

ENGINE IDENTIFICATION

Engine is identified by eighth character of Vehicle Identification Number (VIN). See **ENGINE IDENTIFICATION CODES** table. VIN is located on top of instrument panel, near lower left corner of windshield. VIN is also stamped on Vehicle Certification (VC) label mounted on left door pillar.

Engine code labels are located in engine compartment, in front of radiator and on right valve cover. Label contains engine calibration number, engine build date, engine plant code and engine code.

Emission calibration number label is located on upper radiator shield. This label identifies engine calibration number, engine code number and revision level. Numbers from labels are required when ordering replacement parts.

ENGINE IDENTIFICATION CODES

Engine Type	Fuel System	Engine Plant	VIN Code
4.6L SOHC	SFI	Romeo	W
4.6L SOHC	SFI	Windsor	6

Windsor and Romeo engine plants are producing the 4.6L engine. There are several differences between these engines and many parts are not interchangeable.

The best way to determine manufacturer is by the VIN number. VIN W is a Romeo engine. VIN 6 is Windsor engine. There are a couple external differences. The right valve cover on Windsor engine has 14 bolts, Romeo engine has 11 bolts. Also on Windsor engine there is a W stamped on each valve cover in area of camshaft sprocket.

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

Hydraulic valve lash adjusters are used. No valve adjustment is required.

TROUBLE SHOOTING

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

REMOVAL & INSTALLATION

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

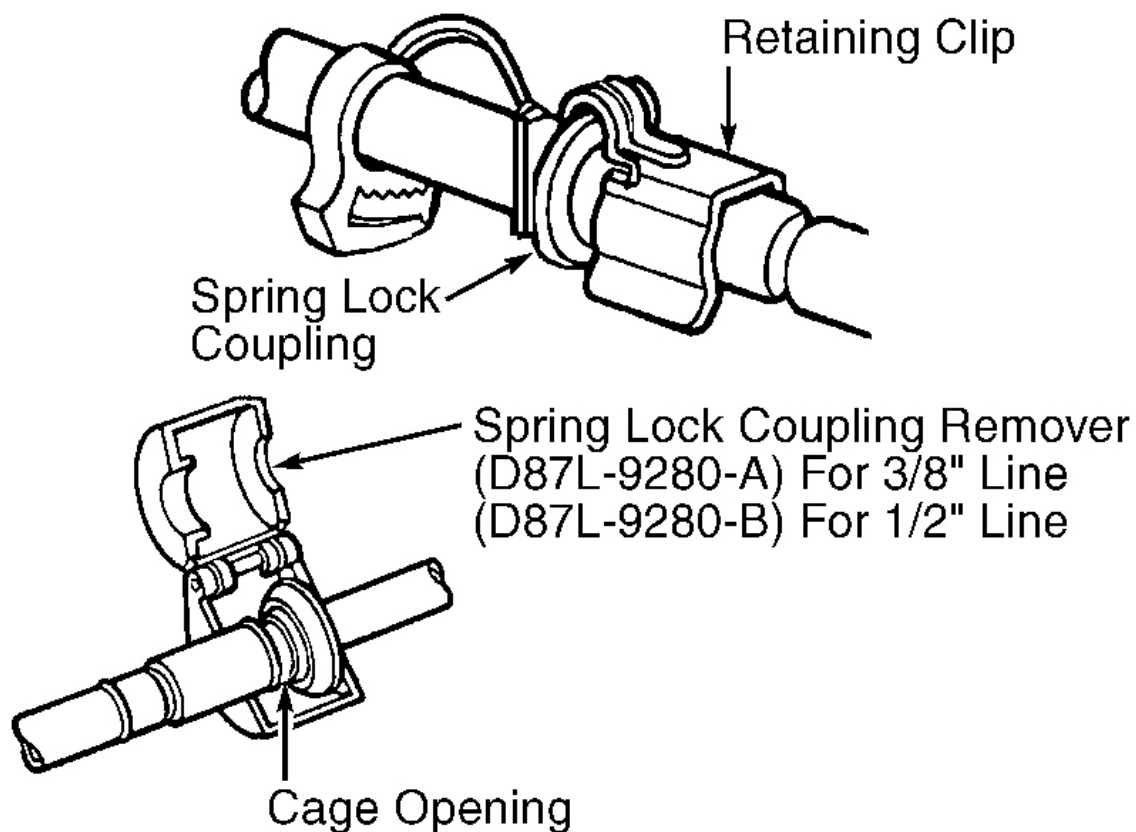
may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See **COMPUTER RELEARN PROCEDURES** article in **GENERAL INFORMATION** before disconnecting battery.

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

FUEL PRESSURE RELEASE & FUEL LINE CONNECTIONS

WARNING: Fuel system is under pressure. Release pressure before servicing fuel system components.

1. Remove fuel cap to release fuel tank pressure. Connect EFI Pressure Gauge (T80L-9974-B) to relief valve on right rear corner of fuel rail. Release pressure using valve on pressure gauge.
2. Before disconnecting fuel lines, disconnect negative battery cable. To disconnect fuel lines, remove retaining clip from outside of fuel line coupling.
3. Install Spring Lock Coupling Remover (D87L-9280-A) for 3/8" line or (D87L-9280-B) for 1/2" line on fuel line coupling so it enters cage opening. See **Fig. 1**.
4. Push spring lock coupling remover into cage opening to release female fitting from garter spring. Pull couplings apart. Remove spring lock coupling remover.
5. When installing fuel lines, fit NEW fuel resistant "O" rings (Brown) on fuel lines. Before installing, lightly coat "O" rings with clean engine oil. Clean fittings, and replace garter spring (if necessary).
6. Install female fitting to male fitting and push until garter spring snaps over flared end of female fitting. Ensure lines lock together and garter spring is over female fitting flared end.
7. Install retaining clip. Install Black retaining clip on fuel supply line and Gray clip on fuel return line. Ensure horseshoe portion of clip is over coupling. DO NOT install retaining clip over rubber fuel line.



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Fig. 1: Disconnecting Fuel Lines
Courtesy of FORD MOTOR CO.

ENGINE

Removal (Expedition, Navigator & F150/250 Pickup)

WARNING: Ensure air suspension system is shut off prior to hoisting, jacking or towing an air suspension vehicle. Air suspension switch is located behind right kick panel. Failure to do so can result in inflation or deflation of air springs, which may cause vehicle to shift during servicing.

1. Disconnect negative battery cable. Remove hood. Drain cooling system. Remove radiator. Discharge A/C system using approved refrigerant recovery/recycling equipment. Release fuel pressure and disconnect fuel lines. See **FUEL PRESSURE RELEASE & FUEL LINE CONNECTIONS**.
2. On Expedition and Navigator, remove air conditioning condenser and EGR manifold tube. Unclip mega fuse holders from junction block bracket. Disconnect starter relay cables.
3. On all models, remove upper intake manifold. See **INTAKE MANIFOLD**. Remove bulkhead connector cover. Disconnect necessary grounds and harness connectors. Disconnect necessary water and vacuum connections. Unbolt power steering bracket, and position reservoir and bracket assembly aside. Remove ignition coils and brackets.
4. Raise and support vehicle. Remove starter. Remove A/C compressor. Remove transmission cooler line

from block mounted clip. Remove transmission inspection cover, torque converter bolts and transmission-to engine bolts. Remove power steering retaining bolts and position power steering pump aside.

5. Disconnect dual-converter "Y" pipe from exhaust manifolds, and position aside. Remove right and left engine mount bolts. Lower vehicle and support transmission. Remove engine from vehicle.

Removal (E150)

1. Disconnect negative battery cable(s). Discharge A/C system using approved refrigerant recovery/recycling equipment. Release fuel pressure and disconnect fuel lines. See **FUEL PRESSURE RELEASE & FUEL LINE CONNECTIONS**.
2. Disconnect necessary harness and ground connections. Remove intake manifold. See **INTAKE MANIFOLD**. Remove air deflector, radiator grille, radiator grille open panel and upper and lower core supports. Remove radiator, fan shroud and cooling fan.
3. Remove headlight and side marker assemblies. Remove A/C condenser. Remove accessory drive belt. Drain power steering fluid by disconnecting reservoir hose at power steering pump. Disconnect high pressure hose at power steering pump. Remove lower radiator hose. Disconnect suction hose at receiver-drier.
4. Raise and support vehicle. Disconnect dual-converter "Y" pipe at exhaust manifold. Drain engine oil and remove oil filter. Remove oil cooler. Remove starter. Remove transmission-to-engine bolts.
5. Remove and discard torque converter nuts. Remove engine mount-to-subframe nuts. Lower vehicle. Remove transmission oil filler tube. Support transmission. Remove engine from vehicle.

Installation (All Models)

1. To install, reverse removal procedure. Tighten all bolts to specification. See **TORQUE SPECIFICATIONS**.
2. When installing fuel lines, fit NEW fuel resistant "O" rings (Brown) on fuel lines. Lightly coat "O" rings with clean engine oil before installing. Clean fittings, and replace garter spring (if necessary).
3. Adjust all control cables and fluid levels. Refill cooling system. Evacuate and recharge A/C system.

INTAKE MANIFOLD

Removal (Upper & Lower)

1. Disconnect negative battery cable(s). Remove engine cover. Release fuel pressure and disconnect fuel lines. See **FUEL PRESSURE RELEASE & FUEL LINE CONNECTIONS**. Drain cooling system. Disconnect upper radiator hose from thermostat housing. Remove air cleaner and outlet tube assembly. Remove throttle body. Remove EGR manifold tube.
2. Disconnect necessary vacuum and water connections. Disconnect necessary wiring connections. Remove spark plug wires. Remove accessory drive belt. Remove alternator. Remove upper intake manifold-to-head retaining bolts in reverse order of tightening sequence. See **Fig. 3**.
3. Lift upper and lower intake manifold assembly. Disconnect electrical connector at manifold tuning valve, and remove intake manifold assembly from vehicle. Remove upper intake manifold-to-lower intake manifold mounting bolts. Remove pushpin retainer from front of manifold insulator. Separate manifold

insulator from lower intake manifold. See **Fig. 2** . Separate upper and lower intake manifolds.

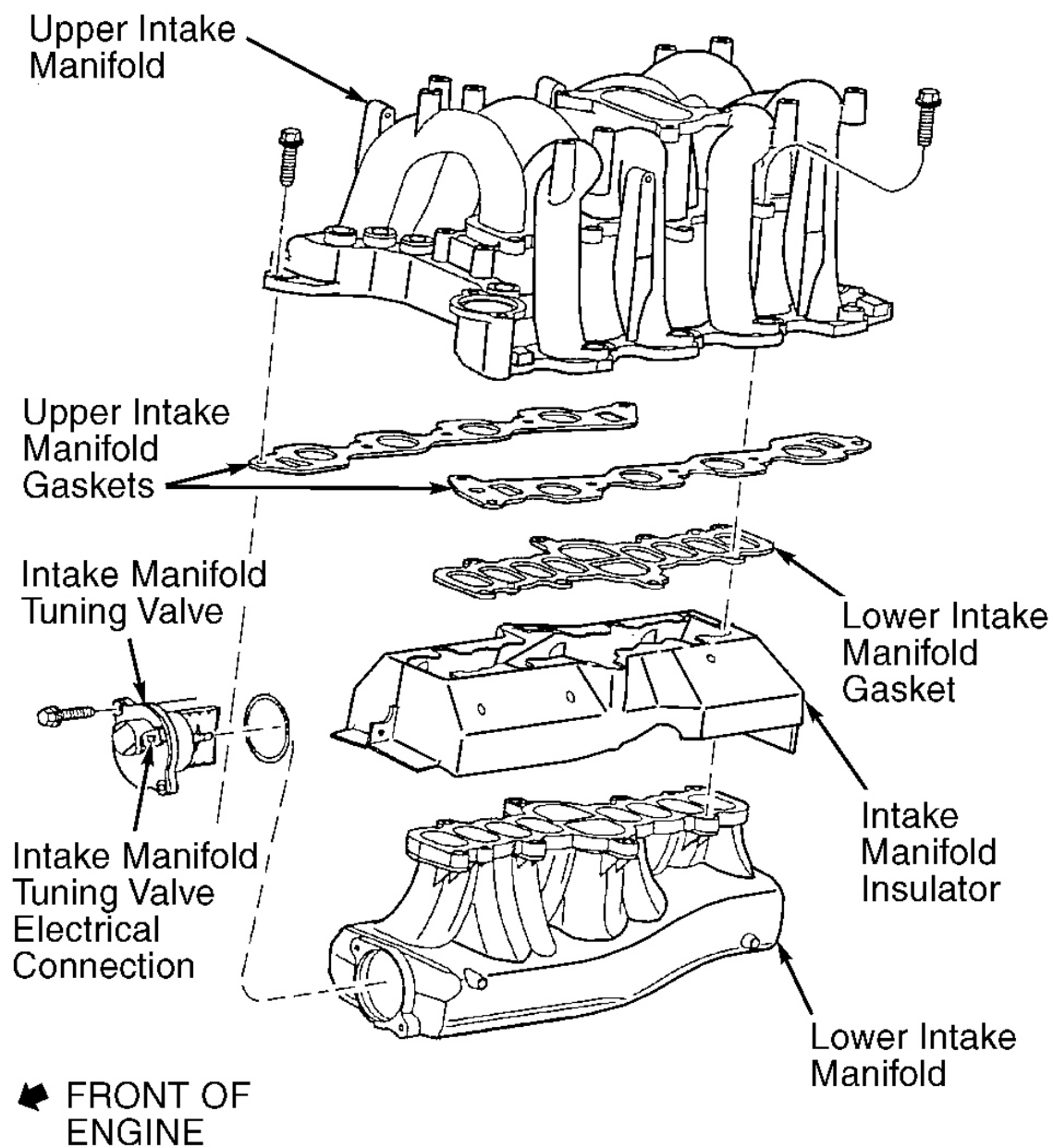
Installation

1. To install, reverse removal procedure. Use NEW gaskets and "O" rings. Lubricate fuel injector "O" rings with Light Grade Oil (ESE-M2C39-F) before installing.
- 2.

CAUTION: Intake manifold bolts must be retightened to specification after engine has reached normal operating temperature.

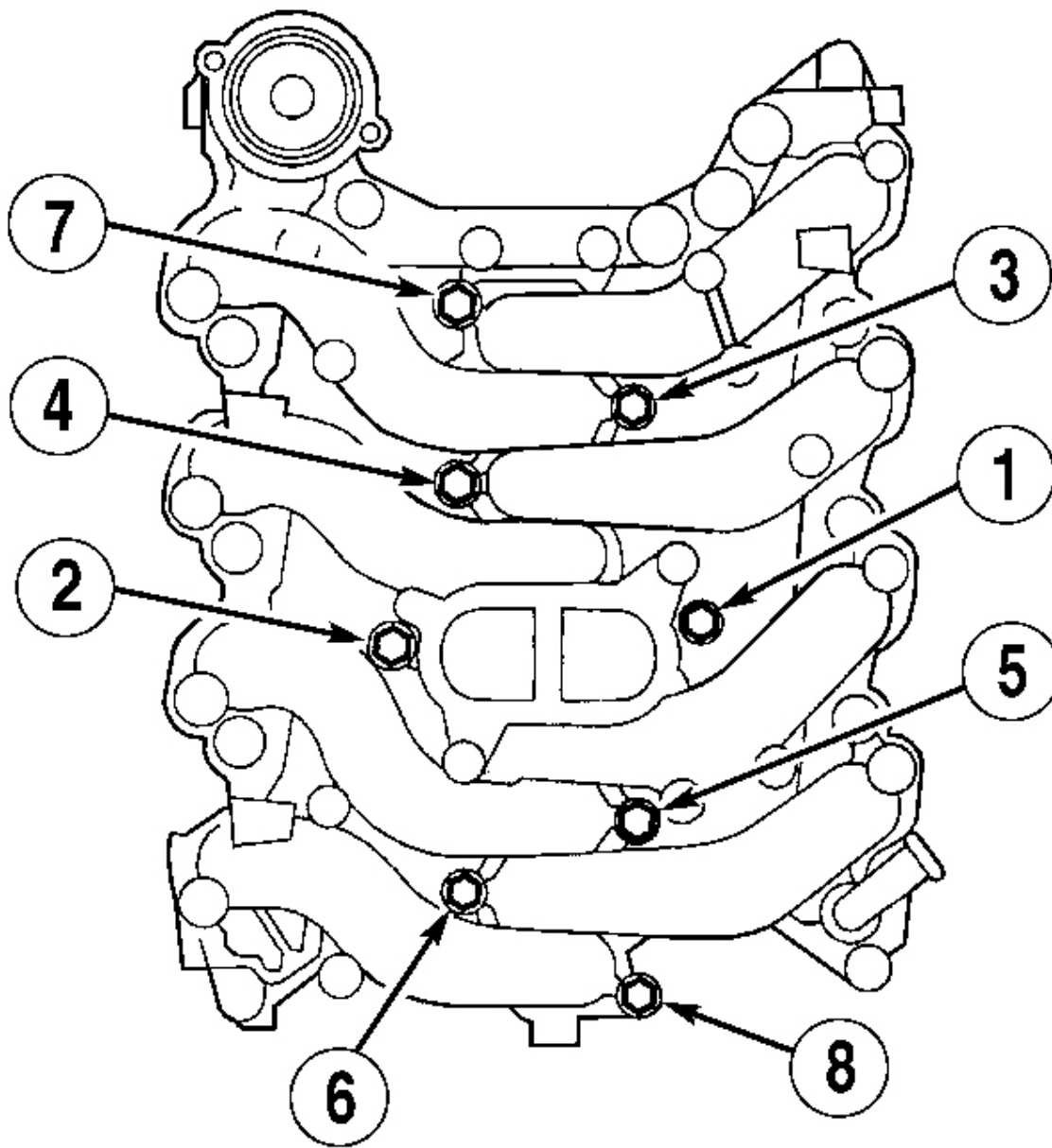
Ensure alignment tabs on intake manifold gaskets align with holes in cylinder head. Tighten upper intake manifold to lower intake manifold bolts to specification in sequence. See **Fig. 3** . Tighten upper intake manifold-to-head bolts to specification in sequence. See **Fig. 4** . See **TORQUE SPECIFICATIONS** .

3. When installing fuel lines, fit NEW fuel resistant "O" rings (Brown) on fuel lines. Lightly coat "O" rings with clean engine oil before installing. Clean fittings, and replace garter spring (if necessary).
4. To install remaining components, reverse removal procedure. Adjust all control cables and fluid levels. Refill cooling system. When installing spark plug wires, ensure wires are in correct position on coils. See appropriate SERVICE & ADJUSTMENT SPECIFICATIONS article in ENGINE PERFORMANCE.



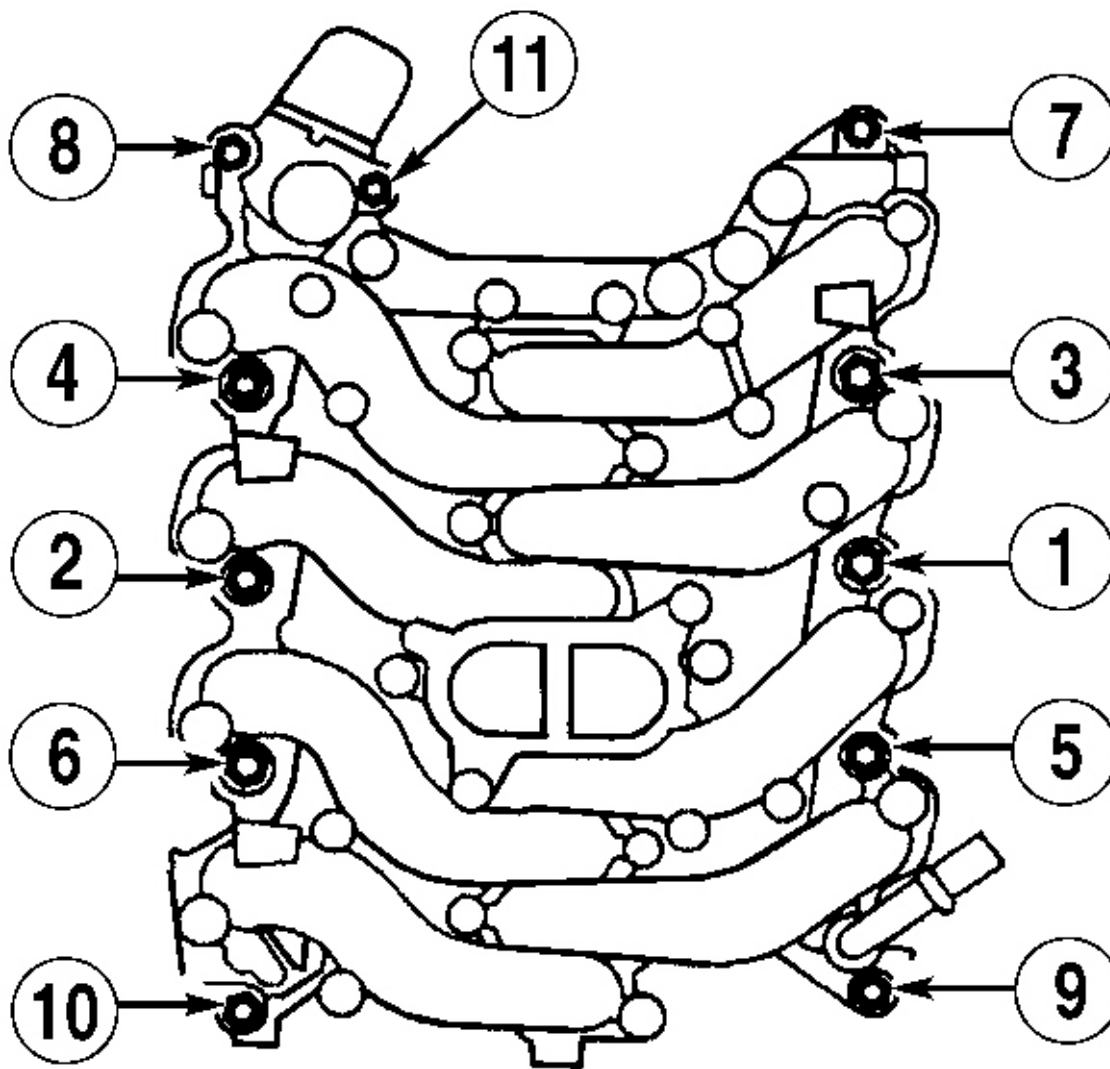
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Fig. 2: Exploded View Of Upper & Lower Intake Manifold
Courtesy of FORD MOTOR CO.



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Fig. 3: Upper Intake Manifold-To-Lower Intake Manifold Bolt Tightening Sequence
Courtesy of FORD MOTOR CO.



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Fig. 4: Upper Intake Manifold-To-Head Bolt Tightening Sequence
 Courtesy of FORD MOTOR CO.

EXHAUST MANIFOLD

Removal (All Models)

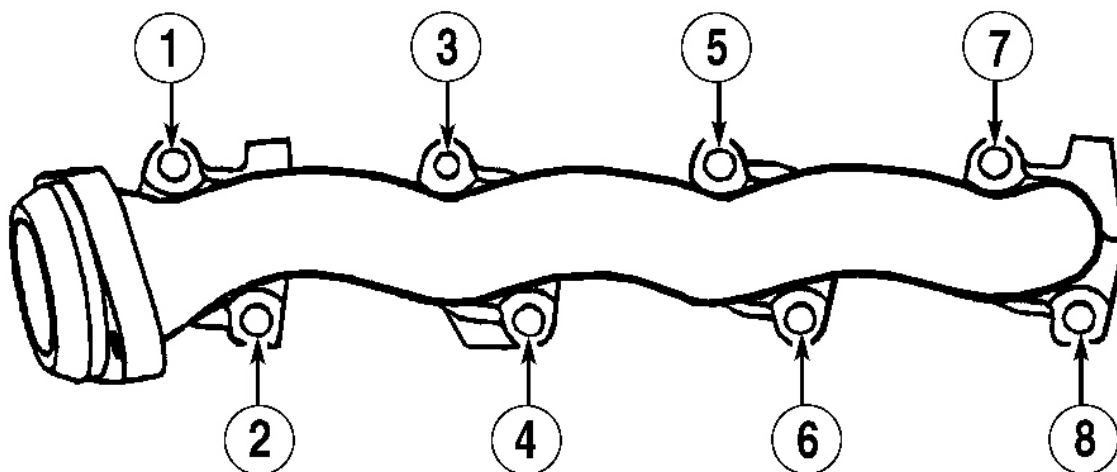
WARNING: Ensure air suspension system is shut off prior to hoisting, jacking or towing an air suspension vehicle. Air suspension switch is located behind right kick panel. Failure to do so can result in inflation or deflation of air springs, which may cause vehicle to shift during servicing.

Raise and support vehicle. Remove front fender splash shield. If removing left side, remove EGR manifold tube and brake vacuum booster hose bracket. On either side, disconnect exhaust manifold flange. Remove exhaust manifold retaining nuts in reverse order of tightening sequence. See **Fig. 5** . Remove exhaust manifold and

gasket.

Installation

To install, reverse removal procedure. Tighten exhaust manifold nuts to specification in sequence. See **Fig. 5** . See **TORQUE SPECIFICATIONS** .



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Fig. 5: Exhaust Manifold Bolt Tightening Sequence
Courtesy of FORD MOTOR CO.

CYLINDER HEAD

CAUTION: If cylinder head-to-block surface refinishing is necessary, **DO NOT** remove more than .010" (.25 mm) from cylinder head surface.

Removal

1. On 1998 models, disconnect negative battery cable(s). Remove intake manifold. See **INTAKE MANIFOLD** . On 1999 models, remove engine. See **ENGINE** . On all models, remove exhaust manifold. See **EXHAUST MANIFOLD** .
2. Remove timing chains. See **TIMING CHAINS** . On 1998 models, disconnect heater hoses. On 1998 Expedition, F150, F250 and Navigator, remove heater pipe-to-engine mounting studs. Remove heater pipe and discard "O" ring. On all models, remove cylinder head bolts in sequence. See **Fig. 6** or **Fig. 7** . Remove cylinder head and gasket.

Inspection

Check cylinder head for warpage, cracks and damage. Maximum warpage information is not available from manufacturer.

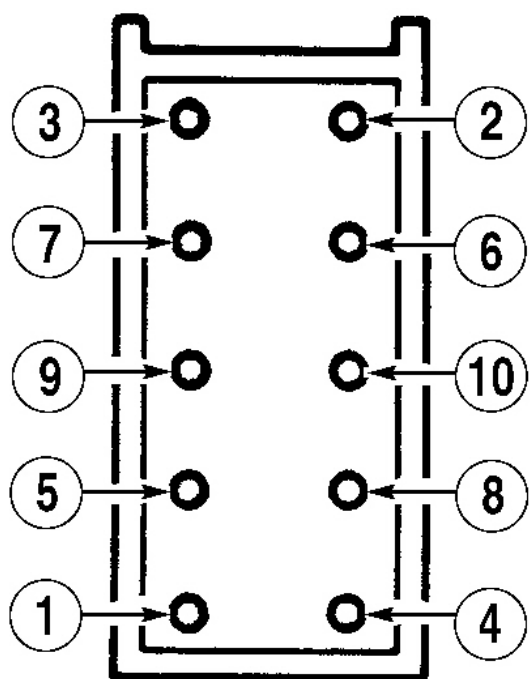
Installation

1. Ensure proper gaskets are installed. Right and left cylinder head gaskets are not interchangeable. Rotate crankshaft 90 degrees counterclockwise from vertical position. See STEP 1 in illustration. See **Fig. 9** . Ensure no piston is at TDC.
- 2.

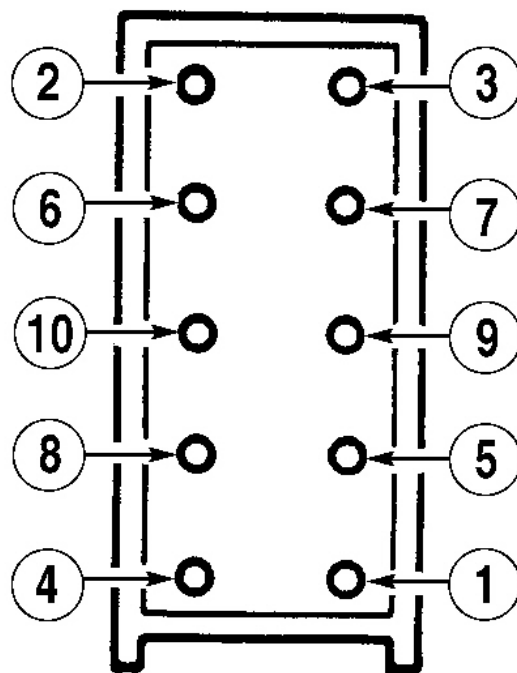
CAUTION: Position camshaft so valves DO NOT extend below cylinder head surface, or ensure Camshaft Positioner (T93P-6256-A) is installed before installing cylinder head. See Fig. 10 . Install NEW cylinder head bolts. DO NOT reuse bolts.

Coat bolt head-to-cylinder head surfaces with engine oil. DO NOT oil threads of cylinder head bolts. Ensure rear cylinder head bolts are installed in cylinder head and secured by rubber bands before installing cylinder head, if necessary. See **Fig. 8** . Install cylinder heads.

3. Tighten cylinder head bolts to specification and in sequence. See **Fig. 6** or **Fig. 7** . See **TORQUE SPECIFICATIONS** . On 1998 Expedition, F150, F250 and Navigator, install a new "O" ring on heater pipe. Lubricate "O" ring with clean coolant and install heater pipe. Tighten heater pipe-to-engine mounting studs to specification. If camshaft positioner was not used during cylinder head installation, rotate camshafts using flats matched at center of camshaft until both cams are in time. Install Camshaft Positioner (T91P-6256-A) on flats of camshaft. This will prevent camshafts from rotating.
4. Rotate crankshaft 45 degrees clockwise. See STEP 2 in illustration. See **Fig. 9** . This will position crankshaft so cylinder No. 1 is at TDC. DO NOT rotate crankshaft past TDC position. Timing chains can now be installed. See **TIMING CHAINS** . To install remaining components, reverse removal procedure.

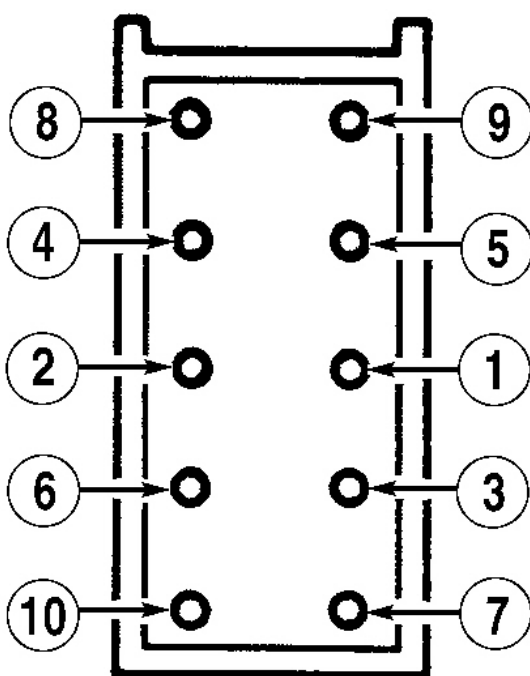


RIGHT CYLINDER HEAD

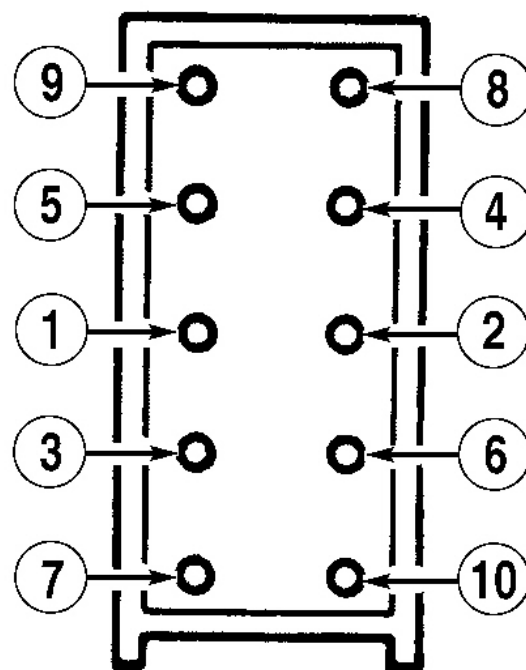


LEFT CYLINDER HEAD

REMOVAL



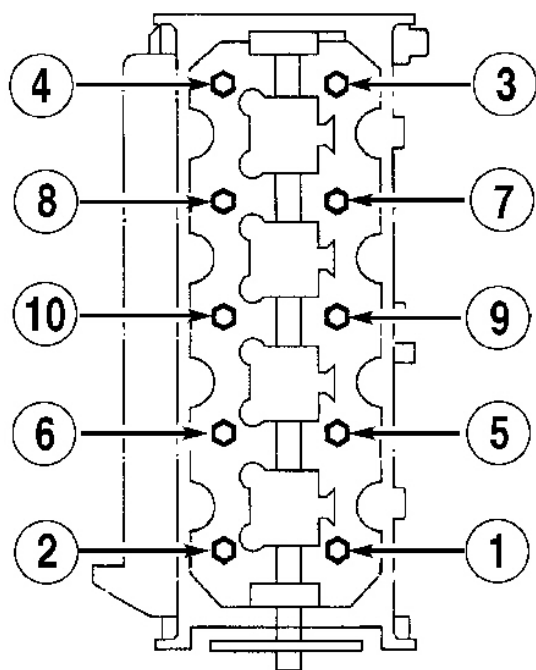
RIGHT CYLINDER HEAD



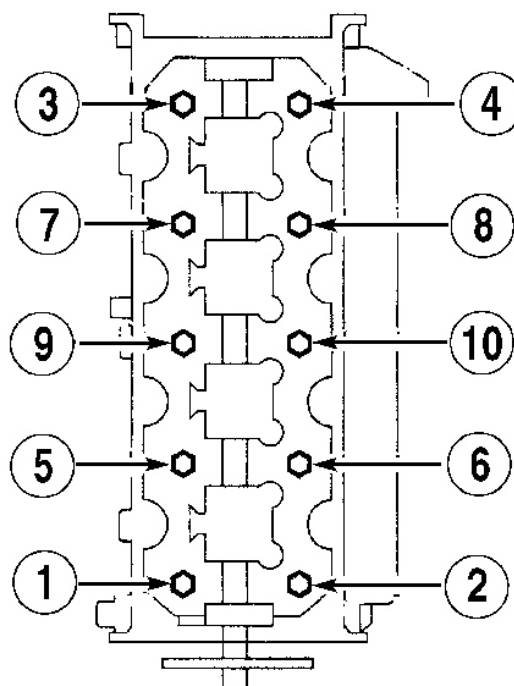
LEFT CYLINDER HEAD

INSTALLATION

Fig. 6: Cylinder Head Bolt Removal & Installation Sequence (Romeo Engine)
Courtesy of FORD MOTOR CO.

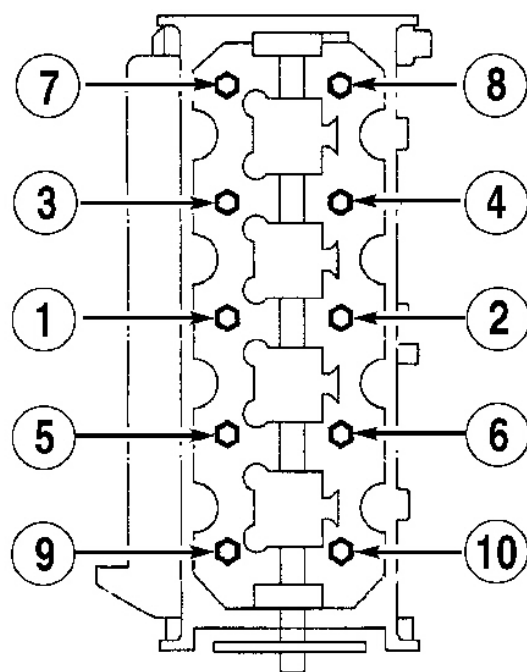


RIGHT CYLINDER HEAD

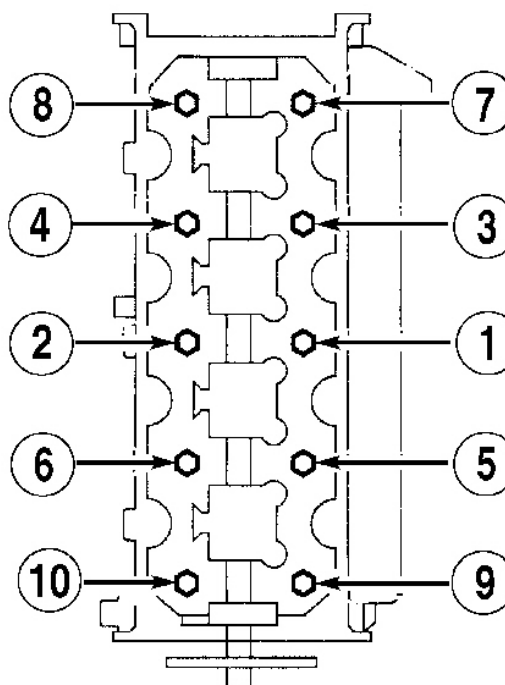


LEFT CYLINDER HEAD

REMOVAL



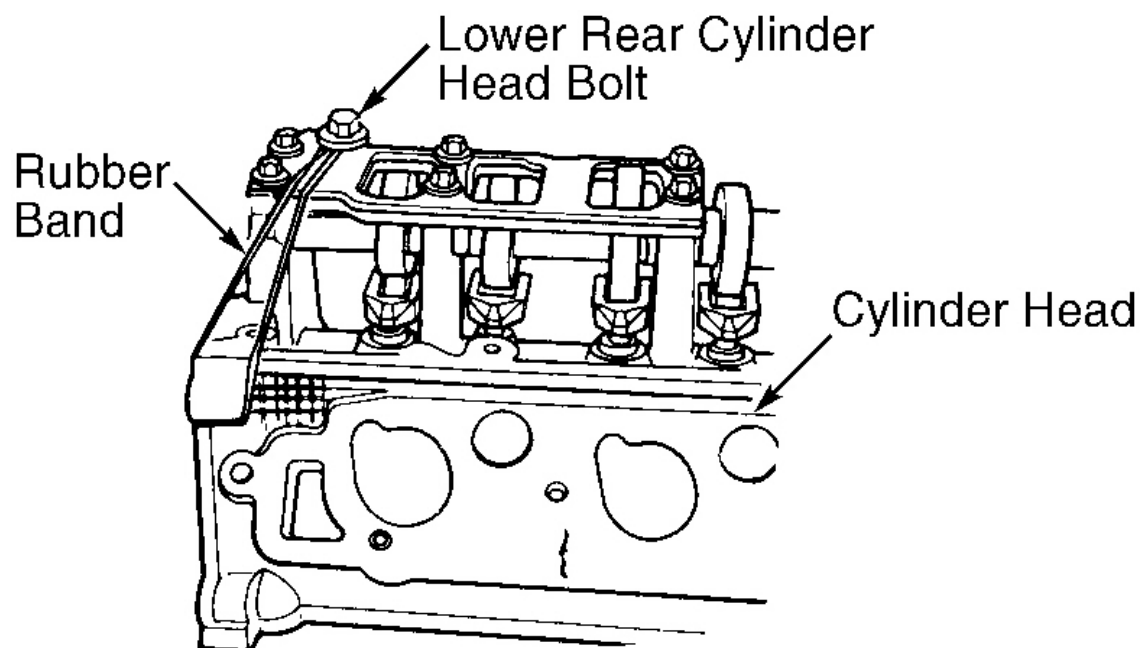
RIGHT CYLINDER HEAD



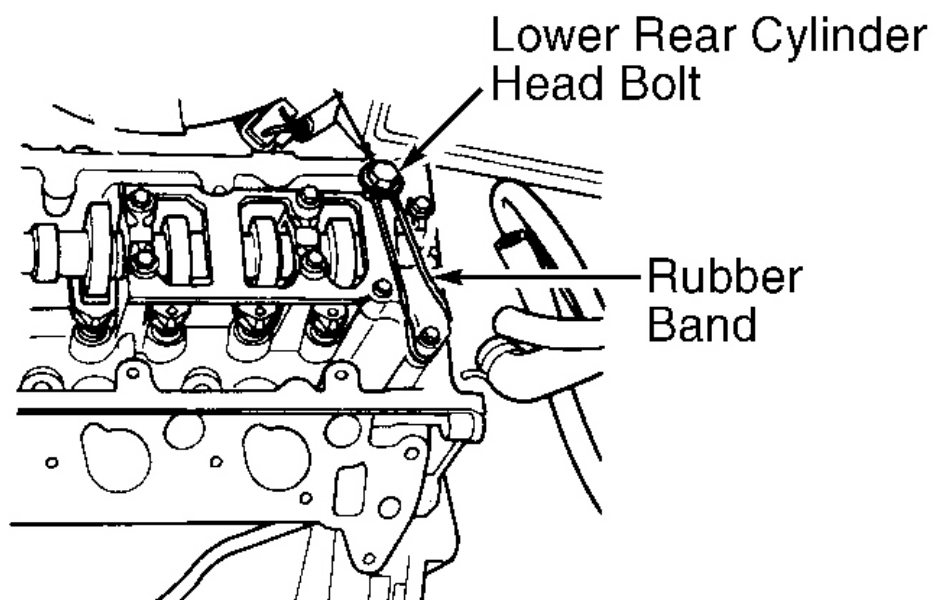
LEFT CYLINDER HEAD

INSTALLATION

Fig. 7: Cylinder Head Bolt Removal & Installation Sequence (Windsor Engine)
Courtesy of FORD MOTOR CO.



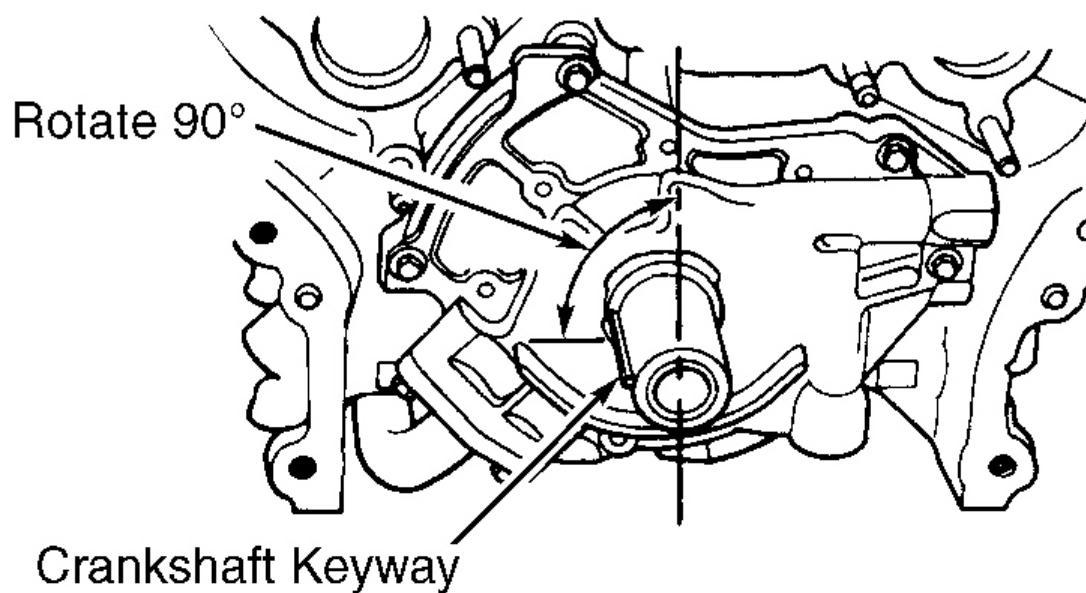
LEFT CYLINDER HEAD



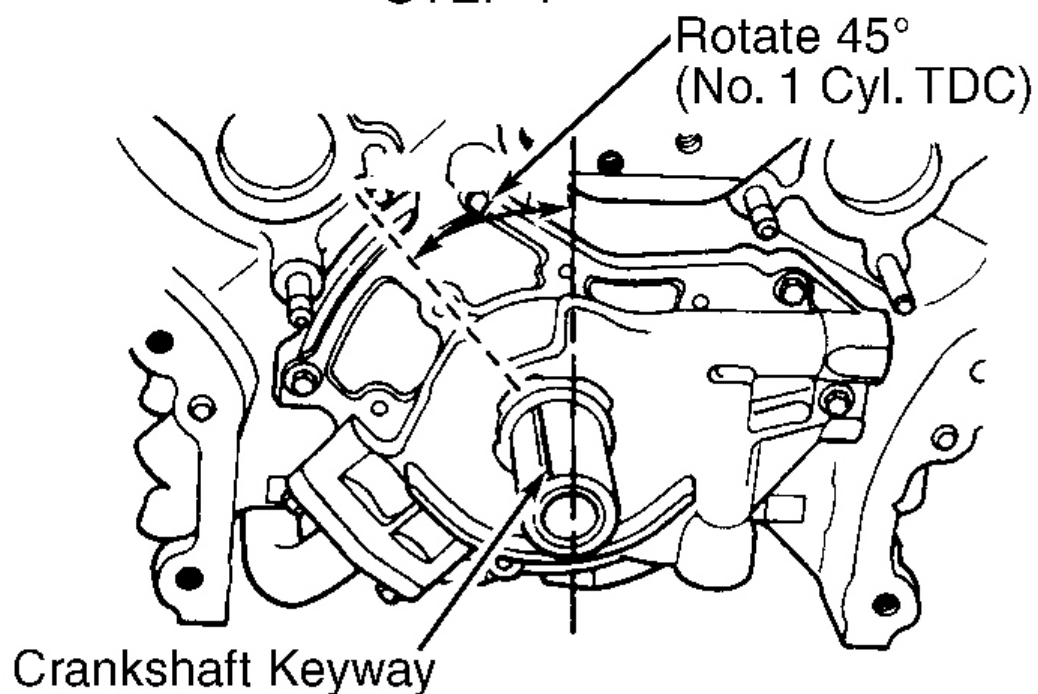
RIGHT CYLINDER HEAD

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Fig. 8: Securing Cylinder Head Bolts
Courtesy of FORD MOTOR CO.



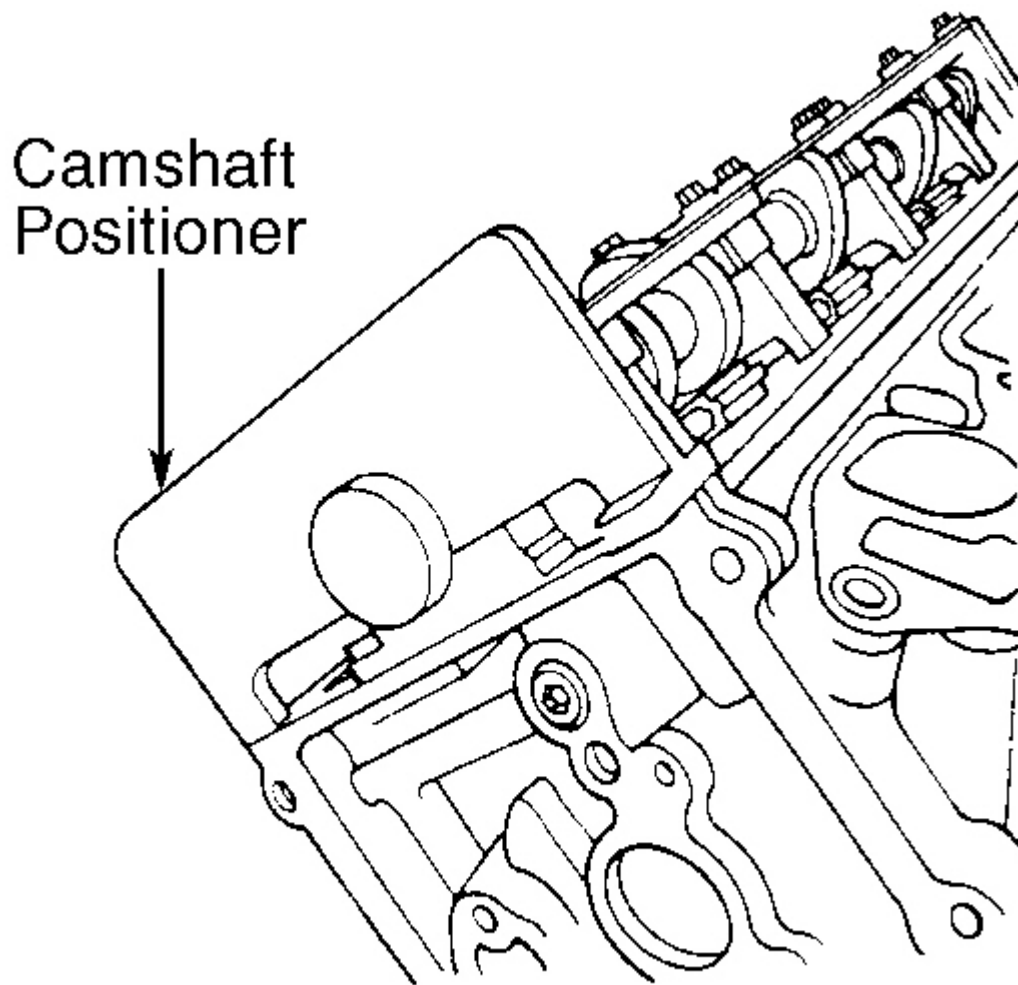
STEP 1



STEP 2

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Fig. 9: Positioning Crankshaft
Courtesy of FORD MOTOR CO.



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Fig. 10: Installing Camshaft Positioner
Courtesy of FORD MOTOR CO.

VALVE COVERS

Removal (Left)

Disconnect negative battery cable(s). Remove air cleaner. On Expedition, Navigator and F150, unbolt power steering reservoir bracket and position reservoir, and bracket assembly aside. On all models, disconnect PCV hose from valve cover. Remove EGR manifold tube. Disconnect fuel injection electrical connections. Loosen valve cover retaining bolts. Retaining bolts are part of valve cover and should not be removed. Remove valve cover and gasket.

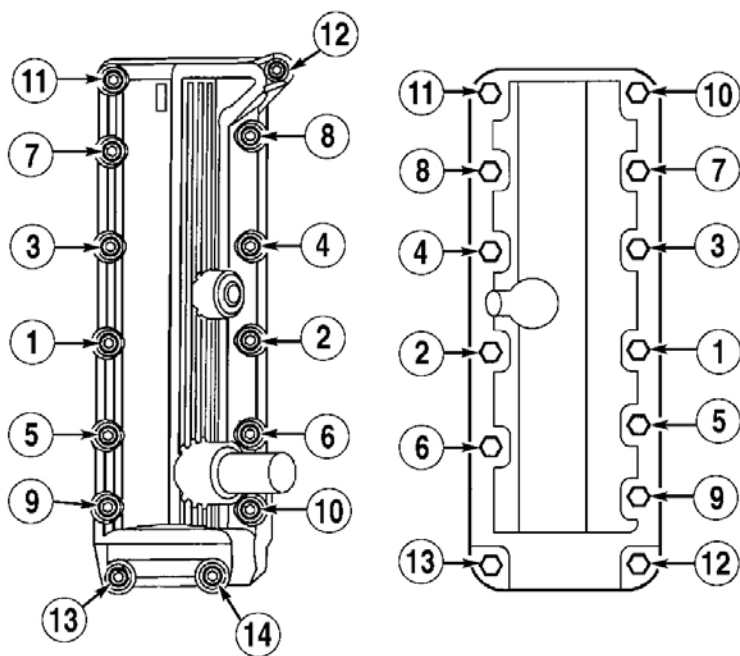
Removal (Right)

On E150, remove air cleaner, oil filler tube and engine cover. On all models, disconnect PCV valve hose from valve cover. Disconnect electrical connections as necessary. Disconnect heater water hose. Loosen valve cover

retaining bolts. Retaining bolts are part of valve cover and should not be removed. Remove valve cover and gasket.

Installation (All Models Left & Right)

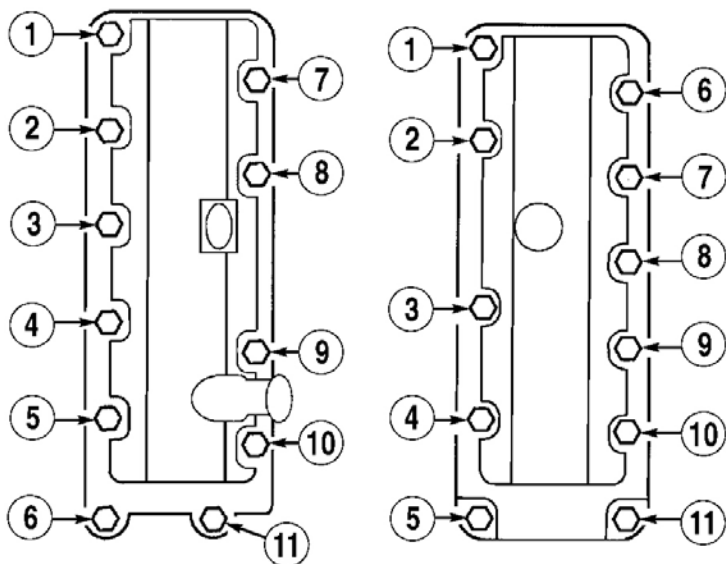
1. Clean sealing surfaces on valve cover and cylinder head. Using gasket adhesive, glue valve cover gasket into valve cover. Apply a bead of silicone gasket adhesive to seam where cylinder head and front cover meet.
2. Install valve cover and valve cover mounting bolts. To complete installation, reverse removal procedure. Tighten bolts to specification. See **Fig. 11** . See **TORQUE SPECIFICATIONS** .
3. When installing fuel lines, fit NEW fuel resistant "O" rings (Brown) on fuel lines. Lightly coat "O" rings with clean engine oil before installing. Clean fittings, and replace garter spring (if necessary).



RIGHT VALVE COVER

LEFT VALVE COVER

WINDSOR ENGINE



RIGHT VALVE COVER

LEFT VALVE COVER

ROMEO ENGINE

↓ FRONT OF ENGINE

G99B03848

Fig. 11: Valve Cover Bolt Tightening Sequence
Courtesy of FORD MOTOR CO.

FRONT COVER OIL SEAL

WARNING: Ensure air suspension system is shut off prior to hoisting, jacking or towing an air suspension vehicle. Air suspension switch is located behind right kick panel. Failure to do so can result in inflation or deflation of air springs, which may cause vehicle to shift during servicing.

Removal

1. Disconnect negative battery cable. Release belt tensioner, and remove accessory drive belt. Remove cooling fan and fan shroud. On E150, remove air cleaner assembly.
2. Raise and support vehicle. Remove crankshaft damper retaining bolt and washer. Using Puller (T58P-6316-D), remove crankshaft damper. Using Seal Remover (T74P-6700-A), remove oil seal from front cover.

Installation

To install, reverse removal procedure. Lubricate oil seal bore and seal lip with engine oil before installing. Use Seal Installer (T88T-6701-A1 and A2) to install oil seal. Apply silicone sealant to keyway of crankshaft damper before installing. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**.

FRONT COVER

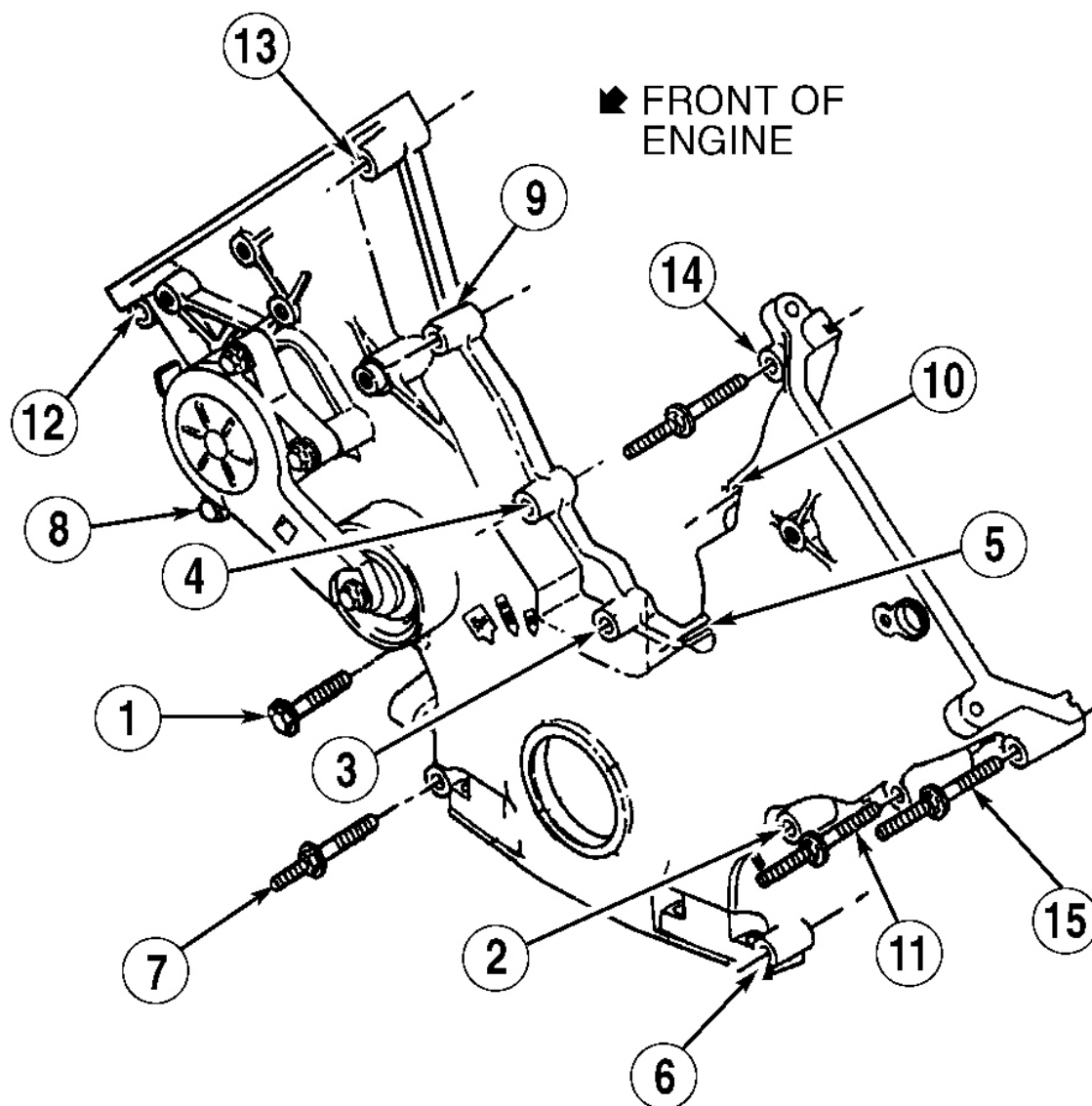
WARNING: Ensure air suspension system is shut off prior to hoisting, jacking or towing an air suspension vehicle. Air suspension switch is located behind right kick panel. Failure to do so can result in inflation or deflation of air springs, which may cause vehicle to shift during servicing.

Removal

1. Disconnect negative battery cable. Remove cooling fan and shroud. Remove radiator. Remove accessory drive belt. Remove water pump pulley. Raise and support vehicle. Remove power steering pump, and secure aside.
2. Drain engine oil. Remove oil pan-to-front cover bolts. Remove crankshaft damper retaining bolt and washer. Using Puller (T58P-6316-D), remove crankshaft damper. Lower vehicle. Remove A/C refrigerant line retainer from right coil bracket, if necessary.
3. Remove both valve covers. See **VALVE COVERS**. Disconnect ignition coils, radio interference capacitor and camshaft position sensor harness connectors. Remove coil brackets and lay coil brackets with spark plug wires on top of engine.
4. Remove idler belt pulley. Disconnect crankshaft position sensor and remove sensor. Remove front cover retaining bolts/studs in reverse order of tightening sequence. See **Fig. 12**. Remove front cover and gasket.

Installation

To install, reverse removal procedure. Apply Sealant (E3AZ-19562-A) at front cover-to-oil pan, cylinder block and valve cover areas. Apply silicone sealant to keyway of crankshaft damper before installing. Tighten bolts to specification. See **Fig. 12**. See **TORQUE SPECIFICATIONS**.



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Fig. 12: Front Cover Tightening Sequence
 Courtesy of FORD MOTOR CO.

TIMING CHAINS

Removal

1. Remove valve covers. See **VALVE COVERS** . Remove front cover. See **FRONT COVER** . Remove crankshaft position sensor pulse wheel from crankshaft.
- 2.

CAUTION: DO NOT rotate engine with timing chain removed. Damage to valve/piston may result.

Rotate crankshaft until No. 1 piston is at TDC. This positions crankshaft keyway 45 degrees from vertical position. See **Fig. 13** . Camshaft keyways will point toward crankshaft.

3.

CAUTION: Mark component location for reassembly reference. Components must be installed in original locations.

Install Camshaft Positioner (T96T-6256-AR) on flat area near rear of camshaft. See **Fig. 10** . Remove retaining bolts, right chain tensioner, right tensioner arm and right chain guide. See **Fig. 14** .

4. Remove right timing chain and crankshaft sprocket. Note direction of sprocket for installation reference. If necessary for clearance, remove retaining bolt, washer, camshaft sprocket and spacer.
- 5.

CAUTION: DO NOT rotate engine with timing chain(s) removed. Damage to valve/piston may result.

Remove retaining bolts, left chain tensioner, left tensioner arm and left chain guide. See **Fig. 14** . Remove left timing chain and crankshaft sprocket. Note direction of sprocket for installation reference. If necessary for clearance, remove retaining bolt, washer, camshaft sprocket and spacer.

Inspection

CAUTION: If components are replaced due to damage, ensure crankshaft is rotated so pistons are below deck surface (crankshaft keyway at 90 degrees) to prevent contact with valves. See STEP 1 in Fig. Fig. 9 . Ensure camshaft positioner is installed on camshaft(s) before installing timing chain(s).

Inspect components for damage. Inspect friction surfaces on tensioner arms and chain guides for wear. Replace components if necessary. If tensioner arms or guides are worn or damaged, remove and clean oil pan. Also, replace oil pump screen cover and tube.

Installation

1. Install spacers, camshaft sprockets and retaining bolts. Ensure components are installed in original locations. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .
2. Install Camshaft Positioner (T92P-6256-A) on flat areas of camshaft if not previously installed. See **Fig. 10** .
- 3.

CAUTION: Install crankshaft sprocket halves with hubs facing each other. See Fig. 15 .

Install crankshaft sprocket for left timing chain. If copper links are not visible on timing chain, fold timing chain in half and mark each end link for timing purposes. See **Fig. 15** . These links will be referred to as copper links when installing.

4. Ensure No. 1 piston is at TDC. This positions crankshaft keyway 45 degrees from vertical position. See

Fig. 9 . Crankshaft keyway will point toward camshaft.

5. Install left timing chain on camshaft and crankshaft sprockets so copper link aligns with timing mark on sprockets. See **Fig. 13** . Install crankshaft sprocket for right timing chain. Ensure sprocket is properly installed.
6. Install right timing chain on camshaft and crankshaft sprockets so copper link aligns with timing mark on sprockets. Install Crankshaft Positioner (T93P-6256-A), to prevent crankshaft movement. Lubricate tensioner arms with engine oil. Install tensioner arms. Install chain guides.
7. Chain tensioners must be bled down so tensioner plunger is compressed in housing before installing. Place chain tensioner in soft-jaw vise. Using small pick, hold ratchet lock mechanism away from ratchet stem. See **Fig. 16** . Slowly close vise to depress tensioner plunger.
8. When tensioner plunger is compressed in housing, continue to hold ratchet lock mechanism and install lock pin in hole on tensioner housing. Ensure ratchet stem is even with tensioner housing before installing lock pin. See **Fig. 16** .
9. Using "C" clamp or suitable tool, remove all slack from timing chain by applying pressure to tensioner arm. While holding pressure on arm, install both chain tensioners and retaining bolts on cylinder block. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .
10. Remove lock pins from both chain tensioners. Ensure all timing marks align. See **Fig. 13** . To check accuracy of valve timing, remove No. 1 spark plug. Using a dial indicator, check for maximum intake valve lift. Maximum intake valve lift should occur at 114 degrees after TDC.
11. To install remaining components, reverse removal procedure. Before installing valve cover, apply silicone sealant at front cover-to-cylinder block areas.
12. When installing fuel lines, fit NEW fuel resistant "O" rings (Brown) on fuel lines. Lightly coat "O" rings with clean engine oil before installing. Clean fittings, and replace garter spring (if necessary).

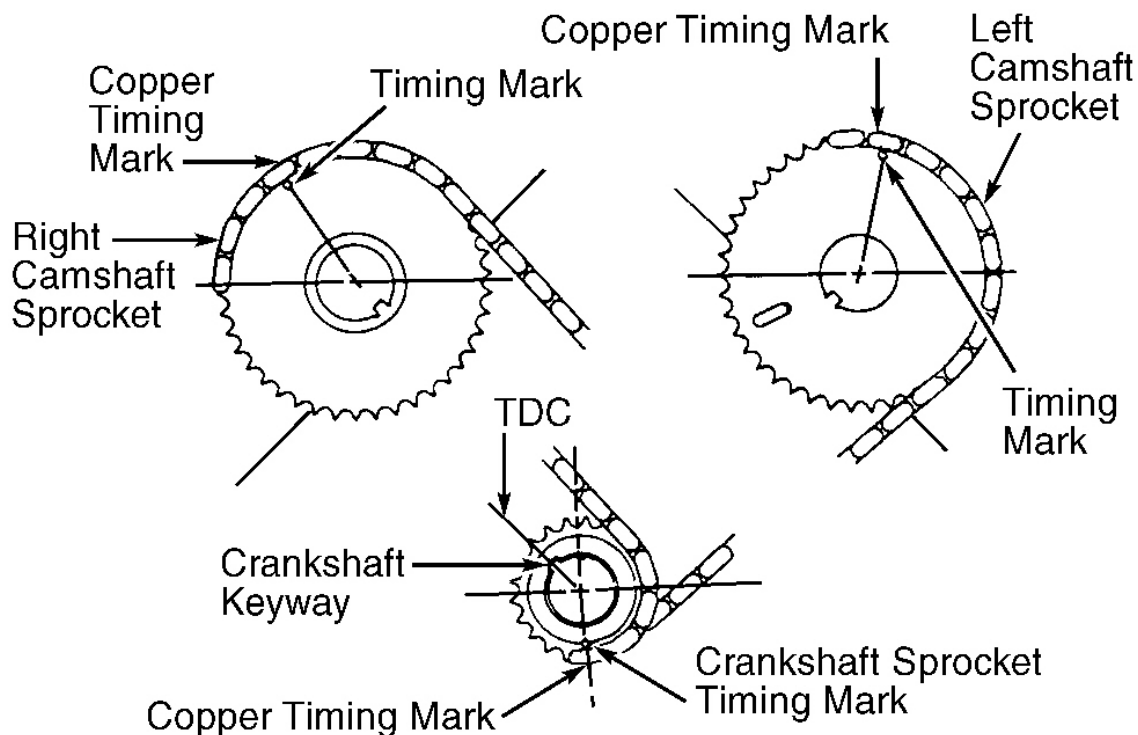
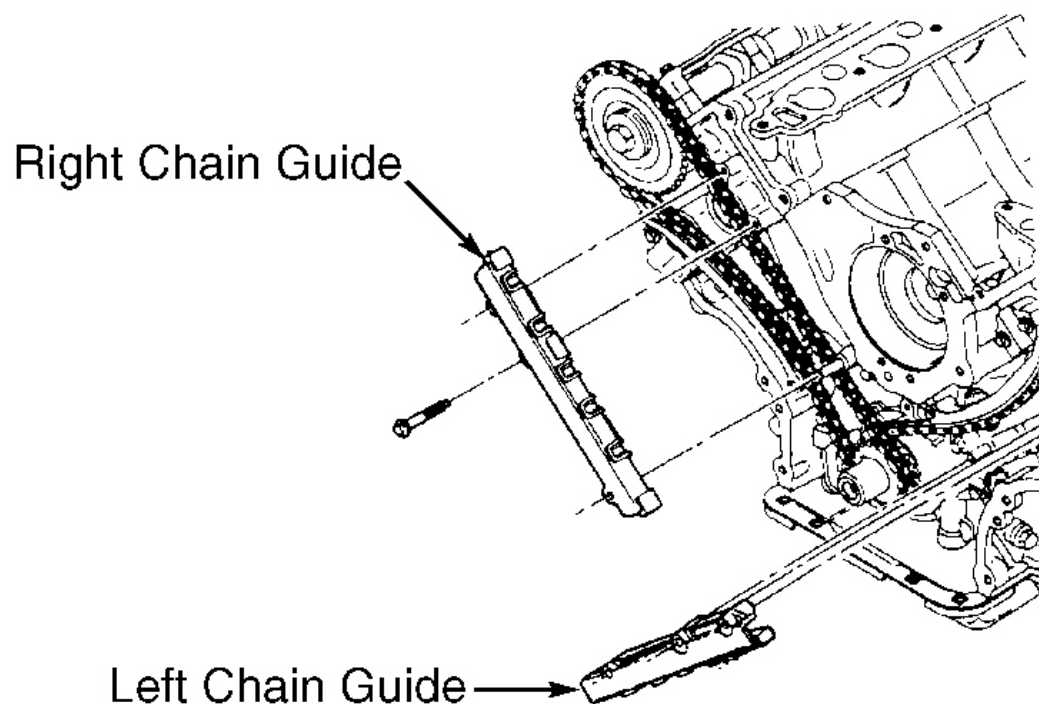
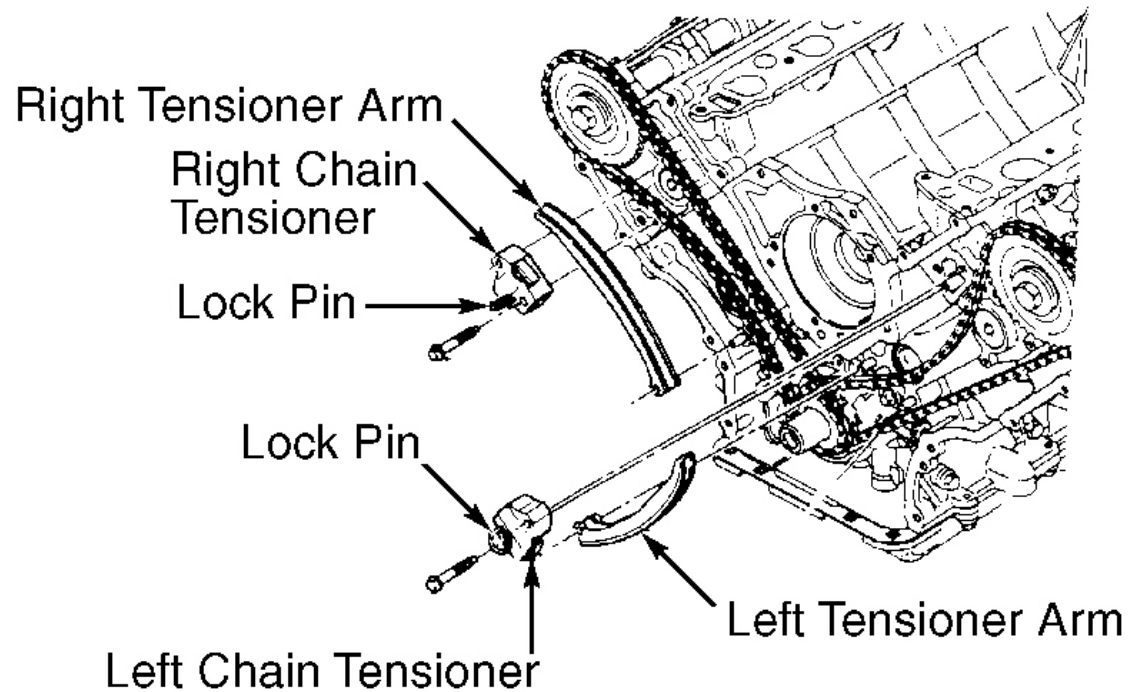


Fig. 13: Identifying Timing Marks
Courtesy of FORD MOTOR CO.



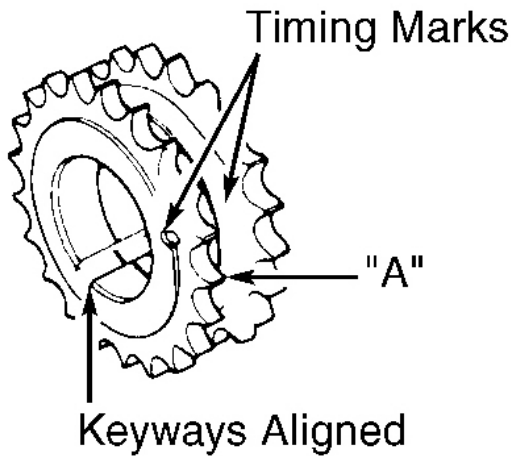
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Fig. 14: Exploded View Of Timing Chain & Components
Courtesy of FORD MOTOR CO.

View "A"



Correct Installation



Timing Marks

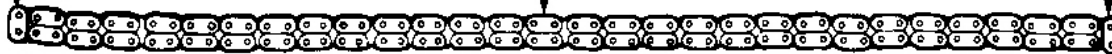
"A"

Keyways Aligned

Mark End Link
For Timing Purposes

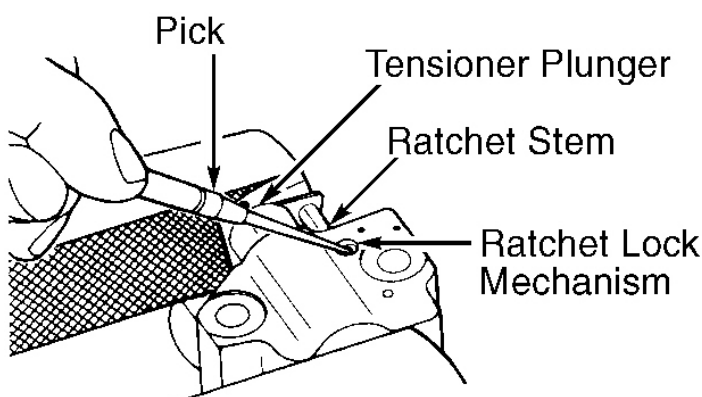
Timing
Chain

Mark End Link
For Timing
Purposes



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Fig. 15: Identifying Crankshaft Sprocket & Timing Chain Timing Marks
Courtesy of FORD MOTOR CO.

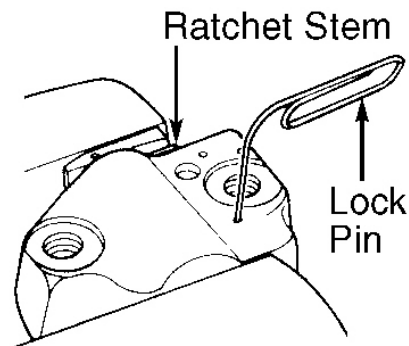


Pick

Tensioner Plunger

Ratchet Stem

Ratchet Lock
Mechanism



Ratchet Stem

Lock
Pin

G91C07210

Fig. 16: Compressing Timing Chain Tensioner Plunger
Courtesy of FORD MOTOR CO.

CAMSHAFT FOLLOWER & LASH ADJUSTER

Removal

1. Remove valve covers. See **VALVE COVERS**. Rotate crankshaft until piston in cylinder to be serviced

is at bottom of its stroke, and camshaft lobe is at base circle.

2. Install Valve Spring Spacer (T91P-6565-AH) between valve spring coils to prevent valve stem oil seal damage. Using Valve Spring Compressor (T91P-6565-A), compress valve spring. Remove camshaft follower and lash adjuster.

Inspection

Inspect components for damage. Measure lash adjuster O.D. and oil clearance. Replace components if damaged or measurements are not within specification. See **VALVE LASH ADJUSTER** table under ENGINE SPECIFICATIONS.

Installation

CAUTION: Before installing, ensure lash adjuster is full of oil and plunger does not have more than .059" (1.49 mm) travel. Ensure piston is at bottom of stroke and camshaft lobe is on base circle.

1. To install, reverse removal procedure. Coat components with engine oil before installing. Before installing valve cover, apply silicone sealant at front cover-to-cylinder block areas.
2. When installing fuel lines, fit NEW fuel resistant "O" rings (Brown) on fuel lines. Lightly coat "O" rings with clean engine oil before installing. Clean fittings, and replace garter spring (if necessary).

CAMSHAFT

Removal

Remove camshaft followers and lash adjusters. See **CAMSHAFT FOLLOWER & LASH ADJUSTER**. Remove timing chains. See **TIMING CHAINS**. Remove camshaft cap bolts in reverse order of tightening sequence. See **Fig. 17**. On Romeo engines, tap camshaft caps in designated areas to remove camshaft caps. See **Fig. 18**. On both engines. remove camshaft caps and camshaft.

Inspection

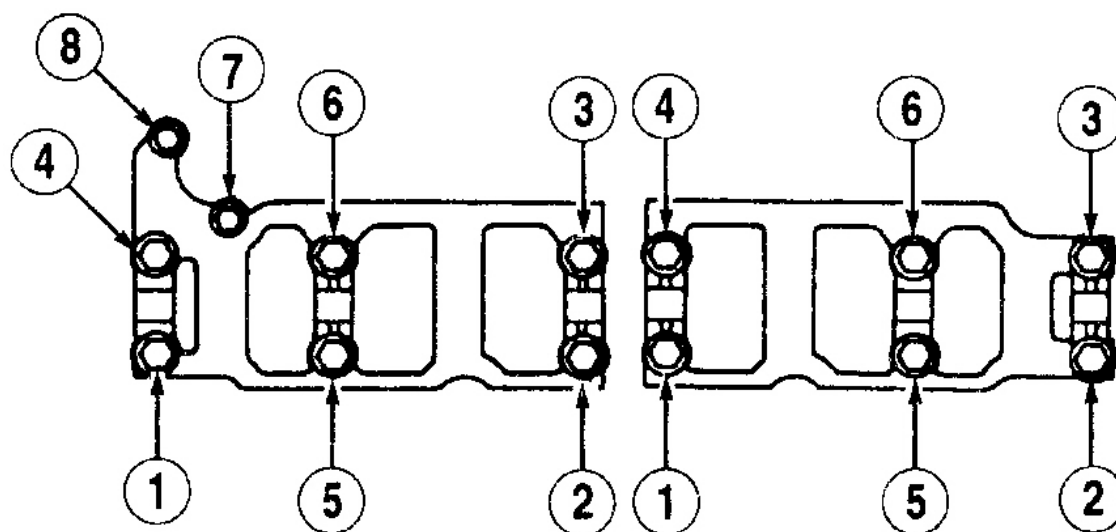
Measure camshaft bore I.D. and journal O.D. to determine oil clearance. Measure lobe lift. Replace camshaft if measurements are not within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.

Installation

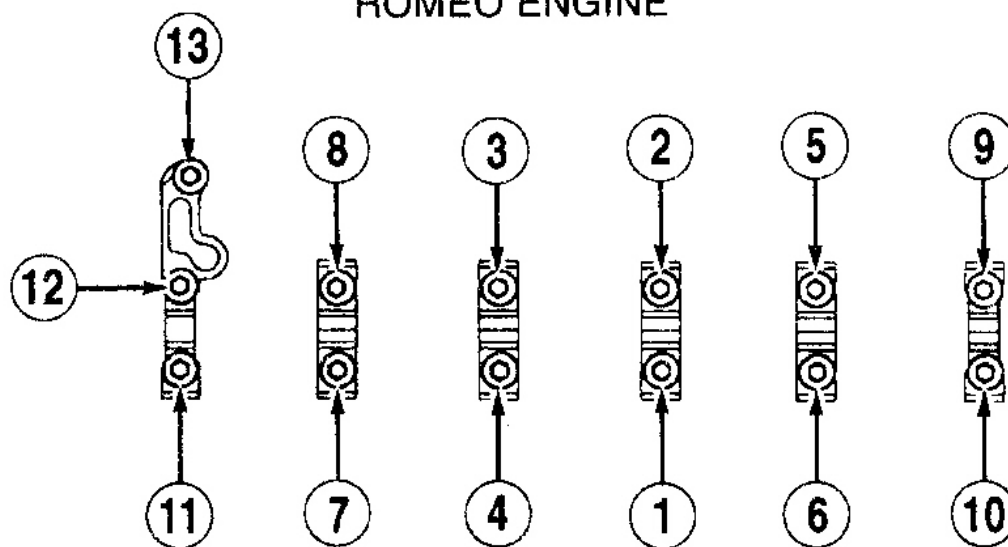
1.
CAUTION: Ensure proper procedure is used when installing timing chains to prevent engine damage. See TIMING CHAINS.

Coat components with engine oil, and install components. Install all bolts for both camshaft caps, and tighten them finger tight. Tighten bolts to 72-106 INCH lbs. (8-12 N.m) in sequence. See **Fig. 17**. Loosen all bolts 2 turns. Retighten bolts to 72-106 INCH lbs. (8-12 N.m) in sequence. Repeat procedure for each camshaft.

2. Ensure camshaft end play is within specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS. To install remaining components, reverse removal procedure. Tighten all bolts to specification. See **TORQUE SPECIFICATIONS**.



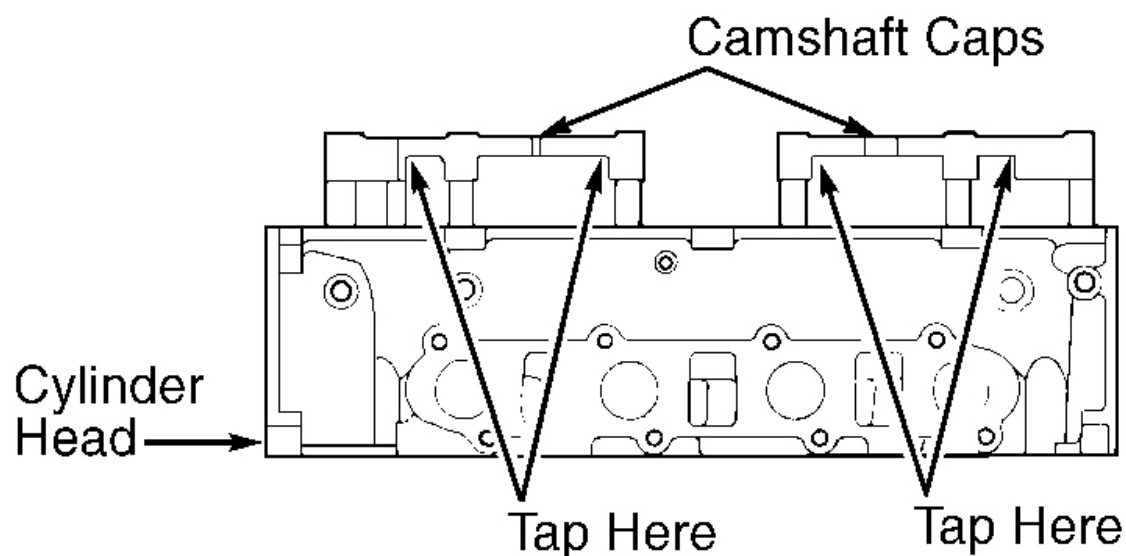
ROMEO ENGINE



WINDSOR ENGINE

G97D03651

Fig. 17: Camshaft Cap Bolt Tightening Sequence
 Courtesy of FORD MOTOR CO.



G91G07212

Fig. 18: Removing Camshaft Caps (Romeo Engine)
Courtesy of FORD MOTOR CO.

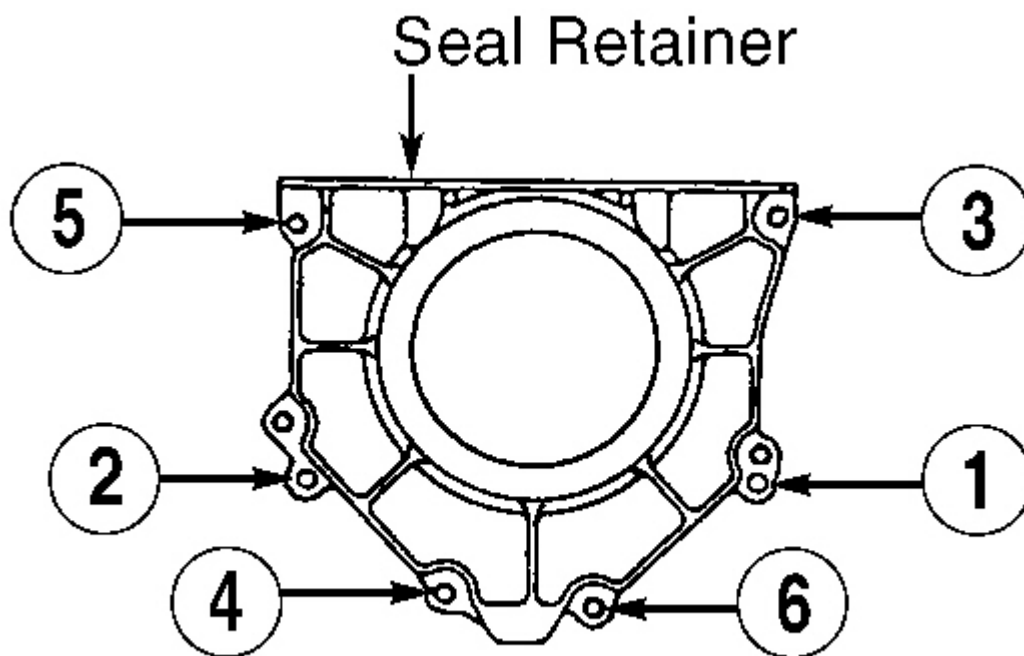
CRANKSHAFT REAR OIL SEAL

Removal

1. Remove transmission. See **TRANSMISSION REMOVAL & INSTALLATION - TRUCKS** article in TRANSMISSION SERVICING. Remove oil pan. See **OIL PAN**. Remove flywheel. Remove rear oil seal retainer.
2. Using Rear Crankshaft Slinger Remover (T95P-6701-AH) and Slide Hammer (T50T-100-A), remove oil slinger. Using Rear Crankshaft Seal Remover (T95P-6701-EH), remove oil seal.

Installation

Clean and inspect all mating surface. Install rear seal retainer. See **Fig. 19**. Using Rear Crankshaft Seal Replacer (T95P-6701-BH) and Rear Crankshaft Seal Adapter (T95P-6701-DH), install rear seal. With rear crankshaft adapter still installed, use Rear Crankshaft Slinger Replacer (T95P-6701-CH) and seal replacer to install seal slinger. To complete installation, reverse removal procedure. Tighten bolts to specifications. See **TORQUE SPECIFICATIONS**.



G91A07214

Fig. 19: Seal Retainer Bolt Tightening Sequence

Courtesy of FORD MOTOR CO.

WATER PUMP

Removal & Installation

1. Drain cooling system. Remove cooling fan and shroud. Release belt tensioner, and remove accessory drive belt. Remove water pump pulley. Remove retaining bolts, water pump and "O" ring.
2. To install, reverse removal procedure. Lubricate "O" ring with coolant before installing. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**. Fill cooling system.

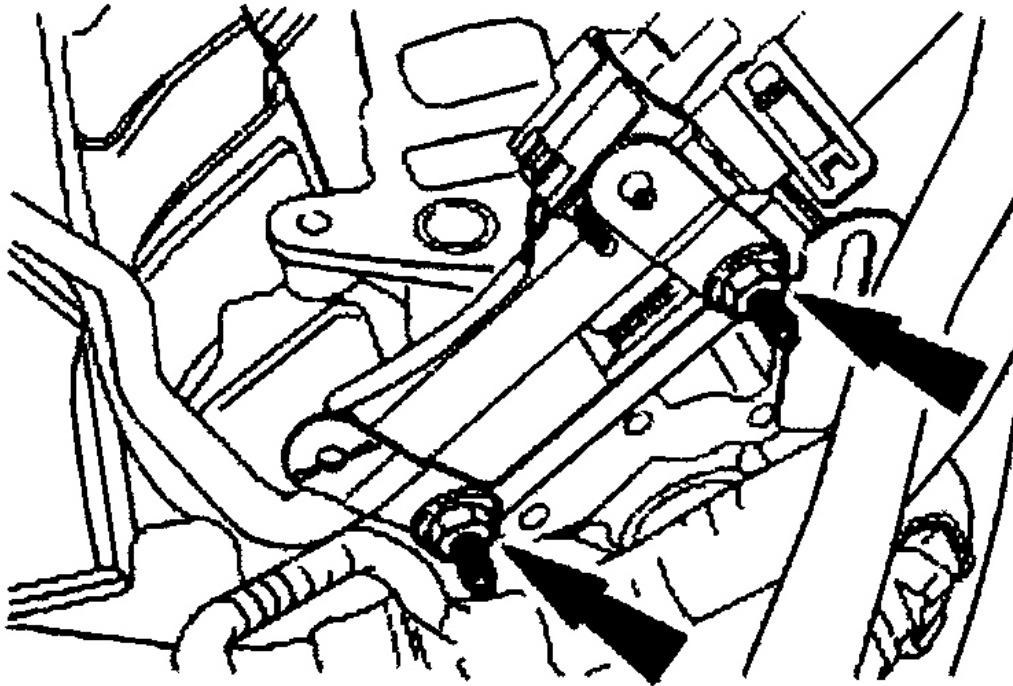
OIL PAN

WARNING: Ensure air suspension system is shut off prior to hoisting, jacking or towing an air suspension vehicle. Air suspension switch is located behind right kick panel. Failure to do so can result in inflation or deflation of air springs, which may cause vehicle to shift during servicing.

Removal (E150)

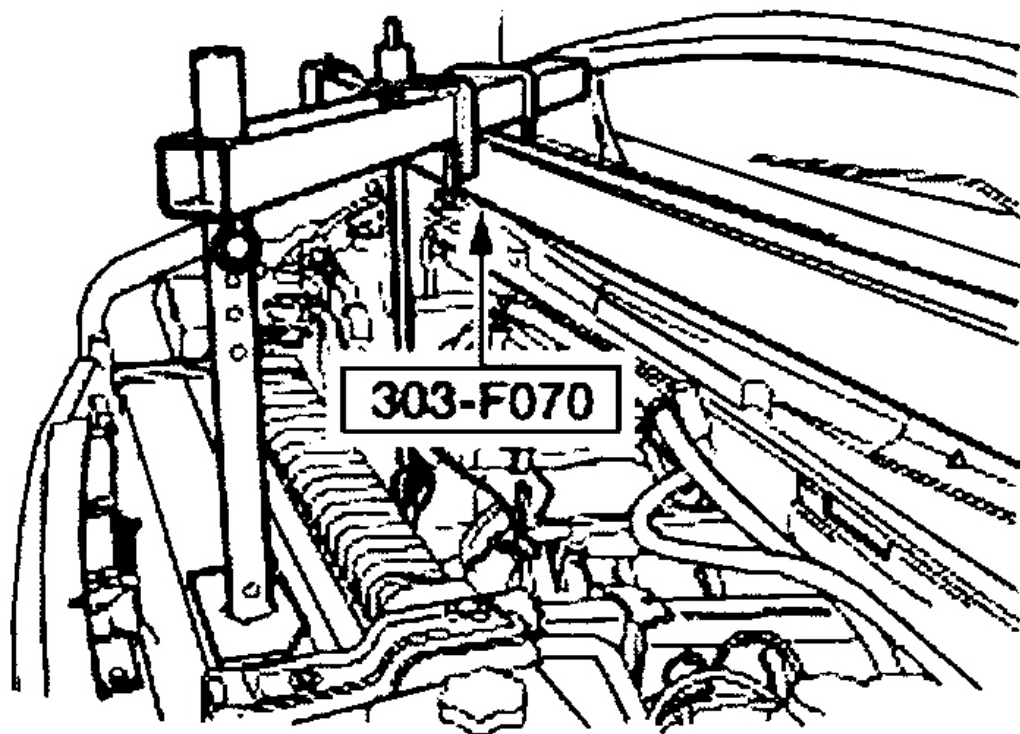
1. Remove the intake manifold. See **INTAKE MANIFOLD**. Remove the plastic rivet retainers and the air deflector. Disconnect the upper radiator hose from the radiator. Disconnect the overflow hose from the radiator. The large clutch assembly nut has a right-hand thread and must be rotated counterclockwise to remove it. Remove the fan and fan clutch from the water pump pulley. Remove the bolts and lift the fan shroud, fan and fan clutch from the vehicle.

2. Remove the retainers and the shield between radiator and radiator support. Remove the nut retaining the transmission filler tube at the rear of the right cylinder head and position the tube aside. Detach the wiring harness retainer. Remove the stud bolts. See **Fig. 20** . Remove the upper 2 transmission-to-engine bolts.
3. Assemble 3-Bar Engine Support, Modular Lifting Bar (303-F047) and Lift Bar Adapter (303-F694). Install the special tools on engine and support the engine. See **Fig. 21** . Raise and support the vehicle. Drain the engine oil, and remove the oil filter. Remove the nuts retaining the front engine support insulator to the front engine support bracket.
4. Remove the flywheel inspection plate. Lower the vehicle. Using the 3-Bar Engine Support, raise the engine 10-1/4 inches from the crankshaft pulley to the lower edge of the No. 1 crossmember. Raise the vehicle. Remove the bolts and partially lower the oil pan.
5. Remove the bolts retaining the oil pump screen cover and tube and let the bolts drop into the oil pan. Remove the oil pan at the rear of the engine. Clean the mating surfaces and clean the oil pan thoroughly. Inspect the oil pan gasket.



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Fig. 20: Locating 2 Stud Bolts
Courtesy of FORD MOTOR CO.



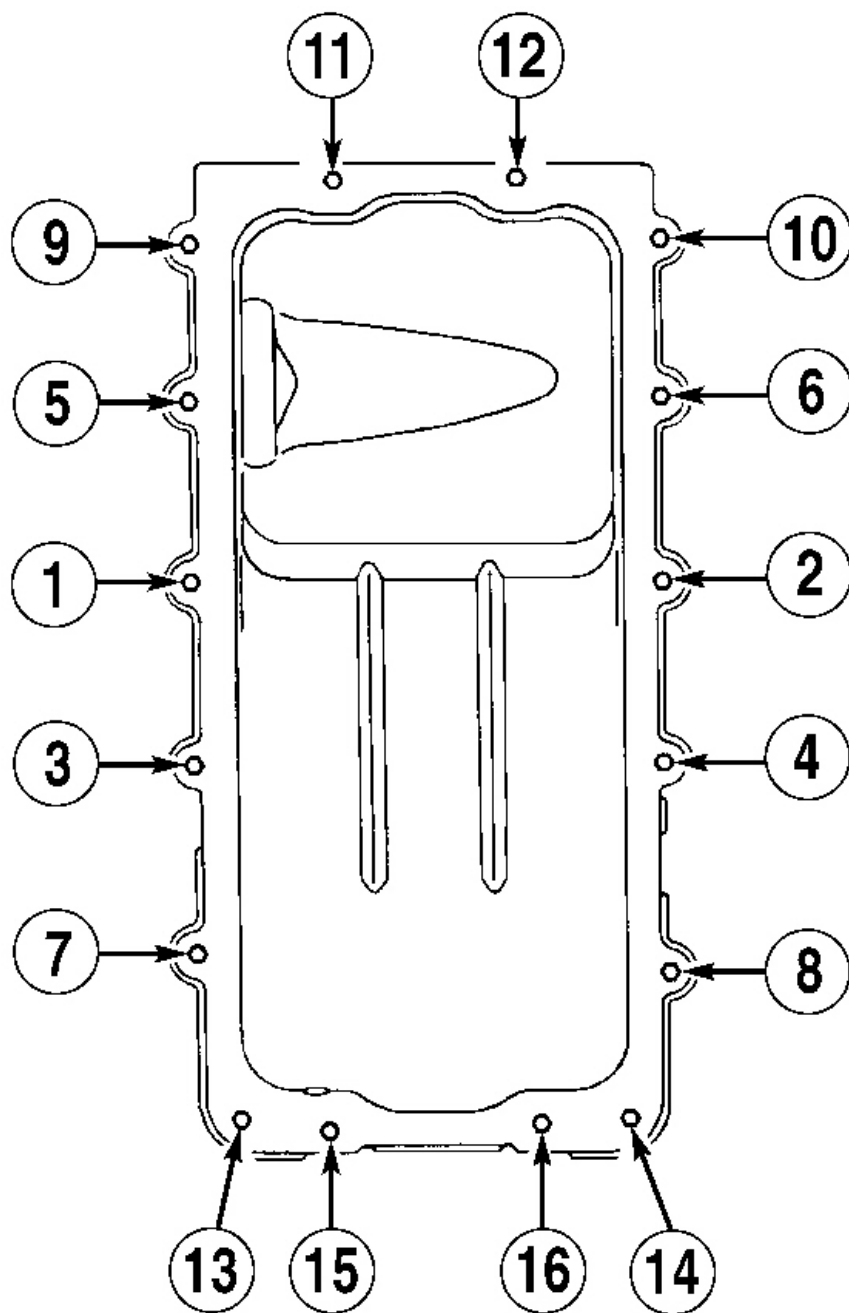
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Fig. 21: Setting Up 3-Bar Engine Support
Courtesy of FORD MOTOR CO.

Installation

CAUTION: Make sure the oil pump screen cover and tube "O" ring seal is in place and not damaged. A missing or damaged "O" ring seal can cause foam in the lubrication system, low oil pressure and severe engine damage.

1. Clean and inspect the mating surfaces and install a new "O" ring seal. Lubricate with Motor Oil. To install, reverse the removal procedure. Tighten the oil pan bolts in three stages, in the sequence shown. See **Fig. 22** . See **TORQUE SPECIFICATIONS** .
2. Lower the vehicle. Remove the special tools. Raise the vehicle. Install the nuts retaining the front engine support insulators to the front engine support brackets. Install the flywheel inspection plate. Install the top 2 transmission-to-engine bolts. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .



↓ FRONT OF
ENGINE

G99D03849

Fig. 22: Oil Pan Bolt Tightening Sequence (All Models)
Courtesy of FORD MOTOR CO.

Removal (4x2)

1. Disconnect the battery ground cable. Drain the cooling system. Remove radiator air deflector screws and remove the radiator air deflector.
2. Remove the accelerator control splash shield. Disconnect the intake air temperature sensor electrical connector. Disconnect the PCV hose and the idle air control valve inlet tube. Loosen the clamps and remove the air cleaner outlet tube and resonator.
3. Remove the throttle return spring. To disconnect the accelerator cable from the throttle body cam, roll the throttle body cam forward and slide the accelerator cable from the throttle body cam. If equipped, to disconnect the speed control actuator cable from the throttle body, remove the cable bracket bolt and disconnect the speed control actuator cable from the throttle body cam and position aside.
4. Disconnect PCV hose to throttle body adapter. Disconnect PCV intake manifold. Disconnect PCV hose to valve cover.
5. Disconnect the following vacuum connections:
 - EGR Vacuum Connector
 - Engine Vacuum Supply Port
 - EVR Vacuum Connector
 - Fuel Pressure Regulator
6. Remove the nut on EGR valve mounting bolt. Disconnect the EGR valve to exhaust manifold tube upper fitting. Disconnect the idle air control electrical connector. Disconnect the brake booster vacuum hose. Remove the throttle body adapter bolts and the throttle body adapter assembly.
7. Remove the fan shroud bolts. Position the fan shroud aside. Remove the drive belt. Remove the generator bracket bolts. Disconnect the ignition wire from the generator bracket. Remove the generator mounting bolts. Disconnect the generator electrical connections. Remove the generator.
8. Install the 3-Bar Modular Engine Support Bracket (303-F070) on the engine using the generator mounting bolts. Raise and support the vehicle. Remove the drain plug and drain the engine oil. Remove the motor mount thru-bolts.
9. Lower the vehicle. Raise the engine using the three bar engine support. Raise the vehicle on the hoist. Be careful when removing the oil pan gasket. The oil pan gasket is reusable if it is not damaged. Remove the oil pan bolts. Position the oil pan aside to gain access to the oil pump screen cover and tube.
10. Remove the bolt securing the rear of the oil pump screen cover and tube. Remove the bolts securing the front of the oil pump screen cover and tube. Remove the oil pan and the oil pump screen cover and tube together.

Installation

CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

1.

CAUTION: Make sure the oil pump screen cover and tube "O" ring seal is in place and not damaged. A missing or damaged "O" ring seal can

cause foam in the lubrication system, low oil pressure and severe engine damage.

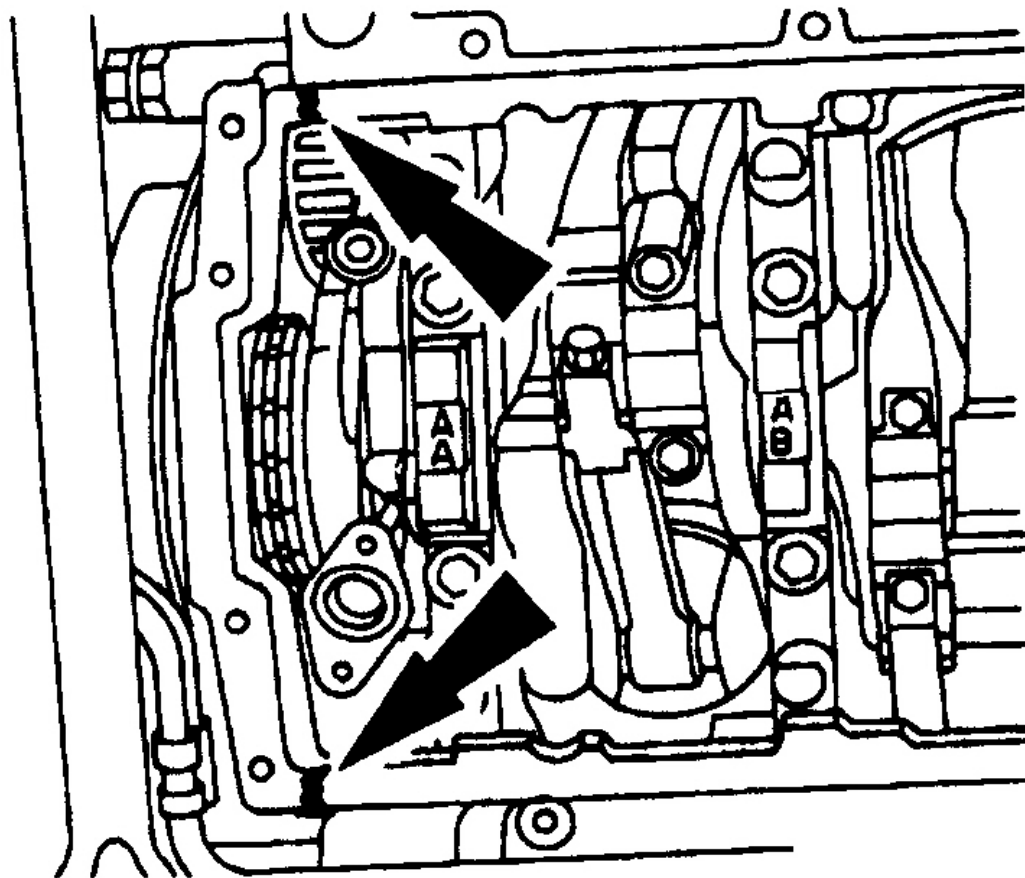
Clean and inspect the mating surfaces. Clean and inspect the mating surfaces and install a new "O" ring seal. Lubricate with motor oil. Position the oil pan gasket, the oil pan and the oil pump screen cover and tube together to the cylinder block. Install the oil pump screen cover and tube bolts.

2.

NOTE: If the oil pan is not secured within four minutes, the sealant must be removed and the sealing area cleaned with Metal Surface Cleaner (F4AZ-19A536-RA). Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure may result in future oil leakage.

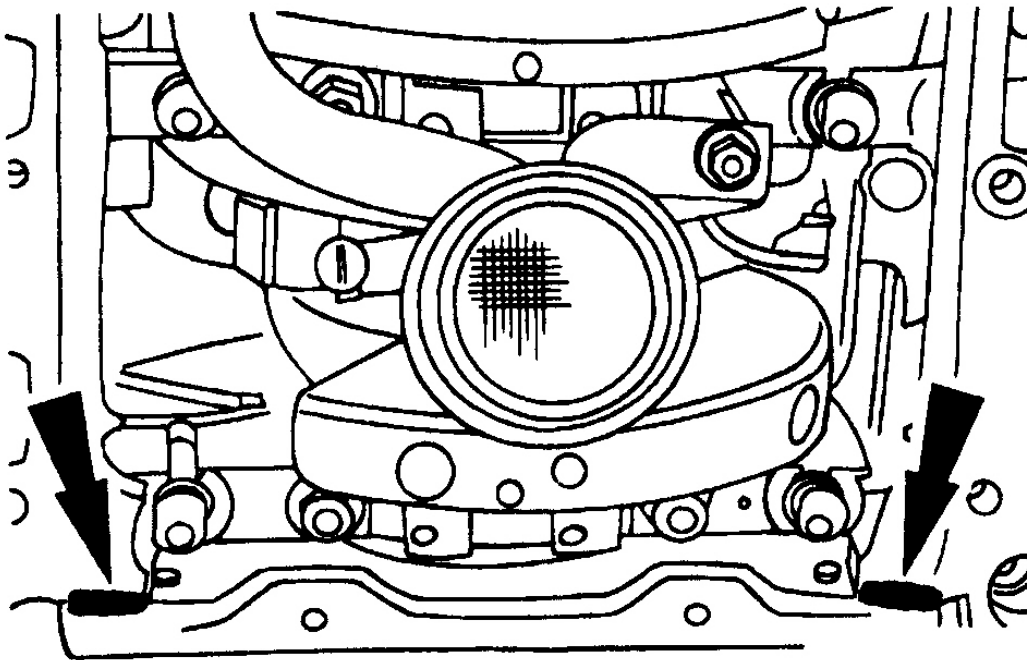
Apply the silicone at the engine front cover to cylinder block mating surface. See **Fig. 23** . Apply the silicone at the rear oil seal retainer to cylinder block sealing surface. See **Fig. 24** .

3. Position the oil pan gasket. Install the bolts and torque in the three stages, in the sequence shown. See **Fig. 22** . See **TORQUE SPECIFICATIONS** . Lower the vehicle. Lower the engine and remove the 3-bar engine support.
4. Raise the vehicle on the hoist. Install the motor mount bolts. Install the drain plug. Lower the vehicle. Remove the 3-bar engine support bracket. Connect the generator electrical connections. Position the generator and install the bolts. Install the bracket bolts finger tight, then tighten to specification. See **TORQUE SPECIFICATIONS** . Attach the ignition wire to the generator bracket. Install the drive belt.
5. Position the fan shroud and install the bolts. Install a new gasket and the throttle body adapter assembly and tighten in two stages. See **TORQUE SPECIFICATIONS** . Connect the brake booster vacuum supply. Connect the IAC electrical connector. Connect the upper EGR valve to exhaust manifold tube nut. Tighten the fitting in two stages. See **TORQUE SPECIFICATIONS** .
6. Install the EGR backpressure transducer nut. Connect crankcase ventilation hose to throttle body adapter. Connect PCV intake manifold. Connect crankcase ventilation hose to valve cover.
7. Connect the following vacuum connections:
 - EGR Vacuum Connector.
 - Engine Vacuum Supply Port.
 - EVR Vacuum Connector.
 - Fuel Pressure Regulator.
8. Connect the TPS electrical connector. If equipped, install the speed control actuator cable on the throttle body. To connect the accelerator cable to the throttle body cam, roll the throttle body cam forward and slide the accelerator cable into the throttle body cam. Install the throttle return spring.
9. Install the air cleaner outlet tube and resonator and tighten the clamps. Connect the PCV hose and the idle air control valve inlet tube. Connect the intake air temperature sensor electrical connector. Install the accelerator control splash shield. Install the radiator air deflector. Connect the battery ground cable. Fill the engine with Premium 5W-30 motor oil. Fill and bleed the cooling system.



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Fig. 23: Locating Silicon Application (Front)
Courtesy of FORD MOTOR CO.



G00368998

Fig. 24: Locating Silicon Application (Rear)
 Courtesy of FORD MOTOR CO.

Removal (4x4)

CAUTION: The air suspension switch must be turned off prior to raising the vehicle. Failure to do so can result in unexpected inflation or deflation of the air springs, which could result in shifting of the vehicle during the repair operation.

1. Turn the air suspension switch off. Raise the vehicle on the hoist. Drain the engine oil.
2. Support the front axle housing with a jack stand. To remove front axle housing support, remove the front axle mount bolt, remove the axle support bolts and remove the axle support. See **Fig. 25**.
- 3.

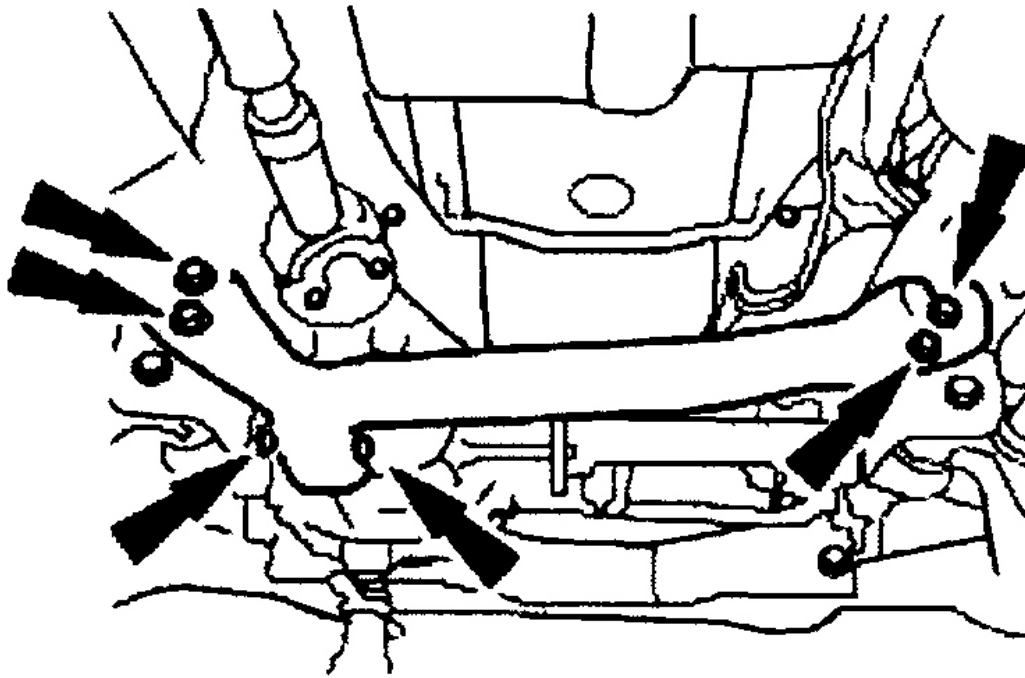
CAUTION: Use care when lowering the front axle housing, or the vacuum lines to the axle solenoid may become disconnected or damaged.

Remove the right and front axle housing mount bolts and lower the axle to allow clearance for the oil pan to be removed. See **Fig. 26**. Remove the oil pan.

- 4.

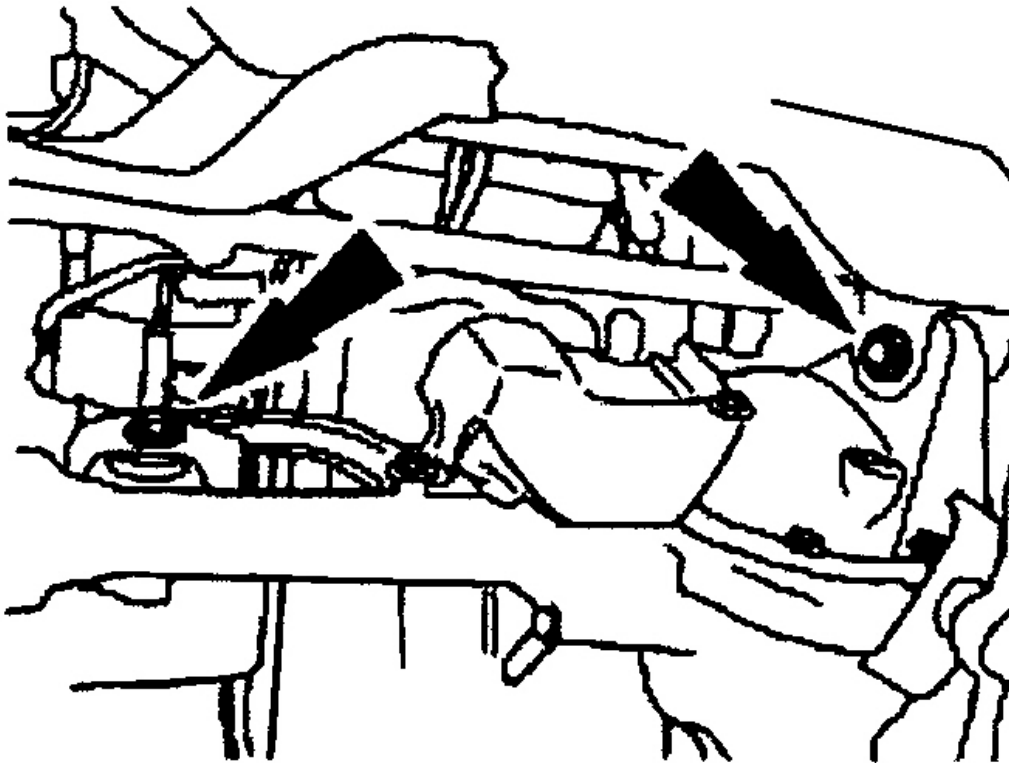
CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs, or other abrasive means to clean the sealing surfaces. These may cause scratches and gouges resulting in leak paths. Use a plastic scraper to clean the sealing surfaces.

Remove and discard the oil pan gasket. Clean the sealing surfaces. Use Metal Surface Cleaner (F4AZ-19A536-RA). Allow the surfaces to dry for four minutes or until there is no sign of wetness, whichever is longest. Failure to do so can cause future oil leaks.



G00368999

Fig. 25: Locating Front Axle Housing Support Bolts
Courtesy of FORD MOTOR CO.



G00369000

Fig. 26: Locating Front Axle Housing Mount Bolts
 Courtesy of FORD MOTOR CO.

Installation

NOTE: If the oil pan and gasket are not secured within four minutes of sealer application, the sealant must be removed and the sealing surfaces cleaned with Metal Surface Cleaner (F4AZ-19A536-RA).

1. Apply silicone gasket and sealant in 4 places. See **Fig. 23** and **Fig. 24** . Position the new oil pan gasket and the oil pan and loosely install the bolts. Tighten the bolts in three stages in the sequence shown. See **Fig. 22** . See **TORQUE SPECIFICATIONS** .
2. Position the front axle housing and loosely install the bolts. See **Fig. 25** . Position the axle support and install the bolts. See **Fig. 26** . Tighten the bolts. See **TORQUE SPECIFICATIONS** .
3. Remove the jack stand. Lower the vehicle. Fill the engine with SAE 5W-30 motor oil. Start the engine and inspect for leaks. Turn on the air suspension switch.

OVERHAUL

NOTE: There are 2 different manufacturers of the 4.6L SOHC engine (Romeo and Windsor). There are several differences. See INTERNAL DIFFERENCES . See ENGINE IDENTIFICATION .

INTERNAL DIFFERENCES

Camshaft Sprockets

Windsor engine uses an interference fit to secure sprocket to camshaft. Romeo engine use a bolt and spacer to secure sprocket to camshaft.

Connecting rods

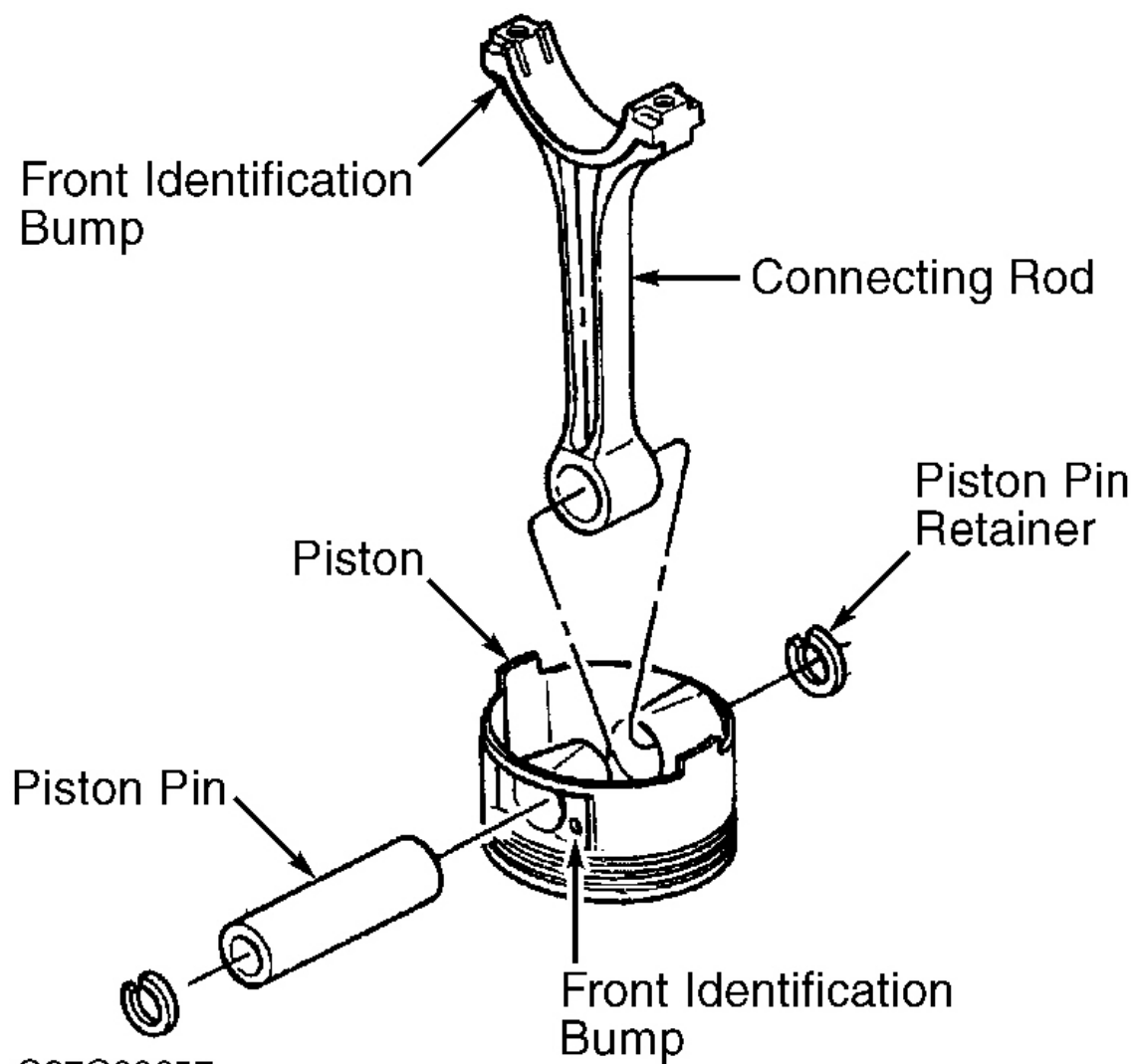
Windsor engine uses a larger connecting rod has a full floating piston pin with 2 retainers. See **Fig. 27** . Romeo engine uses a press fit piston pin without retainers. See **Fig. 28** .

Cylinder Head

Windsor engine has no oil feed reservoir in cylinder head and uses single cam caps. Romeo engine has oil feed reservoir and uses a ladder style cam cap.

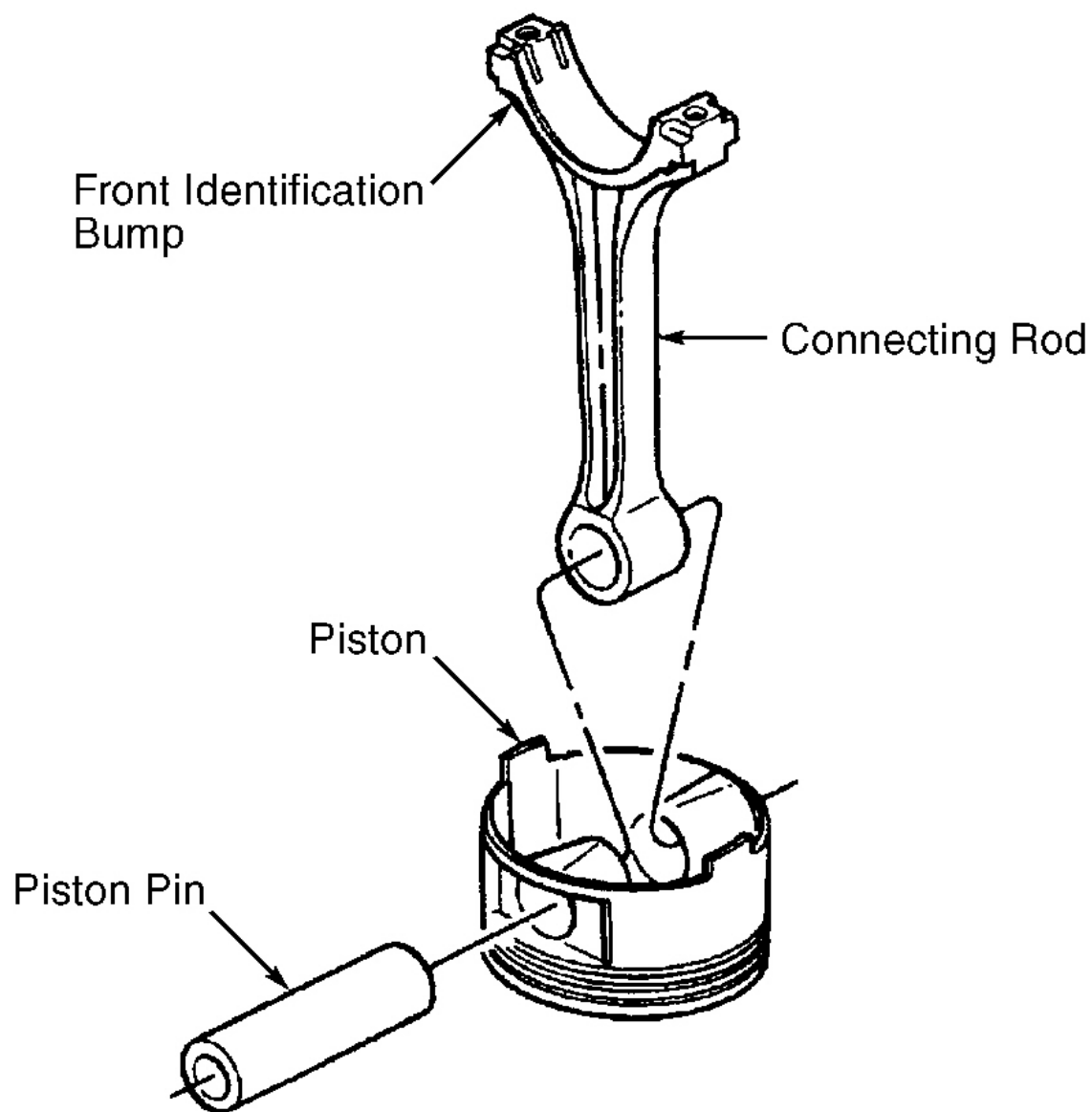
Main Bearings

Windsor engine has larger main bearing caps and uses dowels between main bearing caps and block. See **Fig. 29** . Romeo engine has smaller main bearing caps and uses jack screws between main bearing caps and block. See **Fig. 30** .



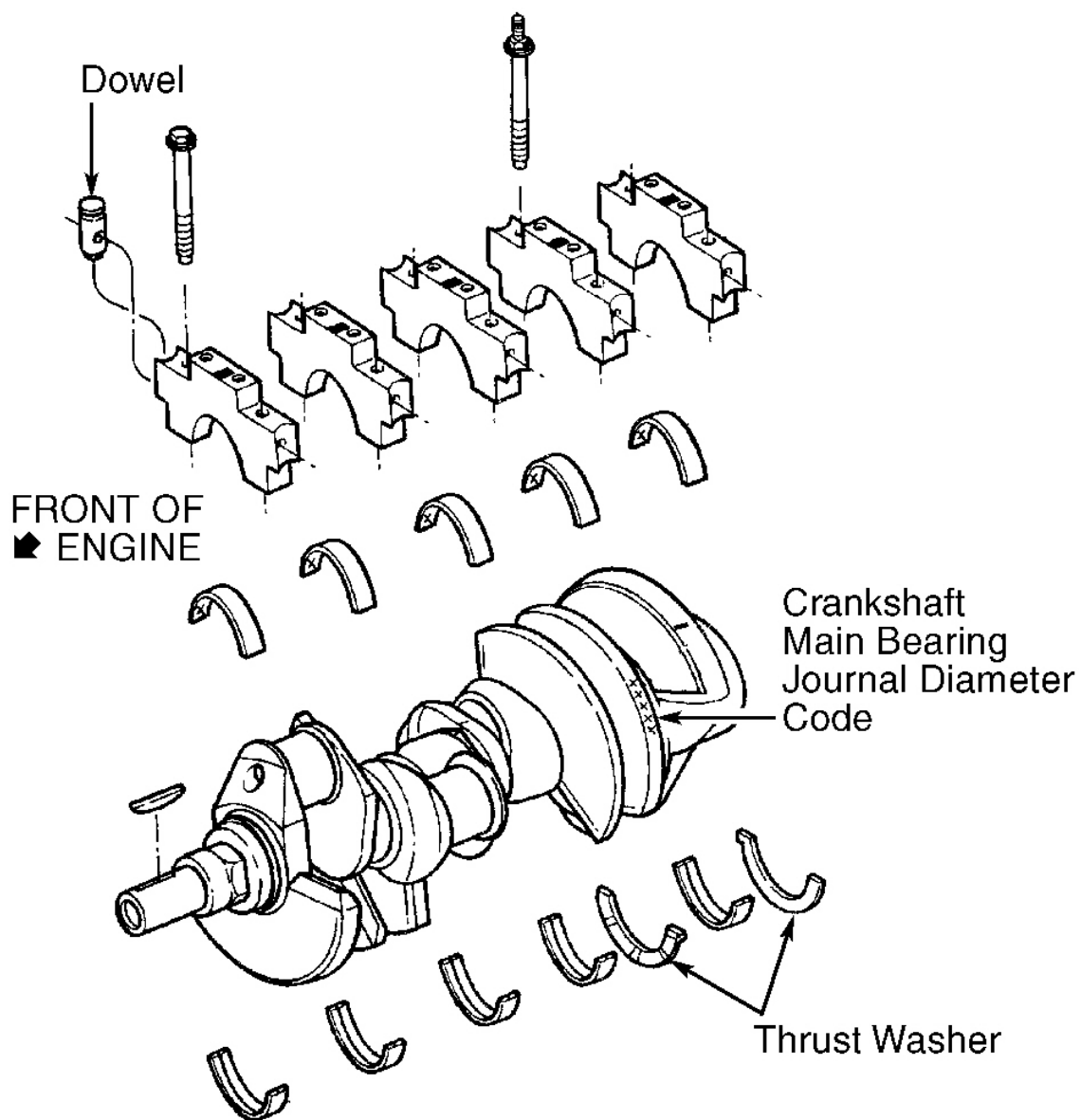
G97G03657

Fig. 27: Identifying Windsor Piston & Rod Assembly
Courtesy of FORD MOTOR CO.



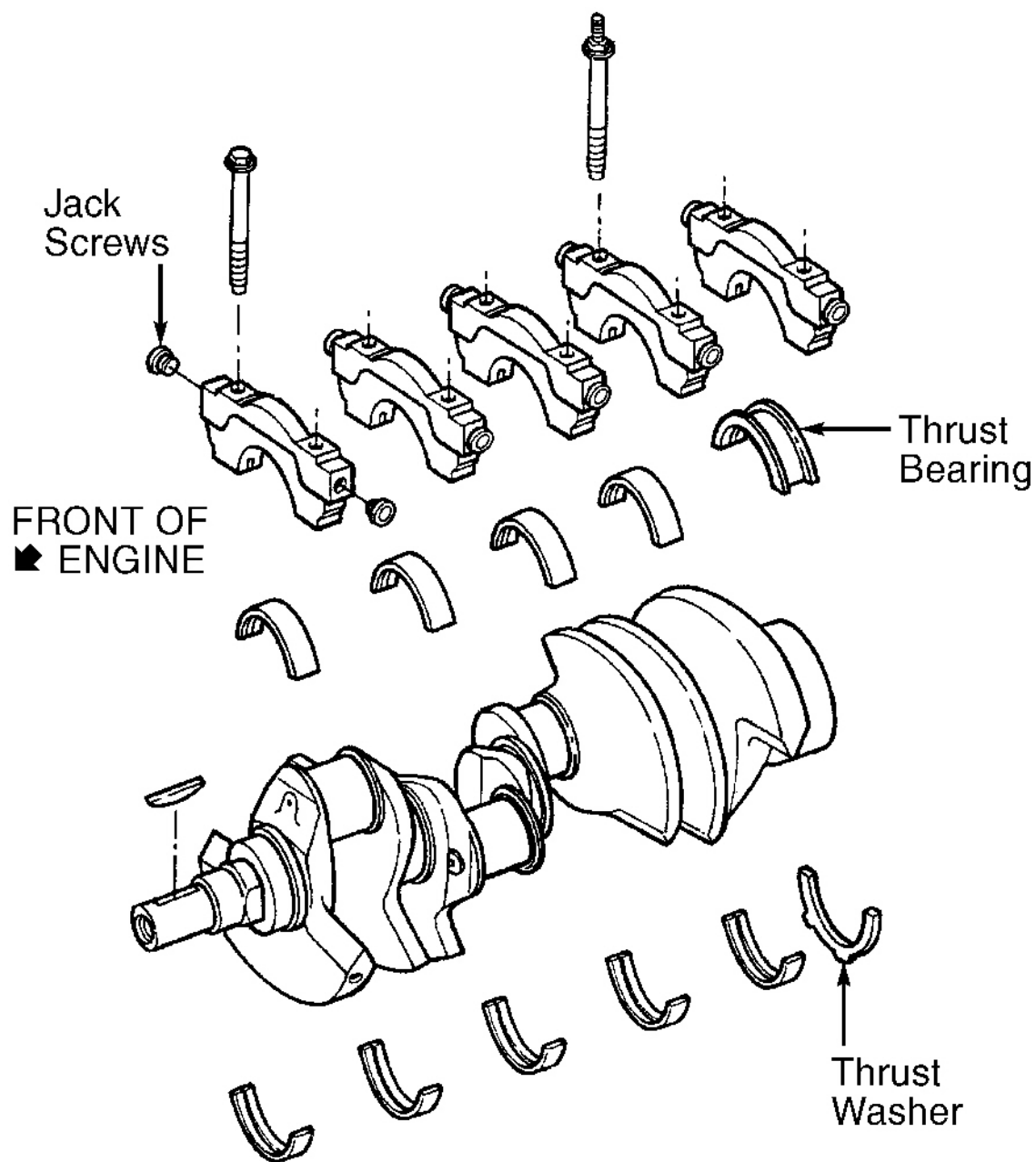
G97A03659

Fig. 28: Identifying Romeo Piston & Rod Assembly
Courtesy of FORD MOTOR CO.



G97C03622

Fig. 29: Exploded View of Windsor Crankshaft & Components
Courtesy of FORD MOTOR CO.



G97G03624

Fig. 30: Exploded View of Romeo Crankshaft & Components
 Courtesy of FORD MOTOR CO.

CYLINDER HEAD

Cylinder Head

CAUTION: If cylinder head-to-block surface refinishing is necessary, replace head.

Check cylinder head for cracks or damage. If maximum warpage exceeds .004" (.10 mm), replace cylinder head.

Valve Springs

Inspect valve spring free length, out-of-square and pressure. Replace valve spring if not as specified. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.

Valve Stem Oil Seals

Use Seal Installer (T91T-6571-A) to install oil seals.

Valve Guides

NOTE: **DO NOT ream valve guides from standard to maximum oversize in one step. Ream guides in gradual steps, so guides are reamed in true relation to valve seat. Valve seats must be ground when valve guide is reamed or replaced.**

1. Valve guides may be reamed for oversize valves if stem-to-guide oil clearance exceeds specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. Valves are available in .015" (.38 mm) and .030" (.76 mm) oversize.
2. Valve guides may also be bored out and replaced with a service guide if oversize valves are not available or guide is damaged. Ream valve guides until proper stem-to-guide clearance exists.

Valve Seat

Ensure valve seat angle, seat width and seat runout are within specification. See **CYLINDER HEAD** table under ENGINE SPECIFICATIONS. Valve seats must be ground when valve guide is reamed or replaced. Replacement information is not available.

Valves

Ensure head diameter, stem diameter, valve face runout and valve margin are within specification. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS.

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

Valve Seat Correction Angles

If seat width is too wide after grinding seat, use a 60-degree stone to remove stock from bottom of valve seat (raise seat) or a 30-degree stone to remove stock from top of seat (lower seat).

CYLINDER BLOCK ASSEMBLY

CAUTION: Connecting rod bearing caps are mechanically fractured during

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**Then Get More
Information.**