GROUP

FRAME AND MOUNTING 02

(6000)

SECTION 02-01 Subframe

VEHICLE APPLICATION

Taurus / Sable.

REMOVAL AND INSTALLATION

Subframe, Front

Tools Required:

- Three Bar Engine Support D88L-6000-A

Removal

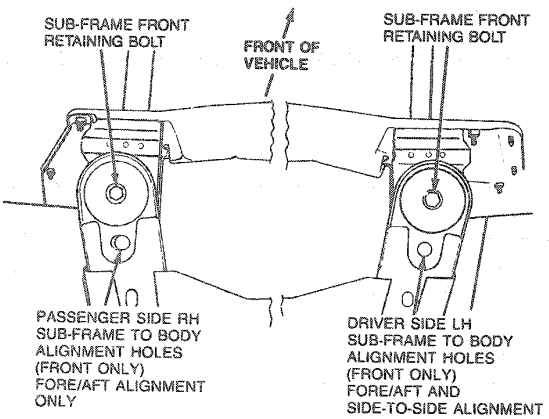
1. Disconnect battery ground cable.
2. Install engine lift eyes.
3. Install Three Bar Engine Support D88L-6000-A or equivalent to existing engine lifting eyes.
4. Raise vehicle on hoist with vehicle resting on four contact points. Refer to Section 00-02.
5. Remove front tires and wheels. Refer to Section 04-04.
6. Support steering gear with wire from the tie rod end to coil spring to hold steering gear in position. Secure housing of gear to suitable support to hold it in position.
7. Disconnect exhaust system at flex coupling and drop down.
8. Disconnect lower control arm at pinch bolts to ball joints.
9. Remove two nuts that attach steering gear to No. 2 crossmember.
10. Remove retaining nuts from RH front engine mount and RH rear engine mount to subframe.
11. Remove stabilizer bar link attachment to stabilizer bar.
12. Remove LH transaxle mount insulator at through bolts to subframe.
13. Support subframe with adjustable jacks at subframe body mount location points.
14. Remove four body mount retaining bolts.
15. With an assistant, lower adjustable jacks and allow subframe to lower. Rotate front of subframe down and pick up rear of subframe off of exhaust pipe. Work subframe rearward until it can be lowered down past exhaust pipe.
16. Place subframe on floor or bench and transfer suspension components to the new subframe.

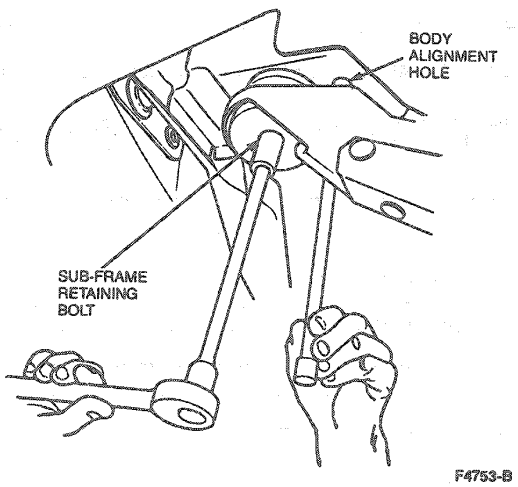
REMOVAL AND INSTALLATION (Continued)

Installation

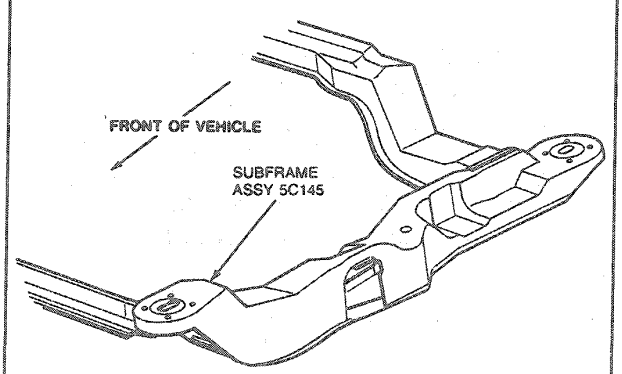
1. On 3.0L SHO engine equipped vehicles with manual transaxle, install four body mount retaining nuts to each mount. Tighten to 8-11 N·m (6-8 lb-ft). On vehicles equipped with 3.0L, 3.2L SHO and 3.8L engines install front body mounts to RH and LH subframe. Install four nuts to each mount and tighten to 8-11 N·m (6-8 lb-ft).

   NOTE: DO NOT TIGHTEN AT THIS TIME.
2. With an assistant, align subframe to body. Install two rear subframe-to-body rubber mounts on 3.0L, 3.2L SHO and 3.8L engine equipped vehicles. Install four bolts into mounts.
3. Install a 19mm (3/4 inch) outside diameter pipe or similar tool into front LH subframe and body alignment holes. After aligning the holes, slightly tighten the LH front body mount bolt.
4. Repeat Step 2 on front RH alignment holes.
5. Check front LH alignment holes with tool.
6. After subframe alignment is complete, tighten four subframe-to-body bolts to 75-102 N·m (55-75 lb-ft).





7. Install LH transaxle mount insulator at through bolts to subframe. Tighten to 81-116 N·m (60-85 lb-ft).
8. Install stabilizer bar link attachment to stabilizer bar. Tighten to 47-65 N·m (35-47 lb-ft).
9. Install two retaining nuts that secure the steering gear to the No. 2 crossmember. Tighten to 115-135 N·m (85-99 lb-ft).
10. Remove wire supporting steering gear from tie rod end to coil spring.
11. Install retaining nuts that secure the RH front engine mount and the RH rear engine mount to subframe. Tighten to 75-102 N·m (55-75 lb-ft).
12. Connect lower control arm at pinch bolts to ball joints.
13. Connect exhaust system at flex coupling and position in place.
14. Install tires and wheels. Refer to Section 04-04.
15. Lower hoist.
16. Remove Three Bar Engine Support D88L-6000-A or equivalent and engine lifting eyes.
17. Check front end alignment. Adjust if necessary. Refer to Section 04-00.



SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft
Body Mount Retaining Bolts	75-102	55-75
Body Mount to Subframe Bolts	8-11	6-8
Transaxle Mount-to-Subframe Bolts (LH)	81-116	60-85
Front Engine Mount-to-Subframe Bolts (RH)	75-102	55-75
Rear Engine Mount-to-Subframe Bolts (RH)	75-102	55-70
Stabilizer Link-to-Stabilizer Bar Nuts	47-65	35-47
Gear-to-Crossmember Nuts	115-135	85-99

SPECIAL SERVICE TOOLS

Tool Number	Description
D88L-6000-A	Three Bar Engine Support

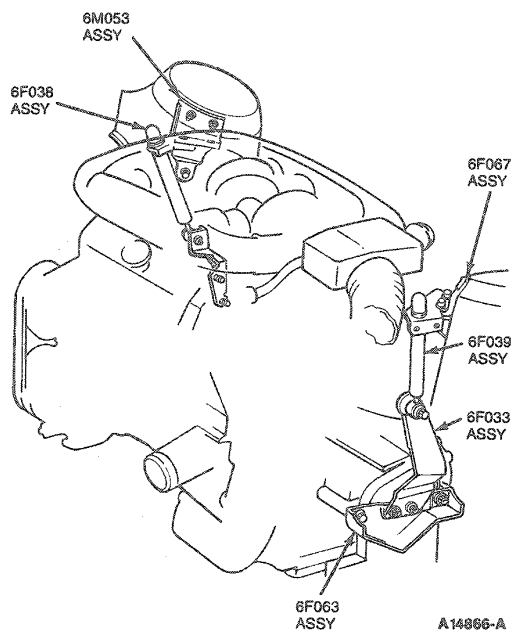
SECTION 02-03 Engine and Transaxle Mounting

VEHICLE APPLICATION

Taurus / Sable.

REMOVAL AND INSTALLATION

Engine Mounts, 3.0L SHO Engine



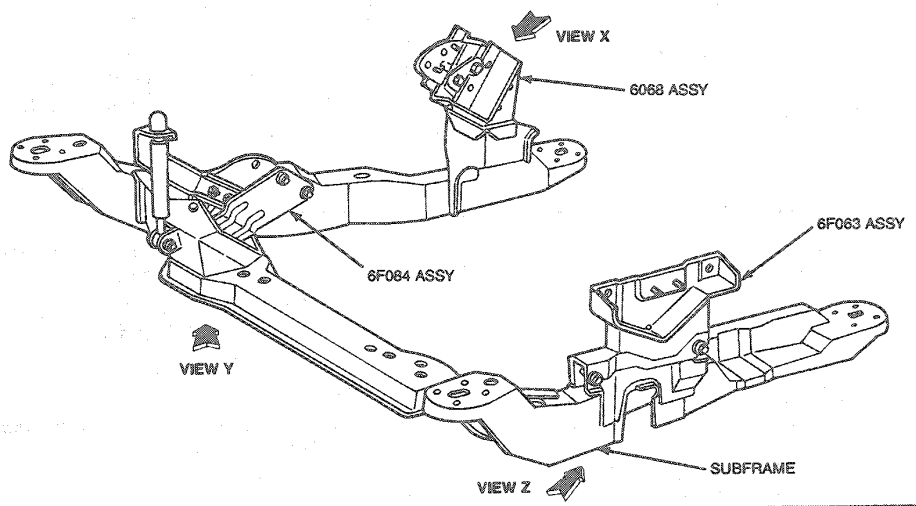
Insulator, RH Front, No. 2 and / or RH Rear, No. 3

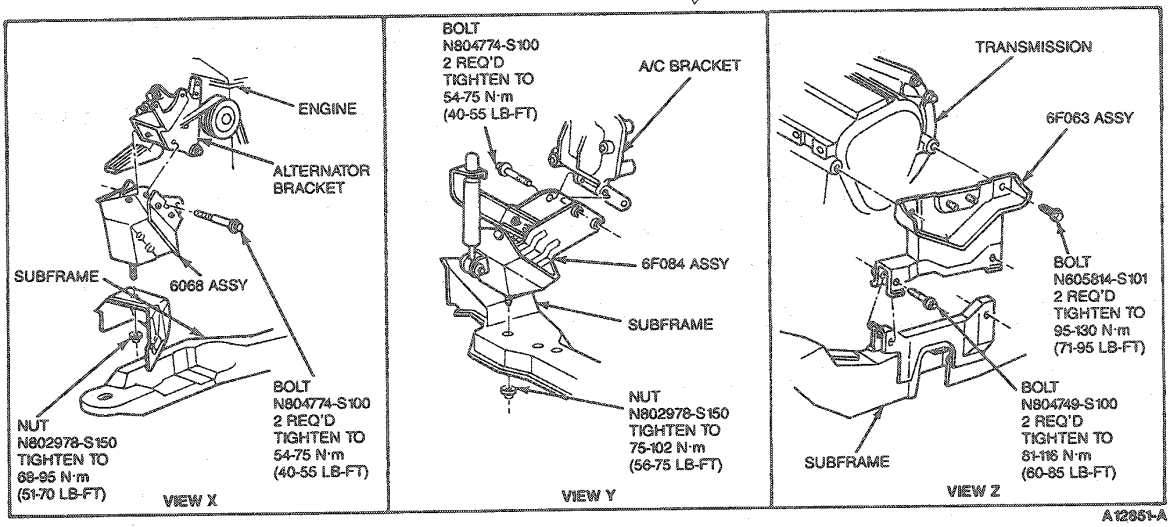
Removal

1. Remove lower damper retaining bolt from RH side of engine.
2. Raise vehicle on hoist. Refer to Section 00-02.
3. Place jack and wood block in suitable place under engine.
4. Remove roll damper to engine mount retaining bolts and remove roll damper.
5. Raise engine with jack (enough to unload insulator).

REMOVAL AND INSTALLATION (Continued)

6. Remove two through bolts and remove insulator from engine bracket.





Installation

1. Install insulator-to-engine support bracket with two through bolts. Tighten through bolts to 54-75 N·m (40-55 lb-ft). Refer to illustration under Removal, Step 6.
2. Lower engine down onto frame.
3. Install nuts retaining RH front and RH rear insulators to frame. Tighten nuts to 75-102 N·m (55-75 lb-ft). Install roll damper. Tighten bolts to 54-75 N·m (40-55 lb-ft).
4. Remove jack and lower vehicle.
5. Install bolt retaining RH engine damper to engine. Tighten bolt to 54-75 N·m (40-55 lb-ft).

Insulator, LH and Support Assembly No. 1A

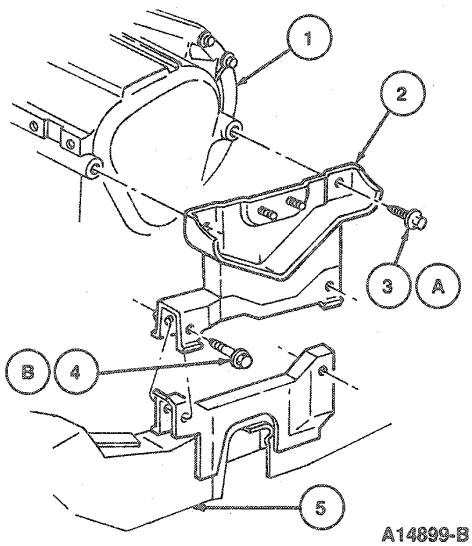
Removal

1. Remove bolt retaining roll damper to lower damper bracket and place damper shaft out of the way.
2. Remove backup lamp switch.
3. Remove energy management bracket.
4. Raise vehicle on hoist. Refer to Section 00-02. Position jackstands under vehicle body allowing subframe to hang.
5. Remove LH tire and wheel.
6. Place jack and wood block in suitable place under transaxle and support transaxle.

REMOVAL AND INSTALLATION (Continued)

7. Remove bolts retaining lower damper bracket to engine mount.
8. Remove bolts retaining insulator to transaxle and subframe.
9. Raise transaxle with jack (enough to unload insulator).
10. Remove insulator and lower damper bracket.

LH, No. 1A



A14899-B

Item	Part Number	Description
1	—	Transaxle
2	6F063	Bracket Assy

(Continued)

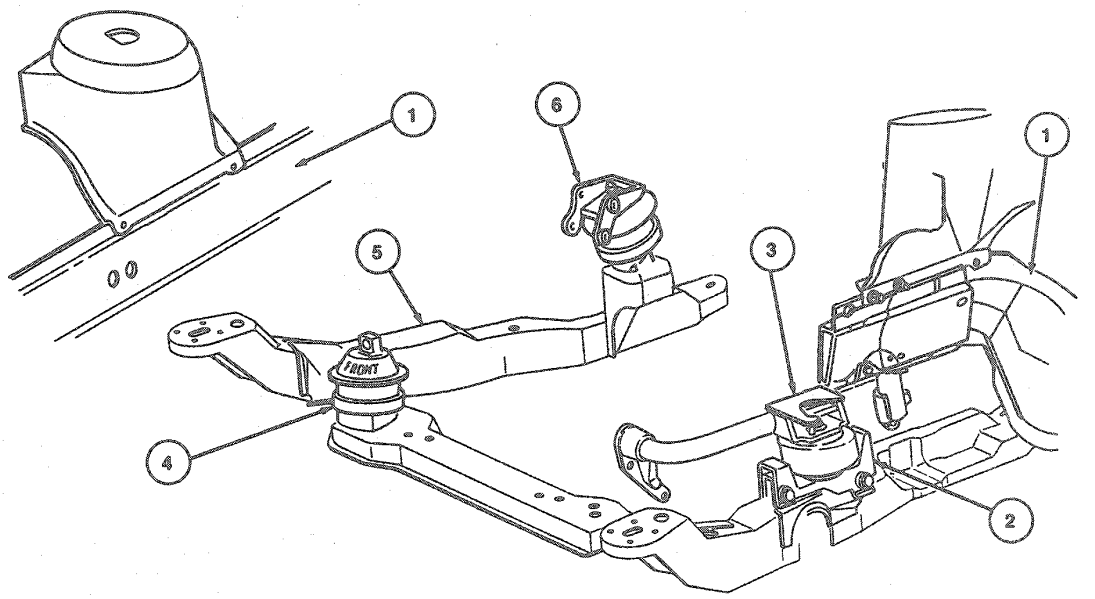
Item	Part Number	Description
3A	N605814-S101	Bolt (2 Req'd)
4B	N804749-S100	Bolt (2 Req'd)
5	—	Subframe
A		Tighten to 95-130 N·m (71-95 Lb-Ft)
B		Tighten to 81-116 N·m (60-85 Lb-Ft)

Installation

1. Loosely install insulator and damper bracket to transaxle and subframe.
2. Install damper bracket to insulator. Tighten bolts to 54-75 N·m (40-55 lb-ft).
3. Install insulator to transaxle. Tighten bolts to 95-130 N·m (71-95 lb-ft).
4. Install insulator to frame. Tighten bolts to 81-116 N·m (60-85 lb-ft).
5. Remove jack and jackstands.
6. Install LH tire and wheel. Tighten wheel lug nuts to 115-142 N·m (85-105 lb-ft).
7. Lower vehicle.
8. Install damper to damper bracket. Tighten bolt to 54-75 N·m (40-55 lb-ft).
9. Install backup lamp switch.
10. Install energy management bracket.

REMOVAL AND INSTALLATION (Continued)

Engine Mounts, 3.0L EFI Engine



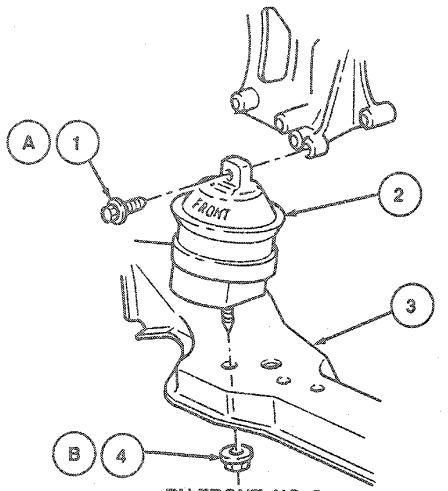
Item	Part Number	Description
1	—	Side Member
2	6F063	Insulator No. 1A
3	6F065	Support Assy
4	6038	No. 2 Insulator
5	—	Frame
6	6068	No. 3 Insulator

Insulator, RH Front, No. 2 and/or RH Rear, No. 3

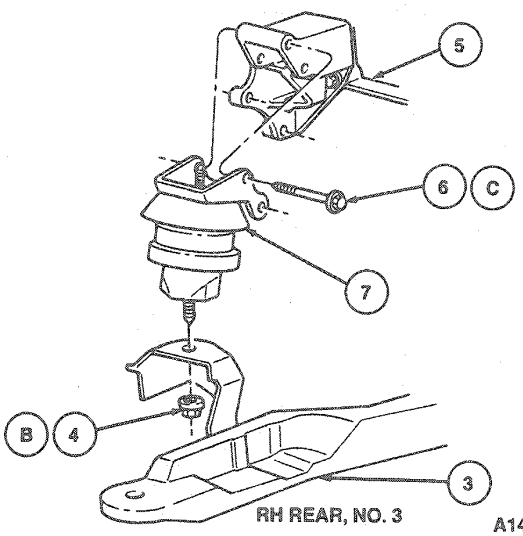
Removal

1. Raise vehicle on hoist. Refer to Section 00-02.
2. Place jack and wood block in suitable place under engine block.
3. Remove nuts retaining RH front and RH rear insulators to frame.
4. Raise engine with jack (enough to unload insulator).
5. Remove two bolts from No. 3 insulator and one bolt from No. 2 insulator and remove insulator from engine bracket.

REMOVAL AND INSTALLATION (Continued)



RH FRONT, NO. 2



RH REAR, NO. 3

A14900-C

Item	Part Number	Description
1A	N605933-S101	Bolt
2	6038	Insulator
3	—	Subframe
4B	N802978-S150	Nut
5	—	Engine
6C	N804774-S100	Bolt (2 Req'd)

(Continued)

Item	Part Number	Description
7	6D089	Insulator
A		Tighten to 164-173 N·m (120-127 Lb-Ft)
B		Tighten to 75-102 N·m (56-75 Lb-Ft)
C		Tighten to 54-75 N·m (40-55 Lb-Ft)

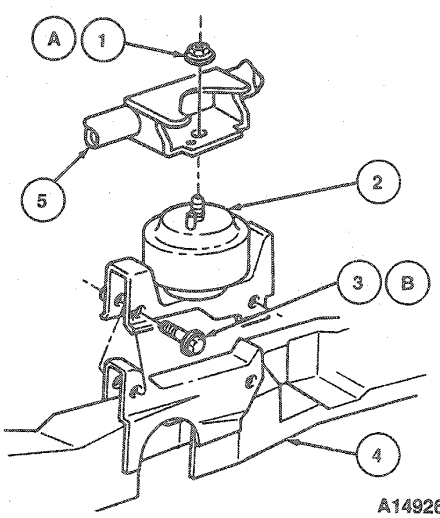
Installation

1. Attach insulator-to-engine support bracket with two bolts on No. 3 insulator. Tighten bolts to 54-75 N·m (40-55 lb-ft). Attach bolt to No. 2 insulator. Tighten bolt to 164-173 N·m (120-127 lb-ft). Refer to illustration under Removal, Step 5.
2. Lower engine down onto frame.
3. Install nuts retaining RH front and RH rear insulators to frame. Tighten nuts to 75-102 N·m (56-75 lb-ft).
4. Remove jack and lower vehicle.

Insulator, LH and Support Assembly No. 1A

Removal

1. Raise vehicle on hoist. Refer to Section 00-02.
2. Remove LH tire and wheel.
3. Place jack and wood block in suitable place under transaxle and support transaxle.
4. Remove two nuts retaining insulator to support assembly.
5. Remove two through bolts retaining insulator to frame.

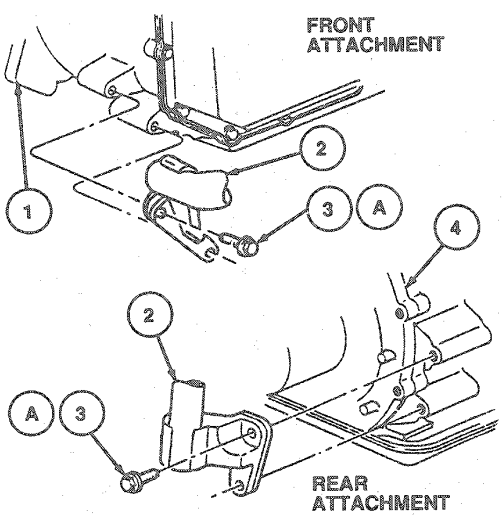


A14926-C

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1A	N800937-S102	Nut
2	6F063(LH)	Engine Mount Assy
3B	N804749-S100	Bolt (2 Req'd)
4	—	Frame
5	6F065	Support Assy
A		Tighten to 74-102 N·m (55-75 Lb-Ft)
B		Tighten to 81-116 N·m (60-85 Lb-Ft)

6. Raise transaxle with jack (enough to unload insulator).
7. Remove bolts retaining support assembly to transaxle.
8. Remove transaxle support assembly by rotating support assembly counterclockwise to disengage upper stud on mount.
9. Remove mount.



A9707-C

Item	Part Number	Description
1	—	Transaxle
2	6F065	Support Assy
3A	N605922-S102	Bolt (2 Req'd)
4	07002	Transaxle
A		Tighten to 54-75 N·m (40-55 Lb-Ft)

Installation

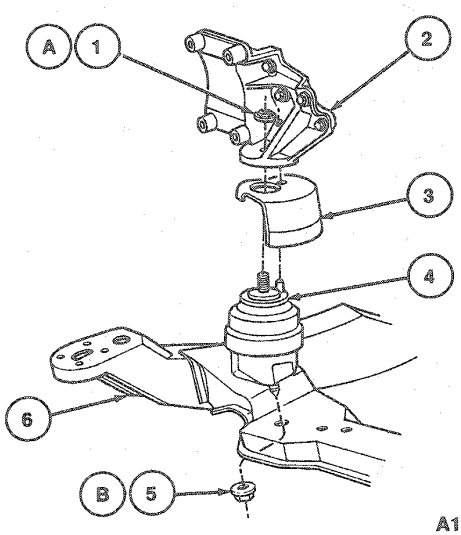
1. Loosely install mount.
2. Attach support assembly to transaxle. Tighten bolts to 54-75 N·m (40-55 lb-ft). Refer to illustration under Removal, Step 8.
3. Attach insulator to frame with two through bolts. Tighten bolts to 81-116 N·m (60-85 lb-ft).
4. Lower transaxle (enough to load insulator).
5. Attach insulator to support assembly with two nuts. Tighten nuts to 74-102 N·m (55-75 lb-ft). Refer to illustration under Removal, Step 5.
6. Attach damper shaft to support assembly using a new flag nut. Tighten bolt to 28-41 N·m (21-30 lb-ft).
7. Remove jack.
8. Install LH tire and wheel. Tighten wheel lug nuts to 115-142 N·m (85-105 lb-ft).
9. Lower vehicle.

Engine Mounts, 3.8L EFI Engine

Tools Required:

- Three Bar Engine Support D88L-6000-A

Hydraulic Engine Mount, RH Front



A14882-B

Item	Part Number	Description
1A	N800937-S102	Nut
2	—	A/C Bracket
3	6C038	Shield
4	6038	Insulator Assy (Color Code Yellow-Non-Police; Color Code Blue-Police)
5B	N802978-S150	Nut
6	—	Frame
A		Tighten to 54-75 N·m (40-55 Lb-Ft)
B		Tighten to 75-102 N·m (55-75 Lb-Ft)

REMOVAL AND INSTALLATION (Continued)

Removal

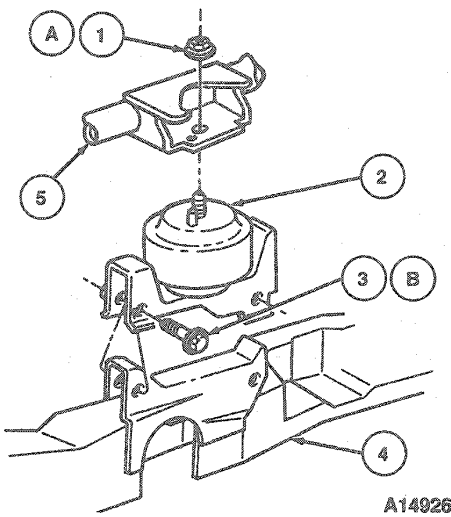
1. Remove mount upper retaining nut through engine compartment between A / C compressor and compressor bracket using a long extension and an 18mm swivel socket.
2. Install Three Bar Engine Support D88L-6000-A or equivalent.
3. Raise vehicle on hoist. Refer to Section 00-02.
4. Loosen RH rear mount lower retaining nut.
5. Remove RH front mount lower retaining nut.
6. Lower vehicle.
7. Raise engine approximately 25mm (1 inch) using engine support tool.
8. Raise vehicle.
9. Remove engine mount.

Installation

1. Install engine mount.
2. Lower vehicle.
3. Lower engine using engine support tool.
4. Raise vehicle.
5. Install RH front mount lower retaining nut and tighten to 75-102 N·m (55-75 lb-ft).

   NOTE: During installation of mount, hold lower can to prevent twisting when lower nut is tightened.
6. Tighten RH rear lower mount retaining nut to 75-102 N·m (55-75 lb-ft).
7. Lower vehicle.
8. Remove engine support tool.
9. Install mount upper retaining nut through engine compartment between A / C compressor and compressor bracket using a long extension and an 18mm swivel socket.
10. Tighten mount upper retaining nut to 54-75 N·m (40-55 lb-ft).

Transaxle Hydramount Assembly, LH



A14926-C

Item	Part Number	Description
1A	N800937-S102	Nut
2	6F063(LH)	Engine Mount Assy
3B	N804749-S100	Bolt (2 Req'd)
4	—	Frame
5	6F065	Support Assy
A		Tighten to 74-102 N·m (55-75 Lb-Ft)
B		Tighten to 81-116 N·m (60-85 Lb-Ft)

Removal

1. Raise vehicle on hoist. Refer to Section 00-02.
2. Remove tire and wheel.
3. Place a jack and wood block in a suitable place under the transaxle and support the transaxle.
4. Remove the nut retaining the transaxle mount to the support assembly.
5. Remove two through bolts retaining the transaxle mount to the frame.
6. Raise the transaxle with the jack (enough to unload mount).
7. Remove the bolts retaining the support assembly to the transaxle.
8. Remove transaxle support assembly by rotating support assembly counterclockwise to disengage upper stud on mount.
9. Remove mount.

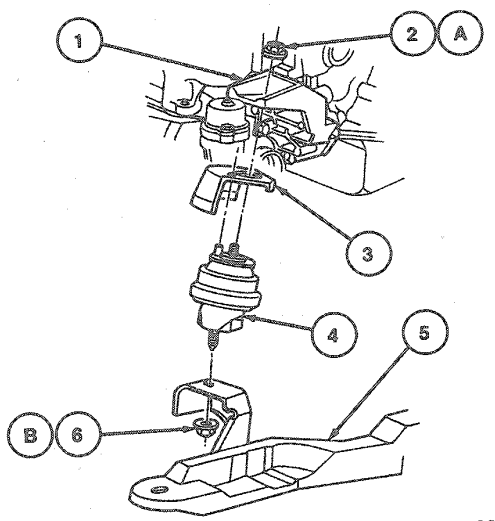
Installation

1. Loosely install mount.
2. Attach support assembly to the transaxle and tighten to 54-75 N·m (40-55 lb-ft).

REMOVAL AND INSTALLATION (Continued)

3. Attach insulator to frame with two through bolts and tighten to 81-116 N·m (60-85 lb-ft).
4. Lower the transaxle (enough to load the mount).
5. Install transaxle mount retaining nut insulator to support assembly and tighten to 74-102 N·m (55-75 lb-ft).
6. Remove jack.
7. Install tire and wheel. Tighten wheel lug nuts to 115-142 N·m (85-105 lb-ft).
8. Lower vehicle.

Engine Mount, RH Rear



A14883-B

Item	Part Number	Description
1	—	Transaxle
2A	N800937-S102	Nut
3	6C038	Shield
4	6068	Insulator Assy (Color Code Green-Non-Police; Color Code Blue-Police)
5	—	Frame
6B	N802978-S150	Nut
A		Tighten to 54-75 N·m (40-55 Lb-Ft)
B		Tighten to 75-102 N·m (55-75 Lb-Ft)

Removal

1. Raise vehicle on hoist. Refer to Section 00-02.
2. Remove the nuts retaining the RH front and RH rear engine mounts to the frame.
3. Lower vehicle.
4. Use Three Bar Engine Support D88L-6000-A or equivalent to support engine. Install J-hook on the alternator bracket. Raise the engine about 25mm (1 inch).
5. Loosen retaining nut on the LH rear (No. 3) mount and heat shield assembly.
6. Raise vehicle on hoist.
7. Remove No. 3 insulator retaining nut. Remove No. 3 insulator and heat shield assembly.

Installation

1. Install mount and position No. 3 mount and heat shield assembly upper stud and anti-rotation pin to the transaxle support bracket. Hand start lower retaining nut.
2. Lower vehicle.
3. Tighten top retaining nut on the No. 3 insulator (LH rear). Tighten to 54-75 N·m (40-55 lb-ft).
4. Lower engine and remove the Three Bar Engine Support.
5. Raise vehicle.
6. Tighten retaining nuts on RH front and RH rear engine mounts. Tighten to 75-102 N·m (55-75 lb-ft).
7. Lower vehicle.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft
Insulator-to-Engine Support Bracket Bolts	54-75	40-55
RH Front RH Rear Insulator-to-Frame Nuts	75-102	55-75
Support Assembly-to-Transaxle Bolts (4 Req'd)	54-75	40-55
RH Front Insulator-to-Frame Nuts	75-102	55-75
RH Rear Insulator-to-Frame Nuts	75-102	55-75
Engine Damper-to-Subframe Bracket Bolt	54-75	40-55
RH Engine Damper-to-Engine Bolts (3.0L SHO Engine)	54-75	40-55
Damper-to-Damper Bracket Bolts	54-75	40-55
Insulator-to-Transaxle Bolts (3.0L SHO Engine)	127-172	94-127
Insulator-to-Frame Bolts (2 Req'd)	81-116	60-85
Wheel Lug Nuts	115-142	85-105
RH Front and RH Rear Insulator-to-Frame Nuts (3.0L SHO Engine)	54-75	40-55
Insulator-to-Support Assembly Nut	74-102	55-75
Insulator-to-Engine A/C Bracket Bolts	54-75	40-55
Damper Shaft-to-Support Assembly Bolt	28-41	21-30
Nut Retaining Mount-to-A/C Bracket Bolt	54-75	40-55
Retaining Nut-to-No. 3 Insulator LH Rear	54-75	40-55

SPECIAL SERVICE TOOLS

Tool Number	Description
D88L-6000-A	Three Bar Engine Support

GROUP

ENGINE 03

(6000 & 9000)

SECTION 03-00 Engine—Service

VEHICLE APPLICATION

Taurus/Sable and Taurus 3.0L/3.2L SHO.

DESCRIPTION

This Section covers various engine tests, adjustments, service procedures and cleaning / inspection procedures. Engine assembly and service specifications appear at the end of the appropriate engine Section.

For engine removal, disassembly, assembly, installation, adjustment procedures and specifications, refer to the appropriate engine Section.

These engines incorporate a closed-type positive crankcase ventilation (PCV) system and exhaust emission control system. All engine / emission control systems are covered in the Powertrain Control / Emissions Diagnosis Manual. [1]

To maintain the required exhaust emission levels, the fuel system, ignition system and engine must be kept in good operating condition and meet recommended adjustment specifications.

When performing tests, adjustments or service to the engine, ignition system or fuel system, it is essential to follow the procedures and specifications in the appropriate service section in this manual, and in the Powertrain Control / Emissions Diagnosis Manual. [1]

Before replacing damaged or worn engine components such as the crankshaft, cylinder heads, valve guides, valves, camshafts or cylinder block, ensure the part(s) are not serviceable.

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

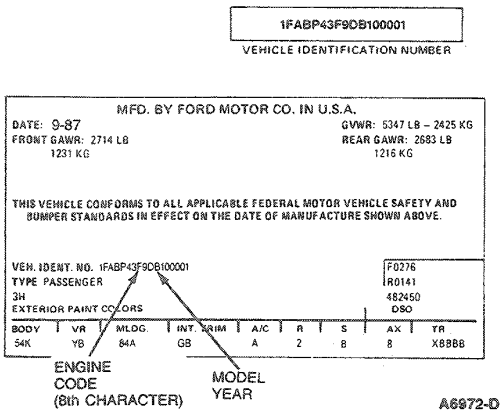
Exhaust Emission Control System

Operation, removal, installation and required maintenance of the exhaust emission control devices used on these engines are covered in the Powertrain Control / Emissions Diagnosis Manual. [1]

Engine Identification

For quick engine identification, refer to the Safety Certification Decal. The decal is mounted on the LH front door lock face panel. Find the engine code (letter or number) on the decal, then refer to the engine identification chart to determine the engine type and size. An engine identification label is also attached to the engine. The symbol code on the identification tag identifies each engine for determining parts usage; for instance, engine cubic inch displacement and model year. Engine decal information is located in Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L).

Safety Certification Decal



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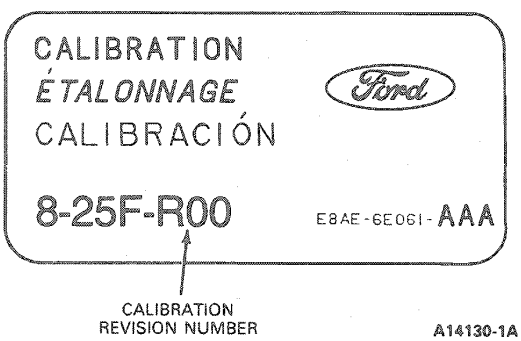
Emission Calibration Label

The emission calibration number label is located on the LH side door or LH door post pillar. It identifies the engine calibration number, the engine code number and revision level.

These numbers are used to determine if parts are unique to specific engines.

Engine Emission Calibration Number Label



A14130-1A

Always refer to these labels when replacement parts are required or when checking engine calibrations. Engine parts often differ within a CID family. Verification of identification codes will ensure that the proper parts are obtained. These codes contain all pertinent information relating to dates, optional equipment and revisions. The Ford Master Parts Catalog contains a complete listing of the codes and their application.

1 Can be purchased as a separate item.

DIAGNOSIS AND TESTING

Closed-Type Positive Crankcase Ventilation (PCV) System

CAUTION: The removal of the crankcase ventilation system from the engine will adversely affect the fuel economy and engine ventilation resulting in a shortened engine life.

A malfunctioning closed crankcase ventilation system may be indicated by loping or rough engine idle. Do not attempt to compensate for this idle condition by disconnecting the positive crankcase ventilation system and making idle speed adjustments. To determine whether the loping or rough idle condition is caused by a malfunctioning crankcase ventilation system, refer to the Powertrain Control / Emissions Diagnosis Manual. [2]

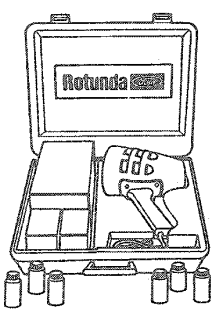
Engine Oil Leaks

Tools Required:

- Rotunda Oil Leak Detector 112-00030

When diagnosing engine oil leaks, it is important that the source and location of the leak be positively identified before service. The following procedure has been found to be very effective and requires minimum equipment. Prior to using this procedure, it is important to clean the cylinder block, cylinder head(s), rocker cover(s), oil pan and flywheel housing areas with a suitable solvent to remove all traces of oil.

To perform oil leak diagnosis use Rotunda Oil Leak Detector 112-00030 or equivalent, perform the following procedure.



ROTUNDA OIL LEAK DETECTOR 112-00030

A15068-A

Fluorescent Oil Additive Method

1. Clean engine with a suitable solvent to remove all traces of oil.
2. Drain engine oil crankcase and refill with recommended oil, premixed with Fluorescent Oil Additive ESE-M99C103-A or equivalent. Use a minimum 14.8ml (1/2 oz) to a maximum 29.6ml (1 oz) of fluorescent additive to all engines. If oil is not premixed, fluorescent additive must be added to crankcase first.
3. Run engine for 15 minutes. Stop engine and inspect all seal and gasket areas for leaks using Rotunda Oil Leak Detector 112-00030 or equivalent. A clear bright yellow or orange area will identify leak. For extremely small leaks, several hours may be required for the leak to appear.
4. If necessary, pressurize main oil gallery system to locate leaks due to improperly sealed, loose or cocked plugs. If flywheel bolts leak oil, look for sealer on threads.
5. Service all leaks as required.

Pressure Method

Alternative Testing Procedure

The crankcase can be pressurized to locate oil leaks. The following materials are required to fabricate the tool to be used.

1. Air supply and air hose.
2. Air pressure gauge that registers pressure in one psi increments.
3. Air line shutoff valve.
4. Appropriate fittings to attach the above parts to oil fill, and PCV grommet holes and rocker arm cover tube.
5. Appropriate plugs to seal any openings leading to the crankcase.
6. A solution of liquid detergent and water to be applied with a suitable applicator such as a squirt bottle or brush

   Fabricate the air supply hose to include the air line shutoff valve and the appropriate adapter to permit the air to enter the engine through the PCV valve opening. Fabricate the air pressure gauge to a suitable adapter for installation on the engine at the oil fill opening.

Testing Procedure

1. Open air supply valve until pressure gauge maintains 34.5 kPa (5 psi).
2. Inspect the sealed and / or gasketed areas for leaks by applying "Snoop Pressure Check" or a solution of liquid detergent and water over the areas for the formation of bubbles, which indicates leakage.

Possible Leakage Points

Examine the following areas for oil leakage

2 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

Underhood

- Rocker cover gaskets
- Intake manifold gaskets
- Cylinder head gasket
- Front cover gasket
- Distributor O-ring
- Oil level indicator (dipstick) tube connection
- Oil pressure sending unit
- Cup plugs and / or pipe plugs at the end of oil passages

Under Engine—With Vehicle on Hoist

- Oil pan gasket
- Oil pan front and rear end seals
- Crankshaft front seal
- Camshaft rear bore plug

With Transaxle and Flywheel Removed

- Crankshaft rear seal

Air leakage in the area around a crankshaft rear oil seal does not necessarily indicate a rear seal leak. However, if no other cause can be found for oil leakage, it can be assumed that the seal is the cause of the oil leakage.

- Rear main bearing cap parting line.
- Rear main bearing cap and seals.
- Rear cup plugs and or pipe plugs at the end of oil passages.

Oil leaks at crimped seams in sheet metal parts and cracks in cast or stamped parts can be detected when pressurizing the crankcase.

NOTE: Light foaming (similar to beer foam) equally around rocker arm cover bolts and crankshaft seals is not detrimental and no corrections are required in such cases.

Compression Tests

Tools Required:

- Rotunda Compression Tester 059-00009

Compression Gauge Check

1. Ensure oil in crankcase is of the correct viscosity and at proper level and battery is properly charged. Operate vehicle until engine is at normal operating temperature. Turn ignition switch to the OFF position, then remove all spark plugs.
2. Set throttle plate in wide-open position.
3. Install a compression gauge such as Rotunda Compression Tester 059-00009 or equivalent in No. 1 cylinder.
4. Install auxiliary starter switch in starting circuit. With ignition switch in OFF position, and using auxiliary starter switch, crank engine at least five compression strokes and record the highest reading. Note the approximate number of compression strokes required to obtain the highest reading.
5. Repeat test on each cylinder cranking the engine approximately the same number of compression strokes.

Test Conclusion

The indicated compression pressures are considered within specification if the lowest reading cylinder is within 75 percent of the highest. Refer to the Compression Pressure Limit Chart.

DIAGNOSIS AND TESTING (Continued)

Compression Pressure Limit Chart

Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI	Maximum PSI	Minimum PSI
134	101	164	123	194	145	224	168
136	102	166	124	196	147	226	169
138	104	168	126	198	148	228	171
140	105	170	127	200	150	230	172
142	107	172	129	202	151	232	174
144	108	174	131	204	153	234	175
146	110	176	132	206	154	236	177
148	111	178	133	208	156	238	178
150	113	180	135	210	157	240	180
152	114	182	136	212	158	242	181
154	115	184	138	214	160	244	183
156	117	186	140	216	162	246	184
158	118	188	141	218	163	248	186
160	120	190	142	220	165	250	187
162	121	192	144	222	166		

CA5015-B

If one or more cylinders read low, squirt approximately one tablespoon of XO-20W30-QR (ESR-M2C179-A) or equivalent engine oil on top of the pistons in the low reading cylinders. Repeat compression pressure check on these cylinders.

1. If compression improves considerably, piston rings are at fault.
2. If compression does not improve, valves are sticking or seating poorly.
3. If two adjacent cylinders indicate low compression pressures and squirting oil on pistons does not increase compression, the cause may be a cylinder head gasket leak between cylinders. Engine oil and / or coolant in cylinders could result from this problem.

   It is recommended the Compression Pressure Limit Chart be used when checking cylinder compression so that the lowest reading number is 75 percent of the highest reading.

Example

If, after checking the compression pressures in all cylinders, it was found that the highest reading obtained was 196 psi and the lowest pressure reading was 155 psi, the engine is within specification and the compression is considered satisfactory.

Excessive Engine Oil Consumption

Tools Required:

- Rotunda Engine Cylinder Leak Detection Kit 014-00705

The amount of oil an engine uses will vary with the way the vehicle is driven in addition to normal engine-to-engine variation. This is especially true during the first 12000 km (7500 miles) when a new engine is being broken in or until certain internal engine components become conditioned. Vehicles used in heavy duty operation may use more oil. The following are examples of heavy-duty operation:

- Trailer towing applications
- Severe loading applications
- Sustained high speed operation

Engines need oil to lubricate the following internal components:

- Engine block cylinder walls
- Pistons and piston rings
- Intake and exhaust valve stems
- Intake and exhaust valve guides
- All internal engine components

When the pistons move downward, a thin film of oil is left on the cylinder walls. The thin film of oil is burned away on the firing stroke during combustion. If an engine burned a drop of oil during each firing stroke, oil consumption would be about one quart for every mile traveled. Fortunately modern engines use much less oil than this example. However, even efficient engines will use some oil or they would quickly wear out. Additionally as the vehicle is operated, some oil is drawn into the combustion chambers past the intake and exhaust valve stem seals and burned.

Many different conditions can affect oil consumption rates. The following is a partial list of these items:

DIAGNOSIS AND TESTING (Continued)

- Engine size
- Operator driving habits
- Ambient temperature
- Quality and viscosity of the oil

Operation under varying conditions can be frequently misleading. A vehicle that has been run for several thousand miles of short trip operation or below freezing ambient temperatures, may have consumed a "normal" amount of oil. However, when checking the engine oil level, it may measure up to the full mark on the dipstick due to dilution (condensation and fuel) in the engine crankcase. The vehicle then might be driven at high speeds on the highway where the condensation and fuel boil off. The next time the engine oil is checked, it may appear that a quart of oil was used in a hundred or so miles. This perceived 160 km (100 miles) per quart oil consumption rate causes customer concern even though the actual overall oil consumption rate was about 2400 km (1500 miles) per quart.

Make sure the selected engine oil meets the recommended API performance category "SG" and SAE viscosity grade as shown in the vehicle Owner Guide. It is also important that the engine oil is changed at the intervals specified for the typical operating conditions. Refer to Section 00-03, Maintenance and Lubrication.

The following diagnostic procedure is intended to be used to determine the source of excessive internal oil consumption.

1. Determine what is considered excessive oil consumption, i.e., how many miles are driven per quart of oil? Also, determine owner's driving habits, i.e., sustained high speed operation, towing, extended idle, etc.

Oil usage is normally greater during the first 7500 miles of service. As mileage increases, oil usage generally decreases. Vehicles in normal service should get at least 900 miles per quart after 7500 miles of service. High speed driving, towing, high ambient temperature etc. may result in greater oil usage.

NOTE: Vehicles over 8500 GVW will consume more oil.

2. Verify engine has no external oil leak as outlined under Engine Oil Leaks.
3. Verify engine has correct engine oil indicator dipstick.
4. Verify that the engine is NOT being run in an overfilled condition. Check the oil level at least 5 minutes after a hot shutdown with the vehicle parked on a level surface. In no case should the level be above the top of cross-hatch area and "F" in FULL. If a significant overfill is indicated, perform steps 5a through 5d.
5. Perform an oil consumption test:
   a. Drain engine oil, remove filter and refill with one quart less than the recommended oil.
   b. Run the engine for three minutes (10 minutes if cold), then allow oil to drain for at least 5 minutes. (Vehicle on level surface)
   c. Remove engine oil dipstick and wipe clean. (Do not wipe with anything contaminated with silicone compounds). Re-install dipstick being sure to seat the dipstick firmly in the tube. Remove the dipstick and scribe a mark on the back (unmarked) surface at the indicated oil level. (This level should be about the same as the ADD mark on the face of the dipstick.)
   d. Add one quart of oil. Restart the engine and allow to idle for at least two minutes. Shut off the engine and allow oil to drain back for at least 5 minutes. Mark the dipstick using the procedure above. (This level may range from slightly below the top of the cross-hatched area to slightly below the letter "F" in FULL).
   e. Record vehicle's mileage.
   f. Instruct the owner to drive the vehicle as usual and:
      (1) Check the oil level regularly at intervals of 100 to 150 miles.
      (2) Return to the service point when the oil level drops below the lower (ADD) mark on the dipstick.
      (3) In an emergency, add only full quarts of the same oil and note the mileage at which the oil is added.
   g. Check the oil level under the same conditions and at the same location as in steps c and d above.
      (1) Measure the distance from the oil level to the UPPER scribe mark on the dipstick and record.
      (2) Measure the distance between the two scribe marks and record.
      (3) Divide the first measurement by the second.
      (4) Divide the distance driven during the oil test by the result. This quantity is the approximate oil consumption rate in miles per quart (MPQ).
   h. If the oil consumption rate determined is unacceptable, proceed to Step 6.
6. Check PCV valve system. Make sure system is not plugged.
7. Check for plugged oil drain-back holes in cylinder head(s), and cylinder block.
8. If, after performing the above, the condition still exists, proceed to Step 9.
9. Perform a cylinder compression test as outlined, and / or perform a cylinder leak detection test with Tester 014-00705. This can be helpful in determining source of oil consumption, i.e., valves, piston rings, etc.

DIAGNOSIS AND TESTING (Continued)

10. Check valve guides for excessive guide clearance. Replace all valve stem / guide seals after correct valve guide clearance has been verified.
11. Worn or damaged internal engine components can cause excessive oil consumption. Small deposits of oil on tip of spark plugs can be a clue to internal oil consumption. If internal oil consumption still persists, proceed as follows:
    a. Remove engine from vehicle and place it on an engine work stand. Remove intake manifold(s), cylinder head(s), oil pan and oil pump. Refer to Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L).
    b. Check piston ring clearance, ring gap and ring orientation. Service as required.
    c. Check for excessive bearing clearance. Service as required.

    NOTE: After checking for worn parts, if it is determined parts should be replaced, make sure correct replacement parts are used.
12. Perform oil consumption test as outlined to confirm oil consumption concern has been resolved.

3.0L and 3.8L Engine

Static Engine Off Valve Train Analysis

(Rocker Arm Cover Removed)

NOTE: Refer to the appropriate engine Section for the Removal and Installation of the engine rocker arm cover.

Check for damaged and / or severely worn parts, for correct assembly, and ensure use of correct parts by proceeding, as follows, with the static engine analysis.

Rocker Arm Assemblies

- Check for loose mounting stud and nut or bolt.
- Check for plugged oil feed in the rocker arm or cylinder head.

Push Rods (if equipped)

- Check for bent push rods and restriction in oil passage.

Valve Springs

- Check for broken or damaged parts.

Retainer and Keys

- Check for proper seating of keys on valve stem.

Positive Rotator and Keys

- Check for proper seating in the positive rotator, and on valve stem.

Valves and Cylinder Head

- Check the cylinder head gasket for proper installation.
- Check for plugged oil drain back holes.
- Check for worn or damaged valve tips.
- Check for missing or damaged guide-mounted valve stem oil seals.
- Check collapsed tappet gap, hydraulic tappet applications.
- Check installed spring height.
- Check for missing or worn valve spring seats, if equipped.

Static checks (engine off) are to be made on the engine prior to the following dynamic procedure.

Dynamic Valve Train Analysis

Start the engine and while running at idle, check for proper operation of all parts. Check the following:

Rocker Arm Assemblies, Individually Mounted

- Check for plugged oil feed in rocker arm or cylinder head.
- Check for proper overhead valve train lubrication.
- Check for plugged oil feed in rocker arm.

Rocker Arm Assemblies

- Check for plugged oil feeds.
- Check for proper overhead valve train lubrication.

If a condition of insufficient oiling is suspected, accelerate the engine to 1200 rpm ± 100 rpm with the transaxle in NEUTRAL and the engine at normal operating temperature. Oil should spurt from the rocker arm oil holes such that valve tips and rocker arm are well oiled and / or, with the rocker arm cover off, oil splash may overshoot rocker arm. If oiling is insufficient for this condition to occur, check oil passages for blockage.

Push Rods

- Check for bent push rods and restriction in oil passage.
- Check for proper rotation of push rod (non-roller tappets).

Positive Rotator and Keys

- Check for proper operation of positive rotator.

Valves and Cylinder Head

- Check for plugged oil drain back holes.
- Check for missing or damaged valve stem oil seals or guide mounted oil seals.

If a condition of insufficient oiling is suspected, check oil passages for blockage, then accelerate the engine to 1200 rpm with the transaxle in NEUTRAL and the engine at normal operating temperature. Oil should spurt from the rocker arm oil holes such that valve tips and rocker arms are well oiled. With the rocker arm cover off, some oil splash may overshoot rocker arm.

DIAGNOSIS AND TESTING (Continued)

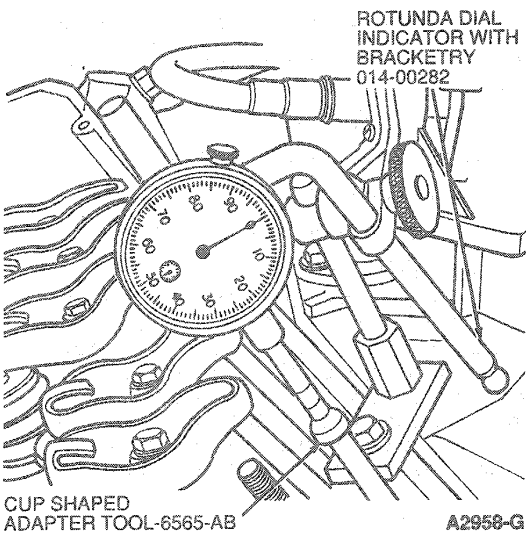
Camshaft Lobe Lift

Tools Required:

- Cup Shaped Adapter TOOL-6565-AB
- Rotunda Dial Indicator with Bracketry 014-00282

Check the lift of each lobe in consecutive order and make a note of the readings.

1. Remove valve rocker arm cover(s).
2. Remove rocker arm fulcrum bolts, fulcrum and rocker arm.
3. Ensure tappet is seated against cam. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent in such a manner as to have ball socket adapter of indicator on top of tappet, or Cup Shaped Adapter TOOL-6565-AB or equivalent on top of push rod and in same plane as tappet or push rod movement.



4. Remove spark plugs.
5. Connect an auxiliary starter switch in starting circuit. Crank engine with ignition switch in OFF position. Bump crankshaft over until tappet is on base circle of camshaft lobe. At this point, tappet will be in its lowest position. If checking during engine assembly, turn crankshaft using a socket or ratchet.
6. Zero dial indicator. Continue to rotate crankshaft slowly until tappet is in fully raised position (highest indicator reading).
7. Compare total lift recorded on indicator with specifications.
8. To check accuracy of original indicator reading, continue to rotate crankshaft until indicator reads zero.

   NOTE: If lift on any lobe is below specified service limits, camshaft and tappet operating on worn lobe(s) must be replaced, as well as any tappet showing pitting or having contact face worn flat or concave. Refer to Camshaft and Hydraulic Lash Adjuster as outlined.
9. Remove dial indicator, adapter and auxiliary starter switch.

   CAUTION: After installing rocker arms, do not rotate crankshaft until tappets have had sufficient time to bleed down. To do otherwise may cause serious valve damage. Manually bleeding down will reduce waiting time.
10. Install valve rocker arm cover.
11. Install spark plugs.

Hydraulic Tappet/Lash Adjuster

Tools Required:

- Hydraulic Tappet Leakdown Tester TOOL-6500-E

Hydraulic tappet noise may be caused by any of the following:

1. Excessive collapsed tappet gap.
2. Sticking tappet plunger.
3. Tappet check valve not functioning properly.
4. Air in lubrication system.
5. Leakdown rate too rapid.
6. Excessive valve guide wear.

Excessive collapsed tappet gap may be caused by loose rocker arm fulcrum bolts, incorrect initial adjustment, or wear of tappet face, push rod, rocker arm, rocker arm fulcrum, or valve tip. With tappet collapsed, check gap between valve tip and rocker arm to determine if any other valve train parts are damaged, worn, or out of adjustment.

A sticking tappet plunger may be caused by dirt, chips, or varnish inside the tappet. The sticking can be corrected by disassembling the tappet and removing the dirt, chips or varnish causing the condition.

A tappet check valve that is not functional may be caused by an obstruction such as dirt or chips preventing it from closing when the cam lobe is lifting the tappet, or it may be caused by a broken check valve spring.

Air bubbles in the lubrication system will prevent the tappet from supporting the valve spring load and may be caused by too high or too low an oil level in the oil pan, or by air being drawn into the system through a hole, crack or leaking gasket on the oil pump pickup tube.

If the leakdown time is below the specified time for used tappets, noisy operation may result. If no other cause for noisy tappets can be found, the leakdown rate should be checked and any outside the specification should be replaced.

DIAGNOSIS AND TESTING (Continued)

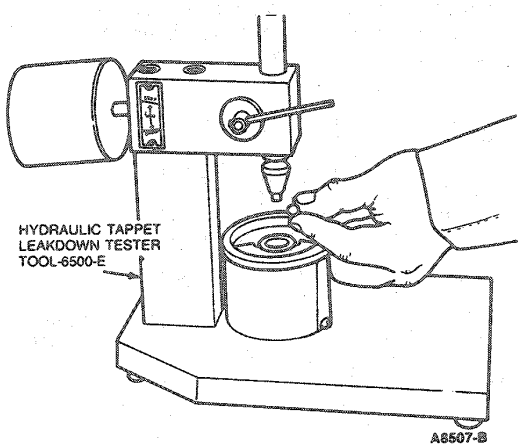
Assembled tappets can be tested with Hydraulic Tappet Leakdown Tester TOOL-6500-E or equivalent to check the leakdown rate. The leakdown rate specification is the time in seconds for the plunger to move a specified distance of its travel while under a 22.7kg (50 lb) load. Test the tappets as follows:

Leakdown Testing

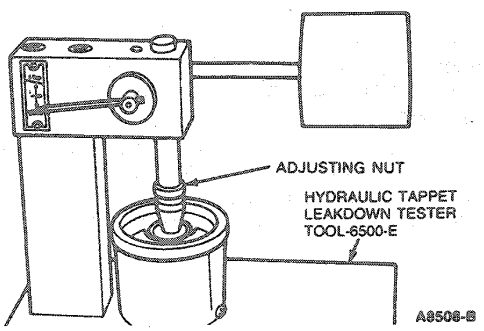
1. Disassemble and clean the tappet to remove all traces of engine oil.

   NOTE: Do not mix parts from different tappets. Parts are select-fitted and are not interchangeable.

   NOTE: Tappets cannot be checked with engine oil in them. Only the testing fluid can be used.
2. Place tappet in tester, with plunger facing upward. Pour hydraulic tester fluid into cup to a level that will cover tappet assembly. The fluid can be purchased from manufacturer of tester. Using kerosene or any other fluid will not provide an accurate test.
3. Place 7.94mm (5/16 inch) steel ball provided with tester in plunger cap.



4. Adjust length of ram so pointer is 1.59mm (1/16 inch) below starting mark when ram contacts tappet plunger, to facilitate timing as pointer passes the Start Timing mark.



   Use the center mark on the pointer scale as Stop Timing point instead of the original Stop Timing mark at top of scale.
5. Work tappet plunger up and down until tappet fills with fluid and all traces of air bubbles have disappeared.
6. Allow ram and weight to force tappet plunger downward. Measure exact time it takes for pointer to travel from Start Timing to the Stop Timing marks of tester.
7. A tappet that is satisfactory must have a leakdown rate (time in seconds) within minimum and maximum limits specified.
8. If tappet is not within specification, replace it with new tappet. If a worn flat tappet is replaced with a new tappet it is recommended that a new camshaft be installed. It is not necessary to disassemble and clean new tappets before testing, because oil contained in new tappets is test fluid.
9. Remove fluid from cup and bleed fluid from tappet by working plunger up and down. This step will aid in depressing tappet plungers when checking valve clearance.

Camshaft End Play

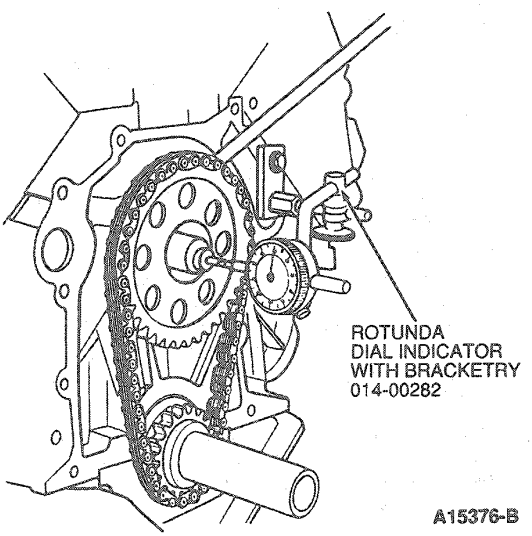
Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

CAUTION: Prying against the camshaft gear with the valve train load on the camshaft can break or damage the gear. Therefore, the rocker arm adjusting nuts must be backed off, or the rocker arm and shaft assembly must be loosened sufficiently to free the camshaft. After checking the camshaft end play, adjust the valve clearance.

DIAGNOSIS AND TESTING (Continued)

1. Push camshaft toward rear of engine. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent so indicator point is on camshaft sprocket retaining screw.



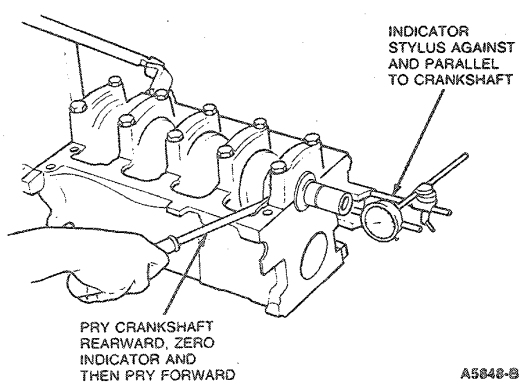
2. Zero dial indicator. Pull camshaft forward and release it. Compare dial indicator reading with specifications. If end play is excessive, replace camshaft thrust plate.
3. Remove dial indicator.
4. After replacing thrust plate, check end play again. If it is still out of specified range, inspect camshaft and cylinder head / cylinder block for excessive wear.

Crankshaft End Play

Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

1. Force crankshaft toward rear of engine.
2. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent so contact point rests against crankshaft flange and indicator axis is parallel to crankshaft axis.



3. Zero dial indicator. Push crankshaft forward and note reading on dial.
4. If the end play exceeds the wear limit listed in the specific engine Section, replace the thrust bearing. Inspect the crankshaft for damage to the thrust face before installing the new bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks or dirt. If thrust faces are not damaged or dirty, they probably were not aligned properly. Lubricate and install the thrust bearing and align the faces, following Main Bearing Replacement procedure recommended in the appropriate engine Section. Check the crankshaft end play.

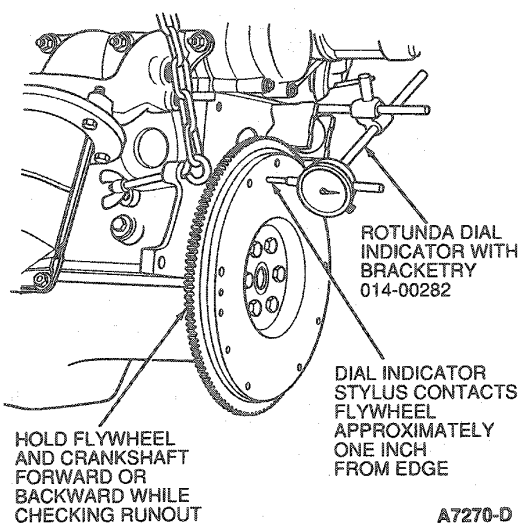
3.0L/3.2L SHO Engine

Flywheel Runout (Manual Transaxle)

Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

1. Remove spark plugs.
2. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent so indicator points rest on face of the flywheel.



3. Hold flywheel and crankshaft forward or backward as far as possible to prevent crankshaft end play from being indicated as flywheel runout.
4. Set indicator dial on zero mark. Turn flywheel one complete revolution while observing total indicator runout reading (TIR). If TIR exceeds specification, flywheel and ring gear assembly must be replaced.

DIAGNOSIS AND TESTING (Continued)

5. If clutch face runout exceeds specification, remove flywheel and check for burrs between flywheel and face of crankshaft mounting flange. If no burrs exist, check runout of crankshaft mounting flange. Replace flywheel or machine crankshaft flywheel mounting face sufficiently to true-up the surface.

Engine Oil Leaks

Tools Required:

- Rotunda Oil Leak Detector 112-00030

Rotunda Oil Leak Detector 112-00030 or equivalent may be used to check for oil leaks.

Compression Tests

Test Conclusion

The compression reading of the lowest cylinder should be within 85-100 percent of the highest.

Example

If, after checking the compression pressures in all cylinders, it was found that the normal reading obtained was 199 psi and the lowest pressure reading was 171 psi, the engine is within specification and the compression is considered satisfactory.

Static Engine Off Valve Train Analysis (Cylinder Head Cover Removed)

Cylinder Head

When inspecting the cylinder head, check the following:

a. Check cylinder head gasket for proper installation.
b. Check for plugged oil drain back holes.
c. Check valve lash.

Dynamic Valve Train Analysis

Cylinder Head Cover

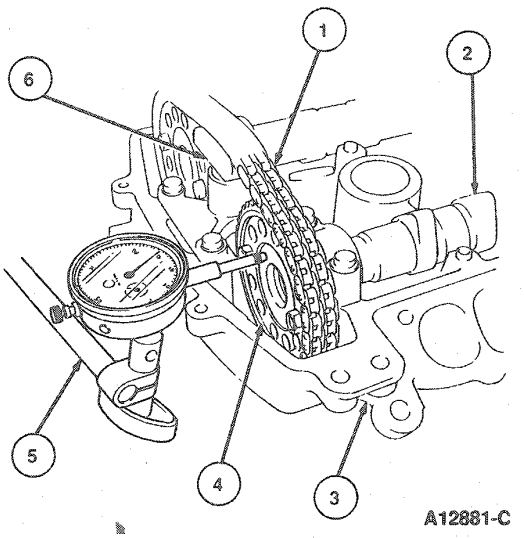
1. Remove all foreign materials from cylinder head gasket groove and cylinder head cover.
2. Apply a coat of Silicone Gasket and Sealant F1AZ-19562-A (WSE-M4G320-A2) or equivalent at gasket corners on each cylinder head as shown.
3. Install cylinder head cover bolts. Tighten to specification in sequence. Refer to Section 03-01B.
4. Connect all hoses, wires, spark plug leads and components.

Camshaft End Play

Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

1. Remove cylinder head covers. Refer to Section 03-01B.
2. Using Rotunda Dial Indicator with Bracketry 014-00282 or equivalent, measure end play while moving camshaft back and forth. If the end play is greater than 0.30mm (0.0118 inch), replace camshaft and/or cylinder head.
3. Install cylinder head covers. Tighten bolts to specification in sequence. Refer to Section 03-01B.



Item	Part Number	Description
1	6268	Camshaft Timing Chain
2	6250	Camshaft
3	6049	Cylinder Head
4	6256	Camshaft Timing Chain Sprocket
5	014-00282	Rotunda Dial Indicator with Bracketry
6	6K261	Chain Tensioner

ADJUSTMENTS

Valve Clearance

3.0L/3.2L SHO

Tools Required:

- Tappet Compressor T89P-6500-A
- Tappet Holder T89P-6500-B
- Pick Tool T71P-19703-C

1. Disconnect negative battery cable.

ADJUSTMENTS (Continued)

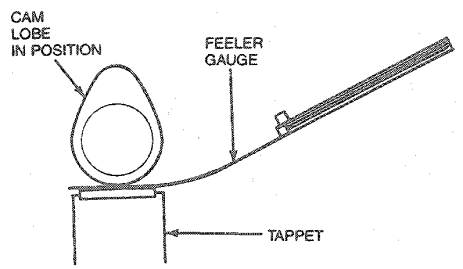
2. Remove intake manifold assembly and cylinder head covers on 3.2L SHO, remove the EGR tube sub assembly from the RH exhaust manifold to obtain clearance to remove the RH rocker cover. Refer to Section 03-01B.

   NOTE: Cam lobes must be directed 90 degrees or more away from tappets.

3. Insert feeler gauge under lobe at 90 degree angle to camshaft.

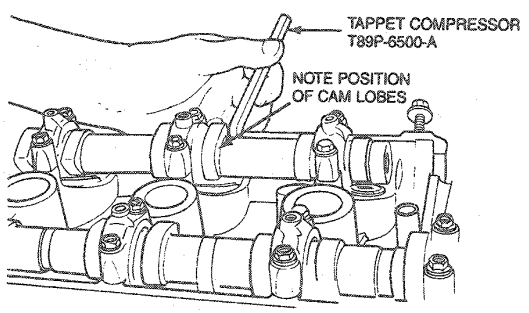
   Valve Lash Intake (Cold): 0.15-0.25mm (0.006-0.010 inch).

   Valve Lash Exhaust (Cold): 0.25-0.35mm (0.010-0.014 inch).



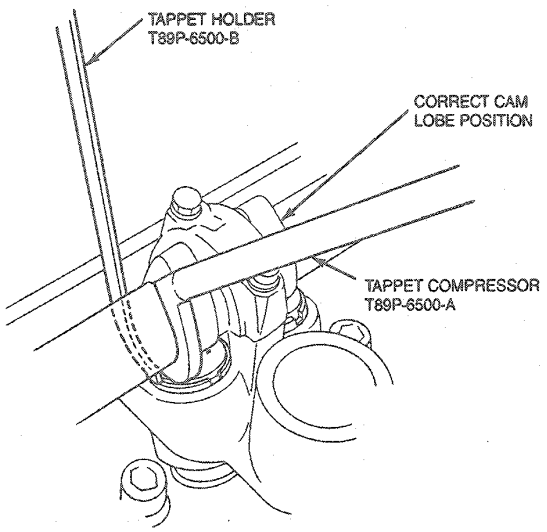
A12911-A

4. To adjust clearance, insert Tappet Compressor T89P-6500-A, under camshaft next to lobe and rotate down to depress bucket tappet.



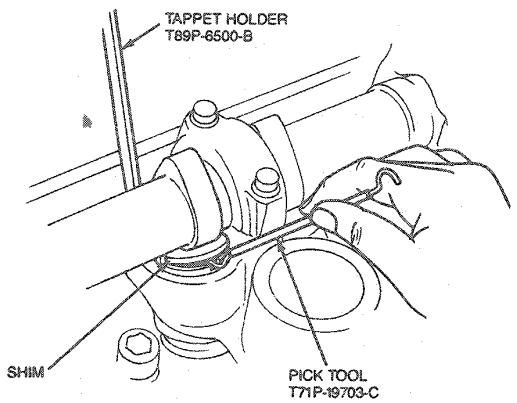
A12910-A

5. Insert Tappet Holder T89P-6500-B, and remove compressor tool.



A12909-A

6. Using Pick Tool T71P-19703-C, lift adjusting shim and remove shim with magnet.



A12908-A

7. Determine size of shim by numbers on bottom face of shim or by measuring with a micrometer. Install replacement shim that will permit specified clearance. Refer to Section 03-01B. Install shim with numbers down. Ensure shim is properly seated.
8. Release tappet holder by installing tappet compressor tool.
9. Repeat procedure for each valve by rotating engine crankshaft as necessary.
10. After all valve clearances are checked and/or adjusted, inspect all valve shims to ensure that they are fully seated in their bucket tappets.

ADJUSTMENTS (Continued)

11. Inspect cylinder head cover gaskets and replace if damaged.
12. Install cylinder head covers and intake manifold assembly. Refer to Section 03-01B.
13. Connect negative battery cable.

OVERHAUL

Service Limit Specifications

Service limit specifications are intended to be a guide only, 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.

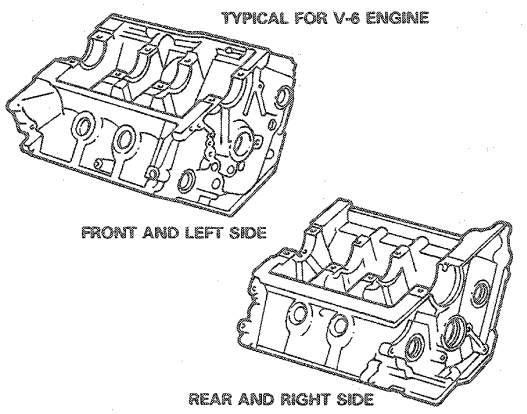
Cylinder Block

Servicing Sand Holes or Porous Engine Castings

Porosity or sand hole(s) which will cause oil seepage or leakage can occur with modern casting processes. A complete inspection of engine and transaxle should be made. If the leak is attributed to the porous condition of the cylinder block or sand hole(s), service can be made with an epoxy sealer meeting specification M3D35-A (E) or equivalent. **Do not service cracks with this material.** Service with this metallic plastic epoxy resin must be confined to those cast iron engine component surfaces 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. **Service is not recommended to the intake manifold exhaust crossover section, since temperatures can exceed the recommended temperature limit of 260°C (500°F).**
d. Cylinder front cover on engines using cast iron material.
e. Cylinder head, along the valve rocker arm cover gasket surface.

The following procedure should be used to service porous areas or sand holes in cast iron.



1. Clean the surface to be serviced 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 serviced 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 service area thoroughly. Metallic plastic (epoxy resin) will not stick to a dirty or oily surface.
2. Mix the metallic plastic (epoxy resin) base and hardener as directed on the container. Stir thoroughly until uniform.
3. Apply the service mixture with a suitable clean tool (putty knife, wood spoon, etc.), forcing the epoxy into the hole or porosity.
4. Allow the service mixture to harden. This can be accomplished by two methods. Heat cure with a 250-watt lamp placed 254mm (10 inches) from the serviced surface, or air dry for 10-12 hours at temperatures above 10°C (50°F).
5. Sand or grind the serviced area to blend with the general contour of the surrounding surface.
6. Paint the surface to match the rest of the block.

Cylinder Walls, Refinishing

Tools Required:

- Engine Cylinder Hone Set T73L-6011-A

OVERHAUL (Continued)

Honing is recommended for refinishing cylinder walls only when no cross-hatch pattern is visible on cylinder walls, 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. After honing, thoroughly clean cylinder bores with a detergent and water solution.

NOTE: Only experienced personnel should be allowed to perform this work.

NOTE: 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.

Cylinder walls that are severely marred and / or worn beyond the specified limits should be refinished. Refinish only the cylinder or cylinders that require it. All pistons are the same weight, both standard and oversize; therefore, various sizes of pistons can be used without upsetting engine balance. Refinish the cylinder with the most wear first to determine the maximum oversize. If the cylinder will not clean up when refinished for the maximum oversize piston recommended, replace the block.

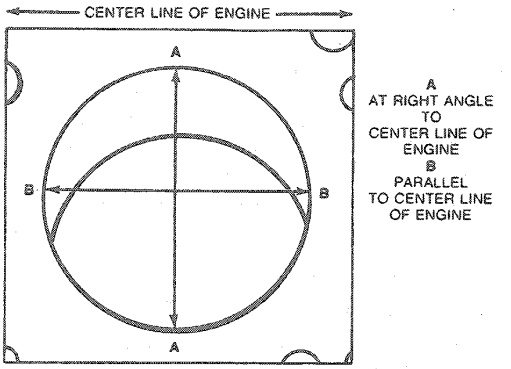
Refinish the cylinder to within approximately 0.038mm (0.0015 inch) of the required oversize diameter. This will allow enough stock for the final step of honing so that the correct surface finish and pattern are obtained. For the proper use of the refinishing equipment, follow the instructions of the manufacturer.

Use a motor-driven, spring pressure-type Engine Cylinder Hone Set T73L-6011-A, hone at a speed of 300-500 rpm. Hones of grit sizes 180-220 will normally provide the desired bore surface finish of 0.20-0.60 mμ (millimicron) per cylinder in production and 0.30-0.51 mμ (millimicron) average for all cylinders.

CAUTION: After the final operation in either of the two refinishing methods described and prior to checking the piston fit, thoroughly clean with a detergent and water solution and oil the cylinder walls.

When honing the cylinder bores, use a lubricant mixture of equal parts of kerosene and XO-10W30-QSP (ESE-M2C153-E) or equivalent engine oil. 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. 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.

Refinish cylinders that are deeply scored, out-of-round, and / or taper exceeds the specification If the cylinder walls have minor surface imperfections, but the out-of-round and taper are within limits, it may be possible to remove the imperfections by honing the cylinder walls and installing new service piston rings, providing the piston clearance is within specification. For Specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L).



1. OUT-OF-ROUND = DIFFERENCE BETWEEN A AND B
2. TAPER = DIFFERENCE BETWEEN THE A MEASUREMENT AT TOP OF CYLINDER BORE AND THE A MEASUREMENT AT BOTTOM OF CYLINDER BORE. A2905-B

Cleaning

CAUTION: If these procedures are not followed, rusting of the cylinder bore(s) may occur.

After any cylinder bore service operation, such as honing or deglazing, clean the bore(s) with soap or detergent and water. Then, thoroughly rinse the bore(s) with clean water to remove the soap or detergent, and wipe the bore(s) dry with a clean, lint-free cloth. Finally, wipe the bore(s) with a clean cloth dipped in XO-10W30-QSP (ESE-M2C153-E) or equivalent engine oil.

If the engine is disassembled, thoroughly clean the block with 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, then bolt holes, etc., with compressed air. Ensure threads in the cylinder head bolt holes are clean. Dirt in the threads may cause binding and result in a false torque reading. Use a tap to true-up threads and to remove all deposits. Thoroughly clean the grooves in the crankshaft bearings and bearing retainers.

Inspection

After the block has been thoroughly cleaned, check it for cracks. Tiny 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. If cracks are present, the coating will become discolored at the defective area. Replace the block if it is cracked.

OVERHAUL (Continued)

Check all machined gasket surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone.

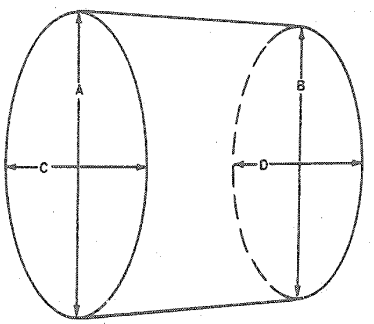
Check the cylinder bore for flatness of the cylinder head gasket surface following the procedure and specifications recommended for the cylinder head. The cylinder block can be machined to bring the cylinder head gasket surface within the flatness specifications listed in Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L), **but not to exceed 0.254mm (0.010 inch) stock removal from the original gasket surface.**

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

Inspect the main and connecting rod journals for cracks, scratches, grooves, scores or rough finish. Inspect the crankshaft oil seal surface for nicks, sharp edges, or burrs that might damage the oil seal during installation or cause premature seal wear.

A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



A7267-B

Core Plugs

Removal and Installation

Tools Required:

- Impact Slide Hammer T59L-100-B or T50T-100-A

To remove a large core plug, drill a 12.70mm (1/2 inch) hole in the center of the plug and remove with a Universal Impact Slide Hammer T59L-100-B, or T50T-100-A, or pry it out with a large drift punch. Clean and inspect the plug bore.

Prior to installing a core plug, the plug bore should be inspected for any damage that would interfere with the proper sealing of the plug. If the bore is damaged, it will be necessary to true-up the surface by boring for the next specified oversize plug.

Oversize (OS) plugs are identified by the "OS" stamped in the flat located on the cup side of the plug.

Coat the plug and/or bore lightly with an oil resistant (oil galley) Stud and Bearing Mount E0AZ-19554-BA (WSK-M2G349-A1) or Threadlock 262 E2FZ-19554-B (WSK-M2G351-A6), or equivalent, and install it following the procedure for cup-type or expansion-type below:

Cup-Type

Cup-type core plugs are installed with the flanged edge outward. The maximum diameter of this plug is located at the outer edge of the flange. The flange on cup-type plugs flares outward with the largest diameter at the outer (sealing) edge.

Expansion-Type

Expansion-type core plugs are installed with the flanged edge inward. The maximum diameter of this plug is located at the base of the flange with the flange flaring inward.

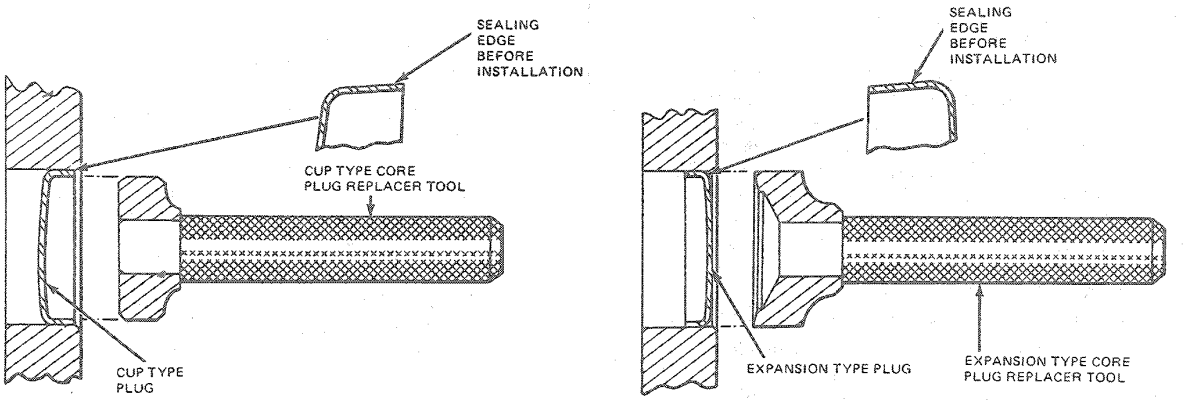
CAUTION: It is imperative to push or drive the plug into the machined bore by using a properly designed tool. Under no circumstances is the plug to be driven using a tool that contacts the crowned portion of the plug. This method will expand the plug prior to installation and may damage the plug and/or plug bore.

When installed, the trailing (maximum) diameter must be below the chamfered edge of the bore to effectively seal the plugged bore.

OVERHAUL (Continued)

If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

CAUTION: It is imperative to pull the plug into the machined bore by using a properly designed tool. Under no circumstances is the plug to be driven into the bore using a tool that contacts the flange. This method will damage the sealing edge and will result in leakage and/or plug blowout.



NOTE: If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

The flanged (trailing) edge must be below the chamfered edge of the bore to effectively seal the plugged bore.

Main and Connecting Rod Bearings

Cleaning

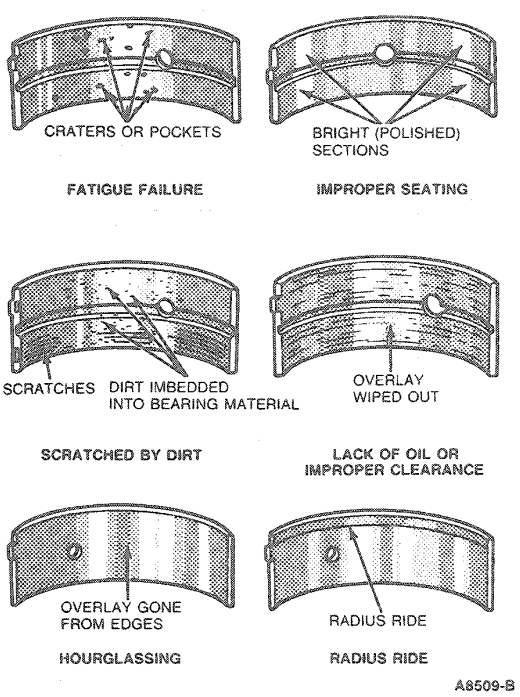
Bearings that are to be reused should be identified so they can be installed in their original locations.

CAUTION: Do not scrape gum or varnish deposits from the bearing shells.

Clean the bearing inserts and caps thoroughly in solvent, and dry them with compressed air.

Inspection

Inspect each bearing carefully. Bearings that have a scored, chipped or worn surface should be replaced. Typical examples of unsatisfactory bearings and their causes are shown in the illustration. The copper lead bearing base may be visible through the bearing overlay. If the base showing is less than 20 percent of the total area, the bearing is not 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 as outlined.



OVERHAUL (Continued)

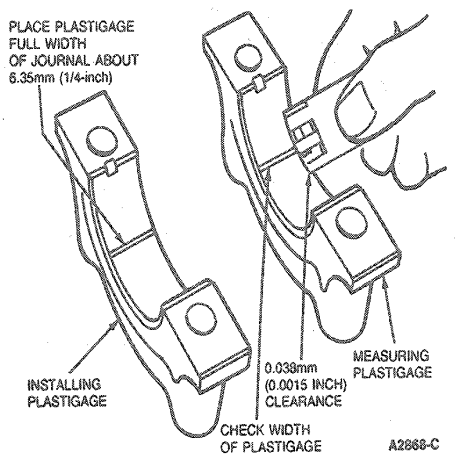
Fitting Main or Connecting Rod Bearings with Plastigage

Tools Required:

- Plastigage D81L-6002-B

1. Clean crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pickup 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.** If the desired clearance cannot be obtained with a standard bearing, try one-half of a 0.025mm (0.001 inch) or 0.050mm (0.002 inch) undersize in combination with a standard bearing to obtain the proper clearance.

   CAUTION: Do not position jack under crankshaft pulley. Crankshaft post damage will result.
2. If fitting a main bearing in the vehicle, position a jack under counterweight adjoining bearing which is being checked. Support crankshaft with jack so its weight will not compress Plastigage D81L-6002-B or equivalent, and provide an erroneous reading.
3. Place a piece of Plastigage D81L-6002-B or equivalent on bearing surface across full width of bearing cup and about 6.35mm (1/4 inch) off center.
4. Install cap and tighten bolts. For specifications, refer to the appropriate engine Section. 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. Check at narrowest point to get maximum clearance. Difference between readings is taper of journals.



6. If bearing clearance exceeds the specified limits, try using one of the various combinations of undersize bearings as directed by the accompanying table. Use of any other bearing combination is not recommended. Bearing clearance must be within specified limits. Refer to appropriate Section under Specifications, for main and connecting rod bearing clearance limits. If use of these bearing combinations do not bring clearance to the desired limits, refinish the crank journal to 0.254mm (0.010 inch) undersize, and use the appropriate undersize bearing.
7. After bearing has been fitted, apply light coat of engine oil to journal and bearings. Install bearing cap. Tighten cap bolts to specification. Refer to Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L).
8. Repeat procedure for remaining bearings that require replacement.

FOR THIS AMOUNT OF BEARING CLEARANCE EXCESS		USE THIS BEARING SIZE			
		UPPER BEARING		LOWER BEARING	
mm	Inch	mm	Inch	mm	Inch
0.0-0.013	0.0-0.0005	0.025	0.001 U.S.	STANDARD	STANDARD
0.013-0.026	0.0005-0.0010	0.025	0.001 U.S.	0.025	0.001 U.S.
0.026-0.039	0.0010-0.0015	0.050	0.002 U.S.	0.025	0.001 U.S.
0.039-0.052	0.0015-0.0020	0.050	0.002 U.S.	0.050	0.002 U.S.

CA9330-A

Crankshaft

Cleaning

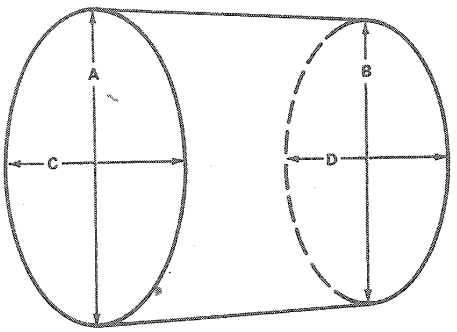
CAUTION: Handle the crankshaft with care to avoid possible fractures or damage to the finished surfaces.

Clean the crankshaft with solvent, then blow out all oil passages with compressed air.

OVERHAUL (Continued)

Measure the diameter of each journal in at least four places to determine an out-of-round, taper or undersize condition. For Specification, refer to Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L).

CHECK FOR OUT-OF-ROUND AT EACH END OF JOURNAL



A VS B = VERTICAL TAPER
C VS D = HORIZONTAL TAPER
A VS C AND B VS D = OUT OF ROUND

A10094-1A

On engines with a manual transaxle, check the fit of the clutch pilot bushing in the bore of the crankshaft. A needle roller bearing and adapter assembly is used as a clutch pilot bearing. It is press fit directly into the crankshaft and should not be loose. Inspect the inner surface of the bushing for wear or a bell-mouth condition. Check the inside diameter of the bearing to see if it is worn, or damaged. The bearing and adapter assembly cannot be serviced separately. The needle bearing clutch pilot can only be installed with the seal end of the bearing facing the transaxle. The bearing and seal are pre-greased and do not require additional lubrication. A new bearing must be installed whenever a bearing is removed.

Inspect the pilot bearing (roller bearing), if so equipped, for roughness, evidence of overheating or loss of lubricant. Replace it if any of these conditions are found.

Journals, Refinishing

CAUTION: Because the 3.8L V-6 engine crankshaft incorporates deep rolling of the main journal fillets, journal refinishing is limited to 0.25mm (0.010-inch) undersize of standard journal dimensions. Further main journal refinishing may result in fatigue failure of the crankshaft.

Dress minor imperfections such as scores, nicks or burrs with an oil stone. If the journals are severely marred or exceed the service limit, they should be refinished to size for the next undersize bearing.

If required, machine the journals to give the proper clearance with the next undersize bearing. If the journals will not clean up to maximum undersize bearing available, replace the crankshaft.

Always reproduce the same journal shoulder radius that existed originally. Too small a radius will result in fatigue failure of the crankshaft. Too large a radius will result in bearing failure due to radius ride of the bearing.

After refinishing the journals, chamfer the oil holes. Polish the journal with a No. 500 grit polishing cloth and engine oil (crocus cloth may also be used as a polishing agent) to obtain a smooth finish.

NOTE: On 3.0L V-6 journal radius is undercut and should be refinished. Do not grind more than 0.20-inch off 3.0L journal or deep fillet rolling for strength increase will be compromised.

Pistons, Pins and Rings

Fitting Pistons

Tools Required:

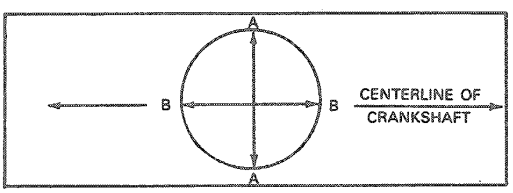
- Engine Cylinder Hone Set T73L-6011-A

Pistons are available for service in standard size and oversize shown in Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L) under Specifications.

The standard size pistons are color-coded red, blue or yellow on the dome.

Measure the cylinder bore and select the piston to ensure the proper clearance. When the bore diameter is in the lower one-third of the specified range, a red piston should be used. When the bore diameter is in the middle one-third, a blue piston should be used. When the bore diameter is in the upper one-third, a yellow piston should be used.

NOTE: Cylinder bore must be clean and dry, and engine block must remain at room temperature (21°C/70°F) for eight hours before taking cylinder measurements.



A - At Right angle to center line of engine
B - Parallel to center line of engine

Top Measurement: Make 12.70mm (1/2 inch) below top of block deck

Bottom Measurement: Make within 12.70mm (1/2 inch) above top of piston - when piston is at its lowest travel (B.D.C)

Bore Service Limit: Equals the average of "A" and "B" when measured at the center of the piston travel.

Taper: Equals difference between "A" top and "A" bottom.

Out-of-Round: Equals difference between "A" and "B" when measured at the center of piston travel.

Refer to Specification tables at end of each engine section.

A4165-1G

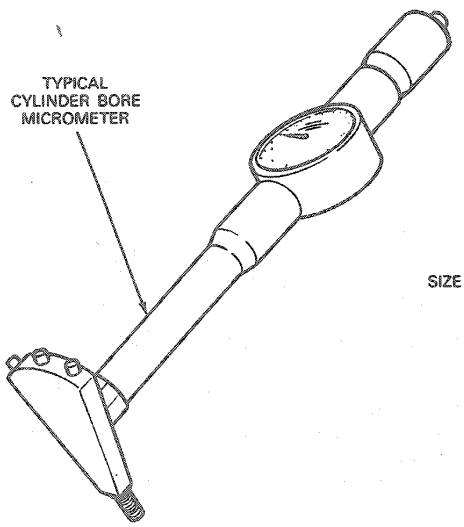
OVERHAUL (Continued)

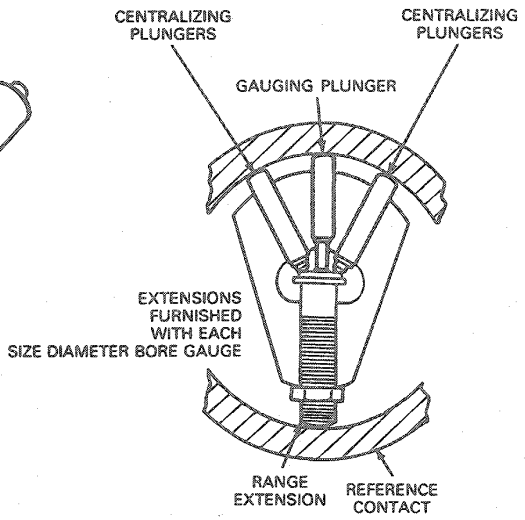
Measure the piston diameter to ensure the specified clearance is obtained. It may be necessary periodically to use another piston (within the same grade size) that is either slightly larger or smaller to achieve the specified clearance.

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.





POSITIVE CENTRALIZATION

CENTRALIZING PLUNGERS AUTOMATICALLY LOCATE THE GAUGING CONTACTS CENTRALLY ON THE BORE DIAMETER EVEN WHEN THE GAUGE IS INSERTED AT AN ANGLE.

A8793-2D

If new rings are to be installed in a used cylinder that has not been refinished, remove the cylinder wall glaze using only spring-loaded Engine Cylinder Hone Set T73L-6011-A, and only if there is no visible sign of cross-hatch markings on the cylinder walls. (Refer to Cylinder block, Cylinder Walls, Refinishing.) Always clean the cylinder bore thoroughly with detergent and water solution.

NOTE: After any refinishing operation, allow cylinder bore to cool, and ensure piston and bore are clean and dry before piston fit is checked.

1. Calculate size piston to be used by taking a cylinder bore check. Follow procedures outlined previously.
2. Select proper size piston to provide desired clearance. Measure piston diameter in-line with centerline of piston pin and at 90 degrees to piston pin axis.
3. Ensure piston and cylinder block are at room temperature, 21°C (70°F).

Measure the piston diameter to ensure 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.

Fitting Piston Rings

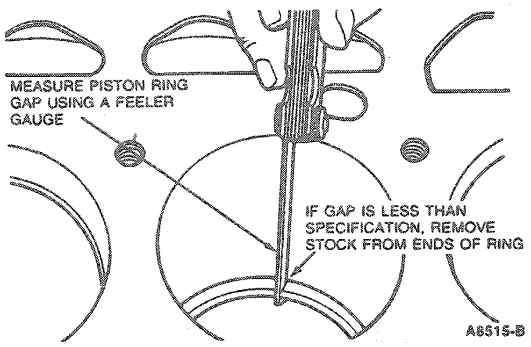
NOTE: Always use a piston ring expanding tool to install rings on a piston.

1. Select proper ring set for the size cylinder bore.
2. Position ring in cylinder bore in which it is going to be used.
3. Push ring down into bore area where normal ring wear is not encountered.

   CAUTION: Use care to avoid damage to ring or cylinder bore.
4. Position ring in bore so ring is square with cylinder wall.

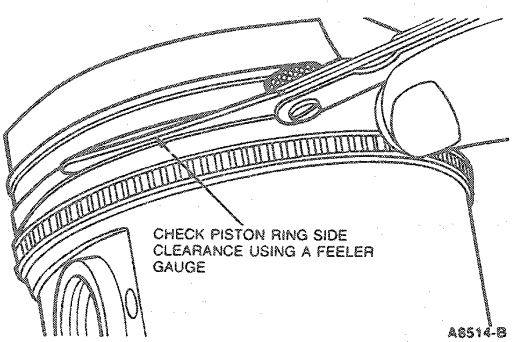
OVERHAUL (Continued)

5. Measure gap between ends of ring with a feeler gauge. If ring gap is less or greater than specified limits, try another ring set. For specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L).



NOTE: If lower lands have high steps, piston should be replaced.

6. Check ring-side clearance of compression rings with a feeler gauge inserted between ring and its lower land. Gauge should slide freely around entire ring circumference without binding. Any wear that occurs will form a step at inner portion of lower land.
7. Piston rings should be staggered on the piston to insure the piston ring end gaps are **not** aligned.



Cleaning

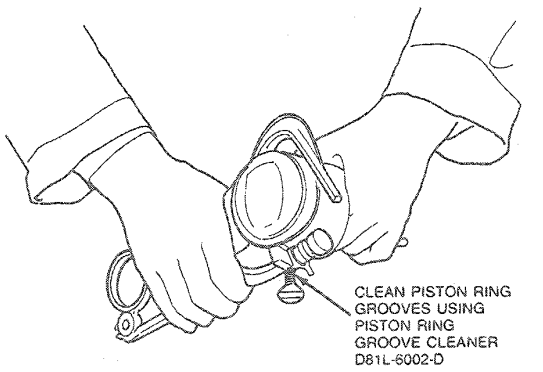
Tools Required:

- Piston Ring Groove Cleaner D81L-6002-D

CAUTION: Do not use a caustic cleaning solution or a wire brush to clean pistons.

Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins, and rings with solvent.

Clean the ring grooves with Piston Ring Groove Cleaner D81L-6002-D or equivalent. Ensure 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 has a high step, replace the piston. The step will interfere with ring operation and cause excessive ring-side clearance.

Spongy, eroded areas near the edge of the top of the piston are usually caused by detonation or pre-ignition. 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 or damage from detonation or pre-ignition.

Check the piston-to-cylinder bore clearance by measuring the piston and bore diameters. Refer to Specifications for the proper clearance. Refer to Cylinder Block Inspection for the bore measurement procedure. Measure the OD of the piston and check the ring side clearance following the procedure under Fitting Pistons, Pins and Rings.

Replace piston showing signs of fracture, etching or wear. Check the piston pin fit in the piston and rod.

Check the OD of the position pin and the ID of the pin bore in the piston. Replace any piston pin or piston that is not within specification. For specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L).

CAUTION: Rings should not be transferred from one piston to another, regardless of mileage.

Replace all rings that are scored, broken, chipped or cracked. Check the end gap and side clearance.

Connecting Rods

Cleaning

CAUTION: Do not use a caustic cleaning solution.

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. Blow out all passages with compressed air.

OVERHAUL (Continued)

Inspection

The connecting rods and related parts should be carefully inspected and checked for conformance to specifications. For specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L). Various forms of engine wear caused by these parts can be readily identified.

A shiny surface on either pin boss side of the piston usually indicates that a connecting rod is bent.

Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, worn or damaged crankpin, or a tapered connecting rod bore.

Twisted connecting rods will not create an 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.

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

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

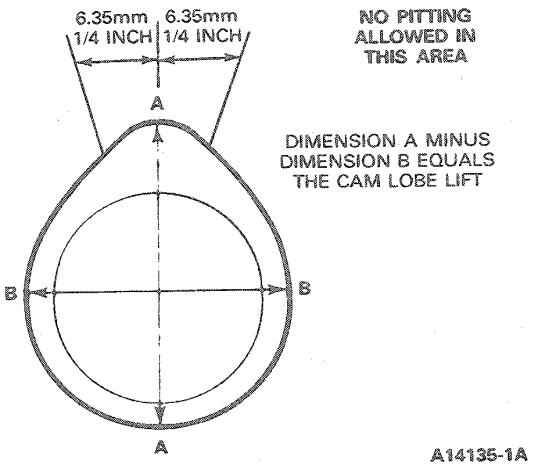
Inspect the connecting rods for signs of fractures and the bearing bores for out-of-round and taper. If the bore exceeds the recommended limits and/or if the connecting rod is fractured, it should be replaced. Check the ID of the connecting rod piston pin bore. If the pin bore in the connecting rod is larger than specification, install a 0.03mm (0.0012 inch) oversize piston pin. First, prefit the oversize piston pin to the piston pin bore by reaming or honing the piston to provide 0.005mm (0.0002 inch)—0.012mm (0.00048 inch) clearance (light slip fit). Assemble the piston, piston pin and connecting rod following the procedures for the specific engine being worked on.

Inspect the camshaft lobes for scoring and signs of abnormal wear. Lobe pitting in the general area of the lobe toe is not detrimental to the operation of the camshaft; therefore, the camshaft should not be replaced unless the lobe lift loss has exceeded specification or pitting has occurred in the lobe lift area.

The lift of the camshaft lobes can be checked with the camshaft installed in the engine or on centers.

To measure the camshaft lobe lift, proceed as follows:

1. Measure distance between major (A-A) and minor (B-B) diameters of each cam lobe with a Vernier caliper and record readings. The difference in readings on each cam diameter is lobe lift.
2. If readings do not meet specification, replace camshaft. For Specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L).



Camshaft

Cleaning

Clean the camshaft in solvent and wipe it dry.

Remove light scuffs, scores or nicks from the camshaft machined surfaces with a smooth oil stone.

NOTE: If camshaft journals are excessively worn or scored, the camshaft must be replaced. Camshaft journals can be refinished to accommodate 0.38mm (0.015 inch) undersize bearing. If the journals do not "clean up," the camshaft must be replaced.

Inspection

Check camshaft bores for size, taper, roundness, alignment and finish. If any of these exceed the limits given in Specifications, install new camshaft bearings.

Hydraulic Tappets/Hydraulic Roller Tappets

CAUTION: If any part of the tappet assembly needs replacing, replace the entire assembly.

The tappet assemblies should be kept in proper sequence so that they can be installed in their original position. Inspect and test each tappet separately so as not to intermix. If a tappet is worn, it is recommended that all tappets and camshaft be replaced.

Cleaning

Thoroughly clean all the parts in clean solvent and wipe them with a clean, lint-free cloth.

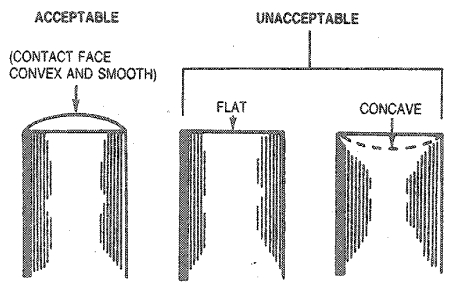
OVERHAUL (Continued)

Inspection

Inspect the parts and discard the entire lash adjuster, tappet assembly if any part shows pitting, scoring or excessive wear. Replace the entire assembly if the plunger is not free in the body. The plunger should drop to the bottom of the body by its own weight when assembled dry.

Assemble the adjuster tappet assembly and check for freeness of operation by pressing down on the plunger. The lash adjuster tappets can also be checked with a hydraulic tester to test the leakdown rate. Follow the instructions of the test unit manufacturer or the Hydraulic Lash Adjuster Tappet procedure under Diagnosis and Testing.

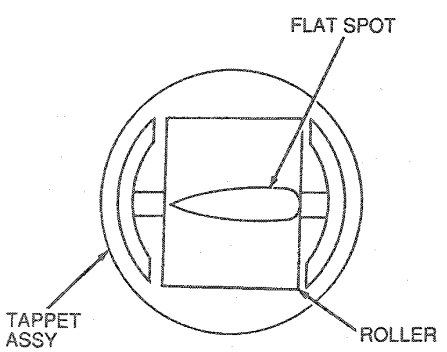
Flat Tappet Wear



A4290-B

Roller Tappet Wear

Inspect roller tappet for flat spots or scoring. If flat spot is found, check camshaft lobes for proper height or wear. Replace as required.



A15295-A

Oil Pump

3.0L/3.8L

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. Ensure all dirt and metal particles are removed.

Inspection

Tools Required:

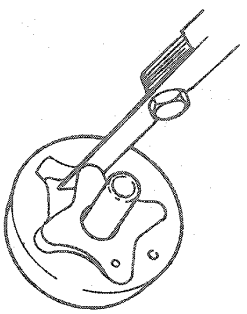
- Straight Edge D83L-4201-A

Refer to Specifications in Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L) for clearances and service limits.

Check the inside of the pump housing and the outer race and rotor for damage or excessive wear.

Check the mating surface of the pump cover for wear. Minor scuff marks are normal, but if the cover mating surface is worn, scored, or grooved, replace the pump (except 3.0L V-6 engines). Inspect the rotor for nicks, burrs or score marks. Remove minor imperfections with an oil stone.

Measure the inner rotor tip clearance.



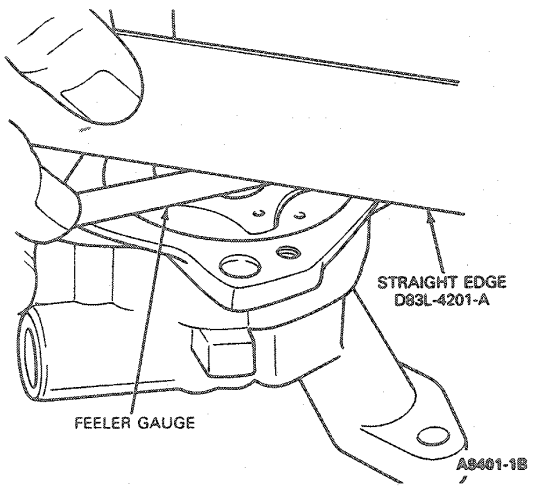
NOTE:
WITH ROTOR ASSEMBLY REMOVED FROM THE PUMP AND RESTING ON A FLAT SURFACE, THE INNER AND OUTER ROTOR TIP CLEARANCE MUST NOT EXCEED 0.30mm (0.012 IN) WITH FEELER GAUGE INSERTED 13mm (0.5 IN) MINIMUM.

A7541-1A

With the rotor assembly installed in the housing, place a straightedge over the rotor assembly and the housing.

OVERHAUL (Continued)

Measure the clearance (rotor end play) between the straightedge and the rotor and outer race. Maximum clearance must not exceed 0.13mm (0.005 inch).

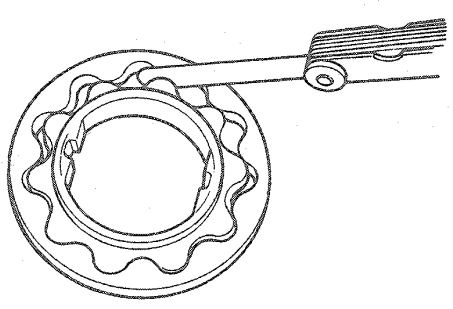


Inspect the relief valve spring to see if it is collapsed or worn. Check the relief valve spring tension. If the spring tension is not within specification and/or the spring is worn or damaged, replace the pump. Check the relief valve piston for free operation in the bore.

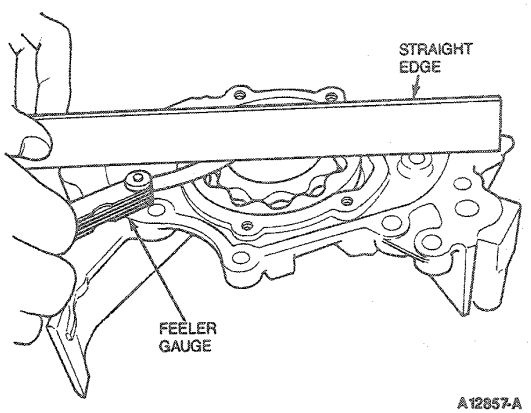
NOTE: Internal components are not serviced. If any component is out of specification, the complete pump must be replaced.

3.0L/3.2L SHO

The inner rotor tip-to-outer rotor tip clearance must not exceed 0.06-0.18 (0.0024-0.0071 inch) with the feeler gauge inserted 12.7mm (1/2 inch) minimum and rotors removed from the pump housing.



With the rotor assembly installed in the pump housing, place a straightedge over the rotor assembly and the housing. Measure the clearance (rotor end play) between the straightedge and the rotor and outer race. The clearance should be 0.03-0.09mm (0.0012-0.0035 inch).



Inspect the relief valve spring to see if it is collapsed or worn. Check the relief valve spring tension. If the spring tension is not within specification or the spring is worn or damaged, replace the pump. Check the relief valve piston for free operation in the bore.

NOTE: Internal components cannot be serviced. If any component is out of specification, the complete pump must be replaced.

Oil Pan

Cleaning

CAUTION: Do not damage the oil level sensor (if equipped) when cleaning the oil pan.

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. Ensure all foreign particles are removed.

Inspection

Check the pan for cracks, holes, damaged drain plug threads. Check the gasket surface for damage caused by over-tightened bolts. Replace with a new oil pan if repairs cannot be made.

Cylinder Heads

Replace the head if it is cracked. **Do not plane or grind more than 0.25mm (0.010 inch) from the original cylinder head gasket surface.** Remove all burrs or scratches with an oil stone.

Cleaning

With the valves installed to protect the valve seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush. Be careful not to damage the cylinder head gasket surface. After the valves are removed, clean the valve guide bores. Use cleaning solvent to remove dirt, grease and other deposits. Clean all bolt holes. Remove all deposits from the valve with a fine wire brush or buffing wheel.

OVERHAUL (Continued)

Inspection

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

Check the cylinder head for cracks and inspect the gasket surface for burrs and nicks. Small imperfections of this type can be dressed down using an oil stone. Replace the head if it is cracked.

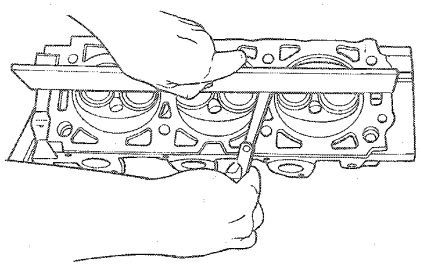
The following inspection procedures are for a cylinder head that is to be completely overhauled. For individual repair operations, use only the pertinent inspection procedure.

Cylinder Head Flatness

Tools Required:

- Straight Edge D83L-4201-A

When a cylinder head is removed because of gasket leaks, check the flatness of the cylinder head gasket surface for conformance to specification using Straight Edge D83L-4201-A or equivalent and a feeler gauge. For Specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L). If necessary to refinish the cylinder head gasket surface, **do not plane or grind off more than 0.254mm (0.010 inch).**



A15267-A

Cylinder Head—3.0L

Replace the head if it is cracked. **Do not plane or grind the cylinder head gasket surface.** Remove all burns or scratches with an oil stone.

When checking cylinder head gasket surfaces, warpage is not to exceed the following specifications. If warpage exceeds these specifications, the head must be replaced.

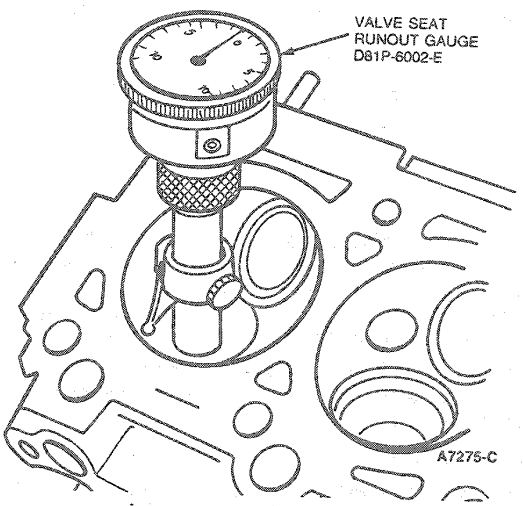
- Cylinder block side: 0.2mm (0.008 inch)
- Intake manifold side: 0.2mm (0.008 inch)
- Exhaust manifold side: 0.3mm (0.012 inch)

Valve Seat Runout

Tools Required:

- Valve Seat Runout Gauge D81P-6002-E

Check the valve seat runout with Valve Seat Runout Gauge D81P-6002-E or equivalent as illustrated below. Follow the instructions of the gauge manufacturer. If the runout exceeds the wear limit, reface the valve and valve seat. For specifications, refer to Section 03-01A.



Valve Stem-to-Guide Clearance

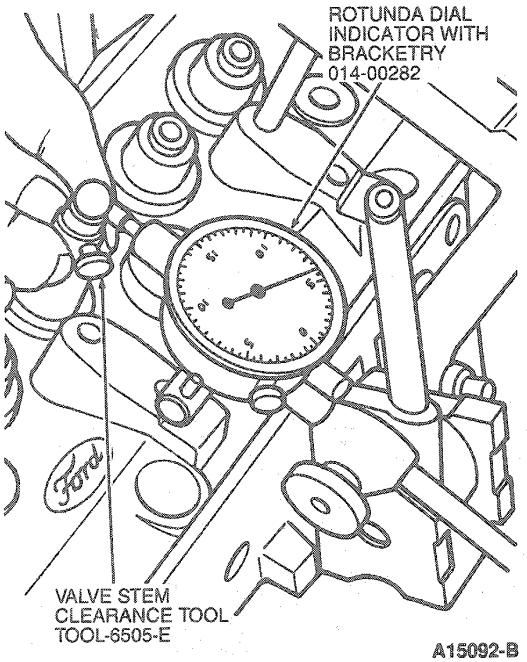
Tools Required:

- Valve Stem Clearance Tool TOOL-6505-E
- Rotunda Dial Indicator with Bracketry 014-00282.

Check the valve stem-to-valve guide clearance of each valve in its respective valve guide with Valve Stem Clearance Tool TOOL-6505-E or equivalent. Use a flat end indicator point.

OVERHAUL (Continued)

Install the tool on the valve stem until it is fully seated. Tighten the knurled setscrew firmly. Permit the valve to drop away from its seat until the tool contacts the upper surface of the valve guide.



Position the Rotunda Dial Indicator with Bracketry 014-00282 or equivalent with its flat tip against the center portion of the tool spherical section at approximately 90 degrees to the valve stem axis. Move the tool back and forth in-line with the indicator stem. Take a reading on the dial indicator without removing the tool from the valve guide upper surface. Divide the reading by two, the division factor for the tool. If valve stem-to-valve guide clearance exceeds the wear limit, ream the valve guide for the next oversize valve stem as outlined under Valves.

Valves, Select Fitting

If the valve stem-to-valve guide clearance exceeds the service clearance, ream the valve guide for the next oversize valve stem. Valves with oversize stem diameters of 0.38mm (0.015 inch) and 0.76mm (0.030 inch) are available for service for all engines. **Always reface the valve seat after the valve guide has been reamed.** Refer to Reaming Valve Guides.

In the case of valve stem-to-valve guide clearance, the service clearance is intended as an aid to diagnosing engine noise only, and does not constitute a failure or indicate need for service. However, when overhauling or reconditioning a cylinder head, the service clearance should be regarded as a practical working value, and used as a determinant for installing the next oversize valve to ensure extended service life.

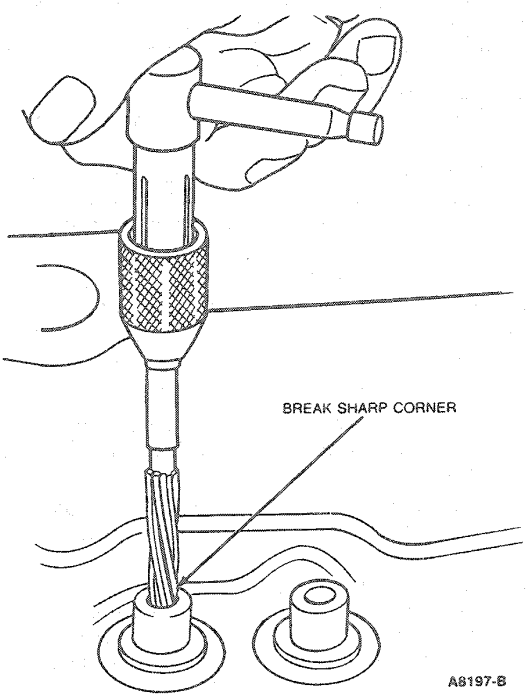
Valves, Select Fitting—3.0L/3.2L SHO

If the valve stem-to-valve guide clearance exceeds the service clearance, ream the valve guide for the next oversize valve stem. Valves with oversize stem diameters of 0.38mm (0.015 inch) and 0.76mm (0.030 inch) are available for service for all engines. **Always reface the valve seat after the valve guide has been reamed.** Refer to Reaming Valve Guides.

Valve Guides, Reaming

CAUTION: Always reface the valve seat after the valve guide has been reamed, and use a suitable scraper to break the sharp corner (ID) at the top of the valve guide.

If it becomes necessary to ream a valve guide to install a valve with an oversize stem, a reaming kit is available which contains the following reamer and pilot combinations: 0.38mm (0.015 inch) "OS" reamer with 0.076mm (0.003 inch) "OS" pilot, and a 0.76mm (0.030 inch) reamer with a 0.38mm (0.015 inch) "OS" pilot.



When replacing a standard size valve with an oversize valve always use the reamer in sequence (smallest oversize first, and then next smallest, etc.) so as not to overload the reamers.

NOTE: If oversize valve stems and oversize stem seals are not available, bore out original guide and install service bushing. Ream ID for specified clearance for standard size valve. Reface valve seat, as required. Install standard size valve stem oil seal.

OVERHAUL (Continued)

CAUTION: The interference angle of the valve and seat should not be lapped out. Remove all grooves or score marks from the end of the valve stem, and chamfer it as necessary. Do not remove more than 0.25mm (0.010 inch) from the end of the valve stem.

If the valve face runout is excessive and/or to remove pits and grooves, reface the valve to a true 44 degree angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the edge of the valve head is less than 0.79mm (1/32 inch) thick after grinding, replace the valve as the valve will run too hot in the engine.

If the valve and/or valve seat has been refaced, it will be necessary to check the clearance between the rocker arm pad and the valve stem with the valve train assembly installed in the engine.

Valve Guides, Reaming—3.0L/3.2L SHO

If it becomes necessary to ream a valve guide to install a valve with an oversize stem, a reaming kit is available which contains the following reamer and pilot combinations: 0.38mm (0.015 inch), OS reamer with 0.076mm (0.003 inch) "OS" pilot, and a 0.76mm (0.030 inch) reamer with 0.38mm (0.015 inch) "OS" pilot.

CAUTION: Always reface the valve seat after the valve guide has been reamed, and use a suitable scraper to break the sharp corner (ID) at the top of the valve guide.

When replacing a standard size valve with an oversize valve always use the reamer in sequence (smallest oversize first, and then the next smallest, etc.) so as not to overload the reamers.

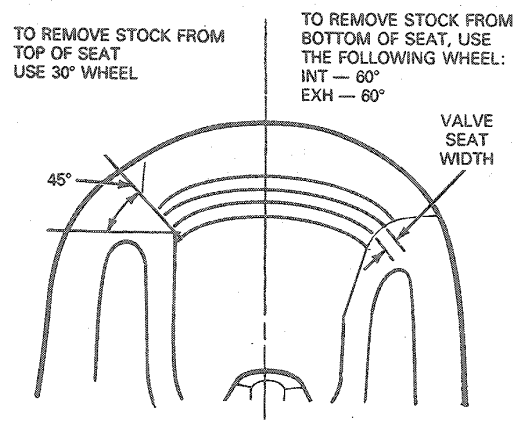
Valve Seats, Refacing

Measure the valve seat width. Reface the valve seat(s) if the width is not within specifications. Refer to Section 03-01B for specifications.

Refer to Engine Service in the Rotunda Tool catalog for a description of the various types of valve seat grinders and cutters available.

Refacing of the valve seat should be closely coordinated with the refacing of the valve face so that the finished seat and valve face will be concentric and the specified interference angle will be maintained. This is important so that the valve and seat will have a compression-tight fit. Ensure refacer grinding wheels are properly dressed.

Grind the valve seats of all engines to a true 45 degree angle. 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. Narrow the seat, if necessary, to bring it within specification. Refer to Section 03-01B for specifications.



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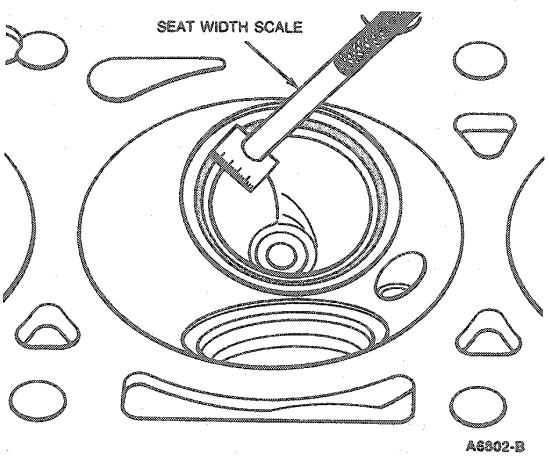


A6802-B

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

For 3.0L and 3.8L engine intake and exhaust seats, use a 60 degree angle grinding wheel to remove stock from the bottom of the seat (raise the seats). A 30 degree angle wheel is used to remove stock from the top of the seats (lower the seats).

On the intake and exhaust seats, use a 60 degree angle grinding wheel to remove stock from the bottom of the seats (raise the seats). A 30 degree angle wheel to remove stock from the top of the seats (lower the seats).

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.

OVERHAUL (Continued)

To do this, coat the seat with Prussian Blue and set the valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of the valve face, the contact 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

The critical inspection points and tolerances of the valve are illustrated. Refer to specifications in Section 03-01B for service limits.

Inspect the valve stem for bends, and the end of the stem for grooves or scoring.

Inspect the valve face and the edge of the valve head for pits, grooves or scores. Inspect the stem for a bend condition and the end of the stem for grooves or scores. Check the valve head for signs of burning or erosion, warpage and cracking. Minor pits, grooves, etc., may be removed. Discard severely damaged valves.

Inspect the valve spring assembly, valve spring retainers, locks and sleeves and discard any visually damaged parts.

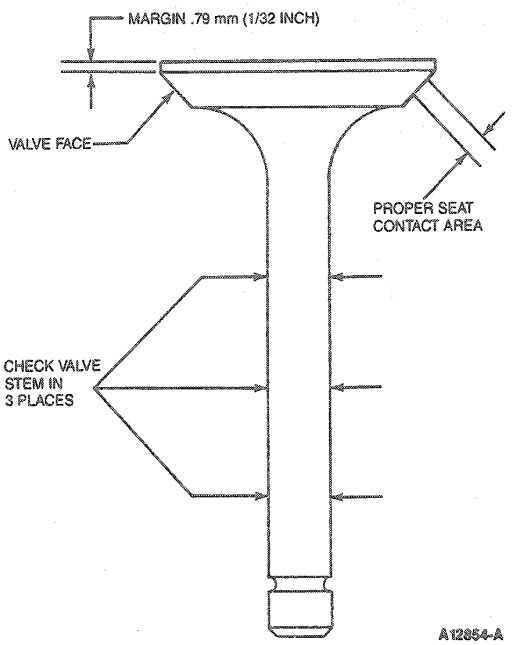
Valves, Refacing

Tools Required:

- Rotunda Motorized Valve Refacer 139-00041

3.0L/3.2L SHO

Using a micrometer, check valve stem in three places to ensure it is within specification. Refer to Section 03-01B for specifications. If the valve stem is not within specifications, or if the valve is damaged, **DISCARD VALVE.** Minor pits, grooves, or runout in the valve face may be removed by refacing.



Use Rotunda Motorized Valve Refacer 139-00041 or equivalent, to reface valves. Carefully review instructions supplied with the kit before starting work.

The valve refacing operation should be closely coordinated with the valve seat reconditioning operation so that the finished angles of the valve face and the valve seat will be to specification and provide a compression-tight fit.

If valve face runout is excessive or it is necessary to remove pits and grooves, reface valve to a 45 degree angle. Remove only enough material to correct runout or to remove pits and grooves. If edge of valve head (margin) is less than 0.79,, (1/32 inch) thick after refacing, replace valve. Lapping of valve and seat is not recommended. Remove any grooves or score marks from valve stem end and chamfer it as necessary. Do not remove more than 0.23mm (0.010 inch) from end of valve stem. It will be necessary to check valve clearance after refacing valve and valve seat.

Except 3.0L/3.2L SHO

CAUTION: Discard any excessively worn or damaged valve train parts.

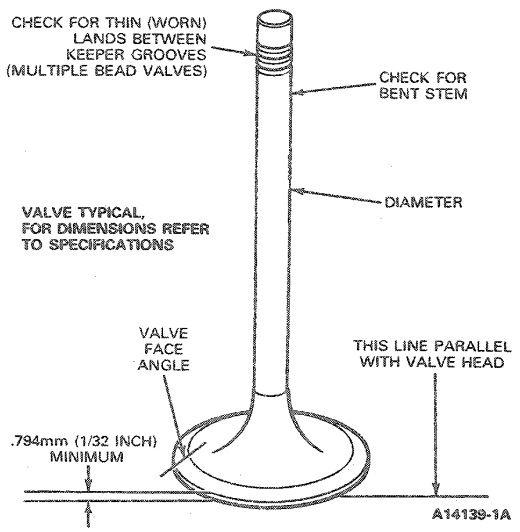
Minor pits, grooves, etc., may be removed. Discard valves that are severely damaged if the face runout cannot be corrected by refinishing or stem clearance exceeds specification. Refer to Section 03-01A (3.0L), 03-01B (3.0L/3.2L SHO) or 03-01C (3.8L) for specifications.

Refer to Engine Service in the Rotunda catalog for a description of the various types of valve resurfacing equipment available.

OVERHAUL (Continued)

The valve refacing operation should be closely coordinated with the valve seat refacing operations so that the finished angles of the valve face and of the valve seat will be to specification and provide a compression-tight fit.

Ensure refacer grinding wheels are properly dressed. Refer to the following illustration for critical valve dimensions.



Valve Seats, Refacing

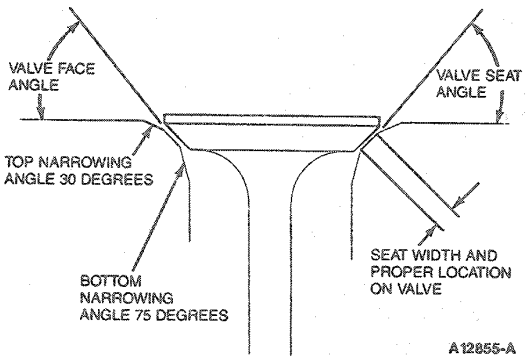
Tools Required:

- Rotunda Valve Seat Cutter Kit 139-00061

3.0L/3.2L SHO

Use Rotunda Valve Seat Cutter Kit 139-00061 or equivalent, to recondition valve seats. Carefully review the instruction booklet provided with the kit before starting work.

Reconditioning of valve seat should be closely coordinated with refacing of valve so that finished seat and valve face will be concentric and specified angle will be maintained. This is important so that valve and seat will have a compression-tight fit.



Select proper size pilot and insert it into finished valve guide. Using the 75 degree cutter, make a light cut until a clean line can be seen all the way around bottom of seat angle. Once this is done, use the 30 degree cutter until there is a clean line all the way around top of seat. Then use the 45 degree cutter until seat is clean, free from pits and has an even width all the way around.

Check seat location and width by coating face of freshly refaced valve with Prussian Blue and set valve in place. With light pressure on valve head, turn valve 1/4-turn and remove. Wipe Prussian Blue from valve and put it back in place. With light pressure on valve, turn it 1/4-turn and remove. Be careful not to touch valve face when removing. Look at valve face. There should be a line of blue about 1/3 of the way down face from margin, all the way around valve face.

If line is not in proper position, the following steps must be taken:

a. If line is too close to margin, use the 30 degree cutter to lower top edge of seat.

b. If line is to far from margin, use the 45 degree cutter to raise top edge of seat.

After moving contact point, always recheck work with Prussian Blue. Then check seat width with a seat width scale. Use the 75 degree cutter to narrow seat width.

Valve Spring Tension

Tools Required:

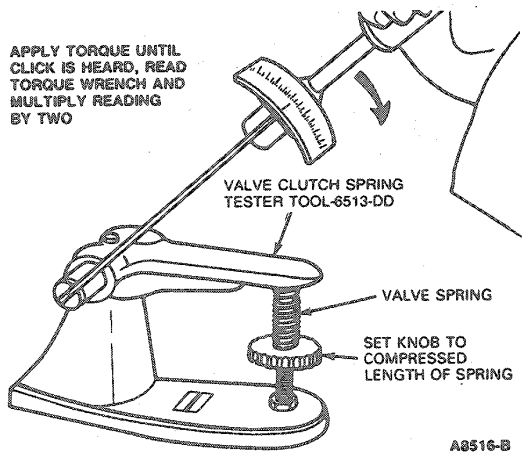
- Valve Clutch Spring Tester TOOL-6513-DD

Inspect the valve spring, valve spring retainers, locks and sleeves for wear or damage. Discard any damaged parts.

OVERHAUL (Continued)

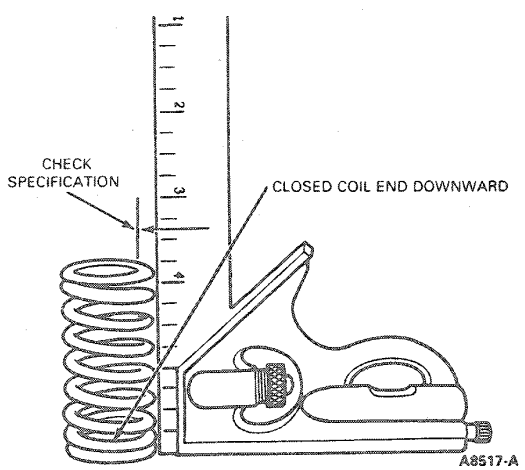
Check springs for proper pressure at the specified spring lengths using Valve / Clutch Spring Tester TOOL-6513-DD or equivalent. Weak valve springs cause poor engine performance. Replace any spring not within specification. For specifications, refer to Section 03-01A (3.0L), 03-01B (3.0L / 3.2L SHO) or 03-01C (3.8L). Manually rotating the valve spring assemblies while installed in the engine will not determine condition of valve springs.

NOTE: Ensure the springs are reassembled to their OWN ORIGINAL DAMPERS by pushing damper on the spring. DO NOT OPEN damper with any kind of tool in order to reassemble.



Valve Spring Squareness

Check each spring for squareness, using a steel square and a flat surface. Stand the spring and square on end on the flat surface. Slide the spring up to the square. Revolve the spring slowly and observe the space between the top coil of the spring and the square. Refer to the illustration below.



Refer to Specifications in Section 03-01B for out-of-square limits. Follow the same procedure to check new valve springs before installation.

NOTE: Ensure the proper spring (color-coded) is installed.

NOTE: Ensure the springs are reassembled to their OWN ORIGINAL DAMPERS by pushing damper on the spring. DO NOT OPEN damper with any kind of tool in order to reassemble.

Valve Rocker Arm

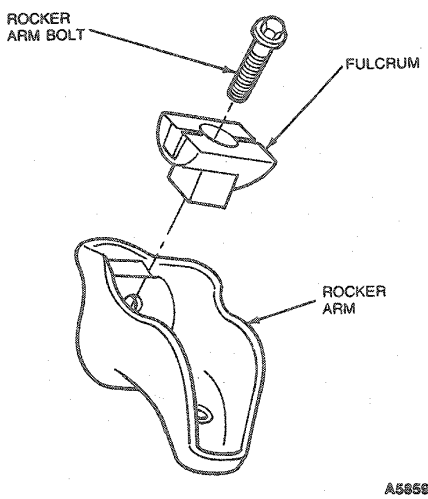
Cleaning

Clean all parts thoroughly. Ensure all oil passages are open.

Ensure oil passage in the push rod end of the rocker arm is open.

Inspection

Inspect the shaft and the rocker arm bore for nicks, scratches, scores or scuffs. Replace any damaged parts.



CAUTION: Do not attempt to true-up this surface by grinding. On pedestal mounted rocker arms, check the rocker arm pad, side rails and fulcrum seat for excessive wear, cracks, nicks or burrs. Check the rocker arm bolt for stripped or broken threads.

Inspect the pad at the valve end of the rocker arm for indications of scuffing or abnormal wear. If the pad is grooved, replace the rocker arm.

Push Rods

Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

OVERHAUL (Continued)

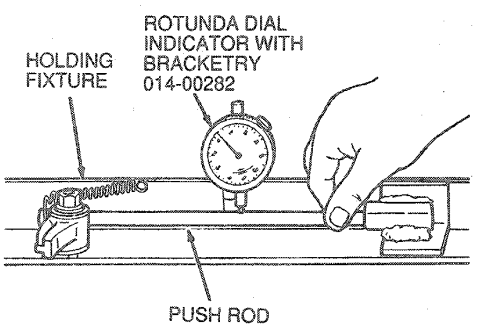
Cleaning

Clean the push rods in a suitable solvent. Blow out the oil passage in the push rods with compressed air.

Inspection

Check the ends of the push rods for nicks, grooves, roughness or excessive wear. Replace damaged push rods.

The push rods can be visually checked for straightness while they are installed in the engine by rotating them with the valve closed. They also can be checked with Rotunda Dial Indicator with Bracketry 014-00282 or equivalent.



A15361-B

CAUTION: Do not attempt to straighten push rods.

If the push rod is bent beyond specification, it should be replaced.

Intake Manifolds

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

CAUTION: Remove all filing and foreign matter that may have entered the manifold as a result of service.

CAUTION: Check the baffle plate(s) on the underside of the manifold if so equipped. The baffle(s) should be securely fastened.

Inspect the manifolds for cracks, damaged gasket surfaces, or other damage that would make them unfit for further service. Replace all studs that are stripped or otherwise damaged. Clean the EGR exhaust passages.

Exhaust Manifolds

Cleaning

Remove all gasket or foreign material from all inlet and outlet sealing surfaces of the manifold.

Inspection

Inspect the cylinder head joining flanges of the exhaust manifold(s) for evidence of exhaust gas leaks.

Inspect the manifolds for cracks, damaged sealing surfaces, or other damage that would make them unfit for further service. Warped or cracked exhaust manifolds must be replaced.

Flywheel

Automatic Transmission

Inspection

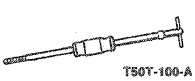
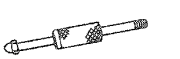
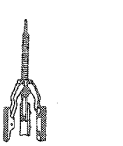
Inspect the flywheel for cracks or other damage that would make it unfit for further service. Inspect the flywheel ring gear for worn, chipped or cracked teeth. If the teeth are damaged, replace the ring gear and flywheel assembly.

Manual Transmission

Inspection

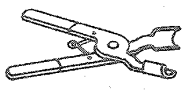
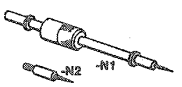
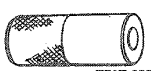
With the flywheel installed on the crankshaft, check the gear face runout.

SPECIAL SERVICE TOOLS

Tool Number/ Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T58L-101-B Puller Attachment	 T58L-101-B
T59L-100-B Impact Slide Hammer	 T59L-100-B
T71P-19703-C Pick Tool	 T71P-19703-C
T73L-6011-A Engine Cylinder Hone Set	 T73L-6011-A
T73L-6600-A Pressure Gauge	 T73L-6600-A

(Continued)

SPECIAL SERVICE TOOLS (Continued)

Tool Number / Description	Illustration
T74P-6666-A Spark Plug Wire Remover	
T78P-3504-N Seal Remover	
T79T-6527-A Rocker Arm Stud Remover	
T79T-6527-B Rocker Arm Stud Replacer	
T86L-6565-A Valve Spring Compressor	
T89P-6500-A Tappet Compressor	
T89P-6500-B Tappet Holder	

Tool Number	Description
D78P-4201-B	Dial Indicator Mag. Base
D78P-4201-F	Dial Indicator Bracketry
D78P-4201-G	Dial Indicator 1" Travel
D79P-100-A	Impact Slide Hammer
D79P-6666-A	Spark Plug Boot Puller
D81L-6002-A	Oil Stone
D81L-6002-B	Plastigage
D81L-6002-D	Piston Ring Groove Cleaner
D81P-6002-E	Valve Seat Runout Gauge
D81P-6666-A	Spark Tester
D83L-4201-A	Straight Edge
TOOL-6500-E	Hydraulic Tappet Leakdown Tester
TOOL-6505-E	Valve Stem Clearance Tool
TOOL-6513-DD	Valve / Clutch Spring Tester
TOOL-6565-AB	Cup Shaped Adapter

ROTUNDA EQUIPMENT

Model	Description
014-00282	Dial Indicator with Bracketry
014-00705	Engine Cylinder Leak Detection Kit
059-00009	Compression Tester
112-00030	Oil Leak Detector
139-00041	Motorized Valve Refacer
139-00061	Valve Seat Cutter Kit

SECTION 03-01A Engine, 3.0L/3.0L FF

VEHICLE APPLICATION

Taurus/Sable and Taurus Flexible Fuel (FF).

DESCRIPTION AND OPERATION

The 3.0L engine has a cast iron, V-block design with overhead valves. The engine is available with an automatic transaxle only and operates on unleaded fuel or fuel methanol on flexible fuel (FF) vehicles. The cast iron cylinder heads feature a central plug, dual squish combustion chamber. The V-6, 3.0L engine is compact and similar to a V-8 engine in construction and components.

Engine Identification

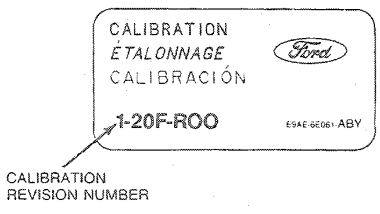
For quick engine identification, refer to the Safety Certification Decal. The decal is mounted on the LH front door lock face panel. Find the engine code (letter or number) on the decal, then refer to the engine identification chart to determine the engine type and size. An engine identification label is also attached to the engine. The symbol code on the identification tag identifies each engine for determining parts usage; for instance, engine cubic inch displacement and model year.

DESCRIPTION AND OPERATION (Continued)

Emission Calibration Label

The emission calibration number label is located on the LH side door or LH door post pillar. It identifies the engine calibration number, the engine code number and revision level. These numbers are used to determine if parts are unique to specific engines.

NOTE: It is imperative that the engine codes and the calibration number be used when ordering parts or making inquiries about the engine.



Induction System

The fuel/air mixture needed for burning in the cylinders is provided by sequential multiport fuel injection (SFI). Refer to Section 03-04A for SFI description and operation.

Fuel is supplied from the vehicle fuel tank by a high pressure electric fuel pump mounted in the fuel tank. The fuel is filtered and sent to the fuel injectors. A regulator on the fuel rail controls the fuel delivery pressure up to 269 kPa (39 psi). Excess fuel supplied by the pump, but not needed by the engine, is returned to the vehicle fuel tank by a fuel return line.

This fuel induction system is mounted on an aluminum intake manifold (9424) which in turn is bolted to cast iron cylinder heads.

Crankshaft and Camshaft

The crankshaft is supported on the bottom of the cylinder block by four steel-backed, over-plated copper-lead main bearings. To provide smooth engine operation, the piston crankpins are positioned to provide a power impulse every 120 degrees of crankshaft rotation. This spacing provides smoothness of operation and quietness. Two sprockets and a timing chain connect the crankshaft with the camshaft and provide a 2:1 drive ratio.

The camshaft is installed in the block and is supported on four bearing inserts. Thrust loads and end play are limited by a thrust plate installed on the front of the camshaft. The distributor or camshaft sensor (FF only) drive gear is located at the rear of the camshaft. The distributor or camshaft sensor (FF only) drive gear is part of the camshaft casting.

Valve Train

Hydraulic tappets, providing automatic lash adjustment, ride on camshaft lobes and transfer up and down motion to the rocker arms through push rods. The rocker arms are pedestal-mounted and pivot on fulcrums bolted to the cylinder head. The valves are arranged alternately, intake/exhaust.

Lubrication System

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft and connecting rod bearings, hydraulic tappets and camshaft bearings. From the tappets, a controlled volume of oil is supplied to the rocker arms through the hollow push rods. All other moving parts are lubricated by gravity flow or splash. The rotary spur-type pump, which develops the oil pressure, is bolted to the No. 4 main bearing cap. The spur driven gear is rotated by the distributor shaft through an intermediate shaft. A full-flow oil filter is externally mounted on the engine block and normally all engine oil passes through the filter element. However, if the element should become restricted, a spring-loaded bypass valve will open and allow an uninterrupted flow of oil to the engine's moving parts.

Moulded Silicone Rubber Gaskets

Many of the component mating surfaces which were formerly sealed with a cork gasket are being sealed with a moulded rubber silicone gasket. This gasket is used in the manufacture of the 3.0L engine and will be specified for service procedures.

Accessory Drive Belt System

Accessories mounted on the front of the engine are belt-driven by the crankshaft. A single 6k rib Poly-Vee drive belt is routed over the water pump, power steering pump, A/C compressor (if so equipped), generator, automatic tensioning pulley and the crankshaft pulley. For service refer to Section 03-05.

IN-VEHICLE SERVICE

Crankshaft Rear Oil Seal

A one-piece crankshaft rear main oil seal is used.

Tools Required:

- Jet Plug Remover T77L-9533-B
- Crankshaft Rear Seal Installer T88L-6701-A

Removal

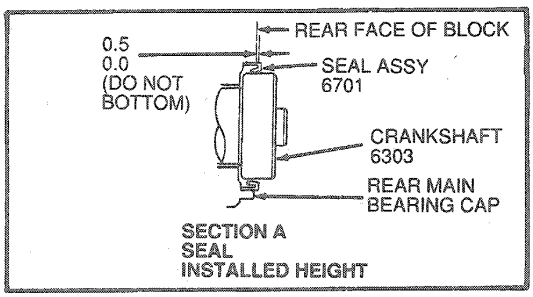
CAUTION: Use care to avoid scratching or damaging the oil seal surface.

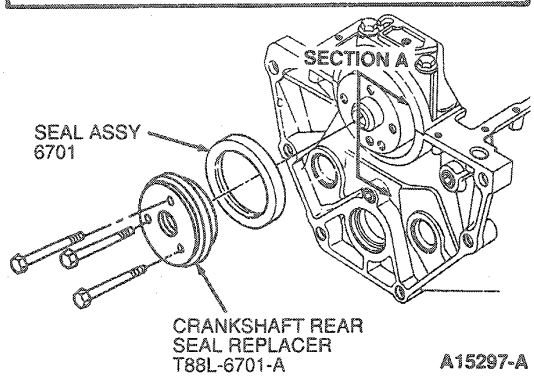
IN-VEHICLE SERVICE (Continued)

1. Using sharp awl, punch one hole into seal metal surface between the seal lip and the engine block.
2. Screw in the threaded end of Jet Plug Remover T77L-9533-B. Use the Jet Plug Remover to remove the seal.

Installation

1. Lubricate seal with engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent.
2. Position oil seal on Crankshaft Rear Seal Installer T88L-6701-A. Position tool and seal on rear of engine. Alternate bolt tightening to properly seat seal.





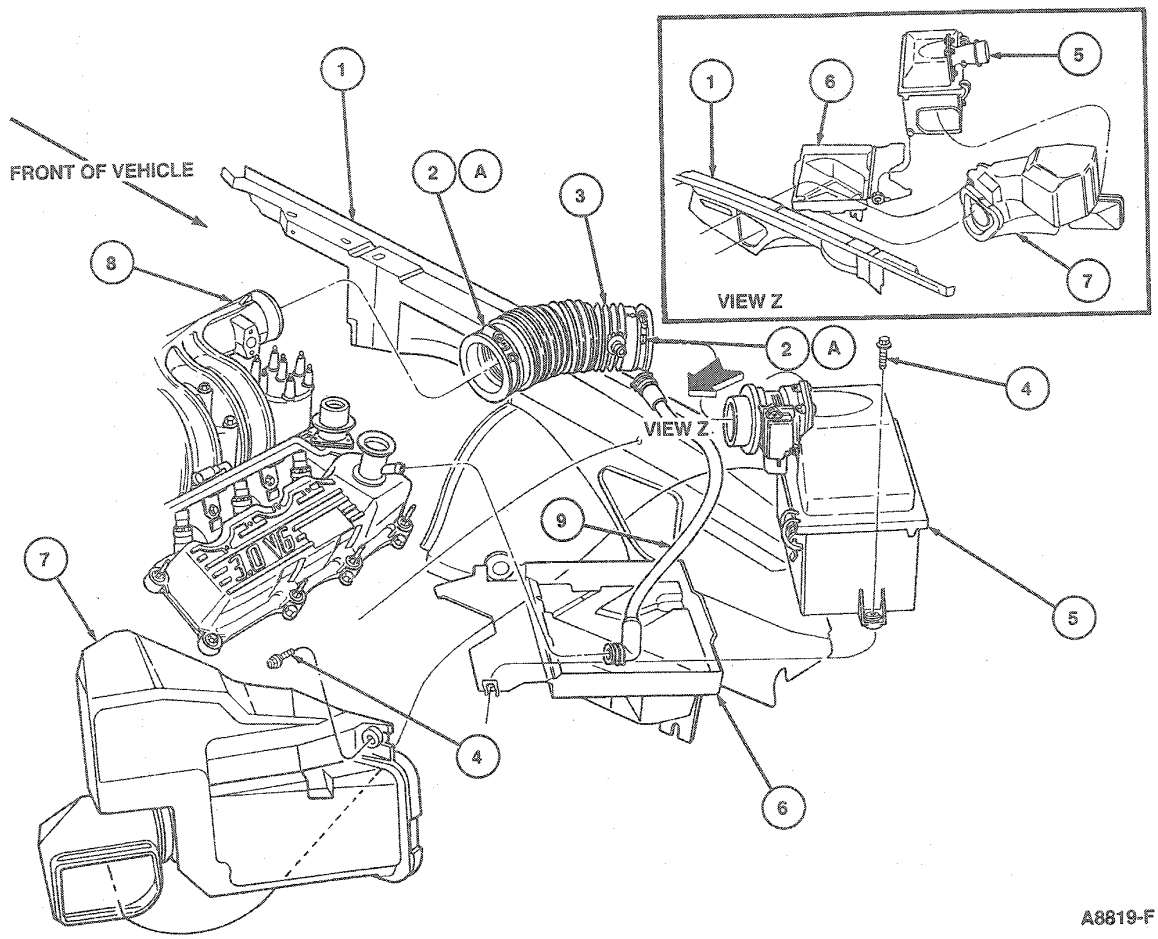
Throttle Body

WARNING: DO NOT MODIFY THE FUEL SYSTEM CONFIGURATION OR COMPONENTS, OR REPLACE COMPONENTS WITH PARTS NOT SPECIALLY DESIGNED FOR USE WITH FLEXIBLE FUEL. FORD MOTOR COMPANY HAS SPECIALLY-DESIGNED THE MATERIALS, COMPONENTS AND SYSTEM CONFIGURATION FOR FLEXIBLE FUELED VEHICLES AND EACH PARTICULAR SYSTEM IS PRECISELY CALIBRATED FOR EFFICIENT OPERATION. THE USE OF DIFFERENT PARTS OR MATERIALS COULD PRODUCE AN UNTESTED CONFIGURATION THAT COULD RESULT IN FIRE, PERSONAL INJURY, OR ENGINE DAMAGE.

Removal and Installation

1. Disconnect battery ground cable and set aside.
2. Loosen air cleaner clean air tube retaining clamps and remove air cleaner outlet tube (9B659).
3. Remove idle air control (IAC) valve (9F715) snowshield.

IN-VEHICLE SERVICE (Continued)



Item	Part Number	Description
1	—	Fender Apron
2A	8287	Hose Clamp (2 Req'd)
3	9B659	Air Cleaner Outlet Tube
4	N806709-S1413	Screw
5	9600	Air Cleaner Assy

(Continued)

Item	Part Number	Description
6	—	Battery Tray
7	9F763	Engine Air Intake Resonator
8	9E926	Throttle Body
9	6A664	PCV System Closure Tube
A		Tighten to 2.7-5.4 N·m (28-48 Lb-In)

4. Disconnect throttle cable from throttle body (TB) (9E926) lever.
5. Remove two throttle cable bracket retaining bolts from side of throttle body and remove bracket.
6. Mark location and remove vacuum hoses attached to vacuum tree and exhaust gas recirculation (EGR) valve.

   NOTE: 3.0L FF uses a differential pressure feedback EGR (DPFE) system.

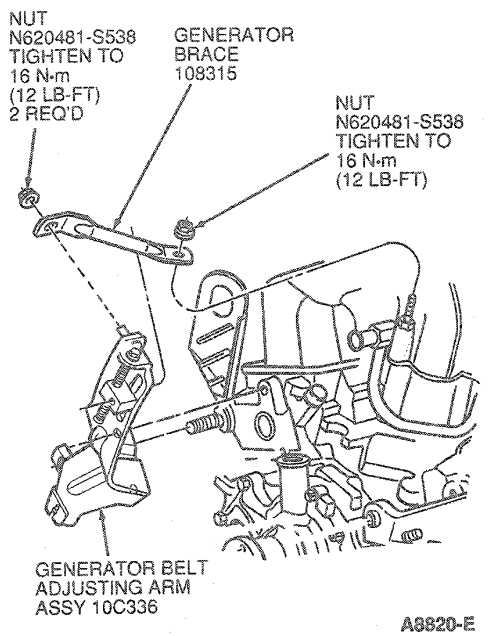
7. Disconnect pressure feedback EGR (PFE) sensor (9J460) hose from EGR tube.
8. Loosen EGR tube nuts at EGR valve and EGR valve tube to manifold connector (9F485). Remove or rotate tube out of the way.
9. Remove positive crankcase ventilation (PCV) hose from the tube underneath throttle body.

IN-VEHICLE SERVICE (Continued)

10. Disconnect electrical connections to the cold start injector (CSI) (9F880) (FF only), intake air temperature (IAT) sensor (12A697) (unleaded gasoline only), idle air control (IAC) sensor (9F715), PFE or DPFE sensor (depending on application) and throttle position (TP) sensors (9B989).
11. Remove generator brace retaining nuts from generator bracket and throttle body stud. Remove brace.

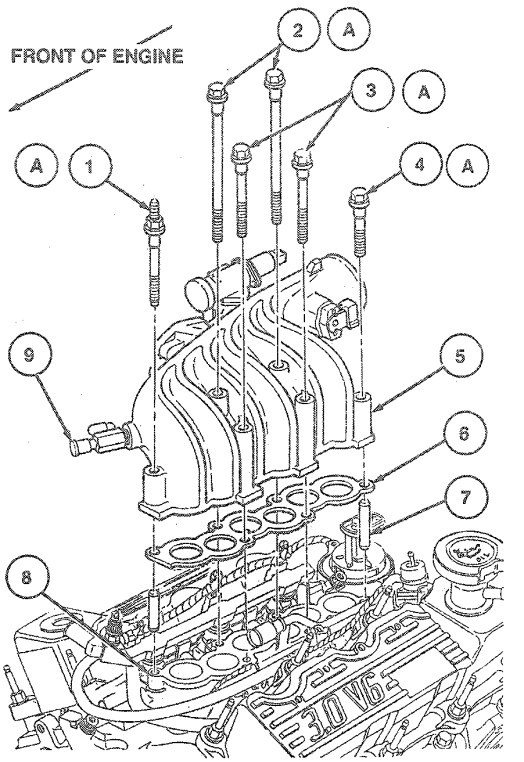
    WARNING: COVER VALVE WITH SHOP CLOTH TO PREVENT ACCIDENTAL FUEL SPRAY INTO EYES.
12. On FF only, remove fuel supply inlet and outlet hoses to cold start injector as outlined in Section 03-04A.

Unleaded Gasoline Shown, FF Similar



A8820-E

Unleaded Gasoline Only

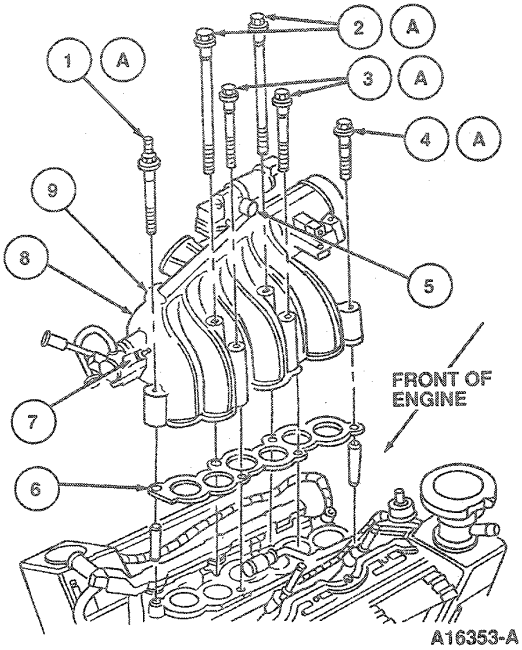


V7667-A

Item	Part Number	Description
1A	—	Stud Bolt
2A	—	Bolt M8 x 1.25 x 130 (2 Req'd)
3A	—	Bolt M8 x 1.25 x 100 (2 Req'd)
4A	—	Bolt M8 x 1.25 x 68
5	9E926	Throttle Body
6	9H486	Intake Manifold Upper Gasket
7	—	Guide Pin (2 Req'd)
8	9424	Intake Manifold
9	9A474	Intake Manifold Vacuum Outlet Fitting and Cap
A		Tighten to 20-30 N·m (15-22 Lb-Ft)

IN-VEHICLE SERVICE (Continued)

Flexible Fuel Vehicles Only



Item	Part Number	Description
1A	—	Stud Bolt
2A	—	Bolt M8 x 1.25 x 130 (2 Req'd)
3A	—	Bolt M8 x 1.25 x 100 (2 Req'd)
4A	—	Bolt M8 x 1.25 x 68
5	—	Purge Port
6	9H486	Intake Manifold Upper Gasket
7	9F880	Cold Start Injector
8	9E926	Throttle Body
9	9A474	Intake Manifold Vacuum Outlet Fitting and Cap
A		Tighten to 25 N·m (19 Lb-Ft)

13. Loosen and remove five throttle body retaining bolts and one stud bolt noting their locations.
14. Lift and remove throttle body assembly from intake manifold. Discard old intake manifold upper gasket (9H486).
15. If replacing throttle body, remove IAT (Unleaded Gasoline Only) or CSI (FF only), refer to Section 03-04A. Remove PFE or DPFE sensor and bracket, intake manifold vacuum outlet fitting and cap (9A474) and EGR valve assembly. Discard old EGR valve gasket.

Installation

NOTE: Lightly oil all bolt and stud bolt threads prior to installation.

CAUTION: Use care when cleaning gasket material as aluminum gouges easily.

1. Clean and inspect sealing surfaces of intake manifold and throttle body.
2. Install guide pins if available.
3. Place intake manifold upper gasket on intake manifold.
4. If throttle body was replaced, install IAT sensor (unleaded gasoline only), tighten to 20 N·m (15 lb-ft). Install CSI and gasket (FF only) as outlined in Section 03-04A, tighten bolts to 10 N·m (7 lb-ft). Install PFE or DPFE sensor and bracket 10 N·m (7 lb-ft), intake manifold vacuum outlet fitting and cap 11 N·m (8 lb-ft) and EGR valve assembly 25 N·m (19 lb-ft) with new gasket.
5. Aligning bolt holes, install throttle body on intake manifold. Install one stud bolt and five retaining bolts. Tighten to 20-30 N·m (15-22 lb-ft).
6. On 3.0L FF, install fuel supply inlet and outlet hoses to CSI as outlined in Section 03-04A.
7. Install generator brace to throttle body and generator bracket. Tighten nuts to 16 N·m (12 lb-ft).
8. Connect PCV hose to tube underneath throttle body.
9. Install EGR valve to exhaust manifold tube (9D477) to EGR valve and EGR valve tube to manifold connector. Tighten to 35-65 N·m (26-48 lb-ft).
10. Connect PFE sensor hose or DPFE sensor hoses (depending upon application) to EGR tube.
11. Connect vacuum hoses to their premarked locations.
12. Connect electrical connections to IAT (unleaded gasoline only), CSI (FF only), IAC, PFE or DPFE sensor and TP sensor.
13. Install throttle cable bracket. Tighten two retaining bolts to 17 N·m (13 lb-ft).
14. Connect throttle cable and speed control cable (if so equipped) to throttle body lever.
15. Connect air cleaner outlet tube to throttle body and engine air cleaner (9600). Tighten clamp to 2.7-5.4 N·m (28-48 lb-in).
16. Connect negative battery terminal.
17. Start engine and check for vacuum leaks.
18. Check engine idle. Adjust as necessary as described in the Powertrain Control/Emissions Diagnosis Manual[1].
19. Install snowshield onto idle air control valve. Tighten screws to 10 N·m (7 lb-ft).

Crankshaft Pulley/Damper/Front Oil Seal

Tools Required:

- Crankshaft Damper Remover T58P-6316-D

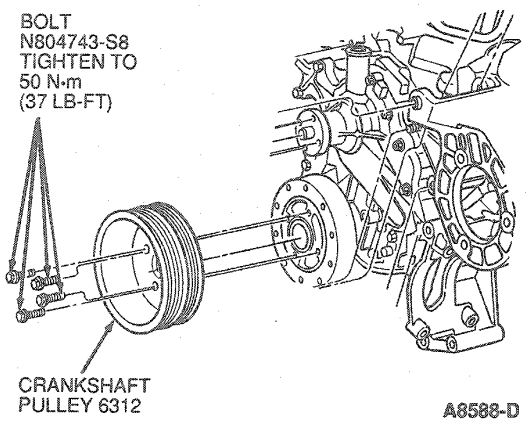
1 Can purchased as a separate item.

IN-VEHICLE SERVICE (Continued)

- Front Cover Seal Replacer T70P-6B070-A
- Vibration Damper and Seal Installer T82L-6316-A
- Vibration Damper Remover Adapter T82L-6316-B

Removal

1. Disconnect battery ground cable and set aside.
2. Remove accessory drive belt. Refer to Section 03-05.
3. Raise vehicle on hoist. Refer to Section 00-02.
4. Remove RH front wheel and tire assembly.
5. Remove four crankshaft pulley retaining bolts and remove pulley.



6. Remove crankshaft damper retaining bolt and washer.

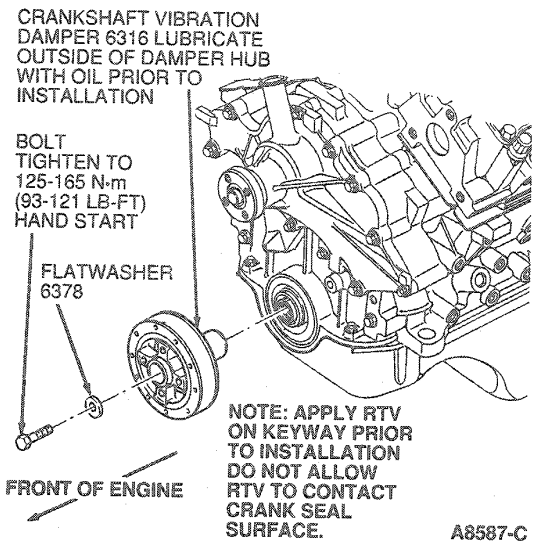
   CAUTION: Use care when removing damper so as not to damage crankshaft or create burrs.

7. Remove damper from crankshaft using Crankshaft Damper Remover T58P-6316-D and Vibration Damper Remover Adapter T82L-6316-B.

   CAUTION: Use care to prevent damage to front cover, crankshaft position sensor and crankshaft.

8. Remove front oil seal cover by prying seal from timing cover with a flat blade screwdriver or other similar tool.

Unleaded Gasoline Shown, FF Similar



Installation

Tool Required:

- Vibration Damper and Seal Installer T82L-6316-A

1. Inspect front cover and shaft seal surface of the crankshaft damper for damage, nicks, burrs or other roughness which may cause the new seal to fail. Service or replace components as necessary.
2. Lubricate seal lip with clean engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent and install seal using Vibration Damper and Seal Installer T82L-6316-A and Front Cover Seal Replacer T70P-6B070-A.
3. Coat crankshaft damper sealing surface with clean engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent. Apply Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A) or equivalent to keyway of damper prior to installation. Install damper using Vibration Damper and Seal Installer T82L-6316-A.
4. Install damper retaining bolt and washer. Tighten to 125-165 N·m (93-121 lb-ft).
5. Install crankshaft pulley and install four retaining bolts. Tighten retaining bolts to 40-60 N·m (30-44 lb-ft).
6. Install RH wheel and tire assembly. Refer to Section 04-04.
7. Lower vehicle.
8. Position drive belt over crankshaft pulley.
9. Check drive belt for proper routing and engagement in the pulleys. Refer to Section 03-05.
10. Connect battery ground cable.
11. Start engine and check for oil leaks.

IN-VEHICLE SERVICE (Continued)

Front Cover

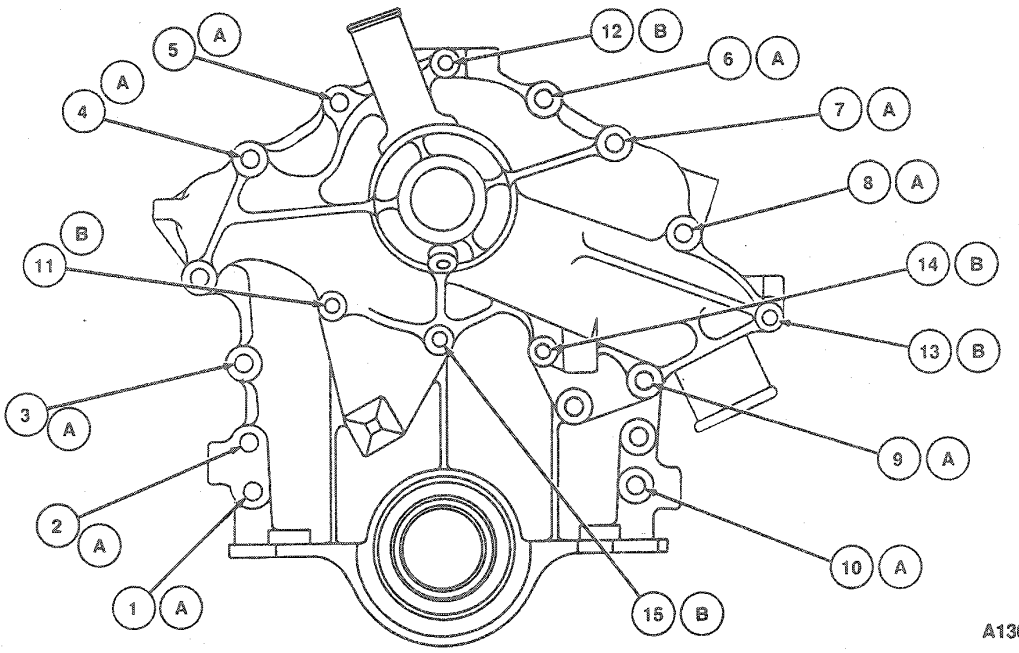
Removal

1. Disconnect battery ground cable.
2. Drain cooling system.
3. Loosen four water pump pulley bolts while 6K belt is in place.
4. Using a 1/2-inch drive breaker bar, rotate automatic belt tensioner to the right to remove 6K drive belt.
5. Remove 6K automatic belt tensioner bolt and nuts.
6. Remove lower radiator hose and heater hose.
7. Remove crankshaft pulley and damper as outlined.
8. Disconnect crankshaft position (CKP) sensor (6C315) wiring harness from sensor and locating stud (FF only).

   NOTE: Do not cut and seal oil pan gasket. Always replace with new rubber gasket.
9. Drain and remove oil pan as outlined. Discard removed gasket.
10. Remove retaining bolts from timing cover to block.

    NOTE: The timing cover and water pump may be removed as an assembly by not removing bolt numbers 11 through 15 as shown.

Unleaded Gasoline Shown, FF Similar



A13096-B

FASTENER AND HOLE NO.	FASTENERS			TORQUE SPECIFICATIONS	
	PART NO.	SIZE	FASTENER APPLICATION	N·m	LB-FT
1	N804113-S8	M8 x 1.25 x 43.5	F/C TO BLOCK	20-30	15-22
2	N804113-S100	M8 x 1.25 x 43.5	F/C TO BLOCK	20-30	15-22
3	N804811-S100	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22
4	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22
5	N605909-S8	M8 x 1.25 x 42	F/C TO BLOCK	20-30	15-22
6	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22
7	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22

(Continued)

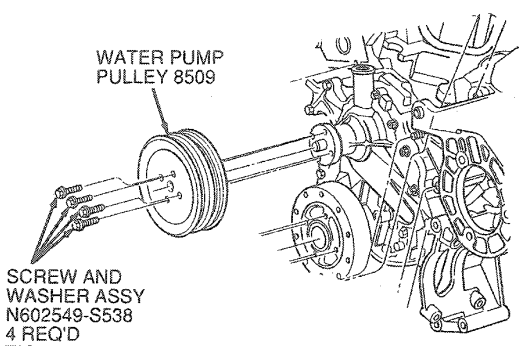
IN-VEHICLE SERVICE (Continued)

FASTENER AND HOLE NO.	FASTENERS			TORQUE SPECIFICATIONS	
	PART NO.	SIZE	FASTENER APPLICATION	N·m	LB-FT
8	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22
9	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22
10	N606543	M8 x 1.25 x 52	F/C TO BLOCK	20-30	15-22
11	N804168-S8	M6 x 1 x 25	W/P TO F/C	8-12	71-106 (lb-in)
12	N804168-S8	M6 x 1 x 25	W/P TO F/C	8-12	71-106 (lb-in)
13	N804168-S8	M6 x 1 x 25	W/P TO F/C	8-12	71-106 (lb-in)
14	N804168-S8	M6 x 1 x 25	W/P TO F/C	8-12	71-106 (lb-in)
15	N804168-S8	M6 x 1 x 25	W/P TO F/C	8-12	71-106 (lb-in)

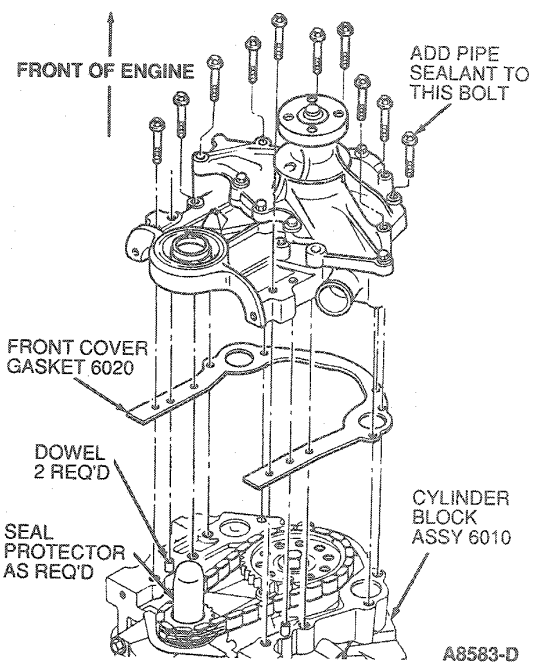
W/P—Water Pump Assy

F/C—Front Cover Assy

11. Carefully remove assembly from block. After cover is away from engine block, remove water pump pulley and bolts.



A15380-A



A8583-D

Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation except those specifying special sealant.

CAUTION: Aluminum gouges easily, use care when scraping gasket from cover.

1. Carefully clean all gasket material from timing cover and cylinder block.
2. Clean RTV from cylinder block to oil pan and timing cover mating surfaces.
3. Inspect timing cover crankshaft seal for wear or damage. Replace if necessary.
4. Align timing cover gasket over cylinder block dowels.
5. Install crankshaft seal protector onto crankshaft if available.

IN-VEHICLE SERVICE (Continued)

6. Install timing cover / water pump assembly onto cylinder block with water pump pulley loosely attached to water pump hub.
7. Hand start cover retaining bolts. Apply Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent to bolt numbers 1, 2 and 3 as illustrated.
8. Tighten retaining bolt numbers 1 through 10 to 25 N·m (19 lb-ft) and numbers 11 through 15 to 10 N·m (7 lb-ft).
9. Clean inside of oil pan and install as outlined. Tighten retaining bolts to 10-14 N·m (8-10 lb-ft).
10. Hand tighten water pump pulley retaining bolts.
11. Install crankshaft damper and pulley as outlined. Tighten damper bolt to 125-165 N·m (93-121 lb-ft) and the four pulley bolts to 20-30 N·m (15-22 lb-ft).
12. If camshaft position (CKP) sensor was removed from front cover (3.0L FF only), install sensor and tighten retaining bolts to 5-7 N·m (44-61 lb-in).
13. Install automatic belt tensioner. Tighten two retaining nuts and bolt to 48 N·m (35 lb-ft).
14. Install 6K accessory drive belt as outlined in Section 03-05. Tighten water pump pulley retaining bolts to 20-30 N·m (15-22 lb-ft).
15. Install lower radiator hose and heater hose. Clamp securely.
16. Fill and bleed cooling system.
17. Fill crankcase with correct viscosity and amount of engine oil.
18. Connect battery ground cable.
19. Start engine and check for cooling, exhaust and oil leaks.

Water Pump

Removal

1. Disconnect battery ground cable and set aside.
2. Drain cooling system.
3. Loosen four water pump pulley retaining bolts while accessory drive belts are still tight.
4. Using a 1/2-inch breaker bar, rotate automatic tensioner to the right. Remove 6K belt.
5. Remove two nuts and one bolt retaining automatic belt tensioner to engine. Remove the assembly.
6. Disconnect and remove heater hose from water pump. Remove CKP sensor wire harness from locating stud (FF only).
7. Remove 11 water pump to engine retaining bolts.
8. Lift water pump and pulley up and out of vehicle.

Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation except those specifying special sealant.

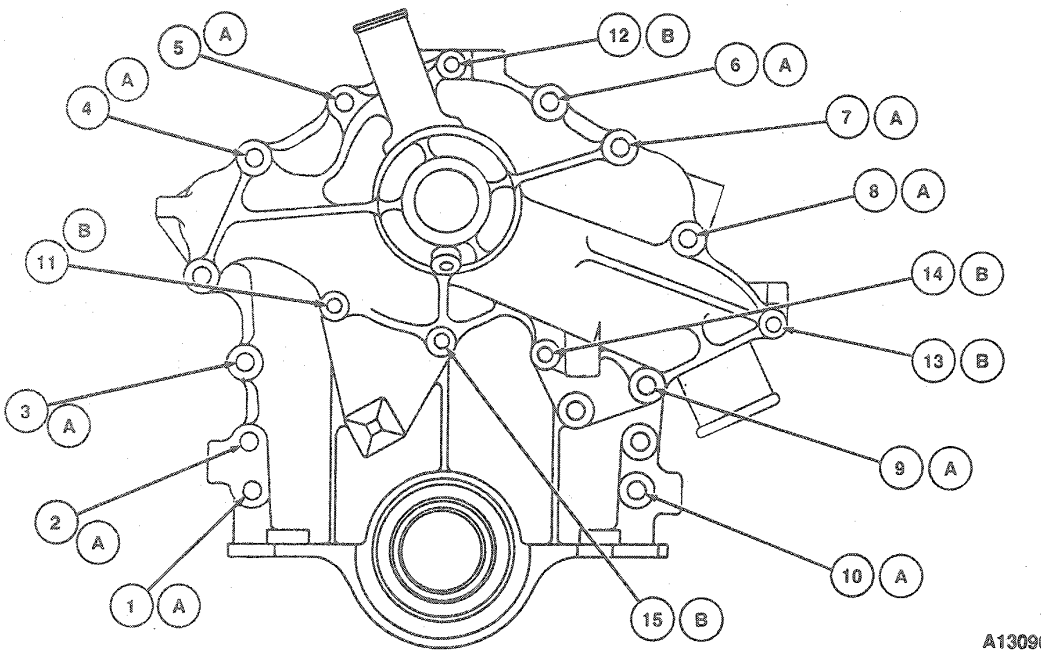
CAUTION: Use care when scraping as aluminum gouges easily which may form leak paths.

1. Clean gasket surfaces on water pump and front cover.
2. Position a new gasket on water pump sealing surface using Gasket and Trim Adhesive D7AZ-19B508-AA (ESR-M11P17-A and ESE-M2G52-A) or equivalent to hold the gasket in place.
3. With pulley loosely positioned on water pump hub, align water pump to timing cover and install retaining bolts.

   NOTE: Apply Pipe Sealant Vibraseal 516 EST-M4G208-B or equivalent to bolt No. 3 (as illustrated) prior to installation.
4. Tighten retaining bolts as follows: No. 3, 4, 6, 7, 8, 9 and 10 to 20-30 N·m (15-22 lb-ft), and No. 11, 12, 13, 14 and 15 to 8-12 N·m (71-106 lb-in). Install CKP sensor wire harness (FF only).
5. Hand tighten water pump pulley retaining bolts.
6. Install automatic belt tensioner assembly. Tighten two retaining nuts and bolt to 48 N·m (35 lb-ft).
7. Install the 6K accessory drive belt as outlined in Section 03-05. Tighten water pump pulley retaining bolts to 20-30 N·m (15-22 lb-ft).
8. Install heater hose. Clamp securely.
9. Fill and bleed cooling system with specified quantity and type coolant.
10. Connect battery ground cable.
11. Start engine and check for coolant and oil leaks.

IN-VEHICLE SERVICE (Continued)

Unleaded Gasoline Shown, FF Similar



A13096-B

FASTENER AND HOLE NO.	FASTENERS			TORQUE SPECIFICATIONS	
	PART NO.	SIZE	FASTENER APPLICATION	N·m	Lb-Ft
1	N804113-S8	M8 x 1.25 x 43.5	F/C TO BLOCK	20-30	15-22
2	N804113-S100	M8 x 1.25 x 43.5	F/C TO BLOCK	20-30	15-22
3	N804811-A100	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22
4	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22
5	N605909-S8	M8 x 1.25 x 42	F/C TO BLOCK	20-30	15-22
6	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22
7	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22
8	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22
9	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK	20-30	15-22
10	N606543	M8 x 1.25 x 52	F/C TO BLOCK	20-30	15-22
11	N804168-S8	M6 x 1 x 25	W/P TO F/C	8-12	71-106 (lb-in)
12	N804168-S8	M6 x 1 x 25	W/P TO F/C	8-12	71-106 (lb-in)
13	N804168-S8	M6 x 1 x 25	W/P TO F/C	8-12	71-106 (lb-in)
14	N804168-S8	M6 x 1 x 25	W/P TO F/C	8-12	71-106 (lb-in)
15	N804168-S8	M6 x 1 x 25	W/P TO F/C	8-12	71-106 (lb-in)

W/P—Water Pump Assy
F/C—Front Cover Assy

T/P—Timing Pointer

IN-VEHICLE SERVICE (Continued)

Rocker Arm Cover

NOTE: The rocker arm covers have integral (built-in) gaskets which should last the life of the vehicle. Follow the steps provided should removal become necessary.

Removal

1. Disconnect battery ground cable and set aside.
2. With a turning motion, disconnect ignition wires from spark plugs.
3. Remove ignition wire/separator assembly from rocker arm cover retaining studs and move out of the way.
4. If LH rocker arm cover is being removed perform the following:
   - Disconnect PCV system closure tube.
   - Remove oil fill cap (if replacing cover).
   - Remove fuel injector harness stand-offs from inboard rocker arm cover studs. Move harness out of the way.
5. If RH rocker arm cover is being removed, perform the following:
   - Remove throttle body as outlined.
   - Loosen lower EGR tube retaining nut and rotate EGR valve to exhaust manifold tube out of the way.
   - Remove PCV valve (if replacing cover).
   - Remove fuel injector harness stand-offs from inboard rocker arm cover studs.
   - Move fuel injector harness out of the way.
6. Loosen rocker arm cover retaining bolts and studs and then carefully slide a sharp, thin bladed knife between cylinder head and rocker cover gasket at the rail step where the intake manifold mates to the cylinder head (two places each side). Cut only the RTV sealer and not the integral gasket, then remove cover making sure the RTV sealer does not pull the integral gasket from the cover.

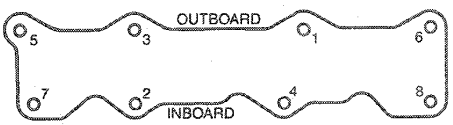
Installation

CAUTION: Check gasket for correct installation. New gasket will lay flat to the rocker cover in both the channel and fastener areas. If the gasket is installed incorrectly, oil leakage will occur.

NOTE: Lightly oil all bolt and stud threads before installation. Using solvent, clean cylinder head and rocker arm cover sealing surfaces to remove all silicone sealer and dirt.

1. Apply bead of Silicone Gasket and Sealant F1AZ-19562-A (WSE-M4G320-A2) or equivalent at cylinder head to intake manifold rail step (two places per rail) as shown.

   CAUTION: Use a straight down approach when installing rocker cover. Any adjustment after RTV sealer contact can roll gasket from cover channel resulting in leaks.
2. Position cover on the cylinder head and hand tighten retaining bolts and studs. Then, tighten in sequence to 10-14 N·m (8-10 lb-ft).



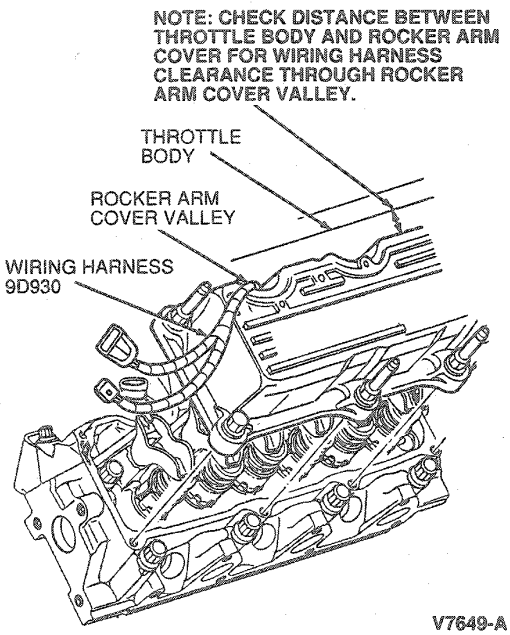
TIGHTENING SEQUENCE — ROCKER ARM COVER A14927-A

3. If LH rocker arm cover is being installed, perform the following:
   - Install oil fill cap (if removed).
   - Connect PCV system closure tube to nipple.
   - Install fuel injector harness stand-offs to the appropriate inboard rocker arm cover studs (two required).
4. For unleaded gasoline only, if RH rocker arm cover is being installed perform the following:
   - Install fuel injector harness stand offs to the appropriate inboard rocker arm cover studs (two required).
   - Install throttle body as outlined.
   - Install PCV valve and connect hoses.
   - Connect EGR valve to exhaust manifold tube to EGR valve. Tighten both retaining nuts to 50 N·m (37 lb-ft).

IN-VEHICLE SERVICE (Continued)

For FF only, if RH rocker cover is being installed, perform the following:

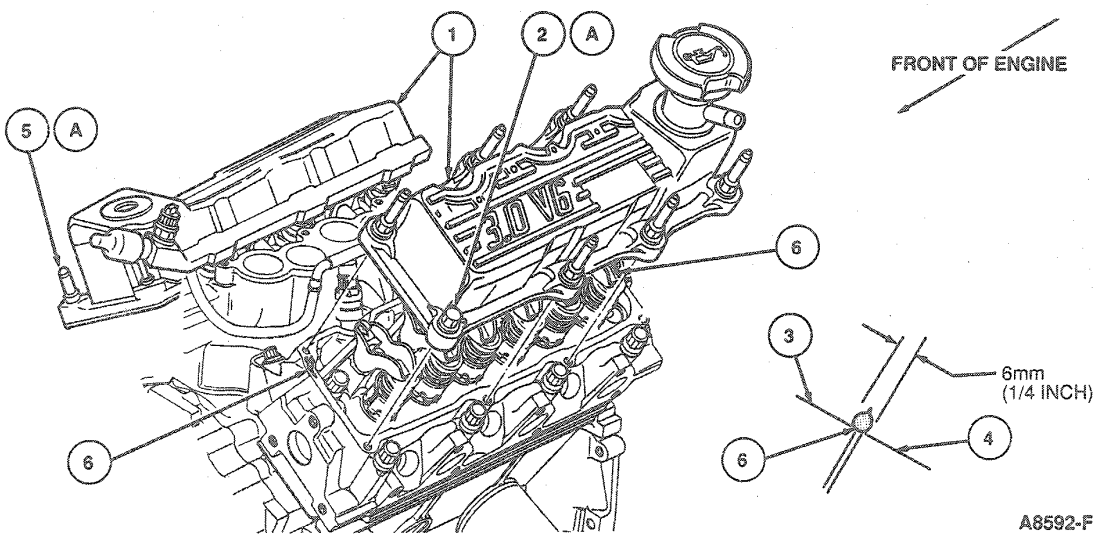
CAUTION: Fuel charging wiring (9D930) connection must face the RH shock tower. Damage may occur to injector and fuel charging wiring if operation is not done.



- Position fuel charging wiring through valley of rocker covers to supply needed clearance.
- Install throttle body as outlined.
- Install PCV valve and connect hoses.
- Connect EGR valve to exhaust manifold tube to EGR valve. Tighten both retaining nuts to 50 N·m (37 lb-ft).

5. Connect ignition wires to spark plugs. Install ignition wire separator stand-offs to the appropriate rocker arm cover studs (three each side).
6. Connect battery ground cable.
7. Start engine and check for oil and vacuum leaks.

Unleaded Gasoline Shown, FF Similar



IN-VEHICLE SERVICE (Continued)

Item	Part Number	Description
1	6A505 LH 6582 RH	Valve Rocker Arm Cover Assy
2A	—	Bolt (2 Req'd)
3	9424	Lower Intake Manifold
4	6049	Cylinder Head Assy

(Continued)

Item	Part Number	Description
5A	—	Stud (6 Req'd)
6	F1AZ-19562-A	Silicone Rubber (2 Places Each Side)
A		Tighten to 10-14 N·m (8-10 Lb-Ft)

TA8592F

Rocker Arm Cover Gasket

Replacement

1. Remove integral gasket by pulling from rocker cover gasket channel. Note bolt / stud locations before removing gasket as fasteners are secured by gasket.
2. Clean gasket channel with soft cloth to remove all dirt.
3. Using a suitable solvent, clean off any remaining RTV sealant.

   CAUTION: Check gasket for correct installation. New gasket will lay flat to the rocker cover in both the channel and fastener areas. If the gasket is installed incorrectly, oil leakage will occur.
4. Aligning fastener holes, lay new gasket onto channel and install with finger.
5. Install gasket to each fastener by securing fastener head with a nut driver or socket. Seat fastener against cover and, at the same time, roll gasket around fastener collar. If installed correctly, all fasteners will be secured by gasket and will not fall out.

Intake Manifold

Removal

1. Disconnect battery ground cable and set aside.
2. Drain engine cooling system.
3. Remove PCV system closure tube from rocker arm cover and air cleaner outlet tube.
4. Remove aspirator hose from air cleaner outlet tube. Remove engine air cleaner from throttle body and air cleaner outlet tube.

   WARNING: COVER VALVE WITH SHOP CLOTH TO PREVENT ACCIDENTAL FUEL SPRAY INTO EYES.
5. Carefully relieve fuel system pressure at fuel pressure relief Schrader valve. Refer to Section 10-01.
6. Remove fuel line clips. Disconnect fuel lines as outlined.
7. Mark locations of vacuum lines and remove.
8. Disconnect IAT and distributor connectors (unleaded gasoline only). Disconnect CSI and camshaft sensor connectors (FF only). On either model, disconnect TP, IAC, ECT, ignition coil, coolant temperature sending unit and PFE or DPFE sensor electrical connectors.
9. Disconnect upper radiator hose from thermostat housing. After loosening retaining clamp, use a twisting motion on hose to loosen from housing.
10. Remove brace spanning from generator bracket to throttle body stud.
11. Remove throttle body as outlined in this section.
12. Loosen EGR tube retaining nut and remove from EGR valve to exhaust manifold tube from exhaust manifold.
13. Disconnect fuel injector harness retaining stand offs from inboard rocker arm cover studs. Carefully disconnect electrical connections to each injector and remove fuel charging wiring from engine.
14. Disconnect heater hoses.
15. Remove ignition wires from spark plugs using a twisting motion on rubber boot. Remove harness retaining stand offs from rocker arm cover studs.

    CAUTION: DO NOT remove or disturb the camshaft sensor during the disassembly process. On 3.0L FF the camshaft sensor position is NOT adjustable and requires specialized tools to correctly index to camshaft position.
16. On unleaded gasoline only, mark distributor housing to block and note rotor position. Remove distributor retaining bolt and washer. Remove distributor.
17. Remove ignition coil from rear of LH cylinder head.
18. Remove rocker arm covers as outlined.
19. Loosen cylinder No. 3 intake valve rocker arm retaining nut and rotate arm off of push rod and away from top of valve stem. Remove push rod.

    NOTE: Intake manifold assembly may be removed with fuel supply manifold and injectors in place.

IN-VEHICLE SERVICE (Continued)

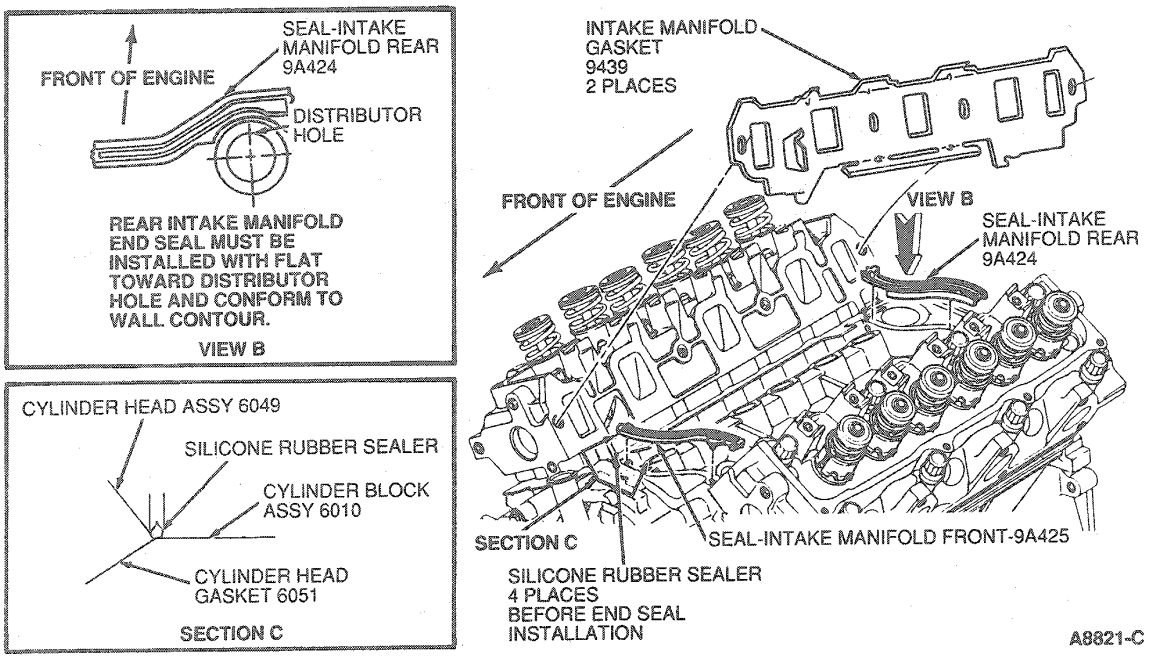
20. Remove intake manifold retaining bolts using a Torx® head socket. Before attempting to remove intake manifold, break seal between manifold and cylinder block. Wedge a large screwdriver or similar tool between intake manifold and block. Pry upward on tool using area between thermostat and transaxle as a leverage point.

Installation

NOTE: Lightly oil all retaining bolt and stud bolt threads before installation.

CAUTION: Aluminum components gouge easily which may cause gasket leaks. Always use care when scraping aluminum gasket surfaces.

1. Clean mating gasket surfaces of intake manifold and cylinder head. Lay a clean cloth or shop cloth in tappet valley to catch any gasket material. After scraping, carefully lift cloth from tappet valley preventing any particles to enter oil drain holes or cylinder head. Use a suitable solvent to remove old rubber sealant.
2. If installing a new intake manifold, transfer ECT sensor, thermostat, gasket and housing, heater hose elbow and coolant temperature sending unit to new manifold as outlined.
3. If removed, install fuel supply manifold. Apply lubricant XO-10W30-QSP (ESE-M2C153-E) or equivalent oil lightly to fuel injector rubber O-rings before installation. Install injectors into fuel supply manifold. Carefully align manifold assembly to intake manifold injector holes. Push one side into place at a time until manifold "clicks" into place. Install fuel supply manifold retaining bolts and tighten to 8-12 N·m (71-106 lb-in).



4. Apply a 5-6mm (1/4-inch) drop of Silicone Rubber D6AZ-19562-AA or BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent to intersection of cylinder block and cylinder head assembly at four corners as shown.
5. Position intake gaskets onto cylinder heads. Align intake gasket locking tabs to provisions on cylinder head gaskets as shown.
6. Install front and rear intake manifold seals as shown. Secure with retainers.

7. Carefully lower intake manifold into position aligning manifold bolt holes to those in cylinder head. Use care to prevent disturbing rubber sealer which can cause sealing voids. Install bolts No. one, two, three and four and hand tighten . Install remaining bolts and tighten in a two step process. Tighten in numerical sequence to 20-30 N·m (15-22 lb-ft), then again in sequence to 26-32 N·m (19-24 lb-ft).

IN-VEHICLE SERVICE (Continued)

8. On unleaded gasoline only, coat distributor gear teeth with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Install distributor and align to premarked location on cylinder block and rotor position. Install retaining bolt and washer and hand tighten.
9. Apply engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent to cylinder No. 3 intake valve push rod and rocker arm. Install push rod. Move rocker arm into position with push rod and snug retaining bolt. Rotate crankshaft to position camshaft lobe straight down and away from valve lifter. Tighten retaining bolt to 7-15 N·m (5-11 lb-ft) to seat rocker arm fulcrum into cylinder head. Final tighten bolt to 26-38 N·m (19-28 lb-ft) in any position.

   NOTE: Fulcrum must be fully seated into cylinder head and push rod must be fully seated in rocker arm and lifter sockets prior to final tightening.
10. Install rocker arm covers as outlined in this section.
11. Install fuel charging wiring to each injector. Secure with stand offs to inboard rocker arm cover studs.
12. Install ignition coil to rear of LH cylinder head. Tighten retaining bolts to 40-55 N·m (29-41 lb-ft).
13. Install distributor cap and ignition wires (unleaded gasoline only). Install wire harness stand offs to rocker arm cover studs and connect wires to spark plugs and ignition coil.
14. Install throttle body assembly and new intake manifold upper gasket as outlined.
15. Install EGR valve to exhaust manifold tube from exhaust manifold (9430) to EGR valve. Tighten retaining nuts to 35-65 N·m (26-48 lb-ft).
16. Install fuel lines. Refer to Section 03-04A.
17. Install fuel line safety clips.
18. Install upper radiator hose and heater hoses. Tighten retaining clamps securely.
19. Connect vacuum lines to premarked locations.
20. Connect electrical connections to IAT and distributor (unleaded gasoline only), CSI and camshaft sensor (FF only). Connect electrical connections to IAC, TP, ECT, PFE or DPFE sensor, ignition coil and coolant temperature sending unit.
21. Fill and bleed cooling system with specified coolant and proper mixture.

    CAUTION: Engine coolant is corrosive to all engine bearing material. Replacing oil after removal of a coolant carrying component prevents damage.
22. Fill crankcase with correct viscosity and amount of engine oil.
23. Install air cleaner outlet tube to throttle body and engine air cleaner. Tighten retaining clamps to 2.7-5.4 N·m (24-48 lb-in).
24. Install PVC system closure tube to rocker arm cover and air cleaner outlet tube provisions. Install aspirator hose to air cleaner outlet tube.
25. Connect battery ground cable.
26. Start engine and check for coolant, oil, fuel and vacuum leaks.

    NOTE: FF base initial engine timing is not adjustable.
27. Verify and if necessary, correct base initial engine timing to 10 degrees BTDC. Refer to the Powertrain Control / Emissions Diagnosis Manual[2]. Tighten distributor retaining bolt to 24 N·m (18 lb-ft).
28. Install idle air control valve snowshield.

Thermostat

Removal

1. Drain cooling system.
2. Remove upper radiator hose from thermostat housing.
3. Remove three retaining bolts.
4. Remove housing and thermostat as an assembly.

   CAUTION: Aluminum gouges easily which forms leak paths. Use care when scraping.
5. Discard gasket. Rotate thermostat counterclockwise and remove from housing. Clean sealing surfaces with gasket scraper.

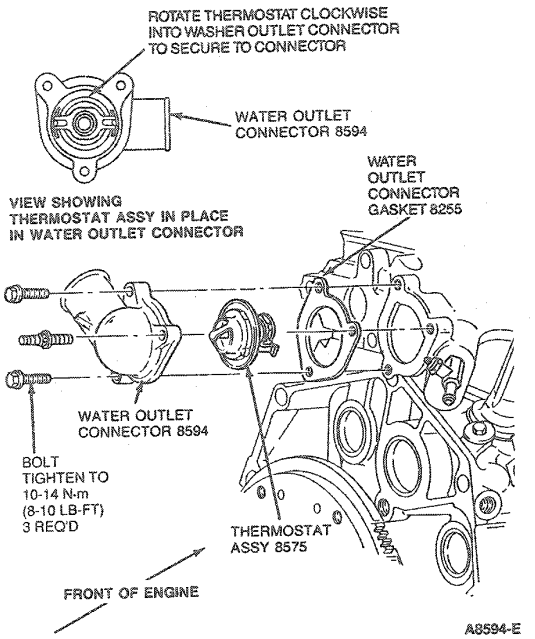
Installation

1. Sealing surfaces must be totally free of gasket material.
2. Install thermostat into housing with valve facing up. Rotate thermostat clockwise to lock into housing. Note location of jiggle valve in relation to housing (up).
3. Position gasket onto housing using bolts as a holding device. Install assembly and tighten bolts to 10-14 N·m (8-10 lb-ft).
4. Install upper radiator hose. Tighten clamp securely.
5. Fill and bleed cooling system with proper amount and mixture.

2 Can be purchased as a separate item.

IN-VEHICLE SERVICE (Continued)

6. Start engine and check for coolant leaks.



Cylinder Heads

Removal

1. Rotate crankshaft to 0 degrees TDC on the compression stroke.
2. Disconnect battery ground cable and set aside.
3. Drain cooling system.
4. Remove air cleaner outlet tube to throttle body.
5. Mark and remove vacuum lines to throttle body.
6. Disconnect PFE or DPFE hose(s) from EGR tube, loosen lower EGR tube nut and rotate EGR valve to exhaust manifold tube away from valve.
7. Disconnect the IAT sensor (unleaded gasoline only), CSI (FF only), TP, IAC, and PFE or DPFE sensor electrical connectors.

   WARNING: COVER VALVE WITH SHOP RAG TO PREVENT ACCIDENTAL FUEL SPRAY INTO EYES.
8. Relieve pressure at the fuel pressure relief Schrader valve. Refer to Section 03-04A.
9. Remove fuel line safety clips.

   CAUTION: Cover fuel line ends with clean shop cloths to prevent dirt from entering opening.
10. Disconnect fuel lines as outlined. Refer to Section 03-04A.
11. Remove throttle body as outlined. Discard old gasket.
12. Disconnect fuel injector harness stand-offs from inboard rocker arm cover retaining studs and each injector and remove from engine.

    NOTE: Injectors and fuel supply manifold may be removed with intake manifold as an assembly.
13. Remove fuel supply manifold and injectors.
14. With a twisting motion, remove ignition wires from spark plugs. Remove harnesses from rocker arm cover retaining studs.
15. Remove ignition coil and bracket from LH front cylinder head and set aside.
16. Disconnect upper radiator and heater hoses.
17. Remove distributor cap rubber boot (unleaded gasoline only).
18. On unleaded gasoline only, mark distributor housing to block, remove distributor cap and note rotor position.
19. On unleaded gasoline only, disconnect distributor ignition (DI) module electrical connector. Remove distributor assembly.
20. Disconnect engine coolant temperature (ECT) sensor and temperature sending unit electrical connectors.
21. If LH (front) cylinder head is being removed, perform the following:
    - Disconnect generator electrical connectors.
    - Using a 1/2-inch breaker bar, rotate 6K belt tensioner clockwise. Remove 6K belt.
    - Remove 6K automatic belt tensioner assembly.
    - Remove generator.
    - Remove power steering support bracket and pump as an assembly and set aside in a position to prevent fluid from leaking out.
    - Remove engine oil dipstick tube retaining nut from exhaust manifold stud. Rotate or remove tube from manifold.
22. If RH (rear) cylinder head is being removed, perform the following:
    - Remove generator belt tensioner bracket.
    - Remove heater supply tube retaining brackets from exhaust manifold (9431).
    - Remove vehicle speed sensor (VSS) (9E731) cable retaining bolt.
    - Remove EGR vacuum regulator (EVR) sensor (9D856) and bracket.
23. Remove rocker arm covers as outlined.

    NOTE: Regardless of cylinder head removal order, the No. 3 cylinder intake valve push rod must be removed to allow removal of intake manifold.
24. Loosen rocker arm fulcrum retaining bolts enough to allow the rocker arm to be lifted off the push rod and rotated to one side.

IN-VEHICLE SERVICE (Continued)

25. Remove push rods. Identify the position of each rod. The rods should be installed in their original position during assembly.
26. Remove intake manifold as outlined in this section.
27. Remove spark plugs.
28. Remove exhaust manifolds as outlined in this section.
29. Remove cylinder head retaining bolts and discard.
30. Remove cylinder head(s).
31. Remove and discard the old cylinder head gasket(s).

Installation

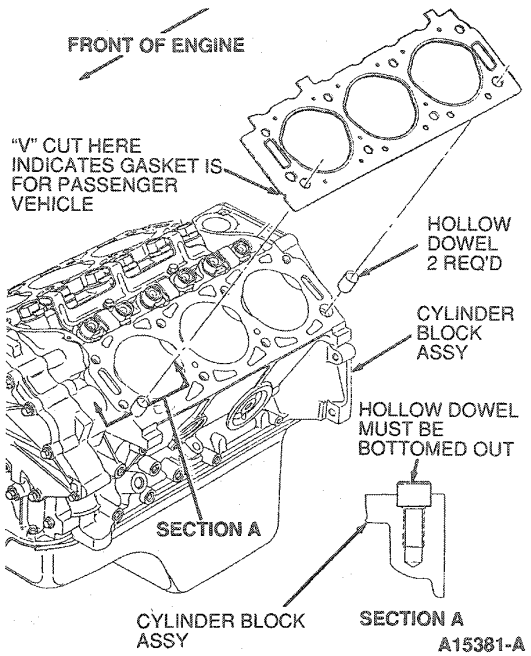
CAUTION: Always use new cylinder head bolts when installing cylinder head.

NOTE: Lightly oil all bolt and stud bolt threads before installation except those specifying special sealant.

CAUTION: Use care when scraping aluminum surfaces to prevent gouging which may cause leak paths.

1. Place shop cloth in lifter valley to catch any dirt or gasket material. Clean cylinder head, intake manifold, rocker arm cover and cylinder head gasket surfaces. If the cylinder head was removed for a cylinder head gasket replacement, check the flatness of the cylinder head and block gasket surfaces. Refer to Section 03-00.
2. Position new head gasket(s), noting UP designation on gasket face, on cylinder block using the dowels for alignment.

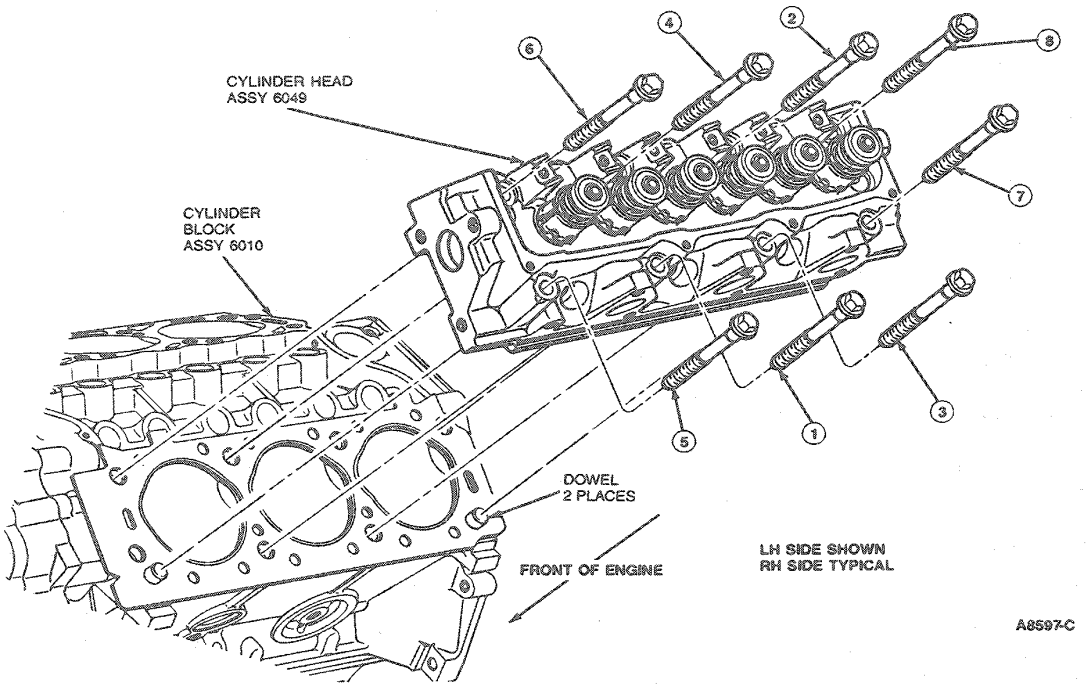
   NOTE: Replace dowels if damaged.



3. Position cylinder head(s) on block over dowels.
4. Install new cylinder head retaining bolts. Tighten retaining bolts in sequence shown to 80 N·m (59 lb-ft), then back off bolts 360 degrees.

IN-VEHICLE SERVICE (Continued)

5. Tighten the cylinder head retaining bolts in two final tightening steps in the following sequence:
   - 50 N·m (37 lb-ft)
   - 92 N·m (68 lb-ft)

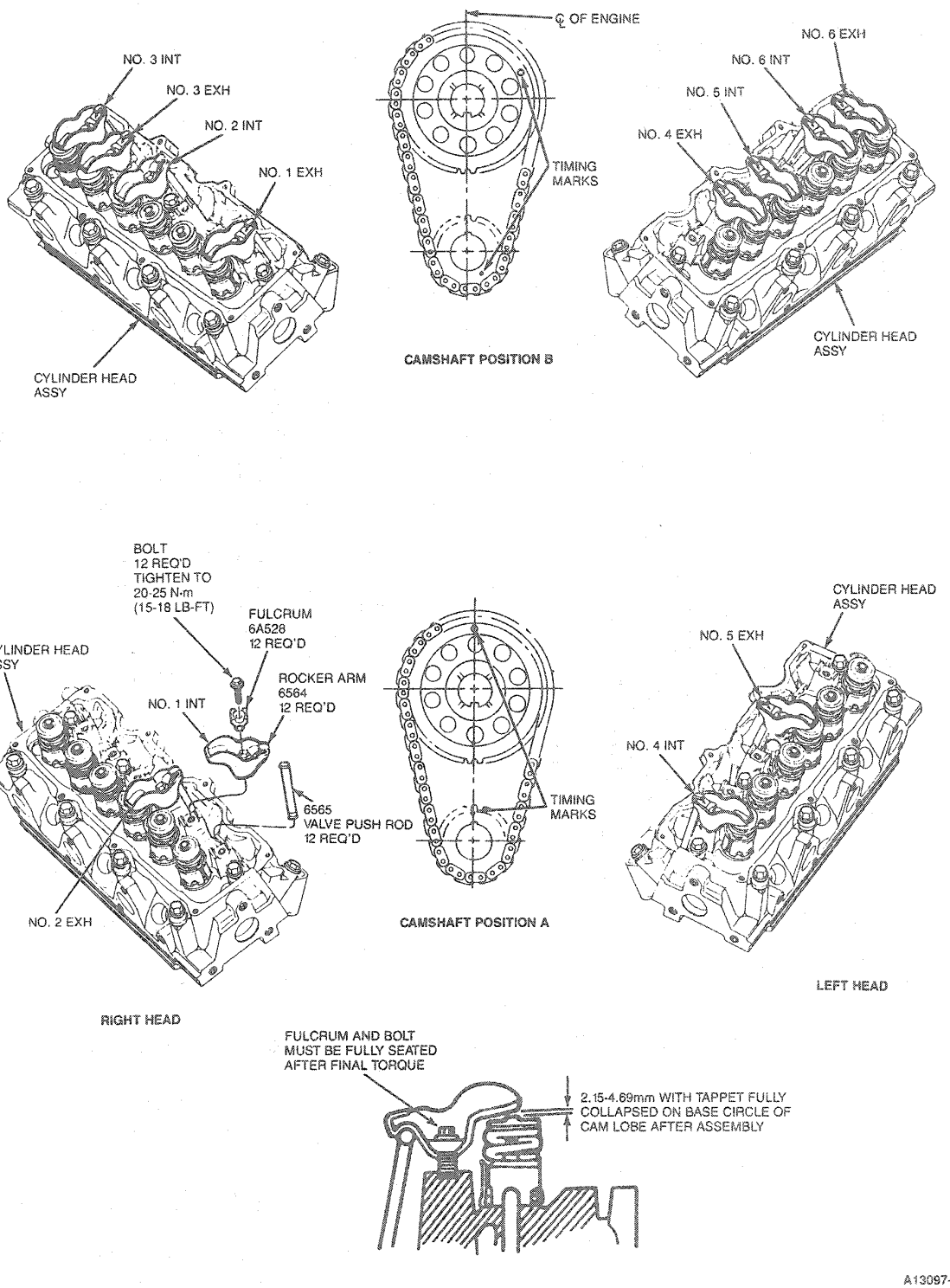


NOTE: When cylinder head retaining bolts have been tightened using the above procedure, it is not necessary to retighten the bolts after extended engine operation. However, the bolts can be checked for tightness if desired.

6. Install intake manifold as outlined. Connect ECT and temperature sending unit electrical connectors.

7. Dip each push rod end in Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil. Install push rods in their original position.

IN-VEHICLE SERVICE (Continued)



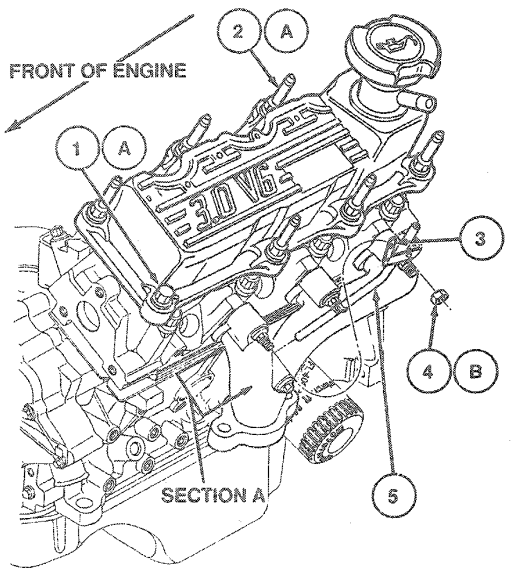
IN-VEHICLE SERVICE (Continued)

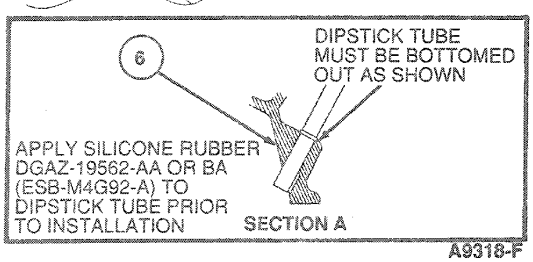
8. Rotate crankshaft clockwise one full turn (360 degrees). Install rocker arms, fulcrums and retaining bolts 25 specified in position "A". Tighten bolts to 7-15 N·m (5-11 lb-ft) to seat fulcrums. Rotate crankshaft clockwise 120 degrees to position "B". Install rocker arms, fulcrums and retaining bolts as specified in camshaft position "B". Tighten bolts to 7-15 N·m (5-11 lb-ft).

   CAUTION: Fulcrums must be fully seated in cylinder head, and push rods must be seated in rocker arm sockets prior to final tightening.

9. Final tighten retaining bolts to 26-38 N·m (19-28 lb-ft) with camshaft in any position.
10. Lubricate all rocker arm assemblies with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil.

    NOTE: If the original valve train components are being installed, a valve clearance check is not required. If a component has been replaced, perform a valve clearance check. Refer to Section 03-00.





Item	Part Number	Description
1A	—	Bolt (2 Req'd)
2A	—	Stud (6 Req'd)
3	—	Harness Locating Tab
4B	—	Nut
5	6754	Dipstick Tube
6	6010	Cylinder Block Assy
A		Tighten to 10-14 N·m (8-10 Lb-Ft)
B		Tighten to 18 N·m (13 Lb-Ft)

11. Install intake manifolds as outlined. Tighten retaining bolts to 25 N·m (19 lb-ft). Then install the inlet pipe retaining nuts. Tighten to 41 N·m (30 lb-ft).
12. Install spark plugs, if removed. Tighten to 7-15 N·m (5-11 lb-ft).
13. Position rocker arm cover on the cylinder head and install retaining bolts. Note the location of spark plug wire routing clip stud bolts.
14. Install fuel charging wiring to injectors and inboard rocker arm cover studs.
15. Install throttle body and new gasket.
16. Install ignition coil and bracket assembly. Tighten retaining bolts to 48 N·m (35 lb-ft).
17. Install distributor as outlined (unleaded gasoline only). Connect ignition wires to the spark plugs and stand-offs to rocker arm cover retaining studs. Connect DI module electrical connector.
18. Connect IAT sensor (unleaded gasoline only), CSI (FF only), TP, IAC, and PFE or DPFE sensor electrical connectors.
19. If LH (front) cylinder head was removed, perform the following:
    - Install or rotate engine oil dipstick tube to exhaust manifold retaining stud. Tighten nut to 18 N·m (13 lb-ft).
    - Install power steering support bracket and pump assembly. Tighten retaining bolt to 48 N·m (35 lb-ft).
    - Install 6K automatic belt tensioner. Tighten retaining nuts / bolt to 48 N·m (35 lb-ft).
20. If RH (rear) cylinder head was removed, perform the following:
    - Install generator belt tensioner bracket.
    - Install EVR sensor and bracket. Tighten retaining bolt to 35 N·m (26 lb-ft).
    - Install heater supply tube retaining brackets to exhaust manifold. Tighten retaining nuts 35 N·m (26 lb-ft).
    - Install VSS cable retaining bracket.
21. Install generator assembly. Tighten long retaining bolt to 48 N·m (35 lb-ft) and short bolt to 37 N·m (27 lb-ft).

IN-VEHICLE SERVICE (Continued)

22. Install the accessory drive belt. Refer to Section 03-05.
23. Connect fuel lines as outlined. Refer to Section 03-04A.
24. Install fuel line safety clips as outlined.
25. Connect upper radiator and heater hoses. Tighten clamps securely.
26. Connect vacuum lines to premarked locations.

    CAUTION: Engine coolant is corrosive to all engine bearing material. Replace engine oil after removal of a coolant carrying component to help prevent future failure.
27. Drain and change engine oil.
28. Install air cleaner outlet tube to throttle body and air cleaner. Install closure tube to rocker arm cover. Tighten clamps to 2.7-5.4 N·m (28-48 lb-in).

    CAUTION: This engine has aluminum components and requires a special corrosion inhibited coolant formulation to avoid cooling system damage. Refer to Section 03-03 for coolant specifications.
29. Fill and bleed cooling system.
30. Connect battery ground cable.
31. Start engine and check for coolant, fuel, oil, vacuum and exhaust leaks.
32. Verify base ignition timing as outlined (unleaded gasoline only).
33. Check, and if necessary, adjust the transaxle throttle linkage and speed control.
34. Install IAC protective snowshield.
35. Install distributor cap rubber boot (unleaded gasoline only).

Tappet

NOTE: Before replacing a tappet for noisy operation, ensure the noise is not caused by improper valve-to-rocker arm clearance or by worn rocker arms or push rods. Refer to Section 03-00.

Removal

1. Rotate crankshaft to 0 degrees TDC on the compression stroke.
2. Disconnect battery ground cable and set aside.
3. Drain engine cooling system.
4. Remove PCV system closure tube from rocker arm cover and air cleaner outlet tube.
5. Remove aspirator hose from air cleaner outlet tube. Remove air cleaner outlet tube from throttle body and engine air cleaner.

   WARNING: COVER THE VALVE WITH A SHOP RAG TO PREVENT ACCIDENTAL FUEL SPRAY INTO THE EYES.
6. Carefully relieve fuel pressure at fuel pressure relief Schrader valve. Refer to Section 03-04A.
7. Disconnect fuel lines. Refer to Section 03-04A.
8. Mark location and remove vacuum lines.
9. Disconnect IAT and distributor connectors (unleaded gasoline only). Disconnect CSI and camshaft sensor connectors (FF only). On either model, disconnect TP, IAC, ECT, ignition coil, coolant temperature sending unit and PFE or DPFE sensor electrical connectors.
10. Disconnect upper radiator hose from thermostat housing. After loosening retaining clamp, use a twisting motion on hose to loosen from housing.
11. Remove brace from generator bracket to throttle body stud.
12. Remove EGR valve to exhaust manifold tube.
13. Remove throttle body as outlined.
14. Disconnect fuel charging wiring retaining stand offs from inboard rocker arm cover studs. Carefully disconnect electrical connectors from each injector and remove fuel charging wiring from engine.
15. Disconnect heater hoses.
16. Remove ignition wires from spark plugs by using a twisting motion on the rubber boot. Remove harness retaining stand offs from rocker arm cover studs.
17. On unleaded gasoline only, mark distributor housing to block and note rotor position. Remove distributor retaining bolt and washer. Remove distributor.
18. Remove ignition coil from rear of LH cylinder head.
19. Remove rocker arm covers as outlined.
20. Loosen cylinder No. 3 intake valve rocker arm retaining nut and rotate arm off of push rod and away from top of valve stem. Remove push rod.

    NOTE: Intake manifold assembly may be removed with fuel supply manifold and injectors in place.
21. Remove intake manifold retaining bolts using a Torx® head socket. Before attempting to remove intake manifold, break seal between intake manifold and cylinder block. Wedge a large screwdriver or similar tool between intake manifold and block. Pry upward on tool using area between thermostat and transaxle as a leverage point.
22. Loosen rocker arm fulcrum retaining bolt of tappet to be replaced enough to allow rocker arm to be lifted off the push rod and rotated to one side.

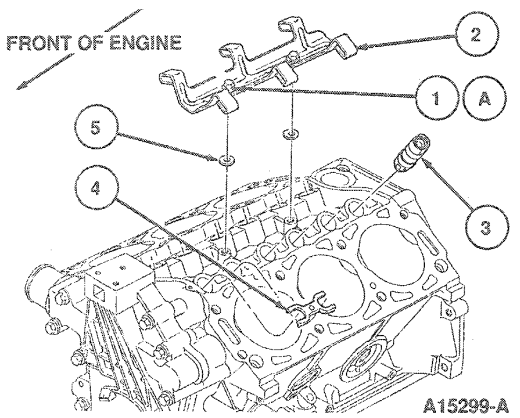
    NOTE: Push rods should be installed in their original location and position during reassembly.
23. Remove push rod(s). If more than one is removed, identify each push rods location.
24. Loosen two roller tappet guide plate retaining bolts. Remove guide plate retainer assembly from tappet valley.

IN-VEHICLE SERVICE (Continued)

25. Remove tappet guide plate(s) from tappets by lifting straight up.

    NOTE: If the tappet(s) are stuck in the bore(s) due to excessive varnish or gum deposits, it may be necessary to use a claw-type tool to aid removal. Rotate the tappet back and forth to loosen it from the deposits.

26. To remove, grasp tappet and pull in line with bore.



Item	Part Number	Description
1A	—	Bolt (2 Req'd)
2	6K564	Guide Plate Retainer Assembly
3	6500	Tappet (12 Req'd)
4	6K512	Guide Plate (6 Req'd)
5	—	Washer (2 Req'd)
A		Tighten to 10-14 N·m (8-10 Lb-Ft)

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Installation

NOTE: Lightly oil all retaining bolt and stud bolt threads before installation.

CAUTION: Aluminum components gouge easily which may cause gasket leaks. Always use care when scraping aluminum gasket surfaces.

1. Clean mating gasket surfaces of intake manifold and cylinder head. Lay a clean cloth or shop cloth in the tappet valley to catch any gasket material. After scraping, carefully lift cloth from tappet valley to prevent any particles from entering oil drain holes or cylinder head. Use a suitable solvent to remove old rubber sealant.
2. Lubricate tappet(s) and bore with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.
3. Install tappet into bore.
4. Aligning tappet flats, install tappet guide plate. Install plate with word "UP" and or button visible.
5. Install guide plate retainer assembly over guide plates. Retainer orientation is not important. Loosely install two retaining bolts. Tighten bolts to 10-14 N·m (8-10 lb-ft).
6. Apply a 6 mm (1/4 inch) drop of Rubber Sealer D6AZ-19562-AA or BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent to intersection of cylinder block and cylinder head assembly at four corners.
7. Position intake gaskets onto cylinder heads. Align intake gasket locking tabs to provisions on cylinder head gaskets.
8. Install front and rear intake manifold seals. Secure with retaining features.
9. Carefully lower intake manifold into position aligning manifold bolt holes to those in cylinder head. Use care to prevent distributing rubber sealer which can cause sealing voids. Install bolts No. one, two, three, and four and hand tighten. Install remaining bolts and tighten in a two step process. Tighten in numerical sequence to 20-30 N·m (15-22 lb-ft), then again in sequence to 26-32 N·m (19-24 lb-ft).
10. On unleaded gasoline only, coat distributor gear teeth with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Install distributor and align to premarked location on cylinder block and rotor position. Install retaining bolt and washer and hand tighten.

    NOTE: Fulcrum must be fully seated into cylinder head and push rod must be fully seated in rocker arm and lifter sockets prior to final tightening.

11. Lubricate removed push rods and rocker arms with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil. Move rocker arms into position with push rods and snug retaining bolt. Rotate crankshaft to position camshaft lobes straight down and away from valve tappet. Tighten retaining bolt to 7-15 N·m (5-11 lb-ft) to seat rocker arm fulcrum into cylinder head. Final tighten bolt to 26-38 N·m (19-28 lb-ft) in any position.
12. Install rocker arm covers as outlined.
13. Install fuel charging wiring to each injector. Secure with stand offs to inboard rocker arm cover studs.
14. Install ignition coil to rear of LH cylinder head. Tighten retaining bolts to 40-55 N·m (29-41 lb-ft).
15. Install distributor cap and ignition wires (unleaded gasoline only). Install wire harness stand offs to rocker arm cover studs and connect wires to spark plugs and ignition coil.
16. Install throttle body assembly and new intake manifold upper gasket as outlined in this section.
17. Install EGR valve to exhaust manifold tube from intake manifold to EGR valve. Tighten retaining nuts to 35-65 N·m (26-48 lb-ft).
18. Install fuel lines. Refer to Section 03-04A.
19. Install fuel line safety clips.

IN-VEHICLE SERVICE (Continued)

20. Install upper radiator hose and heater hoses. Tighten retaining clamps securely.
21. Connect vacuum lines to premarked locations.
22. Connect electrical connections to IAT and distributor (unleaded gasoline only). Connect electrical connections to IAC, TP, ECT, PFE or DPFE sensor, ignition coil and coolant temperature sending unit.

    NOTE: Engine coolant is corrosive to all engine bearing material. Replacing oil after removal of a coolant carrying component prevents damage.
23. Fill and bleed cooling system with specified coolant and proper mixture.
24. Fill crankcase with the correct viscosity and amount of engine oil.
25. Install air cleaner outlet tube to throttle body and engine air cleaner. Tighten retaining clamps to 2.7-5.4 N·m (24-48 lb-in).
26. Install PCV system closure tube to rocker arm cover and air cleaner outlet tube. Install aspirator hose to air cleaner outlet tube.
27. Connect battery ground cable.
28. Start engine and check for coolant, oil, fuel and vacuum leaks.

    NOTE: FF base initial engine timing is not adjustable.
29. Verify and if necessary correct base initial engine timing to 10 degrees BTDC. Refer to the Powertrain Control/Emissions Diagnosis Manual.[3] Tighten distributor retaining bolt to 24 N·m (18 lb-ft).
30. Install idle air control valve snowshield.

Pistons and Connecting Rods

Tools Required:

- Rotunda Piston Ring Compressor 014-00290
- Rotunda Cylinder Ridge Reamer 014-00292

Removal

1. Drain cooling system.
2. Remove throttle body as outlined in this section.
3. Remove intake manifold as outlined in this section.
4. Remove cylinder heads as outlined in this section.
5. Remove oil pan as outlined in this section.
6. Remove oil pump assembly and intermediate shaft.
7. Before removing the piston, inspect the top of each cylinder bore. If a ridge has formed at the top of the cylinder it must be removed before piston removal. Remove ridge as follows:
   a. Turn crankshaft until the piston to be removed is at the bottom of cylinder bore.
   b. Place a clean shop cloth over the piston head to collect cuttings.
   c. Remove ridge using Rotunda Cylinder Ridge Reamer 014-00292 or equivalent. Never cut into the ring travel area more than 0.794mm (1/32 inch) when removing the ridge.
8. Turn crankshaft until the piston to be removed is at the lowest point of its travel. If more than one piston is being removed, identify the pistons and connecting rod caps. Each component should be installed in its original position during assembly.

   NOTE: The cylinder number is stamped on the top of the piston. Matched letters are stamped on the sides of corresponding rod and cap.
9. Remove connecting rod cap retaining nuts and cap.

   CAUTION: Use care to prevent damage to bearing surfaces.
10. Install a 50mm (2 inch) piece of 3/8 inch fuel hose (or similar protector) over connecting rod cap studs and push piston out through top of the cylinder bore.
11. Install connecting rod cap and hold in position with cap retaining nuts.
12. If piston is to be disassembled, refer to Piston Disassembly.
13. Inspect cylinder bore. If new piston rings are to be installed on the piston, a visible cross-hatch pattern should be obvious on cylinder bore wall.

    If honing is required, remove glaze from cylinder wall using spring-loaded hone. Follow manufacturer's instructions when using this type of equipment.

    After honing, thoroughly clean cylinder bore using a detergent and water solution.

Installation

Lightly oil all retaining bolt and stud bolt threads before installation except those specifying special sealant.

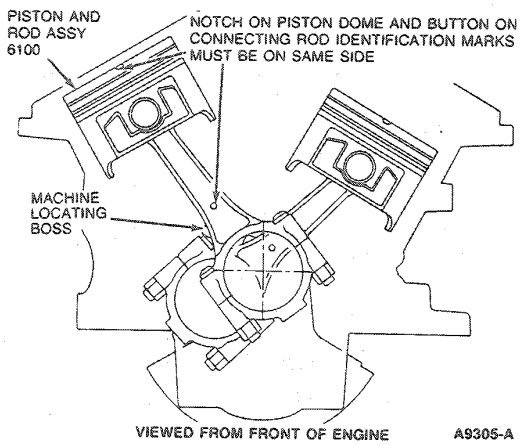
1. Lubricate cylinder wall and piston with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil.
2. Install a 50mm (2 inch) piece of 3/8 inch fuel hose (or similar protector) on the connecting rod studs.

3 Can be purchased as a separate item.

IN-VEHICLE SERVICE (Continued)

3. Install piston using Rotunda Piston Ring Compressor 014-00290 or equivalent.

   Ensure notch in piston dome faces the front of engine and machine locating boss is facing RH side of engine.



CAUTION: As piston is tapped into bore with a wooden hammer handle, guide connecting rod onto crankshaft journal to avoid damage to bearing surfaces.

NOTE: Connecting rod and cap are not identified to cylinder position.

NOTE: Install the pistons in the same cylinders from which they were removed or to which they were fitted. The connecting rod and bearing caps are identified with matching correlation letters. Letters on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is transposed from one block or cylinder to another, new bearings should be fitted.

4. Check connecting rod bearing clearance. Refer to Section 03-00.
5. Lubricate bearing surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent, heavy engine oil.
6. Ensure connecting rod is seated on crankshaft journal. Install connecting rod cap. Tighten the cap retaining nuts to 35 N·m (26 lb-ft).
7. If necessary, check connecting rod side clearance as outlined. Refer to Section 03-00.
8. Install oil pump and intermediate shaft assembly. Tighten retaining bolts to 48 N·m (35 lb-ft).
9. Install oil pan as outlined in this section.
10. Install cylinder heads as outlined in this section.
11. Install intake manifold as outlined in this section.
12. Install rocker arm covers and throttle body as outlined in this section.
13. Fill crankcase with the correct viscosity and amount of engine oil.
14. Fill cooling system with specified coolant.
15. Start engine and check for oil, exhaust and coolant leaks.
16. Check, and if necessary, adjust transaxle throttle linkage and speed control.

Oil Pan and Oil Pump

Removal

1. Disconnect battery ground cable and set aside.
2. Remove oil level dipstick.
3. Raise vehicle on hoist. Refer to Section 00-02.
4. If equipped with a low oil level sensor, remove retainer clip at sensor. Remove electrical connector from sensor.
5. Drain crankcase.
6. Remove starter motor and brace.
7. Disconnect heated oxygen sensor (HO2S) (9F472).
8. Remove catalyst and pipe assembly.
9. Remove lower engine/flywheel dust cover from converter housing.
10. Remove oil pan retaining bolts. Remove oil pan making sure internal pan baffle does not snag oil pump pickup tube and screen.

    NOTE: If replacing oil pump make sure to remove intermediate drive shaft from pump.
11. Remove oil pump.

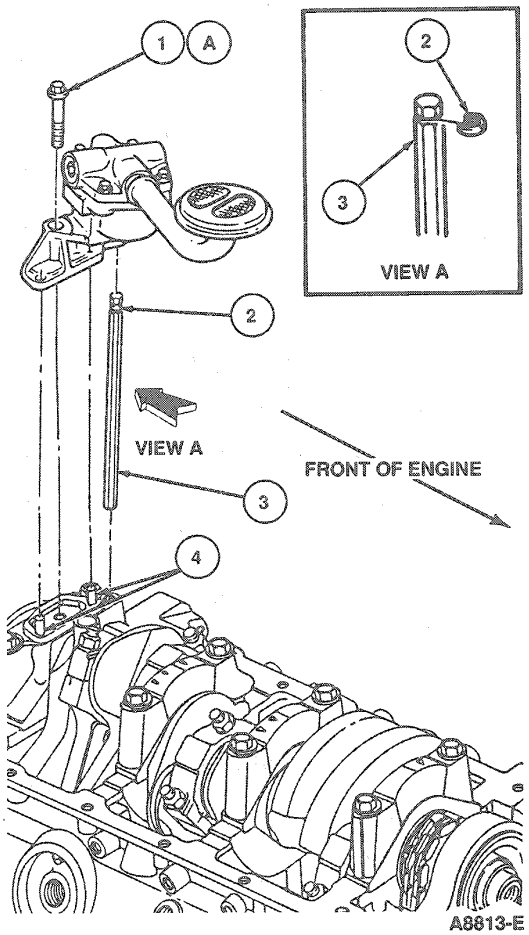
Installation

1. Clean the gasket surfaces on the cylinder block and oil pan.
2. If replacing oil pump, insert oil pump intermediate shaft assembly into hex drive hole in oil pump assembly until retainer "clicks" into place.
3. Install oil pump assembly with intermediate shaft through intermediate shaft hole in rear main bearing cap. Position pump over locating pins.
4. Install retaining bolt and tighten to 40-55 N·m (30-40 lb-ft).

   NOTE: When using silicone rubber sealer, assembly should occur within five minutes after sealer application. After this time, the sealer may start to set-up, and its sealing effectiveness may be reduced.

IN-VEHICLE SERVICE (Continued)

5. Apply a 6mm (1/4-inch) bead of Silicone Gasket and Sealer F1AZ-19562-A (WSE-M4G320-A2) or equivalent, to the junction of the rear main bearing cap and cylinder block and junction of the front cover assembly and cylinder block.



Item	Part Number	Description
1A	—	Bolt
2	6A751	Retainer—Oil Pump Intermediate Shaft
3	6A618	Oil Pump Intermediate Shaft
4	—	Dowel
A		Tighten to 30-40 N·m (40-55 Lb-Ft)

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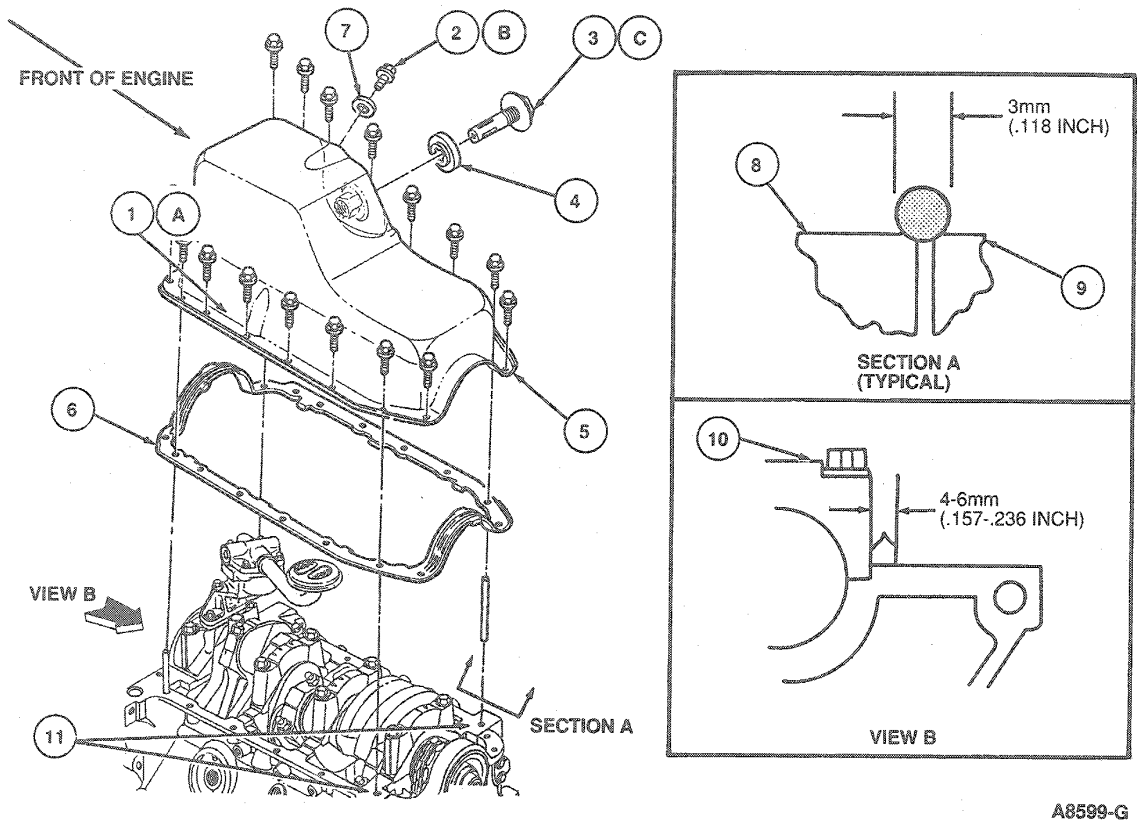
6. Locate oil pan gasket to oil pan with sealing bends against pan surface and secure with Gasket and Trim Adhesive D7AZ-19B508-BB (ESR-M11P17-A and ESE-M2G52-A) or equivalent.
7. Position oil pan.
8. Install oil pan retaining bolts. Tighten to 10-14 N·m (8-10 lb-ft).
9. Back off all bolts and retighten.
10. Install lower engine/flywheel dust cover to the converter housing.
11. Install catalyst and pipe assembly. Connect HO2S.
12. Install starter motor and brace.
13. Install low oil level sensor connector to the sensor and install retainer clip.
14. Lower vehicle.
15. Replace oil level dipstick.
16. Connect battery ground cable.
17. Fill crankcase with the correct viscosity and amount of engine oil.
18. Start engine and check for engine oil and exhaust leaks.

IN-VEHICLE SERVICE (Continued)



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Item	Part Number	Description
1A	—	Screw and Washer Assy (16 Req'd)
2B	6675	Drain Plug Assy
3C	6675	Oil Level Sensor
4	6C626	Oil Level Sensor Gasket
5	6675	Oil Pan Assy
6	6710	Oil Pan Gasket
7	6734	Drain Plug Gasket
8	6010	Cylinder Block Assy

Item	Part Number	Description
9	6019	Front Cover Assy
10	6A325	Rear Main Bearing Cap
11	F1AZ-19562-A	Silicone Sealer (4 Places)
A		Tighten to 10-14 N·m (8-10 Lb-Ft)
B		Tighten to 11-16 N·m (9-12 Lb-Ft)
C		Tighten to 27-41 N·m (20-30 Lb-Ft)

(Continued)

TA8599G

Sensors

Removal

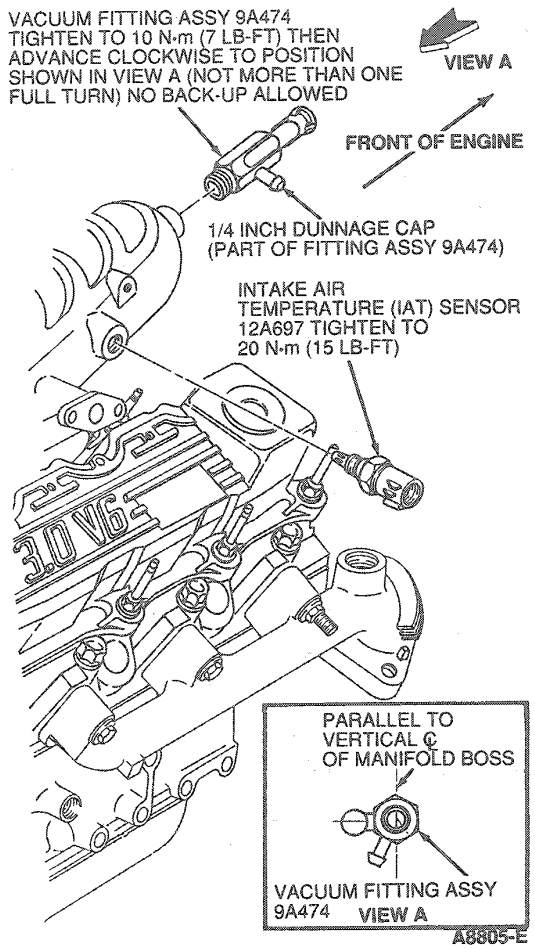
Unless otherwise noted, all sensors are removed by disconnecting wiring connector and unscrewing sensor. Refer to Section 18-01 for electrical connector disengagement.

IN-VEHICLE SERVICE (Continued)

Intake Air Temperature (IAT) Sensor

Unleaded Gasoline Only

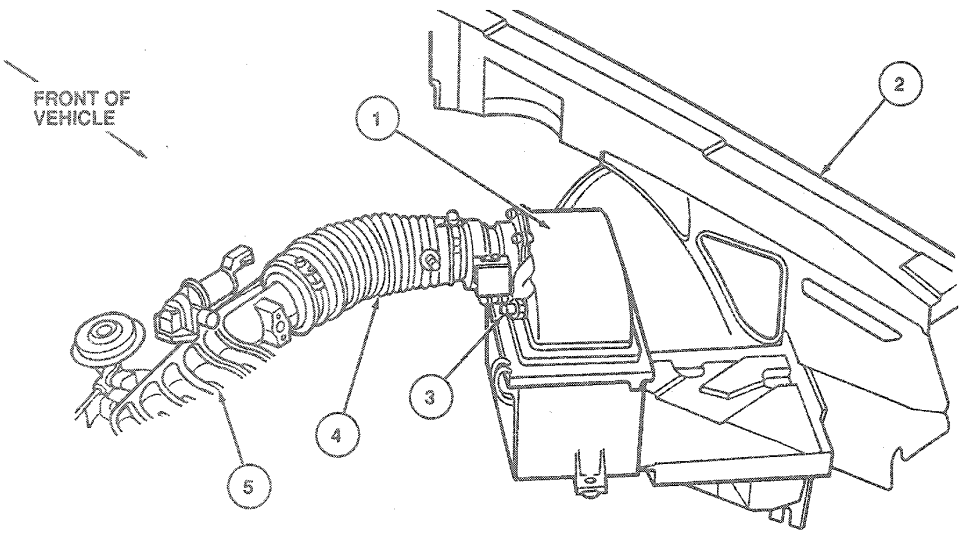
Located in the throttle body. When installing, tighten to 20 N·m (15 lb-ft).



FF Only

Located in the air cleaner assembly. When installing, use care not to damage plastic threads.

IN-VEHICLE SERVICE (Continued)



A16357-A

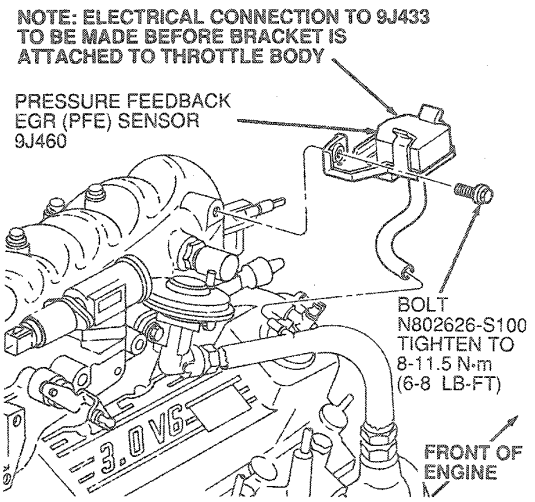
Item	Part Number	Description
1	9600	Engine Air Cleaner
2	—	LH Inner Fender
3	12A697	Intake Air Temperature Sensor
4	9B659	Air Cleaner Outlet Tube
5	9E926	Throttle Body

Heated Oxygen Sensor (HO2S)

Located in the inlet pipes. When installing, tighten to 41 N·m (30 lb-ft).

Pressure Feedback EGR (PFE) Sensor — Unleaded Gasoline Only

Located on throttle body with a hose connected to EGR valve to exhaust manifold tube. Sensor is retained by a clip.

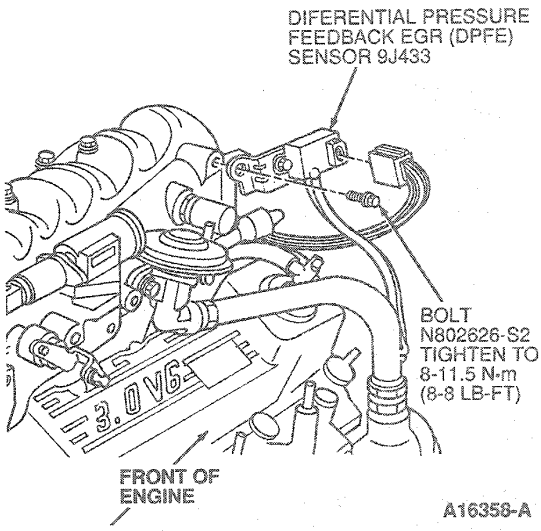


A14929-C

IN-VEHICLE SERVICE (Continued)

Differential Pressure Feedback EGR (DPFE) Sensor—FF Only

Located on the throttle body with two hoses connected to EGR valve to exhaust manifold tube. Sensor is retained by two screws to bracket. Tighten to 1.5 N·m (14 lb-in).

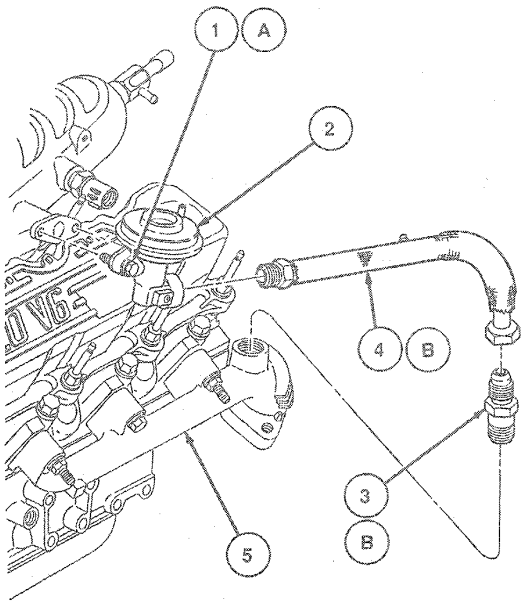


EGR Valve Tube and Fitting/Orifice

Removal

1. Disconnect battery ground cable and set aside.
2. Allow engine to cool sufficiently before proceeding.

   WARNING: EGR COMPONENTS TRANSPORT HOT EXHAUST GASES. CONTACT WITH HOT EXHAUST COMPONENTS MAY CAUSE SEVERE BURNS. ALWAYS ALLOW SUFFICIENT COOL DOWN BEFORE WORKING WITH EXHAUST COMPONENTS.
3. Loosen supply tube retaining nuts at both ends.
4. On unleaded gasoline only, disconnect pressure feedback EGR (PFE) sensor hose from EGR valve to exhaust manifold tube. On FF only, disconnect two differential pressure feedback EGR (DPFE) sensor hoses from EGR supply tube.
5. Pull EGR valve to exhaust manifold tube away from EGR valve enough to release tube flare from valve.
6. Remove EGR valve to exhaust manifold tube.
7. Remove EGR valve tube to manifold connector.



Item	Part Number	Description
1A	N804073-S8	Bolt (2 Req'd)
2	9D460	EGR Valve
3B	9F485	EGR Valve Tube to Manifold Connector
4B	9D477	EGR Valve to Exhaust Manifold Tube
5	9430	Exhaust Manifold
A		Tighten to 20-30 N·m (15-22 Lb-Ft)
B		Tighten to 35-65 N·m (26-48 Lb-Ft)

Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation.

1. Install EGR valve tube to manifold connector into exhaust manifold with small hole facing exhaust manifold. Tighten to 35-65 N·m (26-48 lb-ft).

   NOTE: The flexible end of the EGR valve to exhaust manifold tube connects to the EGR valve tube to manifold connector. Do not tighten.
2. Install EGR valve to exhaust manifold tube to EGR valve tube to manifold connector.
3. Position EGR valve to exhaust manifold tube to EGR valve.
4. Tighten EGR supply tube retaining nuts to 35-65 N·m (26-48 lb-ft).
5. Install PFE hose or DPFE hoses to EGR supply tube.
6. Install battery ground cable.

IN-VEHICLE SERVICE (Continued)

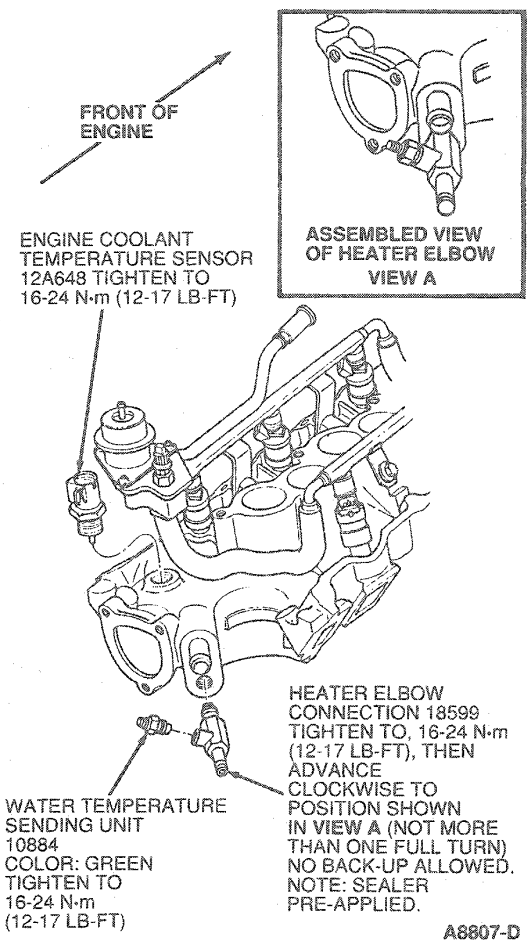
7. Start engine and check for exhaust and vacuum leaks.

Engine Coolant Temperature (ECT) Sensor

Located at the rear of the intake manifold. When installing, tighten to 16-24 N·m (12-17 lb-ft).

NOTE: Apply Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent, before installation.

Unleaded Gasoline Shown, FF Similar



Coolant Bypass Fitting

NOTE: Apply Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent.

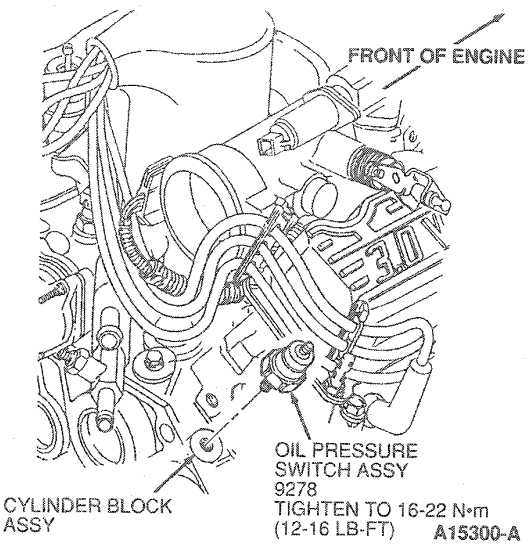
Coolant bypass fitting is located at the rear of the intake manifold. When installing, tighten to 16-24 N·m (12-17 lb-ft). Refer to illustration following ECT.

Low Oil Level Sensor (LOLS)

Located in the oil pan. When installing, tighten to 34 N·m (25 lb-ft). Use a new gasket.

Oil Pressure Sending Switch

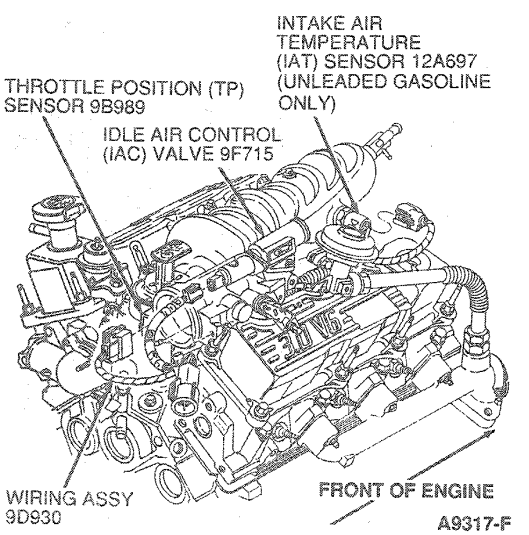
Located in the right rear face of cylinder block. When installing, tighten to 16-22 N·m (12-16 lb-ft).



NOTE: Apply pipe sealant with Teflon ® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent.

Throttle Position Sensor (TP) (9B989)

Located in the throttle body. When installing, tighten to 3 N·m (22 lb-in).



EGR Vacuum Regulator (EVR)

Located on right cylinder head. When installing, tighten to 35 N·m (26 lb-ft).

Throttle position sensor must engage on throttle shaft and then must be clocked into position for attachment.

IN-VEHICLE SERVICE (Continued)

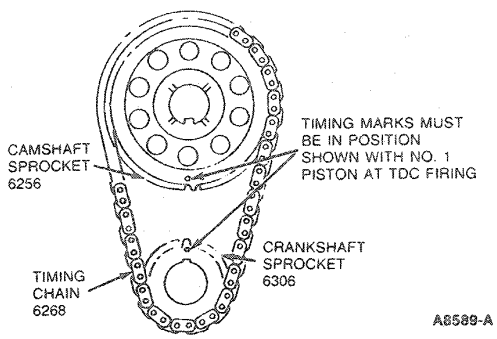
Timing Chain

Tool Required:

- Front Cover Seal Replacer T70P-6B070-A

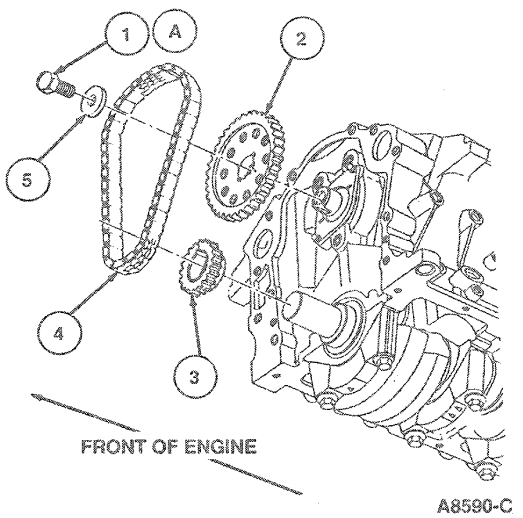
Removal

1. Disconnect battery ground cable.
2. Drain cooling system.
3. Drain crankcase.
4. Remove crankshaft pulley and damper as outlined.
5. Remove timing cover as outlined.
6. Rotate crankshaft until No. 1 piston is at top dead center (TDC) and the timing marks are aligned as illustrated.
7. Remove camshaft sprocket retaining bolt and washer.
8. Check timing chain deflection as outlined for excessive wear.
9. Slide sprockets and timing chain forward and remove as an assembly.
10. Clean timing cover and oil pan sealing surfaces of all gasket material and silicone sealer.



Installation

1. Clean and inspect all parts before installation.
2. Slide sprockets and timing chain on as an assembly with timing marks aligned as illustrated.



Item	Part Number	Description
1A	6279	Bolt
2	6256	Camshaft Sprocket
3	6306	Crankshaft Sprocket
4	6268	Timing Chain Lubricate With Oil
5	6278	Washer-Cam Sprocket
A		Tighten to 50-70 N·m (37-51 Lb-Ft)

TA8590C

CAUTION: The camshaft bolt has a drilled oil passage in it for timing chain lubrication. If damaged do not replace with standard bolt. Clean oil passage with solvent.

3. Install camshaft sprocket retaining bolt and washer. Tighten bolt to 63 N·m (46 lb-ft). Lubricate chain and sprockets with engine oil.
4. Inspect timing cover crankshaft seal for burrs or cuts. If required, replace seal using Front Cover Seal Replacer T70P-6B070-A.
5. Position timing cover gasket onto cylinder block alignment dowels.
6. Install timing cover onto cylinder block using caution to not damage seal.
7. Install bolts and tighten as outlined under Timing Cover Removal and Installation.
8. Install oil pan and new gasket as outlined.
9. Install water pump if removed.
10. Install crankshaft damper and pulley as outlined in this section.
11. Install front end accessory drive components as outlined.
12. Fill crankcase with the correct viscosity and amount of engine oil.

IN-VEHICLE SERVICE (Continued)

13. Fill and bleed cooling system.
14. Connect battery ground cable.
15. Start engine and check for coolant, oil and exhaust leaks.

LH Exhaust Manifold

Front

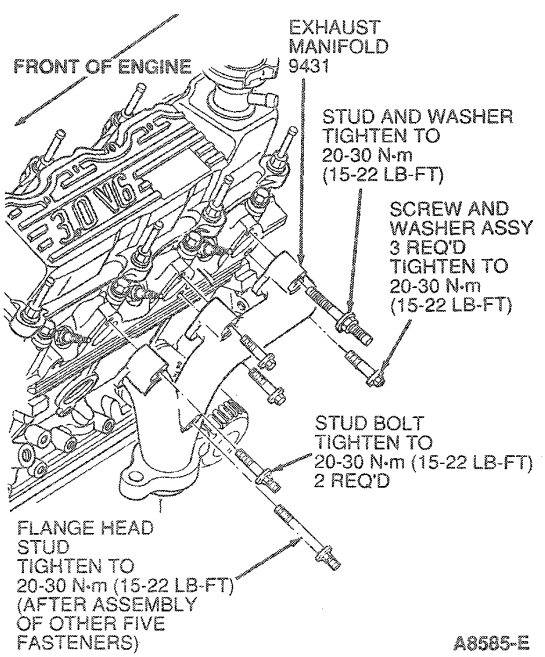
Removal

1. Disconnect battery ground cable and set aside.
2. Remove oil level indicator tube support bracket retaining nut.
3. Remove electrical harness connected to dipstick support bracket and remove dipstick and tube.
4. Remove manifold to exhaust pipe retaining nuts.
5. Remove exhaust manifold retaining bolts and exhaust manifold.

Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation.

1. Clean mating surfaces on the exhaust manifold, cylinder head and exhaust pipe.
2. Position exhaust manifold on the cylinder head and install manifold retaining bolts. Tighten to 20-30 N·m (15-22 lb-ft).



3. Connect exhaust pipe to the exhaust manifold. Tighten the retaining nuts to 34-47 N·m (25-34 lb-ft).
4. Install oil level indicator tube support bracket and position electrical harness. Tighten nut to 15-20 N·m (11-15 lb-ft).
5. Connect battery ground cable.
6. Start engine and check for exhaust leaks.

RH Exhaust Manifold

Rear

Removal

1. Disconnect battery ground cable and set aside.
2. Disconnect PFE or DPFE hose(s) from EGR valve to exhaust manifold tube.
3. Remove EGR valve to exhaust manifold tube from exhaust manifold. Use a backup wrench on the lower adapter.
4. Remove coolant bypass tube.
5. Remove manifold-to-exhaust pipe retaining nuts.
6. Remove exhaust manifold retaining bolts. Remove exhaust manifold.

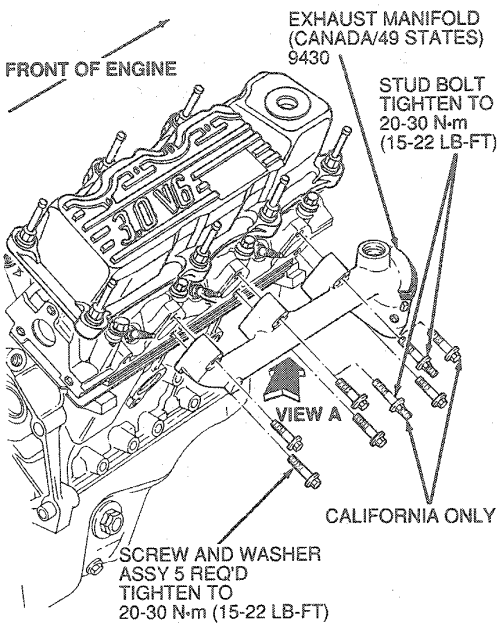
Installation

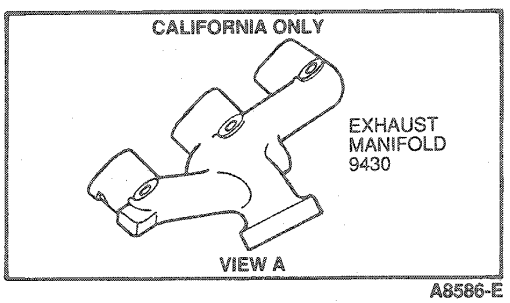
NOTE: Lightly oil all bolt and stud bolt threads before installation.

1. Clean mating surfaces on the exhaust manifold, cylinder head and exhaust pipe.
2. If replacing exhaust manifold, remove the EGR valve to exhaust manifold tube and install it on the new exhaust manifold.

IN-VEHICLE SERVICE (Continued)

3. Position exhaust manifold on the cylinder head and install manifold retaining bolts. Tighten to 20-30 N·m (15-22 lb-ft).





4. Connect exhaust pipe to the exhaust manifold. Tighten the retaining nuts to 34-47 N·m (25-34 lb-ft).
5. Install coolant bypass hose. Tighten retaining nut to 20-30 N·m (15-22 lb-ft).
6. Connect EGR valve to exhaust manifold tube to exhaust manifold. Tighten to 35-65 N·m (26-48 lb-ft).
7. Connect PFE or DPFE hose(s).
8. Connect battery ground cable.
9. Start engine and check for exhaust and coolant leaks.

Main Bearing Inserts

The main bearing inserts are precision selective fit. To check the bearing clearances or to select fit a new bearing, refer to Section 03-00.

Tools Required:

- Main Bearing Insert Remover and Replacer TOOL-6331-E

Removal

1. Remove oil pan as outlined in this section.
2. Remove oil pump as outlined in this section.
3. Remove spark plugs to allow easy crankshaft rotation.
4. Replace one bearing at a time, leaving the other bearings securely fastened. Remove main bearing cap to which new bearings are to be installed.

   NOTE: Rotate remover against end of bearing opposite locating tang.
5. Insert Upper Main Bearing Insert Remover and Replacer TOOL-6331-E or equivalent in the oil hole in the crankshaft.
6. Rotate crankshaft in the direction of the engine rotation to force the bearing out of the block.
7. Clean crankshaft journals. Inspect journals and thrust faces (thrust bearings) for nicks, burrs or bearing pickup that would cause premature bearing wear.
8. If the crankshaft rear oil seal is to be replaced, refer to Crankshaft Rear Oil Seal.

Installation

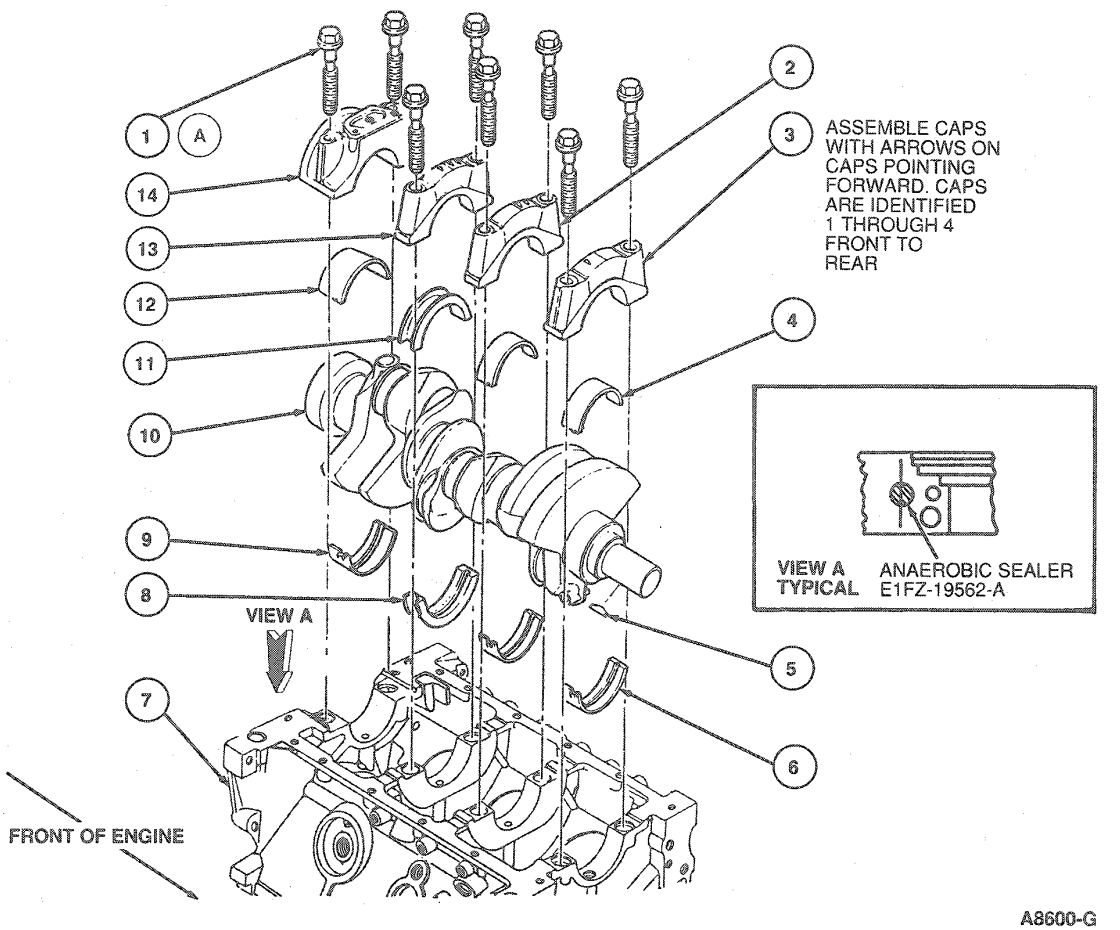
Lightly oil all bolt and stud bolt threads before installation.

1. Lubricate and position the upper bearing insert on the crankshaft journal with the plain end started into the side of the cylinder block with the locking tang slot. Line up the bearing tang with the slot in the block.
2. Install Upper Main Bearing Insert Remover and Replacer TOOL-6331-E or equivalent, in the crankshaft journal oil hole.
3. With the bearing and tool in position, rotate the crankshaft so that the tool catches the edge of the bearing and pushes into position, and seats in the cylinder block. Remove tool.
4. Install bearing insert in the main cap.
5. If bearing insert clearance is to be checked, refer to Section 03-00.
6. If No. 1 or No. 2 bearing insert was removed, lubricate the bearing surface with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent, and install main cap. Tighten retaining bolts to 75-85 N·m (55-63 lb-ft).
7. If the rear main bearing insert was removed, perform the following:
   a. Remove all traces of sealant from the main bearing cap to cylinder block parting line.
   b. Apply a 6mm (1/4-inch) dot of Anaerobic Sealer E1FZ-19562-A or equivalent between rear cap and cylinder block as shown.

IN-VEHICLE SERVICE (Continued)

c. Lubricate bearing surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil, and install main bearing cap. Tighten retaining bolts to 90 N·m (66 lb-ft).

8. If the thrust bearing inserts were removed, perform the following:
   a. Lubricate bearing surface with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil. Install the main bearing cap with the bolts finger-tight.
   b. Pry crankshaft forward against the thrust surface on the upper bearing insert while holding the bearing cap to the rear. This aligns thrust rear surfaces on both halves of the bearing.
   c. While holding the crankshaft forward, tighten cap retaining bolts to 75-85 N·m (55-63 lb-ft).
9. Install crankcase oil baffle and oil pump assembly.
10. Install oil pan.



Item	Part Number	Description
1A	—	Bolt (4 Req'd)
2	6334	Front Intermediate Cap
3	6329	Front Cap
4	6A338	Main Bearing Lower (2 Req'd)
5	—	Key Sprocket and Damper

(Continued)

Item	Part Number	Description
6	6333	Main Bearing Upper (2 Req'd)
7	6010	Cylinder Block Assy
8	6337	Main Thrust Bearing-Upper
9	6W331	Main Bearing Rear-Upper
10	6303	Crankshaft

(Continued)

IN-VEHICLE SERVICE (Continued)

Item	Part Number	Description
11	6A339	Main Thrust Bearing Lower
12	6W332	Main Bearing Rear Lower
13	6327	Rear Intermediate Cap Assy

(Continued)

Item	Part Number	Description
14	6A325	Rear Cap Assy
A		Tighten to 75-85 N·m (55-63 Lb-Ft)

TA8600G

Connecting Rod Bearings

The connecting rod bearings are a selective fit to provide the necessary clearance. Refer to Section 03-00 to measure clearance and select the proper bearing insert.

NOTE: This operation is performed easiest out of the vehicle, but can be done while still in vehicle.

Removal

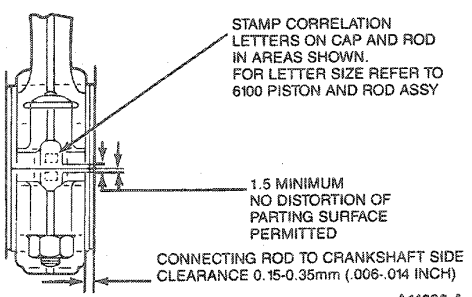
1. Disconnect battery ground cable and set aside.
2. Drain cooling system.
3. Drain crankcase.
4. Remove spark plugs.
5. Raise vehicle on hoist. Refer to Section 00-02.
6. Remove oil pan as outlined in this section.
7. Remove oil pump assembly if required.
8. Turn crankshaft until connecting rod from which the bearings are to be removed is at lowest point of travel.
9. Loosen retaining nuts and remove from cap. Place retaining nuts so that they may be reinstalled on the same rod bolt.
10. Tap cap with a plastic mallet to separate from connecting rod. Carefully remove cap from crankshaft. If lower bearing remained on crankshaft carefully grasp both sides and remove (oil acts as an adhesive between two precision fitted components). Use extreme care to not scratch crankshaft journal.
11. Install protective rubber caps onto connecting rod bolts to protect crankshaft journal from bolt threads. Rubber fuel line can also be used.
12. Remove upper bearing insert. Push piston up enough to grasp bearing. If bearing remained on crankshaft, allow bearing to remain in contact with crankshaft journal and carefully rotate to bottom side of journal. Using care, remove bearing from crankshaft.
13. Inspect bearings, crankshaft journal and connecting rod bearing surfaces for damage or wear.

Installation

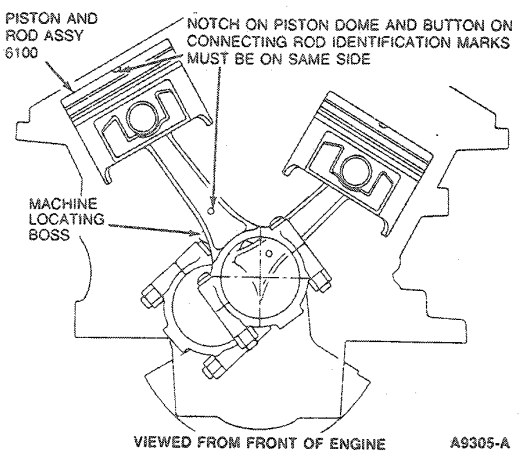
Lightly oil all bolt and stud bolt threads before installation.

CAUTION: Contaminants allowed to remain on the cap or bearing can distort the bearing or damage the crankshaft journals which may result in engine failure.

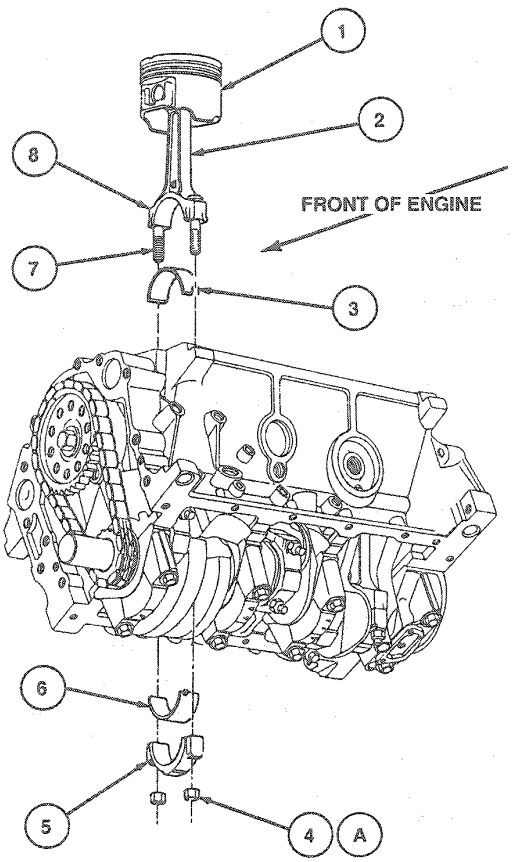
1. Thoroughly clean bearing inserts, connecting rod cap and connecting rod.
2. Lubricate crankshaft journal with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Ensure the entire journal is well lubricated.
3. Install bearing insert in the connecting rod and pull the rod down until it seats on the crankshaft. When installing bearing insert ensure tab on bearing engages slot in rod and that bearing is fully seated in rod.
4. Install bearing insert in connecting rod cap and lubricate bearing surface with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.
5. Remove protective rubber caps from rod bolts.
6. Install connecting rod cap and the retaining nuts. Install caps with code letters on same side as code letters on rods. Tighten nuts to 35 N·m (26 lb-ft).



IN-VEHICLE SERVICE (Continued)



7. Install oil pump assembly if removed. Align intermediate shaft with distributor shaft, then align pump with dowels and install retaining bolt. Tighten to 48 N·m (35 lb-ft).
8. Inspect and clean oil pump intake screen.



Item	Part Number	Description
1	6109	Piston and Pin Assy (6 Req'd)
2	6200	Connecting Rod (6 Req'd)
3	6211	Upper Rod Bearing (6 Req'd)
4A	6212	Nut (12 Req'd)
5	6210	Rod Cap (6 Req'd)
6	6211	Lower Rod Bearing (6 Req'd)
7	6214	Bolt (12 Req'd)
8	6100	Piston and Rod Assy (6 Req'd)
A		Tighten to 35 N·m (25 Lb-Ft)

TA8801D

9. Install oil pan as outlined in this section.
10. Lower vehicle.
11. Install spark plugs. Tighten to 7-15 N·m (5-11 lb-ft).
12. Fill crankcase with the correct viscosity and amount of engine oil.

IN-VEHICLE SERVICE (Continued)

13. Fill and bleed cooling system.
14. Connect battery ground cable.
15. Disconnect ignition coil wire or ignition coil wire harness. Crank engine for 15 seconds to re-establish oil to oil pump assembly and bearing surfaces.
16. Connect ignition coil wire.
17. Start engine and check for coolant, oil and exhaust leaks.

REMOVAL AND INSTALLATION

Engine Assembly

Tools Required:

- Engine Lifting Eyes D61L-6001-D
- Three Bar Engine Support D88L-6000-A

Removal and Installation

1. The engine assembly is removed out of the top without the transaxle.
2. Support the front (bellhousing) end of the transaxle with a floor jack before disconnecting the transaxle from the axle.
3. Lift the engine as outlined in the lifting points procedure.

When removing and installing the engine, refer to the following illustrations. Wherever a triangle appears, it means service that particular component, a rectangle means remove or install and a circle means disconnect or connect.

REMOVAL	INSTALLATION
SERVICE	SERVICE
REMOVE	INSTALL
DISCONNECT	CONNECT

A9319-A

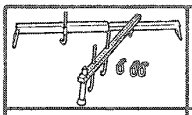
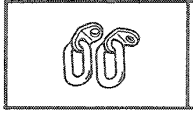
Engine Lifting/Support Points

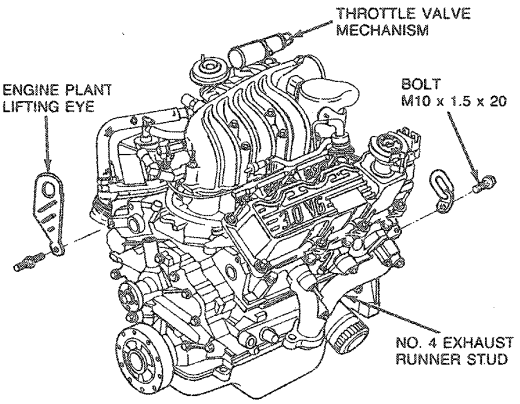
The lift points and procedures are to be used for removing the engine or supporting it during service, such as for transaxle removal. The equipment required is:

- Engine Lifting Eyes D81L-6001-D or equivalent
- Three Bar Engine Support D88L-6000-A or equivalent. An engine support bar may be fabricated from a length of 4x4 wood cut to appropriate length (approximately 1448mm (57 inch)).

Attach engine supports as follows:

1. Attach Engine Lifting Eyes D81L-6001-D or equivalent to LH rear cylinder with a bolt, M10x1.5x20.
2. The engine plant lifting eye should still be on RH front cylinder head. If not, install a second lifting bracket as in Step 1.

	D88L-6000-A	THREE BAR ENGINE SUPPORT
	D81L-6001-D	ENGINE LIFTING EYES



A9887-E

If the engine is being removed, attach lifting chains from lifting brackets and lifting equipment. If the engine is to be supported during a service procedure, proceed with Step 3.

3. Place Three Bar Engine Support D88L-6000-A or equivalent across engine over each rocker arm cover and attach chains to bars and lifting brackets.

When only the two support points above are used, the engine assembly will hang slightly down at the rear (approximately 5 degrees) with the transaxle attached. With the transaxle removed, the engine assembly will hang slightly down at the front (approximately 15 degrees) because of the weight of the accessories.

To eliminate either or both of these tilts, attach supports as follows:

CAUTION: The support hook or chain must angle forward to the front attaching point. Damage WILL result if it runs across the throttle cable or throttle valve mechanism.

REMOVAL AND INSTALLATION (Continued)

1. For the forward tilt, attach a chain from the LH front support bar to the stud on the No. 4 exhaust runner.

2. For the rearward tilt, attach a chain from the RH rear support bar to the exhaust manifold between the No. 2 and No. 3 exhaust runner.

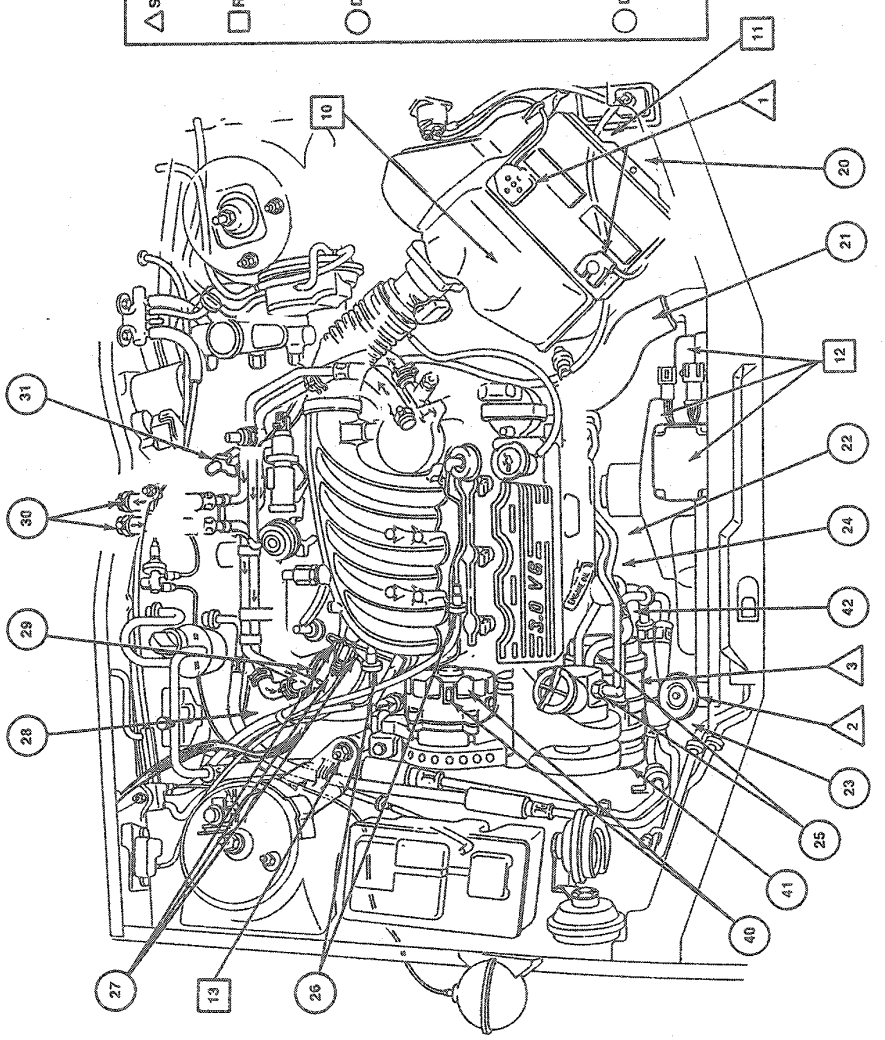
REMOVAL AND INSTALLATION (Continued)

△ SERVICE:
1. DISCONNECT BATTERY CABLES
2. DRAIN RADIATOR
3. DISCHARGE A/C

□ REMOVE/INSTALL
10. AIR CLEANER ASSEMBLY
11. BATTERY AND TRAY
12. INTEGRATED RELAY CONTROLLER, COOLING FAN RADIATOR AND SHROUD
13. ENGINE NVH BRACKET TO SHOCK TOWER

◯ DISCONNECT/CONNECT:
20. EVAPORATIVE EMISSION LINE
21. UPPER RADIATOR HOSE
22. STARTER BRACE
23. LOWER RADIATOR HOSE
24. EXHAUST MANIFOLD AT PIPE
25. POWER STEERING PUMP LINES
26. FUEL LINES
27. VACUUM LINES
28. EXHAUST MANIFOLD AT PIPE
29. GROUND STRAP
30. HEATER LINES
31. ACCELERATOR CABLE LINKAGE THROTTLE VALVE LINKAGE SPEED CONTROL CABLE

◯ DISCONNECT/CONNECT-WIRING:
40. GENERATOR
41. A/C CLUTCH
42. HO2S



UNLEADED GASOLINE ONLY

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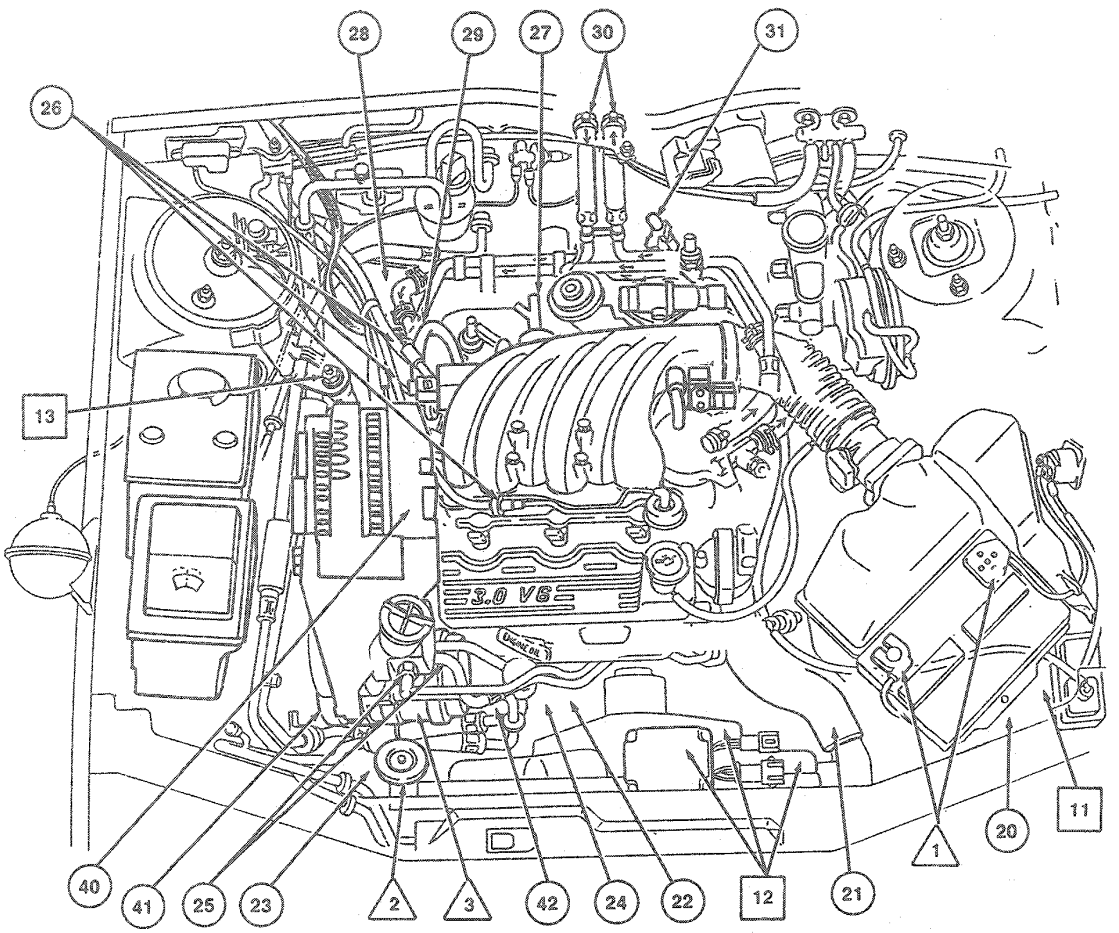
REMOVAL AND INSTALLATION (Continued)

FLEXIBLE FUEL VEHICLE ONLY



△ SERVICE:
1. DISCONNECT BATTERY CABLES
2. DRAIN RADIATOR
3. DISCHARGE A/C

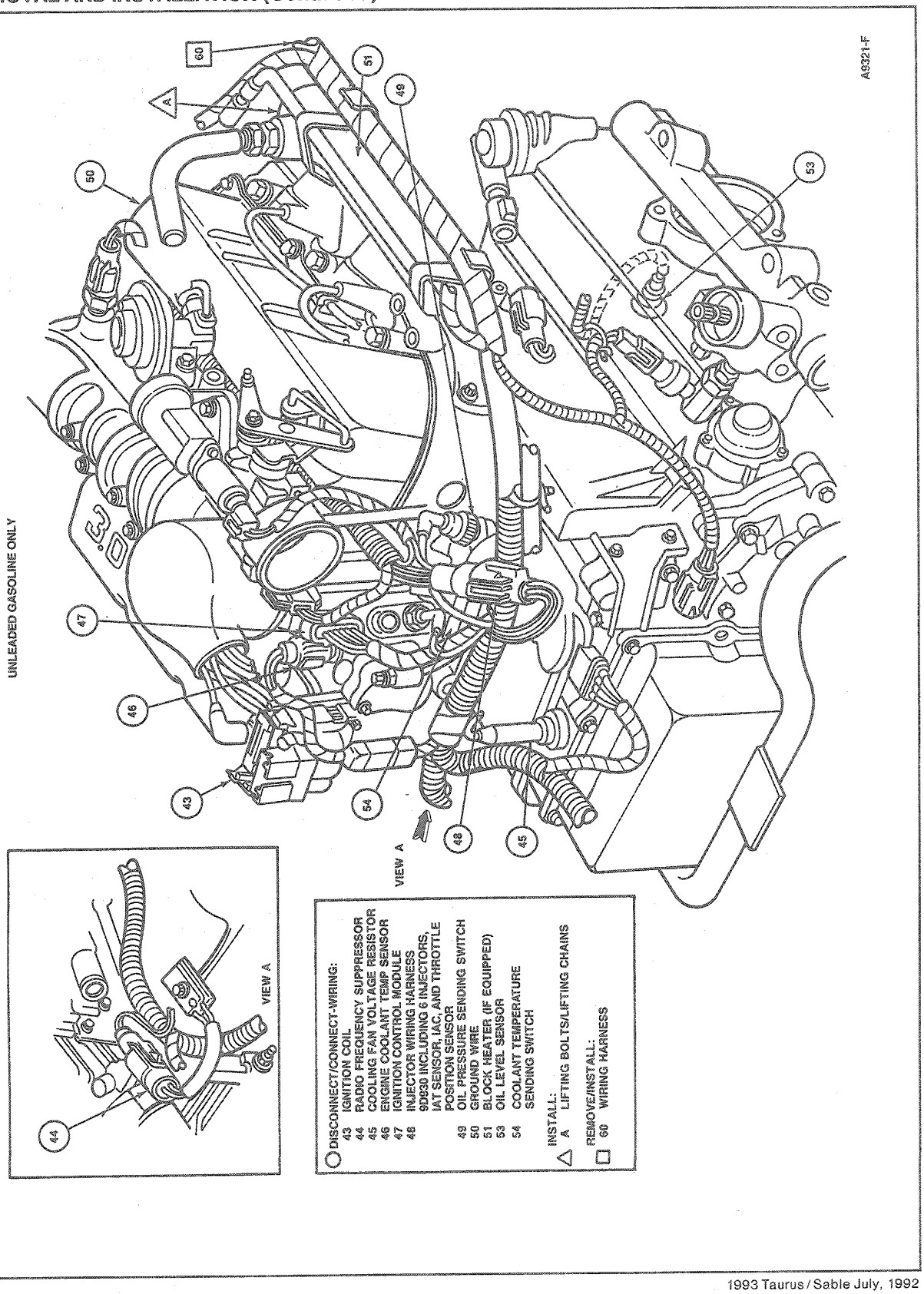
☐ REMOVE/INSTALL
10. AIR CLEANER ASSEMBLY
11. BATTERY AND TRAY
12. CONSTANT CONTROL RELAY MODULE, COOLING FAN RADIATOR AND SHROUD
13. ENGINE NVH BRACKET TO SHOCK TOWER

○ DISCONNECT/CONNECT:
20. EVAPORATIVE EMISSION LINE
21. UPPER RADIATOR HOSE
22. STARTER BRACE
23. LOWER RADIATOR HOSE
24. EXHAUST MANIFOLD AT PIPE
25. POWER STEERING PUMP LINES
26. FUEL LINES
27. VACUUM LINES
28. EXHAUST MANIFOLD AT PIPE
29. GROUND STRAP
30. HEATER LINES
31. ACCELERATOR CABLE LINKAGE THROTTLE VALVE LINKAGE SPEED CONTROL CABLE

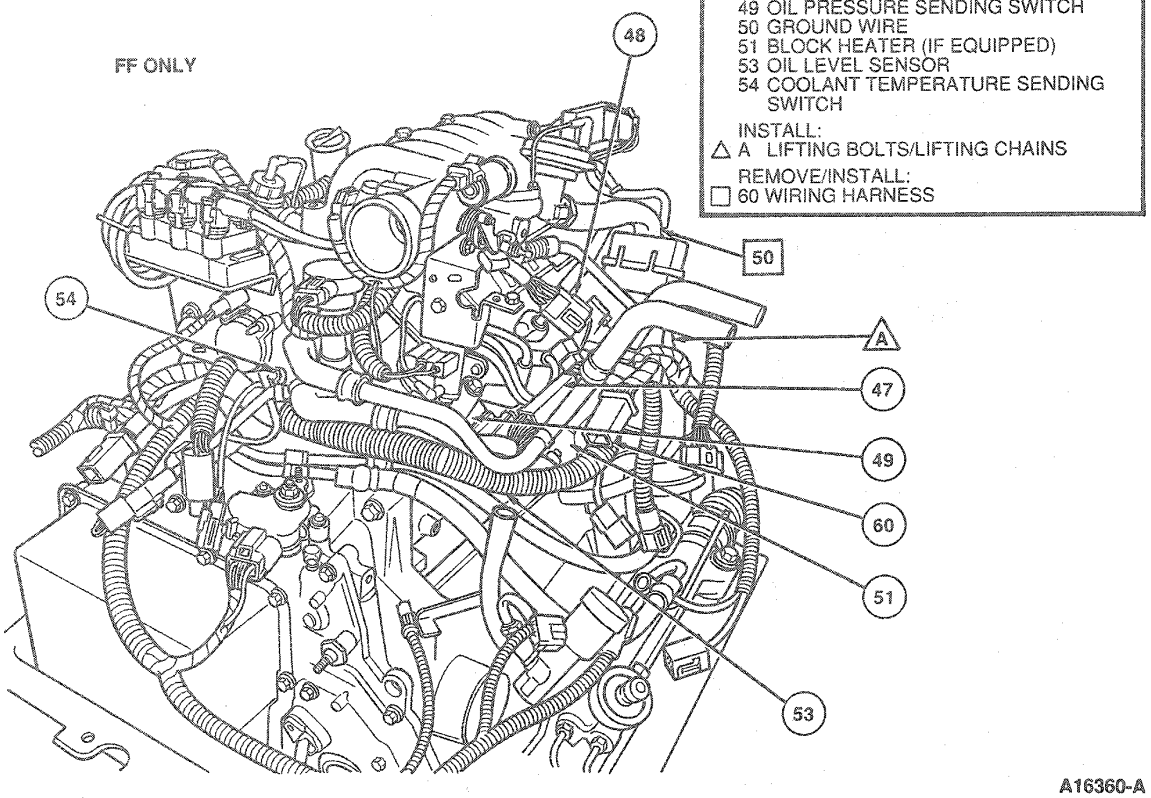
○ DISCONNECT/CONNECT-WIRING:
40. GENERATOR
41. A/C CLUTCH
42. HO2S

A16359-A

REMOVAL AND INSTALLATION (Continued)



REMOVAL AND INSTALLATION (Continued)



Flywheel

Removal

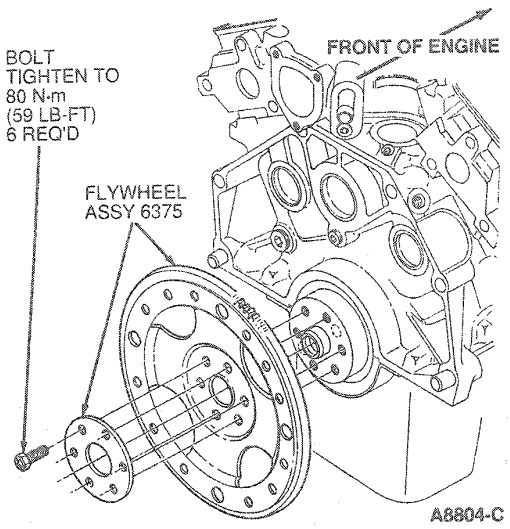
1. Remove engine as outlined in this section.
2. Remove flywheel retaining bolts and flywheel.

Installation

All major rotating components including the flywheel are individually balanced to zero. Engine assembly balancing is not required. Balance weights should **NOT** be installed on new flywheels.

REMOVAL AND INSTALLATION (Continued)

1. Position flywheel on the crankshaft and install retaining bolts. Tighten bolts to 80 N·m (59 lb-ft) using the standard cross-tightening sequence.



2. Install transaxle.

Crankshaft

Removal

1. With engine removed from vehicle and placed on a workstand, remove 6K drive belt as outlined in Section 03-05.
2. Remove oil pan and discard gasket.
3. Remove timing cover assembly as outlined in this section.
4. Check timing chain deflection as outlined in this section. Remove timing chain and sprockets.
5. Invert engine on the work stand. Remove flywheel. Remove oil pump inlet and oil pump assembly.
6. Ensure all bearing caps (main and connecting rod) are marked so that they can be installed in their original positions. Turn crankshaft until connecting rod from which the cap is being removed is up. Remove connecting rod cap. Push connecting rod and piston assembly up in the cylinder. Repeat procedure for the remaining connecting rod assemblies.
7. Remove main bearing caps.

   CAUTION: Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.
8. Carefully lift the crankshaft out of the block so that the upper thrust bearing surfaces are not damaged.

Installation

NOTE: If bearings are to be reused they should be identified to ensure that they are installed in their original positions.

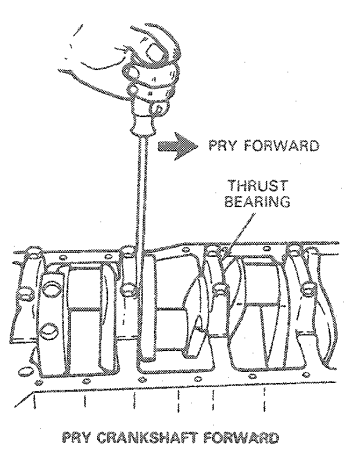
1. Remove main bearing inserts from block and bearing caps.
2. Remove connecting rod bearing inserts from the connecting rods and caps.
3. Inspect all machined surfaces on the crankshaft for nicks, scratches, scores, etc., which could cause premature bearing wear. Lightly stone all such surfaces.
4. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings.

   CAUTION: Ensure bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.
5. Place upper main bearing inserts in position in the bores with the tang fitted in the slot provided.
6. Install lower main bearing inserts in bearing caps.
7. Carefully lower crankshaft into place.
8. Check the clearance of each main bearing. Select fit the bearings for proper clearance. Refer to Section 03-00.

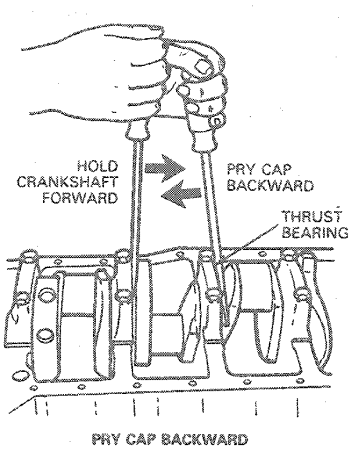
   NOTE: Ensure main bearing caps are installed in their original positions and orientation.
9. After bearings have been fitted, apply a light coat of Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent to the journals bearings and rear seal surface. Install all bearing caps. Apply Anaerobic Sealer E1FZ-19562-A or equivalent to gap between rear main bearing and block. Take care to keep RTV from parting surfaces between block and cap.

REMOVAL AND INSTALLATION (Continued)

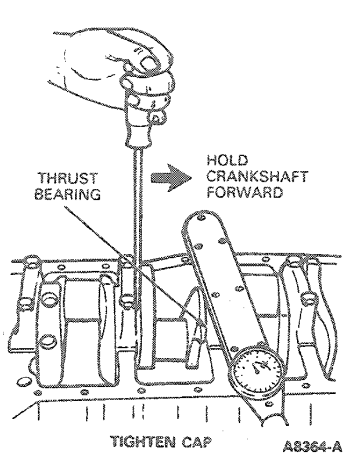
10. Lubricate the journal with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Install the thrust bearing cap with the bolts finger-tight. Pry the crankshaft forward against the thrust surface of the upper half of the bearing. Hold the crankshaft cap to the rear. This will align the thrust surfaces of both halves of the bearing. Retain the forward pressure on the crankshaft.



PRY CRANKSHAFT FORWARD



PRY CAP BACKWARD



TIGHTEN CAP A8364-A

11. Check crankshaft end play. Refer to Section 03-00.
12. If end play exceeds specification, replace upper and lower thrust bearings. If the end play is less than specification, inspect thrust bearing faces for damage, dirt or improper alignment. Install thrust bearing and align the faces. Recheck end play.
13. Install new bearing inserts in the connecting rods and caps. Check the clearance of each bearing. Refer to Section 03-00.
14. If bearing clearances are to specification, apply a light coat of Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent to the journals and bearings.
15. Turn the crankshaft throw to the bottom of the stroke. Push the piston all the way down until the rod bearings seat on the crankshaft journal.
16. Install connecting rod cap.
17. After piston and connecting rod assemblies have been installed, check connecting rod crankshaft journal side clearance.
18. Turn engine on the work stand so that the front end is up. Install timing chain, sprockets, front cover, new oil seal and crankshaft pulley as outlined.

    Turn engine on the work stand so that the rear end is up. Install rear oil seal as outlined.

19. Clean oil pan, oil pump and oil pump screen assembly.
20. Prime oil pump by filling the inlet opening with oil and rotating the pump shaft until oil emerges from the outlet opening. Install oil pump, baffle and oil pan as outlined.
21. Position flywheel on the crankshaft. Tighten to 80 N·m (59 lb-ft).
22. Turn engine on the work stand so that the engine is in the normal upright position. Install accessory drive tensioner. Install accessory drive belt. Refer to Section 03-05.
23. Remove engine from the work stand. Install engine.

Crankshaft Rear Main Oil Seal

Tools Required:

- Jet Plug Remover T77L-9533-B
- Crankshaft Rear Seal Replacer T88L-6701-A

Removal

1. Remove engine as outlined in this section.

   CAUTION: Use care to avoid scratching or damaging oil seal surface.

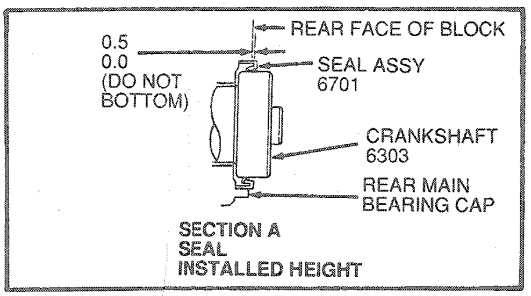
2. Using a sharp awl, punch one hole into the seal metal surface between the lip and block.

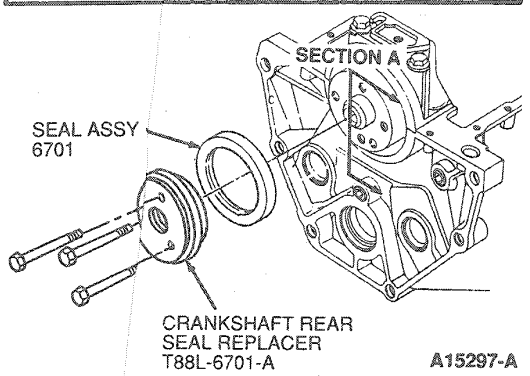
REMOVAL AND INSTALLATION (Continued)

3. Screw in the threaded end of Jet Plug Remover T77L-9533-B. Use the slide hammer to remove seal.

Installation

1. Apply engine oil to outer lips and inner seal edge.
2. Position seal on Crankshaft Rear Seal Replacer T88L-6701-A. Position tool and seal to rear of engine. Alternate bolt tightening to seat the seal properly.
3. Install engine as outlined.





Camshaft

Tools Required:

- Crankshaft Damper Removal Tool T58P-6316-D
- Vibration Damper Remover Adapter T82L-6316-B

Removal

1. Remove engine from the vehicle as outlined and place on a workstand.
2. Rotate crankshaft to 0 degrees at Top Dead Center (TDC) on the compression stroke.
3. Remove throttle body. Refer to Section 03-04A, Fuel Charging and Controls.
4. Disconnect fuel injector harness retaining stand offs from inboard rocker arm cover studs. Carefully disconnect electrical connectors from each injector and remove fuel charging wiring from engine.
5. Remove ignition wires from spark plugs by using a twisting motion on the rubber boot. Remove harness retaining stand offs from rocker arm cover studs.
6. On unleaded gasoline only, mark distributor housing to block and note rotor position. Remove distributor retaining bolt and washer. Remove distributor.
7. Remove ignition coil from rear of LH cylinder head.
8. Remove rocker arm covers as outlined.
9. Loosen cylinder No. 3 intake valve rocker arm retaining nut and rotate arm off of push rod and away from top of valve stem. Remove push rod.
10. Remove generator assembly, brackets and belt tensioner and belt.

    NOTE: Intake manifold assembly may be removed with fuel supply manifold and injectors in place.
11. Remove intake manifold retaining bolts using a Torx® head socket. Before attempting to remove intake manifold, break the seal between the intake manifold and cylinder block. Wedge a large screwdriver or similar tool between intake manifold and block. Pry upward on tool using lug on top of front cover as a leverage point.
12. Loosen rocker arm fulcrum retaining bolts enough to allow the rocker arm to be lifted off the push rods and rotated to one side.
13. Remove push rods. Identify each push rod location. The push rods should be installed in their original location and position during assembly.
14. Loosen roller tappet guide plate two retainer bolts. Remove guide plate retainer assembly from tappet valley.
15. Remove tappet guide plates from tappets by lifting straight up.

    NOTE: If the tappets are stuck in the bores due to excessive varnish or gum deposits, it may be necessary to use a claw type tool to aid removal. Rotate the tappet back and forth to loosen it from the deposits.
16. Remove tappets by grasping each tappet and pulling in line with bore.
17. Remove crankshaft pulley retaining bolts and remove pulley.
18. Remove crankshaft damper retaining bolt and washer. Remove damper using Crankshaft Damper Removal Tool T58P-6316-D and Vibration Damper Remover Adapter T82L-6316-B.
19. Remove oil pan assembly as outlined. Discard gasket.

    NOTE: Water pump may be removed with front cover as an assembly. Do not remove bolts No. 11 through 15 to remove as an assembly. Refer to illustration for bolt location.

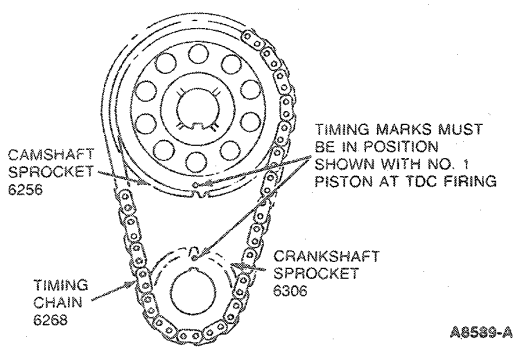
REMOVAL AND INSTALLATION (Continued)

20. Remove front cover assembly retaining bolts.

    CAUTION: Use care to not damage machined surfaces when removing front cover. Only drive screwdriver enough to break gasket seal.

21. Remove front cover and discard old gasket. Place a dull, thin-bladed screwdriver or similar device between front cover and cylinder block and tap to break seal. Walk front cover off cylinder block locating dowels using a soft rocking motion. Use crankshaft seal protector if available.

22. Align marks on camshaft and crankshaft gears as shown.



23. Check camshaft end play. Refer to Section 03-00. If clearance is excessive, replace camshaft thrust plate.

24. Check timing chain deflection. Refer to Section 03-00.

25. Remove camshaft sprocket retaining bolt and washer.

26. Remove timing chain and sprockets. Using one hand on the camshaft sprocket and the other on the crankshaft gear, pull assembly forward and off of crankshaft and camshaft.

27. Remove two camshaft thrust plate retaining bolts and thrust plate.

28. Carefully remove camshaft by pulling slowly toward front of engine keeping camshaft perfectly in line with camshaft bores. Damage to camshaft bearings and / or camshaft can occur if camshaft is allowed to drop on bearing surface or cylinder block.

Installation

NOTE: Lightly oil all retaining bolt and stud bolt threads before installation except those specified for special sealant.

CAUTION: Aluminum components gouge easily which cause gasket leaks. Always use care when scraping aluminum gasket surfaces.

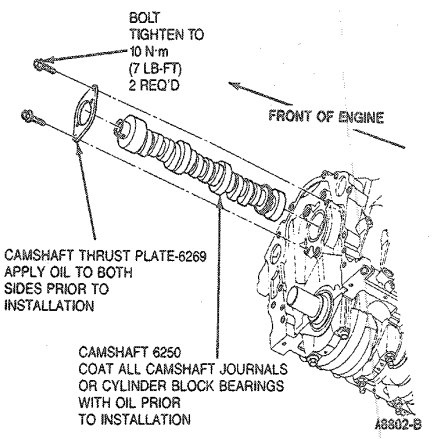
1. Clean mating gasket surfaces of intake manifold and cylinder head. Lay a clean cloth or shop cloth in the tappet valley to catch any gasket material. After scraping, carefully lift cloth from tappet valley preventing any particles to enter oil drain holes or cylinder head. Use a suitable solvent to remove old rubber sealant. Clean gasket mating surfaces of front cover to cylinder block and oil pan to cylinder block.

2. Inspect camshaft bearings for wear. Refer to Section 03-00.

3. Clean and inspect all components before installation.

4. Lubricate camshaft lobes and bearing surfaces liberally with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Coat distributor drive gear with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Carefully slide camshaft through bearings into cylinder block. Keep camshaft in line with front bearing.

5. Lubricate camshaft thrust plate with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent and install with two retaining bolts. Tighten bolts to 10 N·m (7 lb-ft)).

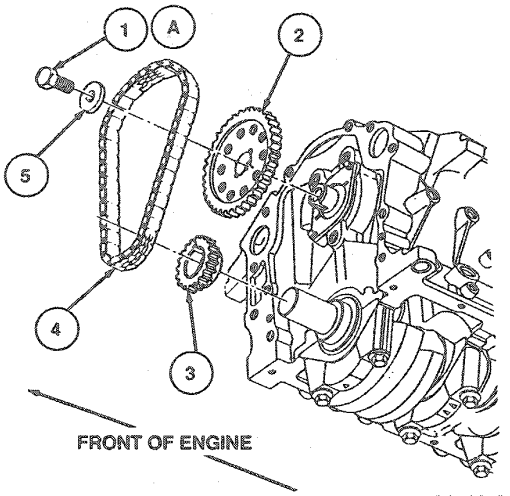


6. If installing a new camshaft, check endplay . Refer to Section 03-00. If clearance is excessive, replace camshaft thrust plate.

   CAUTION: Do not replace camshaft sprocket bolt with a standard bolt or severe engine damage will occur. This bolt is an oil carrying, precision component.

REMOVAL AND INSTALLATION (Continued)

7. Lubricate timing chain and sprockets with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Align marks as illustrated. Inspect camshaft sprocket bolt for blockage of drilled oil passages and clean as required. Install bolt and washer and tighten to 50-70 N·m (41-52 lb-ft).



A8590-C

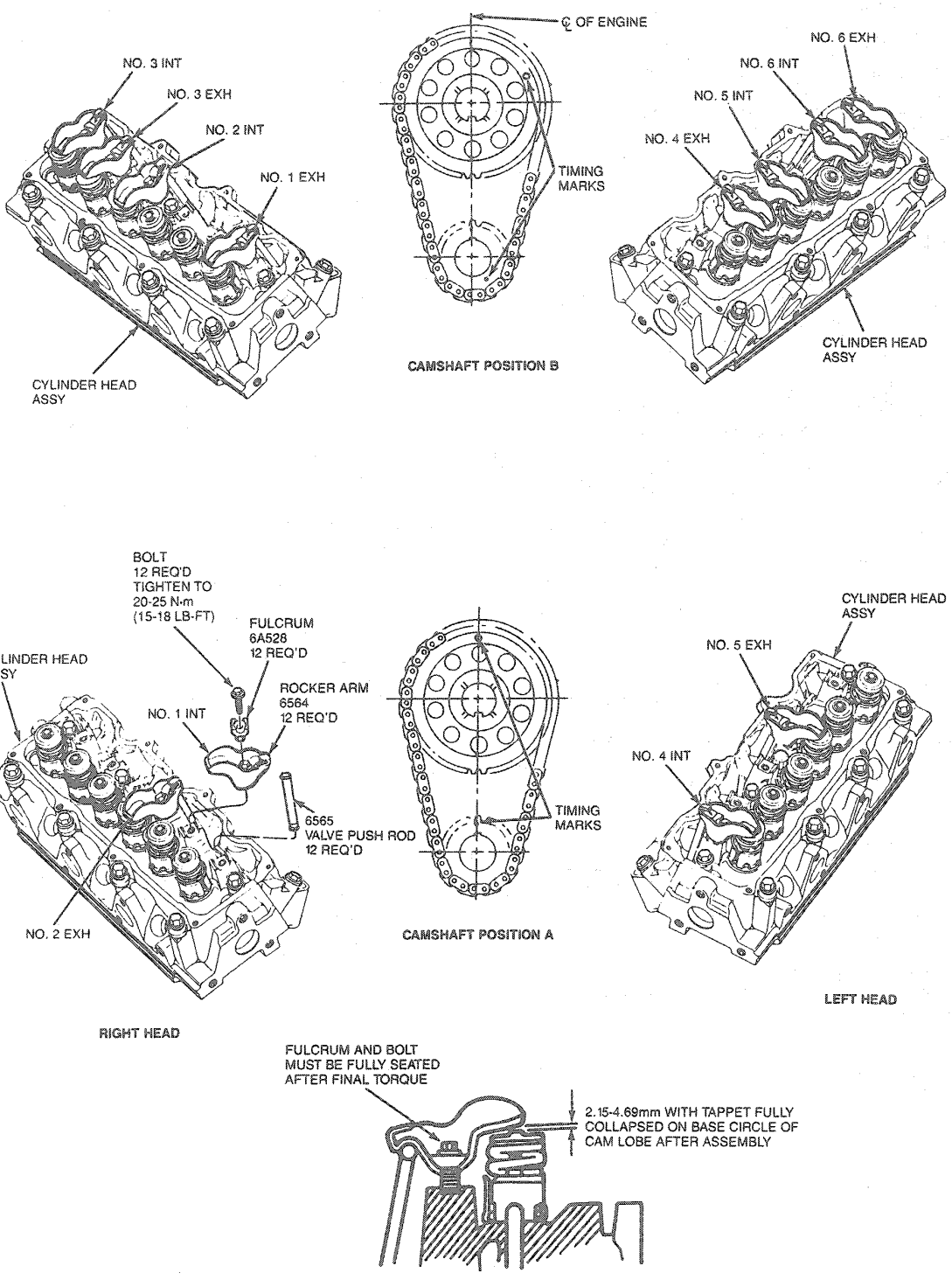
Item	Part Number	Description
1A	6279	Bolt
2	6256	Camshaft Sprocket
3	6306	Crankshaft Sprocket
4	6268	Timing Chain Lubricate With Oil
5	6278	Washer-Cam Sprocket
A		Tighten to 50-70 N·m (37-51 Lb-Ft)

TA8590C

8. Lubricate tappets and bore with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.
9. Install tappets into original bores.

   NOTE: Install plate with the word "UP" and or button visible.
10. Aligning tappet flats, install tappet guide plate.
11. Install guide plate retainer assembly over guide plates. Hand start two retaining bolts. Tighten bolts to 12 N·m (9 lb-ft).
12. Apply a 6mm 1/4 inch drop of Silicone Rubber D6AZ-19562-AA or BA (ESB-M4G92-A) or equivalent to intersection of cylinder block and cylinder head assembly at four corners as shown.
13. Position intake gaskets onto cylinder heads. Align intake gasket locking tabs to the provisions on the cylinder head gaskets as shown.
14. install front and rear intake manifold seals as shown. Secure with retaining features.
15. Carefully lower intake manifold into position aligning manifold bolt holes to those in the cylinder head. Use care to prevent disturbing the rubber sealer which can cause sealing voids. Install bolts No. one, two, three and four and hand tighten. Install remaining bolts and tighten in a two step process. Tighten in numerical sequence to 7-15 N·m (5-11 lb-ft), then again to 26-38 N·m (19-28 lb-ft).
16. On unleaded gasoline only, coat distributor gear teeth with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Install distributor and align to premarked location on cylinder block and rotor position. Install retaining bolt and washer and hand tighten.
17. Apply Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent to removed push rods and rocker arms. Install push rods. Move rocker arms into position with push rod and valve stem.
18. Rotate crankshaft to align camshaft and crankshaft timing marks as shown to position "A". Tighten retaining bolts of specified rocker arms to 11 N·m (8 lb-ft) to seat fulcrums into cylinder head. Rotate crankshaft to position "B". Tighten retaining bolts of remaining rocker arms to 11 N·m (8 lb-ft). Final tighten bolts to 32 N·m (24 lb-ft) in any position. If new tappets are being installed check collapsed tappet gaps. Refer to Section 03-00.

REMOVAL AND INSTALLATION (Continued)



REMOVAL AND INSTALLATION (Continued)

NOTE: Fulcrum must be fully seated into cylinder head and push rod must be fully seated in rocker arm and lifter sockets prior to final tightening.

19. Inspect front cover crankshaft oil seal for damage and replace if required. Install new front cover gasket cover alignment dowels on cylinder block. Install front cover and tighten retaining bolts to 20-30 N·m (15-22 lb-ft). Install water pump and new gasket if removed.
20. Install new oil pan gasket to cylinder block and secure with Gasket and Trim Adhesive D7AZ-19B508-B (ESR-M11P17-A and ESE-M2G52-A) or equivalent. Make sure the gasket retaining tab features are properly installed on cylinder block, rear main bearing and front cover. Install oil pan and all retaining bolts. Tighten four corner bolts to 10-14 N·m (7-10 lb-ft), then the remaining bolts to the same value. Back off all 16 retaining bolts and retighten to 10-14 N·m (7-10 lb-ft).
21. Install crankshaft damper and pulley as outlined in this section.
22. Install rocker arm covers as outlined in this section.
23. Install fuel charging wiring to each injector. Secure with stand offs to inboard rocker arm cover studs.
24. Install ignition coil to rear of LH cylinder head. Tighten retaining bolts to 48 N·m (35 lb-ft).
25. Install throttle body assembly and new gasket. Refer to Section 03-04A.
26. Install distributor cap and ignition wires (unleaded gasoline only). Install wire harness stand offs to rocker arm cover studs and connect wires to spark plugs and ignition coil.
27. Install engine in vehicle.
28. Fill and bleed cooling system with specified mixture and amount.
29. Fill crankcase with the correct viscosity and amount of engine oil.
30. Start engine and check for coolant, oil, exhaust, vacuum and fuel leaks. Check and, if necessary adjust base ignition timing as outlined in the Powertrain Control / Emissions Diagnosis Manual[4] (unleaded gasoline only).

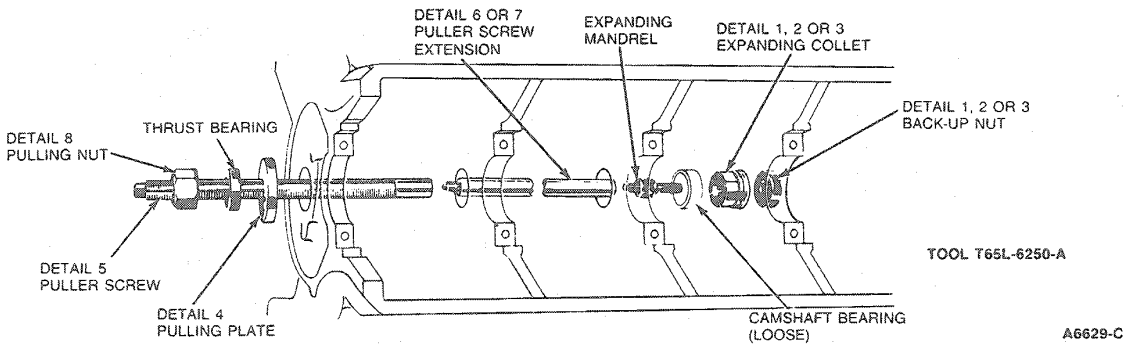
Camshaft Bearings

Tool Required:

- Camshaft Bearing Set T65L-6250-A

Removal

1. Remove engine, as outlined and place on work stand and remove camshaft, crankshaft and rear bearing bore plug as outlined.
2. Remove camshaft bearing with Camshaft Bearing Set T65L-6250-A.
3. Select proper size expanding collet and backup nut, and assemble on the expanding mandrel. With the expanding collet collapsed, install collet assembly in the camshaft bearing, and tighten backup nut on the expanding mandrel until the collet fits the camshaft bearing.



4. Assemble puller screw and extension if necessary, and install on the expanding mandrel. Wrap a cloth around the threads of the puller screw to protect the bearing or journal. Tighten the puller nut against the thrust bearing and pulling plate to remove camshaft bearing. Hold the end of the puller screw to prevent it from turning.
5. Repeat Step 4 for each bearing. To remove the front bearing, install the puller from the rear of the block.

4 Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

Installation

The camshaft bearings are available prefinished to size and require no reaming for standard and 0.38mm (0.015 inch) undersize journal diameters.

CAUTION: Failure to use the correct expanding collet can cause severe bearing damage.

1. Position new bearings at the bearing bores and press them in place with Camshaft Bearing Set T65L-6250-A. Center the pulling plate and puller screw to avoid damage to the bearing.

   NOTE: Align the oil holes in the bearings with the oil holes in the cylinder block before pressing bearings into place.

   Ensure the front bearing is installed 0.51-0.89mm (0.020-0.035 inch) below the front face of the cylinder block.
2. Install camshaft rear bearing bore plug as outlined.
3. Install camshaft, crankshaft, flywheel and related parts as outlined. Do not check connecting rod and main bearing clearances as part of camshaft bearing replacement.
4. Install engine in vehicle as outlined in this section.

Camshaft Rear Bore Plug

Tools Required:

- Impact Slide Hammer T50T-100-A or T59L-100-B

Removal

1. Remove engine assembly as outlined in this section.
2. Remove flywheel.
3. Using a sharp chisel or punch and hammer, cut a hole in the center of the plug.

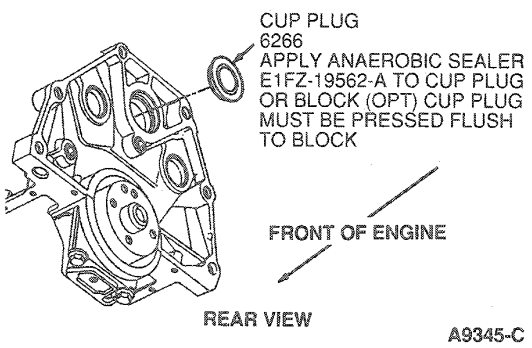
   CAUTION: Use care to prevent damage to the plug bore.
4. Remove the plug using Impact Slide Hammer T59L-100-B or T50T-100-A. The plug can also be pried from the bore using a large punch.

Installation

Prior to installing a core plug the plug bore should be inspected for any damage that would interfere with the proper sealing of the plug. If the bore is damaged it will be necessary to true the surface by boring for the next specified oversize plug. Oversize (OS) plugs are identified by the OS stamped in the flat located on the cup side of the plug.

1. Install bore plug using a suitable driver.

   Apply a light coating of Anaerobic Sealer or equivalent to the sealing edge of the plug before installation.
2. Install flywheel. Tighten bolts to 80 N·m (59 lb-ft).
3. Install engine assembly as outlined in this section.



DISASSEMBLY AND ASSEMBLY

Engine

Tools Required:

- Crankshaft Damper Remover T58P-6316-D
- Spark Plug Wire Remover T74P-6666-A
- Vibration Damper Remover T82L-6316-B
- Crankshaft Seal Replacer T88L-6701-A
- Rotunda Piston Ring Compressor 014-00290
- Rotunda Cylinder Ridge Reamer 014-00292

Disassembly

Before starting disassembly, remove accessories and any emission control equipment which is not directly attached to the engine.

1. Remove flywheel.
2. Remove exhaust manifolds as outlined.

   When exhaust manifold is removed, note the location of the dipstick tube support bracket.
3. Remove the oil filler cap and closure tube.
4. Remove PCV valve.
5. Remove PCV valve grommet and hose, if necessary.
6. Disconnect secondary wires from the spark plugs. Remove distributor cap (with secondary wires) and rotor (unleaded gasoline only).

   When removing a wire from a spark plug, use Spark Plug Wire Remover T74P-6666-A. Grasp and twist the boot back and forth on the plug insulator to free the boot. Use the tool to pull the boot from the plug. Do not pull on the wire directly or it may become separated from the connector inside the boot.
7. Remove EGR valve and EGR gasket, if so required.
8. Remove the throttle body and disconnect the fuel charging wiring harness (9D930) as outlined.

DISASSEMBLY AND ASSEMBLY (Continued)

9. Remove crankshaft pulley and the vibration damper. Use Crankshaft Damper Remover T58P-6316-D and Vibration Damper Remover Adapter T82L-6316-B to remove vibration damper.
10. On unleaded gasoline only, remove distributor hold-down clamp and the distributor.
11. Remove rocker arm covers as outlined in this section.

    CAUTION: Use care to prevent damage to machined surfaces.

    Before attempting to remove the intake manifold, break the seal between the intake manifold and the cylinder block. Wedge a large screwdriver between the intake manifold and the block. Pry downward on the screwdriver using the lug on the water pump as a leverage point.
12. Remove rocker arms and push rods as outlined in this section.

    The location of each rocker arm, push rod and fulcrum should be noted. When engine is assembled each component should be installed in its original position.
13. Remove spark plugs.
14. Remove intake manifold and manifold side gaskets as outlined. Discard intake manifold gaskets.
15. Remove cylinder heads. Discard cylinder head retaining bolts.
16. Remove and discard cylinder head gaskets.

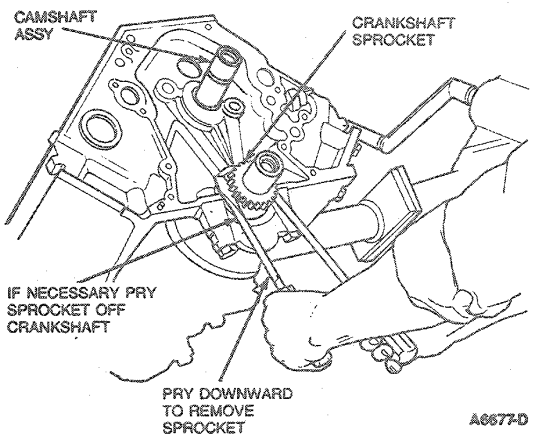
    NOTE: The location of each tappet should be identified. When the engine is assembled each tappet should be installed in its original position.

    If the tappets are stuck in the bores due to excessive varnish or gum deposits, it may be necessary to use a magnet, or claw-type tool to aid removal. When using a remover tool rotate the tappet back and forth to loosen it from the gum or varnish that may have formed on the tappet.
17. Remove valve tappets.
18. Remove oil filter.
19. Remove oil pan and gasket. Discard gasket.
20. Remove oil pump.

    NOTE: If necessary, the water pump can be removed from the front cover. Discard pump gasket after removal.
21. Remove water pump and front cover as an assembly. Remove and discard cover gasket.
22. Remove thrust plate bolts and thrust plate from the end of the camshaft.
23. Remove camshaft sprocket retaining bolt.

    CAUTION: Use care to prevent damage to finished areas on the crankshaft.

    NOTE: If the crankshaft sprocket is difficult to remove, it can be pried off using two large screwdrivers.
24. Remove camshaft sprocket, the crankshaft sprocket and the timing chain as outlined.



25. Remove camshaft. Use care to prevent damage to camshaft bearing surfaces.
26. If necessary, remove camshaft plug from the back of the engine.

    NOTE: Before removing the pistons, inspect the top of the cylinder bores. If necessary, remove the ridge and/or carbon deposits from each cylinder using Rotunda Cylinder Ridge Reamer 014-00292 or equivalent. Before the ridge or deposits are removed, turn the crankshaft until the piston is at the bottom of its stroke. Cover the piston with a clean shop towel to collect the cuttings. After the cutting operation, turn the crankshaft until the piston is at the top of its stroke and remove the shop towel with the cuttings.

    CAUTION: Never cut into the ring travel area in excess of 0.794mm (0.03125-inch).

    NOTE: The cylinder number is stamped on the top of the piston. Matched letters are stamped on the sides of corresponding rod and cap.
27. Remove connecting rod caps and pistons.

    The location of each piston, crank bearing and rod cap should be noted. When the engine is assembled each component should be installed in its original position.
28. Remove main bearing caps and crankshaft.

    The location of the main bearings should be identified. When the engine is assembled each bearing should be installed in its original position.
29. For cleaning purposes, oil gallery and cooling jacket plugs can be removed.

DISASSEMBLY AND ASSEMBLY (Continued)

Assembly

NOTE: During the engine assembly, a Gasket Maker E2AZ-19562-B (WSK-M2G348-A5) or equivalent sealer will be applied to many areas before installation. When the sealant is applied, the component should be installed within 15 minutes. After this time the sealant begins to set-up and its sealing effectiveness can be reduced.

Lightly oil all retaining bolt and stud bolt threads before installation except those specifying special sealant.

1. If removed, install oil gallery and cooling jacket plugs. Tighten plugs to 20 N·m (15 lb-ft). Before installation, coat plug threads with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent.
2. Install crankshaft as follows:
   a. Install main bearing inserts in the appropriate cylinder block saddle. Note that third bearing from front is the thrust bearing.

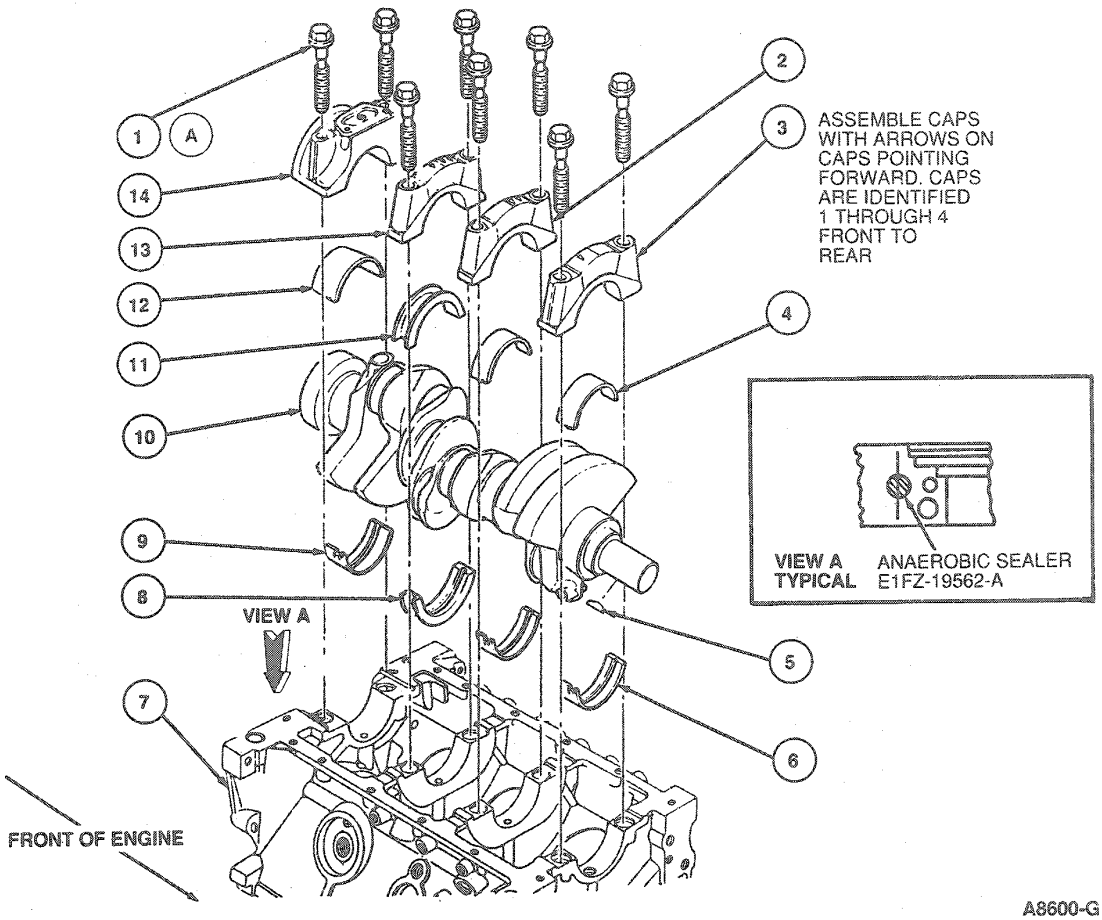
      CAUTION: Use care to prevent damage to bearing surfaces.

   b. Lubricate bearing inserts with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil. Carefully lower the crankshaft into place.
   c. Apply a 6mm (1/4 inch) dot of Anaerobic Sealer E1FZ-19562-A or equivalent, between rear cap and cylinder block as shown.
   d. Install lower bearing inserts in the main caps. Note that caps are numbered with arrow heads. No. 1 is located at front of engine with arrow head facing front of engine. No. 2 is main cap and has two arrow heads pointing to front of engine and so on.

      NOTE: Caps are precision fit to surrounding metal parts. A slight tap with a plastic mallet will help to locate cap. Use care to prevent damage.

   e. Apply oil to bearing caps. Install bolts finger-tight.
   f. Before tightening bearing cap retaining bolts/studs, wedge a large screwdriver between cylinder block web and crankshaft cheek located in front of the No. 3 main bearing. Do not jam the screwdriver into place. Apply sufficient force only to push crankshaft forward while the cap bolts are tightened.
   g. Tighten bearing cap retaining bolts/studs to 80 N·m (60 lb-ft) and remove screwdriver.
   h. Check crankshaft end play. Refer to Section 03-00.

DISASSEMBLY AND ASSEMBLY (Continued)



Item	Part Number	Description
1A	—	Bolt (4 Req'd)
2	6334	Front Intermediate Cap
3	6329	Front Cap
4	6A338	Main Bearing Lower (2 Req'd)
5	—	Key Sprocket and Damper
6	6333	Main Bearing Upper (2 Req'd)
7	6010	Cylinder Block Assy

(Continued)

Item	Part Number	Description
8	6337	Main Thrust Bearing-Upper
9	6W331	Main Bearing Rear-Upper
10	6303	Crankshaft
11	6A339	Main Thrust Bearing Lower
12	6W332	Main Bearing Rear Lower
13	6327	Rear Intermediate Cap Assy
14	6A325	Rear Cap Assy
A		Tighten to 75-85 N·m (55-63 Lb-Ft)

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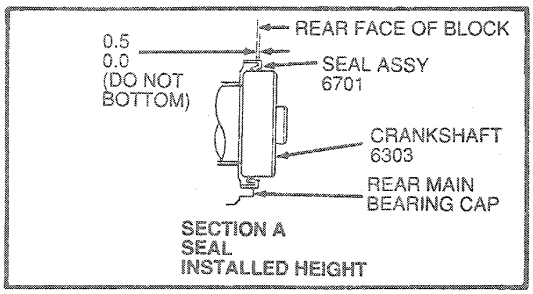
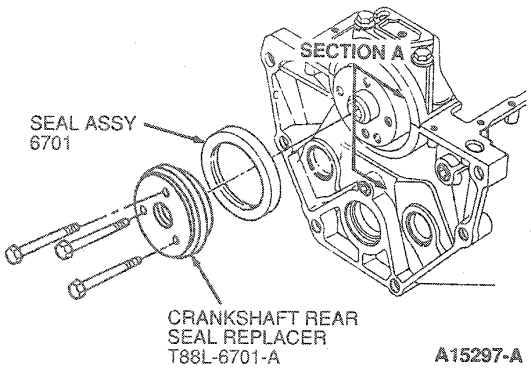
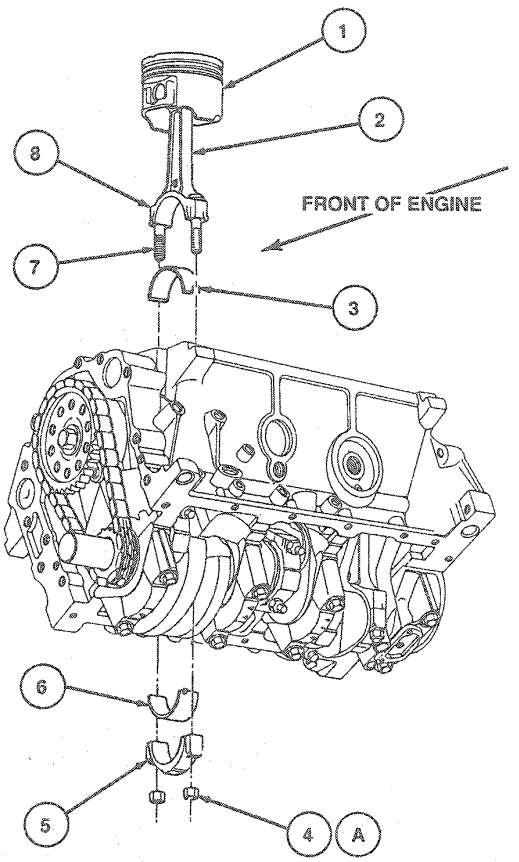
DISASSEMBLY AND ASSEMBLY (Continued)

3. Install rear main seal as outlined in this section.



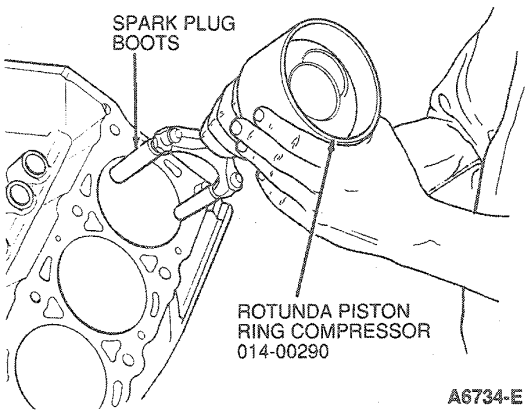


4. Install piston rings on pistons using a ring expander. Make sure piston ring lands are completely clean of carbon deposits before installing rings. Check ring end gap in each cylinder prior to piston installation. Refer to Specifications.
5. Install the piston as follows:
   a. Install bearing inserts in the connecting rods and the connecting rod caps. Make sure bearing locating tang is properly located and bearing is completely seated.
   b. Lubricate piston rings, cylinder walls, and bearing surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.
   c. Arrange piston ring gaps alternately around the pistons so no gaps are in line with another.
   d. Install a 50mm (2 inch) piece of 3/8 inch fuel line (or straight spark plug boot) on both connecting rod bolts to prevent damage to crankshaft rod journals prior to installation.
   e. Install pistons using Rotunda Piston Ring Compressor 014-00290 or equivalent. The notch in the piston dome and button on connecting rod must face the front of the engine.



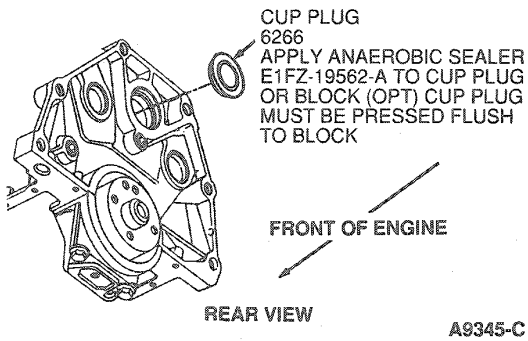
Item	Part Number	Description
1	6109	Piston and Pin Assy (6 Req'd)
2	6200	Connecting Rod (6 Req'd)
3	6211	Upper Rod Bearing (6 Req'd)
4A	6212	Nut (12 Req'd)
5	6210	Rod Cap (6 Req'd)
6	6211	Lower Rod Bearing (6 Req'd)
7	6214	Bolt (12 Req'd)
8	6100	Piston and Rod Assy (6 Req'd)
A		Tighten to 35 N·m (25 Lb-Ft)

DISASSEMBLY AND ASSEMBLY (Continued)

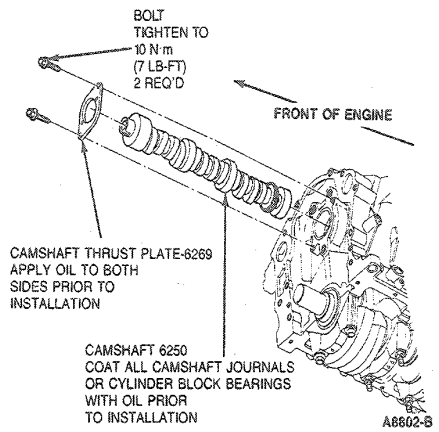


f. Rotate crankshaft journal to bottom of its stroke for each piston installation. Using a wooden hammer handle, tap piston into cylinder bore. At the same time, guide connecting rod end into position onto crankshaft journal. Seat connecting rod bearing fully against journal. Remove rubber protection from rod bolts. Aligning both bearing locating tangs on the same side, install connecting rod cap and retaining nuts. Alternating evenly between both retaining nuts, tighten to 35 N·m (26 lb-ft).

6. Check connecting rod side clearance as outlined.
7. Install camshaft bore plug. Coat the sealing edge of the plug with Anaerobic Sealer B5A-19554-A (ESR-M18P2-A) or equivalent before installation. Using a suitable driver, install plug square into bore.

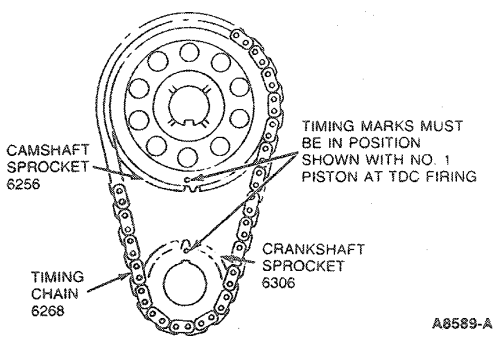


8. If necessary, replace camshaft bearings as outlined in this section.
9. Lubricate entire camshaft with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Carefully slide camshaft through bearings into cylinder block. Remember to keep camshaft perfectly in line with front bearing.
10. Install camshaft thrust plate. Tighten retaining bolts to 10 N·m (7 lb-ft).
11. Check camshaft end play. Refer to Section 03-00.



12. Install timing chain and sprockets as an assembly. Lubricate timing chain with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.

    Rotate crankshaft and camshaft to align sprocket timing marks as shown.

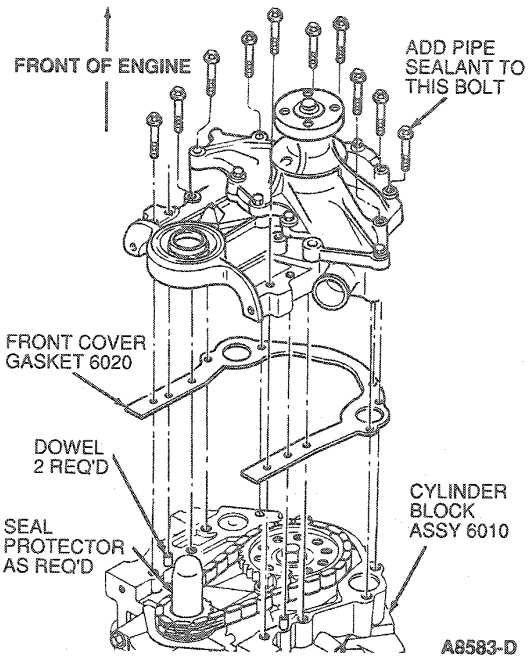


13. Install camshaft sprocket retaining bolt and washer and tighten to 63 N·m (46 lb-ft). Check the drilled oil passages of the bolt to ensure they are not plugged. Clean as required. Do not replace with a standard bolt.

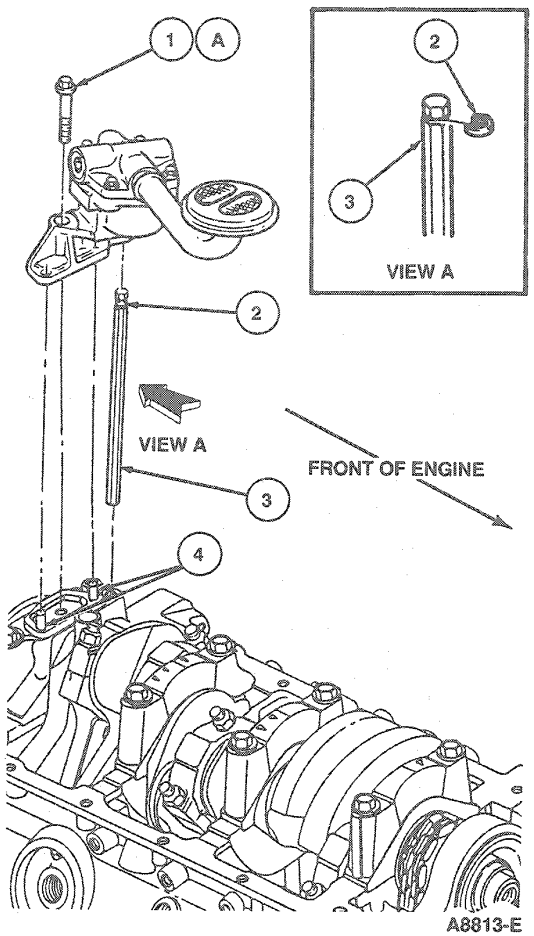
DISASSEMBLY AND ASSEMBLY (Continued)

14. Install the water pump/timing cover as an assembly and a new gasket as outlined in this section.

    Tighten pump retaining bolts as outlined in this section.



15. Install oil pump/intermediate shaft assembly. If installing new pump, insert intermediate shaft into oil pump hex drive hole until retainer clicks into place. Tighten retaining bolts to 40-55 N·m (30-40 lb-ft).



Item	Part Number	Description
1A	—	Bolt
2	6A751	Retainer—Oil Pump Intermediate Shaft
3	6A618	Oil Pump Intermediate Shaft
4	—	Dowel
A		Tighten to 30-40 N·m (40-55 Lb-Ft)

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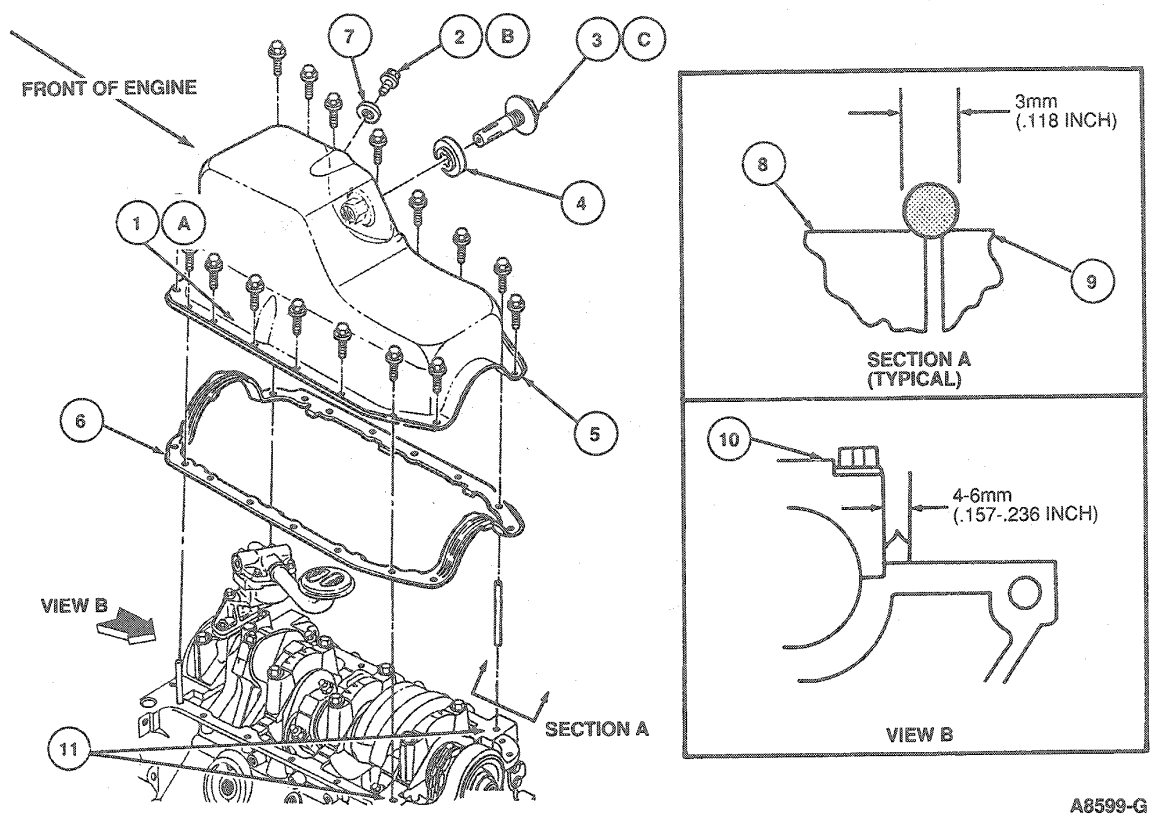
16. Locate oil pan gasket to oil pan and secure with Gasket and Trim Adhesive D7AZ-19B508-AA (ESR-M11P17-A and ESE-M2G52-A) or equivalent. Apply a 5mm (3/16 inch) bead of RTV Silicone Sealer to the timing cover-cylinder block junction, and to the rear main bearing-cylinder block junction.
17. Install oil pan and tighten retaining bolts to 10-14 N·m (8-10 lb-ft). Tighten the four corner fasteners first, then remaining 12. Back off all retaining bolts and then re-tighten to the original value.

DISASSEMBLY AND ASSEMBLY (Continued)



A8599-G

Item	Part Number	Description
1A	—	Screw and Washer Assy (16 Req'd)
2B	6675	Drain Plug Assy
3C	6675	Oil Level Sensor
4	6C626	Oil Level Sensor Gasket
5	6675	Oil Pan Assy
6	6710	Oil Pan Gasket
7	6734	Drain Plug Gasket
8	6010	Cylinder Block Assy

(Continued)

Item	Part Number	Description
9	6019	Front Cover Assy
10	6A325	Rear Main Bearing Cap
11	F1AZ-19562-A	Silicone Sealer (4 Places)
A		Tighten to 10-14 N·m (8-10 Lb-Ft)
B		Tighten to 11-16 N·m (9-12 Lb-Ft)
C		Tighten to 27-41 N·m (20-30 Lb-Ft)

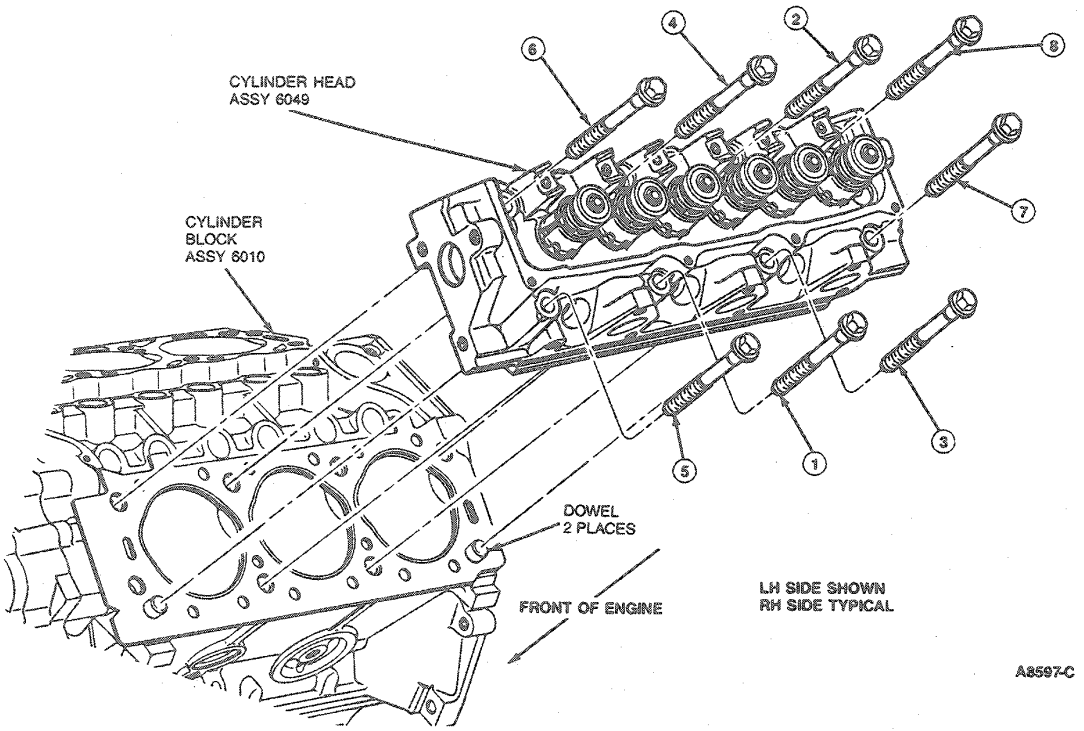
TA8599G

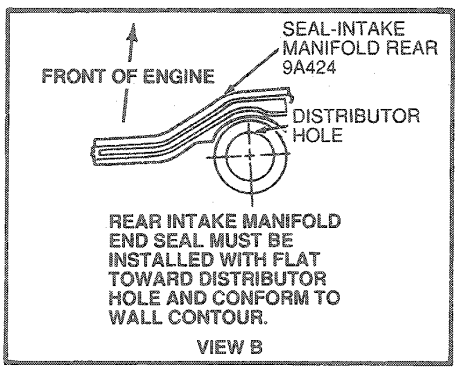
18. Lubricate oil filter gasket with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent engine oil and install.
19. Lubricate tappets with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent and install into their original positions relative to camshaft lobe and push rod.

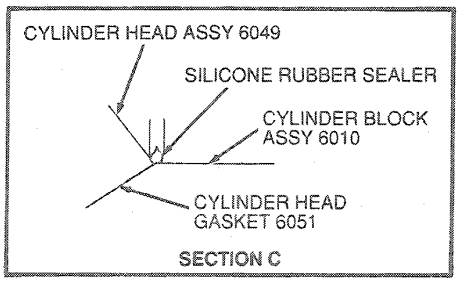
    NOTE: Ensure the "UP" designation is facing the cylinder head.
20. Install new cylinder head gaskets onto cylinder block using the dowels to align the gasket.
21. Install cylinder heads. Tighten retaining bolts in two steps in the sequence as shown:
    - 50 N·m (37 lb-ft)
    - 92 N·m (68 lb-ft)
22. Apply Silicone Rubber D6AZ-19562-AA or AB (ESB-M4G92-A and ESE-M4G195-A) or equivalent to intersection of cylinder block end rails and cylinder heads (four places).

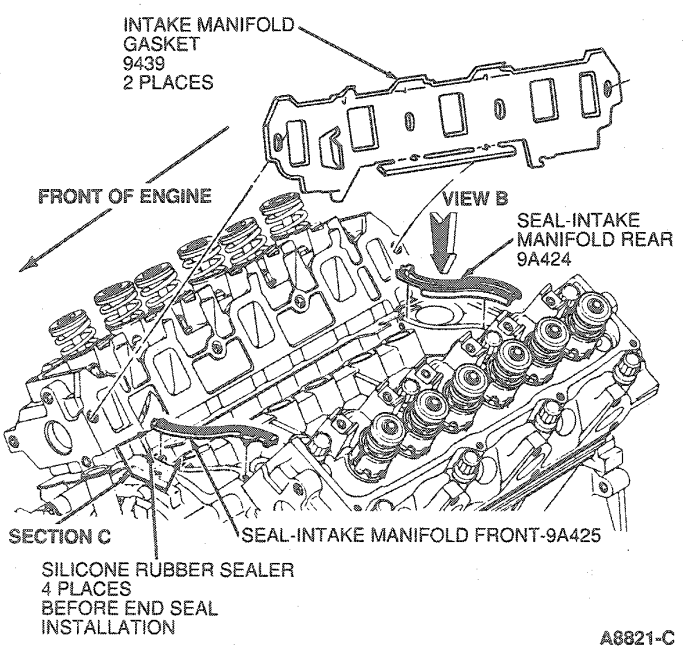
DISASSEMBLY AND ASSEMBLY (Continued)

23. Install front and rear intake manifold end seals. Secure with retaining features.





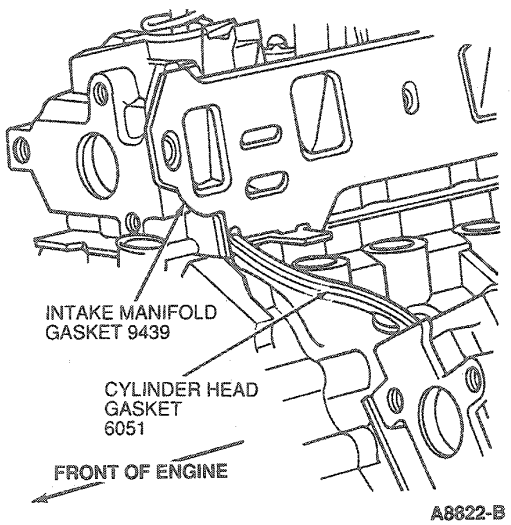




DISASSEMBLY AND ASSEMBLY (Continued)

24. Position intake manifold gaskets in place.

    NOTE: Gaskets are marked "to intake manifold" which faces intake manifold sealing surface. Insert locking tabs over cylinder head gasket locating tabs as shown.

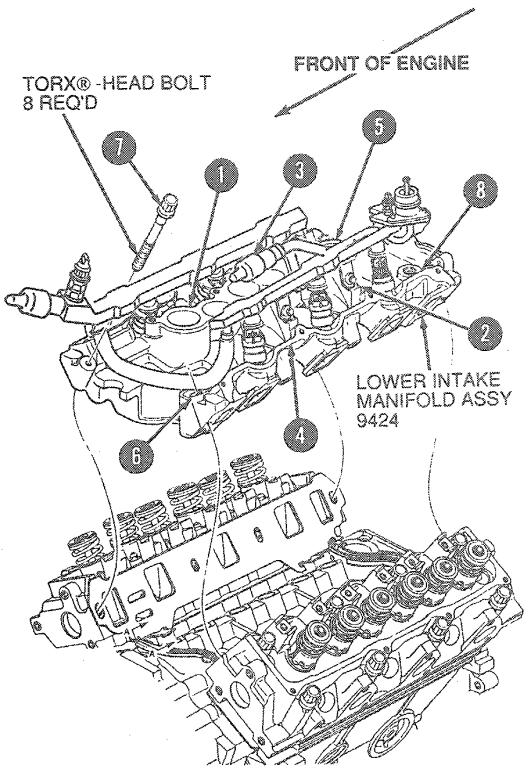


25. Carefully lower intake manifold into position to prevent smearing the silicone sealer and causing leak paths.
26. Install retaining bolts and tighten in numerical sequence as shown to the following specifications in two steps:
    - 20-30 N·m (15-22 lb-ft)
    - 26-32 N·m (19-24 lb-ft)

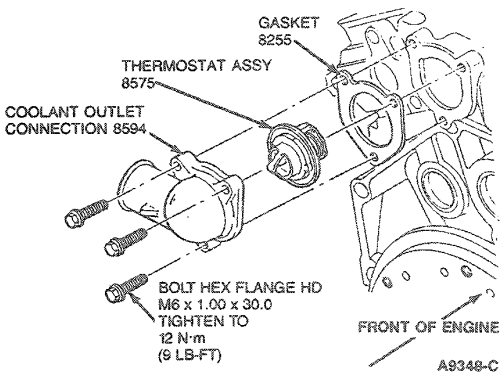
    NOTE: Retaining bolts require a Torx® head socket.

    CAUTION: Fulcrums must be fully seated in cylinder head, and push rods must be seated in rocker arm sockets prior to final tightening.
27. Lubricate push rods and rocker arms with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Install push rods in their original positions. Rotate rocker arms onto push rods making sure push rod is seated properly on tappet assembly and in rocker arm. Tighten retaining bolt to 11 N·m (8 lb-ft) to seal fulcrums into cylinder head. Rotate crankshaft to position tappet on the heel of the camshaft lobe (base circle - 0 lift). Tighten retaining bolts of specified rocker arms to 25 N·m (18 lb-ft). Final tighten all rocker arm bolts (camshaft may be in any position) to 32 N·m (24 lb-ft).

Unleaded Gasoline Shown, FF Similar



28. Install thermostat housing and new gasket as illustrated if removed. Tighten retaining bolts to 12 N·m (9 lb-ft).

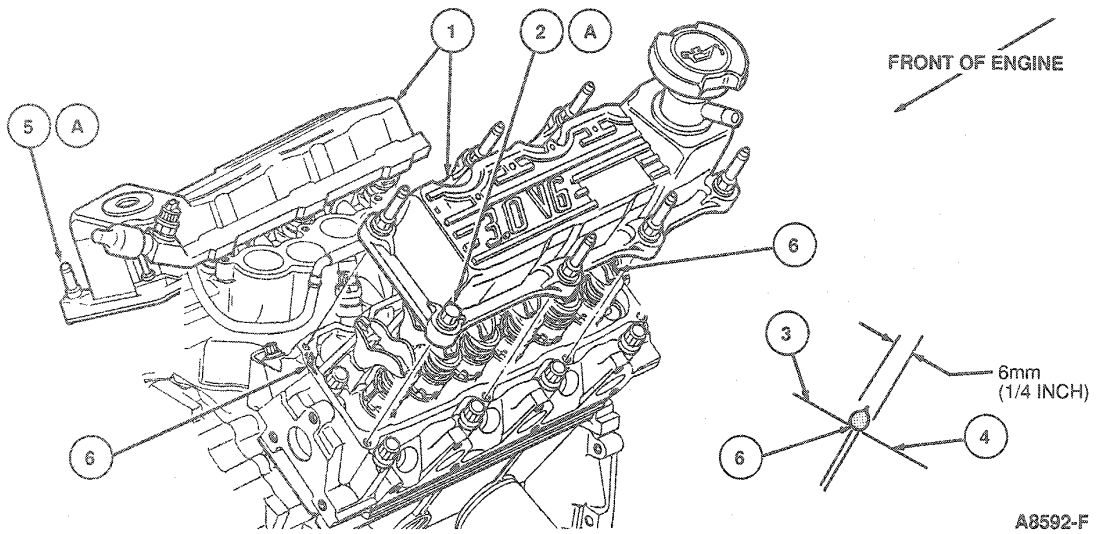


29. Install fuel supply manifold and injectors if removed. Apply Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent oil to injector holes in intake manifold and fuel supply manifold prior to injector installation. Install fuel supply manifold retaining bolts and tighten to 10 N·m (7 lb-ft).

DISASSEMBLY AND ASSEMBLY (Continued)

30. Install rocker arm covers. Install screw / stud assemblies. Tighten to 10-14 N·m (8-10 lb-ft).

Unleaded Gasoline Shown, FF Similar



Item	Part Number	Description
1	6A505 LH 6582 RH	Valve Rocker Arm Cover Assy
2A	—	Bolt (2 Req'd)
3	9424	Lower Intake Manifold
4	6049	Cylinder Head Assy

(Continued)

Item	Part Number	Description
5A	—	Stud (6 Req'd)
6	F1AZ-19562-A	Silicone Rubber (2 Places Each Side)
A		Tighten to 10-14 N·m (8-10 Lb-Ft)

TA8592F

31. Install oil fill cap.
32. Install fuel charging wiring to the appropriate locations. Locate and install harness stand-offs to the rocker arm cover retaining studs.
33. Install throttle body and new gasket. Tighten retaining bolts to 25 N·m (19 lb-ft).
34. On unleaded gasoline only, install distributor to pre-aligned mark. Install retaining bolt and washer. Tighten to 24 N·m (18 lb-ft).
35. Install exhaust manifolds as outlined in this section. Tighten retaining bolts to 25 N·m (18 lb-ft).
36. Install oil level indicator and tube. Apply Perfect Seal Sealing Compound B5A-19554-A (ESR-M18P2-A and ESE-M4G115-A) or equivalent prior to installation. Tighten retaining nut to 15-20 N·m (11-15 lb-ft).
37. Install spark plugs. Tighten to 11 N·m (8 lb-ft).
38. Connect ignition wires to spark plugs. Locate with harness stand-offs to appropriate rocker arm cover retaining studs.
39. Install crankshaft damper using Vibration Damper and Seal Installer T82L-6316-A. Tighten retaining bolt to 125-165 N·m (93-121 lb-ft).

    NOTE: Apply Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent to keyway slot in damper and lubricate outside of damper hub with engine oil XO-10W30-QSP (ESE-M2C153-A) or equivalent prior to installation.
40. Install flywheel. Tighten retaining bolts to 80 N·m (59 lb-ft) in the standard cross-tightening sequence.

Subassemblies

Pistons and Connecting Rods

Tools Required:

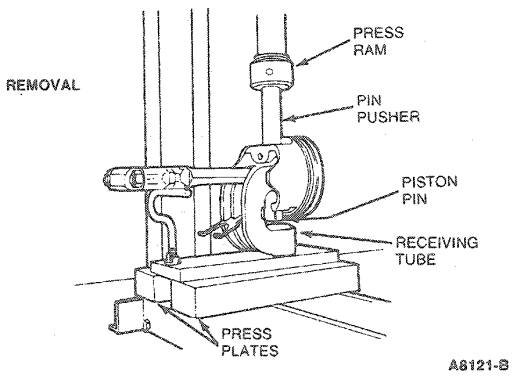
- Piston Pin Remover / Replacer T68P-6135-A
- Feeler Gauge D81L-4201-A

DISASSEMBLY AND ASSEMBLY (Continued)

Disassembly

1. Remove bearing inserts from connecting rod and cap.
2. Remove piston rings using a suitable piston ring expander.
3. Mark connecting rod cap to ensure assembly with the same piston and installation in the same cylinders from which they were removed.

   NOTE: Mark piston to match cylinder number. Matching letters are stamped in the sides of corresponding rod and cap.
4. Using an Arbor Press and Piston Pin Remover / Replacer T68P-6135-A, press the piston pin from the piston and connecting rod.

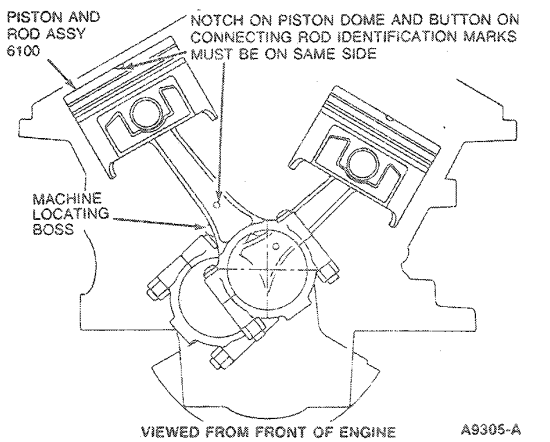


Assembly

Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod.

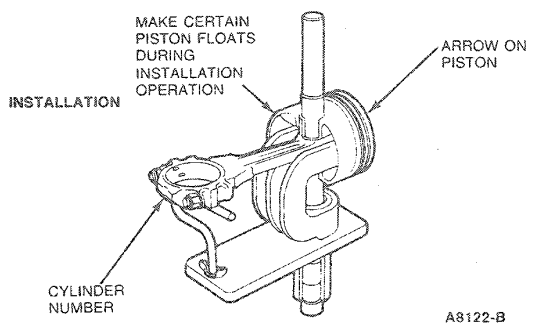
The piston pin bore of a connecting rod and the diameter of the piston pin must be within specification.

1. Apply a light coat of Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent to all parts.
2. Assemble the piston to the connecting rod, putting the notch in the piston dome and the connecting rod on the same side.



On V-6 engines with one rod per pin, both sides of rod have larger chamfers.

3. Start the piston pin in the piston and connecting rod. (This may require a very light tap with a mallet). Using an Arbor Press and Piston Pin Remover / Replacer T68P-6135-A, press the piston pin through the piston until the pin is centered in the piston.



4. Check the end gap of all piston rings. It must be within specification. Follow the instructions contained on the piston ring package and install the piston rings.
5. Check the ring side clearance of the compression rings with Feeler Gauge D81L-4201-A or equivalent, by inserting it between the ring and its lower land. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.
6. Ensure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

DISASSEMBLY AND ASSEMBLY (Continued)

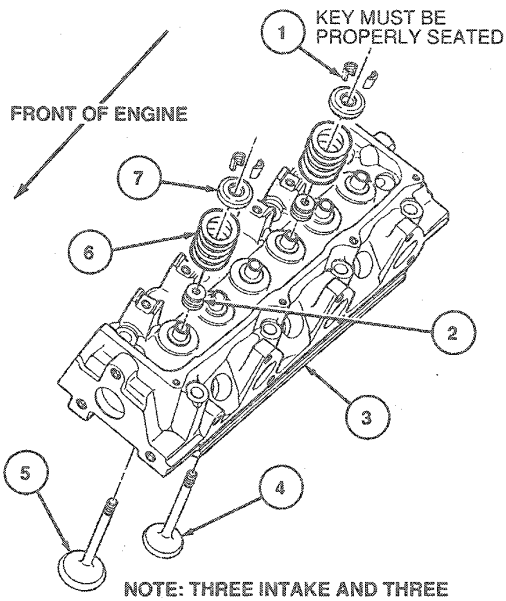
Cylinder Head

Tool Required:

- Valve Spring Compressor T81P-6513-A

Disassembly

1. Remove rocker arm fulcrum retaining bolts, fulcrums and rocker arms.
2. Remove exhaust manifolds, if required, and spark plugs.
3. Clean carbon out of the cylinder head combustion chambers before removing the valves.
4. Compress valve springs using Valve Spring Compressor T81P-6513-A. Remove spring retainer locks and release spring.
5. Remove spring retainer, spring, stem seal and valve. Discard valve stem seals. Identify all valve parts as to which cylinder they were removed from and whether intake or exhaust.



NOTE: THREE INTAKE AND THREE EXHAUST SEALS ARE DIFFERENT.

A8812-B

Item	Part Number	Description
1	6518	Valve Spring Retainer Key
2	6A517	Valve Stem Seal (6 Req'd)
3	6049	Cylinder Head
4	6505	Exhaust Valve (3 Req'd)
5	6507	Intake Valve (3 Req'd)
6	6513	Valve Spring Assy (6 Req'd)
7	6514	Valve Spring Retainer (6 Req'd)

TA8812B

(Continued)

6. Clean, inspect and service the cylinder head as required, or prepare to transfer all usable parts to a new cylinder head.

Assembly

All valves, valve stems and valve guides are to be lubricated with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy oil. The valve tips are to have Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A) or equivalent, applied before installation.

1. Install each valve in the port from which it was removed or to which it was fitted.

   NOTE: Intake seals come with a silver band around them while the exhaust seals use a red band.
2. Install valve stem seal. Use a 5/8-inch deep-well socket and a light mallet or hammer to seat seal on valve stem. Ensure intake seals and exhaust seals are on proper stem.
3. Install valve spring over valve and then install spring retainer. Compress spring and install retainer locks.

   CAUTION: Do not install the spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and/or worn camshaft lobes.
4. Measure the assembled height of the valve spring from the top of the spring seat to the underside of the spring retainer with dividers. Check the dividers against a scale. If the assembled height is greater than specification, install the necessary 0.030 inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended height.
5. Position rocker arms and fulcrums on cylinder head and install fulcrum retaining bolt. **Do not tighten bolts.** The bolts must be loose enough to allow the rocker arm to be rotated to the side.
6. Install exhaust manifolds, if removed, and spark plugs.

INSPECTION

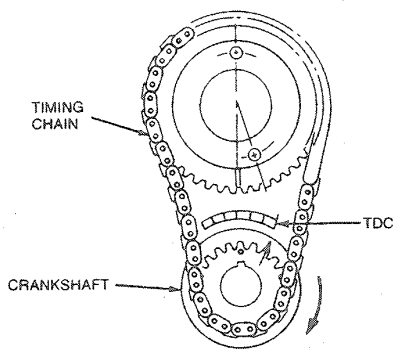
Tool Required:

- Rotunda Dial Indicator with Bracketry 014-00282

INSPECTION (Continued)

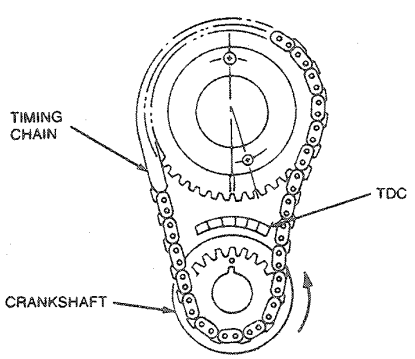
Timing Chain Deflection

1. Remove LH valve rocker arm cover.
2. Loosen No. 5 exhaust rocker arm and rotate to one side.
3. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent on the end of push rod.
4. Turn crankshaft clockwise until No. 1 piston is at TDC. The damper timing mark should point to TDC on the timing degree indicator.



This will also take up slack on RH side of chain.

5. Zero dial indicator.
6. Slowly turn crankshaft counterclockwise until the slightest movement is seen on dial indicator. Stop, and observe damper timing mark for number of degrees of travel from TDC.



7. If reading on timing degree indicator exceeds 6 degrees, replace timing chain and sprockets.

Hydraulic Valve Clearance

1. With No. 1 piston on TDC at the end of compression stroke (Position No 1 in the illustration) check the following valves:

   Position 1

   No. 1 Intake No. 1 Exhaust

   No. 3 Intake No. 2 Exhaust

   No. 6 Intake No. 4 Exhaust

2. Rotate crankshaft 360 degrees to position No. 2 and check the following valves:

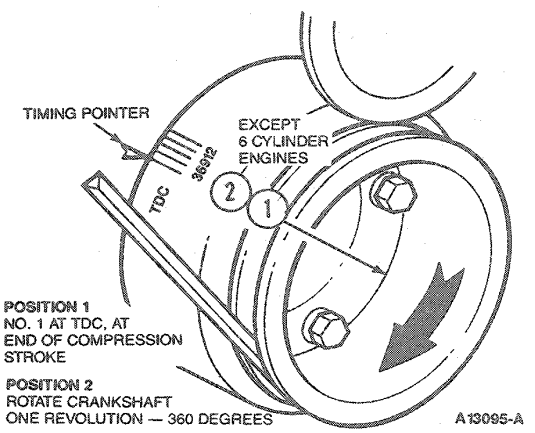
   Position 2

   No. 2 Intake No. 3 Exhaust

   No. 4 Intake No. 5 Exhaust

   No. 5 Intake No. 6 Exhaust

Unleaded Gasoline Shown, FF Similar



SPECIFICATIONS

GENERAL SPECIFICATION	
DISPLACEMENT	3.0L
NUMBER OF CYLINDERS	6
BORE AND STROKE	
Bore	89.00mm (3.50 in.)
Stroke	80.00mm (3.14 in.)
FIRING ORDER	1-4-2-5-3-6
OIL PRESSURE (HOT 2500 RPM)	40-60 PSI
DRIVE BELT TENSION	Self Tensioning

CYLINDER HEAD AND VALVE TRAIN	
COMBUSTION CHAMBER VOLUME (cc)	47.1-50.1cc
VALVE GUIDE BORE DIAMETER	
Intake and Exhaust	8.011-7.986mm (0.315-0.314 in.)
VALVE SEATS	
Width — Intake	1.5-2.0mm (.06-.08 in.)
Exhaust	2.0-2.5mm (.08-.10 in.)
Angle	45°
Runout (T.I.R.)	0.025mm (0.001 in.)
GASKET SURFACE FLATNESS	0.018mm (0.007 in.)
VALVE STEM TO GUIDE CLEARANCE	
Intake	0.026-0.071mm (0.001-0.0028 in.)
Exhaust	0.038-0.083mm (0.0015-0.0033 in.)
VALVE HEAD DIAMETER (GAGE)	
Intake	40.0mm (1.57 in.)
Exhaust	33.0mm (1.30 in.)
VALVE FACE RUNOUT LIMIT	0.05mm (0.002 in.)
VALVE FACE ANGLE	44°
VALVE STEM DIAMETER (STD.)	
Intake	7.960-7.940mm (0.3134-0.3126 in.)
Exhaust	7.948-7.928mm (0.3129-0.3121 in.)
Oversize	
Intake	8.340-8.320mm (0.3283-0.3276 in.)
Exhaust	8.328-8.308mm (0.3279-0.3271 in.)
Oversize	
Intake	8.720-8.700mm (0.3433-0.3425 in.)
Exhaust	8.708-8.688mm (0.3428-0.3420 in.)
VALVE SPRINGS	
Compression Pressure (Kg [Lb] @ Spec. Length)	
Loaded	
(Without Damper)	800.6N (180 lbs.) @ 29.5mm (1.16 in.)
Unloaded	
(Without Damper)	289.1N (65 lbs.) @ 40.1mm (1.58 in.)
Free Length (Approximate)	46.7mm (1.84 in.)
Assembled Height	40.08mm (1.58 in.)
Service Limit	10% Force Loss @ Specified Height
ROCKER ARM	
Ratio	1.61
VALVE TAPPET, HYDRAULIC	
Diameter (Std.)	22.206mm (0.874 in.)
Clearance to Bore	0.018-0.069mm (0.0007-0.0027 in.)
Service Limit	0.127mm (0.005 in.)
Hydraulic Leakdown Rate	(a)
Collapsed Tappet Gap (Nominal)	
Intake and Exhaust	2.15-4.69mm (0.085-0.185 in.)
Tappet Bore Diameter	22.268-22.230mm (0.8767-0.8752 in.)

CYLINDER BLOCK AND VALVE TRAIN — Cam Bores in Block	
CAMSHAFT BORE INSIDE DIAMETER	
No. 1	54.688-54.713mm (2.1531-2.1541 in.)
No. 2	54.188-54.213mm (2.1334-2.1344 in.)
No. 3	54.188-54.213mm (2.1334-2.1344 in.)
No. 4	54.688-54.713mm (2.1531-2.1541 in.)

CAMSHAFT	
LOBE LIFT	
INTAKE	6.604mm (0.260 in.)
EXHAUST	6.604mm (0.260 in.)
Allowable Lobe Lift Loss	0.127mm (0.005 in.)
THEORETICAL VALVE LIFT @ ZERO LASH	
Intake	10.65mm (0.419 in.)
Exhaust	10.65mm (0.419 in.)
ENDPLAY	
Production	0.025-0.13mm (.001-.005 in.)
Service Limit	0.127mm (0.005 in.)
JOURNAL TO BEARING	
CLEARANCE	0.025-0.076mm (0.001-0.003 in.)
JOURNAL DIAMETER	
All	50.987-51.013mm (2.0074-2.0084 in.)
CAM BEARING I.D.	51.038-51.063mm (2.0094-2.0104 in.)
Runout Limit	0.127mm (0.005 in.) Runout of No. 2 or No. 3 relative to No. 1 and No. 4
Out-of-Round Limit	0.010mm (0.0004 in.)

CYLINDER BLOCK	
HEAD GASKET SURFACE	
FLATNESS	0.08mm (0.003 in.) in 152.0mm (6.00 in.)
HEAD GASKET SURFACE FINISH (RMS)	2.3-3.8 micrometers
CYLINDER BORE	
Diameter	89.00mm (3.504 in.)
Surface Finish (RMS) micrometers	0.45-0.96
Out-of-Round Limit	0.015mm (0.0006 in.)
Out-of-Round Service Limit	0.050mm (0.002 in.)
Taper Service Limit	0.050mm (0.002 in.)
MAIN BEARING BORE DIAMETER	68.905mm (2.713 in.) 68.885mm (2.712 in.)

CRANKSHAFT AND FLYWHEEL	
MAIN BEARING JOURNAL	
DIAMETER	63.973-64.003mm (2.5190-2.5198 in.)
Out-of-Round Limit	0.008mm (0.0003 in.)
Taper Limit	0.015mm (0.0006 in.) TOTAL 0.008mm (0.0003 in.) per 25mm (1 in.)
Journal Runout Limit	0.05mm (0.002 in.) (2), 0.05mm (0.002 in.) (3)
Surface Finish (RMS)	0.25 micrometers (10.0 micro in.)
THRUST BEARING JOURNAL	
Length	25.775-25.825mm (1.0148-1.067 in.)
CONNECTING ROD JOURNAL	
Diameter	53.983-54.003mm (2.1253-2.1261 in.)
Out-of-Round Limit	0.008mm (0.0003 in.) MAX. 0.015mm (0.0006 in.) TOTAL
Taper Limit	0.008mm per 25mm (0.0003 in. per in.)
Surface Limit (RMS)	0.25 micrometers (10.0 micro in.)
MAIN BEARING THRUST FACE	
Surface Finish (RMS) 0.4 micrometers (0.157 micro in.) FRONT; 0.4 micrometers (0.157 micro in.) REAR;	
Runout Limit	0.025mm (0.001 in.)

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SPECIFICATIONS (Continued)

CRANKSHAFT AND FLYWHEEL — Continued	
FLYWHEEL RING GEAR LATERAL RUNOUT (T.I.R.)	
Automatic Transmission	1.778mm (0.07 in.)
CRANKSHAFT END PLAY	0.10-0.20mm (0.004-0.008 in.)
CONNECTING ROD BEARINGS	
Clearance to Crankshaft	
Desired	0.025-0.035mm (0.001-0.0014 in.)
Allowable	0.020-0.066mm (0.0086-0.0027 in.)
Bearing Wall Thickness (Std.)	1.557-1.570mm (0.0612-0.0618 in.)
MAIN BEARINGS	
Clearance to Crankshaft	
Desired	0.025-0.035mm (0.001-0.0014 in.)
Allowable	0.020-0.066mm (0.0005-0.0023 in.)
Bearing Wall Thickness (Std.)	N/A

CONNECTING ROD, PISTON AND RINGS	
CONNECTING ROD	
Piston Pin Bore Diameter	23.105-23.145mm (0.9096-0.9112 in.)
Crankshaft Bearing Bore Diameter	57.15-57.17mm (2.250-2.251 in.)
Length (Center-to-Center)	140.46-140.54mm (5.530-5.533 in.)
ALIGNMENT (BORE-TO-BORE MAX. DIFF.)	
Twist	0.050 per 25mm (0.002 per in.)
Bend	0.038 per 25mm (0.0015 per in.)
SIDE CLEARANCE (ASSEMBLED TO CRANK)	
Standard	0.015-0.035mm (0.006-0.014 in.)
Service Limit	0.036mm MAX. (0.014 in. MAX.)

PISTON	
Diameter	
Coded Red	88.962-88.978mm (3.5024-3.5031 in.)
Coded Blue	88.988-89.004mm (3.5035-3.5041 in.)
Coded Yellow	89.014-89.030mm (3.5045-3.051 in.)
PISTON-TO-BORE CLEARANCE	0.036 = 0.056mm (0.0014-0.0022 in.)
Service Limit	0.081mm MAX.

SERVICE PISTON SELECTION (b)

Piston Bore Diameter	Service Piston Grade Required
89.009-89.035mm (3.5043-3.5053 in.)	RED
89.035-89.060mm (3.5053-3.5063 in.)	BLUE
89.060-89.086mm (3.5063-3.5073 in.)	YELLOW

RING GROOVE WIDTH	
Compression (Top)	0.520-0.540mm (0.060-0.061 in.)
Compression (Bottom)	0.520-0.540mm (0.060-0.061 in.)
Oil	4.030-4.055mm (0.1587-0.1596 in.)
PISTON PIN	
Length	69.3-70.1mm (2.728-2.760 in.)
Diameter	23.162-23.175mm (0.9119-0.9124 in.)
PIN TO PISTON CLEARANCE	0.005-0.012mm (0.0002-0.0005 in.)
PIN TO ROD CLEARANCE	Press Fit 4 KiloNewtons (900 lbs.) Min. to Move
PISTON RINGS	
Ring Width	
Compression (Top)	1.460-1.490mm (0.0575-1.0587 in.)
Compression (Bottom)	1.460-1.490mm (0.0575-0.0587 in.)
Oil Ring	Side Seal — Snug Fit
Service Limit	(0.006 in. MAX.)

PISTON Continued	
Ring Gap	
Compression (Top) (In Gauge)	0.025-0.50mm (0.01-0.02 in.)
Compression (Bottom) (In Gauge)	0.25-0.50mm (0.01-0.02 in.)
Oil Ring (Steel Rail) (In Gauge)	0.25-1.25mm (0.010-0.049 in.)
Side Clearance	
1sr Ring	0.030-0.080mm (0.0012-0.0031 in.)
2nd Ring	0.030-0.080mm (0.0012-0.0031 in.)

LUBRICATION SYSTEM	
OIL PUMP	
Relief Valve Spring Tension	
(Force @ Length)	44.9-40.5 N (10.1-9.1 lb.) @ 28.2mm (1.11 in.)
Relief Valve to Bore Clearance	0.073-0.043mm (0.0029-0.0017 in.)
Oil Pump Gear Backlash	0.02-0.03mm (0.008-0.012 in.)
Oil Pump Gear Radial Clearance	
(Idler and Driver)	0.125-0.050mm (0.0055-0.002 in.)
Oil Pump Gear Height Clearance	0.140-0.050mm (0.0055-0.0005 in.)
Idler Shaft to Idler Gear Clearance	0.044-0.010mm (0.0017-0.0004 in.)
Driver Shaft to Housing Clearance	0.048-0.013mm (0.0019-0.0005 in.)
OIL CAPACITY	
Passenger Car: 4 qt. + 0.5 with filter change.	

(a) 20-200 seconds to leakdown 3.18 (0.125 in.) with 225 Newtons (50 pounds) load and tappet filled with leak-down fluid.
(b) When replacing pistons, measure the cylinder bore as described in Section 03-00 and install the indicated service piston.
(1) Smaller than pin bore measured along center to center axis.

CA8816-D

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft	Description	N·m	Lb-Ft
A/C Compressor Bracket to Block (4 Bolts)	48	35	Heater Tube to Intake Manifold Stud Bolt	35	26
A/C Compressor Mounting (4 Bolts)	48	35	Intake Manifold to Cylinder Head Bolt	20-30	15-22
Generator Adjustment Arm (Lock-In Tension Setting) Bolt	37	27	Low Level Oil Sensor	27-41	20-30
Generator Adjustment Arm to Cylinder Head Bolt	48	35	Main Bearing Cap Bolt	75-85	55-63
Generator Brace to Adjustment Arm and Throttle Body (2 Nuts)	16	12	IAT Sensor (Unleaded Gasoline Only)	20	15
Generator Pivot Bolt	58	43	HO2S Sensor	41	30
Auto-Tensioner/Power Steering Bracket to Cylinder Head (2 Nuts)	48	35	TP Sensor	3	22 (Lb-In)
Auto Tensioner to A/C Compressor Bracket Bolt	48	35	Oil Drain Plug	11-16	9-12
Camshaft Sprocket to Camshaft Bolt	63	46	Oil Filter Insert to Cylinder Block	34	25
Camshaft Thrust Plate Bolt	10	7	Oil Filter to Oil Filter Adapter[5]		
Coil and Bracket Assembly to Cylinder Head Bolt	48	35	Oil Indicator Tube to Exhaust Manifold Nut	15-20	11-15
Connecting Rod Nut	35	26	Oil Level Sensor	27-41	20-30
Coolant Temp. Switch	20	15	Oil Pressure Sending Unit	16-22	12-16
Crankshaft Vibration Damper to Crankshaft Bolt	125-165	93-121	Oil Pump to Cylinder Block Bolt	48	35
Crankshaft Pulley to Damper (4 Bolts)	50	37	Power Steering Bracket to Cylinder Head Bolt	40-55	29-41
Cylinder Head Bolt	—	[6]	Power Steering Bracket to Cylinder Head (2 Studs)	5-15	4-11
Distributor Cap	1.75-2.75	16-24 (Lb-In)	Rocker Arm Cover to Cylinder Head Bolts/Studs	10-14	8-10
Distributor Hold-Down Bolt	24	18	Rocker Arm Fulcrum to Cylinder Head Bolt	—	[7]
ECT Sensor	16-24	12-17	Spark Plug to Cylinder Head	7-15	5-11
EGR Valve to Throttle Body Bolt	20-30	15-22	Thermostat Housing to Intake Manifold Bolt	10-14	8-10
EGR Tube to EGR Valve and Exhaust Manifold	35-65	26-48	Throttle Body to Intake Manifold Bolt/Stud	25	19
Exhaust Manifold Bolt/Stud	20-30	15-22	Timing Cover to Cylinder Block Bolt	25	19
Flywheel to Crankshaft Bolt	80	59	Vacuum Tree to Intake Manifold	8-13	6-9.5
Fuel Rail to Intake Manifold (4)	8-12	6-9	Water Pump Pulley to Hub (4 Bolts)	20-30	15-22
Heater Elbow	24	18	Water Pump to Front Cover Bolt	8-12	71-106 (Lb-In)
Hose Clamp	2.7-5.4	28-48	Wiring Retainer Bracket Nut	20-30	15-22
PFE or DPFE Sensor and Bracket	10	7	Tappet Guide Plate to Cylinder Block	10-14	8-10
Throttle Cable Bracket	17	13	Coolant Bypass Fitting	16-24	12-17
Idle Air Control Valve	10	7	EGR Vacuum Regulator	35	26
Exhaust Inlet Pipe to Manifold	34-47	25-34	Throttle Cable Bracket Bolts	17	13
Crankshaft Pulley Nuts	40-60	30-44	Ignition Coil	40-55	29-41
Rocker Arm Bolt	20-25	15-18	Oil Pan to Cylinder Block Bolt	10-14	8-10

(Continued)

5 Advance half-turn after gasket contacts sealing surface.
6 A. Tighten in two steps:
50 N·m (37 Lb-Ft)
92 N·m (68 Lb-Ft)
7 Tighten in two steps: A. 7-15 N·m (5-11 Lb-Ft)
B. 26-38 N·m (19-28 Lb-Ft)

SPECIFICATIONS (Continued)

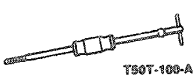
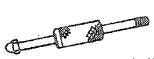
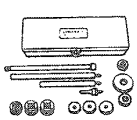
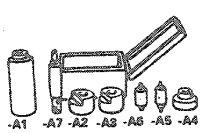
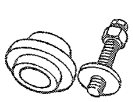
TORQUE SPECIFICATIONS (Cont'd)

Description	N·m	Lb-Ft	Description	N·m	Lb-Ft
Pressure Feedback (EGR) Sensor Bolt	8-11.5	6-8	Crankshaft Pulley Nuts	40-60	30-44
Crankshaft Position Sensor Bolts	5-7	44-61 (Lb-in)			

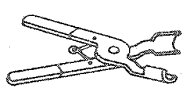
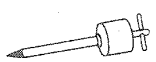
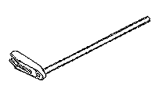
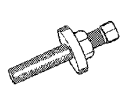
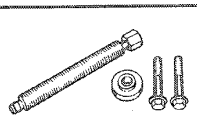
GENERAL SPECIFICATIONS[8]

Thread Size	Torque Cast Iron & Aluminum	Thread Size	Torque Cast Iron & Aluminum
(1/4-18) Pipe	20 N·m (15 Lb-Ft)	M6	14 N·m (10 Lb-Ft)
(3/8-18) Pipe	38 N·m (28 Lb-Ft)	M8	28 N·m (21 Lb-Ft)
		M10	53 N·m (39 Lb-Ft)
		M12	96 N·m (71 Lb-Ft)
		M14	158 N·m (117 Lb-Ft)

SPECIAL SERVICE TOOLS

Tool Number	Description
T50T-100-A Impact Slide Hammer	 T50T-100-A
T58P-6316-D Crankshaft Damper Remover	 T58P-6316-D
T59L-100-B Impact Slide Hammer	 T59L-100-B
T65L-6250-A Camshaft Bearing Set	 T65L-6250-A
T68P-6135-A Piston Pin Remover/Replacer	 -A1 -A7 -A2 -A3 -A6 -A5 -A4 T68P-6135-A
T70P-6B070-A Front Cover Seal Replacer	 T70P-6B070-A

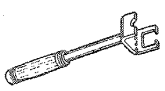
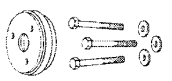
(Continued)

Tool Number	Description
T74P-6666-A Spark Plug Wire Remover	 T74P-6666-A
T77L-9533-B Jet Plug Remover	 T77L-9533-B
T81P-6513-A Valve Spring Compressor	 T81P-6513-A
T81P-9425-A Intake Manifold Torque Adaptor	 T81P-9425-A
T82L-6316-A Vibration Damper and Seal Installer	 T82L-6316-A
T82L-6316-B Vibration Damper Remover Adapter	 T82L-6316-B

(Continued)

8 Unless Otherwise Noted Values for Parts as Supplied

SPECIAL SERVICE TOOLS (Continued)

Tool Number	Description
T82L-6500-A Tappet Collapser	 T82L-6500-A
T88L-6701-A Crankshaft Rear Seal Installer	 T88L-6701-A

Tool Number	Description
D81L-600-A	Lb-In Torque Wrench
D81L-600-B	Lb-Ft Torque Wrench
D81L-4201-A	Feeler Gauge
D81L-6001-D	Engine Lifting Eyes
D88L-6000-A	Three Bar Engine Support
TOOL-6331-E	Bearing Insert Remover / Replacer
TOOL-6500-E	Hydraulic Leakdown Tester
TOOL-6513-DD	Valve / Clutch Spring Tester

ROTUNDA EQUIPMENT

Model	Description
014-00282	Dial Indicator with Bracketry
014-00290	Piston Ring Compressor
014-00292	Cylinder Ridge Reamer
107-00901	Taperset installation Kit

PARTS CROSS-REFERENCE

Base Part #	Part Name	Old Part Name
9424	Intake Manifold	
9430	Exhaust Manifold	
9431	Exhaust Manifold	
9600	Engine Air Cleaner	
9A474	Intake Manifold Vacuum Outlet Fitting and Cap	
9B659	Air Cleaner Outlet Tube	
9D477	EGR Valve to Exhaust Manifold Tube	
9D930	Fuel Charging Wiring	
9F485	EGR Valve Tube to Manifold Connector	
9H486	Intake Manifold Upper Gasket	

SECTION 03-01B Engine, 3.0L/3.2L SHO

VEHICLE APPLICATION

Taurus with 3.0L/3.2L SHO engine.

DESCRIPTION

The 3.0L/3.2L SHO is a high performance V-6 engine with DOHC (double overhead camshafts), four valves per cylinder, and sequential multiport fuel injection (SFI). The engine has aluminum cylinder heads, 24 valves, shim set bucket tappets and a cast-iron, 60 degree V-block.

CAUTION: This engine has aluminum cylinder heads and requires a special corrosion inhibiting coolant to avoid cooling system damage. Refer to Section 03-03 for the coolant specifications.

The left and right bank intake camshafts are driven by a timing belt. Then, the intake camshafts drive the exhaust camshafts on the rear of the engine through timing chains.

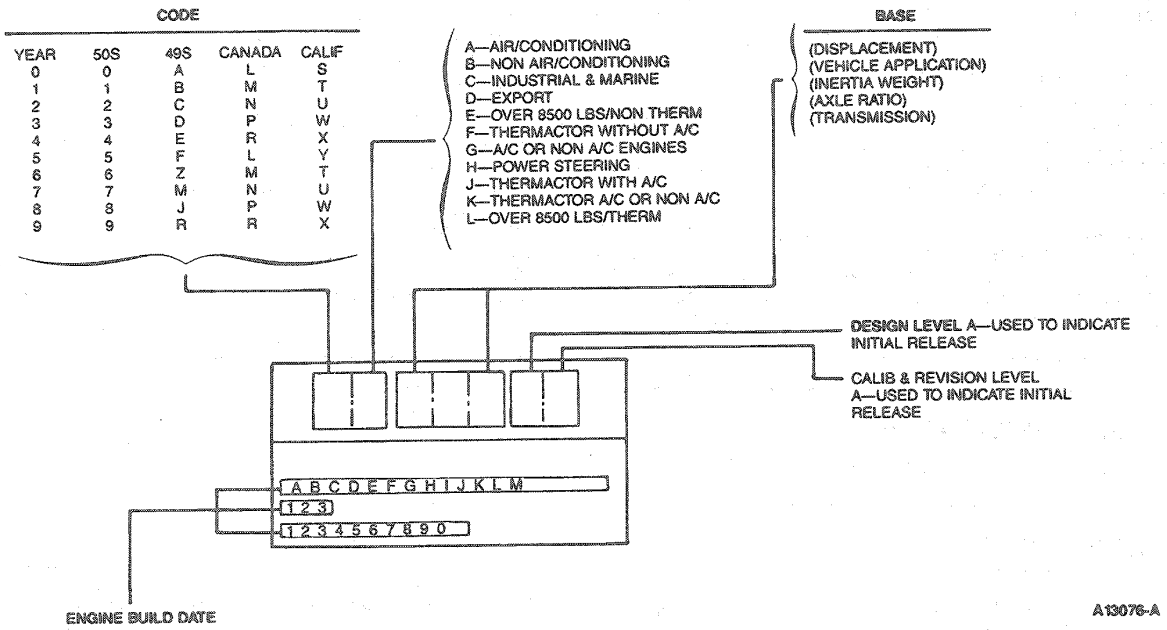
The ignition system is distributorless, with a three pack coil assembly. The ignition control module (ICM) 12A297 is mounted on the upper intake connector tube. The high-energy ignition system is required for fast-burn combustion. The spark plugs are 14mm with a 0.044 inch gap and are centrally located in the combustion chambers.

A unique air intake system utilizes a secondary intake port along with a primary intake port. The secondary port is opened and closed by a vacuum-operated intake air control valve, thus improving low and mid-range torque and fuel efficiency.

DESCRIPTION (Continued)

Engine Code Information Label

The engine code calibration number label is located on the engine right hand camshaft cover, adjacent to the throttle body (9E926). The label contains, among other information, the engine calibration number, engine build date, the engine plant code and an engine code.



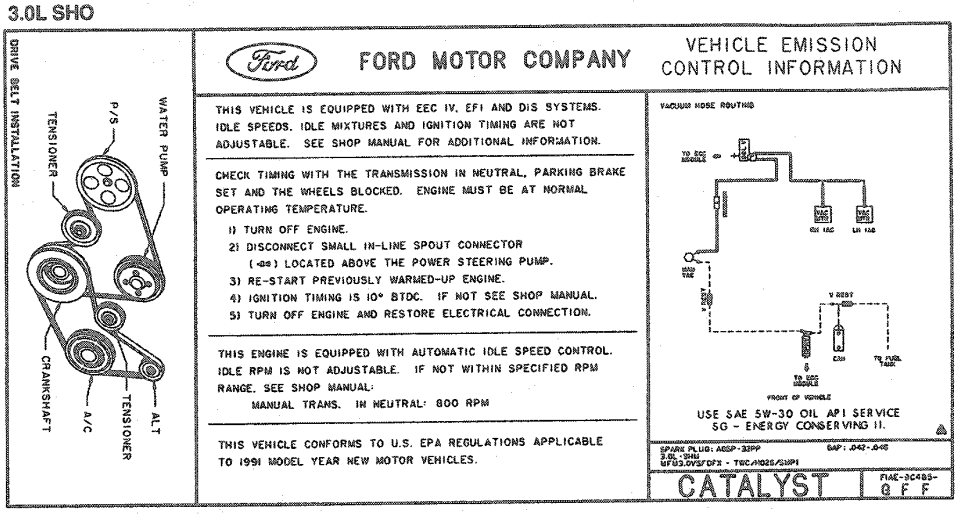
Vehicle Emission Control Information (VECI) Label

The VECI label is located on the upper radiator shield area. It identifies the engine calibration number, the engine code number and revision level. These numbers are used to determine if parts are unique to specific engines.

DESCRIPTION (Continued)

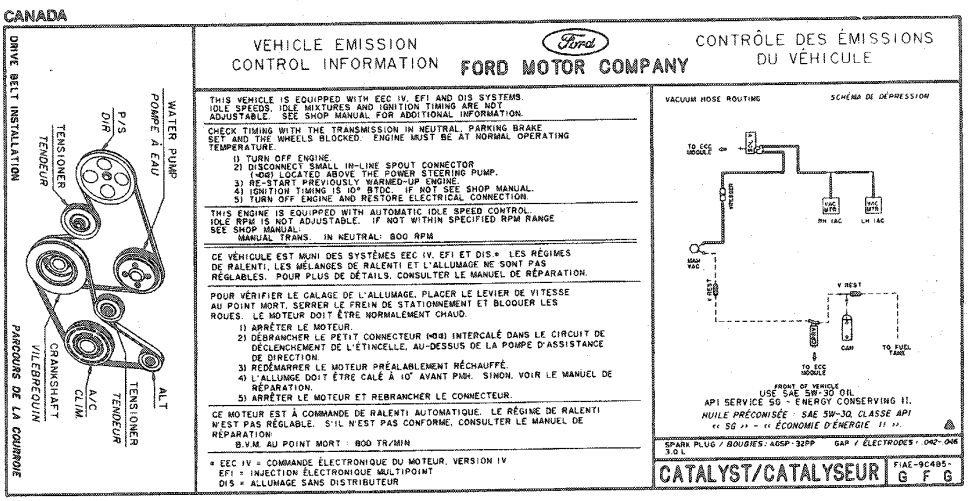
49 States

3.0L SHO



A14863-B

Canada



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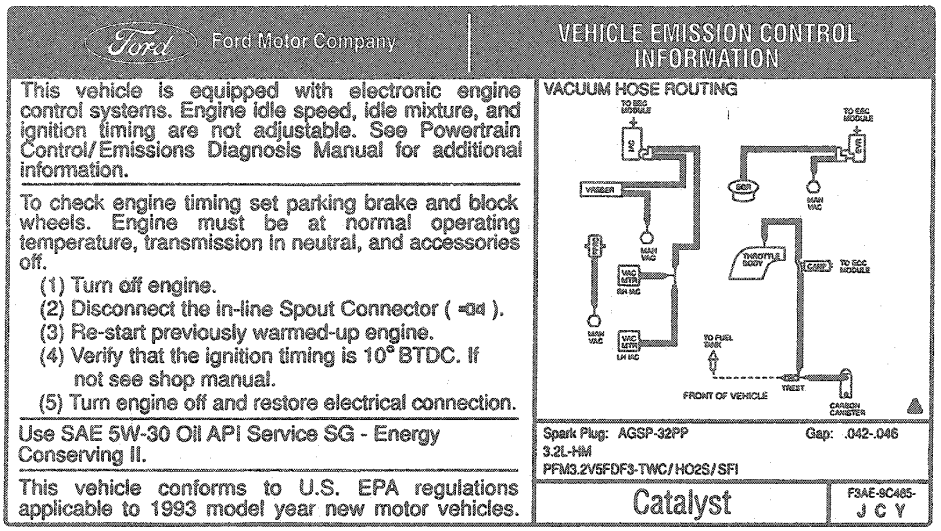
DESCRIPTION (Continued)

49 States



A14865-B

Induction System

The fuel / air mixture needed for burning in the cylinders is provided by sequential multiport fuel injection (SFI).

Fuel is metered into the air intake stream in accordance with engine demand by six solenoid injection valves mounted in the cylinder heads.

Fuel is supplied from the vehicle's fuel tank by a high-pressure electric fuel pump mounted in the fuel tank. The fuel is filtered and sent to the injector fuel rail assembly. A regulator on this rail controls the fuel delivery pressure between 231-269 kPa (33.5-39 psi). The six injector nozzles are mounted above the intake valves and connected in parallel with the fuel pressure regulator. Excess fuel supplied by the pump, but not needed by the engine, is returned to the vehicle fuel tank by a fuel return line.

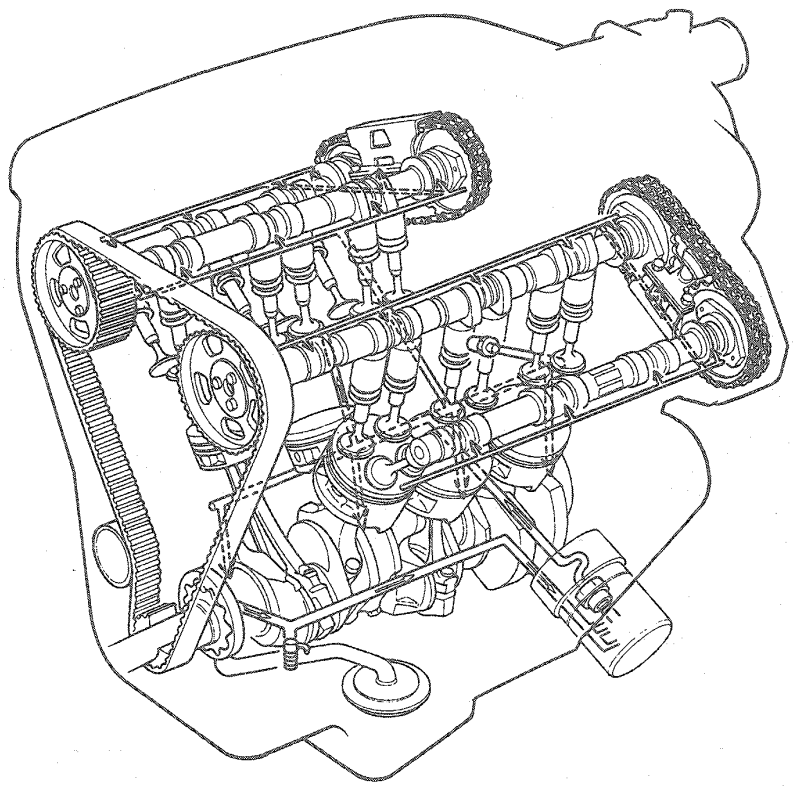
These fuel induction systems are mounted on an aluminum intake manifold (9424) which in turn is bolted to aluminum alloy cylinder heads. The intake manifolds and heads are cast from aluminum to aid in removing weight from the engine. Service procedures related to these components remain similar to those for a V-8 engine. However, a spark plug thread service procedure is provided in the event damage should occur to these threads.

DESCRIPTION (Continued)

Lubrication System

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft and connecting rod bearings, bucket tappets and camshaft bearings.

NOTE: 3.0L/3.2L SHO lubrication systems are alike.



A12693-A

Positive Crankcase Ventilation (PCV)

The Crankcase Emission Control System is a closed ventilation system that is designed to prevent case fumes or combustion gases from escaping through the engine oil filler cap to the atmosphere.

The crankcase control system controls these fumes or vapors (blowby) by directing them back into the intake manifold where they are consumed in the normal combustion process.

The crankcase ventilating air source is the throttle body. The fresh air passes through the engine air cleaner (9600)and then through the ventilation hose (2) connecting the throttle body to the LH cylinder head cover. Then, ventilating air moves down through the oil return passage into the lower crankcase.

The air and crankcase gas mixture flow from the crankcase through the oil separator and ventilation hose (1) to the throttle body and intake manifold.

There are three outlet ports for the air and crankcase mixture, and one port for fresh air in the throttle body. Under the following various throttle positions, the air and crankcase gas mixture flows differently through these outlet ports.

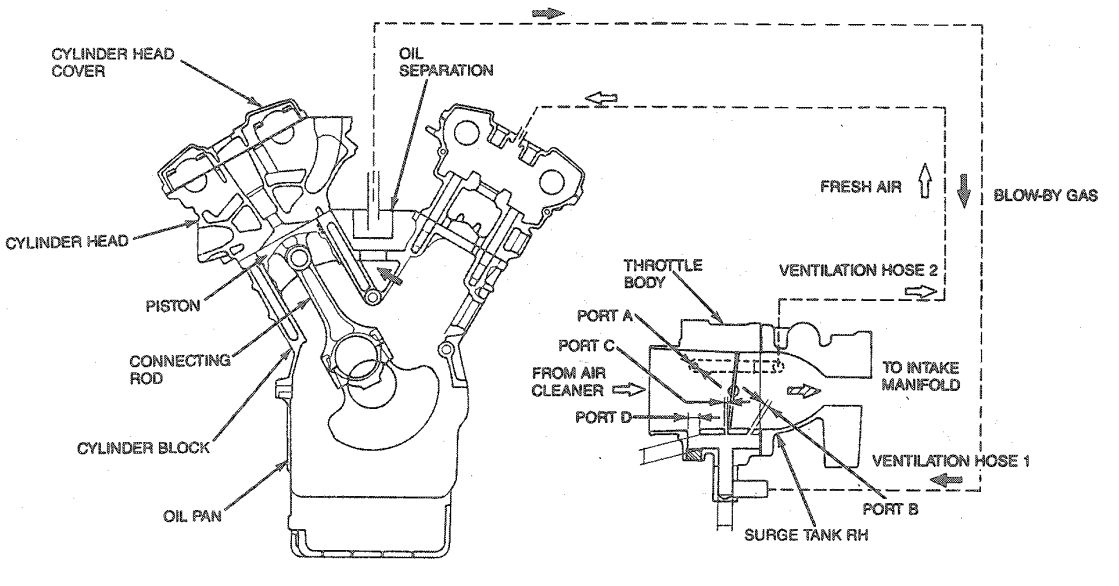
1. Fresh air normally flows through port "A" to the cylinder head.
2. At closed throttle position, the air and crankcase gas mixture flows through port "B" into the intake manifold.
3. At partial open throttle position, the air and crankcase gas mixture flows through ports "B" and "C" into the intake manifold with the air and crankcase gas mixture.

   At the same time, fresh air flows through port "D" to ports "B" and "C" and goes into the intake manifold with the air and crankcase gas mixture.

DESCRIPTION (Continued)

4. At wide open throttle position, the air and crankcase gas mixture flows through ports "B", "C" and "D" into the intake manifold.

   At this time, when crankcase gas is excessive, the crankcase gas also flows through port "A" into the intake manifold from the LH cylinder head. The ventilation process goes on continuously while the engine is running.



REMOVAL AND INSTALLATION

Engine

Tools Required:

- Engine Lifting Bracket D89L-6001-A
- Rotunda Hi-Lift Jack 014-00210
- Rotunda Three Bar Engine Support Kit 014-00750

Removal

1. Drain engine cooling system. Refer to Section 03-03.
2. Disconnect battery cables.
3. Remove battery. Refer to Section 14-01.
4. Remove battery tray assembly.
5. Disconnect wiring connector retaining under hood lamp, if so equipped.
6. Mark position of hood hinges and remove hood.
7. Remove oil level indicator.
8. Disconnect generator and voltage regulator wiring assembly.
9. Remove radiator upper sight shield.
10. Discharge A/C system. Refer to Section 12-00.
11. Remove radiator coolant recovery reservoir assembly.
12. Remove constant control relay module (CCRM).
13. Remove air cleaner hose assembly.
14. Remove upper radiator hose.
15. Remove electric fan and shroud assembly. Refer to Section 03-03.
16. Remove lower radiator hose.
17. Remove radiator assembly. Refer to Section 03-03.
18. Relieve fuel system pressure.
19. Disconnect fuel inlet hose.
20. Disconnect fuel return hose.
21. Remove barometric pressure (BARO) sensor 12A680.

REMOVAL AND INSTALLATION (Continued)

22. Remove engine vibration damper and bracket assembly from RH side of engine.
23. Remove engine to damper bracket.
24. Remove retaining bolt from power steering reservoir and place reservoir out of the way.
25. Disconnect hose to power steering cooler at pump.
26. Disconnect throttle linkage.
27. Disconnect vacuum hoses.
28. Disconnect heater hoses at heater core.
29. Disconnect electrical connectors from harness 12A581 on rear of engine.
30. On 3.0L only, loosen belt tensioner pulley and remove belt from A/C compressor and generator (6 rib). On 3.2L, loosen belt tensioner pulley and remove single accessory drive belt (6 rib).
31. Loosen belt tensioner pulley and remove power steering pump belt (4 rib) on 3.0L only.
32. Remove belt tensioner pulley (lower tensioner on 3.0L only).
33. Disconnect cycling switch on top of suction accumulator/drier.
34. Disconnect A/C line at dash panel and remove accumulator and bracket assembly.
35. Remove generator assembly.
36. Disconnect A/C discharge hose.
37. Remove A/C compressor and bracket assembly.
38. Raise vehicle on hoist. Refer to Section 00-02.
39. Position drain pan beneath vehicle oil pan.
40. Drain motor oil.
41. Remove oil filter element assembly.
42. Position drain pan away from vehicle.
43. Remove wheel and tire assemblies.
44. Disconnect oil level sensor switch.
45. Disconnect RH lower ball joint, tie rod end, and stabilizer bar. Refer to Section 04-01.
46. Disconnect center support bearing bracket, and RH CV joint from transaxle.
47. Disconnect heated oxygen sensor (HO2S)(9F472).
48. Disconnect four exhaust catalyst-to-engine retaining bolts.
49. Remove starter motor assembly.
50. Remove lower transaxle to engine retaining bolts.
51. Remove engine mount to subframe retaining nuts.
52. Remove crankshaft pulley assembly.
53. Lower vehicle.
54. Remove upper transaxle to engine retaining bolts.
55. Install Engine Lifting Bracket D89L-6001-A or equivalent.
56. Position Rotunda Hi-Lift Jack 014-00210 or equivalent under transaxle.
57. Position Rotunda Adjustable Three Bar Engine Support Kit 014-00750 or equivalent.
58. Raise transaxle assembly slightly.
59. Remove engine assembly from vehicle.
60. Place engine on work stand.

Installation

1. Remove engine assembly from work stand.
2. Position engine assembly in vehicle.
3. Install upper transaxle to engine retaining bolts.
4. Remove jack and place out of the way.
5. Remove engine lifting equipment and place out of the way.
6. Remove rear engine lifting eye.
7. Raise vehicle on hoist. Refer to Section 00-02.
8. Install crankshaft pulley assembly. Tighten to 152-172 N·m (112-127 lb-ft).
9. Install engine mount to subframe nuts.
10. Install lower transaxle to engine retaining bolts. Tighten to 34-47 N·m (25-35 lb-ft).
11. Install starter motor assembly.
12. Install four exhaust catalyst to engine retaining nuts. Tighten to 27-47 N·m (20-35 lb-ft).
13. Apply anti-seize compound to the threads, then install heated oxygen sensor (HO2S). Tighten to 37-45 N·m (27-33 lb-ft).
14. Connect center support bearing bracket. Install RH CV joint.
15. Connect RH lower ball joint, tie rod and stabilizer bar. Refer to Section 04-01.
16. Connect oil level sensor.
17. Install wheel and tire assemblies. Tighten wheel lug nuts to 115-142 N·m (85-105 lb-ft).
18. Install oil filter. Ensure oil drain plug is installed, tighten to 20-33 N·m (15-24 lb-ft).
19. Lower vehicle.
20. Install A/C compressor and bracket assembly. Tighten to 36-55 N·m (27-41 lb-ft).
21. Connect A/C discharge hose.
22. Install generator assembly. Tighten to 48-72 N·m (36-53 lb-ft).
23. Install accumulator and bracket assembly.
24. Connect cycling switch to top of accumulator.
25. Install belt tensioner (lower tensioner on 3.0L only).
26. Install power steering belt (4 rib) and tighten belt tensioner pulley on 3.0L only.
27. On 3.0L, install belt on A/C compressor and generator (6 rib). Tighten tensioner pulley. On 3.2L, install single accessory drive belt and release tensioner.
28. Connect electrical connectors from harness 12A581 on rear of engine.

REMOVAL AND INSTALLATION (Continued)

29. Connect heater hoses at heater core.
30. Connect vacuum hoses.
31. Connect throttle linkage.
32. Connect hose from power steering cooler at pump.
33. Install power steering reservoir.
34. Install damper bracket to engine.
35. Install engine vibration damper and bracket assembly to RH side of engine.
36. Install barometric pressure (BARO) sensor.
37. Connect fuel return hose.
38. Connect fuel inlet hose.
39. Install radiator assembly. Refer to Section 03-03.
40. Install lower radiator hose.
41. Install electric fan and shroud assembly. Refer to Section 03-03.
42. Install upper radiator hose.
43. Install air cleaner hose.
44. Install constant control relay module (CCRM).
45. Install radiator coolant recovery reservoir.
46. Install radiator upper sight shield.
47. Connect generator and voltage regulator wiring.
48. Install oil level indicator tube.
49. Install hood.
50. Connect underhood lamp wiring, if so equipped.
51. Install battery tray.
52. Install battery.
53. Connect battery ground cable.
54. Fill crankcase with correct viscosity and amount of engine oil.
55. Refill coolant.
56. Drain, evacuate, pressure test and recharge A/C system. Refer to Section 12-00.
57. Start engine and check for leaks.

Engine Damper, RH

Removal

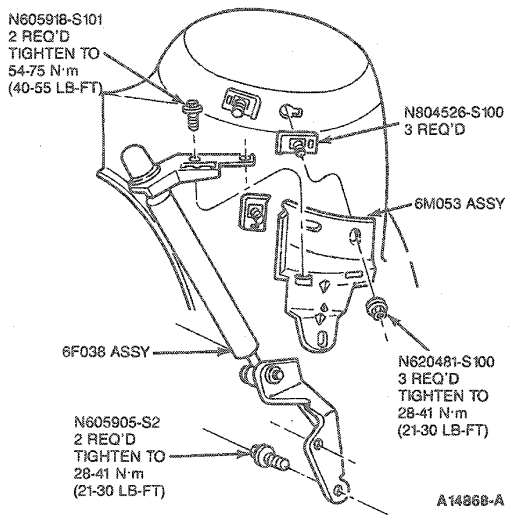
CAUTION: Do not clamp damper tube or piston rod.

NOTE: Whenever self-locking fasteners are removed, replace with new self-locking fasteners.

1. Remove nuts retaining lower end of damper to engine bracket.
2. Remove bolts retaining upper damper bracket to shock tower bracket.
3. Remove engine damper.

Installation

1. Position engine damper lower sleeve to line up with engine bracket notch. Secure with a new nut. Tighten to 28-41 N·m (21-30 lb-ft).
2. Position engine damper with upper bracket to shock tower bracket. Secure with new bolts. Tighten to 54-75 N·m (40-55 lb-ft).



Engine Damper, LH

Removal

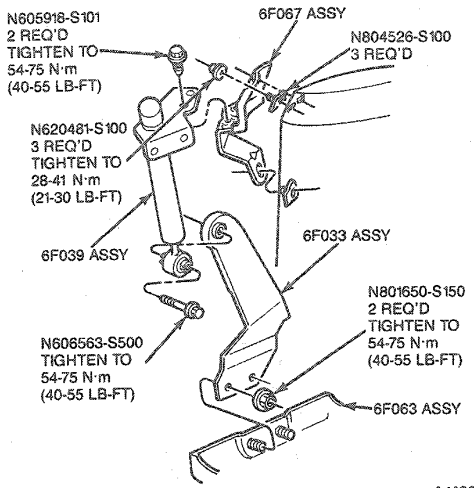
CAUTION: Do not clamp damper tube or piston rod.

NOTE: Whenever self-locking fasteners are removed, replace with new self-locking fasteners.

1. Remove speed control servo and bracket assembly. Refer to Section 10-03.
2. Remove bolt and flag nut retaining lower end of damper to No. 1A engine mount retaining bracket.
3. Remove bolts retaining upper damper bracket to side rail bracket.

REMOVAL AND INSTALLATION (Continued)

4. Remove engine damper.



Installation

1. Insert lower end of damper into engine mount retaining bracket being careful to align groove in damper sleeve with notch in bracket.
2. Insert bolt through bracket and damper and hand start new flag nut. Tighten bolt to 28-41 N·m (21-30 lb-ft).

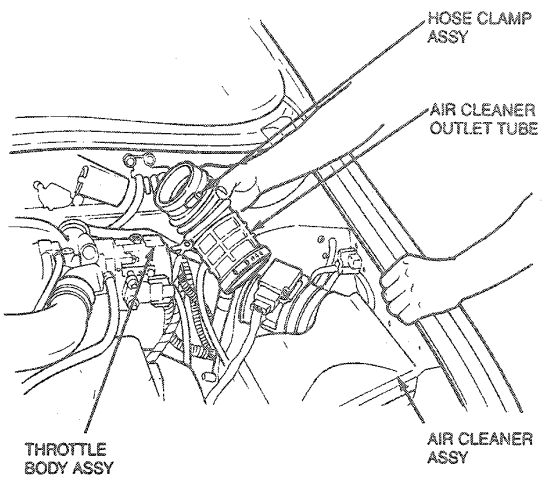
   NOTE: Bolt must be inserted with head toward engine.
3. Pull damper into position against the shock tower mounting bracket.
4. Install speed control servo and bracket assembly. Refer to Section 10-03.

Throttle Body

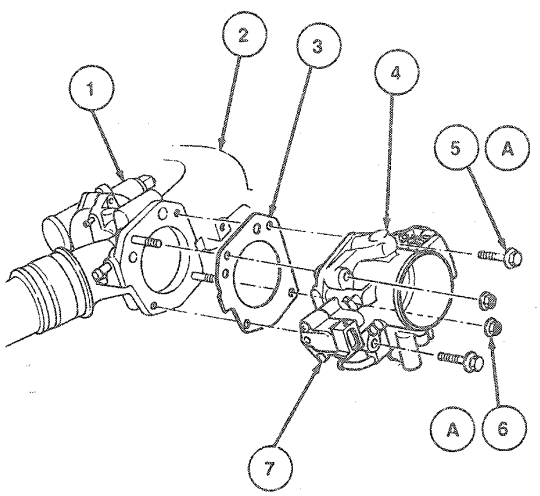
CAUTION: The 3.2L SHO throttle body contains a special coating. DO NOT attempt to clean.

Removal and Installation

1. Loosen hose clamp retaining flex hose to throttle body. Remove air cleaner flex hose.
2. Remove throttle linkage snowshield.



3. Relieve cooling system pressure. Refer to Section 03-03. Loosen and disconnect all vacuum and coolant connections to throttle body.
4. Disconnect throttle linkage. Refer to Section 10-02.
5. Disconnect throttle position sensor (9B989).



Item	Part Number	Description
1	9F715	Idle Air Control Valve
2	9424	Intake Manifold
3	9E936	Air Charge Control to Intake Manifold Gasket
4	9E926	Throttle Body
5A	90105-08536	Bolt

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
6A	90179-15574	Nut
7	9B989	Throttle Position Sensor
A		Tighten to 16-23 N·m (12-16 Lb-Ft)

6. Remove two throttle body retaining bolts and nuts.
7. To install, reverse Removal procedure. Replace air charge control to intake manifold gasket (9E936) if necessary. Tighten nuts and bolts to 16-23 N·m (12-17 lb-ft).
8. Top off coolant.

Timing Belt

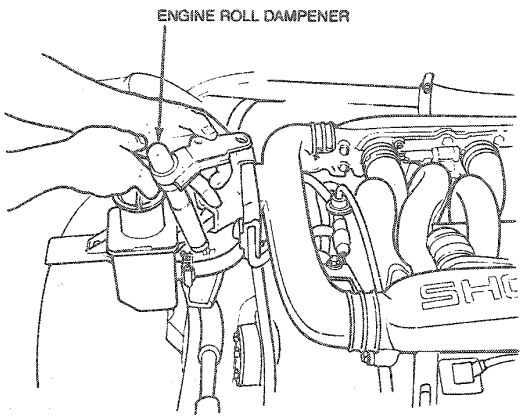
3.0L SHO

Tools Required:

- Puller T67L-3600-A
- Vibration Damper and Seal Installer T82L-6316-A
- Crankshaft Seal Installer / Cover Aligner T88L-6701-A
- Screw and Washer Set T89P-6701-A
- Step Plate Adapter D80L-630-3
- Rotunda Offset Belt Tension Gauge 021-0028A

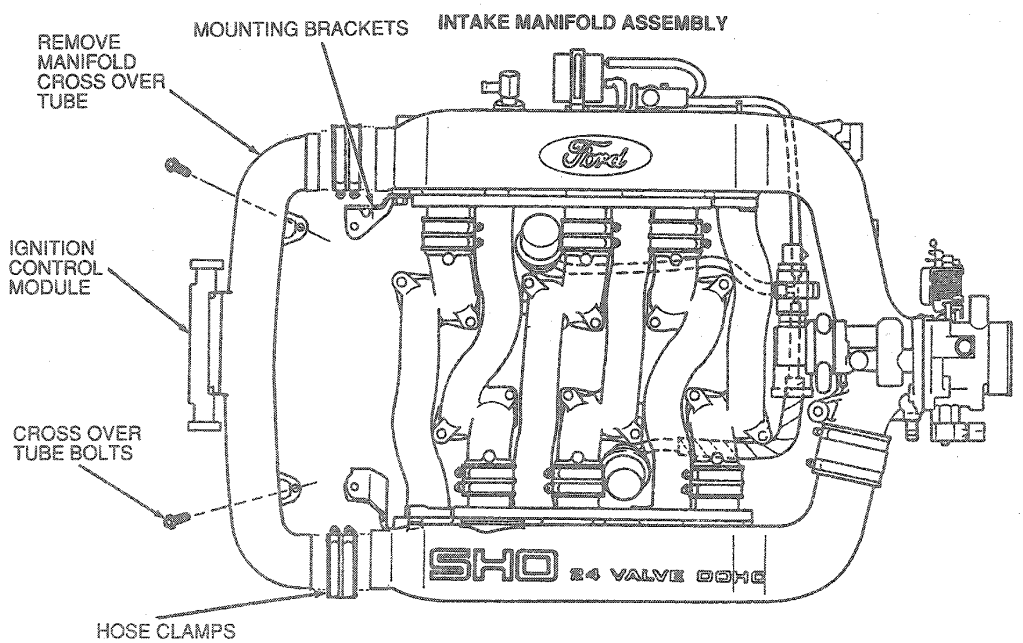
Removal

1. Disconnect battery cables.
2. Remove battery.
3. Remove RH engine roll damper as outlined.



A12904-A

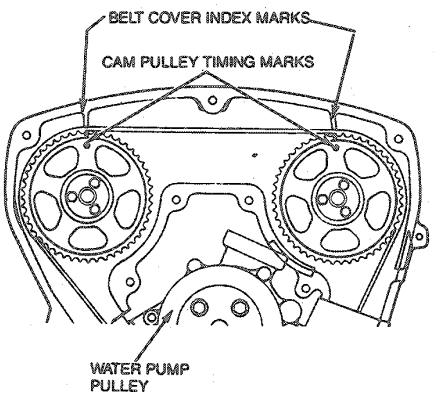
4. Disconnect wiring to ignition control module. (ICM)
5. Remove intake manifold crossover tube bolts.



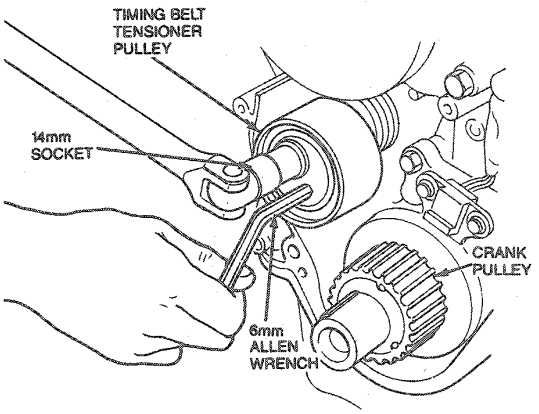
A12903-C

REMOVAL AND INSTALLATION (Continued)

6. Loosen intake manifold crossover tube hose clamps.
7. Remove intake manifold crossover tube.
8. Loosen generator / A / C (6 rib) belt tensioner pulley and relieve tension on belt by backing out adjustment screw.
9. Remove generator / A / C belt.
10. Loosen water pump / power steering (4 rib) belt tensioner pulley and relieve tension on belt by backing out adjustment screw.
11. Remove water pump / power steering belt.
12. Remove generator / A / C belt tensioner pulley and bracket assembly.
13. Remove water pump / power steering belt tensioner pulley only.
14. Remove upper timing belt cover.
15. Disconnect crankshaft sensor connectors.
16. Place gear selector in NEUTRAL.
17. Set engine to TDC on No. 1 cylinder. Ensure that "white" mark on crankshaft damper aligns with 0 degree index mark on lower timing belt cover and that marks on intake camshaft pulleys align with index marks on metal timing belt cover.



18. Raise vehicle on a hoist. Refer to Section 00-02.
19. Remove RH front wheel and tire assembly.
20. Loosen fender splash shield and place out of the way.
21. Remove crankshaft damper using Puller T67L-3600-A, Step Plate Adapter D80L-630-3 and Screw and Washer Set T89P-6701-A or equivalent.
22. Remove lower timing belt cover.
23. Remove center timing belt cover and disconnect crankshaft sensor wire and grommet from the slot in the cover and stud on water pump.
24. Loosen timing belt tensioner, rotate pulley 180 degrees clockwise using an Allen wrench, and tighten tensioner nut to hold pulley in the "unload position."



25. Lower vehicle.
26. Remove timing belt.

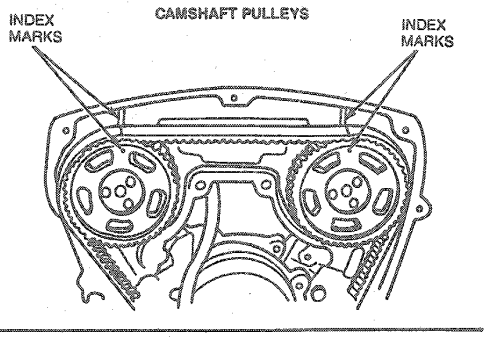
Installation

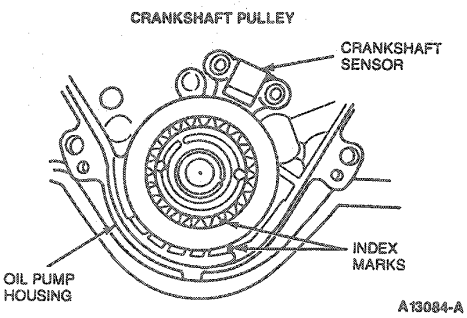
CAUTION: Before installing timing belt, inspect it for cracks, wear or other damage. Replace if damaged. Do not allow timing belt to come in contact with gasoline, oil, water, coolant or steam. Do not turn belt inside out or twist belt.

- Always store belt in a cool dark place.
- Always keep belt in protective packaging until ready for use.
- Never hit or squeeze belt with hammer or screwdriver.

REMOVAL AND INSTALLATION (Continued)

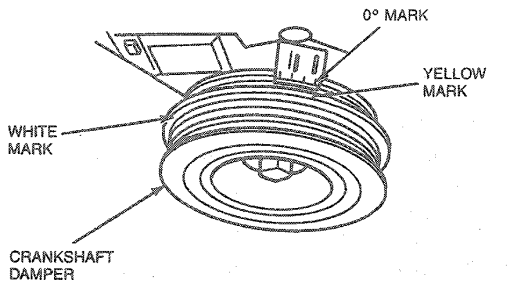
1. Ensure engine is at TDC on No. 1 cylinder. Check that camshaft pulley marks line up with index marks on upper steel belt cover and that crankshaft pulley aligns with index mark on oil pump housing.



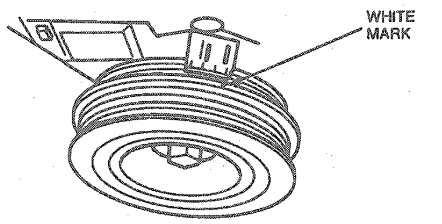


NOTE: The timing belt has three yellow lines. Each line aligns with the index marks shown.

2. Install timing belt on crankshaft pulley and route to camshaft pulleys. Lettering on belt "KOA" should be readable from rear of engine (top of lettering to front of engine). Also ensure that the yellow lines are aligned with the index marks on the pulleys.
3. Release tensioner locknut and leave nut loose.
4. Raise vehicle on hoist. Refer to Section 00-02.
5. Install center timing belt cover. Ensure crankshaft sensor wiring and grommet are installed and routed properly. Tighten retaining bolts to 7-11 N·m (62-97 lb-in).
6. Install lower timing belt cover. Tighten retaining bolts to 7-11 N·m (62-97 lb-in).
7. Install crankshaft damper using Crankshaft Seal Installer / Cover Aligner T88T-6701-A with forcing screw from Vibration Damper and Seal Installer T82L-6316-A or equivalent.
8. Rotate crankshaft two revolutions in the clockwise direction until the yellow mark on damper aligns with 0 degree mark on lower timing belt cover.



9. Remove plastic door in the lower timing belt cover. Tighten belt tensioner lock nut to 33-51 N·m (24-38 lb-ft) and install plastic door.
10. Rotate crankshaft 60 degrees more in the clockwise direction until the white mark on the damper aligns with 0 degree index mark on lower timing belt cover.



11. Lower vehicle.
12. Ensure index marks on camshaft pulleys align with marks on rear metal timing belt cover.
13. Route crankshaft sensor wiring and connect with engine wiring harness.
14. Install upper timing belt cover. Tighten retaining bolts to 7-11 N·m (62-97 lb-in).
15. Install water pump pulley. Tighten retaining nut to 16-23 N·m (12-17 lb-ft).
16. Install generator / A/C tensioner pulley and bracket assembly. Tighten bolts to 15-23 N·m (11-17 lb-ft).
17. Install water pump / power steering (4 rib) belt. Using Rotunda Offset Belt Tension Gauge 021-0028A or equivalent, set tension. Tighten idler pulley retaining nut to 34-50 N·m (25-36 lb-ft).
    - New belt: 690-880 N (154-198 lb)
    - Used belt: 500-700 N (112-157 lb)

REMOVAL AND INSTALLATION (Continued)

18. Install generator / A / C (6 rib) belt. Using Rotunda Offset Belt Tension Gauge 021-0028A or equivalent, set tension. Tighten idler pulley nut to 34-50 N·m (25-36 lb-ft).
    - New belt: 980-1180 N (220-265 lb)
    - Used belt: 660-850 N (148-192 lb)
19. Install intake manifold cross over tube. Tighten bolts to 15-23 N·m (11-17 lb-ft).
20. Install engine roll damper.
21. Install battery.
22. Connect battery cables.
23. Raise vehicle.
24. Install splash shield.
25. Install RH front tire and wheel assembly. Tighten wheel lug nuts to 115-142 N·m (85-105 lb-ft).
26. Lower vehicle.

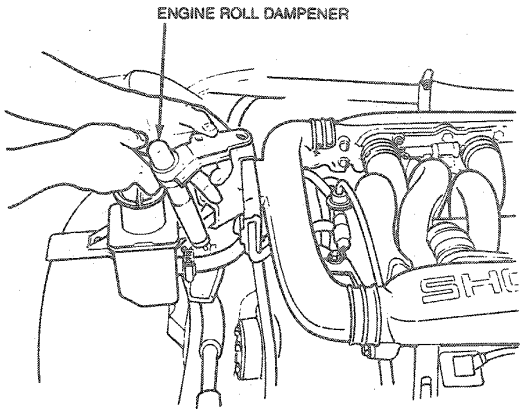
3.2L SHO

Tools Required:

- Puller T67L-3600-A
- Strap Wrench D85L-6000-A
- Step Plate Adapter D80L-630-3
- Inch Pound Torque Wrench D81L-600-A
- Vibration Damper and Seal Installer T82L-6316-A
- Crankshaft Seal Installer / Cover Aligner T88L-6701-A
- Screw and Washer Set T89P-6701-A
- Torque Wrench Attachment T93P-6254-A
- Timing Belt Tensioner Tool T93P-6254-B

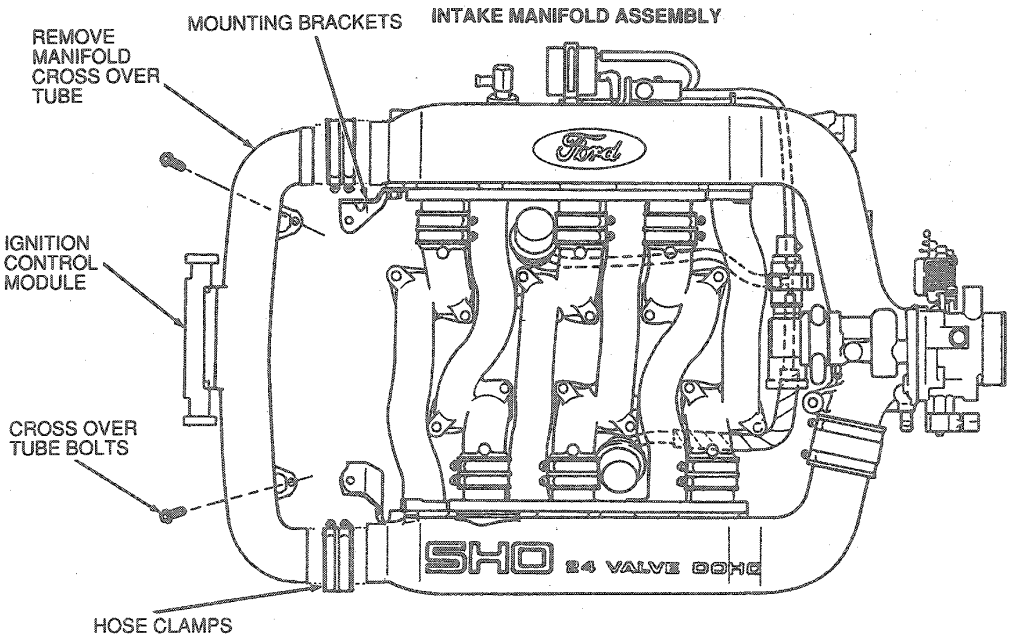
Removal

1. Disconnect battery cables.
2. Remove battery.
3. Remove RH engine roll damper as outlined.



A12904-A

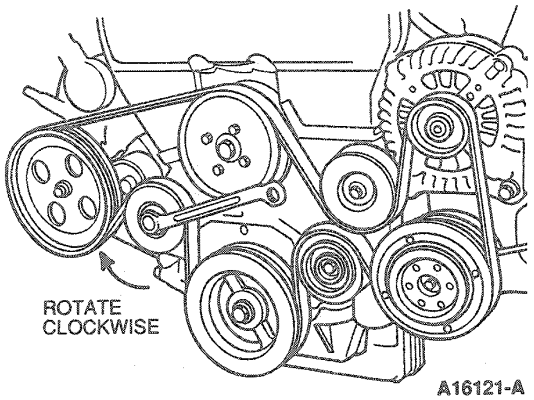
4. Disconnect wiring to ignition control module (ICM).
5. Remove intake manifold crossover tube bolts.



A12903-C

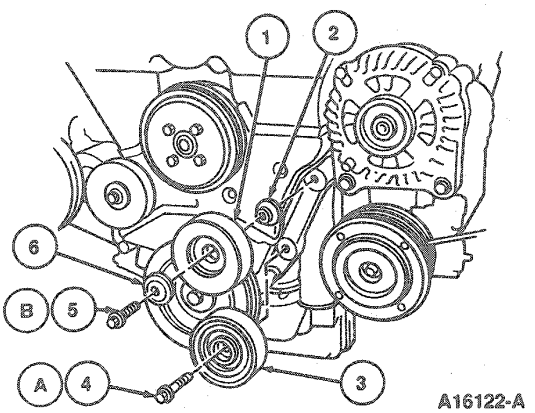
REMOVAL AND INSTALLATION (Continued)

6. Loosen intake manifold crossover tube hose clamps.
7. Remove intake manifold crossover tube.
8. Rotate accessory drive belt tensioner clockwise to relieve tension and remove single accessory drive belt.



A16121-A

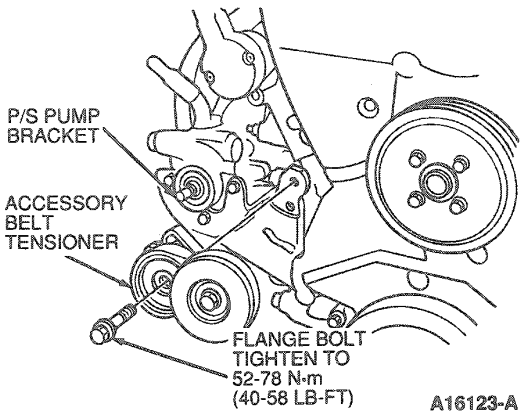
9. Disconnect surge tank fitting.
10. Remove bolts retaining upper and lower idler pulleys to engine and remove pulleys.



A16122-A

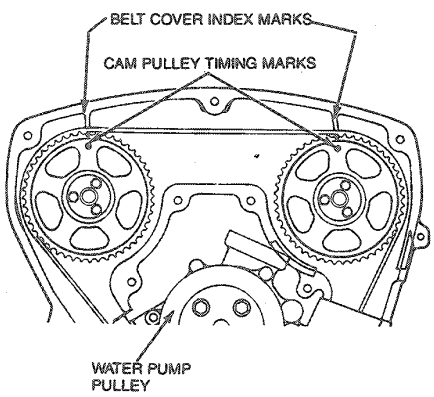
Item	Part Number	Description
1	8679	Upper Idler Pulley
2	8A613	Spacer
3	8679	Lower Idler Pulley
4A	—	Flange Bolt
5B	—	Flange Bolt
6	—	Pulley Plate
A		Tighten to 36-55 N·m (27-41 Lb-Ft)
B		Tighten to 35-51 N·m (26-38 Lb-Ft)

11. Using strap wrench D85L-6000-A or equivalent, to hold power steering pump pulley, remove nut, washer and remove power steering pulley.
12. Remove retaining bolt from belt tensioner and remove tensioner.



A16123-A

13. Remove upper and center timing belt covers.
14. Disconnect crankshaft position (CKP) sensor (12A127) connectors.
15. Place transmission selector lever in NEUTRAL.
16. Set engine to TDC on No. 1 cylinder. Ensure that "white" mark on crankshaft damper aligns with 0 degrees index mark on lower timing belt cover and that marks on intake camshaft pulleys align with index marks on metal timing belt cover.

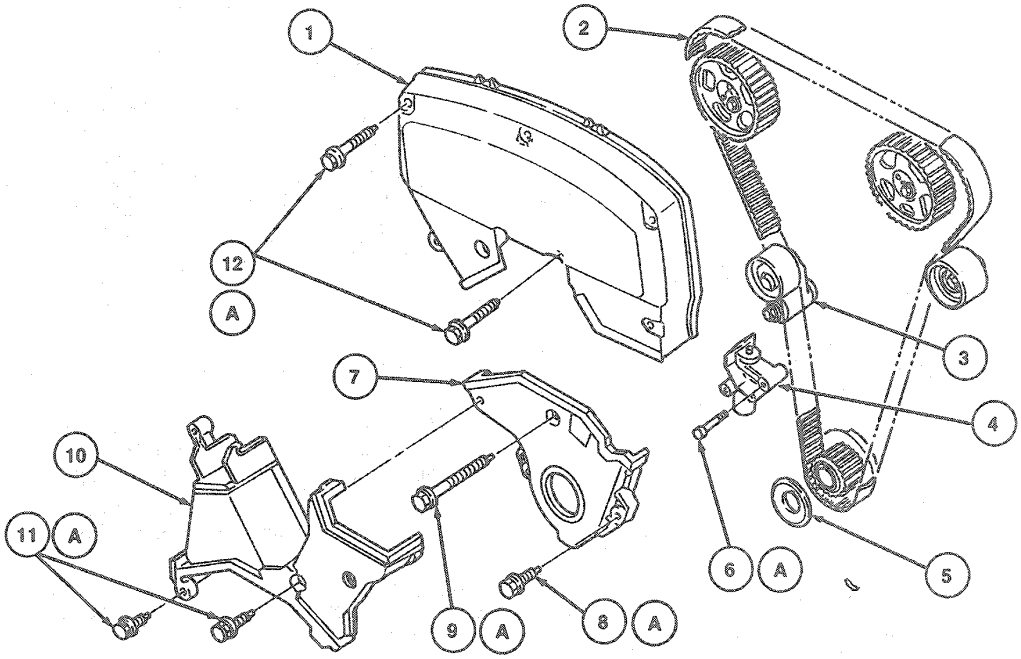


A12900-A

17. Raise vehicle on a hoist. Refer to Section 00-02.
18. Remove RH front wheel and tire assembly.
19. Loosen fender splash shield and place out of the way.
20. Remove crankshaft damper using Puller T67L-3600-A, Step Plate Adapter D80L-630-3 and Screw and Washer Set T89P-6701-A.
21. Remove lower timing belt cover and belt guide.
22. Remove upper timing belt tensioner bolt.

REMOVAL AND INSTALLATION (Continued)

23. Slowly loosen lower timing belt tension bolt and remove tensioner.
24. Lower vehicle.
25. Remove timing bolt.



A16107-A

Item	Part Number	Description
1	6019G	Upper Cover
2	6268B	Timing Belt
3	6K254	Belt Tensioner Pulley Assy
4	6B209	Belt Tensioner
5	6K279	Belt Guide
6A	—	Bolt

(Continued)

Item	Part Number	Description
7	—	Center Cover
8A	—	Bolt (2 Req'd)
9A	—	Bolt
10	6019H	Lower Cover
11A	—	Bolt (3 Req'd)
12A	—	Bolt (8 Req'd)
A		Tighten to 16-23 N·m (12-17 Lb-Ft)

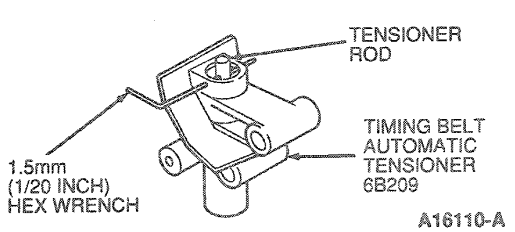
Installation

CAUTION: Before installing timing belt, inspect if for cracks, wear or other damage. Replace if damaged. Do not allow timing belt to come in contact with gasoline, oil, water, coolant or steam. Do not turn belt inside out or twist belt.

- Always store belt in a cool dark place.
- Always keep belt in protective packaging until ready for use.
- Never hit or squeeze belt with hammer of screwdriver.

WARNING: USE CAUTION WHEN COMPRESSING TIMING BELT TENSIONER IN VISE TO ENSURE THAT TENSIONER DOES NOT SLIP FROM VISE.

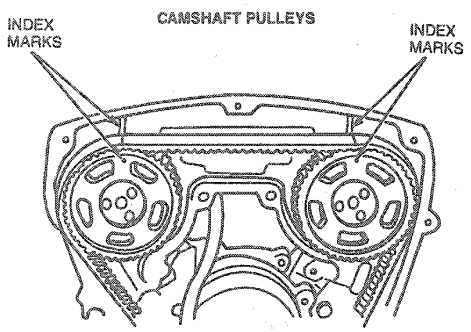
1. Slowly compress timing belt tensioner in a soft jawed vise until hole in tensioner housing aligns with hole in tensioner rod.
2. Insert a 1.5mm (1/20 inch) hex wrench through holes.
3. Release tensioner from vice.

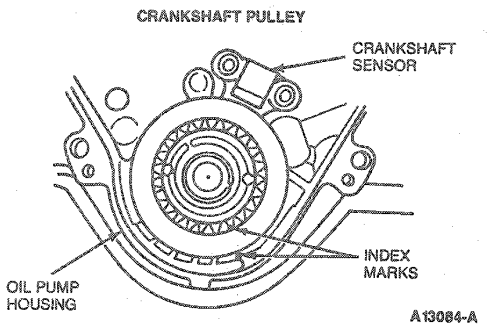


A16110-A

REMOVAL AND INSTALLATION (Continued)

4. If a new timing belt is being installed, loosen timing belt idler bolt.
5. Ensure engine is at TDC on No. 1 cylinder. Check that camshaft pulley marks line up with index marks on upper steel belt cover and that crankshaft pulley aligns with index mark on oil pump housing.



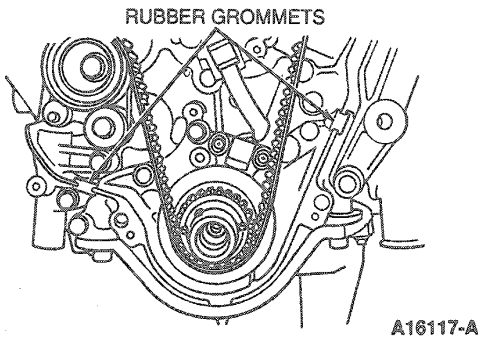


NOTE: The timing belt has three yellow lines. Each line aligns with the index marks shown.

6. Install timing belt on crankshaft pulley and route to camshaft pulleys. Lettering on belt "KOB" should be readable from rear of engine (top of lettering to front of engine). Also ensure that the yellow lines are aligned with the index marks on the pulley.

   CAUTION: Do not install timing belt tensioner with rod extended.

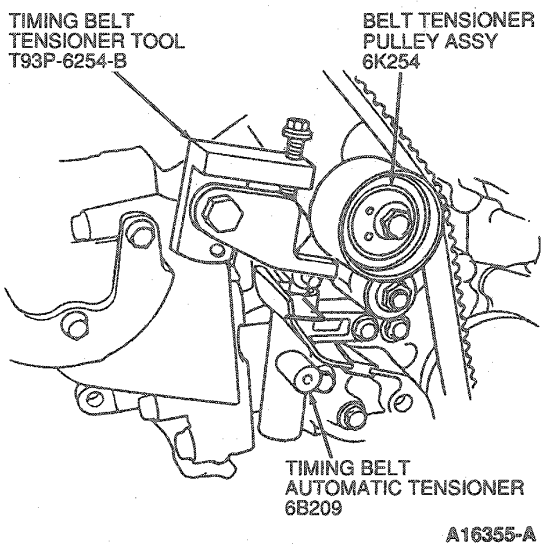
7. Install timing belt tensioner on cylinder block while pushing timing belt idler toward belt. Tighten tensioner bolts to 16-23 N·m (12-17 lb-ft).
8. Install grommets between timing belt tensioner and oil pump.



9. Remove 1.5mm (1/20 inch) hex wrench from timing belt tensioner.

   NOTE: If a new timing belt is being installed, perform steps 10 through 13. **If the original timing belt is being used, go to step 14.**

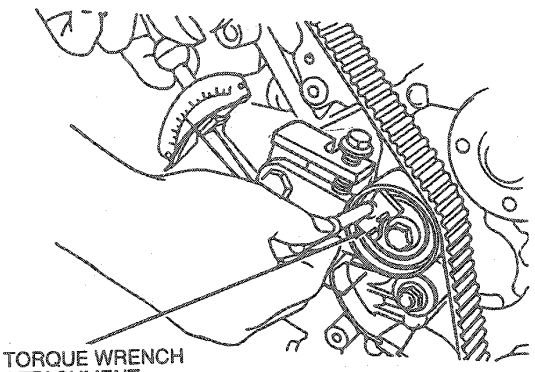
10. Position Timing Belt Tensioner Tool T93P-6254-B using power steering pump bracket holes.



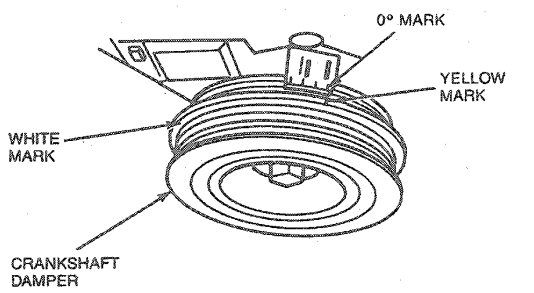
11. Hand-tighten timing belt idler bolt.

REMOVAL AND INSTALLATION (Continued)

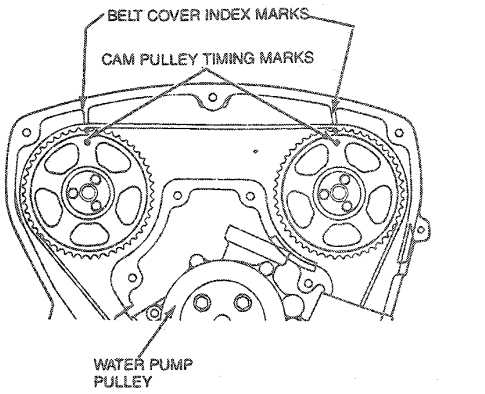
12. Using Inch Pound Torque Wrench D81L-600-A or equivalent, rotate Torque Wrench Attachment T93P-6254-A clockwise to 0.5 N·m (4.3 lb-in).



13. Tighten timing belt tensioner bolts to 36-50 N·m (27-37 lb-ft). Then remove Belt Tensioning Tool T93P-6254-B.
14. Raise vehicle on hoist. Refer to Section 00-02.
15. Install belt guide and lower timing belt cover. Tighten retaining bolts to 16-23 N·m (12-17 lb-ft).
16. Install crankshaft damper using Crankshaft Seal Installer/Cover Aligner T88T-6701-A with forcing screw from Vibration Damper and Seal Installer T82L-6316-A.
17. Rotate crankshaft two revolutions in the clockwise direction until the yellow mark on damper aligns with 0 degree mark on lower timing belt cover.



18. Lower vehicle.
19. Ensure index marks on camshaft pulleys align with marks on rear metal timing belt cover.



20. Route crankshaft sensor wiring and connect with engine wiring harness.
21. Install center timing belt cover. Tighten retaining bolts to 16-23 N·m (12-17 lb-ft).
22. Install upper timing belt cover. Tighten retaining bolts to 16-23 N·m (12-17 lb-ft).
23. Install water pump pulley. Tighten retaining nut to 16-23 N·m (12-17 lb-ft).
24. Install single accessory drive belt while rotating accessory drive belt tension clockwise.
25. Connect surge tank fitting.
26. Install intake manifold cross over tube. Tighten bolts to 15-23 N·m (11-17 lb-ft).
27. Install engine roll damper.
28. Connect wiring to ignition control module (ICM).
29. Install battery.
30. Connect battery cables.
31. Raise vehicle.
32. Install splash shield.
33. Install RH front tire and wheel assembly. Tighten wheel lug uts to 115-142 N·m (85-105 lb-ft).
34. Lower vehicle.

Crankshaft/Damper/Front Oil Seal

Tools Required:

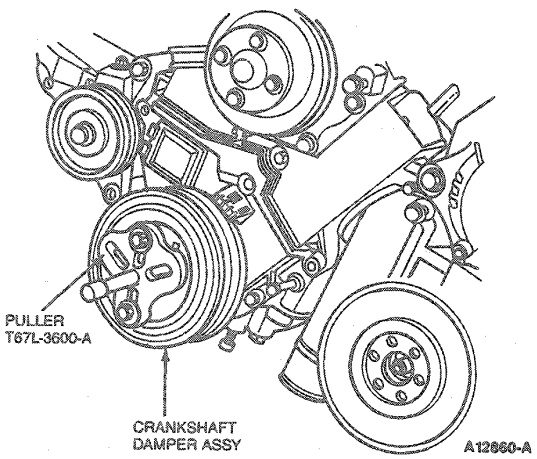
- Puller T67L-3600-A
- Locknut Pin Remover T78P-3504-N
- Vibration Damper and Seal Installer T82L-6316-A
- Crankshaft Seal Installer/Cover Aligner T88T-6701-A
- Crankshaft Seal Installer/Cover Aligner Plate T88T-6701-A2
- Front Crank Seal Installer T89P-6701-B

Removal

1. Loosen accessory drive belts.

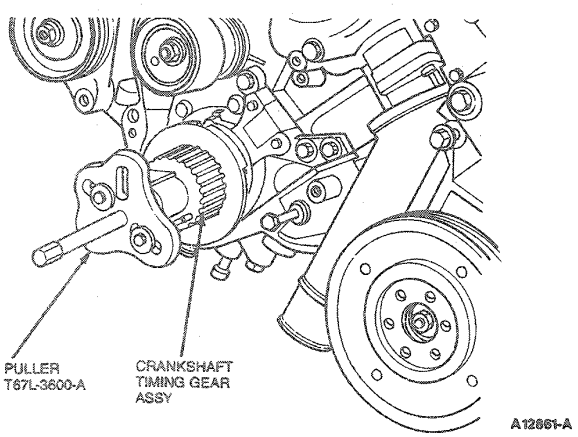
REMOVAL AND INSTALLATION (Continued)

2. Raise vehicle on hoist. Refer to Section 00-02.
3. Remove RH front wheel.
4. Remove damper retaining bolt.
5. Remove accessory drive belts from crankshaft damper.
6. Remove crankshaft damper from crankshaft using Puller T67L-3600-A or equivalent.

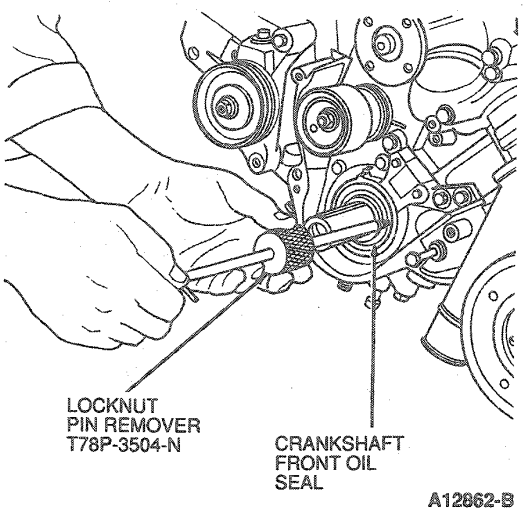


7. Remove timing belt as outlined.
8. Remove crankshaft timing gear using Puller T67L-3600-A.

   NOTE: Be careful not to damage the crankshaft sensor or shutter.

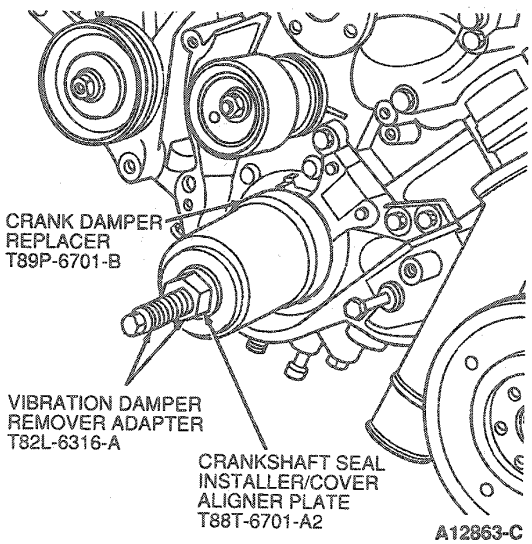


9. Remove crankshaft front oil seal using Locknut Pin Remover T78P-3504-N.



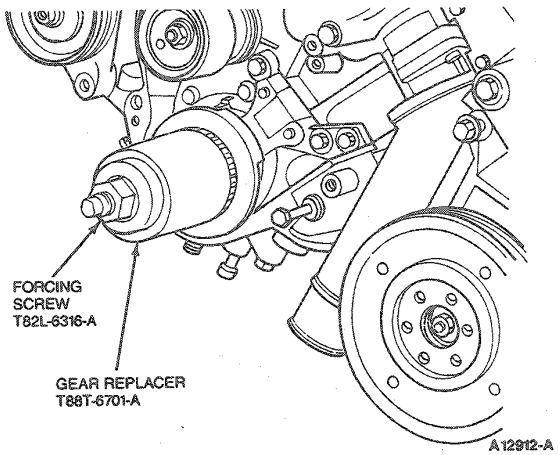
Installation

1. Inspect front cover and shaft seal surface of the crankshaft damper for damage, nicks, burrs or other roughness which may cause the new seal to fail. Service or replace components as necessary.
2. Using Vibration Damper and Seal Installer T82L-6316-A, Crankshaft Seal Installer / Cover Aligner Plate T88T-6701-A2 and Front Crank Seal Installer T89P-6701-B install new front oil seal.



REMOVAL AND INSTALLATION (Continued)

3. Install Crankshaft Seal Installer / Cover Aligner T88T-6701-A with forcing screw from T82L-6316-A to press seal the rest of the way onto crankshaft.



4. Install crankshaft damper using Front Crank Seal Installer T89P-6701-B or equivalent. Install crankshaft damper retaining bolt. Tighten to 152-172 N·m (112-127 lb-ft).
5. Position accessory drive belts over crankshaft damper.
6. Check drive belts for proper routing and engagement in the pulleys. Adjust drive belts to specification. Refer to Section 03-05.
7. Start engine and check for oil leaks.

Water Pump

Tools Required:

- Puller T67L-3600-A
- Screw and Washer Set T89P-6701-A

Removal

1. Remove LH idler pulley and bracket assembly.
2. Remove drive and accessory belts.
3. Remove RH front wheel and inner fender splash panel.
4. Disconnect electrical connector from ignition control module.
5. Loosen four hose clamps and remove two bolts from intake connector tube and remove tube.
6. Remove upper timing belt cover.
7. Remove crankshaft damper using Puller T67L-3600-A or equivalent. Remove lower timing belt cover.
8. Disconnect crankshaft sensor wire assembly and position out of the way.
9. Remove center timing belt cover.
10. Remove pulley from RH idler.
11. Remove six retaining bolts and remove water pump and gasket assembly.

Installation

NOTE: Lightly oil all bolt threads before installation except those specifying special sealant.

1. Clean gasket surfaces on water pump and front cover.
2. Position a new gasket on water pump sealing surface using Gasket and Trim Adhesive D7AZ-19B508-B (ESR-M11P17-A and ESE-M2G52-A) or equivalent to hold the gasket in position.
3. Position water pump to front cover and install retaining bolts. Tighten bolts to 16-23 N·m (12-16 lb-ft).
4. Install pulley on RH idler.
5. Install center timing belt cover.
6. Connect crankshaft sensor wire assembly.
7. Install lower timing belt cover. Install crankshaft damper using Screw and Washer Set T89P-6701-A or equivalent. Install damper retaining bolt and tighten to 152-172 N·m (113-126 lb-ft).
8. Install upper timing belt cover.
9. Install intake connector tube. Tighten bolts to 15-23 N·m (11-16 lb-ft). Secure four hose clamps.
10. Connect ignition control module connector.
11. Install RH front inner splash panel and wheel. Tighten wheel lug nuts to 115-142 N·m (85-105 lb-ft).
12. Position accessory drive belts over pump pulley and adjust drive belts. Refer to Section 03-05.
13. Fill and bleed cooling system.
14. Start engine and check for coolant leaks.

Cylinder Head Cover

Removal

1. Disconnect battery ground cable.
2. Release pressure from fuel system.
3. Disconnect all vacuum lines and electrical connectors from intake manifold assembly.
4. Remove upper intake manifold as outlined.
5. Disconnect spark plug wires.
6. If LH cylinder head cover is being removed perform the following:
   - Remove oil fill cap.
   - Remove coil pack plastic cover.
7. If RH cylinder head cover is being removed, disconnect fuel lines.

REMOVAL AND INSTALLATION (Continued)

8. Remove cylinder head cover retaining bolts and remove cover.

Installation

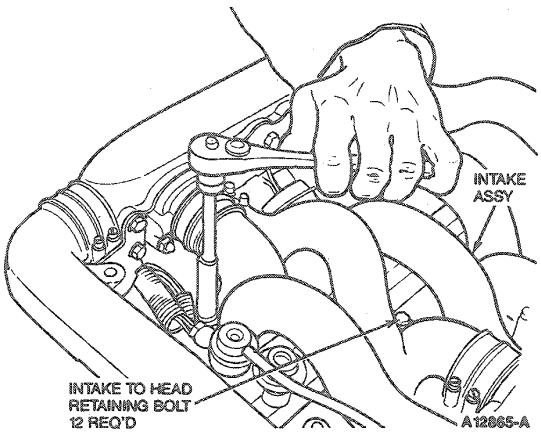
NOTE: Lightly oil all bolt and stud threads before installation. Using solvent, clean cylinder head and rocker arm cover sealing surfaces to remove all gasket material and dirt.

1. Install new gasket and three spark plug hole gaskets on cover. Position cover on the cylinder head and install retaining bolts. Tighten retaining bolts to 9.8-16 N·m (7-12 lb-ft).
2. If LH cylinder head cover is being installed, perform the following:
   - Install coil pack plastic cover.
   - Install oil fill cap.
3. If RH cylinder head cover is being installed, connect fuel lines.
4. Connect spark plug wires.
5. Install upper intake manifold as outlined.
6. Connect all vacuum lines and electrical connectors to intake manifold assembly.
7. Connect battery ground cable.
8. Start engine and check for fuel, coolant and oil leaks.

Intake Manifold

Removal

1. Partially drain engine cooling system.
2. Disconnect battery ground cable.
3. Disconnect electrical connectors and vacuum lines from intake assembly.
4. Remove air cleaner tube.
5. Disconnect coolant lines and cables from throttle body.
6. Remove four bolts retaining upper intake brackets.
7. Loosen four lower bolts and remove brackets.
8. Remove 12 bolts retaining intake manifold to cylinder heads.
9. Remove intake manifold assembly and gaskets.



Installation

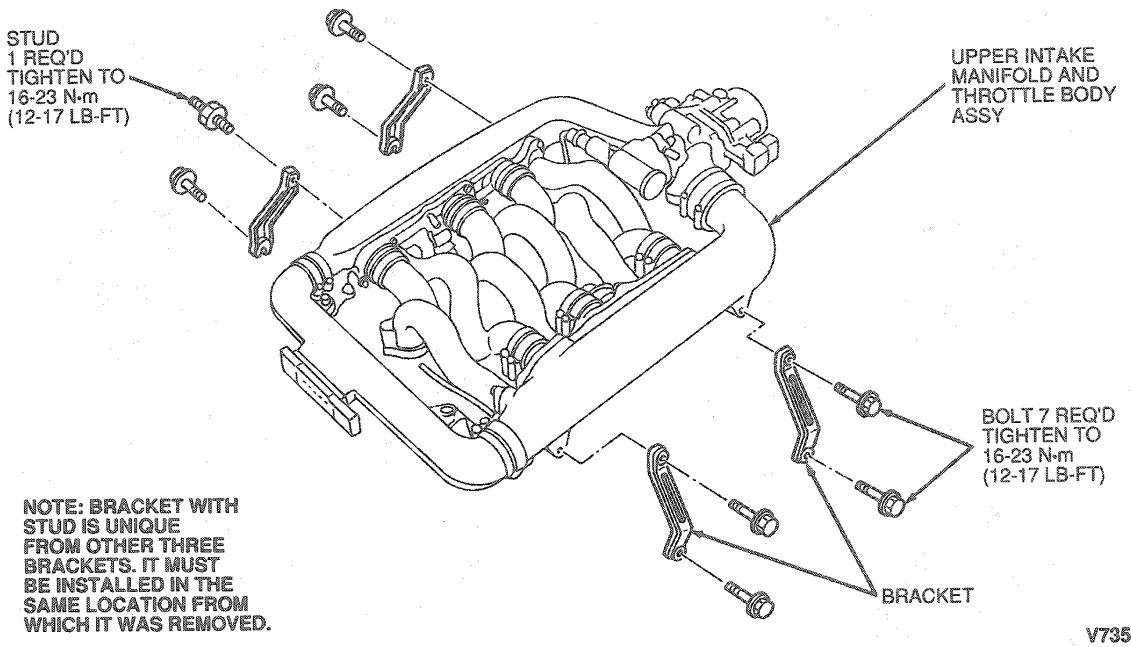
NOTE: Lightly oil all retaining bolts and stud threads before installation.

NOTE: The intake gasket is reusable.

1. Position gasket on cylinder head.
2. Position intake manifold on the cylinder heads.
3. Install 12 retaining bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).
4. Install intake manifold brackets. Tighten retaining bolts to 15-23 N·m (11-17 lb-ft).
5. Connect coolant lines and cables to throttle body.
6. Connect all electrical connectors and vacuum lines to intake manifold.
7. Install air cleaner tube.
8. Fill cooling system.
9. Connect battery ground cable.

REMOVAL AND INSTALLATION (Continued)

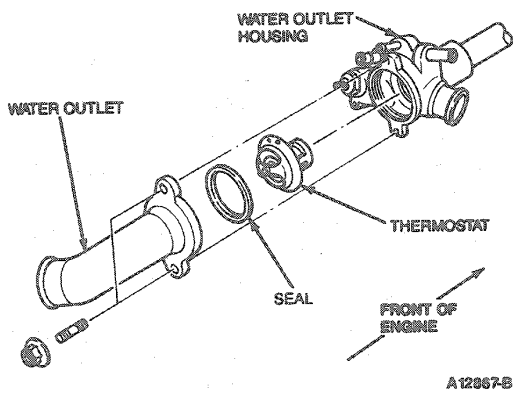
10. Start engine and check for coolant leaks.



Thermostat

Removal

1. Disconnect battery ground cable.
2. Partially drain engine cooling system.
3. Remove air cleaner tube.
4. Disconnect hose from water outlet tube.
5. Remove two retaining nuts and remove water outlet tube.
6. Remove thermostat and seal from water outlet housing.



Installation

NOTE: Align jiggle valve of thermostat with upper bolt on water outlet housing.

1. Install seal around the outer rim of the thermostat, and install thermostat into water outlet housing.
2. Install water outlet tube.
3. Install two retaining nuts. Tighten nuts to 7-11 N·m (62-97 lb-in).
4. Install air cleaner tube.
5. Fill engine cooling system.
6. Connect battery ground cable.
7. Start engine and check for coolant leaks.

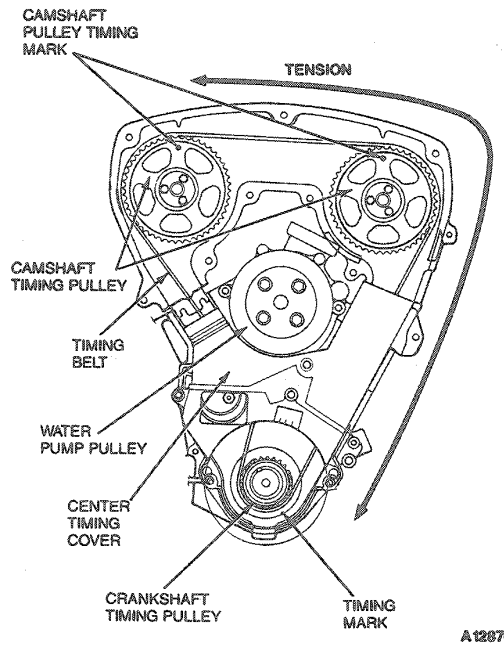
Cylinder Heads

Removal

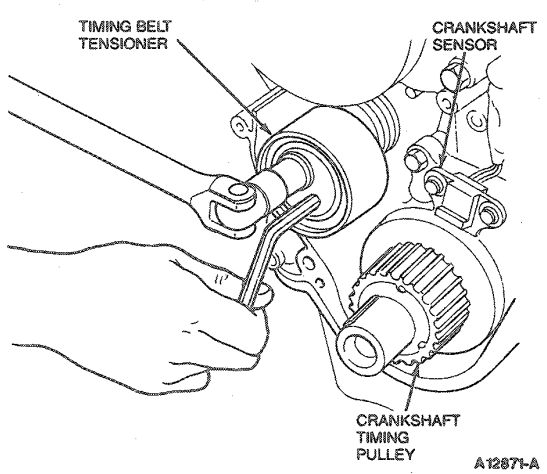
1. Drain cooling system.
2. Disconnect battery ground cable.
3. Remove air cleaner outlet tube.
4. Remove intake manifold as outlined.
5. Loosen accessory drive belt idlers. Remove drive belts.
6. Remove upper timing belt cover.
7. Remove LH idler pulley and bracket assembly.

REMOVAL AND INSTALLATION (Continued)

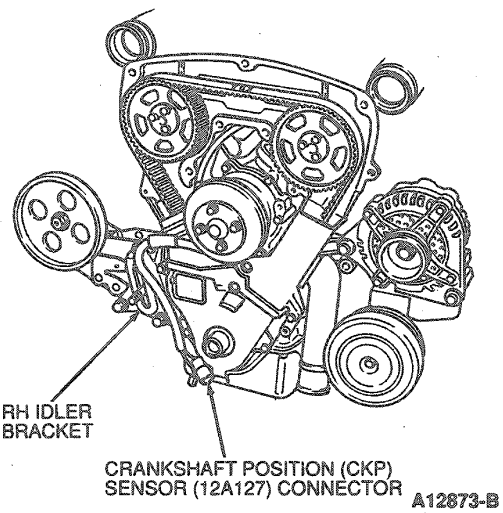
8. Raise vehicle on a hoist. Refer to Section 00-02.
9. Remove RH wheel and inner fender splash shield.
10. Remove crankshaft damper pulley.
11. Remove lower timing belt cover.
12. Align timing marks as shown.



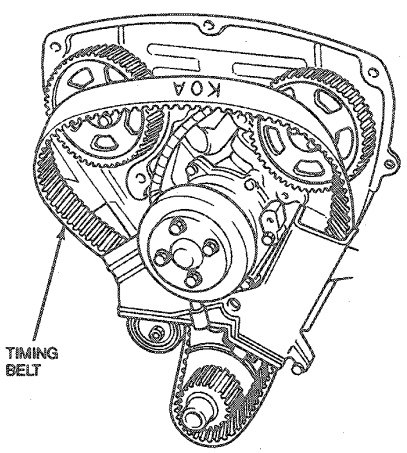
13. Release tension on timing belt by loosening tensioner nut and rotating tensioner with a hex head wrench. When tension is released, tighten nut. This will hold tensioner in place. Lower vehicle until wheels touch and keep supported on hoist.



14. Disconnect crankshaft position (CKP) sensor 12A127 wiring assembly.



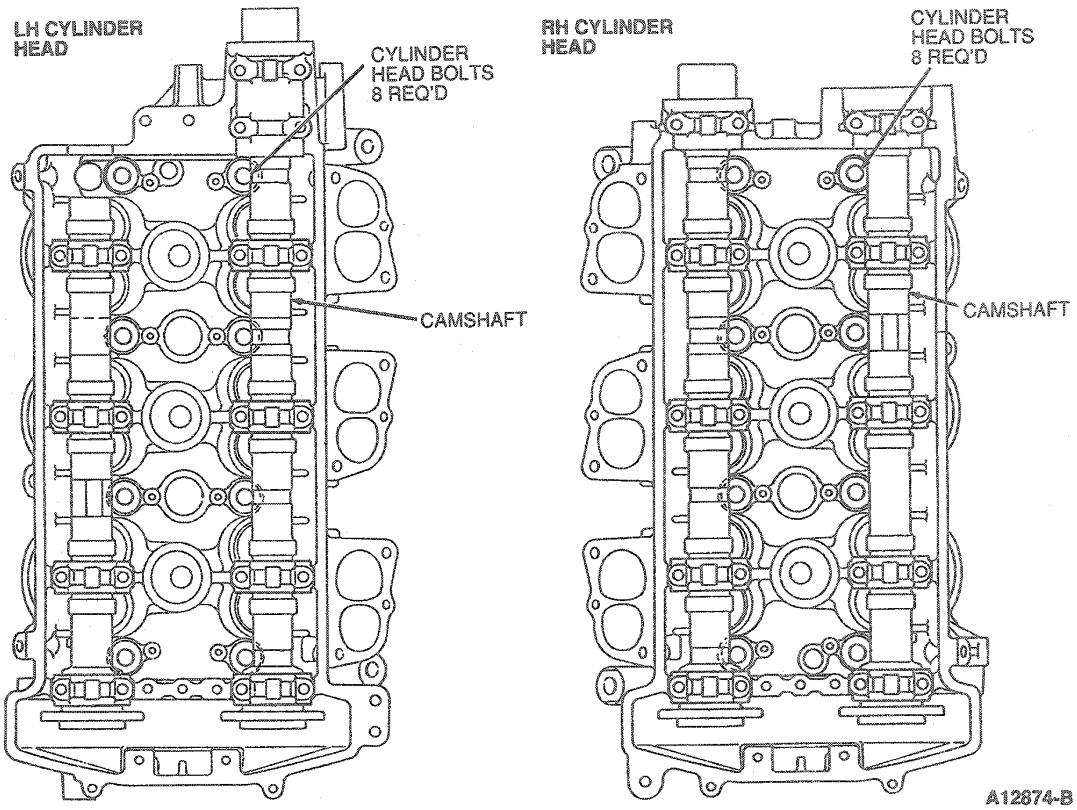
15. Remove center cover assembly.
16. Remove timing belt. Note location of "KOA" (or "KOB" on 3.2L SHO) on timing belt. The belt must be installed in the same direction.



17. Remove cylinder head covers as outlined.
18. Remove camshaft timing pulleys.
19. Remove upper rear and center rear timing belt covers.
20. If LH cylinder head is being removed, remove the ICM coil bracket and oil dipstick tube. If RH cylinder head is being removed, remove coolant outlet hose.
21. Remove exhaust manifold (9431) on LH cylinder head. On RH cylinder head the exhaust manifold (9430) must be removed with the head.
22. Remove eight cylinder head to block retaining bolts.

REMOVAL AND INSTALLATION (Continued)

23. Remove cylinder head assembly.



Installation

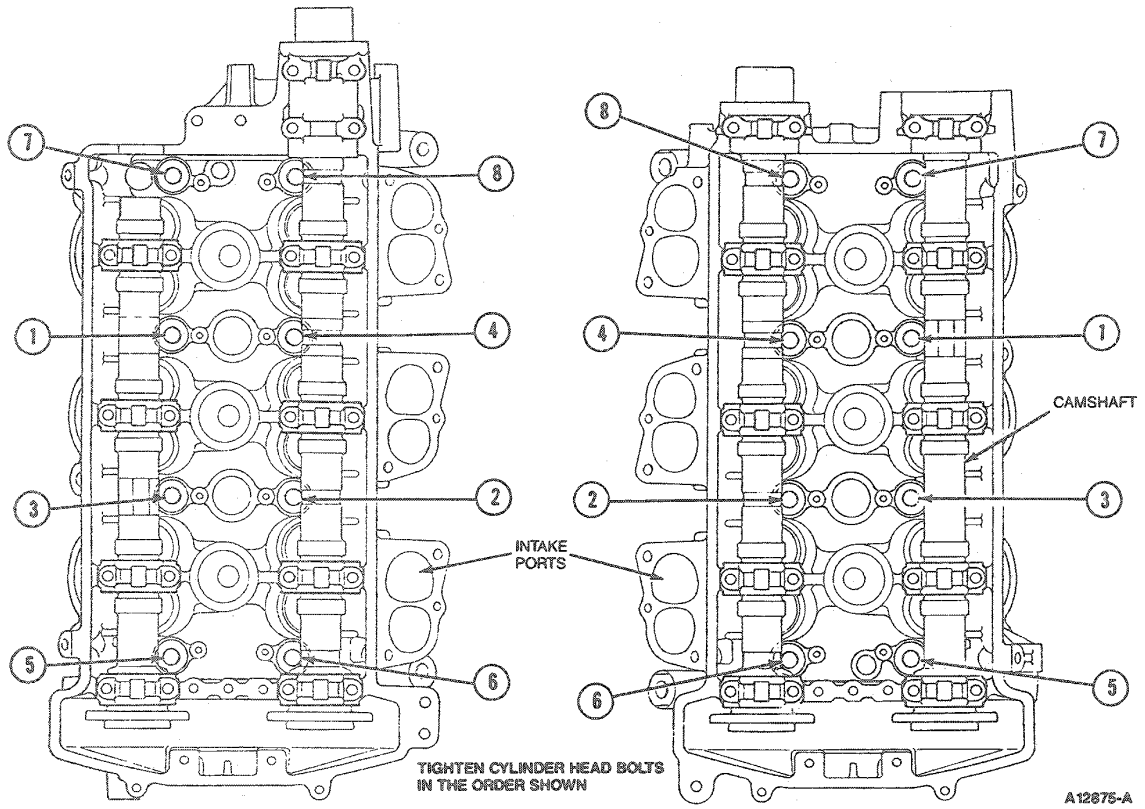
NOTE: Lightly oil all bolt and stud bolt threads before installation except those specifying special sealant.

1. Remove any foreign materials or oil from top of cylinder block and lower surface of cylinder head.

   NOTE: Replace dowels if damaged.
2. Position gasket and cylinder head on cylinder block, align with dowel pins.
3. Install cylinder head bolts and tighten in two steps, in the following sequence:
   - 49-69 N·m (36-51 lb-ft).
   - 83-93 N·m (62-69 lb-ft).
4. If LH cylinder head is being installed, exhaust manifold, ignition control module (ICM) 12A297 coil bracket and oil dipstick tube. On RH cylinder head install coolant outlet hose and connect exhaust catalyst.
5. Install upper rear and center rear timing belt covers.
6. Install camshaft timing pulleys in the timed positions.
7. Install cylinder head covers as outlined.
8. Install timing belt and adjust as outlined.
9. Install center timing belt cover.
10. Connect crankshaft position (CKP) 12A127 sensor wiring assembly.
11. Install lower timing belt cover.
12. Raise vehicle on a hoist. Refer to Section 00-02.
13. Install inner fender splash shield and RH wheel and tire assembly. Tighten wheel lug nuts to 115-142 N·m (85-105 lb-ft).
14. Install LH idler pulley and bracket.
15. Install upper timing belt cover.
16. Install accessory drive belts. Refer to Section 03-05.
17. Install intake manifold as outlined.
18. Install air cleaner outlet tube.
19. Connect battery ground cable.
20. Fill engine cooling system.

REMOVAL AND INSTALLATION (Continued)

21. Start engine and check for coolant, fuel or oil leaks.



Pistons and Connecting Rods

Tools Required:

- Rotunda Piston Ring Compressor 014-00290
- Rotunda Cylinder Ridge Reamer 014-00292

Removal

1. Drain engine cooling system.
2. Remove intake manifold as outlined.
3. Remove spark plugs, plug wires and ignition coil bracket.
4. Remove exhaust manifolds manifolds.
5. Remove cylinder heads as outlined.
6. Remove oil pan and oil baffle.
7. Remove oil pump assembly as outlined.
8. Before removing piston, inspect the top of each cylinder bore. If a ridge has formed at the top of the cylinder it must be removed before piston removal. Remove ridge as follows:
   a. Turn crankshaft until the piston to be removed is at the bottom of cylinder bore.
   b. Place a clean shop cloth over the piston head to collect cuttings.
   c. Remove ridge using Rotunda Cylinder Ridge Reamer 014-00292 or equivalent. Never cut into the ring travel area more than 0.794mm (1/32 inch) when removing the ridge.
9. Turn crankshaft until the piston to be removed is at the high point of its travel. If more than one piston is being removed, identify the pistons and connecting rod caps. Each component should be installed in its original position during assembly.
10. Remove connecting rod cap retaining nuts and cap.
11. Install spark plug boots over connecting rod cap studs and push piston out through top of the cylinder bore. Use care to prevent damage to bearing surfaces.
12. Install connecting rod cap and hold in position with cap retaining nuts.
13. If piston is to be disassembled, refer to Piston Disassembly.

REMOVAL AND INSTALLATION (Continued)

14. Inspect cylinder bore. If new piston rings are to be installed on the piston, a visible cross-hatch pattern should be obvious on cylinder bore wall.

    If honing is required, remove glaze from cylinder wall using spring-loaded hone. Follow manufacturer's instructions when using this type of equipment.

    After honing, thoroughly clean cylinder bore using a detergent and water solution.

Installation

Lightly oil all retaining bolt and stud threads before installation except those specifying special sealant.

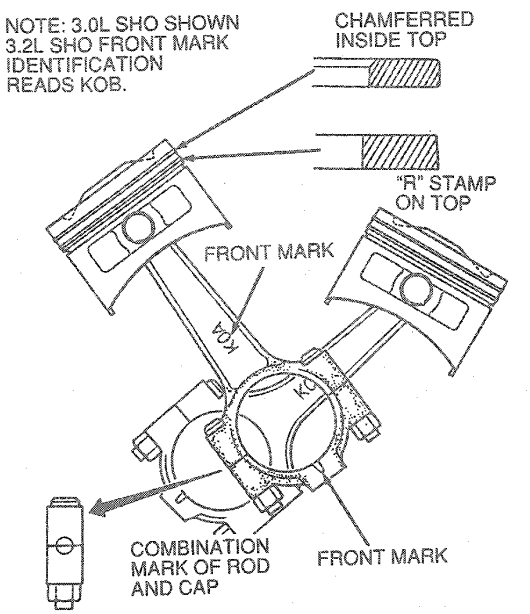
1. Lubricate cylinder wall and piston with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.
2. Install spark plug boots or equivalent protection on the connecting rod studs.

   CAUTION: As piston is tapped into bore with a hammer handle, guide connecting rod into crankshaft journal to avoid damage to bearing surfaces.

   CAUTION: Install the pistons in the same cylinders from which they were removed or to which they were fitted. If a connecting rod is transposed from one block or cylinder to another, new bearings should be fitted.

   NOTE: Connecting rod and cap are not identified to cylinder position.
3. Install piston with connecting rod using Rotunda Piston Ring Compressor 014-00290 or equivalent.

   Ensure notch in piston dome faces the front of engine and machine locating boss is facing RH side of engine.



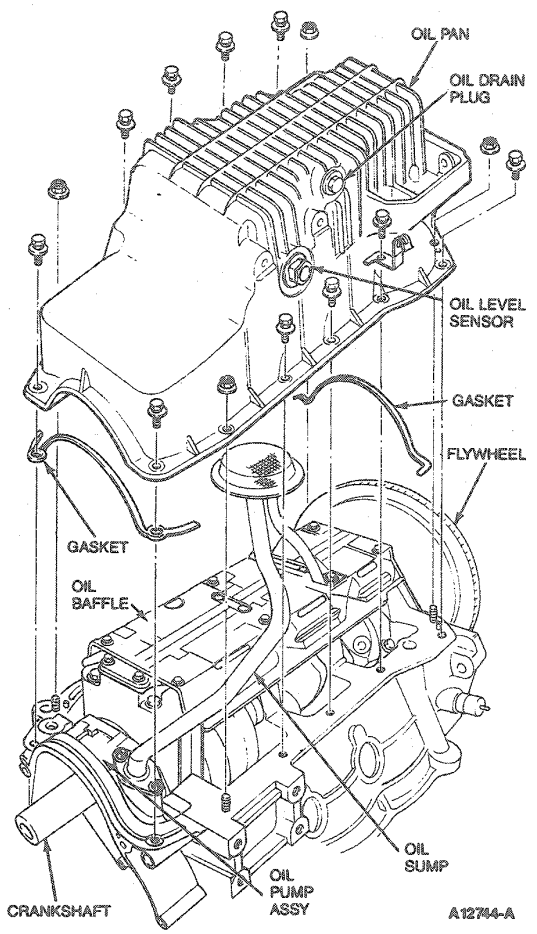
4. Check connecting rod bearing clearance. Refer to Section 03-00.
5. Lubricate bearing surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.
6. Ensure connecting rod is seated on crankshaft journal. Install connecting rod cap. Tighten the retaining nuts in two steps: 30-35 N·m (22-26 lb-ft) 45-50 N·m (33-37 lb-ft).
7. If necessary, check connecting rod side clearance. Refer to Specifications.
8. Install oil pump as outlined.
9. Install upper oil baffle. Tighten bolts to 15-23 N·m (11-17 lb-ft).
10. Install oil pan.
11. Install exhaust manifolds.
12. Install cylinder heads as outlined.
13. Install intake manifold.
14. Install cylinder head cover as outlined.
15. Install coil bracket, plug wires and spark plugs.
16. Fill crankcase with correct viscosity and amount of engine oil.
17. Fill cooling system with specified coolant.
18. Start engine and check for oil, exhaust and coolant leaks.
19. Check, and if necessary, adjust transaxle throttle linkage and speed control.

REMOVAL AND INSTALLATION (Continued)

Oil Pan and Oil Pump

Removal

1. Disconnect battery ground cable.
2. Remove oil level dipstick.
3. Remove accessory drive belts. Refer to Section 03-05.
4. Remove timing belt as outlined.
5. Raise vehicle on hoist. Refer to Section 00-02.
6. If equipped with a low oil level sensor, remove retainer clip at sensor. Remove electrical connector from sensor.
7. Drain crankcase.
8. Remove starter motor. Refer to Section 03-06.
9. Disconnect HO2S's.
10. Remove catalyst and pipe assembly. Refer to Section 09-00.
11. Remove lower engine/flywheel dust cover from converter housing.
12. Remove oil pan retaining bolts. Remove oil pan.
13. Remove oil pan gasket.
14. Remove crankshaft timing belt pulley as outlined.
15. Remove sump to oil pump retaining bolts.
16. Remove oil pump to block retaining bolts and remove pump.



Installation

1. Clean gasket surfaces on the cylinder block and oil pan.
2. Align oil pump on crankshaft and install oil pump retaining bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).
3. Install oil sump to oil pump retaining bolts. Tighten bolts to 7-11 N·m (62-97 lb-in).
4. Install crankshaft timing belt pulley as outlined.

   NOTE: When using silicone rubber sealer, assembly should occur within 15 minutes after sealer application. After this time, the sealer may start to set-up, and its sealing effectiveness may be reduced.
5. Locate oil pan gasket to oil pan with bend against pan surface and secure with Gasket and Trim Adhesive D7AZ-19B508-B (ESR-M11P17-A and ESE-M2G52-A) or equivalent.
6. Position oil pan.
7. Install oil pan. Tighten retaining bolts to 15-23 N·m (11-17 lb-ft).

REMOVAL AND INSTALLATION (Continued)

8. Install lower engine/flywheel dust cover to the converter housing.
9. Install catalyst and pipe assembly. Connect HO2S's.
10. Install starter motor. Refer to Section 03-06.
11. Install low oil level sensor connector to the sensor and install retainer clip.
12. Lower vehicle.
13. Install accessory drive belts. Refer to Section 03-05.
14. Replace oil level dipstick.
15. Connect battery ground cable.
16. Fill crankcase with the correct viscosity and amount of engine oil.
17. Start engine and check for engine oil and exhaust leaks.

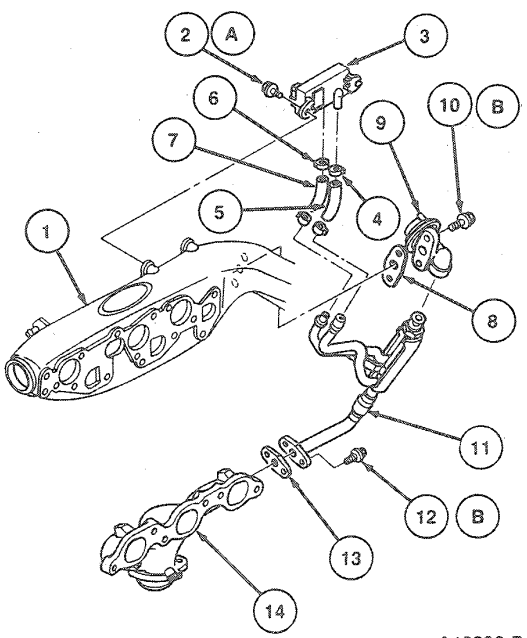
Sensors

Removal

Unless otherwise noted, all sensors are removed by disconnecting wiring connector and unscrewing sensor. Refer to Section 18-01 for electrical connector disengagement.

Differential Pressure Feedback EGR (DPFE) 3.2L SHO Only

Located in the rear of the intake manifold. When installing, tighten to 15-23 N·m (11-17 lb-ft). Sensor is retained by two screws to intake manifold. When installing, tighten to 2-3 N·m (18-27 lb-in).



A12896-B

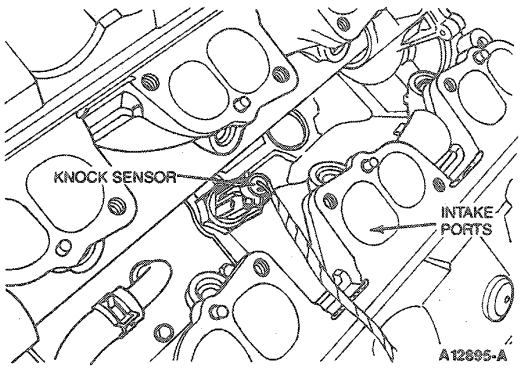
Item	Part Number	Description
1	9424	Upper Intake Manifold
2A	—	Screw (2 Req'd)
3	9J433	EGR Transducer
4	—	Clamp (2 Req'd)
5	—	Hose
6	—	Clamp (2 Req'd)
7	—	Hose
8	9D476	EGR Valve Gasket
9	9D475	EGR Valve
10A	90119-08151	Bolt (2 Req'd)
11	9D477	EGR Valve to Exhaust Manifold Tube
12A	90119-08146	Bolt (2 Req'd)
13	9F470	EGR Cooler Tube Inlet Gasket
14	9430	Exhaust Manifold
A		Tighten to 2-3 N·m (18-27 Lb-In)
B		Tighten to 15-23 N·m (11-17 Lb-Ft)

Engine Coolant Temperature (ECT) Sensor 12A648

Located at the rear of the intake manifold to the rear of the throttle body. When installing, tighten to 16-24 N·m (12-17 lb-ft).

Knock Sensor (KS) 12A699

Located under the intake manifold and fuel rails. When installing, tighten to 29-39 N·m (21-29 lb-ft).



Oil Level Sensor

Located in the oil pan. When installing, tighten to 21-33 N·m (15-24 lb-ft).

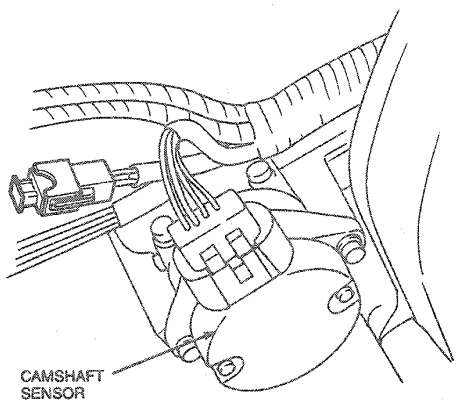
Oil Pressure Sending Switch

Located in the right rear face of cylinder block. When installing, tighten to 16-24 N·m (12-18 lb-ft).

REMOVAL AND INSTALLATION (Continued)

Camshaft Sensor

Located on the RH side of vehicle on end of camshaft No. 1. When installing, tighten to 7-11 N·m (62-97 lb-in).



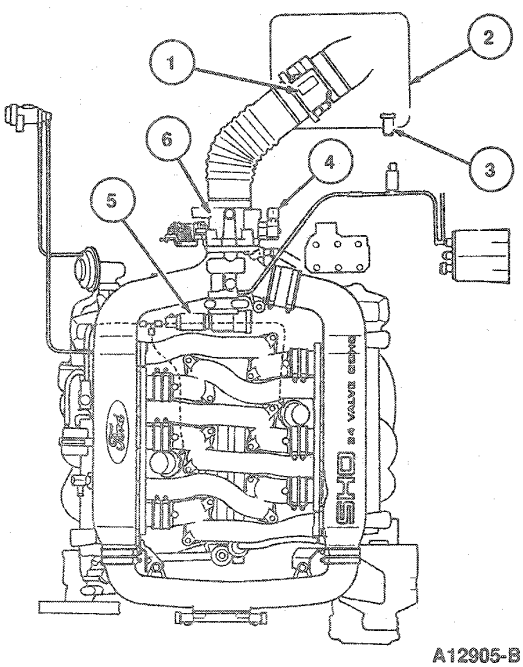
A12697-A

Crankshaft Position Sensor (CKP) 12A127

Located on the front of the engine block just above the crankshaft. When installing, tighten to 1.5-2.5 N·m (13-22 lb-in).

Throttle Position (TP) Sensor

Located on the throttle body. When installing, tighten to 2-3 N·m (18-27 lb-in).



A12905-B

Item	Part Number	Description
1	12B579	MAF Sensor
2	9600	Engine Air Cleaner
3	12A697	Intake Air Temperature (IAT) Sensor
4	9B989	Throttle Position Sensor
5	9F715	Idle Air Control Valve
6	9E926	Throttle Body

Exhaust Manifold, LH

Removal

1. Remove oil level indicator tube support bracket.
2. Remove power steering pump pressure and return hoses.
3. Remove manifold to exhaust pipe retaining nuts.
4. Remove heat shield retaining bolts.
5. Remove exhaust manifold retaining nuts and exhaust manifold.

Installation

NOTE: Lightly oil all bolt and stud threads before installation.

1. Clean mating surfaces on the exhaust manifold, cylinder head and exhaust pipe.
2. Position exhaust manifold on the cylinder head and install manifold retaining nuts. Tighten to 35-52 N·m (26-38 lb-ft).
3. Install heat shield retaining bolts. Tighten to 15-23 N·m (11-17 lb-ft).
4. Connect exhaust pipe to the exhaust manifold. Tighten the retaining nuts to 21-32 N·m (15-24 lb-ft).
5. Connect power steering pump pressure and return hoses.
6. Install oil level indicator tube support bracket.

Exhaust Manifold, RH

Removal

1. Remove RH cylinder head as outlined.
2. Remove heat shield retaining bolts.
3. Remove exhaust manifold retaining nuts and exhaust manifold.

Installation

NOTE: Lightly oil all bolt and stud threads before installation.

1. Clean mating surfaces on the exhaust manifold and install manifold retaining nuts. Tighten to 35-52 N·m (26-38 lb-ft).

REMOVAL AND INSTALLATION (Continued)

2. Position exhaust manifold on the cylinder head and install manifold retaining nuts. Tighten to 35-52 N·m (26-38 lb-ft).
3. Install heat shield retaining bolts. Tighten to 15-23 N·m (11-17 lb-ft).
4. Install RH cylinder head as outlined.
5. Start engine and check for exhaust and coolant leaks.

Main Bearing Inserts

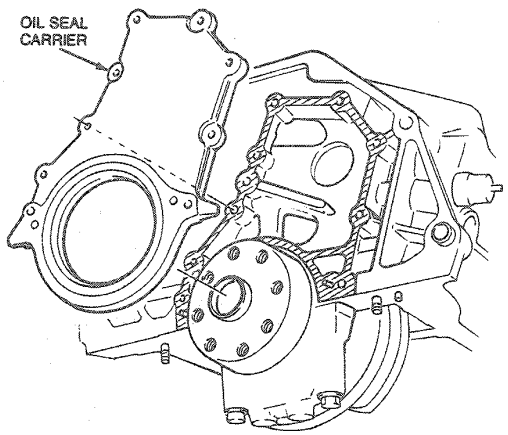
The main bearing inserts are precision selective fit. To check the bearing clearances, or to select fit a new bearing, refer to Specifications.

Tools Required:

- Flywheel Holding Tool T74P-6375-A
- Locknut Pin Remover T78P-3504-N
- Rear Crankshaft Seal Replacer T81P-6701-A
- Clutch Aligner T81P-7550-A
- Rear Crankshaft Seal Replacer T88C-6701-BH
- Rear Seal Replacer Screw Set T89P-6701-C
- Rotunda Dial Indicator with Bracketry 014-00282

Removal

1. Disconnect battery ground cable.
2. Raise vehicle on hoist. Refer to Section 00-02.
3. Remove subframe. Refer to Section 02-01.
4. Remove transaxle. Refer to Section 07-03.
5. Remove clutch cover, disc and flywheel.
6. Remove oil pan as outlined.
7. Remove oil baffle plate and oil pick-up tube.
8. Remove oil seal carrier.

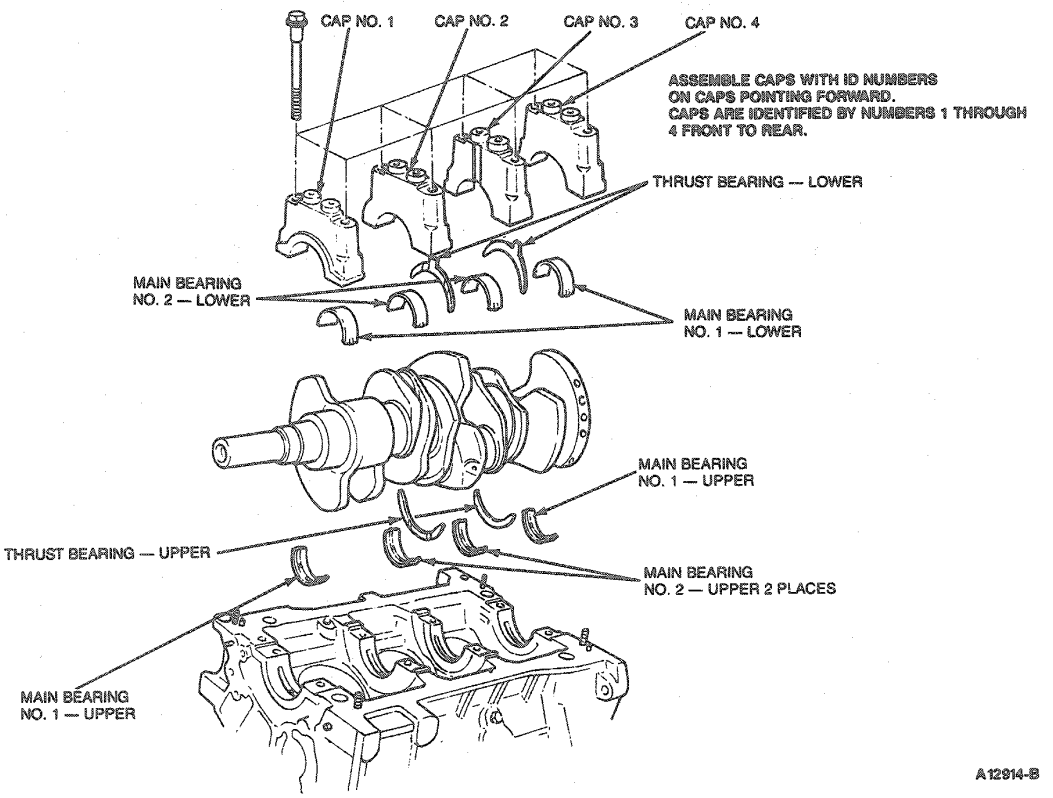


A12913-A

9. Remove oil pump as outlined.
10. Remove main bearing support beam.
11. Remove connecting rod cap nuts.
12. Remove connecting rod bearing caps and note position for assembly.
13. Loosen main bearing cap bolts. Note numerical order and that numbers on caps point forward. Loosen uniformly from innermost bearing outward.

REMOVAL AND INSTALLATION (Continued)

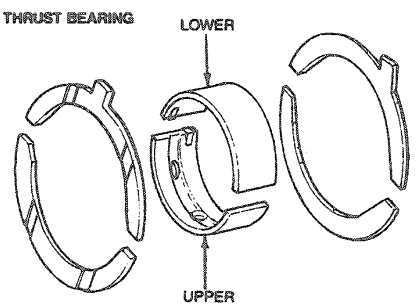
14. Remove all but one bearing cap. With an assistant, support crankshaft and remove remaining bearing cap. Lower crankshaft from engine.



Installation

1. Inspect bearing journals and bearing faces for any damage prior to assembly.
2. Press bearing upper halves into block. Ensure they seat completely.
3. Lubricate bearing surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Install bearings into lower main caps.
4. With an assistant, position crankshaft in block and loosely install No. 1 and 4 bearings caps. Note numbers point forward.

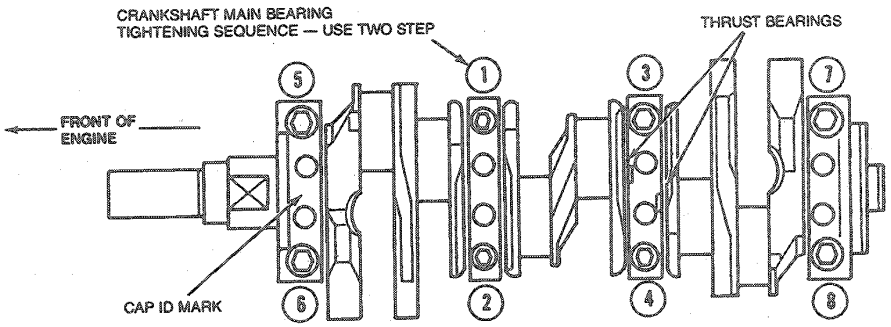
   CAUTION: Oil groove on thrust bearing must face crankshaft.
5. Install upper thrust bearings on the front and rear of the No. 3 journal by moving crankshaft back and forth.



6. Install lower thrust bearings with No. 3 main cap.
7. Install No. 2 main cap.

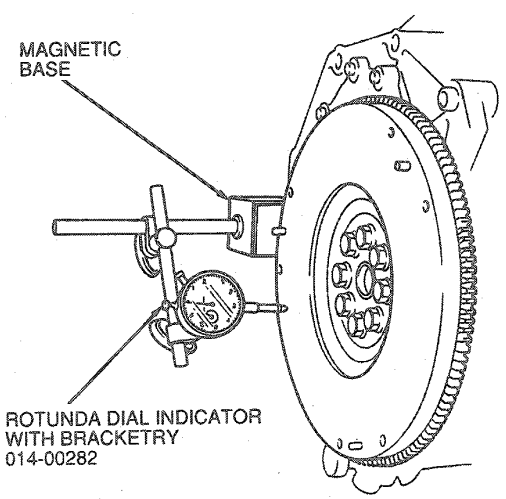
REMOVAL AND INSTALLATION (Continued)

8. Apply a coat of Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent to bearing cap bolts and tighten in sequence shown. Use two-step method. Tighten to 46-69 N·m (34-51 lb-ft), then, tighten to 78-88 N·m (58-65 lb-ft).



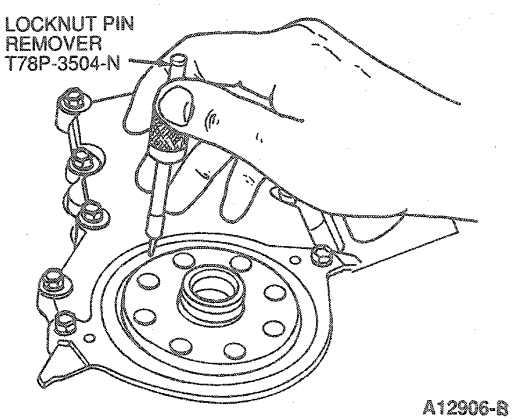
A12920-A

9. Ensure that the crank turns freely. Use caution so as not to contact or jam connecting rods against engine block.
10. With Rotunda Dial Indicator with Bracketry 014-00282 or equivalent, check crankshaft end play: 0.021-0.221mm (0.0008-0.0087 inch). If out of specification, determine if caused by excessive wear on crankshaft, block or both and replace as necessary.



MEASURING CRANKSHAFT ENDPLAY A12916-D

11. Install connecting rods and caps to crankshaft. Tighten retaining bolts using two step method. Tighten to 30-35 N·m (22-26 lb-ft), then to 45-50 N·m (33-37 lb-ft).
12. Install main bearing support beam. Tighten retaining bolts to 21-32 N·m (15-24 lb-ft).
13. Install oil seal carrier with new gasket. Tighten retaining bolts to 6.3-9.4 N·m (56-83 lb-in).
14. Install oil pump with new gasket. Tighten bolts to 15-23 N·m (11-17 lb-ft).
15. Replace front crankshaft oil seal as outlined.
16. Remove rear crankshaft oil seal using Locknut Pin Remover T78P-3504-N or equivalent. Install new rear crankshaft seal with Rear Crankshaft Seal Replacer T81P-6701-A and T88C-6701-BH, with Rear Seal Replacer Screw Set T89P-6701-C or equivalent.



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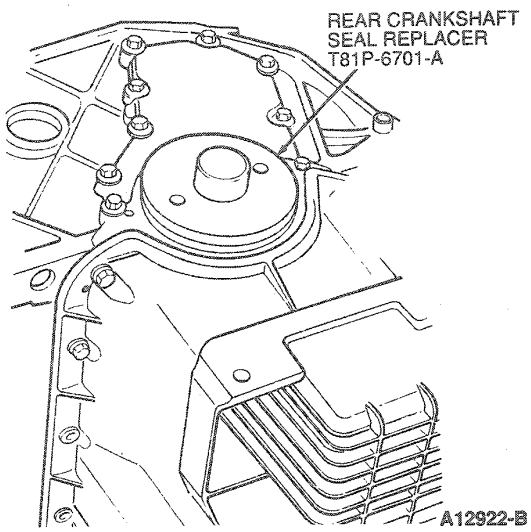
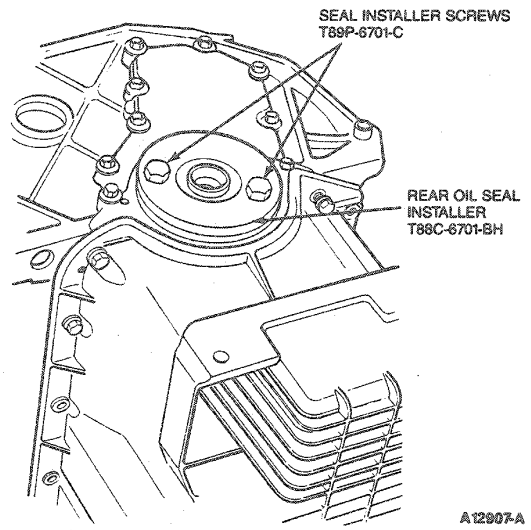
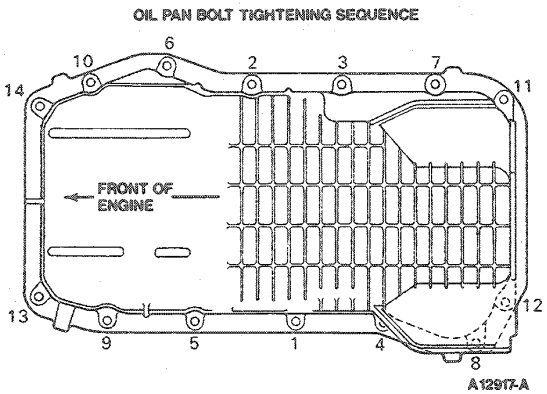
REMOVAL AND INSTALLATION (Continued)



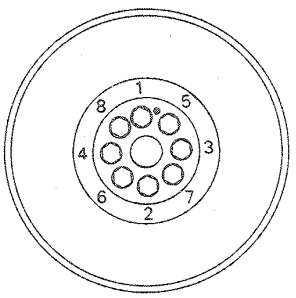


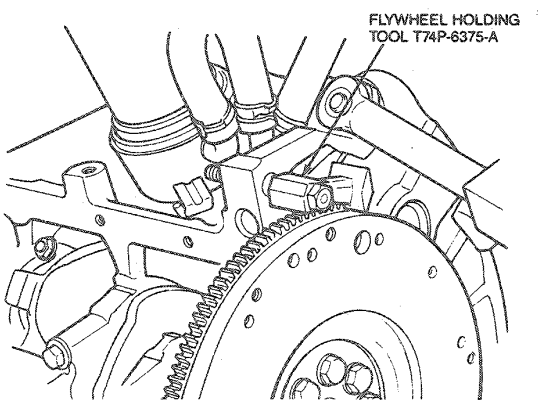
17. Install oil pickup tube with new gasket. Tighten bolts to 7.1-11 N·m (62-97 lb-in). Tighten nuts to 21-32 N·m (15-24 lb-ft).
18. Clean oil pan sealing surfaces. Apply a 5mm (0.2-inch) continuous bead of Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent to oil pan sealing surface.
19. Install new oil pan end gaskets and install oil pan.
20. Tighten oil pan bolts to 15-23 N·m (11-17 lb-ft) in sequence.



21. Install flywheel. Tighten retaining bolts in sequence, in several phases. Tighten to 39-50 N·m (29-39 lb-ft) at first. Then, tighten to 69-78 N·m (51-58 lb-ft) for final torque.

    Use Flywheel Holding Tool T74P-6375-A or equivalent to hold flywheel.





22. Align clutch disc with Clutch Aligner T81P-7550-A or equivalent and install pressure plate and cover assembly. Tighten retaining bolts to 16-33 N·m (12-24 lb-ft).
23. Install transaxle. Refer to Section 07-03.
24. Install subframe. Refer to Section 02-01.

REMOVAL AND INSTALLATION (Continued)

25. Lower vehicle.
26. Fill engine with correct viscosity and amount of engine oil. Connect battery ground cable.

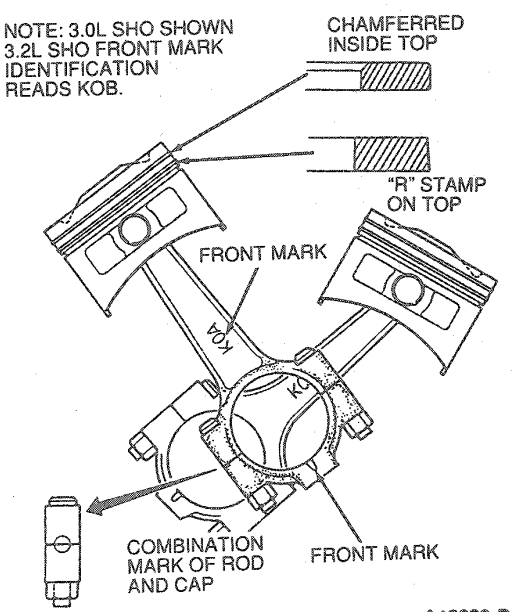
Connecting Rod Bearings

Removal

1. Disconnect battery ground cable.
2. Raise vehicle on hoist. Refer to Section 00-02.
3. Remove oil pan as outlined.
4. Remove connecting rod cap nuts and rod bearing caps. Note order in which they were removed for installation.
5. Remove rod bearings.

Installation

1. Coat new bearing with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent, and install shell halves in connecting rod and bearing caps.
2. Install bearing caps to connecting rod. Ensure combination marks are correct. Install caps in order they were removed.



3. Install connecting rod cap nuts. Tighten nuts using two step method. Tighten to 30-35 N·m (22-26 lb-ft), then to 45-50 N·m (33-37 lb-ft).
4. Install oil pan as outlined.

5. Lower vehicle.
6. Fill engine with correct viscosity and amount of engine oil. Connect battery ground cable.

Camshaft

Tools Required:

- Cam Seal Replacer T89P-6256-A
- Cam Seal Expander T89P-6256-B
- Cam Position Tool T89P-6256-C

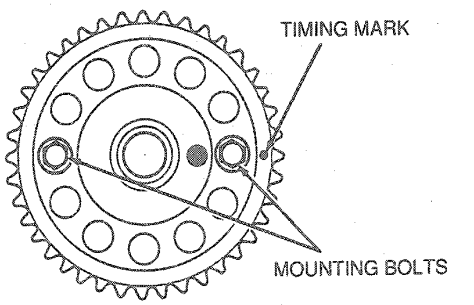
Removal

1. Set engine to TDC on No. 1 cylinder.
2. Remove intake manifold assembly as outlined.
3. Remove timing belt and cover as outlined.
4. Remove cylinder head cover(s).
5. Remove camshaft pulley(s). Note location of dowel pin(s).
6. Remove upper rear timing belt cover.

   CAUTION: If camshaft bearing caps are not uniformly loosened, camshaft damage may result.
7. Uniformly loosen camshaft bearing caps.
8. Remove bearing caps. Note position for installation.
9. Remove camshaft chain tensioner mounting bolts.
10. Remove camshafts together with chain and tensioner.
11. Discard camshaft oil seal.
12. Remove chain sprocket from camshaft.

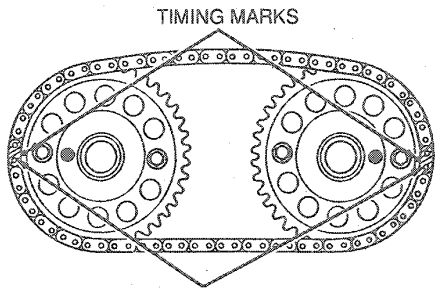
Installation

1. Align timing marks on chain sprocket(s) with camshaft and install sprocket(s). Tighten retaining bolts to 14-18 N·m (10-13 lb-ft).



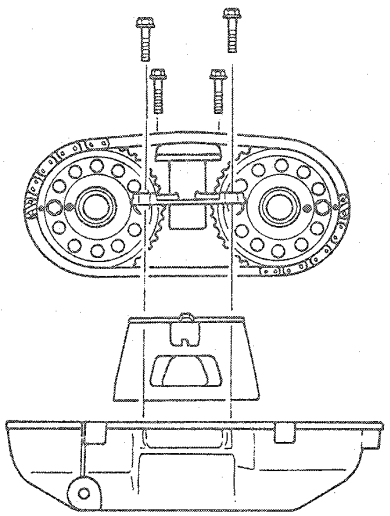
REMOVAL AND INSTALLATION (Continued)

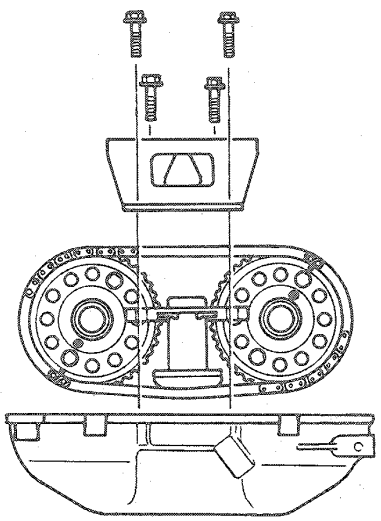
2. Install chain over camshaft sprockets. Align white painted link with timing mark on sprocket.



CAUTION: LH and RH chain tensioners are not interchangeable.

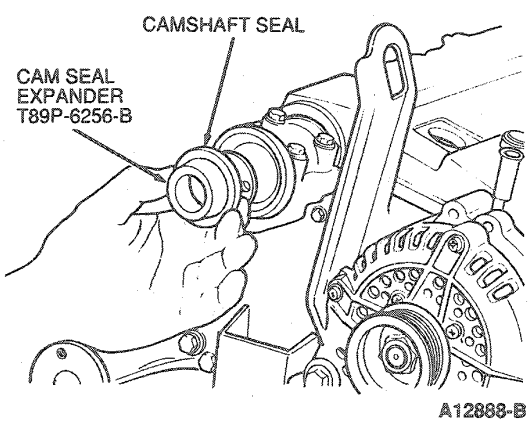
3. Rotate camshafts approximately 60 degrees counterclockwise. Set chain tensioner between sprockets and position camshafts on cylinder head.



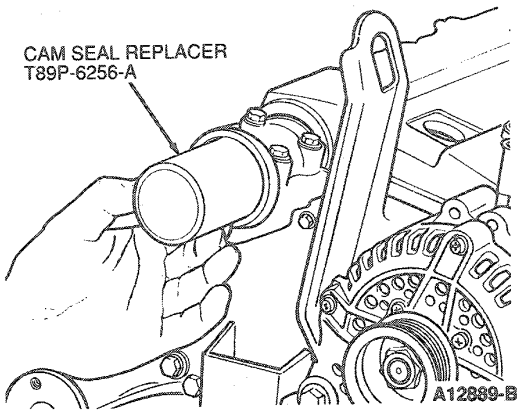


NOTE: Arrows on bearing caps point to front of engine when installed.

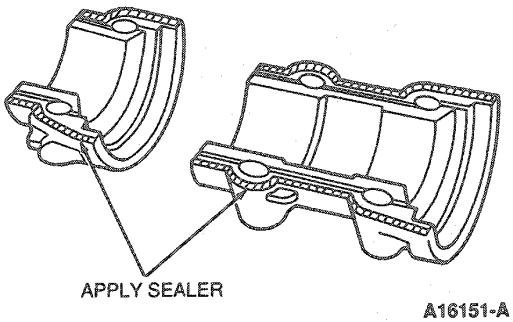
4. Apply a thin coat of Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent to camshaft journals and install bearing caps 2 through 5. Loosely install bearing retaining bolts. Install bearing caps in their original location.
5. Apply Silicone Sealer F1AZ-19562-A (WSE-M4G320-A2) or equivalent to outer diameter of new camshaft seal and seal seating area on cylinder head.
6. Install camshaft seal with Cam Seal Expander T89P-6256-B and Cam Seal Replacer T89P-6256-A.



REMOVAL AND INSTALLATION (Continued)



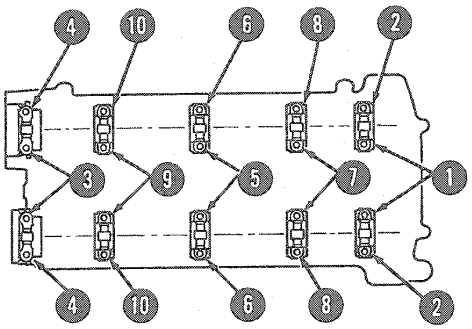
7. Apply a 2.5mm (0.10 inch) bead of Silicone Sealer F1AZ-19568-A (WSE-M4G320-A2) or equivalent to No. 1 bearing cap and install bearing cap while holding cam seal in place with Cam Seal Replacer T89P-6256-A. Loosely install bolts.



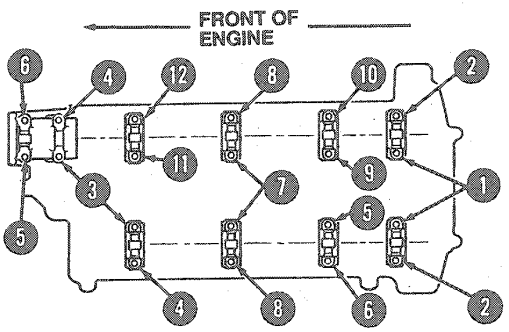
CAUTION: The No. 5 bearing caps function as thrust bearings for the camshaft. Always tighten No. 5 bearing caps first.

NOTE: For LH camshaft installation, apply pressure to chain tensioner to avoid damage to bearing caps.

8. Tighten bearing caps in sequence using two step method. Tighten to 8-12 N·m (71-106 lb-in) then tighten to 16-22 N·m (12-16 lb-ft).



CAMSHAFT BEARING TIGHTENING SEQUENCE RH CYLINDER HEAD



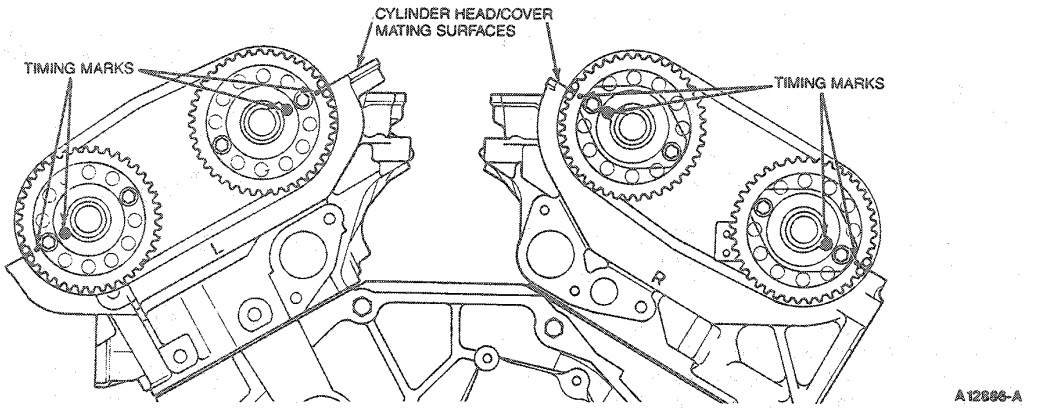
CAMSHAFT BEARING TIGHTENING SEQUENCE LH CYLINDER HEAD A12887-B

CAUTION: LH and RH chain tensioners are different. Be sure to install chain tensioners on the proper side.

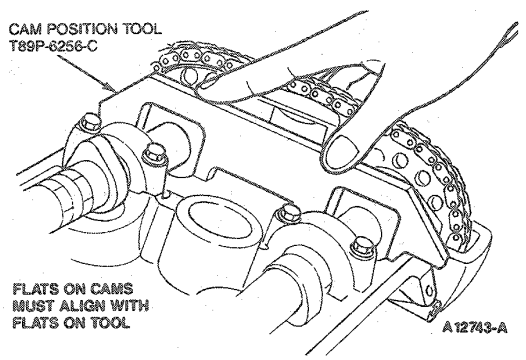
9. Position chain guide and chain tensioner and install retaining bolts. Tighten bolts to 15-19 N·m (11-14 lb-ft).

REMOVAL AND INSTALLATION (Continued)

10. Rotate camshafts 60 degrees clockwise and check for proper alignment of timing marks. Marks on camshaft sprockets should align with cylinder head cover mating surface as shown.



11. Set Cam Position Tool T89P-6256-C on camshafts to ensure correct positioning. Flats on tool should align with flats on camshaft. If tool does not fit and/or timing marks will not line up, repeat procedure from Step 1.



12. Install timing belt rear cover. Tighten bolts to 8.8 N·m (78 lb-in).
13. Install camshaft pulley(s). Tighten bolts to 21-25 N·m (15-18 lb-ft). Ensure proper installation of dowel pin(s).
14. Install timing belt and cover as outlined.
15. Install cylinder head cover(s). Tighten bolts to 9.8-16 N·m (7-12 lb-ft).
16. Install intake manifold assembly as outlined.

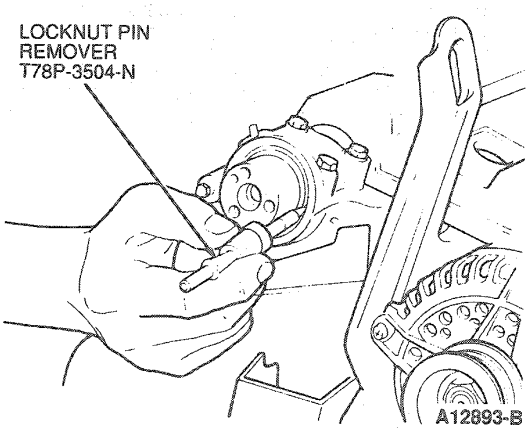
Camshaft Seal(s)

Tools Required:

- Locknut Pin Remover T78P-3504-N
- Cam Seal Replacer T89P-6256-A
- Cam Seal Expander T89P-6256-B

Removal

1. Set engine to TDC on No. 1 Cylinder.
2. Remove timing belt upper cover. Refer to Timing Belt Removal and Installation.
3. Remove timing belt from camshaft pulleys.
4. Remove crankshaft pulley(s). Note location of dowel pin(s).
5. Remove camshaft seal with Locknut Pin Remover T78P-3504-N.

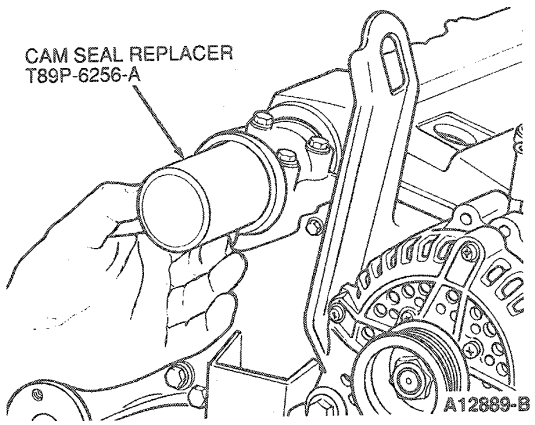


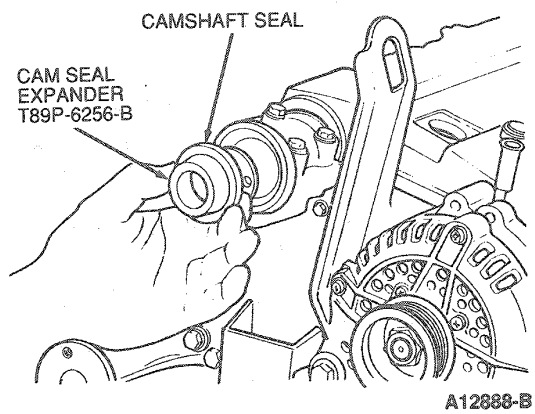
Installation

1. Clean and inspect seal surface area.

REMOVAL AND INSTALLATION (Continued)

2. Apply Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A AND ESE-M4G195-A) or equivalent to seal outer diameter and seal seating surface.
3. Install camshaft seal using Cam Seal Expander T89P-6256-B and Cam Seal Replacer T89P-6256-A.





4. Install camshaft pulley(s). Tighten retaining bolts to 21-25 N·m (15-18 lb-ft). Ensure proper installation of dowel pin(s).
5. Install timing belt and belt cover. Refer to timing belt Removal and Installation as outlined in this section.

DISASSEMBLY AND ASSEMBLY

Engine

NOTE: Reference to the EGR system is for 3.2L SHO engines only.

Tools Required:

- Puller T67L-3600-A
- Rotunda Piston Ring Compressor 014-00290

Disassembly

1. Remove flywheel and rear cover plate.
2. Loosen idler pulley nuts.
3. Turn belt adjusting screws counterclockwise to loosen belts.
4. Remove generator / A / C belt (6 rib) and power steering / water pump belt (4 rib).
5. Remove generator retaining bolts and remove generator.
6. Remove generator bracket.
7. Remove A / C compressor retaining bolts and remove compressor.
8. Remove engine lifting eye retaining bolts and remove lifting eye.
9. Remove A / C compressor bracket.
10. Remove power steering pump retaining bolts and remove power steering pump.
11. Remove power steering pump bracket.
12. Remove retaining bolts from idler pulley brackets and remove.
13. Remove exhaust heat shield retaining bolts and remove heat shield.
14. Disconnect EGR valve to exhaust manifold tube (9D477) from RH exhaust manifold.
15. Remove exhaust manifolds and gaskets.
16. Disconnect electrical connectors and vacuum lines from intake manifold.
17. Disconnect EGR valve to exhaust manifold tube from EGR valve (9D475).
18. Remove intake manifold bracket bolts and remove brackets.
19. Remove 12 bolts retaining intake manifold to cylinder head.
20. Remove intake manifold assembly.
21. Remove upper timing belt cover retaining bolts and remove upper timing belt cover.
22. Remove spark plug connectors and ignition lead.
23. Remove spark plugs.
24. Remove crankshaft damper pulley using Puller T67L-3600-A.
25. Remove lower timing belt cover retaining bolts and remove lower timing belt cover.
26. Remove center timing belt cover retaining bolts and remove center timing belt cover.
27. Loosen timing belt tensioner nut. Using an Allen wrench, rotate tensioner so that tension is released from timing belt, and tighten nut.
28. Remove timing belt.
29. Remove camshaft timing belt pulleys.
30. Remove upper rear timing belt cover retaining bolts and remove cover.
31. Remove center rear timing belt cover retaining bolts and remove cover.

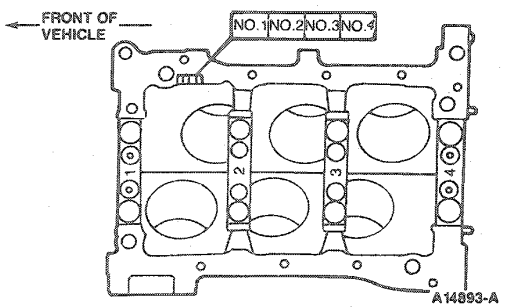
DISASSEMBLY AND ASSEMBLY (Continued)

32. Remove fuel rail retaining bolts and remove fuel rail.
33. Disconnect wiring harness to fuel injectors.
34. Remove six injector insulators from cylinder heads.
35. Remove ignition coil pack retaining screws and remove coil pack.
36. Remove ignition coil pack bracket.
37. Remove water pump retaining bolts and remove water pump.
38. Remove water bypass pipe.
39. Remove water outlet assembly.
40. Remove cylinder head covers and gaskets.
41. Remove oil indicator tube.
42. Disconnect cooler hose from LH head.
43. Remove cylinder head retaining bolts and remove cylinder heads.
44. Disconnect engine oil level sensor.
45. Remove engine oil pan.
46. Remove oil screen assembly.
47. Remove main bearing support beam.
48. Remove oil pump retaining bolts and remove oil pump.
49. Remove oil baffle.
50. Remove connecting rod caps and pistons.
51. Remove crankshaft bearing caps and remove crankshaft.

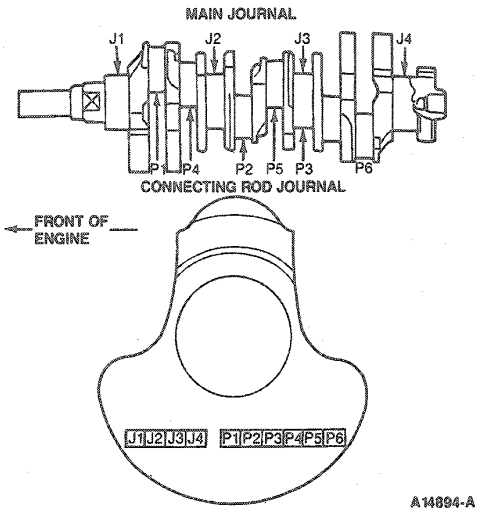
Assembly

NOTE: Check for defects and scratches on main bearing inner face before assembly. Thoroughly clean bearing housings and back face of main bearings. Check all component specifications before installation.

1. Install crankshaft as follows:
   a. Install upper main bearings on cylinder block.

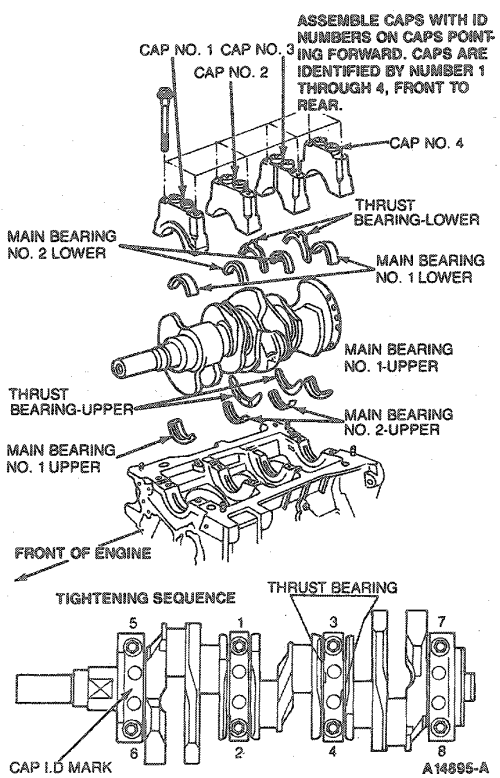


   b. Apply a coat of Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent onto bearings.
   c. Carefully lay crankshaft on bearings.



CAUTION: Make sure oil groove on thrust bearing faces crankshaft.

   d. Install upper thrust bearings on front and rear of No. 3 journal by pushing the crankshaft front and rear.



DISASSEMBLY AND ASSEMBLY (Continued)

NOTE: Install bearing cap 3 with lower thrust bearings and check position front and rear.

e. Lubricate journals of crankshaft with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent and install bearing caps 1 through 4.

f. Apply a coat of Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent to bearing cap bolts and tighten in sequence shown in two steps, first to 46-69 N·m (34-51 lb-ft), then to 78-88 N·m (58-65 lb-ft).

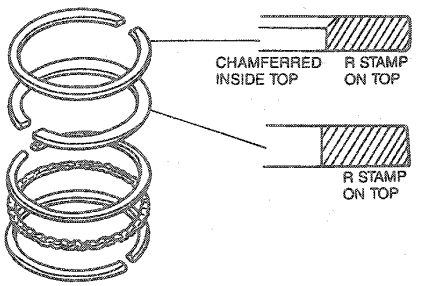
g. Verify the crankshaft can rotate smoothly and end play is within 0.021-0.221mm (0.0008-0.0087 inch). If out of specification, determine if caused by excessive wear on block, crankshaft or both and replace as necessary.

2. Install piston as follows:

a. Install connecting rod bearing to connecting rod and connecting rod cap so the bearing lug can fit in the groove of the connecting rod and rod cap.

b. Apply a light coat of Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent on the piston, piston rings, piston pin, connecting rod bearing and inside the cylinder bore.

c. Position piston ring gaps around the piston so gaps are approximately 120 degrees from each other.



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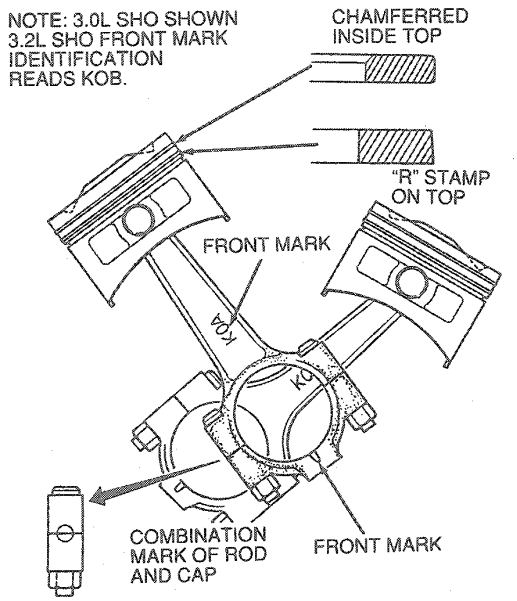
NOTE: Scratching of the crankshaft journal can be prevented by covering the connecting rod bolts with spark plug boots or rubber hose.

d. Install pistons using Rotunda Piston Ring Compressor 014-00290 or equivalent. Ensure the marks on the piston and connecting rod face towards the front of the engine.



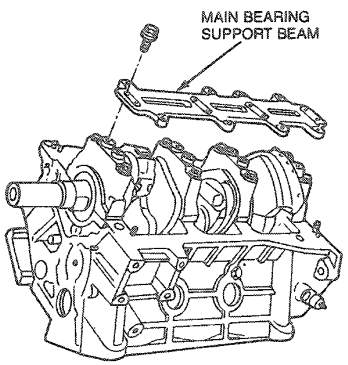
A12883-B

e. Lubricate connecting rod bolts and nuts flange with Premium Long-Life Grease XG-1-C (ESA-M1C75-B) or equivalent. Install connecting rod caps and retaining nuts. Tighten nuts in two steps, 30-35 N·m (22-26 lb-ft), 45-50 N·m (33-37 lb-ft).

3. Install oil baffle retaining bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).

4. Position oil pump and install retaining bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).

5. Install main bearing support beam retaining bolts. Tighten to 21-32 N·m (15-24 lb-ft).



A14887-A

6. Install oil screen retaining bolts. Tighten bolts to 7-11 N·m (62-97 lb-in).

DISASSEMBLY AND ASSEMBLY (Continued)

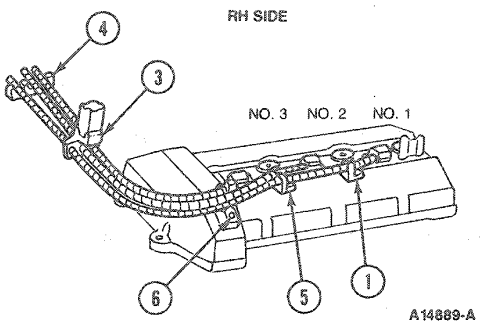
7. Install engine oil pan retaining bolts. Tighten to 15-23 N·m (11-17 lb-ft).
8. Connect engine oil level sensor.
9. Position cylinder heads and gaskets on block and install retaining bolts. Tighten in sequence in two steps:
   - 49-69 N·m (36-51 lb-ft)
   - 83-93 N·m (62-69 lb-ft)
10. Connect cooler hose to LH cylinder head.
11. Install oil indicator tube.
12. Install cylinder head covers and gaskets. Tighten retaining bolts to 9.8-16 N·m (7-12 lb-ft).
13. Install water outlet assembly. Tighten retaining bolts to 15-23 N·m (11-17 lb-ft).
14. Install water bypass pipe.
15. Install water pump retaining bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).
16. Install ignition coil pack bracket retaining bolts. Tighten bolts to 28-42 N·m (21-31 lb-ft).
17. Install ignition coil pack retaining screws. Tighten screws to 4.5-7 N·m (40-62 lb-in).
18. Install six injector insulators in cylinder heads.
19. Install fuel rail assembly retaining bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).
20. Connect wiring harness at fuel injectors.
21. Install center rear timing belt cover.
22. Install upper rear timing belt cover.
23. Install camshaft timing belt pulley retaining bolts. Tighten bolts to 21-25 N·m (15-18 lb-ft).
24. Install timing belt as outlined.
25. Install center timing belt cover.
26. Install lower timing belt cover.
27. Install crankshaft damper pulley.
28. Install spark plugs. Tighten to 22-27 N·m (16-20 lb-ft).
29. Install spark plug connectors and ignition lead.

    NOTE: Ensure connectors are located correctly in clips to prevent improper connection.

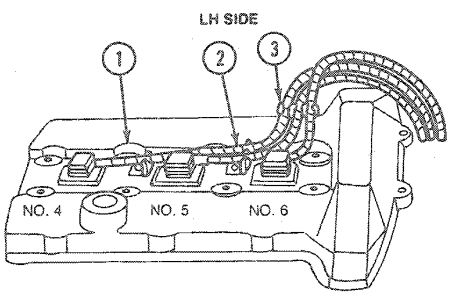
	SHAPE	PART NUMBER/ PART NAME	LOCATION OF INSTALLATION
①		CLAMP, WIRE 1	CYLINDER HEAD COVER
②		CLAMP, WIRE 2	CYLINDER HEAD COVER LH
③		CLAMP, WIRE 3	CYLINDER HEAD COVER RH SURGE TANK RH
④		CLAMP, WIRE 4	
⑤		CLAMP, WIRE 5	CYLINDER HEAD COVER RH
⑥		CLAMP, WIRE 6	CYLINDER HEAD COVER RH

A14891-A

a. Install clamp to cylinder head and wires one through six.
b. Connect plug wires onto spark plug.



A14889-A



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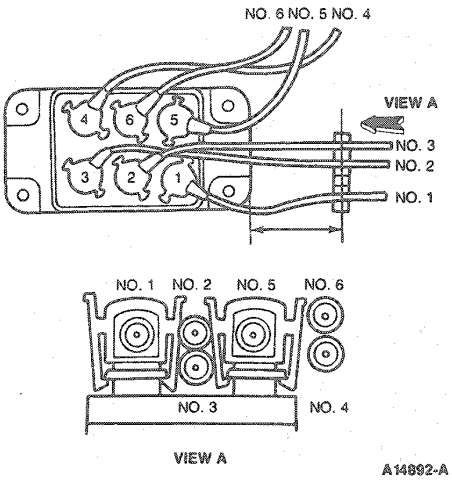
DISASSEMBLY AND ASSEMBLY (Continued)

c. Adjust wire routing.



30. Install upper timing belt cover.
31. Position intake manifold and new gaskets on cylinder heads and install retaining bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).
32. Install intake manifold bracket bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).
33. Connect EGR valve to exhaust manifold tube to EGR valve. Tighten to 25-34 N·m (18-25 lb-ft).
34. Connect electrical connectors and vacuum lines to intake manifold.
35. Install exhaust manifolds and gaskets. Tighten retaining bolts to 35-52 N·m (26-38 lb-ft).
36. Connect EGR valve to exhaust manifold tube to exhaust manifold. Tighten to 15-23 N·m (11-17 lb-ft).
37. Install exhaust heat shield retaining bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).
38. Install idler pulley bracket retaining bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).
39. Install power steering pump bracket retaining bolts. Tighten bolts to 36-55 N·m (27-41 lb-ft).
40. Position power steering pump on bracket and install retaining bolts. Tighten bolts to 20-32 N·m (15-24 lb-ft).
41. Install A/C compressor bracket retaining bolts. Tighten bolts to 36-55 N·m (27-41 lb-ft).
42. Install engine lifting eye retaining bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).
43. Install A/C compressor to bracket retaining bolts. Tighten bolts to 36-55 N·m (27-41 lb-ft).
44. Install generator bracket retaining bolts. Tighten bolts to 36-55 N·m (27-41 lb-ft).
45. Install generator retaining bolts. Tighten bolts to 34-50 N·m (25-37 lb-ft).
46. Install accessory drive belts. Refer to Section 03-05.
47. Install rear cover plate and flywheel. Tighten flywheel retaining bolts in two steps: 39-50 N·m (29-39 lb-ft) 69-78 N·m (51-58 lb-ft).

Subassemblies

Pistons and Connecting Rods

Tools Required:

- Piston Pin Remover/Replacer Base T68P-6135-A1
- Piston Pin Remover/Replacer Sleeve T71P-6135-P1
- Feeler Gauge D81L-4201-A
- Piston Pin Remover and Replacer Driver and Locator D89L-6135-A

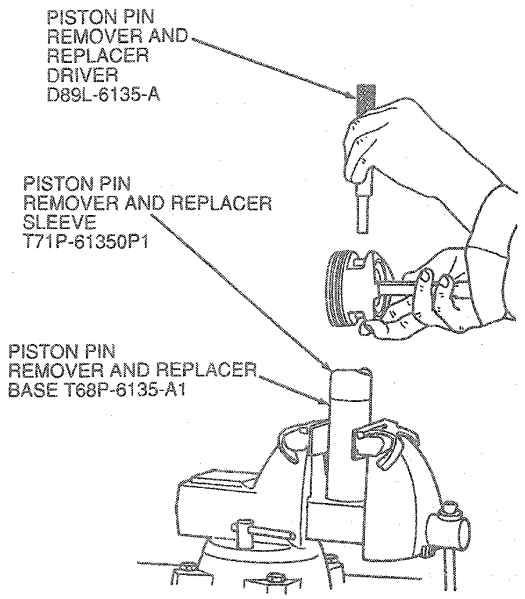
Disassembly

1. Remove bearing inserts from connecting rod and cap.
2. Remove piston rings using a suitable piston ring expander.
3. Mark connecting rod cap to ensure assembly with the same piston and installation in the same cylinders from which they were removed.

DISASSEMBLY AND ASSEMBLY (Continued)

4. Using an arbor press Piston Pin Remover/Replacer Base T68P-6135-A1, Piston Pin Remover/Replacer Sleeve T71P-6135-P1 and Piston Pin Remover and Replacer D89L-6135-A or equivalent drive the piston pin from the piston and connecting rod.

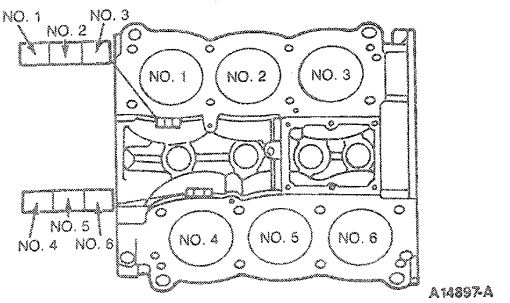
   NOTE: Cylinder number is stamped on top of the piston. Matching letters are stamped in the side of corresponding rod and cap.



Assembly

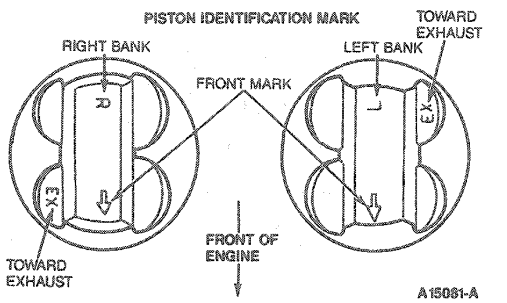
Measure cylinder bore 47mm (1.85 inch) from top face of cylinder block.

Check the new piston diameter which is stamped on the block, and cylinder bore before assembling the piston pin to the connecting rod.



The piston pin bore of a connecting rod and the diameter of the piston pin must be within specification.

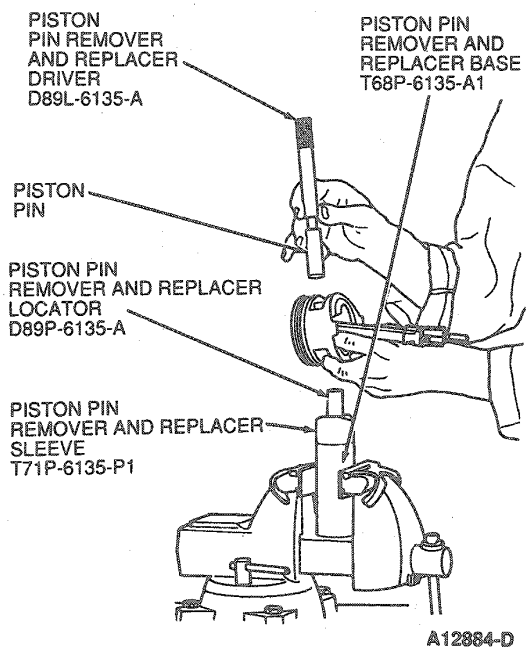
1. Install snap ring onto groove on end of piston pin hole.
2. Apply a light coat of Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent to all parts.
3. Assemble the piston to the connecting rod, putting the notch on the piston dome and the connecting rod on the same side.



4. Start the piston pin in the piston and connecting rod. (This may require a very light tap with a mallet). Using a hammer, Piston Pin Remover/Replacer Base T68P-6135-A1, Piston Pin Remover/Replacer Sleeve T71P-6135-P1 and Piston Pin Remover/Replacer Driver and Locator D89L-6135-A or equivalents, heat the piston top 70-80°C (158-176°F) then press the piston pin into the piston through the connecting rod until centered.

DISASSEMBLY AND ASSEMBLY (Continued)

5. Install the other snap ring in groove of piston pin hole.



6. Install piston rings and check the end gap of all piston rings. Gap must be within specification. Follow the instructions contained on the piston ring package when installing the piston rings.
7. Check the ring side clearance of the compression rings with Feeler Gauge D81L-4201-A or equivalent, by inserting it between the ring and its lower land. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have high steps, the pistons should be replaced.
8. Ensure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

Cylinder Head

Tools Required:

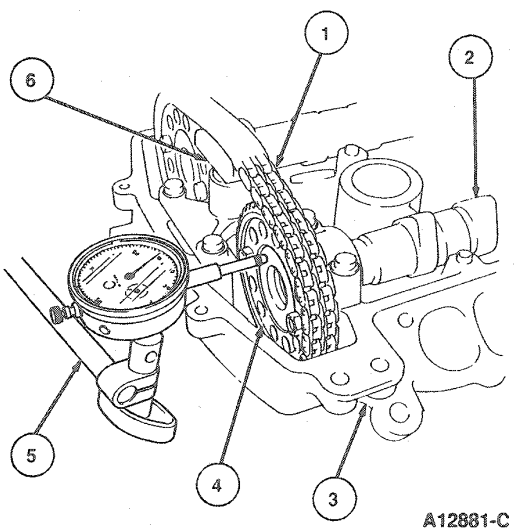
- Impact Slide Hammer T59L-100-B
- Pivot Bar and Stand T87C-6565-A
- Valve Guide Remover/Replacer T89P-6510-A
- Valve Guide Replacer T89P-6510-B
- Valve Stem Seal Replacer T89P-6510-C
- Valve Stem Seal Remover T89P-6510-D
- Valve Spring Compressor Set T89P-6565-A
- Rotunda Dial Indicator with Bracketry 014-00262

Disassembly

1. Disconnect battery ground cable.
2. Drain coolant.
3. Remove intake manifold as outlined.
4. Remove cylinder head covers as outlined.
5. Remove cylinder heads as outlined.
6. Place cylinder head on holding fixture.

   NOTE: Inspect camshaft end play before disassembly. If out of specification, determine if caused by excessive wear on crankshaft, block or both and replace as necessary. Using Rotunda Dial Indicator with Bracketry 014-00282 or equivalent, measure end play while moving camshaft back and forth.

   Maximum play is 0.30mm (0.0118 inch).

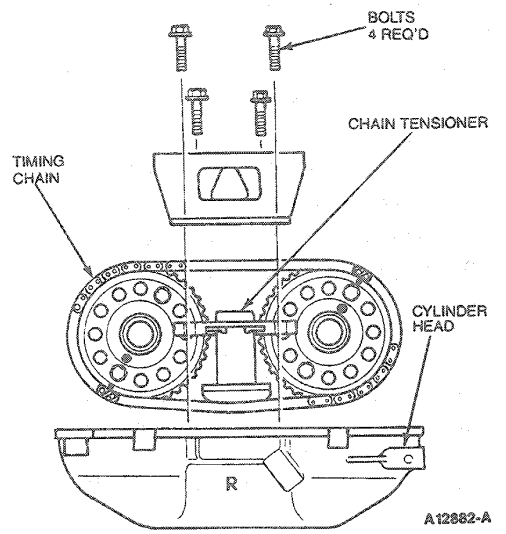


Item	Part Number	Description
1	6268	Camshaft Timing Chain
2	6250	Camshaft
3	6049	Cylinder Head
4	6256	Camshaft Timing Chain Sprocket
5	014-00282	Rotunda Dial Indicator With Bracketry
6	6L266	Chain Tensioner

If end play is greater than maximum, replace camshaft and/or cylinder head.

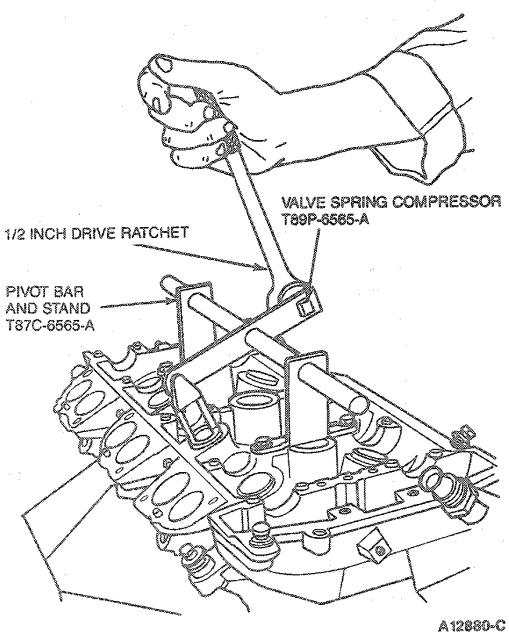
DISASSEMBLY AND ASSEMBLY (Continued)

7. Remove chain tensioner retaining bolts.

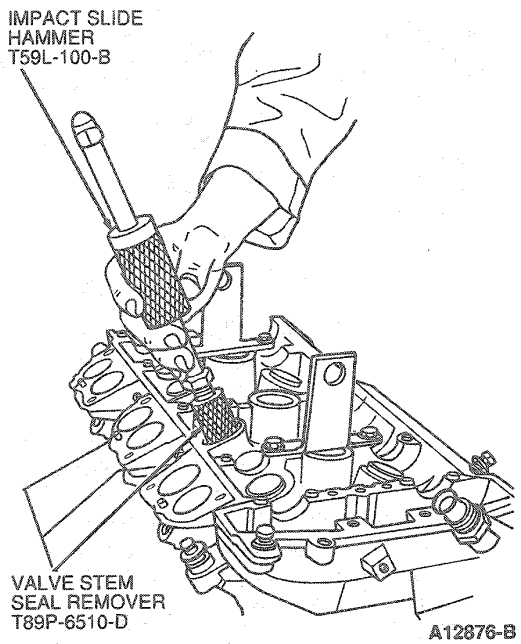


CAUTION: If bearing cap bolts are not removed uniformly the camshaft may be damaged.

8. Uniformly loosen and remove bearing cap bolts.
9. Remove valve shim and bucket.
10. Install Valve Spring Compressor Set T89P-6565-A with Pivot Bar and Stand, T87C-6565-A on cylinder head.

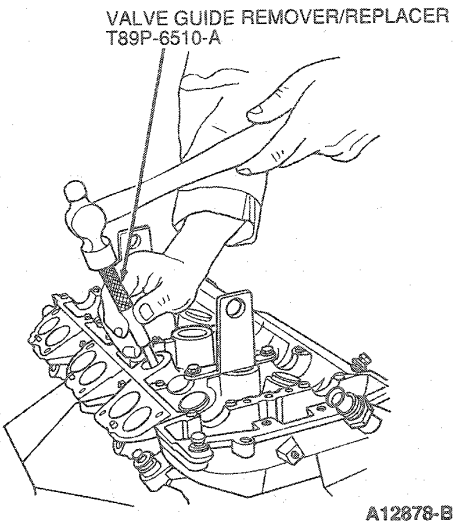


11. Align spring compressor squarely over valve retainer. Attach a 1/2-inch drive ratchet and apply pressure to valve retainer. Support valve in head if necessary to separate retainer from valve stem.
12. Remove keepers with a magnet, and remove valve.
13. Assemble Valve Stem Seal Remover T89P-6510-D and Impact Slide Hammer T59L-100-B or equivalent.
14. Remove valve stem seal.



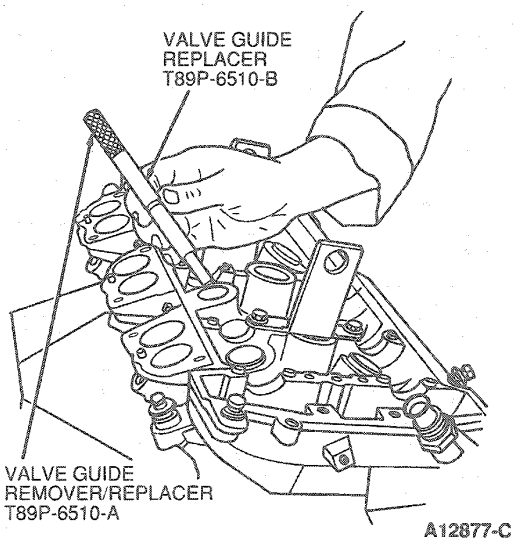
DISASSEMBLY AND ASSEMBLY (Continued)

15. Drive out valve guide with Valve Guide Remover / Replacer T89P-6510-A.



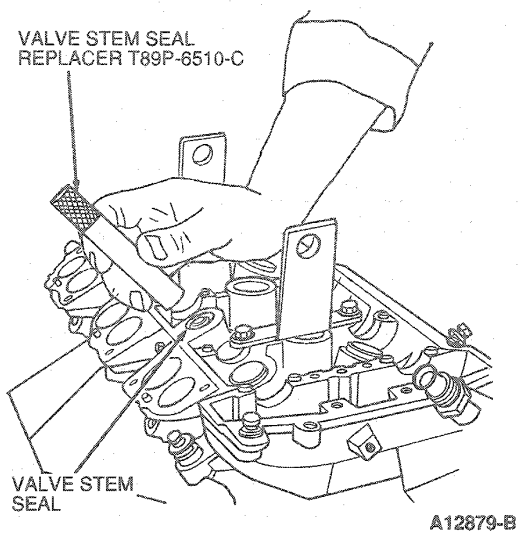
Assembly

1. Install new valve guide with Valve Guide Replacer T89P-6510-B and Valve Guide Remover / Replacer T89P-6510-A. Drive guide until fully seated.



2. Install new valve stem seal with Valve Stem Seal Replacer T89P-6510-C. Press in by hand until fully seated.

   NOTE: Intake valve seals are brown. Exhaust valve seals are black.



3. Lubricate valve stems and valve guides with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.
4. Install valve, valve spring seat (with valve spring-wider pitched side (yellow paint) facing upward) and spring retainer.
5. Using valve Spring Compressor Set T89P-6565-A install valve keepers.
6. Install bucket and adjusting shim with number facing down.
7. Install camshaft as outlined.
8. Install cylinder head as outlined.
9. Adjust valve clearance as outlined.
10. Install cylinder head covers as outlined.
11. Install intake manifold as outlined.
12. Fill engine cooling system.
13. Connect battery ground cable.
14. Start engine and check for coolant, oil and fuel leaks.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft
Crankshaft Pulley Bolt	152-172	112-127
Transaxle-to-Engine Bolts	34-47	25-35
Catalyst-to-Engine Bolts	27-47	20-35
Oil Drain Plug	20-33	15-24
A/C Compressor and Bracket Bolts	36-55	27-41
Generator Bracket Retaining Bolts	48-72	36-53
Insulator-to-Engine Bracket	54-75	40-55

(Continued)

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N·m	Lb-Ft
RH Front and Rear Insulator-to-Frame Nuts	68-95	50-70
Roll Damper Nuts	54-75	40-55
Engine Damper Bolts	54-75	40-55
LH Insulator-to-Bracket Nuts	54-75	40-55
LH Insulator-to-Transaxle	95-130	70-95
LH Insulator-to-Frame	81-116	60-85
RH Engine Damper-to-Engine Bracket	28-41	21-30
RH Engine Bracket-to-Shock Tower Bolts	54-75	40-55
LH Engine Damper Flag Nut	28-41	21-30
Timing Belt Cover Bolts (Front) 3.0L Only	7-11	62-97 (Lb-In)
Tension Locknut 3.0L Only	33-51	24-38
Water Pump Pulley Nut	16-23	12-17
Power Steering Pump Pulley	54-68	40-50
Wheel Lug Nuts	115-142	85-105
Throttle Body Bolts and Nuts	16-23	12-17
Idler Pulley Nut	34-50	25-36
Generator A/C Pulley and Bracket Bolts	15-23	11-17
Intake Manifold Crossover Tube Nuts	15-23	11-17
Water Pump Retaining Bolts	16-23	12-17
Cylinder Head Cover Bolts	9.8-16	7-12
Intake Manifold Retaining Bolts	15-23	11-17
Intake Manifold Bracket Bolts	15-23	11-17
Thermostat Housing Retaining Nuts	7-11	62-97 (Lb-In)
Cylinder Head Bolts	(1)	(1)
Upper Oil Battle Bolts	15-23	11-17
Connecting Rod Nuts	(4)	(4)
Oil Pump Retaining Bolts	15-23	11-17
Oil Sump-to-Oil Pump Bolts	7-11	62-97 (Lb-In)
Oil Pan Retaining Bolts	15-23	11-17
EGR Valve Retaining Bolts	15-23	11-17
Engine Coolant Temperature Sensor	16-24	12-17
Knock Sensor	29-39	21-29
Oil Level Sensor	21-33	15-24
Oil Pressure Sending Switch	16-24	12-18
Camshaft Sensor	7-11	62-97 (Lb-In)
Crankshaft Position Sensor	1.5-2.5	13-22 (Lb-In)
Throttle Position Sensor	2-3	18-27 (Lb-In)
Exhaust Manifold-to-Cylinder Head	35-52	26-38
Heat Shield Retaining Bolts	15-23	11-17

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N·m	Lb-Ft
Exhaust Pipe-to-Manifold Nuts	21-32	15-24
Main Bearing Cap Bolts	(2)	(2)
Main Bearing Support Beam	21-32	15-24
Oil Seal Carrier Bolts	6.3-9.4	56-83 (Lb-In)
Oil Pick-Up Tube Bolts	7.1-11	62-97 (Lb-In)
Oil Pick-Up Tube Nuts	21-32	15-24
Flywheel Bolts	(3)	(3)
Pressure Plate Retaining Bolts	16-33	12-24
Camshaft Sprocket Bolts	14-18	10-13
Camshaft Caps	16-22	12-16
Chain Tensioner Retaining Bolts	15-19	11-14
Timing Belt Rear Cover Bolts	8.8	78 (Lb-In)
Camshaft Pulley Bolts	21-25	15-18
Ignition Coil Pack Screws	4.5-7	40-62 (Lb-In)
Ignition Coil Pack Bracket Bolts	28-42	21-31
Fuel Rail Retaining Bolts	15-23	11-17
Spark Plugs	22-27	16-20
Engine Lifting Eye Bolts	15-23	11-17
Generator Retaining Bolts (3.0L Only)	34-50	25-37
EGR Tube to EGR Valve	25-34	18-25
EGR Tube to Exhaust Manifold	15-23	11-17
HO2S Sensor	37-45	27-33
Crankshaft Position Sensor Retaining Bolts	1.5-2.5	13-22 (Lb-In)
Camshaft Bearing Caps	(5)	(5)
Oil Screen Bolts	7-11	62-97
Oil Fitler	6	6
DPFE Transducer Screws	2-3	18-27 (Lb-In)
Power Steering Pump Bracket Bolts	36-55	27-41
Power Steering Pump Bolts	20-32	15-24
Upper Accessory Drive Idler Pulley Bolt (3.2L Only)	35-51	26-38
Lower Accessory Drive Idler Pulley Bolt (3.2L Only)	36-55	27-41
Accessory Drive Belt Tensioner Bolt (3.2L Only)	53-78	39-58
Timing Belt Front Cover Bolts (3.2L Only)	16-23	12-17
Timing Belt Tensioner Arm Nut (3.2L Only)	36-50	27-37
Timing Belt Tensioner Bolts (3.2L Only)	16-23	12-17
Generator Retaining Bolts (3.2L Only)	36-55	27-41

(1) Tighten in two steps: 49-69 N·m (36-51 Lb-Ft) 83-93 N·m (62-69 Lb-Ft)

SPECIFICATIONS (Continued)

(2) Tighten in two steps: 46-69 N·m (34-51 Lb-Ft) 78-88 N·m (58-65 Lb-Ft)

(3) Tighten in two steps: 39-50 N·m (29-39 Lb-Ft) 69-78 N·m (51-58 Lb-Ft)

(4) Tighten in two steps: 30-35 N·m (22-26 Lb-Ft) 45-50 N·m (33-37 Lb-Ft)

(5) Tighten in two steps: 8-12 N·m (71-106 Lb-In) 16-22 N·m (12-16 Lb-Ft)

(6) Advance 3/4 turn after gasket contacts surface.

SPECIFICATIONS (Continued)

GENERAL SPECIFICATIONS	
DISPLACEMENT	3.0L/3.2L
NUMBER OF CYLINDERS	6
BORE AND STROKE	
Bore 3.0L	89.00mm (3.5039 in)
Bore 3.2L	92.0mm (3.6220 in)
Stroke 3.0L/3.2L	80.00mm (3.1496 in)
FIRING ORDER	1-4-2-5-3-6
OIL PRESSURE (Hot, Idling)	Min. 12.8 PSI
DRIVE BELT TENSION	SEE CHART

CYLINDER HEAD AND VALVE TRAIN	
COMBUSTION CHAMBER VOLUME 3.0L	47.0-48.0 cc
COMBUSTION CHAMBER VOLUME 3.2L	46.7-48.3 cc
VALVE GUIDE BORE DIAMETER	
Intake and Exhaust	6.000-6.018 mm (0.2362-0.2369 in.)
VALVE SEATS	
Width — Intake	1.0-1.4mm (0.039-0.055 in.)
— Exhaust	1.0-1.4mm (0.039-0.055 in.)
Angle	45°
Width Limit	1.5mm (0.06 in.)
GASKET SURFACE FLATNESS	0.2mm (0.008 in.)
VALVE STEM TO GUIDE CLEARANCE	
Intake	0.025-0.058mm (0.0010-0.0023 in.)
Exhaust	0.030-0.063mm (0.0012-0.0025 in.)
VALVE HEAD DIAMETER (GAGE)	
Intake	35mm (1.38 in.)
Exhaust	30mm (1.18 in.)
MARGIN THICKNESS LIMIT	0.5mm (0.02 in.)
VALVE FACE ANGLE	45.5°
VALVE STEM DIAMETER (STD.)	
Intake	5.960-5.975mm (0.2346-0.2352 in.)
Exhaust	5.955-5.970mm (0.2344-0.2350 in.)
VALVE SPRINGS	
Compression Pressure (Kg [Lb] @ Spec. Length)	
Maximum Load	537.4 N (120.8 lbs.) @ 30.2mm (1.19 in.)
Set Load	188.3 N (42.3 lbs.) @ 38.7mm (1.52 in.)
Free Length (Approximate)	44.82mm (1.76 in.)
Service Limit	10% Force Loss @ Specified Height
VALVE LIFTER	
Diameter (Std.)	31.970-31.994mm (1.2587-1.2596 in.)
Clearance to Bore	0.024-0.036mm (0.0009-0.0014 in.)
Service Limit	0.07mm (0.003 in.)
VALVE CLEARANCE	
Intake	0.15-0.25mm (0.006-0.010 in.)
Exhaust	0.25-0.35mm (0.010-0.014 in.)
CAMSHAFT BORE INSIDE DIAMETER	
All	31.000-31.025mm (1.2205-1.2215 in.)

CAMSHAFT 3.0L	
LOBE LIFT	
Intake	8.5mm (0.335 in.)
Exhaust	8.0mm (0.315 in.)
LOBE HEIGHT	
Intake	41.81-41.91mm (1.6461-1.650 in.)
Limit	41.80mm (1.6457 in.)
Exhaust	41.31-41.41mm (1.6264-1.6303 in.)
Limit	41.30mm (1.6260 in.)
END PLAY	
Service Limit	0.30mm (0.012 in.)
JOURNAL TO BEARING	
CLEARANCE	0.025-0.066mm (0.0010-0.0026 in.)
JOURNAL DIAMETER	
All	30.959-30.975mm (1.2189-1.2195 in.)

CAMSHAFT 3.2L	
LOBE LIFT	
Intake	8.0mm (0.315 in.)
Exhaust	8.0mm (0.315 in.)
LOBE HEIGHT	
Intake	41.31-41.41 (1.6264-1.6303)
Limit	41.30 (1.6260 in.)
Exhaust	41.31-41.41mm (1.6264-1.6303 in.)
Limit	41.30mm (1.6260 in.)

ENDPLAY	
Service Limit	0.30mm (0.012 in.)
JOURNAL TO BEARING	
CLEARANCE	0.025-0.066mm (0.0010-0.0026 in.)
JOURNAL DIAMETER	
All	30.959-30.975mm (1.2189-1.2195 in.)

CYLINDER BLOCK	
HEAD GASKET SURFACE	
FLATNESS	0.05mm (0.002 in.)
CYLINDER BORE	
Diameter 3.0L	89.000-89.030mm (3.5039-3.5051 in.)
3.2L	92.000-92.030mm (3.6220-3.6232 in.)
Surface Finish (RMS) micrometers	①
Out-of-Round Limit	0.01mm (0.0004 in.)
Out-of-Round Service Limit	0.02mm (0.0008 in.)
Taper Service Limit	0.02mm (0.0008 in.)
MAIN BEARING BORE	
DIAMETER	68.000mm (2.677 in.)

CRANKSHAFT AND FLYWHEEL	
MAIN BEARING JOURNAL	
DIAMETER	63.976-64.000mm (2.5187-2.5197 in.)
Out-of-Round Limit	0.02mm (0.0008 in.)
Taper Limit	0.02mm (0.0008 in.) TOTAL
Journal Runout Limit	0.06mm (0.0024 in.)
THRUST BEARING	
Thickness	2.227-2.277mm (0.0877-0.0896 in.)
CONNECTING ROD JOURNAL	
Diameter	51.976-52.000mm (2.0463-2.0472 in.)
Out-of-Round Limit	0.02mm (0.0008 in.) MAX
Taper Limit	0.02mm (0.0008 in.) TOTAL

FLYWHEEL RING GEAR LATERAL RUNOUT (T.I.R.)	
CRANKSHAFT END PLAY	0.021-0.221mm (0.0008-0.0087 in.)
CONNECTING ROD BEARINGS	
Clearance to Crankshaft	
Desired	0.024-0.056mm (0.0009-0.0022 in.)
Allowable	0.08mm (0.0031 in.)
Bearing Wall Thickness (Std.)	1.484-1.496mm (0.0584-0.0589 in.)
MAIN BEARINGS	
Clearance to Crankshaft	
Desired	0.028-0.056mm (0.0011-0.0022 in.)
Allowable	0.08mm (0.0031 in.)
Bearing Wall Thickness (Std.)	1.981-1.998mm (0.0780-0.0787 in.)

CONNECTING ROD, PISTON AND RINGS	
CONNECTING ROD	
Piston Pin Bore Diameter 3.0L	21.005-21.017mm (0.8270-0.8274 in.)
3.2L	22.005-22.017 (0.8663-0.8668)
Crankshaft Bearing Bore Diameter	55.000-55.016mm (2.1653-2.1660 in.)
Length (Center-to-Center)	146.75-146.85mm (5.778-5.781 in.)
ALIGNMENT (BORE-TO-BORE MAX. DIFF)	
Twist	0.15 per 100mm (0.0015 per in.)
Bend	0.05 per 100 mm (0.0005 per in.)
SIDE CLEARANCE (ASSEMBLED TO CRANK)	
Standard	0.16-0.312mm (0.0063-0.0123 in.)
Service Limit	0.35mm MAX. (0.0138 in. MAX.)

PISTON 3.0L	
Diameter	
Coded (STD.)	88.960-88.990mm (3.5023-3.5035 in.)
Coded (O/S: 0.25)	①

① Specification not available at time of publication. CA12923-B

SPECIFICATIONS (Continued)

PISTON 3.0L Continued	
Coded (O/S:050)	TBDmm (TBD in.)
PISTON-TO-BORE CLEARANCE	0.030-0.050mm (0.0012-0.0020 in.)
Service Limit	0.080mm MAX.
RING GROOVE WIDTH	
Compression (Top)	1.21-1.23mm (0.0476-0.0484 in.)
Compression (Bottom)	1.505-1.525mm (0.0593-0.0600 in.)
Oil	2.81-2.83mm (0.1106-0.1114 in.)
PISTON PIN	
Length	61/9-62.0mm (2.437-2.441 in.)
Diameter	20.997-21.009mm (0.8267-0.8271 in.)
PIN TO PISTON CLEARANCE	-0.005 + 0.001mm (-0.00020 + 0.0004 in.)
PIN TO ROD CLEARANCE	0.005-0.011mm (0.00020-0.00043 in.)
PISTON PIN INSTALLING TEMPERATURE	70-80°C (158-176°F)
PISTON RINGS	
Ring Width	
Compression (Top)	1.17-1.19mm (0.0461-0.0469 in.)
Compression (Bottom)	1.47-1.49mm (0.0579-0.0587 in.)
Ring Gap	
Compression (Top) (In Gauge)	0.30-0.45mm (0.012-0.018 in.)
Compression (Bottom) (In Gauge)	0.30-0.45mm (0.012-0.018 in.)
Oil Ring (Steel Rail) (In Gauge)	0.20-0.50mm (0.008-0.020 in.)
Side Clearance	
1st Ring	0.02-0.06mm (0.0008-0.0024 in.)
2nd Ring	0.015-0.055mm (0.0006-0.0022 in.)
Oil Ring	0.06-0.15mm (0.0024-0.0059 in.)

PISTON 3.2L	
Diameter	
Coded (STD)	91.960-91.990mm (3.6205-3.6217 in.)
Coded (O/S: 0.25)	TBDmm (TBD in.)
Coded (O/S: 0.50)	TBDmm (TBD in.)
PISTON-TO-BORE CLEARANCE	0.030-0.050mm (0.0012-0.0020 in.)
Service Limit	0.080mm MAX.
RING GROOVE WIDTH	
Compression (Top)	1.23-1.25mm (0.0484-0.0492 in.)
Compression (Bottom)	1.51-1.53mm (0.0594-0.0602 in.)
Oil	2.81-2.83mm (0.1106-0.1114 in.)
PISTON PIN	
Length	61.9-62.0mm (2.437-2.441 in.)
Diameter	21.997-22.009 (0.8660-0.08665 in.)
PIN TO PISTON CLEARANCE	0.005- + 0.001mm (- 0.00020- + 0.00004 in.)
PIN TO ROD CLEARANCE	0.005-0.011mm (- 0.00020- + 0.00004 in.)

PISTON 3.2L Continued	
PIN TO ROD CLEARANCE	0.005-0.011mm (0.00020-0.00043 in.)
PISTON PIN INSTALLING TEMPERATURE	70-80°C (158-176°F)
PISTON RINGS	
Ring Width	
Compression (Top)	1.17-1.19mm (0.0461-0.0469 in.)
Compression (Bottom)	1.47-1.49mm (0.0579-0.0587 in.)
Ring Gap	
Compression (Top) (In Gauge)	0.30-0.45mm (0.012-0.018 in.)
Compression (Bottom) (In Gauge)	0.45-0.60mm (0.018-0.024 in.)
Oil Ring (Steel Rail) (In Gauge)	0.20-0.50mm (0.008-0.020 in.)
Side Clearance	
1st Ring	0.04-0.08mm (0.0016-0.0031 in.)
2nd Ring	0.02-0.06mm (0.0008-0.0024 in.)
Oil Ring	0.06-0.15mm (0.0024-0.0059 in.)

LUBRICATION SYSTEM	
OIL PUMP	
Relief Valve Spring Tension (Force @ Length)	6.05 N/mm (34.5 lb./in.)
Relief Valve to Bore Clearance	0.052-0.088mm (0.0020-0.0035 in.)
Outer and Inner Rotor	
Tip Clearance	0.06-0.018mm (0.0024-0.0071 in.)
Rotor to Housing Side Clearance	0.03-0.09mm (0.0012-0.0035 in.)
Outer Rotor to Housing Radial Clearance	0.10-0.175mm (0.0039-0.0069 in.)
Inner Rotor Shaft to Housing Clearance	0.03-0.095mm (0.0012-0.0037 in.)
OIL CAPACITY	
Passenger Car: 5.0 qt. with filter change.	

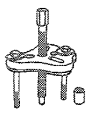
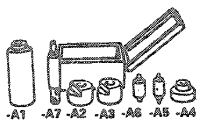
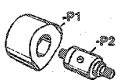
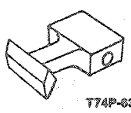
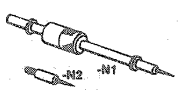
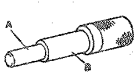
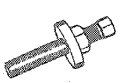
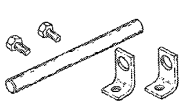
BELT TENSION ALLOWABLE LIMITS — 3.0L SHO ONLY

	Specifications		Allowable Minimum
	New Belt (1) Installation Tension	Used Belt (2) Reset Tension	Cold Belt (2) (3) Audit Check
6 Rib	100-120 kg (220-265 lbs.)	67-87 kg (148-192 lbs.)	N.A.
4 Rib	70-90 kg (154-198 lbs.)	51-71 kg (112-157 lbs.)	

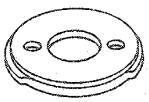
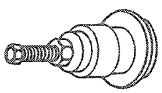
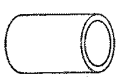
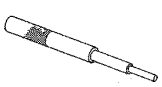
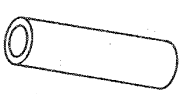
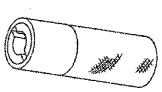
(1) New belt installed and tensioned/engine not rotated.
(2) Used belt is any belt that has rotated on an engine.
(3) Cold belt (i.e., 3-hour soak; 0 warm-up).

CA12924-B

SPECIAL SERVICE TOOLS

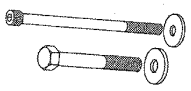
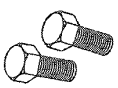
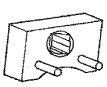
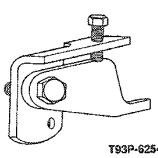
Tool Number/ Description	Illustration
T59L-100-B Impact Slide Hammer	 T59L-100-B
T67L-3600-A Puller	 T67L-3600-A
T68P-6135-A1 Piston Pin Remover/Replacer	 -A1 -A7 -A2 -A3 -A6 -A5 -A4 T68P-6135-A
T71P-6135-P1 Piston Pin Remover/Replacer Sleeve	 -P1 -P2 T71P-6135-P
T74P-6375-A Flywheel Holding Tool	 T74P-6375-A
T78P-3504-N Locknut Pin Remover	 -N2 -N1 T78P-3504-N
T81P-6701-A Rear Crankshaft Seal Replacer	 T81P-6701-A
T81P-7550-A Clutch Aligner	 A B T81P-7550-A
T82L-6316-A Vibration Damper and Seal Installer	 T82L-6316-A
T87C-6565-A Pivot Bar and Stand	 T87C-6565-A

(Continued)

Tool Number/ Description	Illustration
T88C-6701-BH Rear Crankshaft Seal Replacer	 T88C-6701-BH
T88T-6701-A Crankshaft Seal Installer/Cover Aligner Tool Set— Consists of: T88T-6701-A2 Crankshaft Seal Installer/Cover Aligner Plate	 T88T-6701-A
T89P-6256-A Cam Seal Replacer	 T89P-6256-A
T89P-6256-B Cam Seal Expander	 T89P-6256-B
T89P-6256-C Cam Position Tool	 T89P-6256-C
T89P-6510-A Valve Guide Remover/Replacer	 T89P-6510-A
T89P-6510-B Valve Guide Replacer	 T89P-6510-B
T89P-6510-C Valve Stem Seal Replacer	 T89P-6510-C
T89P-6510-D Valve Stem Seal Remover	 T89P-6510-D
T89P-6565-A Valve Spring Compressor Set	 T89P-6565-A

(Continued)

SPECIAL SERVICE TOOLS (Continued)

Tool Number/ Description	Illustration
T89P-6701-A Screw and Washer Set	 T89P-6701-A
T89P-6701-B Front Crank Seal Installer	 T89P-6701-B
T89P-6701-C Rear Seal Replacer Screw Set	 T89P-6701-C
T93P-6254-A Torque Wrench Attachment	 T93P-6254-A
T93P-6254-B Timing Belt Tensioner Tool	 T93P-6254-B

Tool Number	Description
D81L-600-A	Inch Pound Torque Wrench
D81L-4201-A	Feeler Gauge
D85L-6000-A	Strap Wrench

(Continued)

Tool Number	Description
D89L-6001-A	Engine Lifting Bracket
D89L-6135-A	Piston Pin Remover/Replacer Driver and Locator
T80L-630-3	Step Plate Adapter

ROTUNDA EQUIPMENT

Model	Description
014-00210	Hi-Lift Jack
014-00282	Dial Indicator With Bracketry
014-00290	Piston Ring Compressor
014-00292	Cylinder Ridge Reamer
014-00750	3 Bar Engine Support Kit
021-0028A	Offset Belt Tension Gauge

PARTS CROSS-REFERENCE

Base Part #	Part Name	Old Part Name
9424	Intake Manifold	
9430	Exhaust Manifold	
9431	Exhaust Manifold	
9600	Engine Air Cleaner	
9B989	Throttle Position Sensor	Throttle Potentiometer
9D475	EGR Valve	
9D477	EGR Valve to Exhaust Manifold Tube	
9E926	Throttle Body	
9E936	Air Charge Control to Intake Manifold Gasket	
9F472	Heated Oxygen Sensor	Exhaust Gas Oxygen Sensor

SECTION 03-01C Engine, 3.8L

VEHICLE APPLICATION

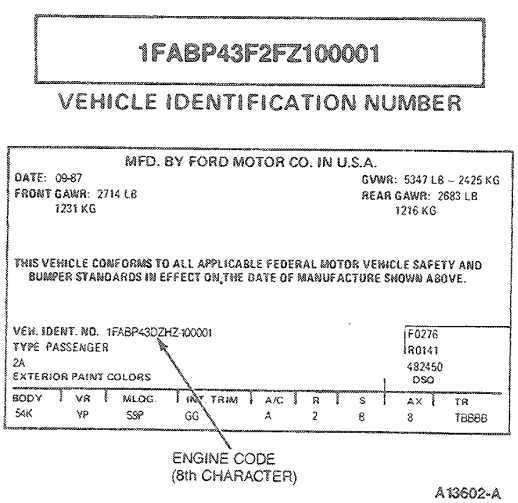
Taurus / Sable.

DESCRIPTION AND OPERATION

Engine Code Information Label

The engine code information label is located on the rocker arm cover. The label contains, among other information, the engine calibration number, engine build date, the engine plant code and an engine code.

The 3.8L engine has a V-block construction with overhead valves. The engine is available with automatic transaxle only and operates on unleaded fuel. The V-6, 3.8L engine is lightweight, compact and is similar to a V-8 engine in construction and components. The similarities and differences between the V-6 and V-8 will be noted in the following descriptions.



DESCRIPTION AND OPERATION (Continued)

Engine Identification

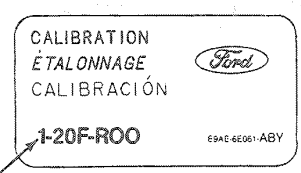
For quick engine identification, refer to the Safety Certification Decal. The decal is mounted on the LH front door lock face panel. Find the engine code (letter or number) on the decal, then refer to the engine identification chart to determine the engine type and size. An engine identification label is also attached to the engine. The symbol code on the identification tag identifies each engine for determining parts usage; for instance, engine cubic inch displacement and model year.

Code	Engines	Cyl.	Fuel Metering
U	3.0L (186 CID)	6	MFI
3	3.8L (231 CID)	6	MFI

Emission Calibration Label

NOTE: It is imperative that the engine codes and the calibration number be used when ordering parts or making inquiries about the engine.

The emission calibration number label is located on the LH side door or door post pillar. It identifies the engine calibration number, the engine code number and revision level. These numbers are used to determine if parts are unique to specific engines.



CALIBRATION REVISION NUMBER

A11644-B

Induction System

The fuel / air mixture needed for burning in the cylinders is provided by Sequential Multiport Fuel Injection (SFI).

Fuel is metered into the air intake stream in accordance with engine demand by six solenoid injection valves mounted in the cylinder heads.

Fuel is supplied from the vehicle's fuel tank (9002) by a high-pressure electric fuel pump mounted in the fuel tank. The fuel is filtered and sent to the injector fuel rail assembly. A fuel pressure regulator (9C968) on this rail controls the fuel delivery pressure at a constant 269 kPa (39 psi). The six injector nozzles are mounted above the intake valves and connected in parallel with the fuel pressure regulator. Excess fuel supplied by the pump, but not needed by the engine, is returned to the vehicle fuel tank by a fuel return line.

These fuel induction systems are mounted on an aluminum intake manifold (9424) which in turn is bolted to aluminum alloy cylinder heads. The manifolds and heads are cast from aluminum to aid in removing weight from the engine. Service procedures related to these components remain similar to those for a V-8 engine. However, a spark plug thread service procedure is provided in the event damage should occur to these threads.

Crankshaft, Camshaft and Balance Shaft

The crankshaft is supported on the bottom of the cylinder block by four steel backed, over-plated copper-lead main bearings. The No. 3 bearing insert limits crankshaft end play and absorbs thrust loads applied to the crankshaft ends. To provide smooth engine operation, the piston crankpins are positioned to provide a power impulse every 120 degrees of crankshaft rotation. This spacing, along with the necessary changes to camshaft lobe and distributor timing, provides smoothness of operation and quietness comparable to a V-8 engine. Two sprockets and a timing chain connect the crankshaft with the camshaft and provide a 2:1 drive ratio.

The camshaft is installed in the block and is supported on four babbit-lined bearing inserts. Thrust loads and end play, however, are limited by a thrust plate installed at the front of the camshaft. Immediately behind the thrust plate are the balance shaft drive gear, the camshaft sprocket, and the distributor drive gear.

The purpose of the balance shaft is to reduce vibration produced by the engine. The balance shaft is gear-driven by the camshaft. The balance shaft is located in the tappet valley of the block and is supported by a babbit bearing at each end.

During operation the balance shaft rotates at engine speed in the opposite direction of crankshaft rotation, producing a force which cancels the rotating couple of the crankshaft.

Valve Train

The configuration of the valve train is identical to that used in V-8 engines. A hydraulic roller tappet, providing automatic lash adjustment, rides on a camshaft lobe and transfers its up-and-down motion to the rocker arm through a push rod. The rocker arms are pedestal-mounted and pivot on fulcrums bolted to the cylinder head. The valves are arranged alternately intake / exhaust.

DESCRIPTION AND OPERATION (Continued)

Lubrication System

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft and connecting rod bearings, hydraulic tappets and camshaft bearings. From the tappets, a controlled volume of oil is supplied to the rocker arms through the hollow push rods. All other moving parts are lubricated by gravity flow or splash. The rotary gear-type pump, which develops the oil pressure, is attached to the front cover assembly. The pump driven gear is rotated by the distributor shaft through an intermediate shaft. A full flow oil filter is externally mounted on the front cover and normally all engine oil passes through the filter element. However, if the element should become restricted, a spring-loaded bypass valve will open, allowing an uninterrupted flow of oil to the engine's moving parts.

Drive Belt, Serpentine

Accessories mounted on the front of the engine are belt-driven by the crankshaft. A serpentine drive belt is routed over each accessory pulley and is driven by a pulley bolted to the crankshaft damper. The belt is held tight against the drive pulleys by an idler pulley attached to a tensioner mounted on the RH side of the engine. For service procedures, including tensioning, refer to Section 03-05.

IN-VEHICLE SERVICE

Exhaust Manifold, LH

Removal

1. Remove oil level dipstick tube support bracket.
2. Disconnect wires from spark plugs.
3. Raise vehicle on hoist. Refer to Section 00-02.
4. Remove manifold-to-exhaust pipe retaining nuts.
5. Lower vehicle.
6. Remove exhaust manifold retaining bolts and exhaust manifold (9431).

Installation

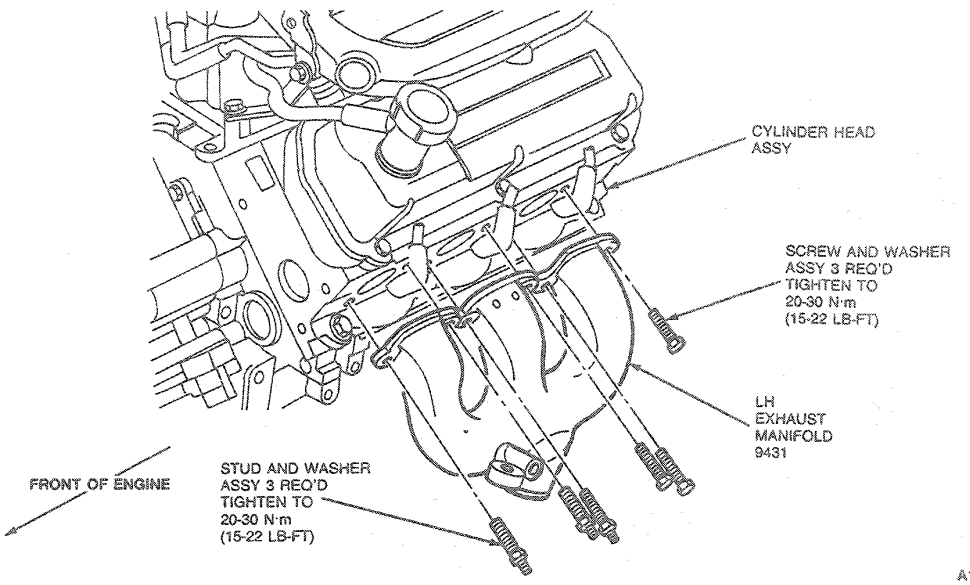
NOTE: Lightly oil all bolt and stud bolt threads before installation except those specifying special sealant.

1. Clean mating surfaces on the exhaust manifold cylinder head and exhaust pipe.
2. Position exhaust manifold on the cylinder head. Install pilot bolt (lower front bolt hole on No. 5 cylinder).

   NOTE: A slight warpage in the exhaust manifold may cause a misalignment between the bolt holes in the head and the manifold. Elongate the holes in the exhaust manifold as necessary to correct the misalignment. Do not elongate the pilot hole (lower front bolt on No. 5 cylinder).
3. Install remaining manifold retaining bolts. Tighten to 20-30 N·m (15-22 lb-ft).
4. Raise vehicle.
5. Connect exhaust pipe to exhaust manifold. Tighten retaining nuts to 21-32 N·m (16-24 lb-ft).
6. Lower vehicle.
7. Connect spark plug wires.
8. Install dipstick tube support bracket retaining nut. Tighten to 20-30 N·m (15-22 lb-ft).

IN-VEHICLE SERVICE (Continued)

9. Start engine and check for exhaust leaks.



Exhaust Manifold, RH

Removal

1. Remove air cleaner assembly and heat tube.
2. Disconnect Secondary Air Injection (AIR) hose from downstream air tube check valve.
3. Disconnect coil secondary wire from coil and wires from spark plugs.
4. Remove spark plugs.
5. Disconnect Exhaust Gas Recirculation (EGR) tube.
6. Raise vehicle on hoist. Refer to Section 00-02.
7. Remove transaxle dipstick tube.
8. Remove manifold-to-exhaust pipe retaining nuts.
9. Lower vehicle.
10. Remove exhaust manifold retaining bolts. Remove exhaust manifold (9430) assembly.

Installation

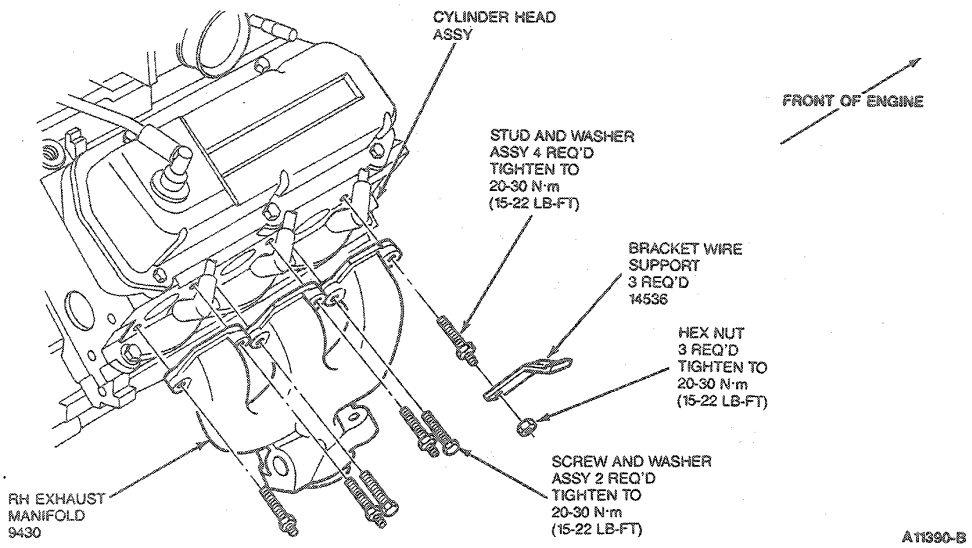
NOTE: Lightly oil all bolt and stud bolt threads before installation except those specifying special sealant.

1. Clean mating surfaces on exhaust manifold, cylinder head and exhaust pipe.
2. Position exhaust manifold on cylinder head. Start two retaining bolts.

   NOTE: A slight warpage in the exhaust manifold may cause a misalignment between the bolt holes in the head and exhaust manifold. Elongate the holes in the exhaust manifold as necessary to correct the misalignment. Do not elongate the pilot hole (lower rear bolt hole on No. 2 cylinder).
3. Install remaining manifold retaining bolts. Tighten all to 20-30 N·m (15-22 lb-ft).
4. Raise vehicle.
5. Connect exhaust pipe to exhaust manifold. Tighten retaining nuts to 21-32 N·m (16-24 lb-ft).
6. Install transaxle dipstick tube.
7. Lower vehicle.
8. Install spark plugs.
9. Connect wires to spark plugs.
10. Connect coil secondary wire to coil.
11. Connect EGR tube.
12. Connect Secondary Air Injection (AIR) hose to downstream air tube and clamp securely.
13. Install air cleaner assembly and heat tube.

IN-VEHICLE SERVICE (Continued)

14. Start engine and check for exhaust leaks. Check transaxle fluid level. Refer to Group 07.



Front Cover Assembly and Timing Chain

If the front cover is being removed to check timing chain deflection, refer to Adjustments for procedure.

Tools Required:

- Crankshaft Damper Remover T58P-6316-D
- Damper / Front Cover Seal Installer T82L-6316-A
- Vibration Damper Remover Adapter T82L-6316-B

Removal

1. Drain cooling system.
2. Disconnect battery ground cable.
3. Remove air cleaner assembly and air intake duct.
4. Loosen accessory drive belt idler. Remove drive belt and water pump pulley.
5. Remove power steering pump mounting bracket retaining bolts.

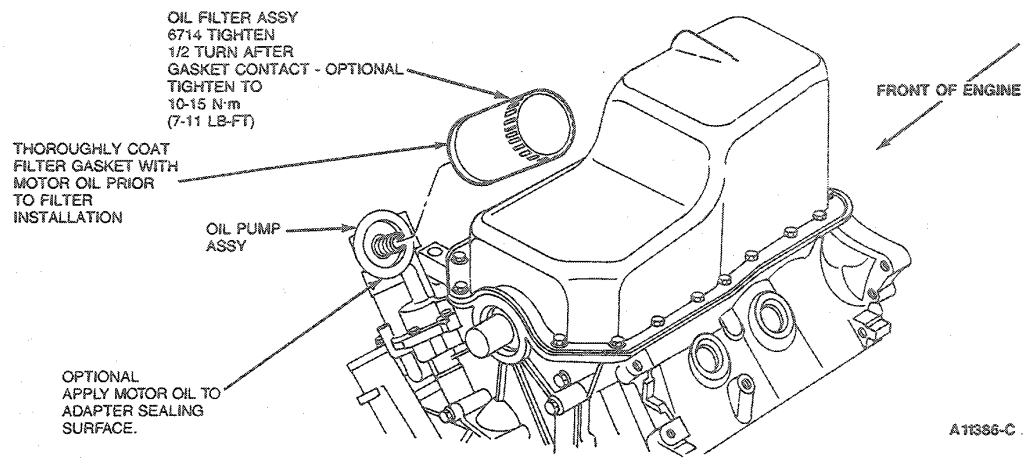
   Leaving hoses connected, place pump / bracket assembly aside in a position to prevent fluid from leaking out.
6. If equipped with air conditioning, remove compressor front support bracket. Leave compressor in place.
7. Disconnect coolant bypass hose at water pump.
8. Disconnect heater hose at water pump.
9. Disconnect radiator upper hose at thermostat housing.
10. Disconnect coil wire from distributor cap and remove cap with secondary wires attached.
11. Remove distributor hold-down clamp and lift distributor out of the front cover.
12. Raise vehicle on hoist. Refer to Section 00-02.

    NOTE: If the crankshaft pulley and vibration damper have to be separated, mark the damper and pulley so that they may be reassembled in the same relative position. This is important as the damper and pulley are initially balanced as a unit.
13. Remove crankshaft damper and pulley using Crankshaft Damper Remover T58P-6316-D and Vibration Damper Remover Adapter T82L-6316-B.

    NOTE: If the crankshaft damper is being replaced, check if the original damper has balance pins installed. If so, new balance pins (6A328 or equivalent) must be installed on the new damper in the same position as the original damper. The crankshaft pulley (new or original) must also be installed in the same relative position as originally installed.

IN-VEHICLE SERVICE (Continued)

14. Remove oil filter.



15. Disconnect radiator lower hose at water pump.

    CAUTION: The front cover cannot be removed without lowering the oil pan.

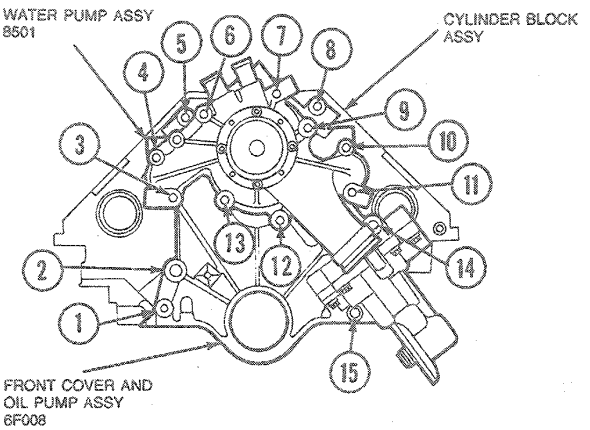
16. Remove oil pan. Refer to Oil Pan, Removal.
17. Lower vehicle.

    CAUTION: Do not overlook the cover retaining bolt located behind the oil filter adapter. The front cover will break if pried upon and all retaining bolts are not removed.

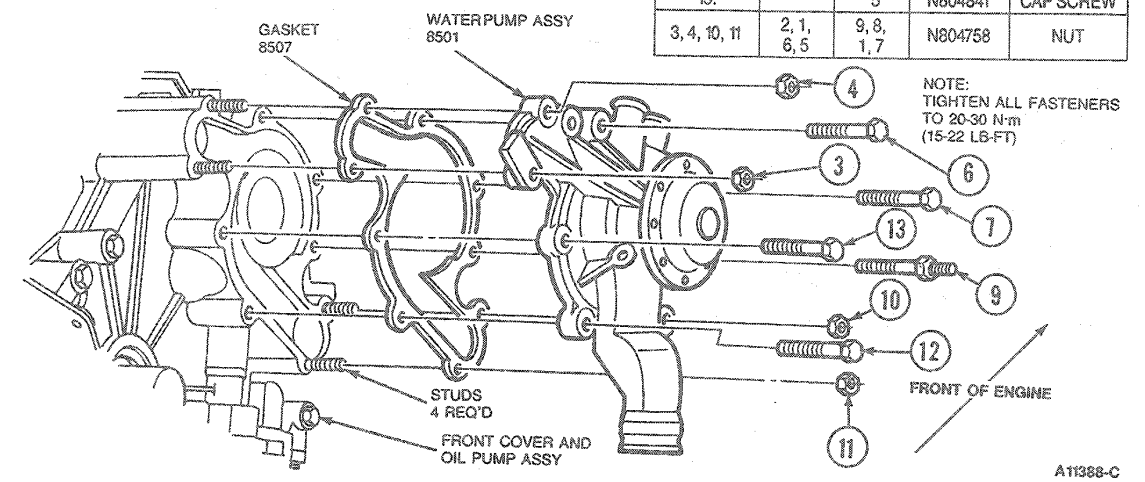
18. Remove front cover retaining bolts. It is not necessary to remove water pump.

IN-VEHICLE SERVICE (Continued)

19. Remove front cover and water pump as an assembly.

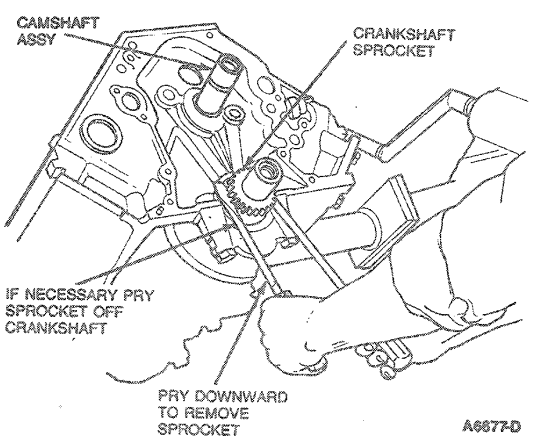


FASTENER AND HOLE NO.	HOLE NO.		FASTENERS	
	WATER PUMP	FRONT COVER	PART NO.	PART NAME
1.		4	N805112	STUD
2.		2	N805112	STUD
3.	2	9	N804757	STUD
4.	1	8	N804757	STUD
5.		10	N605787	BOLT
6.	9	15	N605908	BOLT
7.	8	16	N605908	BOLT
8.		11	N605787	BOLT
9.	7	17	N804756	BOLT
10.	6	1	N805275	STUD
11.	5	7	N804757	STUD
12.	4	13	N605908	BOLT
13.	3	14	N605908	BOLT
14.		6	N804839	BOLT
15.		5	N804841	CAP SCREW
3, 4, 10, 11	2, 1, 6, 5	9, 8, 1, 7	N804758	NUT



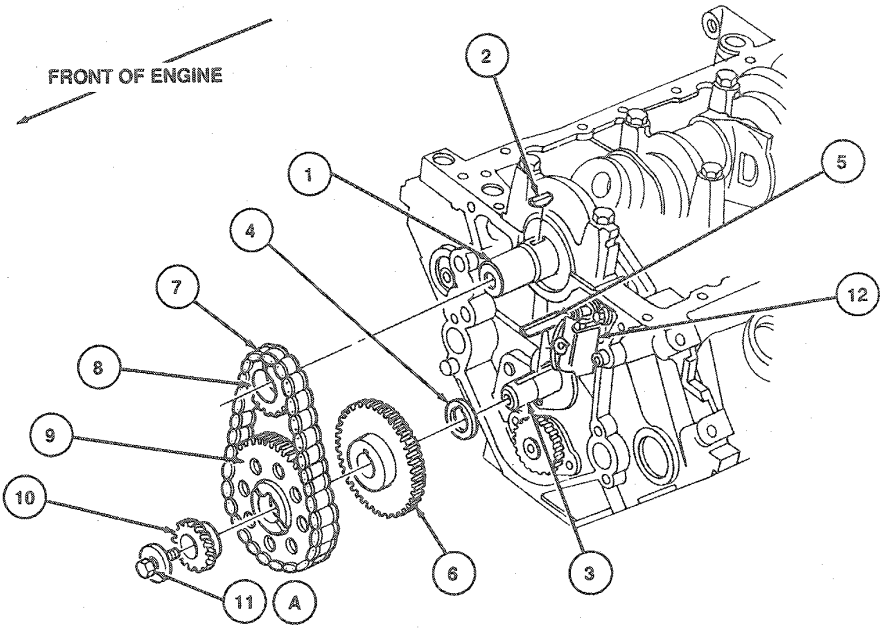
20. Remove cover gasket and discard.
21. Remove camshaft bolt and washer from end of the camshaft.
22. Remove distributor drive gear.

    NOTE: If crankshaft sprocket is difficult to remove, pry sprocket off shaft using a pair of large screwdrivers positioned on both sides of the sprocket.
23. Remove camshaft sprocket, crankshaft sprocket and timing chain.



IN-VEHICLE SERVICE (Continued)

24. Remove chain tensioner assembly (three bolts) from front of cylinder block. (This requires first pulling back on ratcheting mechanism, then installing pin through hole in bracket to relieve tension.)



A11385-E

Item	Part Number	Description
1	6303	Crankshaft
2	6B316	Key Crankshaft
3	6250	Camshaft
4	6265	Spacer
5	6L268	Key Camshaft
6	6A303	Balance Shaft Drive Gear

(Continued)

Item	Part Number	Description
7	6268	Timing Chain
8	6306	Crankshaft Sprocket
9	6256	Camshaft Sprocket
10	6255	Distributor Drive Gear
11A	—	Bolt and Washer Assy
12	6K254	Tensioner and Snubber
A		Tighten to 40-50 N·m (29.5-37 Lb-Ft)

NOTE: The front cover contains the oil pump and water pump. If a new front cover is to be installed, remove the water pump and oil pump from the old front cover. Refer to Front Cover, Assembly.

Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation except those specifying special sealant.

1. Clean all gasket surfaces on the front cover, cylinder block and fuel pump.

   If reusing the front cover, replace crankshaft front oil seal.

2. If a new front cover is to be installed:
   - Install oil pump.
   - Clean water pump gasket surface. Position a new water pump gasket on the front cover and install water pump. Install pump retaining bolts. Tighten to 20-30 N·m (15-22 lb-ft).
3. Rotate crankshaft as necessary to position piston No. 1 at TDC and crankshaft keyway at the 12 o'clock position.
4. Install tensioner assembly using three mounting bolts and tighten bolts to 8-14 N·m (70-124 lb-in). Ensure ratcheting mechanism is in retracted position with pin sticking out drum hole in bracket assembly.

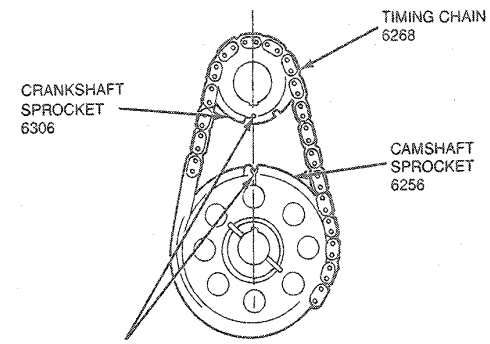
IN-VEHICLE SERVICE (Continued)

5. Lubricate timing chain with XO-10W30-QSP (ESE-M2C153-E) or equivalent engine oil.

   Install camshaft sprocket, crankshaft sprocket and timing chain.

6. Remove pin from tensioner assembly to load tensioner arm against chain.

   Ensure timing marks on sprockets are positioned across from each other.



POSITIONING OF TIMING MARKS AND KEYWAYS IN CAMSHAFT AND CRANKSHAFT SPROCKETS MUST BE IN LINE AS SHOWN WITH NO. 1 PISTON AT TOP DEAD CENTER FIRING.

A12694-A

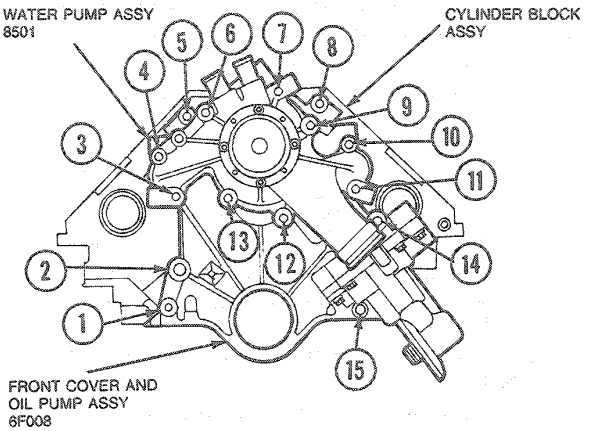
7. Install distributor drive gear.
8. Install bolt and washer assembly at end of camshaft and tighten to 40-50 N·m (30-37 lb-ft).
9. Lubricate crankshaft front oil seal with clean engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent.
10. Position a new cover gasket on the cylinder block and install the front cover / water pump assembly using dowels for proper alignment.

    Gasket and Trim Adhesive D7AZ-19B508-B (ESR-M11P17-A and ESE-M2G52-A) or equivalent is recommended to hold the gasket in position while the front cover is installed.

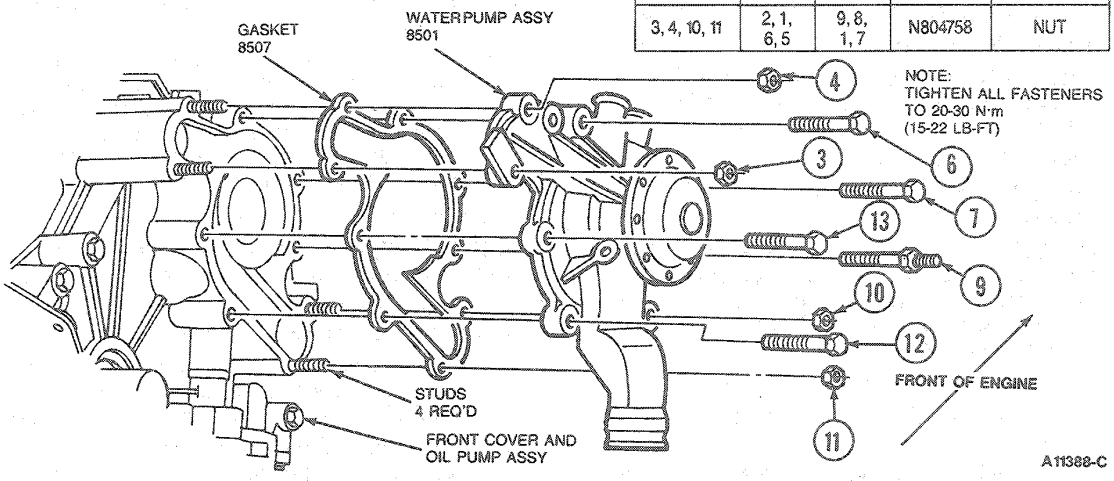
11. Position ignition timing indicator on front cover.

IN-VEHICLE SERVICE (Continued)

12. Install the front cover retaining bolts. Tighten to 20-30 N·m (15-22 lb-ft). Install the capscrew (Part No. N804841) nearest the oil filter flange last, and tighten last. Apply Loctite® or equivalent to bolt prior to installation.



FASTENER AND HOLE NO.	HOLE NO.		FASTENERS	
	WATER PUMP	FRONT COVER	PART NO.	PART NAME
1.		4	N805112	STUD
2.		2	N805112	STUD
3.	2	9	N804757	STUD
4.	1	8	N804757	STUD
5.		10	N605787	BOLT
6.	9	15	N605908	BOLT
7.	8	16	N605908	BOLT
8.		11	N605787	BOLT
9.	7	17	N804756	BOLT
10.	6	1	N805275	STUD
11.	5	7	N804757	STUD
12.	4	13	N605908	BOLT
13.	3	14	N605908	BOLT
14.		6	N804839	BOLT
15.		5	N804841	CAP SCREW
3, 4, 10, 11	2, 1, 6, 5	9, 8, 1, 7	N804758	NUT



13. Raise vehicle.
14. Install oil pan. Refer to illustration under Removal, Step 10.
15. Connect radiator lower hose. Tighten clamp securely.
16. Install oil filter. Refer to illustration following Removal, Step 14.

17. Coat crankshaft damper sealing surface with clean engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent.

    NOTE: When using silicone rubber sealer, assembly must occur within 15 minutes after sealer application. After this time, the sealer may start to set-up, and its sealing effectiveness may be reduced.
18. Apply a small amount of Silicone Gasket and Sealant F1AZ-19562-A (WSE-M4G320-A2) or equivalent to crankshaft keyway.
19. Position crankshaft pulley key in the crankshaft keyway.
20. Install the damper using Damper / Front Cover Seal Installer T82L-6316-A.

IN-VEHICLE SERVICE (Continued)

21. Install damper washer and retaining bolt. Tighten bolt to 140-180 N·m (103-132 lb-ft).
22. Install crankshaft pulley. Tighten retaining bolts to 26-38 N·m (19-28 lb-ft).
23. Lower vehicle.
24. Connect coolant bypass hose. Tighten clamp securely.
25. Install distributor with rotor pointing at No. 1 distributor cap tower. Refer to Section 03-04C.
26. Install distributor cap and coil wire.
27. Connect radiator upper hose at thermostat housing. Tighten clamp securely.
28. Connect heater hose. Tighten clamp securely.
29. If equipped with air conditioning, install compressor and mounting brackets. Tighten retaining bolts to specification. Refer to Group 12 in the applicable Section for torque specifications.
30. Install power steering pump and mounting brackets. Tighten retaining bolts to specification. Refer to Group 11 in the applicable Section for torque specifications.
31. Position accessory drive belt over the pulleys.
32. Install water pump pulley.
33. Position accessory drive belt over water pump pulley and tighten the belt. Refer to Section 03-05.
34. Connect battery ground cable.
35. Fill crankcase with correct viscosity and amount of engine oil.

    CAUTION: This engine has aluminum cylinder heads and requires a special corrosion inhibited coolant formulation to avoid cooling system damage. Refer to Section 03-03 for coolant specifications.
36. Fill cooling system with specified coolant.
37. Start engine and check for coolant, oil or fuel leaks.
38. Check ignition timing and curb idle speed, adjust as required. Refer to Powertrain Control/Emissions Diagnosis Manual[1]. Tighten distributor hold-down bolt to 27-40 N·m (20-29 lb-ft).
39. Install air cleaner assembly and air intake duct.

Tappet (Roller)

NOTE: Before replacing a tappet for noisy operation, ensure the noise is not caused by improper valve-to-rocker arm clearance or by worn rocker arms or push rods.

Tools Required:

- Spark Plug Wire Remover T74P-6666-A

Removal

1. Disconnect secondary ignition wires at the spark plugs. To avoid damaging plug wires use Spark Plug Wire Remover T74P-6666-A.
2. Remove plug wire routing clips from studs on the rocker arm cover retaining bolts. Lay plug wires with routing clips toward front of engine.
3. Remove upper intake manifold as outlined.
4. Remove rocker arm covers as outlined.
5. Remove lower intake manifold as outlined.
6. Sufficiently loosen each rocker arm fulcrum retaining bolt to allow rocker arm to be lifted off push rod and rotated to one side.
7. Remove push rods. The location of each push rod should be identified. When engine is assembled each rod should be installed in its original position.
8. Remove two tappet guide plate retainers and six guide plates.
9. Remove tappets using a magnet. The location of each tappet should be identified. When engine is assembled each tappet should be installed in its original position.

   If tappets are stuck in bores due to excessive varnish or gum deposits, it may be necessary to use a magnet or a claw-type tool to aid removal. When using a remover tool, rotate tappet back and forth to loosen it from gum or varnish that may have formed on the tappet.

Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation except those specifying special sealant.

Using solvent, clean the cylinder head and valve rocker arm cover sealing surfaces.

1. Lubricate each tappet and bore with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil.
2. Install each tappet in bore from which it was removed. If a new tappet(s) is being installed, check new tappet for a free fit in bore.
3. Align flats on sides of tappets and install six guide plates between adjacent tappets (make sure the word "up" and/or button is showing). Install two guide plate retainers and tighten four bolts to 8-14 N·m (6-10 lb-ft).
4. Dip each push rod end in Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil. Install push rods in their original position.
5. For each valve, rotate crankshaft until tappet rests onto heel (base circle) of camshaft lobe. Position rocker arms over push rods. Install fulcrums. Tighten fulcrum retaining bolt to 5 N·m (44 lb-in).

1 Can be purchased as a separate item.

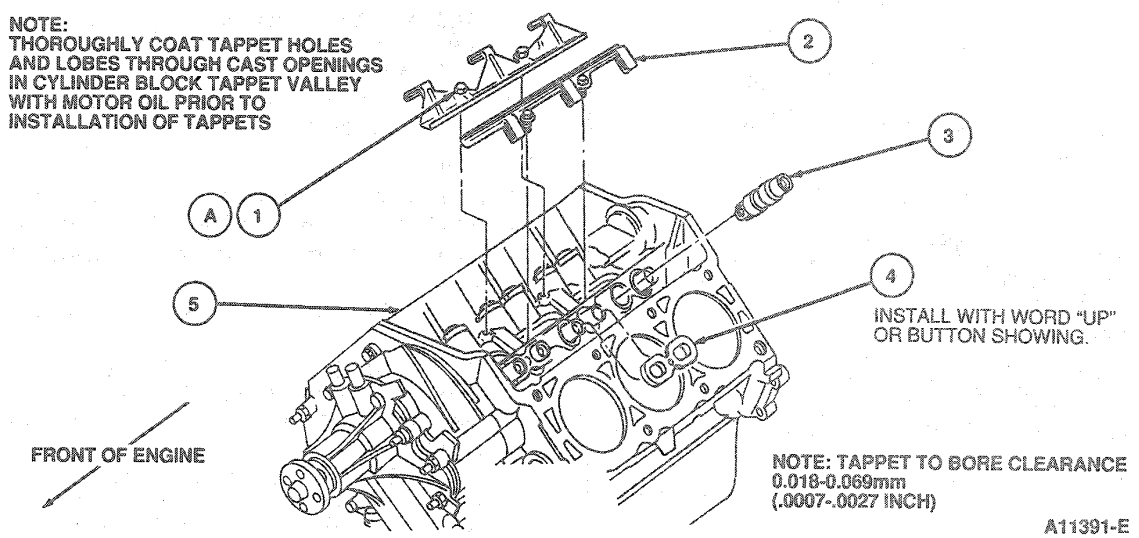
IN-VEHICLE SERVICE (Continued)

6. Lubricate all rocker arm assemblies with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil.

   CAUTION: Fulcrums must be fully seated in cylinder head and push rods must be seated in rocker arm sockets prior to final tightening.

   Final-tighten fulcrum bolts to 25-35 N·m (19-25 lb-ft). For final tightening, the camshaft may be in any position.

7. Install lower intake manifold as outlined.
8. Install valve rocker arm covers as outlined.
9. Install upper intake manifold as outlined.
10. Install plug wire routing clips and connect wires to the spark plugs.
11. Start engine and check for oil or coolant leaks.



Item	Part Number	Description
1A	—	Bolt
2	6K564	Guide Plate and Retainer Assy (2 Req'd)
3	6500	Tappet (12 Req'd)
4	6K512	Guide Plate (6 Req'd)
5	6010	Cylinder Block Assy
A		Tighten to 8-14 N·m (70-124 Lb-in)

Rocker Arm Cover

Removal

1. Disconnect secondary wires from spark plugs.
2. Remove spark plug wire routing clips from rocker arm cover retaining bolt studs.
3. Remove upper intake manifold as outlined.
4. If LH rocker arm cover is being removed, remove oil fill cap.
5. If RH rocker arm cover is being removed, proceed with the following steps:
   a. Position air cleaner assembly aside.
   b. Remove Positive Crankcase Ventilation (PCV) valve.
6. Remove valve rocker arm retaining bolts.

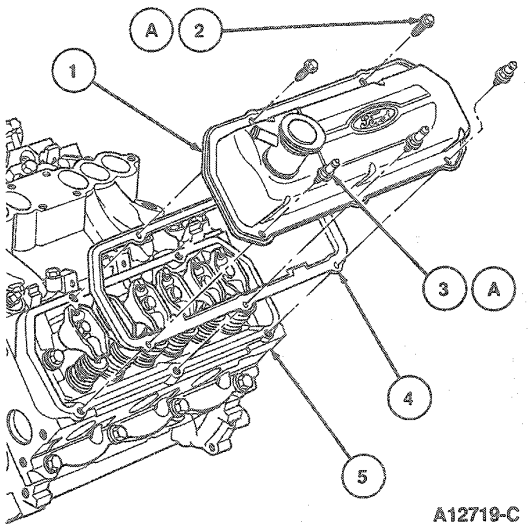
Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation. Using solvent, clean cylinder head and valve rocker cover sealing surfaces to remove all gasket material and dirt.

1. Position a new gasket onto cylinder head.
2. Position cover on the cylinder head and install retaining bolts. Note location of spark plug wire routing clip stud bolts. Tighten retaining bolts to 9-12 N·m (80-106 lb-in).
3. Install upper intake manifold as outlined.
4. If LH rocker arm cover is being installed, install oil filler cap.

IN-VEHICLE SERVICE (Continued)

5. If RH rocker arm cover is being installed perform the following:
   - Install PCV valve
   - Install air cleaner assembly
6. Install spark plug wire routing clips.
7. Connect secondary wires to spark plugs.
8. Start engine and check for oil leaks.



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Item	Part Number	Description
1	6A505 LH 6582 RH	Rocker Arm Cover Assy
2A	—	Bolt (2 Req'd)
3A	—	Stud (3 Req'd) M6 x 1 x 55.1
4	6584	Gasket
5	6049	Cylinder Head Assy
A		Tighten to 9-12 N·m (80-106 Lb-In)

Water Pump

Tools Required:

- Engine Support Bar D88L-6000-A

Removal

1. Drain cooling system.
2. Raise and support engine using Engine Support Bar D88L-6000-A or equivalent.
3. Remove lower nut on both RH engine mounts.
4. Raise engine.
5. Loosen accessory drive belt idler. Remove drive belt and water pump pulley.
6. Remove power steering pump mounting bracket retaining bolts.

   Leaving hoses connected, place pump / bracket assembly aside in a position to prevent fluid from leaking out.
7. If equipped with air conditioning, remove the compressor front support bracket. Leave compressor in place.
8. Disconnect coolant bypass hose at water pump.
9. Disconnect heater hose at water pump.

   CAUTION: If using a prying device to assist in water pump removal, be careful not to damage the mating surfaces.
10. Remove water pump retaining bolts and pump. Discard old gasket.

Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation except those specifying special sealant.

1. Clean gasket surfaces on water pump and front cover.
2. Position a new gasket on water pump sealing surface.

   Gasket and Trim Adhesive D7AZ-19B508-B (ESR-M11P17-A and ESE-M2G52-A) or equivalent is recommended to hold the gasket in position.

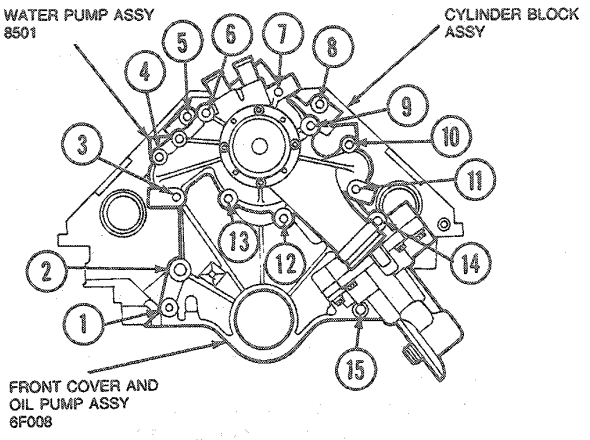
   NOTE: The threads of the No. 1 front cover retaining stud must be coated with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent before installing.
3. Position water pump on the front cover. Install retaining bolts.

   Tighten retaining bolts to 20-30 N·m (15-22 lb-ft).
4. Connect cooling bypass hose, heater hose and radiator lower hose to water pump. Tighten clamps securely.
5. If equipped with air conditioning, install compressor front support bracket. Tighten retaining bolts to 41-61 N·m (30-44 lb-ft).
6. Position power steering pump and mounting brackets. Install the retaining bolts. Tighten to 40-62 N·m (30-45 lb-ft).
7. Position accessory drive belt over pump pulley and adjust drive belt tension. Refer to Section 03-05.

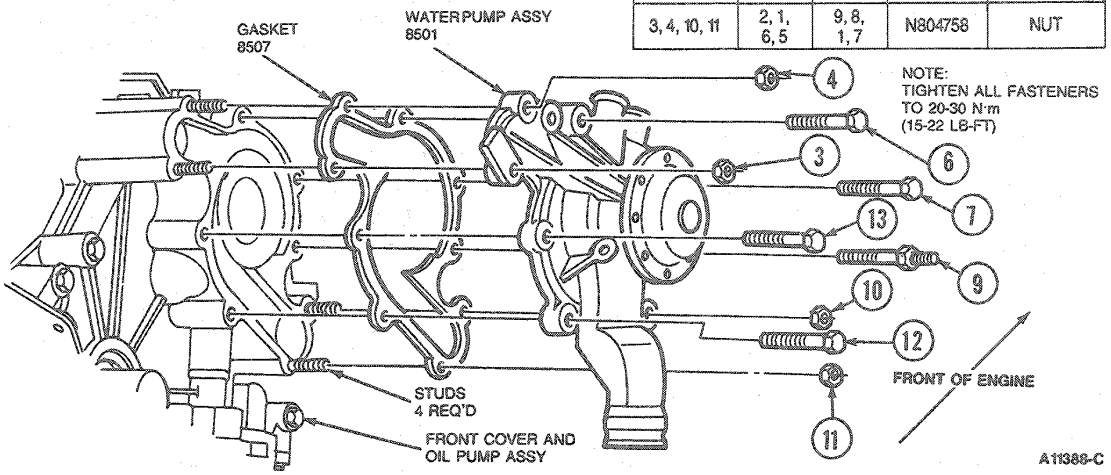
   CAUTION: This engine has aluminum cylinder heads and requires a special corrosion inhibiting coolant to avoid cooling system damage. Refer to Section 03-03 for the coolant specifications.
8. Fill cooling system with specified coolant.

IN-VEHICLE SERVICE (Continued)

9. Start engine and check for coolant leaks.



FASTENER AND HOLE NO.	HOLE NO.		FASTENERS	
	WATER PUMP	FRONT COVER	PART NO.	PART NAME
1.		4	N805112	STUD
2.		2	N805112	STUD
3.	2	9	N804757	STUD
4.	1	8	N804757	STUD
5.		10	N605787	BOLT
6.	9	15	N605908	BOLT
7.	8	16	N605908	BOLT
8.		11	N605787	BOLT
9.	7	17	N804756	BOLT
10.	6	1	N805275	STUD
11.	5	7	N804757	STUD
12.	4	13	N605908	BOLT
13.	3	14	N605908	BOLT
14.		6	N804839	BOLT
15.		5	N804841	CAP SCREW
3, 4, 10, 11	2, 1, 6, 5	9, 8, 1, 7	N804758	NUT



Crankshaft Front Oil Seal

Tools Required:

- Crankshaft Damper Remover T58P-6316-D
- Front Cover Seal Installer T70P-6B070-A
- Damper / Front Cover Seal Installer T82L-6316-A
- Vibration Damper Remover Adapter T82L-6316-B

Removal

1. Loosen accessory drive belt idler.
2. Raise vehicle on hoist. Refer to Section 00-02.
3. Disengage accessory drive belt and remove crankshaft pulley.
4. Remove crankshaft damper using Crankshaft Damper Remover T58P-6316-D and Vibration Damper Remover Adapter T82L-6316-B.

   CAUTION: Use care to prevent damage to front cover and crankshaft.
5. Remove seal from the front cover using a screwdriver.

Installation

1. Inspect front cover and crankshaft damper for damage, nicks, burrs or other roughness which may cause the seal to fail. Service or replace components as necessary.
2. Lubricate the seal lip with clean engine oil and install the seal using Damper / Front Cover Seal Installer T82L-6316-A and Front Cover Seal Installer T70P-6B070-A.

IN-VEHICLE SERVICE (Continued)

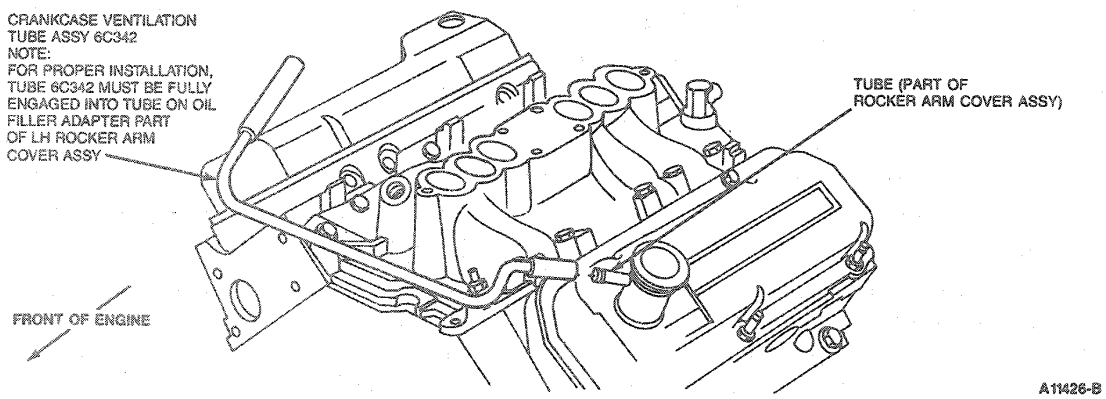
3. Lubricate seal surface on the damper with clean engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent.

   Install damper using Damper / Front Cover Seal Installer T82L-6316-A.
4. Install damper retaining bolt. Tighten to 140-180 N·m (103-132 lb-ft).
5. Position crankshaft pulley and install retaining bolts. Tighten bolts to 26-38 N·m (19-28 lb-ft).
6. Position accessory drive belt over crankshaft pulley.
7. Lower vehicle.
8. Check accessory drive belt for proper routing and engagement in the pulleys. Adjust drive belt to specification. Refer to Section 03-05.
9. Start engine and check for oil leaks.

Upper and Lower Intake Manifolds

Removal

1. Drain engine cooling system.
2. Remove air cleaner assembly including air intake duct and heat tube.
3. Disconnect accelerator cable at throttle body assembly. Disconnect speed control cable, if so equipped.
4. Disconnect the transaxle linkage at the upper intake manifold.
5. Remove retaining bolts from accelerator cable mounting bracket and position cables aside.
6. Disconnect Secondary Air Injection (AIR) air supply hose at the check valve.
7. Disconnect flexible fuel lines from steel lines over rocker arm cover.
8. Disconnect fuel lines at injector fuel rail assembly.
9. Disconnect radiator upper hose at thermostat housing.
10. Disconnect coolant bypass hose at intake manifold.
11. Disconnect heater tube at intake manifold. Remove tube support bracket retaining nut. Remove heater hose at rear of heater tube. Loosen hose clamp at heater elbow and remove heater tube with hose attached. Remove heater tube with fuel lines attached and set assembly aside.
12. Disconnect vacuum lines at fuel rail assembly and intake manifold.
13. Disconnect necessary electrical connectors.
14. If equipped with air conditioning, remove air compressor support bracket.
15. Disconnect PCV lines. One is located on upper intake manifold. The second is located at the LH rocker cover and the lower intake stud.



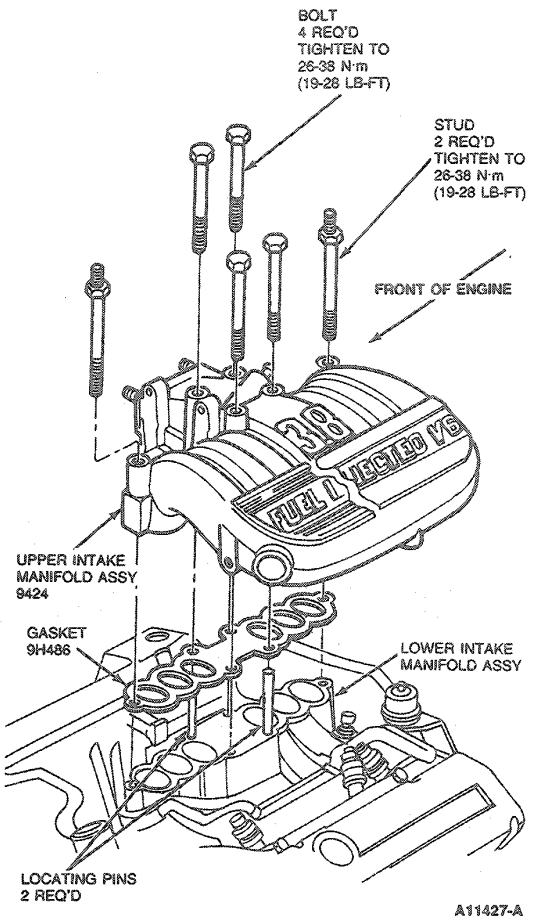
16. Remove throttle body assembly.
17. Remove the EGR valve assembly from the upper manifold.
18. Remove the retaining nut and remove wiring retainer bracket located at the LH front of the intake manifold and set aside with spark plug wires.
19. Remove intake manifold upper gasket (9H486)retaining bolts / studs.
20. Remove intake manifold upper gasket.
21. Remove injectors and fuel injection supply manifold (9F792) assembly.
22. Remove heater water outlet hose.

IN-VEHICLE SERVICE (Continued)

23. Remove lower intake manifoldretaining bolts.

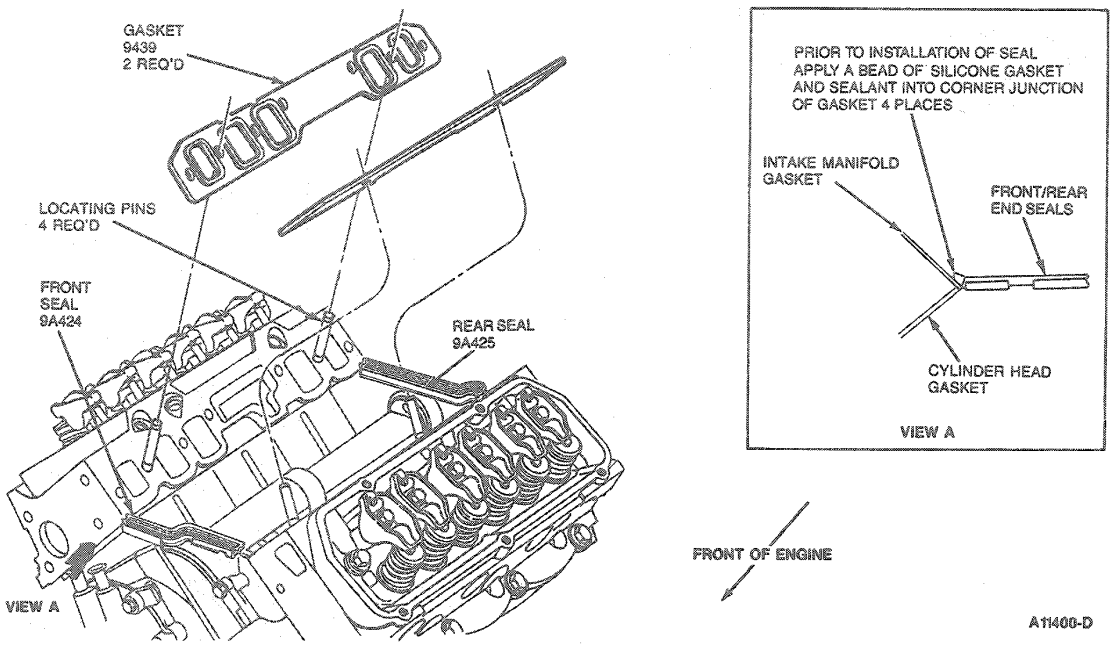
CAUTION: The intake manifold is sealed at each corner with RTV-type sealer. To break the seal, it may be necessary to pry on the front of the manifold with a screwdriver blade. If it is necessary to pry on the intake manifold use care to prevent damage to machined surfaces.

24. Remove lower intake manifold.



IN-VEHICLE SERVICE (Continued)

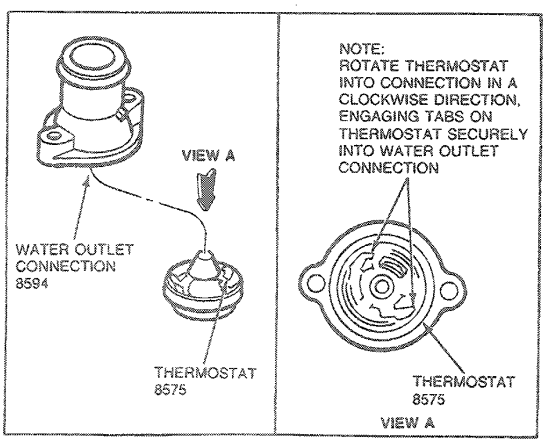
25. Remove intake manifold to cylinder head gasket (9439) and end seals, and discard.

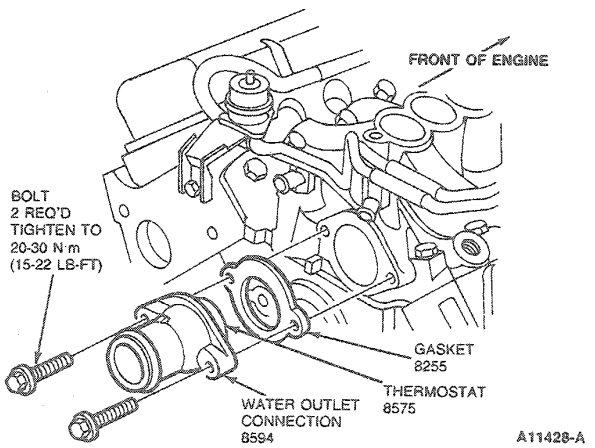


26. If lower intake manifold assembly is to be disassembled, perform the following:

    NOTE: The water bypass tube is pressed-in, and not serviceable.

a. Remove thermostat housing and thermostat.



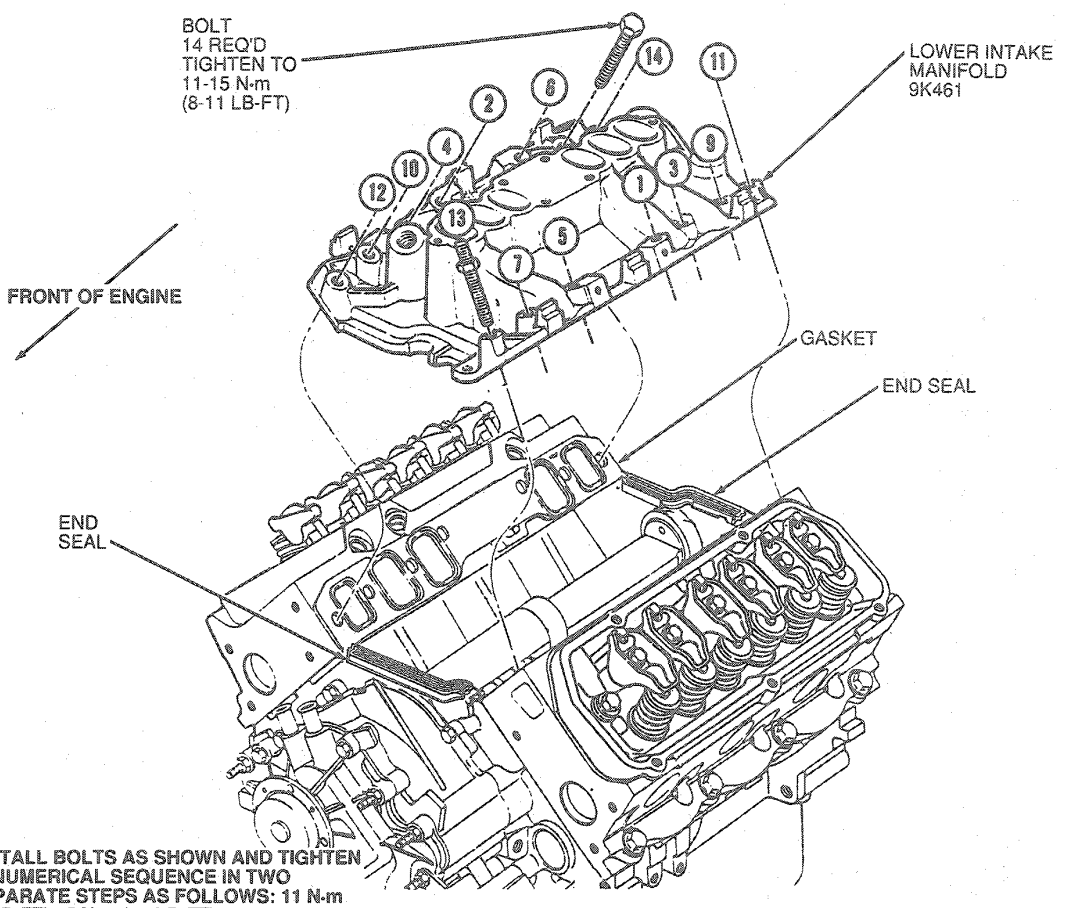


b. Remove water temperature sending unit.

c. Remove heater elbow.

IN-VEHICLE SERVICE (Continued)

d. Remove all vacuum and electrical fittings.



Installation

NOTE: Lightly oil all retaining bolt and stud bolt threads before installation.

NOTE: When using silicone rubber sealer, assembly must occur within 15 minutes after sealer application. After this time, the sealer may start to set-up, and its sealing effectiveness may be reduced.

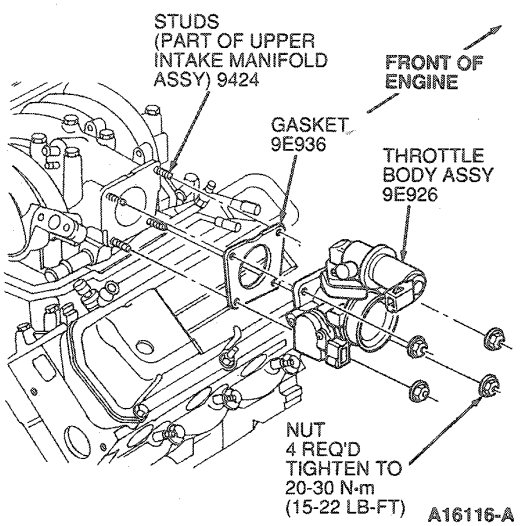
1. The lower intake manifold, cylinder head, and cylinder block mating surfaces should be clean and free of old gasketing material. Use a suitable solvent to clean these surfaces.
2. If intake manifold was disassembled:
   - Apply a coat of Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent to the threads of the temperature sending unit, all vacuum fittings, heater elbows, electrical fittings, if equipped. Refer to Specifications.
   - Install thermostat (note direction) and gasket. Install thermostat housing. Tighten retaining bolts to 20-30 N·m (15-22 lb-ft).

   NOTE: Using solvent, clean sealing surfaces of cylinder heads and intake manifold before applying Silicone Sealer.
3. Apply a dab of Gasket and Trim Adhesive D7AZ-19B508-B (ESR-11P17-A and ESE-M2G52-A) or equivalent to each cylinder head mating surface. Press new intake manifold to cylinder head gaskets into place, using locating pins as necessary to aid in assembly.
4. Apply a 3-4mm (1/8 inch) bead of Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent at each corner where the cylinder head joins the cylinder block.
5. Install front and rear intake manifold end seals.

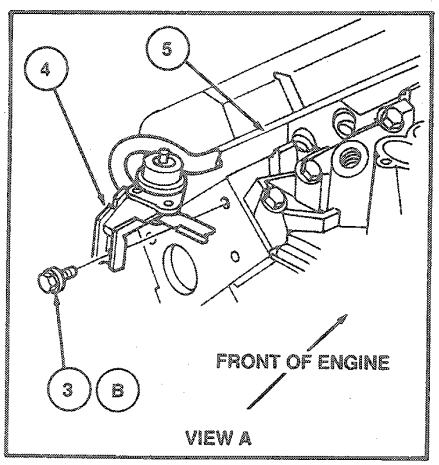
IN-VEHICLE SERVICE (Continued)

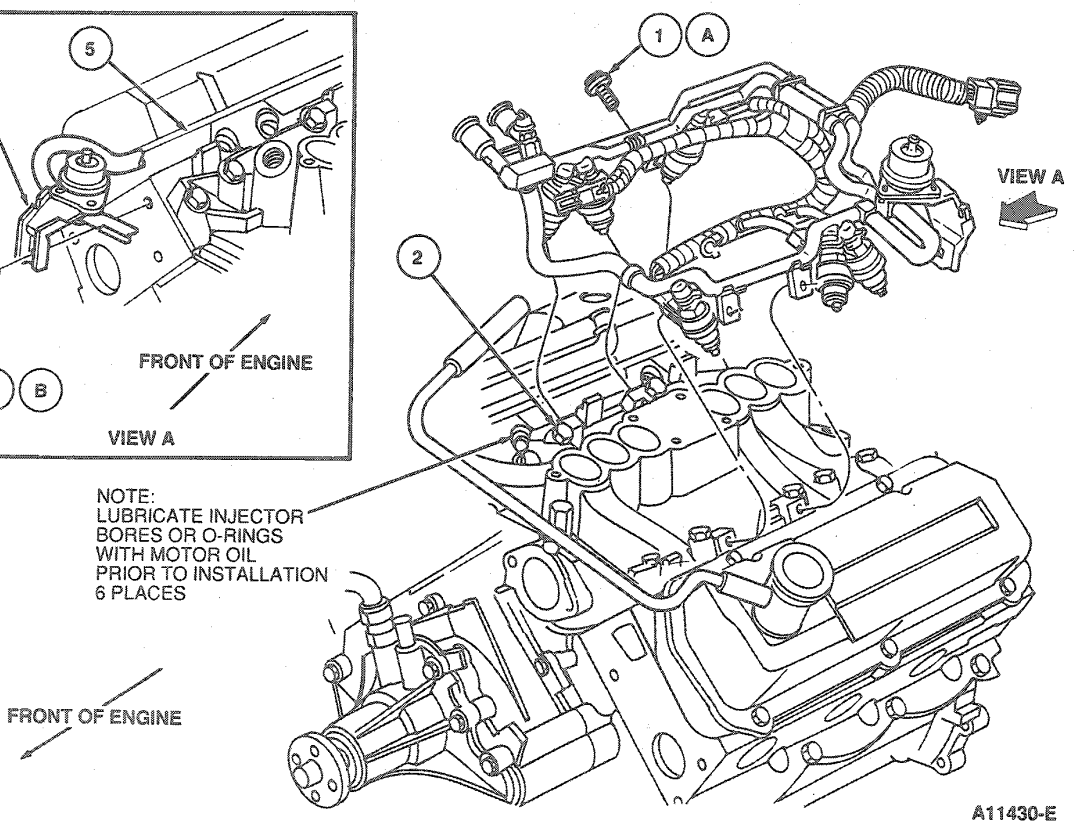
6. Carefully lower intake manifold into position on cylinder block and cylinder heads. Use locating pins as necessary to guide intake manifold.
7. Install bolts in their original locations. Tighten in numerical sequence to the following specifications in two steps:
   - 11 N·m (8 lb-ft)
   - 15 N·m (11 lb-ft)
8. Connect rear PCV line to upper intake tube.
9. Install front PCV tube so the mounting bracket sits over the lower intake stud.
10. Install injectors and fuel rail assembly. Tighten screws to 8-11 N·m (6-8 lb-ft).

    NOTE: Use locating pins to secure position of gasket between manifolds.
11. Position intake manifold upper gasket and intake manifold on top of lower intake.
12. Install bolts and studs in original locations. Tighten four center bolts, then tighten the end bolts. Use the same sequence used in Step 7.
13. Install EGR valve assembly on manifold. Tighten retaining nuts to 20-30 N·m (15-22 lb-ft).
14. Install throttle body. Cross-tighten retaining nuts to 20-30 N·m (15-22 lb-ft).



15. Connect rear PCV line at PCV valve and upper intake manifold.





IN-VEHICLE SERVICE (Continued)

Item	Part Number	Description
1A	—	Screw and Washer Assy (4 Req'd)
2	9424	Lower Intake Manifold
3B	—	Bolt
4	9F797	Charging Assy
5	6049	Cylinder Head Assy
A		Tighten to 8-11 N·m (6-8 Lb-Ft)
B		Tighten to 20-30 N·m (15-22 Lb-Ft)

16. If equipped with air conditioning, install compressor support bracket. Tighten retaining nut to 20-30 N·m (15-22 lb-ft).
17. Connect necessary electrical connectors.
18. Connect necessary vacuum hoses.
19. Connect heater tube hose to heater elbow.
20. Position heater tube support bracket and tighten retaining nut to 20-30 N·m (15-22 lb-ft). Tighten hose clamp at heater elbow securely.
21. Connect heater hose to the rear of the heater tube and tighten hose clamp.
22. Connect coolant bypass hose. Tighten hose clamp securely.
23. Connect radiator upper hose. Tighten hose clamp securely.
24. Connect fuel line(s) at injector fuel injection supply manifold assembly.
25. Connect flexible fuel lines to steel lines.
26. Position accelerator cable mounting bracket. Install and tighten retaining bolts to 20-30 N·m (15-22 lb-ft).
27. Connect speed control cable, if so equipped.
28. Connect transaxle linkage at upper intake manifold.

    CAUTION: This engine has aluminum cylinder heads and requires a special corrosion inhibiting coolant to avoid cooling system damage. Refer to Section 03-03 for the coolant specifications.
29. Fill cooling system with specified coolant.
30. Start engine and check for coolant or fuel leaks.
31. Check and, if necessary, adjust engine idle speed. Refer to Powertrain Control / Emissions Diagnosis Manual[2]. Adjust transaxle throttle linkage and speed control. Refer to Section 10-02.
32. Install air cleaner assembly and air intake duct.

Cylinder Heads

Removal

1. Drain cooling system.
2. Disconnect battery ground cable.
3. Remove air cleaner assembly including air intake duct and heat tube.
4. Loosen accessory drive belt idler. Remove drive belt.
5. If LH cylinder head is being removed perform the following:
   - Remove oil fill cap.
   - Remove power steering pump.

   Leaving hoses connected, place pump / bracket assembly aside in a position to prevent fluid from leaking out.
   - If equipped with air conditioning, remove mounting bracket retaining bolts. Leaving hoses connected, position compressor aside.
   - Remove generator and bracket.
6. If RH cylinder head is being removed perform the following:
   - Disconnect AIR control valve or Secondary Air Injection Bypass (AIRB) valve hose assembly at the air pump.
   - Disconnect AIR tube support bracket from the rear of cylinder head.
   - Remove accessory drive idler.
   - Remove AIR pump pulley. Remove AIR pump.
   - Remove PCV valve.
7. Remove upper intake manifold.
8. Remove valve rocker arm cover retaining screws.
9. Remove injector fuel rail assembly.
10. Remove lower intake manifold.
11. Remove exhaust manifold and exhaust manifold.
12. Loosen rocker arm fulcrum retaining bolts enough to allow rocker arm to be lifted off the push rod and rotate to one side.
13. Remove push rods. Identify position of each rod. Rods should be installed in their original position during assembly.
14. Remove cylinder head retaining bolts and discard.

2 Can be purchased as a separate item.

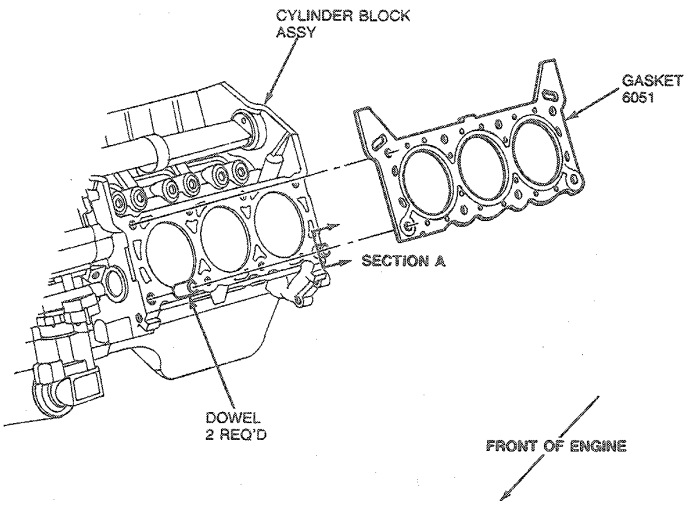
IN-VEHICLE SERVICE (Continued)

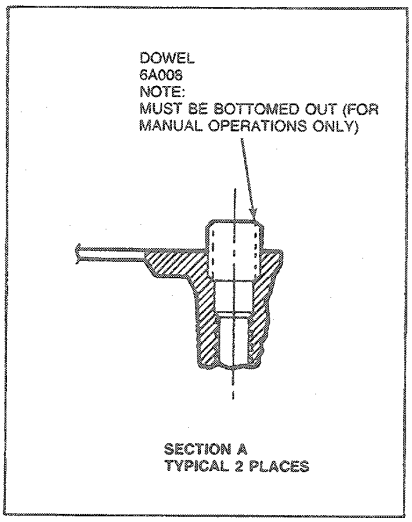
15. Remove cylinder head(s).
16. Remove and discard old cylinder head gasket(s).
17. If disassembling cylinder head(s), refer to Cylinder Head, Disassembly.

Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation except those specifying special sealant.

1. Clean cylinder head, intake manifold, valve rocker arm cover and cylinder head gasket surfaces. If cylinder head was removed for a cylinder head gasket replacement, check flatness of cylinder head and block gasket surfaces. Refer to Section 03-00 for procedure.
2. Position new head gasket(s) onto cylinder block using dowels for alignment.





A11431-A

3. Position cylinder head(s) onto block.

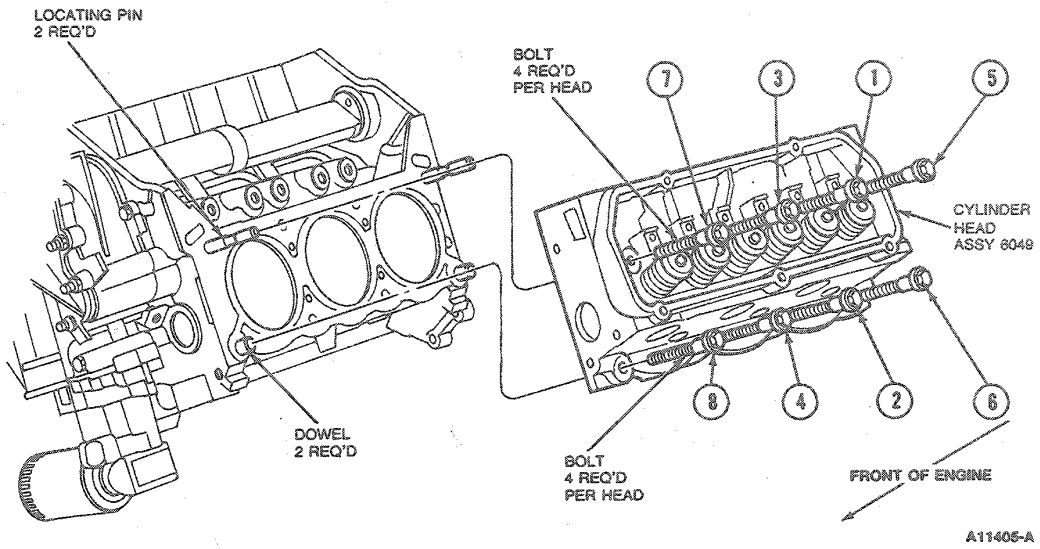
   CAUTION: Always use new cylinder head bolts to ensure a leak-tight assembly. Torque retention with used bolts can vary, which may result in coolant or compression leakage at the cylinder head mating surface area.
4. Install cylinder head bolts (eight each side).
5. Tighten cylinder head retaining bolts in sequence as follows:
   a. 50 N·m (37 lb-ft)
   b. 60 N·m (45 lb-ft)
   c. 70 N·m (52 lb-ft)
   d. 80 N·m (59 lb-ft)

   CAUTION: Do not loosen all of the bolts at the same time, only work on one bolt at a time.

   In sequence, retighten bolts one at a time in the following manner:
   e. Long bolts: Loosen bolt and back out two or three revolutions. Retighten long bolt to 15-25 N·m (11-18 lb-ft). Then tighten bolt an additional 85-95 degrees and go to the next bolt in sequence.

IN-VEHICLE SERVICE (Continued)

f. Short bolts: Loosen bolt and back out two or three revolutions. Retighten to 10-20 N·m (7-15 lb-ft), then rotate an additional 85-95 degrees. Go to next bolt in sequence.



NOTE: When cylinder head retaining bolts have been tightened using the above procedure, it is not necessary to retighten bolts after extended engine operation. However, bolts can be checked for tightness if desired.

6. Dip each push rod end in Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil.

   Install push rods in their original position.

7. For each valve, rotate crankshaft until tappet rests on the heel (base circle) of the camshaft lobe, before tightening fulcrum retaining bolts. Position rocker arms over push rods, install fulcrums. Tighten fulcrum bolts to 5 N·m (44 lb-in) maximum.

8. Lubricate all rocker arm assemblies with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil.

   NOTE: If original valve train components are being installed, a valve clearance check is not required. If a component has been replaced, perform a valve clearance check. Refer to Section 03-00.

   Final-tighten the fulcrum bolts to 25-35 N·m (19-25 lb-ft). For final tightening, camshaft may be in any position.

9. Install exhaust manifold and exhaust manifold.

10. Install lower intake manifold.

11. Install injector fuel rail assembly. Tighten retaining bolts to 8-11 N·m (6-8 lb-ft).

12. Position cover and new gasket on cylinder head and install retaining bolts. Note location of spark plug wire routing clip stud bolts. Tighten bolts to 9-12 N·m (80-106 lb-in).

13. Install upper intake manifold.

14. Install spark plugs, if removed.

15. Connect secondary wires to the spark plugs.

16. If LH cylinder head is being installed, perform the following:

    - Install oil fill cap.
    - If equipped with air conditioning, install compressor mounting and support brackets. Refer to Section 12-03 for torque specifications.
    - Install power steering pump mounting and support brackets. Tighten all bolts to 40-62 N·m (30-45 lb-ft).
    - Install generator / support bracket.

17. If RH cylinder head is being installed, perform the following:

    - Install PCV valve.
    - Install generator bracket. Tighten retaining nuts to 40-55 N·m (30-40 lb-ft).
    - Install Secondary Air Injection (AIR) pump and pump pulley. Refer to Specifications.

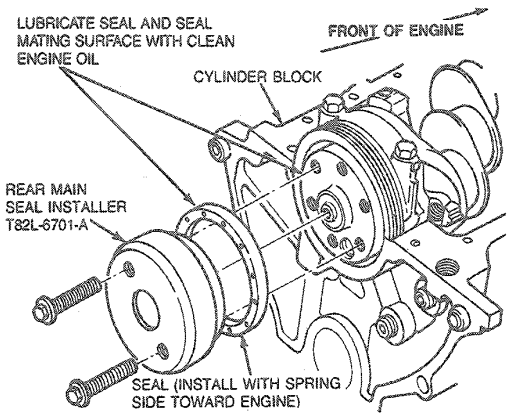
IN-VEHICLE SERVICE (Continued)

- Install accessory drive idler.
- Install AIR control valve or Secondary Air Injection Bypass (AIRB) valve hose. Tighten clamps securely to the air pump assembly.

18. Install accessory drive belt and tighten to specification. Refer to Section 03-05.
    - Install AIR tube(s) support bracket to the rear of the cylinder head. Tighten retaining bolts to 40-55 N·m (30-40 lb-ft).
19. Connect battery ground cable.

    CAUTION: This engine has aluminum cylinder heads and requires a special corrosion inhibited coolant formulation to avoid cooling system damage. Refer to Section 03-03 for the coolant specifications.
20. Fill cooling system with specified coolant.
21. Start engine and check for coolant, fuel and oil leaks.
22. Check and, if necessary, adjust curb idle speed.
23. Install air cleaner assembly including air intake duct and heat tube.

2. Alternate bolt tightening, to seat the seal properly. (Two bolts are supplied with Tool T82L-6701-A. Engine flywheel bolts may be used if necessary.)



Crankshaft Rear Main Oil Seal

A one-piece crankshaft rear main oil seal is used on this engine.

Tools Required:

- Jet Plug Remover T77L-9533-B
- Rear Main Seal Installer T82L-6701-A

Removal

CAUTION: Avoid scratching or damaging oil seal surface.

1. Using a sharp awl, punch one hole into the seal metal surface between lip and block.
2. Screw in the threaded end of Jet Plug Remover T77L-9533-B. Use the Jet Plug Remover to remove seal.

Installation

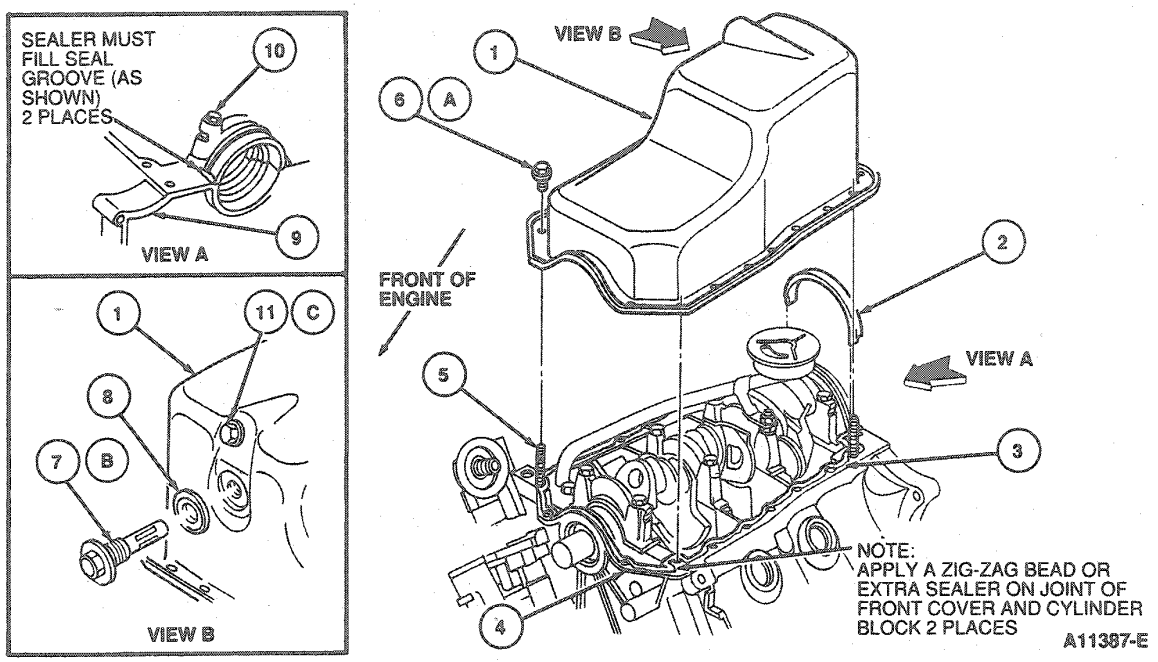
1. Position seal on Rear Main Seal Installer T82L-6701-A. Position tool and seal to rear of engine.

Oil Pan

Removal

1. Disconnect battery ground cable.
2. Raise vehicle on a hoist. Refer to Section 00-02.
3. Drain oil pan.
4. Remove oil filter element.
5. Position drain pan out of the way.
6. Remove catalytic converter assembly.
7. Remove starter motor.
8. Remove torque converter housing cover.
9. Remove bolts retaining oil pan assembly.
10. Remove oil pan assembly.

IN-VEHICLE SERVICE (Continued)



Item	Part Number	Description
1	6675	Oil Pan Assy
2	6723	Rear Seal
3	—	Silicone Rubber Sealer
4	—	Front Cover Assy
5	—	Guide Pin (2 Req'd)
6A	—	Screw and Washer Assy Hex Head
7B	6C644	Low Oil Level Sensor Assy

(Continued)

Item	Part Number	Description
8	6C626	Gasket
9	6010	Cylinder Block Assy
10	—	Rear Cap
11C	—	Oil Pan Drain Plug
A		Tighten to 9-12 N·m (80-106 Lb-In)
B		Tighten to 25-34 N·m (18-25 Lb-Ft)
C		Tighten to 20-34 N·m (15-25 Lb-Ft)

Installation

NOTE: When using silicone rubber sealer, assembly must occur within 15 minutes after sealer application. After this time, the sealer may start to set-up, and its sealing effectiveness may be reduced.

1. Clean gasket surfaces on cylinder block and oil pan.
2. Trial fit oil pan to cylinder block. Ensure enough clearance has been provided to allow oil pan to be installed without sealant being scraped off when pan is positioned under engine.
3. Apply Silicone Gasket and Sealant F1AZ-19562-A (WSE-M4G320-A2) or equivalent to oil pan.
4. Install oil pan assembly. Tighten retaining screws to 9-12 N·m (80-106 lb-in).
5. Install oil filter element assembly.
6. Install torque converter housing cover.
7. Install starter motor. Refer to Section 03-06A.
8. Install catalytic converter assembly. Refer to Section 09-00.
9. Lower vehicle.
10. Fill crankcase with the correct viscosity and amount of engine oil.
11. Connect battery ground cable.
12. Start engine and check for leaks.

IN-VEHICLE SERVICE (Continued)

Main Bearing Inserts

The main bearing inserts are precision selective fit. To check the bearing clearances or to select fit a new bearing, refer to Section 03-00.

Tools Required:

- Main Bearing Insert Tool TOOL-6331-E

Removal

1. Remove oil pan as outlined.
2. Remove oil pickup tube and screen assembly.
3. Replace one bearing at a time, leaving the other bearings securely fastened.

   Remove main bearing cap to which new bearings are to be installed.
4. Insert Main Bearing Insert Tool TOOL-6331-E, or equivalent in the oil hole in the crankshaft.
5. Rotate crankshaft in the direction of engine rotation to force bearing out of the block.
6. Clean crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pickup that would cause premature bearing wear.
7. If the crankshaft rear oil seal is to be replaced, refer to Crankshaft Rear Oil Seal Removal and Installation.

Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation.

1. Lubricate with XO-10W30-QSP (ESE-M2C153-E) or equivalent engine oil and position the upper bearing insert on crankshaft journal with plain end started into the side of cylinder block with locking tang slot. Line up bearing tang with slot in block.
2. Install Main Bearing Insert Tool TOOL-6331-E or equivalent in crankshaft journal oil hole.
3. With bearing and tool in position, rotate crankshaft so that the tool catches the edge of the bearing, pushes into position and sets in cylinder block. Remove tool.
4. Install bearing insert in main cap.
5. If bearing insert clearance is to be checked, refer to Section 03-00.
6. If No. 1 or No. 2 bearing was removed, lubricate bearing surface with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil and install main cap.

   Tighten retaining bolts to 88-110 N·m (65-81 lb-ft).
7. If rear main bearing insert was removed, perform the following:
   a. Remove all traces of sealant from main bearing cap to cylinder block parting line.

      NOTE: The bearing cap must be installed within 15 minutes after the silicone sealer application. After this time, the sealer may start to set-up and its sealing effectiveness may be reduced.
   b. Apply a 3mm (1/8 inch) bead of Silicone Rubber D6AZ-19562-BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent to main bearing cap-to-cylinder block parting line.
   c. Lubricate bearing surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil and install main bearing cap. Tighten retaining bolts to 88-110 N·m (65-81 lb-ft).
8. If thrust bearing insert was removed, perform the following:
   a. Lubricate bearing surface with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil and install main bearing cap with bolt finger-tight.
   b. Pry crankshaft forward against thrust surface on upper bearing insert, while holding bearing cap to the rear. This aligns thrust rear surfaces on both halves of the bearing.
   c. While holding crankshaft forward, tighten cap retaining bolts to 88-110 N·m (65-81 lb-ft).
9. Install oil pickup tube and screen assembly with a new gasket.

   Tighten pickup retaining bolts to 20-30 N·m (15-22 lb-ft).

   Tighten tube support bracket retaining nut to 40-55 N·m (30-40 lb-ft).
10. Install oil pan as outlined.

Connecting Rod Bearings

The connecting rod bearings are a selective fit to provide the necessary clearance. Refer to Section 03-00 to measure clearance and select the proper bearing insert.

Removal

1. Remove spark plugs.
2. Remove oil pan as outlined.

   NOTE: On Taurus Police applications, remove windage tray.
3. Turn crankshaft until connecting rod from which the bearings are to be removed is at the lowest point of travel.
4. Remove connecting rod cap and bearing lower insert.

   CAUTION: Tape or place old spark plug boots over rod bolts to avoid damage to journal during service.
5. Remove upper bearing insert. Push piston up into cylinder bore slightly to provide clearance for removal.

Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation.

IN-VEHICLE SERVICE (Continued)

1. Thoroughly clean bearing inserts, connecting rod cap and connecting rod.

   CAUTION: Contaminants allowed to remain on the cap or bearing can distort bearing or damage crankshaft journals.

2. Clean crankshaft journal and lubricate with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil.
3. Install bearing insert in the connecting rod and pull rod down until it seats on crankshaft.

   When installing bearing insert ensure tab on bearing engages slot in rod and that bearing is fully seated in rod.

4. Install bearing insert in connecting rod cap and lubricate bearing surface with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil.
5. Install connecting rod cap and retaining nuts.

   Tighten nuts to 41-49 N·m (31-36 lb-ft). Back off nuts two to three turns. Final tighten nuts to 41-49 N·m (31-36 lb-ft).

6. Install oil pan as outlined.
7. Install spark plugs.

Crankshaft

Removal

1. Remove engine from vehicle as outlined.
2. Mount engine in a suitable workstand. If necessary, drain crankcase and cylinder block cooling jackets.
3. Disconnect secondary wire from the spark plugs.

   Remove distributor cap and wires as an assembly.

4. Remove spark plugs.
5. Remove oil pan and oil pickup tube.
6. Remove front cover and water pump as an assembly.
7. Remove distributor drive gear.
8. Remove crankshaft sprocket, camshaft sprocket and timing chain. This requires pulling back on ratcheting mechanism of tensioner and installing pin through hole to relieve tension against chain.
9. Remove flywheel and rear cover plate.

   NOTE: On Taurus Police applications remove windage tray.

10. Remove connecting rod caps. Turn crankshaft as necessary to position connecting rod in the low point of travel before removing rod cap.

    Push piston up into cylinder bore after removing connecting rod cap. Ensure the crankshaft journals are not damaged.

    Each connecting rod cap should be identified so it can be installed in its original position during assembly.

11. Remove main bearing caps.
12. Carefully lift crankshaft out of block to prevent damage to bearing surfaces.

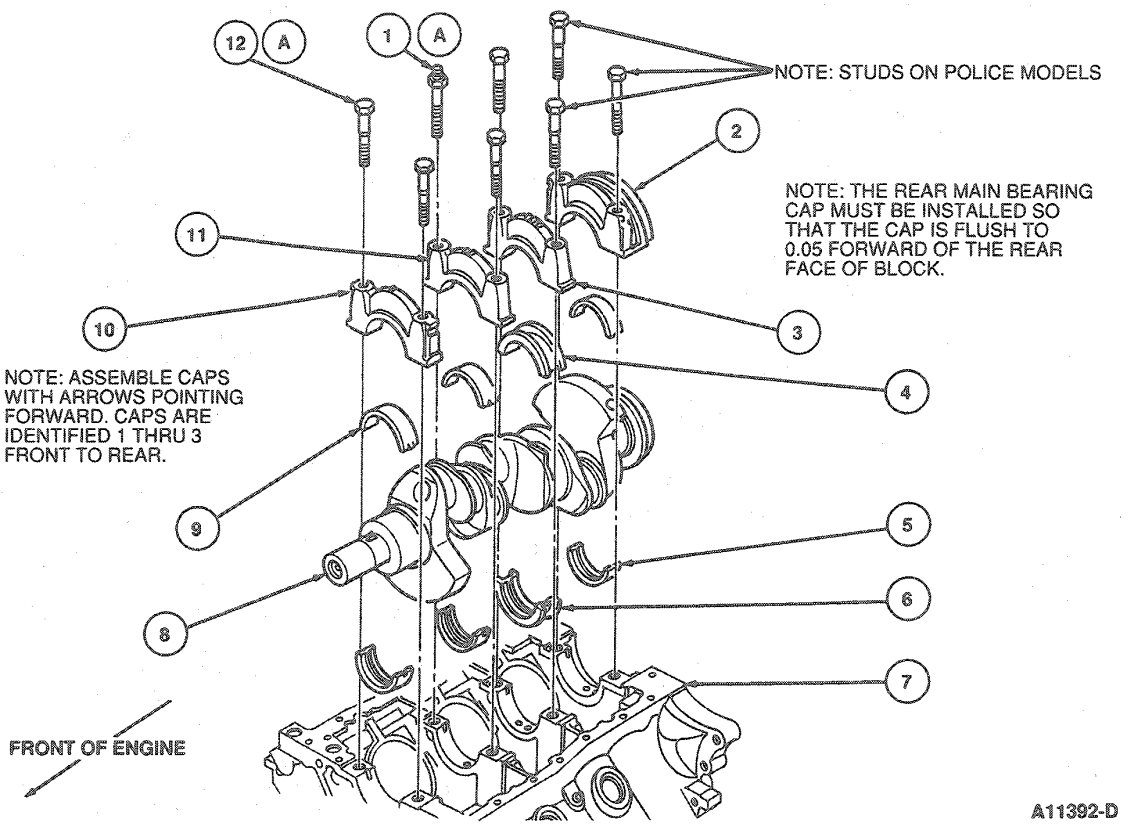
    Handle crankshaft with care to prevent possible damage to finished bearing surfaces.

13. Remove crankshaft rear seal and discard.

    CAUTION: Because the engine crankshaft incorporates deep rolling of the main journal fillets, journal refinishing is limited to 0.25mm (0.010 inch)—undersize standard journal dimensions. Further main journal refinishing may result in fatigue failure of the crankshaft.

    Refer to Section 03-00 for crankshaft cleaning, inspection and refinishing.

IN-VEHICLE SERVICE (Continued)



Item	Part Number	Description
1A	—	Stud
2	6325	Rear Cap
3	6327	Rear Intermediate Cap
4	6A339	Thrust Bearing-Lower
5	6333	Main Bearing-Upper (3 Req'd)
6	6337	Thrust Bearing-Upper

(Continued)

Item	Part Number	Description
7	6010	Cylinder Block Assy
8	6303	Crankshaft Assy
9	6A338	Main Bearing-Lower (3 Req'd)
10	6329	Front Cap
11	6334	Front Intermediate Cap
12A	—	Bolt (7 Req'd)
A		Tighten to 88-110 N·m (65-81 Lb-Ft)

Installation

NOTE: Lightly oil all bolts and stud bolt threads before installation.

CAUTION: Contaminants under a bearing will cause distortion. Contaminants on a bearing surface will cause damage to the crankshaft journals.

1. Ensure all crankshaft bearing surfaces and bearing inserts are clean.
2. If crankshaft main bearing journals have been refinished to a definite undersize, remove main bearing inserts from cylinder block and main bearing caps.

   Loosen lower intake manifold attachments prior to installing bearings or measuring bearing clearance.

   Install new bearings. Ensure tabs on insert assembly engage slots in the cap and block.
3. Ensure seal groove in cylinder block is clean.
4. Carefully lower crankshaft into position in cylinder block. Be careful not to damage thrust bearing.

IN-VEHICLE SERVICE (Continued)

5. Ensure seal groove in rear main cap is clean.

   NOTE: When using silicone rubber sealer, assembly must occur within 15 minutes after sealer application. After this time, the sealer may start to set, and its sealing effectiveness may be reduced.

6. Apply a 3mm (1/8 inch) bead of Silicone Rubber D6AZ-19562-AA (ESB-M4G92-A and ESE-M4G195-A) or equivalent to rear main bearing cap-to-cylinder block parting line.
7. Lubricate bearing surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil. Install main bearing caps and retaining bolts.
8. Tighten main bearing cap retaining bolts as follows:

   NOTE: Do not jam the screwdriver into position. Carefully tap on the screwdriver until it holds crankshaft toward front of engine.

   a. Wedge a screwdriver between cylinder block web and crankshaft cheek in front of the No. 3 main bearing.

      NOTE: No. 2 main bearing retaining stud should be tightened to 90-110 N·m (67-81 lb-ft).

   b. Tighten main bearing cap retaining bolts to 88-110 N·m (65-81 lb-ft).
   c. Remove screwdriver.
9. Check crankshaft end play as outlined.
10. Install crankshaft rear oil seal as outlined.
11. If crankshaft connecting rod journals have been refinished to a definite undersize, remove bearing inserts from connecting rods and rod caps.

    Install new bearings. Ensure tabs on insert securely engage the slots in cap and rod.

12. Rotate crankshaft as necessary to bring each crankshaft throw to lowest point of travel. Pull piston downward until connecting rod seats on crank throw and install rod caps.
13. Check connecting rod clearance. Refer to Section 03-00.

    As each clearance check is completed, lubricate bearing surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil before installing connecting rod cap.

    Tighten retaining nuts to 41-49 N·m (31-36 lb-ft), back off nuts two to three turns. Final tighten the nuts to 41-49 N·m (31-36 lb-ft).

14. Install timing chain and front cover / water pump assembly as outlined.
15. Install distributor drive gear.
16. Install oil pan as outlined.
17. Install rear cover plate and flywheel as outlined.
18. Install spark plugs.
19. Install distributor cap. Connect secondary wires to spark plugs.
20. Tighten lower intake manifold bolts to specification if loosened to service main bearings.
21. Install engine in the vehicle as outlined.

Camshaft

Removal

1. Remove engine from vehicle as outlined.
2. Remove intake manifold as outlined.
3. Remove tappets, guide plates and guide plate retainers as outlined.
4. Remove front cover and timing chain as outlined.
5. Remove oil pan as outlined.
6. Remove thrust plate.
7. Remove camshaft through the front of the engine, being careful not to damage bearing surfaces.

Installation

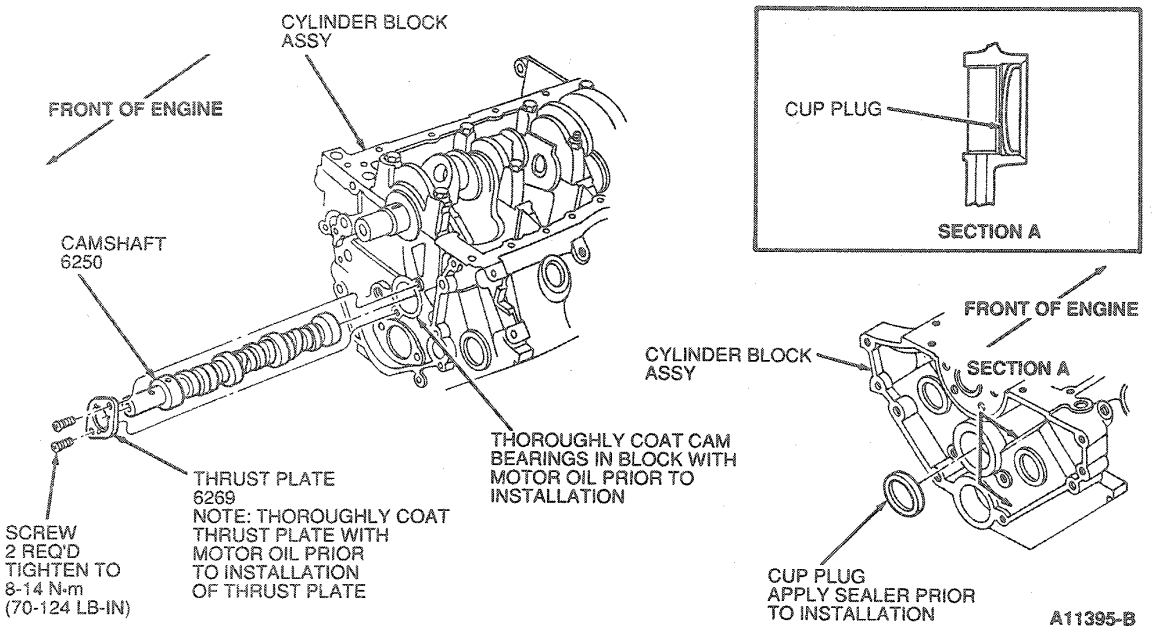
NOTE: Lightly oil all retaining bolts and stud bolt threads before installation except those specifying special sealant.

Inspect bore plug for damage or leakage. Replace or reseal as necessary (engine removed).

1. Lubricate the cam lobes and bearing surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.
2. Install camshaft being careful not to damage bearing surfaces while sliding into position.
3. Install thrust plate. Tighten bolts to 8-14 N·m (70-124 lb-in).
4. Check end play of crankshaft as outlined.
5. Install front cover and timing chain as outlined.
6. Install oil pan as outlined.
7. Install tappets, guide plates and guide plate retainers as outlined.
8. Install intake manifolds as outlined.

IN-VEHICLE SERVICE (Continued)

9. Install engine in vehicle as outlined.



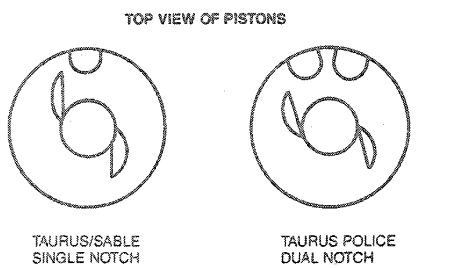
Pistons and Connecting Rods

Tools Required:

- Rotunda Piston Ring Compressor 014-00290
- Rotunda Cylinder Ridge Reamer 014-00292

Removal

CAUTION: Taurus Police vehicles use high silicon alloy pistons. They must be replaced with the same. These pistons are identified by two notches in the top of the piston.



1. Drain engine cooling system.
2. Remove intake manifolds as outlined.
3. Remove cylinder heads as outlined.
4. Remove oil pan as outlined.
5. Remove oil pickup tube and screen assembly.

   NOTE: If additional clearance is needed, remove windage tray for Police application.
6. Before removing piston, inspect top of each cylinder bore. If a ridge has formed at the top of the cylinder it must be removed before piston removal. Remove ridge as follows:
   a. Turn crankshaft until piston to be removed is at bottom of cylinder bore.
   b. Place a clean shop cloth over piston head to collect cuttings.
   c. Remove ridge using Rotunda Cylinder Ridge Reamer 014-00292 or equivalent. Never cut into ring travel area more than 0.8mm (1/32 inch) when removing ridge.
7. Turn crankshaft until piston to be removed is at the low point of its travel.

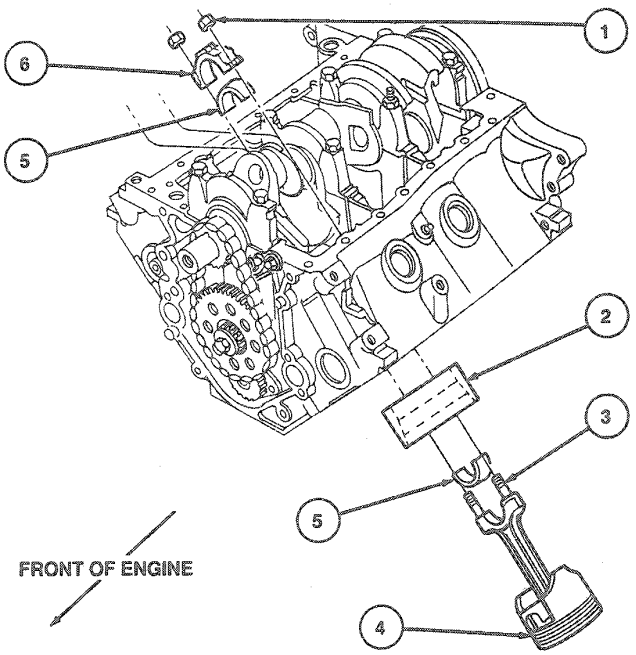
   If more than one piston is being removed, identify the pistons and connecting rod caps. Each component should be installed in its original position during assembly.
8. Remove connecting rod cap retaining nuts and cap.
9. Install spark plug boots or suitable protection over connecting rod cap studs and push piston out through the top of the cylinder bore. Use care to prevent damage to bearing surfaces.
10. Install connecting rod cap and hold in position with cap retaining nuts.

IN-VEHICLE SERVICE (Continued)

11. If piston is to be disassembled, refer to Piston, Disassembly.
12. Inspect cylinder bore. If new piston rings are to be installed on the piston a visible cross-hatch pattern should be obvious on the cylinder bore wall.

    If honing is required, remove glaze from cylinder wall using spring-loaded hone. Follow manufacturer's instructions when using this type of equipment.

After honing, thoroughly clean cylinder bore using a detergent and water solution.



TIGHTENING PROCEDURE:

1. RE-USED NUTS, FOR RE-ASSEMBLY, MUST BE WASHED CLEAN PRIOR TO ASSEMBLY. OIL NUTS OF CONNECTING ROD STUD AND CAP SEAT.
2. HAND START NUT OR USE AUTOMATIC NUT INSTALLATION AND RUN-DOWN.
3. TIGHTEN NUT TO SEAT CAP AND NUT TO 41-49 N•m (31-36 LB-FT).
4. BACK OFF NUT A MINIMUM OF TWO REVOLUTIONS.
5. FINAL TIGHTEN NUT TO 41-49 N•m (31-36 LB-FT).

NOTE:
PRIOR TO INSTALLATION OF PISTON ROD ASSY AND CAP, APPLY OIL TO ALL CRANKSHAFT PIN JOURNALS AND COAT ALL CYLINDER BORE SURFACES AND/OR PISTONS.

INSTALL PISTON AND CONNECTING ROD ASSY'S IN THE FOLLOWING ORDER.

1. **PISTON AND ROD ASSY NO. 1 AND NO. 5**
2. **PISTON AND ROD ASSY NO. 2 AND NO. 6**
3. **PISTON AND ROD ASSY NO. 3 AND NO. 4**

A11397-D

Item	Part Number	Description
1	—	Nut (12 Req'd)
2	014-00290	Piston Ring Compressor
3	6214	Bolt (12 Req'd)
4	6100	Piston and Rod Assy (6 Req'd)
5	6211	Rod Bearing (6 Req'd)
6	6210	Rod Cap (6 Req'd)

Installation

NOTE: Lightly oil all retaining bolt and stud bolt threads before installation except those specifying special sealant.

1. Lubricate cylinder wall and piston with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil.

IN-VEHICLE SERVICE (Continued)

2. Install spark plug boots or suitable protection on connecting rod studs.

   NOTE: Install pistons in the same cylinders from which they were removed or to which they were fitted. The connecting rod and bearing caps are numbered from 1 to 3 in the RH bank and from 4 to 6 in the LH bank, beginning at the front of the engine. Numbers on connecting rod and bearing cap must be on the same side when installed in cylinder bore. If a connecting rod is transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.

3. Install piston using Rotunda Piston Ring Compressor 014-00290 or equivalent.

   CAUTION: As piston is tapped into bore with a hammer handle, guide connecting rod onto crankshaft journal to avoid damage to bearing surfaces.

   Ensure notch in piston dome and button on connecting rod faces front of engine and that connecting rod oil squirt hole is facing RH side of engine.

4. Check connecting rod bearing clearance. Refer to Section 03-00.

5. Lubricate bearing surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.

6. Ensure connecting rod is seated on crankshaft journal. Install connecting rod cap.

   Tighten retaining nuts to 41-49 N·m (31-36 lb-ft). Back-off nuts two or three turns. Final tighten to 41-49 N·m (31-36 lb-ft).

7. If necessary, check connecting rod side clearance as outlined.

   NOTE: Install windage tray for Police application if removed.

8. Install oil pickup tube and screen assembly with a new gasket.

   Tighten pickup retaining bolts to 20-30 N·m (15-22 lb-ft).

   Tighten tube support bracket retaining nut to 40-55 N·m (30-40 lb-ft).

9. Install oil pan as outlined.

10. Check piston deck clearance and bore clearance as outlined in illustration.

11. Install cylinder heads as outlined.

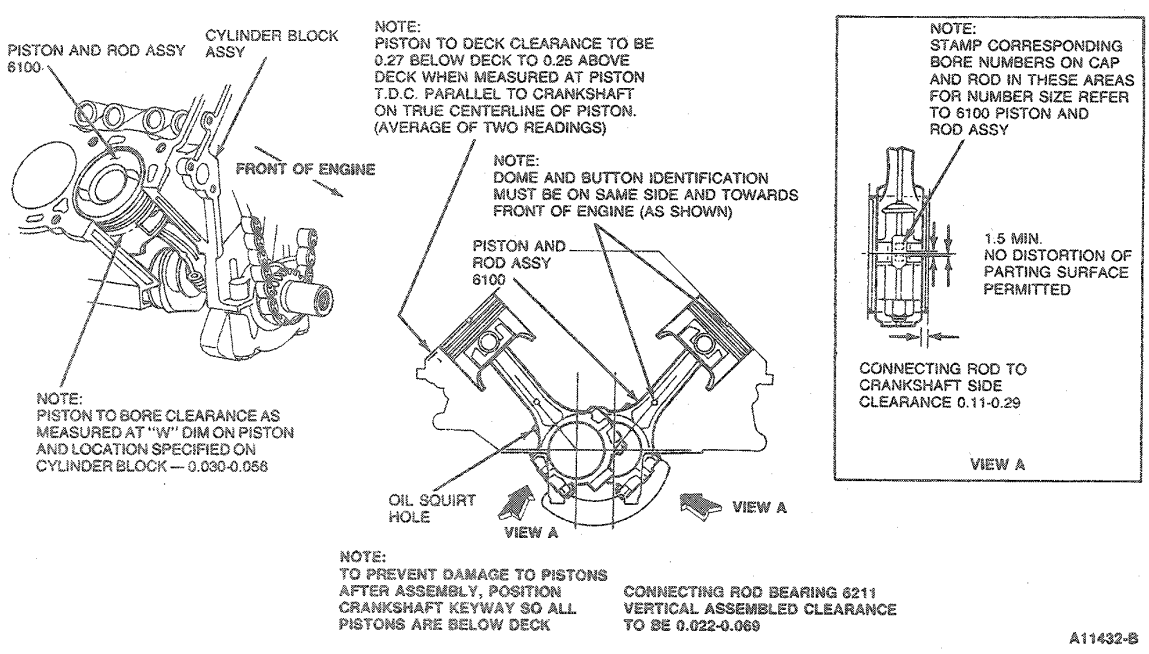
12. Install intake manifold as outlined.

13. Fill crankcase with the correct viscosity and amount of engine oil.

14. Fill cooling system with the specified coolant.

15. Start engine and check for oil and coolant leaks.

16. Check and, if necessary, adjust engine curb idle speed. Refer to Powertrain Control / Emissions Diagnosis Manual[3].



3 Can be purchased as a separate item.

IN-VEHICLE SERVICE (Continued)

Camshaft and Balance Shaft Bearings

Tools Required:

- Camshaft Bearing Set T65L-6250-A

Removal

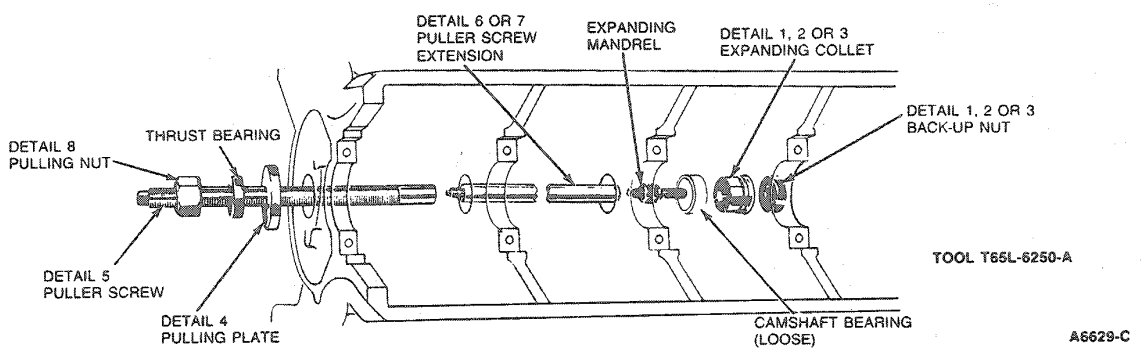
1. Remove engine from vehicle as outlined.
2. Remove flywheel and rear cover plate.
3. Remove camshaft as outlined, (and balance shaft if replacing balance shaft bearings).
4. Remove crankshaft and push piston to top of cylinder bore.
5. Remove camshaft bore plug from rear of cylinder block. (Remove balance shaft bore plug if replacing balance shaft bearings.)
6. Select proper size expanding collet and backup nut and assemble on expanding mandrel from Camshaft Bearing Set T65L-6250-A. With expanding collet collapsed, install collet assembly in camshaft bearing. Tighten backup nut on expanding mandrel until collet fits camshaft bearing.
7. Assemble puller screw and extension if necessary, and install on expanding mandrel. Wrap a cloth around threads of puller screw to protect front bearing or journal. Tighten pulling nut against thrust bearing and pulling plate to remove camshaft bearing. Hold a wrench on end of puller screw to prevent it from turning.
8. Repeat this procedure for each bearing. To remove front bearing, install puller screw from rear of cylinder block.

Installation

Camshaft bearings are available prefinished to size for standard journal diameters. The bearings are not interchangeable from one bore to another.

CAUTION: Failure to use correct expanding collet can cause severe bearing damage. Ensure front bearing is installed specified distance below front face of cylinder block.

1. Position new bearings at bearing bores with oil holes aligned with holes in block. Press them in place using Camshaft Bearing Set T65L-6250-A. Center pulling plate and puller screw to avoid damage to bearing.
2. Install camshaft bore plug as outlined.
3. Install crankshaft as outlined.
4. Install camshaft as outlined.
5. Install rear cover plate and flywheel as outlined.
6. Install engine in vehicle as outlined.



Balance Shaft and Camshaft Rear Bearing Bore Plug

Tools Required:

- Impact Slide Hammer T50T-100-A
- Impact Slide Hammer T50T-100-B

Removal

1. Remove transaxle. Refer to applicable Section in Group 07.
2. Remove flywheel as outlined.
3. Remove engine rear cover plate.
4. Using a sharp chisel or punch and hammer, cut a hole in center of plug.
5. Remove plug using Impact Slide Hammer T59L-100-B or T50T-100-A. The plug can also be pried from bore using a large punch. Use care to prevent damage to plug bore.

Installation

NOTE: Prior to installing a core plug, the plug bore should be inspected for any damage that would interfere with proper sealing of the plug. If the bore is damaged it will be necessary to true the surface by boring for the next specified oversize plug. Oversize (OS) plugs are identified by the OS stamped in the flat located on cup side of plug.

IN-VEHICLE SERVICE (Continued)

Apply a light coating of Perfect-Seal Sealing Compound B5A-19554-A (ESR-M18P2-A and ESE-M4G115-A) or equivalent to sealing edge of plug before installation.

1. Install bore plug using a suitable driver.
2. Install engine rear cover plate.
3. Install flywheel as outlined.
4. Install transaxle. Refer to applicable Section in Group 07.

Flywheel

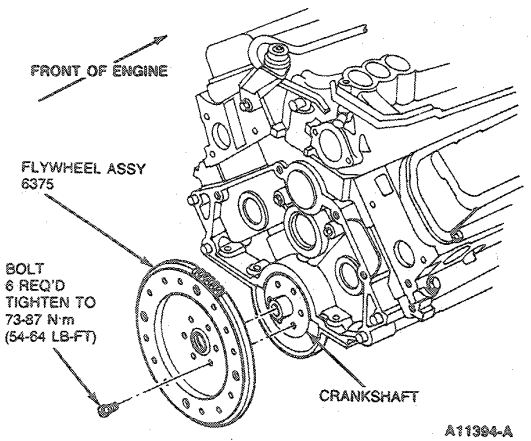
Removal

1. Remove transaxle.
2. Remove flywheel retaining bolts and flywheel.
3. The rear cover plate can be removed, if necessary.

Installation

NOTE: If flywheel is to be replaced, check if original flywheel has balance pins or rivets installed. If so, new balance rivets E2DZ-6A32-A or equivalent, must be installed on new flywheel in same position as on original flywheel.

1. Coat threads of flywheel retaining bolts with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent.
2. Install rear cover plate, if removed.
3. Position flywheel on crankshaft and install retaining bolts. Tighten bolts to 73-87 N·m (54-64 lb-ft) using standard cross-tightening sequence.
4. Install transaxle.



REMOVAL AND INSTALLATION

Engine Assembly

Tools Required:

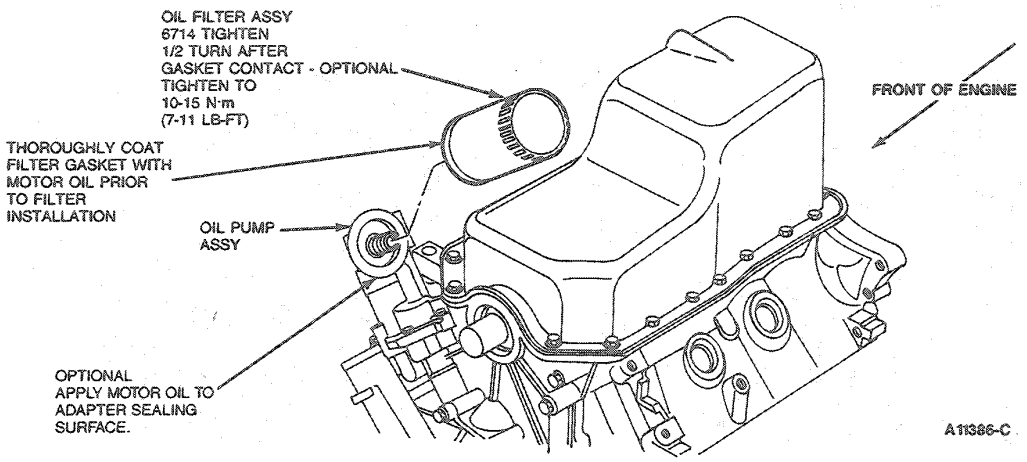
- Engine Lifting Eyes D81L-6001-D

Removal

1. Drain engine cooling system.
2. Disconnect battery ground cable.
3. Disconnect wiring connector retaining underhood lamp.
4. Mark position of hood hinges and remove hood.
5. Remove oil level indicator tube.
6. Disconnect generator to voltage regulator wiring assembly.
7. Remove radiator upper sight shield.
8. Remove engine cooling fan motor relay retaining bolts.
9. Position cooling fan motor relay out of the way.
10. Remove air cleaner assembly.
11. Disconnect radiator electric fan and motor assembly.
12. Remove fan shroud.
13. Remove upper radiator hose.
14. Disconnect transaxle oil cooler inlet and outlet tubes.
15. Disconnect heater hoses.
16. Disconnect power steering pressure hose assembly.
17. Disconnect air conditioner compressor clutch wire assembly.
18. Discharge A/C system. Refer to Section 12-00.
19. Disconnect compressor to condenser line.
20. Remove radiator coolant recovery reservoir assembly.
21. Remove wiring shield.
22. Remove accelerator cable mounting bracket.
23. Disconnect fuel inlet hose.
24. Disconnect fuel return hose.
25. Disconnect power steering pump pressure and return tube bracket.
26. Disconnect powertrain control module (PCM) wiring assembly.
27. Disconnect vacuum hoses.
28. Disconnect ground wire assembly.
29. Remove duct assembly.
30. Disconnect one end of throttle control valve cable.
31. Disconnect bulkhead electrical connector and transaxle pressure switches.
32. Remove bolts retaining transaxle support assembly.
33. Remove transaxle and support assembly from vehicle.

REMOVAL AND INSTALLATION (Continued)

34. Raise vehicle on hoist. Refer to Section 00-02.
35. Position drain pan beneath vehicle oil pan.
36. Drain engine oil.
37. Remove oil filter element assembly.

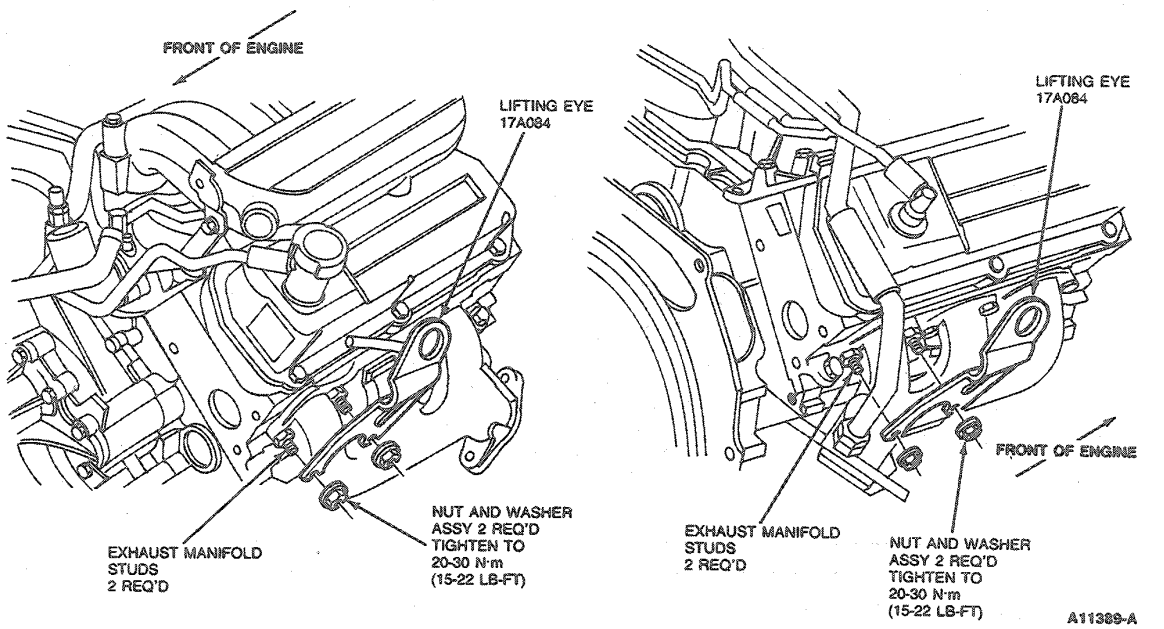


38. Position drain pan away from vehicle.
39. Disconnect heated oxygen sensor (H02S)(9F472).
40. Loosen and remove drive belt assembly.
41. Remove crankshaft pulley assembly.
42. Remove drive belt tensioner assembly.
43. Remove starter motor assembly.
44. Remove catalytic converter housing assembly.
45. Remove converter and inlet pipe assembly.
46. Remove LH front transaxle mount nuts.
47. Remove RH front engine mount retaining nuts.
48. Remove converter-to-flywheel nuts.
49. Disconnect oil level indicator sensor.
50. Remove crankshaft pulley assembly.
51. Disconnect lower radiator hose.
52. Remove engine-to-transaxle bolts.
53. Partially lower engine.

54. Remove wheel and tire assemblies.
55. Remove water pump pulley retaining bolts.
56. Remove water pump pulley.
57. Remove distributor cap and position out of the way.
58. Remove distributor rotor.
59. Remove exhaust manifold bolt lock retaining bolts.
60. Remove AIR pump retaining bolts.
61. Remove AIR pump.
62. Disconnect oil pressure engine unit gauge assembly.
63. Install Engine Lifting Eyes D81L-60001-D or equivalent.
64. Position engine lifting equipment.
65. Position jacks.
66. Raise transaxle assembly slightly.

REMOVAL AND INSTALLATION (Continued)

67. Remove engine assembly from vehicle.



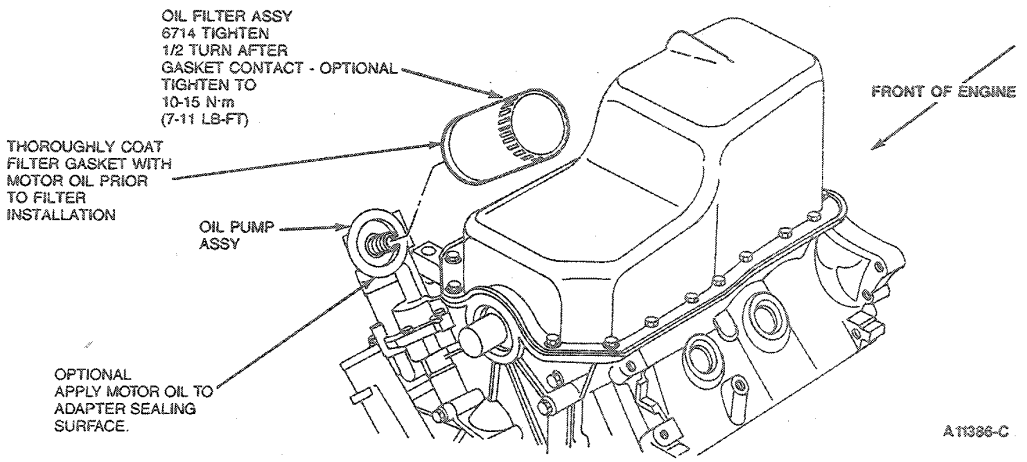
Installation

NOTE: Lightly oil all bolt and stud bolt threads before installation except those specifying special sealant.

1. Position engine assembly in vehicle.
2. Install engine-to-transaxle bolts.
3. Remove jacks and place them out of the way.
4. Remove engine lifting equipment and place out of the way.
5. Remove engine lifting eyes.
6. Tighten engine-to-transaxle bolts to 55-68 N·m (40-50 lb-ft).
7. Connect oil pressure engine unit gauge assembly.
8. Place A/C compressor in proper position and tighten retaining bolts to 41-61 N·m (30-45 lb-ft).
9. Connect compressor to condenser discharge line.
10. Connect air conditioner compressor clutch wire assembly.
11. Connect water heater hoses.
12. Connect fuel tube hose.
13. Connect fuel return line hose.
14. Connect vacuum hose.
15. Connect transaxle oil cooler inlet and outlet tubes.
16. Install radiator assembly.
17. Partially raise vehicle.
18. Install converter-to-flywheel bolts. Tighten to 27-46 N·m (20-34 lb-ft).
19. Install LH and RH transaxle and engine mount retaining nuts.
20. Install converter housing cover.
21. Install starter motor. Refer to Section 03-06A.
22. Connect lower radiator hose.
23. Install drive belt tensioner assembly.
24. Install crankshaft pulley assembly. Tighten retaining bolts to 26-38 N·m (19-28 lb-ft).
25. Install converter assembly.
26. Connect HO2S.

REMOVAL AND INSTALLATION (Continued)

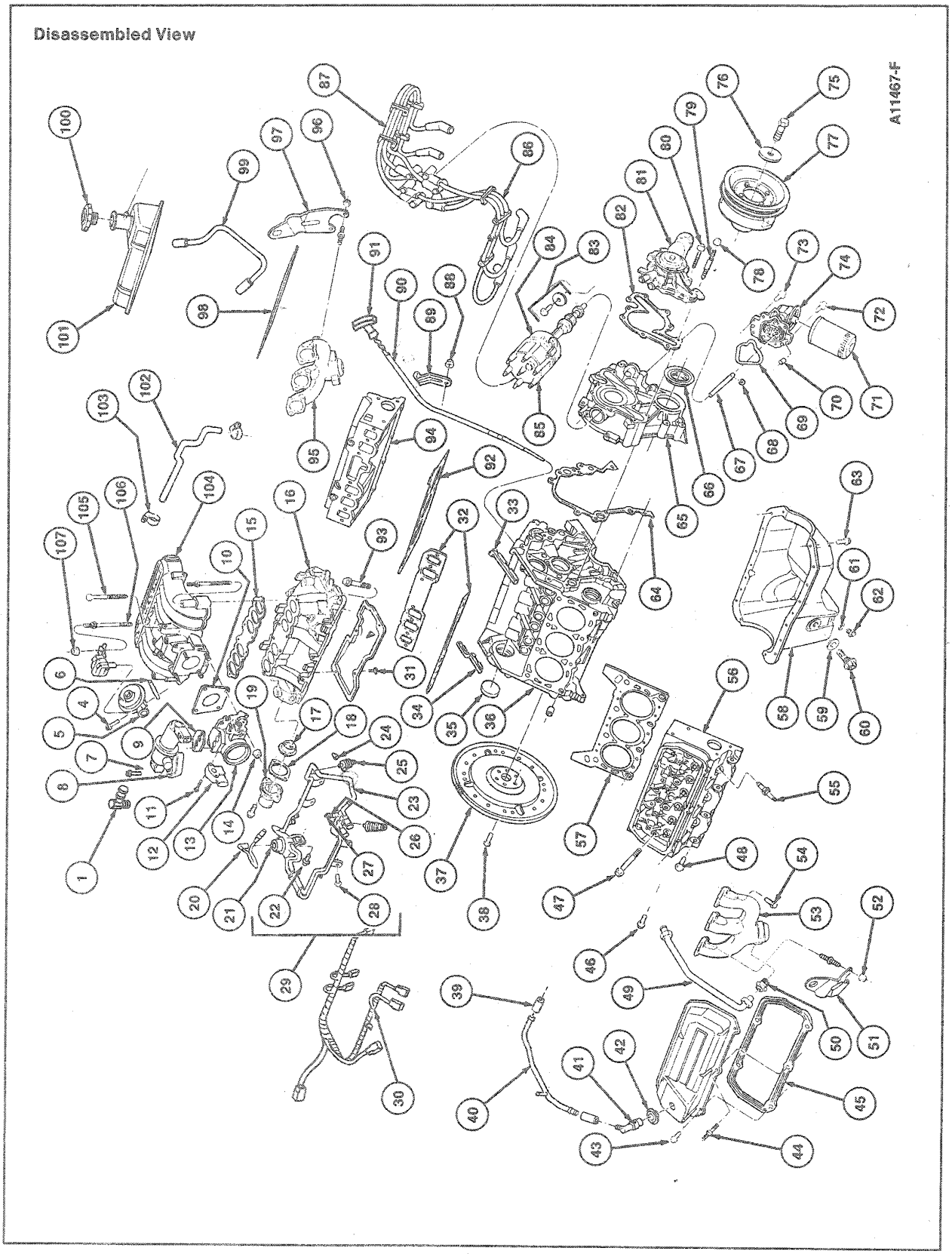
27. Install oil filter.



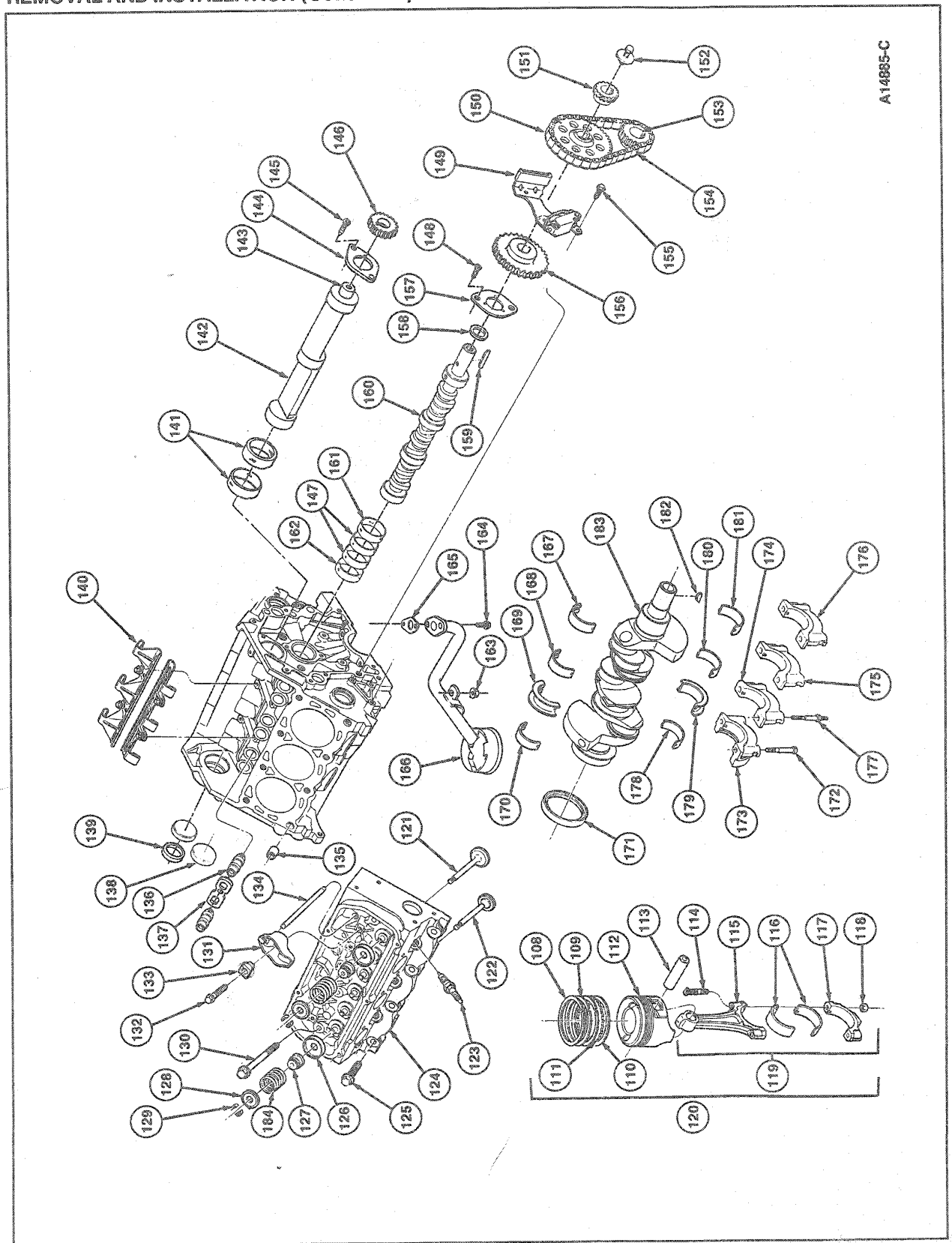
28. Connect oil level indicator sensor.
29. Lower vehicle.
30. Position AIR supply pump and install retaining bolts.
31. Connect vacuum pump.
32. Install AIR pump pulley.
33. Install wiring shield.
34. Install distributor rotor.
35. Install radiator coolant recovery reservoir assembly.
36. Connect upper radiator hose.
37. Install water pump pulley.
38. Connect generator-to-voltage regulator wiring assembly.
39. Connect PCM wiring assembly.
40. Connect wiring assembly ground.
41. Install accelerator cable mounting bracket.
42. Connect power steering pressure hose assembly.
43. Connect power steering line.
44. Install fan shroud.
45. Connect radiator electric motor assembly.
46. Install engine cooling fan motor relay assembly.
47. Position drive belts.
48. Position and install transaxle support assembly.
49. Install radiator upper sight shield.
50. Partially raise vehicle.
51. Install tire and wheel assemblies. Tighten wheel lug nuts to 115-142 N·m (85-105 lb-ft).
52. Install hood.
53. Connect battery ground cable.
54. Fill crankcase with the correct viscosity and amount of engine oil.
55. Refill coolant.
56. Evacuate, pressure test and recharge A/C system.
57. Start engine and check for leaks.

REMOVAL AND INSTALLATION (Continued)

Disassembled View



REMOVAL AND INSTALLATION (Continued)



REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	18599	Tee
2	—	Not Used
3	—	Not Used
4	N804073-S8	Bolt
5	9D475	EGR Valve
6	9S476	Gasket
7	N605774-S100	Screw
8	9F715	Air Bypass Valve
9	9F670	Gasket
10	9E936	Gasket
11	N803851-S2	Screw
12	9B989	Throttle Position Sensor
13	9E927	Throttle Body
14	N804178-S36	Nut
15	9H486	Gasket
16	9K461	Intake Manifold
17	8575	Thermostat
18	8255	Gasket
19	8594	Housing
20	9E498	Hose
21	9C968	Pressure Regulator
22	N606690-S	Bolt
23	9F792	Fuel Rail
24	247111	Retaining Clip
25	9F593	Injector
26	9H321	Valve Assy
27	9H323	Valve Cap
28	N804394-S8M	Bolt
29	9F797	Fuel Rail / Injector Assy
30	9D930	Fuel Injector Harness
31	390633-S2	Bolt
32	9439	Gaskets
33	9A424	Seal
34	9A425	Seal
35	247073	Plug
36	6010	Block
37	6375	Flywheel
38	N805018-S	Bolt
39	381187-S015A	Hose
40	6758	Pipe
41	6B840	PCV Valve
42	6K786	Grommet
43	N803298	Bolt
44	N803262-S2	Bolt / Stud
45	6584	Gasket
46	N602569-S2	Bolt
47	N802516-S	Bolt
48	N802516-S	Bolt
49	9D477	Pipe
50	9J469	Adapter
51	17A084	Lifting Eye
52	N621939-S2	Nut
53	9430	Exhaust Manifold
54	N8D1647-S	Bolt
55	12405	Spark Plug
56	6049	Cylinder Head

(Continued)

Item	Part Number	Description
57	6051	Gasket
58	6675	Oil Pan
59	6C626	Seal
60	6C627	Bolt
61	6734	Washer
62	6730	Bolt
63	N605892-S2	Bolt
64	6020	Gasket
65	6019	Front Cover
66	6700	Seal
67	6A605	Drive Gear
68	6A751	Retaining Clip
69	6C639	Seal
70	N804055-S	Dowel
71	6714	Filter
72	N804601-S2	Bolt
73	N804602-S2	Bolt
74	6603	Pump
75	N800069-S2	Bolt
76	N801539-S2	Washer
77	6B321	Damper
78	245908-S2	Nut
79	245906-S2	Stud
80	246097	Bolt
81	8501	Waterpump
82	6507	Gasket
83	12A309	Holddown Assy
84	12A332	Distributor Assy
85	12106	Cap
86	12280	Wiring Assy (RH)
87	12281	Wiring Assy (LH)
88	N621939-S36M	Nut
89	6786	Bracket
90	6784	Dipstick Tube
91	6750	Dipstick
92	6051	Gasket
93	N803674-S2	Bolt
94	6049	Cylinder Head
95	9431	Exhaust Manifold
96	N621939-S2	Nut
97	17A084	Lifting Eye
98	6584	Gasket
99	6C342	Pipe—Crankcase Ventilation
100	6766	Oil Cap
101	6A505	Cover
102	8597	Pipe—Water-By-Pass
103	383522-S02	Clamp
104	9424	Intake Manifold
105	N804268	Bolt
106	245905-S2	Bolt / Stud
107	N621939-S2	Nut
108	6150	Piston Compression Ring (Top) (6)
109	6152	Piston Compression Ring (Bottom) (6)

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
110	6159	Piston Oil Control Ring (Top Rail) (12)
111	6161	Piston Oil Control Expander (6)
112	6110	Piston (6)
113	6135	Piston Pin (6)
114	6214	Bolt Connecting Rod (12)
115	6205	Connecting Rod (6)
116	6211	Bearing, Connecting Rod (Upper/Lower)(12)
117	6210	Cap, Connecting Rod (6)
118	N800113-S	Nut, Connecting Rod (12)
119	6200	Assy, Connecting Rod
120	6100	Assy, Piston
121	6507	Valve, Intake (6)
122	6505	Valve, Exhaust (6)
123	12405	Spark Plug (6)
124	6049	Head, Cylinder
125	N802516-S	Bolt, Cylinder Head Attaching (Short) (4 Per Side)
126	6A536	Seat, Valve Spring
127	6A517	Oil Seal Valve (6)
128	6514	Retainer, Valve Spring (12)
129	6518	Keys, Valve Spring Retainer (24)
130	N802515-S	Bolt Cylinder Head Attaching (Long) (4 Per Side)
131	6564	Rocker Arm (12)
132	N801365-S100	Bolt, Rocker Arm Retaining (12)
133	6A528	Fulcrum, Rocker Arm (12)
134	6565	Pushrod (12)
135	6A008	Dowel (Split) (4)
136	6500	Roller Tappet (12)
137	6K512	Tappet Guide Plate (6)
138	376958-S102	Cup Plug (2)
139	6A335	Cup Plug
140	6K564	Tappet Guide Plate Retainer (2)
141	6A333	Bearing-Balance Shaft (2)
142	6A306	Balance Shaft
143	73217-S	Key-Balance Shaft
144	6C341	Balance Shaft Thrust Plate

(Continued)

Item	Part Number	Description
145	N804621-S2	Screw—Flat Head (2)
146	6A304	Balance Shaft Driven Gear
147	6267	Bearing—Camshaft Intermediate (2)
148	N804621-S2	Screw—Flat Head (2)
149	6K254	Tensioner and Snubber Assy
150	6256	Camshaft Sprocket
151	6255	Drive Gear
152	N806049-S2	Bolt and Washer Assy
153	6306	Crankshaft Sprocket
154	6268	Timing Chain
155	N605890-S2	Bolt (3)
156	6A303	Balance Shaft Drive Gear
157	6269	Camshaft Thrust Plate
158	6265	Spacer
159	N805256-S	Key, Camshaft
160	6250	Camshaft
161	6261	Bearing—Camshaft Front
162	6263	Bearing—Camshaft Rear
163	N621942-S2	Nut
164	N801689-S	Bolt (2)
165	6625	Gasket
166	6622	Oil Pump Screen and Cover
167	6333	No. 1 Upper Main Bearing
168	6333	No. 2 Upper Main Bearing
169	6337	No. 3 Upper Main Thrust Bearing
170	6333	No. 4 Upper Main Bearing
171	6701	Rear Oil Seal
172	N805416-S	Bolt (7)
173	6325	Rear Main Cap
174	6237	Rear Intermediate Main Cap
175	6334	Front Intermediate Main Cap
176	6329	Front Main Cap
177	N805417-S	Stud
178	6A338	No. 4 Lower Main Bearing
179	6A339	No. 3 Lower Main Bearing
180	6A338	No. 2 Lower Main Bearing
181	6A338	No. 1 Lower Main Bearing
182	388907-S	Key, Crankshaft
183	6303	Crankshaft
184	6513	Valve Spring

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DISASSEMBLY AND ASSEMBLY

Engine

Disassembly

Tools Required:

- Crankshaft Damper Remover T58P-6316-D
- Front Cover Seal Installer T70P-6B070-A
- Spark Plug Wire Remover T74P-6666-A
- Damper/Front Cover Seal Installer T82L-6316-A
- Vibration Damper Remover Adapter T82L-6316-B
- Rotunda Piston Ring Compressor 014-00290
- Rotunda Cylinder Ridge Reamer 014-00292

Before starting disassembly, remove accessories and any emission control equipment which is not directly attached to engine.

1. Remove flywheel and rear cover plate.

DISASSEMBLY AND ASSEMBLY (Continued)

2. Remove exhaust manifold and exhaust manifold.

   When exhaust manifold is removed, note location of dipstick tube support bracket.

3. Remove following positive crankcase ventilation system components:

   a. Front and rear PCV tubes.

   b. PCV valve.

   c. PCV valve grommet.

4. Disconnect engine coolant bypass hose at water pump and intake manifold. Remove hose.

5. Disconnect secondary wires from spark plugs.

   Remove distributor cap (with secondary wires) and rotor.

   When removing a wire from a spark plug, use Spark Plug Wire Remover T74P-6666-A. Grasp and twist boot back and forth on plug insulator to free boot. Use tool to pull boot from plug. Do not pull on wire directly or it may become separated from connector inside boot.

6. Remove following components:

   a. Throttle body (9E926) assembly and gasket.

   b. EGR valve assembly.

7. Remove intake manifold upper gasket.

8. Remove injector fuel rail assembly.

9. Remove crankshaft pulley and vibration damper. Use Crankshaft Damper Remover T58P-6316-D and Vibration Damper Remover Adapter T82L-6316-B to remove vibration damper.

10. Remove distributor hold-down clamp and distributor.

11. Remove rocker arm covers.

    CAUTION: Use care to prevent damage to machined surfaces.

    NOTE: Before attempting to remove lower intake manifold, break seal between intake manifold and cylinder block. Wedge a large screwdriver between intake manifold and block. Pry downward on screwdriver using lug on water pump as a leverage point.

12. Remove lower intake manifold and intake manifold to cylinder head gaskets. Discard intake manifold to cylinder head gaskets and seals.

13. Remove spark plugs.

14. Remove rocker arms and push rods.

    The location of each rocker arm, push rod and fulcrum should be noted. When engine is assembled each component should be installed in its original position.

15. Remove cylinder heads. Discard cylinder head retaining bolts. Remove and discard cylinder head gaskets.

16. Remove valve tappets and guide plate and retainer assemblies.

    The location of each tappet should be identified. When engine is assembled each tappet should be installed in its original position.

    If tappets are stuck in bores due to excessive varnish or gum deposits, it may be necessary to use a magnet or a claw-type tool to aid removal. When using a remover tool, rotate tappet back and forth to loosen it from any gum or varnish that may have formed on tappet.

17. Remove oil filter.

18. Remove oil pan and clean off RTV gasket.

    NOTE: On Taurus Police applications remove windage tray.

19. Remove oil pickup tube and filter assembly. Discard pickup tube gasket.

    NOTE: If necessary, water pump can be removed from front cover. Discard pump gasket after removal.

20. Remove water pump and front cover as an assembly. Remove and discard cover gasket.

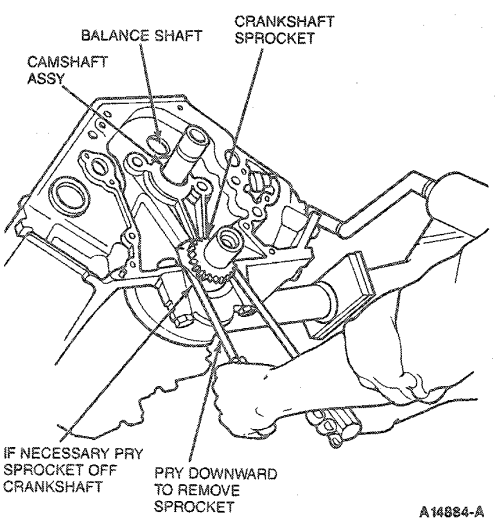
    After removing cover, remove bolt and washer from end of camshaft.

21. Remove distributor drive gear.

    CAUTION: Use care to prevent damage to finished areas on crankshaft and sprocket.

    NOTE: If crankshaft sprocket is difficult to remove, it can be pried off using two large screwdrivers.

    Remove camshaft sprocket, crankshaft sprocket, timing chain and tensioner assembly.



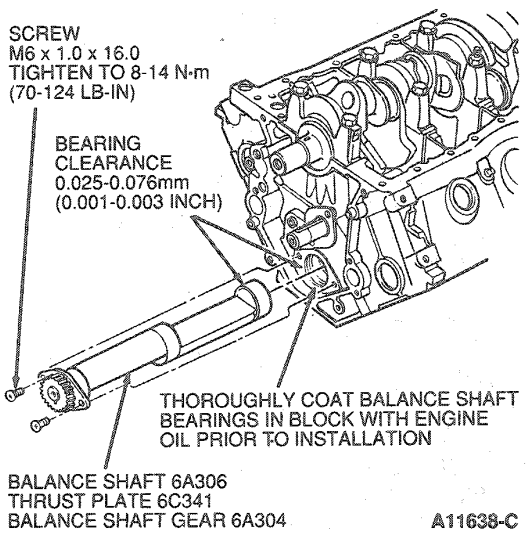
22. Remove balance shaft drive gear and spacer.

23. Remove camshaft thrust plate.

DISASSEMBLY AND ASSEMBLY (Continued)

24. Remove camshaft. Use care to prevent damage to camshaft bearing surfaces.
25. If necessary, remove camshaft plug from back of engine.
26. Remove screws securing balance shaft thrust plate.

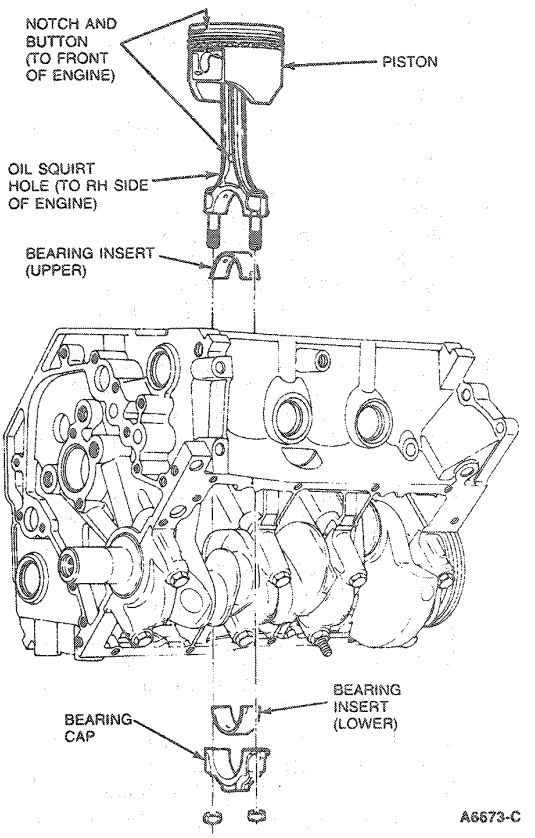
    CAUTION: Use care to prevent damage to bearing surface.
27. Remove balance shaft gear, thrust plate and shaft assembly.



CAUTION: Never cut into ring travel area in excess of 0.794mm (0.0325 inch).

NOTE: Before removing pistons, inspect top of cylinder bores. If necessary, remove ridge and/or carbon deposits from each cylinder using Rotunda Cylinder Ridge Reamer 014-00292 or equivalent. Before ridge or deposits are removed, turn crankshaft until piston is at bottom of its stroke. Cover piston with a clean shop towel to collect cuttings. After cutting operation, turn crankshaft until piston is at top of its stroke and remove shop towel with cuttings.

28. Remove connecting rod caps and pistons.



The location of each piston, crank bearing and rod cap should be noted. When engine is assembled each component should be installed in its original position.

29. Remove main bearing caps and crankshaft.

    The location of main bearings should be identified. When engine is assembled each bearing should be installed in its original position.
30. For cleaning purposes, oil gallery and cooling jacket plugs can be removed.

Assembly

NOTE: During engine assembly, a RTV-type sealer will be applied to many components before installation. When the sealant is applied, the component should be installed within 15 minutes. After this time the sealant begins to set-up and its sealing effectiveness can be reduced.

NOTE: Lightly oil all retaining bolt and stud bolt threads before installation except those specifying special sealant.

1. If removed, install oil gallery and cooling jacket plugs. Tighten plugs to specification.

   Before installation, coat plug threads with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent.

DISASSEMBLY AND ASSEMBLY (Continued)

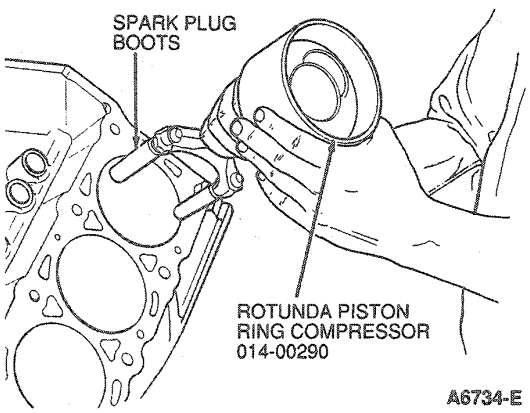
To provide clearance for camshaft sprocket, oil gallery plugs on front of engine must be threaded below machined surface.

2. Install crankshaft as follows:
   a. Install main bearing inserts in cylinder block. Note that third bearing from front is the thrust bearing.
   b. Lubricate bearing inserts with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil, and carefully lower crankshaft into place. Use care to prevent damage to bearing surfaces.
   c. Apply a 3mm (1/8 inch) bead of Silicone Rubber, D6AZ-19562-BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent to cylinder block rear main bearing cap parting line.
   d. Install bearing inserts in main caps and install caps. Note that caps are numbered with triangles. Number one is located at front of engine with triangle facing front of engine.
   e. Install main bearing cap retaining bolts.
   f. Before tightening bearing cap bolts, wedge a large screwdriver between cylinder block web and crankshaft cheek located in front of No. 3 main bearing.

      Do not jam screwdriver into place. Tap into position only enough to hold crankshaft forward while cap bolts are tightened.
   g. Tighten bearing cap retaining bolts to 88-110 N·m (65-81 lb-ft) and remove screwdriver.
3. Check crankshaft end play as outlined.
4. Install pistons as follows:
   a. Install bearing inserts in connecting rods and connecting rod caps.
   b. Install pistons using Rotunda Piston Ring Compressor 014-00290 or equivalent. The notch in piston dome and button on connecting rod have to face front of engine. Oil squirt hole in rod faces RH side of engine.

      Lubricate piston and cylinder walls with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil before installation.

      NOTE: Scratching of crankshaft journal can be prevented by covering connecting rod bolts with spark plug boots or flexible hose.



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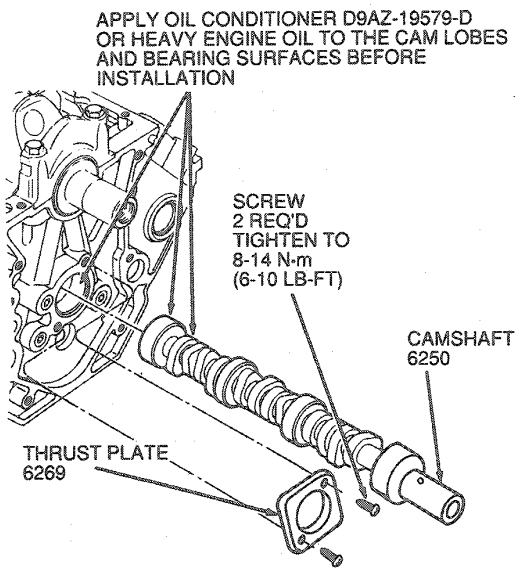

NOTE: THOROUGHLY COAT THRUST PLATE WITH ENGINE OIL PRIOR TO INSTALLATION OF THRUST PLATE

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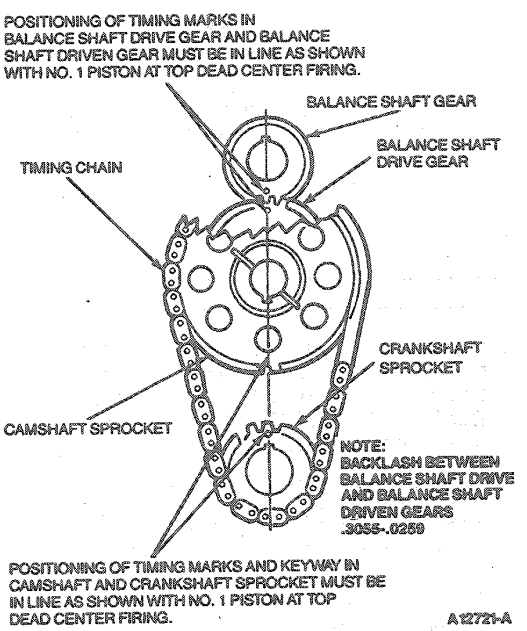
   c. Install connecting rod caps and retaining nuts. Tighten nuts to 41-49 N·m (31-36 lb-ft).
5. Check connecting rod side clearance as outlined.
6. Coat sealing edge of plug with Perfect-Seal Sealing Compound B5A-19554-A (ESR-M18P2-A and ESE-M4G115-A) or equivalent before installation.
7. Install bore plug using a suitable driver.
8. Coat camshaft lobes with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Lubricate camshaft bearings with heavy oil SF.
9. Install camshaft as outlined.
10. Install camshaft thrust plate.
11. Install balance shaft gear.

DISASSEMBLY AND ASSEMBLY (Continued)

12. Install balance shaft, thrust plate and gear, and tighten retaining bolts to 8-14 N·m (70-124 lb-in). Align balance shaft timing marks as shown.
13. Lubricate timing chain with clean engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent.
14. Rotate crankshaft, as necessary, to position crank sprocket keyway in 12 o'clock position. Install balance shaft drive gear spacer. Install timing chain tensioner (retracted position).
15. Install camshaft sprocket, crankshaft sprocket and timing chain. Pull pin on tensioner to release tensioner against chain.
16. Ensure crankshaft keyway, cam sprocket timing mark and crank sprocket timing mark are properly aligned after installation.



17. Install distributor drive gear.
18. If water pump was removed from front cover during engine disassembly, position a new pump gasket on front cover and install water pump.

    Tighten pump retaining bolts to 20-30 N·m (15-22 lb-ft).
19. Install camshaft bolt and washer and tighten to 40-50 N·m (30-37 lb-ft).
20. Position a new front cover gasket on engine. Install cover and ignition timing indicator. Tighten attaching bolts to 20-30 N·m (15-22 lb-ft).
21. Install oil pickup and tube assembly using a new gasket.

    Tighten retaining bolts to 20-30 N·m (15-22 lb-ft), and support bracket retaining nut to 40-55 N·m (30-40 lb-ft).
22. Install oil pan as follows:

    NOTE: Using solvent, clean oil pan and engine block seating surfaces before applying silicone sealer.

    a. Using a small-blade screwdriver remove any sealer which may have been squeezed into seal groove when rear main bearing cap was installed. Place a 6.35mm (1/4 inch) bead of Silicone Gasket and Sealant D6AZ-19562-AA or BA (ESB-M4G92-A and ESE-M4B195-A) or equivalent, into seal groove where bearing cap meets block.

    b. Apply a 3mm (1/8 inch) bead of Silicone Gasket and Sealant Sealer D6AZ-19562-AA or BA (ESB-M4G92-A and ESE-M4G195-A) or equivalent to seams where front cover mates with cylinder block and to each end of pan end seal.

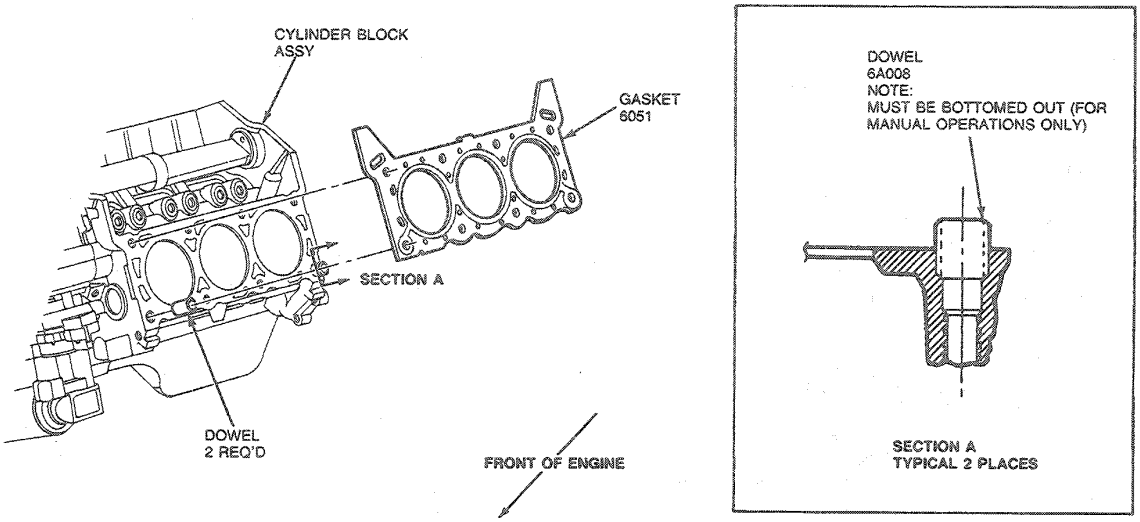
    c. Apply RTV gasket material in zig-zag pattern to oil pan sealing surface.

    d. Install oil pan. Tighten retaining bolts to 9-12 N·m (80-106 lb-in).
23. Lubricate oil filter gasket with clean engine oil and install.

    Thread filter onto adapter until gasket contacts cylinder block and then advance filter an additional one-half turn.
24. Lubricate tappets with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent, and install. Install guide plates and retainers.

DISASSEMBLY AND ASSEMBLY (Continued)

25. Install new cylinder head gaskets using dowels to align gasket.



CAUTION: Always use new cylinder head bolts to ensure a leak-tight assembly. Torque retention with used bolts can vary, which may result in coolant or compression leakage at the cylinder head mating surface area.

Tighten cylinder head retaining bolts in sequence.

a. 50 N·m (37 lb-ft)
b. 60 N·m (45 lb-ft)
c. 70 N·m (52 lb-ft)
d. 80 N·m (59 lb-ft)

In sequence, retighten bolts one at a time in the following manner:

e. Long bolts: Loosen bolt and back out two or three revolutions. Retighten long bolt to 15-25 N·m (11-18 lb-ft). Then tighten an additional 85-105 degrees and go to the next bolt in sequence.
f. Short bolts: Same as long bolt tightening procedure **EXCEPT** once torque of 15-25 N·m (11-18 lb-ft) is reached, bolt should only be tightened an additional 65-85 degrees.

26. Install push rods, rocker arms, fulcrums and retaining bolts. Lubricate push rod ends and fulcrums with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil before installation.

    For each valve, rotate crankshaft until tappet rests on heel (base circle) of camshaft lobe. Tighten fulcrum retaining bolt to 7-15 N·m (62-132 lb-in). Final tighten the fulcrum retaining bolts to 25-35 N·m (19-25 lb-ft). For final tightening, camshaft may be in any position.
27. Install lower intake manifold as outlined.
28. Install spark plugs. Tighten to 7-15 N·m (62-132 lb-in).
29. Install rocker arm covers as follows:

    NOTE: Using solvent, clean valve cover and cylinder head sealing surfaces to remove all gasket material and dirt.

    a. Install a new gasket onto cylinder head.
    b. Install valve cover and retaining bolts. Note location of stud / bolts.
    c. Tighten retaining bolts to 9-12 N·m (80-106 lb-in).
30. Install distributor and hold-down clamp. Tighten hold down bolt to 27-40 N·m (20-29 lb-ft).

DISASSEMBLY AND ASSEMBLY (Continued)

31. Install crankshaft damper using Damper / Front Cover Seal Installer T82L-6316-A and Front Cover Seal Installer T70P-6B070-A. Tighten retaining bolts to 140-180 N·m (103-132 lb-ft).

    Install crankshaft pulley. Tighten retaining bolts to 26-38 N·m (19-28 lb-ft).
32. Install injector and fuel rail assembly and tighten bolts for fuel rail bracket to 8-11 N·m (6-8 lb-ft).
33. Install PCV tubes and valve assembly.
34. Install intake manifold and tighten bolts and studs in two steps:
    a. 11 N·m (8 lb-ft)
    b. 15 N·m (11 lb-ft)
35. Install EGR valve assembly. Tighten bolts to 20-30 N·m (15-22 lb-ft).
36. Install distributor cap. Connect secondary wires to spark plugs.
37. Install coolant bypass hose.
38. Install exhaust manifold and exhaust manifold. Note location of oil dipstick tube support bracket. Tighten exhaust manifold and exhaust heat control retaining bolts to 20-30 N·m (15-22 lb-ft).
39. Apply a thin coat of Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent to flywheel retaining bolt threads before installation.
40. Install rear cover plate and flywheel.
41. Tighten retaining bolts to 73-87 N·m (54-64 lb-ft) in standard cross-tightening sequence.

Subassemblies

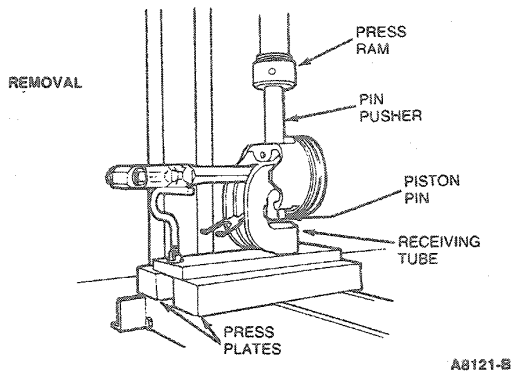
Pistons and Connecting Rods

Tools Required:

- Piston Pin Remover T68P-6135-A
- Feeler Gauge D81L-4201-A

Disassembly

1. Remove bearing inserts from connecting rod and cap.
2. Remove piston rings using a suitable piston ring expander.
3. Mark pistons to ensure assembly with same rod and installation in same cylinders from which they were removed.
4. Using an Arbor Press and Piston Pin Remover and Replacer T68P-6135-A press piston pin from piston and connecting rod.



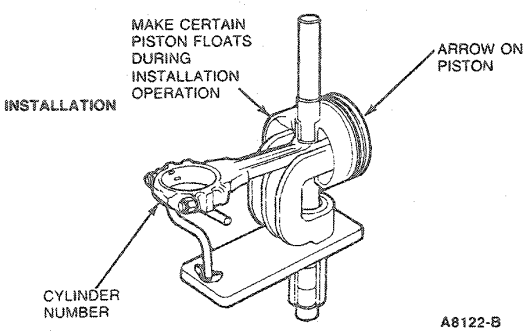
Assembly

Check the fit of a new piston in the cylinder bore before assembling piston and piston pin to connecting rod.

The piston pin bore of a connecting rod and diameter of piston pin must be within specification.

1. Apply light coat of XO-10W30-QSP (ESE-M2C153-E) or equivalent engine oil to all parts.
2. Assemble piston to connecting rod using notch in piston dome and connecting rod oil squirt hole for assembly reference.

   On V-6 engines with one rod per pin, both sides of rod have larger chamfers.
3. Start piston pin in piston and connecting rod (this may require a very light tap with a mallet). Using an Arbor Press and Piston Pin Remover and Replacer T68P-6135-A, press piston pin through piston until the pin is centered.



4. Check end gap of all piston rings. It must be within specification. Follow instructions contained on piston ring package and install piston rings.
5. Check ring side clearance of compression rings with Feeler Gauge D81L-4201-A or equivalent, by inserting it between ring and its lower land. The gauge should slide freely around entire ring circumference without binding. Any wear that occurs will form a step at inner portion of lower land. If lower lands have high steps, piston should be replaced.

DISASSEMBLY AND ASSEMBLY (Continued)

6. Ensure bearing inserts and bearing bore in connecting rod and cap are clean. Foreign material under inserts will distort bearing and cause a failure. Install bearing inserts in connecting rod and cap with tangs fitting in slots provided.

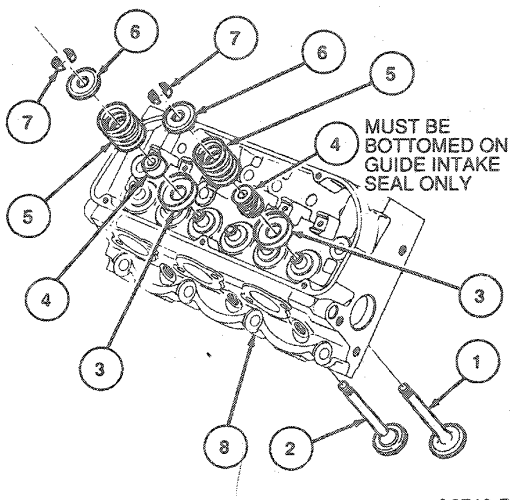
Cylinder Head

Tools Required:

- Valve Spring Compressor T81P-6513-A

Disassembly

1. Remove rocker arm fulcrum retaining bolts, fulcrums and rocker arms.
2. Remove exhaust manifold, if required and spark plugs.
3. Clean carbon out of cylinder head combustion chambers before removing valves.
4. Compress valve springs using Valve Spring Compressor T81P-6513-A. Remove spring retainer locks and release spring.
5. Remove spring retainer, spring, spring seat, stem seal and valve. Discard valve stem seals. Identify all valve parts as to which cylinder they were removed from and whether intake or exhaust.



Item	Part Number	Description
1	6507	Intake Valve
2	6505	Exhaust Valve
3	6A536	Valve Spring Seat
4	6A517	Valve Stem Seal
5	6513	Valve Spring
6	6514	Valve Spring Retainer

(Continued)

Item	Part Number	Description
7	6518	Valve Spring Retainer Keys
8	6049	Cylinder Head

6. Clean, inspect and service cylinder head as required, or prepare to transfer all usable parts to a new cylinder head.

Assembly

All valves, valve stems and valve guides are to be lubricated with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. The valve tips are to have Multi-Purpose Grease D0AZ-19584-AA (ESR-M1C159-A and ESB-M1C93-A) or equivalent applied before installation.

NOTE: Exhaust valve stem seals have a white stripe to identify them.

1. Install each valve in port from which it was removed or to which it was fitted.

   CAUTION: Due to different leakage rates between intake and exhaust valve stems, seals must not be interchanged.
2. Install exhaust valve stem seal. Make sure seal is bottomed on guide.
3. Install intake valve stem seal. Seal must be bottomed on guide.
4. Install spring seat.
5. Install valve spring over valve and then install spring retainer. Compress spring and install retainer locks.

   CAUTION: Do not install the spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing valve springs and overloading camshaft lobes which could lead to spring breakage and/or worn camshaft lobes.
6. Measure assembled height of valve spring from top of spring seat to underside of spring retainer with dividers. Check dividers against a scale. If assembled height is greater than specification, install necessary 0.79mm (0.030 inch) thick spacer(s) between cylinder head spring pad and valve spring seat, to bring assembled height to recommended specification.
7. Position rocker arms and fulcrums on cylinder head and install fulcrum retaining bolts. **Do not tighten bolts.** The bolts must be loose enough to allow rocker arm to be rotated to side.
8. Install exhaust manifold if removed, and spark plugs.

Front Cover Assembly

The front cover assembly contains three components related to the lubrication system. These components are:

DISASSEMBLY AND ASSEMBLY (Continued)

- Oil pump
- Oil pressure relief valve
- Pump drive intermediate shaft

Oil Pump

Disassembly

1. If necessary, remove oil filter.
2. Remove oil pump cover retaining bolts and remove cover.
3. Lift pump gears off pocket in front cover.
4. Remove cover seal and discard.

Pump Cover Flatness

1. Remove all traces of seal material from pump cover.
2. Place a straightedge across mounting surface of pump cover and measure for wear or warpage using a feeler gauge.
3. If surface is out of flat by more than 0.04mm (0.0016 inch) replace cover.

Assembly

1. If necessary, remove pump gears from cover.
2. Lightly pack gear pocket with petroleum jelly or coat all gear surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. **Do not use chassis lubricants.**

   CAUTION: Failure to properly coat the oil pump gears may result in failure of the pump to prime when engine is started.
3. Install gears in cover pocket. Ensure petroleum jelly fills all voids between gears and pocket.
4. Position cover seal and install pump cover.
5. Tighten pump cover retaining bolts to 25-30 N·m (18-22 lb-ft).

Pressure Relief Valve

Removal

1. After drilling a hole through valve plug, remove plug with a slide hammer or by prying.
2. Remove spring and valve from bore.

Inspection

1. Thoroughly clean valve bore and valve to remove any metal chips which may have entered bore as a result of drilling operation.
2. Inspect valve and valve bore for wear, scoring or galling. If inspection determines part(s) to be unserviceable replace valve and / or cover.
3. Check clearance between valve and bore. The valve should slip into bore without side play or binding.
4. Check spring for signs of fatigue or collapse.

Installation

1. Lubricate relief valve with XO-10W30-QSP (ESE-M2C153-E) or equivalent engine oil and install in bore. The end with smaller diameter goes in first.
2. Position spring in bore.
3. Install a new plug. The plug can be tapped into bore using a plastic tipped hammer. Ensure plug is 0-0.25mm (0-0.010 inch) below machined surface.

Intermediate Shaft

Removal

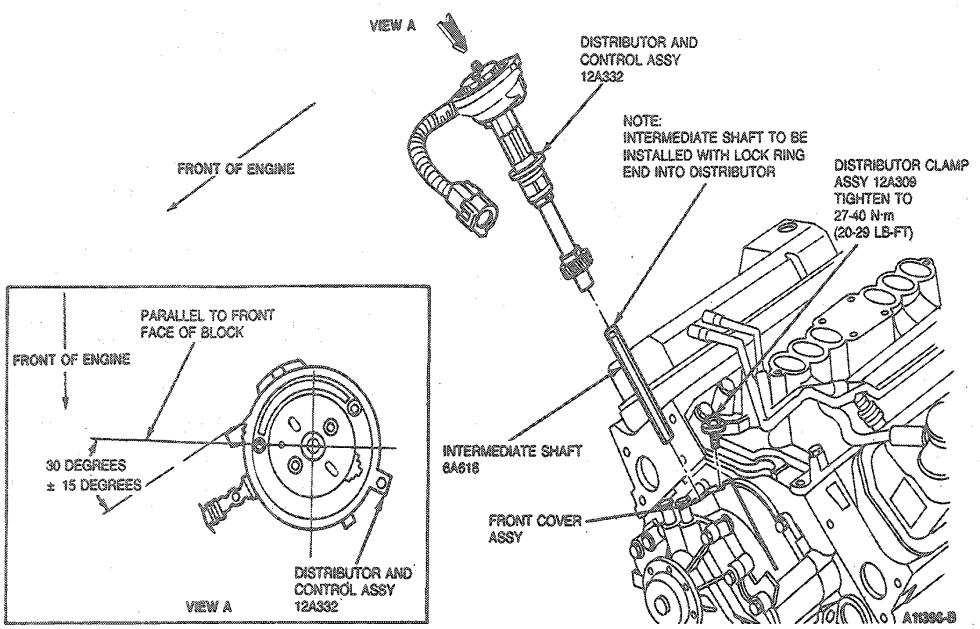
1. Remove distributor assembly.
2. Separate intermediate shaft from distribution.

Installation

1. Push lock ring end of shaft into distributor shaft.
2. Install distributor / shaft assembly, ensuring that end of intermediate shaft is seated in oil pump drive gear.

DISASSEMBLY AND ASSEMBLY (Continued)

3. Install distributor clamp assembly and tighten to 27-40 N·m (20-29 lb-ft).



Spark Plug Thread Service

Tools Required:

- Rotunda Tapersert Installation Kit 107-00901

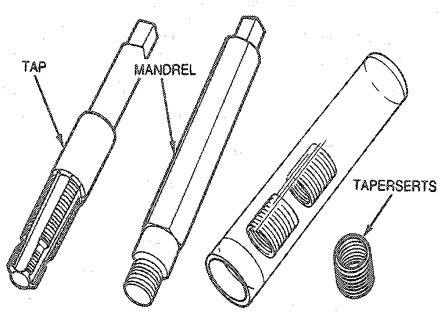
Damaged spark plug threads in the cylinder head can be serviced using Rotunda Tapersert Installation Kit 107-00901 or equivalent.

NOTE: The use of power or air driven tools is not approved for the installation of taperserts.

The procedure involves cutting new threads in the spark plug hole. After rethreading operation, a tapered sleeve will be installed in the head. The sleeve is threaded on the inside and outside. The outside threads into the cylinder head while the inside provides new threads for the spark plug.

This service is permanent and will have no effect on cylinder head or spark plug life.

CAUTION: The cylinder head must be removed from engine before installing a tapersert. The service procedure includes a thread cutting process which produces metal chips. Performing this procedure while the cylinder head is on the engine will cause metal chips to fall into the cylinder. Once in the cylinder, these chips can damage the cylinder wall when the engine is started.



ROTUNDA TAPERSERT INSTALLATION KIT 107-00901
A6651-D

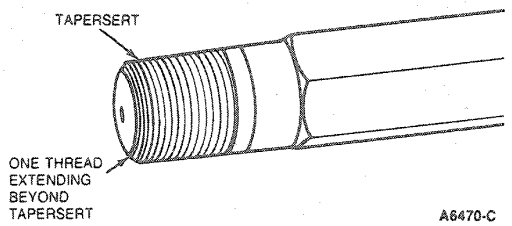
1. Thoroughly clean spark plug counter bore, seat and threads of all dirt or other foreign material.
2. Start tap into spark plug hole being careful to keep it properly aligned.

   As tap begins cutting new threads, apply aluminum cutting oil to tap.

   Continue cutting threads and applying oil until stop ring bottoms against spark plug seat.
3. Remove tap. Remove all metal chips using compressed air.

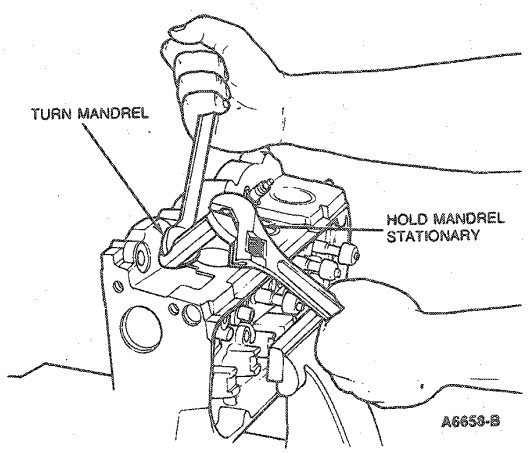
DISASSEMBLY AND ASSEMBLY (Continued)

4. Coat threads of mandrel with cutting oil. Thread tapersert onto mandrel until one thread of mandrel extends beyond tapersert.



5. Thread tapersert into tapped spark plug hole using a torque wrench. Continue tightening mandrel until torque wrench indicates 61 N·m (45 lb-ft).
6. To loosen mandrel for removal, hold mandrel stationary and turn mandrel body approximately one-half turn. Remove mandrel.

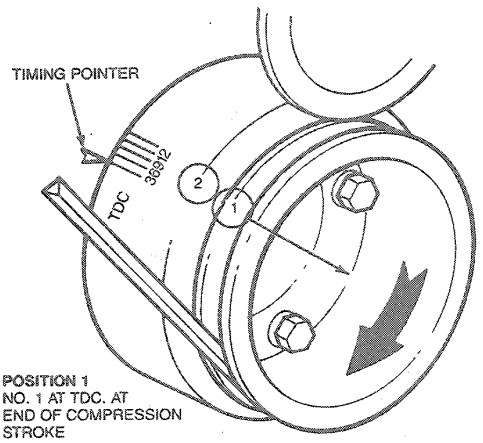
   NOTE: A properly installed tapersert will be flush to one millimeter below spark plug gasket seat.



ADJUSTMENTS

Hydraulic Valve Clearance

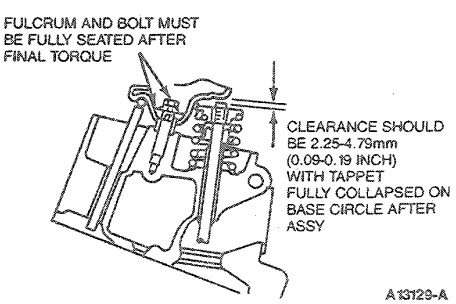
1. With No. 1 piston on TDC at the end of compression stroke (Position 1 in the illustration) check the following valves.



CYL. NO.	CRANKSHAFT POSITION	
	1	2
	SET GAP OF VALVES NOTED	
1	INT — EXH	NONE
2	EXH	INT
3	INT	EXH
4	EXH	INT
5	NONE	INT — EXH
6	INT	EXH

A13128-A

2. When compressing valve spring to remove push rods, ensure piston in individual cylinder is below TDC to avoid contact between valve and piston. To replace a push rod, it will be necessary to loosen the valve rocker arm shaft assembly and rotate rocker arm to the side. Upon replacement of a valve push rod, valve rocker arm assembly or hydraulic valve tappet, the engine should not be cranked or rotated until tappets have an opportunity to leak down to their normal operating position. The leakdown rate can be accelerated by using a tappet bleed-down wrench on valve rocker arm and applying pressure in a direction to collapse lifter.



ADJUSTMENTS (Continued)

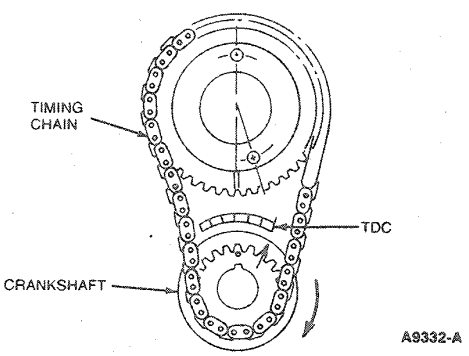
Timing Chain Deflection

Tools Required:

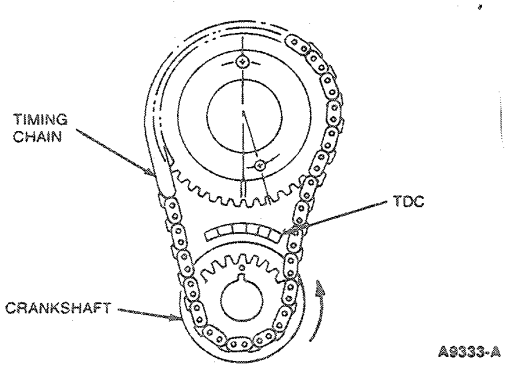
- Rotunda Dial Indicator with Bracketry 014-00282

1. Remove the RH valve rocker arm cover as outlined.
2. Loosen the No. 3 exhaust rocker arm and rotate to one side.
3. Install Rotunda Dial Indicator with Bracketry 014-00282 on the end of the push rod.

   NOTE: Timing chain and sprockets must be removed before tensioner.
4. Remove timing chain and tensioner assembly as outlined.
5. Turn the crankshaft clockwise until No. 1 piston is at TDC. The damper timing mark should point to TDC on the timing degree indicator. This will also take up the slack on the RH side of the chain.



6. Zero the dial indicator.
7. Slowly turn the crankshaft counterclockwise until the slightest movement is seen on the dial indicator. Stop, and observe the damper timing mark for the number of degrees of travel from TDC.



8. If the reading on the timing degree indicator exceeds 6 degrees, replace the timing chain and sprockets.

Crankshaft End Play Check

Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

1. Force crankshaft toward rear of cylinder block.
2. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent so that the contact point rests against crankshaft flange and indicator is parallel to crankshaft axis.
3. Zero dial indicator. Pry crankshaft forward and note reading on dial.
4. If end play exceeds specification, replace thrust bearing.

   If end play is less than specification, inspect thrust bearing surfaces for scratches, burrs, nicks or dirt.
5. Recheck end play.

Balance Shaft End Play Check

Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

1. Force the balance shaft to the rear of the cylinder block.
2. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent so that the contact point rests against the front of the balance and the indicator parallel to the balance shaft axis.
3. Zero the dial indicator. Pry the balance shaft forward and note the reading on the dial.
4. If end play exceeds specification, remove the balance shaft gear and replace the thrust plate. If end play is less than specification, check the thrust plate and balance shaft for scratches, burrs, nicks or dirt.
5. Recheck the end play.

Connecting Rod Side Clearance Check

Tools Required:

- Rotunda Dial Indicator with Bracketry 014-00282

1. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent so that the contact point rests against the connecting rod cap.
2. Pull cap toward front of engine and zero the dial indicator.
3. Push cap toward rear of engine and observe amount of side clearance on dial indicator.
4. If side clearance exceeds specification, replace connecting rod and cap.

   If side clearance is less than specification, remove rod and cap and inspect for scratches, burrs, nicks or dirt between crankshaft and connecting rod.

ADJUSTMENTS (Continued)

Oil Pump Inspection

Tools Required:

- Feeler Gauge D81L-4201-A

Pump Gear End Clearance

1. Inspect pump cover mating surface on front cover and pump body. Visually inspect O-ring for any cuts and/or nicks, replace if necessary. Remove any burrs or nicks.
2. Measure thickness of gear using a micrometer. Gear should be 30.455-30.480mm (1.19-1.20 inch) thick.
   - If gear is less than 30.455mm (1.19 inch) thick, replace gear.
   - If gear thickness is within specification, it may be necessary to replace the pump body.
   - If thickness of gear is within specified limits, proceed to Step 3.
3. Measure depth of the gear pocket in oil pump body. Depth should be 30.49-30.54mm (1.200-1.202 inch).
   - If depth is more than 30.54mm (1.202 inch) replace oil pump body.

Pump Gear Side Clearance

1. Measure side clearance by inserting Feeler Gauge D81L-4201-A or equivalent, between a gear tooth and side wall of the gear pocket.
   - Clearance should be a maximum of 0.13mm (0.005 inch), and gears should be free to turn.
   - If clearance is greater than 0.13mm (0.005 inch) proceed to Step 2.
2. Measure diameter of gear using a micrometer. Gear should be 38.252-38.332mm (1.505-1.509 inch) wide.
   - If gear is less than 38.252mm (1.505 inch) in diameter, replace gear and measure clearance as outlined in Step 1.
   - If diameter of gear is within specified limits go to Step 3.
3. Measure diameter of gear pocket in the front cover. The diameter should be 38.22-38.30mm (1.504-1.507 inch).
   - If diameter is less than 38.22mm (1.504 inch) replace front cover and measure clearance as specified in Step

SPECIFICATIONS

TORQUE SPECIFICATIONS ENGINE ACCESSORIES

Description	N·m	Lb-Ft
A/C Lower Mounting Bracket to Engine Nuts	41-61	30-44
Air Pump Pivot Bolt	54-75	40-55

(Continued)

TORQUE SPECIFICATIONS ENGINE ACCESSORIES (Cont'd)

Description	N·m	Lb-Ft
Air Pump to Support Bracket Bolt	40-55	30-40
Generator Pivot Bolt	61-75	45-57
Bolt A/C Comp. Mounting (5 Places)	41-61	30-45
Bolt Front Brace to Engine Brace A/C	41-61	30-45
Bracket, Idler Front Attach Bolt Lower	40-55	30-40
Bracket, Idler Front Attach Bolt Upper	70-95	52-70
Bracket, Idler Top Bolt	40-55	30-40
Engine Bracket Reinforcement Brace to Engine Bracket Bolt (Damper)	47-67	35-50
Engine Bracket Reinforcement Brace to Engine Bracket Nut (Damper)	80-107	60-80
Front A/C Comp. Plate Nut to Engine Stud (2 Places)	41-61	30-45
Front A/C Comp. Plate to Lower A/C Mounting Bracket Bolt	41-61	30-45
Front Brace, A/C to Engine Stud Nut	20-30	15-22
Insulator to A/C Bracket Bolt	54-75	40-55
Insulators to Frame RH Front, RH Rear Nut	68-95	50-70
Transaxle Support Assembly Bolt	48	35
Transaxle Insulator to Frame Bolt	54-75	40-55
Vertical Restrictor Assembly	54-75	40-55
Transaxle Mount to Insulator Nut	74-102	55-75
Insulator LH Rear Top Nut	54-75	40-55
Generator Bracket	40-55	30-40
Transmission to Engine Bolt	55-68	40-50
Torque Converter to Flywheel Bolt	27-46	20-34
Idler Bracket to Generator Top Attaching Flange Bolt	33-46	24-34
Idler Pulley Adv. Bolts (2 Places)	40-55	30-40
Nut Brace to Engine, A/C	20-30	15-22
Support A/C Comp. Mounting Bolt to Bracket Assembly (2 Places)	41-61	30-45
POWER STEERING WITH A/C		
Front Bracket to Power Steering Pump Bolt (3 Places)	40-62	30-45
Power Steering Brace Bolt (Lower)	24-32	18-24
Power Steering Brace Bolt (Upper)	40-62	30-45
Power Steering Front Bracket Nut (2 Places)	40-62	30-45
Power Steering Front Bracket to A/C Bracket Bolt	40-62	30-45
POWER STEERING W/O A/C		
Power Steering Brace Bolt (2 Places)	40-62	30-45

(Continued)

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS ENGINE ACCESSORIES (Cont'd)

Description	N·m	Lb-Ft
Power Steering Front Bracket Bolt (2 Places)	40-62	30-45
Power Steering Front Bracket Bolt (3 Places)	40-62	30-45

TORQUE SPECIFICATIONS*

Thread Size	Torque Cast Iron & Aluminum
(1/4-18) Pipe	24 N·m (18 Lb-Ft)
(3/8-18) Pipe	38 N·m (28 Lb-Ft)

(Continued)

TORQUE SPECIFICATIONS* (Cont'd)

Thread Size	Torque Cast Iron & Aluminum
M6	14 N·m (10 Lb-Ft)
M8	28 N·m (21 Lb-Ft)
M10	53 N·m (39 Lb-Ft)
M12	96 N·m (71 Lb-Ft)
M14	158 N·m (117 Lb-Ft)

* Uniess Otherwise Noted Values for Parts as Supplied

TA8375C

SPECIFICATIONS (Continued)

GENERAL SPECIFICATION	
DISPLACEMENT	3.8L
NUMBER OF CYLINDERS	6
BORE AND STROKE	
Bore	96.8mm (3.81 in.)
Stroke	86.0mm (3.39 in.)
FIRING ORDER	1-4-2-5-3-6
OIL PRESSURE (HOT 2500 RPM)	40-60 PSI
DRIVE BELT TENSION	Self-Tensioning

CYLINDER HEAD AND VALVE TRAIN	
COMBUSTION CHAMBER VOLUME (cc)	61.48-64.48
VALVE GUIDE BORE DIAMETER	
Intake & Exhaust	8.745-8.720mm (0.3443-0.3433 in.)
VALVE SEATS	
Width — Intake & Exhaust	1.5-2.0mm (.06-.08 in.)
Angle	44.5°
Runout (T.I.R.)	0.076mm (0.003 in.)
BORE DIAMETER (INSERT COUNTERBORE DIAMETER)	
Intake	47.097mm (1.8542 in.) MAX. 47.072mm (1.8532 in.) MIN.
Exhaust	39.739mm (1.5645 in.) MAX.
GASKET SURFACE FLATNESS	0.018mm (0.007 in.)
VALVE STEM TO GUIDE CLEARANCE	
Intake	0.026-0.071mm (0.001-0.0028 in.)
Exhaust	0.038-0.083mm (0.0015-0.0033 in.)
VALVE HEAD DIAMETER	
Intake	45.3mm (1.78 in.)
Exhaust	37.1mm (1.46 in.)
VALVE FACE RUNOUT LIMIT	0.05mm (0.002 in.)
VALVE FACE ANGLE	45.8°
VALVE STEM DIAMETER (STD.)	
Intake	8.694-8.674mm (0.3423-0.3415 in.)
Exhaust	8.682-8.662mm (0.3418-0.3410 in.)
Oversize	
Intake	9.075-9.055mm (0.3573-0.3565 in.)
Exhaust	9.063-9.043mm (0.3568-0.3560 in.)
Oversize	
Intake	9.456-9.436mm (0.3723-0.3715 in.)
Exhaust	9.444-9.424mm (0.3718-0.3710 in.)
VALVE SPRINGS	
Compression Pressure (N [Lb] @ Spec. Length)	
Valve Open (Without Damper)	979N (220 lbs.) @ 30.0mm (1.18 in.)
Valve Closed (Without Damper)	378N (85 lbs.) @ 41.9mm (1.65 in.)
Free Length (Approximate)	
Assembled Height	50.0mm (1.97 in.)
Service Limit	10% Force Loss @ Specified Height
ROCKER ARM	
Ratio	1.73
VALVE TAPPET, HYDRAULIC	
Diameter (Std.)	22.200-22.212mm (0.8740-0.8745 in.)
Clearance to Bore	0.018-0.068mm (0.0007-0.0027 in.)
Service Limit	0.127mm (0.005 in.)
Hydraulic Leakdown Rate	(a)
Collapsed Tappet Gap (Nominal)	
Intake	2.25-4.79mm (0.089-0.189 in.)
Exhaust	2.25-4.79mm (0.089-0.189 in.)
DISTRIBUTOR SHAFT BEARING BORE DIAMETER	
Tappet Bore Diameter	22.268-22.230mm (0.8767-0.8752 in.)
CAMSHAFT BORE INSIDE DIAMETER	
No. 1	55.689-55.664mm (2.192-2.191 in.)
No. 2	55.308-55.283mm (2.177-2.176 in.)
BALANCE SHAFT BORE	
Inside Diameter	55.689-55.664 (2.192-2.191 in.)
End Plug	0.16-0.075 (0.003-0.006 in.)

CYLINDER HEAD AND VALVE TRAIN (Continued)	
BALANCE SHAFT	
End Play	0.075-0.21mm (0.003-0.008 in.)
Journal Diameter	52.108-52.082mm (2.0515-2.0505 in.)
Runout	0.025mm (0.001 in.)
CAMSHAFT BORE INSIDE DIAMETER	
No. 3	55.308-55.283mm (2.177-2.176 in.)
No. 4	55.684-55.664mm (2.192-2.191 in.)

CAMSHAFT	
LOBE LIFT	
INTAKE	6.22 (0.245 in.)
EXHAUST	6.57 (0.259 in.)
Allowable Lobe Lift Loss	0.127mm (0.005 in.)
THEORETICAL VALVE LIFT @ ZERO LASH	
Intake	10.67mm (0.424 in.)
Exhaust	11.37mm (0.448 in.)
ENDPLAY	
Service Limit	0.025-0.150mm (0.001-0.006 in.)
JOURNAL TO BEARING	
CLEARANCE	0.025-0.076mm (0.001-0.003 in.)
JOURNAL DIAMETER	
All	52.108-52.082mm (2.0515-2.0505 in.)
CAM BEARING I.D.	52.158-52.133mm (2.0535-2.0525 in.)
Runout Limit	0.05mm (0.002 in.) Runout of #2 or #3 relative to #1 and #4
Out-of-Round Limit	0.025mm (0.001 in.)

CAMSHAFT DRIVE	
Assembled Gear Face Runout	
Crankshaft	0.10mm (0.004 in.)
Camshaft	0.25mm (0.010 in.)
Timing Chain Deflection	12.7mm (0.5 in.)

CYLINDER BLOCK	
HEAD GASKET SURFACE	
FLATNESS	0.08mm (0.003 in.) in 152.0mm (6.00 in.)
HEAD GASKET SURFACE FINISH (RMS)	2.0 @ 0.8 5.5 @ 2.5
CYLINDER BORE	
Diameter	96.80mm (3.81 in.)
Surface Finish (RMS)	0.45-0.96
Out-of-Round Limit	0.025mm (0.001 in.)
Out-of-Round Service Limit	0.050mm (0.002 in.)
Taper Service Limit	0.050mm (0.002 in.)
MAIN BEARING BORE DIAMETER	68.905mm (2.713 in.) 68.885mm (2.712 in.)

CRANKSHAFT AND FLYWHEEL	
MAIN BEARING JOURNAL	
DIAMETER	63.983-64.003mm (2.5190-2.5198 in.)
Out-of-Round Limit	0.008mm (0.0003 in.) MAX. in 45°, 0.015mm (0.0006 in.) TOTAL
Taper Limit	0.008mm (0.0003 in.) per 25mm (1 in.)
Journal Runout Limit	0.05mm (0.002 in.) (2), 0.05mm (0.002 in.) (3)
Surface Finish (RMS)	0.3 micrometers (11.8 micro in.)
THRUST BEARING JOURNAL	
Length	29.725-29.775mm (1.703-1.703-1.1722 in.)
CONNECTING ROD JOURNAL	
Diameter	58.682-58.702mm (2.3103-2.3111 in.)
Out-of-Round Limit	0.008mm (0.0003 in.) MAX in 45°, 0.015mm (0.0006 in.) TOTAL
Taper Limit	0.008mm per 25mm (0.0003 in. per in.)
Surface Limit (RMS)	0.3 micrometers (11.8 micro in.)
MAIN BEARING THRUST FACE	
Surface Finish (RMS) 0.9 micrometers (0.354 micro in.) FRONT; 0.6 micrometers (0.236 micro in.) REAR;	
Runout Limit	0.025mm (0.001 in.)

CA12722-C

SPECIFICATIONS (Continued)

CRANKSHAFT AND FLYWHEEL (Continued)

FLYWHEEL RING GEAR LATERAL RUNOUT (T.I.R.)	
Automatic Transmission	1.778mm (0.07 in.)
CRANKSHAFT END PLAY	0.10-0.20mm (0.004-0.008 in.)
CONNECTING ROD BEARINGS	
Clearance to Crankshaft	
Desired	0.025-0.035mm (0.001-0.0014 in.)
Allowable	0.022-0.069 (0.00086-0.0027 in.)
Bearing Wall Thickness (Std.)	1.453-1.466mm (0.0572-0.0577 in.)
MAIN BEARINGS	
Clearance to Crankshaft	
Desired	0.025-0.035mm (0.001-0.0014 in.)
Allowable	0.013-0.058mm (0.0005-0.0023 in.)
Bearing Wall Thickness (Std.)	2.431-2.443mm (0.0957-0.957-0.962 in.)

CONNECTING ROD, PISTON AND RINGS

CONNECTING ROD	
Piston Pin Bore Diameter	23.105-23.145mm (0.9096-0.9112 in.)
Crankshaft Bearing Bore Diameter	61.635-61.655mm (2.4266-2.4274 in.)
Out-of-Round Limit — Piston Pin Bore	0.008mm (0.0003 in.) greater to 0.025mm (0.001 in.) (1)
Taper Limit Piston Bore	0.033 per 25mm (0.013 per in.)
Length (Center-to-Center)	150.165-150.240mm (5.912-5.915 in.)
ALIGNMENT (BORE-TO-BORE MAX. DIFF.)	
Twist	0.075 per 25mm (0.003 per in.)
Bend	0.04 per 25mm (0.0016 per in.)
SIDE CLEARANCE (ASSEMBLED TO CRANK)	
Standard	0.11-0.29mm (0.0047-0.0114 in.)
Service Limit	0.36mm MAX. (0.014 in. MAX.)

PISTON

Diameter	
Coded Red	96.761-96.777mm (3.8095-3.8101 in.)
Coded Blue	96.791-96.807mm (3.8107-3.8113 in.)
Coded Yellow	96.821-96.837mm (3.8119-3.8125 in.)
PISTON-TO-BORE CLEARANCE	0.036-0.081mm (0.0014-0.0032 in.)
SERVICE PISTON SELECTION	I.D. Code of Service
Piston Bore Diameter	Piston Required
96.799-96.830mm (3.8110-3.8122 in.)	RED
96.830-96.860mm (3.8122-3.8134 in.)	BLUE
96.860-96.891mm (3.8134-3.8146 in.)	YELLOW

When replacing pistons, measure the cylinder bore as outlined in General Engine Service Section 21-01. Install the service piston matched to the piston bore diameter above.

PIN BORE DIAMETER	23.170-23.185mm (0.9122-0.9128 in.)
RING GROOVE WIDTH	
Compression (Top)	1.550-1.530mm (0.0610-0.0602 in.)
Compression (Bottom)	1.550-1.530mm (0.0610-0.0602 in.)
Oil	4.030-4.055mm (0.1587-0.1596 in.)
PISTON PIN	
Length	76.5-77.2mm (3.012-3.039 in.)
Diameter	23.162-23.175mm (0.9119-0.9124 in.)
PIN TO PISTON CLEARANCE	0.005-0.012mm (0.0002-0.0005 in.)
PIN TO ROD CLEARANCE	Press Fit 8 Kilonewtons (1800 lbs.)
PISTON RINGS	
Ring Width	
Compression (Top)	1.463-1.490mm (0.0576-0.0587 in.)
Compression (Bottom)	1.463-1.490mm (0.0576-0.0587 in.)
Oil Ring	Side Seal — Snug Fit
Service Limit	Side Clearance 0.15mm MAX. (0.0006 in. MAX.)

PISTON (Continued)

Ring Gap	
Compression (Top) (In Gage)	0.29-0.55mm (0.011-0.012 in.)
Compression (Bottom) (In Gage)	0.25-0.50mm (0.01-0.02 in.)
Oil Ring (Steel Rail) (In Gage)	0.38-1.40 (0.015-0.0583 in.)
Side Clearance	
1st Ring	0.040-0.087mm (0.0016-0.0034 in.)
2nd Ring	0.040-0.095mm (0.0016-0.0034 in.)

(a) 20-200 seconds to leakdown 3.18 (0.125 in.) with 225 Newtons (50 pounds) load and tappet filled with leak-down fluid.
(1) Smaller than pin bore measured along center to center axis.
(2) Runout of journals II and III to journals I and IV.
(3) Runout of adjacent journals to each other.
* Engine packages equipped with Tripminder. Return line must be closed when checking pressure.
** Passenger Car: 4 qt. + ½ qt. with filter change.

LUBRICATION SYSTEM

OIL PUMP	
Relief Valve Spring Tension	
(Force @ Length)	76.2-67.6 NT (17.1-15.2 lbs.) @ 30.5mm (1.20 in.)
Relief Valve to Bore Clearance	0.073-0.043mm (0.0029-0.0017 in.)
Oil Pump Gear Backlash	0.02-0.03mm (0.008-0.012 in.)
Oil Pump Gear Radial Clearance (Idler and Drive)	0.125-0.050mm (0.0055-0.002 in.)
Oil Pump Gear End Height (Extends Beyond Housing)	0.140-0.050mm (0.0055-0.0005 in.)
Idler Shaft to Idler Gear Clearance	0.044-0.010mm (0.0017-0.0005 in.)
Driver Shaft to Housing Clearance	0.076-0.038mm (0.0030-0.0015 in.)
OIL CAPACITY**	

CA6634-M

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft
Accelerator Cable Mounting Bracket—Bolt	20-30	15-22
Upper Intake Manifold	26-38	19-28
Balance Shaft Thrust Plate—Bolt	8-14	6-10
Oil Pan Drain Plug	20-34	15-25
Camshaft Sprocket to Camshaft—Bolt	40-50	30-37
Low Level Oil Sensor	25-34	18-25
Camshaft Thrust Plate—Bolt	8-14	70-124 (Lb-In)
Connecting Rod—Nut	41-49	31-36
Main Bearing Cap—Bolt	88-110	65-81
Coolant Temp. Switch	11-16	8-12
MTC Sensor	8-13	6-9.5
Crankshaft Damper to Crankshaft—Bolt	140-180	103-132
Oil Filter Adapter to Front Cover—Bolt	25-30	18-22
Crankshaft Pulley to Damper—Bolt	26-38	103-132
Oil Filter to Oil Filter Adapter		(2)
Cylinder-Head Bolt	—	(1)
Oil Inlet Tube to Cylinder Block—Bolt	20-30	15-22
Distributor Cap	2.0-2.6	18-23 (Lb-In)
Oil Inlet Tube to Main Bearing Cap—Nut	40-55	30-40
Distributor Hold-Down Bolt	27-40	20-29
Oil Pan to Cylinder Block —Bolt	9-12	80-106 (Lb-In)
Distributor Rotor	2.8-3.9	25-35 (Lb-In)
PVS Valve	8-13	6-9.5
ECT Sensor	8-13	6-9.5
PVS Valve	8-13	6-9.5
EGR Valve to Intake Manifold—Nut	20-30	15-22
Rocker Arm Cover to Cylinder Head—Bolts / Studs	9-12	80-106 (Lb-In)
Exhaust Manifold—Bolt / Stud	20-30	15-22
Rocker Arm Function to Cylinder Head—Bolt	—	(4)
Fan Clutch Assembly—Bolt	16-24	12-18
Spark Knock Sensor	20-26.5	15-19
Flywheel to Crankshaft—Bolt	73-87	54-64
Spark Plug to Cylinder Head	7-15	62-132 (Lb-In)
Front Cover to Cylinder Block—Bolt	20-30	15-22
Thermostat Housing to Intake Manifold—Bolt	20-30	15-22
Fuel Pump to Front Cover—Bolt	20-30	15-22

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

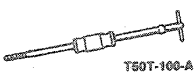
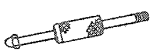
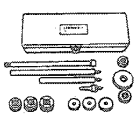
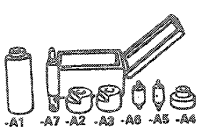
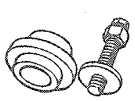
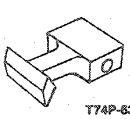
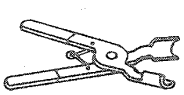
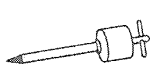
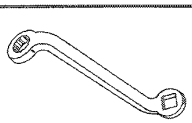
Description	N·m	Lb-Ft
Throttle Body—Nut	20-30	15-22
Fuel Tube Fitting	20-24	15-32.5
Vacuum Fitting to Intake Manifold	17-25	13-19
Fuel Tube Fitting—Inlet	16-20	12-15
Vacuum Tree to Intake Manifold	8-13	6.-9.5
Fuel Tube Fitting—Return	12-16	9-12
Vacuum Tree to Intake Manifold—Studs / Bolts	10-15	7-11
Heater Elbow	8.5-13.5	6.5-10
Water Pump to Front Cover—Bolt	20-30	15-22
Heater Tube to Intake Manifold Stud—Bolt	10-15	7-11
Wiring Retainer Bracket—Nut	10-15	8-11
Intake Manifold to Cylinder Head—Bolt	—	(3)
Oil Pump Cover—Bolt	25-30	18-22
Tappet Guide Plate Bolt	8-14	6-10
Engine Lifting Eye Nuts	20-30	15-22
Engine to Transaxle Bolts	55-68	41-50
Wheel Lug Nuts	115-142	85-105
Exhaust Pipe to Manifold	21-32	16-24
Tensional Mounting Bolts	8-14	6-10
Guide Plate Retainers	8-14	6-10
Fuel Rail	8-11	6-8
Secondary Air Injection Tube Support Bracket Bolt	40-55	30-40
Thrust Plate Screws	8-14	70-124 (Lb-In)

1.
   a. Tighten in (4) Steps: 50 N·m (37 Lb-Ft), 60 N·m (45 Lb-Ft), 70 N·m (52 Lb-Ft), 80 N·m (59 Lb-Ft)

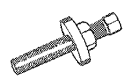
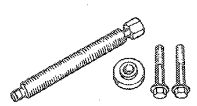
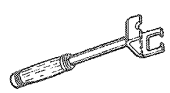
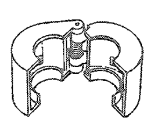
      CAUTION: Do not loosen all of the bolts at the same time, only work on one bolt at a time.

   b. In sequence, one at a time loosen each bolt two or three revolutions.
   c. Tighten long bolts to 15-25 N·m (11-18 Lb-ft) then an additional 85-95 degrees. Tighten short bolts to 10-20 N·m (7-15 Lb-Ft) then an additional 85-95 degrees. Go to next bolt in sequence.
2. Advance half turn after gasket contacts sealing surface.
3. Tighten in Two Steps:
   a. 11 N·m (8 Lb-Ft)
   b. 15 N·m (11 Lb-Ft)
4. Tighten in Two Steps:
   a. 5 N·m maximum (44 Lb-In)
   b. 25-35 N·m (19-25 Lb-Ft)

SPECIAL SERVICE TOOLS

Tool Number / Description	Illustration
T50T-100-A Impact Slide Hammer	 T50T-100-A
T58P-6316-D Crankshaft Damper Remover	 T58P-6316-D
T59L-100-B Impact Slide Hammer	 T59L-100-B
T65L-6250-A Camshaft Bearing Set	 T65L-6250-A
T68P-6135-A Piston Pin Remover and Replacer	 T68P-6135-A
T70P-6B070-A Front Cover Seal Installer	 T70P-6B070-A
T74P-6375-A Flywheel Locking Tool	 T74P-6375-A
T74P-6666-A Spark Plug Wire Remover	 T74P-6666-A
T77L-9533-B Jet Plug Remover	 T77L-9533-B
T81P-6254-A Belt Tension Adaptor	 T81P-6254-A

(Continued)

Tool Number / Description	Illustration
T81P-6513-A Valve Spring Compressor	 T81P-6513-A
T81P-9425-A Intake Manifold Torque Adapter	 T81P-9425-A
T82L-6316-A Damper / Front Cover Seal Installer	 T82L-6316-A
T82L-6316-B Vibration Damper Remover Adapter	 T82L-6316-B
T82L-6500-A Tappet Collapser	 T82L-6500-A
T82L-6701-A Rear Main Seal Installer	 T82L-6701-A
T83P-19623-C Spring Lock Coupling Tool	 T83P-19623-C

Tool Number	Description
D81L-600-A	Lb-In Torque Wrench
D81L-600-B	Lb-Ft Torque Wrench
D81L-4201-A	Feeler Gauge
D88L-6000-A	Engine Support Bar
D81L-6001-D	Engine Lifting Eyes
TOOL-6331-E	Main Bearing Insert Tool
TOOL-6500-E	Hydraulic Leakdown Tester
TOOL-6513-DD	Valve / Clutch Spring Tester

SPECIAL SERVICE TOOLS (Continued)

ROTUNDA EQUIPMENT

Model	Description
014-00282	Dial Indicator with Bracketry
014-00290	Piston Ring Compressor
014-00292	Cylinder Ridge Reamer
107-00901	Tapersert Installation Kit

PARTS CROSS-REFERENCE

Base Part #	Part Name	Old Part Name
9002	Fuel Tank	
9424	Intake Manifold	
9430	Exhaust Manifold	
9431	Exhaust Manifold	
9439	Intake Manifold to Cylinder Head Gasket	
9C968	Fuel Pressure Regulator	
9E926	Throttle Body	
9F472	Heated Oxygen Sensor	Exhaust Gas Oxygen Sensor
9F792	Fuel Injection Supply Manifold	
9H486	Intake Manifold Upper Gasket	

(Continued)

SECTION 03-03 Engine Cooling

VEHICLE APPLICATION

Taurus / Sable and Taurus SHO.

DESCRIPTION AND OPERATION

"Walter C. Avrea, the owner of patents 3, 601, 181 and RE 27, 965, has granted Ford Motor Company rights with respect to cooling systems covered by these patents."

The cooling system includes a radiator, circulating pump, and a cooling fan which is activated by the integrated relay control module. Also included in the cooling system is a separate coolant recovery reservoir which is located beside the radiator and aids in maintaining the correct volume of coolant.

The water pump is of a conventional design and is driven by the accessory drive belt.

A thermostat is located in a water outlet connection housing at one end of the engine. The thermostat ensures rapid engine warm-up by restricting coolant flow at lower operating temperatures. It also assists in keeping the engine operating temperature within predetermined limits.

The coolant normally contains a 50 / 50 mix of water and permanent coolant / antifreeze fluid such as Premium Cooling System Fluid E2FZ-19549-AA (ESE-M97B44-A and ESE-M97B43-A) or equivalent.

CAUTION: The addition of more water than recommended will raise the freezing protection temperature and weaken the corrosion inhibitors.

Refer to Specifications for the cooling system capacity for all vehicles.

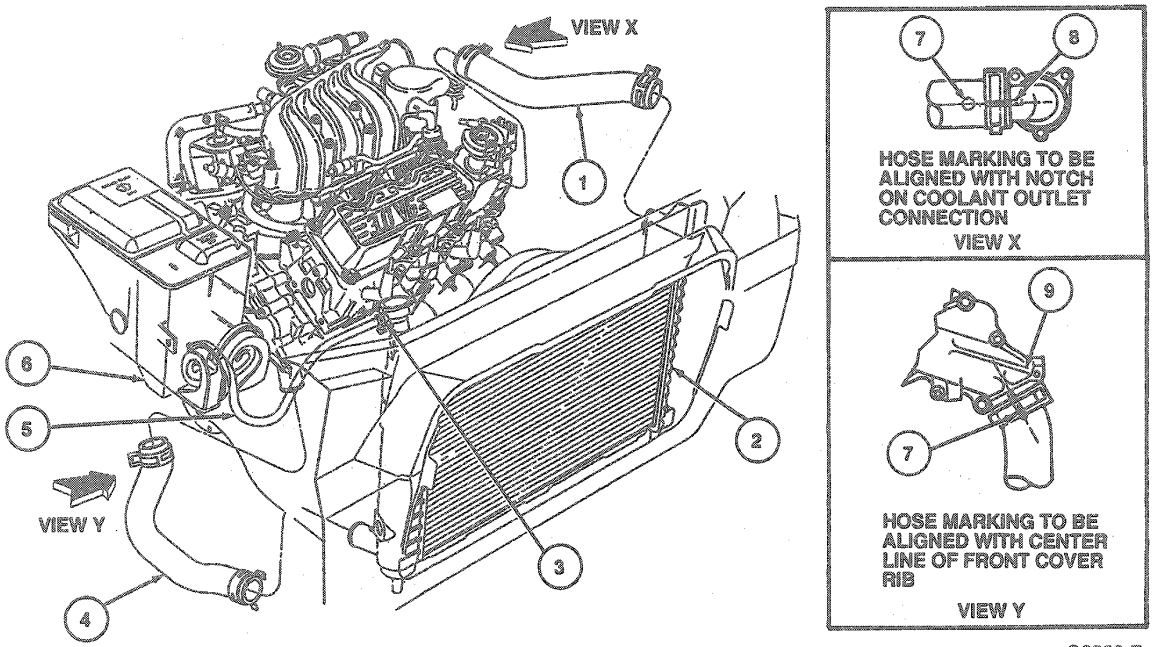
NOTE: The system must be maintained with the correct concentration and type of antifreeze to prevent corrosion damage.

WARNING: DISCONNECT THE COOLING FAN PRIOR TO PERFORMING ANY UNDERHOOD SERVICE, SINCE THE FAN COULD CYCLE IF THE IGNITION SWITCH IS LEFT IN THE RUN POSITION.

The electric radiator cooling fan motor is mounted within a shroud behind the radiator. The integrated relay control module actuates the fan when the coolant reaches a specified temperature, when the engine reaches a specified speed, or when the air conditioning clutch is activated, if so equipped.

DESCRIPTION AND OPERATION (Continued)

Cooling System
3.0L Engine



Q2309-D

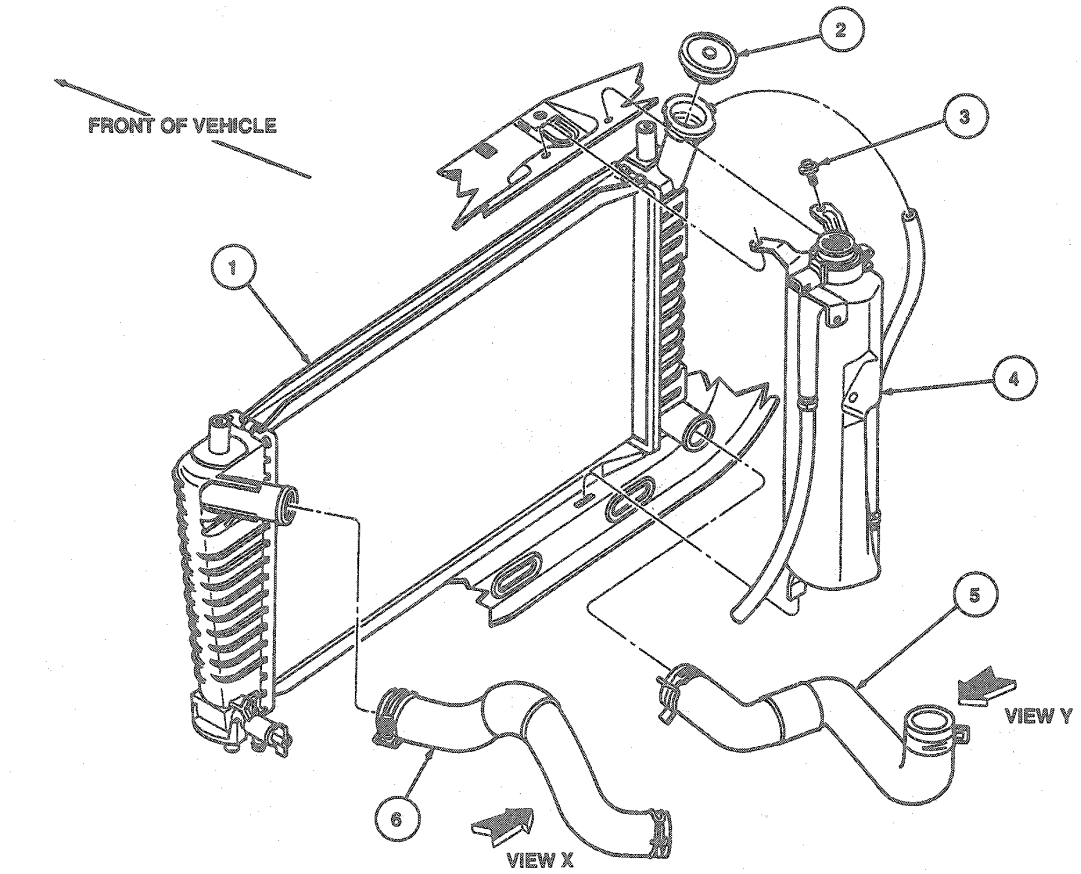
Item	Part Number	Description
1	86274	Upper Radiator Hose
2	8005	Radiator
3	389252-S100	Clamp (2 Req'd)
4	88273	Lower Radiator Hose

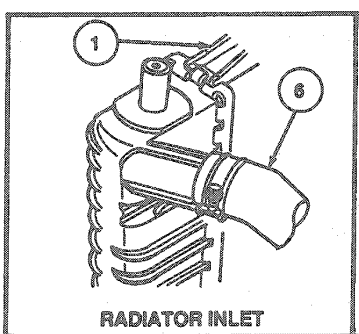
(Continued)

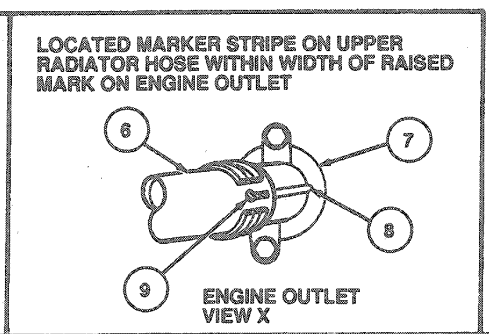
Item	Part Number	Description
5	381214-S200A	Overflow Hose
6	17B613	Reservoir Assy
7	—	Hose Marking
8	—	Notch
9	—	Rib

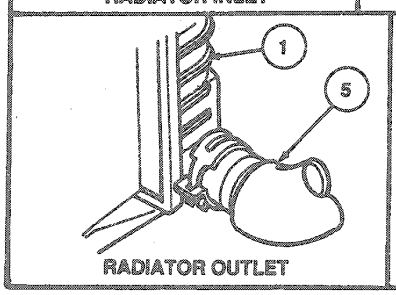
DESCRIPTION AND OPERATION (Continued)

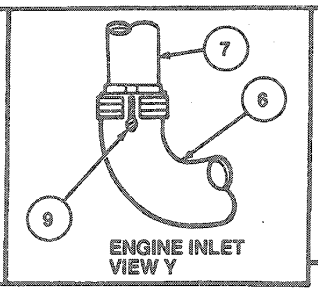
3.0L/3.2L SHO

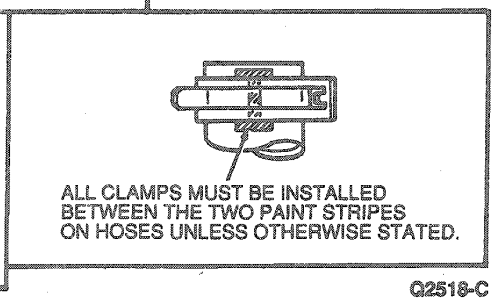












Q2518-C

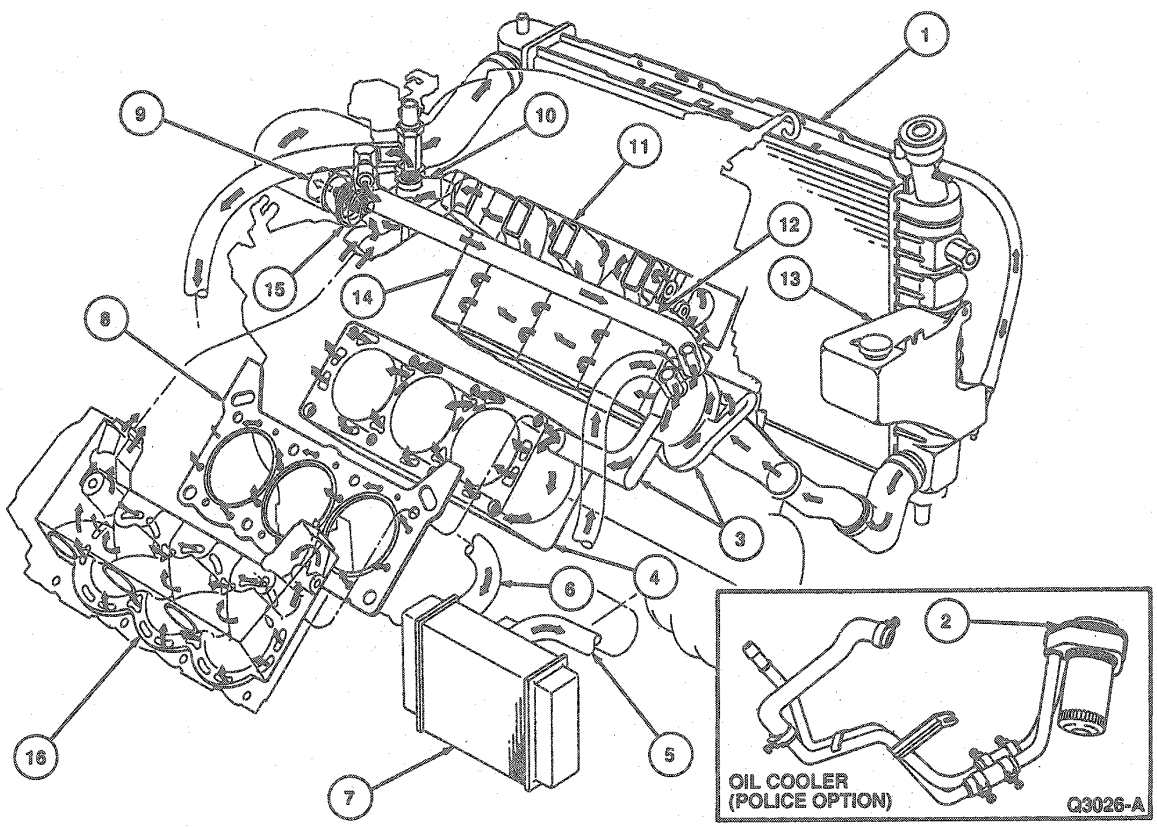
DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	8005	Radiator Assy
2	—	Radiator Cap
3	N800312-S2	Screw and Washer Assy
4	8C045	Reservoir Assy (3.0 Version Shown)

(Continued)

Item	Part Number	Description
5	8B273	Hose and Clamp Assy
6	8B274	Hose and Clamp Assy
7	—	Engine Water Outlet Connection
8	—	Rib Alignment
9	—	Alignment Stripe

3.8L Engine



Item	Part Number	Description
1	8005	Radiator Assy
2	6A642	Oil Cooler
3	8501	Water Pump and Front Cover
4	6010 (RH Bank)	Cylinder Block
5	—	Heater Outlet
6	—	Heater Inlet
7	18476	Heater Core
8	6051	Cylinder Head Gasket

(Continued)

Item	Part Number	Description
9	—	Water Outlet Connector
10	—	Lower Intake Manifold Crossover / Outlet
11	6049 (LH Bank)	Cylinder Head
12	—	Engine Coolant Bypass
13	8A080	Coolant Overflow Reservoir
14	6010 (LH Bank)	Cylinder Block
15	8592	Thermostat Assy
16	6049 (RH Bank)	Cylinder Head

TQ3026B

DESCRIPTION AND OPERATION (Continued)

When the coolant is cold, the thermostat is in the closed position and the coolant flow is restricted to the cylinder block, head, intake manifold and heater. As the temperature increases, the thermostat opens, allowing a portion of the coolant to pass into the radiator. The coolant flows through the radiator tubes and is cooled by air passing over the cooling fins assisted by the cooling fan. Coolant is then circulated from the radiator outlet tank through the water pump and into the cylinder block to complete the circuit.

The coolant expands as the temperature and pressure rise in the system. When the limiting system working pressure is reached, the pressure relief valve in the radiator filler cap is lifted from its seat and allows coolant to flow through the radiator filler neck and the overflow hose into the coolant recovery reservoir. The radiator filler cap has a rubber seal on the underside to prevent leakage.

When the system temperature and pressure drop, the coolant contracts in volume and the pressure in the radiator is reduced. The coolant in the reservoir bottle will then flow back into the radiator through the vacuum relief valve in the radiator filler cap.

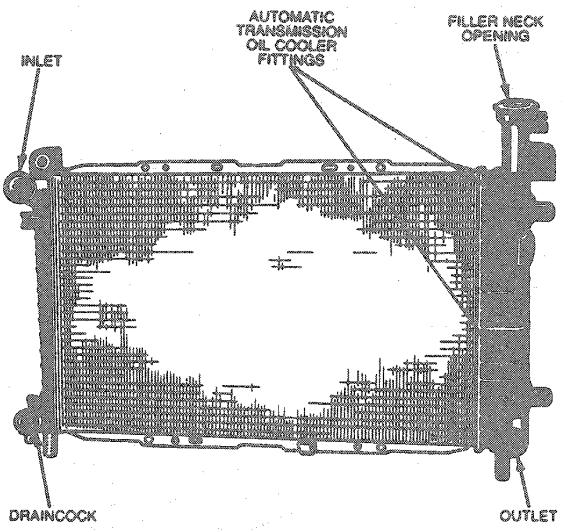
The Constant Control Relay Module (CCRM) activates the cooling fan motor when the coolant reaches a specified temperature, or when the engine reaches a specified temperature. On vehicles equipped with air conditioning, the cooling fan motor is activated whenever the air conditioning clutch is engaged.

NOTE: Cooling fan motor will not cycle with the air conditioning clutch on.

NOTE: An exception to this is when vehicle speed is over 72 km/h (45 mph) and coolant temperature is below 104°C (220°F). The fan will then automatically shut off.

Radiators

The radiator is a brazed aluminum fin and tube-type design arranged for crossflow of the engine coolant. Nylon end tanks on each end of the core allow uniform distribution of engine coolant to the radiator tubes. The nylon end tanks are attached to the aluminum core by bending tabs on the core header over the foot (edge) of the nylon tank. A rubber O-ring gasket is placed between the nylon tank and the radiator core header to achieve a seal between the tank and the radiator core header. The nylon tanks are a moulded one-piece design with mounting brackets as a part of each tank.



WARNING: NEVER REMOVE THE RADIATOR PRESSURE CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND/OR PERSONAL INJURY.

TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR PRESSURE CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN CERTAIN ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON CAP (STILL WITH A CLOTH), TURN AND REMOVE IT.

WARNING: THE ENGINE ELECTRIC COOLING FAN MAY COME ON AT ANYTIME WITHOUT WARNING EVEN IF THE ENGINE IS NOT RUNNING. DISCONNECT BATTERY GROUND CABLE BEFORE SERVICING.

DESCRIPTION AND OPERATION (Continued)

Cooling Fan

The fan control system consists of a two-speed fan on all 3.0L, 3.2L SHO and 3.8L engines with ATX or a one-speed fan on 3.0L SHO engines with an MTX, attached to a fan shroud located behind the radiator. The cooling fan is wired to operate only when the ignition switch is in the RUN position, thereby preventing cooling fan operation after the ignition switch is turned to the OFF position.

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 EVEN THOUGH THE ENGINE IS NOT RUNNING.

The cooling fan is controlled during vehicle operation by the Constant Control Relay Module (CCRM) 12B577 and Powertrain Control Module (PCM) 12A650 which will energize the cooling fan under the following conditions:

- Cooling fan is turned on for the 3.0L SHO and on at low speed for 3.0L, 3.2L SHO and 3.8L if:

a. Engine temperature is higher than normal. (Fan starts running at 102°C (215°F) and stops running at 99°C (210°F).

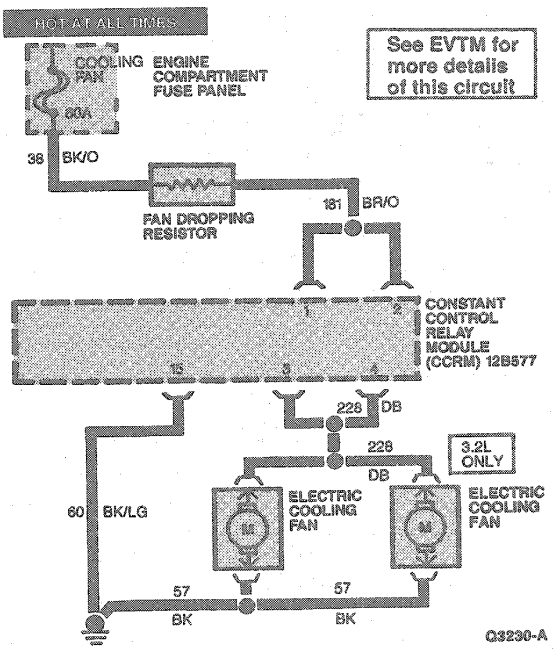
b. A/C is on and vehicle speed does not provide enough natural airflow. (Fan starts running at speeds at or below 69 km/h (43 mph) and stops running at 77 km/h (48 mph).

On 3.0L and 3.2L SHO engines with ATX, low speed cooling fan motor operation is achieved by using a dropping resistor in series with the motor/motors.

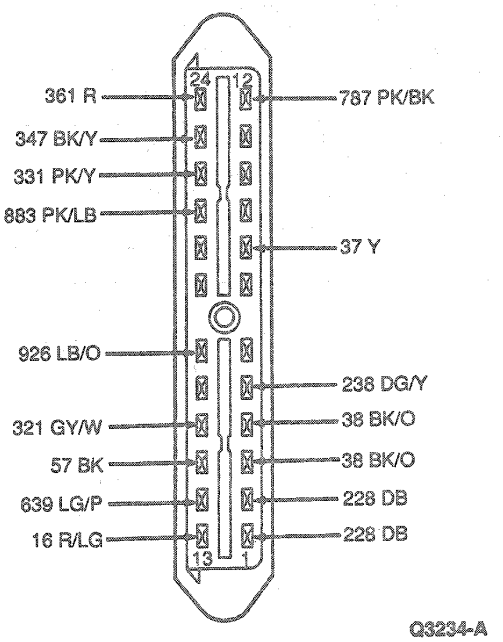
The 3.8L uses a dual winding fan motor in which low speed motor operation is achieved through the low speed motor winding circuit (no dropping resistor).

Normal operation and cycling of the engine cooling fan will cause the temperature gauge indicator to read between the mid-point and upper portion of the temperature gauge scale. The slightly higher indicator reading will return to mid-point when fan operation begins.

Cooling Fan Motor Circuit Diagram — 3.0L with ATX and 3.2L SHO



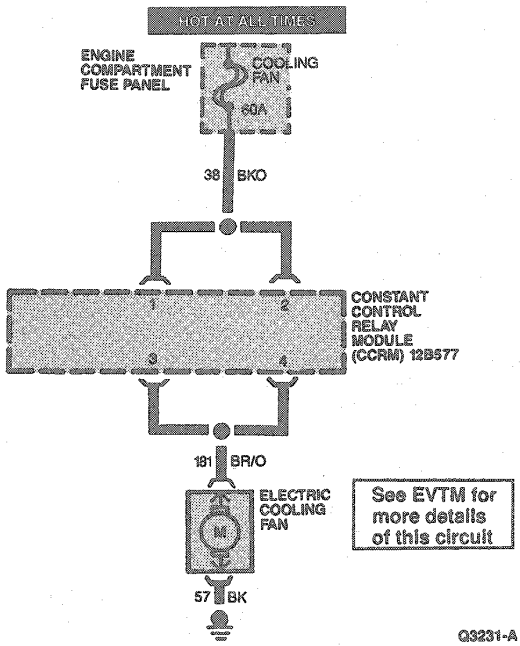
Constant Control Relay Module (CCRM) Connector End View



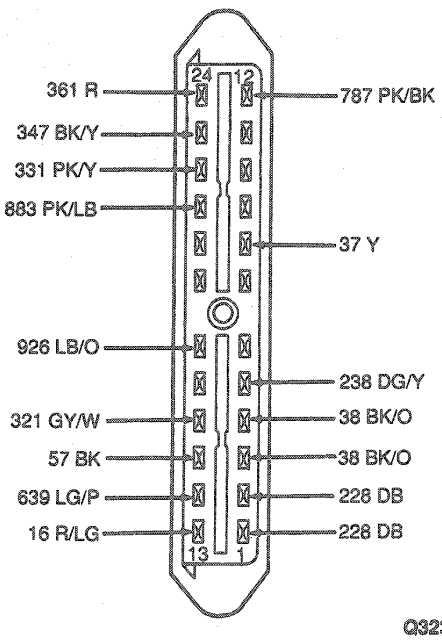
DESCRIPTION AND OPERATION (Continued)

Pin Number	Circuit	Circuit Function
1	181 (BR/O)	Fan Control (FC) Cooling Fan Motor(s) B+
2	181 (BR/O)	Fan Control (FC) Cooling Fan Motor(s) B+
3	228 (DB)	Cooling Fan Motor(s) Feed
4	228 (DB)	Cooling Fan Motor(s) Feed
5	787 (PK/BK)	Fuel Pump Safety Switch to Fuel Pump
6	38 (BK/O)	High Fan Control (HFC) Cooling Fan Motor(s) B+
7	38 (BK/O)	High Fan Control (HFC) Cooling Fan Motor(s) B+
8	37 (Y)	Constant Control Relay Module (CCRM) 12B577 B+
9	—	Not Used
10	—	Not Used
11	—	Not Used
12	38 (BK/O)	Fuel Pump B+
13	16 (R/LG)	B+
14	197 (T/O)	Fan Control (FC) Cooling Fan Ground
15	60 (BK/LG)	Ground
16	57 (BK)	A/C Clutch Ground
17	639 (LG/P)	High Fan Control (HFC) 12A650 Ground
18	926 (LB/O)	Fuel Pump Ground
19	—	Not Used
20	—	Not Used
21	883 (PK/LB)	A/C Mode Input
22	331 (PK/Y)	WOT A/C Cutout
23	347 (BK/Y)	A/C Clutch Feed
24	361 (R)	Powertrain Control Module (PCM) 12A650 B+

Cooling Fan Motor Circuit Diagram—3.0L SHO with MTX



Constant Control Relay Module (CCRM) Connector End View



DESCRIPTION AND OPERATION (Continued)

Pin Number	Circuit	Circuit Function
1	38 (BK/O)	12 Volt Power Supply
2	38 (BK/O)	12 Volt Power Supply
3	181 (BR/O)	Cooling Fan Motor Feed
4	181 (BR/O)	Cooling Fan Motor Feed
5	787 (PK/BK)	Fuel Pump Safety Switch to Fuel Pump
6	—	Not Used
7	—	Not Used
8	37 (Y)	Battery to Load
9	—	Not Used
10	38 (BK/O)	Fan Dropping Resistor
11	926 (LB/O)	Powertrain Control Module (PCM) 12A650
12	38 (BK/O)	12 Volt Power Supply
13	16 (R/LG)	Ignition Switch to Ignition Coil "Battery" Terminal
14	197 (T/O)	Coolant Temperature Switch to Control Relay

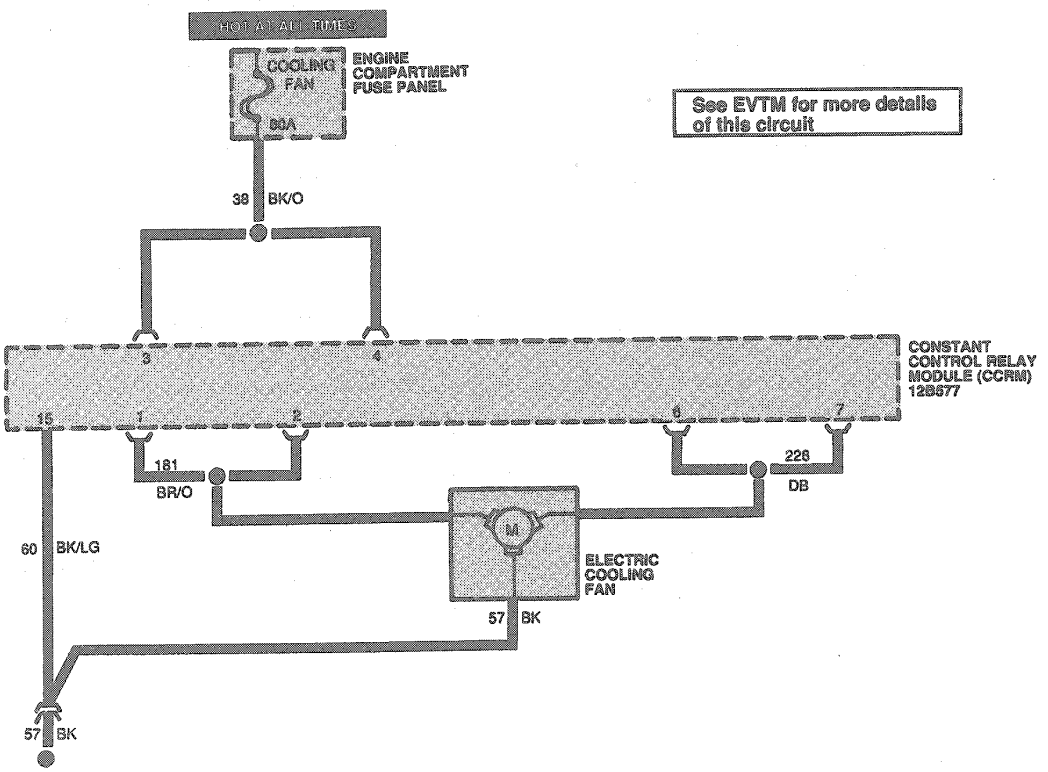
(Continued)

Pin Number	Circuit	Circuit Function
15	60 (BK/LG)	Ground
16	57 (BK)	Ground
17	—	Not Used
18	97 (T/LG)	Low Speed Fuel Pump Relay
19	—	Not Used
20	—	Not Used
21	883 (PK/LB)	Air Conditioning Control Relay Feed
22	331 (PK/Y)	WOT Cutout Relay
23	347 (BK/Y)	Compressor Clutch Feed
24	361 (R)	Power Relays to Powertrain Control Module (PCM) 12A650

- Cooling fan will run at high speed if:

a. Engine temperature is higher than desirable and fan has been operating at low speed. Fan starts running at high speed at 110°C (230°F) and stops running at 107°C (224°F).

Cooling Fan Motor Circuit Diagram—3.8L Engines



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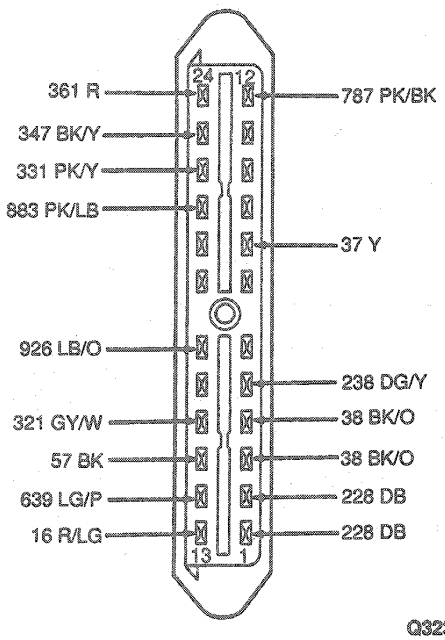
DESCRIPTION AND OPERATION (Continued)

Constant Control Relay Module (CCRM) Connector End View



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Pin Number	Circuit	Circuit Number
1	181 (BR/O)	Fan Control (FC) Motor Feed
2	181 (BR/O)	Fan Control (FC) Motor Feed
3	38 (BK/O)	VB+
4	38 (BK/O)	VB+
5	787 (PK/BK)	Fuel Pump Safety Switch to Fuel Pump
6	228 (DB)	High Fan Control (HFC) Cooling Fan Motor Feed
7	228 (DB)	High Fan Control (HFC) Cooling Fan Motor Feed
8	37 (Y)	Constant Control Relay Module (CCRM) 12B577 B+
9	—	Not Used
10	—	Not Used
11	—	Not Used
12	38 (BK/O)	Fuel Pump VBATT+
13	16 (R/LG)	Ignition Switch B+
14	197 (T/O)	Fan Control (FC) Cooling Fan Ground
15	60 (BK/LG)	Ground
16	321 (GY/W)	A/C Clutch Ground
17	639 (LG/P)	High Fan Control (HFC) Cooling Fan Ground
18	926 (LB/O)	Fuel Pump Ground
19	—	Not Used
20	—	Not Used
21	883 (PK/LB)	A/C Mode Input
22	331 (PK/Y)	WOT A/C Cutout
23	347 (BK/Y)	A/C Clutch Feed
24	361 (R)	Powertrain Control Module 12A650 B+

(Continued)

Several different integrated controller modules are available depending on application. Proper operation of the system cannot be obtained unless the correct integrated controller module is used.

DIAGNOSIS AND TESTING

Thermostat

When investigating a concern of overheating or insufficient heater/defroster performance, the following tests should be performed:

1. Check and service any leaks:
   - Radiator pressure cap
   - Heater hoses
   - Radiator hoses
   - Water outlet connection gasket
   - Head gasket
   - Water pump gasket
2. Check cold engine coolant level in radiator.
   a. If level is below radiator filler neck, fill to filler neck with an approved coolant. Add coolant to recovery reservoir to the FULL COLD mark.

      For Taurus SHO, fill coolant recovery reservoir to one-quarter full.

DIAGNOSIS AND TESTING (Continued)

b. If the cold coolant level in the radiator is sufficient, run the vehicle for 10 minutes with the radiator pressure cap off and check for coolant circulation through the heater and radiator. If the coolant drops below the radiator filler neck, add coolant to the filler neck. Repeat the above procedure until all the air is purged from the cooling system.

When this procedure has been completed, feel the heater inlet and outlet hoses and the underside of the upper radiator hose. The thermostat should be removed only if these hoses are cold or if no coolant circulation is observed through the radiator after 10 minutes of operation.

Cooling System Pressure Test

Tools Required:

- Rotunda Radiator / Heater Core Pressure Tester 021-00012

1. Open hood and place fender covers.

   WARNING: NEVER REMOVE THE RADIATOR PRESSURE CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN PERSONAL INJURY AND/OR DAMAGE TO THE COOLING SYSTEM OR ENGINE. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR.

   WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN CERTAIN ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE CAP (STILL WITH A CLOTH), TURN AND REMOVE.

2. When engine is cool, cautiously remove radiator pressure cap. Disconnect battery. Fit correct adapter to Rotunda Radiator / Heater Core Pressure Tester 021-00012 or equivalent and clip in position onto radiator filler neck.

   NOTE: Small amount of "weeping" from the water pump blend hole is normal.

3. Pump up cooling system to a maximum of 110 kPa (16 psi) and hold for two minutes. If pressure drops within this time, inspect for leaks and service as required.
4. Pressure test radiator pressure cap.
5. Check condition of secondary seal on radiator cap seals.
6. Check coolant level in radiator and in reservoir reservoir. Fill as required with recommended coolant, install radiator pressure cap and connect battery cables.
7. Remove fender covers and close hood.

TESTING

Leak Testing

Clean the radiator before leak testing to prevent contaminating the test tank. Leak test the radiator in clean water with 145 kPa (21 psi) air pressure. Do not leak test an aluminum radiator in the same water that copper / brass radiators are tested in. Flux and caustic cleaners may be present in the tank and they will attack aluminum. A separate clean test tank is necessary for aluminum radiators. If conditions do not allow a separate tank for aluminum radiator leak testing, thoroughly clean the test tank each time before testing an aluminum radiator in the tank.

When a tank is removed to service a tube-to-header leak, the core can be leak tested by clamping the tank (with an O-ring gasket in place) to the core and leak testing with air under water. When service is completed, install the tank. Refer to Radiator Tank Installation.

Always install plugs in the oil cooler fittings before leak testing or cleaning any radiator equipped with an oil cooler.

REMOVAL AND INSTALLATION

Radiator

Tools Required:

- Disconnect Tool T82L-9500-AH

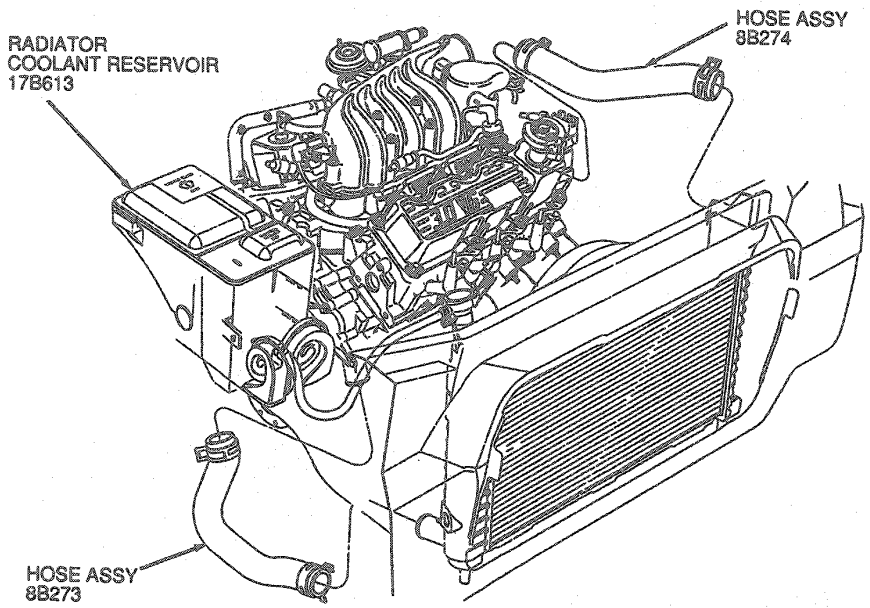
Removal

1. Drain cooling system by removing radiator pressure cap and opening draincock located at lower rear corner of radiator inlet tank. Three revolutions are required to open draincock to full open position.
2. Remove rubber overflow tube from coolant recovery reservoir and detach it from radiator.

   On Taurus SHO, disconnect tube from radiator and remove recovery reservoir. Refer to illustration.

REMOVAL AND INSTALLATION (Continued)

Taurus / Sable 3.0L



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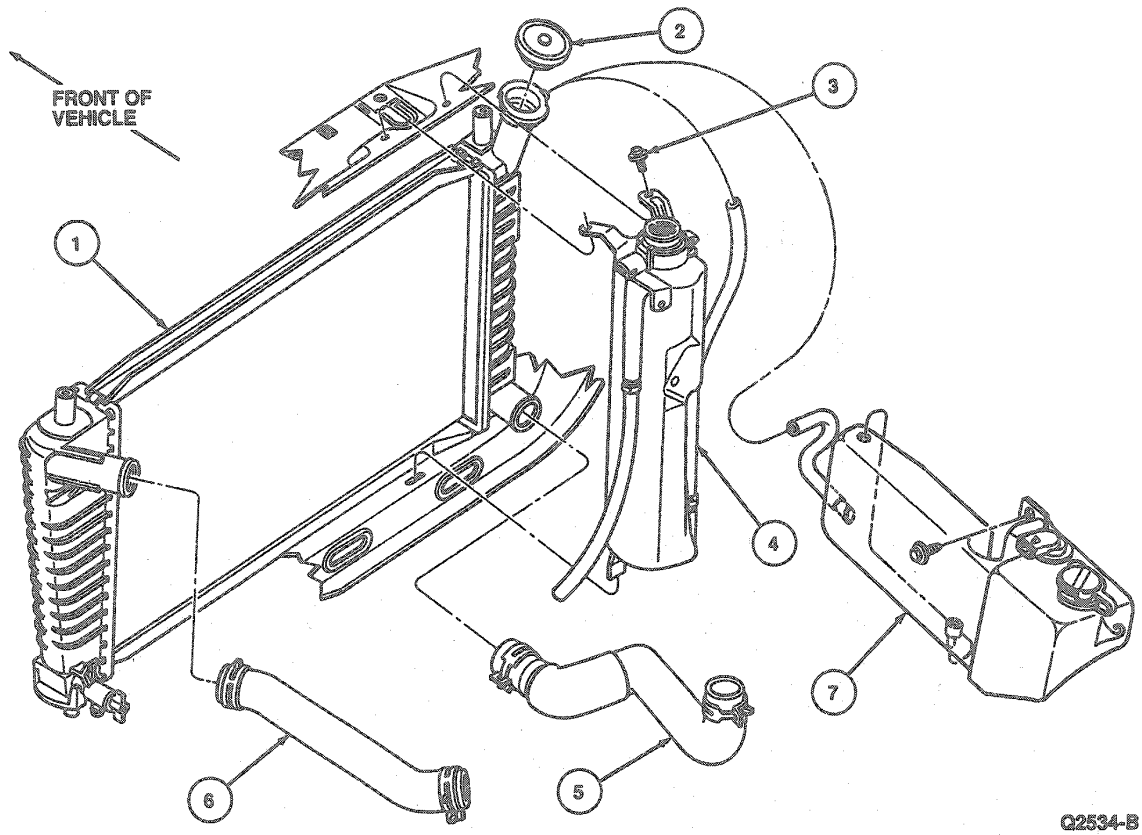
REMOVAL AND INSTALLATION (Continued)

Taurus SHO 3.0L/3.2L



Item	Part Number	Description
1	8005	Radiator Assy
2	—	Radiator Cap Assy
3	N80312-S2	Screw and Washer Assy

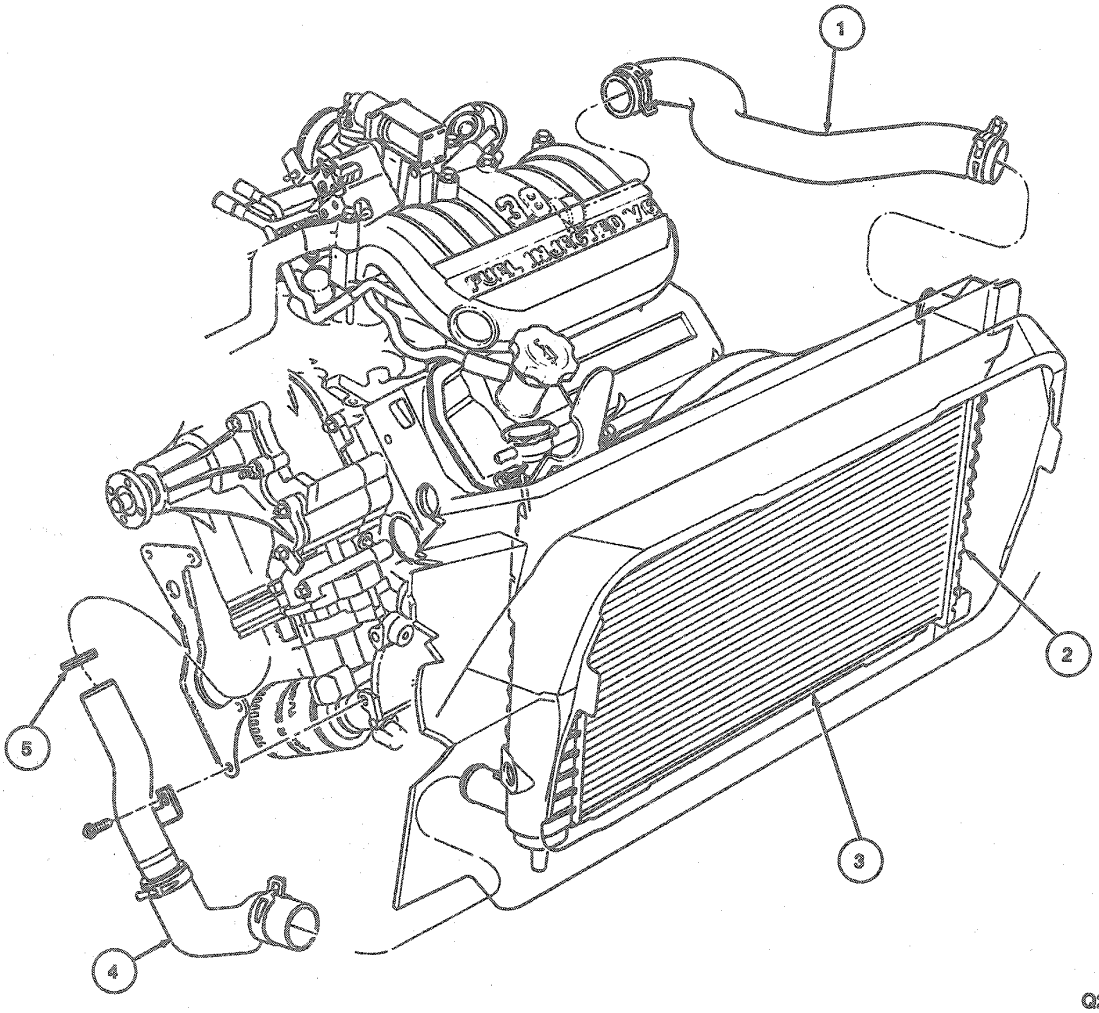
(Continued)

Item	Part Number	Description
4	8C045 (3.0L SHO)	Reservoir Assy
5	8B273	Hose and Clamp Assy
6	8B274	Hose and Clamp Assy
7	8C045 (3.2L SHO)	Reservoir Assy

3. Disconnect battery ground cable.
4. Remove two shroud upper retaining screws and lift shroud out of lower retaining clip.
5. Disconnect the electric cooling fan motor wires and remove fan and shroud assembly.
6. Loosen upper and lower hose clamps at radiator and remove hoses from radiator connectors.
7. Disconnect two automatic transmission oil cooling lines from radiator fittings.
8. On 3.0L engine remove two radiator upper retaining screws.
9. On 3.8L, 3.0L SHO, 3.2L SHO engines remove two hex nuts from RH radiator support bracket. Remove bracket.
10. On 3.8L, 3.0L SHO, 3.2L SHO engines remove two screws from LH radiator support bracket. Remove bracket.
11. Tilt radiator back (rearward) approximately 25mm (1 inch) and lift directly upward, clear of radiator support.
12. If either hose is to be replaced, loosen clamp at engine end and slip hose off connections with a twisting motion.

REMOVAL AND INSTALLATION (Continued)

Taurus / Sable



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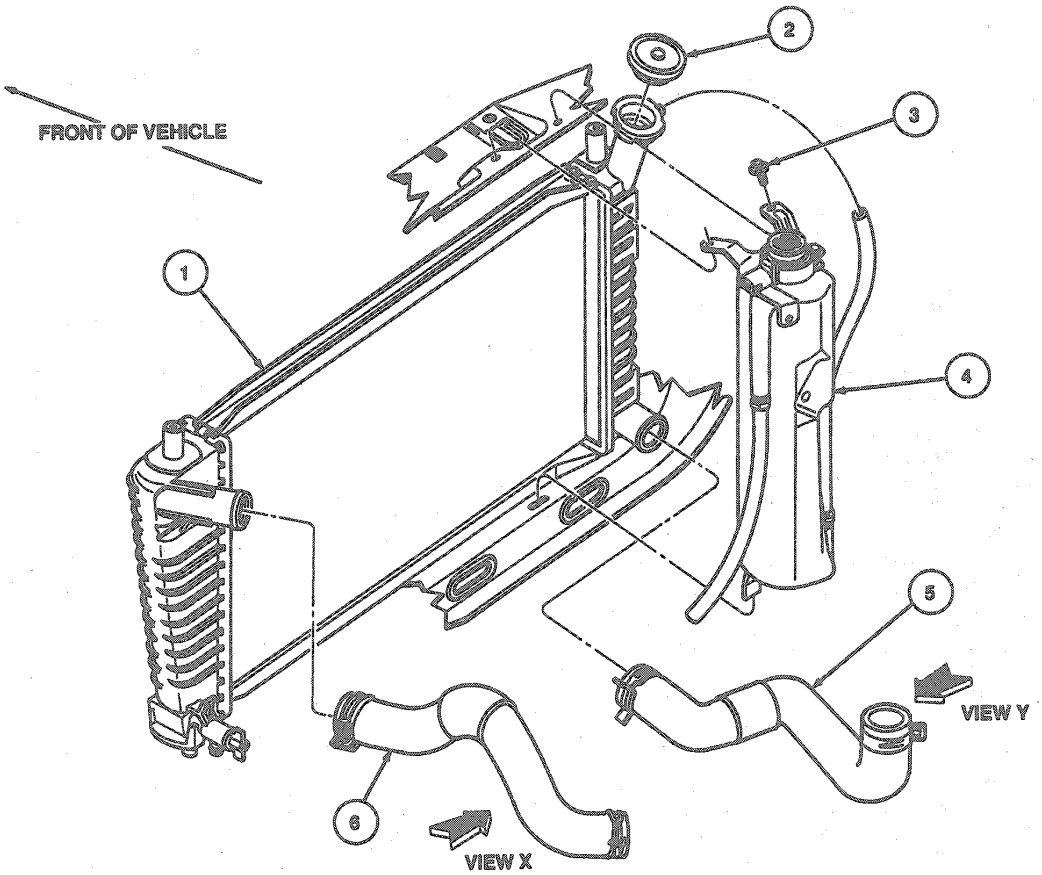
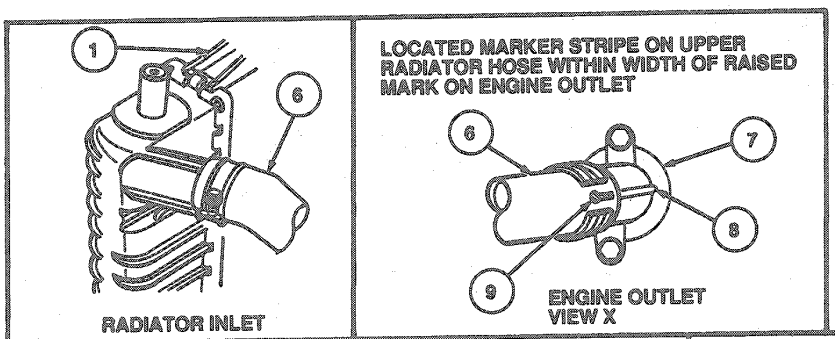
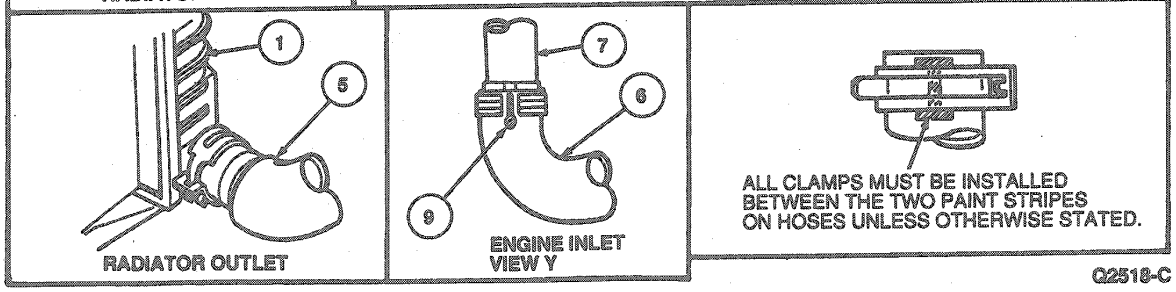
Item	Part Number	Description
1	8B274	Upper Radiator
2	8005	Radiator Assy
3	—	Radiator Core
4	8291	Lower Radiator Hose and Lower Tube Assy
5	87061-S94	O-Ring

REMOVAL AND INSTALLATION (Continued)

Taurus SHO







REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	8005	Radiator Assy
2	—	Radiator Cap
3	N800312-S2	Screw and Washer Assy
4	8C045	Reservoir Assy (3.0 Version Shown)

(Continued)

Item	Part Number	Description
5	8B273	Hose and Clamp Assy
6	8B274	Hose and Clamp Assy
7	—	Engine Water Outlet Connection
8	—	Rib Alignment
9	—	Alignment Stripe

13. Remove radiator lower support rubber pads, if pad replacement is necessary.

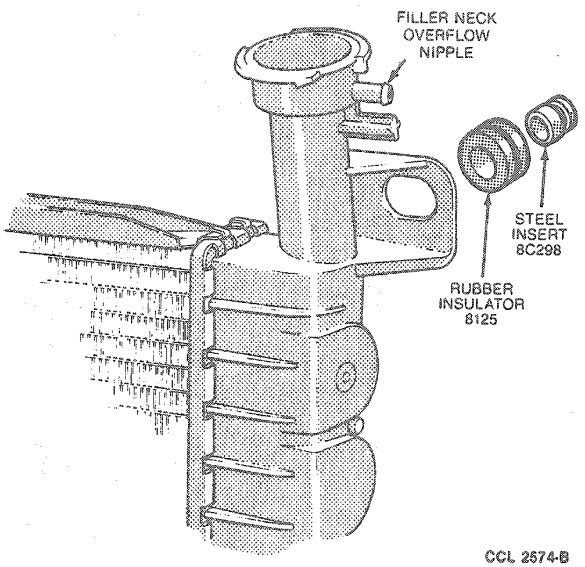
Installation

1. Position radiator lower support rubber pads to lower support, if necessary.
2. If either hose has been replaced, position hose on engine with index arrow in-line with mark on fitting at engine. Position the clamps between the alignment marks on both ends of the hose and slide hose on connections.

   CAUTION: Ensure the clamps are beyond the bead and placed in the center of the clamping surface of the connection.

   Any used hose clamps must be replaced with a new clamp to ensure proper sealing at the connection.

   Tighten screw clamps to 2.2-3.4 N·m (20-30 lb-in).
3. Position radiator into engine compartment and to radiator support. Insert the moulded pins at bottom of each tank through slotted holes in lower support rubber pads.
4. Inspect radiator nylon tank upper mounting bushings for damage. Replace if damaged.
5. On 3.8L, 3.0L SHO, and 3.2L SHO engines inspect LH and RH radiator support brackets. Replace if damaged.



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6. On 3.0L engine only, ensure plastic pads on bottom of radiator tanks are resting on rubber pads. Install two upper retaining bolts to attach radiator to radiator support. Tighten to 5-7 N·m (45-61 lb-in).
7. On 3.8L, 3.0L SHO, and 3.2L SHO engines position LH and RH support bracket over radiator and radiator support. Align holes in bracket with corresponding holes in radiator support and secure with two screws. Tighten screws to 12-24 N·m (9-17 lb-ft).
8. Install radiator upper and lower hoses to radiator. Position hose on radiator connector so that index arrow on hose is in line with mark on connector. Position the clamps between the alignment marks on both ends of the hose and slide hose on connections.

   CAUTION: Ensure the clamps are beyond the bead and placed in the center of the clamping surface of the connection.

   Any used hose clamps must be replaced with a new clamp to ensure proper sealing at the connection.

   Tighten screw clamps to 2.2-3.4 N·m (20-30 lb-in).

REMOVAL AND INSTALLATION (Continued)

On vehicles with automatic transaxles, connect oil cooler lines using Pipe Sealant with Teflon®D8AZ-19554-A (ESG-M4G194-A) or equivalent oil resistant sealer.

9. Install fan and shroud assembly by connecting motor wiring and positioning on lower retainer clips. Attach top of shroud to radiator with two screw and washer assemblies, and nut. Tighten to 4 N·m (36 lb-in).
10. Attach rubber overflow tube to radiator filler neck overflow nipple and coolant recovery reservoir.

    On Taurus SHO, install coolant recovery reservoir and connect overflow hose.
11. Install new 50/50 mixture of water and antifreeze. Operate engine for 15 minutes. Check coolant level and bring it to within 38mm (1-1/2 inch) of radiator filler neck.
12. Connect battery ground cable.

Fan, Motor and Constant Control Relay Module (CCRM)

3.0L

Removal and Installation

1. Remove radiator sight shield.
2. Disconnect electrical connector. Remove integrated relay control assembly located on radiator support.
3. Disconnect electric fan connector.
4. Unbolt fan and shroud assembly from radiator.
5. Rotate fan and shroud assembly and remove past radiator.
6. Remove fan U-spring retainer from motor shaft and remove fan.
7. Unbolt fan motor from shroud.
8. To install, reverse Steps 1 through 7. Tighten fan retaining screws to 11-14 N·m (97-123 lb-in). Tighten shroud retaining bolts to 2.6-3.7 N·m (23-33 lb-in). Tighten shroud retaining nuts to 8-12 N·m (71-106 lb-in).

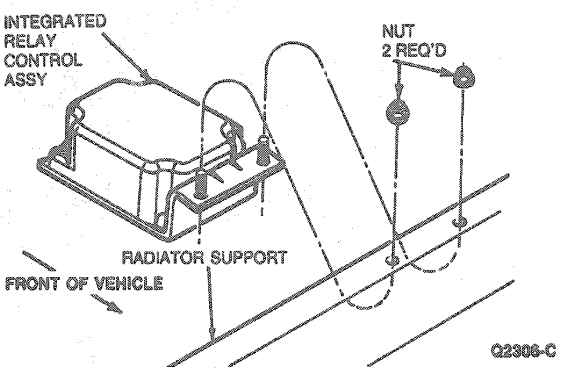
3.8L and 3.0L/3.2L SHO

Removal and Installation

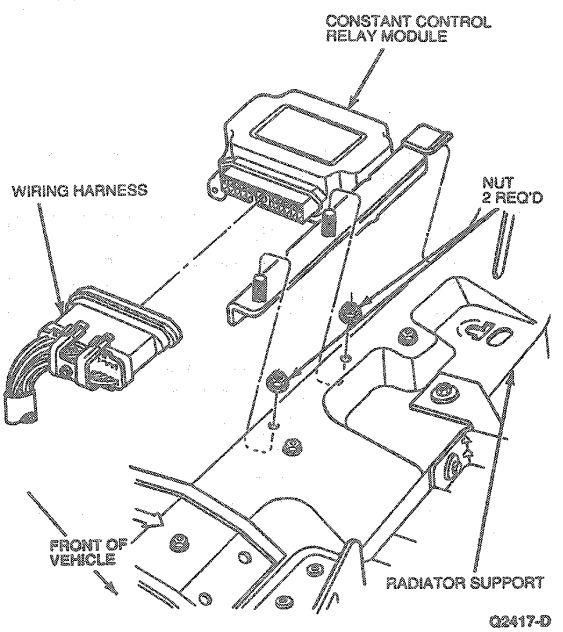
1. Remove radiator sight shield.
2. Disconnect electrical connector. Remove integrated relay control assembly located on radiator support.
3. Disconnect electric fan connector.
4. Unbolt fan and shroud assembly from radiator.
5. Slide cooling fan module clear of radiator hose connector and lift up past radiator.
6. Remove fan U-spring and remove fan.
7. Remove fan motor from shroud.
8. To install, reverse Steps 1 through 7. Tighten fan retaining screws to 10 N·m (86 lb-in). Tighten shroud retaining nuts and bolts to 4 N·m (36 lb-in).

Integrated Relay Control Assembly

3.0L

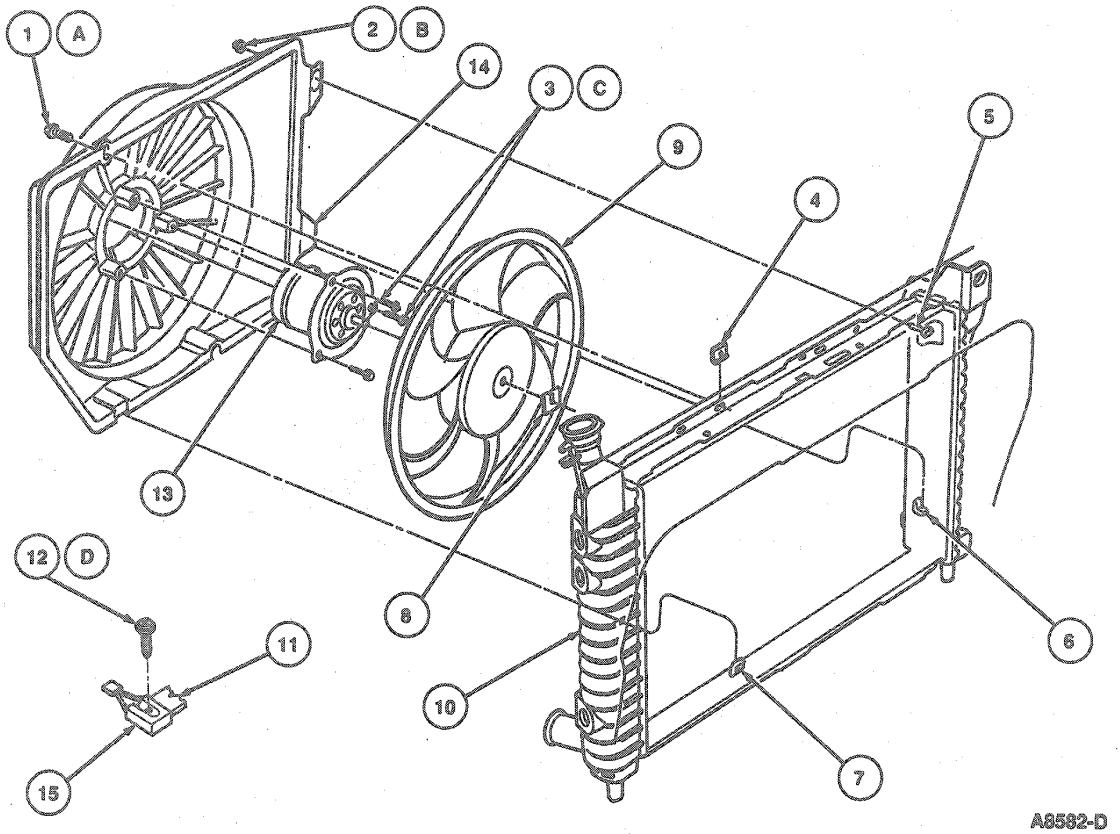


3.0L SHO and 3.8L



REMOVAL AND INSTALLATION (Continued)

Fan and Motor—3.0L



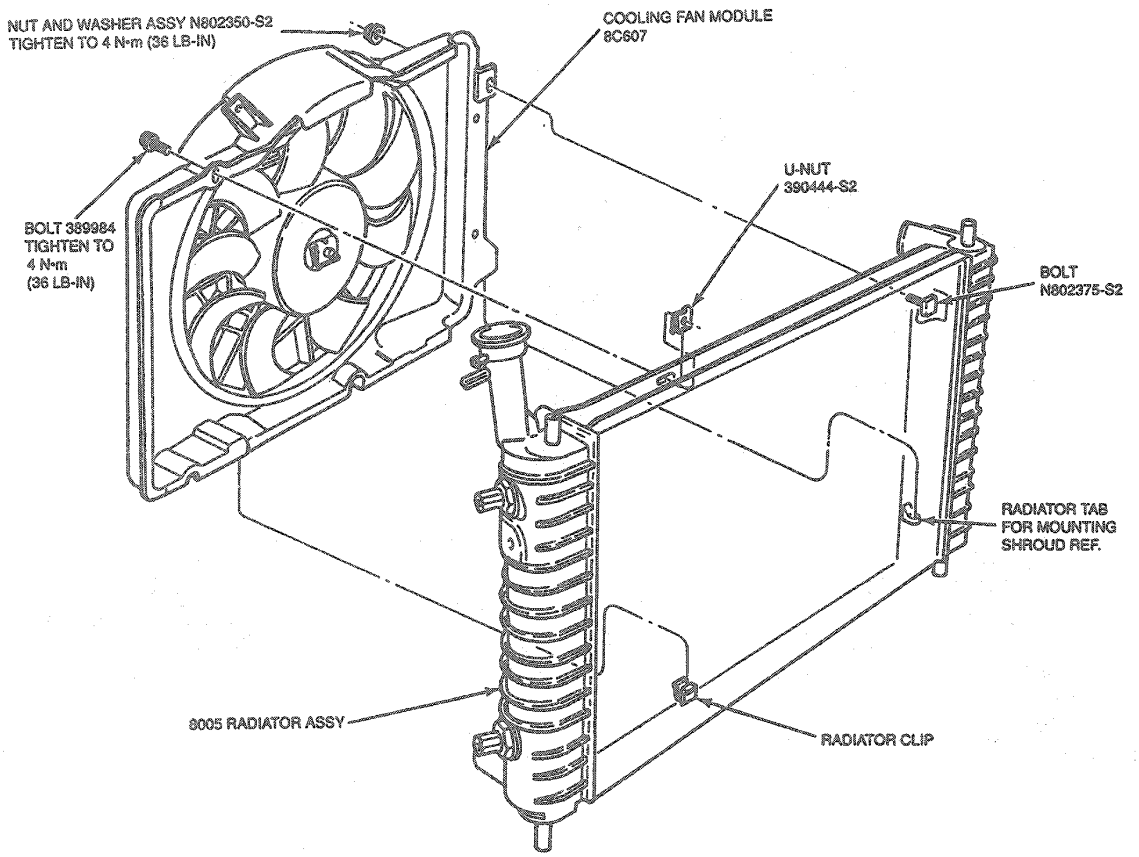
Item	Part Number	Description
1A	389984	Bolt
2B	N802330-S2	Nut and Washer Assy
3C	N804019-S36	Screw and Washer Assy
4	N803191-S2	Nut
5	N802375-S2	Bolt
6	—	Shroud Mounting Tab
7	—	Radiator Clip
8	N801025-S2	U-Spring Retainer
9	8600	Engine Cooling Fan Assy
10	8500	Radiator Assy
11	—	Bracket

(Continued)

Item	Part Number	Description
12D	W611105-S2	Screw and Washer Assy
13	8K621	Fan Motor Assy
14	8146	Fan Shroud
15	—	Cooling Fan Dropping Resistor Assy
A		Tighten to 2.6-3.7 N·m (23-33 Lb-in)
B		Tighten to 8-12 N·m (71-106 Lb-in)
C		Tighten to 11-14 N·m (97-123 Lb-in)
D		Tighten to 5.2-6.8 N·m (46-60) Lb-in)

REMOVAL AND INSTALLATION (Continued)

Fan and Motor — 3.0L SHO



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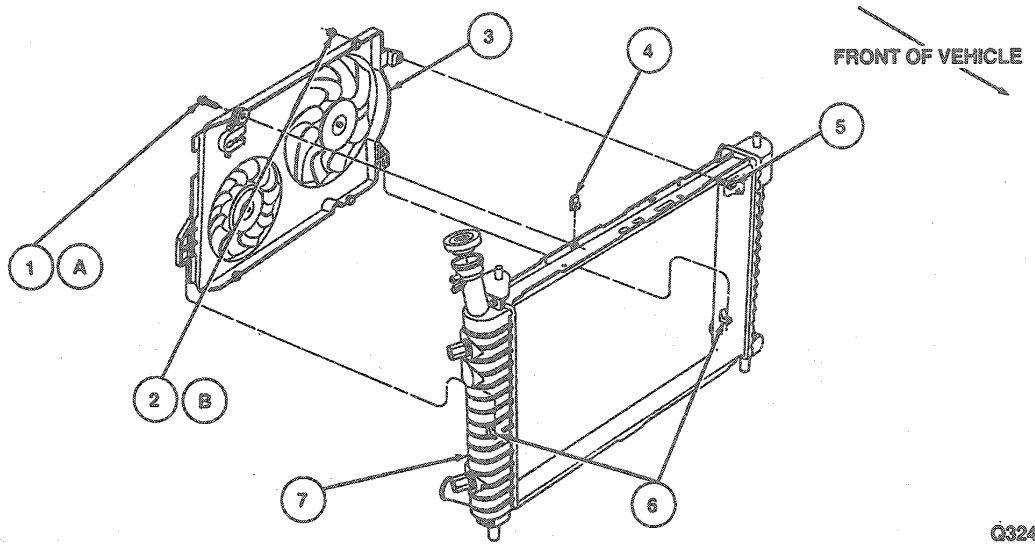
REMOVAL AND INSTALLATION (Continued)

Fan and Motors — 3.2L SHO



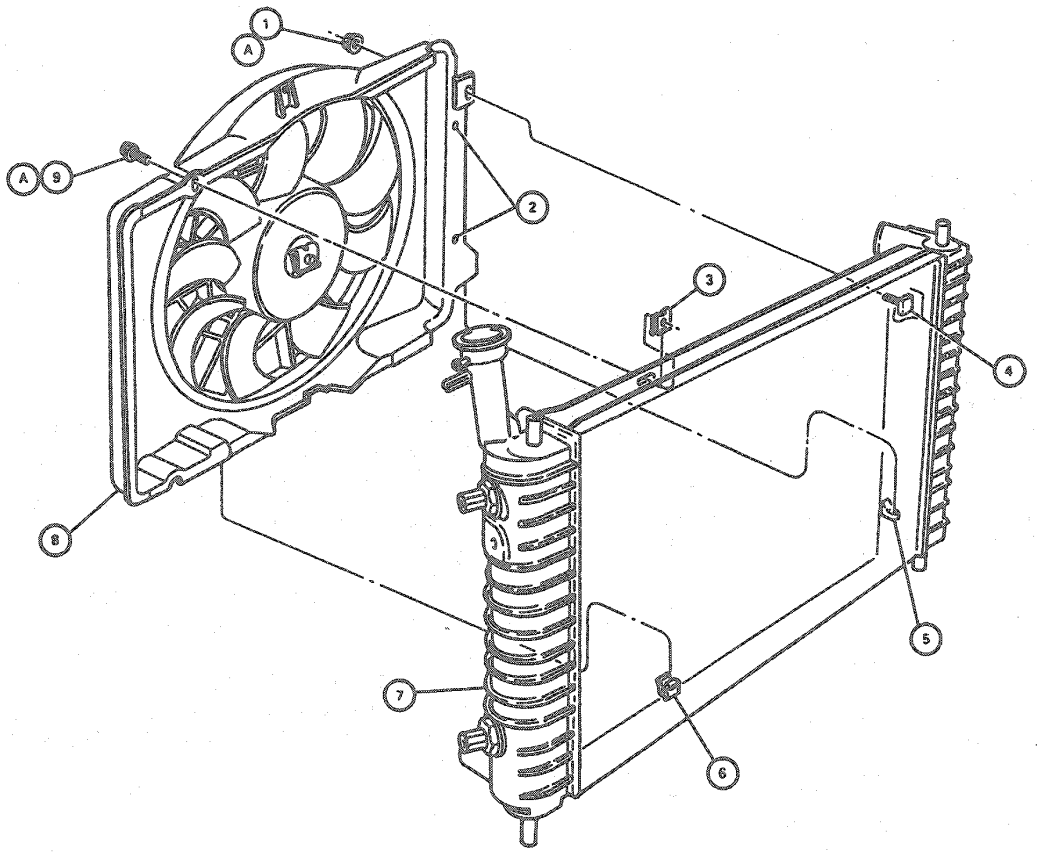
Item	Part Number	Description
1A	N807390-S2	Screw and Washer Assy
2B	N802350-S2	Nut and Washer Assy
3	8C607	Motor and Fan Assy
4	N623330-S2	Nut
5	N802375-S2	Bolt

(Continued)

Item	Part Number	Description
6	—	Radiator Tab for Mounting Shroud
7	8005	Radiator Assy
A		Tighten to 8-11.5 N·m (6-8.5 Lb-Ft)
B		Tighten to 2.5-3.5 N·m (2-2.6 Lb-Ft)

REMOVAL AND INSTALLATION (Continued)

Fan and Motor—3.8L



ITEM	PART NO.	DESCRIPTION
1A	N602350-S2	NUT AND WASHER ASS'Y
2	-------	ENGINE WIRING HARNESS CLIP LOCATIONS
3	45258-S2	U-NUT
4	N602375-S2	BOLT
5	-------	RADIATOR TAB FOR MOUNTING SHROUD
6	-------	RADIATOR CLIP
7	8005	RADIATOR ASS'Y
8	8C607	COOLING FAN MODULE
9A	56950-S2	BOLT (4 REQ'D)
A		TIGHTEN TO 4 N m (36 Lb-in)

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Thermostat

For Taurus SHO, refer to Section 03-01B.

3.0L Engine

Removal

1. Drain cooling system as outlined.
2. Remove upper radiator hose from thermostat housing.

REMOVAL AND INSTALLATION (Continued)

3. Remove three retaining bolts from thermostat housing.
4. Remove housing and thermostat as an assembly.

   CAUTION: Aluminum gouges easily which forms leak paths. Use care when scraping gasket.
5. Discard gasket. Clean sealing surfaces with gasket scraper.

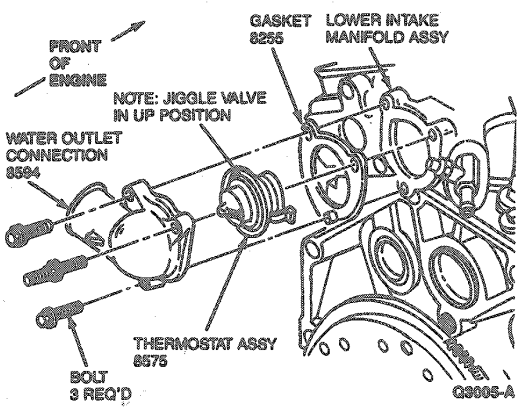
Installation

1. Sealing surfaces must be totally free of gasket material.
2. Install thermostat into housing and rotate clockwise to lock in. Note location of jiggle valve in relation to housing (up).
3. Position gasket onto housing using bolts as a holding device. Install thermostat assembly and tighten bolts to 12 N·m (9 lb-ft).
4. Install upper radiator hose. Position the clamps between the alignment marks on both ends of the hose and slide hose on connections.

   CAUTION: Ensure the clamps are beyond the bead and placed in the center of the clamping surface of the connection.

   Any used hose clamps must be replaced with a new clamp to ensure proper sealing at the connection.

   Tighten screw clamps to 2.2-3.4 N·m (20-30 lb-in).
5. Fill and bleed cooling system with proper amount and mixture.
6. Start engine and check for coolant leaks.



3.8L Engine

Removal

1. Open hood and place fender covers.
2. Disconnect battery cables.
3. Position drain tray below radiator.
4. Remove radiator pressure cap following outlined precautions. Attach 9.5mm (0.4 inch) hose to drain tube and open draincock. Drain radiator to a corresponding level below water outlet connection. Close draincock.

   CAUTION: Do not pry housing off.
5. Loosen top hose clamp at radiator, remove water outlet connection retaining bolts, lift clear of engine and remove thermostat by rotating counterclockwise in water outlet connection until thermostat becomes free to remove.

Installation

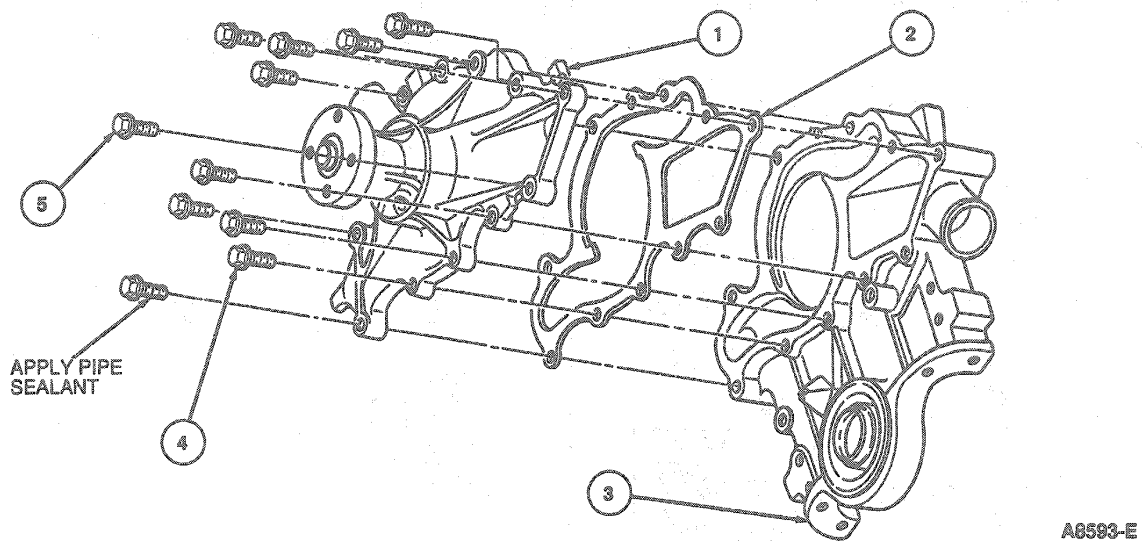
1. Clean water outlet connection pocket and cylinder head mating faces.
2. Place thermostat in position, fully inserted and rotate clockwise in water outlet connection to secure. Position water outlet connection to intake manifold with a new gasket and secure bolts. Tighten to 20-30 N·m (15-22 lb-ft). Position top hose to radiator. Position the clamps between the alignment marks on both ends of the hose and slide hose on connections. Close draincock.

   CAUTION: Ensure the clamps are beyond the bead and placed in the center of the clamping surface of the connection.

   Any used hose clamps must be replaced with a new clamp to ensure proper sealing at the connection.

   Tighten screw clamps to 2.2-3.4 N·m (20-30 lb-in).
3. Refill cooling system with specified antifreeze solution. Refer to Coolant Refill procedure.
4. Connect battery cables. i
5. Start engine and check for leaks.
6. Check coolant level as required.

REMOVAL AND INSTALLATION (Continued)



Item	Part Number	Description
1	8501	Water Pump Assy
2	8507	Water Pump Gasket
3	6019	Front Cover Assy
4	N804168-S8	Bolt (5 Req'd)
5	N804811-S8	Bolt (6 Req'd)

Installation

NOTE: Lightly oil all bolt and stud threads before installation except those requiring special sealant.

CAUTION: Use care when scraping as aluminum gouges easily which may form leak paths.

1. Clean gasket surfaces on water pump and front cover.
2. Position a new gasket on water pump sealing surface using Gasket and Trim Adhesive D7AZ-19B508-B (ESE-M2G52-A and ESE-M2G52-A) or equivalent to hold gasket in place.
3. With pulley loosely positioned on water pump hub, align water pump to timing cover and install retaining bolts.

   NOTE: Apply Pipe Sealant with Teflon®D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent to bolt No. 3 (as illustrated) prior to installation.
4. Tighten retaining bolts as follows: Numbers 3, 4, 6, 7, 8, 9 and 10 to 20-30 N·m (15-22 lb-ft) and Numbers 11, 12, 13, 14 and 15 to 8-12 N·m (71-106 lb-in).
5. Hand tighten water pump pulley retaining bolts.
6. Install automatic belt tensioner assembly. Tighten the two retaining nuts and bolt to 48 N·m (35 lb-ft).
7. Install the generator and power steering drive belts as outlined in Section 03-05. Final tighten water pump pulley retaining bolts to 21 N·m (16 lb-ft).
8. Position the clamps between the alignment marks on both ends of the hose and slide hose on connections.

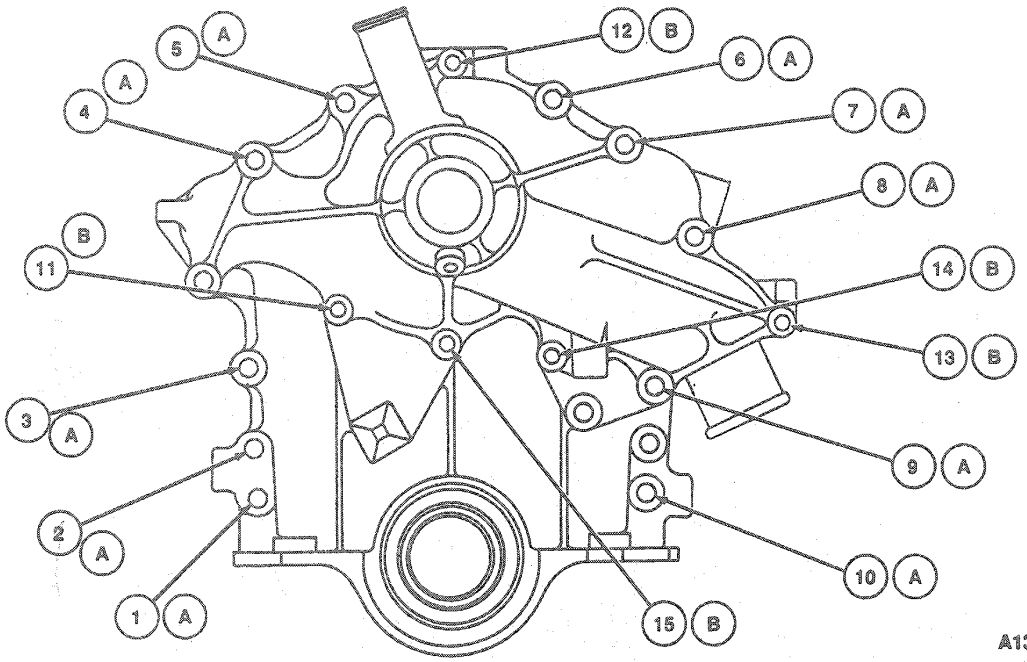
   CAUTION: Ensure the clamps are beyond the bead and placed in the center of the clamping surface of the connection.

   Any used hose clamps must be replaced with a new clamp to ensure proper sealing at the connection.

   Tighten screw clamps to 2.3-3.4 N·m (20-30 lb-in).
9. Fill and bleed cooling system with specified quantity and type.
10. Connect negative battery cable.

REMOVAL AND INSTALLATION (Continued)

11. Start engine and check for leaks.



FASTENER AND HOLE NO.	FASTENERS		
	PART NO.	SIZE	FASTENER APPLICATION
1A	N804113-S8	M8 x 1.25 x 43.5	F/C TO BLOCK
2A	N804113-S100	M8 x 1.25 x 43.5	F/C TO BLOCK
3A	N804811-S100	M8 x 1.25 x 70	W/P & F/C TO BLOCK
4A	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK
5A	N605909-S8	M8 x 1.25 x 42	F/C TO BLOCK
6A	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK
7A	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK
9A	N804811-S8	M8 x 1.25 x 70	W/P & F/C TO BLOCK
10A	N606543-S8	M8 x 1.25 x 52	F/C TO BLOCK
11B	N804168-S8	M6 x 1 x 25	W/P TO F/C
12B	N804168-S8	M6 x 1 x 25	W/P TO F/C
13B	N804168-S8	M6 x 1 x 25	W/P TO F/C
14B	N804168-S8	M6 x 1 x 25	W/P TO F/C
15B	N804168-S8	M6 x 1 x 25	W/P TO F/C

(A) Tighten to 20-30 N·m (15-22 Lb-Ft)
(B) Tighten to 8-12 N·m (71-106 Lb-In)

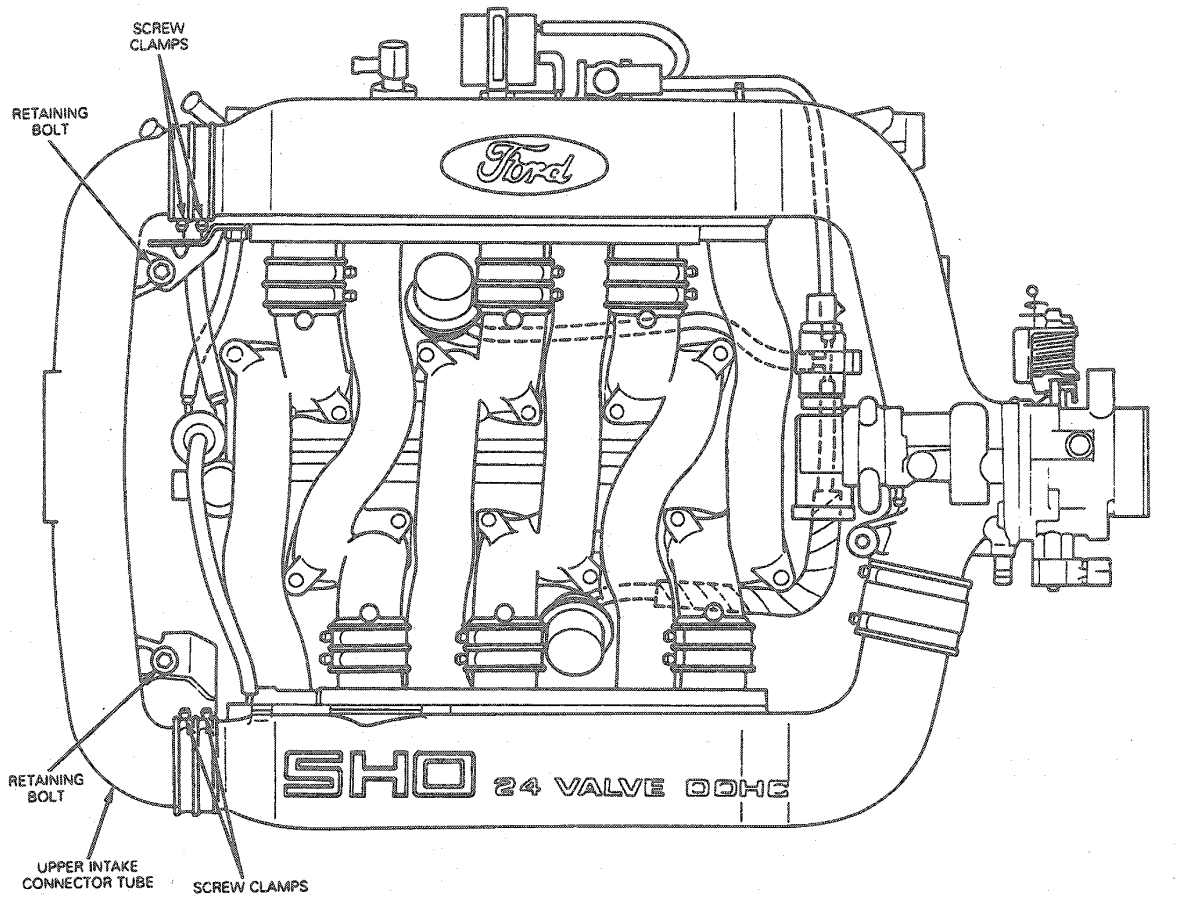
3.0L and 3.2L SHO

Removal

1. Drain engine coolant as outlined.
2. Disconnect battery ground cable.
3. Remove battery and battery tray.
4. Remove accessory drive belts. Refer to Section 03-05.
5. Remove three bolts retaining A/C and generator idler pulley and bracket assembly.
6. Disconnect electrical connector from ignition module and ground strap.
7. Loosen four screw clamps on upper intake connector tube and remove two retaining bolts.

REMOVAL AND INSTALLATION (Continued)

8. Remove upper intake connector tube.



9. Raise vehicle and remove RH tire and wheel assembly. Refer to Section 00-02.
10. Remove splash guard.
11. Remove upper timing belt cover.
12. Remove crankshaft pulley.
13. Remove lower timing belt cover.
14. Remove bolts from center timing belt cover and position out of the way.
15. Remove water pump retaining bolts.
16. Remove water pump.

Installation

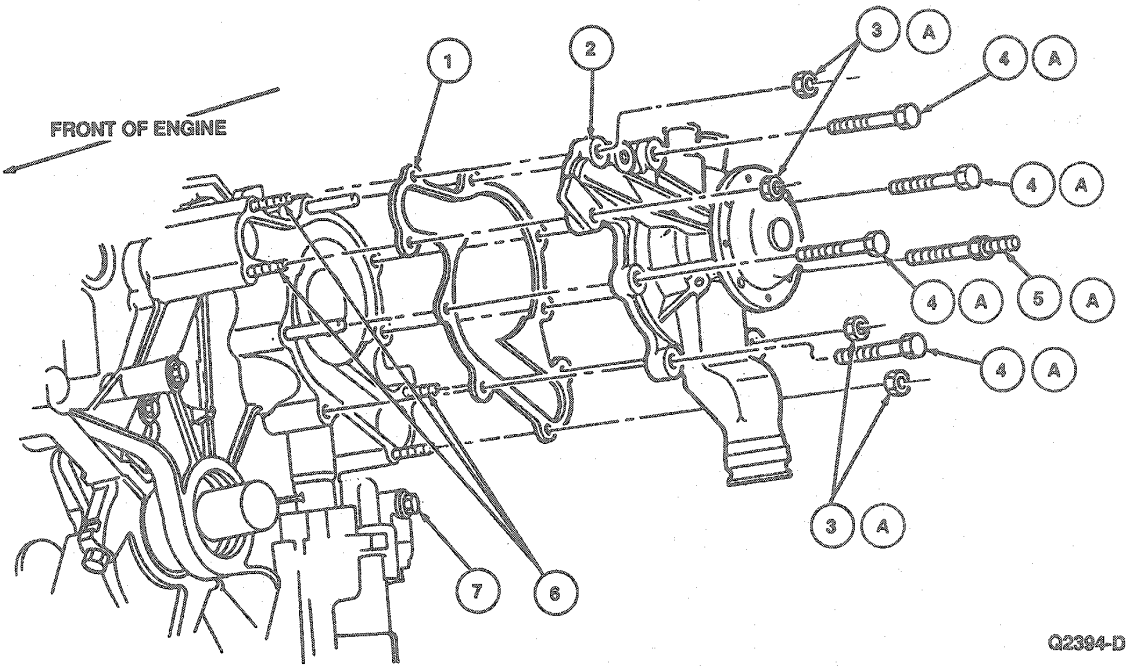
1. Install water pump to cylinder block. Tighten to 15-23 N·m (12-16 lb-ft).
2. Install center timing belt cover.
3. Install lower timing belt cover.
4. Install crankshaft pulley. Tighten to 152-172 N·m (113-126 lb-ft).
5. Install splash guard.
6. Install tire and wheel assembly. Tighten wheel lug nuts to 115-142 N·m (85-105 lb-ft).
7. Install upper timing belt cover.
8. Install upper intake connector tube.
9. Install two bolts on upper intake connector tube. Tighten to 15-23 N·m (12-16 lb-ft). Tighten four screw clamps.
10. Install A/C and generator idler pulley and bracket assembly.
11. Install accessory drive belts. Refer to Section 03-05.
12. Lower vehicle.
13. Connect battery ground cable.
14. Fill engine cooling system as outlined.
15. Start engine and check for leaks.

REMOVAL AND INSTALLATION (Continued)

3.8L Engine

Removal

1. Drain engine coolant. Refer to coolant drain procedure.
2. Disconnect battery ground cable.
3. Loosen accessory drive belt idler and remove drive belts.
4. Remove two nuts and one bolt attaching idler bracket to engine.
5. Disconnect heater hose at water pump.
6. Remove four pulley-to-pump hub bolts. The pulley will remain loose on hub due to insufficient clearance between inner fender and pump, restricting removal from vehicle.
7. Remove 11 water pump-to-engine retaining bolts.
8. Lift water pump and pulley out of vehicle.



Q2394-D

Item	Part Number	Description
1	8507	Gasket
2	8501	Water Pump Assy
3A	N804758	Nut
4A	605908	Bolt

(Continued)

Item	Part Number	Description
5A	N804756	Stud Bolt
6	—	Studs
7	—	Front Cover and Oil Pump Assy
A		Tighten to 20-30 N·m (15-22 Lb-Ft)

Installation

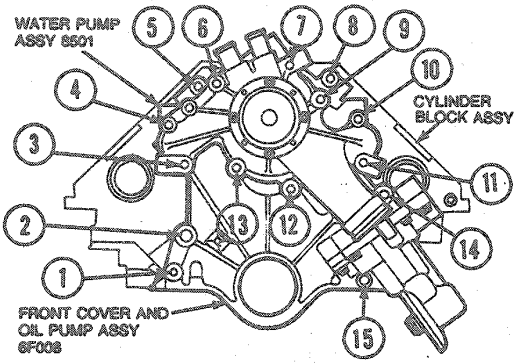
NOTE: Lightly oil all bolt and stud threads before installation except those specifying special sealant.

1. Clean both gasket mating surfaces on water pump and engine front cover.
2. Position gasket on water pump sealing surface using Gasket and Trim Adhesive D7AZ-19B508-BA (ESE-M2G52-A and ESR-M11P17-A) or equivalent.

REMOVAL AND INSTALLATION (Continued)

3. With pulley positioned on water pump hub, position water pump on front cover and install attaching bolts.

   CAUTION: Two lengths of bolts are used. Install bolts as shown.



REF NO.	PART NO.	SIZE	PART NAME
1	N805112	M8 x 1.25 x 98.0	STUD
2	N805112	M8 x 1.25 x 98.0	STUD
3	N805757	M8 x 1.25 x 131.0	STUD
4	N805757	M8 x 1.25 x 131.0	STUD
5	N805787	M8 x 1.25 x 25.0	BOLT
6	N805808	M8 x 1.25 x 35.0	BOLT
7	N805808	M8 x 1.25 x 35.0	BOLT
8	N805787	M8 x 1.25 x 25.0	BOLT
9	N804756	M8 x 1.25 x 61.5	STUD BOLT
10	N805275	M8 x 1.25 x 141.0	STUD
11	N804757	M8 x 1.25 x 131.0	STUD
12	N805808	M8 x 1.25 x 35.0	BOLT
13	N805808	M8 x 1.25 x 35.0	BOLT
14	N804839	M8 x 1.25 x 105.0	BOLT
15	N804841	M8 x 1.25 x 20.0	CAP SCREW

*TIGHTEN ALL RETAINERS TO 20-30 N·m (15-22 LB-FT)

02366-C

4. Tighten retaining bolts to specification. Refer to illustration.
5. Install pulley-to-pump hub bolts. Tighten to 21 N·m (16 lb-ft).
6. Connect coolant bypass / heater hose to water pump.
7. Install idler bracket to front cover.
8. Position accessory drive belt over pump pulley and adjust drive belt tension, if equipped with manual tensioner. Refer to Section 03-05.
9. Connect battery ground cable.
10. Replace engine coolant. Refer to Coolant Refill procedures. Operate engine until normal operation temperature is reached. Check for leaks and check coolant level.

Radiator Hose

Removal

1. Open hood and place fender covers.
2. Disconnect battery ground cable.
3. Position drain tray below radiator.
4. Remove radiator pressure cap, attach a 9.5mm (0.4 inch) ID hose to draincock and drain radiator.
5. Position a drain tray under lower radiator hose. Loosen lower radiator hose clamps. Disconnect hose from water pump or inlet tube, and allow to drain.
6. Loosen clamps, disconnect top hose at radiator and thermostat housing and remove hose.

Installation

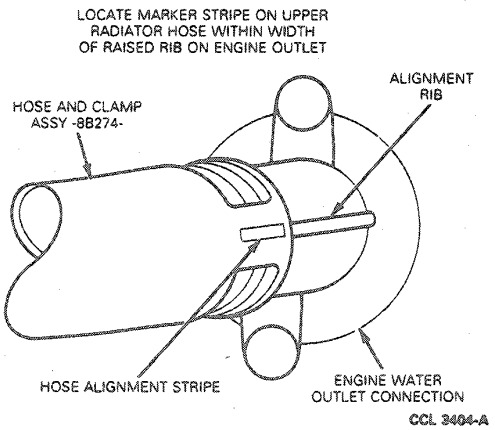
1. Position top hose to radiator and thermostat housing. Position the clamps between the alignment marks on both ends of the hose and slide hose on connections.

   CAUTION: Ensure the clamps are beyond the bead and placed in the center of the clamping surface of the connection.

   Any used hose clamps must be replaced with a new clamp to ensure proper sealing at the connection.

   Tighten screw clamps to 2.2-3.4 N·m (20-30 lb-in).

   On SHO engine, align hose as shown in illustration.
2. Position bottom hose to engine-mounted water pump or inlet tube and radiator. Secure clamps as outlined and close draincock.
3. Fill cooling system with specified cooling system concentrate and water solution. Refer to Coolant Refill procedure.
4. Connect battery cables.
5. Start engine. Check for leaks.
6. Check coolant level as required, only when engine is cool.
7. Remove fender covers and close hood.



CCL 3404-A

REMOVAL AND INSTALLATION (Continued)

Water Pump Inlet Tube Assembly

3.8L Engine

Removal

1. Open and secure hood and place fender covers.
2. Disconnect battery ground cable.
3. Remove radiator pressure cap following outlined precautions.
4. Raise vehicle. Refer to Section 00-02.
5. Position drain pan below radiator under lower radiator hose.
6. Loosen clamp, disconnect lower radiator hose from radiator, and drain engine coolant.
7. Remove inlet tube to engine mount retaining bolt.
8. Carefully remove water pump inlet tube assembly.
9. Remove O-ring from water pump.

Installation

1. Attach inlet tube to engine and install retaining bolt.
2. Position the clamps between the alignment marks on both ends of the hose and slide hose on connections.

   CAUTION: Ensure the clamps are beyond the bead and placed in the center of the clamping surface of the connection.

   Any used hose clamps must be replaced with a new clamp to ensure proper sealing at the connection.

   Tighten screw clamps to 2.2-3.4 N·m (20-30 lb-in).
3. Lower vehicle.
4. Connect battery ground cable.
5. Replace engine coolant. Refer to Coolant Refill procedure. Ensure vent plug on water outlet connection is open during refill. Operate engine until normal operating temperature is reached. Check for leaks and check coolant level.

Coolant Recovery Bottle

Removal

1. Drain radiator until coolant is out of recovery reservoir. Disconnect radiator overflow line at recovery reservoir. Refer to illustration under Radiator Removal, Step 2.
2. Remove overflow tube from recovery reservoir. Remove recovery reservoir retainers and remove recovery reservoir.

Installation

1. Position recovery reservoir in vehicle and install retaining screws. Tighten to 7 N·m (5 lb-ft). On 3.0L SHO, insert tab at bottom of recovery reservoir in slot in lower radiator support.
2. Connect overflow tube to recovery reservoir.
3. Fill and bleed cooling system as outlined. Check for coolant leaks and proper coolant level after engine reaches normal operating temperature.

Radiator Tank

Removal

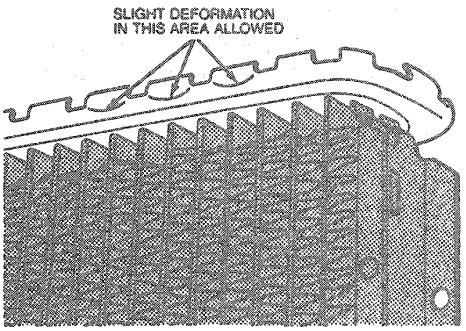
The radiator tank is moulded glass-filled nylon and is attached to the core header by bending the header tabs over the foot (edge) of the tank.

NOTE: The tabs on the vacuum-brazed aluminum radiator are easily work-hardened and require special attention to prevent tab damage.

If outlet end tank is to be removed, metallic pin support bracket must be removed first.

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. 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 Borroughs Tool BT-8260 or equivalent. Follow the manufacturer's instructions for other radiator tab opening and closing tools.



CCL 2175-B

With Screwdriver

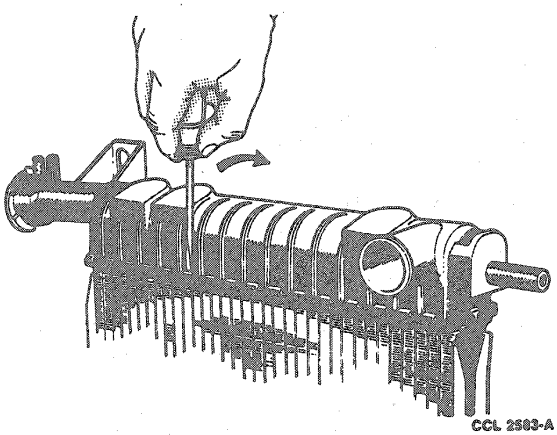
NOTE: Bend (open) the tabs only enough for tank removal.

1. Insert end of medium tip screwdriver between end of header tab and tank. Press screwdriver blade against tank to bend (pry) tab away from tank foot (edge). Repeat procedure for each tab.
2. Lift tank from core header when all of header tabs are bent away from tank foot (edge).
3. Remove O-ring gasket from header.

REMOVAL AND INSTALLATION (Continued)

With BT-8260

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

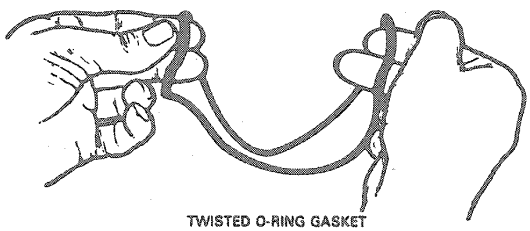


CCL 2563-A

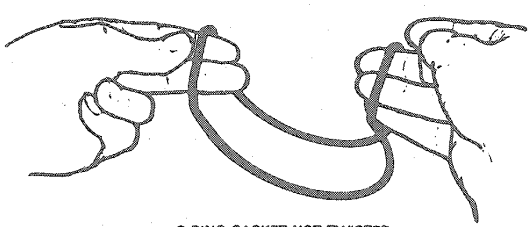
Installation

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

1. Inspect seal surface of radiator core header to ensure it is clean and free of foreign material or damage.
2. Check new O-ring gasket to ensure it is not twisted.



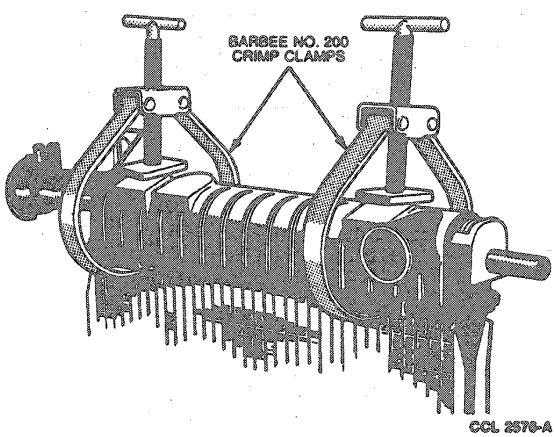
TWISTED O-RING GASKET



O-RING GASKET NOT TWISTED

CCL 2236-A

3. Dip new O-ring gasket in Premium Cooling System Fluid E2FZ-19549-AA (ESE-M97B44-A and ESE-M97B43-A) or equivalent and place gasket in header groove.
4. If outlet tank is being replaced and is equipped with an oil cooler, transfer oil cooler from replaced tank to new tank as outlined.
5. Position tank to header using care not to scratch tank sealing surfaces with header tabs.
6. Clamp tank in position on header with two header clamps as shown. Tighten header clamps to compress O-ring gasket.

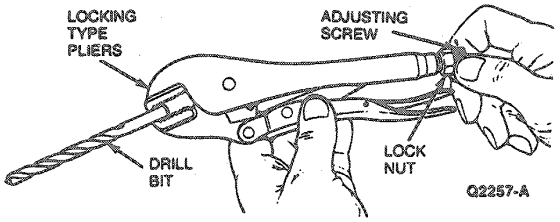


CCL 2576-A

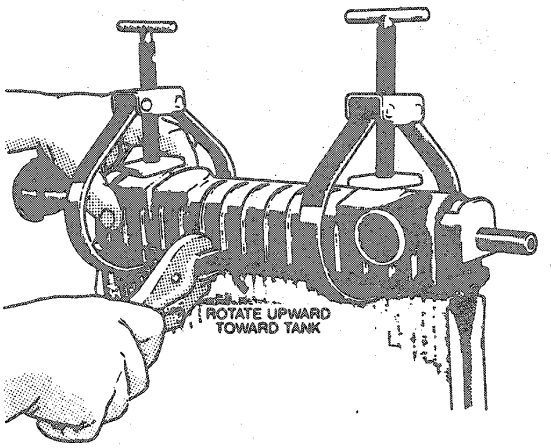
7. If locking-type pliers are used to squeeze header tabs against tank, install a hex nut on pliers adjusting screw.

REMOVAL AND INSTALLATION (Continued)

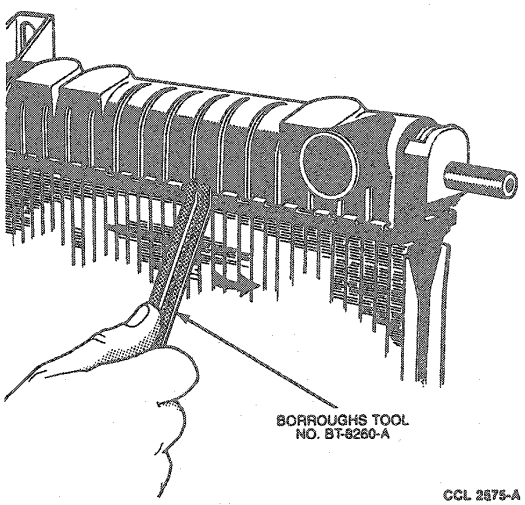
8. With jaws of locking-type pliers closed and locked, turn adjusting screw to position jaws against shank of a 10.9mm (27/64-inch) drill bit. Tighten hex nut on adjusting screw against handle to lock adjustment in place.



9. Squeeze header tabs down against lip of tank base with locking-type pliers while rotating pliers toward tank.

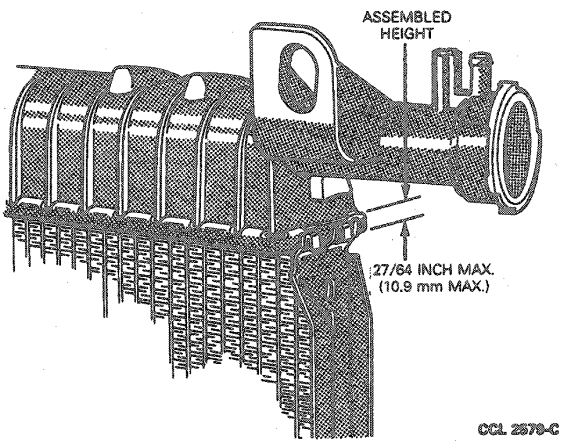


10. If a special crimping tool is used such as the one shown, follow the manufacturer's instructions.



It is important that assembled height of crimp be 10.32mm maximum (13/32 inch) when measured from bottom of header to top of tab.

11. Remove header clamps from radiator and squeeze header tab(s) down that were behind clamps.
12. Leak test radiator at 145 kPa (21 psi). Most minor leaks at tank seal can be corrected by again squeezing header tabs down against tank lip in area of indicated leak.



Oil Cooler Transfer or Replacement

Removal

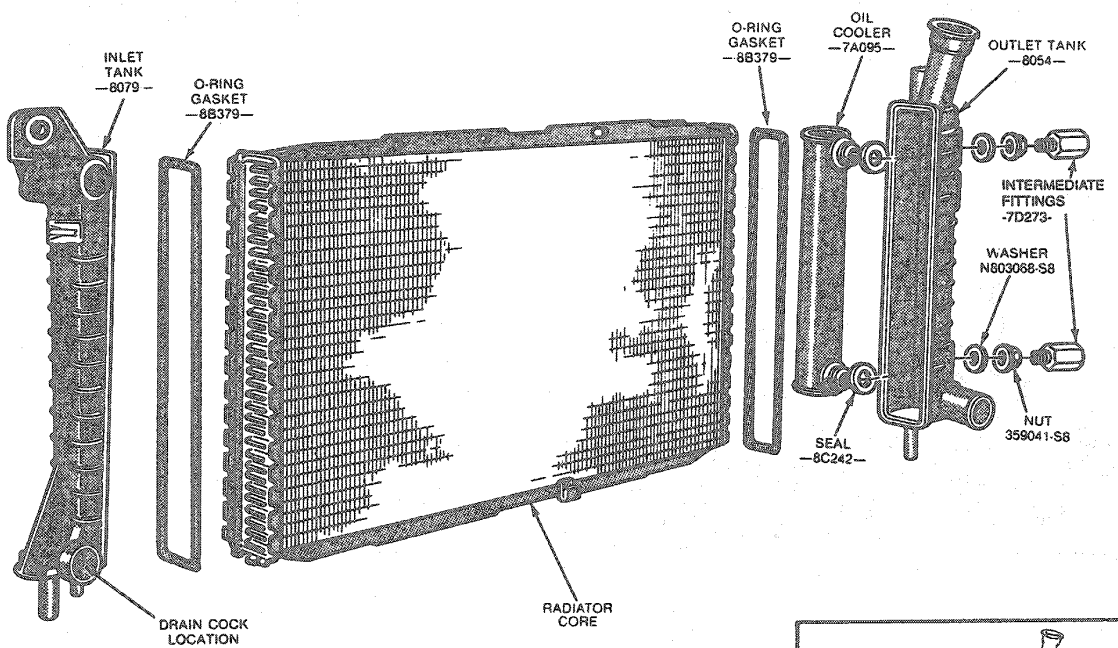
1. Remove outlet tank from radiator following procedure given for Radiator Tank Removal.
2. Remove retaining nuts and washers from oil cooler inlet and outlet connections. Lift oil cooler from radiator outlet tank.

REMOVAL AND INSTALLATION (Continued)

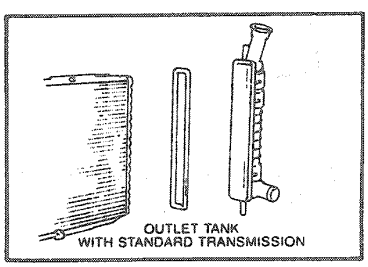
3. Remove rubber gaskets from oil cooler inlet and outlet connections if oil cooler is to be reused.

Installation

1. Position oil cooler to radiator outlet tank and insert inlet and outlet connections through holes in outlet tank.
2. Install flatwasher and nut on each oil cooler connections to retain oil cooler in radiator outlet tank.
3. Tighten oil cooler retaining nuts to 15-19 N·m (12-14 lb-ft). Tighten oil cooler intermediate fitting to 24.4-31.2 N·m (33-42 lb-ft).
4. Install outlet tank on radiator core header following procedure for Radiator Tank Installation.



	SEAL	WASHER	NUT	INTERMEDIATE FITTING	OIL COOLER
3.8L, 3.0L, 3.0L SHO	E4LH-8C242-AA	N803068-S8	359041-S8	E8TA-7D273-EA	E57H-7A095-AA
3.2L SHO	E77H-8C242-AA	N805091-S8	N805092-S8	E87A-7D273-FA	F3DH-7A095-BA



CCL 2582-C

Draincock Replacement

The draincock is located near the bottom of the inlet tank and can be replaced without removing the tank from the radiator. However, the radiator may have to be removed from the vehicle for access to the draincock. All vehicles are equipped with a draincock that seals with an O-ring or a seal.

Removal

1. Turn draincock counterclockwise to unscrew stem. When draincock is unscrewed to end of threads, pull from radiator tank.

Installation

1. On all vehicles, moisten O-Ring before installation.
2. Tighten draincock by turning clockwise until tight. Additional tightening will not improve sealing ability.

CLEANING

External

The aluminum core can be cleaned externally with a soft bristle brush, warm water and a mild household liquid detergent. Do not use a metal brush to clean an aluminum core. Use only horsehair, bristle or nylon brushes. Rinse with clear water.

If the radiator is equipped with an oil cooler, install steel or brass plugs in the oil cooler fittings before cleaning and keep them installed during the entire service operation.

Internal

NOTE: Do not use caustic cleaning solutions or copper / brass radiator cleaning agents on aluminum radiators. Internal cleaning of the aluminum tubes can be accomplished with sonic cleaning equipment or by removing one end of the tank to gain access to the tubes. Clean the tubes with a mild household liquid detergent. Rinse the core with clean water when completed. Do not use a metal brush to clean an aluminum core. Use only horsehair, bristle or nylon brushes.

SERVICE PROCEDURES

Radiator Core

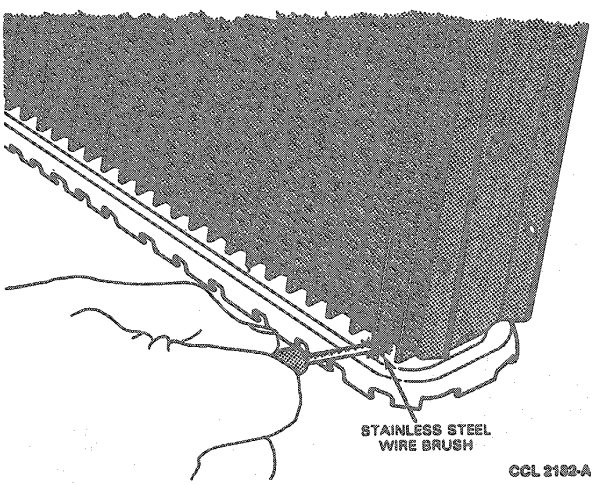
The only approved service method for the aluminum radiator core is using a two-component epoxy material. The materials and supplies necessary to repair the aluminum core are:

- 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.

Service

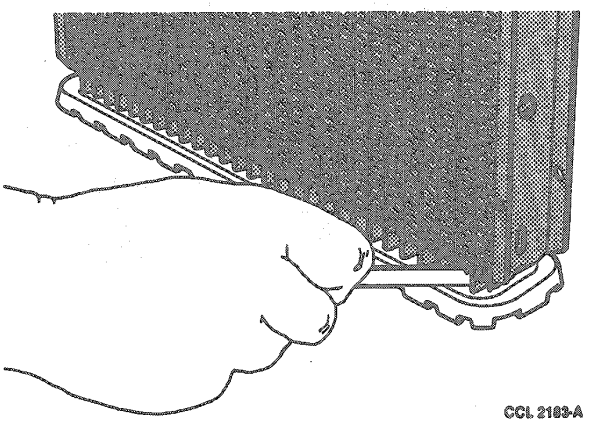
CAUTION: Do not use wire brushes that are not stainless steel.

1. Thoroughly clean the area around leak with a stainless steel wire brush and, if necessary, emery paper to get to hard to reach areas. Use the brush on the epoxy coating as well as on the aluminum.



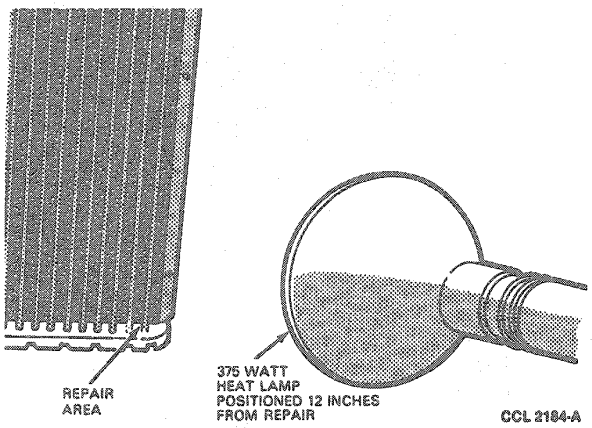
NOTE: Observe all cautions and warnings printed on the repair material containers.

2. Squeeze a bead (long enough to repair the leak) of repair material Part A (resin) on a clean, dry, disposable flat mixing surface. Use uniform pressure to obtain an even bead.
3. Squeeze an equal length bead of hardener (Part B) parallel to the Part A bead.
4. Mix parts A and B together.
5. If it is necessary to have epoxy flow to obtain satisfactory results, warm core around leak with a 375-watt heat lamp. Apply service material to leak.

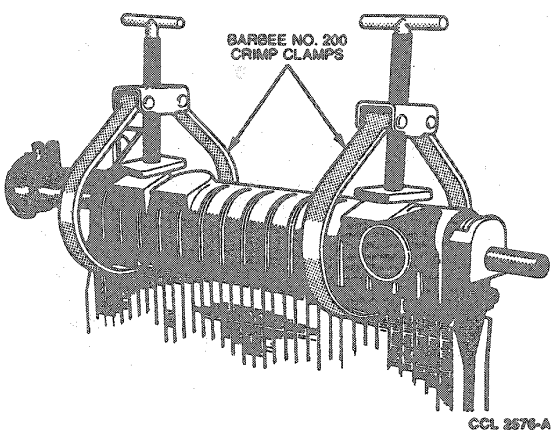


SERVICE PROCEDURES (Continued)

6. Position 375-watt heat lamp 305mm (12 inch) from service area and allow to cure for two hours. **Do not** position heat lamp closer to service area than 305mm (12 inch). **Do not** use a heat gun or **overheat** repair area material.



7. Leak test the serviced area by clamping tank to header with No. 200 Crimp Clamps or equivalent. After a successful leak test, install radiator tank following the procedure for Radiator Tank Installation.



INSPECTION

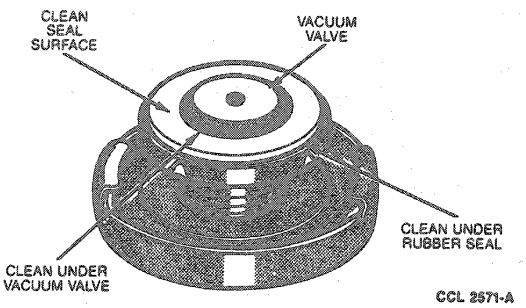
Radiator Pressure Cap

Tools Required:

- Rotunda Radiator / Heater Core Pressure Tester 021-00012

Cleaning and Inspection

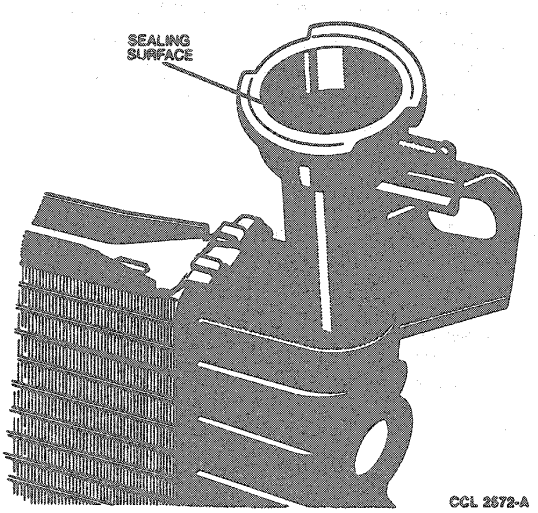
1. Remove radiator pressure cap from radiator filler neck. Follow outlined precautions.
2. Inspect areas under vacuum valve and rubber seal for rust or dirt particles.
3. Using warm tap water, clean the seal surface, raise vacuum valve and rubber seal and thoroughly flush away trapped, loose rust or dirt particles.



4. Inspect and remove any loose or imbedded rust or dirt particles on sealing surfaces of rubber seal.

   NOTE: If paint is observed on filler neck sealing surface, remove it using paint thinner.

5. Inspect radiator filler neck opening for rust or dirt particles on sealing surface at bottom of filler neck opening. Use a clean cloth and wipe sealing surface to remove any rust or dirt particles.



INSPECTION (Continued)

Pressure Check

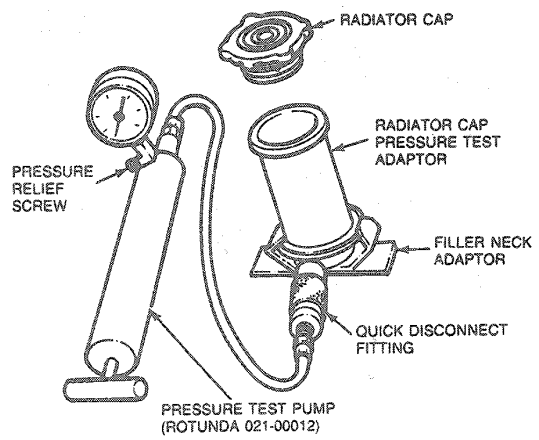
Tools Required:

- Rotunda Radiator / Heater Core Pressure Tester 021-00012

WARNING: NEVER REMOVE THE RADIATOR PRESSURE CAP UNDER ANY CONDITIONS WHILE THE ENGINE IS OPERATING. FAILURE TO FOLLOW THESE INSTRUCTIONS COULD RESULT IN DAMAGE TO THE COOLING SYSTEM OR ENGINE AND / OR PERSONAL INJURY. TO AVOID HAVING SCALDING HOT COOLANT OR STEAM BLOW OUT OF THE RADIATOR, USE EXTREME CARE WHEN REMOVING THE CAP FROM A HOT RADIATOR. WAIT UNTIL THE ENGINE HAS COOLED, THEN WRAP A THICK CLOTH AROUND THE RADIATOR PRESSURE CAP AND TURN IT SLOWLY TO THE FIRST STOP. STEP BACK WHILE THE PRESSURE IS RELEASED FROM THE COOLING SYSTEM. WHEN CERTAIN ALL THE PRESSURE HAS BEEN RELEASED, PRESS DOWN ON THE CAP (STILL WITH A CLOTH), TURN AND REMOVE.

1. Remove radiator pressure cap from radiator filler neck.
2. Use water to clean cap in area of rubber seal and vacuum relief valve. Immerse radiator cap in water and install radiator cap pressure test adapter from Rotunda Radiator / Heater Core Pressure Tester 021-00012 or equivalent.

   NOTE: The filler neck seal is reversible so it may be used on either end of radiator cap pressure test adapter.
3. Immerse filler neck seal in water and install in filler neck adapter. Then, install filler neck adapter with seal on open end of radiator cap pressure test adapter.



CCL 1146-C

4. Connect female quick disconnect fitting of pressure test pump to male quick disconnect fitting of filler neck adapter.

   NOTE: If plunger of pump is depressed too fast, an erroneous pressure reading will result.
5. SLOWLY depress plunger of pressure test pump until pressure gauge reading stops increasing and note highest pressure reading obtained.
6. Release pressure by turning pressure relief screw counterclockwise. Then, tighten pressure relief screw and repeat Step 5 (at least twice) to ensure pressure test reading is repeatable within acceptable gauge reading limits of radiator pressure cap and is not erratic. Refer to Specifications.
7. If pressure test gauge readings are not within acceptable gauge reading limits, replace radiator pressure cap.

Cooling System Hoses and Clamps Check

1. Inspect cooling system hoses and clamped hose connections for leaks and / or excessive deterioration. Service or replace as required.
2. Inspect radiator core and tanks for leaks. Service or replace as required.
3. Inspect cooling system hose routing to ensure sufficient clearance to engine compartment components. Reposition hoses if required.
4. Check radiator supports and brackets for firm radiator assembly retention. Correct as required. The radiator is installed with rubber isolation mounts.

Coolant Level Maintenance

Check coolant level in the coolant recovery reservoir at least once a month.

With cold engine, the level must be maintained at or above the FULL COLD mark. At normal engine operating temperature, the coolant level should be at the FULL HOT mark. If coolant level in the reservoir is below specified levels, a 50 / 50 mixture of Premium Cooling System Fluid E2FZ-19549-AA (ESE-M97B44-A and ESE-M97B43-A) (in Canada, Motorcraft CXC-8-B coolant) or equivalent and water should be added to the reservoir to the specified levels.

If the reservoir is low, add the specified 50 / 50 coolant mixture to the recovery reservoir. Check the coolant level again after one or two occasions of vehicle use.

Coolant Condition Check

Remove radiator pressure cap following outlined precautions. Check coolant for dirty or rusty appearance.

If coolant is not dirty or rusty in appearance, check level and concentration as outlined in the following procedures.

If coolant is dirty or rusty in appearance, proceed to the cooling system drain, flush and refill procedures.

INSPECTION (Continued)

Coolant Concentration Check

Tools Required:

- Rotunda Battery Anti-Freeze Tester 021-00046

(Not Required when Coolant Is Replaced)

Check coolant concentration for recommended protection level using Rotunda Battery Anti-Freeze Tester 021-00046 or equivalent. If concentration is low, partially drain the system and add 100 percent coolant such as Premium Cooling System Fluid E2FZ-19549-AA (ESE-M97B44-A and ESE-M97B43-A) or equivalent to obtain the recommended protection level.

Coolant Drain Procedure

With the engine off and sufficiently cool, place heater temperature control at the maximum heat position, remove radiator pressure cap, open draincock and allow coolant to drain. A 9.5mm (3/8-inch) hose should be attached to the draincock to direct coolant into a suitable container.

Coolant System Flush Procedure

Radiator Installed

1. Drain cooling system as outlined.
2. Install block drain plug, if removed, and close radiator draincock.
3. Fill system with water at radiator filler neck.
4. Idle engine for 3 to 5 minutes.
5. Turn engine OFF and drain water by opening draincock.
6. Repeat Steps 1 through 5 as many times as necessary until nearly clear water is drained from radiator.
7. Allow remaining water to drain, then close draincock.
8. Disconnect overflow hose from radiator filler neck connection.
9. Remove coolant recovery reservoir from fender apron and empty fluid. Flush reservoir with clean water, drain and install reservoir and overflow hose and clamp to radiator filler neck.

Radiator Removed

CAUTION: Radiator internal pressure must not exceed 138 kPa (20 psi). Damage may result.

1. Back-flush radiator. Ensure radiator pressure cap is in position. Turn radiator upside down. Position a high-pressure water hose in bottom hose location and back-flush.
2. Remove thermostat housing and thermostat. Refer to Thermostat Removal.
3. Back-flush engine. Position high-pressure hose into engine through thermostat location and back-flush engine.

Coolant Refill Procedure

With the entire cooling system drained, the following procedure should be used to ensure a complete fill.

NOTE: It is important to maintain engine coolant concentration between 40 percent -24°C (-11°F) and 60 percent -52°C (-62°F) depending on climate conditions. Below 40 percent there is a loss of freeze protection. Above 60 percent the engine may overheat on a warm day. Outside this range protection against rust and corrosion may be greatly reduced. Refer to the Owner Guide for specified coolant.

1. Install block drain plug, if removed, and close draincock. With engine off, add a 50/50 mixture of coolant and water to the bottom of the radiator filler as coolant in radiator filler neck seat. Wait approximately five minutes, as coolant in radiator will drop. Slowly add more coolant until level remains at the filler neck seat. Refer to Specifications for refill capacities. Then, add water until it reaches the radiator filler neck seat.
2. Install radiator pressure cap to first notch to keep spillage to a minimum.
3. Start and idle engine until upper radiator hose is warm. (This indicates thermostat is open and coolant is flowing through entire system).
4. Remove cap carefully and top off radiator with water.
5. Install cap on radiator securely.
6. Fill coolant recovery reservoir to FULL COLD mark with specified 50/50 coolant mixture, then add water to FULL HOT mark. This will ensure a proper mixture in coolant recovery reservoir.

SPECIFICATIONS

COOLING SPECIFICATIONS

Vehicle	Engine	Trans.	Cooling System	Capacity[1]	
				Liters	Quarts
Taurus / Sable	3.0L Sedan	ALL	ALL	10.4	11.0
Taurus / Sable	3.0L Wagon	ALL	A/C	11.2	11.8
Taurus / Sable	3.8L	ALL	ALL	11.5	12.1
Taurus SHO	3.0L / 3.2L SHO	MTX IV	A/C	10.98	11.6

Listed Capacities include heater and coolant reservoir filled to add mark.

Service refill recommendations are 50 / 50 mixture of water and coolant. Use coolant meeting Ford specification ESE-M97B44-A and ESE-M97B43-A, such as Premium Cooling System Fluid E2FZ-19549-AA.

All figures shown are actual, but may vary ± 15 percent due to system variations.

CAP PRESSURE SPECIFICATIONS

Specified Cap Pressure PSI	Lower Limit PSI (Must Maintain)	Upper Limit PSI (Must Relieve)
16	15	18

TORQUE SPECIFICATIONS — 3.0L ENGINE

Description	N·m	Lb-Ft
Water Outlet Connection Bolts	8-12	71-106 (Lb-In)
Water Pump Retaining Bolts (M6)	8-12	71-106 (Lb-In)
Water Pump Retaining Bolts (M8)	20-30	15-22
Automatic Belt Tensioner Nuts / Bolt	48	35
Water Pump Pulley Bolt	20-30	15-22
Oil Cooler	15-19	12-14
RH Support Bracket	12-24	9-17
Thermostat	12	9
Shroud Nuts	8-12	71-106 (Lb-In)
Shroud Bolts	4	36 (Lb-In)
Fan Screws	11-14	97-123 (Lb-In)
Hose Clamps	2.3-3.4	20-30 (Lb-In)
Radiator Support	17-27	13-19
Cooling Fan Resistor	5.2-6.8	46-60 (Lb-In)
Intermediate Transmission Oil Cooler Fitting	24.5-31.2	33-44

TORQUE SPECIFICATIONS — 3.0L / 3.2L SHO ENGINE

Description	N·m	Lb-Ft
Water Outlet Connection Bolts	15-23	12-16
Water Pump Retaining Bolts (M6)	15-23	12-16
Water Inlet Retaining Bolts	15-23	12-16
Clamps	2.3-3.4	20-30 (Lb-In)
Crankshaft Pulley Bolt	152-172	113-126
Wheel Lug Nuts	115-142	85-105
LH and RH Support Bracket	12-24	9-17
Oil Cooler	15-19	12-14
Shroud 3.0L	4	36 (Lb-In)
Fan Screws	10	86 (Lb-In)
Intermediate Transmission Oil Cooler Fitting	24.5-31.2	33-42
Shroud Bolt (3.2L)	8-11.5	6-8.5
Shroud Nut (3.2L)	2.5-3.5	2-2.6

TORQUE SPECIFICATIONS — 3.8L ENGINE

Description	N·m	Lb-Ft
Water Outlet Connection Bolts	20-30	15-22
Water Pump Retaining Bolts (M8)	20-30	15-22
Water Pump Inlet Tube Bolt	10	7
Water Pump Pulley Bolts	21	16
Generator Center Bolt	40-61	30-45
Generator Lower Bolt and Nut	61-71	45-52

(Continued)

1 Includes 1 / 2 liter (1 / 2 quart) in overflow reservoir.

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS—3.8L ENGINE (Cont'd)

Description	N-m	Lb-Ft
Outlet Tank Retaining Bolts	9-13	80-115 (Lb-in)
Radiator Support	17-27	13-19
LH and RH Support Bracket	12-24	9-17
Shroud	4	36 (Lb-in)
Fan Screws	10	86 (Lb-in)
Oiler Cooler	15-19	12-14
Intermediate Transmission Oil Cooler Fitting	24.5-31.2	33-42

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 BT-8260 and 8260-A Radiator Tank Remover and Replacer. Borroughs Tool and Equipment Corporation, 2429 North Burdick St., Kalamazoo, Michigan 49007.
- Hazet 798-10 Constant Tension Clamp Tool: IMS/WINZER 10560 Markinson Rd. Dallas, TX 75238 1-800-527-4126

ROTUNDA EQUIPMENT

Model	Description
021-00012	Radiator/Heater Core Pressure Tester
021-00046	Battery Anti-Freeze Tester

SECTION 03-04A Fuel Charging and Controls—3.0L

VEHICLE APPLICATION

Taurus / Sable and Taurus equipped with 3.0L Flexible Fuel (FF) Engine.

DESCRIPTION

The sequential multiport fuel injection (SFI) system is classified as a multi-point, pulse time, mass air control, fuel injection system. Fuel is metered into each intake port in sequence with the engine firing order in accordance with engine demand through fuel injectors (9F593) mounted on a tuned intake manifold (9424).

WARNING: DO NOT SMOKE, CARRY LIGHTED TOBACCO, OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

NOTE: Fuel methanol refers to a blend of fuel with a maximum of 85 percent methanol.

WARNING: DO NOT SWALLOW FUEL METHANOL. LIKE GASOLINE, IT IS HIGHLY TOXIC AND IF SWALLOWED CAN CAUSE DEATH OR PERMANENT INJURY. SWALLOWING METHANOL CAN ALSO CAUSE BLINDNESS. CALL A PHYSICIAN IMMEDIATELY TO TREAT ANYONE WHO HAS SWALLOWED FUEL METHANOL. VOMITING SHOULD BE INDUCED BY OR UNDER THE DIRECTION OF A PHYSICIAN OR POISON CONTROL CENTER. BE AWARE THAT THE ONSET OF POTENTIAL ILL HEALTH EFFECTS MAY BE DELAYED.

AVOID INHALING FUEL VAPORS. INHALING TOO MUCH FUEL METHANOL OR GASOLINE VAPOR CAN LEAD TO EYE AND RESPIRATORY TRACT IRRITATION. IN SEVERE CASES, EXCESSIVE OR PROLONGED BREATHING OF FUEL METHANOL OR GASOLINE VAPORS CAN CAUSE SERIOUS ILLNESS AND PERMANENT INJURY SUCH AS BLINDNESS.

AVOID GETTING FUEL METHANOL OR GASOLINE LIQUID IN YOUR EYES. IF YOU GET ANY FUEL METHANOL OR GASOLINE IN YOUR EYES, REMOVE CONTACT LENSES (IF WORN), FLUSH IMMEDIATELY WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES AND SEEK MEDICAL ATTENTION.

ALLOWING FUEL METHANOL OR GASOLINE TO GET IN YOUR EYES WILL CAUSE SEVERE IRRITATION. FAILURE TO SEEK PROPER MEDICAL ATTENTION FOR FUEL METHANOL OR GASOLINE CONTACT WITH THE EYES COULD LEAD TO PERMANENT INJURY SUCH AS BLINDNESS.

IF YOU GET FUEL METHANOL OR GASOLINE ON YOUR SKIN, WASH WITH SOAP AND WATER. REPEATED OR PROLONGED SKIN CONTACT WITH METHANOL OR GASOLINE LIQUID OR VAPOR CAUSES SKIN IRRITATION. MAKE SURE YOU WASH YOUR HANDS BEFORE HANDLING FOOD.

DESCRIPTION (Continued)

IF YOUR ARE TAKING MEDICATION FOR THE TREATMENT OF ALCOHOLISM, SUCH AS ANTABUSE OF OTHER FORMS OF DISULFIRAM, SKIN CONTACT WITH FUEL METHANOL OR BREATHING ITS VAPORS CAN CAUSE THE SAME KIND OF ADVERSE REACTION AS DRINKING ALCOHOL. IN SENSITIVE INDIVIDUALS, SERIOUS PERSONAL INJURY OR SICKNESS COULD RESULT. IF YOU ARE TAKING SUCH MEDICATION, YOU SHOULD TAKE EXTRA CARE TO AVOID SKIN CONTACT WITH FUEL METHANOL AND TO AVOID BREATHING ITS VAPORS. IF YOU DO GET FUEL METHANOL ON YOUR SKIN, WASH IF OFF IMMEDIATELY. CONSULT A PHYSICIAN PROMPTLY IF YOU EXPERIENCE AN ADVERSE REACTION.

WARNING: DO NOT MODIFY THE FUEL SYSTEM CONFIGURATION OR COMPONENTS, OR REPLACE COMPONENTS WITH PARTS NOT ESPECIALLY DESIGNED FOR USE WITH FUEL METHANOL. FORD MOTOR COMPANY HAS SPECIALLY-DESIGNED THE MATERIALS, COMPONENTS AND SYSTEM CONFIGURATION FOR METHANOL-FUELED VEHICLES AND EACH PARTICULAR SYSTEM IS PRECISELY CALIBRATED FOR EFFICIENT OPERATION. THE USE OF DIFFERENT PARTS OR MATERIALS COULD PRODUCE AN UNTESTED CONFIGURATION THAT COULD RESULT IN FIRE, PERSONAL INJURY, OR COULD CAUSE ENGINE DAMAGE.

WARNING: DO NOT OPERATE ENGINE OR SMOKE WHILE REFUELING.

CAUTION: Use only fuel methanol which meets Ford Specification ESE-M4C97-B. Use of other fuel methanol may cause powertrain damage as well as loss of vehicle performance. It will also invalidate any extended service agreement.

WARNING: IT IS IMPORTANT THAT YOUR FLEXIBLE FUEL VEHICLE BE PROPERLY MAINTAINED BY FORD FLEXIBLE FUEL TRAINED PERSONNEL. IF A PROBLEM OCCURS, IT IS IMPORTANT THAT PROPERLY TRAINED PERSONNEL DIAGNOSE THE CAUSE. IF THE PROBLEM RELATES TO THE FUEL SYSTEM, PROPER PART REPLACEMENT IS IMPERATIVE TO KEEP YOUR VEHICLE OPERATING AT NORMAL PERFORMANCE. FLEXIBLE FUEL COMPONENTS AND STANDARD FUEL COMPONENTS ARE NOT INTERCHANGEABLE AND IF YOUR VEHICLE IS NOT SERVICED IN ACCORDANCE WITH FLEXIBLE FUEL VEHICLE PROCEDURES, DAMAGE MAY OCCUR AND YOUR WARRANTY MAY BE INVALIDATED.

What Is Fuel Methanol?

Fuel methanol is a mixture of 85 percent methanol and 15 percent unleaded gasoline. The Flexible Fuel (FF) vehicles are able to run of fuel methanol, gasoline or any mixture in between.

Below about 10°C (50°F), the methanol vapor pressure is too low to produce the flammable air / fuel mixture necessary to engine operation.

Adding a co-fuel such as gasoline brings the resulting air / fuel vapor back into the flammable range.

Methanol is more chemically active than gasoline. It corrodes some metals and may cause some plastic and rubber components to swell, or become brittle and crack. For this reason, only FF vehicle components specifically designed for use with fuel methanol should be used.

Advantages of Fuel Methanol

Methanol can be produced from a variety of resources including coal and natural gas. The abundant reserve of coal and natural gas in the United States gives fuel methanol the potential to be an important fuel of the future.

Methanol has a high-octane rating which can be used to improve engine performance and efficiency. Methanol is a clean-burning fuel, making it easier to meet emission standards. Being a liquid fuel used in internal combustion engines, the same basic service procedures used for gasoline engines also are used for engines operating on fuel methanol.

CAUTION: If fuel methanol is spilled onto a painted surface, flush surface with water immediately and allow to air dry. Do not attempt to wipe spilled fuel methanol with any form of cloth of towel as this may damage the paint.

An on-board vehicle powertrain control module (PCM) 12A650 accepts inputs from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air / fuel ratio throughout the entire engine operational range. The PCM then outputs a command to the fuel injector to meter the appropriate quantity of fuel.

The PCM system also determines and compensates for the age of the vehicle and its uniqueness. The system will automatically sense and compensate for changes in altitude (i.e., from sea level to mountains) and will also permit push-starting the vehicle should it become necessary (manual transaxle only).

All engines use a closed-type positive crankcase ventilation (PCV) system and an exhaust emission system to control engine emissions within Government specifications.

To maintain the required exhaust emission levels, the fuel metering system must be kept in good operating condition and adjusted to specifications listed in the applicable Section of the Powertrain Control / Emissions Diagnosis Manual[1], the applicable Section of this Group, or on the Vehicle Emission Control Information (VECI) decal.

Additional engine performance checks are required to keep the exhaust emissions at the specified minimum pollutant level. Refer to the Pre-Delivery manual, Section 00-03 for these performance checks and recommended intervals.

This Section covers cleaning and inspection procedures.

For fuel system component removal, disassembly, assembly, installation and major service operations, refer to the applicable Section of this Group.

1 Can be purchased as a separate item.

DESCRIPTION (Continued)

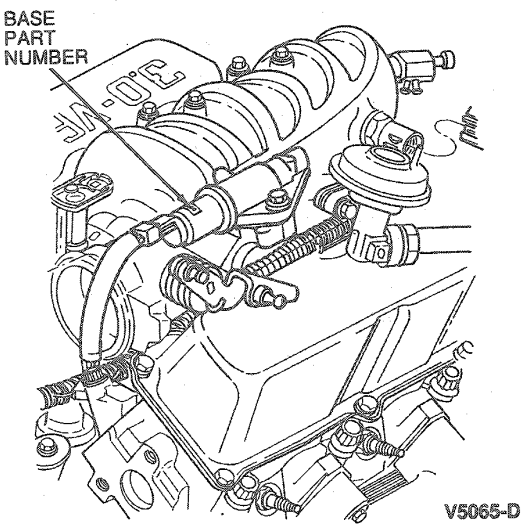
Always refer to the Master Parts List for parts usage and interchangeability before replacing a throttle body (9E926) or a component part of a throttle body.

Fuel Metering Assembly Identification

The base part number of the fuel metering assembly is 9E926. The base part number on 3.0L engine is located underneath the snowshield on the solenoid end of the idle air control (IAC) valve.

The "Unleaded Fuel Only" or "Fuel Methanol or Unleaded Fuel Only" nomenclature must appear:

- Near the fuel filler opening.
- On the instrument cluster.



OPERATION

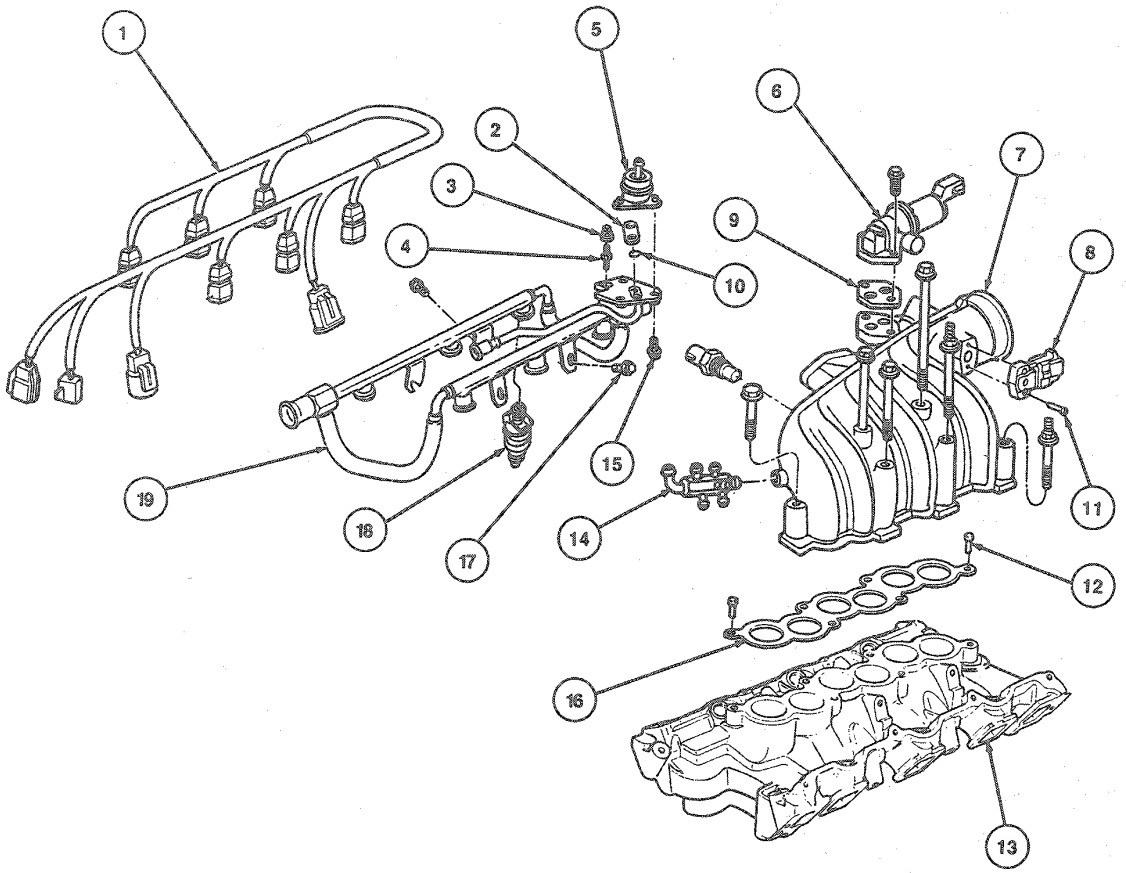
The SFI system can be sub-divided into four distinct categories:

- Fuel Delivery
- Air Induction
- Sensors
- Powertrain Control Module (PCM)

The fuel injectors are energized in the following sequence 1, 4, 2, 5, 3, 6. The period of time that the fuel injectors are energized (injector "on" time or the pulse width) is controlled by the vehicle's powertrain control module (PCM) 12A650. Air entering the engine is measured by a mass air flow (MAF) sensor 12B579. The resultant airflow information and input from various other engine sensors is used to compute the required fuel flow rate necessary to maintain a prescribed air / fuel ratio for the given engine operation. The PCM determines the needed fuel injector pulse width and outputs a command to the fuel injector to meter the exact quantity of fuel.

OPERATION (Continued)

Unleaded Gasoline Vehicles



V7677-B

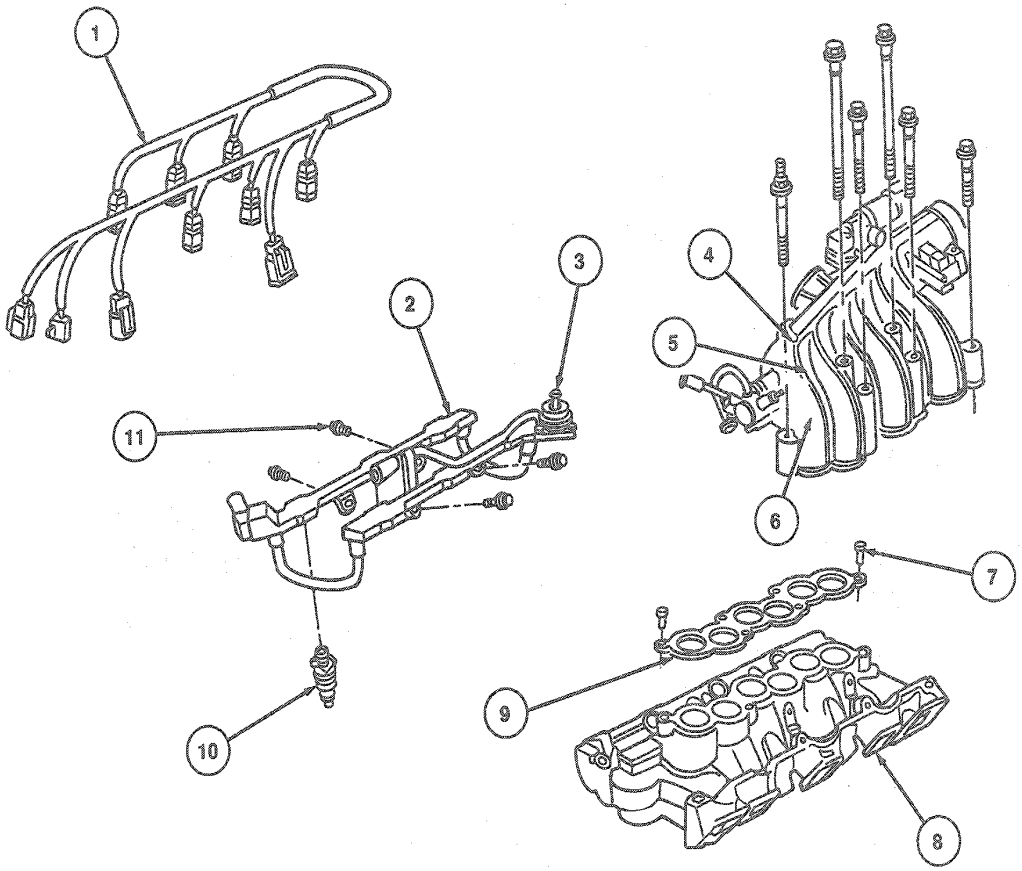
Item	Part Number	Description
1	9D930	Fuel Charging Wiring
2	9C977	Fuel Pressure Regulator Gasket
3	9H323	Fuel Pressure Relief Valve Cap
4	9H321	Fuel Pressure Relief Valve
5	9C968	Fuel Pressure Regulator
6	9F715	Idle Air Control Valve
7	9E926	Throttle Body
8	9B989	Throttle Position Sensor
9	9F670	Secondary Air Injection Bypass Valve Gasket
10	87006-S96	O-Ring Seal 5/16 X .070
11	N603257-S100	Screw Assy

(Continued)

Item	Part Number	Description
12	—	Guide Pin Assy (2 Places)
13	9424	Intake Manifold
14	9A474	Intake Manifold Vacuum Outlet Fitting and Cap
15	N802353-S101	Regulator Assy Holddown Screw
16	9H486	Intake Manifold Upper Gasket
17	N802626-S8-1986 N804394-S8M-1987	Fuel Rail Holddown Screw and Washer Assy
18	9F593	Fuel Injector
19	9F792	Fuel Injection Supply Manifold

OPERATION (Continued)

FF Vehicles



A16104-A

Item	Part Number	Description
1	9D930	Fuel Charging Wiring
2	9F792	Fuel Injection Supply Manifold
3	9C968	Fuel Pressure Regulator
4	9A474	Intake Manifold Vacuum Outlet Fitting and Cap
5	9E926	Throttle Body

(Continued)

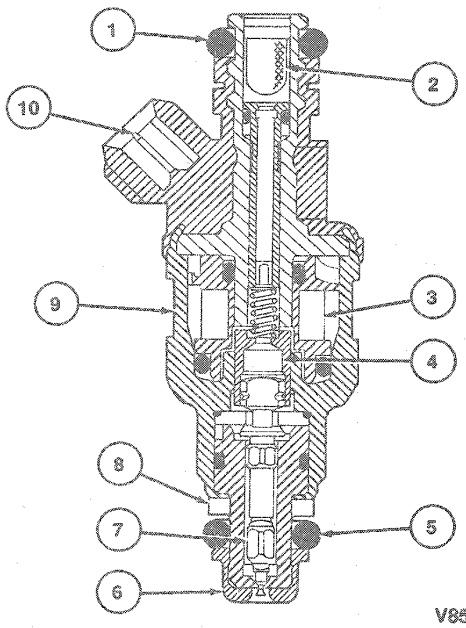
Item	Part Number	Description
6	—	Cold Start Injector
7	—	Guide Pin
8	9424	Lower Intake Manifold
9	9H486	Intake Manifold Upper Gasket
10	9F593	Fuel Injector
11	—	Screw and Washer Assy (4 Req'd)

COMPONENTS

Fuel Injectors

The fuel injectors are electro-mechanical devices which both meter and atomize fuel delivered to the engine. The SFI fuel injectors are mounted in the lower intake manifold and positioned such that their tips are directing fuel just ahead of the engine intake valves. The valve body consists of a solenoid actuated valve assembly. Therefore, fuel flow to the engine is regulated only by how long the solenoid is energized. An electrical signal from the powertrain control module (PCM) activates the injector solenoid causing the needle to move inward off the seat, allowing fuel to flow through the orifice. Atomization of the fuel is obtained by contouring the needle at the point where the fuel separates.

Unleaded Gasoline Only



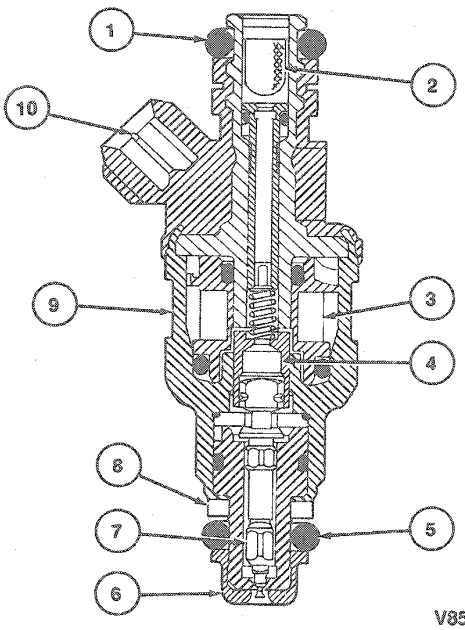
V8562-A

Item	Description
1	Fuel Injection Supply Manifold O-Ring Seal
2	Integral Filter
3	Coil
4	Armature
5	Intake Manifold O-Ring Seal
6	End Cap
7	Stainless Steel Needle and Valve Body
8	Washer
9	Low Carbon Steel Body
10	Electrical Connector

Fuel Injectors

The FF vehicle fuel injectors have a higher fuel flow rate than unleaded gasoline fuel injectors. They are methanol compatible and use methanol compatible O-rings.

FF ONLY



V8562-A

Item	Description
1	Fuel Injection Supply Manifold O-Ring Seal
2	Integral Filter
3	Coil
4	Armature
5	Intake Manifold O-Ring Seal
6	End Cap
7	Stainless Steel Needle and Valve Body
8	Washer
9	Stainless Steel Body
10	Electrical Connector

Cold Start System

The FF vehicles use a cold start injector (CSI) to provide additional fuel to improve cold weather starts. The CSI is mounted on the RH side of the throttle body assembly.

The cold start injector (CSI) is operated by the powertrain control module (PCM). When the powertrain control module (PCM) senses cold engine temperature it energizes the fuel injector and extra fuel is sprayed into the throttle body.

COMPONENTS (Continued)

The CSI assembly has a stainless steel housing that contains a bottom-feed fuel injector and spray bar with two fuel line connections. One connection is the fuel supply inlet to the CSI from the fuel pump (FP). The second line connection is the CSI outlet and the fuel supply inlet for the fuel injection supply manifold (9F792).

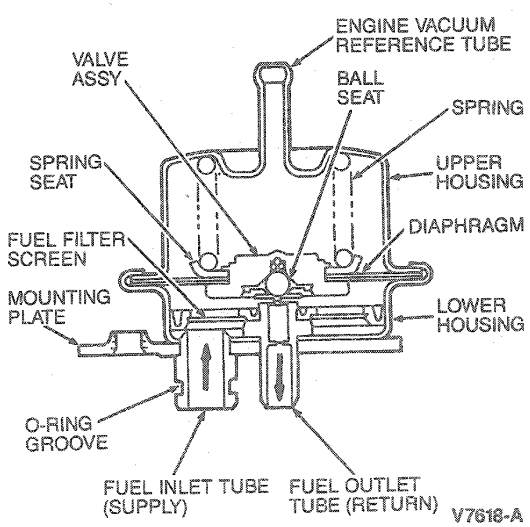
The fuel pressure relief valve (9H321) is located on the side of the CSI housing.

Refer to the illustration under Air Throttle body Assembly.

Fuel Pressure Regulator

NOTE: The flexible fuel pressure regulator (9C968) operates the same as the unleaded gasoline fuel pressure regulator. However, the internal components are strictly methanol compatible.

The fuel pressure regulator is attached to the fuel injection supply manifold assembly downstream of the fuel injector. It regulates the fuel pressure supplied to the fuel injectors. The fuel pressure regulator is a diaphragm-operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold pressure. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the fuel injector. Fuel, in excess of that used by the engine, is bypassed through the fuel pressure regulator and returned to the fuel tank.

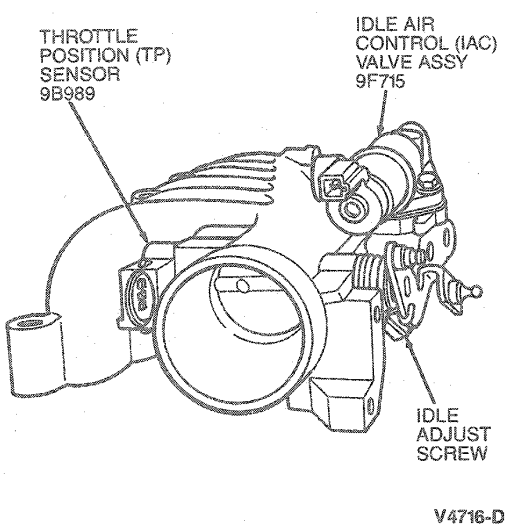


Throttle Body (TB) Assembly

The throttle body assembly controls airflow to the engine through a single butterfly-type valve. The throttle position is controlled by a conventional cable / four bar throttle linkage. The body is a single-piece ECP casting made of aluminum. It has a single bore with an air bypass channel around the throttle plate. This bypass channel controls both cold and warm engine idle airflow as regulated by an idle air control valve (IAC valve)(9F715) assembly mounted directly to the throttle body. The valve assembly is an electro-mechanical device controlled by the powertrain control module (PCM). It incorporates a linear actuator which positions a variable area metering valve.

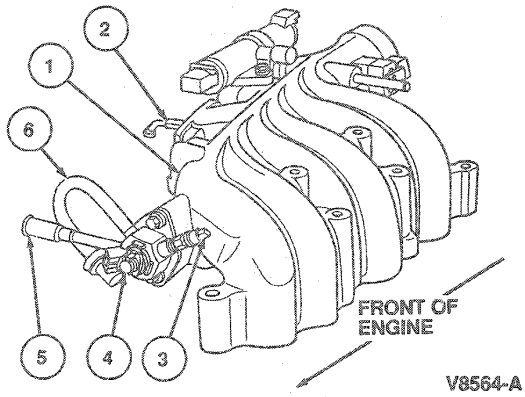
Other features of the throttle body assembly include:

1. An adjustment screw to set the throttle plate at a minimum idle airflow position.
2. A pre-set stop to locate the WOT position.
3. A throttle body-mounted throttle position sensor (TP sensor)(9B989).
4. A positive crankcase ventilation (PCV) fresh air source located downstream of the throttle plate.
5. Individual ported vacuum taps (as required) for PCV and EVAP control signals.



The FF vehicle throttle body has been modified for use with methanol fuel by the addition of a cold start injector (CSI).

COMPONENTS (Continued)



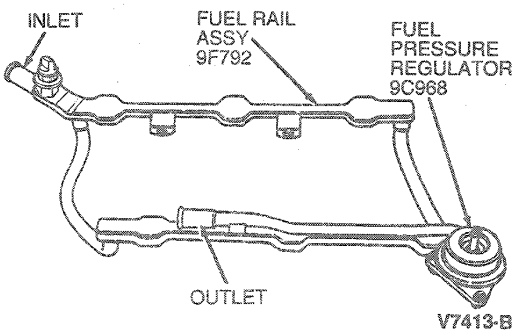
Item	Part Number	Description
1	9E926	Throttle Body
2	9A474	Intake Manifold Vacuum Outlet Fitting and Cap
3	9H321	Fuel Pressure Relief Valve
4	—	Cold Start Injector
5	—	Fuel Inlet Hose
6	—	Fuel Outlet Hose

Fuel Injection Supply Manifold Assembly

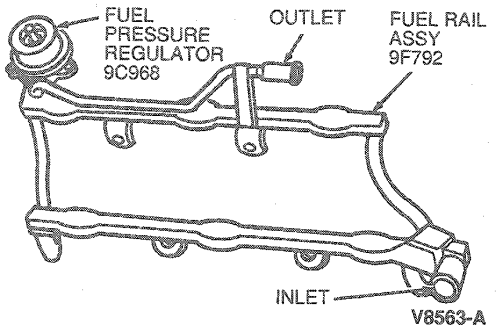
CAUTION: FF Vehicles' fuel supply manifold components are strictly methanol compatible.

The fuel injection supply manifold assembly is the component that delivers high-pressure fuel from the vehicle fuel supply line to the six fuel injector. The assembly consists of a single preformed tube or stamping with one injector connector for each fuel injector a mounting flange for the fuel pressure regulator a fuel pressure relief valve for diagnostic testing or field service fuel system pressure bleed down, and mounting attachments which locate the fuel injection supply manifold assembly and provide fuel injector retention.

Unleaded Gasoline Vehicles



FF Vehicles



Lower Intake Manifold Assembly

The lower intake manifold contains machined pockets for the fuel injectors to prevent both air and fuel leakage. The pockets, in which the fuel injectors are mounted, are placed to direct the injector fuel spray immediately in front of each engine intake valve.

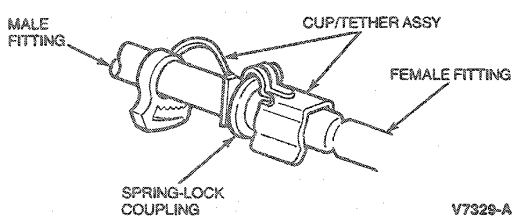
REMOVAL AND INSTALLATION

Spring Lock Coupling

Tools Required:

- Spring Lock Coupling Disconnect Tool D87L-9280-A (3/8 inch) or D87L-9280-B (1/2 inch)

The spring lock coupling is a fuel line coupling held together by a garter spring inside a circular cage. When the coupling is connected together, the flared end of the female fitting slips behind the garter spring inside the cage of the male fitting. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage. As a redundant locking feature, a horseshoe shaped retaining clip is incorporated to improve the retaining reliability of the spring lock coupling.



Removal

1. Release fuel system pressure. Refer to Section 10-01 for fuel system pressure relief procedures. A fuel pressure relief valve on the fuel injection supply manifold assembly is provided for this procedure.

REMOVAL AND INSTALLATION (Continued)

2. Remove retaining clip from spring lock coupling by hand only. Do not use any sharp tool or screwdriver as it may damage the spring lock coupling.
3. Twist fitting to free it from any adhesion at the O-ring seals.
4. Fit Spring Lock Coupling Disconnect Tool D87L-9280-A (3/8 inch) or D87L-9280-B (1/2 inch) or equivalent to coupling.
5. Close tool and push into open side of cage to expand garter spring and release female fitting.
6. After garter spring is expanded, pull fittings apart.
7. Remove tool from disconnected coupling.

Installation

1. Ensure that garter spring is in cage of male fitting. If garter spring is missing, install a new spring by pushing it into cage opening. If garter spring is damaged, remove it from 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 coupling.

   WARNING: FF VEHICLES USE SPECIAL METHANOL COMPATIBLE O-RINGS.
3. Replace missing or damaged O-rings. Use only O-rings listed in Spring Lock Coupling illustration.

   WARNING: 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.

   Lubricate male fitting and O-rings and inside of female fitting with clean engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent.

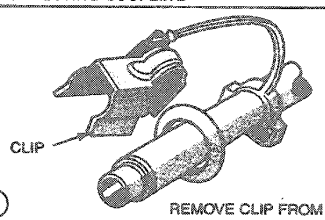
   On FF vehicles use oil with an API designation of Multi-Fuel Vehicles (MFV).
4. Fit female fitting to male fitting and push until garter spring snaps over flared end of female fitting.
5. Ensure coupling engagement by pulling on fitting and visually checking to ensure garter spring is over flared end of female fitting.

   NOTE: All vehicles require the large black clip to be installed on the supply side fuel line and the small gray clip to be installed on the return side fuel line.
6. Position retaining clip over metal portion of spring lock coupling. Firmly push retaining clip onto spring lock coupling. Ensure that horseshoe portion of clip is over the coupling. Do not install retaining clip over rubber fuel line.

REMOVAL AND INSTALLATION (Continued)

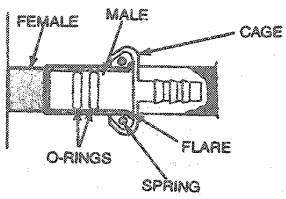
TO DISCONNECT COUPLING

CAUTION — RELIEVE FUEL PRESSURE BEFORE DISCONNECTING COUPLING

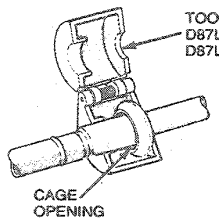


1 REMOVE CLIP FROM COUPLING

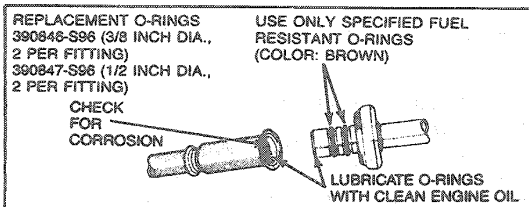
TO CONNECT COUPLING



1



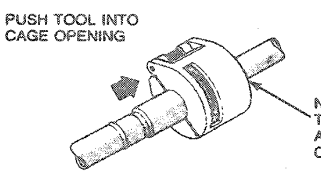
2 FIT TOOL TO COUPLING SO THAT TOOL CAN ENTER CAGE OPENING TO RELEASE THE GARTER SPRING.



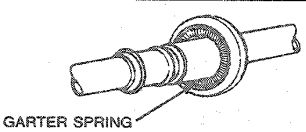
CLEAN FITTINGS WITH SOLVENT. CHECK FOR MISSING OR DAMAGED O-RINGS. REPLACE MISSING O-RINGS. IF EITHER O-RING IS DAMAGED, REPLACE BOTH O-RINGS.

REPLACEMENT GARTER SPRINGS:
3/8-INCH — E1ZZ-19E576-A
1/2-INCH — E1ZZ-19E576-B

2

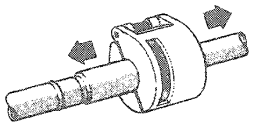


3 PUSH THE TOOL INTO THE CAGE OPENING TO RELEASE THE FEMALE FITTING FROM THE GARTER SPRING

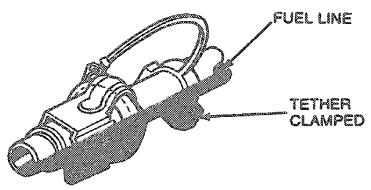


TO ENSURE COUPLING ENGAGEMENT, PULL ON FITTING AND VISUALLY CHECK TO BE SURE GARTER SPRING IS OVER FLARED END OF FEMALE FITTING

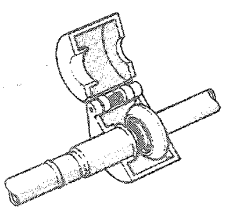
3



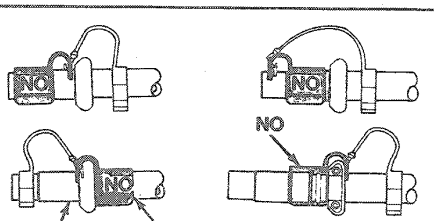
4 PULL THE COUPLING MALE AND FEMALE FITTINGS APART



4 YES



5 REMOVE THE TOOL FROM THE DISCONNECTED SPRING LOCK COUPLING



5 WRONG — WHEN FLARE OR O-RINGS ARE SHOWING

V7332-A

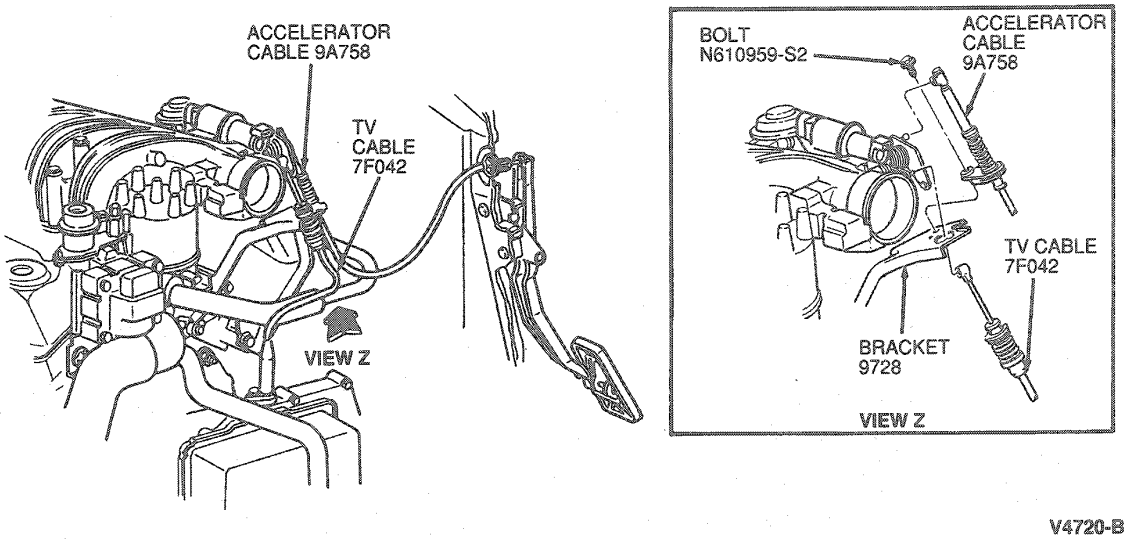
REMOVAL AND INSTALLATION (Continued)

Throttle Body (TB)

Unleaded Gasoline Vehicles

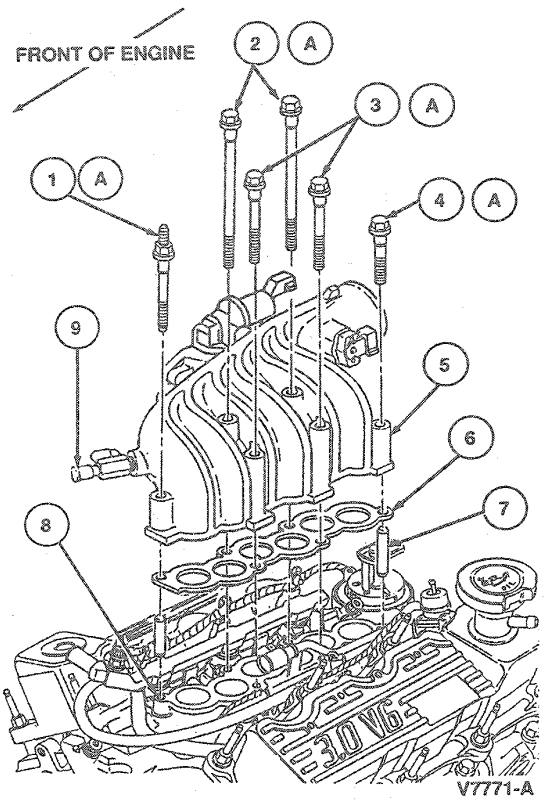
Removal

1. Disconnect negative battery cable.
2. Loosen air cleaner duct hose retaining clamps and remove hose.
3. Remove idle air control (IAC) valve shield.
4. Disconnect throttle cable (9A758) and TV cable from throttle body linkage.



5. Mark location and remove vacuum hoses at vacuum tree.
6. Loosen EGR tube nuts if equipped at EGR valve (9D475) and exhaust manifold fitting. Remove or rotate tube out of the way.
7. Remove PCV hose from tube underneath throttle body.
8. Disconnect electrical connections to IAT, IAG and TP sensors.
9. Remove retaining nuts from generator brace and remove brace.
10. Loosen and remove the six throttle body retaining bolts (note location for installation).
11. Lift and remove throttle body assembly from intake manifold.
12. Discard old intake manifold upper gasket (9H486).

REMOVAL AND INSTALLATION (Continued)



Item	Part Number	Description
1A	—	Stud Bolt
2A	—	Bolt-M8 x 1.25 x 130
3A	—	Bolt-M8 x 1.25 x 100
4A	—	Bolt-M8 x 1.25 x 68
5	9E926	Throttle Body
6	9H486	Intake Manifold Upper Gasket
7	—	Guide Pin
8	9424	Lower Intake Manifold
9	9A474	Intake Manifold Vacuum Outlet Fitting and Cap
A		Tighten to 20-30 N·m (15-22 Lb-Ft)

Installation

NOTE: Lightly oil all bolt and stud threads prior to installation.

1. Clean and inspect sealing surfaces of intake manifold and throttle body.

   CAUTION: Use care when cleaning gasket material as aluminum gouges easily which forms leak paths.

2. Install guide pins as illustrated (if available).
3. Place intake manifold upper gasket on intake manifold.
4. Aligning bolt holes, install throttle body on intake manifold. Install one stud bolt and five retaining bolts. Tighten to 20-30 N·m (15-22 lb-ft).
5. Install generator brace to throttle body and generator bracket. Tighten nuts to 16 N·m (12 lb-ft).
6. Connect PCV hose to tube underneath throttle body.
7. Install EGR tube to EGR valve and exhaust manifold fitting, if equipped. Tighten to 50 N·m (37 lb-ft).
8. Connect vacuum hoses to their pre-marked locations.
9. Connect electrical connections to IAT, IAC and TP sensor.
10. Connect throttle cable and TV cables to throttle body linkage.
11. Connect air cleaner duct hose to throttle body and air cleaner assembly. Tighten clamp to 4 N·m (36 lb-in).
12. Connect negative battery cable.
13. Start engine and check for vacuum leaks.
14. Check engine idle. Adjust as necessary as outlined in the Powertrain Control / Emissions Diagnosis Manual[2].

    NOTE: This adjustment must be performed if the throttle body is removed for any reason and if throttle plate idle adjustment screw position is changed.
15. Adjust TV cable as outlined in Section 07-01.
16. Install shield onto idle air control (IAC). Tighten bolts to 1.4 N·m (13 lb-in).

Throttle Body

Flexible Fuel Vehicles

WARNING: DO NOT MODIFY THE FUEL SYSTEM CONFIGURATION OR COMPONENTS, OR REPLACE COMPONENTS WITH PARTS NOT SPECIALLY DESIGNED FOR USE WITH FUEL METHANOL. FORD MOTOR COMPANY HAS SPECIALLY-DESIGNED THE MATERIALS, COMPONENTS AND SYSTEM CONFIGURATION FOR METHANOL-FUELED VEHICLES AND EACH PARTICULAR SYSTEM IS PRECISELY CALIBRATED FOR EFFICIENT OPERATION. THE USE OF DIFFERENT PARTS OR MATERIALS COULD PRODUCE AN UNTESTED CONFIGURATION THAT COULD RESULT IN FIRE, PERSONAL INJURY, OR COULD CAUSE ENGINE DAMAGE.

Removal

1. Disconnect negative battery terminal and set aside.
2. Remove PCV closure and aspirator hoses from clean air flex tube.

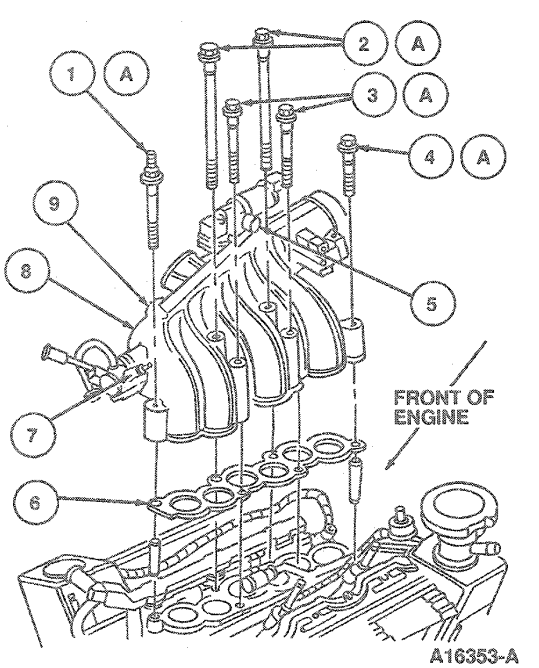
2 Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

3. Loosen clean air flex tube retaining clamp at throttle body and disconnect tube.
4. Relieve pressure at the fuel pressure relief valve.

   WARNING: COVER VALVE WITH SHOP CLOTH TO PREVENT ACCIDENTAL FUEL SPRAY INTO EYES.
5. Disconnect fuel supply hoses to cold start injector (CSI).
6. Remove idle air control (IAC) solenoid snowshield.
7. Disconnect throttle cable from throttle body.
8. Remove two throttle cable bracket retaining bolts from side of throttle body and remove bracket.
9. Mark location and remove vacuum hoses attached to vacuum tree and EGR valve.
10. Disconnect differential pressure feedback (DPFE) sensor hoses from EGR tube nipples.
11. Loosen EGR tube nut at EGR valve.
12. Remove vapor purge hose from fitting near throttle position sensor.
13. Disconnect electrical connections to idle air control (IAC), differential pressure feedback (DPFE), cold start injector (CSI) and throttle position sensors.
14. Remove generator brace retaining nuts from generator bracket and throttle body stud. Remove brace.
15. Loosen and remove five throttle body retaining bolts and stud bolt noting their locations.
16. Lift throttle body straight up and remove PCV hose from tube beneath assembly. Maneuver throttle body away from EGR tube and remove assembly. Discard old intake manifold upper gasket.
17. Cover intake manifold ports to prevent foreign material from entering manifold.

    NOTE: The throttle body is to be replaced as an assembly only for the FF vehicle. Reuse original vacuum tree, EGR valve and DPFE assembly with new throttle body.



Item	Part Number	Description
1A	—	Stud Bolt
2A	—	Bolt M8 X 1.25 X 130 (2 Req'd)
3A	—	Bolt M8 X 1.25 X 100 (2 Req'd)
4A	—	Bolt
5	—	Purge Port
6	9E926	Throttle Body
7	—	Cold Start Injector
8	9E926	Throttle Body
9	9A474	Intake Manifold Vacuum Outlet Fitting and Cap
A		Tighten to 25 N·m (19 Lb-Ft)

Installation

NOTE: Lightly oil all bolt and stud threads prior to installation.

1. Clean and inspect sealing surfaces of intake manifold and throttle body.

   CAUTION: Use care when cleaning gasket surfaces as aluminum gouges easily which forms leak paths.
2. Install guide pins if available in front and rear bolt holes.
3. Place new intake manifold upper gasket over guide pins.

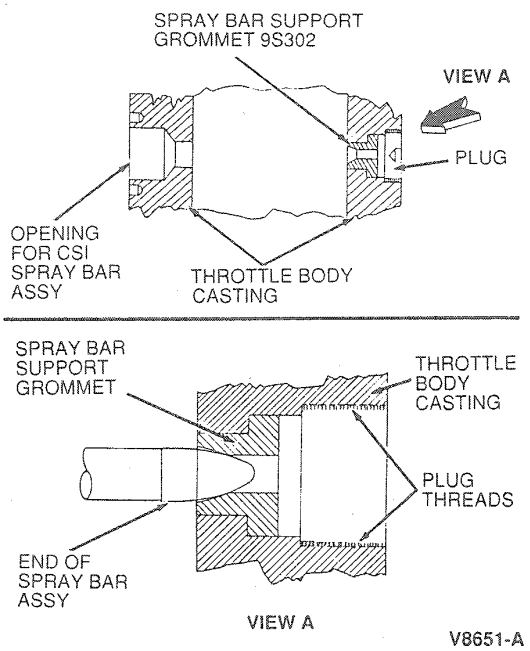
REMOVAL AND INSTALLATION (Continued)

4. Aligning bolt holes, lower assembly enough to install PCV hose to tube beneath throttle body. Align EGR tube nut to EGR valve and lower assembly onto intake manifold. Start EGR tube nut engagement to EGR valve. Install four center retaining bolts and hand tighten. Remove guide pins. Install stud bolt and remaining retaining bolt. Tighten retaining bolts to 20-30 N·m (15-22 lb-ft) in sequence as illustrated.
5. Install generator brace to throttle body and generator bracket. Tighten nuts to 12-20 N·m (9-15 lb-ft).
6. Tighten EGR tube nut to 35-65 N·m (26-48 lb-ft).
7. Connect DPFE sensor hoses to EGR tube nipples. Check for cracked or deformed condition and replace as necessary.
8. Connect premarked vacuum lines to their original locations. Check for cracked or deformed condition and replace as necessary.
9. Connect electrical connections to TP, DPFE, CSI and IAC sensors.
10. Install vapor purge hose to fitting near TP sensor.
11. Install throttle cable bracket to side of throttle body. Tighten retaining bolts to 17 N·m (13 lb-ft).
12. Connect throttle cable and TV cable to throttle body lever.
13. Connect fuel supply tubes to CSI assembly.
14. Install clean air flex tube to throttle body. Tighten retaining clamp to 2.7-4.5 N·m (24-48 lb-in). Connect PCV closure and aspirator hose to their original locations.
15. Connect negative battery terminal.
16. Start engine and check for vacuum, exhaust and fuel leaks.
17. Check engine idle. Adjust as necessary. Refer to the Powertrain Control / Emissions Diagnosis manual.[3]
18. Install snowshield onto IAC valve. Tighten retaining screw to 8-12 N·m (6-8 lb-ft).

Cold Start Injector (CSI)

Removal and Installation

1. Remove flexible fuel throttle body as outlined.
2. Remove two bolts retaining CSI spray bar assembly (9F880) to throttle body.
3. Remove CSI and gasket from throttle body.
4. Using a 1/4 inch allen wrench, remove plug located on throttle body opposite CSI mounting surface.



CAUTION: Use care when installing spray bar to throttle body. DO NOT FORCE or damage to CSI and spray bar assembly will occur.

5. Install CSI and spray bar assembly with new gasket (9P849) to throttle body, with end of spray bar assembly (9F880) resting in support grommet located behind plug in throttle body casting.
6. Align CSI to throttle body and install retainer bolts. Tighten bolts to 8-11 N·m (70-97 lb-in).
7. Verify that end of spray bar is resting in support grommet. If not, repeat Steps 1 through 6.
8. Apply Pipe Sealant with Teflon® D8AZ-19544-A (ESG-M4G194-A) or equivalent in a clockwise direction to plug and install plug in throttle body. Tighten plug to 10-15 N·m (7-11 lb-ft).
9. Reinstall throttle body as outlined. Inspect for leaks with engine running.

Idle Air Control (IAC) Valve Assembly

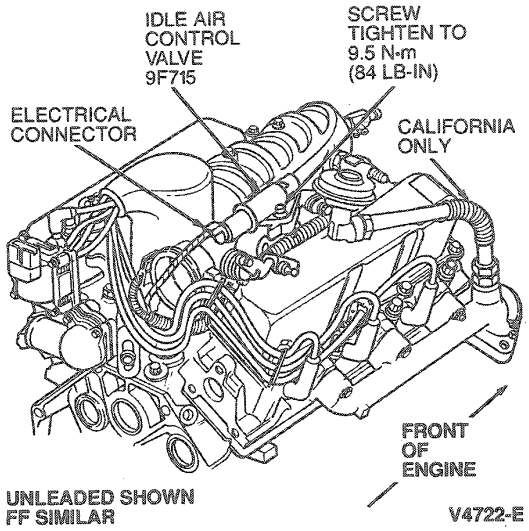
Removal

1. Disconnect idle air control (IAC) valve assembly connector from wiring harness.

3 Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

2. Remove two idle air control (IAC) valve retaining screws.

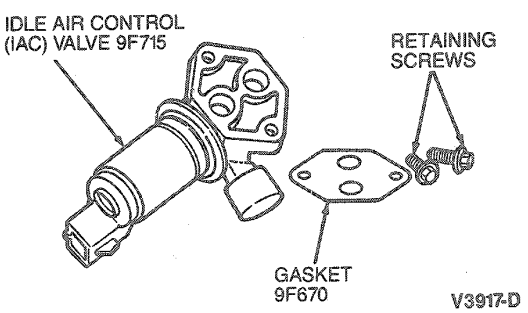


3. Remove idle air control valve and gasket.

   NOTE: If scraping is necessary, be careful not to damage idle air control valve or gasket surfaces, or drop material into throttle body.

Installation

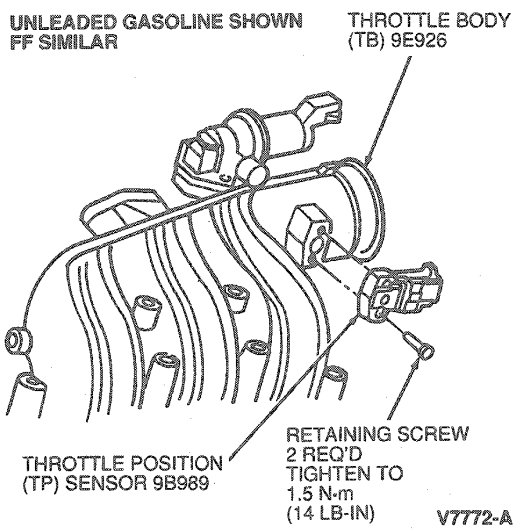
1. Ensure that both throttle body and idle air control (IAC) valve gasket surfaces are clean.
2. Install gasket on throttle body surface and mount idle air control (IAC) valve assembly, securing it with two retaining screws. Tighten to 9.5 N·m (84 lb-in).
3. Connect electrical connector for idle air control (IAC) valve.



Throttle Position (TP) Sensor

Removal

1. Disconnect throttle position sensor from wiring harness.
2. Remove two throttle position sensor retaining screws.
3. Remove throttle position sensor.



Installation

CAUTION: Slide rotary tangs into position over throttle shaft blade, then rotate throttle position sensor clockwise to installed position only. Failure to install the throttle position sensor in this manner may result in excessive idle speeds.

1. Install throttle position sensor. Ensure that rotary tangs on sensor are in proper alignment and that the red seal is inside the connector housing.

   NOTE: This throttle position sensor is not adjustable.
2. Secure throttle position sensor to throttle body assembly with two retaining screws. Tighten to 1.5 N·m (14 lb-in).
3. Connect electrical connector to harness.

Fuel Pressure Relief Valve (Schrader Valve)

Tools Required:

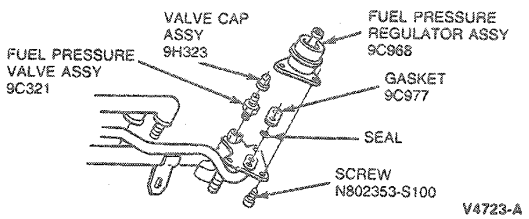
- Fuel Pressure Gauge T80L-9974-B

REMOVAL AND INSTALLATION (Continued)

Removal

1. If fuel rail assembly is mounted to engine, remove fuel tank cap, then release pressure from system at fuel pressure relief valve on fuel injection manifold or, cold start injector (FF vehicles only), using Fuel Pressure Gauge T80L-9974-B.

   NOTE: Fuel pressure relief valve cap (9H323) on fuel pressure relief valve must be removed.



2. Using an open-end wrench or suitable deep well socket, remove fuel pressure relief valve.

Installation

Install fuel pressure relief valve and fuel pressure relief valve cap. Tighten valve to 7.75 N·m (66 lb-in) and the cap to 0.6 N·m (5.5 lb-in).

Fuel Injector Manifold Assembly

Unleaded Vehicles

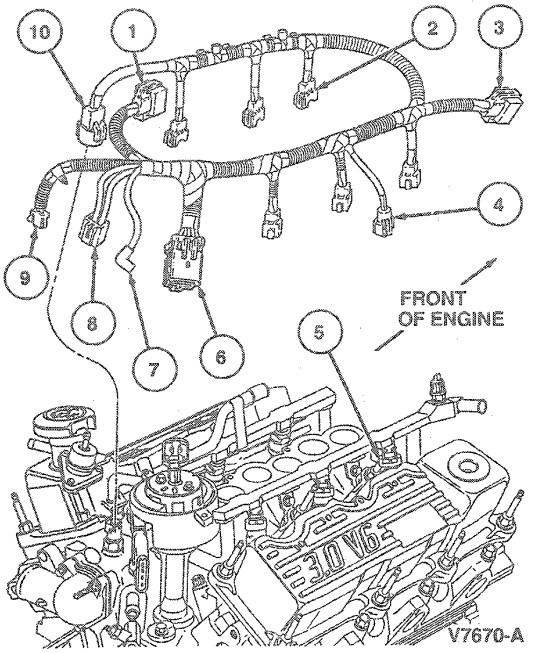
Removal

1. Remove throttle body as outlined.

   NOTE: Prior to fuel injection supply manifold removal, perform the following steps.

   - Scribe an alignment mark on base of distributor and lower intake manifold.
   - Remove distributor hold-down clamp.
   - Lift distributor enough to allow fuel injection supply manifold to clear distributor housing and lower intake manifold.

2. Disconnect fuel supply and fuel return lines as described under Fuel Metering and Air Intake / Throttle Body Components, Removal and Installation..
3. Carefully disconnect fuel charging wiring (9D930) from fuel injector.

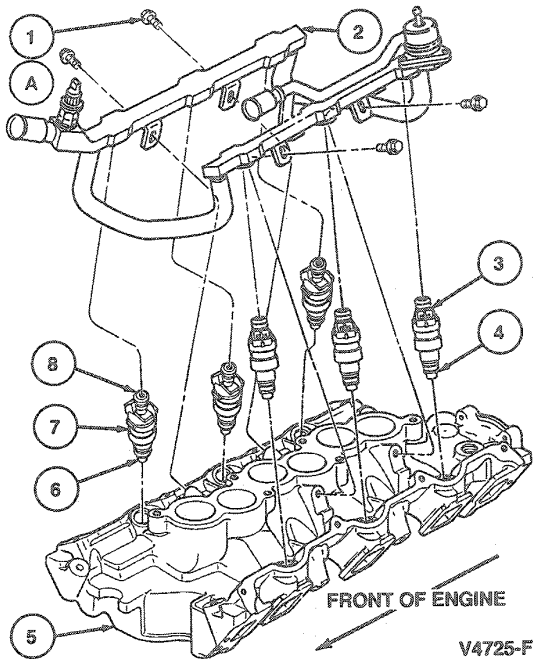


Item	Part Number	Description
1	—	To Throttle Position Sensor
2	9D930	Fuel Charging Wiring
3	—	To DPFE Transducer Assy
4	—	To Air Charge Temperature Sensor
5	9F593	Fuel Injector (6 Req'd)
6	12A581	To Harness Assy
7	—	To Oil Pressure Switch Assy
8	—	TO EGR Vacuum Regulator Assy
9	—	To Idle Air Control
10	—	To Engine Coolant Temperature Sensor

4. Disconnect vacuum line from fuel pressure regulator.
5. Remove four fuel injector manifold retaining bolts (two on each side).

REMOVAL AND INSTALLATION (Continued)

Unleaded Gasoline Shown
FF Similar



Item	Part Number	Description
1A	—	Screw and Washer Assy - M6 x 1 X 22 Hex Head (4 Req'd)
2	9F792	Fuel Injection Supply Manifold
3	—	Upper O-Ring Seal
4	—	Lower O-Ring Seal
5	9424	Lower Intake Manifold
6	—	Outlet End
7	9F593	Fuel Injector
8	—	Inlet End
A		Tighten to 10 N·m (7 Lb-Ft)

6. Carefully disengage fuel injection supply manifold assembly from fuel injector by lifting and gently rocking the rail.

   CAUTION: Fuel injector and fuel injection supply manifold must be handled with extreme care to prevent damage to sealing areas and sensitive fuel metering orifices.

7. Remove fuel injector by lifting while gently rocking side to side.
8. Place removed components in a clean container to avoid dirt or other contamination.

Installation

NOTE: When installing fuel injection supply manifold assemblies with new or used fuel injectors particular attention should be paid to proper O-ring seating to ensure that no fuel leaks exist.

1. Examine injector O-rings for deterioration. Install new O-rings if required.
2. Lubricate new O-rings and install two on each injector using clean engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent.
3. Ensure injector cups are clean and free of contamination or damage.
4. Install fuel injectors in fuel rail using light twisting-pushing motion.

   NOTE: Prior to installation perform the following steps:

   - Lift distributor enough to allow fuel injection supply manifold to clear distributor housing and lower intake manifold and position fuel injection supply manifold.
   - Lower distributor into position.
   - Install distributor hold down clamp and align scribe marks. Tighten hold down clamp bolt to 24 N·m (18 lb-ft)

5. Carefully install fuel injection supply manifold assembly and Fuel Injectors into lower intake manifold, one side at a time. To ensure that O-rings are seated, push down on fuel injection supply manifold.
6. While holding fuel injection supply manifold assembly in place, install two retaining bolts and tighten to 10 N·m (7 lb-ft).
7. Before connecting the fuel charging wiring, turn ignition switch to the ON position. This will pressurize the fuel system.
8. Using a clean paper towel, check for leaks where the fuel injector connects to the fuel injection supply manifold. If leaks are detected, service as required.
9. Connect the fuel charging wiring and start the engine, let it idle for two minutes.
10. Using a clean paper towel, check for leaks where the fuel injector is installed into intake manifold.
11. Connect fuel supply (1/2 inch) and fuel return (3/8 inch) lines as outlined in this Section.
12. Connect fuel fuel charging wiring at fuel injector.
13. Connect vacuum line to fuel pressure fuel pressure regulator.
14. Install air intake throttle body as outlined.

REMOVAL AND INSTALLATION (Continued)

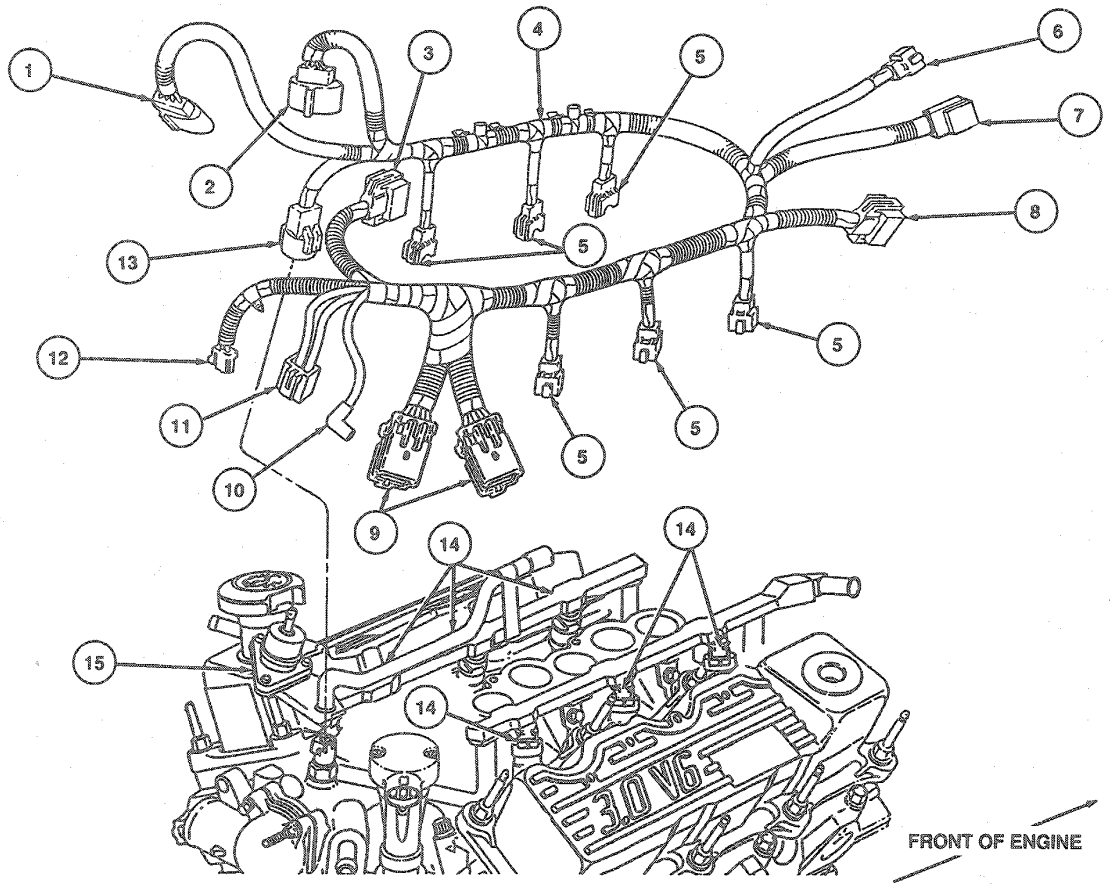
FF Vehicles

Removal

WARNING: DO NOT MODIFY THE FUEL SYSTEM CONFIGURATION OR COMPONENTS, OR REPLACE COMPONENTS WITH PARTS NOT SPECIALLY DESIGNED FOR USE WITH FUEL METHANOL. FORD MOTOR COMPANY HAS SPECIALLY-DESIGNED THE MATERIALS, COMPONENTS AND SYSTEM CONFIGURATION FOR METHANOL-FUELED VEHICLES AND EACH PARTICULAR SYSTEM IS PRECISELY CALIBRATED FOR EFFICIENT OPERATION. THE USE OF DIFFERENT PARTS OR MATERIALS COULD PRODUCE AN UNTESTED CONFIGURATION THAT COULD RESULT IN FIRE, PERSONAL INJURY, OR COULD CAUSE ENGINE DAMAGE.

NOTE: Clean contaminants away from all components.

1. Remove throttle body as outlined.
2. Carefully disconnect fuel charging wiring from fuel injector.



Item	Part Number	Description
1	—	To Synchronizer Assy
2	—	To Ignition Coil

(Continued)

Item	Part Number	Description
3	—	To TP Sensor
4	9D930	Fuel Charging Wiring

(Continued)

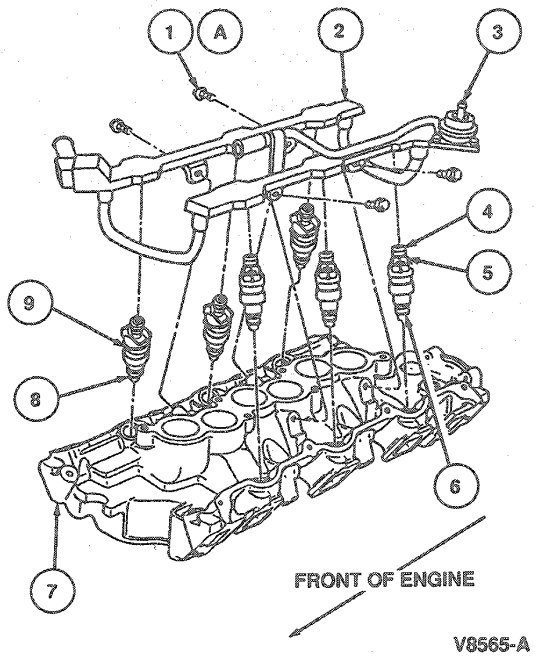
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
5	—	To Fuel Injector
6	—	To CSI
7	—	To Crankshaft Position CKP Sensor
8	—	To DPFE Sensor
9	—	To 12A581 Harness

(Continued)

Item	Part Number	Description
10	—	To Oil Pressure Switch
11	—	To EVR
12	—	To Idle Air Control (IAC)
13	—	To ECT
14	—	Fuel Injector
15	9F792	Fuel Injection Supply Manifold

3. Disconnect vacuum line from fuel fuel pressure regulator.
4. Remove four fuel injection supply manifold retaining bolts (two on each side).
5. Carefully disengage fuel injection supply manifold assembly from fuel injectors by lifting and gently rocking the fuel injection supply manifold.
6. Remove fuel injectors by lifting while gently rocking side-to-side.



Item	Part Number	Description
1A	—	Screw and Washer Assy (4 Req'd)
2	9F792	Fuel Injection Supply Manifold
3	—	Fuel Pressure Regulator
4	—	Inlet End
5	—	Upper O-Ring Seal

(Continued)

Item	Part Number	Description
6	—	Lower O-Ring Seal
7	9424	Lower Intake Manifold
8	—	Outlet End
9	9F593	Fuel Injector
A		Tighten to 8-12 N·m (6-8 Lb-Ft)

7. Place removed components in a clean container to avoid dirt or other contamination.

CAUTION: Fuel injector and fuel injection supply manifold must be handled with extreme care to prevent damage to sealing areas and sensitive fuel metering orifices.

Installation

NOTE: When installing fuel injection supply manifold assemblies with new or used fuel injectors particular attention should be paid to proper O-ring seating to ensure that no fuel leaks exist.

WARNING: TO AVOID CUTTING O-RINGS, DO NOT ATTEMPT TO INSTALL THEM IF THEY ARE SWOLLEN. ALLOW THEM TO DRY OUT FIRST.

NOTE: Use only fuel methanol compatible O-rings when replacement is necessary.

1. Examine injector O-rings for deterioration or excessive swelling. Install new O-rings if required.
2. Install upper and lower O-rings on each fuel injector. Lubricate outer surface of O-rings with 2 to 3 drops of mineral oil.
3. Ensure injector cups are clean and free of contamination or damage.
4. Install fuel injector in lower intake manifold using light twisting-pushing motion.
5. Position fuel injection supply manifold cups over each fuel injector.
6. Carefully push fuel injection supply manifold fully down onto fuel injector one at a time. To ensure that O-rings are fully seated, twist each injector back and forth several times.
7. Holding fuel injection supply manifold assembly in fully down position, install four retaining bolts and tighten to 10 N·m (7 lb-ft).
8. Connect fuel charging wiring to fuel injectors.
9. Connect vacuum line to fuel pressure regulator.

REMOVAL AND INSTALLATION (Continued)

10. Install throttle body as outlined.
11. Connect fuel supply (1/2 inch) to cold start injector, fuel rail inlet and fuel return (3/8 inch) lines as outlined.
12. Before connecting the fuel charging wiring to vehicle harness, turn ignition switch to the ON position to pressurize the fuel system.
13. Using a clean paper towel and rubber gloves, check for leaks where the fuel injector connects to the fuel injection supply manifold. If leaks are detected, service as required.
14. Connect the fuel charging wiring to vehicle harness and start the engine. Check and adjust timing. Let engine idle for two minutes.
15. Using a clean paper towel and rubber gloves, check for leaks where the fuel injector is installed into the intake manifold and service as necessary.

Fuel Pressure Regulator

Tools Required:

- Fuel Pressure Gauge T80L-9974-B

Removal

1. Verify fuel injection supply manifold assembly is depressurized by removing fuel tank cap and releasing pressure from fuel system at fuel pressure relief valve on fuel injection supply manifold assembly using Fuel Pressure Gauge T80L-9974-B or equivalent.
2. Remove vacuum line at fuel pressure regulator.
3. Remove two fuel rail-to-lower intake manifold retaining bolts. Carefully lift fuel injection supply manifold (regulator side only) off of fuel injector to gain access to fuel pressure regulator retaining screws.
4. Remove three Allen retaining screws from regulator housing and discard.
5. Remove fuel pressure regulator assembly, gasket and O-ring. Discard fuel pressure regulator gasket (9C977) and O-ring.

   NOTE: If scraping is necessary, be careful not to damage fuel pressure regulator or fuel rail gasket surfaces.

Installation

CAUTION: Flexible fuel vehicle fuel pressure regulator components are strictly methanol compatible.

1. Lubricate new fuel pressure regulator O-ring with clean engine oil.
2. Ensure gasket surfaces of fuel pressure regulator and fuel injection supply manifold are clean.
3. Install new O-ring and new gasket on regulator.
4. Using new Allen head retaining screws, install fuel pressure regulator on fuel injection supply manifold. Tighten three retaining screws to 3.75 N·m (34 lb-in).
5. Carefully install regulator side of fuel injection supply manifold to fuel injectors. If fuel injectors were completely disengaged from fuel rail cup(s), lubricate injector O-rings with clean engine oil prior to inserting in fuel injection supply manifold cups. Push regulator side of fuel rail down on fuel injectors and tighten retaining bolts to 10 N·m (7 lb-ft) while holding down on fuel injection supply manifold.

Fuel Sensor

Tools Required:

- Fuel Line Disconnect Tool T90T-9550-C

REMOVAL AND INSTALLATION (Continued)

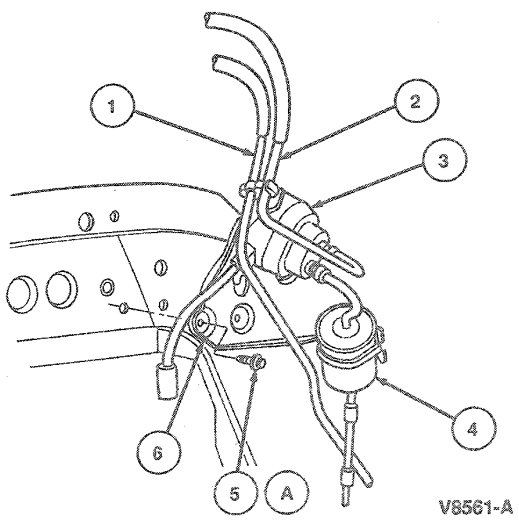
Flexible Fuel Vehicles

The fuel sensor is designed to measure the amount of fuel methanol in the fuel mixture. The sensor sends a variable signal to the PCM through the wiring harness. The PCM adjusts outputs to the engine to provide optimum driveability based on the signal received. For diagnosis refer to the 1993 Powertrain Control / Emission Diagnosis manual[4].

WARNING: DO NOT MODIFY THE FUEL SYSTEM CONFIGURATION OR COMPONENTS, OR REPLACE COMPONENTS WITH PARTS NOT SPECIALLY DESIGNED FOR USE WITH FUEL METHANOL. FORD MOTOR COMPANY HAS SPECIALLY-DESIGNED THE MATERIALS, COMPONENTS AND SYSTEM CONFIGURATION FOR METHANOL-FUELED VEHICLES AND EACH PARTICULAR SYSTEM IS PRECISELY CALIBRATED FOR EFFICIENT OPERATION. THE USE OF DIFFERENT PARTS OR MATERIALS COULD PRODUCE AN UNTESTED CONFIGURATION THAT COULD RESULT IN FIRE, PERSONAL INJURY, OR COULD CAUSE ENGINE DAMAGE.

Removal and Installation

1. Disconnect negative battery terminal from battery.
2. Relieve fuel system pressure. Refer to Section 10-01 for fuel system pressure relief procedures.
3. Disconnect fuel sensor (9C044) electrical connector.
4. Raise vehicle on hoist. Refer to Section 00-02A.
5. Remove RH front tire and wheel assembly. Refer to Section 04-04.
6. Remove fuel line retaining clip and fuel line from fuel mixer (9S301) at inlet hose, using Fuel Line Disconnect Tool T90T-9550-C.



Item	Part Number	Description
1	9J279	Fuel Return Line
2	9J285	Fuel Supply Line
3	9C044	Fuel Sensor Assy
4	9S301	Fuel Mixer Assy
5A	W611081-S56	Screw (2 Req'd)
6	9D319	Fuel Sensor Bracket
A		Tighten to 8-11.5 N·m (6-8 Lb-Ft)

WARNING: COVER VALVE WITH SHOP CLOTH TO PREVENT ACCIDENTAL FUEL SPRAY INTO EYES.

7. Disconnect fuel sensor outlet hose using Fuel Line Disconnect Tool T90T-9550-C.
8. Remove fuel sensor bracket to frame rail retaining bolts and fuel sensor / mixer and bracket assembly from vehicle.
9. Loosen fuel mixer retainer clamp and disconnect fuel mixer outlet tube from fuel sensor using Fuel Line Disconnect Tool T90T-9550-C.
10. Remove fuel sensor retaining bolts and fuel sensor from bracket.
11. To install, reverse Removal procedures. Tighten fuel sensor retainer-to-bracket bolts to 3-4 N·m (27-34 lb-in). Tighten mixer retaining clamp to 5.8-9.3 N·m (51-82 lb-in). Tighten fuel sensor / mixer and bracket-to-frame fasteners to 8-11.5 N·m (6-8 lb-ft). Tighten the wheel lug nuts to 115-142 N·m (85-105 lb-ft).

Fuel Injection Wiring Harness

Removal

NOTE: Ensure ignition switch is in OFF position and fuel system is depressurized.

1. Remove throttle body as outlined.
2. Disconnect electrical connectors from fuel injectors.
3. Disconnect connectors from main wiring harness and throttle position sensor, intake air temperature (IAT) sensor and idle air control (IAC) valve.
4. Remove fuel charging wiring assembly.

Installation

1. Position fuel charging wiring along side fuel injectors.

   CAUTION: Check distance between throttle body and rocker arm cover fuel charging wiring clearance at rocker arm cover valley on FF vehicles.

2. Snap electrical connectors into position on fuel injectors.
3. Install throttle body as outlined.

4 Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

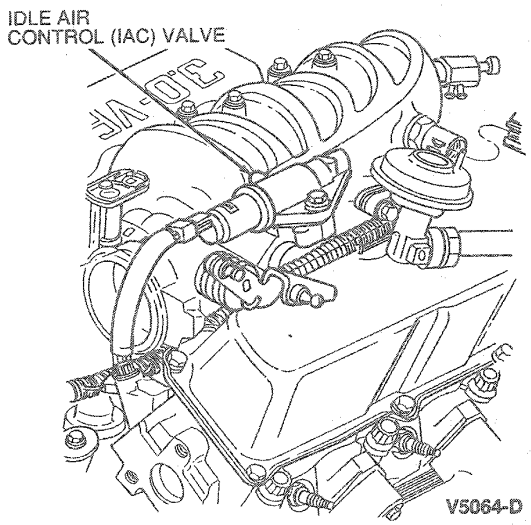
4. Verify that all electrical connectors are firmly seated.
5. Use data link connector (DLC) and procedure to check for sensor function.

CLEANING AND INSPECTION

NOTE: The throttle body for this vehicle is a sludge resistant design and should not be cleaned.

Idle Air Control (IAC) Valve

CAUTION: Do not use the cleaning procedure on idle air control (IAC) valves, as valve damage may occur.



Air Cleaner

NOTE: If air cleaner cover assembly requires replacement, specify 3.0L or 3.0L flexible fuel (FF) vehicle.

Refer to Section 00-03 for the recommended air cleaner assembly maintenance mileage interval. **Cleaning the air cleaner or crankcase ventilation filter elements is not recommended.** They should be replaced at the specified mileage intervals. Clean the air cleaner body and the cover with a solvent or compressed air. Wipe the air cleaner body and cover dry if a solvent is used. Inspect the air cleaner body and cover for distortion or damage at the gasket mating surfaces. Replace cover or body if they are damaged beyond service. Hold filter in front of a light and carefully inspect it for any splits or cracks. If filter is split or cracked, replace it.

ADJUSTMENTS

Refer to the Powertrain Control Emissions / Diagnosis Manual[5] for adjustment procedures.

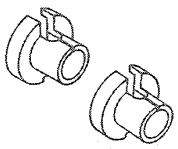
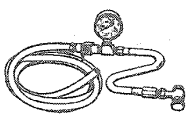
SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N-m	Lb-in
Air Supply Tube Clamps	4	36
Throttle Body (TB) to Lower Intake Manifold Bolts	20-30	15-22 (Lb-Ft)
Idle Air Control Valve to Throttle Body	9.5	84
Throttle Position Sensor to Throttle Body	1.5	14
Fuel Pressure Relief (Schrader) Valve	7.75	66
Fuel Pressure Relief Valve Cap	0.6	5.5
Fuel Injection Supply Rail Assembly to Lower Intake Manifold	10	7 (Lb-Ft)
Fuel Pressure Regulator to Fuel Injection Supply Rail	3.75	34
Generator Brace to Throttle Body and Generator Bracket	16	12 (Lb-Ft)
EGR Tube to EGR Valve	50	37 (Lb-Ft)
Idle Air Control Valve Shield	1.4	13
Distributor Hold-Down Clamp	24	18 (Lb-Ft)
Throttle Bracket to Throttle Body	17	13 (Lb-Ft)
ESR Valve-to-Throttle Body	25	19 (Lb-Ft)
Vacuum Distributor Tree-to-Throttle Body	8-13	6-9 (Lb-Ft)
CSI Retainer Bolts	8-11	70-97
CSI Spray Bar Plug to Throttle Body	10-15	7-11 (Lb-Ft)
Fuel Sensor to Bracket Bolts	3-4	27-34
Fuel Sensor Bracket to Frame Bolts	8-11.5	6-8 (Lb-Ft)
Fuel Mixer Retainer Clamp	5.8-9.3	51-82

5 Can be purchased as a separate item.

SPECIAL SERVICE TOOLS

Tool Number / Description	Illustration
T90T-9550-C Fuel Line Disconnect Tool	
T80L-9974-B Fuel Pressure Gauge	

Tool Number	Description
D87L-9280-A	Spring Lock Coupling Disconnect Tool (3/8 inch)
D87L-9280-B	Spring Lock Coupling Disconnect Tool (1/2 inch)

ROTUNDA EQUIPMENT

Model	Description
113-00001	Injector Tester / Cleaner

PARTS CROSS-REFERENCE

Base Part #	Part Name	Old Part Name
9424	Intake Manifold	
9A758	Throttle Cable	
9B989	Throttle Position Sensor	Throttle Potentiometer
9C968	Fuel Pressure Regulator	
9C977	Fuel Pressure Regulator Gasket	
9D475	EGR Valve	
9D930	Fuel Charging Wiring	
9E926	Throttle Body	
9F593	Fuel Injector	
9F715	Idle Air Control Valve	Throttle Air Bypass Valve
9F792	Fuel Injection Supply Manifold	
9H321	Fuel Pressure Relief Valve	
9H323	Fuel Pressure Relief Valve Cap	
9H486	Intake Manifold Upper Gasket	

SECTION 03-04B Fuel Charging and Controls—3.0L/3.2L SHO

VEHICLE APPLICATION

Taurus SHO.

DESCRIPTION

The sequential multiport fuel injection (SFI) system is classified as a multi-point, pulse time, speed density control, fuel injection system. Fuel is metered into each intake port in sequence with the engine firing order in accordance with engine demand through six fuel injectors (9F593) mounted on a tuned intake manifold.

WARNING: DO NOT SMOKE, CARRY LIGHTED TOBACCO, OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

An on-board vehicle powertrain control module (PCM) (12A650) accepts inputs from various engine sensors to compute the fuel flow rate necessary to maintain a prescribed air/fuel ratio throughout the entire engine operational range. The PCM then outputs a command to the fuel injectors to meter the appropriate quantity of fuel.

The EEC-IV engine control system also determines and compensates for the age of the vehicle and its uniqueness. The system will automatically sense and compensate for changes in altitude (i.e. from sea level to mountains) and will also permit push-starting the vehicle if necessary (manual transaxle only).

All engines use a closed-type positive crankcase ventilation (PCV) system and an exhaust emission system to control engine emissions within Government specifications.

To maintain the required exhaust emission levels, the fuel metering system must be kept in good operating condition and adjusted to specifications listed in the applicable Section of the Powertrain Control/Emissions Diagnosis Manual[1], the applicable Section of this Group, or on the Vehicle Emission Control Information (VECI) decal.

Additional engine performance checks are required to keep the exhaust emissions at the specified minimum pollutant level. Refer to the Pre-Delivery manual, Section 00-03, for these performance checks and recommended intervals.

Always refer to the Master Parts List for parts usage and interchangeability before replacing a throttle body (9E926) or a component part of a throttle body.

1 Can be purchased as a separate item.

OPERATION

The fuel delivery sub-system consists of a high-pressure in-tank mounted fuel pump (9350) and a fuel filter/reservoir delivering fuel from the fuel tank (9002) through a 20-micron fuel filter to a fuel charging manifold assembly.

The fuel charging manifold assembly incorporates electrically actuated fuel injectors directly above each of the engine's six intake ports. The injectors, when energized, spray a metered quantity of fuel into the intake air stream.

A constant fuel pressure drop is maintained across the fuel injectors by a fuel pressure regulator (9C968). The regulator is connected in series with the fuel injectors and is positioned downstream from them. Excess fuel supplied by the pump, but not required by the engine, passes through the fuel pressure regulator and returns to the fuel tank through a fuel return line.

Each fuel injector is energized once every other crankshaft revolution in sequence with engine firing order. The period of time that the fuel injectors are energized (injector "on time" or pulse width) is controlled by the vehicle's powertrain control module (PCM). Air entering the engine is monitored by speed, pressure and temperature sensors. The outputs of these sensors are processed by the powertrain control module (PCM). The PCM determines the needed injector pulse width and outputs a command to the fuel injector to meter the exact quantity of fuel.

Air Intake Manifold

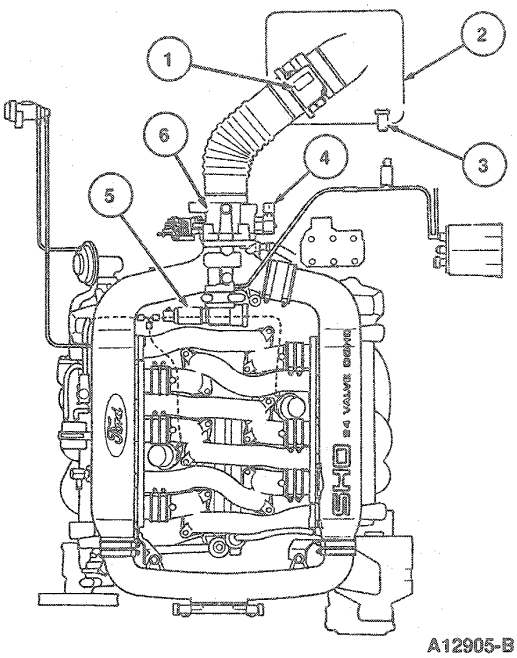
The air intake manifold for the 3.0L SHO is made up of three sections: surge plenums, the primary intake runners and the secondary intake runners. Runner lengths are tuned to optimize engine torque and horsepower output.

The entire intake system can be removed as an assembly to allow access to the fuel injectors and fuel injection supply manifold (9D280).

The manifold provides mounting flanges for the throttle body assembly, and the ignition control module (ICM) (12A297) on the surge plenum assembly.

The unique air intake manifold (9424) for the 3.0L SHO engine features the following items:

1. Two surge plenums connected by a crossover tube.
2. Primary and secondary intake runners. The primary runner (longer length) is always open. A secondary runner (shorter length) is controlled by a vacuum-operated idle air control valve (9F715) and is open at high engine rpm. Each secondary port has a tuning horn upstream of the idle air control valve and inside surge tanks.
3. Vacuum taps for EGR valve (9D475), fuel pressure regulator, idle air control valve, canister purge and brake booster are provided on the surge plenums.



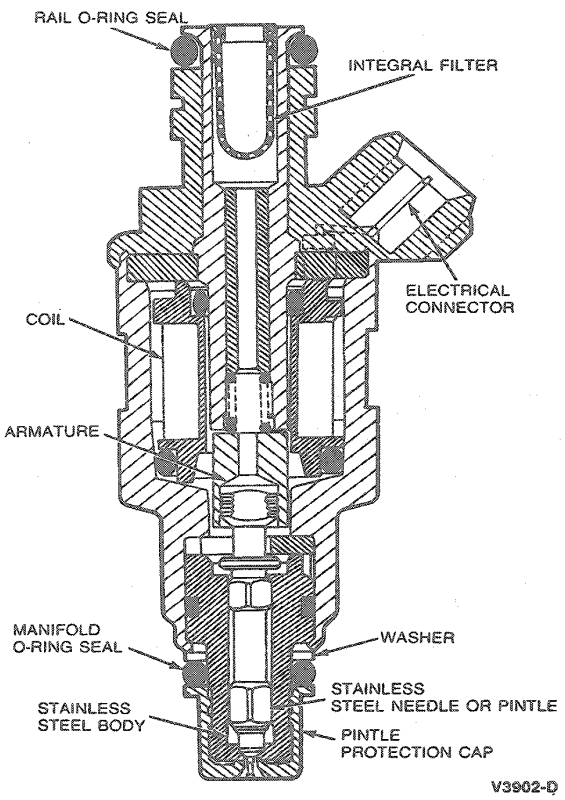
A12905-B

Item	Part Number	Description
1	12B579	Mass Air Flow Sensor
2	9600	Engine Air Cleaner
3	12A697	Intake Air Temperature Sensor
4	9B989	Throttle Position Sensor
5	9F715	Idle Air Control Valve
6	9E926	Throttle Body

COMPONENTS

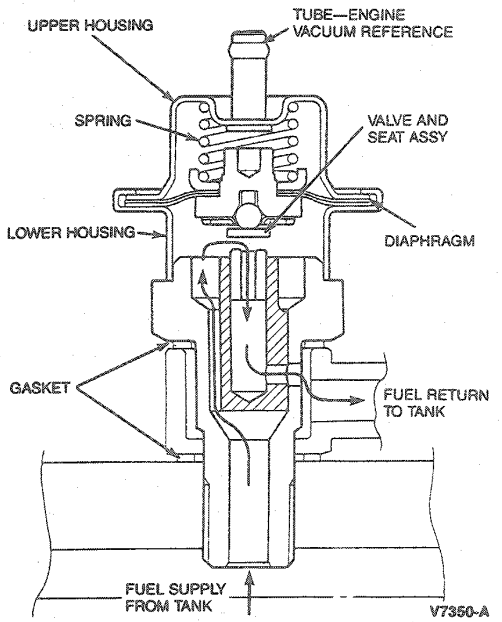
Fuel Injectors

The fuel injectors are electro-mechanical devices which meter and atomize fuel delivered to the engine. The multiport fuel injection (MFI) fuel injectors are mounted in the lower intake manifold and positioned so that their tips are directing fuel just before the engine intake valves. The valve body consists of a solenoid actuated valve assembly. Therefore, fuel flow to the engine is regulated only by how long the solenoid is energized. An electrical signal from the powertrain control module (PCM) activates the solenoid, causing the pintle to move inward off the seat. This allows fuel to flow through the orifice. The pintle is contoured at the point where the fuel separates in order to atomize it.



Fuel Pressure Regulator

The fuel pressure regulator is attached to the fuel injection supply manifold downstream of the fuel injectors. It regulates the fuel pressure supplied to the fuel injectors. The fuel pressure regulator is a diaphragm-operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold vacuum. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the fuel injectors. Excess fuel is bypassed through the fuel pressure regulator and returned to the fuel tank.



Fuel Injection Pulse Dampener

The fuel injection pulse dampener (9F775) is attached to the fuel injection supply manifold upstream of the fuel injector to reduce fuel pressure pulsation.

COMPONENTS (Continued)

Throttle Body Assembly

The throttle body assembly controls airflow to the engine via a butterfly-type valve. The throttle position is controlled by a single lever and cable linkage. The body is a single-piece die casting made of aluminum. It has a single bore with an idle air control (IAC) channel around the throttle valve. This bypass channel controls both cold and warm engine idle airflow control as regulated by an idle air control valve assembly mounted directly to the throttle body. The valve assembly is an electro-mechanical device controlled by the powertrain control module (PCM). It incorporates a linear actuator which positions a variable area metering valve.

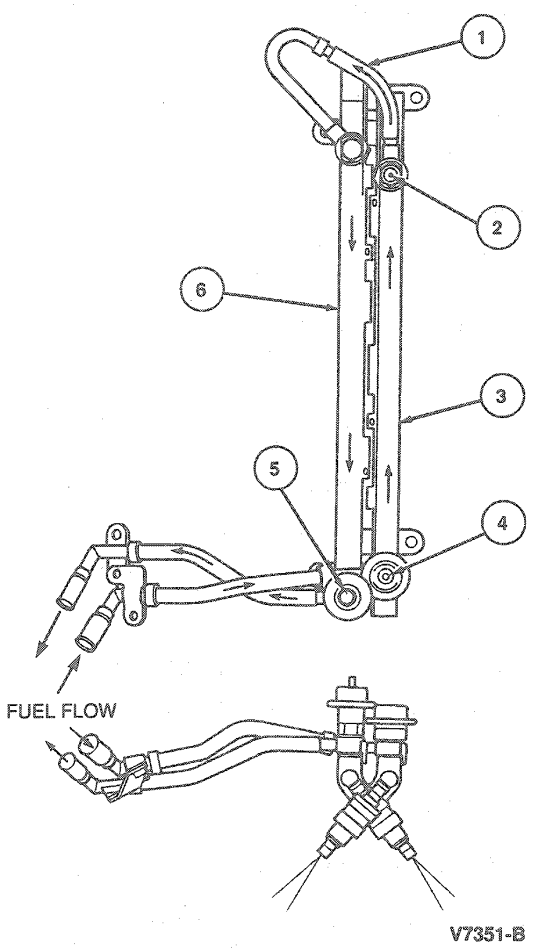
Other features of the throttle body assembly include:

1. An adjustment screw to set the throttle valve at a minimum idle airflow position with a disconnected idle air control (IAC) valve.
2. A throttle body-mounted throttle position sensor (9B989).
3. A PCV fresh-air source upstream of the throttle valve.
4. Two PCV orifices for air and crankcase mixture upstream of the throttle valve, and two downstream of the throttle valve.

Fuel Injection Supply Manifold Assembly

The fuel injection supply manifold assembly is the component that delivers high-pressure fuel from the vehicle fuel supply line to the six fuel injector. The assembly consists of two fuel rails with injector connectors, mounting flanges for the fuel injection pulse dampener and fuel pressure regulator and mounting attachments which locate the fuel injection supply manifold assembly and provide fuel injector retention. The fuel inlet and outlet connections have push-connect (CCD) fittings.

A fuel pressure relief valve (9H321) is located on the fuel injection supply manifold assembly for diagnostic tests and field service fuel pressure bleed.



Item	Part Number	Description
1	—	Fuel Rail Connector
2	9H321	Fuel Pressure Relief Valve
3	—	RH Fuel Rail
4	9F775	Fuel Injection Pulse Dampener
5	9C968	Fuel Pressure Regulator
6	—	LH Fuel Rail

REMOVAL AND INSTALLATION

Fuel Charging Assembly

Throttle Body, Upper and Lower Manifolds

Pre-Service Procedures

The fuel charging assembly consists of the throttle body, and the upper and lower intake manifolds. Prior to service or removal of the fuel charging assembly, the following Steps must be taken:

1. Open hood and install protective covers.

REMOVAL AND INSTALLATION (Continued)

2. Disconnect battery ground cable and secure it out of the way.
3. Remove fuel cap and release tank pressure.
4. Release pressure from fuel system. Refer to Section 10-01 for fuel system pressure relief procedures. A fuel pressure relief valve on the fuel rail assembly is provided for this procedure.

Post-Service Procedures

After the service is complete and the fuel charging assembly is installed onto engine, the following Steps must be taken:

1. Install fuel cap at tank.
2. Connect battery ground cable.
3. Add engine coolant if required.

   CAUTION: The fuel system is normally pressurized to 276 kPa (40 psi).

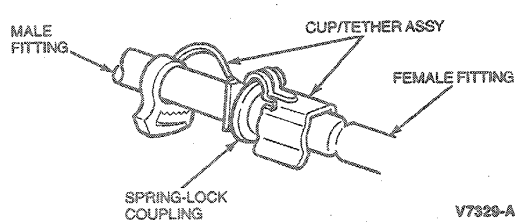
   NOTE: Check all connections at fuel rails, push connect fittings, etc.
4. Turn ignition switch ON/OFF several times without starting engine to check for fuel leaks.
5. Start engine and warm to operating temperature. Check for coolant leak if coolant was removed.
6. Perform powertrain control module (PCM) Self-Test to check systems function. Refer to the Powertrain Control/Emissions Diagnosis Manual[2].

Spring Lock Coupling

Tools Required:

- Spring Lock Coupling Disconnect Tool D87L-9280-A (3/8 inch) or D87L-9280-B (1/2 inch)

The spring lock coupling is a fuel line coupling held together by a garter spring inside a circular cage. When the coupling is connected together, the flared end of the female fitting slips behind the garter spring inside the cage of the male fitting. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage. As a redundant locking feature, a horseshoe-shaped retaining clip is incorporated to improve the retaining reliability of the spring lock coupling.



Removal

1. Release fuel system pressure. Refer to Section 10-01 for fuel system pressure relief procedures. A fuel pressure relief valve on the fuel injection supply manifold assembly is provided for this procedure.
2. Remove retaining clip from spring lock coupling by hand only. Do not use any sharp tool or screwdriver as it may damage the spring lock coupling.
3. Twist fitting to free it from any adhesion at the O-ring seals.
4. Fit Spring Lock Coupling Disconnect Tool D87L-9280-A (3/8 inch) or D87L-9280-B (1/2 inch) or equivalent to coupling.
5. Close tool and push into open side of the cage to expand garter spring and release female fitting.
6. After garter spring is expanded, pull fittings apart.
7. Remove tool from disconnected coupling.

Installation

1. Ensure that garter spring is in cage of male fitting. If garter spring is missing, install a new spring by pushing it into cage opening. If garter spring is damaged, remove it from 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 coupling.

   WARNING: 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.
3. Replace missing or damaged O-rings. Use only O-rings listed in Spring Lock Coupling illustrations.
4. Lubricate male fitting and O-rings and inside of female fitting with clean engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent.
5. Fit female fitting to male fitting and push until garter spring snaps over flared end of female fitting.
6. Ensure coupling engagement by pulling on fitting and visually checking to ensure garter spring is over flared end of female fitting.

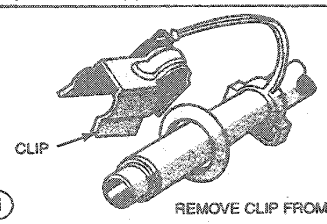
   NOTE: All vehicles require the large black clip to be installed on the supply side fuel line and the small gray clip to be installed on the return side fuel line.
7. Position retaining clip over metal portion of spring lock coupling. Firmly push retaining clip onto spring lock coupling. Ensure that horseshoe portion of clip is over the coupling. Do not install retaining clip over rubber fuel line.

2 Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

TO DISCONNECT COUPLING

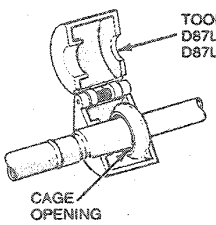
CAUTION — RELIEVE FUEL PRESSURE BEFORE DISCONNECTING COUPLING



1 REMOVE CLIP FROM COUPLING

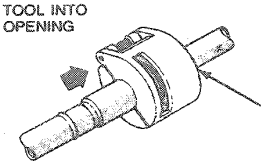
USE SPECIFIED TOOL OR EQUIVALENT

TOOL:
D87L-9280-A — 3/8 INCH
D87L-9280-B — 1/2 INCH

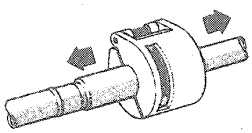


2 FIT TOOL TO COUPLING SO THAT TOOL CAN ENTER CAGE OPENING TO RELEASE THE GARTER SPRING.

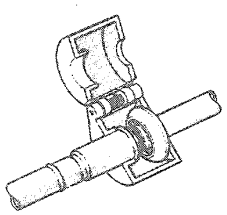
PUSH TOOL INTO CAGE OPENING



3 PUSH THE TOOL INTO THE CAGE OPENING TO RELEASE THE FEMALE FITTING FROM THE GARTER SPRING

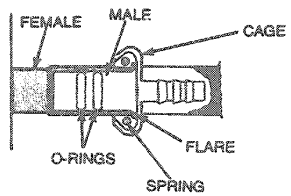


4 PULL THE COUPLING MALE AND FEMALE FITTINGS APART



5 REMOVE THE TOOL FROM THE DISCONNECTED SPRING LOCK COUPLING

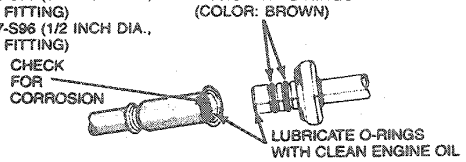
TO CONNECT COUPLING



1

REPLACEMENT O-RINGS
390846-S96 (3/8 INCH DIA., 2 PER FITTING)
390847-S96 (1/2 INCH DIA., 2 PER FITTING)

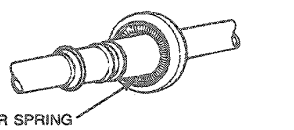
USE ONLY SPECIFIED FUEL RESISTANT O-RINGS (COLOR: BROWN)



CLEAN FITTINGS WITH SOLVENT. CHECK FOR MISSING OR DAMAGED O-RINGS. REPLACE MISSING O-RINGS. IF EITHER O-RING IS DAMAGED, REPLACE BOTH O-RINGS.

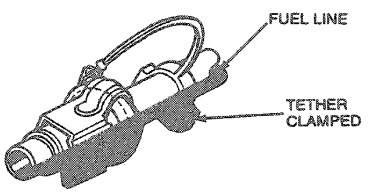
REPLACEMENT GARTER SPRINGS:
3/8-INCH — E1ZZ-19E576-A
1/2-INCH — E1ZZ-19E576-B

2

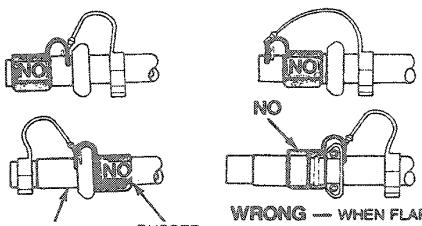


TO ENSURE COUPLING ENGAGEMENT, PULL ON FITTING AND VISUALLY CHECK TO BE SURE GARTER SPRING IS OVER FLARED END OF FEMALE FITTING

3



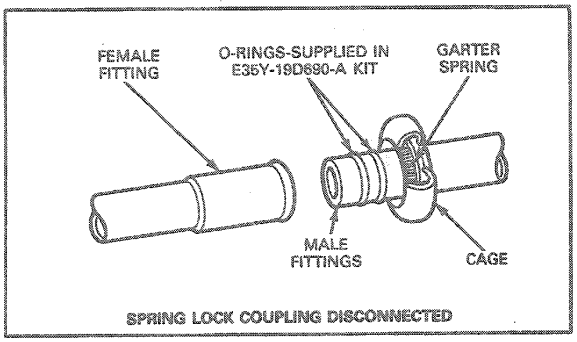
4 YES



5 WRONG — WHEN FLARE OR O-RINGS ARE SHOWING

V7332-A

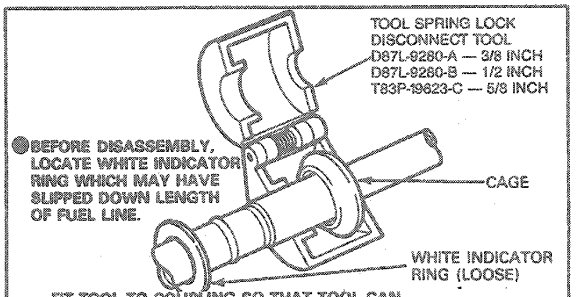
REMOVAL AND INSTALLATION (Continued)



SPRING LOCK COUPLING DISCONNECTED

TO DISCONNECT COUPLING

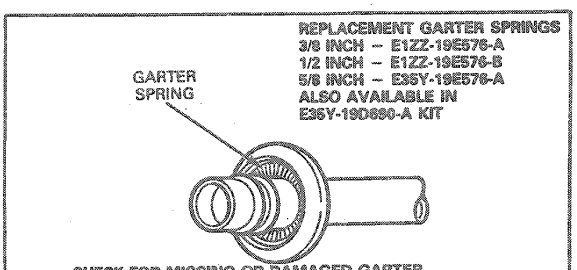
CAUTION – DISCHARGE SYSTEM BEFORE DISCONNECTING COUPLING



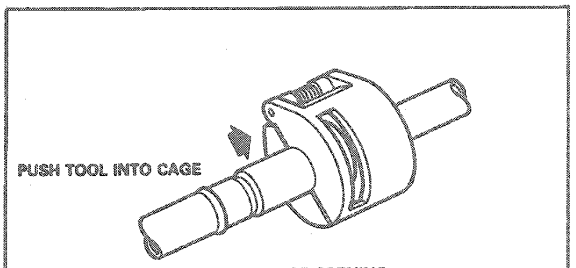
● BEFORE DISASSEMBLY, LOCATE WHITE INDICATOR RING WHICH MAY HAVE SLIPPED DOWN LENGTH OF FUEL LINE.

● FIT TOOL TO COUPLING SO THAT TOOL CAN ENTER CAGE TO RELEASE THE GARTER SPRING.

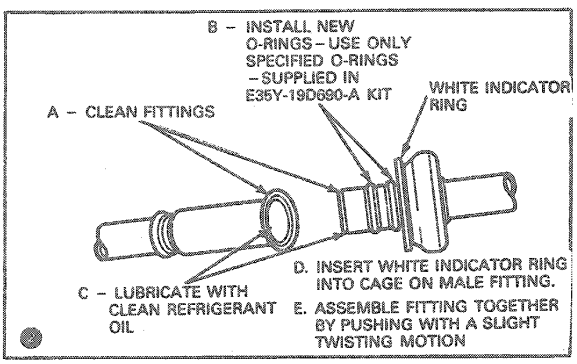
TO CONNECT COUPLING

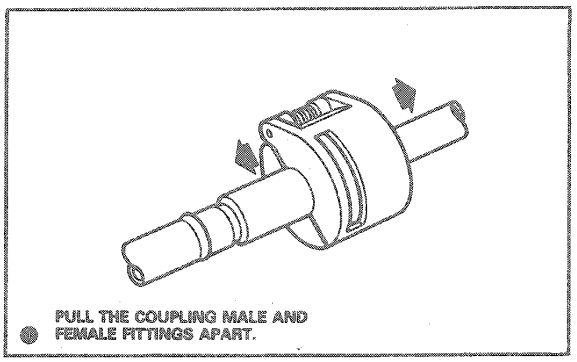


● CHECK FOR MISSING OR DAMAGED GARTER SPRING – REMOVE DAMAGED SPRING WITH SMALL HOOKED WIRE – INSTALL NEW SPRING IF DAMAGED OR MISSING.

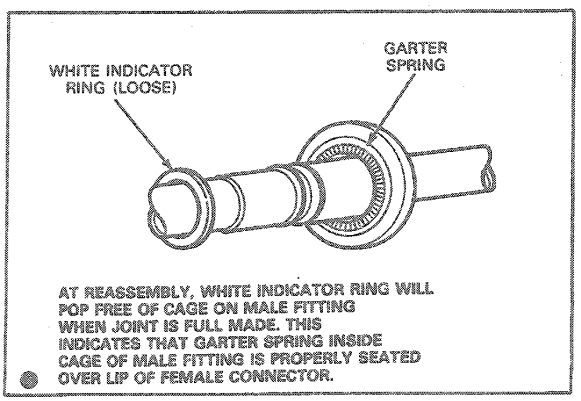


● PUSH THE TOOL INTO THE CAGE OPENING TO RELEASE THE FEMALE FITTING FROM THE GARTER SPRING.

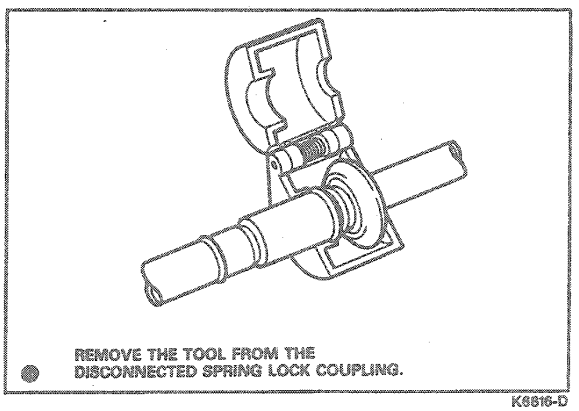




● PULL THE COUPLING MALE AND FEMALE FITTINGS APART.



● AT REASSEMBLY, WHITE INDICATOR RING WILL POP FREE OF CAGE ON MALE FITTING WHEN JOINT IS FULL MADE. THIS INDICATES THAT GARTER SPRING INSIDE CAGE OF MALE FITTING IS PROPERLY SEATED OVER LIP OF FEMALE CONNECTOR.



● REMOVE THE TOOL FROM THE DISCONNECTED SPRING LOCK COUPLING.

K9816-D

REMOVAL AND INSTALLATION (Continued)

Intake Manifold and Throttle Body

NOTE: Any reference to EGR pertains only to California vehicles.

Removal

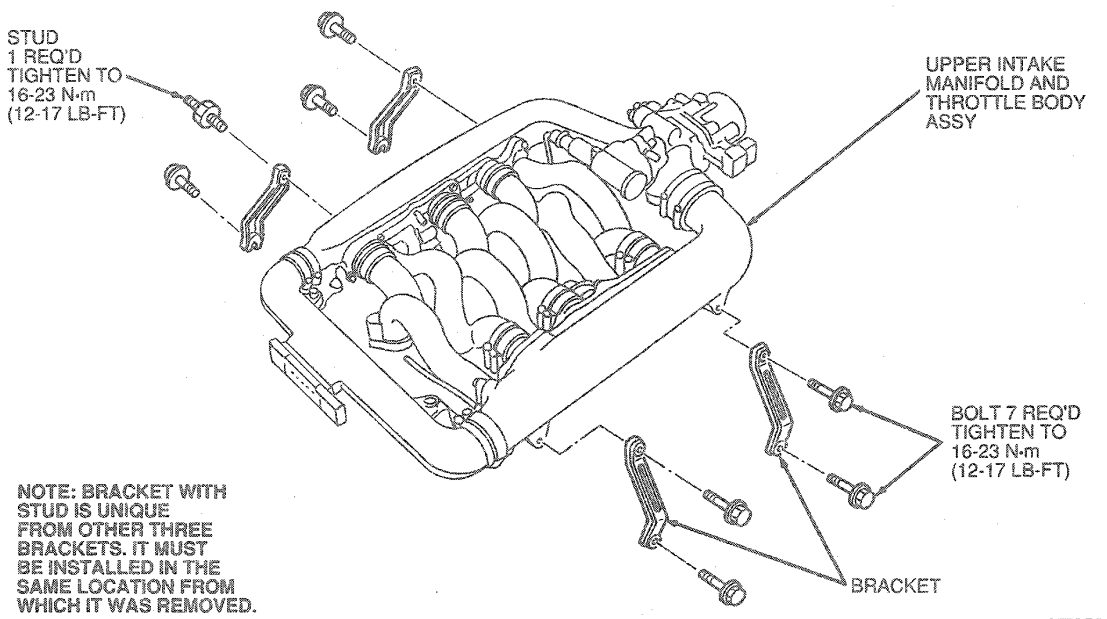
1. Remove intake air tube from throttle body and mass airflow (MAF) (12B579) sensor. Disconnect throttle cables.
2. Disconnect electrical connectors at throttle position sensor, idle air control (IAC) valve, vacuum switching valve and ignition control module (ICM).

   WARNING: COOLING SYSTEM MAY BE UNDER PRESSURE. RELEASE PRESSURE AT RADIATOR PRESSURE CAP BEFORE REMOVING HOSES. ENSURE ENGINE IS COOL BEFORE REMOVING CAP.
3. Disconnect coolant bypass hoses and vacuum lines.
4. Disconnect EGR valve to exhaust manifold tube (9D477) from EGR valve.
5. Remove eight bolts at intake manifold support brackets and remove brackets.
6. Remove bolt retaining coolant hose bracket.
7. Disconnect PCV hoses.
8. Remove 12 manifold retaining bolts.
9. Remove intake manifold and throttle body assembly.

Installation

NOTE: Metal intake manifold gaskets can be reused if undamaged.

1. Clean and inspect gaskets and mounting surfaces.
2. Position manifold gaskets.
3. Position manifold assembly, being careful not to pinch any hoses or wires.
4. Install 12 intake manifold retaining bolts. Tighten bolts to 15-23 N·m (11-17 lb-ft).
5. Connect PCV hoses.
6. Install manifold support brackets and coolant hose bracket. Tighten bolts to 15-23 N·m (11-17 lb-ft).
7. Connect EGR valve to exhaust manifold tube to EGR valve.
8. Connect coolant bypass hoses and vacuum lines.
9. Connect electrical connectors at ignition control module (ICM), vacuum switching valve, throttle position sensor and idle air control (IAC) valve.
10. Install throttle cables and intake air tube.
11. Check and top-off coolant.



Air Intake Throttle Body

Removal

1. Remove intake air tube and throttle cables.

REMOVAL AND INSTALLATION (Continued)

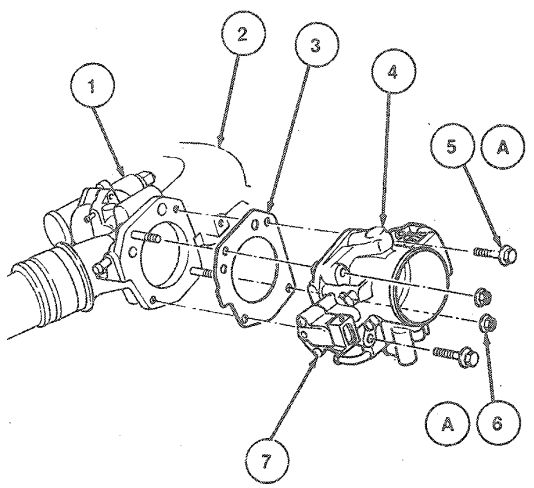
2. Disconnect electrical connectors at throttle position sensor and idle air control (IAC) valve.

   WARNING: COOLING SYSTEM MAY BE UNDER PRESSURE. RELEASE PRESSURE AT RADIATOR PRESSURE CAP BEFORE REMOVING HOSES.

3. Remove coolant bypass hoses.
4. Disconnect PCV hoses.
5. Remove throttle body retaining bolts and nuts and remove throttle body.

Installation

1. Clean and inspect mounting surfaces.
2. Install new air charge control to intake manifold gasket (9E936).
3. Position throttle body and install retaining bolts and nuts. Tighten to 16-23 N·m (12-17 lb-ft).
4. Connect PCV hoses.
5. Connect coolant bypass hoses.
6. Connect electrical connectors at throttle position sensor and idle air control (IAC) valve.
7. Install throttle cables and intake air tube.



A12859-C

Item	Part Number	Description
1	9F715	Idle Air Control Valve
2	9424	Intake Manifold
3	9E936	Air Charge Control to Intake Manifold Gasket
4	9E926	Throttle Body Assy
5A	—	Bolt
6A	—	Nut
7	9B989	Throttle Position Sensor
A		Tighten to 16-23 N·m (12-17 Lb-Ft)

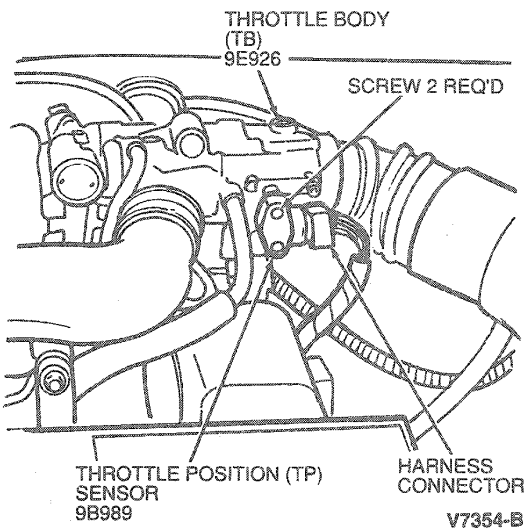
Throttle Position Sensor

Removal

1. Remove electrical connector from throttle position sensor.
2. Remove screws retaining sensor to throttle body and remove throttle position sensor.

Installation

1. Align tab on throttle shaft with slot in throttle position sensor and rotate throttle position sensor into position.
2. Install two sensor retaining screws. Tighten to 1.6-1.8 N·m (14-16 lb-in).
3. Connect electrical connector to throttle position sensor.



V7354-B

Idle Air Control (IAC) Valve Assembly

Removal

1. Disconnect electrical connector at idle air control (IAC) valve.

   NOTE: Remove top screw first and swing valve up to provide clearance to remove lower screw.

2. Remove mounting screws and remove idle air control (IAC) valve.

Installation

1. Inspect gaskets for damage and replace if necessary.
2. Position idle air control (IAC) valve and install screws. Tighten screws to 7.1-11 N·m (63-97 lb-in).
3. Connect electrical connection at valve.

REMOVAL AND INSTALLATION (Continued)

Fuel Rail Assembly

Removal

1. Remove intake manifold assembly as outlined.

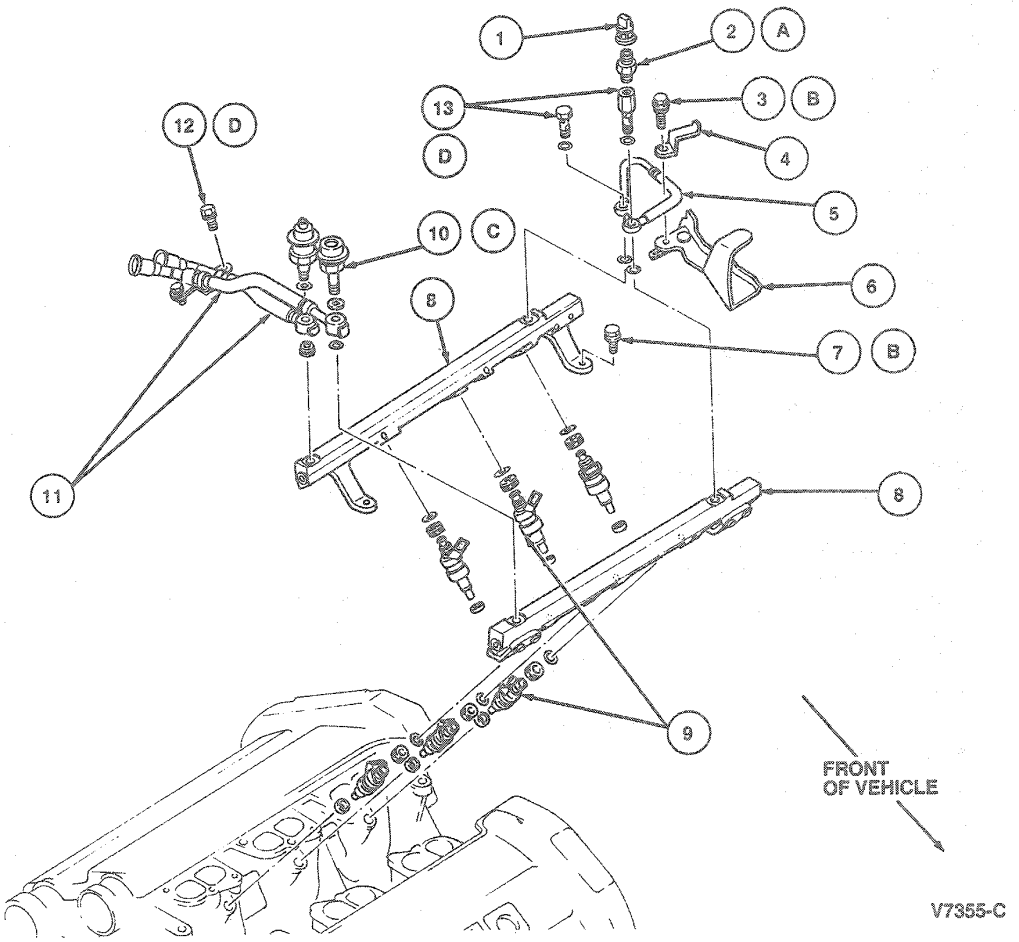
   WARNING: THE FUEL SYSTEM IS NORMALLY PRESSURIZED TO 276KPA (39 PSI). RELEASE PRESSURE FROM FUEL SYSTEM BEFORE DISCONNECTING FUEL LINES. REFER TO SECTION 10-01.
2. Disconnect fuel line spring lock couplings.
3. Disconnect electrical connectors at fuel injectors. Disconnect vacuum connection at fuel pressure regulator assembly.
4. Remove four fuel rail retaining bolts and remove fuel injection supply manifold assembly.

   NOTE: Fuel injection supply manifold is mounted on bushings. Retain bushings for installation.

Installation

WARNING: ALWAYS USE NEW GASKETS WHEN ASSEMBLING FUEL RAIL COMPONENTS TO AVOID COMBUSTION FROM FUEL LEAKAGE.

1. Install fuel injection supply manifold assembly, ensure all fuel injectors are properly seated.
2. Install four fuel rail retaining bolts. Tighten to 15-23 N·m (11-17 lb-ft).
3. Connect electrical connectors at fuel injectors.
4. Connect fuel line spring lock couplings.
5. Install intake manifold.
6. Connect vacuum lines and remaining electrical connectors.
7. Run engine and check for leaks.



REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9H323	Fuel Pressure Relief Valve Cap
2A	9H321	Fuel Pressure Relief Valve
3B	—	Bolt
4	—	Clip
5	—	Fuel Rail Connector
6	—	Bracket
7B	—	Bolt (4 Req'd)
8	9D280	Fuel Injection Supply Manifold
9	9F593	Fuel Injector Assy (6 Req'd)

(Continued)

Item	Part Number	Description
10C	9F775	Fuel Injection Pulse Dampener
11	—	Fuel Supply and Return Lines
12D	—	Bolt (2 Req'd)
13D	—	Bolt
A		Tighten to 5-9 N·m (44-80 Lb-In)
B		Tighten to 15-23 N·m (11-17 Lb-Ft)
C		Tighten to 25-34 N·m (18-25 Lb-Ft)
D		Tighten to 24-34 N·m (18-25 Lb-Ft)

Fuel Injector(s)

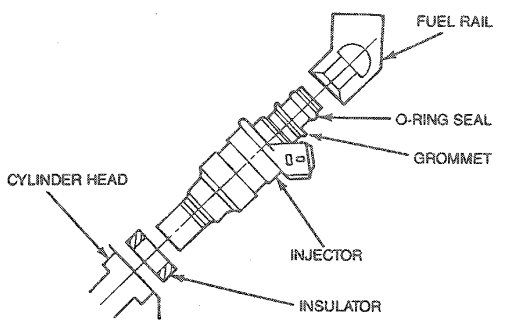
Removal

1. Remove intake manifold as outlined.
2. Release fuel system pressure. Refer to Section 10-01.
3. Disconnect electrical connector(s) at fuel injector(s).
4. Remove fuel rail retaining bolts.
5. Raise and slightly rotate fuel injection supply manifold assembly and remove fuel injector(s).

Installation

1. Inspect injector O-ring seals and insulators for damage or deterioration. Replace if necessary.
2. Lubricate O-rings with clean engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent.
3. Install fuel injector(s) in fuel injection supply manifold. Lightly twist and push fuel injector(s) into position.
4. Install fuel injection supply manifold, ensure fuel injector(s) seat properly in cylinder head.
5. Install fuel rail retaining bolts. Tighten to 15-23 N·m (11-17 lb-ft).

   NOTE: Fuel injection supply manifold is mounted on bushings.
6. Connect electrical connector(s) at fuel injector(s).
7. Install intake manifold.
8. Run engine and check for leaks.



Fuel Pressure Regulator

Removal

1. If removing fuel pressure regulator with fuel injection supply manifold installed in vehicle, release fuel system pressure. Refer to Section 10-01.
2. Disconnect vacuum line at fuel pressure regulator.
3. Remove fuel pressure regulator from fuel return line and fuel injection supply manifold and discard gaskets.

Installation

1. Install fuel pressure regulator into fuel return line and fuel injection supply manifold using new sealing gaskets. Tighten regulator to 25-34 N·m (18-25 lb-ft).
2. Connect vacuum hose to fuel pressure regulator.
3. Run engine and check for leaks.

REMOVAL AND INSTALLATION (Continued)

Fuel Injection Pulse Dampener

Removal

1. If removing fuel pressure regulator with fuel injection supply manifold installed in vehicle, release fuel system pressure. Refer to Section 10-01.
2. Remove fuel injection pulse dampener from fuel injection supply manifold and supply line. Discard sealing gaskets.

Installation

1. Install fuel injection pulse dampener through supply line and into fuel injection supply manifold using new sealing gaskets. Tighten fuel injection pulse dampener screws to 25-34 N·m (18-25 lb-ft).
2. Run engine and check for leaks.

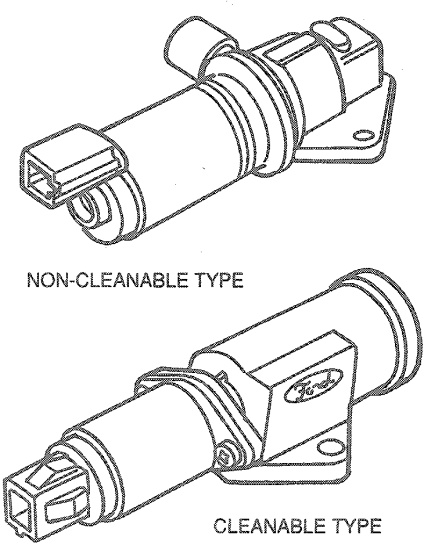
CLEANING AND INSPECTION

Preferred Cleaning Procedure

CAUTION: Do not clean black plastic bypass valves. Use only specified cleaner. Do not spray directly on throttle plate or use any type of scrubbing method. Do not run engines of vehicles with airflow meters during cleaning.

Idle Air Control Valves

IDLE AIR CONTROL (IAC) VALVES 9F715



1. Ensure bypass actuator is operating properly. Refer to Powertrain Control / Emissions Diagnosis Manual[3].
2. Remove throttle inlet air tube.
3. Disconnect idle air control (IAC) valve connector.
4. Connect Rotunda Air Bypass Actuator 113-00009 and Injector Tester / Cleaner 113-00001 or equivalent.
5. Start the actuator. **Do not** start engines of vehicles equipped with airflow meters.
6. Spray Carburetor Tune-Up Cleaner D9AZ-19579-BA (ESR-M14P9-A) or equivalent into idle air control (IAC) valve passage for five seconds while actuator is operating.
7. Turn off the actuator. Allow solvent to soak for 15 minutes.
8. Turn on actuator.
9. Spray carburetor cleaner into idle air bypass passage for no more than six seconds.
10. Turn off actuator.
11. Install intake air tube. Start actuator and engine and run engine for one minute, to dry out solvent residue.
12. Disconnect actuator from idle air control (IAC) valve. Connect idle air control (IAC) valve signal lead electrical connector.
13. Start engine and check for normal operation.

Alternate Cleaning Procedure

NOTE: This procedure should only be done when recommended tools are not available.

Remove the idle air control (IAC) valve from the throttle body assembly. Remove the electrical solenoid assembly from the mechanical portion of the air bypass valve by removing the two screws, then sliding the mechanical portion away from the solenoid.

CAUTION: Do not exceed three minutes soak time, and do not use choke cleaner as an internal O-ring may begin to deteriorate.

Soak the mechanical portion in Carburetor Tune-Up Cleaner D9AZ-19579BA (ESR-M14P9-A), or equivalent for two to three minutes maximum.

With the mechanical portion completely submerged, shake in all directions: up, down, right and left. Then push in on the rod that mates with the solenoid assembly, and again shake in all directions with the unit submerged and the rod held in as far as possible.

Remove the unit from the cleaning fluid and dry out thoroughly using shop air.

3 Can be purchased as a separate item.

CLEANING AND INSPECTION (Continued)

Air Cleaner

Refer to Section 00-03 for the recommended air cleaner assembly maintenance mileage interval. **Cleaning the air cleaner or crankcase ventilation filter elements is not recommended.** They should be replaced at the specified mileage intervals. Clean the air cleaner body and the cover with a solvent or compressed air. Wipe the air cleaner body and cover dry if a solvent is used. Inspect the air cleaner body and cover for distortion or damage at the gasket mating surfaces. Replace cover or body if they are damaged beyond service. Hold filter in front of a light and carefully inspect it for any splits or cracks. If filter is split or cracked, replace it.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N-m	Lb-Ft
Intake Manifold-to-Cylinder Head Bolts	15-23	11-17
Intake Manifold Support Bracket Bolts	15-23	11-17
Throttle Body-to-Intake Manifold Bolts and Nuts	16-23	12-17
Throttle Position Sensor-to-Throttle Body Screws	1.6-1.8	14-16 Lb-In
Air Control Valve-to-Intake Manifold Screws	7.1-11	63-97 Lb-In
Fuel Injection Supply Manifold-to-Cylinder Head Bolts	15-23	12-17
Fuel Injection Supply Manifold Connector Retaining Bolts	24-34	18-25
Fuel Pressure Relief Valve	5-9	44-80 Lb-In
Fuel Pressure Regulator to Fuel Injection Supply Manifold	25-34	18-25
Fuel Injection Pulse Dampener to Fuel Injection Supply Manifold	25-34	18-25

SPECIAL SERVICE TOOLS

Tool Number	Description
D87L-9280-A	Spring Lock Coupling Disconnect Tool (3/8 inch)
D87L-9280-B	Spring Lock Coupling Disconnect Tool (1/2 inch)

ROTUNDA EQUIPMENT

Model	Description
113-00001	Injector Tester/Cleaner
113-00009	Air Bypass Actuator

PARTS CROSS-REFERENCE

Base Part #	Part Name	Old Part Name
9002	Fuel Tank	
9350	Fuel Pump	
9424	Intake Manifold	
9B989	Throttle Position Sensor	Throttle Potentiometer
9C968	Fuel Pressure Regulator	
9D280	Fuel Injection Supply Manifold	
9D475	EGR Valve	
9D477	EGR Valve to Exhaust Manifold Tube	
9E926	Throttle Body	
9E936	Air Charge Control to Intake Manifold Gasket	
9F593	Fuel Injector	
9F715	Idle Air Control Valve	Throttle Air Bypass Valve
9F775	Fuel Injection Pulse Dampener	
9H321	Fuel Pressure Relief Valve	

SECTION 03-04C Fuel Charging and Controls—3.8L

VEHICLE APPLICATION

Taurus / Sable.

DESCRIPTION

The multiport fuel injection (MFI) system is classified as a multi-point, pulse time, speed density control, fuel injection system. Fuel is metered into each intake port in a sequential firing order. Injectors pulse to follow engine firing order in accordance with engine demand through fuel injectors (9F593) mounted on the cylinder heads.

WARNING: DO NOT SMOKE, CARRY LIGHTED TOBACCO, OR OPEN FLAME OF ANY TYPE WHEN WORKING ON OR NEAR ANY FUEL-RELATED COMPONENT. HIGHLY FLAMMABLE MIXTURES ARE ALWAYS PRESENT AND MAY BE IGNITED, RESULTING IN POSSIBLE PERSONAL INJURY.

An on-board vehicle powertrain control module (PCM) 12A650 accepts inputs from various engine sensors to compute the required fuel flow rate necessary to maintain a prescribed air / fuel ratio throughout the entire engine operational range. The PCM then outputs a command to the fuel injectors to meter the appropriate quantity of fuel.

The EEC-IV engine control system also determines and compensates for the age of the vehicle and its uniqueness. The system will automatically sense and compensate for changes in altitude (i.e. from sea level to mountains).

All engines use a closed-type positive crankcase ventilation (PCV) system and an exhaust emission system to control engine emissions within Government specifications.

To maintain the required exhaust emission levels, the fuel metering system must be kept in good operating condition and adjusted to specifications listed in the applicable Section of the Powertrain Control / Emissions Diagnosis Manual[1], the applicable Section of this Group, or on the Vehicle Emission Control Information (VECI) decal.

Additional engine performance checks are required to keep the exhaust emissions at the specified minimum pollutant level. Refer to the Pre-Delivery manual, Section 00-06, for these performance checks and recommended intervals.

Always refer to the Master Parts List for parts usage and interchangeability before replacing a throttle body (9E926)or a component part of a throttle body.

Fuel Metering Assembly Identification

The base part number of the fuel metering assembly is 9E926. The base part number on 3.8L engines is located on the boss near the throttle position sensor (9B989).

The "Unleaded Fuel Only" nomenclature must appear:

- Near the fuel filler opening.
- On the instrument cluster.

1 Can be purchased as a separate item.

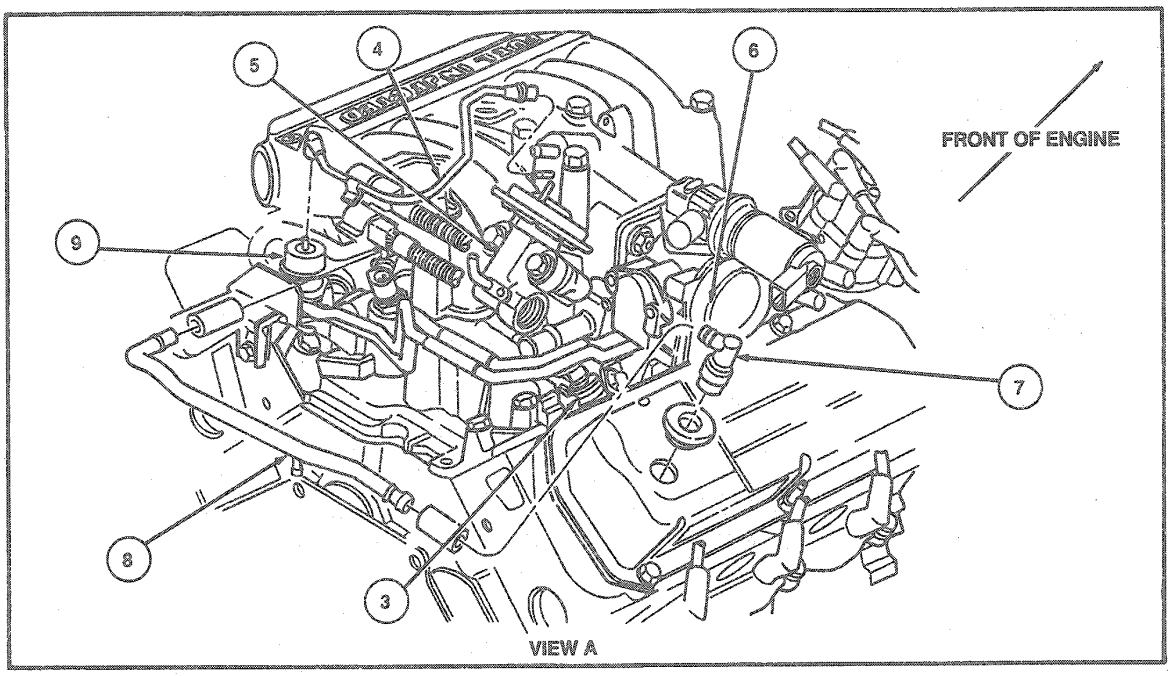
OPERATION

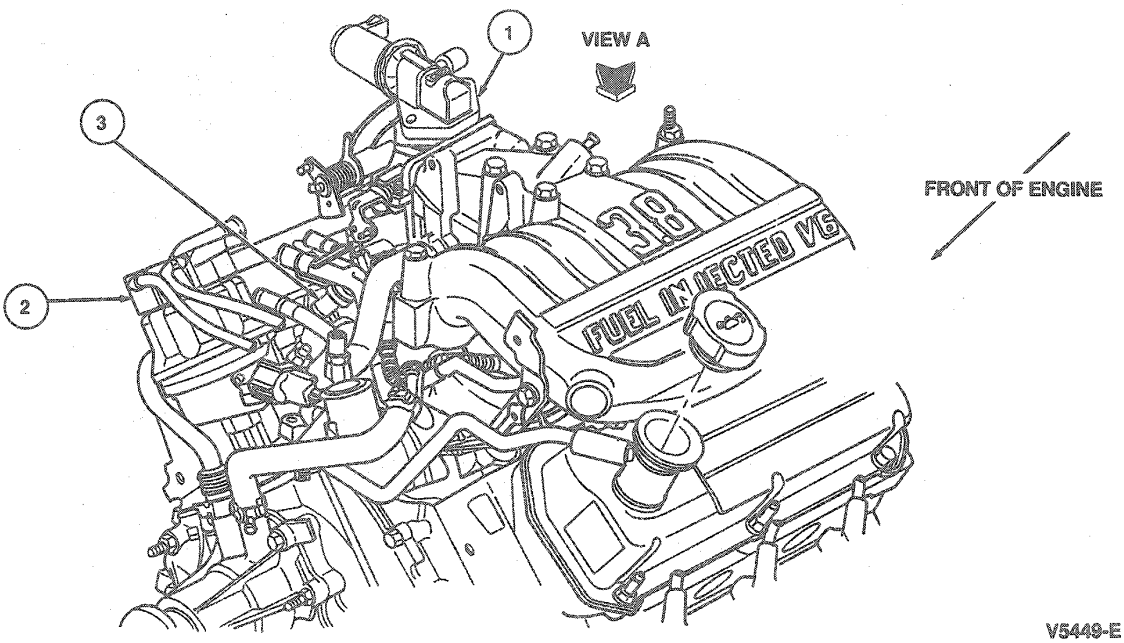
The fuel delivery sub-system consists of a high-pressure in-tank mounted electric fuel pump and a fuel filter / reservoir.

A constant fuel pressure drop is maintained across the injector nozzles by a fuel pressure regulator (9C968). The fuel pressure regulator is connected in series with the fuel injector and is positioned downstream from them. Excess fuel supplied by the pump, but not required by the engine, passes through the fuel pressure regulator and returns to the fuel tank through a fuel return line.

Each fuel injector is energized once every other crankshaft revolution in sequence with engine firing order. The period of time that the fuel injectors are energized (injector "on time" or pulse width) is controlled by vehicle's powertrain control module (PCM). Air entering the engine is monitored by speed, pressure and temperature sensors. The outputs of these sensors are processed by the powertrain control module (PCM). The powertrain control module (PCM) determines the needed injector pulse width and outputs a command to the fuel injector to meter the exact quantity of fuel.

OPERATION (Continued)





Item	Part Number	Description
1	9F715	Idle Air Control Valve
2	—	Distributor and Cap Assy
3	9F593	Fuel Injector
4	—	Fuel Pressure Regulator Vacuum Harness

Item	Part Number	Description
5	9D475	EGR Valve
6	9E926	Throttle Body
7	6B890	PCV Valve
8	—	Crankcase Vent Tube
9	9C968	Fuel Pressure Regulator

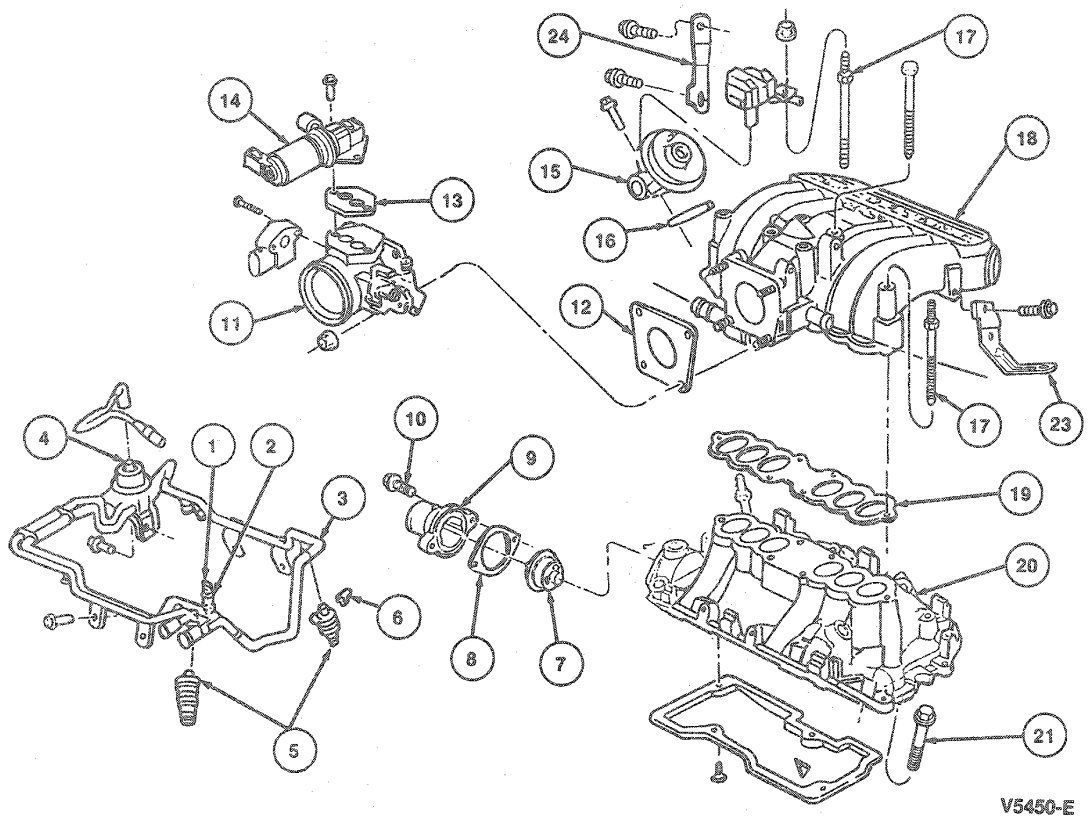
(Continued)

TV5449E

OPERATION (Continued)

Air Intake Manifold

The air intake manifold (9424) is a two-piece (upper and lower intake manifold) aluminum casting. Runner lengths are tuned to optimize engine torque and power output. The manifold provides mounting flanges for the air throttle body assembly, fuel injection supply manifold (9F792), accelerator control bracketry and the EGR valve (9D475) and supply tube. Vacuum taps are provided to support various engine accessories.



V5450-E

Item	Part Number	Description
1	9H323	Fuel Pressure Relief Valve Cap
2	9H321	Fuel Pressure Relief Valve
3	9F792	Fuel Injection Supply Manifold
4	9C968	Fuel Pressure Regulator
5	9F593	Fuel Injector
6	247111	Retainer
7	8575	Thermostat
8	8255	Gasket
9	8594	Housing
10	N605909-S8	Bolt
11	9E926	Throttle Body
12	9E936	Air Charge Control to Intake Manifold Gasket

Item	Part Number	Description
13	9F670	Secondary Air Injection Bypass Valve Gasket
14	9F715	Idle Air Control Valve
15	9D475	EGR Valve
16	9D476	EGR Valve Gasket
17	245905-S2	Bolts / Stud
18	9424	Upper Intake Manifold
19	9H486	Intake Manifold Upper Gasket
20	9424	Lower Intake Manifold
21	N803674-S2	Bolt
22	9J444	Front Intake Manifold Support
23	9J444	Rear Intake Manifold Support

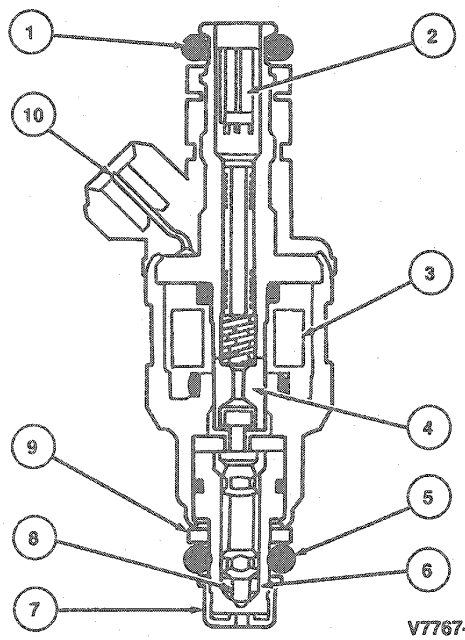
(Continued)

TV5450E

COMPONENTS

Fuel Injectors

The fuel injector nozzles are electro-mechanical devices which both meter and atomize fuel delivered to the engine. The multiport fuel injection (MFI) fuel injectorsare mounted in the cylinder head pockets and positioned so that their tips are directing fuel just before the engine intake valves. The valve body consists of a solenoid actuated valve assembly. Therefore, fuel flow to the engine is regulated only by how long the solenoid is energized. An electrical signal from the powertrain control module (PCM) activates the solenoid, causing the needle to move inward off the seat, allowing the fuel to flow through the orifice. Atomization of the fuel is obtained by a director / metering plate where the fuel separates.



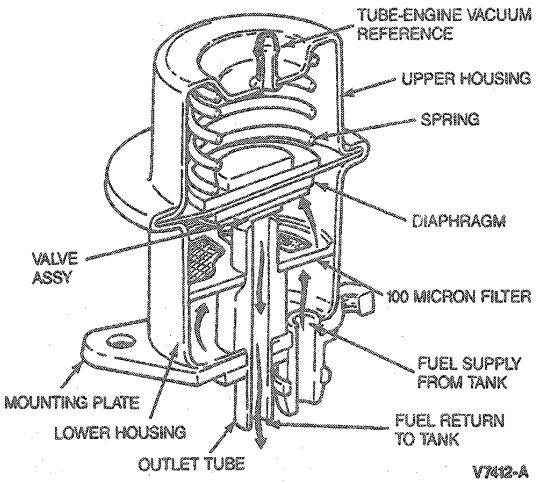
V7767-A

Item	Description
1	Outer O-Ring Seal (Upper)
2	Integral Filter
3	Coil
4	Armature
5	Outer O-Ring Seal (Lower)
6	Stainless Steel Body
7	End Cap
8	Stainless Steel Needle
9	Washer
10	Electrical Connector

TV7767A

Fuel Pressure Regulator

The fuel pressure regulator is attached to the fuel injection supply manifold assembly downstream of the fuel injectors. It regulates the fuel pressure supplied to the fuel injectors. The regulator is a diaphragm operated relief valve in which one side of the diaphragm senses fuel pressure and the other side is subjected to intake manifold vacuum. The nominal fuel pressure is established by a spring preload applied to the diaphragm. Balancing one side of the diaphragm with manifold pressure maintains a constant fuel pressure drop across the fuel injectors. Fuel in excess of that used by the engine, is bypassed through the fuel pressure regulator and returned to the fuel tank.



V7412-A

Throttle Body Assembly

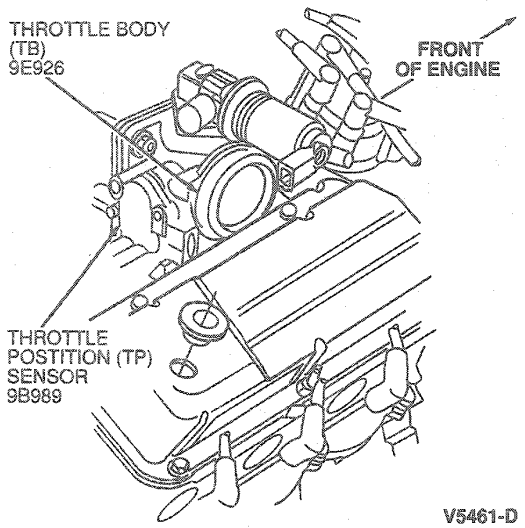
The throttle body assembly controls airflow to the engine. The throttle position is controlled by a single lever and cable linkage. The body is a single-piece die casting made of aluminum. It has a single bore with an air bypass channel around the throttle plate. This bypass channel controls both cold and warm engine idle airflow control as regulated by an idle air control valve (9F715) assembly mounted directly to the throttle body. The valve assembly is an electro-mechanical device controlled by the powertrain control module (PCM). It incorporates a linear actuator which positions a variable area metering valve.

Other features of the air throttle body assembly include:

1. A pre-set stop to locate the WOT position.

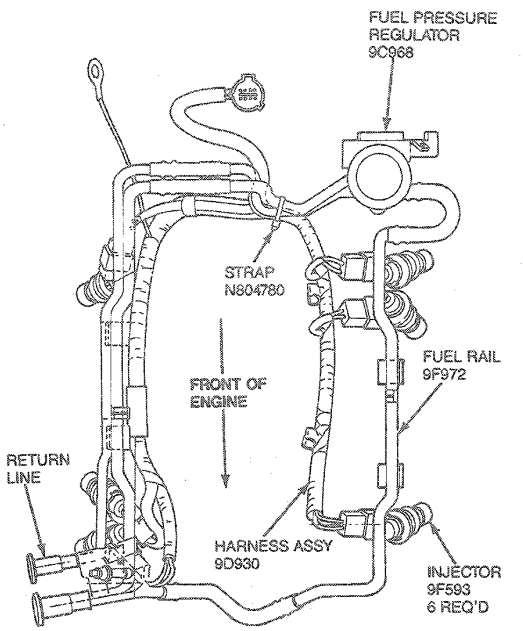
COMPONENTS (Continued)

2. A throttle body-mounted throttle position sensor.



Fuel Injection Supply Manifold Assembly

The fuel injection supply manifold assembly is the component that delivers high-pressure fuel from the vehicle fuel supply line to the fuel injectors. The assembly consists of a tubular fuel rail, injector connectors, a mounting flange to the fuel pressure regulator and mounting attachments which locate the fuel injection supply manifold assembly and provide fuel injector retention. The fuel inlet and outlet connections have push-connect (CCD) fittings.



REMOVAL AND INSTALLATION

Fuel Charging Assembly

Throttle Body, Upper and Lower Manifolds

Pre-Service Procedures

The fuel charging assembly consists of the air throttle body and the upper and lower intake manifolds. Prior to service or removal of the fuel charging assembly, the following Steps must be taken:

1. Open hood and install protective covers.
2. Disconnect battery ground cable and secure it out of the way.
3. Remove fuel cap and release tank pressure.

   CAUTION: The fuel system is normally pressurized to 276 kPa (40 psi).
4. Release pressure from fuel system. Refer to Section 10-01 for fuel system pressure relief procedures. A fuel pressure relief valve (9H321) on the fuel injection supply manifold assembly is provided for this procedure.

Post-Service Procedures

After the service is complete and the fuel charging assembly is installed onto engine, the following Steps must be taken:

1. Install fuel cap at tank.
2. Connect battery ground cable.
3. Add engine coolant, if necessary.

REMOVAL AND INSTALLATION (Continued)

4. Turn ignition switch from ON / OFF several times without starting engine to check for fuel leaks.

   CAUTION: The fuel system is normally pressurized to 276 kPa (40 psi).

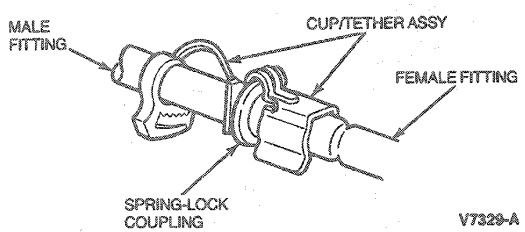
   NOTE: Check all connections at fuel injection supply manifold, push-connect fittings, etc.
5. Start engine and warm to operating temperature. Check for coolant leak if coolant was removed.
6. Perform powertrain control module (PCM) Self-Test to check systems function. Refer to the Powertrain Control / Emissions Diagnosis Manual[2].

Spring Lock Coupling

Tools Required:

- Spring Lock Coupling Disconnect Tool D87L-9280-A (3 / 8 inch) or D87L-9280-B (1 / 2 inch)

The spring lock coupling is a fuel line coupling held together by a garter spring inside a circular cage. When the coupling is connected together, the flared end of the female fitting slips behind the garter spring inside the cage of the male fitting. The garter spring and cage then prevent the flared end of the female fitting from pulling out of the cage. As a redundant locking feature, a horseshoe-shaped retaining clip is incorporated to improve the retaining reliability of the spring lock coupling.



Removal

1. Release fuel system pressure. Refer to Section 10-01 for fuel system pressure relief procedures. A fuel pressure relief valve on the fuel injection supply manifold assembly is provided for this procedure.
2. Remove retaining clip from spring lock coupling by hand only. Do not use any sharp tool or screwdriver as it may damage the spring lock coupling.
3. Twist fitting to free it from any adhesion at the O-ring seals.
4. Fit Spring Lock Coupling Disconnect Tool D87L-9280-A (3 / 8 inch) or D87L-9280-B (1 / 2 inch) or equivalent to coupling.
5. Close tool and push into open side of the cage to expand garter spring and release female fitting.
6. After garter spring has expanded, pull fittings apart.
7. Remove tool from disconnected coupling.

Installation

1. Ensure that garter spring is in cage of male fitting. If garter spring is missing, install a new spring by pushing it into cage opening. If garter spring is damaged, remove it from 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 coupling.

   WARNING: 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.
3. Replace missing or damaged O-rings. Use only O-rings listed in Spring Lock Coupling illustrations.

   Lubricate male fitting and O-rings and inside of female fitting with clean engine oil XO-10W30-QSP (ESE-M2C153-E) or equivalent.
4. Fit female fitting to male fitting and push until garter spring snaps over flared end of female fitting.
5. Ensure coupling engagement by pulling on fitting and visually checking to ensure garter spring is over flared end of female fitting.

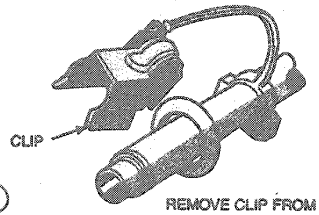
   NOTE: All vehicles require the large black clip to be installed on the supply side fuel line and the small gray clip to be installed on the return side fuel line.
6. Position retaining clip over metal portion of spring lock coupling. Firmly push retaining clip onto spring lock coupling. Ensure that horseshoe portion of clip is over the coupling. Do not install retaining clip over rubber fuel line.

2 Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

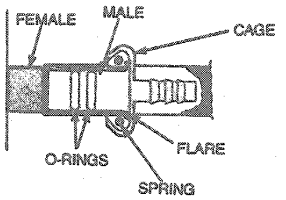
TO DISCONNECT COUPLING

CAUTION — RELIEVE FUEL PRESSURE BEFORE DISCONNECTING COUPLING

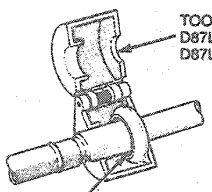


1 REMOVE CLIP FROM COUPLING

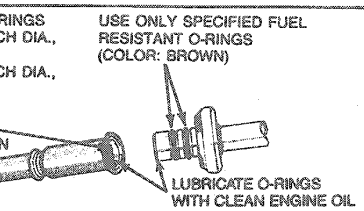
TO CONNECT COUPLING



1



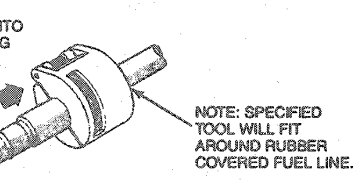
2 FIT TOOL TO COUPLING SO THAT TOOL CAN ENTER CAGE OPENING TO RELEASE THE GARTER SPRING.



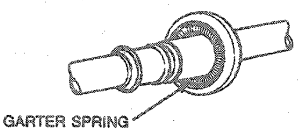
CLEAN FITTINGS WITH SOLVENT. CHECK FOR MISSING OR DAMAGED O-RINGS. REPLACE MISSING O-RINGS. IF EITHER O-RING IS DAMAGED, REPLACE BOTH O-RINGS.

REPLACEMENT GARTER SPRINGS:
3/8-INCH — E1ZZ-19E576-A
1/2-INCH — E1ZZ-19E576-B

2

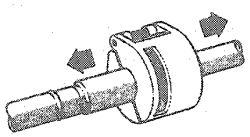


3 PUSH THE TOOL INTO THE CAGE OPENING TO RELEASE THE FEMALE FITTING FROM THE GARTER SPRING

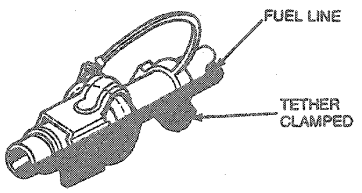


TO ENSURE COUPLING ENGAGEMENT, PULL ON FITTING AND VISUALLY CHECK TO BE SURE GARTER SPRING IS OVER FLARED END OF FEMALE FITTING

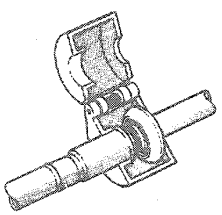
3



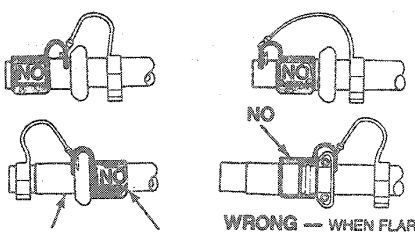
4 PULL THE COUPLING MALE AND FEMALE FITTINGS APART



4 YES



5 REMOVE THE TOOL FROM THE DISCONNECTED SPRING LOCK COUPLING



5 WRONG — WHEN FLARE OR O-RINGS ARE SHOWING

V7332-A

REMOVAL AND INSTALLATION (Continued)

Upper Intake Manifold and Throttle Body

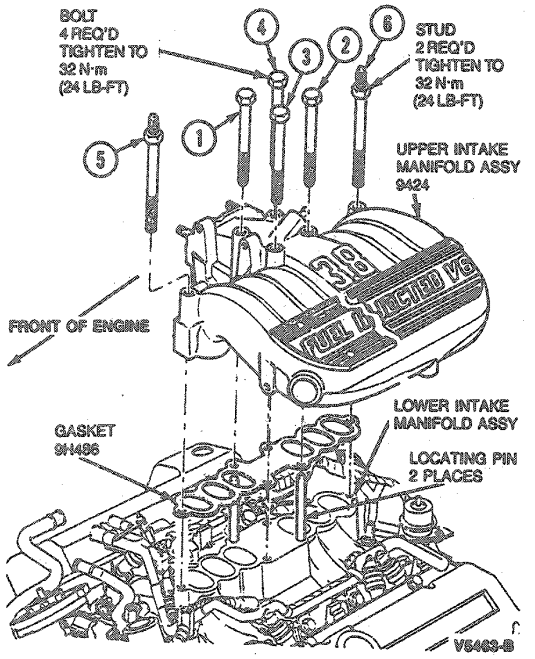
Removal

1. Disconnect electrical connectors at idle air control (IAC) valve, throttle position sensor and EGR pressure valve sensor (9J460).
2. Disconnect throttle linkage at throttle ball and transmission linkage from throttle body. Remove two bolts securing bracket to intake manifold and position bracket with cables out of way.
3. Disconnect upper intake manifold vacuum fitting connections by disconnecting all vacuum lines to vacuum tree, vacuum lines to EGR valve and vacuum line to fuel pressure regulator.
4. Disconnect PCV system by disconnecting hose from fitting on rear of upper intake manifold.
5. Remove nut retaining EGR transducer to upper intake manifold.
6. Loosen EGR tube at exhaust manifold and disconnect at EGR valve.
7. Remove two bolts retaining EGR valve to upper intake manifold and remove EGR valve and EGR transducer as an assembly.
8. Remove six upper intake manifold retaining bolts.
9. Remove two retaining bolts on front and rear edges of upper intake manifold where intake manifold supports (9J444) are located.
10. Remove nut retaining generator bracket to upper intake manifold and two bolts retaining generator bracket to water pump and generator.
11. Remove upper intake manifold and throttle body as an assembly from lower intake manifold.

Installation

1. Clean and inspect the mounting surfaces of the lower and upper intake manifolds.
2. Position new gasket on lower intake manifold mounting surface. The use of alignment studs may be helpful.
3. Install upper intake manifold and throttle bodyassembly to lower intake manifold. Ensure gasket remains in place (if alignment studs are not used).
4. Install four center retaining bolts and two studs to upper intake manifold and tighten to 10 N·m (8 lb-ft). Repeat sequence in two steps: 20 N·m (15 lb-ft) and 32 N·m (24 lb-ft).
5. Install two bolts retaining intake manifold supports to upper intake manifold and tighten to 25 N·m (19 lb-ft).
6. Position generator bracket and install two retaining bolts to water pump and generator. Install generator bracket to upper intake manifold retaining nut. Tighten to 25 N·m (19 lb-ft).
7. Connect EGR valve to EGR tube making sure tube is properly seated in EGR valve. Connect EGR valve to upper intake manifold and tighten to 25 N·m (19 lb-ft).
8. Connect PCV hose to rear of upper intake manifold.
9. Connect vacuum lines to vacuum tree, EGR valve and fuel pressure regulator.
10. Position throttle linkage bracket with cables to upper intake manifold. Install two retaining bolts and tighten to 17 N·m (13 lb-ft). Connect throttle cable and AXOD-E transaxle cable to throttle body.
11. Connect electrical connectors at idle air control (IAC) valve, throttle position sensor and EGR pressure valve sensor.

    NOTE: If lower intake manifold was removed, fill and bleed cooling system. Refer to Section 03-03.



Throttle Body

Removal

1. Disconnect throttle position sensor and idle air control (IAC) valve connectors.
2. Remove four throttle body retaining nuts.
3. Remove and discard air charge control to intake manifold gasket (9E936) between throttle body and upper intake manifold.

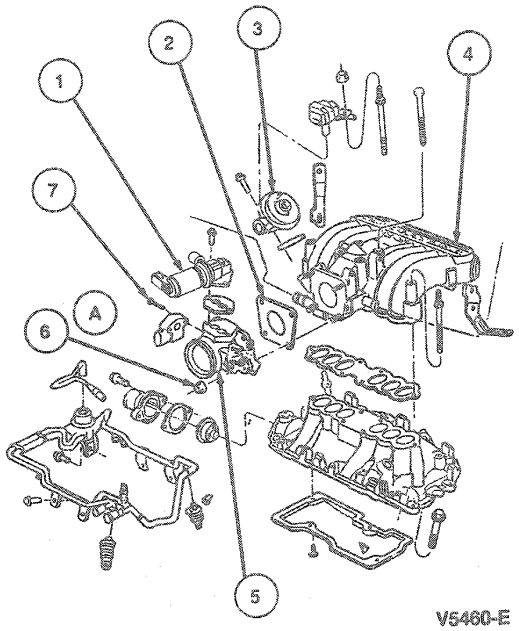
Installation

NOTE: If scraping is necessary, be careful not to damage gasket surfaces or allow material to drop into intake manifold.

1. Clean gasket mating surfaces.

REMOVAL AND INSTALLATION (Continued)

2. Install throttle body with new air charge control to intake manifold gasket on the four studs of the upper intake manifold. Tighten retaining nuts to 25 N·m (19 lb-ft).
3. Connect throttle position sensor and idle air control (IAC) valve.



V5460-E

Item	Part Number	Description
1	9F715	Idle Air Control Valve
2	9E936	Air Charge Control to Intake Manifold Gasket
3	9D475	EGR Valve
4	9424	Upper Intake Manifold
5	9E926	Throttle Body
6A	—	Nut
7	N603257-S100	Screw
A		Tighten to 25 N·m (19 Lb-Ft)

TV5460E

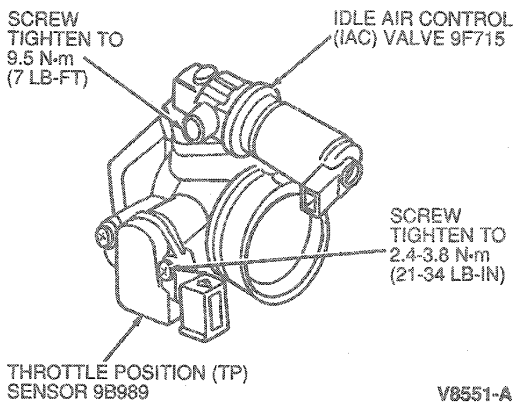
Throttle Position (TP) Sensor

Removal

1. Disconnect throttle position sensor from wiring harness.
2. Scribe a reference mark across the edge of the sensor and to the throttle body to ensure correct position during installation.
3. Remove two throttle position sensor retaining screws.
4. Remove throttle position sensor.

Installation

1. To install throttle position sensor, reverse Removal procedure.
2. Tighten retaining screws to 2.4-3.8 N·m (21-34 lb-in).
3. If required, adjust throttle position sensor, refer to the Powertrain Control / Emissions Diagnosis Manual[3].



V8551-A

Idle Air Control (IAC) Valve Assembly

Removal

1. Disconnect the idle air control valve assembly connector from the wiring harness.
2. Remove the two idle air control (IAC) valve retaining screws.
3. Remove the idle air control (IAC) valve and gasket.

Installation

1. Clean gasket mating surfaces.

   NOTE: If scraping is necessary, be careful not to damage idle air control (IAC) valve or throttle body gasket surfaces, or drop material into throttle body.
2. To install valve, reverse Removal procedure.
3. Tighten retaining screws to 9.5 N·m (7 lb-ft).

Fuel Rail Assembly

Tools Required:

- Spring Lock Coupling Disconnect Tool D87L-9280-A (3/8 inch) or D87L-9280-B (1/2 inch)

Removal

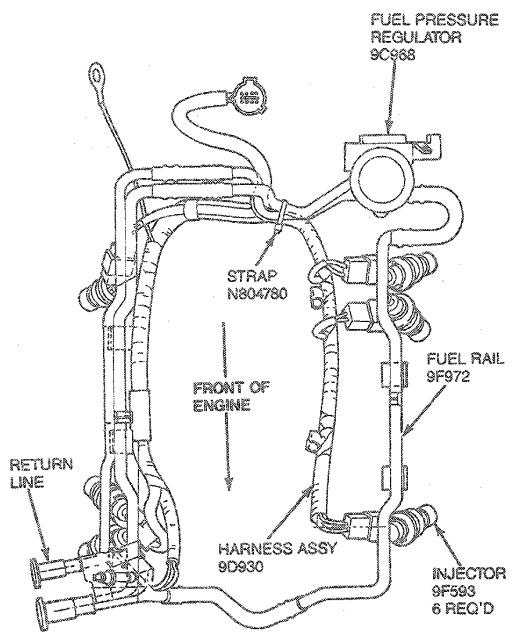
1. Perform Steps 1 through 4 under Fuel Charging Assembly, Pre-Service Procedures.

3 Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

2. Remove upper intake manifold assembly as outlined.
3. Remove spring lock coupling retaining clips from fuel inlet and return fittings.
4. Using Spring Lock Coupling Disconnect Tool D87L-9280-A, D87L-9280-B or equivalent disconnect the inlet and outlet fuel lines from the fuel rail assembly.
5. Remove four fuel injection supply manifold assembly retaining bolts (two on each side).

   NOTE: It may be easier to remove fuel injectors with the fuel injection supply manifold as an assembly.
6. Carefully disengage fuel injection supply manifold from fuel injectors and remove fuel injection supply manifold.
7. Use a rocking, side-to-side motion while lifting to remove fuel injectors from cylinder head pockets.



Installation

CAUTION: When installing fuel injection supply manifold assemblies with new or used fuel injectors, particular attention should be paid to proper O-ring seating to ensure that no fuel leaks exist.

1. Push fuel injection supply manifold down to ensure all injector O-rings are fully seated in the fuel rail cups and cylinder head pockets.
2. Install retaining bolts while holding fuel injection supply manifold down. Tighten bolts to 10 N·m (8 lb-ft).
3. Install spring lock coupling as outlined.
4. With fuel injector wiring disconnected, turn ignition to the RUN position to allow the fuel tank sending unit and pump (9H307) to pressurize the system.
5. Using a clean towel, check for fuel leaks.
6. Connect fuel injector wiring harness. Run vehicle at idle for two minutes.
7. Turn engine OFF and inspect for leaks.

Fuel Pressure Regulator

Removal

1. Perform Steps 1 through 4 under Fuel Charging Assembly, Pre-Service Procedures if removing fuel pressure regulator while fuel injection supply manifold assembly is installed on engine.
2. Remove vacuum line at fuel pressure regulator.
3. Remove three Allen head retaining screws from regulator housing.
4. Remove fuel pressure regulator assembly, gasket and O-ring. Discard gasket and inspect O-ring for signs of cracks or deterioration.
5. If scraping is necessary, be careful not to damage fuel pressure regulator or fuel injection supply manifold gasket surfaces.

Installation

WARNING: NEVER USE SILICONE GREASE. IT WILL CLOG THE FUEL INJECTORS.

1. Lubricate fuel pressure regulator O-ring with clean engine oil.
2. Ensure gasket surfaces of fuel pressure regulator and fuel injector assembly are clean.
3. Install O-ring and new gasket on fuel pressure regulator.
4. Install fuel pressure regulator on fuel injection supply manifoldassembly. Tighten three retaining screws to 4.0 N·m (34 lb-in).
5. Install vacuum line to fuel pressure regulator.
6. Perform Steps 1 through 6 under Fuel Charging Assembly, Post-Service Procedure.

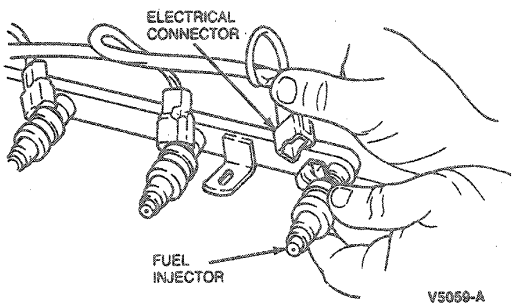
Fuel Injector

Removal

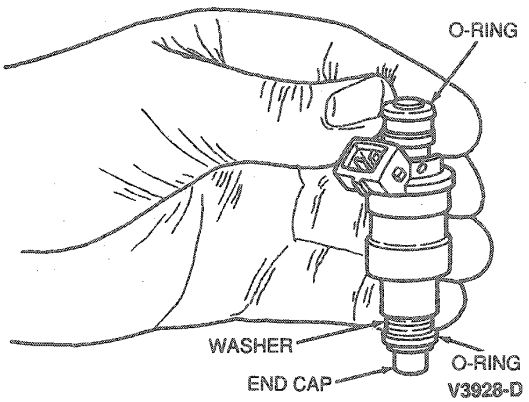
1. Perform Steps 1 through 4 under Fuel Charging Assembly, Pre-Service Procedures.
2. Remove upper intake manifold as outlined.
3. Remove fuel injection supply manifold assembly as outlined.
4. Remove fuel injector retaining clips as required.

REMOVAL AND INSTALLATION (Continued)

5. Carefully remove electrical harness connectors from individual fuel injectors as required.



6. Grasping injector body, pull up while gently rocking fuel injector from side-to-side.
7. Inspect fuel injector O-rings (two per injector) for signs of deterioration. Replace as required.
8. Inspect fuel injector body, end cap and washer for signs of dirt and deterioration.



Installation

NOTE: Never use silicone grease. It will clog the fuel injectors.

1. Lubricate O-rings with light grade oil XO-10W30-QSP (ESE-M2C153-E) or equivalent.
2. Install fuel injectors. Use a light, twisting, pushing motion to install them.
3. Reconnect fuel injector retaining clips as required.
4. Install fuel injection supply manifold assembly as outlined.
5. Install electrical harness connectors to fuel injectors.
6. Install upper intake manifold as outlined. Perform Steps 1 through 6 of Fuel Charging Assembly, Post-Service Procedures.

CLEANING AND INSPECTION

NOTE: The throttle body for this vehicle is a sludge resistant design and should not be cleaned.

Air Cleaner

CAUTION: Cleaning the air cleaner or crankcase ventilation filter elements is not recommended.

Refer to Section 00-03 for the recommended air cleaner assembly maintenance mileage interval. They should be replaced at the specified mileage intervals. Clean the air cleaner body and the cover with a solvent or compressed air. Wipe the air cleaner body and cover dry if a solvent is used. Inspect the air cleaner body and cover for distortion or damage at the gasket mating surfaces. Replace cover or body if they are damaged beyond service. Hold filter in front of a light and carefully inspect it for any splits or cracks. If filter is split or cracked, replace it.

Idle Air Control (IAC) Valve

The idle air control (IAC) valve used on all 3.8L engines cannot be cleaned. It must be replaced.

CAUTION: Do not use Carburetor Tune-Up Cleaner D9AZ-19579-BA (ESR-M14P9-A) or any other type solvent or damage to the valve internal components may result.

SPECIFICATIONS

Description	N·m	Lb-Ft
Lower Intake Manifold to Head	32	23
Upper Intake Manifold to Lower Intake Manifold Bolts	—	[4]
Throttle Body to Upper Intake Manifold	25	19
Air Control Valve to Throttle Body	9.5	7
Throttle Position Sensor to Throttle Body	2.4-3.8	21-34 Lb-In
Fuel Pressure Regulator to Fuel Rail Assembly	4	34 Lb-In
Fuel Rail Assembly to Intake Manifold	10	8
Throttle Cable Bracket to Manifold	17	13
Manifold Support Bracket	25	19
Generator Brace to Generator	51	37
Generator Brace to Water Pump and Upper Manifold	25	19
EGR Valve to Upper Manifold	25	19
EGR Tube to EGR Valve and Exhaust Manifold	41	30

SPECIAL SERVICE TOOLS

Tool Number	Description
D87L-9280-A	Spring Lock Coupling Disconnect Tool (3/8 inch)
D87L-9280-B	Spring Lock Coupling Disconnect Tool (1/2 inch)

ROTUNDA EQUIPMENT

Model	Description
113-00001	Injector Tester/Cleaner

PARTS CROSS-REFERENCE

Base Part #	Part Name	Old Part Name
9424	Intake Manifold	
9B989	Throttle Position Sensor	Throttle Potentiometer
9C968	Fuel Pressure Regulator	
9D475	EGR Valve	
9E926	Throttle Body	
9E936	Air Charge Control to Intake Manifold Gasket	
9F593	Fuel Injector	
9F715	Idle Air Control Valve	Throttle Air Bypass Valve
9F792	Fuel Injection Supply Manifold	
9H307	Fuel Tank Sending Unit and Pump	
9H321	Fuel Pressure Relief Valve	
9J444	Intake Manifold Support	
9J460	EGR Pressure Valve Sensor	

4 Tighten bolts and studs in three steps: 10 N·m (8 Lb-Ft) 20 N·m (15 Lb-Ft) 32 N·m (24 Lb-Ft)

SECTION 03-05 Drive Belts, Accessory

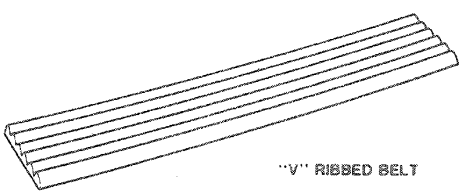
VEHICLE APPLICATION

Taurus/Sable and Taurus SHO.

DESCRIPTION

Taurus/Sable and Taurus SHO vehicles are equipped with V-ribbed belts. To ensure maximum life, replacement belts should be of the same type as originally installed. Some systems are equipped with an automatic belt tensioner on the belt and will not require any tension adjustment for the life of the belt. Loose belt(s) will result in slippage which may cause a noise complaint or improper accessory operation (generator will not charge, etc). Over-tightening accessory belts will place a severe load on accessory bearings.

NOTE: The drive belt condition should be checked at 96,000 Km (60,000 miles) and then every 24,140 Km (15,000 miles).



"V" RIBBED BELT

Q2258-A

NOTE: When an accessory drive belt is replaced or reinstalled after a service procedure, the belt does not fully seat into pulley grooves until engine has run for several minutes. On accessory drive belt systems that do not have automatic tensioners, belt seating can cause sufficient tension loss to reduce stabilized belt tension below the specified range, resulting in excessive wear and belt squeal. The amount of belt seating cannot be compensated for by increasing the initial belt tension because this can cause damage to the belt.

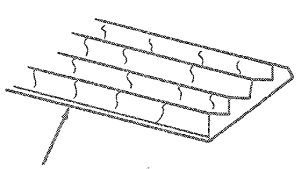
To ensure stabilized belt tensions within specification, accessory drive belt systems without an automatic tensioner should be reset after belt has been fully seated by running engine for five minutes. It is important to keep the belt seated in the pulley grooves by not allowing belt to relax while resetting belt tension. If belt does unseat from any pulley in the drive system while resetting tension, "set-reset" procedure must be repeated.

DIAGNOSIS

Belt Cracking/Chunking

Under severe operating conditions (high temperatures, low humidity), belt rib cracking can occur at less than 96,000 km (60,000 miles). Belt rib cracking is not a reason for concern and has no detrimental effect on belt performance. The belt is still perfectly functional until rib "chunking" occurs. Belt "chunking" is where the rubber material actually chunks out between the cracks. The belt should be replaced if chunking occurs.

"V" Ribbed Belt With Cracks Across Backing

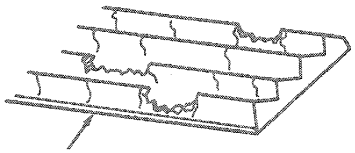


CRACKS ACROSS BACKING ARE ACCEPTABLE.
CRACKS PARALLEL TO BACKING ARE NOT.

Q2059-B

DIAGNOSIS (Continued)

"V" Ribbed Belt With Chunks of Rib Missing



CHUNKS OF RIBS MISSING NOT ACCEPTABLE Q3243-A

Belt Noise

Belt chirp is regularly occurring "chirping" noise that occurs due to pulley misalignment or excessive pulley runout. It can be a result of a damaged pulley or an improperly replaced pulley that was not properly aligned.

To correct, determine the area where the noise comes from. Then check each of the pulleys in that area with a straightedge to the crankshaft pulley and look for the accessory pulley to be out of position in the fore / aft direction or at an angle to the straightedge.

Belt squeal is an intermittent noise that occurs when the belt slips on a pulley during certain conditions such as: engine start up, rapid engine excels or A / C clutch engagement.

Belt squeal can occur under the following conditions:

1. If the A / C discharge pressure goes above 2895 kPa (420 psi). This can occur if:
   a. The A / C system is overcharged.
   b. The A / C condenser airflow is blocked.
   c. The engine fan is not engaging fully at idle.
2. If A / C off equalized pressure (the common discharge and suction pressure that occurs after several minutes) exceeds 965 kPa (140 psi), which is a rare occurence at high ambient temperatures with a hot engine, turn A / C OFF for a few seconds and then back ON after fan begins to cool condenser.
3. If any of the accessories are damaged, have a worn or damaged bearing or internal torsional resistance above normal for any reason. All of the accessories should be rotatable by hand in the unloaded condition. If any are not, the accessory should be inspected.
4. If fluids get on the belt. This would include power steering fluid, engine coolant, engine oil, air conditioning system lubricant.

   If fluids get on the belt during service, the best policy is to clean the belt with soap and water and thoroughly rinse with clean water. The belt does not have to be replaced if no apparent damage has occurred.
5. If the belt is too long. A belt that is too long will allow the tensioner arm to go all the way to tensioner arm travel stop under certain load conditions, which will untension the belt. If the tensioner is resting on the stop, replace the belt.
6. If the tensioner is worn or damaged. Only replace the tensioner if a torque reading of under 40 N·m (30 lb-ft) is measured with a 1 / 2-inch drive torque wrench, in the tensioner lifting 1 / 2-inch hole, with the torque wrench in the vertical position.

   NOTE: The tensioner arm should rotate freely without binding.

ADJUSTMENTS

To ensure proper tension, follow these procedures. Refer to the applicable adjustment illustration and belt tension specification chart.

NOTE: Use Rotunda Offset Belt Tension Gauge 021-00028-A or equivalent on 3.0L SHO engine equipped vehicles only.

3.0L SHO Engine

1. Loosen idler pulley nut and turn adjusting screw until belt is adjusted to specification.

   NOTE: Turning wrench to right tightens belt and turning wrench to left loosens belt.
2. Tighten idler pulley nut to 34-50 N·m (25-37 lb-ft) and check belt tension.

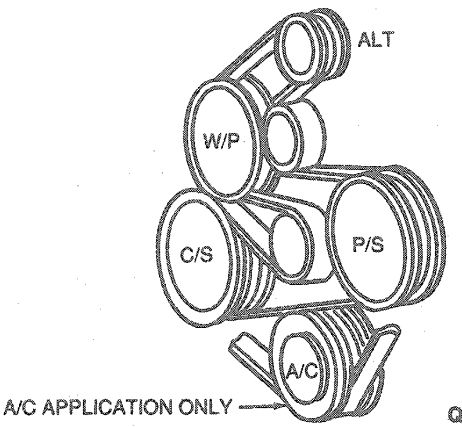
The generator, power steering, air conditioning drive belt should be checked for proper tension after both belts are adjusted and the component retaining bolts are properly tightened.

ADJUSTMENTS (Continued)

3.0L SFI/3.0L FF Engines

With Automatic Tensioner

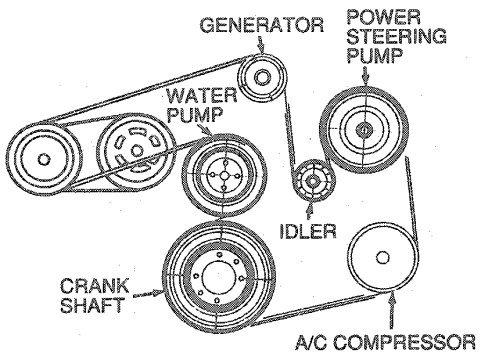
Belt tension is maintained by an automatic tensioner and cannot be adjusted.



3.8L SFI Engines—With Automatic Tensioner

Generator, Power Steering and A/C Belt

Belt tension is maintained by an automatic tensioner and does not require adjustment.



SPECIAL INSTRUCTIONS:

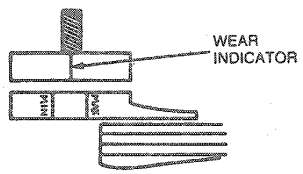
1. LIFT AUTOMATIC TENSIONER USING A 1/2-INCH DRIVE BREAKER BAR IN DIRECTION OF ARROW
2. INSTALL DRIVE BELT OVER PULLEYS PER APPRORIATE BELT ROUTING

Q2392-C

Automatic belt tensioners are spring loaded devices which set and maintain the drive belt tension. The drive belt should not require tension adjustment for the life of the belt. Automatic tensioners have belt wear indicator marks. If the indicator mark is not between the MIN and MAX marks, the belt is worn or an incorrect belt is installed.

NOTE: The indicator mark inspection is done with the engine OFF.

Automatic tensioners do not have to be removed to remove a drive belt. To remove a drive belt, rotate the tensioner away from the belt.



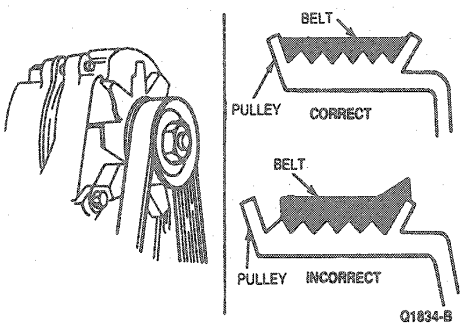
REMOVAL AND INSTALLATION

Conditions requiring belt replacement are excessive wear, rib chunkout, severe glazing, frayed cords, etc. Replace any belt exhibiting any of these conditions.

NOTE: Minor cracks in the V-grooved portion of the belt are considered normal and acceptable. If the belt has chunks missing from the ribs it should be replaced.

NOTE: Refer to the illustrations under Adjustments while performing the following Removal and Installation procedures.

NOTE: When installing belts on pulley, ensure that all V-grooves make proper contact with pulleys.



Drive Belt, Generator/A/C

3.0L SHO Engine

Removal

1. Loosen nut in center of idler pulley.
2. Loosen idler adjusting screw until old belt can be removed.

REMOVAL AND INSTALLATION (Continued)

3. Remove belt.

Installation

1. Install new belt over pulleys. Ensure all V-grooves make proper contact with pulleys.
2. Adjust belt tension as outlined.
3. Tighten idler pulley nut to 34-50 N·m (25-37 lb-ft).

Drive Belt, Power Steering/Water Pump

3.0L SHO Engine

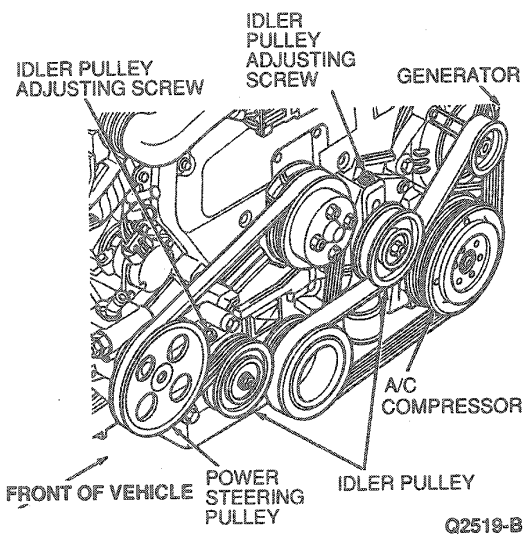
Removal

1. Remove generator belt as outlined.
2. Loosen nut on tensioner pulley.
3. Turn belt adjusting screw on tensioner counterclockwise until belt can be removed.
4. Remove belt.

Installation

1. Position belt over pulleys and belt tensioner. Ensure that all V-grooves make proper contact with pulleys.
2. Install generator belt as outlined.
3. Adjust belt tension for both belts as outlined.

3.0L SHO Accessory Drive Belts



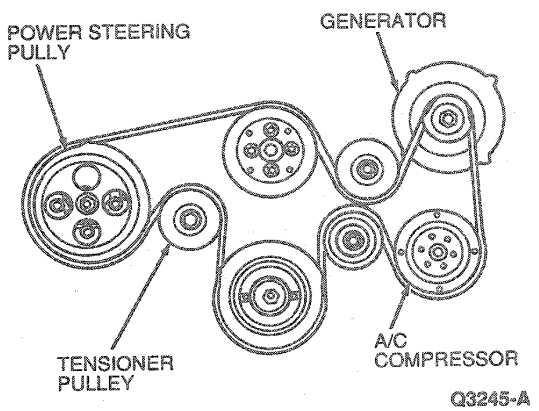
Q2519-B

3.2L SHO With Automatic Tensioner

Removal

WARNING: USE CAUTION WHEN REMOVING/INSTALLING BELTS TO ENSURE THAT TOOL DOES NOT SLIP.

1. Place a 14mm socket over bolt on tensioner pulley and rotate clockwise (downward) to release belt tension.



Q3245-A

2. Remove belt from pulleys.

Installation

1. Install belt over all pulleys except power steering pump pulley.
2. Place a 14mm socket over bolt on tensioner pulley and rotate clockwise (downward) and install belt over power steering pump pulley.

   NOTE: Ensure that all V-grooves make proper contact with pulleys.

3.0L SFI, 3.0L FF and 3.8L SFI Engines With Automatic Tensioner

Removal

1. Insert a 1/2-inch flex handle in square hole in tensioner. On 3.8L engines, the tensioner has a 1/2-inch square hole cast into the rear of the tensioner arm directly behind the pulley. On 3.0L and 3.8L engines use a 15mm socket for bolt attaching tensioner pulley. Rotate clockwise to remove belt from pulleys.

   WARNING: USE CAUTION WHEN REMOVING OR INSTALLING BELTS TO ENSURE THAT TOOL DOES NOT SLIP.

Installation

1. Install belt over all pulleys (except idler pulley on 3.0L).
2. Rotate tensioner as described under Removal and install belt over generator pulley. Ensure that all V-grooves make proper contact with pulleys.
3. On 3.0L, install belt over idler pulley last.

SPECIFICATIONS

BELT TENSION SPECIFICATIONS

Engine	Belt Type	New Installation	Used Belt Reset	Allowable Minimum
3.0L SHO Engine	Air Conditioning / Generator	980-1180 N 220-265 Lbs	660-850 N 148-192 Lbs	535 N 120 Lbs
3.0L SHO Engine	Power Steering / Water Pump	690-880 N 154-198 Lbs	500-700 N 112-157 Lbs	357 N 80 Lbs

TORQUE SPECIFICATIONS

Engine	Description	N·m	Lb-Ft
3.0L SHO	Idler Pulley Nut	34-50	25-37
3.8L	Generator Pivot Bolt	40-55	30-41
3.8L	A/C Bracket to Block	40-55	30-41
3.8L	A/C Compressor to Bracket	20-30	15-22
3.8L	Tensioner to Tensioner Bracket	70-95	52-70

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Model	Description
021-00028-A	Offset Belt Tension Gauge

SECTION 03-06 Starting System

VEHICLE APPLICATION

Taurus / Sable.

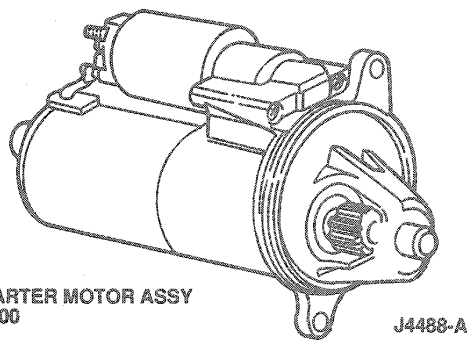
DESCRIPTION AND OPERATION

The function of the starting system is to crank the engine at a speed fast enough to permit the engine to start. Heavy cables, connectors, and switches are used in the starting system because of the large current required by the starter while it is cranking the engine. The amount of resistance in the starting circuit must be kept to an absolute minimum to provide maximum current for starter operation. A discharged or damaged battery, loose or corroded connections, or partially broken cables will result in slower than normal cranking speeds, and may even prevent the starter from cranking the engine.

In case of starting system trouble, the operator may have discharged the battery before calling for assistance. A road service procedure is presented to aid the service technician in such cases of starting trouble. Be sure to follow diagnosis procedures in the Powertrain Control / Emissions Diagnosis Manual [1], in order to locate the cause of the starting difficulty. Road service is not a part of the diagnosis procedures.

The starting system includes the permanent magnet gear-reduction starter motor with a solenoid-actuated drive, the battery, a remote control starter switch (part of the ignition switch), the manual lever position (MLP) sensor (automatic transaxle), clutch pedal position (CPP) switch (manual transaxle) and heavy circuit wiring.

Typical Starter Shown



STARTER MOTOR ASSY
11000

J4488-A

Vehicles equipped with a manual transaxle have a clutch pedal position (CPP) switch in the starter circuit that prevents operation of the starter unless the clutch pedal is depressed.

Vehicles equipped with an automatic transaxle have a MLP sensor in the starter control circuit, which prevents operation of the starter unless the selector lever is in the NEUTRAL or PARK position.

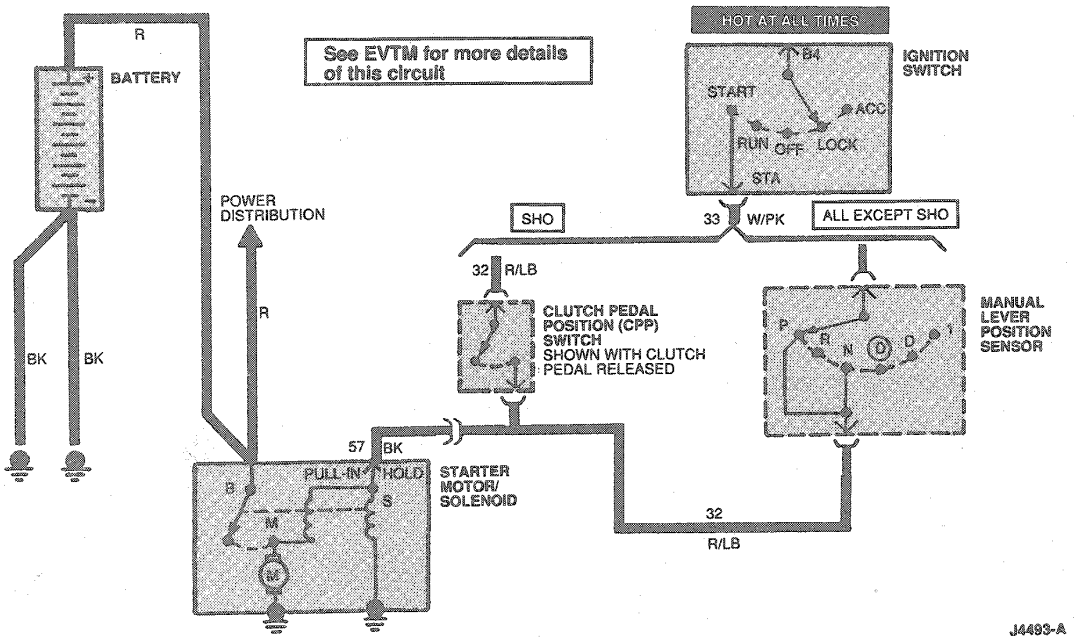
Sequence of Operation

1. The ignition switch is turned to the START position.
2. The starter solenoid is energized, creating a magnetic field in the solenoid coil.
3. The iron plunger core is drawn into the solenoid coil.
4. A lever connected to the drive assembly engages the drive pinion gear to the flywheel ring gear.
5. When the iron plunger core is all the way into the coil, its contact disc closes the circuit between the battery and the motor terminals.
6. The current flows to the motor, and the drive pinion gear cranks the flywheel and the engine crankshaft.

1 Can be purchased as a separate item.

DESCRIPTION AND OPERATION (Continued)

7. As current flows to the motor, the solenoid pull-in coil is bypassed.
8. The hold-in coil keeps the drive pinion gear engaged with the flywheel.
9. The gear remains engaged until the ignition switch is released from the START position.



An overrunning clutch in the drive assembly protects the starter from excessive speeds during the brief period before the driver releases the ignition switch from the START position (as the engine starts).

Road Service

For cases of a starter that cranks the engine very slowly, connect a 12-volt booster battery to the system.

Jump Starting

To avoid damage to the vehicle and battery or the possibility of personal harm, follow these instructions and precautions:

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.

CAUTION: Do not disconnect the battery of the vehicle to be started. Disconnecting the battery could damage the vehicle's electronic system.

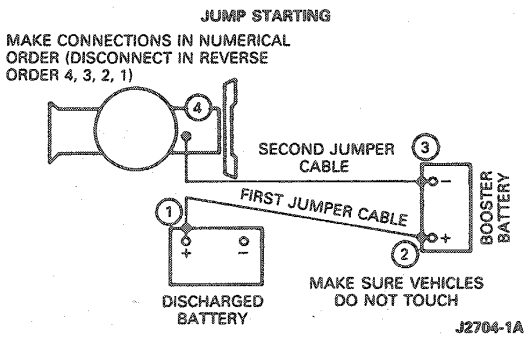
Negative Grounded Battery

WARNING: TO AVOID ANY POSSIBILITY OF INJURY, USE PARTICULAR CARE WHEN CONNECTING A BOOSTER BATTERY TO A DISCHARGED BATTERY.

1. Position vehicles so jumper cables will reach, being careful that vehicles do not touch.
2. Turn on heater blower motor of vehicle to be started (set control on DEFROST for vehicles equipped with automatic temperature control). Turn off other switches and lamps.

DESCRIPTION AND OPERATION (Continued)

3. Make jumper cable connections.
   - Connect one end of first jumper cable to the battery positive voltage (+) terminal of discharged battery and other end to the battery positive voltage (+) terminal of booster battery.
   - Connect one end of second jumper cable to battery negative voltage (-) terminal of booster battery. Connect other end to an engine bolthead or good metallic contact spot on engine of vehicle to be started, NOT TO BATTERY NEGATIVE VOLTAGE (-) TERMINAL.



WARNING: MAKING THE FINAL CABLE CONNECTION COULD CAUSE AN ELECTRICAL SPARK NEAR THE BATTERY AND COULD CAUSE AN EXPLOSION. REFER TO WARNING AT THE BEGINNING OF THE JUMP STARTING PROCEDURE.

WARNING: WHEN SERVICING THE STARTER OR PERFORMING OTHER UNDERHOOD WORK IN THE VICINITY OF THE STARTER, BE AWARE THAT THE HEAVY GAUGE BATTERY INPUT LEAD AT THE STARTER SOLENOID IS "ELECTRICALLY HOT" AT ALL TIMES.

A PROTECTIVE CAP OR BOOT IS PROVIDED OVER THIS TERMINAL THAT MUST BE REPLACED AFTER SERVICING. BE SURE TO DISCONNECT BATTERY NEGATIVE CABLE BEFORE SERVICING STARTER.

- Make sure jumper cables are not in way of moving engine parts.
- Start engine of vehicle with good battery. Run engine at a moderate speed.
- Start engine of vehicle with discharged battery. Follow starting instructions in the Owner Guide.
- Leave all switches off except heater blower motor. Reduce engine speed to idle on both vehicles to prevent possible damage to vehicle electrical systems.

4. Remove cables in exact REVERSE sequence. Begin by removing cable from engine of vehicle that had discharged battery.

If the starter does not turn the engine over, even with the booster battery attached, refer to Starter System Diagnosis in this Section.

DIAGNOSIS AND TESTING

System Inspection

CAUTION: When disconnecting the plastic hardshell connector at the solenoid "S" terminal, grasp the plastic connector and pull lead off. DO NOT pull separately on lead wire.

WARNING: WHEN SERVICING STARTER OR PERFORMING OTHER UNDERHOOD WORK IN THE VICINITY OF THE STARTER, BE AWARE THAT THE HEAVY GAUGE BATTERY INPUT LEAD AT THE STARTER SOLENOID IS "ELECTRICALLY HOT" AT ALL TIMES.

A PROTECTIVE CAP OR BOOT IS PROVIDED OVER THIS TERMINAL THAT MUST BE REPLACED AFTER SERVICING. BE SURE TO DISCONNECT BATTERY NEGATIVE CABLE BEFORE SERVICING STARTER.

1. Inspect starting system for loose connections.
2. If system does not operate properly, note condition and continue diagnosis using the symptom chart.

   WARNING: WHEN WORKING IN AREA OF THE STARTER, BE CAREFUL TO AVOID TOUCHING HOT EXHAUST COMPONENTS.

STARTER SYSTEM DIAGNOSIS

CONDITION	POSSIBLE SOURCE	ACTION
Starter solenoid does not pull-in and starter does not crank (Audible click may or may not be heard).	• Open fuse. • Low battery. • Open circuit or high resistance in external feed circuit to starter solenoid. • Inoperative starter.	• Check fuse continuity. • Refer to Section 14-00. • Go to Pinpoint Test A. • Replace starter as outlined.

DIAGNOSIS AND TESTING (Continued)

STARTER SYSTEM DIAGNOSIS (Continued)

CONDITION	POSSIBLE SOURCE	ACTION
Unusual starter noise during starter overrun.	• Starter not mounted flush (cocked). • Noise from other components. • Ring gear tooth damage or excessive ring gear runout. • Worn or damaged starter.	• Realign starter on transaxle converter housing. • Refer to Section 00-04. Investigate other powertrain accessort noise contributors. • Refer to Section 03-01A. • Replace starter as outlined.
Starter cranks but engine does not start.	• Concern in fuel system. • Concern in ignition system. • Engine related problem.	• Refer to Section 10-00. • Refer to Section 03-07. • Refer to 03-01A.
Starter cranks slowly.	• Low battery. • High resistance or loose connections in starter solenoid battery feed or ground circuit. • Ring gear runout excessive. • Worn or damaged starter.	• Refer to Section 14-00. • Check that all connections are secure. • Refer to Section 03-01A. • Replace starter as outlined.
Starter remains engaged and runs with engine.	• Shorted ignition switch. • Battery cable touching solenoid 'S' terminal (defective or mispositioned cable). • Worn or damaged starter.	• Refer to Section 11-05. • Replace or relocate cable and replace starter as outlined. • Replace starter as outlined.

TJ4464A

PINPOINT TEST A: CHECK STARTER MOTOR

TEST STEP		RESULT ▶	ACTION TO TAKE
A1	CHECK FOR VOLTAGE TO STARTER		
	NOTE: Hoist vehicle (if necessary) to access starter solenoid terminals. **CAUTION: Remove plastic safety cap on starter solenoid and disconnect hardshell connector at solenoid 'S' terminal as described under Removal and Installation in this Section.** • Key OFF. Transmission in PARK or NEUTRAL. • Check for voltage between starter B+ terminal and starter drive housing. • **Is voltage between 12 and 12.45 volts?**	Yes ▶ No ▶	GO to A2. CHECK wire connections between battery and starter solenoid and the ground circuit for open or short.
A2	CHECK STARTER MOTOR		
	• Key OFF. Transmission in PARK or NEUTRAL. • Connect one end of a jumper wire to the starter B+ terminal and momentarily touch the other end to solenoid 'S' terminal. • **Does starter crank?**	Yes ▶ No ▶	CHECK connections from ignition circuitry to solenoid 'S' blade terminal for open or short. REPLACE starter as outlined.

TJ4469A

Starter Load Test

Tools Required:

- Rotunda Starting / Charging Tester 078-00005

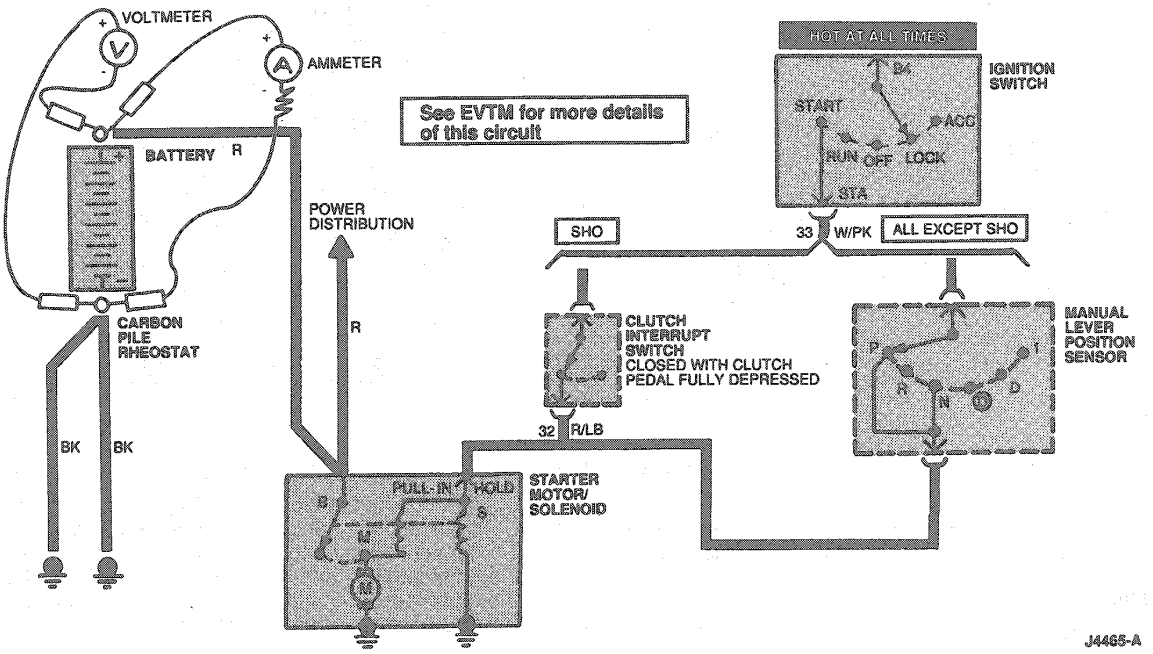
Conduct this test if the starter cranks slowly and it is desired to compare current to specifications.

1. Connect Rotunda Starting and Charging Tester 078-00005 or equivalent. Make sure that current is not flowing through ammeter and heavy-duty carbon pile rheostat portion of circuit (rheostat at maximum counterclockwise position).
2. Place transaxle in NEUTRAL or PARK. Crank engine with ignition off, and determine exact reading on voltmeter. This test is accomplished disconnecting push-on connector at solenoid 'S' terminal and by connecting a remote control starter switch from positive battery terminal to solenoid 'S' terminal.

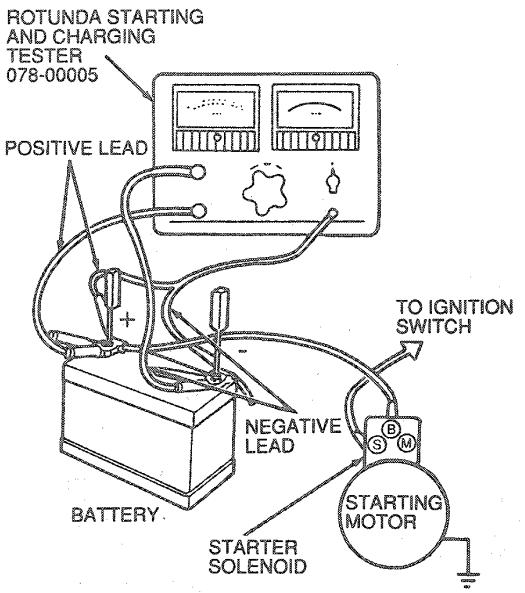
   NOTE: Make sure ignition switch is in the OFF position and 'S' terminal connector has been removed so engine does not start.

DIAGNOSIS AND TESTING (Continued)

3. Stop cranking engine, and reduce resistance of carbon pile until voltmeter indicates same reading as that obtained while starter cranked the engine. The ammeter will indicate starter current draw under load. Check this with value listed in Specifications.



DIAGNOSIS AND TESTING (Continued)



Bench Tests

Tools Required:

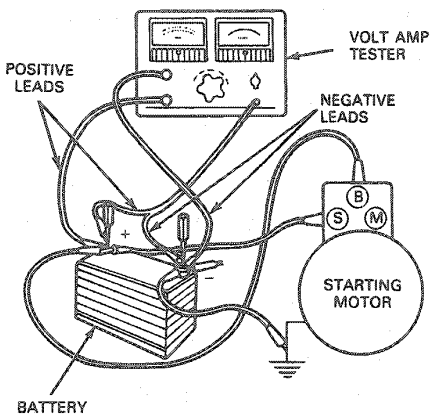
- Rotunda Starting and Charging Tester 078-00005
- Rotunda Digital Volt-Ohmmeter 007-00001

Starter No-Load Test

The starter no-load test will uncover such conditions as open or shorted windings, or rubbing armature. The starter can be tested, at no-load, on the test bench only.

1. Make test connections with Rotunda Starting and Charging Tester 078-00005 or equivalent cables connected to starter, large enough to carry high current (the same as in the vehicle). The starter will run at no-load. Be sure that no current is flowing through ammeter (rheostat at maximum counterclockwise position). Determine exact reading on voltmeter.

   CAUTION: Make sure that the starter is securely mounted in bench vise while energizing, as starter will move or jump.



(CONVENIENT GROUND ON STARTER SUCH AS MOUNTING EAR ON CASTING.)

2. Disconnect starter from battery. Then, reduce resistance of rheostat until voltmeter indicates same reading as that obtained while starter was running. The ammeter will indicate starter no-load current draw. Refer to Specifications at the end of this Section for a comparative value.
3. If current exceeds specification, check for rubbing armature, bent shaft, binding bearings, or shorts in armature, or brush assembly.

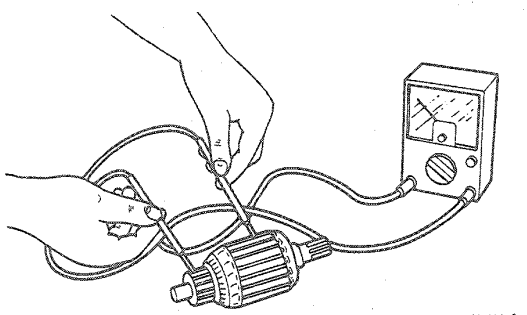
Armature Open Circuit Test

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

DIAGNOSIS AND TESTING (Continued)

Grounded Armature 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 Rotunda Digital Volt-Ohmmeter 007-00001 or equivalent. Infinite resistance indicates a normal condition.



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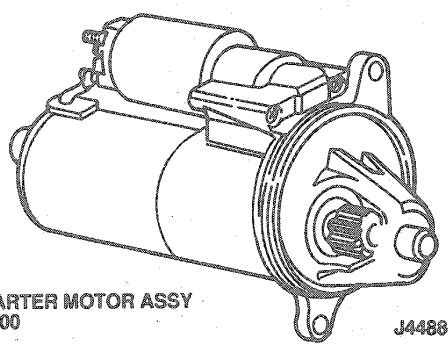
Starter Solenoid Test

Ensure that the solenoid is isolated electrically from the motor. Using a DVOM, check for continuity between S terminal and M terminal, and between S terminal and ground (frame). If there is no continuity, the following conditions may exist:

(1) Open wire; replace solenoid.

(2) Ice, dirt or other foreign material preventing contact; service as necessary.



STARTER MOTOR ASSY
11000

J4488-A

REMOVAL AND INSTALLATION

Starter Motor

Removal

WARNING: WHEN SERVICING STARTER OR PERFORMING ANY MAINTENANCE IN THE AREA OF THE STARTER, NOTE THE HEAVY GAUGE INPUT LEAD CONNECTED TO THE STARTER SOLENOID IS HOT AT ALL TIMES. MAKE SURE THE PROTECTIVE CAP IS INSTALLED OVER THE TERMINAL AND IS REPLACED AFTER SERVICE.

NOTE: When the battery has been disconnected and reconnected, some abnormal drive symptoms may occur while the powertrain control module (PCM) 12A650 relearns its adaptive strategy. The vehicle may need to be driven 10 miles or more to relearn the strategy.

1. Disconnect the battery negative battery cable.
2. Raise the vehicle on a hoist. Refer to Section 00-02.
3. Disconnect starter cable and push-on connector from starter solenoid.

   CAUTION: When disconnecting hardshell connector at 'S' terminal, grasp the plastic shell and pull off. Do not pull on wire. Be careful to pull straight off to prevent damage to the connector and 'S' terminal. If any part of the connection is damaged, replace the damaged components.
4. Remove upper bolt.
5. Remove lower bolt.

Installation

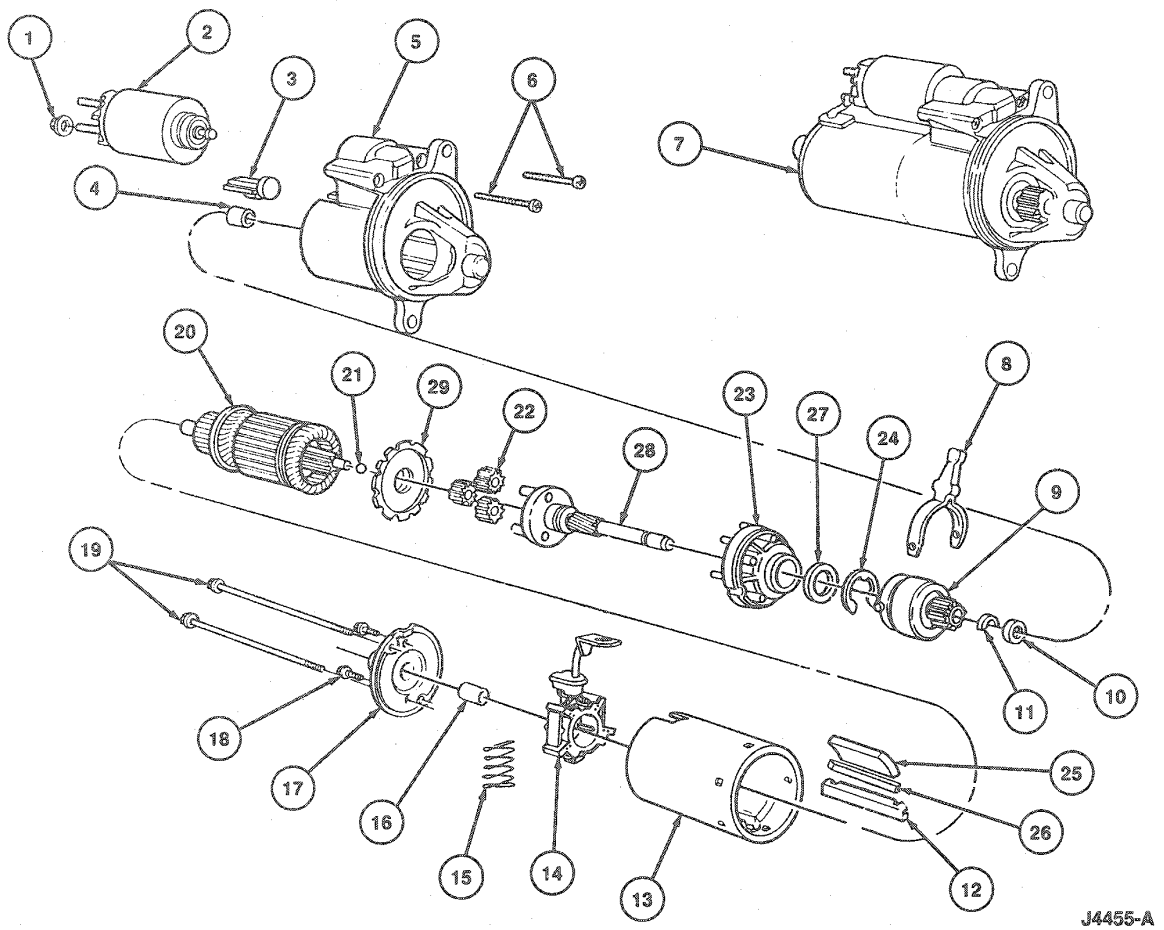
1. Position starter motor to engine and install upper and lower bolts finger-tight.
2. Tighten the upper bolt to 20-27 N·m (15-20 lb-ft).
3. Tighten the lower bolt to 20-27 N·m (15-20 lb-ft).
4. Connect starter solenoid connector. Be careful to push straight on and make sure connector locks in position with a notable click or detent.
5. Install starter cable nut to starter terminal. Tighten to 9-14 N·m (80-124 lb-in).
6. Replace red solenoid safety cap.
7. Lower vehicle to floor.
8. Connect negative battery ground cable.

DISASSEMBLY AND ASSEMBLY

NOTE: Although disassembly and service procedures are shown for the starter motor in this section, it is recommended that the starter motor be returned to Ford Return Parts Center for analysis and review.

DISASSEMBLY AND ASSEMBLY (Continued)

Starter Motor—Exploded View



Item	Part Number	Description
1	N805403	Terminal Nut
2	11390	Starter Solenoid
3	11A171	Housing Seal Assy
4	11135	Bushing Bearing
5	11130	Drive End Housing
6	N805405	Solenoid Screw (2 Req'd)
7	11000	Starter Motor Assy
8	11070	Drive Lever
9	11350	Drive Assy
10	11223	Stop Ring Retainer
11	11222	Stop Ring
12	11A169	Magnet Retainer (6 Req'd)
13	11076	Starter Frame
14	11434	Brush Assy
15	11059	Spring

(Continued)

Item	Part Number	Description
16	11135	Bushing Bearing
17	11050	Brush End Plate
18	N805406	Brush Plate Screw (2 Req'd)
19	N805428	Through-Bolt (2 Req'd)
20	11005	Armature Assy
21	11A172	Armature Thrust Ball
22	11K190	Planet Gear
23	11A165	Stationary Gear Assy
24	N805404	Truarc E-Ring
25	11A168	Magnet Pole Piece (6 Req'd)
26	11A161	Pole Shunt (6 Req'd)
27	11A075	Armature
28	11A160	Shaft Assy
29	11A167	Gear Retainer

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DISASSEMBLY AND ASSEMBLY (Continued)

Disassembly

1. Remove positive brush connector from solenoid motor (M) terminal.
2. Remove solenoid retaining screws and solenoid.
3. Remove through-bolts and separate drive end housing from starter frame. Remove housing seal assembly from drive. Remove drive and gear assembly from drive end housing.
4. Remove drive lever from drive assembly. Remove stop ring and retainer from driveshaft, then remove drive assembly from shaft. Push E-ring off driveshaft, and separate gear assembly from driveshaft.
5. Remove brush plate screws and brush end plate from starter frame. Remove brush assembly and push armature out of frame.

Assembly

NOTE: Sealer material (ESA-M4G294-A or equivalent) should be replaced on starter during re-assembly.

1. Install armature assembly in starter frame. Apply a thin coating of ESF-M1C218-A Grease or equivalent low temperature grease on both ends of armature shaft and spline. Install brush assembly while making sure brushes fit over commutator. Apply grease to bearing bore in brush end plate. Push back grommet onto frame and attach brush end with brush plate screws. Tighten to 2-3 N·m (18-27 lb-in).
2. Apply grease to driveshaft spline and place stationary gear assembly over driveshaft. Install armature thrust washer and push E-ring onto driveshaft. Place drive assembly onto shaft and install stop ring and retainer. Attach drive lever to drive assembly.
3. Grease and install planet gears.
4. Apply grease into drive end housing bearing bore (approximately one-quarter full). Install drive gear assembly into housing, making sure to line up bolt holes in gear assembly and housing. Place gear retainer over gear assembly. Install housing seal assembly into drive end housing.
5. Position starter frame to housing and install through-bolts. Tighten to 5-10 N·m (45-89 lb-in).
6. Position solenoid to housing ensuring that solenoid plunger is attached through drive lever (bottom solenoid terminal (M) should have a metal strip attached to it). Tighten solenoid bolts to 5-10 N·m (45-89 lb-in).
7. Attach positive brush connector to solenoid (bottom terminal). Tighten nut to 9-14 N·m (80-124 lb-in).
8. Check that starter no-load current draw is within specification. Refer to Bench Tests under Diagnosis and Testing.

Starter Drive Replacement

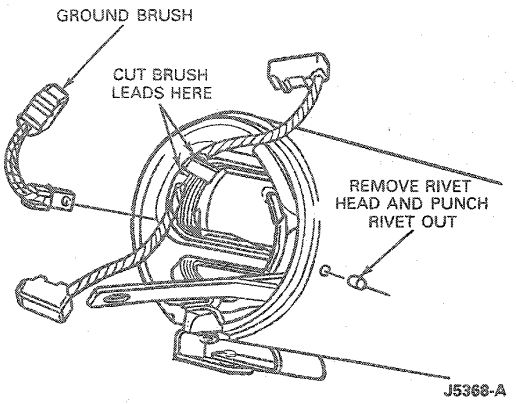
1. Remove positive brush connector from solenoid motor (M) terminal. Remove solenoid retaining screws and remove solenoid.
2. Remove through-bolts and separate motor assembly drive end housing. Remove housing seal from drive end housing. Remove drive gear assembly from housing and detach drive lever.
3. Remove stop ring and retainer from driveshaft and then remove drive assembly.
4. Apply a thin coating of ESF-M1C218-A Grease or equivalent low temperature grease on driveshaft spline. Install new drive gear assembly on driveshaft. Install new stop ring and retainer. Attach drive lever.
5. Partially fill drive end housing bearing bore with grease (approximately one-quarter full). Install drive gear assembly in housing, making sure to line up bolt holes in gear assembly and housing.
6. Install lever support and housing seal in drive end housing.
7. Position starter frame to housing and install through-bolts. Tighten to 5-10 N·m (45-89 lb-in).
8. Install solenoid. Refer to Assembly.

Starter Motor Brushes Replacement

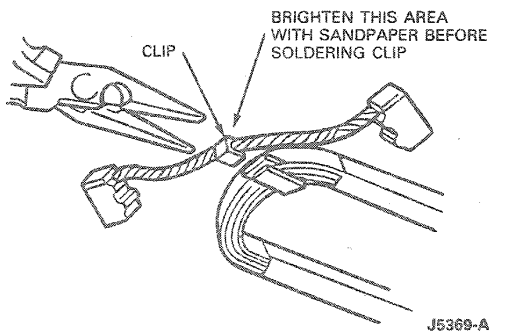
1. Remove starter drive plunger lever cover.
2. Remove the two through-bolts from the starter.
3. Remove the brush end plate.
4. Remove brush spring and pull brushes loose from brush holder.
5. Remove brush holder.
6. Remove the drive end housing and the plunger lever return spring.
7. Remove the starter drive plunger lever pivot pin and lever and remove the armature.
8. Remove ground brush rivet head with file or chisel and remove rivet with 1/8-inch punch.

DISASSEMBLY AND ASSEMBLY (Continued)

9. Cut the brush leads from the field coils as close to the field connection point as possible.



10. Clean and inspect the starter motor.
11. Position the new field brush lead on the field coil connection. Position and crimp the clip provided with the brushes to hold the brush lead to the connection. Solder the lead clip and connection together using rosin core solder. Use a 300 watt iron.
12. Rivet the ground brush leads to the frame with rivets provided in the brush kit.
13. Clean the commutator with 00 or 000 sandpaper.
14. Install the armature in the starter frame.
15. Install the starter drive gear plunger lever to the frame and starter drive assembly and install the pivot pin.
16. Install brush holder and insert brushes in holder and install brush springs.
17. Install the brush end plate.
18. Install the two through bolts to the starter frame.
19. Install starter drive plunger lever cover and tighten retainer screw.
20. Connect the starter to a battery to check operation.



Armature Replacement

1. Remove positive brush connector from solenoid motor (M) terminal.
2. Remove through-bolts and separate motor from gear assembly and drive end housing.
3. Remove brush end plate screws, brush end plate and brush assembly from starter frame. Remove armature from frame.
4. Install new armature in frame. Apply a thin coating of ESF-M1C218-A Grease or equivalent low temperature grease on both ends of armature shaft and pinion.
5. Install brush assembly. Using tool, make sure that brushes fit over commutator. Push black grommet onto frame. Apply grease to bearing bore in brush end plate and attach to starter frame.
6. Position starter frame to gear assembly and drive end housing and install through-bolts. Tighten to 5-10 N·m (45-89 lb-in).
7. Attach positive brush connector to solenoid (bottom terminal). Tighten nut to 9-14 N·m (80-124 lb-in).
8. Check that starter no-load current draw is within specification. Refer to Bench Testing under Diagnosis and Testing.

Cleaning and Inspection

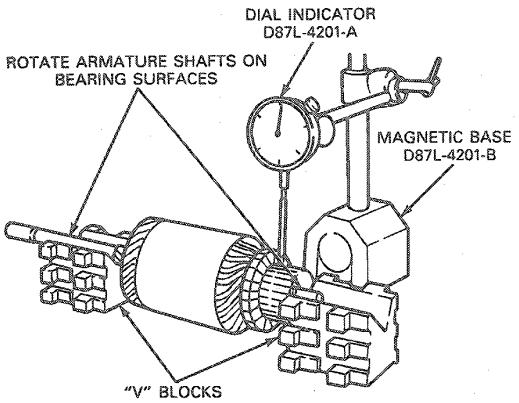
CAUTION: Do not wash the drive because the solvent will wash out the lubricant causing drive to slip. Use a brush or compressed air to clean the drive, armature, brush, and gear assemblies, drive end housing, pole pieces and planet gears. Wash all other parts in solvent and dry.

1. Inspect armature windings for broken or burned insulation and unwelded or open connections.
2. Check armature for open circuits, shorts and grounds. Check for pole rub or rub on magnetic shunts.

DISASSEMBLY AND ASSEMBLY (Continued)

3. Check commutator for runout. Inspect armature shaft and two bearings for scoring and excessive wear with Dial Indicator D87L-4201-A and Magnetic Base D87L-4201-B or equivalent. If commutator is rough, or more than 0.12mm (0.005 inch) out of round, it must be replaced.

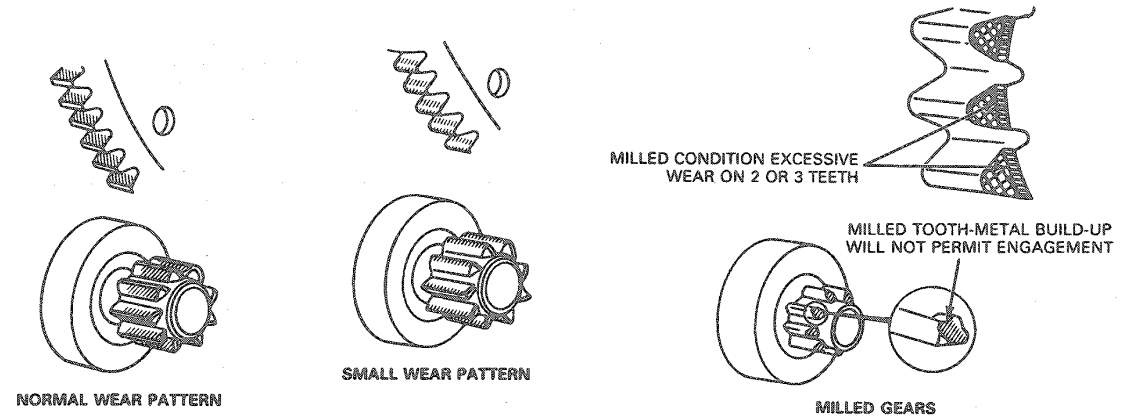
COMMUTATOR RUNOUT CHECK



J2711-C

4. Examine gears, spline on driveshaft, and drive pinion for chipped, broken or worn conditions. Replace if required.

PINION AND RING GEAR WEAR PATTERNS



J2713-2A

SPECIFICATIONS

Starter Motor						Starter Brushes	
Motor Diameter	Current Draw Under Normal Load	Normal Engine Cranking Speed	Min. Stall Torque @ 5 Volts	Max. Load	No Load	Mfg. Length	Spring Tension
101.6mm (4 Inches)	130-220 Amps	140-220 RPM	14.7 N-m (11.0 Lb-Ft)	800 Amps	70 ± 10 Amps	16.8mm (0.66 inch)	18 N (64 oz.)

Maximum commutator runout is 0.12mm (0.005 inch). Maximum starting circuit voltage drop (battery positive terminal to starter terminal) at normal engine temperature is 0.5 volt.

TJ4456A

SPECIFICATIONS (Continued)

TORQUE SPECIFICATIONS

Description	N·m	Lb-In
Solenoid Bolt	5-10	45-89
M Terminal Nut	9-14	80-124
B Terminal Nut	9-14	80-124
Through-Bolt	5-10	45-89
Mounting Bolt	20-27	15-20 (Lb-Ft)
Brush Plate Screw	2-3	18-27

TJ4459A

SPECIAL SERVICE TOOLS

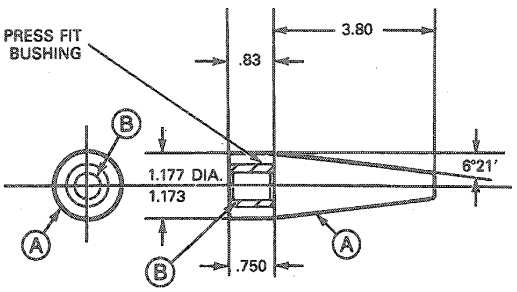
Tool Number	Description
D87L-4201-A	Dial Indicator
D87L-4201-B	Magnetic Base

ROTUNDA EQUIPMENT

Model	Description
007-00001	Digital Volt-Ohmmeter
078-00005	Starting and Charging Tester

TJ4458A

TOOL TO ASSEMBLE BRUSH HOLDER TO ARMATURE



BRUSH HOLDER ASSEMBLY

(A) MANDREL
MAT'L: MICAATA LL221
TAN-TYPE FBL

STK: 13/8 DIA. + A-LG
(1) REQ'D

(B) BUSHING
UNIVERSAL HEADLESS TYPE
PRESS FIT BUSHING
CAT. NO. GS-93
.471/.472 I.D. .7518 O.D. .750 LG.
(1) REQ'D

J4974-A

SECTION 03-07A Distributor Ignition (DI)

VEHICLE APPLICATION

Taurus / Sable.

DESCRIPTION

This Section is designed to serve as a guide in understanding, testing and servicing the Distributor Ignition (DI) system.

Distributor Ignition (DI) Systems Features

The DI system features a camshaft driven distributor which uses no centrifugal or vacuum advance. The distributor has a diecast base which incorporates a Hall effect stator assembly.

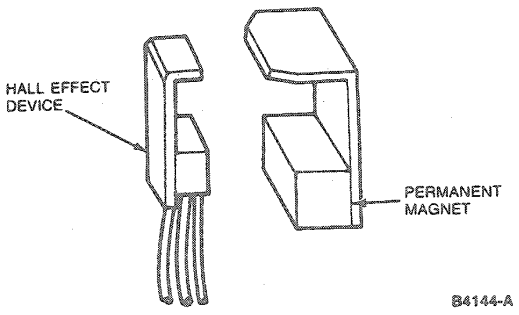
Initial timing adjustments are not required unless the distributor has been moved from its factory setting or removed from the engine. Ignition timing procedures and diagnostics are found in Section 8A of the Powertrain Control / Emissions Diagnosis Manual[1].

NOTE: Do not change timing by use of different octane rods without first having the proper authorization; federal emission requirements will be affected.

The Ignition Control Module (ICM) 12A199 with Computer Controlled Dwell (CCD), features Powertrain Control Module (PCM) 12A650 controlled ignition coil charge times.

OPERATION

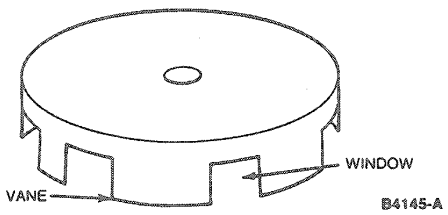
The universal distributor operates by using a Hall effect vane switch assembly, causing the ignition coil to be switched off and on by the PCM and ICM. The vane switch is an encapsulated package consisting of a Hall sensor on one side and a permanent magnet on the other side.



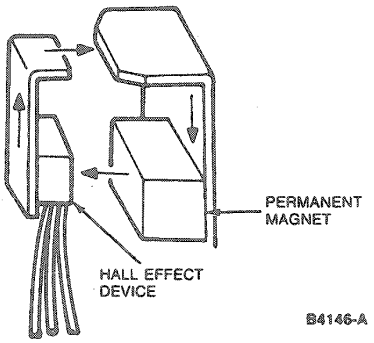
1 Can be purchased as a separate item.

OPERATION (Continued)

A rotary vane cup, made of ferrous metal, is used to trigger the signal off and on.

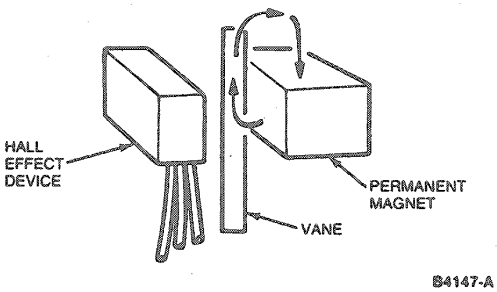


When the window of the vane cup is between the magnet and the Hall effect device, a magnetic flux field is completed from the magnet through the Hall effect device and back to the magnet.



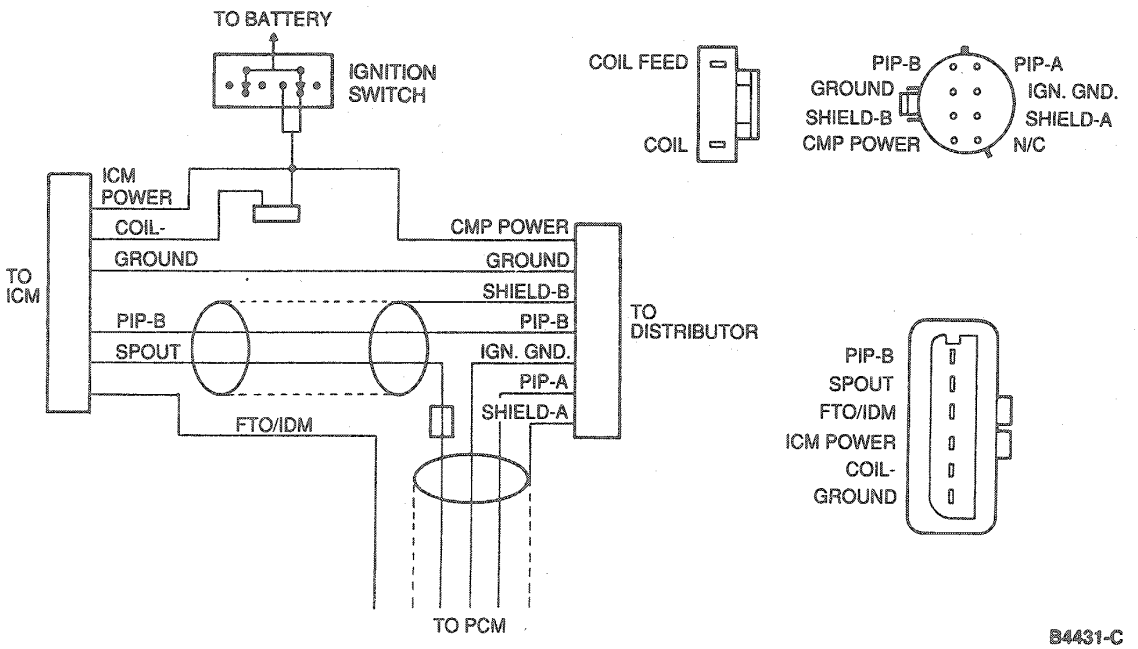
As the vane passes through this opening, the flux lines are shunted through the vane and back to the magnet.

During this time, a voltage is produced as the vane passes through the opening. When the vane clears the opening, the window edge causes the signal to go to zero volts. The signal is then used by the PCM for crankshaft position sensing and the computation of the desired spark advance based on engine demand and calibration. The conditioned spark advance and voltage distribution is accomplished through a conventional rotor, cap and ignition wires.



Distributor Ignition (DI) System and Closed Bowl Distributor

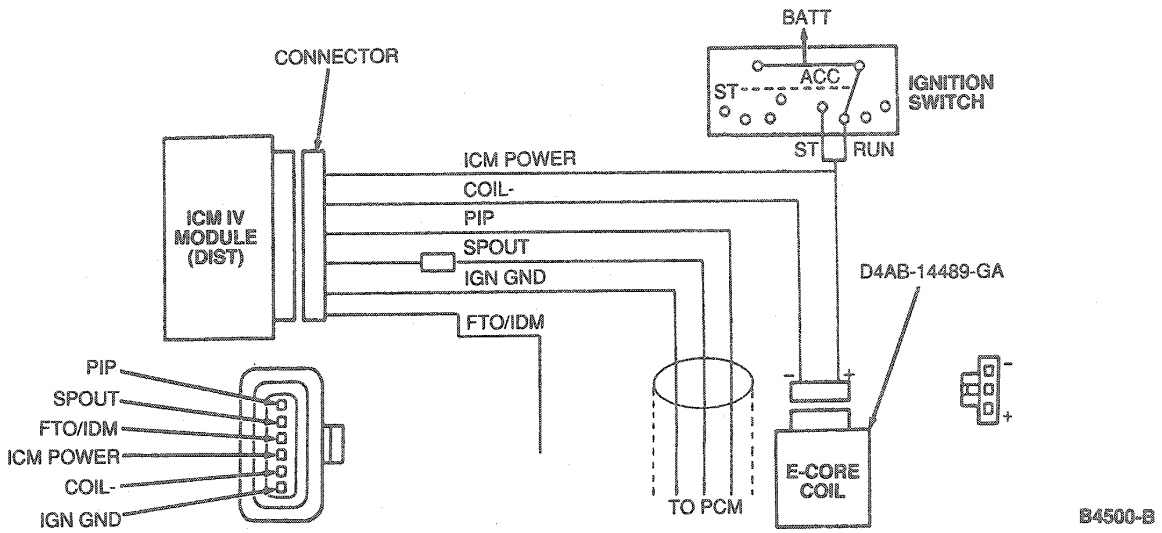
3.8L Engines



OPERATION (Continued)

Distributor Ignition (DI) System with Open Bowl Distributor

3.0L Engines



REMOVAL AND INSTALLATION

Distributor Cap

Removal

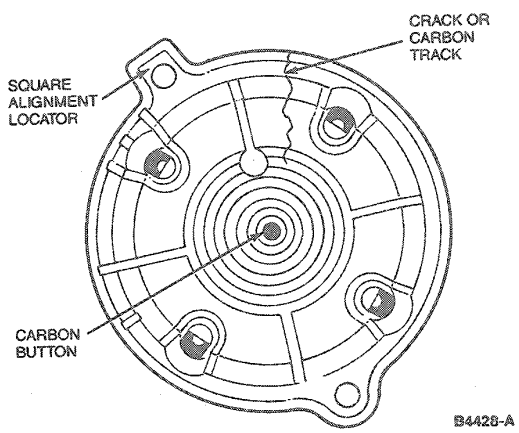
Loosen distributor cap hold-down screws. Remove cap straight off distributor to prevent damage to rotor blade and spring.

Cleaning and Inspection

Wash both inside and outside surfaces of the distributor cap with soap and water. Dry cap with compressed air. Inspect cap for cracks, broken carbon button or carbon tracks. Also, inspect cap terminals for dirt and corrosion. Replace the cap if it is damaged.

Installation

1. Position distributor cap on distributor base noting the square alignment locator. Tighten hold-down screws to 2.0-2.6 N·m (18-23 lb-in).
2. Re-install any ignition wires that were removed, noting their correct locations on the distributor cap.



Distributor Rotor

Removal

With distributor cap removed, pull rotor upward to remove it from distributor shaft and armature.

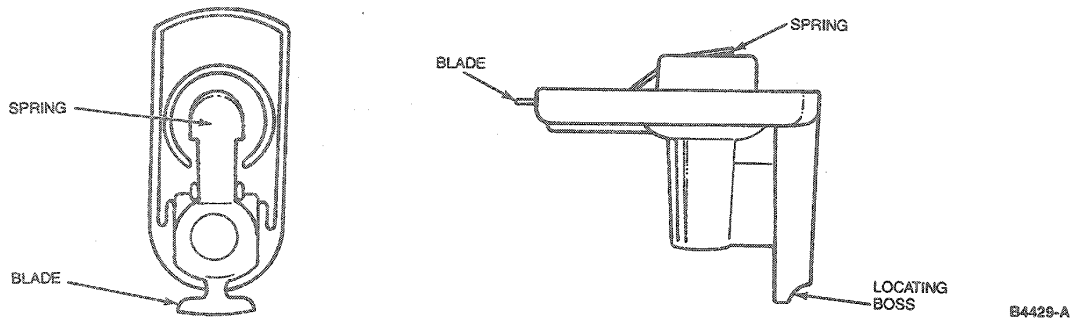
Cleaning and Inspection

Wash rotor with soap and water. Dry with compressed air. Inspect and replace rotor if cracks, carbon tracks, burns or damage to blade or spring are observed.

REMOVAL AND INSTALLATION (Continued)

Installation

Align locating boss on rotor with hole on armature. Fully seat rotor on distributor shaft. Re-install distributor cap.



Distributor Assembly

Removal

1. Disconnect distributor from wiring harness.
2. Mark position of No. 1 cylinder wire tower on distributor base for reference when installing distributor.
3. Loosen distributor cap hold-down screws. Remove cap straight off distributor to prevent damage to rotor blade and spring. Position cap and attached wires aside so as not to interfere with distributor removal.
4. Remove rotor by pulling upward to remove it from the distributor shaft and armature.
5. Remove distributor hold-down bolt and clamp. Remove distributor by pulling upward.
6. Cover distributor opening in the cylinder block or head with a clean shop towel to prevent the entry of foreign material or dirt into the engine.

Installation

Before installing distributor, visually inspect distributor. Inspect O-ring. It should fit tightly and be free of cuts. The drive gear should be free of nicks, cracks and excessive wear. Rotate distributor drive shaft. It should move freely, without binding.

1. To install distributor correctly, No. 1 piston must be at Top Dead Center (TDC) of compression stroke. Remove No. 1 cylinder spark plug and rotate engine clockwise until No. 1 piston is on the compression stroke.
2. With No. 1 piston on compression stroke, align timing pointer with TDC on the crankshaft damper.
3. Align locating boss on rotor with hole on armature. Fully seat rotor on distributor shaft.
4. Rotate distributor shaft so blade on rotor is pointing toward mark on distributor base, that was previously made in Step 2 of the Removal procedure.
5. While installing distributor, continue rotating rotor slightly so leading edge of the vane is centered in vane switch stator assembly.
6. Rotate distributor in block to align leading edge of vane and vane switch stator assembly. Verify rotor is pointing at No. 1 mark on distributor base.

   If vane and vane switch stator cannot be aligned by rotating distributor in cylinder block, remove distributor enough to just disengage distributor gear from camshaft gear. Rotate rotor enough to engage distributor gear on another tooth of camshaft gear. Repeat Step 1 if necessary.
7. Install distributor hold-down clamp and bolt. Tighten bolt, but leave it loose enough to rotate distributor.
8. Install distributor cap, No. 1 spark plug and ignition wires. Check that ignition wires are securely connected to the cap and spark plugs. Tighten distributor cap hold-down screws to 2.0-2.6 N·m (18-23 lb-in).
9. Reconnect distributor to wiring harness.
10. Set initial timing according to procedures found in Section 13 of the Powertrain Control / Emissions Diagnosis Manual[2].
11. After timing is set, tighten distributor hold-down bolt. Refer to Specifications.
12. Recheck initial timing. Adjust if necessary.

3.0L Engine

Tools Required:

- Axle Bearing / Seal Plate T75L-1165-B
- Pinion Bearing Cone Remover D79L-4621-A

2 Can be purchased as a separate item.

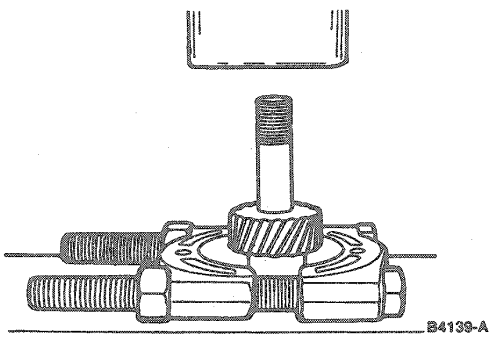
REMOVAL AND INSTALLATION (Continued)

Removal

NOTE: Do not attempt to replace stator without an arbor press.

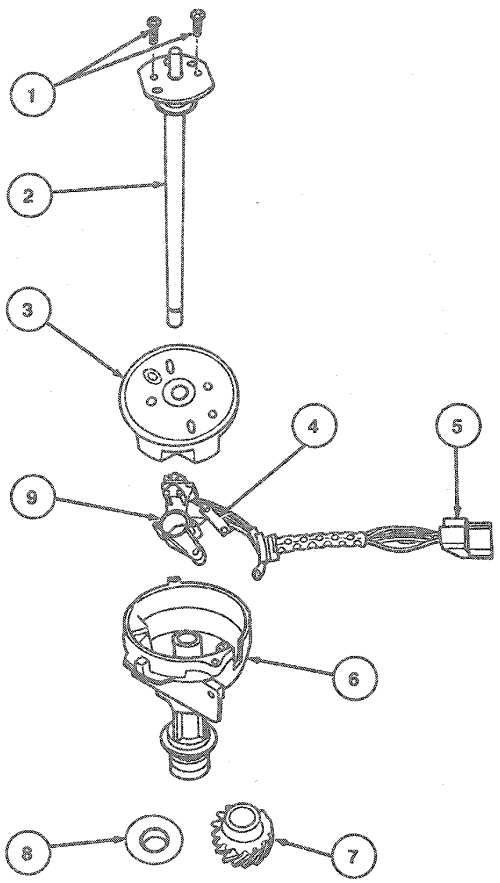
1. Using a screwdriver, remove distributor cap, position the cap and wires aside so as not to interfere with work area. Disconnect distributor from harness.
2. Remove distributor from block as outlined.
3. Remove rotor.
4. Remove two screws holding ICM to the base, if so equipped.
5. Remove module, wipe grease from base and module, keeping surfaces free of dirt, if so equipped.

   NOTE: Hold gear to loosen armature screws, do not hold armature.
6. Remove two screws holding armature and remove armature.
7. To ease assembly, mark armature and gear with a felt tip pen, to note orientation.
8. Remove and discard pin in gear.
9. Invert distributor and place in Axle Bearing / Seal Plate T75L-1165-B, and press off gear using the Pinion Bearing Cone Remover D79L-4621-A or equivalent.
10. Remove the thrust washer from the distributor and set it aside for assembly.

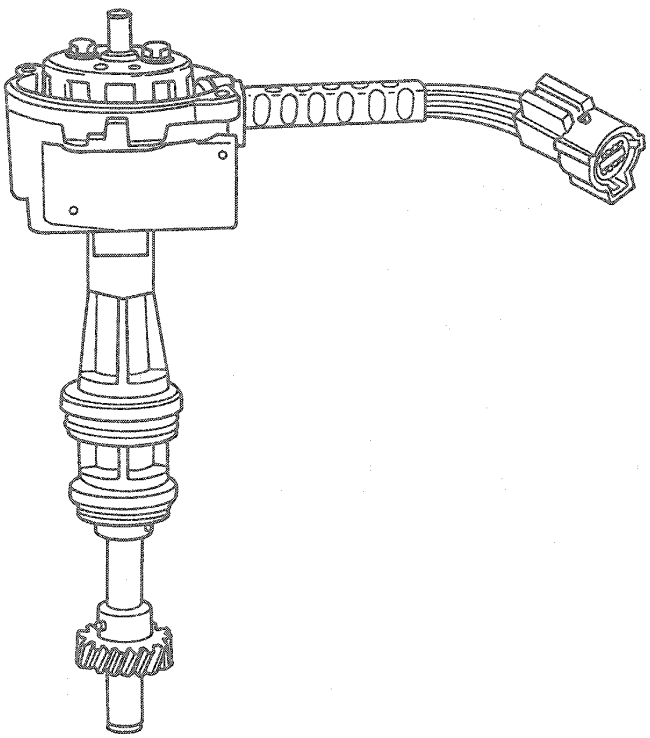


11. Deburr and polish shaft with emery paper and wipe such that shaft slides out freely from distributor base.
12. Remove shaft assembly.
13. Remove two stator assembly screws and retain.
14. Remove screw retaining octane rod and remove octane rod.
15. Remove stator assembly from top of bowl.
16. Inspect base bushing for wear or signs of excess heat concentration. Replace complete distributor assembly if damaged.
17. Inspect base O-ring for cuts or damage and replace O-ring if necessary.
18. Inspect base for cracks and wear. Replace complete distributor assembly if damage is found.

REMOVAL AND INSTALLATION (Continued)



DISASSEMBLED VIEW



ASSEMBLED VIEW 3.8L

B4409-C

Item	Part Number	Description
1	—	Screws (2 Req'd)
2	—	Shaft Assy
3	—	Rotary Vane
4	—	Octane Rod

(Continued)

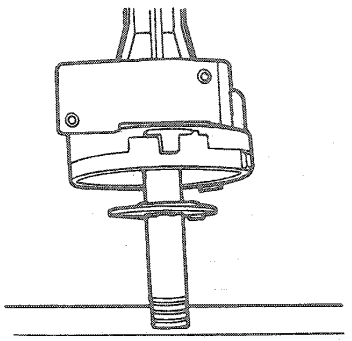
Item	Part Number	Description
5	—	Connector
6	—	Base Assy
7	—	Gear
8	—	Collar
9	—	Hall Effect Vane Stator Switch Assy

Installation

1. Place stator assembly over bushing and press down to seat.
2. Place stator connector in position. Tab should fit in notch on base and fastening eyelets aligned with screw holes.
3. Position wires away from moving parts.
4. Install two stator screws and tighten to 1.7-4.0 N·m (15-35 lb-in).
5. Install octane rod and retaining screw. Tighten to 1.7-4.0 N·m (15-35 lb-in).
6. Apply a light coat of Motor Oil XO-10W30-QSP (ESE-M2C153-E) or equivalent, to distributor shaft below armature.
7. Insert shaft through base bushing.
8. Place a 1/2-inch deep well socket over shaft, invert and place on arbor plate.

REMOVAL AND INSTALLATION (Continued)

9. Install gear thrust washer.



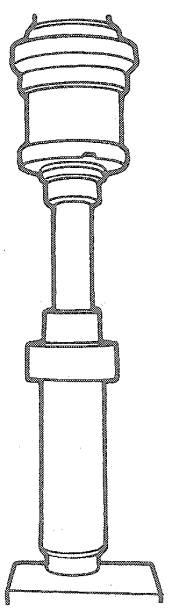
NOTE: The hole in the shaft and gear must be lined up as accurately as possible to ensure ease of roll pin insertion.

10. Place the distributor gear on shaft end. Line up the mark on armature and gear.

NOTE: If the gear holes do not align, the gear must be removed and repressed on. A drift punch will not align the holes.

11. Place a 5/8-inch deep well socket over the shaft and gear and press gear to align with original drill hole.

CAUTION: If gear is damaged, do not replace gear. Serious engine damage may result. Replace complete distributor assembly.



12. Insert new roll pin through gear and shaft. Pin should have proper extrusion.
13. Replace armature and tighten screws to 2.8-4.0 N·m (25-35 lb-in).

NOTE: If the armature contacts the stator, replace the entire distributor.

14. Check distributor for free movement over full rotation of shaft.
15. Wipe back of ICM and distributor ICM mounting face free of all dirt, if so equipped.
16. Apply Silicone Dielectric Compound WA-10 D7AZ-19A331-A (ESE-M1C171-A) or equivalent to the back of the ICM and spread thinly and evenly, if so equipped.
17. Turn distributor base upside down so that the stator connector is in full view.
18. Insert ICM and watch that the three ICM pins are inserted into the stator connector. Fully seat the module into the connector and against base.
19. Install two ICM screws and tighten to 1.7-4.0 N·m (15-35 lb-in), if so equipped.
20. Install the distributor into block per distributor replacement procedure.
21. Connect distributor module to wiring harness.
22. Replace rotor.
23. Replace cap and tighten screws to 2.0-2.6 N·m (18-25 lb-in).
24. Set engine timing.

3.8L Engine

Tools Required:

- Axle Bearing/Seal Plate T75L-1165-B
- Pinion Bearing Cone Remover D79L-4621-A

Removal

NOTE: Do not attempt to replace stator without an arbor press.

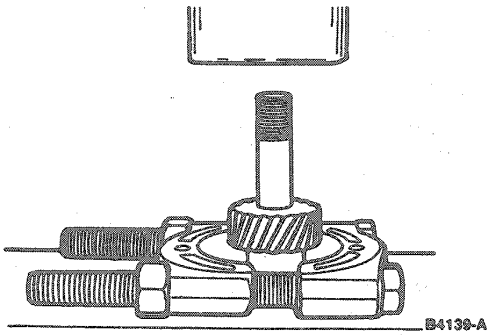
1. Using a screwdriver, remove distributor cap, position the cap and wires aside so as not to interfere with work area. Remove distributor harness connector.
2. Remove distributor from block as outlined.
3. Remove rotor.

NOTE: Hold gear to loosen armature screws. Do not hold armature.

4. Remove two screws holding armature and remove armature.
5. To ease assembly, mark armature and gear with a felt tip pen, to note orientation.
6. Remove and discard pin in gear and collar.

REMOVAL AND INSTALLATION (Continued)

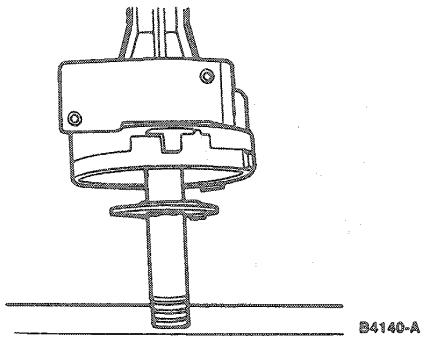
7. Invert distributor and place in Axle Bearing / Seal Plate T75L-1165-B, and press off gear using the Pinion Bearing Cone Remover D79L-4621-A or equivalent.



8. Remove collar.
9. Deburr and polish shaft with emery paper and wipe such that shaft slides out freely from distributor base.
10. Remove shaft assembly.
11. Remove stator assembly screw and retain.
12. Remove octane rod retaining screw and octane rod.
13. Remove stator assembly from top of bowl.
14. Inspect base bushing for wear or signs of excess heat concentration. Replace complete distributor assembly if damaged.
15. Inspect base O-ring for cuts or damage and replace O-ring if necessary.
16. Inspect base for cracks and wear. Replace complete distributor assembly if damage is found.

Installation

1. Place stator assembly over bushing and press down to seat.
2. Place stator connector in position. Tab should fit in notch on base and fastening eyelets aligned with screw holes.
3. Position wires away from moving parts.
4. Install stator screw and tighten to 1.7-4.0 N·m (15-35 lb-in).
5. Install octane rod and retaining screw. Tighten to 1.7-4.0 N·m (15-35 lb-in).
6. Apply a light coat of Motor Oil XO-10W30-QSP (ESE-M2C153-E) or equivalent, to distributor shaft below armature.
7. Insert shaft through base bushing.
8. Install collar and new roll pin.
9. Place a 1/2-inch deep well socket over shaft, invert and place on arbor plate.



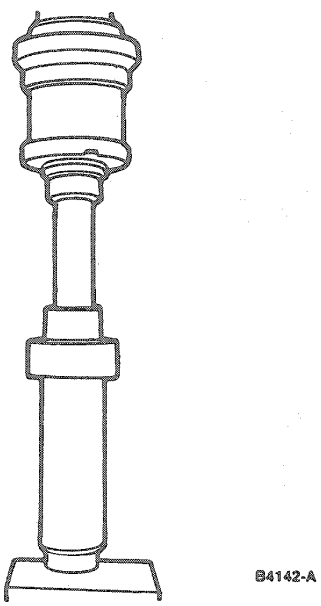
NOTE: The hole in the shaft and gear must be lined up as accurately as possible to ensure ease of roll pin insertion.

10. Place the distributor gear on shaft end. Line up the mark on armature and gear.

    NOTE: If the gear holes do not align, the gear must be removed and re-installed. A drift punch will not align the holes.

11. Place a 5/8-inch deep well socket over the shaft and gear and press gear to align with original drill hole.

    CAUTION: If gear is damaged, do not replace gear. Serious engine damage may result. Replace complete distributor assembly.



12. Insert new roll pin through gear and shaft. Pin should have proper extrusion.

REMOVAL AND INSTALLATION (Continued)

13. Replace armature and tighten screws to 2.8-4.0 N·m (25-35 lb-in).

    NOTE: If the armature contacts the stator, replace the entire distributor.
14. Check distributor for free movement over full rotation of shaft.
15. Install the distributor into block per distributor replacement procedure.
16. Connect distributor module to wiring harness.
17. Replace rotor.
18. Replace cap and tighten screws to 2.0-2.6 N·m (18-23 lb-in).
19. Set engine timing.

Ignition Control Module (ICM)

3.0L Engine

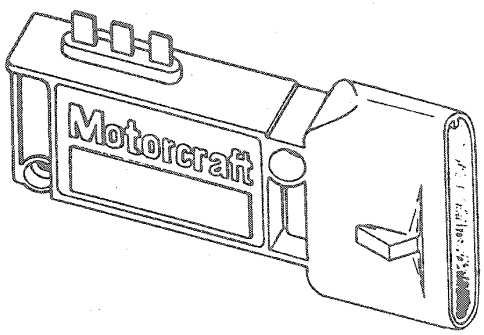
Removal

1. Using a screwdriver, remove distributor cap and position it and attached wires aside so as not to interfere with work area.
2. Remove ICM harness connector.
3. Remove distributor from engine.
4. Place distributor on work bench. Remove two ICM mounting screws.

   CAUTION: Do not attempt to lift ICM from mounting surface prior to moving entire ICM toward distributor flange as pins will break at distributor/module connector.
5. Pull RH side of ICM down distributor mounting flange and back up to disengage module terminals from connector in distributor base. The ICM may be pulled toward flange and away from distributor.

Installation

1. Coat metal base plate of ICM uniformly with silicone compound, approximately 0.79mm (1/32 inch) thick. Use Silicone Dielectric Compound WA-10, D7AZ-19A331-A (ESE-M1C171-A) or equivalent.
2. Place ICM on distributor base mounting flange.
3. Carefully position ICM toward distributor bowl and engage three distributor connector pins securely.
4. Install two ICM mounting screws and tighten to 1.7-4.0 N·m (15-35 lb-in) starting with upper RH screw.
5. Install distributor on engine.
6. Install distributor cap. Tighten cap mounting screws to 2.0-2.6 N·m (18-23 lb-in).
7. Install ICM harness connector.
8. Using an induction timing lamp, verify engine timing. Refer to Vehicle Emission Control Information decal located in the engine compartment.



B4046-A

3.8L Engine

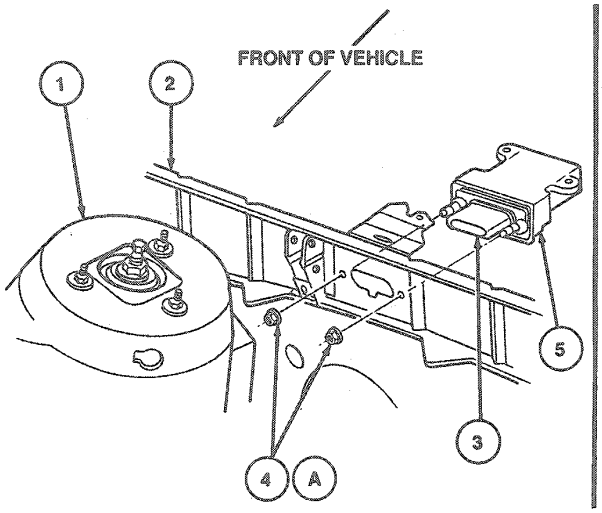
Removal

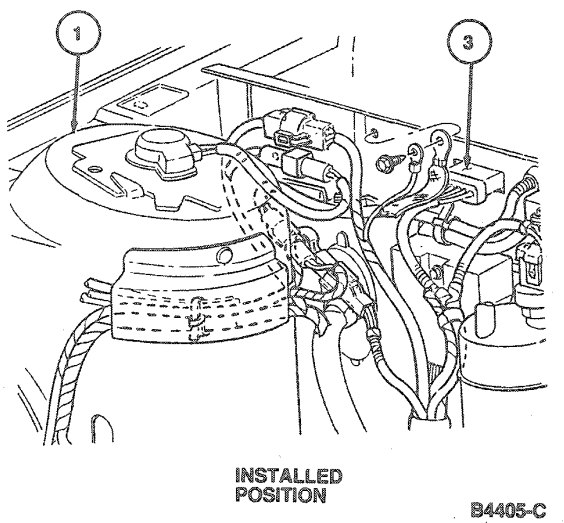
1. Using a Phillips head screwdriver, remove screws attaching leaf screen to top of cowl assembly.
2. Separate engine compartment/cowl seal strip from leaf screen and cowl dash extension panel in area of ICM.
3. Lift off leaf screen to allow access to ICM.

   NOTE: The connector latch is underneath ICM shroud and must be pressed upward to unlatch.
4. Disconnect harness connector from the ICM assembly.
5. Remove two nut/washer assemblies (11mm hex-head) attaching ICM/heatsink assembly to cowl dash extension panel.

   NOTE: The assembly is mounted with heatsink fins pointed downward.
6. Remove ICM/heatsink assembly.
7. Remove two ICM retaining screws and remove ICM from heatsink.
8. While holding ICM connector shroud with one hand, pull seal off other end of ICM.

REMOVAL AND INSTALLATION (Continued)





B4405-C

Item	Part Number	Description
1	—	RH Shock Tower
2	—	Cowl
3	12A199	Ignition Control Module (ICM)

(Continued)

Item	Part Number	Description
4A	—	Retaining Nuts (2 Req'd)
5	—	Heat Sink
A		Tighten to 5-8 N·m (44-70 Lb-In)

TB4405C

Installation

1. Coat metal base plate of ICM uniformly with silicone compound, approximately 0.79mm (1/32 inch) thick. Use Silicone Dielectric Compound WA-10, D7AZ-19A331-A (ESE-M1C171-A) or equivalent.
2. Place ICM onto heatsink. Install two retaining screws. Tighten to 1.7-4.0 N·m (15-35 lb-in).
3. Push seal over ICM connector shroud and heatsink studs with metal part toward heatsink.
4. Insert ICM/heatsink assembly into cowl dash extension panel enough to have mounting studs protrude into the engine compartment side.
5. Hand-tighten previously removed nut/washer assemblies. Tighten nuts to 5-8 N·m (44-70 lb-in).
6. Connect wire harness connector to ICM.
7. Install leaf screen and screws.
8. Install engine compartment/cowl panel and seal strip.

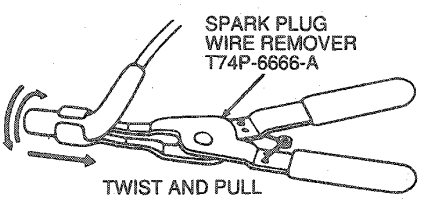
Spark Plug Wires

Tools Required:

- Spark Plug Wire Remover T74P-6666-A

Removal

1. When removing wires from spark plugs, use Spark Plug Wire Remover T74P-6666-A. Grasp and twist the boot back and forth on plug insulator to free boot. Use special tool to pull boot from plug. Do not pull on wire directly, or it may become separated from connector inside boot.



A6626-D

2. When removing wires from distributor cap or coil, grasp boot by hand and remove with twisting and pulling motion. **Do not pull on wire.**

REMOVAL AND INSTALLATION (Continued)

Installation

1. Whenever a high tension wire is removed for any reason from a spark plug, coil or distributor cap, or a new high tension wire is installed, Silicone Dielectric Compound WA-10, D7AZ-19A331-A (ESE-M1C171-A) or equivalent must be applied to boot before it is reconnected. Using a small clean tool, coat entire interior surface of boot with Silicone Dielectric Compound WA-10, D7AZ-19A331-A (ESE-M1C171-A) or equivalent.
2. Insert each wire on proper terminal of distributor cap. Ensure wires are all the way down over their terminals. The No. 1 terminal is identified on cap. Install wires starting with No. 1 terminal.
3. Remove wire retaining brackets from old high tension wire set and install them on new set in same relative position. Install wires in brackets on valve rocker arm covers.
4. Connect wires to proper spark plugs.
5. Install coil wire.

Spark Plugs

Removal and Installation

Refer to the appropriate engine section for spark plug removal and installation.

Refer to the Spark Plug Inspection Chart to determine the condition of the spark plugs.

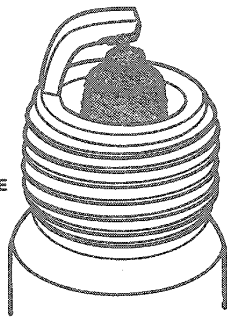
REMOVAL AND INSTALLATION (Continued)

Spark Plug Inspection Chart

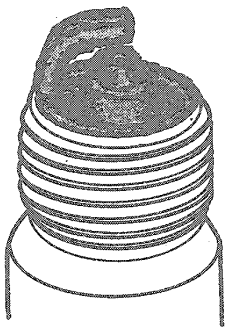
GAP BRIDGED

IDENTIFIED BY DEPOSIT BUILD—UP CLOSING GAP BETWEEN ELECTRODES.

CAUSED BY OIL OR CARBON FOULING, REPLACE PLUG, OR, IF DEPOSITS ARE NOT EXCESSIVE THE PLUG CAN BE CLEANED.



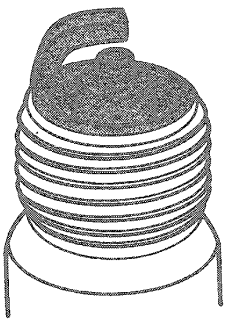
OIL FOULED



IDENTIFIED BY WET BLACK DEPOSITS ON THE INSULATOR SHELL BORE ELECTRODES.

CAUSED BY EXCESSIVE OIL ENTERING COMBUSTION CHAMBER THROUGH WORN RINGS AND PISTONS, EXCESSIVE CLEARANCE BETWEEN VALVE GUIDES AND STEMS, OR WORN OR LOOSE BEARINGS. CORRECT OIL PROBLEM. REPLACE THE PLUG.

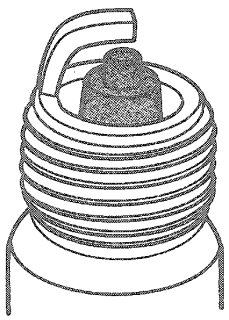
CARBON FOULED



IDENTIFIED BY BLACK, DRY FLUFFY CARBON DEPOSITS ON INSULATOR TIPS, EXPOSED SHELL SURFACES AND ELECTRODES.

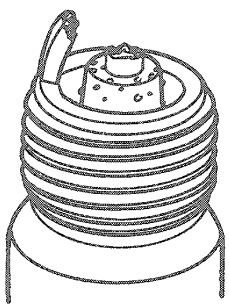
CAUSED BY TOO COLD A PLUG, WEAK IGNITION, DIRTY AIR CLEANER, DEFECTIVE FUEL PUMP, TOO RICH A FUEL MIXTURE, IMPROPERLY OPERATING HEAT RISER OR EXCESSIVE IDLING. CAN BE CLEANED.

NORMAL



IDENTIFIED BY LIGHT TAN OR GRAY DEPOSITS ON THE FIRING TIP.

PRE-IGNITION



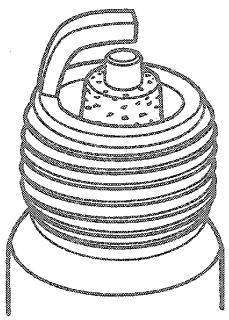
IDENTIFIED BY MELTED ELECTRODES AND POSSIBLY BLISTERED INSULATOR. METALIC DEPOSITS ON INSULATOR INDICATE ENGINE DAMAGE.

CAUSED BY WRONG TYPE OF FUEL, INCORRECT IGNITION TIMING OR ADVANCE, TOO HOT A PLUG, BURNT VALVES OR ENGINE OVERHEATING. REPLACE THE PLUG.

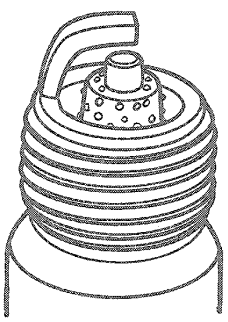
OVERHEATING

IDENTIFIED BY A WHITE OR LIGHT GRAY INSULATOR WITH SMALL BLACK OR GRAY BROWN SPOTS AND WITH BLUISH-BURNT APPEARANCE OF ELECTRODES.

CAUSED BY ENGINE OVER-HEATING, WRONG TYPE OF FUEL, LOOSE SPARK PLUGS, TOO HOT A PLUG, LOW FUEL PUMP PRESSURE OR INCORRECT IGNITION TIMING. REPLACE THE PLUG.



FUSED SPOT DEPOSIT



IDENTIFIED BY MELTED OR SPOTTY DEPOSITS RESEMBLING BUBBLES OR BLISTERS.

CAUSED BY SUDDEN ACCELERATION. CAN BE CLEANED IF NOT EXCESSIVE, OTHERWISE REPLACE PLUG.

84084-E

REMOVAL AND INSTALLATION (Continued)

Spark Plug Hole Taperset Installation

CAUTION: Use protective eye glasses at all times.

NOTE: Cylinder head must be removed from vehicle to prevent metal shavings from entering engine.

Refer to appropriate engine Section for cylinder head removal and installation.

Tap

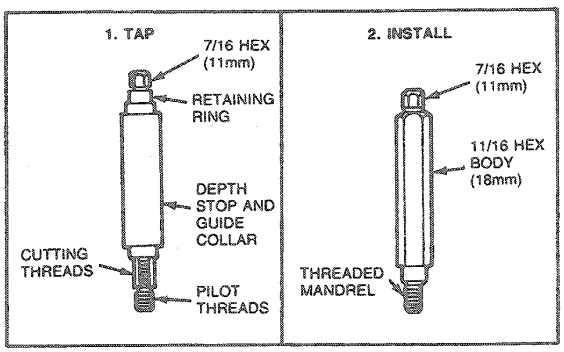
1. Thoroughly clean spark plug counterbore walls and seat of all dirt and foreign material.
2. Lubricate cutting threads of tap with cutting oil.
3. Engage tap pilot into spark plug port threads.

   NOTE: Use of power tools is not approved for installation of tapersets.
4. Using ratchet wrench and keeping tap aligned, rotate tap until depth stop collar bottoms on face of port and tighten against retaining ring.
5. Using an air hose, blow out as many shavings as possible.
6. If stop collar is loose, tap has not penetrated to full depth.
7. Remove tap from hole.
8. Clear shavings from hole and cylinder with air hose.

Installation

CAUTION: Repeat Steps 1 through 8 to ensure a clean bore.

1. Lubricate mandrel threads and taperset with aluminum cutting coil. Then thread taperset onto mandrel with larger counterbore end toward 18mm (11/16 inch) hex body until one thread of mandrel shows beyond tip of taperset.



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   NOTE: Taperset should be flush to 1mm (0.039 inch) below spark plug gasket seat.
2. Install taperset into tapped hole. Tighten 18mm (11/16 inch) hex to 68 N·m (50 lb-ft).
3. Holding 11mm (7/16 inch) hex mandrel to prevent rotation, loosen 18mm (11/16 inch) hex body approximately one-half turn to achieve breakaway action.
4. Remove tool from installed taperset.
5. Thoroughly clean cylinder head before installing spark plug. Tighten spark plugs to 9-20 N·m (7-15 lb-ft).

CLEANING AND INSPECTION

Ignition Coil

Wipe coil tower with a clean cloth dampened with soap and water. Remove any soap film and dry with compressed air. Inspect for cracks, carbon tracking and dirt.

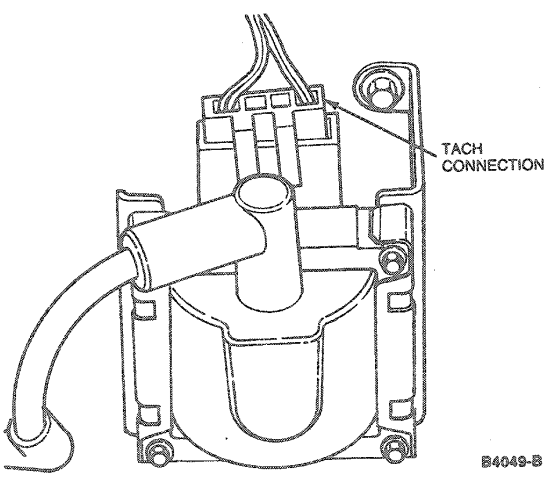
Spark Plug Wires

Without removing the high tension wires from the spark plugs, distributor cap or coil, wipe the wires with a clean, damp cloth and inspect them for visible damage such as cuts, pinches, cracks or torn boots. Replace only wires that are damaged. Refer to Spark Plug Wire, Removal and Installation.

Tachometer Connection

CAUTION: Do not allow this clip to accidentally ground to a metal surface. It may permanently damage the coil.

The ignition coil connector allows a tachometer connection using an alligator clip, without removing the coil connector. This is accomplished by inserting the alligator clip into the back of the connector, onto the dark green/yellow dotted wire.



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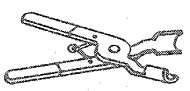
SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb-in
Distributor Hold-Down Bolts—3.0L	19-28	14-21 (Lb-Ft)
Distributor Hold-Down Bolts—3.8L	20-30	15-22 (Lb-Ft)
Stator Assembly Screws	1.7-4.0	15-35
Spark Plugs	9-20	7-15 (Lb-Ft)
Ignition Control Module	1.7-4.0	15-35
Heat Sink to Dash Retaining Nuts	5-8	44-70
Distributor Cap Hold-Down Screws	2.0-2.6	18-23
Octane Rod Retaining Screw	1.7-4.0	15-35
Armature Retaining Screws	2.8-4.0	25-35
Octane Rod Retaining Screws	1.7-4.0	15-35

SPECIAL SERVICE TOOLS

Tool Number / Description	Illustration
T74P-6666-A Spark Plug Wire Remover	 T74P-6666-A
T75L-1165-B Axle Bearing / Seal Plate	 T75L-1165-B

Tool Number	Description
D79L-4621-A	Pinion Bearing Cone Remover

SECTION 03-07B Electronic Ignition (EI) System

VEHICLE APPLICATION

Taurus with 3.0L / 3.2L SHO engines.

DESCRIPTION AND OPERATION

Components

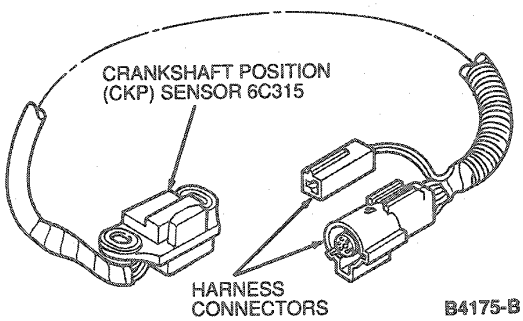
The electronic ignition (EI) system for the 3.0L / 3.2L SHO engines consists of the following components:

- Crankshaft position (CKP) sensor 6C315
- Camshaft position (CMP) sensor 12126
- Ignition control module (ICM) 12A199
- Ignition coil pack
- The spark angle portion of powertrain control module (PCM) 12A650
- Related wiring

Crankshaft Position (CKP) Sensor

The crankshaft position sensor is a single Hall effect magnetic switch, which is activated by three vanes on the crankshaft timing pulley. The signal generated by this sensor is called CKP. The CKP signal provides base timing and RPM information to the ICM and the powertrain control module (PCM).

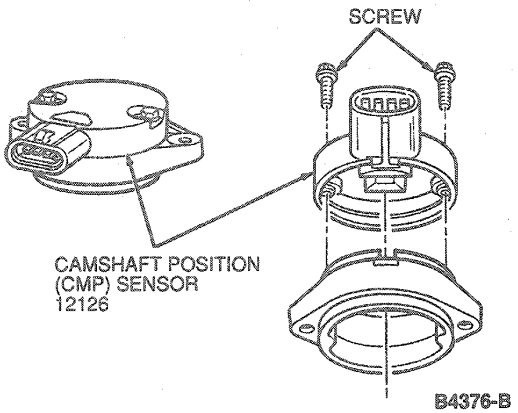
Based timing is set at 10 degrees ± 2 degrees BTDC and is not adjustable.



DESCRIPTION AND OPERATION (Continued)

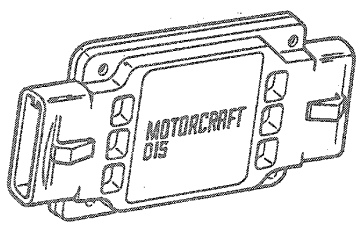
Camshaft Position (CMP) Sensor

This sensor is a single Hall effect magnetic switch, which is activated by a single vane driven by the camshaft. This sensor provides camshaft position information. The ICM uses CMP for coil fire sequencing and is also used by the PCM for fuel synchronization.



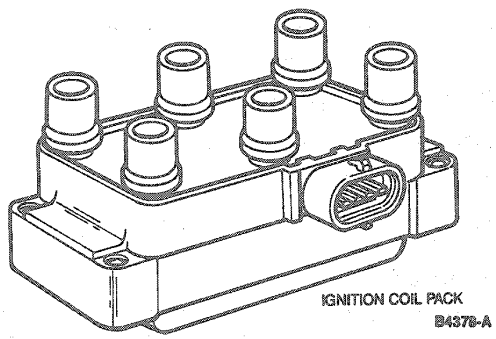
Ignition Control Module (ICM)

The ICM receives the CKP signal from the crankshaft position sensor, the CMP signal from the camshaft position sensor, and SPOUT (spark out) signal from the PCM module. During normal operation, CKP is sent to the PCM module from the crankshaft timing sensor and provides base timing and RPM information. The CMP signal provides the ignition control module with the information required to synchronize the ignition coils so that they are fired in the proper sequence. The SPOUT signal contains the optimum spark timing and dwell time information. The spark angle is determined by the rising edge of SPOUT, this is when coil current "turns off" and spark occurs. The dwell time is controlled by varying the duty cycle (duration) of the SPOUT signal. Current flows in a coil (dwell) when SPOUT is "low". This feature is called CCD (Computer Controlled Dwell). With the proper inputs of CKP, CMP and SPOUT the ICM turns the ignition coils on and off in the proper sequence for spark control.



Ignition Coil Pack

The ignition coil pack contains three separate ignition coils which are controlled by the ICM through three coil leads. Each ignition coil fires two spark plugs simultaneously, one spark plug on the compression stroke and one on the exhaust stroke. The spark plug fired on the exhaust stroke uses very little of the ignition coil stored energy. The majority of the ignition coil energy is used by the spark plug on the compression stroke. Since these two spark plugs are connected in series, the firing voltage of one spark plug will be negative with respect to ground, while the other will be positive with respect to ground. Refer to the Powertrain Control / Emissions Diagnosis Manual[1] for additional information on spark plug polarity.



Ignition Diagnostic Monitor

The ignition diagnostic monitor (IDM) is a function of the ICM. The ICM sends information on system failures to the PCM which stores the information for diagnostic self tests. The IDM signal is also used to drive the vehicle instrument tachometer and test tachometer for system diagnosis.

Failure Mode Effects Management

During some EI system faults, the failure mode effects management (FMEM) portion of the ICM will maintain vehicle operation. If the ICM does not receive the SPOUT input, it will automatically turn the ignition coils on and off using the CKP signal. However, this will result in fixed spark timing (10 degrees BTDC) and fixed dwell time (no CCD). If the ICM does not receive the CMP input during engine cranking, random coil synchronization will be attempted by the ICM. Therefore, several start attempts (cycling ignition switch from OFF to START) may be required to start the engine. If the ICM loses CMP input while engine is running, the ICM will remember the proper firing sequence and continue to fire to maintain engine operation.

1 Can be purchased as a separate item.

DESCRIPTION AND OPERATION (Continued)

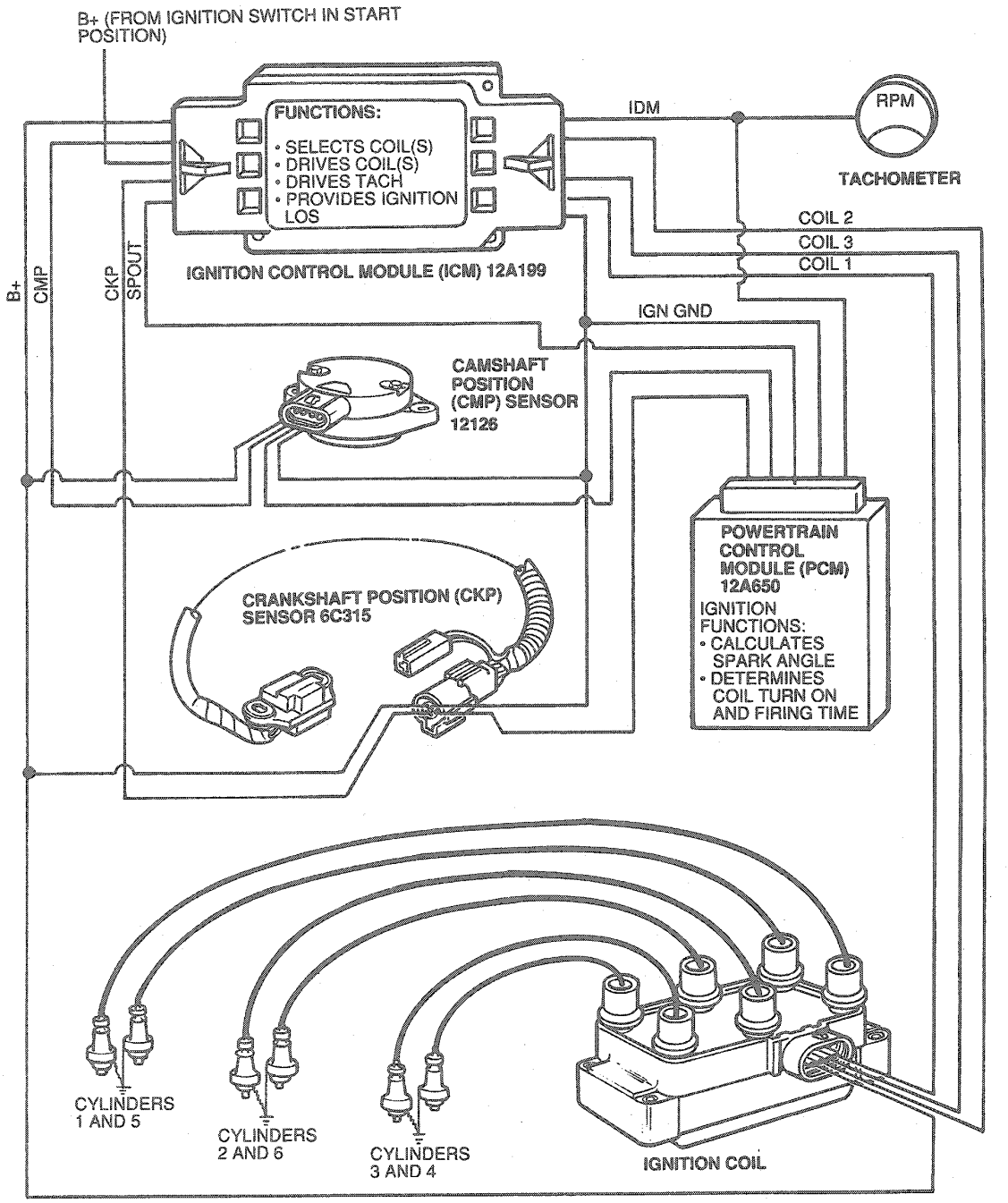
For additional information on the electronic ignition system theory of operation, refer to the Powertrain Control / Emissions Diagnosis Manual[2].

EI System Diagram

NOTE: This diagram is not meant to show detailed wiring interconnections. Refer to vehicle wiring diagrams for this information.

2 Can be purchased as a separate item.

DESCRIPTION AND OPERATION (Continued)



DIAGNOSIS AND TESTING

Procedures for diagnosis and testing of the EI system can be found in the Powertrain Control / Emissions Diagnosis Manual[3].

REMOVAL AND INSTALLATION

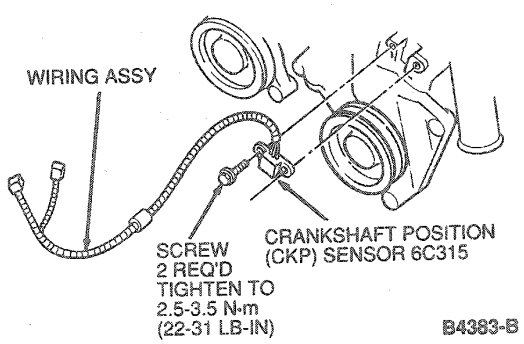
Crankshaft Position (CKP) Sensor Assembly

Tools Required:

- Universal Puller T67L-3600-A
- Crank Gear and Damper Replacer T83T-6316-B2

Removal

1. Disconnect battery ground cable.
2. Loosen tensioner pulleys for A / C compressor and power steering pump belts.
3. Remove belts from crankshaft pulley.
4. Disconnect ICM and remove intake manifold crossover tube.
5. Remove upper timing belt cover.
6. Disconnect sensor wiring harness at connector and route wiring harness through belt cover.
7. Raise vehicle and suitably support. Refer to Section 00-02.
8. Remove RH front wheel and tire assembly. Refer to Section 04-04.
9. Remove crankshaft pulley using Universal Puller T67L-3600-A.
10. Remove center and lower timing belt covers.
11. Rotate crankshaft by **HAND** to position the metal vane of shutter outside of sensor air gap.
12. Remove crankshaft sensor retaining screws and remove sensor.

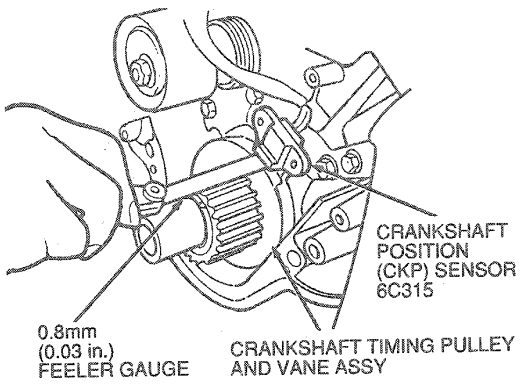


Installation

1. Route sensor wiring harness through belt cover. Install sensor assembly on mounting pad and install retaining screws loosely. Do not tighten screws at this time.

   CAUTION: This is a critical torque. Overtightening can cause damage to timing sensor.

2. Set clearance between crankshaft position sensor assembly and one vane on crankshaft timing pulley and vane assembly using a 0.8mm (0.03 inch) feeler gauge. Tighten screws to 2.5-3.5 N·m (22-31 lb-in).



3. Install lower timing belt cover. Take care not to damage sensor wiring harness. Install crankshaft pulley using Crank Gear and Damper Replacer T83T-6316-B2. Tighten pulley bolt to 152-172 N·m (112-127 lb-ft).
4. Install center timing belt cover.
5. Install RH front wheel and tire assembly. Tighten wheel lug nuts to 115-142 N·m (85-105 lb-ft).
6. Lower vehicle.
7. Route and connect sensor wiring harness.
8. Install upper timing belt cover.
9. Install intake manifold crossover tube and connect ICM. Refer to Section 03-01C.
10. Install A / C and power steering belts and adjust to proper tension.
11. Connect battery ground cable.

Camshaft Position (CKP) Sensor Assembly

Removal

1. Disconnect negative battery cable.
2. Remove engine torque strut.
3. Remove power steering belt.
4. Remove power steering pump pulley.
5. Disconnect camshaft position sensor wiring connector.
6. Remove camshaft position sensor retaining bolts and remove sensor.

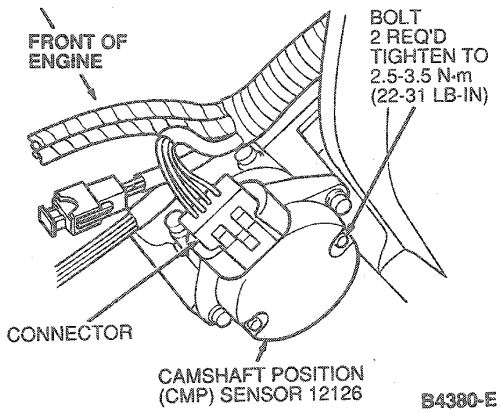
Installation

1. Install camshaft position sensor and retaining bolts. Tighten bolts to 2.5-3.5 N·m (22-31 lb-in).

3 Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

2. Connect sensor wiring connector.
3. Install power steering pump pulley. Refer to Section 11-02.
4. Install power steering belt. Refer to Section 03-05.
5. Install engine torque strut.
6. Connect battery ground cable.



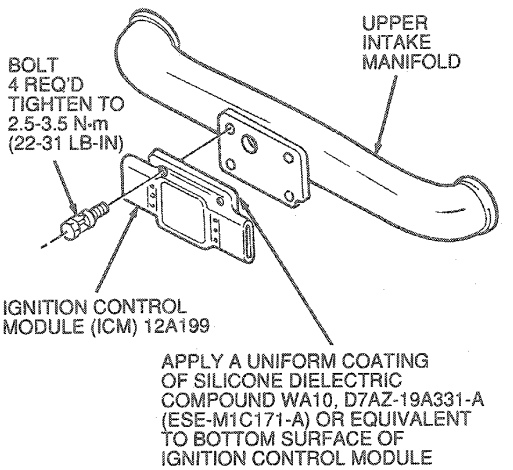
Ignition Control Module (ICM)

Removal

1. Disconnect battery ground cable.
2. Disconnect both electrical connectors at ICM assembly by pressing down on locking tabs where it is stamped PUSH and remove connector.
3. Remove ICM retaining bolts and remove module.

Installation

1. Apply an even coat of approximately 0.80mm (1/32 inch), of Silicone Dielectric Compound WA-10, D7AZ-19A331-A (ESE-M1C171-A) or equivalent to mounting surface of ICM. Install ICM and retaining bolts. Tighten bolts to 2.5-3.5 N·m (22-31 lb-in).
2. Connect both electrical connectors to ICM.
3. Connect battery ground cable.



Ignition Coil Pack

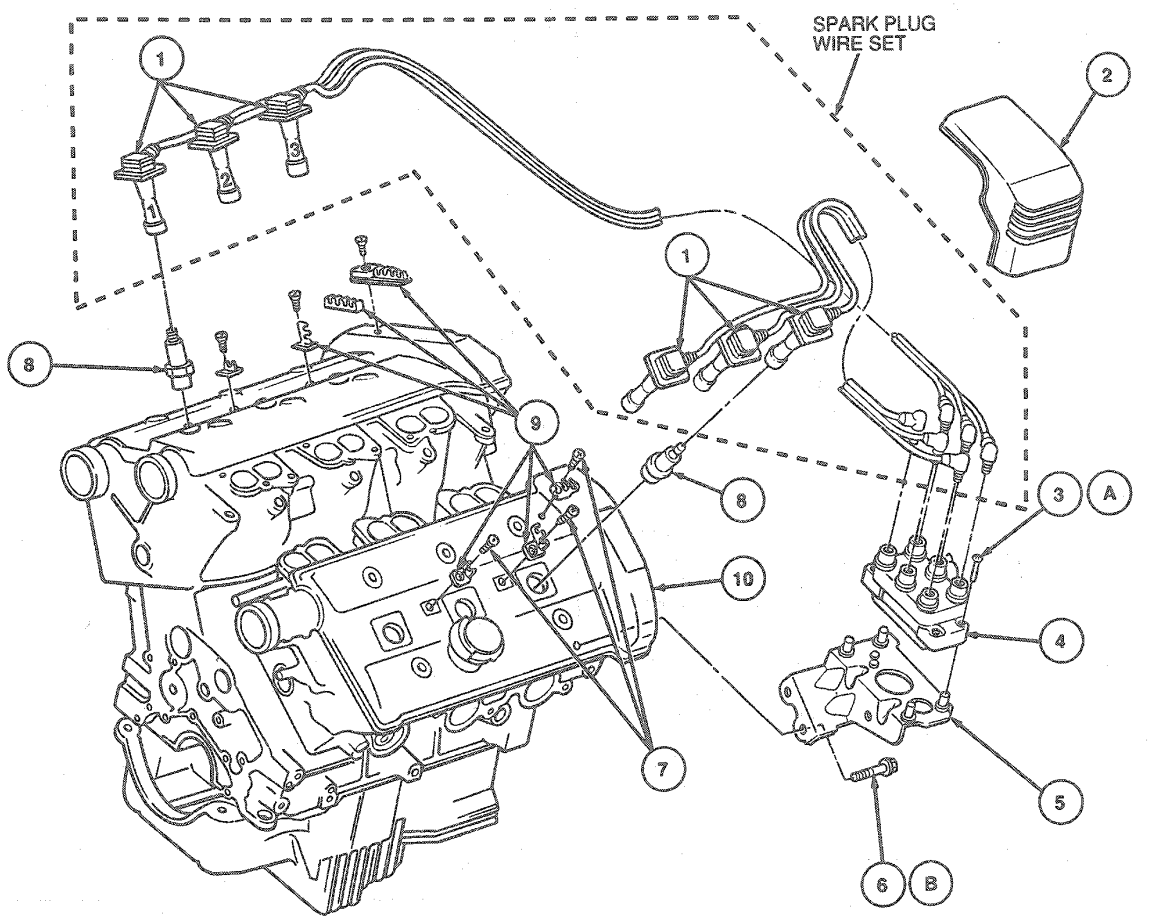
Removal

1. Disconnect battery ground cable.
2. Remove cover from coil pack and disconnect electrical connector.
3. Remove spark plug wires by squeezing locking tabs to release coil boot retainers.
4. Remove coil pack retaining screws and remove coil pack.

Installation

1. Install coil pack and retaining screws. Tighten screws to 4.5-7 N·m (40-62 lb-in).
2. Connect plug wires (see illustration for sequence) and connect electrical connector.
3. Install coil pack cover.
4. Connect battery ground cable.

REMOVAL AND INSTALLATION (Continued)



Item	Part Number	Description
1	12259	Spark Plug Wire Assemblies
2	—	Coil Pack Cover
3A	—	Screw and Washer (4 Req'd)
4	12029	Ignition Coil Pack
5	—	Coil Mounting Bracket
6B	—	Bolt (2 Req'd)

(Continued)

Item	Part Number	Description
7	—	Screw (3 Req'd Each Side)
8	12405	Spark Plug
9	—	Wire Clamp
10	6007	Engine Assy
A		Tighten to 4.5-7 N·m (40-62 Lb-In)
B		Tighten to 28-42 N·m (21-31 Lb-Ft)

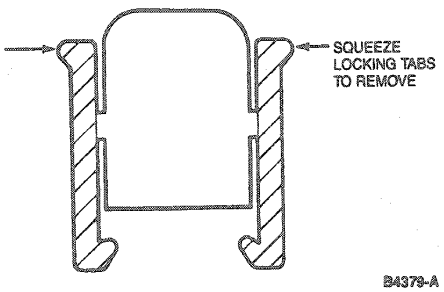
Spark Plug Wires

Removal

When removing spark plug wires from spark plug, grasp and twist the boot back and forth on the plug insulator to free the boot. Use a twisting and pulling motion to pull the boot from the plug. Do not pull on the wire directly, as it may become separated from the connector inside the boot.

REMOVAL AND INSTALLATION (Continued)

When removing wires from the ignition coil pack, squeeze the locking tabs of the coil wire retainer and remove using a twisting and pulling motion. Do not pull on the wire.



Installation

CAUTION: Proper installation of spark plug wires is critical to vehicle operation. If one spark plug wire is not properly installed on spark plug or ignition coil, both spark plugs connected to that ignition coil may not fire under load.

1. Whenever a high tension wire is removed for any reason from a spark plug or ignition coil, or a new high tension wire is installed, Silicone Dielectric Compound WA-10, D7AZ-19A331-A (ESE-M1C171-A) or equivalent must be applied to the boot prior to installation. Using a small clean tool, coat the entire interior surface of the boot with Silicone Dielectric Compound WA-10, D7AZ-19A331-A (ESE-M1C171-A) or equivalent.
2. Install each wire on the proper ignition coil terminal per illustration following Ignition Coil Pack, Installation. The terminal cylinder numbers are identified on the ignition coil pack. Ensure that the coil wire boots are fully seated and that both coil boot retainer locking tabs have engaged. The firing order is 1-4-2-5-3-6.
3. Route the new ignition wire set on the engine in the same relative position as the old set. Then install wires in wire routing brackets on the engine.
4. Connect wires to proper spark plugs.

CLEANING AND INSPECTION

Ignition Coils

Wipe the coil towers with a clean cloth dampened with soap and water. Remove any soap film and dry with compressed air. Inspect for cracks, carbon tracking and dirt.

Spark Plug Wires

Wipe the wires with a clean, damp cloth prior to inspection. Without removing high tension wires from the spark plugs or coils, inspect wires for visible damage such as cuts, pinches, cracks or torn boots. Replace damaged wires as necessary. Refer to Spark Plug Wires, Removal and Installation as outlined.

ADJUSTMENTS

Initial Timing

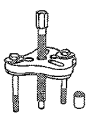
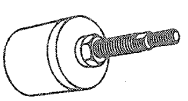
Initial timing is preset at 10° ± 2° BTDC and **is not adjustable.**

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb-Ft
Crankshaft Pulley Bolt	152-172	112-127
Crankshaft Position Sensor Retaining Screws	2.5-3.5	22-31 (Lb-In)
Camshaft Position Sensor Retaining Bolts	2.5-3.5	22-31 (Lb-In)
Ignition Control Module Retaining Bolts	2.5-3.5	22-31 (Lb-In)
Ignition Coil Pack Retaining Screws	4.5-7.0	40-62 (Lb-In)
Ignition Coil Pack Bracket-to-Cylinder Head Bolts	28-42	21-31
Wheel Lug Nuts	115-142	85-105

SPECIAL SERVICE TOOLS

Tool Number/ Description	Illustration
T67L-3600-A Universal Puller	 T67L-3600-A
T83T-6316-B2 Crank Gear and Damper Replacer	 T83T-6316-B

SECTION 03-07C Electronic Ignition (EI) — High Data Rate System, Flexible Fuel (FF)

VEHICLE APPLICATION

Taurus 3.0L Flexible Fuel (FF) Vehicles.

DESCRIPTION AND OPERATION

Components

The Electronic Ignition (EI) System — High Data Rate for the 3.0L FF engine consists of the following components:

- Crankshaft position (CKP) 6C315 sensor
- Ignition control module (ICM) 12A310
- Ignition coil pack
- Desired spark angle signal from the Powertrain Control Module (PCM) 12A650
- Related wiring

Crankshaft Position (CKP) Sensor

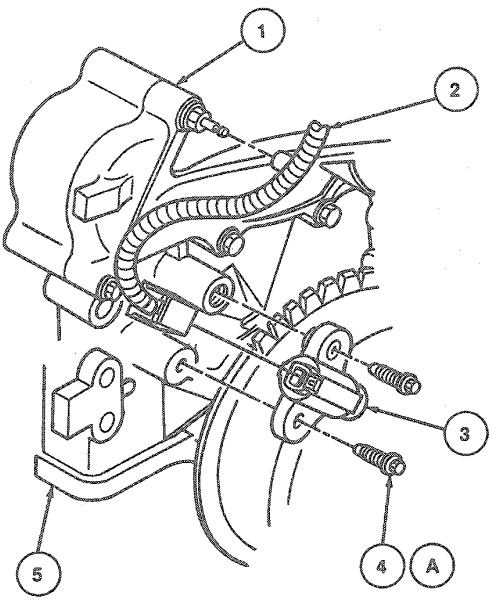
The crankshaft position (CKP) sensor is a variable reluctance sensor triggered by a 36-minus-1 tooth trigger wheel located inside the front cover.

The sine wave type signal generated from the variable reluctance sensor (VRS) provides two types of information. One is the position of the crankshaft in 10 degree increments. The other is the crankshaft speed (rpm).

The ignition control module (ICM) uses this information with the spark advance information from the powertrain control module (PCM) to determine ignition coil turn on and turn off time.

Base ignition timing is referenced to the position of the crankshaft sensor and is at 10 ± 2 degrees BTDC and is not adjustable.

DESCRIPTION AND OPERATION (Continued)



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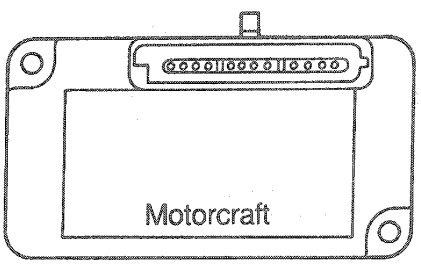
Item	Part Number	Description
1	—	Water Pump
2	9D930	Fuel Charging Wiring
3	6C315	Crankshaft Position Sensor
4A	N606500-S8	Bolt (2 Req'd)
5	—	Engine Front Cover
A		Tighten to 5-7 N·m (44-61 Lb-in)

Ignition Control Module (ICM)

The ignition control module (ICM) is a custom microprocessor-based thick film electronic module. The ignition control module (ICM) receives engine position and speed information from the crankshaft position (CKP) sensor, and desired spark advance information from the powertrain control module (PCM). The ignition control module (ICM) uses this information to direct which coil to fire, calculating the turn on / off times of the coils required to achieve the correct dwell and spark advance. The ignition control module (ICM) also synthesizes a Profile Ignition Pickup (PIP) signal and an Ignition Diagnostic Monitor (IDM) signal for use by the PCM. The ignition control module (ICM) sends information on system failures through the IDM signal to the powertrain control module (PCM) which stores information for Diagnostic Self Tests. The ignition diagnostic monitor (IDM) also provides the signal to drive the tachometer.

The ignition control module (ICM) is located on the cowl, in the engine compartment.



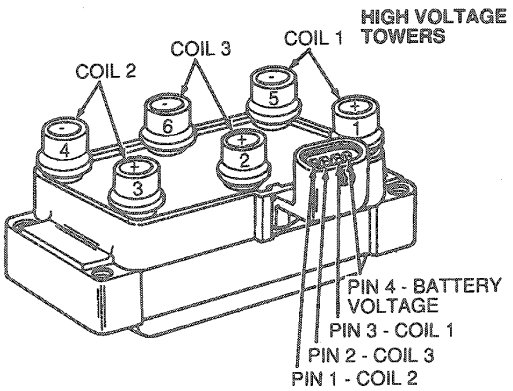
IGNITION CONTROL MODULE (ICM)
12K072

B4909-A

DESCRIPTION AND OPERATION (Continued)

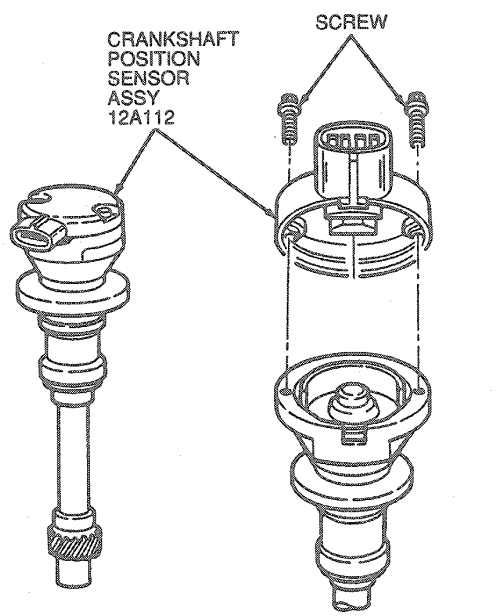
Ignition Coil Pack

The coil pack is mounted on the rear of the LH cylinder head. The ignition coil pack contains three separate ignition coils which are controlled by the ignition control module (ICM) through three coil leads. Each ignition coil fires two spark plugs simultaneously; one plug on the compression stroke and one on the exhaust stroke. The spark plug fired on the exhaust stroke uses very little of the ignition coil's stored energy. The majority of the energy is used by the spark plug on the compression stroke. Since these two spark plugs are connected in series, the firing voltage of one plug will be negative with respect to ground, while the voltage of the other will be positive with respect to ground. Refer to the Powertrain Control / Emissions Diagnosis Manual[1] for additional information on spark plug polarity.



Camshaft Position Sensor (CMP)

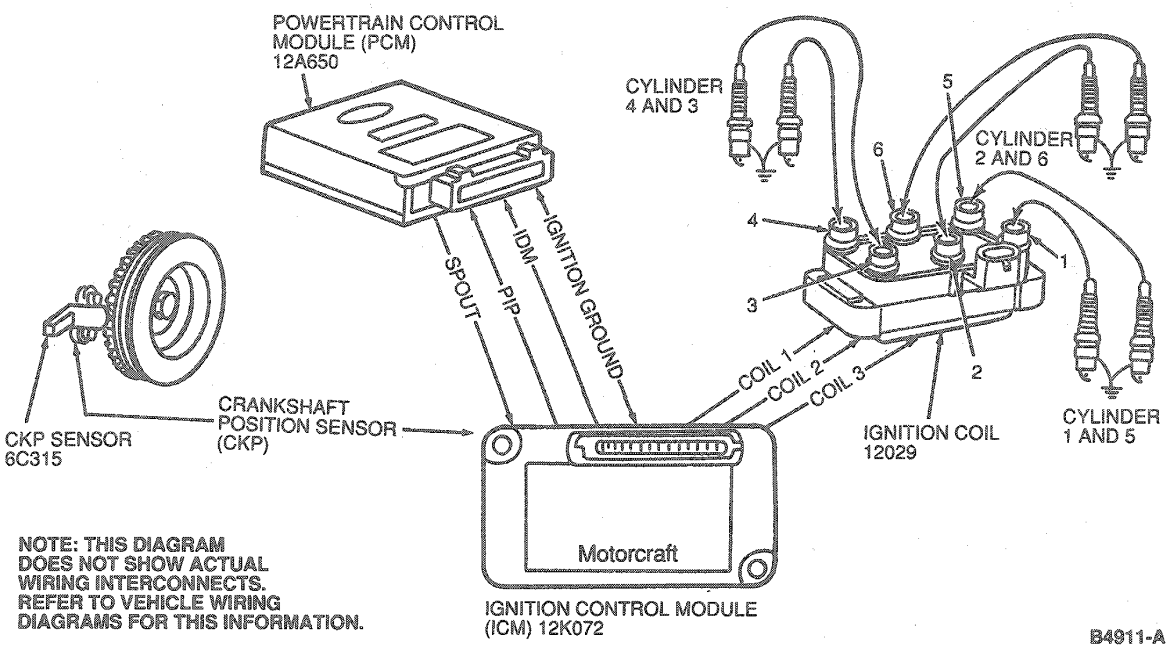
The camshaft position sensor is a single Hall effect magnetic switch, activated by a single vane which is driven by the camshaft. This sensor provides cylinder identification (CID) information. The electronic ignition (EI) uses CID for coil fire sequencing and is also used by the powertrain control module (PCM) for fuel synchronization.



1 Can be purchased as a separate item.

DESCRIPTION AND OPERATION (Continued)

System Block Diagram



DIAGNOSIS AND TESTING

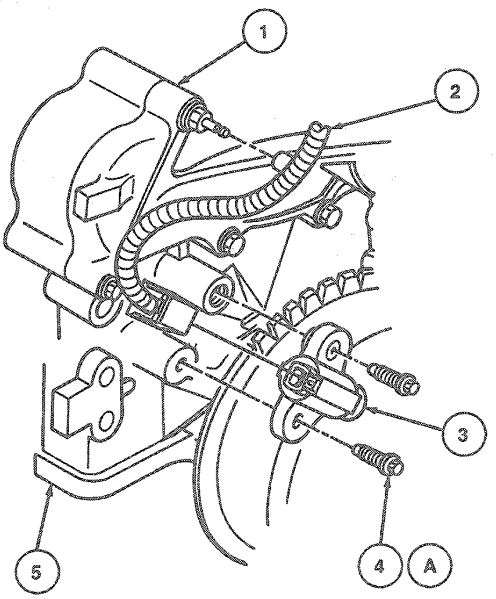
Procedures for diagnosis and testing of the EI—High Data Rate ignition system can be found in the Powertrain Control / Emissions Diagnosis Manual[2].

REMOVAL AND INSTALLATION

Crankshaft Position Sensor (CKP) Assembly

Removal

1. Disconnect negative battery cable.
2. Raise vehicle on a hoist. Refer to Section 00-02.
3. Disconnect CKP sensor electrical connector from the fuel charging wiring (9D930).
4. Remove crankshaft position (CKP) sensor retaining screws and remove sensor.



2 Can be purchased as a separate item.

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	—	Water Pump
2	9D930	Fuel Charging Wiring
3	6C315	Crankshaft Position Sensor
4A	N606500-S8	Bolt (2 Req'd)
5	—	Engine Front Cover
A		Tighten to 5-7 N·m (44-61 Lb-In)

Installation

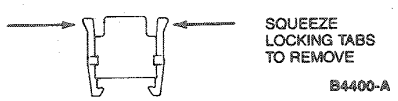
CAUTION: Do not overtighten screw.

1. Position sensor assembly and install retaining screws. Tighten to 5-7 N·m (44-61 lb-in).
2. Properly route engine fuel charging wiring and connect electrical connector to crankshaft sensor.
3. Lower vehicle.
4. Connect negative battery cable.

Electronic Ignition (EI) Coil Pack

Removal

1. Disconnect electrical connectors from coil pack and capacitor.
2. Disconnect spark plug wires by squeezing locking tabs and twisting while pulling upward.



3. Remove four coil pack retaining bolts and remove coil pack and capacitor. Save capacitor for installation with new coil pack.

Installation

1. Position coil pack and capacitor to mounting bracket.
2. Install retaining bolts and tighten to 5-7 N·m (44-61 lb-in).
3. Apply Silicone Dielectric Compound D7AZ-19A331-A (ESE-M1C171-A) or equivalent to all spark plug wire boots.
4. Install each wire connector to the proper terminal on the coil pack. Make sure boots are fully seated.
5. Connect coil pack and capacitor electrical connectors.

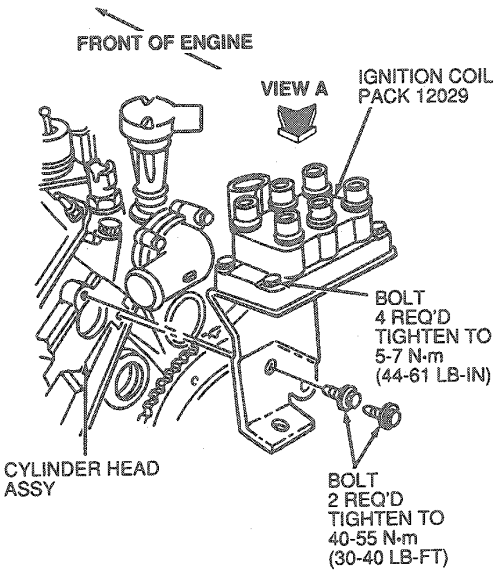
Coil Pack Bracket

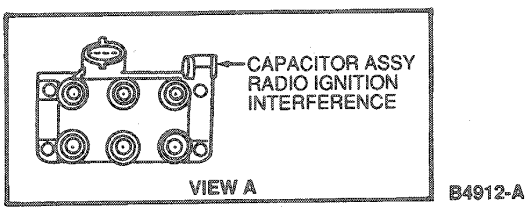
Removal

1. Remove the coil pack assembly as outlined in this section.
2. Remove the two bracket mounting bolts and bracket.

Installation

1. Position the coil pack bracket on the cylinder head and install two mounting bolts. Tighten the bolts to 44-55 N·m (30-40 lb-ft).
2. Install the coil pack assembly as outlined in this section.



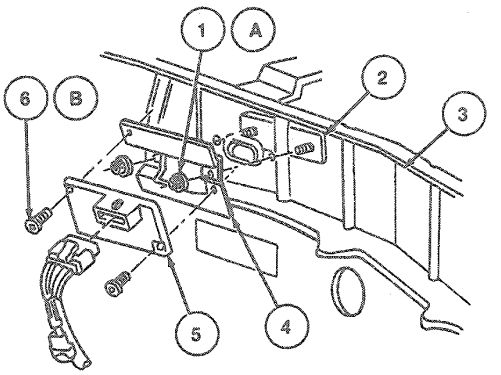


Ignition Control Module (ICM)

Removal

1. Disconnect ignition control module (ICM) electrical connector by pushing down on the connector finger ends while grasping the connector body and pulling away from the ignition control module (ICM).
2. Remove two ICM retaining screws and remove module.

REMOVAL AND INSTALLATION (Continued)



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Item	Part Number	Description
1A	—	Nut (2 Req'd)
2	12B360	Cover and Seal Assy
3	—	Cowl
4	12A360	Ignition Control Module Bracket
5	12K072	Ignition Control Module
6B	—	Screw (2 Req'd)
A		Tighten to 8-11 N·m (71-97 Lb-in)
B		Tighten to 2.7-3.7 N·m (24-32 Lb-in)

Installation

1. Position module to bracket and install retaining screws. Tighten to 2.7-3.7 N·m (24-32 lb-in).
2. Connect module electrical connector by pushing until connector fingers are locked over locking wedge feature on ignition control module (ICM). Locking the connector is important to ensure sealing of the connector and ignition control module (ICM) interface.

Ignition Control Module (ICM) Bracket

Removal

1. Remove the ICM as outlined in this section.
2. Remove the two bracket retaining nuts that hold the bracket to the cover and seal assembly and remove bracket.

Installation

1. Clean inside the cowl area and the seal assembly to ensure a good seal.
2. Position the seal assembly through the backside of the cowl and position the bracket on the studs.
3. Install the retaining nuts and tighten to 8-11 N·m (71-97 lb-in).
4. Install the ICM as outlined in this section.

Spark Plug Wires

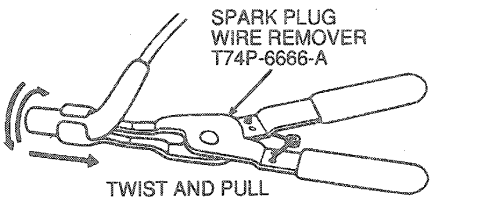
Tools Required:

- Spark Plug Wire Remover T74P-6666-A

Removal

CAUTION: Do not pull on the wire as it may separate from the connector inside the boot.

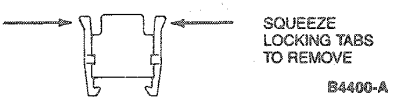
1. When removing spark plug wires from spark plugs, use Spark Plug Wire Remover T74P-6666-A. Grasp and twist the boot back and forth on the plug insulator to free the boot. Do not pull on the wire directly as it may separate from the connector inside the boot.



A6626-D

CAUTION: Do not pull on the wire as it may separate from the connector inside the boot.

2. Disconnect the wire from the coil pack by squeezing the locking tabs and twisting while pulling upward.



B4400-A

3. Open wire separators and remove spark plug wire.

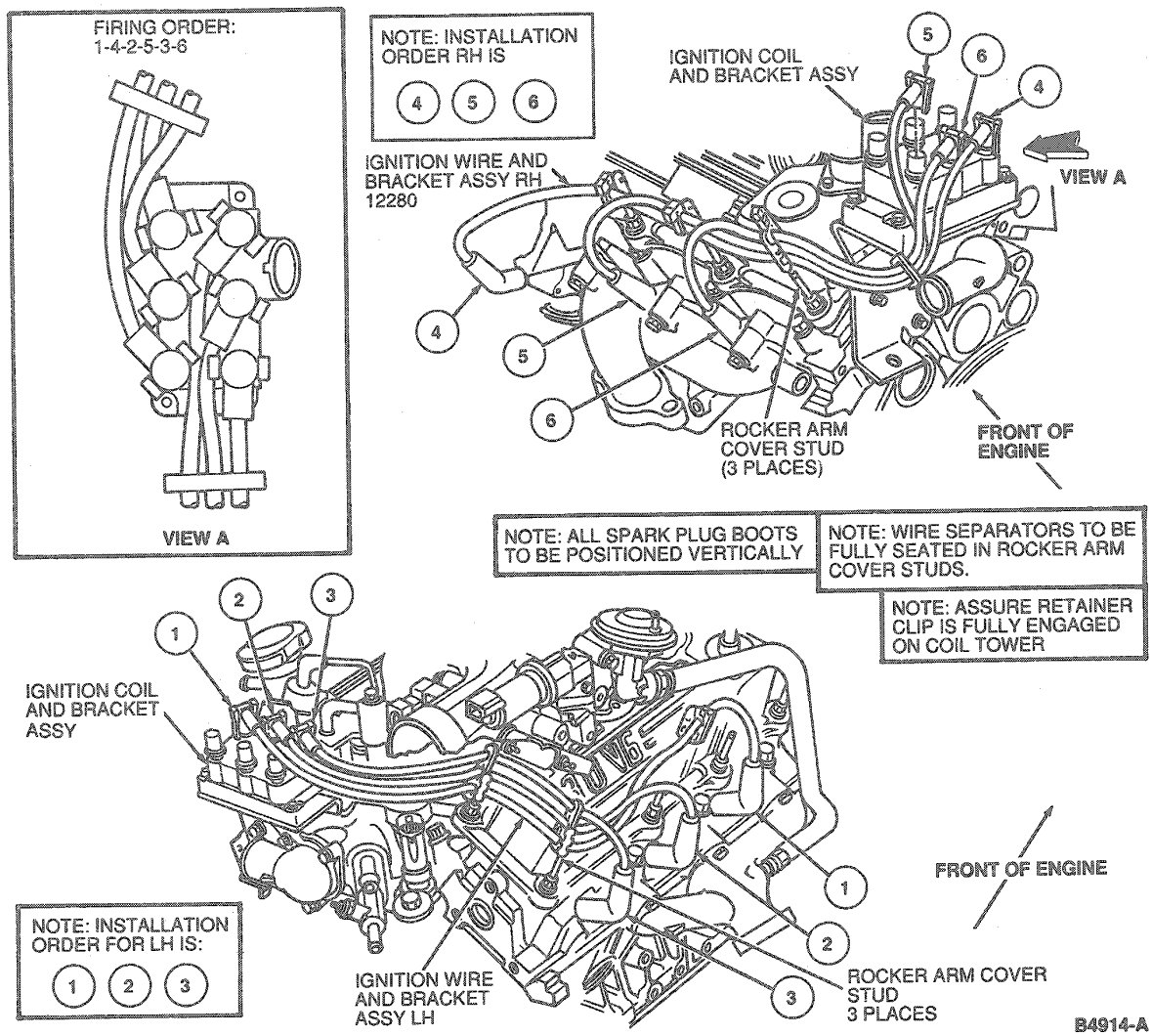
Installation

CAUTION: Proper installation of spark plug wires is critical to vehicle operation. If one spark plug wire is not properly installed on spark plug or ignition coil, both spark plugs connected to that ignition coil may not fire under load.

1. Whenever a high tension wire is removed for any reason from a spark plug or ignition coil, or a new high tension wire is installed, Silicone Dielectric Compound D7AZ-19A331-A (ESE-M1C171-A) or equivalent must be applied to the boot prior to installation. Using a small, clean tool, coat the entire interior surface of the boot with Silicone Dielectric Compound D7AZ-19A331-A (ESE-M1C171-A) or equivalent.
2. Install each wire to the proper terminal on the coil pack. The terminals on the coil pack are numbered. Make sure the boots are fully seated and that both coil boot locking tabs are engaged.
3. Route wire and close retainer clips.

REMOVAL AND INSTALLATION (Continued)

4. Connect wire to spark plug.



CLEANING AND INSPECTION

Ignition Coil Packs

Wipe the coil towers with a clean cloth dampened with soap and water. Remove any soap film and dry with compressed air. Inspect for cracks, carbon tracking and dirt.

Spark Plug Wires

Wipe the wires with a clean, damp cloth prior to inspection. Without removing the high-tension wires from the spark plugs or coils, inspect the wires for visible damage such as burns, cuts, pinches, cracks or torn boots. If necessary, replace the damaged spark plug wires as outlined.

ADJUSTMENTS

Initial Timing

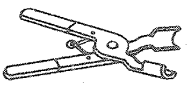
Initial timing is 10 ± 2 degrees BTDC and is NOT adjustable.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb-In
Crankshaft Position Sensor Screw	5-7	44-61
Ignition Control Module Screws	2.7-3.7	24-32
Ignition Coil Pack Screw	5-7	44-61
Coil Bracket Bolts	40-55	30-40 (Lb-Ft)
Ignition Control Module Bracket Nuts	8-11	71-97

SPECIAL SERVICE TOOLS

Tool Number / Description	Illustration
T74P-6666-A Spark Plug Wire Remover	 T74P-6666-A

PARTS CROSS-REFERENCE

Base Part #	Part Name	Old Part Name
9D930	Fuel Charging Wiring	

SECTION 03-12 Air Intake System

VEHICLE APPLICATION

Taurus / Sable and Taurus SHO.

DESCRIPTION

The air cleaner and duct system provides clean air to the throttle body (9E926). Outside air enters from an opening in the fender through the engine air cleaner intake tube and duct (9A673) and then into the engine air cleaner (9600) where it is filtered through the air cleaner element. From the engine air cleaner assembly it travels through the engine air outlet tube (9B647) and into the throttle body. On 3.0 / 3.2L SHO, from the engine air cleaner it travels through the Mass Air Flow (MAF) sensor 12B579 to the engine air outlet tube and into the throttle body. The positive crankcase ventilation (PCV) system is supplied clean air from a fitting on the engine air outlet tube on the 3.0L and 3.8L engines. Air induction noise is effectively eliminated by means of a sealed and tuned resonator chamber located in the air cleaner cover assembly and a secondary tuned venturi section in the inlet tube on the 3.8L engine. 3.0L engines use a secondary resonator in the inlet tube in addition to the resonator in the air cleaner cover.

The PCV system on 3.0 / 3.2L SHO engines is supplied clean air from a hose off the throttle body (TB) 9E926 to the LH (front) camshaft cover. Refer to Section 03-01B.

REMOVAL AND INSTALLATION

Air Filter Element—Replacement

Refer to Section 00-03 for the Emissions Systems Maintenance Schedule for frequency of filter inspection / replacement.

Removal

1. Loosen air cleaner outlet tube clamps at both ends and remove air cleaner outlet tube (9B659). On 3.0L, loosen clamp at throttle body only and leave air cleaner outlet tube connected to cover.
2. On Taurus SHO and 3.0L, disconnect airflow sensor electrical connector.
3. Release air cleaner upper cover clips, or remove bolts.
4. Remove air cleaner cover. Remove filter element.

Inspection

Visually inspect the element and the air cleaner cover and tray for signs of dust or dirt leaking through holes in the filter or past the end seals. Place a light on the inside (clean side) of the filter and look through the filter at the light. Even the smallest hole is cause for replacement.

Also check the element for deformed seals or brittle spots that could fail under engine operation and cause a hole. Discoloration only, is not cause for replacement. Visually inspect a new element for possible damage in handling such as deformed seals or holes in paper.

Installation

1. Clean inside surfaces of air cleaner body. Install filter element.
2. Install air cleaner upper cover. Install bolts or fasten clips.

REMOVAL AND INSTALLATION (Continued)

3. Connect airflow sensor electrical connector.
4. Install air cleaner outlet tube.

Air Cleaner

3.0L Base Engine

Removal

1. Disconnect closure hose from air cleaner outlet tube and remove.
2. Disconnect and remove PCV hose, if equipped, from air cleaner outlet tube.
3. Disconnect MAF electrical connector.
4. Remove air cleaner to battery tray retaining screw.

   NOTE: Engine air cleaner and engine air intake resonator (9F763) assembly may be removed together by removing resonator to fender retaining screw.
5. If engine air intake resonator is not being removed, unfasten air cleaner cover retaining clips and remove cover. Remove air cleaner element and reach inside to disconnect resonator to air cleaner locking tabs.
6. Remove air cleaner body.
7. Inspect inside surfaces of cover for traces of dirt leakage past element as a result of damaged element seals, incorrect element usage, or inadequate torque of cover retaining clips.
8. Clean sealing surfaces on tray and cover. Inspect element for possible damage in handling such as deformed seals or holes in paper.

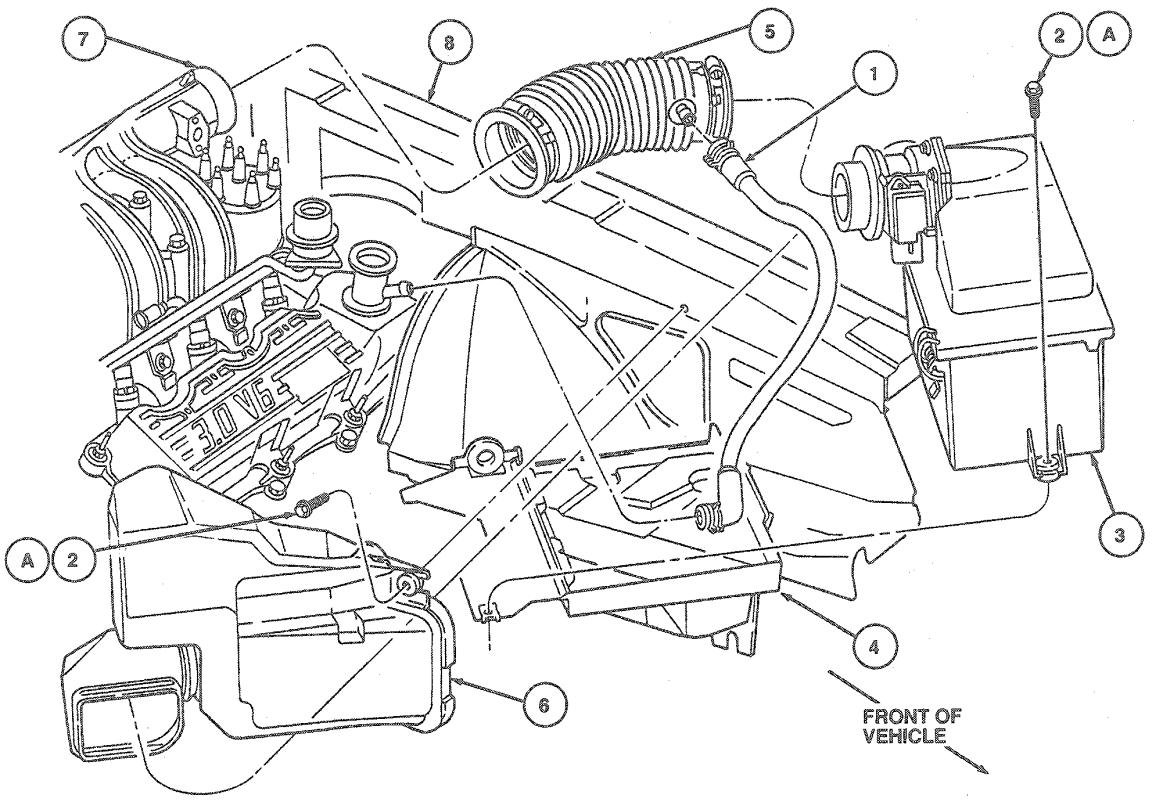
Installation

NOTE: Ensure resonator tabs are fully locked into air cleaner opening.

1. Position air cleaner body on battery tray. Ensure that mounting grommet is installed with metal side up and locating boss is firmly seated in battery tray grommet.
2. Install screw through grommet (metal side up) into J-clip in battery tray. Tighten screw to 4 N·m (36 lb-in).
3. Install air cleaner element, if removed.
4. Install air cleaner lid, if required. Make sure rear of cover is fully engaged with wedge. Close retaining clamps.
5. Install air cleaner outlet tube. Tighten clamp to 4 N·m (36 lb-in).
6. Connect PCV and closure hoses.
7. Connect MAF electrical connector.
8. Start engine and check for vacuum leaks around both ends of air cleaner outlet tube.

REMOVAL AND INSTALLATION (Continued)

3.0L Engine



V7422-C

Item	Part Number	Description
1	6C342	Hose Assy
2A	806215-S141B	Screw (2 Req'd)
3	9600	Engine Air Cleaner
4	10732	Battery Tray

(Continued)

Item	Part Number	Description
5	9B659	Air Cleaner Outlet Tube
6	9F763	Engine Air Intake Resonator
7	—	Manifold Assy
8	—	LH Fender Apron
A		Tighten to 2.7-5.4 N·m (24-47 Lb-In)

3.0/3.2L SHO Engine

Removal

1. Loosen air cleaner outlet tube clamp and disconnect air cleaner outlet tube.
2. Disconnect electrical connections at MAF sensor jumper wire and intake air temperature (IAT) sensor 12A697.
3. Remove air cleaner retaining screws and remove engine air cleaner from vehicle.
4. Inspect inside surfaces of cover for traces of dirt leakage past element as a result of damaged element seals, wrong element usage, or inadequate tension on cover retaining clips.
5. Remove air cleaner element and clean sealing surfaces on tray and cover. Inspect new element for possible damage in handling such as deformed seals or holes in paper.

Installation

NOTE: The air cleaner assembly mounting tab must be engaged with the battery tray grommet boss.

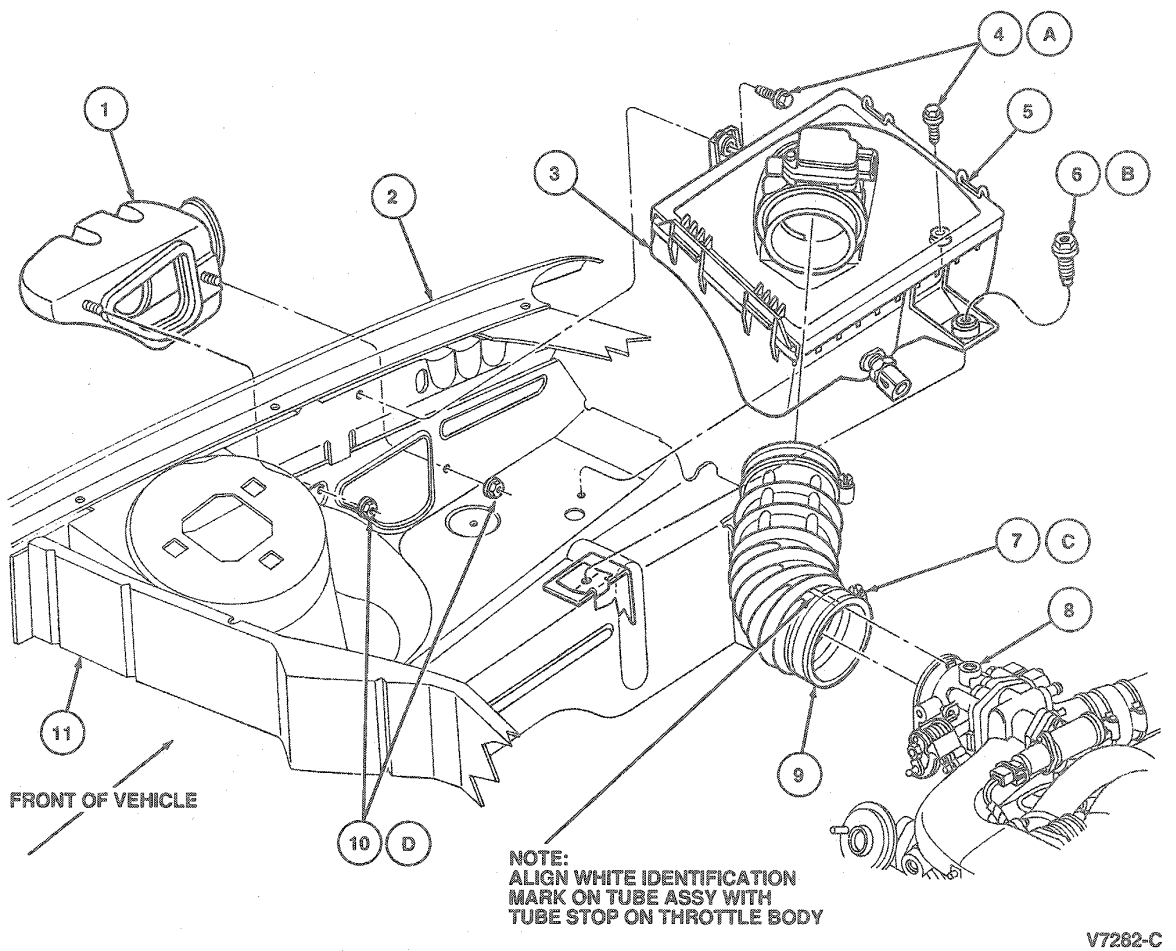
1. Install a new element.
2. Position engine air cleaner to engine compartment side panel. Ensure that mounting grommet is installed with metal side up and battery tray grommet is fully seated in battery tray. Check air cleaner cover hinge assembly. Secure retaining clips.

REMOVAL AND INSTALLATION (Continued)

3. Install screw through rubber grommet (metal side up) into J-clip in battery tray.
4. Connect electrical connections to mass airflow (MAF) sensor jumper wire and intake air temperature (IAT) sensor.
5. Connect air cleaner outlet tube and tighten clamp to 1.4-2.3 N·m (12-20 lb-in).

   NOTE: Align white identification mark on air cleaner outlet tube assembly with tube stop on throttle body.

3.0/3.2L SHO Engines



Item	Part Number	Description
1	9F763	Engine Air Intake Resonator
2	—	LH Fender
3	9600	Engine Air Cleaner
4A	N611061-S56	Screw
5	—	Air Cleaner Cover Retainer Clip
6B	N605894-S141B	Bolt
7C	—	Clamp Assy (2 Req'd)
8	9E926	Throttle Body

(Continued)

Item	Part Number	Description
9	9B659	Air Cleaner Outlet Tube
10D	N621905-S56	Nut and Washer Assy
11	—	Cowl
A		Tighten to 12-18 N·m (9-13 Lb-Ft)
B		Tighten to 8-11 N·m (6-8 Lb-Ft)
C		Tighten to 1.4-2.3 N·m (12-20 Lb-In)
D		Tighten to 5-5.7 N·m (49-62 Lb-In)

REMOVAL AND INSTALLATION (Continued)

3.8L Engine

Refer to Section 00-03 for the Emissions Systems Maintenance Schedule for frequency of filter inspection / replacement.

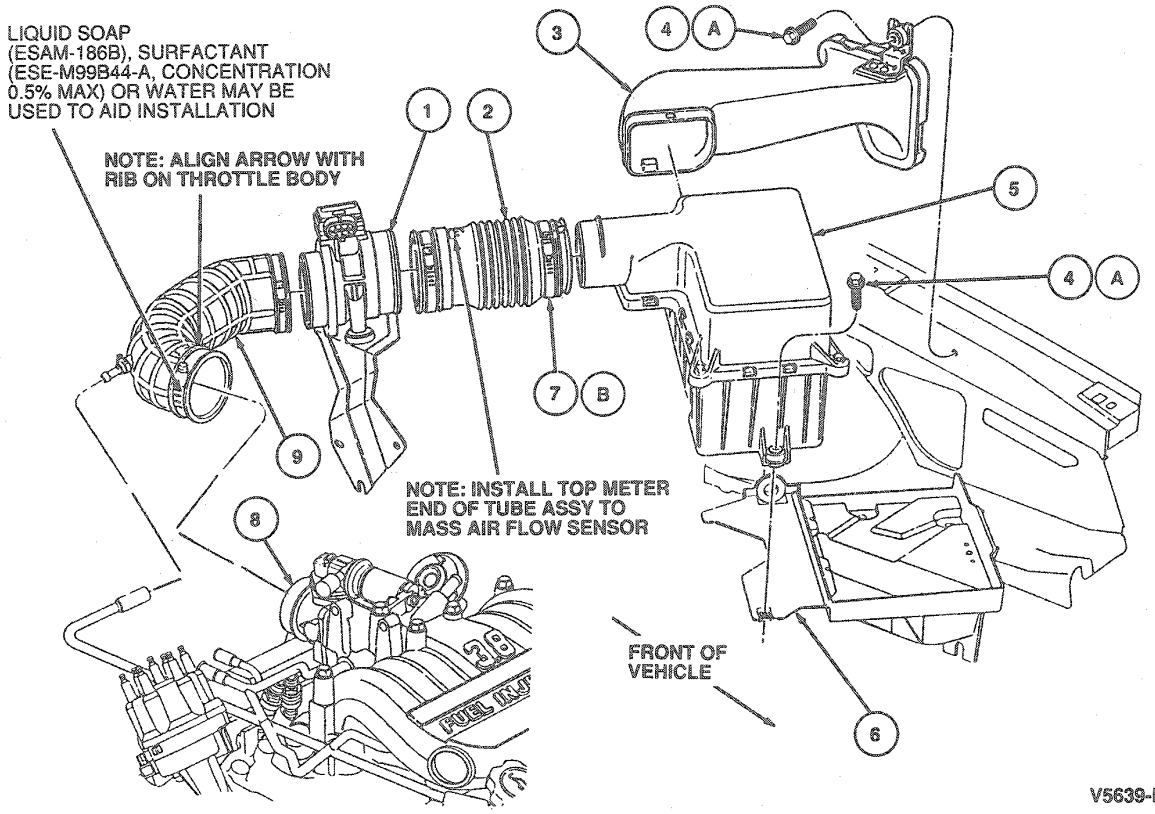
Removal

1. Loosen engine air cleaner tube clamp (9C632) at engine air cleaner and disconnect engine air outlet tube.
2. Loosen four air cleaner cover assembly retaining screws until cover is free from air cleaner tray. Do not remove screws.
3. Remove air cleaner cover assembly. Remove filter element.

Installation

1. Clean inside surfaces of air cleaner body. Install filter element.
2. Position air cleaner cover assembly on air cleaner tray. Tighten four retaining screws to 2.5-3.5 N·m (20-30 lb-in).
3. Install engine air outlet tube. Tighten clamps to 1.4-2.5 N·m (12-22 lb-in).

3.8L Engine



V5639-E

Item	Part Number	Description
1	12B601	Mass Air Flow Sensor and Bracket Assy
2	9B647	Engine Air Outlet Tube
3	9A673	Engine Air Cleaner Intake Tube and Duct
4A	N806215-S141B	Screw
5	9600	Engine Air Cleaner

(Continued)

Item	Part Number	Description
6	10732	Battery Tray
7B	9C632	Engine Air Cleaner Tube Clamp
8	9E926	Throttle Body
9	9B659	Air Cleaner Outlet Tube
A		Tighten to 4 N·m (36 Lb-In)
B		Tighten to 1.4-2.5 N·m (12-22 Lb-In)

REMOVAL AND INSTALLATION (Continued)

Air Inlet Resonator

3.0/3.2L SHO Engines

Removal

1. Remove engine air cleaner as outlined.
2. Remove inner LH fender splash shield. Refer to Section 01-02.
3. Remove attaching nuts and remove engine air intake resonator assembly.

Installation

1. Install engine air intake resonator assembly to inner fender panel and install two attaching nuts. Tighten nuts to 5.5-7 N·m (49-62 lb-in).
2. Install inner LH fender splash shield. Refer to Section 01-02.
3. Install engine air cleaner as outlined.

Mass Air Flow (MAF) Sensor

3.0L Engine

Removal

1. Remove air cleaner outlet tube as outlined in this section.
2. Disconnect electrical connector from sensor.
3. Remove four retaining screws.
4. Carefully remove sensor. Discard gasket.

Installation

1. Position sensor with new gasket onto air cleaner cover.
2. Install four retaining screws. Tighten to 3.5 N·m (25 lb-in).
3. Install air cleaner outlet tube as outlined.
4. Connect electrical connector to sensor.
5. Start engine and check for vacuum leaks.

SPECIFICATIONS

TORQUE SPECIFICATIONS

Description	N·m	Lb-in
Air Cleaner Assembly-to-Bracket Screw	4	36
Shroud to Exhaust Manifold Nut	13.5-20.5	10-15 (Lb-Ft)

(Continued)

TORQUE SPECIFICATIONS (Cont'd)

Description	N·m	Lb-in
Air Cleaner Assembly to Bracket—3.0L, 3.8L	2.7-5.4	24-47
Air Cleaner Adapter to Air Cleaner Lid	3.5	25
Resonator Assy to Inner Fender—3.0/3.2L SHO	5.5-7	49-62
Air Cleaner Assembly to Inner Fender—3.0L	12-18	9-13 (Lb-Ft)
Air Cleaner Assembly to Fender—3.0/3.2L SHO	8-11	6-8 (Lb-Ft)
Cover Assembly Screws—3.8L	2.5-3.5	20-30
Engine Air Cleaner Tube Clamp—3.8L	1.4-2.5	12-22
Air Cleaner Outlet Tube Clamp—3.0/3.2L SHO	1.4-2.3	12-20
Clean Air Flex Hose Clamp	4	36

PARTS CROSS-REFERENCE

Base Part #	Part Name	Old Part Name
9600	Engine Air Cleaner	
9A673	Engine Air Cleaner Intake Tube and Duct	
9B647	Engine Air Outlet Tube	
9B659	Air Cleaner Outlet Tube	
9C632	Engine Air Cleaner Tube Clamp	
9E926	Throttle Body	
9F763	Engine Air Intake Resonator	

SECTION 03-13 Evaporative Emissions

VEHICLE APPLICATION

Taurus / Sable, Taurus SHO and Taurus Flexible Fuel.

DESCRIPTION AND OPERATION

Fuel Vapor Emission Control System

As a part of the fuel system, vehicles are equipped with a fuel evaporative emission control system designed to meet federal and state requirements in effect at the time of production.

Fuel Tank Evaporative Emission System

This system consists of:

- Sealed fuel tank and filler pipe
- Pressure / vacuum relief fuel filler cap
- Fuel tank vapor valve assembly with pressure relief and open flow to vacuum (Unleaded Gasoline Only)
- Vapor Control Valve (FF Only)
- Vapor tube, hoses and connectors
- Carbon canister (4 canisters for FF only)
- Purge solenoid (Vapor Management Valve (VMV) for FF only)

Not all of these components are used on any one system, since usage depends on the calibration of the complete vehicle.

System control and operation are accomplished through four separate basic functions in the system:

1. Fill control venting with filler cap off.
2. Tank vapor venting and storage with filler cap on.
3. Fuel vapor purge.
4. Pressure and vacuum relief (fuel cap and tank vent valve).

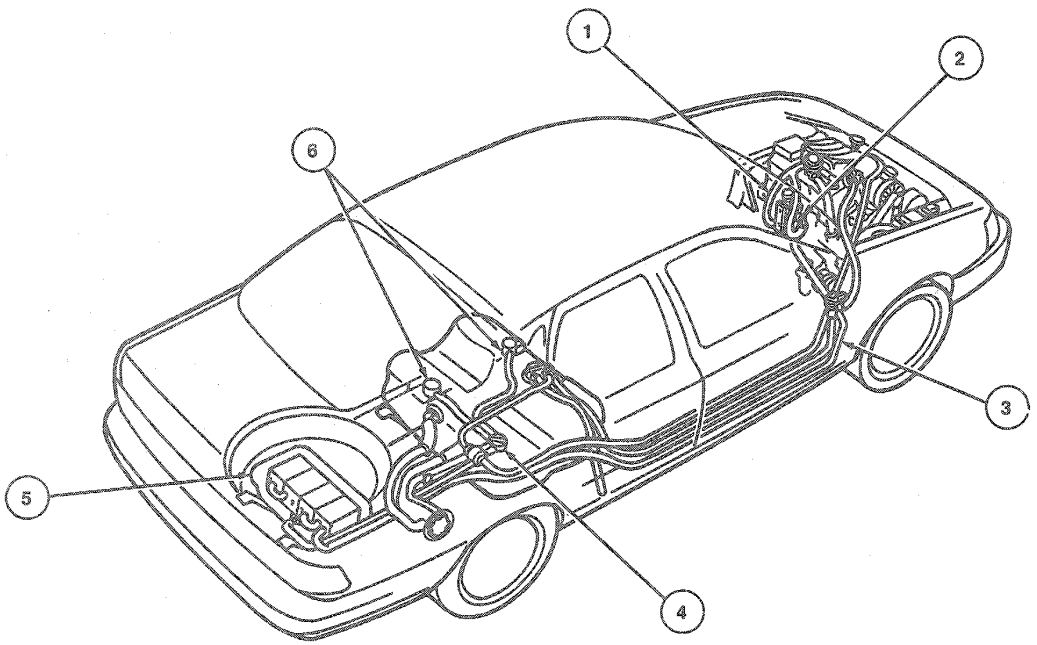
DESCRIPTION AND OPERATION (Continued)

Fill Control/Vapor Vent System

Unleaded Gasoline Only

Fill control is accomplished through a vent line, attached to the filler pipe, which extends inside the fuel tank. The small vapor orifice mounted in the top of the fuel tank and attached vapor line to the canister, control fuel tank fill by controlling pressure in the tank when the fuel level covers the fill vent opening in the 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. The clearance is sufficient to allow vapor venting through the orifice under all static and most dynamic vehicle conditions.

Flexible Fuel (FF) Evaporative Emission System



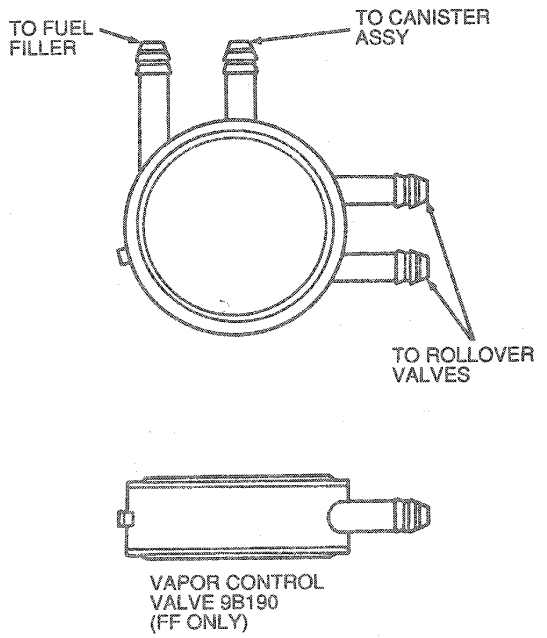
V7760-A

Item	Part Number	Description
1	—	Vacuum Control Line
2	9C915	Vapor Management Valve
3	—	Canister Purge Line
4	9B190	Vapor Control Valve
5	9E857	Vapor Storage Canister Assy
6	9B593	Fuel Vapor Valve

DESCRIPTION AND OPERATION (Continued)

Vapor Control Valve

The vapor control valve is located in the line between the vapor rollover valve and the carbon canisters. The vapor control valve is mounted on the fuel tank by a bracket. The vapor control valve senses filler cap removal by a change in pressure of the tank through a filler pipe sensing tube. The vapor control valve closes the flow path from the vapor rollover valves to the carbon canisters during refueling to prevent overfilling of the fuel tank.

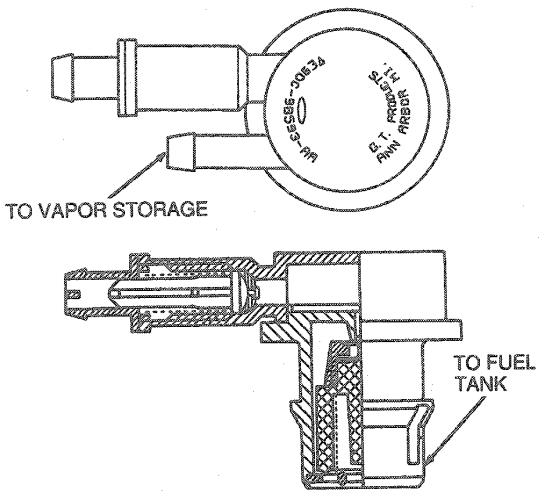


V8558-A

Fuel Tank Vapor Orifice, Pressure Relief and Rollover Valve Assembly

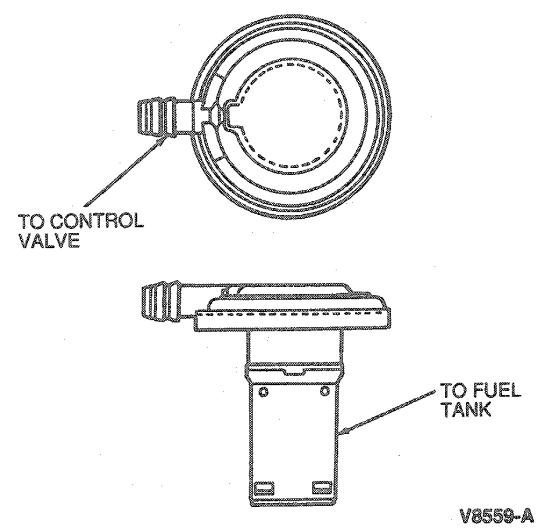
The fuel tank vapor orifice, pressure relief and rollover valve assembly makes use of a small orifice and shutoff valve that tends to allow only fuel vapor, not liquid, to pass into the line routed forward to the vapor storage canister. This assembly mounts directly to the fuel tank, using a rubber grommet.

Unleaded Gasoline Only



V7539-B

FF Only



V8559-A

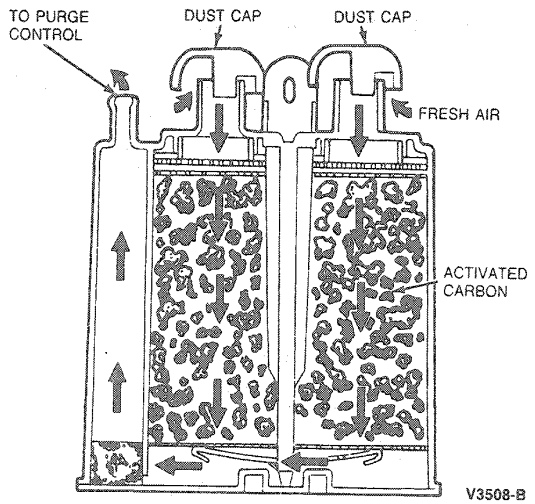
Fuel vapors in the sealed tank are vented through the orifice in the top of the tank. The vapors are transmitted through a single vapor tube to the carbon canister at the front of the vehicle. A spring loaded poppet valve provides relief ahead of the orifice to the canister. This valve gradually opens above 5-6 kPa (20-25 inches H_2O) to vent vapors to atmosphere through a second vapor tube.

DESCRIPTION AND OPERATION (Continued)

Carbon Canister (Fuel Vapor Storage System)

Fuel vapor generated from the fuel tank is stored in a carbon-filled canister until the engine is started, at which time the vapor is drawn into the intake system. On some vehicles, a secondary fuel tank vapor orifice may be installed in the tank vent line connection at the canister. If this orifice becomes plugged, abnormal operation of the fuel system may result.

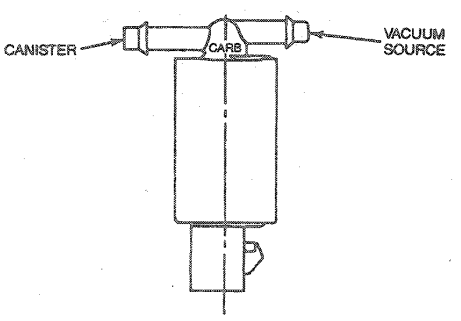
FF vehicles use four carbon canisters mounted on a bracket as an assembly under the luggage compartment floor. The FF canister system operates the same as unleaded gasoline systems.



Purge Solenoid Valve

Unleaded Gasoline Only Vehicles

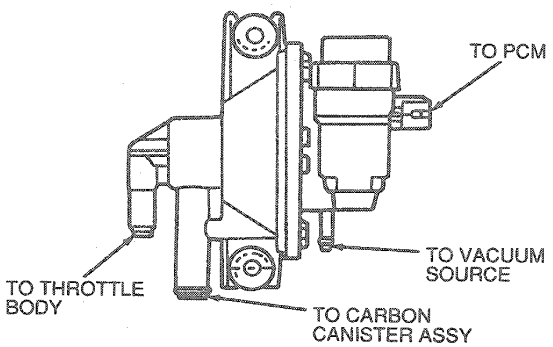
The purge solenoid valve is in-line with the carbon canister and controls the flow of fuel vapors out of the canister. It is normally closed. When the engine is shut off, vapors from the fuel tank flow into the canister. After the engine is started, the solenoid is engaged and opens, purging the vapors into the engine with the valve open. Vapors from the fuel tank are routed directly into the engine.



Vapor Management Valve

FF Vehicles Only

The vapor management valve (VMV) is in-line with the carbon canister assembly and controls the flow of fuel vapors out of the canister assembly. The VMV closes off vapor flow from the canisters when the engine is not running. After the engine is started, in response to a signal from the powertrain control module (PCM) (12A650), the VMV opens and closes to allow vapors to flow from the canisters to the engine.



VAPOR MANAGEMENT VALVE (VMV)

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 1.7 kPa (0.25 psi) and pressure relief above 14 kPa (2 psi). Under normal operating conditions, the fill cap operates as a check valve, allowing air to enter the tank as gasoline is used, while preventing vapors from escaping the tank through the cap.

DIAGNOSIS AND TESTING

Refer to the Powertrain Control / Emissions Diagnosis Manual[1] for diagnosis of Engine Evaporative Emission System.

Fuel Tank Evaporative Emission System

The following is a diagnostic guide for check and / or servicing concerns of internal fuel tank pressure buildup or fuel odor. A typical concern may be a rush of air as the fuel cap is removed.

The fuel evaporative emission system allows for controlled release of fuel tank vapor to a carbon vapor storage canister. Under normal operating conditions, this system will allow sufficient venting to prevent a buildup 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 with low fuel level.
- Climbing long grades, especially while towing a trailer, or while fully loaded.

No service is required if these conditions caused the customer concern.

A normally functioning evaporative emission system will relieve the pressure buildup.

A blocked fuel evaporative emission system can cause abnormal fuel tank pressure and must be serviced. Refer to the following charts for diagnosis and flow test.

PINPOINT TEST A: EVAPORATIVE EMISSIONS DIAGNOSIS (UNLEADED GASOLINE ONLY)

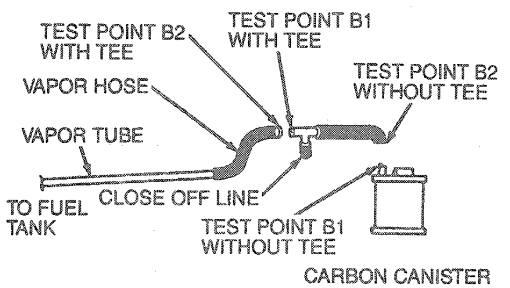
TEST STEP		RESULT ▶	ACTION TO TAKE
A1	FUNCTIONAL TEST ● Test canister hose and inlet nipple for blockage. ● **Are hoses or inlet blocked?**	Yes ▶ No ▶	REMOVE blockage. GO to **B1.**
A2	FUNCTIONAL TEST ● Test fuel evaporative emission system for blockage. ● **Are all system passages open?**	Yes ▶ No ▶	REMOVE blockage or REPLACE component. GO to **B2.**
A3	VISUAL INSPECTION ● Inspect vapor tube and hoses for kinks or pinched areas. ● **Are tube or hoses kinked or pinched?**	Yes ▶ No ▶	SERVICE or REPLACE tube or hoses. VERIFY service. GO to **A4.**
A4	VISUAL INSPECTION ● Inspect vapor hose routing between fuel tank and body for pinch. ● **Is vapor hose pinched?**	Yes ▶ No ▶	LOOSEN fuel tank and reroute hose. VERIFY service. GO to **A5.**
A5	VISUAL INSPECTION ● Remove fuel tank. ● Remove vapor separator valve. ● Inspect valve for open air passage through orifice. ● **Is air passage open?**	Yes ▶ No ▶	INSTALL valve in tank. INSTALL tank system test complete. REPLACE valve. VERIFY service.

TV3507H

1 Can be purchased as a separate item.

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST B: FLOW TEST—FUEL EVAPORATIVE SYSTEM (UNLEADED GASOLINE ONLY)

TEST STEP		RESULT ▶	ACTION TO TAKE
B1	FLOW TEST		
	CAUTION: Do not use other high pressure air supplies. Will result in damage to canister. ● Install hand pump and pressure gauge Rotunda 021-00014 Vacuum and Pressure Tester or equivalent in vapor hose at test point B1. ● Hand pump to a maximum of 17.2 kPa (2.5 psi).	Pressure drop: Drops to zero immediately ▶ Holds pressure or leaks down slowly ▶	 System flow OK, no servicing required. PERFORM Pinpoint Test Step **A3.**
B2	FLOW TEST		
	CAUTION: Failure to remove fuel cap may result in damage to fuel tank. ● Remove fuel cap from fuel filler pipe. **CAUTION: Do not use other high pressure air supplies. May result in damage to fuel tank.** ● Install hand pump and pressure gauge onto tee or canister nipple at test point B2. ● Hand pump to a maximum of 17.2 kPa (2.5 psi).  V7578-A	Pressure drop: Drops to zero immediately ▶ Holds pressure or leaks down slowly ▶	 System OK, no servicing required. PERFORM Pinpoint Test Step **A4.**

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PINPOINT TEST A: EVAPORATIVE EMISSIONS DIAGNOSIS (FLEXIBLE FUEL ONLY)

TEST STEP		RESULT ▶	ACTION TO TAKE
A1	FUNCTIONAL TEST		
	● With the fuel level below 1/2 tank, disconnect carbon canister assembly vapor supply line at canister assembly. ● Plug the vapor supply line. ● Using Stant Fuel System Pressure Tester SFT-265, pressurize the fuel system through the test fuel cap. ● Remove plug from the canister assembly vapor supply line. ● **Did the fuel system pressure decay?**	Yes ▶ No ▶	GO to **A2.** GO to **B1.**
A2	FUNCTIONAL TEST		
	● Disconnect the vapor control valve signal line from the fuel fill tube. ● Plug the signal line at the fuel fill tube. ● Plug the carbon canister assembly vapor supply line at canister assembly. ● Pressurize the fuel system. ● Remove plug from the canister assembly vapor supply line. ● **Did the fuel system pressure decay?**	Yes ▶ No ▶	REPLACE the vapor control valve. VERIFY service. GO to **C1.**

DIAGNOSIS AND TESTING (Continued)

PINPOINT TEST B: EVAPORATIVE EMISSIONS DIAGNOSIS (FLEXIBLE FUEL ONLY)

TEST STEP		RESULT ▶	ACTION TO TAKE
B1	FUNCTIONAL TEST		
	• Remove vapor line from rear rollover valve at vapor control valve. • **Did the fuel system pressure decay?**	Yes ▶ No ▶	GO to B2. GO to D1.
B2	FUNCTIONAL TEST		
	• Connect vapor line from rear rollover valve to vapor control valve. • Pressurize the fuel system. • Remove vapor line from front rollover valve at vapor control valve. • **Did the fuel system pressure decay?**	Yes ▶ No ▶	REPLACE the vapor control valve. VERIFY service. REPLACE front rollover valve and grommet. VERIFY service

PINPOINT TEST C: EVAPORATIVE EMISSIONS DIAGNOSIS (FLEXIBLE FUEL ONLY)

TEST STEP		RESULT ▶	ACTION TO TAKE
C1	FUNCTIONAL TEST		
	• Remove vapor line from rear rollover valve at vapor control valve. • **Did the fuel system pressure decay?**	Yes ▶ No ▶	GO to C2. GO to D1.
C2	FUNCTIONAL TEST		
	• Connect vapor line from rear rollover valve to vapor control valve. • Pressurize the fuel system. • Remove vapor line from front rollover valve at vapor control valve. • **Did the fuel system pressure decay?**	Yes ▶ No ▶	System OK, no servicing required. REPLACE front rollover valve and grommet. VERIFY service.

PINPOINT TEST D: EVAPORATIVE EMISSIONS DIAGNOSIS (FLEXIBLE FUEL ONLY)

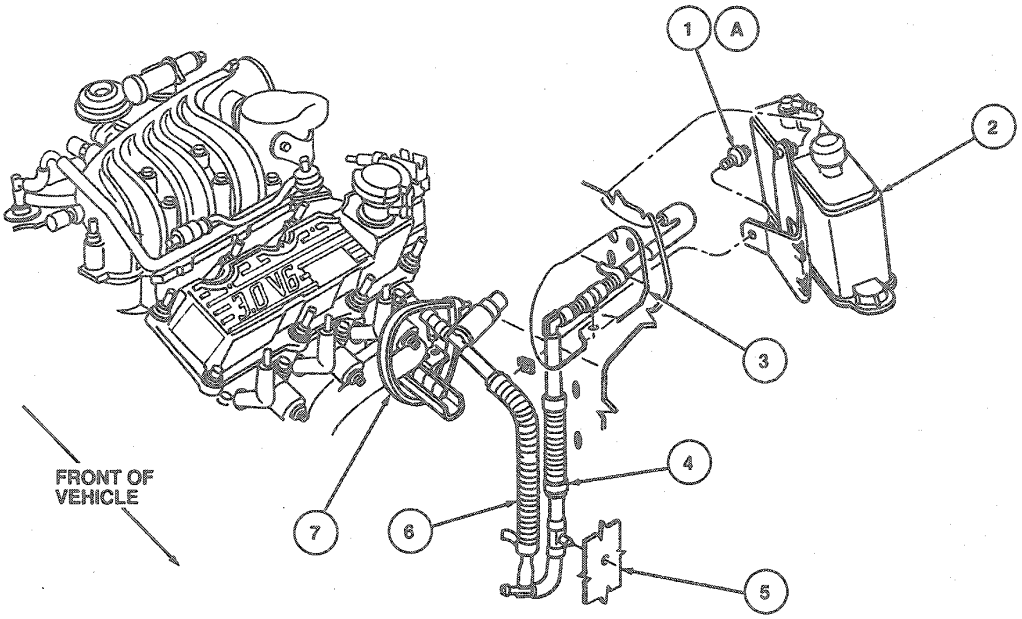
TEST STEP		RESULT ▶	ACTION TO TAKE
D1	FUNCTIONAL TEST		
	• Remove vapor line from front rollover valve at vapor control valve. • **Did the fuel system pressure decay?**	Yes ▶ No ▶	REPLACE rear rollover valve and grommet. VERIFY service. REPLACE both rollover valves and grommets. VERIFY service.

REMOVAL AND INSTALLATION

Most component parts of the standard fuel system are retained by a simple nut, bolt or screw. Refer to individual system illustrations for specific part references.

REMOVAL AND INSTALLATION (Continued)

Evaporative Emission System, 3.0L (Unleaded Gasoline Only)



V7755-A

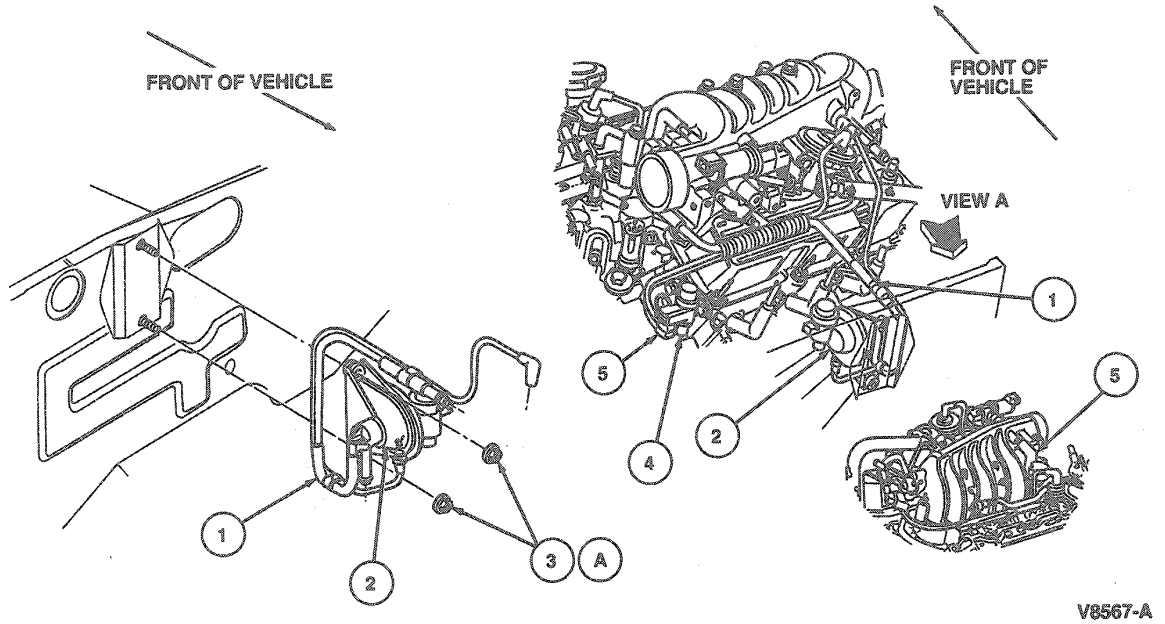
Item	Part Number	Description
1A	N606688-S2	Screw and Washer Assy
2	9E857	Canister and Bracket Assy
3	—	LH Headlamp Opening
4	9K313	Fuel Vapor Front Hose

(Continued)

Item	Part Number	Description
5	—	Radiator Support
6	9C987	Hose and Valve Assy
7	—	Tie Strap
A		Tighten to 21.2-28.8 N·m (15-21 Lb-Ft)

REMOVAL AND INSTALLATION (Continued)

Evaporative Emission System 3.0L (FF Only)



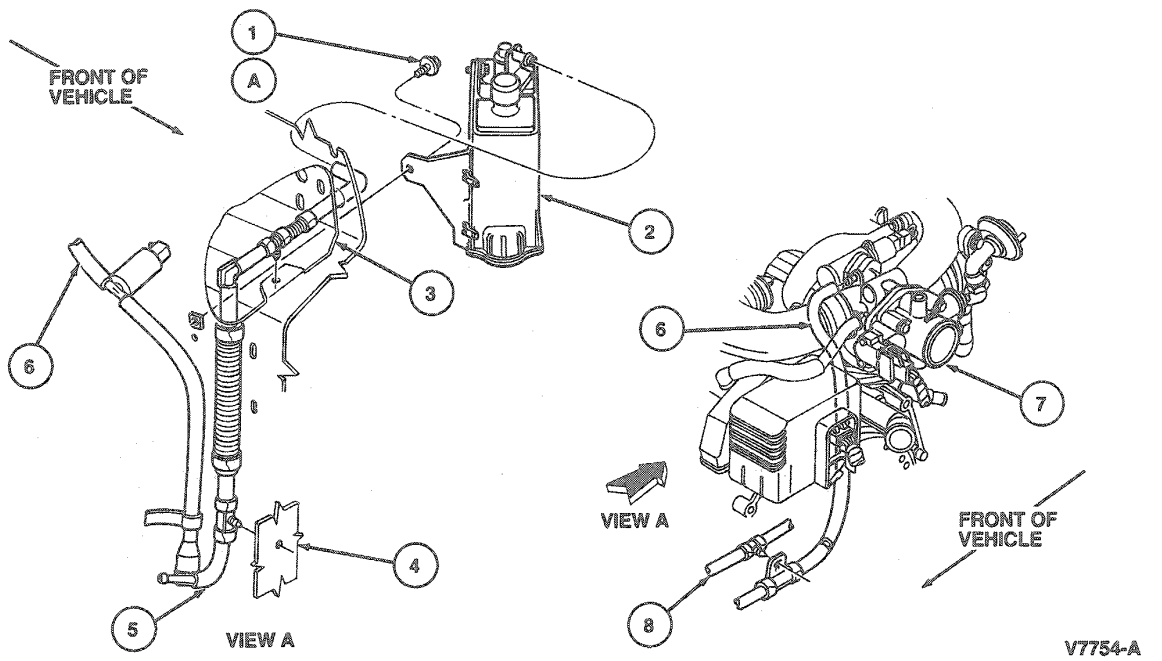
Item	Part Number	Description
1	9E498-EC	Main Emission Vacuum Control Connector
2	9C915	Fuel Vapor Canister Purge Regulator Valve
3A	N621905-S8	Nut and Washer Assy (2 Req'd)

(Continued)

Item	Part Number	Description
4	9J472	EGR Vacuum Regulator Bracket
5	93498-DD	Main Emission Vacuum Control Connector
A		Tighten to 6-11 N·m (53-97 Lb-In)

REMOVAL AND INSTALLATION (Continued)

Evaporative Emission System, 3.0L SHO



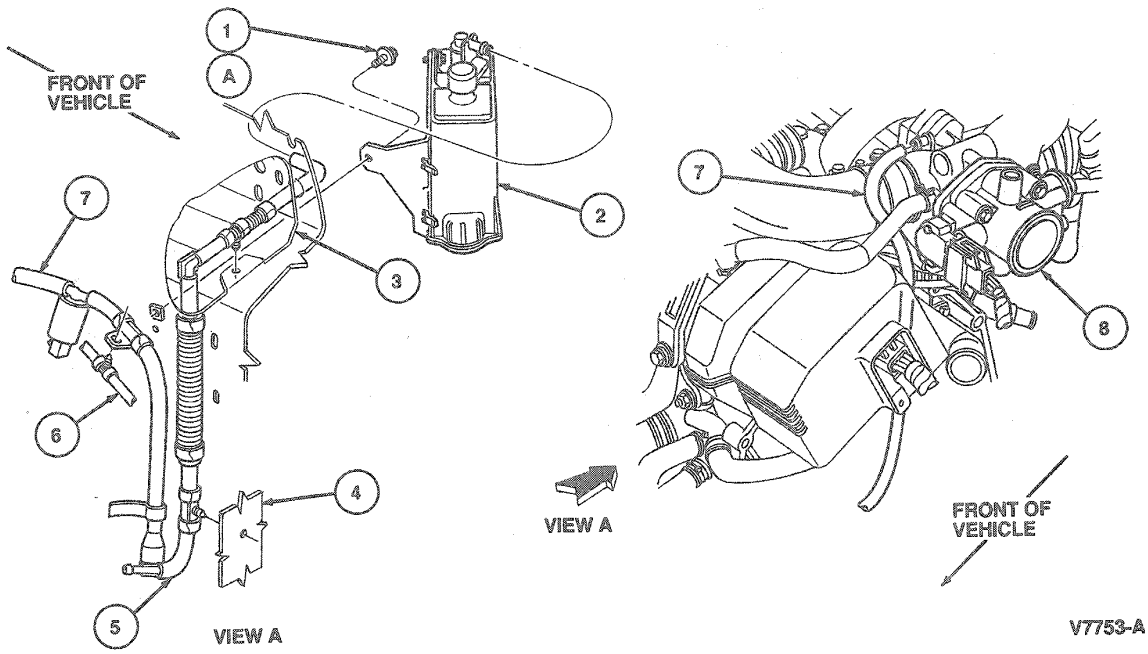
Item	Part Number	Description
1A	N606688-S2	Screw and Washer Assy
2	9E857	Canister and Bracket Assy
3	—	LH Headlamp Opening
4	—	Radiator Support

(Continued)

Item	Part Number	Description
5	9K313	Fuel Vapor Front Hose
6	9C987	Hose and Valve Assy
7	9E926	Throttle Body
8	—	Battery Cable
A		Tighten to 21.2-28.8 N·m (15-21 Lb-Ft)

REMOVAL AND INSTALLATION (Continued)

Evaporative Emission System, 3.2L SHO

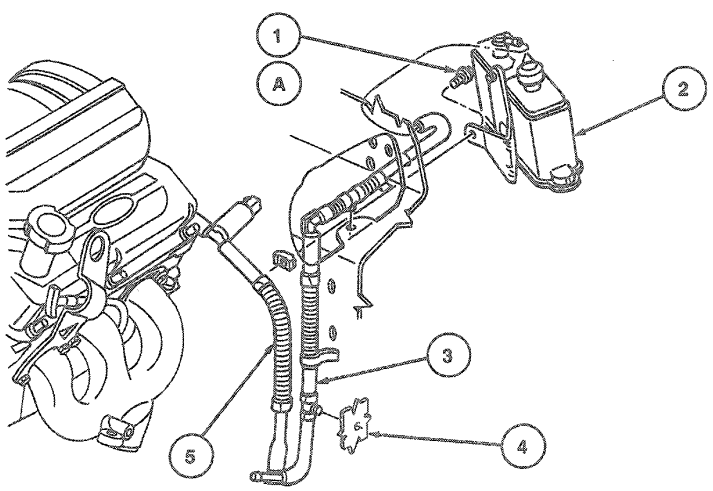


Item	Part Number	Description
1A	N606689-S2	Screw and Washer Assy
2	9E857	Canister and Bracket Assy
3	—	LH Headlamp Opening
4	—	Radiator Support

(Continued)

Item	Part Number	Description
5	9K313	Fuel Vapor Front Hose
6	—	Battery Cable
7	9C987	Hose and Valve Assy
8	9E926	Throttle Body
A		Tighten to 21.2-28.8 N·m (15-21 Lb-Ft)

Evaporative Emission System, 3.8L



REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1A	N606688-S2	Screw and Washer Assy
2	9E857	Canister and Bracket Assy
3	9K313	Fuel Vapor Front Hose
4	—	Radiator Support
5	9C987	Hose and Valve Assy
A		Tighten to 21.2-28.8 N·m (15-21 Lb-Ft)

SPECIAL SERVICE TOOLS

ROTUNDA EQUIPMENT

Model	Description
021-00014	Rotunda Vacuum and Pressure Tester

Tool Number	Description
SFT-265	Stant Fuel System Pressure Tester