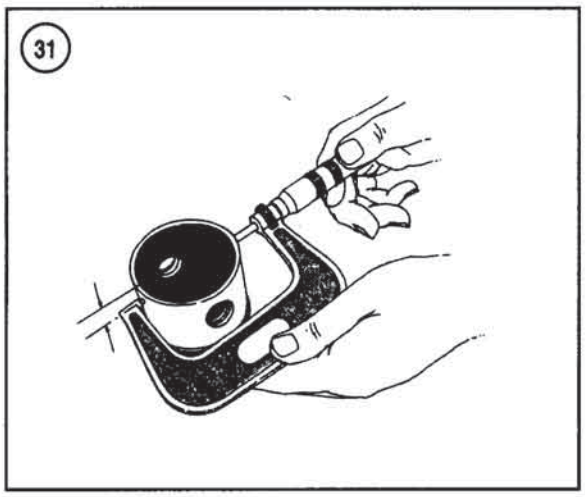
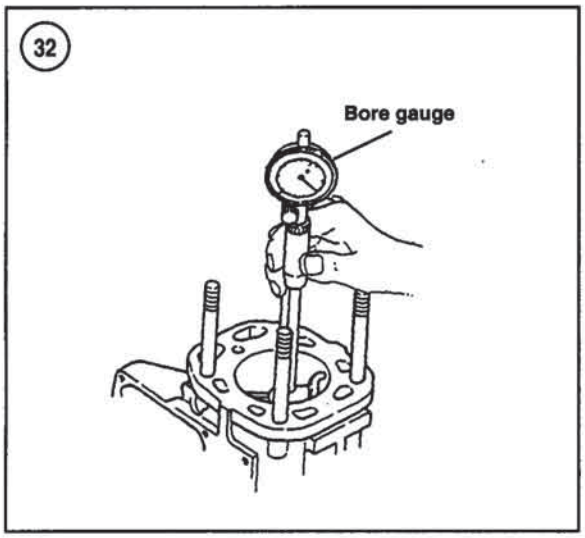
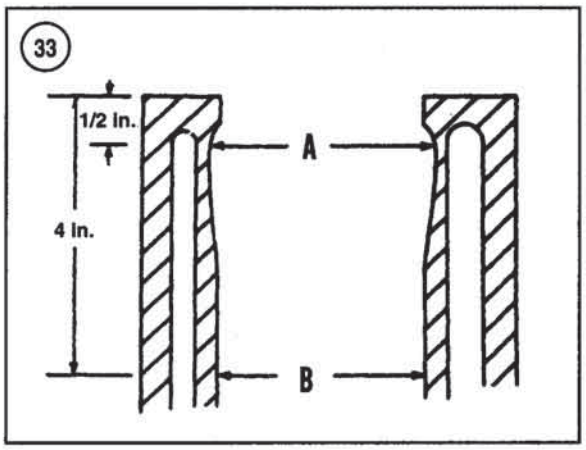
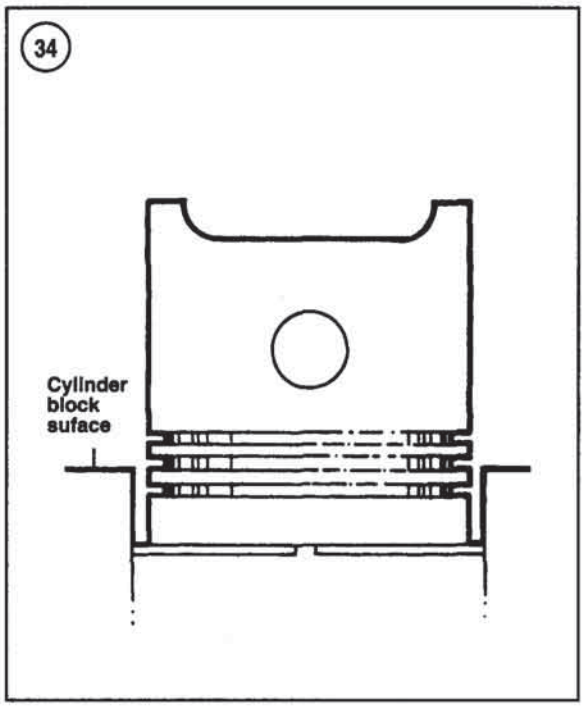








2. Measure the cylinder bore diameter at several points with a bore gauge (**Figure 32**, typical). **Figure 33** shows the points of normal cylinder wear. If dimension A exceeds dimension B by more than 0.02 mm (0.0008 in.), rebore the cylinder and install a new piston/ring assembly.

3. If the cylinder bore is damaged or excessively worn, rebore the cylinder bore and install a new piston. If the piston is worn, but the cylinder bore is good, install a new piston.

NOTE

Obtain the new piston and have it available so the machine shop can bore the cylinder to the correct oversize dimension.

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 34**.

NOTE

If the cylinder has 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 35**. Compare the measurement with specifications in **Tables 1-3**. If the measurement is not within specification, the rings must be replaced as a set. Check the gap of new rings as well. If the gap is too small, file the ends of the ring to correct it (**Figure 36**).

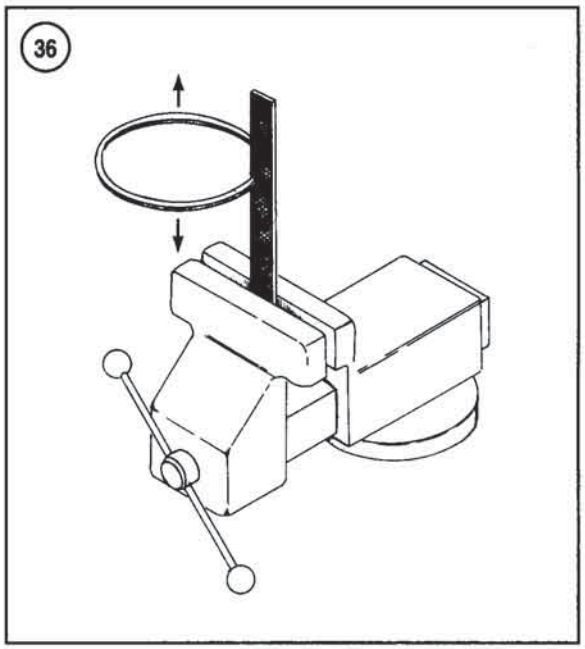
3. Check the side clearance of the rings as shown in **Figure 37**. Place the feeler gauge alongside the ring all the way into the groove. If the measurement is not within specifications (**Tables 1-3**), either the rings or the ring grooves are worn. Inspect and replace them as required.

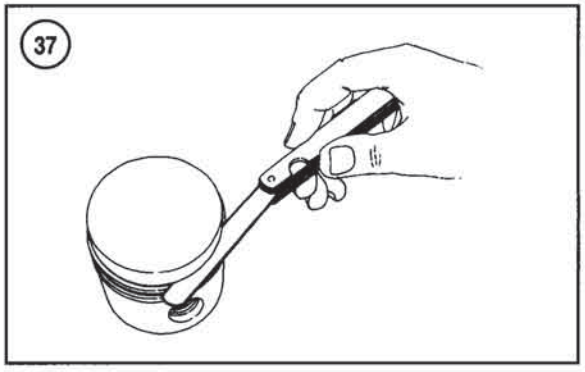
4. Using a ring expander tool (**Figure 38**), carefully install the oil control ring, then the compression rings. The oil ring consists of two pieces, the outer ring and the inner expansion spring. Assemble the oil ring on the piston so the expansion spring gap is on the opposite side of the piston from the ring end gap. See **Figure 39**. The second compression ring is tapered while the top compression ring has a barrel face. The top of each compression ring is marked and must face toward the piston crown.

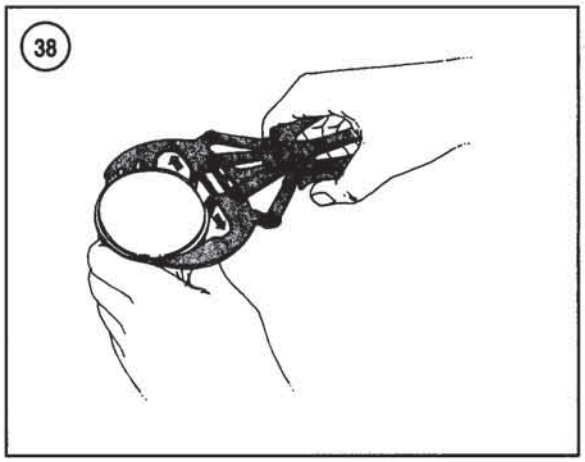
Connecting Rod Inspection

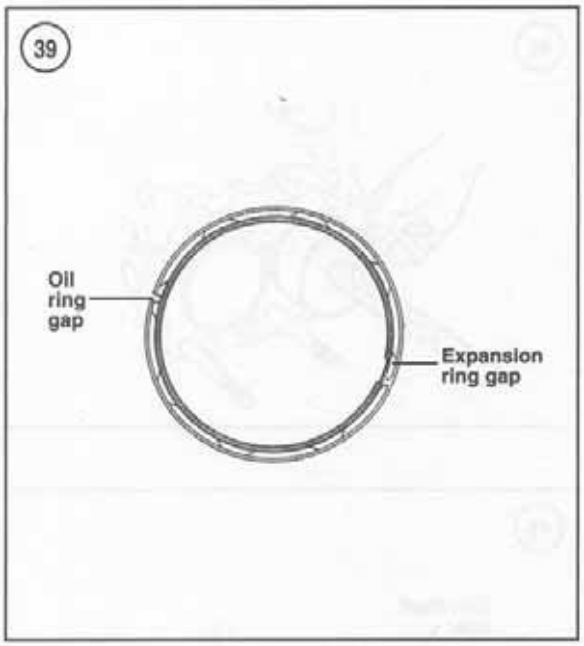
Have the connecting rod checked for straightness by a dealer or machine shop.

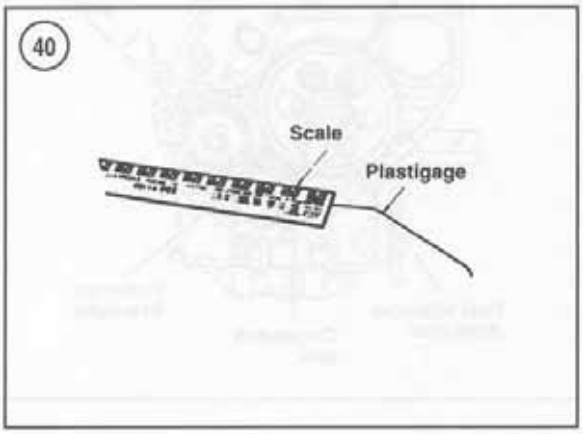
The piston pin end of the connecting rod is equipped with a bushing. Refer to **Tables 1-3** for bushing specifications. If bushing replacement is required, a press is necessary to remove the old bushing and install a new bushing. The oil holes in the bushing and connecting rod must align. Ream the bushing to obtain the desired clearance in **Tables 1-3**.









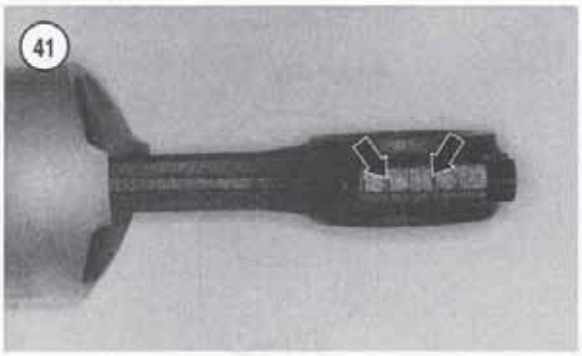


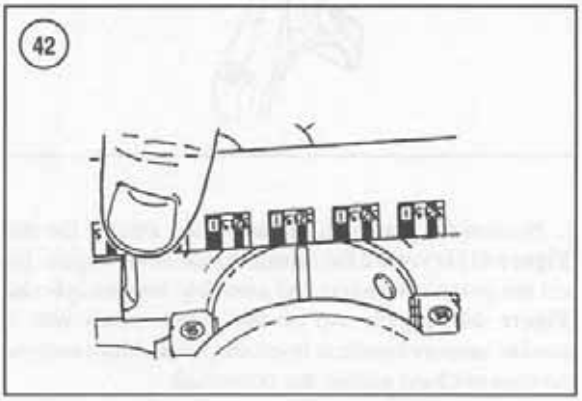
Connecting Rod Bearing Clearance Measurement

1. Place the connecting rod and upper bearing half on the connecting rod journal.
2. Cut a piece of Plastigage the width of the bearing (**Figure 40**). Place the Plastigage on the journal, then install the rod cap and bearing. Be sure to install the cap so the marks on the cap and rod are on the same side (**Figure 41**).

NOTE

Do not place Plastigage over the journal oil hole.





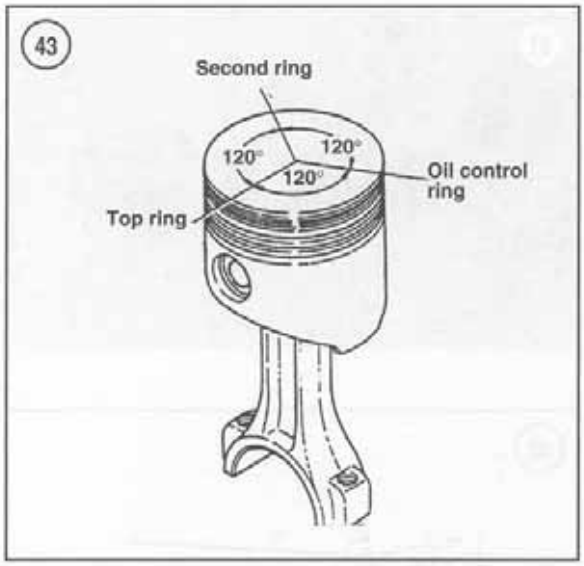
3. Tighten the connecting rod cap to specification (**Table 4**). Do not rotate the crankshaft while the Plastigage is in place.
4. Remove the connecting rod cap. To determine bearing clearance, compare the width of the flattened Plastigage to the markings on the envelope (**Figure 42**). If the clearance is excessive, have the crankshaft reground and install undersize bearings.

Piston/Connecting Rod Installation

1. Rotate the crankshaft so the crankpin is at bottom dead center.
2. Make sure the ring gaps are positioned as shown in **Figure 43**.
3. Immerse the entire piston in clean engine oil. Coat the cylinder wall with oil.
4. Install a piston ring compressor on the piston around the piston rings.

CAUTION

Use extreme care in Step 5 to prevent the connecting rod from nicking the crankshaft journal.



5. Position the piston so the numbered side of the rod (**Figure 41**) is toward the camshaft side of the engine. Insert the piston/connecting rod assembly into the cylinder (**Figure 44**). Lightly tap on the piston crown with a wooden hammer handle to insert the piston. Make sure the rod does not bang against the crankshaft.

6. Clean the connecting rod bearings carefully, including the back sides. Coat the crankpin journal and bearings with clean engine oil. Place the bearings in the connecting rod and cap.

7. Pull the connecting rod and bearing into position against the crankpin. Lightly lubricate the connecting rod bolt threads with engine oil.

8. Install the connecting rod cap. Make sure the rod and cap are properly aligned. Install the cap bolts finger-tight.

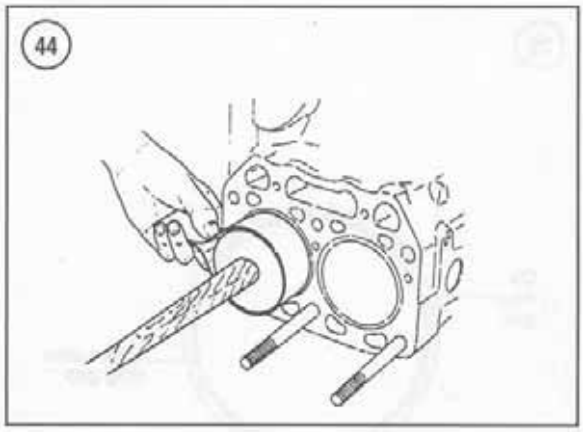
9. Tighten the cap retaining bolts to specification (**Table 4**).

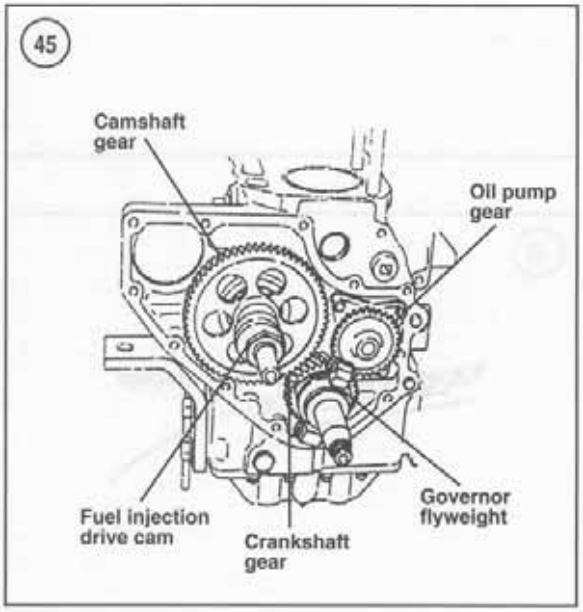
10. Check the connecting rod side clearance as described under *Piston/Connecting Rod Removal* in this chapter.

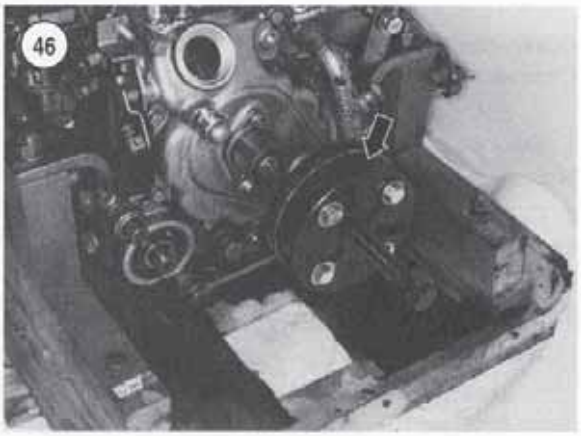
TIMING GEARCASE

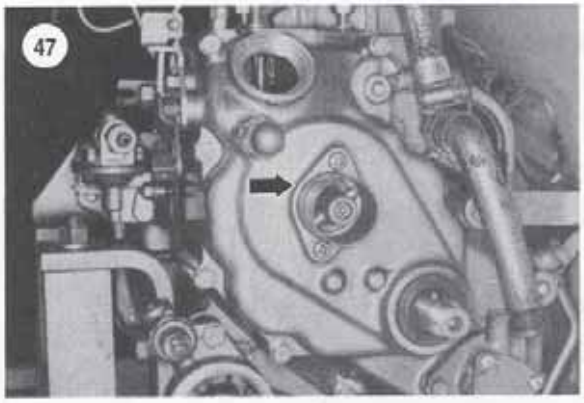
The timing gearcase covers the camshaft and crankshaft gears and the oil pump (**Figure 45**). The timing gearcase also contains the governor mechanism and serves as the mounting location for the fuel injection pump. A ball bearing in the timing gearcase supports the outer end of the crankshaft.

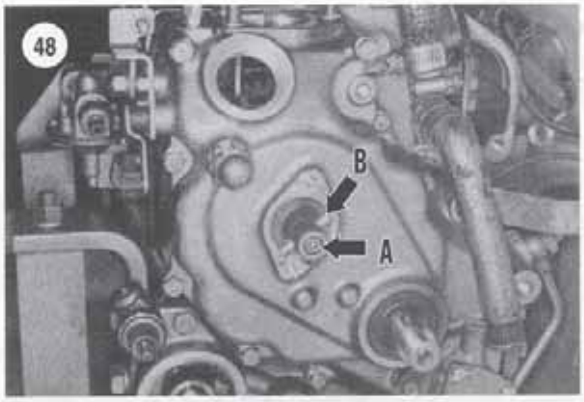
To remove and reinstall the timing gearcase, proceed as follows:

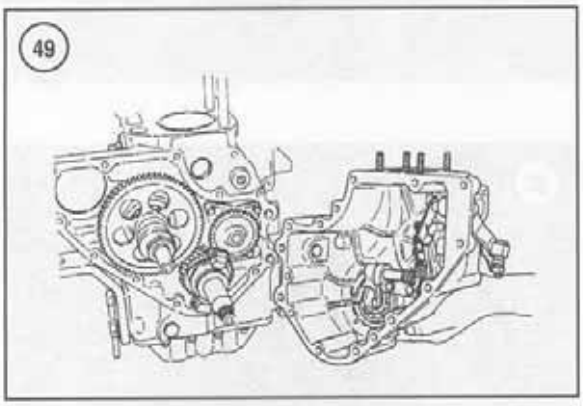












1. Disconnect the negative battery cable from the negative battery terminal.

2. Remove the alternator as described in Chapter Nine.

3. Remove the oil filter.

4. Detach the control cables from the speed control lever and the stop lever.

5. Remove the fuel injection pump as described in Chapter Seven.

6. Remove the seawater pump as described in Chapter Eight.

7. Remove the crankshaft pulley retaining nut. Using a suitable puller, remove the crankshaft pulley (**Figure 46**, typical). Remove the drive key from the crankshaft.

8. Remove the manual starter cover (**Figure 47**, typical).

9. Remove the setscrew in the end of the camshaft (A, **Figure 48**, typical), then remove the manual starter drive pin (B).

10. Remove the timing gearcase (**Figure 49**).

11. Remove the gasket and any residue from the gearcase and crankcase surfaces.

12. If crankshaft or starter seal replacement is necessary, proceed as follows:

   a. Pry the old seal from the gearcase with a large screwdriver. Work carefully to prevent damage to the gearcase seal surface.

   b. Clean the seal recess in the cover with solvent and blow it dry with compressed air.

   c. Apply gasket sealer to the periphery of the seal.

   d. Position a new seal in the cover recess with its open end facing the inside of the gearcase. Drive the seal into place with a suitably sized seal driver or socket.

13. If crankshaft bearing replacement is necessary, proceed as follows:

   a. Refer to Chapter Seven and remove governor shaft from timing gearcase.

   b. Pry the seal from the gearcase with a large screwdriver. Work carefully to prevent damage to the gearcase seal surface.

   c. Drive or press out the bearing. Force the bearing toward the inside of the gearcase.

   d. Clean the seal and bearing recesses in the cover with solvent and blow them dry with compressed air.

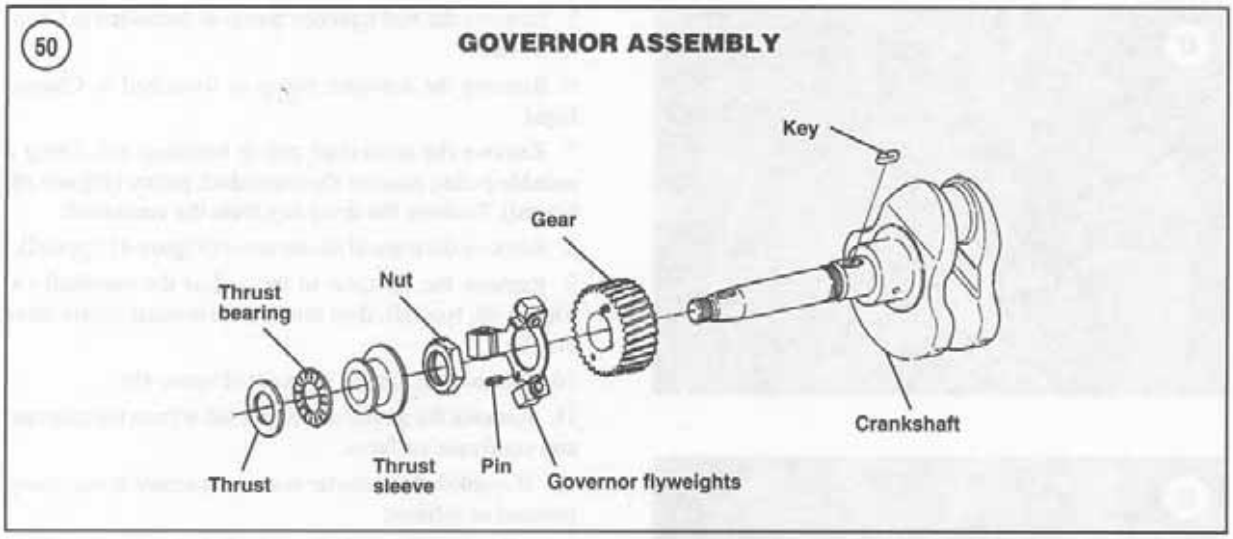
   e. Drive or press in a new bearing until the bearing seats in the recess in the gearcase.

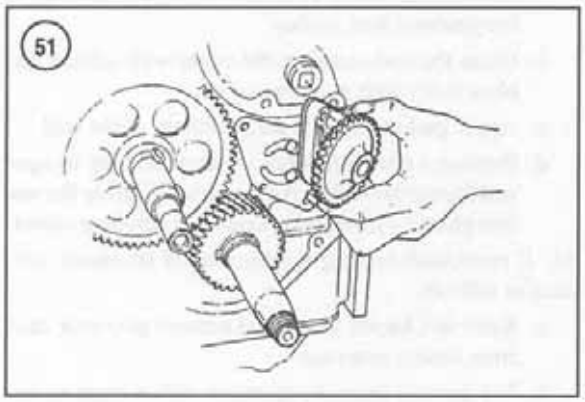
   f. Apply gasket sealer to the periphery of the seal.

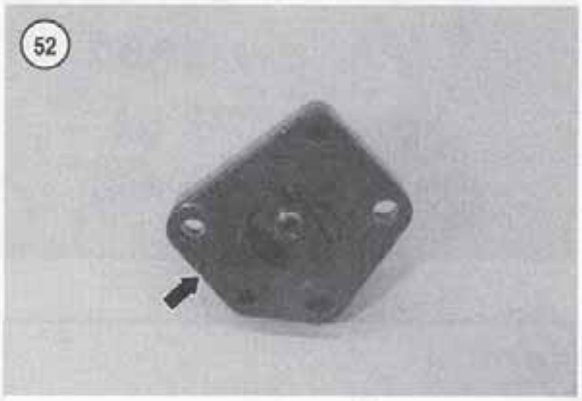
   g. Position a new seal in the cover recess with its open end facing the inside of the gearcase. Drive the seal into place with a suitably sized seal driver or socket.

   h. Refer to Chapter Seven and reinstall the governor shaft.

14. Reverse the removal procedure to reinstall the timing gearcase. Refer to **Table 4** for the tightening torque of the gearcase retaining screws.







LUBRICATION SYSTEM

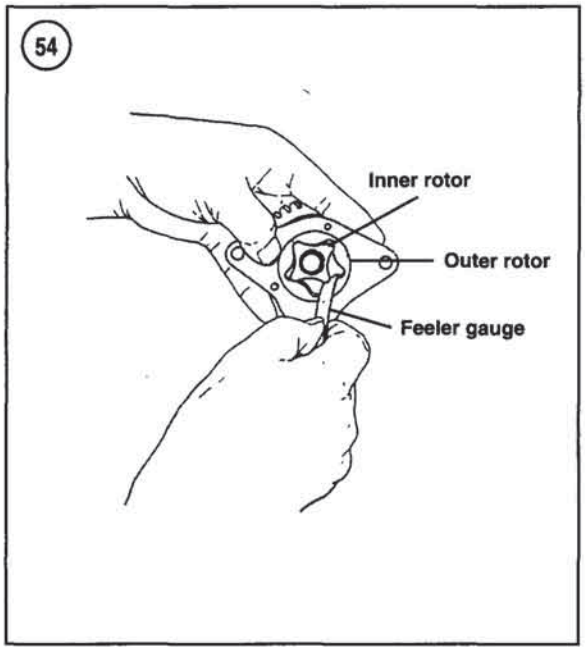
Refer to Chapter Two for lubrication system operation, diagrams and oil pressure test.

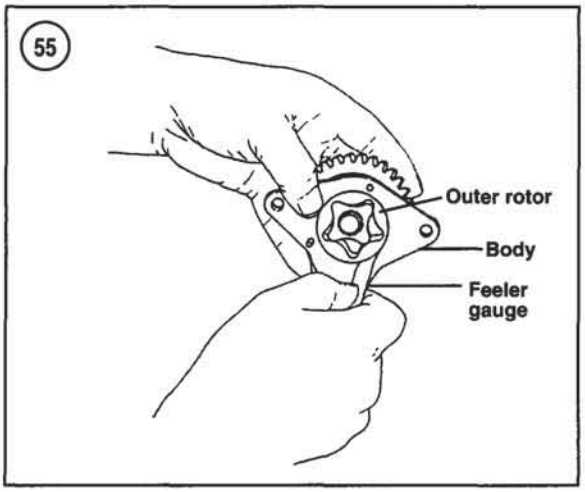
Oil Pump

The oil pump is mounted on the front (timing gear) side of the cylinder block (**Figure 45**).

Removal and installation

1. Remove the timing gearcase as previously described.
2. Remove the governor thrust washer (**Figure 50**), thrust bearing and thrust sleeve from the crankshaft.
3. Using a suitable tool (if available, Yanmar special tool 124085-92700), unscrew the crankshaft nut.
4. Remove the governor flyweight assembly.
5. Remove the oil pump (**Figure 51**) and gasket.
6. Clean any gasket residue from the oil pump and engine.

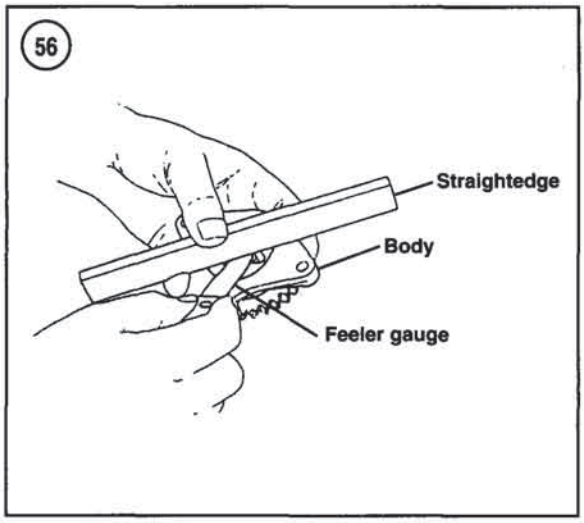




7. Installation is the reverse of removal. Tighten the oil pump retaining screws to the tightening torque specified in **Table 2**. Be sure the governor flyweight assembly is positioned on the locating pin (**Figure 50**).Tighten the crankshaft nut to the tightening torque specified in **Table 4**.

Disassembly, inspection and reassembly

1. Remove the oil pump cover (**Figure 52**).
2. Lift out the inner and outer pump rotors (**Figure 53**).



3. Thoroughly clean all parts in solvent and blow them dry with compressed air.
4. Check the drive spindle and pump rotors for signs of wear, scoring or damage. Replace damaged parts.

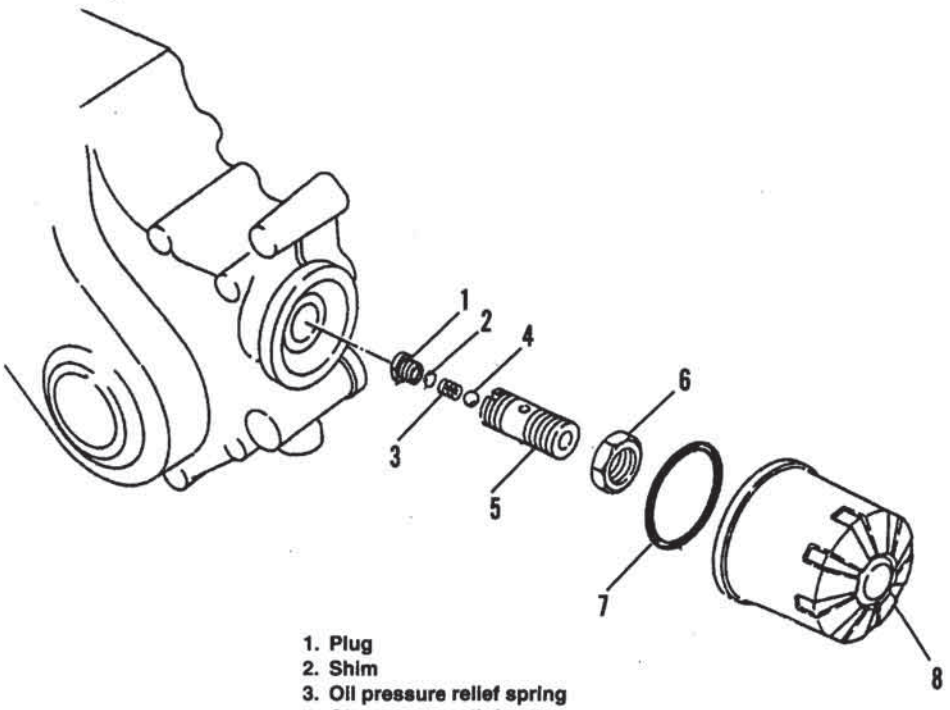
NOTE

The oil pump shaft and gear are pressed together; do not attempt to disassemble them. The oil pump must be replaced as a unit assembly if any parts are damaged.

5. Reinstall the inner rotor in the pump body. Reinstall the outer rotor in the pump body.
6. Measure the clearance between the inner rotor tip and outer rotor tip (**Figure 54**). Compare the results with specifications in **Table 1**.
7. Measure the clearance between the outer rotor and the pump body (**Figure 55**). Compare the results with specifications in **Table 1**.
8. Place a straightedge across the pump body. Measure the side clearance between the rotors and straightedge with a flat feeler gauge (**Figure 56**). Compare the measurement with specifications in **Tables 1-3**.
9. Measure the diameter of the inner rotor shaft. Measure the shaft bore of the pump body. Calculate shaft clearance and compare it with specifications in **Tables 1-3**.
10. If any clearance measured in Steps 6-9 is not with specifications, replace the pump. Individual components are not available. The pump must be replaced as a unit.
11. When reassembling the oil pump, be sure to lubricate the rotors, body and shaft with engine oil.

(57)

OIL PRESSURE REGULATOR



1. Plug
2. Shim
3. Oil pressure relief spring
4. Oil pressure relief ball
5. Pipe
6. Nut
7. O-ring
8. Oil filter

Pressure relief valve

An oil pressure relief valve is located in the oil filter mounting pipe (**Figure 57**). If oil pressure exceeds 300-400 kPa (43-57 psi), the relief valve opens and expels oil into the timing gearcase.

Do not attempt to disassemble the oil pressure relief valve. The valve is sealed and it must be replaced as a unit assembly.

Oil pickup

The oil pickup is located in the oil pan. The pickup includes a strainer to prevent foreign matter from entering the lubrication system.

To remove the oil pickup, remove the oil pan and unscrew the jam nut (**Figure 58**).

FLYWHEEL

Removal/Installation

1. Remove the engine from the boat.
2. Remove the transmission.
3. Remove the drive disc (**Figure 59**, typical).
4. Gradually loosen and remove the flywheel bolts, working in a diagonal pattern. Install two drive disc screws into two outer holes in the flywheel (**Figure 60**, typical), then use the screws to pull and remove the flywheel.
5. Inspect the ring gear. If the ring gear is excessively worn or damaged, use the following procedure to remove the ring gear:
   a. Heat the ring gear evenly, then drive the ring gear off the flywheel.

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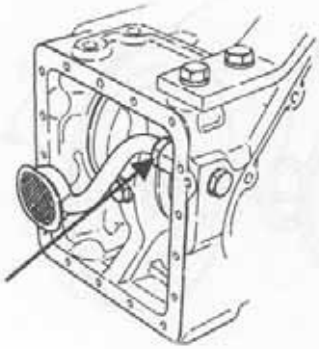
OIL PICKUP
2GM, 1GM10, 3GM AND 3GM30
(TYPICAL)



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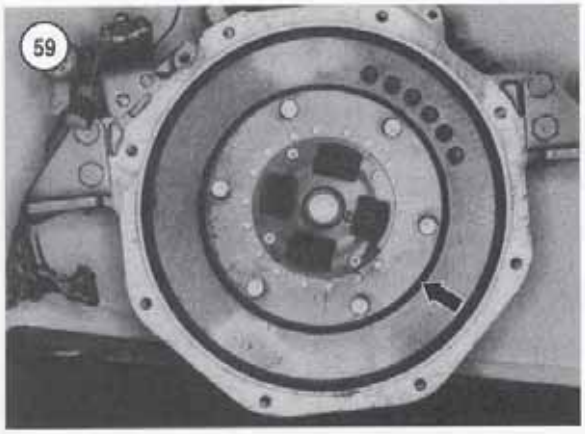

b. Heat the ring gear prior to installation. Drive the ring gear onto the flywheel while being careful not to damage the gear teeth.

6. Reverse the removal procedure to install the flywheel. Tighten the flywheel retaining bolts to the tightening torque specified in **Table 4**. Refer to Chapters Ten and Eleven to install the drive disc and transmission.

DRIVE DISC

Refer to Chapters Ten and Eleven for information concerning the drive disc (**Figure 59**).

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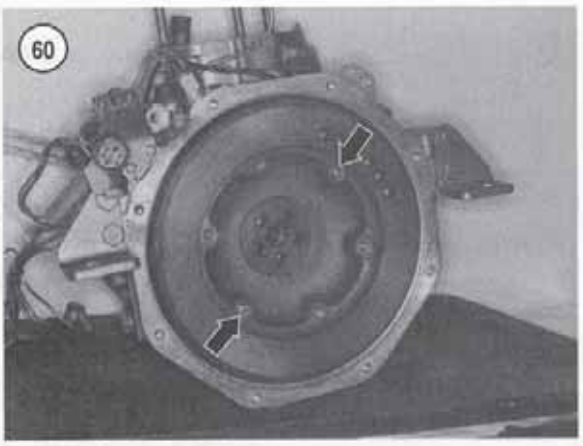

6

CRANKSHAFT

Removal and Installation

Refer to **Figure 61** for an exploded view of the crankshaft assembly.

1. Remove the flywheel as previously described.
2. Remove the bellhousing (A, **Figure 62**, typical).
3. Remove the piston and connecting rod as previously described.
4. Remove the oil pump as previously described.
5. Remove the crankshaft gear.
6. Install a dial indicator as shown in **Figure 63** and measure crankshaft end play. Compare the measurement with the specification in **Tables 1-3**. If end play is excessive, inspect the main bearing as described in *Main Bearings*.
7. Remove the main bearing housing (B, **Figure 62**, typical).
8. Position the engine so the crankshaft is vertical with the flywheel end up.
9. Attach a hoist to the flywheel end of the crankshaft.

NOTE

Two-cylinder engines are equipped with one intermediate bearing carrier. Three-cylinder engines are equipped with two intemediate bearing carriers.

10. Remove the retaining bolt(s) for the intermediate main bearing carrier(s). See **Figure 64**.

NOTE

Adjusting the lifting tension on the crankshaft may ease or increase the force necessary to unscrew the retaining bolt(s) for the intermediate main bearing carrier(s).

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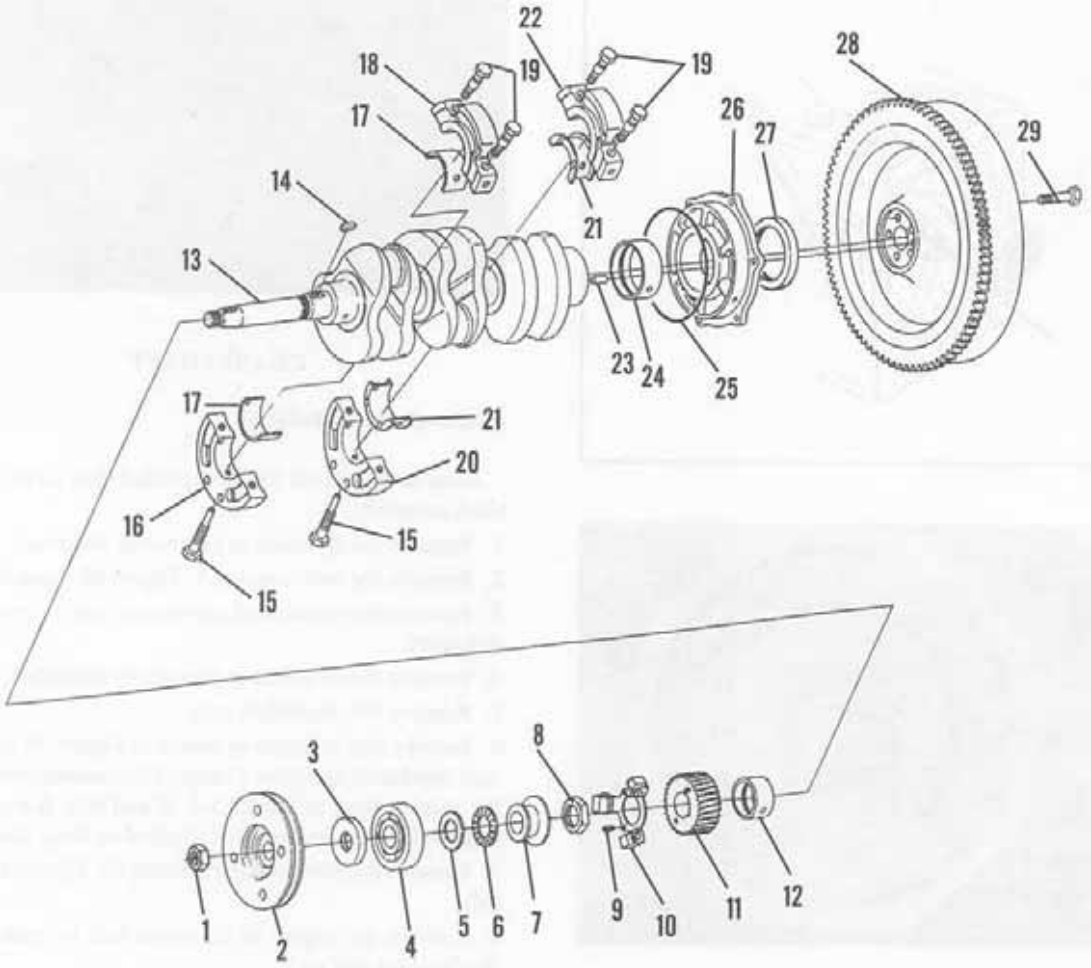
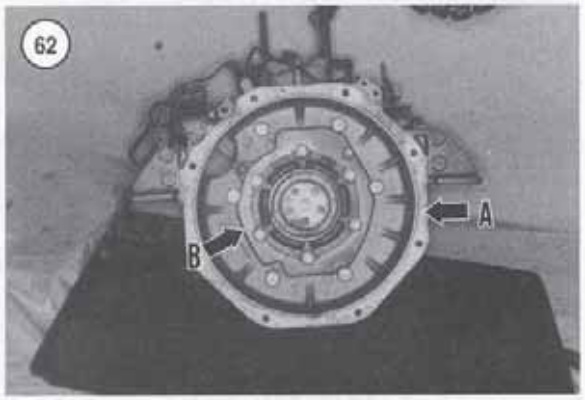
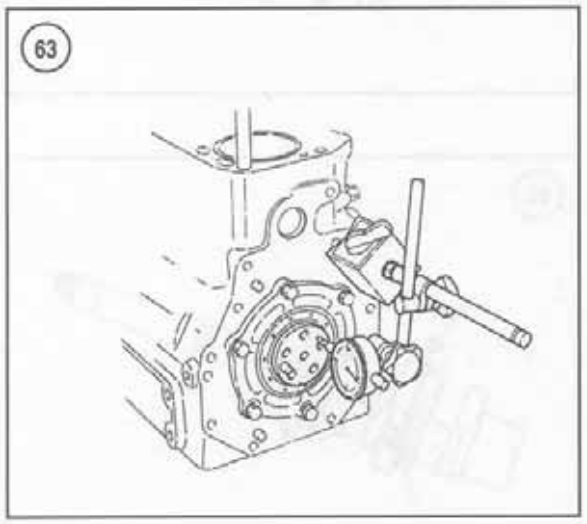
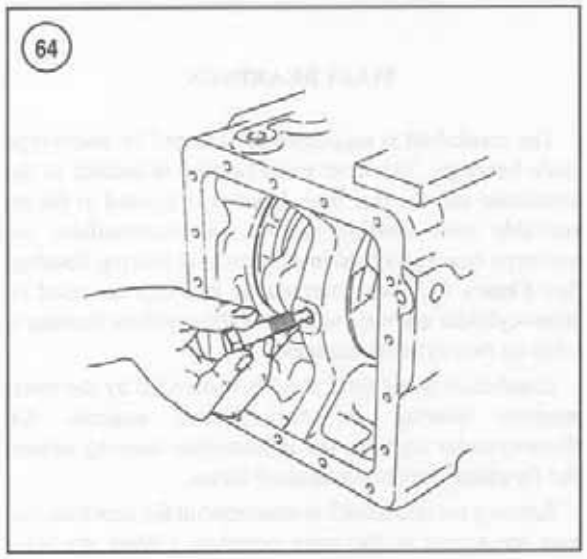
CRANKSHAFT

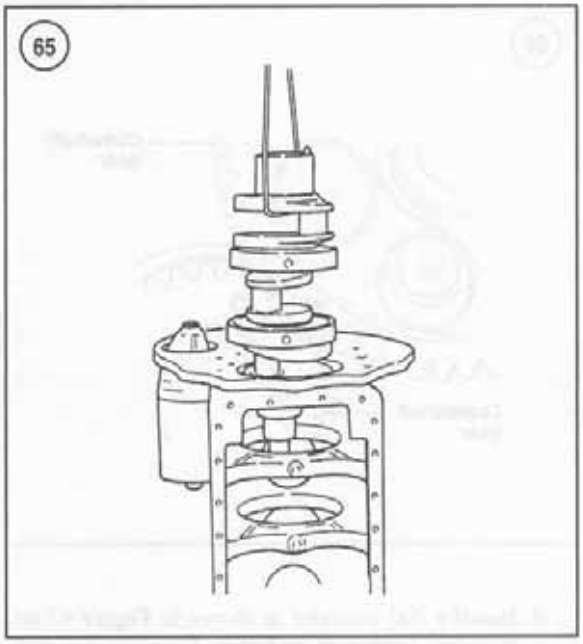


1. Nut
2. Pulley
3. Oil seal
4. Bearing
5. Thrust washer
6. Thrust bearing
7. Thrust sleeve
8. Nut
9. Pin
10. Governor flyweight assy.
11. Gear
12. Main bearing
13. Crankshaft
14. Key
15. Bolt
16. Lower main bearing holder
17. Main bearing insert
18. Upper main bearing holder
19. Bolts
20. Lower main bearing holder
21. Main bearing insert
22. Upper main bearing holder
23. Pin
24. Main bearing
25. O-ring
26. Main bearing holder
27. Oil seal
28. Flywheel
29. Bolt









11. Carefully lift the crankshaft out of the engine (**Figure 65**).

12. Proceed as follows to replace the crankshaft seal in the main bearing housing:

a. Pry the old seal from the main bearing housing with a large screwdriver. Work carefully to prevent damage to the main bearing housing seal surface.

b. Clean the seal recess in the housing with solvent and blow it dry with compressed air.

c. Apply gasket sealer to the periphery of the seal.

d. Position the new seal in the housing recess with its open end facing the inside of the bearing housing. Drive the seal into place with a suitably sized seal driver.

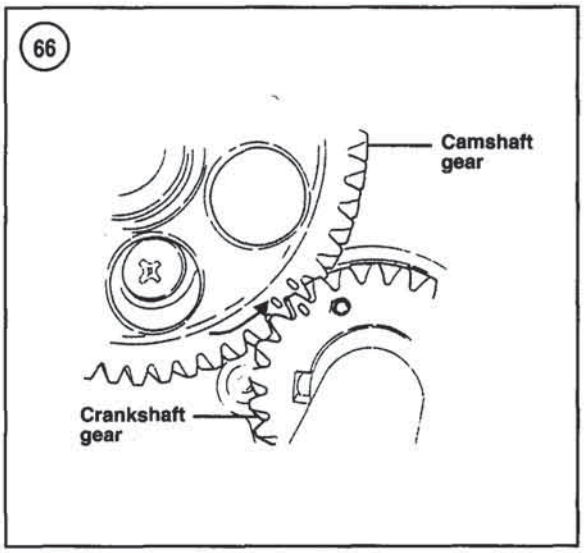
13. Refer to the *Main Bearings* section for information concerning service to the main bearings and thrust bearings.

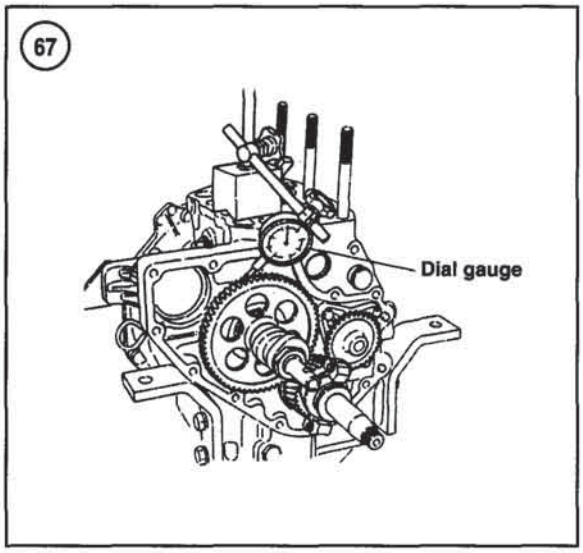
14. Reinstall the crankshaft by reversing the removal procedure while noting the following:

a. Thoroughly lubricate the main bearings and thrust bearings.

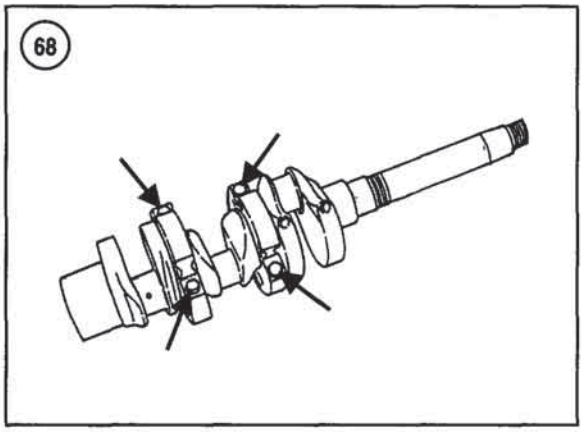
b. Be sure to install a new O-ring on the main bearing housing.

c. Tighten the main bearing and intermediate housing bolts to the tightening torque specified in **Table 4**. After tightening, rotate the crankshaft to be sure it rotates freely. If not, loosen, then retighten the intermediate main bearing housing bolts.





d. Install a dial indicator as shown in **Figure 63** and measure crankshaft end play. Compare the measurement with the specification in **Tables 1-3**. If end play is incorrect, refer to the *Main Bearings* section to determine the cause.
e. Align the timing marks (**Figure 66**) on the camshaft and crankshaft gears when installing the crankshaft gear.
f. Check timing gear backlash by installing a dial indicator as shown in **Figure 67** or by rotating the gear teeth with soft solder between the gear teeth. Compare the measurement with the specification in **Tables 1-3**. If gear backlash is incorrect, replace the camshaft and crankshaft gears.



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 wear, scratches, grooves, scoring or cracks. Check oil seal surface for burrs, nicks or other sharp edges that might damage a seal during installation.

NOTE

Unless precision measuring equipment is available, have a machine shop perform Step 3.

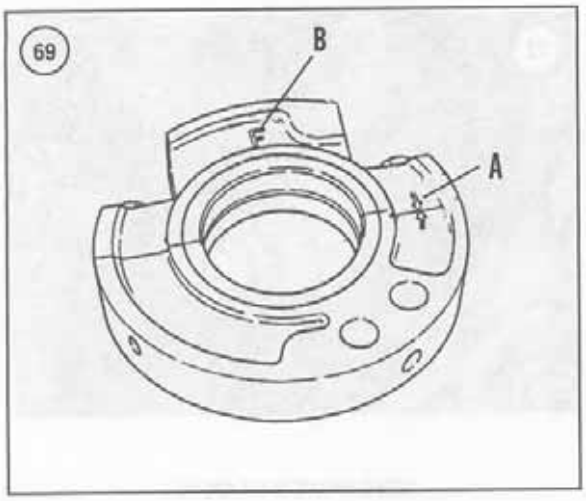
3. Check all journals against specifications (**Tables 1-3**) for out-of-roundness and taper. Have the crankshaft reground, if necessary, and install new undersize bearings.

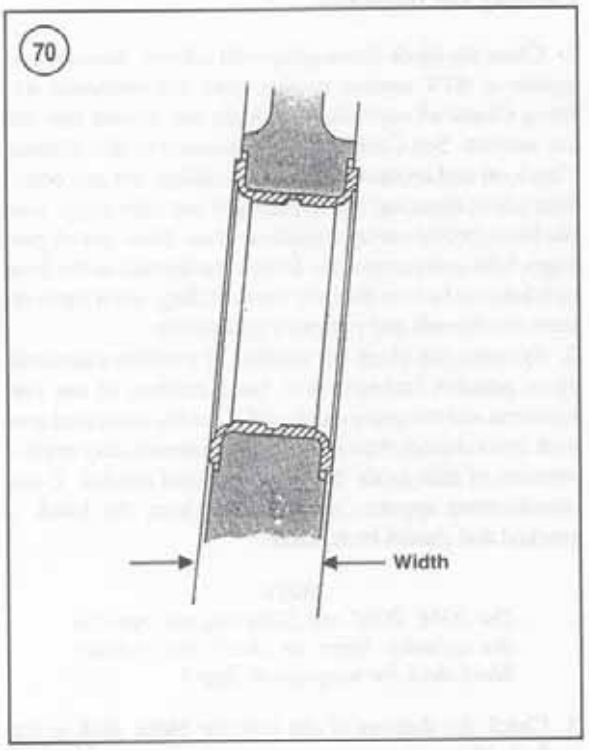
MAIN BEARINGS

The crankshaft is supported at each end by insert-type main bearings. The front main bearing is located in the crankcase and the rear main bearing is located in the removable main bearing carrier. The intermediate, insert-type bearing is held in a removable bearing housing. See **Figure 61**. Two intermediate bearings are used on three-cylinder engines, while one intermediate bearing is used on two-cylinder engines.

Crankshaft thrust (end play) is controlled by the intermediate bearing on two-cylinder engines. On three-cylinder engines, the intermediate bearing nearest the flywheel controls crankshaft thrust.

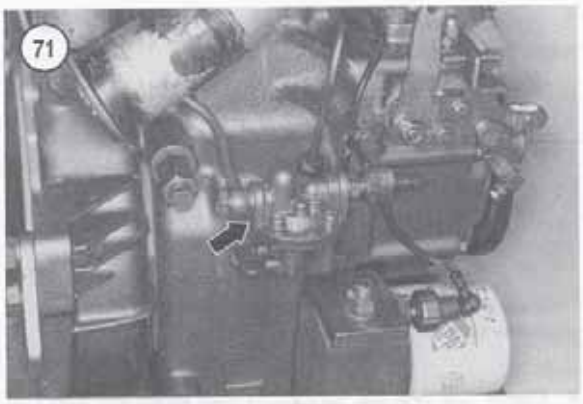
Remove the crankshaft as described in the previous section for access to the main bearings. Unless precision





measuring equipment is available, have a dealership or machine shop measure main bearing dimensions. Refer to specifications in **Tables 1-3**.

If front or rear bearing replacement is necessary, have the main bearings replaced by a dealership or machine shop. Be sure the oil holes in the main bearings align with the oil passages in the crankcase and main bearing carrier.



Intermediate Main Bearing

1. Remove the intermediate bearing housing bolts (**Figure 68**).
2. Separate the intermediate bearing housing halves from the crankshaft.
3. Inspect the bearings for excessive wear and damage.
4. Reassemble the intermediate bearing housing including the bearing inserts. Assemble the bearing housing so the arrows (A, **Figure 69**) at the parting surfaces are on the same side. Tighten the bolts to the torque specified in **Table 2**.
5. Measure the crankshaft and bearing diameters and compare them with the specifications in **Tables 1-3**.
6. Measure the width of the intermediate thrust bearing (**Figure 70**) and compare it with the specification in **Table 1**.
7. Be sure to lubricate the bearing inserts with oil before installing the intermediate main bearing housing on the crankshaft. Install the bearing housing on the crankshaft so the F mark (B, **Figure 69**) on the housing faces toward the flywheel end of the crankshaft.
8. Tighten the bearing housing bolts to the torque specified in **Table 4**.

CAMSHAFT

Removal and Installation

1. Remove the fuel transfer pump (**Figure 71**, typical).
2. Remove the crankshaft as previously described.
3. Prevent rotation of the camshaft gear by holding a screwdriver or other tool against the camshaft bearing retaining screw (**Figure 72**, typical).
4. Remove the camshaft gear nut (**Figure 73**), fuel injection pump cam and camshaft gear.

5. Position the engine so the valve lifters will not fall out when the camshaft is withdrawn.

6. Remove the bearing retaining screw (**Figure 74**), then withdraw the camshaft.

7. Remove the valve lifters and mark them so they may be reinstalled in their original locations.

NOTE

If precision measuring equipment is not available, have Step 8 performed by a dealership or machine shop.

8. Check the bearing journal(s) and lobes for signs of wear or scoring.

9. Measure the bearing journal(s) and lobes (**Figure 75**) and compare the results to the specifications in **Tables 1-3**. Replace the camshaft if the journal or lobes do not meet specifications.

10. Measure the stem diameter of the valve lifters and compare it to the specification in **Tables 1-3**. Measure the lifter bores in the cylinder block. Calculate the lifter clearance and compare it with the specification in **Tables 1-3**. Replace the valve lifters if they do not meet specifications. Replace the valve lifter if the lifter face is scored, galled, excessively worn or otherwise damaged.

11. Replace the ball bearing if it is damaged or feels rough during rotation.

12. Installation is the reverse of removal. Note the following:

a. If installing a new camshaft, coat the camshaft lobes with camshaft break-in lubricant. If reinstalling the original camshaft, apply heavy oil to the camshaft lobes.

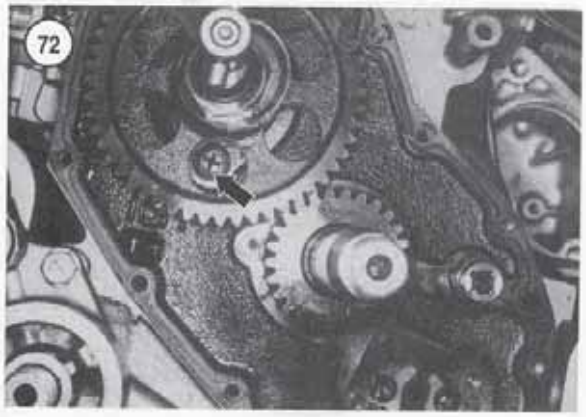
b. Lubricate the camshaft bearing journal(s) with heavy engine oil before reinstallation.

c. Lightly tap the end of the camshaft to seat the ball bearing in the engine. Rotate the camshaft to be sure it rotates freely.

d. Align the timing marks (**Figure 76**) on the camshaft and crankshaft gears when installing the camshaft gear.

e. Install the fuel injection cam so the side marked with a zero is out (**Figure 77**, typical).

f. Check gear backlash by installing a dial indicator as shown in **Figure 67** or by rotating the gear teeth with soft solder between the gear teeth. Compare the measurement with the specification in **Tables 1-3**. If gear backlash is incorrect, replace the camshaft and crankshaft gears.



CYLINDER BLOCK

Cleaning and Inspection

1. Clean the block thoroughly with solvent. Remove any gasket or RTV sealant residue from the machined surfaces. Check all core plugs for leaks and replace any that are suspect. See *Core Plug Replacement* in this chapter. 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 restore the threads and remove any deposits.

2. Examine the block for cracks. To confirm suspicions about possible leakage areas, use a mixture of one part kerosene and two 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.

NOTE

On 2GM, 3GM and 3HM engines, remove the cylinder liners to check the cylinder block deck for warpage in Step 3.

3. Check the flatness of the cylinder block deck or top surface. Place an accurate straightedge on the block. If there is any gap between the block and straightedge, measure it with a flat feeler gauge (**Figure 78**). Measure from end to end and from corner to corner. Have the block resurfaced if it is warped more than 0.07 mm (0.0028 in.).

4. *On 2GM20, 3GM30 and 3HM35 models*—Measure the cylinder bores with a bore gauge (**Figure 79**) for out-of-roundness or excessive wear as described in *Piston/Cylinder Bore Check* in this chapter. If the cylinders exceed maximum tolerances, they must be rebored.

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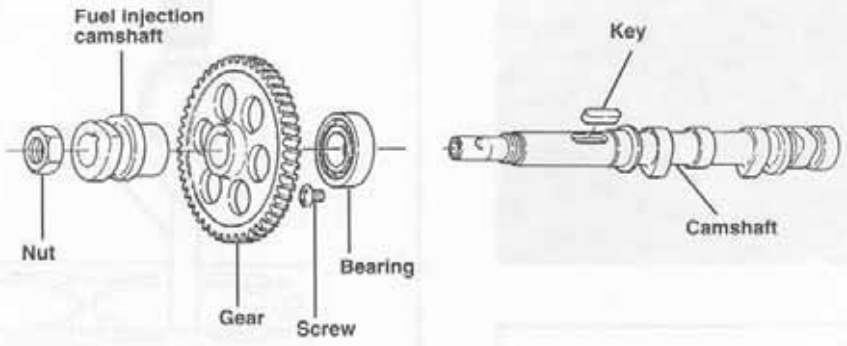
CAMSHAFT ASSEMBLY



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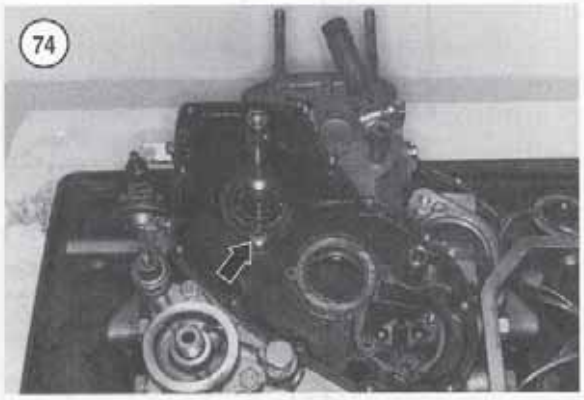

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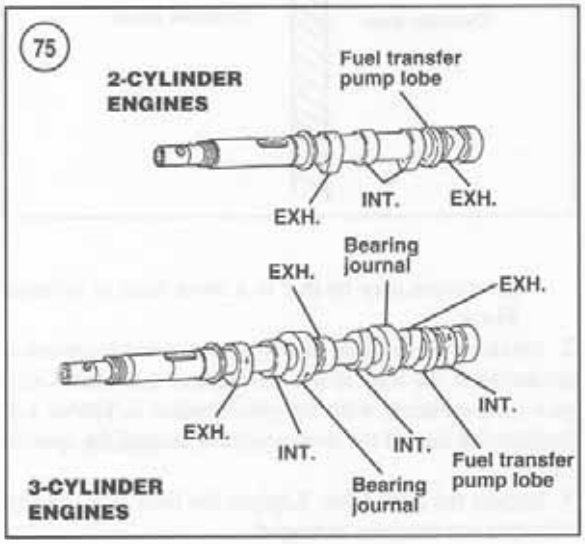

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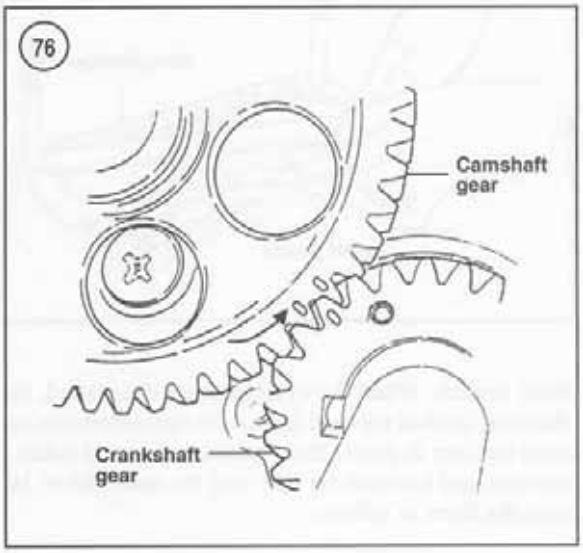
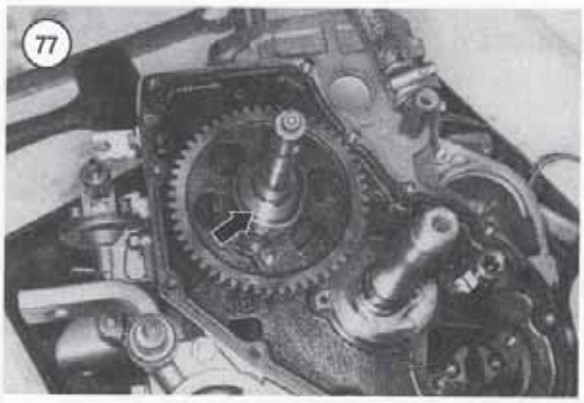
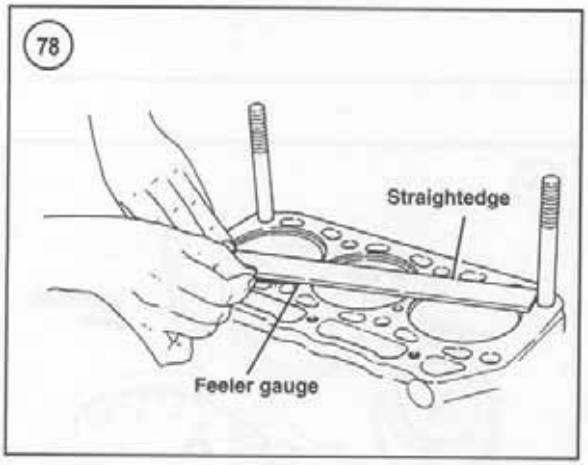


Reboring is also necessary if the cylinder walls are badly scuffed or scored.

Cylinder Liners 2GM, 3GM and 3HM (Including F and D Series) Models

Have cylinder liners replacement performed by a dealership or diesel engine shop. The liner is available in different outside diameters so a precise fit between the liner and cylinder block may be obtained. The upper flanged end of the liner fits in a step at the upper end of the cylinder bore. Each liner must protrude above the cylinder



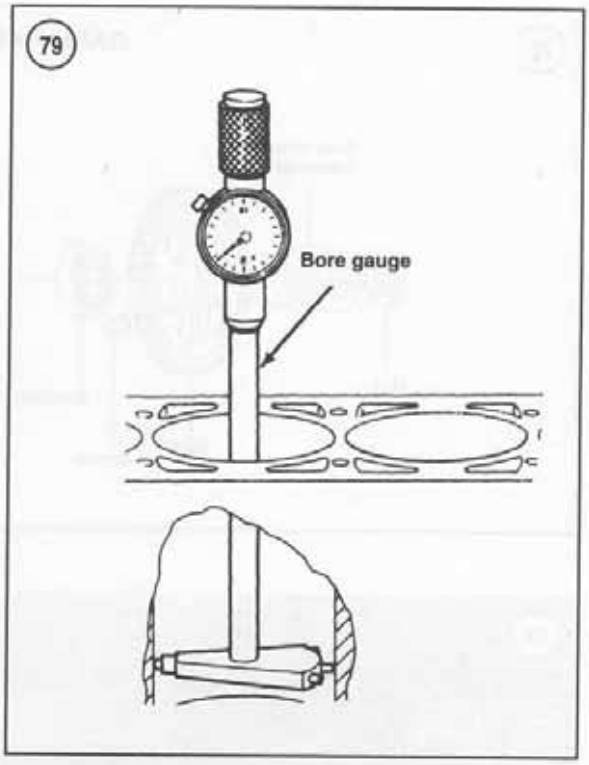


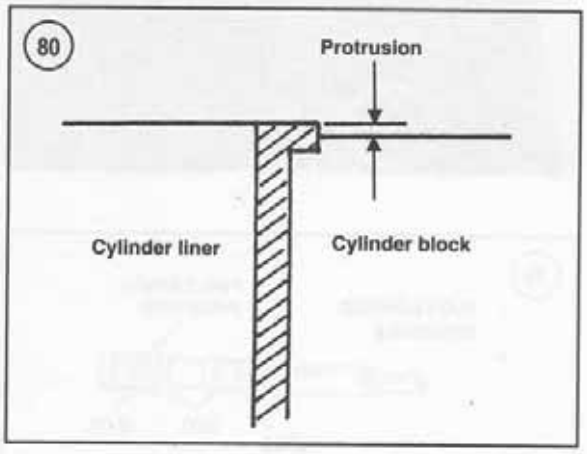
block surface. When the cylinder head is installed, the clamping force of the head against the liner protrusion secures the liner in place. The protrusion also establishes a gas-tight seal between the liner and the head gasket. Inspect the liners as follows:

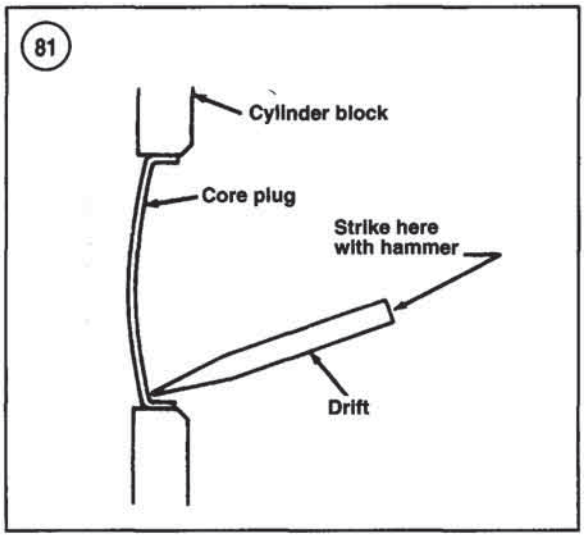
NOTE

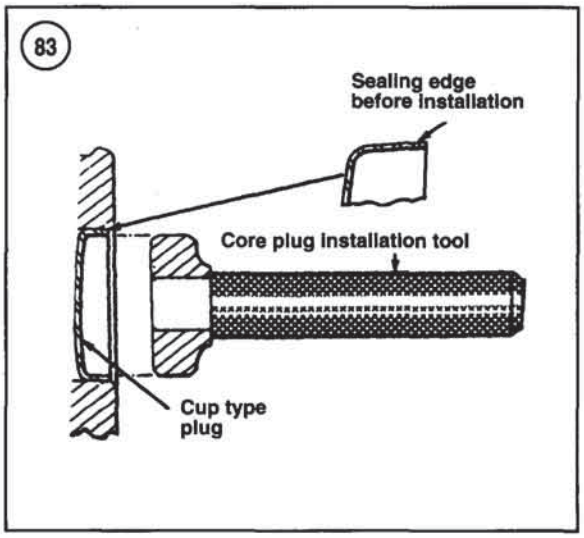
The liner is a close fit in the block, but it may be movable. Distortion or corrosion may freeze the liner in the block, which will necessitate a puller to remove the liner.

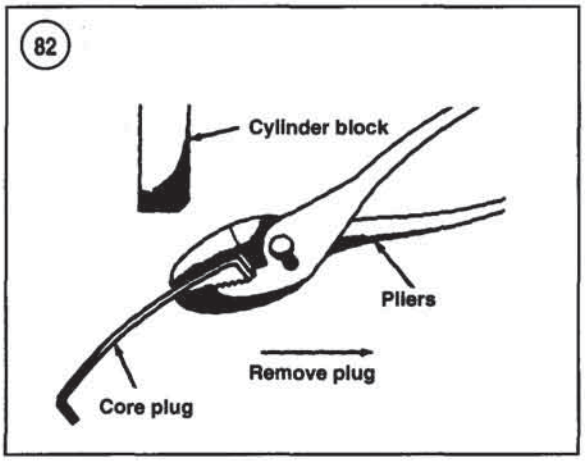
1. Measure liner protrusion above the cylinder block (**Figure 80**) and compare the result with the specification in **Tables 1-3**.
   a. Excess protrusion may damage the head gasket. Excess protrusion may be caused by improper seating of the liner flange in the block, possibly due to corrosion.
   b. Insufficient protrusion may allow compression leaks and liner movement in the block. Insufficient protrusion may be due to a worn liner or cylinder block.
2. Measure the cylinder liner bore at several locations to determine if the liner is out-of-round or distorted. Compare measurements with the specification in **Tables 1-3**. Replace the liner if the measurements exceed the specification.
3. Inspect the liner bore. Replace the liner if it is rusty, corroded or otherwise damaged.











Core Plug Replacement

Check the condition of all core plugs in the block whenever the engine is out of the boat for service. If any signs of leakage or corrosion are found around one core plug, replace them all. Core plugs in the cylinder block prevent damage to the block should the coolant freeze. The cylinder block of 2GM, 3GM and 3HM engines is equipped with cast iron, removable cylinder liners. See *Cylinder Liners* in this chapter.

NOTE

A machine shop can replace core plugs inexpensively. If machine work on the engine is necessary, have the core plugs replaced at the same time.

Removal and 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 81**).
2. Grip the top of the plug firmly with pliers. Pull the plug from its bore (**Figure 82**) and discard.

NOTE

It is also possible to remove core plugs by drilling a hole in the center of the plug and prying it out with an appropriate size drift or pin punch. When removing a large core plug, the use of a universal impact slide hammer is recommended.

3. Clean the plug bore thoroughly to remove all traces of the old sealer. Inspect the bore for any damage that might interfere with proper sealing of the new plug.
4. Coat the inside diameter of the plug bore and the outer diameter of the new plug with sealer. Use an oil-resistant sealer if the plug is to be installed in an oil gallery or a water-resistant sealer for plugs installed in the water jacket.
5. Install the new core plug with an appropriate size core plug installation tool (**Figure 83**), driver or socket. Position the outside edge of the plug 2-3 mm (0.08-0.12 in.) inside the block.
6. Repeat Steps 1-5 to replace each remaining core plug.

Table 1 ENGINE SPECIFICATIONS (2GM AND 2GM20)

Bore	
2GM	72 mm (2.83 in.)
2GM20	75 mm (2.95 in.)
Stroke	72 mm (2.83 in.)
Displacement	
2GM	586 cc (35.7 cu. in.)
2GM20	636 cc (38.8 cu. in.)
Number of cylinders	2
Firing order	1-2
Cylinder liner diameter (2GM)	72.000 mm (2.8346 in.)
Cylinder liner protrusion (2GM)	0.005-0.075 mm (0.0002-0.0030 in.)
Cylinder bore diameter (2GM20)	75.000-75.030 mm (2.9528-2.9540 in.)
Bore/liner out-of-round—max.	0.02 mm (0.0008 in.)
Cylinder block warpage—max.	0.05 mm (0.002 in.)
Piston diameter	
2GM	
Standard	71.913-71.943 mm (2.8312-2.8324 in.)
Wear limit	71.850 mm (2.8287 in.)
2GM20	
Standard	74.910-74.940 mm (2.9492-2.9504 in.)
Wear limit	74.850 mm max. (2.9468 in.)
Piston top clearance	0.68-0.88 mm (0.027-0.035 in.)
Piston ring side clearance	
Top ring	0.065-0.100 mm (0.0026-0.0039 in.)
Second ring	0.035-0.070 mm (0.0014-0.0028 in.)
Oil ring	0.020-0.055 mm (0.0008-0.0022 in.)
Ring end gap (all rings)	0.20-0.40 mm (0.008-0.016 in.)
Piston pin diameter	19.991-20.000 mm (0.7870-0.7874 in.)
Piston pin hole diameter	
In piston	19.995-20.008 mm (0.7872-0.7877 in.)
In rod	20.000 mm (0.7874 in.)
Piston pin clearance	
In rod	0.025-0.047 mm (0.0010-0.0019 in.)
In piston	0.005 mm tight-0.017 mm loose (0.0002 in. tight-0.0007 in. loose)
Piston ring width	
Top and second ring	1.97-1.99 mm (0.0776-0.0783 in.)
Oil control ring	3.97-3.99 mm (0.1563-0.1571 in.)
Cylinder liner protrusion (2GM)	0.005-0.075 mm (0.0002-0.0030 in.)
Crankshaft main journal diameter	
Timing gear end	43.950-43.964 mm (1.7303-1.7309 in.)
Center	43.950-43.964 mm (1.7303-1.7309 in.)
Flywheel end	59.950-59.964 mm (2.3602-2.3608 in.)
Journal out-of-round—max.	0.01 mm (0.0004 in.)
Crankshaft end play	0.09-0.19 mm (0.0035-0.0075 in.)
Crankshaft runout—max.	0.15 mm (0.006 in.)
Main bearing clearance	
Timing gear end	0.036-0.092 mm (0.0014-0.0036 in.)
Center	0.036-0.092 mm (0.0014-0.0036 in.)
Flywheel end	0.036-0.095 mm (0.0014-0.0037 in.)
Intermediate thrust bearing width—min.	24.63 mm (0.970 in.)
Crankpin diameter	39.950-39.964 mm (1.5728-1.5734 in.)
Journal out-of-round—max.	0.01 mm (0.0004 in.)
Crankpin bearing clearance	0.028-0.086 mm (0.0011-0.0034 in.)
Connecting rod side clearance	0.2-0.4 mm (0.008-0.016 in.)
Cylinder head warpage—max.	0.07 mm (0.003 in.)
Camshaft	
Valve lobe lift	35.000 mm (1.3780 in.)
Fuel pump lobe lift	33.000 mm (1.2992 in.)
Journal diameter	30.000 mm (1.1811 in.)
Runout	0.02 mm max. (0.0008 in. max.)

(continued)

Table 1 ENGINE SPECIFICATIONS (2GM AND 2GM20) (continued)

Timing gear backlash	0.05-0.13 mm (0.002-0.005 in.)
Maximum allowable	0.3 mm (0.012 in.)
Push rod runout—max.	0.03 mm (0.0012 in.)
Valve lifter	
Type	Mechanical
Outside diameter	10.000 mm (0.3937 in.)
Outside diameter—min.	9.95 mm (0.3917 in.)
Clearance in block	0.010-0.040 mm (0.0004-0.0016 in.)
Max. clearance	0.10 mm (0.004 in.)
Valve face angle	45°
Valve seat angle	45°
Valve head margin	0.75-1.15 mm (0.030-0.045 in.)
Seat width (int. and exh.)	1.77 mm (0.070 in.)
Valve depth—max.	1.25 mm (0.049 in.)
Valve stem clearance	
Intake	0.040-0.065 mm (0.0016-0.0026 in.)
Exhaust	0.045-0.070 mm (0.0018-0.0028 in.)
Max. stem clearance	0.15 mm (0.006 in.)
Valve stem diameter	7.000 mm (0.2756 in.)
Valve stem wear limit	6.900 mm (0.2717 in.)
Valve stem runout—max.	0.03 mm (0.0012 in.)
Valve guide diameter	7.000 mm (0.2756 in.)
Valve guide wear limit	7.080 mm (0.2878 in.)
Valve guide protrusion	7.0 mm (0.276 in.)
Valve spring	
Standard free length	38.5 mm (1.52 in.)
Min. free length	37 mm (1.46 in.)
Installed height	29.2 mm (1.15 in.)
Pressure at installed height	16.16 kg at 29.2 mm (35.63 lb. at 1.15 in.)
Rocker arm shaft clearance	0.016-0.052 mm (0.0006-0.0020 in.)
Rocker arm shaft clearance—max.	0.15 mm (0.006 in.)
Rocker arm bore wear limit	14.10 mm (0.555 in.)
Rocker arm shaft wear limit	13.90 mm (0.547 in.)
Oil pump	
Inner rotor tip-to-outer rotor tip	0.050-0.105 mm (0.0020-0.0041 in.)
Max.	0.15 mm (0.006 in.)
Outer rotor-to-pump body	0.050-0.105 mm (0.0020-0.0041 in.)
Max.	0.15 mm (0.006 in.)
Rotor side clearance	0.030-0.080 mm
Max.	0.13 mm (0.005 in.)
Shaft clearance	0.015-0.050 mm (0.0006-0.0020 in.)
Max.	0.20 mm (0.0079 in.)

Table 2 ENGINE SPECIFICATIONS (3GM AND 3GM30)

Bore	
3GM	72 mm (2.83 in.)
3GM30	75 mm (2.95 in.)
Stroke	72 mm (2.83 in.)
Displacement	
3GM	879 cc (53.6 cu. in.)
3GM30	954 cc (58.2 cu. in.)
Number of cylinders	3
Firing order	1-2-3
Cylinder liner diameter (3GM)	72.000 mm (2.8346 in.)
Cylinder liner protrusion (3GM)	0.005-0.075 mm (0.0002-0.0030 in.)
Cylinder bore diameter (3GM30)	75.000-75.030 mm (2.9528-2.9540 in.)
Bore/liner out-of-round—max.	0.02 mm (0.0008 in.)

(continued)

Table 2 ENGINE SPECIFICATIONS (3GM AND 3GM30) (continued)

Cylinder block warpage—max.	0.05 mm (0.002 in.)
Piston diameter	
3GM	
Standard	71.913-71.943 mm (2.8312-2.8324 in.)
Wear limit	71.850 mm (2.8287 in.)
3GM30	
Standard	74.910-74.940 mm (2.9492-2.9504 in.)
Wear limit	74.850 mm (2.9468 in.)
Piston top clearance	0.68-0.88 mm (0.027-0.035 in.)
Piston ring side clearance	
Top ring	0.065-0.100 mm (0.0026-0.0039 in.)
Second ring	0.035-0.070 mm (0.0014-0.0028 in.)
Piston ring side clearance (continued)	
Oil ring	0.020-0.055 mm (0.0008-0.0022 in.)
Ring end gap (all rings)	0.20-0.40 mm (0.008-0.016 in.)
Piston pin diameter	19.991-20.000 mm (0.7870-0.7874 in.)
Piston pin hole diameter	
In piston	19.995-20.008 mm (0.7872-0.7877 in.)
In rod	20.000 mm (0.7874 in.)
Piston pin clearance	
In rod	0.025-0.047 mm (0.0010-0.0019 in.)
In piston	0.005 mm tight-0.017 mm loose (0.0002 in. tight-0.0007 in. loose)
Piston ring width	
Top and second ring	1.97-1.99 mm (0.0776-0.0783 in.)
Oil control ring	3.97-3.99 mm (0.1563-0.1571 in.)
Crankshaft main journal diameter	
Timing gear end	43.950-43.964 mm (1.7303-1.7309 in.)
Center	43.950-43.964 mm (1.7303-1.7309 in.)
Flywheel end	59.950-59.964 mm (2.3602-2.3608 in.)
Journal out-of-round—max.	0.01 mm (0.0004 in.)
Crankshaft end play	0.09-0.19 mm (0.0035-0.0075 in.)
Crankshaft runout—max.	0.15 mm (0.006 in.)
Main bearing clearance	
Timing gear end	0.036-0.092 mm (0.0014-0.0036 in.)
Center	0.036-0.092 mm (0.0014-0.0036 in.)
Flywheel end	0.036-0.095 mm (0.0014-0.0037 in.)
Crankpin diameter	39.950-39.964 mm (1.5728-1.5734 in.)
Journal out-of-round—max.	0.01 mm (0.0004 in.)
Intermediate thrust bearing width—min.	24.63 mm (0.970 in.)
Crankpin bearing clearance	0.028-0.086 mm (0.0011-0.0034 in.)
Connecting rod side clearance	0.2-0.4 mm (0.008-0.016 in.)
Cylinder head warpage—max.	0.07 mm (0.003 in.)
Camshaft	
Valve lobe lift	35.000 mm (1.3780 in.)
Fuel pump lobe lift	33.000 mm (1.2992 in.)
Journal diameter	
End journal	30.000 mm (1.1811 in.)
Center journal	41.500 mm (1.6339 in.)
Runout	0.02 mm max. (0.0008 in. max.)
Timing gear backlash	0.05-0.13 mm (0.002-0.005 in.)
Maximum allowable	0.3 mm (0.012 in.)
Push rod runout—max.	0.03 mm (0.0012 in.)
Valve lifter	
Type	Mechanical
Outside diameter	10.000 mm (0.3937 in.)
Outside diameter—min.	9.95 mm (0.3917 in.)
Clearance in block	0.010-0.040 mm (0.0004-0.0016 in.)
Max. clearance	0.10 mm (0.004 in.)
Valve face angle	45°
Valve seat angle	45°

(continued)

Table 2 ENGINE SPECIFICATIONS (3GM AND 3GM30) (continued)

Valve head margin	0.75-1.15 mm (0.030-0.045 in.)
Seat width (int. and exh.)	1.77 mm (0.070 in.)
Valve depth—max.	1.25 mm (0.049 in.)
Valve stem clearance	
Intake	0.040-0.065 mm (0.0016-0.0026 in.)
Exhaust	0.045-0.070 mm (0.0018-0.0028 in.)
Max. stem clearance	0.15 mm (0.006 in.)
Valve stem diameter	7.000 mm (0.2756 in.)
Valve stem wear limit	6.900 mm (0.2717 in.)
Valve stem runout—max.	0.03 mm (0.0012 in.)
Valve guide diameter	7.000 mm (0.2756 in.)
Valve guide wear limit	7.080 mm (0.2878 in.)
Valve guide protrusion	7.0 mm (0.276 in.)
Valve spring	
Standard free length	38.5 mm (1.52 in.)
Min. free length	37 mm (1.46 in.)
Installed height	29.2 mm (1.15 in.)
Pressure at installed height	16.16 kg at 29.2 mm (35.63 lb. at 1.15 in.)
Rocker arm shaft clearance	0.016-0.052 mm (0.0006-0.0020 in.)
Rocker arm shaft clearance—max.	0.15 mm (0.006 in.)
Rocker arm bore wear limit	14.10 mm (0.555 in.)
Rocker arm shaft wear limit	13.90 mm (0.547 in.)
Oil pump	
Inner rotor tip-to-outer rotor tip	0.050-0.105 mm (0.0020-0.0041 in.)
Max.	0.15 mm (0.006 in.)
Outer rotor-to-pump body	0.050-0.105 mm (0.0020-0.0041 in.)
Max.	0.15 mm (0.006 in.)
Rotor side clearance	0.030-0.080 mm
Max.	0.13 mm (0.005 in.)
Shaft clearance	0.015-0.050 mm (0.0006-0.0020 in.)
Max.	0.20 mm (0.0079 in.)

Table 3 ENGINE SPECIFICATIONS (3HM AND 3HM35)

Bore	
3HM	75 mm (2.95 in.)
3HM35	80 mm (3.15 in.)
Stroke	85 mm (3.35 in.)
Displacement	
3HM	1126 cc (68.7 cu. in.)
3HM35	1282 cc (78.2 cu. in.)
Number of cylinders	3
Firing order	1-2-3
Cylinder bore diameter (3HM35)	80.000-80.030 mm (3.1496-3.1508 in.)
Cylinder liner diameter (3HM)	75.00 mm (2.9528 in.)
Max.	75.10 mm (2.9567 in.)
Cylinder liner protrusion (3HM)	0.005-0.075 mm (0.0002-0.0030 in.)
Bore/liner out-of-round—max.	0.02 mm (0.0008 in.)
Cylinder block warpage—max.	0.05 mm (0.002 in.)
Piston diameter	
3HM	
Standard	74.907-74.937 mm (2.9491-2.9503 in.)
Wear limit	74.850 mm max. (2.9468 in.)
3HM35	
Standard	79.902-79.932 mm (3.1457-3.1470 in.)
Wear limit	79.840 mm max. (3.1433 in.)
Piston top clearance	0.66-0.86 mm (0.026-0.034 in.)
Piston ring side clearance	
Top ring	0.065-0.100 mm (0.0026-0.0039 in.)
Second ring	0.035-0.070 mm (0.0014-0.0028 in.)

(continued)

Table 3 ENGINE SPECIFICATIONS (3HM AND 3HM35) (continued)

Piston ring side clearance (continued)	
Oil ring	0.020-0.055 mm (0.0008-0.0022 in.)
Ring end gap	
Top ring	0.25-0.45 mm (0.010-0.018 in.)
Second ring	0.20-0.40 mm (0.008-0.016 in.)
Oil ring	0.25-0.45 mm (0.010-0.018 in.)
Piston pin diameter	22.991-23.000 mm (0.9052-0.9055 in.)
Piston pin hole diameter	
In piston	22.995-23.008 mm (0.9053-0.9058 in.)
In rod	23.000 mm (0.9055 in.)
Piston pin clearance	
In rod	0.025-0.047 mm (0.0010-0.0019 in.)
In piston	0.005 mm tight-0.017 mm loose (0.0002 in. tight-0.0007 in. loose)
Piston ring width	
Top and second ring	1.97-1.99 mm (0.0776-0.0783 in.)
Oil control ring	3.97-3.99 mm (0.1563-0.1571 in.)
Crankshaft main journal diameter	
Timing gear end	46.950-46.964 mm (1.8484-1.8490 in.)
Intermediate	46.950-46.964 mm (1.8484-1.8490 in.)
Flywheel end	64.950-64.964 mm (2.5571-2.5576 in.)
Journal out-of-round—max.	0.01 mm (0.0004 in.)
Crankshaft end play	0.09-0.18 mm (0.0035-0.007 in.)
Crankshaft runout—max.	0.15 mm (0.006 in.)
Main bearing clearance	
Timing gear end	0.036-0.095 mm (0.0014-0.0037 in.)
Intermediate	0.036-0.095 mm (0.0014-0.0037 in.)
Flywheel end	0.036-0.099 mm (0.0014-0.0039 in.)
Intermediate thrust bearing width—min.	29.63 mm(1.166 in.)
Intermediate thrust bearing width—min.	
2GM, 2GM20, 3GM, 3GM30	24.63 mm (0.970 in.)
3HM, 3HM35	29.63 mm (1.166 in.)
Crankpin diameter	43.950-43.964 mm (1.7303-1.7309 in.)
Journal out-of-round—max.	0.01 mm (0.0004 in.)
Crankpin bearing clearance	0.036-0.092 mm (0.0014-0.0036 in.)
Connecting rod side clearance	0.2-0.4 mm (0.008-0.016 in.)
Cylinder head warpage—max.	0.07 mm (0.003 in.)
Camshaft	
Valve lobe lift	35.000 mm (1.3780 in.)
Fuel pump lobe lift	33.500 mm (1.3189 in.)
Journal diameter	
End journal	30.000 mm (1.1811 in.)
Center journal	41.500 mm (1.6339 in.)
Runout	0.02 mm max. (0.0008 in. max.)
Timing gear backlash	0.05-0.13 mm (0.002-0.005 in.)
Maximum allowable	0.3 mm (0.012 in.)
Push rod runout—max.	0.03 mm (0.0012 in.)
Valve lifter	
Type	Mechanical
Outside diameter	10.000 mm (0.3937 in.)
Outside diameter—min.	9.95 mm (0.3917 in.)
Clearance in block	0.010-0.040 mm (0.0004-0.0016 in.)
Max. clearance	0.10 mm (0.004 in.)
Valve face angle	45°
Valve seat angle	45°
Valve head margin	0.85-1.15 mm (0.034-0.045 in.)
Seat width (int. and exh.)	1.77 mm (0.070 in.)
Valve depth—max.	1.55 mm (0.061 in.)
Valve stem clearance	
Intake	0.040-0.065 mm (0.0016-0.0026 in.)
Exhaust	0.045-0.070 mm (0.0018-0.0028 in.)

(continued)

Table 3 ENGINE SPECIFICATIONS (3HM AND 3HM35) (continued)

Valve stem clearance (continued)	
Max. stem clearance	0.15 mm (0.006 in.)
Valve stem diameter	7.000 mm (0.2756 in.)
Valve stem wear limit	6.900 mm (0.2717 in.)
Valve stem runout—max.	0.03 mm (0.0012 in.)
Valve guide diameter	7.000 mm (0.2756 in.)
Valve guide wear limit	7.080 mm (0.2878 in.)
Valve guide protrusion	7.0 mm (0.276 in.)
Valve spring	
Standard free length	38.5 mm (1.52 in.)
Min. free length	37 mm (1.46 in.)
Installed height	30.2 mm (1.19 in.)
Pressure and installed height	14.43 kg at 30.2 mm (31.81 lb. at 1.19 in.)
Rocker arm shaft clearance	0.016-0.052 mm (0.0006-0.0020 in.)
Rocker arm shaft clearance—max.	0.15 mm (0.006 in.)
Rocker arm bore wear limit	14.10 mm (0.555 in.)
Rocker arm shaft wear limit	13.90 mm (0.547 in.)
Oil pump	
Inner rotor tip-to-outer rotor tip	0.050-0.105 mm (0.0020-0.0041 in.)
Max.	0.15 mm (0.006 in.)
Outer rotor-to-pump body	0.050-0.105 mm (0.0020-0.0041 in.)
Max.	0.15 mm (0.006 in.)
Rotor side clearance	0.030-0.080 mm
Max.	0.13 mm (0.005 in.)
Shaft clearance	0.015-0.050 mm (0.0006-0.0020 in.)
Max.	0.20 mm (0.0079 in.)

Table 4 TIGHTENING TORQUES

Fastener	N•m	ft.-lb.	in.-lb.
Connecting rod	25	18	216
Cylinder head			–
M8	30	22	–
M12	120	88	–
3HM, 3HM35			
M8	30	22	–
M12	130	95	–
Exhaust elbow (2GM, 2GM20)	45	33	–
Exhaust manifold (3-cylinder)	45	33	–
Flywheel	65-70	48-51	–
Intermediate bearing housing			
2GM, 2GM20, 3GM, 3GM30	30-35	22-25	–
3HM, 3HM35	45-50	33-36	–
Retaining (set) bolt	45-50	33-36	
Rear main bearing housing	25	18	–
Timing gearcase	15	11	–
Oil pump	8	–	17