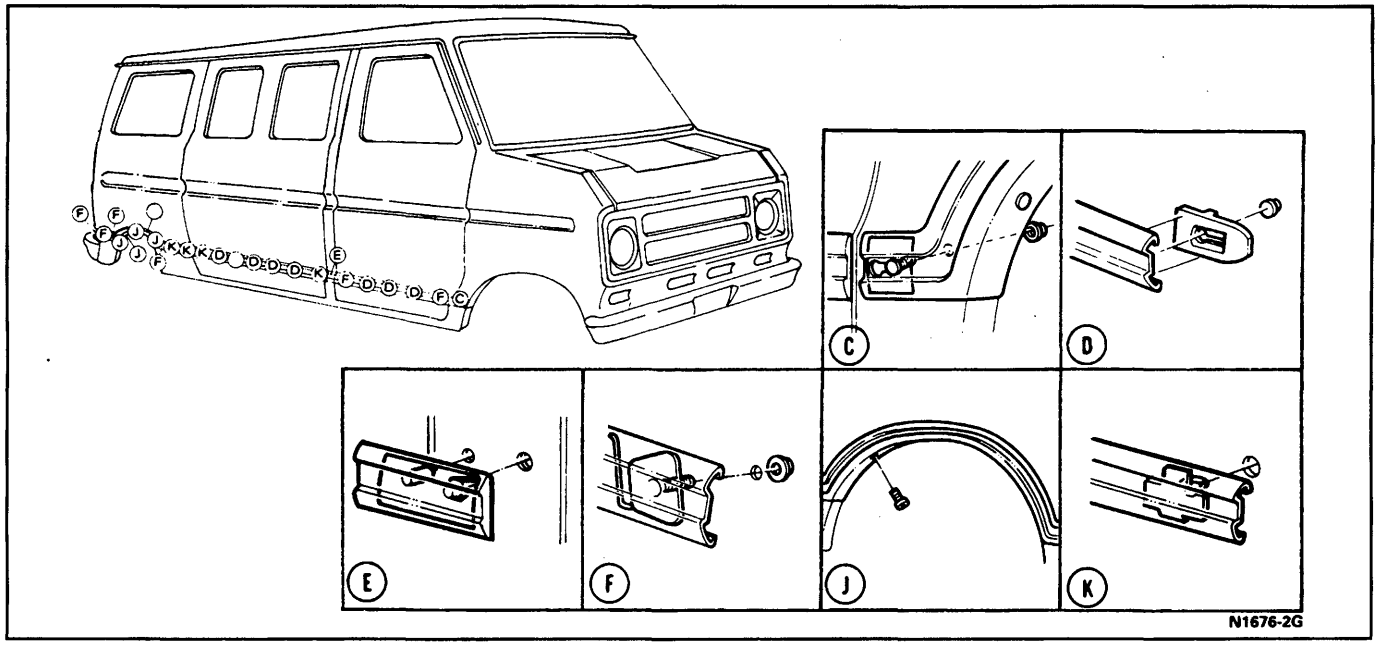


FIG. 8 Exterior Side Mouldings

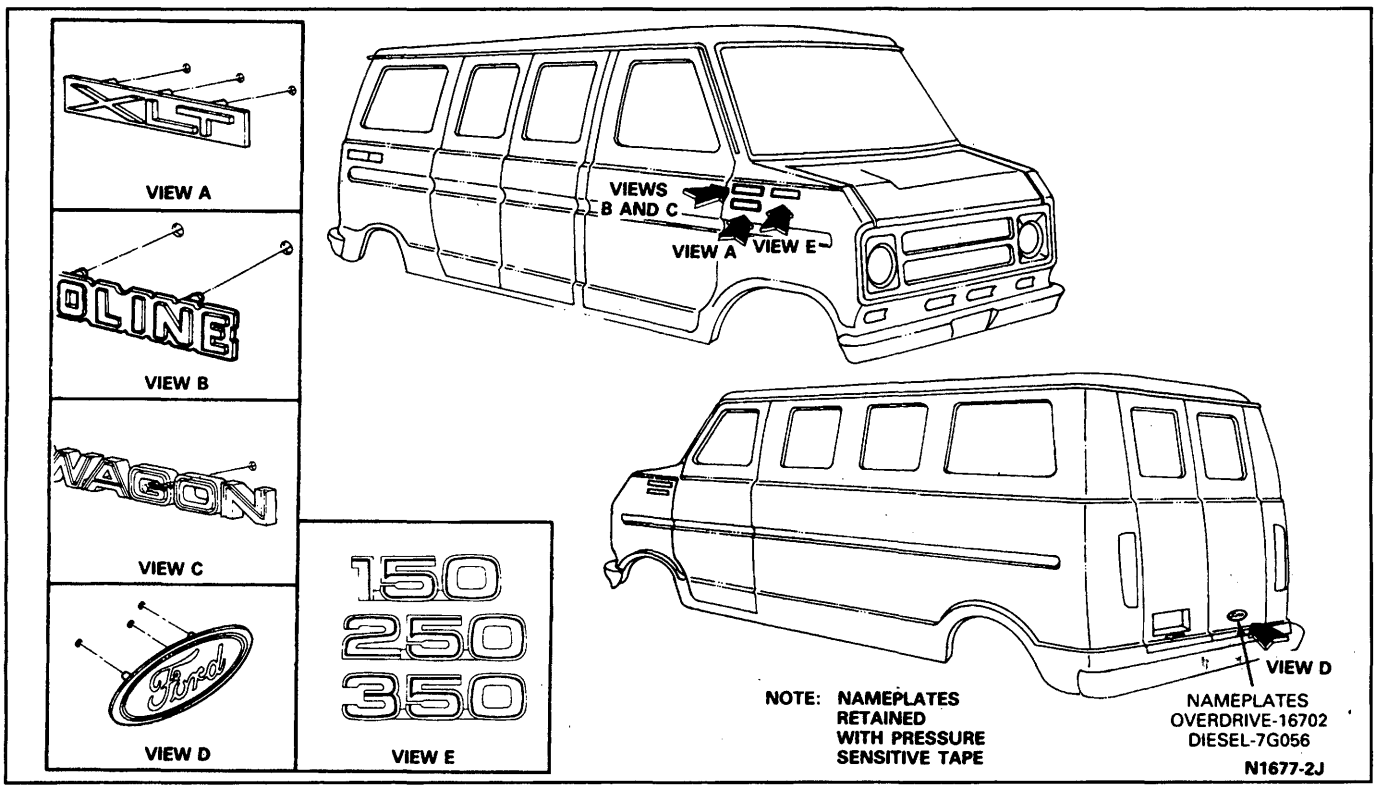


FIG. 9 Exterior Ornamentation

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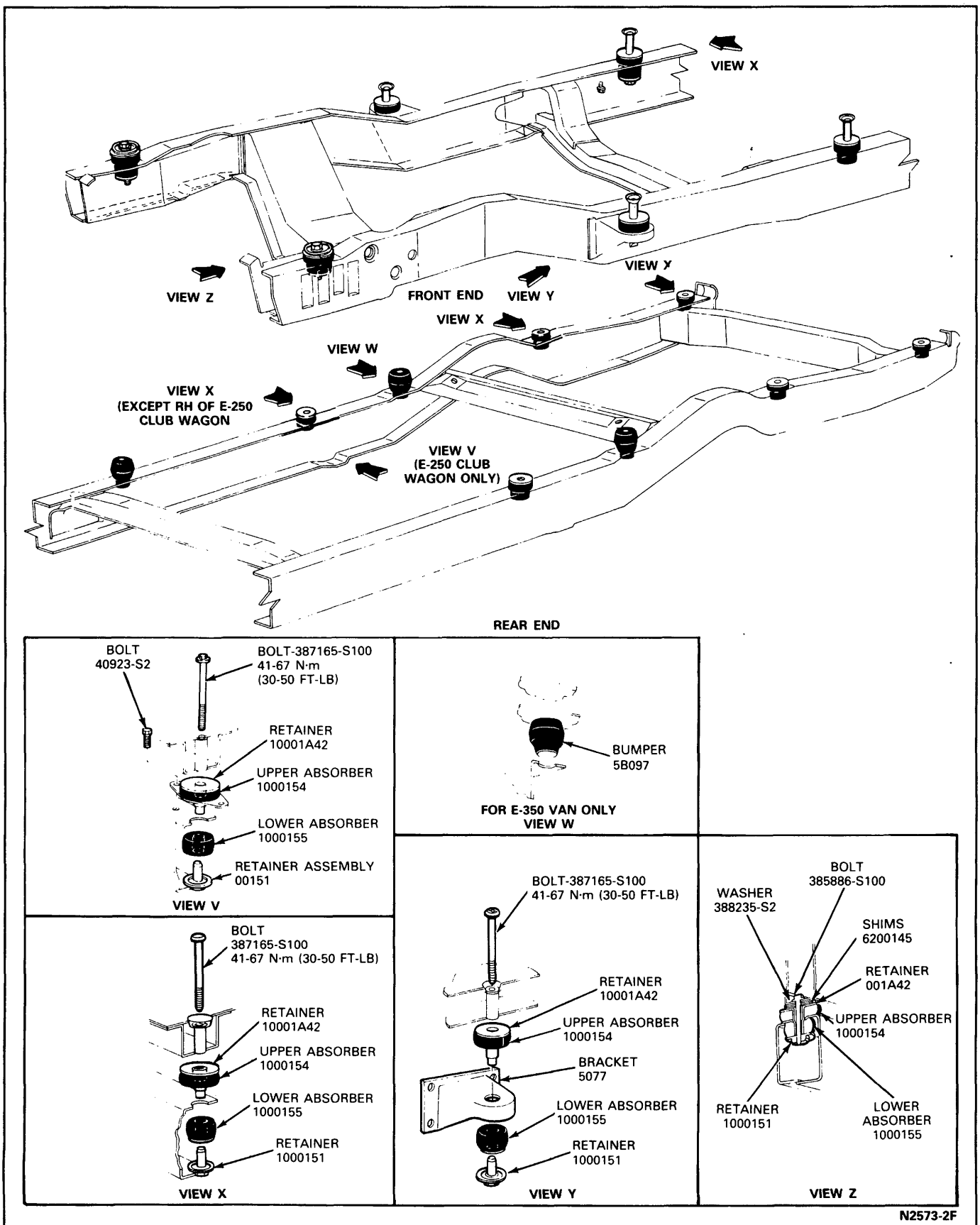


FIG. 10 Body Mounts—Vans and Club Wagons

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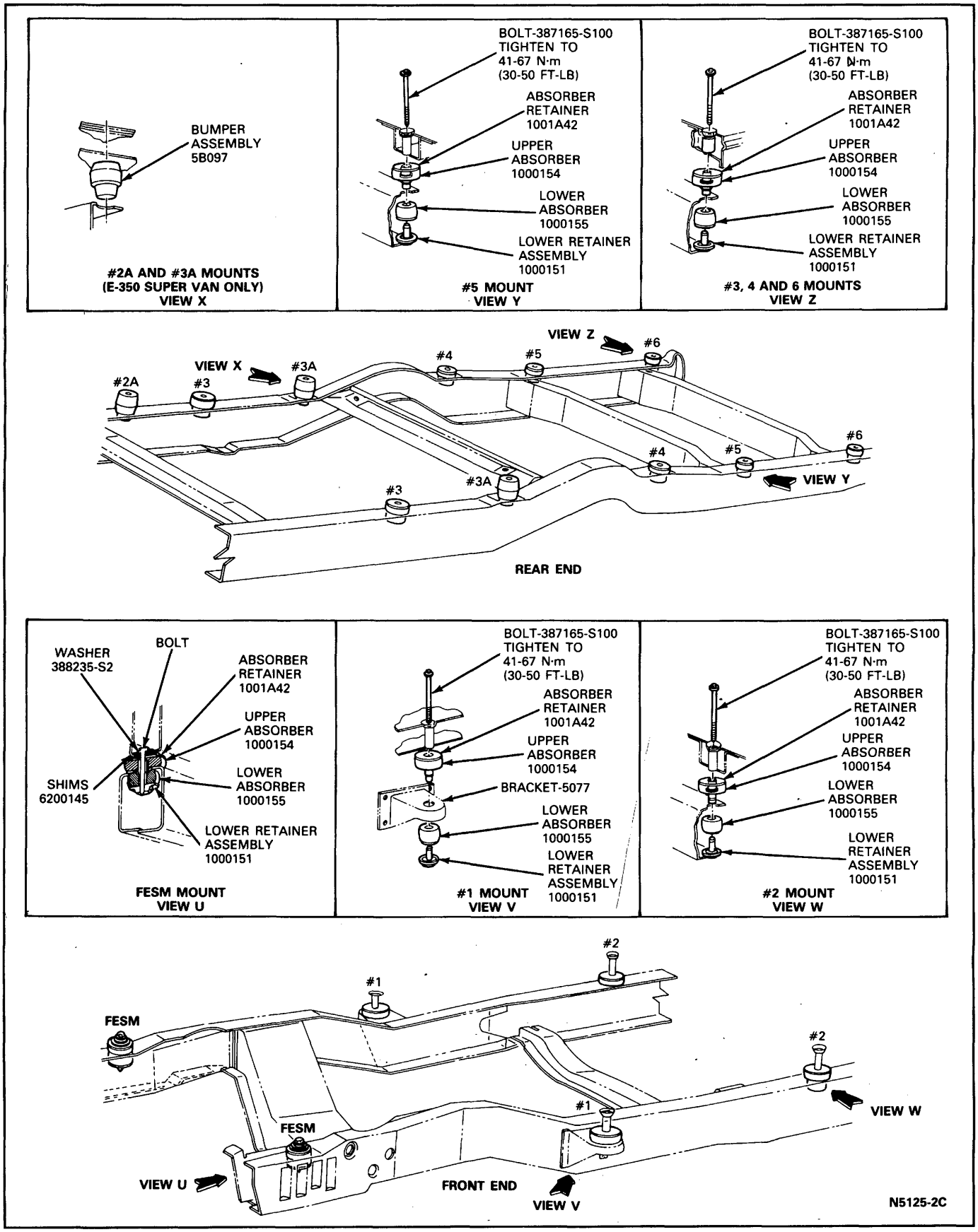


FIG. 11 Body Mounts—Supervans and Superwagons

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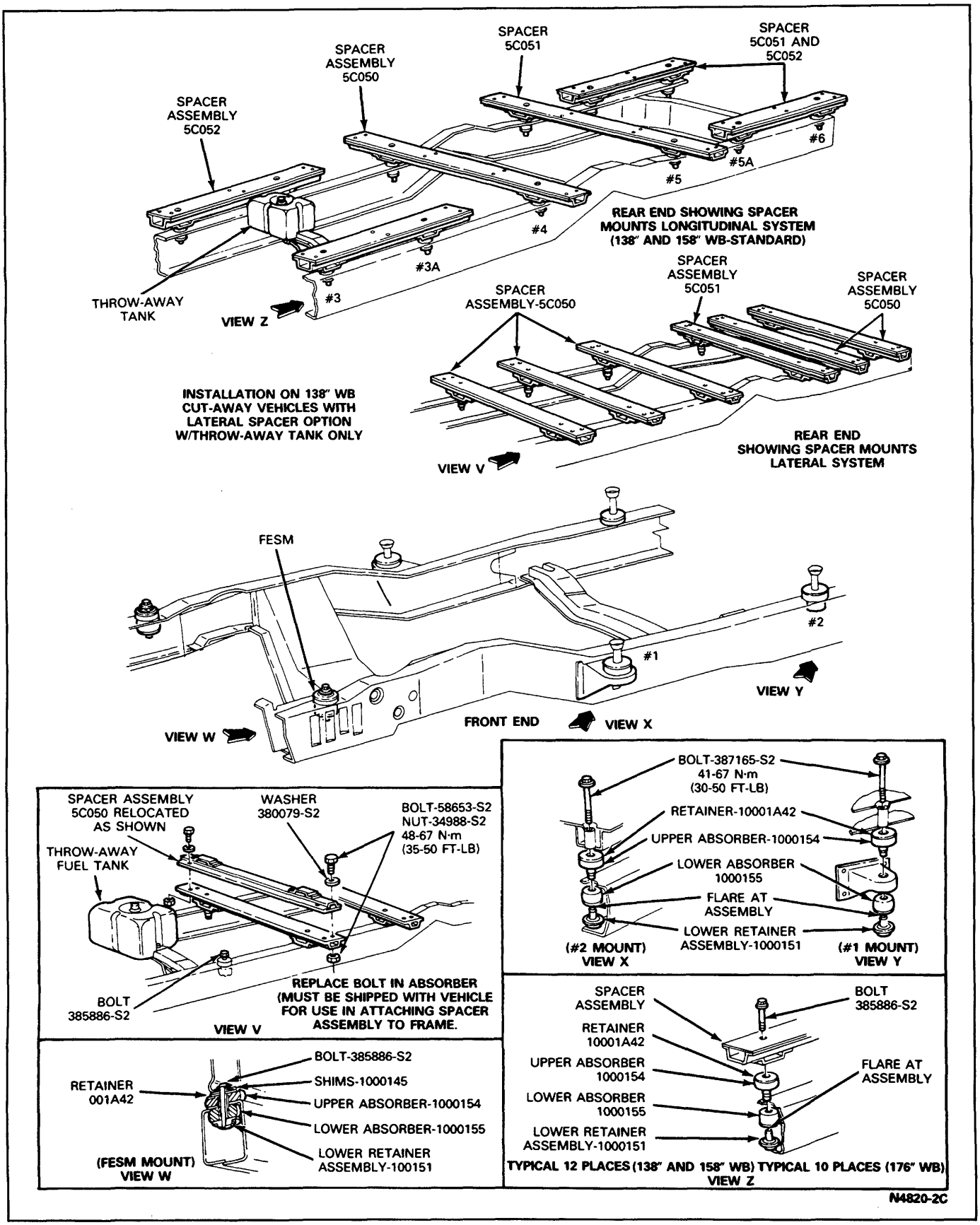


FIG. 12 E-350 Body Mounts and Spacers—Cutaway

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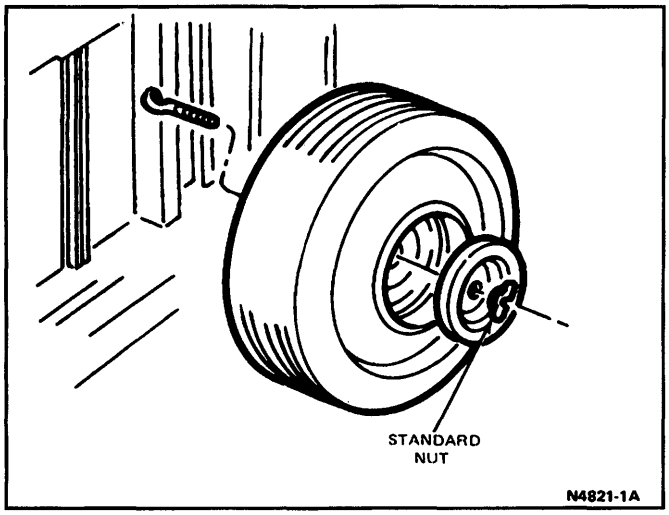


FIG. 13 Side-Mounted Sparewheel Stowage All Vans and 5, 7, 8, and 11-Passenger Club Wagons, Except with Seat/Bed Option

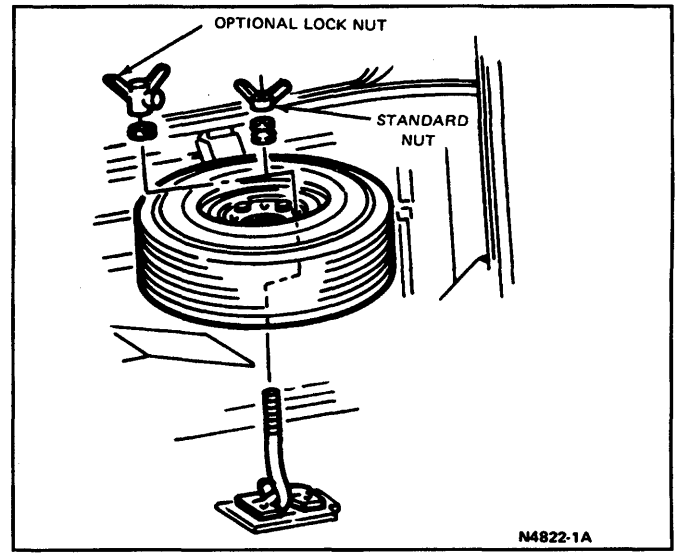


FIG. 14 Floor-Mounted Sparewheel Stowage 12-Passenger Club Wagon, Club Wagon with Optional Seat/Bed and 15-Passenger Super Wagon Only

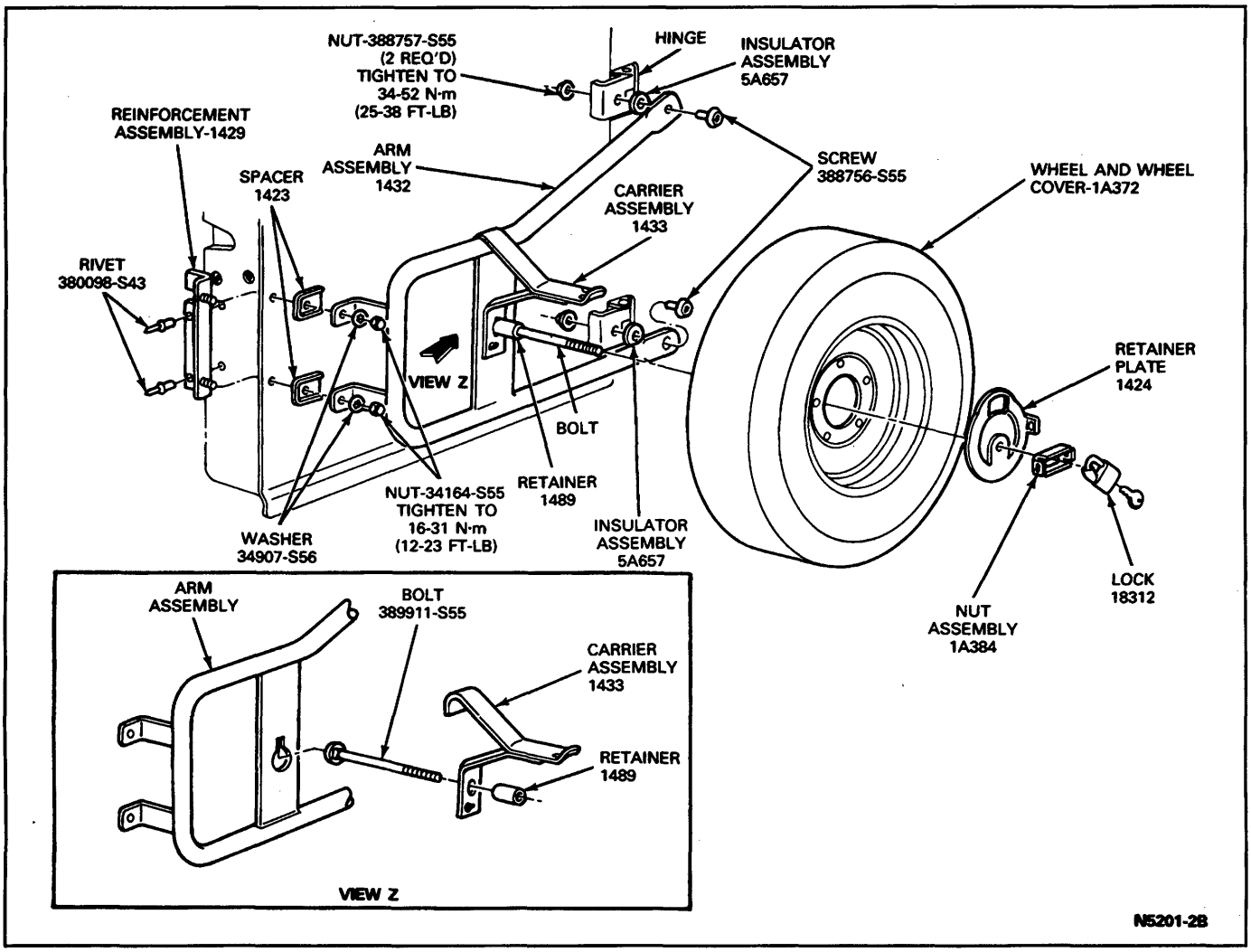


FIG. 15 E-150—Optional Outside Mounting

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METRICS

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Decimal/Metric Equivalents Chart	4
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Nomenclature for Bolts	2
Strength Identification	
Bolts	2
Hex Nuts	3
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Tapping Screws	3
Thread Forming Screws	3
U-Nuts	3
Torque Conversion Chart	6

INTRODUCTION

Most threaded fasteners are covered by specifications that define required mechanical properties, such as tensile strength, yield strength, proof load and hardness. These specifications are carefully considered in initial selection of fasteners for a given application. To assure continued satisfactory vehicle performance, replacement fasteners used should be of the correct strength, as well as the correct nominal diameter, thread pitch, length, and finish.

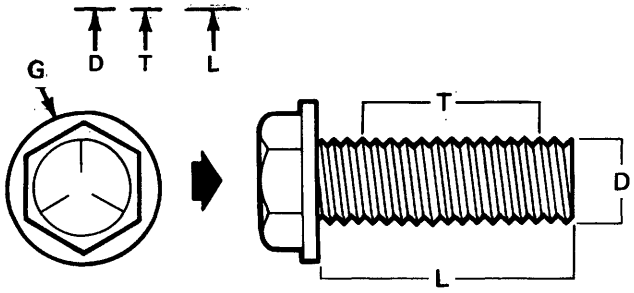
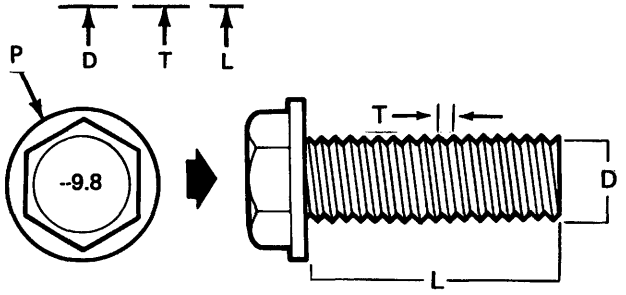
Most original equipment fasteners (English system or metric) are identified with markings or numbers indicating the strength of the fastener. These markings are described in the pages that follow. Attention to these markings is important in assuring that the proper replacement fasteners are used.

Further, some metric fasteners, especially nuts, are colored blue. This metric blue identification is in most cases a temporary aid for production start-up, and color will generally revert to normal black or bright after start-up.

English system and metric system fasteners are available through your Ford Parts and Service operation.

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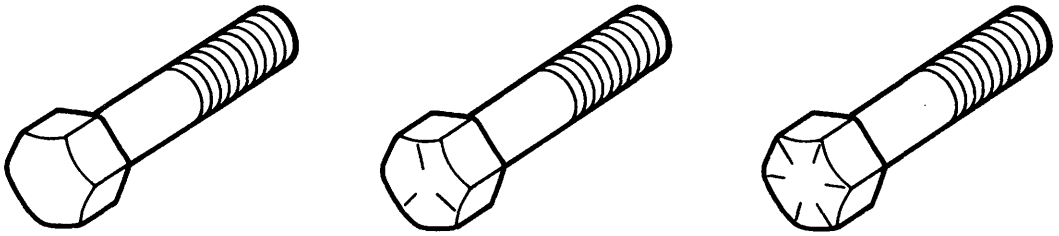
NOMENCLATURE FOR BOLTS

(ENGLISH) INCH SYSTEM	METRIC SYSTEM
Bolt, 1/2-13x1.25	**Bolt M12-1.75x25**
	
D- Nominal Diameter (inches) G- Grade Marking (bolt strength) L- Length, (inches)** T- Thread Pitch (thread/inch)	D- Nominal Diameter (millimeters) L- Length (millimeters)** P- Property Class* (bolt strength) T- Thread Pitch (thread width crest to crest mm)

*The property class is an Arabic numeral distinguishable from the slash SAE English grade system.
**The length of all bolts is measured from the underside of the head to the end.

BOLT STRENGTH IDENTIFICATION

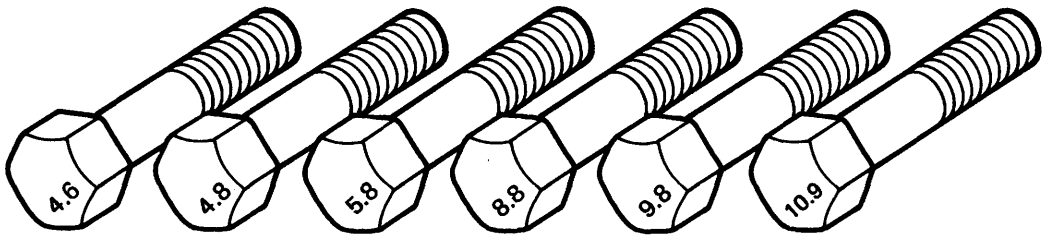
(ENGLISH) INCH SYSTEM



Grade 1 or 2 | Grade 5 | Grade 8

(English) Inch bolts - Identification marks correspond to bolt strength - increasing number of slashes represent increasing strength.

METRIC SYSTEM



Metric bolts — Identification class numbers correspond to bolt strength - increasing numbers represent increasing strength. Common metric fastener bolt strength properties are 9.8 and 10.9 with the class identification embossed on the bolt head.

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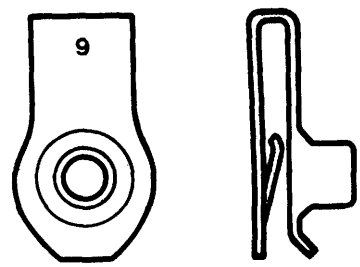
HEX NUT STRENGTH IDENTIFICATION

(ENGLISH) INCH SYSTEM		METRIC SYSTEM	
Grade	**Identification**	**Class**	**Identification**
Hex Nut Grade 5	 3 Dots	Hex Nut Property Class 9	 Arabic 9
Hex Nut Grade 8	 6 Dots	Hex Nut Property Class 10	 Arabic 10
Increasing dots represent increasing strength.		May also have blue finish or paint daub on hex flat. Increasing numbers represent increasing strength.	

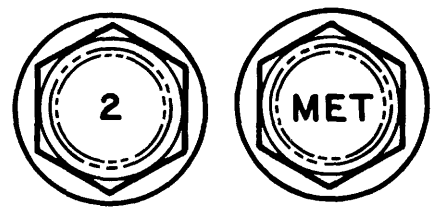
OTHER TYPES OF PARTS

Metric identification schemes vary by type of part, most often a variation of that used of bolts and nuts. Note that many types of English and metric fasteners carry no special identification if they are otherwise unique.

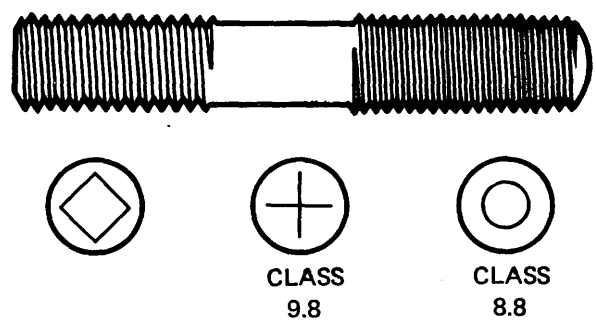
–Stamped "U" Nuts



–Tapping, thread forming and certain other case hardened screws



–Studs, Large studs may carry the property class number. Smaller studs use a geometric code on the end.



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DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal In.	Metric mm.	Fractions	Decimal In.	Metric mm.
1/64	.015625	.397	33/64	.515625	13.097
1/32	.03125	.794	17/32	.53125	13.494
3/64	.046875	1.191	35/64	.546875	13.891
1/16	.0625	1.588	9/16	.5625	14.288
5/64	.078125	1.984	37/64	.578125	14.684
3/32	.09375	2.381	19/32	.59375	15.081
7/64	.109375	2.778	39/64	.609375	15.478
1/8	.125	3.175	5/8	.625	15.875
9/64	.140625	3.572	41/64	.640625	16.272
5/32	.15625	3.969	21/32	.65625	16.669
11/64	.171875	4.366	43/64	.671875	17.066
3/16	.1875	4.763	11/16	.6875	17.463
13/64	.203125	5.159	45/64	.703125	17.859
7/32	.21875	5.556	23/32	.71875	18.256
15/64	.234375	5.953	47/64	.734375	18.653
1/4	.250	6.35	3/4	.750	19.05
17/64	.265625	6.747	49/64	.765625	19.447
9/32	.28125	7.144	25/32	.78125	19.844
19/64	.296875	7.54	51/64	.796875	20.241
5/16	.3125	7.938	13/16	.8125	20.638
21/64	.328125	8.334	53/64	.828125	21.034
11/32	.34375	8.731	27/32	.84375	21.431
23/64	.359375	9.128	55/64	.859375	21.828
3/8	.375	9.525	7/8	.875	22.225
25/64	.390625	9.922	57/64	.890625	22.622
13/32	.40625	10.319	29/32	.90625	23.019
27/64	.421875	10.716	59/64	.921875	23.416
7/16	.4375	11.113	15/16	.9375	23.813
29/64	.453125	11.509	61/64	.953125	24.209
15/32	.46875	11.906	31/32	.96875	24.606
31/64	.484375	12.303	63/64	.984375	25.003
1/2	.500	12.7	1	1.00	25.4

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ENGLISH METRIC CONVERSION

	multiply	by	for equiv. no. of:
ACCELERATION	Foot/sec^2	0.304 8	meter/sec^2 (m/s^2)
	Inch/sec^2	0.025 4	meter/sec^2
TORQUE	Pound-inch	0.112 98	newton-meters (N·m)
	Pound-foot	1.355 8	newton-meters
POWER	horsepower	0.746	kilowatts (kw)
PRESSURE or STRESS	inches of water	0.249 1	kilopascals (kPa)
	pounds/sq. in.	6.895	kilopascals (kPa)
ENERGY or WORK	BTU	1 055.	joules (J)
	foot-pound	1.355 8	joules (J)
	kilowatt-hour	3 600 000. or 3.6 x 10^6	joules (J=one W's)
LIGHT	foot candle	10.76	lumens/meter^2 (lm/m^2)
FUEL PERFORMANCE	miles/gal	0.425 1	kilometers/liter (km/l)
	gal/mile	2.352 7	liters/kilometer (l/km)
VELOCITY	miles/hour	1.609 3	kilometer/hr. (km/h)
LENGTH	inch	25.4	millimeters (mm)
	foot	0.304 8	meters (m)
	yard	0.914 4	meters
	mile	1.609	kilometers (km)
AREA	inch^2	645.2	millimeters^2 (mm^2)
		6.45	centimeters^2 (cm^2)
	foot^2	0.092 9	meters^2 (m^2)
	yard^2	0.836 1	meters^2
VOLUME	inch^3	16 387.	mm^3
		16.387	cm^3
	quart	0.016 4	liters(1)
	quart	0.946 4	liters
	gallon	3.785 4	liters
	yard^3	0.764 6	meters^3 (m^3)
MASS	pound	0.453 6	kilograms (kg)
	ton	907.18	kilograms (kg)
	ton	0.907	tonne (t)
FORCE	kilogram	9.807	newtons (N)
	ounce	0.278 0	newtons
	pound	4.448	newtons
TEMPERATURE	degree farenheit	(1°F 32) 1.8	degree Celsius

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TORQUE CONVERSION

NEWTON METERS (N·m)	POUND-FEET (LB.-FT.)
1	0.7376
2	1.5
3	2.2
4	3.0
5	3.7
6	4.4
7	5.2
8	5.9
9	6.6
10	7.4
15	11.1
20	14.8
25	18.4
30	22.1
35	25.8
40	29.5
50	36.9
60	44.3
70	51.6
80	59.0
90	66.4
100	73.8
110	81.1
120	88.5
130	95.9
140	103.3
150	110.6
160	118.0
170	125.4
180	132.8
190	140.1
200	147.5
225	166.0
250	184.4

POUND-FEET (LB.-FT.)	NEWTON METERS (N·m)
1	1.356
2	2.7
3	4.0
4	5.4
5	6.8
6	8.1
7	9.5
8	10.8
9	12.2
10	13.6
15	20.3
20	27.1
25	33.9
30	40.7
35	47.5
40	54.2
45	61.0
50	67.8
55	74.6
60	81.4
65	88.1
70	94.9
75	101.7
80	108.5
90	122.0
100	135.6
110	149.1
120	162.7
130	176.3
140	189.8
150	203.4
160	216.9
170	230.5
180	244.0

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