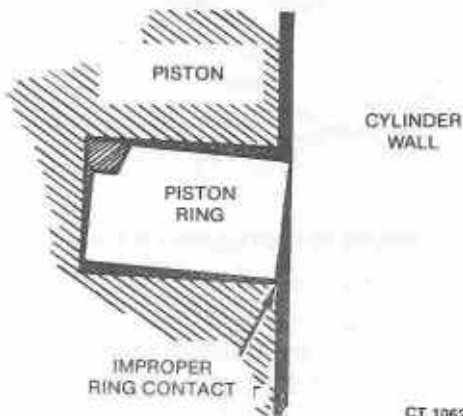


CT 1061

FIGURE 73. CHECKING RING LAND

Improper width rings or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves don't have good cylinder wall contact (Figure 74).



CT 1062

FIGURE 74. NEW RING IN WORN RING GROOVE

Replace pistons showing signs of scuffing, scoring, worn ring lands, fractures or damage from preignition.

**Connecting Rod Inspection:** Replace connecting rod bolts and nuts with damaged threads. Replace connecting rods with deep nicks, signs of fractures, scored bores or bores out of round more than 0.002 inch (0.05 mm).

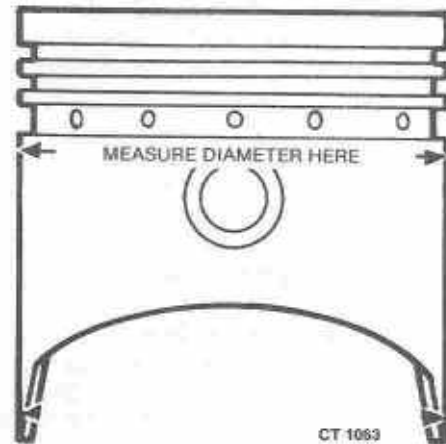
Use a new piston pin to check connecting rod for wear. A push fit clearance is required and varies from engine to engine. If a new piston pin falls through a dry rod pin bore as a result of its own weight, replace the rod or bushing as required.

**Piston Pin Inspection:** Replace piston pins that are cracked, scored, or out of round more than 0.002 inch (0.05 mm).

**Bearing Inspection:** Inspect bearings for burrs, breaks, pitting and wear. Replace bearing inserts that are scored, have the overlay wiped out, show fatigue failure, or are badly scratched. If bearings appear to be serviceable, check them for proper clearance.

### Piston Clearance

Proper piston tolerances must be maintained for satisfactory operation. Use a micrometer to measure the piston diameter at the point shown in Figure 75. When the cylinder bore is measured (see Cylinder Block section), subtract the piston diameter from the cylinder bore diameter to obtain the piston to cylinder wall clearance. Refer to the Dimensions And Clearances section for the recommended piston clearance.



CT 1063

FIGURE 75. PISTON CLEARANCE MEASUREMENT

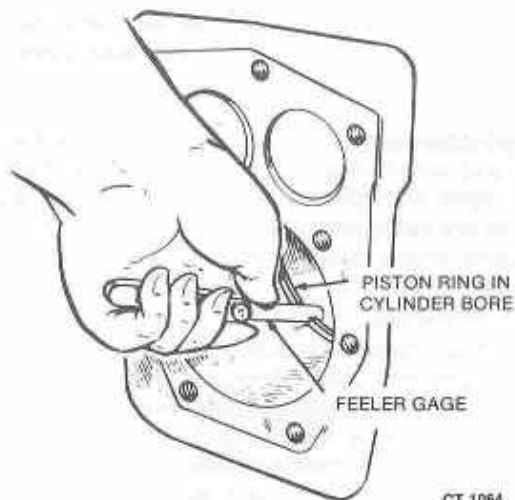
### Fitting Piston Rings

Before installing new rings on the piston, check the ring gap by placing each ring squarely in its cylinder, at a position corresponding to the bottom of its travel (Figure 76). The gap between the ends of the ring is given in Dimensions and Clearances section.

If the ring gap does not meet specifications, verify that the correct replacement ring was obtained for the bore size. Do not file the ring end to increase the end gap.

Standard size rings may be used on 0.005 inch (0.13 mm) oversize pistons. Rings that are 0.010, 0.020, 0.030 and 0.040 inch (0.25, 0.51, 0.76, and 1.02 mm) oversize are to be used on corresponding oversize pistons. Rings of the tapered type are usually marked TOP on one side, or identified in some other manner. Install these rings with the identification mark toward the closed end of the piston.

Engines that have been fitted with 0.005 inch (0.13 mm) oversize pistons at the factory are identified by the letter E after the serial number which is stamped on the cylinder block and on the unit nameplate.



CT 1064

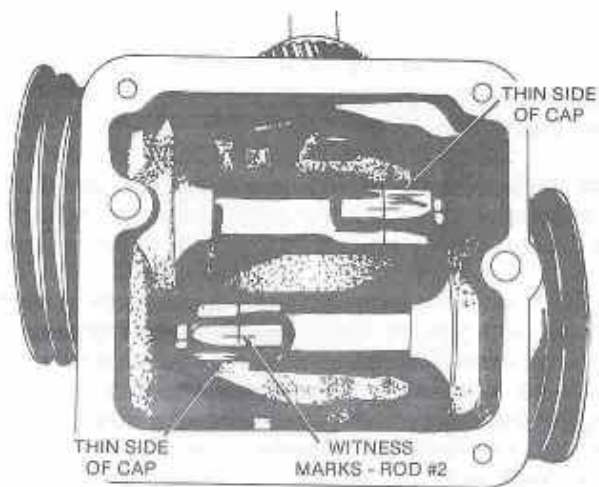
FIGURE 76. CHECKING RING GAP

### Piston Assembly Installation

Install rings on pistons starting at the bottom with the oil control ring expander and oil control ring. Use a piston ring spreader to prevent twisting or excessive expansion of the ring.

The two upper grooves are fitted with the compression rings. The moly-coated ring should be used in the top groove. Space each ring gap one-third of the way around the piston from the preceding ring, with no gap directly in line with the piston pin.

The piston is fitted with a full-floating type piston pin. The pin is kept in place by two lock rings in the piston, one at each side. Be sure these lock rings are properly in place before installing the piston and connecting rod in the engine.

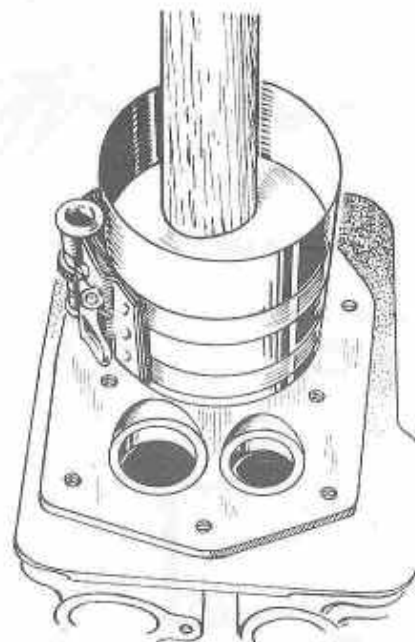


CT 1065

FIGURE 77. ROD CAP ALIGNMENT

**Installing Piston In Cylinder:** When installing the piston assembly, the raised lines (witness marks - see Figure 77) on the rods and caps must be aligned. Also, note that the connecting rod bolt is offset to one side of the cap. When assembled on the crankshaft, the thin side of the cap should be next to the cylinder block. The rod and cap stamped #2 should be installed next to the bearing plate.

1. Turn crankshaft to position rod bearing journal at bottom if its stroke.
2. Lubricate piston assembly and inside of cylinder. Compress rings with a ring compressor as shown in Figure 78. Install bearing insert in rod.



CT 1066

FIGURE 78. INSTALLING PISTON

3. Position piston and rod assembly in cylinder block.
4. Tap piston down into bore with handle end of hammer until connecting rod is seated on journal. Check bearing clearance before proceeding to step #5 (see Rod Bearing Clearance section).
5. Lubricate the rod bearing journal and install the connecting rod cap. Tighten connecting rod bolts to specified torque.

The bearing cap must be tapped several times to properly align it with the connecting rod. Clearance varies on the journal if this is not done. Install the remaining pistons and rods in the same manner. Crank the engine by hand to see that all bearings are free.

### Rod Bearing Clearance

1. Mark all parts so they can be installed in their original positions; and wipe all parts clean of any oil or grease.

- Place a piece of the correct size Plastigage across the full width of the bearing cap about 1/4-inch (6 mm) off center.
- Install the bearing cap and tighten to the specified torque. Do not rotate the crankshaft after the cap is in place.
- Remove the bearing cap and leave the flattened Plastigage on the part to which it adheres. Compare the widest point of the flattened Plastigage with the graduations on the envelope (see Figure 79) to determine the bearing clearance.

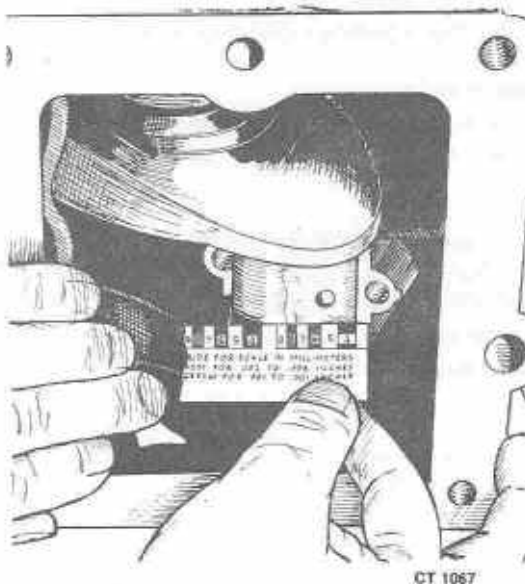


FIGURE 79. MEASURING BEARING CLEARANCE

## CRANKSHAFT

To remove the crankshaft, loosen the rear bearing plate screws and remove the bearing plate, gasket, thrust washer, and shims. Turn the crankshaft so the crankthrow is aligned with the notch in the rear opening of the crankcase. Carefully slide the crankshaft out of the crankcase.

### Inspection

Inspect the rod and main bearing journals. If they are worn or scored and cannot be smoothed out by polishing, either the journals should be reground to use one of the standard undersize bearings or the crankshaft should be replaced. Remove only as much metal as is required to restore the journal surface while maintaining the recommended bearing clearance.

Whenever making major repairs on the engine, always inspect the drilled passages of the crankshaft. Clean them to remove any foreign material and to assure proper lubrication of the connecting rods.

### Installation

Lubricate the front and rear main bearings with engine oil. Use oil or gear lubricant to hold the front thrust washer in place against the engine block. The flat side of the thrust washer goes against the block. Position the

crankshaft so the crank throw is aligned with the notch at the rear of the crankcase and install the crankshaft. Make sure the front thrust washer did not slip out of place during installation.

Place the oil seal loader on the oil seal guide and driver and insert into the rear bearing plate. Remove the seal guide and driver leaving the loader in the bearing plate. The loader prevents the seal from being cut on the crankshaft keyway during installation of the rear bearing plate.

Use oil or gear lubricant to hold the shim(s) and rear thrust washer in position on the rear bearing plate (see Figure 83). The shim goes against the bearing plate and the flat surface of the thrust washer goes against the shim.

Place the bearing plate gasket in position on the block, making sure the oil hole on the back of the block is exposed. Install the rear bearing plate and fasten with two nuts (or capscrews) tightened to the specified torque. Make sure the rear thrust washer and shim(s) did not slip out of place during installation. The crankshaft should turn freely by hand.

### Checking Endplay

After tightening two rear bearing plate nuts (or capscrews) to the specified torque, check the crankshaft endplay at the point shown in Figure 80 using a feeler gauge. Lightly tap the front of the crankshaft with a plastic-faced hammer to take up the freeplay. Refer to the Dimensions and Clearances section for the recommended crankshaft endplay. If necessary, remove the rear bearing end plate and add or remove shims as required. Install the end plate and tighten all nuts (or capscrews) to the specified torque. Make sure the shim and thrust washer are in place, and recheck crankshaft endplay. Verify that the crankshaft turns freely without binding.

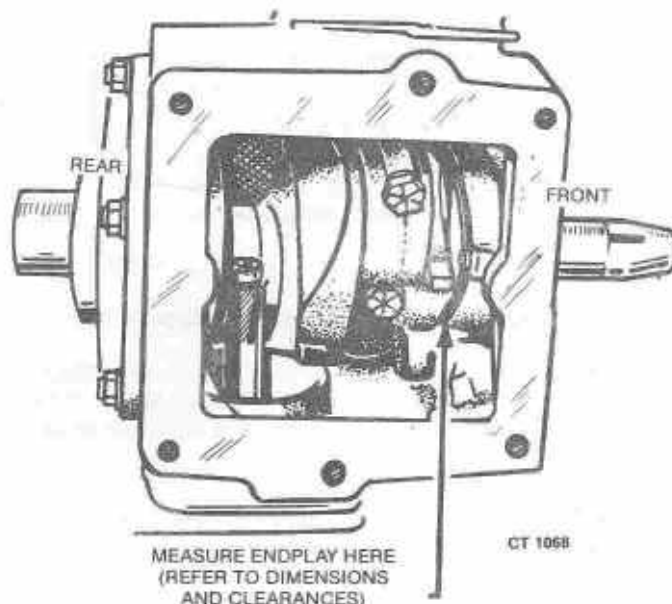


FIGURE 80. CHECKING ENDPLOY

## CYLINDER BLOCK

Inspect the cylinder bores for scratches, scoring, and cracks. Verify that the rear wench plug is tight and does not leak. Inspect the block for broken or missing fins that might affect cooling.

### Cylinder Measurement

The cylinder bores should be measured for taper, out-of-round, and wear using a telescoping gauge and outside micrometer or an inside micrometer. Measure the cylinder in four places as shown in Figure 81. Measurements A and B are taken on the thrust side of the cylinder, perpendicular to the piston pin. Measurements C and D are taken parallel with the piston pin. Record the measurements for each cylinder.

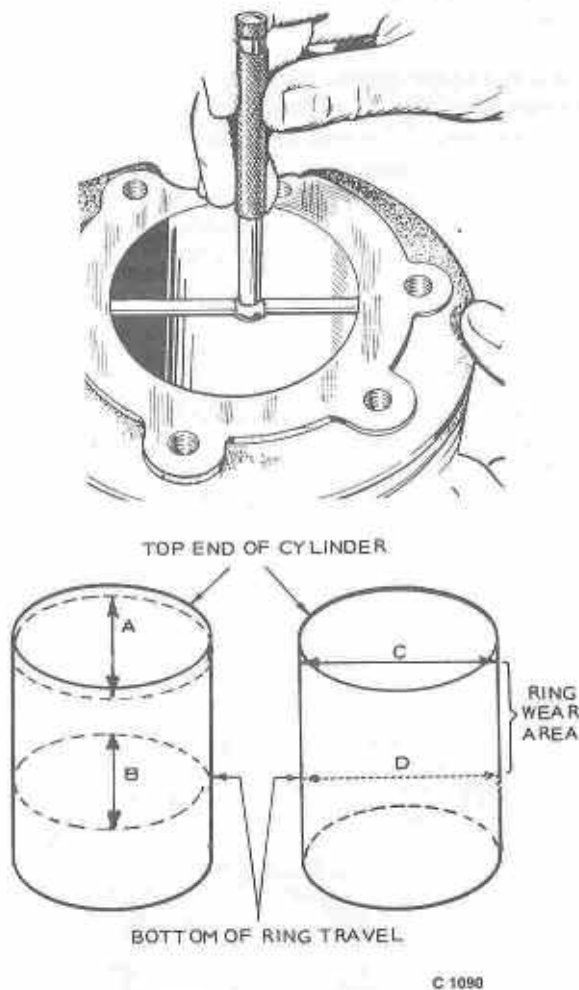


FIGURE 81. MEASURING CYLINDER DIAMETER

**Taper:** Subtract measurement A from B and measurement C from D to obtain the cylinder taper. If taper exceeds 0.005 inch (0.13 mm), the cylinder must be rebored.

**Out-Of-Round:** Subtract measurement C from A and measurement D from B to obtain the cylinder out-of-round. If the out-of-round exceeds 0.002 inch (0.05 mm), the cylinder must be rebored.

**Wear:** Compare measurements A, B, C, and D with the bore size specified in the Dimensions And Clearances section to determine the amount of cylinder wear.

### Service And Reconditioning

A cylinder that exceeds the limits for taper or out-of-round or that is worn excessively must be rebored and honed for the next oversize piston. A cylinder that is within the limits for taper and out-of-round and that is not worn excessively may be reconditioned without reboring. If the crosshatch pattern is still visible on the cylinder walls, use a glaze breaker to recondition. If the crosshatch pattern is not visible on the cylinder walls, use a hone to refinish. Refer to the Cylinder Honing section for the recommended procedures.

### Cylinder Honing

Cylinders that are within the taper and out-of-round limits can be reconditioned using the following procedures:

1. Anchor the block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill which operates at approximately 250 to 450 rpm.
2. Connect drill to hone and start drill. Move the hone up and down in the cylinder approximately 40 times per minute. Usually the bottom of the cylinder must be worked out first because it is smaller. Then when the cylinder takes a uniform diameter, move the hone up and down all the way through the bore. Follow the hone manufacturer's recommendations for wet or dry honing and oiling the hone.
3. Check the diameter of the cylinder regularly during honing. Use a telescoping gauge and outside micrometer or use an inside micrometer. Measure the bore twice at the top, middle, and bottom with a 90 degree separation between measurements.
4. The crosshatch formed by the scratching of the stones should form an angle of 23 degrees. This can be achieved by moving the hone up and down in the cylinder about 40 times per minute (Figure 82).
5. Clean the cylinder block thoroughly with soap, water and clean rags. Do not use a solvent or gasoline since they wash the oil from the walls but leave the metal particles.
6. Dry the crankcase and coat it with oil.

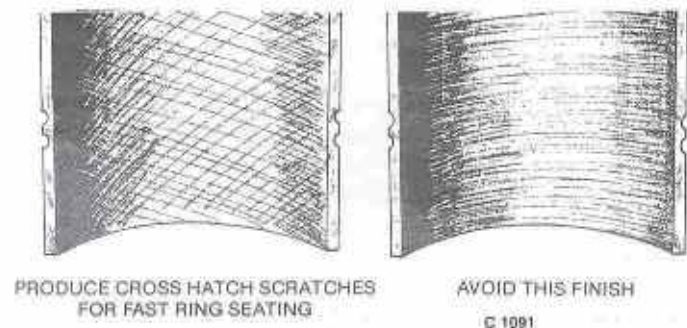


FIGURE 82. CROSS HATCH FINISH

## BEARINGS

Removal of the camshaft or crankshaft bearings requires complete disassembly of the engine. Use a combination main and cam bearing removal tool and a hammer to drive out the bearings. Support the casting to avoid distorting or damaging the bearing bores.

### Camshaft Bearings

Replacement camshaft bearings are precision type and do not require line reaming or line boring after installation. Coat the bearing with lubricating oil. Position the front bearing so the oil hole in the bearing is aligned with the oil hole (see Figure 83) in the block. Position the rear bearing so the elongated slot is aligned with the breaker point plunger hole in the top of the block.

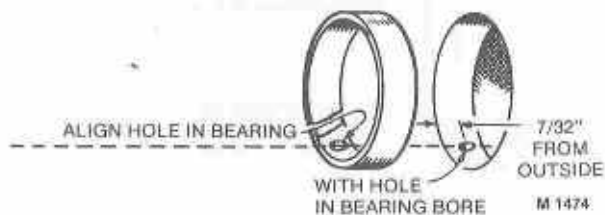


FIGURE 83. CAMSHAFT BEARINGS

Use the combination main and cam bearing driver and a hammer to install the front and rear cam bearings. Drive in the bearings to the depth allowed by the flange on the driver.

### Crankshaft Bearings

New crankshaft main bearings are precision type which do not require line reaming or line boring after installation. They are available in standard size, 0.002, 0.010, 0.020, or 0.030 inch (0.05, 0.25, 0.51, or 0.76 mm) undersize.

For putting in either the front or rear main bearing, always align the oil hole(s) in the bearing with the oil hole(s) in the bearing bore. The oil passage must be at least 1/2 open.

**Rear Bearing:** Use the combination main and cam bearing driver and a hammer to install the rear main bearing. Drive the bearing into the bearing plate from the inner side (see Figure 84) to the depth allowed by the flange on the driver.

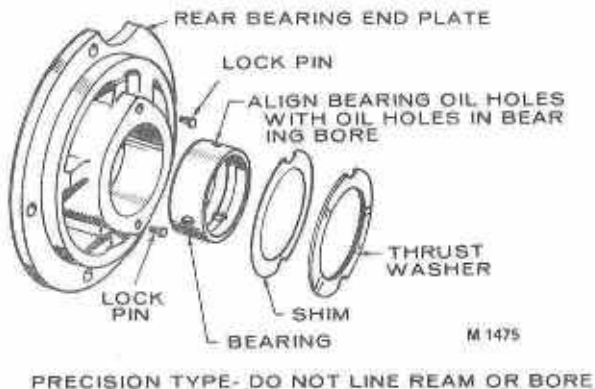


FIGURE 84. REAR BEARING

**Front Bearing:** Locktite Bearing Mount is used when installing the front bearing. Use the towelette furnished with the bearing kit to clean the outside of the bearing and the bearing bore in the block. Apply the Locktite Bearing Mount to the mating surfaces of the bearing and bearing bore. Allow three to four minutes for drying.

NOTE: DO NOT ADD ADDITIONAL THRUST WASHER WHEN REPLACING FRONT BEARING.

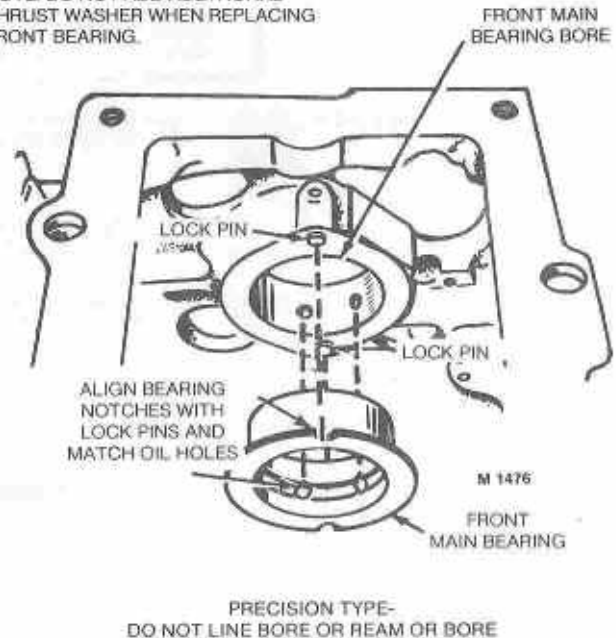


FIGURE 85. FRONT BEARING

**WARNING** Breathing vapor from towelette and prolonged contact with skin can be harmful. Be sure area is well-ventilated.

Use the combination main and cam bearing driver and a hammer to install the front bearing. Drive in the bearing to the depth allowed by the flange on the driver. Wipe off any excess Locktite and allow one hour for hardening at room temperature.

Engines shipped from the factory have separate thrust washers and main bearings for both front and rear of engine. Front bearing replacement part is a one piece bearing (with attached thrust washer) as shown in Figure 85. Do not add an additional thrust washer to this front bearing.

## OIL SEALS

Remove the rear bearing plate to replace the rear oil seal. Remove the gear cover to replace the front oil seal. Use an oil seal remover to pry out the front or rear oil seal.

Use an oil seal guide and driver to press or drive the rear seal into the rear bearing plate until it bottoms against the shoulder of the plate (see Figure 86). Press or drive the front oil seal into the gear cover until it is  $0.97 \pm 0.02$  inch ( $24.6 \pm 0.5$  mm) from the mounting face of the cover.

Lubricate the lips of the replacement seal with a light coating of grease before installing the rear bearing plate or gear cover. This provides initial lubrication until engine oil reaches the seal. Refer to the Crankshaft

section for the rear bearing plate installation procedures. Refer to the Gear Cover section for the gear cover installation procedures.

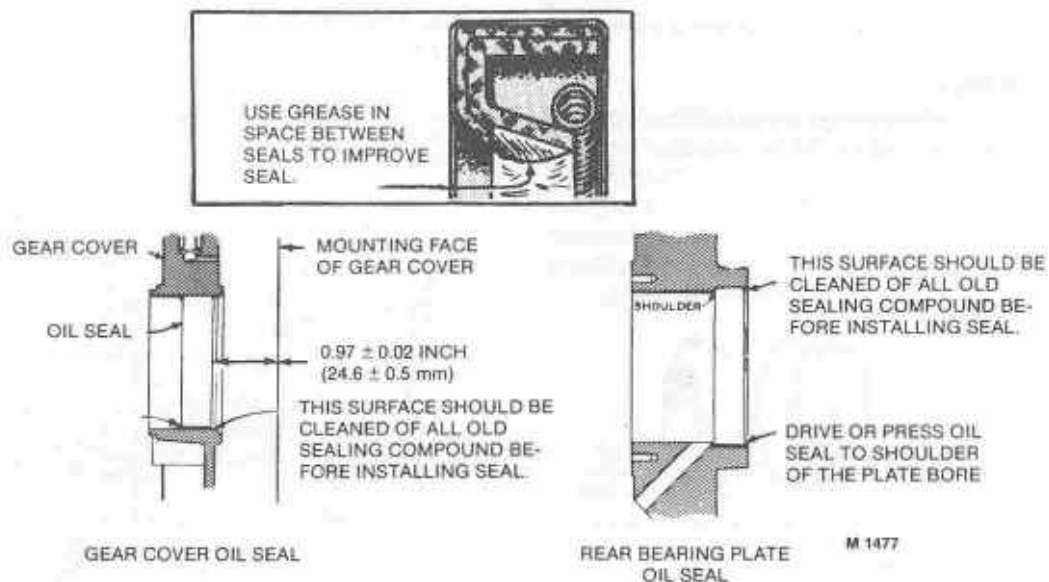


FIGURE 86. OIL SEALS

# Service Checklist

After servicing, inspect and test the complete installation to confirm that the generator set will operate properly and will pull full rated load. Check each of the following areas before putting the set into service.

## MOUNTING

Examine all mounting bolts and supporting members to verify that the generator set is properly mounted. All fasteners should be tightened securely to prevent them from working loose when subjected to vibration.

### Vibration Mounts

The vibration mounts must be assembled properly or the set will vibrate excessively. Refer to Figure 87 for the correct assembly sequence.

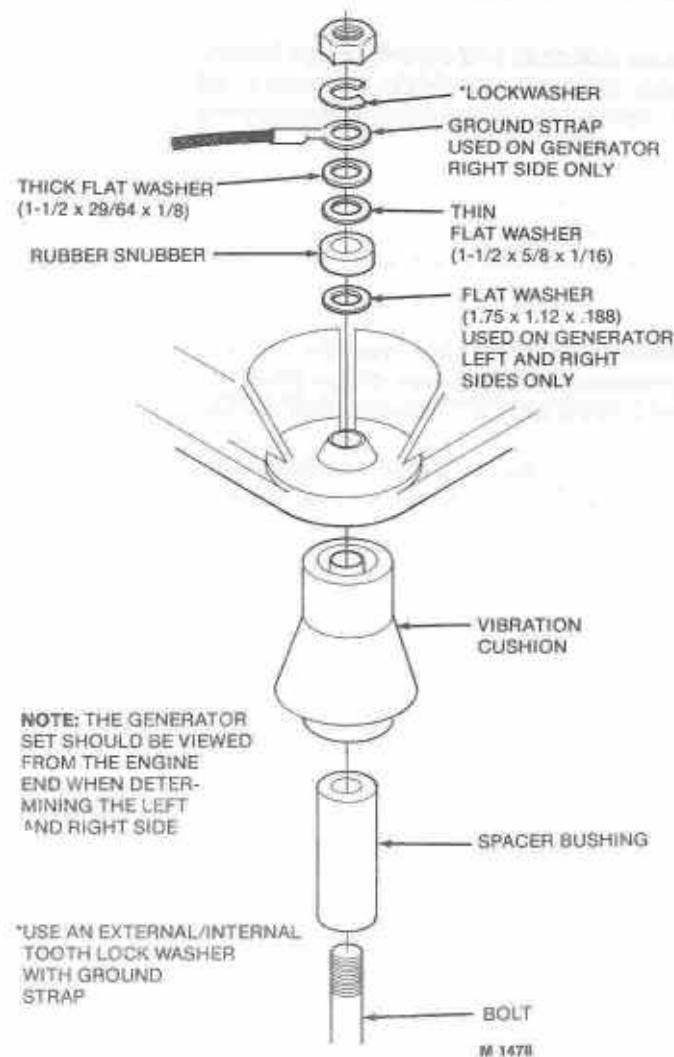


FIGURE 87. VIBRATION MOUNT

**CAUTION** Installing vibration isolator hardware in the wrong sequence will cause the generator set to vibrate excessively and might damage the mounts. Follow proper installation sequence.

## LUBRICATION

If the engine oil was drained, fill the crankcase with oil of the recommended classification and viscosity. Refer to the appropriate Operators Manual for the specific recommendations and procedures.

## WIRING

Verify that all wiring connections are tight and hooked up properly. Check each of the following:

- Load Wires
- Control Wires
- Ground Strap
- Battery Cables

## INITIAL START ADJUSTMENTS

Adjust the carburetor idle and adjustment screw and main adjustment screw as specified in the Fuel System section to allow starting.

Start the set and immediately adjust the governor speed adjustment nut to obtain a safe no-load operating speed (127 volts at 61 Hertz). With no load applied, listen for any unusual sounds or vibrations. When the choke is completely open, adjust the carburetor and governor as specified in the Fuel System section.

## OUTPUT CHECK

Apply a full load to verify that the set will produce its full rated output. Use a load test panel to apply a progressively greater load until full load is reached.

## EXHAUST SYSTEM

With the generator set operating, inspect the entire exhaust system including the exhaust manifold, muffler, and exhaust pipe. Visually and audibly check for leaks at all connections, welds, gaskets, and joints and also make sure that exhaust pipes are not heating surrounding areas excessively. If leaks are detected, correct immediately.

**WARNING** Inhalation of exhaust gases might result in serious personal injury or death. Inspect exhaust system audibly and visually for leaks daily. Repair leaks immediately.

## FUEL SYSTEM

With the generator set operating, inspect the fuel supply lines, return lines, filters, and fittings for leaks. Check any flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause breakage.

**CAUTION** *Leaking fuel will create a fire hazard which might result in severe personal injury or death if ignited by a spark. If leaks are detected, correct immediately.*

## CONTROL

Stop and start the generator set several times at the set control and remote control to verify that the control functions properly.

## MECHANICAL

Stop the generator set and inspect for leaking gaskets, loose fasteners, damaged components, or interference problems. Repair as required. Inspect the generator set compartment and verify that there are no breaks or openings in the vapor-proof wall that separates the compartment from the coach interior. Seal openings as required. Make sure all soundproofing material is in place.

## **⚠ WARNING**

### **EXHAUST GAS IS DEADLY!**

*Exhaust gases contain carbon monoxide, an odorless and colorless gas formed during the combustion of hydrocarbon fuels. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning are the following:*

- *Inability to Think Coherently*
- *Vomiting*
- *Muscular Twitching*
- *Throbbing in Temples*
- *Dizziness*
- *Headache*
- *Weakness and Sleepiness*

*If you or anyone else experience any of these symptoms, shut down the unit and get out into the fresh air immediately. If symptoms persist, seek medical attention. DO NOT OPERATE THE UNIT UNTIL IT HAS BEEN INSPECTED AND REPAIRED.*

*The best protection against carbon monoxide inhalation is proper installation and regular, frequent visual and audible inspections of the complete exhaust system.*