

## Chapter Eight

# Ford V8 Engines

The 302 cid and 351 W cid Ford engines are lightweight, small block **V8** designs. Both use a 4 in. bore; the 302 cid has a shorter stroke than the 351 W. The 2 engines are closely related in design, but the 351 W has a taller block with longer **pushrods** and connecting rods.

The cylinders are numbered from front to rear: 1-2-3-4 on the starboard bank and 5-6-7-8 on the port bank. Valve arrangement from front to rear is I-E-I-E-I-E-I-E on the starboard bank and E-I-E-I-E-I-E-I on the port bank. The cylinder firing order is 1-3-7-2-6-5-4-8.

The 302 cid engine is used with Models 888, 215, 225-S, 225-TR and **225II-TR**. The 351 cid engine is used with Models 233, **255-TR**, **255II-TR** and **255-TRS** (serial No. 4175499 and below).

Hydraulic valve lifters and **pushrods** operate the rocker arms and valves. No lash adjustment is necessary in service or during assembly unless some component in the valve train has been replaced.

The crankshaft is supported by 5 main bearings, with the No. 3 bearing taking the end thrust. Crankshaft rotation is counterclockwise when seen from the drive unit end of the engine.

The chain-driven camshaft is supported by 5 bearings and is located above the crankshaft between the 2 cylinder banks.

The oil pump is located on the bottom front of the block and is driven by the distributor through an intermediate shaft.

**Figure 1** shows the internal components typical of the 302 and 351W engine.

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

### ENGINE SERIAL NUMBER

The engine serial number is stamped on a plate mounted either on the rear top of the cylinder block between the intake manifold and flywheel housing (**Figure 2**) or on the end of the cylinder head at the rear of the engine (**Figure 3**).

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 Ford engine overhaul, the tool numbers are provided. Mercury Marine part numbers have a "C" prefix. Ford part numbers are identified by name. While Ford tools can sometimes be rented from rental dealers, they can

be purchased from Owatonna Tools, Inc., Attn: Ford Order Desk, Owatonna, Minnesota 55060.

### 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.

### 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.

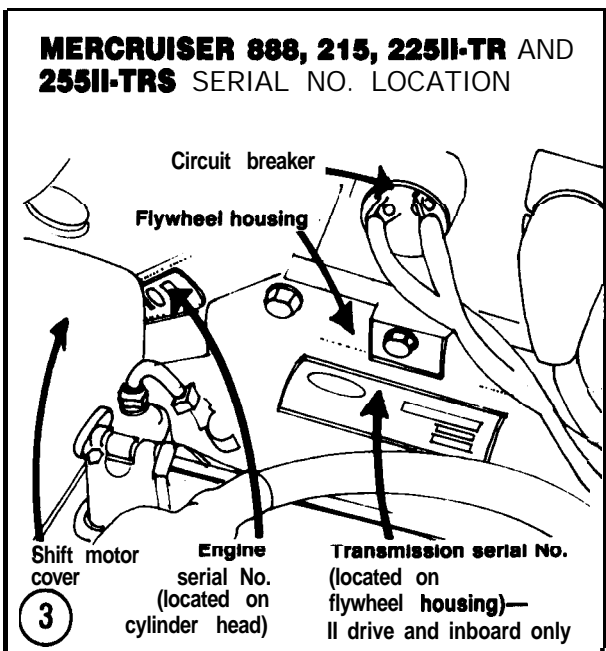
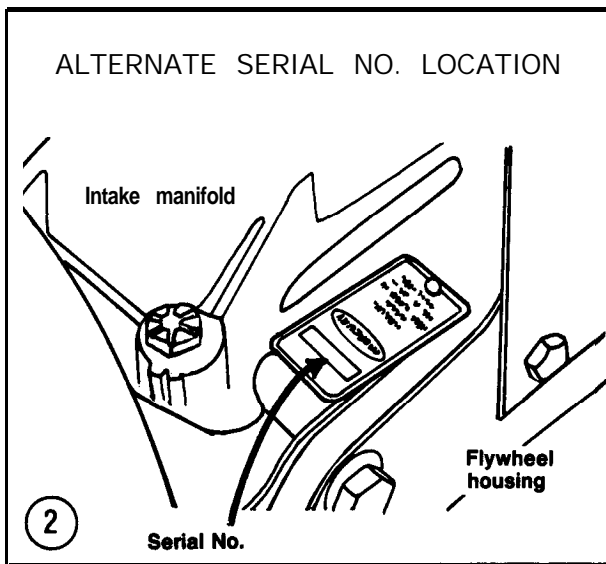
#### WARNING

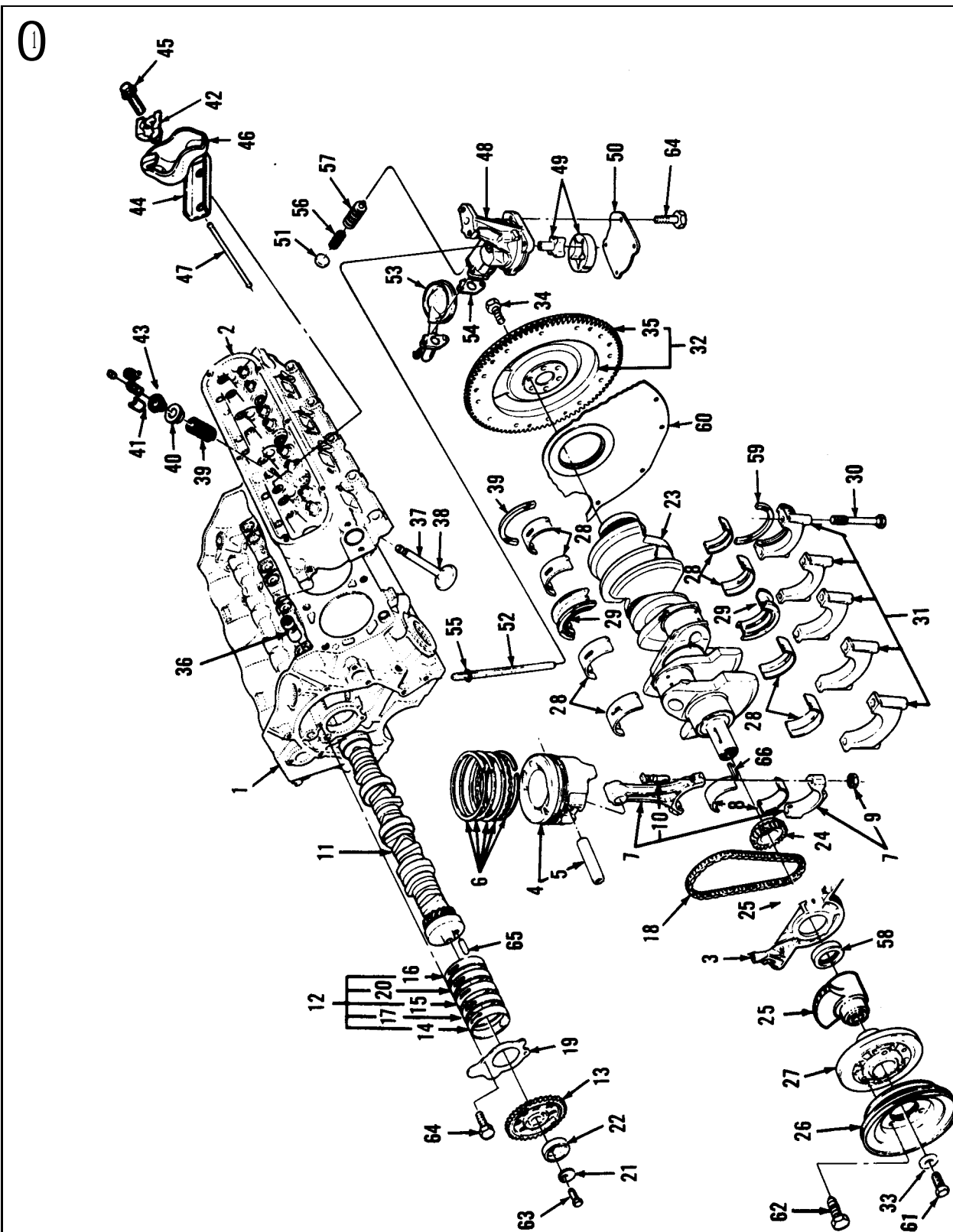
*The engine is heavy, awkward to handle and has sharp edges. It may shift or drop suddenly during removal. To prevent serious injury, always observe the following precautions.*

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.





**ENGINE INTERNAL VIEW**  
**302/351W CID V8**

- |   |   |  |
|---|---|--|
| 1. <b>Block</b> assembly                | 23. Crankshaft assembly                       | 45. <b>Valve</b> rocker arm attaching <b>bolt</b>      |
| 2. Cylinder head                        | 24. Crankshaft sprocket                       | 48. Valve rocker <b>arm</b>                            |
| 3. cylinder front <b>plate</b>          | 25. Crankshaft oil slinger                    | 47. Valve <b>pushrod</b>                               |
| 4. Piston assembly                      | 28. <b>Pulley assembly</b>                    | 48. Oil pump assembly                                  |
| 5. Piston <b>pin</b>                    | 27. Crankshaft damper assembly                | 49. Oil pump drive rotor and shaft assembly            |
| 6. Piston ring set                      | 28. Crankshaft main bearing (except center)   | 50. Oil pump body plate                                |
| 7. Connecting rod assembly              | 29. Crankshaft bearing (center)               | 51. Oil pump relief <b>valve</b> plug                  |
| 8. Connecting rod bearing               | 39. Crankshaft main bearing cap <b>bolt</b>   | 52. Oil pump <b>intermediate</b> shaft <b>assembly</b> |
| 9. Connecting rod nut                   | 31. <b>Main bearing cap</b>                   | 53. Oil pump screen, tube, and cover assembly          |
| 10. Connecting rod <b>bolt</b>          | 32. Flywheel assembly                         | 54. Oil pump inlet tube gasket                         |
| 11. Camshaft                            | 33. Crankshaft <b>pulley</b> retaining washer | 55. Oil pump intermediate shaft O-ring                 |
| 12. Camshaft bearing kit (standard)     | 34. Flywheel-to-crankshaft <b>bolt</b>        | 58. Oil pump <b>relief valve</b> spring                |
| 13. Camshaft sprocket                   | 35. flywheel ring gear                        | 57. Oil pump <b>relief</b> valve plunger               |
| 14. Camshaft front bearing              | 38. Hydraulic tappet assembly                 | 58. Cylinder front seal                                |
| 15. Camshaft center bearing             | 37. Exhaust <b>valve</b>                      | 59. Crankshaft rear packing                            |
| 18. Camshaft rear bearing               | 38. Intake valve                              | 80. Engine rear plate                                  |
| 17. Camshaft front intermediate bearing | 39. Valve spring                              | 81. <b>Bolt</b>  |
| 18. timing chain                        | 49. Valve spring retainer                     | 82. Bolt   |
| 19. Camshaft thrust plate               | 41. Valve spring retainer key                 | 83. Bolt   |
| 20. Camshaft rear intermediate bearing  | 42. <b>Valve</b> rocker arm fulcrum seat      | 84. Bolt   |
| 21. Camshaft sprocket washer            | 43. Valve stem seal                           | 85. Dowel pin  |
| 22. Two-piece fuel pump eccentric       | 44. Valve <b>pushrod</b> valley <b>baffle</b> | 88. Woodruff key                                       |

3. Disconnect the throttle cable at the carburetor (A, **Figure 4**). If necessary, remove cable from anchor plate (B, **Figure 4**).
4. Disconnect the engine-to-dash wiring harness.
5. Disconnect the fuel lines at the fuel pump. Plug the fuel lines to prevent leakage.
6. Disconnect the water inlet hose.
7. Disconnect the exhaust elbow bellows.
8. Disconnect the shift cable from the flywheel housing or exhaust manifold.
9. Open the engine drain valve(s) and drain all water from the block.
10. 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.*

11. Remove the bell housing-to-engine bolts.
12. Remove the engine mount-to-deck mount bolts.
13. If clearance is limited, remove the engine mounting brackets.
14. Slide the engine forward sufficiently to disengage it from the drive shaft assembly.
15. Remove the engine from the boat with the hoist.

### ENGINE INSTALLATION

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

1. Use guide bolts to align the engine to the bell housing. 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.
2. Coat the engine coupling splines with multi-purpose lubricant.

#### CAUTION

*If the alignment tool specified in Step 3 is not available, take the boat to a MerCruiser dealer for proper alignment. Drive shaft/coupling spline misalignment can cause serious damage.*

3. Coat the solid end of alignment tool part No. C-91-57797A3 with multi-purpose lubricant and insert it from outside the boat through the U-joint

bellows into the gimbal bearing. Index the bearing and drive shaft with the engine coupling splines. If indexing is difficult, raise or lower the engine with the hoist as required to permit indexing with no resistance.

4. Tighten all fasteners to specifications (**Table 2**). Remove the alignment tool.
5. Close all water drain valves.
6. Fill the engine with an oil recommended in Chapter Four.
7. Fill the cooling system, if equipped with a closed system. See Chapter Twelve.
8. Adjust the drive belts. See Chapter Thirteen.

### DISASSEMBLY CHECKLISTS

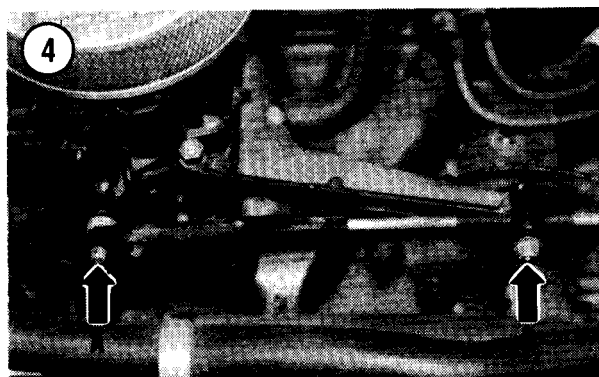
To use the checklists, remove and inspect each part in the order mentioned. To reassemble, go through the checklists backwards, installing the parts in order. Each major part is covered under its own heading in this chapter, unless otherwise noted.

#### Decarbonizing or Valve Service

1. Remove the rocker arm cover.
2. Remove the intake and exhaust manifolds.
3. Remove the rocker arm.
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 chain 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

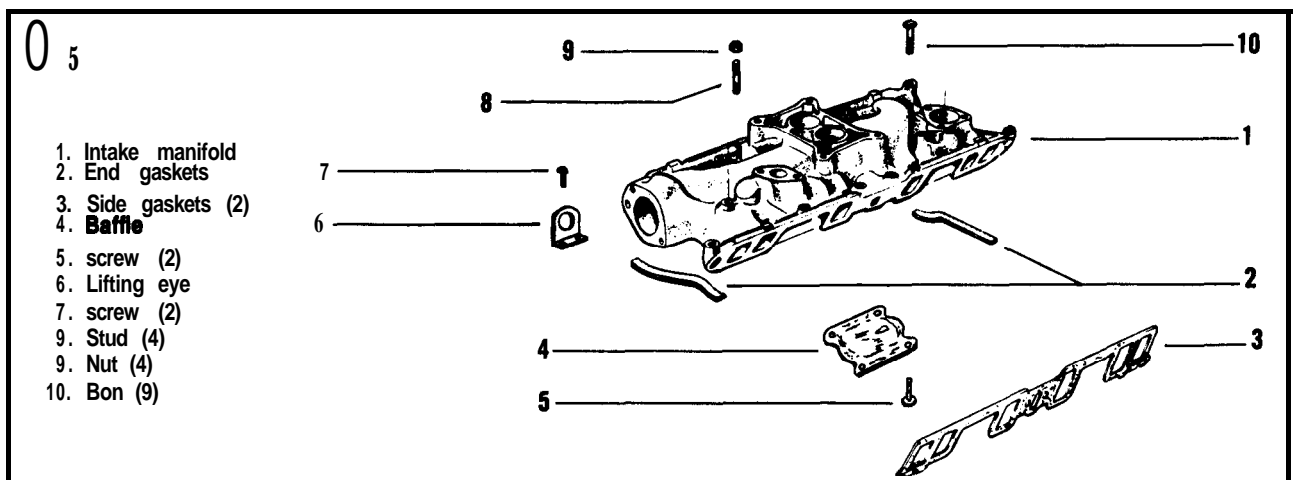
1. Remove the carburetor vent hose from the starboard cover.
2. Disconnect the spark plug cables at the plugs and remove the plug cable retainers from their brackets on the cover.
3. Remove the cover attaching screws.
4. Tap the rocker arm cover with a plastic mallet to break the gasket seal. Remove 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 2).
9. Install the spark plug cable retainers on the rocker arm cover brackets. Connect the wires to the appropriate spark plugs.
10. Install the carburetor vent hose in the rocker arm cover.

### INTAKE MANIFOLD

#### Removal/Installation

Refer to Figure 5 for this procedure.

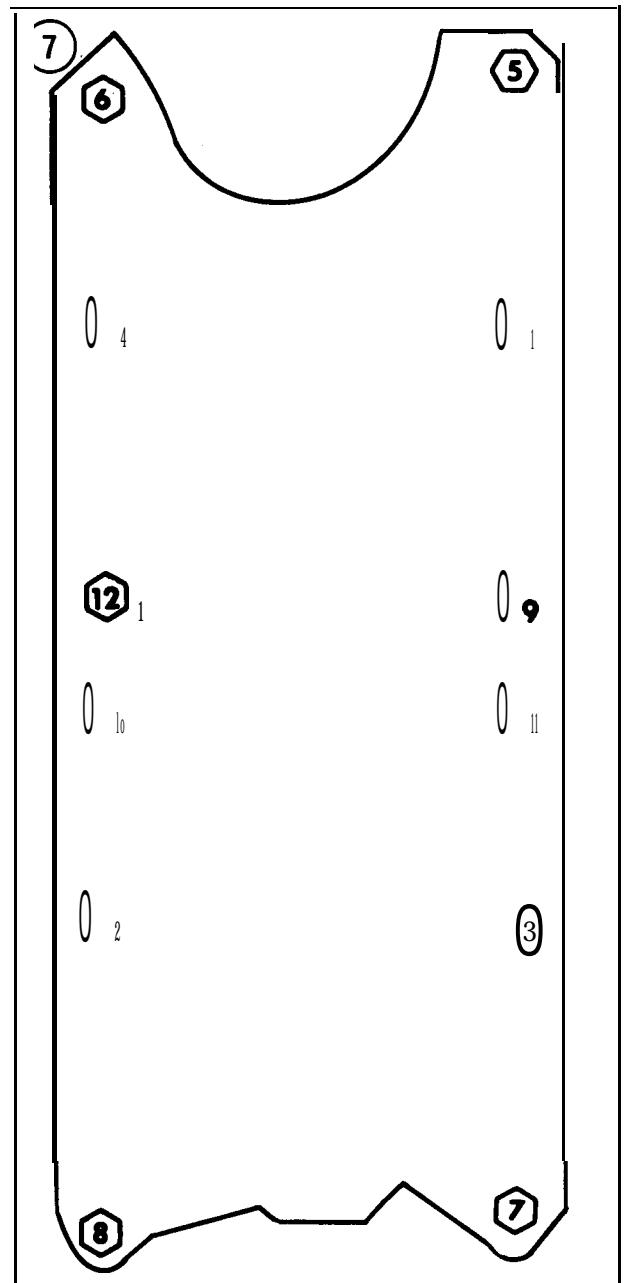
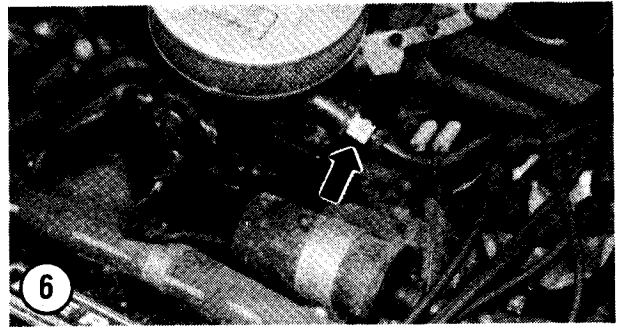
1. Disconnect the negative battery cable.
2. Disconnect the crankcase vent hose at the starboard rocker cover. Remove the flame arrestor.



3. Open the cylinder block water drain(s) and allow all water to drain.
4. Remove the coil bracket bolt. Move the coil to one side out of the way.
5. Disconnect the temperature sender leads.
6. Disconnect the spark plug cables. Remove the cable retainers from the rocker arm covers. Remove the distributor cap and place cap with plug cables attached to one side out of the way.
7. Mark the position of the distributor rotor relative to the engine block. Loosen the hold-down clamp and remove the distributor. See Chapter Thirteen.
8. Remove the thermostat housing bolts.
9. Disconnect the fuel inlet line at the carburetor (**Figure 6**). Plug the line to prevent leakage.
10. Disconnect the throttle cable linkage at the carburetor. See **Figure 4**.
11. Remove the bolts and stud nuts holding the intake manifold in place.
12. Pry the intake manifold loose and remove it from the engine.
13. Remove and discard the intake manifold gaskets and seals. Discard the attaching bolt sealing washers.
14. Clean all gasket residue from the block, cylinder heads and intake manifold with degreaser and a putty knife.
15. Coat the cylinder block sealing surfaces with Perfect Seal (part No. C-92-34227).
16. Install new seals on the cylinder block. Install new gaskets on the cylinder heads. Make sure gaskets interlock with seal tabs and holes in gaskets are aligned with holes in cylinder heads.
17. Lower intake manifold into position on cylinder block. Check seal area to make sure seals are in their proper position. If not, remove the manifold, correct the seal positioning and reinstall manifold.
18. Install manifold attaching bolts/nuts with new sealing washers. Tighten manifold fasteners to specifications (**Table 2**) in the sequence shown in **Figure 7**.
19. Reverse Steps 1-10 to complete installation.

### Inspection

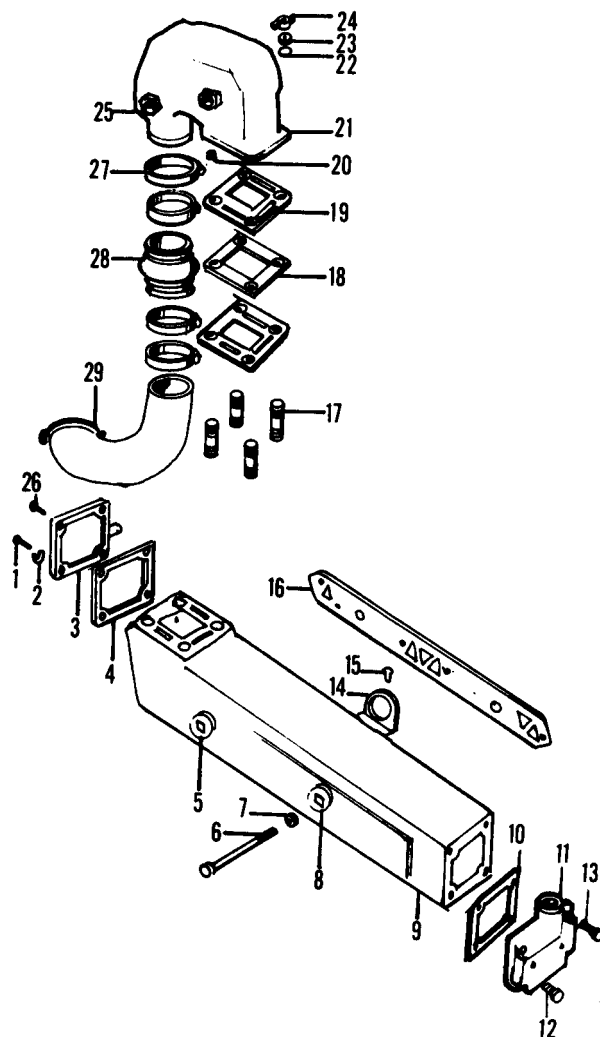
1. Check manifold for cracks or distortion. Replace as required.
2. Check gasket surfaces for nicks or burrs. Small burrs may be removed with an oilstone.
3. Place a straightedge across the manifold gasket surfaces. If there is any gap between the gasket



8

STARBOARD EXHAUST  
MANIFOLD (TYPICAL)

1. Screw
2. Clip
3. End cap
4. **Gasket**
5. Water drain plug
6. Screw
7. Washer
8. Plug
9. Exhaust manifold
10. **Gasket**
11. End cap
12. Screw
13. screw
14. Lifting eye
15. Screw
16. **Gasket**
17. Stud
19. Exhaust elbow plate
19. **Gasket**
20. Water drain plug
21. Exhaust elbow
22. Lockwasher
23. Nut
24. Fitting
25. Plug
29. Screw
27. Clamp
29. Exhaust bellows
29. Exhaust elbow



surface and straightedge, measure it with a feeler gauge. Measure from end to end and corner to corner.

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

## EXHAUST MANIFOLDS

## Removal/Installation

Refer to **Figure 8** for this procedure.

1. Disconnect the negative battery cable.
2. Open the cylinder block water drain(s) and allow all water to drain.

3. Remove the manifold cooling hose.

4. Remove dipstick bracket and fuel filter mount from port manifold.

5. Remove solenoid bracket, if so equipped.

6. Disconnect the exhaust hoses. Drain any water remaining in the manifold housing and elbow.

7. Remove attaching nuts, bolts and washers. Remove the manifold.

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

9. Install manifold on cylinder head with a new gasket. Tighten fasteners to specifications (**Table 2**) working from the center to the ends.

10. Reverse Steps 1-6 to complete installation.



**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 AND VIBRATION DAMPER

**Removal/Installation**

Refer to **Figure 9** for this procedure.

1. Remove alternator drive belt. See Chapter Thirteen.
2. Remove pulley attaching bolts. Remove pulley.
3. Remove vibration damper retaining bolt.

**NOTE**

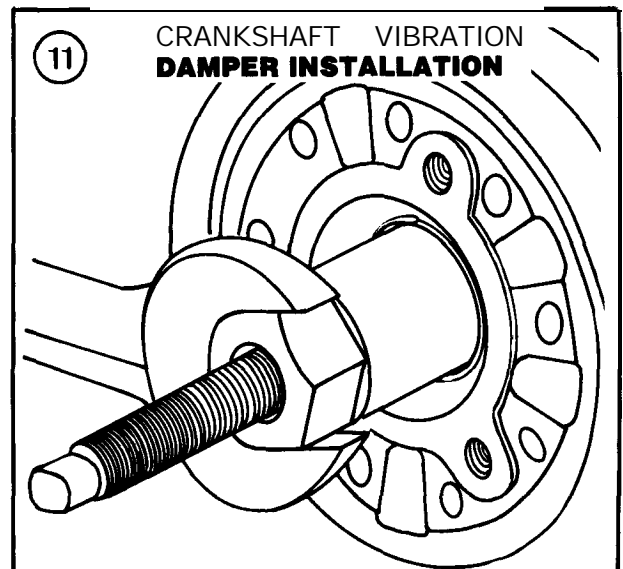
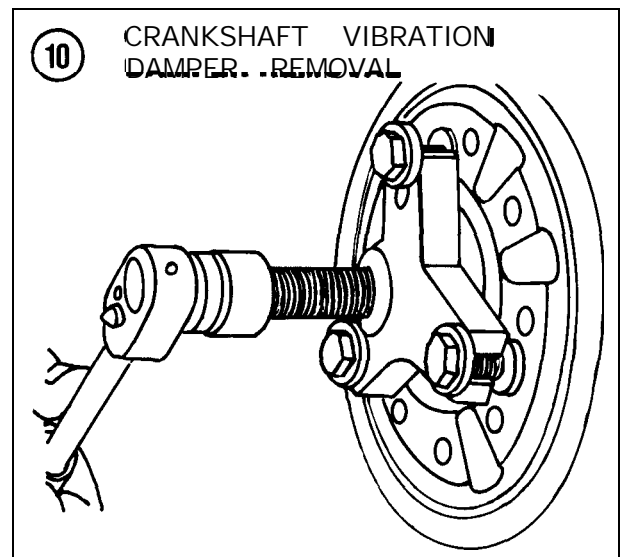
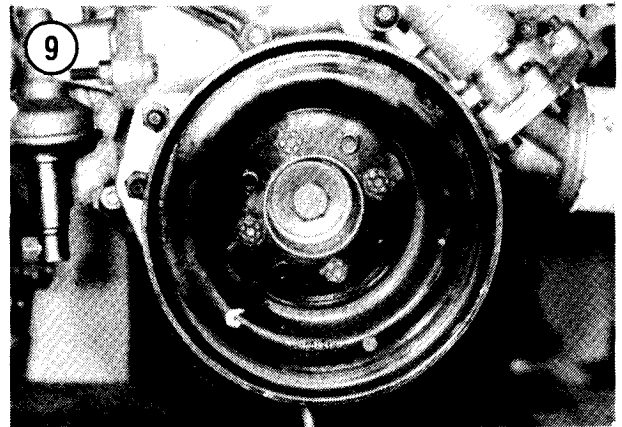
*If a 3-leg puller is not available, a universal puller can be used in Step 4.*

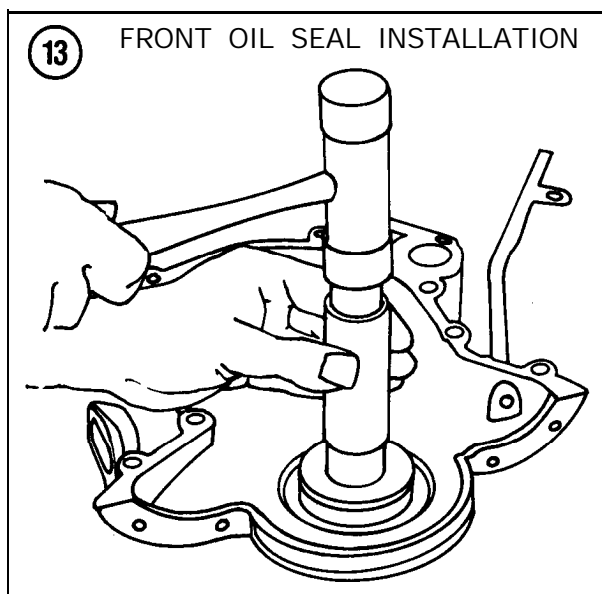
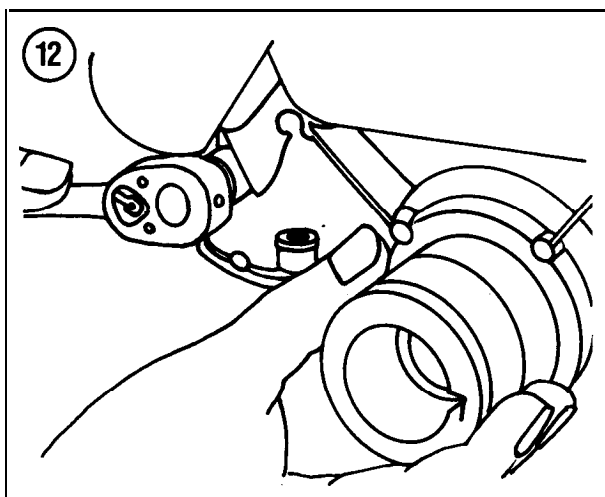
4. Install a 3-leg puller as shown in **Figure 10** and remove vibration damper.
5. Coat the front of the crankshaft and the oil seal rubbing surface on the inner hub of the vibration damper with Ford polyethylene grease (part No. DOAZ- 19584-A) or equivalent to prevent damage to the front cover seal.
6. Position vibration damper on crankshaft and install Ford tool part No. T52L-6306-AEE or T52L-6306-AJ. See **Figure 11**. Draw vibration damper onto crankshaft and remove tool.
7. Install damper retaining bolt/washer and tighten to specifications (**Table 2**).
8. Install pulley and tighten attaching bolts to specifications (**Table 2**).
9. Install and adjust alternator drive belt. See Chapter Thirteen.

### FRONT COVER AND SEAL

**Front Cover Removal/Installation**

This procedure can generally be performed without removing the engine from the boat,





provided you are careful in cutting the gasket in Step 9.

1. Open the engine drain valve(s) and drain all the water from the block.
2. Drain the crankcase. See Chapter Four.
3. Remove the alternator and seawater pump as an assembly. See Chapter Thirteen.
4. Remove any accessory brackets attached to the circulating water pump. Remove the pump pulley and drive belt.
5. Disconnect the outlet line to the fuel pump. Plug the line to prevent leakage.
6. Remove the fuel pump with the inlet line still attached and move pump out of the way. See Chapter Eleven.

7. Remove the crankshaft pulley/vibration damper as described in this chapter.
8. Remove the bolts holding the front of the oil pan to the front cover.
9. Use a sharp X-acto knife to cut the oil pan gasket flush with the cylinder block face.
10. Remove the front cover bolts. Remove the cover and water pump as an assembly.
11. Remove and discard the front cover gasket.
12. Clean the gasket mounting surfaces on the block and cover with degreaser and a putty knife.
13. Lubricate the timing chain with engine oil.
14. Coat the gasket surfaces of the block and front cover with Perfect Seal (part No. C-92-34227) or equivalent and install a new gasket on the block.
15. Use the cut portion of the oil pan gasket as a template and cut a matching section from a new gasket for use in Step 16.
16. Coat the exposed surface of the oil pan flange with Perfect Seal (part No. C-92-34227) or equivalent and install the gasket portion cut in Step 15. Coat the exposed gasket surface with Perfect Seal.
17. Position the front cover on the engine block. Work carefully to prevent damage to the oil seal or movement of the gaskets.
18. Install Ford alignment tool part No. T61P-6019-B or T61P-6059-F as shown in Figure 12.
19. Apply downward pressure on the cover and install the oil pan attaching screws.
20. Coat the attaching bolt threads with Perfect Seal (part No. C-92-34227) or equivalent. Install the bolts. Tighten cover bolts and oil pan screws to specifications (Table 2).
21. Remove the alignment tool and reverse Steps 1-7 to complete installation.

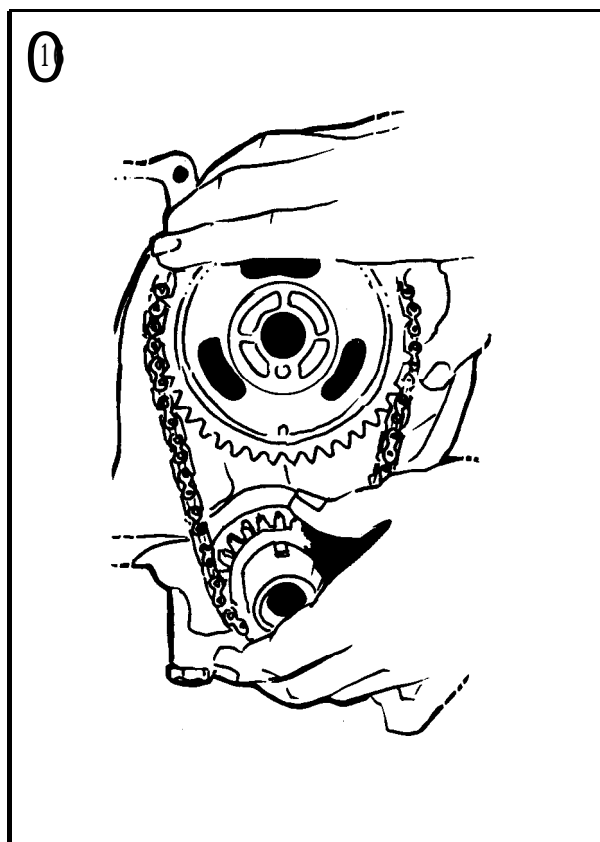
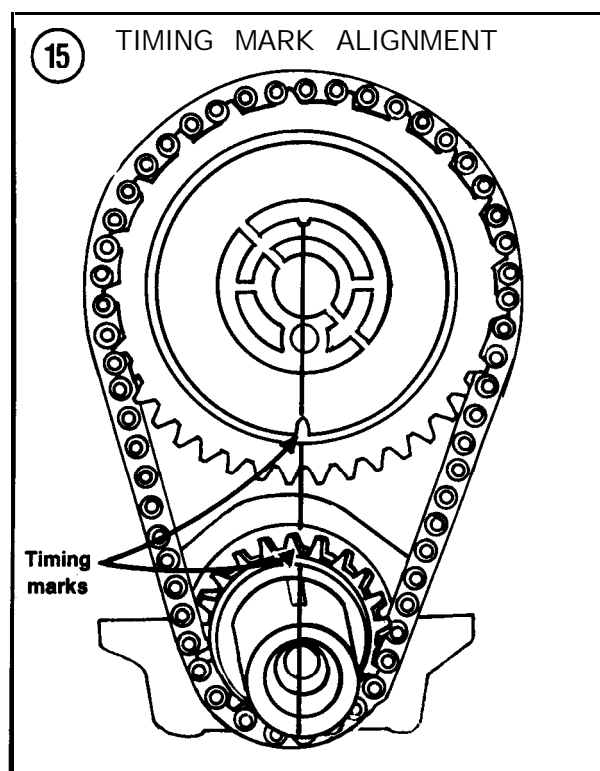
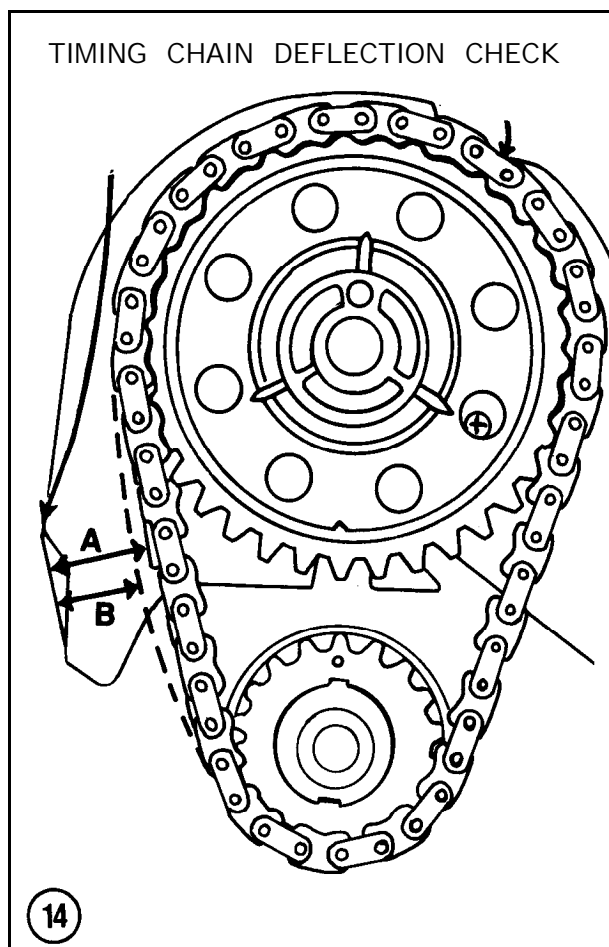
### Front Cover Seal Replacement

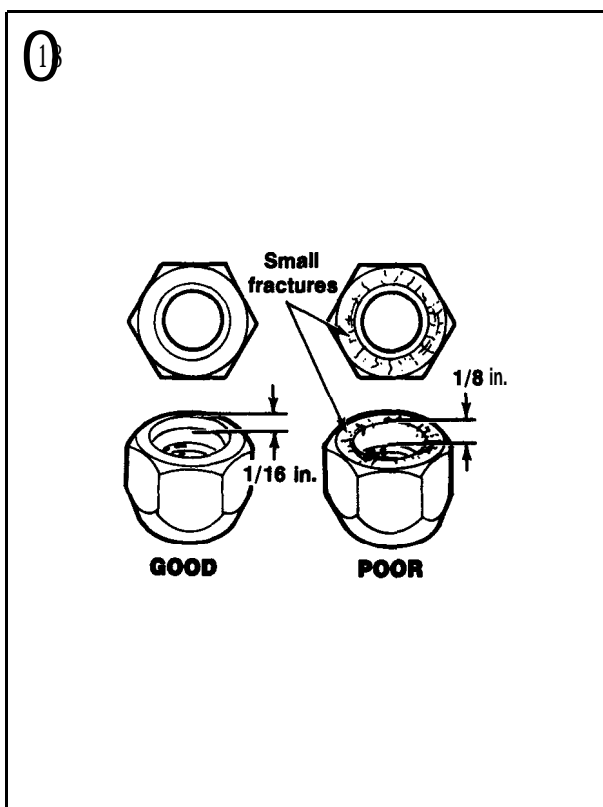
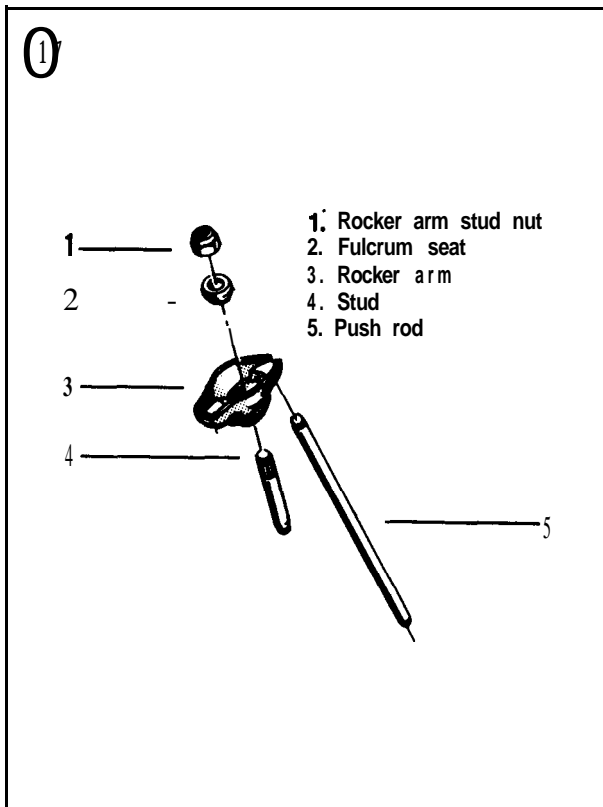
1. Remove front cover as described in this chapter.
2. Place cover on a clean flat workbench surface.
3. Use a pin punch to drive out the old seal.
4. Clean the seal recess in the cover with solvent and blow dry.
5. Wipe a new seal with Ford polyethylene grease (part No. DOAZ-19584-A) or equivalent.
6. Position new seal in cover recess and install with Ford seal installer part No. T58P-6700-B. See Figure 13.
7. Check seal to make sure it is fully seated and that the seal spring is properly positioned.
8. Install front cover as described in this chapter.

## TIMING CHAIN AND SPROCKET

## Removal

1. Remove the front cover as described in this chapter.
2. Remove the crankshaft oil slinger.
3. Rotate crankshaft clockwise to take up slack on left side of chain. Measure distance A, **Figure 14**, then rotate crankshaft counterclockwise to take up slack on right side of chain. Force left side of chain outward with fingers, then measure distance B, **Figure 14**. Subtract B from A to determine timing chain deflection. If the difference or deflection is greater than 0.5 in., replace the timing chain and sprockets during reassembly.
4. Rotate crankshaft until sprocket timing marks are positioned as shown in **Figure 15**.
5. Remove camshaft sprocket cap screw, washers and fuel pump eccentric.
6. Grasp the 2 sprockets and timing chain as an assembly and slide forward to remove from engine.





### Installation

1. Assemble the timing chain to the camshaft and crankshaft sprockets with the sprocket timing marks aligned as shown in **Figure 15**.
2. Install the timing chain/sprocket assembly to the camshaft and crankshaft (**Figure 16**). Recheck to make sure the timing marks are properly positioned.
3. Install the fuel pump eccentric, washers and camshaft sprocket cap screw. Tighten the cap screw to specifications (**Table 2**).
4. Install the crankshaft oil slinger.
5. Install the front cover as described in this chapter.

### ROCKER ARM ASSEMBLIES

#### Removal/Installation

1. Remove the rocker arm cover as described in this chapter.
2. Remove each rocker arm stud nut, fulcrum seat, rocker arm and **pushrod**. See **Figure 17**.
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.
4. Coat the top of each valve stem and fulcrum seat with Lubriplate or equivalent. Lubricate the rocker arms with heavy engine oil.
5. Install the pushrods, making sure that each fits into its lifter cup.
6. Install the rocker arms, fulcrum seats and stud nuts.
7. Check the valve clearances as described in this chapter.
8. 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, fulcrum seat and **pushrod** for scuffing, pitting or excessive wear.
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. Inspect stud nuts for damage as shown in **Figure 18**. If the nut chamfer width exceeds 1/16 in., replace the nut.
5. Replace parts as required.

## CAMSHAFT

### Lube 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. The lobe lift should be:
  - a. Models 888 and 215-0.260-0.278 in.
  - b. Model 255-0.267-0.273 in.
  - c. All others-0.278-0.283 in.
7. Repeat Steps 4-6 for each **pushrod**. If all lobes are within the specifications in Step 6, reinstall the rocker arm assemblies.
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. Remove the rocker arm covers, intake manifold, front cover and timing chain as described in this chapter.
2. Loosen the rocker arm stud nuts enough to rotate the rocker arms to one side.
3. Remove the **pushrods** and identify each for reinstallation in their original location.

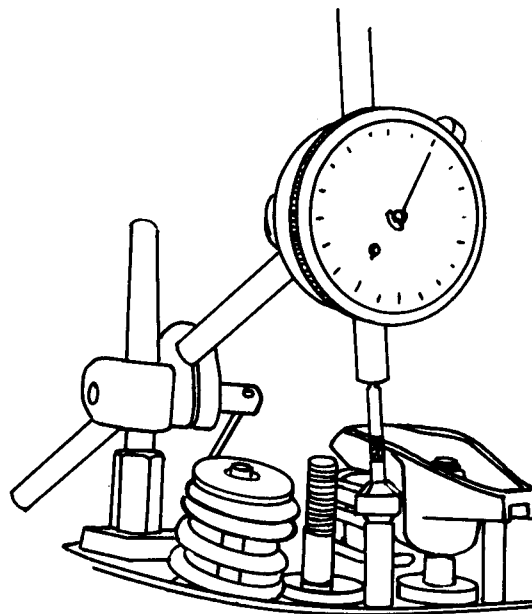
#### NOTE

*If the lifters are stuck in their bores, use Ford tool part No. T52T-6500-DJD or T52T-6500-D to rotate the lifter back and forth. This will break the varnish or gum seal that is holding the lifter in place and allow its removal.*

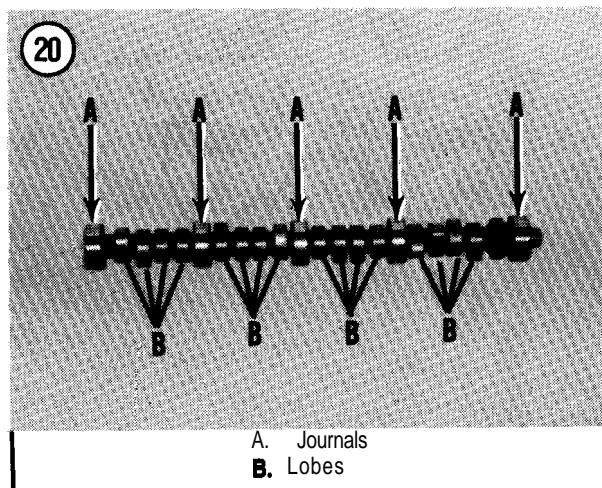
4. Remove the valve lifters with a pencil-type magnet. Place them in a rack in order of removal for reinstallation in their original location.

19

### CAMSHAFT LOBE LIFT CHECK



20



5. Remove the camshaft thrust plate.
6. Carefully withdraw the camshaft from the front of the engine to avoid damage to the bearings.
7. 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 end play as described in this chapter before tightening rocker arms in place. Check valve clearance as described in this chapter.

### Inspection

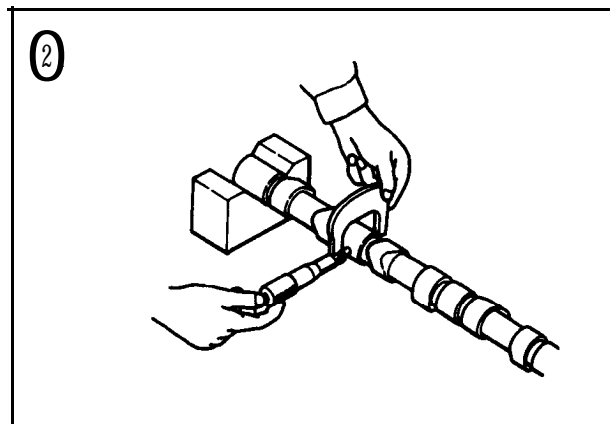
1. Check the journals and lobes for signs of wear or scoring. **See Figure 20.** Lobe pitting in the toe area is not sufficient reason for replacement, unless the lobe lift loss is excessive.

2. Check each valve lifter for signs or wear, pitting or scoring. Replace as required.

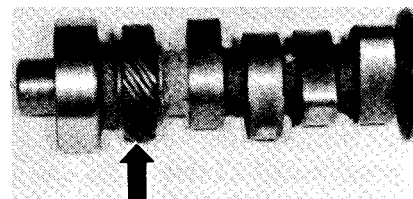
### NOTE

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

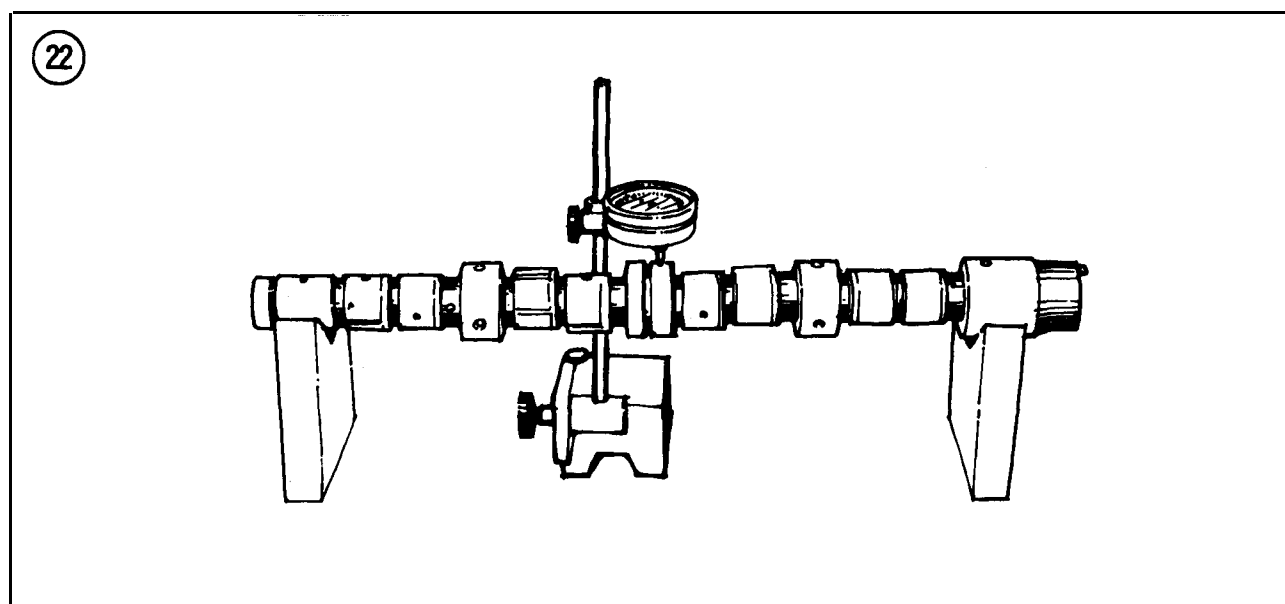
3. Measure the camshaft journal diameters with a micrometer (**Figure 21**) and compare to specifications. Replace the camshaft if one or more journals do not meet specifications.
4. Suspend the camshaft between V-blocks and check for **warpage** with a dial indicator. **See Figure 22.** Replace if reading is greater than 0.002 in.
5. Check the distributor drive gear (**Figure 23**) for excessive wear or damage.



20



8



### Bearing Replacement

Camshaft bearings are available pre-finished to the correct size and are not interchangeable between bores. A special puller and expanding collet are required for this procedure, which is not recommended for the **amateur** mechanic. Improper use of the special tools or use of the wrong expanding collet can result in severe bearing damage. If the bearings require replacement, have the job done by a **MerCruiser** or Ford dealer or a qualified machine shop.

### End Play

Applying force against the camshaft sprocket with the valve train load on the camshaft can damage or break the sprocket. Make sure rocker arm nuts are loose before performing this procedure.

1. Push the camshaft to the rear of the engine as far as possible.
2. Install a dial indicator with its tip on the camshaft sprocket cap screw. Zero the indicator.
3. Place a large screwdriver or pry bar between the camshaft sprocket and block. Pull the camshaft forward and release it.
4. Compare the dial indicator reading with specifications (**Table 1**). If end play is excessive, replace the thrust plate.
5. Tighten rock& arm nuts.

## OIL PAN

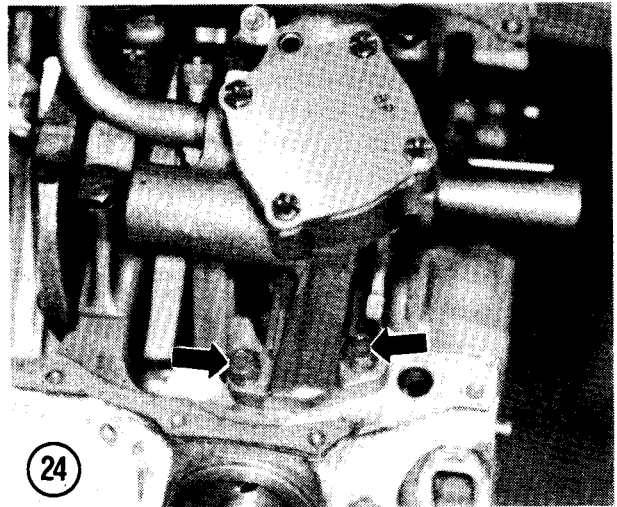
### Removal

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 bring the oil pan in an upright position.
4. Remove the oil pan attaching screws. Remove the oil pan.



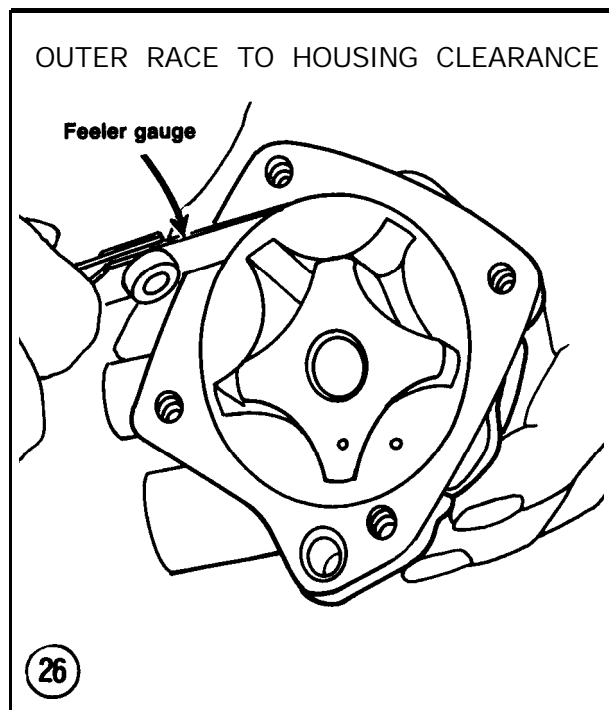
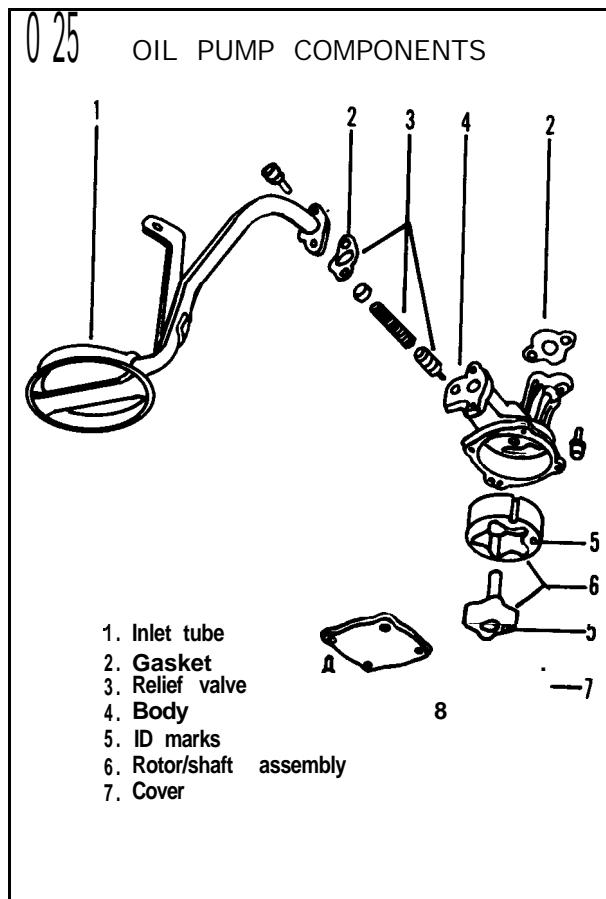
5. Remove and discard the **2-piece** pan gasket and the front/rear seals.

### 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. Coat the block side rails with Perfect Seal (part No. C-92-34227) or equivalent and position the 2 side gaskets on the side rails.
2. Install the front pan seal on the front cover with the seal tabs *over* the side gaskets.
3. Install the rear seal on the rear main bearing cap with the seal tabs over the side gaskets.
4. Carefully place the oil pan in position, make sure the gaskets and seal are not misaligned and install a pan attaching screw finger-tight on each side of the block.
5. Install the remaining screws and tighten all to specifications (**Table 2**). Work from the center outward in each direction.
6. Install the engine in the boat as described in this chapter and fill the crankcase with oil recommended in Chapter Four.



## OIL PUMP

## Removal

1. Remove the oil pan as described in this chapter.
2. Remove the oil pump attaching bolts (**Figure 24**). Remove the oil pump, gasket and intermediate drive shaft.

## Disassembly/Assembly

Refer to **Figure 25** for this procedure.

1. Remove the oil inlet tube and gasket from pump. Discard the gasket.
2. Remove the cover screws and cover.
3. Remove the inner rotor and shaft assembly.
4. Remove the outer race.
5. Install a self-threading sheet metal screw in the oil pressure relief valve cap. Pull cap from pump chamber.
6. Remove the pressure relief spring and plunger.
7. Oil all parts thoroughly before reassembly.
8. Install pressure relief plunger and spring with a new cap.
9. Install outer race, inner rotor and shaft as a unit. Make sure the identification dot on the outer race faces outward and is on the same side as the corresponding identification dot on the rotor.
10. Install cover and tighten screws to 9-12 ft.-lb. (12-17 N•m).
11. Install oil inlet tube with a new gasket and tighten bolts to 12-15 ft.-lb. (17-21 N•m).

## Inspection

## NOTE

*The inner rotor, shaft and outer race are serviced as an assembly. If one component is defective, replace them all.*

1. Clean all parts thoroughly in solvent. Brush the inside of the body and the pressure relief 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 relief valve spring. If worn, damaged or collapsed, replace spring.
4. Check relief valve plunger for scoring. Check for free operation in the pump bore.
5. Install outer race in pump body and check the clearance with a feeler gauge (**Figure 26**). If clearance exceeds 0.013 in., replace race/rotor/shaft assembly.
6. Install rotor/shaft assembly in pump body. Place a straightedge over the assembly and body.



Measure end play between the rotor/outer race and straightedge. See **Figure 27**. If end play exceeds 0.104 in., replace the race/rotor/shaft assembly.

### Installation

1. Fill pump with oil through either the inlet or outlet port. Rotate the pump shaft to distribute oil inside the pump body.
2. Insert the intermediate drive shaft into the oil pump and position the assembly against the crankcase. If the pump does not seat easily, rotate the drive shaft slightly so that its hex aligns with the distributor shaft.
3. Install the attaching bolts and tighten to specifications (**Table 2**).
4. Install the oil pan as described in this chapter.

## CYLINDER HEAD

### Removal

1. Remove the intake and exhaust manifolds as described in this chapter.
2. Remove the rocker arm cover as described in this chapter.
3. Loosen the rocker arms and rotate them to one side. Remove the **pushrods** and identify each for reinstallation in their original position.
4. Loosen the cylinder head bolts, working from the center of the head to the end in each direction.
5. 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.

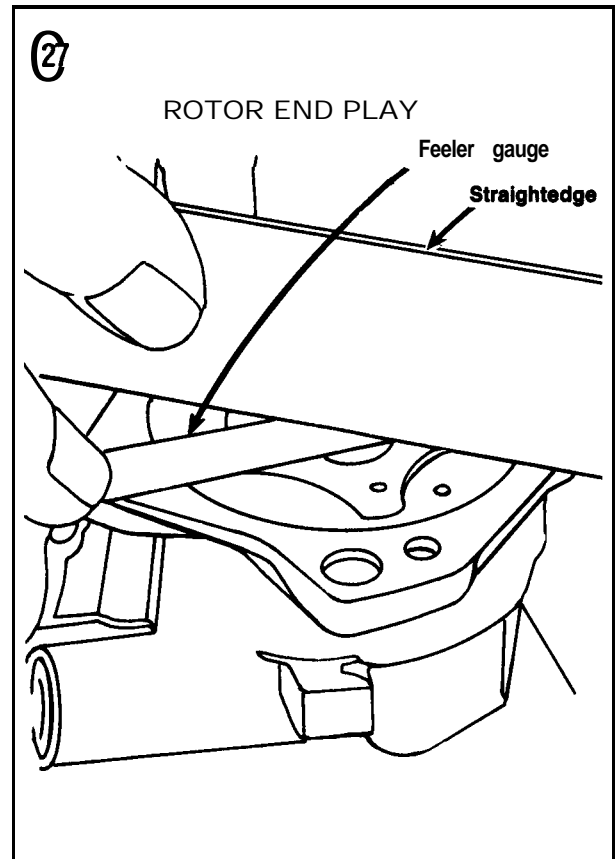
### CAUTION

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

6. Remove and discard the head gasket.

### Decarbonizing

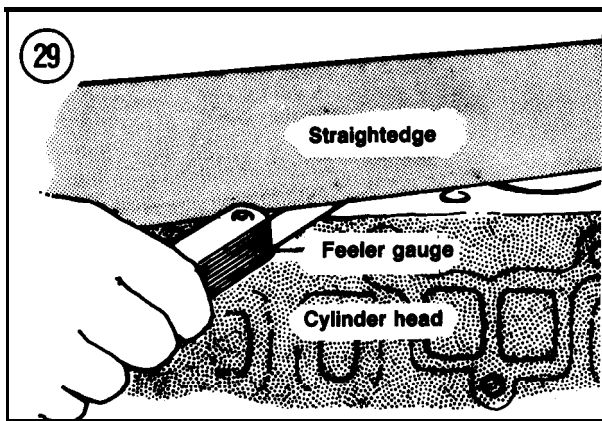
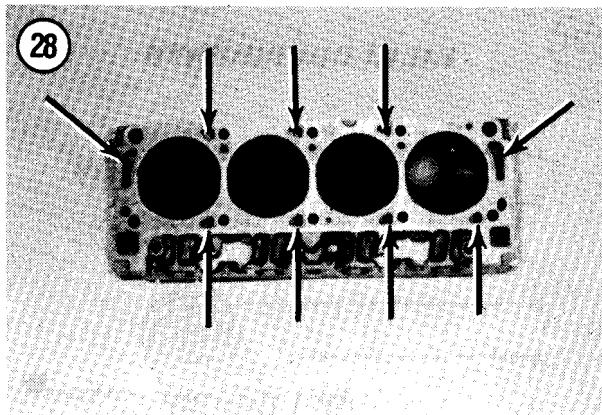
1. Without removing the valves, remove all deposits from the combustion chambers, intake ports and exhaust ports. Use a fine wire brush dipped in solvent or make a scraper from hardwood. Be careful not to scratch or gouge the combustion chambers.
2. After all carbon is removed from the combustion chambers 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 solvent 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 28**). 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 **warp** with a straightedge and feeler gauge (**Figure 29**). Compare to specifications (**Table 1**). If



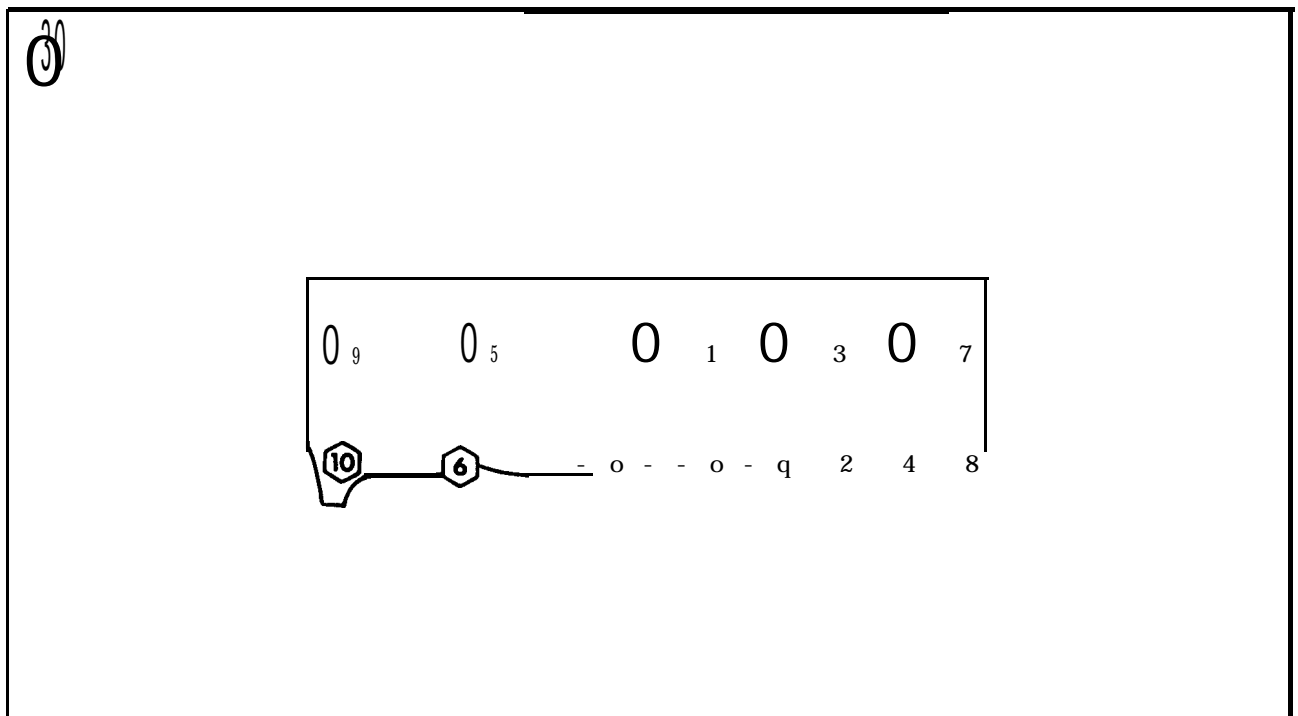
gap exceeds specifications, have the head resurfaced by a dealer or machine shop.

#### CAUTION

*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.
3. Fit a new head gasket over the cylinder dowels on the block.
4. Install the cylinder head to the block. Install the head bolts.
- 5A. 302 cid tighten the head bolts in 2 stages, following the sequence shown in Figure 30:
  - a. Stage 1-55-65 ft.-lb. (75-88 N•m).
  - b. Stage 2-65-72 ft.-lb. (65-72 N•m).
- 5B. 351 cid-tighten the head bolts in 3 stages, following the sequence shown in Figure 30:
  - a. Stage 1-85 ft.-lb. (115 N•m).
  - b. Stage 2-95 ft. lb. (129 N•m).
  - c. 3-105-122 ft.-lb. (142-151 N•m).



### 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 31** 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 32**. Remove the retainer locks and release the spring tension.
4. Remove the retainer and valve spring. On some models, there may be a sleeve on top of the retainer, a stem cap on top of the exhaust valve stem or a damper spring inside the intake valve spring.
5. Remove the valve stem seal with a pair of pliers. Discard the seal.

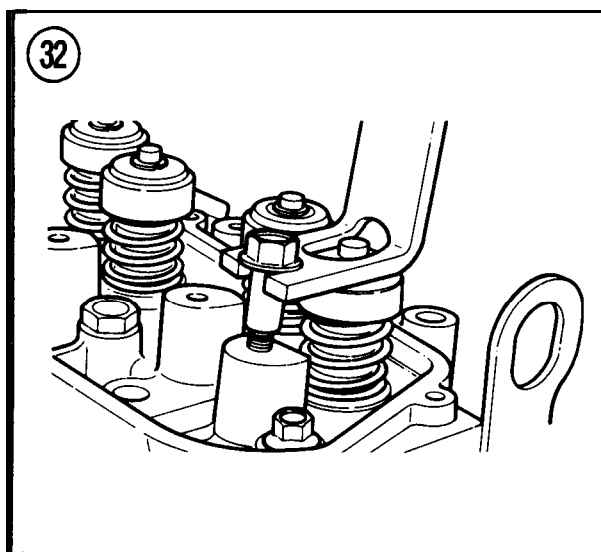
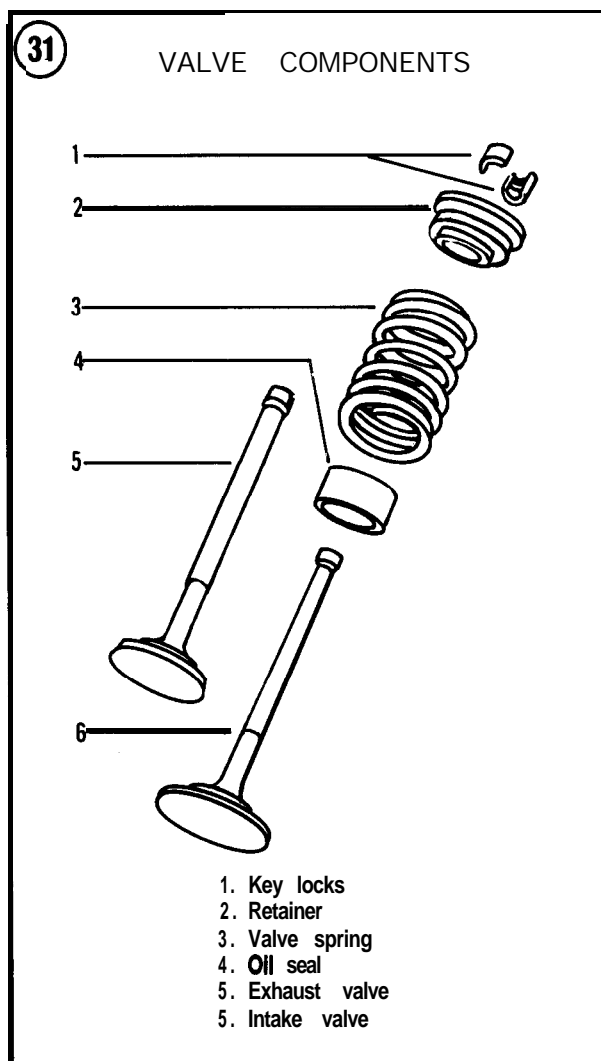
#### CAUTION

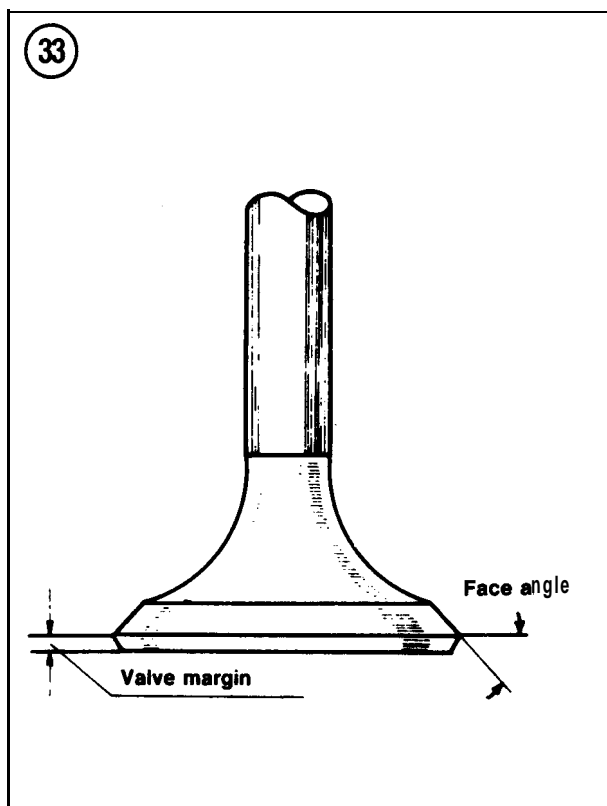
*Remove any burrs from the valve stem lock grooves before removing the valves or the valve guides will be damaged.*

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 33. 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

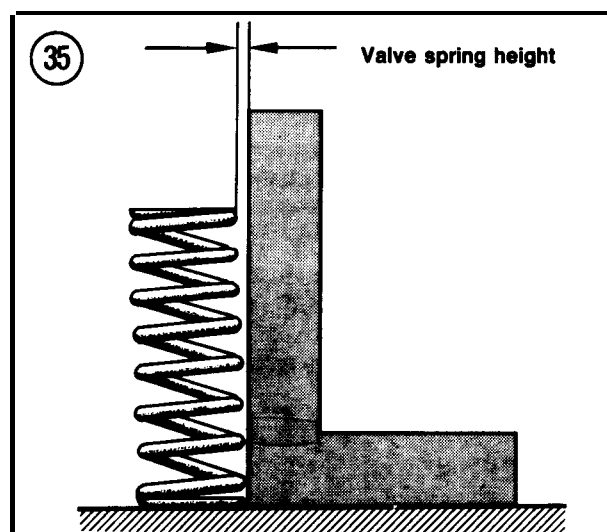
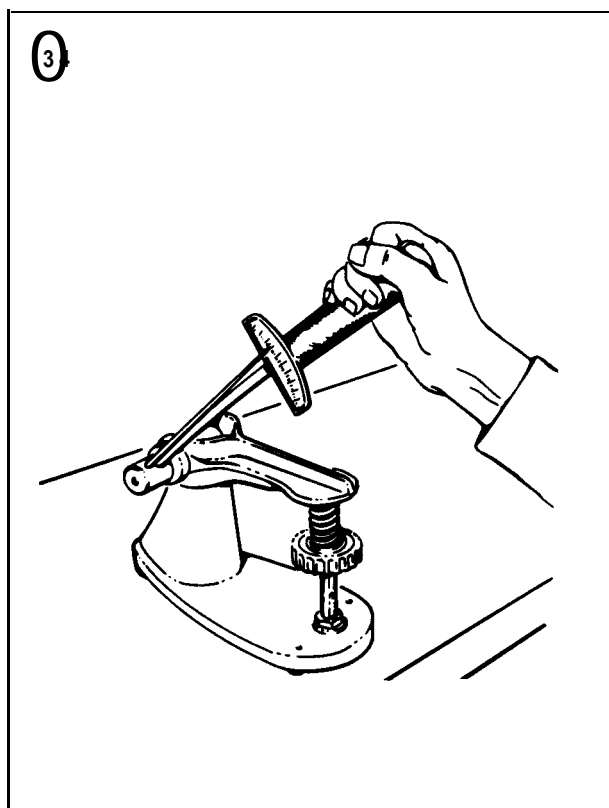
*The next step assumes that all valve stems have been measured and are within specifications. Replace valves with worn stems before performing this step.*

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) 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 34). Replace any weak springs.

7. Check each spring on a flat surface with a steel square. See Figure 35. 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 36**) 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

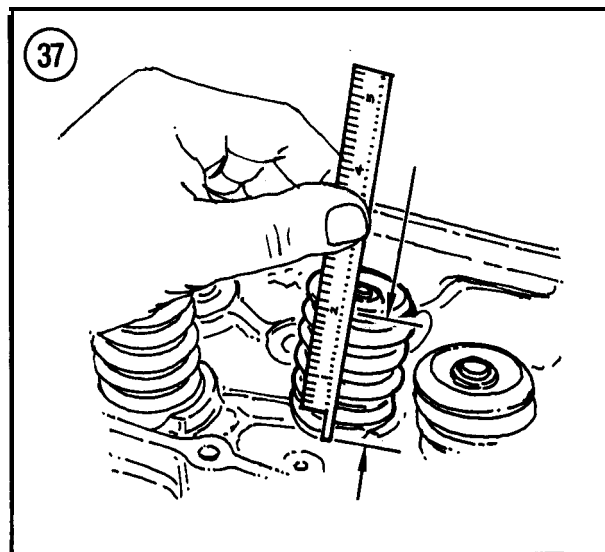
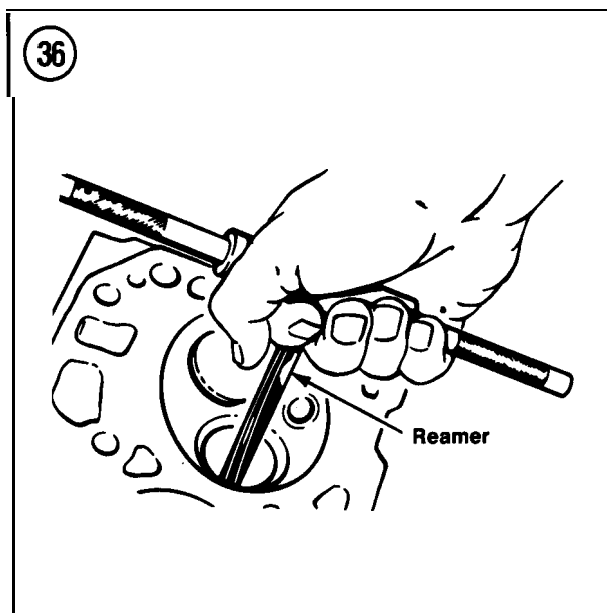
1. Cut the valve seats to the specified angle (**Table 1**) with a dressing stone. Remove only enough metal to obtain a good finish.
2. Use tapered stones to obtain the specified seat width when necessary.
3. Coat the corresponding valve face with Prussian blue dye.
4. Insert the valve into the valve 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.*

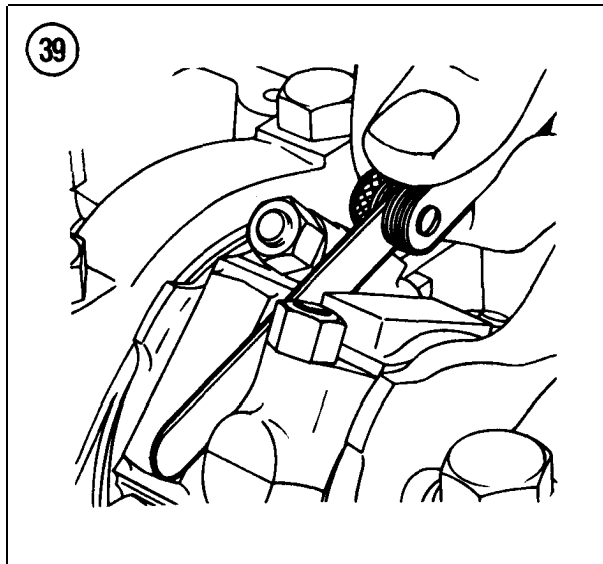
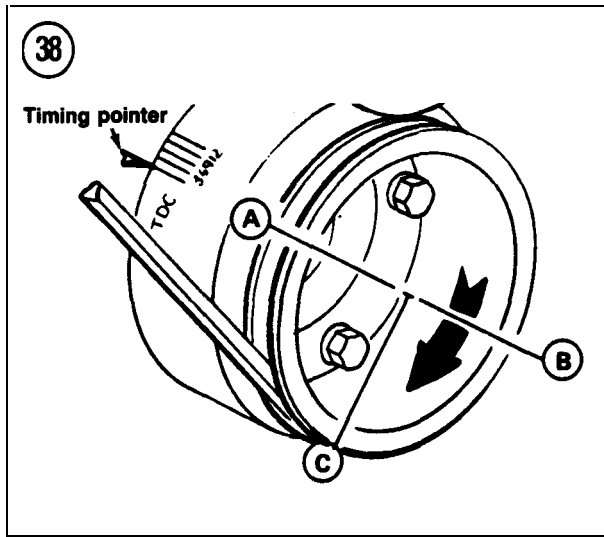
1. Coat the valves with oil and install them in the cylinder head.
2. Install new oil seals on each valve with a deep socket and hammer.
3. Install the valve spring over the valve, then install the spring retainer. Install sleeve, stem cap or damper spring, if so equipped.
4. Compress the spring and 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 37**. If height is greater than specifications (**Table 1**), replace the spring.



### Valve Clearance 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.

The valves are not adjustable, but compensation for dimensional changes in the valve train can be made by installing a slightly longer or shorter



**pushrod**, as required. Whenever any component in the valve train is replaced, the following procedure should be performed to determine if **pushrod** replacement is necessary.

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

1. Rotate the crankshaft until the No. 1 piston is at TDC at the end of its compression stroke. See **A**, **Figure 38**.
2. Make a chalk mark at points **B** and **C**, **Figure 38**.

#### NOTE

The valve arrangement of the port bank is E-I-E-I-E-I-E-I. The starboard bank is I-E-I-E-I-E-I-E.

3. With the crankshaft in position **A**, **Figure 38**, install Ford tool part No. 65 13-AC on the rocker arm of each valve listed below. Apply pressure slowly to bleed lifter down completely, hold lifter down with tool and check the clearance between the valve stem and rocker arm with a feeler gauge no wider than  $\frac{3}{8}$  in. Write down the clearance and repeat for each valve listed below:

- a. No. 1 intake, No. 1 exhaust.
- b. No. 4 intake, No. 3 exhaust.
- c. No. 8 intake, No. 7 exhaust.

4. Rotate crankshaft 180° to align position **B** mark with timing pointer. Repeat Step 3 to check clearance of the following valves:

- a. No. 3 intake, No. 2 exhaust.
- b. No. 7 intake, No. 6 exhaust.

5. Rotate crankshaft another 270° to align position **C** mark with timing pointer. Repeat Step 3 to check clearance of the following valves:

- a. No. 2 intake, No. 4 exhaust.
- b. No. 5 intake, No. 5 exhaust.
- c. No. 6 intake, No. 8 exhaust.

6. Compare clearances to specifications (**Table 1**). If less than specified, install a shorter **pushrod**. If greater than specified, install a longer **pushrod**. See dealer for **pushrod** selection.

## 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 intake and exhaust manifolds as described in this chapter.
4. Remove the cylinder heads 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 39**). If the clearance exceeds specifications (**Table 1**), replace the connecting rod.

9. Remove the nuts holding the connecting rod cap. Lift off the cap, together with the lower bearing insert (Figure 40).

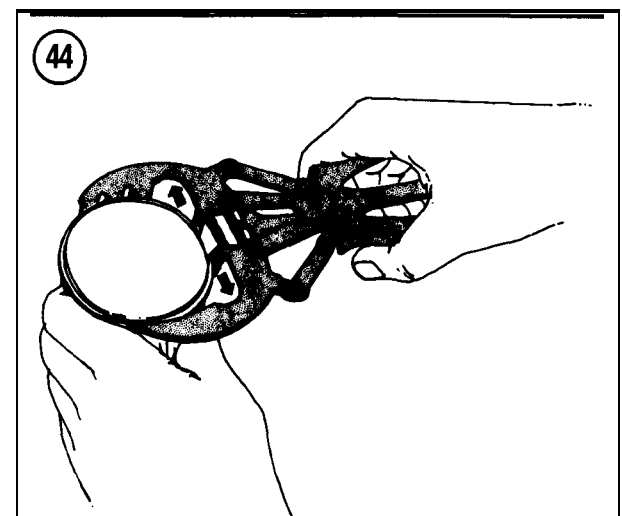
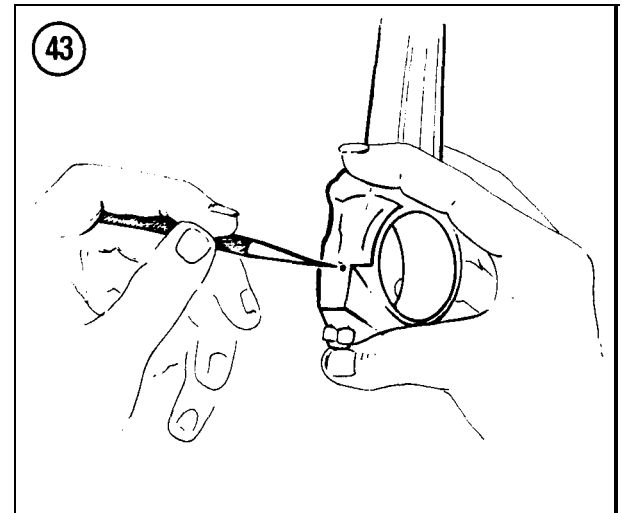
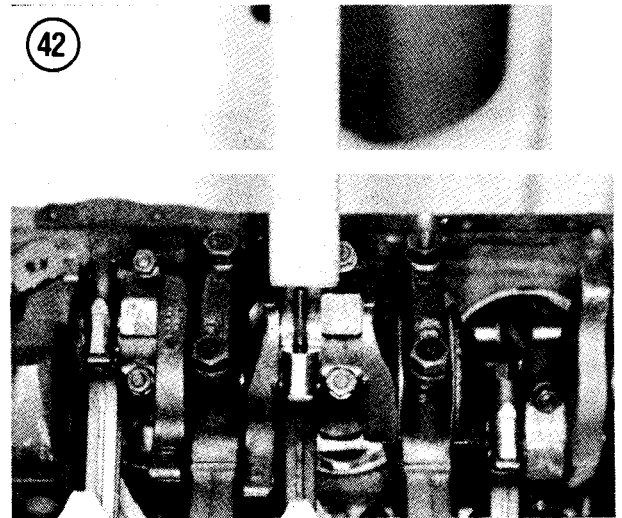
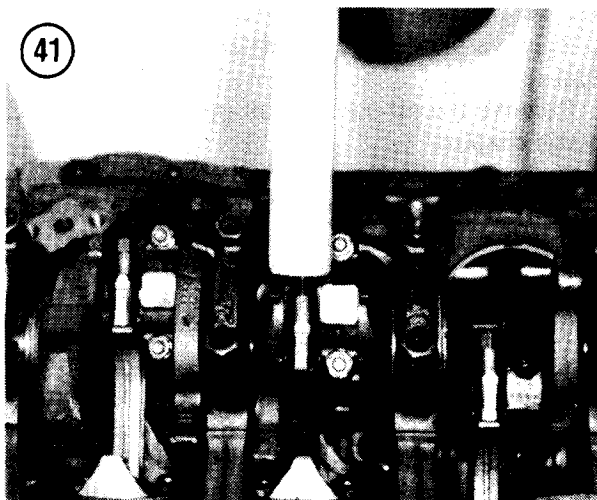
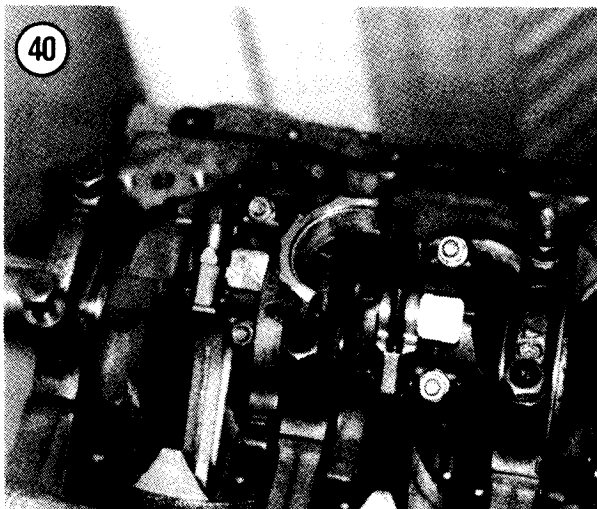
**NOTE**

*If the connecting rod caps are difficult to remove, tap the studs with a wooden hammer handle. See Figure 41.*

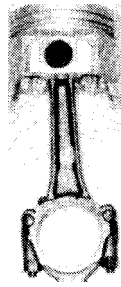
10. Use a wooden hammer handle to push the piston and connecting rod from the bore (Figure 42).

**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 43).*



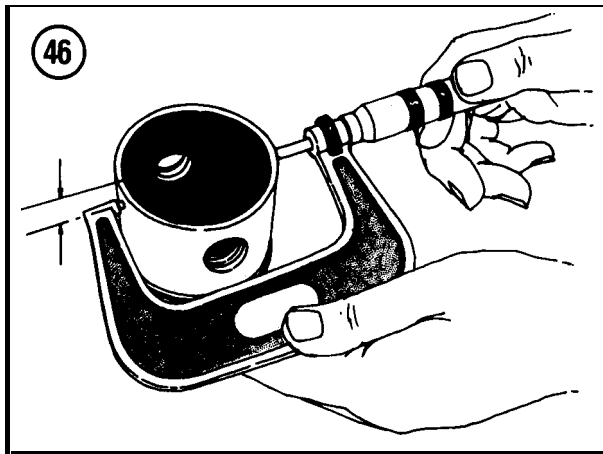
45



11. Remove the piston rings with a ring remover (Figure 44).

#### Piston Pin Removal/Installation

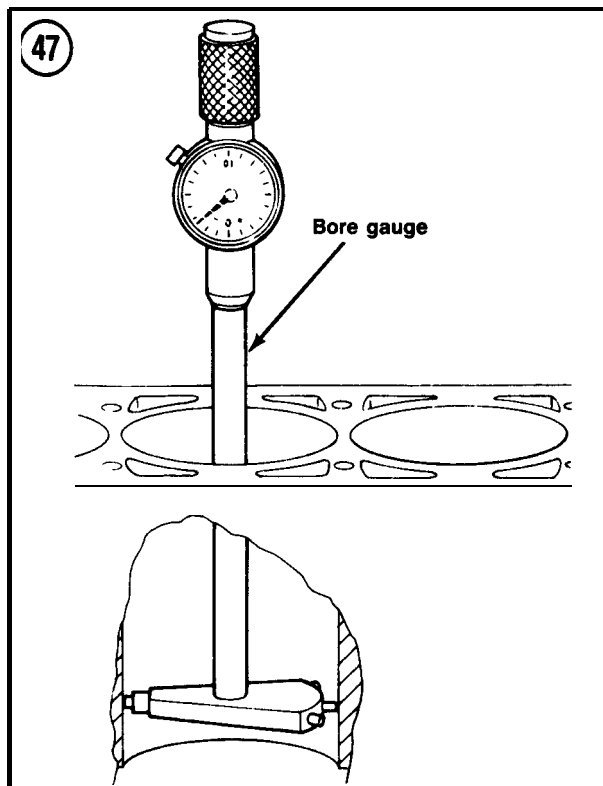
The piston pins are press-fitted to the connecting rods and hand-fitted to the pistons. See Figure 45. Removal requires the use of a press and support stand. This is a job for a dealer or machine shop equipped to fit the pistons to the pin, ream the pin bushings to the correct diameter and install the pistons and pins on the connecting rods.



#### Piston Clearance Check

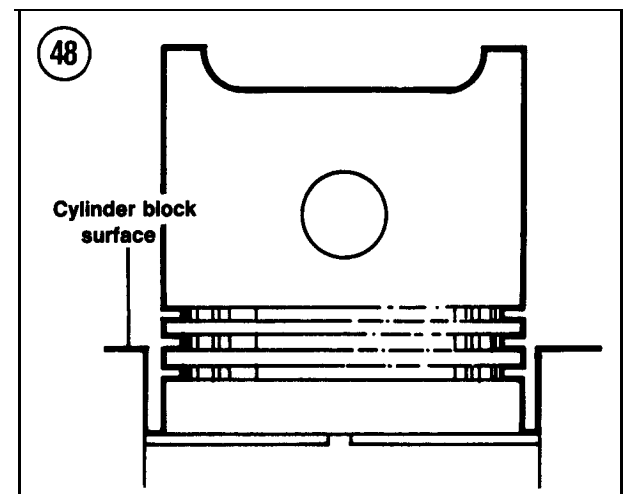
Unless you have precision measuring equipment and know how to use it properly, have this procedure done by a machine shop.

1. Measure the piston diameter with a micrometer (Figure 46). Measure just below the rings at right angles to the piston pin bore.
2. Measure the cylinder bore diameter with a bore gauge (Figure 47). 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), 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 48.





**NOTE**

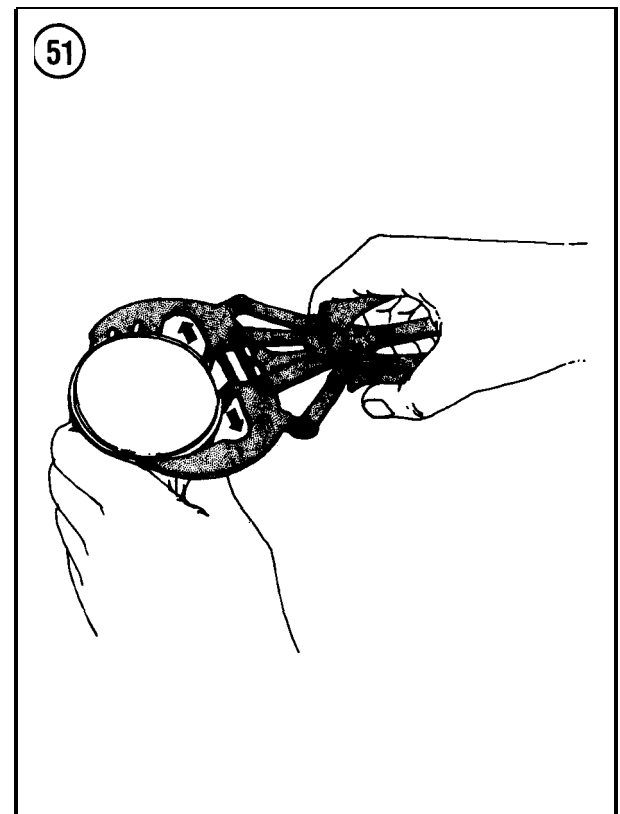
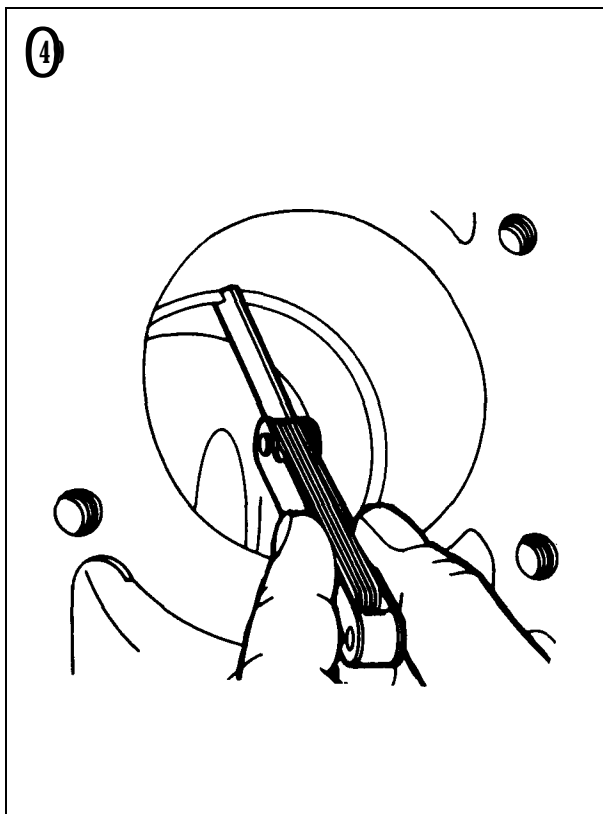
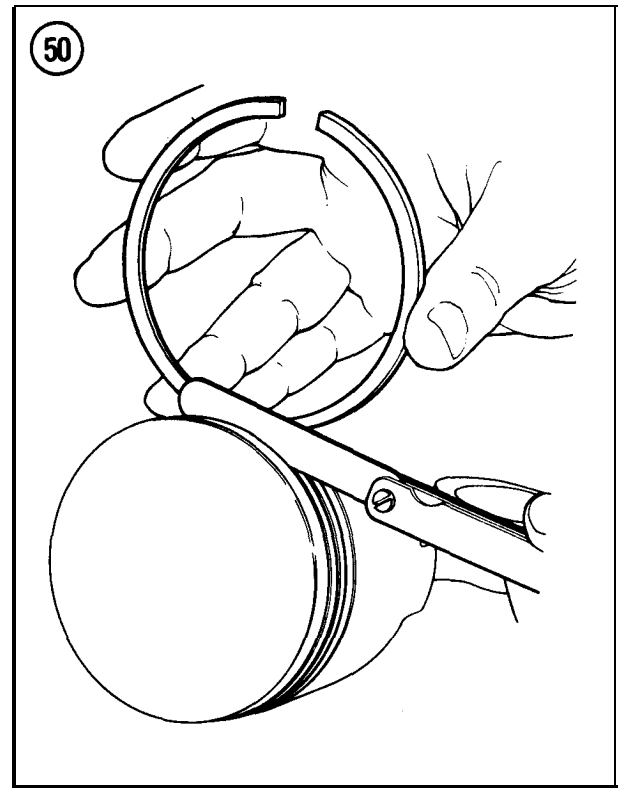
*If the cylinders have not been rebored, check the gap at the bottom of the ring travel, where the cylinder is least worn.*

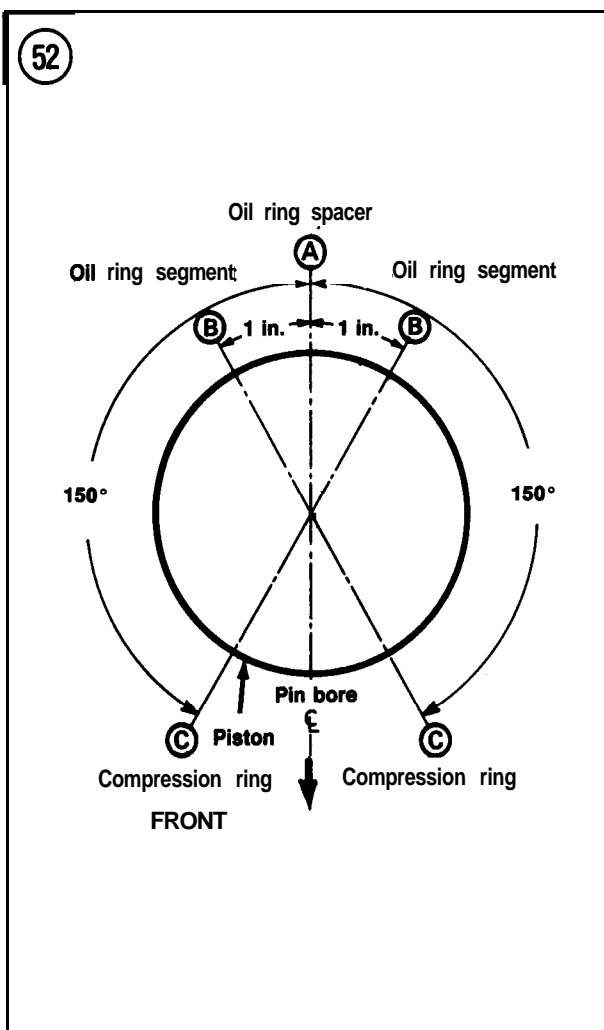
2. Measure the ring gap with a feeler gauge as shown in **Figure 49**. Compare with specifications. If the measurement is not 'within specifications (**Table 1**), replace the rings as a set.
3. Check the side clearance of the compression rings as shown in **Figure 50**. Place the feeler gauge alongside the ring all the way into the groove. If the measurement is not within specifications (**Table 1**), either the rings or ring grooves are worn. Inspect and replace as necessary.
4. Using a ring expander tool (**Figure 51**), 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.*

5. Position the ring gaps as shown in **Figure 52**.





### 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 53). Place the Plastigage on the journal, then install the lower bearing half and cap.

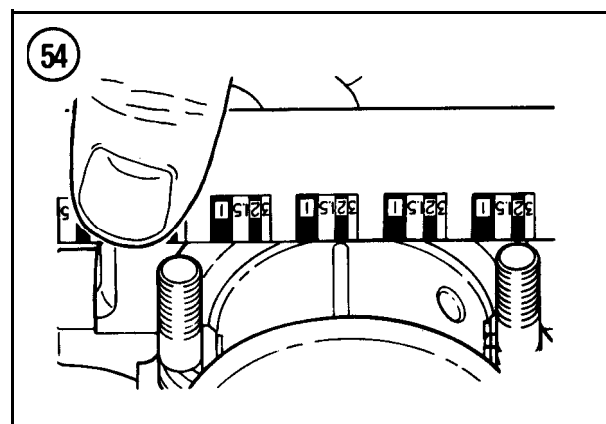
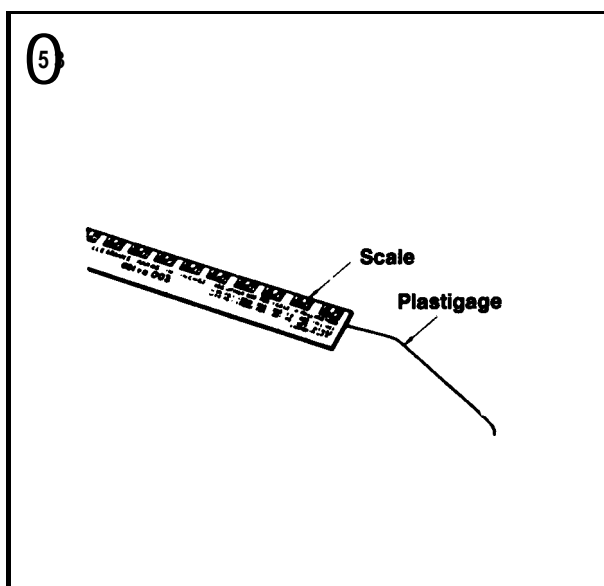
#### NOTE

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

3. Tighten the connecting rod cap to specifications (Table 2). 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 54. If the clearance is excessive, the crankshaft must be reground and undersize bearings installed.

### Installing Piston/Connecting Rod Assemblies

Connecting rods and bearing caps are numbered from 1 to 4 in the starboard bank and from 5 to 8 in the port bank. The numbers on the rod and cap



must be on the same side when installed in the cylinder. When transposing a connecting rod from one block or cylinder to another, always fit new bearings and number the rod and cap to correspond with the new cylinder number.

1. Make sure the pistons are correctly installed on the connecting rod. The cylinder number side of the connecting rod and piston arrow or notch should be positioned as shown in **Figure 55**.
2. Make sure the ring gaps are positioned as shown in **Figure 52**.
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 56**. 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.*

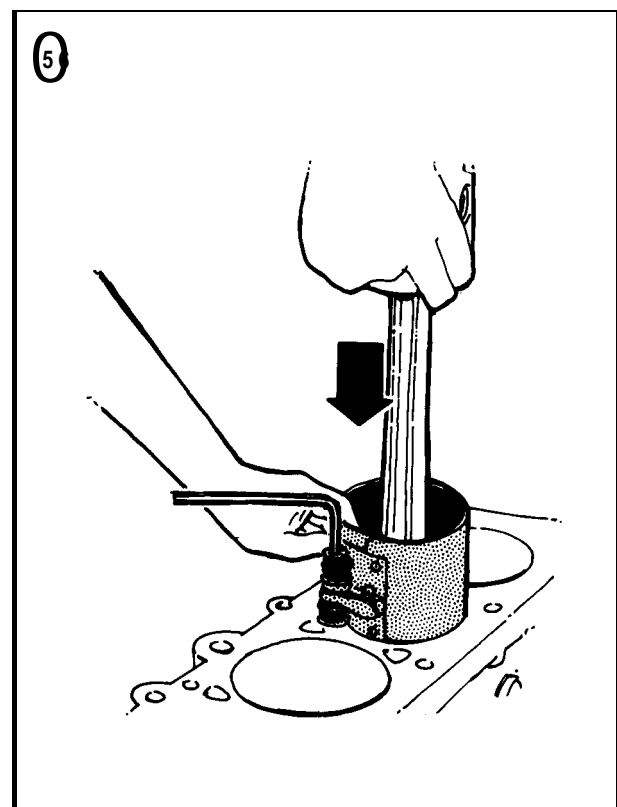
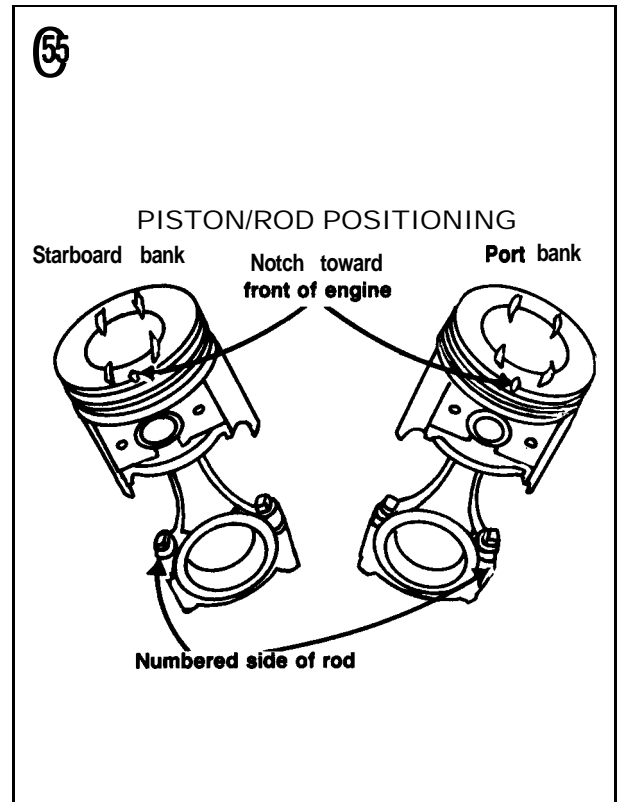
6. Clean the connecting rod bearings carefully, including the back sides. Coat the journals and bearings with clean engine oil. Place the bearings in the connecting rod and cap.
7. Remove the protective hose or tape and install the connecting rod cap (**Figure 40**). Make sure the rod and cap marks align. Tighten the cap nuts to specifications (**Table 2**).
8. Check the connecting rod big-end play as described under *Piston Removal*.

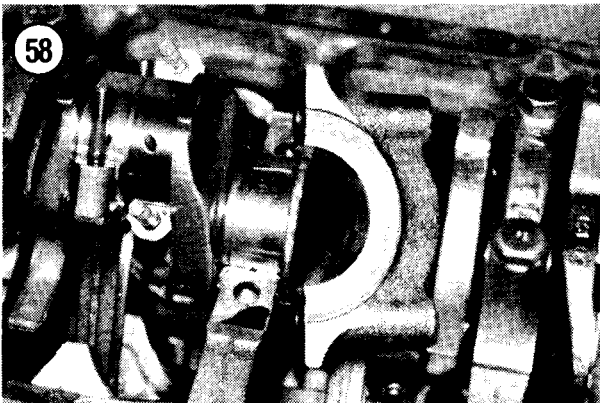
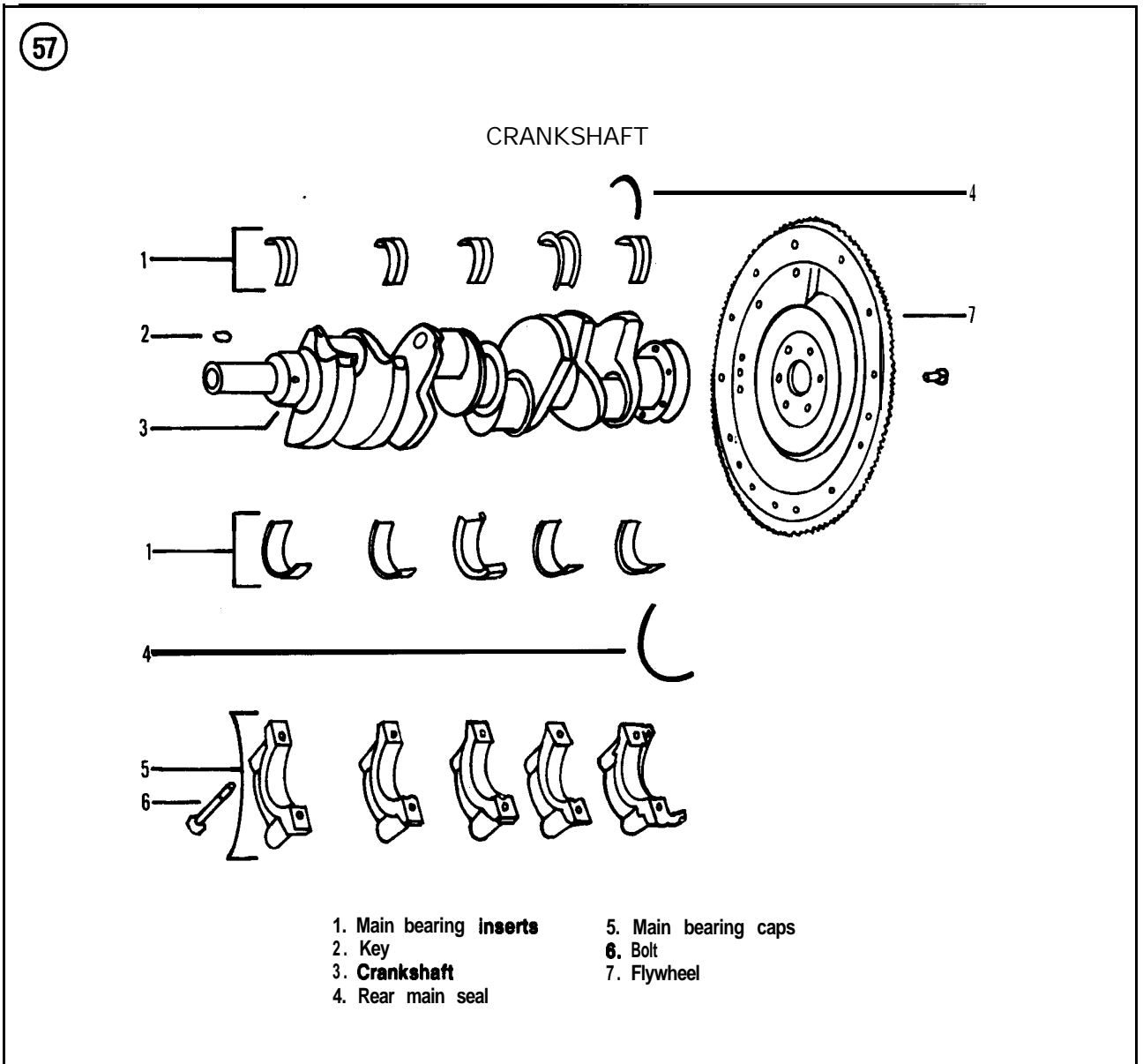
### CRANKSHAFT

#### Removal

Refer to **Figure 57** for this procedure.

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. Invert the engine to bring the oil pan to an upright position.
5. Remove the oil pan and oil pump as described in this chapter.
6. Remove the front cover as described in this chapter.





7. Remove the spark plugs to permit easy rotation of the crankshaft.
8. Remove the timing chain and sprockets as described in this chapter.
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 40). 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 58).

**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.

**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**

Unless you have precision measuring equipment and know how to use it, have a machine shop perform Step 3.

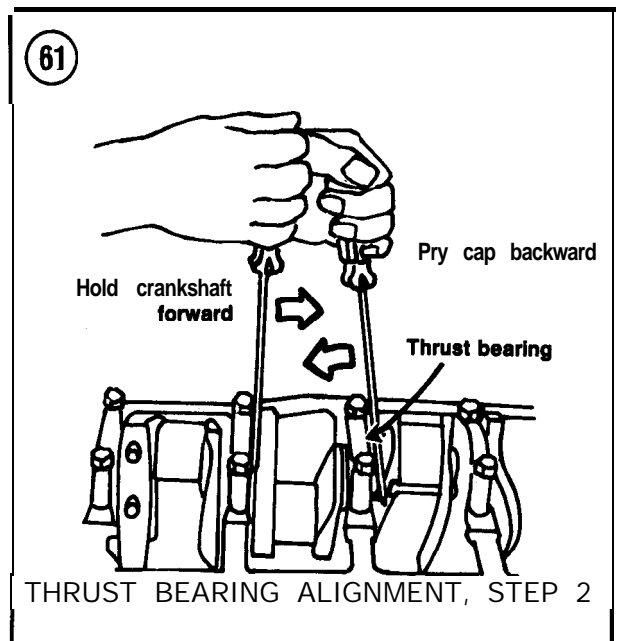
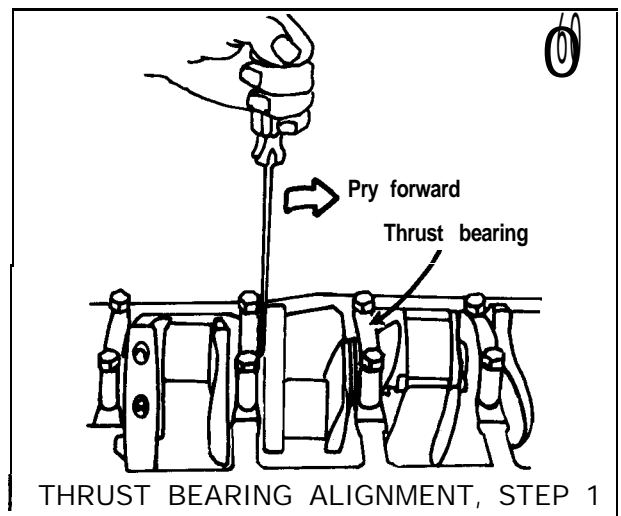
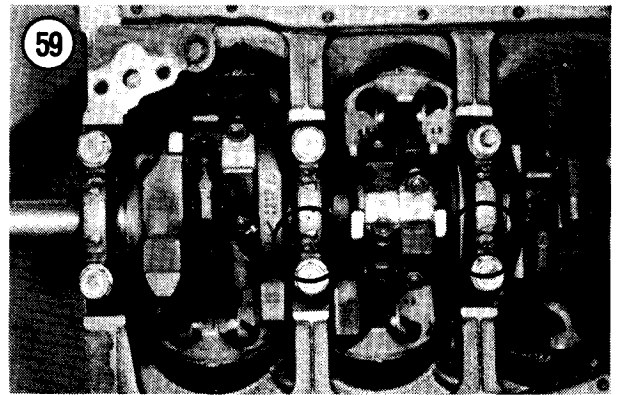
3. Check all journals against specifications for out-of-roundness and taper. If necessary, have the crankshaft reground and undersize bearings installed.

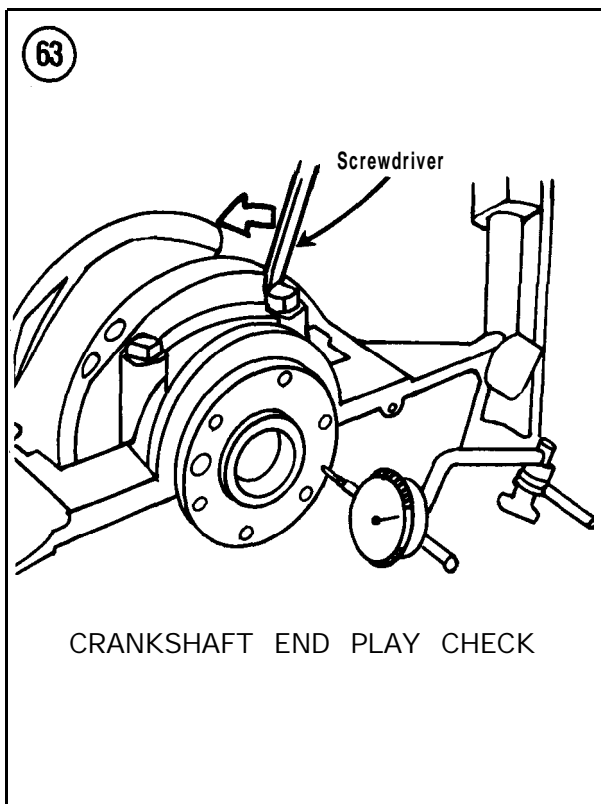
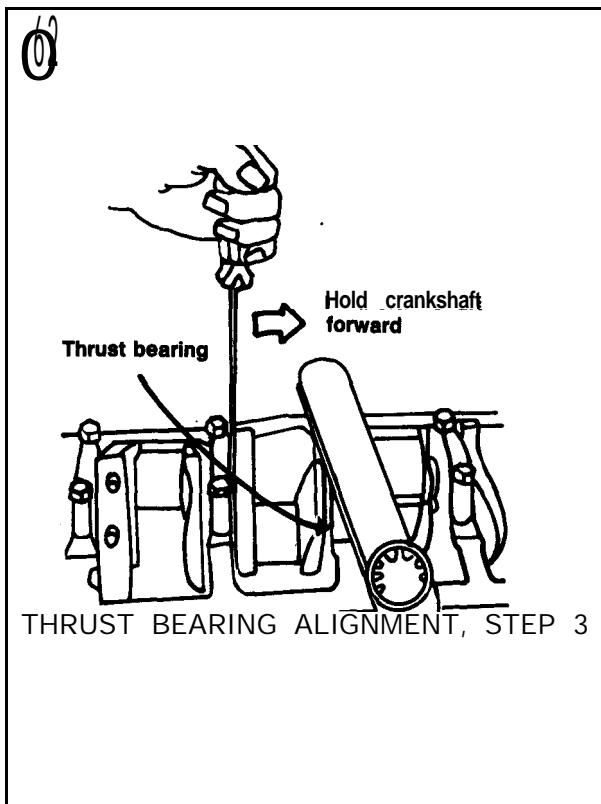
**Main Bearing Clearance Measurement**

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 reground or both.

**Installation**

1. Install a new rear main bearing oil seal as described in this chapter.
2. Install the main bearing inserts in the bores with the tang engaging the slot provided in the block.
3. Install the main bearing inserts in the bearing caps.
4. Carefully lower the crankshaft into position in the block.
5. Install all bearing caps *except* No. 3 and tighten the bolts to specifications (Table 2). Make sure the arrows on each cap point toward the front of the engine (Figure 59).





6. Install the No. 3 (thrust) bearing cap and tighten finger-tight.

7. Pry the crankshaft forward against the thrust surface of the upper half of No. 3 bearing. See **Figure 60**.

8. Hold the crankshaft in this position and pry the thrust cap toward the rear of the engine (**Figure 61**) to align the thrust surfaces of both halves of the bearing.

9. Hold the crankshaft in the forward position and tighten the bearing caps to specifications (**Table 2**). See **Figure 62**.

10. Force the crankshaft to the rear of the engine and check end play as described in this chapter.

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

#### End Play Measurement

1. Make sure the crankshaft is forced all the way to the rear of the engine.

2. Install a dial indicator with its contact point resting against the crankshaft flange. The indicator axis should be parallel to the crankshaft axis. See **Figure 63**.

3. Zero the dial indicator. Force the crankshaft forward as far as it will go and compare the reading to specifications (**Table 1**).

4. Replace the thrust bearing if end play is excessive. If end play is under specifications, remove crankshaft and recheck thrust bearing for scratches, nicks, burrs or dirt. If none of these are found, improper alignment is probably the cause. Reinstall bearing and repeat Steps 7-9 of *Installation* in this chapter.

#### REAR MAIN BEARING OIL SEAL

##### Replacement

Replacement seals are of the split lip variety. If the rear main cap contains a rear seal retainer pin, it must be removed to prevent damage to the new seal.

1. Remove the engine as described in this chapter;
2. Remove the oil pan as described in this chapter.
3. Loosen all main bearing caps enough to permit the crankshaft to be moved a maximum of 1/8 in.
4. Remove rear main bearing cap. Remove oil seal from cap and cylinder block.
5. Clean seal grooves in cap and block with solvent and a brush.
6. Dip the 2 halves of the new seal in clean engine oil.

7. Position the cylinder block half of the seal with its undercut side facing the front of the engine. Install it by rotating it into the seal journal until about  $\frac{3}{8}$  in. remains above the parting surface. See **Figure 64**. Make sure that none of the seal rubber was shaved off by the bottom edge of the groove. If it was, discard the seal and install another.

8. Tighten the loose cap bolts to specifications (Table 2).

9. Install the cap portion of the seal with its undercut side facing the front of the engine. Again, allow about  $\frac{3}{8}$  in. of the seal end to protrude so it will mate with the other half when the cap is installed. Refer to **Figure 64**.

#### CAUTION

*Do not apply sealant to the area forward of the side seal groove in Step 10.*

10. Apply a thin coat of Perfect Seal (part No. C-92-34277) or equivalent to the rear of the cap's top mating surface.

11. Install the rear bearing cap and tighten to specifications.

12. Install **oil pan** as described in this chapter.

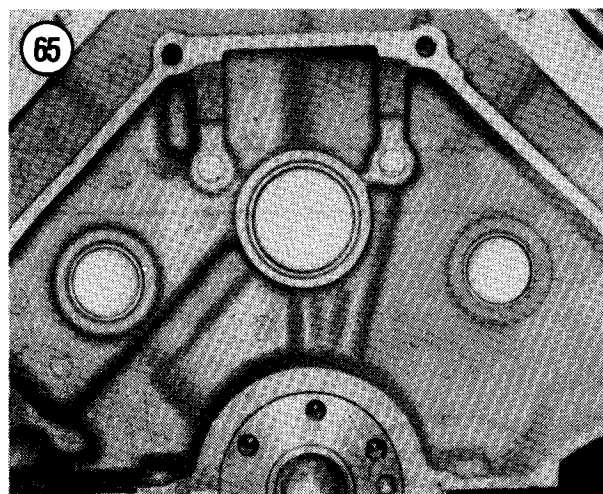
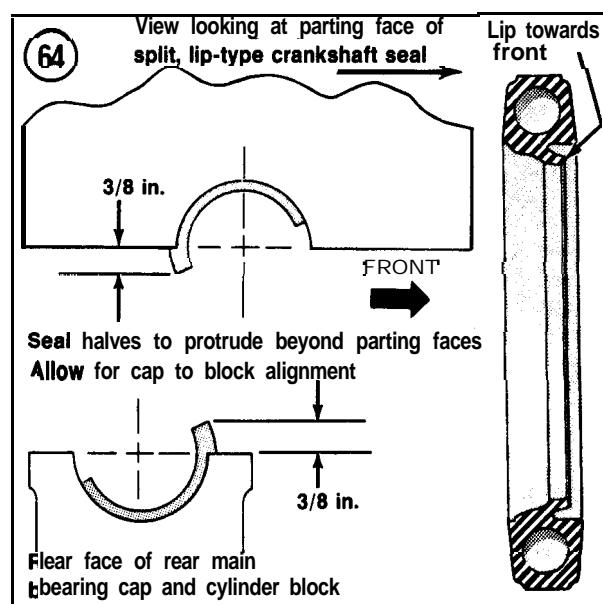
### FLYWHEEL

#### Removal/Installation

1. Remove the engine as described in this chapter.
2. Remove the flange bolts holding the flywheel to the crankshaft. Remove the flywheel.
3. Installation is the reverse of removal. Tighten bolts to specifications in a diagonal pattern. Wipe all oil, grease and other contamination from the flywheel surface.

#### Inspection

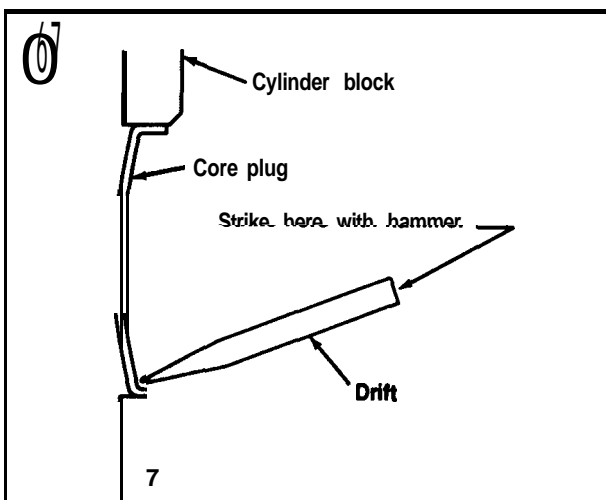
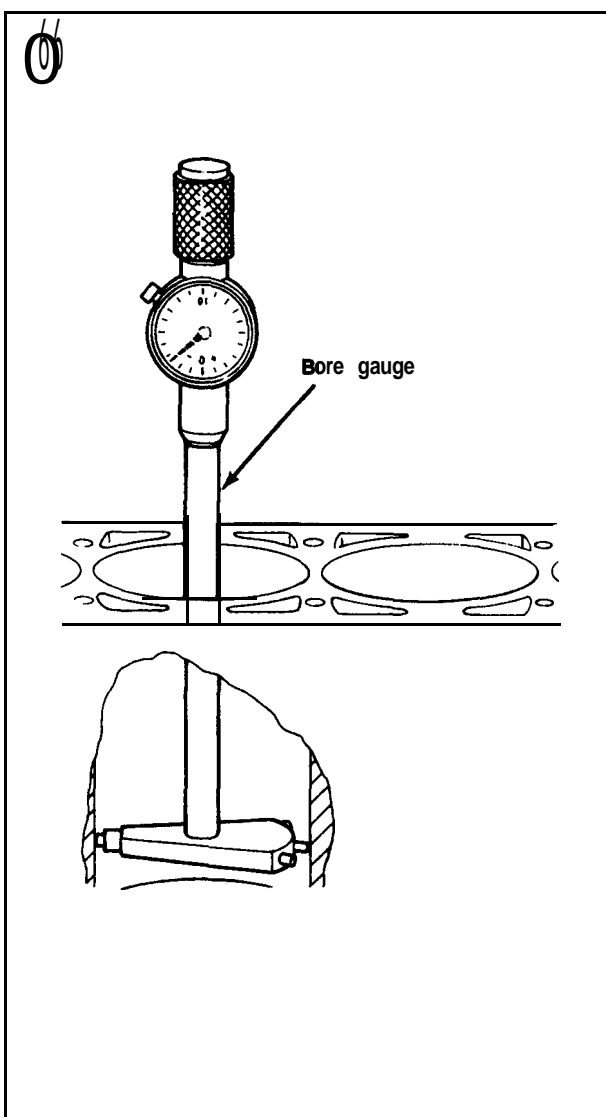
1. Visually check the flywheel surfaces for cracks, deep scoring, excessive wear, heat discoloration and checking.
2. Have the face **runout** checked with a dial indicator and compare to specifications.
3. Check surface flatness with a straightedge and feeler gauge.
4. Inspect the ring gear teeth for cracks, broken teeth or excessive wear. If severely worn, check the starter motor drive teeth for similar wear or damage. Replace as indicated.



### 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. **Figure 65** shows typical core plug locations. See **Core 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.

4. Measure the cylinder bores with a bore gauge (Figure 66) 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 2**.

### CORE PLUGS

Check the condition of all core plugs in the block (Figure 65) 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 67).

2. Grip the top of the plug with pliers. Pull the plug from its bore (Figure 68) 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.



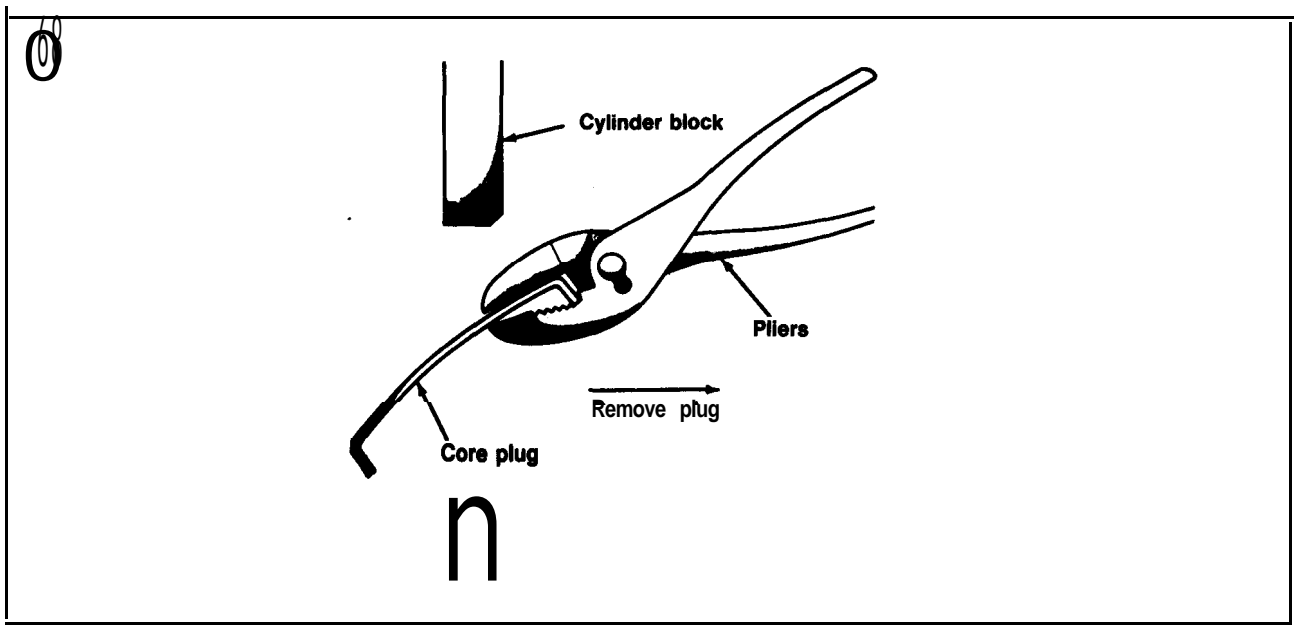


Table 1 **ENGINE** SPECIFICATIONS

<b>General</b>	
Piston displacement	
302 cid	4,949 cc (302 cu. in.)
351 cid	5,752 cc (351 cu. in.)
Bore	4.00 in.
Stroke	
302 cid	3.00 in.
351 cid	3.50 in.
Cylinder numbering (front to rear)	
Starboard bank	1-2-3-4
Port bank	5-6-7-8
Firing order	1-3-7-2-6-5-4-8
Cylinder bore	
Diameter	4.00 in.
Out-of-round	0.005 in. max.
Taper	
Thrust side	0.0005 in. max
Relief side	0.001 in. max.
Piston clearance	0.0018-0.0026 in.
Piston rings	
Compression rings	
Groove clearance	0.002-0.004 in.
<b>Gap</b>	0.010-0.020 in.
Oil ring	
Groove clearance	Snug
<b>Gap</b>	
Model 888,215, 225-5	0.015-0.055 in.
Ail others	0.015-0.055 in.
Piston pin	
Diameter	0.9119-0.9124 in.
Clearance	
302 cid	0.0002-0.0004 in.
351 cid	0.0003-0.0005 in.
Fit in rod	interference
Crankshaft	
Main journal diameter	
302 cid	<b>2.2482-2.2490 in.</b>
351 cid	2.9994-3.0002 in.
Main journal taper	0.0003 in.
Main journal out-of-round	0.0004 in.
Main bearing clearance	
302 cid	
No. 1	0.0001-0.0018 in.
No. 2-4	0.0005-0.0024 in.
No. 5	0.0029-0.0045 in.
351 cid (ail)	0.0008-0.0026 in.
End play	0.004-0.008 in.

(continued)

Table 1 ENGINE **SPECIFICATIONS** (continued)

<b>Crankshaft (cont.)</b>	
Connecting rod journal diameter	2.1228-2.1238 in.
302 cid	<b>2.3103-2.3111</b> in.
351 cid	0.0004 in.
Connecting rod journal taper	0.0004 in.
Connecting rod journal out-of-round	0.001-0.0015 in.
Connecting rod bearing clearance	0.010-0.020 in.
Connecting rod side clearance	
<b>Camshaft</b>	
Lobe lift (intake)	
Models 888, 215, 225-S	0.280 in.
Models <b>225TR</b> , 233	0.278 in.
Model 255	0.287 in.
Lobe lift (exhaust)	
Models 888, 215, 225-S	0.278 in.
Models <b>225TR</b> , 233	0.283 in.
Model 255	0.273 in.
Journal diameter	
No. 1	<b>2.0805-2.0815</b> in.
No. 2	<b>2.0655-2.0665</b> in.
No. 3	2.0505-2.0515 in.
No. 4	<b>2.0355-2.0365</b> in.
No. 5	2.0505-2.0515 in.
<b>Runout</b>	0.005 in. max.
Cylinder head	
Gasket surface flatness	0.003 in. any 8 in. or 0.007 in. overall max.
<b>Valve system</b>	
Lifter	Hydraulic
Rocker arm ratio	<b>1.6:1</b>
Face angle	44°
Seat angle	45°
Seat <b>runout</b>	0.0015 in. max.
Seat width	
Model 888 and 215 (302 cid)	<b>1/16-5/64</b> in.
Model 225TR (302 cid)	0.080 in.
All 351 cid	0.080 in.
Stem clearance	
Intake	0.0010-0.0027 in.
Exhaust	0.0015-0.0032 in.
<b>Valve springs</b>	
Free length	2.07 in.
Pressure	
Closed	<b>71-79</b> ft.-lb.
Open	<b>190-210</b> ft.-lb.
Installed height	<b>1 3/4-1 13/16</b> in.
<b>Oil pump</b>	
Outer race to housing clearance	<b>0.006-0.013</b> in.
Rotor end play	0.001 in.-0.0041 in.
Drive shaft to housing bearing clearance	0.0015-0.0029 in.

Table 2 **TIGHTENING TORQUES**

Fastener	<b>ft.-lb.</b>	
	<b>302 cld</b>	<b>351 cid</b>
Camshaft		
Sprocket	43	43
Thrust plate	8	8
Crankshaft damper	80	80
Carburetor	11	11
Connecting rod cap	24	40
Cylinder head	70	108
Distributor hold-down	15	15
Drive plate	18	18
Exhaust manifold	25	25
Flywheel	80	80
Flywheel coupler		
5/8 in. hex	45	45
5/8 in. hex crownlock	35	35
11/16 in. hex	40	40
Flywheel housing-to-block	40	40
Front cover	13	13
Front mount	30	30
Fuel pump	22	22
Intake manifold	25	25
Main bearing cap	85	100
Oil cooler-to-housing	11	
Oil pan screw		
1/4-20	7	7
5/16-18	10	10
Oil drain plug	20	15
Oil pump	25	25
Oil pump cover	12	12
Oil pump pickup tube	14	22
Rear mount	45	
Rocker arm cover	4	4
Spark plugs	15	15
Thermostat housing	15	15
Water pump	14	14