2000-01 ENGINES

7.3L V8 Turbo Diesel

ENGINE IDENTIFICATION

NOTE: This article also applies to Cab & Chassis.

The Power Stroke 7.3L diesel engine may be identified by eighth character of Vehicle Identification Number (VIN). VIN is stamped on a metal tab located near lower left corner of windshield. VIN is also located on Vehicle Safety Compliance Certification Label on driver-side door, or on driver-side door pillar post.

Engine serial number is stamped on driver-side of cylinder block, just behind the oil filter. Engine calibration code is stamped on engine calibration code label. Engine calibration code label is located on driver-side door pillar post. Engine serial number and engine calibration code may be required when ordering replacement components.

ENGINE IDENTIFICATION CODE

Application	Code
7.3L Turbo Diesel	F

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

NOTE: Hydraulic valve lifters are used. No adjustment is required.

FUEL INJECTION TIMING

NOTE: The amount of time each fuel injector is energized for delivering fuel to the cylinder is electronically controlled by the Powertrain Control Module (PCM).

TROUBLE SHOOTING

NOTE: To trouble shoot engine mechanical components, see ENGINE MECHANICAL in BASIC TROUBLE SHOOTING article in GENERAL INFORMATION.

REMOVAL & INSTALLATION

NOTE: For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks on engine hood and other major assemblies before removal.

CAUTION: When battery is disconnected, vehicle computer and memory systems

may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

COOLING SYSTEM BLEEDING

Fill radiator until coolant level is 1.5" (38 mm) below cap seal in filler neck on radiator. Install radiator cap. Start engine and warm engine to normal operating temperature. Shut off engine. Allow engine to cool. Remove radiator cap and recheck coolant level. Add coolant if necessary.

FUEL LINE DISCONNECT FITTINGS

CAUTION: Fuel system is under pressure. Use care when servicing any fuel system components.

NOTE: Fuel lines may contain spring lock coupling or a push lock coupling. See Fig. 1 and Fig. 2 . Determine type of disconnect fitting used and use proper procedure for proper disconnect fitting.

Relieving Fuel Pressure

Place container under fuel filter/water separator drain hose. Open drain valve on fuel filter/water separator and allow fuel to drain into container. When filter is drained, close drain valve.

Removal (Spring Lock Coupling)

1. Relieve fuel pressure. See **RELIEVING FUEL PRESSURE**. Remove retaining clip from spring lock coupling. See **Fig. 1**. DO NOT use screwdriver or sharp object when removing retaining clip, as spring lock coupling may be damaged.
2. Twist both fuel lines to release seal adhesion on "O" rings. Spring Lock Coupling Remover (D87L-9280-A for 3/8" fuel line) or (D87L-9280-B for 1/2" fuel line) is used to release spring lock coupling.
3. Install spring lock coupling remover on spring lock coupling so spring lock coupling remover enters cage opening on spring lock coupling. See **Fig. 1**. This allows garter spring in spring lock coupling to be released.
4. Push spring lock coupling remover into cage opening to release female fitting on fuel line from garter spring in spring lock coupling. Pull fuel lines apart. Remove spring lock coupling remover.

Installation (Spring Lock Coupling)

1. Ensure garter spring is installed in cage on spring lock coupling. If garter spring is damaged, replace garter spring.

CAUTION: Use only specified type "O" rings on fuel lines, as they are made of special material. Use of improper type "O" rings may result in a fuel

leak.

2. Ensure fuel lines and spring lock coupling are clean. Replace any missing or damaged "O" rings. Lubricate "O" rings and inside of female fitting with clean engine oil.
3. Push fuel lines together. Pull on both fuel lines to ensure spring lock coupling is properly locked together. Visually check that garter spring is positioned over flared end of female fitting on fuel line. Install retaining clip. Ensure retaining clip is fully seated and horseshoe portion of retaining clip is installed over spring lock coupling.

Removal (Push Lock Coupling)

1. Relieve fuel pressure. See **RELIEVING FUEL PRESSURE**. Lift retaining clip upward from push lock coupling. See **Fig. 2**. Push Lock Coupling Remover (T90T-9550-B) for 5/16" fuel line, or (T90T-9550-C) for 3/8" fuel line is used to release push lock coupling.
2. Install push lock coupling remover on fuel line. See **Fig. 2**. Slide push lock remover into female fitting on push lock coupling to release retaining fingers on push lock coupling. See **Fig. 2**. Pull fuel lines apart. Remove push lock coupling remover.

Installation (Push Lock Coupling)

1. Inspect push lock coupling for any internally damaged components before installing. If any internal components are damaged, replace fuel line.
2. Ensure fuel lines and push lock coupling are clean. Push fuel lines together until click sound is heard. Pull on both fuel lines to ensure push lock coupling is properly locked together. Push retaining clip downward on to push lock coupling.

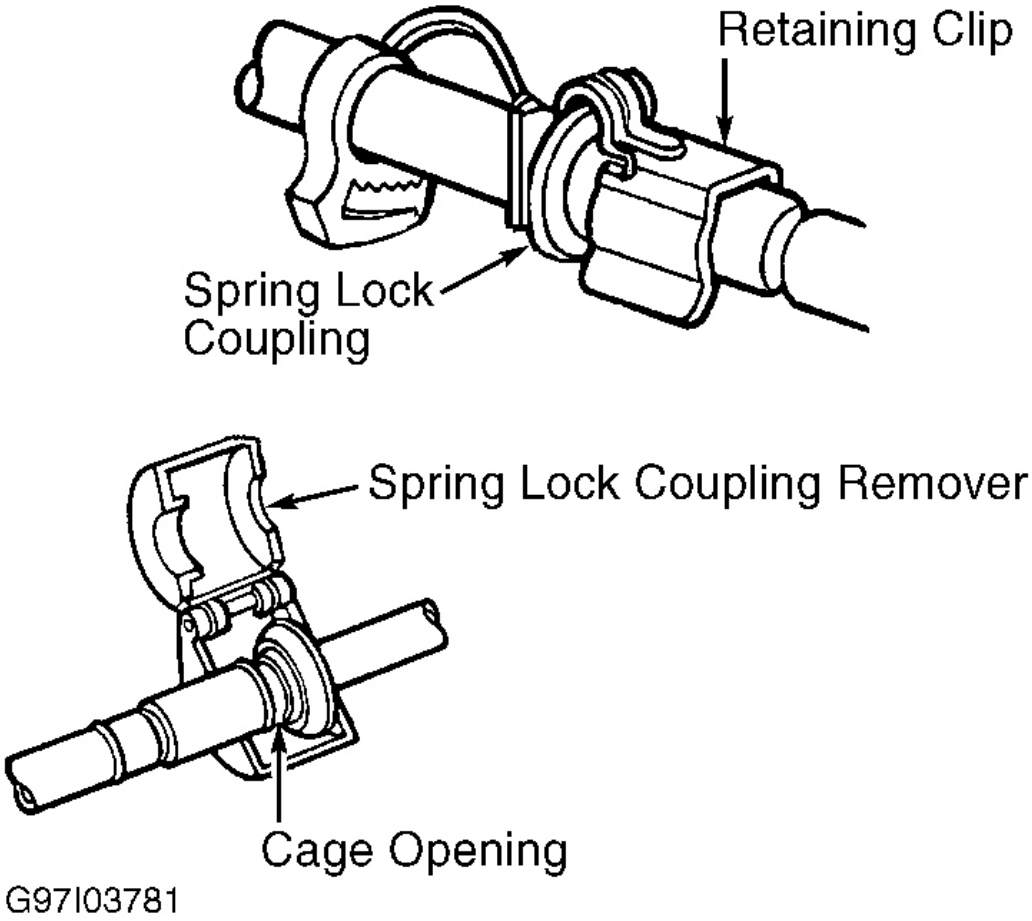


Fig. 1: Identifying, Removing & Installing Spring Lock Coupling
Courtesy of FORD MOTOR CO.

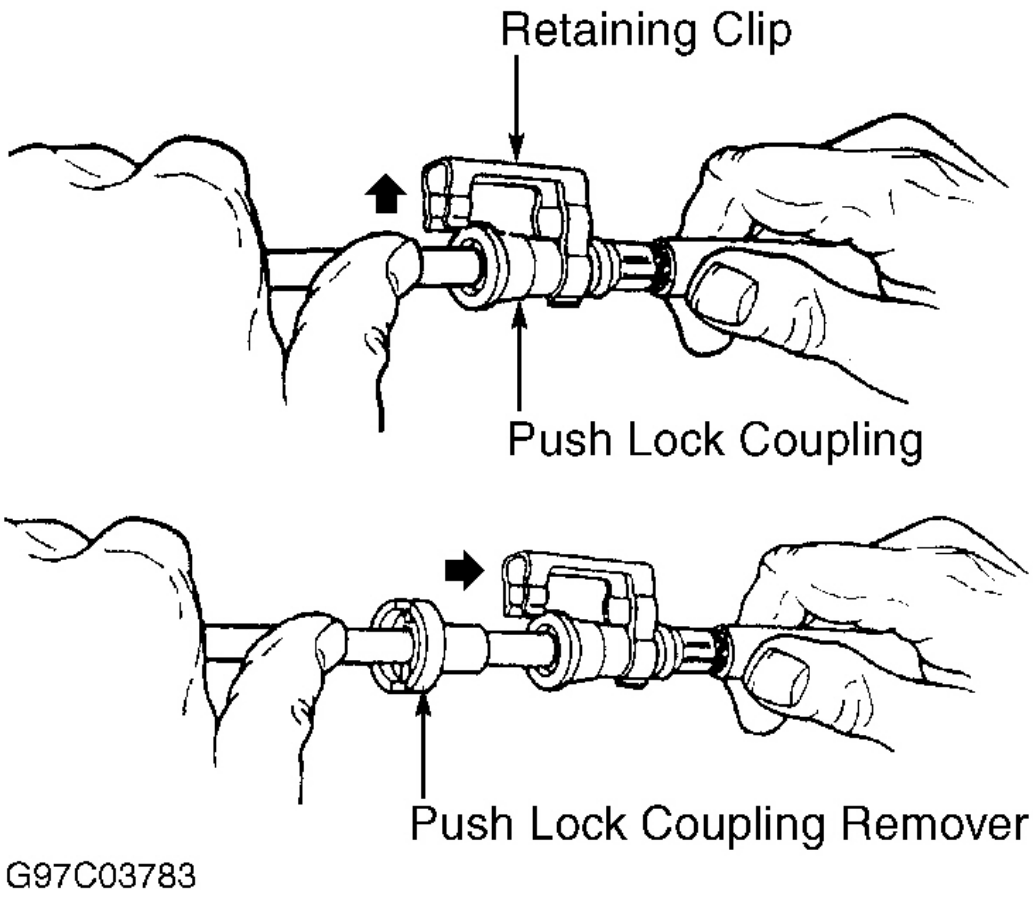


Fig. 2: Identifying, Removing & Installing Push Lock Coupling
Courtesy of FORD MOTOR CO.

ENGINE

Removal (Excursion & F250-F550 Super Duty)

1. Disconnect negative battery cables. On M/T models, remove transmission. See appropriate CLUTCHES article in TRANSMISSIONS. On all models, remove air inlet duct assembly. Remove turbocharger. See **TURBOCHARGER** under REMOVAL & INSTALLATION.
2. Drain cooling system. On A/C equipped models, discharge A/C system using approved refrigerant recovery/recycling equipment. On all models, disconnect upper radiator hose and coolant recovery reservoir hose at radiator.

CAUTION: Fan clutch assembly uses right-hand threads to hold assembly on water pump.

3. Using Fan Clutch Holder (T84T-6312-C) and Fan Clutch Nut Wrench (T9T-6312-B), remove fan and fan clutch assembly from water pump. Place fan and fan clutch assembly in fan shroud.
4. Remove fan shroud along with fan and fan clutch assembly. Disconnect remaining coolant hoses from radiator. On A/T models, disconnect transmission oil cooler lines from radiator. On all models, remove radiator.
5. Loosen clamps on charge air cooler ducts and remove ducts. Remove 2 stud bolts and remove charge air cooler . Note direction of drive belt routing for installation reference. Rotate accessory drive belt tensioner away from accessory drive belt. Remove accessory drive belt.
6. On A/C equipped models, disconnect electrical connector from A/C compressor clutch. Disconnect A/C refrigerant lines from A/C compressor, and plug line openings. Disconnect A/C refrigerant lines from condenser, and plug line openings. Position A/C refrigerant lines aside. Remove condenser.
7. Remove parking lamp and headlight assemblies. Remove grille, grille opening panel and upper and lower radiator supports. Remove front bumper. Disconnect electrical connectors from generator. Disconnect MAP sensor hose. Remove generator retaining bolt, and position heater hose aside. Remove generator mounting bracket and generator as an assembly. Remove ground cable from engine block.
8. Disconnect power steering lines from power steering pump. Disconnect engine control sensor electrical connector. Disconnect heater hoses.
9. Disconnect necessary fuel lines using proper procedure. See **FUEL LINE DISCONNECT FITTINGS**.
10. On A/T models, remove transmission sensor harness retaining bolt and harness. On all models, remove fuel line retaining bolt at front of engine block. Install Engine Lift Adapters (D83T-6000-B) to front of engine block. Install Engine Lifting Eye (D94T-6000-C) on right cylinder head.
11. Raise and support vehicle. Disconnect wiring for starter and lay on engine. Remove starter. On A/T models, remove flywheel housing cover. Remove torque converter-to-flywheel nuts. On all models, drain engine oil and remove oil filter.
12. Disconnect electrical connector at cylinder block heater. Cylinder block heater is located on driver-side rear corner of cylinder block, just below exhaust manifold, near oil filter.
13. On A/T models, support transmission with transmission jack. Remove transmission-to-cylinder block bolts. Remove transmission oil filler tube. On all models, lower vehicle
14. Install suitable engine lifting device to engine. Raise engine enough to clear No. 1 crossmember. Pull engine forward and remove from vehicle.

Installation (Excursion & F250-F550 Super Duty)

1. To install, reverse removal procedure. Tighten bolts/nuts to specification. See **TORQUE SPECIFICATIONS**. On A/T models, use NEW torque converter-to-flexplate nuts when installing transmission. Fill transmission with Motorcraft Mercon ATF.
2. On all models, use proper procedure when installing fuel lines. See **FUEL LINE DISCONNECT FITTINGS**. Refill power steering system with Motorcraft Mercon ATF. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. On A/C equipped models, evacuate and recharge A/C system.

Removal (Van)

1. Disconnect negative battery cables. Remove hood. On A/C equipped models, discharge A/C system using approved refrigerant recovery/recycling equipment. Remove air cleaner housing and duct assembly.

2. On all models, drain cooling system. Remove front bumper, grille, air deflector and gravel deflector.
3. Remove headlight and park light assemblies. Position transmission oil cooler aside. On A/C equipped models, disconnect A/C refrigerant lines from condenser and plug line openings. Remove condenser.

CAUTION: Fan clutch assembly uses right-hand threads to hold assembly on water pump.

4. On all models, remove support bracket located on top of radiator. Using Fan Clutch Holder (T94T-6312-AH) and Fan Clutch Nut Wrench (T83T-6312-B), remove fan and fan clutch assembly from water pump. Place fan and fan clutch assembly in fan shroud.
5. Remove fan shroud along with fan and fan clutch assembly. Disconnect transmission oil cooler lines and coolant hoses from. Remove radiator.
6. Remove brackets for headlight assemblies. Remove radiator support and oil filler tube. Note direction of accessory drive belt routing for installation reference. Rotate accessory drive belt tensioner away from accessory drive belt. Remove accessory drive belt.
7. On A/C equipped models, disconnect electrical connector from A/C compressor clutch. Disconnect A/C refrigerant lines from A/C compressor and plug line openings. Remove A/C compressor mounting bracket.
8. On all models, disconnect vacuum hose from vacuum pump. Disconnect power steering lines from power steering pump. Disconnect electrical connectors from generator. Remove generator mounting bracket and generator as an assembly.

WARNING: Ensure negative battery cables are disconnected before disconnecting engine wiring harness. Injector Driver Module (IDM) supplies 115 volts DC to each fuel injector on engine wiring harness.

9. Disconnect plug for engine wiring harness from driver-side of engine compartment. Lay engine wiring harness back over engine.
10. Disconnect necessary ground cables from cylinder block. Disconnect vacuum hose for Manifold Absolute Pressure (MAP) sensor from passenger-side intake manifold cover. Disconnect remaining coolant hoses from engine.
11. Remove turbocharger. See **TURBOCHARGER**. Disconnect necessary fuel lines using proper procedure. See **FUEL LINE DISCONNECT FITTINGS**.
12. Disconnect remaining electrical connectors and hoses for engine removal. Disconnect electrical connectors from transmission. Remove transmission oil fill tube.
13. Install 2 Engine Lift Adapters (D94T-6000-A) on front of cylinder block. Install Engine Lifting Bracket (D94T-6000-C) on right cylinder head. Raise and support vehicle. Remove starter. Remove engine mount nuts. Remove torque converter cover. Remove torque converter-to-flywheel nuts. Drain engine oil and remove oil filter.
14. Disconnect electrical connector at cylinder block heater. Cylinder block heater is located on driver-side rear corner of cylinder block, just below exhaust manifold, near oil filter. Lower vehicle. Support transmission with transmission jack.
15. Remove transmission-to-engine bolts. Install Engine Lifting Fixture (D83T-6000-B) to engine. Raise engine high enough to clear No. 1 crossmember. Pull engine forward and remove engine.

Installation (Van)

1. To install, reverse removal procedure. Tighten bolts/nuts to specification. See **TORQUE SPECIFICATIONS**. Use NEW torque converter-to-flexplate nuts when installing transmission. Fill transmission with Motorcraft Mercon ATF.
2. Use proper procedure when installing fuel lines. See **FUEL LINE DISCONNECT FITTINGS**. Refill power steering system with Motorcraft Mercon ATF. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. On A/C equipped models, evacuate and recharge A/C system.

FUEL FILTER/WATER SEPARATOR

NOTE: Manufacturer lists procedure for servicing of fuel filter/water separator housing along with fuel filter/water separator filter. It may not be necessary to remove fuel filter/water separator housing when only servicing fuel filter/water separator filter.

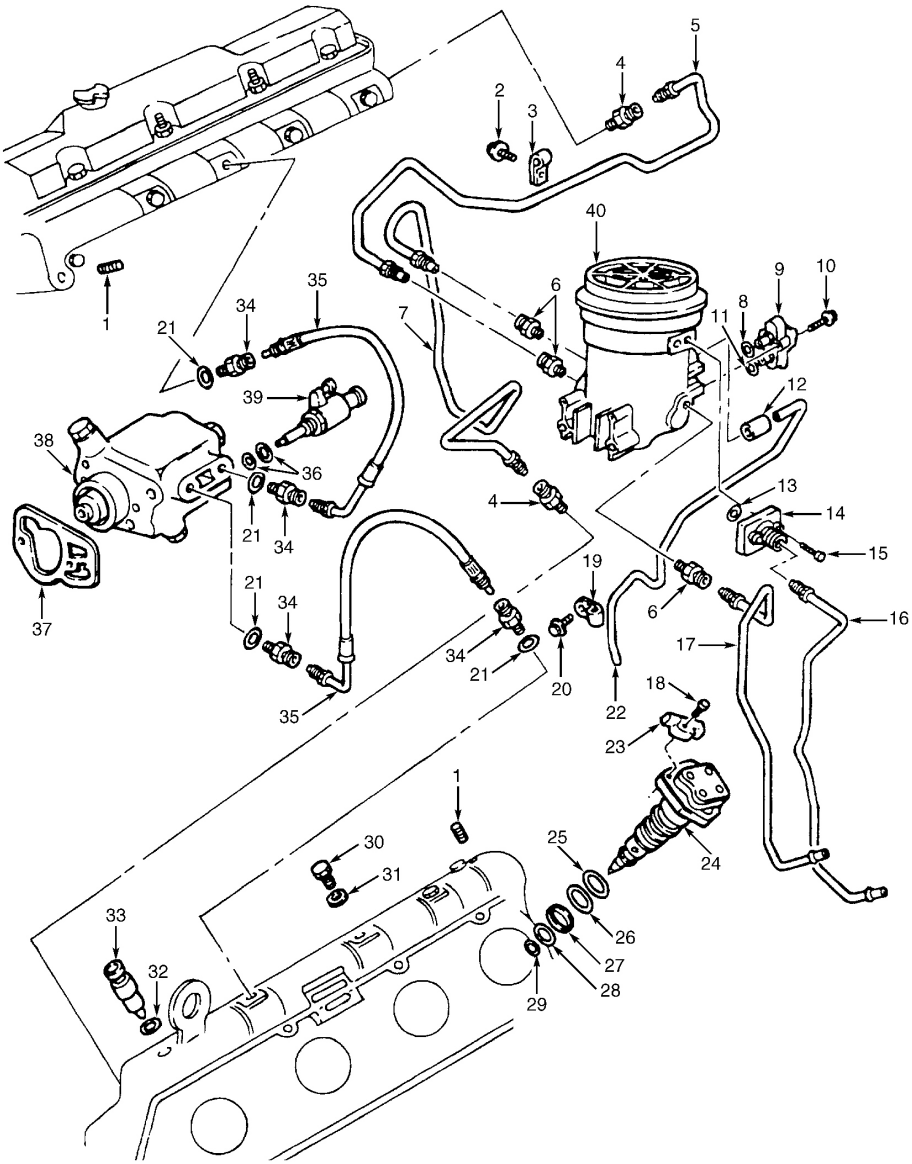
Removal

1. Disconnect negative battery cables. Remove necessary air intake components for access to fuel filter/water separator as necessary. Fuel filter/water separator is located on top of engine, between valve covers. See **Fig. 3**.
2. Place container below water drain line at bottom of fuel filter/water separator housing. Rotate water drain lever away from fuel filter/water separator housing and allow fuel to drain. Disconnect fuel supply and return lines from filter/separator.
3. Remove 2 fuel supply hoses connecting regulator block to both cylinder heads. Disconnect clip for wiring harness from side of fuel filter/water separator housing. Disconnect necessary electrical connectors for removal of fuel filter/water separator housing. Remove bolts and fuel filter/water separator housing.

NOTE: Fuel filter/water separator filter must be properly installed in housing or engine will not operate properly.

Installation

1. To install, reverse removal procedure using NEW seal ring. Apply diesel fuel to seal ring before installing. Ensure seal ring is installed with beveled area facing original direction.
2. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**. Ensure fuel/filter water separator filter is securely locked on cap.
3. Fill fuel/filter water separator housing with diesel fuel before installing cap and fuel/filter water separator filter. Tighten cap until cap just contacts fuel/filter water separator housing. Ensure water drain lever is fully closed.



1. 1/8" Pipe Plug
2. Stud Bolt
3. Clamp Wrap
4. One-Way Flow Fitting
5. Fuel Delivery Line (Left Head)
6. Fitting
7. Fuel Delivery Line (Right Head)
8. "O" Ring
9. Fuel Heater Thermostat/ Water Sensor
10. Screw
11. "O" Ring
12. Hose
13. "O" Ring
14. Fuel Regulator Cap
15. Screw
16. Fuel Return Line
17. Fuel Supply Line
18. Screw
19. Clamp Wrap
20. Screw
21. "O" Ring
22. Water Drain Tube
23. Oil Deflector
24. Fuel Injector
25. Back-Up "O" Ring
26. Cushion Ring
27. Fuel Injector Middle Seal
28. Fuel Injector Lower Seal
29. Copper Fuel Injector Gasket
30. Pipe Plug
31. "O" Ring
32. "O" Ring
33. Oil Pressure Sensor
34. Quick Connect Fitting
35. High-Pressure Oil Lines
36. "O" Ring
37. High-Pressure Oil Pump Flange Gasket
38. High-Pressure Oil Pump
39. Injection Pressure Regulator
40. Fuel Filter

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Fig. 3: Locating Fuel System Components
Courtesy of FORD MOTOR CO.

FUEL HEATER

Removal & Installation

1. Fuel heater is located inside fuel filter/water separator housing, just below fuel filter/water separator filter. Remove fuel filter/water separator filter from fuel filter/water separator housing. See **FUEL FILTER/WATER SEPARATOR**.
2. Remove 2 attaching screws and remove filter heater thermostat from housing. Disconnect electrical connector for fuel heater. Remove fuel heater from bottom of fuel filter/water separator housing.
3. To install, reverse removal procedure. Ensure proper procedure is followed when installing fuel filter/water separator filter. See **FUEL FILTER/WATER SEPARATOR**.

FUEL INJECTOR

WARNING: Ensure negative battery cables are disconnected before disconnecting engine wiring harness. Injector Driver Module (IDM) supplies 115 volts DC to each fuel injector on engine wiring harness. DO NOT pierce any wires in engine wiring harness when servicing fuel injector.

Removal

1. Disconnect negative battery cables. Loosen drain plugs at rear of each cylinder head, and drain fuel from heads. Remove necessary components for access to valve covers. Remove valve covers. Note location of wires on fuel injector for installation reference. Disconnect engine wiring harness wires from fuel injector. DO NOT pierce any wires in engine wiring harness.

CAUTION: Oil rail drain plugs must be removed from cylinder head before removing fuel injector. Oil rail drain plugs are located inside cylinder head.

2. Remove oil rail drain plugs from cylinder head. Oil rail drain plugs are located on inside of cylinder head, near push rods. See **Fig. 4**.
3. Remove oil deflector retaining bolt and oil deflector from cylinder head. See **Fig. 5**. Remove fuel injector retaining bolt. See **Fig. 4**.

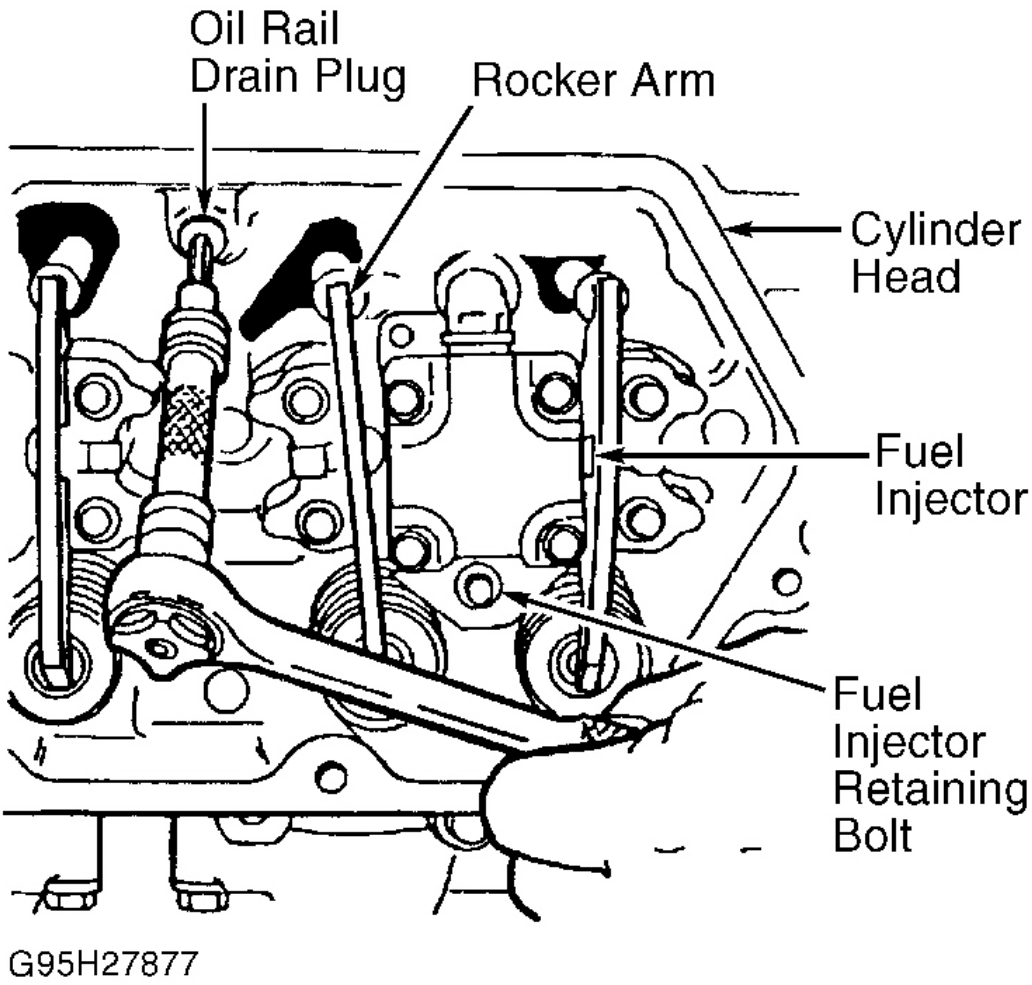


Fig. 4: Locating Oil Rail Drain Plug & Fuel Injector Retaining Bolt
Courtesy of FORD MOTOR CO.

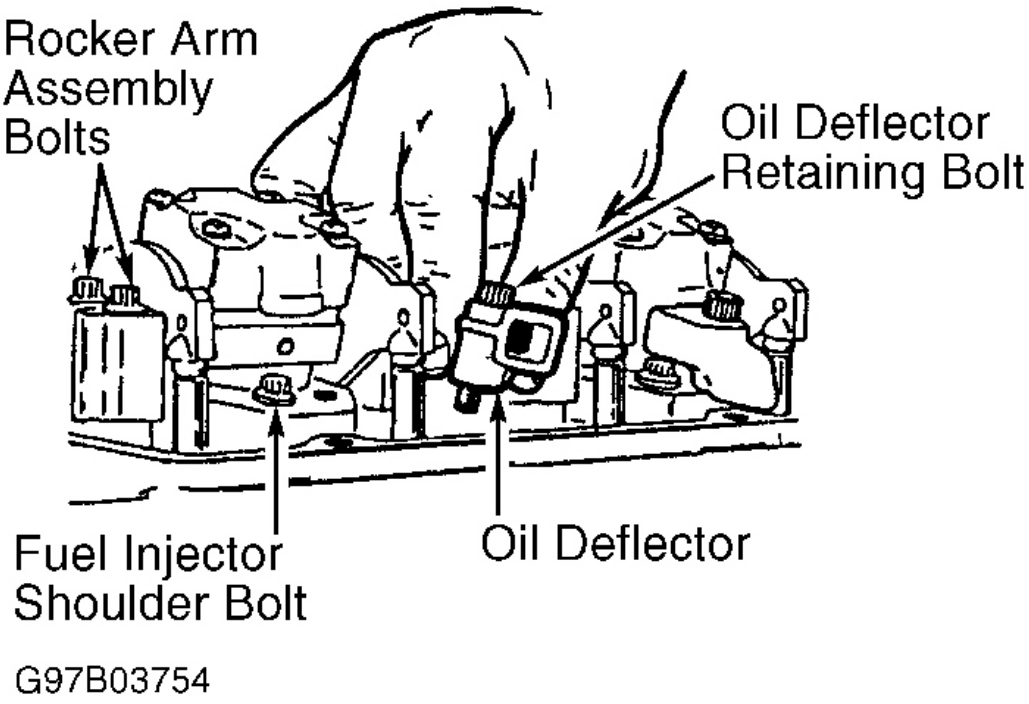


Fig. 5: Locating Oil Deflector, Oil Deflector Retaining Bolt Fuel Injector Shoulder Bolt & Rocker Arm Bolts
Courtesy of FORD MOTOR CO.

4. Using Fuel Injector Remover (T94T-9000-AH1), remove fuel injector from cylinder head. See **Fig. 6**. Ensure all cushion rings, seals and copper washer are still on fuel injector. See **Fig. 7**. Remove any cushion rings, seals or copper washer from fuel injector sleeve in cylinder head if they are not on fuel injector.

CAUTION: DO NOT disassemble fuel injector. If fuel injector is disassembled, fuel injector calibration will be incorrect.

NOTE: Manufacturer states that cylinder head must be removed for servicing of fuel injector sleeve. If necessary to remove cylinder head, see CYLINDER HEAD.

5. If removing fuel injector sleeve from cylinder head, install plug from Fuel Injector Sleeve Tap (D94T-9000B) in fuel injector sleeve to prevent debris from falling into cylinder. Install tap and tap pilot into fuel injector sleeve and tighten 1 1/2 - 2 full turns.
6. Install slide hammer on fuel injector sleeve tap. Using slide hammer, pull fuel injector sleeve from cylinder head. Remove fuel injector sleeve tap from fuel injector sleeve.

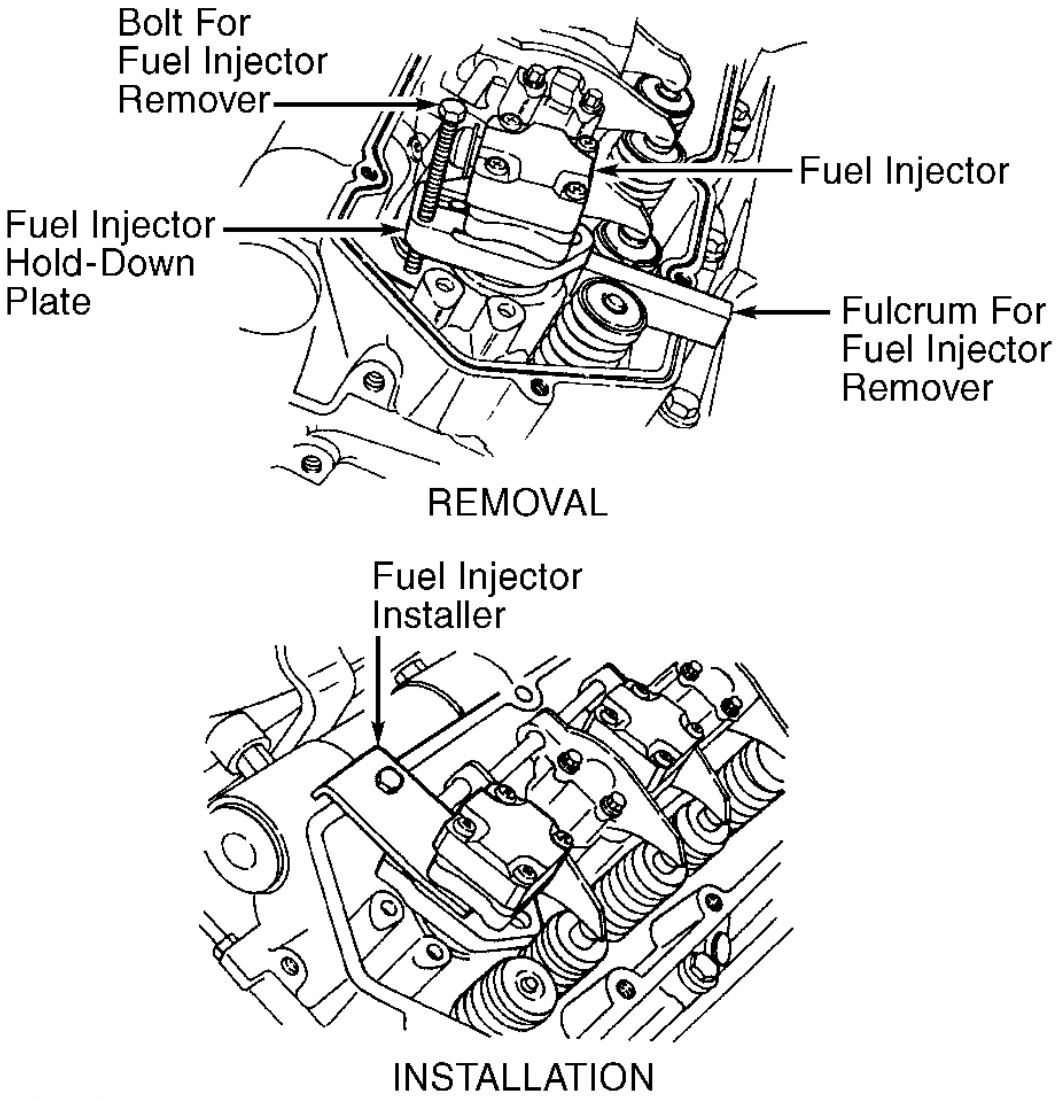


Fig. 6: Removing & Installing Fuel Injector
Courtesy of FORD MOTOR CO.

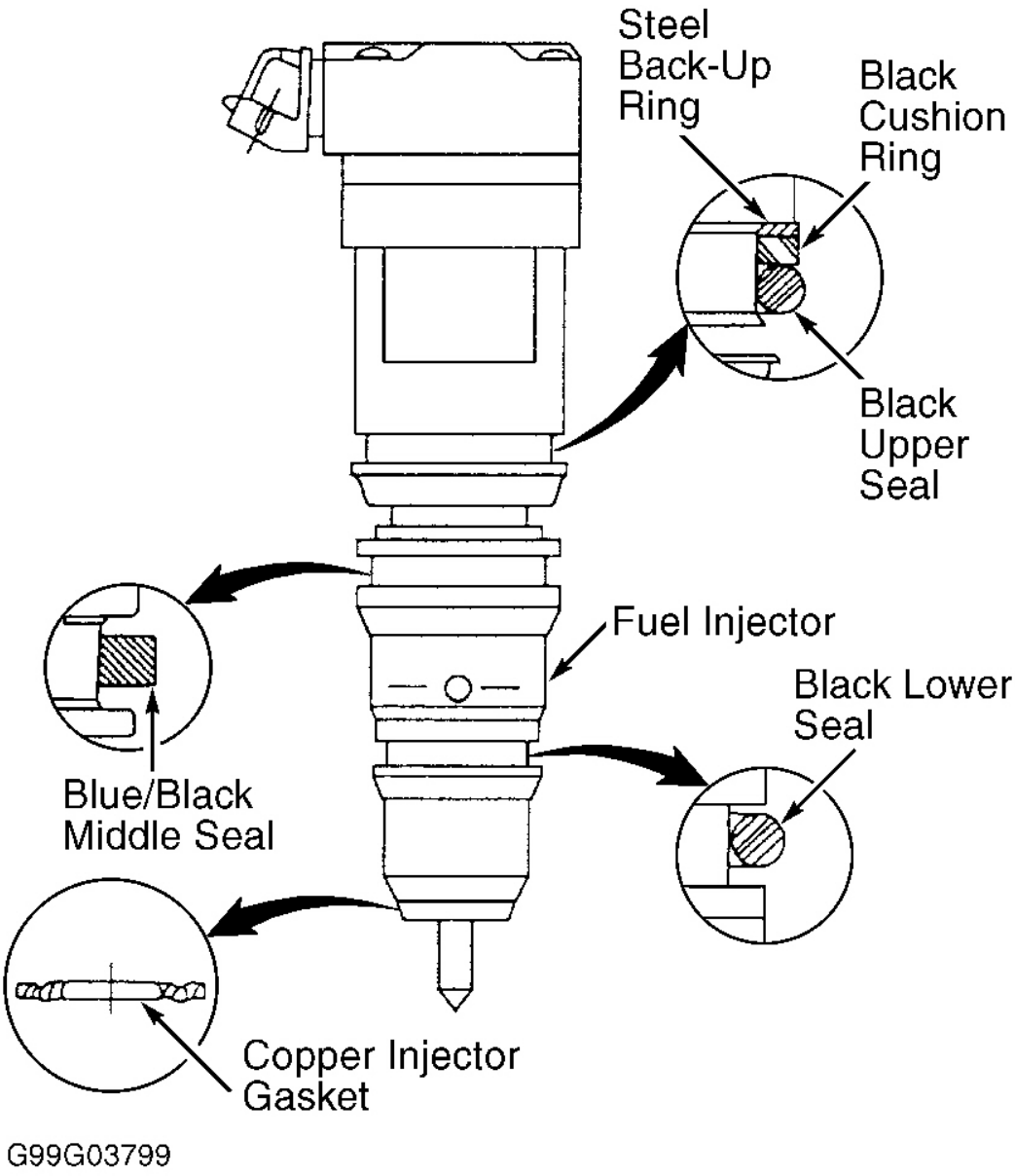


Fig. 7: Locating Back-Up Ring, Cushion Rings, Seals & Copper Washer On Fuel Injector
Courtesy of FORD MOTOR CO.

Installation

1. If fuel injector sleeves are not being installed, go to step **3)** . If installing fuel injector sleeve in cylinder head, use Fuel Injector Sleeve Brush (D94T-9000-D) and clean bore in cylinder head for fuel injector sleeve. Ensure all debris are cleaned from bore.
2. Apply Threadlock® Sealant 262 at designated areas on fuel injector sleeve. See **Fig. 8**. Using rubber

hammer and Fuel Injector Sleeve Installer (D94T-9000-C), tap fuel injector sleeve into cylinder head. Remove fuel injector sleeve installer.

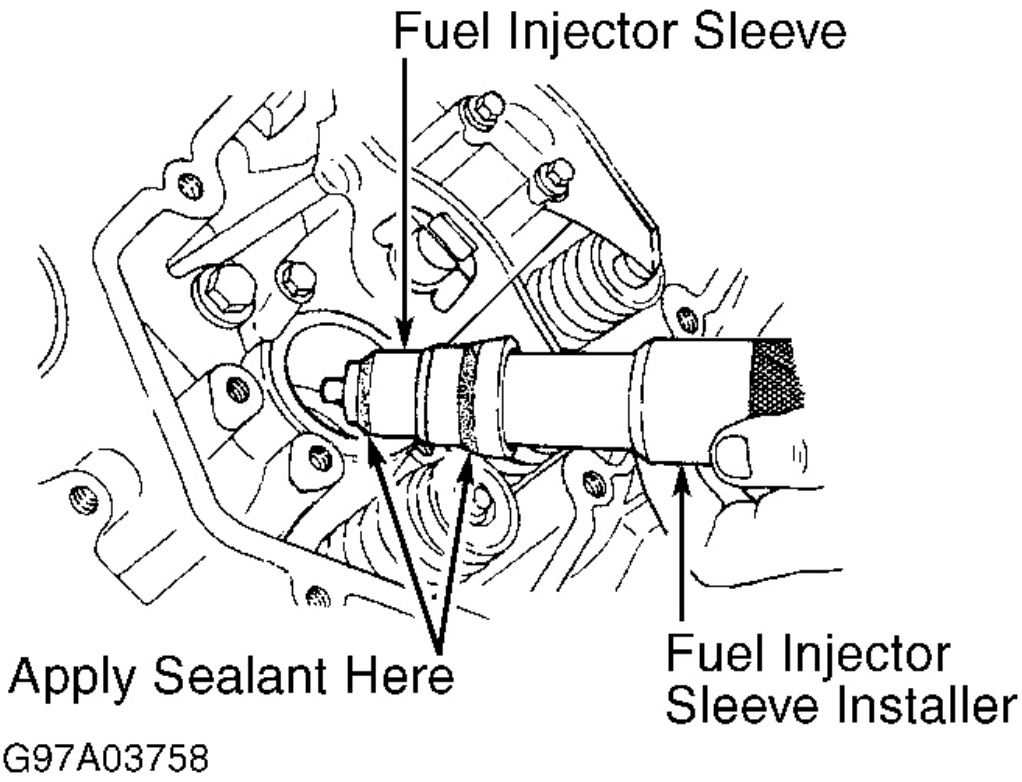


Fig. 8: Applying Sealant On Fuel Injector Sleeve
Courtesy of FORD MOTOR CO.

CAUTION: Two different fuel injectors may be available, a 49 state fuel injector and a California fuel injector. These fuel injectors must not be interchanged, as Powertrain Control Module (PCM) is calibrated for specified fuel injector. Before replacing any fuel injectors, refer to Vehicle Emission Control Information decal for proper fuel injector application. Decal is located under hood. Improper fuel injector application may result in poor engine performance, high emission levels and/or damage to engine.

CAUTION: All fuel and oil must be removed from cylinders before installing fuel injectors. Failure to ensure cylinders are clean may result in engine damage caused by hydrostatic lock.

3. Using proper size brush from Brush Set (D94T-9000-D), clean bore for fuel injector in fuel injector sleeve. Ensure seating area at end of fuel injector sleeve is clean.
4. Ensure fuel and oil are removed from cylinders before installing fuel injectors. Install NEW back-up ring, cushion rings, seals and copper washer on fuel injector. Ensure components are installed in correct location. See **Fig. 7**.

CAUTION: DO NOT tap on top of fuel injector to seat fuel injector in fuel injector sleeve or fuel injector will be damaged. Ensure copper washer does not fall from fuel injector during fuel injector installation.

5. Lubricate fuel injector, back-up ring, cushion rings and seals with clean engine oil. Using Fuel Injector Installer (D94T-9000-AH2), install fuel injector in cylinder head until fuel injector is fully seated. See **Fig. 6**.
6. Remove fuel injector installer. Install oil deflector. Tighten oil deflector retaining bolt to specification. See **TORQUE SPECIFICATIONS**. Install and tighten fuel injector retaining bolt and oil rail drain plugs to specification.
7. Reinstall engine wiring harness wires on fuel injector. DO NOT pierce any wires in engine wiring harness. To install remaining components, reverse removal procedure. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**.

FUEL PUMP

Removal & Installation

1. Fuel pump is located inside left-side frame rail. Open fuel filter/water separator drain valve to release fuel pressure. Disconnect negative battery cables. Raise and support vehicle.
2. Disconnect fuel pump electrical connector. Remove fuel line retaining clip and disconnect fuel line from fuel pump. Slide retaining clip up on quick connect fitting. Using Fuel Line Disconnect (T90T-9550-S) tool, remove fuel pump delivery line. Remove 2 fuel pump attaching bolts and remove fuel pump and mounting bracket.
3. Disconnect fuel pump wiring push pin. Remove pinch bolt from mounting bracket. Remove fuel pump from mounting bracket. To install reverse removal procedure. Install NEW retaining clip on fuel line-to-fuel pump connection. Install and tighten bolts to specification. See **TORQUE SPECIFICATIONS**.

HIGH-PRESSURE OIL PUMP

NOTE: High-pressure oil pump is used in high-pressure oil system which supplies oil pressure for fuel injector operation. See Fig. 9.

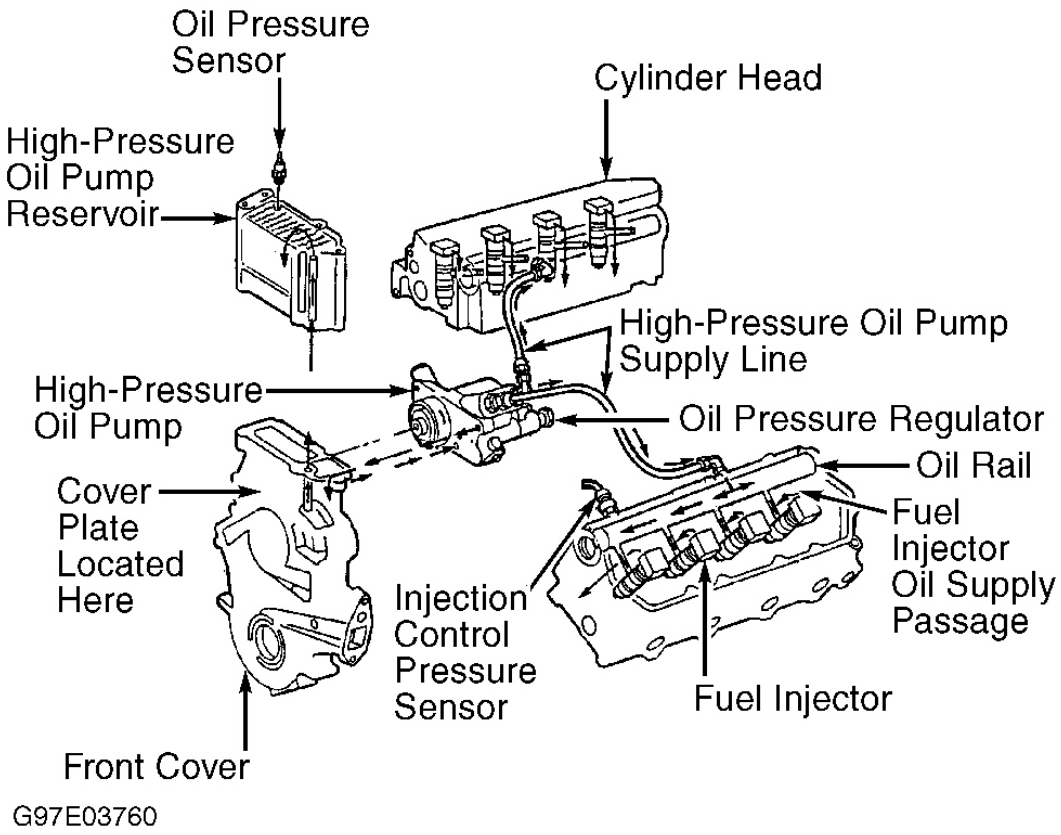


Fig. 9: High-Pressure Oiling System
Courtesy of FORD MOTOR CO.

Removal

1. On Van, remove air cleaner housing and air inlet duct. Remove accessory drive belt and belt idler pulley, if required.
2. On all models, loosen clamps and remove compressor manifold from turbocharger for access to high-pressure oil pump. Remove fuel filter/water separator housing. See **FUEL FILTER/WATER SEPARATOR**. Remove plug from top of high-pressure oil pump reservoir and use vacuum pump to remove oil from high-pressure oil pump reservoir.
3. Disconnect high-pressure oil pump supply lines from high-pressure oil pump. Disconnect necessary electrical connectors for removal of high-pressure oil pump.
4. Remove cover plate for access to high-pressure oil pump drive gear bolt. Cover plate is bolted on front cover, just below high-pressure oil pump reservoir.
5. Remove high-pressure oil pump drive gear bolt and washer. Remove retaining bolts, high-pressure oil pump and gasket.

Installation

1. Using NEW gasket, install high-pressure oil pump. Install and tighten bolts to specification. See **TORQUE SPECIFICATIONS**.

CAUTION: High-pressure oil pump drive gear must be fully seated on shaft of high-pressure oil pump before installing high-pressure oil pump drive gear bolt and washer. End of shaft should be even with front edge of high-pressure oil pump drive gear.

2. Ensure high-pressure oil pump drive gear is fully seated on shaft of high-pressure oil pump. End of shaft should be even with front edge of high-pressure oil pump drive gear. Ensure washer is installed on high-pressure oil pump driver gear bolt.
3. Install and tighten high-pressure oil pump drive gear bolt to specification. See **TORQUE SPECIFICATIONS**. Apply RTV sealant on front cover at cover plate sealing surface. Install cover plate and tighten bolts.
4. To install remaining components, reverse removal procedure. Ensure seal is properly seated when installing compressor manifold on turbocharger. Tighten high-pressure oil pump supply line fittings at high-pressure oil pump to specification. See **TORQUE SPECIFICATIONS**.

CAUTION: High-pressure oil pump reservoir must be filled with engine oil.

5. Fill high-pressure oil pump reservoir with clean engine oil. Install plug. Ensure proper procedure is used when installing fuel filter/water separator housing. See **FUEL FILTER/WATER SEPARATOR**.

HIGH-PRESSURE OIL PUMP DRIVE GEAR

Removal

1. On Van, remove air cleaner housing and air inlet duct. Remove accessory drive belt and belt idler pulley, if required.
2. On all models, loosen clamps and remove compressor manifold from turbocharger for access to high-pressure oil pump. Remove fuel filter/water separator housing. See **FUEL FILTER/WATER SEPARATOR**. Remove plug from top of high-pressure oil pump reservoir, and use vacuum pump to remove oil from high-pressure oil pump reservoir.
3. Disconnect high-pressure oil pump supply lines from high-pressure oil pump. Disconnect necessary electrical connectors for removal of high-pressure oil pump.
4. Remove bolts/nuts, high-pressure oil pump reservoir and gasket. Using dial indicator, check gear backlash on high-pressure oil pump drive gear while moving gear back and forth by hand. Replace high-pressure oil pump drive gear if gear backlash is not .0055-.0101" (.140-.256 mm).
5. Remove high-pressure oil pump for removal of high-pressure oil pump drive gear. See **HIGH-PRESSURE OIL PUMP**. Remove high-pressure oil pump drive gear from front cover.

Installation

1. To install, reverse removal procedure. Ensure sealing surfaces on high-pressure oil pump reservoir and

front cover are clean. Install NEW gasket on front cover and apply RTV sealant on front cover before installing high-pressure oil pump reservoir.

2. Ensure high-pressure oil pump reservoir is filled with clean engine oil. Ensure seal is properly seated when installing compressor manifold on turbocharger.

TURBOCHARGER

Removal (Excursion & F250-F550 Super Duty)

1. Disconnect negative battery cables. Remove charge air cooler intake and outlet ducts from compressor manifold. Disconnect pressure lines and pressure valve electrical connector. Loosen turbocharger-to-compressor manifold clamps. Remove compressor manifold.
2. Loosen exhaust outlet pipe-to-turbocharger clamp. Pull exhaust outlet pipe away from turbocharger. Slide retaining clip away from exhaust backpressure valve actuator lever. Pull actuator rod free of actuator lever.
3. Loosen air inlet tube clamps. Disconnect pressure line from inlet tube. Remove air inlet tube. Loosen turbocharger clamps. Remove turbocharger attaching bolts.
4. Disconnect exhaust backpressure solenoid electrical connector. Remove turbocharger pedestal assembly-to-cylinder block bolts. See **Fig. 10**. Remove turbocharger and pedestal. Remove "O" rings located between cylinder block and turbocharger pedestal assembly.

Inspection (Excursion & F250-F550 Super Duty)

For inspection and overhaul procedures, see **TURBOCHARGER** under OVERHAUL.

Installation (Excursion & F250-F550 Super Duty)

To install, reverse removal procedure using NEW "O" rings. Ensure seal is properly seated when installing compressor manifold on turbocharger. Tighten all bolts/nuts to specification. See **TORQUE SPECIFICATIONS**.

Removal (Van)

1. Disconnect negative battery cables. Remove interior engine cover. Remove heat shield from turbocharger. Disconnect air intake hose from turbocharger.
2. Remove front exhaust pipe-to-turbocharger clamp. Remove exhaust inlet pipes for turbocharger. Exhaust inlet pipes fit between exhaust manifolds and exhaust inlet adapter on turbocharger. Loosen clamp and remove inlet hose.
3. Loosen clamps and remove compressor manifold from rear of turbocharger. See **Fig. 10**. Disconnect electrical connectors. Remove turbocharger pedestal assembly-to-cylinder block bolts. See **Fig. 10**. Remove turbocharger assembly. Remove "O" rings located between cylinder block and turbocharger pedestal assembly.

Inspection (Van)

For inspection and overhaul procedures, see **TURBOCHARGER** under OVERHAUL.

Installation (Van)

1. Ensure right rear turbocharger pedestal assembly-to-cylinder block bolt is installed before installing turbocharger on cylinder block. To install, reverse removal procedure using NEW "O" rings. Ensure seal is properly seated when installing compressor manifold on turbocharger.
2. Ensure all bolts/nuts are loosely installed in exhaust inlet pipes before tightening to specification. Tighten all bolts/nuts to specification. See **TORQUE SPECIFICATIONS**.

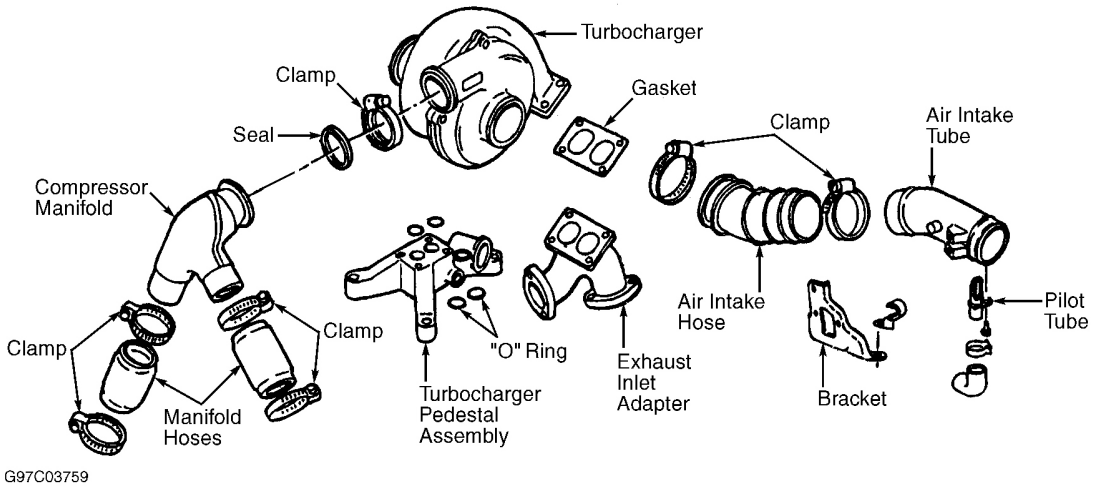


Fig. 10: Exploded View Of Turbocharger
Courtesy of FORD MOTOR CO.

EXHAUST MANIFOLD

Removal (Excursion & F250-F550 Super Duty)

1. Disconnect negative battery cables. On A/T models, when removing passenger-side exhaust manifold, remove transmission fill tube bracket bolts. Rotate transmission fill tube and bracket aside.
2. On all models, raise and support vehicle. Remove exhaust inlet pipe-to-exhaust manifold bolt/nuts. Exhaust inlet pipe fits between exhaust manifold and exhaust inlet adapter on turbocharger. Remove bolts and exhaust manifold.

Inspection (Excursion & F250-F550 Super Duty)

Using feeler gauge and straightedge, check exhaust manifold warpage. Resurface exhaust manifold if warpage exceeds .005" (.13 mm) between ports on exhaust manifold or .010" (.25 mm) overall. DO NOT machine more than .010" (.25 mm) from exhaust manifold.

Installation (Excursion & F250-F550 Super Duty)

To install, reverse removal procedure. Apply anti-seize on threads of exhaust manifold bolts before installing. Tighten bolts/nuts to specification. See **TORQUE SPECIFICATIONS**.

Removal (Van)

1. Disconnect negative battery cables. Remove interior engine cover. When removing passenger-side exhaust manifold, remove air cleaner assembly. Remove oil level indicator tube and retaining nut.
2. Raise and support vehicle. Remove exhaust inlet pipe-to-exhaust manifold bolt/nuts. Exhaust inlet pipe fits between exhaust manifold and exhaust inlet adapter on turbocharger. On right side, disconnect exhaust backpressure line from manifold. On both sides, remove bolts and exhaust manifold.

Inspection (Van)

Using feeler gauge and straightedge, check exhaust manifold warpage. Resurface exhaust manifold if warpage exceeds .005" (.13 mm) between ports on exhaust manifold or .010" (.25 mm) overall. DO NOT machine more than .010" (.25 mm) from exhaust manifold.

Installation (Van)

To install, reverse removal procedure. Apply anti-seize on threads of exhaust manifold bolts before installing. Tighten bolts/nuts to specification. See **TORQUE SPECIFICATIONS**.

VALVE COVERS

Removal & Installation (Left Side - Excursion & "F" Series)

1. Disconnect negative battery cable. If vehicle is equipped with dual batteries, disconnect both negative battery cables. Remove the air cleaner outlet tube. See **Fig. 11**. Remove the air charge cooler. Remove the turbocharger intake tube and bracket assembly.
2. Disconnect the fuel injector/glow plug retaining clip. See **Fig. 12**. Disconnect the fuel injector/glow plug 9 pin harness connector. Disconnect the engine control sensor wiring. See **Fig. 13**.
3. Position aside the wiring bracket. Remove the breather assembly. See **Fig. 14**. Remove 10 valve cover bolts and remove the valve cover.
4. Disconnect the 4 electrical leads from the glow plugs. See **Fig. 15** and **Fig. 16** . Disconnect the 4 electrical connectors from the fuel injectors. Remove the valve cover gasket.
5. To install, reverse the removal procedure. Install NEW valve cover gasket. Tighten air cleaner outlet tube clamps, valve cover bolts, breather assembly bolts and battery cable terminals to specification. See **TORQUE SPECIFICATIONS**.

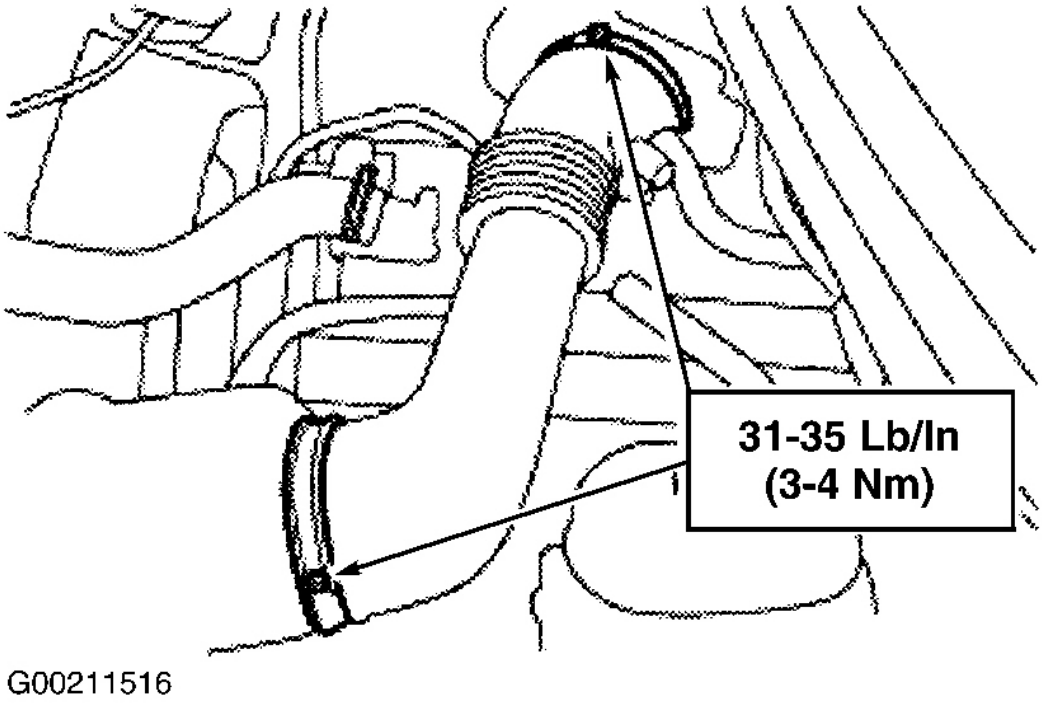


Fig. 11: Removing & Installing Air Cleaner Outlet Tube
Courtesy of FORD MOTOR CO.

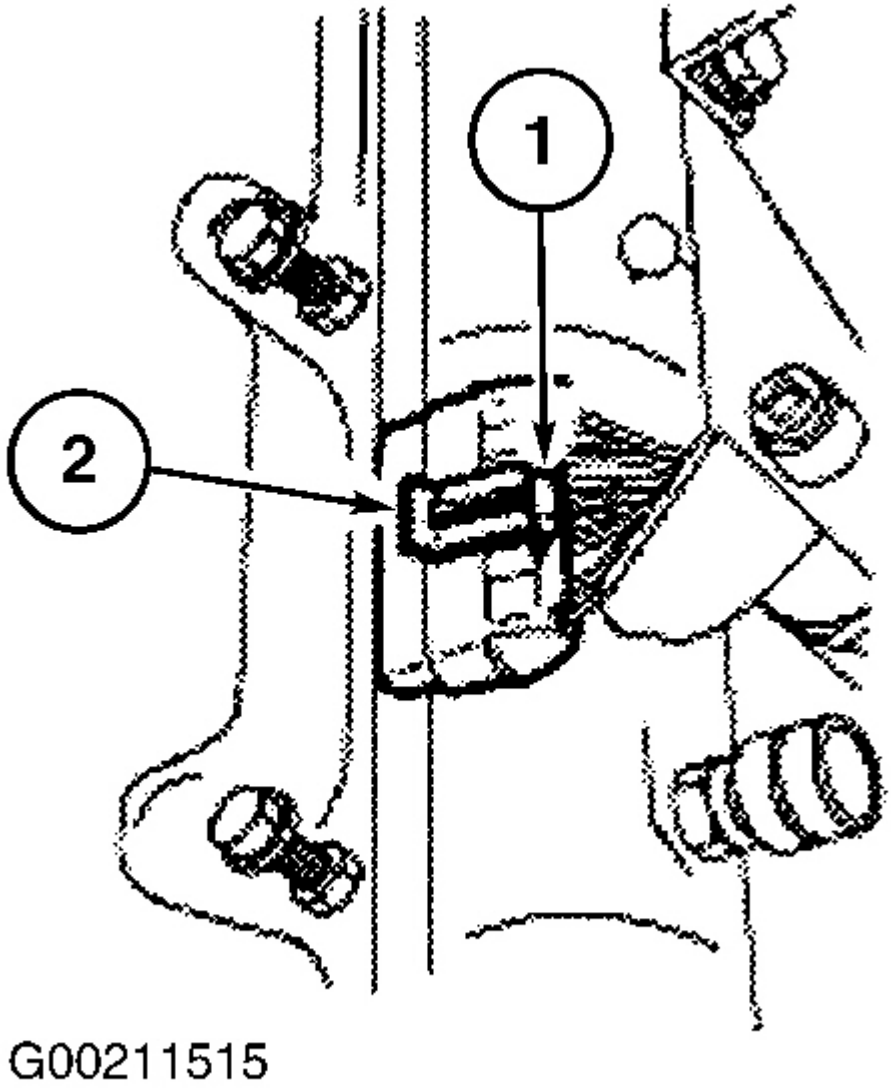


Fig. 12: Disconnecting & Connecting Fuel Injector/Glow Plug Wire Harness Connector
Courtesy of FORD MOTOR CO.

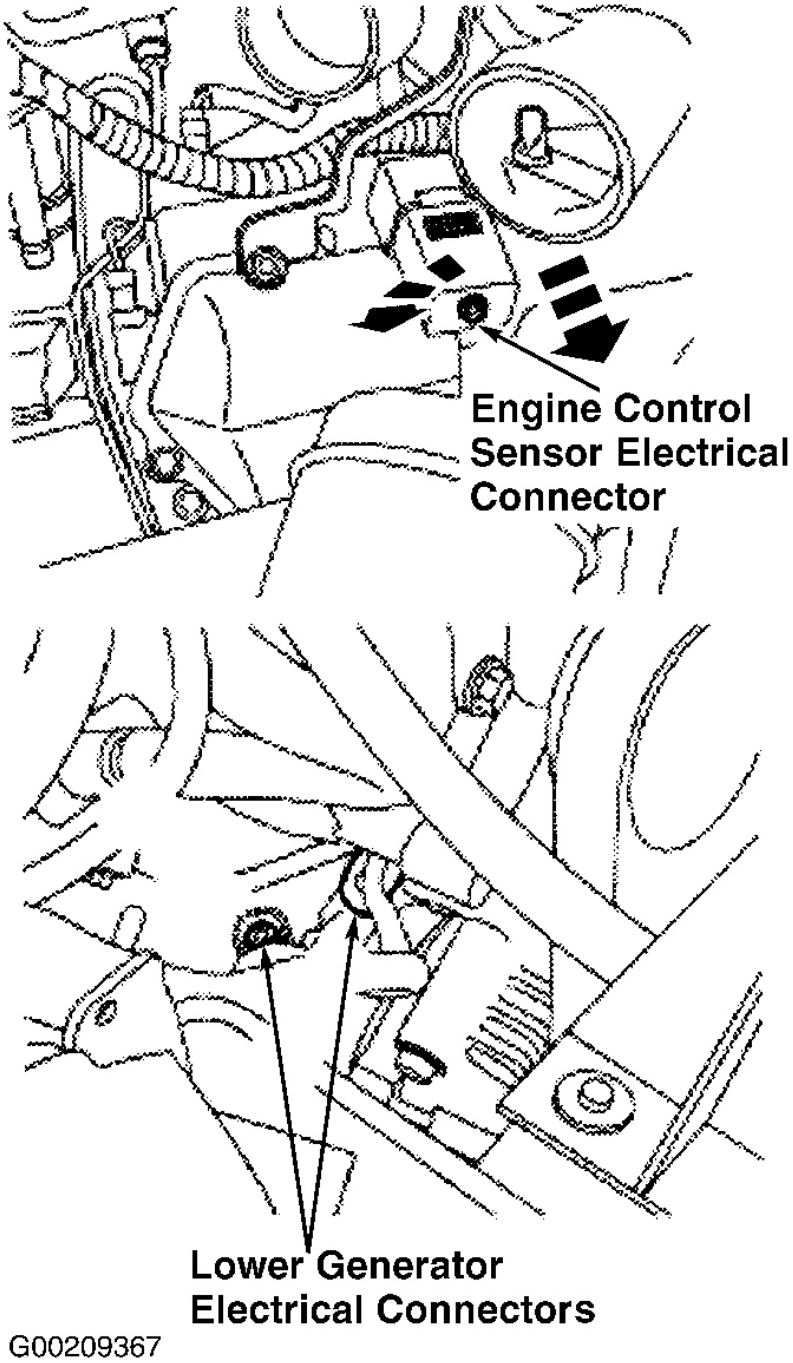


Fig. 13: Locating Engine Control Sensor & Lower Generator Electrical Connectors
Courtesy of FORD MOTOR CO.

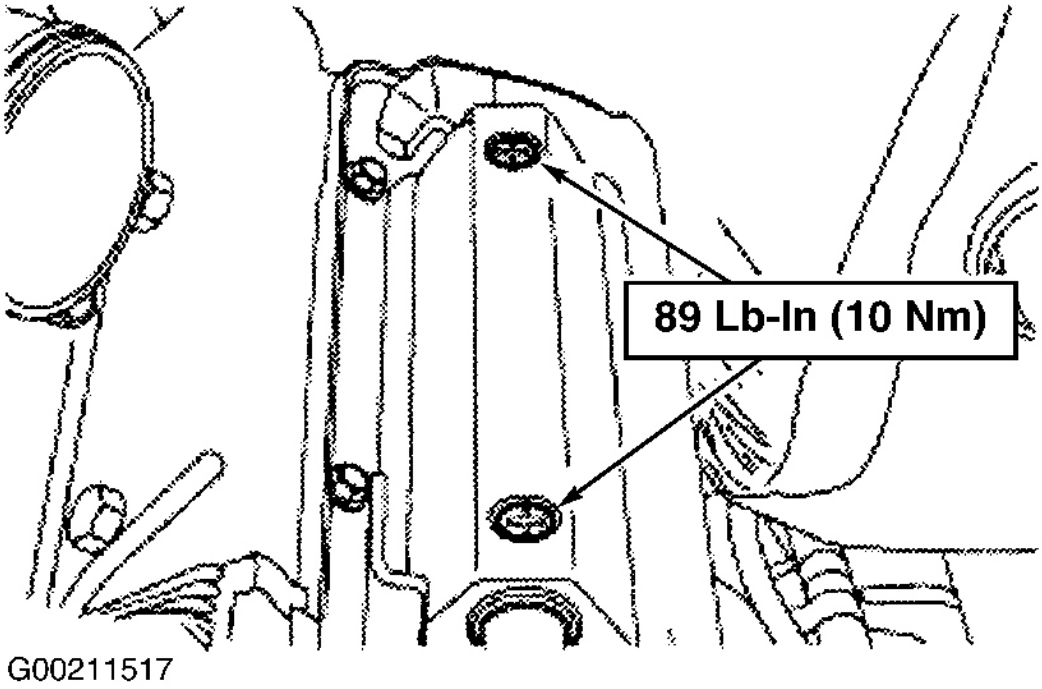


Fig. 14: Removing & Installing Breather Assembly
Courtesy of FORD MOTOR CO.

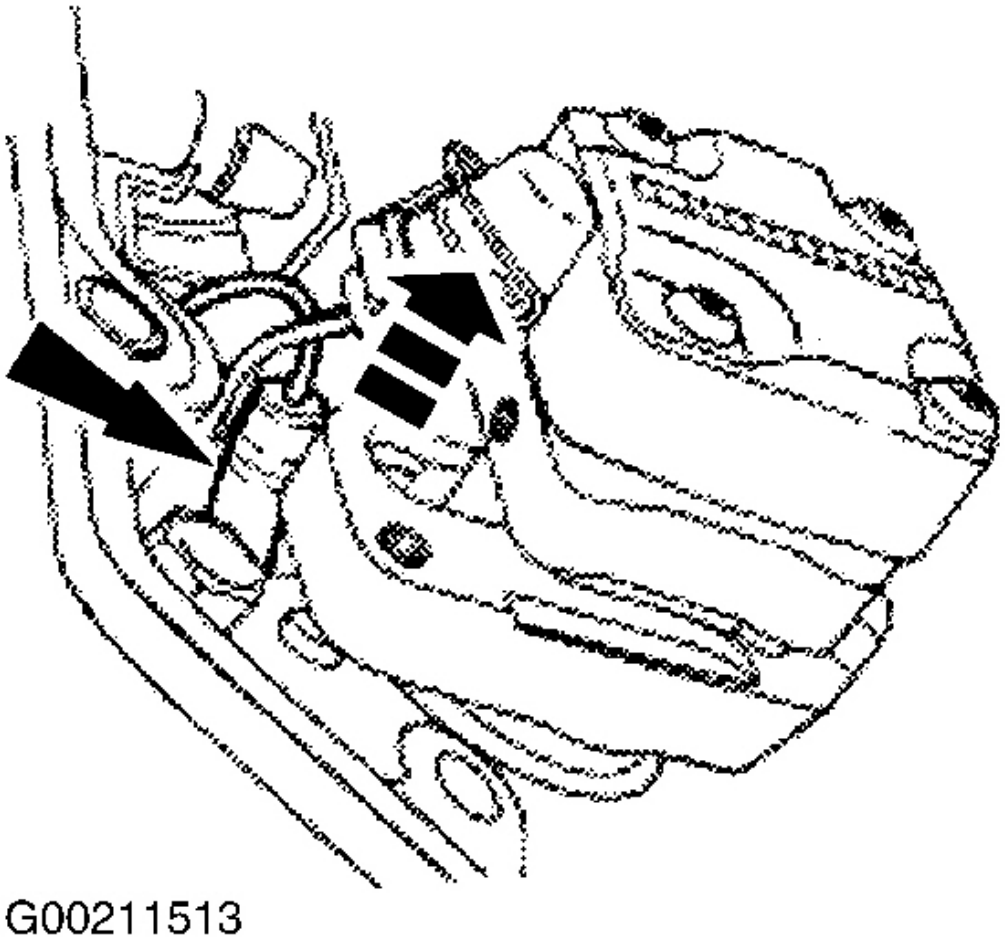


Fig. 15: Disconnecting & Connecting Glow Plug Harness Connector
Courtesy of FORD MOTOR CO.

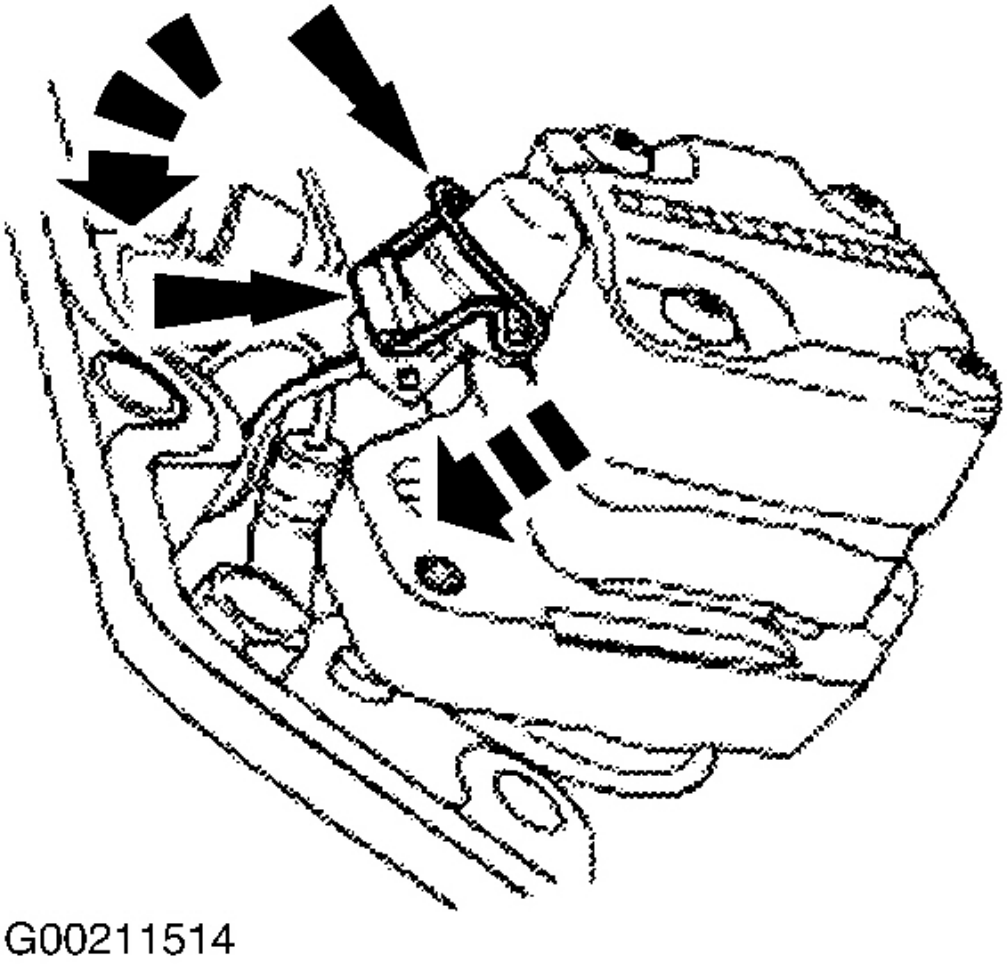


Fig. 16: Disconnecting & Connecting Fuel Injector Harness Connector
Courtesy of FORD MOTOR CO.

Removal & Installation (Right Side - Excursion & "F" Series)

1. Disconnect negative battery cable. If vehicle is equipped with dual batteries, disconnect both negative battery cables. Disconnect the Manifold Absolute Pressure (MAP) sensor harness connector and vacuum line. See **Fig. 17**.
2. Remove the air charge cooler inlet tube. See **Fig. 18**. Detach the heater hoses from the stand-offs. See **Fig. 19**. Remove the stand-offs. See **Fig. 20**. Detach the wiring harness. See **Fig. 21**.
3. Remove the oil level indicator tube nut and position the oil level indicator tube aside. See **Fig. 22**. Disconnect the fuel injector/glow plug retaining clip and disconnect the fuel injector/glow plug 9 pin harness connector.

4. Remove the 10 valve cover bolts and the valve cover. Remove the valve cover gasket. Disconnect the 4 electrical leads from the glow plugs. See **Fig. 15** and **Fig. 16** . Disconnect the 4 electrical connectors from the fuel injectors. Remove the valve cover gasket.
5. To install, reverse the removal procedure. Install NEW valve cover gasket. Install positive and negative battery cables to battery. Tighten valve cover bolts and battery cable terminals to specification. See **TORQUE SPECIFICATIONS**.

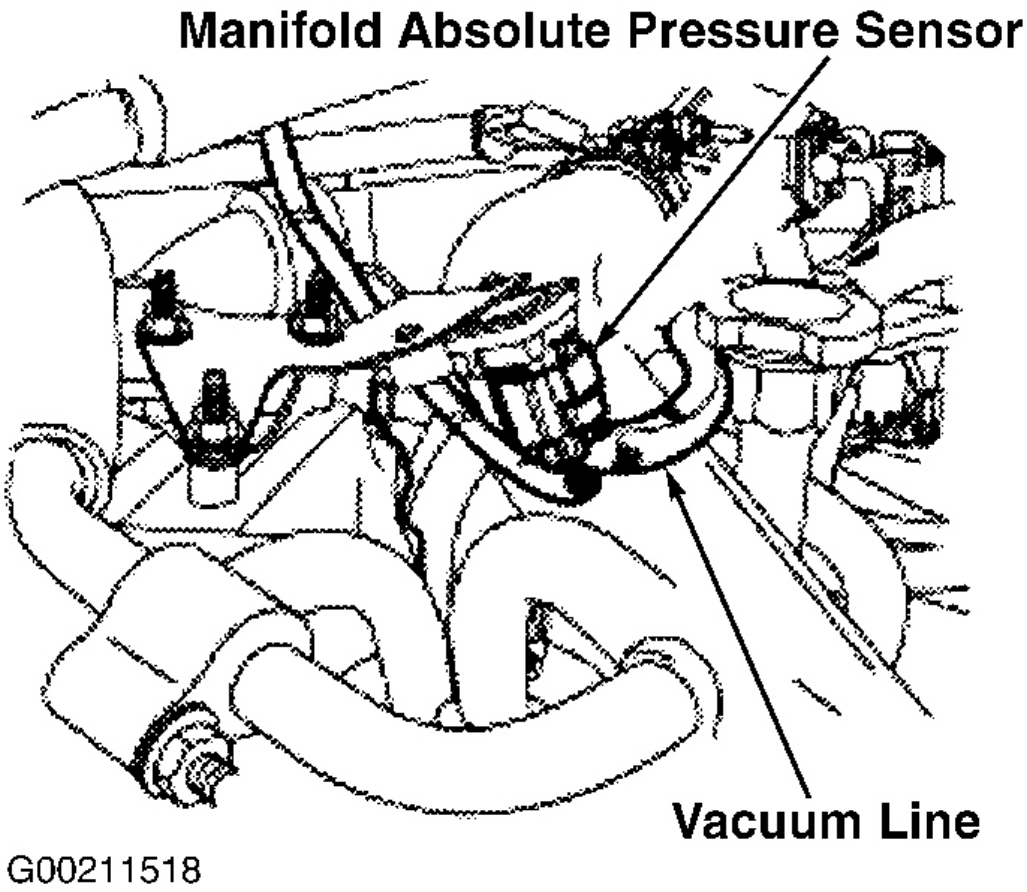


Fig. 17: Locating Manifold Absolute Pressure Sensor (Excursion & "F" Series)
Courtesy of FORD MOTOR CO.

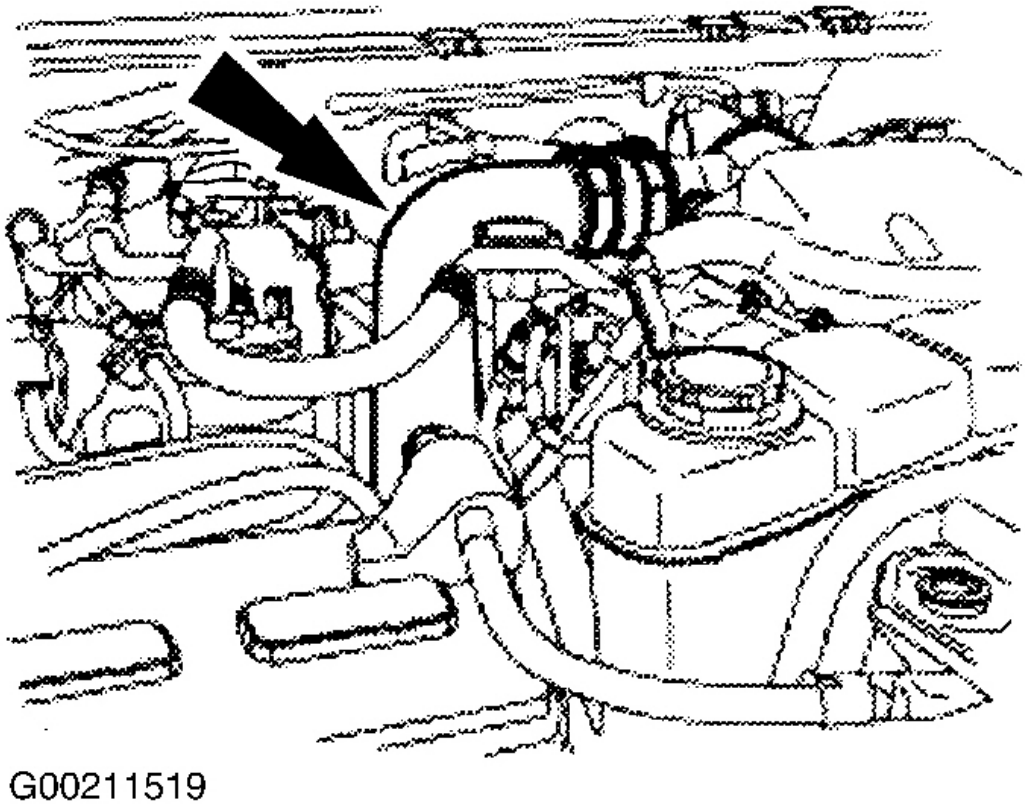


Fig. 18: Removing Air Charge Cooler Inlet Tube (Excursion & "F" Series)
Courtesy of FORD MOTOR CO.

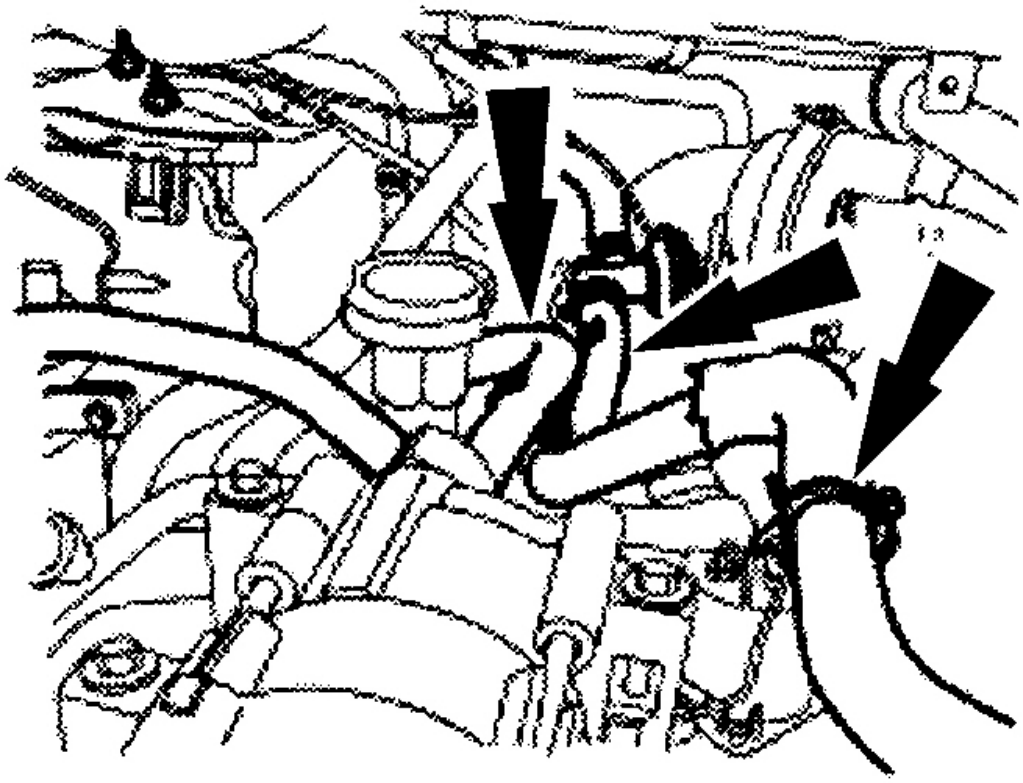


Fig. 19: Removing & Installing Heater Hoses (Excursion & "F" Series)
Courtesy of FORD MOTOR CO.

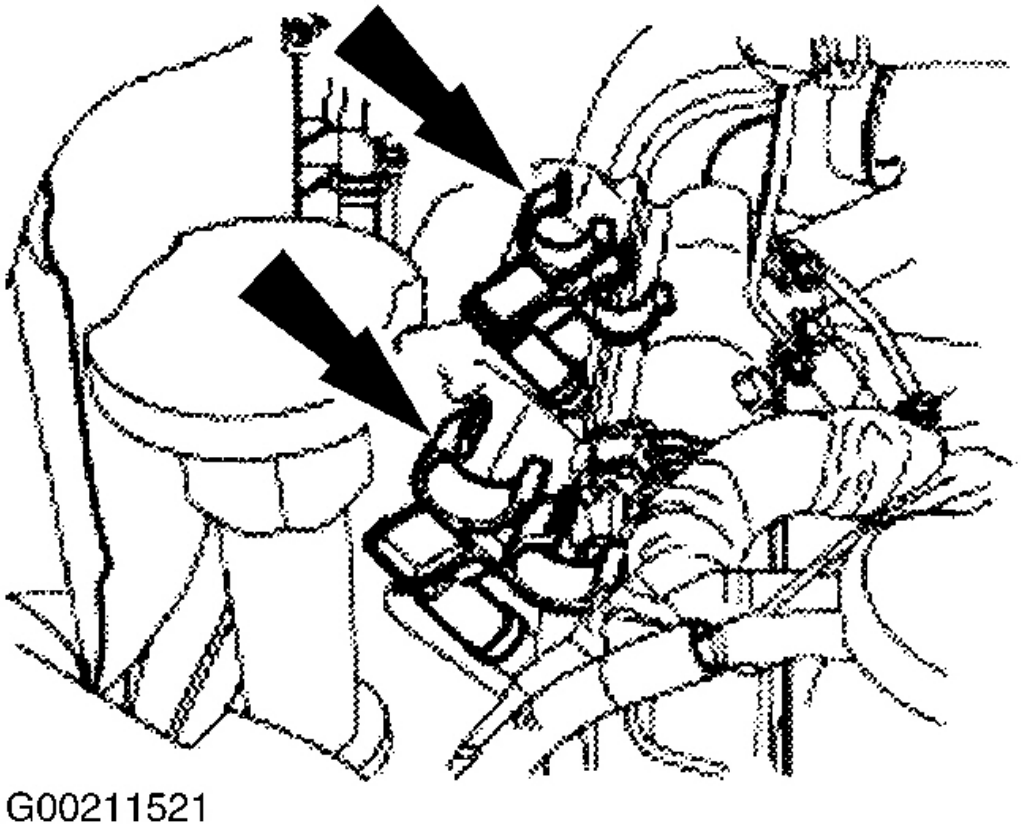


Fig. 20: Removing & Installing Heater Hose Stand-Offs (Excursion & "F" Series)
Courtesy of FORD MOTOR CO.

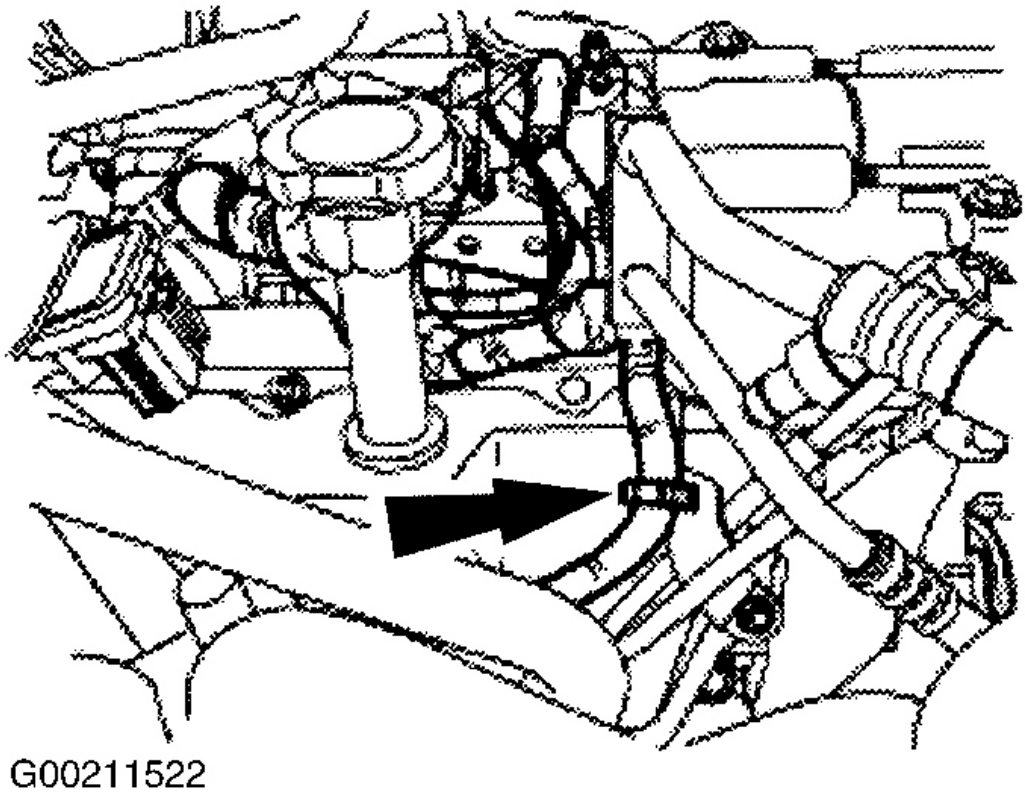


Fig. 21: Removing & Installing Wiring Harness (Excursion & "F" Series)
Courtesy of FORD MOTOR CO.

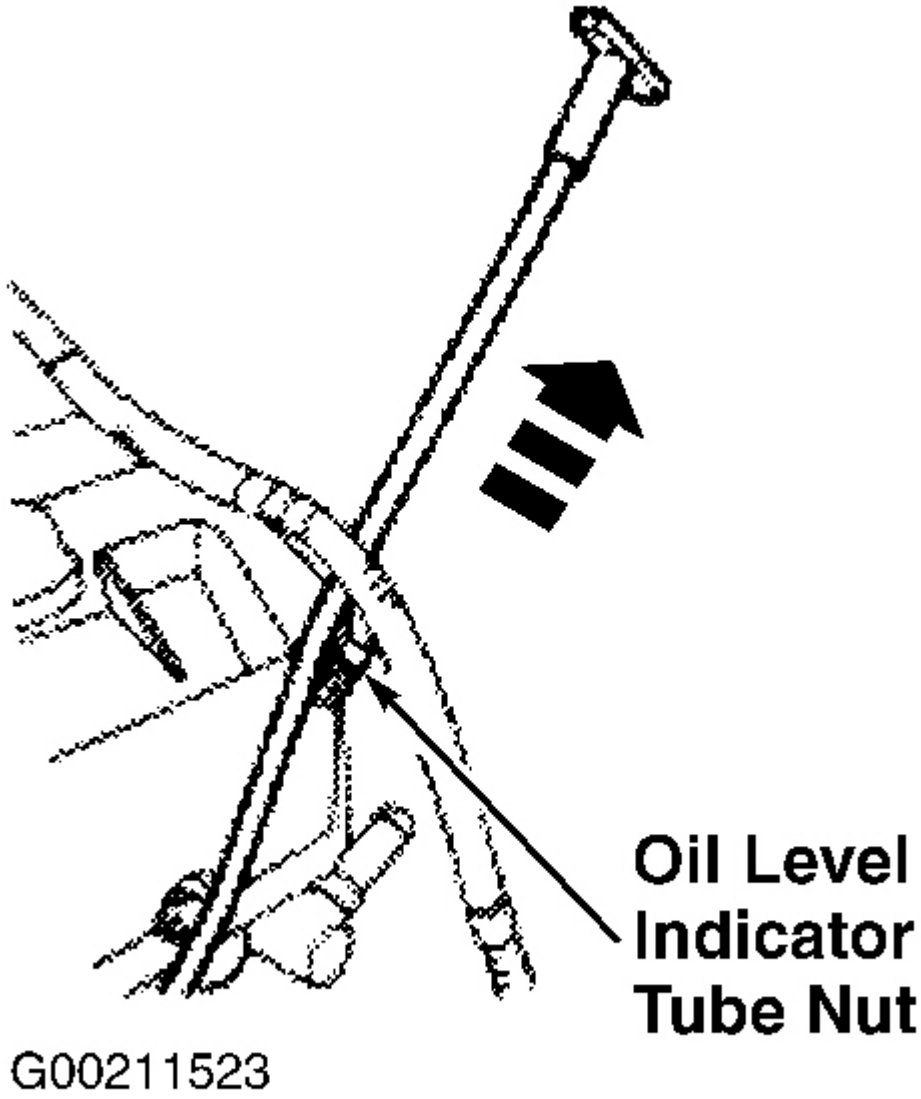


Fig. 22: Removing & Installing Oil Level Indicator Tube (Excursion & "F" Series)
Courtesy of FORD MOTOR CO.

Removal & Installation (Left Side - "E" Series)

1. Disconnect negative battery cable. If vehicle is equipped with dual batteries, disconnect both negative battery cables. Remove the air cleaner assembly. Remove the engine cover.
2. On E550 vehicles, disconnect the vacuum hoses and position the vacuum hoses out of the way. See **Fig. 23**.

3. On all vehicles, Remove the oil fill tube. Remove the inlet duct, tube and bracket assembly. See **Fig. 24**.
4. Disconnect the fuel injector/glow plug harness connector retaining clip and disconnect the 9 pin harness connector. See **Fig. 13**.
5. Remove the 10 valve cover bolts and remove the valve cover.
6. Disconnect the 4 electrical leads from the glow plugs and disconnect the 4 electrical connectors from the fuel injectors. See **Fig. 15** and **Fig. 16** . Remove the valve cover gasket.
7. To install, reverse the removal procedure. Install NEW valve cover gasket. Tighten valve cover bolts and both negative battery cable terminals to specification. See **TORQUE SPECIFICATIONS**.

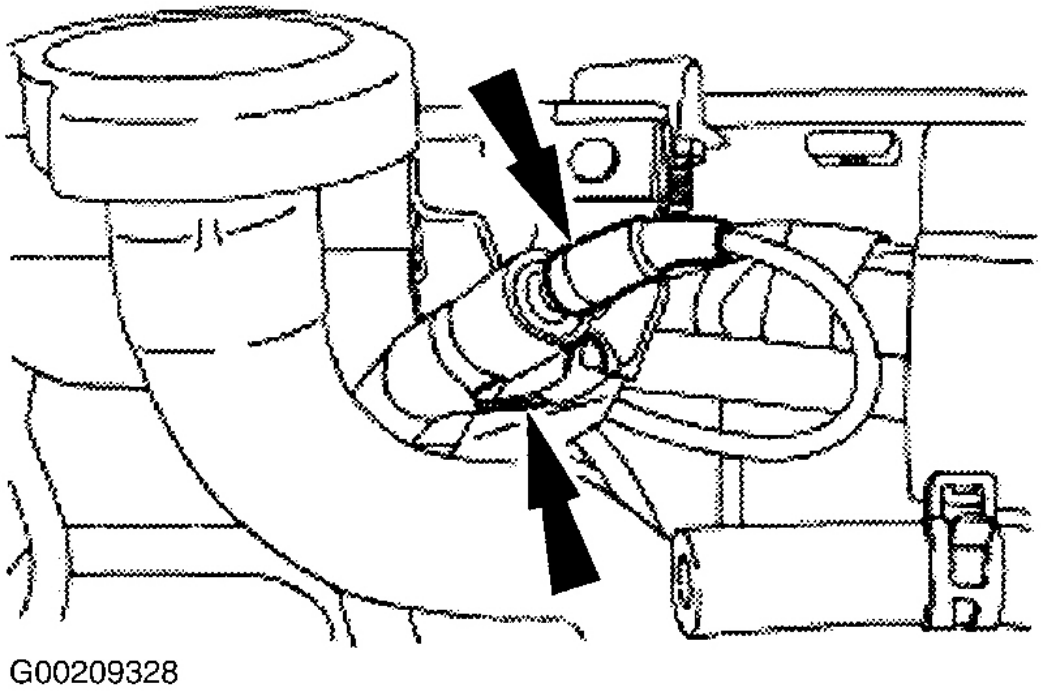


Fig. 23: Removing & Installing Vacuum Line At Oil Filler Tube (E550)
Courtesy of FORD MOTOR CO.

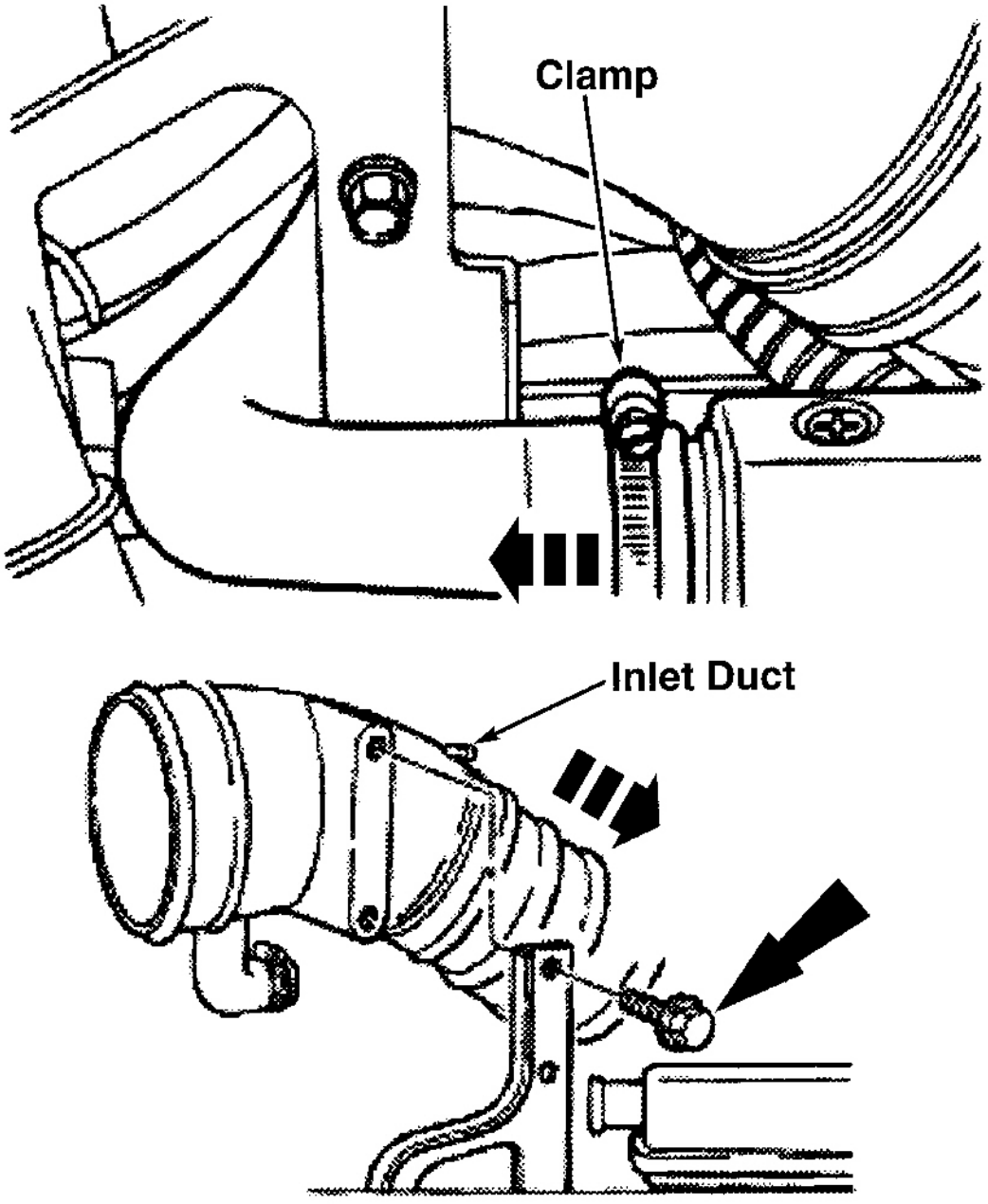


Fig. 24: Removing & Installing Inlet Duct ("E" Series)
Courtesy of FORD MOTOR CO.

Removal & Installation (Right Side - "E" Series)

1. Disconnect negative battery cable. If vehicle is equipped with dual batteries, disconnect both negative

battery cables. Remove the engine cover.

2. Remove the air cleaner assembly. See **Fig. 25**. Loosen the clamp, and disconnect the air inlet tube from the resonator. See **Fig. 26**. Remove the 3 nuts and the turbocharger heat shield.
3. Remove the resonator retaining bolt and the resonator from the vehicle. See **Fig. 27**. Remove the resonator bracket and the resonator assembly.
4. Remove the oil level indicator tube nut and pull upward to remove the oil level indicator tube. See**Fig. 22**. Disconnect the fuel injector/glow plug retaining clip and disconnect the fuel injector/glow plug 9 pin harness connector.
5. Remove the 10 valve cover bolts, resonator bracket nut, and the valve cover. Remove the valve cover gasket. Disconnect the 4 electrical leads from the glow plugs. See **Fig. 15** and **Fig. 16** . Disconnect the 4 electrical connectors from the fuel injectors. Remove the valve cover gasket.
6. To install, reverse the removal procedure. Install NEW valve cover gasket. Install positive and negative battery cables to battery. Tighten valve cover bolts and battery cable terminals to specification. See **TORQUE SPECIFICATIONS**.

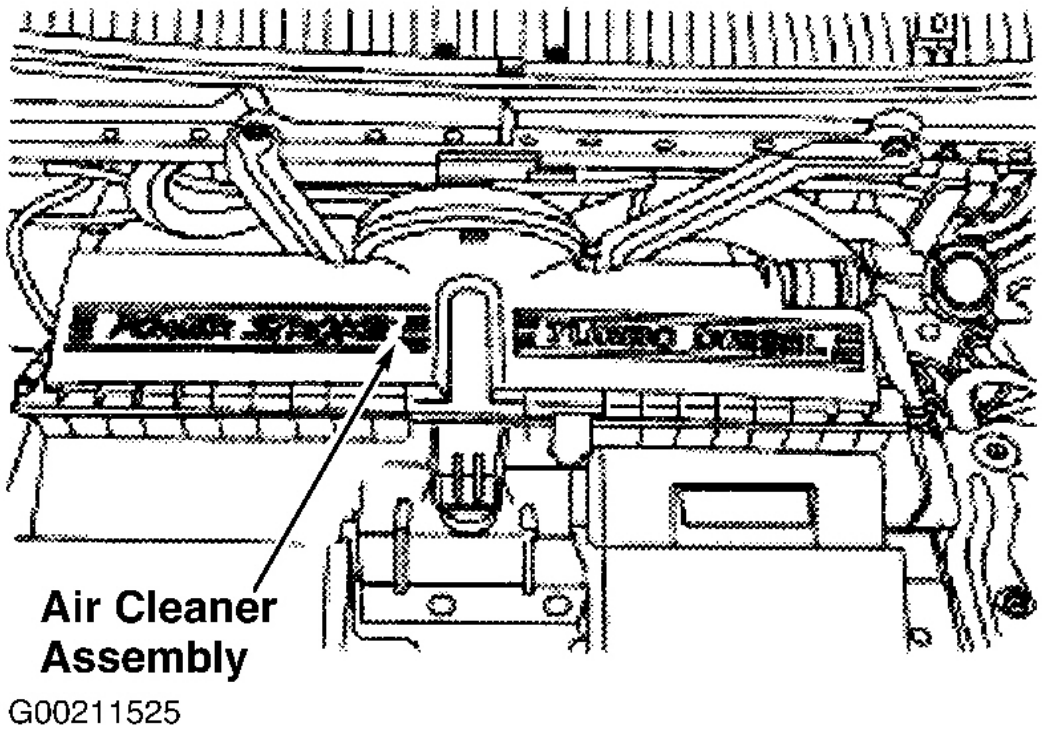


Fig. 25: Removing & Installing Air Cleaner Assembly
Courtesy of FORD MOTOR CO.

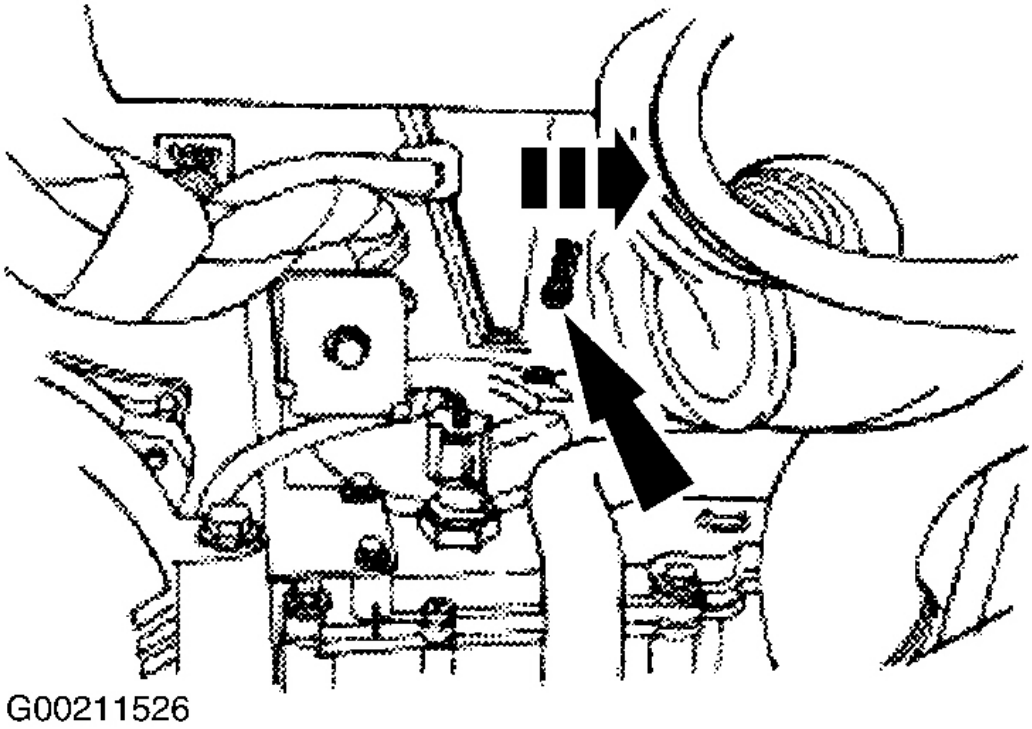


Fig. 26: Locating Air Inlet Tube Clamp
Courtesy of FORD MOTOR CO.

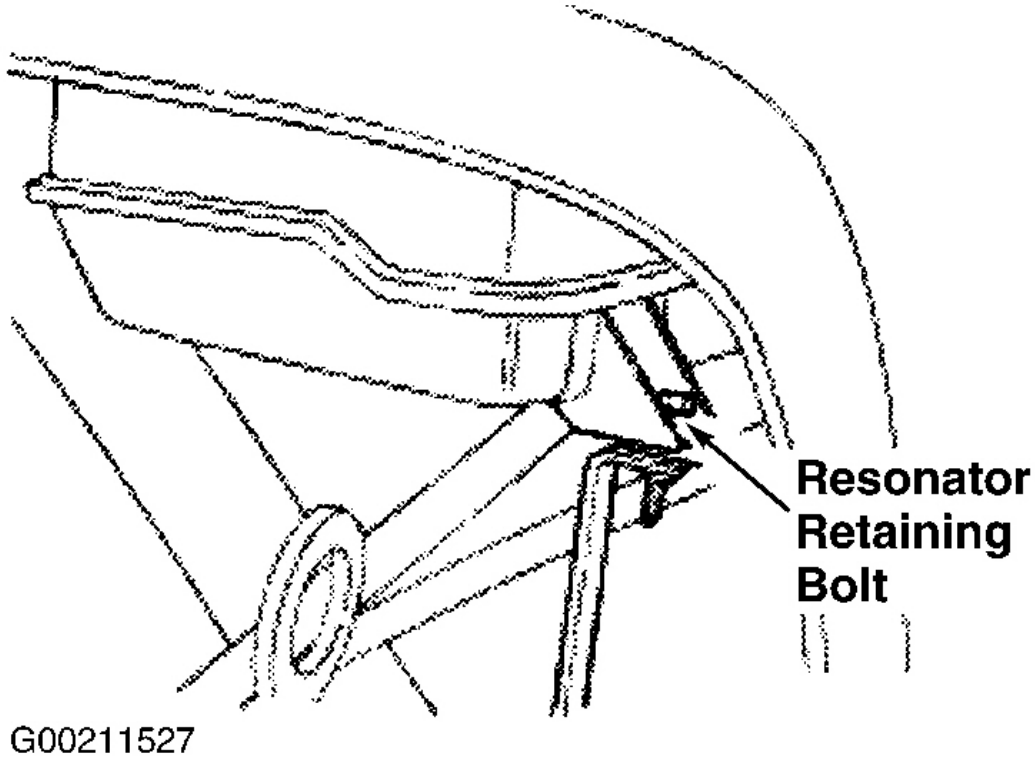


Fig. 27: Locating Resonator Retaining Bolt
Courtesy of FORD MOTOR CO.

CYLINDER HEAD

WARNING: When servicing cylinder head, use care when working with engine wiring harness for fuel injectors, as Injector Driver Module (IDM) supplies 115 volts DC to each fuel injector on engine wiring harness. DO NOT pierce any wires in engine wiring harness. Ensure negative battery cables are disconnected before servicing engine components in which contact with engine wiring harness for fuel injectors may exist.

Removal (Excursion & F250-F550 Super Duty)

1. Disconnect negative battery cables. Drain cooling system. Place container below water drain line at bottom of fuel filter/water separator housing.
2. Rotate water drain lever away from fuel filter/water separator housing and allow fuel to drain. Water drain lever is located near top of fuel filter/water separator housing.
3. Disconnect fuel line assembly from rear of cylinder heads. This is fuel line that fits between fuel pump and cylinder heads. DO NOT bend fuel line. For driver-side cylinder head, go to step 6.

4. On passenger-side cylinder head, note direction of accessory drive belt routing for installation reference. Rotate accessory drive belt tensioner away from accessory drive belt. Remove accessory drive belt. Remove turbocharger compressor manifold. Disconnect electrical connectors from generator. Remove engine ground cable. Remove generator mounting bracket and generator as an assembly. Remove A/T oil dipstick and dipstick tube. Remove screws from Manifold Absolute Pressure (MAP) sensor, and position sensor aside.
5. Discharge A/C system (if equipped) using approved refrigerant recovery/recycling equipment. Disconnect electrical connector from A/C compressor clutch. Disconnect A/C refrigerant lines from A/C compressor and plug line openings. Remove A/C compressor and mounting bracket. Go to step **7)** .
6. On driver-side, disconnect lines at power steering pump. Remove generator mounting bracket, if equipped. Disconnect high pressure line. Disconnect injection pressure sensor connector. On A/C equipped models, remove heater water hoses and standoffs.

WARNING: Injector Driver Module (IDM) supplies 115 volts DC to each fuel injector on engine wiring harness. DO NOT pierce any wires in engine wiring harness when servicing valve cover gasket and fuel injector.

7. On all models, disconnect engine wiring harness wires from valve cover gasket connector. DO NOT pierce any wires in engine wiring harness. Remove valve cover. Disconnect engine wiring harness wires from fuel injectors and glow plugs. DO NOT pierce any wires in engine wiring harness.
8. Remove 10 bolts to remove valve cover. Remove valve cover. Remove valve cover gasket from cylinder head. Remove fuel injectors from cylinder head. See **FUEL INJECTOR**. Remove glow plugs from cylinder head.
9. Remove rocker arm assemblies and push rods. See **ROCKER ARM ASSEMBLY & PUSH ROD**. Remove exhaust manifold. See **EXHAUST MANIFOLD**.
10. Disconnect necessary ground straps at cylinder head. Disconnect fuel return line from cylinder head. Remove 4 fuel injector shoulder bolts. Remove cylinder head bolts, cylinder head and cylinder head gasket.

CAUTION: DO NOT resurface cylinder head. If cylinder head warpage exceeds specification, replace cylinder head.

Inspection (Excursion & F250-F550 Super Duty)

1. Check cylinder head for cracks and warpage at cylinder head gasket surface. Replace cylinder head if warpage exceeds specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. DO NOT resurface cylinder head.
2. Measure cylinder head height from top of valve cover gasket surface on cylinder head to cylinder head gasket surface. Replace cylinder head if cylinder head height is not within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.
3. Check cylinder block deck surface for warpage at cylinder head gasket surface. Resurface cylinder block if warpage exceeds specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS. DO NOT remove more than .010" (.25 mm) of material from cylinder block if resurfacing cylinder block.

CAUTION: All fuel and oil must be removed from cylinders before installing cylinder head and fuel injectors. Failure to ensure cylinders are clean may result in engine damage caused by hydrostatic lock.

Installation (Excursion & F250-F550 Super Duty)

1. Ensure fuel and oil are removed from cylinders before installing cylinder head. To install, reverse removal procedure using NEW cylinder head gasket. Lightly coat threads of cylinder head bolts with engine oil before installing.

CAUTION: DO NOT apply excessive amount of engine oil on threads of cylinder head bolts or threads and/or sealing surfaces may be damaged. DO NOT use any other lubricants on threads of cylinder head bolts except engine oil.

2. Install and tighten cylinder head bolts to specification in 3 steps. See **Fig. 28**. See **TORQUE SPECIFICATIONS**.
3. To install remaining components, reverse removal procedure. Install fuel injectors using proper procedure. See **FUEL INJECTOR**.
4. Ensure proper procedure is used when installing rocker arm assemblies and push rods. See **ROCKER ARM ASSEMBLY & PUSH ROD**.
5. Adjust all fluid levels. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. On A/C equipped models, evacuate and recharge A/C system if system was discharged.

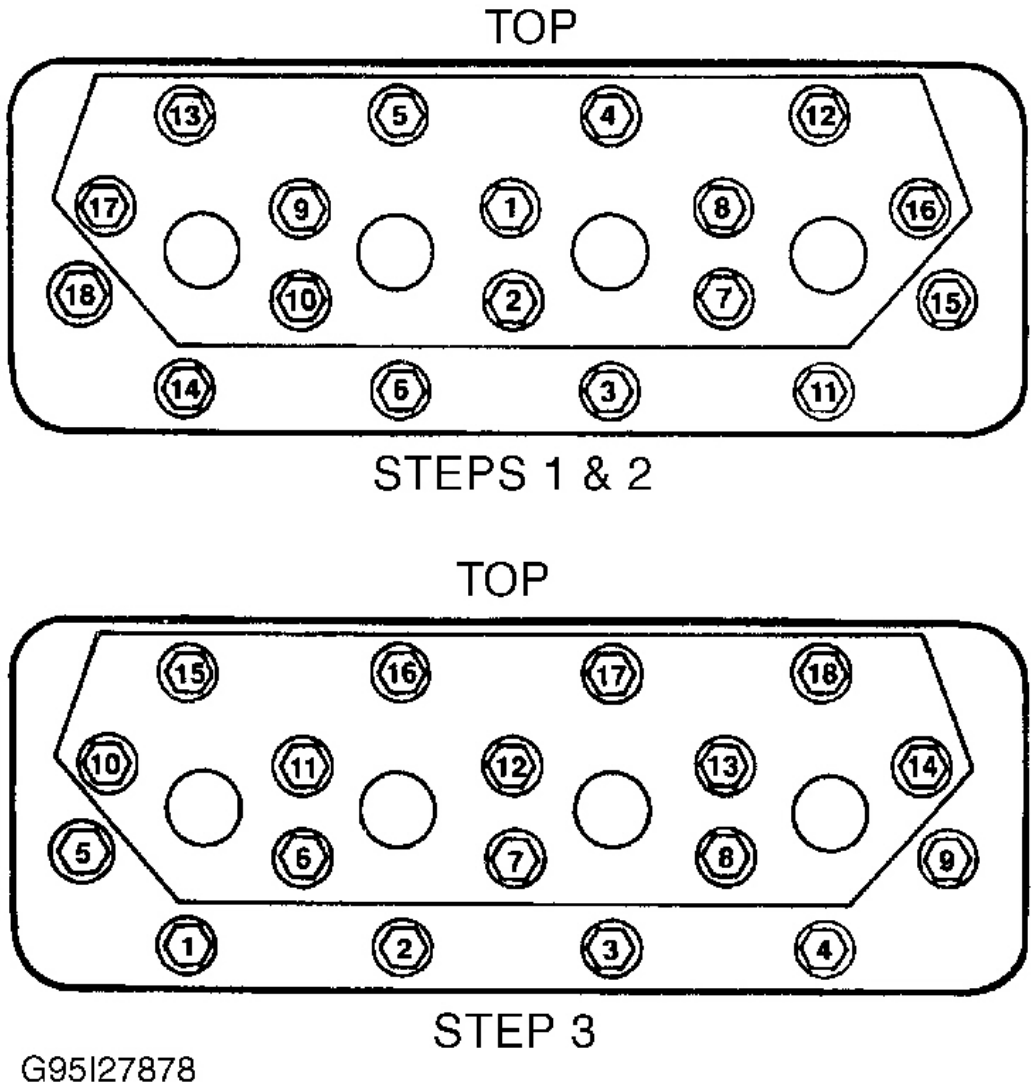


Fig. 28: Cylinder Head Bolt Tightening Sequence
Courtesy of FORD MOTOR CO.

Removal (Van)

1. Disconnect negative battery cables. Remove interior engine cover. Remove air cleaner assembly. Remove headlight and park light assemblies.

CAUTION: Fan clutch assembly uses right-hand threads to hold assembly on water pump.

2. Drain cooling system. Remove air deflector located above radiator. Using Fan Clutch Holder (T94T-6312-AH) and Fan Clutch Nut Wrench (T83T-6312-B), remove fan and fan clutch assembly from water pump. Place fan and fan clutch assembly in fan shroud.
3. Remove fan shroud along with fan and fan clutch assembly. Disconnect transmission oil cooler lines and coolant hoses from radiator. Remove radiator.
4. On A/C equipped models, discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect A/C refrigerant lines from condenser, and plug line openings. Remove condenser.
5. Remove grill, grill opening panel and upper radiator support. Loosen clamps and remove compressor manifold from turbocharger. See **Fig. 10**. Disconnect necessary coolant hoses, clamps and brackets for cylinder head removal. Remove accessory drive belt. Disconnect vacuum lines. Disconnect generator electrical connectors. Remove ground cable. Remove generator mounting bracket bolts and remove mounting bracket. Remove generator.

WARNING: Injector Driver Module (IDM) supplies 115 volts DC to each fuel injector on engine wiring harness. DO NOT pierce any wires in engine wiring harness when servicing valve cover gasket and fuel injector.

6. Disconnect engine wiring harness wires from valve cover gasket connector. DO NOT pierce any wires in engine wiring harness. Remove valve cover. Disconnect engine wiring harness wires from fuel injectors and glow plugs. DO NOT pierce any wires in engine wiring harness. Remove valve cover gasket from cylinder head.
7. On passenger-side cylinder head applications, remove glow plug relay. On all cylinder head applications, disconnect fuel line assembly from rear of cylinder heads. This is fuel line that fits between fuel pump and cylinder heads. DO NOT bend fuel line.
8. Disconnect high-pressure oil pump supply line from cylinder head. Remove fuel injectors from cylinder head. See **FUEL INJECTOR**.
9. Remove rocker arm assemblies and push rods. See **ROCKER ARM ASSEMBLY & PUSH ROD**. It may be necessary to remove exhaust manifold for cylinder head removal. See **EXHAUST MANIFOLD**.
10. Disconnect fuel return line from cylinder heads. Remove 4 fuel injector shoulder bolts. See **Fig. 5**. Remove cylinder head bolts, cylinder head and cylinder head gasket.

CAUTION: DO NOT resurface cylinder head. If cylinder head or cylinder block surface warpage exceeds specification, replace component.

Inspection (Van)

1. Check cylinder head for warpage at cylinder head gasket surface. Replace cylinder head if warpage exceeds specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. DO NOT resurface cylinder head.
2. Measure cylinder head height from top of valve cover gasket surface on cylinder head to cylinder head gasket surface. Replace cylinder head if cylinder head height is not within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.
3. Check cylinder block deck surface for warpage at cylinder head gasket surface. Resurface cylinder block

if warpage exceeds specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS. DO NOT remove more than .010" (.25 mm) of material from cylinder block if resurfacing cylinder block.

Installation (Van)

1. Ensure fuel and oil are removed from cylinders before installing cylinder head. To install, reverse removal procedure using NEW cylinder head gasket. Lightly coat threads of cylinder head bolts with engine oil before installing.

CAUTION: DO NOT apply excessive amount of engine oil on threads of cylinder head bolts or threads and/or sealing surfaces may be damaged. DO NOT use any other lubricants on threads of cylinder head bolts except engine oil.

2. Install and tighten cylinder head bolts to specification in 3 steps. See **Fig. 28**. See **TORQUE SPECIFICATIONS**.
3. To install remaining components, reverse removal procedure. Install fuel injectors using proper procedure. See **FUEL INJECTOR**.
4. Ensure proper procedure is used when installing rocker arm assemblies and push rods. See **ROCKER ARM ASSEMBLY & PUSH ROD**.
5. Adjust all fluid levels. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. On A/C equipped models, evacuate and recharge A/C system.

CRANKSHAFT FRONT SEAL

Removal

1. Disconnect negative battery cables. Drain cooling system. Disconnect upper radiator hose and coolant recovery reservoir hose at radiator. Remove necessary components for access to radiator. Note direction of accessory drive belt routing for installation reference. Rotate accessory drive belt tensioner away from accessory drive belt. Remove accessory drive belt.

CAUTION: Fan clutch assembly uses right-hand threads to hold assembly on water pump.

2. Using Fan Clutch Holder (T94T-6312-AH) and Fan Clutch Nut Wrench (T83T-6312-B), remove fan and fan clutch assembly from water pump. Place fan and fan clutch assembly in fan shroud.
3. Remove fan shroud along with fan and fan clutch assembly. Disconnect remaining coolant hoses from radiator. On A/T models, disconnect transmission oil cooler lines from radiator. On all models, remove radiator.
4. On A/T models, remove flywheel housing cover. On all models, remove vibration damper bolt and washer. Using puller, remove vibration damper. Wear ring on seal area on rear of vibration damper should be replace anytime vibration damper is removed.
5. Using Step Plate Adapter (D80L-630-A), Wear Ring Remover (T94T-6379-AH1), Bearing Collet Sleeve (T77F-7025-C), Remover Tube (T77J-7025-B) and Forcing Screw (T84T-7025-B), remove wear ring

from rear of vibration damper.

6. Using Seal Remover (T86P-70001) and slide hammer, pull crankshaft front seal from front cover. DO NOT scratch sealing surfaces on crankshaft and front cover.

CAUTION: DO NOT clean vibration damper in petroleum based solvent or rubber dampening element in vibration damper will be damaged.

Installation

1. Ensure all sealing surfaces are clean. Coat outside sealing surface of seal with multipurpose grease. Using Seal Installer (T94T-6700-AH), Thread Adapter (T94T-6379-AH3), Driver Sleeve (T79T-6316-A4) and Driver/Puller Screw (T79T-6316-A), install seal until seal is fully seated in front cover. Ensure seal installer aligns with key in crankshaft when installing seal.
2. Apply Loctite No. 271 to inside diameter of NEW wear ring. Using Driver Handle (T80T-4000-W) and Damper Wear Ring Installer (T94T-6379-AH2), install NEW wear ring onto vibration damper. Ensure wear ring is fully seated on vibration damper.

CAUTION: RTV sealant should be applied on crankshaft keyway before installing vibration damper.

3. Apply RTV sealant on crankshaft keyway. Using Driver/Puller Screw (T79T-6316-A1), Driver Sleeve (T79T-6316-A4) and Thread Adapter (T94T-6379-AH3), install vibration damper. Install vibration damper bolt with washer and tighten to specification. See **TORQUE SPECIFICATIONS**
4. To install remaining components, reverse removal procedure. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**. Add engine oil if necessary.

ROCKER ARM ASSEMBLY & PUSH ROD

WARNING: Injector Driver Module (IDM) supplies 115 volts DC to each fuel injector on engine wiring harness. Ensure negative battery cables are disconnected before servicing rocker arm assembly and push rod.

Removal (Excursion & F250-F550 Super Duty)

1. Disconnect negative battery cables. Remove charge air cooler inlet tube. Remove oil dipstick and dipstick tube. On driver-side of engine, remove air cleaner-to-air inlet duct. Loosen clamp, and remove crankcase breather hose. Remove 2 mounting bolts and remove air intake tube.

WARNING: Injector Driver Module (IDM) supplies 115 volts DC to each fuel injector on engine wiring harness. DO NOT pierce any wires in engine wiring harness when servicing valve cover gasket and fuel injector.

2. On both sides of engine, disconnect fuel injector/glow plug jumper 9-pin electrical connector. On driver-side, disconnect engine control sensor connector. On both sides of engine, remove 10 valve cover

attaching bolts, and remove valve covers.

3. Disconnect engine wiring harness wires from fuel injectors and glow plugs. DO NOT pierce any wires in engine wiring harness. Remove valve cover gasket from cylinder head.
4. Remove rocker arm assembly bolts. See **Fig. 5**. Remove rocker arm assembly. Note direction of push rod installation, as Copper end of push rod should be facing upward, toward rocker arm. Remove push rod. Mark rocker arm assembly and push rod location for installation reference.
5. If disassembling rocker arm assembly, note location of components on rocker arm assembly. See **Fig. 29**.

NOTE: When disassembling rocker arm assembly, DO NOT lose steel ball.

6. Remove retaining clip from rocker arm assembly. Remove rocker arm and steel ball from rocker arm pedestal. DO NOT lose steel ball from rocker arm.

Installation

1. If assembling rocker arm assembly, place steel ball in cup area on rocker arm. Lubricate steel ball with engine oil. Install rocker arm pedestal on steel ball and rocker arm. Install retaining clip. Ensure retaining clip is fully snapped into position.

CAUTION: Ensure push rods are installed with copper end facing upward, toward rocker. Engine must be positioned with timing mark on vibration damper at 11 o'clock position before installing rocker arm assembly to prevent bent valves and engine damage when installing rocker arm assembly.

2. Lubricate ends of push rods with engine oil. Install push rods in original location. Ensure Copper end of push rod is facing upward. Rotate engine until timing mark on vibration damper is at 11 o'clock position. This must be done to prevent bent valves and engine damage when installing rocker arm assembly.
3. Install rocker arm assembly. Install and tighten rocker arm assembly bolts to specification. See **TORQUE SPECIFICATIONS**. To install remaining components, reverse removal procedure. Tighten bolts to specification.

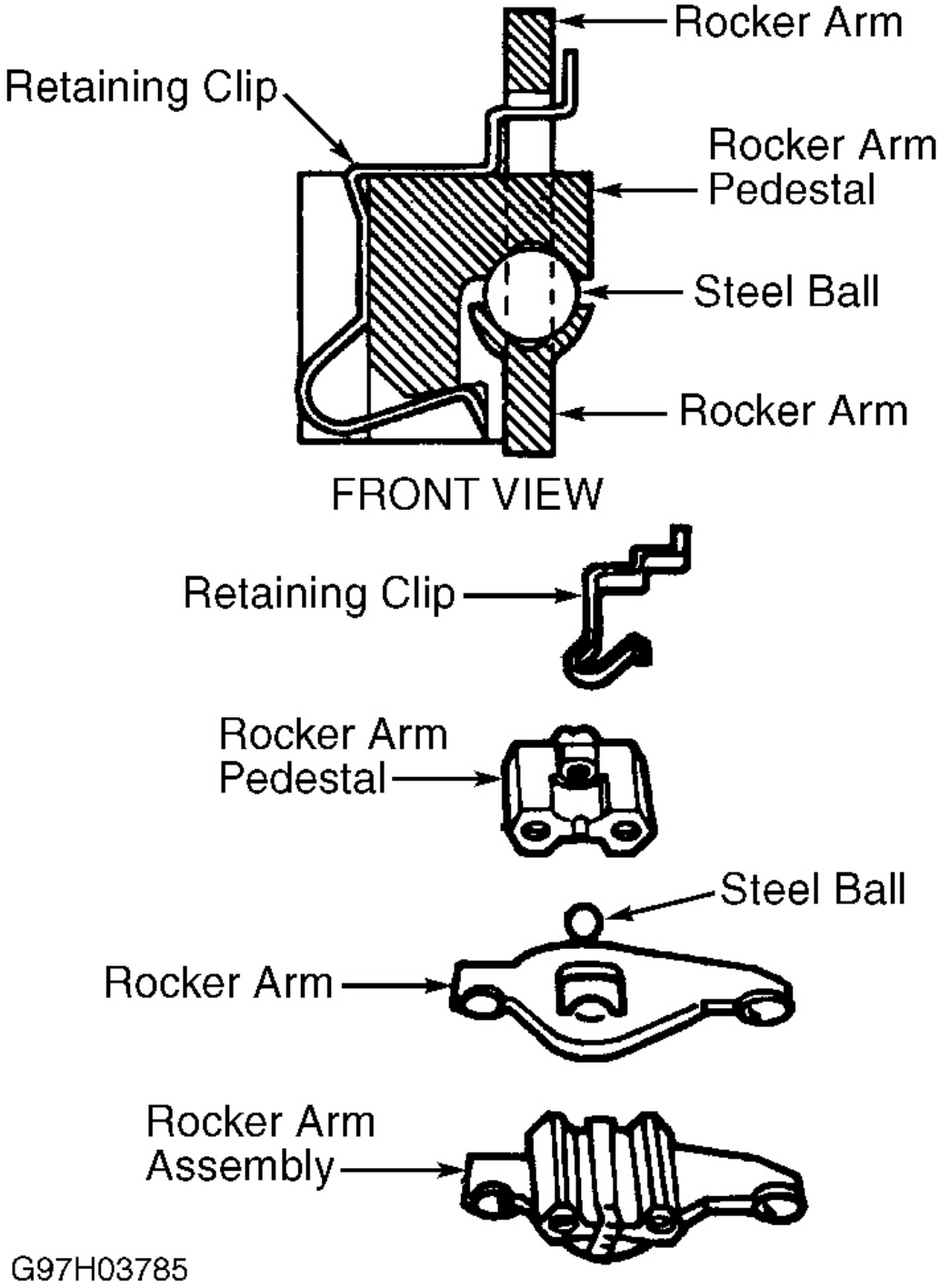


Fig. 29: Identifying Rocker Arm Assembly Components
Courtesy of FORD MOTOR CO.

Removal (Van)

1. Disconnect negative battery cables. Remove air cleaner assembly. Remove interior engine cover. When servicing rocker arm and push rod on passenger-side cylinder head, remove oil dipstick tube mounting bracket. Remove remaining components for access to valve cover. Go to step **3)** .
2. When servicing rocker arm and push rod on driver-side cylinder head, remove air intake tube and oil fill tube for access to valve cover.

WARNING: Injector Driver Module (IDM) supplies 115 volts DC to each fuel injector on engine wiring harness. DO NOT pierce any wires in engine wiring harness when servicing valve cover gasket and fuel injector.

3. On all models, disconnect engine wiring harness wires from valve cover gasket connector. DO NOT pierce any wires in engine wiring harness.

NOTE: Left hand engine mount isolator must be removed to provide clearance to remove push rods. Mounting nuts on right-side engine mount must be loosened to allow engine to pivot. Engine must be raised to provide clearance to remove engine mount isolator.

4. Raise and support vehicle. Remove 2 left-side engine mount isolator nuts. Remove 2 left-side engine mount isolator bolts. Loosen right-side engine mount nuts. Install Adjustable Vehicle Stand (164-R6241) to crankshaft vibration damper assembly. Raise engine enough to remove engine mount isolator. Lower engine until oil pan rests on crossmember. Remove tool and lower vehicle.
5. Remove valve covers. Disconnect engine wiring harness wires from fuel injectors and glow plugs. DO NOT pierce any wires in engine wiring harness. Remove valve cover gasket from cylinder head.
6. Remove rocker arm assembly bolts. See **Fig. 5**. Remove rocker arm assembly. Note direction of push rod installation, as Copper end of push rod should be facing upward, toward rocker arm. Remove push rod. Mark rocker arm assembly and push rod location for installation reference.
7. If disassembling rocker arm assembly, note location of components on rocker arm assembly. See **Fig. 29**.

NOTE: When disassembling rocker arm assembly, DO NOT lose steel ball.

8. Remove retaining clip from rocker arm assembly. Remove rocker arm and steel ball from rocker arm pedestal. DO NOT lose steel ball from rocker arm.

Installation

1. If assembling rocker arm assembly, place steel ball in cup area on rocker arm. Lubricate steel ball with engine oil. Install rocker arm pedestal on steel ball and rocker arm. Install retaining clip. Ensure retaining clip is fully snapped into position.

CAUTION: Push rods must be installed with Copper end facing upward, toward rocker. Engine must be positioned with timing mark on vibration

damper at 11 o'clock position before installing rocker arm assembly to prevent bent valves and engine damage when installing rocker arm assembly.

2. Lubricate ends of push rods with engine oil. Install push rods in original location. Ensure Copper end of push rod is facing upward. Rotate engine until timing mark on vibration damper is at 11 o'clock position. This must be done to prevent bent valves and engine damage when installing rocker arm assembly.
3. Install rocker arm assembly. Install and tighten rocker arm assembly bolts to specification. See **TORQUE SPECIFICATIONS**. Raise and support vehicle. Raise engine using Adjustable Vehicle Stand (164-R6241). Install left-side engine mount isolator. Install isolator-to-bracket mounts. Lower engine and install engine mount retaining nuts and tighten to 71-94 ft. lbs. (96-127 N.m). Tighten engine mount retaining bolts on both sides to 148-218 ft. lbs. (200-295 N.m). To install remaining components, reverse removal procedure. Tighten bolts to specification. On A/C equipped models, evacuate and recharge A/C system if system was discharged.

VALVE LIFTER

NOTE: Mark valve lifters for location, as valve lifter must be installed in original location.

Removal

1. Remove appropriate cylinder head. See **CYLINDER HEAD**.
2. Remove retaining bolt and camshaft follower guide. See **Fig. 30**.
3. Mark valve lifter location for installation reference. Remove valve lifter from cylinder block. If necessary to disassemble valve lifter, remove retainer and components from valve lifter body. See **Fig. 31**.

Inspection

1. Ensure roller rotates smoothly and without excessive play. Inspect all components for damage. Ensure plunger moves freely in plunger body. Replace valve lifter if plunger fails to move freely in plunger body or if any components are damaged. Valve lifter must be replace as an assembly.
2. Measure valve lifter outside diameter and valve lifter bore diameter in cylinder block. determine oil clearance. Replace valve lifter if oil clearance is not within specification. See **VALVE LIFTERS** table under ENGINE SPECIFICATIONS.

Installation

1. If assembling valve lifter, coat all components with engine oil and reassemble. To install, reverse removal procedure. Ensure valve lifter and valve lifter bore in cylinder block are coated with engine oil before installing. Valve lifter must be installed in original location.
2. Install cylinder head using proper procedure. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.

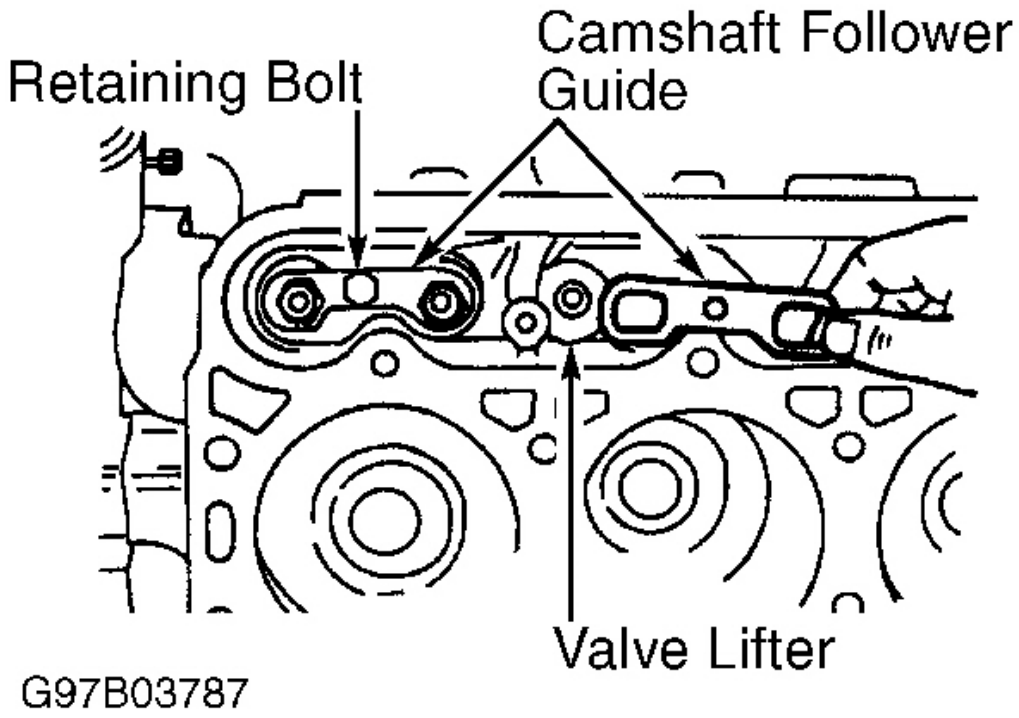


Fig. 30: Locating Camshaft Follower Guide
Courtesy of FORD MOTOR CO.

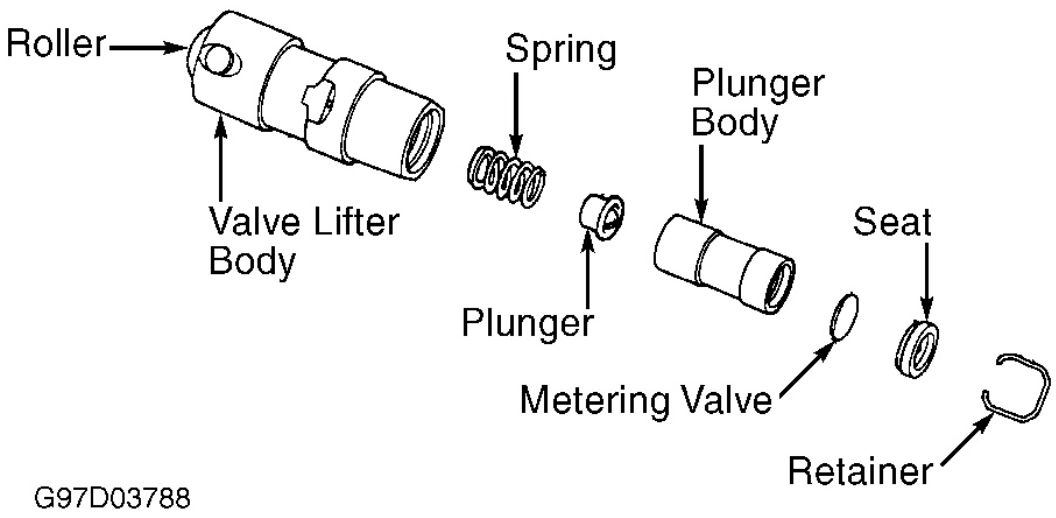


Fig. 31: Exploded View Of Valve Lifter
Courtesy of FORD MOTOR CO.

FRONT COVER

Removal

1. Manufacturer recommends removing engine for servicing front cover. Remove engine. See **ENGINE**. Remove water pump. See **WATER PUMP**. Remove vibration damper bolt and washer. Using puller, remove vibration damper.

NOTE: If necessary to remove high-pressure oil pump or high-pressure oil pump reservoir, see HIGH-PRESSURE OIL PUMP and HIGH-PRESSURE OIL PUMP DRIVE GEAR .

2. Remove oil pan and oil pump pick-up tube. Remove front cover retaining bolts. See **Fig. 32**. Remove front cover and gaskets.

Installation

1. Ensure sealing surfaces on cylinder block and front cover are clean. Install NEW gaskets on front cover and apply silicone sealant to sealing grooves on front cover. See **Fig. 33**.
2. Install front cover on cylinder block with retaining bolts finger tight. Using NEW gasket, install water pump. Tighten water pump bolts to specification. See **TORQUE SPECIFICATIONS**.
3. Tighten front cover retaining bolts to specification. See **TORQUE SPECIFICATIONS**. To install remaining components, reverse removal procedure. Ensure proper procedure is used when installing vibration damper. See **CRANKSHAFT FRONT SEAL**.

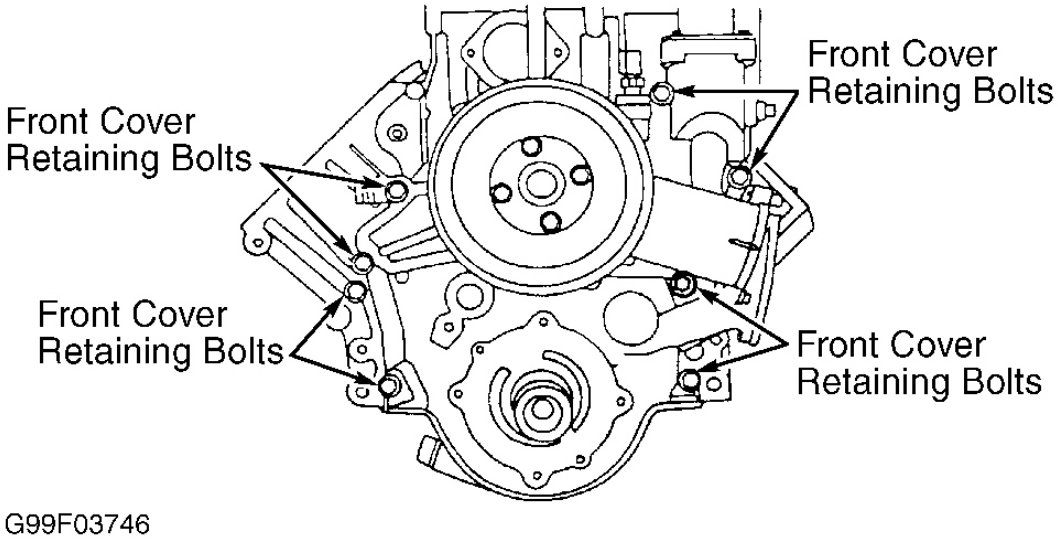


Fig. 32: Locating Front Cover Retaining Bolts
Courtesy of FORD MOTOR CO.

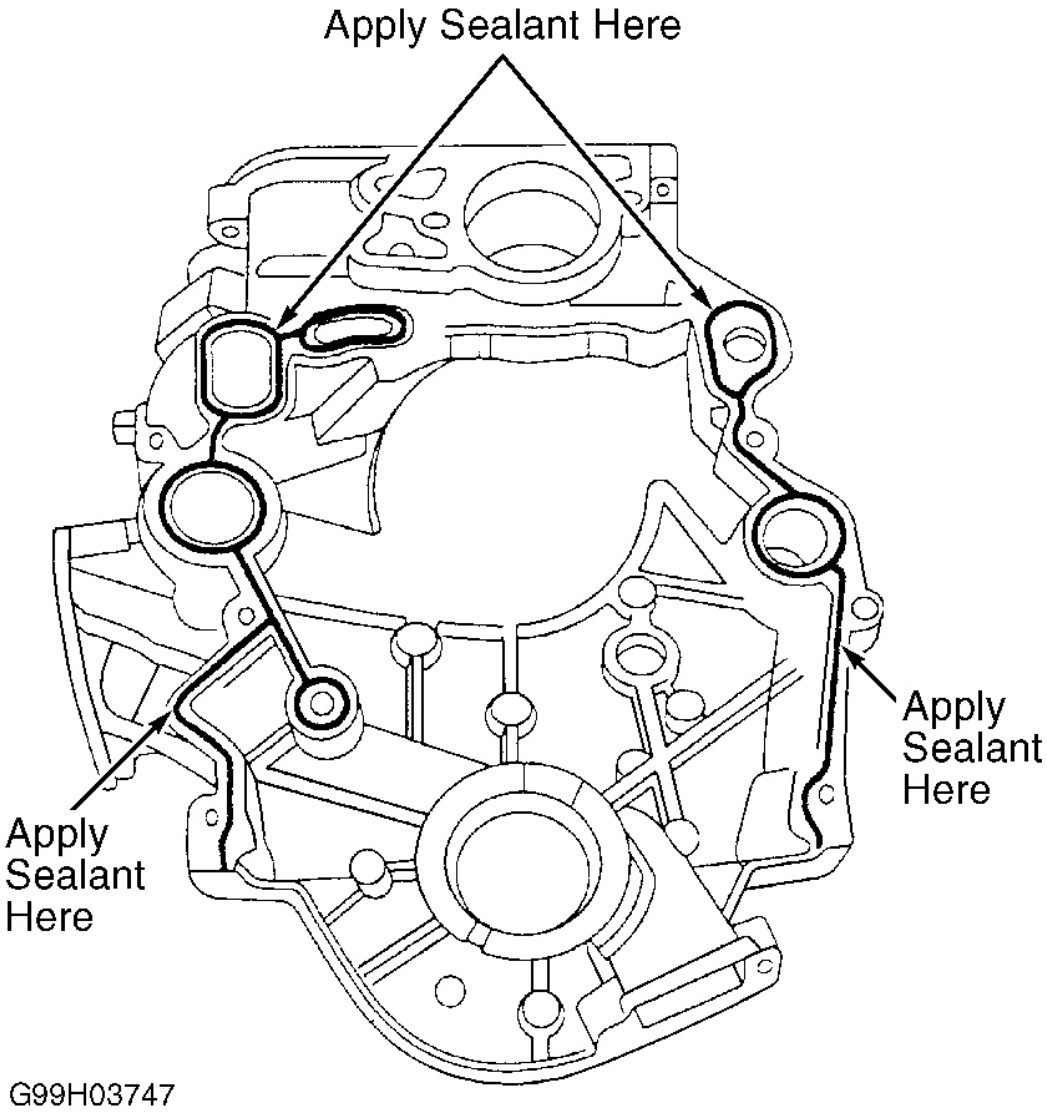


Fig. 33: Applying Sealant On Front Cover
Courtesy of FORD MOTOR CO.

CAMSHAFT

Removal

1. Remove front cover. See **FRONT COVER**. Using dial indicator, check gear backlash on camshaft gear. Replace camshaft gear if gear backlash exceeds specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.
2. Remove rocker arm assemblies and push rods. See **ROCKER ARM ASSEMBLY & PUSH ROD**. Remove valve lifters. See **VALVE LIFTER**.

3. Using dial indicator, check camshaft end play. Replace camshaft thrust plate if camshaft end play exceeds specification. **See CAMSHAFT** table under ENGINE SPECIFICATIONS.
4. Rotate crankshaft so camshaft timing mark and crankshaft timing mark are aligned. See **Fig. 34**. Remove camshaft thrust plate bolts. See **Fig. 34**. Remove camshaft, camshaft gear and camshaft thrust plate as an assembly.
5. If necessary to remove camshaft gear or camshaft thrust plate from camshaft, use press and support blocks to press camshaft from camshaft gear. Remove camshaft thrust plate from camshaft.

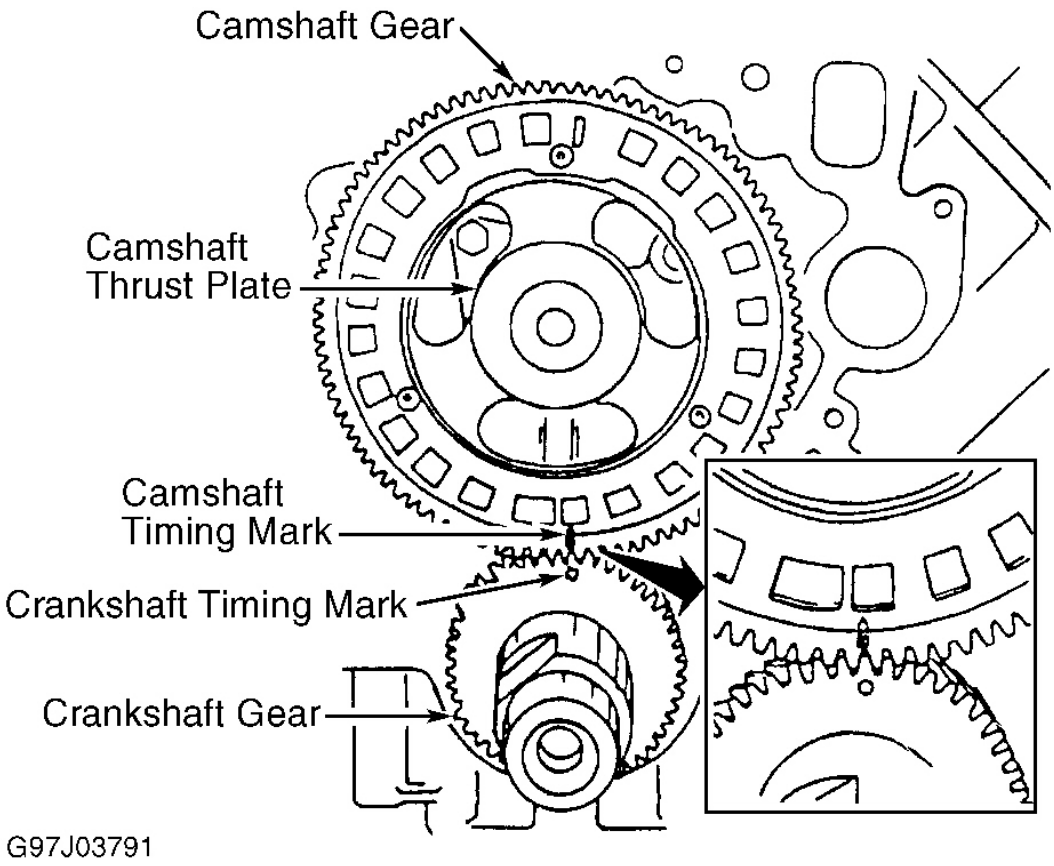


Fig. 34: Aligning Timing Marks & Locating Camshaft Thrust Plate
Courtesy of FORD MOTOR CO.

Inspection

1. Inspect camshaft for wear. Ensure camshaft journal diameter is within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.
2. Inspect camshaft bearings for damage. Measure camshaft bearing inside diameter. Replace camshaft bearing if inside diameter is not within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS. If necessary to replace camshaft bearings, see **CAMSHAFT BEARINGS**.

3. Using micrometer, measure thickness of camshaft thrust plate if removed from camshaft. Replace camshaft thrust plate if thickness is not within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.

Installation

1. If installing camshaft thrust plate and camshaft gear on camshaft, install camshaft thrust plate on camshaft. Ensure key is installed in camshaft and camshaft gear keyway and key are free of burrs.

CAUTION: DO NOT heat camshaft gear at more than 500°F (260°C) or camshaft gear will be distorted.

2. Heat camshaft gear to 500°F (260°C). DO NOT exceed specified temperature of camshaft gear will be distorted. Press heated camshaft gear onto camshaft, with timing mark facing away from camshaft. Ensure camshaft gear is seated against shoulder on camshaft.
3. To install, lubricate camshaft journals with engine oil and camshaft lobes with multipurpose grease. Install camshaft so camshaft timing mark and crankshaft timing mark are aligned. See **Fig. 34**. Install and tighten camshaft thrust plate bolts to specification. See **TORQUE SPECIFICATIONS**.
4. To install remaining components, reverse removal procedure. Ensure proper procedure is used when installing front cover, rocker arm assemblies and push rods.

CAMSHAFT BEARINGS

NOTE: Manufacturer recommends removing crankshaft when servicing camshaft bearings. All camshaft bearings are interchangeable except front camshaft bearing which is wider than others.

Removal

1. Remove camshaft from cylinder block. See **CAMSHAFT**. Remove flywheel. See **FLYWHEEL**.
2. Remove crankshaft with pistons and connecting rods remaining in cylinder block. See **CRANKSHAFT & MAIN BEARINGS** under CYLINDER BLOCK ASSEMBLY under OVERHAUL.

CAUTION: Protective tubing must be placed on connecting rod bolts to prevent damaging crankshaft during crankshaft removal and installation. Pistons must be pushed upward toward top of cylinder bore when servicing camshaft bearings. DO NOT allow piston to contact piston cooling oil jets when pushing piston to top of cylinder bore.

3. Push piston upward toward top of cylinder bore. DO NOT damage piston cooling oil jets when pushing piston upward in cylinder bore. Using Camshaft Bearing Remover/Installer (T65L-6250-A), remove camshaft bearings from cylinder block.

Installation

1. To install, reverse removal procedure. Ensure oil hole in camshaft bearing aligns with oil hole in cylinder block.

CAUTION: Front camshaft bearing must be installed to specified installed depth to prevent damage to engine components.

2. Install front camshaft bearing in cylinder block so front camshaft bearing installed depth is .020-.050" (.51-1.27 mm). Front camshaft bearing installed depth is measured from face of cylinder block to front edge of front camshaft bearing. Install NEW cylinder block camshaft core plug. To install remaining components, reverse removal procedure.

CRANKSHAFT GEAR

Removal & Installation

Crankshaft and crankshaft gear are serviced as an assembly. DO NOT attempt to remove crankshaft gear from crankshaft, as crankshaft gear and crankshaft will be damaged.

FLYWHEEL

Removal

1. On A/T models, a standard type flywheel is used. On M/T models a dual mass flywheel is used. Dual mass flywheel is consists of 2 flywheels. See **Fig. 35**. On all models, remove transmission. For A/T, see appropriate TRANSMISSION REMOVAL & INSTALLATION article in TRANSMISSION SERVICING. For M/T, see appropriate CLUTCHES article in TRANSMISSIONS.
2. On A/T models, remove flywheel-to-crankshaft bolts and flywheel. On M/T models, remove clutch assembly from flywheel. Remove 2 flywheel-to-crankshaft bolts and install guide studs. Remove remaining flywheel-to-crankshaft bolts. Remove reinforcing plate, secondary flywheel and primary flywheel. Remove secondary flywheel bolts and separate primary flywheel from secondary flywheel.

Inspection

1. On A/T models, inspect flywheel and starter ring for damage. Replace flywheel if damaged.
2. On M/T models, inspect secondary flywheel for grooves or damaged areas in clutch disc area. Resurface secondary flywheel as necessary. Replace secondary flywheel if secondary flywheel thickness is less than 1.41" (35.8 mm) after machining, or more than .060" (1.52 mm) is machined from original thickness on secondary flywheel.

CAUTION: DO NOT use secondary flywheel if secondary flywheel thickness is less than 1.41" (35.8 mm) after machining, as this may cause damage to primary flywheel.

Installation

1. To install, reverse removal procedure. On M/T models, install primary flywheel on secondary flywheel.

Install and tighten secondary flywheel bolts to specification. See **TORQUE SPECIFICATIONS**. Apply Threadlock® sealant to threads on flywheel-to-crankshaft bolts before installing.

2. On all models, install and tighten flywheel-to-crankshaft bolts to specification. See **TORQUE SPECIFICATIONS**.

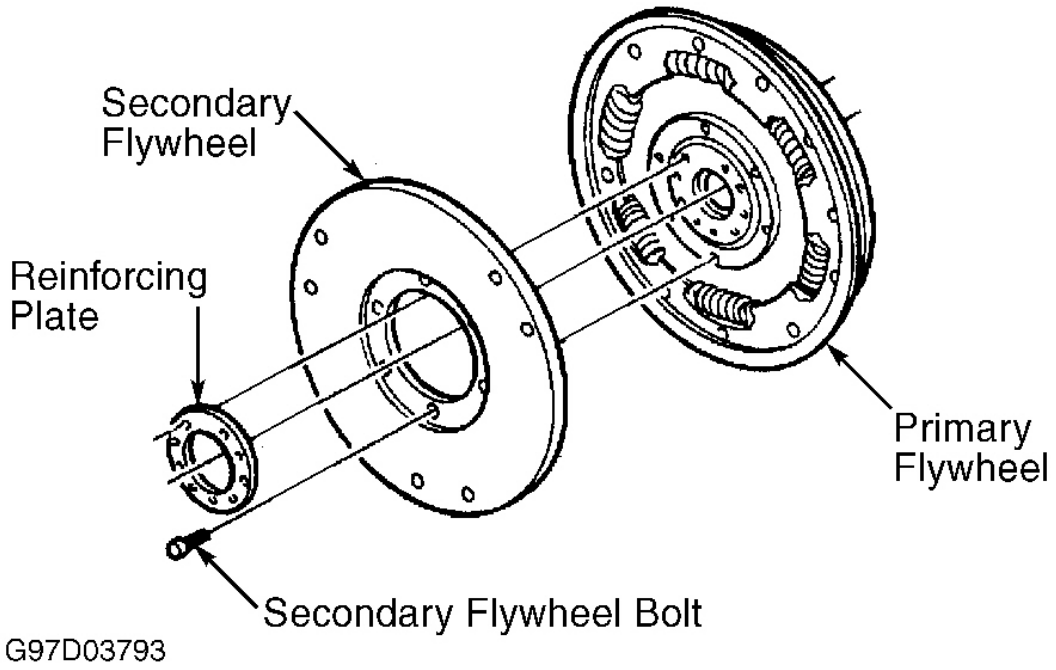


Fig. 35: Identifying Dual Mass Flywheel Components (Excursion & F250-F550 Super Duty With M/T)
Courtesy of FORD MOTOR CO.

CRANKSHAFT REAR OIL SEAL

Removal

1. Remove transmission. For A/T, see appropriate TRANSMISSION REMOVAL & INSTALLATION article in TRANSMISSIONS. For M/T, see appropriate CLUTCHES article in TRANSMISSIONS. On M/T models, remove flywheel. See **FLYWHEEL**. On A/T models, remove bolts, spacer and flexplate. On all models, remove flywheel adapter housing retaining rings. Remove flywheel front adapter, using care not to damage alignment dowel pins.
2. Remove crankshaft rear oil seal retaining bolts from rear of cylinder block. Remove crankshaft rear oil seal. Remove engine rear cover retaining bolts and rear cover. Clean cover sealing surfaces. Clean crankshaft rear oil seal surfaces. If equipped with crankshaft wear sleeve, remove crankshaft wear sleeve using Crankshaft Service Set (T94T-6701-AH) and Handle (T80T-4000-W).

Installation

1. Ensure sealing surfaces are clean and all silicone sealant is removed. Apply silicone sealant to engine rear cover sealing surface. Install rear engine cover. Apply silicone sealant to crankshaft rear oil seal retaining ring and threads of crankshaft rear oil seal retaining bolts.
2. Using Crankshaft Seal Replacer (T94T-6701-AH3), Crankshaft Seal Replacer (T94T-6701-AH4), Handle (T80T-4000-W) and guide pins, install crankshaft wear ring (if equipped) and crankshaft rear oil seal.
3. Install and tighten crankshaft rear oil seal retaining bolts. To install remaining components, reverse removal procedure.

WATER PUMP

Removal

1. Disconnect negative battery cables. Partially drain cooling system. Remove upper radiator hose. Disconnect coolant recovery hose from radiator.

CAUTION: Fan clutch assembly uses right-hand threads to hold assembly on water pump.

2. Using Fan Clutch Holder (T94T-6312-AH) and Fan Clutch Nut Wrench (T83T-6312-B), remove fan and fan clutch assembly from water pump. Place fan and fan clutch assembly in fan shroud. Remove bolts, fan shroud along with fan and fan clutch assembly.
3. Loosen water pump pulley bolts. Note direction of accessory drive belt routing for installation reference. Rotate accessory drive belt tensioner away from accessory drive belt. Remove accessory drive belt.
4. Remove bolts and water pump pulley. Disconnect necessary electrical connectors and coolant hoses for removal of water pump. Note water pump bolt location for installation reference. Remove bolts, water pump and gasket.

Installation

To install, reverse removal procedure using NEW gasket. Tighten bolts/nuts to specification. See **TORQUE SPECIFICATIONS**. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING**.

THERMOSTAT

NOTE: Manufacturer does not supply complete information for thermostat removal and installation on "E" series vehicles. The following procedure is for Excursion and "F" series vehicles and is similar to "E" series vehicles.

Removal

1. Partially drain the cooling system. See **COOLING SYSTEM BLEEDING**. Disconnect the upper radiator hose from the thermostat housing.
2. Remove the thermostat housing bolts and remove the thermostat housing. See **Fig. 36**. Remove the thermostat and "O" ring seal. Discard the "O" ring seal.

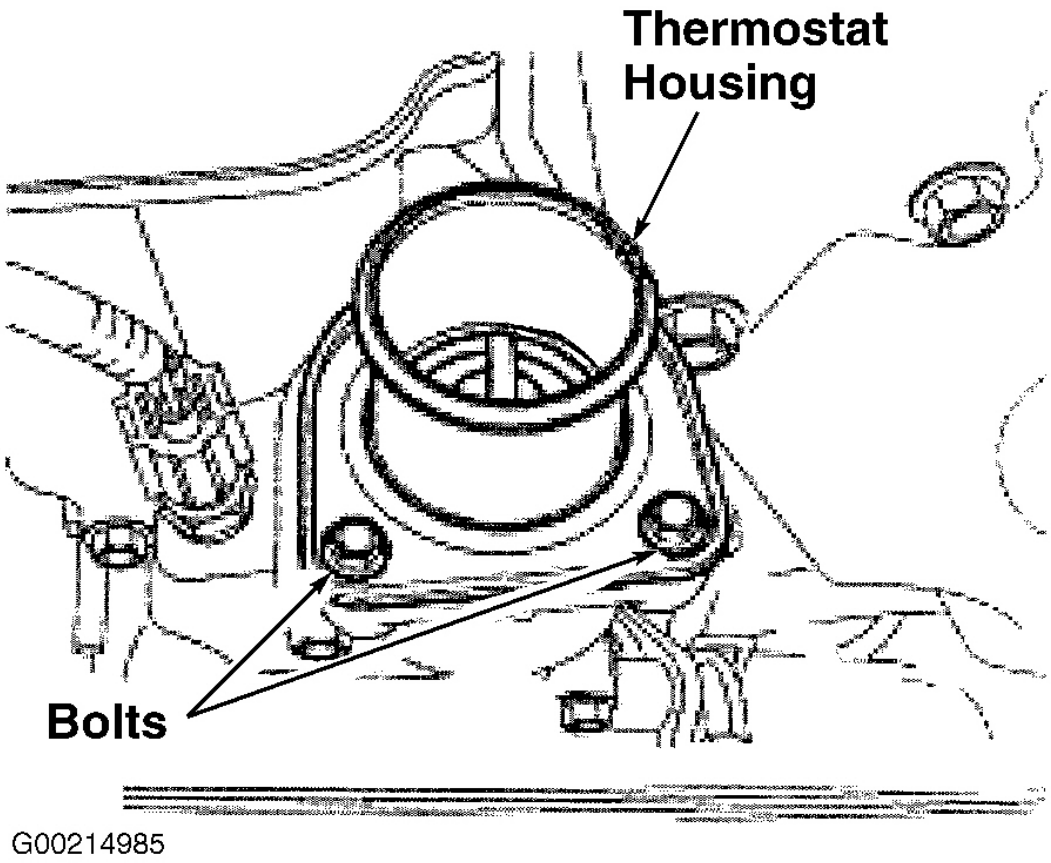


Fig. 36: Removing & Installing Thermostat Housing (Excursion & "F" Series Shown; "E" Series Similar)
Courtesy of FORD MOTOR CO.

Installation

1. Use a NEW "O" ring seal to position the water thermostat in the upper intake manifold.
2. Install the thermostat housing. See **Fig. 36**. Install the thermostat housing bolts. Tighten thermostat housing bolts to specification. See **TORQUE SPECIFICATIONS**.
3. Connect the upper radiator hose to the thermostat housing. Fill and bleed the cooling system. See **COOLING SYSTEM BLEEDING**.

OIL PAN

Removal

1. Manufacturer recommends removing engine for servicing oil pan. Remove engine. See **ENGINE** under REMOVAL & INSTALLATION. Remove oil pan bolts. It may be necessary to cut silicone sealant on each side of oil pan. Pry upward on one side of oil pan to break seal on silicone sealant. Remove oil pan.

2. If necessary to remove oil pump pick-up tube, remove oil pump pick-up tube-to-front cover bolts. Remove oil pump pick-up tube support bracket nut at top of main bearing cap. Remove oil pump pick-up tube and gasket.

Installation

1. Using NEW gasket, install oil pump pick-up tube if removed. Install and tighten oil pump pick-up tube-to-front cover bolts and oil pump pick-up tube support bracket nut at top of main bearing cap to specification. See **TORQUE SPECIFICATIONS**.
2. Apply a 1/8" (3.2 mm) bead of RTV sealant on sealing surfaces on sides of oil pan with sealant located on inside of bolt holes. Apply a 1/4" (6.35 mm) bead of RTV sealant on oil pan sealing surfaces at front and rear of oil pan.
3. Install oil pan using guide studs. Ensure all oil pan bolts are installed before tightening. To install remaining components, reverse removal procedure.

OIL COOLER ASSEMBLY

For servicing of oil cooler assembly, see **OIL COOLER ASSEMBLY** under ENGINE OILING.

OVERHAUL

CYLINDER HEAD

Cylinder Head

1. Check cylinder head for cracks and warpage at cylinder head gasket surface. Replace cylinder head if warpage exceeds specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. DO NOT resurface cylinder head.
2. Measure cylinder head height from top of valve cover gasket surface on cylinder head to cylinder head gasket surface. Replace cylinder head if cylinder head height is not within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.
3. If removing intake manifold covers from cylinder head, remove bolts and intake manifold cover. Intake manifold cover is located on side of cylinder head. DO NOT bend intake manifold cover, as RTV sealant retains cover on cylinder head. To install, apply RTV sealant on sealing surfaces of intake manifold cover. Install intake manifold cover. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**.
4. Remove injector control pressure sensor and "O" ring from cylinder head if necessary. Injector control pressure sensor is located on driver-side cylinder head. Before installing injector control pressure sensor, apply Threadlock® sealant on threads of injector control pressure sensor. Install injector control pressure sensor using NEW "O" ring. Tighten injector control pressure sensor to specification. See **TORQUE SPECIFICATIONS**.
5. If necessary to replace fuel injector sleeve in cylinder head, see **FUEL INJECTOR** under REMOVAL & INSTALLATION.

Valve Springs

1. Check valve spring free length, out-of-square and pressure. Replace valve spring if not within

specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.

2. Measure valve spring installed height from bottom of spring seat in cylinder head to bottom of surface of spring retainer. Ensure valve spring installed height is within specification.

Valve Stem Oil Seals

Valve stem seals are used on intake and exhaust valves. No special installation procedure is required for valve stem oil seals.

Valve Guides

Check valve stem-to-guide oil clearance. Ensure valve stem diameter is within specification. Replace cylinder head if oil clearance exceeds specification, as valve guides are not serviceable. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS.

Valve Seat

Check valve seat width and runout. Grind valve seat if not within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. Ensure valve spring installed height is correct after grinding valve seats.

Valves

1. Ensure valve stem diameter and valve margin are within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS. Resurface tip of valve stem if necessary. DO NOT grind more than .010" (.25 mm) from tip of valve stem.

CAUTION: DO NOT grind more than .010" (.25 mm) from tip of valve stem when resurfacing tip of valve stem.

2. Once valves are re-ground, install valve in cylinder head. Using dial indicator, measure valve head recession by measuring distance from deck surface on cylinder head to valve head. Valve head recession should be within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.

VALVE TRAIN

Rocker Arm Assembly

For disassembly and reassembly of rocker arm assembly, see **ROCKER ARM ASSEMBLY & PUSH ROD** under REMOVAL & INSTALLATION.

Valve Lifters

1. Ensure roller rotates smoothly and without excessive play. Measure valve lifter outside diameter and valve lifter bore diameter in cylinder block. determine oil clearance. Replace valve lifter if oil clearance is not within specification. See **VALVE LIFTERS** table under ENGINE SPECIFICATIONS.
2. If necessary to disassemble valve lifter, remove retainer and components from valve lifter body. See **Fig.**

31. Inspect all components for damage. Ensure plunger moves freely in plunger body. Replace valve lifter if plunger fails to move freely in plunger body or if any components are damaged. Valve lifter must be replace as an assembly.

CYLINDER BLOCK ASSEMBLY

Piston & Rod Assembly

1. Ensure connecting rod and connecting rod cap are marked with corresponding cylinder number before removing. If removing piston from connecting rod, remove snap rings from piston. Tap piston pin from piston.
2. Ensure crankpin bore diameter, out-of-round and taper are within specification. See **CONNECTING ROD** table under ENGINE SPECIFICATIONS. Replace connecting rod if not within specification. Check connecting rod center-to-center length, bend and twist. Replace connecting rod if not within specification. See **CONNECTING ROD** table under ENGINE SPECIFICATIONS.
3. Measure piston pin bushing bore diameter on connecting rod. Bushing may be replaced if diameter exceeds specification. See **CONNECTING ROD** table under ENGINE SPECIFICATIONS. If bushing is to be replaced, press bushing from connecting rod. Install NEW bushing and ream to obtain correct inside diameter. See **CONNECTING ROD** table under ENGINE SPECIFICATIONS.
4. For measuring piston diameter, see **FITTING PISTONS** under CYLINDER BLOCK ASSEMBLY under OVERHAUL.

Fitting Pistons

1. Measure piston diameter 1.68" (42.7 mm) below lower land of oil ring at 90-degree angle to piston pin. Replace piston if piston diameter is not within specification. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS.
2. Measure cylinder bore diameter at top, middle and bottom of cylinder bore parallel with crankshaft and at a 90-degree angle to crankshaft. Ensure cylinder bore diameter, out-of-round and taper are within specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS.
3. Ensure piston clearance is within specification. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS. If piston clearance is not within specification, hone or bore cylinders on cylinder block for oversize pistons. Pistons are available in .010" (.25 mm), .020" (.51 mm) and .030" (.76 mm) oversize.

Piston Rings

1. Ring end gap should be measured with piston ring positioned in cylinder bore at area where no piston ring wear exists. Ensure ring end gap is within specification. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS.
2. To check side clearance on No. 1 and 2 (upper) compression rings, use feeler gauge to measure clearance between piston ring and piston. Ensure side clearance is within specification. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS.

NOTE: No. 1 (upper) compression ring contains one identification mark and No. 2 (lower) compression rings contains 2 identification marks. Ensure

compression rings are installed in correct location with identification mark toward top of piston.

3. Install piston rings on piston, with identification mark on piston ring toward top of piston. Ensure piston ring end gaps are properly positioned. See **Fig. 37**.

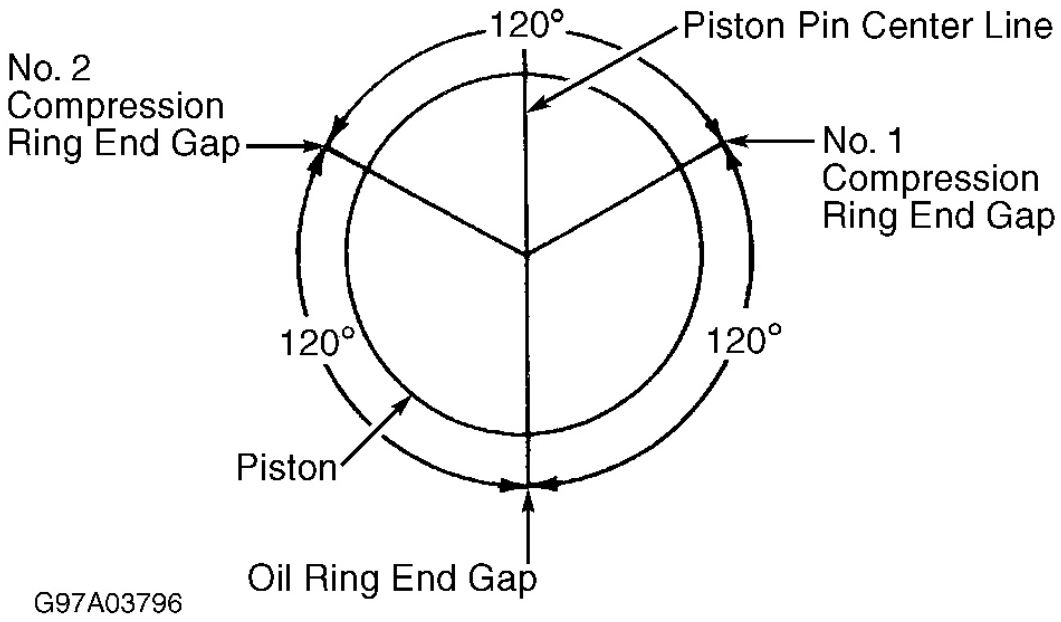


Fig. 37: Positioning Piston Rings
Courtesy of FORD MOTOR CO.

CAUTION: If rod bearing failure exists, oil cooler must be replaced and turbocharger must be checked. For replacement of oil cooler, see OIL COOLER ASSEMBLY under REMOVAL & INSTALLATION.

Rod Bearings

1. Ensure connecting rod and connecting rod cap are marked with corresponding cylinder number before removing.
2. Use Plastigage to check rod bearing clearance. Apply light coat of engine oil to connecting rod bolt threads before tightening nut to specification. See **TORQUE SPECIFICATIONS**.
3. Ensure oil clearance and side play are within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** and **CONNECTING RODS** tables under ENGINE SPECIFICATIONS.

CAUTION: If main bearing failure exists, oil cooler must be replaced and turbocharger

must be checked. For replacement of oil cooler, see OIL COOLER ASSEMBLY under REMOVAL & INSTALLATION.

Crankshaft & Main Bearings

1. Ensure main bearing caps are marked or location and direction of installation before removing from cylinder block. Ensure connecting rod journals, crankshaft main bearing journal diameter, taper and out-of-round are within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.
2. Apply light coat of engine oil to main bearing cap bolt threads before tightening bolt to specification. See **TORQUE SPECIFICATIONS**. Ensure oil clearance and end play are within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

Thrust Bearing

Thrust bearing is located on No. 5 (rear) main bearing. Replace thrust bearing if crankshaft end play is not within specification. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

Cylinder Block

1. Check cylinder block deck surface for warpage at cylinder head gasket surface. Resurface cylinder block if warpage exceeds specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS. DO NOT remove more than .010" (.25 mm) of material from cylinder block if resurfacing cylinder block.
2. Measure cylinder bore diameter at top, middle and bottom of cylinder bore parallel with crankshaft and at a 90-degree angle to crankshaft. Ensure cylinder bore diameter, out-of-round and taper are within specification. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS.
3. If cylinder bore diameter, out-of-round or taper exceeds specification, hone or bore cylinders on cylinder block for oversize pistons. Pistons are available in .010" (.25 mm), .020" (.51 mm) and .030" (.76 mm) oversize.

CAUTION: Ensure piston cooling oil jets are removed before honing or boring cylinder bores to prevent damage to cooling jet.

TURBOCHARGER

Preliminary Inspection

1. Disconnect air intake tube and exhaust pipe from turbocharger. Rotate turbine wheel, shaft assembly and compressor wheel inside turbocharger. Shaft assembly should rotate smoothly. Perform STEP 1 in illustration. See **Fig. 38**.
2. Push compressor wheel and shaft assembly as far in one direction as possible while rotating shaft assembly. Ensure compressor wheel does not contact compressor housing while rotating shaft assembly. Push turbine wheel and shaft assembly as far in one direction as possible while rotating shaft assembly. Ensure turbine wheel does not contact turbine housing while rotating shaft assembly.

3. If compressor wheel or turbine wheel does not contact housing while rotating shaft assembly, bearings in turbocharger are okay. Go to next step. If compressor wheel or turbine wheel contacts housing while rotating shaft assembly, bearings in turbocharger are defective. Replace turbocharger.
4. Install dial indicator so stem on dial indicator contacts end of shaft assembly at compressor wheel. Perform STEP 2 in illustration. See **Fig. 38**. Push shaft assembly as far in one direction as possible and zero dial indicator. Push shaft assembly as far in opposite direction and note shaft end play. Replace turbocharger if shaft end play is not .0008-.0040" (.020-.10 mm).

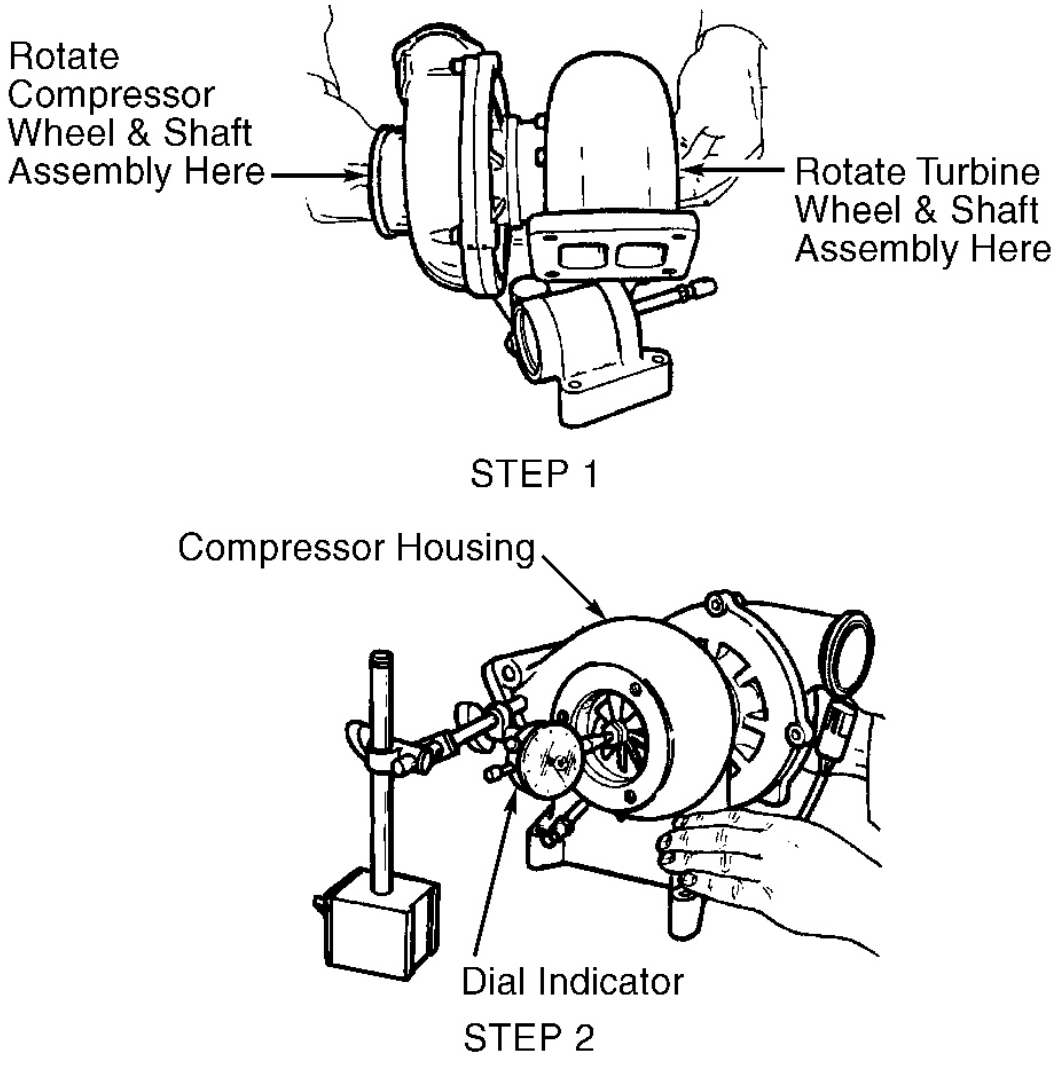


Fig. 38: Checking Turbocharger
Courtesy of FORD MOTOR CO.

FUEL FILTER/WATER SEPARATOR

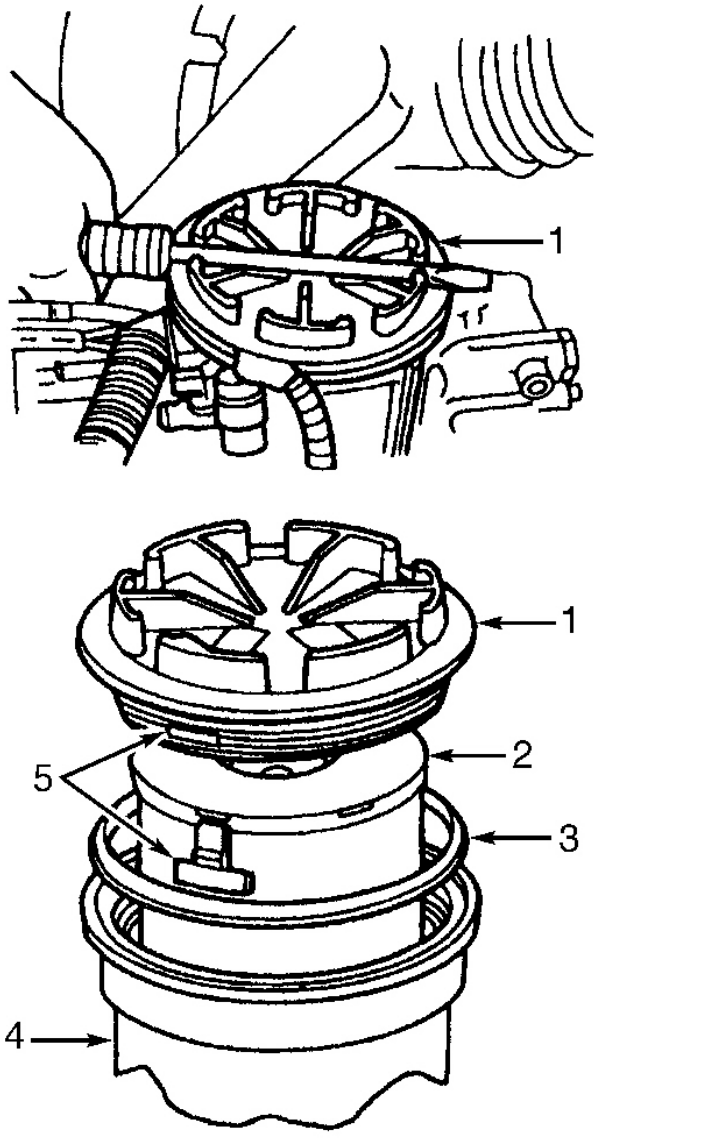
Removal

1. Remove all hose connections attached to fuel filter assembly. Place suitable container at end of drain hose to catch fuel and open filter drain. Remove water drain hose from fuel filter assembly.
2. Remove fuel outlet hose, located between fuel pump and filter housing. Remove fuel return hose from fuel pressure regulating valve. Remove 2 fuel supply hoses connecting regulator block to cylinder head fuel rails.
3. Loosen clamp at fuel pump end on hose connecting fuel filter to inlet of high pressure stage to fuel pump. Unclip wiring harness from right-side of filter housing. Disconnect electrical connectors from water in fuel sensor and fuel heater.
4. Remove 2 capscrews securing fuel filter base to crankcase and remove fuel filter. Using a screwdriver or bar, remove fuel filter cap. Fuel filter element will come out with cap. Remove and discard bevel gasket. Carefully clean mating surfaces. Press in on fuel filter element locking tabs to separate element from cap.

NOTE: Engine will not run if fuel filter in not correctly installed in housing.

Installation

1. Apply a coating of clean diesel fuel to new bevel gasket and install onto fuel filter housing gland. Install new fuel filter element onto cap. Place new fuel filter element and cap into fuel filter housing. Allow fuel to soak into fuel filter element.
2. Tighten cap onto fuel filter housing until cap contacts aluminum housing. Mount fuel filter base to crankcase with two capscrews. Tighten to 24-38 ft. lbs. (33-52 N.m). To install remaining hose connections, reverse removal procedure.



1. Fuel Filter Cap
2. Fuel Filter Element
3. Fuel Filter Bevel Cut Gasket
4. Fuel Filter Housing & Gland
5. Fuel Filter Element & Cap Locking Tabs

G50C16685

Fig. 39: Fuel Filter Assembly
Courtesy of FORD MOTOR CO.

ENGINE OILING

ENGINE LUBRICATION SYSTEM

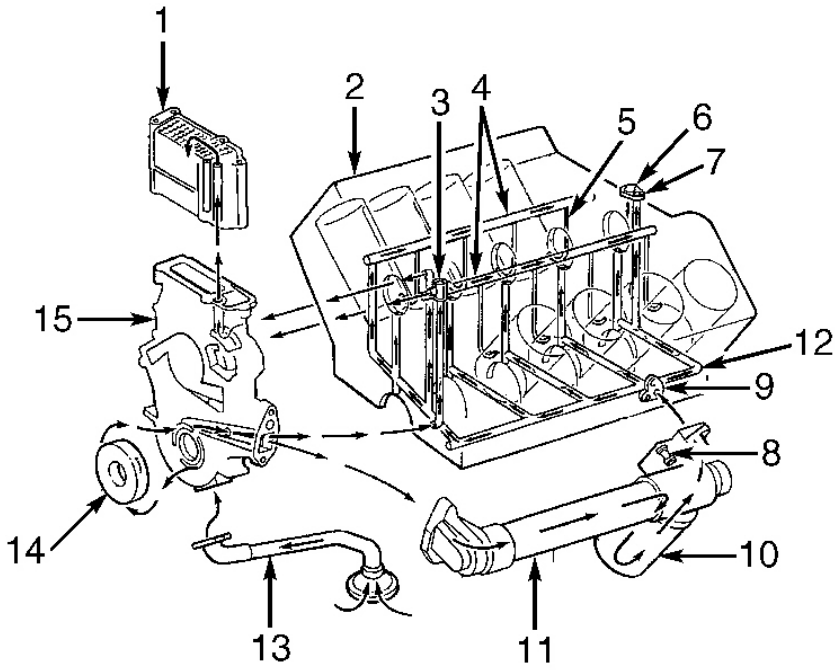
NOTE: Engine contains a high-pressure oiling system and a low-pressure oiling system.

High-Pressure Oiling System

High-pressure oiling system supplies oil pressure for fuel injector operation. See **Fig. 9**. During initial start or cold start, gear-driven high-pressure oil pump receives unfiltered engine oil from driver-side valve lifter oil galley through anti-drain check ball. Once engine starts or during warm engine starts, anti-drain check ball closes and high-pressure oil pump receives filtered engine oil from high-pressure oil pump reservoir. High-pressure oil pump delivers engine oil through oil rail in cylinder head at pressures of 600-3000 psi (42.19-210.93 kg/cm^2) to fuel injectors.

Low-Pressure Oil System

Crankshaft-driven low-pressure oil pump supplies pressurized lubrication for engine oiling system. See **Fig. 40**. Oil cooler is used for cooling of engine oil.



1. High-Pressure Oil Pump Reservoir
2. Cylinder Block
3. Anti-Drain Check Ball
4. Valve Lifter Oil Galley
5. Piston Cooling Oil Jet
6. Turbocharger Oil Return Galley
7. Turbocharger Oil Supply Galley
8. Pressure Relief/Regulator Valve
9. Oil Filter By-Pass Drain
10. Oil Filter
11. Oil Cooler Assembly
12. Main Oil Galley
13. Oil Pump Pick-Up Tube
14. Low-Pressure Oil Pump
15. Front Cover

G97A03800

Fig. 40: Engine Low-Pressure Engine Oiling System
Courtesy of FORD MOTOR CO.

Crankcase Capacity

Crankcase capacity is 14 qts. (13.2L) with oil filter.

Oil Pressure

Oil pressure should be 40-70 psi (2.8-4.9 kg/cm^2) at 3300 RPM, with engine at normal operating temperature.

HIGH-PRESSURE OIL PUMP

For servicing of high-pressure oil pump, see **HIGH-PRESSURE OIL PUMP** under REMOVAL &

INSTALLATION.

LOW-PRESSURE OIL PUMP

Removal & Disassembly

1. Low-pressure oil pump is located on front cover. See **Fig. 40**. Remove vibration damper. See **CRANKSHAFT FRONT SEAL** under REMOVAL & INSTALLATION.
2. Remove bolts, low-pressure oil pump body, outer gerotor and inner gerotor. See **Fig. 41**.

Inspection

1. Inspect components for damage and wear. Install inner and outer rotors in low-pressure oil pump body. Place straightedge across low-pressure oil pump body so it is above both rotors. Using feeler gauge, measure rotor end clearance between rotor and straightedge. Rotor end clearance should be .0010-.0030" (.025-.076 mm).
2. With both rotors installed in low-pressure oil pump body, use feeler gauge to measure clearance between outer edge of outer gerotor and oil pump body. Outer gerotor-to-oil pump body clearance should be .028-.032" (.71-.81 mm). Replace low-pressure oil pump if any measurement is not within specification.

Reassembly & Installation

1. To reassemble, reverse disassembly procedure. Ensure components are installed in original location.
2. To install, reverse removal procedure using "O" ring. Ensure outer gerotor is lubricated with engine oil before installing low-pressure oil pump body. Install and tighten low-pressure oil pump body-to-front cover bolts.
3. Manufacturer recommends installing NEW crankshaft front seal any time vibration damper is removed. For proper installation procedure of crankshaft front seal, see **CRANKSHAFT FRONT SEAL** under REMOVAL & INSTALLATION.

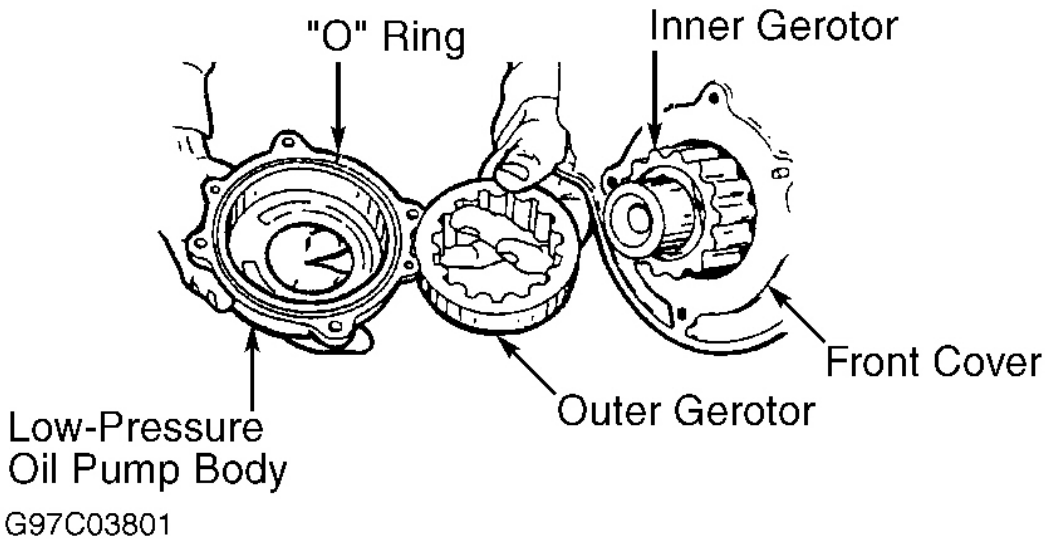


Fig. 41: Locating Low-Pressure Oil Pump Components
Courtesy of FORD MOTOR CO.

OIL COOLER ASSEMBLY

CAUTION: If main bearing or rod bearing failure exists, oil cooler must be replaced.

Removal & Disassembly

1. Disconnect negative cables. Drain cooling system. Raise and support vehicle.
2. Disconnect exhaust pipe at turbocharger for access to oil cooler if necessary. Remove oil cooler front header-to-cylinder block bolts. See **Fig. 42**. Drain engine oil and remove oil filter.
3. Disconnect retainer and cable from cylinder block heater. Cylinder block heater is located on driver-side rear corner of cylinder block, just below exhaust manifold, near oil filter.
4. Remove oil cooler rear header-to-cylinder block bolts. See **Fig. 42**. Remove oil cooler assembly and gaskets. Perform oil cooler leakage test to ensure oil cooler is not defective.

Oil Cooler Leakage Test

1. Using NEW gaskets, install Oil Cooler Leakage Tester (014-00726) on oil cooler assembly. Apply 40 psi (2.8 kg./cm^2) air pressure on fitting on coolant side of oil cooler front header.
2. Inspect for air leakage at plastic tubes and at oil cooler front and rear header cover plates. If no air leakage exists, place a cup of water up to plastic tubes, and check for bubbles.
3. If no bubbles exist, no internal leak exists and oil cooler is okay. If bubbles exist, an internal leak exists in

oil cooler. If internal leak exists, disassemble oil cooler assembly and replace oil cooler.

4. Release air pressure. Remove oil cooler leakage tester.

Disassembly & Cleaning

1. Using soft-faced hammer, tap on oil cooler front and rear headers to loosen "O" rings. Remove oil cooler front and rear headers from oil cooler by using twisting motion.
2. Thoroughly clean all components with solvent. Ensure oil cooler is thoroughly flushed to ensure all residue is cleaned from oil cooler. Dry components with compressed.

Reassembly

1. Apply engine oil to NEW "O" rings and "O" ring mating surfaces. Install large "O" rings and then small "O" rings on oil cooler.
2. Install oil cooler front and rear headers on oil cooler. Ensure locating clips align in slots and headers are installed evenly on oil cooler. Perform oil cooler leakage test to ensure oil cooler is properly sealed.

Installation

1. Using NEW gaskets, install oil cooler assembly on cylinder block. Install and tighten oil cooler rear header-to-cylinder block bolts until bolts are snug. Install and tighten oil cooler front header-to-cylinder block bolts to specification. See **TORQUE SPECIFICATIONS**.
2. Lower engine. Install driver-side engine mount. Tighten oil cooler rear header-to-cylinder block bolts to specification. See **TORQUE SPECIFICATIONS**. To install remaining components, reverse removal procedure. Adjust engine oil level. Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING** under REMOVAL & INSTALLATION.

NOTE: If engine oil leaked into cooling system due to defective oil cooler, drain and flush cooling system as necessary. If coolant leaked into crankcase due to defective oil cooler, change engine oil and oil filter.

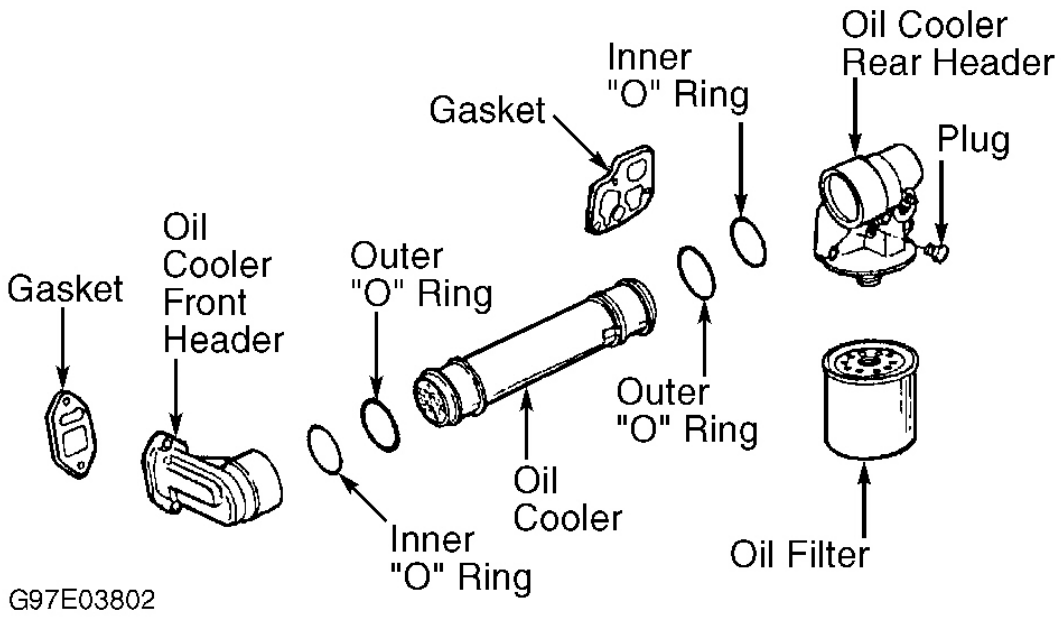


Fig. 42: Exploded View Of Oil Cooler Assembly
Courtesy of FORD MOTOR CO.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
A/C Compressor Mounting Bracket Bolt	36 (49)
A/C Line Manifold-To-A/C Compressor Bolt	13-17 (18-23)
A/C Mounting Bolts	50 (68)
Air Cleaner Housing Mounting Bolts	22 (30)
Air Cleaner Support Bracket Mounting Bolts	21 (28)
A/T Flexplate Bolts	89 (121)
Belt Tensioner Mounting Bolt	32 (43)
Camshaft Position (CMP) Sensor Mounting Bolt	18 (25)
Camshaft Thrust Plate Bolt	18 (25)
Connecting Rod Cap Nut	
Stage 1	53 (71)
Stage 2	80 (108)
Crankshaft Rear Oil Seal Retaining Bolts	15 (20)
Crankshaft Vibration Dampener Bolt	212 (258)
Cylinder Head Bolt (1)	
Step 1	65 (88)

Step 2	85 (115)
Step 3	95 (129)
Drive Gear Access Cover Retaining Bolts	20 (27)
Engine Mount Nut	71-94 (96-127)
Engine Front Cover Bolts	15 (20)
Engine Rear Cover Bolts	15 (20)
Engine Support Bracket Mounting Bolts	76 (103)
Exhaust Bracket-To-Engine Support Bracket Mounting Bolts	37 (50)
Exhaust Inlet Pipe-To-Exhaust Inlet Adapter Bolt	18 (25)
Exhaust Inlet Pipe-To-Exhaust Manifold Bolts/Nuts	18 (25)
Exhaust Manifold Mounting Pipe Bolts & Nuts	45 (61)
Fan Clutch Hub-To-Water Pump	84-112 (113-153)
Flywheel-To-Crankshaft Bolt	
Excursion & F250-F550 Super Duty	
A/T	89 (121)
M/T (2)	89 (121)
Van	23-39 (31-53)
Flywheel Housing Cover	14-17 (18-23)
Fuel/Filter Water Separator Housing Bolt	23 (31)
Fuel Line Assembly-To-Fuel Pump Banjo Bolt	40 (54)
Generator Mounting Bracket Bolt	36 (49)
Generator Retaining Bolt	30-40 (41-54)
Glow Plug	15 (20)
High-Pressure Oil Pump Drive Gear Bolt	95 (129)
High-Pressure Oil Pump Retaining Bolt	16-20 (22-27)
High-Pressure Oil Pump Supply Line-To-Cylinder Head	19 (26)
High-Pressure Oil Pump Supply Line-To-High-Pressure Oil Pump Fitting	19 (26)
Idler Pulley Mounting Bolt	41 (55)
Injector Control Pressure Sensor	21 (29)
Intake Manifold Cover Bolt	18 (25)
Main Bearing Cap Bolt	
Step 1	75 (102)
Step 2	95 (129)
Muffler Assembly Mounting Nuts	37 (50)
Number Two Crossmember Mounting Bolts	66 (90)
Oil Cooler Front Header-To-Cylinder Block Bolt	18 (25)
Oil Cooler Rear Header-To-Cylinder Block Bolt	18 (25)
Oil Level Indicator Tube Adaptor Nut	24 (33)
Oil Pan Drain Plug	27 (37)

Oil Pan Mounting Bolts	18 (24)
Oil Pump Bolt	
Low Pressure	10 (14)
High Pressure	18 (25)
Oil Pressure Regulator-To-High-Pressure Oil Pump	35 (47)
Oil Pump Pick-Up Tube Support Bracket Nut	38 (52)
Oil Pump Pick-Up Tube-To-Front Cover Bolt	18 (25)
Parking Brake Cable Bracket Mounting Bolt A/T	21 (28)
Parking Brake Cable Clamp Mounting Bolts M/T	21 (28)
Power Steering Pressure Line-To-Power Steering Pump Fitting	22-29 (30-39)
Power Steering Pump Mounting Nuts	41 (55)
Rear Bracket-To-Frame Mounting Nuts	184 (250)
Rear Support Cap Mounting Nuts	106 (144)
Rocker Arm Assembly Bolts	20 (27)
Slave Cylinder Lock Nut	24 (33)
Slave Cylinder Interlock Bracket Mounting Bolts	44 (59)
Starter Motor Mounting Bolts	38 (52)
Torque Converter-To-Flexplate Nut (A/T)	23-30 (30-40)
Transmission Oil Cooler Hoses	21 (28)
Transmission Shift Lever Housing Mounting Bolts	40 (54)
Transmission-To-Clutch Housing Bolt (M/T)	39-53 (53-72)
Transmission-To-Cylinder Block Bolt (A/T)	38-52 (52-70)
Turbocharger Exhaust Inlet Pipe-To-Exhaust Manifold Bolts	21 (28)
Turbocharger Mounting Bolts	18 (24)
Turbocharger Pedestal Assembly-To-Cylinder Block Bolt	18 (25)
Turbocharger Pedestal Assembly-To-Turbocharger Center Housing Bolt	18 (25)
Water Outlet Housing Bolts	15-22 (20-30)
Water Pump Bolts	18 (25)
Water Pump Pulley Bolts	18 (25)
	INCH Lbs. (N.m)
Battery Cable Battery Post Terminals	62 (7)
Breather Assembly Retainers	89 (10)
Exhaust Backpressure Control Valve-To-Compressor Housing Bolt	62-80 (7.0-9.0)
Fuel Injector Retaining Bolt	108 (12.2)
Fuel Injector Shoulder Bolt	124 (14)
Oil Deflector Retaining Bolt	124 (14)
Oil Rail Drain Plug	53 (6)
Piston Cooling Jet Bolts	97 (11)
Valve Cover Bolts/Nuts	97 (11)

(1) Tighten bolts to specification in sequence. See **Fig. 28**.

(2) Apply Threadlock® sealant on bolt threads.

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS

Application	Specification
Displacement	444 Cu. In. (7.3L)
Bore	4.11" (104.4 mm)
Stroke	4.18" (106.2 mm)
Compression Ratio	17.5:1
Fuel System	Direct Injection

CRANKSHAFT, MAIN BEARINGS & CONNECTING ROD BEARINGS SPECIFICATIONS

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

Application	In. (mm)
Crankshaft	
End Play	
Standard	.0025-.0085 (.064-.216)
Wear Limit	.020 (.50)
Main Bearings	
Journal Diameter	3.1228-3.1236 (79.319-79.339)
Journal Out-Of-Round	.0002 (.005)
Journal Taper	.00015 (.0038) Per 1.0 (25 mm)
Oil Clearance	
Standard	.0018-.0046 (.046-.117)
Wear Limit	.0046 (.117)
Connecting Rod Bearings	
Journal Diameter	2.4980-2.4990 (63.449-63.475)
Journal Out-Of-Round	.0002 (.005)
Journal Taper	.00026 (.0066) Per 1.0 (25 mm)
Oil Clearance	.0015-.0045 (.038-.114)

CONNECTING RODS SPECIFICATIONS

CONNECTING RODS

Application	In. (mm)
Bore Diameter	

Pin Bushing Bore	1.3085-1.3088 (33.236-33.244)
Crankpin Bore	2.6905-2.6915 (68.339-68.364)
Crankpin Bore Maximum Out-Of-Round	.0005 (.013)
Crankpin Bore Maximum Taper	.0005 (.013)
Center-To-Center Length	7.130 (181.10)
Maximum Bend	.001 (.03) Per 1.0 (25 mm)
Maximum Twist	.002 (.05) Per 1.0 (25 mm)
Side Play	.012-.024 (.30-.61)

PISTONS, PISTON PINS & PISTON RINGS SPECIFICATIONS

PISTONS, PINS & RINGS

Application	In. (mm)
Pistons	
Diameter	4.1069-4.1076 (104.315-104.333)
Clearance	.0044-.0061 (.1118-.1549)
Piston Height Above Cylinder Block	.010-.031 (.25-.79)
Pins	
Diameter	1.3079-1.3081 (33.220-33.226)
Piston Fit	.0003-.0007 (.007-.018)
Rod Fit	.0004-.0009 (.010-.023)
Rings	
No. 1	
End Gap	.014-.024 (.36-.61)
Side Clearance	(1)
No. 2	
End Gap	.062-.072 (1.57-1.83)
Side Clearance	.002-.004 (.05-.10)
No. 3 (Oil)	
End Gap	.012-.024 (.30-.61)

(1) For measuring of side clearance, see **PISTON RINGS** under CYLINDER BLOCK ASSEMBLY under OVERHAUL.

CYLINDER BLOCK SPECIFICATIONS

CYLINDER BLOCK

Application	In. (mm)
Cylinder Bore	

Standard Diameter	4.1096-4.1103 (104.384-104.402)
Maximum Taper	.0005 (.013)
Maximum Out-Of-Round	.0005 (.013)
Maximum Deck Warpage	(1)

(1) Warpage should not exceed .0030" (.076 mm) within a 6.0" (152 mm) area or .0060" (.152 mm) overall. Cylinder block may be resurfaced. DO NOT remove more than .010" (.25 mm) of material from cylinder block if resurfacing cylinder block.

ENGINE VALVES & VALVE SPRINGS SPECIFICATIONS

VALVES & VALVE SPRINGS

Application	Specification
Intake Valves	
Face Angle	30°
Minimum Margin	.112" (2.84 mm)
Stem Diameter	.31185-.31255" (7.9210-7.9388 mm)
Valve Head Recession	.046-.058" (1.17-1.47 mm)
Exhaust Valves	
Face Angle	37.5°
Minimum Margin	.054" (1.37 mm)
Stem Diameter	.31185-.31255" (7.9210-7.9388 mm)
Valve Head Recession	.052-.064" (1.32-1.63 mm)
Valve Springs	
Free Length	1.925-2.225" (48.90-56.52 mm)
Installed Height	
Intake	1.767" (44.88 mm)
Exhaust	1.833" (46.56 mm)
Out-Of-Square	.078" (1.98 mm)
	Lbs. @ In. (kg @ mm)
Pressure	
Valve Closed	71-79 @ 1.833 (32-36 @ 46.56)

CYLINDER HEAD SPECIFICATIONS

CYLINDER HEAD

Application	Specification
Cylinder Head Height	5.095-5.105" (129.41-129.67 mm)
Maximum Warpage	(1)

Valve Seats	
Intake Valve	
Seat Angle	30°
Seat Width	.065-.095" (1.65-2.41 mm)
Maximum Seat Runout	.002" (.05 mm)
Exhaust Valve	
Seat Angle	37.5°
Seat Width	.065-.095" (1.65-2.41 mm)
Maximum Seat Runout	.002" (.05 mm)
Valve Guides	
Intake & Exhaust	
Valve Guide I.D.	.3736-.3746" (9.490-9.514 mm)
Valve Stem-To-Guide Maximum Oil Clearance	.0055" (.140 mm)
(1) Warpage should not exceed .0010" (.025 mm) within a 2.0" (51 mm) area or .0040" (.102 mm) overall. Replace cylinder head if warpage exceeds specification. DO NOT resurface cylinder head.	

CAMSHAFT SPECIFICATIONS

CAMSHAFT

Application	In. (mm)
End Play	.002-.008 (.051-.203)
Journal Diameter	(1)
Camshaft Bearing I.D.	2.102-2.105 (53.39-53.47)
Oil Clearance	.002-.006 (.05-.15)
Front Camshaft Bearing Installed Depth (2)	.020-.050 (.51-1.27)
Gear Backlash	.0015-.0120 (.038-.305 mm)
Camshaft Thrust Plate Thickness	
In Thrust Area	.151-.155 (3.85-3.93)
Outside Thrust Area	.149-.157 (3.78-3.98)

(1) Information not available.

(2) Specification listed is distance from face of cylinder block to the front edge of front camshaft bearing.

VALVE LIFTERS SPECIFICATIONS

VALVE LIFTERS

Application	In. (mm)
Lifter Diameter	.9209-.9217 (23.391-23.411)
Oil Clearance	.0011-.0034 (.028-.086)
Collapsed Lifter Clearance	.185 (4.70)

