Disassembly (Pump 131-0257)

1. Disconnect all hoses and remove the pump from the engine.
2. Loosen the pulley set screw and remove the pulley from the pump shaft.
3. Remove the impeller housing screws, impeller housing, and gasket.
4. Pull the impeller out of the impeller housing.
5. Remove the wear plate from the pump housing, using a screwdriver to pry loose the plate if necessary.
6. Remove the external retaining ring from the impeller end of the water pump shaft.
7. Remove the two piece seal assembly. The spring portion of the seal is removed first. The second portion of the seal can be loosened and removed with a screwdriver or needle-nose pliers.
8. Remove the internal retaining ring from the drive pulley end of the pump housing.
9. Carefully drive out the shaft and bearing assembly from the impeller end of the housing.
10. Remove the slinger from the water pump shaft.

Assembly (Pump 131-0257)

Inspect the impeller housing for wear, rough surfaces, or pitting and replace if any of these conditions exist. Replace any other worn components such as bearings, seals, or impeller and use a new impeller housing gasket.

1. Install the new slinger on the water pump shaft.
2. Install the ceramic part of the two piece seal assembly in the pump housing. The rubber side of the seal should be toward the bearings.
3. Coat the inside of the water pump housing and the outside of the ball bearing races with grease.
4. Insert the water pump shaft into the pump housing, and install the internal retaining ring in the drive pulley end of the housing.
5. Install the spring portion of the two piece seal on the pump shaft and secure in place with the external retaining ring.
6. Install the wear plate so that the notch in the plate fits into the machining in the pump housing.
7. Coat the inside of the impeller housing with grease.
8. Install the impeller in the impeller housing by twisting it clockwise while pushing it into place.
9. While holding the gasket in place against the pump housing, install the impeller housing securing it with four screws removed during disassembly.
10. Mount the pump on the engine and attach the hoses.
11. Align the pump drive pulley with the crankshaft drive pulley and tighten the set screw.

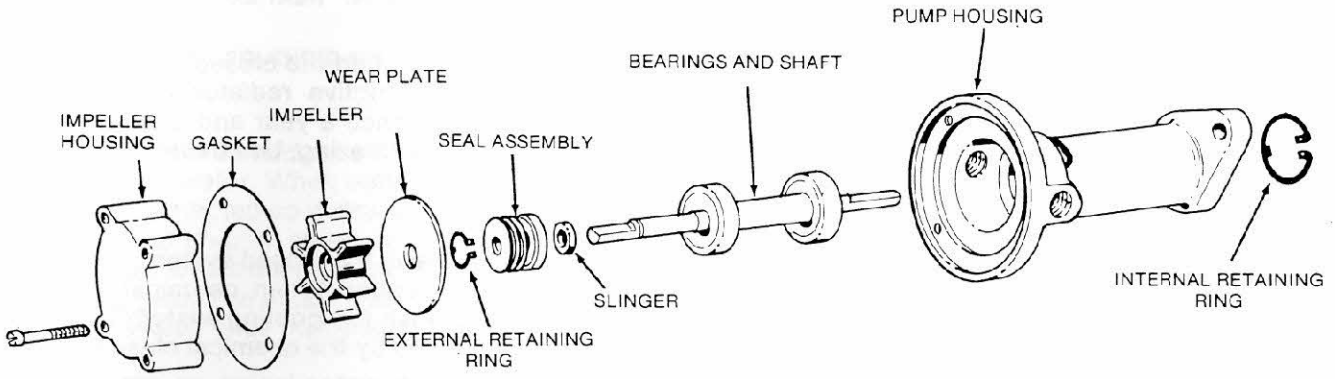


FIGURE 27. PUMP 131-0257

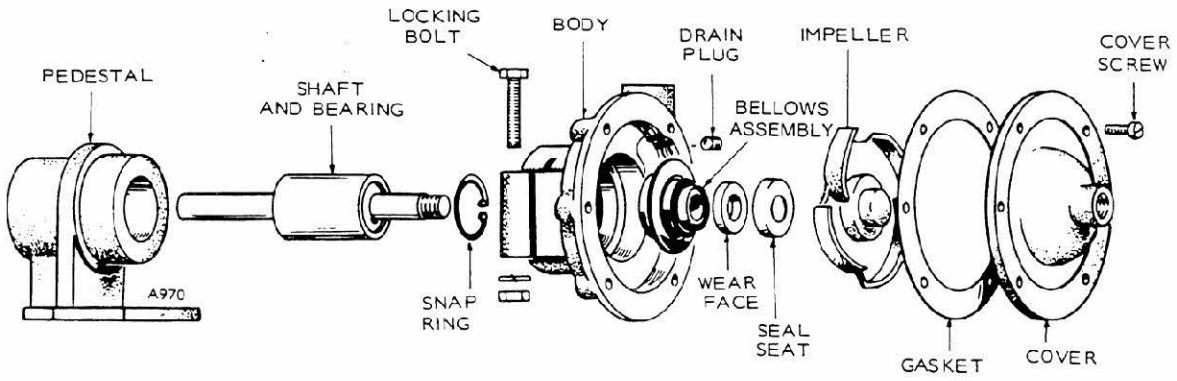


FIGURE 28. CENTRIFUGAL PUMP 132-0110

Disassembly (Centrifugal Pump 132-0110)

1. Remove the water inlet fitting, drive belt pulley, cover screws, and pump cover gasket.
2. Unscrew the threaded impeller from the pump shaft by turning the impeller in a counterclockwise direction when facing impeller.
3. Slide the seal seat, wear face, and bellows assembly off the shaft. Loosen the clamp screw and slide the pump body off the pedestal.
4. Remove the bearing lock ring and drive the shaft and bearing assembly out of the pedestal. The bearing is press fit on the shaft and comes off in one integral part. The bearing is packed with a lifelong lubricant and is sealed at each end.

Assembly (Pump 132-0110)

Replace all worn components such as bearings, seals, wear face, and impeller and use a new cover gasket. Assembly sequence is the reverse of the disassembly procedure.

HEAT EXCHANGER

Closed-type cooling systems are commonly referred to as fresh water cooling or heat exchanger cooling. Water circulated through the engine is called fresh water, hot water, etc. Water circulated through the heat exchanger only is called raw water, sea water, cold water, discharged water, etc. This system with an anti-freeze coolant is recommended where freezing coditions exist, or where the owner wants to prevent the possibility of salt water or rust problems.

The closed water system continually recirculates captive water through the water jacket, exhaust manifold, centrifugal pump, and one side of the heat exchanger. Figure 29 shows a typical heat exchanger.

CAUTION ***Do not use the existing neoprene impeller water pump in the hot water side of the cooling system. Heat or soluble oil (in many rust inhibitors and anti-freezes) will damage the impeller. Instead, connect the neoprene impeller pump on the cold water side. Use a metal impeller, centrifugal-type water pump (Onan 132-0110 or equal) in the fresh water side. See Figure 28.***

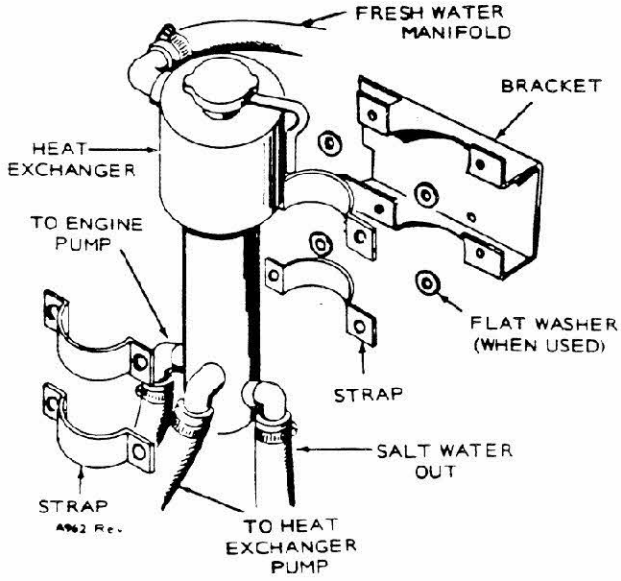


FIGURE 29. HEAT EXCHANGER

Maintenance: Maintain the closed water system the same as an automotive radiator cooling system. Clean and flush once a year and use anti-freeze if there is danger of freezing. Use a rust inhibitor in the closed water system.

Cleaning: To clean the closed system, drain and fill with radiator cleaner. When chemical cleaning is done, always flush the cooling system to wash out deposits loosened by the chemical cleaning.

Flush the engine water jacket as previously discussed. First remove the water outlet hose from the engine water jacket to the heat exchanger. Flush both the open and closed water system sides of the heat exchanger. Remove the rubber impeller pump cover to flush the open system. Also flush the water-cooled exhaust manifold. When flushing is completed, check the system thoroughly for leaks.

Starting System

STARTER

A solenoid-shift starter is shown in Figure 30. After the starter button is pushed, battery current energizes the start solenoid. The solenoid causes an arm to push the starter pinion into the flywheel ring gear. Simultaneously, the start solenoid contacts close and allow the starter motor to start turning. The starter remains engaged until the start button is released. An overrunning clutch protects the starter from damage before it can be disengaged from the flywheel.

Beginning with Spec H, the starter motor on MCCK engines is the gear drive starter shown in Figure 30a.

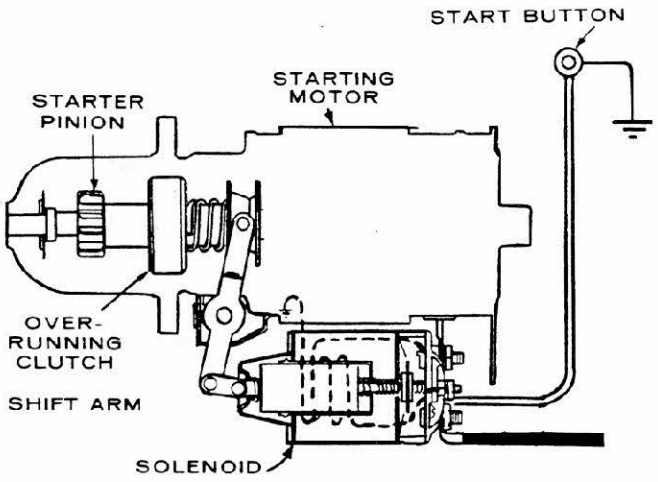


FIGURE 30. SOLENOID-SHIFT STARTER

The gear drive is mounted on a shaft which extends from the starter motor. When not running, the drive pinion gear is retracted so it clears the flywheel ring gear. When starting, a spiral spring through increasing speed forces the drive pinion to engage the flywheel ring gear. The pinion and flywheel ring gear teeth have beveled ends that ensure their engaging properly.

CAUTION ***Starter motors are not designed for continuous operation. Do not operate more than 30 seconds per ON cycle. Do not operate starter more than 10 seconds in a stall condition if engine will not rotate. Serious damage could result if these time limits are exceeded.***

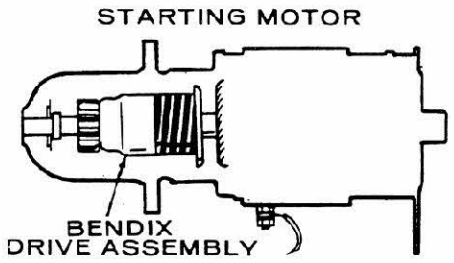


FIGURE 30a. GEAR-DRIVE STARTER

Maintenance

For proper cranking-motor operation with a minimum of trouble, a periodic maintenance procedure should be followed. Periodic lubrication, inspection of the brushes, and commutator as described in this section will insure long cranking motor life. Periodic disassembly (see *Disassembly*) of the cranking motor for a thorough overhaul is recommended as a safeguard against accumulations of dust, grease, and parts wear.

Lubricate all oil-type bearings with 8 to 10 drops of light engine oil (SAE 20). All oil-less type bearings and bushings should be given a few drops of light oil. Lubricate the cranking motor drives with a few drops of light engine oil.

Never oil the commutator. Oil on the commutator reduces the cranking ability of the motor.

The commutator can be cleaned by using number 00 sandpaper. Never use emery cloth. If the commutator is out of round or has high mica, remove it from the cranking motor. Turn the commutator down on a lathe being careful to remove only enough material to true up the commutator and remove high mica.

It is not necessary to undercut mica on starter motor commutators.

Replace worn brushes. If brushes wear rapidly, check for excessive brush spring tension and roughness or high mica on the commutator.

Solenoid Shift

Periodically inspect solenoid and shift lever to make sure they are operating properly. Keep the solenoid shift lever free of dirt and excess grease.

The overrunning clutch is packed in a special high melting point grease and after its initial assembly, needs no further lubrication. This clutch prevents the engine from turning the starter motor at too high a speed once it is started. Do not subject the overrunning clutch to grease dissolving or high temperature cleaning methods. This may cause the clutch to lose some or all of its grease.

If the pinion does not turn freely in the clutch in the overrunning direction, or the clutch tends to slip in the opposite direction, replace the assembly. A worn clutch indicated by excessive looseness of the pinion requires replacement.

Never attempt to repair or relubricate a defective clutch.

Pinion Clearance

The pinion clearance is adjusted by increasing or decreasing the fiber washer thickness at the mounting surface of the shift solenoid.

More washers decrease the clearance while less washers increase the pinion clearance.

The clearance between the pinion and the housing should be 0.02 to 0.08 inch (0.5 to 2 mm) when the pinion is in the cranking position, Figure 30b.

Drive Pinion

The teeth of the drive pinion are chamfered on only one side and specially rounded and polished to make the automatic meshing with the flywheel ring gear more efficient. The drive is designed so that if the ends of the pinion teeth meet end to end with the ring gear teeth (keep in mind that the drive is freely mounted on the drive shaft), the drive assembly can move back a slight amount against the pressure of the driving spring. The longitudinal movement permits the pinion to turn farther and enter the flywheel ring gear.

It is important the correct length of drive spring be used when making replacements. The length of the drive spring controls the longitudinal movement of the bendix pinion (meshing and unmeshing of the pinion and flywheel ring gear).

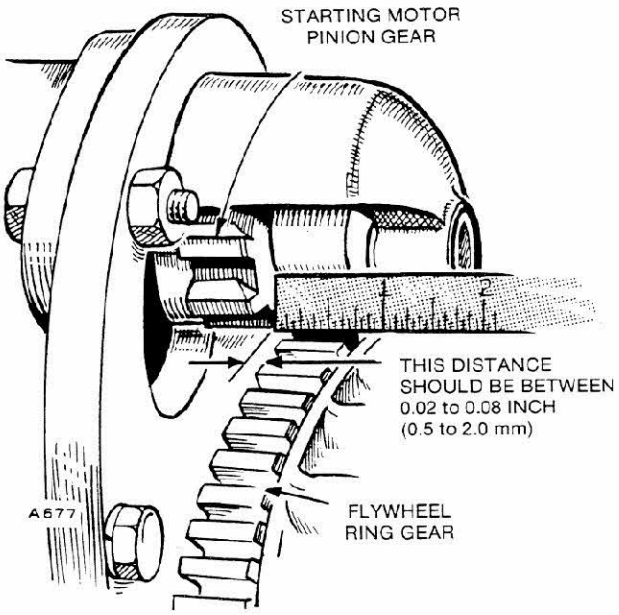
Keep the drive shaft free of rust, burrs or bends so the drive can move freely along it. A damaged pinion necessitates the replacement of the assembly.

Onan recommends replacement of faulty gear drive assemblies and provides no further service information concerning their repair. For further repair information, contact the manufacturer of your starter motor.

Disassembly

1. Remove all wires to the starting unit. Tag each wire so it can be reconnected as originally.
2. Remove the solenoid (where applicable).
3. Remove the starter motor thru-bolts and divide the starter into three main assemblies — the front bracket, the housing, and the rear bracket. On some model starters, short screws are used to hold the three starter sections together (Figure 31). The spacers on the solenoid starters are used for adjustment of the thrust gap of the armature shaft and are located between the rear bracket and the commutator shaft.

On the solenoid shift models, the steel spacing washer is on the commutator side.



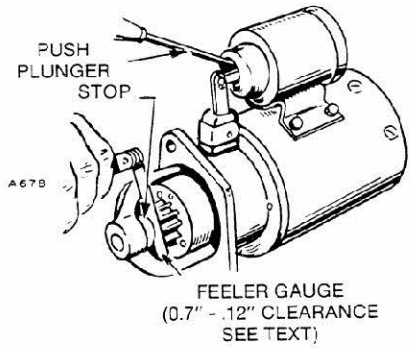


FIGURE 30b. PINION CLEARANCES (GEAR DRIVE)

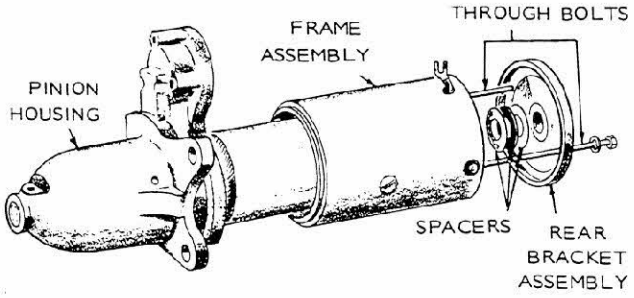


FIGURE 31. SOLENOID SHIFT STARTER

4. **Solenoid Starter Only:** The armature can now be removed from the front bracket. Be careful not to miss the small steel washer used in the end of the armature shaft. Remove the shift lever at the same time the armature is removed. The spring holder, lever springs, and retainer can be removed prior to removing the lever (Figure 31a).

5. **Solenoid Starter Only:** Remove the ring after driving the pinion stopper toward the pinion gear, using a cylindrical tool (Figure 32). Remove the overrunning clutch and the pinion stopper at the same time.

6. **Gear Drive Starter Only:** The entire assembly is mounted on the armature shaft. When disassembling the starter, pay particular attention to the various parts and their positioning in the starter assembly (Figure 33). If the gears of the pinion are damaged, replace the entire pinion. Inspect the screw shaft for rust and burrs.

7. Remove the brushes from the brushholder and inspect them (inspection of brushes and brush springs discussed later).

8. Remove the pole shoes, if necessary, by removing the flathead machine screws which anchor them to the frame.

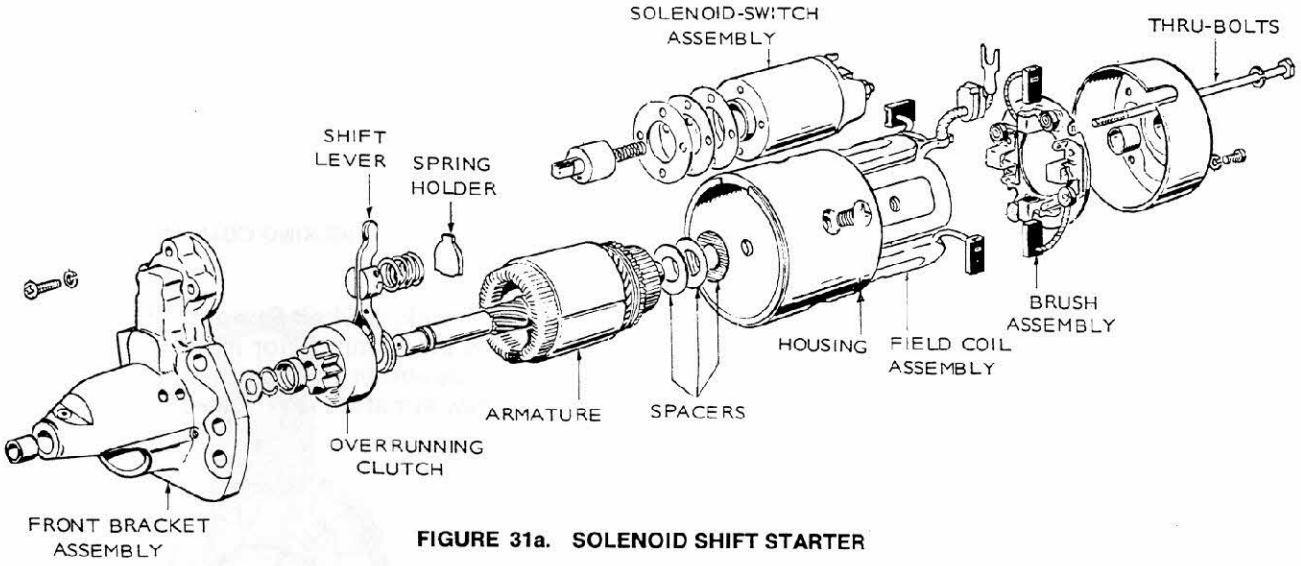


FIGURE 31a. SOLENOID SHIFT STARTER

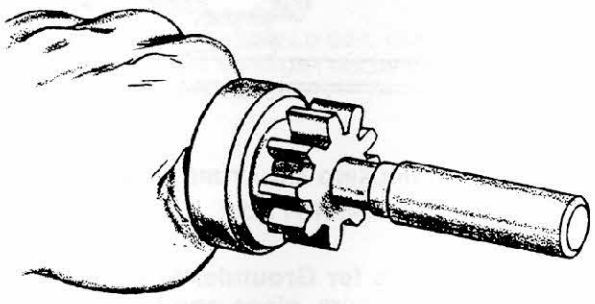


FIGURE 32. TOOL FOR DRIVING PINION STOPPER

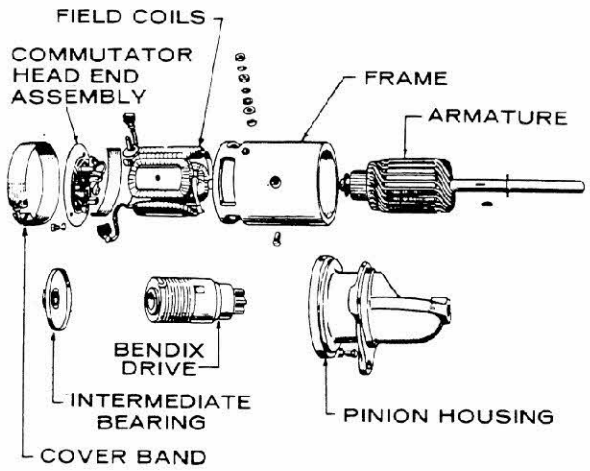


FIGURE 33. GEAR DRIVE STARTER

ELECTRIC STARTER INSPECTION AND TROUBLESHOOTING

Testing the Armature for Shorts: Place the armature in the growler and hold a thin steel blade parallel to the core and just above it, while slowly rotating the armature in the growler (Figure 34). A shorted armature causes the blade to vibrate and move toward the core. A shorted armature must be replaced.

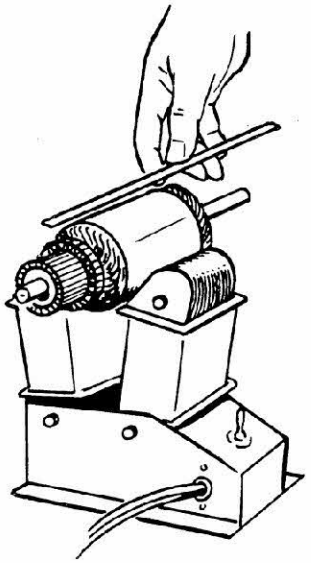


FIGURE 34. TEST FOR SHORTED ARMATURE

Testing Armature for Grounds: Touch armature shaft or core and the end of each commutator bar with a pair of ohmmeter leads (Figure 35). If the ohmmeter reading is low, it indicates a grounded armature. Replace a grounded armature.

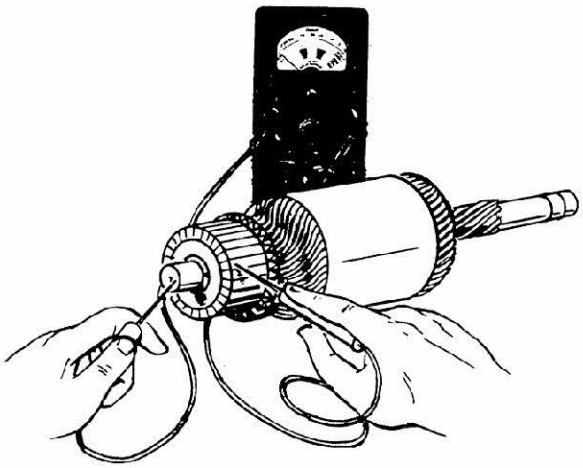


FIGURE 35. TEST FOR GROUNDED ARMATURE

Testing the Armature for Open Circuit: The most common place for an open circuit is at the commutator riser bars. Inspect conductors for loose connections at points where they are joined to the commutator bars.

Testing Commutator Runout: Place the commutator on a test bench and check runout with a dial indicator (Figure 36). When commutator runout exceeds 0.004 inch, reface the commutator.

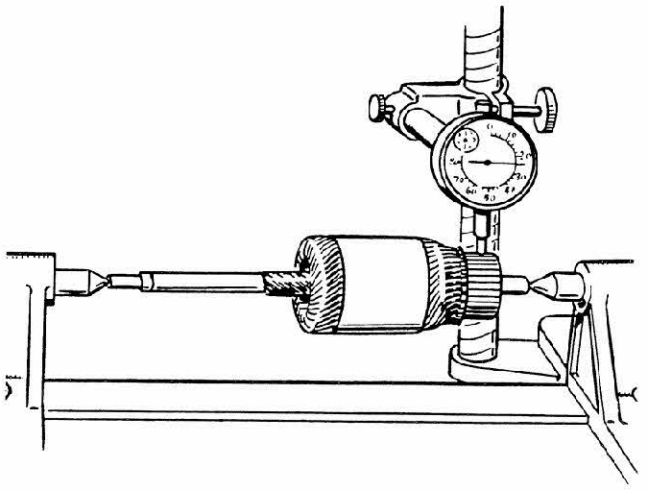


FIGURE 36. CHECKING COMMUTATOR RUNOUT

Testing Armature Shaft Runout: The armature shaft as well as the commutator may be checked. A bent armature can often be straightened, but if the shaft is worn a new armature is required (Figure 37).

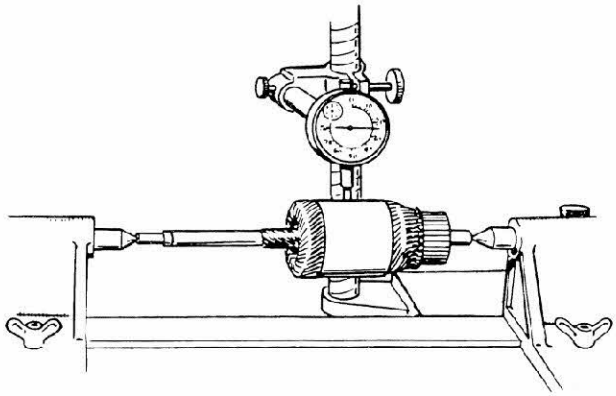


FIGURE 37. CHECKING ARMATURE SHAFT RUNOUT

Testing Field Coils for Grounds: After unsoldering the shunt field coil wire, place one test prod on the connector and the other on a clean spot on the frame. If the ohmmeter indicates continuity, the fields are grounded either at the connector or in the windings (Figure 37a).

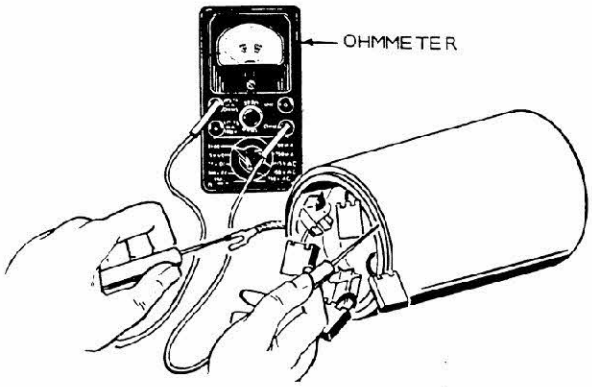


FIGURE 37a. FIELD COIL GROUND TEST

Testing Field Coils for Open Circuits: Place one prod on the connector and the other on a clean spot on the brushholder (Figure 38). If continuity is good, the field coil is good. Check all brushholders in the same manner.

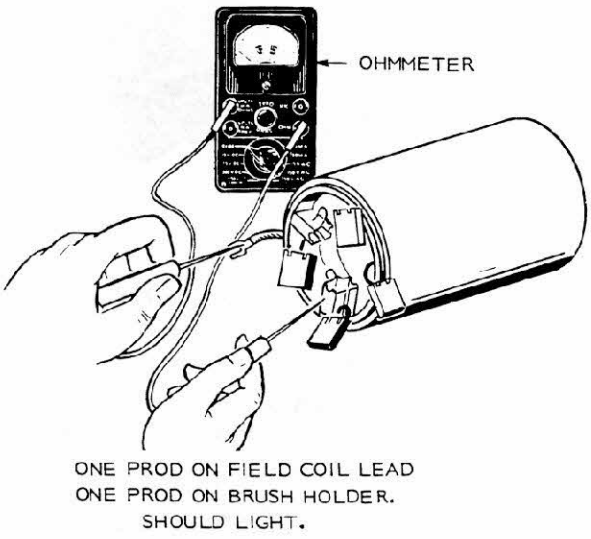


FIGURE 38. TEST FOR OPEN FIELD COIL

Inspection of Brushes: When brushes are worn more than 0.3 inch, replace them. Figure 39 shows the wear limit. See that the brushes move smoothly in the brushholders.

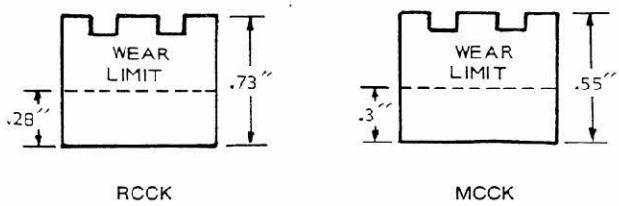


FIGURE 39. BRUSH WEAR LIMITS

Inspection for Brush Spring Tension: Measure brush spring tension with a tension meter (Figure 39a). Push the brush into its holder and take the reading just as the brush slightly projects from the brushholder. On a new brush the spring tension should be 49 to 59 ounces (1.37—1.65 kPa) for RCCK engines and 29 to 38 ounces (0.81 to 1.06 kPa) for MCCK engines.

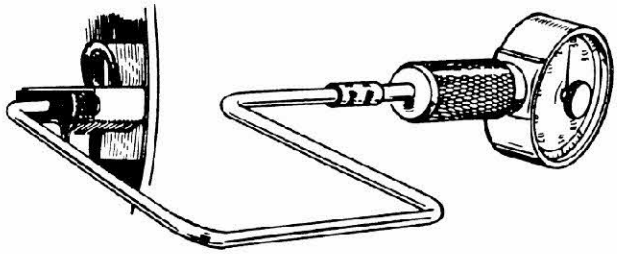


FIGURE 39a. MEASURING BRUSH SPRING TENSION

Assembly: Reassembly is much the reverse of disassembly procedure. Follow these precautions and procedures:

1. Clean all parts carefully with a dry cloth and compressed air if available.

   CAUTION ***Do not immerse bearing equipped parts in cleaning fluid. Clean with a brush dipped in mineral spirits.***

   CAUTION ***Do not clean overrunning clutch in solvent or liquid cleaning solution. Washing the clutch will cause the grease to leak out.***

2. Apply 20 weight oil to armature shaft and splines. Use grease sparingly on solenoid starter shift lever pin, joint of shift lever and plunger, plunger and spacing washers at end of the shaft.
3. Use spacing washers to adjust armature end play of 0.004 to 0.020 inch (0.102 to 0.508 mm).
4. When assembling starter to engine oil base, do not draw the mounting bolts up tight. The gears should have 0.004 to 0.007 inch backlash. Tap the starter in or out from the oil base to adjust. Then tighten starter mounting bolts to 30 ft.-lb. (41 Nm).

Engine Disassembly

If engine disassembly is necessary, first remove all the complete assemblies (e.g. manifold with carburetor and vacuum speed booster). Individual assemblies, as the carburetor, can be removed and serviced later, if necessary. Follow the general disassembly steps given below and refer to the appropriate detailed instructions in this section. When reassembling, check the text for special assembly instructions.

Keep all parts in their respective order . . . valve assemblies, rod caps for respective rod and piston assemblies, etc. Analyze reasons for parts failures. Use new gaskets for assembly.

GENERAL DISASSEMBLY

1. Drain crankcase oil.
2. Disconnect exhaust pipe, fuel line, battery cables, and electrical connections.
3. Remove flywheel using Onan flywheel puller.
4. Remove gear cover using care to protect oil seals from keyway damage.
5. Remove snap ring and remove crankshaft gear using a gear pulling ring and gear puller.
6. Remove air cleaner, manifold assembly (with carburetor and vacuum speed booster), fuel pump, fuel lines, spark plugs, ignition breaker box, etc.
7. Remove cylinder heads, oil base and oil pump.
8. Remove valves, springs, tappets, etc.
9. Remove camshaft and gear assembly.
10. Remove connecting rods, pistons and bearings.
11. Remove rear bearing plate.
12. Remove crankshaft.
13. Remove bearings as needed using correct bearing remover.

GENERAL ASSEMBLY

Engine assembly usually is the reverse of the disassembly procedure. Use a torque wrench whenever possible and observe proper clearances throughout assembly. Coat all internal parts with oil. During assembly, turn engine over by hand — should turn over freely.

1. Install new main bearings, if required, using proper bearing driver.
2. Install crankcase and rear bearing plate (check end play).
3. Install pistons, rods, bearings and rod caps.
4. Install crankshaft and timing gear assembly.
5. Install oil pump and oil base.
6. Install crank gear aligning timing mark with mark on camshaft gear.
7. Install valve assemblies and cylinder heads.
8. Install gear cover and oil seal.
9. Install flywheel.
10. Install fuel pump, manifold assembly, air cleaner, fuel lines, spark plug, breaker box, etc.
11. Connect electrical wires, exhaust line and battery.
12. Fill crankcase with proper oil.

FLYWHEEL

To remove the flywheel, turn the flywheel mounting screw outward about two turns and use Onan puller 420-0100 to pull the flywheel, Figure 40.

Do not drop the flywheel. Always use a steel key for mounting the flywheel.

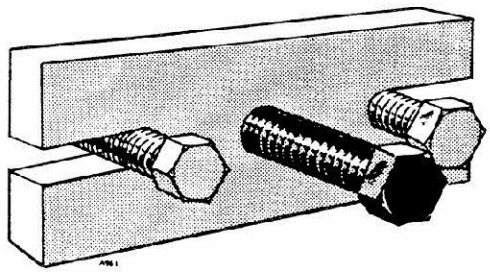


FIGURE 40. ONAN FLYWHEEL PULLER

GEAR COVER

After removing the flywheel key and mounting screws, tap the gear cover gently with a soft-faced hammer to loosen it.

CAUTION ***When installing the gear cover, make sure that roll pin in the gear cover engages the governor cup correctly. Figure 41.***

Turn the governor cup so that the plastic bushed hole is at the three o'clock position. The smooth side of the governor yoke must ride against the governor cup. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. be careful not to damage the gear cover oil seal. Adjust the roll (stop) pin to protrude to a joint 3/4 inch from the cover mounting surface. See Figure 41.

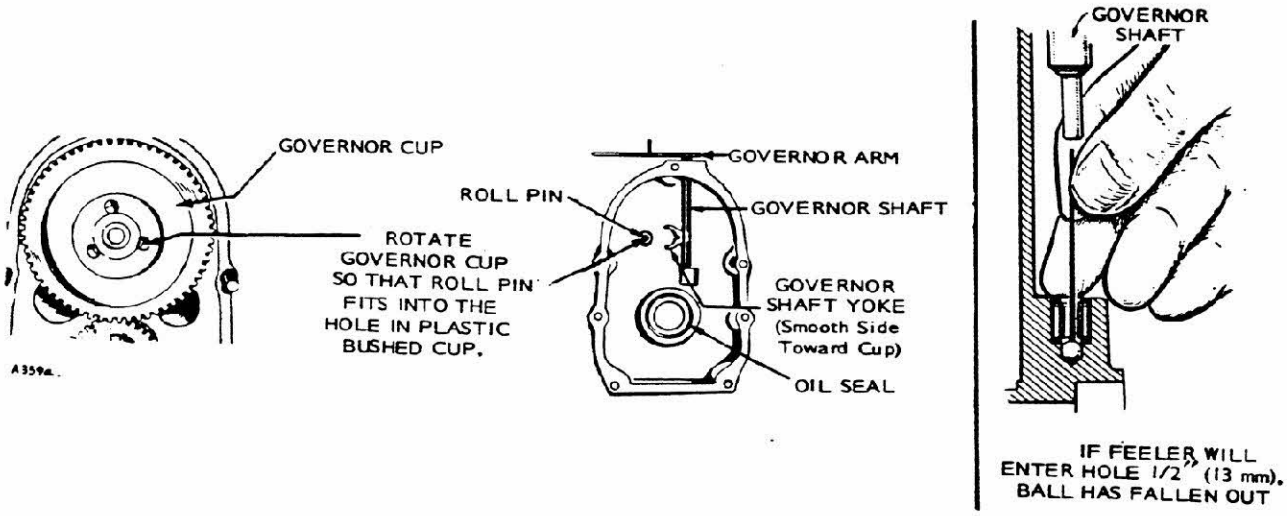


FIGURE 41. GEAR COVER ASSEMBLY

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin. Catch the flyballs while sliding the cup off. See Figure 41.

Replace any flyball that is grooved or has a flat spot. If the arms of the ball spacer are worn or otherwise damaged, replace the entire timing gear set. The governor cup must spin freely on the camshaft center pin without excessive looseness or wobble. If the race surface of the cup is grooved or rough, replace it with a new one.

When installing the governor cup, tilt the engine so the gear is up, put the flyballs in place and install the cup and snap ring on the center pin, Figure 42.

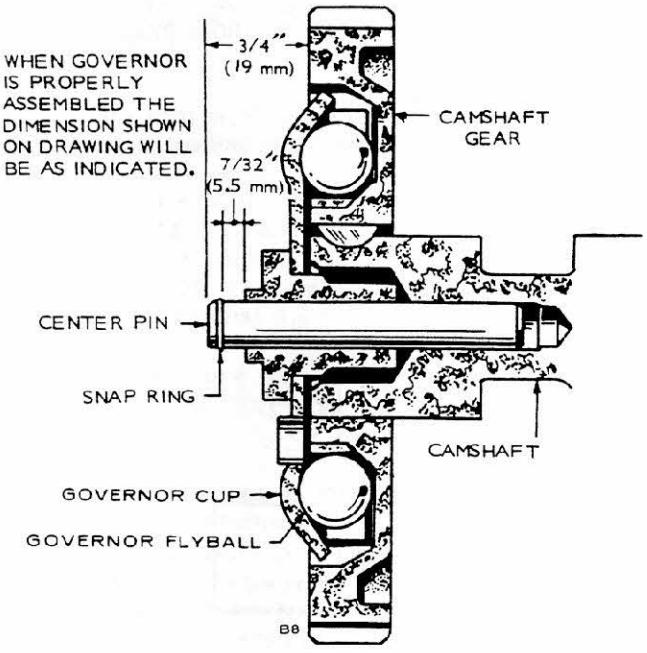


FIGURE 42. GOVERNOR CUP

The camshaft center pin extends out 3/4 inch from the end of the camshaft. This distance provides and in and out travel distance of 7/32 inch for the governor cup, as illustrated. Hold the cup against the flyballs when measuring. If the distance is less (the engine may race, especially at no load), remove the center pin and press a new pin in only the required amount. otherwise, grind off the hub of the cup as required. The camshaft center pin cannot be pulled outward nor removed without damage. If the center pin extends out too far, the cup will not hold the flyballs properly.

TIMING GEARS

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, install both gears new, never one only. Use a gear pulling ring to remove the crankshaft gear. Be sure to remove the snap ring first.

The camshaft gear is pressed on and keyed to the camshaft. The camshaft and gear must be removed as an assembly after first removing the crankshaft gear lock ring and washer. Before removing the camshaft and gear assembly, remove the cylinder head and valve assemblies. Remove the operating plunger for the breaker points. Remove the fuel pump and tappets.

The camshaft may be pressed out of the gear by use of a hollow tool or pipe which will fit over the camshaft center pin. Do not press on the center pin or damage it in any way. The governor ball spacer is a press fit to the camshaft gear.

When pressing a camshaft gear onto the camshaft, be sure the gear is started straight and that the key is properly in place. Install the governor cup assembly before installing the camshaft and gear in the engine.

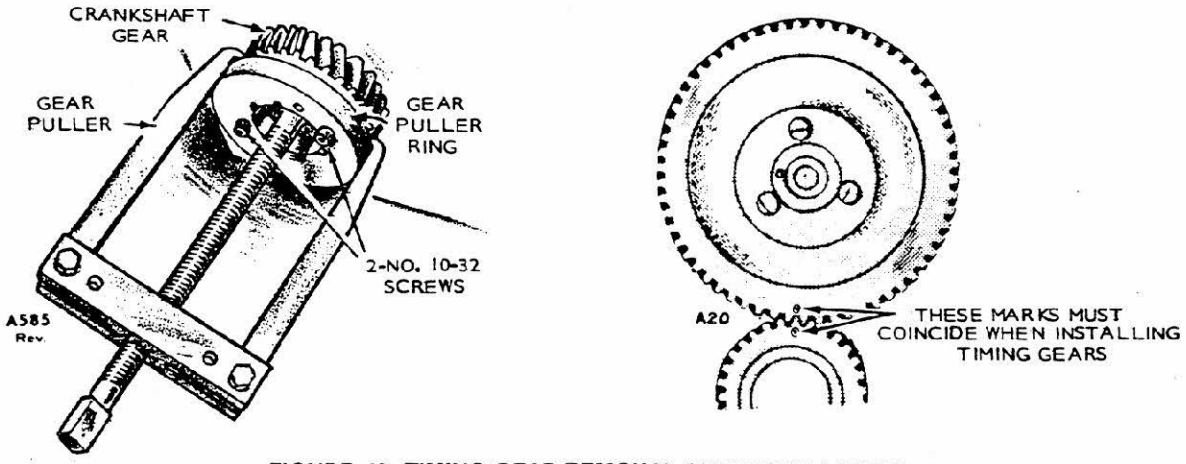


FIGURE 43. TIMING GEAR REMOVAL AND INSTALLATION

Each timing gear is stamped with an "O" mark near the edge. The gear teeth must mesh so that these marks coincide exactly when the gears are installed in the engine, Figure 43. Be sure, when installing the camshaft gear and shaft assembly, that the thrust washer is properly in place behind the camshaft gear. Replace the camshaft retaining washer and lock ring to the crankshaft.

CYLINDER HEADS

The cylinder head should be tightened in the order designated per Figure 44 to a torque of 5 foot-pounds (6.8 N•m), then 10 foot-pounds (13.5 N•m), etc. until all are torqued to 29 to 31 foot-pounds (39-42 N•m).

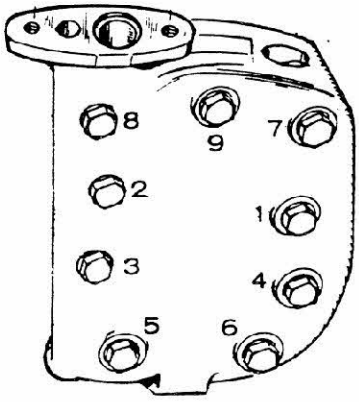


FIGURE 44. CYLINDER HEAD BOLT TORQUE SEQUENCE

VALVES

Properly seated valves are essential to good engine performance. The cylinder head is removable for valve servicing. Do not use a pry to loosen the cylinder head. Rap sharply on the edge with a soft-faced hammer, taking care not to break any cooling fins. A conventional type valve spring lifter may be used when removing the valve spring locks, which are of the split type. Clean all carbon deposits from the cylinder head, piston top, valves, guides, etc. If a valve face is burned or warped, or the stem worn, install a new valve.

Worn valve stem guides may be replaced from inside the valve chamber. See Figure 45. A seal is provided behind the intake valve guides only. The smaller diameter of the tapered valve guides must face toward the valve head.

Tappets are also replaceable from the valve chamber, after first removing the valve assemblies.

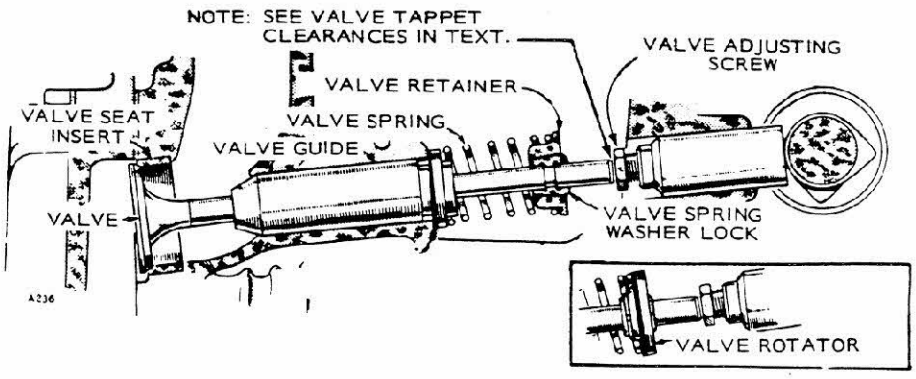


FIGURE 45. VALVE SYSTEM

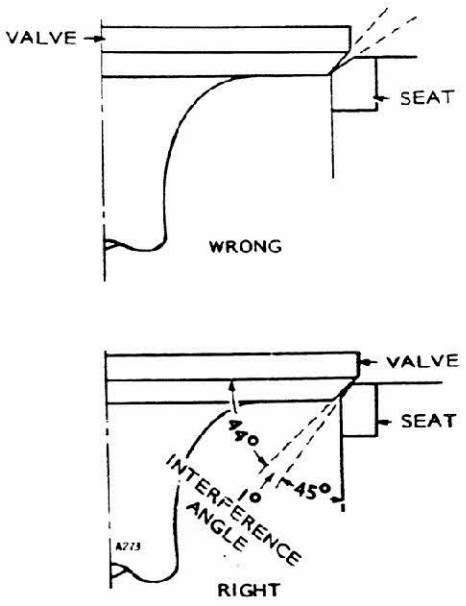


FIGURE 46. VALVE FACE AND SEAT ANGLES

The valve face angle is 44 degrees. The valve seat angle is 45 degrees. This 1 degree interference angle results in a sharp seating surface between the valve and the top of the valve seat. The interference angle method of grinding valves minimizes face deposits and lengthens valve life, Figure 46.

The valves should not be hand lapped, if at all avoidable, since the sharp contact may be destroyed. This is especially important where chrome-cobalt faced valves and seats are used. Valve faces should be finished in a machine to 44 degrees. Valve seats should be ground with a 45 degree stone and the width of the seat band should be 1/32 to 3/64 (0.79-1.2 mm) of an inch wide. Grind only enough to assure proper seating.

Remove all grinding compound from engine parts and place each valve in its proper location. Check each valve for a tight seat, using an air pressure type testing tool. If such a tool is not available, make pencil marks at intervals across the valve face and observe if the marks rub off uniformly when the valve is rotated part of a turn against the seat.

Lightly oil the valve stems and reassemble all parts removed. Adjust the valve clearance (see *Tappet Adjustment).*

The positive type valve rotocoils serve to prolong valve life and decrease valve repairs. Check the rotocoils periodically by removing the cylinder heads and cranking the engine. When functioning properly, the valve is rotated a fraction of a turn each time it opens. If rotocoils are faulty, install new ones.

TAPPET ADJUSTMENT

The engine is equipped with adjustable tappets. To make a valve adjustment, remove the valve covers. Crank the engine over slowly by hand until the left hand intake valve, when facing the flywheel, opens and closes. Continue about 1/4 turn until the correct timing marks align. This should place the left hand piston at the top of its compression stroke, the position it must be in to get proper valve adjustment for the left hand cylinder. Clearances are shown in *DIMENSIONS AND CLEARANCES* section. For each valve, the gauge should just pass between the valve stem and valve tappets (Figure 47).

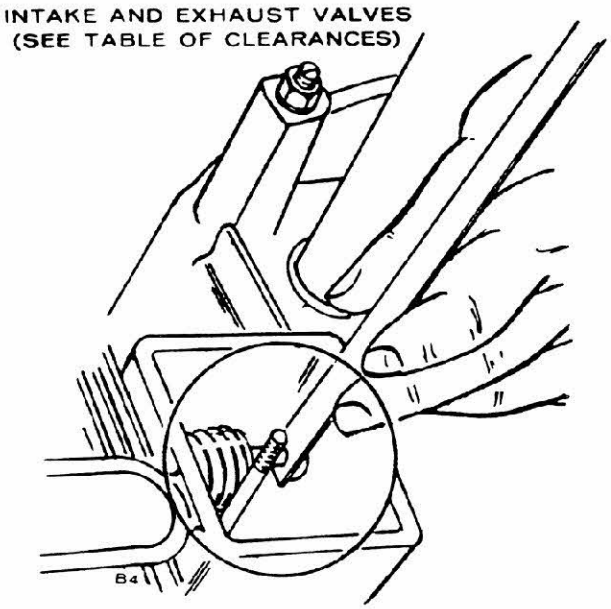


FIGURE 47. TAPPET ADJUSTMENT

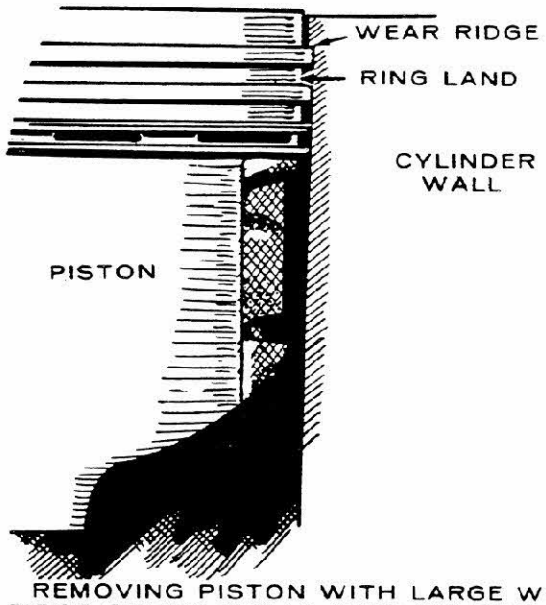
To correct the valve clearance, turn the adjusting screw as needed to obtain the right clearance. The screw is self-locking.

To adjust the valves on the right hand cylinder, crank the engine over one complete revolution and again line up the correct timing marks. Then follow the adjustment given for the valves of the left hand cylinder.

PISTON AND RINGS

Whenever there is a noticeable wear ridge at the top of each cylinder, remove the ridge with a ridge reamer before removing the pistons. If not, the rings can catch the ridge when pushing out the pistons and cause a ring land fracture, Figure 48.

To remove the piston and connecting rod assemblies, turn the crankshaft until a piston is at the bottom of the stroke. Remove the nuts from the connecting rod bolts. Lift the rod bearing cap from the rod and push the rod and piston assembly out the top of the



REMOVING PISTON WITH LARGE WEAR RIDGE COULD BREAK RING OR RING LAND.

FIGURE 48. WEAR RIDGE ON CYLINDER WALL

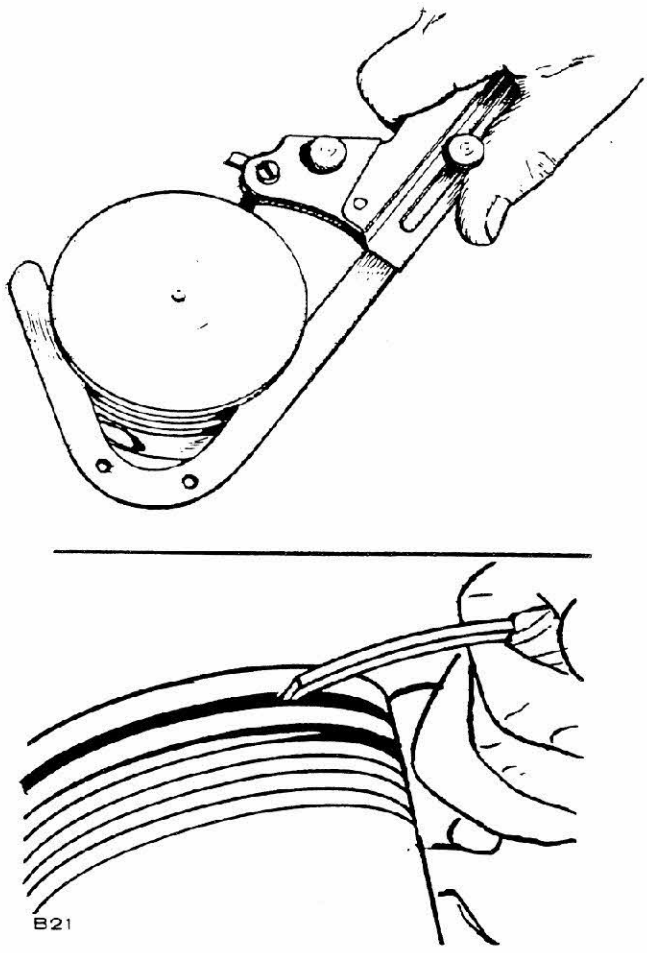


FIGURE 49. CLEANING PISTON RING GROOVES

cylinder with the handle end of a hammer. Be careful not to scratch the crankpin or the cylinder wall when removing these parts.

Keep the connecting rod bearing caps and bearings with their respective rods.

The pistons are fitted with two compression rings and one oil control ring with an expander. Remove these rings from the piston using a piston ring spreader.

Clean the piston ring grooves with a groove cleaner or the end of a broken ring filed to a sharp point, Figure 49. All passages should be cleaned with a non-caustic solvent. Clean the rod bores and the back of the connecting rod bearings thoroughly.

Mark each piston to make sure the rod will be assembled on the piston from which it was removed. Remove the piston pin retainer from each side and push the pin out.

Inspect the pistons for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring land using new rings and a feeler gauge as shown in Figure 50. See *DIMENSIONS AND CLEARANCES* section for proper side clearance measurement and ring groove widths.

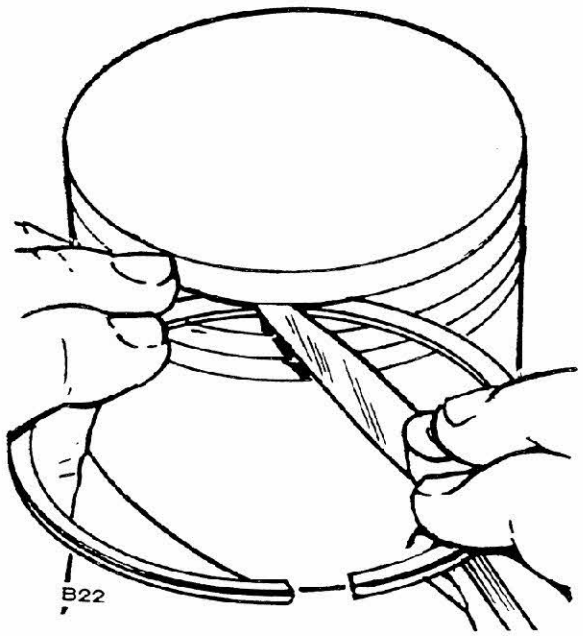


FIGURE 50. INSPECTING RING LANDS

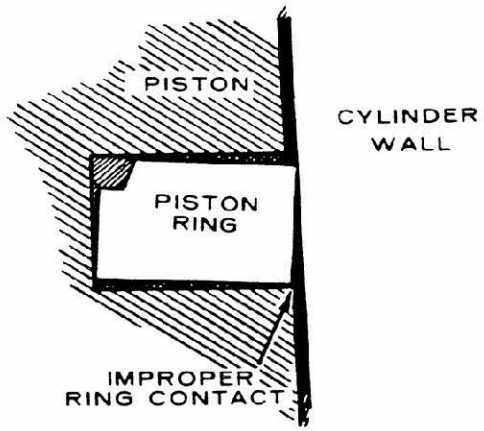


FIGURE 51. NEW RING IN WORN PISTON RING GROOVE

Improper width rings or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves do not have good cylinder wall contact, Figure 51.

Replace pistons showing signs of bad scoring or burring, excessive skirt clearance, wavy or worn ring lands, fractures or damage from detonation. Replace piston pins showing fractures, scored bores or bores out of round more than 0.002 inch (0.051 mm).

Use a new piston pin to check the pin bushing in the connecting rod for wear. The clearance should be as shown in *DIMENSIONS AND CLEARANCES* section.

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 52). The gap between the ends of the ring is given in *DIMENSIONS AND CLEARANCES* section.

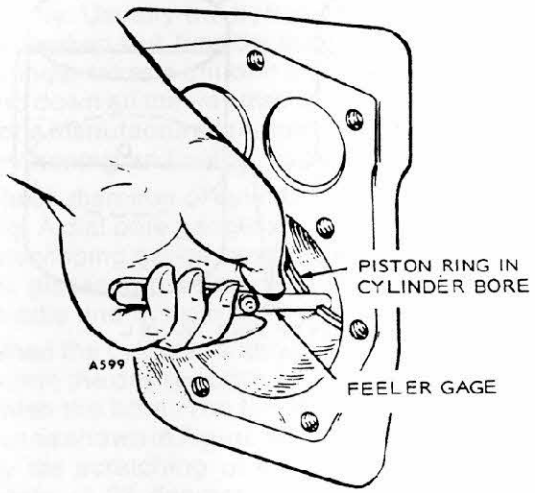


FIGURE 52. FITTING PISTON RINGS TO CYLINDER

Rings which are slightly oversize may be filed as necessary to obtain the correct gap, but do not use rings which require too much filing. Standard size rings may be used on 0.005 inch oversize pistons. Other oversize rings must be used with corresponding oversize pistons. Rings of the tapered type are usually marked top on one side, or identified in some other manner and the ring must be installed with this mark toward the closed end of the piston.

Space each gap one third of the way around the piston from the preceding one, with no gap directly in line with the piston pin. The bottom piston ring groove should be fitted with an expander and an oil control ring and the two upper grooves fitted with compression rings. If a chrome faced ring is used, it will be in the top groove. The oil control ring is selected for best performance in regard to the correct unit pressure characteristics.

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. Refer to *DIMENSIONS AND CLEARANCES* section for the correct piston-to-cylinder clearance.

CONNECTING RODS

The connecting rods should be serviced at the same time the pistons or rods are serviced. Rods must be removed with the piston. Replaceable bushings and bearings are used.

Proper clearance is obtained by replacing the pin bushing and the bearings. The rod bearings are precision size and require no reaming.

Install the connecting rods and caps with raised lines (witness marks) aligned and with the caps facing toward the oil base. The rod and cap numbered 2 fits on the crankshaft journal nearest the bearing plate. Coat the crankshaft journal bearing surfaces with oil before installing the rods. Crank the engine by hand to see that the rods are free. If necessary, rap the connecting rod cap screws sharply with a soft-faced hammer to set the rod square on the journal.

Checking Bearing Clearance With Plastigage: Make certain that all parts are marked or identified so that they are reinstalled in their original positions.

Place a piece of correct size Plastigage in the bearing cap the full width of the bearing insert about 1/4 inch (6.35 mm) off center, Figure 53.

Rotate the crank about 30 degrees from bottom dead center and reinstall the bearing cap. Tighten the bolts to the torque specified in the *ASSEMBLY TORQUES* section. Do not turn the crankshaft.

Remove the bearing cap. Leave the flattened

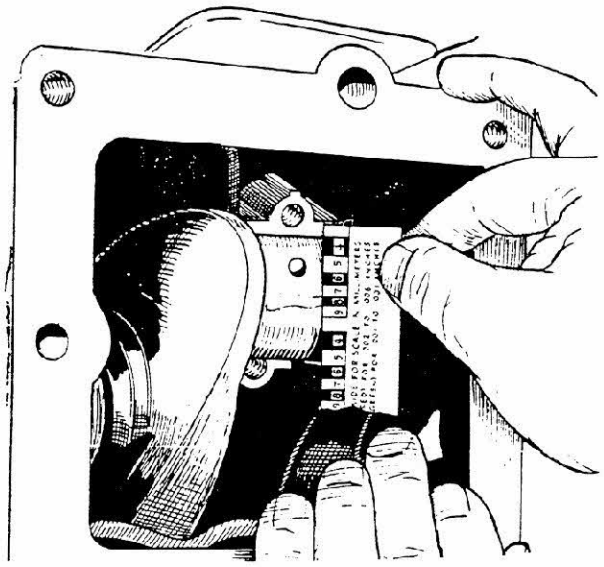


FIGURE 53. MEASURING BEARING CLEARANCE WITH PLASTIGAGE

Plastigage on the part to which it has adhered and compare the widest point with the graduations on the Plastigage envelope to determine bearing clearance.

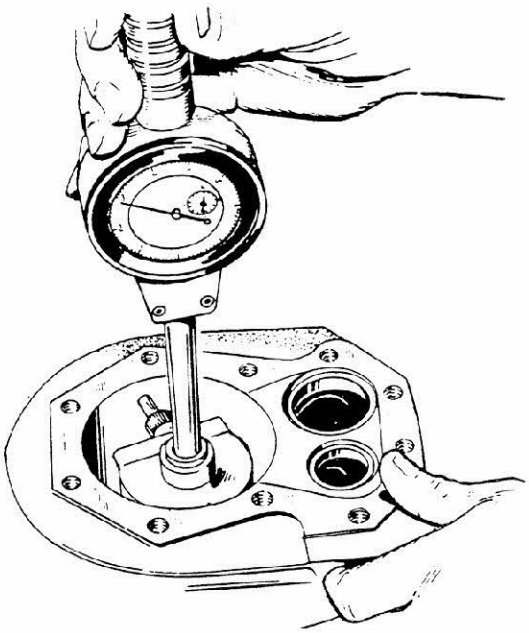
CYLINDER BLOCK

Inspection:

1. Make a thorough check for cracks. Minute cracks may be detected by coating suspected area with a mixture of 25 percent kerosene and 75 percent light motor oil. Wipe the part dry and immediately apply a coating of zinc oxide (white lead) dissolved in wood alcohol. If cracks are present, the white coating will become discolored at defective area.
2. Inspect cylinder bore for scoring. Check Welsh plugs for a tight, even fit and the fins for breakage.
3. Check cylinder bore for taper, out of round and wear with a cylinder bore gauge, telescope gauge or inside micrometer, Figure 54. These measurements should be taken at four places — near top and bottom of piston ring travel.
4. Referring to Figure 54, measure cylinder diameter and record the readings as follows:
   a. Measure reading A across top of cylinder where greatest piston ring wear occurs.
   b. Measure reading B across cylinder at bottom of piston ring travel.
   c. Measure reading C across top of cylinder where greatest ring wear occurs.
   d. Measure reading D across cylinder at bottom of piston ring travel.
5. Compare reading A with reading B, then compare reading C with reading D to determine cylinder taper due to wear.

   If taper exceeds 0.005 inch (0.127 mm), rebore and hone cylinder to accommodate the next oversize piston.
6. Reading A compared to C and reading B compared to D indicates whether or not the cylinder is out of round.

   If cylinder is out of round 0.002 inch (0.051 mm), rebore and hone cylinders for next oversize piston.



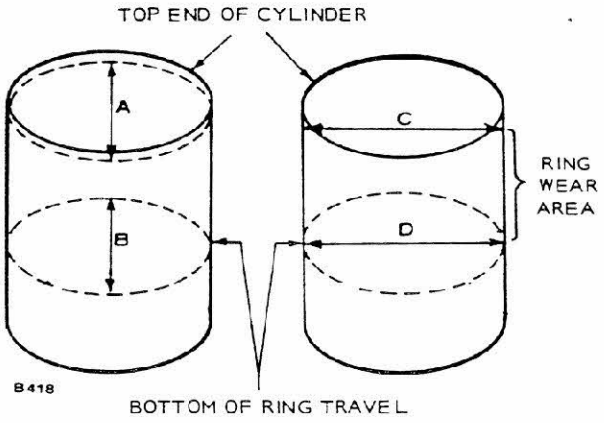


FIGURE 54. CYLINDER BORE MEASUREMENT

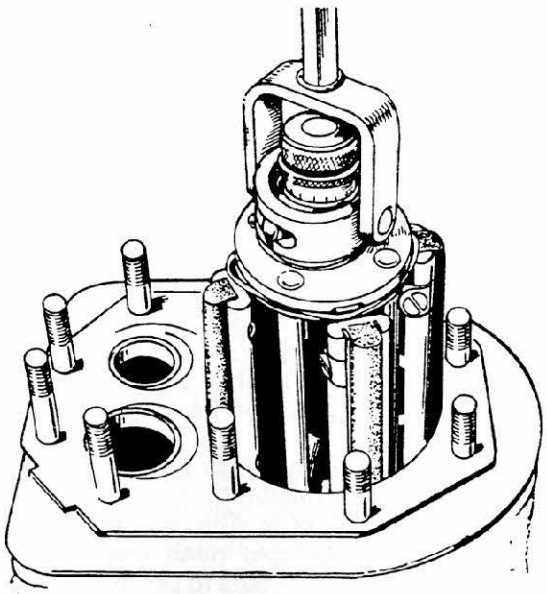


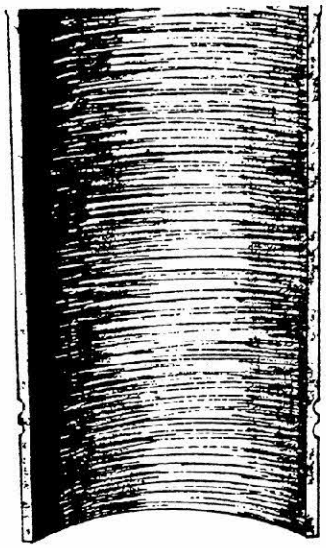
FIGURE 55. HONING CYLINDER

HONING PROCEDURE

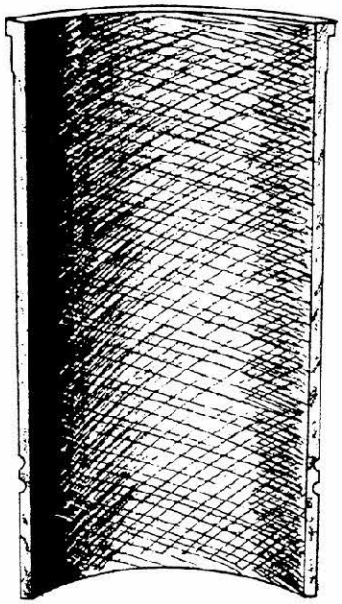
1. A hone can be used to rebore a cylinder, Figure 55. Remove stock to 0.002 inch (0.051 mm) less than finished bore with coarse hone (100 grit), then complete honing with finish hones (300 grit).
2. Anchor block solidly for either vertical or horizontal honing. Use either a drill press or heavy-duty drill which operates at about 250 to 450 rpm.
3. Lower hone into cylinder until it protrudes 1/2 to 3/4 inch (13 to 19 mm) past end of cylinder. Rotate adjusting nut until stones come in contact with cylinder wall at narrowest point.
4. Loosen adjusting nut until hone can be turned by hand.
5. Connect drill to hone and start drill. Move hone up and down in the cylinder about 40 cycles per minute. Usually the bottom of the cylinder must be worked out first because it is smaller. When cylinder takes a uniform diameter, move 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.
6. Check diameter of cylinder regularly during honing. A dial bore gauge is the easiest method but a telescoping gauge can be used. Check the size at six places in the bore; measure twice at the top, middle and bottom at 90 degree angles.
7. When the cylinder is about 0.002 inch (0.051 mm) within the desired bore, change to fine stones and finish the bore. The finish should not be smooth but as shown in Figure 56. 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 cycles per minute.
8. Clean cylinder block thoroughly with soap, water and clean rags. A clean white rag should not be soiled on the wall after cleaning is complete.

CAUTION ***Never use gasoline or commercial cleaners to clean cylinder bores after deglazing or honing. These solvents will not remove abrasives from the walls. Abrasives not removed from engine will rapidly wear rings, cylinder walls, and bearing surfaces of all lubricated parts.***

9. Dry crankcase and coat it with oil.



AVOID THIS FINISH



PRODUCE CROSS HATCH SCRATCHES FOR FAST RING SEATING

FIGURE 56. CORRECT HONE FINISH

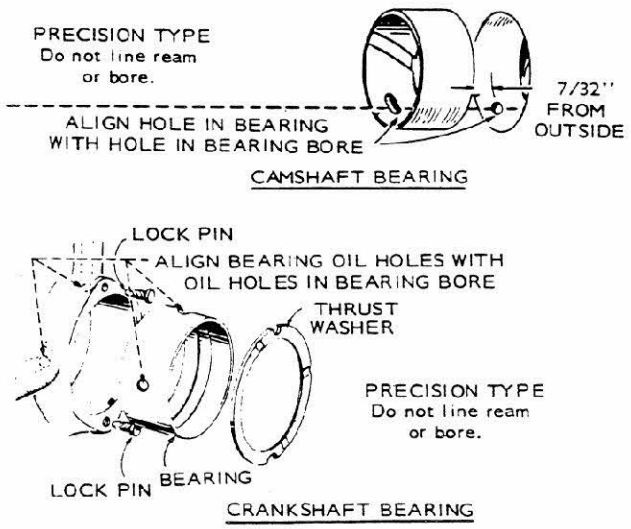


FIGURE 57. INSTALLATION OF CAM AND CRANKSHAFT BEARINGS

BEARINGS

Removal of the camshaft or crankshaft bearings requires complete disassembly of the engine. Use a press or a suitable plug to remove the bearings. Support the casting to avoid distortion and avoid damaging the bearing bore during removal and installation. Use oil on the bearings to reduce friction when installing and again lubricate with oil after installing. See Figure 57. Use combination bearing driver to install the camshaft bearings.

Camshaft

Replacement camshaft bearings are precision type which do not require line reaming or line boring after installation. Coat the bearing with lubricating oil to reduce friction. Place the bearing on the crankcase over the bearing bore with the lubricating hole (front only) in proper position. Be sure to start the bearing straight. Press the front bearing in flush with the outside end of the bearing bore. Press the rear bearing in until past the ignition plunger hole.

Crankshaft

New crankshaft main bearings are precision type which do not require line reaming or line boring after installation. Before putting in the main bearings, expand the bearing bore by placing the casting in hot water or in an oven heated to 200°F (93°C). If practical, cool the precision bearing to shrink it.

For putting in either the front or rear main bearing, using instructions following, always align the oil hole(s) in the bearing bore. The oil passage must be at least half open. The cold oiled precision bearing should require only light taps to position it. Install the bearing flush with the inside end of the bore. If the head of a lock pin is damaged, use side cutters or "Easy-Out" tool to remove pin. Then install a new lock pin. Apply oil to the thrust washers to hold in place when the crankshaft is installed. The oil grooves in the thrust washer bearing must face the crankshaft. Be sure two notches fit over lock pins.

OIL SEALS

The bearing plate must be removed to replace its oil seal. Drive the oil seal out from the inside using a bearing plate driver and gear cover driver. See *Special Tools* section.

Before installing the seals, fill the space between seals with a fibrous grease or stiff cup grease. This will improve sealing. See Figure 58.

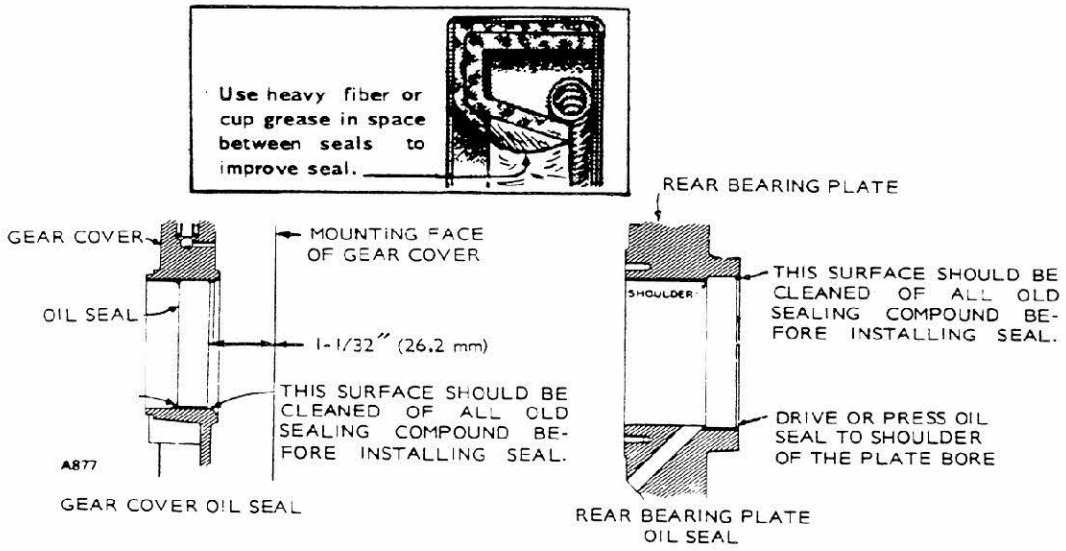


FIGURE 58. GEAR COVER AND REAR BEARING PLATE OIL SEALS

When installing the gear cover oil seal, tap the seal inward until it is 1-1/32 (26.2 mm) of an inch from the mounting face of the cover.

When installing the bearing plate oil seal, tap the seal into the bearing plate bore to bottom against the shoulder in the plate bore. Use a seal expander, or place a piece of shim stock around the end of the crankshaft when replacing the bearing plate to avoid damaging the seal. Remove the shim stock as soon as the plate is in place.

CRANKSHAFT ENDPLAY

After the rear bearing end plate has been tightened using the torque recommended in *ASSEMBLY TORQUES* section, check the crankshaft endplay as shown in Figure 59. If there is too much endplay (see *DIMENSIONS AND CLEARANCES* section for minimum and maximum endplay), remove the rear bearing end plate and replace the gasket with a thinner gasket from the gasket kit. For too little endplay, remove the rear bearing end plate and replace the gasket with a thicker one. Reinstall the end plate making sure the thrust washer notches line up with the lock pins. Torque and recheck endplay of the crankshaft.

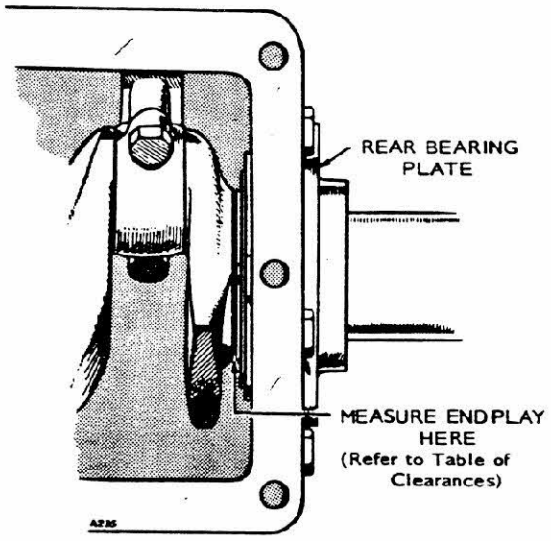


FIGURE 59. MEASURING CRANKSHAFT ENDPLAY

OIL PUMP

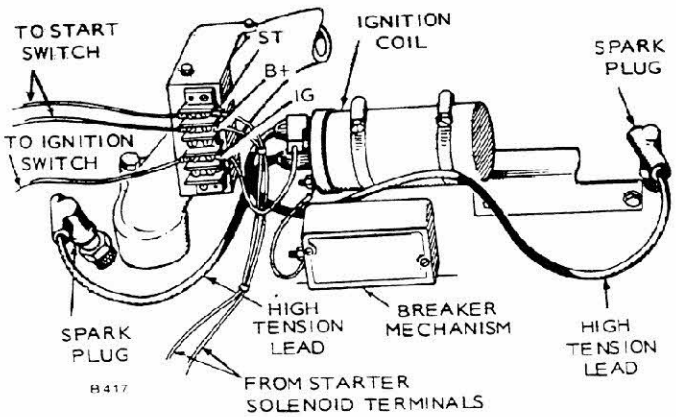
Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for gaskets, the component parts of the pump are not available individually. The suction cup is available separately. Install a new pump assembly, if required.

Wiring Diagram

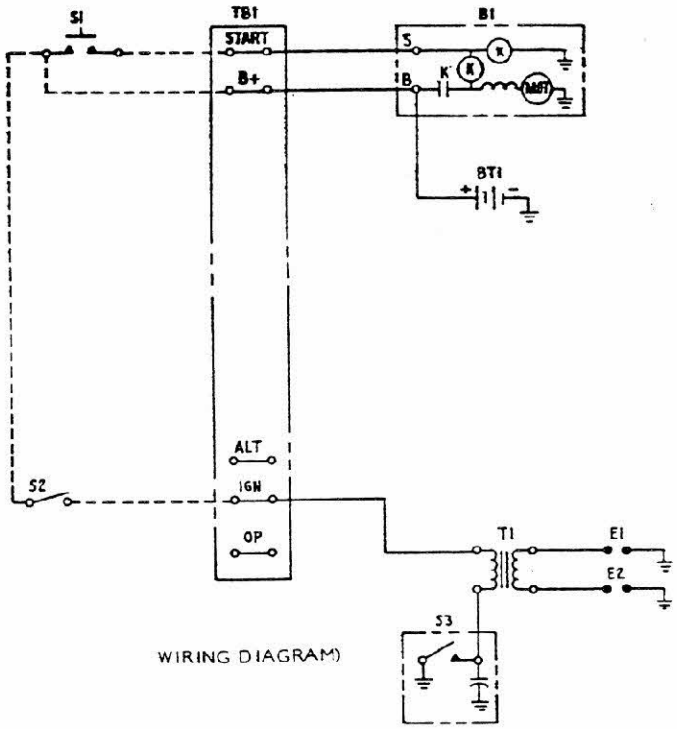
LEGEND

E1, E2 ..... SPARK PLUGS
B1 ..... STARTER
BT1 ..... BATTERY
S1* ..... START SWITCH
S2* ..... IGNITION SWITCH
S3 ..... BREAKER POINTS
T1 ..... IGNITION COIL
TB1 ..... TERMINAL BOARD

* - CUSTOMER SUPPLIED.



BATTERY IGNITION SYSTEM



WIRING DIAGRAM)

Onan

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763-574-5000
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