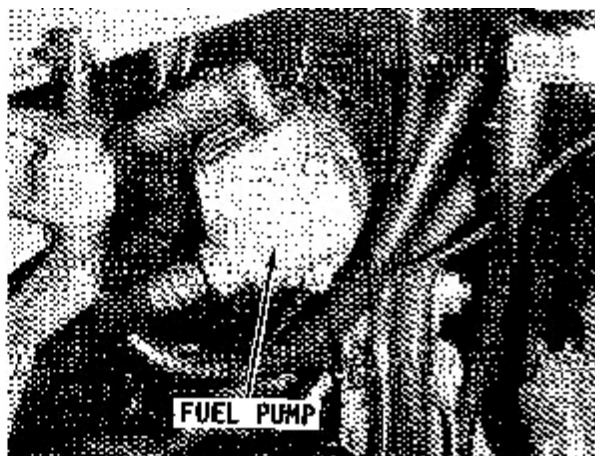
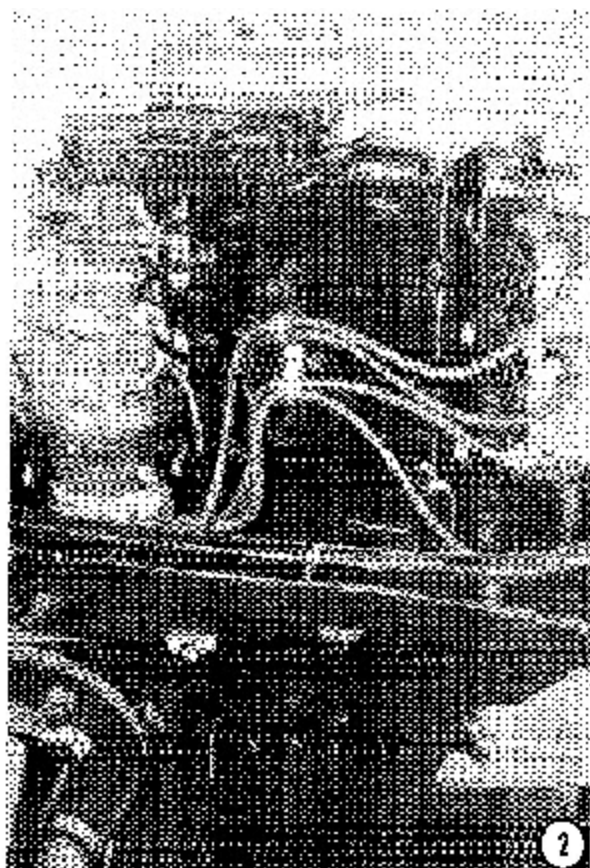


mounting nuts, and then the rear cowl supports.

2- Remove the locknuts from the top and bottom front cowl support shock mounts, and then remove the front cowl support. Remove the four sta-straps from the front of the engine. Remove the center cowl support.

STOP, and carefully observe the wiring and hose connections before proceeding. Because there are so many different engines and the arrangement is slightly different on each, it is not possible to illustrate all of them. Even if they were shown, you would



Typical fuel pump installation on powerheads covered in this manual.

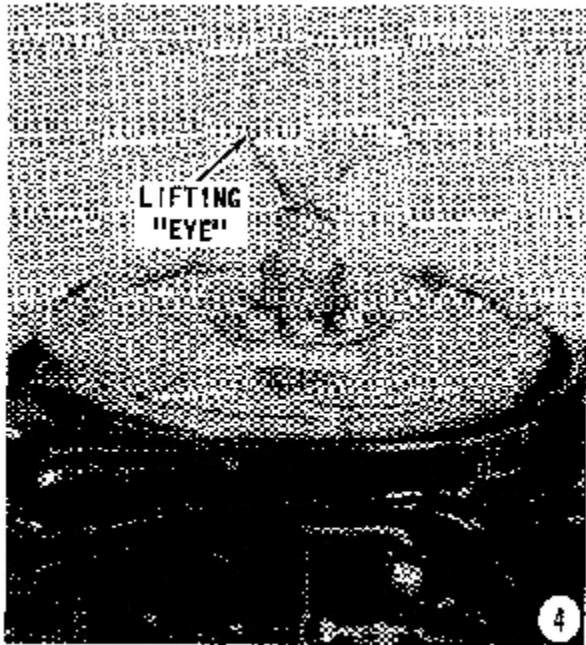
not be able to identify the engine being serviced. Therefore, **TAKE TIME** to make notes and tag the wiring and hoses. You may elect to follow the practice of many professional mechanics by taking a series of photographs of the engine, one from the top, and couple from the sides showing the wiring and arrangement of parts.

3- Disconnect the fuel line from the fuel pump. Disconnect the water hose from the exhaust plate elbow. Disconnect the hose from the tattle-tale fitting in the rear support. Remove the nuts on the bottom side of the powerhead from the exhaust housing.

4- Remove the plastic cap from the flywheel and thread a lifting eye onto the end of the crankshaft as far as it will go.

5- Remove the nuts from the studs securing the powerhead to the driveshaft housing. If working on a three-cylinder





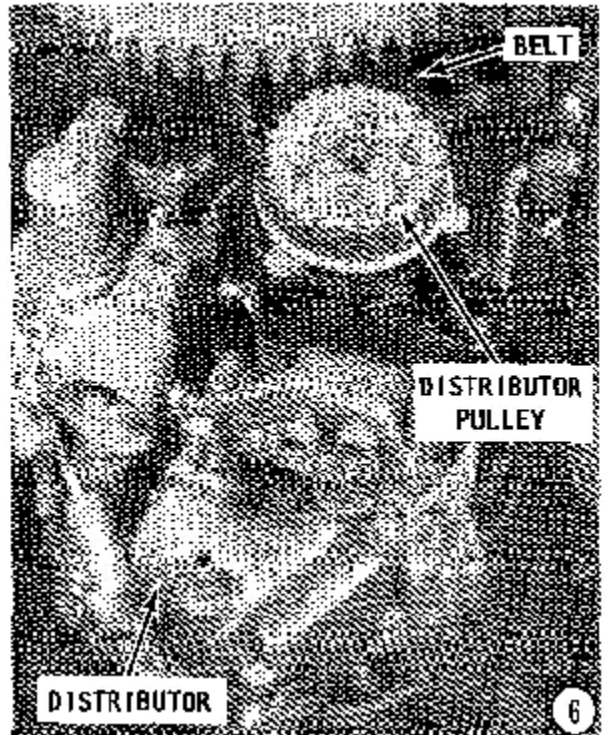
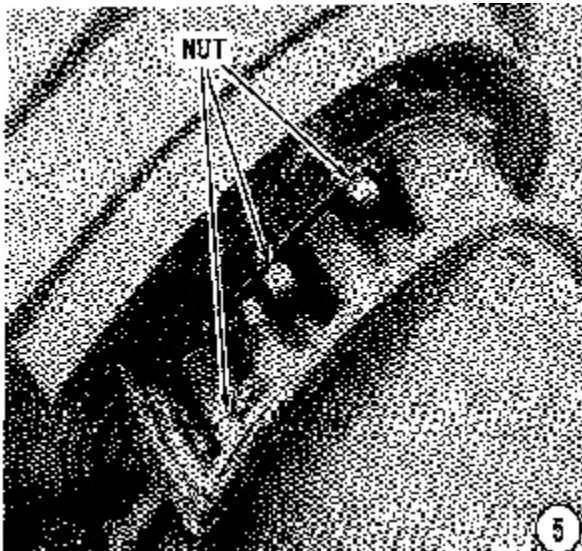
powerhead, remove the three cap screws from under the exhaust plate. Using a suitable hoist, lift the powerhead free of the driveshaft housing.

BAD NEWS

If the unit is several years old, or if it has been operated in salt water, or has not had proper maintenance, or shelter, or any number of other factors, then separating the powerhead from the driveshaft housing may not be a simple task.

An air hammer may be required on the studs to shake the corrosion loose; heat may have to be applied to the casting to expand it slightly; or other devices employed in order to remove the powerhead.

One very serious condition would be the driveshaft "frozen" with the crankshaft. In this case, a circular plug-type hole must be



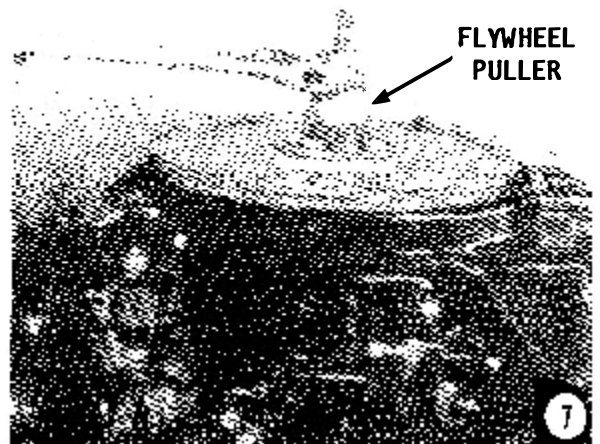
drilled and a torch used to cut the drive-shaft.

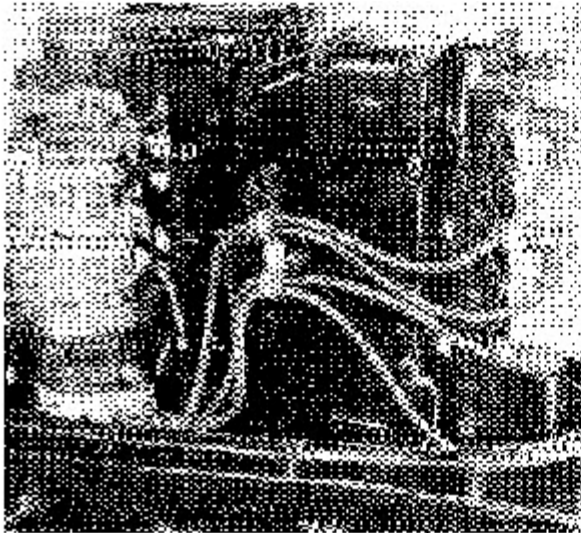
The following procedures pickup the work after the powerhead has been separated from the driveshaft housing.

POWERHEAD DISASSEMBLING

6- Because there are so many models with varying electrical and ignition systems, refer to Chapter 5 and Chapter 6 for disassembly procedures of the ignition system. If a distributor is used, remove the timing belt pulley cover and slip the belt free of the pulley on the distributor.

7- To remove the flywheel: Remove the flywheel nut. It may be necessary to use a flywheel strap to prevent the flywheel from

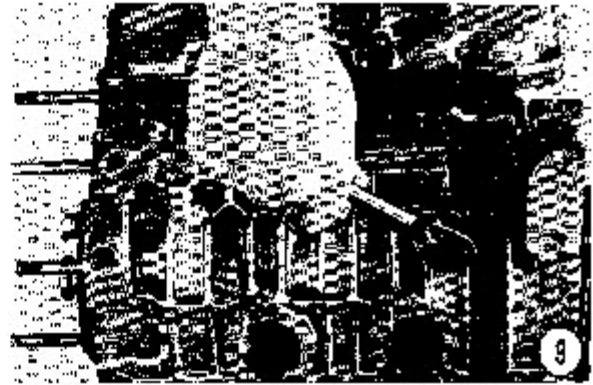
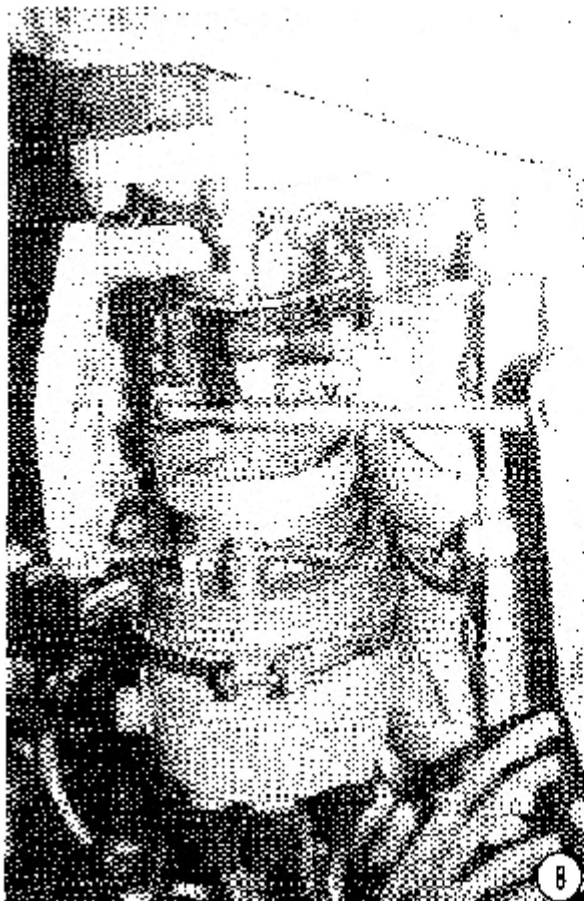




Typical high-tension lead wire pattern to the spark plugs on a four-cylinder powerhead.

turning in order to loosen the nut. Install a flywheel puller, C-91-48501A1, and a crankshaft protector cap, C-91-24161. These two items are necessary and may be obtained from the local marine dealer. Tighten the large square of the puller until the screw is tight against the end of the driveshaft.

Now, tighten the center bolt on the puller. Continue to tighten on the center bolt until the flywheel breaks loose from the

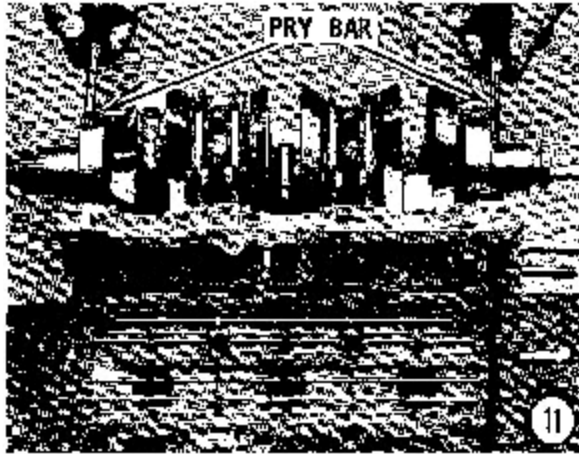


crankshaft. **NEVER** strike the flywheel with a mallet or other tool in an effort to break the flywheel loose. Such action will loosen the bottom seal, **DESTROY** the lower bearing, or possibly damage the crankshaft. Lift the flywheel from the crankshaft. Remove the puller and the protective cap. Remove the stator and trigger plate assembly.

8- To remove the distributor, if one is used: Remove the ground wire from the engine to the distributor. Remove the high-tension leads from the spark plugs. **ALWAYS** use a pulling and twisting motion as a precaution against damaging the connection. Remove the two retaining bolts from the distributor, and at the same time hold the distributor to prevent it from falling and being damaged. Remove all carburetors together as an assembly. This is accomplished by first disconnecting the fuel lines to the carburetors, and then removing the four attaching nuts from the carburetors. Remove the fuel pump, the switch box, and the starter.

9- Remove the crankcase cover bolts and the end cap bolts. **NEVER** pry between the block and the crankcase with **ANY** type of tool. Use a soft-headed mallet and tap on the side of the cover to jar it loose from the block.





10- Remove the end caps by tapping on them with a soft-headed mallet. **DO NOT** tap on the shims.

11- Pad the crankcase mating surface near the ends of the crankshaft with small pieces of wood. Now, use two pry-bars, one at each end, and work the crankshaft assembly supports loose from the locating pins in the cylinder block. Lift the crankshaft assembly clear of the cylinder block and place it on a clean work surface.

ADVICE

The exhaust cover should always be removed during an engine overhaul. Many

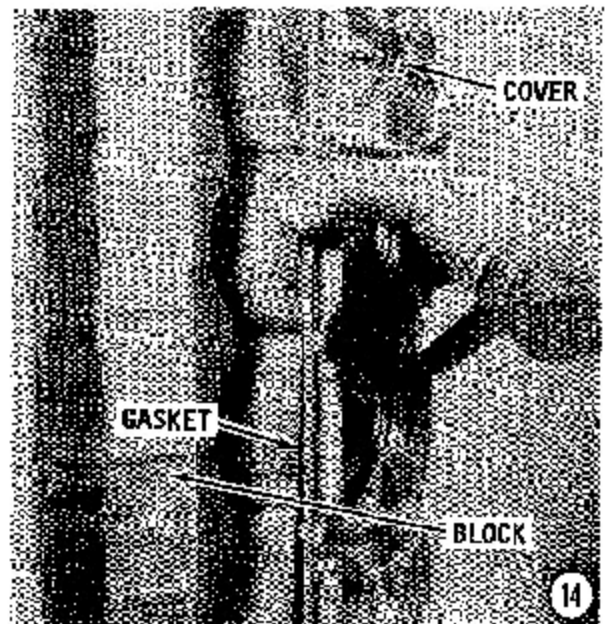


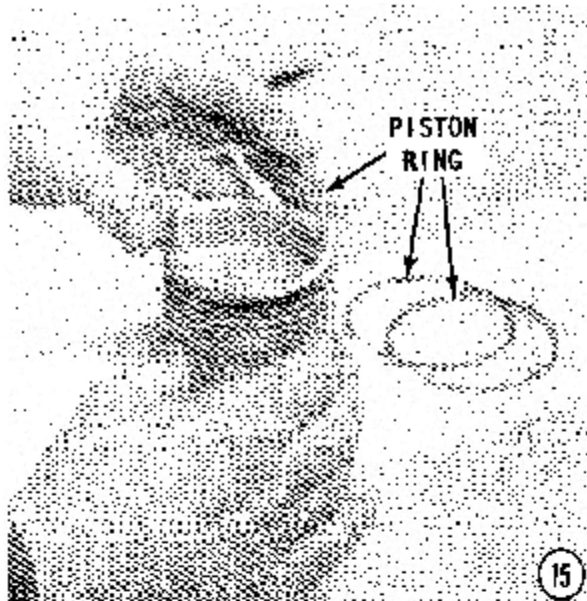
times water in the engine is caused by a leaking exhaust cover gasket or plate.

12- Remove the retaining bolts from the exhaust cover, and then remove the exhaust cover and baffle plate. **NEVER** pry between the block and the cover with **ANY** kind of tool. Tap the cover loose with a soft-headed mallet, and then tap the plate loose with a punch.

13- Turn the cylinder block over and remove the bolts from the transfer port covers. Remove the cover. **NEVER** pry between the block and the cover with **ANY** kind of tool. Tap the cover loose with a soft-headed mallet.

14- Cover the work bench with a clean towel. Lay the block on the clean surface with the crankshaft side down. **TAKE CARE**

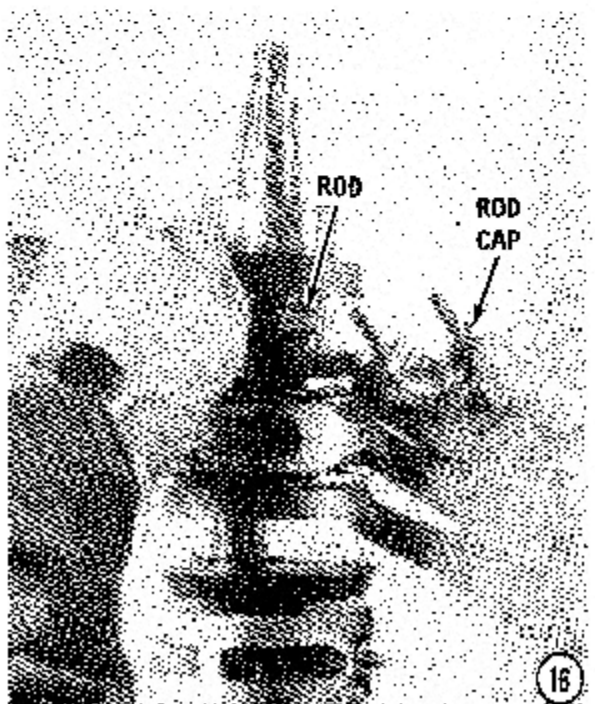




not to damage the side of the block. Remove the bolts from the cylinder block cover, and then remove the cover. **NEVER** pry between the block and the cover with **ANY** kind of tool. Tap the cover loose with a soft-headed mallet.

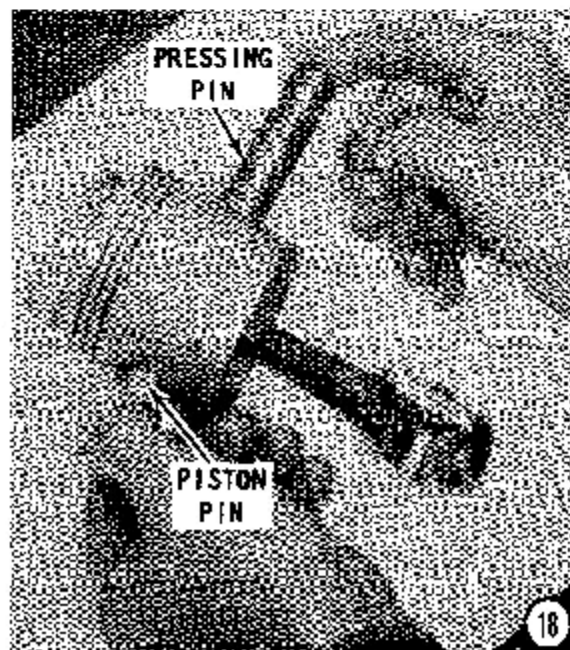
15- Good shop practice dictates to replace the rings during a powerhead overhaul. However, if the rings are to be used again, expand them **ONLY** enough to clean the piston and the grooves because used rings break easily. If new rings are to be installed, use a piston ring expander and remove the old rings from the piston.

ADVICE: New needle bearings should be installed in the connecting rods, even though



they may appear to be in serviceable condition. New bearings will ensure lasting service after the overhaul work is completed. If it is necessary to install the used bearings, keep them separate and identified to ensure they will be installed onto the same crankpin throw and with the same connecting rod from which they were removed.

16- Remove the connecting rod nuts and bolts, and then remove the rod cap and connecting rod, bearings and cages. Immediately after disassembling the rod from the cap and crankshaft, temporarily install the cap and rod together to ensure they will be installed properly. Check each mark alignment.



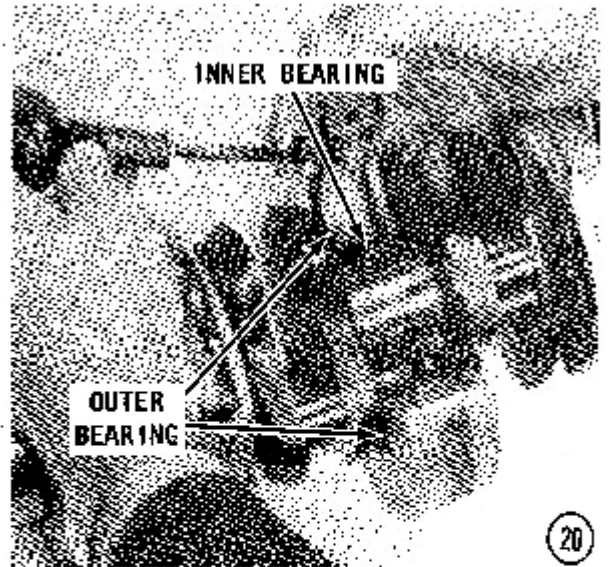
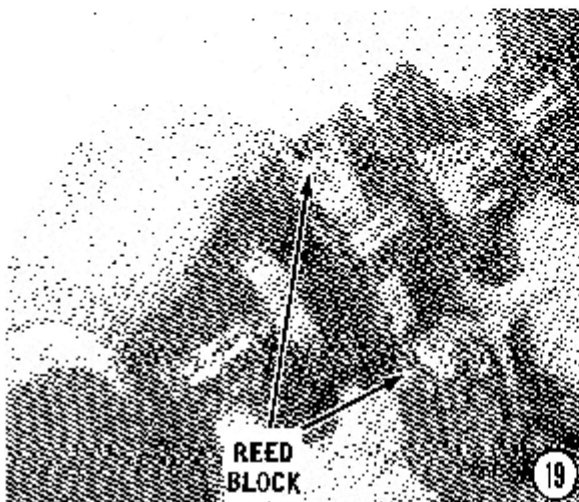
17- WEAR eye protection glasses while removing the piston pin lockrings, because the lockring is made of spring steel and may slip out of the pliers or pop out of the groove with considerable force. Remove the two G-type lockrings using a pair of needle-nose pliers. A lockring tool, C-91-5252A1, may be used to remove the lockring. A third alternative, is to use a punch to pop the lockring out. If a punch is used **TAKE CARE** not to damage the piston. **DISCARD** the lockrings, because they should not be used a second time.

18- Handle the piston with care because the skirt can be easily bent out-of-round. **TAKE TIME** to scribe an identification mark with an awl on the "I" beam of each rod and a matching mark on the inside of each piston skirt. These identification marks will ensure the same rod will be matched with the same piston and installed into the same cylinder bore during assembly. Remove the piston from the rod by first inserting a pressing pin into the hollow end of the piston pin. Next, support the bottom of the piston with one hand and drive the pin thru the piston with a mallet and the pressing pin.

BAD NEWS:

On some models it may be necessary to heat the top of the piston to approximately 190° with hot water or a heat lamp before the piston pin can be driven out. On some models, needle bearings are used with the piston pin. These bearings will fall out after the pin has been removed.

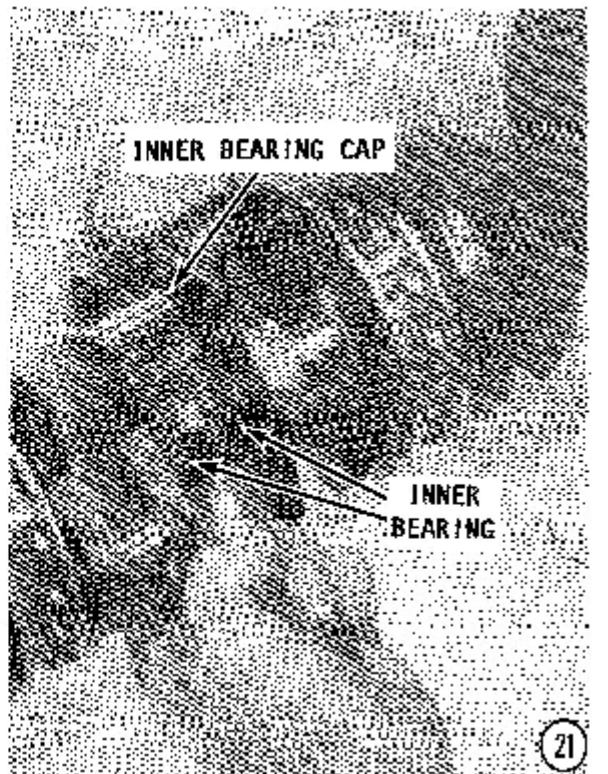
19- Remove the valve-type main bearing by removing the two Phillips head screws. **TAKE CARE** not to bend or distort the reed



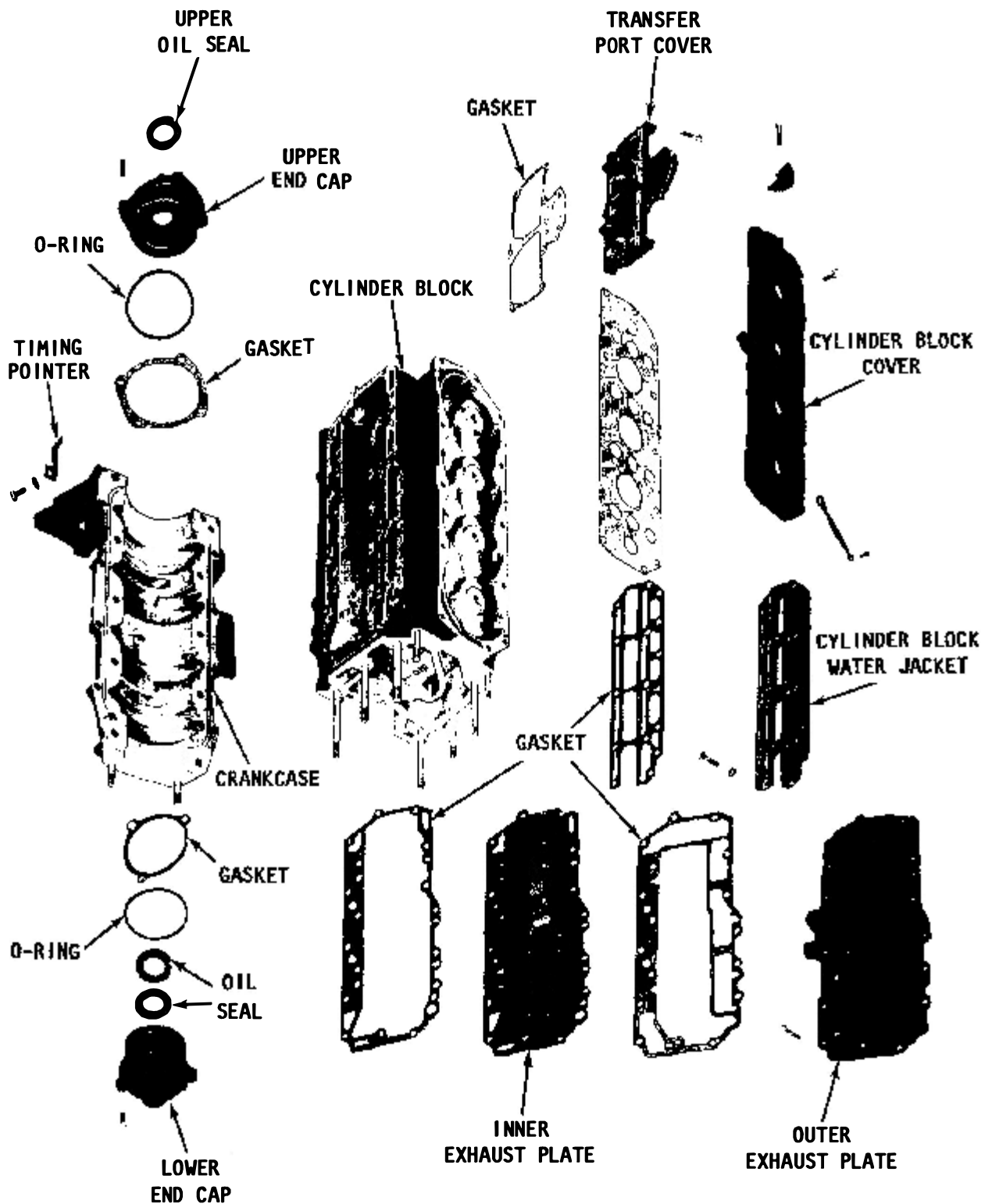
valve stops. Tap the side of the reed cage at the solid section with a soft-headed mallet to separate the halves. After the halves have been removed, assemble them together again, to ensure they remain as a matched set. Reed box repair is covered in the last part of this chapter, Section 3-4.

20- Remove the snap ring from the main bearing and remove the main bearing outer races and bearings. **TAKE CARE** not to distort the snap ring during removal. Keep the bearing halves together in a clean area.

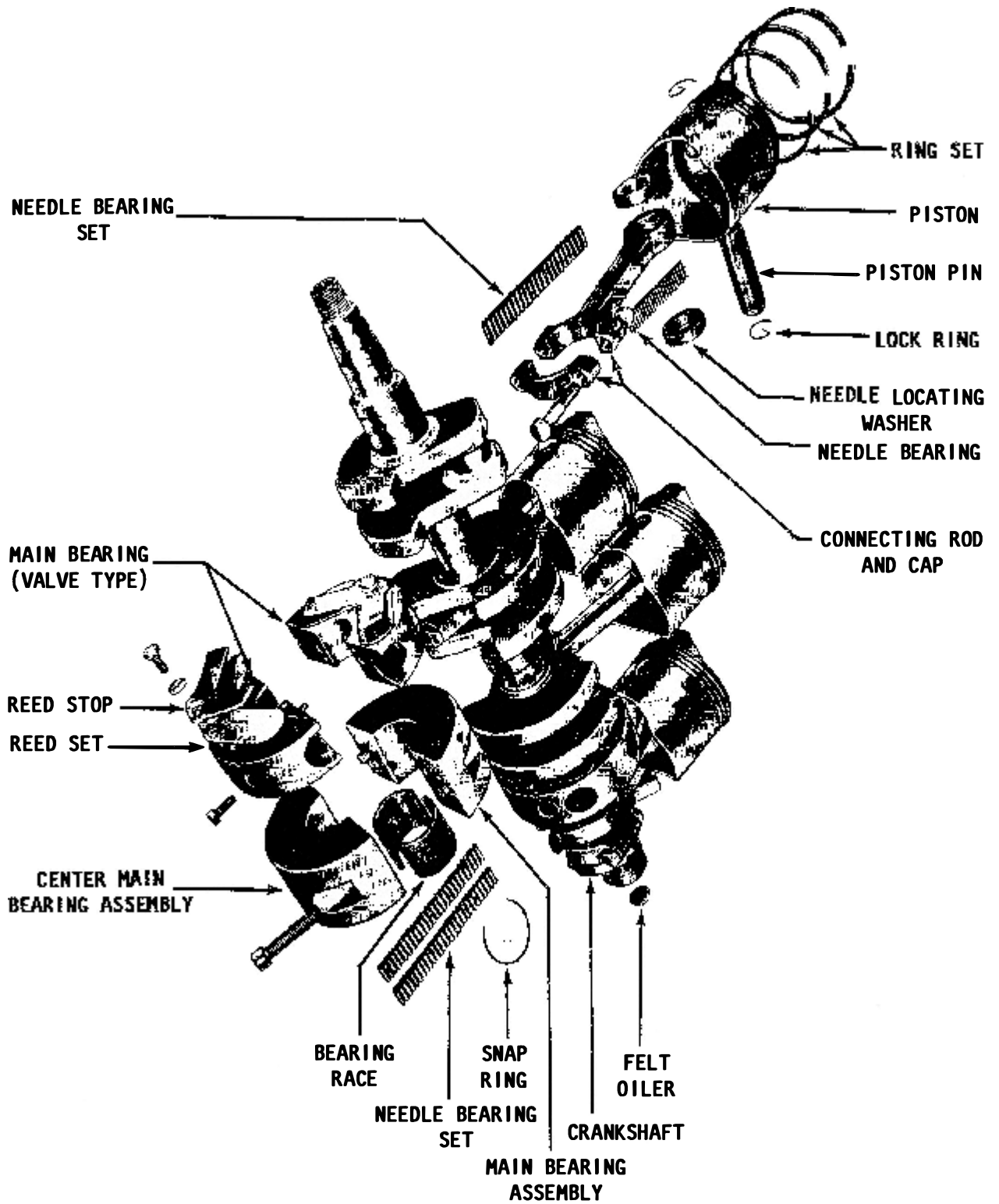
21- Continue removing the other bearings. **TAKE CARE** not to damage the crank-



3-12 POWERHEAD



Arrangement of cylinder block and crankcase assembly parts for the 4-cylinder powerheads covered in this manual.



Exploded drawing of the complete crankshaft, rod, and piston assemblies used on the 4-cylinder powerhead.

3-14 POWERHEAD

shaft bearing surfaces while they are exposed during service work.

CLEANING AND INSPECTING

See the last portion of this chapter, Section 3-4, for detailed, comprehensive procedures to clean and inspect all components of the powerhead.

POWERHEAD ASSEMBLING AND INSTALLATION

FIRST, THESE WORDS: Be sure all parts to be re-used have been carefully cleaned and thoroughly inspected, as outlined in Section 3-4. Parts that have not been properly cleaned, or parts not suitable for service can damage a good powerhead within a few minutes after starting the engine.

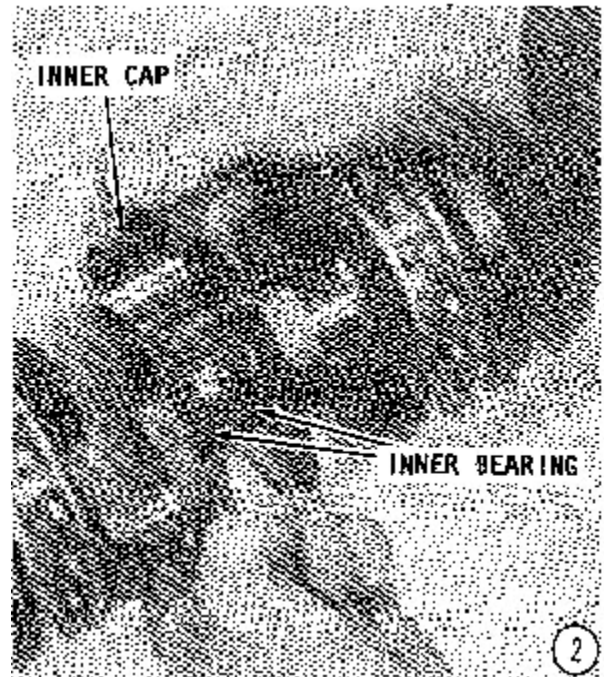
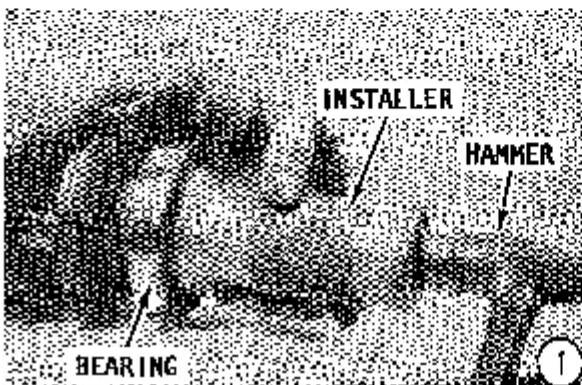
NEW gaskets **MUST** always be used during an overhaul.

A torque wrench is essential to correctly assemble the powerhead. **NEVER** attempt to assemble a powerhead without a torque wrench. Attaching bolts **MUST** be tightened to the required torque value in three progressive stages, following the specified tightening sequence. Tighten all bolts to 1/3 the torque value, then repeat the sequence tightening to 2/3 the torque value. Finally, on the third and last sequence, tighten to the full torque value.

ASSEMBLING

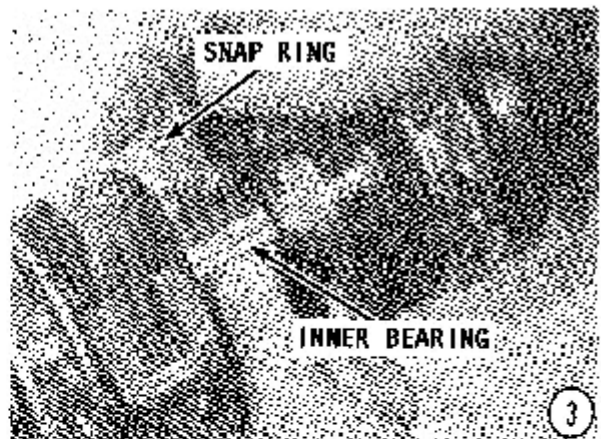
1- To replace the upper and lower bearings: Place one of the bearings onto the crankshaft, and then press the bearing into place on the shaft. Using a press is the preferred method as a precaution against damaging the bearing. However, an installer and hammer may be used **WITH CARE**, as shown.

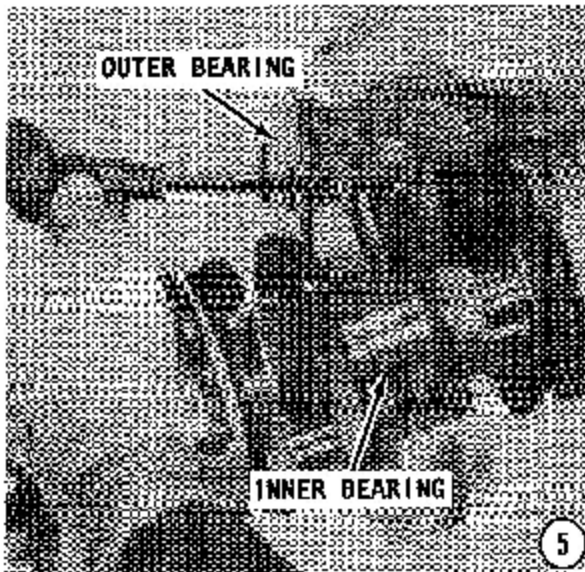
2- Lubricate the main bearing inner race with Multipurpose Lubricant, or equivalent,



and then place the needle bearings around the crankshaft. **NEVER** mix new needle bearings with used bearings in the same race. If some of the bearings require replacement, **ALL** bearings must be replaced.

3- Install the bearing onto the crankshaft with the snap ring **TOWARD** the top of the crankshaft. Place the snap ring in the groove of the bearing. Observe that the mating surfaces of the bearing are rough



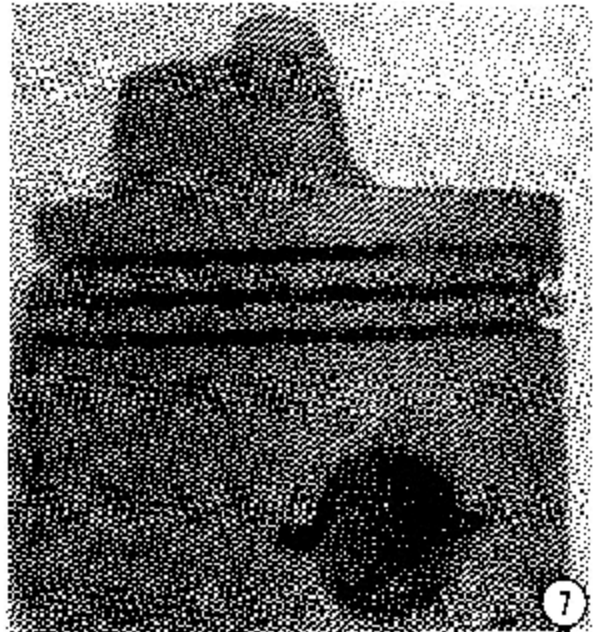
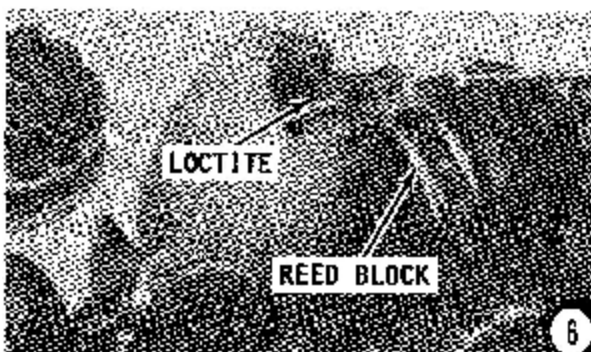


breaks. Check to be sure the mated areas are together. Repeat Steps 2 and 3 for the other main bearing.

4- Check the number of needle bearings inside the main bearing race by first sliding the bearing race upward, and then inserting the pointed end of an awl between the needle bearings. If the bearing race halves separate, the race is full. Remove the awl and slide the race downward into place. Repeat the check with the awl on the upper row of needle bearings. Check the other main bearing in the same manner.

5- Install the main bearing outer caps around the inner main bearing. Check to be sure the pin in the outer cap indexes with the hole of the inner bearing. Coat the threads of the bolts with a thin film of light-weight oil. Install and tighten the bolts alternately to a torque value of 150 in lb (17Nm).

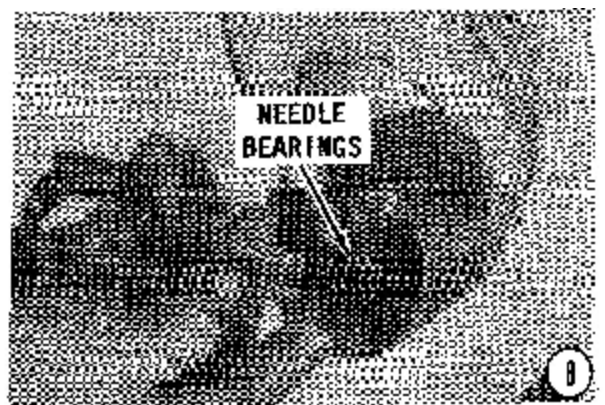
6- Install the reed block halves around the crankshaft. Check to be sure the pin on one of the reed block halves indexes into the matching hole of the other half. Coat the threads of the two bolts with a thin film of light-weight oil. Install and tighten the bolts to a torque value of 30 in lb (3.5Nm).

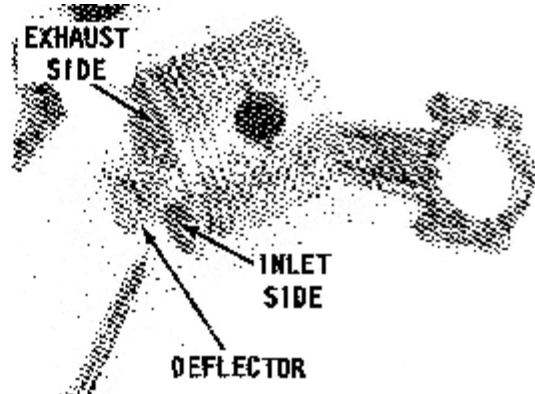
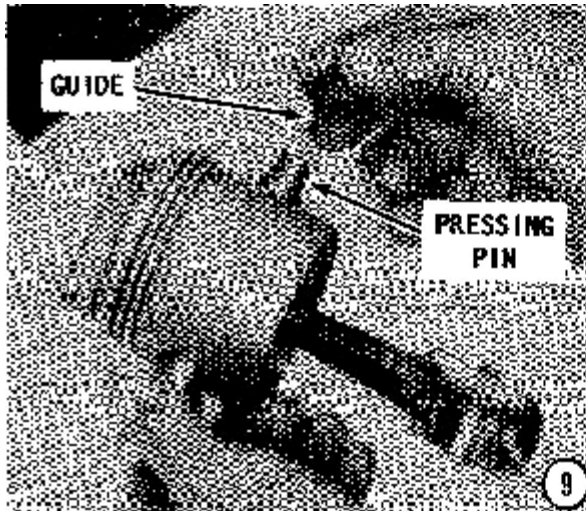


7- Place the piston in a container of hot water, approximately 190°F. Leave the piston in the hot water, ready for installation later in Step 9.

8- To replace the piston pin and the needle bearings into the piston, first lay the needles on a clean piece of paper. Next, coat the sleeve portion of a piston pin installation tool with a small amount of Multi-purpose Lubricant, or equivalent. If a piston pin tool is not available, a drift slightly smaller in diameter than the pin, may be used. Install the retainer and the needle bearings onto the end of the tool. Leave **ONE** needle bearing **OUT**. Push the bearings and the tool into the rod piston pin bore. Now, install the last needle bearing. Place the top retainer on the side of the rod. Finally, ease the tool out of the rod, and at the same time hold onto the needle bearing retainer washers.

9- Carefully position the piston over the end of the rod, paying attention that the retainer washers remain in place, and at the





Assembled piston and rod ready for installation into the powerhead. Notice the relationship of the intake and exhaust deflector on the piston crown to the position of the rod.

same time ease the needle bearing tool down through the piston pin bore and through the rod. **DO NOT** force the tool through the needle bearings. **STOP:** Check to be sure the piston is facing the proper direction, the slope area towards the exhaust port of the block and the intake side of the deflector towards the intake port.

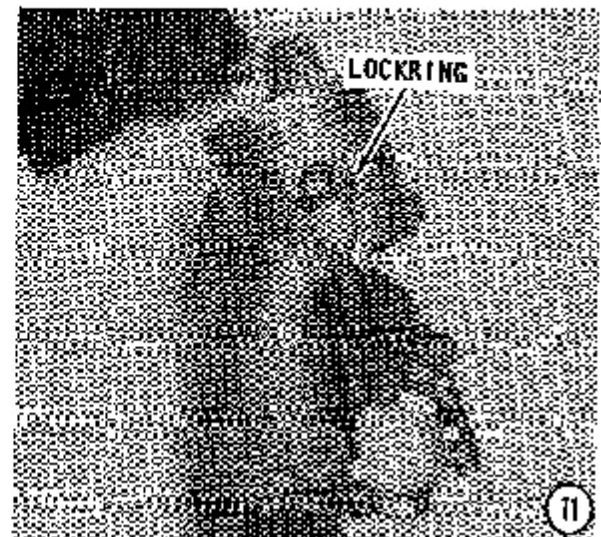
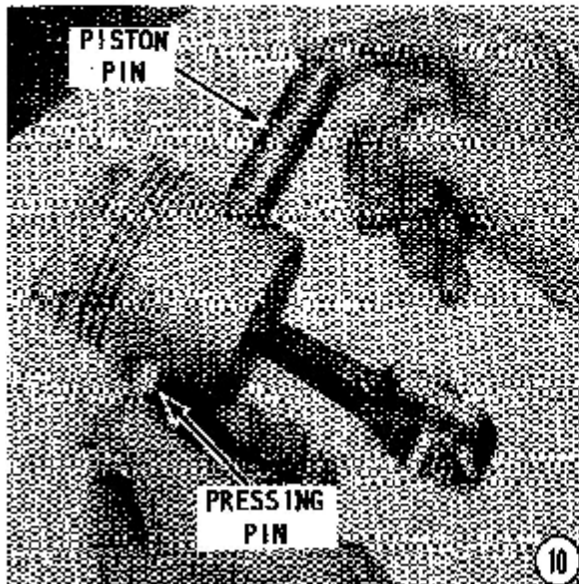
10- Now, bring the piston pin up to the bottom side of the piston and through the pin bore of the piston. Hold the pin tool tightly down against the piston pin, and at the same time use a mallet and drive the pin up and through the piston and rod bearing. As soon as the pin is almost flush with the piston surface, remove the piston pin tool and use it to drive the pin upward until the backing ring grooves are visible.

11- Piston pin locking clips should not be used a second time. Therefore, snap **NEW** locking clips into the groove of the piston pin bore in the piston. **WEAR** eye protection

glasses while installing the piston pin lockrings, because the lockring is made of spring steel and may slip out of the pliers or pop out of the groove with considerable force. Install the two lockrings using a pair of needle-nose pliers. A lockring tool C-91-5252A1, may be used to install the lockrings. The clip retains the piston pin in place after the piston becomes hot during operation.

12- Expand the ring slightly with the fingernail of each of your thumbs and at the same time support the back of the ring with your fingers. Now, slide the ring down over the piston and into its proper groove. After the rings are in place, each ring should rotate freely. Lubricate the piston, the rings, and the cylinder bore with a good grade of outboard motor oil. Rotate the rings in their grooves until the ends of each ring is over the locating pin in the groove of the piston.

Repeat Steps 7 thru 12 for the other pistons and rods.



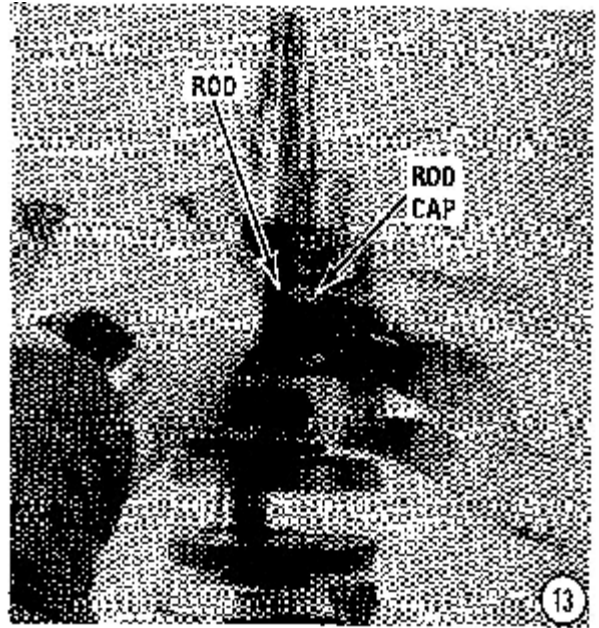
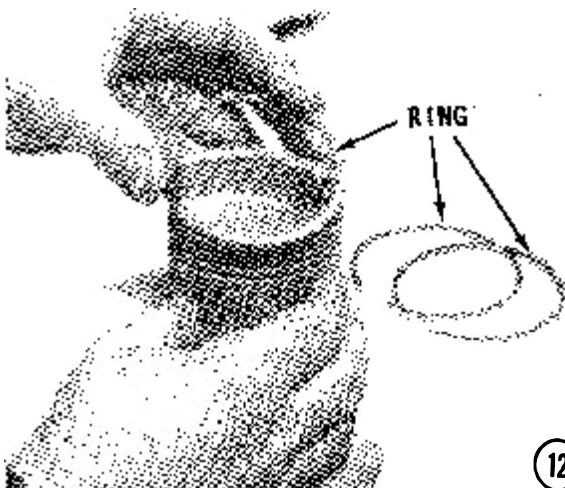
13- Work each piston one at-a-time. Remove the rod cap from the rod. (The caps were temporarily attached to the rods immediately after removal to ensure they would not become separated.) The manufacturer recommends new rod cap bolts and nuts. The small cost involved is justified compared with the time and expense of the powerhead overhaul work. Therefore, **DISCARD** the cap bolts and nuts. Apply a small amount of Multi-purpose Lubricant, or equivalent, onto each bearing race half to hold the roller bearings and retainers in place. Insert the retainer into the race, and then insert the roller bearings into the retainers.

NEVER mix new roller bearings with used bearings in the same race. If some of the bearings require replacement, **ALL** bearings must be replaced. Position the connecting rod and cap onto the crankshaft throw with the etched marks aligned. **ALWAYS** clean new or old connecting rod bolts and nuts with solvent. New bolts and nuts have a protective coating to protect the threads during shipment. This coating **MUST** be removed. Blow them dry with compressed air.

NEVER oil the nuts or bolts prior to installation. Install the new cleaned rod bolts and nuts and bring them up snug. Tighten the nuts alternately in three stages, to a torque value of 180 in lb (20Nm).

On the first stage, tighten to 1/3 the torque value. On the second stage, tighten to 2/3 the total torque value. Finally, on the third and last stage, tighten to the full torque value.

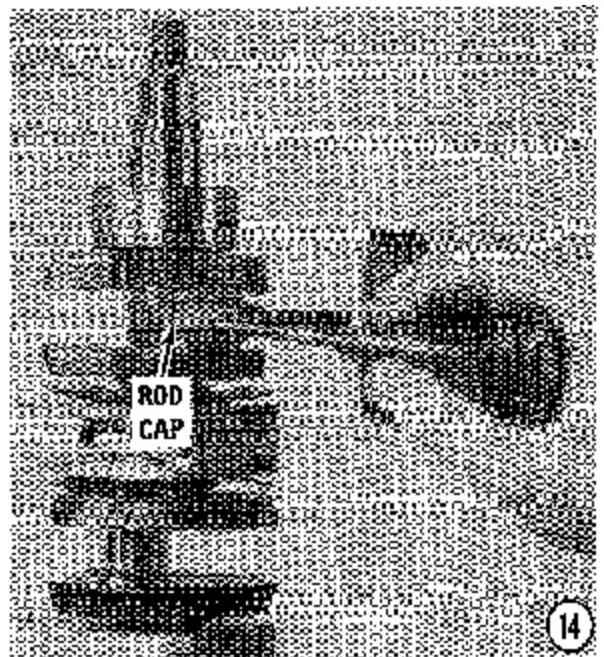
14- After the nuts have been tightened properly, rotate the connecting rod and verify that it turns freely without any evidence

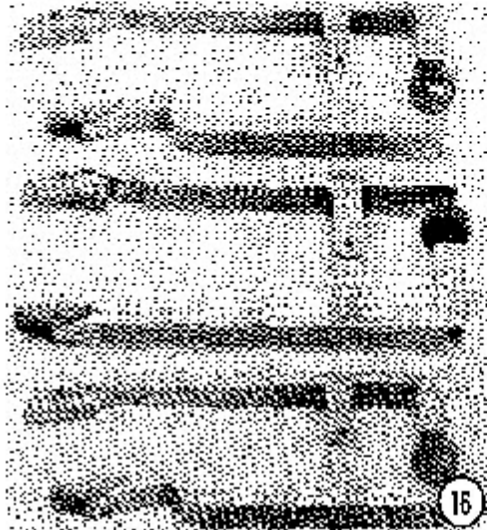
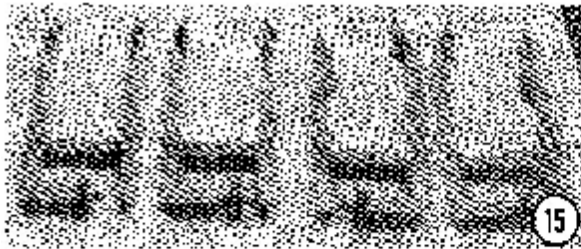


of binding or "rough" spots. If a "rough" spot is felt, remove the rod cap, check the roller bearings, retainer, and race, then install the cap again. Repeat the procedure in this step for each connecting rod.

WORDS FROM EXPERIENCE

There is no easy way to install the assembled pistons and crankshaft into the block. Without ring compressor tools, the job is even more difficult. Three compressors are needed. A straight one for the top piston and two off-set compressors for the No. 2 and No. 3 pistons. Marine ring com-

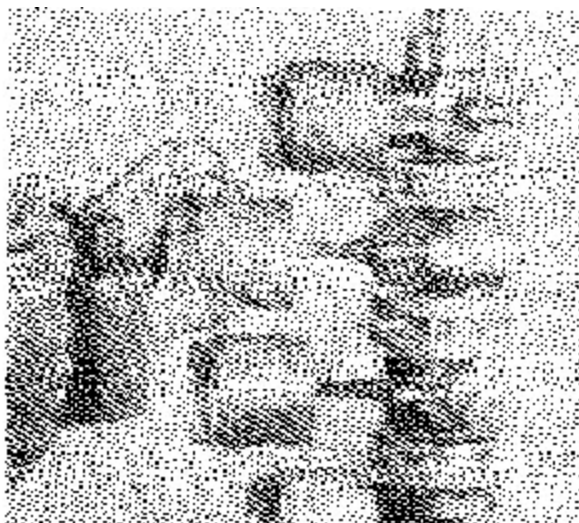




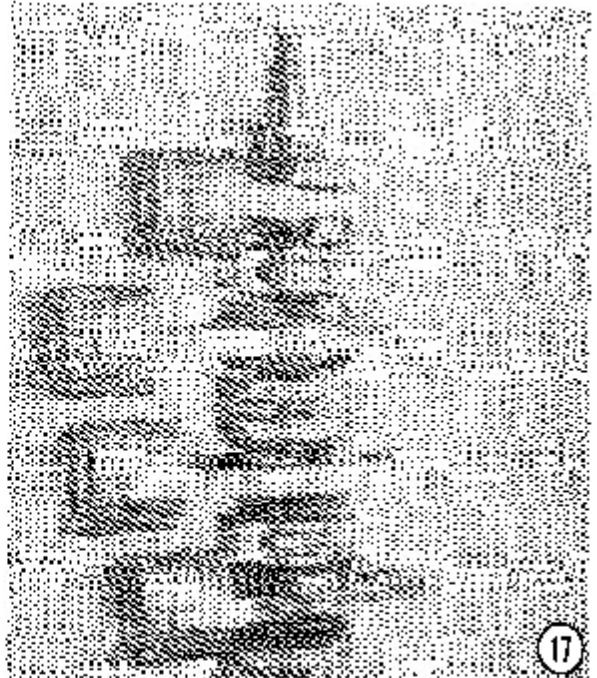
pressor tools are usually available at modest cost from the local dealer.

15- On 4-cylinder engines: Use the straight ring compressor on the No. 1 and 2 pistons. Use the off-set ring compressor on the No. 3 and 4 pistons.

16- On 3-cylinder engines: Use the off-set ring compressor on the No. 1 and No. 3 pistons. Use the straight compressor on the No. 2 piston.

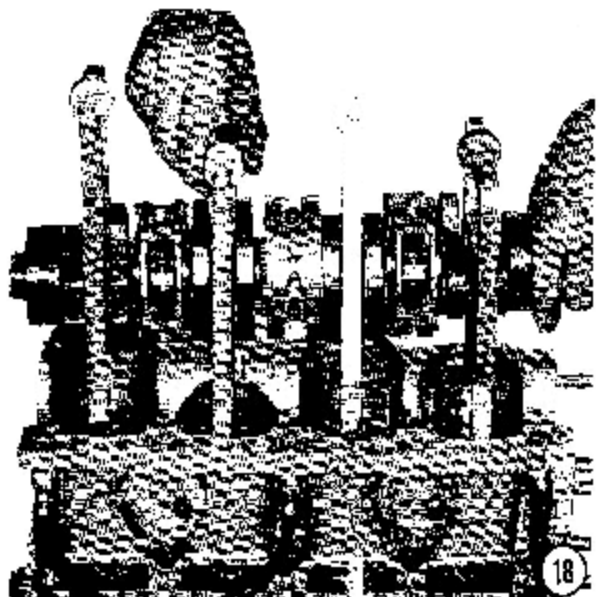


This individual, applying a liberal amount of lubrication to the crankshaft assembly parts prior to installation into a 6-cylinder powerhead, probably wishes the unit was from a 3- or 4-cylinder outboard, as covered in this manual.



17- Place the ring compressor tool over the crankshaft and down the skirt of the piston onto the rings. Begin to tighten the tool onto the rings, and at the same time, check to be sure the ring ends are over the piston pin. Continue to tighten the tool until the rings are almost flush with the surface of the piston. Repeat the procedure for the other pistons.

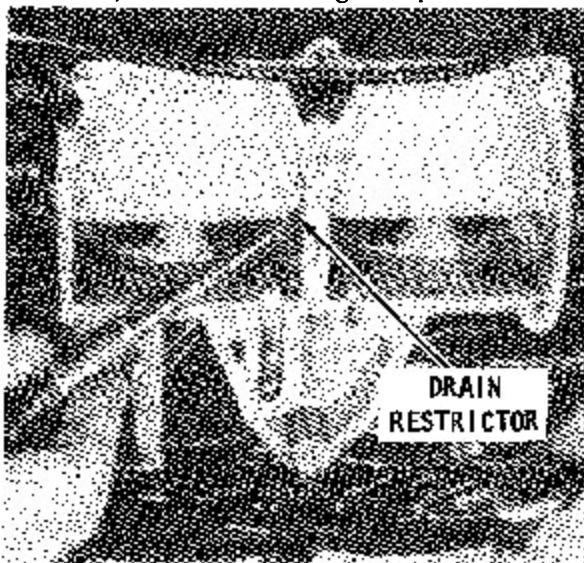
18- Insert the reed block locating pins into the block, if they were removed. **CHECK** to be sure the flywheel end of the crankshaft is facing the top of the engine. (Would you believe, the crankshaft could be installed upside down?) Check to be sure **EACH** piston is facing the proper direction, the slope area toward the exhaust port of



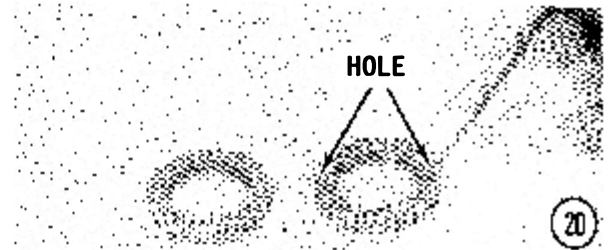


the block and the intake side of the deflector toward the intake port. If a piston has been installed onto the rod improperly, the piston pin will have to be removed, the piston rotated 180°, and the piston pin installed again.

Now, lower the piston and crankshaft assembly into the cylinder block with one piston down. Work the "down" piston into the cylinder bore and at the same time, lower the crankshaft, reed block, and the other pistons downward. When the second piston reaches the cylinder bore in the cylinder block, work both pistons and the crankshaft assembly downward. When the third piston reaches the cylinder, work all three into the cylinder bores. Continue until each piston is worked into the cylinder bore. As a piston is worked into the cylinder bore, remove the ring compressor from



Checking to be sure the drain restrictor is in place.



Lower crankshaft oil seals. If one of the seals has holes, as shown, then that seal must be installed as the bottom one of the two.

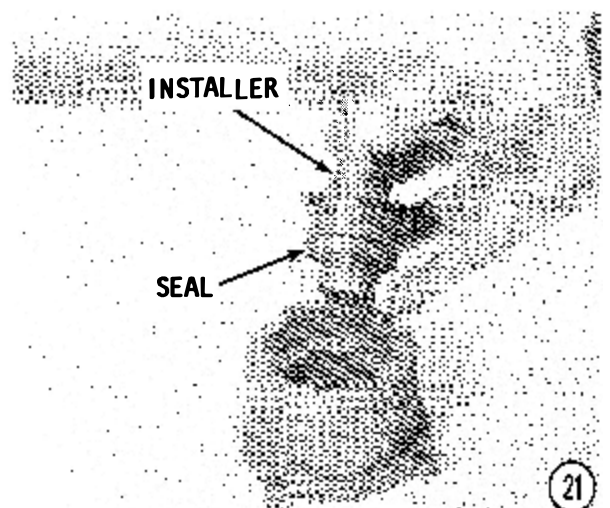
that piston. Continue working the pistons into the cylinder bores until the reed blocks make contact with the cylinder block.

Align each reed block with the locating pin in the cylinder block, and then push the complete crankshaft assembly into final position in the block.

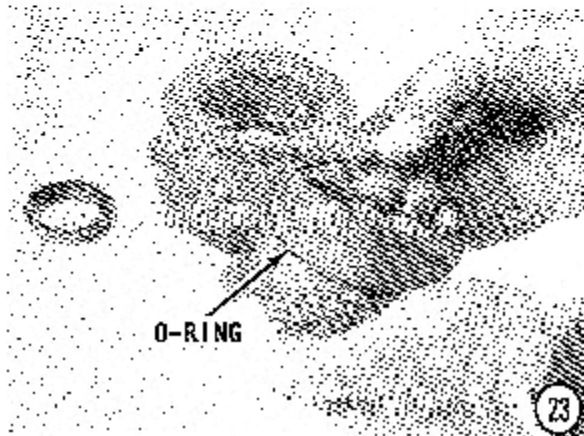
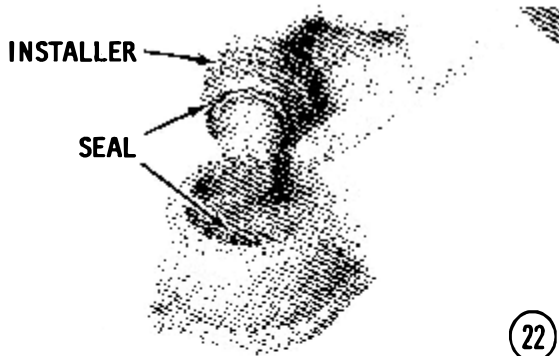
19- Check to be sure each piston ring has spring tension. This is accomplished by **CAREFULLY** pressing on each ring with a screwdriver extended through the intake ports. If spring tension cannot be felt (the spring fails to return to its original position) the ring was probably broken during the piston and crankshaft installation process. **TAKE CARE** not to burr the piston rings while checking for spring tension.

20- Apply a coating of Loctite Type "A" to the outer diameter of all the oil seals. The proper size mandrel from Bearing Removal and Installation Kit C-91-31229A1, must be used for seal installation. Press the seal into the upper end cap with the lip of the seal toward the **INSIDE** of the cylinder block. Clean away any excess Loctite.

21- Press the outer seal into the lower end cap with the lip of the seal toward the **OUTSIDE** of the cylinder block. Clean away any excess Loctite.



3-20 POWERHEAD

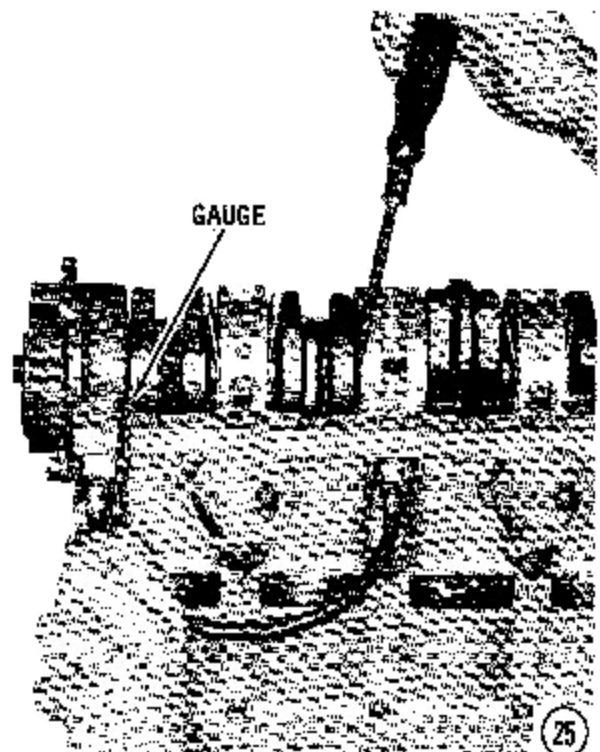
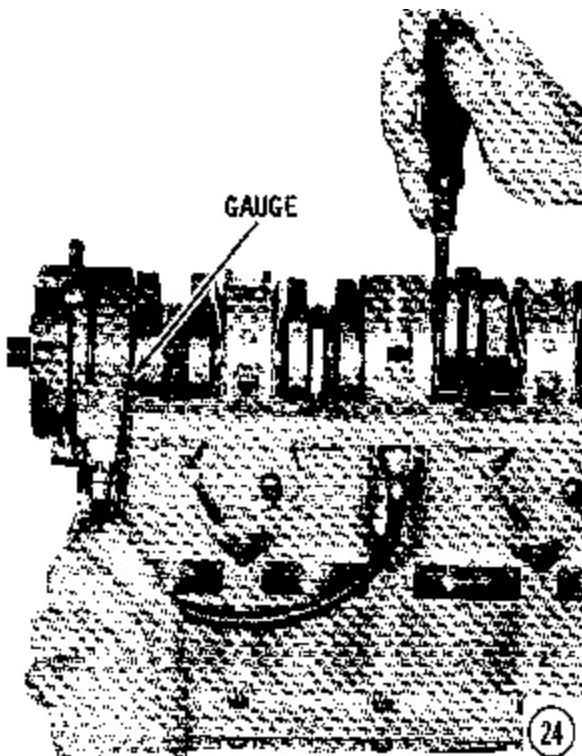


22- Press the inner oil seal into the lower end cap with the lip of the seal toward the **OUTSIDE** of the cylinder block. Continue pressing the seal into place until the seal surface is flush with the bottom of the bearing. Clean away any excess Loctite.

23- Place the O-rings onto the end caps. Apply a coating of Multi-purpose Lubricant to the O-rings and lips of the oil seals. With the original shims intact, temporarily install the upper and lower end caps onto the crankshaft and secure the crankshaft to the cylinder block with the end cap bolts. **DO NOT** install the crankcase cover.

24- Determine the crankshaft end play in the following manner: With one hand, hold the crankshaft from bouncing back. With the other hand and a soft-headed mallet, tap the crankshaft toward the stud end of the cylinder block. Hold the crankshaft in this position and measure the distance between the inner face of the end cap and the top (first) counterweight of the crankshaft with a feeler gauge. This measurement should be approximately 0.050" (1.27mm).

25- Now, tap the crankshaft in the opposite direction, and again measure the distance between the inner face of the end cap and the top counterweight of the crankshaft. Subtract the first measurement from the second. The difference between the two measurements is the crankshaft end play. The end play should be 0.004 - 0.012" (0.10 - 0.30mm). If the final end play measurement is not within this tolerance, adjust the end play by adding shim material to increase end play or removing shim material to decrease end play.



Alternate Method

26- A more accurate method, and one recommended by the manufacturer, is to install a dial indicator at the upper end of the crankshaft, as shown. Now, move the crankshaft as far as possible in both directions and record the amount of movement. Remember, to insert an equal amount of shim material at both ends to ensure each throw will be aligned with the center of the cylinder.

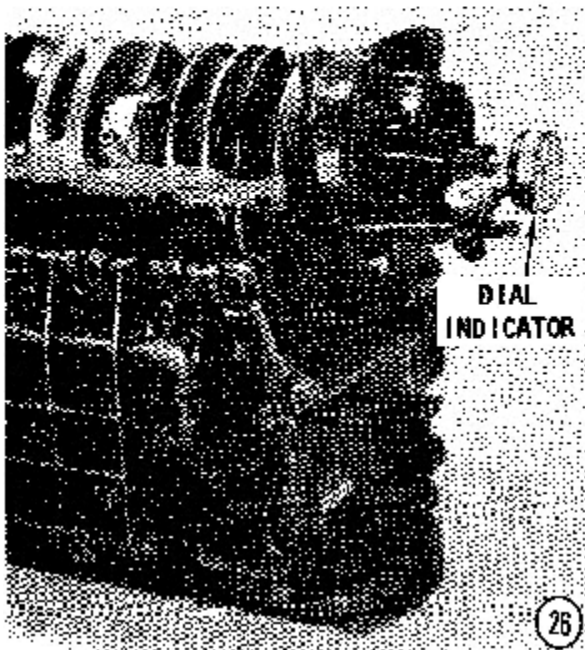
CRITICAL WORDS: The amount of shim material between the upper end cap and the cylinder block, and the amount of shim material between the lower end cap and cylinder block should be approximately the same. This is the **ONLY** way to ensure the crankpin throws are centered over the cylinder bores.

After the end play adjustment has been satisfactorily completed, loosen the end cap to cylinder block bolts several turns. Slide the end caps away from the cylinder block to permit the crankcase cover to be installed.

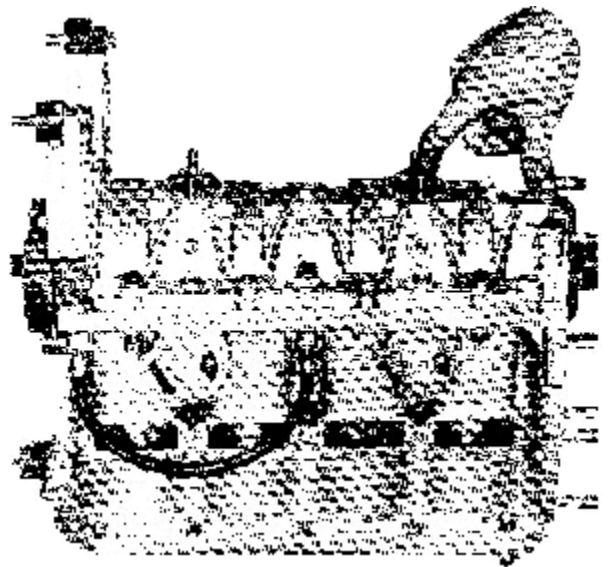
27- Before mating the crankcase cover and the block, check to be sure:

a- The mating surfaces are clean. **NEVER** use any kind of tool or abrasive material to clean the surfaces. Use only solvent and elbow grease.

b- The crankshaft is properly seated.



26

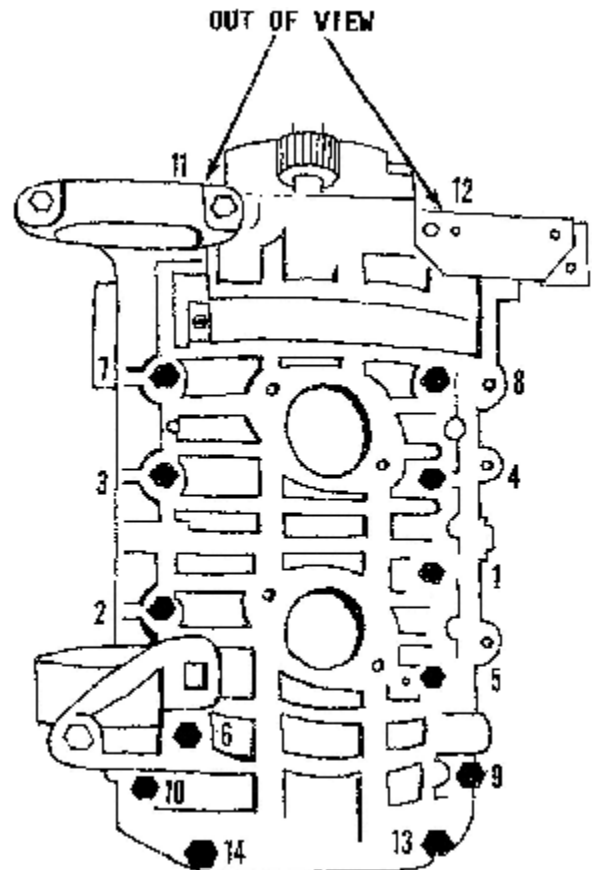


27

c- The rod caps have been correctly installed.

d- The reed blocks are properly seated into the cylinder block.

Use Loctite Primer "T" to clean the crankcase cover and cylinder block surfaces.



29