1984 Car Shop Manual

SUPPLEMENT

2.4L Diesel Turbo Engine
ZF Transmission

Continental/Mark VII

Ford

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. If you have a manual transmission, it should be in REVERSE. Place wood blocks of a 4″ × 4″ size 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 a vehicle.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing before beginning to work on a vehicle.

FOREWORD

This Car Shop Manual Supplement provides information covering normal service, repairs, and maintenance for Body, Chassis, Electrical and Powertrain systems for Mark VII and Continental passenger cars manufactured in the United States and Canada.

This manual is organized into Groups covering general systems. The basic part numbers for components covered in the Group are included in parenthesis after the Group Number. For example:

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

Some component parts may not have the same basic part numbers. In these cases, more than one basic part number will appear with the Group Number. For example:

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

Within each Group, the information is further divided into Sections. There is one Section for each component or sub-system. Some Groups contain a Service Section to cover procedures common to several components or sub-systems 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 subjects in this manual, use the Table of Contents on the following pages.

As a further aid, there is an index on the first page of each Group which lists the Section title and Section number for each component covered within the group. The first page of each Section also 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: 11-02-3 = (Group) 11 — (Section) 02 — (Page) 3

The descriptions and specifications contained in this manual were in effect at the time this manual was approved for printing. Ford Motor Company reserves the right to discontinue models at any time, or change specifications or design without notice and without incurring obligation.

For service information on specific car lines for Body, Chassis and Electrical; Powertrains; Emissions; and/or Pre-Delivery, refer to the Cross Index in the front of this manual.

For information on ordering Special Service Tools, refer to the last page of this manual.

Ford Parts and Service Division
Training and Publications Department

CROSS INDEX

MANUAL SUFFIX	VEHICLE LINES	MANUAL CONTENT
A	LINCOLN TOWN CAR FORD CROWN VICTORIA/ MERCURY GRAND MARQUIS	BODY, CHASSIS, ELECTRICAL
B	MARK VII / CONTINENTAL, THUNDERBIRD/COUGAR, LTD/MARQUIS, MUSTANG/CAPRI	BODY, CHASSIS, ELECTRICAL
C	TEMPO/TOPAZ, ESCORT/LYNX, EXP	BODY, CHASSIS, ELECTRICAL
D	ALL CAR MODELS EXCEPT TEMPO/TOPAZ, ESCORT/LYNX, EXP	POWERTRAIN
E	TEMPO/TOPAZ, ESCORT/LYNX, EXP	POWERTRAIN
F	ALL CAR MODELS	PRE-DELIVERY
HC	ALL CAR MODELS	ENGINE/ EMISSIONS DIAGNOSIS

SECTION INDEX

SECTION 13-06 Steering Column—Modular I (Extruded Absorber Type)

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The 2.4L diesel engine uses a unique steering column with a shift selector insert plate, (part number E45C-7A216-AA, refer to Figs. 1 and 2, part 56), color coded yellow. The standard and heavy duty insert plates are color coded purple and green respectively.

CAUTION: The insert plates are not interchangeable and incorrect useage may result in transmission damage.

For further information regarding the steering column, refer to the 1984 Car Shop Manual, Volume B, Section 13-06.

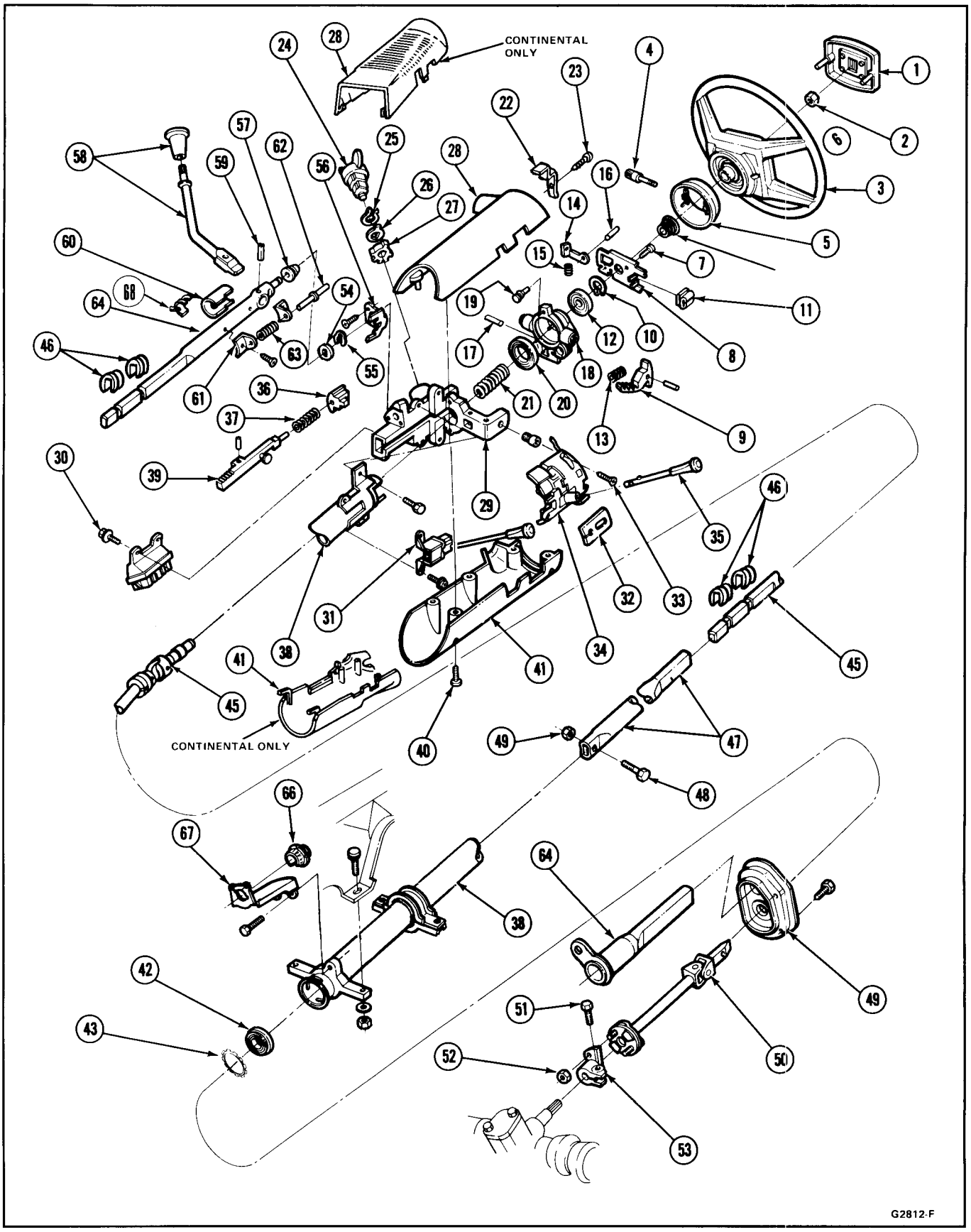


FIG. 1 Steering Wheel—Column Shift—Exploded View

1. 3A515 — EMBLEM ASSY.
2. 33850-S2 — NUT 5/8-18 HEX
3. 3600 — WHEEL ASSY. — STRNG.
4. HANDLE & SHANK ASSY.
   3F609 — TILT STRNG. WHEEL LEVER
5. 3R564 — EXTENSION — STRNG. COL. SHROUD
6. 3520 — SPRING — STRNG. COL. UPPER BEARING
7. 52794-S2 — SCREW
8. 3L525 — PLATE STRNG. COL. CLIP RETAINER
9. 3B662 — LEVER STRNG. COL. LINK
10. 97476-S100 — RING 3/4 RETAINING TYPE
11. 3K712 — CLIP — STRNG. COL. SHROUD
12. 3517 — BEARING ASSY. — STRNG. COL. UPPER
13. N800328-S — PIN 4mm x 25.6 STRAIGHT ROUND END
14. 3D544 — RELEASE LEVER
15. 3C732 — SPRING — STRNG. COL. RELEASE LEVER
16. N800329 — PIN — 4mm x 5.75
17. 3D739 — PIVOT PIN
18. 3511 — FLANGE CASTING
19. 3D656 — BUMPERS
20. 3517 — BEARING ASSY. — STRNG. COL. UPPER
21. 3D655 — POSITION SPRING
22. 3E745 — COVER — STRNG. COL. LOCK ACTUATOR
23. 52794-S2 SCREW NO. 8-18 x .62 PAN HEAD TAPPING
24. LOCK CYL. (BODY)
25. N800205-S100 — RING 24 x 1.07 RETAINER TYPE
26. 3E700 — BEARING
27. 3E717 — GEAR — STRNG. COL. LOCK
28. 3530 — SHROUD — UPPER
29. 3E643 — HOUSING — STRNG. COL. LOCK CYL.
30. N800207-S100 — BOLT (BREAK OFF HEAD) (2 REQ'D.)
31. WASH/WIPE SWITCH & SCREWS (BODY)
32. 13B365 FOAM COVER — TURN SIGNAL & W W SWITCH
33. 52794-S2 SCREW NO. 8-18 x .62 PAN HEAD TAP (2 REQ'D.)
34. TURN SIGNAL SWITCH
35. 13305 — HANDLE & SHANK ASSY. — TURN SIG. SWITCH
36. 3E691 — PAWL — STRNG. COL. LOCK
37. 3E696 — SPRING — STRNG. COL. LOCK
38. 3A617 — TUBE ASSY. COL. OUTER
39. 3E723 — ACTUATOR ASSY. — STRNG. COL. LOCK
40. 55931-S2 SCREW NO. 8-18 x 1.50 PAN HEAD TAP (5 REQ'D.)
41. 3530 — SHROUD — STRNG. COL. LOWER
42. 3E733 — BEARING ASSY. — STRNG. GEAR SHAFT LOWER
43. 3F543 — RING — STRNG. GEAR SHAFT LOWER BEARING RETAINER
44. 3E735 — BOOT ASSY. — STRNG. COL.
45. 3A526 — SHAFT ASSY. — STRNG. COL. UPPER
46. 3E629 — ANTI-RATTLE CLIPS
47. 3E628 — SHAFT — STRNG. GEAR LOWER
48. 58655-S2 — BOLT 7/16-14 x 1.50 HEX
49. 388795-S100 — NUT 7/16-14 HEX LOCK
50. 3C662 — SHAFT ASSY. — STRNG. COL. LOWER
51. 385970-S100 BOLT — 3/8-24 x 1.22
52. 34977-S2 — NUT 3/8-16 HEX LOCK
53. 3459 — FLANGE — STRNG. SHAFT LOWER
54. 388021-S2 — RING — 5/16 RETAINER
55. N800178-S2 — WASHER — 8.23 FLAT
56. 7A216 — INSERT — TRANS. CONTROL SELECTOR POSITION
57. 7225 — BEARING — TRANS. GEAR SHIFT LEVER SOCKET
58. 7202 — LEVER ASSY. — TRANS. CONTROL SELECTOR
59. N100198 — PIN 5mm SPRING COILED
60. 7C369 — COVER — TRANS. CONTROL SELECTOR LEVER OPENING
61. N800210-S2 — SCREW 4mm — 0.7 x 12.7 TYPE "D" OVAL (2 REQ'D.)
62. 7361 — PLUNGER — TRANS. CONTROL SELECTOR LEVER
63. 7B071 — SPRING — TRANS. CONTROL SELECTOR LEVER RETURN
64. 7212 — TUBE ASSY. — TRANS. CONTROL SELECTOR
66. 7K189 — BUSHING — TRANS. GEAR SHIFT SHAFT
67. 7K738 — BRKT. — TRANS. GEAR SHIFT SUPPORT
68. 3C686 — SPACER CLIP

CG2813-D

FIG. 2 Steering Wheel—Column Shift—Exploded View Index

SECTION 13-51 Steering Pump, Power—Ford Model CII

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The power steering pump is mounted above the A/C compressor in a large cast aluminum bracket. The bracket is supported on the outboard side by a tubular brace which is secured to the engine mount. A flat plate brace connects the A/C compressor mounting face to the power steering pump mounting face. A pivoting tensioner/idler mounts to the front face of the casting.

Refer to the 1984 Car Shop Manual, Volume B, Section 13-51 for Description, Diagnosis and Testing, and Disassembly and Assembly of the power steering pump.

REMOVAL AND INSTALLATION

Steering Pump, Power

Removal

Refer to Fig. 1.

1. To remove the power steering fluid from the pump reservoir, disconnect the fluid return hose(s) at the reservoir, and drain the fluid into a container.
2. Remove the pressure hose from the pump fitting.

   NOTE: Do not remove the fitting from the pump.
3. Disconnect the belt from the pulley, and remove the pulley. Remove the pump.

Installation

NOTE: Prior to pump installation, remove the shipping tube nut from the pressure fitting.

1. Place the pump on the mounting bracket, and install the bolts at the front of the pump. Tighten to 40-62 N·m (30-45 lb-ft).
2. Install the pump pulley, place the belt on the pulley, and adjust belt tension.
3. Install the pressure hose to the pump fitting. Tighten the tube nut with a tube nut wrench rather than with an open end wrench. Do not overtighten this fitting. Tighten to 14-20 N·m (10-15 lb-ft). Swivel and/or end play of the fitting is normal and does not indicate a loose fitting.

   NOTE: Overtightening the tube nut can collapse the tube nut wall, resulting in a leak and requiring replacement of the entire pressure hose assembly. Use of an open end wrench to tighten the nut can deform the tube nut hex which may result in improper torque and may make further servicing of the system difficult.
4. Connect the return hose(s) to the pump, and tighten the clamp(s).
5. Fill the reservoir with specified power steering fluid.

   Use start-up procedure in the 1984 Car Shop Manual, Volume B, Section 13-51 after power steering pump or gear overhaul.
6. Check for leaks, and recheck the fluid level. Add fluid if necessary.

Power Steering Pump Bracket

Removal

Refer to Fig. 1.

1. Remove fuel line clip.
2. Loosen idler/tensioner mounting bolt and remove belt from pulleys. Remove pulley from pump and remove pump.
3. Remove brace.
4. Remove A/C compressor.
5. Remove two bolts on in-board side of bracket (accessible from front of engine).
6. Remove nut on engine mount stud.
7. Remove remaining bolts.

Installation

1. Position bracket on engine mount stud. Hand start/ tighten two bolts to side of engine.
2. Hand start two bolts to front of engine and tighten to specification. (Refer to Fig. 1 for all torque specifications).
3. Install nut on engine mount. Tighten both bolts and nuts.
4. Install A/C compressor and brace and tighten to specification.
5. Install power steering pump with three bolts and tighten to specification.
6. Install brace with two bolts and tighten to specification.
7. Install fuel line clip.

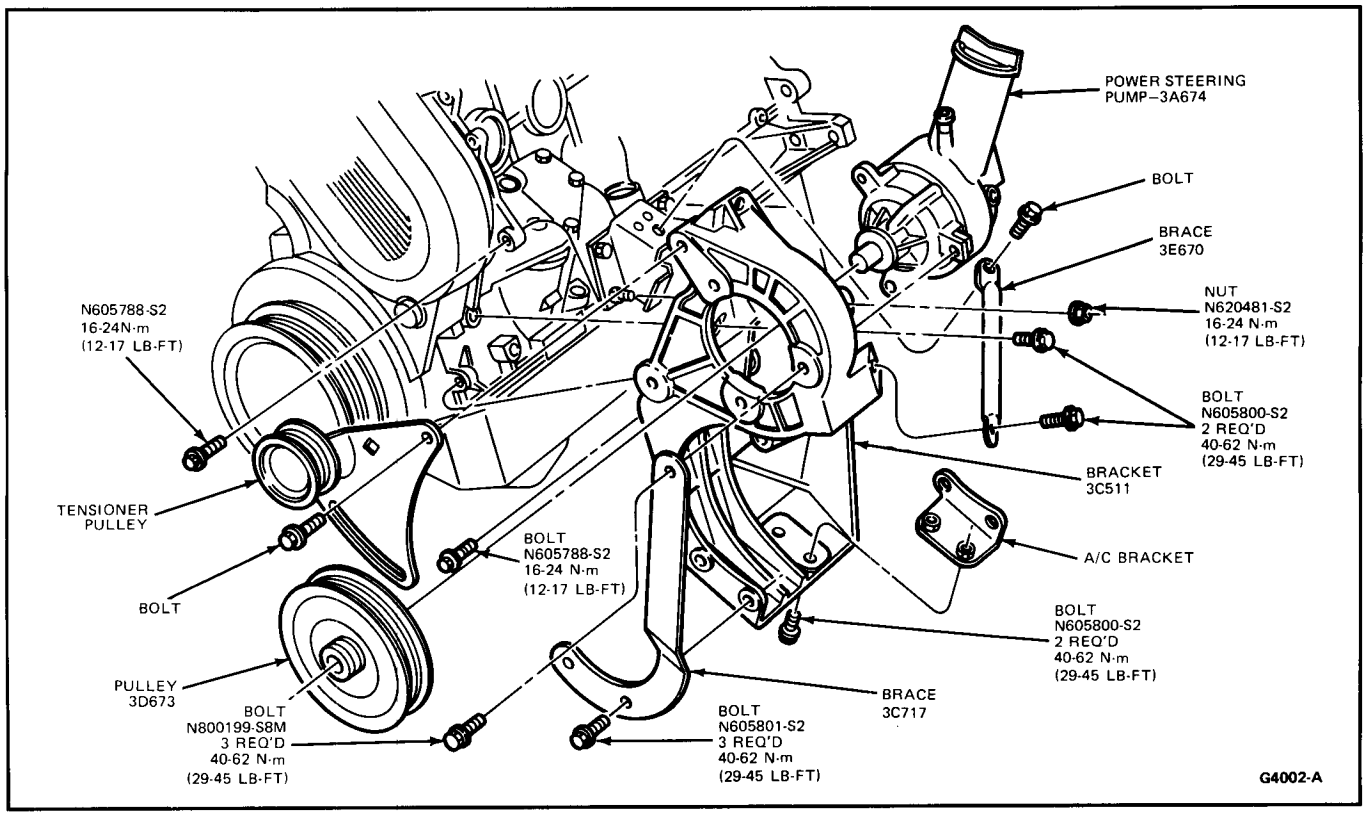


FIG. 1 Power Steering Pump and Bracket—Installation

SECTION 17-02 Shift Control Linkage

VEHICLE APPLICATION

Mark VII/Continental.

ADJUSTMENTS

The transmission control linkage adjustments should be performed in the order in which they appear.

Manual Linkage

Column Shift

1. Place selector lever in the Overdrive Ⓓ position tight against the Overdrive stop. A 3.6 Kg (8 lb) weight should be hung on the selector lever to be sure the lever remains against the Overdrive stop during the linkage adjustment.
2. Remove the shift rod adjusting stud nut and remove shift rod from stud (Fig. 1).

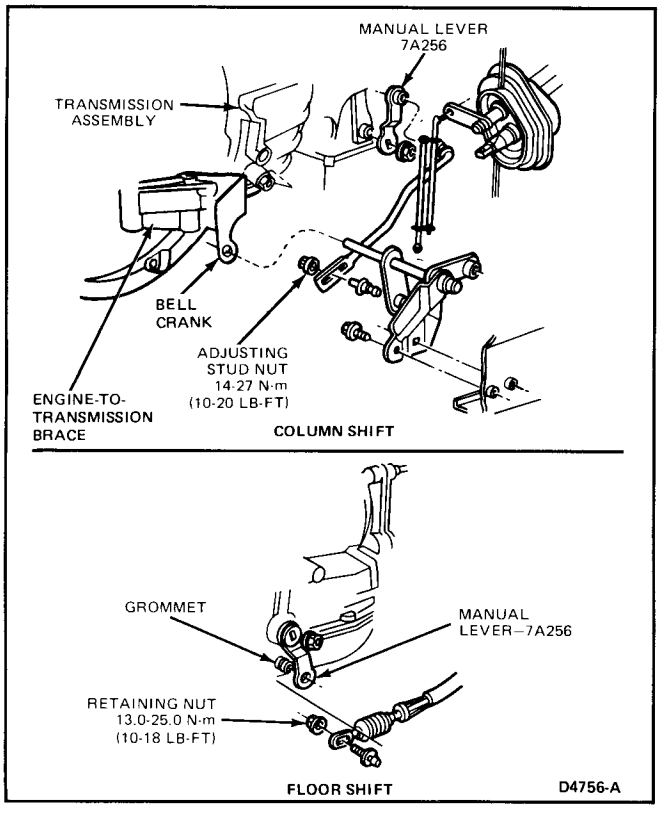


FIG. 1 Transmission Shift Linkage or Cable

3. Shift the transmission into Overdrive Ⓓ by rotating the column shift lever (7A256) three detents from the most counterclockwise position.
4. Make sure that the selector lever has not moved from the Overdrive stop. Reinstall the shift rod on the adjusting stud and tighten the nut to 14-27 N·m (10-20 lb-ft).
5. Check the transmission operation for all selector lever detent positions.

Console or Floor Shift

1. Position the transmission selector lever in Overdrive Ⓓ against the rearward Overdrive stop.

   NOTE: The shift lever should be held against the rearward Overdrive stop when the linkage is adjusted.
2. Raise the vehicle and loosen the manual lever shift cable retaining nut (Fig. 1). Move the transmission manual lever to the Overdrive position (third detent position from the back of the transmission).
3. With the transmission selector lever and manual lever in the Overdrive position, tighten the manual lever shift cable retaining nut to 13-25 N·m (10-18 lb-ft).

Throttle and Kickdown Cable

Adjusting the throttle cable is important to be certain the throttle and kickdown systems are properly adjusted. The kickdown system should come in when the accelerator is pressed through detent, and not before detent. Refer to Section 25-60 for throttle cable adjustment procedures. Refer to Section 17-12 for kickdown (TV) cable adjustments.

REMOVAL AND INSTALLATION

Shift Linkage Grommet

The automatic transmission linkage systems use a urethan plastic grommet to connect the various rods and levers. 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 Tool T67P-7341-A or equivalent between the lever and the rod (Fig. 2). Position the stop pin against the end of the rod (Fig. 2), and force the rod end out of the grommet. Remove the grommet from the lever by cutting off the large shoulder with a sharp knife.

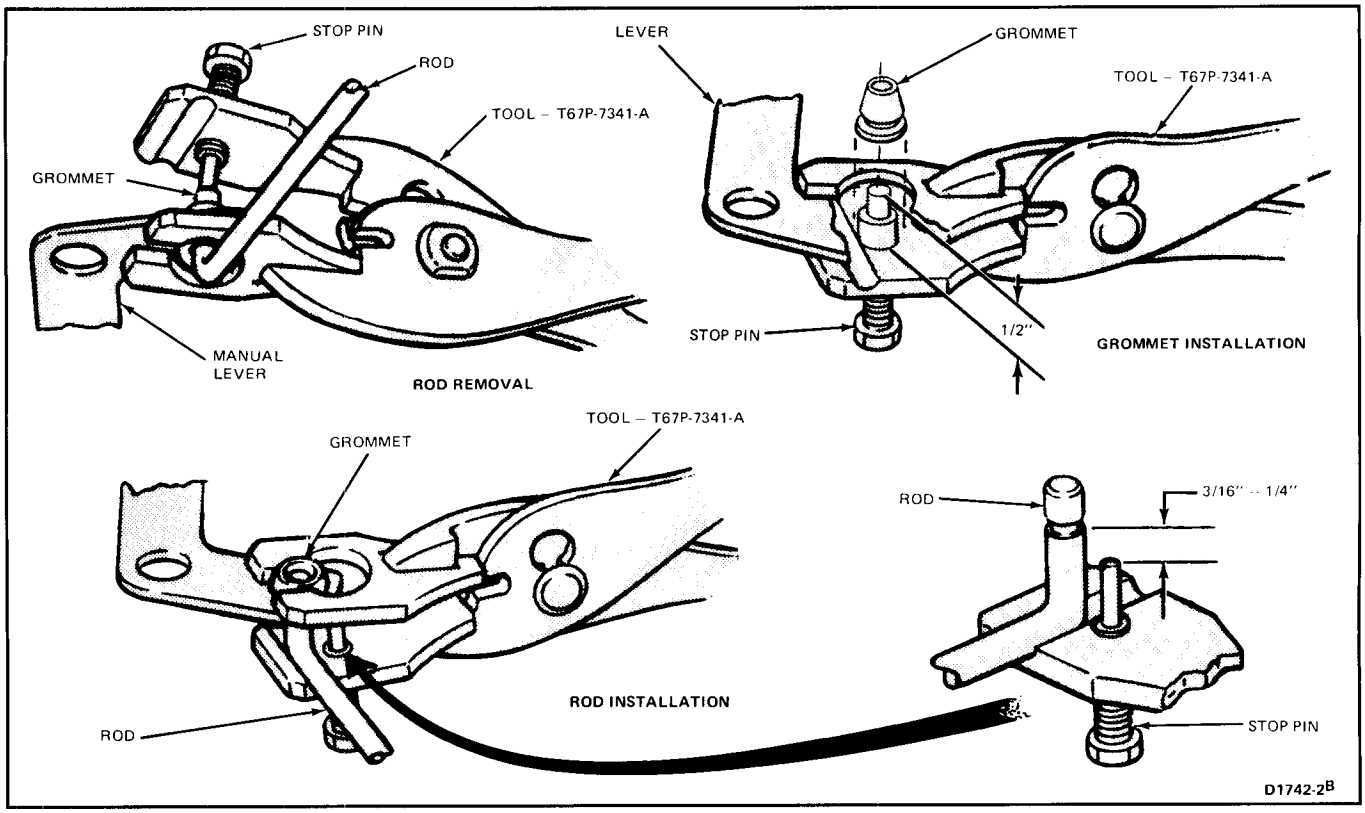


FIG. 2 Linkage Grommet—Removal and Installation

2. Adjust the stop to 12.7mm (1/2-inch) and coat the outside of the grommet with lubricant. 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. Squeeze the rod into the bushing until the stopwasher seats against the grommet.

Neutral Start Switch

1. Disconnect the electrical connector from the neutral start switch pigtail (Fig. 3).
2. Remove the bolt, washer and retainer plate retaining the switch to the transmission case and remove switch (Fig. 3).

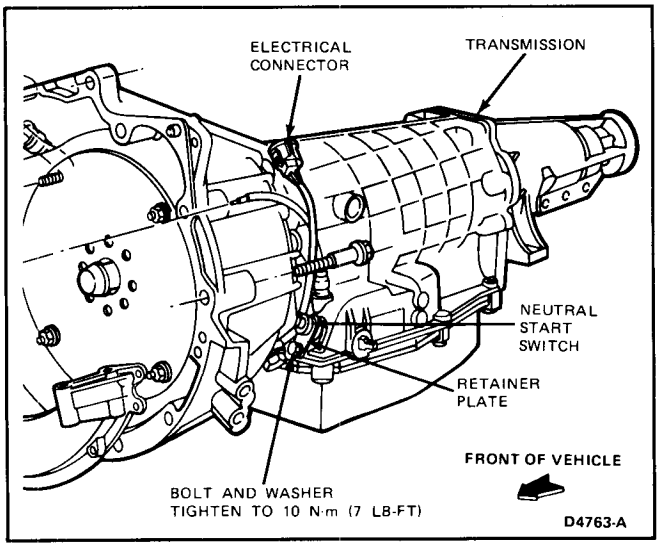


FIG. 3 Neutral Start Switch—Installation

Installation

1. Install neutral start switch, retainer plate bolt and washer and tighten to 7 N·m (10 lb-ft).
2. Connect electrical connector to neutral start switch.

Selector Lever—Console Floor Shift

Removal

Refer to Fig. 4.

1. Remove the console applique.
2. Remove the two nuts in the front and two bolts in the rear which attach the shifter to mounting brackets.
3. Remove the screw attaching the key release cable.
4. Lift shifter from the console, while rotating sideways, to gain access to the shift cable.
5. Remove the clip retaining the cable and disengage the ball stud.
6. Disconnect illumination lamp electrical connector by unplugging the socket, and remove the lamp.

Installation

1. Insert the illumination lamp and snap into place.
2. Attach the shift cable by inserting "C" clip into bracket and snapping ball stud into the shifter arm.
3. Attach key cable to shifter bracket with screw. Tighten to 3.3-4.4 N·m (2.5-3.2 lb-ft).
4. Locate the shifter on two front mounting studs and install nuts. Tighten to 3.9-5.6 N·m (2.9-4.1 lb-ft).
5. Install two rear mounting bolts. Tighten to 8.0-13 N·m (5.9-9.5 lb-ft).
6. Install console applique.

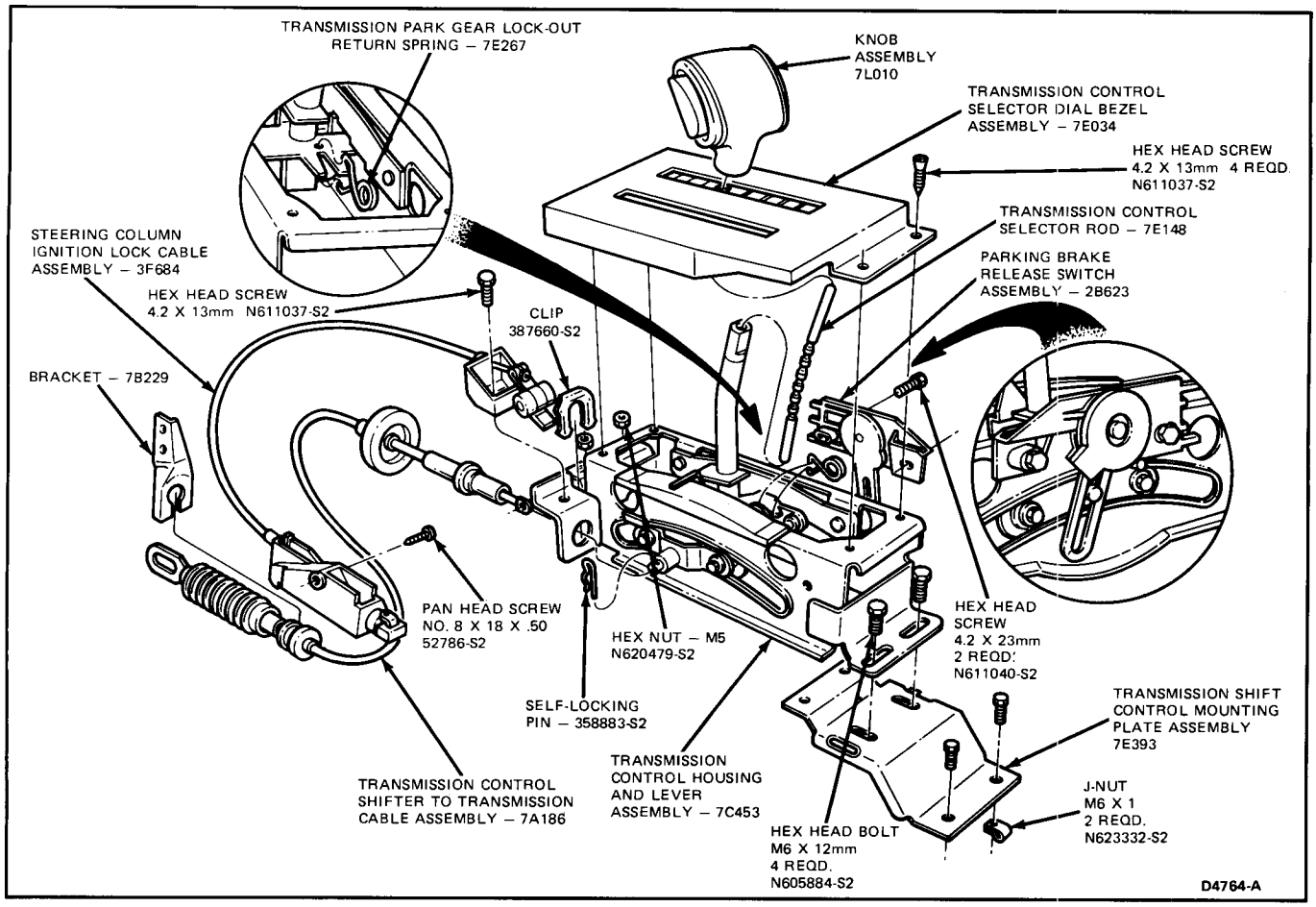


FIG. 4 Shift Selector—Installation

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft	Description	N·m	Lb-Ft
Selector Lever Adjusting Stud Retaining Nut	14-27	10-20	Manual Lever-to-Case Attaching Nut	14-27	10-20
Selector Lever Shift Cable Retaining Nut	13-25	10-18	Neutral Start Switch to Case (C3, C5)	10	84 Lb-In

CD4760-A

SECTION 17-12 Transmission, Automatic—ZF

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The ZF automatic is a four-speed transmission that provides automatic upshifts and downshifts through four forward gear ratios. Selector positions are the same as AOD (automatic overdrive), but with an entirely different gear train and torque converter lock-up feature.

Torque Converter

The torque converter operates as a conventional torque multiplier and fluid coupling in all gears except fourth (overdrive). In fourth gear, a specific combination of road speed and accelerator position signals calls for a lockup to mechanical drive. When this happens, the valve body applies pressure to a hydraulic clutch in the converter, which locks the impeller to the turbine.

Drive Train

The drive train is controlled by seven disc clutches and three one-way clutches. It has a front compound planetary gear train that operates in first, second, third and reverse. A separate overdrive gear set provides fourth gear and is locked up for direct (through) drive in all other gears. The output shaft is housed in a conventional Ford extension housing, with a C3 bushing and slip yoke seal. A pawl and gear are used for park lock.

Hydraulic System

The valve body is controlled by the manual selector, a centrifugal governor on the output shaft, and a manual TV/kickdown cable to signal throttle position. The cable is attached to the cable bracket and injection pump side lever.

Shift Selector Positions and Operation

The ZF transmission is fully automatic in either the Ⓓ (overdrive) or D (overdrive lock-out) positions. Manual upshifting and downshifting is available through the forward drive positions Ⓓ, D, L.

Ⓓ (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, third and fourth gears. The transmission will automatically downshift as vehicle speed decreases.

NOTE: The transmission will not shift into or remain in overdrive (fourth) gear when the accelerator is pushed to the floor.

D (Overdrive Lockout) - In this position the transmission operates as in Ⓓ (Overdrive) except there will be no shift into the overdrive 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.

L (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 L (Low). At vehicle speeds above approximately 32 km/h (20 mph) the transmission will shift to second gear, and remain in second gear. When vehicle speed drops below approximately 32 km/h (20 mph) the transmission will downshift to first gear, and remain in first gear. Upshifts from L (Low) can be made by manually shifting to Ⓓ (Overdrive) or D (Overdrive Lockout). When the L (Low) position is selected for initial driveaway, the transmission will remain in the selected gear range until the selector is moved into another gear position.

P, R and N - These positions operate the same as other Ford automatics.

Reverse Inhibitor - If the selector is moved to R with the vehicle moving forward at 30 km/h (19 mph) or more, the transmission will not shift to reverse gear.

Forced Downshifts

- At vehicle speeds from approximately 80 km/h to 32 km/h (50 mph to 20 mph) with the transmission 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 80 km/h (50 mph) the transmission will not downshift to second gear.
- At vehicle speeds below approximately 32 km/h (20 mph) the transmission will downshift to first gear when the accelerator is pushed to the floor.
- At most vehicle speeds, when the transmission is in Ⓓ (Overdrive) the transmission will downshift from fourth gear to third gear when the accelerator is pushed for moderate to heavy acceleration.

SERVICE

The ZF transmission torque converter and gear train are not serviced in dealerships. If diagnosis determines that the converter or gear train parts need service, the entire transmission and converter assembly must be removed and exchanged. The identification tag is shown in Fig. 1.

ADJUSTMENTS

No internal adjustments are possible on this transmission. The only adjustments possible are for the kickdown (TV) cable.

When installing a new TV cable, the reference bead will be loose on the cable. Refer to New Cable Installation for the adjustment of this bead.

Kickdown (TV) Cable

Refer to Fig. 2.

1. Set the injection pump lever at the full throttle position.
2. Tighten the rear adjusting nut on the threaded barrel until a gap of 39-40mm (1.54-1.57 inches) exists between the edge of the crimped bead on the cable closest to the barrel and the end of the threaded barrel.
3. Tighten the forward adjusting nut to lock the cable assembly to the bracket to 9-12 N·m (80-106 lb-in).
4. Recheck the gap and readjust as necessary.

   NOTE: Kickdown on this transmission is controlled by the injection pump linkage adjustments. Refer to the Engine/Emissions Diagnosis Manual, Section 31, for injection pump linkage adjustments.

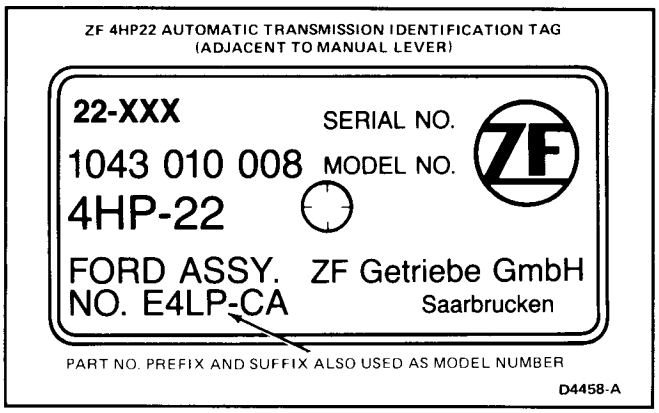


FIG. 1 Transmission Identification Tag

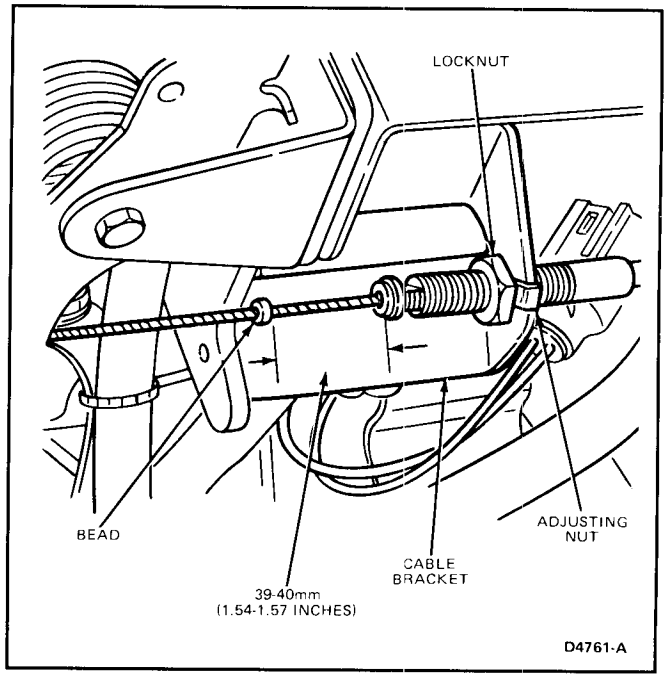


FIG. 2 Kickdown (TV) Cable Adjustment

REMOVAL AND INSTALLATION

Transmission and Converter Assembly

Removal

Refer to Fig. 3.

1. Remove the kickdown (TV) cable and insert from the injection pump side lever and cable bracket in the engine compartment (Fig. 3).
2. Place the transmission selector lever in N (Neutral). Raise the vehicle on a hoist.
3. Remove the outer manual lever and nut from the transmission selector shaft.
4. Remove position sensor from converter housing.
5. Remove the engine brace from the lower end of the converter housing.
6. Place a transmission jack under the transmission.
7. Place a wrench on the crankshaft pulley attaching bolt and turn the converter to gain access to the converter-to-flywheel attaching nuts. Remove the converter-to-flywheel attaching nuts.

   NOTE: The converter studs are installed in the converter with Loc-Tite. During disassembly the nuts may override the Loc-Tite and the nut and stud come out as a "bolt". This poses no concern. The stud and converter threads should be cleaned, Loc-Tite applied, and the "bolt" reinstalled and tightened to specification.
8. Disconnect the driveshaft from the rear axle and slide shaft rearward from the transmission.

   NOTE: To maintain driveshaft balance, mark the rear driveshaft yoke and axle companion flange so the driveshaft can be installed in its original position. Install a seal installation tool in the extension housing to prevent fluid leakage.
9. Disconnect the neutral start switch electrical connector (Fig. 3).
10. Remove the extension housing damper.

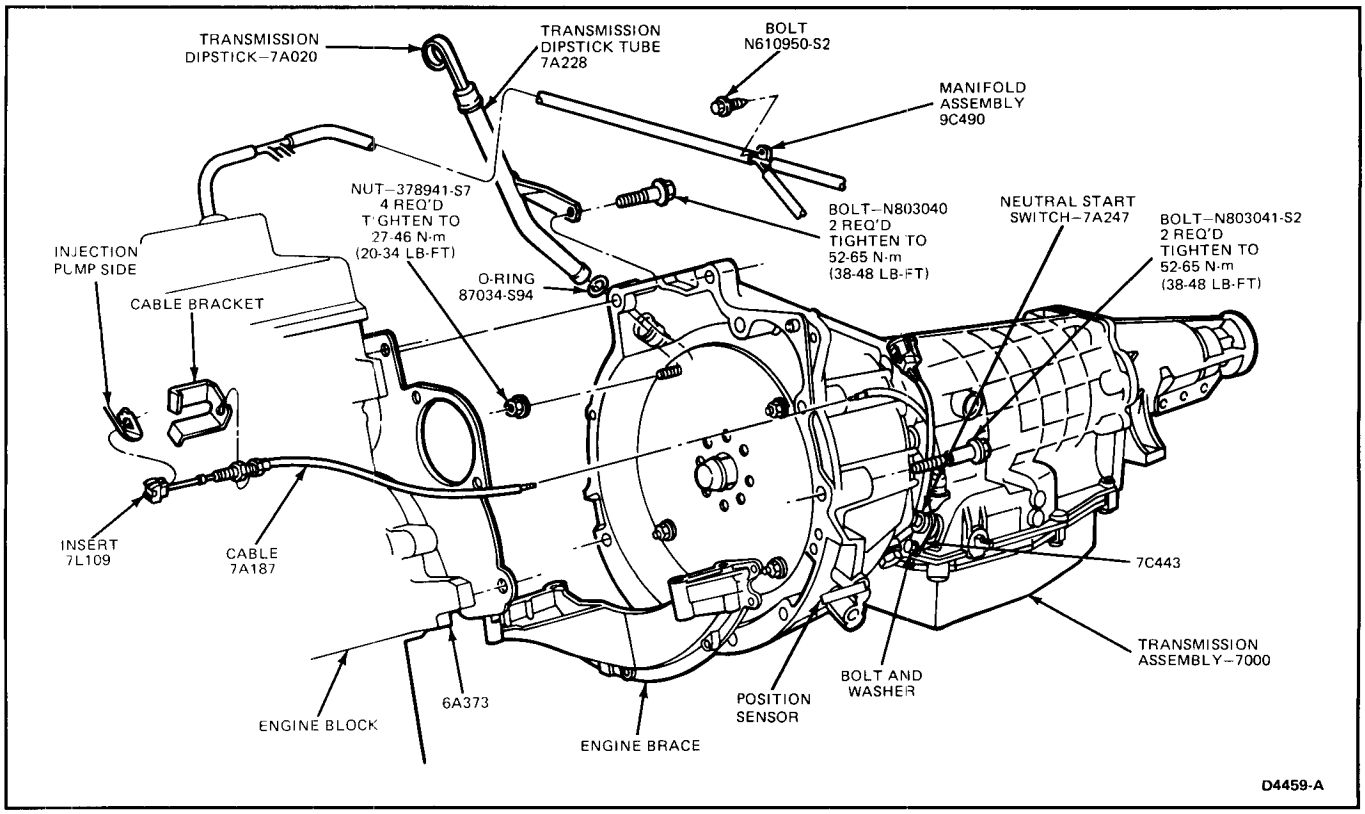


FIG. 3 ZF Transmission—Removal and Installation

11. Remove the rear support-to-crossmember attaching nuts and the two crossmember-to-side support attaching bolts.
12. Remove the two engine rear support-to-extension housing attaching bolts and remove the rear mount from the exhaust system.

    NOTE: On some models, exhaust system hardware may have to be removed to facilitate removal of crossmember and transmission.
13. On Continental with column shift, remove the two bolts securing the bellcrank bracket to the engine-to-transmission brace.
14. Disconnect each oil line from the fittings on the transmission using push connect service Tool T82L-9500-AH or equivalent.
15. Disconnect the speedometer wiring harness from the extension housing.
16. Remove the two converter housing to starter motor bolts.
17. Secure the transmission to the jack with a safety chain and lower the jack slightly.
18. Remove the four converter housing-to-cylinder block attaching bolts.
19. Remove the filler tube and dipstick.
20. Carefully move the transmission and converter assembly away from the engine and, at the same time, lower the jack to clear the underside of the vehicle.
21. Mount the transmission in a holding fixture.

Installation

1. Place the transmission on the jack. Secure the transmission to the jack with a safety chain.
2. Rotate the converter until the studs are in alignment with the holes in the flywheel and flexplate.
3. Move the converter and transmission assembly forward into position, using care not to damage the flywheel, flexplate and the converter pilot. The converter face must seat squarely against the flexplate (This indicates that the converter pilot is not binding in the engine crankshaft).
4. Install the filler tube and dipstick, position bracket over the upper right housing to engine bolt holes.
5. Install and tighten the four converter housing-to-engine attaching bolts to 52-65 N·m (38-48 lb-ft).
6. Remove the safety chain from around the transmission.
7. Connect the oil cooler lines by pushing them into the fittings on the transmission (located on the intermediate plate).
8. Connect the speedometer wiring harness to the extension housing.
9. Install the extension housing damper with three bolts. Tighten bolts to 24-34 N·m (18-25 lb-ft).
10. Install the rear support on the exhaust system.
11. Install the crossmember on the side supports and install the attaching bolts and nuts. Position the rear support on the crossmember and tighten the nuts to specification.
12. Secure the engine rear support to the extension housing and tighten the bolts to specification.
13. If removed, install exhaust system hardware.
14. Lower the transmission and remove the jack.
15. On the Continental equipped with column shift, position the bellcrank to the engine-to-transmission

brace and install the two attaching bolts. Tighten the bolts to 14-27 N·m (10-20 lb-ft).

16. Guide the kickdown (TV) cable up into the engine compartment.
17. Install the outer manual lever on the transmission selector shaft. Tighten the attaching nut to 14-27 N·m (10-20 lb-ft).
18. Install the converter to flywheel attaching nuts (or bolts) and tighten to 27-46 N·m (20-34 lb-ft).
19. Install the engine brace on the lower end of the converter housing and engine block. Tighten the bolts to 20-24 N·m (15-18 lb-ft).
20. Connect the neutral start switch harness at the transmission.
21. Install position sensor to converter housing.
22. Connect the driveshaft to the rear axle. Install the driveshaft so the index marks, made during removal, are correctly aligned.

    NOTE: Lubricate the yoke splines with C1AZ-19590-B or equivalent.
23. Adjust the manual shift linkage as described in Section 17-02.
24. Lower the vehicle and adjust the kickdown (TV) cable as outlined.
25. Fill the transmission to the correct level with the specified fluid. Start the engine and shift the transmission to all positions, then recheck the fluid level.

Valve Body (Main Control Assembly)

Removal

1. Raise vehicle on a hoist so the transmission and fluid pan are accessible.
2. Place a drain pan under the transmission fluid pan. Remove the oil pan plug and allow the fluid to drain (Fig. 4).
3. Disconnect the filler tube from the oil pan.
4. Using a 10mm socket, remove bolts and clamps attaching oil pan to case. Remove fluid pan while allowing the remaining fluid to drain.
5. Remove three Torx head bolts retaining fluid pan screen and remove screen (Figs. 4 and 5).
6. Remove 13 additional attaching bolts to remove valve body from transmission (Fig. 5).
7. Clean case and valve body mating surfaces. Inspect for burrs or distortion of surfaces.

Installation

1. Position valve body under case to engage detent plate pin in manual valve (Fig. 6, Circle A).
2. Pull on kickdown cable to position accelerator cam so that roller on throttle piston clears the cam (Fig. 6, Circle B).
3. Position valve body against the case. Install 13 valve body bolts fingertight to hold the valve body in alignment to the case. Refer to Fig. 5 for bolt length identification.
4. Align the valve body by inserting the valve body gauge T84P-77003-A or equivalent, between the throttle piston pin and the valve body housing (Fig. 7). If the piston pin interferes with the gauge and does not allow it to pass through, use the notch in the gauge handle to grip the pin and draw the throttle piston further out of its bore.
5. Push the valve body forward (toward the converter) until the gauge is held snug. (Light pressure is required to move the gauge up and down.)

   Tighten bolt "B1" firmly, as shown in Fig. 7 to hold the valve body in place.

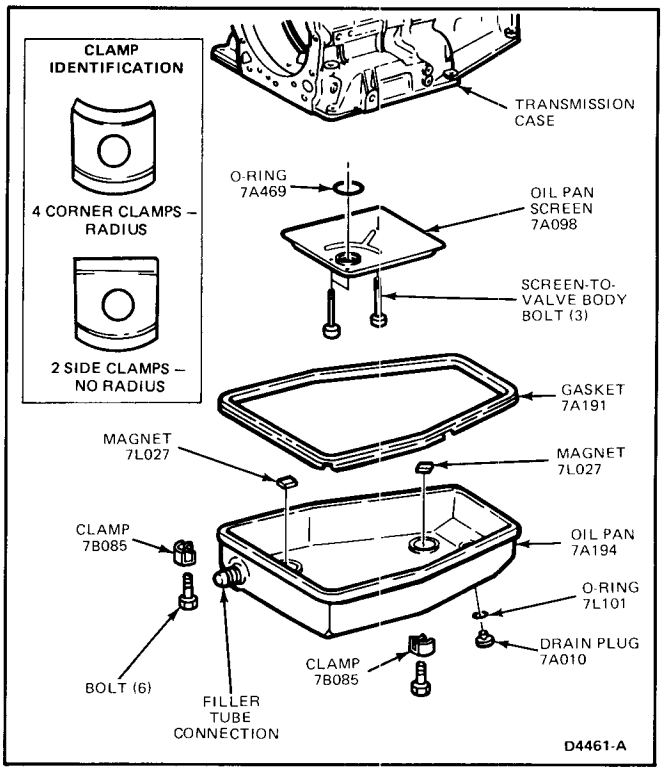


FIG. 4 Transmission Oil Pan, Screen and Gasket—Removal

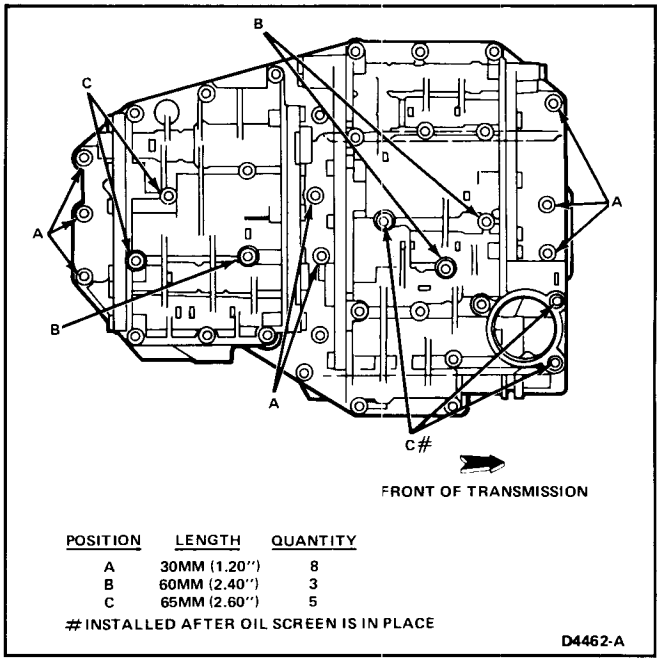


FIG. 5 Valve Body Retaining Bolts

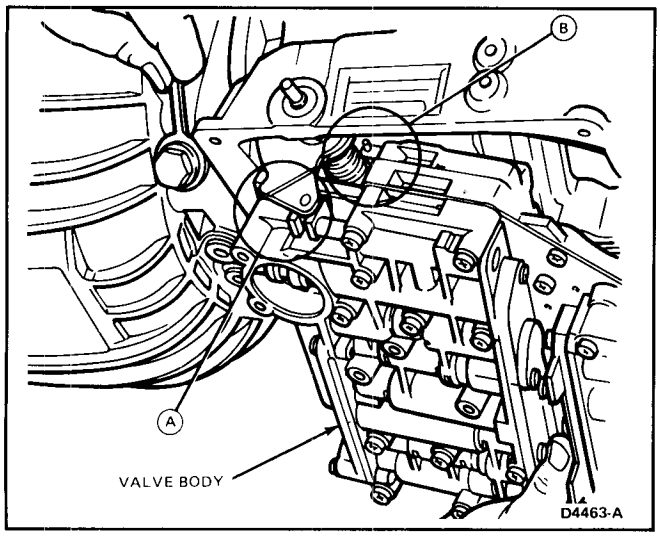


FIG. 6 Valve Body—Installation

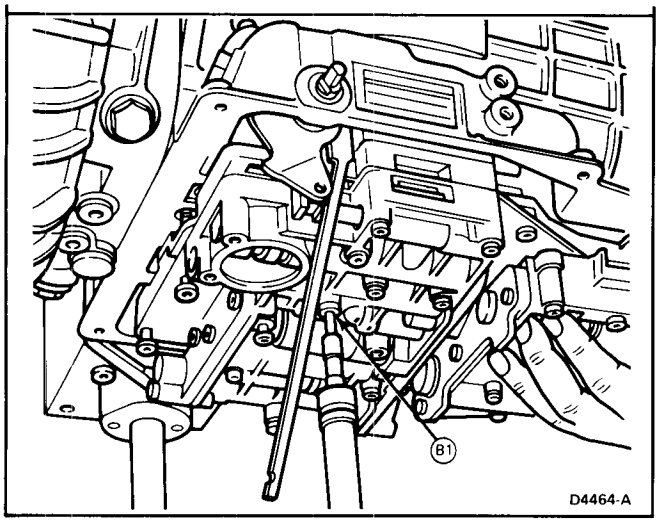


FIG. 7 Valve Body Alignment

NOTE: Do not allow the valve body to move after this operation. Tighten all 13 bolts to 8 N·m (71 lb-in).

6. Clean the filter screen with solvent. If required, install a new O-ring onto the inlet of the oil screen. Install the oil screen using three Torx head bolts (Figs. 4 and 5) and tighten to 8 N·m (71 lb-in).
7. If required, place a magnet into the indentations in the oil pan (Fig. 4).
8. Install the fluid pan gasket on the fluid pan (Fig. 4). Install the long clamps on all four corners and the short clamps on both sides of the fluid pan. Install six 10mm bolts and tighten to 5.9-6.1 N·m (52-54 lb-in).
9. Lower the vehicle and fill the transmission with the proper grade (Dexron ® II) and quantity of fluid.
10. Operate the vehicle and verify proper operation.

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. To maintain driveline balance, mark the rear driveshaft yoke and axle companion flange so the driveshaft can be installed in its original position.
3. Disconnect the speedometer wiring harness from the extension housing.
4. Remove position sensor from converter housing.
5. Remove the engine rear support-to-extension housing attaching bolts.
6. Place a jack under the transmission and raise it just enough to remove the weight from the engine rear support.
7. Remove the nuts that secure 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 nine extension housing attaching bolts (Fig. 8). Slide the extension housing off the output shaft and allow the fluid to drain.
10. Remove and discard extension housing gasket.

Installation

1. Clean and inspect the extension housing as described in the 1984 Car Shop Manual, Volume D, Section 17-01.
2. Install a new extension housing gasket on the case (Fig. 7).
3. Install guide pins into the extension housing and position the extension housing to the case (Fig. 9). Install nine bolts to secure extension housing to case and tighten to 23 N·m (17 lb-ft).
4. Install the rear support and lower the transmission.
5. Install the attaching bolts and tighten to specification. Remove the transmission jack.
6. Install position sensor to converter housing.
7. Install the speedometer wiring harness.
8. Install the driveshaft using the scribe mark as a guide to assure correct balance.
9. Lower the vehicle and fill the transmission with fluid, adding as required while running the engine.
10. Check the extension housing area for fluid leakage.

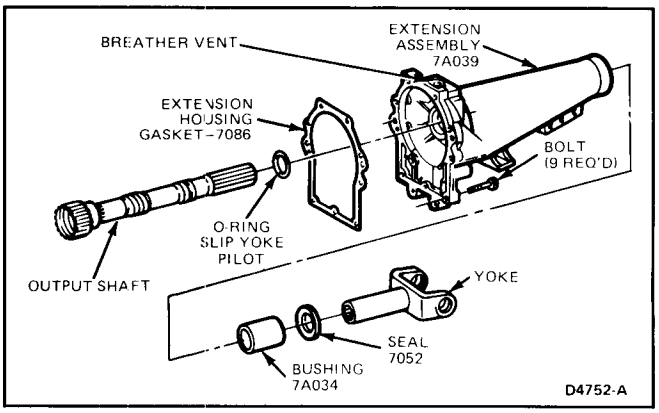


FIG. 8 Extension Housing—Removal and Installation

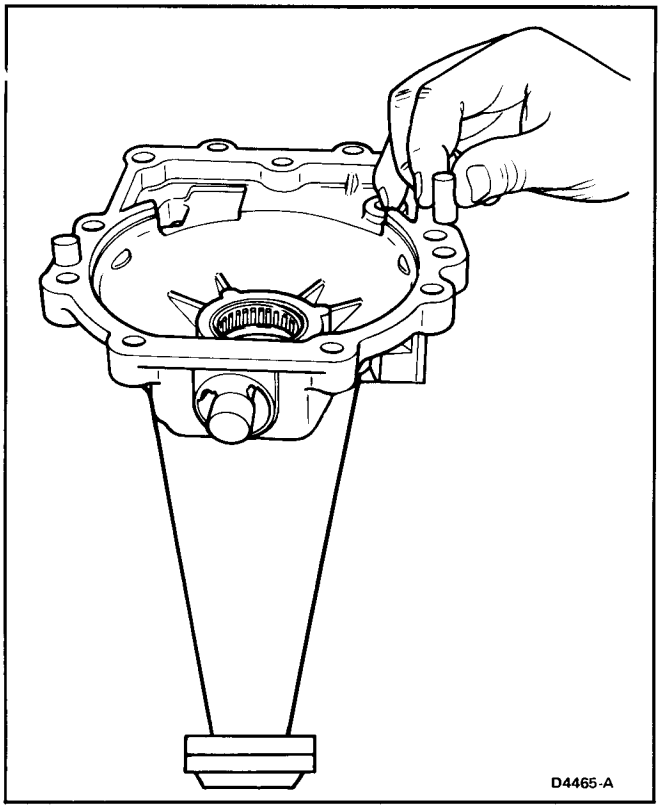


FIG. 9 Extension Housing Guide Pins

Extension Housing Bushing and Rear Seal

Removal

1. Raise the vehicle and disconnect the driveshaft at the transmission. To maintain driveline balance mark the rear driveshaft yoke and axle companion flange so the driveshaft can be installed in its original position.
2. Remove the seal with Extension Housing Seal Removal Tool T71P-7657-A or equivalent (Fig. 10).
3. Remove the bushing as shown in Fig. 10. Carefully use the Extension Housing Bushing Removal Tool T77L-7697-E or equivalent so that the output shaft spline is not damaged.

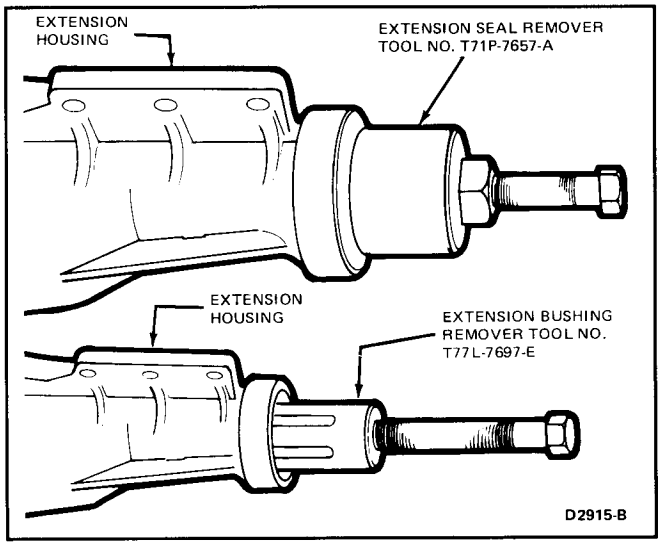


FIG. 10 Rear Seal and Bushing—Removal

Installation

1. When installing a new bushing use Extension Housing Bushing Replacer, Tool T77L-7697-F or equivalent (Fig. 11).
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 Extension Housing Seal Replacer, Tool T74P-77052-A or equivalent (Fig. 11). The seal should be firmly seated in the bore. Coat the inside diameter of the rubber portion of the seal with C1AZ-19590-B or equivalent lubricant.
5. Install the driveshaft so that the index marks, made during removal, are correctly aligned.

   NOTE: Lubricate yoke splines with C1AZ-19590-B grease or equivalent.

Breather Assembly

Removal

1. Remove the extension housing as outlined.
2. Remove the breather cap from the breather.
3. With pliers remove the lock washer retaining the breather assembly to the extension housing (Fig. 12).
4. Remove the breather assembly from the inside of the extension housing (Fig. 12).

Installation

1. Install the breather assembly into the extension housing (Fig. 12).
2. Install the lockwasher to retain the breather assembly to the extension housing.
3. Snap the breather cap onto the breather.
4. Install the extension housing as outlined.

Parking Pawl, Shaft and Spring

Removal

1. Remove the extension housing as outlined.

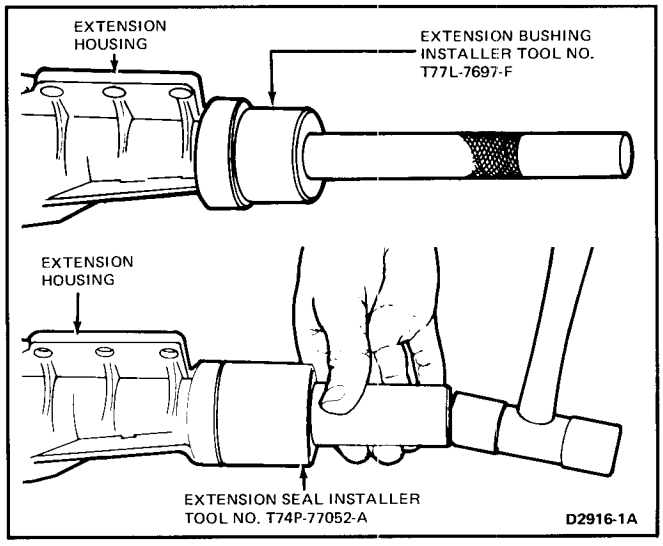


FIG. 11 Rear Seal and Bushing—Installation

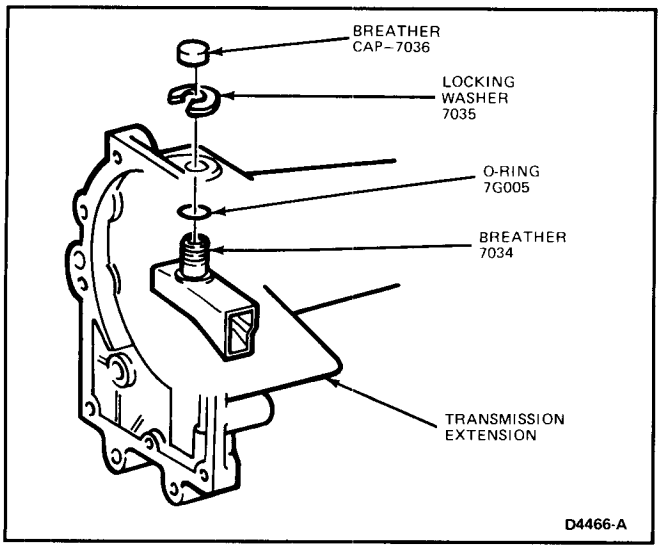


FIG. 12 Breather Tube

2. Remove the bolt attaching the guide plates to the transmission case and remove plates (Fig. 13).
3. Remove the parking pawl, shaft and leg spring from transmission case (Fig. 13).

   NOTE: The leg spring tension is reduced when the shaft and pawl are removed.

Installation

1. Install the parking pawl shaft and leg spring into the transmission case (Fig. 13).
2. Install the parking pawl onto the shaft and set spring tension by rotating leg of spring 90 degrees into the hole in the pawl (Fig. 14).

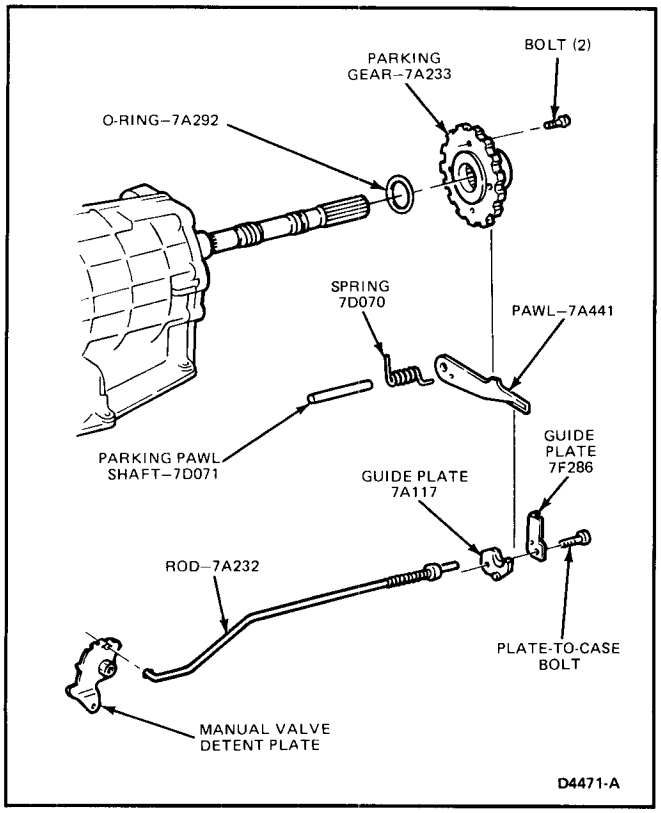


FIG. 13 Parking Pawl, Shaft and Spring

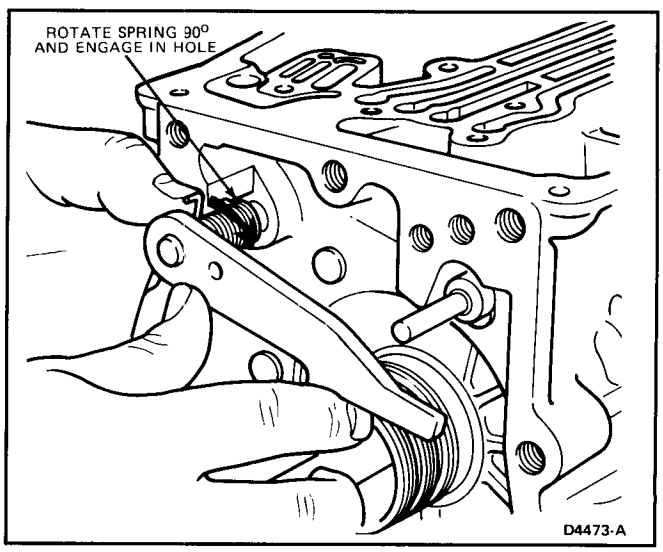


FIG. 14 Parking Pawl Spring—Installation

3. Install the guide plates with one bolt as shown in Fig. 15. Tighten to 10 N·m (88 lb-in).
4. Install extension housing as outlined.

Selector Linkage, Accelerator Cam and Parking Pawl Rod

Removal

Refer to Fig. 16.

1. Put selector in Neutral before raising vehicle.
2. Disconnect and remove the outer manual lever (Fig. 16).
3. Remove the oil pan, screen and valve body as outlined.
4. Disconnect the T-bar end of the kickdown cable from its seat in the accelerator cam (Fig. 16).
5. Punch out the roll pin from the detent plate and manual lever shaft (Fig. 17).
6. Pull out the shaft to remove the leg spring, cam and detent plate (Fig. 16).
7. Unhook the parking pawl rod and pull it out of the case.

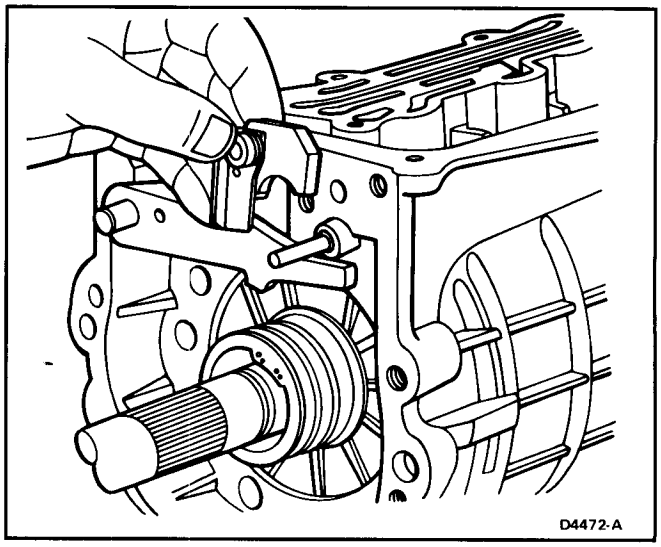


FIG. 15 Guide Plate—Installation

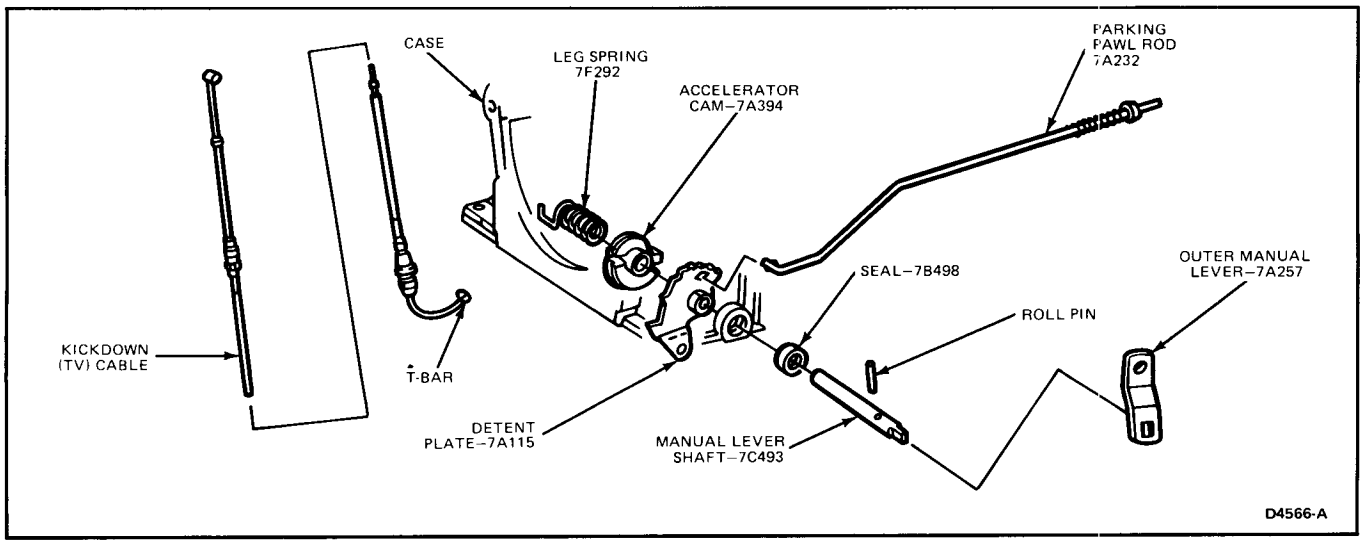


FIG. 16 Accelerator Cam, Parking Pawl Rod and Selector Linkage—Exploded View

8. Remove and discard the shaft seal.

Installation

1. Install a new manual lever shaft seal. Drive it in flush with the case.
2. Connect the park rod to the detent plate as shown in Fig. 18.
3. Install the rod and plate as shown. Be sure the rod protrudes through the guide plate in the rear of the case.
4. Install the manual lever shaft through the case and into the detent plate bore (Fig. 18).
5. Fit the leg spring into the cam (Fig. 19).
6. Install the cam and spring in the case, with the leg of the spring on the case support (Fig. 19).
7. Push the shaft in until it stops.
8. Align the holes in the shaft and detent plate.
9. Install a new roll pin, with the slot to the rear of the transmission.
10. Revolve the cam once to tension the leg spring; then seat the T-bar end of the cable in the cam.
11. Install the valve body, screen and oil pan.

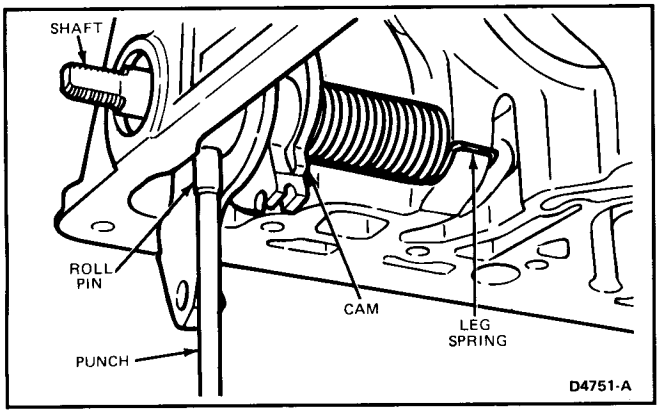


FIG. 17 Roll Pin—Removal

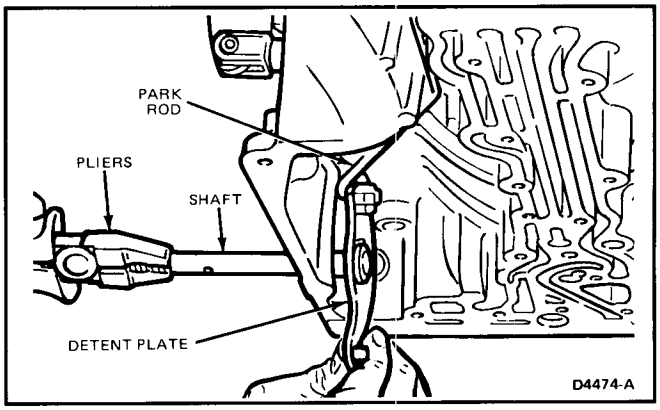


FIG. 18 Manual Lever—Installation

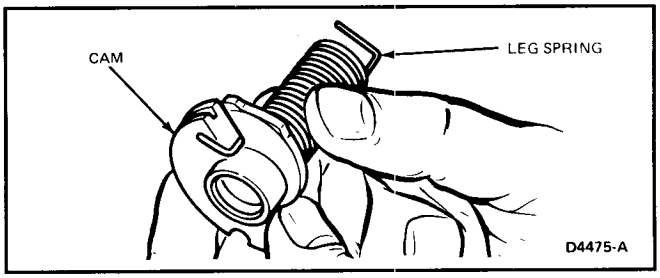


FIG. 19 Accelerator Cam Spring—Installation

Converter Housing Intermediate Plate Gasket and Pump Seal

Removal

1. Remove transmission and converter assembly from vehicle as outlined. (If the studs come out of the converter cover, screw them back in).
2. Remove converter assembly from housing using handles, T81P-7902-C, or equivalent (Fig. 20).

   NOTE: Oil will be running out of converter. Handle carefully to avoid damage to pump bushing and oil seal lip.
3. Mount transmission assembly in holding fixture.

4. Remove 12 long bolts closest to pump shaft. Pull converter housing and intermediate plate assembly away as a unit.

   NOTE: Be careful not to disturb input shaft and clutch cylinder.

5. Remove the pump seal with an appropriate tool.
6. Remove six short bolts farthest from pump shaft and remove converter housing from intermediate plate assembly (Fig. 20).

Installation

1. Position intermediate plate to converter housing and install with six bolts. Tighten bolts to 46 N·m (34 lb-ft) (Fig. 20).
2. Install pump seal flush with the pump surface using a block of wood to tap the seal into place.
3. Install converter housing and intermediate plate assembly onto pump shaft. Make sure thrust washers and thrust bearings are properly positioned as shown in Fig. 20. Use petroleum jelly to hold in place while plate is assembled. Install 12 bolts and tighten to 46 N·m (34 lb-ft).
4. Guide converter carefully onto pump shaft using handles, T81P-7902-C, or equivalent until it seats.
5. Install transmission and converter assembly as outlined.

Kickdown (TV) Cable

Removal

1. In the engine compartment, remove the cable and insert from the injection pump side lever and cable bracket (Figs. 21 and 22).
2. Raise the vehicle on a hoist.
3. Remove the transmission fluid pan, sump screen and valve body as described.
4. Pry the cable out of the case with two screwdrivers as shown (Fig. 23).
5. Unhook the T-bar end of the cable from the accelerator cam and remove the cable (Fig. 24).

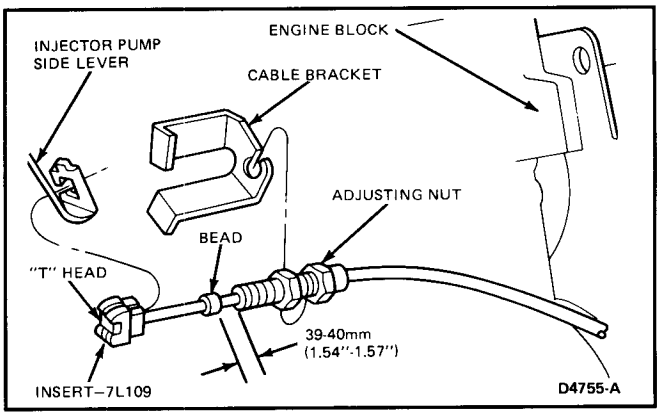


FIG. 21 Kickdown (TV) Cable (In Engine Compartment)—Exploded View

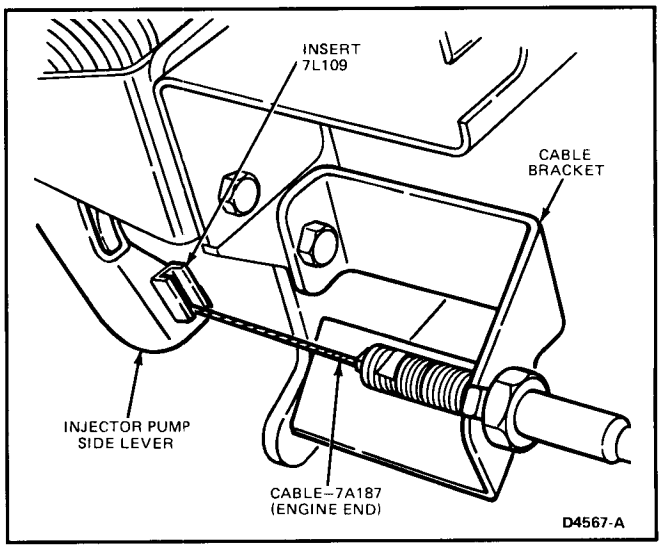


FIG. 22 Kickdown Cable (In Engine Compartment)—Installed

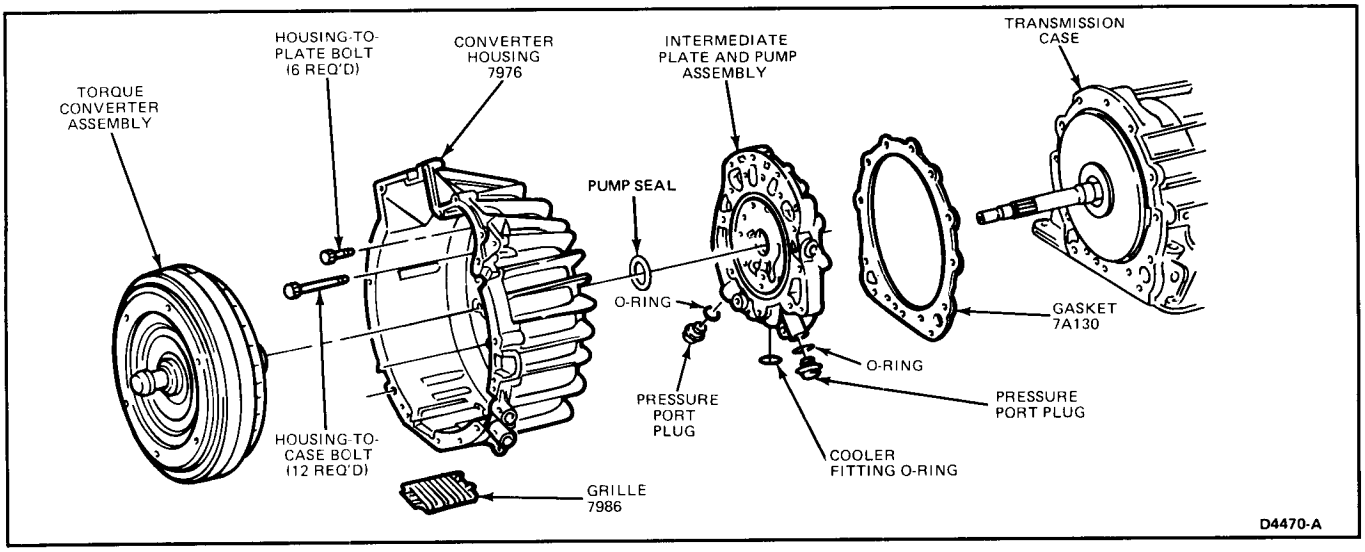


FIG. 20 Converter Housing, Intermediate Plate Gasket and Pump Seal—Removal

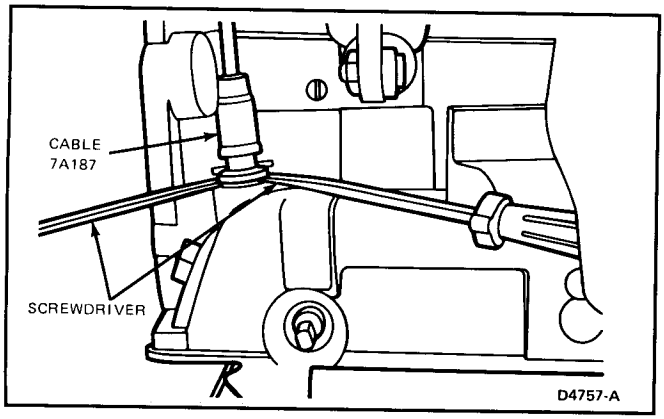


FIG. 23 Kickdown (TV) Cable to Transmission Case—Removal and Installation

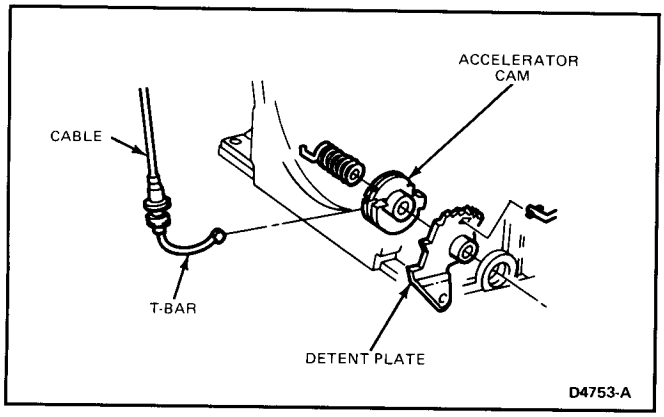


FIG. 24 Kickdown (TV) Cable (At Transmission)

Installation

1. Install the T-bar end of the cable to the accelerator cam (Fig. 24).
2. Push the cable cover into the transmission housing.
3. Install the valve body, sump screen, and transmission fluid pan as described.
4. **For a New Cable:**
   a. Spin the rearward adjusting nut back to the end of the threaded barrel and place the threaded barrel through the slot in the cable bracket (Figs. 21 and 22).
   b. Pull the threaded barrel into the hole in the bracket (Figs. 21 and 22).
   c. Set adjusting nuts approximately in the center of the threaded barrel.
   d. Pull the "T" head until you feel the wide-open throttle stop, about 6.4mm (0.25 inch) before maximum cable travel. **Do not pull any farther.**
   e. Slide the bead along the cable until there is a gap of 39-40mm (1.54-1.57 inch) between the end of the threaded barrel and the end of the bead closest to the barrel (Fig. 21).
   f. Crimp the bead to the braided cable core with a wire terminal crimper. Be careful to distort the bead as little as possible.
   g. Remove the cable from the bracket and proceed to Used Cable Installation that follows.
5. **For a Used Cable:**
   a. Rest the braided cable core wire on the split in the white plastic lever insert with the "T" head on the trunnion side and pull it through.
   b. Snap the "T" head into the insert trunnions (Fig. 21).
   c. Snap the insert into the lower rectangular hole in the injection pump side lever after threading the braided cable core through the slot (Fig. 21).
   d. Spin the rearward adjusting nut back to end of the threaded barrel and place the threaded barrel through the slot in the cable bracket.
   e. Pull the threaded barrel into the hole in the bracket.
   f. Adjust the cable as outlined.

DISASSEMBLY AND ASSEMBLY

Governor

Disassembly

Refer to Fig. 25.

1. Remove the snap ring from the output shaft (Fig. 25).
2. Remove parking gear, governor and split drive ring which is splined to the output shaft (Fig. 25).
3. Remove two bolts retaining the governor housing to the governor hub.
4. Remove the governor hub-to-parking gear attaching bolts.
5. Remove the counterweight and clamp.
6. Remove the O-ring, steel ring and piston rings.

Assembly

1. Install the parking gear onto the governor hub with two bolts. Tighten to 10 N·m (88 lb-in).
2. Install the governor housing to the governor hub with two bolts. Tighten to 10 N·m (88 lb-in).
3. Lubricate O-ring on the output shaft and slide parking gear with the split driver ring, and governor assembly onto the output shaft, until it reaches the stop.
4. Install the snap ring to the output shaft.
5. Insert the counterweight into the governor hub and secure with clamp (Fig. 26).

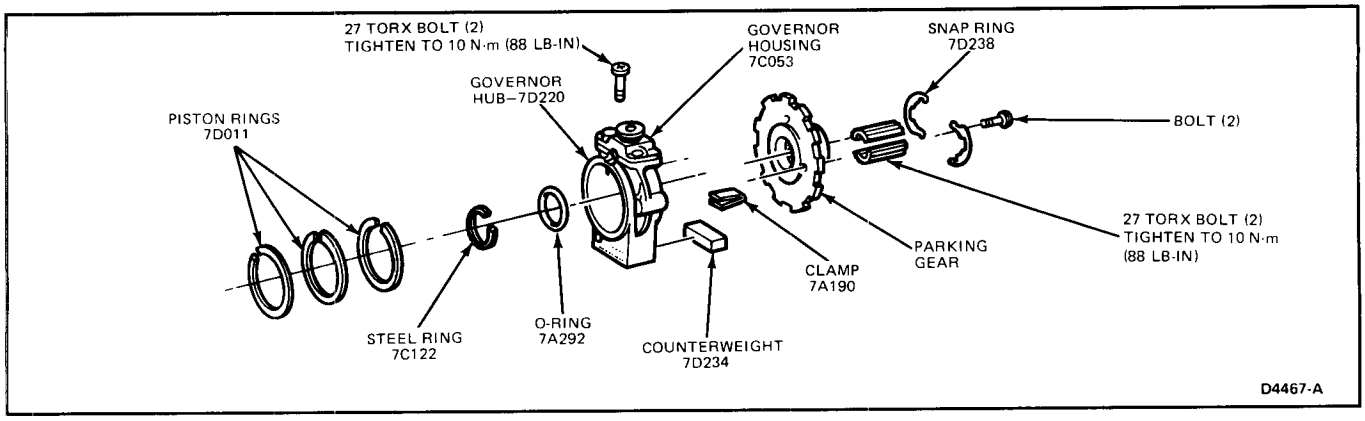


FIG. 25 Extension Housing Assembly—Exploded View

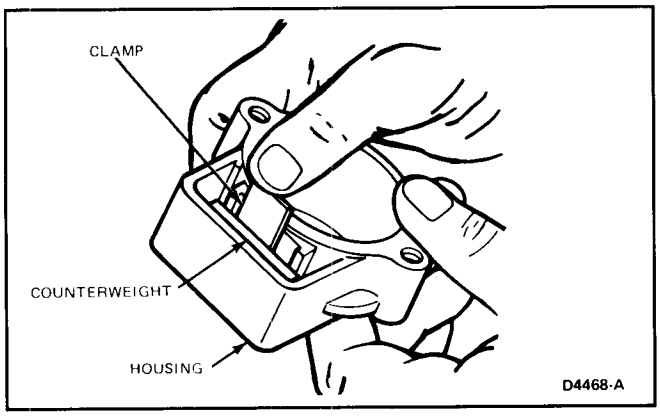


FIG. 26 Counterweight—Installation

SPECIAL SERVICE TOOLS

Tool Number	Description
T71P-7657-A	Extension Housing Seal Remover
T77L-7697-E	Extension Housing Bushing Remover
T77L-7697-F	Extension Housing Bushing Replacer
T84P-77003-A	ZF — Valve Body Gauge Block
T74P-77052-A	Extension Housing Seal Replacer
T81P-7902-C	Converter Handles
T82L-9500-AH	Quick Connect Disconnect Tool

CD4759-A

SECTION 22-07 Engine, 2.4L Diesel Turbo

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The 2.4L diesel engine is a four cycle, turbocharged, in-line six cylinder, with an overhead camshaft (Figs. 1, 2 and 3). Number one cylinder is located at the front of the engine.

The engine is a lightweight, compact design displacing 2,443cc (149 CID). The crankcase uses piston cooling jets, which direct oil to a port on the underside of the piston. The port is connected to a circular chamber cast into the top of the piston. The oil flowing through the chamber helps to cool the piston during engine operation.

The crankshaft is a seven main bearing unit with fore and aft thrust controlled at the No. 6 main bearing.

A cogged drive belt is used to drive the camshaft, injection pump and intermediate shaft. The intermediate shaft is used to operate the oil pump.

The camshaft is supported by seven machined bearing bores in the cylinder head. The bearing caps are numbered, front to rear, and must be installed in the same position from which they were removed, with all the numbers facing the same way. Bearing inserts are not

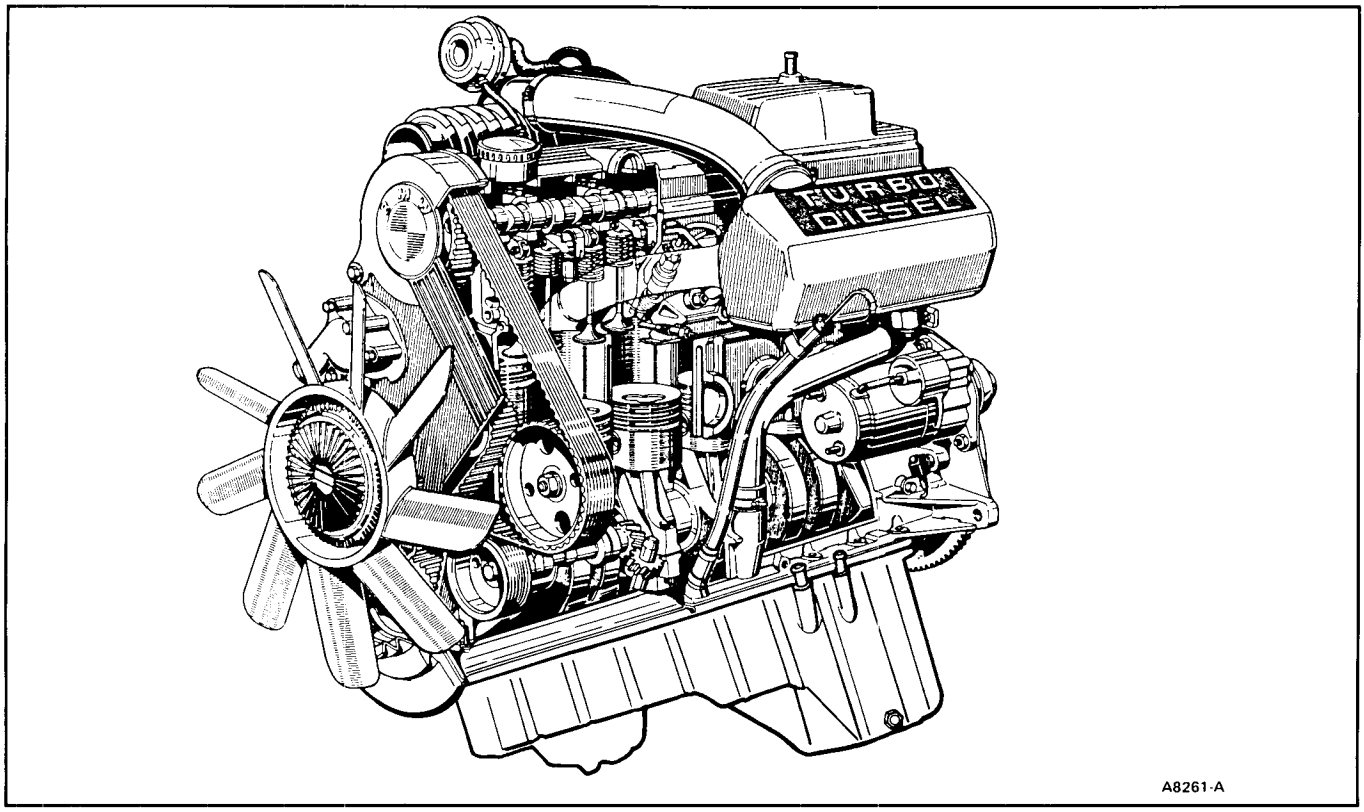


FIG. 1 Engine, Right Front—Cutaway View

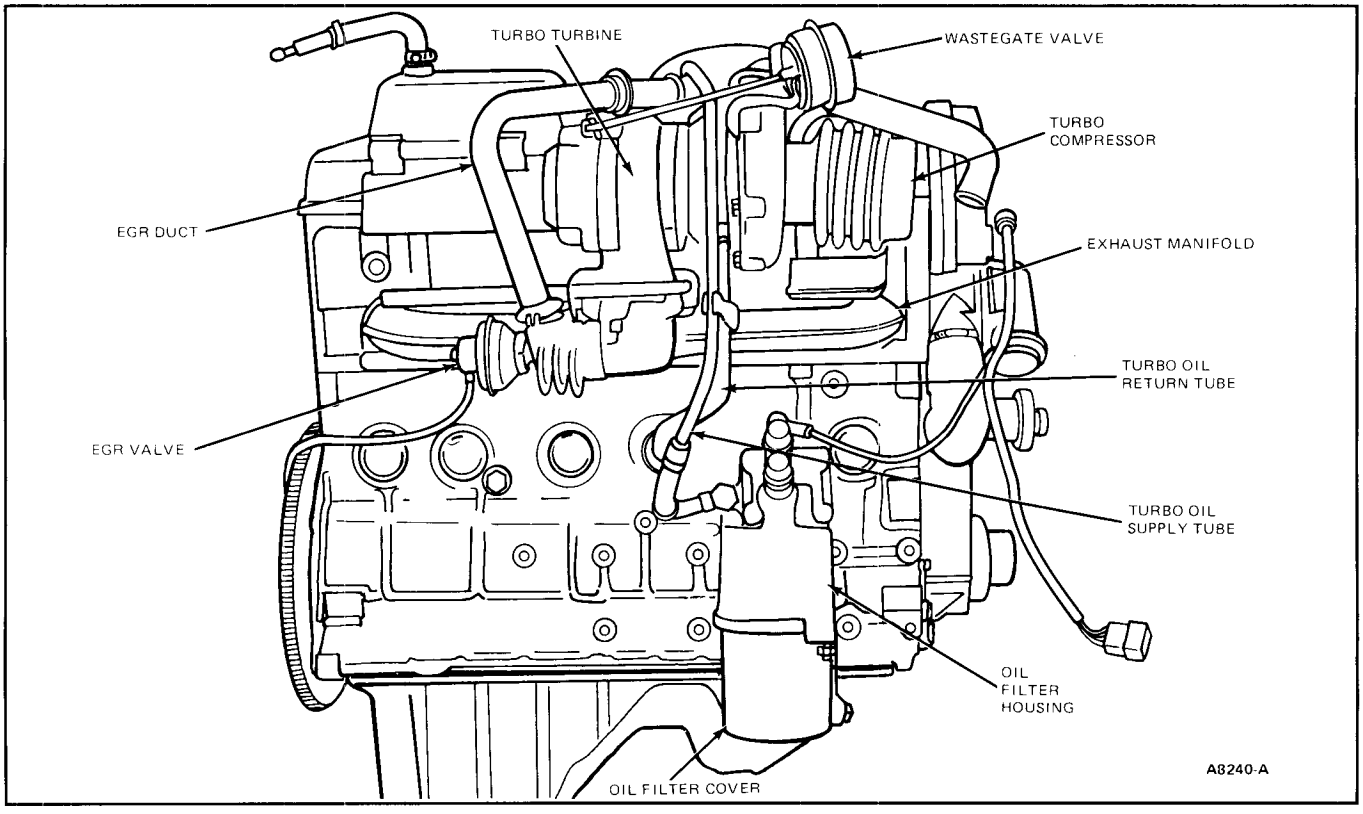


FIG. 2 Engine, Left Side View

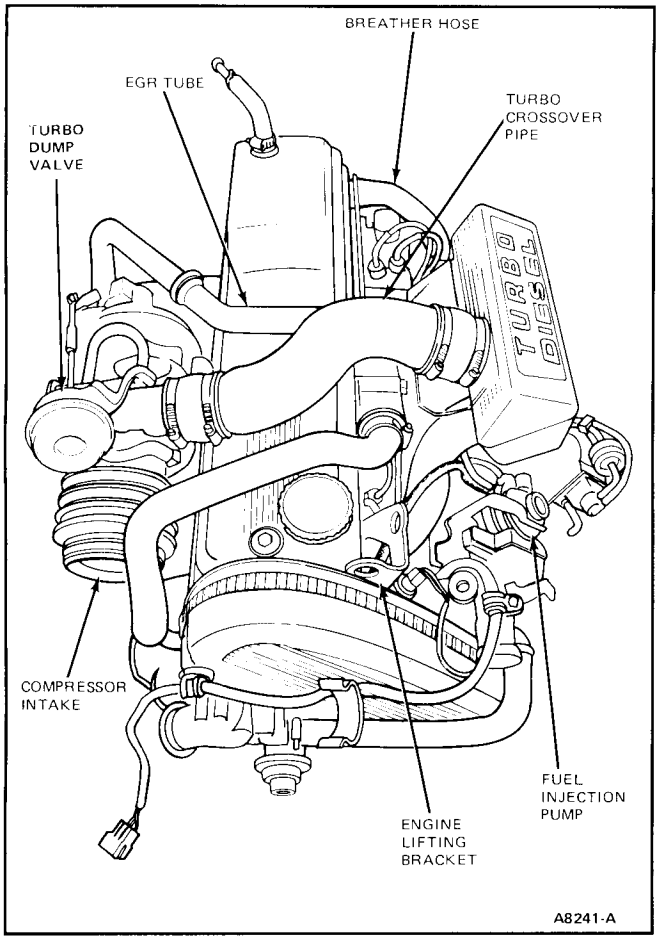


FIG. 3 Engine, Top Front View

available for the camshaft. Camshaft thrust is controlled by a thrust washer located next to the No. 1 camshaft bearing.

The camshaft has an additional lobe, located between the intake and exhaust valve lobes for No. 5 cylinder. This lobe is used to operate the vacuum pump located on top of the camshaft. A replaceable, hardened steel sleeve is installed on this lobe.

The valves are adjusted by an eccentric located on the tip of the rocker arm, at the top of the valve stem.

The water pump and fan are driven by a separate, conventional V-belt, which also drives the alternator. A separate V-ribbed belt is used to drive the other accessories.

Lubrication System

Refer to Fig. 4.

Cooling System

The cooling system uses a coolant expansion tank, an aluminum cross flow radiator, and a 105 kPa (15 psi) expansion bottle cap. It is a pressurized system using a coolant expansion bottle to expel air from the coolant. Coolant passes through the aluminum radiator and is cooled by two cooling fans; an engine driven clutch fan and an electric pusher fan, mounted in front of the radiator, that only operates when the A/C is on.

WARNING: TO AVOID THE POSSIBILITY OF HUMAN INJURY OR DAMAGE TO THE VEHICLE, DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS BEEN FIRST EXAMINED FOR POSSIBLE CRACKS AND SEPARATION.

Exhaust Emission Control System

Operation, and required maintenance of the exhaust emission control devices used on this engine are provided in the Engine/Emissions Diagnosis Manual.

Crankcase Ventilation System

This engine is equipped with a positive, closed-type crankcase ventilation system, recycling crankcase vapors to the intake manifold.

Fuel Injection Pump

The fuel injection pump meters an exact amount of fuel to the fuel nozzles, in the specified order, as required by the engine operating condition at precisely the right time at an extremely high pressure. The fuel injection pump is driven by the crankshaft through the camshaft drive belt.

Fuel Injection Nozzles

The nozzles are connected to the injection pump with high pressure lines. The fuel is delivered to the nozzle, from the injection pump. When the pressure in the nozzle reaches approximately 14,696 kPa (2133 psi), the nozzle opens and fuel is injected into the turbulence chamber. The fuel nozzles are connected in series with each other with a fuel return hose. This hose returns excess fuel in the nozzles to the injection pump.

The No. 4 nozzle has a sensor which is used to signal the beginning and duration of injection at the nozzle. The signal it sends is used by the message center for gas mileage related information messages and also signals service. On California vehicles, the No. 5 nozzle has a similar sensor, which is used to help control emissions and fuel economy.

Fuel injection nozzles are not repairable. If a nozzle is determined to be faulty, it must be replaced with a new one. Whenever a nozzle is removed, the heat shield ring must be replaced.

Glow Plug and Cold Start Timing Advance Systems

These systems are used to enable the engine to start more quickly when the engine is cold.

Glow Plug System

Refer to Fig. 5.

The glow plug system used on the 2.4L diesel engine consists of 6 glow plugs located one in each cylinder, a glow plug control module located on the cowl panel apron, a glow plug temperature sensor located on the LH front of the cylinder head, and a Wait-to-Start indicator lamp located in the lower warning indicator module in the center of the instrument panel.

With the ignition switch in Start or Run, power flows to the glow plugs from the control module. With the engine coolant temperature below 70°C (158°F), the Wait-to-Start Indicator will turn On and the glow plugs will start heating. After two to ten seconds, the Wait-to-Start Indicator will turn Off, depending on engine coolant temperature, and the engine can then be started.

The glow plugs continue to heat up during engine start and for a short time after the engine starts depending on coolant temperature.

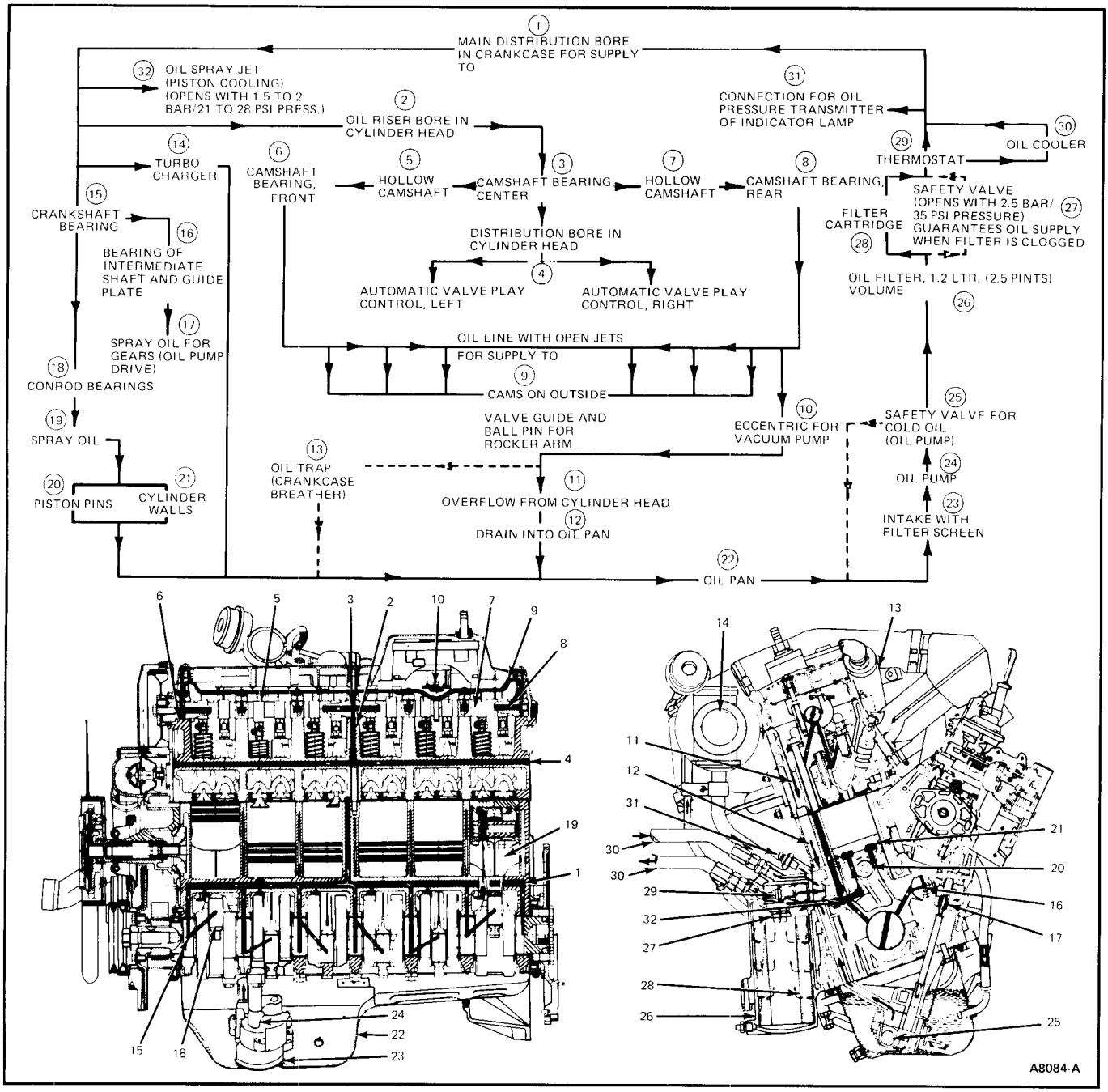


FIG. 4 Lubrication System

If the engine is started before the Wait-to-Start Indicator turns Off, the glow plugs will continue to heat up after the engine is started.

The glow plug control module has a built-in timing circuit which will turn off the glow plugs 8-13 seconds after the Wait-to-Start Indicator turns off, if the engine has not been started. If the engine is started after this time period, the glow plugs will heat up while the engine is being started.

Cold Start Timing Advance System

Refer to Fig. 6.

The cold start timing advance system consists of a cold start advance solenoid, which is attached to the injection pump, and a cold start temperature switch located at the LH rear of the cylinder head.

When engine coolant temperature is below 30°C (86°F) the cold start temperature switch is closed. With the ignition switch in Run, power flows through the cold start temperature switch, energizing the cold start advance solenoid. When the cold start advance solenoid is energized, the injection pump timing is advanced to provide a smoother running cold engine.

When the engine coolant temperature reaches 30°C (86°F), the cold start temperature switch opens and the cold start solenoid is de-energized, returning the injection timing back to normal.

Turbocharger

The turbocharger turbine wheel is driven by exhaust gas flow from the engine. The turbine wheel is connected, by a shaft, to the compressor wheel. The compressor wheel takes in fresh air from the air cleaner, compresses and

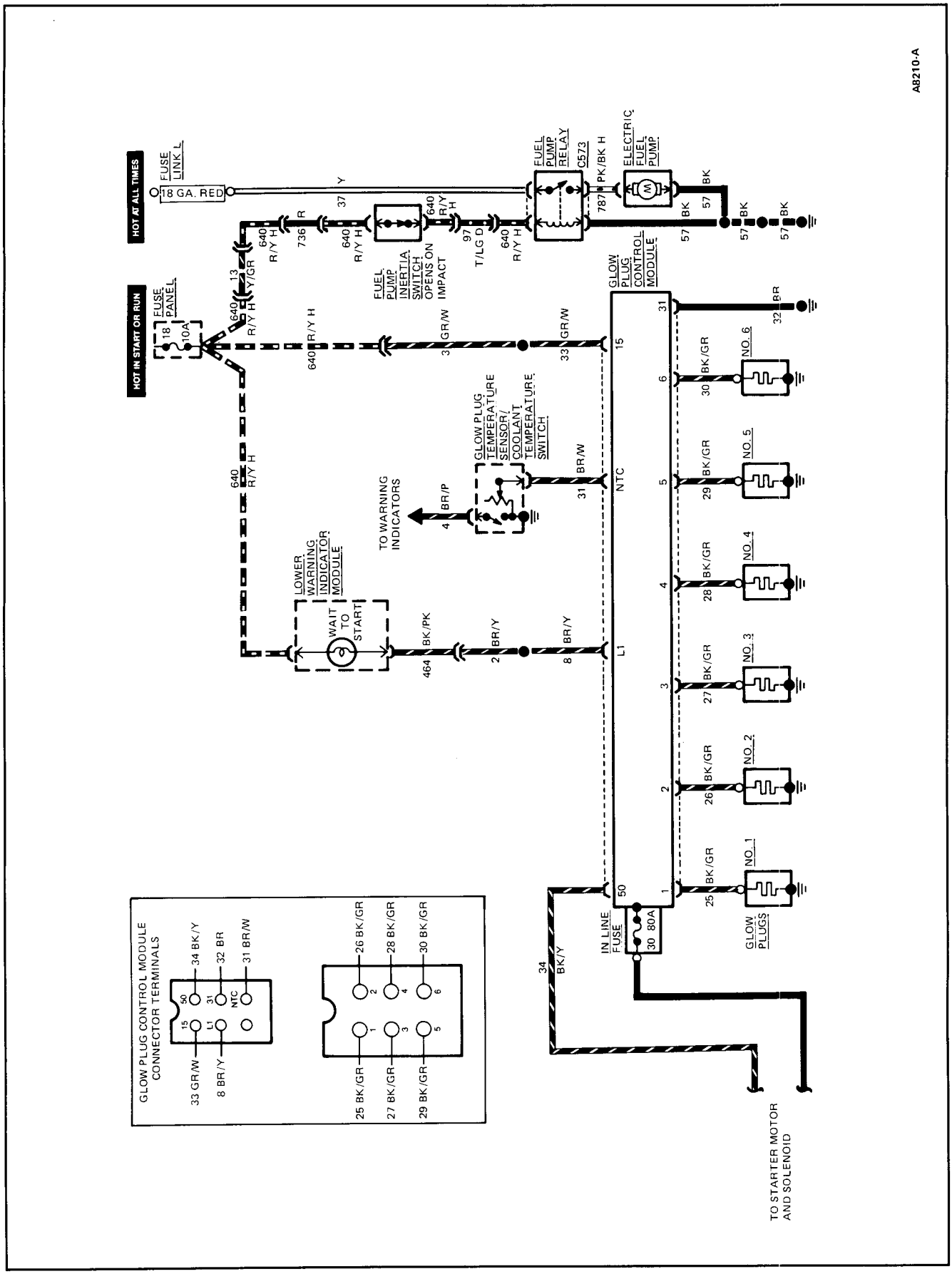


FIG. 5 Glow Plug System

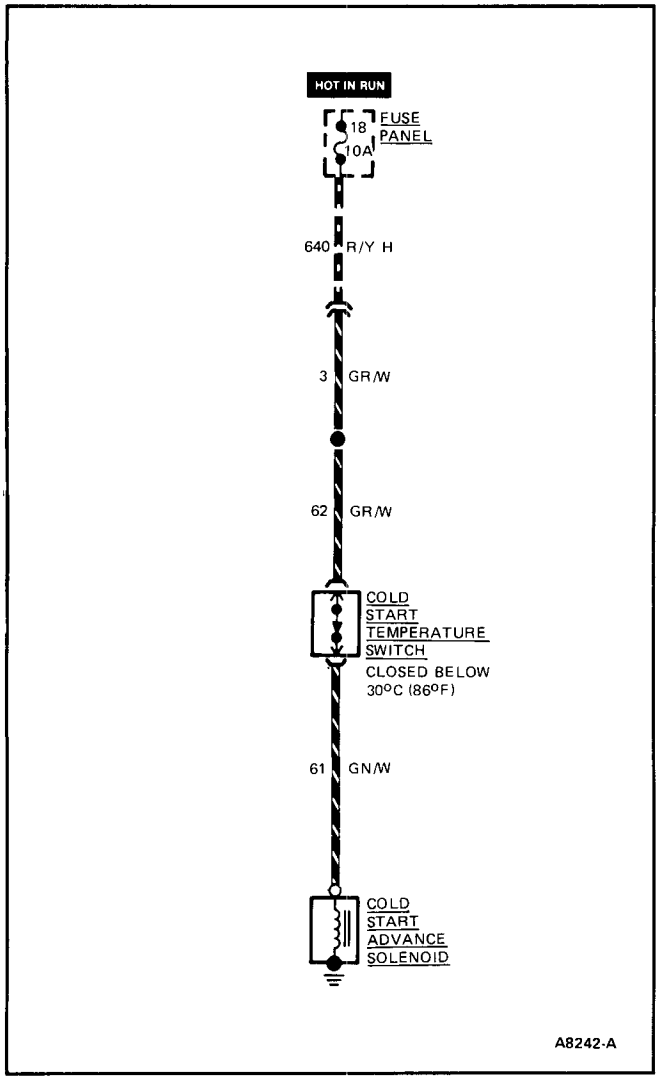


FIG. 6 Cold Start Timing Advance System

boosts the pressure and supplies it to the engine through the intake manifold. Once maximum turbo pressure is reached, a dump valve opens in the turbine side of the turbo, and dumps the excess pressure into the exhaust system, downstream from the turbo.

ADJUSTMENTS

Valve Clearance (Cold Engine)

1. Remove valve cover as outlined.
2. Position camshaft so that base circle of the lobe of the valve to be adjusted is facing the rocker arm (Fig. 7).
3. Loosen adjusting eccentric locknut using valve clearance adjusting Wrench, Tool T84P-6575-A, or equivalent and a 12mm open end wrench (Fig. 8).
4. Rotate eccentric using a small punch until valve clearance is adjusted to specification: Intake: 0.3mm (0.012 inch); Exhaust: 0.04mm (0.016 inch). Tighten eccentric locknut (Fig. 9).
5. Repeat Steps 2, 3 and 4 for each valve.
6. Install valve cover as outlined.
7. Start engine and check for oil leaks.

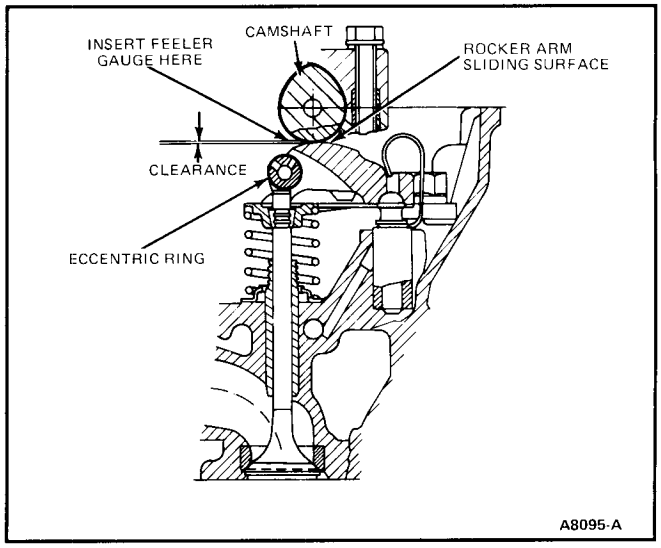


FIG. 7 Valve—Cross-Sectional View

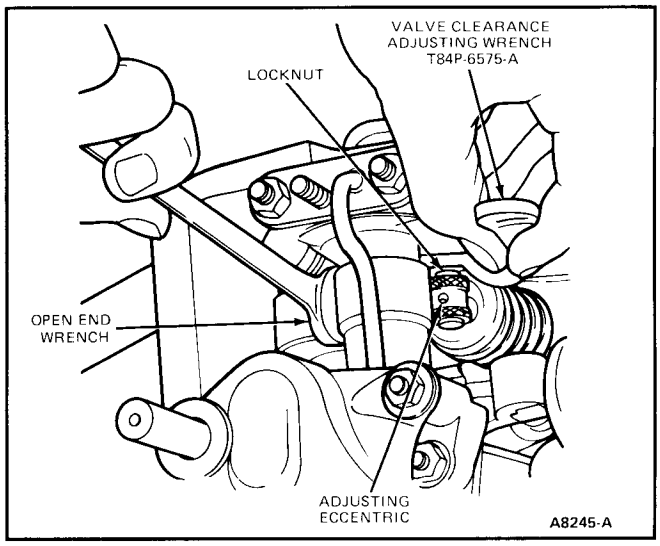


FIG. 8 Eccentric Locknut Adjustment

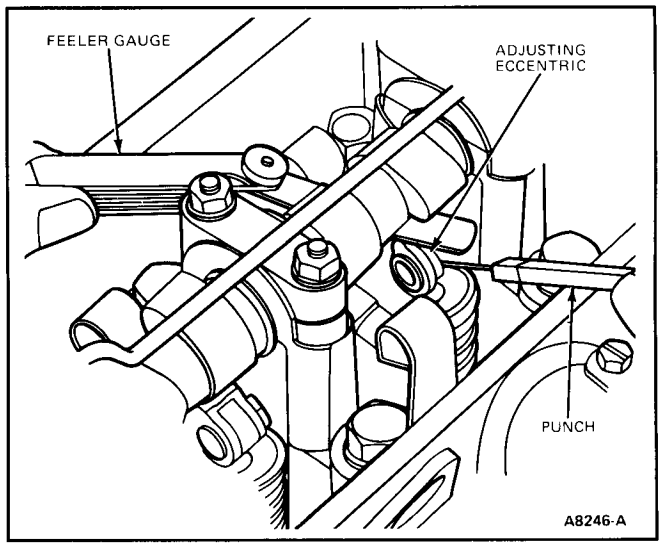


FIG. 9 Valve Adjustment

Fuel Injection System

Refer to the Engine/Emissions Diagnosis Manual, Section 31, for timing, and idle adjustments.

Accessory Drive Belts

Refer to Section 27-02.

REMOVAL AND INSTALLATION

Engine

Removal and Installation procedures were not available at time of publication.

Support Insulators, Front

Removal

1. Raise the vehicle.
2. Remove the insulator to the No. 2 crossmember nuts (Fig. 10).
3. Raise the engine to clear the No. 2 crossmember.
4. Remove the insulator to bracket bolts.
5. Remove the insulator.

Installation

1. Position insulators to brackets and secure with bolts (Fig. 10). Tighten to 48-68 N·m (35-50 lb-ft).
2. Lower the engine onto the No. 2 crossmember.
3. Install the insulator to the No. 2 crossmember nuts and tighten to 108-142 N·m (80-105 lb-ft).

Support Brackets, Front

Removal

1. Raise the vehicle.
2. Remove the insulators as outlined.
3. Remove the bracket to engine bolts (Fig. 10).

   NOTE: The lower LH fastener on the driver's side bracket is a shouldered stud. Removal of the power steering bracket is required in order to remove this stud.

Installation

1. Position bracket to engine and attach with bolts (Fig. 10).

   NOTE: The lower LH fastener on the driver's side bracket is a shouldered stud. This stud must be installed before the power steering bracket. Tighten bolts to 34-47 N·m (25-35 lb-ft).
2. Install the insulators as outlined.
3. Lower the vehicle.

Support, Rear

Removal

1. Raise the vehicle.
2. Remove the two bolts attaching the rear insulator to the transmission (Fig. 10).
3. Remove the two nuts attaching the rear insulator to the No. 3 crossmember.
4. Using a transmission jack, place a block of wood between the jack and the transmission oil pan and raise the transmission.
5. Remove the insulator.

Installation

1. Install insulator to transmission (Fig. 10), and tighten bolts to 68-95 N·m (50-70 lb-ft).

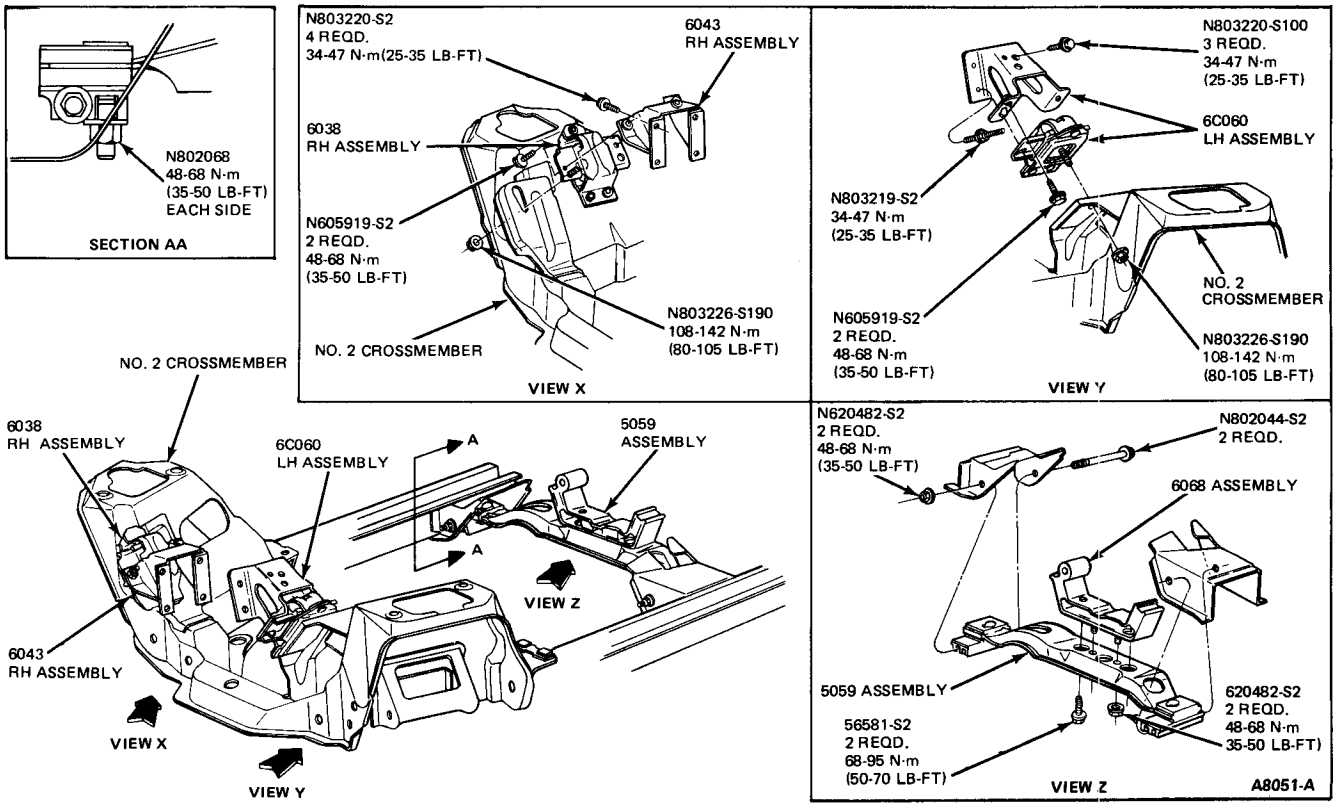


FIG. 10 Engine Mount Installation—Front and Rear

2. Lower the transmission to the No. 3 crossmember.
3. Install the insulator to No. 3 crossmember and tighten nuts to 48-68 N·m (35-50 lb-ft).
4. Remove the jack and block of wood.
5. Lower the vehicle.

Rocker Arm Cover

Removal

1. Loosen turbo crossover pipe boot clamps and remove pipe (Fig. 11).
2. Disconnect vacuum pump hose (Fig. 11).
3. Disconnect breather hose.
4. Remove oil trap.
5. Remove threaded sleeves attaching rocker arm cover to cylinder head and remove cover (Fig. 12).

Installation

1. Inspect cover gasket and vacuum pump outlet O-ring (Fig. 13). Replace, if necessary.
2. Install valve cover on cylinder head and tighten bolts to 8-10 N·m (6-7 lb-ft).

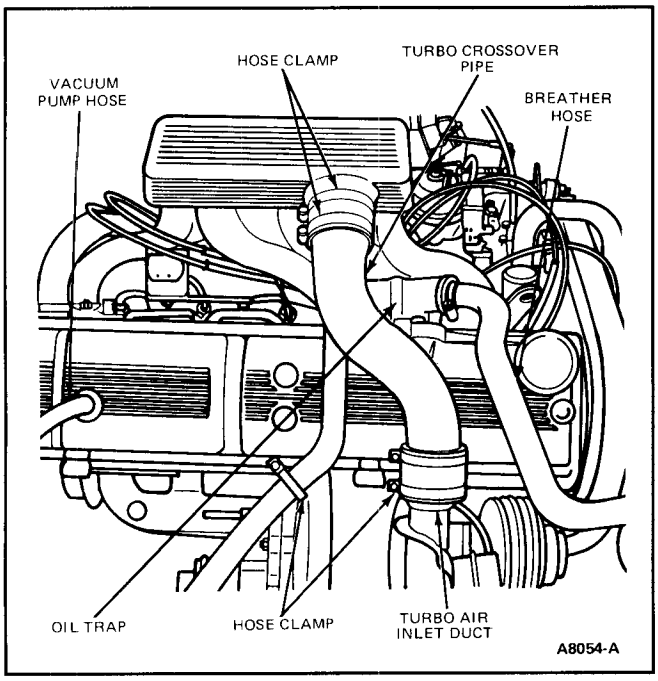


FIG. 11 Turbo Crossover Pipe

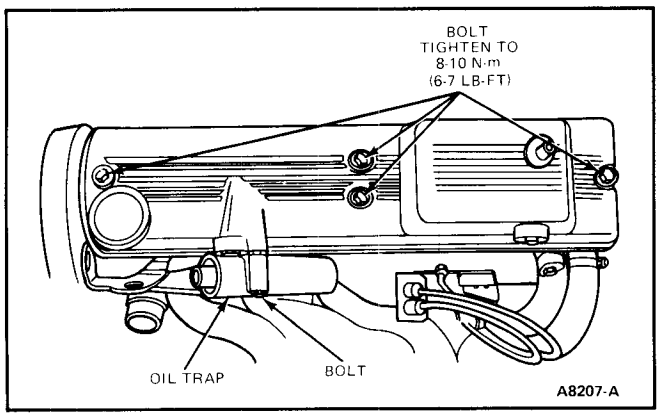


FIG. 12 Rocker Arm Cover—Removal and Installation

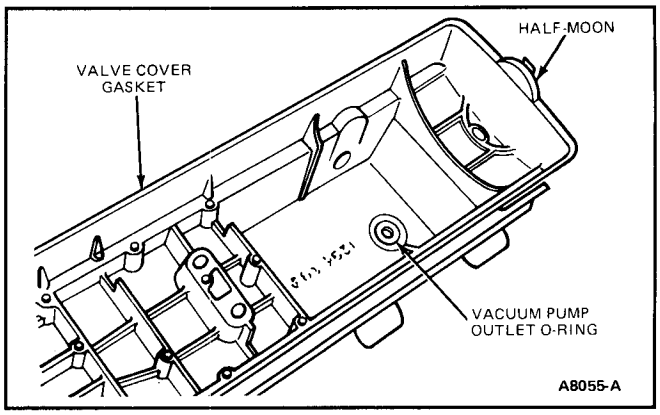


FIG. 13 Valve Cover Gasket and Vacuum Pump O-Ring

CAUTION: Be sure half-moon on gasket is fully seated in cylinder head (Fig. 13).

3. Install oil trap and tighten bolt to 15-19 N·m (11-14 lb-ft).
4. Connect breather hose.
5. Connect vacuum hose.
6. Install turbo crossover pipe (Fig. 13).
7. Run engine and check for oil and intake air leaks.

Vacuum Pump

Removal and Installation

1. Remove valve cover as outlined.
2. Rotate engine until vacuum pump eccentric is on low side of camshaft.
3. Remove bolts attaching vacuum pump to cylinder head, and remove pump.
4. Install vacuum pump on cylinder head and evenly tighten bolts to 8-10 N·m (6-7 lb-ft).
5. Inspect vacuum pump outlet port O-ring in valve cover (Fig. 13). Replace, if necessary.
6. Install valve cover as outlined.
7. Run engine and check for oil leaks.

Rocker Arms

Removal

1. Remove valve cover and vacuum pump as outlined.
2. Rotate engine until cam lobe for cylinder of rocker arm to be removed is on base circle.
3. Remove rocker arm retaining clip (Fig. 14).
4. Compress spring assembly using Valve Spring Compressor Tool, T84P-6513-C or equivalent, and remove rocker arm (Fig. 15).

   CAUTION: Be sure that valve spring retainers remain locked in valve stem.

5. Remove rocker arm pivot ball pin (Fig. 16), if necessary, using Tool D84P-6564-A or equivalent.

Installation

1. Install rocker arm pivot ball pin (Fig. 16).

   NOTE: Coat barrel of pivot ball pin with Loctite 270 or equivalent before installation.

2. Compress spring assembly using Valve Spring Compressor Tool, T84P-6513-C or equivalent, and

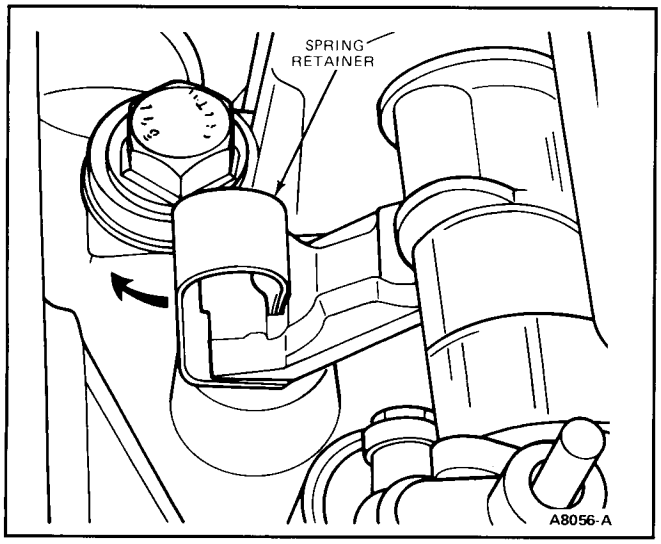


FIG. 14 Rocker Arm Retaining Clip

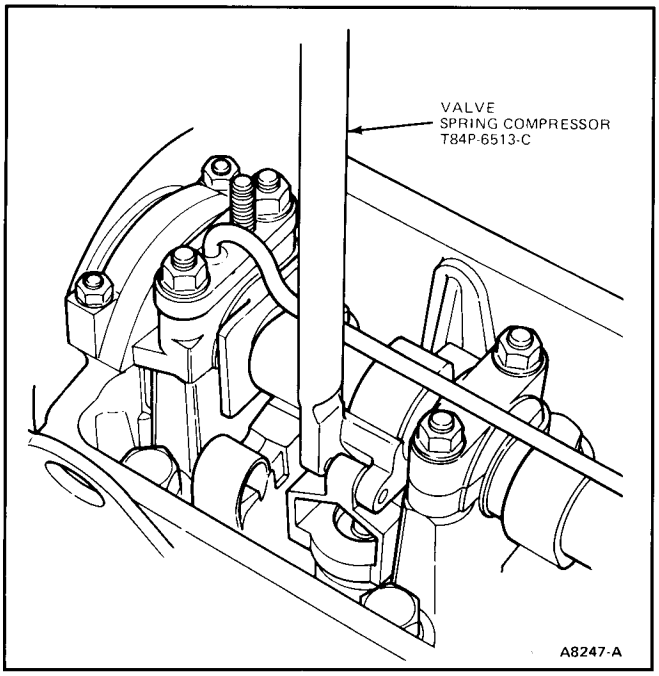


FIG. 15 Valve Spring Compressor Tool

install rocker arm, making sure rocker arm is seated on pivot ball pin (Fig. 17).

3. Install rocker arm retaining clip, making sure clip is engaged in groove on pivot ball pin (Fig. 16).
4. Adjust valve clearance as outlined.
5. Install vacuum pump and valve cover as outlined.
6. Start engine and check for oil and intake air leaks.

Valve Spring, Retainer and Stem Seal

Removal

1. Remove the valve rocker arm cover as outlined.
2. Remove the rocker arm as outlined.
3. Rotate the crankshaft until the piston for the cylinder being serviced is at TDC.
4. Compress the spring using Valve Spring Compressor Tool T84P-6513-C, or equivalent, and remove the retainer locks, spring retainer, and valve spring (Fig. 15).
5. Using a pair of pliers, remove and discard the valve stem seal.
6. Inspect the valve stem for damage. Rotate the valve and check the stem tip for eccentric movement. Move the valve up and down through normal travel in the valve guide and check the stem for binds. If the valve has been damaged, it will be necessary to remove and service the cylinder head as outlined.

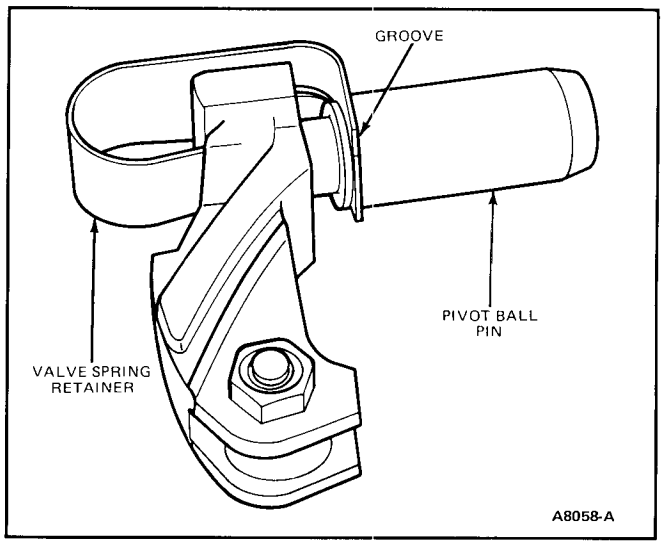


FIG. 16 Rocker Arm Pivot Ball

Installation

1. Install a new valve stem seal using Tool T84P-6571-B, or equivalent (Fig. 17).

   NOTE: Install plastic sleeve provided with Valve Stem Kit, on end of valve stem before installing seal, to protect seal during installation. Remove after seal is installed.

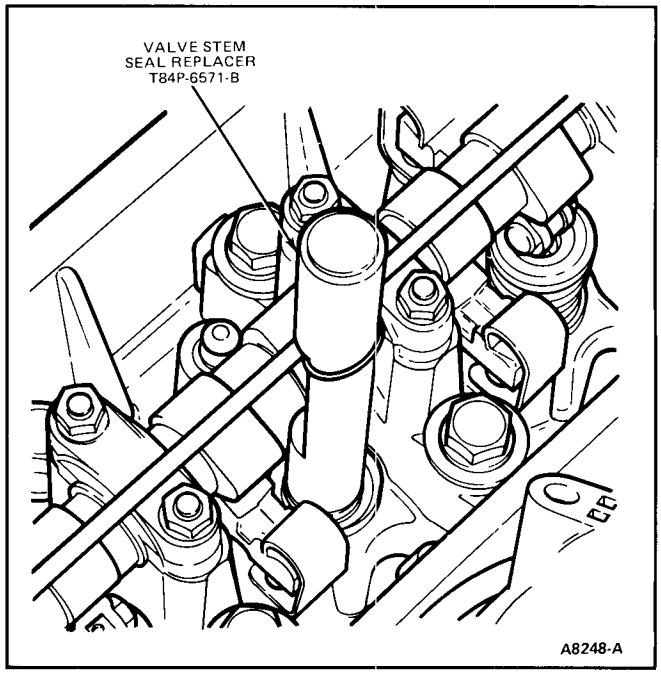


FIG. 17 Valve Stem Seal Installation

2. Install the valve spring, retainer and locks using Valve Spring Compressor Tool T84P-6513-C, or equivalent (Fig. 17).
3. Apply Ford Polyethylene Grease, DOAZ-19584-A, or equivalent, to all contact surfaces of the rocker arm, and install the rocker arm as outlined.
4. Repeat this procedure for each valve as necessary.
5. Adjust the valve(s) as outlined.
6. Install the valve rocker arm cover as outlined.
7. Run engine and check for oil and intake air leaks.

Camshaft

Removal

1. Disconnect battery ground cable.
2. Remove valve cover as outlined.
3. Remove vacuum pump as outlined.
4. Remove fan and clutch assembly as outlined.
5. Remove camshaft drive belt cover as outlined.
6. Remove rocker arms as outlined.
7. Rotate engine until No. 1 cylinder is at TDC of compression stroke. Install TDC Aligning Pin, T84P-6400-A, or equivalent (Fig. 18).
8. Loosen camshaft sprocket bolt.
9. Loosen drive belt tension roller nut and bolt.
10. Remove camshaft sprocket.
11. Remove camshaft bearing caps and mark the caps so that they can be installed in their original position, and remove camshaft.

Installation

1. Install camshaft in position on cylinder head.
2. Install camshaft bearing caps, making sure they are installed in the correct position. Tighten 6mm nuts to 8-10 N·m (6-7 lb-ft) and 8mm nuts to 20-24 N·m (14-17 lb-ft).
3. Install camshaft sprocket but do not tighten at this time.
4. Install and adjust camshaft drive belt as outlined.
5. Adjust cam and pump timing as outlined in the Engine/Emissions Diagnosis Manual, Section 31.
6. Remove TDC Aligning Pin Tool T84P-6400-A or equivalent, (Fig. 18).
7. Install rocker arms as outlined.

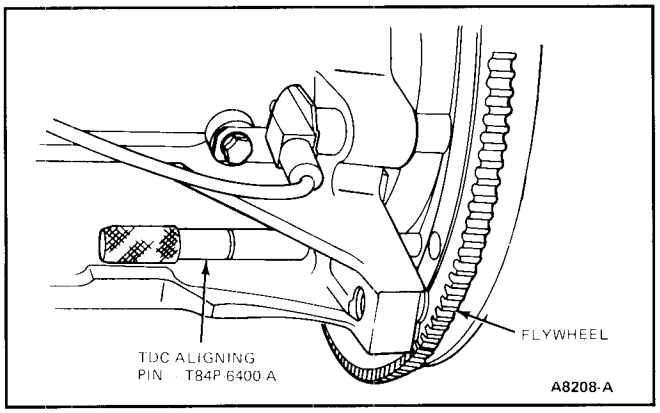


FIG. 18 TDC Aligning Pin

8. Install camshaft drive belt cover and tighten bolts to 8-10 N·m (6-7 lb-ft).
9. Install fan and clutch assembly as outlined.
10. Install vacuum pump as outlined.
11. Install rocker arm cover as outlined.
12. Connect battery ground cable.
13. Run engine and check for oil, intake air, and coolant leaks.

Intake Manifold

Removal

1. Disconnect battery ground cable.
2. Remove diagnostic plug bracket and position out of the way (Fig. 19).
3. Disconnect turbo boost pressure indicator connector.
4. Disconnect oil dipstick tube clamp from intake manifold and position dipstick out of the way (Fig. 20).
5. Loosen clamp at turbo crossover pipe boot (Fig. 11).
6. Remove bolts attaching intake manifold to cylinder head and remove intake.

Installation

1. Clean intake manifold and cylinder head gasket mating surfaces.
2. Install intake manifold on cylinder head, with new gasket, making sure inlet port is installed in turbo crossover pipe boot.
3. Tighten intake manifold bolts to 20-24 N·m (14-17 lb-ft), and tighten crossover pipe boot clamp.
4. Connect turbo boost pressure indicator switch connector.
5. Install diagnostic plug bracket and tighten bolts to 20-24 N·m (14-17 lb-ft) (Fig. 19).

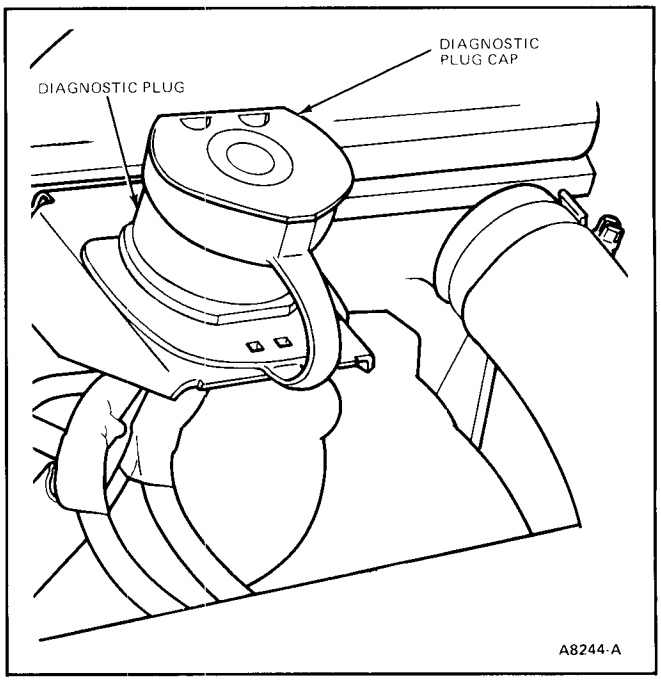


FIG. 19 Diagnostic Plug Bracket

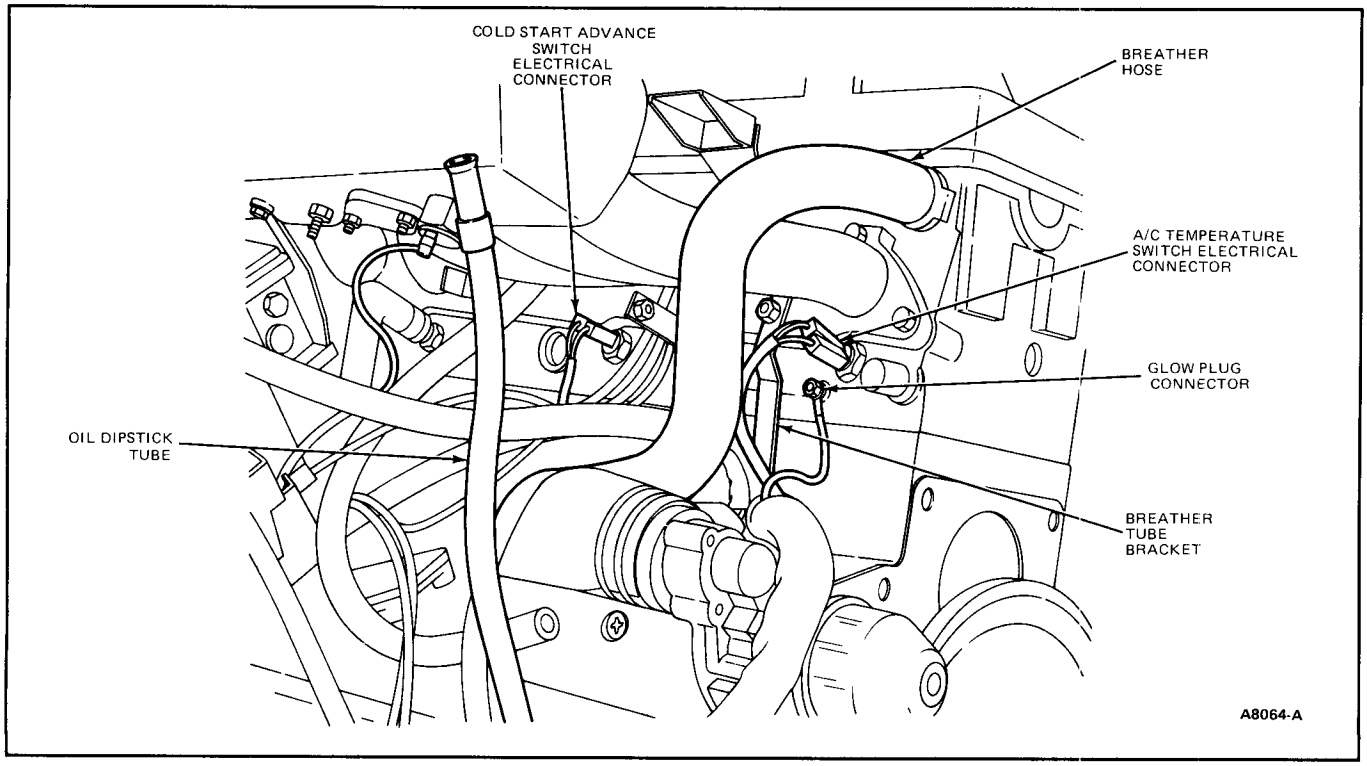


FIG. 20 Engine—Left Hand Side

6. Connect battery ground cable.
7. Start engine and check for intake leaks.

Exhaust Manifold

Removal

1. Disconnect battery ground cable.
2. Disconnect muffler inlet pipe at turbo outlet and cap turbo outlet using Tool T84P-9395-B or equivalent (Fig. 21).
3. Disconnect EGR valve vacuum line.
4. Disconnect inlet duct at turbo and cap turbo inlet using Tool T84P-9395-B or equivalent (Fig. 11).
5. Loosen clamp at turbo crossover pipe boot (Fig. 11).
6. Remove clamp attaching turbo oil feed tube to oil return tube (Fig. 21).
7. Remove bolts attaching oil feed tube to turbo (Fig. 21).

   CAUTION: Cap oil feed tube and oil feed inlet port on turbo, using Tool T84P-9395-B or equivalent, to prevent contamination of turbo oiling system.

8. Disconnect oil return line from turbo oil drain port (Fig. 21).

   CAUTION: Cap oil return iine and oil return port on turbo, using Tool T84P-9395-B or equivalent, to prevent contamination of turbo oiling system.

9. Remove bolts attaching exhaust manifold to cylinder head and remove exhaust manifold and turbo as an assembly. Cap turbo outlet to crossover pipe.

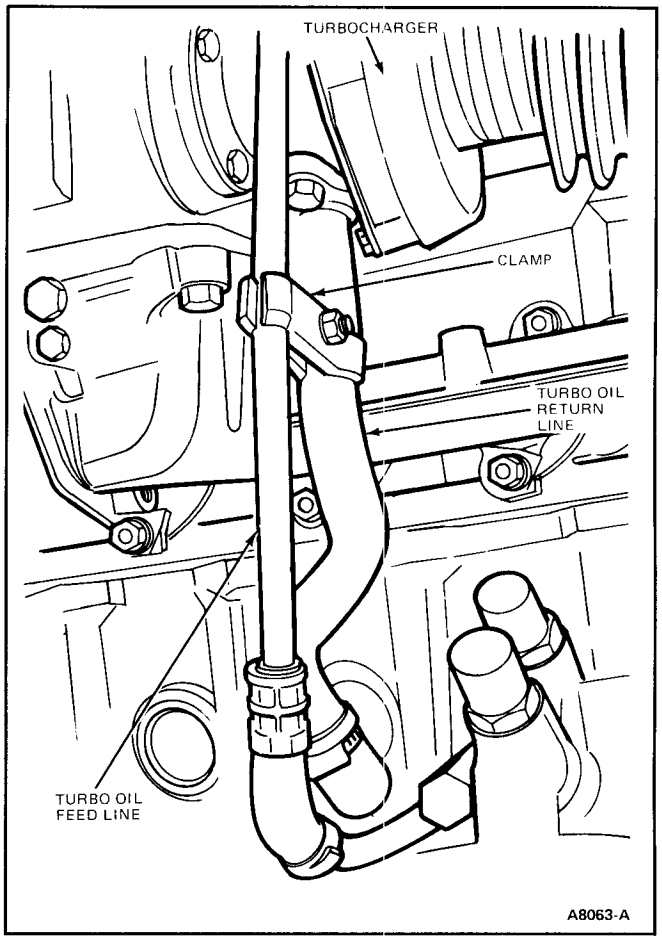


FIG. 21 Turbo Oil Feed and Return Lines

Installation

1. Clean exhaust manifold and cylinder head gasket mating surfaces.
2. Install exhaust manifold, with new gasket, making sure turbo outlet is installed in crossover pipe boot. Tighten bolts to 20-24 N·m (14-17 lb-ft), and tighten crossover pipe boot clamp.
3. Remove caps and install oil feed line, with new gasket, on turbo oil inlet port. Tighten bolts to 20-24 N·m (14-17 lb-ft).
4. Remove caps and connect oil return line to turbo oil return port. Tighten fitting to 40-50 N·m (29-36 lb-ft).
5. Install oil feed tube to exhaust manifold clamp and tighten to 8-10 N·m (6.5-7 lb-ft).
6. Remove cap and connect inlet duct to turbo inlet (Fig. 11).
7. Remove cap and connect muffler inlet pipe to turbo exhaust outlet. Tighten bolts to 43-48 N·m (31-35 lb-ft).
8. Connect EGR valve vacuum line.
9. Connect battery ground cable.
10. Run engine and check for intake, exhaust and oil leaks.

Cylinder Head

Removal

1. Disconnect battery ground cable.
2. Drain cooling system.
3. Disconnect heater hose.
4. Loosen and remove accessory drive belts. Refer to Section 27-02.
5. Remove valve cover, as outlined.
6. Disconnect diagnostic connectors (Fig. 19).
7. Disconnect coolant temperature switch and glow plug connector.
8. Disconnect breather hose and bracket.
9. Remove clamp attaching oil dipstick tube to intake manifold and position dipstick out of the way (Fig. 20).
10. Disconnect boost pressure switch connector.
11. Disconnect radiator hose from cylinder head.
12. Disconnect temperature controlled idle boost coolant hose.
13. Remove vacuum pump from cylinder head.
14. Disconnect No. 1 nozzle to injection pump leak hose (Fig. 22).
15. Disconnect injection lines from nozzles and injection pump using Fuel Line Wrench, T84P-9396-A, or equivalent (Fig. 23).

    CAUTION: Cap nozzles and lines using Tool T84P-9395-B, or equivalent (Fig. 24).
16. Disconnect turbocharger oil lines.
17. Rotate crankshaft until No. 1 cylinder is at TDC of compression stroke (intake and exhaust valves on base circle). Install TDC Aligning Pin, T84P-6400-A or equivalent (Fig. 18).
18. Loosen camshaft drive sprocket retaining bolt.

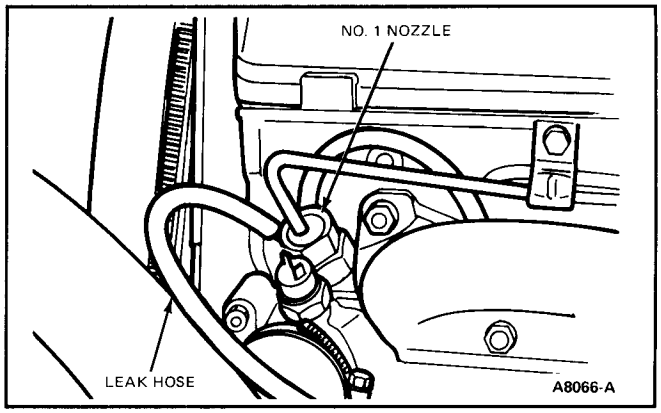


FIG. 22 Injection Pump Leak Hose

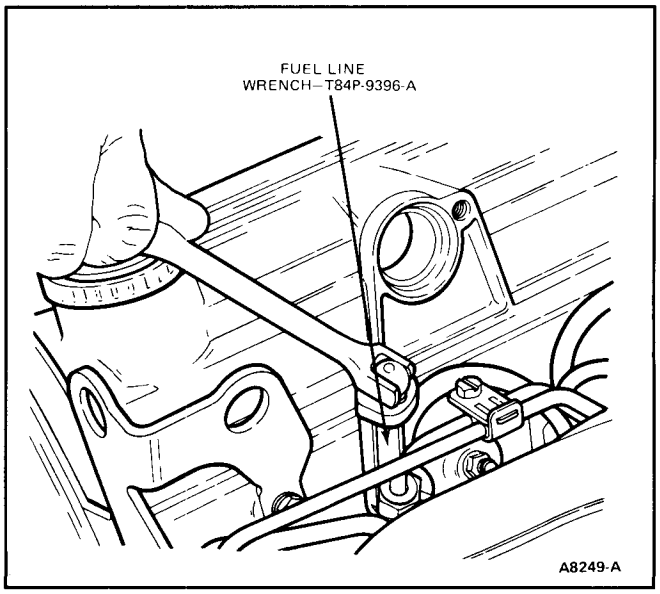


FIG. 23 Injection Pump Nozzle High Pressure Line Removal

19. Loosen camshaft drive belt tensioning roller nut and bolt, and remove drive belt (Fig. 37).
20. Loosen cylinder head bolts in order shown in the squares in Fig. 25, and remove cylinder head.

Installation

1. Clean gasket sealing surfaces on cylinder head and crankcase. Check for warpage (Fig. 26).

   CAUTION: Use care when cleaning gasket surfaces. Slight scoring of these surfaces can cause leakage due to high compression pressures.
2. Clean top of each piston.
3. Using dial indicator D82L-4201-A and Piston Height Gauge D84P-6100-A or equivalent, measure the amount the piston top extends above crankcase gasket surface as follows:
   a. Mount dial indicator and bracket as shown in Fig. 27 with dial indicator tip on piston.
   b. Rotate crankshaft to position piston at TDC, using dial indicator.
   c. Zero dial indicator with tip on crankcase (Fig. 28).

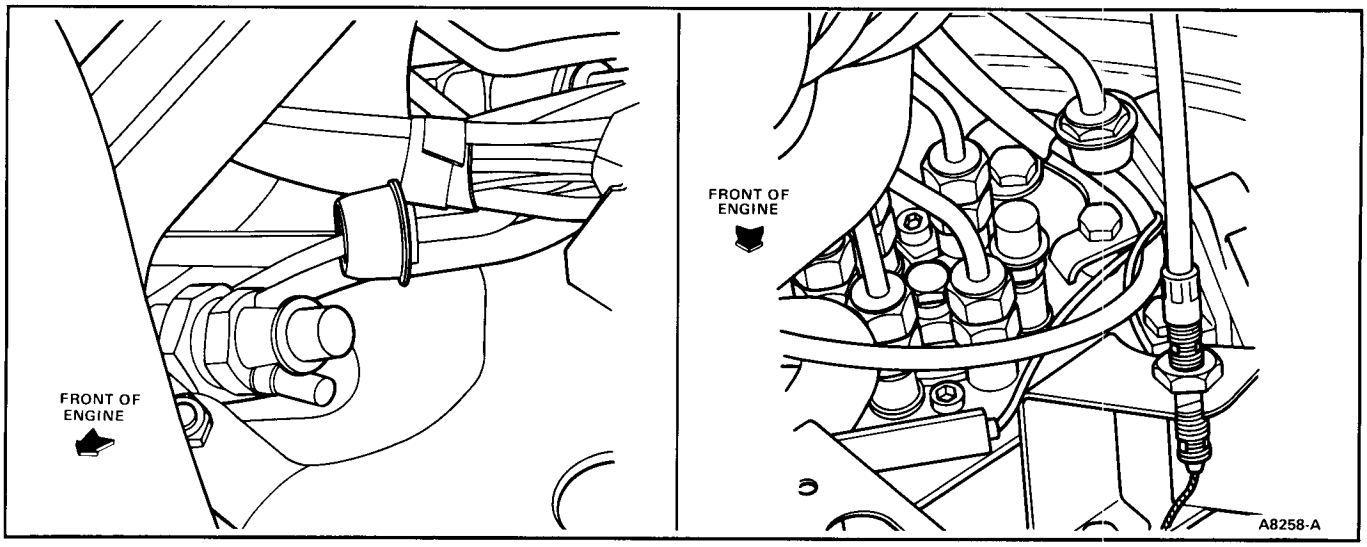


FIG. 24 Cap Fuel Injection Lines

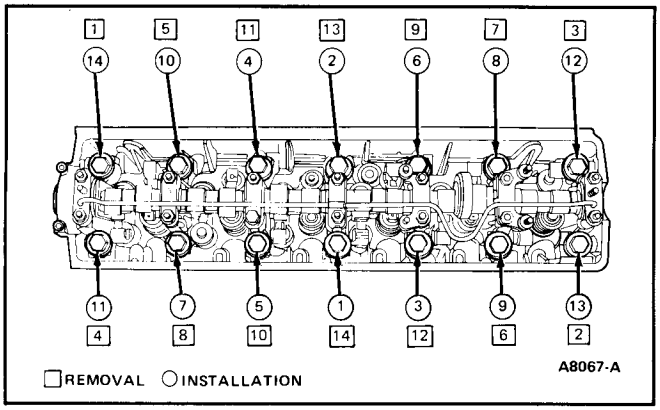


FIG. 25 Cylinder Head Bolt Removal Order

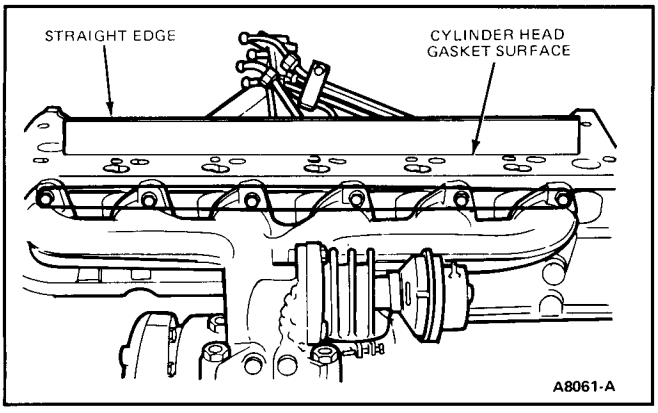


FIG. 26 Cylinder Head Warpage Check

d. Move tip to front of piston. Record measurement.

e. Move tip to rear of piston. Record measurement.

f. Repeat this procedure for each cylinder.

g. Average the two readings for each cylinder.

h. Using measurement of highest piston, refer to Fig. 29 and select correct cylinder head gasket.

4. Clean carbon and oil deposits from cylinder head bolts.

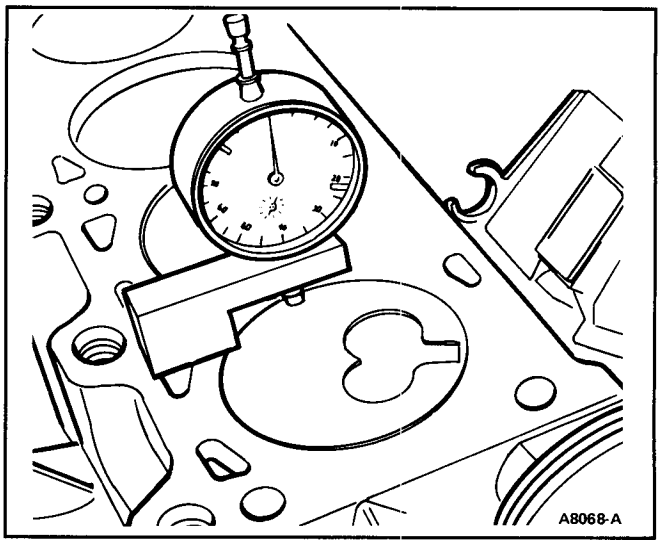


FIG. 27 Mounting Dial Indicator

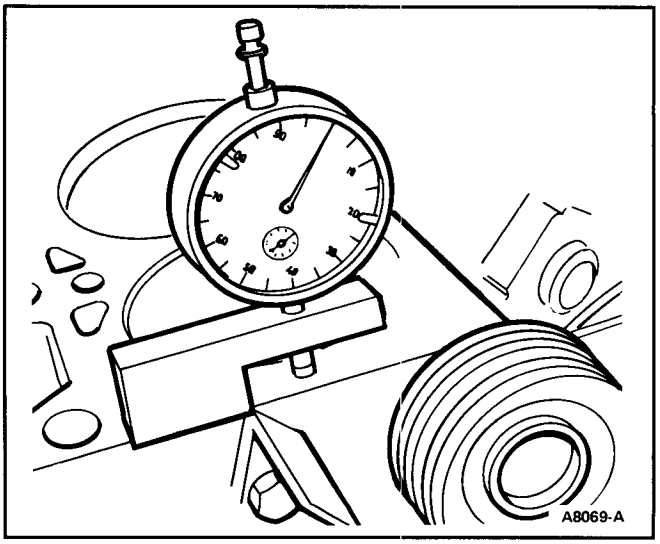
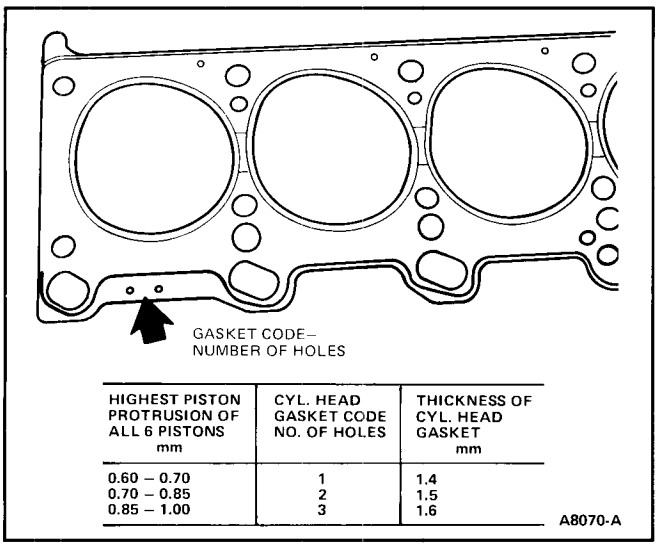


FIG. 28 Zeroing Dial Indicator



HIGHEST PISTON PROTRUSION OF ALL 6 PISTONS mm	CYL. HEAD GASKET CODE NO. OF HOLES	THICKNESS OF CYL. HEAD GASKET mm
0.60 – 0.70	1	1.4
0.70 – 0.85	2	1.5
0.85 – 1.00	3	1.6

FIG. 29 Selecting Proper Cylinder Head Gasket

CAUTION: Keep oil and/or antifreeze from entering cylinder head bolt holes. If either enters bolt holes, carefully blow out with compressed air. The presence of oil and/or antifreeze in bolt holes could result in insufficient cylinder head bolt tightening, or a cracked crankcase.

5. Position correct cylinder head gasket on crankcase.
6. Carefully lower cylinder head onto crankcase, using care not to damage gasket.
7. Install and tighten cylinder head bolts, in sequence shown in Fig. 25, to 50-60 N·m (36-43 lb-ft). Wait 15 minutes and tighten bolts, in sequence shown in Fig. 25 to 90-95 N·m (65-69 lb-ft).
8. Install and adjust drive belt, as outlined.
9. Connect turbocharger oil lines and tighten to 20-24 N·m (14-17 lb-ft) (Fig. 21).
10. Connect nozzle high pressure lines to nozzles and injection pump. Tighten to 20-25 N·m (14-18 lb-ft), using fuel line wrench, T84P-9396-A or equivalent (Fig. 23).
11. Connect No. 1 nozzle to injection pump leak hose (Fig. 22).
12. Install vacuum pump on cylinder head and tighten to 8-10 N·m (6-7 lb-ft).
13. Connect temperature controlled, idle boost coolant hose.
14. Connect radiator hoses to cylinder head.
15. Connect oil pressure switch connector.
16. Install oil dipstick tube.
17. Install breather hose and bracket.
18. Connect coolant temperature switch and glow plug connectors.
19. Connect diagnostic connectors.
20. Install valve cover, as outlined.
21. Install and adjust accessory drive belts. Refer to Section 27-02.
22. Connect heater hose.
23. Fill and bleed coolant system. Refer to Section 27-03.
24. Connect battery ground cable.
25. Start engine and idle for 15 minutes. Check for fuel, coolant and oil leaks.
26. After 15 minutes running time:
    a. Stop engine.
    b. Remove valve cover.
    c. Using a breaker bar, tighten cylinder head bolts another quarter turn (90 ± 5 degrees) (Fig. 30).
    d. Adjust valves as outlined.
    e. Install valve cover, run engine and check for oil leaks.

Water Pump

Removal

1. Drain cooling system.
2. Loosen and remove accessory drive belts. Refer to Section 27-02.
3. Remove fan and clutch assembly as outlined in Section 27-05.
4. Remove water pump pulley.
5. Disconnect heater hose from thermostat housing.
6. Remove camshaft drive belt cover.
7. Remove three bolts attaching water pump to crankcase and remove water pump.

   NOTE: Do not loosen cam belt.

Installation

1. Clean gasket mating surfaces of water pump and crankcase.
2. Install water pump with new gasket, on crankcase and tighten bolts to 20-24 N·m (14-17 lb-ft).
3. Install camshaft drive belt cover and tighten bolts to 8-10 N·m (6-7 lb-ft).
4. Connect heater hose to thermostat housing.
5. Install water pump pulley and tighten bolts to 8-10 N·m (6-7 lb-ft).
6. Install fan and clutch assembly as outlined in Section 27-05.
7. Install and adjust accessory drive belts. Refer to Section 27-02.

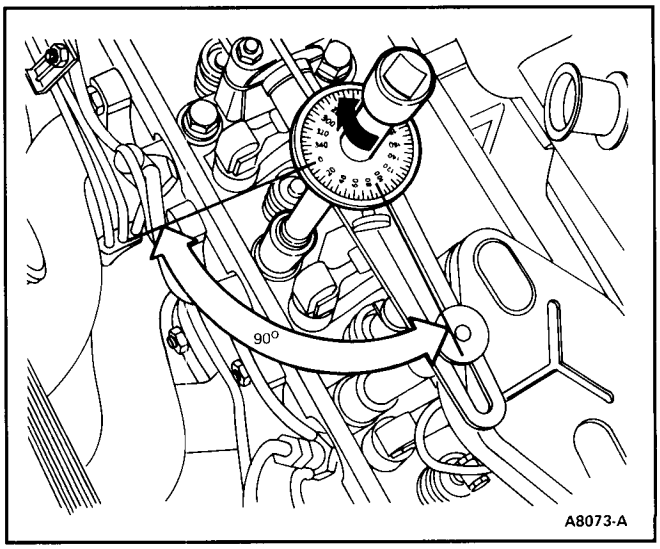


FIG. 30 Cylinder Head Bolt Tightening

8. Fill and bleed cooling system. Refer to Section 27-03.
9. Run engine and check for coolant leaks.

Crankshaft Pulley, Vibration Damper and Crankshaft Flange

Removal

1. Remove fan and clutch assembly as outlined in Section 28-05.
2. Remove accessory drive belts. Refer to Section 27-02.
3. Remove six bolts retaining crankshaft pulley and vibration damper.
4. Install Holding Tool T84P-6316-A or equivalent, (Fig. 32), onto crankshaft pulley with two bolts supplied with tool. Remove flange retaining bolt and remove flange using Puller T67L-3600-A or equivalent.

   NOTE: Remove Allen head screws from Holding Tool, T84P-6316-A or equivalent before installing on crankshaft flange.

Installation

1. Slide crankshaft flange onto crankshaft.

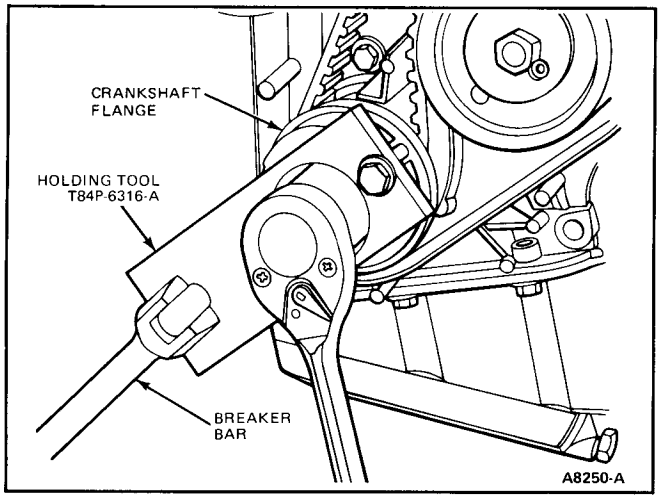


FIG. 31 Crankshaft Flange Removal

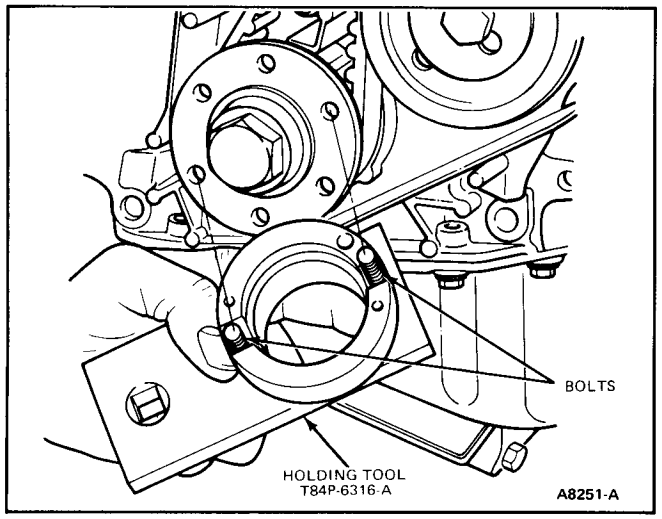


FIG. 32 Align Bolts in Vibration Damper

2. Install Holding Tool T84P-6316-A or equivalent, (Fig. 31) with two bolts supplied with tool.
3. Install crankshaft flange retaining bolt and tighten to 390-430 N·m (282-311 lb-ft).
4. Install vibration damper onto crankshaft flange.

   NOTE: Make sure to align small guide pin into the damper.
5. Position crankshaft pulley to damper and install with six bolts. Tighten bolts to 20-30 N·m (15-22 lb-ft).
6. Install and adjust accessory drive belts. Refer to Section 27-02.
7. Install fan and clutch assembly fan as outlined in Section 27-05.

Camshaft Drive Belt

Removal

1. Disconnect battery ground cable.
2. Drain cooling system.
3. Remove accessory drive belts. Refer to Section 27-02.
4. Remove fan, clutch and water pump pulley assembly as outlined in Section 27-05.
5. Remove vibration damper and pulley as outlined.
6. Disconnect heater hose from thermostat housing.
7. Remove four bolts attaching camshaft drive belt cover to crankcase, and remove cover.
8. Remove rocker cover as outlined.
9. Rotate engine until No. 1 cylinder is at TDC on compression stroke (intake and exhaust valves on base circle), and install TDC Aligning Pin T84P-6400-A or equivalent (Fig. 18).
10. Install Cam Positioning Tool T84P-6256-A or equivalent, (Fig. 33).

    NOTE: Flat side of nut or cam position tool should be facing down (Fig. 34).
11. Loosen camshaft sprocket bolt.
12. Using a piece of chalk, or similar marker, mark direction of engine rotation on drive belt, if it is to be reinstalled.
13. Loosen two bolts on belt tensioner.
14. Remove camshaft drive belt.

Installation

1. Insert a 2.5mm (0.098 inch) thick feeler gauge blade between Cam Positioning Tool T84P-6256-A or equivalent, and the right front corner of the gasket mating surface of the cylinder head (Fig. 35) if using a new drive belt or a drive belt used with less than 16,000 km (10,000 miles).
2. Install Injection Pump Aligning Pin T84P-9000-A or equivalent, through injection pump sprocket (Fig. 36).
3. Rotate cam sprocket clockwise against pin.
4. Install camshaft drive belt. Starting at crankshaft, route belt around intermediate shaft sprocket, injection pump sprocket, camshaft sprocket and then tension roller, keeping slack to a minimum (Fig. 37).

   CAUTION: Used drive belts must be installed in same direction of engine rotation as removed.

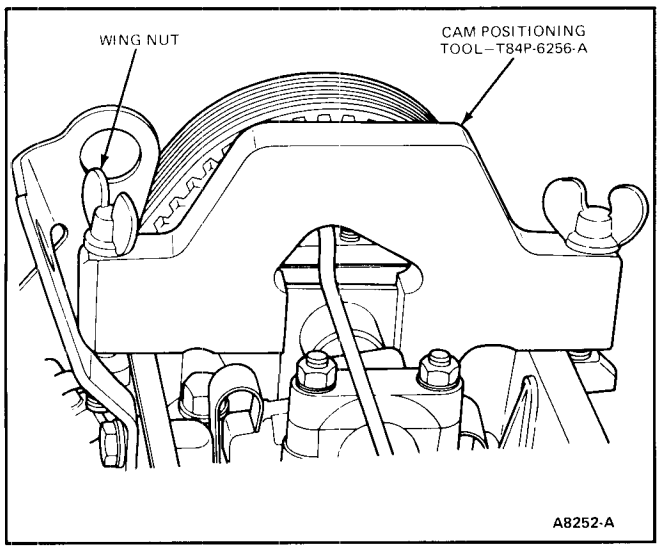


FIG. 33 Cam Positioning Tool

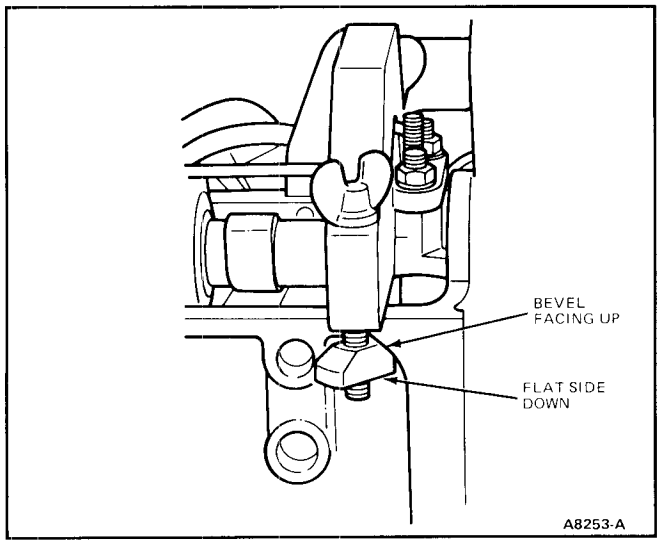


FIG. 34 Cam Positioning Tool Nut

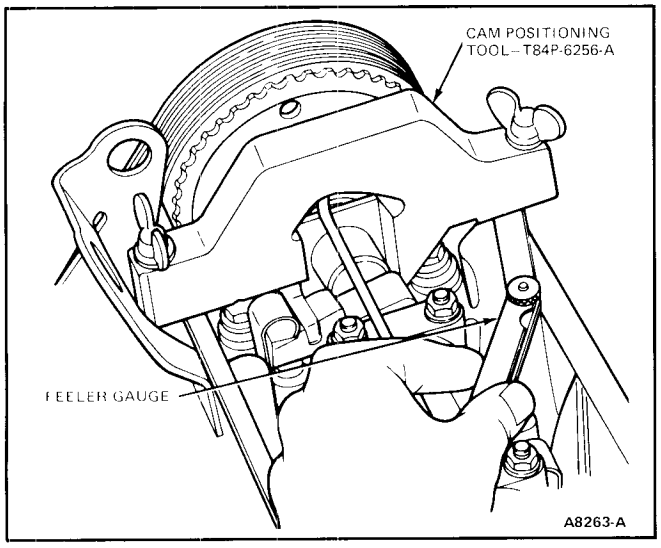


FIG. 35 Cam Positioning with Feeler Gauge

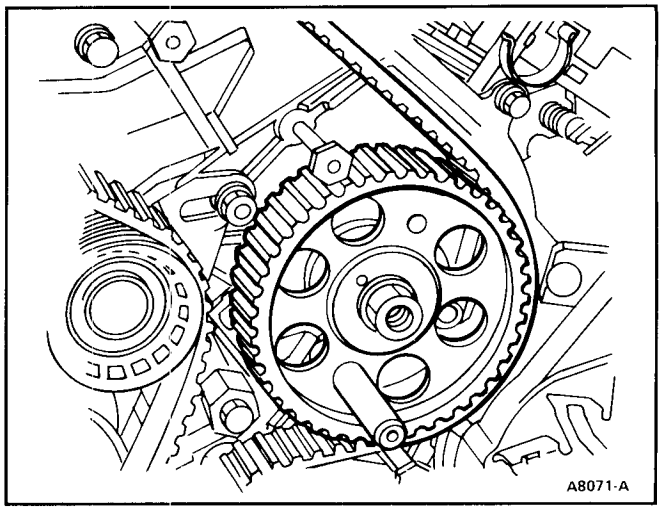


FIG. 36 Injection Pump Aligning Pin

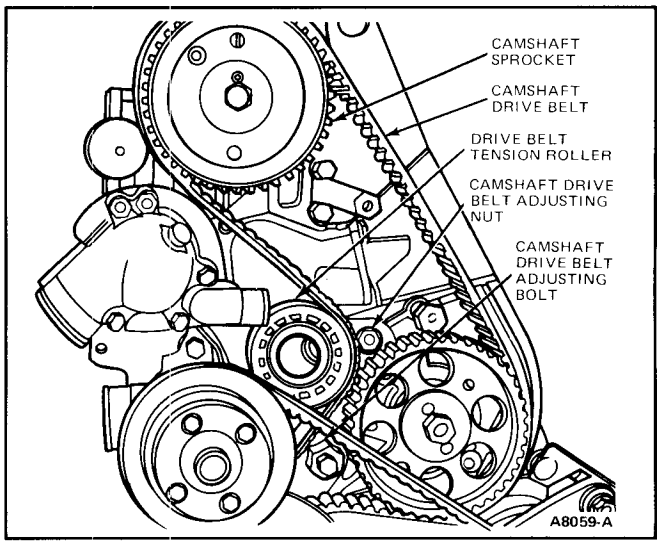


FIG. 37 Camshaft Drive Belt Installation

CAUTION: Make sure V side of belt correctly positioned in V's of the pulley.

5. Hand tighten belt with belt tensioner until all slack is gone.
6. Remove Injection Pump Aligning Pin, T84P-9000-A or equivalent, from injection pump sprocket.
7. Adjust belt tension by tightening belt tensioner. Tighten belt tensioner to 45-50 N·m (34-36 lb-ft) on belts with less than 16,000 km (10,000 miles) and 30-35 N·m (23-25 lb-ft) for belts with more than 16,000 km (10,000 miles).

   NOTE: Use only a dial type torque wrench.
8. Tighten two belt tensioner holding bolts to 20-24 N·m (15-18 lb-ft).
9. Tighten camshaft sprocket to 55-65 N·m (41-47 lb-ft).
10. Remove Cam Positioning Tool, T84P-6265-A, and TDC Aligning Pin, T84P-6400-A or equivalent.
11. Install camshaft drive belt cover and tighten bolts to 8-10 N·m (6-7 lb-ft).
12. Connect heater hose to thermostat housing.
13. Install vibration damper as outlined.

14. Install fan, clutch and water pump pulley assembly as outlined in Section 27-05.
15. Install and adjust accessory drive belts. Refer to Section 27-02.
16. Fill and bleed cooling system. Refer to Section 27-03.
17. Connect battery ground cable.
18. Run engine and check for oil and coolant leaks.
19. Check injection pump timing (refer to Engine/ Emissions Diagnosis Manual, Section 31) and adjust as required.

Engine Front Cover

Removal

1. Disconnect battery ground cable.
2. Drain cooling system. Refer to Section 27-03.
3. Loosen and remove accessory drive belts.
4. Remove engine cooling fan and clutch assembly as described in Section 27-05.
5. Remove vibration damper as outlined.
6. Disconnect heater hose from thermostat housing.
7. Remove four bolts attaching camshaft drive belt cover to crankcase and remove cover.
8. Remove camshaft drive belt as outlined.
9. Remove bolts attaching intermediate shaft sprocket using Holding Tool T84P-6316-A or equivalent (Fig. 38).

   NOTE: Be sure Allen head screws are aligned with holes in intermediate shaft sprocket (Fig. 39).
10. Remove vibration damper flange and sprocket retaining bolt and remove flange and sprocket using puller, T67L-3600-A or equivalent (Fig. 40).
11. Remove three oil pan-to-front cover attaching bolts. Loosen, but **DO NOT REMOVE,** remaining oil pan bolts.
12. Remove six bolts attaching front cover to crankcase, and remove cover.

Installation

1. Clean front cover and crankcase gasket mating surfaces.
2. Inspect and replace crankshaft and intermediate shaft oil seals as outlined, if necessary.

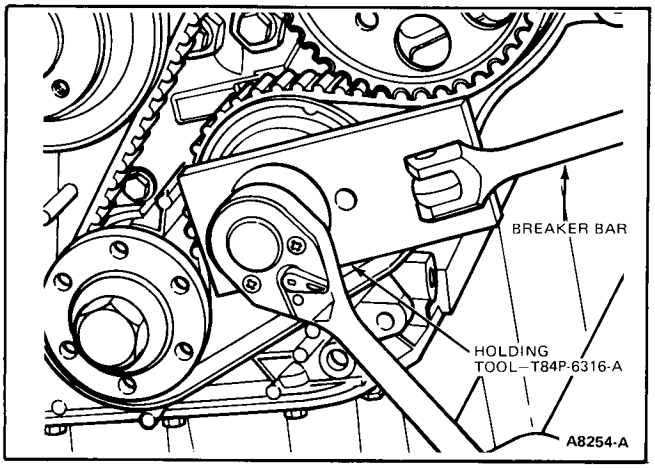


FIG. 38 Intermediate Shaft Sprocket Removal

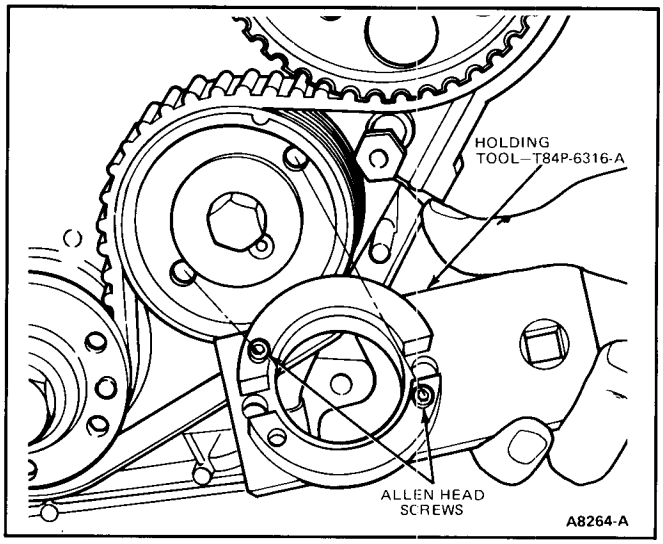


FIG. 39 Intermediate Shaft Allen Head Screws

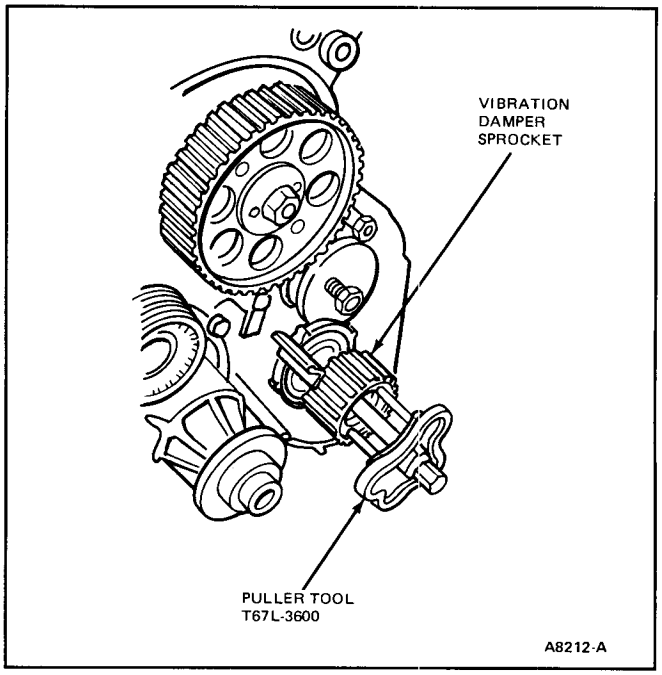


FIG. 40 Vibration Damper Sprocket Removal

3. If oil pan gasket is damaged, install new oil pan gasket as outlined.
4. Install new front cover gasket.

   NOTE: Coat areas where front cover gasket meets oil pan gasket with a 6.35mm (1/4 inch) RTV Sealant, D6AZ-19562-A or equivalent sealer, (Fig. 41).

   NOTE: RTV Sealant should be applied immediately prior to front cover installation. When applying RTV Sealant always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to "set-up" and its sealing effectiveness may be reduced.
5. Position front engine cover on crankcase, and tighten 6mm bolts to 8-10 N·m (6-7 lb-ft) and 8mm bolts to 20-24 N·m (14-17 lb-ft).
6. Install three oil pan-to-front cover attaching bolts. Tighten oil pan bolts to 9-10 N·m (6.5-7 lb-ft).

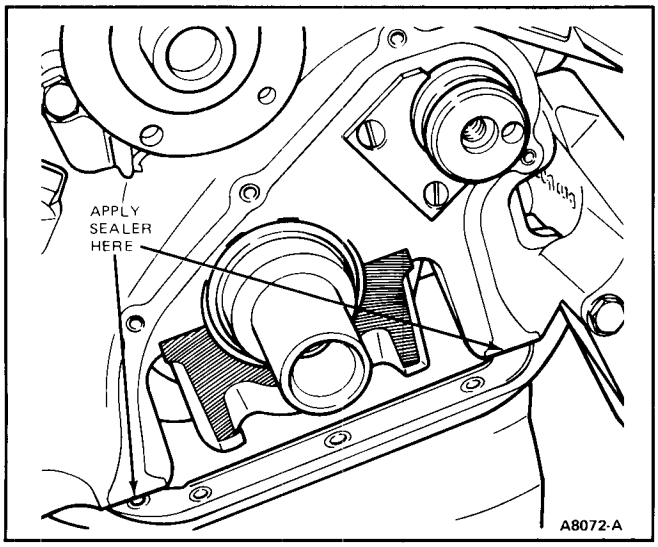


FIG. 41 Front Cover Gasket Sealing Areas

7. Position vibration damper flange and sprocket on crankshaft, with shoulder toward front of vehicle.
8. Position intermediate shaft sprocket on intermediate shaft, guiding locating pin into bore.
9. Install Holding Tool T84P-6316-A or equivalent (Fig. 31).

   NOTE: Align Allen head screws in tool with holes in intermediate shaft.
10. Install and tighten vibration damper flange and sprocket bolt to 390-430 N·m (282-311 lb-ft).
11. Install and tighten intermediate shaft sprocket bolt to 55-65 N·m (40-47 lb-ft). Remove Tool T84P-6316-A or equivalent.
12. Install and adjust camshaft drive belt as outlined.
13. Install camshaft drive belt cover and tighten bolts to 8-10 N·m (6-7 lb-ft).
14. Connect heater hose to thermostat housing.
15. Install vibration damper and pulley and tighten to 22-24 N·m (16-17 lb-ft).
16. Install fan and clutch assembly as outlined in Section 27-05.
17. Install and adjust accessory drive belts. Refer to Section 27-02.
18. Connect battery ground cable.
19. Start and idle engine. Check for oil leaks.

Oil Seal, Front—Crankshaft/Intermediate Shaft

Removal

1. Remove engine front cover as outlined.
2. Using an arbor press, press old seal(s) out of front cover.

Installation

1. Position new seal on front cover and install, using T84P-6019-B for crankshaft seal, or T84P-6020-A or equivalent for intermediate shaft seal (Figs. 42 and 43).
2. Lubricate sealing lips with engine oil.
3. Install engine front cover as outlined.

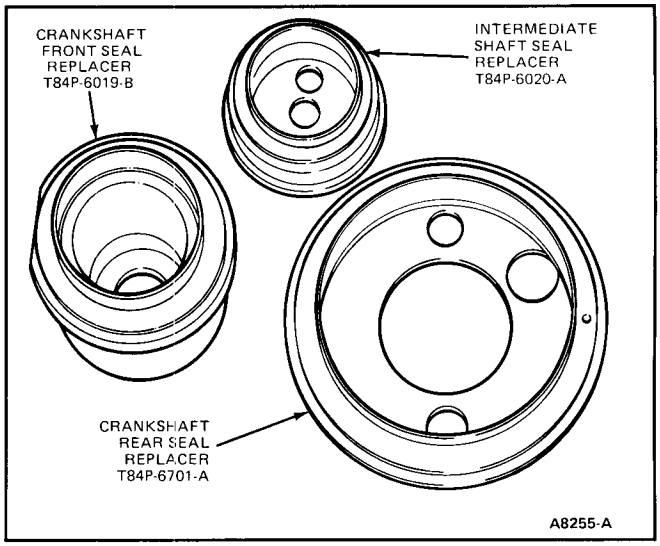


FIG. 42 Crankshaft—Front and Rear, and Intermediate Shaft Seals Installation Tools

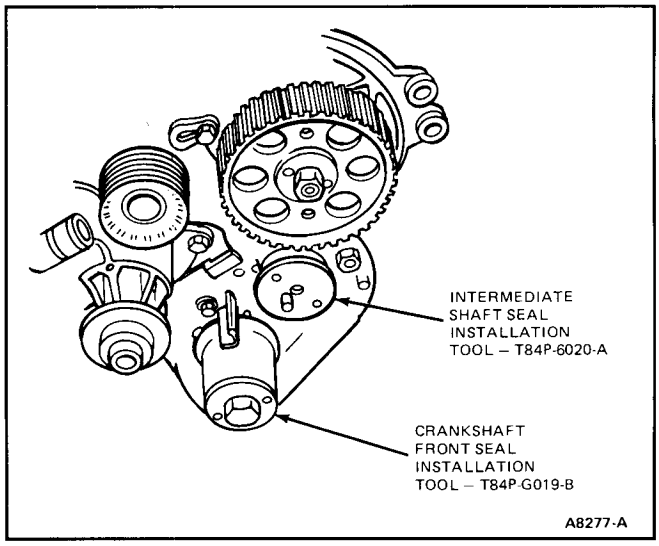


FIG. 43 Front Crankshaft and Intermediate Shaft Installation Tools—Shown Installed

Flywheel

Removal

1. Remove transmission. Refer to Section 17-12.
2. Install Holding Tool, T84P-6316-A or equivalent onto crankshaft flange (Fig. 31).
3. Remove bolts attaching flywheel to crankshaft, and remove flywheel and flex plate.

Installation

1. Clean threads of flywheel bolts and apply Locktite 270 or equivalent to threads.
2. Position flywheel and flex plate on crankshaft and install attaching bolts.
3. Install Holding Tool T84P-6316-A or equivalent, onto crankshaft flange and tighten flywheel bolts to 98-112 N·m (71-81 lb-ft).

Rear Main Oil Seal

Removal

1. Raise vehicle on hoist.

2. Remove transmission. Refer to Section 17-12.
3. Remove flywheel as outlined.
4. Remove four oil pan to rear engine cover attaching bolts (Fig. 44).
5. Loosen, but **DO NOT REMOVE** remaining oil pan bolts.
6. Remove six engine rear cover bolts and remove cover (Fig. 44).

Installation

1. Clean crankcase and engine rear cover gasket mating surfaces.
2. Replace oil pan gasket, if damaged, as outlined.
3. Using an arbor press, press old seal out of cover.
4. Position new seal on cover and press in using Crankshaft Rear Seal Replacer T84P-6701-A, or equivalent (Fig. 42).
5. Lubricate sealing lips on seal with engine oil.
6. Position new rear cover gasket on crankcase.
7. Apply gasket sealer at points where rear cover gasket meets the oil pan gasket (Fig. 45).
8. Position rear cover on crankshaft.
9. Install rear cover bolts and tighten 6mm bolts to 8-10 N·m (6-7 lb-ft), and 8mm bolts to 20-24 N·m (14-17 lb-ft) (Fig. 44).
10. Install four oil pan to rear cover attaching bolts (Fig. 44). Tighten all oil pan bolts to 9-10 N·m (6.5-7 lb-ft).
11. Install flywheel as outlined.

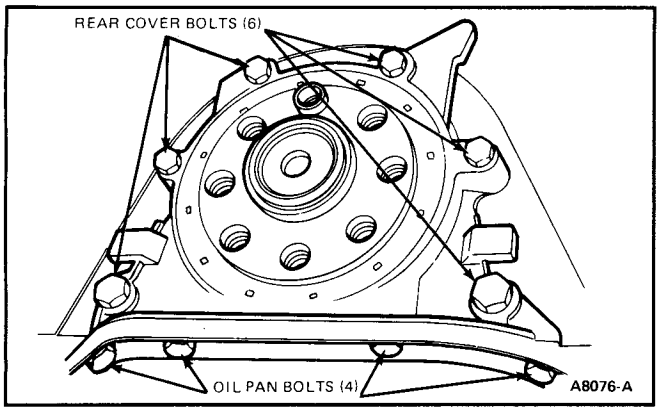


FIG. 44 Rear Cover Attaching Bolts

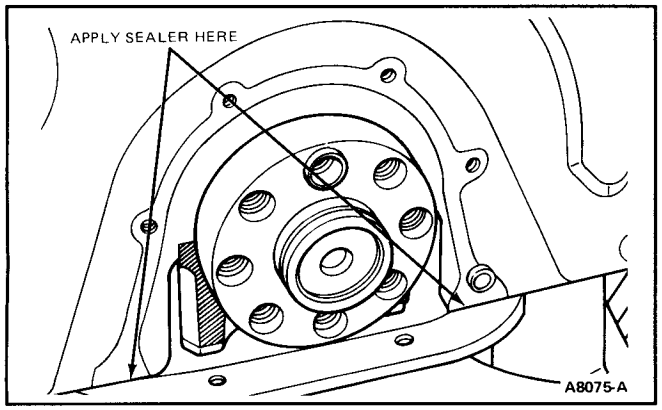


FIG. 45 Rear Cover Gasket to Oil Pan Sealing Points

12. Install transmission. Refer to Section 17-12.
13. Lower vehicle.
14. Run engine and check for oil leaks.

Oil Pan and Oil Pump

Removal

1. With engine removed from vehicle and placed on an engine stand, remove bolts attaching oil pan to crankcase.
2. Remove two bolts attaching oil pump pickup to crankcase (Fig. 46).
3. Remove three bolts attaching oil pump to crankcase, and remove oil pump (Fig. 46).
4. Remove oil pump driveshaft, if necessary (Fig. 47).

Installation

1. Install oil pump driveshaft, if removed, making sure it is fully engaged with intermediate shaft (Fig. 47).
2. Install oil pump on crankcase, making sure driveshaft is fully engaged in oil pump. Tighten oil pump and oil pick-up bolts to 22-24 N·m (16-17 lb-ft).

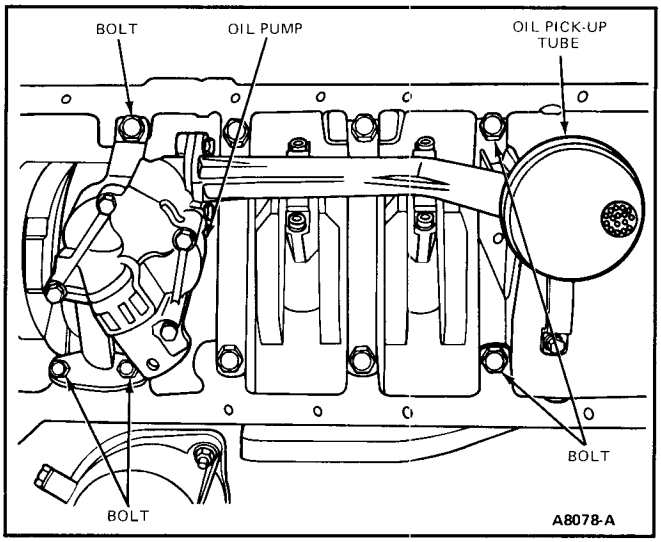


FIG. 46 Oil Pump Installation

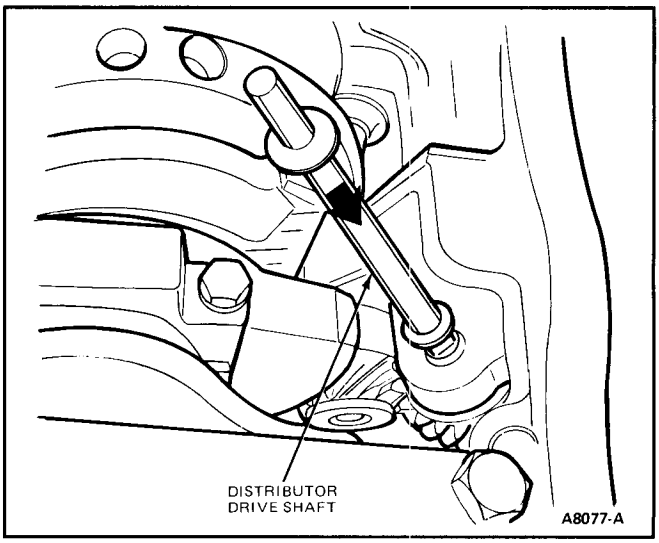


FIG. 47 Oil Pump Shaft Driveshaft

3. Clean oil pan and crankcase gasket mating surfaces.
4. Apply a 6.35mm (1/4 inch) bead of RTV Sealant D6AZ-19562-A or equivalent, on split lines between engine front and rear covers, and crankcase.

   NOTE: RTV Sealant should be applied immediately prior to crankcase installation. When applying RTV Sealant always use the bead size specified and join the components within 15 minutes of application. After this amount of time the sealant begins to "set-up" and its sealing effectiveness may be reduced.
5. Position new oil pan gasket on crankcase, and install oil pan. Tighten bolts to 9-10 N·m (6.5-7 lb-ft).

Oil Filter

Removal and Installation

1. Raise vehicle on a hoist.
2. Remove oil filter drain plug and drain oil from filter (Fig. 48).
3. Remove nuts attaching oil filter cover and remove cover and filter element (Fig. 49).
4. Clean oil filter cover using a suitable solvent.
5. Install new gasket on oil filter cover.
6. Install oil filter element and cover (Fig. 49). Tighten bolts to 21-25 N·m (15-18 lb-ft).
7. Install oil filter drain plug and tighten to 10-13 N·m (7-9 lb-ft).
8. Lower vehicle and fill crankcase with specified quantity and quality of oil.

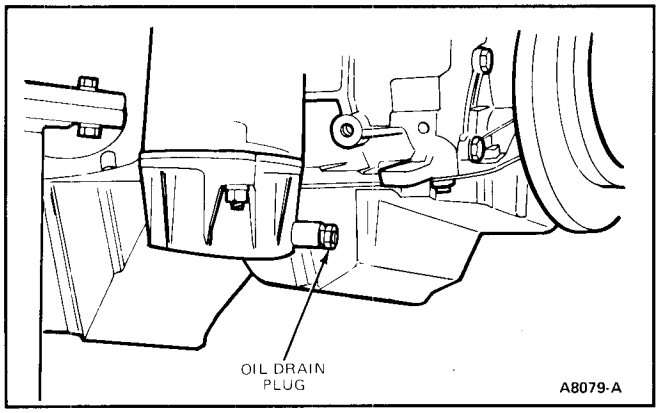


FIG. 48 Oil Filter Drain Plug

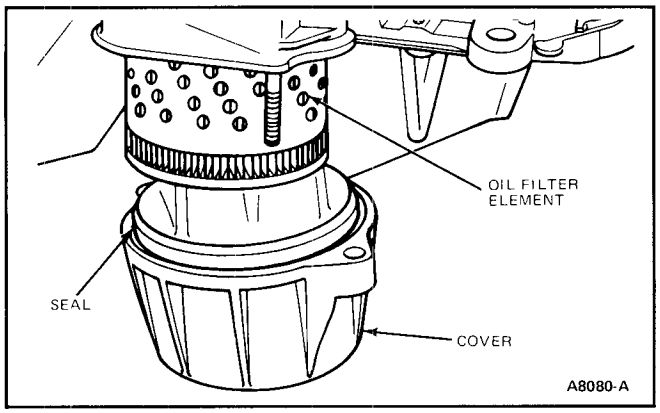


FIG. 49 Oil Filter Cover and Element

9. Run engine and check for oil leaks.

Oil Cooler

Removal

1. Drain oil from crankcase.
2. Remove and cap oil cooler lines at oil cooler (Fig. 50).
3. Remove three bolts retaining oil cooler to mounting bracket (Fig. 50).
4. Remove one oil cooler-to-radiator side support retaining screw.
5. Remove oil cooler assembly from vehicle.

Installation

1. Position oil cooler assembly to vehicle and install four bolts to attach to mounting bracket (Fig. 50).
2. Install one oil cooler-to-radiator side support retaining screw.
3. Remove caps from oil cooler lines and attach oil cooler lines to oil cooler.
4. Fill crankcase with specified quantity and quality of oil.
5. Run engine and check for oil leaks.

   NOTE: Oil will not flow through the oil cooler until the oil temperature reaches at least 95°C (203°F).

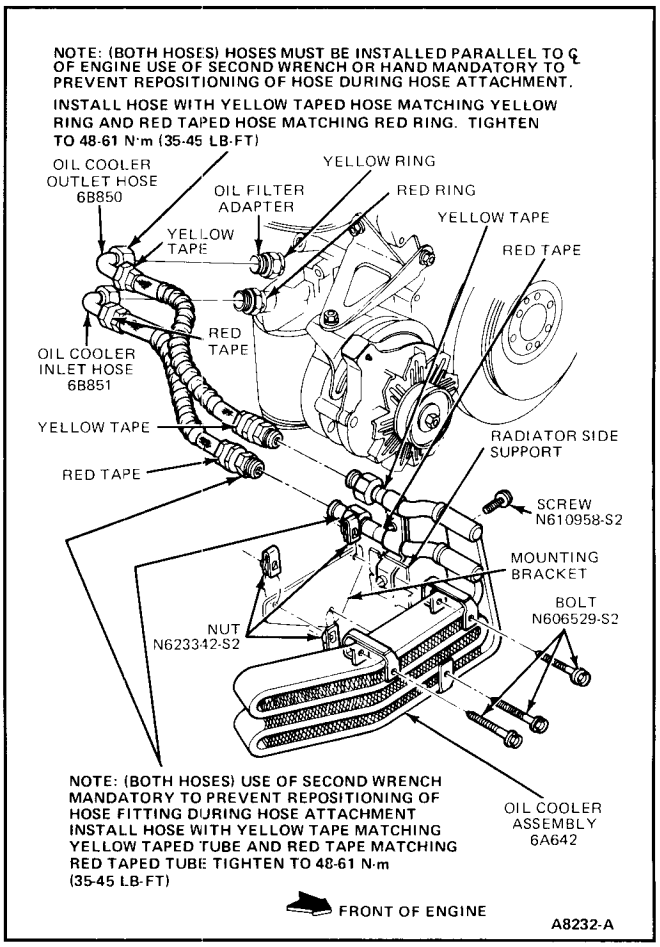


FIG. 50 Oil Cooler Assembly Installation

Oil Filter Housing

Removal

1. Raise vehicle on hoist.
2. Drain oil from crankcase.
3. Disconnect oil pressure switch connector.
4. Remove oil filter element and cover (Fig. 49) as outlined.
5. Remove and cap oil cooler lines at filter housing (Fig. 50).
6. Remove bolts attaching oil filter housing to crankcase and remove housing.

Installation

1. Clean oil filter housing and crankcase gasket mating surfaces. Clean oil filter housing using a suitable solvent.
2. Install oil filter housing, with new gasket, on crankcase, and tighten bolts to 20-24 N·m (14-17 lb-ft).
3. Connect oil cooler lines to oil filter housing, (Fig. 50), and tighten fittings to 30-40 N·m (22-29 lb-ft).
4. Install oil filter element and cover as outlined.
5. Connect oil pressure switch connector.
6. Lower vehicle and fill crankcase with specified quantity and quality of oil.
7. Run engine and check for oil leaks.

Injection Pump

Removal

1. Disconnect battery ground cable.
2. Drain cooling system. Refer to Section 27-03.
3. Remove accessory drive belts. Refer to Section 27-02.
4. Remove fan and clutch assembly as outlined in Section 27-05.
5. Remove camshaft drive belt as outlined.
6. Install Injection Pump Sprocket Aligning Pin T84P-9000-A or equivalent, and remove nut and washer attaching sprocket to injection pump (Fig. 36).
7. Install puller T67L-3600-A or equivalent and remove sprocket.
8. Remove woodruff key from pump shaft.
9. Disconnect clamp attaching oil dipstick tube to intake manifold, and position out of the way.
10. Disconnect turbo pressure indicator switch connector.
11. Remove diagnostic plug bracket and position out of the way (Fig. 19).
12. Loosen clamp attaching turbo crossover pipe boot to intake manifold (Fig. 11).
13. Remove nuts attaching intake manifold to cylinder head, and remove cylinder head.

    NOTE: To prevent fuel system contamination, cap all fuel lines and fittings, using Protective Cap Set T84P-9395-B or equivalent.
14. Disconnect and cap nozzle fuel lines at nozzles.
15. Remove injection nozzle lines from injection pump using Fuel Line Nut Wrench T84P-9396-A or equivalent (Fig. 23). Install caps on each end of each fuel line and pump fitting as it is removed and identify each fuel line accordingly.
16. Disconnect coolant hoses from the idle speed boost housing (Fig. 51).
17. Disconnect electrical connectors to the fuel shut-off and cold start accelerator valves, micro-switch and fuel pressure switch.
18. Disconnect nozzle return line at injection pump.
19. Disconnect fuel return hose from fuel return line on left fender apron.
20. Disconnect fuel inlet hose from fuel inlet line on left fender apron.
21. Disconnect vacuum hoses at altitude compensation valve. Note position of hoses, so they may be returned to the original position.
22. Disconnect throttle cable and speed control cable, if so equipped, from injection pump (refer to Sections 25-60 and 37-05).
23. Remove three nuts attaching injection pump to bracket (Fig. 52).
24. Remove two nuts attaching injection pump to engine front cover, and remove injection pump (Fig. 53).

Installation

1. Install injection pump in position. Line up mark on front cover with the mark on the injection pump mounting boss. Install attaching nuts and bolts, (Figs. 52 and 53), and tighten to 20-24 N·m (14-17 lb-ft).
2. Connect throttle cable, and speed control cable, if so equipped (refer to Sections 25-60 and 37-05).
3. Remove protective caps and install fuel inlet hose to fuel inlet line on left fender apron.
4. Connect fuel return hose to fuel return line on left fender apron.
5. Connect vacuum hoses to altitude compensation valve. Refer to VECI decal.
6. Connect nozzle return line to injection pump.

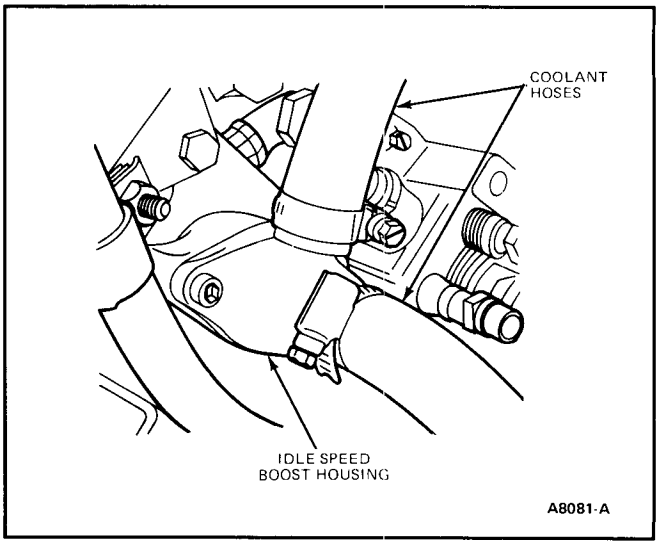


FIG. 51 Idle Speed Boost Housing

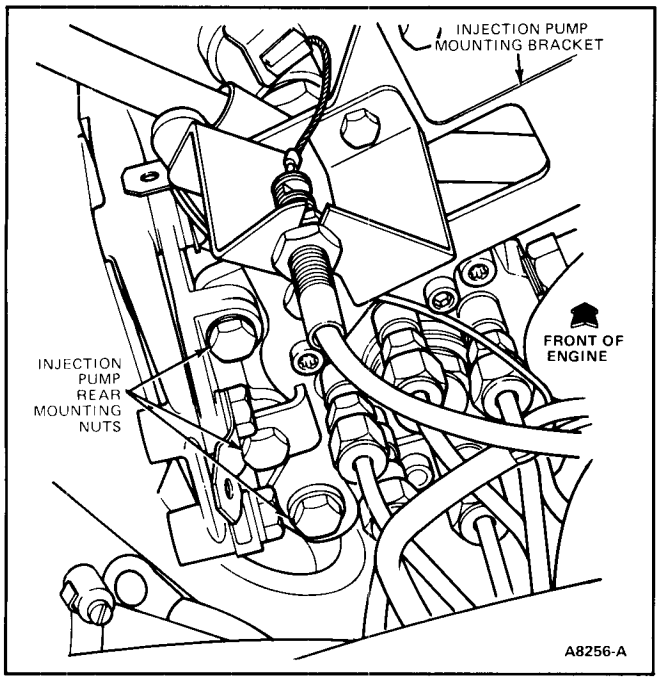


FIG. 52 Injection Pump—Rear Mounting Nuts

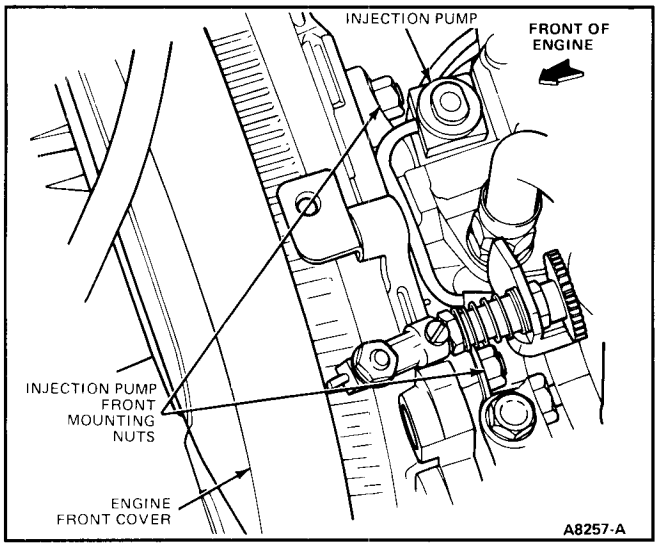


FIG. 53 Injection Pump—Front Mounting Nuts

7. Connect electrical connectors to fuel pressure sensor, micro-switch, cold start accelerator valve and fuel shut-off valve.
8. Connect coolant hoses to idle speed boost housing (Fig. 51).
9. Install fuel lines on injection pump, using Tool T84P-9396-A or equivalent, and tighten to 20-25 N·m (14-17 lb-ft) (Fig. 23).
10. Connect fuel lines to nozzles and tighten to 20-25 N·m (14-17 lb-ft).
11. Clean intake manifold and cylinder head gasket mating surfaces.
12. Position new intake manifold gasket on cylinder head, and install intake manifold. Be sure intake manifold inlet port is inserted into turbo crossover pipe boot (Fig. 11). Tighten attaching bolts to 20-24 N·m (14-17 lb-ft). Tighten clamp at crossover pipe boot.
13. Install diagnostic plug bracket on cylinder head (Fig. 19), and tighten to 20-24 N·m (14-17 lb-ft).
14. Connect turbo pressure indicator switch connector.
15. Position oil dipstick tube to intake manifold and install clamp.
16. Install woodruff key in injection pump shaft.
17. Install sprocket on injection pump. Install Injection Pump Aligning Pin T84P-9000-A or equivalent, in sprocket (Fig. 36). Install sprocket attaching washer and nut and tighten to 45-50 N·m (33-36 lb-ft).
18. Install and adjust camshaft drive belt as outlined.
19. Install camshaft drive belt cover and tighten to 8-10 N·m (6-7 lb-ft).
20. Install fan and clutch assembly as outlined in Section 27-05.
21. Install and adjust accessory drive belts. Refer to Section 27-02.
22. Fill and bleed cooling system. Refer to Section 27-03.
23. Air bleed fuel system as outlined.
24. Adjust injection pump timing. Refer to Engine/Emissions Diagnosis Manual, Section 31.
25. Connect battery ground cable.
26. Start engine and check for fuel, coolant and oil leaks.
27. Adjust curb idle, fast idle and injection pump timing. Refer to Engine/Emissions Diagnosis Manual, Section 31.

Fuel Shut-Off Valve

Removal

1. Disconnect battery ground cable.
2. Remove nut attaching electrical connector to shut-off valve and remove connector (Fig. 54).
3. Remove shut-off valve.

CAUTION: Piston and spring may fall out when removing valve (Fig. 55).

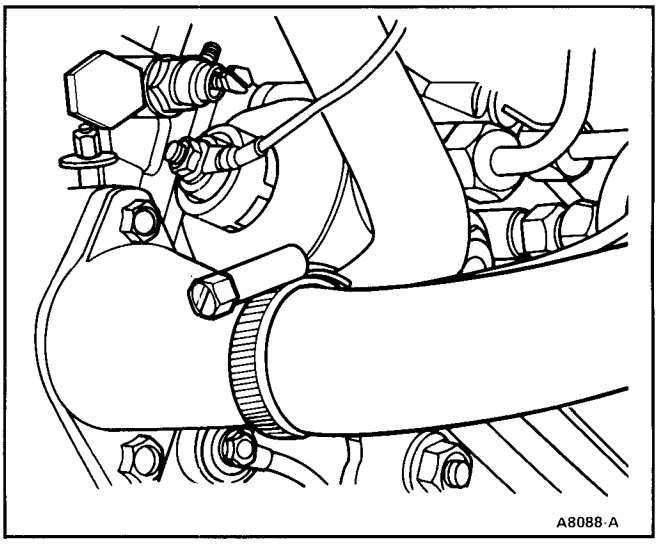


FIG. 54 Fuel Shut-Off Valve Removal

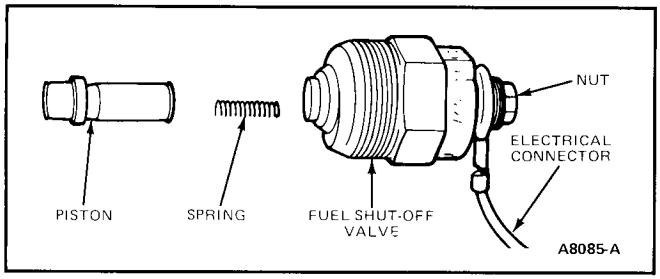


FIG. 55 Fuel Shut-Off Valve—Exploded View

Installation

1. Replace O-ring and valve, and install valve on injection pump. Tighten valve to 15-25 N·m (11-18 lb-ft).

   CAUTION: Piston and spring may fall out when installing valve (Fig. 55).

2. Install connector on shut-off valve (Fig. 54). Tighten nut to 4-5 N·m (3-3.5 lb-ft).
3. Connect battery ground cable.
4. Run engine and check for fuel leaks.

Injection Nozzles

Refer to Figs. 56 and 57.

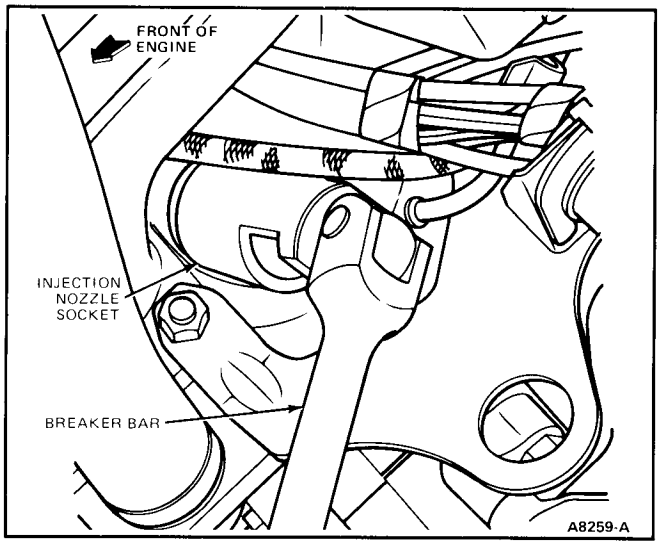


FIG. 56 Injection Nozzle Removal and Installation

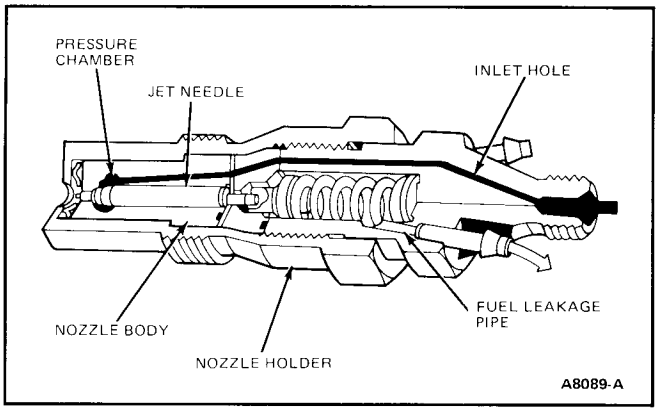


FIG. 57 Injection Nozzle—Cutaway View

Removal

1. Pull off leak oil lines on injector nozzles.

   NOTE: Make sure area around injector is clean.

2. Remove fuel lines at injectors and at fuel injection pump with Fuel Line Wrench T84P-9395-A or equivalent. Cap all fuel lines and openings with Protective Cap Set T84P-9395-B or equivalent as fuel lines are removed.
3. Unscrew fuel injectors with Injector Nozzle Socket T84P-9527-A or equivalent. Note injector order for installation.

   NOTE: On injectors with sensors, disconnect sensor plug wires and guide sensor wires through Injector Nozzle Socket T84P-9527-A or equivalent, while installing tool on injector.

4. Plug cylinder block injector nozzle opening.

Installation

1. Clean injector nozzle opening in cylinder block.
2. Install new heat shields into injection nozzle openings.
3. Apply copper based, anti-sieze compound to injector nozzle threads. Remove protective plug in cylinder block and install injector nozzles in original positions with Injector Nozzle Socket T84P-9527-A or equivalent, and tighten to 40-45 N·m (30-33 lb-ft).

   NOTE: On injectors with sensors, guide sensor plug wire through socket before installing injector nozzle. Reconnect sensor wire after nozzle installation.

4. Remove protective caps from fuel lines, injector pump and injector nozzles and install fuel lines using Fuel Line Wrench T84P-9396-A or equivalent. Tighten to 20-25 N·m (15-18 lb-ft).

Injection Nozzle Fuel Lines

Removal

1. If all the fuel lines are being removed, remove intake manifold as outlined, and then remove all fuel lines as an assembly.

   NOTE: Do not remove the two clamps holding the fuel lines together.

2. Remove fuel line(s) at injector nozzles and at fuel injection pump with Fuel Line Wrench T84P-9395-A or equivalent. Cap all fuel lines and openings with Protective Cap Set T84P-9395-B or equivalent, as fuel lines are removed.
3. If only one fuel line is being removed, remove the clamps holding fuel lines together and remove the fuel line.

Installation

1. If the fuel lines are being installed as an assembly, remove protective caps and install fuel lines (with clamps installed) to injector nozzles and injection pump using Fuel Line Wrench T84P-9395-A or equivalent.
2. If only one fuel line is being installed, remove protective caps and position fuel line to injector nozzle, and injection line using Fuel Line Wrench T84P-9395-A or equivalent. Install clamps holding fuel lines together.
3. Install intake manifold as outlined if it was previously removed.

Glow Plugs

Removal

1. Disconnect battery ground cable.
2. Unscrew glow plug electrical connection and remove wire.
3. Remove glow plug using a 12mm deepwell socket.

Installation

1. Coat glow plug threads with a copper based, anti-sieze compound.
2. Install glow plug into engine block using a 12mm deepwell socket.
3. Tighten glow plug to 20-30 N·m (15-22 lb-ft).
4. Connect electrical wire to glow plug with nut and tighten to 4-5 N·m (3-4 lb-ft).
5. Connect battery ground cable.

Piston and Connecting Rods

NOTE: Do not use a power wrench for removing or installing connecting rod bolts, nuts and washers. Such practice will cause seizure of connecting rod bolt or nut threads.

Removal

1. With engine removed from vehicle and placed on an engine stand, remove flywheel, injection pump, intake manifold, cylinder heads, oil pan and oil pump, as outlined in this Section.
2. Remove any ridges and/or deposits from upper end of cylinder bores using Tool T64L-6011-EA or equivalent as follows:
   a. Turn crankshaft until piston to be removed is at the bottom of its travel and place a cloth on piston head to collect cuttings. Remove any ridge and/or deposits from upper end of cylinder bores. Remove cylinder ridge with a ridge cutter. Follow instructions furnished by tool manufacturer.

   CAUTION: Never cut into ring travel area in excess of 0.79mm (1/32-inch) when removing ridges.
3. Make sure all connecting rods and caps are marked so that they can be installed in their original positions.
4. Turn crankshaft until connecting rod being removed is down (BDC).
5. Remove connecting rod nuts and cap.
6. Install Connecting Rod Guide Sleeves Tool D84P-6136-A or equivalent on connecting rod stud (Fig. 58).
7. Push connecting rod and piston assembly out top of cylinder with handle end of a hammer.

   CAUTION: Avoid damage to cooling jets, crankshaft journal or cylinder wall when removing piston and rod.
8. Remove bearing inserts from connecting rod and cap.
9. Install cap on connecting rod from which it was removed.

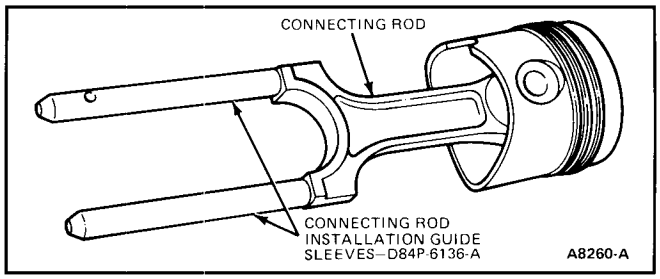


FIG. 58 Connecting Rod Installation Guide

Installation

1. If new piston rings are to be installed, remove cylinder wall glaze. Follow instructions of the tool manufacturer. Cylinder bores must be cleaned with a soap and water solution after deglazing or honing. Dry and oil cylinder walls immediately after cleaning as outlined. Use proper size ring installer tool.
2. Oil piston rings, piston and cylinder walls with recommended quality engine oil. **Be sure to install pistons in same cylinders from which they were removed or to which they were fitted. The numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with a new cylinder number.**
3. Make sure ring gaps are properly spaced around circumference of piston (Fig. 59).
4. Turn crankshaft piston throw to TDC position.
5. Install connecting rod upper bearing, and install Connecting Rod Guide Sleeves Tool D84P-6136-A or equivalent (Fig. 57). Install piston ring compressor Tool D81L-6002-C or equivalent on piston and push piston in with a hammer handle until it is slightly below top of cylinder (Fig. 60). Guide connecting rods to avoid damaging cooling jets and crankshaft journals. **Install piston with arrow on pistonhead toward drivebelt (Fig. 61).**
6. Push piston all the way down until connecting rod bearing seats on crankshaft journal. Remove protective sleeves and install lower bearing cap.
7. Check clearance of each bearing and connecting rod side clearance following procedure outlined under Main and Connecting Rod Bearings.

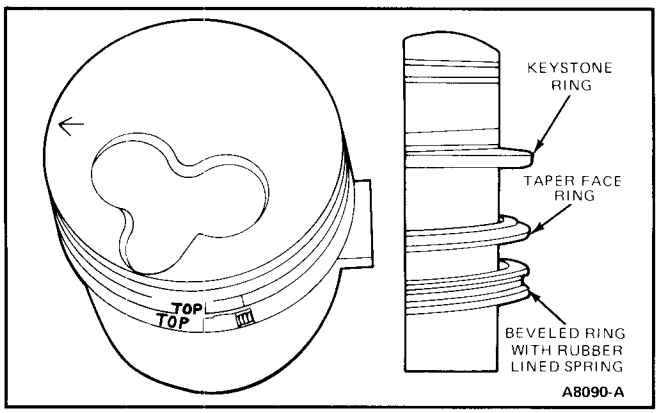


FIG. 59 Piston Ring Spacing

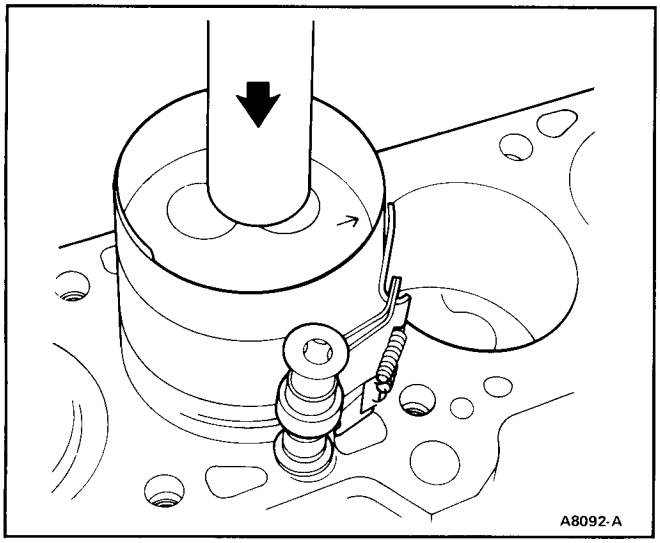


FIG. 60 Fitting Pistons

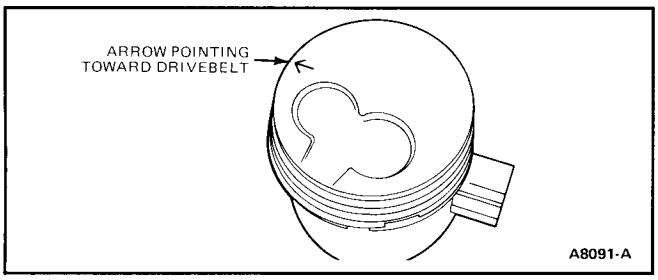


FIG. 61 Arrow on Piston Head

8. After bearings have been fitted, apply a light coat of recommended quality engine oil to journals and bearings.
9. Install connection rod cap and bearing. Tighten connecting rod nuts alternately to 20 N·m (14 lb-ft). Then tighten nuts another 70 degrees of rotation (Fig. 62).

   NOTE: Lightly coat bolt threads with oil before installing.

Crankshaft

Removal

1. With engine removed from vehicle and placed on an engine stand, remove flywheel, engine front and rear covers, oil pan, and oil pump and pick up, as outlined.
2. Measure crankshaft end play as outlined.
3. Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations.
4. Turn crankshaft until connecting rod from which cap is being removed is down (BDC), and remove bearing cap. Install connecting rod guide Tool D84P-6136-A or equivalent and push connecting rod and piston assembly up into cylinder. Repeat this procedure until all connecting rods are removed.

   CAUTION: Use care to avoid damage to crankshaft journal, cooling jets and cylinder wall when moving piston assembly.
5. Remove main bearing caps. Main bearing caps are numbered from front of engine.

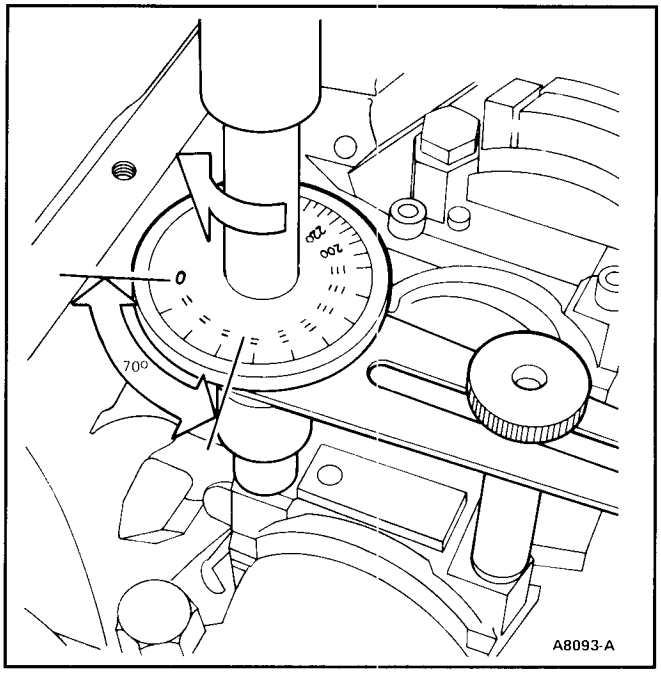


FIG. 62 Connecting Rod Cap Tightening

6. Carefully lift crankshaft out of block so that thrust bearing surfaces are not damaged. **Handle crankshaft with care to avoid possible fracture or damage to finished surfaces. (Refer to Cleaning and Inspection in this Section).**

Installation

1. Remove main bearing inserts from block and bearing caps.
2. Clean mating surfaces of block and main bearing caps.
3. Remove connecting rod bearing inserts from connecting rods and caps.
4. If crankshaft main bearing journals have been refinished to a definite undersize, install correct undersize bearings. Be sure bearing inserts and bearing bores are clean. Foreign material under inserts will distort bearings and cause a failure.
5. Place upper main bearing inserts with oil holes in position in bores, except thrust bearing (No. 6 main bearing), with tang fitting in slot provided.
6. Install No. 6 main bearing (thrust flanges and oil hole) by rolling main bearing into saddle.
7. Install lower main bearing inserts in bearing caps.
8. Carefully lower crankshaft into place. **Be careful not to damage bearing surface.**
9. Check clearance of each main bearing following procedure outlined under Fitting Main and Connecting Rod Bearings.
10. Apply recommended quality engine oil to journals and bearings.
11. Install all bearing caps, except thrust bearing cap (No. 6). **Be sure that main bearing caps are installed in their original locations.** Tighten bearing cap bolts to 60-67 N·m (45-49 lb-ft).
12. Install thrust bearing cap with bolts finger tight.
13. Pry crankshaft forward against thrust surface of upper half of bearing (Fig. 60).

14. Hold crankshaft forward and pry thrust bearing cap to rear. This will align thrust surfaces of both halves of bearing.
15. Retain forward pressure on crankshaft. Tighten cap bolts to 60-67 N·m (44-49 lb-ft).
16. Force crankshaft toward rear of engine.
17. Check crankshaft end play as outlined.

Oil Cooling Jet

Removal

Remove two bolts retaining oil cooling jet to engine block (Fig. 63), and remove oil cooling jet.

Installation

Install oil cooling jet with two bolts. Tighten bolts to specification.

OVERHAUL, CLEANING AND INSPECTION

"Service Limit" Specifications

"Service Limit" specifications are intended to be a guide to be used when overhauling or reconditioning an engine or engine component. A determination can be made, whether a component is suitable for continued service or should be replaced for extended service, while the engine is disassembled.

In the case of "Valve Stem to Valve Guide Clearance," the "Service Clearance" is intended as an aid in diagnosing engine noise only, and does not constitute a failure or indicate need for service. However, when servicing a cylinder head, the service clearance should be regarded as a practical working value, and used as a determinant for installing new valve guides and/or valves to assure extended service life.

The cleaning and inspection procedures are for a complete engine overhaul. For partial engine overhaul or parts replacement, follow the applicable cleaning and/or inspection procedure.

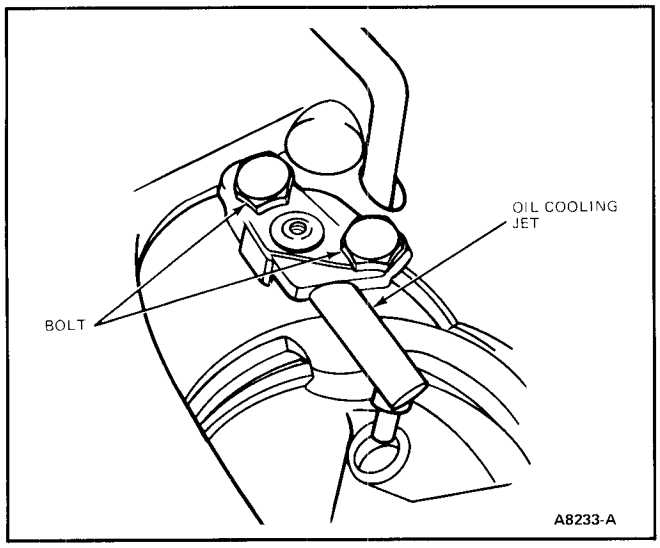


FIG. 63 Oil Cooling Jet

Breather Hose, Valve Cover and Oil Separator

Cleaning and Inspection

1. Remove valve cover and breather hose from engine.
2. Clean rubber breather hose by passing a suitable cleaning brush through it.
3. Thoroughly wash breather hose in a low volatility petroleum base solvent and dry with compressed air.
4. Thoroughly clean oil separator in valve cover with solvent to assure unobstructed flow of crankcase gases.

Cylinder Head

CAUTION: Cylinder head is aluminum and should be handled carefully to prevent damage.

Disassembly

Install cylinder head on Holding Fixture, Rotunda model 014-00318 (D83L-500-A) or equivalent.

With valves installed to protect the valve seats, remove deposits from combustion chambers and valve heads with a scraper and a wire brush.

CAUTION: Be careful not to damage cylinder head gasket surface.

1. Using a suitable valve spring compressor, remove valve spring retainer locks, retainer, spring and damper assemblies, intake valve oil seals and valves.

   NOTE: Keep individual valve assemblies together so that they may be returned to their original positions.
2. Remove glow plugs and injection nozzles as outlined.

Cleaning

After valves are removed, clean valve guide bores with a valve guide cleaning tool. Using cleaning solvent to remove dirt, grease and other deposits. Clean all bolt holes. Be sure oil transfer passage is clean.

Remove all deposits from valves with a fine wire brush or buffing wheel.

Inspection

Inspect cylinder head for cracks or excessively burned areas in exhaust outlet ports.

Check cylinder head for cracks and inspect gasket surface for burrs and nicks. Replace head if cracked.

Flatness

When cylinder head is removed because of gasket leaks, check flatness of cylinder head gasket surface with 0.15mm (0.006 inch) feeler straight edge, Rotunda model 014-00319 (D83L-4201-A) or equivalent. Check for warpage as shown in Fig. 64. If warped, replace cylinder head.

NOTE: Cylinder head cannot be resurfaced.

Valve Stem Clearance

Valve Installed

1. Remove valve cover and vacuum pump as outlined.
2. Remove rocker arm(s) for valve(s) to be checked.

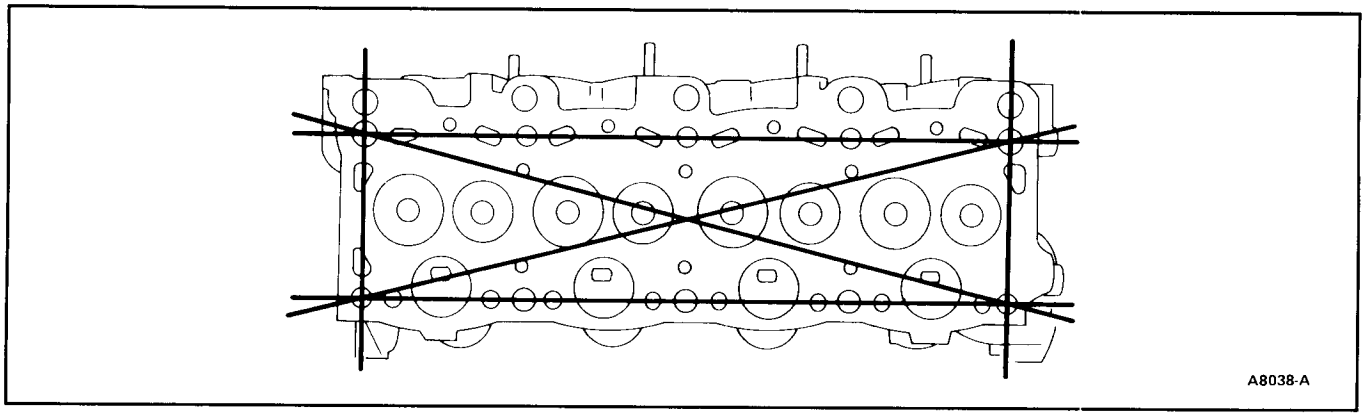


FIG. 64 Cylinder Head Flatness Check

3. Remove valve spring using Tool T84P-6513-A or equivalent.
4. Install valve stem clearance Adapter Ball (part of D84P-6505-A) or equivalent on valve stem (Fig. 65).
5. Install Dial Indicator Bracketry D78P-4201-G and Dial Indicator D82L-4201-A, with Bracketry Adapter (Part of D84P-6505-A) or equivalent (Fig. 66).
6. Check valve stem clearance. Clearance should be a maximum of 0.25mm (0.010 inch). If valve stem clearance is excessive, remove cylinder head, and follow procedures for Valve Stem Clearance—Valve Removed.

Valve Removed

1. Install Dial Indicator Bracketry D78P-4201-G and Dial Indicator D82L-4201-A or equivalent, as shown in Fig. 67.
2. Install a new valve in valve guide so that end of stem is even with valve guide.
3. Rock valve back and forth and check valve stem clearance. Clearance should be a maximum of 0.8mm (0.031 inch).
4. If valve stem clearance is excessive, ream out valve guide using reamer and aligning tool from Valve Guide Service Set D84P-6085-A, or equivalent (Fig. 68). Then, install an oversize valve.

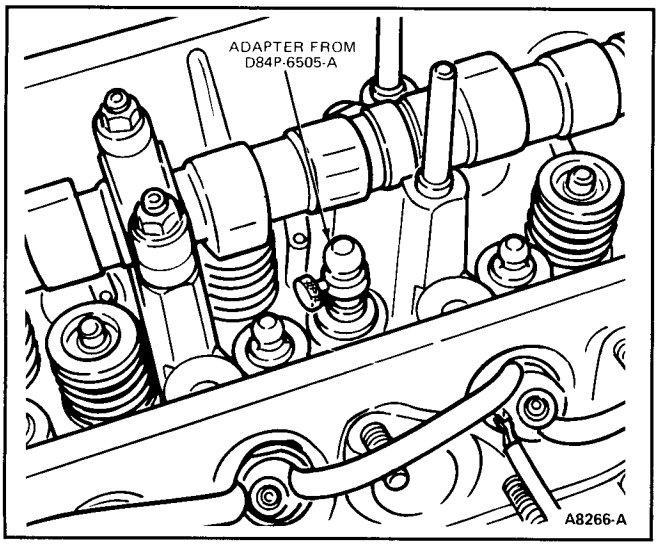


FIG. 65 Valve Stem Clearance Adapter

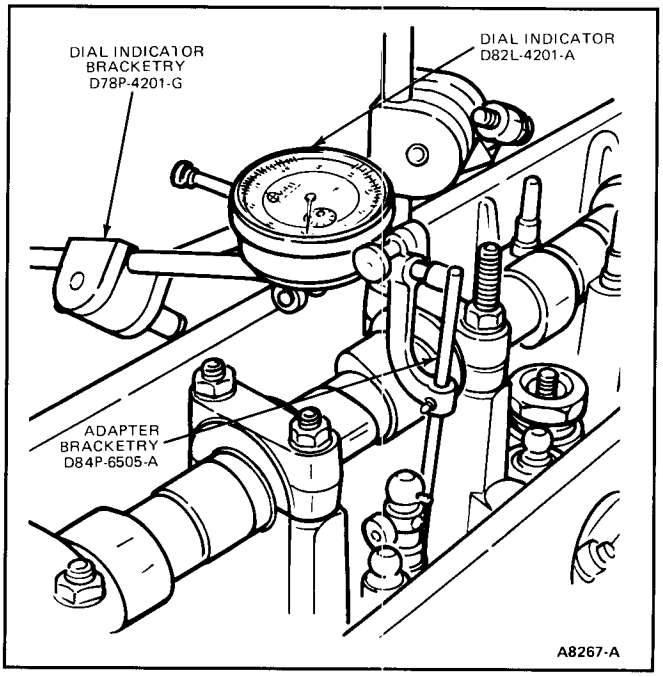


FIG. 66 Valve Stem Clearance Bracketry

NOTE: After guide has been reamed, valve seat must be refaced.

Valve Seat Runout

Check the valve seat runout with Runout Gauge Tool D81P-6002-E or equivalent (Fig. 69). Follow the instructions of the gauge manufacturer. If the runout exceeds the service limit, reface the valve and valve seat.

Valve Seats, Refacing

Grind the valve seats to the angles shown in Fig. 70. Remove only enough stock to clean up pits and grooves or to correct the valve seat runout. After the seat has been refaced, use a seat width scale or a machinist scale to measure the seat width (Fig. 71). Narrow the seat, if necessary to bring it within specifications (Fig. 70).

If the valve seat width exceeds the maximum limit, remove enough stock from the top edge and/or bottom edge of the seat to reduce the width to specification.

The finished valve seat should contact the approximate center of the valve face. It is good practice to determine where the valve seat contacts the face. To do this, coat the seat with Prussian blue and set the valve

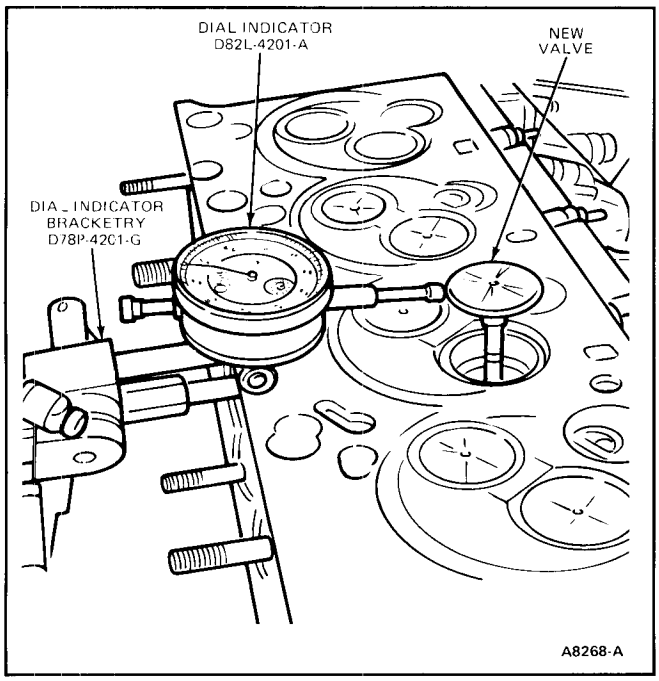


FIG. 67 Valve Guide Wear Check

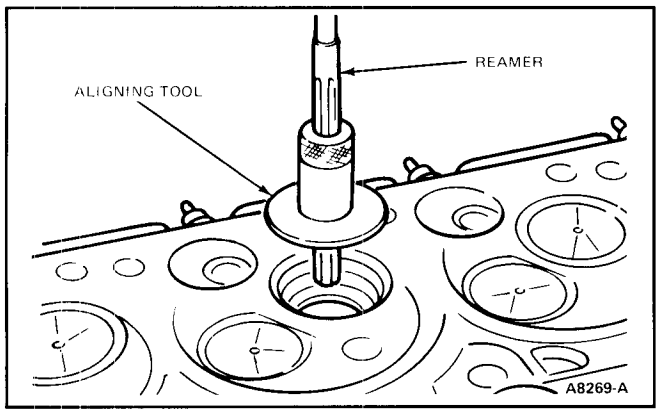


FIG. 68 Reaming Valve Guide

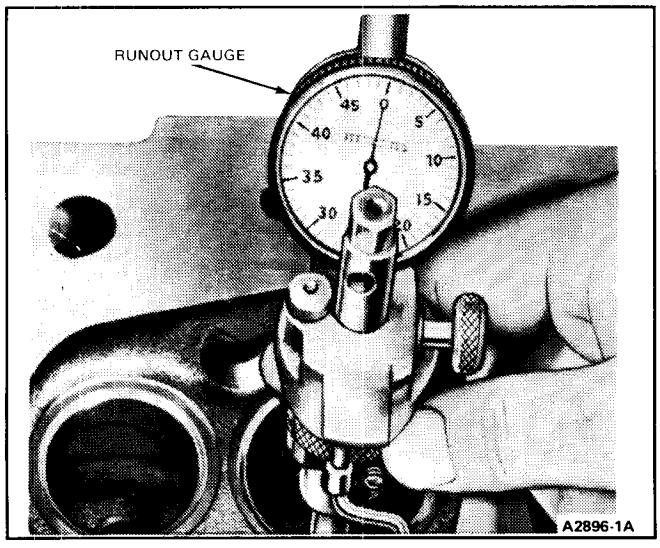


FIG. 69 Valve Seat Runout Check

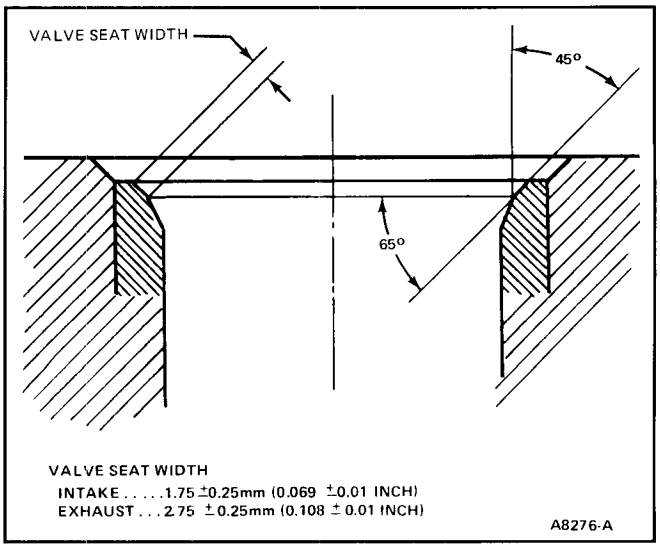


FIG. 70 Valve Seat, Refacing

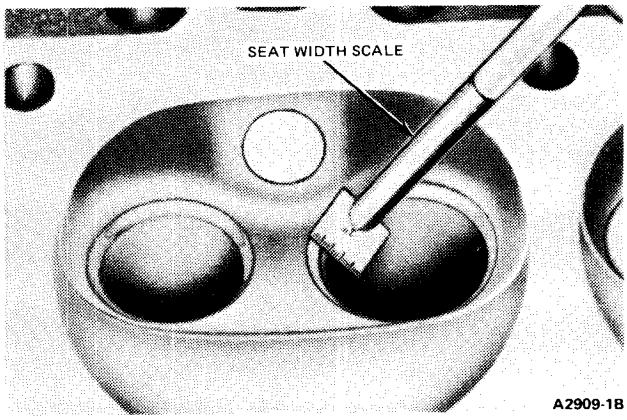


FIG. 71 Valve Seat Width Check

in place. Rotate the valve with light pressure. If the blue is transferred to the center of the valve face, the contract is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat. If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

Valves

Check critical valve dimensions (Fig. 72). Minor pits, grooves, etc., cannot be removed. Discard valves that are severely damaged, or if the valve stem clearance exceeds specification.

Discard any worn or damaged valve train parts. Valves may not be refaced.

If the valve seat has been refaced, the depth (or R) (Fig. 73) of the valve in the cylinder head must be checked.

Dimension R:

Intake: 0.55 to 0.75mm (0.022 to 0.029 inch).

Exhaust: 0.75 to 0.95mm (0.029 to 0.037 inch).

If dimension R exceeds specification, replace valve.

Valve Spring Pressure

Check the springs for proper pressure (Fig. 74) at the specified spring lengths using TOOL-6513-DD or equivalent. If the pressure of any spring is lower than the service limit, replace the spring.

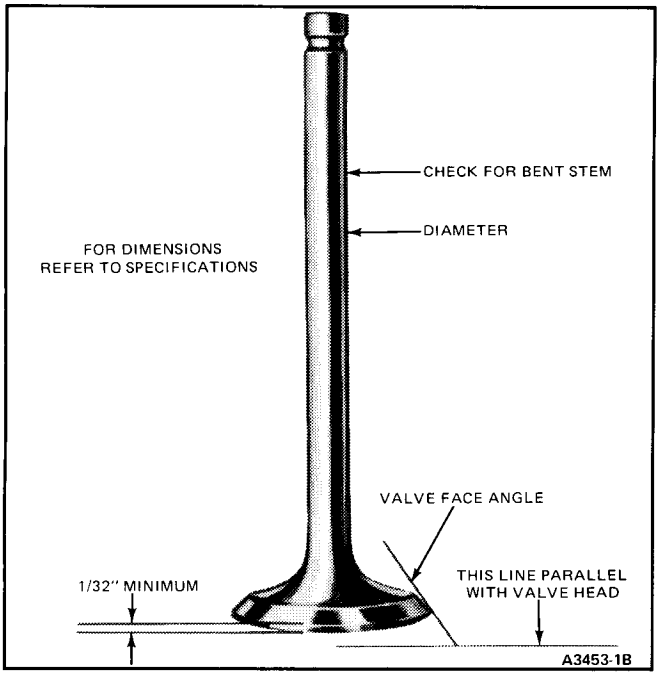


FIG. 72 Critical Valve Dimensions—Typical

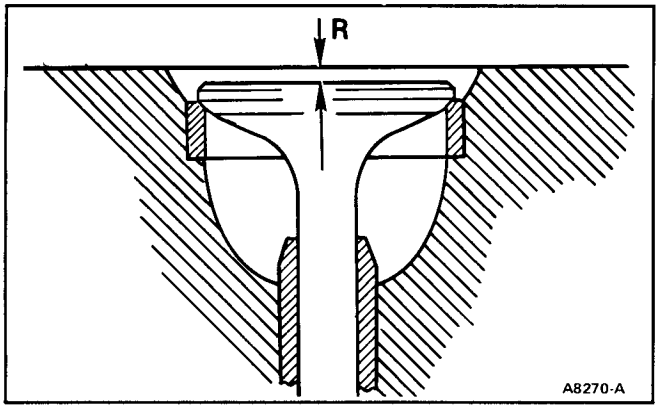


FIG. 73 Dimension R

Valve Spring Squareness

Check spring for squareness using a steel square and a surface plate (Fig. 75). Stand the spring and square on end on the surface plate. Slide the spring up to the square. Rotate the spring slowly and observe the space between the top coil of the spring and square. If the spring squareness exceeds 1.58mm (0.0622 inch), replace it.

Follow the same procedure to check new valve springs before installation.

Make certain the proper spring is installed.

Intake Manifold

Cleaning

Remove all gasket material from the machined surfaces of the manifold. Clean the manifold in a suitable solvent and dry it with compressed air.

Inspection

Inspect the manifold for cracks, nicked gasket surfaces, or other damage that would make it unfit for further service. **Remove all filings and foreign matter that may have entered the manifold as a result of service.**

Exhaust Manifolds

Cleaning

Remove all gasket material from the manifold.

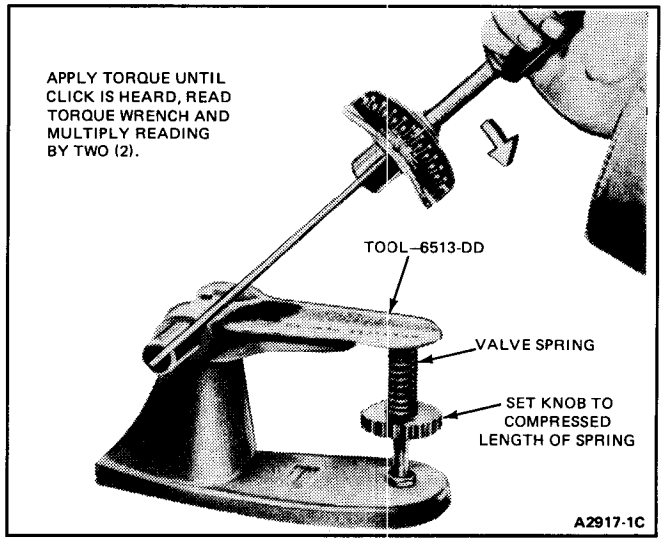


FIG. 74 Valve Spring Pressure Check

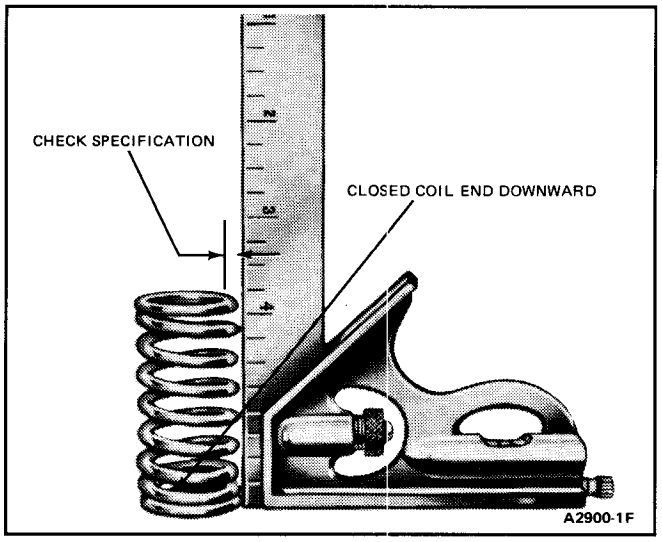


FIG. 75 Valve Spring Squareness Check

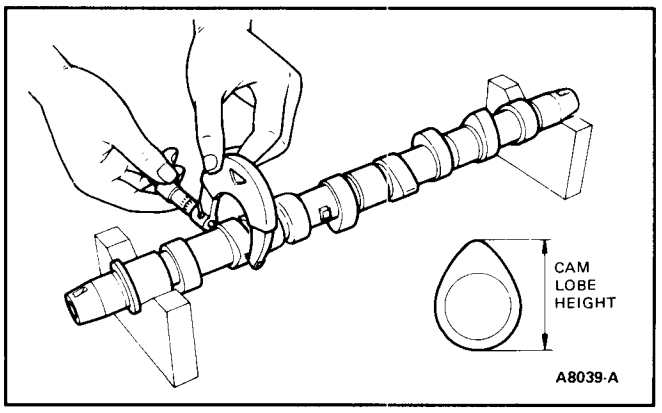


FIG. 76 Measuring Cam Lobe—Typical

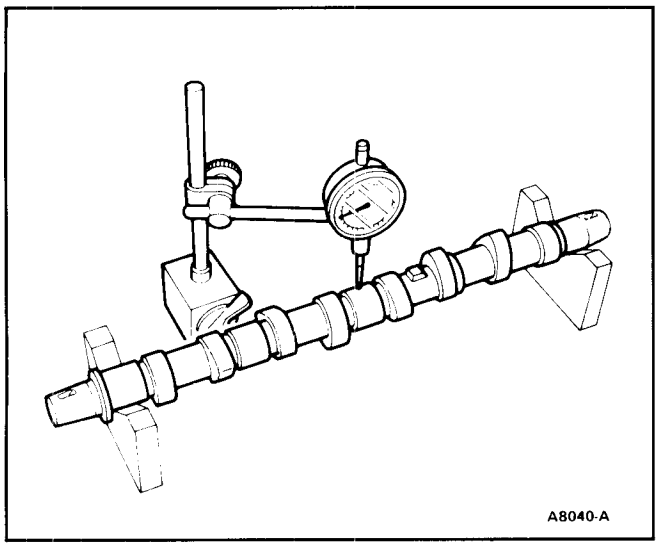


FIG. 77 Measuring Camshaft Runout—Typical

Inspection

Inspect the manifold for cracks, damaged gasket surfaces, or other wear or damage that would make it unfit for further service. Inspect the cylinder head joining flanges of the exhaust manifold for evidence of exhaust gas leaks.

Camshaft

Cleaning

Clean the camshaft in solvent and wipe it dry. Inspect the camshaft lobes for scoring and signs of abnormal wear. Lobe wear characteristics may result in pitting in the general area of the lobe toe. This pitting is not detrimental to the operation of the camshaft. Remove pitting with a smooth oil stone. Be careful not to deform the original shape of the cam lobe.

Inspection

Measure cam lobe height (Fig. 76). Replace camshaft if lobe wear has exceeded specification.

Intake: 43.900mm (1.7284 inch).

Exhaust: 44.900mm (1.7677 inch).

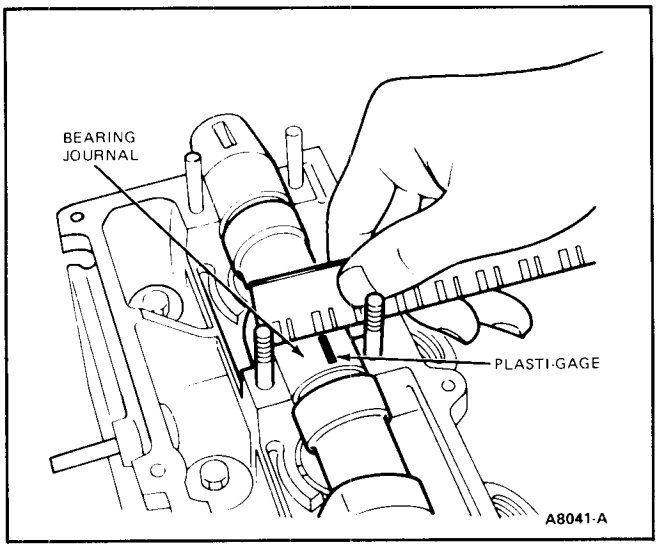


FIG. 78 Camshaft Oil Clearance Measurement

Measure camshaft bearing journals. Replace camshaft if any journal has exceeded 31.959-31.975mm (1.2582-1.2589 inch).

Support both ends of camshaft on V-blocks and measure journal runout (Fig. 77). Replace camshaft if runout exceeds 0.10mm (0.0039 inch).

Measuring Camshaft Oil Clearance

NOTE: Before performing this procedure, be sure camshaft bearing journals are within specification. Refer to Camshaft Inspection.

1. Install camshaft and bearing caps as outlined.

   CAUTION: Steps 2, 3 and 4 must be performed on one bearing at a time.

2. Remove bearing cap. Position a piece of plastigage on top of the bearing journal, in-line with the camshaft.
3. Install bearing cap and tighten to 20-27 N·m (15-19 lb-ft).
4. Remove bearing cap and measure the oil clearance (Fig. 78). Clearance should not exceed 0.1mm (.0039 inch).
5. If oil clearance is within specification, proceed to the next bearing. Repeat Steps 2, 3 and 4 for each bearing, one bearing at a time. If the oil clearance for any bearing exceeds specification, replace the cylinder head and bearing caps.

Crankshaft

Cleaning

Handle the crankshaft with care to avoid possible fractures or damage to the finish surfaces. Clean the crankshaft with solvent, and blow out all oil passages with compressed air.

Inspection

Inspect the main and connecting rod journals for cracks, scratches, grooves or scores.

Measure the diameter of each journal at least four places to determine out-of-round, taper or undersize conditions (Fig. 79).

Dress minor scores with an oil stone. If the journals are severely marred or exceed the service limit, the crankshaft must be replaced.

Main and Connecting Rod Bearing

Cleaning

Clean the bearing inserts and caps thoroughly in solvent, and dry them with compressed air. **Do not scrape gum or varnish deposits from bearing shells.**

Inspection

Inspect each bearing carefully. Bearings that have a scored, chipped, or worn surface should be replaced. Typical examples of bearings that should be replaced and the causes are shown in Fig. 80. The copper-lead bearing base may be visible through the bearing overlay in small localized areas. This may not mean that the bearing is excessively worn. **It is not necessary to replace the bearing if the bearing clearance is within recommended limits.** Check the clearance of bearings that appear to be satisfactory with Plastigage or its equivalent. Fit new bearings.

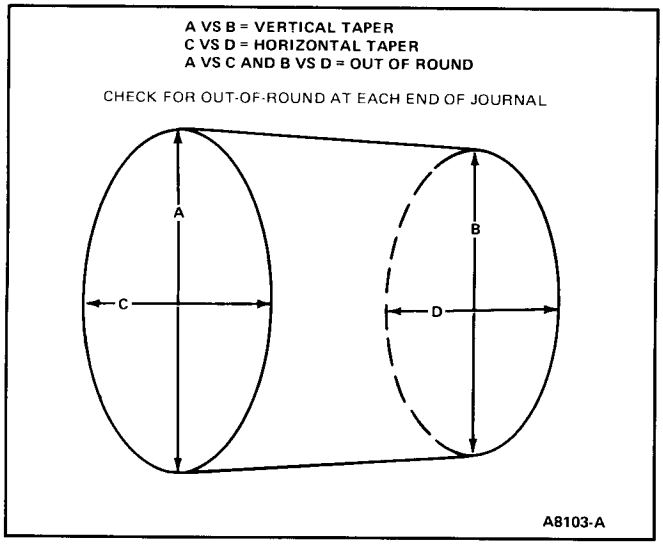


FIG. 79 Crankshaft Journal Measurement

Fitting Main or Connecting Rod Bearings With Plastigage

1. Clean crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pick-up that would cause premature bearing wear. When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance.
2. If fitting a main bearing, position a jack under counterweight adjoining bearing which is being checked. **Do not place jack under front post of crankshaft.** Support crankshaft with jack so its weight will not compress Plastigage and provide an erroneous reading.

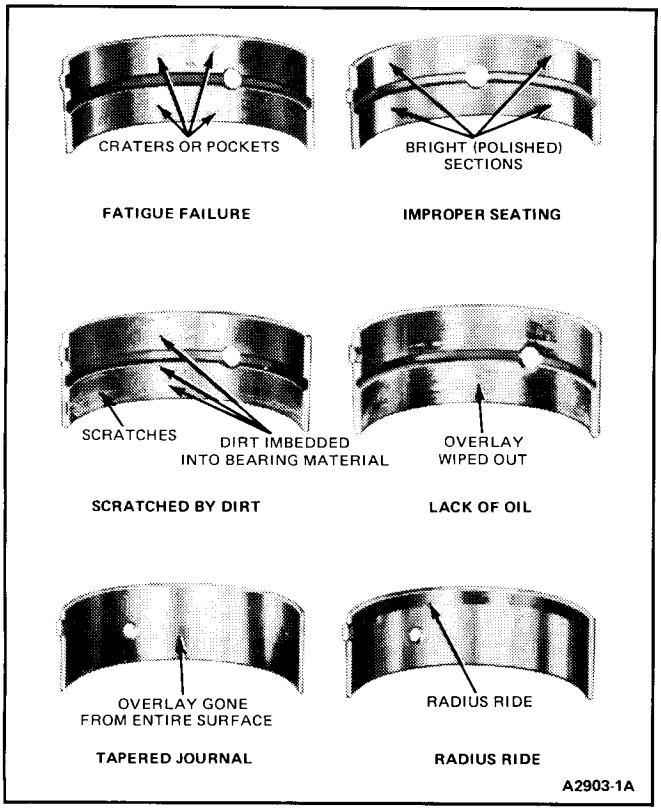


FIG. 80 Bearing Failures—Typical

3. Place a piece of Plastigage or its equivalent, on bearing surface across full width of bearing cap and about 6.35mm (1/4-inch) off center (Fig. 81).
4. Install cap and tighten bolts to specification. Do not turn crankshaft while Plastigage is in place.
5. Remove cap. Using Plastigage scale, check width of Plastigage at widest point to get minimum clearance (Fig. 81). Check at narrowest point to get maximum clearance. Difference between readings is taper of journal.
6. After bearing has been fitted, apply light coat of engine oil to journal and bearings. Install bearing cap. Tighten cap bolts to specification.
7. Repeat procedures for remaining bearings that require replacement.

Connecting Rods

Cleaning

Remove the bearings from the rod and cap. Identify the bearings if they are to be used again. Clean the connecting rod in solvent, including the rod bore and the back of the inserts. **Do not use a caustic cleaning solution. Blow out all passages with compressed air.**

Inspection

The connecting rods and related parts should be carefully inspected and checked for conformance to specifications. Various forms of engine wear caused by these parts can be readily identified.

A shiny surface on the pin boss side of the piston usually indicates that a connecting rod is bent or the piston hole is not in proper relation to the piston skirt and ring grooves.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, an improperly machined journal, or tapered connecting rod bore.

Twisted connecting rods will not create an easily identifiable wear pattern, but badly twisted rods will disturb the action of the entire piston, rings, and connecting rod assembly and may be the cause of excessive oil consumption.

Inspect the connecting rods for signs of fractures and the bearing bores for out-of-round and taper. If the bore

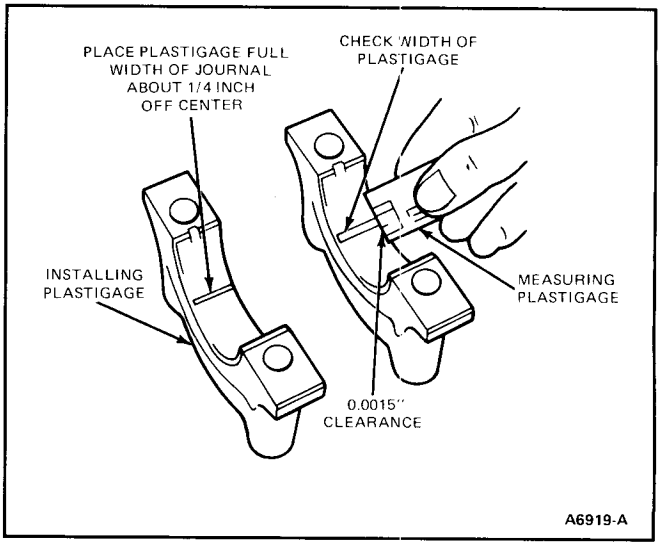


FIG. 81 Installing and Measuring Plastigage

exceeds the recommended limit and/or if the rod is fractured, it should be replaced.

Check the connecting rods for bends or twists on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. If the bend and/or twist exceeds specifications, the connecting rods must be replaced.

Check the ID of the connecting rod piston pin bore. If the pin bore in the connecting rod is larger than specification, replace connecting rod.

It is not necessary to ream or hone the pin bore in the connecting rod. Replace damaged connecting rod nuts and bolts.

Pistons, Pins and Rings

Cleaning

Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins and rings with solvent. **Do not use a caustic cleaning solution or a wire brush to clean pistons.** Clean the ring groove with a ring groove cleaner (Fig. 82). Make sure the oil ring slots (or holes) are clean.

Inspection

Carefully inspect the pistons for fractures at the ring lands, skirts, and pin bosses, and for scuffed, rough, or scored skirts. If the lower inner portion of the ring grooves have high steps, replace the piston. Steps will interfere with ring operation and cause excessive ring side clearance.

A shiny surface on the thrust surface of the piston, offset from the centerline between the piston pin holes, can be caused by a bent connecting rod. Replace pistons that show signs of excessive wear, wavy ring lands or fractures.

Check the piston to cylinder liner clearance by measuring the piston and liner diameters. Refer to the specifications for the proper clearance. Refer to Cylinder Block Inspection in this Section for the bore measurement procedure. **Measure the OD of the piston with micrometer at position H 19mm (0.7480 inch) from bottom edge of skirt and at 90 degrees to the pin bore axis (Fig. 83). Check the ring side clearance following the procedure Fitting Piston Rings.**

Replace piston pins showing signs of fracture, etching or wear. Check the piston pin fit in the piston and rod. Refer to Piston and Connecting Rod Assemblies.

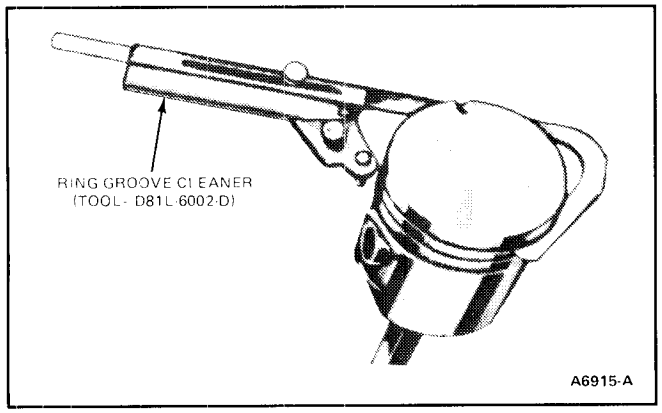


FIG. 82 Piston Ring Grooves—Cleaning

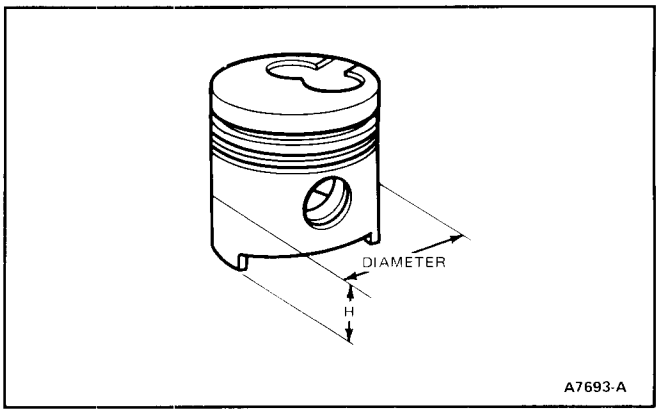


FIG. 83 Piston Diameter Measurement

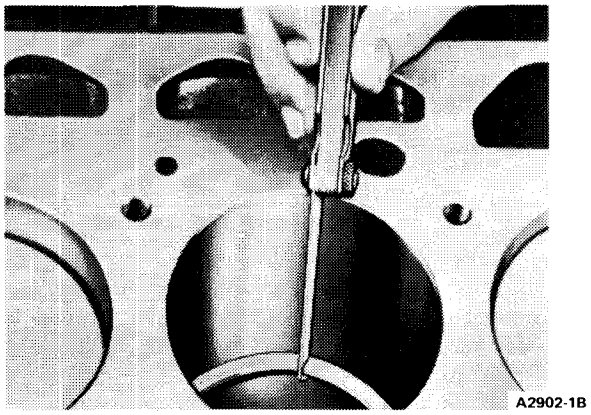


FIG. 84 Piston Ring Gap Check

Check the OD of the piston pin and the ID of the pin bore in the piston. Replace any piston pin or piston that is not within specifications.

Replace all rings that are scored, broken, chipped or cracked. Check the end gap and side clearance (Figs. 84 and 85). It is good practice to always install new rings when overhauling an engine. Rings should not be transferred from one piston to another regardless of mileage.

Fitting Pistons

Pistons are available in standard size or oversize for service.

Measure the cylinder bore, and select the piston to assure the proper clearance.

Measure the piston diameter to ensure that the specified clearance is obtained. It may be necessary periodically to use another piston (within the same grade size) that is either slightly larger, or smaller to achieve the specified clearance.

If none can be fitted, refinish the cylinder to provide the proper clearance for the piston.

When a piston has been fitted, mark it for assembly in the cylinder to which it was fitted.

If the taper, out-of-round and piston to cylinder bore clearance conditions of the cylinder bore are within specified limits, new piston rings will give satisfactory service. **If new rings are to be installed in a used cylinder that has not been refinished, remove the cylinder wall glaze (refer to Cylinder Block,**

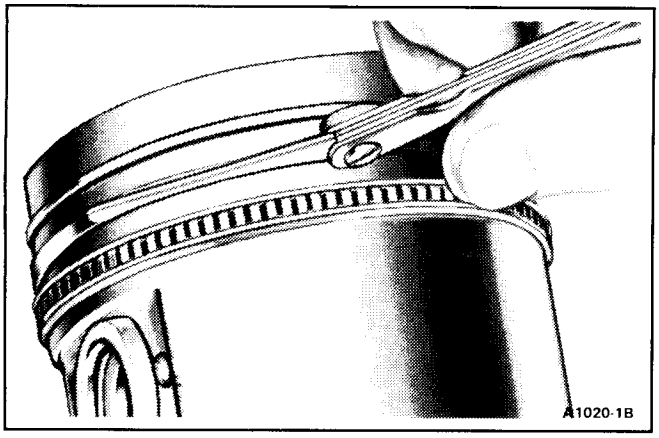


FIG. 85 Piston Ring Side Clearance Check

Refinishing Cylinder Walls). Be sure to clean the cylinder bore thoroughly with soap and water.

1. Calculate the size piston to be used by taking a cylinder bore check.
2. Select the proper size piston to provide the desired clearance (refer to the specifications). Measure the piston diameter in line with the centerline of the piston pin and at 90 degrees to the piston pin axis.
3. Make sure the piston and cylinder block are at room temperature 70°F. After any refinishing and washing operation allow the cylinder bore to cool, and make sure the piston and bore are clean and dry before the piston fit is checked.

Cylinder Block

Cleaning

If the engine is disassembled, thoroughly clean the block in solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs that seal oil passages; then clean out all the passages. Blow out all passages, bolt holes, etc., with compressed air.

Make sure the threads in the cylinder head bolt holes are clean. Dirt in the threads may result in a false torque reading. Use a tap to true-up threads and to remove any deposits.

Inspection

After the block has been thoroughly cleaned, check it for cracks. Minute cracks not visible to the naked eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil. Wipe the part dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. Avoid use of methanol substitute rubbing alcohol. If cracks are present, the coating will become discolored at the cracked area. Replace the block if it is cracked.

Check all machined gasket surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone. Check the cylinder block head gasket surface for distortion with straight edge Rotunda model 014-00319 (D83L-4201-A) or equivalent (Fig. 86). If distortion exceeds specification, the cylinder block must be replaced.

Replace all expansion-type plugs that show evidence of leakage.

Inspect the cylinder walls for scoring, roughness, or other signs of wear. Check the cylinder wall for out-of-round and taper. Measure the wall with an accurate bore gauge following the instructions of the manufacturer. Measure the diameter of each cylinder wall at the top, middle and bottom with the gauge placed at right angles and parallel to the centerline of the engine (Fig. 87). Use only the measurements obtained at 90 degrees to the engine centerline when calculating the piston to cylinder wall clearance.

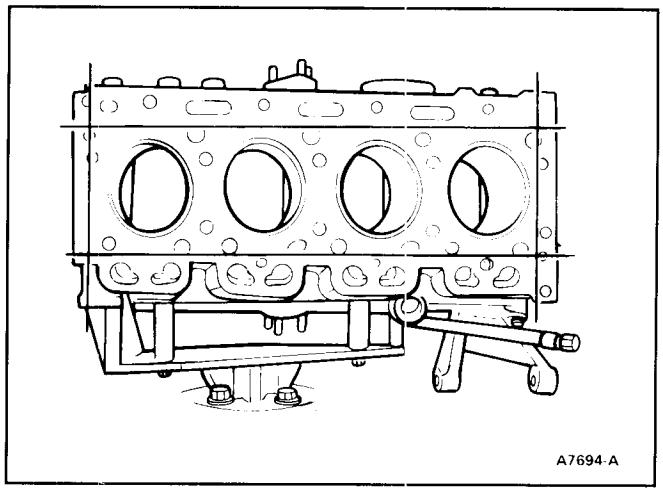


FIG. 86 Check Cylinder Block For Distortion—Typical

Cylinder Walls, Refinishing

Honing is recommended for refinishing cylinder walls only when there is no visible sign of cross hatching (hone pattern) remaining, the walls have minor scuffs or scratches, or for fitting pistons to the specified clearance. The grade of hone to be used is determined by the amount of metal to be removed. Follow the instructions of the hone manufacturer. If coarse stones are used to start the honing operation, leave enough material so that all hone marks can be removed with the finishing hone which is used to obtain the proper piston clearance. Thoroughly clean the cylinder bore walls with detergent and water solution after honing.

Cylinder walls that are severely marred and/or worn beyond the specified limits should be refinished. **Before any cylinder is refinished, all main bearing caps must be in place and tightened to the proper torque, so that the crankshaft bearing bores will not become distorted from the refinishing operation.**

Refinish all cylinders to same size. If any cylinders are worn beyond specification, all cylinders must be refinished to the same size, and all six pistons must be replaced.

Refinish the cylinder with the most wear first to determine the maximum oversize. f the cylinder will not clean up when refinished for the maximum oversize piston recommended, replace the block.

Refinish the cylinder to within approximately 0.038mm (0.0015 inch) of the required oversized diameter. This will allow enough stock for the final step of honing so that the correct surface finish and pattern are obtained.

For the proper use of the refinishing equipment, follow the instructions of the manufacturer. Only experienced personnel should be allowed to perform this work.

Use a motor-driven, spring pressure-type hone at a speed of 300-500 rpm. Hones of grit sizes 180-220 will normally provide the desired bore surface finish. When honing the cylinder bores, use a lubricant mixture of equal parts of kerosene and SAE No. 20 motor oil.

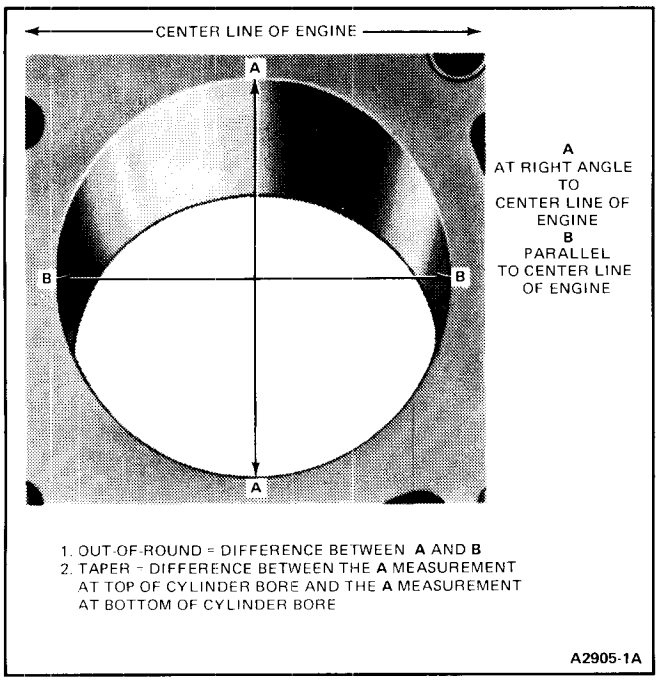


FIG. 87 Cylinder Bore Out-of-Round and Taper

Operate the hone in such a way as to produce a cross-hatch finish on the cylinder bore. The cross-hatch pattern should be at an angle of approximately 30 degrees to the cylinder bore.

After the final operation and prior to checking the piston fit, thoroughly clean the cylinder walls with detergent and water solution, dry thoroughly and oil the cylinder walls. Mark the pistons to correspond to the cylinders in which they are to be installed. When the refinishing of all cylinders that require it has been completed and all pistons are fitted, thoroughly clean the entire block and oil the cylinder walls.

Repairing Engine Castings Having Sand Holes or Being Porous

Porosity or sand hole(s) which will cause oil seepage or leakage can occur with modern casting processes. A complete inspection of engine and transmission should be made. If the leak is attributed to the porous condition of the cylinder block or sand hole(s), repairs can be made with metallic plastic (Epoxy Resin) (C6AZ-19554-A or an equivalent metallic plastic). **Do not repair cracks with this material. Repairs with this metallic plastic (Epoxy Resin) must be confined to those cast iron engine component surfaces (Fig. 88) where the inner wall surface is not exposed to engine coolant pressure or oil pressure.** For example:

a. Cylinder block surfaces extending along the length of the block, upward from the oil pan rail to the cylinder water jacket but not including machined areas.

b. Lower rear face of the cylinder block.

c. Intake manifold casting.

d. Cylinder head, along the rocker arm cover gasket surface.

The following procedures should be used to repair porous areas or sand holes in cast iron.

1. Clean the surface to be repaired by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut the hole or porosity to a greater depth than the rest of the cleaned surface. Solid metal must surround the hole. Openings larger than 6.35mm (1/4-inch) should not be repaired using metallic plastic (Epoxy Resin). Openings in excess of 6.35mm (1/4-inch) can be drilled, tapped and plugged using common tools. Clean the repair area thoroughly. Metallic plastic will not stick to a dirty or oily surface.

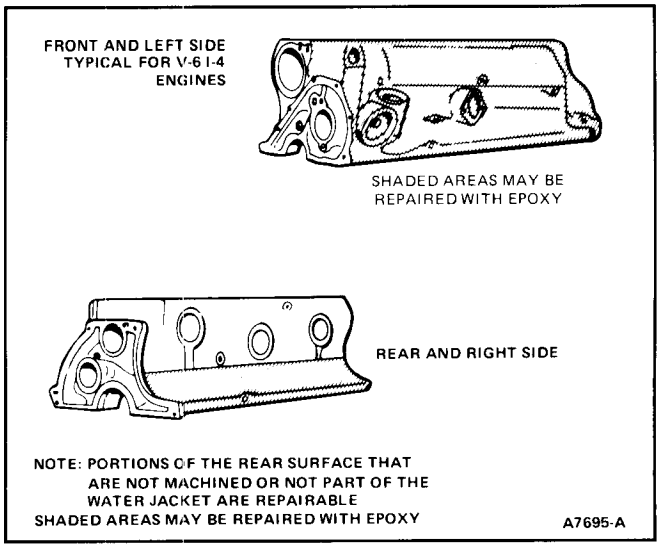


FIG. 88 Typical Cast Iron Cylinder Block Areas Repairable with Metallic Plastic (Indicated by Shaded Areas)

2. Mix the Epoxy Resin 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 metallic plastic into the hole or porosity.

4. Allow the repair mixture to harden. This can be accomplished by 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 to blend with the general contour of the surrounding surface.

6. Paint the surface to match the rest of the block.

Flywheel

Inspection

Inspect the flywheel for cracks, heat checks, or other damage that would make it unfit for further service.

Inspect the ring gear for worn, chipped, or cracked teeth. If the teeth are damaged, replace the ring gear.

With the flywheel installed on the crankshaft, check the flywheel face runout, following the procedure under Diagnosis and Testing in this Section.

Oil Pan

Cleaning

Scrape any dirt or metal particles from the inside of the pan. Scrape all old gasket material from the gasket surface. Wash the pan in a solvent and dry it thoroughly.

Inspection

Check the pan for cracks, holes, and damaged drain plug threads. Check the gasket surface for damage caused by over-tightened bolts. Straighten the surface as required to restore original flatness.

Replace the pan if repairs cannot be made.

Oil Pump

Cleaning

Wash all parts in a solvent and dry them thoroughly with compressed air. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Be sure all dirt and metal particles are removed.

Inspection

Refer to Specifications for clearances and service limits.

Check the inside of the pump housing and the gears for damage or excessive wear or scoring.

Check the mating surface of the pump cover for wear. If the cover mating surface is worn, scored or grooved, replace the pump.

Measure the gear tip clearance.

With the gear assembly installed in the housing, place a straight edge over the gear assembly and the housing. Measure the clearance (gear end play) between the straight edge and the gears.

Detail components of the oil pump are not serviced. If any part of the oil pump requires replacement, replace the entire pump assembly.

Inspect the relief valve spring for a collapsed or worn condition. Check the relief valve spring tension.

Check the relief valve piston for scores and free operation in the bore.

Oil Pump Bearing

Replacement

1. Remove injection pump as outlined.
2. Remove oil pump driveshaft.
3. Remove top oil pump bearing cover.
4. Remove oil pump as outlined.
5. Pull top and bottom oil pump bearing out using Tools D80L-100-G and D80L-100-M or equivalent.
6. Replace bearings using Tool T84P-6603-A or equivalent (Fig. 89).
7. Install oil pump as outlined.
8. Install top oil pump bearing cover.
9. Install oil pump driveshaft.
10. Install injection pump as outlined.

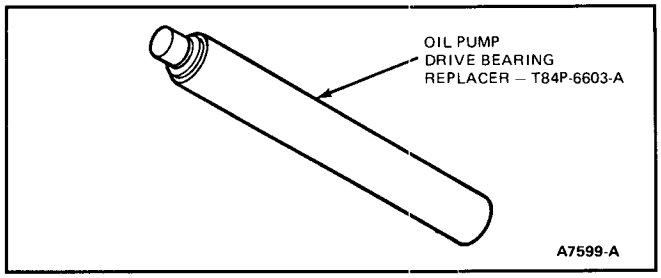


FIG. 89 Oil Pump Drive Bearing Replacer

SPECIFICATIONS

ENGINE	
Type	6-cylinder, in-line, 4-cycle, overhead valve, water-cooled
Bore	3.150 in (80mm)
Stroke	3.189 in (81mm)
Displacement	149 cu in (2442.9 cc)
Compression ratio	23:1
Horsepower	114 (85 kw) at 4800 rpm
Minimum Torque	150 lb ft (210 N•m) at 2400 rpm
Compression pressure	348 psi (2400 kPa)
Valve clearance (cold engine)	Intake: 0.010 in (0.3mm)
	Exhaust: 0.010 in (0.3mm)
Cam Timing	
Intake valve opens	6° BTDC
Intake valve closes	34° ABDC
Exhaust valve opens	46° BBDC
Exhaust valve closes	6° ATDC
Intake valve lift	0.374 in (9.5mm)
Exhaust valve lift	0.376 in (9.55mm)
Weight	433 lbs (196.4 kg) dry
FUEL SYSTEM	
Injection firing order	1 5 3 6 2 4
Idle speed	750 + 50 – 0 rpm
Fast idle (cold-start) speed	900-1050 rpm
Injection pump timing	2.5° BTDC at 750-800 rpm
LUBRICATION SYSTEM	
Complete System w/o oil cooler	7.1 qts (6.7L)
Complete System	7.9 qts (7.5L)
Engine oil pressure	57-85 psi at 4000 rpm

CA8273-A

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft	Bolt Sizes
Main bearing caps	60-67	43-48	M10×21
Engine support straps	39-47	28-34	M10×21
Valve cover	8-10	6-7	M8×21
Oil trap to valve cover	15-19	11-14	M8×21
Cylinder head bolts			M11×21
Step 1	50-60 wait 15 min.	36-43	
Step 2	90-95 run warm about 15 min.	65-69	
Step 3 (torque angle)		90 ± 5°	
Oil spray bar to cylinder head	20-24	14-17	M8×21
Oil drain plug	33-36	24-26	M12×21
Oil pan to crankcase	9-10	6.5-7	M6×21
Front/rear end covers to crankcase	8-10 20-24	6-7 14-17	M6×21 M8×21
Flywheel to crankshaft (installed with Loctite No. 270)	98-112	71-81	M12×21
Vibration damper hub to crankshaft	390-430	282-311	M18×21
Pulley/vibration damper to vibration damper hub	22-24	16-17	M8×21
Connecting rod bolts			M21
Step 1	20	14	
Step 2 (torque angle)		70°	
Sprocket to camshaft	55-65	40-47	M10.9×21
Bearing cap of camshaft	8-10 20-24	6-7 14-17	M6×21 M8×21
Tensioning roller holder to crankcase	20-24	14-17	M8×21
Clamping bolt in rocker arm	7-9	5-6.5	M6×21
Sprocket to auxiliary shaft	55-65	40-47	M10.9×21
Oil pressure switch	30-40	22-29	M21
Oil pump to crankcase	22-24	16-17	M8×21
Oil pump cover	8-10	6-7	M6×21
Oil filter housing to crankcase	20-24	14-17	M8×21
Oil filter cover	21-25	15-18	M8×21
Oil filter drain plug	10-13	7-9	M12×21
Oil spray jet to crankcase	8-10	6-7	M6×21
Oil cooler oil lines to oil filter housing	30-40	22-29	M21
Oil lines to turbocharger	20-24	14-17	M8×21

Description	N·m	Lb-Ft	Bolt Sizes
Oil line from turbocharger to crankcase 22mm width across flats hollow bolt	40-50	29-36	M16×21
Water pump to crankcase	20-24	14-17	M8×21
Fan coupling to water pump nut with left-hand threads	50	36	M21
Fan to fan coupling	8-10	6-7	M6×21
Pulley to water pump	8-10	6-7	M6×21
Thermostat housing	8-10	6-7	M6×21
Bleeder screw	6-10	4-7	M8×21
Temperature sensor/temperature switch	17-19	12-14	M14×21
Intake manifold to cylinder head	20-24	14-17	M8×21
Exhaust manifold to cylinder head (upper row of staybolts installed with Loctite 270)	20-24	14-17	M8×21
Turbocharger to exhaust manifold	23-27	17-20	M10×21
Exhaust to turbocharger	43-48	31-35	M10×21
Vacuum pump	8-10	6-7	M6×21
Pulse sensor to engine (holder)	8-10	6-7	
Glow plugs	20-30	14-22	
Temperature switch to fuel filter housing	30	22	
Wire to glow plug	4-5	3-4	
Fuel filter housing to holder	43-48	31-35	
Injection pump to holder, rear (nuts and bolts)	20-24	14-17	
Injection pump to holder, front	20-24	14-17	
Electric shut-off to injection pump	15-25	11-18	
Electric valve for cold start accelerator to injection pump	15-20	11-14	
Injection pump gear to injection pump	45-50	33-36	
Tensioning torque for tensioning roller holder	45-50	33-36	
Tensioning roller holder to engine (M8 nut and bolt)	25	18	
Combination fuel injector in cylinder head	40-45	29-33	
Injection line (coupling nut)	20-25	14-18	
Nozzle holder to injection pump	45	33	
Spill valve to injection pump (hollow bolt)	20-30	14-22	

CA8272-A

SPECIAL SERVICE TOOLS

Tool Number	Description	Tool Number	Description
D80L — 100-G	Actuator Pin	T84P — 6316-A	Damper Flange & Pulley Holding Tool
D80L — 100-M	Collet	T84P — 6400-A	TDC Aligning Pin
T67L — 3600-A	Steering Wheel Remover	D84P — 6505-A	Valve Stem Clearance Checking Tool
D78P — 4201-G	Dial Indicator — 1 Inch Travel	T84P — 6513-C	Valve Spring Compressor
D81L — 4201-A	Feeler Gauge	TOOL —6513-DD	Valve/Clutch Spring Tester
D82L — 4201-A	Metric Dial Indicator	D84P — 6564-A	Ball Stud Remover
D83L — 4201-A	Straight Edge	T84P — 6571-B	Valve Stem Seal Replacer
D83L — 500-A	Cylinder Head Holding Fixture	T84P — 6575-A	Valve Clearance Adjusting Wrench
D81L — 6002-C	Piston Ring Compressor	T84P — 6603-A	Oil Pump Drive Bearing Replacer
D81L — 6002-D	Piston Ring Groove Cleaner	T84P — 6701-A	Crankshaft Rear Oil Seal Replacer
D81P — 6002-E	Valve Seat Runout Gauge	T84P — 9000-A	Injector Pump Aligning Pin
T64L — 6011-EA	Cylinder Ridge Reamer	T84P — 9395-B	Fuel System Protector Cap Set
T84P — 6019-B	Crank Front Seal Replacer	T84P — 9396-A	Fuel Line Wrench
T84P — 6020-A	Intermediate Shaft Seal Replacer	T84P — 9527-A	Injector Nozzle Socket
D84P — 6085-A	Valve Guide Service Set Adapters	Rotunda 014-00318	Cylinder Head Holding Fixture
D84P — 6100-A	Piston Height Gauge	Rotunda 014-00319	Straight Edge
D84P — 6136-A	Connecting Rod Installation Guides	Rotunda 014-00320	Feeler Gauge
T84P — 6256-A	Cam Positioning Tool		

CA7598-A

SECTION 25-35 Fuel Pump, Electric

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION AND OPERATION

On the 2.4L diesel, a solenoid-type electric fuel pump is used to transfer fuel from the fuel tank to the engine compartment and also is used to assure pressurized fuel at the mechanical injection pump inlet. The pressure limit provided by this fuel pump will allow for proper fuel metering of the mechanical injection pump.

The fuel pump is located on the LH engine mount between the engine starter motor and the mechanical fuel injection pump (Fig. 1). The diesel fuel lines route fuel from the fuel filter and heater assembly to the inlet of the electric fuel pump. Discharge flow goes directly to the inlet of the mechanical injection pump.

The electric fuel pump is a solenoid type that pulses a plunger at approximately 24 Hz. Proper flow direction and efficiency are assured by two one-way check valves located inside the fuel pump.

With the ignition switch in the Run or Start position, power flows to the fuel pump relay mounted on the LH fender apron (Fig. 2). When the relay closes, power flows from the battery through an 18 gauge fuse link at the starter relay, and turns the fuel pump on.

In the event of an accident, the fuel pump inertia switch (Fig. 3), opens and cuts off power to the fuel pump relay, turning off the fuel pump.

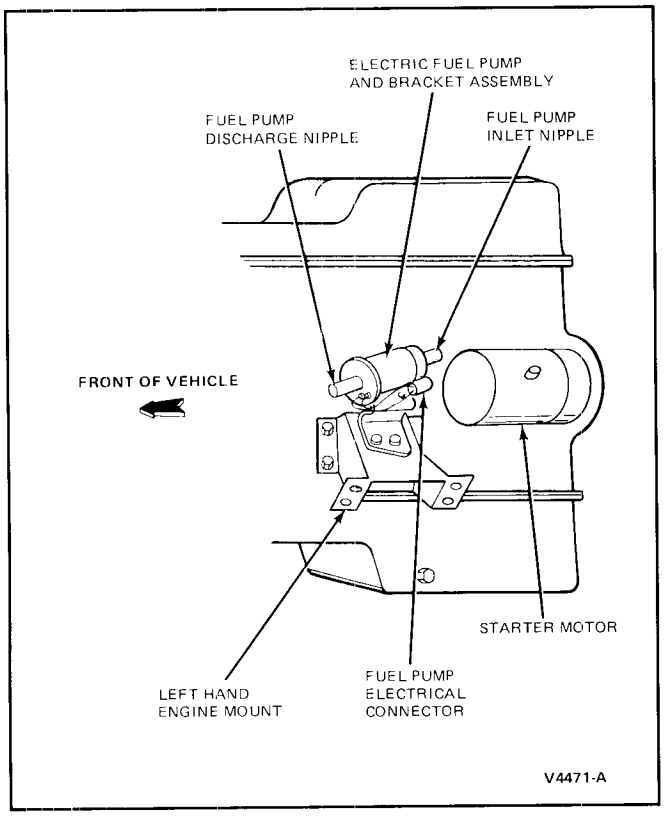


FIG. 1 Electric Fuel Pump Location

DIAGNOSIS

Refer to Fig. 4 and the Diagnostic charts.

REMOVAL AND INSTALLATION

Fuel Pump

Removal

Refer to Fig. 5.

1. Disconnect electric fuel pump electrical connector.
2. Remove hose clamp on inlet and outlet lines and remove hoses from fuel pump.
3. Remove two fuel pump retaining screws and remove fuel pump.

Installation

To install, reverse removal steps. Tighten attaching screw to 11.5-14.9 N·m (9-11 lb-ft).

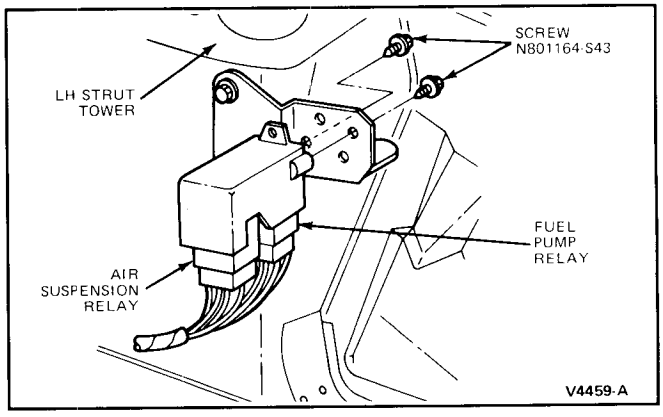


FIG. 2 Fuel Pump Relay—Installation

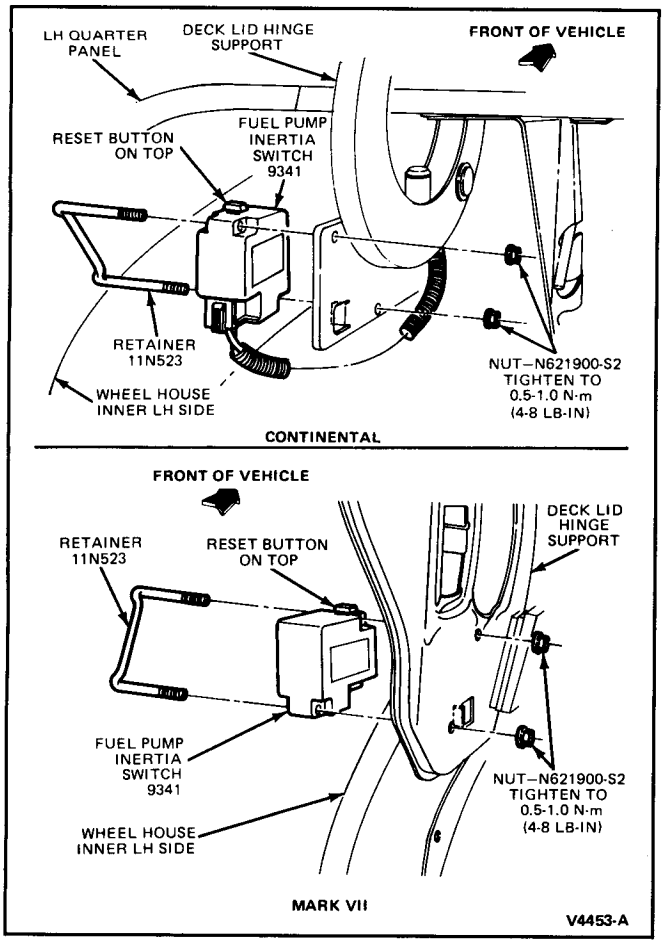


FIG. 3 Fuel Pump Inertia Switch—Installation

SERVICE

Fuel Pump—Cleaning

Due to the precision tolerances of the mechanical injection pump, the inside of the electric fuel pump must be clean of contaminating particles. If the pump becomes contaminated, flush the pump assembly by pumping a petroleum base solvent or diesel fuel through it until internal cleanliness is assured.

Fuel System Priming

The fuel pump is not intended to be a fuel system priming pump; however the pump can be used to help prime the fuel system.

1. Make sure pump plunger and cylinder are lubricated with a film of petroleum based solvent or diesel fuel.
2. Run the pump for two minutes or until the fuel is primed, whichever comes first.

   CAUTION: Do not allow the pump to run for longer than two minutes when priming the fuel system, to prevent damage to the pump.
3. If fuel system does not prime on the first attempt, tap into the pump inlet fuel line and relubricate the plunger/cylinder interface. Reconnect the fuel line to the fuel system, and operate pump for another two minutes or until the system is primed.

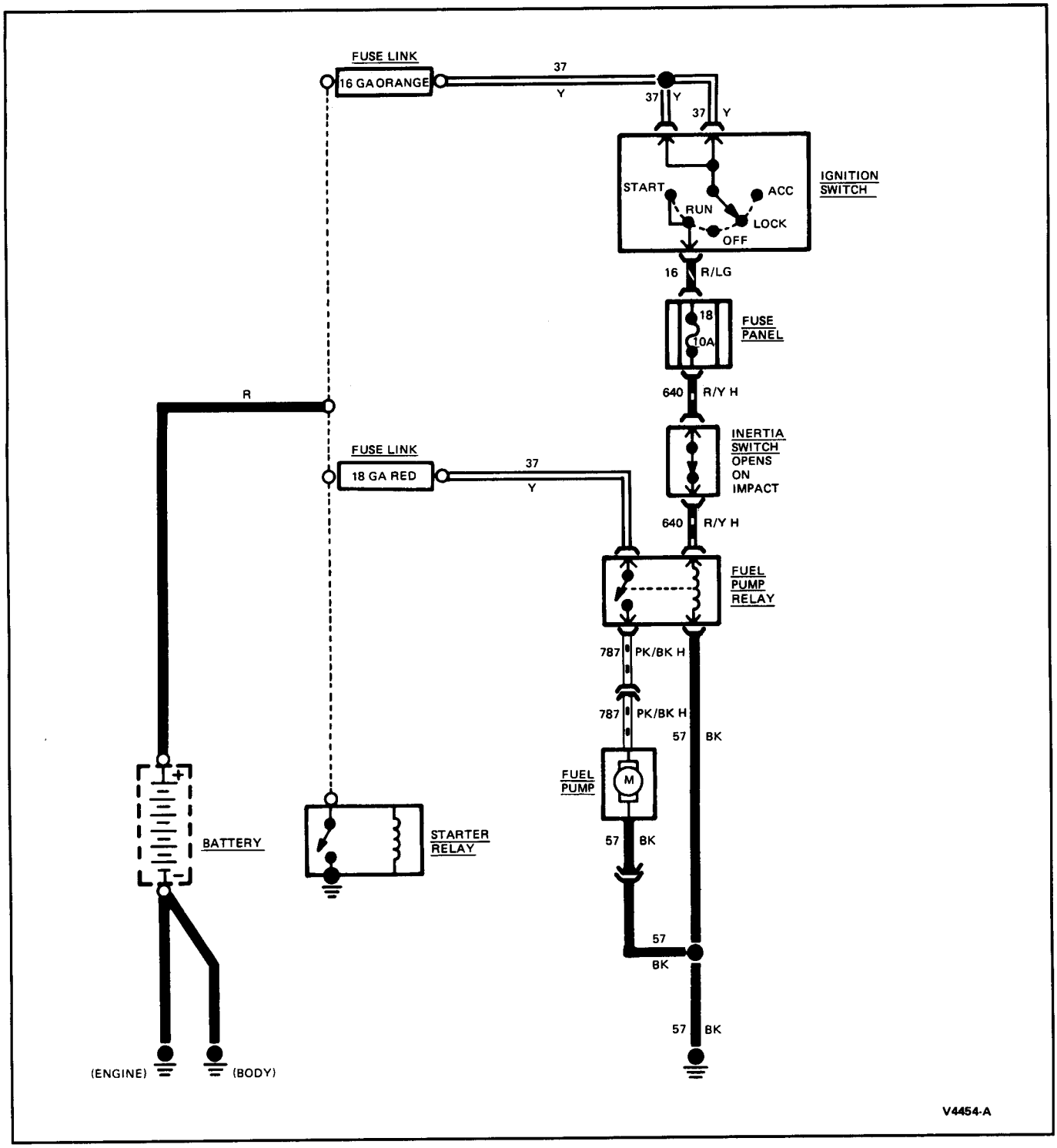


FIG. 4 Wiring Schematic

PUMP DOES NOT OPERATE

TEST STEP		RESULT ▶	ACTION TO TAKE
A1	CHECK FOR VOLTAGE		
• Disconnect electrical connector at fuel pump. • Connect a volt meter to circuit 787 PK/BK H wire. • With the ignition switch in Run, voltmeter should indicate battery voltage.		(OK) ▶ (OK) ▶	GO to **A2**. GO to **A3**.
A2	CHECK GROUND		
• Using an ohmmeter, check for continuity between circuit 57 BK at fuel pump connector and a good ground.		(OK) ▶ (OK) ▶	REPLACE fuel pump. CHECK fuel pump operation. SERVICE circuit 57BK between fuel pump and ground on LH fender apron. CHECK fuel pump operation.
A3	CHECK CIRCUIT 640 R/Y H		
• With ignition switch in Run, check for battery voltage on circuit 640 R/Y H at fuel pump relay.		(OK) ▶ (OK) ▶	GO to **A7**. GO to **A4**.
A4	CHECK FUSE		
• With ignition switch in Run, check for battery voltage at Fuse 18 in the fuse panel.		(OK) ▶ (OK) ▶	GO to **A5**. REPLACE fuse. CHECK fuel pump operation.
A5	CHECK INERTIA SWITCH		
• With an ohmmeter, check for continuity across inertia switch in luggage compartment.		(OK) ▶ (OK) ▶	SERVICE circuit 640 R/Y H between inertia switch and fuel pump relay. CHECK fuel pump operation. GO to **A6**.
A6	RESET INERTIA SWITCH		
• Reset inertia switch button. • Check for continuity across inertia switch.		(OK) ▶ (OK) ▶	REPEAT Test Step **A3**. REPLACE inertia switch. CHECK fuel pump operation.

CV4455-A

PUMP DOES NOT OPERATE

TEST STEP		RESULT ▶	ACTION TO TAKE
A7	CHECK CIRCUIT 37 Y		
• Check for battery voltage on circuit 37 Y at fuel pump relay.		(OK) ▶	GO to **A8**.
		(OK) ▶	SERVICE circuit 37 Y and/or fuse link between starter relay and fuel pump relay. CHECK fuel pump operation.
A8	CHECK RELAY GROUND 57 BK		
• With ignition switch in Run, jumper between 57 BK wire at fuel pump relay and a good ground. • Fuel pump should operate.		(OK) ▶	SERVICE circuit 57 BK between fuel pump relay and ground on LH fender apron. CHECK pump operation.
		(OK) ▶	REPLACE fuel pump relay. CHECK fuel pump operation.

CV4456-A

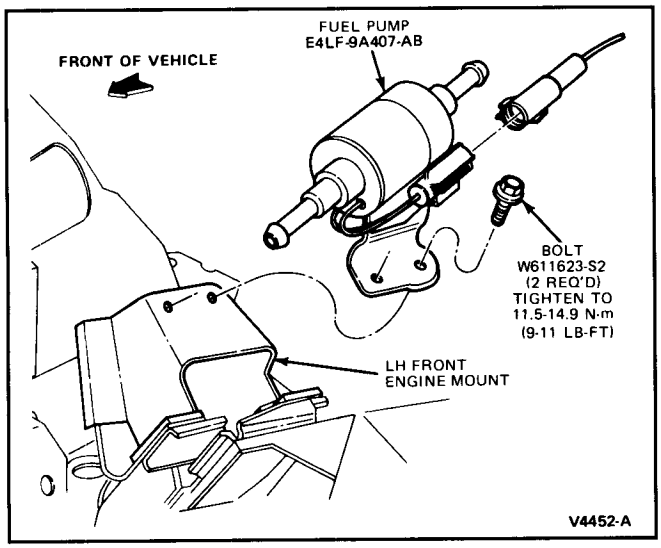


FIG. 5 Electric Fuel Pump Installation

SECTION 25-41 Air Cleaner and Duct System—Diesel

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The 2.4L diesel engine is equipped with a dry type air cleaner with replaceable air filter element. The air cleaner assembly is mounted on the left front fender apron. The fresh air intake tube is connected to the air cleaner assembly on one side and intakes air through an opening in the RH fender apron. On the other side, the air cleaner assembly is connected to the turbocharger by the air cleaner outlet tube (Fig. 1).

REMOVAL AND INSTALLATION

Air Filter Element

Refer to Section 50-29 for the Emissions Systems Maintenance Schedule for frequency of filter inspection and/or maintenance.

Removal

1. Unfasten two air cleaner cover retaining clips (Fig. 1).
2. Push the inboard half of the housing towards the engine.
3. Remove the air filter element.

Inspection

Visually inspect the element and the air cleaner cover and body for signs of dust or dirt leaking through holes in the filter element or past the end seals. Any hole in the element, even the smallest, is cause for replacement. Also check the element for deformed seals or for charred (burned) or brittle spots that could fail under engine operating vibration and cause a hole. Discoloration only is not a cause for replacement.

Installation

1. Wipe all inside surfaces of the air cleaner tray and cover. Install the air filter element (Fig. 1).
2. Install the air cleaner housing and ensure that it is properly positioned.
3. Fasten the retaining clips.

Air Cleaner Assembly

Removal

Refer to Fig. 1.

1. Remove oil separator hose from air cleaner housing.
2. Loosen clamp retaining the air duct bellows to the turbocharger and disengage bellows from turbocharger.
3. Cap turbocharger air intake using Protective Cap Set, T84P-9395-B or equivalent.
4. Remove the two screws attaching air cleaner assembly to the right fender apron.
5. Tilt air cleaner assembly inward toward the engine and lift to remove from vehicle.

Installation

1. Position air cleaner assembly to vehicle and install with two screws (Fig. 1).
2. Remove Protective Cap Set, T84P-9395-B or equivalent, from turbocharger air intake and attach air duct bellows to the turbocharger with one clamp.
3. Install oil separator hose to the air cleaner housing.

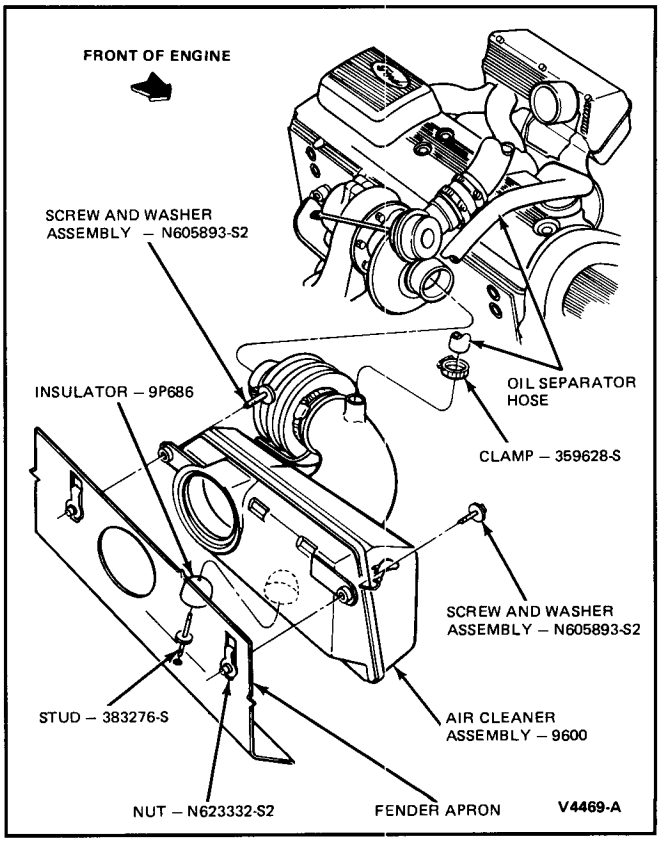


FIG. 1 Air Cleaner Assembly

SECTION 25-45 Turbocharger—Diesel

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The 2.4L turbocharged diesel engine offers improved performance without penalty to fuel economy.

The turbocharger boosts gross engine output over normally aspirated engines. The turbocharger is an "on-demand" system that boosts engine output at high-load/high-speed conditions, but has little effect on fuel economy at moderate to light load conditions.

The turbocharger (Figs. 1 and 2) is mounted on the right side of the engine, and is a blow-through type. In a blow-through type turbocharger system, fuel is introduced downstream of the compressor.

CAUTION: The turbocharger operates at high speed. Keep fingers and other objects away from openings to avoid injury.

The turbocharger consists of only five major components (Fig. 3):

1. The PRESSURE REGULATOR is a spring-loaded diaphragm device that senses and controls the pressure from the compressor outlet.
2. The COMPRESSOR is a centrifugal, radial outflow type.
3. The TURBINE is a centripetal, radial inflow type, which drives the compressor.
4. The WASTEGATE ASSEMBLY allows a portion of the exhaust gas to bypass the turbine wheel limiting compressor speed.
5. The CENTER HOUSING supports the bearings, the compressor, turbine wheels and oil seals.

OPERATION

Refer to Fig. 3.

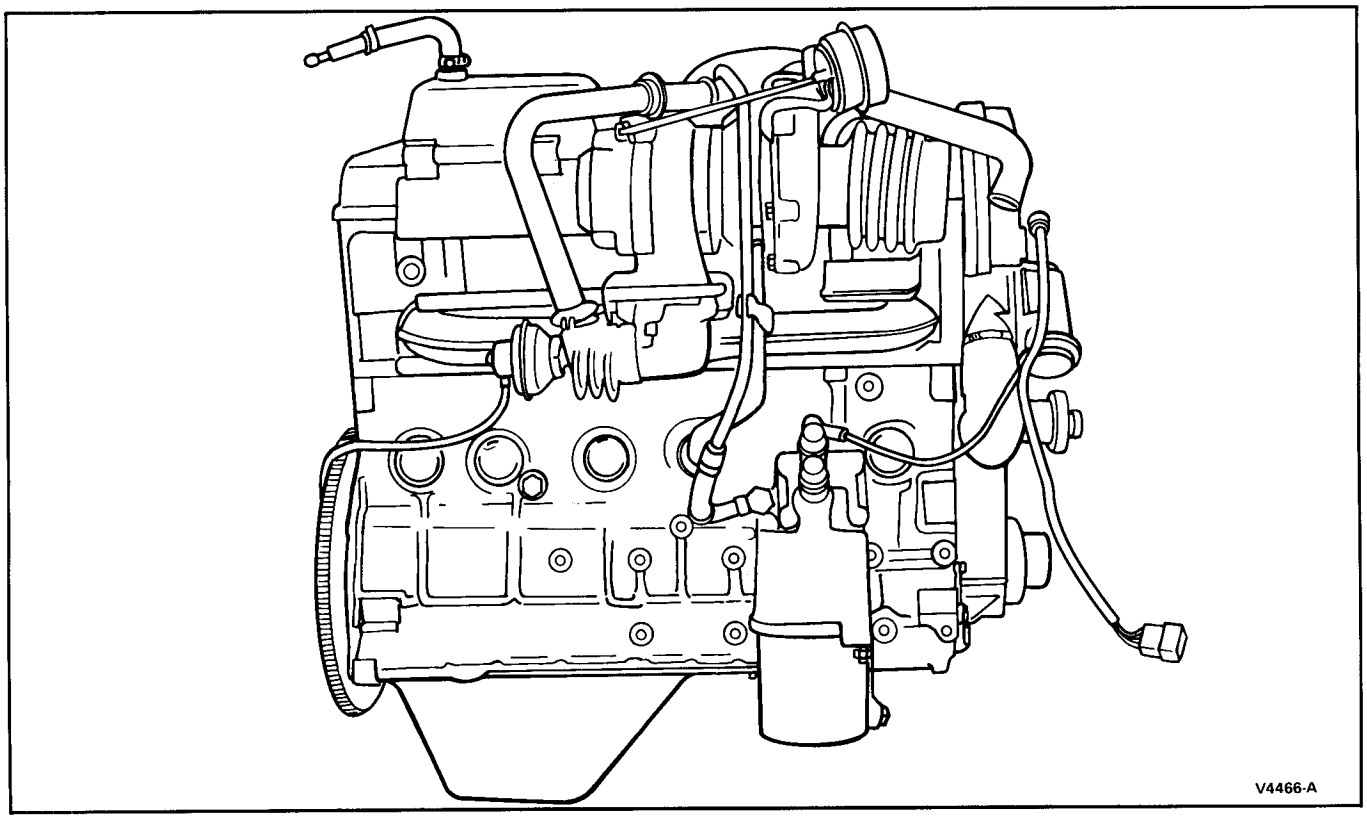


FIG. 1 Turbocharged Engine—Right Side View

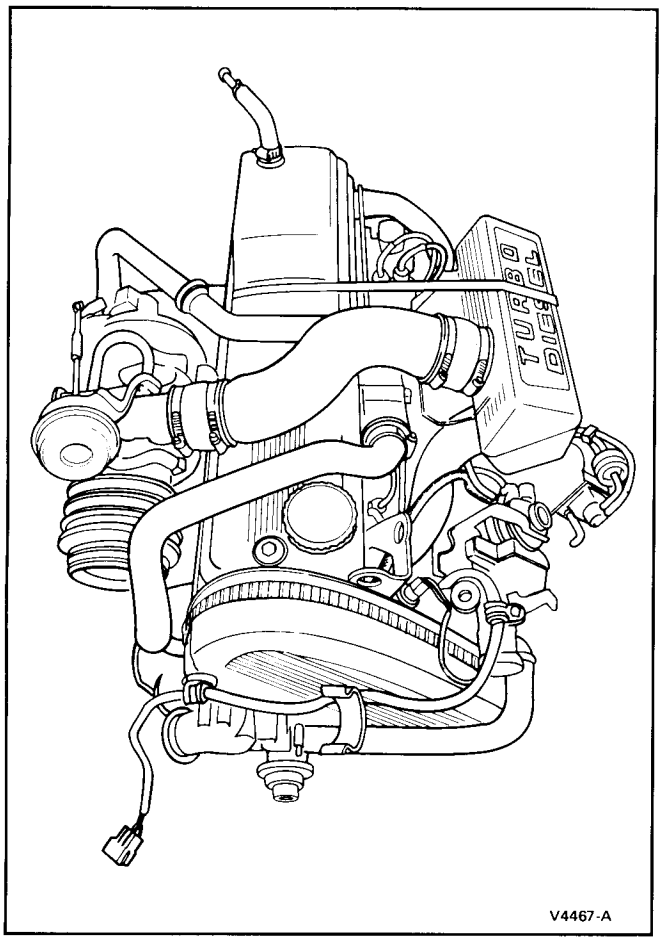


FIG. 2 Turbocharged Engine—Top Front View

A turbocharger is used on the 2.4L diesel engine to improve its efficiency and performance. During operation, the turbine wheel of the turbocharger is driven by exhaust gas flow. The turbine drives a compressor wheel that is on the same shaft. The compressor wheel takes in fresh air, compresses it, and supplies it to the engine. The extra volume of air supplied to the engine is called "boost". The total volume of boost is controlled by a waste gate and pressure regulator.

The pressure regulator contains a diaphragm that is exposed to turbocharger boost, and as pressure increases, the diaphragm will be pushed inward against spring pressure. Attached to the diaphragm is a connecting rod that controls the opening of the waste gate, which limits boost by diverting exhaust gas away from the turbine, and back into the exhaust system. The waste gate should open at approximately 81 kPa (12 psi) and keep turbocharger boost from rising beyond this point.

In the event that the waste gate cannot divert enough exhaust gas away from the turbine, in order to limit boost, or there is a malfunction in the pressure regulator or waste gate, a safety pressure relief valve, (Fig. 4), will divert excess boost to the atmosphere. It is located on the bottom of the intake manifold plenum, and will open when turbocharger boost reaches approximately 90 kPa (13 psi). The safety pressure relief valve is hooked into the "check engine" circuit and will cause this lamp to come on when the valve opens, indicating an overboost condition. The lamp will go out when boost goes below 90 kPa (13 psi) and the valve closes.

LUBRICATION

The turbocharger is supplied with oil from the engine oil circuit. It is extremely important that oil flow to and from

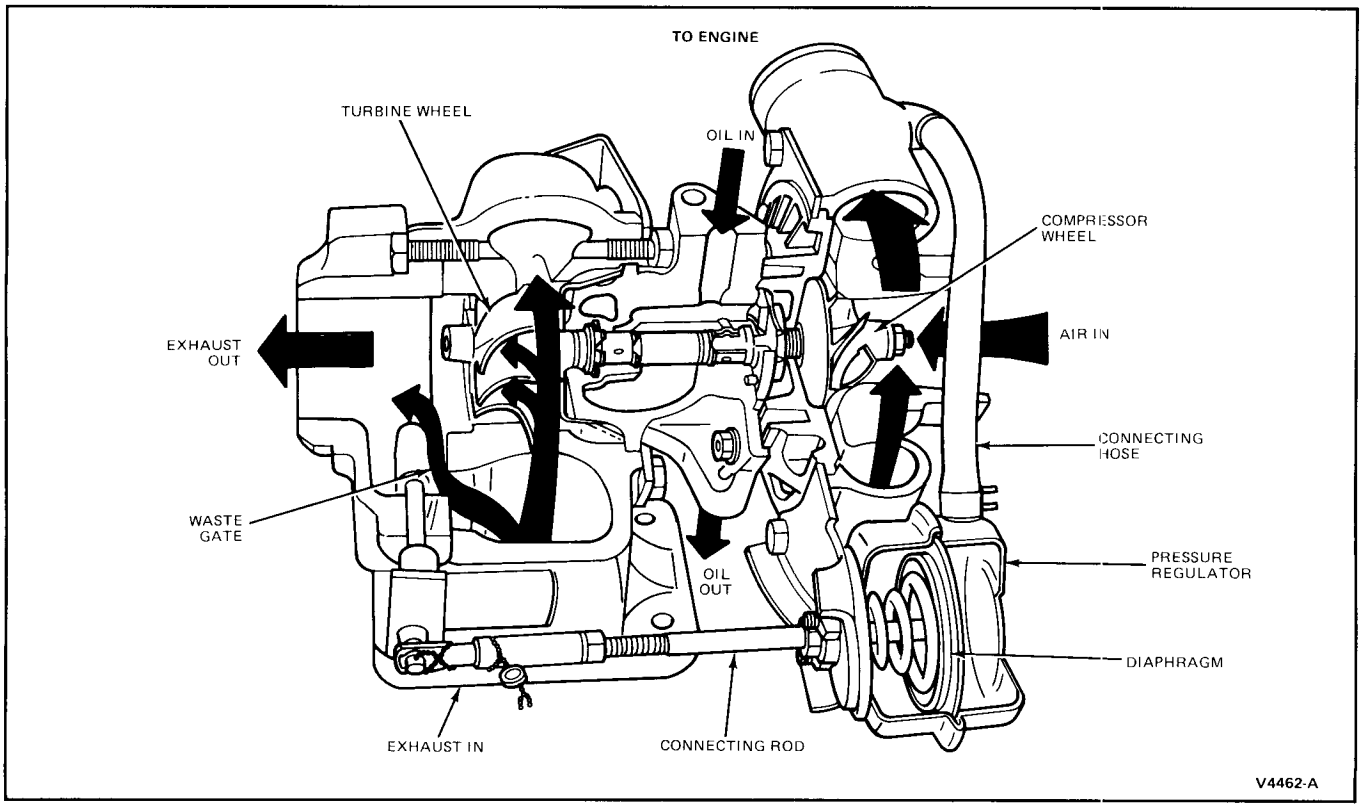


FIG. 3 Turbocharger—Cutaway View

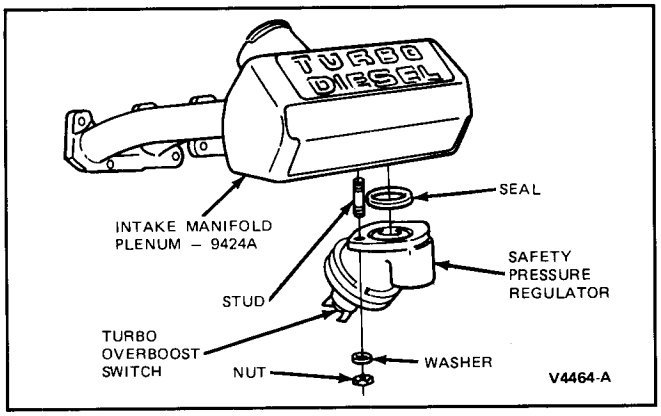


FIG. 4 Turbocharger Safety Pressure Relief Valve

the turbocharger, not be restricted under any circumstances, because of possible damage to the turbocharger. Keep in mind that the turbocharger is operating at speeds often in excess of 40,000 rpm under extremely high temperatures. Low quality lubricants, low oil level, clogged PCV system, etc. can all contribute to turbocharger damage. Be sure, therefore, that the lubrication system is adequately maintained.

CAUTION: Do not accelerate the engine before engine oil pressure has been built up. Also do not switch off the engine while it is running at high speed (the turbocharger will continue to spin for a long time without oil pressure). These conditions can damage the engine and/or turbocharger.

DIAGNOSIS

Refer to the Engine/Emissions Diagnosis Manual, Section 31 for Turbocharger Diagnostics.

REMOVAL AND INSTALLATION

Turbocharger

Removal

1. Remove two bolts attaching exhaust pipe to turbocharger.
2. Remove EGR tube and clamps.
3. Loosen four hose clamps on crossover tube and remove tube.
4. Remove air cleaner assembly and bellows. Refer to Section 25-41. Cap turbocharger openings using protective caps T84P-9395-B or equivalent.
5. Remove two oil supply line bolts on top of turbocharger center housing.
6. Remove clamp from oil lines (Fig. 5).
7. Remove oil return line.
8. Remove bolt and sealing washers attaching oil supply line to oil filter housing.
9. Disconnect and remove EGR valve.
10. Remove four bolts attaching turbocharger to exhaust manifold and remove turbocharger.

Installation

1. Clean mating surfaces of turbocharger and exhaust manifold.

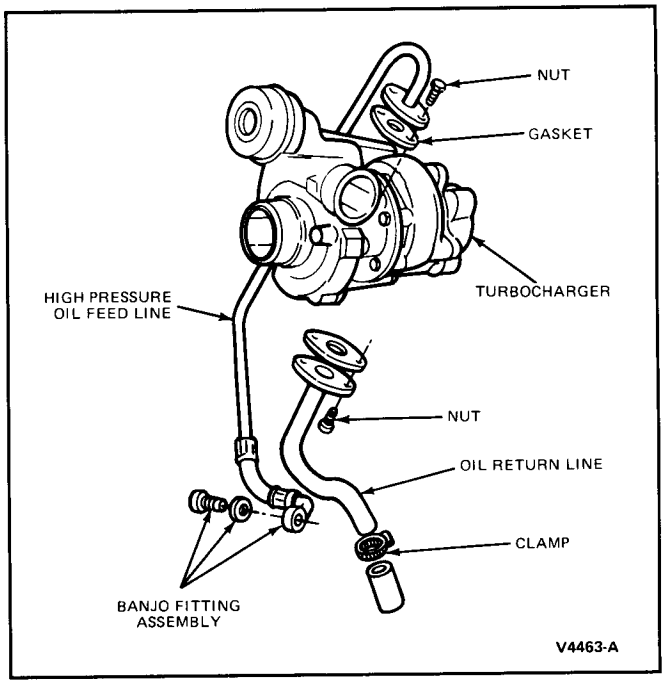


FIG. 5 Turbocharger Oil Lines

2. Position turbocharger on exhaust manifold and install four mounting bolts. Tighten to 23-27 N·m (17-20 lb-ft).
3. Install EGR valve. Tighten to 25 N·m (18 lb-ft).
4. Install oil supply line using new seals. Tighten bolt to 35-45 N·m (26-33 lb-ft).

   CAUTION: Do not overtighten bolt. Oil leaks may occur if overtightened.
5. Install clamp retaining oil lines.
6. Install oil supply line bolts to turbocharger housing and tighten to 20-24 N·m (15-18 lb-ft).
7. Remove protective caps from turbocharger and install air cleaner assembly and bellows. Refer to Section 25-41.
8. Install crossover tube. Tighten hose clamps snug.
9. Install EGR tube clamp.
10. Install two bolts attaching exhaust pipe to turbocharger and tighten to 23-27 N·m (17-20 lb-ft).
11. Run engine and check for oil and air leaks.

SPECIFICATIONS

Description		N·m	Lb-Ft (Lb-In)
EGR Valve		25	18
Hose Clamps		1.7-2.5	(15-22)
Oil Supply Line	To Turbo	20-24	15-18
	To Engine Block	35-45	26-33
Oil Return Line — To Turbo		20-24	15-18
Turbocharger-to-Exhaust Manifold		23-27	17-20
Turbocharger-to-Exhaust Pipe		23-27	17-20

CV4470-A

SECTION 25-50 Fuel Tanks and Lines—2.4L Diesel Engine

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION AND OPERATION

On the 2.4L diesel engine, fuel is drawn from the fuel tank up to the engine by an electric in-line fuel pump mounted to the engine mount. The injection pump then distributes fuel to the fuel injectors. These vehicles are equipped with fuel return lines which return excess fuel from the engine back to the fuel tank.

Fuel Filter/Sedimenter/Heater

The fuel filter, fuel/water separator and fuel heater are combined into one unit. Refer to Sections 25-51 and 25-55.

Fuel Lines

Diesel engines use steel and plastic fuel lines with both rubber fuel hose connections and nylon push connect fittings.

Fuel Cap

The fuel cap is a threaded screw-on design and is secured to the vehicle by means of a tether. The fuel cap assembly provides pressure and vacuum relief functions and should be replaced with the proper pressure/vacuum relief cap to prevent possible system malfunction (Fig. 1).

Fill Control/Vapor Vent System

Fill control is accomplished through the filler pipe configuration which extends inside the fuel tank. The vent system is designed to provide an air space, approximately 10 percent of the tank volume, above the fuel level in a full tank. The air space allows for thermal expansion of fuel and provides clearance between the fuel level and the vapor orifice and rollover valve assembly, which is mounted in the top panel of the fuel tank. The clearance is sufficient to allow vapor venting through the orifice under all static and most dynamic vehicle conditions.

Fuel Tank Vapor Orifice and Roll Over Valve Assembly

The fuel tank vapor orifice and roll over valve assembly makes use of a small orifice and shutoff valve that tends to allow only fuel vapor, not liquid, to pass into the line routed along the outside of the fuel tank. This assembly mounts directly to the fuel tank, using a rubber grommet (Fig. 2).

Push Connect Fittings

Push connect fittings are used to make some fuel line connections in diesel fuel systems. These fittings must be serviced using the procedures described in this Section.

Service is not possible if the fitting is damaged, except to replace a damaged retaining clip.

Pressure and Vacuum Relief System

Sealed Fill Cap

The fill cap is a sealed cap with a built-in pressure-vacuum relief valve. Fuel system vacuum relief is provided after negative 3.45 kPa (.50 psi) and pressure relief above 12.41 kPa (1.8 psi). Under normal operating conditions, the fill cap operates as a check valve, allowing air to enter the tank as fuel is used, while preventing vapors from escaping the tank through the cap.

DIAGNOSIS

Physical damage, leaks, contaminated fuel, and missing items are the major answers to diagnosis of fuel tank and fuel line complaints.

Fuel Tank Venting System

The following is a diagnostic guide for checking and/or service concerns of internal fuel tank pressure build-up. A typical concern may be a rush of air as the fuel cap is removed.

The fuel tank vapor orifice and roll over valve assembly allows for controlled release of fuel tank pressure. Under normal operating conditions, this

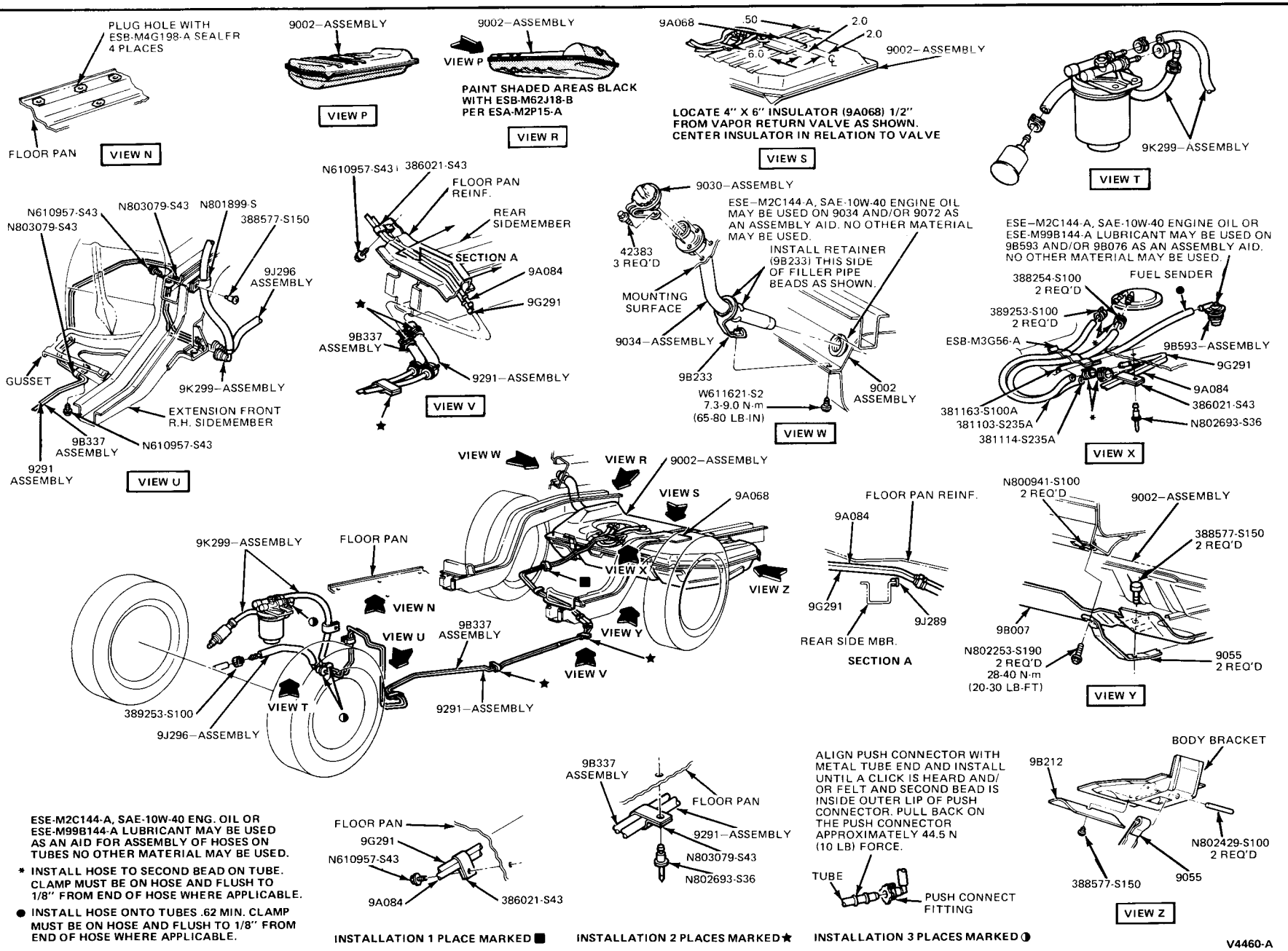


FIG. 1 2.4L Diesel Engine

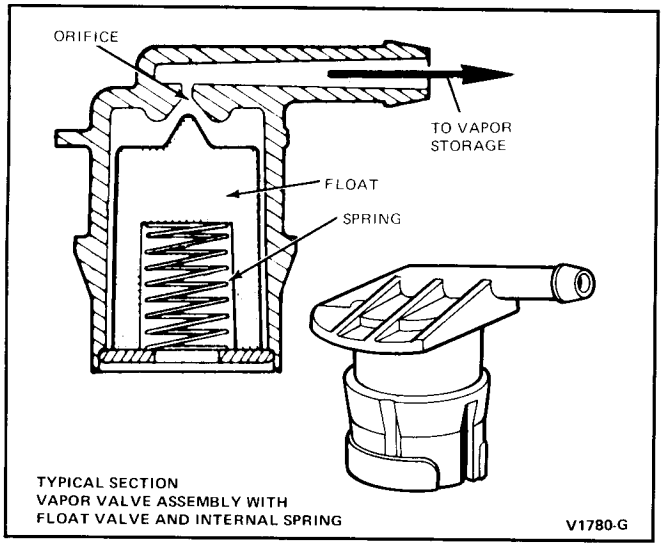


FIG. 2 Fuel Tank Vapor Orifice and Roll Over Valve Assembly

system will allow sufficient venting to prevent a build-up of internal fuel tank pressure.

Some operating conditions may cause temporary internal fuel tank pressure. In a normally functioning system, pressure will be relieved through vapor venting. Some of these conditions are:

- On warm or hot days, parking the vehicle after filling the fuel tank, the fuel is cool from underground storage and vaporizes rapidly when warmed.
- Parking after driving over rough roads, washboard, etc., after filling the fuel tank. Agitation of fuel increases vaporization.
- Parking after driving long distances in high temperature conditions.

No service is require if these conditions caused the customer complaint. A blocked fuel tank vapor orifice and roll over valve assembly or hose can cause abnormal fuel tank pressure and must be serviced.

REMOVAL AND INSTALLATION

Most component parts of the 2.4L diesel fuel system are serviced by a simple nut, bolt, or screw for removal and installation. Refer to Fig. 1 for specific part references.

Fuel Tank

Removal

1. Fuel should be drained from the tank as completely as possible prior to tank removal.
2. Disconnect the fuel hoses and tubes.
3. Disconnect electric hook-up to the fuel tank sender unit. The electrical connection is inaccessible on top of the tank and no intermediate connection point is provided. The electrical connector must be disconnected from the fuel sender with tank partially removed from vehicle.
4. Place a safety support under the tank and remove the bolts from the fuel tanks straps. The straps are hinged at one end. Remove the bolts from the unhinged end and swing the straps out of the way. The fuel tank shield, if equipped, should be left in place if at all possible to prevent it from being misplaced or installed incorrectly.
5. Partially remove the tank and disconnect the electrical connector from the fuel gauge sender.
6. Remove tank from the vehicle.

Installation

1. Before proceeding, check the following items:
   a. Leak check the sender unit.
   b. Be sure vapor separator valve is installed completely on the tank top.
   c. Make all required fuel lines, fuel return lines, vapor vent, fuel filler hoses and electrical connections which will be inaccessible after the tank is installed.
   d. Replace or reinstall all body mounted fuel tank shields.
2. Place the fuel tank in the proper position in the vehicle.
3. Bring the fuel tank straps around the tank and start the attaching bolts. Align the tank with the straps.
4. Check the hoses and wiring mounted on the tank top, to be sure they are correctly routed and will not be pinched between the tank and body.
5. Tighten the fuel strap attaching bolts to specification.
6. Reconnect the fuel tank hoses and lines. Be certain that the fuel supply, fuel return and vapor vent connections are made correctly.

   Trace the various lines to the engine, refer to Fig. 1 to be sure the proper lines are connected.
7. Reconnect electrical connections.
8. Reinstall the fuel filler hoses which connect the fuel tank to the fuel filler pipe. Install new hose clamps and tighten to specification.
9. Replace fuel drained from the tank.
10. Check all connections for leaks.

Straps

Removal

Straps may be removed, and/or replaced without removing the tank; if each strap is removed and reinstalled one at a time and a support is provided under the tank, or by following the procedure for fuel tank removal.

The hinged end of the strap attachment holds the strap in place after the fuel tank is removed. This hinged end uses a pin type attachment through a loop in the end of the strap.

To remove the strap, push the strap up into the bracket until the pin can be removed.

Installation

1. Push the strap into the bracket opening.
2. Insert the pin into the loop in the strap.
3. Pull the strap down until the pin is fully seated on the bottom of the bracket.

   CAUTION: The pin must rest flat against the bottom of the bracket. If it is not, the fuel tank could be damaged. Do not install the tank. Attempt to position the pin so that it will seat properly. If unsuccessful remove the pin and strap. Check for, and remove any obstruction

that may be inside the bracket. Check to be sure the pin is the correct length.

Push Connect Fittings

Push connect fittings are designed with hairpin retaining clips (Fig. 3). Push connect fitting disassembly must be accomplished prior to fuel component removal (filter, pump, etc.).

5/16 Inch Fittings (Hairpin Clip)

Removal

Refer to Fig. 3.

1. Inspect internal portion of fitting for dirt accumulation. If more than a light coating of dust is present, clean the fitting before disassembly.

   Some adhesion between the seals in the fitting and in the tubing occurs with time. Twist the fitting on the tube, then push and pull the fitting until it moves freely on the tube.

2. To remove hairpin type clip from fitting, bend the shipping tab downward so it will clear the body. Then, (using hands only) spread the two clip legs about 1/8 inch each to disengage the body and push the legs into the fitting. Complete removal is accomplished by lightly pulling from the triangular end of the clip and working it clear of the tube and fitting.

   CAUTION: Do not use any tools.

3. Grasp the fitting and hose assembly and pull in an axial direction to remove the fitting from the steel tube.

4. When fitting is removed from the tube end, inspect the fitting and tube for any internal parts that may have been dislodged from the fitting. Any loose internal parts should be immediately reinstalled, using the mating tube to insert the parts. It is recommended that the original clip **not** be reused in the fitting. To install the new clip, insert clip into any two adjacent openings with the triangular portion pointing away from the fitting opening. Install clip to fully engage the body (legs of hairpin clip locked on outside of body). Piloting with an index finger is necessary.

Installation

1. Before reinstalling fitting on the tube, wipe tube end with a clean cloth. Inspect the inside of the fitting to ensure it is free of dirt and/or obstructions.

2. To reinstall the fitting onto the tube, align the fitting and tube axially and push the fitting onto the tube end. When the fitting is engaged, a definite click will be heard. Pull on fitting to ensure it is fully engaged.

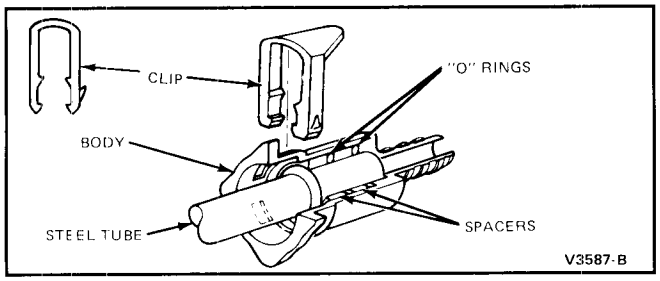


FIG. 3 Push Connect Fitting With "Hairpin" Clip

Fuel Lines and Hoses

With Push Connect Fittings

Steel fuel lines and nylon fuel hose assemblies with push connect fittings are used on some applications. This type of system has special removal and installation procedures. Refer to the Push Connect Fittings procedure in this Section.

The metal tubes attached to the vehicle underbody may be serviced. The metal underbody tubes must be cut and formed out of rolls of fuel system service tubing available at a dealership.

A damaged section of tubing can be cut out of the existing line and replaced by a comparable service tubing section, spliced into the line by means of threaded fasteners and connectors.

All replacement hoses can be serviced using approved service parts shown in Fig. 4.

Fuel Tubes—Steel

Removal

1. Drain the fuel from the tank.
2. Disconnect the line(s) at the fuel tank and at the engine. Remove the lines from the holding clips along the underbody. Remove all damaged hoses and tube sections.

Installation

1. Cut a new section of tubing to approximately the same length as the section to be replaced allowing for the threaded connectors/fasteners.
2. Bend the tube section to conform to the contour of the original tube.
3. Square the ends of the cut tubing with a file. Remove burrs.
4. Position the lines in the underbody clips. Do not tighten at this time.
5. Assemble the fitting by sliding the nut over the tubing with threaded (open) end out.
6. Slide the ferrule on the tubing with the cutting edge out, the large head end should be inside of the nut.
7. Lubricate the ferrule and the threads on the fasteners with oil.
8. Bottom the tube in the fitting, and tighten the nut until the ferrule just grips the tube. When the tube can no longer be turned by hand, the ferrule has started to grip the tube.
9. After the ferrule grips the tube, tighten the nut one full turn.
10. Tighten the fuel line to the underbody clips to secure the fuel lines.
11. Fill the fuel tank and check for leaks.

    NOTE: After disassembly of the flareless fitting joint, the flareless fitting can be re-assembled. To reassemble, reconnect the threaded fitting and seat the ferrule to be fingertight. When the ferrule is seated, draw the nut up approximately 1/6 to 1/3 turn with a wrench to complete the tightening operation.

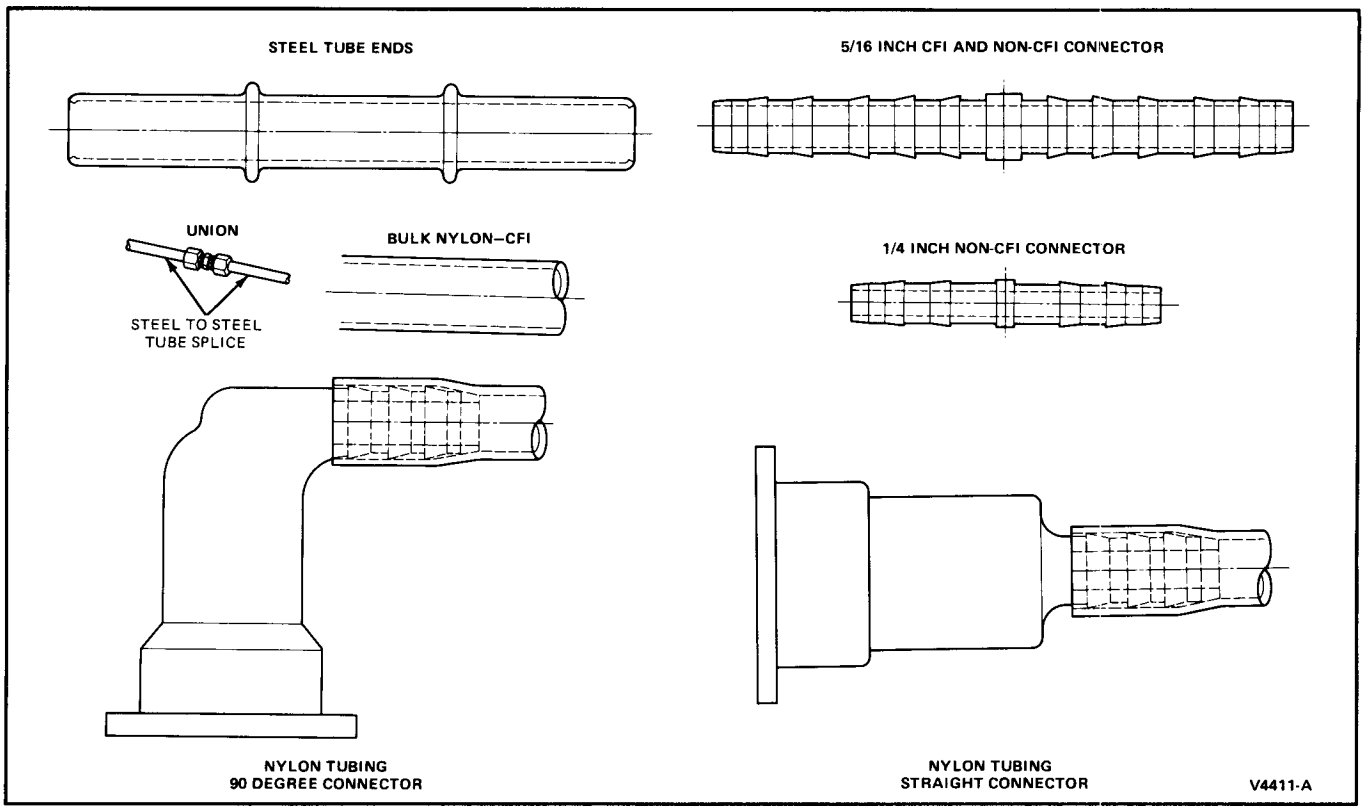


FIG. 4 Fuel Line Service Parts

Replacing Damaged Steel Push Connect Tube Ends

1. Relieve fuel system pressure as outlined in this Section. Read cautionary note prior to relieving pressurized fuel system.
2. Using a tube cutter, remove the damaged push connect tube end at a convenient distance from the end.

   NOTE: Allow for adequate room to tighten a union with a wrench at this location.
3. Choose a proper replacement push connect tube end (refer to Fig. 4).
4. If required, form the new tube end to the same shape as the damaged tube end which was removed.
5. Select the proper size union (Fig. 4) and attach the new steel tube end to the original tube.
6. Clean off the steel tube end and replace the push connector onto the tube. (A new retainer clip is recommended).
7. Check that the underbody clips are properly securing the fuel tubes.
8. Start engine and check for leaks.

MAJOR SERVICE OPERATIONS

Fuel Lines and Rubber Hoses

Diesel vehicles with steel fuel lines and rubber hose connections must be cut, squared and formed out of rolls of fuel system service tubing and hose material available at dealerships.

A damaged section of tubing longer than 305mm (12-inches) can be cut out of the existing line and replaced by a comparable service tubing section, spliced into the line by means of connecting hoses and retaining clamps. A damaged section of tubing shorter than 305mm (12-inches) can be cut out of the line and replaced by a length of service hose and two retaining clamps.

Removal

1. Drain the fuel from the tank.
2. Disconnect the line at the fuel gauge sender unit at the fuel pump. Remove the lines from the holding clips along the underbody, remove all damaged hose section and tube sections.

Installation

1. Cut a new section of tubing to approximately the same length as the section to be replaced. Allow extra length for flaring the ends of the tubing. Square the ends of the cut tubing with a file.
2. Ream the inside edges of the cut tubing with the reamer blade on the tube cutter. Be sure metal chips are removed from inside the tube(s). Double flare the ends of the cut tubing, as required.
3. Bend the tube section to conform to the contour of the original tube. Cut an ample length of hose to form a coupling between the flared ends of the fuel lines. Connect the hose couplings to the tubing and install the retaining clamps.
4. Position the lines in the underbody clips and tighten the clips. Connect the line to the fuel gauge sender unit and the fuel pump. Fill the tank and check for leaks.

SPECIFICATIONS

Vehicle	Model Usage	Approximate Fuel Tank Capacity		
		U.S.	Imp.	Liters
Mark VII/ Continental	2.4L Diesel Engine	22.6	22.0	87.0

CV4461-A

SPECIAL SERVICE TOOLS

Tool Number	Description
T74P-9275-A	Fuel Tank Sender Wrench
T80L-9974-A	Pressure Gauge Tool

CV4135-A

Part Number	Component
N802239	Hair Pin Clip — 5/16 Inch Connector

CV4136-A

SECTION 25-51 Fuel Filter/Water in Fuel Sensor

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The 2.4L Diesel engine uses a spin-on cartridge-type fuel filter. The filter assembly is mounted on a bracket on the LH strut tower in the engine compartment (Fig. 1). The filter is used to provide a clean supply of fuel to the injection pump and to separate water from the fuel. A fuel heater, used to warm the fuel during cold weather, is built-in to the fuel filter housing. The removal and installation of the fuel heater and service procedures are described in Section 25-55.

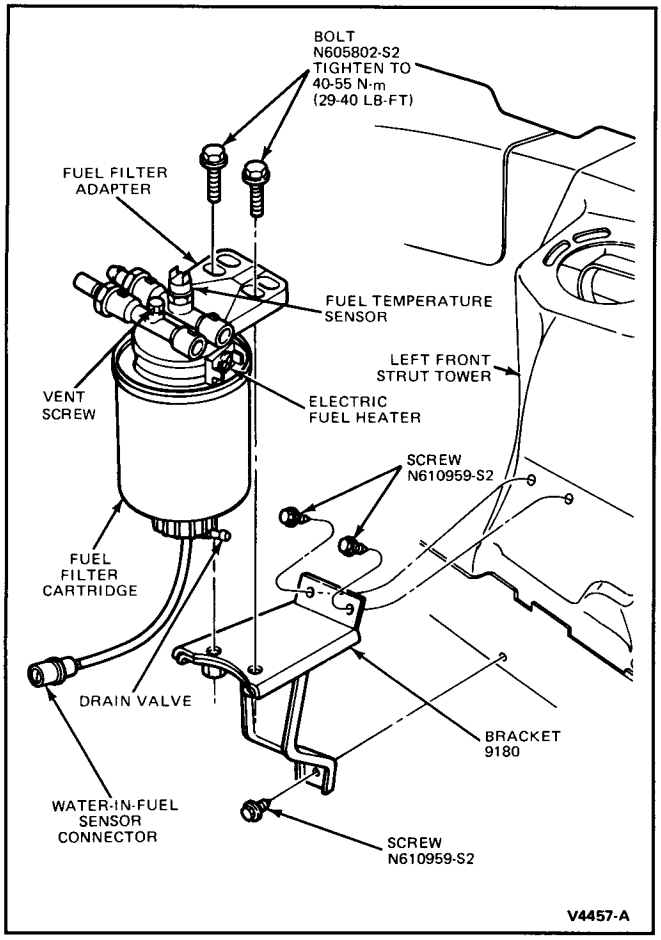


FIG. 1 Fuel Filter Assembly—Installation

When the water level in the fuel filter reaches a certain point, a sensor in the filter turns On the Water-in-Fuel indicator on the instrument panel. When this indicator comes on, the vehicle should be stopped as soon as possible and the water drained from the filter. This is accomplished by opening the vent screw on the top of the filter and then depressing the drain valve on the bottom of the filter cartridge (Fig. 2).

REMOVAL AND INSTALLATION

Removal

1. Drain the fuel from the fuel filter by opening the vent screw on the top of the filter and then depressing the drain valve on the bottom of the filter (Fig. 2).
2. Disconnect the Water-in-Fuel sensor connector (Fig. 1).
3. Remove the filter cartridge using a standard oil filter wrench, if necessary.
4. Remove protective cover.

Installation

1. Remove the drain valve from the old filter and install on the new filter.
2. Install protective cover.
3. Coat the surface of the sealing gasket with engine oil and install the filter on the adapter. Turn the filter until the gasket contacts the sealing surface of the filter adapter.
4. Turn the filter an additional one-half turn.
5. Close vent screw.
6. Start the engine and check for fuel leaks, tightening the filter further, if necessary.

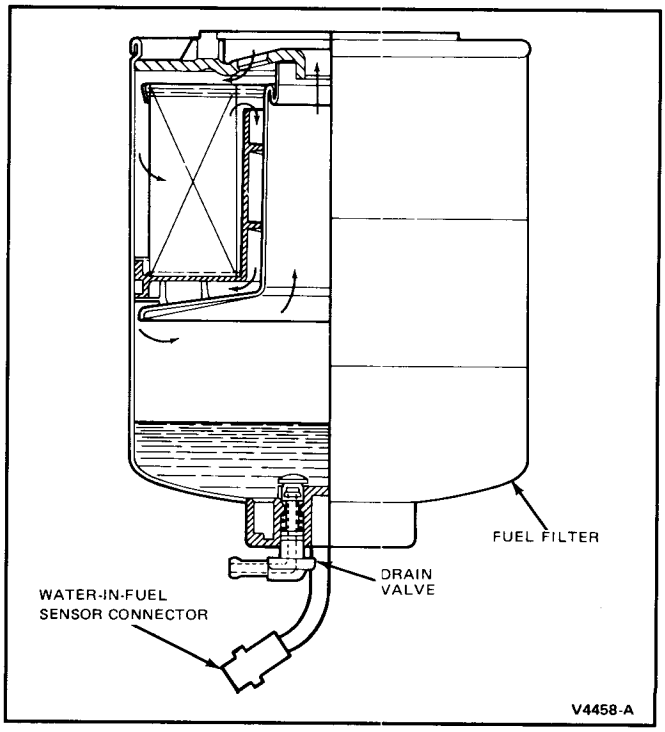


FIG. 2 Fuel Filter Drain Valve

SECTION 25-55 Fuel Heater

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The electric fuel heater is standard equipment on vehicles equipped with the 2.4L diesel engine. It is located between the top of the fuel conditioner and the filter element (Fig. 1), and is serviced independently from the rest of the system. Power (approximately 200 watts) is available to the fuel heater whenever the key is in the On position, but is used only when the fuel is cold (Fig. 2). A bimetallic snap switch is located below the connector, and is exposed to diesel fuel contained in the fuel conditioner. The snap switch senses fuel temperature and operates within a temperature range between -1 and 13°C (30 and 55°F). This means that the heater will be operating at a fuel temperature of -1°C (30°F) or lower, and must cease operating at a fuel temperature of 13°C (55°F) and above.

When the switch snaps into the ON position, it supplies current through a relay (mounted on the dash panel) to a positive temperature coefficient (PTC) heater. This heater is self-regulating because as its temperature goes up, so does its resistance to electrical flow, thereby limiting the maximum temperature.

REMOVAL AND INSTALLATION

Fuel Heater

Removal

1. Disconnect the water-in-fuel sensor connector, fuel temperature sensor and fuel heater connector (Fig. 1).
2. Drain the fuel from the fuel filter by opening the vent screw on the top of the filter and depressing the drain valve on the bottom of the filter.
3. Remove the filter cartridge using a standard oil filter wrench, if necessary.
4. Remove fuel lines from fuel filter adapter.
5. Remove the two bolts retaining the fuel heater/filter adapter to the bracket (Fig. 1), and remove from vehicle.
6. Unscrew fuel heater assembly from fuel filter adapter.

Installation

1. Coat the seal with engine oil and install the fuel heater on the fuel filter adapter.
2. Position the fuel filter adapter (with fuel heater attached) to the bracket and install with two bolts (Fig. 1). Tighten to 40-55 N·m (29-40 lb-ft).
3. Coat the surface of the sealing gasket with engine oil and install the filter on the adapter. Turn the filter until the gasket contacts the sealing surface of the filter adapter.
4. Turn the filter an additional half turn.
5. Connect the Fuel-in-Water sensor, temperature sensor and fuel heater connectors.
6. Reconnect fuel lines to fuel filter and tighten the vent screw.
7. Start the engine and check for fuel leaks, tightening the filter further, if necessary.

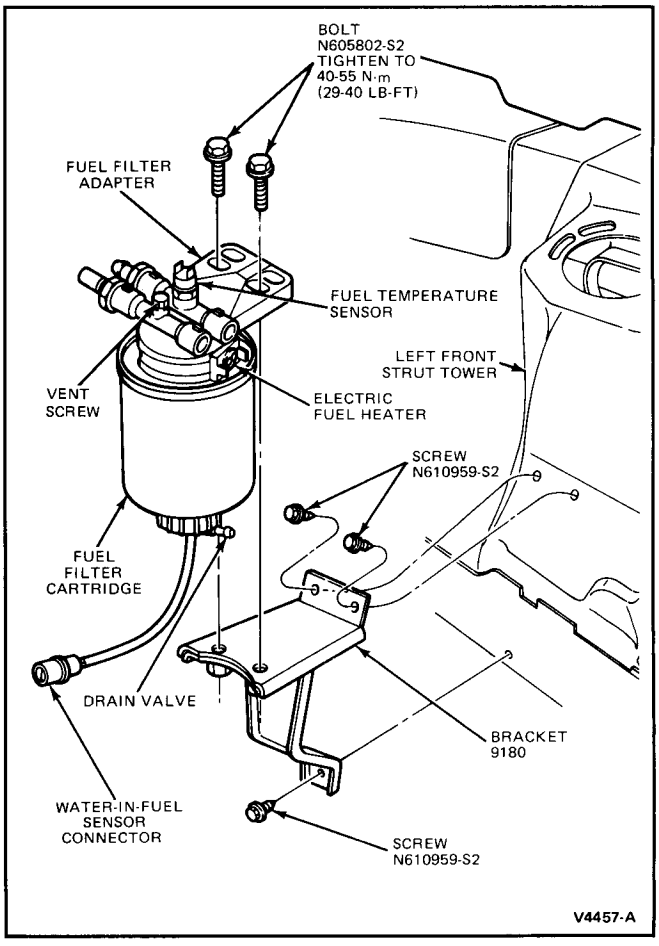


FIG. 1 Fuel Heater Assembly Installation

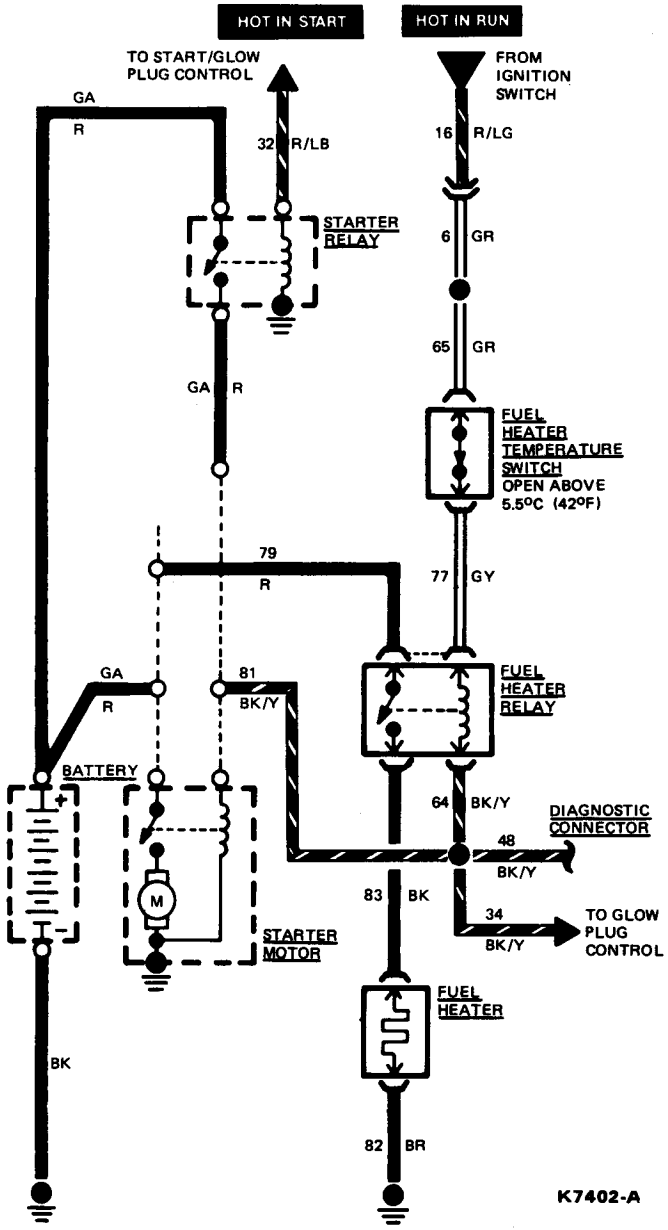


FIG. 2 Fuel Heater Wiring Diagram

SECTION 25-60 Throttle Linkage

VEHICLE APPLICATION

Mark VII/Continental.

ADJUSTMENTS

TV Control Cable

Refer to Section 17-12 for Removal and Installation, and Adjustments.

Idle Speed Adjustment

Refer to the Engine/Emissions Diagnosis manual, Section 31.

REMOVAL AND INSTALLATION

Accelerator Cable

Removal

1. Using a suitable tool, push the accelerator cable nylon bushing out of the accelerator pedal arm (Fig. 1).
2. Remove the body insulation retainer from the cable housing. The retainer is located inside the vehicle where the housing passes through the dash panel into the passenger compartment.
3. Disconnect the accelerator cable at the injection pump side lever by inserting a screwdriver between the cable and the throttle lever and giving a twist (Fig. 1).
4. Remove the screw attaching the cable housing to the engine mounting bracket.
5. Remove the screws attaching the cable housing to the dash panel and remove the assembly.

Installation

1. Insert the pedal end of the cable, with cover installed, through the dash panel and install the screws attaching the housing to the dash panel.
2. Position the cable housing in the engine mounting bracket and install the attaching screw.
3. Connect the cable to the injection pump side lever.
4. Install the body insulation retainer on the cable housing. Make sure the retainer is pushed onto the housing at least 6.4mm (0.25 inch).
5. Press the nylon bushing on the accelerator cable into the accelerator pedal arm (Fig. 1).
6. Check installation for binding or interference. Be sure the cable movement is restriction free.

Mounting Bracket

Removal

1. Remove the screw attaching the cable housing to the mounting bracket. Disconnect the TV return spring from the engine bracket.
2. Remove the bolts securing the accelerator cable mounting bracket to the engine.
3. Lift the cable housing out of the mounting bracket and remove the bracket.

Installation

1. Position the mounting bracket on the engine and install the attaching bolts. Tighten the bolts to 13.5-20.5 N·m (10-15 lb-ft).
2. Position the cable housing in the mounting bracket and install the attaching screw. Attach the TV cable return spring to the tab on the bracket.

Accelerator Pedal Assembly

Removal

1. Using a suitable tool, push the accelerator cable nylon bushing out of the accelerator pedal arm (Fig. 1).
2. Remove the two nuts attaching the accelerator pedal assembly to the floor.
3. If replacing the pedal assembly and if the vehicle is equipped with a pedal pad trim cover, uncrimp the pedal pad cover and remove it from the pedal.

Installation

1. Install the pedal pad trim cover, if so equipped, and carefully crimp the retaining tabs.
2. Position the pedal assembly on the two mounting studs and install the two attaching nuts (Fig. 1). Tighten the nuts to 13.5-20.5 N·m (10-15 lb-ft).
3. Check to be sure that carpeting and/or body insulation is properly positioned.
4. Press the nylon bushing on the accelerator cable into the accelerator pedal arm.
5. Check to be sure the pedal motion is without interference and restriction free.

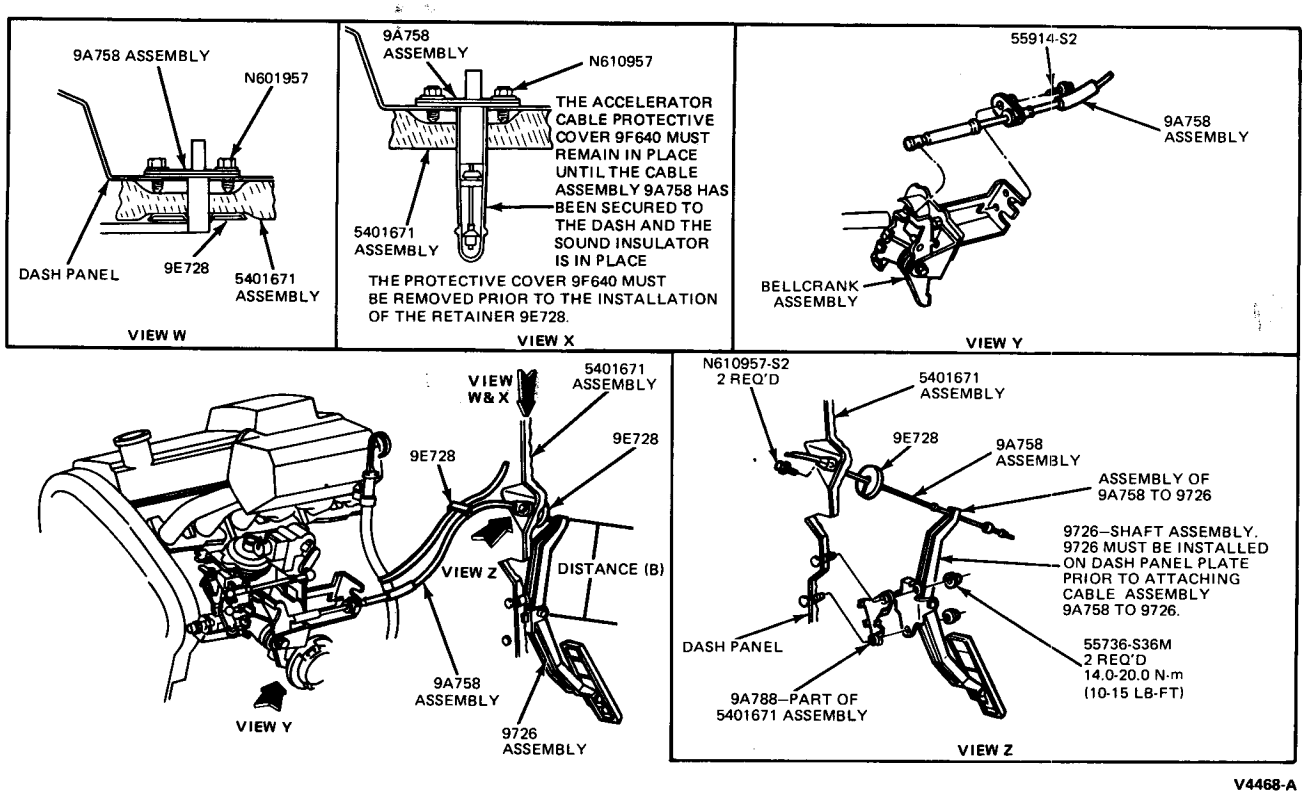


FIG. 1 Throttle Linkage

SECTION 26-30 Exhaust System—Dual

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The exhaust system for the 2.4L Diesel engine consists of a resonator and inlet pipe, a muffler Y-pipe, two muffler assemblies, and hanger assemblies.

Service replacement parts for the exhaust system usually consist of more pieces than do the factory-installed systems shown in the illustration. Refer to the Master Parts catalog for information on the available service assemblies.

CAUTION: The operating temperature of the exhaust system is very high. Never attempt to service any part of the system until it has cooled.

REMOVAL AND INSTALLATION

Resonator Pipe

Removal

Refer to Fig. 1.

1. Raise the vehicle.
2. Remove the bolts, springs and nuts attaching resonator pipe to Y-pipe.
3. Remove the nuts attaching resonator to turborcharger turbine outlet.
4. Remove resonator pipe from vehicle.

Installation

1. Clean the gasket material from connection flanges.
2. Position the resonator pipe to the turbocharger turbine outlet making sure the pipe is installed in the hanger. Start the attaching nuts.
3. Using a new gasket and springs, position the resonator pipe to the Y-pipe and start the attaching nuts, springs and bolts.
4. Align the exhaust system to conform to clearance specifications (Fig. 1).
5. Tighten the resonator-to-turbocharger nuts to 34-44 N·m (25-35 lb-ft). Tighten the resonator to Y-pipe nuts and bolts to 27-40 N·m (20-30 lb-ft).

   NOTE: The bolt shoulder must be completely seated against the resonator outlet pipe flange.
6. Check the exhaust system for leaks and lower the vehicle.

Y-Pipe

Removal

1. Raise the vehicle.
2. Remove the clamps attaching the Y-pipe to the mufflers.
3. Remove the bolts, springs and nuts attaching the Y-pipe to the resonator pipe and remove the Y-pipe.

Installation

1. Clean the gasket material from the Y-pipe to resonator connections.
2. Install the Y-pipe on the muffler inlets.
3. Using a new gasket and springs position the Y-pipe to the resonator pipe and start the attaching nuts and bolts.
4. Install new exhaust clamps on the muffler inlets and start the nuts.
5. Align the exhaust system to conform to clearance specifications (Fig. 1).
6. Tighten the Y-pipe to resonator nuts and bolts to 27-40 N·m (20-30 lb-ft). Position and tighten the muffler clamps to 34-47 N·m (25-35 lb-ft).
7. Check the exhaust system for leaks and lower the vehicle.

Muffler Assemblies

NOTE: Procedure is the same for LH and/or RH muffler assemblies.

Removal

1. Raise the vehicle by means of the frame lift points to allow the axle full downward travel. This will provide the clearance necessary to remove and replace the muffler assembly(s).
2. Remove the clamps attaching the muffler inlet to the Y-pipe.
3. Remove the screws attaching the support bracket to the tailpipe.
4. Remove the screws attaching the support bracket to the muffler and remove the muffler assembly.
5. Slide the muffler assembly rearward until the inlet is separated from the Y-pipe, then forward to remove from the vehicle.
6. Replace any damaged parts.

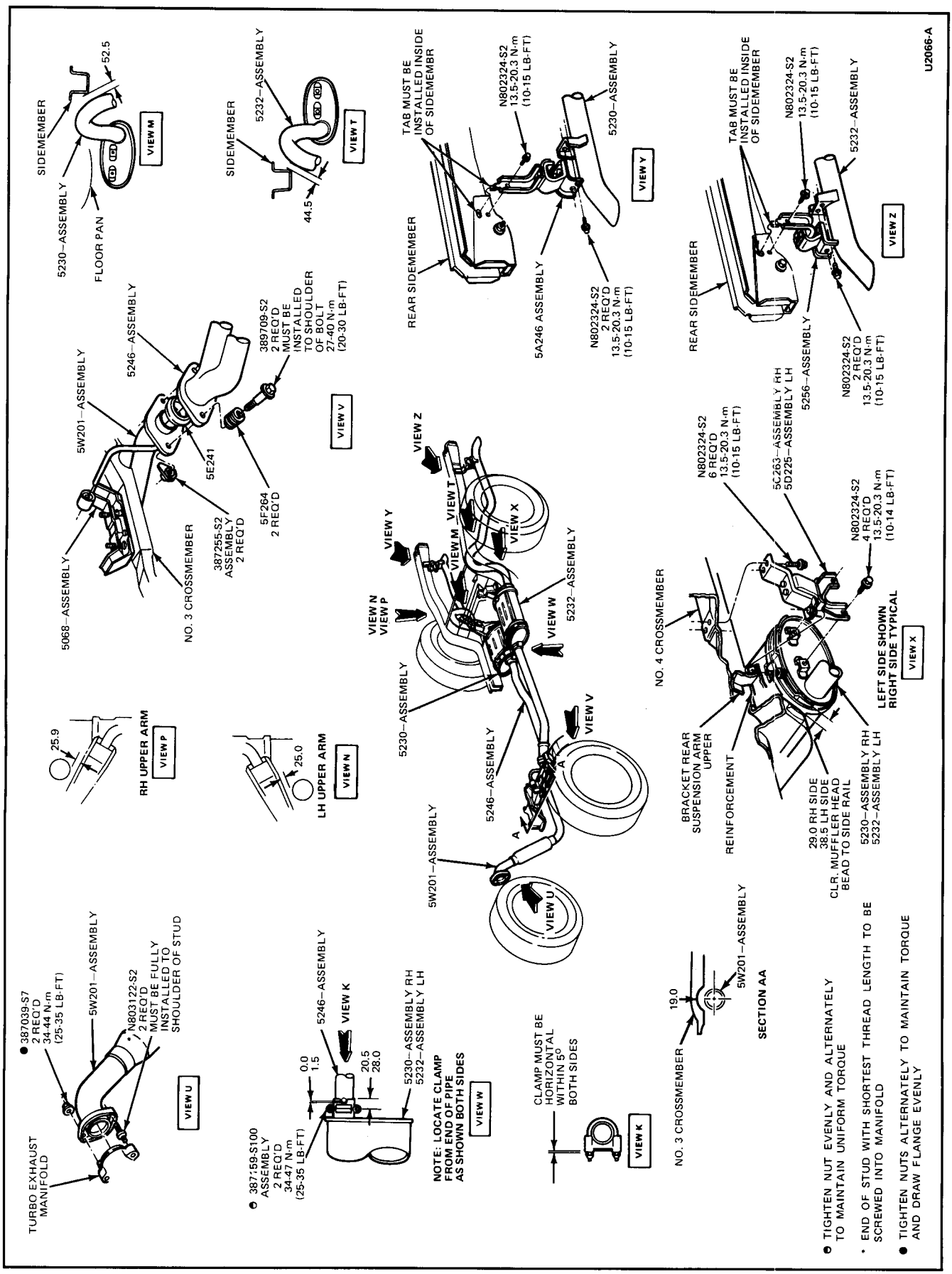


FIG. 1 Exhaust System

Installation

1. Position the muffler assembly over the rear axle and install the muffler support bracket attaching screws. Do not tighten screws.
2. Install the tailpipe support bracket attaching screws. Do not tighten the screws.
3. Position the muffler inlet pipe to the Y-pipe. Install but do not tighten the attaching clamps.
4. Align the exhaust system to conform to clearance specifications (Fig. 1).
5. Tighten the support bracket attaching screws to 13.5-20 N·m (10-15 lb-ft). Position and tighten the muffler inlet to Y-pipe clamps to 34-47 N·m (25-35 lb-ft).
6. Check the system for leaks and lower the vehicle.

SECTION 27-02 Drive Belts, Accessory—Service

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

Vehicles are equipped with conventional V and V-ribbed accessory drive belts as shown in Fig. 1. Replacement belts should be of the same type as originally installed.

Belts must be properly adjusted at all times. Loose belts will result in slippage which may cause a noise complaint or improper accessory operation (alternator will not charge, etc.). Overtightening accessory drive belts will place a severe load on accessory bearings.

ADJUSTMENTS

To assure proper tension, these guidelines should be followed:

1. Use belt tension gauge Tool T63L-8620-A or equivalent as shown in Fig. 2.
2. If belt tension gauge is unobtainable, the belt deflection method may be used for conventional V-belts only.
   a. Press firmly on belt.
   b. Deflection should be as follows:
      - 3mm-6mm (1/8-1/4 inch). (Belts spanning less than 300mm (12-inches).
      - 3mm-10mm (1/8-3/8 inch). (Belts spanning more than 300mm (12-inches).

NOTE: Do not use deflection method for V-ribbed belts.

3. Set belt tension as shown in Fig. 4. The proper sequence is as follows:

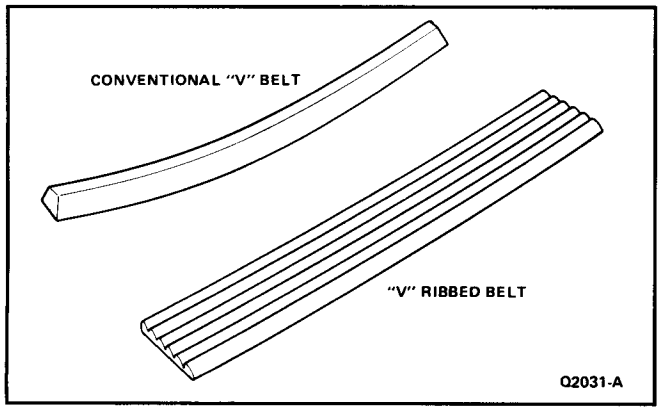


FIG. 1 Drive Belts

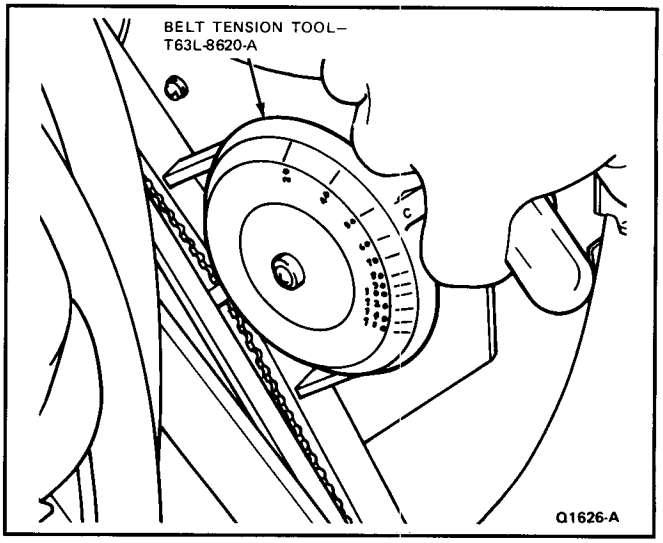


FIG. 2 Checking Belt Tension With Gauge

   a. Loosen accessory adjustment and pivot bolts.
   b. Pry accessory as shown (use care not to damage accessory housing) (Figs. 5 and 6).
   c. Tighten accessory bolt to specification (Fig. 3).
   d. Release pressure.
   e. Tighten pivot bolt to specification.
   f. Check belt tension (Fig. 2).
   g. Reset tension if not to specification.

REMOVAL AND INSTALLATION

Conditions requiring belt replacement include: excessive wear, severe glazing, frayed cords, etc. Replace any belt exhibiting any of these conditions.

NOTE: Minor cracks in the back of a belt are considered acceptable.

Removal and Installation

1. Loosen adjustment and pivot bolts on accessories which need belts replaced as shown in Fig. 3.
2. Remove old belts.
3. Install new belt over pulleys. For V-ribbed belts, make sure that all V-grooves make proper contact with the pulley as shown in Fig. 3.
4. Adjust tension to specification (Fig. 4).

   Refer to Fig. 5 for V-belt and Fig. 6 for V-ribbed belt tensioning procedure.

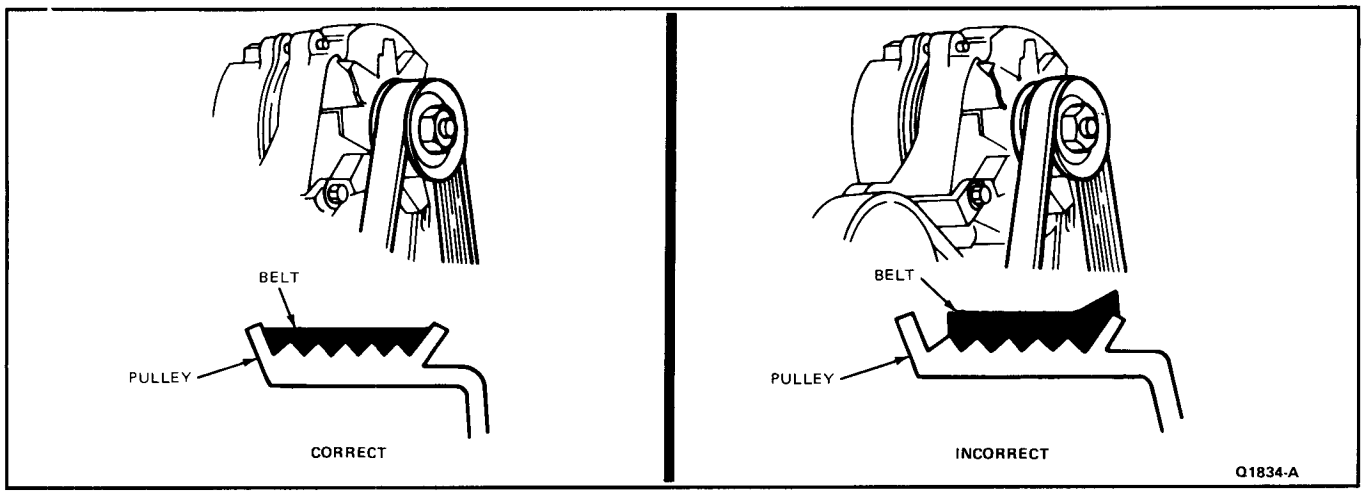


FIG. 3 V-Ribbed Belt

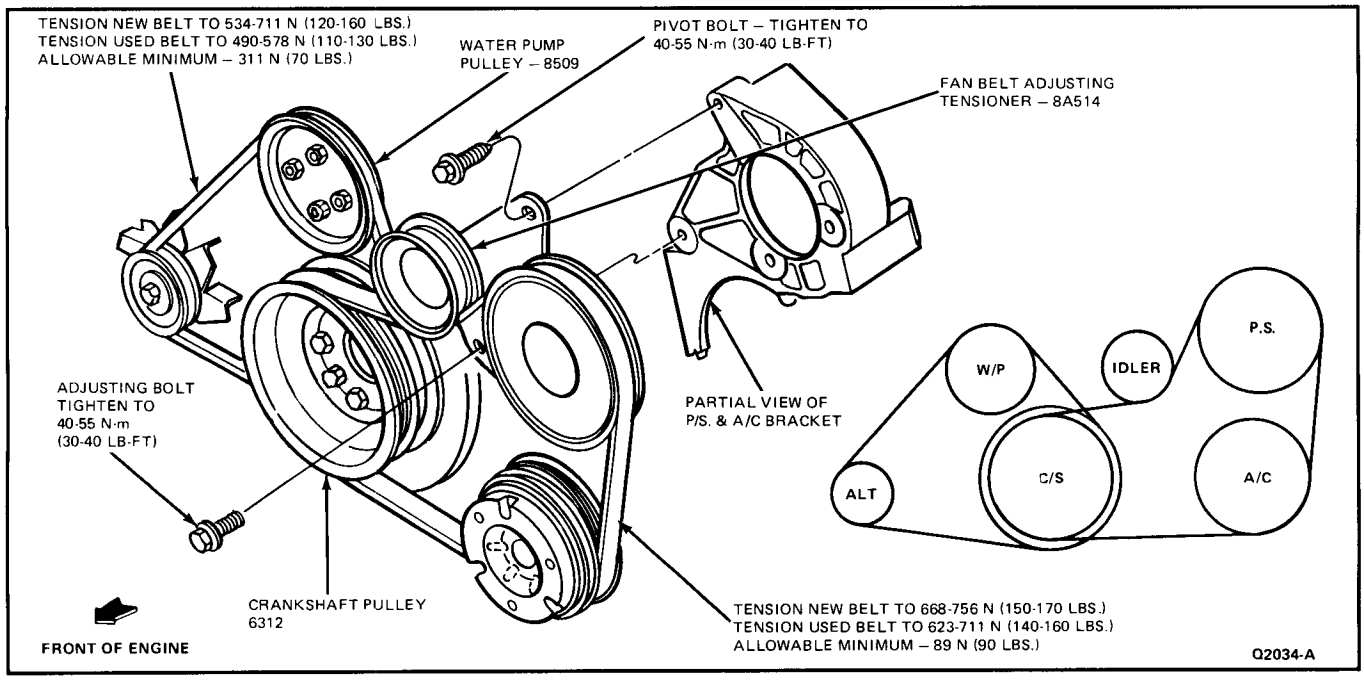


FIG. 4 Belt Tension Adjustment

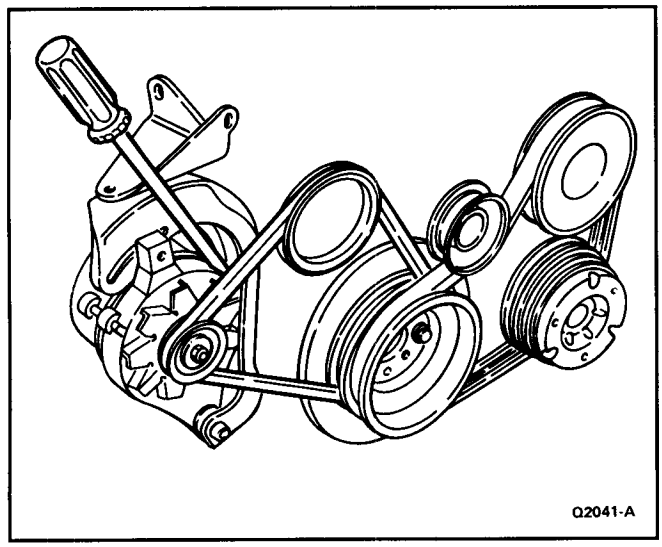


FIG. 5 Tensioning the V-Belt

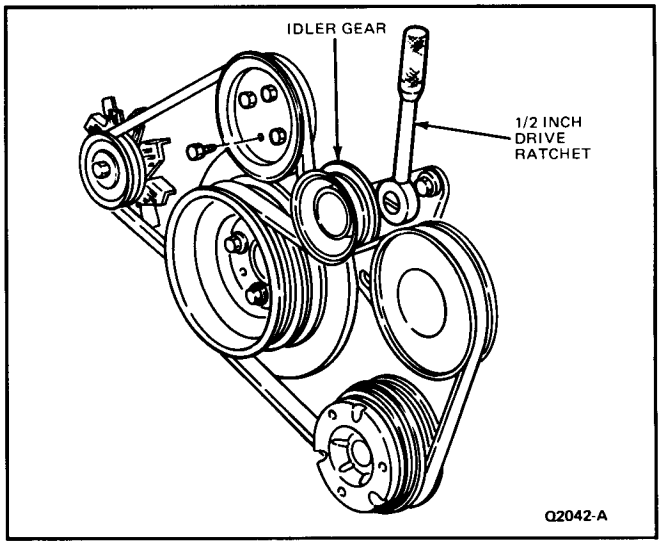


FIG. 6 Tensioning the V-Ribbed Belt

SECTION 27-03 Radiators—Aluminum Core

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

Refer to Fig. 1.

The cooling system used on the 2.4L diesel uses a coolant expansion bottle, an aluminum cross flow radiator, and a 105 kPa (15 psi) expansion bottle cap. It is a pressurized system using a coolant expansion bottle to expel air from the coolant. Coolant passes through the aluminum radiator and is cooled by two cooling fans; an engine driven clutch fan and an electric pusher fan, mounted in front of the radiator, that only operates when the A/C is on.

The cooling system is filled at the expansion bottle in this system. The expansion bottle is at the highest point in the system and will gather any air bubbles that are flowing with the coolant.

NOTE: the formation of air bubbles along cylinder walls and in the cylinder head can cause severe damage because of the hot spots that develop when the coolant is not in contact with the metal. Cracks in the cylinder head and/or block and seized or scored pistons are often the result of air bubbles in the cooling system.

WARNING: DO NOT ATTEMPT TO REMOVE THE COOLANT EXPANSION BOTTLE CAP UNDER ANY CIRCUMSTANCES WHILE THE ENGINE IS OPERATING. TO DO SO MIGHT LEAD TO COOLING SYSTEM AND ENGINE DAMAGE, AND COULD RESULT IN SERIOUS INJURY FROM HOT COOLANT OR STEAM.

The expansion bottle used in this system is not the same as a coolant recovery bottle because there is a flow of coolant to it, and it is **exposed to cooling system pressure at all times.** Excessive cooling system pressure is vented from the expansion tank through a tube to the atmosphere.

Coolant flow is controlled by a dual-acting thermostat that is located on the inlet side of the engine on the lower part of the block. Coolant flow during warm and cold operation is shown in Fig. 1. Opening temperature of this thermostat is approximately 80°C (176°F).

Coolant used in this engine must meet Ford Specification ESE-M97B44-A or equivalent and should be mixed in a 50/50 ratio with soft (demineralized) water.

CAUTION: Use of coolants that do not meet Ford Specification ESE-M97B44-A, could cause damage to the aluminum cylinder head and to other aluminum engine components. Use only soft (demineralized) water in the coolant mixture.

ADJUSTMENTS

Filling the Cooling System

One of the most important procedures in servicing the cooling system on the 2.4L diesel engine is the filling procedure on a dry system. To properly fill the cooling system, use the following method:

NOTE: The cooling system on the 2.4L diesel is very slow to fill.

1. Fill the expansion bottle with coolant.
2. Loosen the bleed screw on the thermostat housing and maintain coolant level in the expansion bottle.
3. When coolant appears at the bleed screw, close it off.
4. Start the engine and turn on the heater.
5. Maintain the coolant level in the expansion bottle.
6. Run the engine at operating temperature until it will not take any more coolant, then take the vehicle for a test drive.
7. Verify that the coolant level is correct. Coolant system capacity is 11.2 liters (11.8 quarts).

REMOVAL AND INSTALLATION

Radiator

Removal

1. Drain cooling system. Disconnect radiator upper and lower hoses and bleed hose from expansion bottle.
2. Disconnect the automatic transmission fluid cooler inlet and outlet lines from the radiator using Tool T82L-9500-AH or equivalent (Fig. 3).
3. Remove two upper fan shroud attaching bolts at radiator support. Lift fan shroud sufficiently to disengage lower retaining clips and lay shroud back over fan.
4. Remove radiator upper support attaching bolts and remove support(s). Lift the radiator from the vehicle.

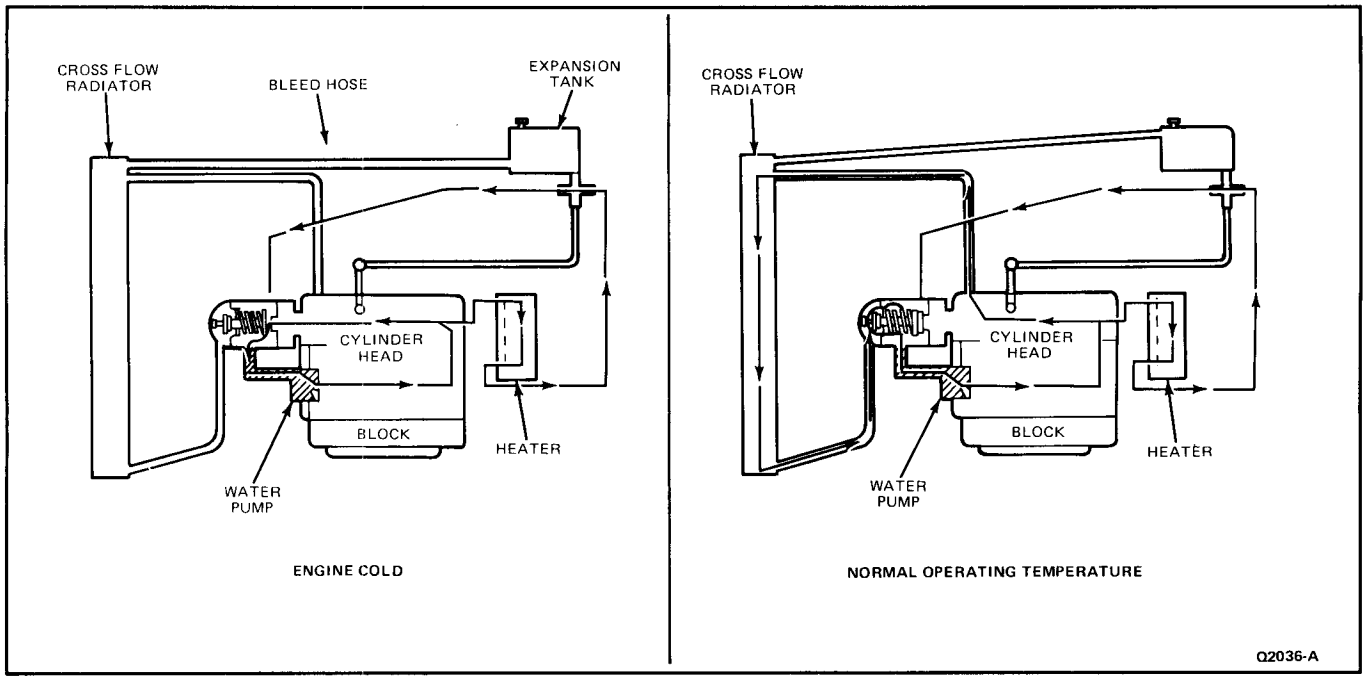


FIG. 1 Coolant Flow

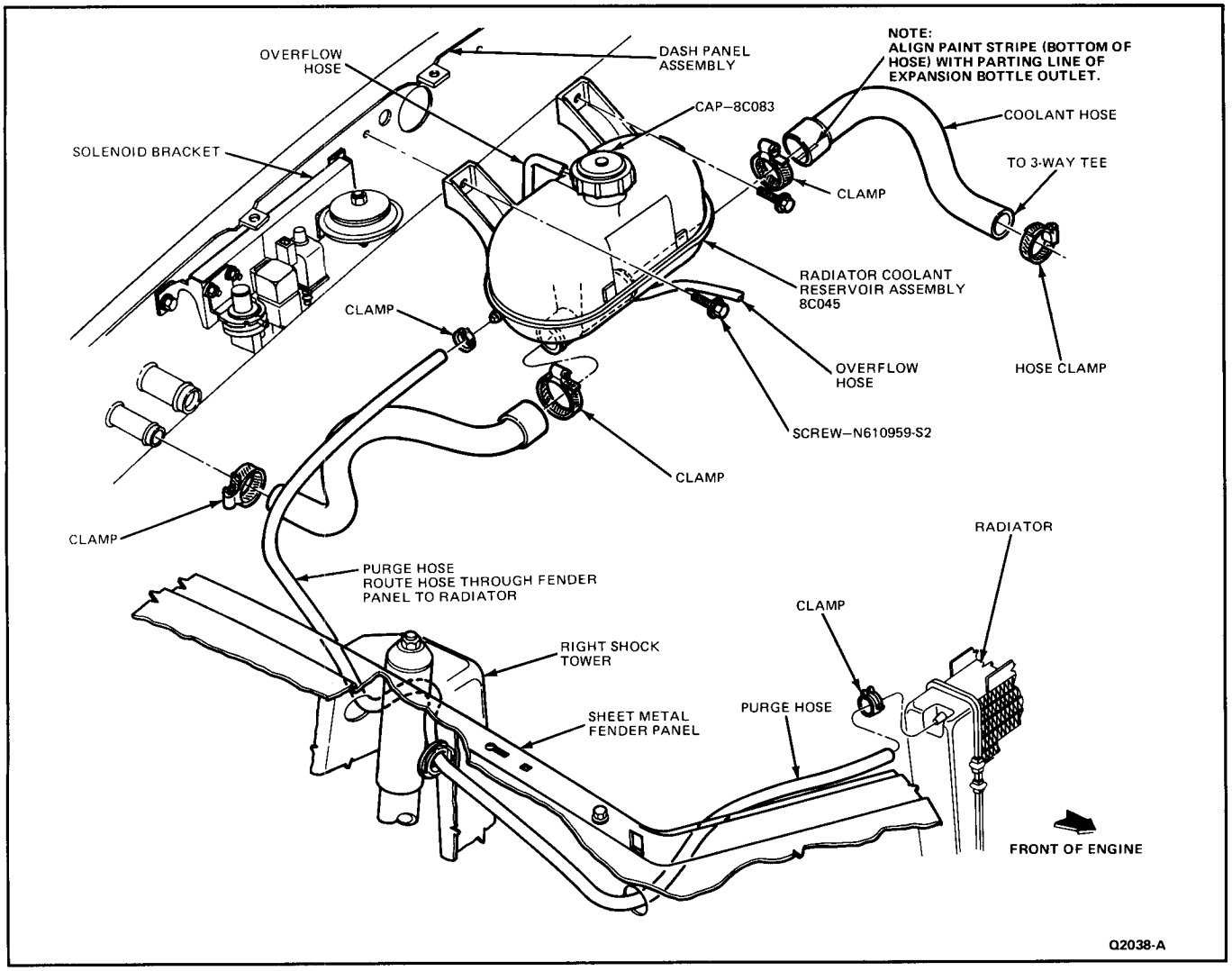


FIG. 2 Expansion Bottle Installation

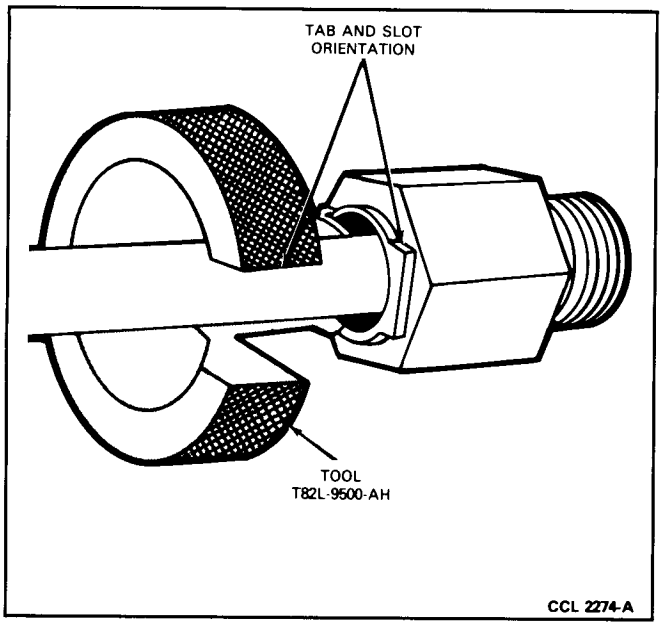


FIG. 3 Oil Cooler Line Quick Connect Coupling Disconnect Tool

Installation

1. If a new radiator is to be installed, remove the draincock from the old radiator and install it on the new radiator.
2. If a new radiator is to be installed, transfer the transmission fluid cooler line connectors (Fig. 4) to the new radiator, using oil resistant sealer.
3. Position the radiator assembly into the vehicle. Install upper supports and secure with the bolts.
4. Connect the transmission fluid cooler lines to the radiator.
5. Place fan shroud into clips on lower radiator support of radiator. Secure to upper support with two bolts. Position shroud to maintain a minimum of 9.7mm (0.38 inch) radial clearance to fan blade tips.
6. Connect the radiator upper, lower and expansion bottle bleed hoses. Close the draincock. Fill the cooling system as outlined.

   WARNING: TO AVOID THE POSSIBILITY OF HUMAN INJURY OR DAMAGE TO THE VEHICLE, DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS BEEN FIRST EXAMINED FOR CRACKS AND SEPARATION.
7. Operate the engine and check for leaks at the hose connections and the automatic transmission fluid cooler lines. Check the automatic transmission and expansion bottle fluid levels.

Expansion Bottle

Removal

1. Drain cooling system.
2. Remove radiator bleed hose and cooling system hoses.
3. Remove two bolts attaching expansion bottle to dash panel (Fig. 2).

Installation

1. Position expansion bottle to dash panel and install with two attaching bolts (Fig. 2).
2. Attach radiator bleed hose and cooling system hose to expansion bottle.
3. Fill cooling systems as outlined.

SERVICE PROCEDURES

Repair of the vacuum brazed aluminum radiator (Fig. 5) can be broken down into three types of service.

- Draincock replacement.
- Tank replacement and/or tank to header leaks.
- Tube to header leaks and/or tube repair.

The recommended service of the vacuum brazed aluminum radiator core is with a two-part epoxy material as outlined.

Draincock Replacement

The draincock (Ford Service Part Number E1FZ-8115-A) is located near the bottom of the inlet tank and can be replaced without removing the tank from the radiator.

Removal

1. Turn the draincock stem counterclockwise to unscrew the stem. When the stem is unscrewed to the end of the threads, pull the stem (Fig. 6) from the radiator tank and draincock body.
2. Remove the draincock body from the radiator tank by squeezing the sides together with a pair of needle nose pliers (Fig. 7). Then, pull the body from the inlet tank.

Installation

1. Check the draincock to be sure the body is installed loosely on the stem (Fig. 8). If the stem is screwed into the body, the draincock cannot be installed into the tank opening.
2. Push the loosely assembled draincock assembly body into the tank opening until it snaps into place.
3. Tighten the draincock stem by turning clockwise to 2.0-2.7 N·m (18-25 lb-in).

Radiator Tank

Removal

The radiator tanks are molded glass filled nylon and are attached to the core header by bending the header tabs over the edge of the tank.

NOTE: The tabs on the vacuum brazed aluminum radiator are more brittle than tabs on previous Ford nylon tank radiators and require special attention to prevent tab damage.

When removing a nylon tank, a screwdriver or one of the various special tools available can be used to open the header tabs. Some of these tools, including a screwdriver, may cause a small section of the header side to bend with the tabs as they are opened (Fig. 9). This slight deformation is permissible, provided the tabs are opened only enough for tank removal. The header sides will usually return to the normal position when the tabs are recrimped during tank installation.

Procedures given are for tank removal using a screwdriver or a Burroughs Tool BT-8260 or equivalent. Follow the manufacturers instructions for other radiator tab opening and closing tools.

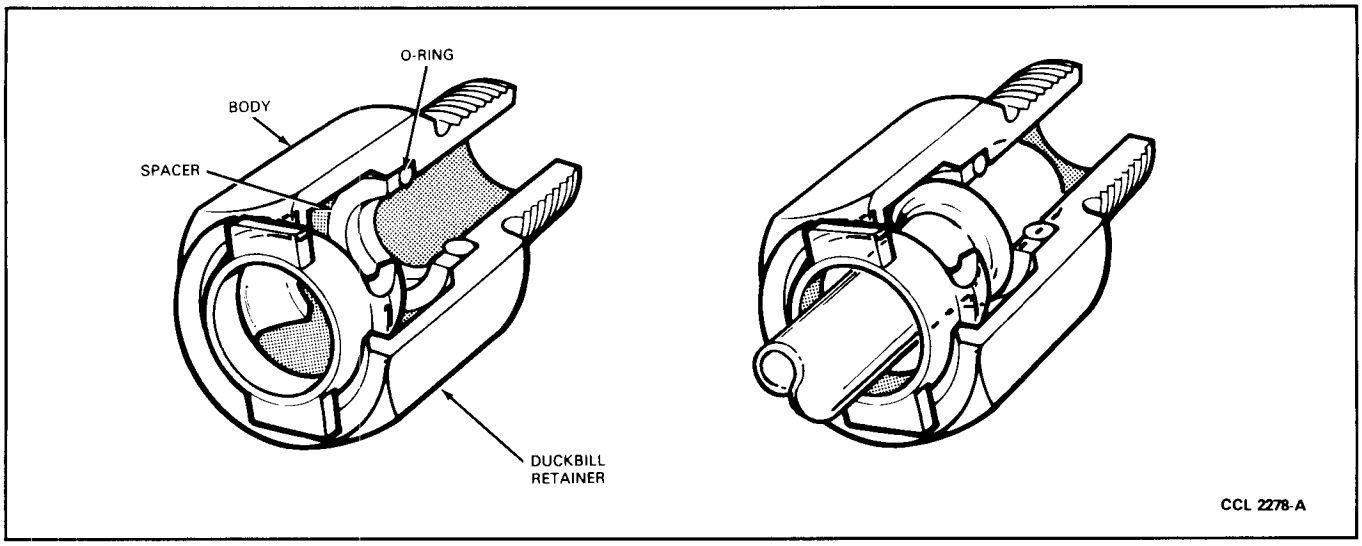


FIG. 4 Oil Cooler Line Quick Connect Coupling—Sectional Views

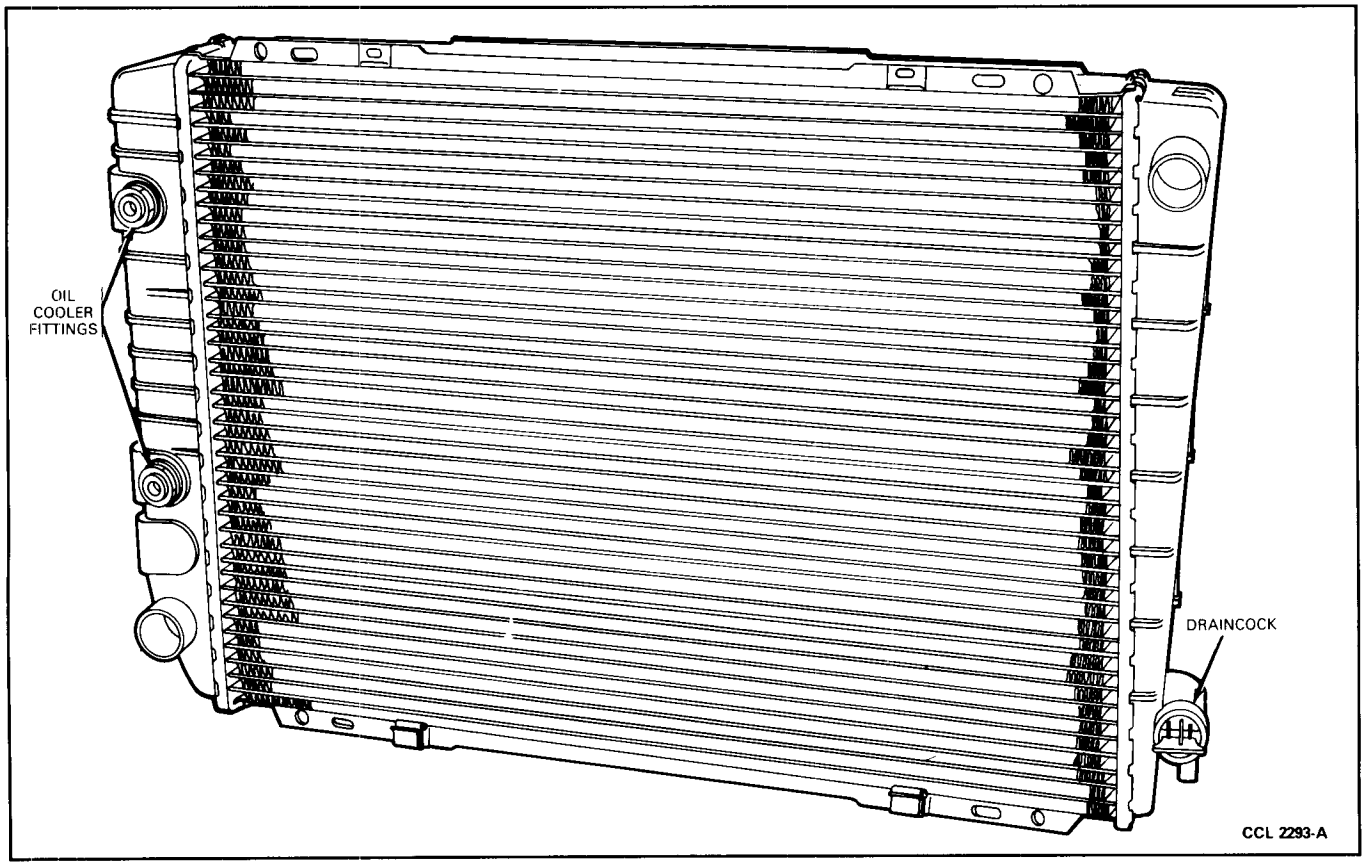


FIG. 5 Radiator, Aluminum

With Screwdriver

1. Insert the end of a medium tip screwdriver between the end of the header tab and the tank. Then, press the screwdriver blade against the tank to bend (pry) the tab away from the tank edge. Repeat this procedure for each tab.

   NOTE: Bend (open) the tabs only enough for tank removal.

2. Lift the tank from the core header when all of the header tabs are bent away from the tank edge.
3. Remove the O-ring seal from the header.

With BT-8260

1. Insert the end of Tool BT-8260 or equivalent between the end of the header tab and the tank. Then, push the tool handle down towards the core to bend the tab away from the radiator tank (Fig. 10). **Do not open the tabs more than is necessary for tank removal.**
2. Repeat Step 1 for each header tab. Then, lift the tank from the header.
3. Remove the O-ring seal from the header.

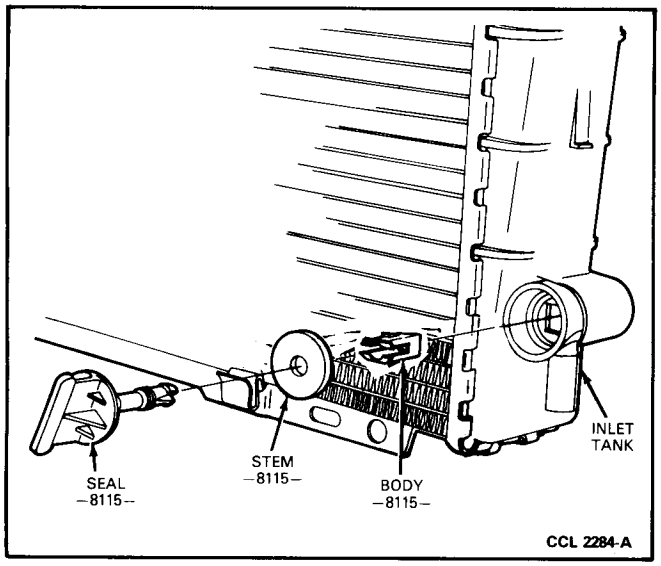


FIG. 6 Draincock—Disassembled

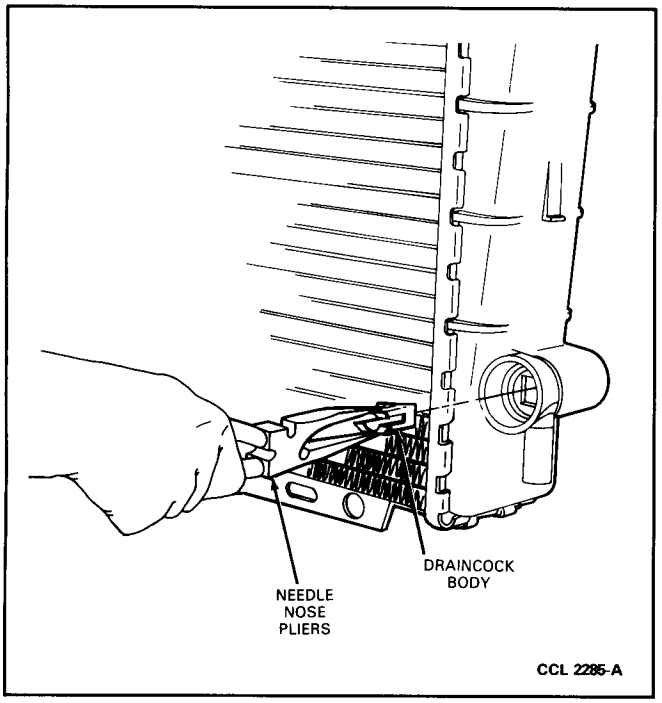


FIG. 7 Removing Draincock Body from Inlet Tank

Installation

NOTE: If any header tabs are missing from an aluminum core, the core should be replaced.

1. Inspect the seal surface of the radiator core header to be sure it is clean and free of foreign material or damage.
2. Check the New O-ring gasket to be sure it is not twisted (Fig. 11).
3. Dip the new O-ring gasket in glycol or silicone or equivalent and place the gasket in the heading groove.
4. If the outlet tank is being replaced and is equipped with an oil cooler, transfer the oil cooler from the replaced tank to the new tank as outlined.

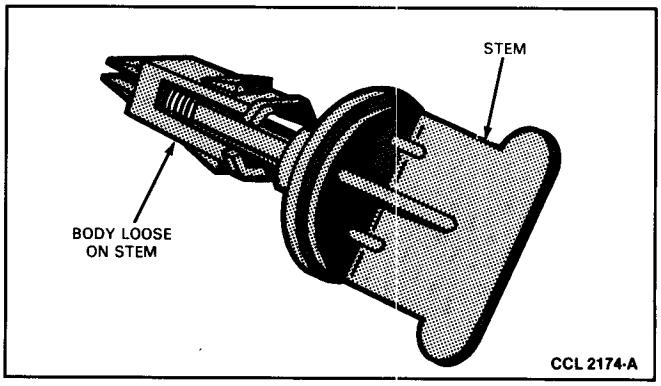


FIG. 8 Draincock Assembled for Installation

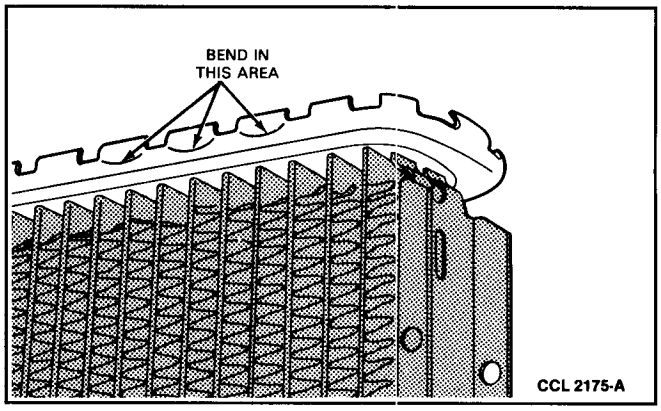


FIG. 9 Header Tabs Opened

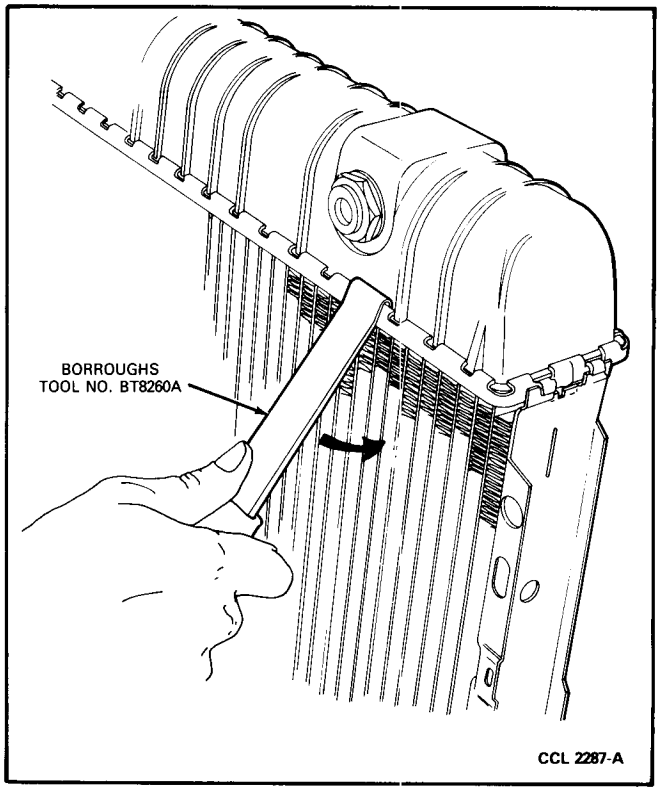


FIG. 10 Opening Header Tabs Using Burroughs Tool

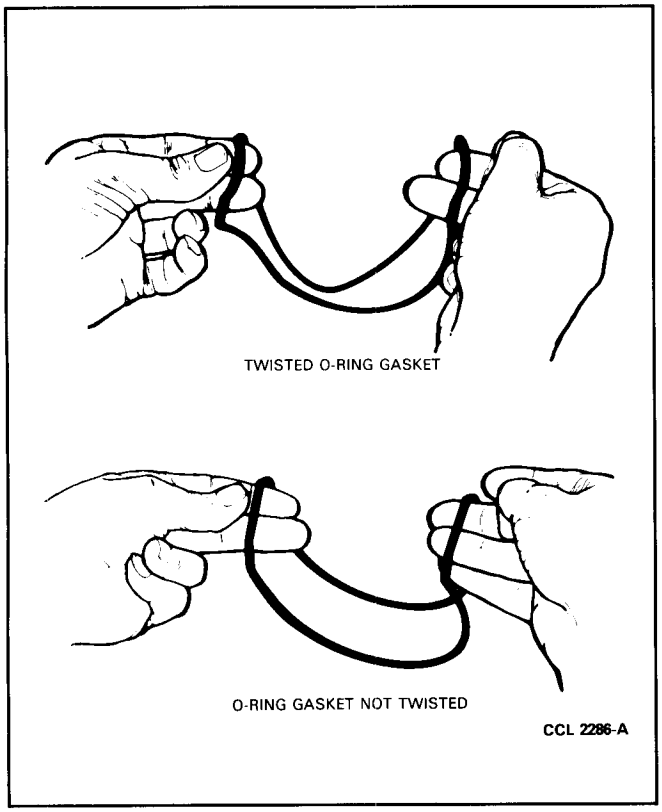


FIG. 11 O-Ring Gasket Check

5. Position the tank to the header using care not to scratch the tank sealing surfaces with the header tabs. Be sure the top and bottom of the tank is positioned properly with the other tank.
6. Clamp the tank in position on the header with two header clamps as shown in Fig. 12. Tighten the header clamps to compress the O-ring gasket.
7. If locking type pliers are used to squeeze the header tabs against the tank, install a hex nut on the pliers adjusting screw (Fig. 13).
8. With the jaws of the locking type pliers closed and locked, turn the adjusting screw to position the jaws against the shank of a 13/32 inch drill bit (Fig. 13). Then, tighten the hex nut on the adjusting screw against the handle to lock the adjustment in place.
9. Squeeze the header tabs down against the lip of the tank base with the locking type pliers while rotating the pliers toward the tank (Fig. 14).
10. If a special crimping tool is used such as the one shown in Fig. 15, follow the manufacturers instructions. It is however, important that the assembled height of the crimp be 13/32 inch when measured from the bottom of the header to the top of the tab (Fig. 16).
11. Remove the header clamps from the radiator and squeeze the header tab(s) down that were behind the clamps.

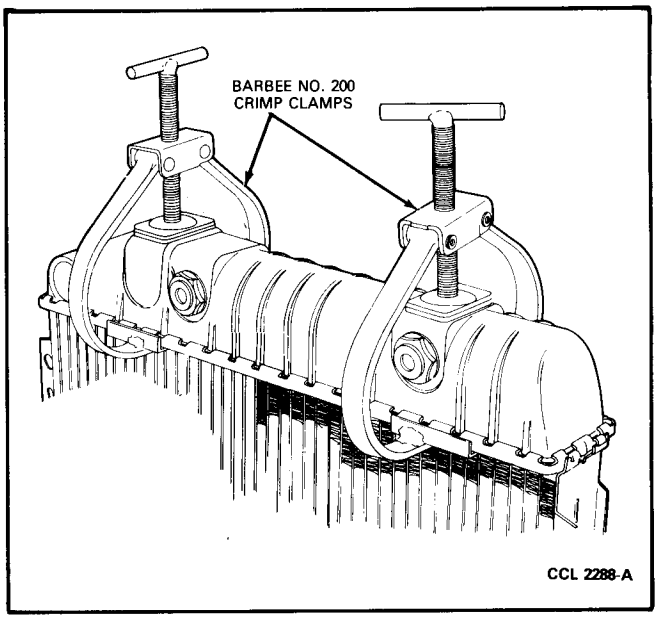


FIG. 12 Tank Clamped to Header for Crimping

12. Leak test the radiator at 21 psig. Most minor leaks at the header to tank seal can be corrected by again squeezing the header tabs down against the tank lip in the area of the indicated leak.

Core Repair

At the preset time, the only approved repair method for the aluminum radiator core is using a 2 component epoxy material. The materials and supplies necessary to repair the aluminum core are:

- EPOXI-PATCH KIT No. 6C Aluminum Hysol Division of the Dexter Corporation, Olean, New York 14760.
- Sandpaper and/or emery paper — 80 or 100 Grit.
- Stainless steel wire brush No. 23151 or equivalent. The Milwaukee Brush Manufacturing Co., Menomonee Falls, Wisconsin 53051.
- 375 watt heat lamp.
- Mixing card and spatulas.

Procedure

1. Thoroughly clean the area around the leak with a stainless steel wire brush (Fig. 17) and, if necessary, emery paper to get to hard to reach areas. **DO NOT USE WIRE BRUSHES THAT ARE NOT STAINLESS STEEL.** Use the brush on the epoxy coating as well as on the aluminum.
2. Squeeze a bead (length) of repair material Part A (resin) on a clean, dry, disposable flat mixing surface. Use uniform pressure to obtain an even bead.

   NOTE: Observe all cautions and warnings printed on the repair material containers.
3. Squeeze an equal length bead of hardener (Part B) parallel to the Part A bead.

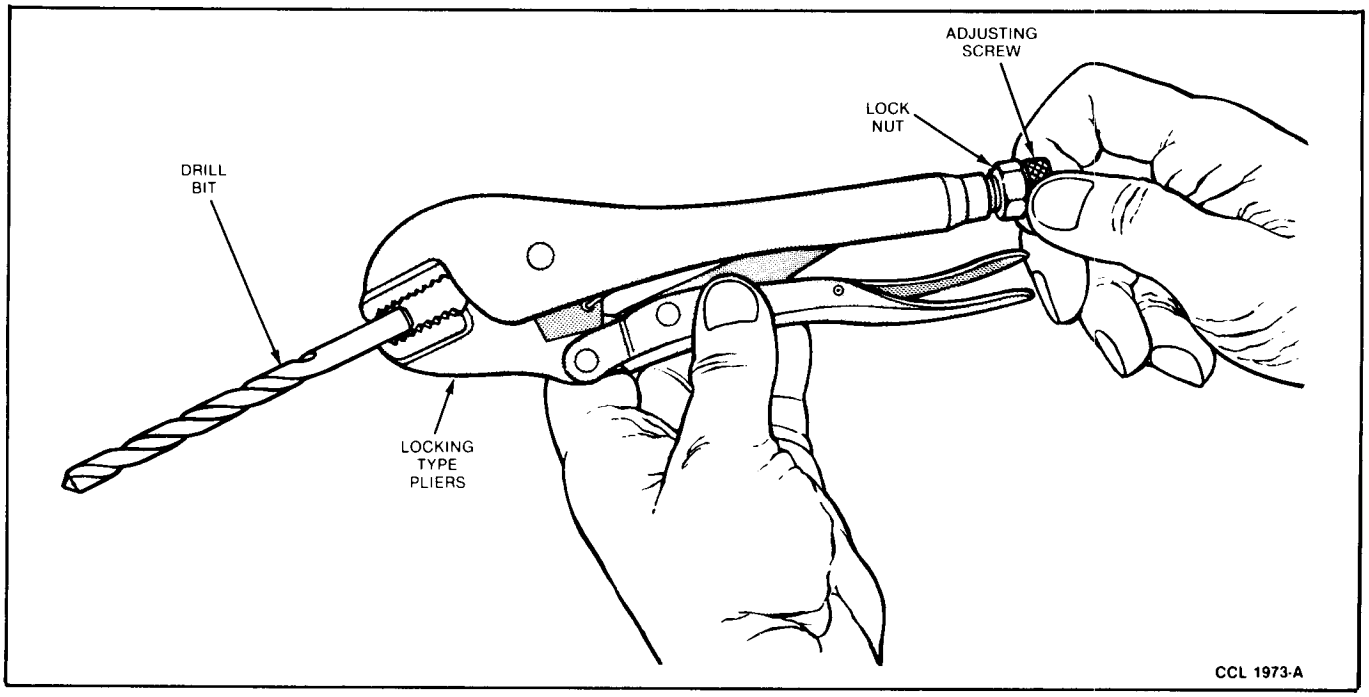


FIG. 13 Jaw Adjustment to Specified Opening

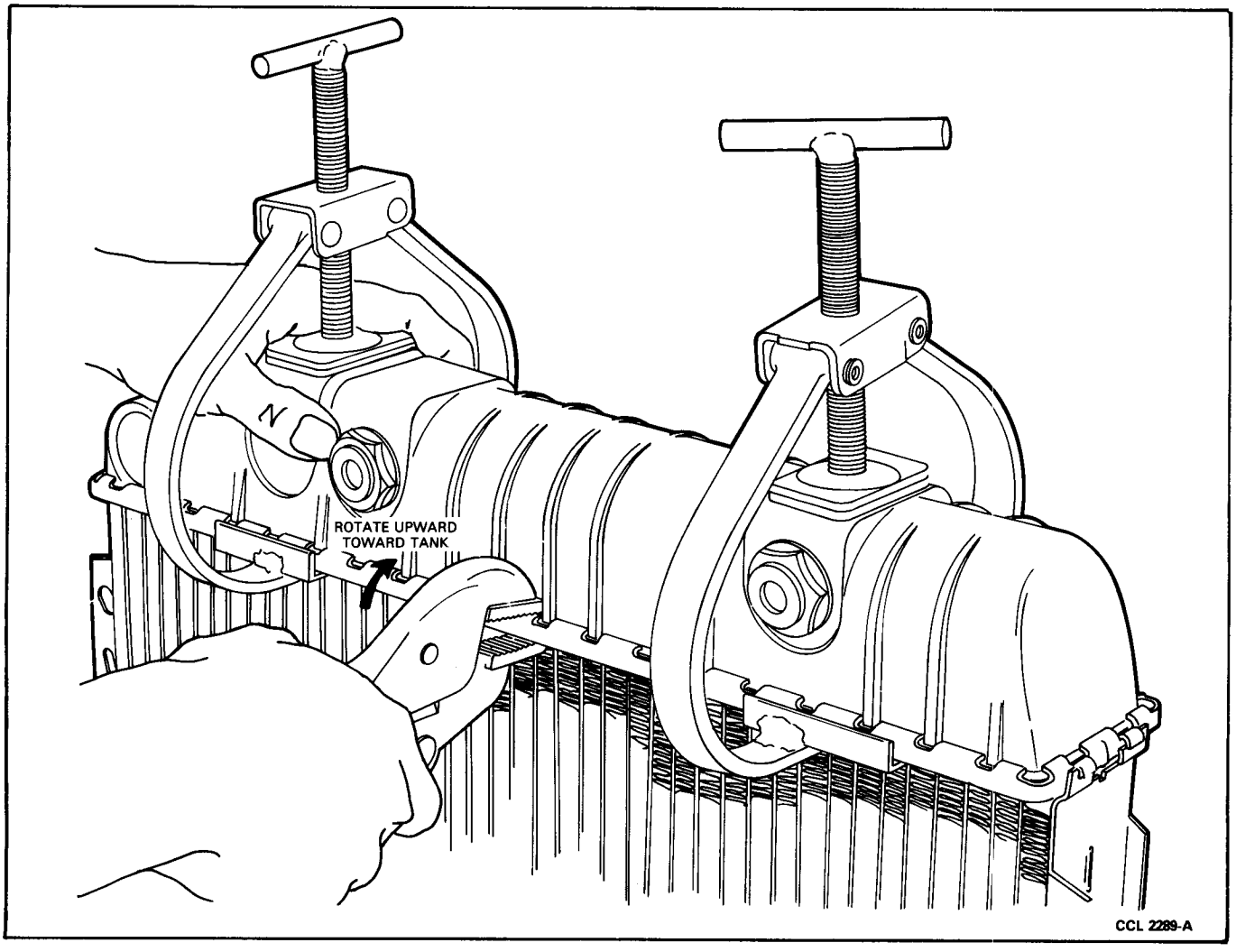


FIG. 14 Header Tabs Installation

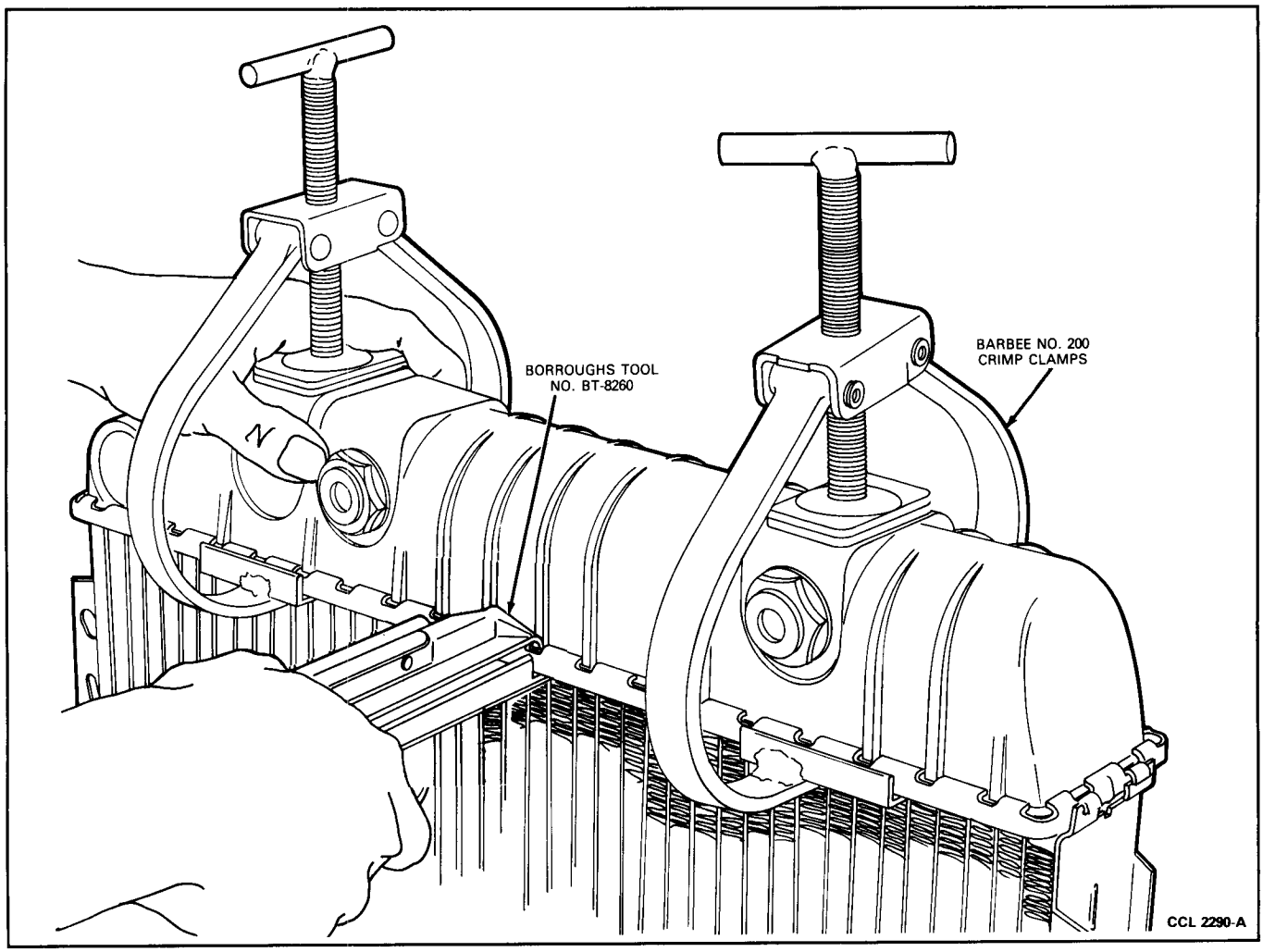


FIG. 15 Crimp Header Tabs with Burroughs Tool

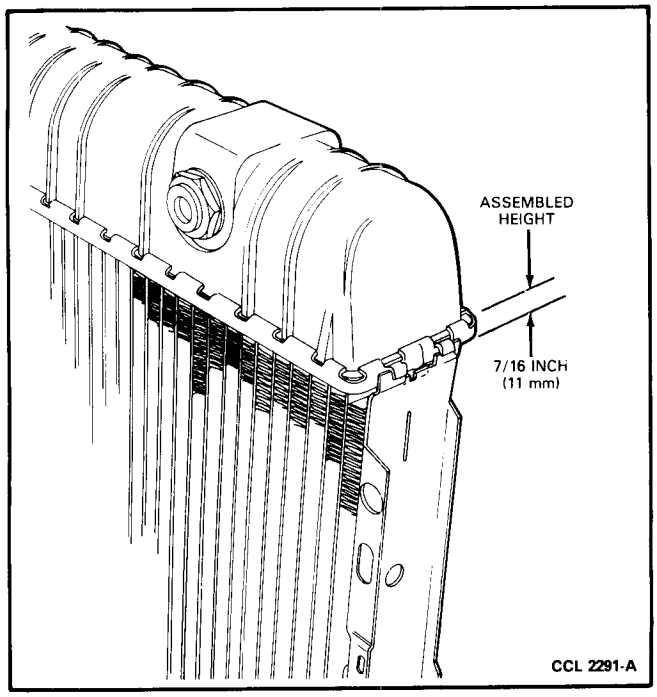


FIG. 16 Crimp Assembled Height

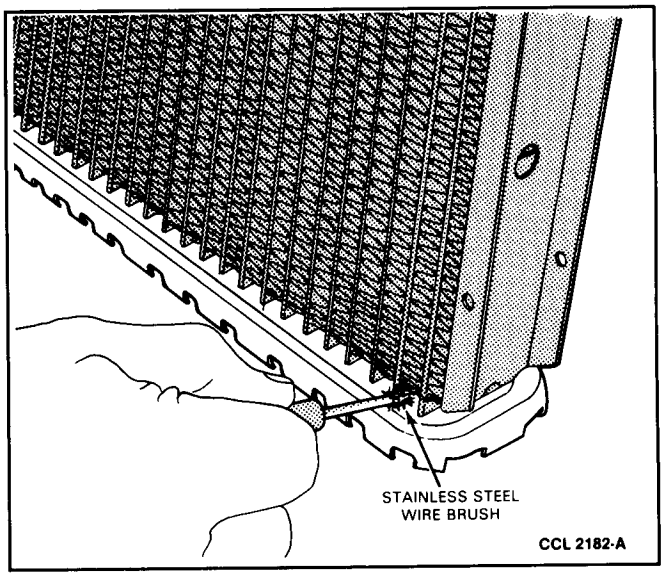


FIG. 17 Cleaning Repair Area With Stainless Steel Wire Brush

4. Mix parts A and B together.
5. If it is necessary to have the epoxy flow to obtain a satisfactory repair, warm the core around the leak with a 375 watt heat lamp. Then, apply the repair material to the leak (Fig. 18).
6. Position the 375 watt heat lamp, 305mm (12 inches) from the repair and allow the repair to cure for 2 hours (Fig. 19). **DO NOT** position the heat lamp closer to the repair than 305mm (12 inches). **DO NOT** use a heat gun or **overheat** the repair material.
7. Leak test the repair by clamping the tank to the header with No. 200 crimp clamps or equivalent. After a successful leak test, install the radiator tank as outlined.

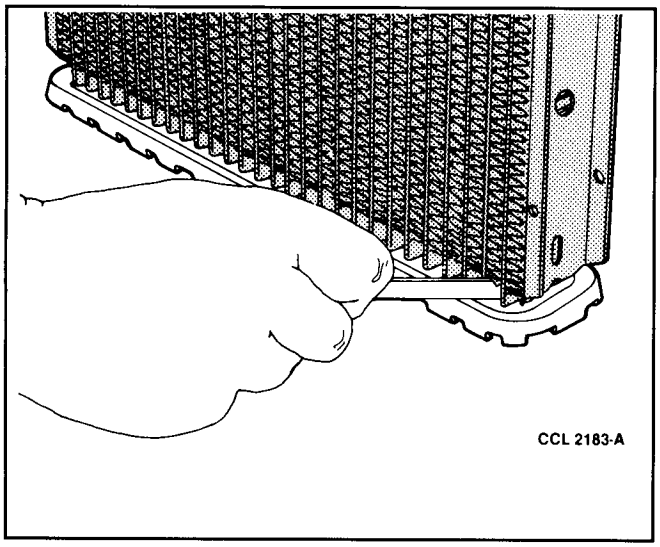


FIG. 18 Applying Repair Material

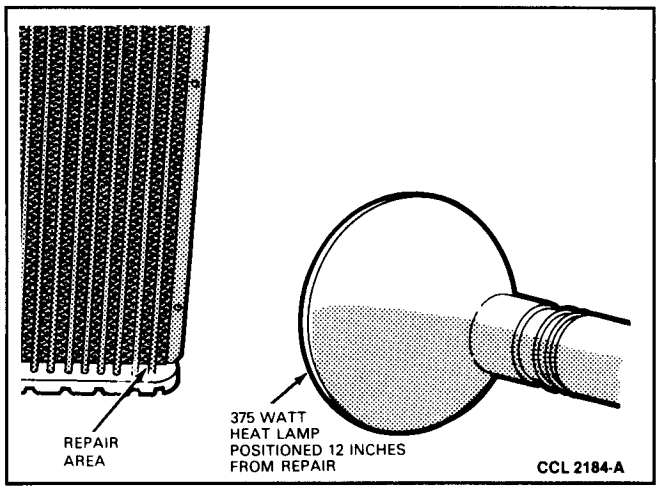


FIG. 19 Heat Lamp Positioned to Cure Repair

Oil Cooler Transfer or Replacement

Removal

1. Remove the outlet tank from the radiator following the procedure given for radiator tank removal.
2. Remove the retaining nuts and washers from the oil cooler inlet and outlet connections (Fig. 20). Then, lift the oil cooler from the radiator outlet tank.
3. Remove the rubber gaskets from the oil cooler inlet and outlet connections if the oil cooler is to be reused.

Installation

1. Install new rubber gaskets (Fig. 20) on the oil cooler inlet and outlet connections.
2. Position the oil cooler to the radiator outlet tank and insert the inlet and outlet connections through the holes in the outlet tank.
3. Install the flat washer and nut on each oil cooler connection to retain the oil cooler in the radiator outlet tank.
4. Tighten the oil cooler retaining nuts to 12-15 N·m (9-11 lb-ft).
5. Install the outlet tank on the radiator core header as outlined.
6. Clamp the tank in position on the header with two header clamps as shown in Fig. 12. Tighten the header clamps to compress the O-ring gasket.
7. If locking type pliers are used to squeeze the header tabs against the tank, install a hex nut on the pliers adjusting screw (Fig. 13).
8. With the jaws of the locking type pliers closed and locked, turn the adjusting screw to position the jaws against the shank of a 13/32 inch drill bit (Fig. 13). Then, tighten the hex nut on the adjusting screw against the handle to lock the adjustment in place.

SPECIAL SERVICE TOOLS AND EQUIPMENT

- No. 200 Crimp Clamp
  The Barbee Company
  P.O. Box 323
  Louisville, Kentucky 40201.
- No. 23151 Stainless Steel Wire Brush
  The Milwaukee Brush Manufacturing Co.
  P.O. Box 830
  Menomonee Falls, Wisconsin 53051.
- Heat Lamp and Socket—375 Watt.
- Sandpaper or Emery Paper 80 or 100 Grit.
- Methylene Chloride Solvent.
- Mixing Card.
- Spatulas—Wood.
- Epoxi-Patch Kit No. 6C Aluminum
  Hysol Division of the Dexter Corporation
  Olean, New York 14760.
- O.T.C. Line Disconnect Tool T82L-9500-AH.
- Tool BT8260 and 8260-A Radiator Core Remover and Replacer
  Burroughs Tool and Equipment Corporation
  2429 North Burdick St.
  Kalamazoo, Michigan 49007.

SECTION 27-05 Fan Drive Clutch

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION AND OPERATION

The fan clutch (Fig. 1) permits use of a powerful fan without paying the penalty of power loss or noise. It is basically a temperature-controlled fluid coupling that regulates fan speed according to the temperature of the air coming through the radiator core and flowing around the bimetal control valve located on the forward face of the clutch.

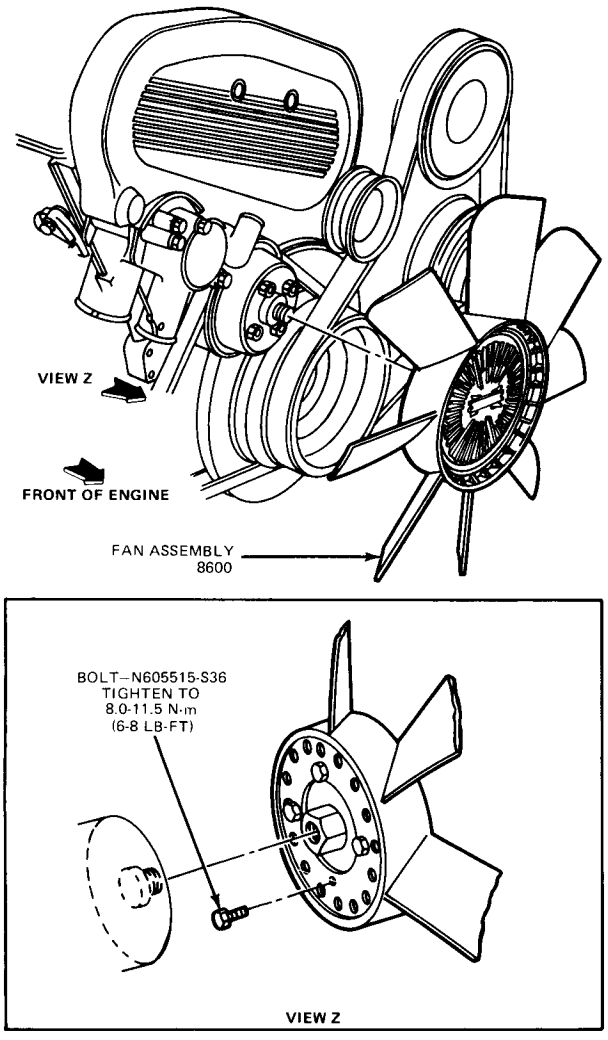


FIG. 1 Viscous Clutch—Installation

REMOVAL AND INSTALLATION

WARNING: TO AVOID THE POSSIBILITY OF HUMAN INJURY OR DAMAGE TO THE VEHICLE, DO NOT OPERATE THE ENGINE WITH THE HOOD OPEN UNTIL THE FAN HAS BEEN FIRST EXAMINED FOR POSSIBLE CRACKS AND SEPARATION.

Removal

1. Remove the cooling fan shroud.
2. Using Water Pump Holding Tool T84P-6312-A and Fan Clutch Wrench T84P-6312-B or equivalent, remove the viscous clutch from the water pump hub (Fig. 2).

   CAUTION: This nut has a left-hand thread and must be rotated clockwise for removal.
3. Remove the bolts attaching the fan to the viscous clutch, if necessary.

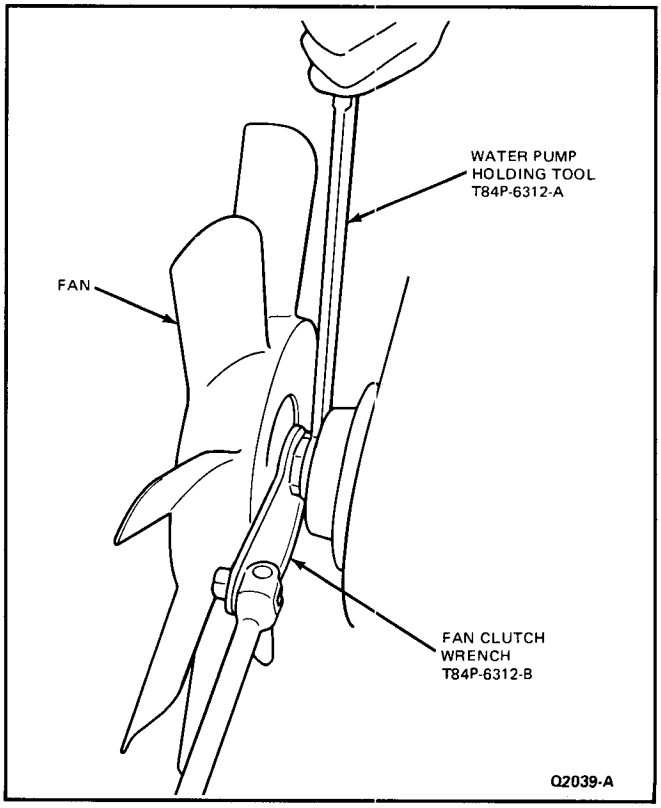


FIG. 2 Fan Clutch—Removal and Installation

Installation

1. Install the fan on the viscous clutch, if removed, and tighten the bolts to 8-11.5 N·m (6-8 lb-ft).
2. Install the fan assembly on the water pump hub using Water Pump Holding Tool T84P-6312-A and Fan Clutch Wrench T84P-6312-B, or equivalent.

   CAUTION: This nut has a left-hand thread and must be rotated counter-clockwise to tighten.

3. Tighten the nut to 41 N·m (30 lb-ft).
4. Install the cooling fan shroud.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft
Fan to Fan Clutch	8-11.5	6-8
Fan Clutch to Water Pump	41	30

CQ2028-A

SPECIAL SERVICE TOOLS

Tool Number	Description
T84P-6312-A	Water Pump Holding Tool
T84P-6312-B	Fan Clutch Wrench

CQ2030-A

SECTION 27-10 Fan, Electro-Drive Cooling

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The 2.4L Diesel engine has an electric pusher fan mounted behind the grill (Fig. 1), in addition to the belt driven engine cooling fan attached to the water pump.

The electric cooling fan system consists of a fan and an electric motor mounted to the fan shroud, an ambient temperature switch and a cooling fan relay (Fig. 2).

The electric cooling fan is wired to operate only when the A/C compressor is operating and the ambient temperature is above 7°C (70°F). The cooling fan relay (Fig. 3), is energized by power from the A/C blower motor speed controller which then allows battery current to flow to the electric cooling fan. The cooling fan relay is energized only when the A/C compressor clutch field coil is engaged and the ambient temperature switch, located on the hood lock support, is closed. The electric cooling fan will only operate when the ignition switch is in the Run position, since the A/C system can only operate when the ignition switch is in Run.

The A/C clutch field coil is powered through the A/C cutout relay, which is energized to turn off power to the clutch field coil in one of two ways:

1. With EGR vacuum below 24 kPa (7 in. Hg) and turbo boost pressure below 14 kPa (2 psi) the A/C cutout switch and the A/C turbo boost switch are closed, providing a ground to energize the A/C cutout relay. With the relay energized, the current to the A/C clutch field coil is turned off.
2. With engine coolant temperature above 112°C (233°F), the coolant temperature switch closes, providing the ground to energize the A/C cutout relay.

WARNING: DISCONNECT THE COOLING FAN PRIOR TO PERFORMING ANY UNDERHOOD SERVICE SINCE THE FAN COULD CYCLE IF THE IGNITION SWITCH IS LEFT IN THE ON POSITION AND THE A/C IS TURNED ON, EVEN THOUGH THE ENGINE IS NOT RUNNING.

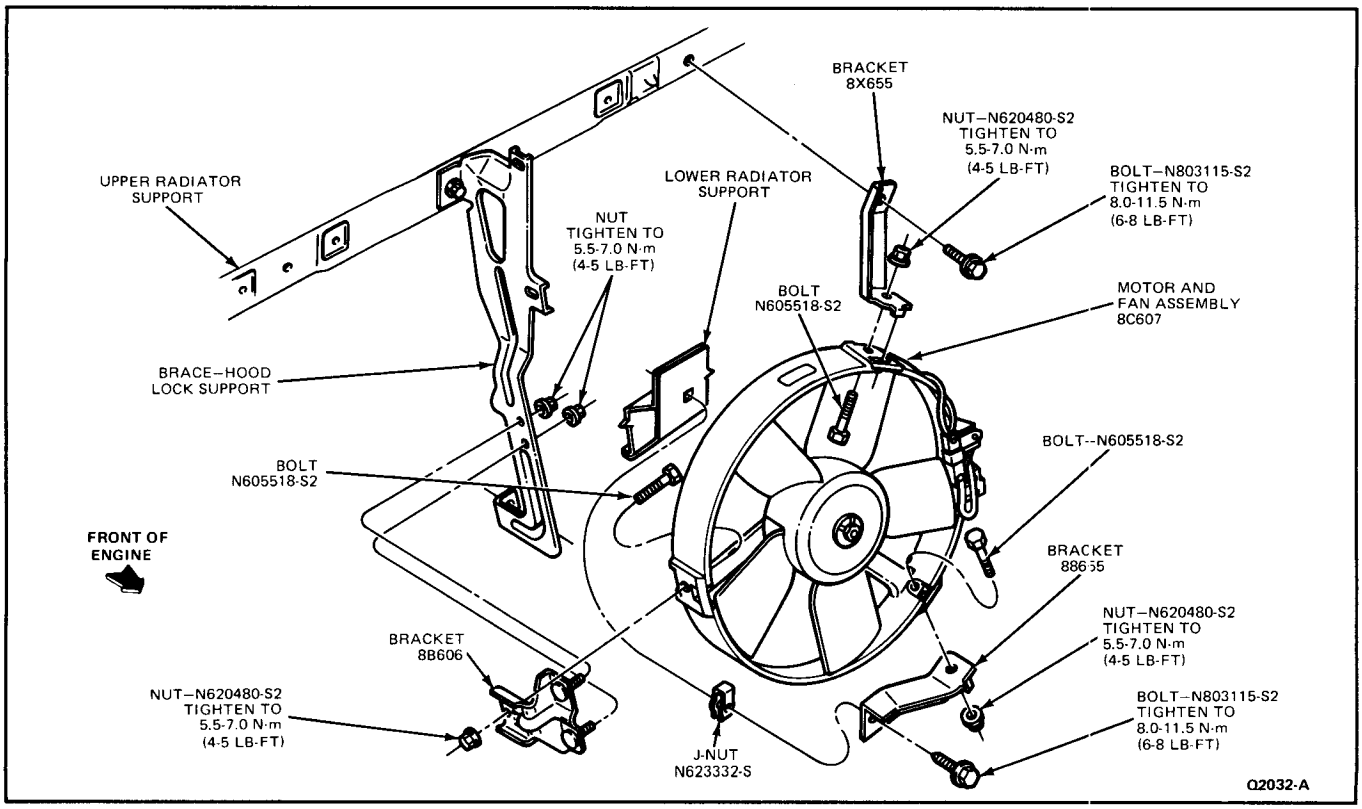


FIG. 1 Cooling Fan Installation

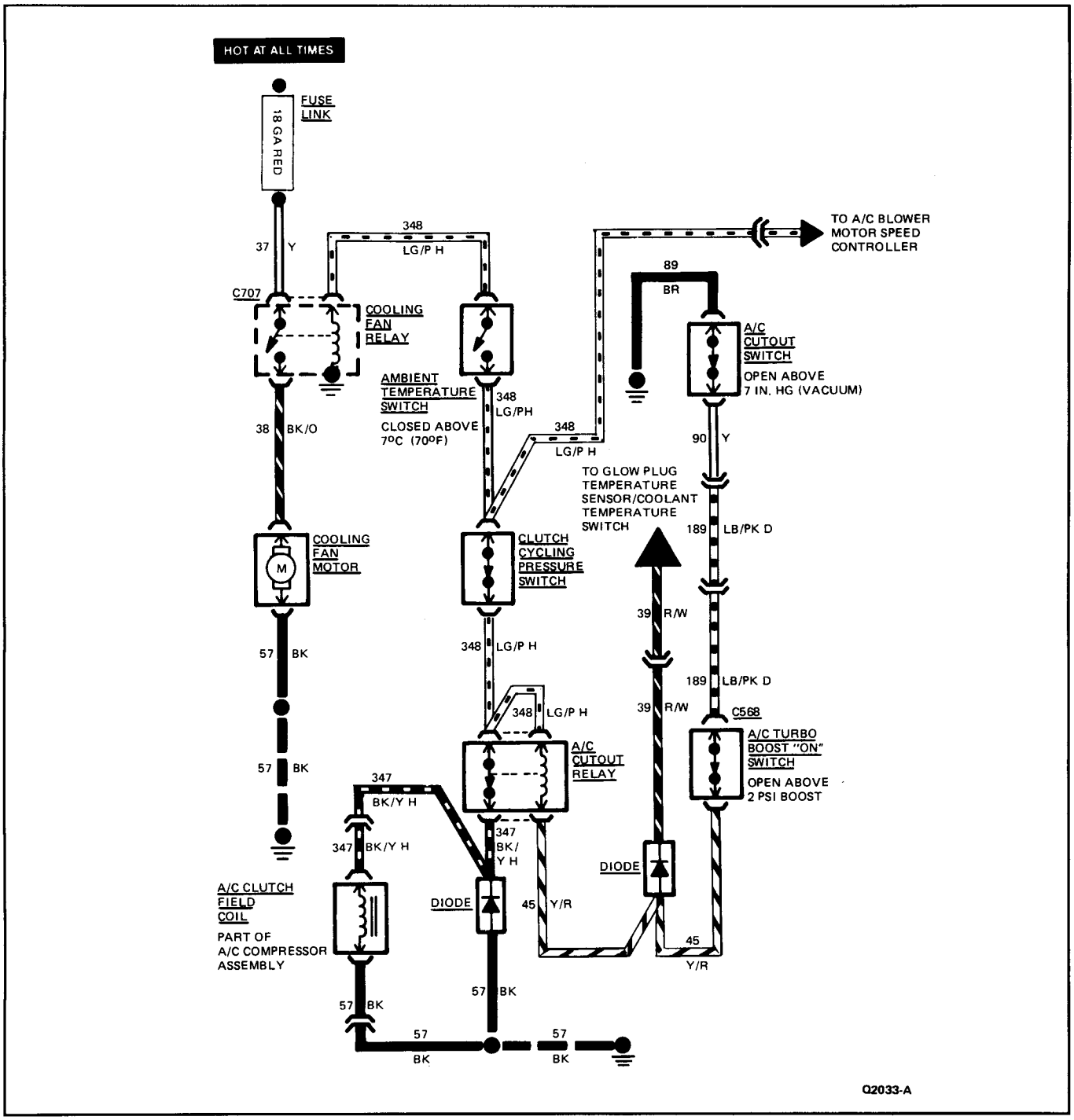


FIG. 2 Cooling Fan Electrical Schematic

REMOVAL AND INSTALLATION

Cooling Fan

Procedures not available at time of publication.

Cooling Fan Relay

Removal and Installation

1. Disconnect battery ground cable.
2. Disconnect cooling fan relay connector.
3. Remove two screws retaining relay to right shock tower and remove relay.
4. To install, reverse Steps 1, 2 and 3.

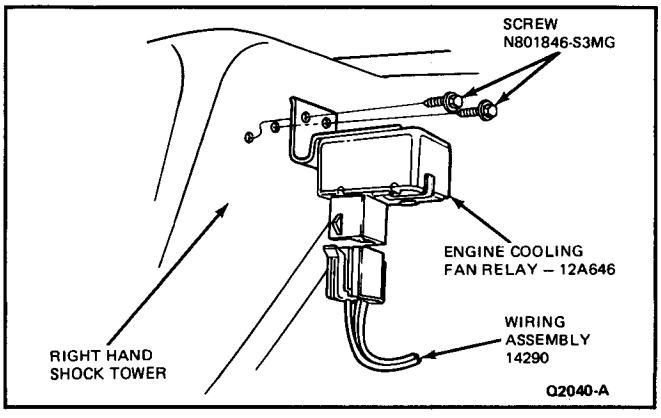


FIG. 3 Cooling Fan Relay

SECTION 28-05 Starter—2.4L Diesel

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION AND OPERATION

The 2.4L diesel starter is a 12-volt unit that has the solenoid mounted on the starter housing (Figs. 1 and 2). The solenoid is energized when the starter relay contacts are closed. This action engages the starter drive with the flywheel ring gear, starting the engine. An overrunning clutch in the drive protects the starter from excessive speed when the engine starts. The current flows through the solenoid energizing coil until the solenoid plunger is at the end of its travel. The plunger then closes a set of contacts that by-pass the energizing coil, letting the holding coil keep the starter drive engaged and passing starting current to the starter.

TESTING

Road Service

On road service calls or cases of a starter that will not crank the engine or a starter that cranks very slowly, a booster battery may be connected to the 12-volt system. If the engine still will not turn with the booster connected, refer to the following tests:

Jump Starting

Negative Grounded Battery

CAUTION: To prevent damage to electrical or lighting components during jump starting, the following procedure must be followed:

1. Turn all lamps Off before and during jump starting.
2. Turn heater blower motor On to remove transient voltage.

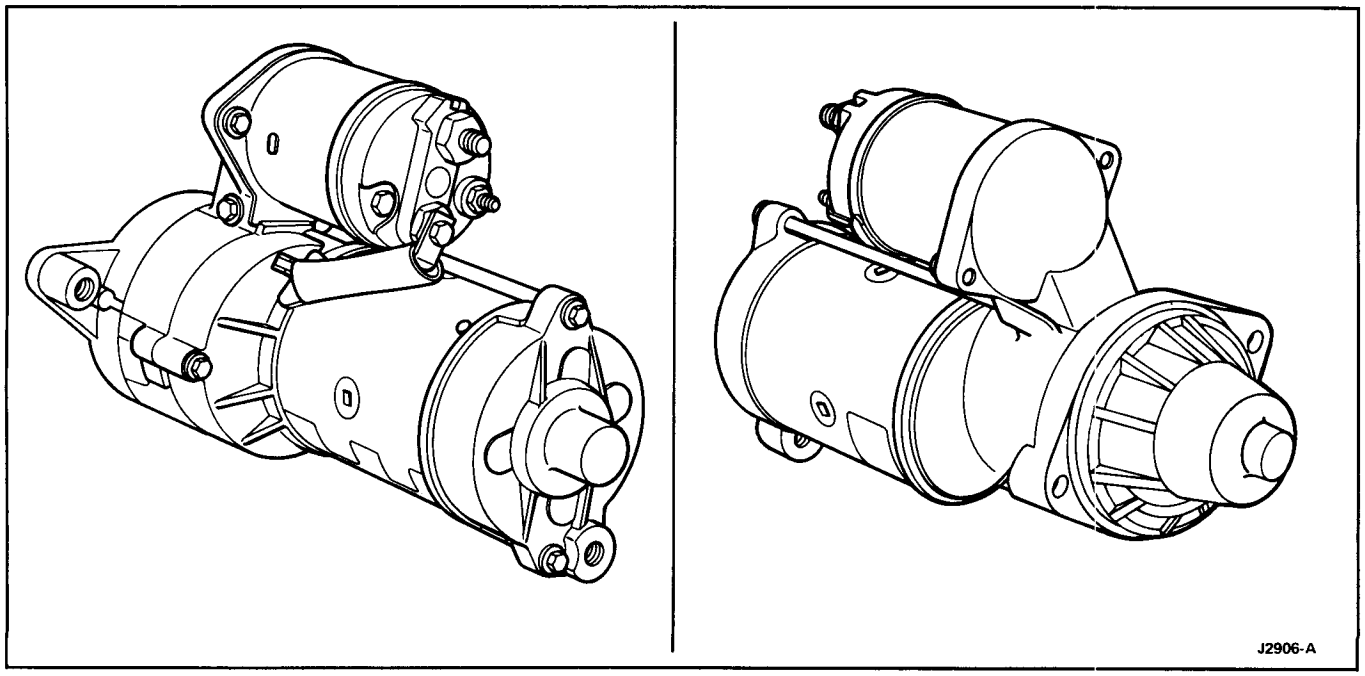


FIG. 1 Starter Assembly—2.4L Diesel Engine

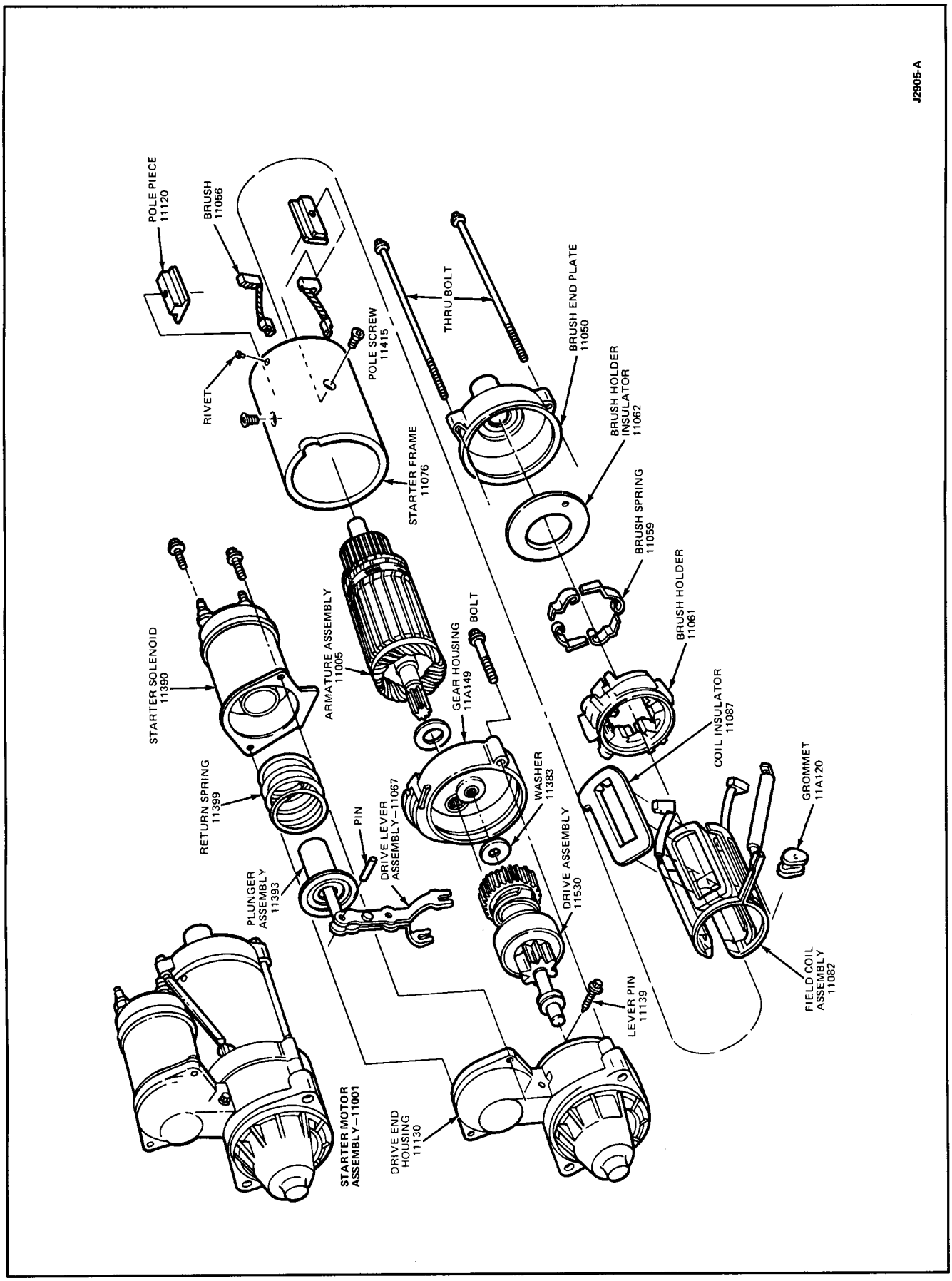


FIG. 2 Starter—Disassembled View

3. Shield eyes. Use safety goggles or similar eye protection.
4. Connect one end of the other cable to negative (-) terminal of booster battery.
5. Connect other end of cable to engine bolthead or similar good contact spot on the vehicle being started (NOT to negative (-) terminal of battery).
6. To prevent damage to other electrical components on vehicle being started, make certain that engine is at idle speed before disconnecting jumper cables.
7. Remove cable from engine block before disconnecting cable from battery positive terminal. Lamps may now be turned On.

WARNING: BATTERIES ARE HEAVY, WEIGHING 30 LBS. OR MORE. LIFT THEM WITH YOUR LEGS RATHER THAN YOUR BACK TO PREVENT MUSCLE STRAINS, AND BE CAREFUL NOT TO DROP THEM (POSSIBLE BREAKAGE) NOR TO SPILL THE CONTENTS (SULFURIC ACID).

CAUTION: 12-volt starting motors can be damaged beyond repair if connected to a 24-volt power supply (two 12-volt batteries in series, or a 24-volt motor-generator set), even when cranking loads are relatively light. Extensive starting motor damage is more likely if the starter is connected to a 24-volt supply while being subjected to prolonged heavy cranking loads such as attempting to start an engine in subzero temperatures.

On Vehicle Testing

Starter Cranks Slowly:

1. **Battery:** Use jumper cables per instructions. If this corrects problem, check condition of battery, recharge or replace if necessary. Clean battery posts, cable lugs and tighten. Refer to the 1984 Car Shop Manual, Volume B, Section 31-02.
2. **Cables:** If above does not correct problem, clean and tighten connections at starter, relay and battery ground on engine. Eyelet terminals should not be easily rotated by hand. Also check for short to ground.

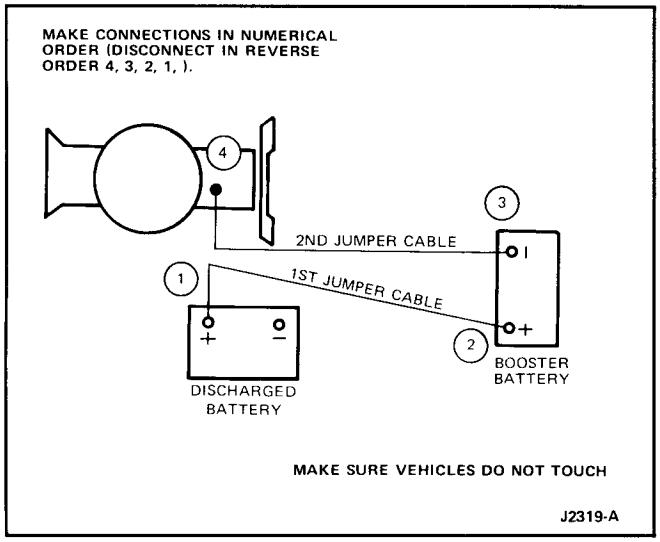


FIG. 3 Jump Starting—Cable Hookup

3. **Starter:** If above does not correct problem, replace starter.

Starter Does Not Crank But Starter Solenoid Operates (Clicks):

1. **Battery:** Use jumper cables, check battery, etc. as above.
2. **Cable:** Clean and tighten connections at starter and relay. Make sure wire strands are secure in eyelets.
3. **Starter:** Jumper terminals B and M on starter solenoid (Fig. 1). If starter does not operate, replace starter.

Starter Does Not Crank and Relay Chatters Or Does Not Click:

1. **Battery:** Use jumper cables, check battery, etc. as above.
2. **Relay:** Remove push-on connector from relay terminal S and make sure connection is clean and secure.

   If connections are good, check operation by jumping with push-on connection off and transmission in Neutral. Jumper terminal to battery positive connection at relay. If this corrects problem, check ignition switch, and wiring in start circuit for open or loose connections.

   If jumper across solenoid does not correct problem, replace relay.

Starter Spins (Humming Noise) But Does Not Crank Engine:

Starter: Remove and check driveshaft for corrosion, clean or replace. If no corrosion, drive assembly is slipping and must be replaced.

Starter Load Test

Conduct this test if the starter cranks slowly and a comparison of the current output with specifications is desired.

Connect the test equipment as shown in Fig. 4. Be sure that no current is flowing through the ammeter and heavy-duty carbon pile rheostat portion of the circuit (rheostat at maximum counterclockwise position).

Crank the engine with the ignition Off, and determine the exact reading on the voltmeter. This test is accomplished by disconnecting the push-on connectors at the starter relay and by connecting the remote control starter switch from the positive battery terminal to the S terminal of the starter relay.

Stop cranking the engine. Then reduce the resistance of the carbon pile until the voltmeter indicates the same reading as that obtained while the starter cranked the engine. The ammeter will indicate the starter current draw under load. Refer to Specifications.

Bench Tests

Starter No-Load Test

The starter no-load test will uncover open or shorted windings, rubbing armature, and bent armature shaft.

The starter can be tested, without a load, on the test bench only.

Make the test connections as shown in Fig. 5. The starter will run without a load. Be sure that no current is flowing through the ammeter (rheostat at maximum

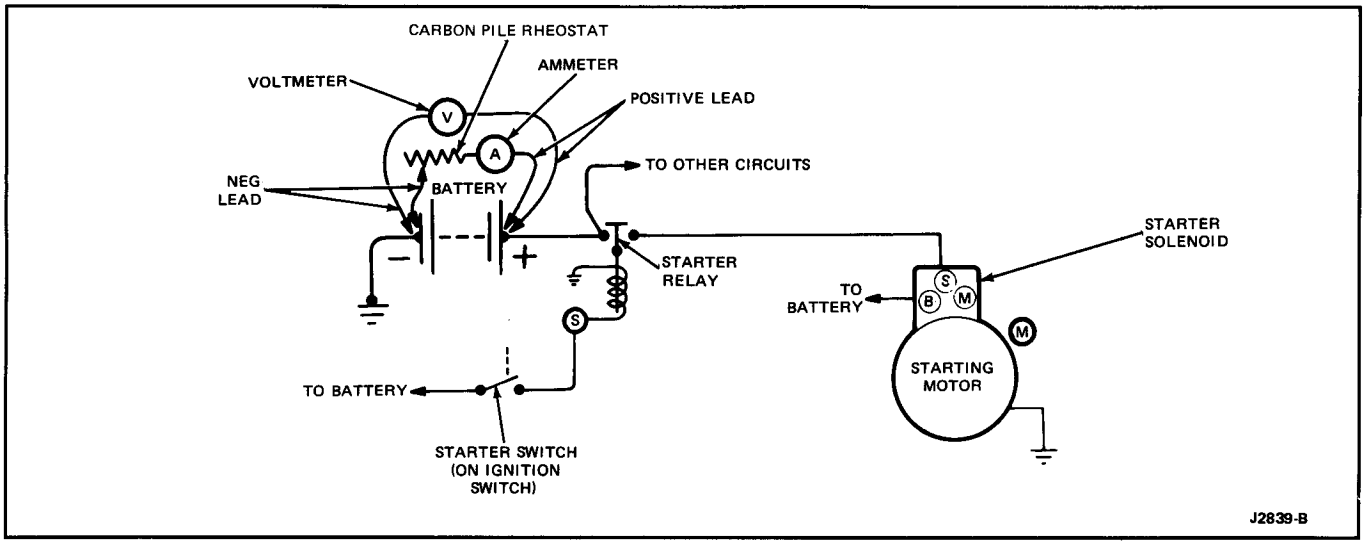


FIG. 4 Starter Load Test

counterclockwise position). Determine the exact reading on the voltmeter.

Disconnect the starter from battery. Then, reduce the resistance of the rheostat until the voltmeter indicates the same reading as that obtained while the starter was running. The ammeter will indicate the starter no-load current draw.

Armature Open Circuit Test

An open circuit armature may sometimes be detected by examining the commutator for evidence of burning. A spot burned on the commutator is caused by an arc formed every time the commutator segment connected to the open circuit winding passes under a brush.

Armature and Field Grounded Circuit Test

This test will determine if the winding insulation has been damaged, permitting a conductor to touch the frame or armature core.

To determine if the armature windings are grounded, check with a VOM, as shown in Fig. 6. Infinite resistance indicates a normal condition.

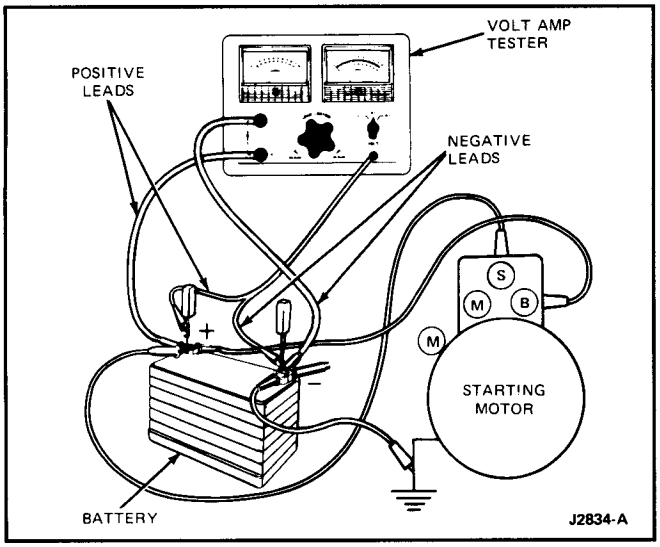


FIG. 5 Starter No-Load Test

Check the insulation between the yoke and field terminal with a VOM, as shown in Fig. 7. Infinite resistance indicates a normal condition.

Check the continuity between the lead wires with the VOM. If continuity exists, the connection is good.

Starter Solenoid Test

Using a VOM, check for continuity between S terminal and M terminal, and between S terminal and ground (body). If there is no continuity, the wire is broken and solenoid should be replaced (Fig. 8).

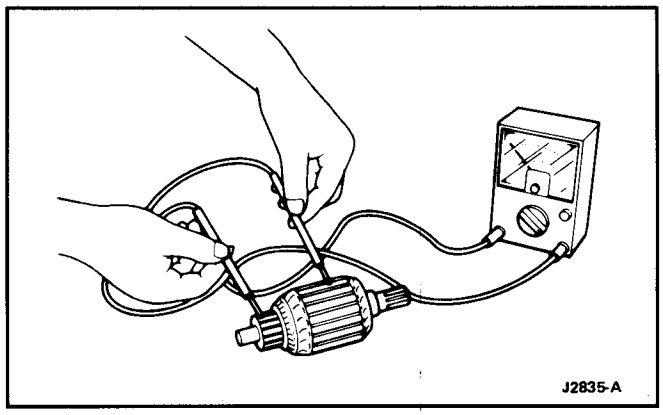


FIG. 6 Armature Grounded Circuit Test

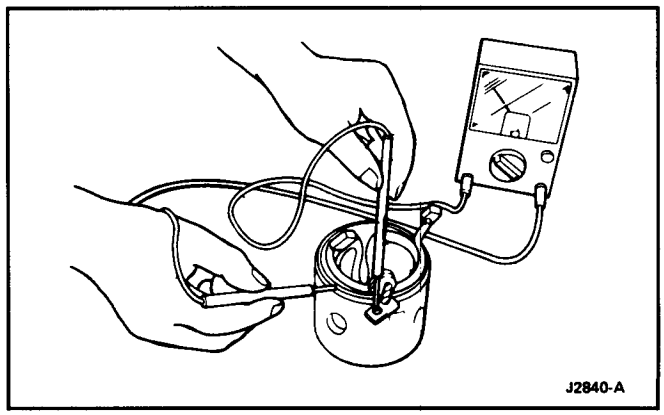


FIG. 7 Field Grounded Test

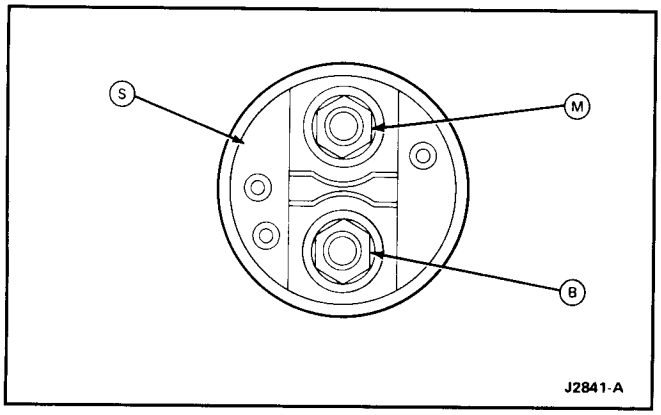


FIG. 8 Starter Solenoid Terminals

REMOVAL AND INSTALLATION

Starter

Removal and Installation procedures were not available at time of publication.

DISASSEMBLY AND ASSEMBLY

Starter

Disassembly

Refer to Fig. 2.

1. Disconnect the field coil connection from the solenoid motor terminal.
2. Remove solenoid attaching screws. Solenoid and plunger return spring. (Rotate solenoid 90 degrees to remove).
3. Remove through-bolts and brush end plate.
4. Remove brush springs and brushes from plastic brush holder and remove brush holder. Note location of brush holder with respect to ground brush terminals.
5. Remove frame assembly.
6. Remove armature assembly.
7. Remove screw from gear housing and remove gear housing.
8. Remove plunger and lever pivot screw and remove plunger and lever assembly.
9. Remove gear, output shaft and drive assembly.
10. Remove thrust washer, retainer, drive stop ring and slide drive assembly off output shaft.

Cleaning and Inspection

CAUTION: Do not wash the drive because the solvent will wash out the lubricant, causing drive to slip. Use a brush or compressed air to clean drive, field coils, armature, gear and housing.

1. Inspect the armature windings for broken or burned insulation and open connections at commutator. Check for grounds.
2. Check commutator for run out. If commutator is rough or more than .127mm (.005 inch) out-of-round, service as necessary.
3. Check plastic brush holder for cracks or broken pads. Replace brushes if worn to 6.35mm (.25 inch) in length. Inspect field coils and plastic bobbins for burned or damaged conditions. Check continuity of coil and brush connections. A brush replacement kit is available. All other assemblies are to be replaced rather than repaired.
4. Examine gears, spline on output shaft, and drive pinion for chipped or broken conditions. Replace if required.

Assembly

1. Apply a thin coat of lubriplate 777 or equivalent on output shaft spline. Slide drive assembly onto shaft and install a new stop ring, retainer and thrust washer. Install shaft and drive assembly into drive end housing.
2. Install plunger and lever assembly making sure lever notches engage flange ears of starter drive. Attach lever pin screw and tighten to 9-15 N·m (7-11 lb-ft).
3. Lubricate gear and washer. Install gear and washer on end of output shaft.
4. Install gear housing and attach with mounting screw and tighten to 7-9 N·m (5-7 lb-ft).
5. After lubricating pinion, install armature with washer on gear end of shaft.
6. Position grommet around field lead and press into starter frame notch. Install frame assembly to gear housing making sure grommet is positioned in notch in gear housing.
7. Install brush holder on end of frame, lining up notches in brush holder with ground brush terminals. Brush holder is symmetrical and can be installed with either notch and brush terminal.
8. Install brush springs and brushes. Positive brush leads must be placed in their respective slots to prevent grounding.
9. Install brush end plate (be certain end plate insulator is positioned properly in end plate) and install thru bolts and tighten to 7-9 N·m (5-7 lb-ft).

   NOTE: Brush end plate has threaded hole in protruding ear which must be oriented properly so starter to vacuum pump support bracket can be installed.
10. Install return spring on solenoid plunger and install solenoid. Attach two solenoid attaching screws and tighten to 7-9 N·m (5-7 lb-ft). Apply sealing compound to junction of solenoid case flange, gear and drive end housings.
11. Attach motor field terminal to M terminal of solenoid, and tighten to 2.25-3.4 N·m (20-30 lb-in).
12. Check starter no load current draw.

SPECIFICATIONS

POSITIVE ENGAGEMENT STARTER

Applicable Engine			2.4L Diesel
Voltage (V)			12
Rated Time (Sec.)			30
Current Draw Under Normal Load (Amps)			Less than 375
Normal Engine Cranking Speed (RPM)			250-350
Current Draw Under No Load (Amps)			Less than 190
Pinion Travel			15mm (0.60 in.)
Brushes	Number		4
	Length	Standard	12.3mm (0.485 in.)
		Wear Limit	6.35mm (0.25 in.)
Weight			Approx. 5.9 kg. (13.0 lbs.)

CJ2836-A

TORQUE SPECIFICATIONS

Component	N•m	Lb-Ft
Starter Mounting Bolts	39-56	—
Solenoid Mounting Screws	7-9	5-7
Through Bolts	7-9	5-7
Lever Pin Screw	9-15	7-11
M Terminal Screw	2.25-3.4	20-30 (lb-in)
B Terminal Nut	9-13	80-120 (lb-in)
S Terminal Nut	2.3-3.4	1.7-2.5
Center Housing Bolt	7-9	5-7

CJ2837-A

SECTION 31-12 Alternator—Side Terminal

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

Refer to the 1984 Car Shop Manual, Volume B, Section 31-12 for Description, Operation, Testing, and Disassembly and Assembly of the alternator used on the 2.4L Turbocharged Diesel engine. Refer to Section 27-02 for alternator belt adjustment procedures.

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 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, 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.

Removal

1. Disconnect the ground cable from the battery.
2. Loosen the alternator pivot bolt and remove the adjusting bolt (Fig. 1).
3. Disengage the alternator drive belt from the drive pulley.
4. Disconnect the wiring terminals from the back of the alternator. The stator and field wiring terminals are the push-on type. After depressing the lock tab, the push-on type terminal should be pulled straight off the terminal to prevent damage (Fig. 2).
5. Remove the alternator pivot bolt.
6. Remove the alternator.

Installation

1. Position the alternator on the engine.
2. Install the alternator pivot bolt and adjuster bolt. Do not tighten the bolts until the drive belt is tensioned.

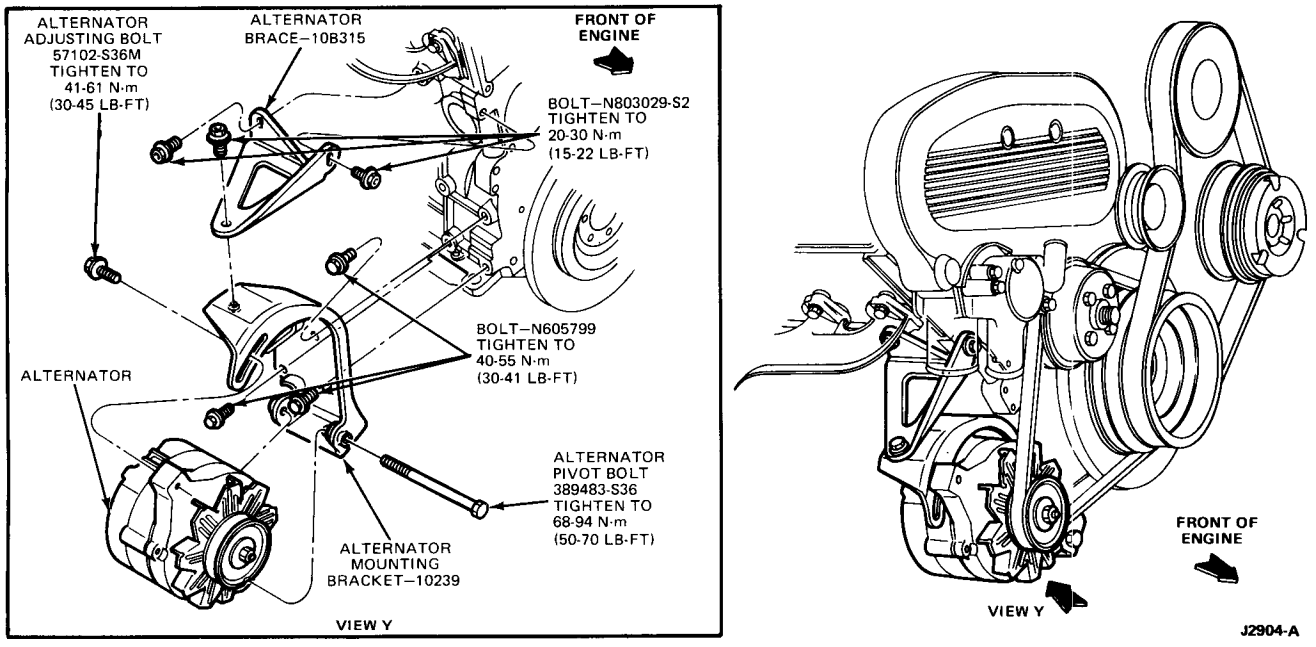


FIG. 1 Alternator—Removal and Installation

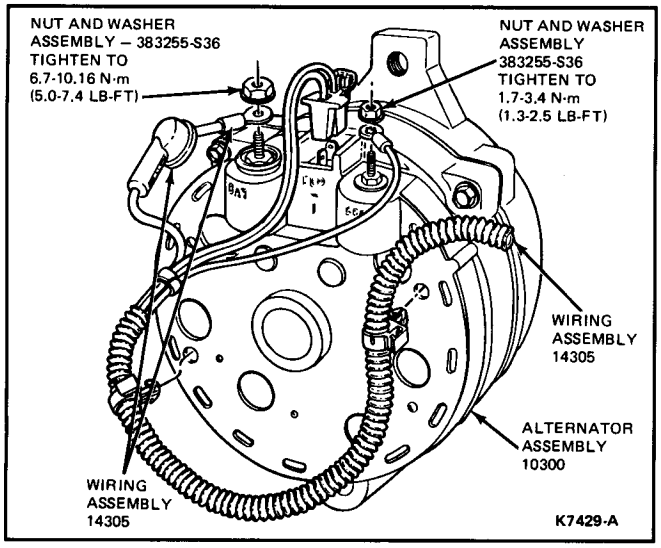


FIG. 2 Alternator Wiring

3. Connect the wiring terminals to the alternator (Fig. 2).
4. Install the drive belt over the alternator drive pulley.
5. Adjust the drive belt tension. Refer to Section 27-02. Tighten the adjuster bolt to 41-61 N·m (30-45 lb-ft). Tighten pivot bolt to 68-94 N·m (50-70 lb-ft). **Apply pressure on the front housing only when adjusting belt tension.**
6. Connect ground cable to battery.

SECTION 33-34 Warning System—Water-in-Fuel

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The Water-in-Fuel warning system consists of a warning lamp and a water level sensor, located inside the fuel filter housing (Fig. 1). The Water-in-Fuel warning lamp flashes On and Off when there is approximately 82 ml (2.8 ounces) of water present in the bottom of the fuel filter. The warning lamp is located in the lower warning indicator module on the Mark VII and in the upper warning indicator module on the Continental.

OPERATION

The fuel filter should be drained as soon as possible when the Water-in-Fuel warning indicator lamp comes On. Refer to Section 25-51 for fuel filter water draining procedure. If the lamp lights repeatedly soon after the filter is drained of water and more water comes out, the fuel is water contaminated. In such cases, the fuel tank should be drained and filled with clean fuel. Refer to Section 25-50 for fuel tank draining procedure.

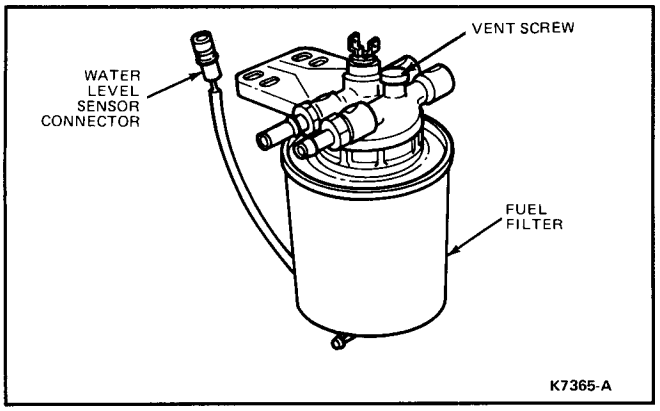


FIG. 1 Water Level Sensor Connector

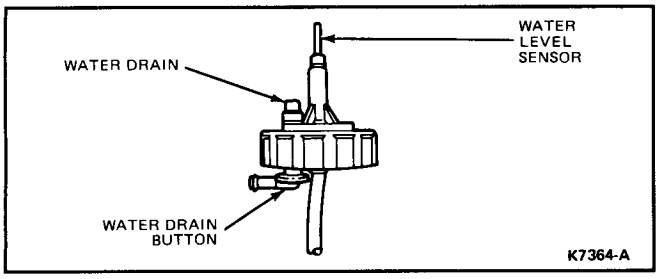


FIG. 2 Water Level Sensor

Power is supplied to the Water-in-Fuel indicator lamp in Start or Run. When there is excessive water in the fuel filter, the water level sensor, (Fig. 2), provides a ground circuit for the warning lamp circuit (Figs. 3 and 4). This system operates on the principal that diesel fuel is a much better insulator than water.

DIAGNOSIS AND TESTING

A quick check of the Water-in-Fuel warning system is done by performing the following steps:

1. Remove water level sensor at the filter assembly as outlined and connect a jumper wire between the sensor and ground.
2. Turn ignition switch to the On position. The Water-in-Fuel warning lamp should activate.
3. Reinstall water level sensor as outlined and check for leaks.

REMOVAL AND INSTALLATION

Water Level Sensor

Removal

1. Disconnect battery ground cable.
2. Disconnect water level sensor electrical connector (Fig. 1).
3. Open the vent on top of the fuel filter housing and drain fuel from fuel system into a suitable container by connecting a hose to the water drain button and pressing up on the button (Fig. 2).
4. When fuel flow stops, disconnect hose from water drain button and unscrew cap containing water level sensor from bottom of fuel filter.

Installation

1. Screw cap containing water level sensor to bottom of fuel filter housing (Fig. 2), and tighten cap.
2. Connect water level sensor connector (Fig. 1).
3. Bleed fuel system. Refer to Section 25-50.
4. Start engine and check for fuel leaks.

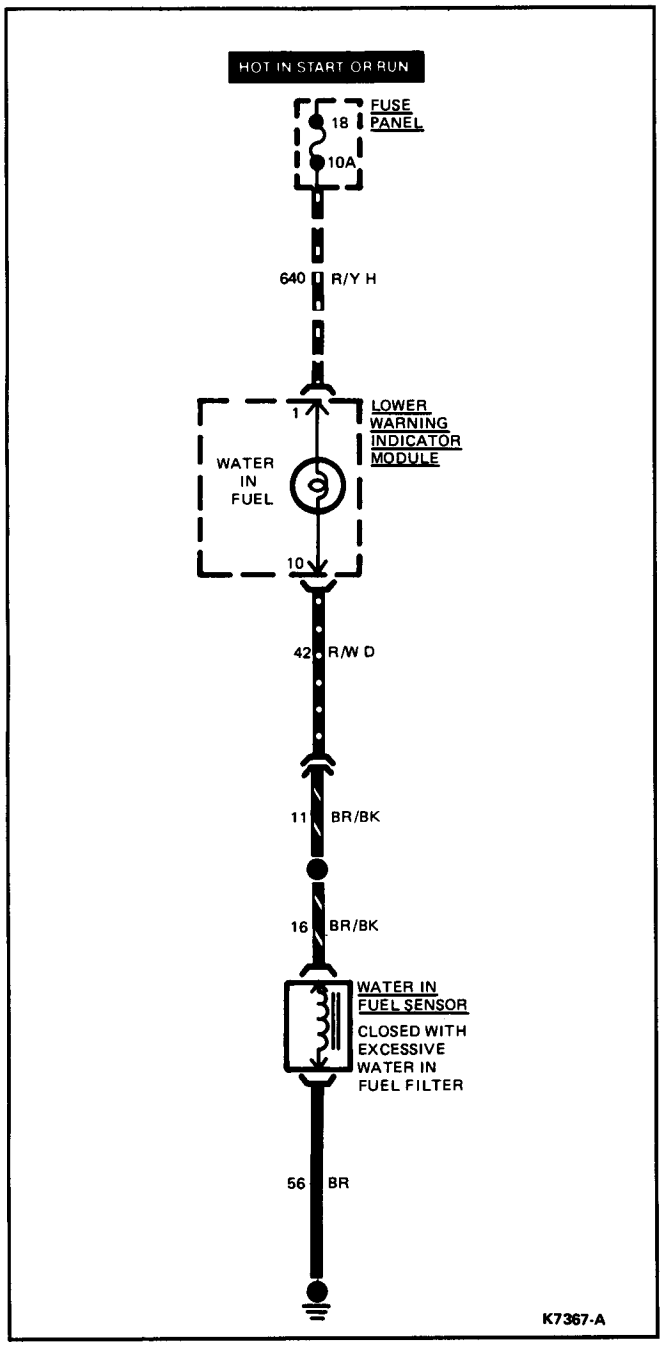


FIG. 3 Water-in-Fuel Warning System Circuit Diagram—Mark VII

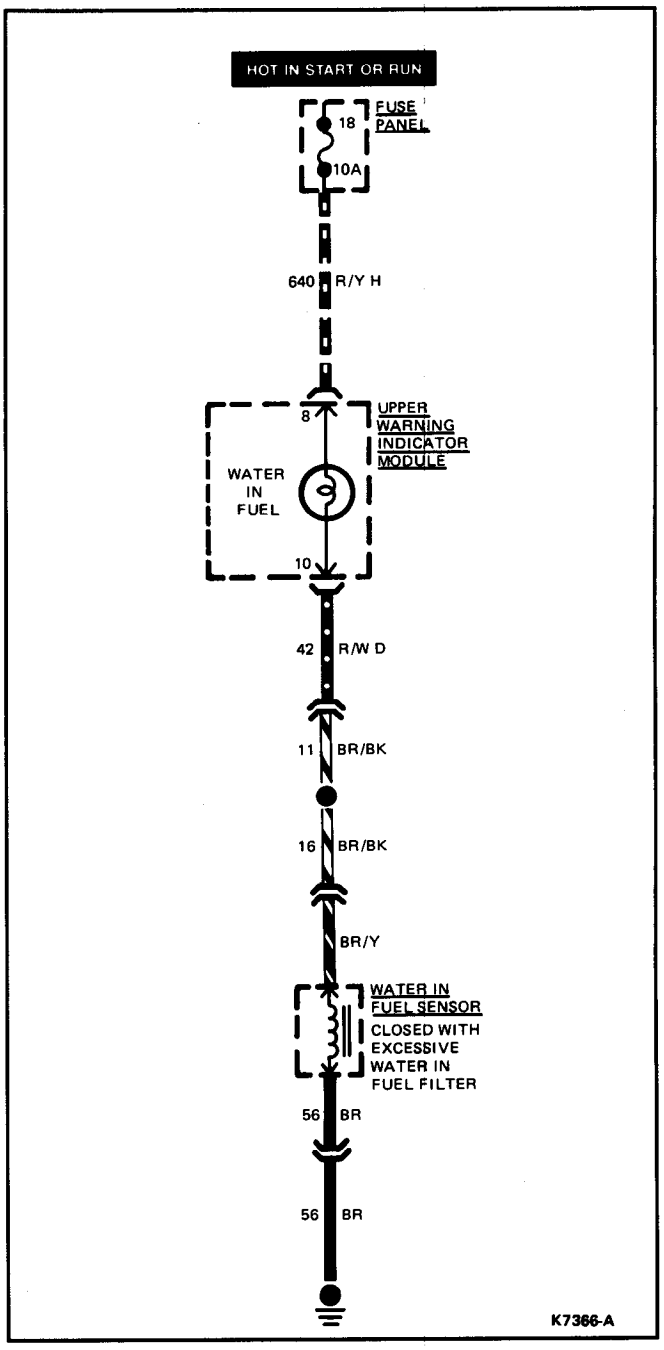


FIG. 4 Water-in-Fuel Warning System Circuit Diagram—Continental

SECTION 33-35 Warning System—Turbocharger Overboost

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The turbo overboost warning system consists of a turbo overboost switch located in the bottom of the intake manifold, and a Check Engine lamp located in the upper warning indicator module on the Mark VII and in the lower warning indicator module on the Continental.

The Check Engine indicator lamp will light when turbo boost pressure exceeds 90 kPa (13 psi) and the safety pressure regulator opens. The lamp will go out when boost goes below 90 kPa (13 psi) and the valve closes.

TESTING

Refer to Figs. 1 and 2.

REMOVAL AND INSTALLATION

Turbo Overboost Switch

Removal

1. Disconnect turbo overboost switch electrical connection (Fig. 3).
2. Remove two nuts and two washers attaching safety pressure regulator to intake manifold plenum (Fig. 3).
3. Remove pressure regulator and seal.

Installation

1. Position seal and pressure regulator to intake manifold plenum and install with two nuts and two washers (Fig. 3). Tighten nuts to 49-62 N·m (11-14 lb-ft).
2. Reconnect turbo overboost switch electrical connection.

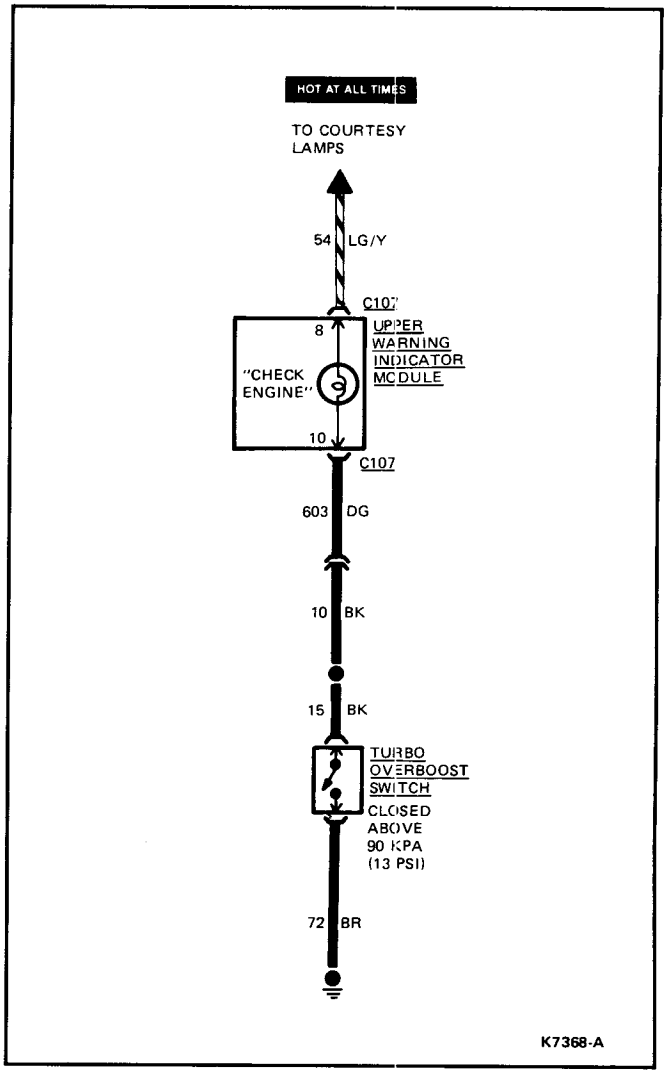


FIG. 1 Turbocharger Overboost Warning—Mark VII

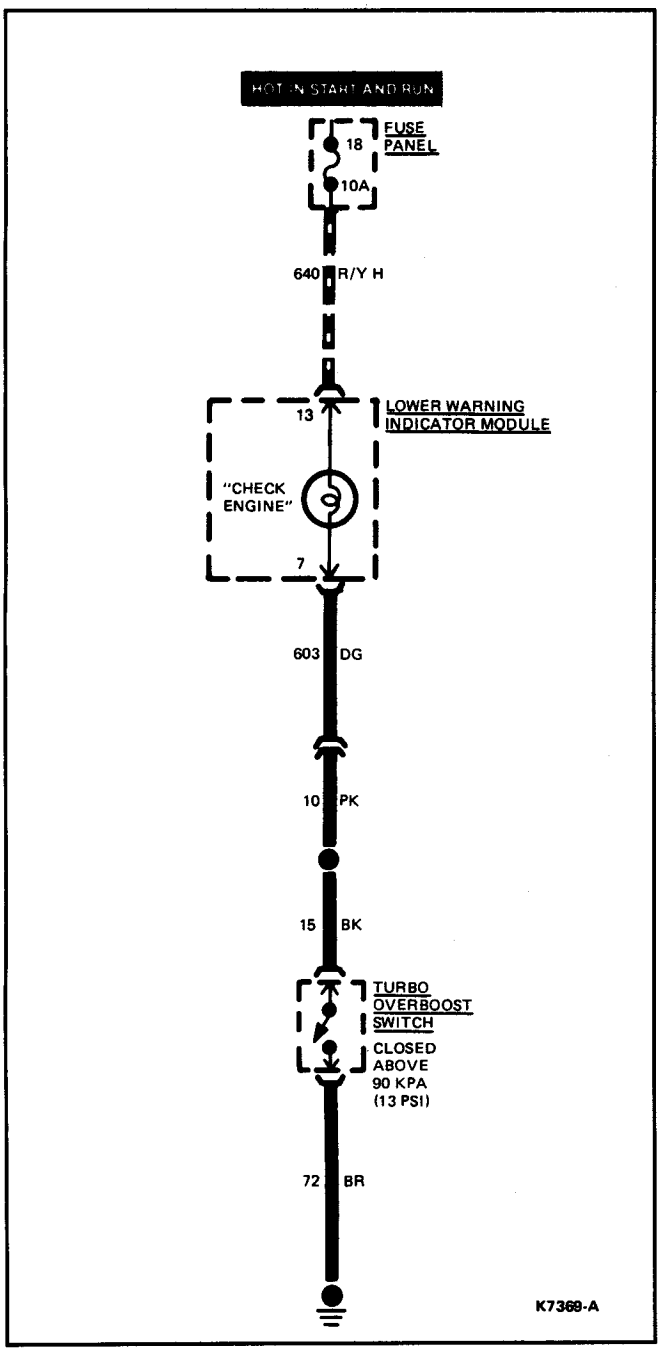


FIG. 2 Turbocharger Overboost Warning—Continental

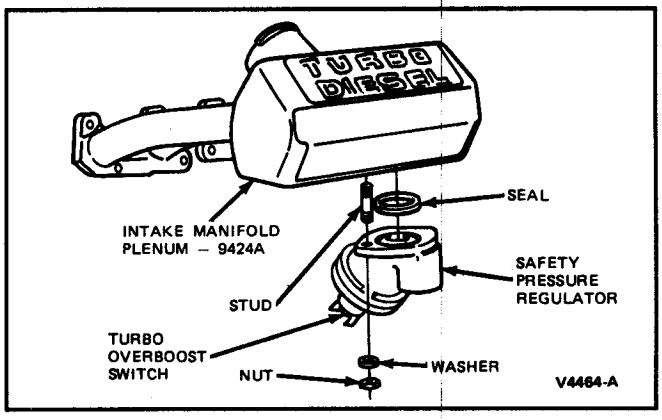


FIG. 3 Turbo Overboost Switch—Removal and Installation

SECTION 33-40 Temperature Indicating System—Conventional

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION AND OPERATION

The temperature lamp system provides the driver with an indication of engine coolant temperature by means of a switch mounted in the LH front of the cylinder head (Fig. 1), and a red TEMP/ENGINE lamp mounted on the center of the instrument panel in the lower warning indicator module.

The temperature switch has a temperature sensitive bi-metallic arm which completes the lamp circuit through the switch to engine ground. The TEMP lamp will light with the ignition switch in the START position and the ENGINE lamp will light with the ignition switch in the RUN position. This indicates the lamp and wiring are functioning properly. If the engine coolant temperature reaches approximately 112°C (233°F), the TEMP/ ENGINE lamp will come on, indicating an overheated engine.

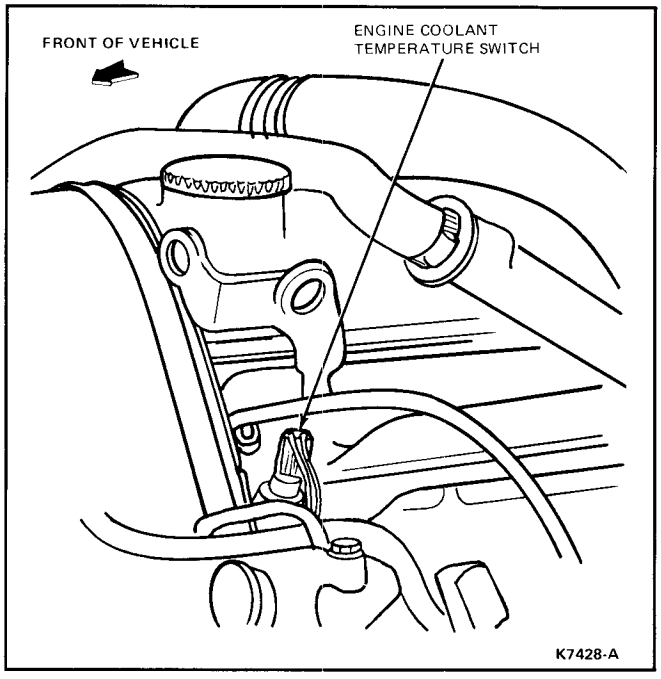


FIG. 1 Temperature Switch

Mark VII

The ENGINE lamp is controlled by the temperature and oil pressure switches and should come on with the ignition switch in the RUN position (engine not running). This indicates that the lamp bulb and wiring are OK. The oil pressure switch (normally closed) completes a prove-out circuit to ground in the RUN position (Fig. 2).

Continental

The TEMP lamp is controlled by the temperature switch and should come on with the ignition switch in the Start position indicating that the lamp and wiring are functioning properly (Fig. 3). A set of contacts in the ignition switch (normally open) completes a prove-out circuit to ground in the Start position.

DIAGNOSIS AND TESTING

Refer to the Wiring Schematics (Figs. 2 and 3) and the Diagnosis Charts in this Section for diagnosis and testing of these systems.

REMOVAL AND INSTALLATION

Temperature Switch

Removal and Installation

1. Disconnect the two wires from the temperature switch.
2. Prepare a new switch for installation by installing a new copper sealing ring.
3. Remove the radiator pressure cap to release pressure and reinstall cap.

   WARNING: FOLLOW ALL SAFETY PRECAUTIONS OUTLINED IN THE 1984 CAR SHOP MANUAL, VOLUME D, SECTION 27-01.
4. Remove switch and install the new temperature switch with a new sealing washer. Tighten to 16-19 N·m (12-14 lb-ft). Connect the two wires to the switch.
5. Check the coolant level, start the engine, and check temperature system function and check for coolant leaks.

Indicator Lamp Replacement

Refer to the 1984 Car Shop Manual, Volume D, Section 33-92.

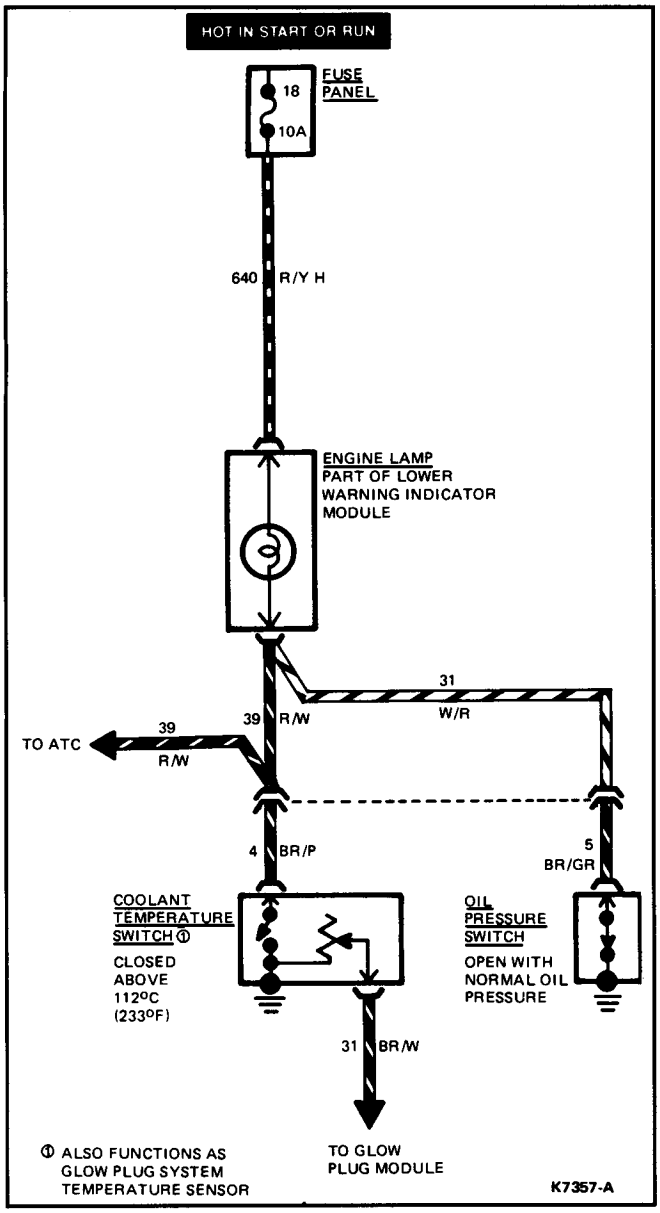


FIG. 2 Wiring Schematic—Mark VII

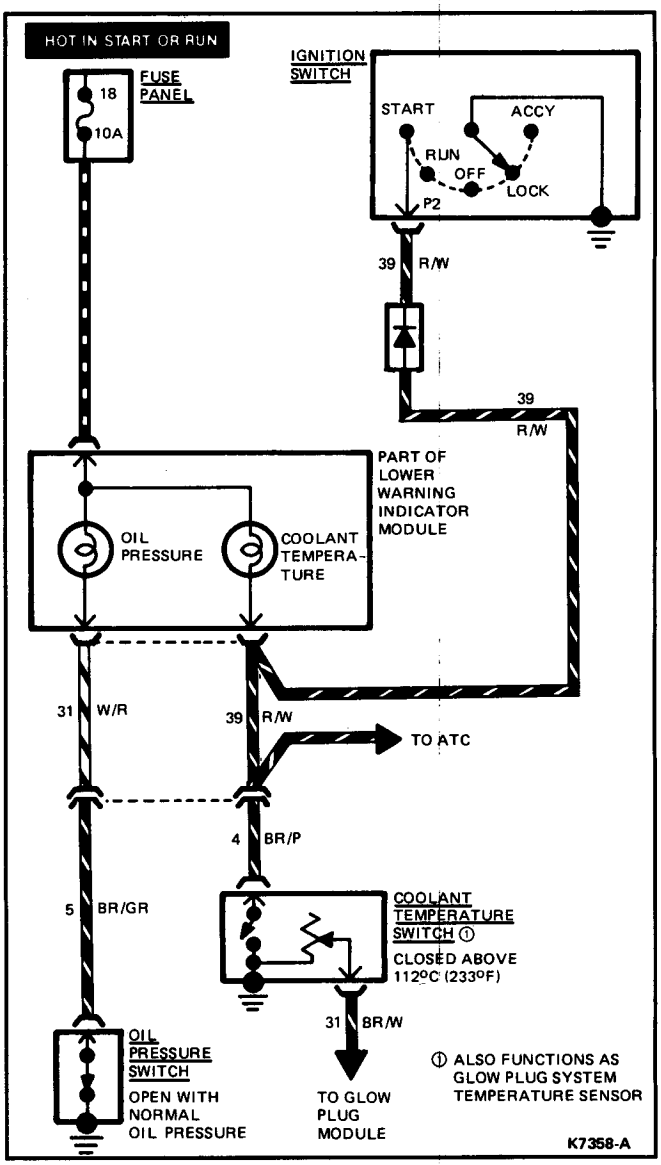


FIG. 3 Wiring Schematic—Continental

ENGINE LAMP DOES NOT COME ON ENGINE OVERHEATING

TEST STEP		RESULT ▶	ACTION TO TAKE
A1	CHECK LAMP OPERATION		
• Turn ignition switch to Run position. • Lamp should light.		(OK) ▶	GO to **A2**.
		(OK) ▶	GO to **A3**.
A2	BYPASS TEMPERATURE		
• Disconnect BR/GR wire at oil pressure switch (top of oil filter housing). • Disconnect BR/P wire at temperature switch and jumper to ground. • With ignition switch in Run position, lamp should light.		(OK) ▶	CONNECT BR/GR wire at oil pressure switch. REPLACE temperature switch. CHECK system operation.
		(OK) ▶	SERVICE open circuit between lamp and temperature switch. CHECK system operation.
A3	BYPASS OIL PRESSURE SWITCH		
• Disconnect BR/GR wire at oil pressure switch (top of oil filter housing) and jumper wire to ground. • With ignition switch in Run position, lamp should light.		(OK) ▶	REPLACE oil pressure switch, CHECK system operation.
		(OK) ▶	GO to **A4**.
A4	CHECK FUSE		
• Check fuse 18 for continuity.		(OK) ▶	CHECK for and SERVICE open circuit between Fuse 18 and oil pressure switch, including ENGINE lamp bulb. CHECK system operation.
		(OK) ▶	REPLACE fuse. CHECK system operation.

CK7359-A

ENGINE LAMP STAYS ON — ENGINE NOT OVERHEATING, ADEQUATE ENGINE OIL PRESSURE

TEST STEP	RESULT ▶	ACTION TO TAKE
B1 BYPASS SWITCHES • Disconnect BR/GR wire at oil pressure switch (top of oil filter housing) and disconnect BR/P wire at coolant temperature switch. • Turn ignition switch to Run position. • Lamp should not light.	(OK) ▶	GO to **B2**.
	(OK) ▶	SERVICE short circuit between Engine lamp and temperature switch and/or oil pressure switch. CHECK system operation.
B2 CONNECT SWITCHES • Turn ignition switch to Run position. • Connect BR/P wire to temperature switch and observe ENGINE lamp. • Disconnect BR/P wire from temperature switch. • Connect BR/GR wire to oil pressure switch and observe ENGINE lamp.	ENGINE lamp lights when temperature switch is connected (OK) ▶	REPLACE temperature switch. CHECK system operation.
	ENGINE lamp lights when oil pressure switch is connected (OK) ▶	REPLACE oil pressure switch. CHECK system operation.

CK7360-A

TEMP LAMP DOES NOT COME ON — ENGINE OVERHEATING

TEST STEP	RESULT ▶	ACTION TO TAKE
C1 CHECK LAMP OPERATION • Disconnect R/LB wire at starter relay on LH fender apron. • Turn ignition switch to Start position. • Lamp should light.	(OK) ▶	CONNECT R/LB wire to starter relay. REPLACE TEMP switch. CHECK system operation.
	(OK) ▶	GO to **C2**.
C2 BYPASS TEMP SWITCH • Disconnect BR/P wire at TEMP switch and jumper to ground. • Turn ignition switch to Run position. • Lamp should light.	(OK) ▶	SERVICE open circuit 39 R/W between TEMP lamp and ignition switch terminal P2. CHECK lamp operation.
	(OK) ▶	GO to **C3**.
C3 CHECK FUSE • Check fuse 18 in fuse panel for continuity.	(OK) ▶	CHECK and SERVICE open circuit between Fuse 18 and TEMP switch, including TEMP lamp bulb, as necessary. CHECK system operation.
	(OK) ▶	REPLACE Fuse 18. CHECK system operation.

CK7361-A

TEMP LAMP STAYS ON — ENGINE NOT OVERHEATING

TEST STEP		RESULT ▶	ACTION TO TAKE
D1	BYPASS SWITCH		
• Disconnect BR/P wire at TEMP switch. • Turn ignition switch to Run position. • TEMP lamp should be Off.		(OK) ▶	REPLACE TEMP switch. CHECK system operation.
		(OK) ▶	SERVICE short circuit between TEMP lamp and ignition switch, or between TEMP lamp and TEMP switch. CHECK system operation.

CK7362-A

SECTION 33-84 Instrument Cluster—Electronic

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

Continental

The Continental Electronic Instrument Cluster (EIC) is divided into three sections (Fig. 1):

- **Electronic Instrument Module (EIM):** Consists of a digital fuel gauge, digital speedometer and electronic odometer.
- **Non-Volatile Memory Module (NVMM):** Provides permanent memory for the odometer, fuel gauge and diagnostic counts.
- **Conventional Feature Section (CFS):** Consists of a transmission selector indicator, turn signal indicators, high beam indicator and fasten belt indicator.

Electronic numerals will appear blue/green and logos such as GAL, MPH, MILES, etc., will appear yellow.

Mark VII

The Mark VII Electronic Instrument Cluster (EIC) is also divided into three sections (Fig. 2). They have the same feature content as the Continental except for the Conventional Feature Section.

- **Electronic Instrument Module (EIM):** Consists of a digital fuel gauge, digital speedometer and electronic odometer.
- **Non-Volatile Memory Module (NVMM):** Provides permanent memory for the odometer, fuel gauge and diagnostic counts.
- **Conventional Feature Section (CFS):** Consists of turn signal indicators and high beam indicator.

Electronic numerals will appear blue/green and logos such as GAL, MPH, MILES, etc., will appear yellow.

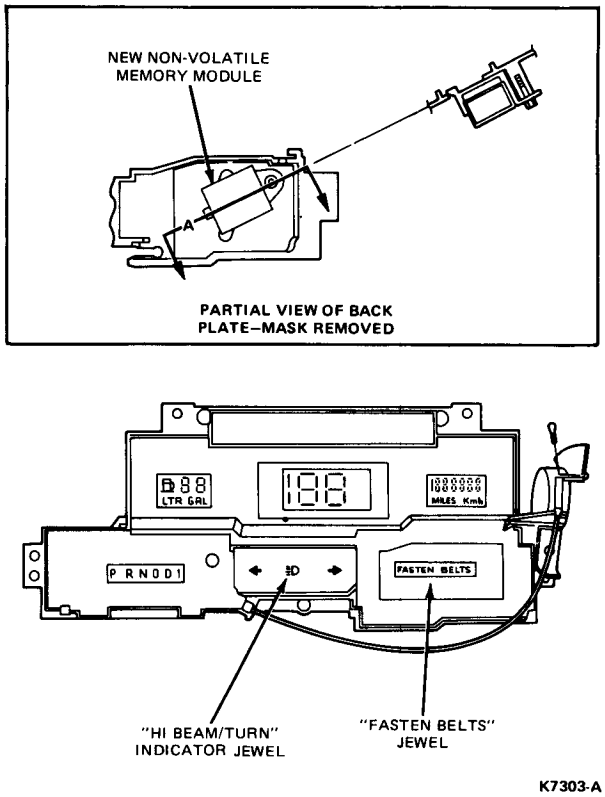


FIG. 1 Electronic Instrument Cluster—Continental

Electronic Instrument Module (EIM)

The Electronic Instrument Module (EIM) is a single service part containing a digital fuel gauge, digital speedometer and electronic odometer (Fig. 3). Within the EIM, all displays share common electronic circuitry such as power supply, dimming control and a central microcomputer. Input/output interface connections are made via a flexible printed circuit connector located at the rear of the cluster assembly (Fig. 4). EIM feature content, function and input/output interface is the same

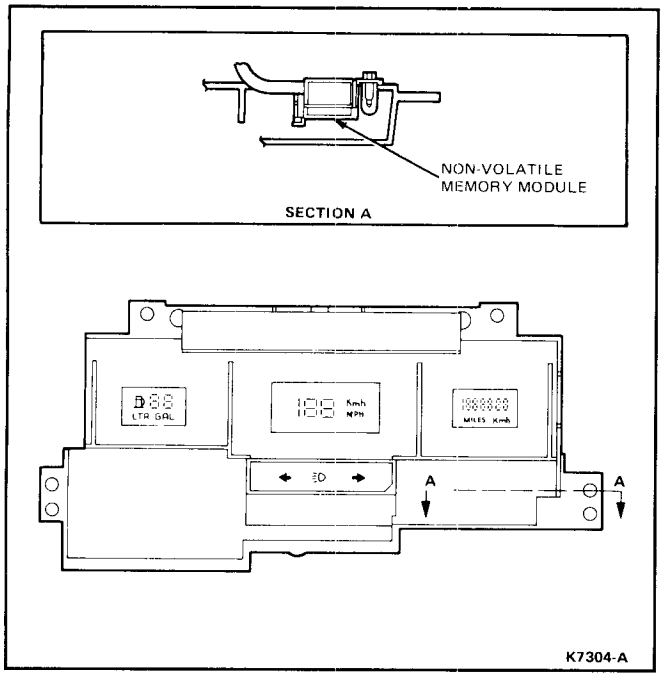


FIG. 2 Electronic Instrument Cluster—Mark VII

for both the Continental and Mark VII except for the location and shape of the flexible printed circuit. As a result, the Mark VII EIM is not interchangeable with the Continental EIM.

When the ignition switch is in the Run or Acc positions or the door handle is pulled, the EIM is illuminated at maximum display brightness and is operational.

Dimming Controls and Operation

Turning the parking lamps or headlamps On activates the EIM dimming control circuitry through circuit 19 and the displays are automatically dimmed (Fig. 5). EIM displays will step dim when lamps are turned on. Additional dimming is controlled by rotating the instrument panel mounted rheostat. This single rheostat controls the brightness of all instrument panel displays and lamps. Since the EIM is located in the drivers primary viewing zone, their displays are brighter and have a greater dimming range than other electronic displays in the instrument panel (i.e. Message Center, radio, etc.). As a result, the EIM displays will dim faster and their intensity in full dim position will be lower than other panel displays.

English-Metric Mode Selection and Operation

Display units (i.e. Ltr-GAL, Km/h-MPH and Km-MILES) are selected by pushing the Message Center MILES-Km button. When the cluster turns On, the display units will be the same as when the cluster was turned Off. The display mode is stored in Message Center's memory. The signal that controls the EIM's english/metric display is circuit 506 and is common to all instrument panel electronic displays (Fig. 6).

System Performance, General

The digital fuel display is located in the LH section of the EIM. Fuel level is displayed on two, seven segment digits (Fig. 7). Also displayed is an International Standards Organization (ISO) fuel pump symbol and the display units (GAL or Ltr). For fuel levels greater than 75.7 ltr. (20 gal.), F will be displayed representing full. Correspondingly, for fuel levels less than 7.57 ltr. (2 gal.), E will be displayed for empty.

The fuel display has two response modes. After the display prove-out sequence has been completed, the gauge automatically enters a fast response mode if fuel has been added or removed from the tank (approximately 8.3 ltr. (2.2 gal.) is required for detection). In this mode, the fuel level sensor signal is converted to a corresponding display within several seconds allowing rapid fuel level updates when the fuel level is rapidly changing. This allows a customer to observe the fuel tank being filled.

When the vehicle is moved and the first speed pulse is received by the EIM, the fuel gauge will enter a normal response mode. In this mode, the software logic will inhibit display oscillations due to fuel slosh as experienced during normal vehicle acceleration, sudden stops and cornering. Additional slosh filtering will be provided by the in-tank reservoir.

When the ignition switch is turned Off, the fuel level is stored in the Non-Volatile Memory Module. This will improve the consistency of the gauge reading from ignition Off to ignition On. Variations will be limited to plus or minus one display unit unless fuel has been added or the vehicle is parked on inclines.

Display Prove-Out

When the cluster is turned On a two second display prove-out sequence will be initiated which will allow the driver to verify illumination of all individual display segments. If the fuel display is operating correctly, the sequence shown in Fig. 8 will be observed.

Low Fuel Displays

A continuously flashing (once per second) fuel ISO symbol provides a low fuel alert. The ISO symbol will begin to flash with a nominal 10.7 ltr. (2.83 gal.) usable fuel remaining. Since the electronics rounds the english fuel display this will occur during the 3 gal. display.

At fuel levels less than 7.57 ltr. (2 gal.) an 'E' is displayed with the ISO symbol flashing. Approaching zero usable fuel, the 'E' begins to flash with ISO symbol. Typical low fuel displays are shown in (Fig. 9).

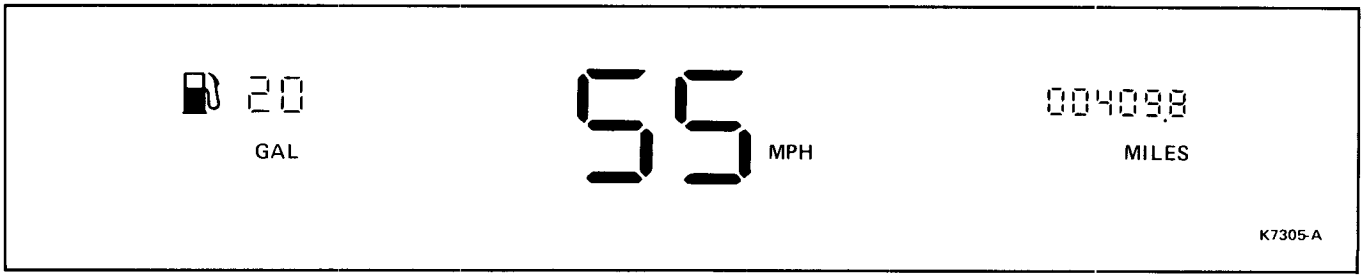


FIG. 3 Electronic Instrument Module

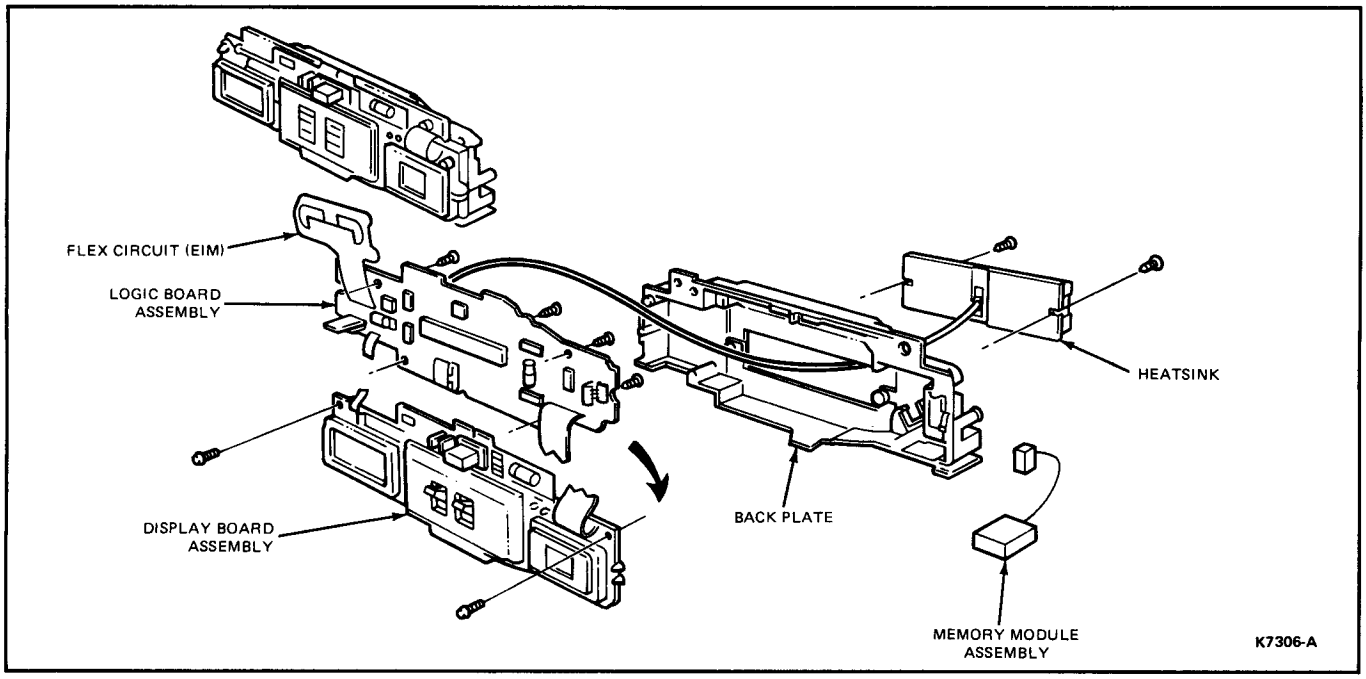


FIG. 4 Electronic Instrument Module (EIM)

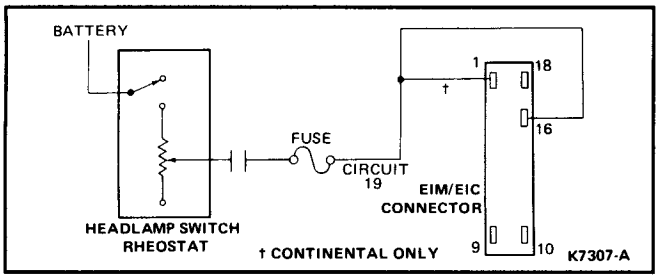


FIG. 5 Display Dimming Control Circuit

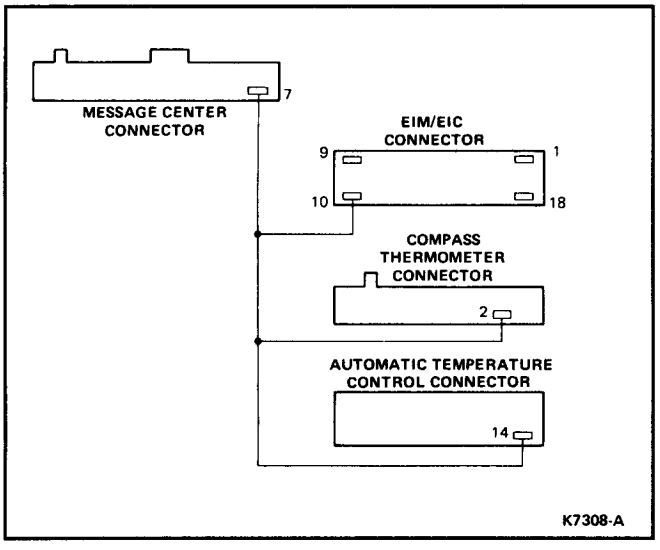


FIG. 6 English/Metric Mode Control Circuit

Service Alerts

If an open circuit exists between the fuel level sensor and gauge, a CO will be displayed on the fuel display (Fig. 10). This Circuit Open alert will be displayed until the condition is corrected.

If a short circuit exists between the fuel level sensor and gauge a CS will be displayed on the fuel display (Fig. 11).

This Circuit Shorted alert will be displayed until the condition is corrected.

NOTE: It may require several minutes for the fuel gauge to acknowledge the insertion of a short or open circuit.

Fuel Level Sensor

The fuel level sensor (Fig. 12), is similar to the conventional fuel gauge level sensor except that its resistance ranges from a minimum of 11 ohms at empty stop to maximum of 165 ohms at the full stop. This resistance produces a voltage at the fuel gauge which transforms this signal to corresponding indication on the display.

Tank Capacity

Nominal fuel capacity is 84.4 usable ltr. (22.3 gal.) on the Continental and Mark VII.

Message Center Interface

The fuel gauge receives a voltage signal from the fuel level sensor circuit 29. It then sends a buffered voltage signal to the Message Center fuel input circuitry (circuit 205). This voltage should be identical to circuit 29 (Fig. 12).

Electronic Digital Speedometer

The electronic digital speedometer is located in the center display section of the EIM (Fig. 13). It can display vehicle speeds from zero to maximum of 85 mph or 137 Km/h. For vehicle speeds exceeding these limits, the reading is maintained at the maximum indication. This limit is used for both the U.S. and Canadian vehicles.

Speed information is provided by a transmission mounted, variable reluctance speed sensor via circuits 150 and 359. This sensor also provides speed

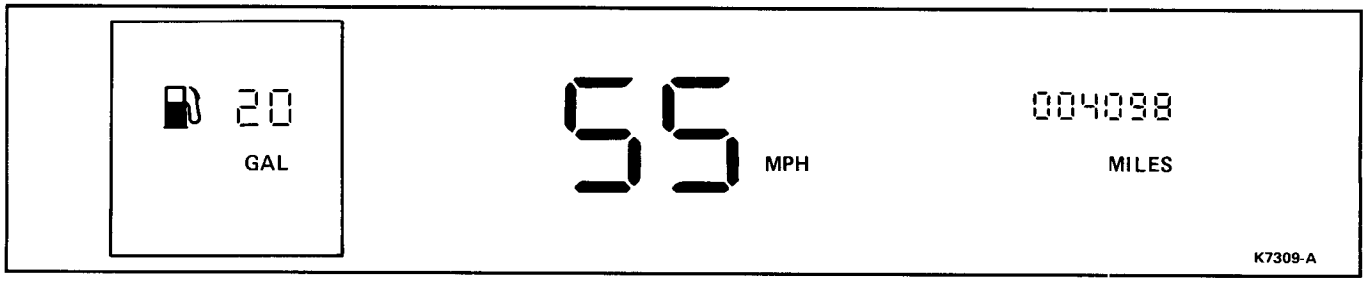


FIG. 7 Electronic Digital Fuel Gauge

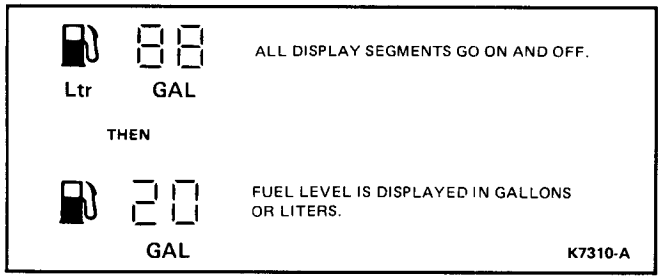


FIG. 8 Fuel Display Prove-Out Displays

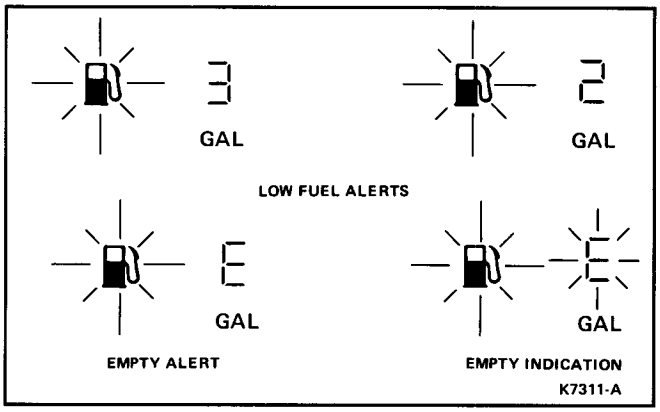


FIG. 9 Low Fuel Level Displays

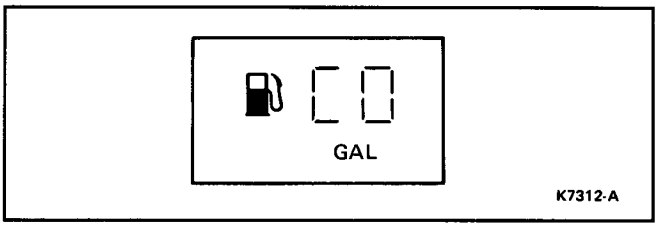


FIG. 10 Fuel Display Circuit Open Alert

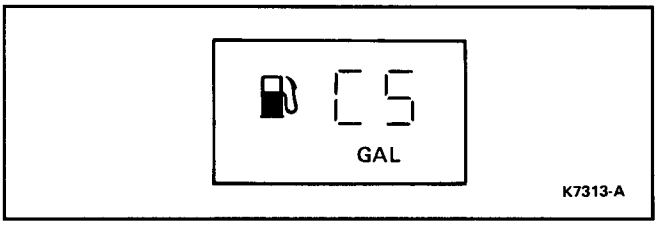


FIG. 11 Fuel Display Circuit Shorted Alert

information directly to the Message Center and speed control module (Fig. 14).

Under drive conditions, it is normal for the speedometer to display consecutive numbers during slow accelerations and decelerations and to skip several consecutive numbers during quick starts or stops.

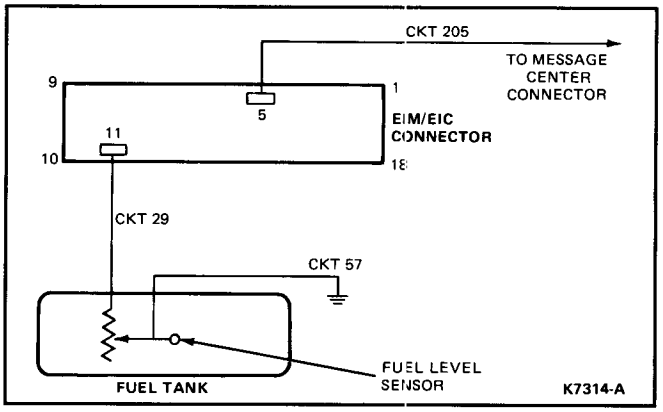


FIG. 12 Fuel Gauge Wiring Circuitry

Display updates are made every half second. The vehicle speed is displayed regardless of whether the vehicle is moving in the forward or reverse direction.

Display Prove-Out

When the cluster is turned On, the speedometer will initiate a two second self check sequence which will allow verification of the speedometer display segments illumination. If the speedometer system is in good condition, the display sequence shown in Fig. 15 will be observed.

Electronic Odometer

Located in the RH section of the EIM is the electronic odometer (Fig. 16). Accumulated distance traveled will be shown on a six and 1/2 digit, seven segment display with decimal point. The odometer is capable of displaying from 00000.0 to 199999.9. When 199999.9 is exceeded, the display will roll-over to 100000.0.

Distance information is provided by the same transmission mounted sensor used to provide speed information.

Odometer memory is provided by the Non-Volatile Memory Module (NVMM) which has non-power data retention. Updating of the NVMM occurs every 16 Km (10 miles) during vehicle operation and also when the ignition switch is turned Off. Odometer mileage will accumulate when the vehicle driven wheels are turning in either forward or reverse direction providing the sensor is connected and the cluster turned On.

Service Procedures

Failure of the EIM does not require replacement of the NVMM, therefore vehicle mileage is not lost and a service indication is not required.

If the NVMM requires service, it is replaced with a special service unit and the vehicle mileage recorded on the door jamb sticker provided with module. The service NVMM is specially programmed allowing the EIM's

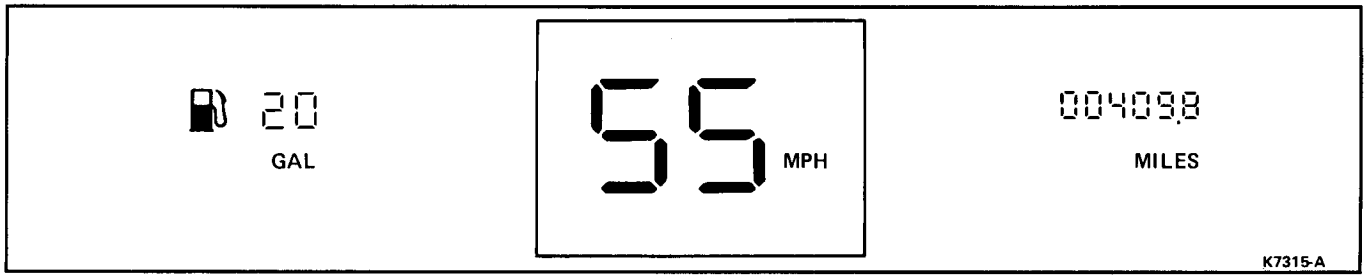


FIG. 13 Electronic Digital Speedometer

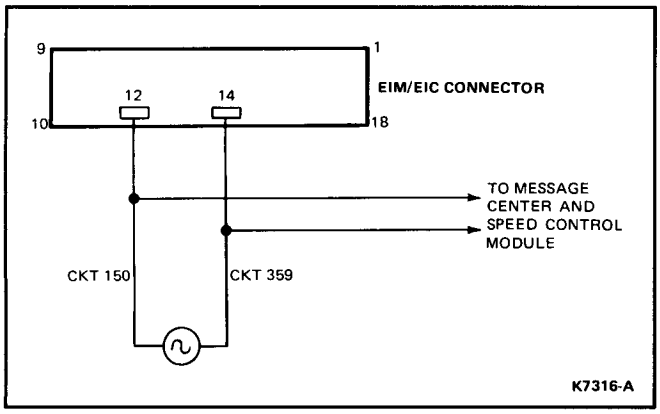


FIG. 14 Speed Sensor Wiring Circuitry

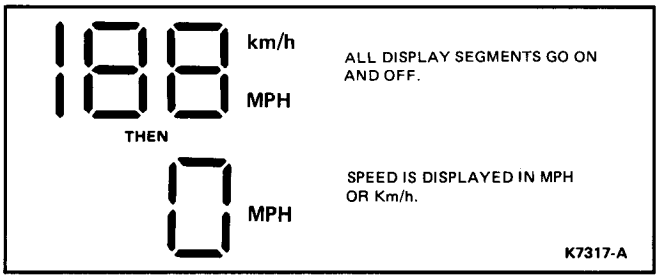


FIG. 15 Speedometer Display Prove-Out Displays

microcomputer to identify it as a service unit and light the service indicator located between the MILES and Km legends as shown in Fig. 17.

Display Prove-Out

When the cluster is turned On, a two second prove-out sequence will be initiated which allows driver verification of the illumination of all individual display segments. If the odometer display is operating correctly, the display sequence shown in Fig. 18 will be observed.

Service Alerts

If a condition exists where the EIM cannot read a valid odometer memory value from the NVMM, the word Error

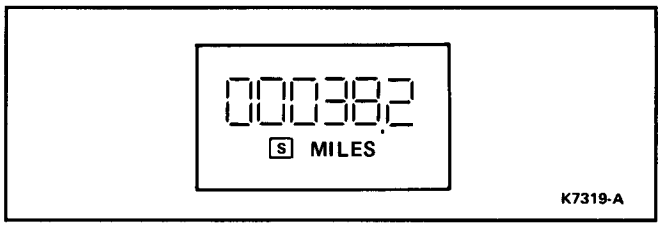


FIG. 17 Service Odometer Display

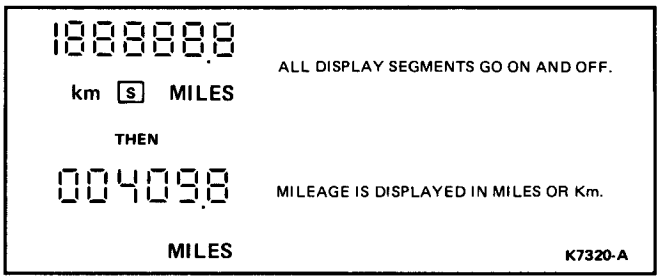


FIG. 18 Odometer Display Prove-Out Displays

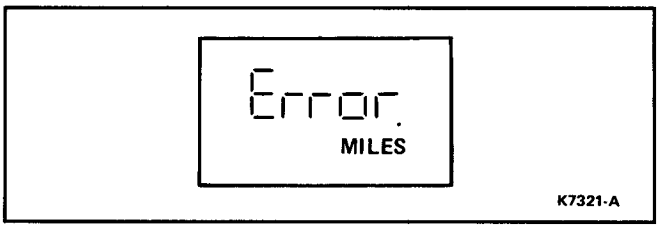


FIG. 19 Odometer Display Error Alert

will be displayed. This alert will be displayed until the condition is corrected (Fig. 19).

DIAGNOSIS AND TESTING

Use the Diagnosis charts to direct you to Specific Pinpoint Tests for problems with Electronic Instrument Cluster.

Refer to the 1984 Car Wiring Diagrams Manual for the wiring schematic of the vehicle you are servicing.

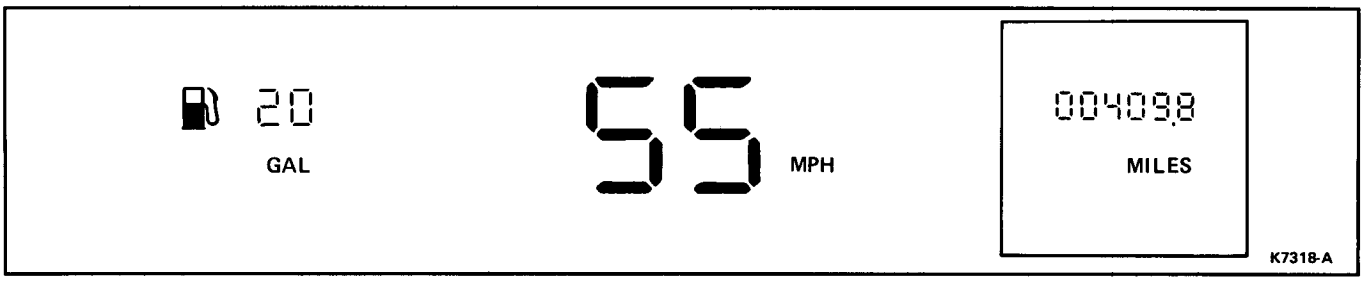


FIG. 16 Electronic Odometer

FUEL GAUGE DIAGNOSIS

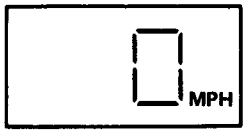
A DISPLAY TOTALLY BLANK 	GO to **Pinpoint Test A**.
B DISPLAY BRIGHTNESS DOES NOT CHANGE WITH DIMMING CONTROL 	GO to **Pinpoint Test B**.
C CO DISPLAYED 	GO to **Pinpoint Test C**.
D CS DISPLAYED 	GO to **Pinpoint Test D**.
E DOES NOT DISPLAY FLASHING E WHEN FUEL TANK IS EMPTY 	GO to **Pinpoint Test E**.
F DOES NOT DISPLAY F WHEN FUEL TANK IS FULL 	GO to **Pinpoint Test F**.
G FUEL GAUGE DISPLAY ERRATIC • Display blinks On/Off. • CO or CS displayed intermittently. • Fuel gauge display varies more than two gallons during normal driving conditions.	GO to **Pinpoint Test G**.

CK7277-A

FUEL GAUGE DIAGNOSIS

H	FUEL GAUGE WILL NOT SWITCH BETWEEN ENGLISH AND METRIC	GO to **Pinpoint Test H.**
J	FUEL GAUGE DISPLAY SEGMENTS MISSING OR EXTRA SEGMENTS ON	GO to **Pinpoint Test J.**
K	INACCURATE FUEL INDICATION	GO to **Pinpoint Test K.**

SPEEDOMETER DIAGNOSIS

L	DISPLAY TOTALLY BLANK 	GO to **Pinpoint Test A.**
M	READS 0 MPH (KM/H) AT ALL SPEEDS WHEN VEHICLE IN MOTION 	GO to **Pinpoint Test M.**
N	DISPLAY BRIGHTNESS DOES NOT CHANGE WITH DIMMING CONTROL 	GO to **Pinpoint Test B.**
P	DISPLAY INCORRECT, SEGMENTS MISSING, OR DISPLAY INDICATES WRONG VALUE ALL THE TIME	GO to **Pinpoint Test J.**
Q	SPEEDOMETER WILL NOT SWITCH BETWEEN MPH AND KM/H	GO to **Pinpoint Test H.**

CK7278-A

SPEEDOMETER DIAGNOSIS

R	SPEEDOMETER READS CONSTANTLY TOO HIGH OR TOO LOW	GO to **Pinpoint Test R.**
S	DISPLAY BLINKS ON AND OFF	GO to **Pinpoint Test G.**
T	SPEED INDICATION JUMPS UP AND DOWN ERATICALLY	GO to **Pinpoint Test T.**

CK7280-A

ODOMETER DIAGNOSIS

U	DISPLAY TOTALLY BLANK 	GO to **Pinpoint Test A.**
V	DISPLAY BRIGHTNESS DOES NOT CHANGE WITH DIMMING CONTROL	GO to **Pinpoint Test B.**
W	DISPLAY READS ERROR 	GO to **Pinpoint Test W.**
X	DISPLAY WILL NOT SWITCH BETWEEN MILES AND KM/H MODES	GO to **Pinpoint Test H.**
Y	DISPLAY HAS [S] ILLUMINATED 	GO to **Pinpoint Test Y.**
Z	DISPLAY ERRATIC — BLINKS ON AND OFF	GO to **Pinpoint Test G.**
AA	ODOMETER DOES NOT ACCUMULATE MILEAGE, OR COUNTS 10 MILES AND JUMPS BACK 10 MILES	GO to **Pinpoint Test AA.**
BB	ODOMETER READING INCORRECT, INCREASES OR DECREASES A LARGE AMOUNT	GO to **Pinpoint Test BB.**

CK7281-A

ODOMETER DIAGNOSIS

CC	DISPLAY SHOWS EXTRA SEGMENTS OR HAS SEGMENTS MISSING	GO to **Pinpoint Test J**.
DD	MILEAGE CONSTANTLY READS TOO HIGH OR TOO LOW	GO to **Pinpoint Test M**.

CK7282-A

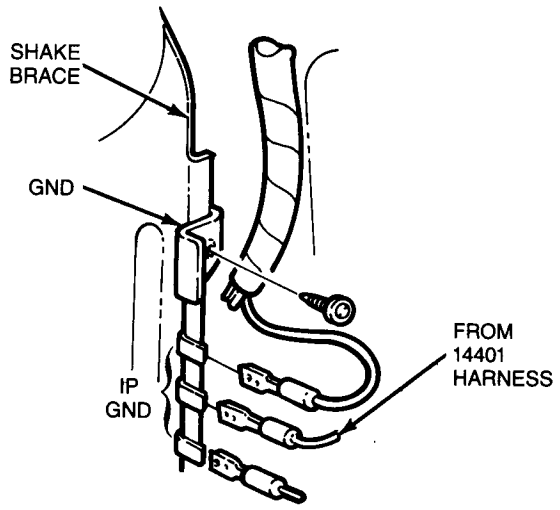
DISPLAY TOTALLY BLANK

TEST STEP		RESULT	ACTION TO TAKE
A0	VERIFY CONDITION	Display blank	Go to **A1**.
A1	CHECK ILLUMINATION OF OTHER DISPLAYS • Turn ignition key to RUN or Acc. • Check illumination of other EIM displays.	Other displays lit Other displays not lit	REPLACE EIM. GO to **A2**.
A2	CHECK ILLUMINATION OF MESSAGE CENTER	MC display lit MC display not lit	GO to **A7**. GO to **A3**.
A3	CHECK ELECTRONIC CLUSTER FUSE (15A)	Fuse OK Fuse bad	GO to **A5**. GO to **A4**.
A4	CHECK FOR SHORT IN CIRCUIT 797 • Before replacing fuse: • Turn ignition switch to OFF. • Disconnect battery ground cable. • Connect ohmmeter from circuit 797 (lt. green/purple stripe) side of fuse to ground. • Check for short circuit.	No short Short	REPLACE fuse. SERVICE circuit 797 for short circuit.
A5	CHECK VOLTAGE — CIRCUIT 797 • Check that voltage on circuit 797 is equal to battery voltage (10 V. minimum).	Voltage OK Voltage not OK	GO to **A6**. SERVICE circuit 797 for open circuit from fuse to ignition switch to battery. SERVICE as required.
A6	CHECK VOLTAGE — CIRCUIT 295 • With ignition switch in Run or Acc., check voltage on circuit 295 is equal to battery voltage (10V. minimum).	Voltage OK Voltage not OK	GO to **A7**. SERVICE circuit 297 for open from fuse to ignition switch to battery.

CK5544-C

DISPLAY TOTALLY BLANK

TEST STEP		RESULT ▶	ACTION TO TAKE
A7	CHECK ELECTRONIC CLUSTER GROUND CONNECTION		
	• Check for secure connection of electronic cluster ground terminal located on the shake brace beneath the instrument panel.	Ground connection (OK) ▶	GO to **A8**.
		Ground (OK) ▶	SERVICE as required.
A8	CHECK EIM CONNECTOR		
	• Check that EIM connector is securely attached to EIM.	(OK) ▶	GO to **A9**.
		(OK) ▶	SECURE connector to EIM.
A9	CHECK VOLTAGE BETWEEN GROUND AND CIRCUIT 797 ON EIM CONNECTOR		
	• Remove electronic cluster (EIC/EIM). • Disconnect harness connector. • Measure voltage between terminal 17 (ckt. 797, lt. green/purple stripe) and terminal 13 (ckt. #359, black with white stripe).	Greater than 10 volts ▶	GO to **A10**.
		Less than 10 volts ▶	SERVICE circuits 797 and/or #359 (ground).
A10	CHECK VOLTAGE BETWEEN GROUND AND CIRCUIT 295 ON EIM CONNECTOR		
	• Remove electronic cluster (EIC/EIM). • Disconnect harness connector. • Measure voltage between terminal 18 (ckt. 295, lt. blue/pink stripe) and terminal 13 (ckt. #359, black with white stripe).	Greater than 10 volts ▶	REPLACE EIM.
		Less than 10 volts ▶	SERVICE circuits #295 (accessory) and/or #359 (ground).



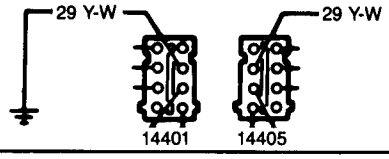
CK5545-D

DISPLAY BRIGHTNESS DOES NOT CHANGE WITH DIMMING CONTROL

TEST STEP		RESULT	ACTION TO TAKE
B0	VERIFY THE CONDITION	▶	Go to **B.1**.
B1	CHECK OTHER DISPLAYS		
	• Turn ignition switch to RUN or ACC. • Check dimming of other displays when headlamp switch is turned on and thumb wheel rotated.	(OK) ▶ (OK) ▶	REPLACE EIM. GO to **B2**.
B2	CHECK DIMMING, CONTROL OF MESSAGE CENTER DISPLAY		
		(OK) ▶ (OK) ▶	GO to **B6**. GO to **B3**.
B3	CHECK INSTRUMENT PANEL FUSE		
	• Check fuse No. 4.	Fuse (OK) ▶ Fuse (OK) ▶	GO to **B4**. GO to **B5**.
B4	CHECK FOR SHORT IN CKT. 19		
	Before replacing the fuse: • Turn ignition switch to OFF. • Check for short to ground in ckt. 19 (lt. blue/red stripe) with an ohmmeter at the fuse panel.	No short ▶ Short circuit ▶	REPLACE fuse. SERVICE circuit 19 as required.
B5	CHECK INPUT VOLTAGE TO FUSE IS GREATER THAN 10 VOLTS		
		(OK) ▶ (OK) ▶	GO to **B6**. SERVICE circuit 19 at headlamp switch. SERVICE as required.
B6	CHECK RHEOSTAT VOLTAGE AND DIMMING POTENTIOMETER RESISTANCE		
	• Remove EIC/EIM from instrument panel. • Disconnect harness connector. • Verify rheostat voltages at terminal 2 (ckt. 19B, lt. blue/red stripe) to ground is less than 3 volts with headlamp switch OFF and greater than 5 volts with the headlamp switch ON. • Turn ignition switch to OFF. • Measure the voltage between terminal 16 (brown/white stripe) and ground changes from battery voltage to in the full CCW position, to one half battery voltage in the full CW position.	(OK) ▶ (OK) ▶	REPLACE EIM. SERVICE electrical circuit 19 between EIM connector and headlamp control switch.

CK5652-C

FUEL GAUGE CO DISPLAYED

TEST STEP		RESULT	ACTION TO TAKE
C1	VERIFY THE CONDITION	CO Displayed ▶	GO to **C2**.
C2	CHECK FOR OPEN IN EIM		
• Disconnect the 14405/14401 harness connector located under the instrument panel at the fuse holder and short terminal No. 7 (yellow, white stripe) of the mating 14401 harness connector to ground. 		CO Displayed ▶ CS Displayed ▶	GO to **C3** (remove jumper short). GO to **C5** (remove jumper short).
C3	CHECK FOR OPEN IN 14401		
• Disconnect and remove EIM. • Verify continuity between pin 11 of the EIC connector and pin 7 of the 14405 connector.		(OK) ▶ (OK) ▶	GO to **C4**. SERVICE as required for open circuit.
C4	CHECK FUEL SENDER GROUND CONNECT		
• Reconnect the 14405 connector and the EIM connector. • Verify that the fuel sender ground wire located in the vehicle luggage compartment is securely fastened. • Verify continuity between pin 14 of the EIM ground and the sender ground.		(OK) ▶ (OK) ▶	REPLACE EIM. SERVICE ground circuit as required.
C5	CHECK FUEL SENDER WIRING		
• Reconnect the 14405 connector. • Lower fuel tank to gain access to the fuel sender connector. • Short the fuel sender harness connector with jumper wire. • Turn ignition switch to Run or Acc.		CO Displayed ▶ CS Displayed ▶	SERVICE fuel sender wiring for open circuit. GO to **C6**.
C6	CHECK FUEL SENDER		
• Turn ignition switch Off. • Measure the resistance of the fuel sender at the sender terminals. • Verify that the resistance is between 13 and 166 ohms.		(OK) ▶ (OK) ▶	REPLACE sender. INSPECT fuel sender wiring connector female terminals for flash or loose fit. SERVICE as required.

CK7074-A

FUEL GAUGE CS DISPLAYED

TEST STEP		RESULT ▶	ACTION TO TAKE
D1	VERIFY THE CONDITION	Display CS	GO to D2.
D2	CHECK FOR SHORT IN EIM		
• Disconnect 14405 connector under the instrument panel at fuse panel. • Turn the switch to Run or Acc.		CS Displayed ▶ CO Displayed ▶	GO to D3. GO to D4.
D3	CHECK FOR SHORT IN 14401		
• Remove and disconnect EIM. • Measure for short between pin 11 (circuit 29) and pin 14 of 18 pin harness connector for EIM.		(OK) ▶ (OK) ▶	REPLACE EIM. SERVICE 14401 harness for short to ground.
D4	CHECK FOR SHORT IN SENDER		
• Reconnect the 14405 connector. • Lower the fuel tank to gain access to the fuel sender connector. • Disconnect the connector from the fuel sender. • Turn ignition switch to Run or Acc.		CS Displayed ▶ CO Displayed ▶	SERVICE circuit 29, short to ground. SERVICE fuel sender for short to ground. REPLACE as required.

CK7283-A

FUEL GAUGE DOES NOT DISPLAY FLASHING E WHEN TANK EMPTY

TEST STEP		RESULT ▶	ACTION TO TAKE
E1	CHECK FUEL SENDER		
• Disconnect the 14401 connector from the 14405 connector. • Using an ohmmeter, check resistance between terminal 7 (circuit 29, Y/W) of the 14401 connector and the electronic instrument cluster ground. • Resistance should be less than 20 ohms with the tank drained.		(OK) ▶ (OK) ▶	REPLACE EIM. GO to E2.
E2	CHECK FUEL SENDER		
• Lower the fuel tank to gain access to the fuel sender, and remove the sender. • Measure the resistance of the sender: Empty Stop Resistance — 10 to 18 ohms Full Stop Resistance — 154 to 166 ohms		(OK) ▶ (OK) ▶	INSPECT fuel tank for distortion and/or free movement of sender in tank. SERVICE or REPLACE as necessary. REPLACE fuel sender.

CK7284-A

FUEL GAUGE DOES NOT DISPLAY F WHEN TANK IS FULL

TEST STEP		RESULT ▶	ACTION TO TAKE
F1	CHECK FUEL SENDER		
• Disconnect the 14401 connector from the 14405 connector. • Using an ohmmeter, check resistance between terminal 7 (circuit 29, Y/W) of the 14401 connector and the electronic instrument cluster ground. • Resistance should be 143-161 ohms with the tank full.		(OK) ▶ (OK) ▶	REPLACE EIM. GO to **F2**.
F2	CHECK FUEL SENDER		
• Lower the fuel tank to gain access to the fuel sender, and remove the sender. • Measure the resistance of the sender: Empty Stop Resistance — 10 to 18 ohms Full Stop Resistance — 154 to 166 ohms		(OK) ▶ (OK) ▶	INSPECT fuel tank for distortion and/or free movement of sender in tank. SERVICE or REPLACE as necessary. REPLACE fuel sender.

CK7285-A

DISPLAY ERRATIC

TEST STEP		RESULT ▶	ACTION TO TAKE
G1	VERIFY CONDITION		
• Verify type of erratic display.		Display blinks on and off ▶ CO or CS displayed intermittently ▶ Fuel display varies more than 2 gal. ▶	GO to **G2**. GO to **G5**. GO to **G10**.
G2	CHECK OTHER DISPLAYS		
• Turn ignition switch to Run or Acc. • Check operation of other EIM displays while fuel gauge display repeats condition.		Other displays normal ▶ Other displays blink or are erratic ▶	REPLACE EIM. GO to **G3**.
G3	CHECK MESSAGE CENTER (MC)		
• With EIM displaying erratic condition, check MC display for operation.		(OK) ▶ (OK) ▶	GO to **G4**. CHECK circuits 293, 297 and 797 between EIM and MC for intermittent opens and SERVICE as necessary.
G4	CHECK EIM WIRING		
• Check EIM circuits 295, 797 and 359 for intermittent opens, loose connections, frayed wiring, corroded or dirty connections, etc.		(OK) ▶ (OK) ▶	REPLACE EIM. SERVICE circuits as necessary.

CK7286-A

DISPLAY ERRATIC

TEST STEP	RESULT ▶	ACTION TO TAKE
G5 ACTIVATE EIM SELF-TEST		
• Turn ignition switch to Run or Acc. • Locate two terminal test connector. Jumper terminals. NOTE: Continental — connector taped to LH courtesy lamp under instrument panel. Mark VII — connector attached to fuse panel. • Check Fuel Gauge Display.	Display unchanged ▶	Jumper not making connections. REINSTALL and RECHECK display.
	Display reads: 01 F5 000118 ▶	GO to **G6**.
	Display reads: anything else ▶	REPLACE EIM.
G6 CONTINUE EIM SELF-TEST		
• Depress Miles/Km switch on MC once only. • Display should read 02 000000.	(OK) ▶	Condition was one time only. No problem found.
	(OK) ▶	REMOVE jumper. GO to **G7**.
G7 CHECK HARNESS WIRING		
• Check EIC 14401 to 14405 connector and fuel sender connector for dirt, corrosion, looseness, etc. Check for frayed wires, pinches, etc.	(OK) ▶	GO to **G8**.
	(OK) ▶	SERVICE connectors and/or wiring as necessary. GO to **G8**.
G8 CLEAR EIM SELF-TEST		
• Turn ignition switch to Run or Acc. • Connect jumper to test connector. • Turn ignition switch to Off. Wait 30 seconds. Turn ignition switch to Run or Acc. Verify 01 F5 000118 display. • Depress Miles/Km switch on MC once only. (This clears Self-Test of intermittent counts.)	02 000000 displayed ▶	REMOVE jumper. GO to **G9**.
	Any other display ▶	REPEAT G8 until 02 000000 is displayed. REMOVE jumper. Then, GO to **G9**.
G9 TEST DRIVE		
• Test drive vehicle over rough road. • Repeat test steps G5 and G6. • Verify display at end of test step G6.	02 000000 displayed ▶	Vehicle OK. REMOVE jumper.
	Any other display ▶	GO to **G7**. If test fails second time, REPLACE EIM.
G10 CHECK SPEEDOMETER OPERATION		
• Test drive vehicle and check speedometer operation.	(OK) ▶	Lower fuel tank. Check sender for proper operation. REPAIR or REPLACE as necessary.
	(OK) ▶	GO to Test **P1**.

CK7288-B

EIM WILL NOT SWITCH BETWEEN ENGLISH AND METRIC

TEST STEP		RESULT ▶	ACTION TO TAKE
H1	CHECK MESSAGE CENTER		
	• Turn ignition switch to Run or Acc. • Depress MILES/km switch on MC. • MC should switch English to Metric or Metric to English.	(OK) ▶ (OK) ▶	GO to **H2**. Refer to Section 33-86 for MC diagnosis.
H2	CHECK CLIMATE CONTROL (ATC)		
	• Depress MILES/km switch on MC. • ATC display should switch from English to Metric or Metric to English.	(OK) ▶ (OK) ▶	GO to **H3**. GO to **H7**.
H3	CHECK EIM CONNECTOR		
	• Remove instrument cluster finish panel. • Check 18 pin EIM connector for looseness, bent pins, etc.	(OK) ▶ (OK) ▶	GO to **H4**. SERVICE connector as necessary. GO to **H1**.
H4	CHECK VOLTAGE		
	• With the EIM connector connected, check voltage at pin 10. • With MC in MILES mode, voltage should be greater than 3.5 volts. • With MC in Km mode, voltage should be less than 1.5 volts.	(OK) ▶ (OK) ▶	GO to **H5**. GO to **H7**.
H5	CHECK EIM METRIC MODE		
	• With the EIM connected, ground pin 10. • Display should be in Metric mode.	(OK) ▶ (OK) ▶	GO to **H6**. REPLACE EIM.
H6	CHECK EIM ENGLISH MODE		
	• Disconnect EIM connector. • Remove pin 10 from connector and tape. • Connect EIM. • Display should be in English mode.	(OK) ▶ (OK) ▶	SERVICE connector as necessary. REPLACE EIM.
H7	CHECK WIRING		
	• Inspect circuit 506 between EIM, MC, ATC and electronic compass/thermometer for shorts or opens.	(OK) ▶ (OK) ▶	System OK. SERVICE wiring as necessary.

CK7290-A

SEGMENTS MISSING OR EXTRA SEGMENTS ON

TEST STEP		RESULT ▶	ACTION TO TAKE
J0	VERIFY CONDITION		Go to J1.
J1	CHECK EIM CONNECTOR		
	• Turn ignition switch to Run or Acc. • Locate two terminal test connector. Jumper terminals. NOTE: Continental — connector taped to LH courtesy lamp under instrument panel. Mark VII — connector attached to fuse panel. • Check display.	Display unchanged ▶	Jumper not making connections. REINSTALL and RECHECK display.
		Display reads: 01 F5 000118 ▶	GO to J2.
		Display reads anything else ▶	REPLACE EIM.
J2	CHECK SEGMENTS ON		
	• Depress MILES/km switch nine times to advance to all segments on display. • All segments should be On.	(OK) ▶	GO to J3.
		(OK) ▶	REPLACE EIM.
J3	CHECK SEGMENTS OFF		
	• Depress MILES/km switch one more time. • All segments should be Off.	(OK) ▶	GO to J4.
		(OK) ▶	REPLACE EIM.
J4	CHECK WALKING SEGMENTS		
	• Depress MILES/km switch two more times. • Segments should light, one at a time.	Only one segment on at a time ▶	System OK.
		Two or more segments on at once ▶	REPLACE EIM.

CK7291-A

INACCURATE FUEL INDICATION

TEST STEP		RESULT ▶	ACTION TO TAKE
K1	CHECK EIM RESPONSE		
	• Disconnect the 14401/14405 connector located under the instrument panel. CAUTION: Ignition switch must be Off when connecting or disconnecting resistor to 14401 harness. • Connect a 47 (±5%) ohm resistor between pin 7 (yellow/white stripe) of the 14401 connector and ground. • Turn ignition switch to Run or Acc. • Fuel gauge display should read 19-22 liters (5-6 gal.).	(OK) ▶ (OK) ▶	Turn ignition switch to Off. GO to **K2**. GO to **K3**.
K2	CHECK EIM RESPONSE		
	• CAUTION: Ignition switch MUST be Off when connecting or disconnecting resistor to 14401 harness. • Connect a 100 (±5%) ohm resistor between pin 7 (yellow/white stripe) of the 14401 connector and ground. • Turn ignition switch to Run or Acc. • Fuel gauge display should read 53-56 liters (14-15 gal.).	(OK) ▶ (OK) ▶	GO to **K4**. GO to **K3**

CK7292-A

INACCURATE FUEL INDICATION

TEST STEP		RESULT ▶	ACTION TO TAKE
K3	CHECK 14401 HARNESS RESISTANCE		
	• Disconnect EIM connector. • With an ohmmeter, measure resistance of circuit 29 (yellow/white stripe) between EIM connector and 47 ohm and 100 ohm resistors connected to 14401 connector. • Ohmmeter should read 47 ohms and 100 ohms respectively.	(OK) ▶ (OK) ▶	REPLACE EIM. SERVICE circuit 29 as necessary.
K4	CHECK 14405 HARNESS RESISTANCE		
	• Lower fuel tank to gain access to fuel sender. • Jumper sender connector. • Measure resistance between 14405 connector and ground.	Resistance is 0-1 ohm ▶ Resistance is greater than 1 ohm ▶	GO to **K5**. SERVICE circuit 29 as necessary.
K5	CHECK FUEL SENDER		
	• Check fuel sender for binding, sticking, etc.	(OK) ▶ (OK) ▶	GO to **K6**. SERVICE or REPLACE fuel sender as necessary.
K6	CHECK FUEL TANK		
	• Check fuel tank for dents, bulges or other damage.	(OK) ▶ (OK) ▶	System OK. Fault caused by other vehicle system(s). REPLACE fuel tank.

CK7293-A

SPEEDOMETER READS 0 MPH (Km/h) WHEN VEHICLE IS IN MOTION

	TEST STEP	RESULT	ACTION TO TAKE
M0	VERIFY THE CONDITION		Go to **K1**.
M1	VERIFY POWER UP DISPLAY CHECK SEQUENCE • Turn ignition key to "RUN" or "ACC." • Verify sequence. 1. Displays 188.  2. Display blank.  3. Displays 0 mph. 	Sequence OK ▶ Sequence NOT OK ▶	GO to **M2**. REPLACE EIM.
M2	CHECK THAT ODOMETER ADVANCES WHEN VEHICLE IS DRIVEN FORWARD	NOT OK ▶ OK ▶	GO to **M3**. REPLACE EIM.
M3	CHECK WIRING TO SPEED SENSOR • Check electrical connections between 14401 harness connector and 14290 harness connector, located at LH fender apron near dash panel. • Check electrical connections between 14290 harness and 7C078 transmission harness located near transmission dipstick. • Using an ohmmeter, check resistance between circuit 359 (black/white stripe) in 14401 to 14290 connector and circuit 150 (dark green/white stripe) in 14290 to 7C078 connector. • Resistance should be 200-230 ohms.	OK ▶ NOT OK ▶	GO to **M6**. GO to **M4**.
M4	CHECK SPEED SENSOR CONNECTOR • Check connector at speed sensor located on transmission.	OK ▶ NOT OK ▶	GO to **M5**. SERVICE connector and/or wiring as necessary. Check speedometer operation.
M5	CHECK SPEED SENSOR RESISTANCE • Using an ohmmeter, check resistance at speedometer sensor. • Resistance should be 200-230 ohms.	OK ▶ NOT OK ▶	GO to **M6**. REPLACE speedometer sensor. CHECK speedometer operation.
M6	CHECK DRIVEN GEAR AND RETAINER CLIP • Disconnect cable from transmission. Verify presence of driven gear with all teeth in good condition and the presence of retainer clip.	NOT OK ▶ OK ▶	REPLACE with proper gear and/or clip. GO to **M7**.
M7	CHECK DRIVEN GEAR ON OUTPUT SHAFT • Verify presence of drive gear on transmission output shaft.	NOT OK ▶ OK ▶	SERVICE transmission gear. GO to **M8**.

CK7294-A

SPEEDOMETER READS 0 MPH (Km/h) WHEN VEHICLE IS IN MOTION

TEST STEP		RESULT ▶	ACTION TO TAKE
M8	TEST DRIVE VEHICLE		
	• Test drive vehicle and check operation of speed control.	(OK) ▶	GO to **M9**.
		(OK) ▶	CHECK wiring to speed control to verify correct location of circuits 359 (black/white) and 150 (dark green/white) in connectors. SERVICE as necessary.
M9	CHECK MESSAGE CENTER		
	• While test driving vehicle, check operation of Message Center Elapsed Mileage display	(OK) ▶	GO to **M10**.
		(OK) ▶	CHECK wiring to Message Center to verify correct location of circuits 359 (black/white) and 150 (dark green/white) in connector. SERVICE as necessary.
M10	CHECK WIRING TO EIM		
	• Check connectors to EIM. • Using an ohmmeter, check resistance between pins 12 and 13 of EIM connector. • Resistance should be 200-230 ohms.	(OK) ▶	REPLACE EIM.
		(OK) ▶	SERVICE wiring, speed control or Message Center as necessary.

CK7295-A

SPEEDOMETER CONSTANTLY TOO HIGH OR TOO LOW

TEST STEP		RESULT ▶	ACTION TO TAKE
R0	VERIFY THE CONDITION		
	• Read this entire procedure before performing any part of this test.	▶	GO to **R1**.
R1	CHECK ODOMETER ACCURACY		
	• Over a known distance, compare the odometer reading with the distance traveled.	(OK) ▶	GO to **R2**.
		(OK) ▶	GO to **R3**.
R2	COMPARE READINGS		
	• Compare odometer and speedometer readings to Message Center displays. NOTE: This test step can be performed while performing test step M1 or in garage with rear wheels lifted.	(OK) ▶	System OK.
		(OK) ▶	REPLACE EIM.
	• Press RESET, then DIST buttons on the Message Center. Verify that Odometer and Distance readings are the same over a known distance.		
	• Press RESET, then AV SPD buttons on the Message Center. Verify that speedometer and average speed readings are within ±2 miles of each other.		
R3	CHECK SPEED SENSOR DRIVE GEAR		
	• Remove speed sensor from transmission and verify that correct drive gear is installed for vehicle transmission/axle/tire combination.	(OK) ▶	GO to **R4**.
		(OK) ▶	INSTALL correct gear with retaining clip.
R4	CHECK DRIVE GEAR ON TRANSMISSION OUTPUT SHAFT		
	• Check that correct drive gear is installed on transmission output shaft.	(OK) ▶	REPLACE EIM.
		(OK) ▶	INSTALL correct shaft/ gear.

CK7296-A

SPEEDOMETER SPEED INDICATION JUMPS UP AND DOWN ERRATICALLY

TEST STEP		RESULT ▶	ACTION TO TAKE
T0	VERIFY CONDITION		GO to **T1**.
T1	CHECK SPEED SENSOR DRIVE GEAR		
	• Remove speed sensor from transmission. • Check that all gear teeth are in good condition, retainer clip is installed and gear does not slip on shaft.	(OK) ▶ (OK) ▶	GO to **T2**. REPLACE drive gear and/or retaining clip.
T2	CHECK WIRING		
	• Check wiring from EIM to speed sensor for intermittent opens or shorts, by performing test steps M3, M4, M5, M9 and M10.	(OK) ▶ (OK) ▶	REPLACE EIM. SERVICE wiring and/or connectors as necessary.

CK7298-B

ODOMETER DISPLAYS ERROR

TEST STEP		RESULT ▶	ACTION TO TAKE
W0	VERIFY CONDITION	▶	Go to **W1**.
W1	CHECK NON-VOLATILE MODULE (NVM) CONNECTOR ON EIM		
	• Remove EIM. • Check NVM connector for damage.	(OK) ▶ (OK) ▶	REPLACE NVM module. AFFIX odometer sticker to door pillar. Check odometer display. If ERROR still displayed, REPLACE EIM. SERVICE connector as necessary.

CK7299-A

ODOMETER DISPLAYS S

TEST STEP		RESULT ▶	ACTION TO TAKE
Y0	VERIFY CONDITION	▶	Go to **Y1**.
Y1	DETERMINE IF NON-VOLATILE MODULE (NVM) IS ORIGINAL		
	• Check for mileage sticker on door pillar. • Remove EIM and check for service decal of NVM: White — Original White with decal — Replacement	Original NVM ▶ Replacement NVM ▶	GO to **Y2**. System OK.
Y2	REMOVE NVM		
	• Remove NVM from EIM. • Turn power On to EIM. • Odometer will display ERROR. • Check odometer for S display.	S illuminated ▶ S not illuminated ▶	REPLACE EIM. NOTE: Transfer NVM from old EIM to new EIM. REPLACE NVM. AFFIX sticker, with original vehicle mileage to door pillar. S should be illuminated and odometer should indicate 0 miles.

CK7300-B

ODOMETER DOES NOT ACCUMULATE MILEAGE

TEST STEP		RESULT ▶	ACTION TO TAKE
AA0	VERIFY CONDITION		
		Odometer will not accumulate ▶	GO to **AA1.**
		Odometer accumulates 10 miles, then loses 10 miles ▶	GO to **AA2.**
AA1	VERIFY SPEEDOMETER		
	• Verify that speedometer works properly.	(OK) ▶	REPLACE EIM.
		(OK) ▶	GO to **Pinpoint Test M.**
AA2	REPLACE NON-VOLATILE MODULE (NVM)		
	• Replace NVM. Affix mileage sticker with original vehicle mileage to door pillar. • Check odometer operation.	(OK) ▶	System OK.
		(OK) ▶	REPLACE EIM.

CK7301-B

ODOMETER READING INCORRECT

TEST STEP		RESULT ▶	ACTION TO TAKE
BB0	VERIFY CONDITION		
	• Test drive vehicle over a known distance and check for correct odometer display.	(OK) ▶	System OK.
		(OK) ▶	GO to **BB1.**
BB1	CHECK SPEEDOMETER		
	• Check speedometer for correct operation.	(OK) ▶	REPLACE EIM.
		(OK) ▶	GO to **Pinpoint Test M.**

CK7302-B

REMOVAL AND INSTALLATION

Continental

Removal and Installation

Refer to Fig. 20.

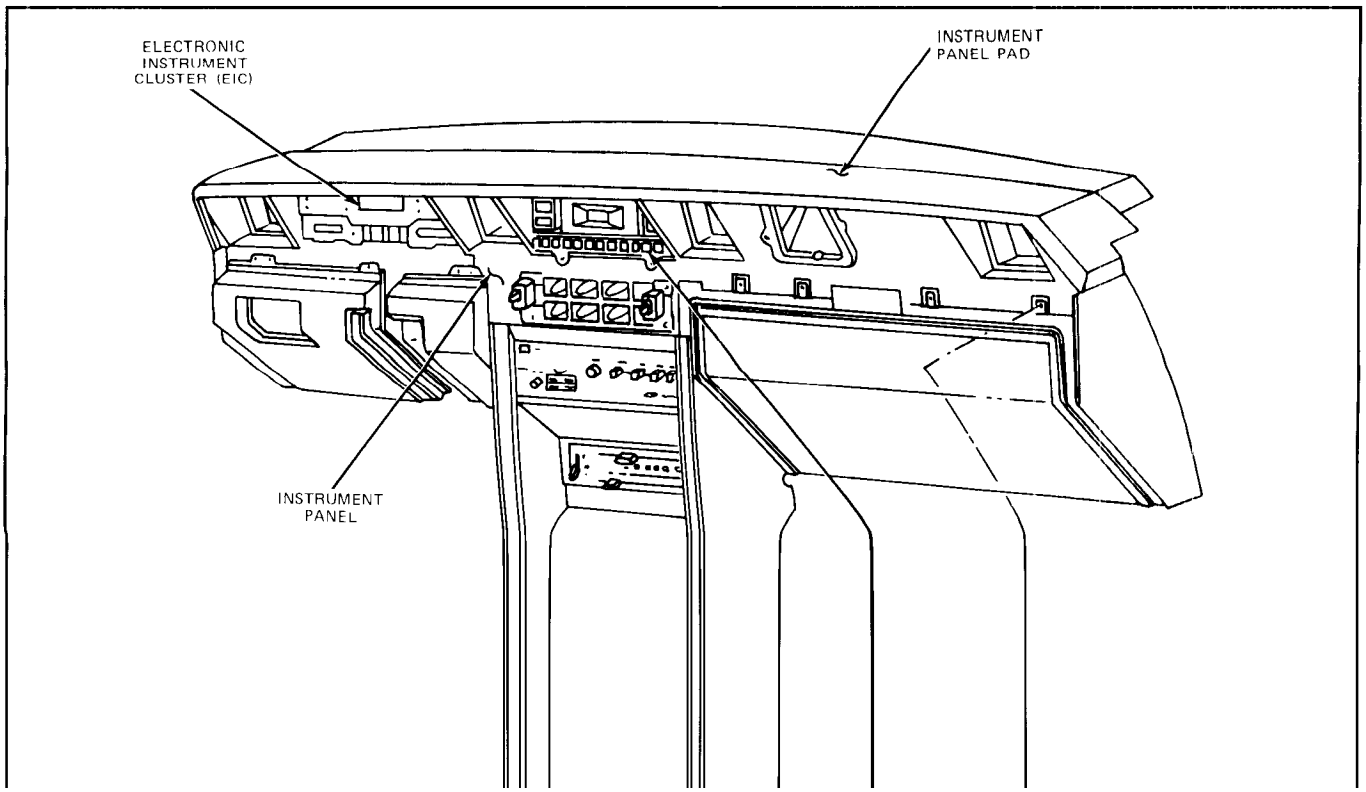
1. Remove the steering column shroud.
2. Remove left and right instrument panel mouldings. Mouldings are held in with retaining clips.
3. Remove the two center moulding retaining screws and remove moulding above climate control head.
4. Remove the ash receptacle.
5. Remove the two remaining screws and remove center moulding.
6. Remove 17 screws retaining instrument cluster finish panel and remove panel.
7. Disconnect PRNDL cable at steering column.
8. Remove the four screws retaining the cluster to the instrument panel.
9. Disconnect the electrical connector at the lower left rear corner of the cluster and remove the cluster.
10. To install, reverse Steps 1 through 9.

Mark VII

Removal and Installation

Refer to Fig. 21.

1. Remove four screws retaining instrument finish panel and rotate top of panel toward steering wheel and remove.
2. Remove six screws retaining instrument panel pad and rotate pad toward steering wheel and remove.
3. Remove four screws retaining instrument cluster to instrument panel and remove.



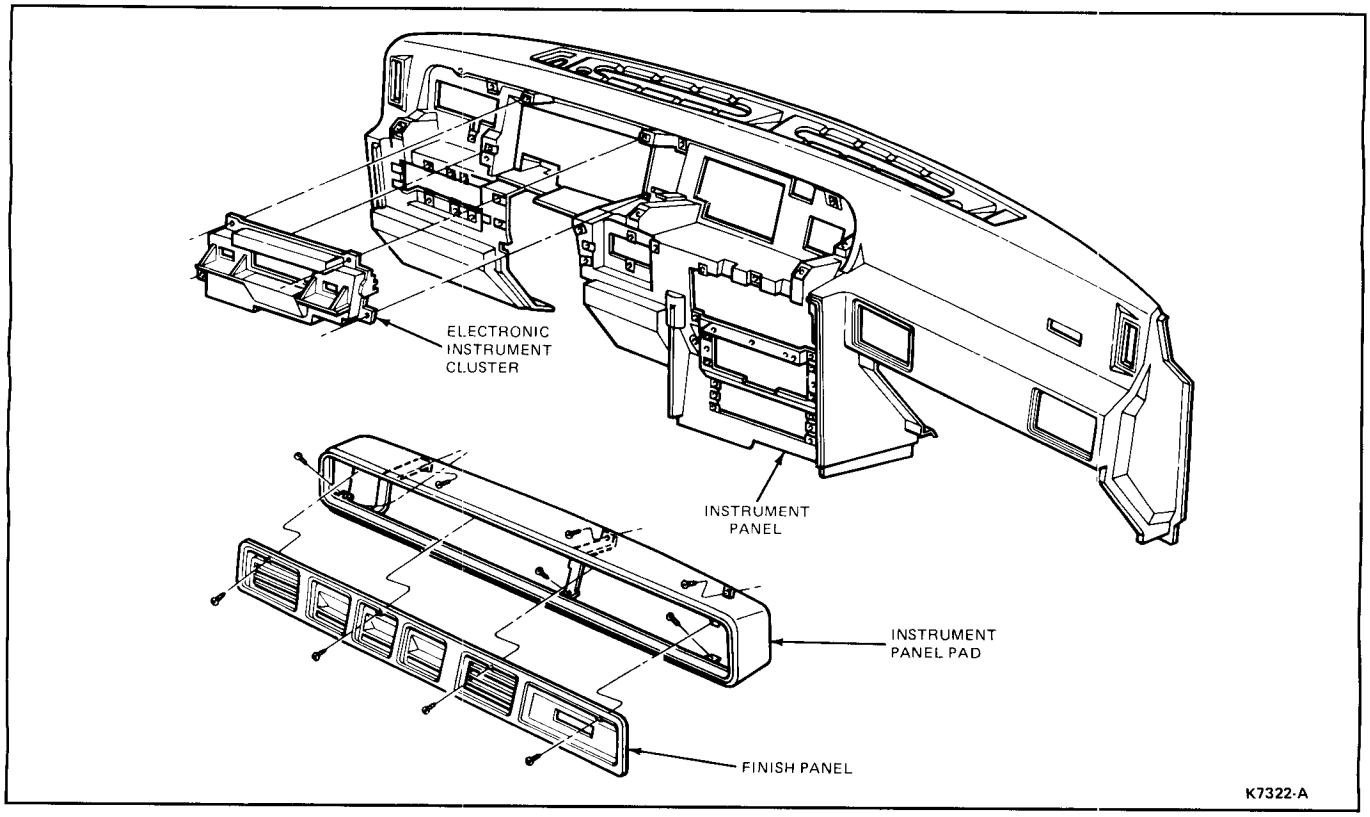


FIG. 21 Finish Panel Removal—Mark VII

4. Disconnect electrical connector at lower left rear corner of cluster.
5. To install, reverse Steps 1 through 4.

Electronic Instrument Module (EIM)

Removal and Installation

Refer to Fig. 22.

1. Remove Electronic Instrument Cluster as outlined in this Section.
2. Remove screw retaining Non-Volatile Memory Module (NVMM) cable connector at back of EIM.
3. Remove NVMM cable from under two tab retainers.
4. Remove EIM ribbon connector from four mounting tabs on lower back plate.
5. Remove four screws retaining EIM.
6. Remove EIM by sliding rearward.
7. To install, reverse Steps 1 through 6.

Non-Volatile Memory Module (NVMM)

Removal and Installation

Refer to Fig. 22.

1. Remove the Electronic Instrument Cluster as outlined in this Section.
2. Remove screw retaining NVMM cable connector to back of Electronic Instrument Module.
3. Remove cable from under two retaining tabs.
4. Remove connector.
5. On Continental, remove five screws retaining mask to instrument cluster and lower backplate.

   On Mark VII, remove the extra cable stored in lower backplate.
6. Remove NVMM retaining screw.
7. Remove NVMM by lifting mounting tab at lower backplate upward to disengage tab and remove NVMM.
8. To install, reverse Steps 1 through 7.

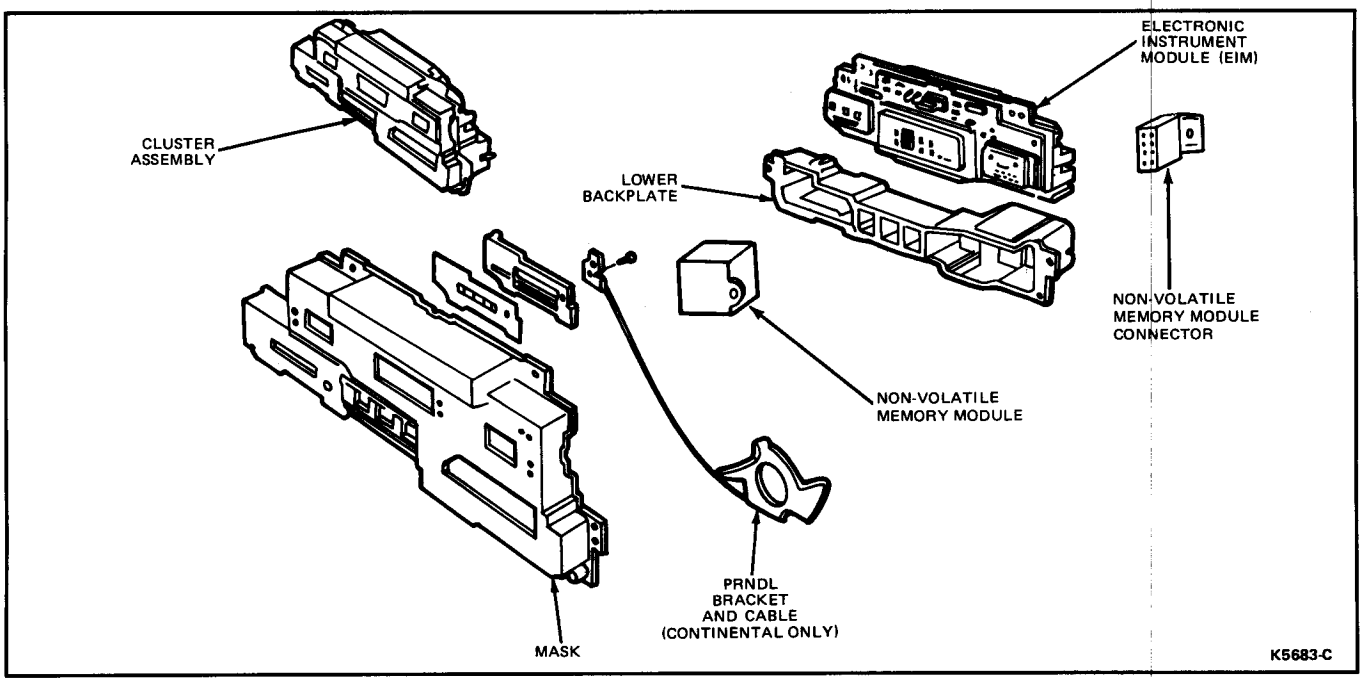


FIG. 22 Electronic Instrument Module—Continental Shown—Mark VII Similar

SPECIFICATIONS

SPEEDOMETER CALIBRATION TOLERANCE SPECIFICATIONS — ALL VEHICLES

30 mph (48 km/h) Actual Speed	60 mph (97 km/h) Actual Speed	Odometer Measure Over Actual 10 Miles (16 km) Distance
28-35 mph (45-56 km/h)	58-67 mph (93-108 km/h)	9.6-10.4 Miles (15.4-16.7 km)

CK4091-D

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft
Transmission Mounting Clip Bolt	4-6	3-4.5

CK5722-A

SECTION 33-86 Message Center

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION AND OPERATION

Message Center (MC)

The message center is standard on the Mark VII/ Continental. The system is composed of a message center display module, electronic tone generator, sensors and related wiring, (Fig. 1).

The message center features include:

- Clock.
- Time Alarm.
- Elapsed-Time.
- ETA (Estimated Time of Arrival).
- Distance to Destination.
- Elapsed Distance.
- Average Speed.
- Instantaneous Fuel Economy.
- Average Fuel Economy.
- Distance to Empty.

The message center also includes two warning lamps to indicate:

Windshield Washer Fluid: Near Empty.

Anti-Theft: Flashes On-Off when anti-theft system is on standby, and the door is open (this reminds the driver to remove key from ignition and lock the door upon exiting from vehicle). When the system is armed (door lock activated) the lamp will stay On for 2 seconds then go Off. Lamp will also flash On-Off when first entering the vehicle. Refer to the 1984 Car Shop Manual, Volume B, Section 44-20 for information on the Anti-Theft Protection System.

NOTE: The warning lamps are a complete separate system from the message center. For information pertaining to this system and the warning system refer to the 1984 Car Shop Manual, Volume B, Section 33-92.

The panel illumination is at maximum intensity for daytime driving. Turning on the headlamps or parklamps, automatically dims the panel lighting for nighttime driving. The degree of brightness, however, can be adjusted by turning the knob on the headlamp switch, whenever its headlamps or parklamps are On, as it is on conventional panels.

Clock

The clock is the basic display of the message center. It will be displayed each time the ignition key is turned to either the Run or Acc position.

If power is interrupted from the system, the clock will require resetting. Once power is restored, the clock will start elapsing time at approximately 12:00 am Jan 1 Mon. The clock will also require resetting on February 29 of the leap year, as the clock will normally display March 1st following February 28th. Refer to owner's guide for clock/date operation and resetting.

Mesage Center Keyboard

The keyboard consisting of 12 keys aligned in a row across the center of the instrument panel gives the vehicle operator direct access to the message center (Fig. 2). Through the keyboard, the driver can command a variety of information to be displayed. It is illuminated only when the headlamps or parklamps on On.

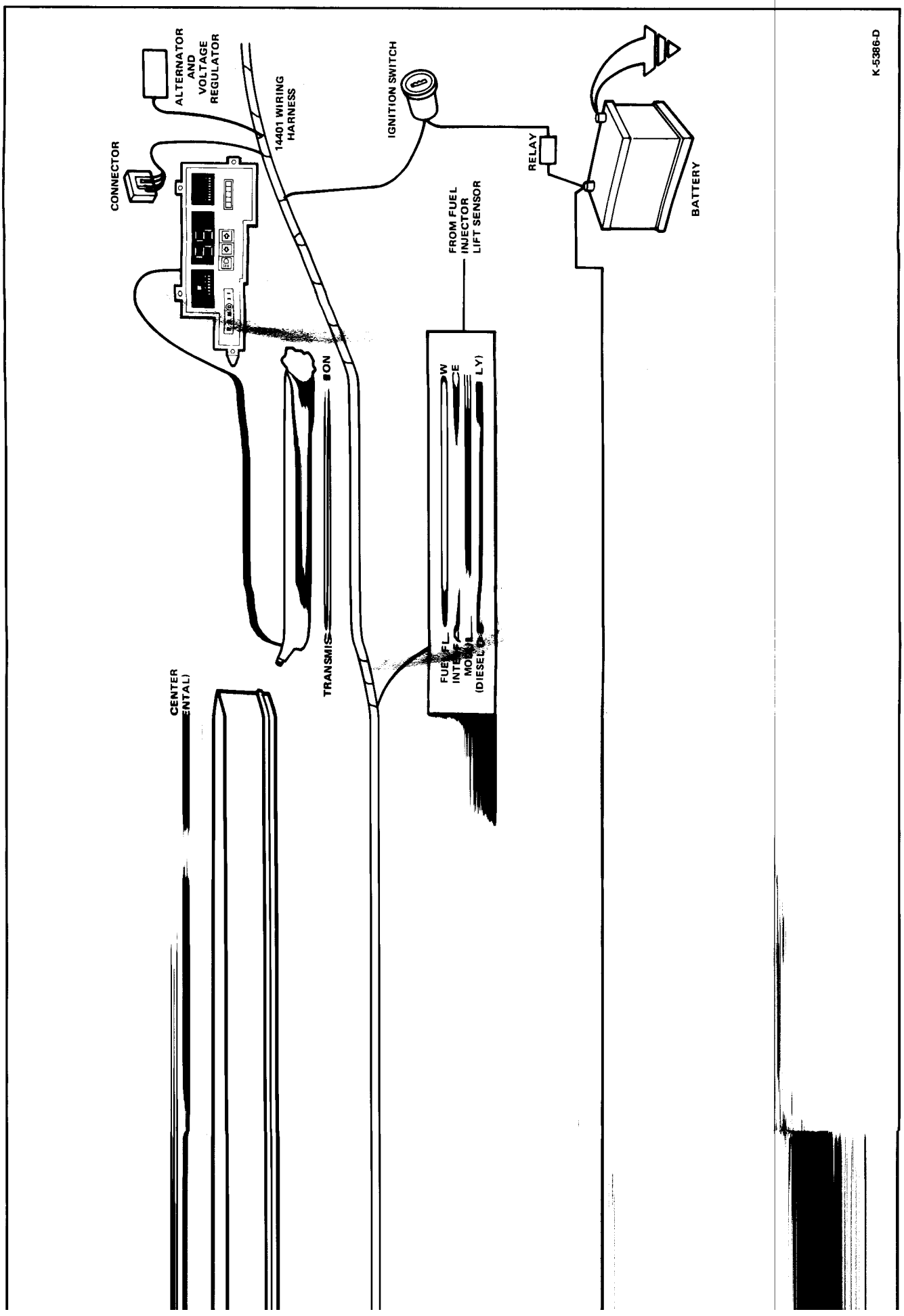
Each time a key is depressed it will be acknowledged with an audible tone to affirm that the signal has been properly received by the message center. Any message called up by depressing a key will continue to be displayed until the ignition key is turned Off or another key is pushed. Each key is labeled with a number and a designated function, or just a designated function (Fig. 2). Although the numbers help in locating specific keys quickly, they are used only for entering trip data into the message center. Reading from left to right across the keyboard the abbreviated designated function of the keys are as follows:

1	CLOCK	Select clock or portion to be set.
2	ALARM	Select alarm or portion to be set.
3	E/TIME	Elapsed Time
4	ETA	Estimated Time of Arrival
5	DEST	Distance to Destination
6	DIST	Elapsed Distance
7	AV SPD	Average Speed Since Reset
8	F/ECON	Average Fuel Economy Since Reset/ Instantaneous Fuel Economy
9	DTE	Distance to Empty
0	SET	Day/Date/Alarm Set
	MILES/KM	English/Metric
	Reset	Reset All Functions

CK5389-B

Tone Generator

Refer to the 1984 Car Shop Manual, Volume B, Section 33-90.


ALTERNATOR AND VOLTAGE REGULATOR
14401 WIRING HARNESS
IGNITION SWITCH
RELAY
BATTERY
CONNECTOR
FROM FUEL INJECTOR LIFT SENSOR
TRANSMIS
ON
CENTER
K-5386-D

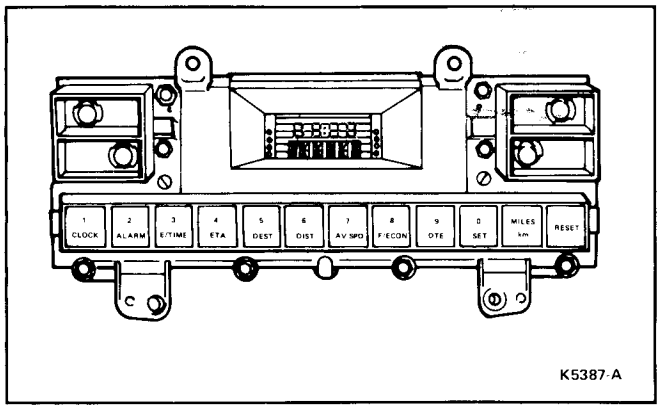


FIG. 2 Message Center

DIAGNOSIS

The Mark VII/Continental message center is self-contained, with the control module, keyboard and display all in one unit and does not display flashing warning messages. Any malfunction with the buttons, display segments, clock or alarm functions will result in replacement of the message center. By selecting the appropriate test listed below, the problem can be easily diagnosed in a minimum of Steps. The following chart will help to identify any further problems with the message center and lists the test to perform.

NOTE: If the distance to empty (DTE) display appears unusually high (greater than 600 miles) or stuck at zero (with fuel in tank) momentarily disconnect the power to circuit 54 (battery) to reinitialize the message center module.

NOTE: Do not use a test lamp in conjunction with message center troubleshooting. The test lamp may limit current draw required by the message center to operate property. Use an appropriately sized ammeter to check for Current draw. (Message center requires approximately 0.35 Amps).

The message center contains a field diagnostic mode of operation which is used in many of the tests listed above. The field diagnostics is summarized below:

Test	Description
A	Display and Dimming Test
B	Clock Test
C	Alarm Test
D	Elapsed Time (E Time) Test
E	Estimated Time of Arrival (ETA) Test
F	Destination (DEST) Test
G	Distance (DIST) Test
H	Average Speed (AV SPD) Test
J	Fuel Economy (F ECON) Test
K	Distance to Empty (DTE) Test
L	English Metric (MILES KM) Test
M	Set and Reset Button Test
N	Tone Generator Test

CK5390-B

To enter field diagnostics simply press the clock button and the miles/km button simultaneously. The Time 1 test will be displayed. If field diagnostics cannot be displayed, replace the message center. The following Chart describes each test:

Refer to Figs. 3 and 4 for message center connector wiring for the following diagnostic tests.

Button Pressed	Display	Description
1 CLOCK	00:00 TIME 1	Upper row counts from 00:00 to 99:99
2 ALARM	X FLOW 2	X is a number for 0 to 25.5 designating flow from the flow sensor
3 E/TIME	X FUEL 3	X is a number from 0 to 25.5 relating to fuel level in tank
4 ETA	X DIST 4	X is a number from 0 to 25.5 relating to the odometer
5 DEST	X DIM 5	X is a number from 0 to 25.5 varied by the IP dimmer switch
6 DIST	66:66 NNNNNN	Display Test
7 AV	777.7 ZZZZZZ	Display Test
8 F/ECON	8888 ++++++	Display Test
9 DTE	777.7 ZZZZZZ	Display Test
0 SET	CTM X	X is the level of MC; Tone Test
MILES/km (In CTM.5 and above units only)	XXXX FLOW 5	If upper row all Cs, sense pin (#11) is grounded. This is correct configuration.
MILES/km (In CTM.5 and below units only)	66:66 NNNNNN	Display Test
RESET	Clock Display	Exits Diagnostic Mode. Press MILES/km to avoid resetting any functions.

The sequence of tests is not important and can be chosen in any order and as many times as desired. **CK5391-C**

Circuit Number	Description	Color Code
19	Instrument Panel Lights	Lt. Blue/Red Stripe
54	Battery Power	Lt. Green/Yellow Stripe
57	Ground	Black
150	Vehicle Speed (Signal)	Dk. Green/White Stripe
183	Tone Generator	Tan/Yellow Stripe
205	Fuel Level (Signal)	Dk. Blue/Lt. Green Stripe
295	Accessory (Tripminder & EIC)	Lt. Blue/Pink Stripe
296	Accessory (Tone Gen)	White/Purple Stripe
359	Fuel Flow (Ground) (Can.)	Black/White Stripe
361	Fuel Flow (Signal) (Can.)	Red
506	Speedometer MPH — Km/h	Red
687	Fuel Flow (Power) (Can.)	Gray/Yellow Stripe

CK5686-B

FIG. 3 Wiring Connector Terminal Description

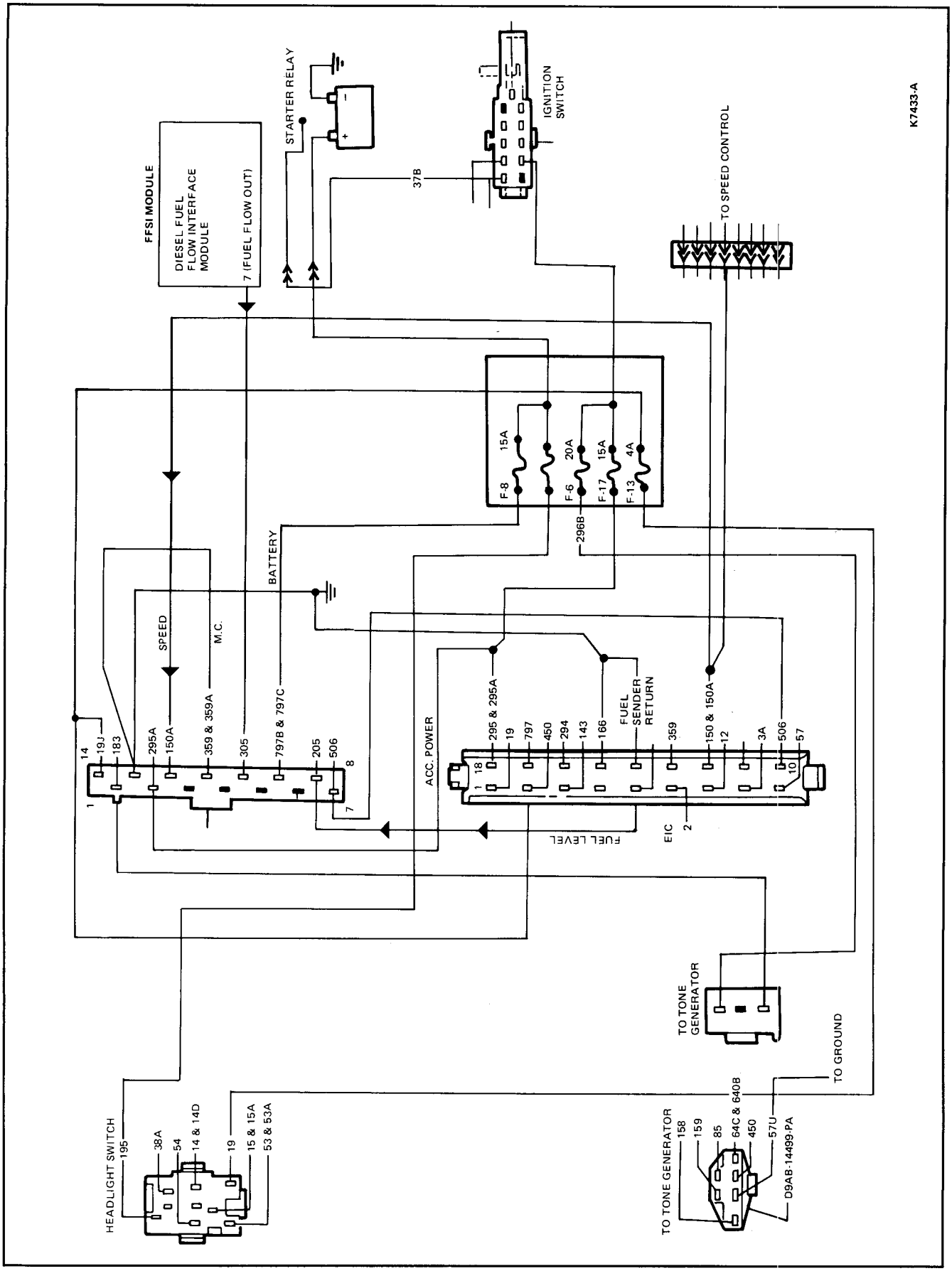
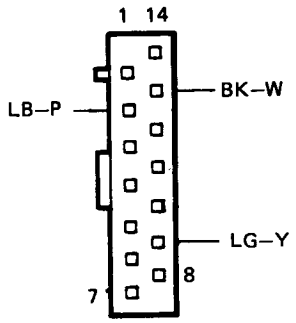


FIG. 4 Message Center Wiring

DISPLAY AND DIMMING TEST A

TEST STEP	RESULT ▶	ACTION TO TAKE
A1		
• Turn key to Acc or Run. • Observe Message Center display.	Is the display lit? YES ▶ NO ▶	 GO to **A5**. GO to **A2**.
A2		
• Turn key to Off. • Depress [1 CLOCK] button and hold at least 5 seconds.	Is the display lit? YES ▶ NO ▶	 REMOVE Message Center from dash and GO to **A12**. GO to **A3**.
A3 FUSE?		
• Check fuse No.	Is the fuse OK? YES ▶ NO ▶	 REMOVE Message Center from dash and GO to **A4**. REPLACE fuse.
A4 WIRING?		
• Check for battery on pin 9 (LT. GREEN/YELLOW STRIPE) of Message Center connector. • Check for battery on pin 2 (LT. BLUE/PINK STRIPE) with key in Run or Acc. • Check for ground on pin 13 (BLACK/WHITE STRIPE).  	Is there battery voltage on pins 2 and 9 and ground on pin 13? YES ▶ NO, faulty wiring or connectors ▶	 REPLACE Message Center. SERVICE circuits as necessary.

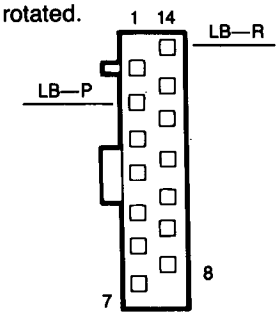
CK5687-C

DISPLAY AND DIMMING TEST A — Continued

TEST STEP	RESULT ▶	ACTION TO TAKE
A5 DISPLAY SEGMENTS? • Press [1 CLOCK] and [MILES KM] buttons simultaneously to enter self-diagnostics.	Does the upper row display an incrementing four digit number 00:00 to 99:99 and display a "time 1" on the lower row? YES ▶ NO display or incrementing count ▶	 GO to **A6**. REPLACE Message Center.
A6 DISPLAY SEGMENTS? • Press button [6 DIST]	Does display look identical to? [66:66 NNNNN] YES ▶ NO ▶	 GO to **A7**. REPLACE Message Center.
A7 DISPLAY SEGMENTS? • Press button [7 AV SPD]	Does display look identical to? [777.7 ZZZZZZ] YES ▶ NO ▶	 GO to **A8**. REPLACE Message Center.
A8 DISPLAY SEGMENTS? • Press button [8 F/ECON]	Does display look identical to? [8888 + + + + + +] YES ▶ NO ▶	 GO to **A9**. REPLACE Message Center.

CK5688-C

TEST A — Continued
DISPLAY AND DIMMING

TEST STEP	RESULT ▶	ACTION TO TAKE
A9 DISPLAY DIMMING?		
• Pull headlamp dimmer switch and rotate it.	• Do all instrument panel displays dim?	
	YES ▶	Message Center system works OK, check operator's manual.
	NO, fuel and speedometer dim but Message Center does not dim. ▶	GO to **A10**.
	No dimming on any displays. ▶	REFER to Group 32.
A10		
• Press button [5 DEST] • Pull and rotate dimmer switch to verify proper switch operation and connecting wiring.	Does the upper row display a number that will vary from 11.0 to 25.5 and the lower row read "DIM 5" during switch rotation?	
	YES ▶	REPLACE Message Center.
	NO ▶	GO to **A11**.
A11		
• Disconnect Message Center harness. • Check pin 14 (LT. BLUE/RED STRIPE) for variable voltage of 5 volts to 14 volts as headlamp/dimmer switch is pulled and rotated. 	Does the voltage vary with switch?	
	YES ▶	REPLACE Message Center (since Message Center failed in **A10** above).
	NO ▶	SERVICE wiring problem back to headlamp/ dimmer switch.
A12 IGNITION SWITCH?		
• Check for battery voltage on Pin 2 (LT. BLUE/PINK STRIPE) of Message Center connector with ignition switch in Run or Acc.	Is there battery voltage on Pin 2?	
	YES ▶	REPLACE Message Center.
	NO ▶	SERVICE wiring problem or ignition switch.

CK5689-C

TEST B
CLOCK

TEST STEP		RESULT ▶	ACTION TO TAKE
B1	CLOCK POWER UP?		
• Turn key to Acc or Run position. • Press [1 CLOCK] button and release.		Does Message Center display time? YES ▶ NO ▶	 GO to **B2**. REPLACE Message Center.
B2	CLOCK SETTABLE?		
• Set clock to 11:59 PM SUN 31 (see clock setting procedure in owner's manual).		Can clock be set to 11:59 PM SUN 31? YES ▶ NO ▶	 GO to **B3**. REPLACE Message Center.
B3	CLOCK ADVANCES?		
• Press [1 CLOCK] button and wait one minute.		Does clock advance to 12:00 MON 1? YES ▶ NO ▶	 GO to **B4**. REPLACE Message Center.
B4	KEY OFF MODE?		
• Turn key to Off position and depress [1 CLOCK]		Does clock display? YES ▶ NO ▶	 Message Center is OK. RESET clock to current time and date. REPLACE Message Center.

CK5691-C

TEST E
ESTIMATED TIME OF ARRIVAL (ETA)

	TEST STEP	RESULT ▶	ACTION TO TAKE
E1	ETA SELECTED?		
	• Turn key to Run or Acc. • Depress [4 ETA] button. NOTE: X implies any number.	Does display look similar to: [XX:XX ETA XM] OR [——:—— ETA] YES ▶ NO, neither of above displays ▶	 GO to **E2**. REPLACE Message Center.
E2	AV SPD FUNCTIONS?		
	• Press [7 AV SPD] button. • Observe AV speed. NOTE: Average speed is a stored number and will only go to zero when the reset and AV SPD buttons are pressed.	If the average speed is 25 mph or greater ▶ If the average speed is less than 25 mph ▶ If the average speed is not displayed ▶	GO to **E3**. GO to **E4**. REPLACE Message Center.
E3	ETA FUNCTIONS		
	• Set clock to 12:00 AM (see clock setting). • Set DESTination to 100 miles. • Press [4 ETA] button. • Read ETA.	If the Message Center displays approximately [4:00 ETA] If the DESTination cannot be set or ETA is grossly inaccurate ▶	Message Center is OK. REPLACE Message Center.
E4	ETA FUNCTIONS?		
	• Set clock to 12:00 AM (See clock setting procedure). • Set DESTination to same number as AV SPD noted in **E2** (See DEST SETTING). • Press [4 ETA] button. • Read ETA.	If the Message Center displays: [1:00 ETA AM] If the DESTination can not be set or has inaccurate ETA ▶	Message Center is OK. REPLACE Message Center.

CK5694-C

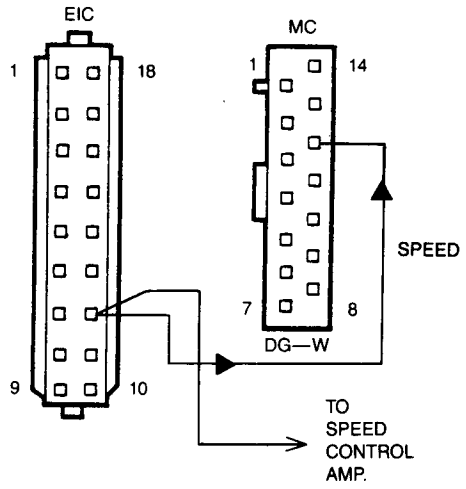
TEST F
DESTINATION (DEST)

NOTE: If the speedometer and/or speed control does not work, service that first, then return to appropriate section in Shop Manual.

	TEST STEP	RESULT ▶	ACTION TO TAKE
F1	DEST SELECT & RESET?		
	• Turn key to Run or Acc. • Press [RESET] button. • Press [5 DEST] button.	Does display look identical to? [.0 DES MI] YES ▶ NO ▶	 GO to **F2**. REPLACE Message Center.
F2	DESTINATION SETTABLE?		
	• Press [1 CLOCK] button. • Press [2 ALARM] button. • Press [5 DEST] button. • Press [RESET] button.	Does display look identical to? [125.0 DES MI] YES ▶ NO ▶	 GO to **F3**. REPLACE Message Center.
F3	DEST FUNCTIONS?		
	• With rear wheels of vehicle hoisted off of floor, run the engine with transmission in drive. • Observe display.	Does the DES number decrease? YES ▶ NO ▶	 Message Center is OK. GO to **F4**.

CK5696-C

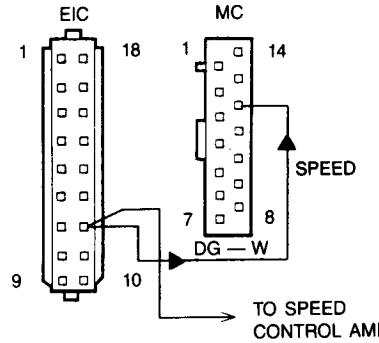
TEST F — Continued
DESTINATION (DEST)

TEST STEP	RESULT ▶	ACTION TO TAKE
F4		
• Press [1 CLOCK] and [MILES KM] buttons simultaneously to enter self test. • Press [4 ETA] button to put Message Center in distance test mode. • Run engine with transmission in drive for 20 seconds at 30 mph.	Does the Message Center display a number that increases approximately every second? YES ▶ NO ▶	 REPLACE Message Center (since Message Center failed in **F3**). GO to **F5**.
F5 MC OR WIRING PROBLEM?		
• Check for continuity and short conditions. (DK. GREEN/WHITE STRIPE WIRE) pin 12 of Message Center module to pin 12 of EIC. NOTE: Assuming EIC is functioning properly.  	Does the connector wiring show continuity and no shorted condition? YES ▶ NO ▶	 REPLACE Message Center (provided EIC & speed control function properly.) SERVICE wiring/ connector.

CK5697-D

TEST G
DISTANCE (DIST)

NOTE: If the speed control and/or speedometer are not functioning, service these problems first.

TEST STEP	RESULT ▶	ACTION TO TAKE
G1		
• Turn key to Run or Acc. • Press RESET button. • Press 6 DIST button. • Press MILES KM button if necessary.	Does display look identical to? .0 EL MI YES ▶ NO ▶	GO to **G2**. REPLACE Message Center.
G2		
• With rear wheels of the vehicle hoisted off the floor, run engine with transmission in drive. • Observe EL MI number.	Does EL MI number increase? YES ▶ NO ▶	Message Center is OK. GO to **G3**.
G3		
• Press 1 CLOCK and MILES KM buttons simultaneously to enter self test. • Press 4 ETA button to put Message Center in distance test mode. • Run engine with transmision in drive for 20 seconds at 30 mph.	Does the Message Center display a number that increases approximately every second? YES ▶ NO ▶	REPLACE Message Center (since Message Center failed **G2** above). GO to **G4**.
G4 MC OR WIRING PROBLEM		
• Check for continuity and short conditions on (DK. GREEN/WHITE STRIPE WIRE) pin 12 of Message Center module to pin 12 of EIC. NOTE: Assuming EIC functions properly. 	Does the connector wiring show continuity and no short conditions? YES ▶ NO ▶	REPLACE Message Center (providing EIC & speed control function properly). SERVICE wiring/ connectors.

CK5698-D

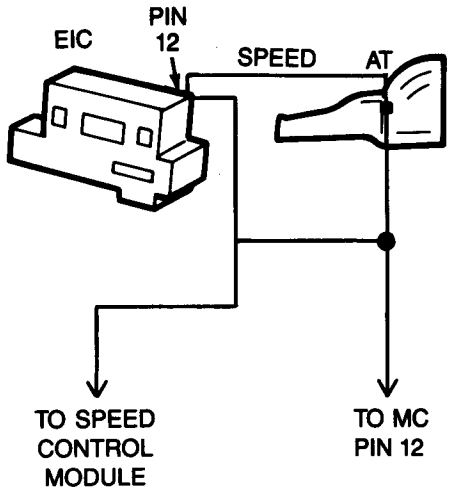
TEST H
AVERAGE SPEED (AV SPD)

NOTE: If the Speedometer and/or Speed Control does not work, service these problems first.

TEST STEP	RESULT ▶	ACTION TO TAKE
H1		
• Turn key to Run or Acc. • Press [7 AV SPD] button. NOTE: Average speed is a stored number and will only go to zero when the reset and AV SPD buttons are pressed.	Does Message Center display? [XXX.X AV MPG] YES ▶ NO ▶ NOTE: X implies any number.	GO to **H2**. REPLACE Message Center.
H2		
• With rear wheels of vehicle hoisted off of floor, run the engine with transmission in drive for 20 seconds at 25 mph and hold at constant speed. • Press RESET button after speed is stabilized. • Press [7 AV SPD] button.	Do EIC speedometer function properly? Does the EIC speedometer and AV SPD display approximately the same value? YES ▶ NO, Different value ▶	Message Center is OK. GO to **H3**.
H3 MC OR SPEED SIGNAL?		
• Press [1 CLOCK] and [MILES KM] buttons simultaneously to enter self test. • Press [4 ETA] button to put Message Center in distance test mode. • Run engine with transmission in drive for 20 seconds at 30 mph.	Does the Message Center display a number that increases approximately every second? YES ▶ NO ▶	REPLACE Message Center (since Message Center failed in **H2** above). GO to **H4**.

CK5700-C

TEST H — Continued
AVERAGE SPEED (AV SPD)

TEST STEP		RESULT	ACTION TO TAKE
H4	MC OR WIRING?		
	Check for continuity and short conditions (DK. GREEN/WHITE STRIPE WIRE) pin 12 of Message Center module to pin 12 of EIC. Check for open wire or a short ground. 	Does the connector wiring show continuity and no shorted condition? YES ▶ NO ▶	REPLACE Message Center (Assuming EIC functioning properly). SERVICE wiring/ connectors.

CK5726-C

TEST J
FUEL ECONOMY (F/ECON)

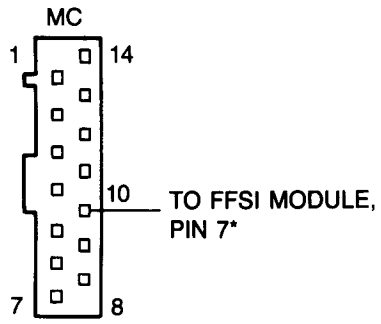
Complaints of average fuel economy readings of greater than 40 MPG (17 km/l) or less than 8 MPG (3.4 km/l) can be diagnosed using the following procedure. Average fuel economy readings within this range (8 MPG to 40 MPG or 3.4 km/l are possible and if they seem low can be attributable to a number of factors: poorly tuned engine, driving conditions, gasoline leaks, etc. The fuel flow sensor has been constructed so as to assure its accuracy.

FUEL ECONOMY LESS THAN 8 MPG OR GREATER THAN 40 MPG

TEST STEP	RESULT ▶	ACTION TO TAKE
J1		
• Turn key to Run or Acc. • Press [8 F/ECON] button. • Select miles mode if necessary.	Does display look similar to: (for the first second) [X AV MPG] YES ▶ NO ▶ NOTE: X implies any number.	 GO to **J2**. REPLACE Message Center.
J2		
• Hoist rear wheels of vehicle off of floor. Run the engine with transmission in drive for 20 seconds at 25 mph. • Press [RESET] button. • Press [7 AV SPD] button.	Does the EIC speedometer and Message Center AV SPD display within 2 mph of each other? YES ▶ NO ▶	 GO to **J3**. GO to Section H — Average Speed Test.
J3		
• Press [1 CLOCK] and [MILES KM] buttons simultaneously to enter self test. • Press [2 ALARM] button to put Message Center in the flow test mode. • Display reads [XX FLOW 2] • Rev the engine to approximately 1600 rpm and hold.	Does the XX reading increase in value as the engine is running? YES ▶ NO ▶ NOTE: Number increases as fuel is consumed. The value of the number is meaningless as long as it increases in value with fuel consumption.	 F/ECON is OK. Go to **J4**.

CK5727-D

TEST J (Continued)
FUEL ECONOMY (F/ECON)

TEST STEP	RESULT	ACTION TO TAKE
J4		
• Check the wiring from the FFSI harness connector Pin 7 to the Message Center connector Pin 10, for shorts to ground or open circuits.  *Refer to Fig. 4 for details.	Is the wiring OK? (No shorts to ground or open circuits?) YES ▶ NO ▶	 REPLACE FFSI MODULE. SERVICE wiring as necessary.

CK7434-A

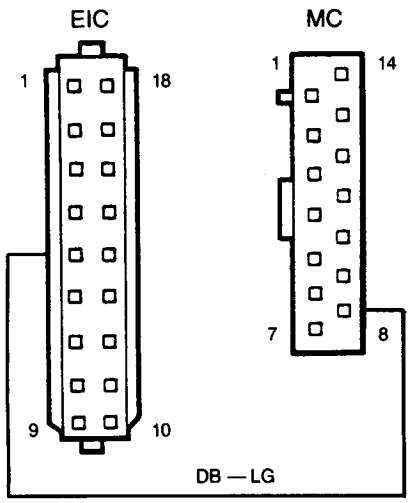
TEST K
DISTANCE TO EMPTY (DTE) (REFER TO NOTE)

TEST STEP	RESULT ▶	ACTION TO TAKE
K1		
• Turn ignition to Run or Acc. • Press [9 DTE] BUTTON. • Press [MILES KM] BUTTON. If necessary for miles mode.	Does the Message Center display? [XXX DTE MI] YES ▶ NO ▶ NOTE: X implies any number	GO to **K2**. REPLACE Message Center.
K2		
• Read fuel level on fuel gauge. • Estimate DTE by multiplying the number of gallons of fuel times estimated MPG. NOTE: The Mark VII/Continental has a 23 gallon fuel tank.	Does displayed DTE seem reasonable? YES ▶ NO ▶	DTE function is OK. GO to **K3.**
K3		
• Press [1 CLOCK] AND [MILES KM] buttons simultaneously to enter self-test • Press [3 E/TIME] BUTTON to put Message Center in fuel level test. • Read display and compare to chart.	Does the Message Center "XX.X Fuel 3" display agree with chart? YES ▶ NO, value does not agree with chart ▶ NO, cannot get this display ▶	GO to **K4**. GO to **K5**. REPLACE Message Center.

Fuel Gauge Display	Corresponding Display on Message Center
F	19.5 to 24.5
20	18.5 21.5
19	17.5 20.5
18	16.5 19.5
17	15.5 18.5
16	14.5 17.5
15	13.5 16.5
14	12.5 15.5
13	11.5 14.5
12	10.5 13.5
11	9.5 12.5
10	8.5 11.5
9	7.5 10.5
8	6.5 9.5
7	5.5 8.5
6	4.5 7.5
5	3.5 6.5
4	2.5 5.5
3	1.5 4.5
2	0.5 3.5
Empty	0 3.0

NOTE: If the Distance to Empty (DTE) display appears unusually high (greater than 600 miles) or stuck at zero (with fuel in the tank) momentarily disconnect the power to Circuit No. 54 (battery) to reinitialize the Message Center module. **CK5730-D**

TEST K — Continued
DESTINATION TO EMPTY (DTE)

TEST STEP	RESULT ▶	ACTION TO TAKE
K4		
• Hoist rear wheels of vehicle off floor. • Run engine with transmission in drive. • Press [1 CLOCK] and [MILES KM] buttons simultaneously to enter self-test. • Press [2 ALARM] button to put Message Center in flow test mode. • Display reads [XX.X FLOW 2] • Rev and hold the engine at approximately 1600 rpm. NOTE: X implies any number.	Does Message Center "XX.X FLOW 2" display increase as the engine is running? YES ▶ NO, number does not change ▶ ▶	REPLACE Message Center (since Message Center failed K3). REPLACE fuel flow sensor. (For Canadian vehicles.) REPLACE EEC Module.
K5		
• Check wiring from to EIC (Circuit No. 205-DARK BLUE/LIGHT GREEN WIRE) from pin 8 of Message Center to pin 5 of EIC. 	Are the wiring and connectors OK? YES ▶ NO ▶	REPLACE Message Center. SERVICE wiring/ connectors.

CK5731-D

ENGLISH/METRIC (MILES/KM) TEST L — Continued

TEST STEP	RESULT ▶	ACTION TO TAKE
L4		
• Connect jumper from Pin 10 of EIC to ground. • Observe miles/km on EIC speedometer.	Does the EIC speedometer display km/h with Pin 10 grounded and MPH with Pin 10 not grouned.?	
	YES ▶	REPLACE Message Center.
	NO ▶	REPLACE EIC.

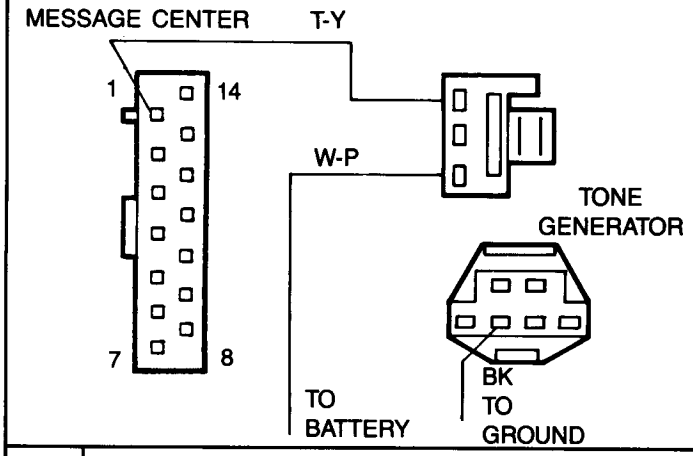
CK5734-C

TEST M
SET AND RESET BUTTON

NOTE: IF IT IS NOT POSSIBLE TO SET OR RESET A FUNCTION (CLOCK, ALARM, TRIP FUNCTION) AS DESCRIBED IN THE OWNER'S GUIDE — REPLACE THE MESSAGE CENTER.

CK5735-C

TEST N
TONE GENERATOR

TEST STEP	RESULT ▶	ACTION TO TAKE
N1		
• Turn key to Acc. • Press each button and listen for tone.	Is a tone heard when each button is pressed?	
	YES ▶	Message Center tone generator is OK.
	NO, steady continuous tone ▶	GO to **N5**.
	NO tone on any button ▶	GO to **N2**.
	NO tone heard on some buttons ▶	Tone generator OK, REPLACE Message Center.
N2		
• Connect jumper wire from ground to pin No. 2 (TAN/YELLOW WIRE) of tone generator.* • Listen for tone. NOTE: Leave tone generator connected for this test. 	Is tone heard when pin No. 2 is grounded?	
	YES ▶	GO to **N3**.
	NO ▶	GO to **N4**.
N3		
• Check wire (TAN/YELLOW STRIPE) from Pin No. 2 of tone generator to Pin No. 1 of Message Center.	Is there continuity from Pin 2 to Pin 1?	
	YES ▶	REPLACE Message Center.
	NO ▶	SERVICE wiring/ connectors.

CK5736-C

TEST N
TONE GENERATOR — Continued

TEST STEP	RESULT ▶	ACTION TO TAKE
N4		
• Check for battery power on Pin No. 1 (WHITE/PURPLE) of tone generator connector.	Is there battery voltage on Pin No. 1?	
	YES ▶	REPLACE tone generator (refer to Section 33-90).
	NO ▶	SERVICE tone generator circuitry (refer to Section 33-90).
N5		
• Check for grounded wire (BROWN/LIGHT BLUE HASH) circuit No. 183 to tone generator from the Message Center.	Is the wire grounded?	
	YES ▶	SERVICE circuit.
	NO ▶	REPLACE Message Center.

CK5737-C

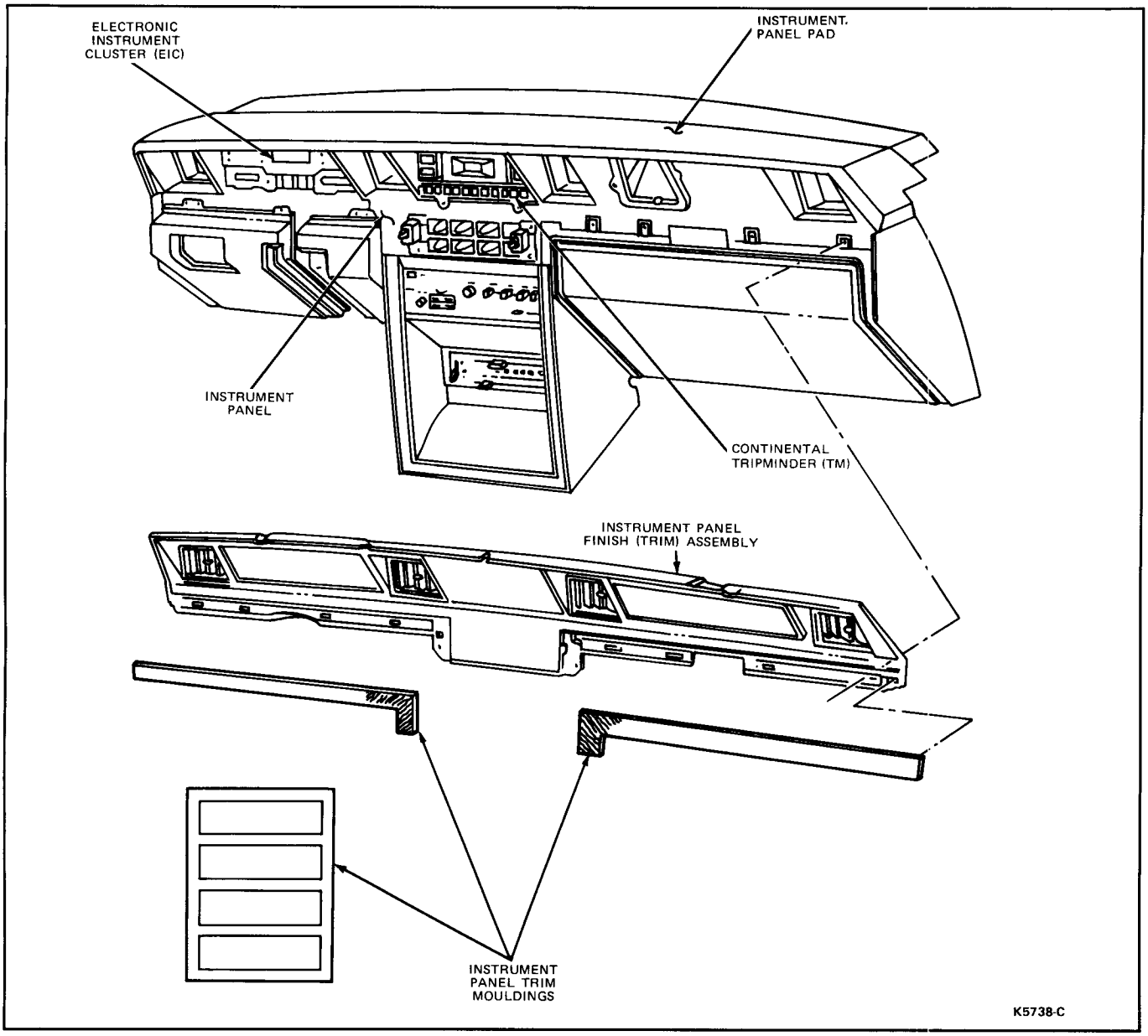


FIG. 5 Instrument Panel Finish Assembly—Continental

REMOVAL AND INSTALLATION

Removal

1. Disconnect battery ground cable.
2. On Continental, remove the mouldings (snap out) covering the instrument panel finish (trim) assembly retaining screws (Fig. 5).
3. For Continental, remove the 17 screws holding the finish assembly and remove the finish assembly (lift the instrument panel pad). On Mark VII, remove the attaching screws and the finish panel RH insert (Fig. 6).
4. Remove the four screws that attach the message center to the instrument panel (Fig. 7).
5. Remove the message center partially from the instrument panel.
6. Disconnect the two connectors from the rear of the message center.

Installation

1. Connect the two connectors to the rear of the message center.
2. Position the message center to the instrument panel, and install the four screws that secure the message center to instrument panel.
3. On Continental, position finish assembly to the instrument panel and install the eight screws that secure the finish assembly to the instrument panel. For Mark VII, install the finish panel RH insert and attaching screws.
4. On Continental, position the instrument panel pad to the instrument panel and install the nine screws that secure the instrument panel pad to instrument panel.
5. Connect battery ground cable.

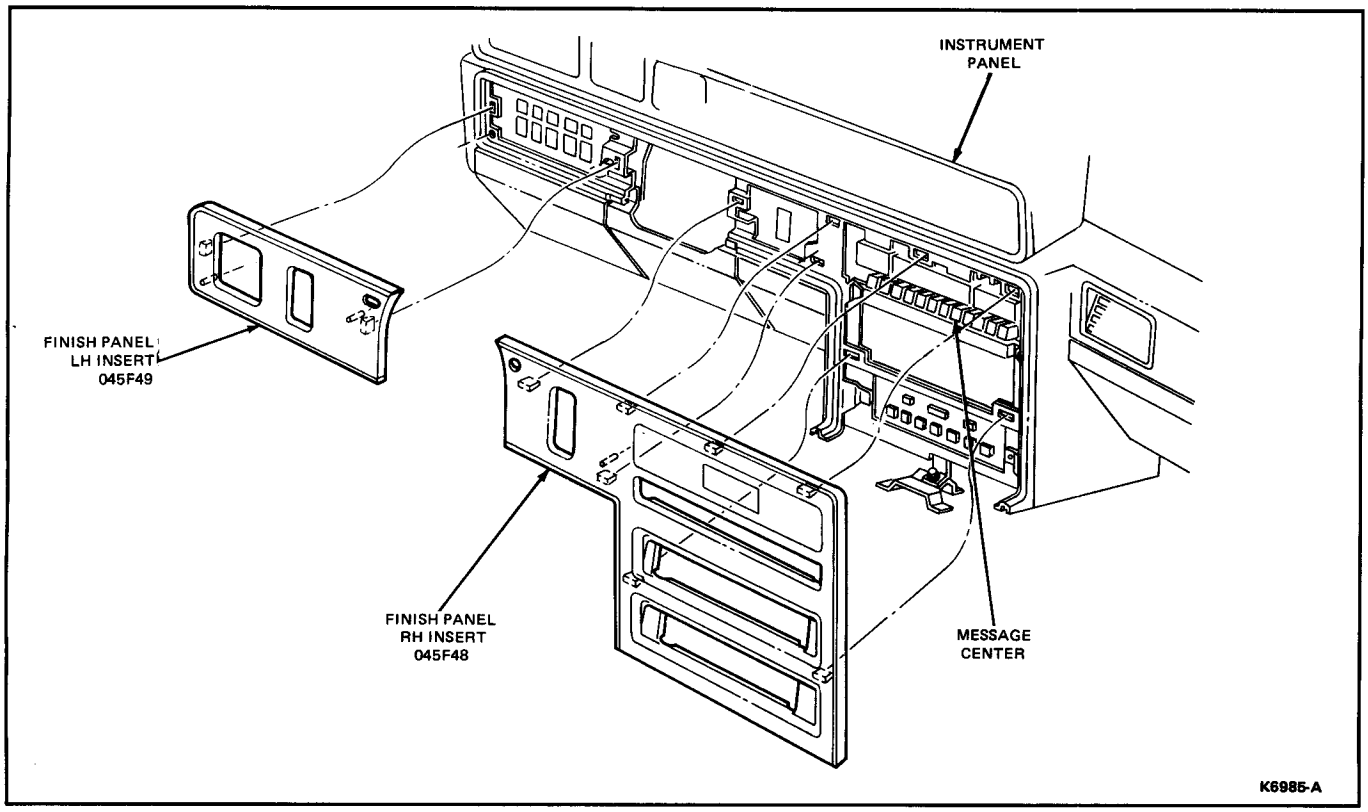


FIG. 6 Instrument Panel/Finish Panels—Mark VII

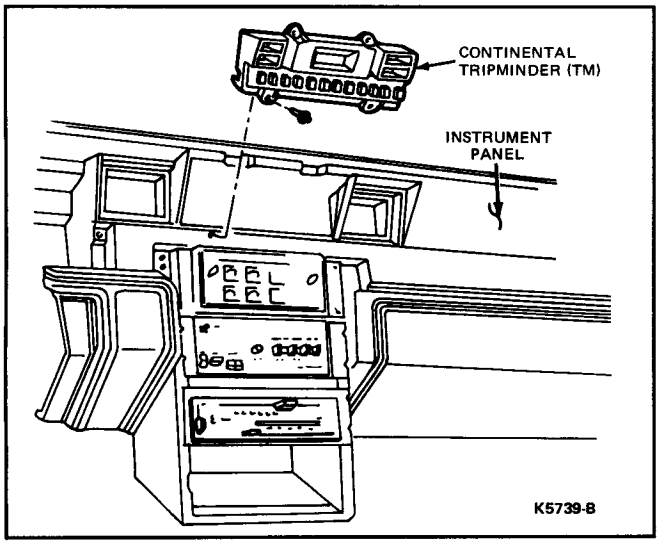


FIG. 7 Message Center

TEST C
ALARM

TEST STEP		RESULT ▶	ACTION TO TAKE
C1	ALARM FUNCTION?		
• Turn key to Run or Acc. • Set alarm to 12:01 AM (follow alarm setting procedure). • Set clock to 12:00 AM (follow clock setting procedure). • Wait one minute and observe Message Center.		Does tone generator sound 8 times and does display look identical to? 12:01 AL AM	
		YES ▶	Message Center alarm is OK.
		NO, display is incorrect ▶	REPLACE Message Center.
		No sound ▶	GO to **C2**.
C2	TONE GENERATOR?		
• Listen for a tone whenever any button is pressed.		Is the tone heard when a button is pressed but no tone was heard in **C1** above?	
		YES ▶	REPLACE Message Center.
		NO, tones are absent on all buttons ▶	GO to **Section N**.

CK5692-C

TEST D
ELAPSED TIME (E/TIME)

TEST STEP		RESULT ▶	ACTION TO TAKE
D1	E/TIME RESETS?		
• Turn key to Run or Acc. • Press reset button. • Press 3 E/TIME button.		Does Message Center display appear as below with bottom row counting? 00:00 00:ET	
		YES ▶	GO to **D2**.
		NO ▶	REPLACE Message Center.
D2	E/TIME ADVANCES?		
• Observe elapsed time counting up.		Does E/TIME advance like a stopwatch?	
		YES ▶	Message Center E/TIME function is OK.
		NO ▶	REPLACE Message Center.

CK5693-C

SECTION 34-10 Wiring Harness—Forward Engine Compartment

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The dash panel-to-headlamp junction wiring harness (14290) connects to the main wiring harness (14401) in the forward area of the LH apron and routes across the radiator support to the front lamps and other electrical items mounted at the forward section of the fender aprons.

REMOVAL AND INSTALLATION

Removal and Installation

Refer to Figs. 1 through 5.

1. Disconnect wiring harness 14290 from main wiring harness 14401 at front of LH apron (Fig. 1).
2. Disconnect wiring harness 14290 from forward headlamp wiring and other connections shown in Figs. 1 and 2.
3. Disconnect wiring harness 14290 from connections in the RH fender apron area (Fig. 4). Disconnect harness from RH cowl side wiring.
4. Remove wiring harness 14290.
5. To install, reverse Steps 1 through 4.

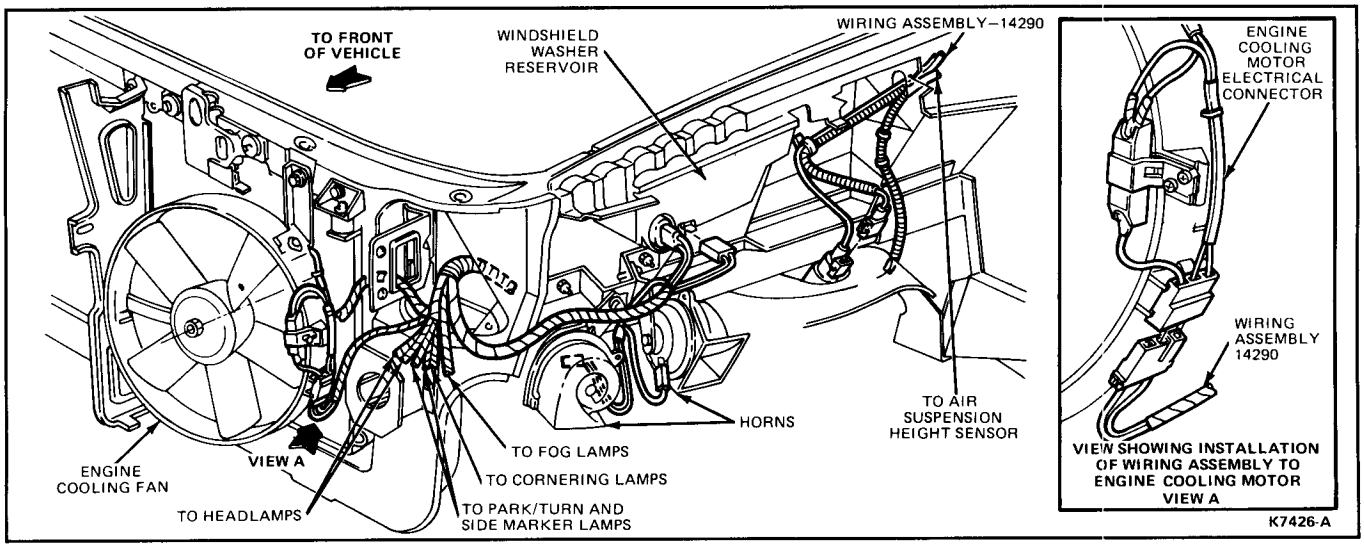


FIG. 1 LH Apron Wiring

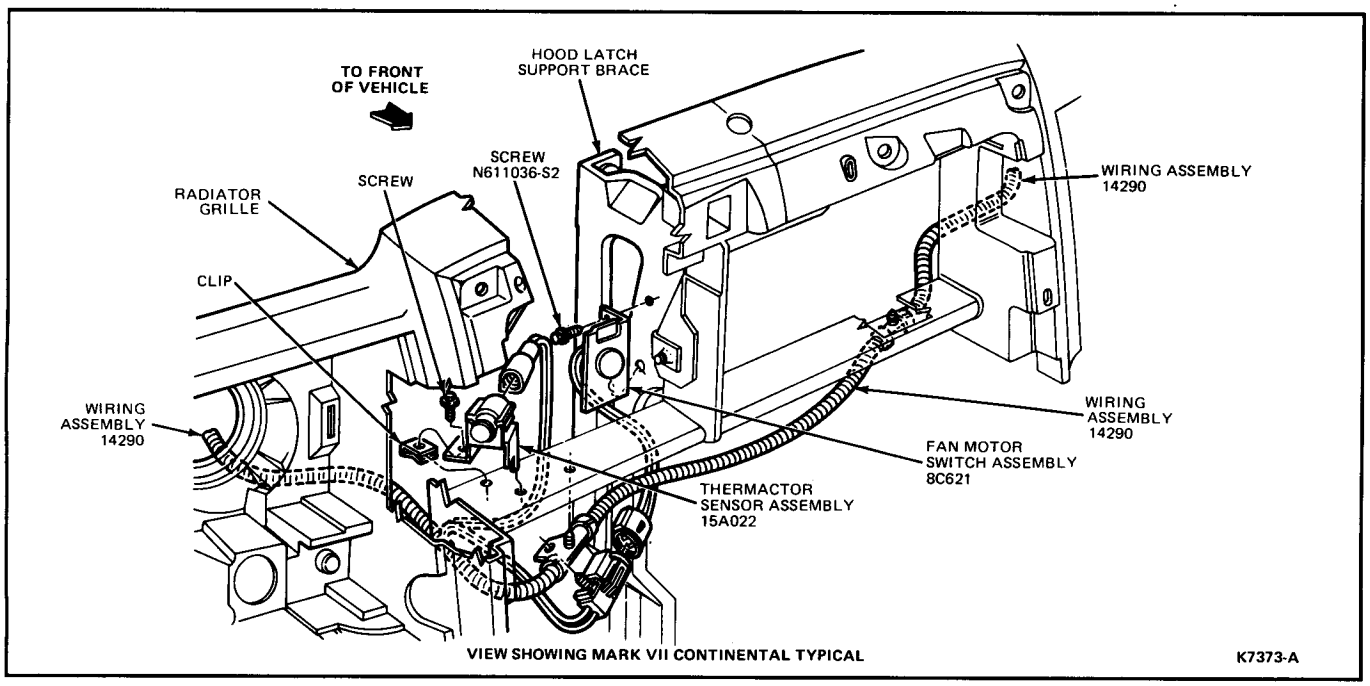


FIG. 2 Radiator Support Wiring

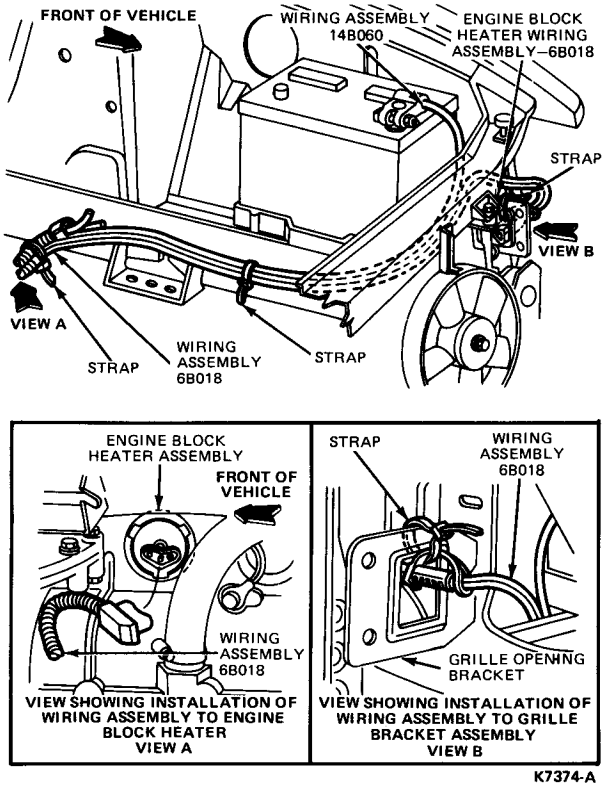


FIG. 3 Engine Block Heater Wiring

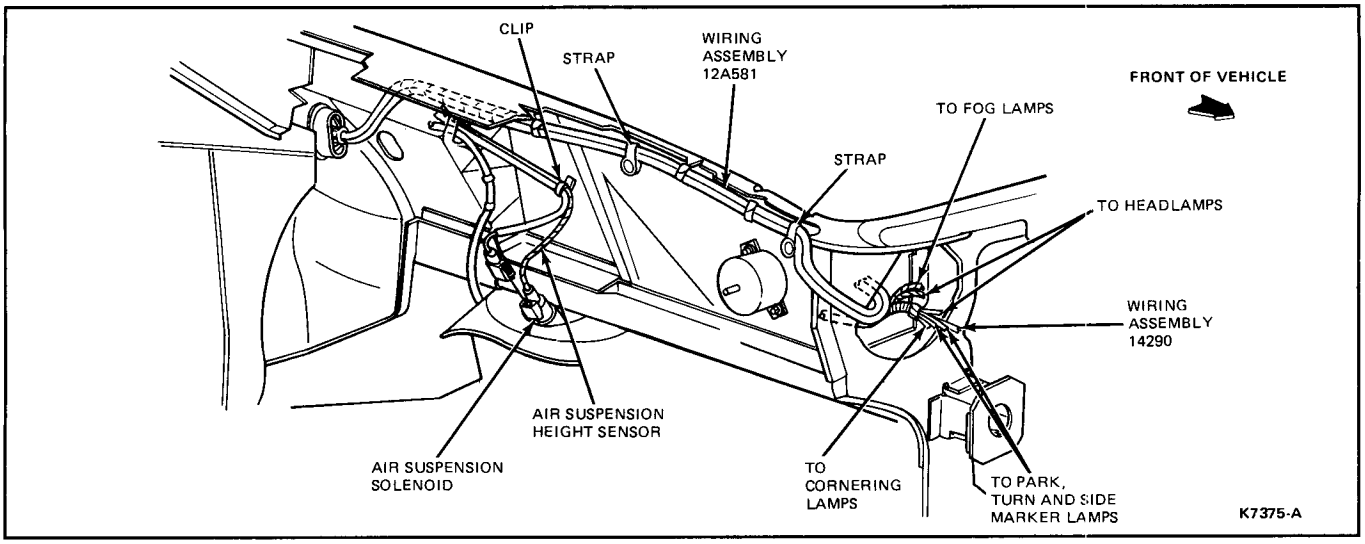


FIG. 4 RH Fender Apron Wiring

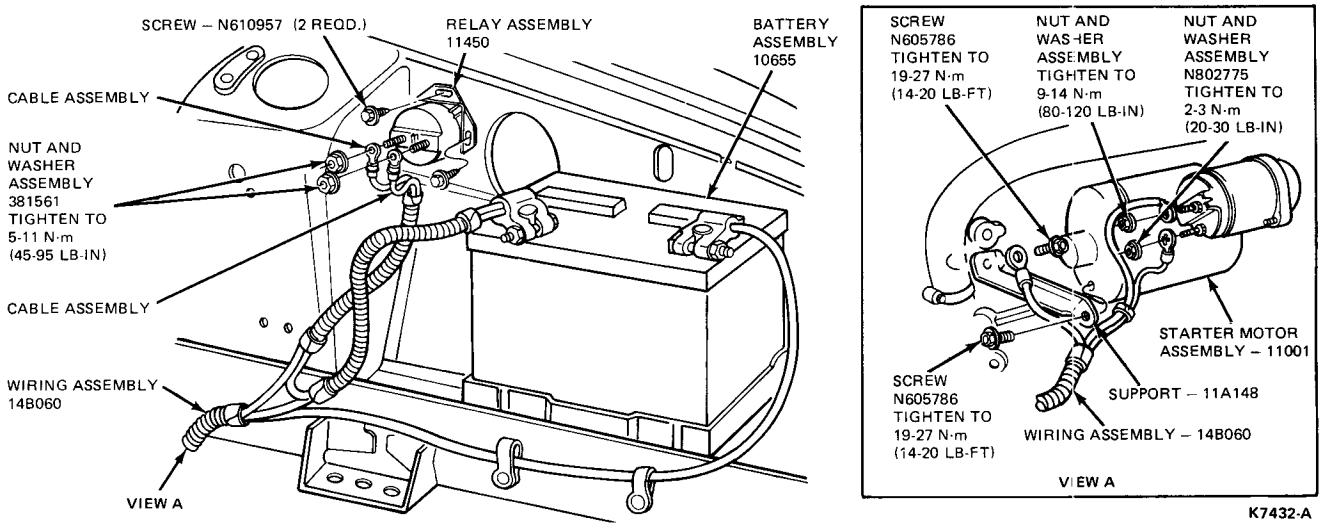


FIG. 5 Battery and Starter Motor—Installation

SECTION 34-20 Wiring Harness—Engine

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The engine wiring harness connects to the forward engine compartment harness (14290) at the left side near the shock tower and to the engine at various points.

REMOVAL AND INSTALLATION

Remove and install engine compartment wiring harness as shown in Fig. 1.

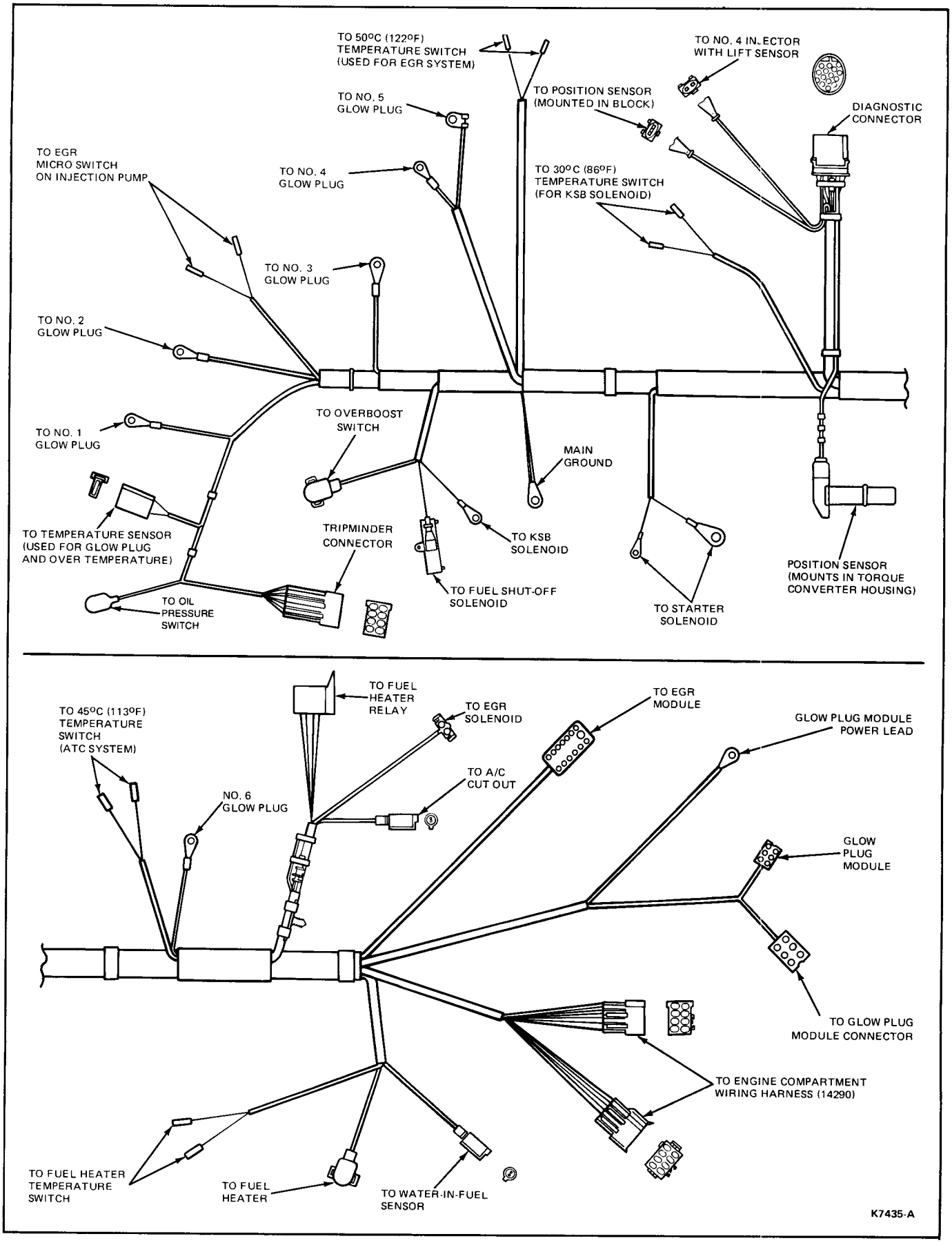


FIG. 1 Engine Wiring Harness

SECTION 36-75 Automatic Temperature Control—Electronic

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The push button electronic ATC system is standard equipment on Mark VII/Continental. This system is represented in the block diagram in Fig. 1.

With the use of a micro-computer the control assembly analyzes four major inputs:

1. The customer's temperature and mode selections.
2. In-vehicle temperature.
3. Ambient temperature.
4. Engine temperature.

Using these inputs the micro-computer determines the correct conditions of the six outputs:

1. A/C compressor clutch engagement.
2. Blower speed.
3. Blend door position.
4. Mode door position.
5. Panel/Defrost door position.
6. F/A Recirc door position.

Small DC electric motors or actuators are used to operate each of four air distribution doors. A feedback circuit is used in each motor so that the computer can identify the door's position. The A/C compressor clutch and blower motor are controlled by the control assembly through the blower speed controller (BSC). The BSC is required to convert the low power signal from the control head to the high power required to drive the clutch and blower.

Fig. 2 shows the control assembly response to the seven customer mode selections.

A self test feature has been included in the control assembly. This allows the technician to gain access to an error code which directs him to the damaged component. The self test is described later in this Section.

Control Assembly

The electronic automatic temperature control assembly consists of nine push buttons for customer input, a vacuum fluorescent display (VFD) and seven light emitting diodes (LEDs) to display the set temperature and the mode selection (Fig. 3). The VFD is also used to display diagnostic codes. The set temperature can be raised or lowered in one degree increments (between 65°F and 85°F) through the use of a warmer or cooler button. There is also a 60 setting for max cool and a 90 setting for max heat. The remaining seven buttons select system mode—OFF, ECON, LO AUTO, AUTO, HI AUTO, MIX and DEFROST. The temperature setting can be displayed in Centigrade or Fahrenheit. Pushing the miles/km button on the message center will change the display.

The control assembly performs the following functions:

- Processes data from the customer's input to the control panel, from in vehicle, ambient and engine temperature sensors, and from four actuator position sensors.
- When turned On remembers the last temperature and mode selected before the last shutoff.
- Provides continuous position control of the blend and mode actuators.

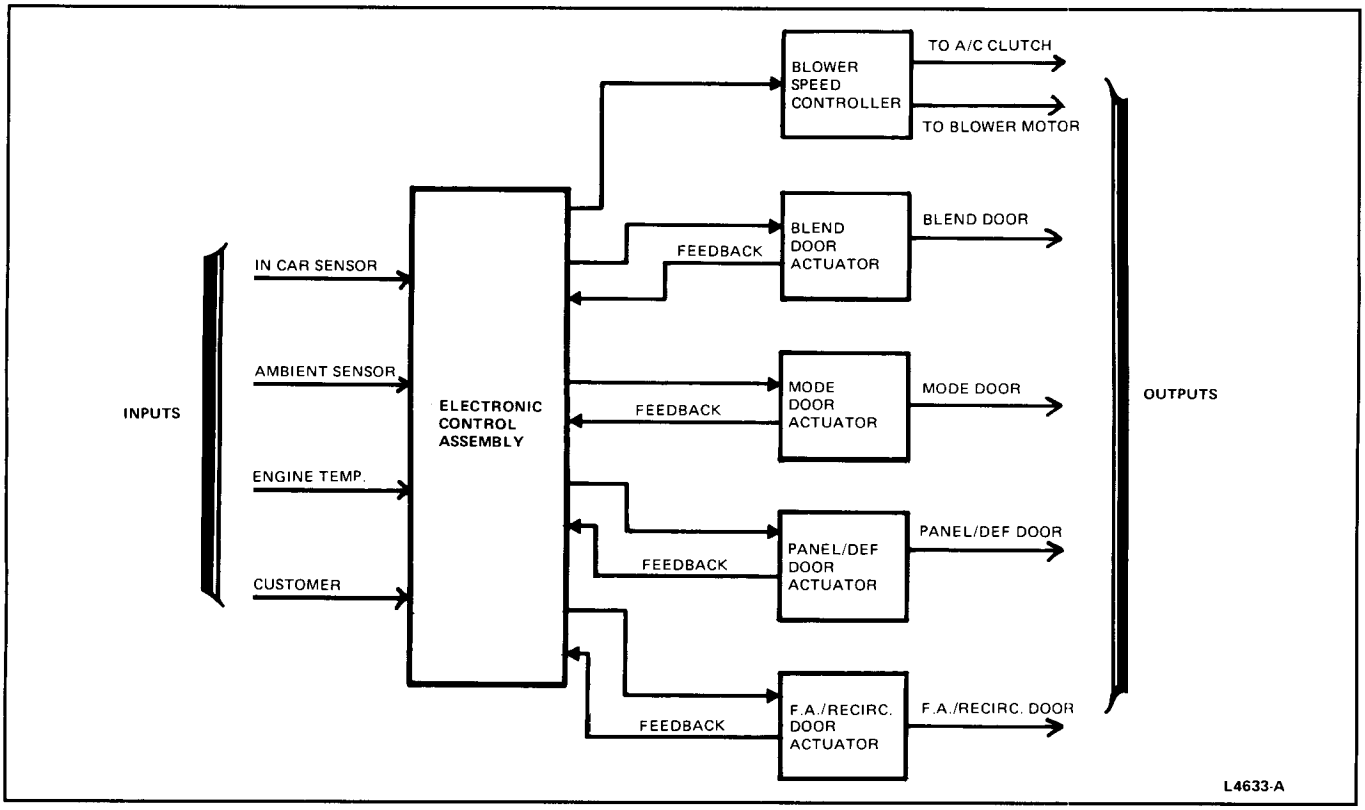


FIG. 1 System Block Diagram

Control Assembly Mode Selection	Blower Response		F/A/Recirc. Door Response		Blend Door Response	Mode Door Response	Pan/Def. Door (Plenum) Response	A/C Clutch Response
	Engine Coolant Above 120°F or A/C Required	Engine Coolant Below 120°F and Heating Required	Engine Coolant Above 120°F or A/C Required	Engine Coolant Below 120°F and Heading Required				
Off	Blower Off	Blower Off	Fixed in Recirc.	Fixed in Recirc.	Varies according to sensor's temperatures — door in heat position when sensor is cool — door in A/C position when sensor is hot	Air to Plenum	Fixed in Panel	Clutch Off
Econ	Variable Blower Speeds		Fixed in F/A			Air to Plenum with small bleed to floor		
Lo Auto	Fixed Low Blower Speed		Recirculate air when maximum air conditioning is required otherwise F/A			Air to Floor during heating/ air to plenum during cooling/ air to both between heating and cooling	Air to Def. Nozzle during heating/air to panel during cooling	Clutch on if outside temperature is above 50°F
Auto	Variable Blower Speeds							
Hi Auto	Fixed High Blower Speed							
Mix	Variable Blower Speeds	Variable Blower Speeds	Fixed in F/A	Fixed in F/A		Air to Plenum and to floor	Fixed in Def.	
Def.	Fixed High Blower Speed	Fixed High Blower Speed				Air to Plenum with small bleed to floor		

CL4634-A

FIG. 2 System Response

- Provides discrete two position control of the PAN/ DEF and FA/REC actuators.
- Provides a continuously variable blower signal which is amplified by the solid state Blower Speed Control (BSC) module to control the blower voltage.
- Provides an AC clutch On-Off signal which is amplified and delivered to the pressure switch by the BSC module.

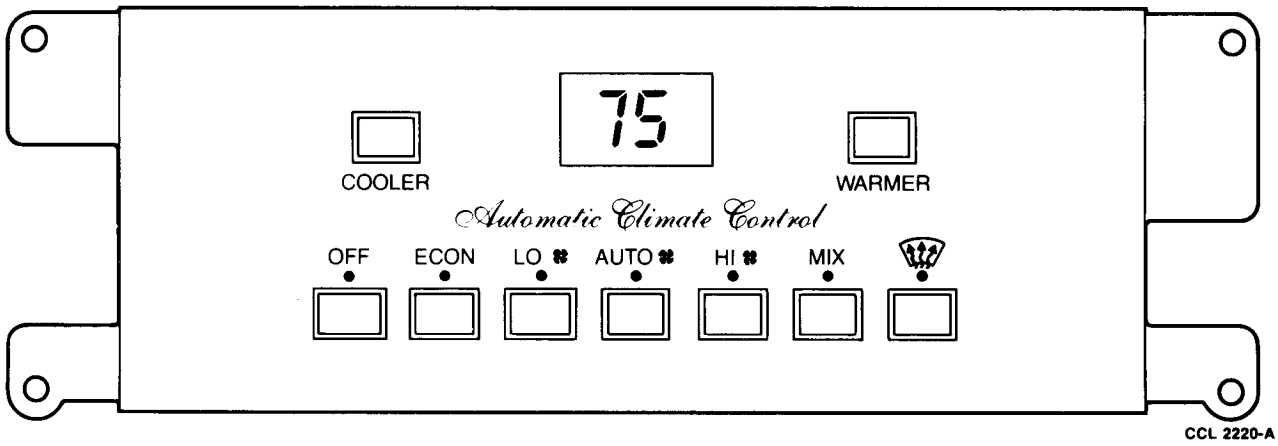


FIG. 3 Control Assembly

Sensors

Each Electronic Automatic Temperature Control system has an in-vehicle temperature sensor (Figs. 4 and 5) and an ambient temperature sensor (Fig. 6). The in-vehicle sensor in the Mark VII is located behind the warning lamp module. In the Continental, the in-vehicle sensor is located behind the instrument panel above the glove box. The ambient sensor in both vehicles is located at the top of the rear side of the blower motor housing. Both sensors contain thermistors (temperature sensitive resistors) which provide input signals to the control assembly. The calibration curve (resistance vs temperature) for each sensor is shown in Figs. 7 and 8.

Aspirator

The in-vehicle sensor is connected by a hose to the aspirator which is located on the evaporator case at the blower motor housing outlet.

The aspirator, shown as part of the evaporator case in Fig. 22, is designed to create a slight vacuum at its elbow when air from the blower motor flows through it. The in-vehicle sensor hose is connected to this elbow, which results in air from the passenger compartment being pulled through the sensor grille and across the sensor. This allows the in-vehicle sensor to input a signal to the microprocessor based upon true in-vehicle air temperature.

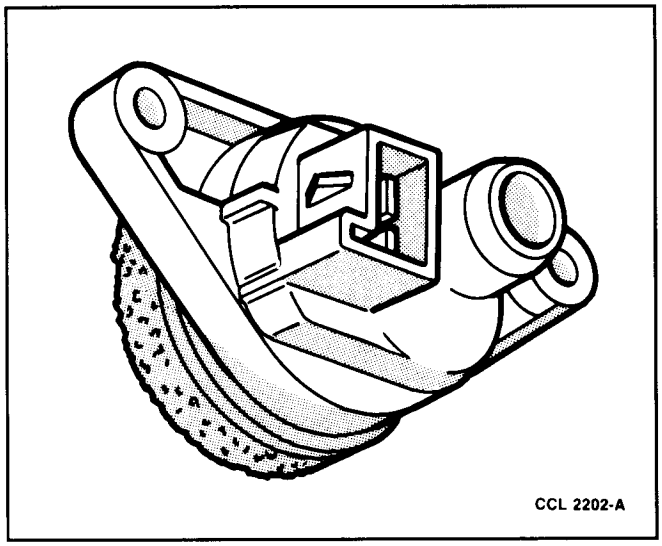


FIG. 4 In-Vehicle Sensor—Continental

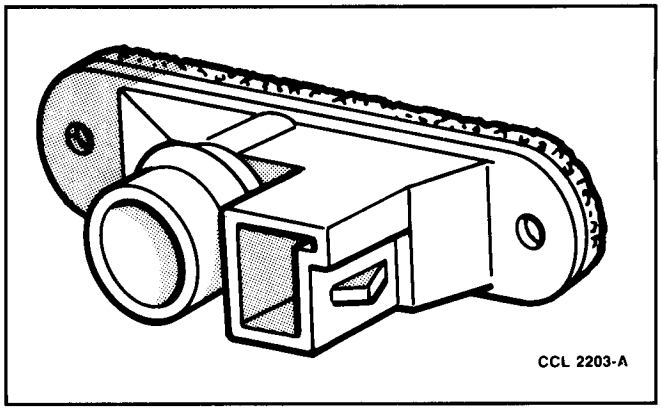


FIG. 5 In-Vehicle Sensor—Mark VII

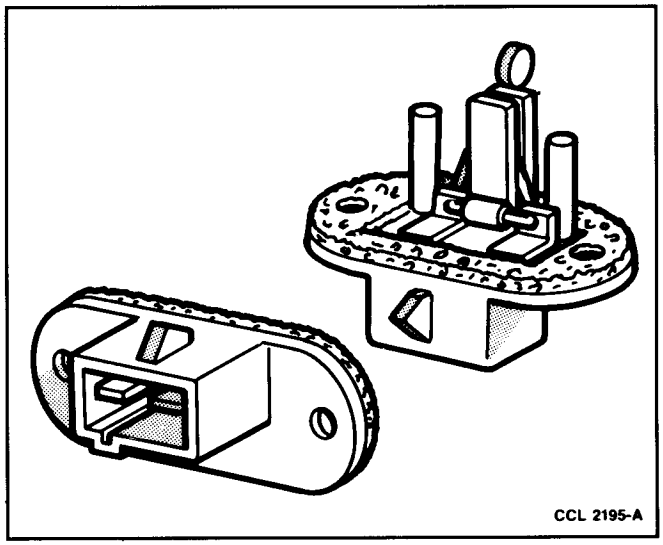


FIG. 6 Ambient Sensor

Actuators

Each electronic automatic temperature control system has four electric motor driven actuators mounted in various areas on the system evaporator assembly or plenum (refer to Figs. 18, 19 and 22 for locations). The actuator output arms operate in a circular motion and are

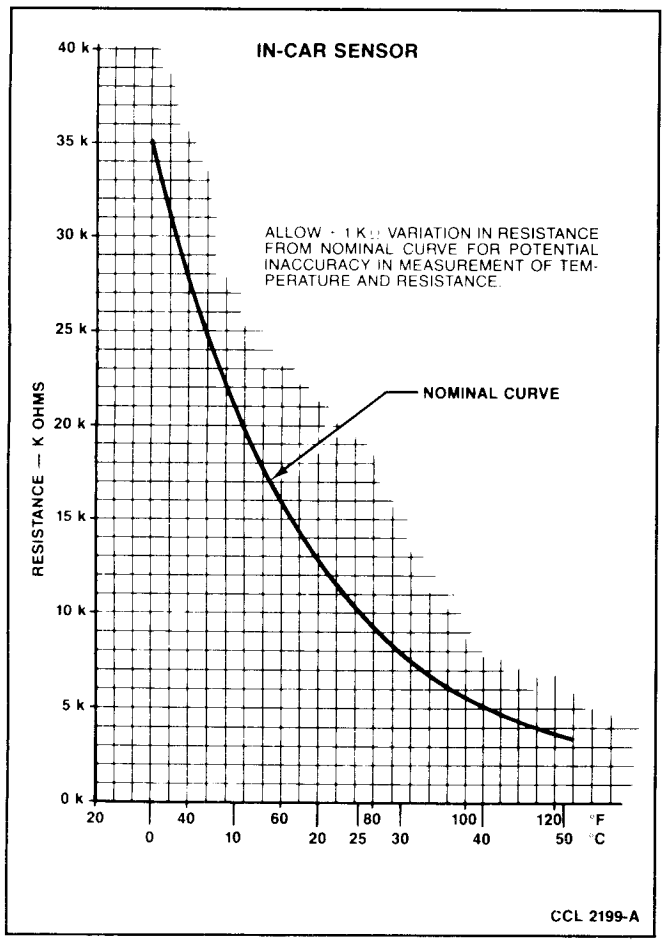


FIG. 7 In-Vehicle Sensor Temperature

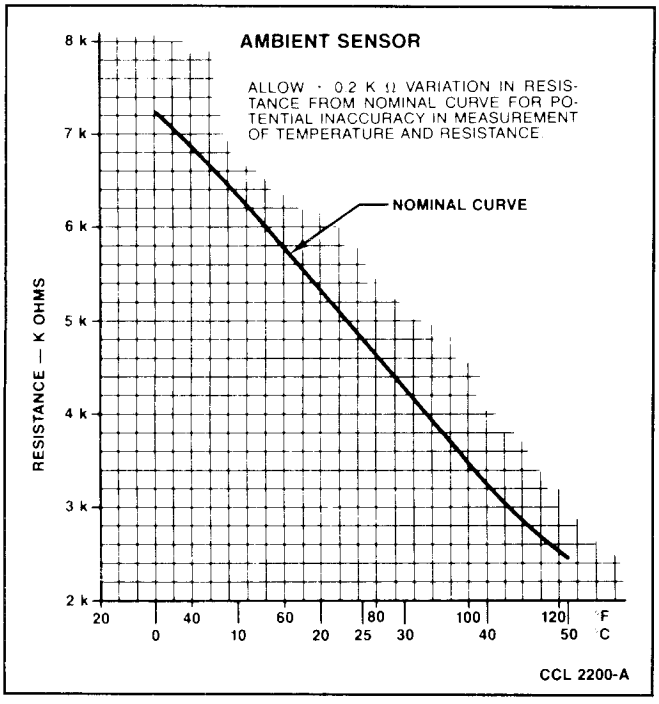


FIG. 8 Ambient Sensor Temperature

connected via linkage to doors within the plenum and ducts. These doors set up the air flow pattern and help establish the system functional operation (e.g. Heat, Defrost, A/C, Temp., etc.). Overall EATC system characteristics for optimum performance are programmed into the control head to be consistent with operator input and ambient conditions. As a consequence, the control head controls the system door positions via the actuators. Each actuator contains drive and feedback circuitry. The control head senses the door position through the actuator feedback circuitry and controls the door by powering each actuator until the programmed position is reached. The control head automatically changes door position during operation as operator input or ambient conditions change consistent with the programmed performance requirements.

Each system of four actuators is comprised of two each of two types which are designated as continuous position and two position actuators. These are described below:

- **Continuous Position Actuators (Fig. 9):** The continuous position actuators operate the blend door and the floor/panel mode door. These actuators are identical and therefore completely interchangeable, independent of function or mounting location. They operate in both the clockwise and counterclockwise directions and will stop at any position within their 180 degrees operating range as directed by the signals from the control head.
- **Two Position Actuators (Fig. 10):** The two position actuators operate the panel defrost door and the fresh air/recirc door. These actuators operate only in a counterclockwise direction and stop in one of two pre-established positions, 180 degrees apart, as signalled from the control head. The two position actuators within each system are not interchangeable, since the stop points for each actuator are not identical. The output arms of the two position actuators are color coded for easy identification. The panel/defrost actuator arm is silver and the F/A/Recirc actuator arm is black. Care should be exercised to ensure that each two position actuator is installed only in its correct location (i.e. Panel/Defrost or F/A/Recirc) to ensure proper system performance. Each two position actuator has four mounting holes, however, only three of the mounting holes are utilized in each mounting location. The mounting hole closest to the electrical connector is not used.

Blower Speed Controller

The blower speed controller (Fig. 11) is located in the evaporator case, downstream of the evaporator core. Its function is to convert low current signals from the electronic control assembly to a high current, variable ground feed to the blower motor. Blower motor speed is infinitely variable and is controlled by the electronic control assembly software and blend door actuator position. A delay function provides a gradual increase or decrease in blower motor speed under all conditions.

Also contained in the blower motor control unit is a power transistor circuit which supplies voltage to the AC clutch pressure switch, which, in turn, supplies voltage to engage the AC clutch.

CAUTION: The system should not be operated with the blower motor disconnected. Damage may occur to the electronic blower speed controller if cooling air is not provided by the blower motor.

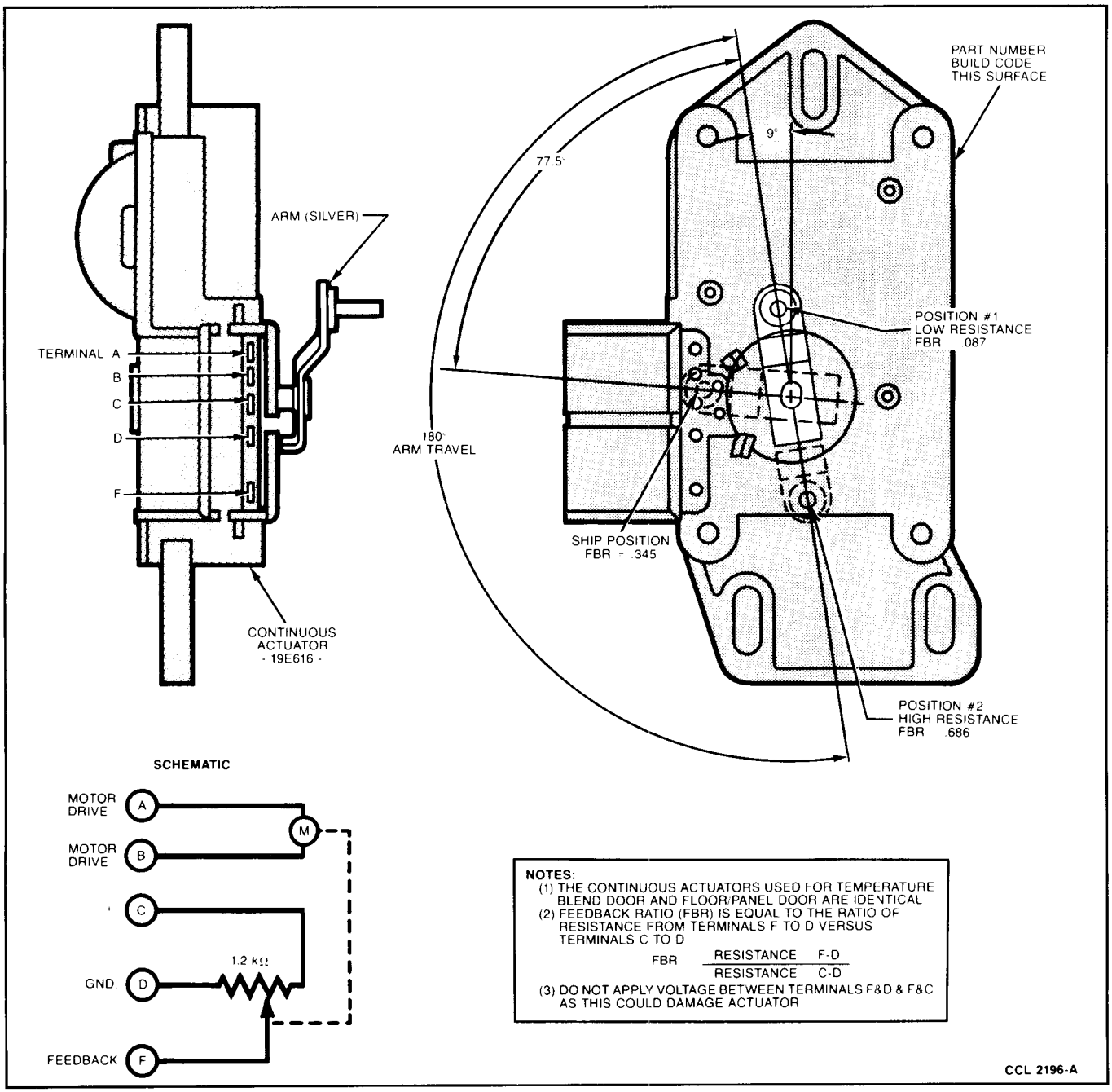


FIG. 9 Continuous Position Actuator—Temperature Blend and Floor/Panel

DIAGNOSIS

Refer to the diagnosis charts for electronic ATC system diagnosis.

TESTING

Self Test System

The control head has a self test feature that aids in locating trouble in the EATC system. To get reliable results the following procedure must be followed. Turn On the ignition and set the control head to 90, OFF. Wait 40 seconds. If the vacuum fluorescent display (VFD) begins to flash, then there is a malfunction in the blend actuator wiring, the actuator itself or the control head. If the light emitting diode (LED) begins to flash then there is a malfunction in one or more of the other actuators' wiring, the actuator (mode, PAN/DEF, or FA/REC) or the control assembly. If no flashing occurs, set the control assembly to 60, DEF. Wait 40 seconds, look for a flashing VFD or LED. If no flashing occurs, then no malfunctions in the actuator drive or feedback circuits have been detected. Whether or not flashing has occurred, the self test mode should now be entered for further diagnostic information. To ensure accurate self test results the above procedure must be followed before entering the self test mode.

To enter the self test mode push the OFF and DEFROST mode buttons simultaneously. Within two seconds, push the AUTO mode button. If an 88 is displayed, no malfunctions have been detected by the control assembly. Refer to Diagnosis in this Section. If a control assembly detectable malfunction has occurred the appropriate error code will be displayed. Refer to Self Test—Error Code. The error code sequence will

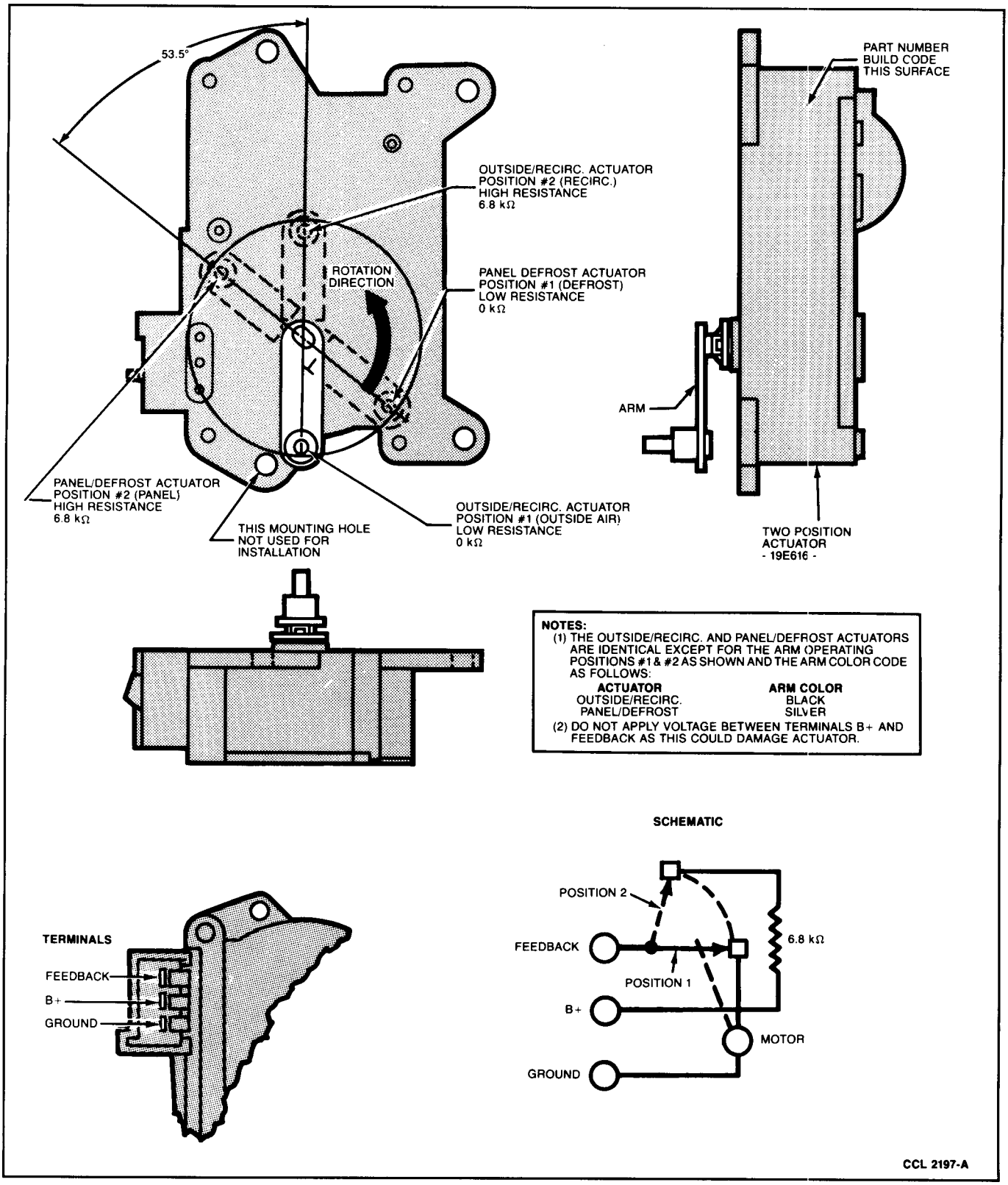


FIG. 10 Two Position Actuators—Outside/Recirc and Panel/Defrost

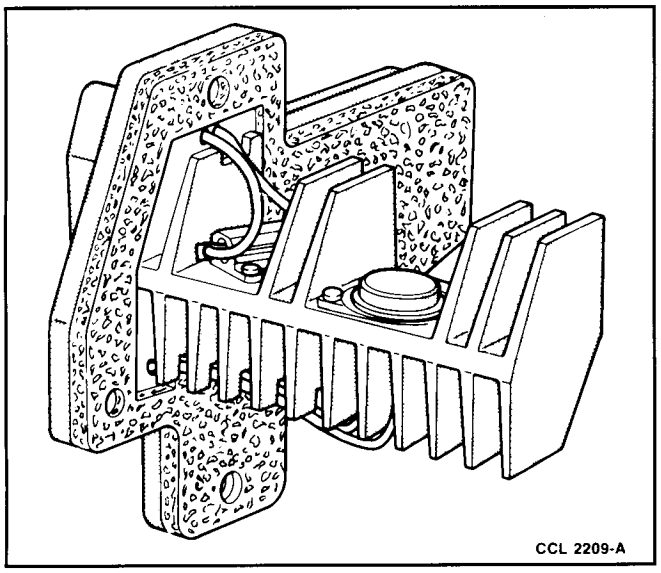


FIG. 11 Blower Speed Control

continue until the cooler button is pushed. When the cooler button is pushed the system will revert to the AUTO mode at a temperature setting one less than the setting before entering the self test mode. Always exit the self test mode by pushing the cooler button before turning Off the ignition. This procedure will ensure the proper resetting of the control assembly when the ignition is turned On.

REMOVAL AND INSTALLATION

Control Assembly

Removal

1. Disconnect the ground cable from the battery negative (-) terminal.
2. On Continental, open ashtray and remove ashtray receptacle. Remove four screws attaching center finish panel to the instrument panel at the ashtray opening and at upper edge of finish panel (Fig. 14). For Mark VII, remove finish panel RH insert attaching screws.
3. Pull the lower edge of the center finish panel (Continental) or finish panel RH insert (Mark VII) away from the instrument panel and disengage the upper tabs of the finish panel or insert from the instrument panel (Figs. 14 and 15).
4. Remove four screws attaching the control assembly to the instrument panel.
5. Slide control assembly out from the instrument panel opening and disconnect the two harness connectors from the control assembly by disengaging the latches on the bottom of the control.

Installation

1. Connect the two harness connectors to the control assembly.
2. Position the control assembly to the instrument panel opening and install the four attaching screws.
3. Position the center finish panel (Continental) or finish panel RH insert (Mark VII) to the instrument panel and install the attaching screws (Figs. 14 and 15).
4. On Continental, install ashtray receptacle.
5. Connect the ground cable to the battery negative (-) terminal.
6. Check the system for proper operation.

Register Assemblies

Removal

1. Insert a thin blade screwdriver under the retaining tab and pry the retaining tab toward the louvers until the retaining tab pivot clears the hole in the register opening (Fig. 16).
2. Pull the register assembly end out from the housing only enough to prevent the pivot from going back into the pivot hole.
3. Repeat Step 1 for the other retaining tab and pull the register assembly from the register opening.

Installation

Depress the retaining tabs, push the register assembly into the register opening and engage the retaining tab pivots in the pivot holes.

In-Vehicle Sensor Assembly

Continental

Removal

1. Disconnect the ground cable from the battery negative (-) terminal.
2. Remove the instrument panel pad.
3. Disconnect the electrical connector from the sensor assembly.
4. Remove two mounting screws from the sensor assembly.
5. Hold the aspirator hose and rotate the sensor assembly clockwise to disconnect the hose from the sensor assembly. Remove sensor.

Installation

1. Insert the new sensor into aspirator hose and rotate sensor counterclockwise to connect sensor to the hose.
2. Position sensor assembly to the instrument panel and install the two attaching screws.
3. Connect electrical connector to the sensor assembly.
4. Install the instrument panel pad.
5. Connect ground cable to the battery negative terminal.
6. Check system for proper operation.

Mark VII

Removal

1. Disconnect the negative (ground) cable from the battery.
2. Remove instrument cluster finish panel assembly (Fig. 15).
3. Disconnect aspirator hose from the sensor assembly by carefully disengaging the elbow latch.
4. Disconnect electric connectors from the warning lamp module and the in-vehicle sensor (Fig. 17).
5. Remove the two sensor attaching screws and remove the sensor assembly (Fig. 17).

SYMPTOM	POSSIBLE SOURCE	ACTION
Insufficient cooling when at 60/auto setting. Blower is operating. Air is from panel.	• Clutch not engaged.	• Visually check for compressor operation. If not operating — see BSC checkout procedure conditions #6 & #7, under Testing in this section.
	• Refrigerant circuit defective (low charge, etc.)	• Check refrigerant circuit.
	• Blend door not in full A/C position (counterclockwise)	• Place in 60 and auto. Wait 30 sec. Enter diagnostic self test. Codes 1 and/or 5 should appear. If so, check for blend door binding. If no binding, replace actuator.
	• F/A/recirc. door not moving to recirc. position.	• Place in 60 and auto. Visually check for recirc. position.
Blower does not operate.	• Open wiring/blown fuse. • Inoperative blower motor. • Inoperative BSC. • Inoperative control assembly.	• Self test condition #1 or #2. Refer to Testing in this section.
Blower operates on High only.	• Open or short circuited wiring. • Inoperative BSC. • Inoperative control assembly.	• Self test condition #3. Refer to testing in this section.

CL4636-A

SYMPTOM	POSSIBLE SOURCE	ACTION
Control assembly digits and LEDs do not light up. Blower at hi speed or off.	• Ignition circuit #296 not connected to the control assembly or to BSC.	• Service wiring or replace fuse.
One LED does not light.	• Inoperative control assembly.	• Replace control assembly.
Cold air is delivered during heating when engine is cold.	• Inoperative wiring. • Inoperative engine temperature switch. • Inoperative control assembly.	• Place system at 90/auto. With engine off ground circuit #244 at engine temp. switch. Start vehicle. If blower is off, repair engine temp. switch. If blower is on, check wiring. If OK, replace control assembly.
Temp. set point does not repeat after turning off ignition.	• Circuit #297 not connected to control head. • Inoperative control assembly.	• Remove control head connector. With ignition off check for 12 volts at pin 12. If no voltage, check wiring. If voltage is present, replace control assembly.

CL4637-A

1. Securely cement bottom half of sound cover to actuator (arm side) with ESH-M2G78-B cement or equivalent.
2. Attach actuator to evaporator case (three screws).
3. Ensure that Fresh Air/Recirculation door is not obstructed by moving crank arm through travel.
4. Attach link from Fresh Air/Recirculation door crank arm on evaporator case to output arm pin on actuator and secure with push nut.
5. Attach electrical connector to actuator.
6. Connect battery ground cable.
7. Turn ignition switch to Acc position.
8. Depress ECON button on control panel. Actuator should position F/A/Recirc door in F/A position.
9. Depress OFF button on control panel. Door should move to Recirc position.
10. Repeat Steps 8 and 9 several times to ensure correct actuator operation.
11. Disconnect battery ground cable.
12. Securely cement top half of sound cover to actuator with ESH-M2G78-B cement, or equivalent.
13. Install aspirator to evaporator case (one screw).
14. Connect electrical connector for glove box lamp.

SYMPTOM	POSSIBLE SOURCE	ACTION
The temperature display will not switch to centigrade when the miles/Km button on the message center is pressed.	• Inoperative wiring. • Inoperative message center. • Inoperative control assembly.	• CAUTION: ACCIDENTAL SHORTING OF THE WRONG PIN COULD DESTROY THE CONTROL HEAD. Short out pin 14 of connector #2 (circuit 506). • If the display switches from °F to °C, then circuit 506 is open or the message center is inoperative. • If the display does not switch from °F to °C when circuit 506 (at the control assembly) is shorted to ground then the control head is inoperative.
When the parking lights or headlights are turned On, the control assembly displays (VFD, LED and backlighting) black out.	• Open or short circuited wiring. • Inoperative headlight switch. • Inoperative control assembly.	• With the headlight switch on, measure the voltage at pin 1 of connector #1 (circuit 19). If less than six volts, then circuit 19 is not delivering the rheostat voltage. Check wiring or headlight switch. • If the voltage of circuit 19 (at the control head pin) is greater than six volts, then the control head is inoperative.
When the parking lights or headlights are turned On the backlighting operates properly, but the VFD and LED do not dim.	• Open or short circuited wiring. • Inoperative headlight switch. • Inoperative control assembly.	• With the headlights on measure the voltage at pin 13 of connector #2 (circuit 14). • If the voltage is less than 10 volts the wiring or headlight switch is inoperative. • If the voltage is greater than 10 volts then the control head is inoperative.
VFD fades at low idle.	• Charging system malfunction.	• Refer to Section 31-01 for charging system diagnosis.

CL4638-A

SYMPTOM	POSSIBLE SOURCE	ACTION
System does not control temperature.	• Sensor hose not connected to aspirator or sensor.	• Inspect and service.
	• Aspirator not secured to evaporator case.	• Inspect and service.
	• Sensor seal(s) missing or not installed properly.	• Inspect and service.
	• Aspirator or sensor hose blocked.	• Inspect and service.

CL4639-A

15. Install pressed paper shield behind glove box (seven screws).
16. Install glove box and sound shield beneath instrument panel at glove box (three screws). (One shorter screw attaches glove box only and two longer screws secure both the shield and glove box.)
17. Attach glove box retaining straps (Continental).
18. Connect ground cable to battery.

Temperature Blend Door Actuator

Removal

1. Disconnect ground cable from battery.
2. Remove sound shield beneath instrument panel at glove box (two screws).
3. Remove glove box (one screw additional to Step 1 and two retaining straps—Continental).

SELF TEST — ERROR CODE

CODE	SYMPTOM	POSSIBLE SOURCE
1	Blend actuator is out of position. VFD flashes.	• Open circuit in one or more of the actuator leads. • Actuator output arm jammed. • Actuator inoperative. • Control assembly inoperative.
2	Mode actuator is out of position. LED flashes.	• Same as 1.
3	Pan/Def actuator is out of position. LED flashes.	• Same as 1.
4	Fresh air/recirculator actuator is out of position. LED flashes.	• Same as 1.
1, 5	Blend actuator output shorted. VFD flashes.	• Outputs A or B shorted to ground, or to the supply voltage or together. • Actuator inoperative. • Control assembly inoperative.
2, 6	Mode actuator output shorted. LED flashes.	• Same as 1, 5.
3, 7	Pan/Def actuator output shorted. LED flashes.	• The actuator output is shorted to the supply voltage. • Actuator inoperative. • Control assembly inoperative.
4, 8	Fresh air/recirculator actuator output shorted. LED flashes.	• Same as 3, 7.
9	No failures found. See Supplemental Diagnosis.	
10, 11	A/C clutch never on.	• Circuit 321 open. • BSC inoperative. • Control assembly inoperative.
10, 11	A/C clutch always on.	• Circuit 321 shorted to ground. • BSC inoperative. • Control assembly inoperative.
12	System stays in full heat. In-car temperature must be stabilized above 60°F for this test to be valid.	• Circuit 788, 470, 767, or 790 is open. • The ambient or in-car temperature sensor is inoperative.
13	System stays in full A/C.	• Remove control assembly connectors. Measure the resistance between pin 10 of connector #1 and pin 2 of connector #2. • If the resistance is less than 3K ohms, check the wiring and in-car and ambient temperature sensors. • If the resistance is greater than 3K ohms, replace the control assembly.
14	Blower always at maximum speed.	• Turn off ignition. Remove connector #2 from control assembly. Using a small screwdriver remove terminal #5 from the connector. Replace connector, tape terminal end and turn on ignition. • If blower still at maximum speed, then check circuit 184 and the BSC. • If the blower stops then the control assembly is inoperative.
15	Blower never runs.	• Circuit 184 shorted to the power supply. • BSC inoperative. • Control assembly inoperative.

CL4640-A

SELF TEST — BLOWER CONTROLLER

Do not use test light; testing requires volt-ohm meter. Refer to Fig. 12 for terminal pin locations.

CONDITION #1

No blower — ignition On, Auto Mode, 60 degree setting.

	VOLTMETER CONNECTION	RESULT ▶	ACTION
A	V ignition pin #6 to ground pin #5.	0 volts ▶	CHECK V ignition circuit continuity/fuse.
		More than 10 volts ▶	GO to **B**.
B	Controller input pin #1 to ground pin #5.	Fluctuating voltage less than 3 volts ▶	GO to **C**.
		More than 3 volts ▶	GO to **D**.
C	Controller output pin #3 to ground pin #5.	Less than 1 volt ▶	Faulty motor, B+ feed to motor.
		More than 1 volt ▶	REPLACE blower controller.
D	Driver side control head connector, pin #5 to pin #4, same connector.	More than 3 volts ▶	REPLACE control assembly.
		Less than 3 volts ▶	CHECK circuit continuity.

CL4642-A

4. Remove pressed paper shield behind glove box (seven screws).
5. Disconnect electrical connector for glove box lamp.
6. Remove ash tray (Continental).
7. Remove instrument panel radio/ash tray bezel (four screws Continental and snap in clips Mark VII).
8. Remove radio (four screws).
9. Disconnect radio electrical connectors and antenna lead.
10. Remove shield which is mounted over actuator and linkage (three screws).
11. Disconnect electrical connector from actuator.
12. Remove push nut from actuator arm and disconnect link from arm.
13. Remove actuator (three screws).

Installation

1. Ensure that actuator arm is correctly positioned by verifying that the resistance across connector terminals D and F (Fig. 9) divided by the resistance across terminals C and D is equal to .34-.36. Resistance across terminals D and F must be measured with a torque applied to the output arm in clockwise direction from arm side of actuator.
2. Ensure that temperature blend door is not obstructed by moving crank arm through travel.
3. Attach actuator loosely to evaporator case to allow adjustment (three screws).
4. Attach link from blend door crank arm to the actuator arm with push nut.
5. Attach actuator cover so that one screw which attaches cover to evaporator case (driver's side) is secure and the two screws which attach to the actuator are loose to allow actuator adjustment.
6. Adjust the actuator so that the distance between the outside diameter of the blend door crank arm and the left outer edge of the 19E617 actuator cover is 28mm (1.1 inch) when measured approximately 25.4mm (1-inch) out from actuator. If cover has step on left edge of part, use step for location of scale out from actuator.
7. Maintain actuator positioned per Step 5 and tighten actuator attaching screw on passenger side of actuator (single slot end).
8. Remove actuator cover (three screws).
9. Tighten two actuator attaching screws on driver side of actuator (double slot end).
10. Attach electrical connector to actuator.
11. Connect battery ground cable.
12. Turn ignition switch to Acc position.
13. With control head in AUTO mode, set temperature to 60°F. Blend door should move to full A/C position.
14. Change temperature to 90°F, blend door should move to full heat.
15. Apply hand load to crank arm in full heat direction to ensure blend door is against stops.
16. Repeat Steps 13, 14 and 15 several times to ensure correct actuator operation.
17. If actuator does not fully seat blend door in full heat position, readjust actuator.
18. Securely reattach actuator cover (three screws).
19. Connect radio electrical connectors and antenna lead.
20. Install radio (four screws).
21. Install instrument panel radio/ashtray bezel (four screws Continental and snap in Mark VII).
22. Install ashtray (Continental).
23. Connect glove box lamp electrical connector.

SELF TEST — BLOWER CONTROLLER

CONDITION #2

No blower — ignition On, engine warm, Auto Mode, 90° setting.

	VOLTMETER CONNECTION	RESULT	ACTION
A	Go to 60° setting.	Blower On	GO to **B**.
		No blower	GO to **Condition 1**.
B	Disconnect cold engine lock out (CELO) switch connector at engine, go to 90° setting.	Blower On	Faulty CELO switch.
		No blower	CELO wire grounded

CL4643-A

SELF TEST — BLOWER CONTROLLER

CONDITION #3

High blower only. No low blower in Lo Mode.

	VOLTMETER CONNECTION	RESULT	ACTION
A	Controller input pin #1 to ground pin #5, Lo Auto Mode.	Less than 7 volts fluctuating	REPLACE control assembly.
		Above 7 volts fluctuating	REPLACE blower controller.

CL4644-A

SELF TEST — BLOWER CONTROLLER

CONDITION #4

No high blower in Hi Auto or Defrost.

	VOLTMETER CONNECTION	RESULT	ACTION
A	Controller input pin #1 to ground pin #5, Hi Auto Mode.	Above 3 volts fluctuating	REPLACE control assembly.
		Less than 3 volts	GO to **B**.
B	Controller output pin #3 to ground pin #5.	Less than 1	Faulty motor, B+ feed to motor.
		More than 1 volt	REPLACE blower controller

CL4645-A

24. Install pressed paper shield behind glove box (seven screws).
25. Attach glove box and sound shield beneath instrument panel (three screws) (two retaining straps Continental).
26. Connect ground cable to battery.

Floor/Panel Mode Door Actuator

Removal

1. Disconnect ground cable from battery.
2. Loosen instrument panel and pull back from cowl.
3. Loosen evaporator assembly from dash panel and pull back to expose actuator on left (driver's side) end of assembly.
4. Remove actuator cover (two screws and one push nut).
5. Remove electrical connector.
6. Remove push nut and link from actuator arm.
7. Note position of actuator screws in slots so new actuator can be approximately positioned accordingly.
8. Remove actuator (three screws).

Installation

1. Mark screw locations in actuator slots equivalent to removed actuator.
2. Ensure that floor/panel mode door is not obstructed by moving crank arm through travel.
3. Attach actuator loosely to evaporator assembly (three screws).
4. Attach link to actuator arm with push nut.
5. Adjust actuator so screws align with marking from Step 1 and tighten the three screws.
6. Attach electrical connector.
7. Connect battery ground cable.
8. Turn ignition switch to Acc position.

SELF TEST — BLOWER CONTROLLER

CONDITION #5

Blower speed does not vary in Econ, Auto or Mix Modes.

	VOLTMETER CONNECTION	RESULT ▶	ACTION
A	Controller input pin #1 to ground pin #5, Auto Mode. Change temperature setting from 65°F to 85°F.	Voltage fluctuates below 7 volts, then above 7 volts, then back below 7 volts ▶	GO to **B**.
		No change in voltage ▶	REPLACE control assembly.
B	Controller output pin #3 to ground pin #5, Auto Mode. Change temperature setting from 60° to 90°.	Voltage changes from less than 1 volt to 7 volts, then back to 1 volt ▶	Faulty blower motor, B+ feed to motor
		No change in voltage ▶	REPLACE blower controller.

CL4646-A

SELF TEST — CLUTCH CONTROL

Do not use test lamp, testing requires volt-ohm meter.

CONDITION #6

No clutch operation — ignition On, Auto Mode, 60° setting, ambient temperature above 50°F.

	VOLTMETER CONNECTION	RESULT ▶	ACTION
A	Across clutch coil.	8-12 volts ▶	Poor ground or faulty clutch.
		0 volts ▶	GO to **B**.
B	Remove pressure switch connector and install a jumper wire.	Clutch engages ▶	Low freon charge or faulty pressure switch.
		Clutch does not engage ▶	GO to **C**.
C	V ignition pin #6 to ground pin #5.	0 volts ▶	CHECK V ignition circuit continuity.
		More than 10 volts ▶	GO to **D**.
D	Clutch input pin #2 to ground pin #5.	8-12 volts ▶	GO to **E**.
		Less than 8 volts ▶	GO to **F**.
E	Driver side control head connector, pin #11 to pin #4, same connector.	8-12 volts ▶	REPLACE control head.
		Less than 8 volts ▶	CHECK circuit continuity.
F	Clutch output pin #4 to ground pin #5.	8-12 volts ▶	CHECK clutch output circuit continuity.
		0 volts ▶	REPLACE blower controller.

CL4647-A

SELF TEST — CLUTCH CONTROL

CONDITION #7

Clutch does not disengage — ignition Off, Econ Mode.

	VOLTMETER CONNECTION	RESULT	ACTION
A	Across clutch coil.	0 volts	Faulty clutch.
		8-12 volts	GO to **B**.
B	Clutch input pin #2 to ground pin #5.	8-12 volts	REPLACE blower controller.
		Less than 8 volts	GO to **C**.
C	Driver side control head connector, pin #11 to pin #4, same connector.	8-12 volts	CHECK circuit continuity.
		Less than 8 volts	REPLACE control assembly.

CL4648-A

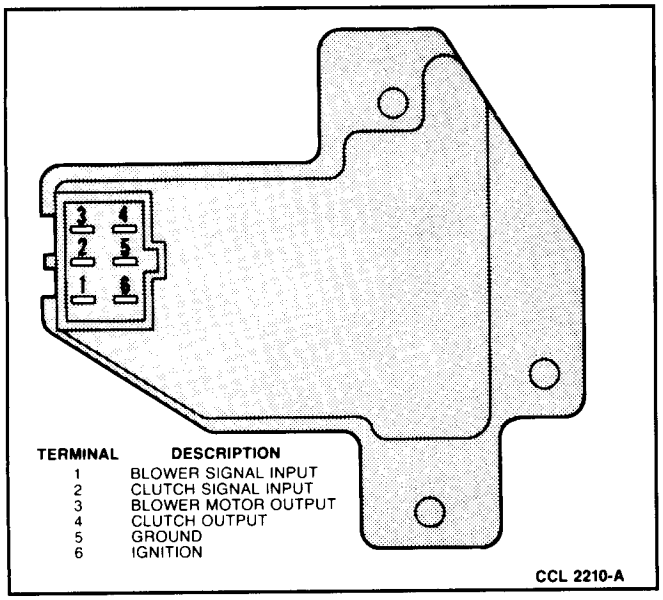


FIG. 12 Blower and A/C Clutch Control Terminals

9. Set temperature on control assembly to 90°F.
10. Depress LO button on control assembly. Mode door should move to floor position. Ensure that link to crank arm has minimum .03 inch compression.
11. Depress OFF button on control head, mode door should move to panel position. Ensure the link has minimum .03 inch compression.
12. Repeat Steps 10 and 11 several times to ensure correct actuator operation.
13. If link does not have .03 inch minimum compression at each end of travel, readjust actuator.
14. Disconnect battery ground cable.
15. Attach actuator cover (two screws and one push nut).
16. Secure evaporator assembly to dash panel.
17. Reattach instrument panel and associated components.
18. Connect ground cable to battery.

Panel/Defrost Actuator

Removal

1. Disconnect ground cable from battery.
2. Loosen instrument panel and pull back from cowl exposing panel/defrost duct attached to instrument panel.
3. Disconnect electrical connector from electric actuator attached to panel defrost duct.
4. Remove black PVC sound cover from top of actuator.
5. Remove push nut from pin on actuator arm and disconnect link (Figs. 18 and 19).
6. Remove actuator from panel/defrost duct (three screws) (Figs. 18 and 19).

Installation

NOTE: Be sure to install the correct actuator (silver arm). Refer to Specifications.

1. Securely cement bottom half of sound cover to actuator (arm side) with ESH-M2G78B cement, or equivalent.
2. Attach actuator to panel/defrost duct.
3. Ensure that panel/defrost door is not obstructed by moving crank arm through travel.
4. Attach link from panel/defrost door crank arm to actuator arm and secure with push nut.
5. Attach electrical connector to actuator.
6. Connect battery ground cable.
7. Turn ignition switch to Acc position.
8. Depress DEF button on control panel. Actuator should position panel/defrost door in defrost position.
9. Depress OFF button on control panel. Actuator should position door in panel position.
10. Repeat Steps 8 and 9 several times to ensure correct actuator operation.
11. Disconnect battery ground cable.
12. Securely cement top half of sound cover to actuator with ESH-M2G78B cement or equivalent.

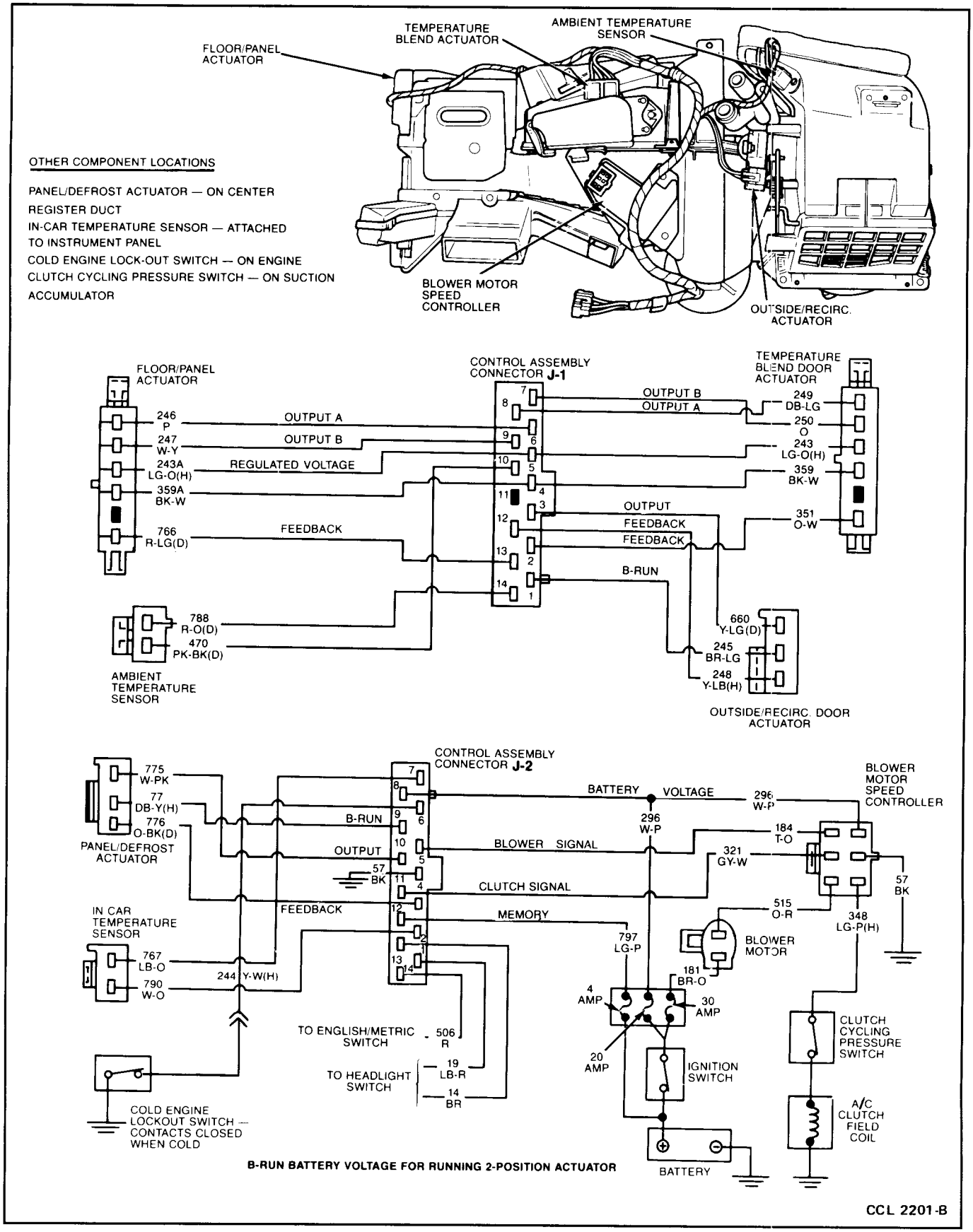


FIG. 13 System Wiring Diagram

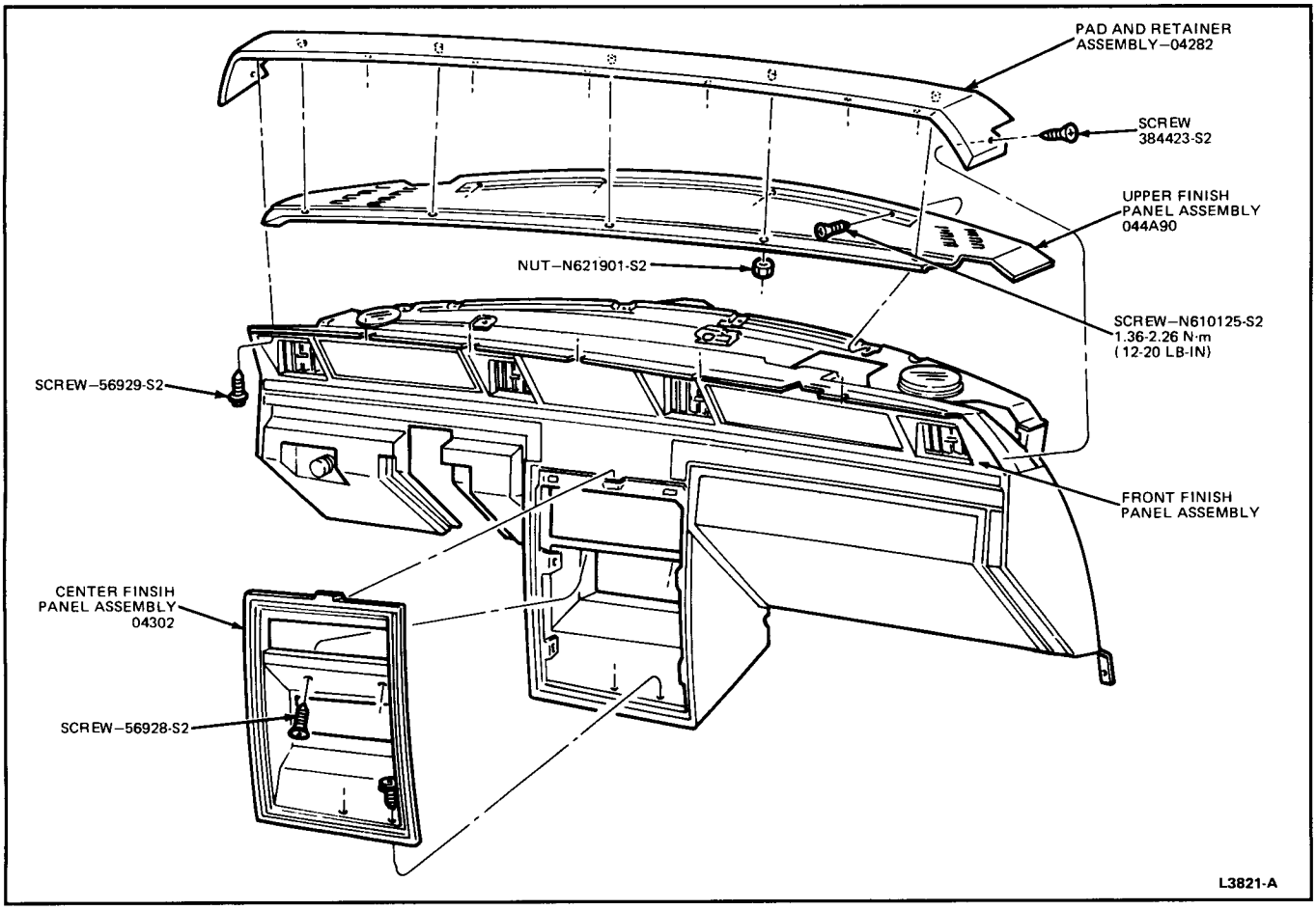


FIG. 14 Instrument Panel Finish Panels—Continental

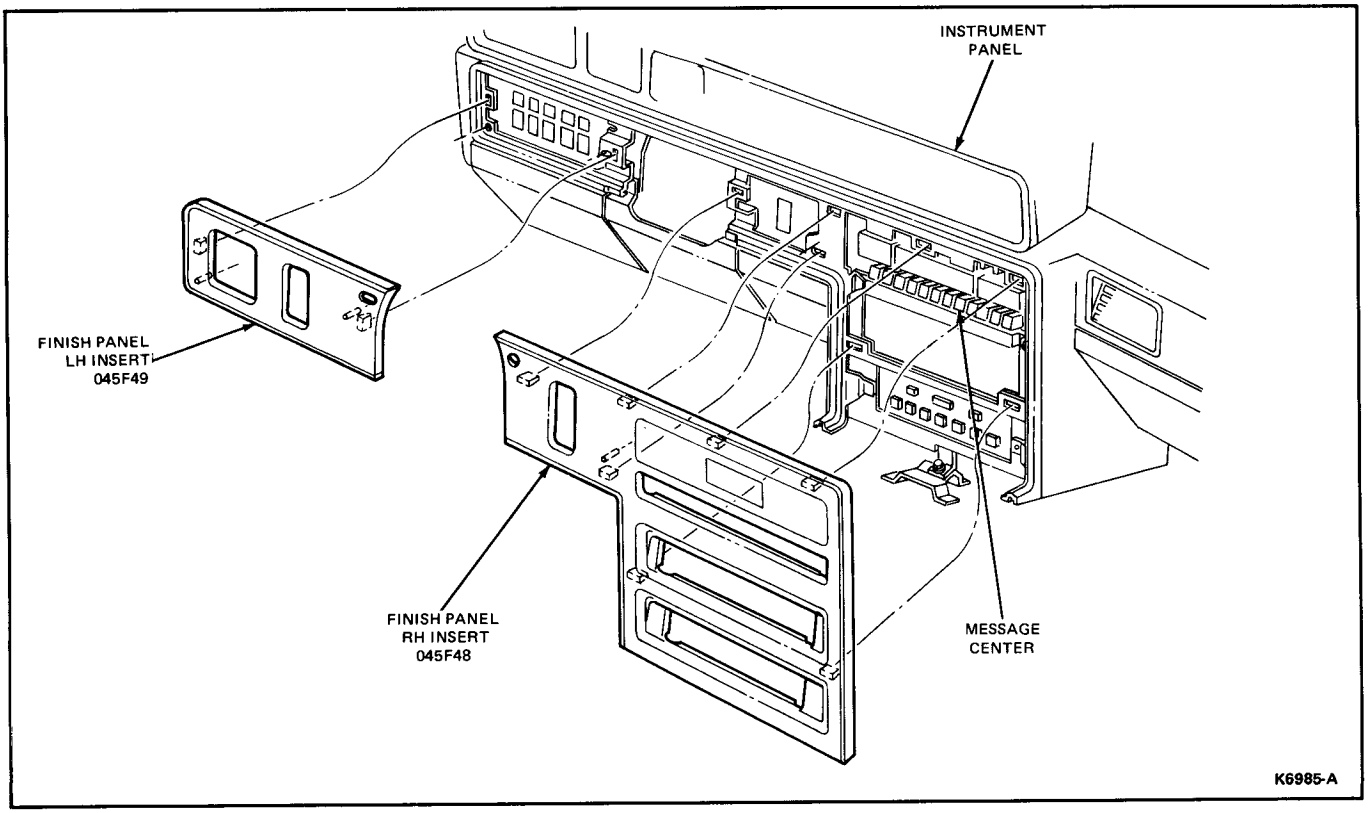


FIG. 15 Instrument Panel Finish Panels—Mark VII

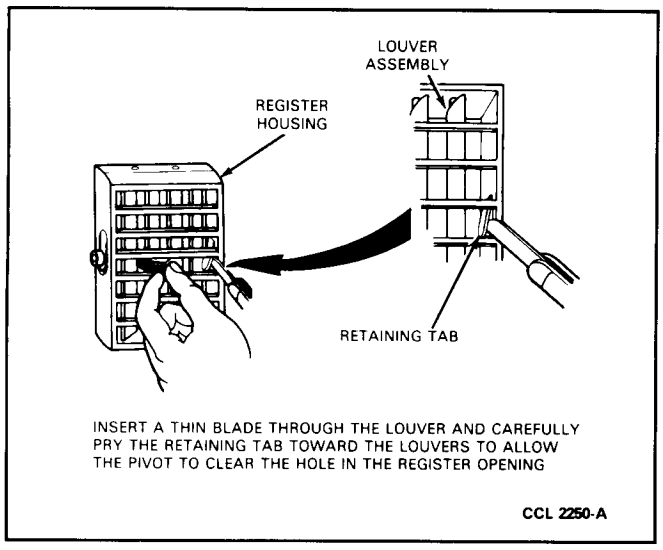


FIG. 16 Register Assembly—Removal

13. Reattach instrument panel and associated components.
14. Connect ground cable to battery.

Blower Motor Controller

Removal

1. Disengage glove compartment door stops and allow the door to hang by the hinge.
2. Remove sight shield behind the glove compartment.
3. Remove screw attaching the lower right end of the instrument panel to the side cowl panel.
4. On Continental, open ashtray door and remove the ash receptacle.
5. On Mark VII:
   a. Loosen floor console and move it rearward.
   b. Remove ATC control assembly.
   c. Remove screws attaching the instrument panel to the floor pan.
6. Working through the glove box opening, disconnect the snap-lock wire connector from the blower controller.
7. Remove the three screws attaching the blower controller to the evaporator case and remove the controller. **Do not touch** the fins of the controller if it is **HOT.**

Installation

1. Position the blower controller to the evaporator case and install the three attaching screws.
2. Connect wire connector to the blower controller.
3. On Mark VII:
   a. Install screws to attach the instrument panel to the floor pan.
   b. Install the ATC control assembly.
   c. Position the floor console forward to the instrument panel and secure in place.
4. On Continental, reinstall the ash receptacle.
5. Install the screw to attach the lower right end of the instrument panel to the side cowl.
6. Install the sight shield behind the glove compartment opening.
7. Close the glove compartment door.
8. Check system for proper operation.

Instrument Panel

Continental

Removal and Installation

Refer to Figs. 20 and 21.

1. Remove panel below glove box.
2. Remove ash receptacle.
3. Remove instrument panel to floor attaching screws.
4. Remove cowl side trim panels. Refer to the 1984 Car Shop manual, Volume B, Section 45-03.
5. Remove cowl side instrument panel attaching screws.
6. Remove trim panel below steering column.
7. Remove steering column opening cover.
8. Remove steering column shroud.
9. Disconnect PRNDL from steering column.
10. Remove hood release.
11. Remove left and right instrument panel mouldings.
12. Remove switch knobs.
13. Remove instrument panel lens assembly.
14. Remove screws and remove instrument cluster.
15. Disconnect speedometer cable.
16. Remove safety cover.
17. Disconnect multiplug behind kick pad and place out of way.
18. Remove steering column nuts and lower column to seat.
19. Remove instrument panel to brake support attaching screw.
20. Remove top instrument panel attaching screws.
21. Remove instrument panel and lay it on seat.
22. To install, reverse Steps 1 through 21.

Mark VII

Mark VII instrument panel removal and installation information not available at time of publication.

Evaporator Case

Removal

1. Remove instrument panel and lay it on the front seat.
2. Discharge the refrigerant from the A/C system at the service gauge port valve located on the suction line following approved safety precautions (refer to the 1984 Car Shop manual, Volume B, Section 36-32).
3. Once refrigerant is discharged from system, remove high and low pressure hoses. Use backup wrench to prevent component damage. Cap the hose openings to prevent entrance of dirt and excessive moisture.

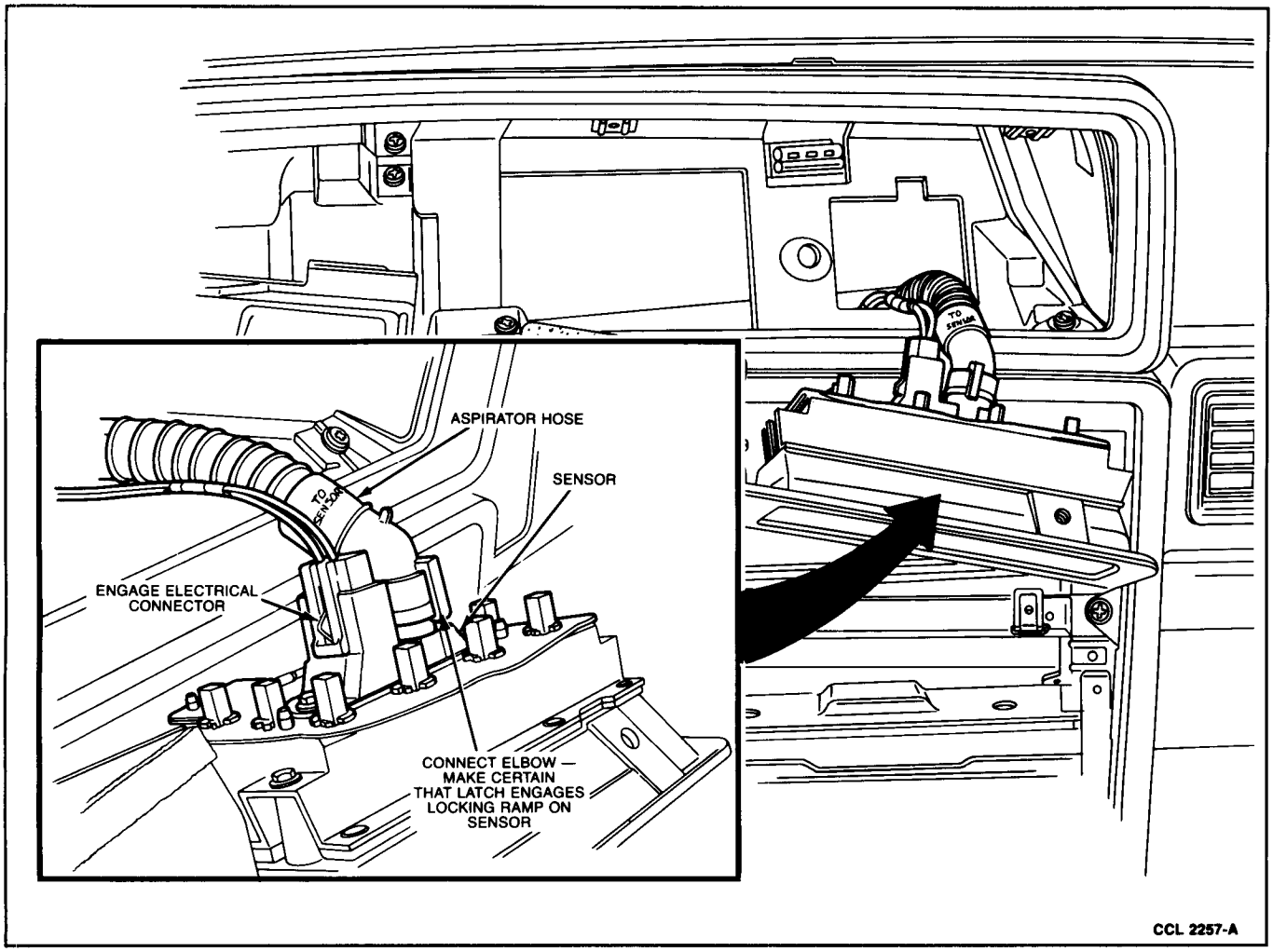


FIG. 17 Sensor Installation—Mark VII

4. Drain the engine coolant from the cooling system and remove the hoses from the heater core. Plug the hoses and core.
5. Remove the screw attaching the air inlet duct and blower housing assembly support brace to the cowl top panel (Fig. 22).
6. Disconnect the ATC wiring as necessary.
7. Working under the hood, remove two nuts retaining the evaporator case to the dash panel.
8. In the passenger compartment, remove the screw attaching the evaporator case support bracket to the cowl top panel.
9. Remove one screw retaining the bracket below the evaporator case to the dash panel.
10. Carefully pull the evaporator case away from the dash panel and remove the evaporator case assembly from the vehicle.

Installation

1. Position the evaporator case assembly in the vehicle and install the screw attaching the evaporator case support bracket to the cowl top panel.
2. Check the evaporator case drain tube to be sure it is through the dash panel and is not pinched or kinked.
3. Install one nut retaining the mounting bracket at the left end of the evaporator case to the dash panel, and another nut to retain the bracket below the evaporator case to the dash panel.
4. Working under the hood, install two nuts retaining the evaporator case to the dash panel. Tighten the four nuts (two in engine compartment and two in the passenger compartment) and the one support bracket attaching screw.
5. Connect the ATC system wiring.
6. Connect the high and low pressure refrigerant hoses to the evaporator using new O-rings dipped in specified refrigerant oil.
7. Install the instrument panel.
8. Connect the heater hoses to the heater core and fill the cooling system.
9. Leak test, evacuate and charge the refrigeration system following the recommended procedures and safety precautions.

Evaporator Core

Removal

1. Remove the evaporator case from the vehicle. Then, remove the air inlet duct and blower housing assembly from the evaporator case.

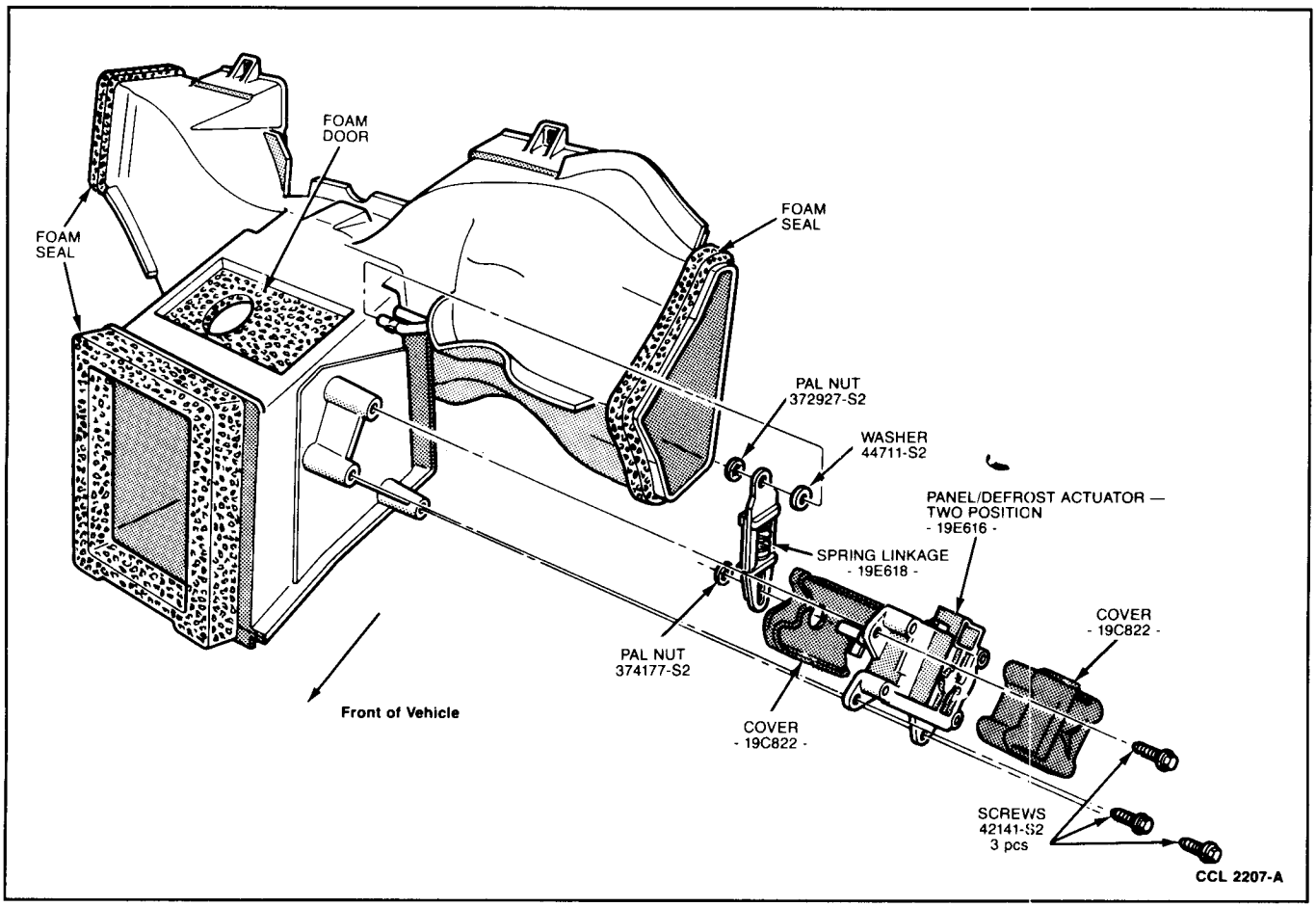


FIG. 18 Panel/Defrost Door Actuator—Continental

2. Remove seven screws and six snap clips retaining the two halves of the evaporator case together, and separate the two halves of the evaporator case (Fig. 22).
3. Lift the evaporator core and seal from the lower half of the evaporator case.

Installation

1. Position the evaporator core in the lower half of the evaporator case fitting the seal over the edge of the case lower half.
2. Position the case upper half on the case lower half making sure the temperature blend door and the heat defrost door are properly positioned.
3. Install the seven screws and six snap clips to retain the two halves of the housing together.
4. Install the air inlet duct and blower housing assembly on the evaporator case.
5. Install the evaporator case in the vehicle.

Heater Core

Removal

1. Remove instrument panel and lay it on the front seat.
2. Remove evaporator case assembly from vehicle.
3. Remove five heater core access cover attaching screws, and remove the access cover from the evaporator case.
4. Lift heater core and seals from evaporator case.
5. Remove the two seals from the heater core tubes.

Installation

1. Install the heater core tube seals on the heater core tubes, the thin seal first.
2. Install the heater core in the evaporator case with the seals on the outside of the case.
3. Position the heater core access cover on the evaporator case and install the five attaching screws.
4. Install evaporator case assembly into vehicle.
5. Install instrument panel.

Air Inlet Duct and Blower Housing Assembly

Removal

1. Remove the glove compartment and shield, then, disconnect the wire connector from the outside-recirc actuator (motor). Disconnect the hose from the outside recirc door vacuum motor (Fig. 23).
2. Remove the instrument panel lower right-to-side cowl attaching bolt.
3. Remove the screw attaching the support brace to the top of the air inlet duct.
4. Disconnect the blower motor power lead.
5. Remove the nut retaining the blower housing lower support bracket to the evaporator case.
6. Remove the side cowl trim panel.
7. Open ashtray door and remove ash receptacle.

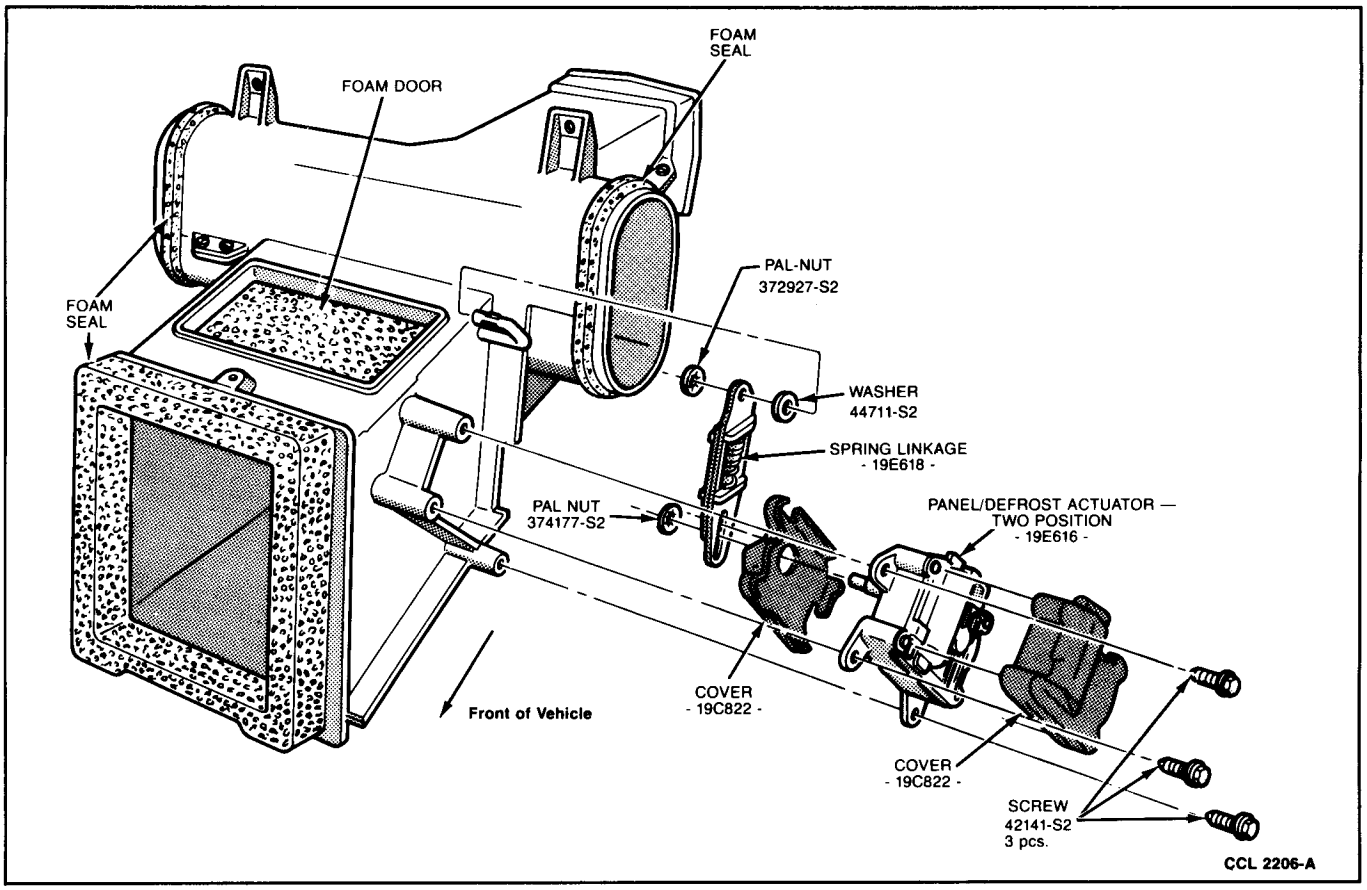


FIG. 19 Panel/Defrost Door Actuator—Mark VII

8. Remove two screws attaching instrument panel to transmission tunnel at ashtray opening.
9. Remove one screw attaching the top of the air inlet duct to the evaporator case (Fig. 23).
10. Move the air inlet duct and blower housing assembly down and away from the evaporator case.

Installation

1. Tape the blower motor power lead to the air inlet duct to keep the wire away from the blower outlet during installation.
2. Position the air inlet duct and blower housing assembly to the evaporator case, inserting the flange at the top of the blower outlet into the opening in the evaporator case. Slide the blower housing lower bracket over the stud and install the retaining nut. Be sure the blower wire is routed to the passenger side of the evaporator case.
3. Install the screw to retain the air inlet duct to the evaporator case.
4. Open the outside recirc door and rotate the blower wheel to be sure it rotates freely. If an interference exists, remove the blower motor and wheel and correct the condition.
5. Connect the blower motor power lead.
6. Install the air inlet duct-to-cowl support brace attaching screw.
7. Connect the wiring to the outside-recirc door actuator door and install the glove compartment and shield.
8. Install two screws attaching instrument panel to transmission tunnel.
9. Install ash receptacles.
10. Install the instrument panel lower right side attaching bolt. Then, install the right cowl side trim panel.

Blower Motor and Wheel Assembly

Removal

1. Remove the air inlet duct and blower housing assembly from the vehicle.
2. Remove four blower motor mounting plate screws and remove the blower motor and wheel assembly from the blower housing (Fig. 24). **Do not remove the mounting plate from the motor.**
3. Remove the blower wheel from the motor shaft.

Installation

1. Install the blower wheel on the blower motor shaft until the outside edge of the blower wheel is 3-1/2 to 3-5/8 inches from the blower motor mounting plate. Then, install the new retaining clip on the blower wheel (Fig. 24).
2. Position the blower motor and wheel assembly to the blower housing with the flat side of the flange near the blower outlet. Install the four attaching screws.
3. Tape the blower motor power lead to the air inlet duct to keep the wire away from the blower outlet during installation.

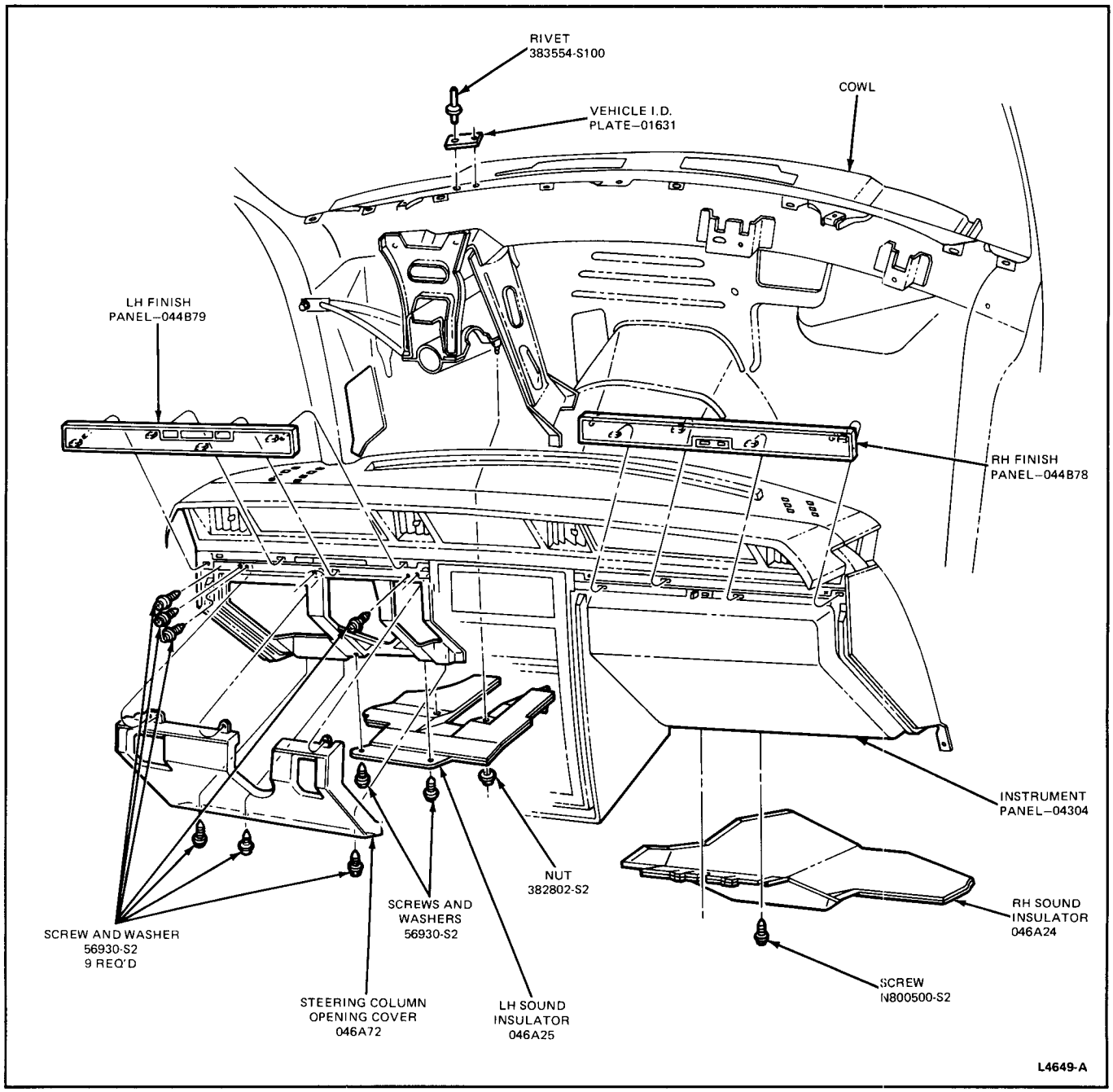


FIG. 20 Instrument Panel Trim Installation—Continental

4. Install the air inlet duct and blower housing assembly in the vehicle.

Register Ducts and Defroster Nozzle

Removal

1. Remove the instrument panel and lay it against the front seat.
2. Working through the slot in the instrument panel, remove one screw attaching the defroster nozzle to the A/C plenum chamber assembly.
3. Remove four screws attaching the defroster nozzle to the top of the instrument panel and remove the defroster nozzle.
4. To remove the right or left register duct, remove screws attaching the duct to the instrument panel.
5. To remove the A/C plenum chamber assembly, remove the right and left register ducts. Then, remove one screw from each center register opening and remove the plenum chamber assembly from the instrument panel.

Installation

1. Position the A/C plenum chamber assembly to the instrument panel and install one screw over each center register to retain the A/C plenum chamber assembly to the instrument panel.
2. Install the right and left register ducts retaining each duct in place with two screws.
3. Position the defroster nozzle to the instrument panel and the A/C defrost distribution duct. Then, install four screws to attach the defroster duct to the instrument panel at the defroster openings.

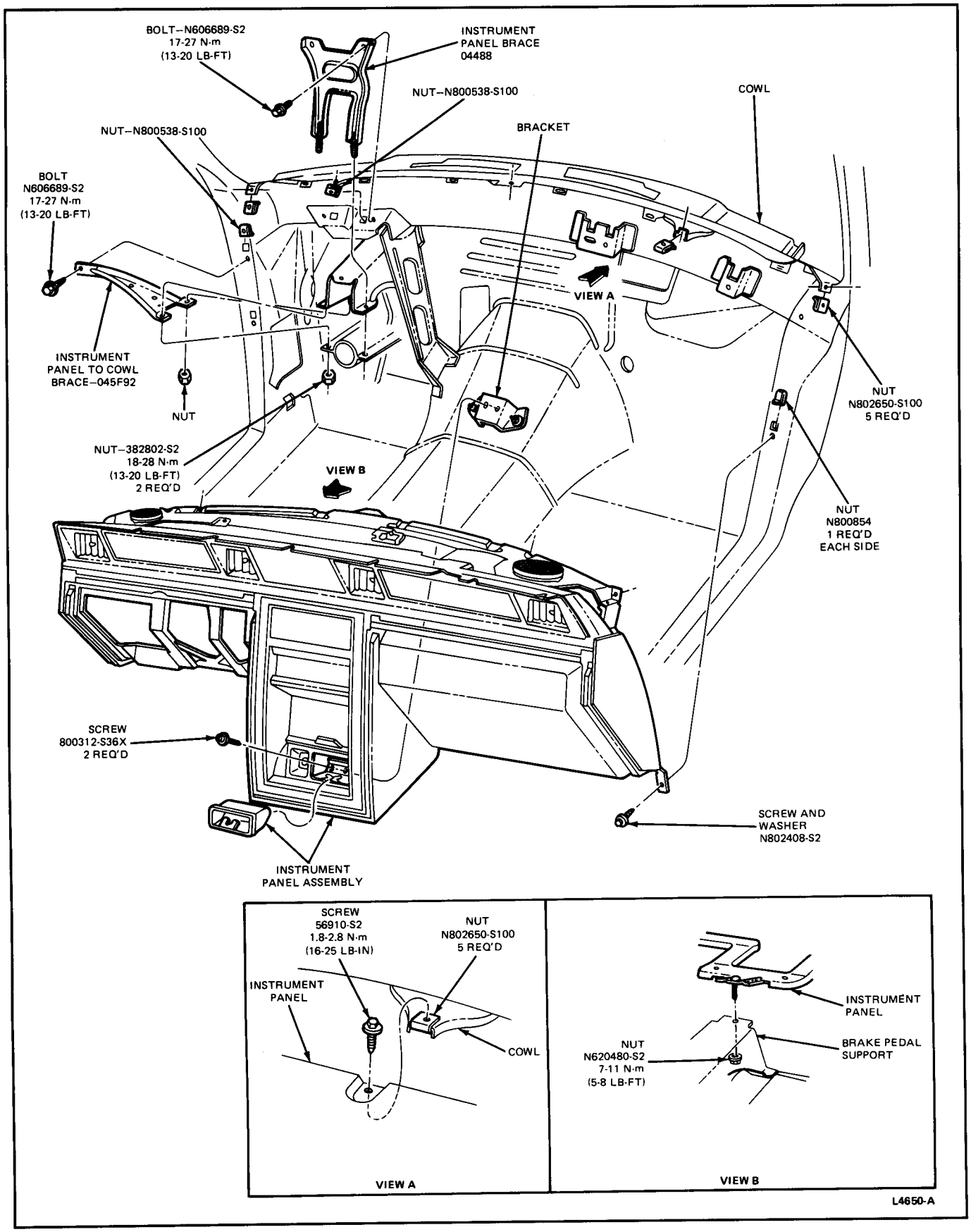


FIG. 21 Instrument Panel Installation—Continental

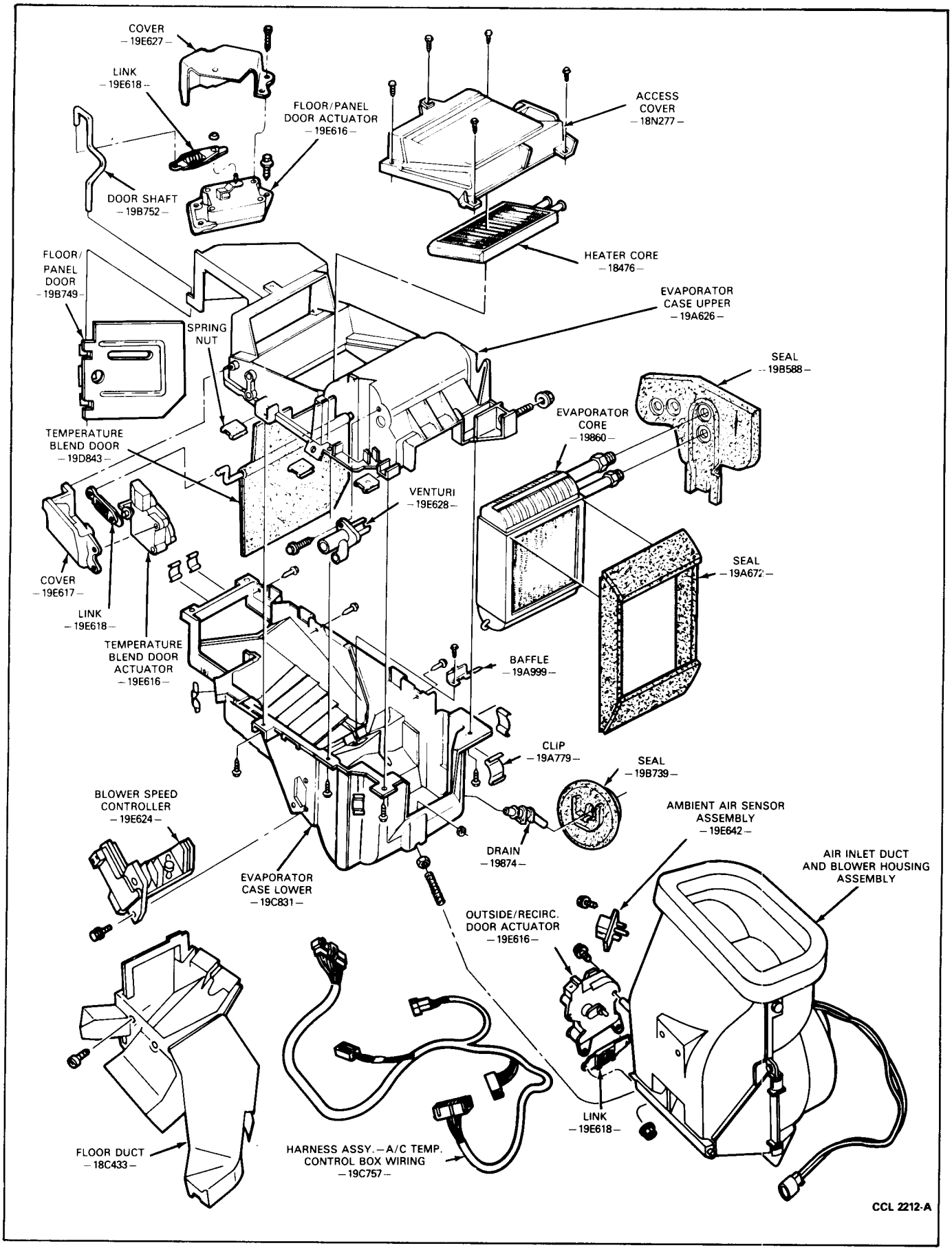


FIG. 22 Evaporator Case Assembly—Disassembled

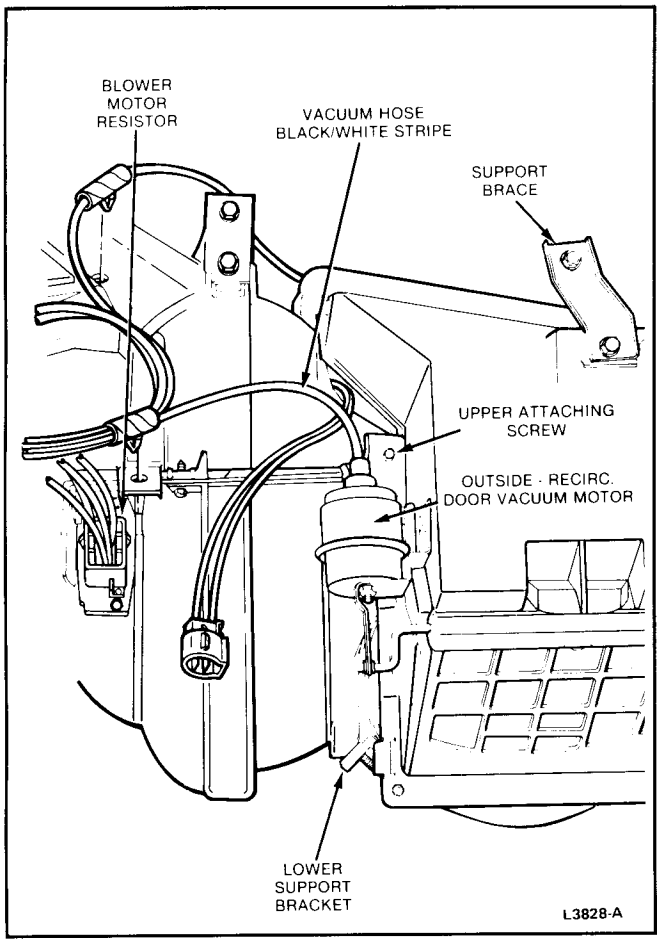


FIG. 23 Air Inlet Duct and Blower Housing Assembly

4. Working through the slot in the instrument panel, install one screw to attach the defroster nozzle to the A/C plenum chamber assembly.
5. Install instrument panel.

Floor Air Distribution Duct

Removal and Installation

1. Remove two screws attaching the duct to the evaporator case assembly just below the A/C heat distribution duct.
2. Pull the floor air distribution duct away from the evaporator case.
3. To install, position the duct to the evaporator case. Make sure the retainer at the forward edge of the duct is inserted over the edge of the opening in the evaporator case. Then install the two attaching screws.

Temperature Blend Door

Removal

1. Remove the evaporator case from the vehicle.
2. Remove the air inlet duct and blower housing assembly.
3. Remove seven screws and six snap clips retaining the two halves of the evaporator case together, and separate the two halves of the evaporator case.
4. Disconnect the door shaft from the actuator link and remove the temperature blend door from the evaporator case.

Installation

1. Position the temperature blend door on the lower half of the evaporator case.
2. Place the upper half of the evaporator case on the lower half making sure the door shaft does not move out of position.
3. Install the seven screws and six clips to retain the two halves of the case together.
4. Connect the actuator link to the door shaft.
5. Install the air inlet and blower housing assembly.
6. Install the evaporator case in the vehicle.

Outside-Recirc Door and/or Shaft

Removal

1. Remove the air inlet duct and blower housing assembly from the vehicle.
2. Remove three snap clips and two screws attaching the air inlet duct to the blower housing. Then, separate the duct from the blower housing (Fig. 24).
3. Remove the screw retaining the door to the shaft and pull the door from the shaft.
4. To remove the shaft, disconnect the shaft from the actuator link and remove the shaft from the duct.

Installation

1. If the shaft was removed, insert the shaft into the duct and connect the actuator link to the shaft.
2. Slide the outside-recirc door on the shaft and install the retaining screw.
3. Position the air inlet duct to the blower housing. Then, install the two attaching screws and three snap clips.
4. Install the air inlet duct and blower housing assembly in the vehicle (Fig. 23).

Heat Defrost Door

Removal

1. Remove the instrument panel.
2. Press on the tabs retaining the heat-defrost door to the door shaft and pull door from door shaft.
3. Slide the door off the shaft and remove the door from the evaporator case.

Installation

1. Position heat defrost door in the evaporator case and slide it on the shaft. Be sure it is firmly seated on the shaft and retained by all three tabs on the door.
2. Install the instrument panel.

Continental

Removal

1. Remove A/C plenum chamber assembly.
2. Press down on tabs retaining A/C-defrost door to door crank and pull door from door crank.

Installation

1. Position the A/C-defrost door on crank so the door is on the same side of the crank as the vacuum motor.

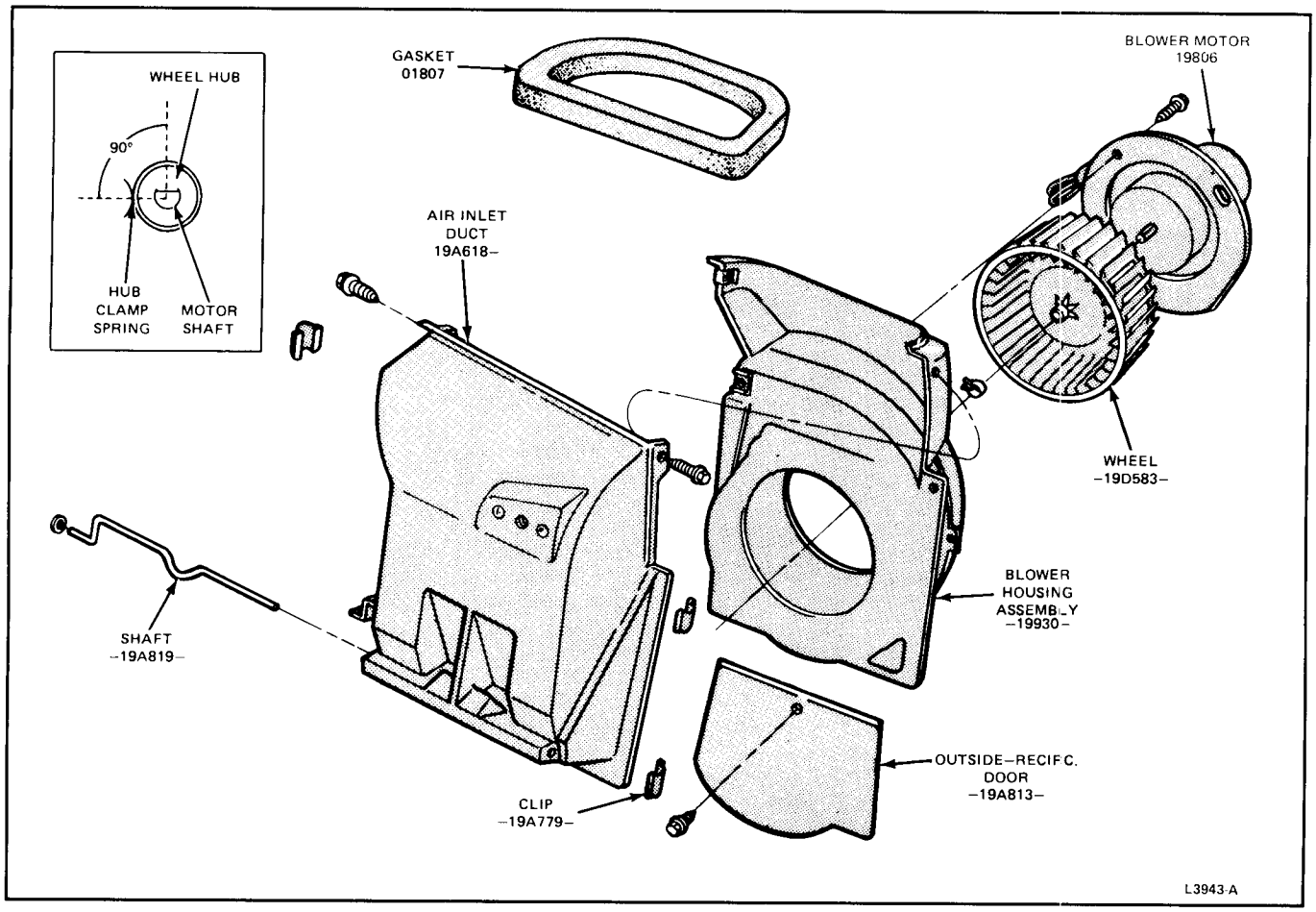


FIG. 24 Air Inlet Duct and Blower Housing Assembly—Disassembled

2. Then, push the door on the shaft and check that door is properly seated on shaft and retained by all three tabs on the door.
3. Install A/C plenum chamber assembly.

Suction Accumulator/Drier

Removal

1. Discharge the refrigerant from the A/C system following the recommended service procedures. Observe all safety precautions.
2. Disconnect the suction hose at the compressor. Cap the suction hose and compressor to prevent the entrance of dirt and moisture.
3. Disconnect the accumulator/drier inlet tube, (Fig. 25) from the evaporator core outlet. Use two wrenches to prevent component damage.
4. Disconnect the wire harness connector from the pressure switch on top of the accumulator/drier.
5. Remove the screw holding the suction accumulator/drier in the accumulator bracket and remove the suction accumulator/drier.

Installation

1. Position the suction accumulator/drier to the vehicle and route the suction hose to the compressor.
2. Using a new O-ring lubricated with clean refrigerant oil, connect the accumulator/drier inlet tube to the evaporator core outlet. Tighten the connection to specification using a back-up wrench to prevent component damage.
3. Install the screw in the suction accumulator/drier bracket.
4. Using a new O-ring lubricated with clean refrigerant oil, connect the suction hose to the compressor. Tighten the connection to specification.
5. Leak test, evacuate and charge the system following the recommended service procedures. Observe all safety precautions.
6. Check the system for proper operation.

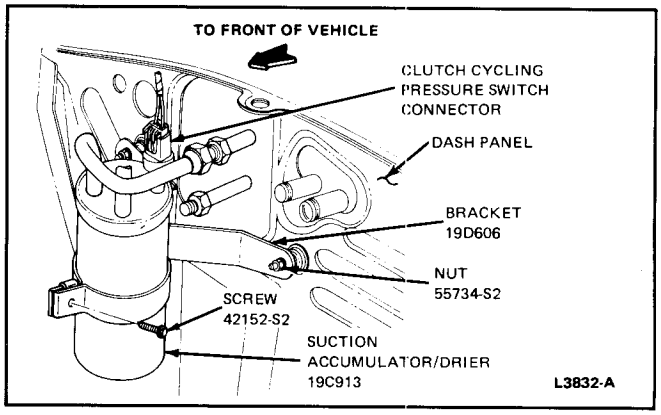


FIG. 25 Suction Accumulator/Drier

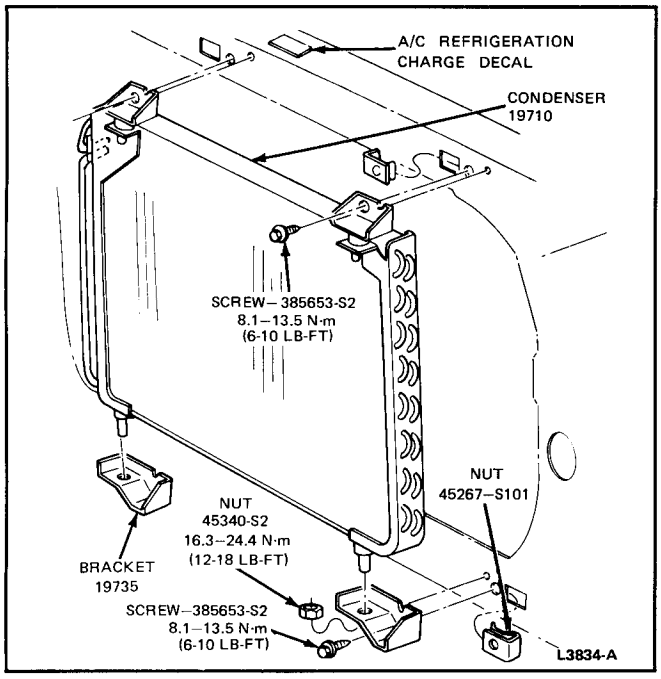


FIG. 26 Condenser and Receiver Drier Installation

Clutch Cycling Pressure Switch

Removal

1. Disconnect the wire harness connector from the pressure switch (Fig. 25).
2. Unscrew the pressure switch from the top of the suction accumulator/drier.

Installation

1. Lubricate the O-ring on the accumulator nipple with clean refrigerant oil.
2. Screw the pressure switch on the accumulator nipple and tighten the switch to specification. Hand tighten if plastic nipple.
3. Connect the wire connector to the pressure switch.
4. Check the pressure switch installation for refrigerant leaks.
5. Check the system for proper operation.

Fixed Orifice Tube

The fixed orifice tube is located in the liquid line near the condenser and is an integral part of the liquid line. If it is necessary to replace the orifice tube, the liquid line must be replaced.

Condenser

Removal

1. Discharge the refrigerant from the A/C system at the service access gauge port valve located on the suction line. Observe all safety precautions.
2. Disconnect and remove battery from battery tray.
3. Disconnect the two refrigerant lines at the fittings on the right side of the radiator (Fig. 26). Refer to the procedure for disconnecting spring lock couplings.
4. Remove four bolts attaching the condenser to the radiator support and remove the condenser from the vehicle.

Installation

1. Position the condenser assembly to the radiator support brackets and install the attaching bolts.
2. Connect the refrigerant lines to the condenser assembly as outlined in Spring Lock Coupling Installation.
3. Install and connect the battery.
4. Leak test, evacuate and charge the refrigerant system following the recommended procedures and safety precautions.

Spring Lock Coupling

The spring lock coupling (Fig. 27) is a two-piece refrigerant line coupling that is held together by a garter spring. When connected together, two O-rings seal between the two fittings of the connector. A garter spring within the cage of the male fitting expands over the flared lip of the female fitting and prevents connector separation.

To Disconnect The Coupling

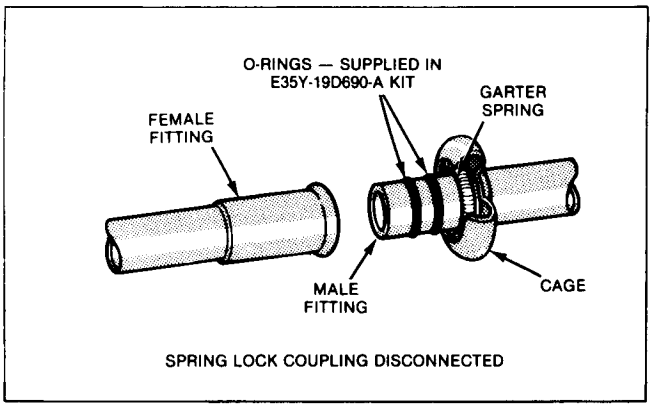
1. Discharge the refrigerant from the system following approved procedures. Then, fit Tool T81P-19623-G for 3/8 and 1/2-inch couplings or Tool T83P-19623-C for 5/8-inch coupling or equivalent to the coupling as shown in Fig. 27. The larger opening end of Tool T81P-19623-G or equivalent is for 1/2-inch compressor discharge lines and the smaller end is for 3/8-inch liquid lines. The 5/8-inch Tool T83P-19623-C or equivalent is used at the HR980 compressor suction line.
2. Close the tool and push the tool into the open side of the cage to expand the garter spring and release the female fitting.

   NOTE: The garter spring may not release if tool is cocked while pushing it into the cage opening.
3. After garter spring is expanded, pull fittings apart.
4. Remove the tool from the disconnected coupling.

To Connect The Coupling

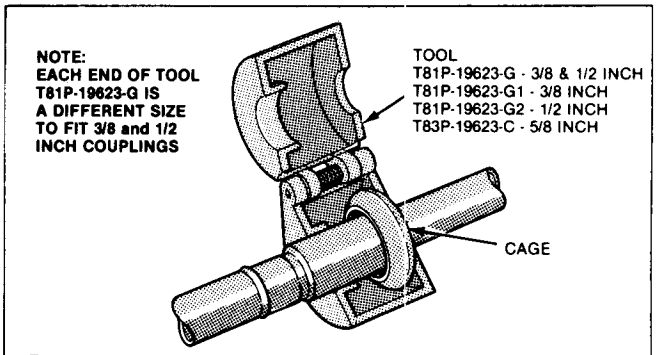
1. Ensure that the garter spring is in the cage of the male fitting. If the garter spring is missing, install a new spring by pushing it into the cage opening. If the garter spring is damaged, remove it from the cage with a small wire hook (do not use a screwdriver) and install a new spring.
2. Clean all dirt or foreign material from both pieces of the coupling.
3. Install new O-rings on the male fitting.

   NOTE: Use only the specified O-rings as they are made of a special material. The use of any O-ring other than the specified O-ring may allow the connection to leak intermittently during vehicle operation.
4. Lubricate the male fitting and O-rings and the inside of the female fitting with clean refrigerant oil.
5. Fit the female fitting to the male fitting and push until the garter spring snaps over the flared end of the female fitting.
6. To ensure coupling engagement, pull the female fitting and visually check to be sure the garter spring is over the flared end of the female fitting.



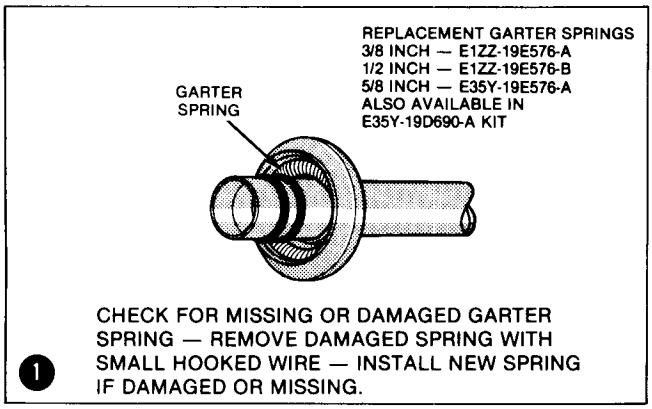
TO DISCONNECT COUPLING

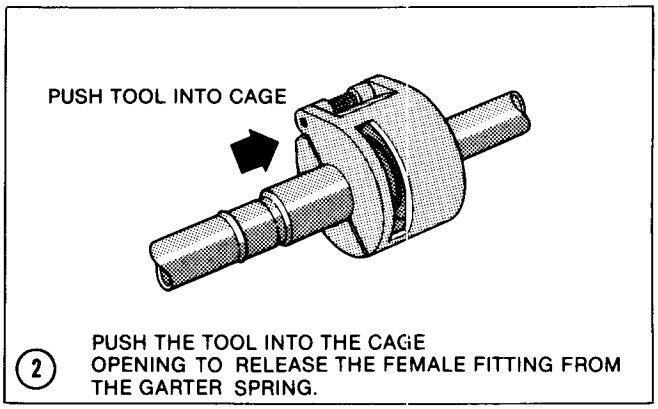
CAUTION — DISCHARGE SYSTEM BEFORE DISCONNECTING COUPLING

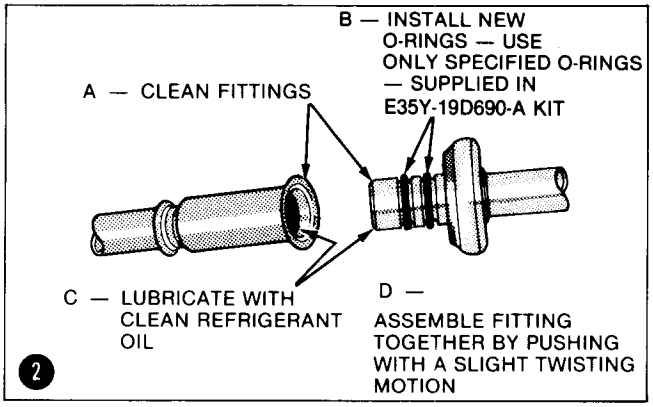


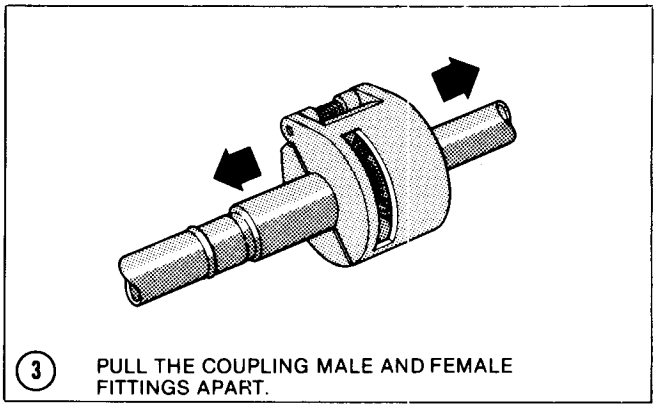
1. FIT TOOL TO COUPLING SO THAT TOOL CAN ENTER CAGE TO RELEASE THE GARTER SPRING.

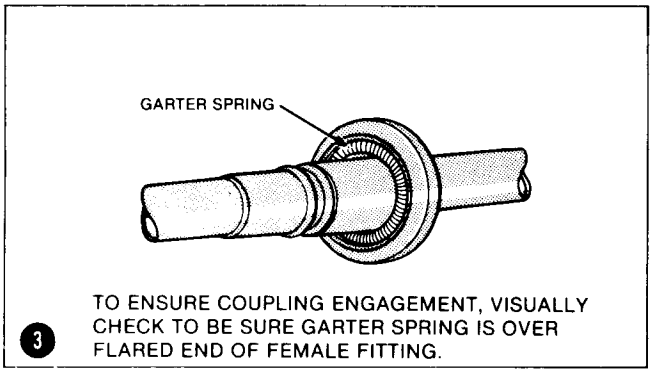
TO CONNECT COUPLING











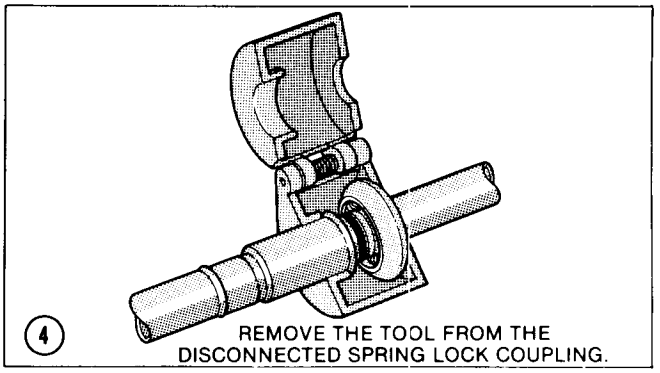


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FIG. 27 Spring Lock Couplings

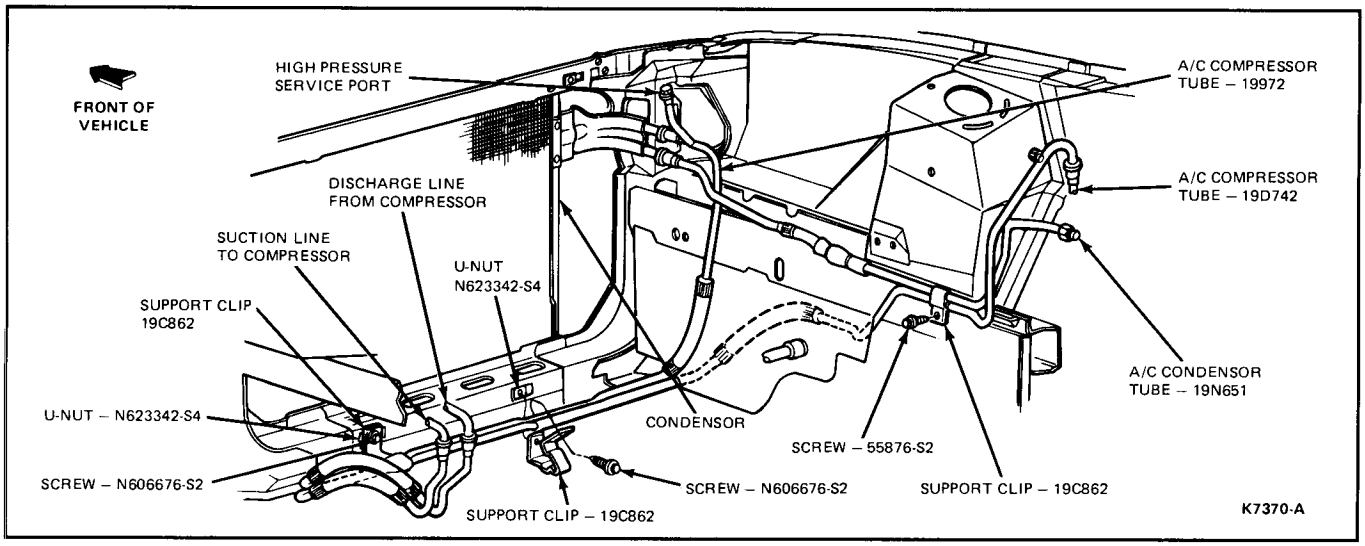


FIG. 28 A/C Hose Installation

Part Number	Description
E35Y-19D690-A	O-ring Seal Kit — A/C Spring Lock Coupling (Kit contains 3/8, 1/2 and 5/8 inch coupling O-rings and 3/8, 1/2 and 5/8 inch coupling garter springs.)

CL3811-C

Refrigerant Lines

1. Discharge the refrigerant from the A/C system at the service access gauge port valve located on the suction line. Observe all safety precautions.
2. Disconnect and remove the refrigerant line. Refer to Spring Lock Coupling Removal.
3. Route the new refrigerant line with the protective caps installed (Fig. 28).
4. Connect the refrigerant line into the system using Spring Lock Coupling procedure.
5. Leak test, evacuate and charge the refrigerant system following the recommended procedures and safety precautions.

Heater Hoses

Refer to Fig. 29 for heater hose routings.

Compressor

Removal

Refer to Fig. 30.

1. Discharge the system following the recommended service procedures. Observe all safety precautions.
2. Disconnect compressor clutch wires at the field coil connector on compressor (Fig. 31).
3. Disconnect the discharge and suction hoses from the compressor manifolds. Cap the refrigerant lines and compressor manifolds to prevent the entrance of dirt and moisture.
4. Remove two bolts from rear support bracket. Remove three bolts attaching compressor tab and front legs to front support. Remove one bolt from front of flat brace. Remove flat brace from vehicle.

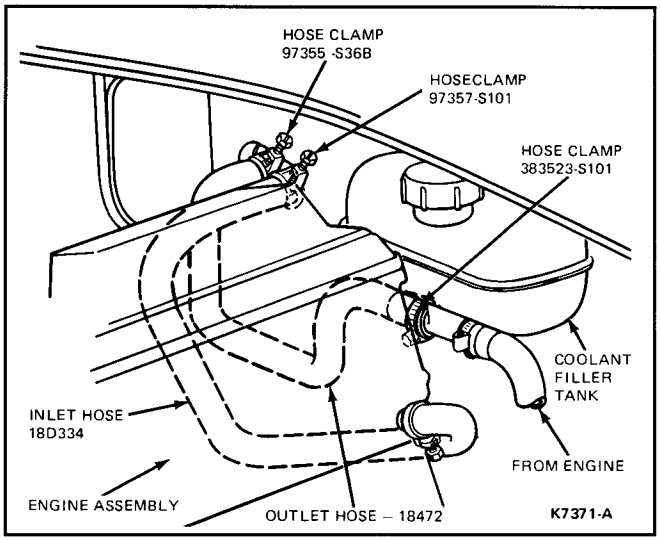


FIG. 29 Heater Hose Installation

5. Rotate the compressor outboard (toward left side of engine compartment) until compressor upper boss clears support.
6. Remove compressor assembly and rear support from vehicle as a unit.
7. Remove two bolts attaching rear support to compressor and remove rear support.
8. If the compressor is to be replaced, remove the clutch and field coil assembly from compressor.

Installation

1. A new service replacement FS-6 compressor contains 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.
2. Reverse Removal procedure.
3. Using new O-rings lubricated with clean refrigerant oil, connect the suction and discharge lines to the compressor manifolds. Tighten each fitting to specification.

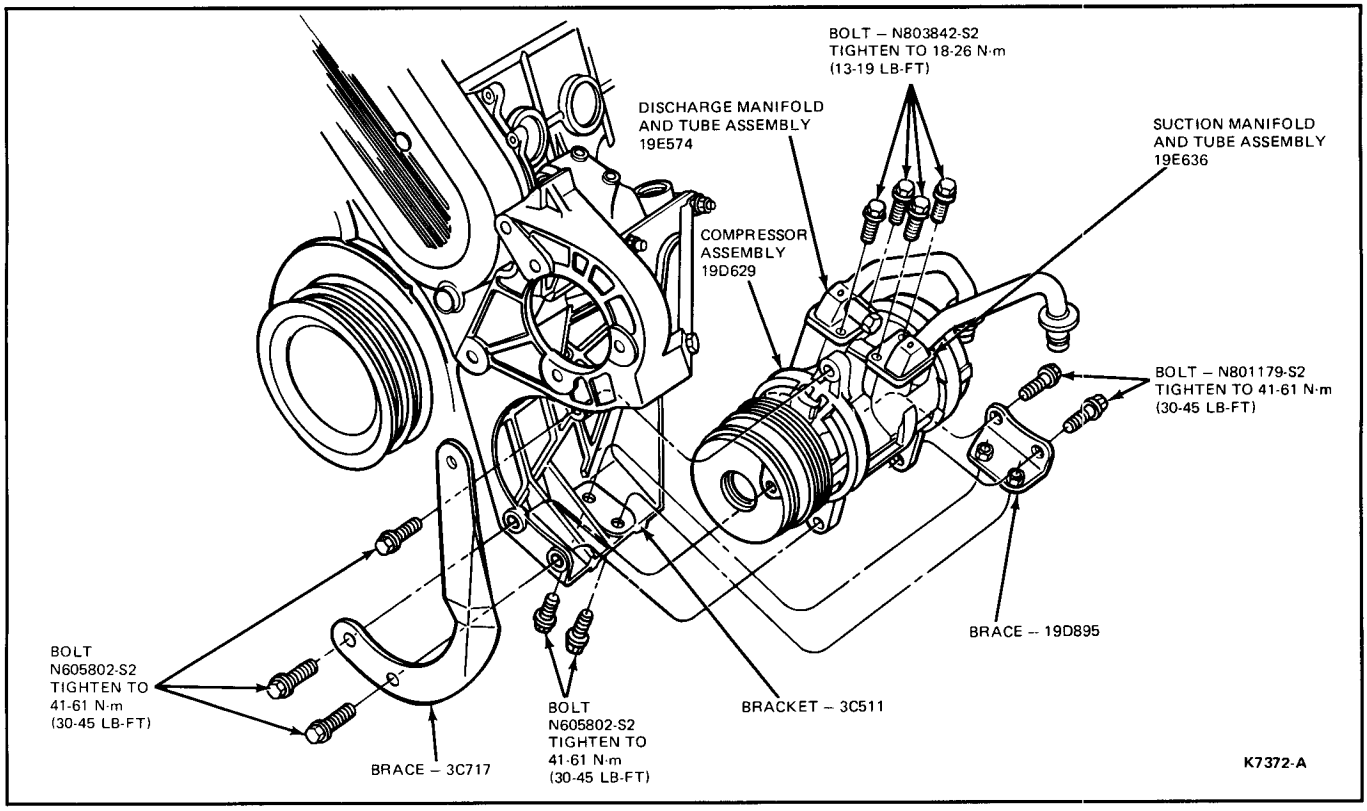


FIG. 30 A/C Compressor Installation

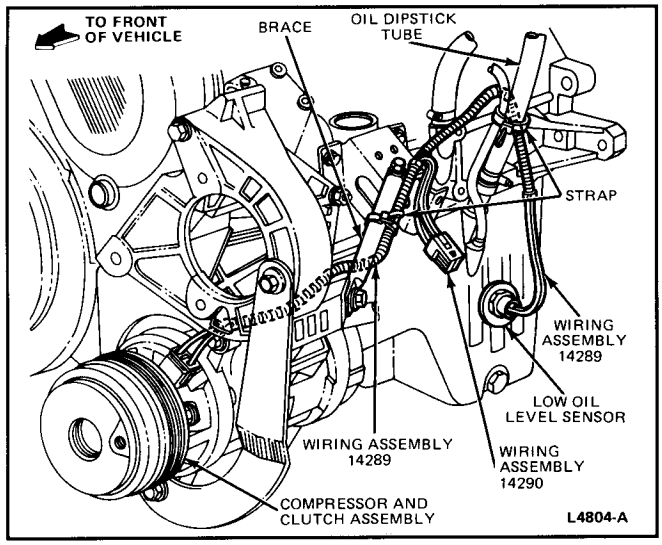


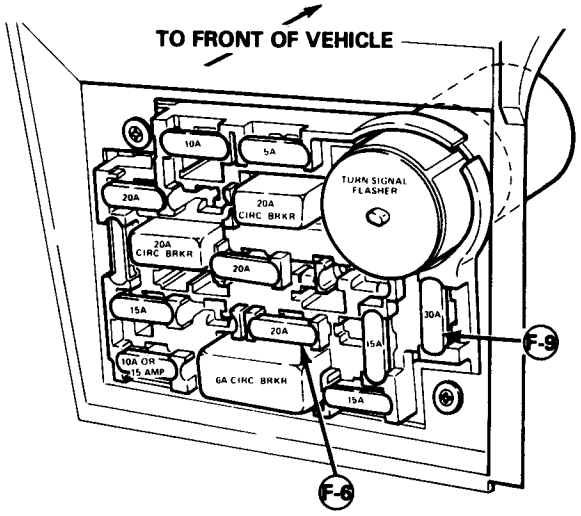
FIG. 31 A/C Compressor Clutch Field Coil Electrical Connector

4. Connect the clutch wires to the field coil connector.
5. Install the drive belt. Adjust the drive belt to specification. Refer to Section 27-02.
6. Leak test, evacuate and charge the system following the recommended service procedures. Observe all safety precautions.
7. Check the system for proper operation.

SPECIFICATIONS

REFRIGERANT

Type Ford Specification Ford Part Number Capacity	Refrigerant 12 (R-12) Dichlorodifluoromethane CCL^2F^2 ESA-M17B2A D4AZ-19B519-A +2 Oz. 1182.80 ml (40 Oz.) 59.14 ml (−2 Oz.)		
Refrigerant Oil Ford Specification Ford Part Number Oil Capacity	 ESA-M2C31-A C9AZ-19577-B 295.70 ml (10 Fluid Ounces)		
Drive Belt Tension	New — 120-160 Lbs. Used — 90-120 Lbs. (after operation of 10 minutes)		
Blower Motor Current Draw (Amps and Voltage)	**Blower Speed**	**Amps**	**Volts**
	Low	3.5-5	3.5-4.5
	Med. Low	6-8	5.5-7
	Med. High	10-14	7.5-10.5
	High	15-22	11-14
Protective Device	30 Amp. Fuse in Blower Circuit F-9 (Lt. Green) 20 Amp. Fuse in Clutch Circuit F-6 (Natural) Thermal Limiter in Blower Resistor Circuit (Integral with Resistor)		



The fuse panel is located in the lower left side of the instrument panel, behind a cover which must be removed for access.

CL3550-E

REFRIGERANT COMPONENTS AND CAPACITIES

Vehicle①	Compressor FS-6	Orifice Tube	Clutch Cycling Pressure Switch②	Refrigerant Capacity* Oz.	Kg.
Mark VII	X	X	X	40	1.34
Continental③	X	X	X		

*Plus (2 oz.) (.056 kg.) minus (2 oz.) (.056 kg.)
①All models equipped with Suction Accumulator Drier
②Pressure Switch opens at 169 kPa (24.5 psi)
③Continental models equipped with discharge muffler

CK7337-A

ACTUATOR GENERAL INFORMATION AND IDENTIFICATION

	Actuator			
	Temp. Blend Door	Floor/Panel Mode Door	Fresh Air/ Recirculation Door	Panel/ Defrost Door
Type	Continuity	Continuity	Two Position	Two Position
Rotation (Arm Side)	CW/CCW	CW/CCW	CCW	CCW
Operating Range	180°	180°	360°	360°
Sound Shields	No	No	Yes	Yes
Arm Color	Silver	Silver	Black	Silver
Arm Ship Position	A	A	Pos. 2	Pos. 2
Mounting Location	B	C	D	E

Function	Max. Heat	Max. A/C	Air to Floor	Air to Plenum	Fresh Air	Recirc.	Defrost	Panel
Arm Position	1	2	1	2	1	2	1	2
Resistance	—	—	—	—	0K	6.8K	0K	6.8K
Feedback Ratio	.087	.686	.087	.686	—	—	—	—
Between Terminals	F	F	F	F	G	G	G	G

A. Feedback Ratio (FBR) — .34-.36 with a clockwise torque applied to actuator arm from arm side
B. Front Center of Evaporator Assembly directly behind radio
C. Top Left Corner (Driver's Side) of Evaporator Assembly
D. Attached to Panel/Defrost Plenum which is mounted to underside of Instrument Panel
E. Right Front of Evaporator Assembly directly behind Glove Box Opening
F. The Feedback Ratio (FBR) equals the ratio of resistance across terminals F&D divided by the resistance across terminals C&D
G. The resistance is measured between the B+ and Feedback terminals

CK7338-A

SPECIAL SERVICE TOOLS

Rotunda Part Number	Motorcraft Part Number	Description
T63L-8620-A	YT-371	Belt Tension Gauge
D81L-19703-A	YT-367	Quick Connect Service Access Adapter (High Pressure)
055-00007	YT-288	Electronic Leak Detector
023-00006	YT-202	Flame Type Leak Detector
023-00007	YT-227	Dial Thermometer
023-00009	YT-229	Small Can Adapter
063-00010	YT-201	Manifold Gauge Set
T70P-4067-A	YT-499	Spanner Wrench
T81P-19623-G	OD	Spring-Lock Coupling Disconnect Tool 3/8 and 1/2 Inch
T83P-19623-C	—	Spring-Lock Coupling Disconnect Tool 5/8 Inch (HR-980)
T83L-19990-A	YT-1008	Orifice Tube Remover and Installer (HR-980)
T83L-19990-B	YT-1009	Orifice Tube Extractor (HR-980)

CL3260-E

SECTION 37-05 Speed Control System with Resume

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

Refer to the 1984 Car Shop Manual, Volume B, Section 37-05 for the Description, Operation, Diagnosis and Testing of speed control system. Refer to Fig. 1 for the electrical schematic for the speed control system.

ADJUSTMENTS

Linkage Adjustment

Actuator Cable Linkage

1. Make sure engine is at normal operating temperature (injection top lever against idle stop bolt, Fig. 2).
2. Remove speed control cable retaining clip (Fig. 3).
3. Push speed control cable through adjuster until a slight tension is felt.

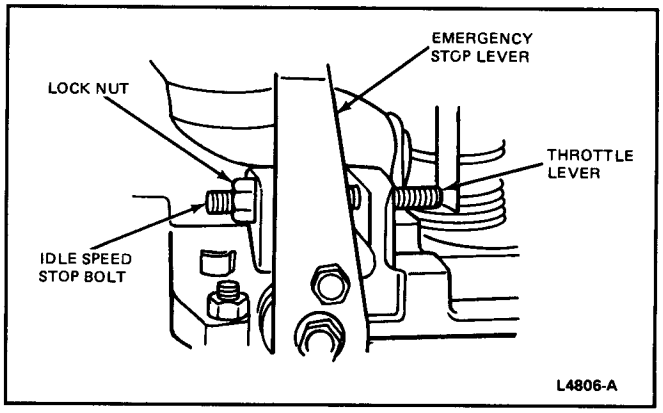
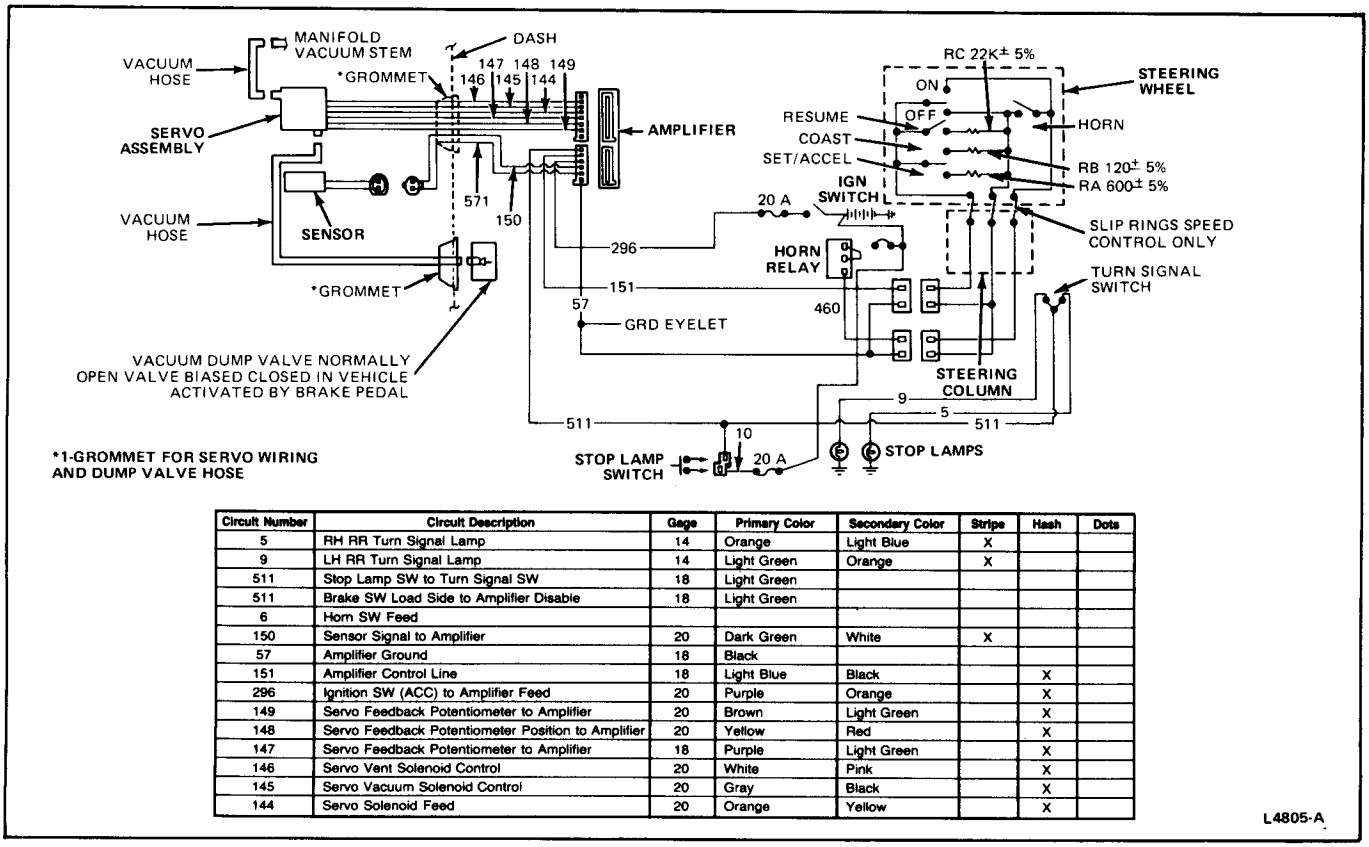


FIG. 2 Idle Stop Bolt



Circuit Number	Circuit Description	Gage	Primary Color	Secondary Color	Stripe	Hash	Dots
5	RH RR Turn Signal Lamp	14	Orange	Light Blue	X		
9	LH RR Turn Signal Lamp	14	Light Green	Orange	X		
511	Stop Lamp SW to Turn Signal SW	18	Light Green				
511	Brake SW Load Side to Amplifier Disable	18	Light Green				
6	Horn SW Feed						
150	Sensor Signal to Amplifier	20	Dark Green	White	X		
57	Amplifier Ground	18	Black				
151	Amplifier Control Line	18	Light Blue	Black		X	
296	Ignition SW (ACC) to Amplifier Feed	20	Purple	Orange		X	
149	Servo Feedback Potentiometer to Amplifier	20	Brown	Light Green		X	
148	Servo Feedback Potentiometer Position to Amplifier	20	Yellow	Red		X	
147	Servo Feedback Potentiometer to Amplifier	18	Purple	Light Green		X	
146	Servo Vent Solenoid Control	20	White	Pink		X	
145	Servo Vacuum Solenoid Control	20	Gray	Black		X	
144	Servo Solenoid Feed	20	Orange	Yellow		X	

FIG. 1 Speed Control Electrical Schematic

4. Insert the cable retaining clip and snap into place.

Vacuum Dump Valve

The vacuum dump valve is movable in its mounting bracket (Fig. 4). It should be adjusted so that it is closed (no vacuum leak) when the brake pedal is in its normal released position (not depressed), and open when the pedal is depressed. Use a hand vacuum pump to make this adjustment.

REMOVAL AND INSTALLATION

Servo Assembly

Removal

1. Disconnect speed control actuator cable from accelerator cable (Fig. 3).
2. Disconnect servo electrical connector inside engine compartment (Fig. 5).
3. Engage emergency brake.
4. Jack up vehicle on front driver's side.

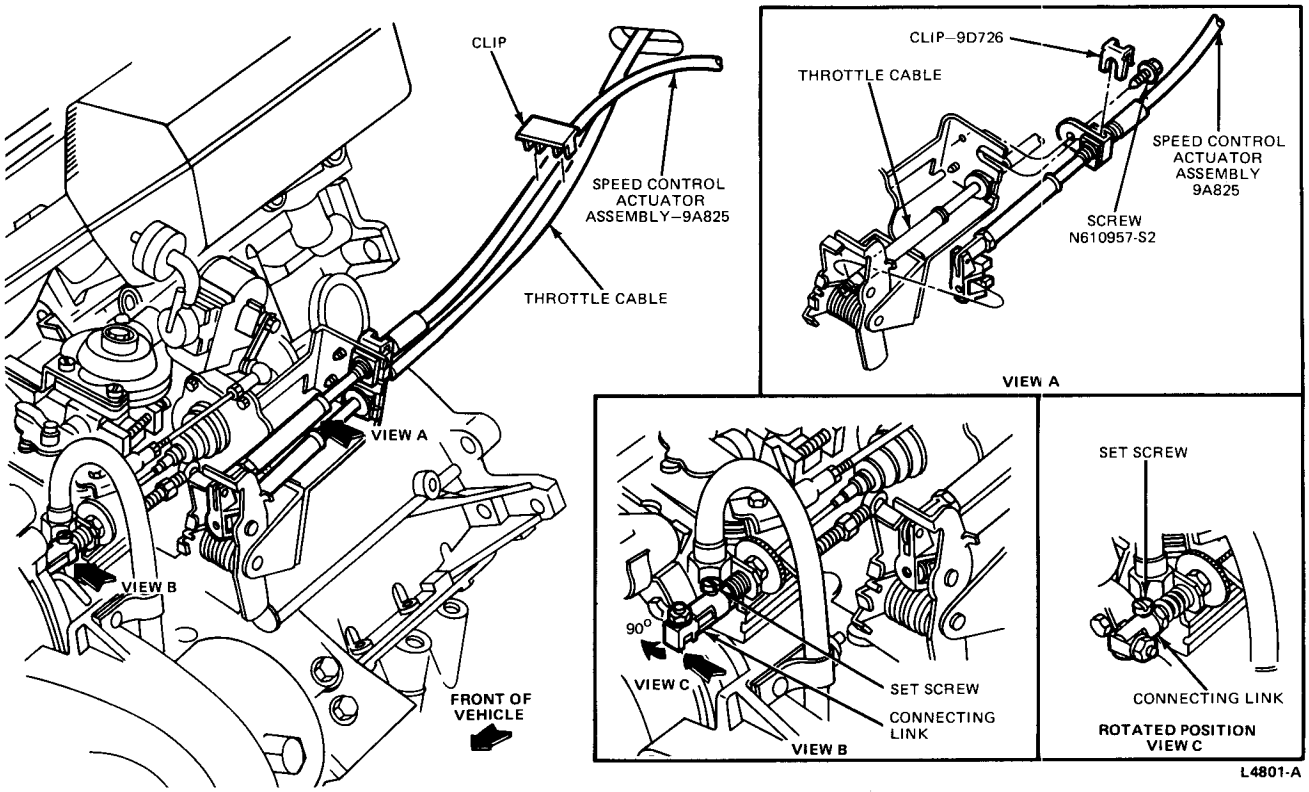


FIG. 3 Actuator Cable—Installation

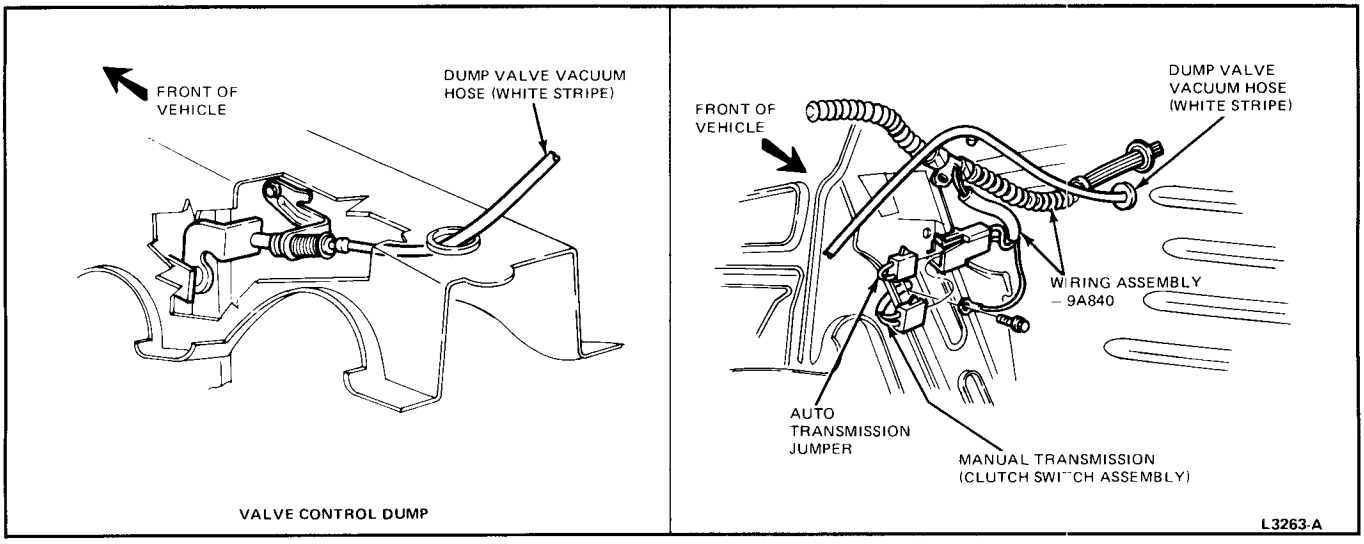


FIG. 4 Dump Valve Installation—Typical

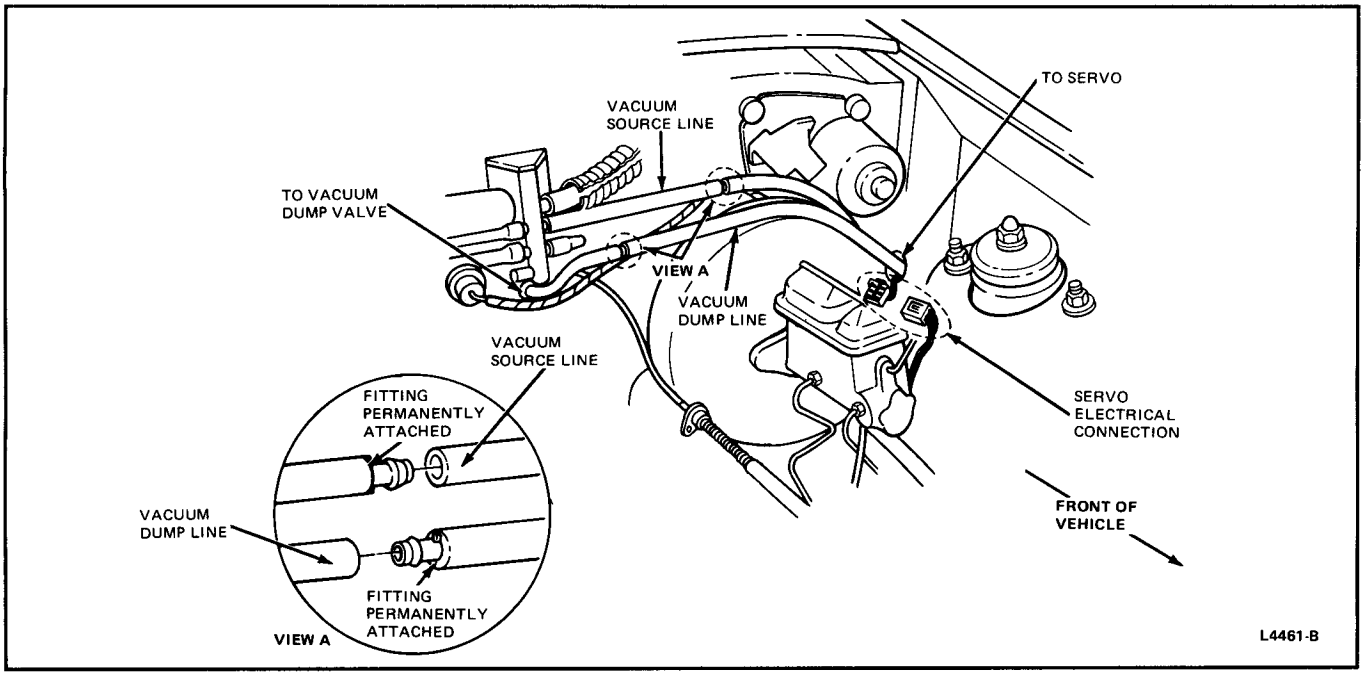


FIG. 5 Servo Electrical and Vacuum Hose Connections

5. Remove tire and wheel (driver's side).
6. Remove inner fender splash shield.
7. Remove two vacuum hoses from servo assembly (Fig. 6).
8. Remove two screws holding servo mounting bracket to A-pillar.
9. Remove two nuts from actuator cable cover at the servo. Remove the cable and cover.
10. Remove two nuts attaching the servo to the mounting bracket.
11. If replacing servo with service stock, remove two bolt assemblies from the front of servo (Fig. 7).

Installation

1. Attach two bolt assemblies to the front of servo (Fig. 7).
2. Attach servo-to-mounting bracket with two nuts. Tighten to 5-7 N·m (45-65 lb-in) (Fig. 6).
3. Attach actuator cable to servo plunger. Attach cable cover to servo with two nuts. Tighten to 5-7 N·m (45-65 lb-in).
4. Attach servo and bracket to the A-pillar with two screws (Fig. 6).
5. Attach two vacuum hoses to servo in their correct positions (Fig. 6).
6. Replace inner fender splash shield.
7. Replace tire and wheel.
8. Lower vehicle.
9. Reconnect servo electrical connector inside engine compartment (Fig. 5).
10. Reconnect the speed control actuator cable to the accelerator cable.

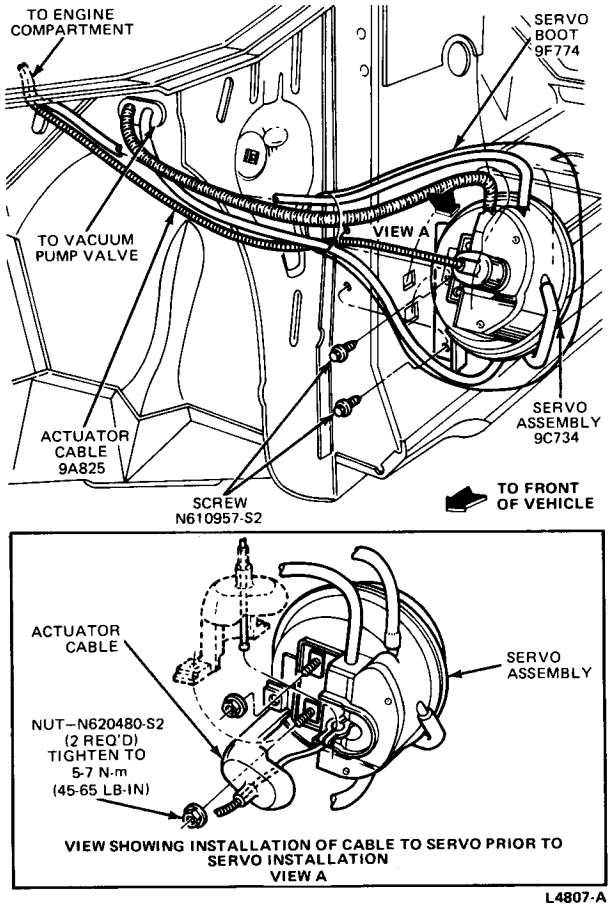


FIG. 6 Servo Installation

Actuator Cable

To replace the actuator assembly, remove the servo assembly, attach the new actuator cable assembly to the servo, and reinstall the total assembly.

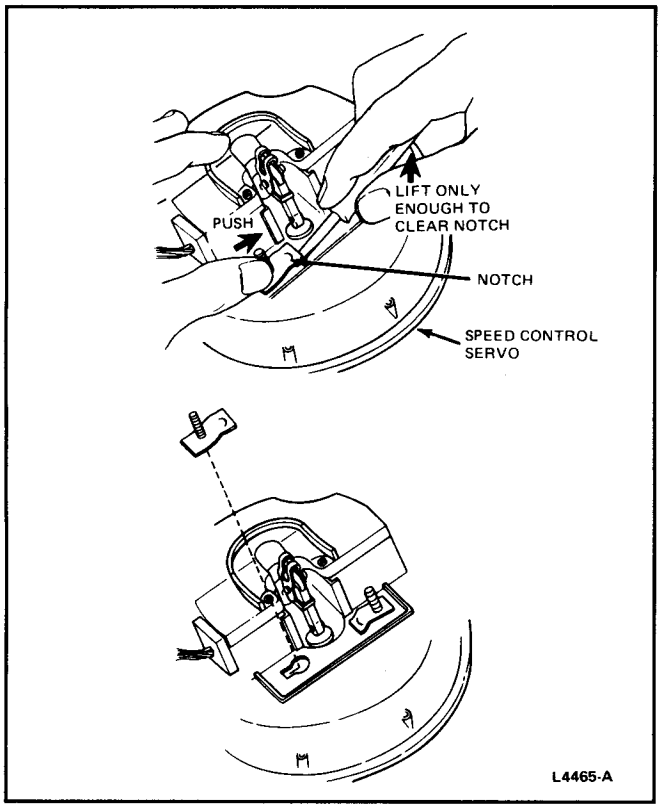


FIG. 7 Servo Bolt Assembly Removal

Installation

1. Position sensor assembly to the instrument panel and install the two attaching screws.
2. Connect the electric connectors to the in-vehicle sensor and the warning lamp module.
3. Connect the aspirator hose to the sensor assembly making certain the elbow latch engages the locking ramp on the sensor (Fig. 17).
4. Install the instrument cluster finish panel assembly (Fig. 15).
5. Connect the ground cable to the battery.
6. Check system for proper operation.

Ambient Sensor

Removal and Installation

1. Remove blower motor housing as outlined in this Section.
2. Remove two ambient sensor mounting screws and remove sensor.
3. To install, reverse Steps 1 and 2.

Aspirator

Removal

1. Disconnect glove compartment door stops and let the door hang by the hinge. Remove shield behind the glove compartment.
2. Remove one hex head screw.
3. Lift aspirator upward and out to disengage the lower locating tab.
4. Disengage the sensor hose assembly locking tab from the aspirator elbow and remove the aspirator.

Installation

1. Install the sensor hose assembly into the aspirator elbow, making sure that the locking tab engages the back surface of the elbow ramp.
2. Install the aspirator into the evaporator case. Ensure that the aspirator locating tab fits into the case locating pocket.
3. Install one hex head screw.

Fresh Air/Recirculation Door Actuator

Removal

1. Disconnect ground cable from battery.
2. Remove sound shield beneath instrument panel at glove box (two screws).
3. Remove glove box (one screw and two retaining straps).
4. Remove pressed paper shield behind glove box (seven screws).
5. Disconnect electrical connector for glove box lamp.
6. Disconnect electrical connector to actuator.
7. Remove aspirator from evaporator case (one screw).
8. Remove black PVC sound cover from top of actuator.
9. Remove push nut from pin on actuator arm and disconnect link.
10. Remove actuator from evaporator case (three screws).

Installation

NOTE: Be sure to install the correct actuator (black arm). Refer to Specifications.

SYMPTOM	POSSIBLE SOURCE	ACTION
Insufficient heating when at 90/auto setting. Blower is operating. Air is from floor.	• Low engine coolant.	• Check coolant and fill if low.
	• Blend door not in full heat position (clockwise)	
	• Open or leaking thermostat.	• Check heater hose temperature.
Insufficient heating when at 85/auto. Heating OK at 90. Blower is operating. Air is from floor.	• Shorted sensor string.	• Enter self test. Code 12 should appear. If so, service short.
		If no code
		• Check ambient sensor resistor.
		If OK
		• Check in-car sensor resistor.
	• Factory calibration not to customer's preference.	• Adjust temp. setting on left side of water radiator.
Insufficient cooling when at 65/auto setting. Cooling OK at 60. Blower is operating. Air is from panel.	• Open sensor string.	• Enter self test. Code 13 should appear. Refer to testing in this section.
	• Ambient sensor defective (open shunt resistor).	• Check ambient sensor resistance.
	• Factory calibration not to customer's preference.	

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SECTION 50-03 Lubrication Points and Lubricant Specifications

VEHICLE APPLICATION

Mark VII/Continental.

LUBRICATION

Lubrication Charts

Figs. 1 and 2 show typical chassis and engine service and lubrication points for current production vehicles. Vehicles with optional or special equipment may have slightly different or additional lubrication points.

A table of recommended lubricants is included at the end of this Section.

Refer to Section 50-29 for recommended service intervals.

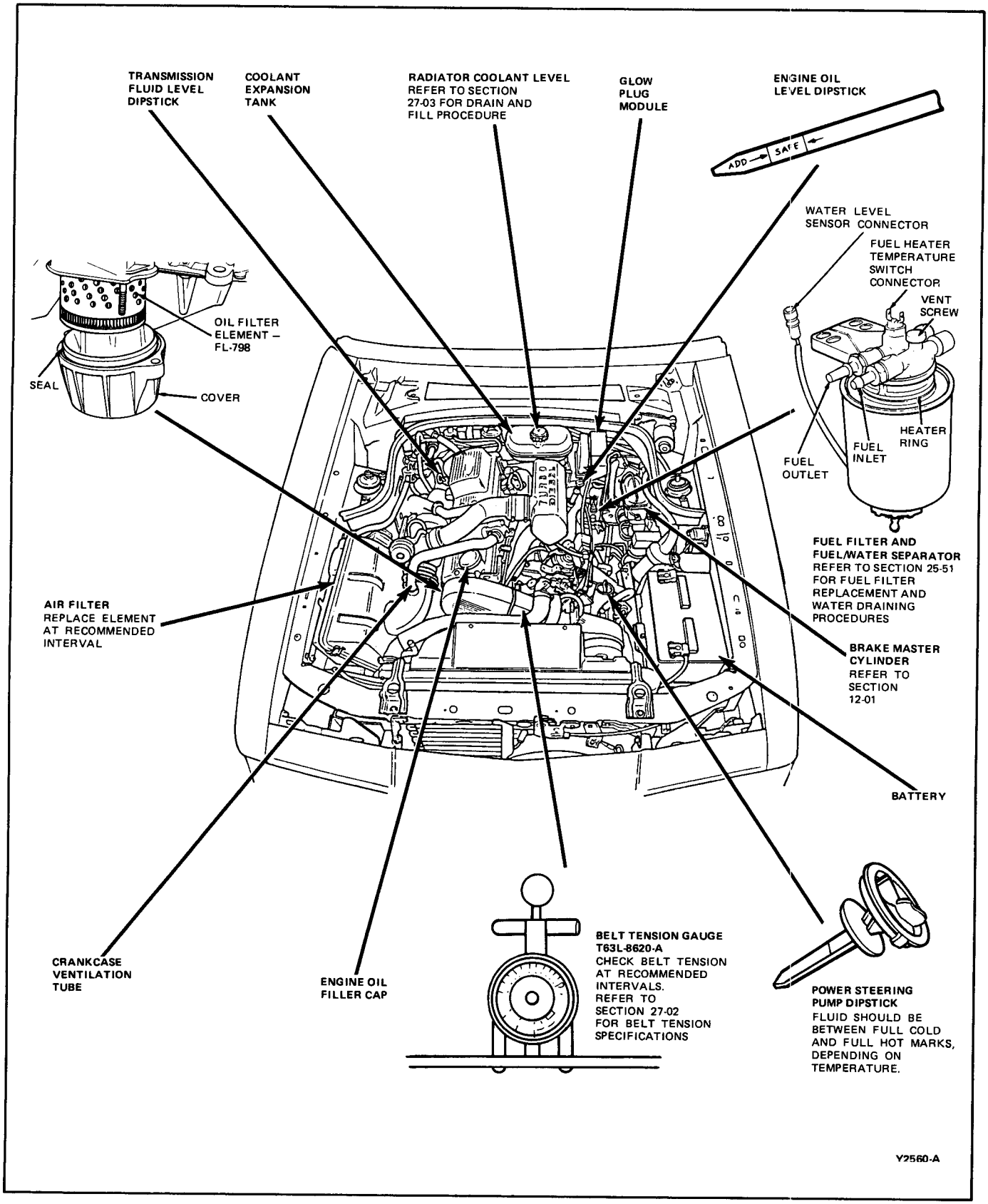

FIG. 1 Engine Compartment Rack Service Points

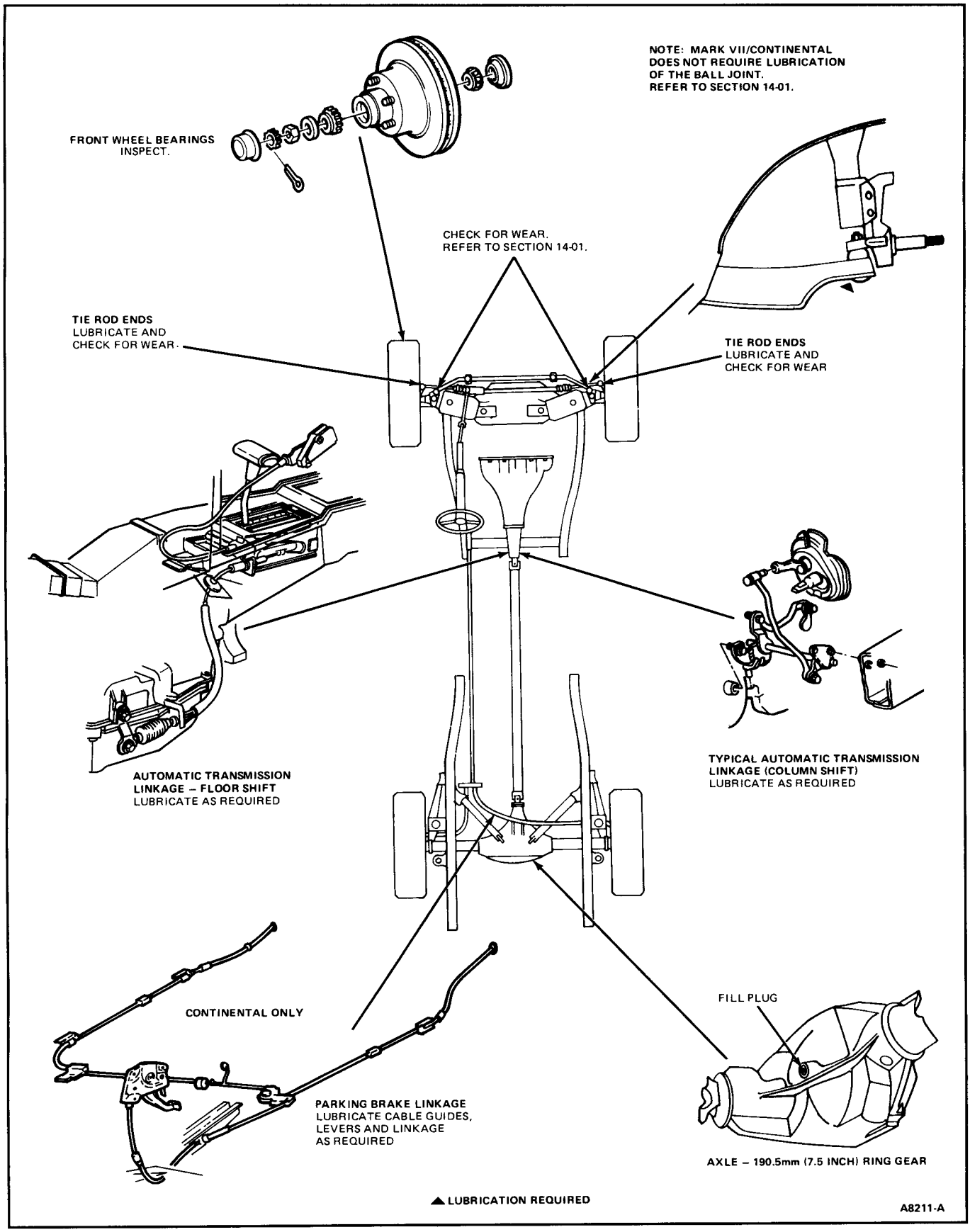

FIG. 2 Chassis Lubrication Points

SPECIFICATIONS

LUBRICANT SPECIFICATIONS

Item	Part Name	Ford Part Number	Ford Specification
Hinges, Hinge Checks and Pivots	Polyethylene Grease	D7AZ-19584-A	ESR-M1C159-A
Steering Linkage	Steering Linkage Lube	D4AZ-19590-A	ESA-M1C92-A Type II
Transmission Shift Linkage & Controls	Long Life Lubricant	C1AZ-19590-B	ESA-M1C75-B
Steering Arm Stops	Long Life Lube	C1AZ-19590-B	ESA-M1C75-B
Hood Latch and Auxiliary Catch	Polyethylene Grease	D7AZ-19584-A	ESR-M1C159-A
Lock Cylinders — Door Latches	Lock Lubricant	D8AZ-19587-A	ESB-M2C20-A
Rear Axle (All) Conventional and Traction-Lok	Hypoid Gear Lube	E0AZ-19580-A, B, C	ESP-M2C154-A
Steering Gear (Rack and Pinion) Manual	Steering Gear Grease	D8AZ-19578-A	ESA-M1C175-A
Steering — Power (Pump Reservoir)	Motorcraft Auto. Trans. Fluid (Type F)	XT-1-QF	ESW-M2C33-F
Fuel Filter Element		E45Y-9365-A (FD-821)	
Air Filter Element		E45Y-9601-A (FA-1005)	
Transmission (Automatic) ZF	Motorcraft DEXRON®-II Auto. Trans. Fluid	XT-2-QDX	DEXRON®-II
Engine Oil Filter	Long Life Oil Filter	E45Y-6731-A (FL-798)	
Engine Oil	Motorcraft: SAE-30 Single Weight 15W-40 Super Duty	 XO-30-QSD XO-15W40-QSD	 ESE-M2C153-C and API Category SF/CD
Engine Coolant	Cooling System Fluid	E2FZ-19549-A or -B	ESE-M97B44-A
Front Wheel Bearings and Hubs Front Wheel Bearing Seals	Long Life Lubricant	C1AZ-19590-B	ESA-M1C75-B
Brake Master Cylinder	H.D. Brake Fluid	C6AZ-19542-A	ESA-M6C25-A
Brake Master Cylinder Push Rod and Bushing	SAE 10W-30 Engine Oil	XO-10W30-QP	ESE-M2C153-B
Drum Brake Shoe Ledges and Disc Brake Caliper and Anchor Plate Slides	Disc Brake Caliper Lubricant	D7AZ-19590-A	ESA-M1C172-A
Parking Brake Cable	Polyethylene Grease	D0AZ-19584-A	ESR-M1C159-A
Brake Pedal Pivot Bushing	Motorcraft SAE 10W-30 Engine Oil	XO-10W30-QP	ESE-M2C153-B
Tire Mounting Bead (of Tire)	Tire Mounting Lube	D9AZ-19583-A	ESA-M1B6-A
Clutch Pedal Pivot Bushing	Motorcraft SAE 10W-30 Engine Oil	XO-10W30-QP	ESE-M2C153-B

NOTE: DEXRON® is a registered trademark of General Motors Corporation. **CY2626-A**

SECTION 50-22 Engine, Diesel

VEHICLE APPLICATION

Mark VII/Continental.

LUBRICATION

Engine Oil and Filter

To help achieve proper engine performance and durability, use only engine lubricating oils of the proper quality. These oils also help provide maximum efficiency which reduces air pollution.

Use Motorcraft oil or equivalent that meets Ford Specification ESE-M2C153-B, and the API categories SF/CD.

Engine oils of improved fuel economy properties (energy conserving) are currently available. They offer the potential for small improvements in vehicle fuel economy by reducing the amount of fuel burned to overcome engine friction. Often these improvements are difficult to measure in your everyday driving but over the course of a year can offer significant cost and energy savings. These engine oils are recommended to be used only in conjunction with the recommended API categories.

Proper oil filtration is also necessary. Use a Motorcraft long life oil filter or one that meets Ford specification E1ZE-6714-AA or equivalent.

Oil Viscosity (Thickness)

When you change or add oil, select oil with the proper viscosity. Check the accompanying table and select the oil which most closely matches the temperature range you expect during the service interval.

MAINTENANCE

Engine maintenance is in Section 50-29. Refer to Engine/Emissions Diagnosis manual, Section 31 for engine diagnosis.

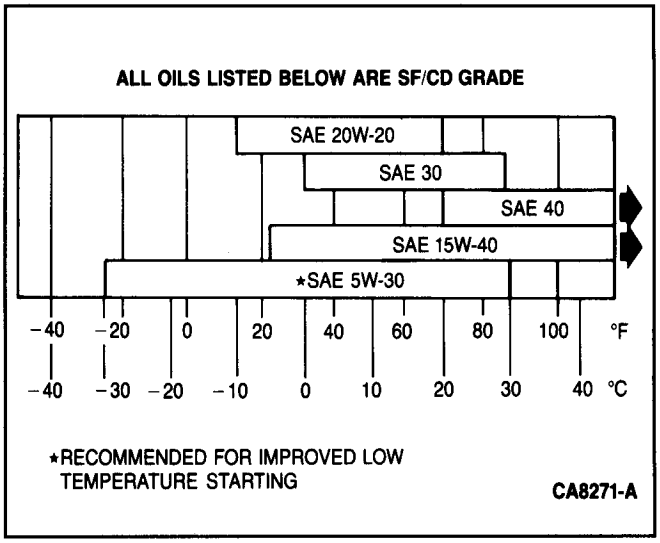

FIG. 1 Oil Viscosity Recommendations

SPECIFICATIONS AND SPECIAL SERVICE TOOLS

Refer to Section 22-07 for Specifications and Special Service Tools.

SECTION 50-29 Emission Systems Scheduled Maintenance

VEHICLE APPLICATION

Mark VII/Continental.

DESCRIPTION

The Emission Systems Required Maintenance Schedule lists the items required to maintain the vehicle emission systems at levels determined by the Federal Government (Environmental Protection Agency). Directly following the schedule(s) is an index to a number of maintenance procedures, each of which is related to an item listed on the maintenance schedule. Use these procedures to perform the required emission system maintenance items listed on the maintenance schedules.

Maintenance service adjustments must conform to specifications contained herein, listed in the Specifications manual or shown on the Vehicle Emission Control Information decal, or the emissions system may become inoperative.

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 is set and the wheels are blocked.

Vehicle Emission Control Information Decal

Vacuum hoses on the engine use a color stripe to aid in hose routing checks. The stripe will usually be the same color as on the Vehicle Emission Control Information (VECI) label, but the correct vacuum hose routing must be verified by using the correct component connections shown on the VECI label (Fig. 1). The label is located in a folder assembly on the radiator shroud, (Fig. 2).

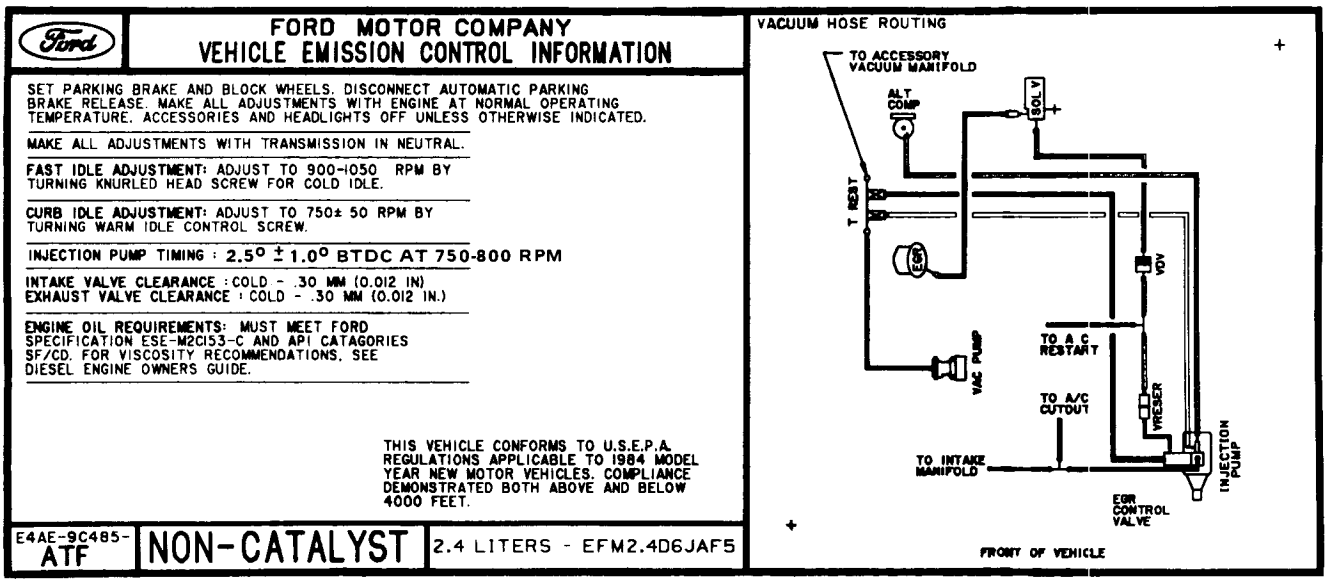

FIG. 1 Vehicle Emission Control Information Decal

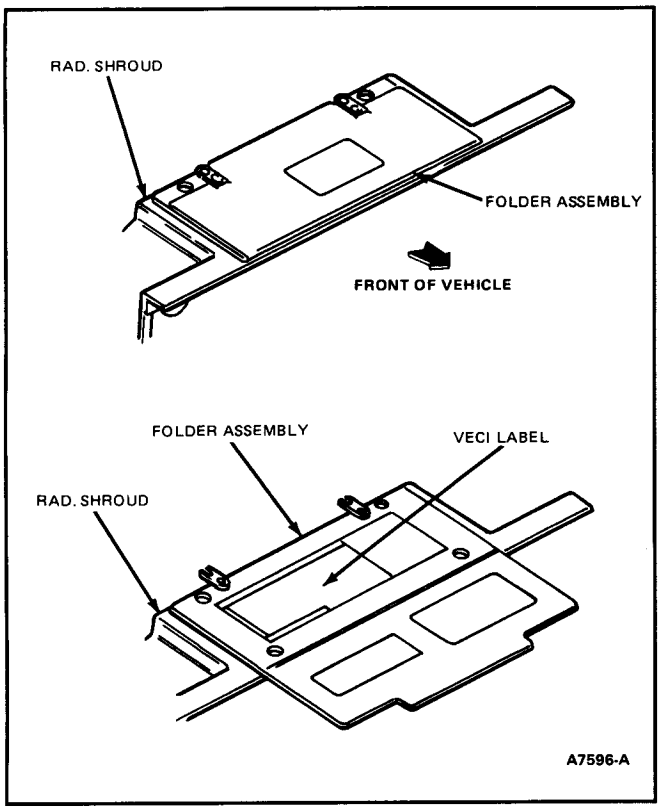

FIG. 2 Vehicle Emission Control Information Label Location

MAINTENANCE PROCEDURE INDEX

PROCEDURE	MANUAL AND SECTION
I Engine Mechanical Sub-Systems	
• Change Engine Oil and/or Filter	Powertrain Manual, Section 22-07, 2.4L Diesel Engine
• Coolant Condition and Protection	Powertrain Manual, Section 27-01, Cooling System — Service
• Cooling System Check and Coolant Replacement	Powertrain Manual, Section 27-01, Cooling System — Service
• Drive Belt Condition and Tension	Powertrain Manual, Section 27-02, Accessory Drive Belts
II Ignition Sub-Systems	
• Exhaust Heat Control Valve	Engine/Emissions Diagnosis Manual, Section 31
• Glow Plug Replacement	Powertrain Manual, Section 22-07, 2.4L Diesel Engine System — Service
III Fuel System	
• Engine Idle Speed Adjustment	Engine/Emissions Diagnosis Manual, Section 31

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SCHEDULED MAINTENANCE SERVICES — 2.4L Diesel Engine

MAINTENANCE OPERATION

The following services are required to be performed at scheduled intervals because they are considered essential to the life and performance of your vehicle. All items with either a "B" or a "(B)" code are required to be performed in all states except California. For vehicles sold in California, only "B" items are required to be performed. However, Ford recommends that you also perform maintenance on items designated by a "(B)" in order to achieve best vehicle operation.

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	65	70	75	80	85	90	95	100	105
	KILOMETERS (Thousands)	8	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168
Change Engine Oil*		B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Change Engine Oil Filter*		B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Inspect and Adjust Valves		B		B			B			B			B			B			B			B
Fuel Filter: Drain Water Separator		B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
Check Drive Belt Tension and Condition		(B)					B						B						B			
Replace Coolant and Check Hoses & Clamps — Every 36 Months or													B									
Check Coolant		Annually, prior to cold weather if possible.																				
Replace Timing Belt													B									
Check Idle RPM							B						B						B			
Replace Air Cleaner Element*							B						B						B			
Replace Fuel Filter Element							B						B						B			
Replace Glow Plugs													(B)									Ba
Check Fuel Injectors													B									
Check Dynamic Inspection Setting							B						B						B			
Change Automatic Transmission Fluid (ZF-4HP22)*							B						B						B			

***UNIQUE DRIVING CONDITIONS (SEVERE SERVICE)**

If your driving habits include: — Frequent short trips of 10 miles (16km) or less when the temperature remains below 10°F (−12°C) for 60 days or more — Sustained high speed driving during hot weather (90°F, 32°C) — Towing a trailer for long distances — Driving in severe dust conditions — Extensive idling, such as police, taxi, or door-to-door delivery use — the following severe service maintenance intervals apply:

Engine Oil — Change every 3 months or 3,000 miles (4,800km), whichever occurs first.

Engine Oil Filter — Replace at every oil change.

Air Cleaner Filters — If operating in severe dust conditions, ask your dealer for proper replacement intervals.

Automatic Transmission Fluid — Change every 30,000 miles 48,000km) — Not required for severe dust, short trips or extensive idling.

a. Required for California, if not performed at 60K.

CA7597-A

TORQUE CONVERSION

NEWTON METRES (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 METRES (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

METRICS

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.

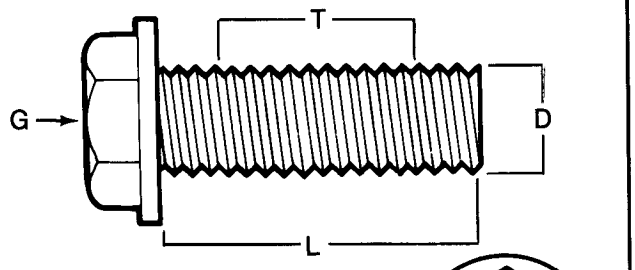
Most original equipment fasteners (English system or Metric) are identified with markings or numbers indicating the strength of the fastener. These markings are described in the pages that follow. Attention to these markings is important in assuring that the proper replacement fasteners are used.

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.

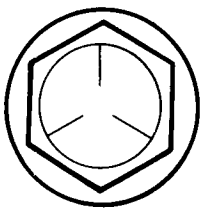
English system and metric system fasteners are available through your Ford Parts and Service operation.

NOMENCLATURE FOR BOLTS

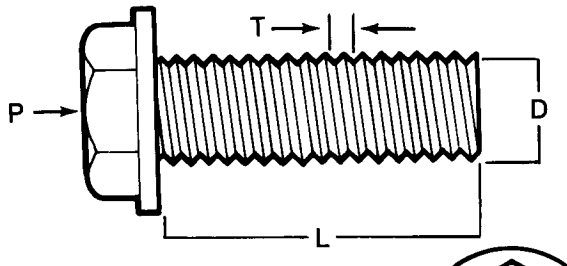
(ENGLISH) INCH SYSTEM
Bolt, 1/2-13x1



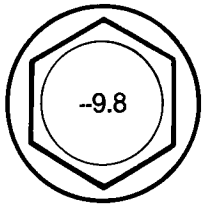
G—Grade Marking (bolt strength)
L—Length, (inches)**
T—Thread Pitch (thread/inch)
D—Nominal Diameter (inches)



METRIC SYSTEM
Bolt M12-1.75x25



P—Property Class* (bolt strength)
L—Length (millimeters)**
T—Thread Pitch (thread width crest to crest mm)
D—Nominal Diameter (millimeters)

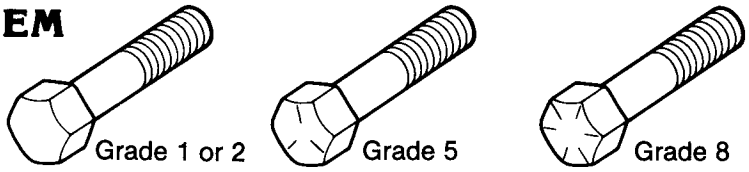


*The property class is an Arabic numeral distinguishable from the slash SAE English grade system.

**The length of all bolts is measured from the underside of the head to the end.

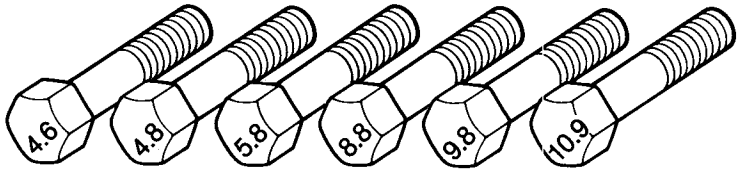
BOLT STRENGTH IDENTIFICATION

(ENGLISH) INCH SYSTEM



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 property are 9.8 and 10.9 with the class identification embossed on the bolt head.

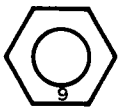
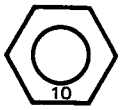
HEX NUT STRENGTH IDENTIFICATION

(ENGLISH) INCH SYSTEM

Grade	Hex Nut Grade 5	Hex Nut Grade 8
Identification		
	3 Dots	6 Dots

Increasing dots represent increasing strength.

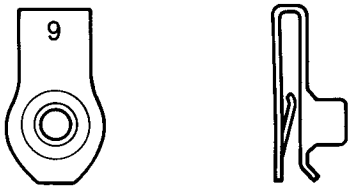
METRIC SYSTEM

Class	Hex Nut Property Class 9	Hex Nut Property Class 10
Identification		
	Arabic 9	Arabic 10

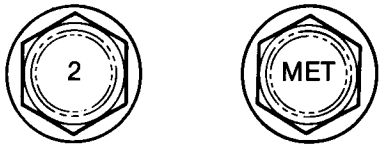
May also have blue finish or paint daub on hex flat. Increasing numbers represent increasing strength.

OTHER TYPES OF PARTS

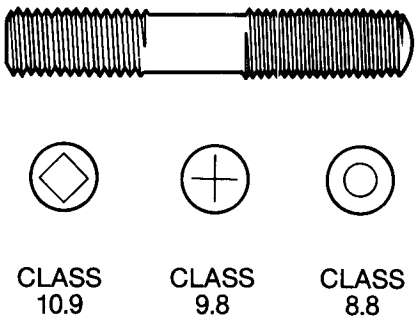
Metric identification schemes vary by type of part, most often a variation of that used of bolts and nuts. Note that many types of English and metric fasteners carry no special identification if they are otherwise unique.



—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.

DECIMAL AND METRIC EQUIVALENTS

Fractions	Decimal Inch	Metric mm
1/64	.015625	.397
1/32	.03125	.794
3/64	.046875	1.191
1/16	.0625	1.588
5/64	.078125	1.984
3/32	.09375	2.381
7/64	.109375	2.778
1/8	.125	3.175
9/64	.140625	3.572
5/32	.15625	3.969
11/64	.171875	4.366
3/16	.1875	4.763
13/64	.203125	5.159
7/32	.21875	5.556
15/64	.234375	5.953
1/4	.250	6.35
17/64	.265625	6.747
9/32	.28125	7.144
19/64	.296875	7.54
5/16	.3125	7.938
21/64	.328125	8.334
11/32	.34375	8.731
23/64	.359375	9.128
3/8	.375	9.525
25/64	.390625	9.922
13/32	.40625	10.319
27/64	.421875	10.716
7/16	.4375	11.113
29/64	.453125	11.509
15/32	.46875	11.906
31/64	.484375	12.303
1/2	.500	12.7

Fractions	Decimal Inch	Metric mm
33/64	.515625	13.097
17/32	.53125	13.494
35/64	.546875	13.891
9/16	.5625	14.288
37/64	.578125	14.684
19/32	.59375	15.081
39/64	.609375	15.478
5/8	.625	15.875
41/64	.640625	16.272
21/32	.65625	16.669
43/64	.671875	17.066
11/16	.6875	17.463
45/64	.703125	17.859
23/32	.71875	18.256
47/64	.734375	18.653
3/4	.750	19.05
49/64	.765625	19.447
25/32	.78125	19.844
51/64	.796875	20.241
13/16	.8125	20.638
53/64	.828125	21.034
27/32	.84375	21.431
55/64	.859375	21.828
7/8	.875	22.225
57/64	.890625	22.622
29/32	.90625	23.019
59/64	.921875	23.416
15/16	.9375	23.813
61/64	.953125	24.209
31/32	.96875	24.606
63/64	.984375	25.003
1	1.00	25.4

ORDERING SPECIAL SERVICE TOOLS

Special service tools, as designated in this manual, are easy to order and you will receive prompt shipment to assist you in servicing the vehicle.

In U.S.A., to order tools simply contact Owatonna Tools, Inc., by mail, telex or phone.

If you wish to order by mail, send your order with your complete address to Owatonna Tools, Inc., Owatonna, Minnesota 55060. Order forms are available upon request.

If you wish to use their Telex, the number is 29-0876.

If you would like to call, the phone number is 507-455-2626. Ask for the Ford Order Desk.

The telephone order desk is open 24 hours every day to provide you with immediate response to your "special tool" requirements.

Customer Special Service is available for the unusual situations.

A. Emergency orders. In these cases call and place your order. Please specify that you do have an emergency order. Shipment will be made the same day if at all possible.

B. If you require information regarding tracing, order follow-ups, pricing information or assistance in any way, please call or write.

State and local sales taxes will be added to the invoice if applicable.

All tool shipments will be made F.O.B. Owatonna, Minnesota. Shipments will be made by any method specified. Normal methods include United Parcel Service or Parcel Post.

In Canada, Special Service Tools are available from Jobborn Manufacturing (1979) Ltd. . . . 97 Frid St., Hamilton, Ontario L8P 4M3, 416-522-2580.

ENGLISH METRIC CONVERSION

Description	Multiply	By	For Metric Equivalent
ACCELERATION	Foot/sec^2	0.304 8	metre/sec^2 (m/s^2)
	Inch/sec^2	0.025 4	metre/sec^2
TORQUE	Pound-inch	0.112 98	newton-metres (N·m)
	Pound-foot	1.355 8	newton-metres
POWER	horsepower	0.746	kilowatts (kw)
PRESSURE or STRESS	inches of water	0.2488	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 × 10^6	joules (J = one W's)
LIGHT	foot candle	10.76	lumens/metre^2 (lm/m^2)
FUEL PERFORMANCE	miles/gal	0.425 1	kilometres/litre (km/l)
	gal/mile	2.352 7	litres/kilometre (l/km)
VELOCITY	miles/hour	1.609 3	kilometres/hr. (km/h)
LENGTH	inch	25.4	millimetres (mm)
	foot	0.304 8	metres (m)
	yard	0.914 4	metres (m)
	mile	1.609	kilometres (km)
AREA	inch^2	645.2	millimetres^2 (mm^2)
		6.45	centimetres^2 (cm^2)
	foot^2	0.092 9	metres^2 (m^2)
	yard^2	0.836 1	metres^2
VOLUME	inch^3	16 387.	mm^3
	inch^3	16.387	cm^3
	quart	0.016 4	litres (1)
	quart	0.946 4	litres
	gallon	3.785 4	litres
	yard^3	0.764 6	metres^3 (m^3)
MASS	pound	0.453 6	kilograms (kg)
	ton	907.18	kilograms (kg)
	ton	0.90718	tonne
FORCE	kilogram	9.807	newtons (N)
	ounce	0.278 0	newtons
	pound	4.448	newtons
TEMPERATURE	degree farenheit	0.556 (°F -32)	degree Celsius (°C)

WE SUPPORT VOLUNTARY MECHANIC CERTIFICATION

Ford Parts and Service Division
Training and Publications Department

FPS 365-126-84D1 Litho in U.S.A. January, 1984