

# Chapter Six

## GM Inline Engines

This chapter covers the GM 153 and 181 cid **4-cylinder** engines and the GM 194, 230, **250** and 292 cid 6-cylinder **inline** engines used on **MerCruiser** 110 through 200 models. Although differing in displacement, these engines are essentially the same design with many interchangeable parts.

These engines are used with the following MerCruiser models:

- a. Model 110, 120, 120R and **120MR—153** cid.
- b. Model 140-181 and 194 cid.
- c. Model 140R and **140MR—** 181 cid.
- d. Model 150-230 cid.
- e. Model 160 and 165-250 cid.
- f. Model 200-292 cid.

The cylinders are numbered from front to rear: 1-2-3-4 (**4-cylinder**) and 1-2-3-4-5-6 (6-cylinder). Engine firing order is also standard: 1-3-4-2 (**4-cylinder**) and 1-5-3-6-2-4 (**6-cylinder**).

Rocker arms are retained on individual threaded studs. A ball pivot valve train is used, with camshaft motion transferred through the hydraulic lifters to the rocker arms by pushrods.

The **4-cylinder** crankshaft may be supported by 4 or 5 main bearings; the **6-cylinder** crankshaft has 7 main bearings. The rear bearing on each takes the end thrust. Crankshaft rotation is counterclockwise when seen from the drive unit end of the engine.

The gear-driven camshaft is supported by 4 bearings and is located above the crankshaft in the engine block.

The oil pump is located on the bottom front of the block on the starboard side and is driven by the distributor shaft. The distributor is driven by a gear on the camshaft.

Specifications (**Table 1** and **Table 2**) and tightening torques (**Table 3**) are at the end of the chapter.

### ENGINE SERIAL NUMBER

The engine serial number is stamped on a plate mounted on the right rear side of the engine block above the starter motor (**Figure 1**).

This information identifies the engine and indicates if there are unique parts or if internal changes have been made during the model run. It is important when ordering replacement parts for the engine.

### SPECIAL TOOLS

Where special tools are required or recommended for GM engine overhaul, the tool numbers are provided. Mercury Marine tool part numbers have a “C” prefix. GM tool part numbers have a “J” prefix. While GM tools can sometimes be rented from rental dealers, they can be purchased from Kent-Moore, Inc., 28635 Mound Road, Warren, MI 48089.

### REPLACEMENT PARTS

Various changes are made to automotive engine blocks used for marine applications. Numerous part changes are required due to operation in fresh and salt water. For example, the cylinder head gasket must be corrosion-resistant. Marine engines use head gaskets of copper or stainless steel instead of the standard steel used in automotive applications. Brass expansion or core plugs must be used instead of the steel plugs found in automotive blocks.

Since marine engines are run at or near maximum rpm most of the time, the use of special valve lifters, springs, pistons, bearings, camshafts and other heavy-duty moving components is necessary for maximum life and performance.

For these reasons, automotive-type parts should not be substituted for marine components. In addition, Mercury recommends that only Quicksilver parts be used. Parts offered by other manufacturers may look alike, but may not be

manufactured to Mercury's specifications. Any damage resulting from the use of other than Quicksilver parts is not covered by the Mercury Marine warranty.

### ENGINE REMOVAL

Some service procedures can be performed with the engine in the boat; others require removal. The boat design and service procedure to be performed will determine whether the engine must be removed. In some installations, it may be necessary to remove the stern drive unit first. See Chapter Fourteen.

#### WARNING

*The engine is heavy, awkward to handle and has sharp edges. It may shift or drop suddenly during removal. To prevent serious injury, always observe the following precautions.*

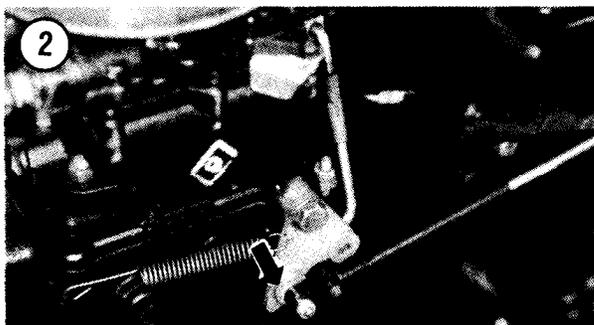
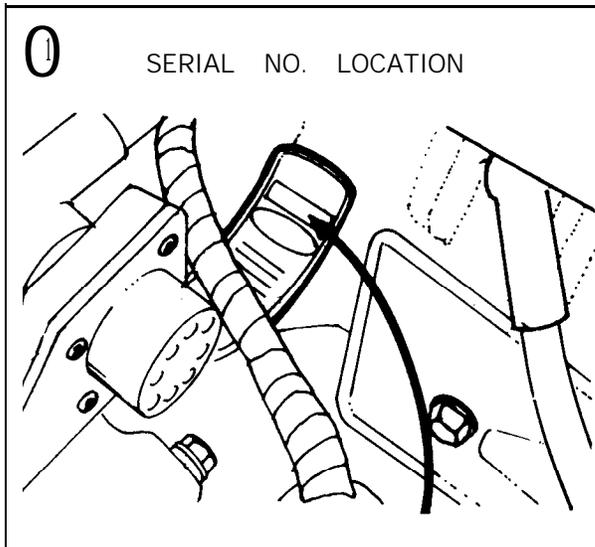
**1. Never place any part of your body where a moving or falling engine may trap, cut or crush you.**

**2. If you must push the engine during removal, use a board or similar tool to keep your hands out of danger.**

**3. Be sure the hoist is designed to lift engines and has enough load capacity for your engine.**

**4. Be sure the hoist is securely attached to safe lifting points on the engine.**

**5. The engine should not be difficult to lift with a proper hoist. If it is, stop lifting, lower the engine back onto its mounts and make sure the engine has been completely separated from the boat.**



1. Remove the engine hood cover and all panels that interfere with engine removal. Place to one side out of the way.
2. Disconnect the negative battery cable, then the positive battery cable. As a precaution, remove the battery from the boat.
3. Disconnect the throttle cable at the carburetor (Figure 2). If necessary, remove cable from anchor plate.
4. Disconnect the engine-to-instrument panel wiring harness.
5. Disconnect the fuel lines at the fuel pump (Figure 3). Plug the fuel lines to prevent leakage.
6. Disconnect the brown and black (shift interlock) wires from the shift plate terminal block.
7. Disconnect the red and black power trim pump motor wires at the engine.
8. Disconnect the trim indicator sender wires (if so equipped).

9. Disconnect the water inlet hose. Open the engine drain valve(s) and drain all water from the block.
10. Disconnect the exhaust elbow bellows.
11. Disconnect the drive unit shift cable from the J-clamp on the flywheel housing.
12. Disconnect the intake manifold vacuum hose, if so equipped.
13. Disconnect any accessories connected to the engine that will interfere with removal.
14. Attach a lifting bracket to the engine lifting eyes. Connect the bracket to an engine hoist and elevate it enough to remove all slack.

#### NOTE

*At this point, there should be no hoses, wires or linkage connecting the engine to the boat or stern drive unit. Recheck this to make sure nothing will hamper engine removal.*

15. Remove the front and rear engine mounting bolts.
16. Slide the engine forward sufficiently to disengage it from the drive shaft assembly.
17. Remove the engine from the boat with the hoist.

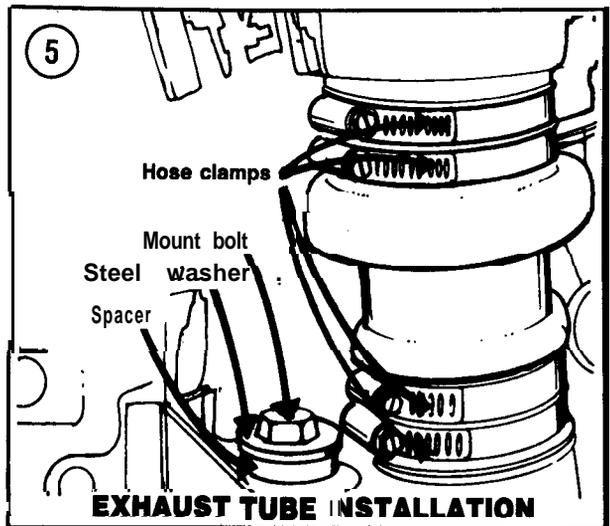
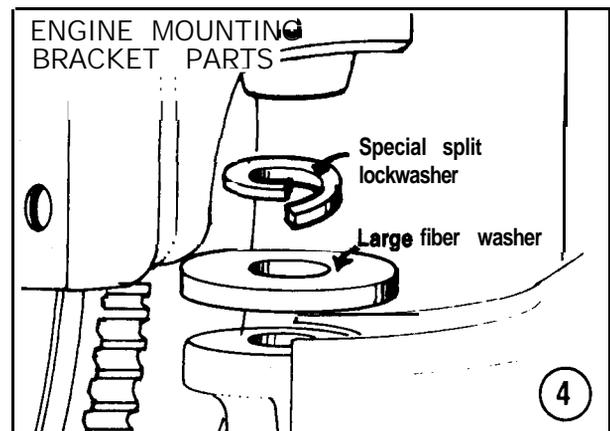
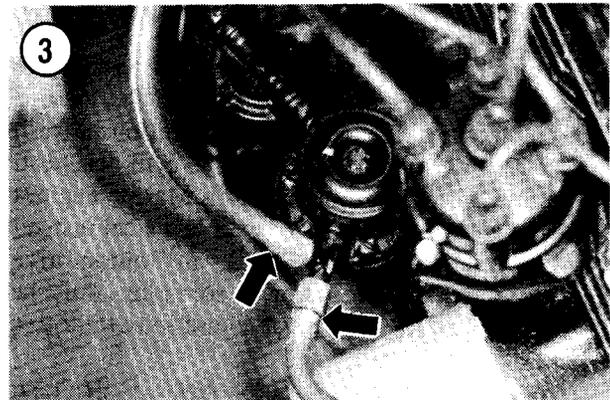
### ENGINE INSTALLATION

Engine installation is the reverse of removal, plus the following.

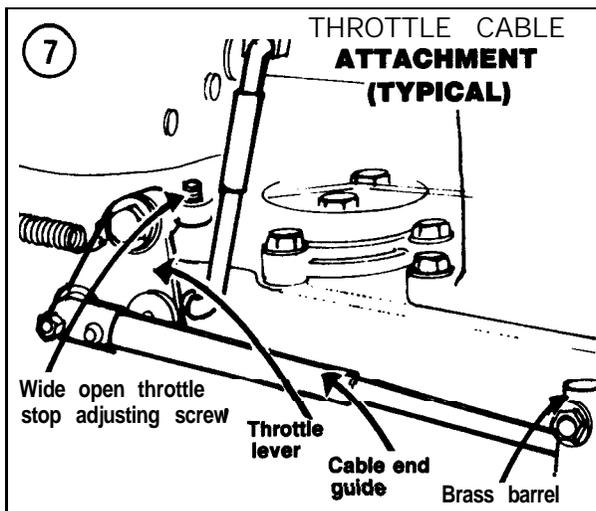
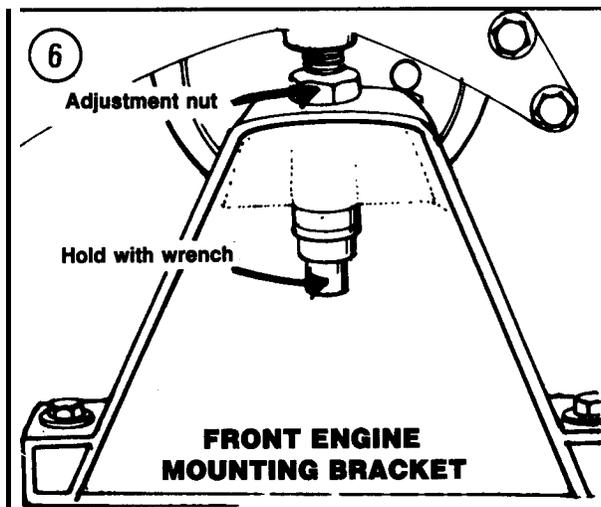
1. Coat the engine coupling splines with Universal Joint Lubricant (part No. C-92-74058).
2. It may be necessary to rotate the crankshaft slightly to align the engine coupling splines with the drive shaft. You may also rotate the drive shaft by placing the **outdrive** in forward gear and rotating the propeller.
3. Install the front engine mount bracket.
4. Position a large fiber washer on top of the inner transom plate mounting brackets. Position the special split lockwasher inside the fiber washer. See Figure 4.
5. Position engine over the transom plate mounting brackets. Install hose clamps over the rubber exhaust elbow bellows, then fit bellows over the exhaust manifold outlet and tighten the clamps securely. See Figure 5.

#### CAUTION

*Elastic stop nuts should never be used more than twice. It is a good idea to replace such nuts with new ones each time they are removed. Never use worn-out stop nuts or non-locking nuts.*



6. Install steel washers and spacers on the mounting bolts, then insert bolts down through the rear engine mounts, washers and mounting brackets. See Figure 5. Install elastic stop nuts on bolts and tighten to specifications (Table 3).



7. Turn adjusting nuts in front mounting bracket until bracket rests solidly on the mount location in the boat. See Figure 6. Install mount to boat.

#### CAUTION

*If the alignment tool specified in Step 8 is not available, take the boat to a MerCruiser dealer for proper alignment. Drive shaft/coupling spline misalignment can cause serious damage.*

8. Coat the solid end of alignment tool part No. C-9 1-48247 with multipurpose lubricant and insert it from outside the boat through the gimbal bearing. Index the bearing and drive shaft with the engine coupling splines. If indexing is difficult, loosen the front mount and raise or lower the

engine with the hoist as required to permit indexing with no resistance.

9. Tighten all fasteners to specifications (Table 3). Remove the alignment tool.

10. Refer to Figure 7 and connect the throttle cable as follows:

- a. Move remote control to neutral gear, idle position.
- b. Connect cable end guide to throttle lever with flat washer and nut.
- c. Holding throttle cable behind the brass barrel, push it toward the throttle lever. Adjust barrel to align with anchor stud, then connect barrel to stud with flat washer and nut.
- d. Make sure throttle valves are wide open when remote control is in full-forward position, then turn wide-open throttle stop adjusting screw clockwise until it just touches the throttle lever.
- e. Tighten set nut securely, return control to neutral gear, idle position and make sure that idle stop screw rests against the stop.

11. Fill the engine with an oil recommended in Chapter Four.

12. Fill the cooling system, if equipped with a closed system. See Chapter Twelve.

13. Adjust the drive belts. See Chapter Thirteen.

#### DISASSEMBLY CHECKLIST

To use the checklists, remove and inspect each part in the order mentioned. To reassemble, go through the checklists backwards, installing the parts in order. Each major part is covered under its own heading in this chapter, unless otherwise noted.

#### Decarbonizing or Valve Service

1. Remove the rocker arm cover.
2. Remove the intake and exhaust manifolds.
3. Remove the rocker arm assembly.
4. Remove the cylinder head.
5. Remove and inspect the valves. Inspect valve guides and seats, repairing or replacing as required.
6. Assemble by reversing Steps 1-5.

#### Valve and Ring Service

1. Perform **Decarbonizing or Valve Service**.
2. Remove the oil pan.
3. Remove the pistons with the connecting rods.

4. Remove the piston rings. It is not necessary to separate the pistons from the connecting rods unless a piston, connecting rod or piston pin needs repair or replacement.
5. Assemble by reversing Steps 1-4.

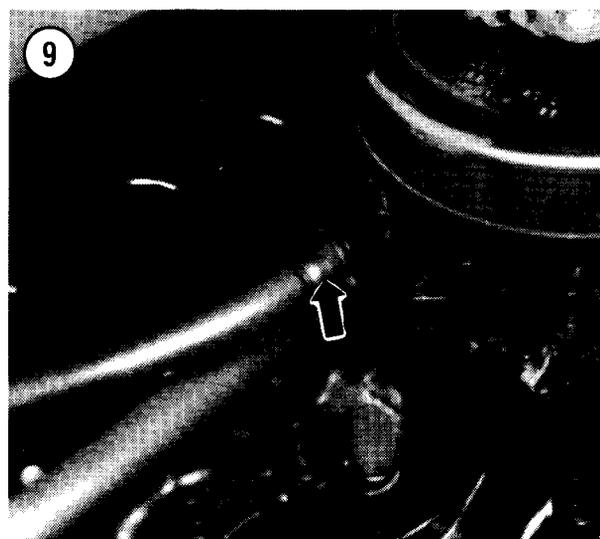
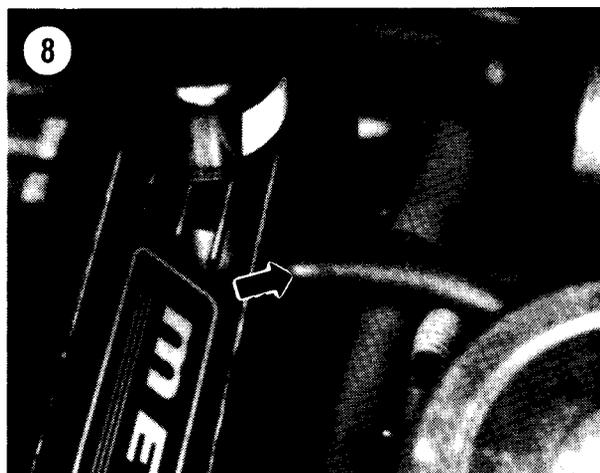
### General Overhaul

1. Remove the engine from the boat.
2. Remove the flywheel.
3. Remove the engine mount brackets and oil pressure sending unit from the engine.
4. If available, mount the engine on an engine stand. These can be rented from equipment rental dealers. The stand is not absolutely necessary, but it will make the job much easier.
5. Check the engine for signs of coolant or oil leaks.
6. Clean the outside of the engine.
7. Remove the distributor. See Chapter Thirteen.
8. Remove all hoses and tubes connected to the engine.
9. Remove the fuel pump. See Chapter Eleven.
10. Remove the intake and exhaust manifolds.
11. Remove the thermostat. See Chapter Twelve.
12. Remove the rocker arm assemblies.
13. Remove the crankshaft pulley/vibration damper and timing case cover. Remove the timing gear and sprockets.
14. Remove the camshaft.
15. Remove the seawater pump, if so equipped. See Chapter Twelve.
16. Remove the cylinder head.
17. Remove the oil pan and oil pump.
18. Remove the pistons and connecting rods.
19. Remove the crankshaft.
20. Inspect the cylinder block.
21. Assemble by reversing Steps 1- 19.

### ROCKER ARM COVER

#### Removal/Installation

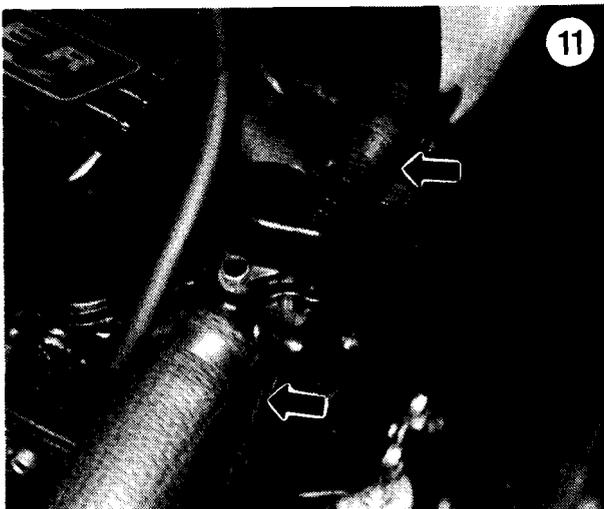
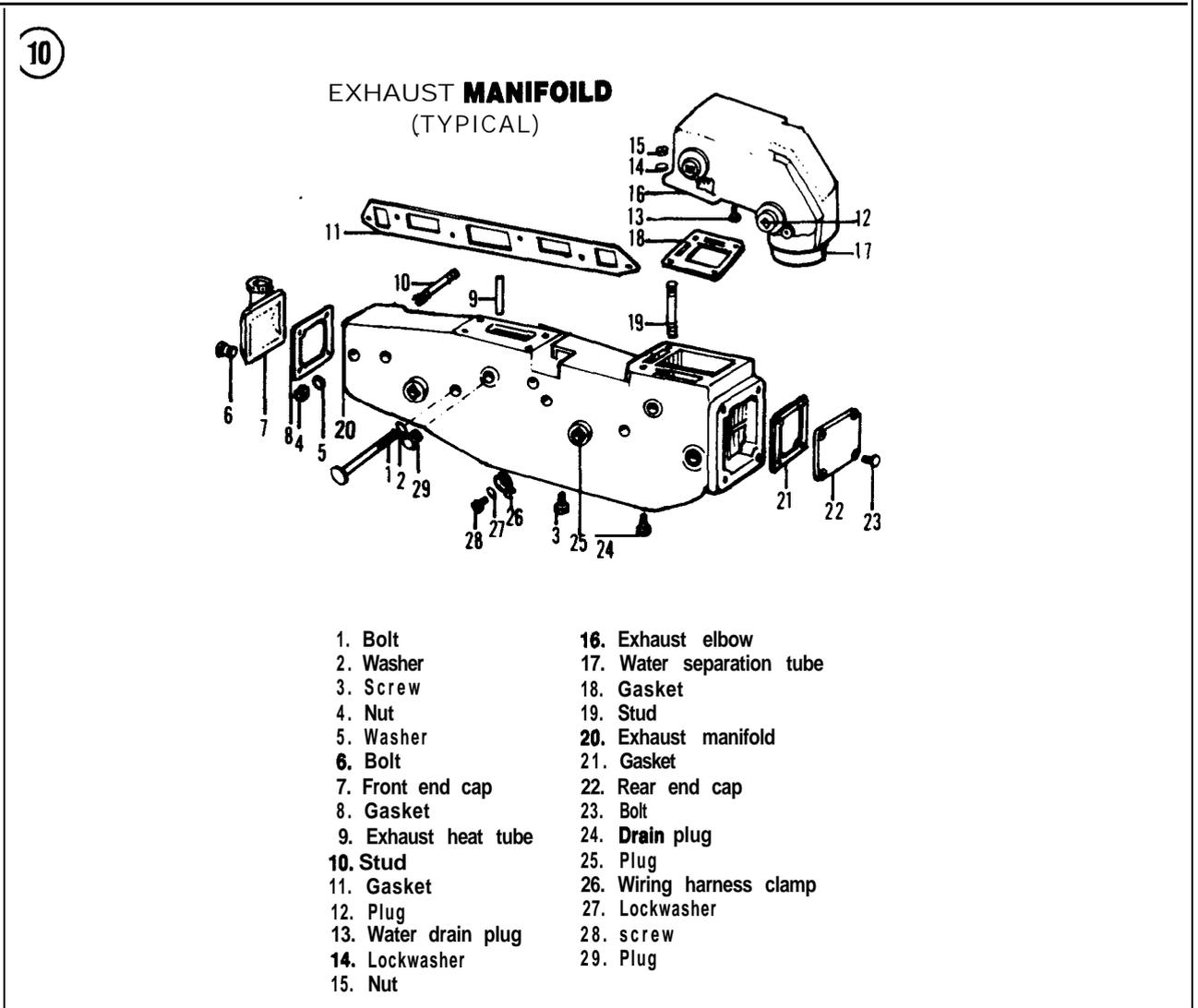
1. Remove the crankcase vent line(s) from the rocker arm cover (**Figure 8**).
2. Unclip or detach any wires or wire looms attached to the rocker arm cover.
3. Disconnect the fuel line at the carburetor (**Figure 9**). Plug the line to prevent leakage.
4. Remove the cover attaching screws. Tap the rocker arm cover with a plastic mallet to break the gasket seal. Remove the rocker arm cover.



5. Clean any gasket residue from the cylinder head and rocker arm cover with degreaser and a putty knife.
6. Coat one side of a new gasket with an oil-resistant sealer and install sealer-side down in the rocker arm cover. Gasket tabs must engage cover notches.
7. Install the cover on the cylinder head.
8. Install the attaching screws and tighten to specifications (**Table 3**).
9. Install the crankcase vent line in the rocker arm cover (**Figure 8**).

### INTAKE/EXHAUST MANIFOLDS

The intake and exhaust manifolds are combined in one unit. **Figure 10** shows a typical exhaust manifold assembly.



### Removal/Installation

1. Disconnect the negative battery cable.
2. Open the cylinder block water drain(s) and allow all water to drain.
3. Disconnect the throttle cable at the carburetor and remove the return spring.
4. Remove the manifold cooling hose(s) at the thermostat housing (Figure 11).
5. Disconnect the exhaust hose. Drain any water remaining in the manifold housing and elbow.
6. Disconnect the fuel line at the carburetor. Plug the line to prevent leakage.
7. Disconnect the crankcase vent line(s) at the rocker arm cover (Figure 8).

8. Remove the wiring harness clamps at the manifold.

9. Unbolt alternator bracket from manifold (Figure 12).

10. Remove manifold assembly fasteners and washers. Remove the manifold assembly with carburetor attached. Discard the manifold gasket.

11. Separate the manifolds, if required.

12. Clean all gasket residue from the cylinder head and manifold mating surfaces with degreaser and a putty knife.

13. Combine manifolds, if separated in Step 11, and install on cylinder head with a new gasket. Tighten fasteners to specifications (Table 3) working from the center to the ends. The remainder of installation is the reverse of removal.

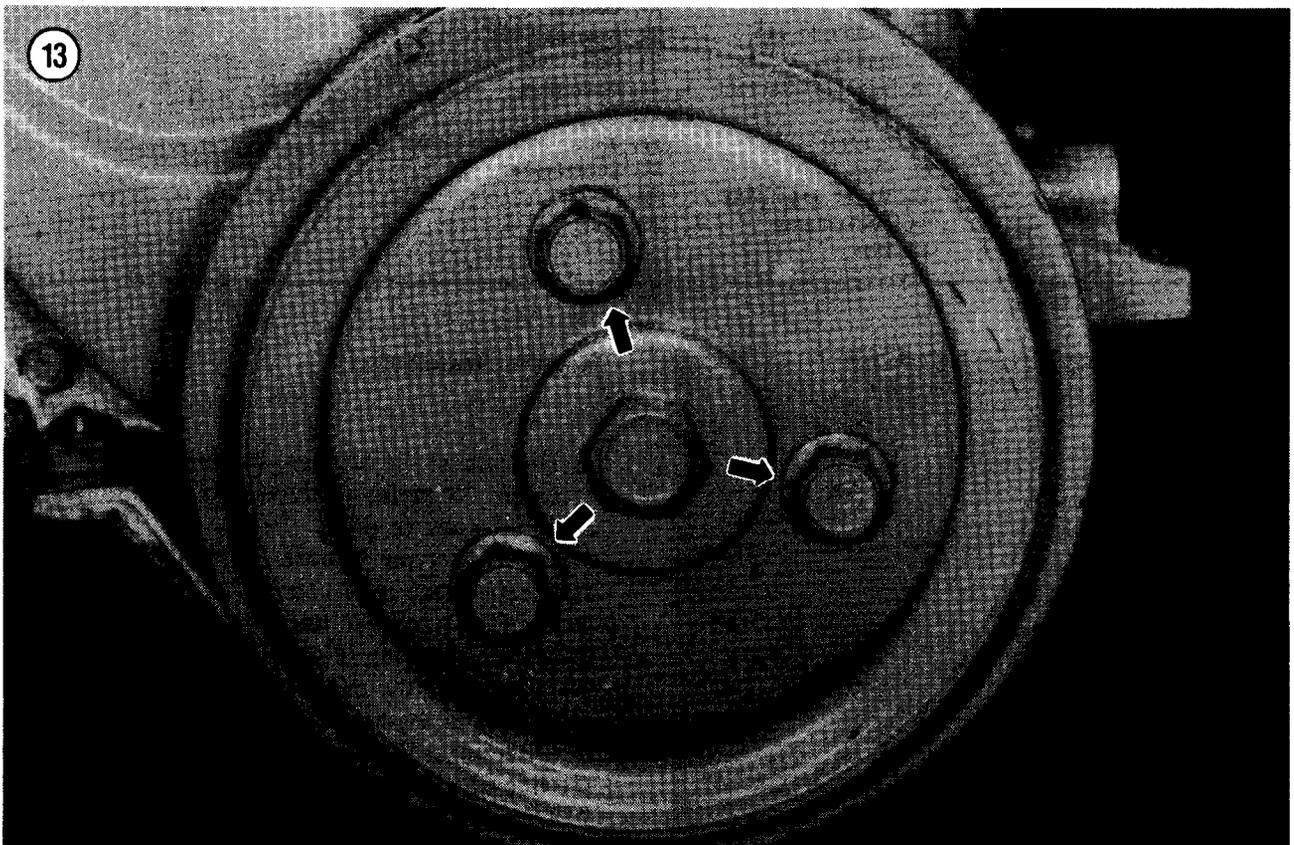
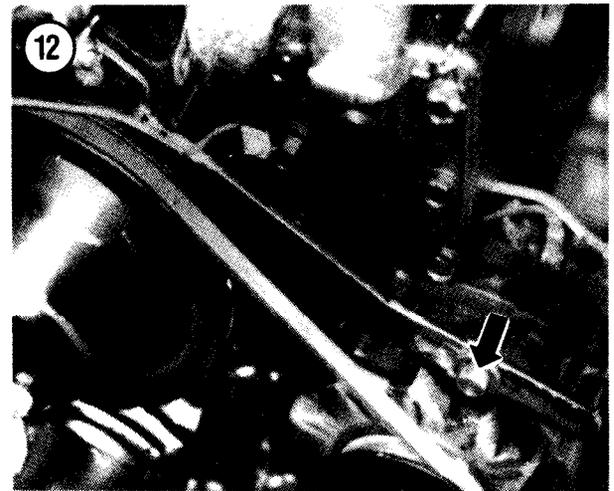
#### Intake Manifold Inspection

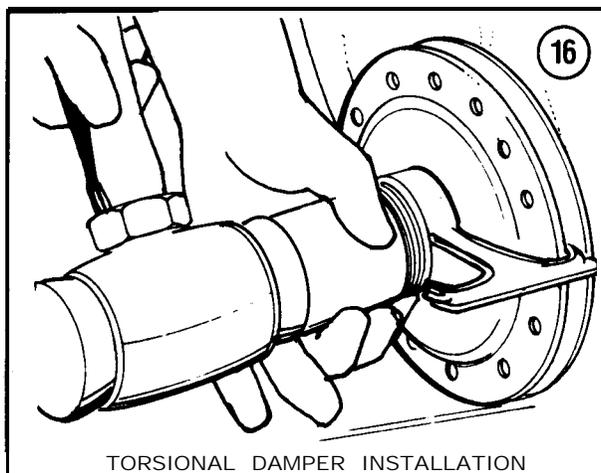
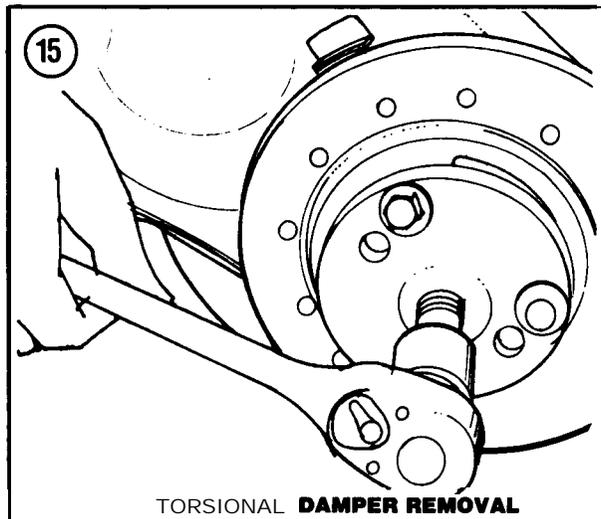
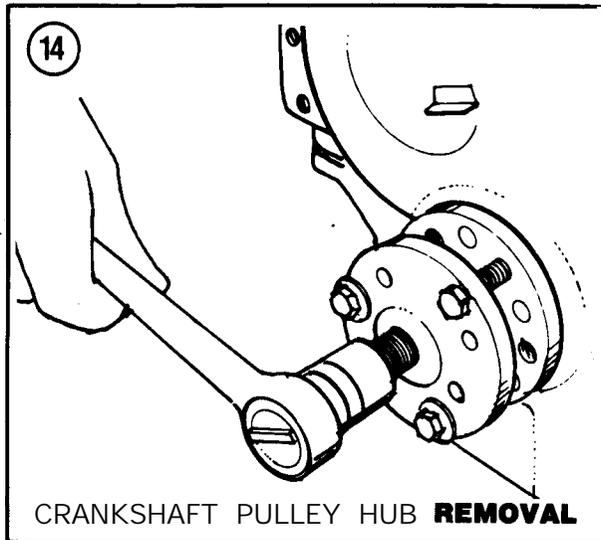
1. Remove carburetor from manifold. Check manifold for cracks or distortion. Replace as required.

2. Check mating surfaces for nicks or burrs. Small burrs may be removed with an oilstone.

3. Place a straightedge across the manifold mating surface. If there is any gap between the mating surface and straightedge, measure it with a feeler gauge. Measure from end to end and corner to corner.

4. The mating surface should be flat within 0.006 in. per foot of manifold length. If not, replace the manifold.





### Exhaust Manifold Inspection/Cleaning

1. Inspect engine exhaust ports for signs of rust or corrosion. Replace manifold if such signs are found.
2. Check water passage in exhaust elbow for clogging.
3. Check inside of exhaust hose for signs of burning. Replace if burning is noted.

### CRANKSHAFT PULLEY/TORSIONAL DAMPER

#### Pulley Removal/Installation

1. Remove alternator drive belt. See Chapter Thirteen.
2. Remove pulley attaching bolts (Figure 13). Remove pulley from hub.
3. Install puller part No. J-6978 to pulley hub with pulley attaching bolts and remove hub. See Figure 14.
4. Lubricate timing gear cover seal lip with clean engine oil.
5. Position hub on crankshaft end and start with a mallet, then use tool part No. J-5590 to strike the hub until it is fully seated against the crankshaft gear. Crankshaft will extend through the hub slightly when bottomed.
6. Install and adjust alternator drive belt. See Chapter Thirteen.

#### Torsional Damper Removal/Installation

1. Remove alternator drive belt. See Chapter Thirteen.
2. Install puller part No. J-6978 to torsional damper and remove damper. See Figure 15.
3. Lubricate timing gear cover seal lip with clean engine oil.
4. Install tool part No. J-8792 to damper (Figure 16), place damper and tool against crankshaft and drive onto the crankshaft until fully seated. Remove tool.

5. Install and adjust alternator drive belt. See Chapter Thirteen.

### TIMING GEAR COVER AND SEAL

#### Removal/Installation

This procedure can generally be performed without removing the engine from the boat, provided you are careful in cutting the oil pan seal in Step 4.

1. Remove the crankshaft pulley/hub or torsional damper as described in this chapter.

2. Remove the 2 screws holding the front of the oil pan to the timing gear cover (bottom arrows, Figure 17).

3. Pull the timing gear cover slightly away from the block.

4. Use a sharp X-acto knife to cut the oil pan seal flush with the cylinder block face.

5. Remove the timing gear cover bolts. See Figure 17. Remove the cover, cover gasket and cut portion of the oil pan seal. Discard the cover gasket. Keep the pan seal segment for use as a template in Step 8.

6. Clean the gasket mounting surfaces on the block and cover with degreaser and a putty knife.

7. Coat the gasket surfaces of the block and timing gear cover with Perfect Seal (part No. C-92-34227) or equivalent and install a new gasket on the block.

8. Use the cut portion of the oil pan seal as a template and cut a matching section from a new seal for use in Step 9.

9. Install the cut portion of seal to the bottom of the timing gear cover, inserting the seal tips into the cover holes.

10. Apply a 1/8 in. bead of room temperature vulcanizing (RTV) sealer along the joint on each side where the oil pan meets the block.

11. Install alignment tool part No. J-23042 through the timing gear cover seal. Position the timing gear cover on the engine block. Work carefully to prevent damage to the oil seal or movement of the gaskets.

12. Apply upward pressure on the oil pan and install the pan attaching screws.

13. Install the cover attaching bolts. Tighten cover bolts and oil pan screws to specifications (Table 3).

14. Remove the alignment tool and install the crankshaft pulley/hub or torsional damper as described in this chapter.

#### Seal Replacement

1. Remove timing gear cover as described in this chapter.

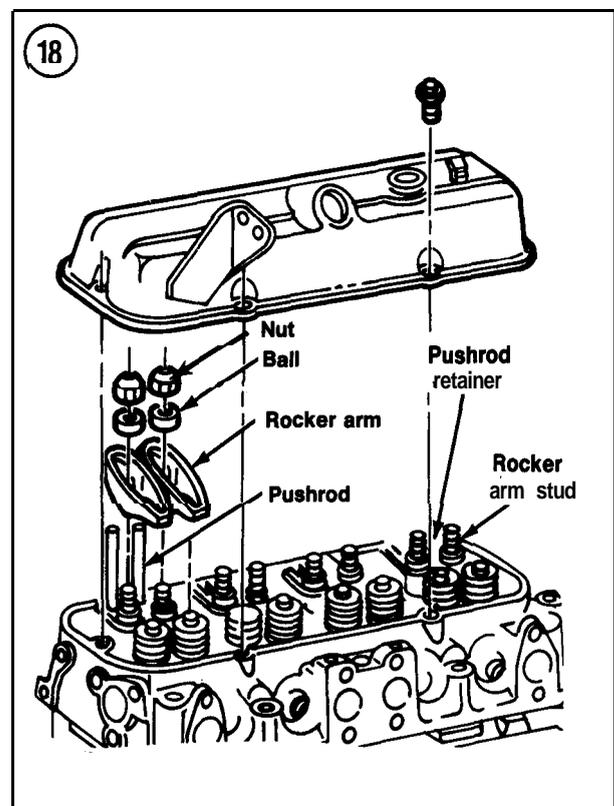
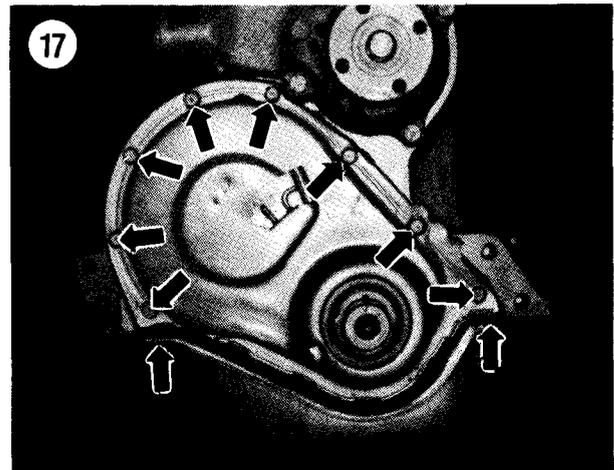
2. Place cover on a clean flat workbench surface.

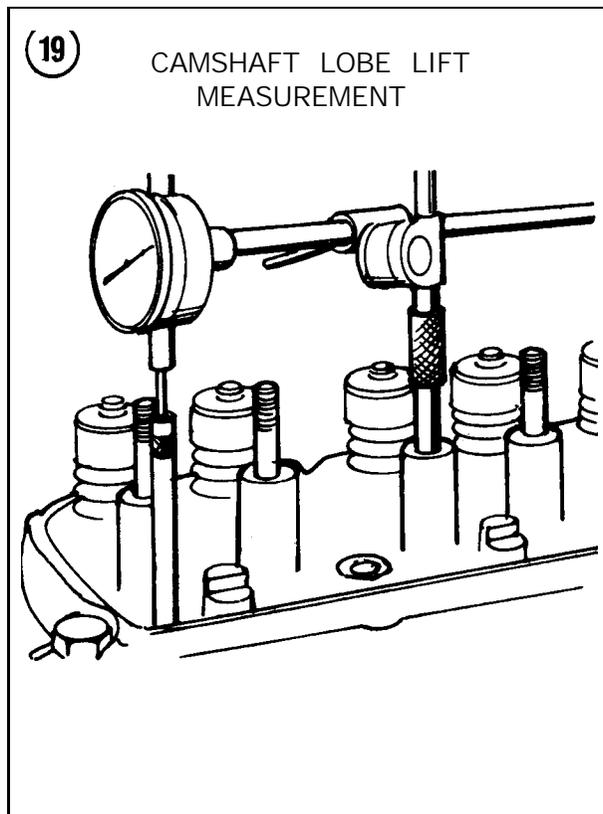
3. Pry old seal from cover with a screwdriver.

4. Clean the seal recess in the cover with solvent and blow dry.

5. Position new seal in cover recess with open end of seal facing cover. Support cover at seal area and drive seal into place with tool part No. J-23042.

6. Install timing gear cover as described in this chapter.





### ROCKER ARM ASSEMBLIES

#### Removal/Installation

Each rocker arm moves on its own pivot ball. The rocker arm and pivot ball are retained by a nut.

It is not necessary to remove the rocker arm for pushrod replacement; simply loosen the nut and move the arm away from the pushrod. Refer to Figure 18 for the complete removal procedure.

1. Remove the rocker arm cover as described in this chapter.
2. Remove each rocker arm nut, ball, rocker arm and pushrod.
3. Place each rocker arm/pushrod assembly in a separate container or use a rack to keep them separated for reinstallation in the same position from which they were removed.

#### NOTE

*When installing new valve lifters, rocker arms or rocker arm balls, coat the contact surfaces with engine oil or Molykote.*

4. Install the pushrods, making sure that each fits into its lifter socket.
5. Install the rocker arms, balls and nuts.
6. Adjust the valves as described in this chapter.
7. Install the rocker arm cover as described in this chapter.

#### Inspection

1. Clean all parts with solvent and use compressed air to blow out the oil passages in the pushrods.
2. Check each rocker arm, ball, nut and pushrod for scuffing, pitting or excessive wear. Replace as necessary.
3. Check pushrods for straightness by rolling them across a flat, even surface such as a pane of glass. Replace pushrods that do not roll smoothly.
4. If a pushrod is worn from lack of lubrication, replace the corresponding lifter and rocker arm as well.

### CAMSHAFT

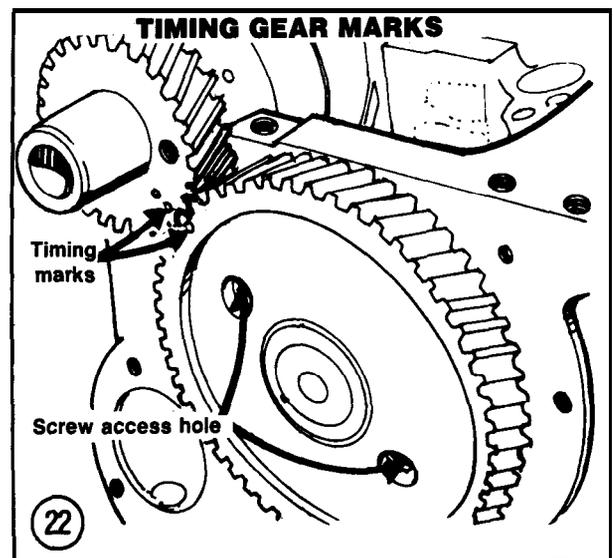
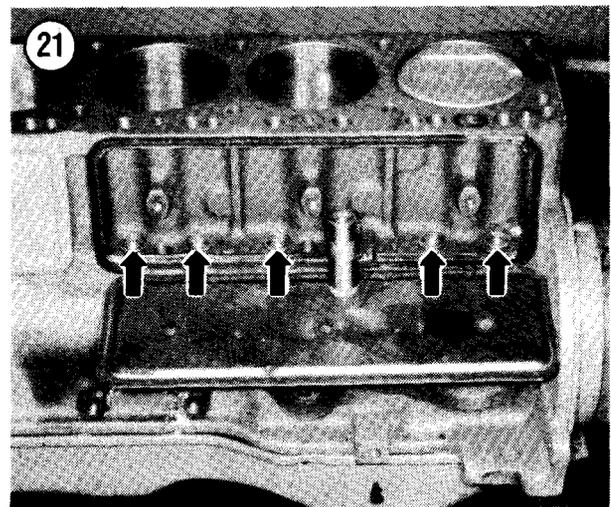
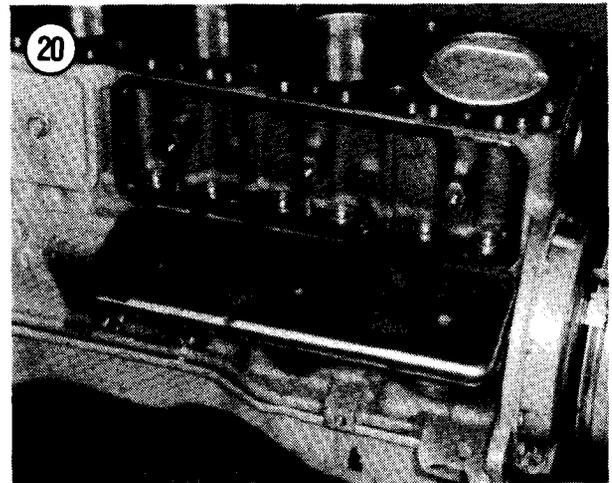
#### Lobe Lift Measurement

Camshaft lobe lift can be measured with the camshaft in the block and the cylinder heads in place. The lifters must be bled down slowly or the readings will be incorrect.

1. Remove the rocker arm covers as described in this chapter.
2. Remove the rocker arm assemblies as described in this chapter.
3. Remove the spark plugs.
4. Install a dial indicator with a ball socket adapter to fit over the pushrod. See Figure 19.
5. Turn the crankshaft in the normal direction of rotation until the valve lifter seats on the heel of the cam lobe. This positions the pushrod at its lowest point.
6. Zero the dial indicator, then slowly rotate the crankshaft until the pushrod reaches its maximum travel. Note the indicator reading and compare to specifications (Table 1 or Table 2).
7. Repeat Steps 4-6 for each pushrod. If all lobes are within specifications, reinstall the rocker arm assemblies and adjust the valves as described in this chapter.
8. If one or more lobes are worn beyond specifications, replace the camshaft as described in this chapter.
9. Remove the dial indicator and reverse Steps 1-3.

### Removal/Installation

1. Crank the engine over until the No. 1 piston is at the top of its compression stroke. The timing mark on the pulley/damper will align with the TDC mark on the timing gear cover and the distributor rotor will point to the No. 1 spark plug terminal in the distributor cap. Remove the distributor. See Chapter Thirteen.
2. Remove the rocker arm cover as described in this chapter.
3. Remove the timing gear cover as described in this chapter.
4. Remove the fuel pump. See Chapter Eleven.
5. Remove the rocker arm assemblies as described in this chapter.
6. Remove the **pushrod covers** (Figure 20) and discard the gaskets.
7. Remove the valve lifters and place in a rack or other container in the order removed so they may be reinstalled in their original locations. Figure 21 shows lifter location, with one lifter removed.
8. Rotate the camshaft to align the timing gear marks (Figure 22).
9. Working through the access holes in the camshaft gear, remove the 2 camshaft thrust plate screws. See Figure 23.
10. Carefully withdraw the camshaft from the front of the engine to avoid damage to the bearings.
11. Installation is the reverse of removal. Coat the camshaft lobes with Lubriplate or equivalent and the journals with heavy engine oil before reinstalling in the block. Check gear run-out and backlash as described in this chapter.



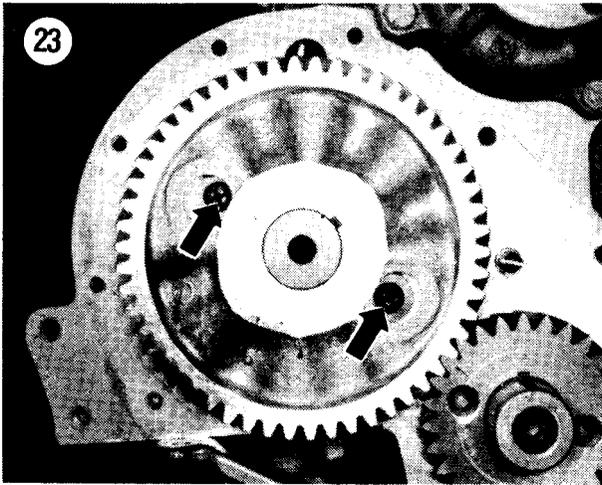
### Inspection

1. Check the journals and lobes for signs of wear or scoring. Lobe pitting in the toe area is not sufficient reason for replacement, unless the lobe lift loss is excessive.
2. Check each valve lifter for signs or wear, pitting or scoring. Replace as required.

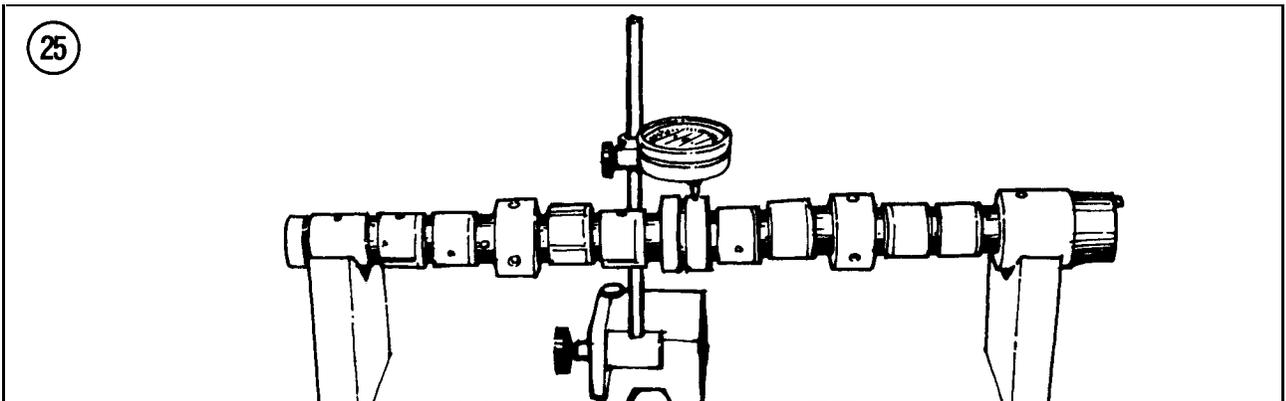
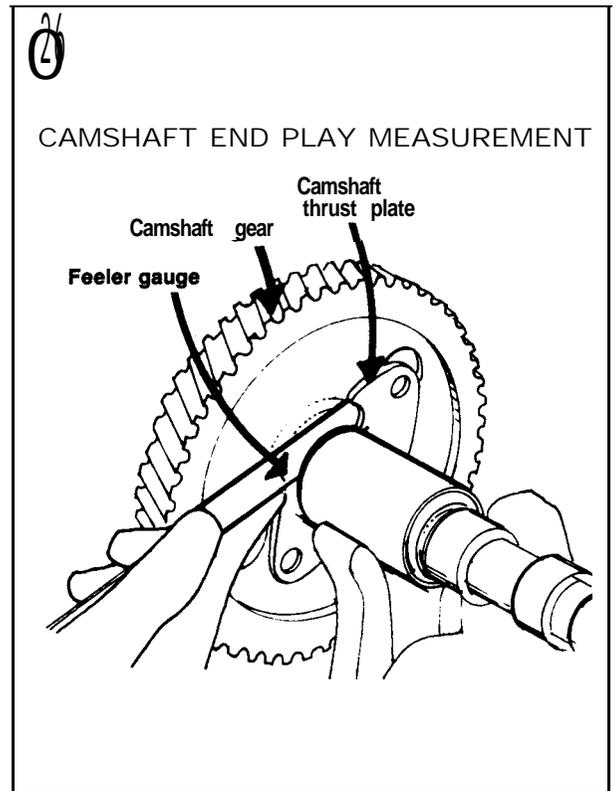
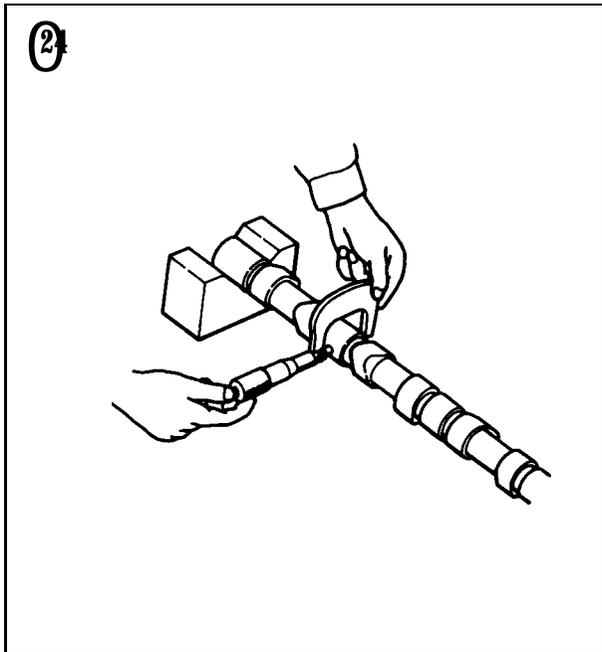
#### NOTE

*If you do not have precision measuring equipment, have Step 3 done by a machine shop.*

3. Measure the camshaft journal diameters with a micrometer (Figure 24). If any journal exceeds 0.001 in. out-of-round, replace the camshaft.



4. Suspend the camshaft between V-blocks and check for **warp** with a dial indicator. See Figure 25. Replace if reading is greater than 0.002 in.
5. Check the distributor drive gear for excessive wear or damage.
6. Check camshaft gear and thrust plate for wear or damage. Insert a feeler gauge between the thrust plate and camshaft to measure end play. See Figure 26. If end play exceeds 0.005 in., remove the camshaft gear as described in this chapter and replace the thrust plate.



### Camshaft/Crankshaft Gear Runout and Backlash

1. Install a dial indicator as shown in **Figure 27**. Rotate camshaft 360° to check **runout**. If camshaft gear **runout** exceeds 0.004 in., replace the gear.
2. Reposition the dial indicator so its contact plunger touches the face of the crankshaft gear. Repeat Step 1. If **runout** exceeds 0.003 in., replace the gear.
3. Install dial indicator as shown in **Figure 28** to check gear teeth backlash. If backlash is not between 0.004-0.006 in., replace both gears.

### Bearing Replacement

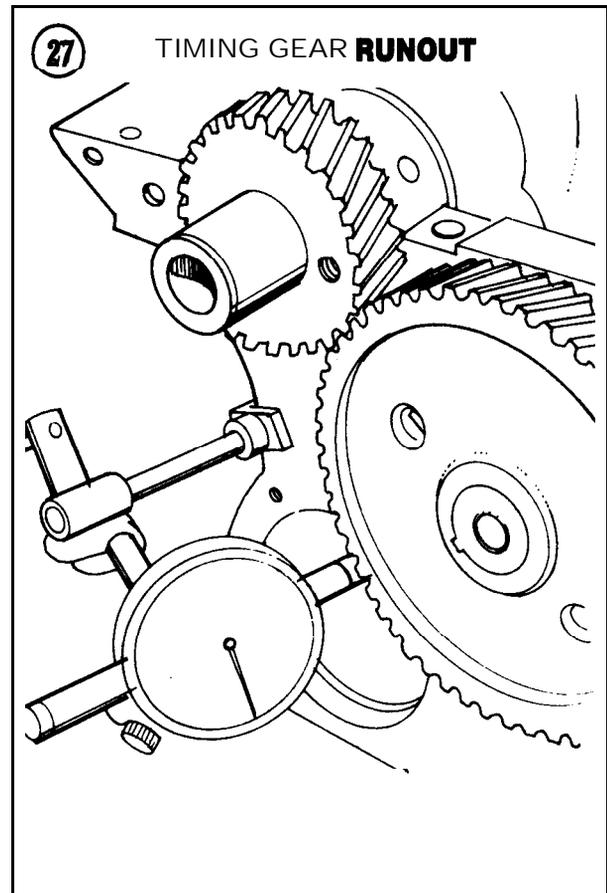
Camshaft bearings can be replaced without complete engine disassembly. Camshaft bearing/installer tool part No. J-6098 is required for bearing replacement.

1. Remove the camshaft as described in this chapter.
2. Remove the crankshaft as described in this chapter.
3. Drive the camshaft rear plug from the cylinder block.
4. Secure the connecting rods to the side of the engine to keep them out of the way while replacing the cam bearings.
5. Install the nut and thrust washer to tool part No. J-6098. Index the tool pilot in the front cam bearing. Install the puller screw through the pilot.
6. Install tool part No. J-6098 with its shoulder facing the front intermediate bearing and the threads engaging the bearing.
7. Hold the puller screw with one wrench. Turn the nut with a second wrench until the bearing has been pulled from its bore.
8. Repeat Steps 5-7 to remove the center bearing.
9. Remove the tool and index it to the rear bearing to remove the rear intermediate bearing from the block.
10. Remove the front and rear bearings by driving them toward the center of the block.

#### CAUTION

*Improper rear bearing alignment in Step 11 will restrict oil pressure reaching the valve train.*

11. Installation is the reverse of removal. Use the same tool to pull the new bearings into their bores. Bearing oil holes must align with those in the block. Since the oil hole is on the top of the

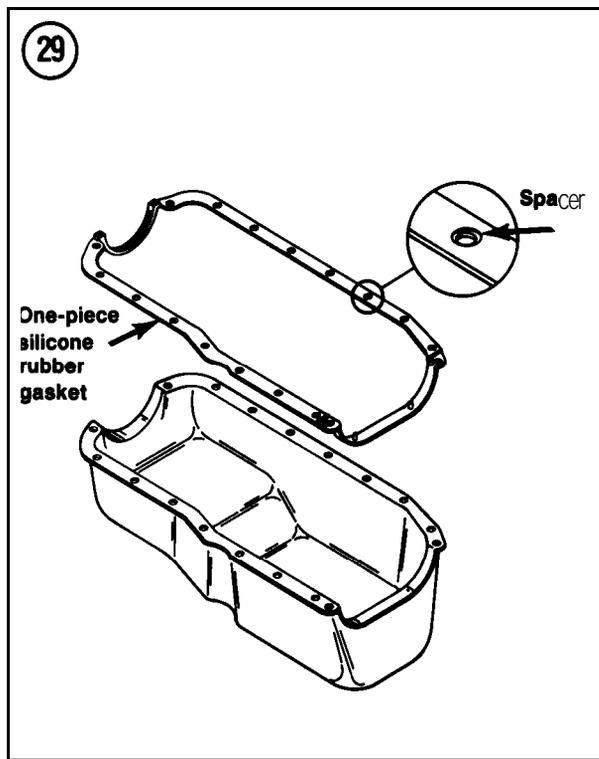
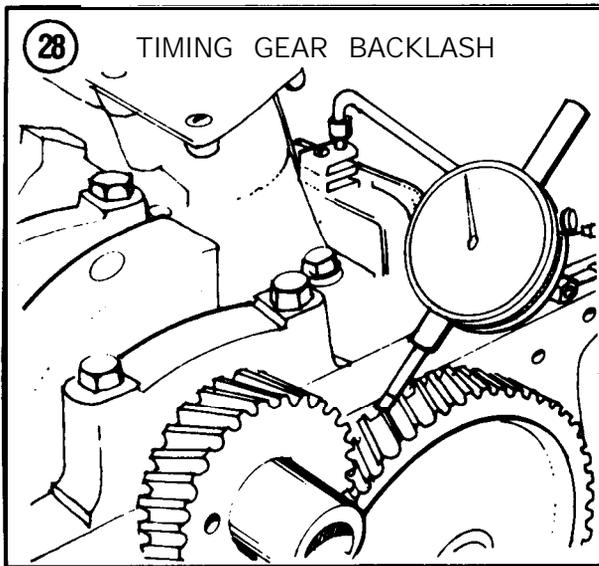


bearings (and cannot be seen during installation), align bearing oil hole with hole in bore and mark opposite side of bearing and block at bore to assist in positioning the oil hole during installation.

12. Wipe a new camshaft rear plug with Perfect Seal (part No. C-92-34227) and install it flush to 1/32 in. deep to maintain a level surface on rear of block.

### Timing Gear Replacement

If inspection indicates that the camshaft, gear or thrust plate should be replaced, press the gear from the camshaft with an appropriate size support sleeve. Position the thrust plate so that it will not be damaged by the Woodruff key in the shaft when it separates from the gear. If the gear is to be reused, support its hub before applying pressure or it will be ruined. Install the camshaft gear by pressing it onto the shaft, then check end play as described in Step 6, *Inspection* in this chapter.



OIL PAN

**Oil Leaks**

Constant oil leakage around the oil pan can be caused by 1 of several factors:

- a. Excessive torquing of the oil pan screws. This squeezes the 2-piece gasket out and causes the rubber end seals to split.

- b. Gaskets with insufficient crush (contact) in certain areas to make a good seal.
- c. Defective or improperly installed seals.
- d. Mid-machining of the crankshaft and/or block.

On installations manufactured after October 1985, GM used RTV sealant on the oil pan gaskets and end seals. This was replaced in January 1986 by a new 2-piece "high-swell" gasket which expanded when exposed to oil. In May 1986, a 1-piece silicone rubber gasket (Figure 29) superseded all previous gaskets. The soft rubber fills in small gaps that might otherwise leak; metal spacers around each of the screw holes prevent damage from overtightening. The 1-piece silicone gasket should be used as a replacement whenever the oil pan is removed from earlier models.

If oil leakage continues to be a problem after installation of the new gasket (part No. 27-14901A1), remove the engine from the boat. Remove the oil pan and measure at the following areas:

- a. Crankshaft diameter at the seal area. It should be 2.43-2.432 in.
- b. Inside diameter of the seal shoulder. It should be 2.775-2.778 in.

If the measurements are not within the specifications provided, the crankshaft and/or block were incorrectly machined. See your MerCruiser dealer.

**Removal**

1. Remove the engine as described in this chapter.
2. Place a 6-quart container under the oil pan drain plug. Remove the plug and let the crankcase drain.

**NOTE**

*A modification kit is available from marine dealers to assist in draining the oil when the engine is in the boat. This kit can be installed on any engine oil pan when the engine is removed for service.*

3. If mounted in an engine stand, rotate the engine 180° to place the oil pan in an upright position.
4. Remove the oil pan attaching screws. Remove the oil pan.
5. Remove and discard the pan gasket and the front/rear seals, if used.

**Inspection**

1. Remove all gasket residue from the oil pan flanges and crankcase side rails with degreaser and a putty knife.
2. Clean the pan thoroughly in solvent.
3. Check the pan for dents or warped gasket surfaces. Straighten or replace the pan as necessary.

**Installation**

1. Install a new 1-piece gasket on the pan flanges. Insert a screw on each side and at each end of the pan to position the gasket.
2. Carefully position the oil pan in place, make sure the gasket is not misaligned and tighten the screws inserted in Step 1 finger-tight.
3. Install the remaining screw and tighten all to specifications (Table 3). Work from the center outward in each direction.
4. Install the engine in the boat as described in this chapter and fill the crankcase with oil recommended in Chapter Four.

**OIL PUMP****Removal/Installation**

1. Remove the oil pan as described in this chapter.

**NOTE**

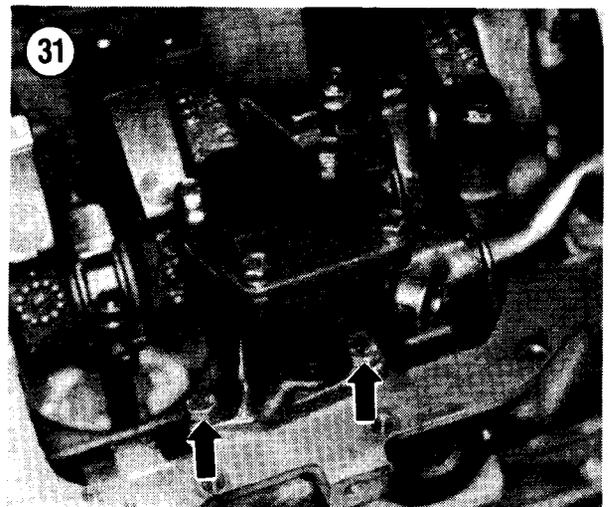
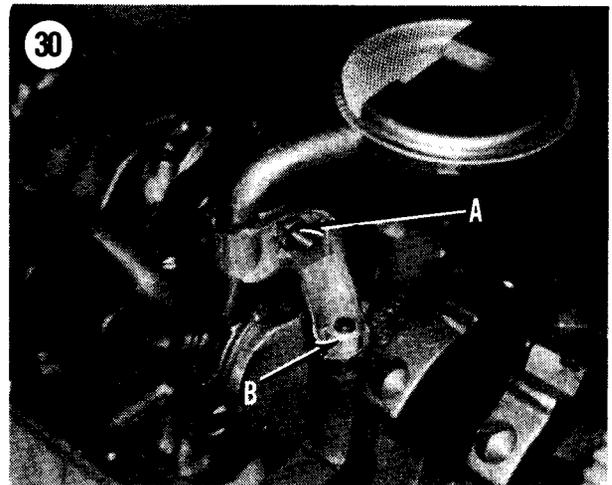
*The oil pump pickup tube and screen are a press fit in the pump housing and should not be removed unless replacement is required.*

2. Loosen the pickup tube bracket bolt (A, Figure 30). Remove bracket attaching nut (B, Figure 30).
3. Remove the oil pump attaching bolts (Figure 31). Remove the oil pump, gasket and pickup tube/screen as an assembly.
4. To install, align the pump gear shaft slot with the distributor shaft drive tang.
5. Install pump to block. Tighten pump attaching bolts to specifications (Table 3).
6. Install the oil pan as described in this chapter.

**Disassembly/Assembly**

Refer to Figure 32 for this procedure.

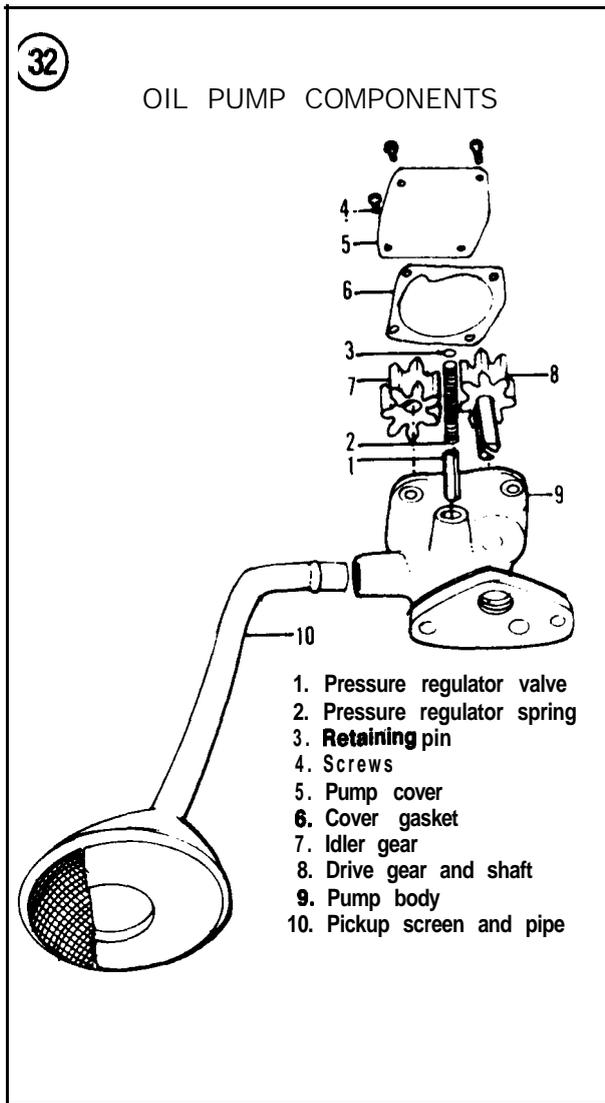
1. Remove the cover screws, cover and gasket. Discard the gasket.



2. Mark gear teeth to assure reassembly with identical gear indexing and remove idler and drive gear with shaft from the body.
3. Remove pressure regulator valve pin, regulator, spring and valve.
4. Oil all parts thoroughly before reassembly.
5. Assembly is the reverse of disassembly. Index gear marks, install a new cover gasket and rotate pump drive shaft by hand to check for smooth operation.

**Inspection****NOTE**

*The pump body and gears are serviced as an assembly. If one or the other is worn or damaged, replace the entire pump. No wear specifications are provided by the manufacturer.*

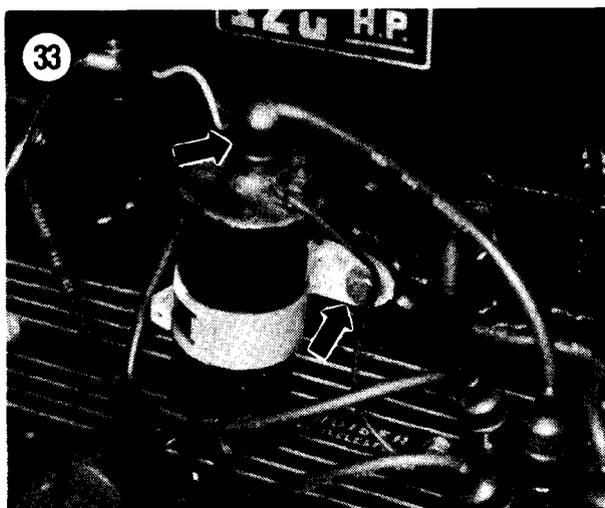


1. Clean all parts thoroughly in solvent. Brush the inside of the body and the pressure regulator chamber to remove all dirt and metal particles. Dry with compressed air, if available.
2. Check the pump body and cover for cracks or excessive wear.
3. Check the pressure regulator valve for a proper fit.
4. Check the pump gears for damage or signs of excessive wear.
5. Check the drive gear shaft-to-body fit for excessive looseness.
6. Check the inside of the pump cover for wear that could allow oil to leak around the ends of the gears.

**CYLINDER HEAD**

**Removal**

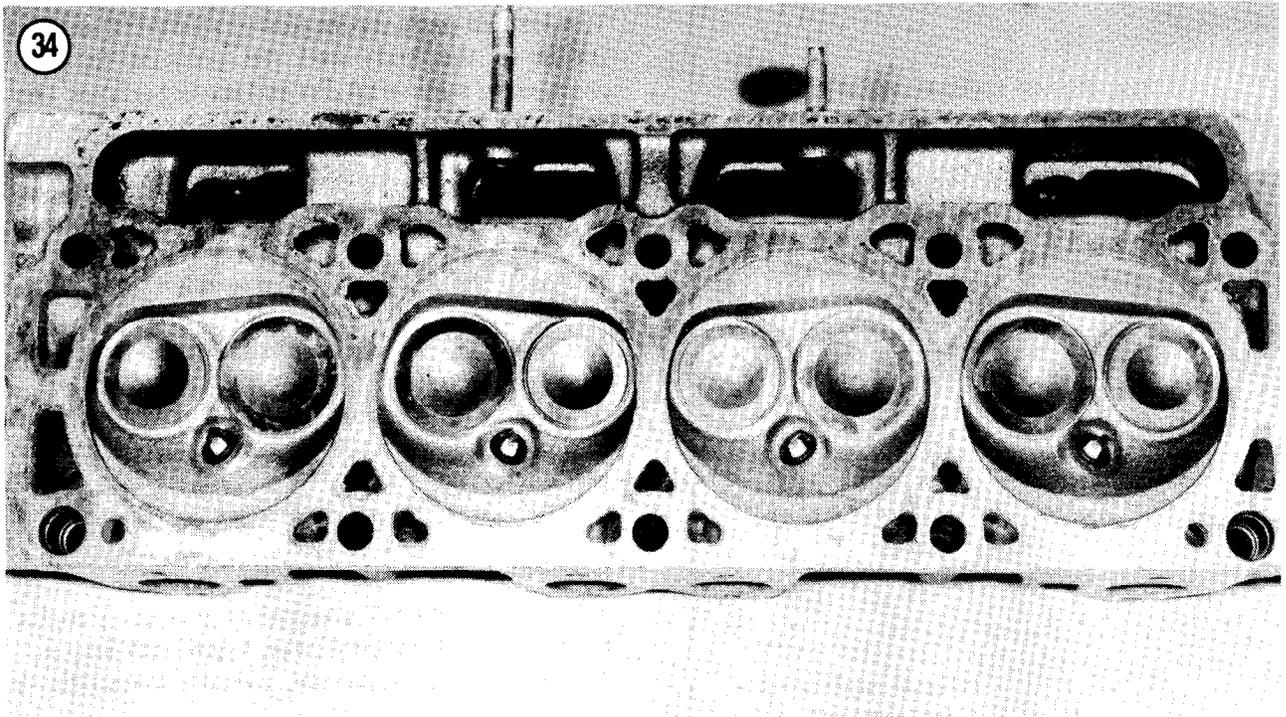
- Perform Steps 1-8 if engine is in boat. If engine has been removed from boat, begin with Step 9.
1. Remove the intake and exhaust manifolds as described in this chapter.
  2. Open the engine block drain valve(s) and allow the water to drain.
  3. Disconnect the fuel line support clamps. Remove the fuel line.
  4. Disconnect the cooling hoses at the water distribution housing.
  5. Disconnect the temperature sending lead and remove the water distribution housing.
  6. Disconnect and remove ignition coil. (Figure 33).
  7. Remove circuit breaker bracket and engine lifting eye.
  8. Disconnect all spark plug cables. Remove the spark plugs.
  9. Remove the rocker arm cover as described in this chapter.
  10. Loosen the rocker arms and rotate them to one side. Remove the **pushrods** and identify each for reinstallation in their original position.
  11. Loosen the cylinder head bolts, working from the center of the head to the end in each direction.
  12. Remove the head bolts. Tap the end of the head with a plastic hammer to break the gasket seal. Remove the head from the engine.



**CAUTION**

*Place the head on its side to prevent damage to the spark plugs or head gasket surface.*

13. Remove and discard the head gasket.



### Decarbonizing

1. Without removing the valves, remove all deposits from the combustion chambers, intake ports and exhaust ports. Use a fine wire brush dipped in solvent or make a scraper from hardwood. Be careful not to scratch or gouge the combustion chambers.
2. After all carbon is removed from the combustion chambers and ports, clean the entire head in solvent.
3. Clean away all carbon on the piston tops. Do not remove the carbon ridge at the top of the cylinder bore.
4. Remove the valves as described in this chapter.
5. Clean the **pushrod** guides, valve guide bores and all bolt holes. Use a cleaning **solent** to remove dirt and grease.
6. Clean the valves with a fine wire brush or buffing wheel.

### Inspection

1. Check the cylinder head for signs of oil or water leaks before cleaning.
2. Clean the cylinder head thoroughly in solvent. While cleaning, look for cracks or other visible signs of damage. Look for corrosion or foreign

material in the oil and water passages (**Figure 34**). Clean the passages with a stiff spiral brush, then blow them out with compressed air.

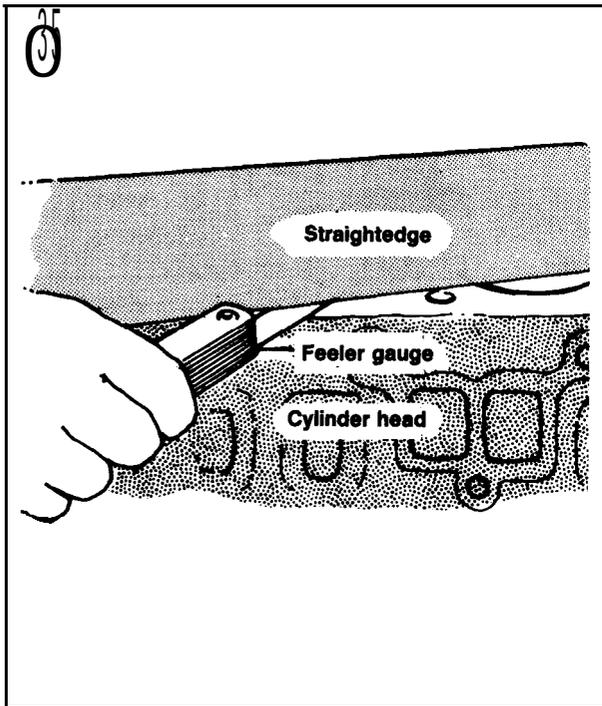
3. Check the cylinder head studs for damage and replace, if necessary.
4. Check the threaded rocker arm studs or bolt holes for damaged threads. Replace if necessary.
5. Check the cylinder head-to-block surface for **warpage** with a straightedge and feeler gauge (**Figure 35**). Compare to specifications (**Table 1** or **Table 2**). If gap exceeds specifications, have the head resurfaced by a dealer or machine shop. If head resurfacing is required, do not remove more than 0.010 in. Replace the head if a greater amount must be removed to correct **warpage**.

### Installation

1. Make sure the cylinder head and block gasket surfaces and bolt holes are clean. Dirt in the block bolt holes or on the head bolt threads will affect tightening torque.
2. Recheck all visible oil and water passages for cleanliness.

### CAUTION

*Do not use steel automotive-type gaskets. Use only MerCap replacement head gaskets in Step 3.*



3. Fit a new MerCap head gasket over the cylinder dowels on the block (Figure 36).
4. Install the cylinder head to the block. Wipe the head bolt threads with Perfect Seal (C-92-34227) and install finger-tight.
5. Tighten head bolts 1/2 turn at a time following the sequence shown in Figure 37 until specified torque is reached. See Table 3.

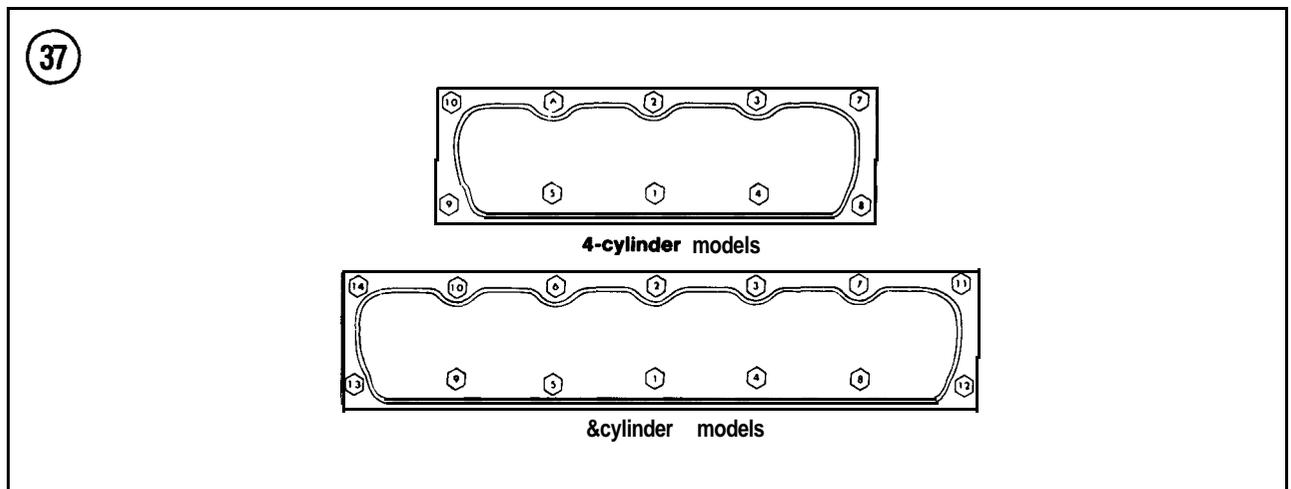
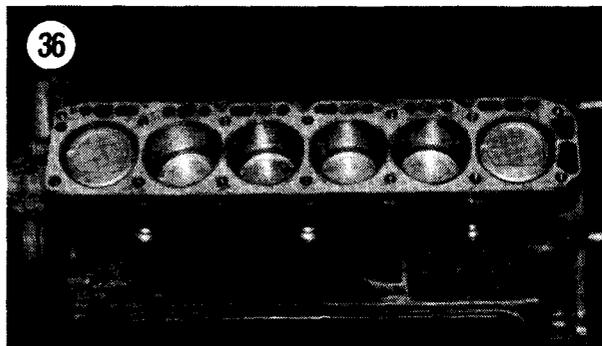
**CAUTION**

*Retorque & cylinder head bolts during 20-hour checkup. This will prevent possible poor engine performance, a blown head gasket, burned valves and other engine problems.*

6. If engine is in boat, reverse Steps 1- 10 of **Removal** in this chapter. If engine is out of boat, reverse Step 9 and Step 10 of **Removal** to complete installation.

**VALVES AND VALVE SEATS**

Some of the following procedures must be done by a dealer or machine shop, since they require special knowledge and expensive machine tools. Others, while possible for the home mechanic, are difficult or time-consuming. A general practice among those who do their own service is to remove the cylinder head, perform all disassembly except valve removal, then take the head to a machine shop for inspection and service. Since the cost is low relative to the required effort and equipment, this is usually the best approach, even for experienced mechanics. The following procedures are given to acquaint the home mechanic with what the dealer or machine shop will do.



### Valve Removal

Refer to **Figure 38** for this procedure.

1. Remove the cylinder head as described in this chapter.
2. Remove the rocker arm assemblies as described in this chapter.
3. Compress the valve spring with a compressor tool like the one shown in **Figure 39**. Remove the retainer locks and release the spring tension.
4. Remove the valve spring cap, shield, spring and damper assembly.
5. Remove the valve stem seal with a pair of pliers. See **Figure 40**. Discard the seal.

#### CAUTION

*Remove any burrs from the valve stem lock grooves before removing the valves or the valve guides will be damaged.*

6. Remove the valve and repeat Steps 3-5 on each remaining valve.
7. Arrange the parts in order so they can be returned to their original positions when reassembled.

### Inspection

1. Clean the valves with a fine wire brush or buffing wheel. Discard any cracked, warped or burned valves.
2. Measure valve stems at the top, center and bottom for wear. A machine shop can do this when the valves are ground. Also measure the length of each valve and the diameter of each valve head.

#### NOTE

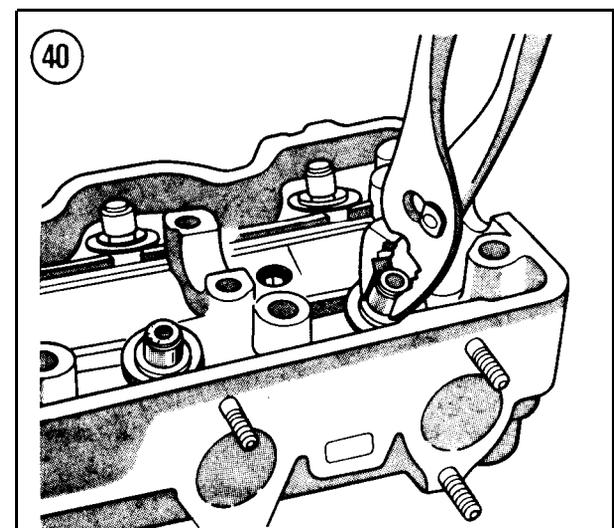
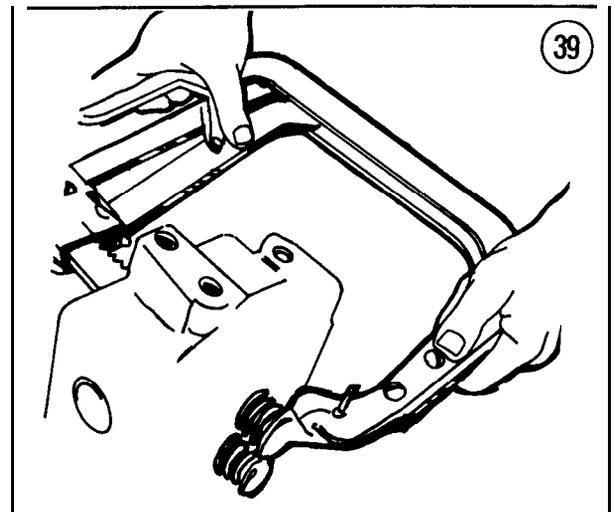
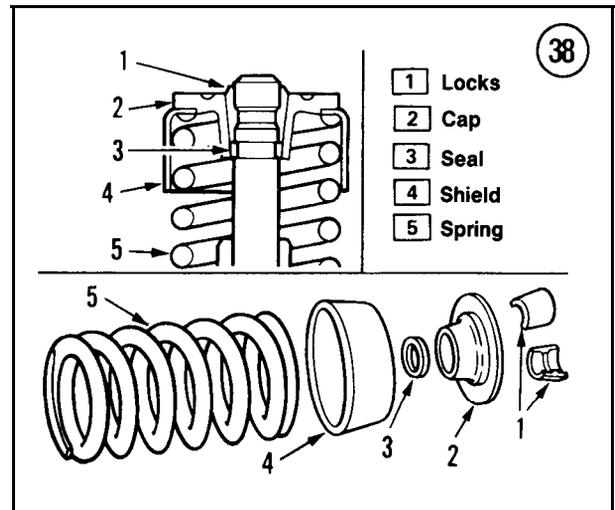
*Check the thickness of the valve edge or margin after the valves have been ground. See **Figure 41**. Any valve with a margin of less than 1/32 in. should be discarded.*

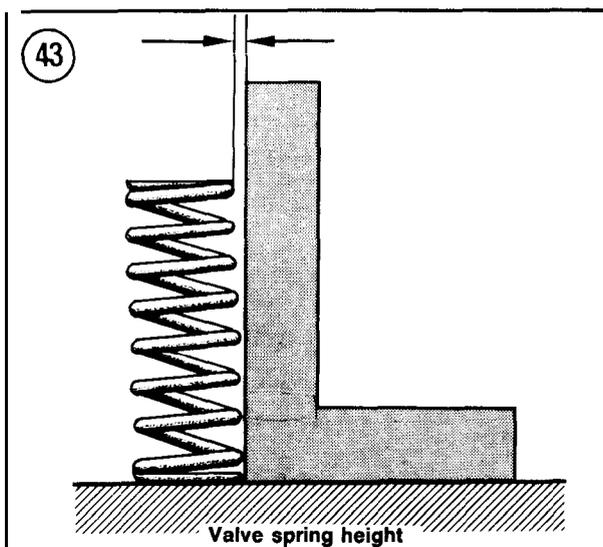
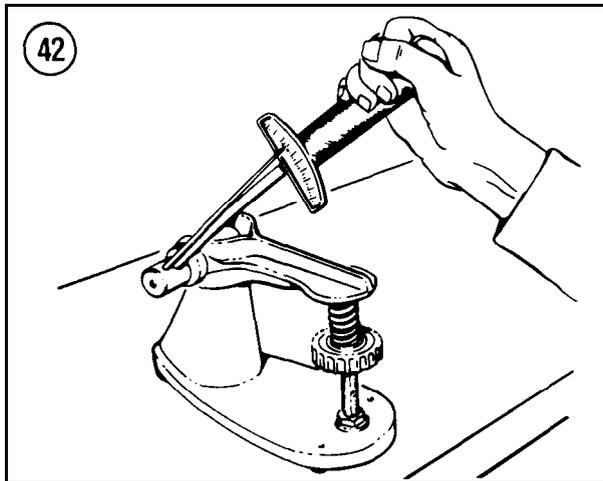
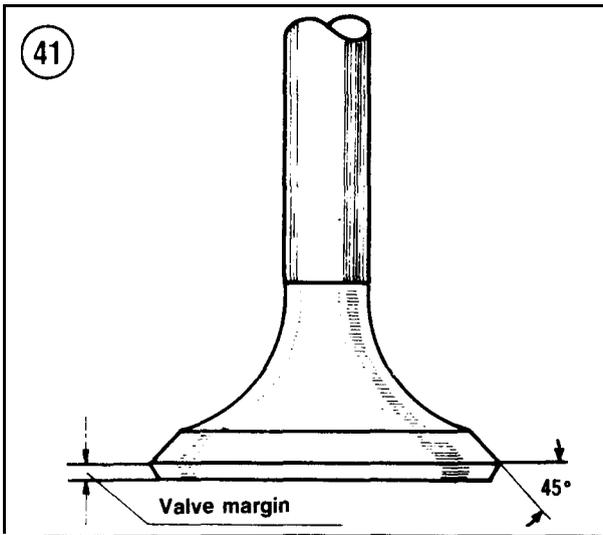
3. Remove all carbon and varnish from the valve guides with a stiff spiral wire brush.

#### NOTE

*The next step assumes that all valve stems have been measured and are within specifications. Replace valves with worn stems before performing this step.*

4. Insert each valve into the guide from which it was removed. Holding the valve just slightly off its seat, rock it back and forth in a direction parallel





with the rocker arms. This is the direction in which the greatest wear normally occurs. If the valve stem rocks more than slightly, the valve guide is probably worn.

5. If there is any doubt about valve guide condition after performing Step 4, have the valve guide measured with a valve stem clearance checking tool. Compare the results to specifications (**Table 1** or **Table 2**) according to engine. Worn guides must be reamed for the next oversize valve stem.

6. Test the valve springs under load on a spring tester (**Figure 42**). Replace any weak springs.

7. Check each spring on a flat surface with a steel square. **See Figure 43.** Slowly revolve spring 360 and note the space between the top of the coil and the square. If it exceeds 5/16 in. at any point, replace the spring.

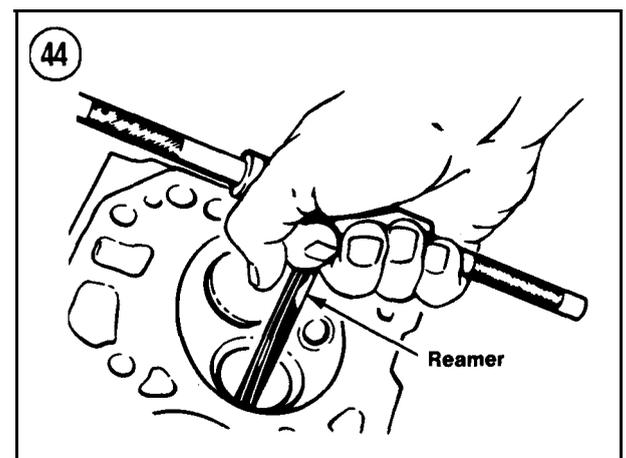
8. Inspect the valve seat inserts. If worn or burned, they must be reconditioned. This is a job for a dealer or machine shop, although the procedure is described in this chapter.

#### Valve Guide Reaming

Worn valve guides must be reamed to accept a valve with an oversize stem. Reaming must be done by hand (**Figure 44**) and is a job best left to an experienced machine shop. The valve seat must be refaced after the guide has been reamed.

#### Valve Seat Reconditioning

1. Cut the valve seats to the specified angle (**Table 1** or **Table 2**) with a dressing stone. Remove only enough metal to obtain a good finish.



2. Use tapered stones to obtain the specified seat width when necessary.
3. Coat the corresponding valve face with Prussian blue dye.
4. Insert the valve into the valve guide.
5. Apply light pressure to the valve and rotate it approximately 1/4 turn.
6. Lift the valve out. If it seats properly, the dye will transfer evenly to the valve face.
7. If the dye transfers to the top of the valve face, lower the seat. If it transfers to the bottom of the valve face, raise the seat.

### Valve Installation

#### NOTE

Install *all* parts in the same positions from which they were removed.

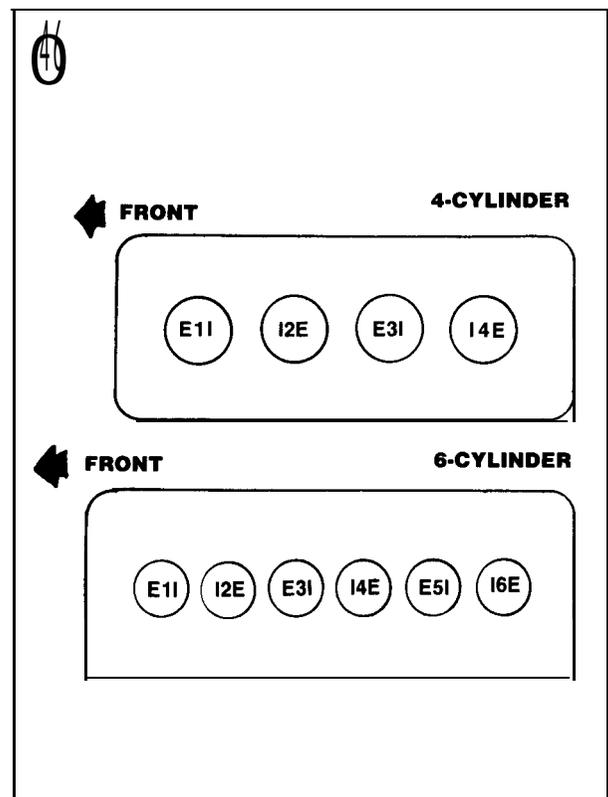
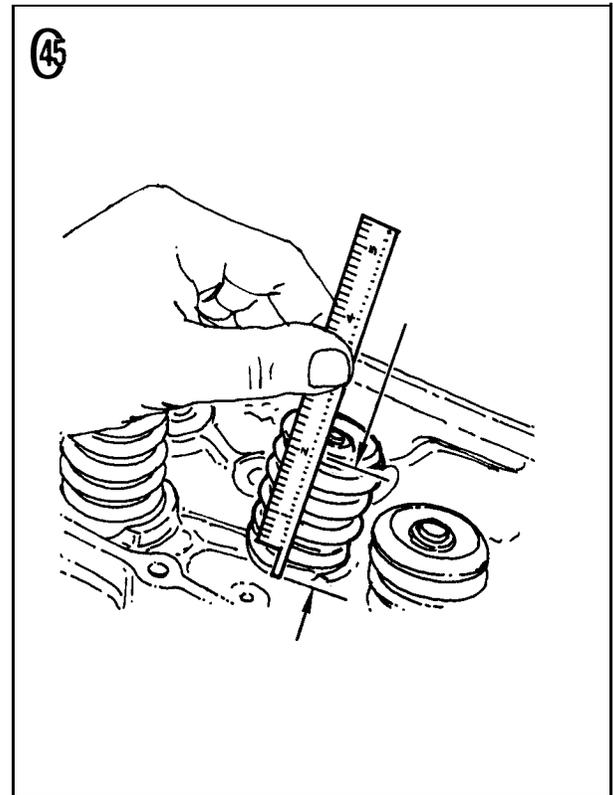
1. Coat the valves with oil and install them in the cylinder head.
2. Install new oil seals on each valve with a deep socket and hammer.
3. Drop the valve spring shim around the valve guide boss. Install the valve spring over the valve, then install the spring retainer.
4. Compress the spring and install the locks. Make sure both locks seat properly in the upper groove of the valve stem.
5. Measure the installed spring height between the top of the valve seat and the underside of the spring retainer. **See Figure 45.** If height is greater than specifications, install an extra spring seat shim about 1/16 in. thick and remeasure the height.

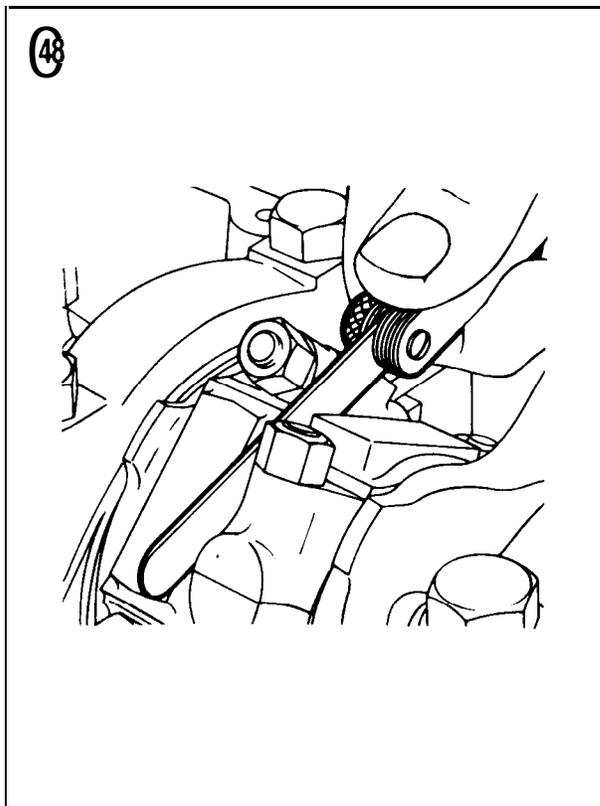
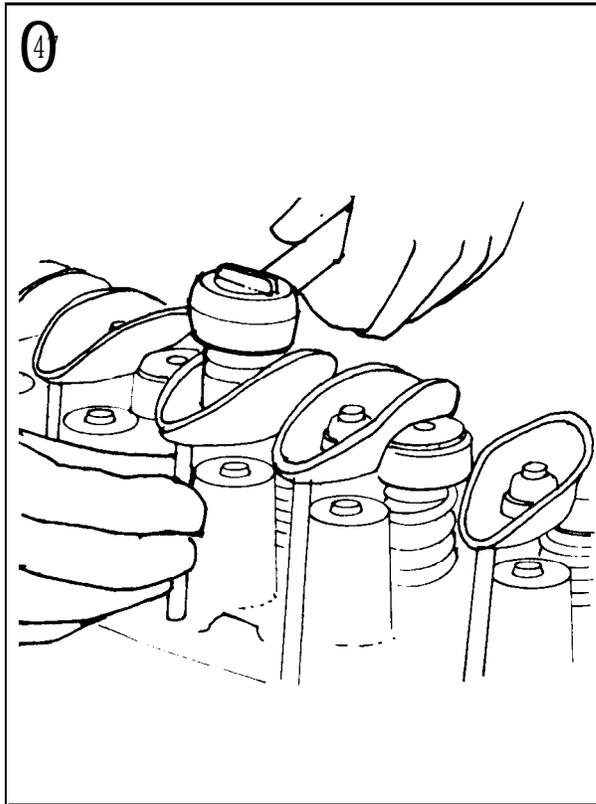
### Valve Adjustment

Stem-to-rocker arm clearance must be within specifications when the hydraulic lifter is completely collapsed. If valve clearance is not sufficient, the valve opens early and closes late, resulting in a rough engine idle. Excessive clearance lets the valve open too soon and close too early, causing valve bounce and damage to the camshaft lobe.

Valve adjustment is only required when the cylinder head valve train has been disassembled. Adjust the valves with the lifter on the base circle of the camshaft lobe.

1. Rotate the crankshaft until the pulley notch aligns with the zero mark on the timing tab. This positions the No. 1 cylinder at TDC. This position can be verified by placing a finger on the No. 1





rocker arms as the pulley notch nears the zero mark. If the valves are moving, the engine is in the No. 4 (4-cylinder) or No. 6 (6-cylinder) firing position. Rotate the crankshaft pulley one full turn to reach the No. 1 firing position.

2. With the engine in the No. 1 firing position, refer to **Figure 46** and adjust the following valves:

- a. No. 1 exhaust and intake.
- b. No. 2 intake.
- c. No. 3 exhaust.
- d. No. 4 intake.
- e. No. 5 exhaust (6-cylinder only).

3. Back off the adjusting nut until lash is felt at the **pushrod**, then turn the nut in to remove all lash. When lash has been removed, the **pushrod** will not rotate. Turn the nut in an additional 3/4 turn to center the lifter plunger. See **Figure 47**.

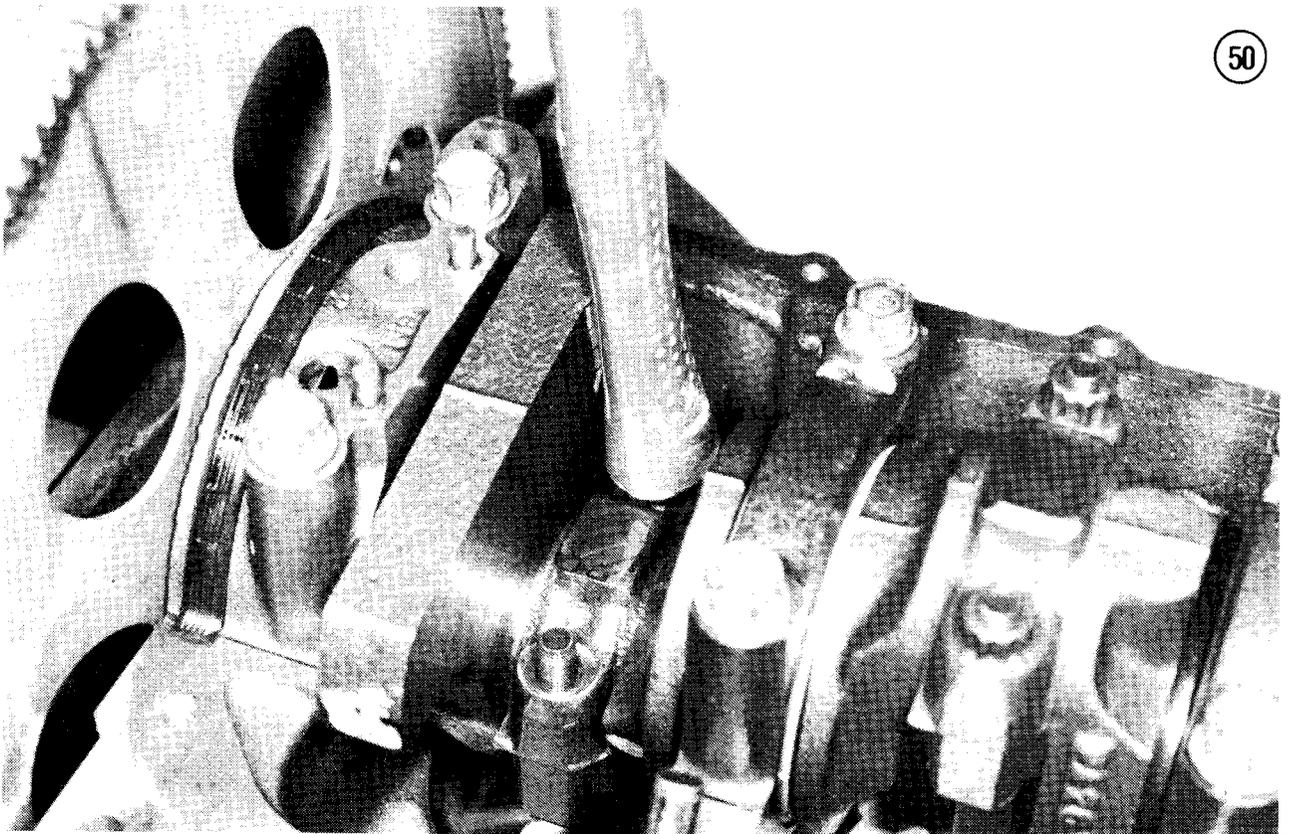
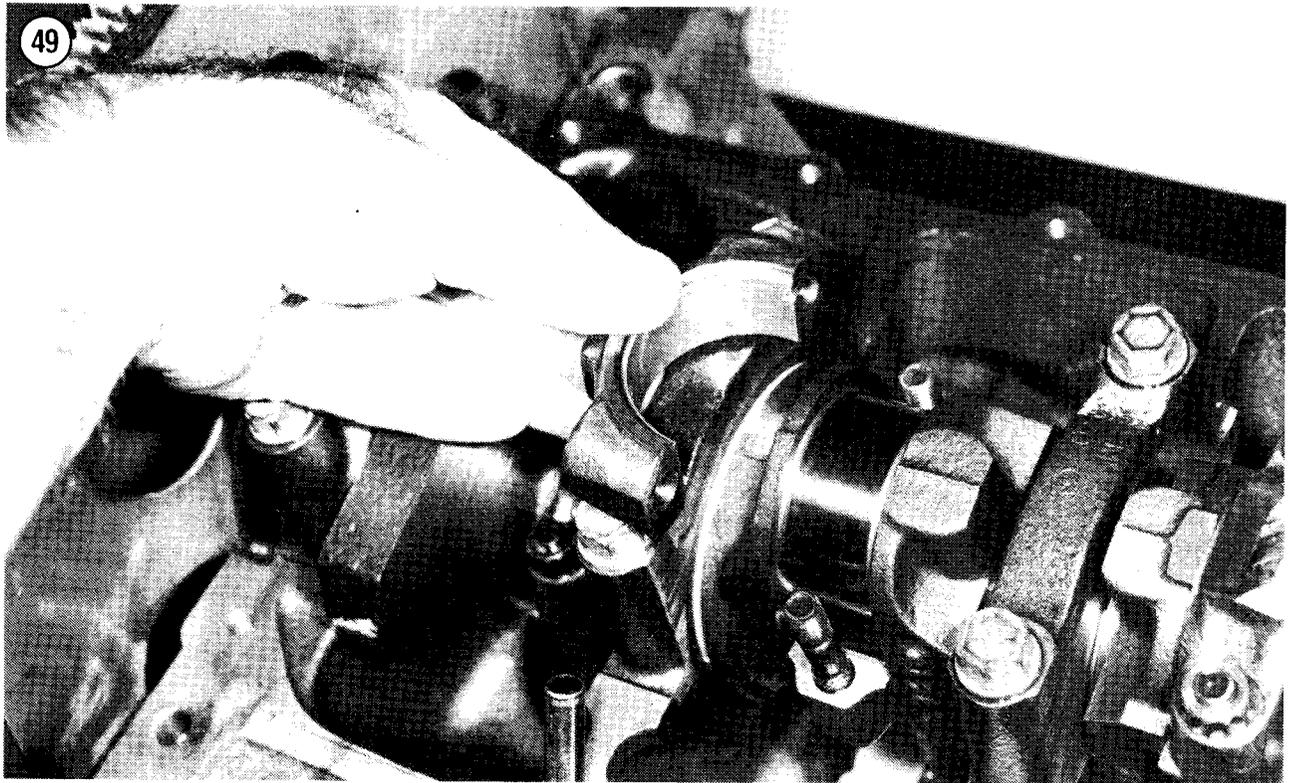
4. Rotate the crankshaft one full turn to realign the pulley notch and the timing tab zero mark in the No. 4 (4-cylinder) or No. 6 (6-cylinder) firing position. Refer to **Figure 46** and adjust the following valves:

- a. No. 2 exhaust.
- b. No. 3 intake.
- c. No. 4 exhaust.
- d. No. 5 intake (6-cylinder only).
- e. No. 6 intake and exhaust (6-cylinder only).

## PISTON/CONNECTING ROD ASSEMBLY

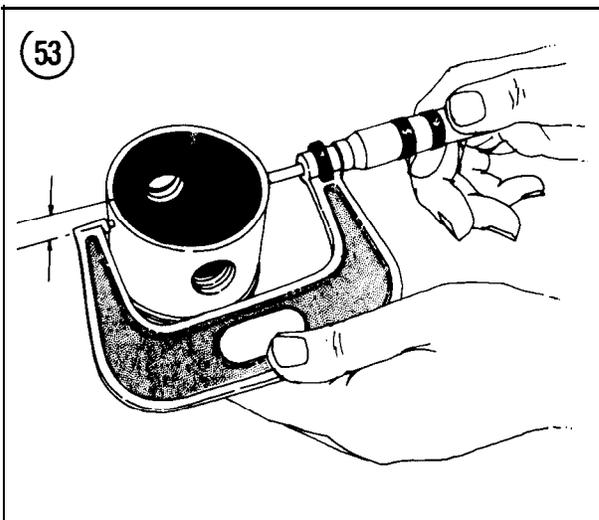
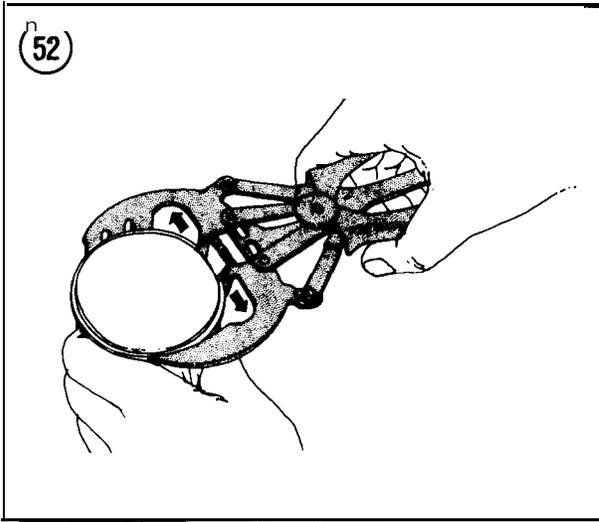
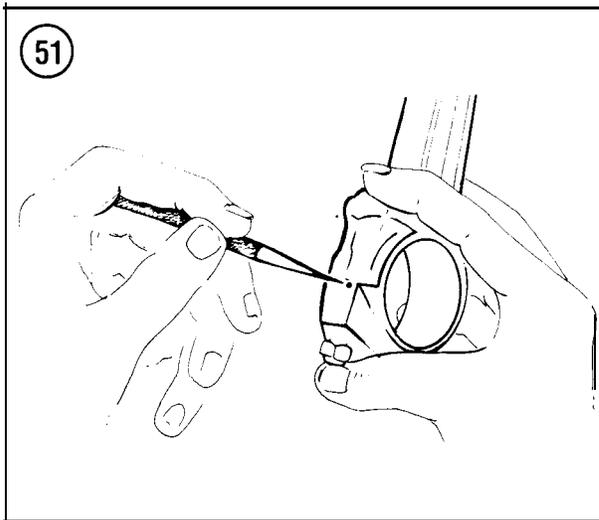
### Piston Removal

1. Remove the engine as described in this chapter.
2. Place a 6-quart container under the oil pan and remove the drain plug. Let the crankcase oil drain.
3. Remove the exhaust manifold as described in this chapter.
4. Remove the cylinder head as described in this chapter.
5. Remove the oil pan and oil pump as described in this chapter.
6. Pack the cylinder bore with clean shop rags. Remove the carbon ridge at the top of the cylinder bore with a ridge reamer. These can be rented for use. Vacuum out the shavings, then remove the shop rags. Repeat this step for each cylinder.
7. Rotate the crankshaft so the connecting rod is centered in the cylinder bore.
8. Measure the clearance between each connecting rod and the crankshaft journal flange with a feeler gauge (**Figure 48**). If the clearance exceeds specifications (**Table 1** or **Table 2**), replace the connecting rod.



49

50



9. Remove the nuts holding the connecting rod cap. Lift off the cap, together with the lower bearing insert (**Figure 49**).

**NOTE**

*If the connecting rod caps are difficult to remove, tap the studs with a wooden hammer handle (**Figure 50**).*

10. Use the wooden hammer handle to push the piston and connecting rod from the bore.

**NOTE**

*Mark the cylinder number on the top of each piston with quick-drying paint. Check for cylinder numbers or identification marks on the connecting rod and cap. If they are not visible, make your own (**Figure 51**).*

11. Remove the piston rings with a ring remover (**Figure 52**).

#### Piston Pin Removal/Installation

The piston pins are press-fitted to the connecting rods and hand-fitted to the pistons. Removal requires the use of a press and support stand. This is a job for a dealer or machine shop equipped to fit the pistons to the pin, ream the pin bushings to the correct diameter and install the pistons and pins on the connecting rods.

#### Piston Clearance Check

Unless you have precision measuring equipment and know how to use it properly, have this procedure done by a machine shop.

1. Measure the piston diameter with a micrometer (**Figure 53**). Measure just below the rings at right angles to the piston pin bore.
2. Measure the cylinder bore diameter with a bore gauge (**Figure 54**). Measure at the top, center and bottom of the bore, in front-to-rear and side-to-side directions.
3. Subtract the piston diameter from the largest cylinder bore reading. If the difference exceeds specifications (**Table 1** or **Table 2**), the cylinder must be rebored and oversized pistons installed.

#### Piston Ring Fit/Installation

1. Check the ring gap of each piston ring. To do this, position the ring at the bottom of the ring

travel area and square it by tapping gently with an inverted piston. See **Figure 55**.

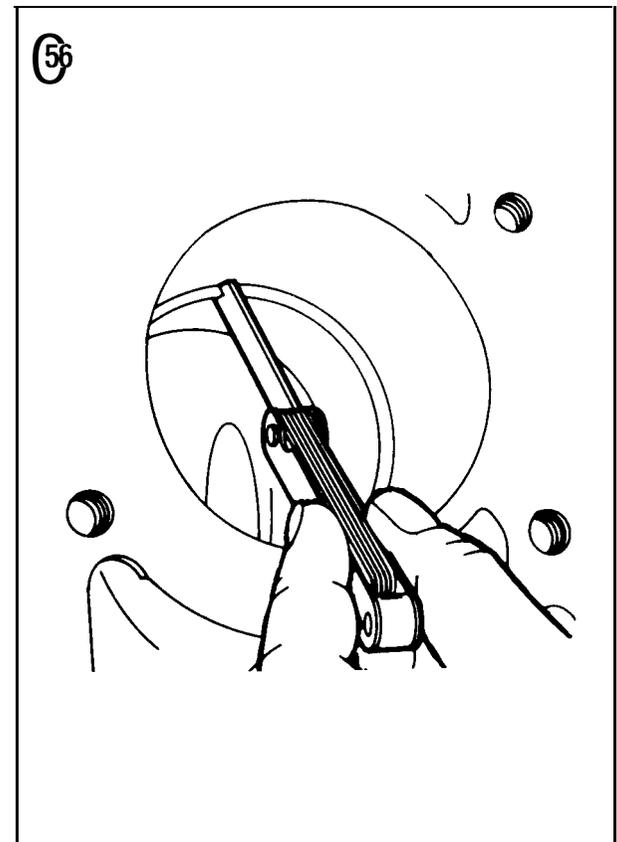
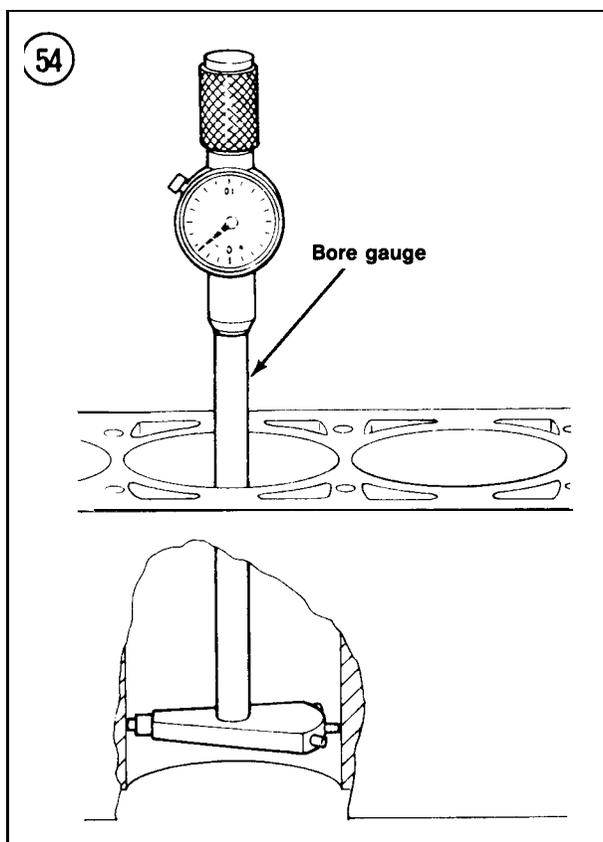
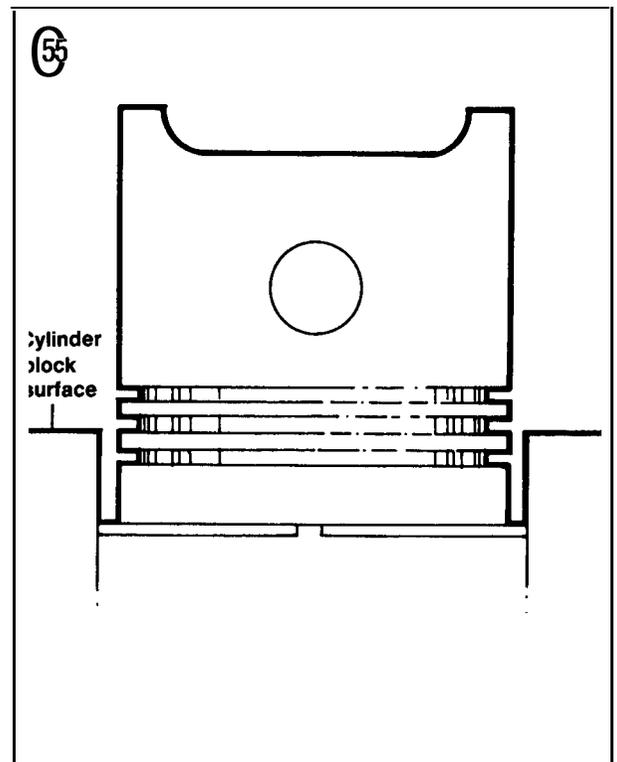
**NOTE**

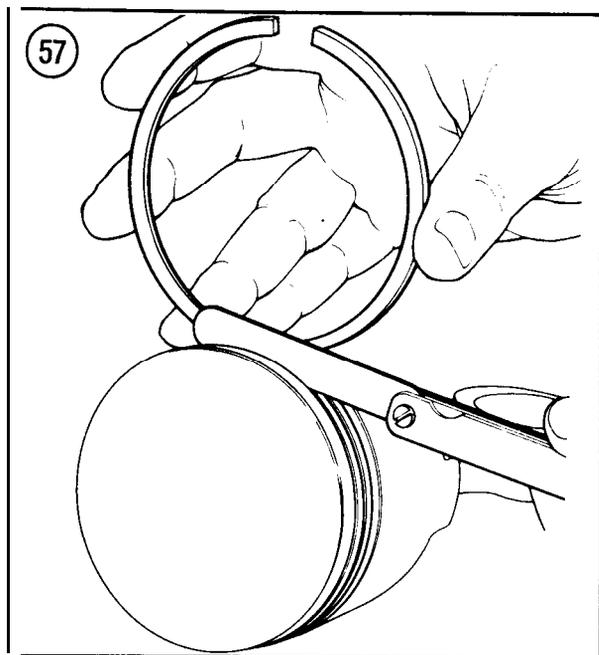
**If** the cylinders have not been rebored, check the gap at the bottom of the ring travel, where the cylinder is least worn.

2. Measure the ring gap with a feeler gauge as shown in **Figure 56**. Compare with specifications. If the measurement is not within specifications (**Table 1** or **Table 2**), replace the rings as a set.
3. Check the side clearance of the compression rings as shown in **Figure 57**. Place the feeler gauge alongside the ring all the way into the groove. If the measurement is not within specifications (**Table 1** or **Table 2**), either the rings or ring grooves are worn. Inspect and replace as necessary.
4. Using a ring expander tool (**Figure 58**), carefully install the oil control ring, then the compression rings.

**NOTE**

Oil rings consist of 3 segments. The wavy segment goes between the flat segments to act as a spacer. Upper and lower flat segments are





interchangeable. The top sides of both compression rings are marked with a symbol. The marked side **of** the ring must face the top of the piston.

5. Position the ring gaps as shown in **Figure 59**.

**Connecting Rod Inspection**

Have the connecting rods checked for straightness by a dealer or machine shop. Connecting rods can spring out of alignment during shipping or handling. When installing new connecting rods, have them checked for misalignment before installing the piston and piston pin.

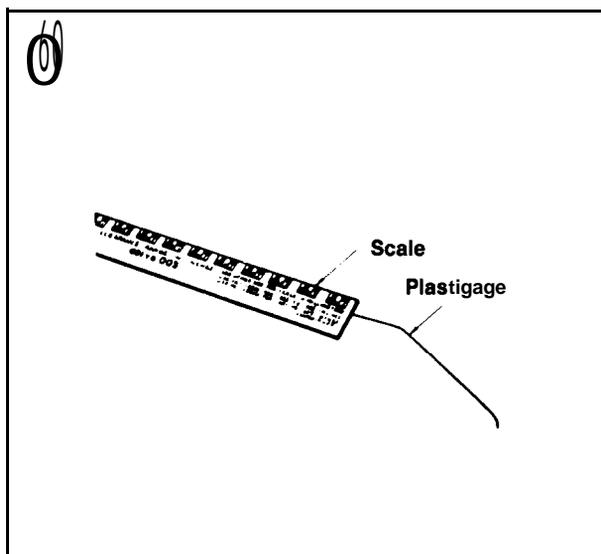
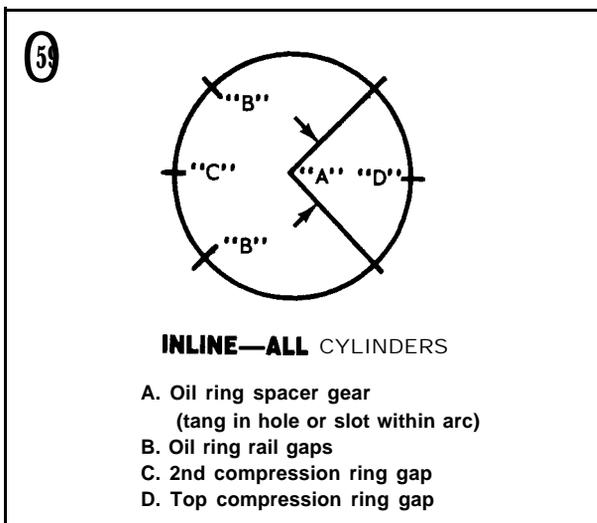
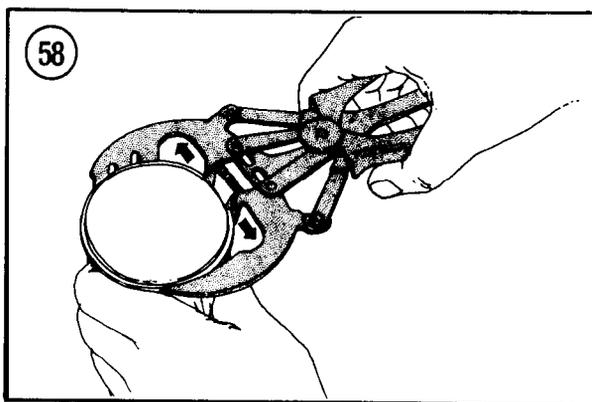
**Connecting Rod Bearing Clearance Measurement**

1. Place the connecting rods and upper bearing halves on the proper connecting rod journals.
2. Cut a piece of Plastigage the width of the bearing (**Figure 60**). Place the Plastigage on the journal, then install the lower bearing half and cap.

*NOTE*

*Do not place Plastigage over the journal oil hole.*

3. Tighten the connecting rod cap to specifications (**Table 3**). Do not rotate the crankshaft while the Plastigage is in place.
4. Remove the connecting rod cap. Bearing clearance is determined by comparing the width of

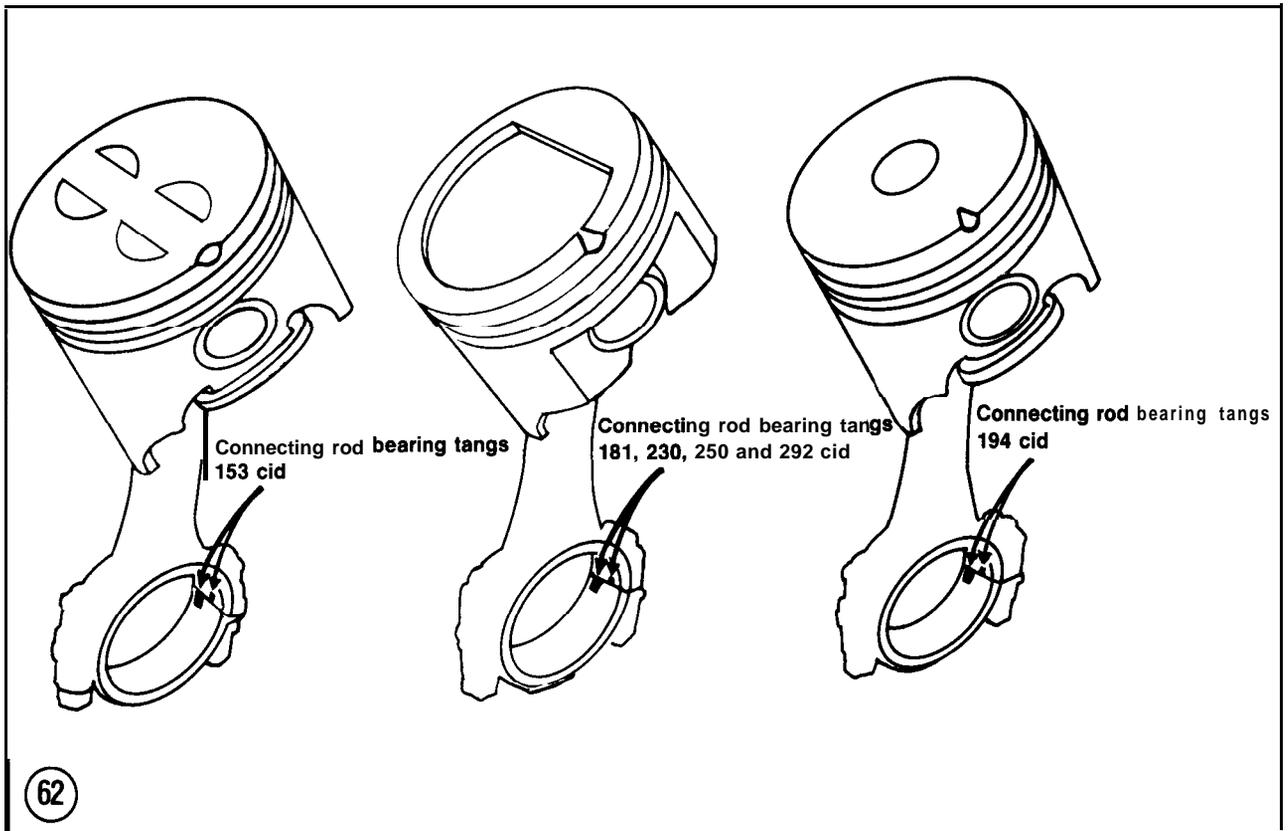
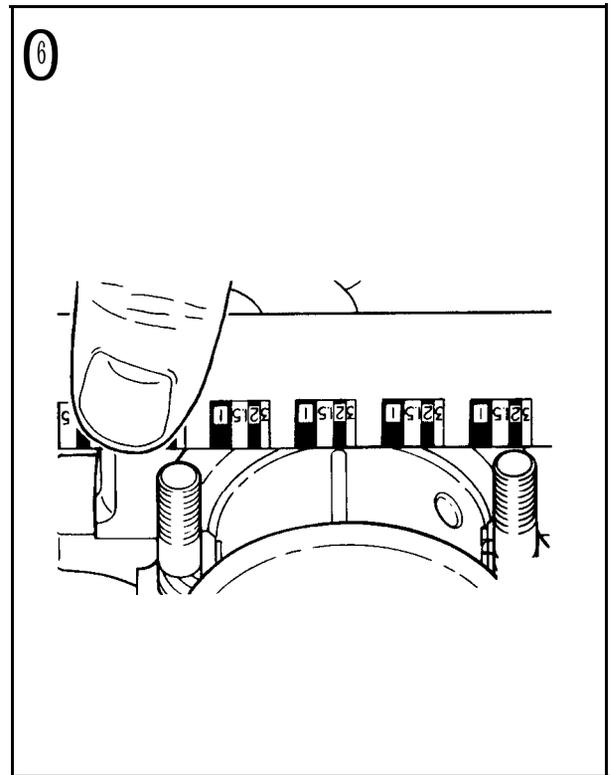


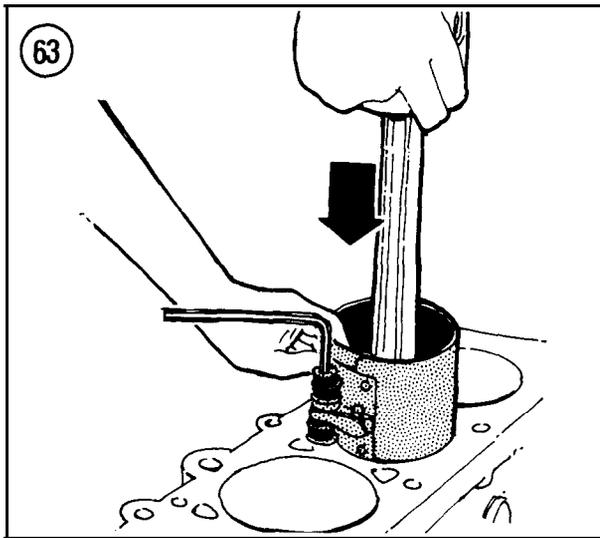
the flattened Plastigage to the markings on the envelope. See **Figure 61**. If the clearance is excessive, the crankshaft must be reground and undersize bearings installed.

### Installing Piston/Connecting Rod Assemblies

The No. 2 connecting rod on early 181 cid engines has a ground recess on the camshaft side to provide clearance for the camshaft fuel pump lobe. For this reason, the No. 2 rod on these engines **must** be reinstalled in its correct cylinder. If this connecting rod is replaced, the camshaft must also be replaced, as replacement rods are not ground for proper clearance and replacement cams have a smaller fuel pump lobe.

1. Make sure the pistons are correctly installed on the connecting rods. The small rod bearing tang should be on the same side as the arrow or notch in the piston head. See **Figure 62**.
2. Make sure the ring gaps are positioned as shown in **Figure 59**.



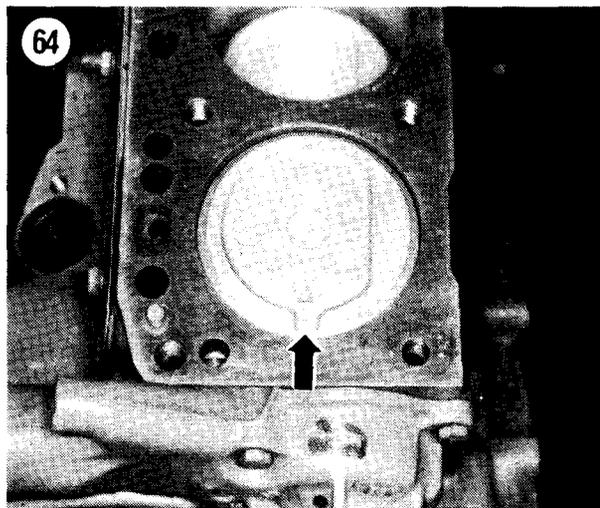


3. Slip short pieces of hose over the connecting rod studs to keep them from nicking the crankshaft. Tape will work if you do not have the right diameter hose, but it is more difficult to remove.
4. Immerse the entire piston in clean engine oil. Coat the cylinder wall with oil.
5. Install the piston/connecting rod assembly in its cylinder as shown in **Figure 63**. Make sure the number painted on the top of the piston before removal corresponds to the cylinder number.

**NOTE**

*The notch on the piston must face the front of the engine (Figure 64).*

**6**

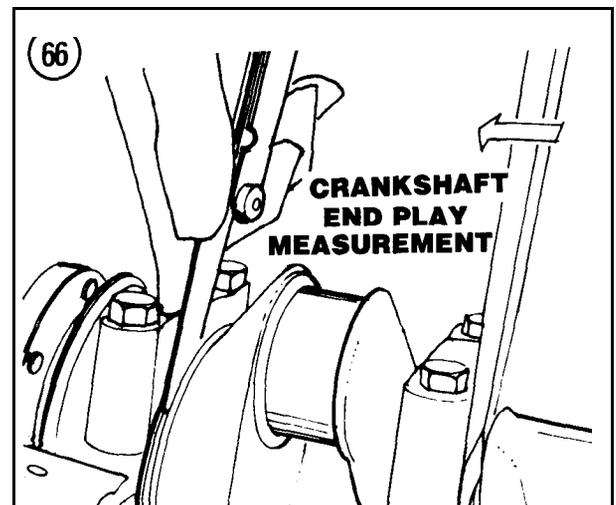
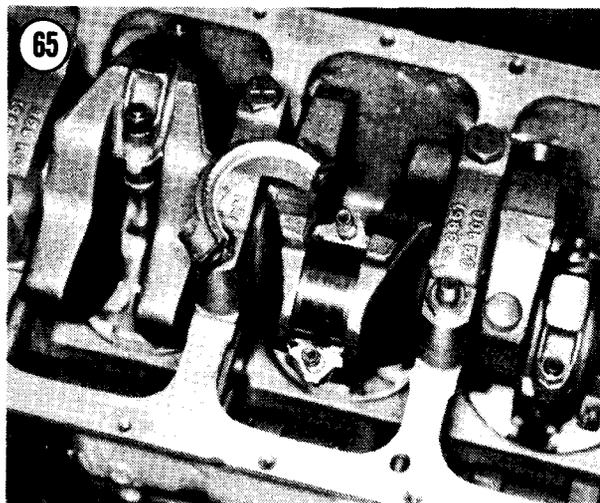


6. Clean the connecting rod bearings carefully, including the back sides. Coat the journals and bearings with clean engine oil. Place the bearings in the connecting rod and cap.
7. Remove the protective hose or tape and install the connecting rod cap (**Figure 65**). Make sure the rod and cap marks align. Tighten the cap nuts to specifications (**Table 3**).
8. Check the connecting rod big-end play as described under *Piston Removal*.

**CRANKSHAFT**

**End Play Measurement**

1. Pry the crankshaft to the front of the engine with a large screwdriver.
2. Measure the crankshaft end play between the front of the rear main bearing and the crankshaft thrust surface with a feeler gauge. **See Figure 66**. Compare to specifications (**Table 1** or **Table 2**).



3. If end play is excessive, replace the rear main bearing. If less than specified, check the bearing faces for imperfections.

### Removal

1. Remove the engine as described in this chapter.
2. Remove the flywheel as described in this chapter.
3. Mount the engine on an engine stand, if available.
4. Remove the starter.
5. Invert the engine to bring the oil pan to an upright position.
6. Remove the oil pan and oil pump as described in this chapter.
7. Remove the timing gear cover as described in this chapter.
8. Remove the spark plugs to permit easy rotation of the crankshaft.
9. Rotate the crankshaft to position one connecting rod at the bottom of its stroke.
10. Remove the connecting rod bearing cap and bearing (**Figure 65**). Move the piston/rod assembly away from the crankshaft.
11. Repeat Step 9 and Step 10 for each piston/rod assembly.
12. Unbolt and remove the main bearing caps with bearing inserts (**Figure 67**).

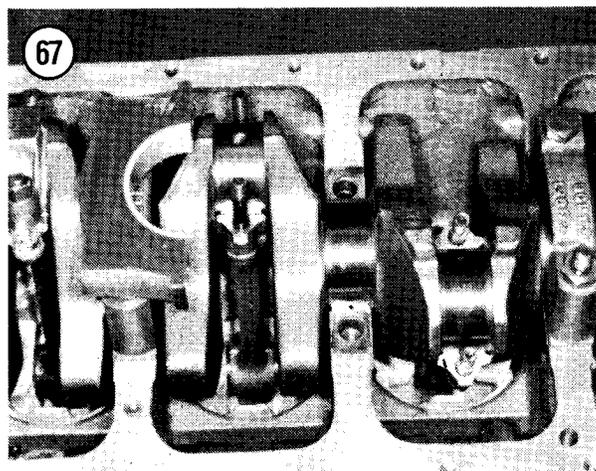
#### NOTE

*If the caps are difficult to remove, lift the bolts partway out, then pry the caps from side to side.*

13. Check the caps for identification numbers or marks. If none are visible, clean the caps with a wire brush. If marks still cannot be seen, make your own with quick-drying paint.
14. Carefully lift the crankshaft from the engine block. Lay the crankshaft, main bearings and bearing caps in order on a clean workbench.
15. Remove the main bearing oil seal from the cylinder block and rear bearing cap.

### Inspection

1. Clean the crankshaft thoroughly with solvent. Blow out the oil passages with compressed air.
2. Check the main and connecting rod journals for scratches, grooves, scoring or cracks. Check oil seal surface for burrs, nicks or other sharp edges which might damage a seal during installation.



#### NOTE

*If you do not have precision measuring equipment and know how to use it, have a machine shop perform Step 3.*

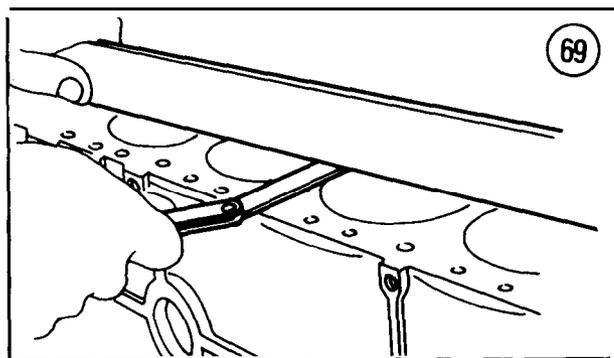
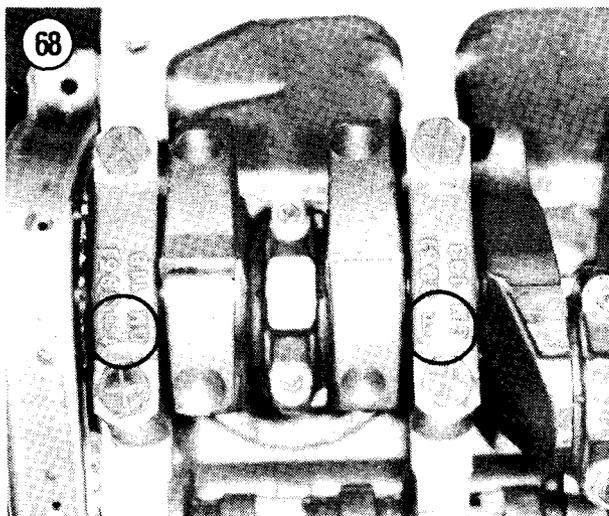
3. Check all journals and crankpins against specifications for out-of-roundness and taper. If necessary, have the crankshaft reground and install new undersize bearings.

### Main Bearing Clearance Measurement

Main bearing clearance is measured with Plastigage in the same manner as connecting rod bearing clearance, described in this chapter. Excessive clearance requires that the bearings be replaced, the crankshaft be reground or both.

### Installation

1. Install a new rear main bearing oil seal in the cylinder block and bearing cap grooves. Seal lip should face front of engine.
2. Lubricate seal lip with clean engine oil. Make sure oil is kept away from the parting line surface.
3. Install the main bearing inserts in the bores with their tangs engaging the slots provided in the block.
4. Install the main bearing inserts in the bearing caps.
5. Carefully lower the crankshaft into position in the block.
6. Install main bearing caps with their arrows pointing toward the front of the engine. **See Figure 68**.
7. Tighten all bearing caps except the rear main to 10- 12 ft.-lb. Tighten rear main cap to specifications (**Table 3**). Tap front of crankshaft with a hammer



to drive it rearward, then tap the rear to drive it forward. This aligns the rear main bearing and crankshaft thrust surfaces.

8. Retighten all main bearing caps to specifications (Table 3).

9. Measure crankshaft end play as described in this chapter.

10. Reverse Steps 1- 10 of *Removal* in this chapter.

### FLYWHEEL

#### Removal/Installation

1. Remove the engine as described in this chapter.
2. Remove the bell housing.
3. Remove the coupler retaining nuts and washers. Remove the coupler.
4. Unbolt and remove the flywheel.
5. To install, align dowel hole in flywheel with dowel hole in crankshaft flange and position flywheel on studs.

6. Fit drive coupling on studs. Install washers and locknuts. Tighten nuts to specifications.
7. Install bell housing.

#### Inspection

1. Visually check the flywheel surfaces for cracks, deep scoring, excessive wear, heat discoloration and checking.
2. Have the face **runout** checked with a dial indicator and compare to specifications.
3. Check surface flatness with a straightedge and feeler gauge.
4. Inspect the ring gear teeth for cracks, broken teeth or excessive wear. If severely worn, check the starter motor drive teeth for similar wear or damage. Replace as indicated.
5. Lubricate engine coupling splines with Multipurpose Lubricant (part No. C-92-63250). If boat is used mainly for trolling, use Universal Joint Lubricant (part No. C-92-74057A1) for better results.

### CYLINDER BLOCK

#### Cleaning and Inspection

1. Clean the block thoroughly with solvent. Remove any gasket residue from the machined surfaces. Check all core plugs for leaks and replace any that are suspect. See *Cove Plugs* in this chapter. Remove any plugs that seal oil passages. Check oil and coolant passages for sludge, dirt and corrosion while cleaning. If the passages are very dirty, have the block boiled out by a machine shop. Blow out all passages with compressed air. Check the threads in the head bolt holes to be sure they are clean. If dirty, use a tap to true up the threads and remove any deposits.
2. Examine the block for cracks. To confirm suspicions about possible leak areas, use a mixture of one part kerosene and 3 parts engine oil. Coat the suspected area with this solution, then wipe dry and immediately apply a solution of zinc oxide dissolved in wood alcohol. If any discoloration appears in the treated area, the block is cracked and should be replaced.
3. Check flatness of the cylinder block deck. Place an accurate straightedge on the block. If there is any gap between the block and straightedge, measure it with a feeler gauge. Measure from end to end and from corner to corner, as shown in **Figure 69**. Have block resurfaced if out of specifications.

4. Measure the cylinder bores with a bore gauge (Figure 70) as described in Step 2, *Piston Clearance Check* in this chapter. If the cylinders exceed maximum tolerances, they must be rebored. Reboring is also necessary if the cylinder walls are badly scuffed or scored. Before boring, install all main bearing caps and tighten the cap bolts to specifications in **Table 3**.

### CORE PLUGS

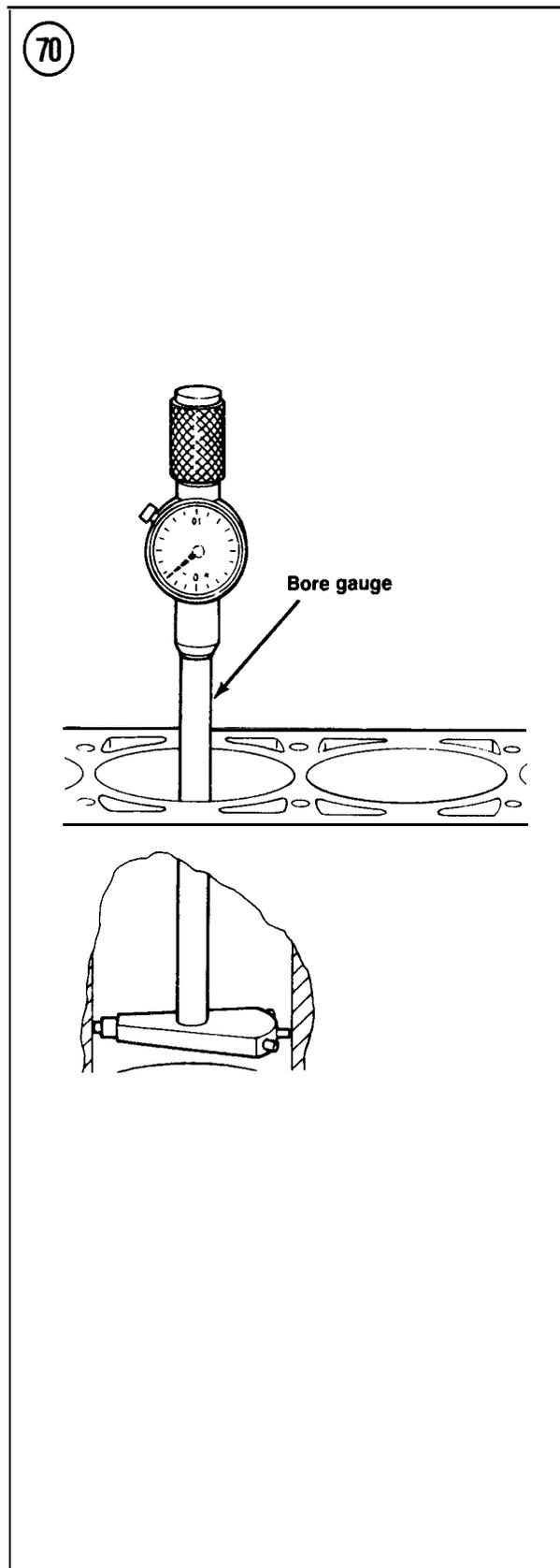
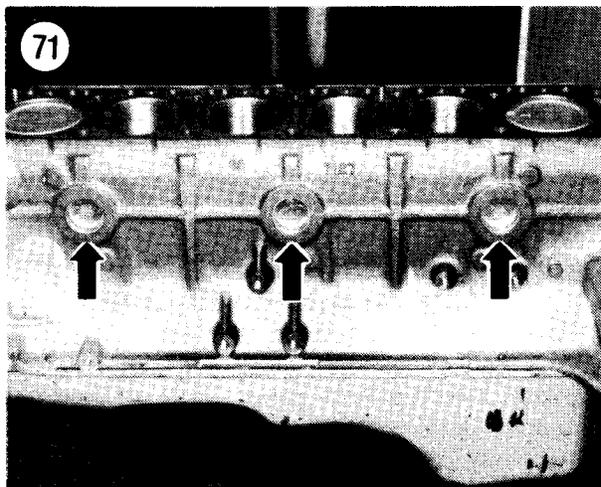
Check the condition of all core plugs in the block (Figure 71) and cylinder head whenever the engine is out of the boat for service. If any signs of leakage or corrosion are found around one plug, replace them all.

#### Removal/Installation

##### CAUTION

*Do not drive core plugs into the engine casting. It will be impossible to retrieve them and they can restrict coolant circulation, resulting in serious engine damage.*

1. Tap the bottom edge of the core plug with a hammer and drift. Use several sharp blows to push the bottom of the plug inward, tilting the top out (Figure 72).
2. Grip the top of the plug with pliers. Pull the plug from its bore (Figure 73) and discard.
3. Clean the plug bore thoroughly to remove all traces of the old sealer.
4. Apply a light coat of Loctite Stud N' Bearing mount or equivalent to the plug bore.
5. Install the new core plug with an appropriate size driver or socket. The sharp edge of the plug should be at least 0.02 in. inside the lead-in chamfer.



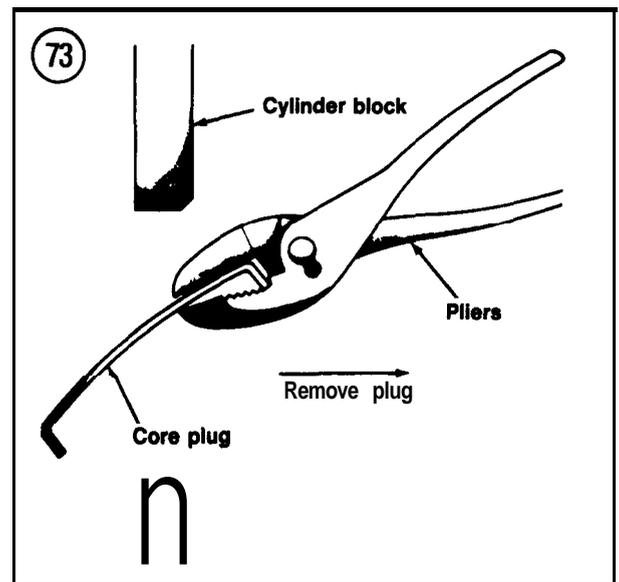
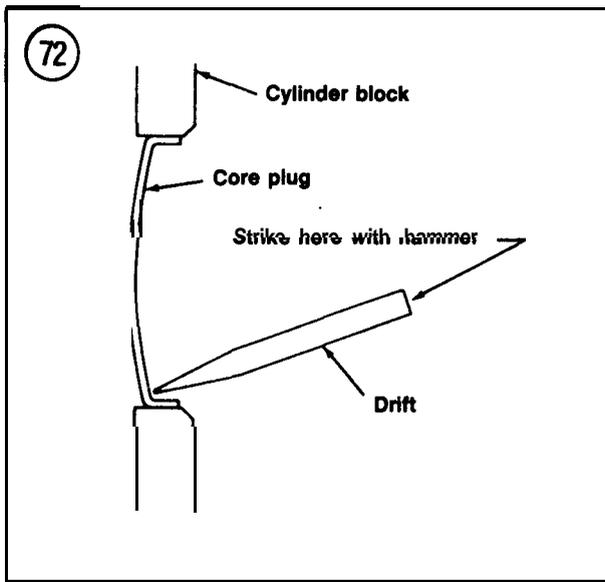


Table 1 **4-CYLINDER** ENGINE SPECIFICATIONS

Type	Inline 4-cylinder
Displacement	
Model 110 and 120	153 cid
Model 140	181 cid
Bore	
153 cid	3.875 in.
181 cid	4.000 in.
Stroke	
153 cid	3.25 in.
181 cid	3.80 in.
Cylinder numbering (front to rear)	1-2-3-4
Firing order	1-3-4-2
Cylinder bore	
Out-of-round	0.0005 in. max.
Taper	0.0005 in. max.
Head-to-block surface	0.005 in. per 8 ins.
Piston clearance	0.0005-0.0015 in.
Piston rings	
Groove clearance	
Top compression	0.0012-0.0027 in.
2nd compression	0.0012-0.0032 in.
Oil	0.000-0.005 in.
<b>Gap</b>	
Top compression	0.010-0.020 in.
2nd compression	0.010-0.030 in.
Oil	0.015-0.055 in.
Piston pin	
Diameter	0.9270-0.9273 in.
Clearance	0.00015-0.00025 in.
Fit in rod	0.0008-0.0016 interference

(continued)

Table 1 **4-CYLINDER** ENGINE SPECIFICATIONS (continued)

<b>Crankshaft</b>	
Main journal diameter	<b>2.2983-2.2993 in.</b>
Main journal taper	0.0002 in. max.
Main journal out-of-round	0.0002 in. max.
Main bearing clearance	<b>0.0003-0.0029 in.</b>
End play	<b>0.002-0.006 in. max.</b>
<b>Crankpin diameter</b>	
153 cid	<b>1.999-2.000 in.</b>
181 cid	<b>2.099-2.100 in.</b>
<b>Crankpin taper</b>	0.0003 in. max.
<b>Crankpin out-of-round</b>	0.0002 in. max.
<b>Connecting rod</b>	
<b>Bearing clearance</b>	
153 cid	0.0007-0.0027 in.
181 cid	0.0007-0.0028 in.
<b>Side clearance</b>	
153 cid	<b>0.0085-0.0135 in.</b>
181 cid	<b>0.009-0.013 in.</b>
<b>Camshaft</b>	
<b>Lobe lift</b>	
Model 110 (153 cid)	<b>0.1914 in.</b>
Model 120 (153 cid)	0.2325 in.
Model 140 (181 cid)	0.2525 in.
Journal diameter	<b>1.8882-1.8692 in.</b>
<b>Runout</b>	<b>0.0015 in. max.</b>
<b>Valves</b>	
Lifter	<b>Hydraulic</b>
Rocker arm ratio	<b>1.75:1</b>
Lash	<b>3/4 turn down from zero lash</b>
Face angle	45°
Seat angle	46°
Seat runout	0.002 in. max.
<b>Seat width</b>	
Intake	<b>1/32-1/16 in.</b>
Exhaust	<b>1/16-3/32 in.</b>
<b>Stem clearance</b>	
Intake	<b>0.0010-0.0027 in.</b>
Exhaust	<b>0.0015-0.0032 in.</b>
<b>Valve springs</b>	
<b>Free length</b>	
153 cid	2.08 in.
181 cid	<b>Not specified</b>
<b>Pressure</b>	
153 cid	
Closed	78-88 lb. @ 1.86 in.
Open	170-180 lb. @ 1.26 in.
181 cid	
Closed	83 lb. @ 1.66 in.
Open	175 lb. @ 1.26 in.
Installed height ( $\pm 1/32$ in.)	1.8562 in.
Damper free length 153 cid	1.94 in.

Table 2 **6-CYLINDER ENGINE SPECIFICATIONS**

<b>Type</b>	
<b>Displacement</b>	
Model 140	194 cid
Model 150	230 cid
Model 160 and 165	250 cid
Model 200	292 cid
<b>Bore</b>	
194 cid	3.56 in.
230 cid	3.675 in.
250 cid	3.675 in.
292 cid	3.875 in.
<b>Stroke</b>	
194 cid	3.25 in.
230 cid	3.25 in.
250 cid	3.53 in.
292 cid	4.12 in.
Cylinder numbering (front to rear)	1-2-3-4-5-6
Firing order	1-5-3-6-2-4
<b>Cylinder bore</b>	
Out-of-round	0.0005 in. max.
Taper	0.0005 in. max.
Head-to-block surface	0.005 in. per 6 ins.
<b>Piston clearance</b>	
194 cid	0.0006-0.0010 in.
230,250 cid	<b>0.0005-0.0015</b> in.
292 cid	0.0026-0.0032 in.
<b>Piston rings</b>	
<b>Groove clearance</b>	
Except 292 cid	
Top compression	<b>0.0012-0.0027</b> in.
2nd compression	0.0012-0.0032 in.
Oil	<b>0.000-0.005</b> in.
292 cid	
Top compression	<b>0.0020-0.0040</b> in.
2nd compression	<b>0.0020-0.0040</b> in.
Oil	<b>0.0005-0.0055</b> in.
<b>Gap</b>	
Top compression	0.010-0.020 in.
2nd compression	0.010-0.030 in.
Oil	0.015-0.055 in.
<b>Piston pin</b>	
Diameter	0.9270-0.9273 in.
<b>Clearance</b>	
Except 292 cid	<b>0.0015-0.00025</b> in.
292 cid	<b>0.025-0.00035</b> in.
Fit in rod	<b>0.0008-0.0016</b> interference

(continued)

Table 2 &CYLINDER **ENGINE** SPECIFICATIONS (continued)

<b>Crankshaft</b>	
Main journal diameter	2.2993-2.2993 in.
Main journal taper	0.0002 in. max.
Main journal out-of-round	0.0002 in. max.
Main bearing clearance	
194 cid	<b>0.0008-0.0034</b> in.
230, 250 cid	<b>0.0003-0.0029</b> in.
292 cid	<b>0.0008-0.0034</b> in.
End play	0.002-0.006 in. max.
<b>Crankpin</b> diameter	1.999-2.000 in.
<b>Crankpin</b> taper	0.0093 in. max.
<b>Crankpin</b> out-of-round	0.0002 in. max.
<b>Connecting rod</b>	
Bearing clearance	
194, 230, 250 cid	0.0007-0.0027 in.
292 cid	0.0007-0.0028 in.
Side clearance	<b>0.0085-0.0135</b> in.
194 cid	0.0008-0.0014 in.
230, 250, 292 cid	0.0085-0.0135 in.
<b>Camshaft</b>	
Lobe lift	
194, 230 cid	0.1914 in.
250 cid	0.2297 in.
292 cid	0.2525 in.
Journal diameter	1.8682-1.8692 in.
<b>Runout</b>	0.0015 in. max.
<b>Valves</b>	
Lifter	Hydraulic
Rocker arm ratio	<b>1.75:1</b>
Lash	<b>3/4 turn</b> down from zero lash
Face angle	
Intake	45°
Exhaust	
194, 230, 250 cid	45°
292 cid	46°
Seat angle	46°
Seat runout	0.002 in. max.
Seat width	
Intake	
194, 292 cid	<b>1/32-1/16</b> in.
230, 250 cid	<b>1/32-3/32</b> in.
Exhaust	<b>1/16-3/32</b> in.
Stem clearance	
Intake	0.0010-0.0027 in.
Exhaust	0.0015-0.0032 in.

(continued)

Table 2 **6-CYLINDER** ENGINE SPECIFICATIONS (continued)

Valve springs	
Free length	
194 cid	2.03 in.
230, 250, 292 cid	1.90 in.
Pressure	
194 cid	
Closed	84-92 lb. @ 1.88 in.
Open	183-173 lb. @ 1.33 in.
230 cid	
Closed	54-84 lb. @ 1.80 in.
Open	170-184 lb. @ 1.33 in.
250 cid	
Closed	54-84 lb. @ 1.88 in.
Open	180-192 lb. @ 1.27 in.
292 cid	
Closed	85-93 lb. @ 1.89 in.
Open	174-184 lb. @ 1.30 in.
Installed height ( ± 1/32 in.)	
Except 292 cid exhaust	1.8582 in.
292 cid exhaust	1.825 in.
Damper free length	
292 cid	1.94 in.

Table 3 TIGHTENING TORQUES

Fastener	ft.-lb.
Camshaft thrust plate	8
Carburetor flange bolts	12
Connecting rod cap nuts	
11/32-24	33
3/8-24	40
Crankshaft pulley	18
Coupling-to-flywheel	80
1987	35
All others	
Cylinder head bolts	93
Distributor clamp	20
Flywheel housing-to-block	21
Front mount-to-block	21
Main bearing cap	85
Manifold-to-head	23
Oil pan	
Side screws	7
End screws	10
Drain plug	23
Oil pump	
Cover	8
To block	10
Pickup	5
Rocker arm cover	4
Spark plugs	
With gasket	25
Without gasket	15
Timing gear cover	8
Water pump-to-block	15