

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

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## 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

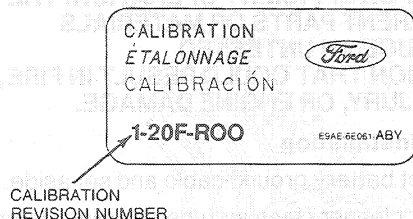
For quick engine identification, refer to the Safety Certification Decal. The decal is mounted on the LH front door lock face panel. Find the engine code (letter or number) on the decal, then refer to the engine identification chart to determine the engine type and size. An engine identification label 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.

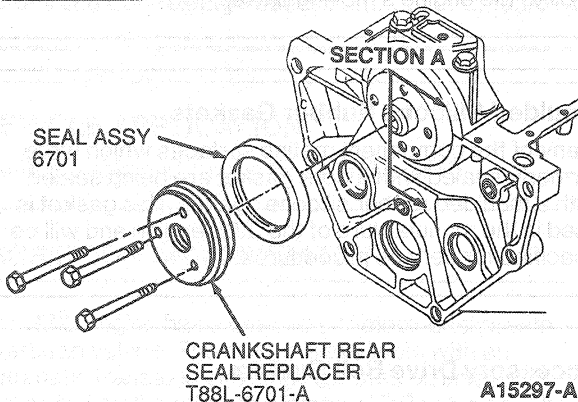
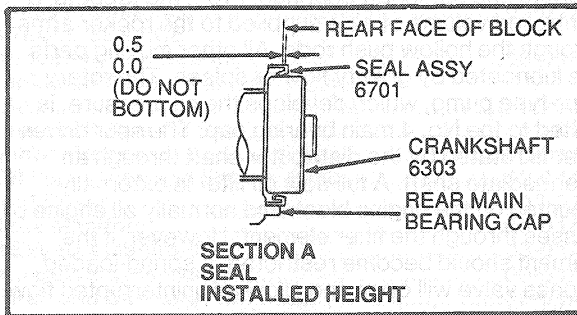


## IN-VEHICLE SERVICE (Continued)

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.



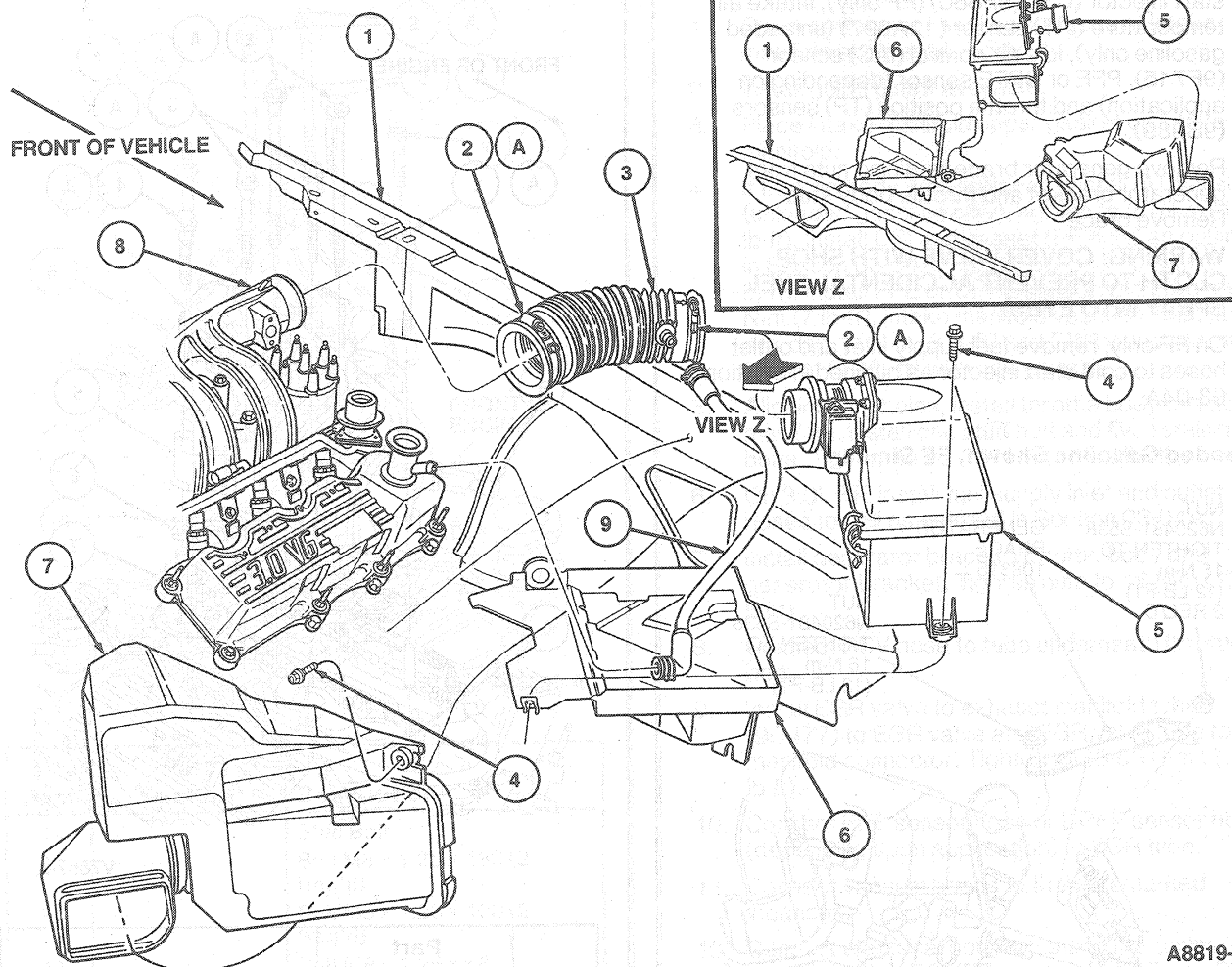
## Throttle Body

**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)



A8819-F

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

NUT  
N620481-S538  
TIGHTEN TO  
16 N·m  
(12 LB-FT)  
2 REQ'D

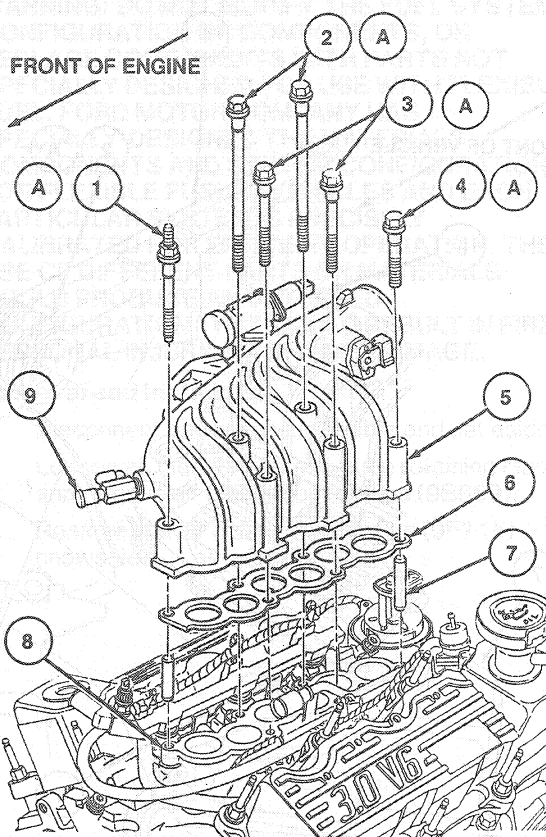
GENERATOR  
BRACE  
108315

NUT  
N620481-S538  
TIGHTEN TO  
16 N·m  
(12 LB-FT)

GENERATOR BELT  
ADJUSTING ARM  
ASSY 10C336

A8820-E

## Unleaded Gasoline Only

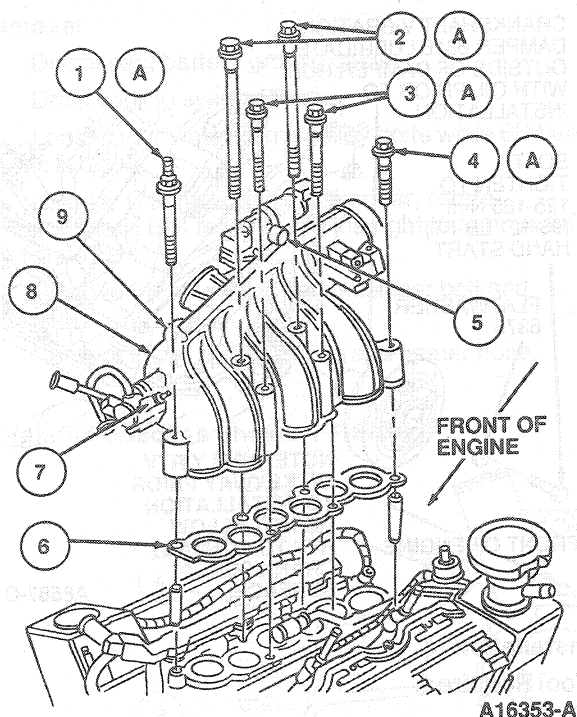


V7667-A

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<sup>1</sup>.
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

<sup>1</sup> Can purchased as a separate item.

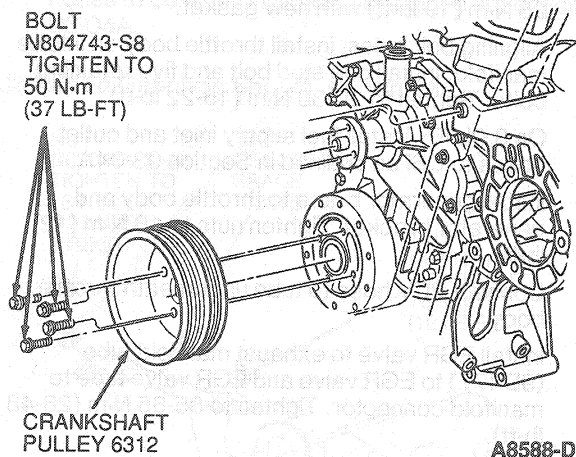


## IN-VEHICLE SERVICE (Continued)

- 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

CRANKSHAFT VIBRATION  
DAMPER 6316 LUBRICATE  
OUTSIDE OF DAMPER HUB  
WITH OIL PRIOR TO  
INSTALLATION

BOLT  
TIGHTEN TO  
125-165 N·m  
(93-121 LB-FT)  
HAND START

FLATWASHER  
6378

FRONT OF ENGINE

NOTE: APPLY RTV  
ON KEYWAY PRIOR  
TO INSTALLATION  
DO NOT ALLOW  
RTV TO CONTACT  
CRANK SEAL  
SURFACE.

A8587-C

## 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).  

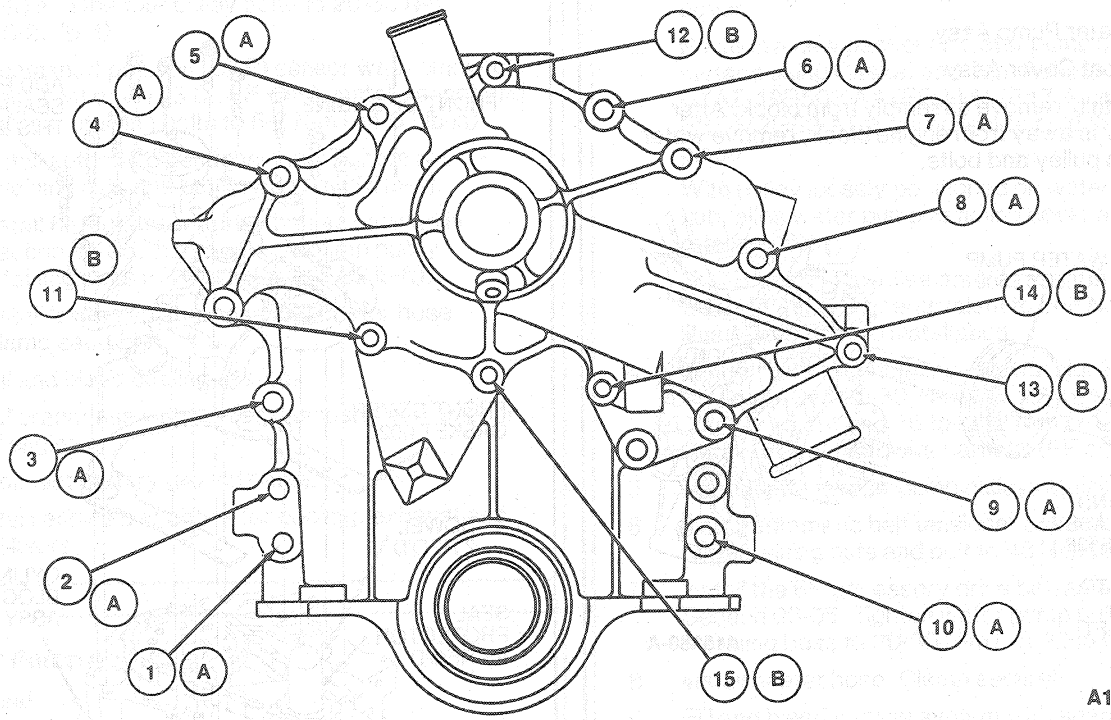
NOTE: Do not cut and seal oil pan gasket. Always replace with new rubber gasket.

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

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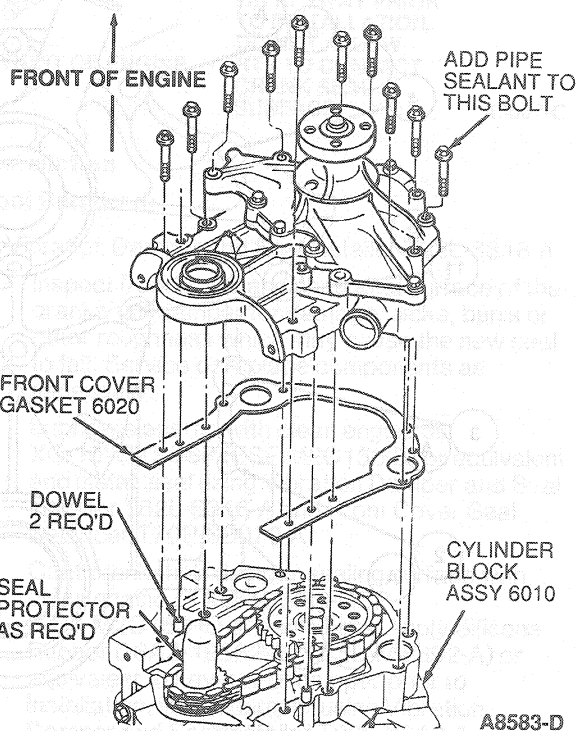
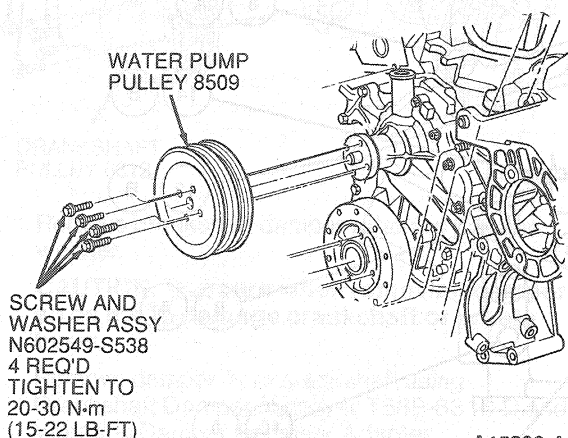
## IN-VEHICLE SERVICE (Continued)

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.



## 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.

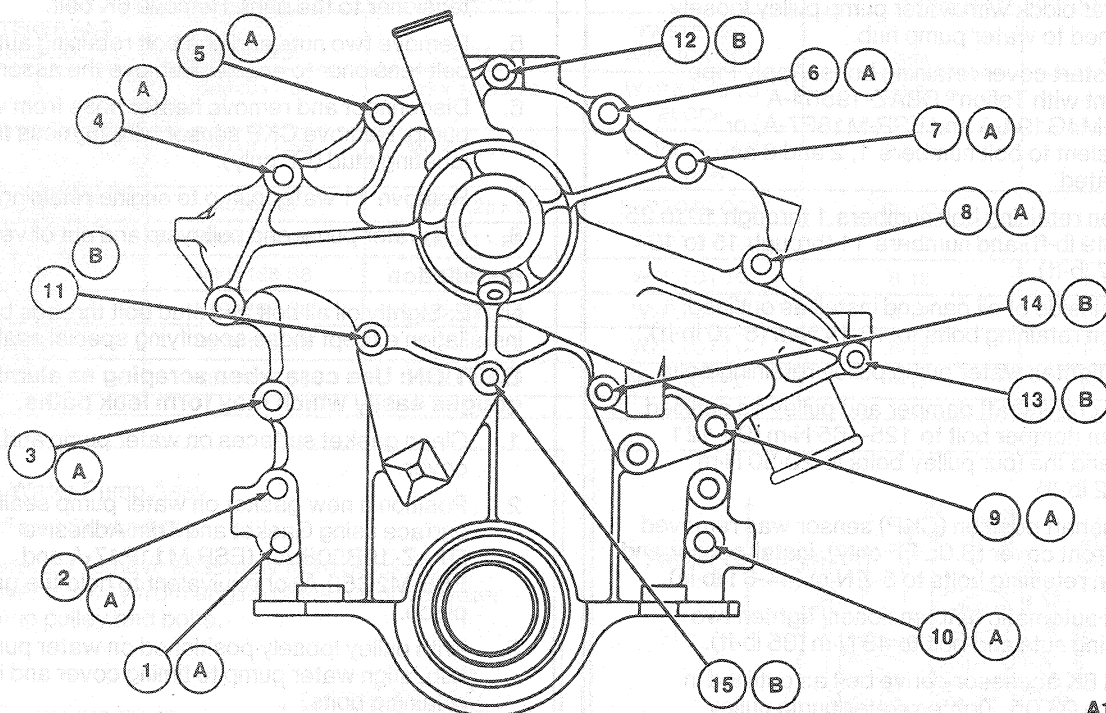
NOTE: Apply Pipe Sealant Vibraseal 516 EST-M4G208-B or equivalent to bolt No. 3 (as illustrated) prior to installation.

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**

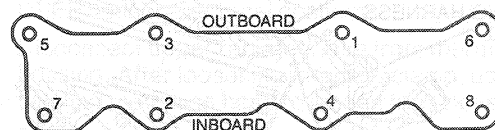
**CAUTION:** Check gasket for correct installation. New gasket will lay flat to the rocker cover in both the channel and fastener areas. If the gasket is installed incorrectly, oil leakage will occur.

**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

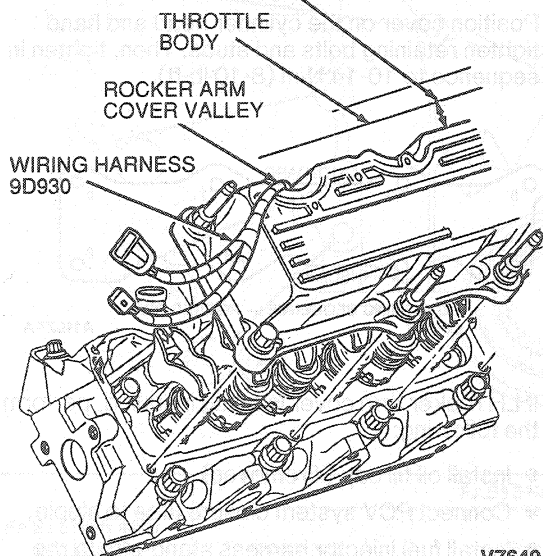
3. If LH rocker arm cover is being installed, perform the following:
  - Install oil fill cap (if removed).
  - Connect PCV system closure tube to nipple.
  - Install fuel injector harness stand-offs to the appropriate inboard rocker arm cover studs (two required).
4. For unleaded gasoline only, if RH 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:

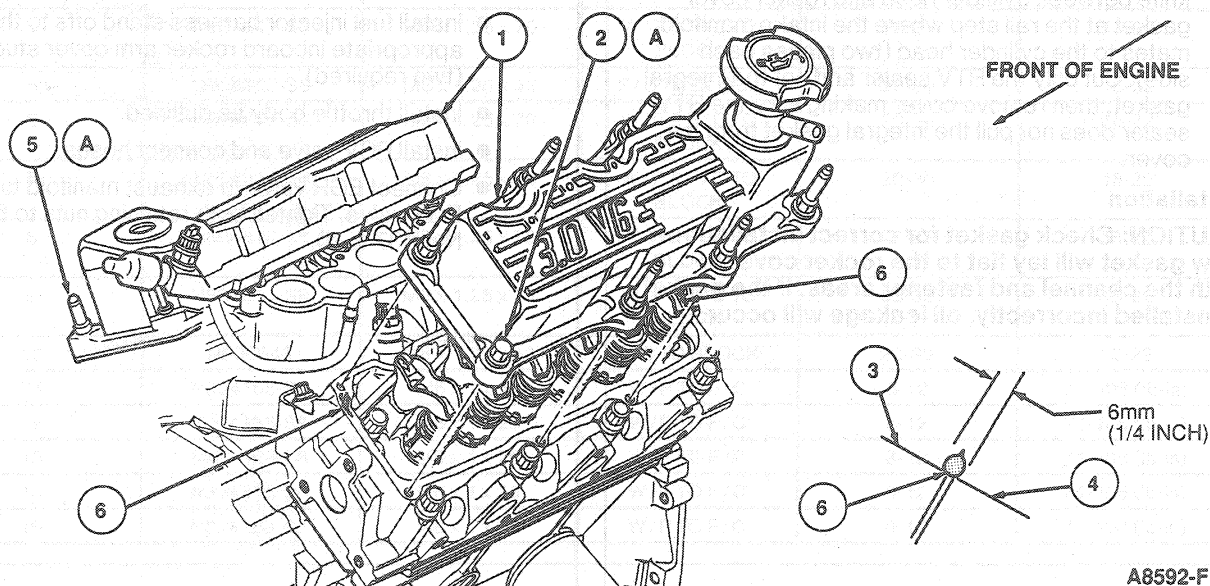
**CAUTION: Fuel charging wiring (9D930) connection must face the RH shock tower. Damage may occur to injector and fuel charging wiring if operation is not done.**

**NOTE: CHECK DISTANCE BETWEEN THROTTLE BODY AND ROCKER ARM COVER FOR WIRING HARNESS CLEARANCE THROUGH ROCKER ARM COVER VALLEY.**



V7649-A

Unleaded Gasoline Shown, FF Similar



A8592-F

- 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.

## 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.**



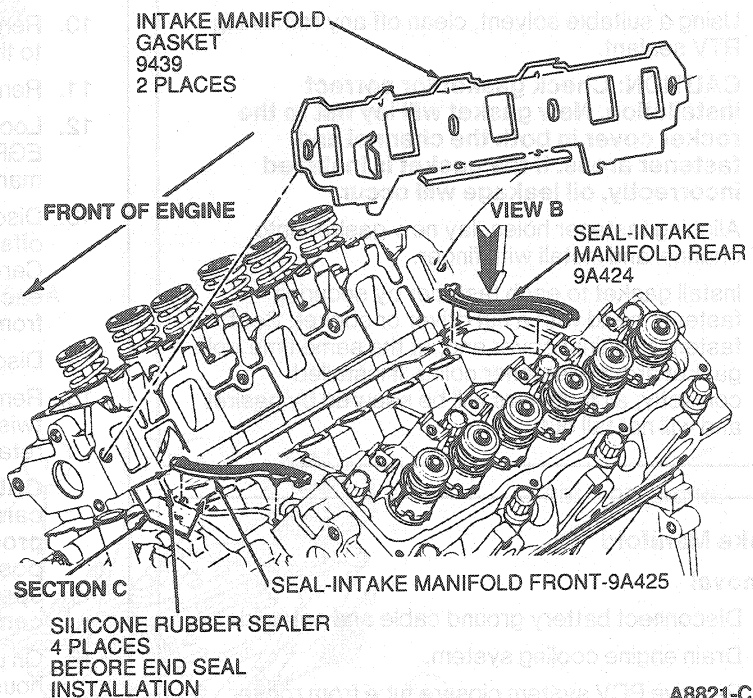
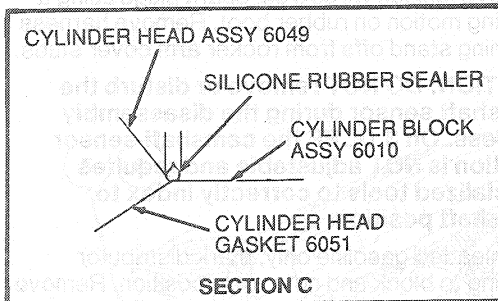
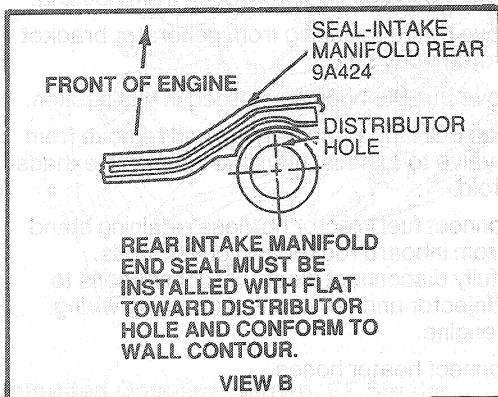
## IN-VEHICLE SERVICE (Continued)

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.**



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.

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).

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-M2C 153-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<sup>2</sup>. 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.

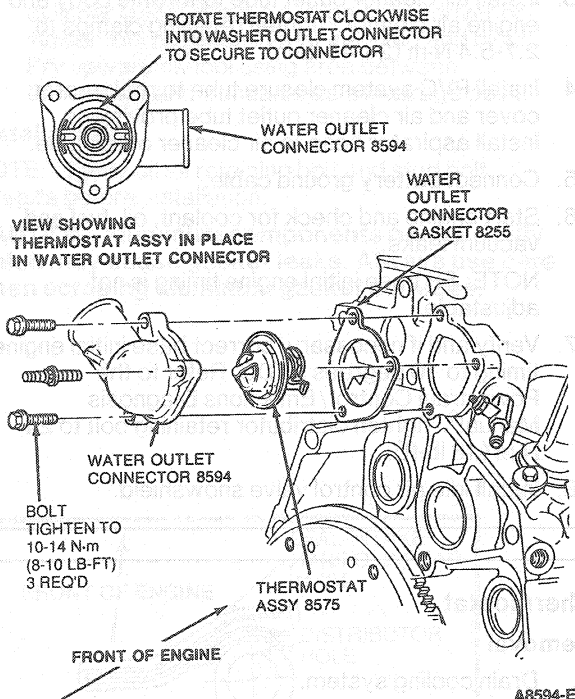
## Installation

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.

<sup>2</sup> 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**

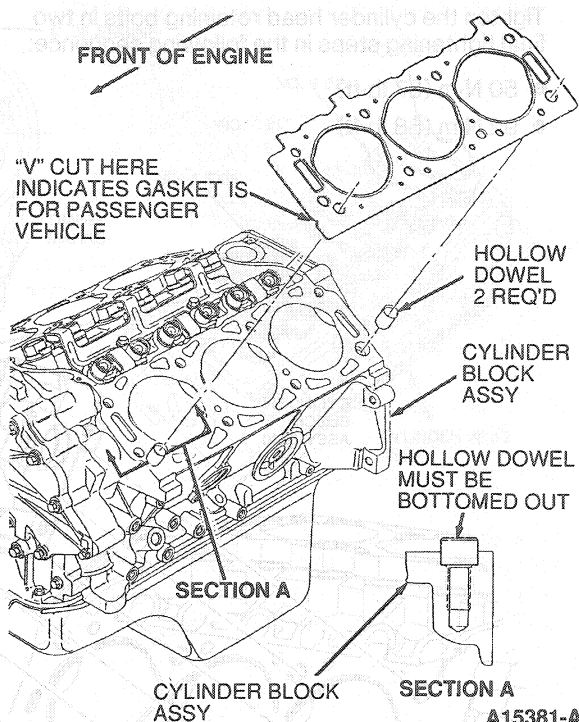
**CAUTION:** Always use new cylinder head bolts when installing cylinder head.

**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.



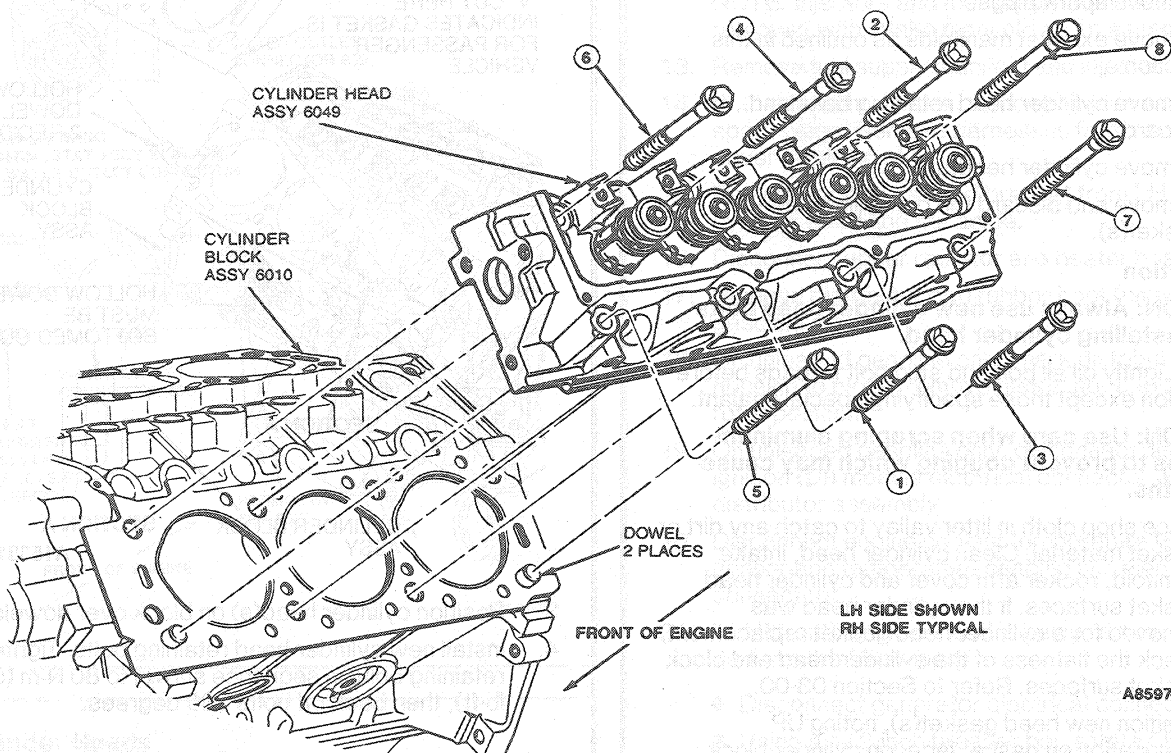
3. Position cylinder head(s) on block over dowels.
4. Install new cylinder head retaining bolts. Tighten retaining bolts in sequence shown to 80 N·m (59 lb-ft), then back off bolts 360 degrees.



## 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)

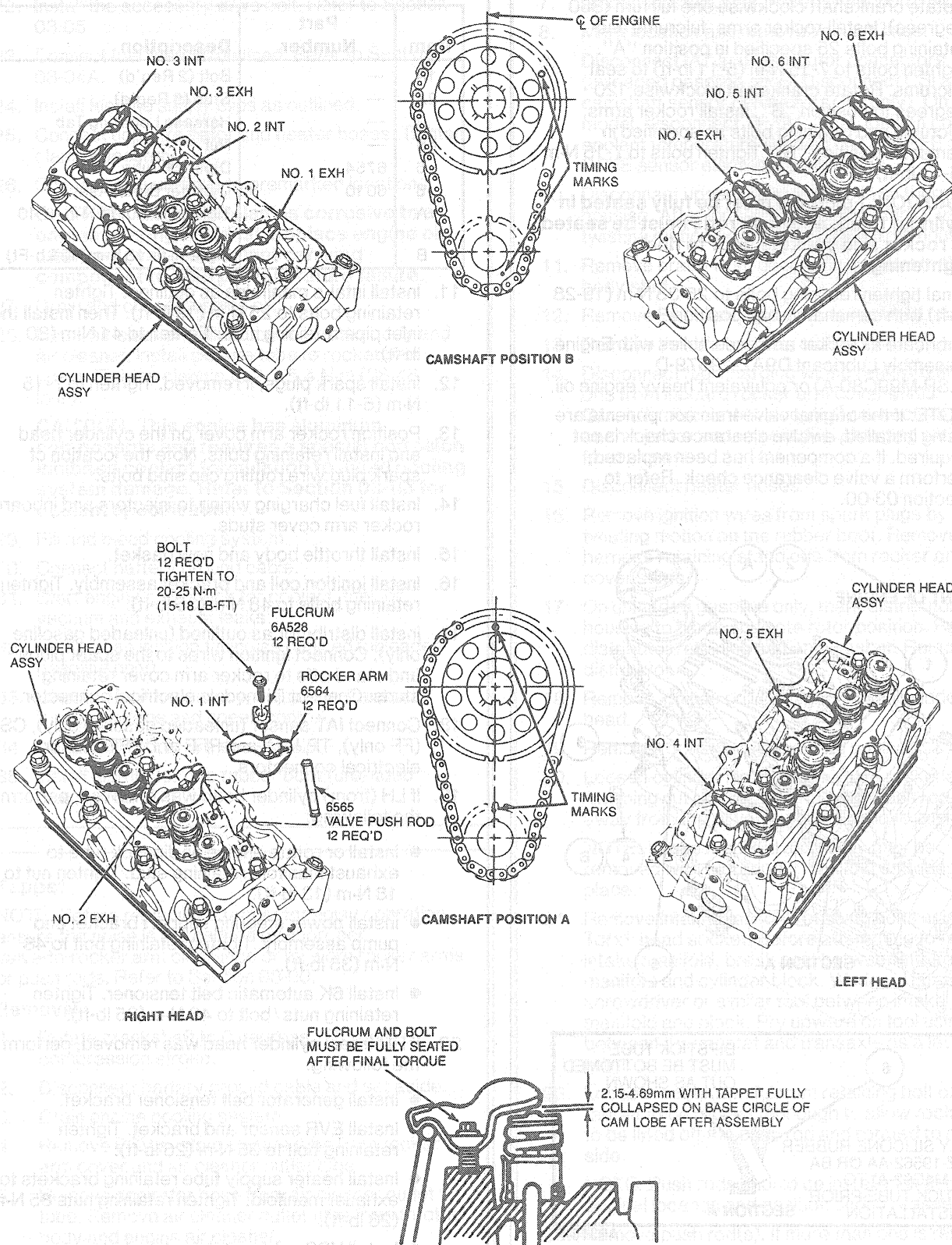


**NOTE:** When cylinder head retaining bolts have been tightened using the above procedure, it is not necessary to retighten the bolts after extended engine operation. However, the bolts can be checked for tightness if desired.

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)



A13097-B

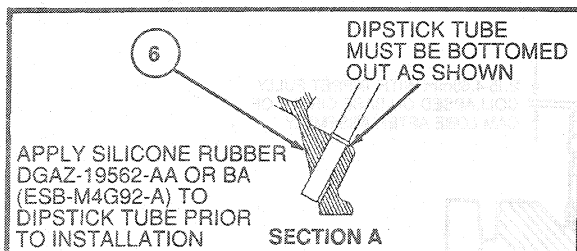
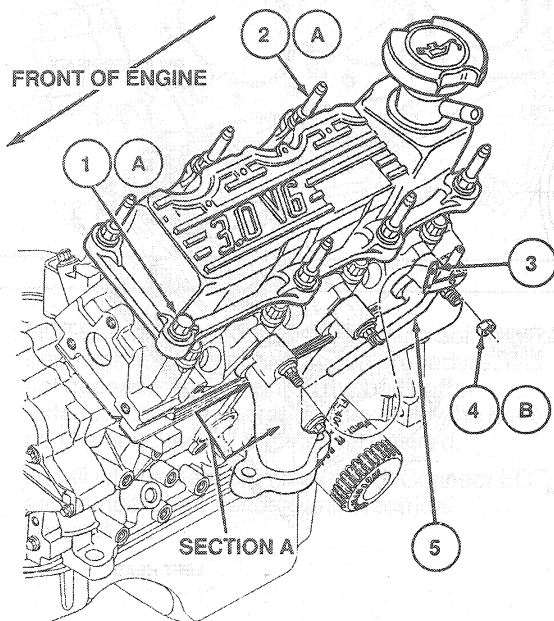
## IN-VEHICLE SERVICE (Continued)

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.



A9318-F

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.

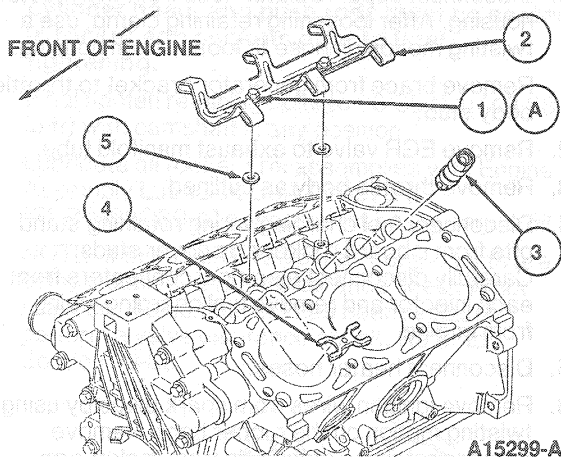


## IN-VEHICLE SERVICE (Continued)

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)

TA15299A

## 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.**

- 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.
- Lubricate tappet(s) and bore with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.
- Install tappet into bore.
- Aligning tappet flats, install tappet guide plate. Install plate with word "UP" and or button visible.

- 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).
  - 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.
  - Position intake gaskets onto cylinder heads. Align intake gasket locking tabs to provisions on cylinder head gaskets.
  - Install front and rear intake manifold seals. Secure with retaining features.
  - 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).
  - 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.
- 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.
  - Install rocker arm covers as outlined.
  - Install fuel charging wiring to each injector. Secure with stand offs to inboard rocker arm cover studs.
  - Install ignition coil to rear of LH cylinder head. Tighten retaining bolts to 40-55 N·m (29-41 lb-ft).
  - 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.
  - Install throttle body assembly and new intake manifold upper gasket as outlined in this section.
  - 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).
  - Install fuel lines. Refer to Section 03-04A.
  - 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.<sup>3</sup> 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.

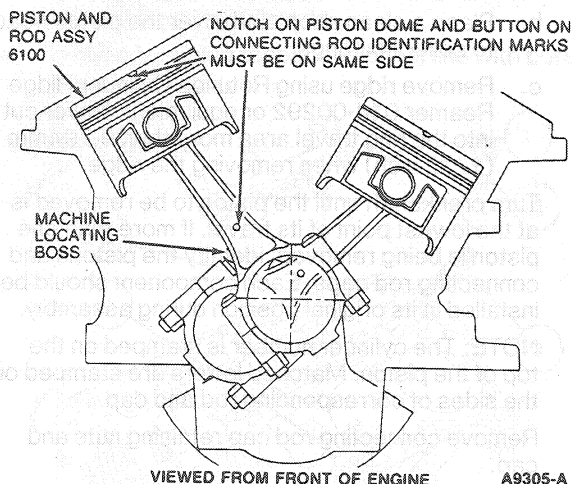
1. Lubricate cylinder wall and piston with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent heavy engine oil.
2. Install a 50mm (2 inch) piece of 3/8 inch fuel hose (or similar protector) on the connecting rod studs.

<sup>3</sup> 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.

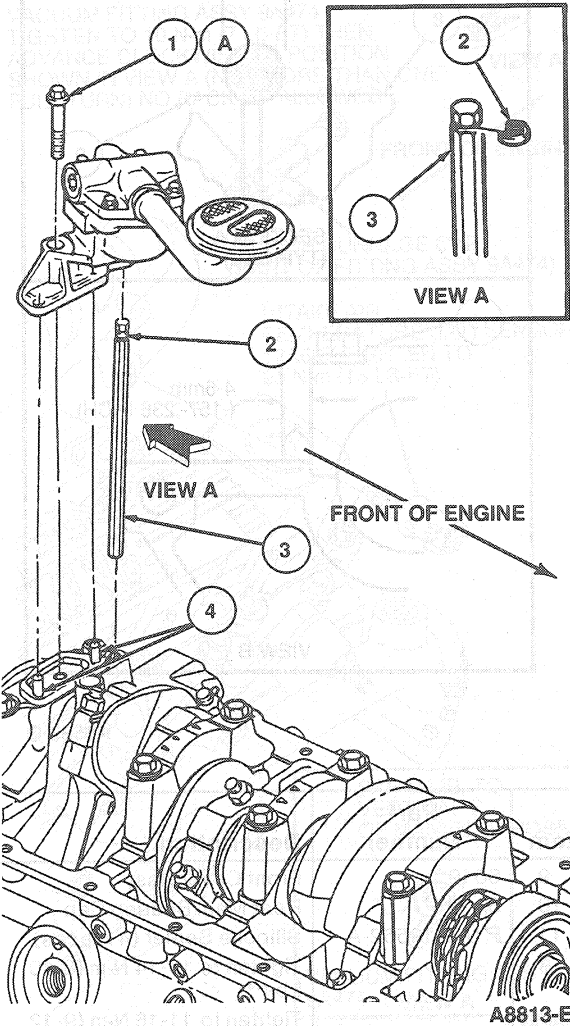
## Installation

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.

Item	Part Number	Description
1	6A751	Retainer—Oil Pump Intermediate Shaft
2	6A618	Oil Pump Intermediate Shaft
3	—	Dowel
4	—	Bolt
5	6A751	Retainer—Oil Pump Intermediate Shaft
6	6A618	Oil Pump Intermediate Shaft
7	—	Dowel
8	—	Bolt

(Continued)



IN-VEHICLE SERVICE (Continued)

SECTION A (TYPICAL)

VIEW B

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

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

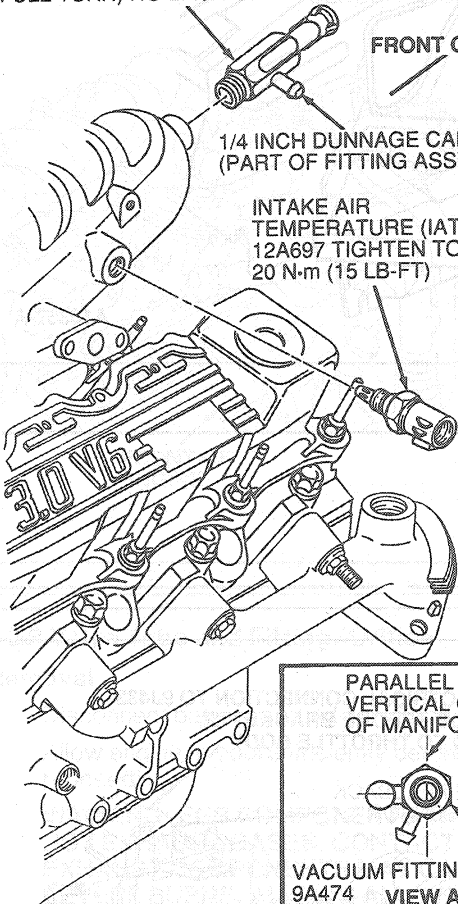
Located in the throttle body. When installing, tighten to 20 N·m (15 lb-ft).

VACUUM FITTING ASSY 9A474  
TIGHTEN TO 10 N·m (7 LB-FT) THEN  
ADVANCE CLOCKWISE TO POSITION  
SHOWN IN VIEW A (NOT MORE THAN ONE  
FULL TURN) NO BACK-UP ALLOWED

VIEW A  
FRONT OF ENGINE

1/4 INCH DUNNAGE CAP  
(PART OF FITTING ASSY 9A474)

INTAKE AIR  
TEMPERATURE (IAT) SENSOR  
12A697 TIGHTEN TO  
20 N·m (15 LB-FT)



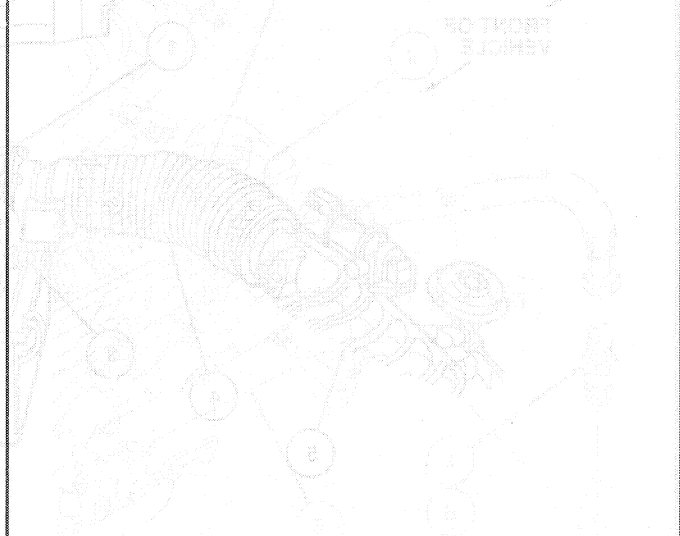
PARALLEL TO  
VERTICAL C  
OF MANIFOLD BOSS

VACUUM FITTING ASSY  
9A474 VIEW A

A8805-E

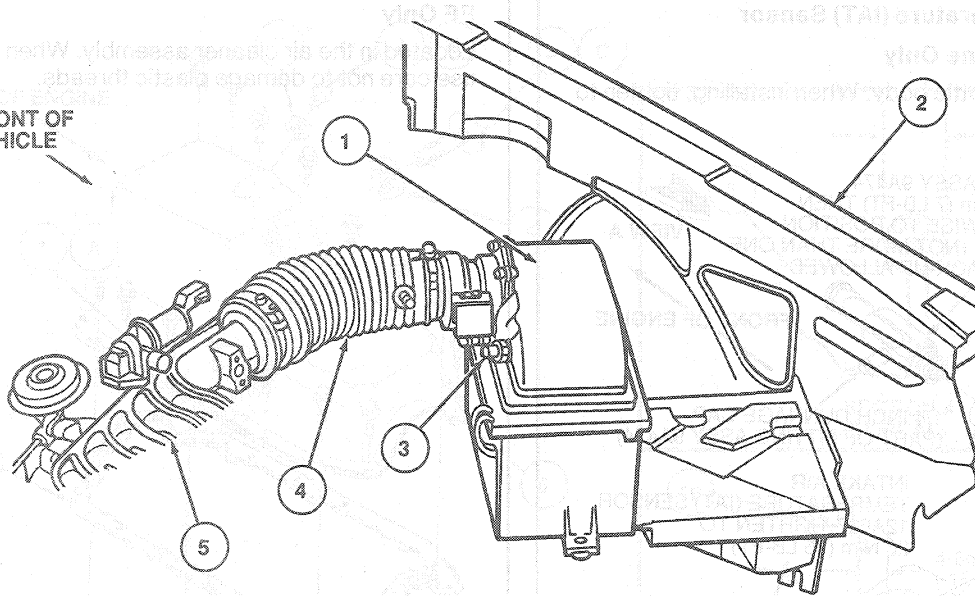
FF Only

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



Item	Number	Description
1	12A697	Intake Air Temperature Sensor
2	9A474	Vacuum Fitting Assy
3	12A697	Intake Air Temperature Sensor
4	9A474	Vacuum Fitting Assy
5	12A697	Intake Air Temperature Sensor
6	9A474	Vacuum Fitting Assy

## 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)**

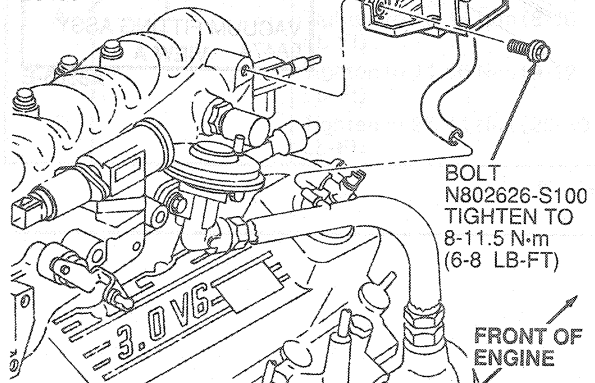
Located in the inlet pipes. When installing, tighten to 41 N·m (30 lb-ft).

**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.

**NOTE: ELECTRICAL CONNECTION TO 9J433 TO BE MADE BEFORE BRACKET IS ATTACHED TO THROTTLE BODY**

PRESSURE FEEDBACK  
EGR (PFE) SENSOR  
9J460



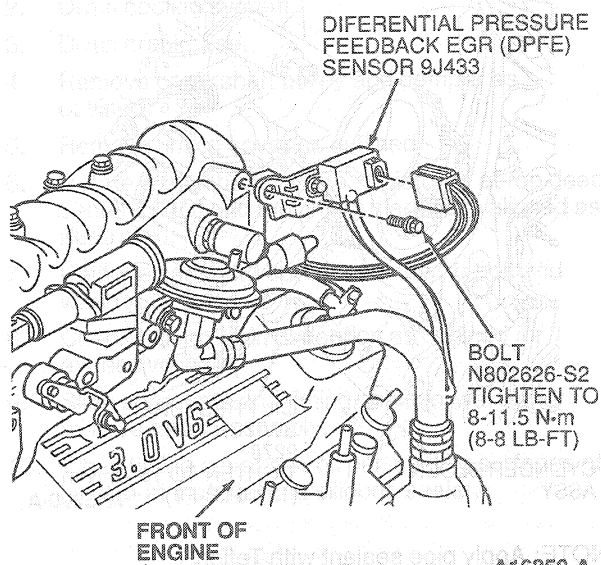
BOLT  
N802626-S100  
TIGHTEN TO  
8-11.5 N·m  
(6-8 LB-FT)

A14929-C

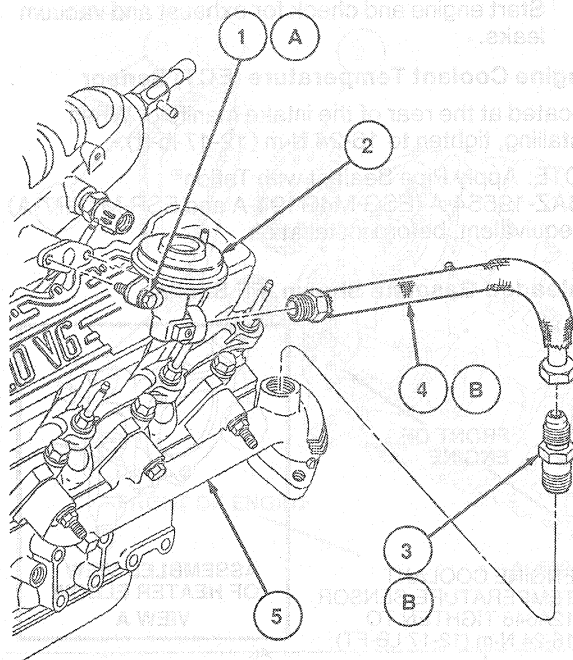
## IN-VEHICLE SERVICE (Continued)

**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.



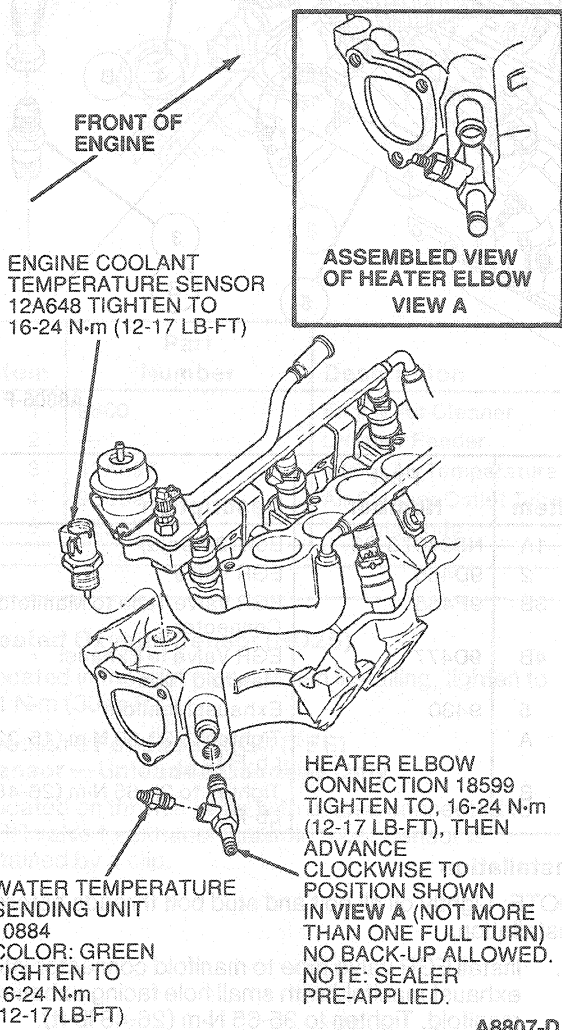
## IN-VEHICLE SERVICE (Continued)

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.

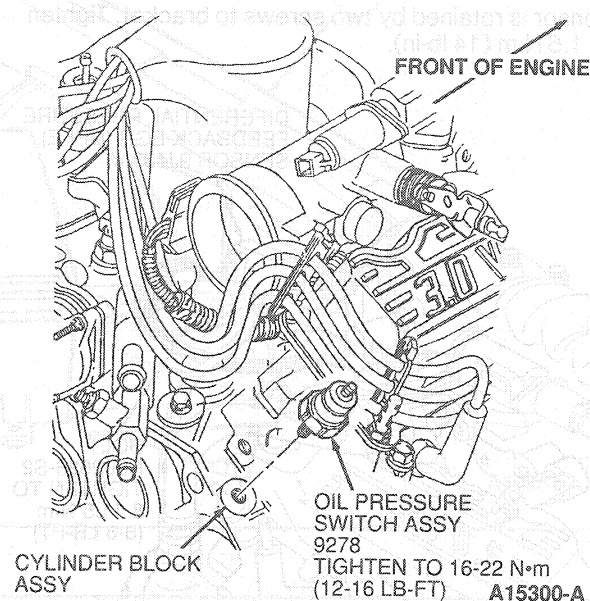
Coolant bypass fitting is located at the rear of the intake manifold. When installing, tighten to 16-24 N·m (12-17 lb-ft). Refer to illustration following ECT.

**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**

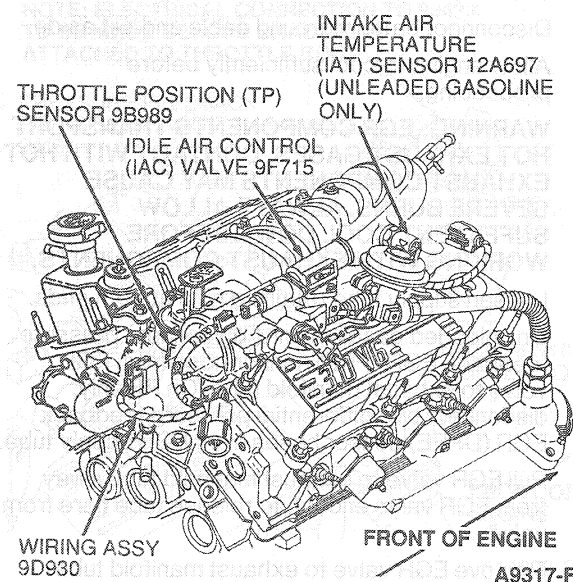
Located in the right rear face of cylinder block. When installing, tighten to 16-22 N·m (12-16 lb-ft).



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)

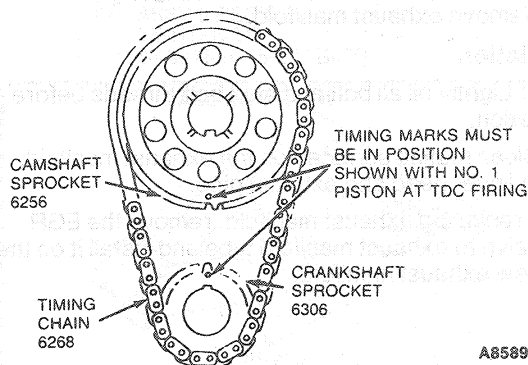
## Timing Chain

## Tool Required:

- Front Cover Seal Replacer T70P-6B070-A

## Removal

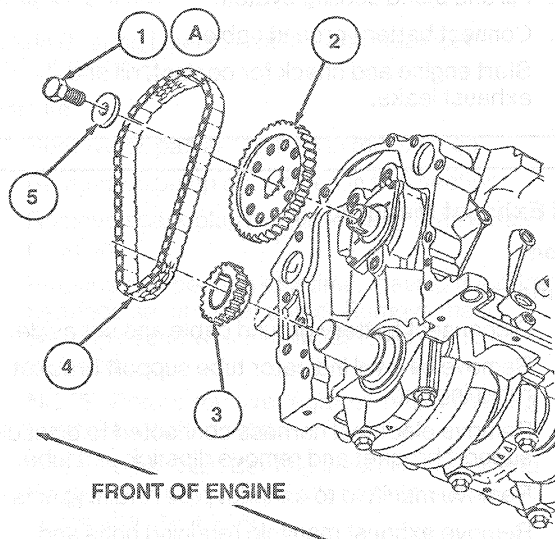
1. Disconnect battery ground cable.
2. Drain cooling system.
3. Drain crankcase.
4. Remove crankshaft pulley and damper as outlined.
5. Remove timing cover as outlined.
6. Rotate crankshaft until No. 1 piston is at top dead center (TDC) and the timing marks are aligned as illustrated.
7. Remove camshaft 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.



A8589-A

## 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.



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

**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

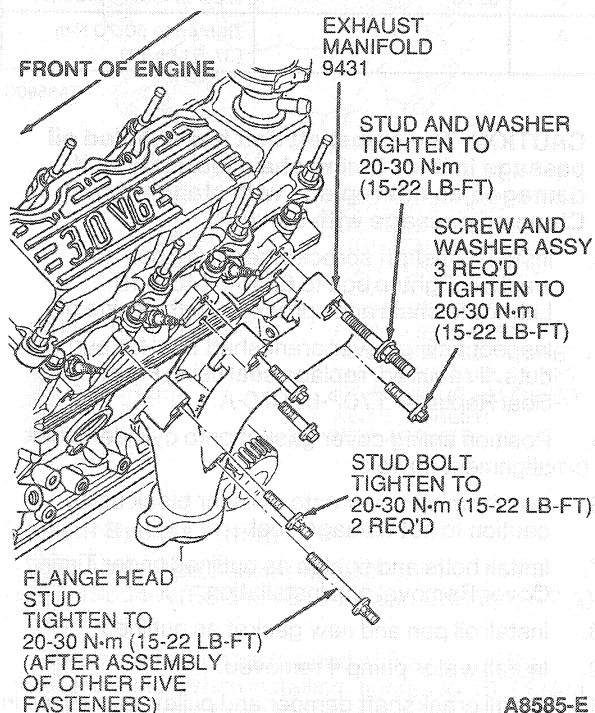
## Removal

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.

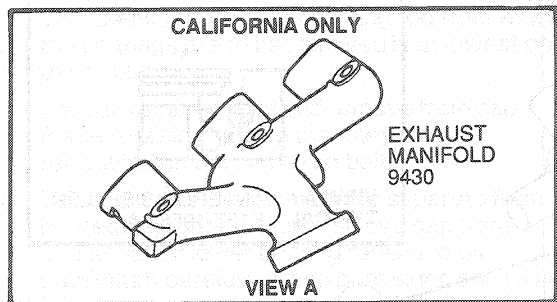
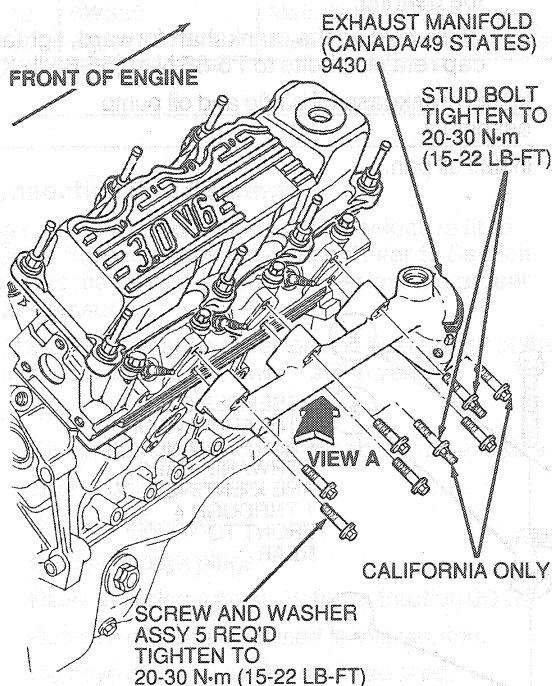
## Installation

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).



A8586-E

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).

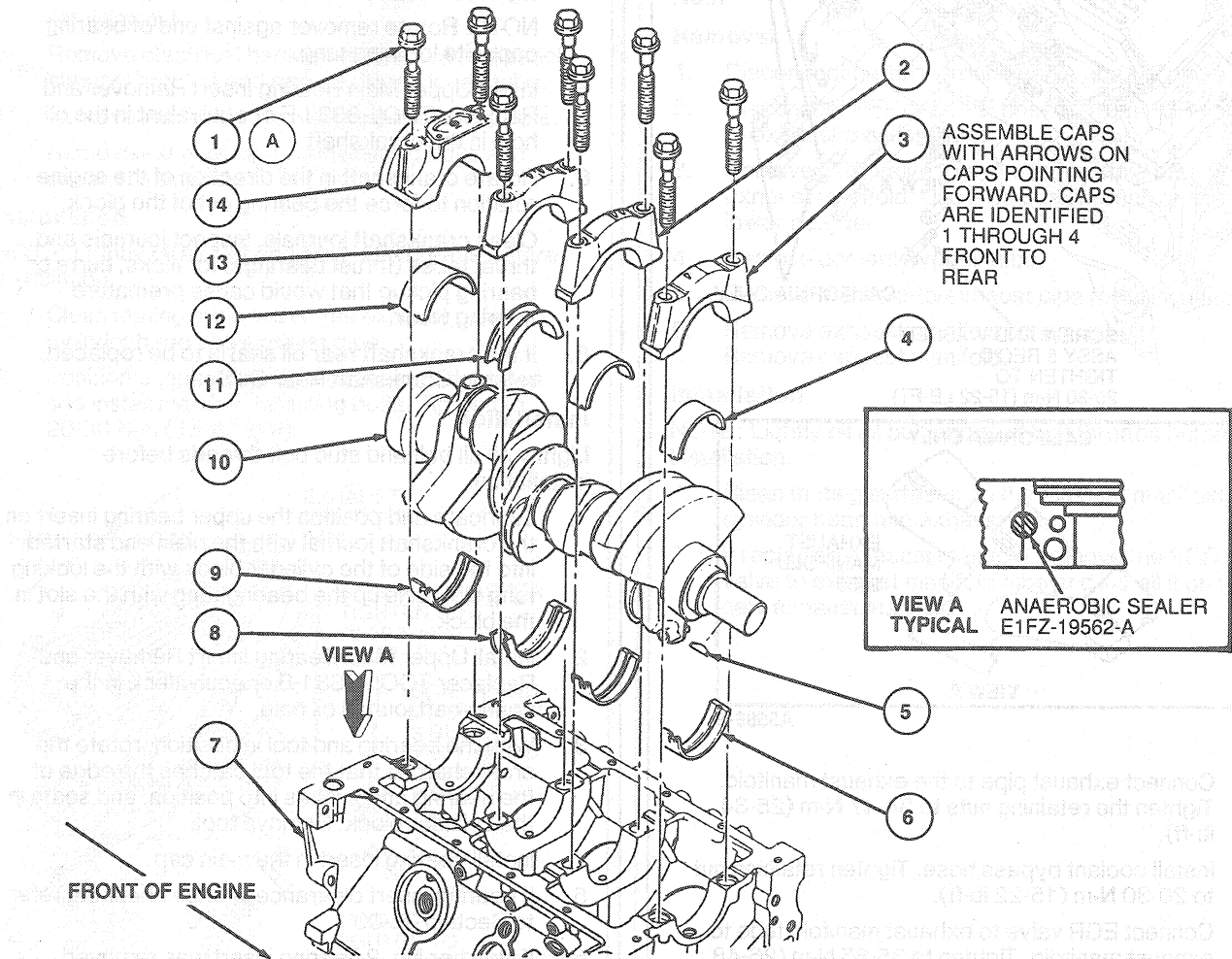
8. If the thrust bearing inserts were removed, perform the following:

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.



A8600-G

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 A	6A325	Rear Cap Assy 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

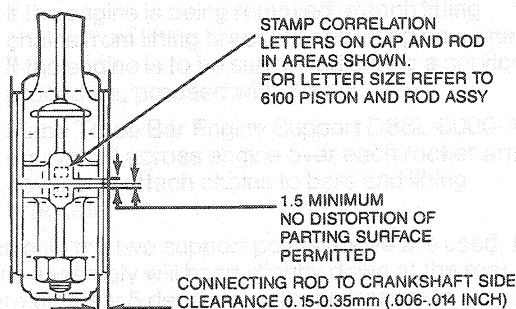
1. Disconnect battery ground cable and set aside.
2. Drain cooling system.
3. Drain crankcase.
4. Remove spark plugs.
5. Raise vehicle on hoist. Refer to Section 00-02.
6. Remove oil pan as outlined in this section.
7. Remove oil pump assembly if required.
8. Turn crankshaft until connecting rod from 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.

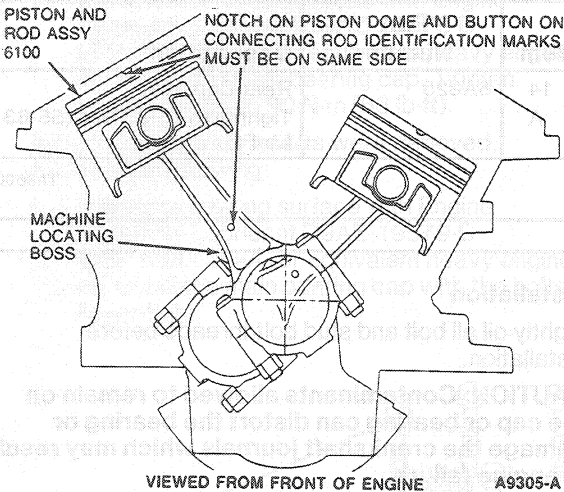
**CAUTION:** Contaminants allowed to remain on the cap or bearing can distort the bearing or damage the crankshaft journals which may result in engine failure.

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).

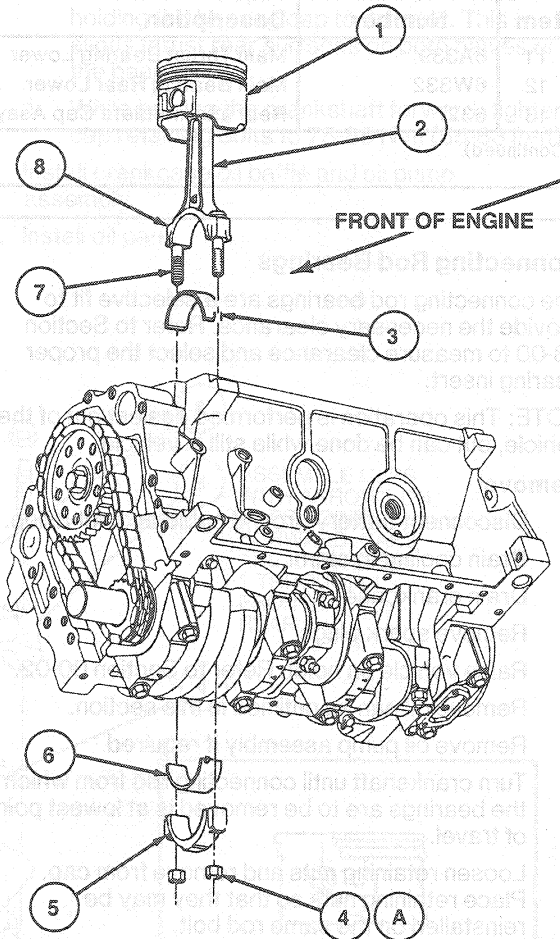


A14930-A

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 D81L-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

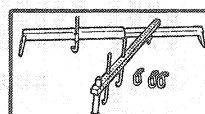
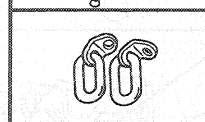
## Engine Lifting / Support Points

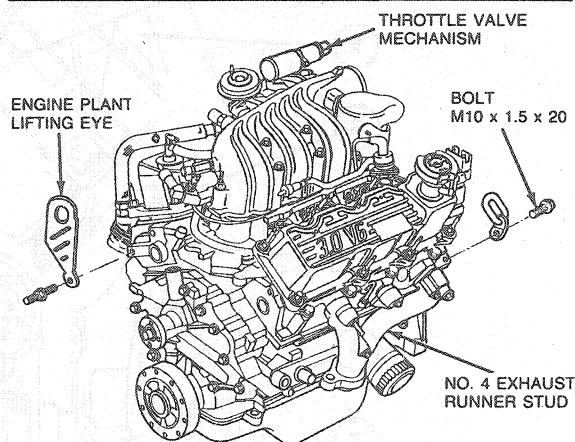
The lift points and procedures are to be used for removing the engine or supporting it during service, such as for transaxle removal. The equipment required is:

- 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.

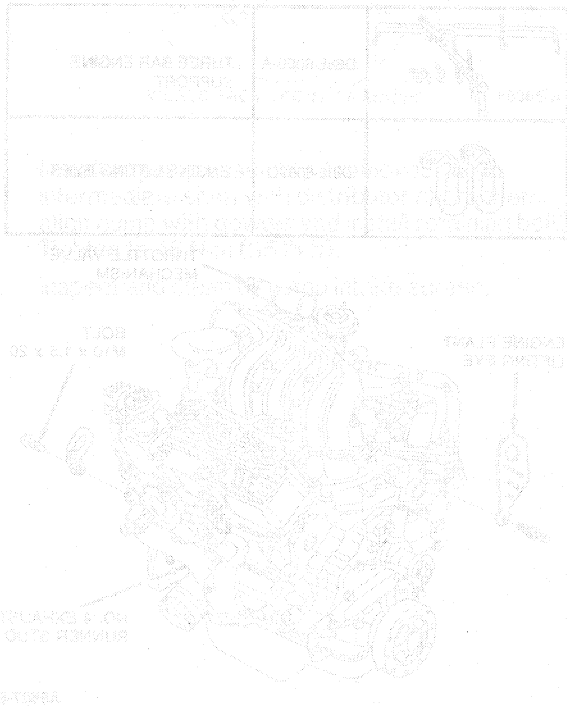
To eliminate either or both of these tilts, attach supports as follows:

**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.



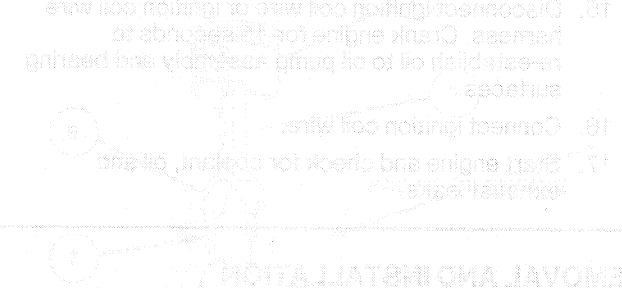
If the engine is being removed, attach lifting chains from lifting brackets and lifting equipment. If the engine is to be supported during a service procedure, proceed with Step 3.

3. Place Three Bar Engine Support D88L-8000-A or equivalent across engine over each rocker 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.

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.



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

Tools Required:  
 • Engine Lifting Bar, as D88L-8000-A  
 • Three Bar Engine Support D88L-8000-A  
 • Removal and Installation

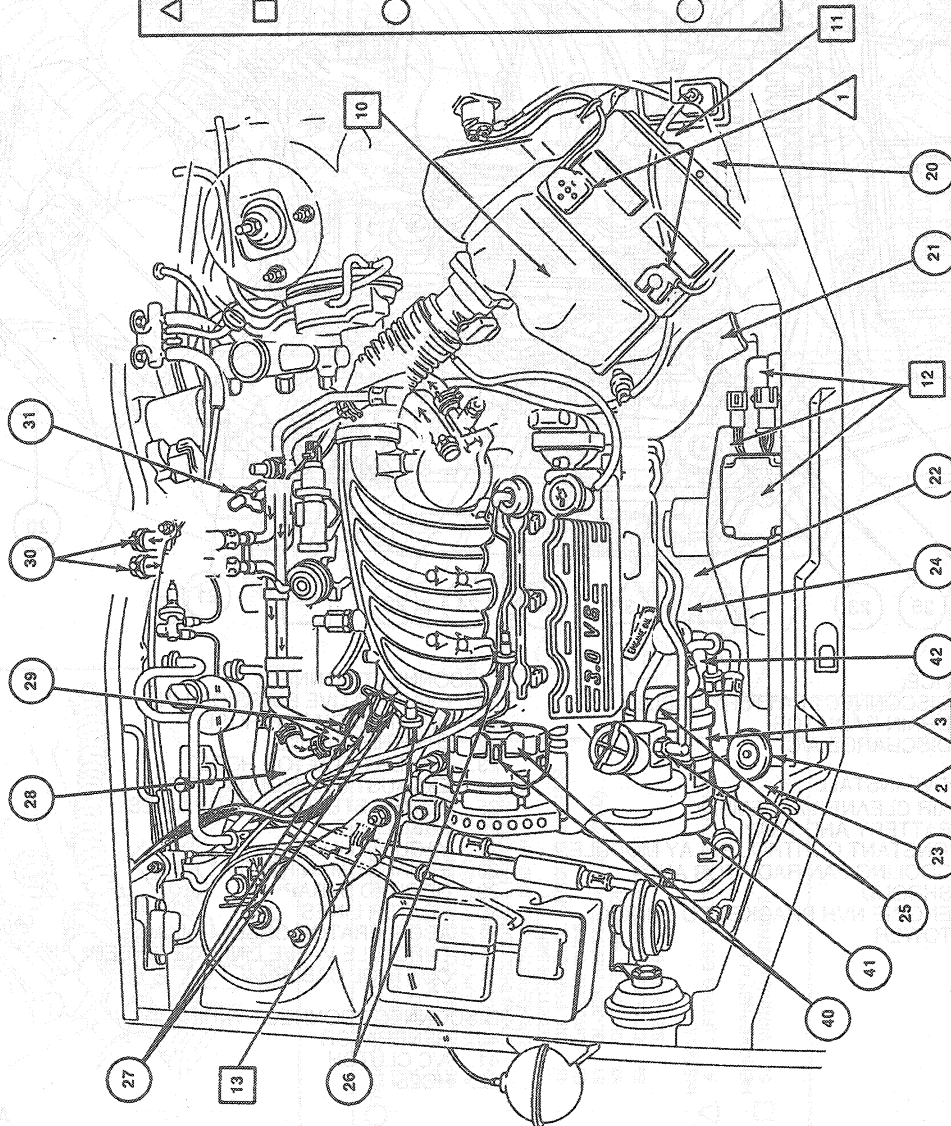
1. The engine assembly is removed out of the top without the transaxle.
2. Support the front (left) portion of the engine with a hook before disconnecting the transaxle from the base.
3. Lift the engine as outlined in the lifting points procedure.

REMOVAL	INSTALLATION

Lifting 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 for this service is as follows:  
 • 10' x 12' x 12' of 2x4's  
 • 10' x 12' x 12' of 2x4's  
 • 10' x 12' x 12' of 2x4's

## REMOVAL AND INSTALLATION (Continued)

UNLEADED GASOLINE ONLY



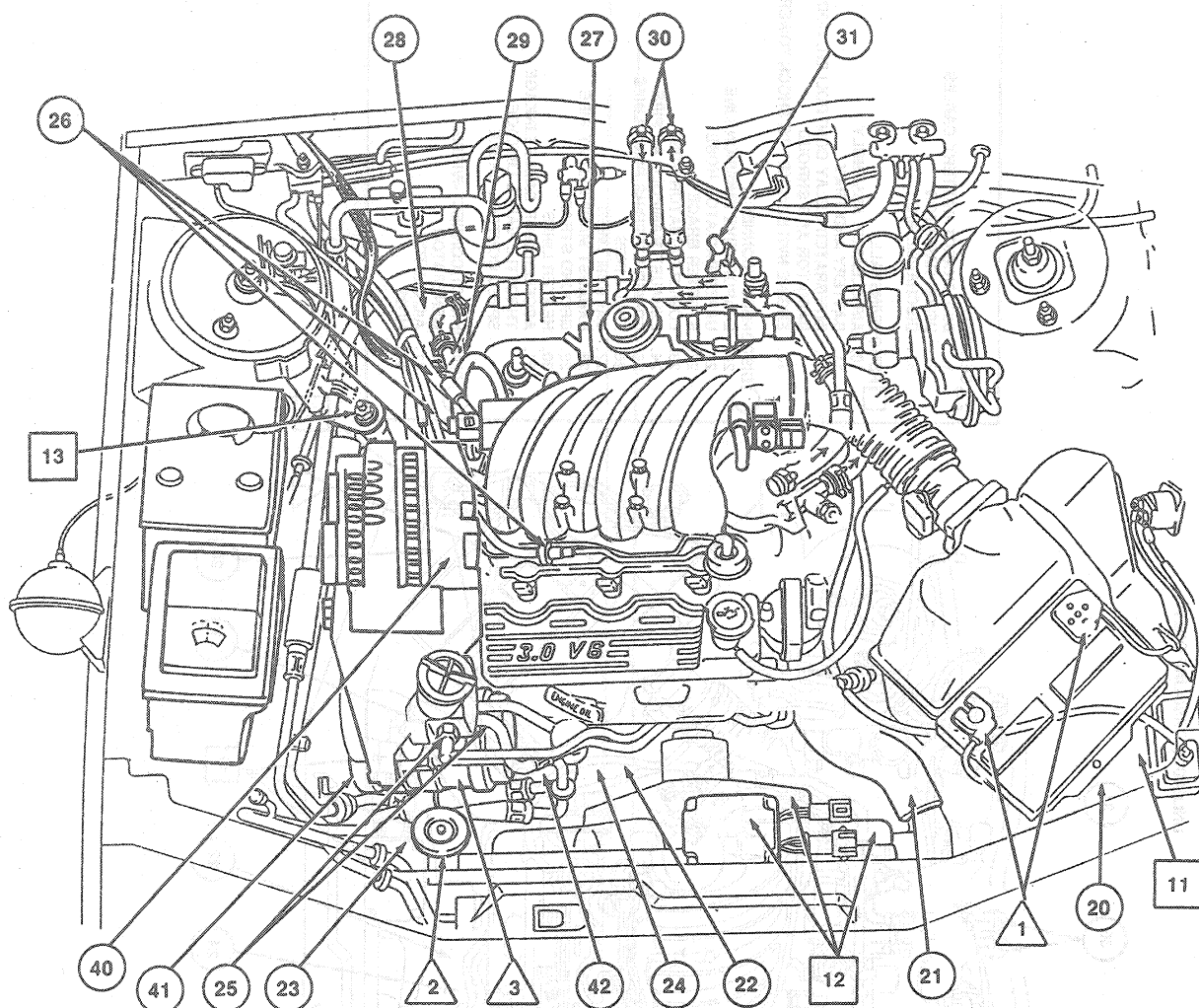
- △ SERVICE:
1. DISCONNECT BATTERY CABLES
  2. DRAIN RADIATOR
  3. DISCHARGE A/C
- REMOVE/INSTALL:
10. AIR CLEANER ASSEMBLY
  11. BATTERY AND TRAY
  12. INTEGRATED RELAY CONTROLLER, COOLING FAN RADIATOR AND SHROUD
  13. ENGINE NVH BRACKET TO SHOCK TOWER
- DISCONNECT/CONNECT:
20. EVAPORATIVE EMISSION 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

A9320-D

## REMOVAL AND INSTALLATION (Continued)

(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

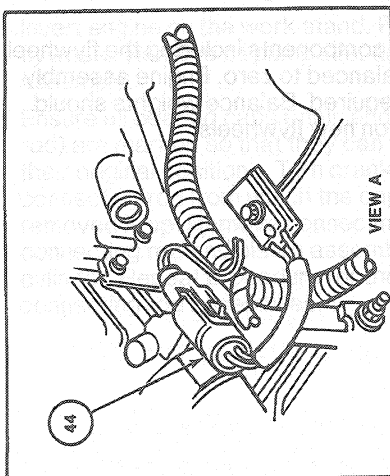
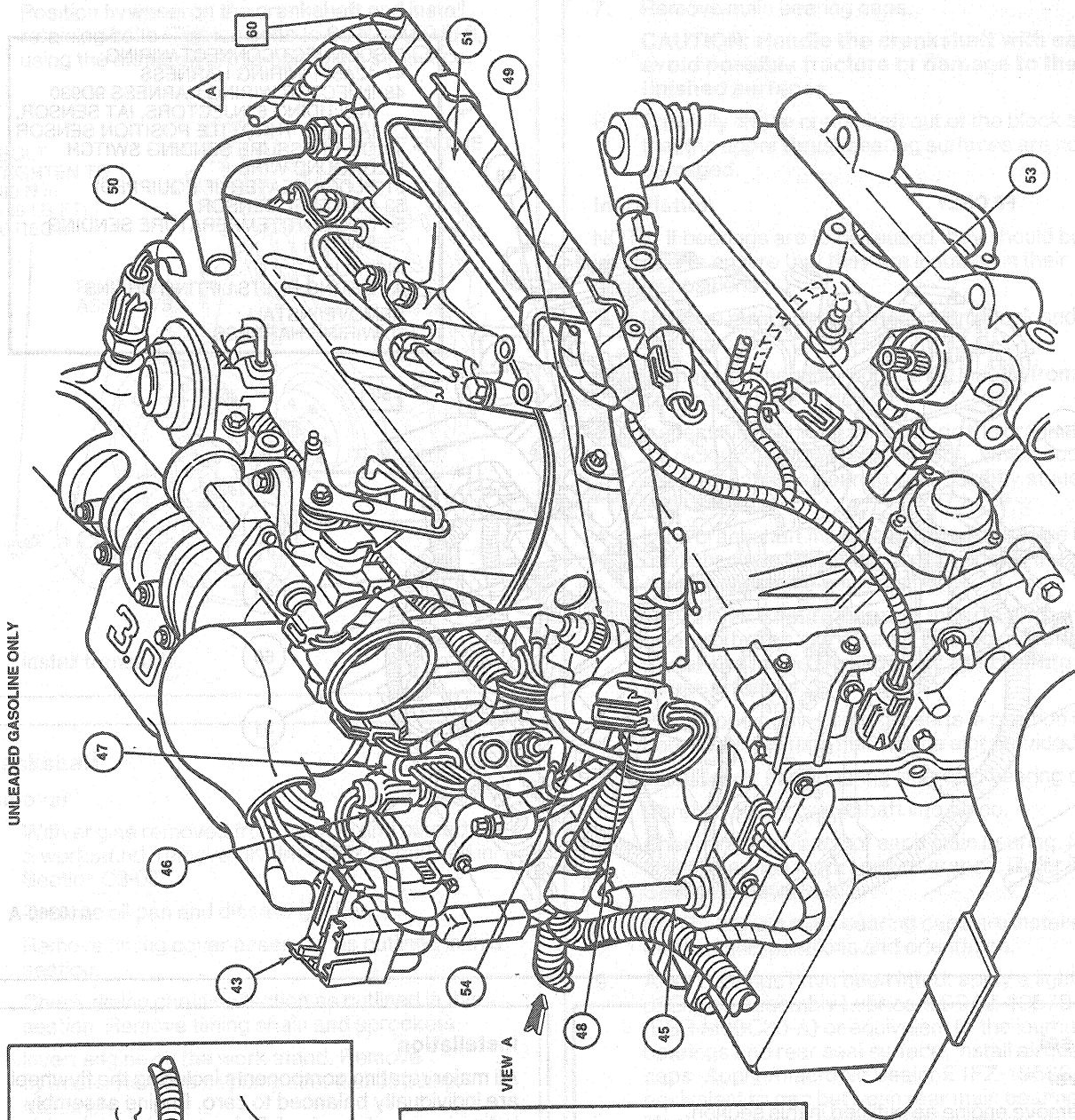
## ○ DISCONNECT/CONNECT-WIRING:

40. GENERATOR
41. A/C CLUTCH
42. HO2S

A16359-A

## REMOVAL AND INSTALLATION (Continued)

A9321-F



## DISCONNECT/CONNECT-WIRING:

- 43 IGNITION COIL
- 44 RADIO FREQUENCY SUPPRESSOR
- 45 COOLING FAN VOLTAGE RESISTOR
- 46 ENGINE COOLANT TEMP SENSOR
- 47 IGNITION CONTROL MODULE
- 48 INJECTOR WIRING HARNESS 9D930 INCLUDING 6 INJECTORS, IAT SENSOR, IAC, AND THROTTLE POSITION SENSOR
- 49 OIL PRESSURE SENDING SWITCH
- 50 GROUND WIRE
- 51 BLOCK HEATER (IF EQUIPPED)
- 53 OIL LEVEL SENSOR
- 54 COOLANT TEMPERATURE SENDING SWITCH

## INSTALL:

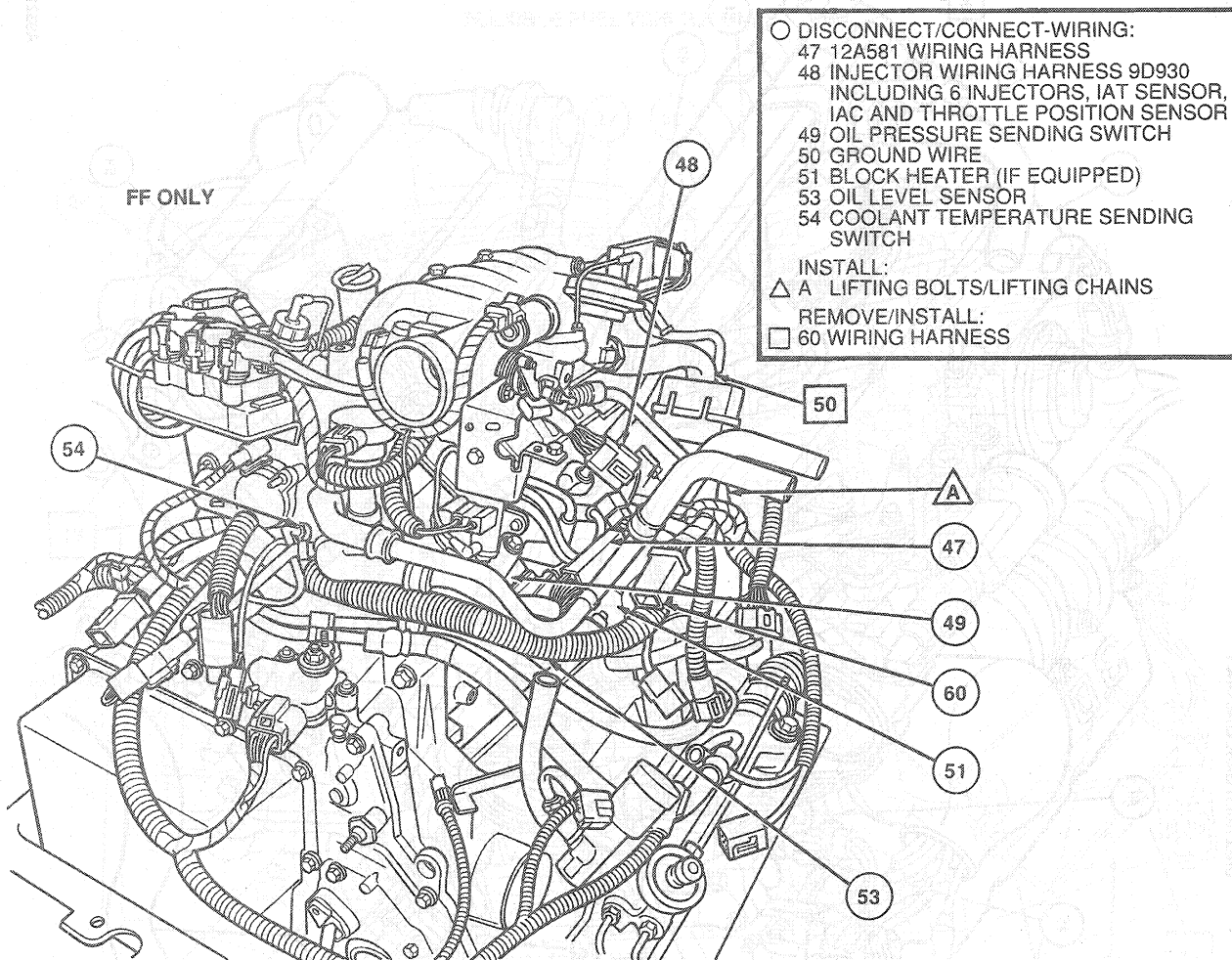
- △ A LIFTING BOLTS/LIFTING CHAINS

## REMOVE/INSTALL:

- 60 WIRING HARNESS



## REMOVAL AND INSTALLATION (Continued)



A16360-A

**Flywheel****Removal**

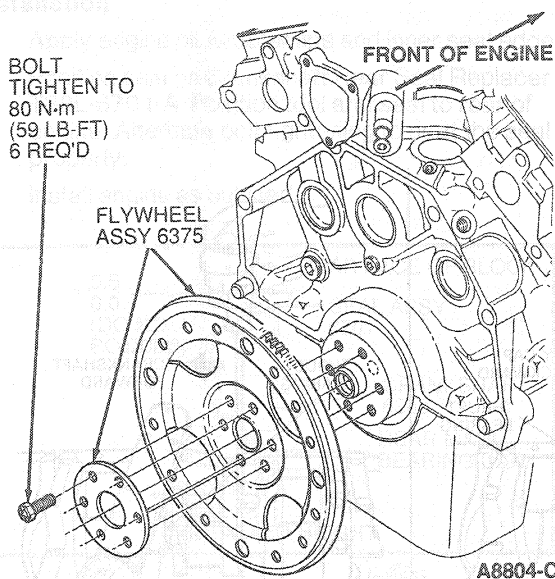
1. Remove engine as outlined in this section.
2. Remove flywheel retaining bolts and flywheel.

**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.

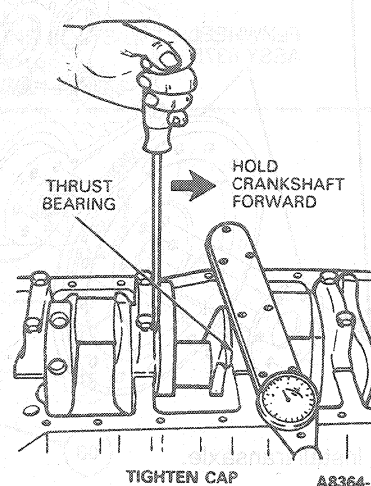
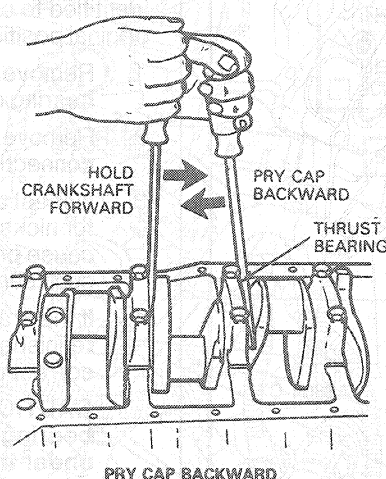
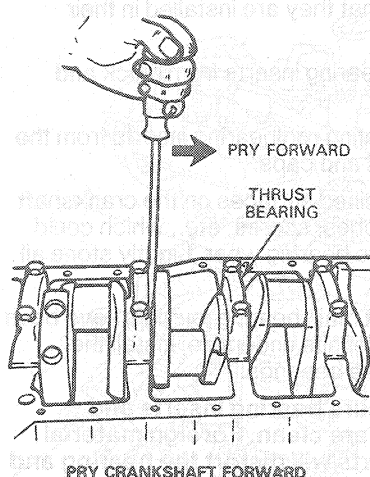
5. Place upper main bearing inserts in position in the bores with the tang fitted in the slot provided.
6. Install lower main bearing inserts in bearing caps.
7. Carefully lower crankshaft into place.
8. Check the clearance of each main bearing. Select fit the bearings for proper clearance. Refer to 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.



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.**

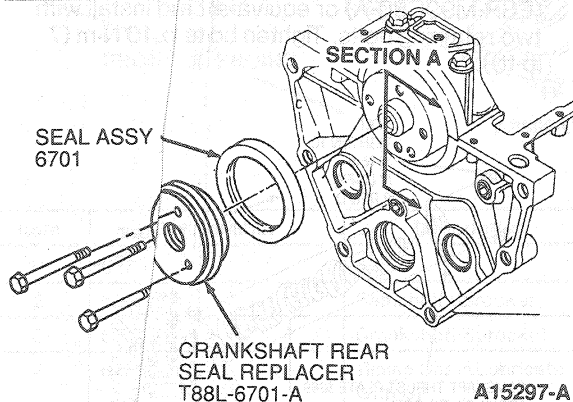
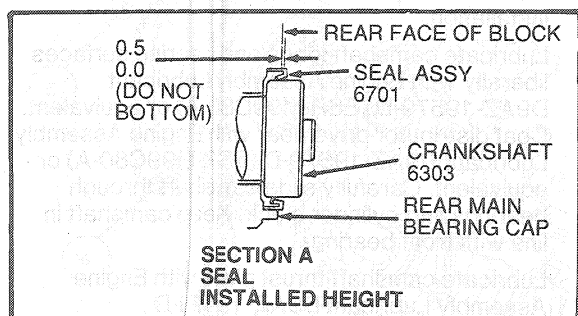
2. Using a sharp awl, punch one hole into the seal metal surface between the lip and block.

## 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 off 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.

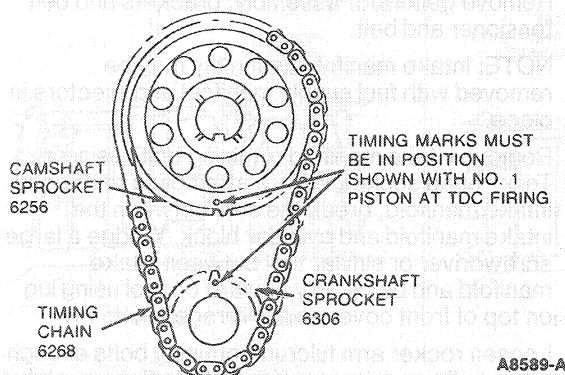


## REMOVAL AND INSTALLATION (Continued)

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.



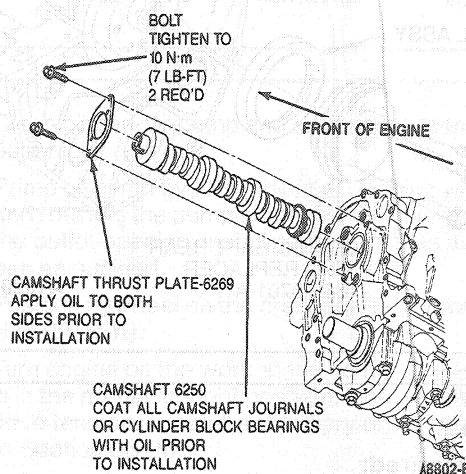
23. Check camshaft end play. Refer to Section 03-00. If clearance is excessive, replace camshaft thrust plate.
24. Check timing chain deflection. Refer to Section 03-00.
25. Remove camshaft sprocket retaining bolt and washer.
26. Remove timing chain and sprockets. Using one hand on the camshaft sprocket 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).

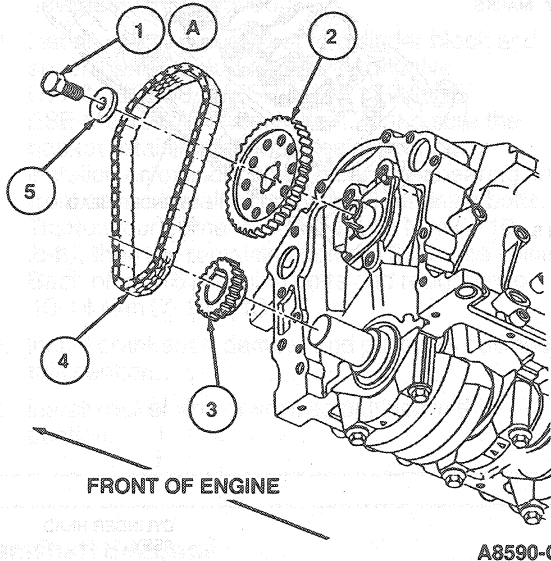


6. If installing a new camshaft, check endplay. Refer to Section 03-00. If clearance is excessive, replace camshaft thrust plate.

**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).



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)

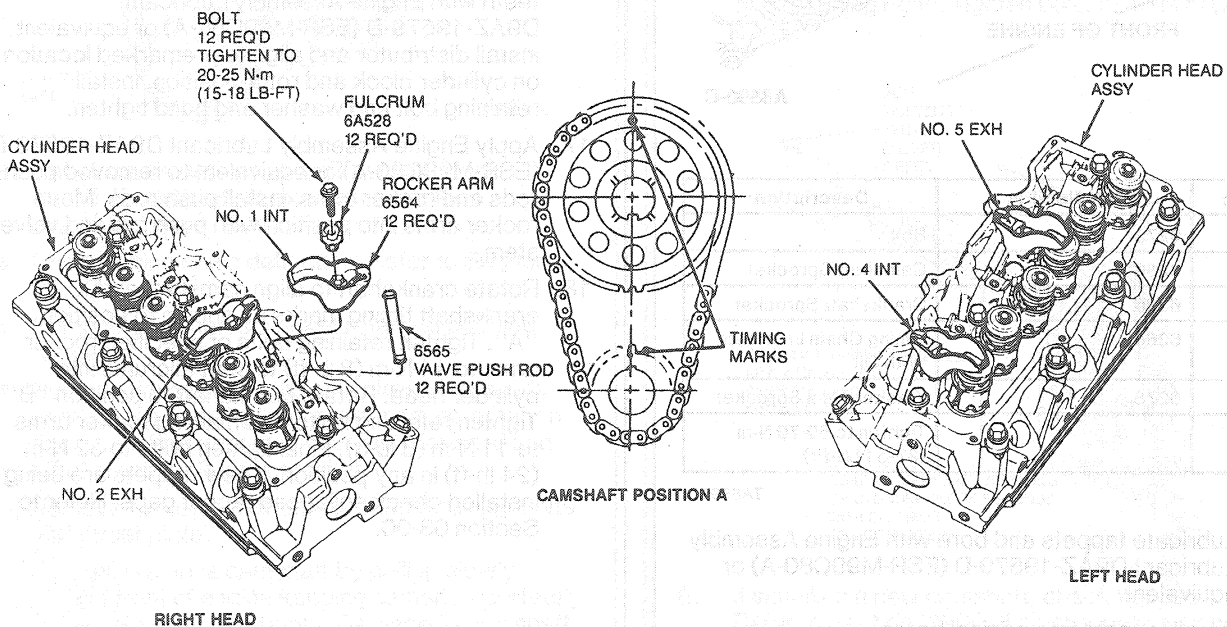
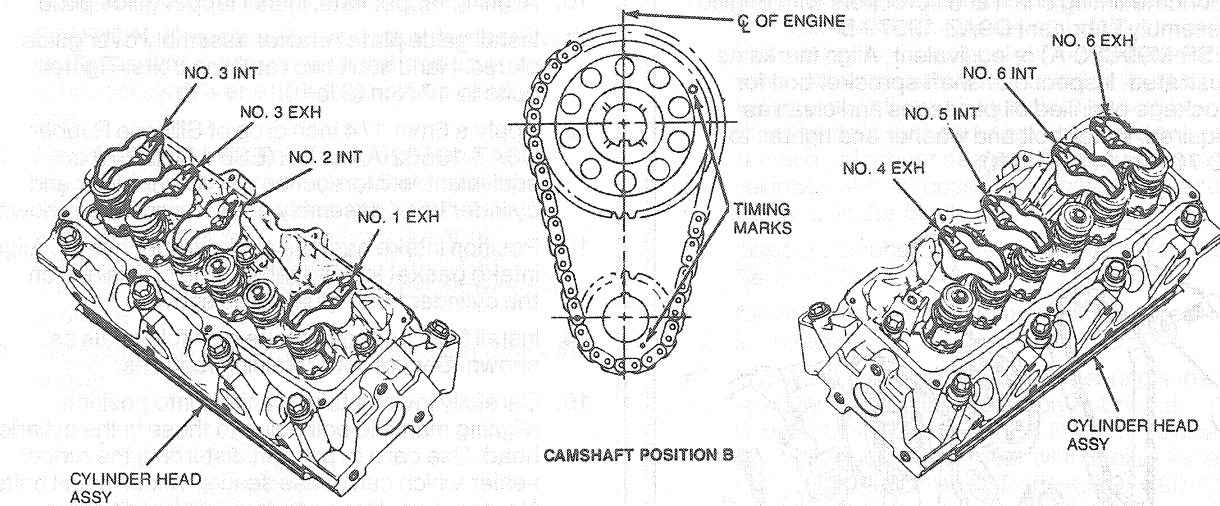
TA8590C

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.

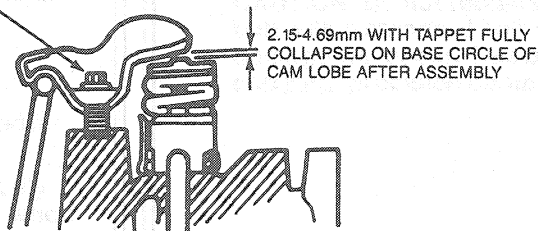
10. Aligning tappet flats, install tappet guide plate.
11. Install guide plate retainer assembly over guide plates. Hand start two retaining bolts. Tighten bolts to 12 N·m (9 lb-ft).
12. Apply a 6mm 1/4 inch drop of Silicone Rubber D6AZ-19562-AA or BA (ESB-M4G92-A) or equivalent to intersection of cylinder 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)

(Continued)



FULCRUM AND BOLT  
MUST BE FULLY SEATED  
AFTER FINAL TORQUE



A13097-B

## 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<sup>4</sup> (unleaded gasoline only).

## Camshaft Bearings

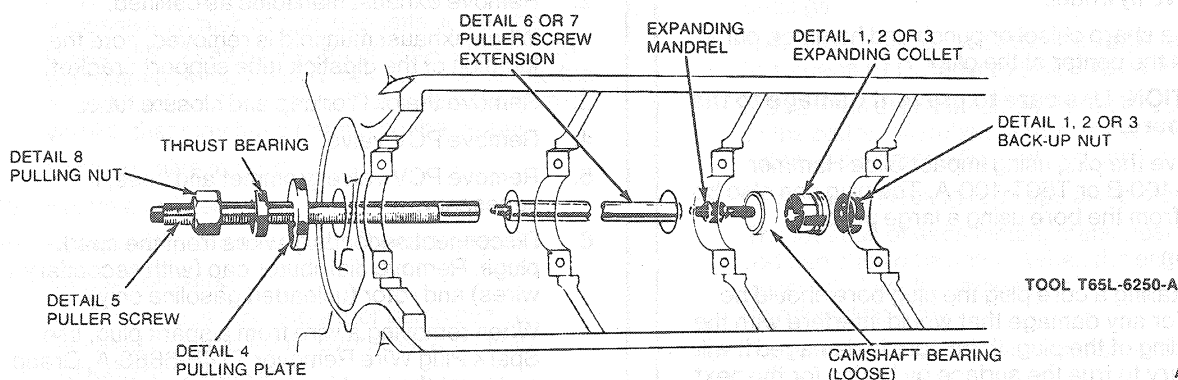
## Tool Required:

- 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.

<sup>4</sup> 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.

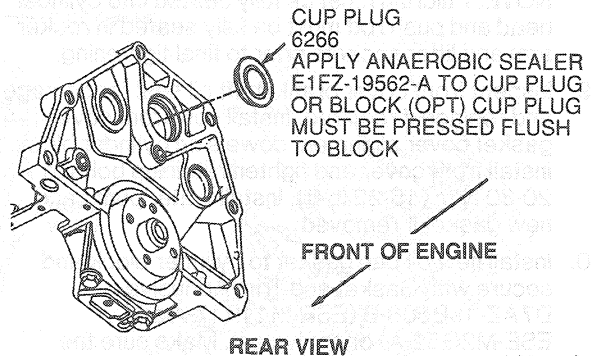
**CAUTION: Use care to prevent damage to the plug bore.**

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.



A9345-C

## 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.

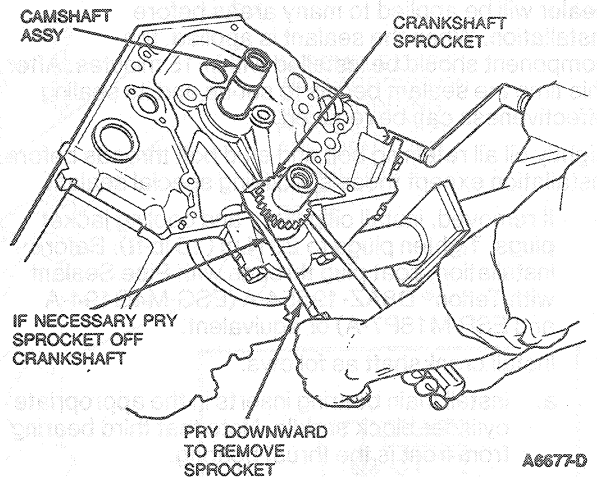
If the tappets are stuck in the bores due to excessive varnish or gum deposits, it may be necessary to use a magnet, or claw-type tool to aid removal. When using a remover tool rotate the tappet back and forth to loosen it from the gum or varnish that may have formed on the tappet.

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.

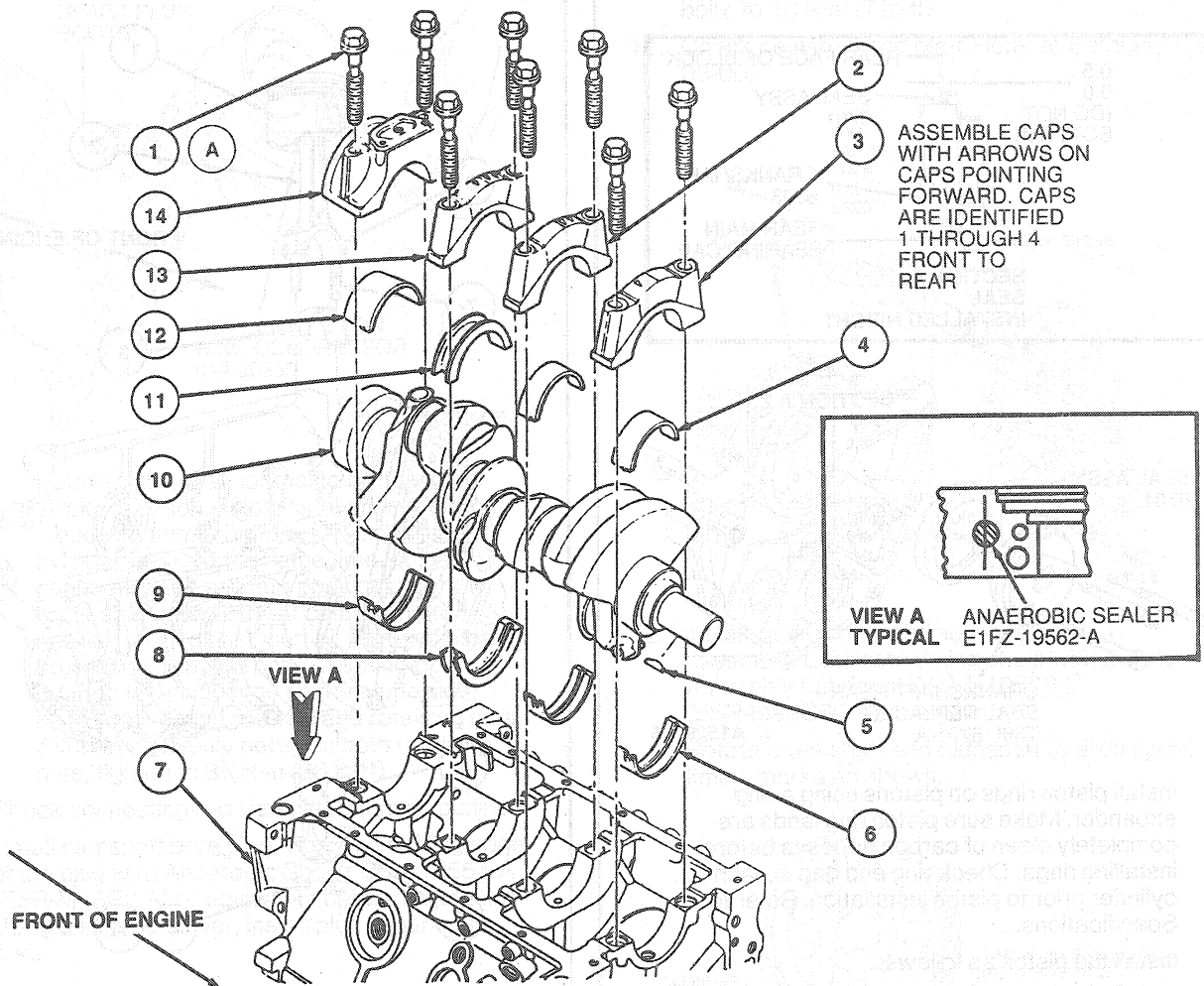
1. If removed, install oil gallery and cooling jacket plugs. Tighten plugs to 20 N·m (15 lb-ft). Before installation, coat plug threads with Pipe Sealant with Teflon® D8AZ-19554-A (ESG-M4G194-A and ESR-M18P7-A) or equivalent.
2. Install crankshaft as follows:
  - a. Install main bearing inserts in the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



A8600-G

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

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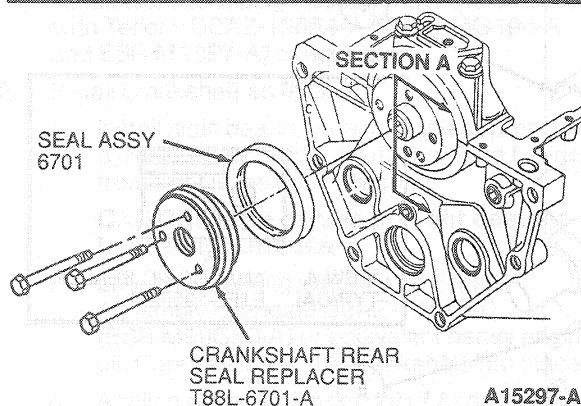
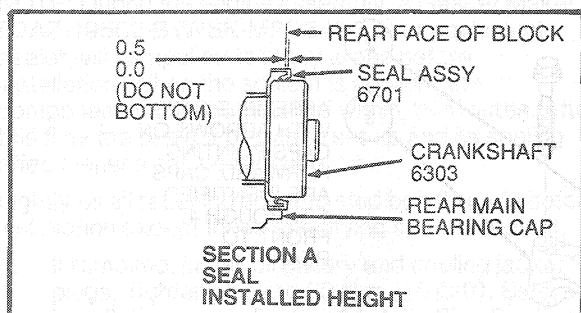
Item	Part Number	Description
8	6337	Main Thrust Bearing-Upper
9	6W331	Main Bearing Rear-Upper
10	6303	Crankshaft
11	6A339	Main Thrust Bearing Lower
12	6W332	Main Bearing Rear Lower
13	6327	Rear Intermediate Cap Assy
14	6A325	Rear Cap Assy
A		Tighten to 75-85 N·m (55-63 Lb·Ft)

TA8600G

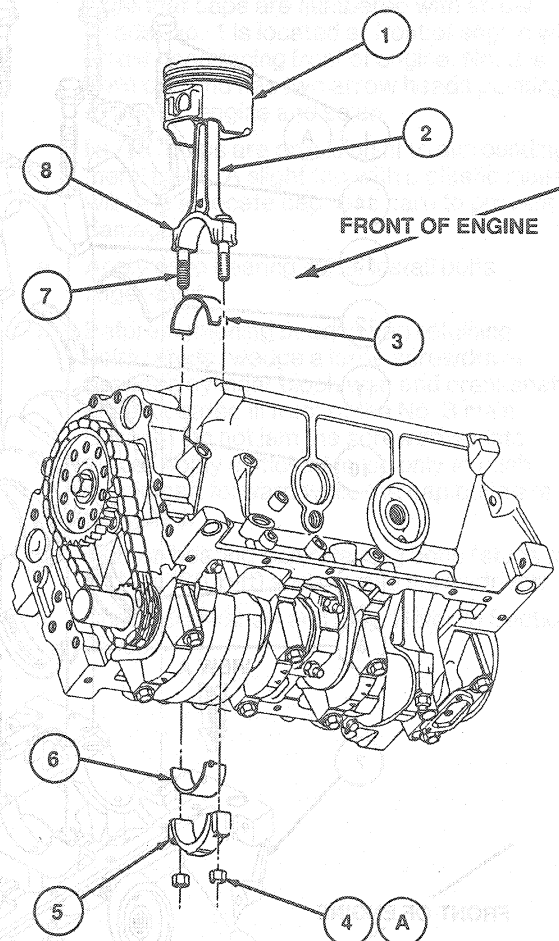


## DISASSEMBLY AND ASSEMBLY (Continued)

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



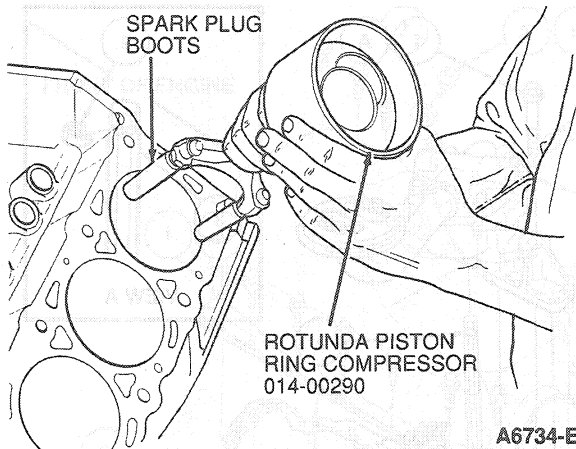
4. Install piston rings on pistons using a ring expander. Make sure piston ring lands are completely clean of carbon deposits before installing rings. Check ring end gap in each cylinder prior to piston installation. Refer to Specifications.
5. Install the piston as follows:
- Install bearing inserts in the connecting rods and the connecting rod caps. Make sure bearing locating tang is properly located and bearing is completely seated.
  - Lubricate piston rings, cylinder walls, and bearing surfaces with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent.
  - Arrange piston ring gaps alternately around the pistons so no gaps are in line with another.
  - 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.
  - 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.



A8801-C

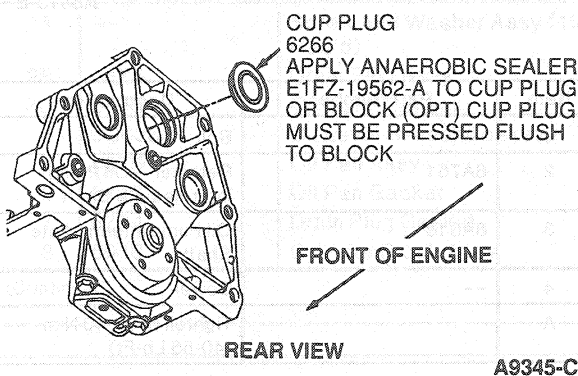
Item	Part Number	Description
1	6109	Piston and Pin Assy (6 Req'd)
2	6200	Connecting Rod (6 Req'd)
3	6211	Upper Rod Bearing (6 Req'd)
4A	6212	Nut (12 Req'd)
5	6210	Rod Cap (6 Req'd)
6	6211	Lower Rod Bearing (6 Req'd)
7	6214	Bolt (12 Req'd)
8	6100	Piston and Rod Assy (6 Req'd)
A		Tighten to 35 N·m (25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

## DISASSEMBLY AND ASSEMBLY (Continued)



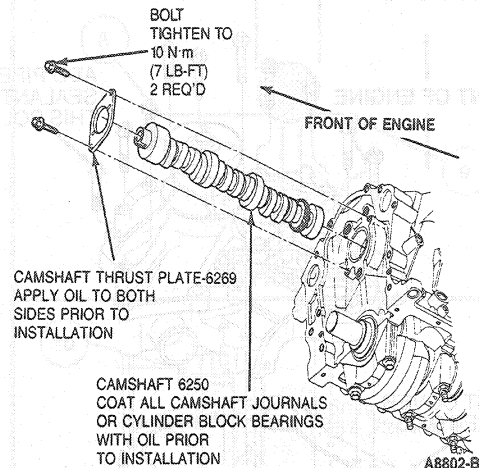
- f. Rotate crankshaft journal to bottom of its stroke for each piston installation. Using a wooden hammer handle, tap piston into cylinder bore. At the same time, guide connecting rod end into position onto crankshaft journal. Seat connecting rod bearing fully against journal. Remove rubber protection 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.



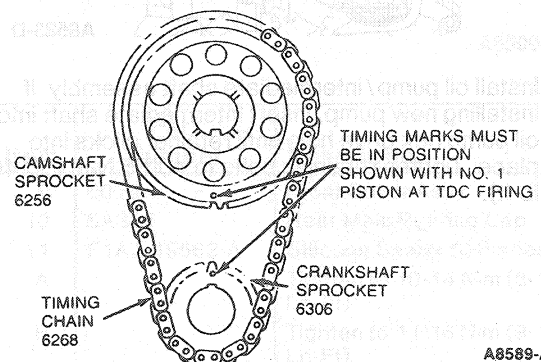
8. If necessary, replace camshaft bearings as outlined in this section.
9. Lubricate entire camshaft with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent. Carefully slide camshaft through bearings into cylinder block. Remember to keep camshaft perfectly in line with front bearing.

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.

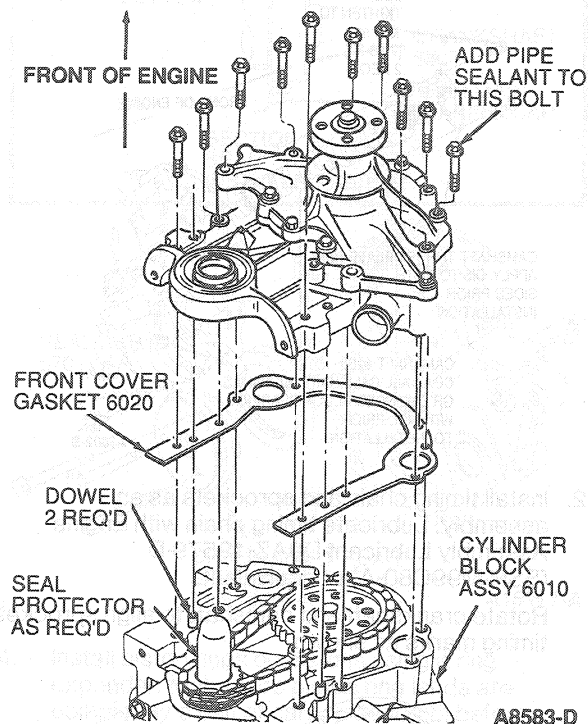


13. Install camshaft sprocket retaining bolt and washer and tighten to 63 N·m (46 lb-ft). Check the drilled oil passages of the bolt to ensure they are not plugged. Clean as required. Do not replace with a standard bolt.

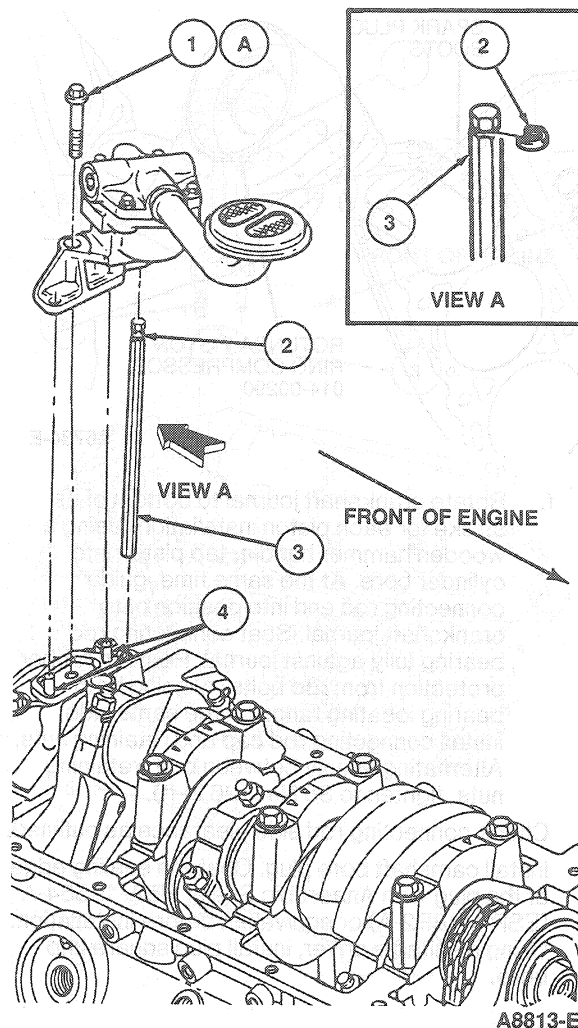
## DISASSEMBLY AND ASSEMBLY (Continued)

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)

TA8813E

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)

FRONT OF ENGINE

VIEW B

SECTION A

SECTION A (TYPICAL)

VIEW B

3mm (.118 INCH)

4-6mm (.157-.236 INCH)

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

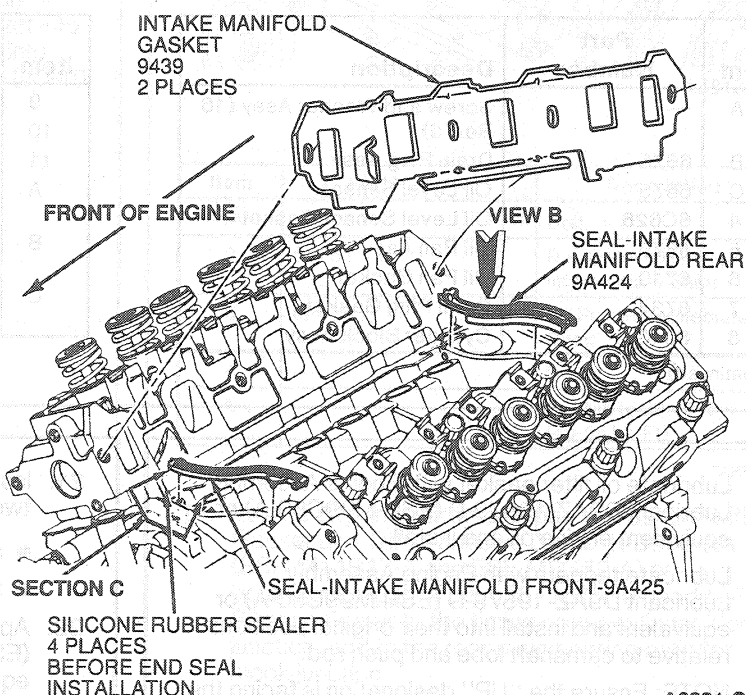
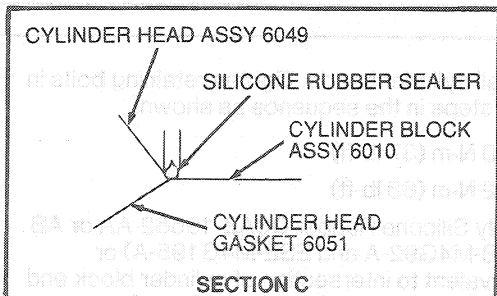
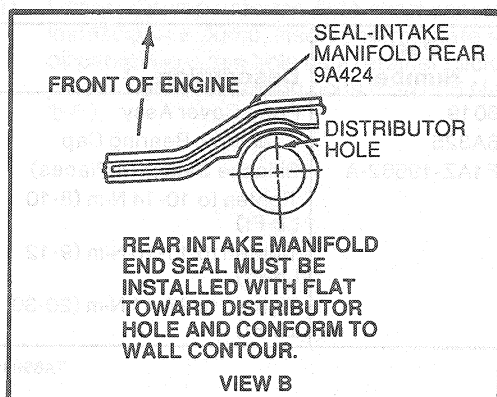
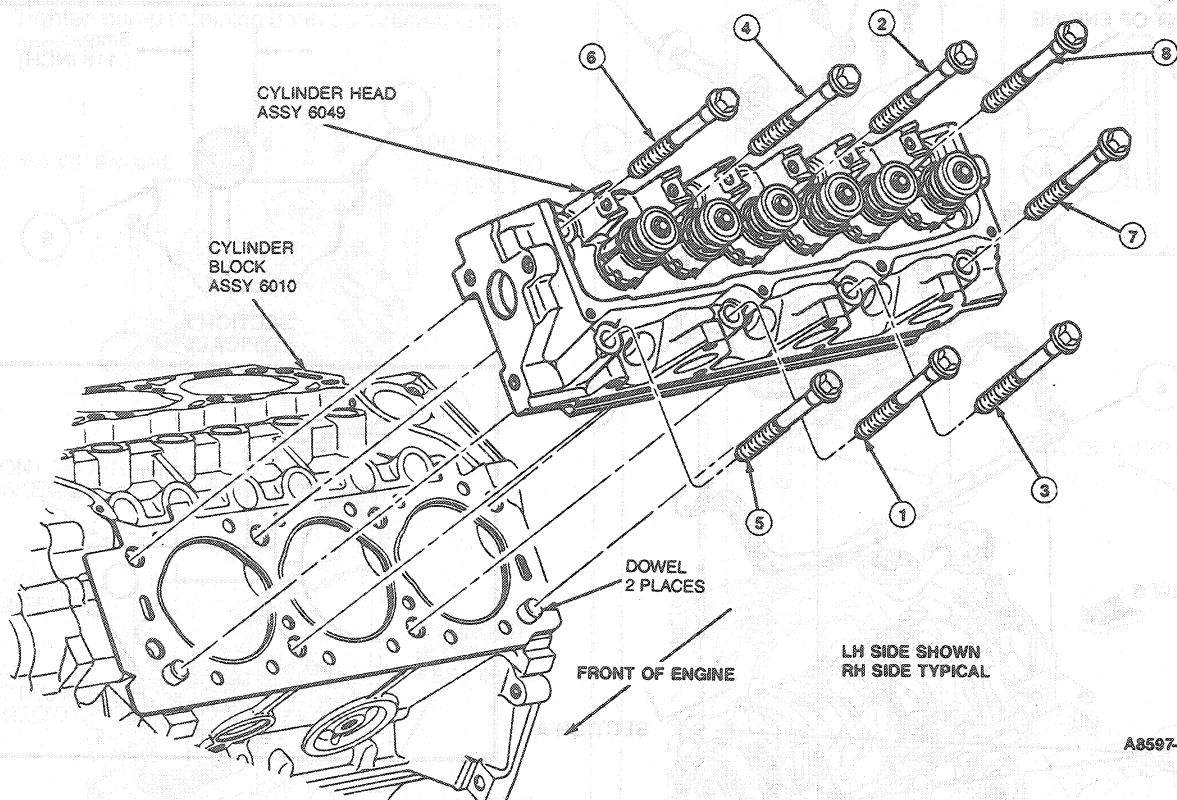
18. Lubricate oil filter gasket with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent engine oil and install.
19. Lubricate tappets with Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent and install into their original positions relative to camshaft lobe and push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

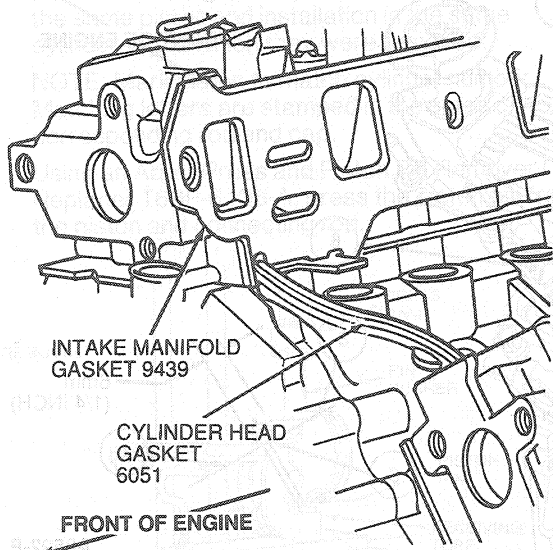
23. Install front and rear intake manifold end seals.  
Secure with retaining features.



## 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:

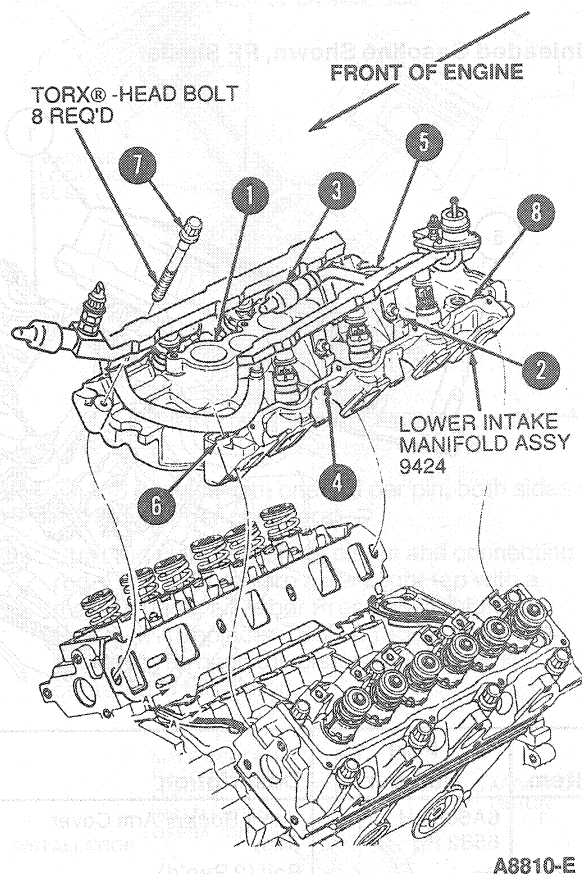
- 20-30 N·m (15-22 lb-ft)
- 26-32 N·m (19-24 lb-ft)

NOTE: Retaining bolts require a Torx® head socket.

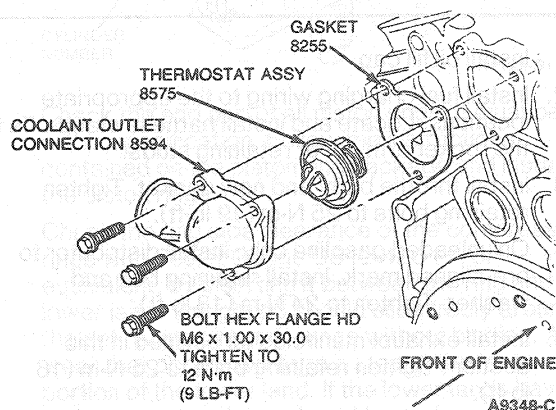
**CAUTION: Fulcrums must be fully seated in cylinder head, and push rods must be seated in rocker arm sockets prior to final tightening.**

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).

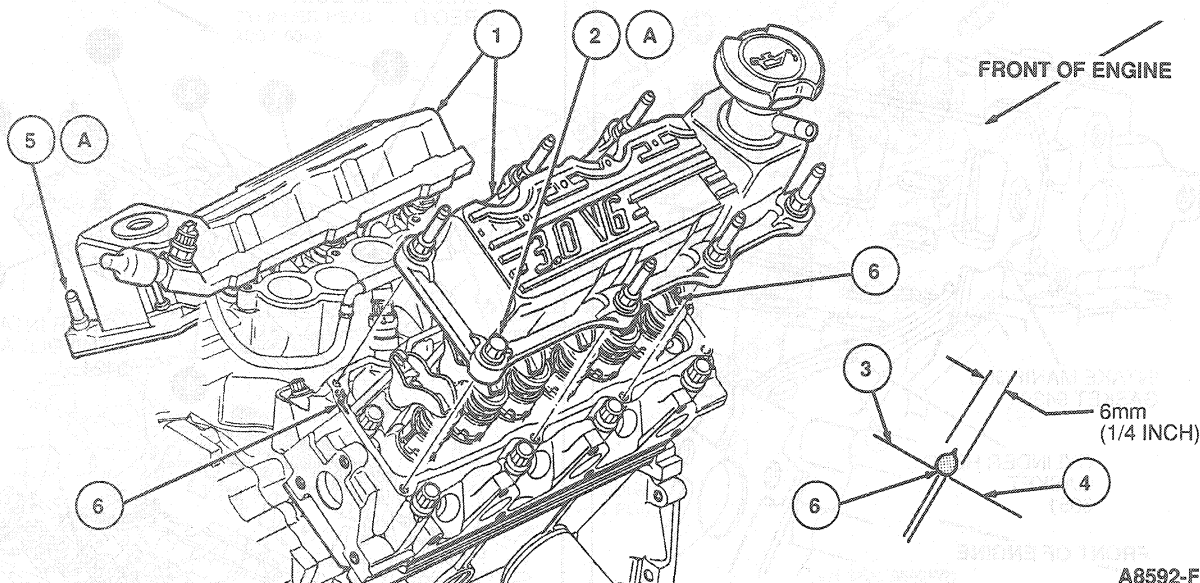


29. Install fuel supply manifold and injectors if removed. Apply Engine Assembly Lubricant D9AZ-19579-D (ESR-M99C80-A) or equivalent oil to injector holes in intake manifold and fuel supply manifold prior to injector installation. Install fuel supply manifold retaining bolts and tighten to 10 N·m (7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



A8592-F

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

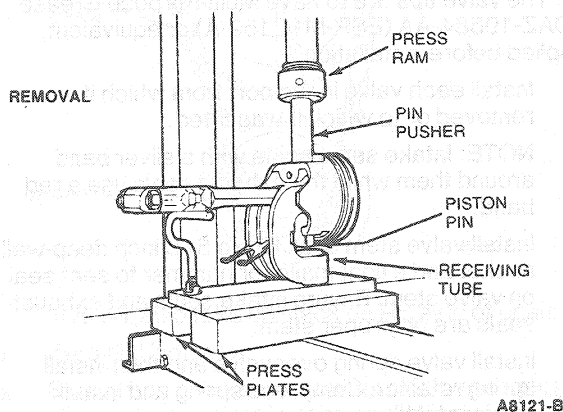
## DISASSEMBLY AND ASSEMBLY (Continued)

## 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.

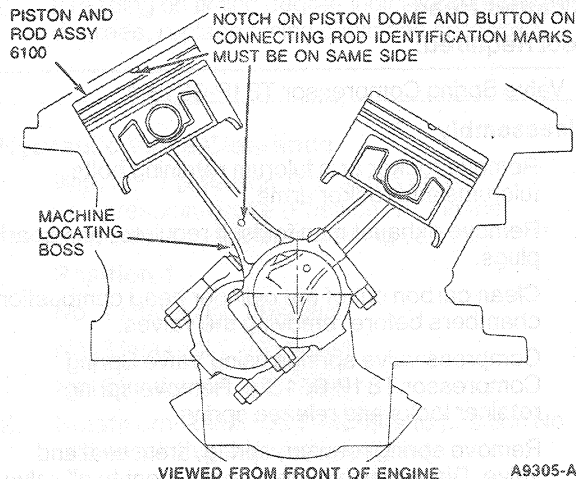


## Assembly

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

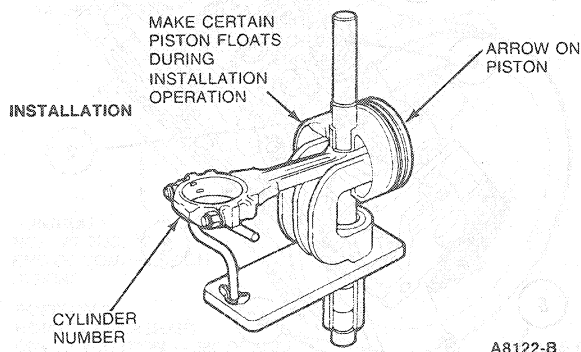
The piston pin bore of a connecting rod and the diameter of the piston pin must be within specification.

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)

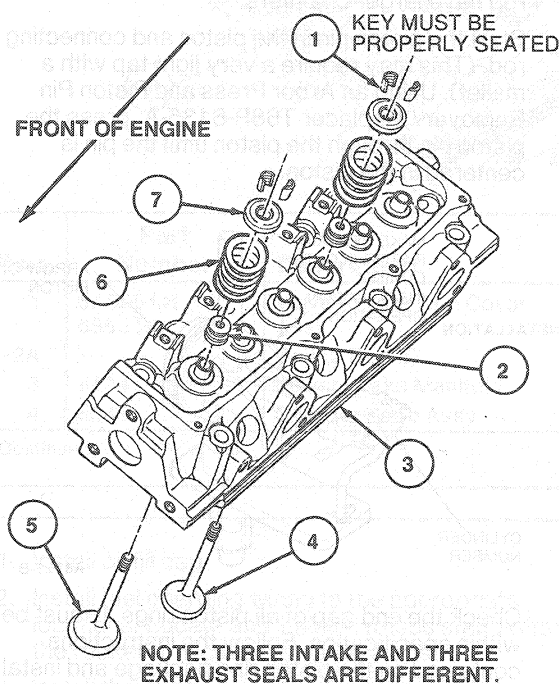
## Cylinder Head

## 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.



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)

(Continued)

Item	Part Number	Description
6	6513	Valve Spring Assy (6 Req'd)
7	6514	Valve Spring Retainer (6 Req'd)

TA8812B

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

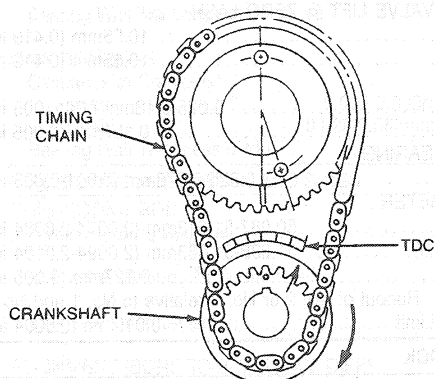
## Tool Required:

- Rotunda Dial Indicator with Bracketry 014-00282

## INSPECTION (Continued)

## Timing Chain Deflection

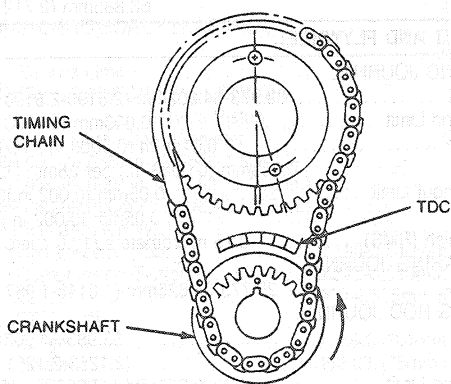
1. Remove LH valve rocker arm cover.
2. Loosen No. 5 exhaust rocker arm and rotate to one side.
3. Install Rotunda Dial Indicator with Bracketry 014-00282 or equivalent on the end of push rod.
4. Turn crankshaft clockwise until No. 1 piston is at TDC. The damper timing mark should point to TDC on the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



A9332-A

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.



A9333-A

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

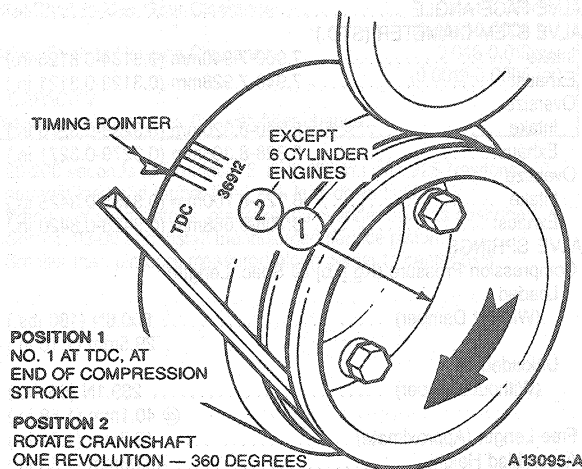
No. 1 Intake No. 1 Exhaust  
No. 3 Intake No. 2 Exhaust  
No. 6 Intake No. 4 Exhaust

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



A13095-A

POSITION 1  
NO. 1 AT TDC, AT  
END OF COMPRESSION  
STROKE

POSITION 2  
ROTATE CRANKSHAFT  
ONE REVOLUTION — 360 DEGREES

## 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.)
Unloaded	289.1N (65 lbs.)
(Without Damper)	29.5mm (1.16 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.)
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## JOURNAL DIAMETER

All	50.987-51.013mm (2.0074-2.0084 in.)
-----	-------------------------------------

## CAM BEARING I.D.

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.)
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## 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.)
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## THRUST BEARING JOURNAL

Length	25.775-25.825mm (1.0148-1.067 in.)
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## 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;
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Runout Limit	0.025mm (0.001 in.)
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CA8815-E

## SPECIFICATIONS (Continued)

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.) ..... 1.5571-1.570mm  
(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  
(3.5045-3.5051 in.)PISTON-TO-BORE CLEARANCE ..... 0.036 = 0.056mm  
(0.0014-0.0022 in.)

Service Limit ..... 0.081mm MAX.

**SERVICE PISTON SELECTION (b)****Service Piston****Piston Bore Diameter****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 (0.0575-0.0587 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**

1st 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**

(Idle 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.)Idle Shaft to Idle 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.

- 20-200 seconds to leakdown 3.18 (0.125 in.) with 225 Newtons (50 pounds) load and tappet filled with leak-down fluid.
- When replacing pistons, measure the cylinder bore as described in Section 03-00 and install the indicated service piston.
- 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 <sup>5</sup>		
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	—	<sup>6</sup>	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	—	<sup>7</sup>
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)

<sup>5</sup> Advance half-turn after gasket contacts sealing surface.<sup>6</sup> A. Tighten in two steps:

50 N-m (37 Lb-Ft)

92 N-m (68 Lb-Ft)

<sup>7</sup> Tighten in two steps: A. 7-15 N-m (5-11 Lb-Ft)

B. 26-38 N-m (19-28 Lb-Ft)

## SPECIFICATIONS (Continued)



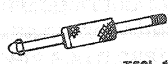
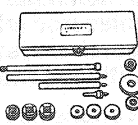
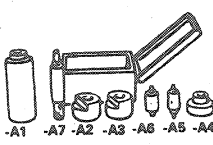

## TORQUE SPECIFICATIONS (Cont'd)

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)			

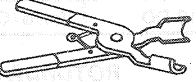
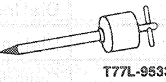
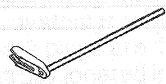
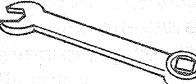
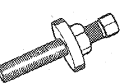
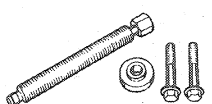
GENERAL SPECIFICATIONS<sup>8</sup>

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

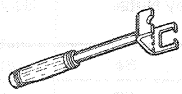
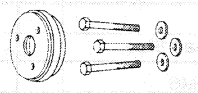
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Tool Number	Description
T74P-6666-A Spark Plug Wire Remover	 T74P-6666-A
T77L-9533-B Jet Plug Remover	 T77L-9533-B
T81P-6513-A Valve Spring Compressor	 T81P-6513-A
T81P-9425-A Intake Manifold Torque Adaptor	 T81P-9425-A
T82L-6316-A Vibration Damper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

(Continued)

<sup>8</sup> 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	