TOYOTA REPAIR MANUAL

TYPE F ENGINE

TOYOTA MOTOR SALES CO., LTD.

TOYOTA
REPAIR MANUAL
TYPE F ENGINE

CONTENTS

SECTION I

GENERAL DESCRIPTION

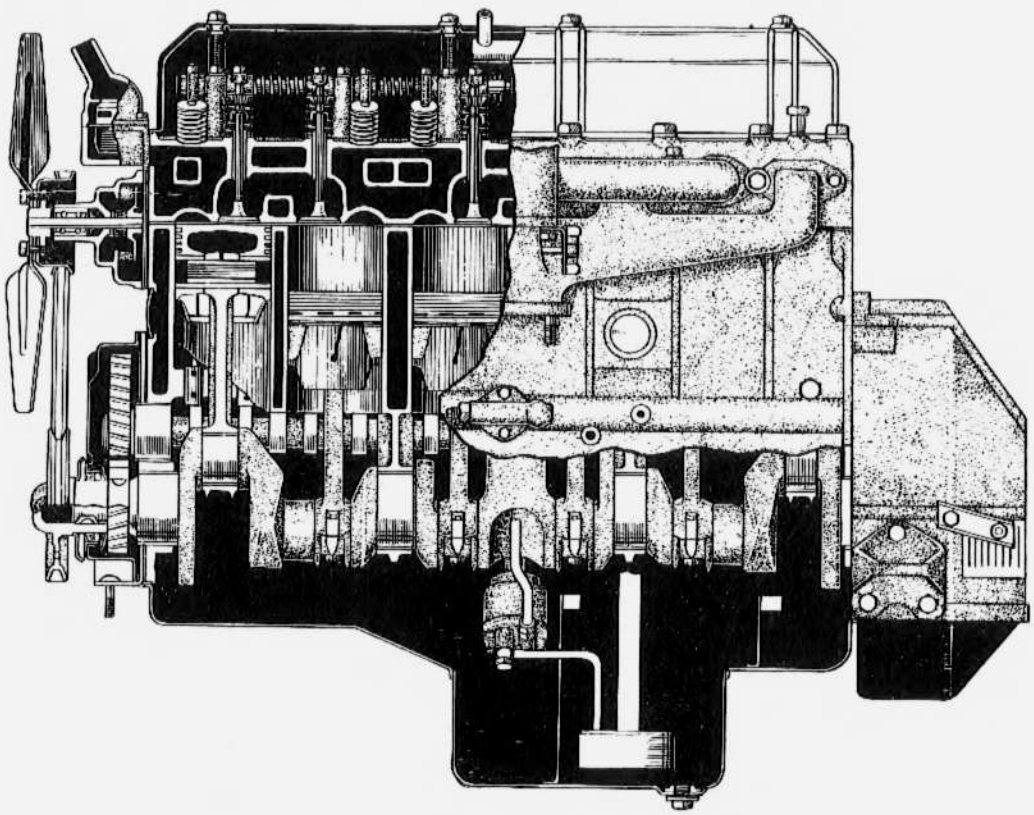

Figure 1—Engine Cross Section

2. GENERAL DESCRIPTION.

The engine (Figs. 1, 2) is a six cylinder over-head-valve type. This engine

has a displacement of 3.878 liters using a 90 mm bore and 101.6 mm stroke. The engine incorporates full pressure lubrication.

The cylinder head assembly as installed on this engine includes the valve guides, valves, valve springs, rocker arm and shaft assemblies, spark plugs, water thermal unit, water outlet, thermostat, thermostat case, exhaust and intake manifolds and other assembling parts. The carburetor and air cleaner assembly bolts to the top of the manifold and the rocker arm cover attaches to the top of the head to enclose the valve mechanism.

The cylinder block and crankcase assembly is the major section of the engine as it is fitted with the camshaft, crankshaft, crankcase front end plate, timing gear cover, crankshaft and camshaft gears, pistons, piston rings, piston pins, connecting rods and miscellaneous parts.

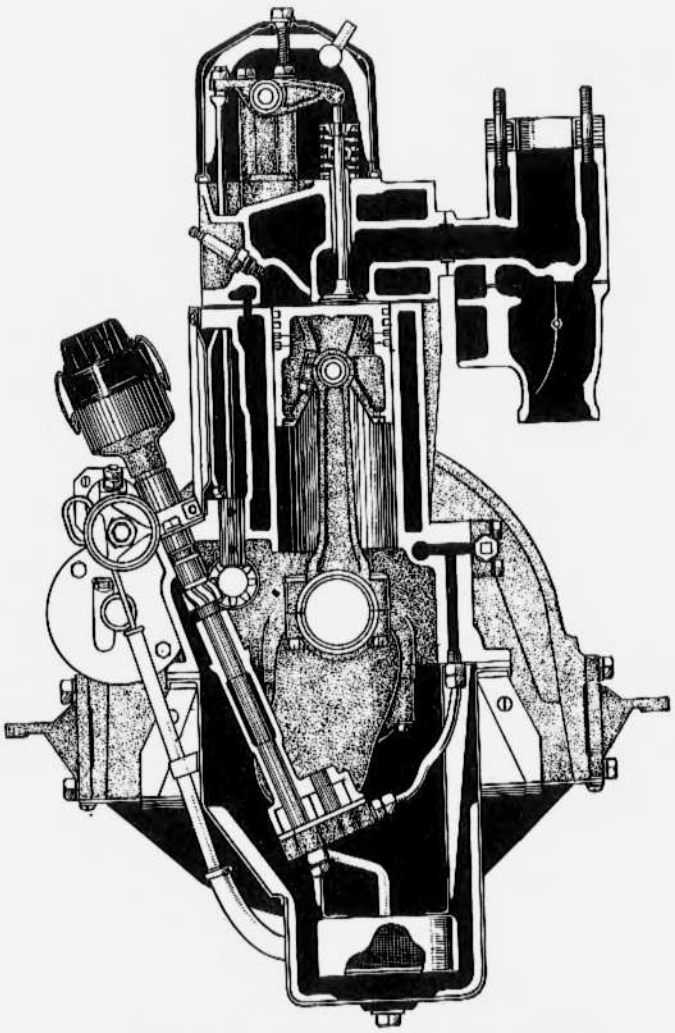

Figure 2—Engine Cross Section

In addition to the above parts which are part of a cylinder block assembly, the following units are attached to this assembly when in the vehicle– water pump, oil pump, distributor, starter motor, generator, flywheel, clutch, clutch housing, fuel pump and other miscellaneous parts. A "V" type fan belt operating from a crankshaft pulley on the front of the crankshaft drives the generator, water pump and fan.

The distributor, mounted on the right side of the engine, is gear driven from the camshaft. The oil pump connects to the lower end of the distributor shaft and is driven at distributor speed. The fuel pump mounts on the right side of the engine and is operated by special cam on the camshaft.

Piston of special light alloy (Low–Ex) is of slipper type and cam ground to provide slightly greater diameter at right angles to the piston pin. Piston has four piston ring grooves over piston pin boss. Piston pin of this piston is offset 1.5 mm toward camshaft side which contributes to smooth engine operation. Two compression rings and two oil rings are used in each piston.

Four camshaft bearings are steel backed and babbitt lined providing uniform expansion and long life. The bearings are installed in the cylinder block and finish bored for perfect alignment.

Four crankshaft main bearings are steel backed babbitt type with the NO. 3 main bearing serving as the thrust bearing.

The crankshaft has four unusually large bearing journals and is heavily counterbalanced which contributes to smooth engine performance.

The four bearing camshaft is designed to provide accurate, quiet valve action and hold the valves open long enough to provide complete discharge of the exhaust gases and allow a full charge of fuel mixture. The cams have a wear resisting treatment, which combined with lifters, provide unusually long life and quiet operation.

Connecting rods are of drop forged steel "I" beam construction for rigidity. The upper end is fitted with a clamp bolt for securely attaching the rod to the piston pin. Connecting rod bearings are precision interchangeable insert type and are of the thin wall babbitt type. Thickness of babbitt is 0.15 mm.

On engine a heavy cast iron flywheel bolts to the flange at the rear end of the crankshaft and a steel ring gear is shrunk on the outer diameter of the flywheel, the starter motor drive pinion engages this ring gear when cranking the engine. Flywheel and crankshaft are accurately balanced to prevent engine vibration and the rear flywheel face is accurately machined for clutch mounting.

The cylinder head is constructed as to size and shape of the combustion chambers, location and size of the valves, shape and size of the intake and exhaust ports, location of spark plugs, size and shape of the water passages. The combustion chambers provide for the 7.2 to 1 compression ratio and for different valve positions. The intake and exhaust valve ports and passages are larger permitting freer intake of fuel mixture and expulsion of exhaust gases.

Intake and exhaust valve are both made of heat resistant steel. The head of exhaust valve is made of heat resistant steel comprising a considerable

amount of nickle by which the life of exhaust valve can be greatly prolonged.

The intake manifold used on engine is a "D" shape cross section which results in good atomizing and even distribution of the fuel mixture to each of the six cylinders.

The exhaust manifold is designed to reduce back pressure to a minimum. Located on the inside of the exhaust manifold is the thermostatically operated heat control valve.

This valve in the exhaust manifold directs the hot exhaust gases against the center of the intake manifold when the engine is cold as shown at the left of Figure 3. As the engine warms up, the heat control valve coil closes the valve and directs the exhaust gases away from the intake manifold as shown at the right of Figure 3. This thermostatic control results in the proper temperature of the incoming gases under all operating conditions.

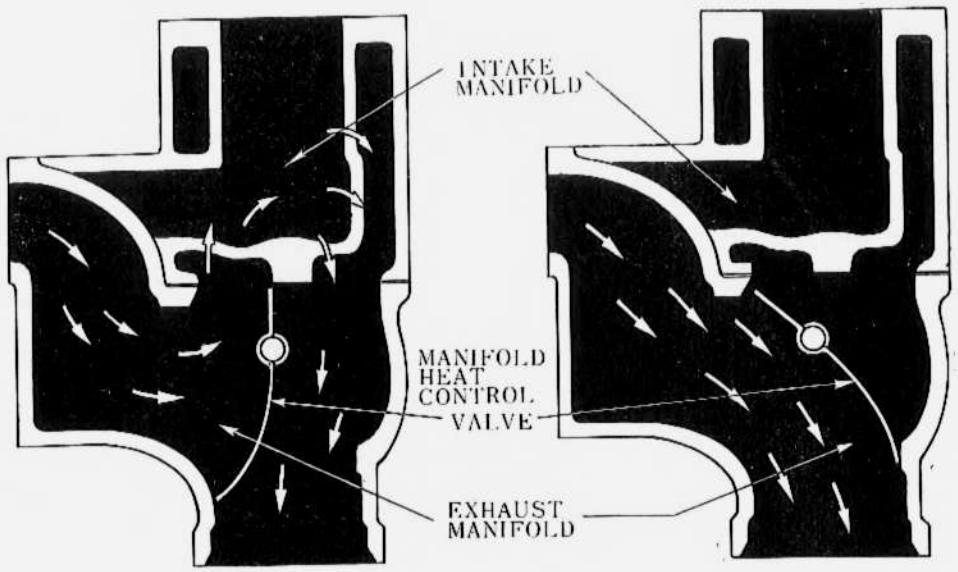

Figure 3—Manifold Heat Riser and Heat Control Valve

The tension of heat control valve coil is very important. When too tight, the heat will not be turned off the intake heat riser as the engine warms up, with the result that the incoming gases will be expanded several times greater than normal and it will be impossible to get a normal fuel charge into the cylinders. This condition will reduce power and maximum speed and cause detonation as well as sticking valves. Therefore, it is important that the heat control valve coil be wound up just enough to slip its outer end over the dowel pin (Fig. 4) in the manifold and no more. This is approximately ½ turn of the coil from its position when unhooked.

Sometimes the heat control valve shaft becomes frozen in the manifold;

when this condition occurs the valve may stick in either the "heat on" or "heat off" position.

If it sticks in the "heat on" position, it will result in poor engine performance, overheating and detonation. On the other hand, if it should stick in the "heat off" position the heat will be turned off the intake heat riser at all times and result in poor performance, particularly while the engine is warming up and driving at lower speeds.

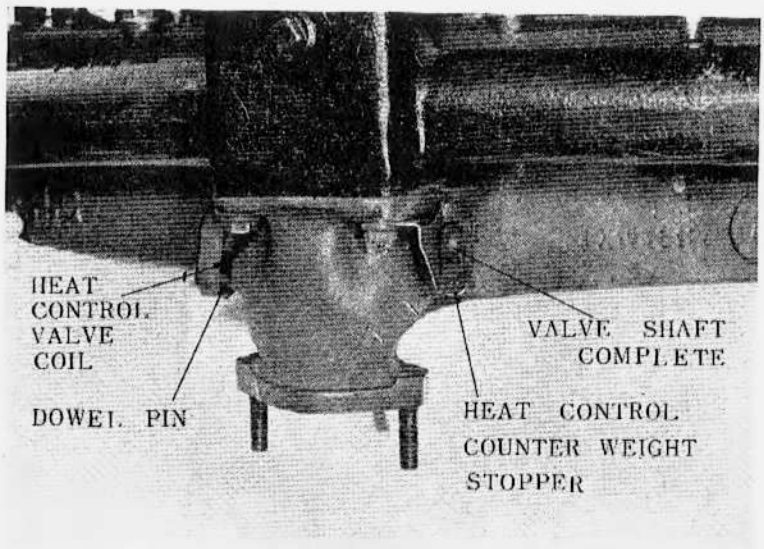

Figure 4 - Manifold Heat Control Valve Coil

On all engine tune-up jobs and also on complaints of poor performance, overheating and detonation the operation and adjustment of the manifold heat control valve should be closely checked and any necessary corrections made.

The lubricating method on this engine is an all force feed type insuring positive lubrication (Fig. 5). The high pressure oil discharged from the oil pump is divided into two parts, one part entering the oil hole in the cylinder while the other parts after passing through the oil distributor, flows through the oil cleaner where it is cleaned and returns to the oil pan. The oil stream entering the oil hole lubricates the main bearings and is again divided into two parts, one part lubricating the camshaft bearings. The other part passes through the crankshaft holes and lubricates the connecting rod bearings and in addition lubricates the pistons and cylinders through the holes in the connecting rods. The oil stream lubricating the camshaft bearings is again divided, the part lubricating the second bearing after passing through a pipe passes through the rocker shaft and lubricates the push rods and lifters. The part lubricating the front bearing on the camshaft passes through the oil passage in the front end plate gasket is discharged through the timing gear oil nozzle and lubricates the timing gear.

The oil pressure in the lubricating system is maintained within the spe-

cified pressure of 3 kg/cm² by means of a safety valve in the oil distributor. When the pressure rises above this value, the oil is by-passed to the oil pan to reduce the pressure.

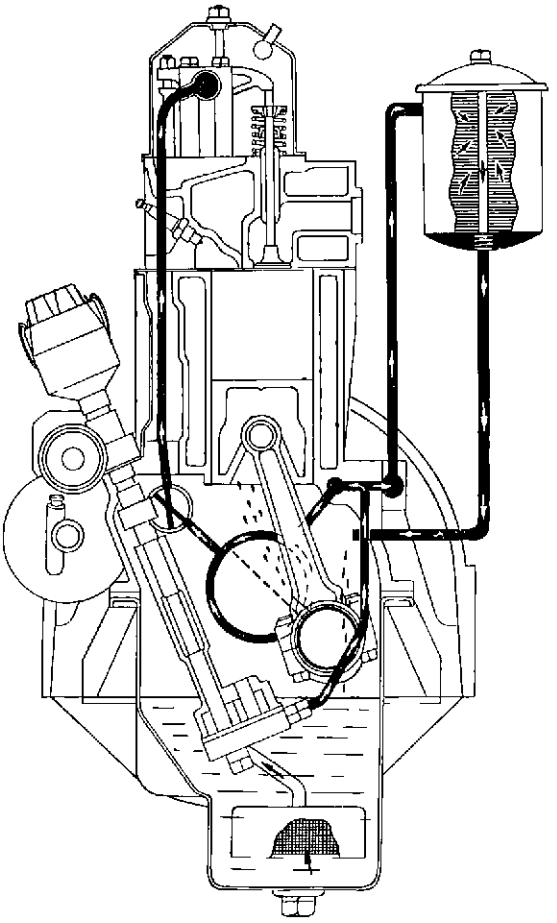

Figure 5—Lubricating System

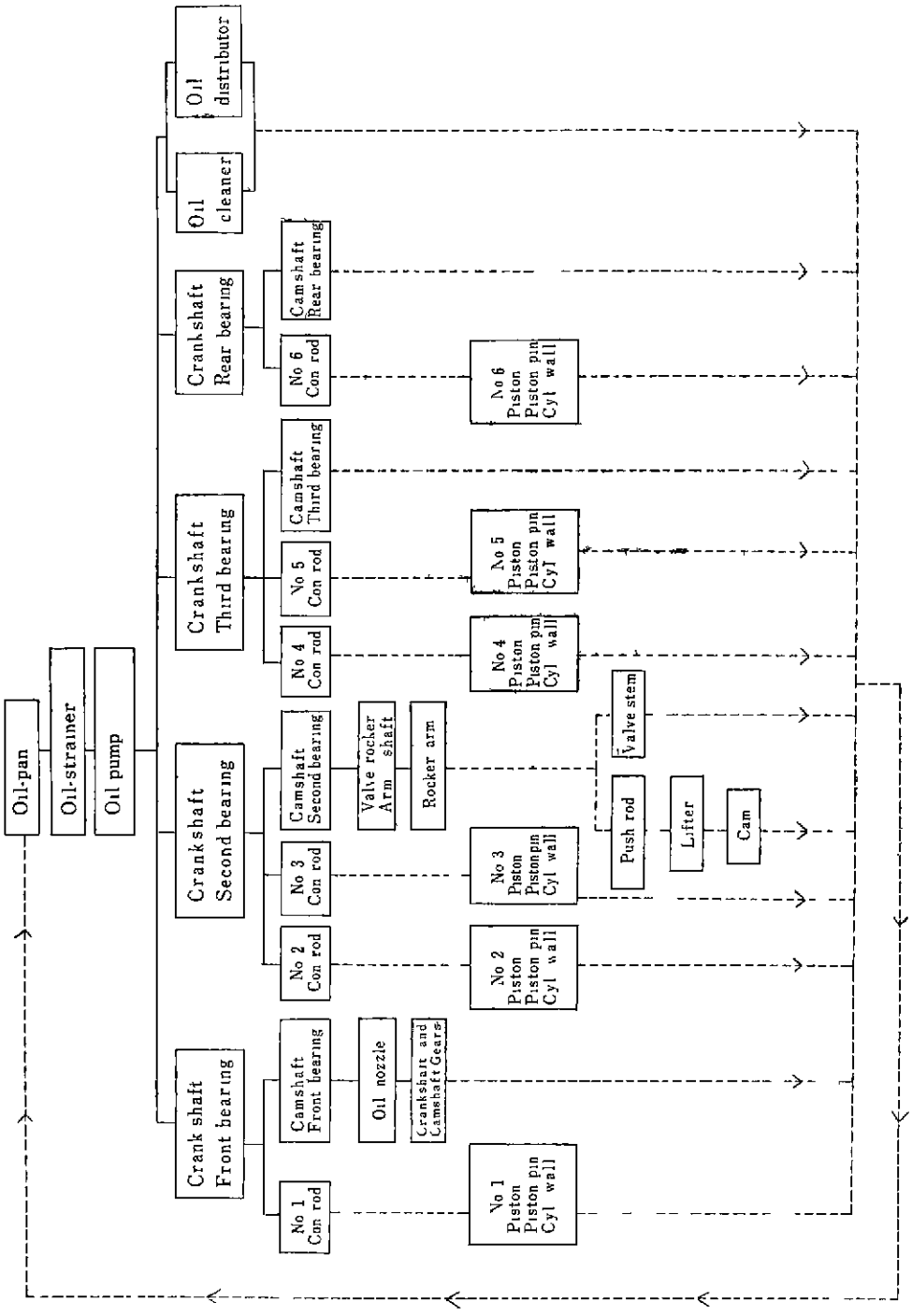

Figure 6 – Lubricating System

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SECTION II

MINOR SERVICE OPERATIONS

3. VALVE TIMING.

Valve timing diagram (Fig. 7) is applicable to this engine. Note that the

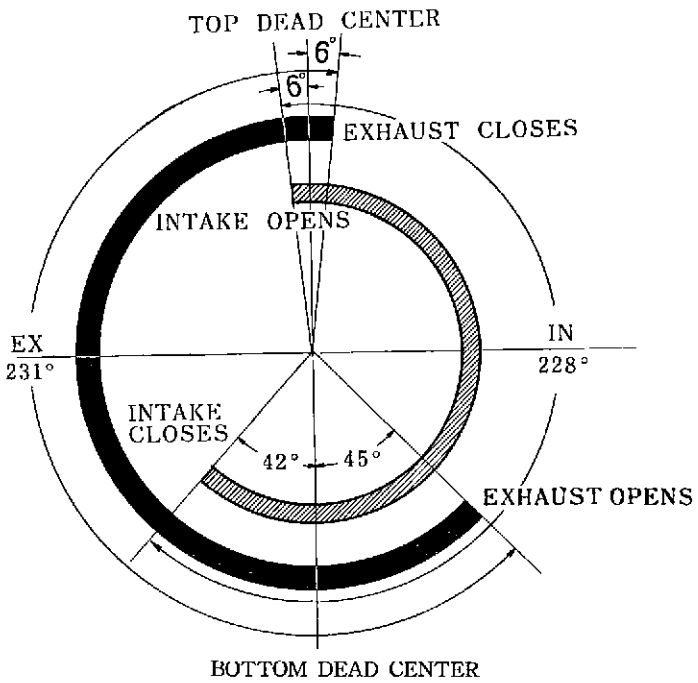


Figure 7 Valve Timing on this Engine

intake valve starts to open 6 degrees before the top dead center and remains open for 228 degrees, closing 42 degrees past the bottom dead center.

The exhaust valve starts to open 45 degrees before the bottom dead center and remains open for 231 degrees, closing 6 degrees past the top dead center.

The reasons for advancing and retarding the opening and closing of the valves are as follows.

By advancing the opening of the intake valve and retarding its closing, a larger amount of mixed gas can be sucked into the cylinders so that it increases the generated power. In making the intake valve to open 6 degrees before the top dead center while the exhaust valve is still open, the speed of the flow of exhaust gas is utilized so that the mixed gas is not only drawn into the cylinder, but is also pushed in by the pressure of the intake gas in the manifold.

Thus, opening the intake valve before the piston reaches the top dead center enables the engine to suck the mixed gas effectively into the cylinders even at very high speeds.

On the other hand, the closer the piston comes to the bottom dead center, the faster the mixed gas is sucked in. To utilize this inertia to the fullest extent, that is, until the inertia speed is almost zero, the intake valve is not closed until it is 42 degrees past the bottom dead center enabling a larger amount of gas to be sucked in.

In this manner, as much mixed gas as possible is sucked in, and through raising intake efficiency, the generated power is increased.

On the exhaust valves, the reason for opening them 45 degrees before the bottom dead center is, if the combustion gas is allowed to expand all of the way down to the bottom dead center, not only will the piston and cylinder get badly overheated, but in the following exhaust stroke there will be difficulty in driving out the burned gas so a back pressure will be created on the piston and decrease the generated power. Thus, advancing the opening of the exhaust valve will prevent overheating of the engine and facilitate the exhausting by utilizing the self expansion of gas.

Also, the reason for closing the exhaust valve 6 degrees after the top dead center is to clear out burned gas from the cylinder as completely as possible and to aid the suction of the newly mixed gas from the intake valve which opens 6 degrees before the top dead center.

From the above reasons, the opening and closing of the valves bear a great effect on the power output, fuel consumption and life of the engine so that the operator and maintenance personnel should have a thorough understanding of the valve principles, together with valve timing which controls valve openings.

4. VALVE ADJUSTMENT.

On engine before adjusting the valve stem to rocker arm clearance, it is extremely important that the engine be thoroughly warmed up to normalize

the expansion of all parts. This is very important because during the warm-up period, the valve clearances will change considerably. To adjust the valves during or before this warm-up period will produce clearances which will be far from correct after the engine reaches normal operating temperature.

Tests have shown that valve clearances will vary as much as 0.13mm from a cold check through the normalizing range; consequently the engine should be run approximately 30 minutes to properly normalize all parts.

Covering the radiator will not materially hasten this normalizing process because even with the water temperature quickly raised to 85°C it does not change the rate at which the oil temperature increases or the engine parts become normalized.

The actual temperature of the oil is not as important as stabilizing the oil temperature. The expansion or contraction of the valves, rocker shaft supports, push rods, cylinder head and cylinder block are relative to this oil temperature.

Therefore, only after the oil temperature is stabilized, do these parts stop expanding and valve clearance changes cease to take place.

(1) Disconnect ventilating rubber hose at rocker arm cover, and disconnect bond strap at each side of rocker arm cover, and then remove rocker arm cover attaching nuts and cover and gasket.

(2) Run engine at fast idle (approximately 600 rpm) and check oil temperature with a thermometer (**at least 70°C**).

(3) Tighten all manifold bolts, valve rocker shaft support bolts and cylinder head bolts.

Cylinder head bolt	85~95 ft-lbs
Valve rocker shaft support bolt	30~45 ft-lbs
Manifold bolt	25~40 ft-lbs

(4) Lubricate valve stems with engine oil to insure free movement of

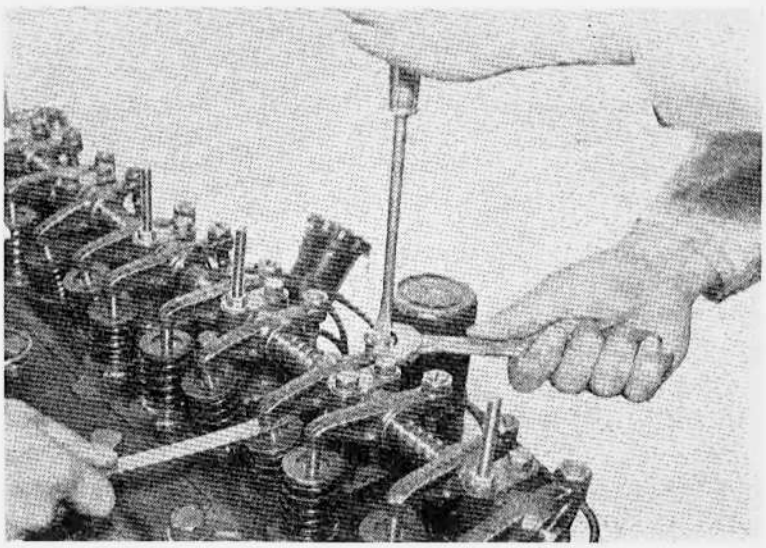


Figure 8 Valve Adjustment

valves in their guides.

(5) Adjust valve clearance hot as follows (Fig. 8).

Intake	0.010″ (0.254mm)
Exhaust	0.014″ (0.356mm)

(6) Install rocker arm cover using a new gasket, tighten nuts to 5 ft-lbs torque maximum and check for oil leaks. Connect ventilating rubber hose at rocker arm cover, and connect bond strap at each side of rocker arm cover.

5. CYLINDER HEAD AND VALVE CONDITIONING.

The condition of the cylinder head and valve mechanism, more than anything else, determines the power, performance and economy of a over-head-valve engine. Extreme care should be exercised when conditioning the cylinder head and valves to maintain correct valve stem to guide clearance, correctly ground valves, valve seats of correct width and correct valve adjustment.

a. Removal and Disassembly.

(1) Drain radiator, raise engine hood. Remove ventilating rubber hose from air cleaner cap to rocker arm cover, and loosen air cleaner clamp and remove air cleaner. Disconnect throttle and choke rods at carburetor.

(2) Remove cotter pin at lower end of accelerator link and disconnect link from accelerator link arm stopper.

(3) Disconnect gas and vacuum lines from carburetor.

(4) Disconnect fuel and vacuum pipe support clamp at water outlet. Remove gas and vacuum lines from fuel pump and vacuum controller respectively.

(5) Remove bolts and clamps that attach manifold assembly to cylinder head and pull manifold assembly off the manifold dowel pins. Remove intake manifold side collars and gaskets.

(6) Disconnect radiator inlet hose and bypass hose from thermostat case.

(7) Disconnect bond strap at each side of rocker arm cover. Remove rocker arm cover attaching nuts and remove cover and gasket.

(8) Disconnect spark plug wires at their respective terminals and remove all spark plugs.

(9) Disconnect primary lead at coil, remove coil attaching bolts and remove coil from cylinder head.

(10) Remove lifter cover attaching bolts and remove cover and gasket.

(11) Remove water thermal unit from cylinder head.

(12) Disconnect oil delivery pipe from rocker shaft oil delivery union. Remove oil connect sleeve, spring and delivery union from open ends of two rocker shafts.

(13) Remove four bolts and two nuts which retain rocker shaft assembly to cylinder head and remove one rocker shaft assembly. Remove other assembly with similar manner.

(14) Remove twelve push rods and twelve valve lifters.

NOTE: Valve lifters and push rods should be placed in a rack in their sequence so they may be reinstalled in the same positions in the cylinder block at assembly.

(15) Disconnect oil delivery pipe from union bolt of block. Remove oil delivery pipe.

(16) Remove the cylinder head bolts, and then remove air cleaner bracket, two bond straps, cylinder head and gasket.

(17) Place cylinder head assembly on its side on a bench then, using valve lifter tool compress valve spring and remove cap stopper, valve stem oil seal, spring cap and spring. Repeat this operation on each valve (Fig. 9).

(18) Remove valves from cylinder head and keep them in their proper sequence for inspection and reassembly.

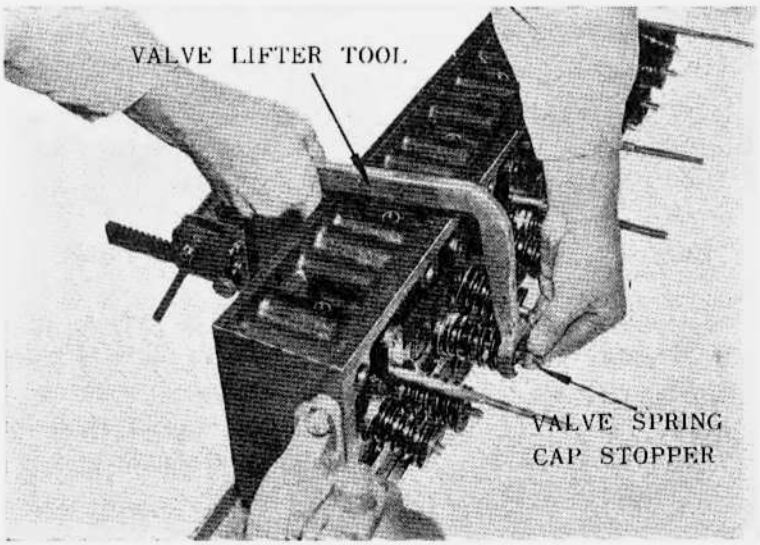


Figure 9—Valve Lifter Tool

b. Cleaning.

(1) Clean all carbon from combustion chambers and valve ports using carbon removing brush, etc.

(2) Thoroughly clean the valve guides, using valve guide cleaner.

(3) Clean all carbon from push rods and valve lifters.

(4) Clean valve stems and heads on a buffing wheel.

(5) Clean carbon deposits from pistons and cylinders.

(6) Wash all parts in cleaning solvent and dry them thoroughly.

c. Inspection.

(1) Inspect the cylinder head for cracks in the exhaust ports, combustion chambers.

(2) Inspect the valves for burned heads, cracked faces or damaged stems.

(3) Check fit of valve stems in their respective guides (Fig. 10). Lift up the valve 10 mm above the cylinder head and then attach dial gage to valve head.

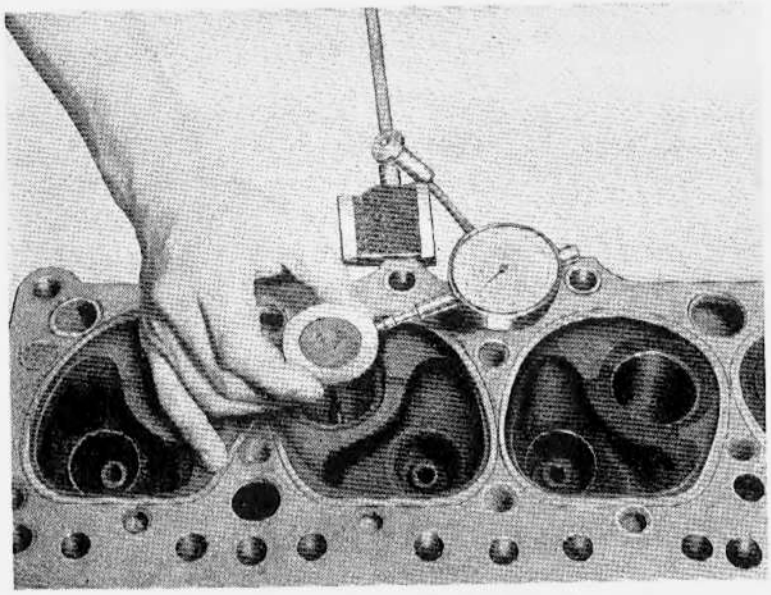


Figure 10 – Checking Valve to Guide Clearance

NOTE: Excessive valve to guide clearance will cause lack of power, rough idling and noisy valves. Insufficient clearance will result in noisy and sticky functioning of the valve and disturb engine smoothness of operation. Intake valve stem to guide clearance should be 0.025~0.042 mm while exhaust stem clearance should be 0.040~0.060 mm. By trying new valves in the old guides it can be determined whether the valves or guides or both should be replaced.

(4) Check valve spring tension with spring tester (Fig. 11).

Free Length	52.3 mm
Kg, Pressure at 43.4mm (In)	2.46~2.86 kg
Kg, Pressure at 43.6mm (Ex)	2.39~2.79 kg

(5) Check valve lifters for free fit in block. The end that contacts the camshaft should be smooth. If this surface is worn or rough the lifter should be replaced.

(6) Check push rods for bent condition.

d. Repairs.

(1) Replace Valve Guides.

(a) Place the cylinder head on the table of an arbor press and press the old valve guides out using valve guide tool (BX SST-1003) (Fig. 12).

(b) Press new exhaust (short) guides into the cylinder head using valve guide tool (BX SST-1003) (Fig. 13).

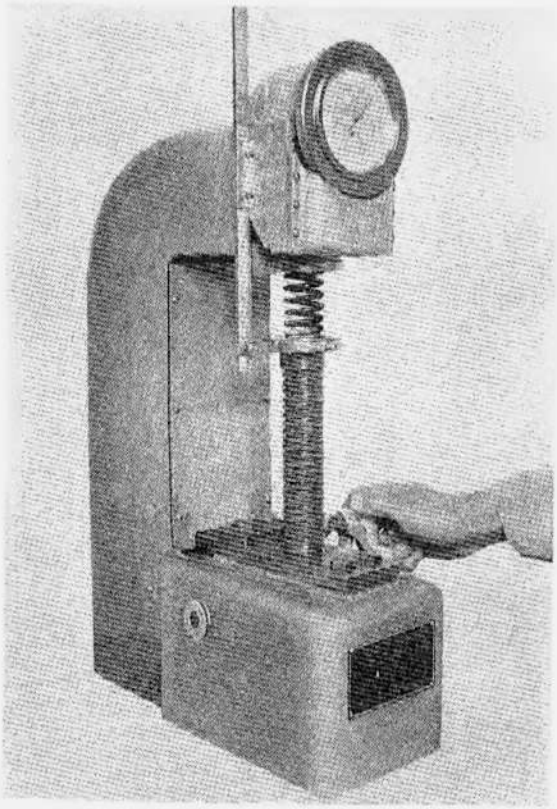


Figure 11 – Checking Valve Spring Tension

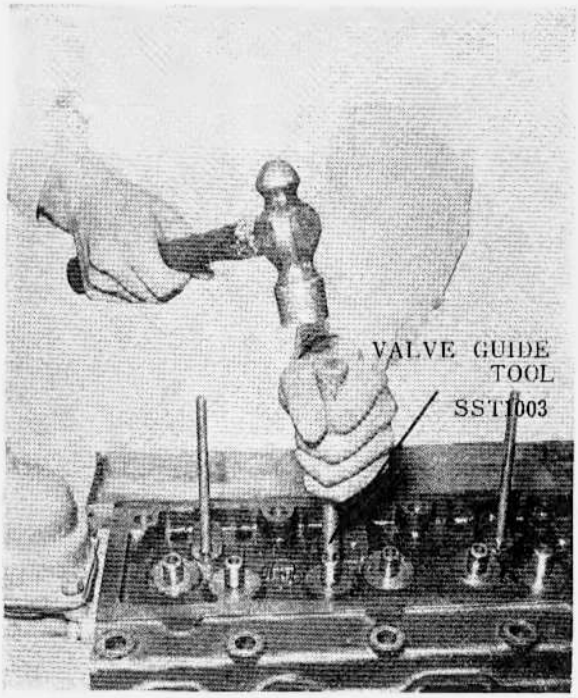


Figure 12 – Removing Valve Guide

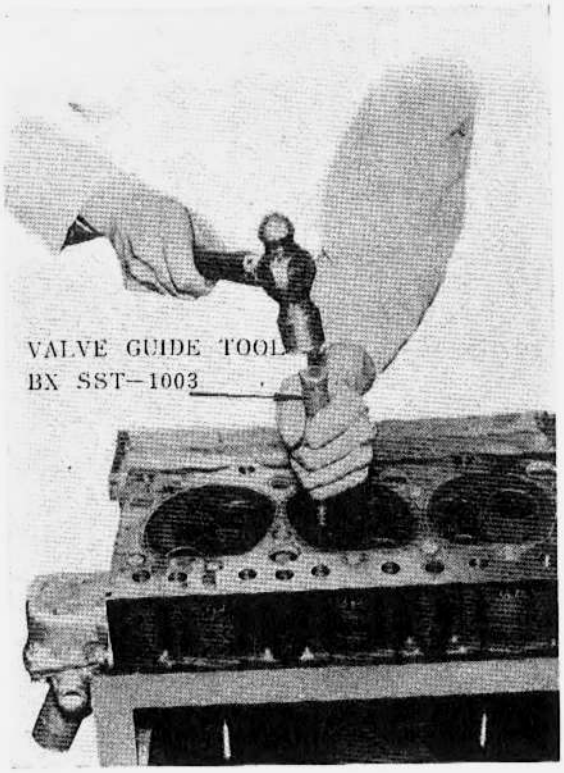
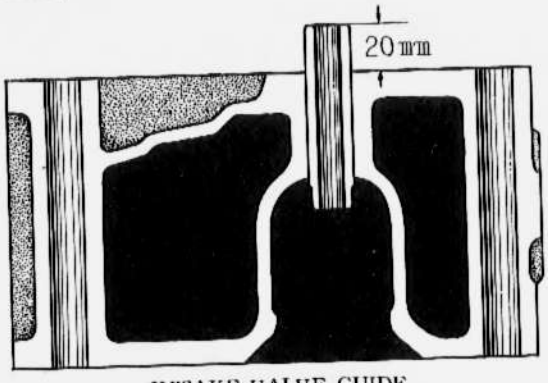
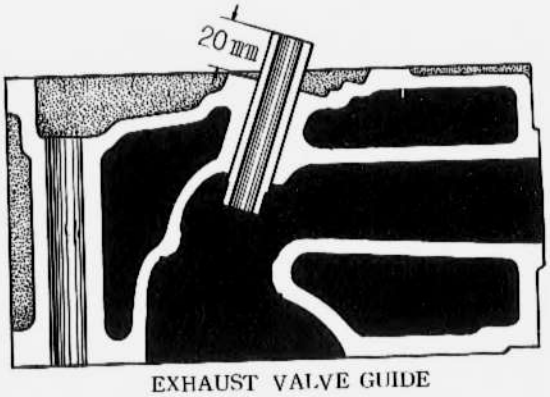


Figure 13 – Replacing Valve Guides



INTAKE VALVE GUIDE



EXHAUST VALVE GUIDE

Figure 14 – Valve Guides

(c) Press new intake (long) guide into the cylinder head using valve guide tool (BX SST-1003) (Fig. 13).

(d) The exhaust guides are installed in the head so they will extend 20 mm above the head and the intake guides extend 20 mm above the head (Fig. 14).

(e) Finish ream all guides with hand reamer.

(2) Reseating Valve Seats.

Reconditioning the valve seats is very important, because the seating of valves must be perfect for the engine to deliver the power and performance built into it.

Another important factor is the cooling of the valve heads. Good contact between each valve and its seat in the head is imperative to insure that the heat in the valve head will be properly carried away.

Several different types of equipment are available for reseating valve seats; the recommendations of the manufacturer of the equipment being used should be carefully followed to attain proper results.

Valve seat reamer set (Fig. 15) contains all necessary valve seat reconditioning equipment necessary for proper renewing of valve seats. Regardless

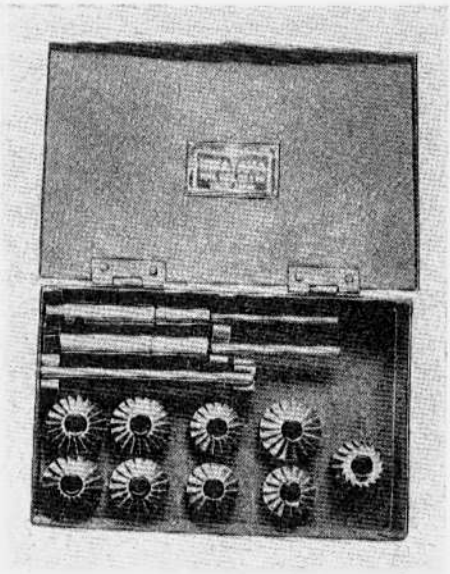


Figure 15 Valve Seat Reamer Set

of what type of equipment is used, however, it is essential that valve guides are free from carbon or dirt to insure proper centering of pilot in the guide.

The valve seat angle is 45° for both the intake and exhaust valves. The valve seat reamer is used to reface the valve seat, three different reamers, 15°, 45° and 75° being required.

(a) The valve seat angle is 45° and seat width is from 1.2 mm to 1.4 mm. If this seat width exceeds 1.4 mm, correct to proper width by cutting down the bottom part 15° and upper part 75° such that proper valve contact is still retained.

(b) After correction, the valve should contact the valve seat exactly at the center. To check this, place a thin coating of red lead on the valve seat and insert the valve in place. If the valve is found to be seating too high, lower by using 75° cutter. Conversely, if too low, raise by using 15° cutter.

(c) After correcting valves and valve seats, it is recommended that they be lapped lightly together.

NOTE: Procedures for Using Valve Seat Reamer (Fig. 16).

1. Using 15° reamer, ream seat face roughly to size.

2. Using 75° reamer, ream seat face to leave seat face approximately to size.

3. Using 45° reamer, ream seat to correct size. Ream lightly to leave allowance for lapping.

4. Finish by lapping seat to proper width of 1.2~1.4 mm.

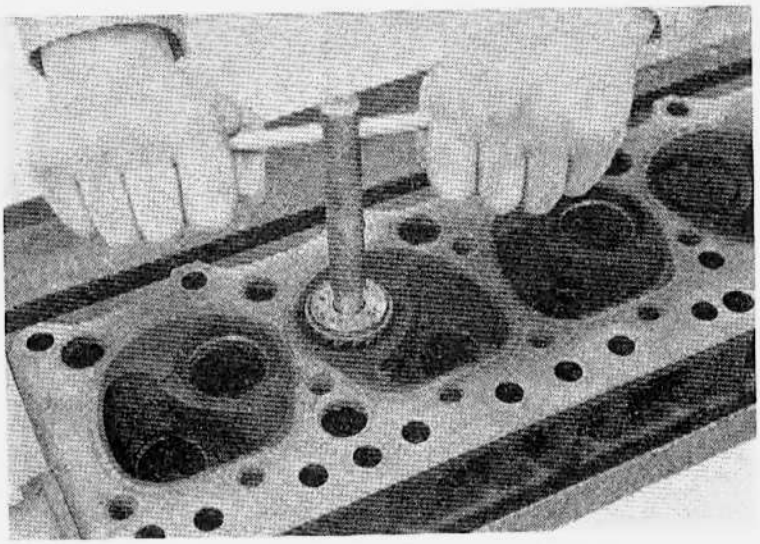


Figure 16 – Valve Seat Refacing

CAUTION: If the valve seat appears to have been refaced previously, check the depth of valve seat after refacing using a steel straightedge and scale (Fig. 17). If the depth measured exceeds 2.0 mm, install valve insert or else replace cylinder head.

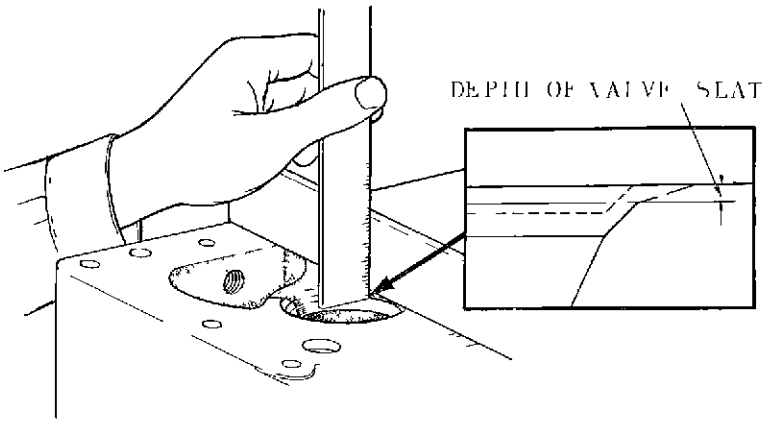


Figure 17 Depth of Valve Seat

(3) Valve Insert.

If after several valve reseating operations, the valve seat depth becomes lower than 2.0 mm, the valve insert is installed in the cylinder head to reclaim the cylinder head for further service. The general procedure for installing valve insert is as follows:

(a) As the valve insert must be in perfect alignment with the valve stem guide, first inspect valve stem guide for wear as previously outlined. If worn beyond the limit specified, replace with new valve guides before attempting to install valve insert.

(b) Bore cylinder head for valve insert with end milling machine or other suitable equipment making sure that bore is centered accurately with valve stem guide. Valve insert bore should be made 0.15 0.20 mm larger than the O.D. of insert.

(c) Cool valve insert in a mixture of dry ice and acetone for about ten minutes before installing.

(d) Heat cylinder head uniformally to about 150°C.

(e) Blow out valve seat bore with compressed air to clean before installing insert, then tap the insert properly into position, performing these operations as rapidly as possible.

(4) Refacing Valves.

Valves that are pitted can be refaced to the proper angle, insuring correct relation between the head and stem on a valve refacing machine. Valve stems which show excessive wear, or valves that are warped excessively should be replaced. When a valve head which is warped excessively is refaced, a knife edge will be ground on part or all of the valve head due to the amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or pre-ignition due to heat localizing on this knife edge.

If the edge of the valve head is less than 0.8 mm on the intake valves and 1.0mm on the exhaust valves after grinding, the valve should be replaced (Fig. 18).

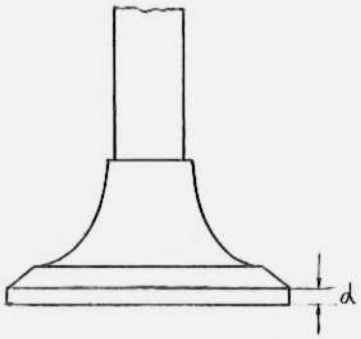


Figure 18 – The Edge of the Valve Head

(a) If necessary, dress the valve refacing machine grinding wheel to make sure it is smooth and true. Set the chuck at the 45° mark for grinding 45° valve seats for both intake and exhaust valves (Fig. 19).

(b) Clamp the valve stem in the chuck of the machine.

(c) Start the grinder and move the valve head out in line with the grinder wheel by moving the lever to the left.

(d) Turn the feed screw until the valve head just contacts wheel. Move

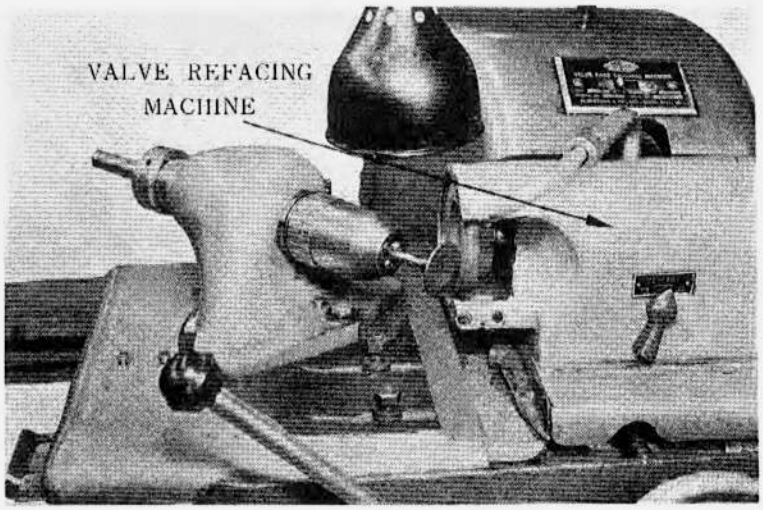


Figure 19 – Refacing Valve Head

valve back and forth across the wheel and regulate the feed screw to provide light valve contact.

(e) Continue grinding until the valve face is true and smooth all around valve. If this makes the valve head thin the valve must be replaced as the valve will overheat and burn.

(f) Remove valve from chuck and place stem in "V" block. Feed valve squarely against grinding wheel to grind any pit from rocker arm end of stem (Fig. 20).

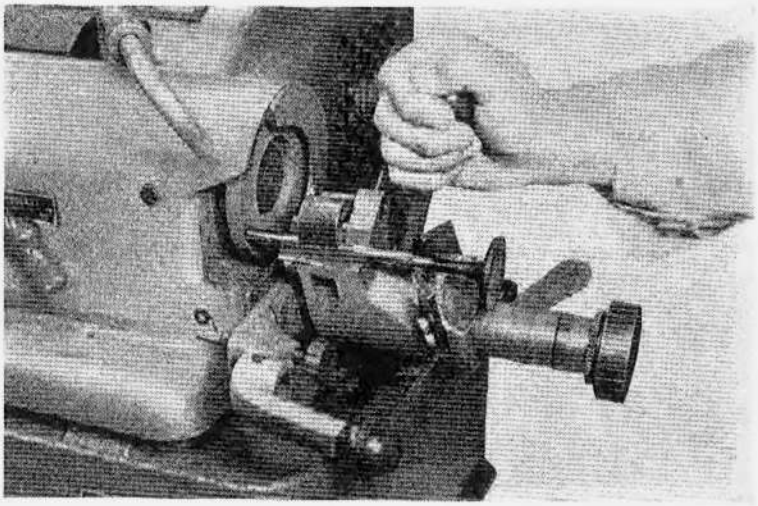


Figure 20 – Refacing Valve Stem

NOTE: Only the extreme end of the valve stem is hardened to resist wear. Do not grind end of stem excessively.

(g) Make pencil marks about 6 mm apart across the valve face, place the valve in cylinder head and give the valve 1/2 turn in each direction while exerting firm pressure on face of valve (Fig. 21).

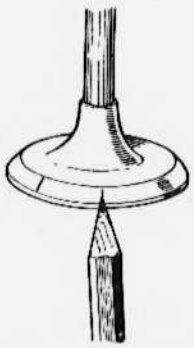


Figure 21 – Making Pencil Marks across the Valve Face

(h) Remove valve and check face carefully. If all pencil marks have not been removed at the point of contact with the valve seat, it will be necessary to repeat the refacing operation, and again recheck for proper seating.

(i) Grind and check the remaining valves in the same manner.

(5) Rocker Arms and Shafts.

Sludge and gum formation in the rocker shafts and rocker arms will restrict the normal flow of oil to the rocker arms and valves. Each time the rocker arm and shaft assemblies are removed they should be disassembled and thoroughly cleaned.

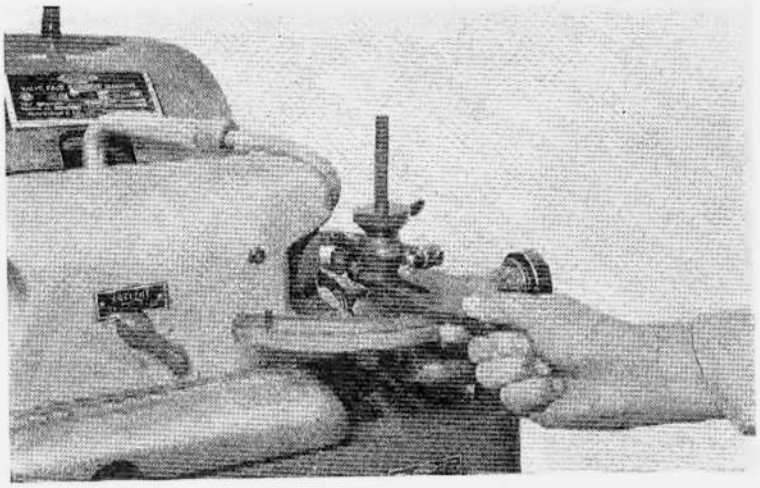


Figure 22 – Refacing the Valve End of Rocker Arms

(a) Remove the rocker shaft lock springs and disassemble rocker arm parts.
(b) Clean all sludge or gum formation from the inside and outside of the shafts.
(c) Clean oil holes and passages in the shafts and rocker arms.
(d) Clean oil connect sleeve, spring and oil delivery union.
(e) Inspect the shafts for wear. Check the fit of rocker arms on the shafts and check the valve end of rocker arms for excessive wear. Replace all worn parts.

NOTE: The valve end of rocker arm can be corrected to a certain degree by using the valve refacing machine (Fig. 22).

(f) The proper location of the rocker arms according to number are as follows:

Type Rocker Arm	Part Number	For Cylinder No.
L.H Intake	F 14605	2-4-6 Intake
R.H Intake	F 14604	1-3-5 Intake
Exhaust	F 14606	Exhaust

(g) One end of each rocker shaft is plugged; the open end of each shaft must be toward the center when assembled. (The oil delivery union, connect sleeve and spring are assembled between the two rocker shafts).
(h) Install the rocker arms, springs, supports, support bolts and lock springs in their correct position by referring to the above chart and Figure 23.

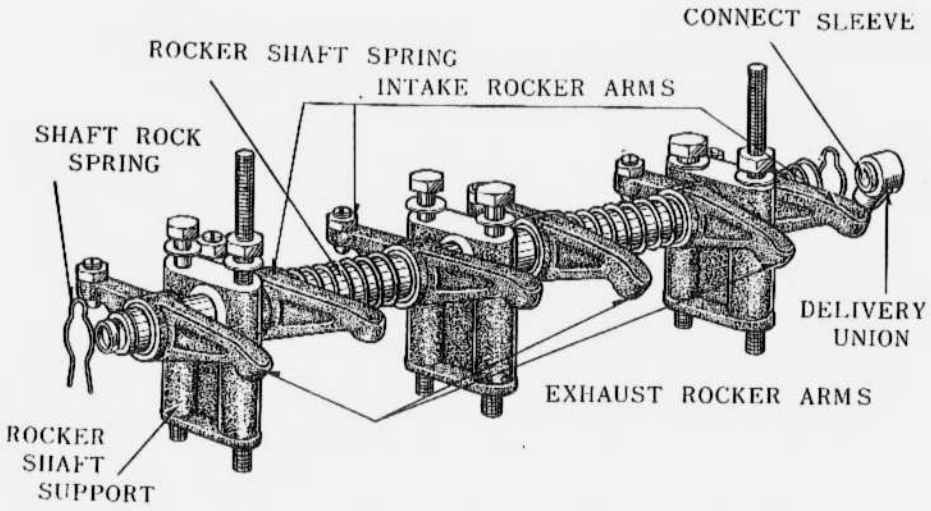


Figure 23 – Layout of Rocker Arm and Shaft Parts

e. Cylinder Head Assembly.

(1) Clean valves, valve seats, valve guides and cylinder head thoroughly.

(2) Starting with No.1 cylinder, place the exhaust valve in the port and place the valve spring and cap in position. Then using valve lifter tool, compress the spring and install cap stopper.

See that the cap stopper seat properly in valve stem groove (Fig. 24).

NOTE: Valve stem oil seal is provided only on the intake valve. When installing intake valve, do not forget to install this oil seal (Fig. 24).

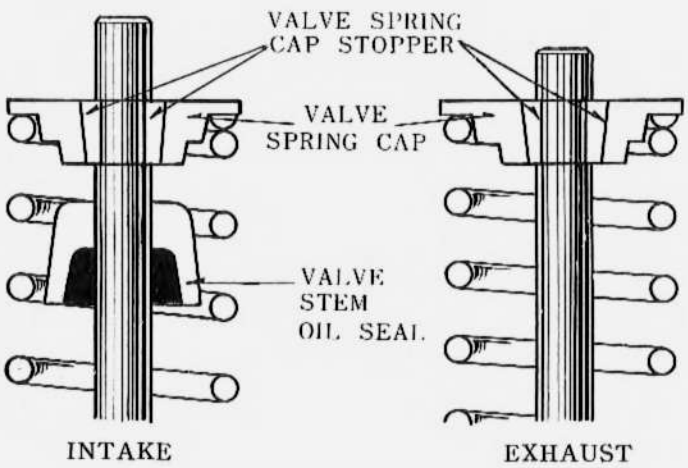


Figure 24 – Valve, Seal, Cap and Stopper

(3) Assemble the remaining valves, valve springs, spring caps, oil seals and cap stoppers in the cylinder head (Fig. 25).

NOTE: Irregular pitch valve springs are used. Place sides painted either yellow or green toward the bottom when assembling.

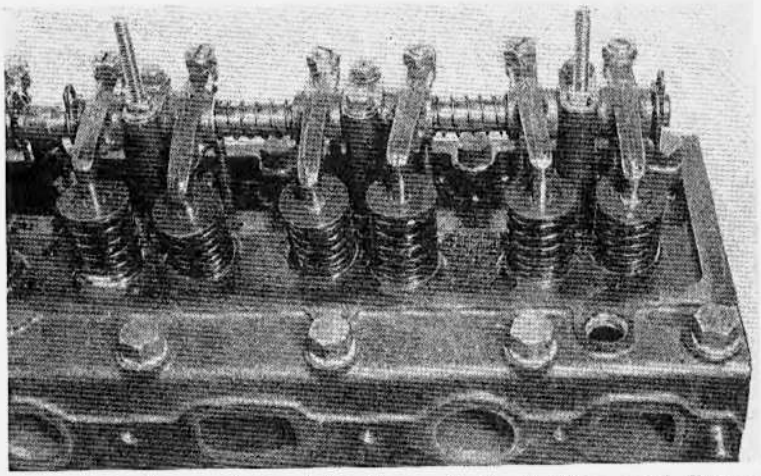


Figure 25 – Correct Installation of Seal, Cap and Stopper

(4) After reassembling valves, check the installed length of valve springs. The installed length is measured from the point where the spring contacts the valve spring seat up to the point where it contacts the valve spring cap (Fig.26).

Specified Installed Length
INTAKE 43.4 mm
EXHAUST 43.6 mm

If the installed length exceeds the specified value by more than 1.0 mm, install valve spring seat spacer (thickness 2.0 mm) instead of valve spring seat (thickness 1.0 mm).

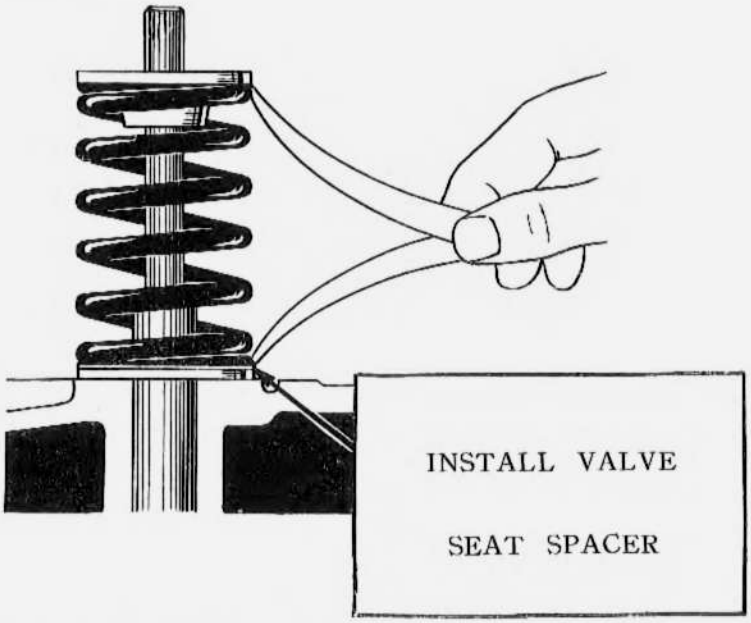


Figure 26 – Checking Installed Length of Valve Spring

NOTE: It is important that the valve springs be installed to proper lengths. If the installed length is too long, the spring tension will be weakened to cause the valve to float at high speeds and prevent proper operation of the engine.

f. Installation.

(1) Thoroughly clean out cylinder head bolt holes in the block and clean cylinder bolt threads.

Place new cylinder head gasket on cylinder block. Take care not to place this wrong side up. (The side marked F–11213 should be place up.)

This assures alignment of water passages and bolt holes in the block and head with openings in the gasket.

(2) Place the cylinder head in position over the gasket.

(3) Oil threads of cylinder head bolts and install bolts finger tight. In installing cylinder head bolts, bond straps should be installed together with the first and last bolts on left side of cylinder head, and air cleaner bracket with the second and third bolts from the front on left side of cylinder head.

(4) Tighten the cylinder head bolts a little at a time in the order shown Figure 27.

Cylinder Head Bolt Tightening Method.

First pass	30 ~ 40 ft-lbs
Second pass	55 ~ 65 ft-lbs
Third pass	75 ~ 65 ft-lbs
Final pass	85 ~ 95 ft-lbs
After warming up	85 ~ 95 ft-lbs

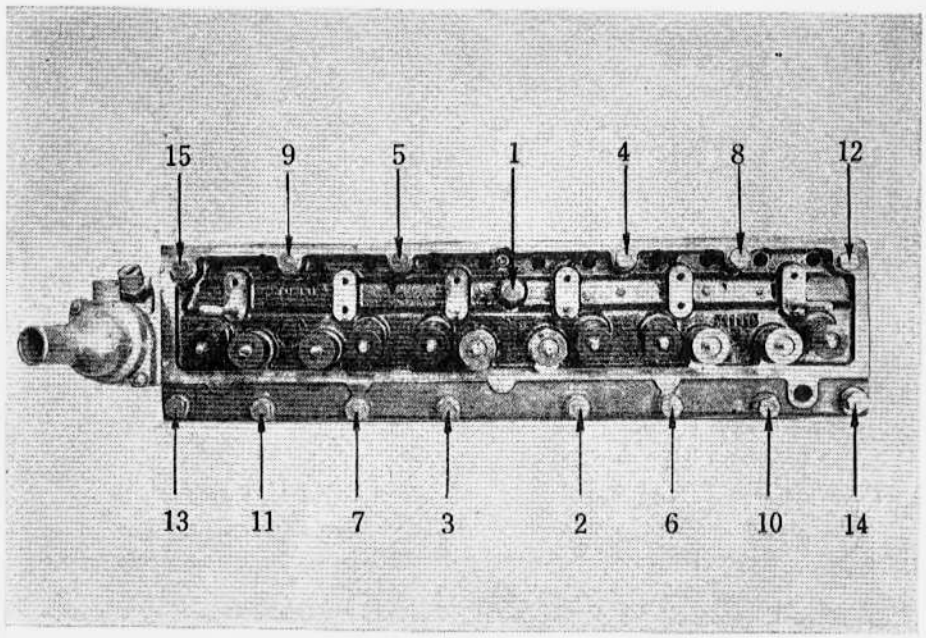


Figure 27 – Cylinder Head Bolt Tightening Diagram

(5) Install twelve valve lifters in right side of block and drop the twelve push rods down through the openings in the cylinder head and seat them in the lifters.

(6) Drop oil delivery pipe down through the openings in the cylinder head and tighten it to oil delivery union of block.

(7) Place two rocker shaft assemblies on the cylinder head so that the studs on the cylinder head will the respective supports on each shaft.

(8) Install four bolts and two stud nuts which retain each rocker shaft assembly to cylinder head and tighten evenly to 30~45 foot-pounds torque. Place the oil connect sleeve, spring, union over open ends of the two rocker shaft assemblies.

(9) Connect oil delivery pipe to rocker shaft oil delivery union and tighten securely. Figure 28 shows rocker arm and shaft assemblies correctly installed on head.

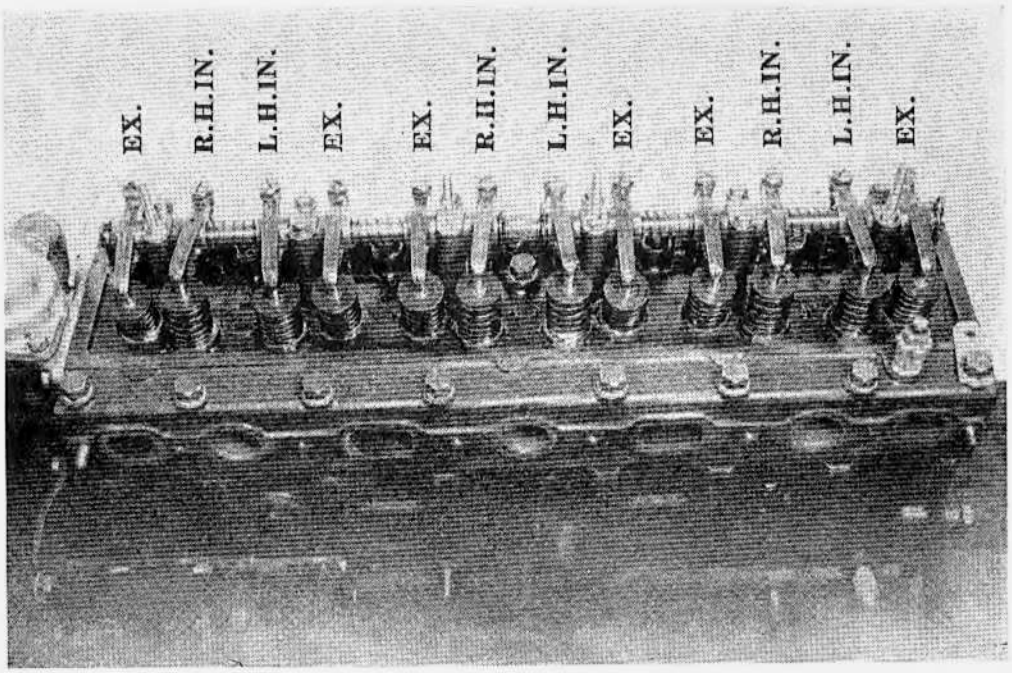


Figure 28 - Valve Rocker Arms Correctly Assembled

(10) Install water thermal unit and tighten securely.

(11) Connect radiator inlet hose and bypass hose to thermostat case.

(12) Install valve lifter cover using a new gasket and tighten lifter cover bolts to 2~4 ft lbs torque. Place coil in position at right side of head, and install attaching bolts and tighten to 10~15 ft-lbs torque.

(13) When the engine is overhauled, all spark plugs and spark plug gaskets should be replaced with new parts. Always check new spark plugs for proper gap, using a 0.9 mm spark plug gage. Tighten spark plugs to 12~18 foot-pounds tension. If torque wrench is not available, tighten finger tight and one-half turn more.

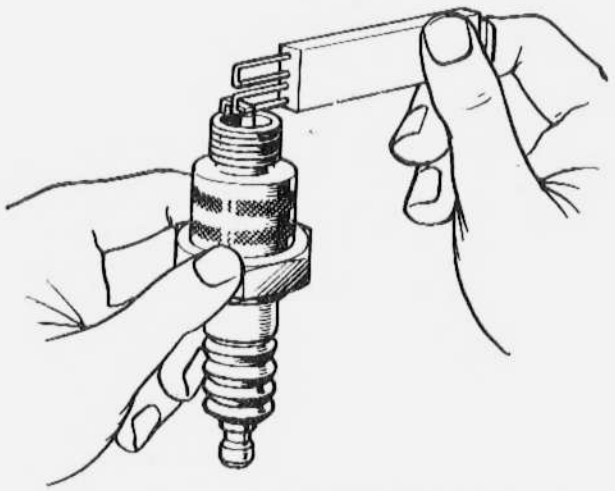


Figure 29 – Adjust Spark Plug Gap

(14) Connect spark plug wires to their respective terminals and the primary lead to the coil.

(15) Clean gasket flanges on cylinder head and manifold, install new manifold gaskets, intake manifold side collars and install the four bolts with clamps loosely to hold the gaskets in place. Position the manifold and slide it into place over the dowel pins and side collars making sure that it seats against the gaskets.

(16) Install two bolts with washers, turn the clamps into position against the manifold and tighten clamp bolts to 20–25 foot pounds tension.

(17) Connect throttle and choke rods at carburetor connect lower end of accelerator link to accelerator link arm stopper and install a new cotter pin.

(18) Connect gas and vacuum lines to carburetor.

(19) Attach fuel and vacuum pipe support clamp to water outlet. Connect gas and vacuum lines at fuel pump and vacuum controller respectively.

(20) Fill cooling system and check for water leaks.

(21) Roughly set all valve clearances to make sure that all valves have clearance. Adjust valves as instructed under "Valve Adjustment" in this section.

(22) Install new gasket and rocker arm cover. Connect bond strap at each side of rocker arm cover.

(23) Clean air cleaner and install. Install ventilating rubber hose from air cleaner cap to rocker arm cover.

(24) Lower engine hood.

6. ENGINE MOUNTINGS.

The engine mounting is a four-point system with two front mountings and two rear mountings. The front engine mounts are through the engine front

support member and support cushions to engine front support brackets (Fig. 30).

The rear engine mounts are through the engine rear support arms, installed on the clutch housing, and support cushions to engine rear support brackets (Fig. 31). This four-point mounting gives exceedingly good stability to the

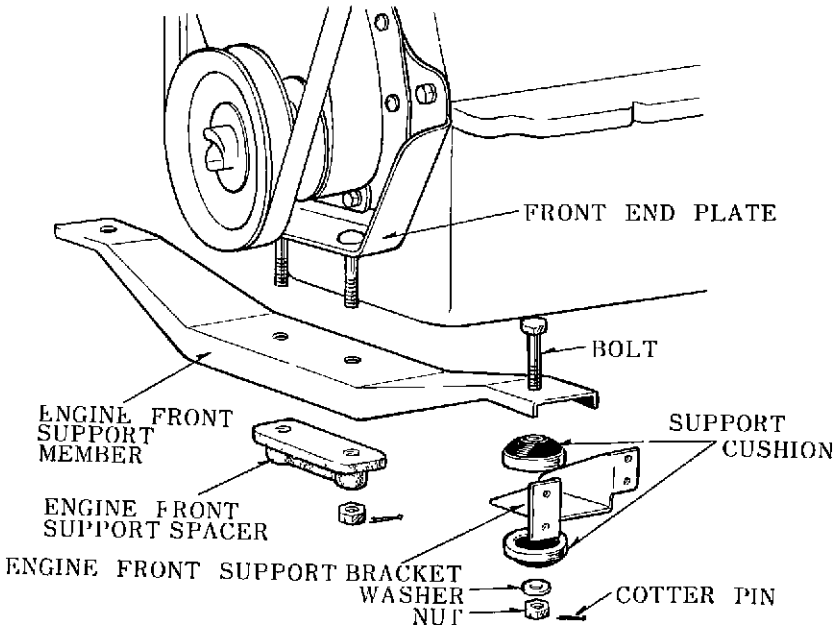


Figure 30 – Engine Front Mounts

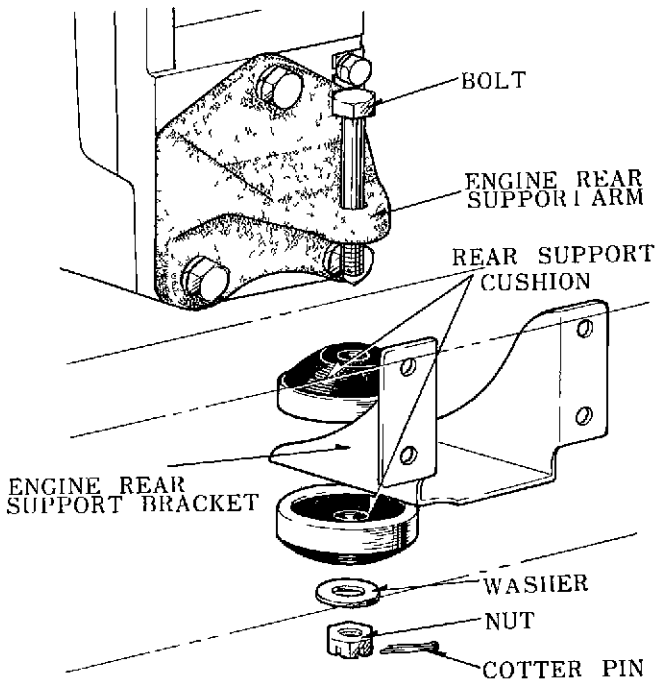


Figure 31 – Engine Rear Mounts

engine while the support cushions provided on the front and rear supports deadens engine vibration to prevent it from being transmitted to the body.

a. Engine Front Mounts—Replacement.

(1) Pull out cotter pin and remove nut from each of the two bolts welded on the crankcase front end plate. Remove engine front support spacer.

(2) Lift up front end of engine and separate support member from bolts welded on front end plate.

(3) Pull out cotter pin and remove nut from each of the engine front support bolts and take off front support member from engine front support brackets.

(4) Remove support cushions from each side.

(5) Using new support cushions, install front support member to engine front support brackets.

(6) Lower front end of engine and allow front support member bolt holes to fit into front end plate bolts.

(7) Install nut to each of the two bolts welded on front end plate over support spacer and tighten the nuts to 40~55 foot-pounds torque.

(8) Lock two nuts with cotter pins.

b. Engine Rear Mounts– Replacement

(1) Pull out cotter pins, and remove nut and support cushion from each of the two engine rear support bolts, and take out the bolts.

(2) Lift up rear end of engine and separate rear support arms from engine rear support brackets.

(3) Remove three bolts holding each of the engine rear support arms to the clutch housing and take out the support arms. Remove old support cushions.

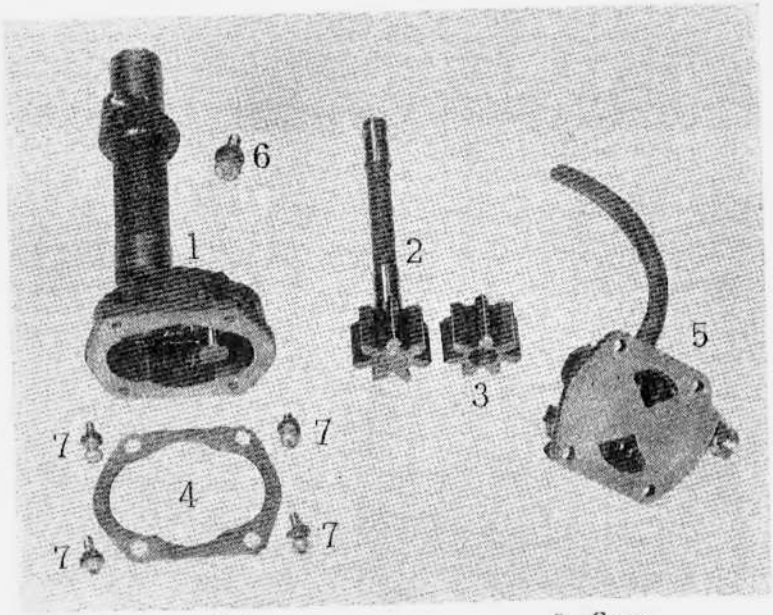
(4) Install rear support arms on clutch housing and install the attaching bolts and tighten down these bolts to 20~30 foot-pounds torque.

(5) Lower engine on new support cushions and insert engine rear support bolt to each of engine rear mounts.

(6) Install nut to each of the two rear support bolts over new support cushions and tighten nuts to 45~60 foot-pounds torque and lock nuts with cotter pins.

7. OIL PUMP.

Oil pump (Fig. 32) consists of two gears and a pressure relief valve enclosed in a oil pump cover and driven from the distributor drive shaft which in turn is driven by a spiral gear on the camshaft. Pump suction pipe is fitted with a fine mesh screen strainer to prevent entry of small particles of sludge, etc., into the oil lines.



1. Oil Pump Body
2. Oil Pump Shaft and Main Gear
3. Idler Gear
4. Cover Gasket
5. Cover
6. Bolt
7. Screw

Figure 32 – Layout of Oil Pump Parts

a. Removal and Disassembly.

(1) Drain oil and remove both engine under covers.
(2) Remove clutch housing under cover and flywheel side cover.

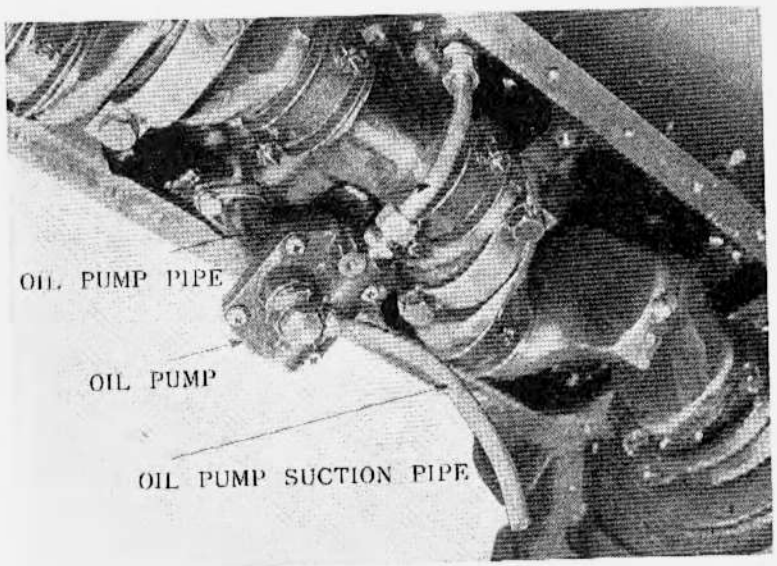


Figure 33 – Oil Pump-Attached

(3) Remove oil pan attaching bolts and place jack under front bumper and raise frame sufficiently to enable oil pan to clear tie rod. Remove oil pan and jack down.

(4) Remove oil pump strainer.

(5) Remove oil pump suction pipe and remove oil pump pipe (Fig. 33).

(6) Remove oil pump from cylinder block and remove pump cover attaching screws to enable removal of cover, gasket, idler gear, and main gear and shaft.

(7) Wash all parts in cleaning solvent and dry by using compressed air if available.

b. Inspection.

(1) Inspect pump body and cover for cracks or other damages. If defective, replace pump assembly.

Inspect oil pump gears for excessive wear or damage. If defective, replace gears.

(2) Measure outside diameters of pump shaft and idler gear shaft. If shaft is worn such that diameter is less than 13.9 mm, replace shaft as outlined in subparagraph c below.

(3) Install idler gear on idler gear shaft. Press gear toward center of pump body and measure clearance between gear teeth and pump body with feeler gage (Fig. 34). If clearance exceeds 0.2 mm, replace gear.

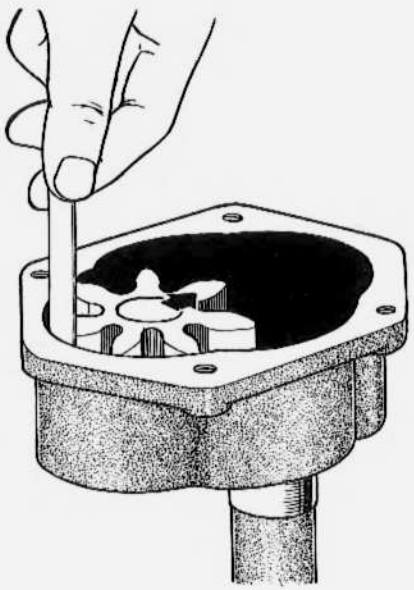


Figure 34 – Checking Idler Gear and Shaft Clearance

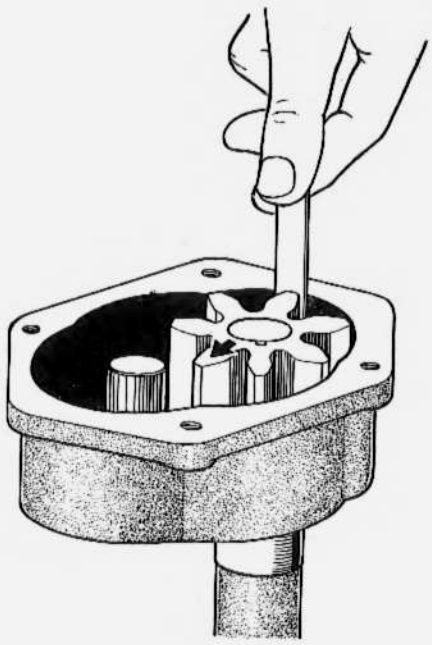


Figure 35 – Checking Pump Shaft Clearance

(4) Remove idler gear and install pump shaft with main gear attached to pump. Press gear toward center of pump body and measure clearance between gear teeth and pump body with feeler gage (Fig. 35). If clearance exceeds 0.2 mm, replace gear or shaft, or both. If clearance still exceeds the limit after replacement, replace pump assembly.

(5) Place a new gasket on pump body cover flange and lay a steel straightedge on gasket. Measure the space between the gear and straightedge with feeler gage (Fig. 36). Lay the straightedge on pump cover and measure the space between the straightedge and gear contacting surface on pump cover with feeler gage (Fig. 36). If the sum of these values measured exceeds 0.15 mm, replace gears or pump assembly.

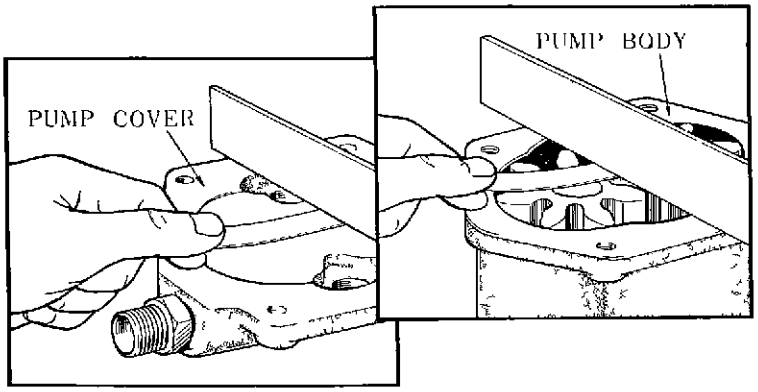


Figure 36 – Checking Gears End Play

(6) Measure backlash between main and idler gears with narrow feeler gage (Fig. 37). If backlash exceeds 0.2 mm, replace both gears.

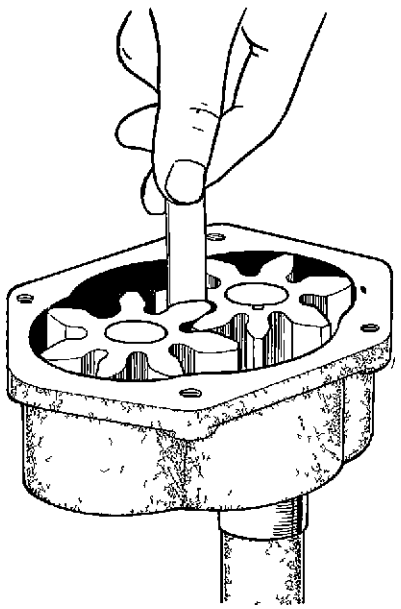


Figure 37 – Check Main and Idler Gears Backlash

c. Repairs.

(1) Idler gear shaft is press-fitted to pump body. A press must always be used to remove or install the shaft in order to prevent damaging the pump body. When installing, press in the shaft until its end is flush with the surface of pump cover flange (Fig. 38).

(2) To remove main gear from pump shaft, use a universal puller. To install, place key in position and force gear onto the shaft with a press until the end face of gear is within 0.5 mm of pump shaft end.

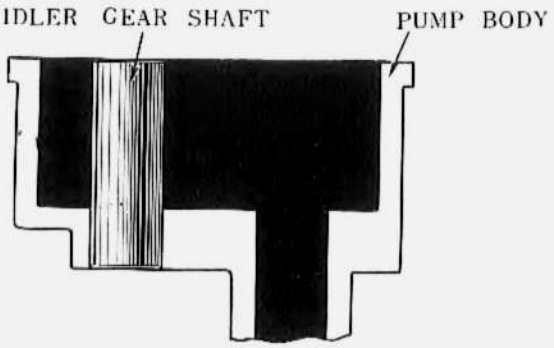


Figure 38 – Proper Installing of Idler Gear Shaft

d. Assembly.

(1) Place main gear and shaft in pump body.

(2) Install idler gear to idler gear shaft and fill gear clearance with oil.

(3) Install new gasket to assure correct end clearance of the gears.

(4) Install cover and attaching screws. Tighten screws securely and check to see that shaft turns freely.

(5) Install oil pump suction pipe to pump body.

CAUTION: After reassembling, the oil pump must be checked to see whether it operates satisfactorily or not. To check, immerse the oil pump suction pipe in new oil and while closing the oil outlet hole with thumb, turn the drive slot end of oil pump shaft with a screw driver. If the oil pressure is strong enough to push the thumb back, the pump is satisfactory. If not, disassemble and repair once more, or else replace with a new pump.

e. Installation.

(1) Place oil pump in block fitting aligning oil pipes and making sure drive slot aligns properly with tang on distributor shaft, and install bolt to block, locking the bolt with set wire.

(2) Tighten oil pump pipe to block oil line and replace oil pump strainer.

(3) Jack up and raise frame sufficiently.

(4) Install oil pan using a new oil pan gasket. Tighten oil pan attaching bolts to 4–8 foot pounds and tighten oil pan drain plug. Lower frame and remove jack.

(5) Replace engine under covers, and replace clutch housing under cover side cover and flywheel. Refill with oil.

8. CRANKSHAFT PULLEY AND TIMING GEAR COVER.

Crankshaft pulley, timing gear cover and associated parts are assembled as shown in Figure 39.

The oil deflector is assembled in front of the crankshaft gear. The crankshaft pulley passes through the oil seal installed on the timing gear and is keyed on the crankshaft. An oil stopper collar is attached on the timing gear cover against the inner side of the oil seal, this collar being provided

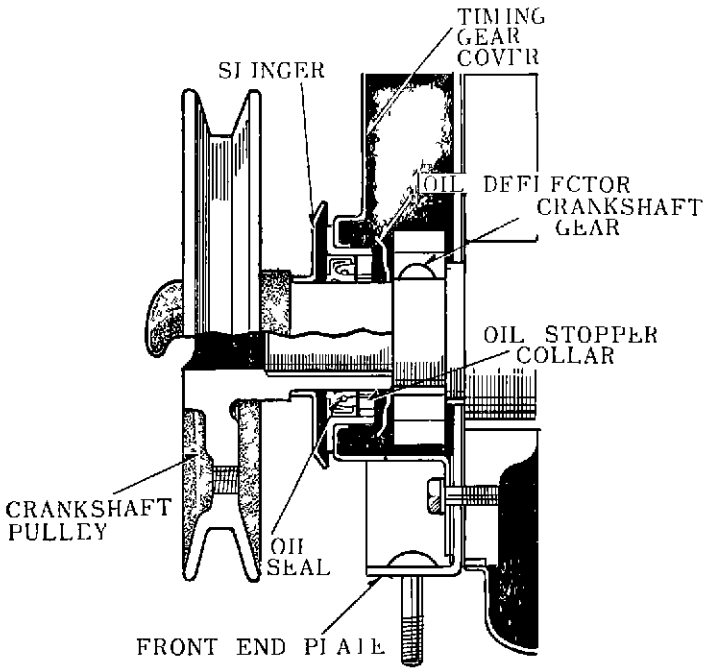


Figure 39 – Crankshaft Pulley and Timing Gear Cover Assembly

with internal reverse threads to scrape the oil back when the shaft is rotating. A slinger is attached on the crankshaft pulley to protect the oil seal against dust, thus providing adequate dust-proofing at the front end of the engine.

a. Removal.

(1) Drain radiator and disconnect radiator inlet and outlet hoses.
(2) Remove radiator grille and side wind guides as an assembly.
(3) Remove radiator.
(4) Unloosen generator adjusting bar bolt and remove fan belt.
(5) Pull out cotter pin and remove nut from each of the two bolts welded

on the front end plate, and remove engine front support spacer. Then place jack under front end of engine and raise engine about one inch.

NOTE: When removing the crankshaft pulley, the crankshaft pulley may fail to clear the rear side of the first crossmember.

(6) Install crankshaft puller (BX SST-1022) and turn puller screw to remove pulley (Fig. 40).

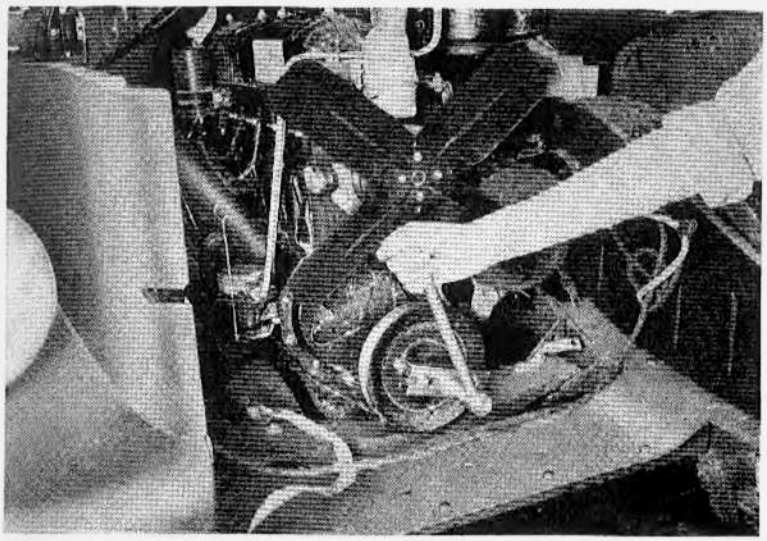


Figure 40 – Removing Crankshaft Pulley

(7) Remove timing gear cover attaching screws and two bolts, and remove cover and gasket.

(8) Remove crankshaft oil deflector.

b. Repairs.

Timing Gear Cover Oil Seal-Replace

(1) Pry old oil seal out of cover from the front with a large screwdriver.

(2) Drive in new oil seal with oil seal replacer (Fig. 41).

c. Installation.

(1) Make certain that cover mounting face and crankcase front end plate face are clean.

(2) Install crankshaft oil deflector.

(3) Install timing gear cover aligner (BX SST-1026) over end of crankshaft.

(4) Coat the rubber oil seal with light grease and using new cover gasket, install cover and gasket over aligner (Fig. 42).

(5) Install cover screws and two bolts, tightening bolts to 12 – 20 foot pounds torque. Remove aligner.

NOTE: It is important that the aligner be used to align the timing

gear cover so that the crankshaft pulley will not damage the seal and to provide uniform seal tension on the hub of the pulley.

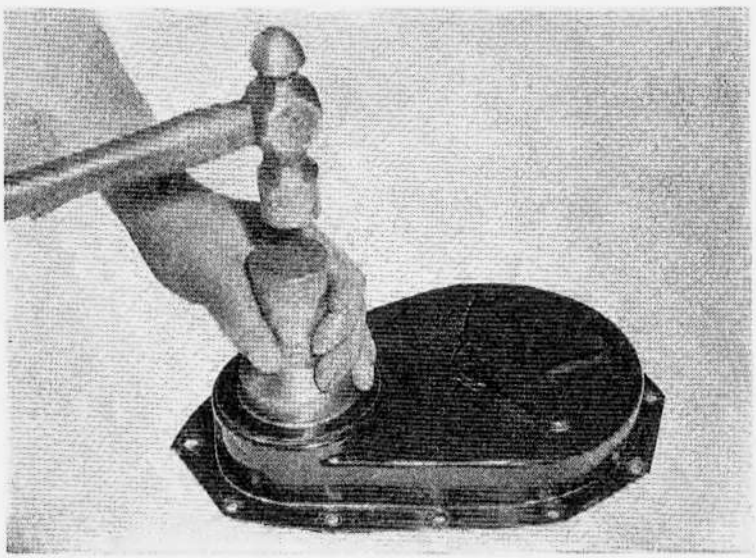


Figure 41 – Replace Timing Gear Cover Oil Seal

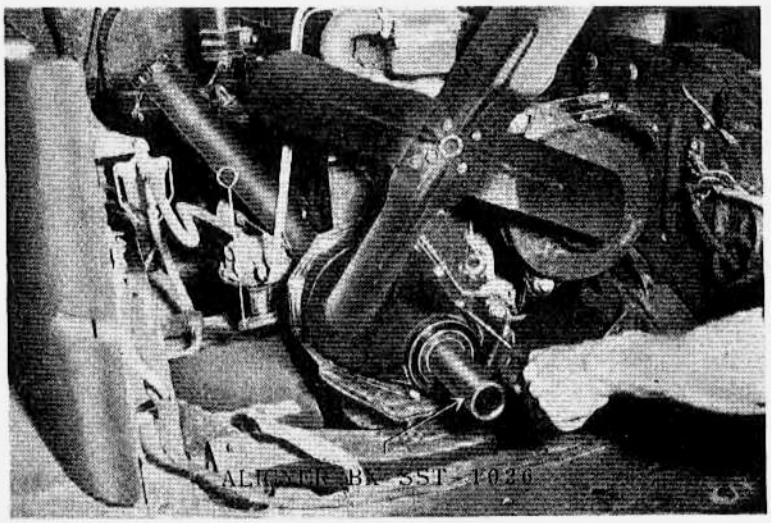


Figure 42 – Timing Gear Cover Installation

(6) Place pulley replacer (BX SST–1023) on crankshaft pulley, and by hitting the replacer with a hammer, the pulley can be easily driven in (Fig. 43). Drive the pulley onto shaft until it bottoms against crankshaft gear.

(7) If the engine had been raised when removing the crankshaft pulley, lower the front end of engine and tighten down support member to front end plate bolts over support spacer. Tighten nuts securely and install cotter pins.

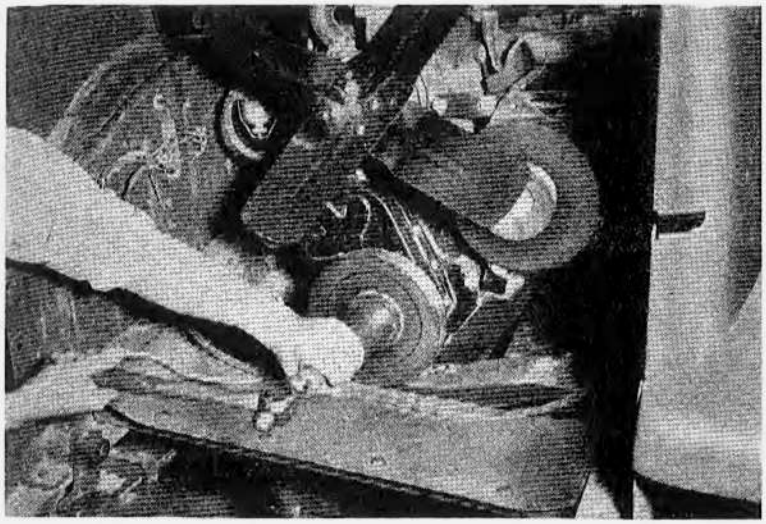


Figure 43 – Crankshaft Pulley Installation

(8) Replace fan belt. The belt should be adjusted to give about 13 mm deflection at this point (Fig. 44).

(9) Replace radiator.

(10) Replace radiator inlet and outlet hoses, refill cooling system.

(11) Replace radiator grille and side wind guides as an assembly.

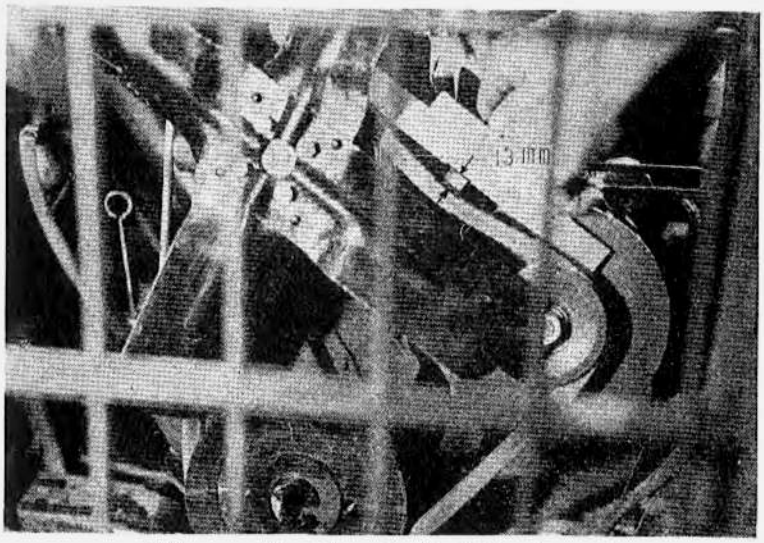


Figure 44 – Fan Belt Adjustment

9. CRANKCASE VENTILATION.

Positive crankcase ventilation system employed in the engine serves the following purposes;

(1) Provides constant ventilation of the crankcase with clean air, to prolong the lives of the main and connecting rod bearings, piston rings, cylinder walls and other moving parts by preventing dust or dirt from entering into the crankcase and lubricating system.

(2) Maintains the pressure inside the engine slightly lower than atmospheric, to aid in preventing oil from leaking out of the engine.

a. Operation.

Positive crankcase ventilation is accomplised by installing a ventilating rubber hose at air cleaner cap and leading it inside the rocker arm cover. As the engine is made air tight, the low pressure in the rubber hose draws out the air infiltrating into the crankcase to effect ventilation (Fig 45).

b. Maintenance.

At regular intervals, clean out the rubber hose to allow free passage of air and prevent clogging. Also service the oil bath air cleaner every 2,000 kilometers. If it becomes evident that the pressure inside the crankcase is high, this indicates that either the rubber hose or the strainer inside the air cleaner is clogged, necessitating cleaning of these parts.

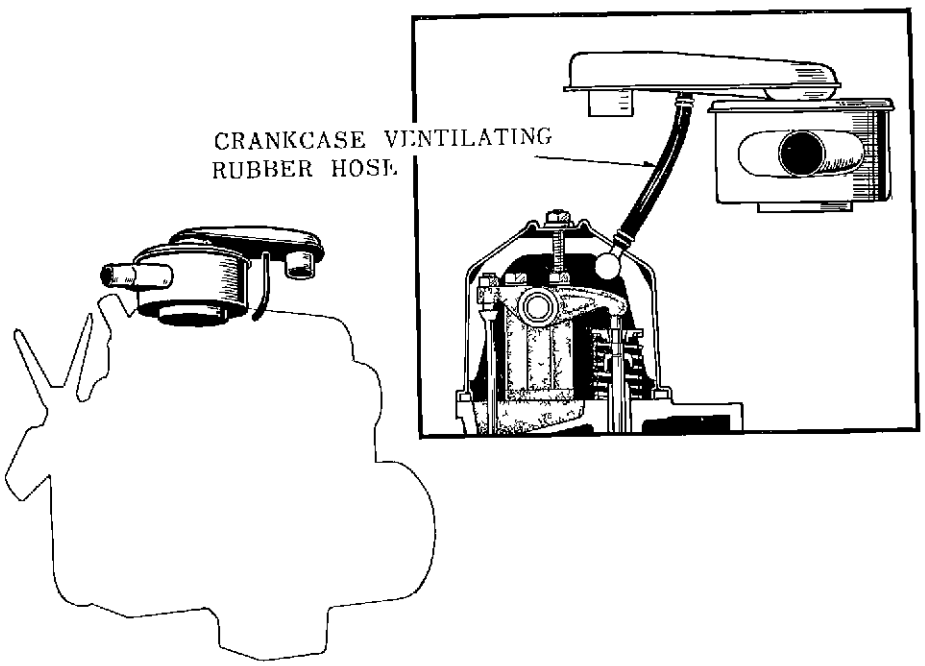


Figure 45 – Crankcase Ventilation.

10. ENGINE TUNE-UP.

One of the most important duties to perform on modern high compression engines is proper engine tune-up. This operation more than any other deter-

mines whether or not the vehicle will produce the maximum amount of economy. Only by performing these operations and staying within limits, clearances and specifications is it possible to obtain the performance and economy built into the engine.

a. Compression.

Before making any checks on an engine it should be run for several minutes and allowed to warm up. Lubricate the valve mechanism. The compression of each cylinder should be checked first because An Engine With Uneven Compression Cannot Be Tuned Successfully.

(1) Turn the ignition off and pull the hand throttle control out to open position or block the throttle in an open position.

(2) Remove all spark plugs from engine.

(3) Insert compression gage in a spark plug hole and hold it tightly in position. Crank the engine with the starter motor until gage reaches its highest reading, which requires only a few turns of the engine.

(4) Repeat this test on all cylinders and make a note of the compression reading on each cylinder.

(5) Compression on all cylinders should be 100 pounds or better on engine. All cylinders should read alike within 10 pounds for satisfactory engine performance.

Should a low compression reading be obtained on two adjacent cylinders, it indicates the possibility of a leak from one cylinder to the other, usually caused by a leak at the cylinder head gasket.

If the compression readings are low, or vary widely, the cause of the trouble may be determined by injecting a liberal supply of engine oil on top of the pistons of the low reading cylinders.

Crank the engine over several times, and then take a second compression test. If there is practically no difference in the readings when compared with the first test, it indicates sticky or poorly seating valves. However, if the compression on the low reading cylinders is higher and about uniform with the other cylinders it indicates compression loss past the pistons and rings.

The cause of low or uneven compression must be corrected before proceeding with an engine tune-up job.

b. Spark Plugs.

Clean the spark plugs thoroughly, using an abrasive type cleaner. If the porcelains are badly glazed or blistered, the spark plugs should be replaced. All spark plugs must be of the same make and number or heat range. Engine are equipped with N-F 27630 spark plugs (medium type).

Adjust the spark plug gaps to 0.9mm using a round feeler gage.

Caution: In adjusting the spark plug gap never bend the center electrode which extends through the porcelain center.

Always make adjustment by bending the side electrode. Install the spark

plugs in the engine using new gaskets whenever possible and tighten to 12~18 foot-pounds tension. If torque wrench is not available, tighten finger tight and ½ turn more using new gaskets.

Plugs are of 14-millimeter size and care must be exercised when installing or the setting of the gap may be upset.

c. Battery Test.

Connect the positive terminal of a voltmeter to the ignition and starter switch terminal and the negative terminal of the voltmeter to a good ground.

Close the starter motor switch and crank the engine for 30 seconds. If the starter motor cranks the engine at a good rate of speed during this period with the voltmeter reading 9 volts or better, it indicates a satisfactory starting circuit, which includes the condition of the battery terminals and cables.

However, if the cranking speed is slow, or the voltmeter reading is under 9 volts, the starter motor, battery and battery terminals should be checked individually to locate the source of the trouble.

d. Ignition Distributor.

(1) Remove the ignition coil wire and spark plug wires from the distributor cap and examine the terminals for corrosion. The wires should be checked for damaged insulation and oil soaked condition.

(2) Remove the distributor cap. Check the cap and distributor rotor for cracks or burned or pitted contacts.

(3) Check the distributor automatic advance mechanism by turning the distributor cam in a clockwise direction as far as possible, then release the cam and see if the springs return it to its retarded position. If the cam does not return readily, the distributor must be disassembled and the cause of the trouble corrected. See "engine electrical" for "Distributor Repair"

(4) Examine the distributor points. Dirty points should be cleaned, and pitted or worn points should be replaced. Check the points for alignment and align them if necessary.

(5) Crank the engine until the distributor point cam follower rests on the peak of the cam. Adjust the point gap (Fig. 46) using a feeler gage. This operation must be performed very accurately because it affects the point dwell or length of time the points remain closed in operation and, in turn, ignition coil performance.

NOTE: The standard point setting on distributor, is 0.45 mm. When new points are installed, adjust points to 0.50 mm because the cam follower will wear down slightly while seating to the cam.

(6) Crank the engine until the cam follower is located between the cams. Hook the end of a distributor point scale over the movable point and pull steadily on the spring scale until the points just start to open. At this point the reading on the scale should be between 450~650 gram for distributor.

(7) Check to see that the vacuum control operates freely by turning the

distributor body counterclockwise and see that the spring returns it to the retarded position. Any stiffness in the operation of the vacuum control will affect the ignition timing.

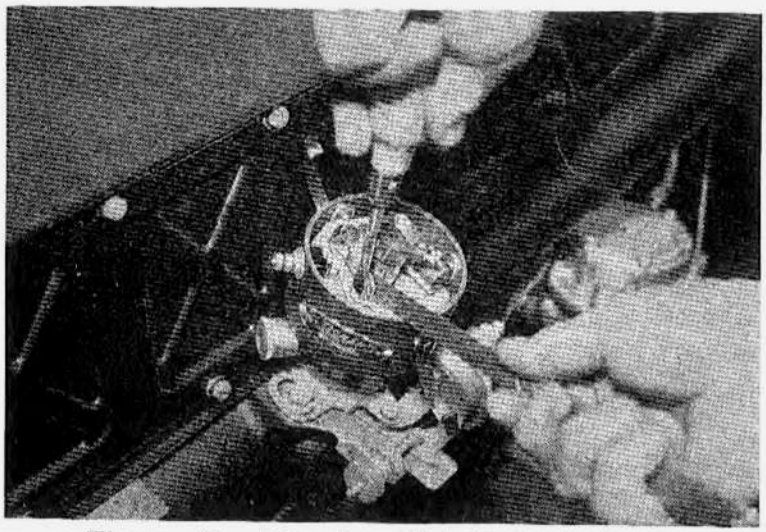


Figure 46 – Adjusting Distributor Points

(8) Install the rotor and distributor cap to the distributor body and ignition coil wire and spark plug wires to cap. Make sure that the terminal of the primary lead at the ignition coil and distributor are clean and tight.

e. Coil and Condenser.

The ignition coil and condenser should be checked following the instructions given by the manufacturer of the test equipment being used.

f. Ignition Timing.

(1) Set the octane selector at "O" on the scale (Fig.47) and attach a Neon

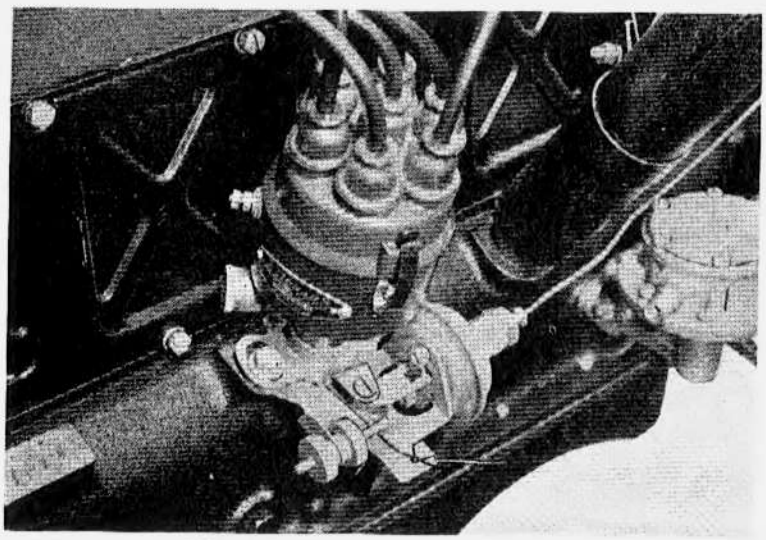


Figure 47 – Octane Selecter

Timing Light to the No. 1 spark plug and a good ground. Start the engine and run it at idling speed with light aimed at clutch housing opening.

(2) Loosen distributor clamp and rotate distributor body clockwise or counterclockwise until the steel ball in the flywheel lines up with the pointer on the clutch housing.

(3) Tighten distributor clamp screw and remove timing light.

NOTE: The engine are timed 7° before top dead center.

g. Fuel Filter.

(1) Disconnect inlet and outlet pipes at fuel filter.

(2) Loosen bowl bail nut. Remove fuel filter bowl and screen and wash them thoroughly in cleaning solvent.

(3) Reassemble bowl and screen making sure that filter bowl gasket is in good condition and properly seated. Tighten bowl bail nut sufficiently to prevent leak.

(4) Connect inlet and outlet pipes at fuel filter.

h. Air Cleaner.

This type of cleaner should be disassembled and cleaned every 2000 kms. Check the cleaning of air cleaner as outlined in "Fuel System" of this manual

i. Crankcase Ventilation

On this model that are equipped with positive crankcase ventilation, perform maintenance operations as outlined under " Crankcase Ventilation-Maintenance "

j. Carburetor.

(1) Remove carburetor from engine, disassemble, inspect and reassemble as outlined in "Fuel System."

(2) Reassemble carburetor and air cleaner to the engine. Tighten carburetor stud nuts to 20~25 ft-lbs torque.

k. Manifold Heat Control Valve.

(1) Unhook the heat control valve coil from dowel pin and check the adjustment.

(2) Proper adjustment and hook up requires only ½ turn of the coil from its unhooked position to slip it over the dowel pin.

NOTE: Should this coil be distorted in any way it should be replaced.

(3) Check valve shaft to make sure it is free in the manifold. If shaft is sticking, free it up with kerosene containing a small amount of baking soda.

l. Valve Adjustment.

(1) Start the engine and while it is warming up, tighten cylinder head

bolts, rocker shaft support bolts and nuts and the manifold bolts and clamp bolts.

NOTE: Cylinder head bolts should be tightened to 85~95 foot pounds and rocker shaft support bolts to 30~45 foot pounds.

(2) Normalize the engine and adjust the valves according to procedure in this section under "Valve Adjustment."

m. Idling Adjustment.

(1) Warm up engine to normal operating temperature.

(2) Attach vacuum gage to intake manifold fitting.

(3) Set idling speed to approximately 450~500 rpm by adjusting screw on carburetor throttle valve lever.

(4) Turn idling screw gradually to right or left to give highest reading on vacuum gage. This reading should range between 17 and 21 inches.

(5) If engine idles too fast after this adjustment, readjust throttle screw until correct idling speed is obtained.

n. Cooling System.

(1) Tighten all cooling system hose connections and check for indications of leakage.

(2) Check fan belt for proper tension and adjust if necessary. See "Cooling System" for Fan Belt Adjustment.

NOTE: With correct adjustment, a light pressure on the belt at a point midway between the pulleys should cause a 13mm maximum deflection with the belt used on model.

o. Generator Regulator.

Check the adjustment of the generator regulator as outlined in "Engine Electrical System" of this manual.

p. Road Test.

After completion of the above operations, the vehicle should be road tested for performance. During this test the octane selector should be adjusted for the grade of gasoline being used. For peak performance and maximum gasoline economy, the octane selector should be set so the engine will produce a slight "ping" on acceleration to wide open throttle.

M E M O

SECTION III

MAJOR SERVICE OPERATIONS

11. ENGINE REMOVAL.

(1) Drain radiator and cylinder block, and remove hose connections.

(2) Drain oil pan and transmission case.

(3) Disconnect engine hood hinges and bond straps, and remove engine hood from vehicle.

(4) Remove ground cable from battery to frame. Disconnect battery starter cable at battery terminal.

(5) Remove radiator grille and side wind guides as an assembly.

(6) Remove two brace rods from radiator to cowl and then remove radiator lower supporting bolt nuts through two holes of the first crossmember using socket wrench. Disconnect bond strap from radiator. Remove radiator from vehicle carefully.

(7) Disconnect battery starter cable from starter motor and disconnect ground cable at engine under cover right.

(8) Disconnect starter wires from starter motor.

(9) Disconnect ignition coil primary lead at coil.

(10) Disconnect gas inlet line from fuel pump.

(11) Disconnect crankcase ventilating rubber hose at air cleaner, and remove air cleaner.

(12) Disconnect choke and throttle rods from carburetor.

(13) Disconnect oil pressure gage pipe from block and remove water thermal unit from cylinder head.

(14) Disconnect oil cleaner inlet pipe at oil distributor and outlet pipe at nipple of block. Loosen outlet pipe clamp at steering gear box.

(15) Disconnect exhaust pipe from manifold.

(16) Disconnect accelerator link rod from accelerator link shaft.

(17) Disconnect wiring from generator and bond strap from generator adjusting bar.

(18) Remove transmission cover from driver's compartment.

(19) Remove transmission gear shift lever.

(20) Remove hand brake lever from transmission.

(21) Disconnect speedometer cable at transmission.

(22) Disconnect transfer shift lever from the right side of transmission.

(23) Disconnect intermediate shaft at transfer case front universal joint retainer.

(24) Remove return spring from clutch fork to bracket and remove clutch fork pull rod from clutch fork.

(25) Disconnect bond strap at front end of clutch housing pull rod. Remove clutch housing pull rod from engine rear support arm left to engine front support bracket left.

(26) Remove engine under covers, right and left.

(27) Remove engine rear mounting bolt nuts. On front engine mounting, take out front support spacer after removing nuts from set bolts welded on front end plate.

(28) Disconnect bond strap from each side of valve rocker arm cover and then remove valve rocker arm cover.

(29) Remove the fifth cylinder head bolt from the rear on the left side and the third cylinder head bolt from the rear on the right side. Then using engine lifting attachment, raise engine slightly.

(30) Raise engine enough to separate engine front support member from set bolts welded on front end plate. Remove rear mounting bolts.

(31) Raise the engine and transmission assembly from the chassis as a unit (Fig. 48).

(32) Mount engine in engine stand and clamp it securely so that the engine can be turned over when necessary and remove lifting attachment.

(33) Remove flywheel side cover and clutch housing under cover.

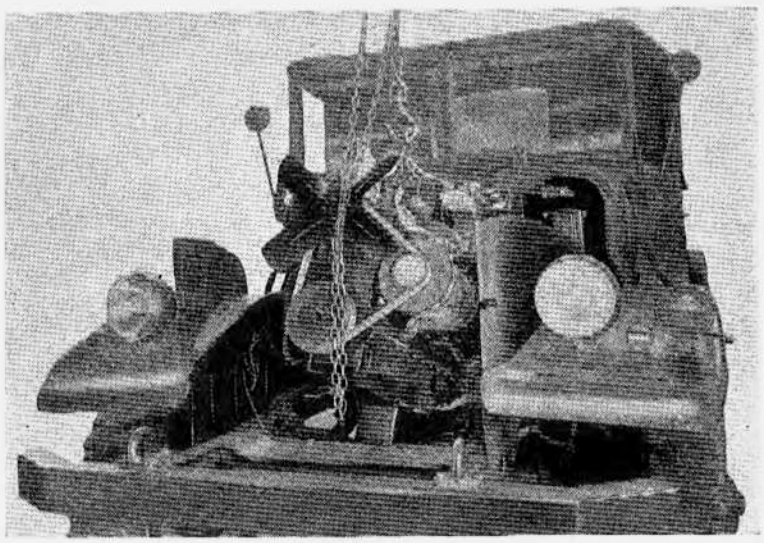


Figure 48 – Removing Engine

(34) Remove bolts attaching transmission to clutch housing and disconnect bond strap from transmission case cover. Remove transmission from clutch housing.

12. ENGINE DISASSEMBLY.

(1) Remove release bearing from clutch fork and remove fork.

(2) Install clutch guide tool (FA70 SST-1072) to support clutch during disassembly. Loosen clutch to flywheel bolts a turn at a time (to prevent distortion of clutch cover) until the clutch spring pressure is released. Remove all bolts, guide tool, cover assembly and disc.

(3) Remove flywheel and then remove clutch housing.

(4) Remove starter motor.

(5) Remove generator and fan belt.

(6) Remove spark plug wires to spark plugs and remove spark plugs.

(7) Remove ignition coil and remove octane selector retaining bolt and disconnect vacuum pipe from vacuum control. Lift the distributor up and out of the engine.

(8) Disconnect fuel pipe from fuel pump, remove fuel pump mounting bolts and fuel pump and gasket.

(9) Disconnect fuel and vacuum pipe support clamp at water outlet and disconnect pipes from carburetor and remove pipes.

(10) Remove lifter cover and gasket, remove oil feeder tube and oil level gage rod.

(11) Remove two nuts attaching thermostat case to water outlet and remove thermostat case and thermostat.

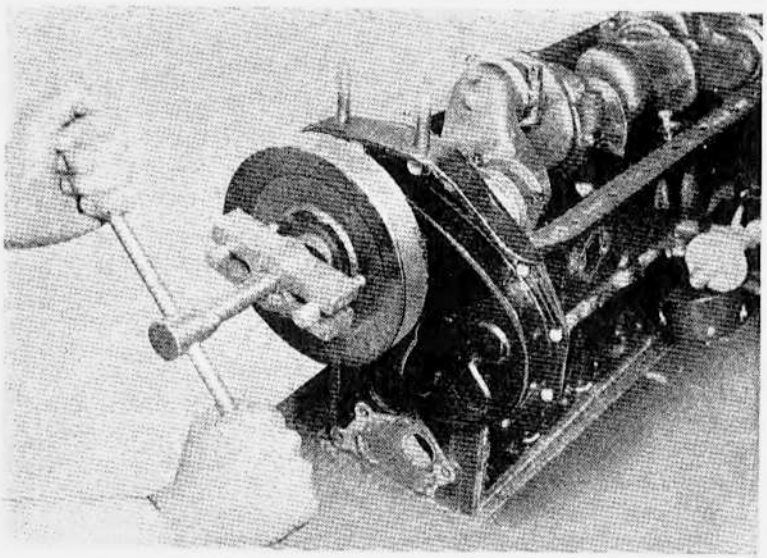


Figure 49 – Crankshaft Pulley Puller

(12) Remove two bolts attaching water outlet to cylinder head and remove water outlet and gasket.

(13) Remove water pump retaining bolts and remove generator adjusting bar and pump and gasket.

(14) Attach crankshaft pulley puller (BX SST-1022) to pulley and turn puller screw to remove pulley (Fig. 49).

(15) Disconnect accelerator link from carburetor.

(16) Remove accelerator link arm pin, accelerator link arm and link arm stopper from cylinder block. Remove accelerator link tension springs.

(17) Remove carburetor attaching nuts and remove carburetor.

(18) Remove bolts and clamp bolts attaching manifold to cylinder head and remove manifold assembly and gaskets and side collars. If necessary, remove oil cleaner from intake manifold.

(19) Remove bolts attaching oil distributor to block and remove oil distributor and gasket.

(20) Disconnect oil delivery pipe and remove it. Remove oil connect sleeve, spring and delivery pipe union from valve rocker shaft assemblies. Remove valve rocker shaft assemblies from cylinder head.

(21) Remove twelve push rods and twelve valve lifters.

(22) Remove the cylinder head attaching bolts, cylinder head, gasket, air cleaner bracket and two bond strap pieces.

(23) Using valve lifter tool, compress the valve springs and remove cap stoppers, spring caps, oil seals, springs and valves.

(24) Turn the block assembly over in the engine stand and remove oil pan attaching bolts, oil pan and gasket.

(25) Remove the timing gear cover attaching screws and bolts, and remove cover and gasket. Remove oil deflector.

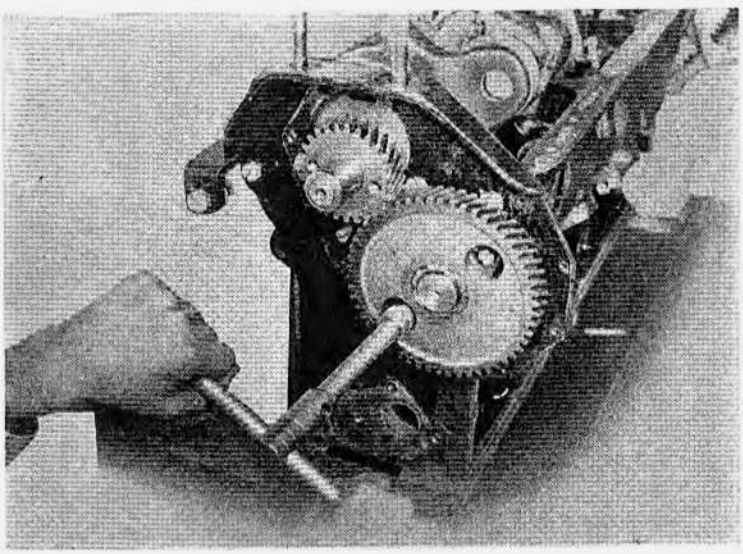


Figure 50 – Removing Camshaft Thrust Plate Bolts

(26) Remove the two camshaft thrust plate bolts by working through the two holes in the camshaft gear (Fig. 50).

(27) Remove the camshaft and gear assembly by pulling it out through the front of the block.

NOTE: Support shaft carefully when removing so as not to damage camshaft bearings.

(28) Pull the crankshaft gear with gear puller (BX SST-1022) by attaching it to the gear and turning puller handle (Fig. 51).

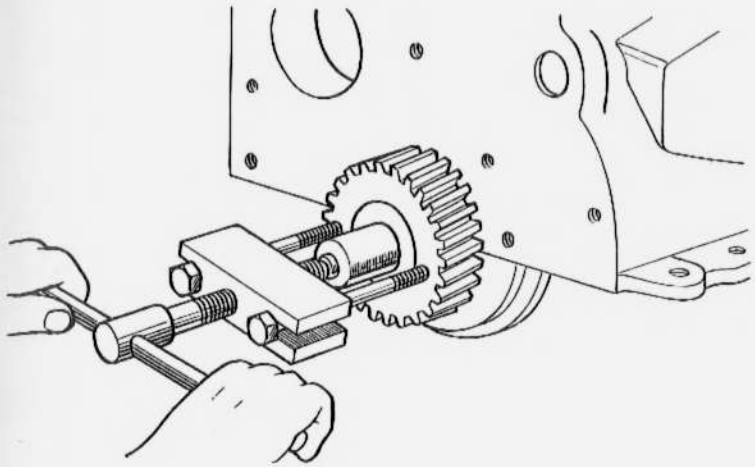


Figure 51 – Removing Crankshaft Gear

(29) Remove the crankcase front end plate attaching screws and remove plate and gasket.

(30) Remove oil pump strainer.

(31) Disconnect oil pump pipe at block and remove oil pump pipe.

(32) Remove oil pump retaining bolt and remove oil pump with pump suction pipe.

(33) Remove oil pump cover attaching screws, cover, gasket, idler gear, and main gear and shaft.

(34) Check the connecting rods and pistons for cylinder number identification and, if necessary, mark them.

(35) Remove connecting rod bolt cotter pins, bolt nuts and rod caps, and cover connecting rod bolts with vinyl tubings. Push the rods away from the crankshaft.

(36) Push piston and rod away from crankshaft and out of their cylinders. Remove vinyl tubings from connecting rod bolts. Install caps and nuts loosely to their respective bolts. If piston rings strike ridge at top of cylinder, remove ridge to prevent damaging piston ring lands.

NOTE: It will be necessary to turn the crankshaft slightly to dis-

connect some of the rods and to push them out of the cylinder.

(37) Remove piston rings by expanding them and sliding them off the ends of the pistons.

(38) Clamp the piston in a piston vise (Fig. 52).

Remove the connecting rod to piston pin clamp bolt and push the piston pin out (all pistons).

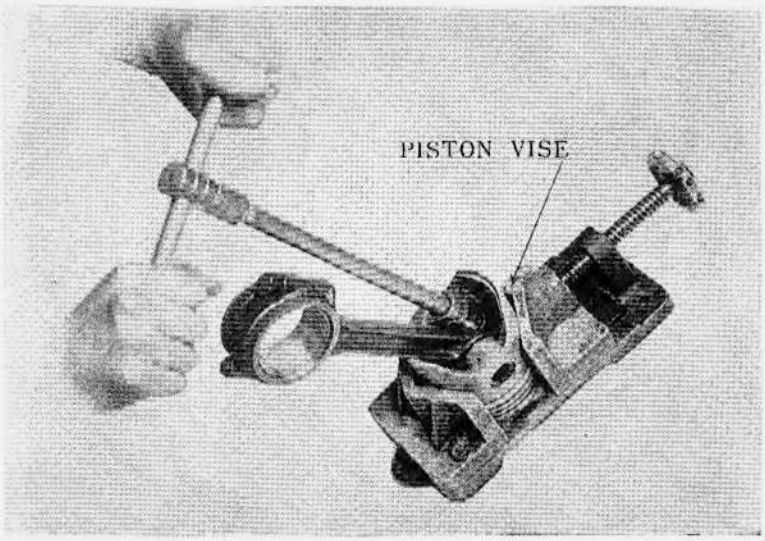


Figure 52 – Piston in Piston Vise

(39) Unloosen main bearing cap bolt locks. Remove main bearing cap bolts and remove the bearing caps and shims.

(40) Remove rear oil seal from crankshaft rear flange.

(41) Lift the crankshaft out of the block and place it where it will not get damaged.

(42) Lift crankshaft main bearings from block.

13. ENGINE CLEANING AND INSPECTION.

(1) Wash all parts thoroughly in cleaning solvent.

(2) Remove main oil gallery plugs located one at left front and one at left rear face of cylinder block.

This passage should be thoroughly cleaned by using compressed air or a wire brush. Plugs may easily be removed with a sharp punch or they may be drilled and pried out.

(3) Clean all oil passages in the cylinder block by blowing them out with compressed air. It is good practice to blow them out separately. This can be done by plugging the holes in three of the bearings and placing the nozzle of the air gun in the oil inlet of the cylinder bearing oil passages. Continue this until all passages are clean. Blow through the passages to the camshaft bearings.

(4) Blow out the rocker arm shaft oil line. Blow out oil pump pipes.

(5) Clean carbon from piston heads,ring grooves and inside of piston head. Clean carbon from cylinder head combustion chambers and valve ports with carbon removing brush. Clean valve guides with valve guide cleaner. Clean valve stems and heads on a buffing wheel.

(6) Check the cylinder block for cracks in the cylinder walls, water jacket and main bearing webs.

(7) Check the cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a inside dial gage (Fig. 53). Set the gage so that the thrust pin must be forced in about 6 mm to enter gage in cylinder bore. Center gage in cylinder and turn dial to "0". Carefully work gage up and down cylinder to determine taper and turn it to different points around cylinder wall to determine the out-of-round condition.

(8) Set the gage to the standard cylinder size using a pair of micrometers. Then, by checking the cylinders, the oversize pistons required and the amount necessary to be removed from the cylinders can be determined.

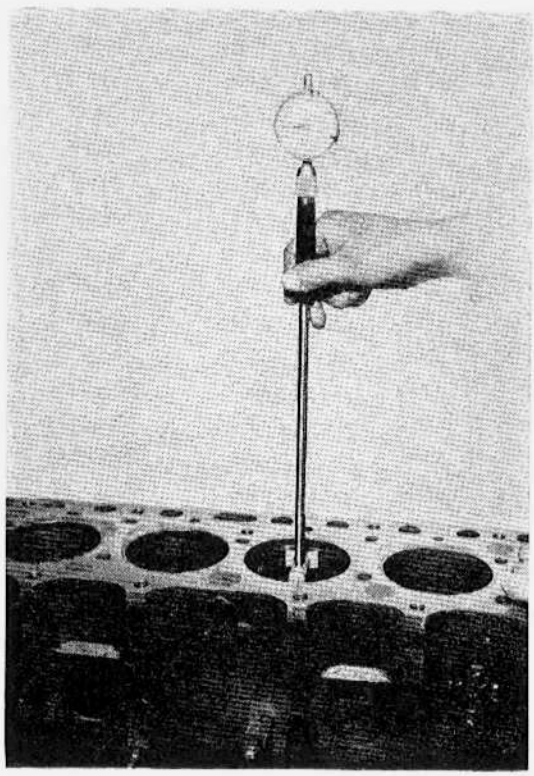


Figure 53 – Checking Cylinder Bore with Inside Dial Gage

(9) Inspect the main bearings for wear or damage that would make replacement necessary.

(10) Inspect camshaft bearings for wear or damage that would make replacement necessary.

NOTE: Camshaft bearings should not be removed from the case unless new bearings are to be installed.

(11) Inspect the camshaft for damaged cams or bearing journals. If the journals are out-of-round more than 0.025 mm the shaft should be replaced. Check the fit of the camshaft in the bearings.

(12) Inspect the crankshaft journals and crankpins for roughness and scores. Check them with a micrometer for out-of-round or taper. If out of-round more than 0.025 mm or tapered, the shaft should be replaced or reconditioned.

(13) Inspect the connecting rod bearings for damage that would make replacement necessary.

(14) Determine whether or not pistons are to be replaced. New piston assemblies and rings are required when the cylinders are to be honed or rebored. If the pistons are to be used again, check the piston pin fit.

(15) Inspect the crankshaft and camshaft gears for excessive tooth wear and for loose hub in camshaft gear. Inspect the camshaft thrust plate for excessive wear.

(16) Check the cylinder head for being warped, for having clogged water passages, cracked valve seats or worn valve guides.

(17) Inspect the manifolds for excessive carbon in the ports. Check the operation of the heat control valve and make sure that the gasket between the manifolds is in good condition.

(18) Inspect the oil pump gears for wear, check the shaft for looseness in the body and the inside of cover for wear that would permit oil to leak past end of gears.

(19) Instructions for inspection and repair of the fuel pump, carburetor, air cleaner, generator, starter motor, distributor, clutch and water pump will be found in their respective sections of this maunal.

14. ENGINE REPAIRS.

Some of the following repair operations may not be required on all engine overhauls, depending upon the result of the inspections made. In making some of the repairs, certain engine assembling operations must be performed; therefore, the assembling operations will start with the engine partly assembled as covered under repair operations.

a. Cylinder Conditioning.

If the cylinder block inspection indicated that the block was suitable for continued use except for out-of-round or tapered cylinders, they can be conditioned by honing or boring and honing.

High limit standard size pistons are available for service use so that proper clearances can be obtained for slightly worn cylinder bores and blocks requiring only light honing to clean up the bores.

The pistons are serviced in .010″, .020″, .030″, .040″ oversizes. If the cylinders

were found to have less than 0.05mm taper or wear they can be conditioned with a hone and fitted with the high limit standard size pistons. If more than 0.05mm taper or wear they should be bored and honed to the smallest oversize that will permit complete resurfacing of all cylinders. The use of an inside dial gage set up with a pair of micrometers to the standard cylinder bore size as outlined under "Cleaning and Inspection," will aid in determining the size pistons for which the cylinders must be bored.

(1) Cylinder Boring.

(a) Before using any type boring bar, the top of the cylinder block should be filed off to remove any dirt or burrs. This is very important, otherwise the boring bar may be tilted which would result in the rebored cylinder wall not being at right angles to the crankshaft.

(b) In engine the piston to be fitted should be checked with a micrometer, measuring at the piston skirt and at right angles to the piston pin (Fig. 54). The cylinder should be bored to the same diameter as the piston.

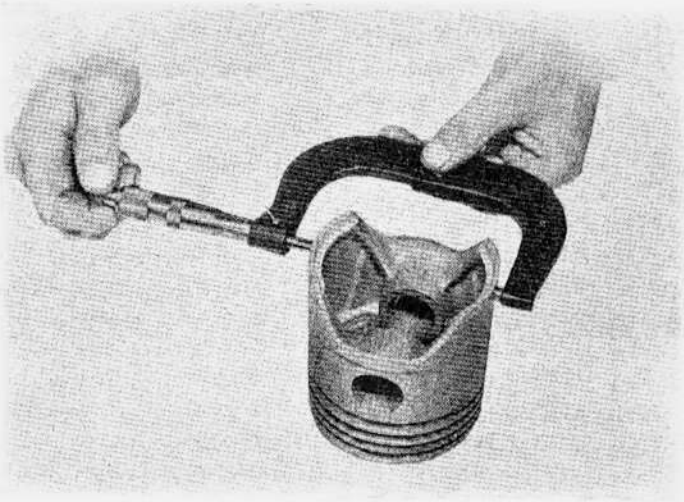


Figure 54 – Measuring Piston Skirt

(c) If a micrometer is not available to measure the piston, the cylinder should be bored .002″ (0.05mm) less than the overize piston to be fitted. For example, when fitting a .020″ (0.5mm) oversize piston, the cylinder should be bored .018″ (0.45mm) oversize.

(d) The instructions furnished by the manufacturer of the equipment being used should be very carefully followed (Fig. 55).

NOTE: Piston with piston pin attached is available in the following nominal sizes. Each nominal size is again available in five different sizes spaced 0.01 mm apart.

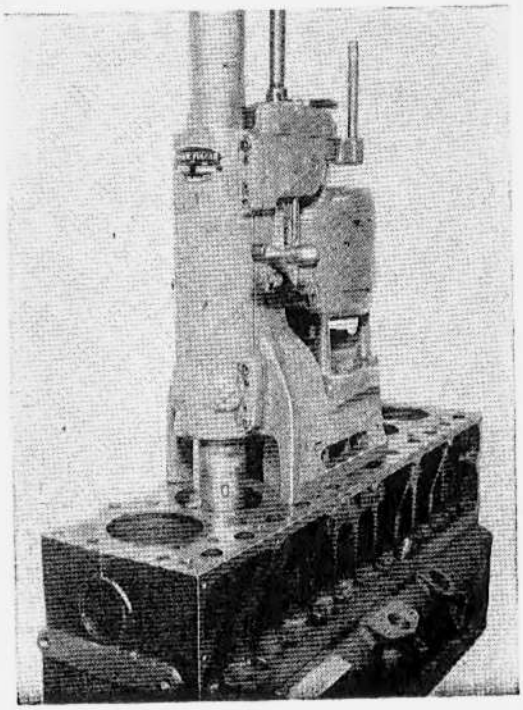


Figure 55 – Cylinder Boring

Nominal Size	O.D. (Actual Size)
STD	89.960 mm 89.970 89.980 89.990 90.000
0.010″ O/S	90.214 mm 90.224 90.234 90.244 90.254
0.020″ O/S	90.468 mm 90.478 90.488 90.498 90.508
0.030″ O/S	90.722 mm 90.732 90.742

	90. 752 90. 762
0.040″ O/S	90. 976 mm 90. 986 90. 996 91. 006 91. 016

These sizes are marked on the label pasted on outer side of paper-carton containing the pistons, an example of which is shown in the Figure 56.

Figure 56 – Selecting Piston Size

(Example) Figure 56 is 0.010″ O/S piston with outer diameter of 90.224 mm.

(2) Cylinder Honing and Piston Fitting.

(a) When the cylinders are to be honed only for high limit standard size pistons or for final finishing after they have been rebored to within .002″ (0.05 mm) of the desired size, they should be finish honed and polished with a hone similar to the one shown in Figure 57. This is an expanding type hone with the blades or stones expanding when the nut on top of the hone is turned. Rough stones may be used at first and fine stones for the polishing operation.

(b) Place the hone into a cylinder bore and expand the stones until the hone can just be turned by hand. Connect the electric drill of honing machine to the hone and drive hone at drill speed while slowly moving hone up and down entire length of cylinder until hone begins to run free. During this operation a liberal amount of kerosene should be used as a cutting fluid to keep the stones of the hone clean.

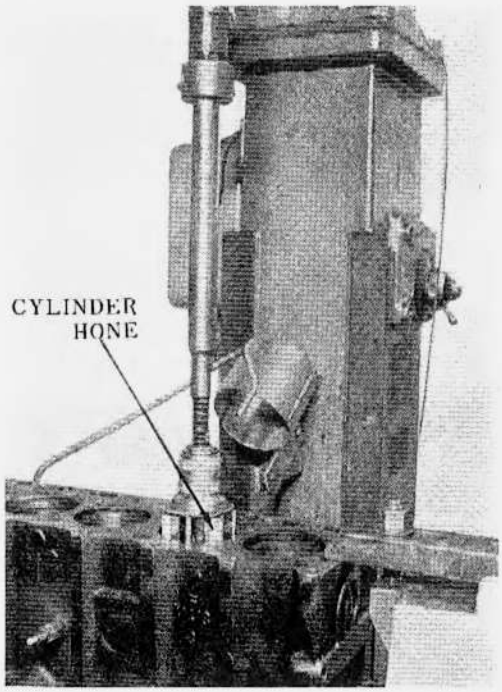


Figure 57 – Cylinder Honing

(c) Expand the stones out against the cylinder bore and repeat the honing operation until the desired bore diameter is obtained (Fig. 57).

(d) Occasionally during the honing operation the cylinder bore should be thoroughly cleaned and the piston selected for the individual cylinder checked for correct fit.

(e) Check fit of the pistons in the following manner;

(1) Invert the piston, skirt end up, and place a .0015″ by ½″ wide feeler ribbon, part of piston fitting gage and scale tool on the side of the piston 90° from the piston pin holes.

(2) Insert the feeler ribbon and inverted piston into the cylinder bore so that the center of the piston pin is flush with the top surface of the cylinder block. Keep the feeler ribbon straight up and down and keep the piston pin parallel with the crankshaft axis.

(3) Pull the feeler gage straight up and out, noting at the same time the scale reading which should be between 2 and 5 pounds (Fig. 58).

(4) If the scale reading is greater than the maximum allowable pull, try another piston or lightly hone the cylinder bore to obtain the proper fit.

(5) Should the scale reading be less than the minimum allowable pull, try another piston, or if standard size, try a standard high limit piston. If proper fit cannot be obtained, it will be necessary to rebore the cylinder to the next oversized piston.

CAUTION: In any given engine, all pistons used must be of the same

nominal size. Although for a given nominal size there are available five different piston sizes as described before, these can be used indiscriminately to obtain proper fit without otherwise affecting the performance of the engine.

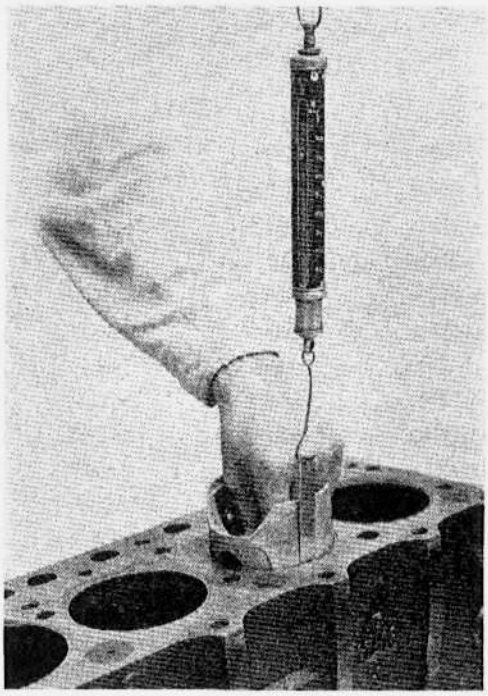


Figure 58 – Fitting Pistons

(6) Mark each piston after fitting to correspond with the cylinder to which it has been fitted. This will assure proper installation.

(f) Permanently mark the piston for the cylinder to which it has been fitted and proceed to hone cylinders and fit the remaining pistons.

CAUTION: Handle the pistons with care and do not attempt to force them through the cylinder until the cylinder has been bored to correct size as this type piston can be distorted through careless handing.

(g) Clean the cylinder bores and block to remove all cuttings.

(3) Cylinder Sleeves.

In cases where the cylinder block, already rebored to fit 0.040″ oversize pistons is worn beyond the limit or where the wear is such that it cannot be bored to fit 0.040″ oversize pistons, the cylinder block can still be made serviceable by fitting on cylinder sleeves. These cylinder sleeves are initially bored and honed to fit standard size pistons, thus making it possible to rebore the sleeves up to 0.040″ oversize. When worn beyond this limit, the old sleeves can be replaced with new sleeves to continue further usage of the cylinder block.

Cylinder sleeves are available in the following three sizes:

Nominal Size	Sleeve O.D.	Cyl. Blk. Bore	Sleeve Bore
	mm mm	mm mm	mm mm
0.160″	94.16 - 94.21	94.06 — 94.10	90.00 — 90.04
0.180″	94.67 — 94.72	94.57 — 94.61	90.00 — 90.04
0.200″	95.18 — 95.23	95.08 — 95.12	90.00 — 90.04

(a) Installing.

At first installation, the smallest size sleeve i. e. 0.160″ nominal size should be used. The cylinder should be bored to 94.06 - 94.10mm and then 0.160″ size sleeve is forced in under pressure with a press. The proper fit is when the sleeve can be pressed in with 2 to 3 tons pressure. (If the forcing-in pressure is less than 2 — 3 tons, bore the cylinder block to fit the next oversize sleeve and insert the next oversize sleeve.) After the sleeve is inserted, bore and hone the sleeve to fit standard size piston i. e. 90.00 - 90.04mm. When the initial sleeve has been bored to 0.040″ oversize and worn out, remove by forcing it out on a press. If found difficult to force out, bore the sleeve to reduce its wall thickness. This will make it easy to remove. After removing the sleeve, insert next oversize sleeve with the same above method.

(4) Piston Pin Fitting.

All new pistons are serviced with properly fitted piston pins; therefore, pin fitting is unnecessary when new pistons are installed. Where cylinder condition and piston fit justify the use of old pistons, it may be desirable to install new piston pins which are available for engines in .005″ oversize. Correct alignment of the bores is essential; therefore, the following procedure should be carefully followed.

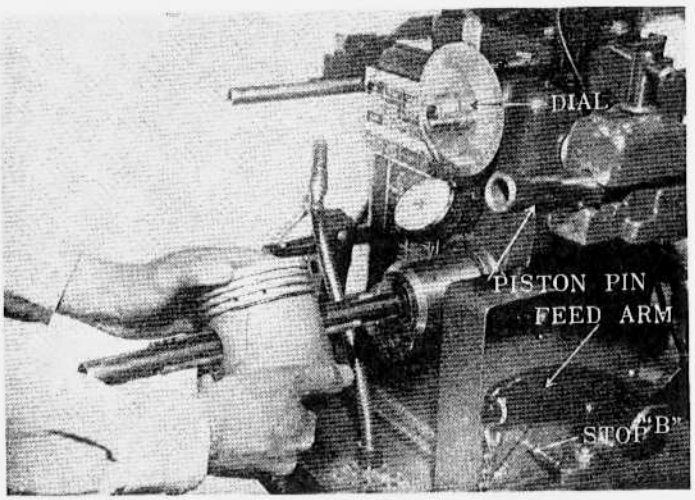


Figure 59 - Honing Machine

The proper fit between the piston pin and piston boss is 0.002 mm at 20°C. Piston pin fitting can be made to great accuracy by using a honing machine (Fig. 59).

The procedure for operating this honing machine is outlined below:

(a) The mandrel selector of honing machine is tapered so that it can be inserted into the piston pin hole. As shown in Figure 60, slip the selector into the hole until snug and read from the scale the largest size mandrel that will go through the hole.

(b) From the reading obtained, select the proper size mandrel and install it in the spindle chuck of honing machine.

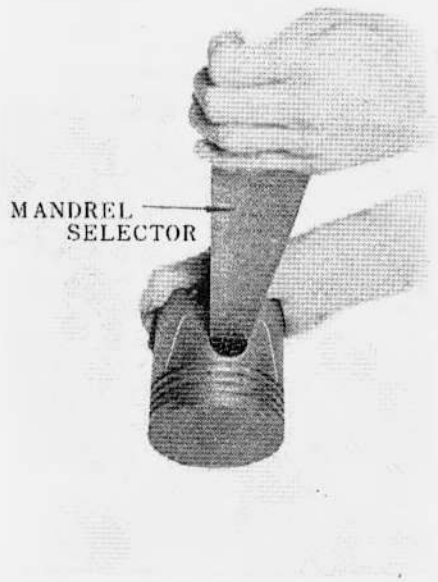


Figure 60 – Mandrel Selector and Piston

(c) Adjust the flexible oil hose to direct honing oil on the mandrel. Turn motor on and regulate oil to a steady flow with just enough pressure to cover the stones.

(d) With motor on, turn micrometer dial to left, retracting stone within mandrel. Place work on rear of mandrel and depress foot pedal until feed arm hits STOP B. Then while stroking the work back and forth, slowly turn dial to right until the stone start to cut.

Always start honing on the back of mandrel. Take a few strokes to permit the stone to seat, then gage hole on pin fitting gage to determine amount of stock to be removed.

(e) Advance the dial the amount indicated by the gage [allowing .001″ (0.025 mm) to .0015″ (0.038 mm) for finishing] and start rough honing.

(f) Always put work on before mandrel starts turning. Press foot pedal all the way down so feed arm rests on STOP B and stroke back and forth about 100 strokes per minute. When stone start cutting free, release foot pedal and again gage work.

(g) If hole is not yet to size, advance dial the additional amount indicated by gage and continue honing.

(h) With the first hole honed to size, the machine is set to rough out other holes to the same size, the only necessity being to advance the dial for each succeeding part enough to take up for stone wear.

NOTE: Reverse work end for end frequently, stopping mandrel before removing work. Take work off stone immediately when it cuts free.

(i) After all parts have been roughened to size, insert mandrel with finishing stone and set machine as for rough honing. Advance dial the amount required for finishing and start honing.

(j) Try the first pin for fit and when correct, the machine is then set for finishing all other parts to that same size. The dial may require advancing a slight amount with each part to compensate for stone wear.

NOTE: Be sure that finishing mandrel and stone are true before using.

b. Camshaft.

The camshaft bearing journal sizes are as follows:

Front	47. 955 mm ~ 47. 975 mm	Second	46. 455 mm ~ 46. 475 mm
Third	44. 955 mm ~ 44. 975 mm	Rear	43. 455 mm ~ 43. 475 mm

These dimensions should be checked with a micrometer for an out-of-round condition. If the journals exceed 0.025 mm out-of-round, the camshaft should be replaced.

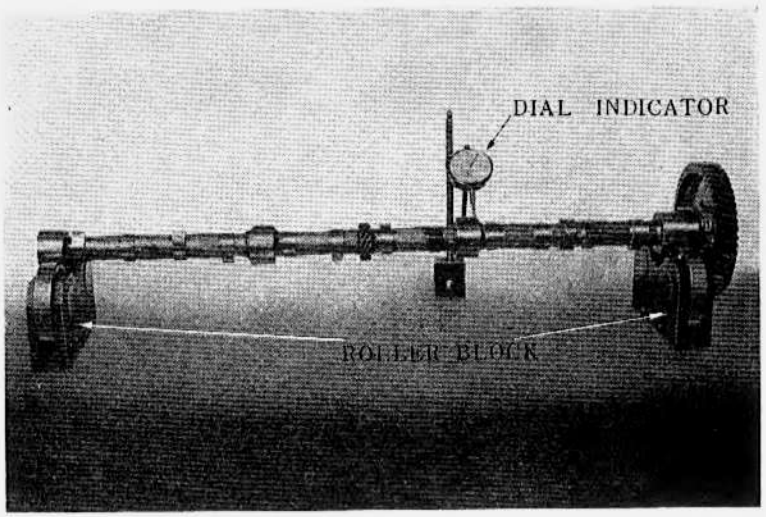


Figure 61 – Checking Camshaft Alignment

The camshaft should also be checked for alignment. The best method is by use of roller blocks else "V" blocks and a dial indicator (Fig. 61). The dial indicator will indicate the exact amount the camshaft is out of true.
If it is out more than 0.05 mm dial indicator reading, the camshaft should be straightened. When checking, the high reading of the dial indicator indicates the high point of the shaft. This point should be chalk marked to tell exactly where to apply pressure when straightening.

NOTE: During the straightening operation, care should be taken to protect the bearing journals and prevent damage of their surfaces.

After the camshaft has been straightened, it should be rechecked to be sure it is within 0.05 mm dial indicator reading for alignment.

c. Camshaft Bearings.

All four of the steel backed, babbitt lined camshaft bearings are pressed into the crankcase and staked in place to prevent rotation or endwise movement in the bores. The camshaft bearings are lubricated through holes that line up with oil passages leading from the main bearings.

Replacement of these bearings is seldom necessary; however, if the inspection previously made indicates that replacement is necessary the camshaft bearing removing and replacing tools shown in Figure 62 must be used.

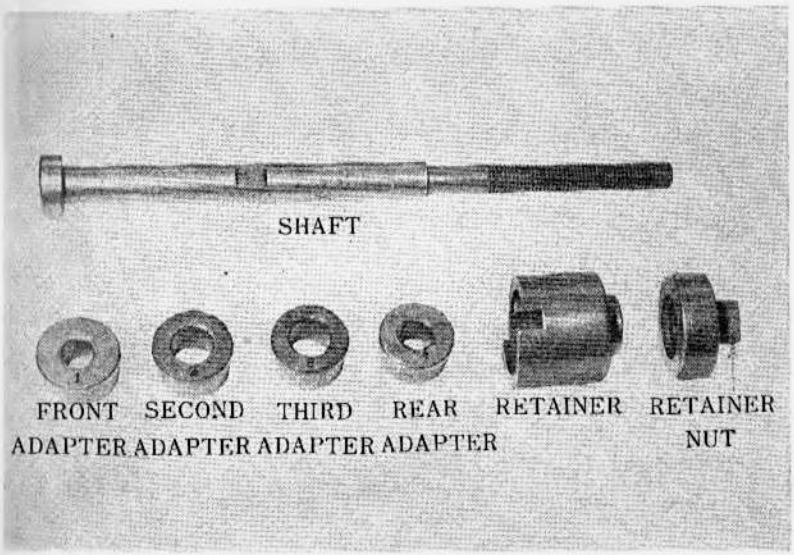


Figure 62 – Camshaft Bearing Replacer (BX SST-1025)

(1) Removal.

(a) With camshaft removed, drive out expansion plug at the rear end of rear camshaft bearing from the cylinder block, driving it out from the inside.

(b) Remove front and second bearings using camshaft bearing replacer (BX SST-1025) as follows:

Place front and second bearing adapters against the rear ends of their respective bearings and place replacer retainer against the front part of cylinder block. Insert the replacer shaft into these three parts and screw on retainer nut to replacer shaft. Hold the slotted portion of shaft with a wrench to prevent the shaft from turning. By screwing in the retainer nut with another wrench, the front and second bearings will be pulled out to the front (Fig. 63).

NOTE: The bearing adapters are marked with the bearing numbers.

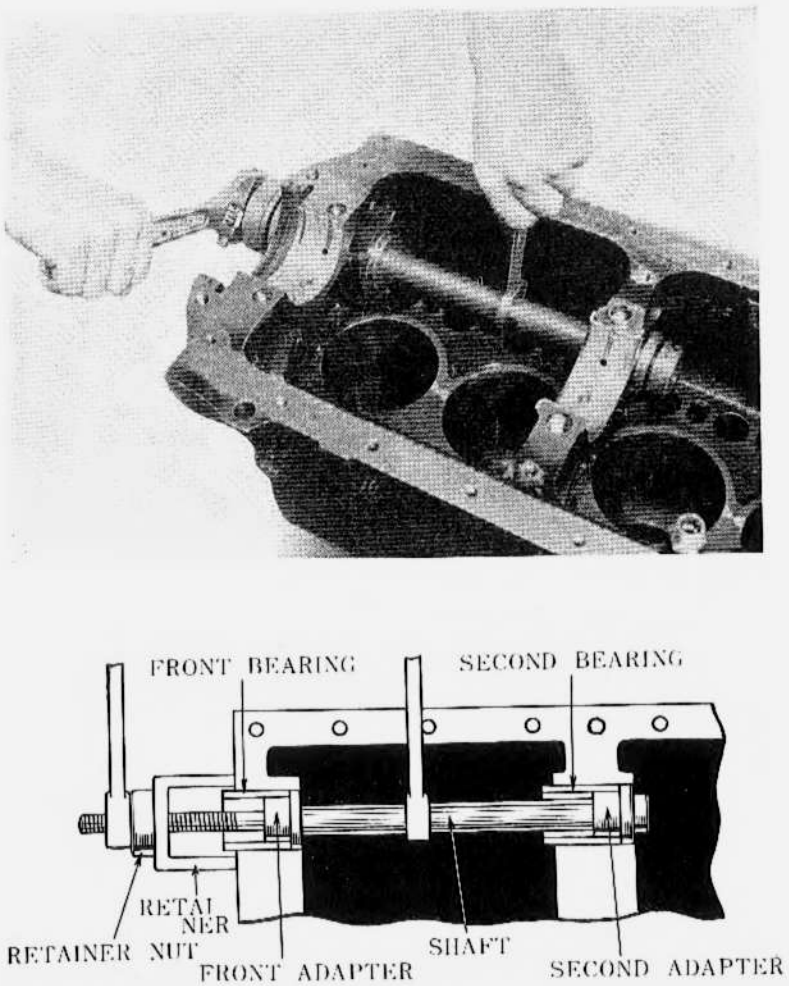
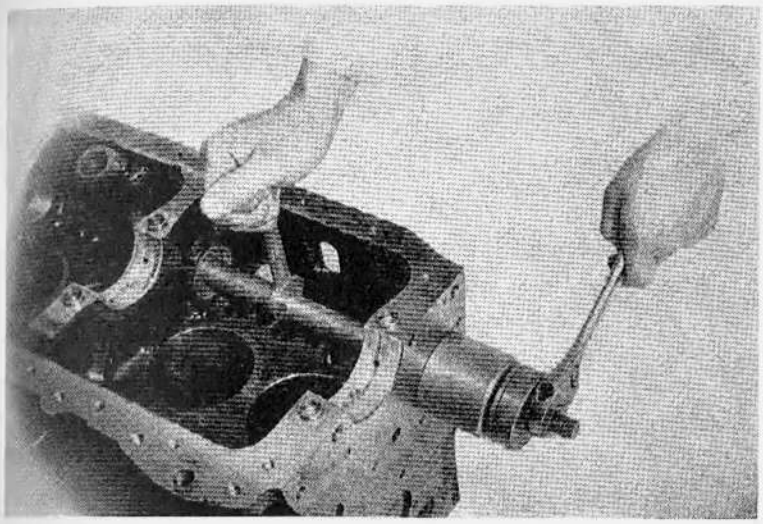


Figure 63 - Removing Camshaft Front and Second Bearings

(c) Remove third and rear bearings using camshaft bearing replacer in similar manner. However, in this case use third and rear adapters and pull out bearings to the rear of cylinder block (Fig. 64).



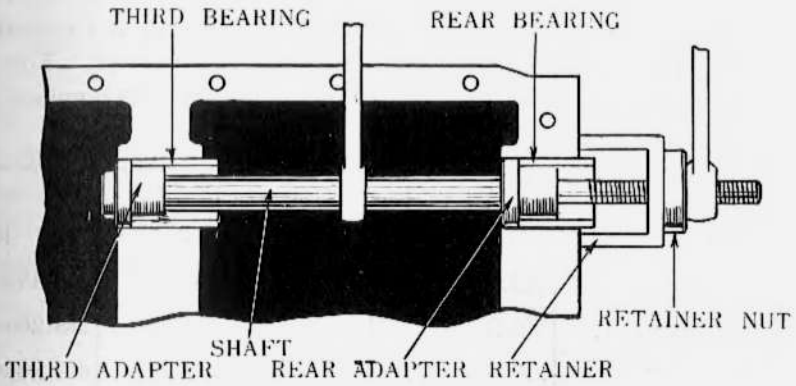


Figure 64 -- Removing Camshaft Third and Rear Bearings

(2) Inspection.

(a) Measure camshaft journal diameters with a micrometer. Measure camshaft bearing inner diameters with an inside dial gage (Fig. 65). The difference between the bearing inner diameter and journal diameter is the bearing clearance. If this value exceeds 0.15 mm, the camshaft bearing must be replaced.

(b) Bearings showing excessively poor contact, worn thin, partially melted or heavily scored must be replaced with new bearings.

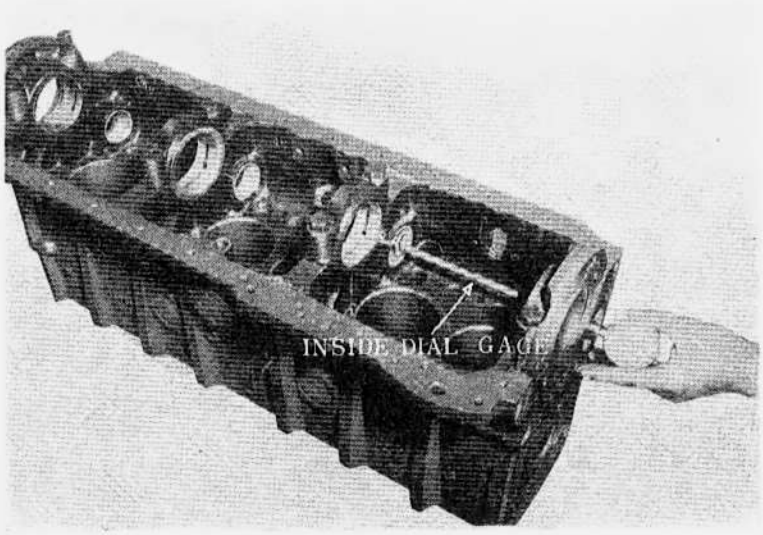


Figure 65 – Measuring Camshaft Bearing Bore

(3) Replacement.

(a) By the time the camshaft bearings are worn to require replacement, the camshaft journals will also be worn out-of-round. Thus, when replacing bearings, the camshaft journals must first be reground on a camshaft grinder to sizes which will permit use of undersize camshaft bearings. The diameters to which the camshaft journals must be reground to fit the nominal undersize bearings are shown in the table below.

Brg. Size	Camshaft Journal Diameters			
	Front	Second	Third	Rear
STD	47.955–47.975 mm	46.455–46.475 mm	44.955–44.975 mm	43.455–43.475 mm
0.010″ U/S	47.701–47.721	46.201–46.221	44.701–44.721	43.201–43.221
0.020″ U/S	47.447–47.467	45.947–45.967	44.447–44.467	42.947–42.967
0.030″ U/S	47.193–47.213	45.693–45.713	44.193–44.213	42.673–42.713
0.040″ U/S	46.939–46.959	45.439–45.459	43.939–43.959	42.439–42.459

(b) Before installing bearings, mark the position of the oil hole in the bore on the front face of each bearing bore to enable lining up the oil hole in the bearing with that in the bore.

(c) Install the new proper sized camshaft bearings using camshaft bearing replacer (BX SST-1025). Install by similar methods to that employed in removing the old bearings.

NOTE: Make sure to line up the bearing oil holes with those in the bearing bores when installing the new bearings.

(d) After installing the four undersized bearings, ream the bearing bores

using a line reamer (Fig. 66) and ream to provide bearing clearance of 0.025 – 0.075 mm.

NOTE: If the bearings have been properly installed, only a very light cut is required to ream the bearings to proper size.

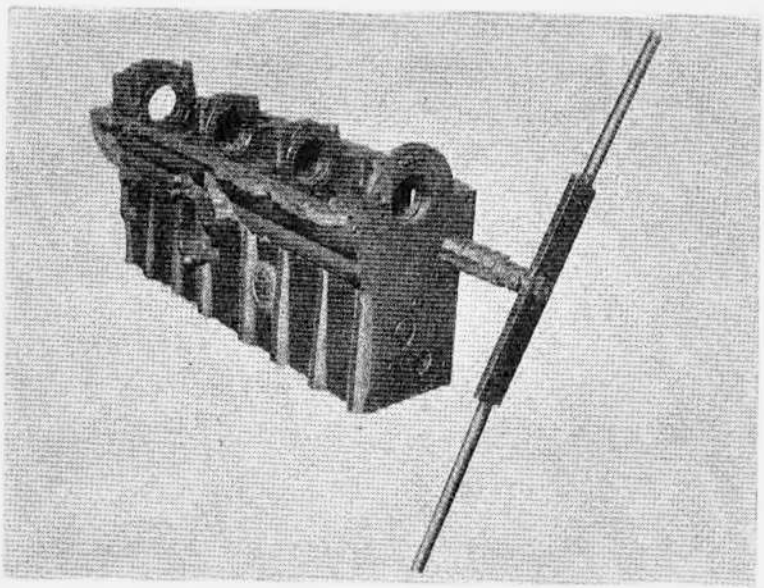


Figure 66 Line Reaming Camshaft Bearings

(e) Blow all cuttings from the bearings with compressed air and wash cylinder block out thoroughly with cleaning solvent. Blow out all oil passages.

(f) Install a new camshaft end plug in the back end of the cylinder block at the rear camshaft bearing.

d. Crankshaft.

The crankshaft main bearing journal and crankpin journal sizes are as follows:

Front	66.970 mm – 67.000 mm
Second	68.470 mm – 68.500 mm
Third	69.970 mm – 70.000 mm
Rear	71.470 mm – 71.500 mm
Crankpin journal	53.980 mm – 54.000 mm

These dimensions should be checked with a micrometer for out of round, taper or undersize. If the journal exceeds 0.025 mm out-of-round or taper, the crankshaft should be replaced or reconditioned to an undersize figure that will enable the installation of undersize bearings.

The crankshaft should also be checked for runout. To perform this operation, support the crankshaft as shown in Figure 67 and indicate the runout

of all the front, second, third and rear journals using a dial indicator.

The runout limit of each of these journals is 0.05 mm. If the runout exceeds 0.05 mm, the crankshaft must be straightened.

In reconditioning the crankshaft, the main bearing journals must be reground on a crankshaft grinder to the sizes shown in the following table.

NOTE: For a given nominal undersize, the journals must be finished to the diameters listed under that nominal undersize.

Crankshaft Main Bearing Journal Diameter (unit mm)				Nominal Undersize
Front	Second	Third	Rear	
66.716—66.746	68.216—68.246	69.716—69.746	71.216—71.246	.010″ U/S
66.462—66.492	67.962—67.992	69.462—69.492	70.962—70.992	.020″ U/S
66.206—66.236	67.706—67.736	69.206—69.236	70.706—70.736	.030″ U/S
65.952—65.982	67.452—67.482	68.952—68.982	70.452—70.482	.040″ U/S

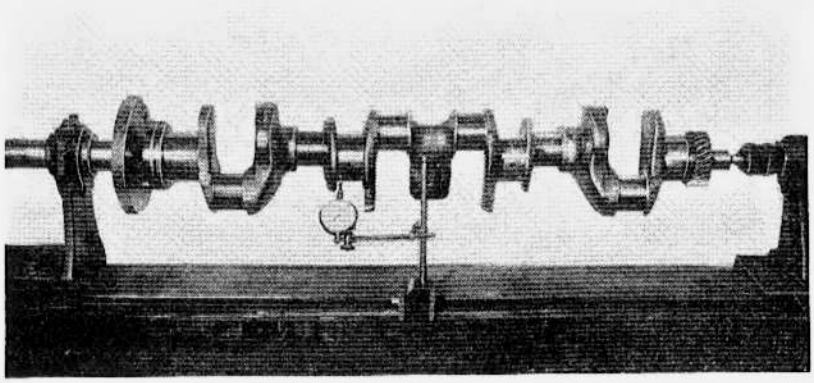


Figure 67 - Checking Crankshaft Runout

e. Main Bearing.

In general, the lower half of the bearing shows a greater wear and the most distress from fatigue. If upon inspection, the lower half is suitable for use, it can safely be assumed that the upper half is also satisfactory. If the lower half is fatigue cracked to the point of near failure, both upper and lower halves should be replaced. Never should one-half be replaced without replacing the other half.

Experience has shown that clearance increase from wear in main bearing is not only due to bearing wear, but is also due in part to crankshaft journal wear. Thus, when found necessary to replace bearings, always measure the crankshaft journal diameters to check the amount of wear and recondition the crankshaft to allow use of semi-undersized bearing.

Semi-undersized bearings are manufactured with their bores left unfinished, thus making it necessary to line-bore these bearings to fit the reconditioned crankshaft. Two sizes of semi-undersized bearings are available; those to be line-bored to fit crankshaft journals reground to nominal undersizes of from 0.010″ to 0.030″ and those to be line–bored to fit crankshaft journals reground to nominal undersize of 0.040″.

(1) Inspection.

(a) Bearings showing excessively poor contact, worn thin, partially melted or heavily scored must be replaced with new bearings.

(b) Check bearing clearance using plastigage. If bearing clearance exceeds 0.08 mm, bearings must be replaced with new bearings.

(c) Check the end play by forcing the crankshaft to its extreme rear position and measuring at the rear side of the third bearing with a feeler gage (Fig. 68). If this end play exceeds 0.25 mm, the third thrust bearing must be replaced with new bearing.

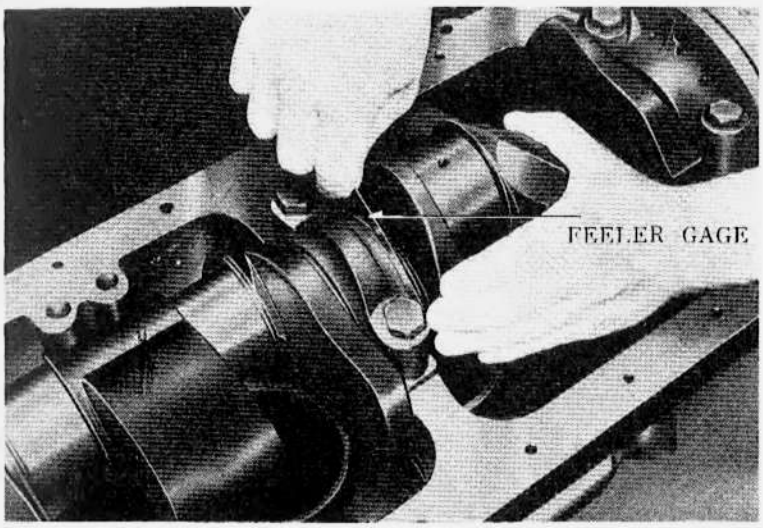


Figure 68 – Checking Crankshaft End Play

(2) Replacement.

(a) Remove old bearings if not already removed from cylinder block and caps.

(b) Set cylinder block in line-boring machine. Set center of line boring bar on the the basis of crankshaft main bearing housing bores.

(c) Install semi-sized bearing upper and lower halves into main bearing housings and caps using 0.2 mm shim under each side of bearing cap.

NOTE: Main bearings with oil holes are the upper halves of the bearings and are inserted between the crankshaft and cylinder block.

(d) Measure the diameters of reconditioned crankshaft journals with a micrometer. The journal diameter plus 0.04 mm oil clearance is the value to which the semi-undersized bearing must be line-bored (Fig. 69).

NOTE:

(1) Crankshaft journals must always be reground to size when semi-undersized bearings are used.

(2) Always install a 0.2 mm shim under each side of bearing cap.

(3) Make sure to tighten bearing caps to specified torques as follows:

Front, second, third ..... 90 — 110 ft-lbs

Rear ..... 75 — 90 ft-lbs

(4) Make sure that bearing backs and cylinder block and cap bores are absolutely clean.

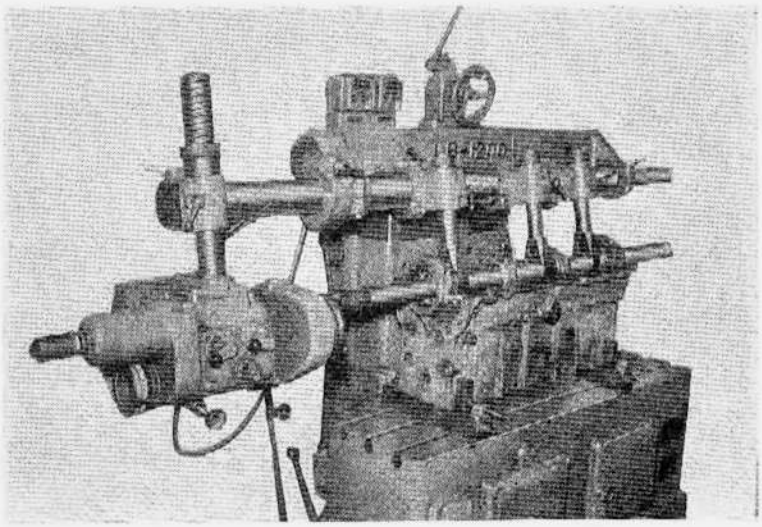


Figure 69 – Line Boring Main Bearings

(e) Use side cutter on line boring bar and machine both sides of third bearing to adjust end play. This end play should be from 0.03 to 0.13 mm.

NOTE: Make sure that the same amount of metal is removed from both sides of the third bearing to maintain alignment between pistons and crankshaft.

(f) Blow all cuttings from the bearings with compressed air and wash cylinder block out thoroughly with cleaning solvent. Blow out all oil passages.

(g) Apply engine oil thoroughly to all main bearings and crankshaft main journals.

(h) Replace crankshaft and install bearing caps, tightening cap bolts to following torque.

And then lock cap bolts with locks.

Front ..... 95 — 110 ft-lbs

Second ..... 95 — 110 ft-lbs

Third ..... 95 — 110 ft-lbs

Rear ..... 75 — 90 ft-lbs

(3) Instructions for using **PLASTIGAGE.**

Plastigage consists of a wax-like plastic material which will compress evenly between the bearing and journal surfaces without damaging either surface. To obtain the most accurate results with Plastigage, certain precautions should be observed.

NOTE: To assure the proper seating of the crankshaft, remove crankshaft rear oil seal. In addition, preparatory to checking fit of bearings the surface of the crankshaft journal and bearing should be wiped clean of oil. If the plastigage check is to be made on engine in the chassis, the crankshaft must be supported by a jack or blocks, up against the upper bearings.

(a) Starting with the rear main bearing, remove bearing cap and wipe oil from journal and bearing cap.

NOTE: The other bearings must be left at their specified torque.

(b) Place a piece of plastigage the full width of the bearing (parallel to the crankshaft) on the journal (Fig. 70).

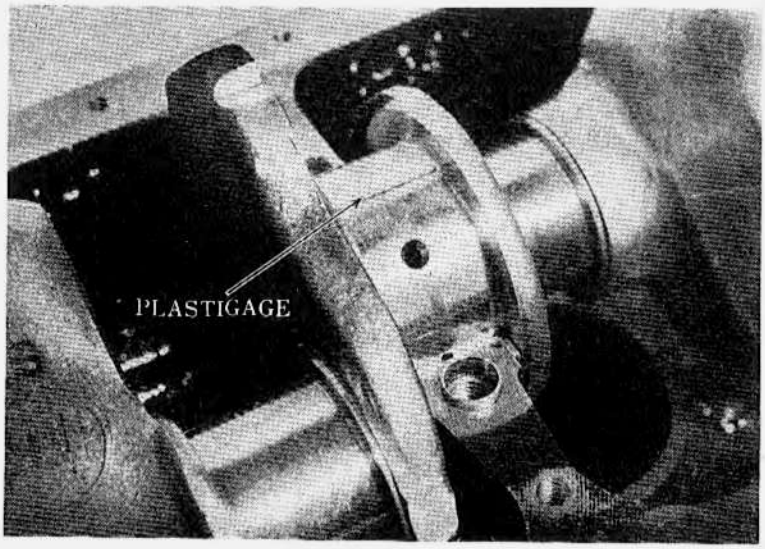


Figure 70 – Plastigage on Journal

(c) Install the bearing cap and shims removed and evenly tighten the retaining bolts to 75—90 ft-lbs torque.

(Front, second, third 95 110 ft-lbs torque.)

CAUTION: Do not rotate the crankshaft while the plastigage is between the bearing and journal.

(d) Remove bearing cap, the flattened plastigage will be found adhering to either the bearing or journal. On the edge of plastigage packing envelope

there is a graduated scale which is correlated in thousandths of a mm.

(e) Without removing the plastigage, check its compressed width (at the widest point) with the graduations on the plastigage envelope (Fig. 71).

NOTE: Normally, main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal be sure to fit to the maximum diameter of the journal. If the bearing is fitted to the minimum diameter of the journal and the journal is out-of-round 0.0254 mm or more, interference between the bearing and journal will result in rapid bearing failure. If the flattened plastigage tapers toward the middle or ends, there is a difference in clearance indicating a taper, low spot or other irregularity of the bearing or journal. Be sure to check the journal with a micrometer it the flattened plastigage indicates more than 0.0254 mm difference.

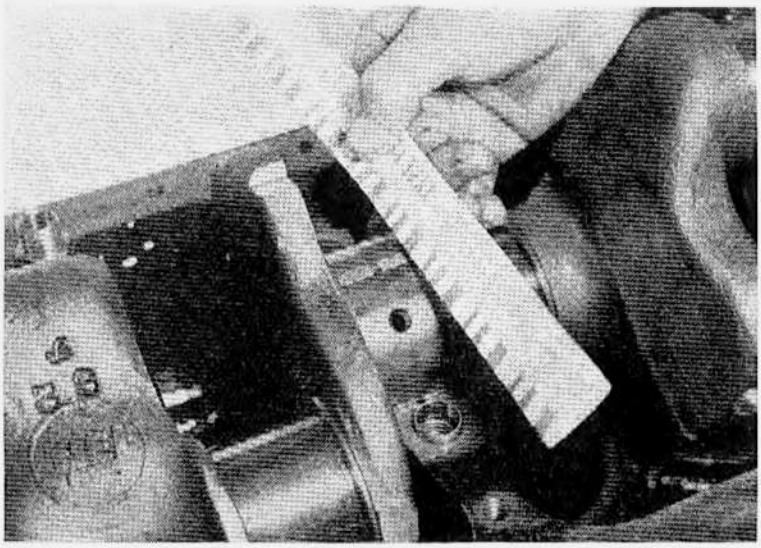


Figure 71 – Measuring Plastigage

f. Crankshaft Rear Oil Seal - Replacement.

Sealing at the crankshaft rear main bearing is made very effective due to machining a groove in the rear bearing cap and cylinder block to receive an oil seal (Fig. 72).

NOTE: Whenever this oil seal or rear bearing cap is removed, the oil seal must be replaced with new part otherwise adequate oil sealing at this part cannot be assured.

To replace the oil seal in the rear main bearing cap and block, proceed as outlined below.

NOTE: Due to the form of oil seal used (Fig. 72), it is necessary that

the flywheel be removed from the crankshaft rear flange to enable oil seal replacement.

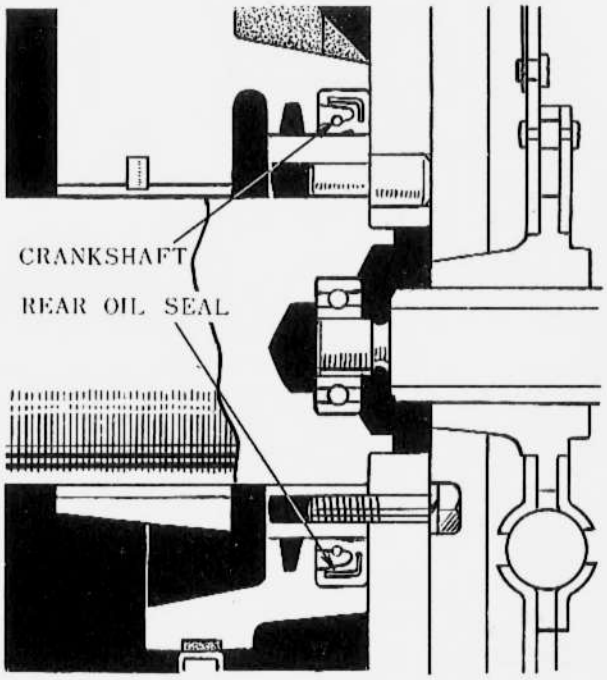


Figure 72 – Crankshaft Rear Oil Seal

(1) Remove rear bearing cap.

(2) Remove old oil seal from groove. Oil seal can be removed by removing only the rear bearing cap without necessity of removing front, second, and third bearing caps.

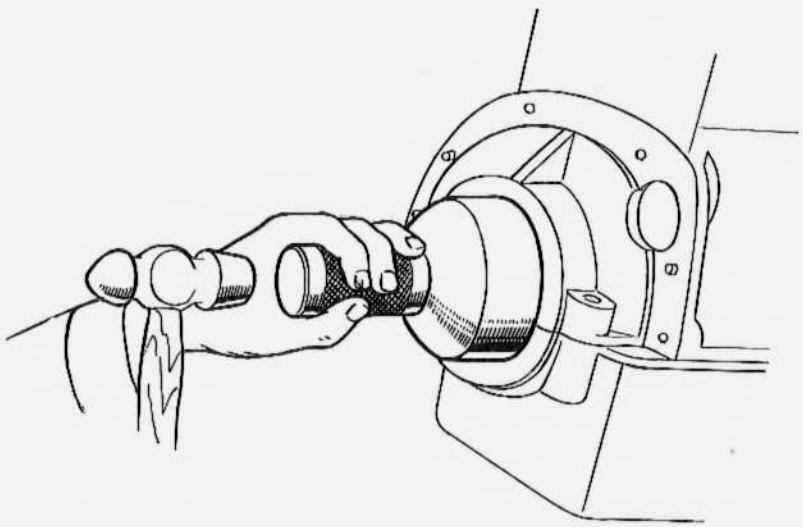


Figure 73 – Installing Crankshaft Rear Oil Seal

(3) Install rear bearing cap. Tighten rear bearing cap bolts to 75 to 90 ft-lbs torque and lock bolts with cap bolt locks.

(4) Make sure oil seal groove is clean.

(5) Apply thin coat of oil on new oil seal and install into oil seal groove using replacer (FA70 SST-1072) (Fig. 73).

The inner surface of the oil seal slides against the crankshaft rear flange to prevent oil leaking out from this part.

15. ASSEMBLY-CYLINDER BLOCK.

a. Front End Plate.

(1) Install new oil gallery plugs at front and rear face of block making sure they seat properly.

(2) Install new front end plate gasket and end plate, and hold in position with three screws and two hex head bolts. Tighten screws to 15—25 foot-pounds and stake securely at bottom of slot.

NOTE: Make sure the gasket surfaces on block and on end plate are thoroughly cleaned.

b. Timing Gear Oil Nozzle.

The timing gear oil nozzle is a screw-cap type. Examine the oil nozzle and in the event it is damaged, the oil nozzle can be replaced with a new one.

NOTE: In replacing timing gear oil nozzle, screw oil nozzle into front end plate a few turns and position the small oil feed hole of oil nozzle such that the oil will be directed against the timing gear (Fig. 74). Peen edge of oil nozzle on front end plate.

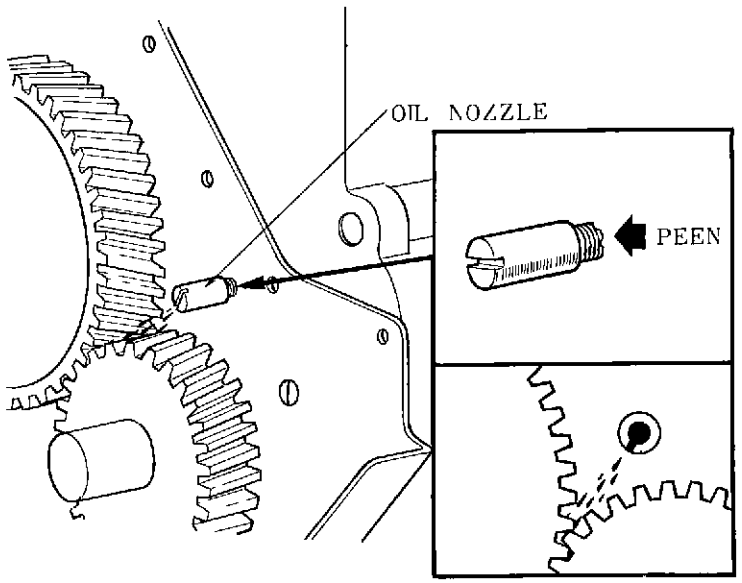


Figure 74 – Installing Timing Gear Oil Nozzle

c. Crankshaft Gear.

(1) Place key in the keyway in crankshaft.

(2) Place the crankshaft gear on the end of crankshaft with keyway in line with key.

(3) Drive the gear onto the shaft, using replacer (BX SST–1023) until gear bottoms against shoulder on shaft (Fig. 75).

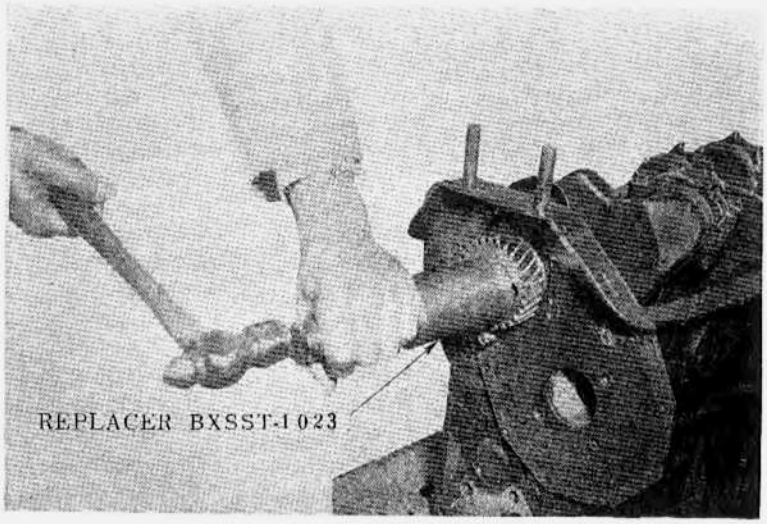


Figure 75 – Installing Crankshaft Gear

d. Camshaft, Camshaft Gear and Thrust Plate.

(1) If the inspection indicated that the camshaft, gear and thrust plate were in good condition, the camshaft end play should be checked (Fig. 76).

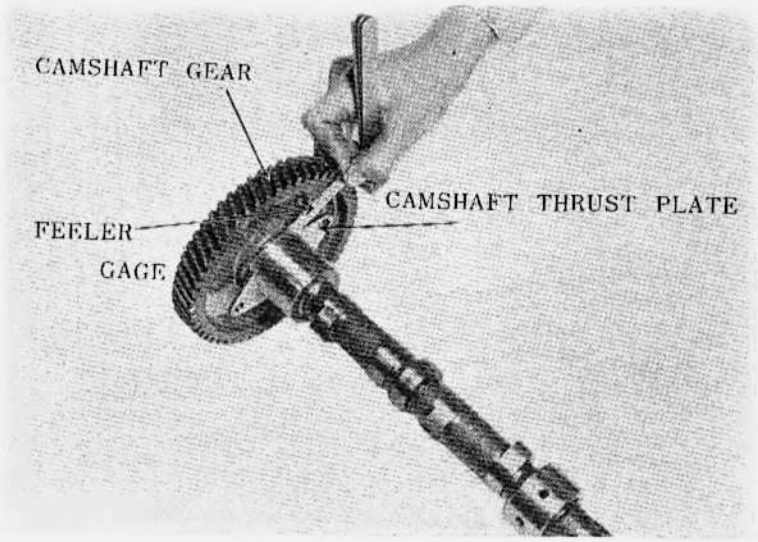


Figure 76 – Checking Camshaft End Play

If this clearance is over 0.15 mm the gear should be pressed onto the shaft until the thrust plate will turn free, but does not have over 0.15 mm clearance.

(2) If the inspection indicated that the shaft, gear or plate should be replaced, the gear must be removed from the shaft.

(3) Remove camshaft snap ring (Fig. 77). Place the camshaft on table of a press and press shaft out of gear (Fig. 78).

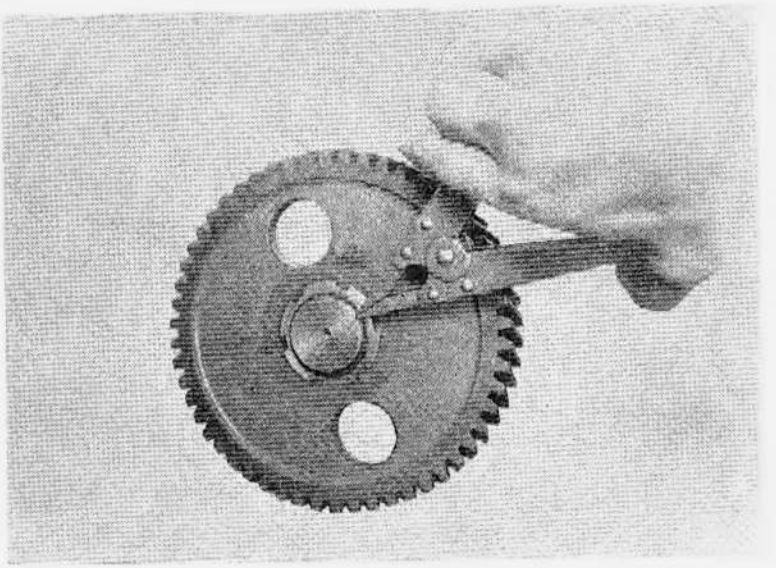


Figure 77 – Removing Camshaft Snap Ring

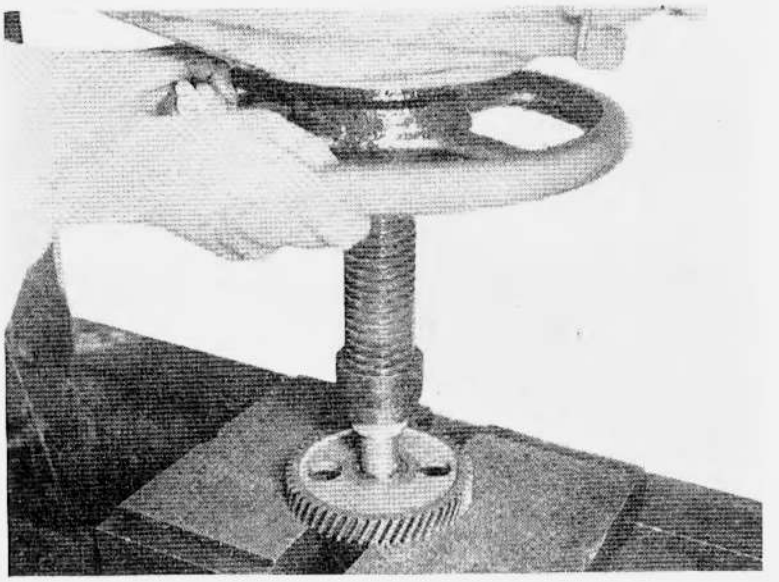


Figure 78 – Removing Camshaft Gear

CAUTION : Thrust plate must be so positioned that woodruff key in

shaft does not damage it when shaft is pressed out of gear.

(4) To assemble camshaft gear and thrust plate to shaft, firmly support shaft at back of the front journal in an arbor press. Place thrust plate over end of shaft, make sure woodruff key is seated in shaft keyway, install camshaft gear and press into position (Fig. 79).

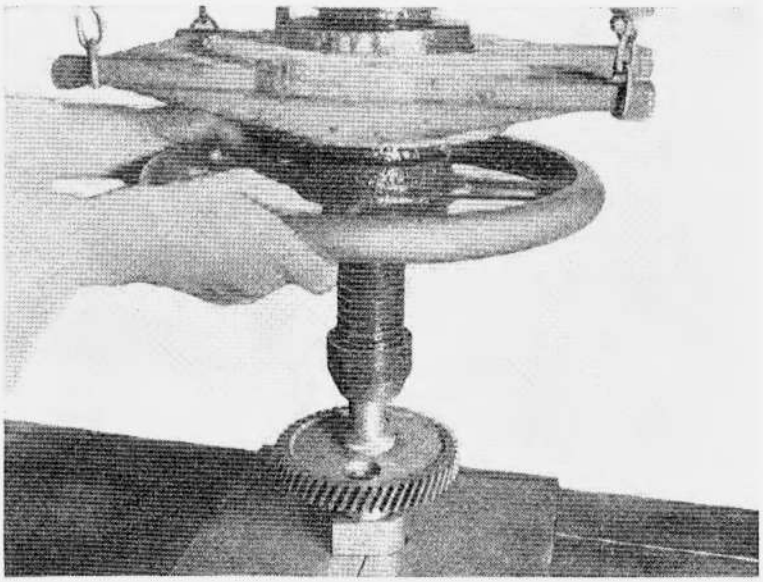


Figure 79 – Replacing Camshaft Gear

NOTE: Press on the steel hub of the gear or the gear will be seriously damaged.

(5) As the gear is being pressed onto the shaft, check space between thrust plate and shoulder of shaft. The plate must turn freely, but not have over 0.11 mm clearance.

(6) Install camshaft assembly being careful not to damage bearings or cams.

(7) **Turn crankshaft and camshaft so that the Valve Timing Marks on the gear teeth will line up and push camshaft into position.** Install camshaft thrust plate bolts to block and tighten them securely.

(8) Check camshaft and crankshaft gear runout with a dial gage (Fig. 80). The camshaft gear runout should not exceed 0.10 mm and the crankshaft gear runout should not exceed 0.08 mm.

(9) If gear runout is excessive, the gear will have to be removed and any burrs cleaned from the shaft or the gear replaced.

(10) Check the backlash between the gear teeth with a narrow feeler gage (Fig. 81). The backlash should not be less than 0.08 mm nor more than 0.20 mm.

e. Oil Deflector.

Before installing timing gear cover, install oil deflector in front of crankshaft gear.

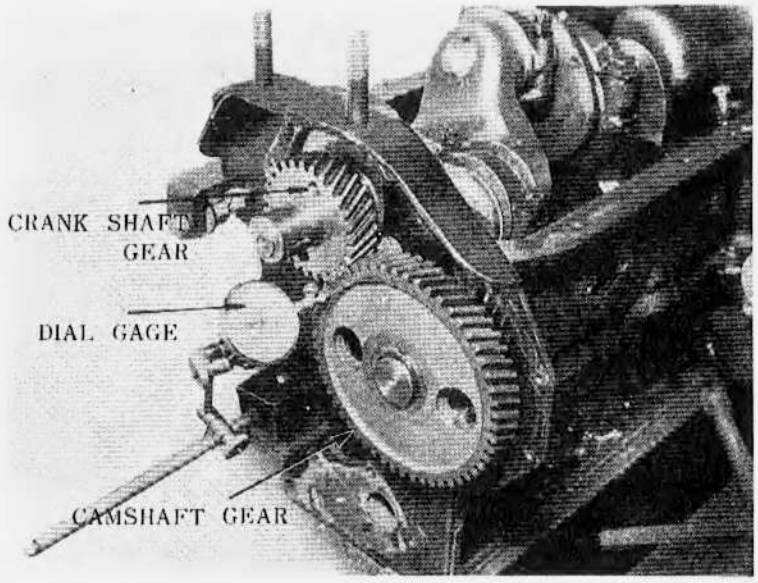


Figure 80 – Checking Runout of Timing Gears

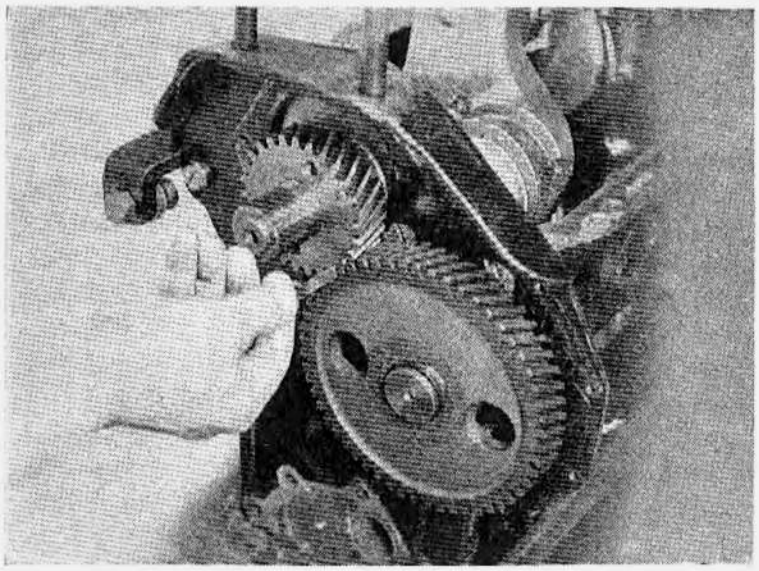


Figure 81 – Checking Timing Gear Backlash

f. Timing Gear Cover.

As shown in Figure 82, the oil stopper collar on timing gear cover is cut with reverse threads, these threads serving to force the oil back when shaft is rotating.

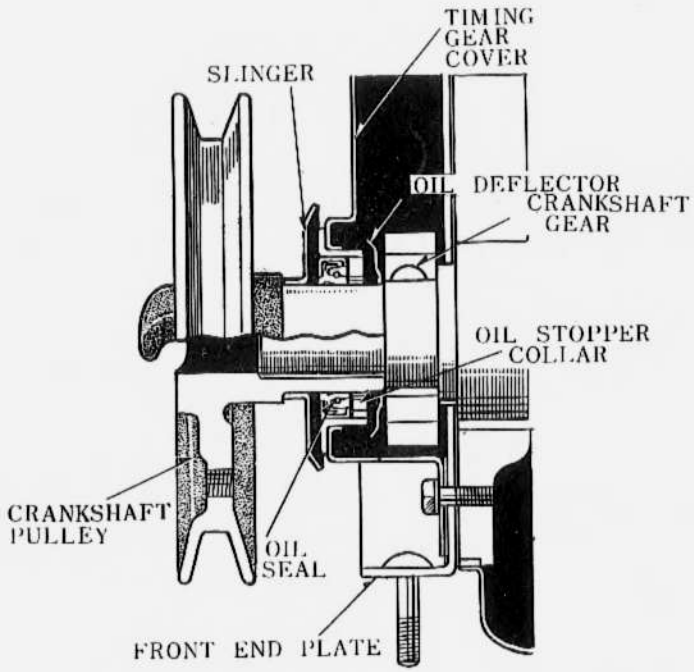


Figure 82 – Timing Gear Cover and Crankshaft Pulley Assembly

(1) A spring loaded rubber oil seal is pressed into the crankshaft opening of the timing gear cover to prevent oil leakage around the hub of the crankshaft pulley.

(2) If this seal shows signs of wear or damage, it should be replaced by prying it out of the cover from the front with a large screw-driver.

(3) Install new seal so that open end of the rubber is toward the inside of the cover and drive in place with oil seal replacer.

(4) Make certain that cover mounting face and cylinder block front end plate face are clean.

(5) Install timing gear cover aligner (BX SST-1026) over end of crankshaft. See "Minor Service operation" for timing gear cover.

(6) Coat the rubber oil seal with light grease and using a new cover gasket install cover and gasket over aligner.

(7) Install cover screws and two bolts tightening bolts to 12 20 foot pounds torque using a torque wrench. Remove aligner.

NOTE : It is important that the aligner be used to align the timing gear cover so that the crankshaft pulley installation will not damage the seal and to provide uniform seal tension on the hub of the pulley.

g. Crankshaft Pulley.

(1) Remove puller bolts from crankshaft pulley.

(2) Line up keyway on crankshaft pulley with key on crankshaft and install pulley using pulley replacer (BX SST-1023).

(3) Oil seal slinger attaches on crankshaft pulley.

h. Main Drive Gear Front Bearing (Clutch Pilot Bearing).

Main drive gear front bearing is of ball bearing type and installed in a pocket in rear end of crankshaft. To remove this bearing for replacement when worn, use clutch pilot bearing puller (FA SST-1075) (Fig. 83). To install, use brass rod taking not to cock bearing (Fig. 84).

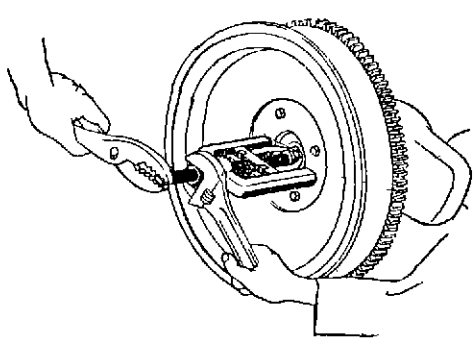


Figure 83 – Removing Clutch Pilot Bearing

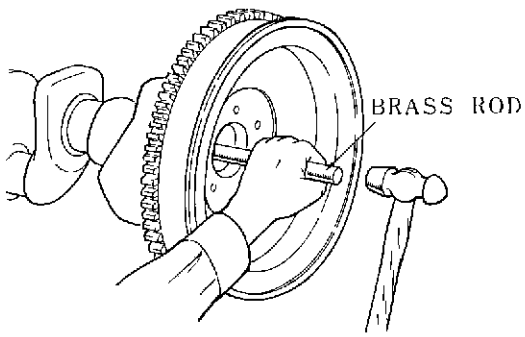


Figure 84 – Installing Clutch Pilot Bearing

i. Clutch Housing.

Position clutch housing on the cylinder block through the two dowels on the block surface.

On this engine, parallelism of the face must be within 0.20 mm and total bore runout must not exceed 0.15 mm.

Procedure for installing this clutch housing on the engine, checking alignment correction, is as follows.

(a) Remove old clutch housing from cylinder block.

(b) Carefully clean mating surfaces of block and new housing of dirt, burrs, nicks, etc.

(c) Install new clutch housing to block, install attaching bolts and tighten evenly to 45~60 ft-lbs torque.

(1) Alignment Check.

(a) Install dial indicator to indicator extension rod and set indicator to read zero at the six o'clock position on the clutch housing face.

(b) Indicate face of housing and take readings at the 9, 12 and 3 o'clock positions. The runout limit is 0.20 mm (Fig. 85).

NOTE : Care should be exercised so that the indicator button is not on the edge of a bolt hole when the readings are taken.

(c) Reset the indicator to read zero at the six o'clock position on the

machined inside diameter of the clutch housing bore, being careful that the indicator button is centered on the narrow machined flange and does not touch flange step.

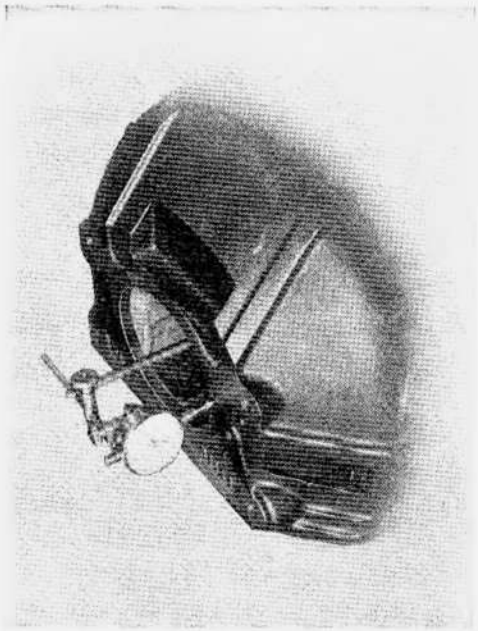


Figure 85 – Checking Face Parallelism

(d) Take readings at the 9, 12, and 3 o'clock positions, carefully lifting indicator button over each cutaway section of flange. The runout should not exceed 0.15 mm (Fig. 86).

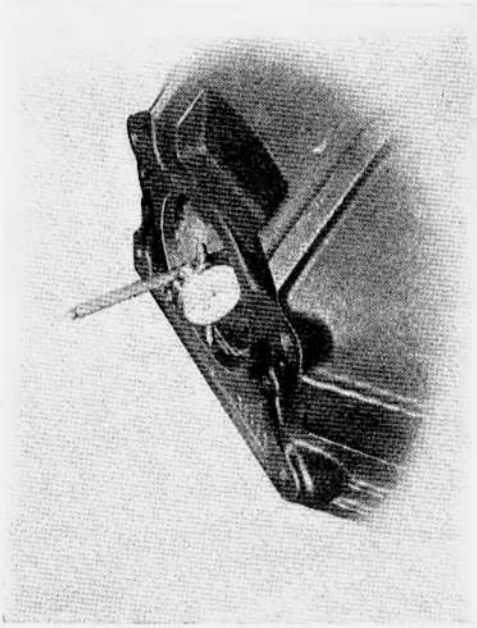


Figure 86 – Checking Bore Runout

(2) Alignment Correction.

(a) If bore runout is in excess of 0.15 mm or if housing face parallelism exceeds 0.20 mm, remove indicator and the clutch housing from the cylinder block.

(b) Drill out the two dowels in the cylinder block and reinstall the dowels with the clutch housing in correct alignment; or make a close check of the housing and if warping or other defects are present, replace with new housing.

NOTE : Normally, the above alignment correction is not necessary as correct alignment is usually the rule.

j. Flywheel Installation.

(1) Clean the mating flanges of flywheel and crankshaft carefully and make sure there are no burrs on either mounting face.

(2) Place the flywheel in the clutch housing and position it so that the one evenly spaced dowel in crankshaft flange will enter the holes in the flywheel.

(3) Install the six bolts using new lock plates under each pair of bolts.

(4) Tighten bolts to 40~55 foot-pounds with a torque wrench.

(5) Mount a dial indicator on the clutch housing so that the button of the indicator will contact the machined surface of flywheel (Fig. 87), and check the flywheel runout.

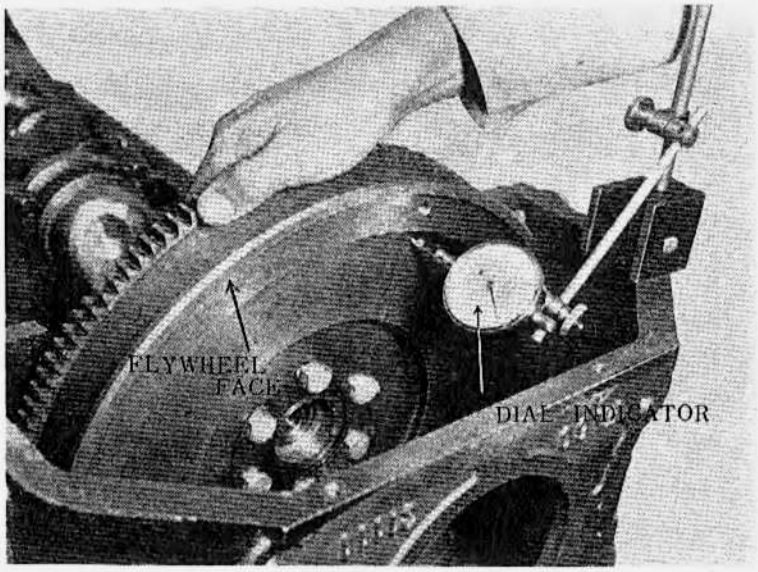


Figure 87 - Checking Flywheel Runout

(6) Runout should not exceed 0.20 mm. If excessive, remove flywheel and recheck for burrs or replace flywheel.

(7) Securely lock the mounting bolts by bending the lock plates up against the bolt heads.

k. Connecting Rod Alignment.

Correct alignment of the connecting rods is important. Whether new rods are being used or the old ones reinstalled they must be checked for alignment.

(1) Place the piston pin in the eye of the connecting rod and tighten the piston pin bolt.

(2) Place the connecting rod on the arbor of the aligning fixture and tighten the connecting rod bolts.

(3) Place "V" block on piston pin and slide it against the face plate. If all three points on "V" block contact the face plate, the connecting rod alignment can be considered satisfactory.

(4) If any of the three points on "V" block fails to contact the face plate to produce clearance at this point, the connecting rod is out of alignment (Fig. 88).

(5) In such a case, correct the bending or twisting in connecting rod until all three points on the "V" block contact the face plate properly.

(6) The fixture is sufficiently strong to hold the connecting rod for straightening. Place a bending bar on the rod and twist or bend the rod as required and recheck. Continue this operation until all pins just touch the face plate.

(7) Place the "V" block on the piston pin so that the "V" block rests

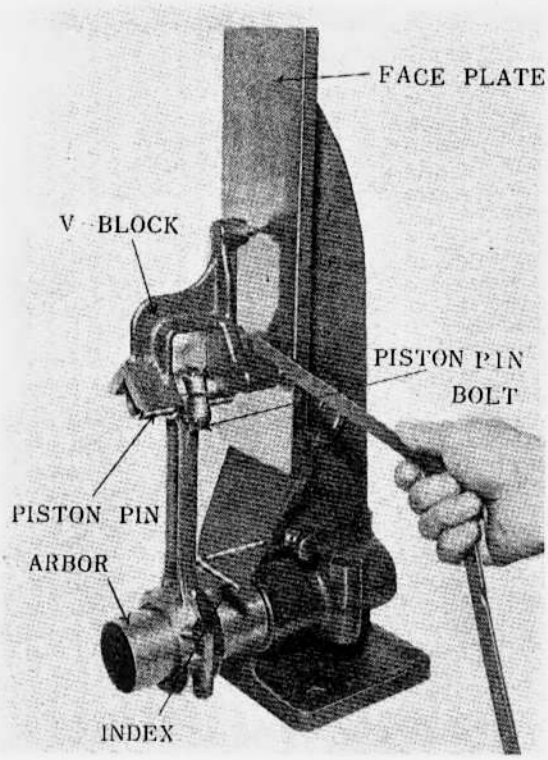


Figure 88 – Connecting Rod Alignment Fixture

against the outside edge of the connecting rod and move the rod and "V" block toward the face plate until all three pins touch.

(8) Place the index on the bottom of the fixture so that it touches the large end of the connecting rod bearing. Remove the rod from the arbor and turn it around.

(9) Assemble it again to the arbor and place the "V" block on the piston pin in the same place as when checking the other side. Move rod and "V" block toward the face plate until either the index touches the bearing or the pins touch the face plate.

(10) If the index does not touch the rod bearing with the three pins touching the face plate, check the distance between the rod bearing and the index with a feeler gage. If this distance is greater than 0.65 mm, the rod should be straightened until pins touch the face plate and the index touches the rod bearing within 0.65 mm.

(11) If the index touches the rod bearing and the three pins do not touch the face plate, the distance between the pins and the face plate should also be checked with a feeler gage. If this distance is more than 0.65 mm, the rod should be straightened until the pins on the "V" block touch the plate and the index touches the rod bearing within 0.65 mm.

l. Assemble Connecting Rod to Piston.

(1) Place the piston in piston vise. Assemble the rod to the piston and install the piston pin. Before tightening the piston pin bolt, center the piston pin in the piston and the connecting rod in the center of the two piston pin bosses. Figure 89 shows component parts of the piston assembly.

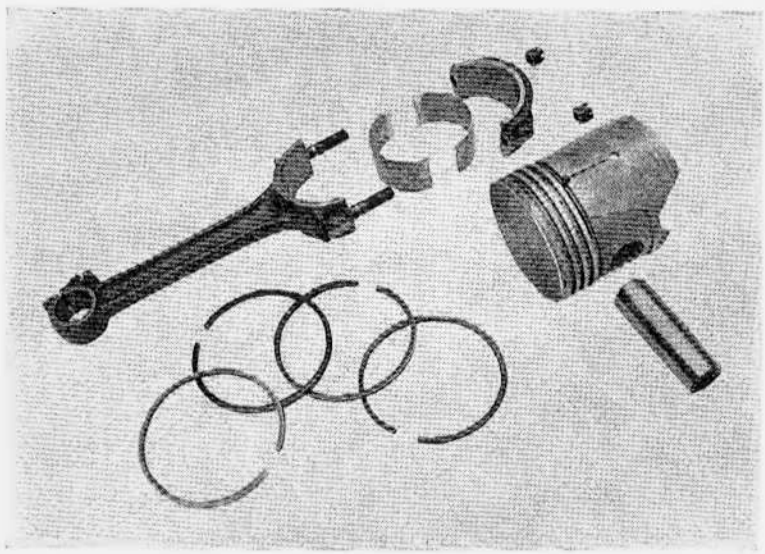


Figure 89 – Piston Assembly

(2) Tighten the piston pin bolt to 45～60 ft-lbs torque and move piston

on pin from side to side, checking to see that the connecting rod is centered on the piston pin.

(3) Assemble remaining rods to pistons.

NOTE : The connecting rod should never be clamped in a bench vise when installing the piston on it as tightening the piston pin bolt will likely twist the rod.

m. Piston Ring Fitting.

Four piston rings comprising of two compression rings and two oil rings are used. These rings are as shown in Figure 90. Note that all these rings are stamped with markings. Place the marked side up when assembling.

Piston rings are furnished in standard sizes as well as .010″, .020″, .030″, .040″ .050″, .060″ oversizes.

(1) Select rings comparable in size to the pistons being used.

(2) Slip the ring in the cylinder bore; then, using the head of a piston, press the ring down into the cylinder bore about two inches.

NOTE : Using a piston in this way will place the ring square with the cylinder walls.

(3) Check the space or gap between the ends of the ring with a feeler gage (Fig. 91). This gap should be from 0.15 mm to 0.45 mm on top compression and top oil rings and from 0.15 mm to 0.40 mm on second compression and second oil rings.

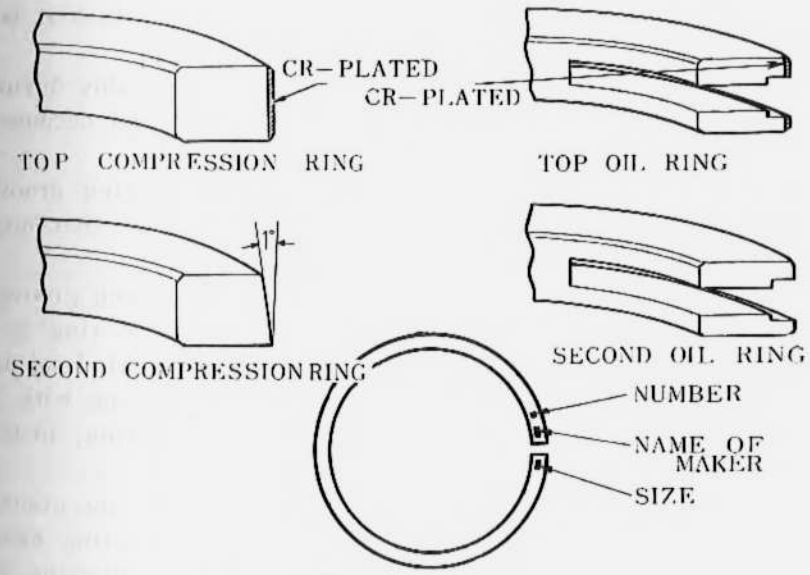


Figure 90 – Piston Rings

(4) If the gap between the ends of the ring is less than 0.15 mm for all rings, remove the ring and try another for fit, or the gap in the tight fitting ring may be enlarged as follows.

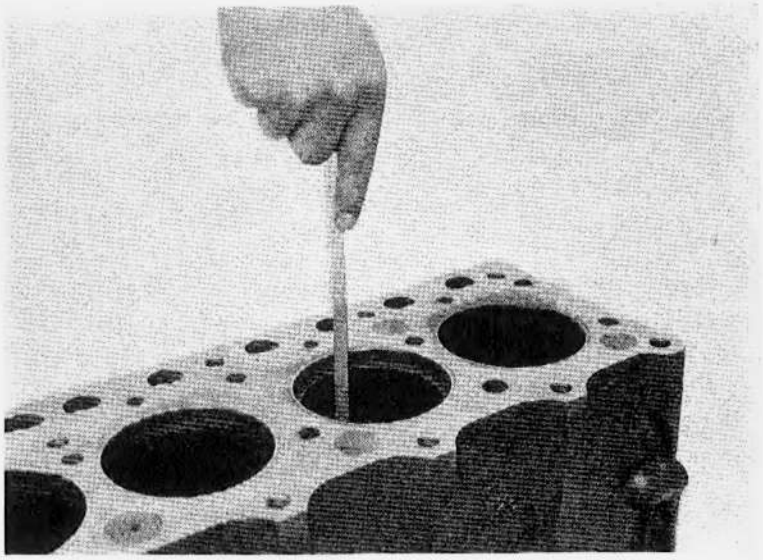


Figure 91 – Measuring Piston Ring Gap

(5) Remove the ring from the cylinder. Clamp a fine cut file in a vise. Grasping each end of the ring firmly between the thumb and fingers, work the two ends of the ring across the surfaces of the file, pressing the ring together at the gap lightly until the proper gap is obtained. Be careful not to distort the ring during this operation or it may bind in the ring groove of the piston. Fit each ring separately to the cylinder in which it is going to be used.

(6) New pistons, rings and cylinder bores wear considerably during seating and gaps widen quickly; however, engine operation will not become seriously affected if ring gaps do not become greater than 0.8 mm.

(7) Carefully remove all particles of carbon from the ring grooves in the piston and inspect the grooves carefully for burrs or nicks that might cause the rings to hang up.

(8) Slip the outer surface of the ring into the piston ring groove and roll the ring entirely around the groove to make sure that the ring is free and does not bind in the groove at any point (Fig. 92). If binding occurs the cause should be determined and removed by carefully dressing with a fine cut file. However, if the binding is caused by a distorted ring, install a new ring.

(9) Proper clearance of the piston ring in its piston ring groove is very important in maintaining engine performance and in preventing excessive oil consumption. Therefore, when fitting new rings, the following clearances between the top and bottom surfaces of the ring grooves should be provided.

(10) The top compression and top oil rings should be fitted so that a 0.04 mm feeler gage will be free but a 0.085 mm feeler will cause a rather heavy drag.

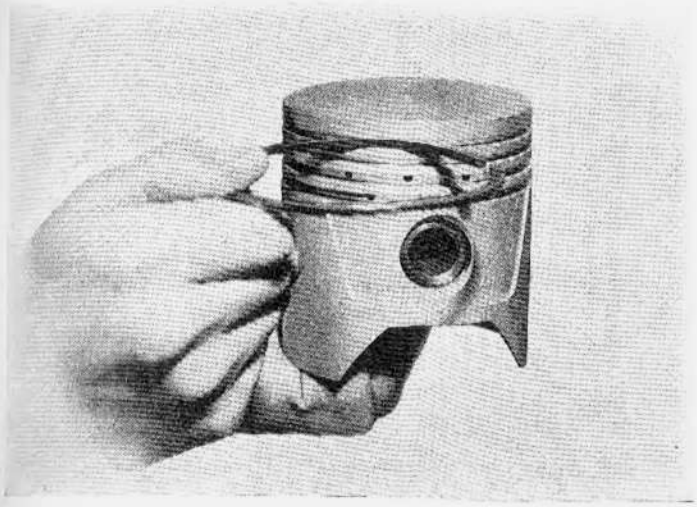


Figure 92 – Rolling Piston Ring in Ring Groove

(11) The second compression and second oil rings should be fitted so that a 0.04 mm feeler gage will be free but a 0.085 mm feeler will cause a rather heavy drag (Fig. 93).

Figure 93 – Checking Piston Ring Clearance in Ring Groove

(12) Assemble the rings to the pistons as they are fitted using piston ring tool (Fig. 94) and make a final test of the ring fit in the grooves by repeating the fitting procedure given above.

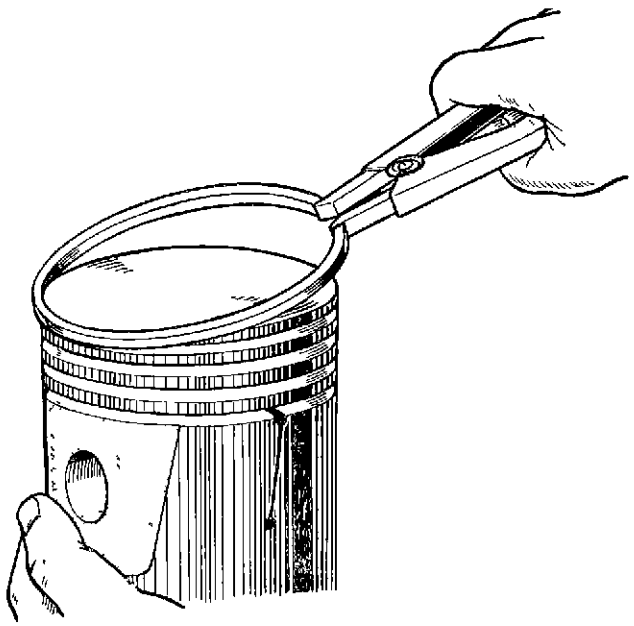


Figure 94 – Assembling Piston Rings to Piston

NOTE: It is important that each ring be fitted to its individual cylinder for proper gap spacing and to its individual piston and groove for proper groove clearance.

n. Assemble Pistons and Connecting Rods to Engine.

When the rods are being reassembled, they should be installed in the same cylinder from which they were removed and with the stamped number on the camshaft side.

The condition of the crankpins on the crankshaft should be checked when installing new rod. Damaged crankpins can only be corrected by the installation of a new crankshaft, as it is impossible to insure connecting rod bearing life on a damaged crankpin.

(1) Position piston rings in piston ring grooves so that gaps will be spaced as Figure 95.

CAUTION : Never install pistons with piston ring gaps in line as gaps in this position will allow gases to leak by at this point.

(2) Lubricate pistons and cylinder bores, remove bearing caps and cover connecting rod bolts with vinyl tubings. And then install piston and rod assemblies using piston inserter (Fig. 96).

NOTE : Piston and rods must be installed with piston pin bolt on the camshaft side.

(3) The connecting rod is equipped with precision interchangeable insert bearings and do not require shims.

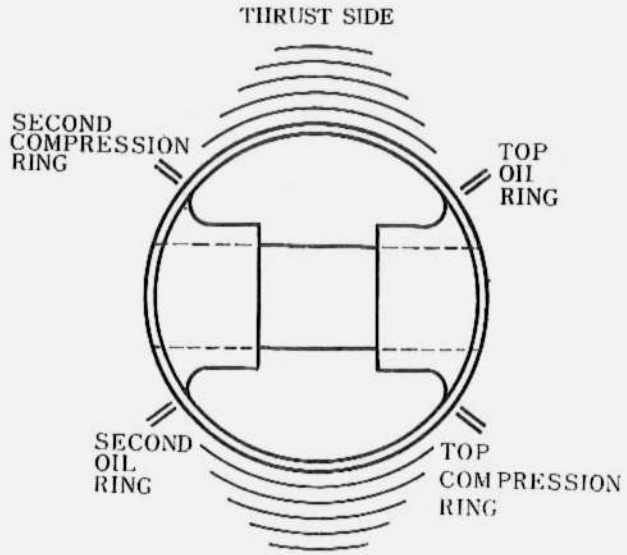


Figure 95 – Position of Ring Gaps when Piston Is Installed

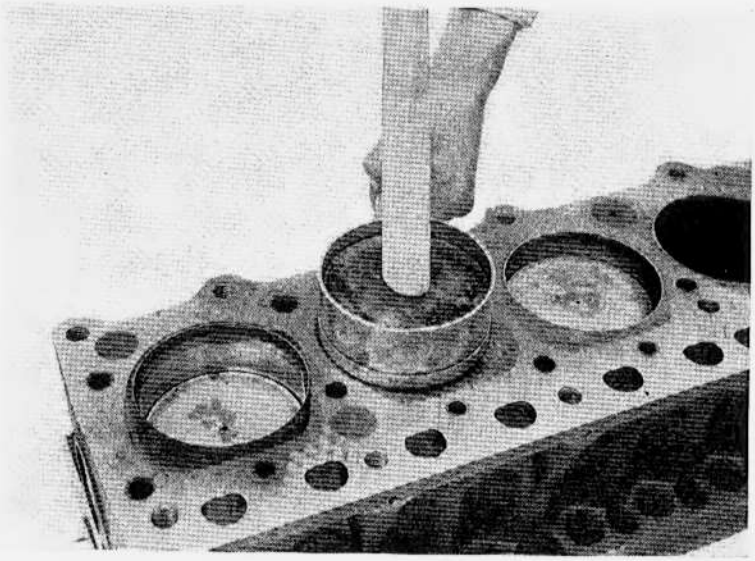


Figure 96 – Installing in Cylinder Bore

(4) After pull out vinyl tubings from connecting rod bolts, install the bearing cap with the marked side toward the camshaft (Fig. 97). Assemble and tighten the bearing cap nuts to 45～55 foot-pounds torque. And then install cotter pin.

(5) Install remaining piston and connecting rod assemblies as described above.

(6) Adjust connecting rod bearings.

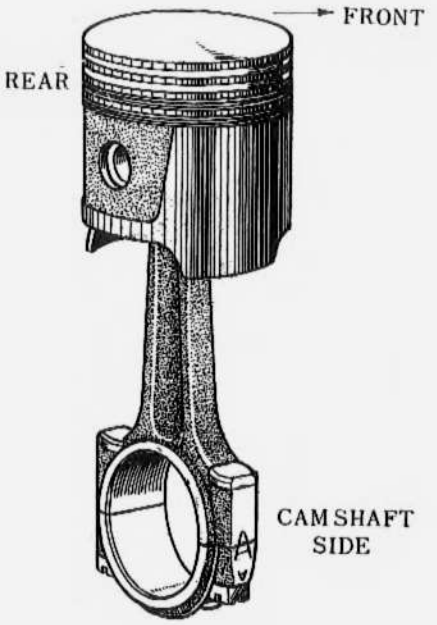


Figure 97 – Piston and Connecting Rod

o. Connecting Rod Bearing Adjustment: —Plastigage Method.

Connecting rod bearing inserts are available in standard size and undersizes of .010″, .020″, .030″, and .040″. These bearings are not shimmed and when clearances become excessive the next undersize bearing insert should be used. DO NOT FILE ROD OR ROD CAPS.

(1) Remove the connecting rod bearing cap.

(2) Wipe bearing insert shell type bearings, and crankpin clean of oil.

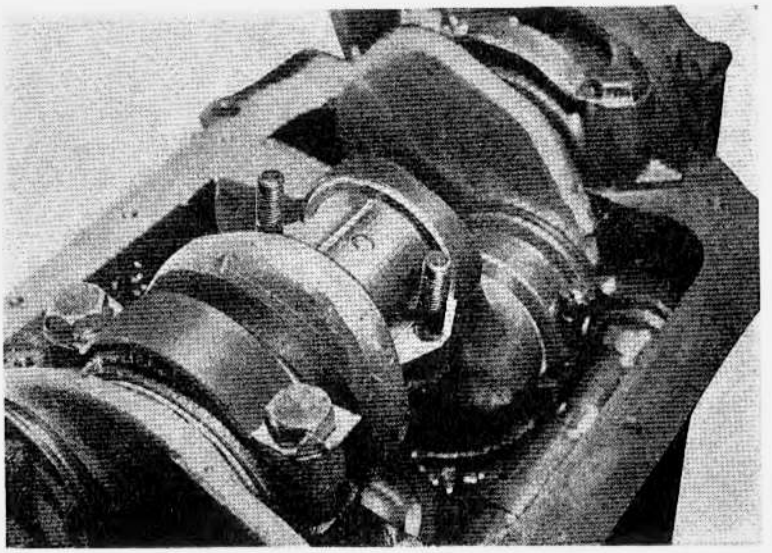


Figure 98 – Plastigage on Crankpin

(3) Place a piece of plastigage the full width of the bearing or crankpin (parallel to the crankshaft) (Fig. 98).

(4) Reinstall the bearing cap and evenly tighten the retaining bolts to 45~55 ft-lbs torque (Fig. 99).

CAUTION : Do not turn crankshaft with the plastigage installed.

(5) Remove the bearing cap and without removing the plastigage, check its width at the widest point with the plastigage scale (Fig. 100).

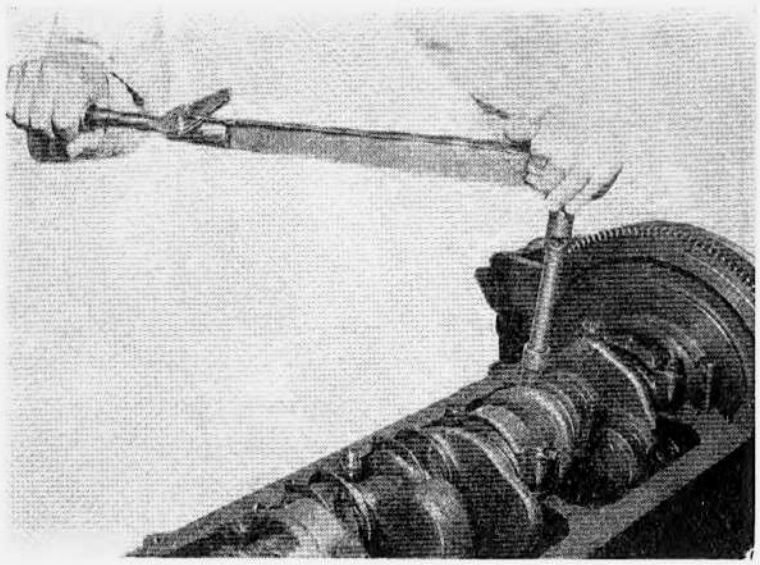


Figure 99 -- Tightening Retaining Bolts

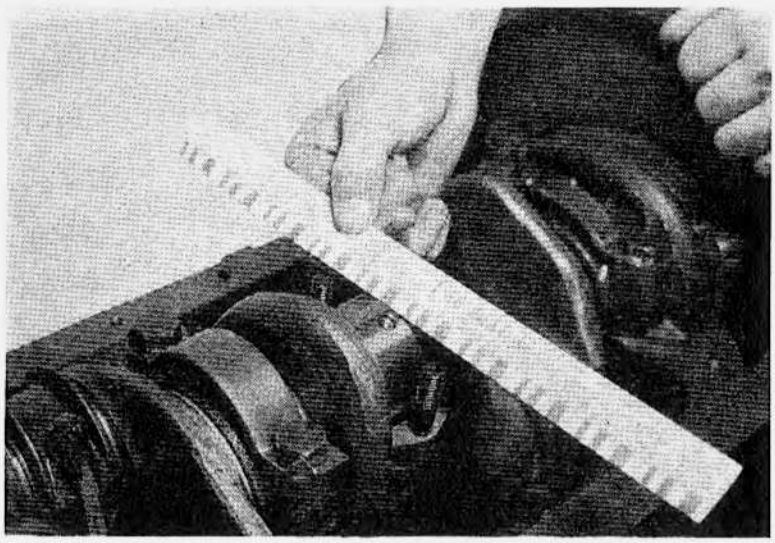


Figure 100 - Measuring Compressed Plastigage

NOTE: If the crankpin is out-of-round be sure to fit the bearing

to the maximum diameter of the crankpin. If the flattened plastigage is not uniform from end to end in its width, the crankpin or bearing is tapered, has a low spot or some other irregularity. Check the crankpin with a micrometer for taper if the flattened plastigage indicates more than a 0.025 mm difference.

(6) If the reading is not over 0.06 mm or not less than 0.02 mm the fit is satisfactory. If however, the clearances exceeds 0.08 mm, on bearing insert shell type, replace the bearing with the proper undersize bearing.

It may be necessary in this case to regrind the crankpin. The relation between the crankpin journal and undersize bearings are as shown in the following table.

Crank Pin Journal Diameter (mm)	Undersize
53.980 — 54.000	STD
53.726 — 53.746	0.010″ U/S
53.472 — 53.492	0.020″ U/S
53.218 — 53.238	0.030″ U/S
52.964 — 52.984	0.040″ U/S

NOTE : The insert bearing shells are not adjustable and no attempt should be made to adjust by filing the bearing caps.

(7) New bearing inserts type bearing clearance should be 0.05 mm maximum and 0.02 mm minimum.

(8) Rotate the crankshaft after bearing adjustment to be sure the bearings are not too tight. Install cotter pins to connecting rod bolts.

(9) Check connecting rod side clearance between connecting rod cap and side of crankpin (Fig. 101). See engine fits and tolerances for clearance.

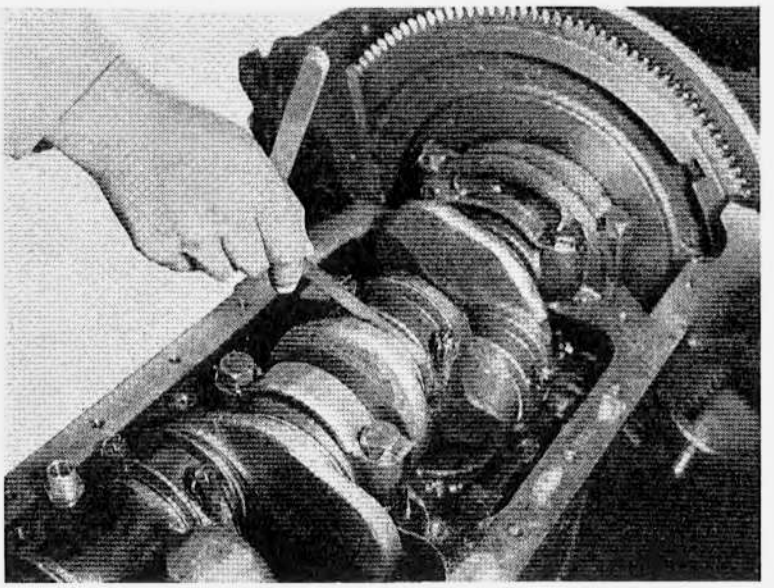


Figure 101 – Measuring Connecting Rod Side Clearance

p. Connecting Rod Bearing Adjustment:—

Micrometer and Inside Dial Gage Method.

When plastigage is not available, the micrometer and inside dial gage are used to determine bearing clearance for making adjustments.

In this method, the connecting rod is removed from the block and the connecting rod bearing inner diameter measured with inside dial gage and the crankpin diameter measured with micrometer to determine bearing clearance.

(1) Disassembly.

(a) Remove connecting rod cap.

(b) Cover connecting rod bolts with vinyl tubings and pull out connecting rod from crankpin. Use of these tubings is to prevent damages to the crank pin journal.

(c) Always make sure to leave the connecting rod and cap as a set. There is danger of interchanging these parts during reassembly if left separately. The mating mark between the connecting rod and cap is the "A" mark shown in Figure 103. The cylinder number is stamped on the top of the piston but there is no corresponding mark stamped on the connecting rod so that care should be taken if the piston is replaced.

(d) Remove the connecting rod bearings from the rod and cap.

(2) Inspection.

Bearing inserts found partially melted, badly scored, showing poor contact, and other defects should be replaced with new parts.

(3) Adjustment.

Connecting rod bearing are of the replaceable insert type and by using proper sizes, correct bearing clearances can be obtained.

(a) Shim adjustments should not be made.

(b) Bearings must never be scraped to provide proper contact.

(c) Use of red lead to determine bearing contact is prohibited.

(d) Do not file rod or rod caps to adjust bearing clearance.

(e) Bearing inserts must not be sand papered, stretched, or altered to provide proper fit.

(f) When bearing clearance exceeds the allowable max clearance 0.08 mm, use the next undersize bearing. It may be necessary in this case to regrind the crankpin. The relation between the crankpin journal and undersize bearings are as shown in the following table.

Crank Pin Journal Diameter (mm)	Undersize
53.980 — 54.000	STD
53.726 — 53.746	0.010″ U/S
53.472 — 53.429	0.020″ U/S
53.218 — 53.238	0.030″ U/S
52.964 — 52.984	0.040″ U/S

(g) Crankpin found damaged must be reground Connecting rod installed without correcting the damage will have the life of its bearing badly reduced.

(h) Crankpin journals with diameter worn or tapered more than 0 025 mm must be reground down to enable using undersize bearing inserts.

(4) Measurement:—Micrometer, Inside Dial Gage Method.

(a) Measure diameter of crankpin journal with outside micrometer. Measure vertically and horizontally at front, center and rear for a total of six measurements.

If the crankpin journal is found worn more than 0 025 mm out-of-round, the journal must be reground and undersize bearings used.

(b) Tighten down connecting rod bearings to 45 to 55 foot pounds torque and measure the bearing centerline diameters with inside dial gage (Fig. 102). Measure bearing diameters at front, center and rear for a total of three measurements.

Centerline Diameter of Con-rod Bearing (Both Marks A and B)	Undersize
54.020 — 54.040 mm	STD
53.766 — 53.786 mm	0.010″ U/S
53.512 — 53.532 mm	0.020″ U/S
53.258 — 53.278 mm	0.030″ U/S
53.004 — 53.024 mm	0.040″ U/S

(c) The average between the maximum and minimum readings is used to determine the bearing clearance.

(d) The micrometer and inside dial gage used must be checked for accuracy before using.

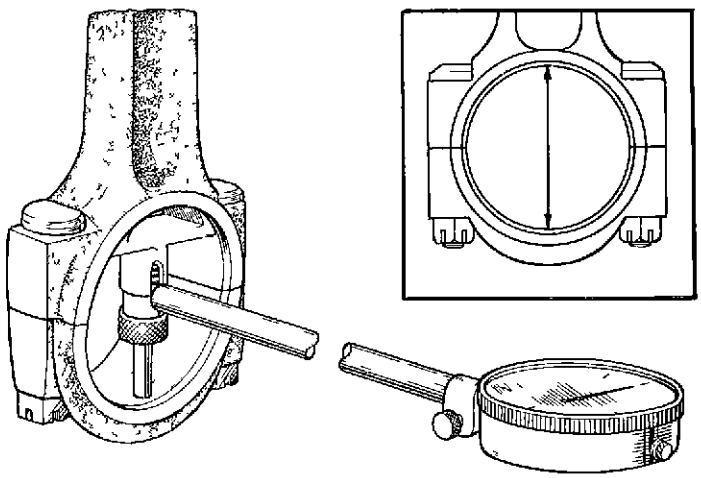


Figure 102 – Measuring Bearing Inside Diameter

(5) Reassembly.

(a) As it is specially important to have exceeding accurate clearances when

using bearing inserts, the connecting rods and bearing inserts are made with selective fit.

For this purpose, both of these parts are marked either A or B. Parts with the same marking must be mated (Fig. 103).

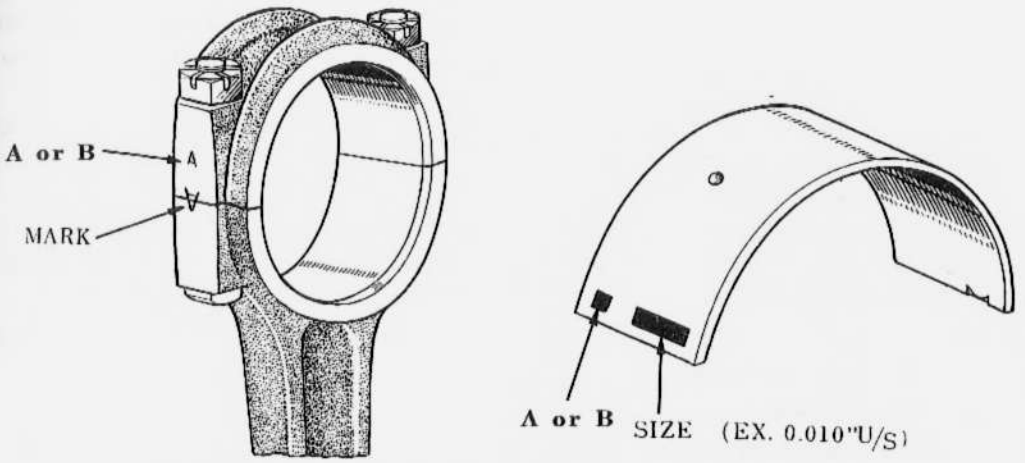


Figure 103 – Con-rod and Bearing Marks A or B

Connecting rod mark A must be assembled with bearing insert marked A and connecting rod marked B must be assembled with bearing insert marked B. This ruling applies to all standard and undersize parts.

(Example) When the crankpin is to be reground to 0.010″ undersize, the crankpin will be reground to 53.726 mm—53.746 mm diameter. Assume that the connecting rods have the following markings.

Cylinder Number	1	2	3	4
Connecting Rod Mark	A	B	A	B

Select the 0.010″ undersize bearing inserts as shown below and assemble to respective connecting rods.

Cylinder Number	1	2	3	4
0.010″ U/S Insert Mark	A	B	A	B

(b) The lining on the precision type insert bearing are only 0.15 mm thick making it impossible for any large foreign particles to become embedded into the lining, thus necessitating special care to keep the engine parts clean. By observing this rule, the life of these bearings will be greatly prolonged.

(1) The bearing itself should be thoroughly cleaned inside and outside. The connecting rod large end should also be cleaned carefully and burrs present due to wear should be removed with sandpaper.

(2) The oil hole should be blown clean with compressed air.

(3) Replace engine oil if it is deteriorated or contaminated. Neglecting to do so will not only affect the bearings but will also have adverse effects on all the sliding parts of the engine.

(c) Assemble connecting rod on to crankshaft and measure end play with feeler gage. If this measures within 0.11 mm—0.23 mm, the amount of play is satisfactory. If this end play exceeds 0.30 mm, connecting rod should be replaced with new rod.

(d) When the bearing inserts are not replaced, make sure not to interchange the upper and lower inserts. There is danger that the fit will be changed if these inserts are interchanged.

(e) In replacing the bearings, the upper and lower halves must always be replaced as a set. When replacing one half of the bearing, make sure to replace its other half.

(f) Lubricate crankpin with engine oil and assemble on connecting rod. Cover connecting rod bolts with vinyl tubings when fitting on to crankpin.

(g) Install connecting rod cap.

(h) Screw down both nuts evenly and tighten down to 45—55 foot pounds torque. Install cotter pins.

16. ENGINE ASSEMBLY.

(1) Place the oil pump in position in the block fitting. Install the oil pump retaining bolt and tighten it to 10 to 15 foot pounds torque. Lock this bolt by inserting a set wire through the hole in bolt head and wrapping it against the pump body.

(2) Install the oil pump pipe to block oil line and tighten the union nuts securely. Install oil pump strainer, insert suction pipe into strainer shell and tighten suction pipe union bolt securely.

(3) Check to see that all connecting rod bolt nuts and main bearing cap bolts are properly tightened and locked. Check to see that the crankcase is clean.

(4) Install new oil pan gaskets. Carefully place the oil pan in position and tighten oil pan bolts securely.

NOTE: Tighten oil pan bolts to 4 to 8 foot-pounds.

(5) Install clutch housing on cylinder block tightening attaching bolts to 45 to 60 foot pounds.

(6) Install flywheel on crankshaft rear flange.

(7) Place the clutch disc and clutch cover assembly in position and install the clutch guide tool.

(8) Install attaching bolts loosely and then tighten them a turn at a time to take up the spring pressure evenly and prevent clutch distortion. Make final tightening to 18 to 22 foot pounds with a torque wrench and remove guide tool.

(9) Insert clutch fork into clutch fork leather cover and install clutch release bearing.

(10) Turn engine assembly over in engine stand.

(11) Place new cylinder head gasket on cylinder block. Take care not to place this wrong side up. (The side marked F-11213 should be place up.) This assumes alignment of water passages and bolt holes in head and block.

(12) Place cylinder head with valves assembled according to procedure give under "Minor Service Operations" on the cylinder block. Install all cylinder head bolts and tighten them finger tight.

NOTE: In installing cylinder head bolts, bond strap pieces should be installed together with the first and last bolts on left side of cylinder head, and air cleaner bracket with the second and third bolts from the front on left side of cylinder head.

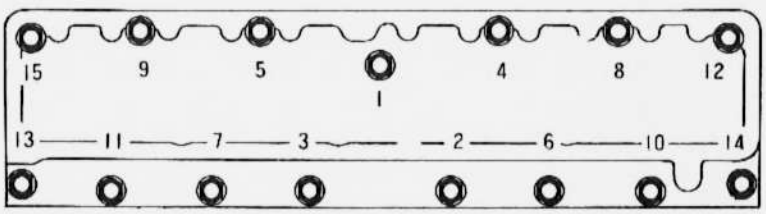


Figure 104 – Cylinder Head Bolt Tightening Diagram

(13) Tighten the cylinder head bolts a little at a time in order shown in Figure 104. The final tightenning should be 85 to 95 foot pounds.

NOTE: Cylinder Head Bolt Tightening Method

First pass	**30 — 40 ft-lbs**
Second pass	**55 — 65 ft-lbs**
Third pass	**75 — 85 ft-lbs**
Final pass	**85 — 95 ft-lbs**
After warming up	**85 — 95 ft-lbs**

(14) Install the twelve valve lifters in right side of block and install oil delivery pipe making connection at cylinder block.

(15) Install valve lifter cover using a new gasket and tighten attaching bolts evenly to 2 to 4 foot pounds.

(16) Install intake manifold side collars, new end and center gaskets, manifold assembly and attaching parts. Tighten clamp bolts and bolts to 25 to 45 foot pounds. Check manifold heat control valve as instructed under "Engine Tune-Up". Install oil cleaner to intake manifold. Tighten oil cleaner outlet pipe.

(17) Install oil distributor on left side of block using a new gasket. Tighten attaching bolts to 10 to 15 foot pounds. Tighten oil cleaner inlet pipe.

(18) Install water pump using a new gasket and tighten attaching bolts to 10 to 15 foot pounds.

(19) Install water outlet, place thermostat in case and install thermostat case using a new gasket. Tighten attaching bolts securely.

(20) Install accelerator link arm pin, link arm and stopper in block. Install carburetor and tighten nuts securely. Place accelerating links in position and connect them to the link arm and stopper. Install accelerator link tension spring.

(21) Install oil feeder tube in block. Insert oil level gage rod.

(22) Install the fuel pump using a new gasket and tighten attaching bolts to 10 to 15 foot pounds. Place the fuel pump to carburetor gas pipe and the carburetor vacuum control pipe in position and connect them to carburetor and clip at water outlet. Connect the other end of gas pipe to the fuel pump.

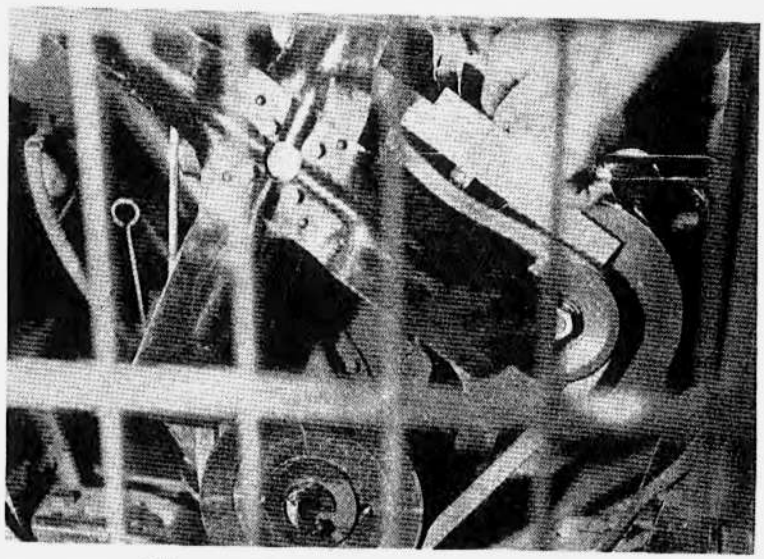


Figure 105 – Fan Belt Adjustment

(24) Carefully clean the mating face on clutch housing. Pilot main drive gear shaft of transmission through the release bearing and into clutch disc and main drive gear front bearing. Work the transmission up against the clutch housing until main drive gear shaft pilots into front bearing of crankshaft. Install and tighten securely the transmission mounting bolts. Connect bond strap at transmission case cover.

NOTE: Properly support the transmission as it is being installed or the clutch disc may be damaged.

(25) Install the clutch housing under cover and flywheel side cover and retaining bolts.

(26) Install starter motor and tighten attaching nuts securely.

(27) Install generator loosely and attach adjusting bar. Place fan belt over fan and around pump, generator and crankshaft pulleys. Shift the generator

to properly align pulleys and tighten bolts. Force the generator away from engine to tighten belt until it deflects 13 mm midway between generator and pump pulley (Fig. 105). Tighten generator to adjusting bar bolt securely to secure generator.

(28) Adjust spark plug gaps to 0.9 mm and install plugs using new gaskets. Tighten to 12 to 18 foot pounds or tighten finger tight plugs ½ turn more. Tighten spark plug wires to spark plugs.

(29) Remove the third cylinder head bolt from the rear on the right side and the fifth cylinder head bolt from the rear on the left side. Then, install the proper lifting attachment, release engine and transmission assembly from stand and lift engine and transmission assembly with hoist.

17. ENGINE INSTALLATION.

(1) Lower engine and transmission assembly into chassis with transmission end slightly tilted up to bring the two set bolts welded on crankcase front end plate into holes in engine front support member and locate the engine rear supports on support cushions.

(2) Install engine front support spacer to engine front set bolts welded on front end plate.

Install washers and nuts over support spacer and tighten nuts finger tight.

(3) Install engine rear mounting bolts through rear support cushions to engine rear support brackets which riveted on frame side rails. Screw on nuts finger tight over washers.

(4) Tighten the nuts of the two bolts welded on front end plate to 40—55 foot pounds and the nuts of engine rear mounting bolts to 45—60 foot pounds torque.

Lock nuts with cotter pins.

(5) Install the front end of clutch housing pull rod and connect bond strap at engine front support bracket left, and then install the rear end of pull rod to engine rear support arm left.

(6) Remove engine lifting attachment, install cylinder head bolts and tighten to 85 to 95 foot pounds torque.

(7) Drop the twelve push rods down through openings in head and position them in the valve lifters respectively.

(8) Place valve rocker shaft supports over studs in cylinder head to locate one valve rocker shaft assembly and locate other in similar manner.

(9) Install bolts and stud nuts which retain each rocker shaft, draw them down evenly to 30 to 45 foot pounds torque.

(10) Place the oil connect sleeve, spring and oil delivery union over the open ends of the two rocker shaft assemblies.

(11) Connect oil delivery pipe to oil delivery union and tighten securely.

(12) Connect intermediate shaft at transfer case front universal joint retainer.

(13) Install hand brake lever on transmission.

(14) Connect transfer shift lever to the right side of transmission.

(15) Connect speedometer cable at transmission.

(16) Install transmission gear shift lever and replace transmission cover.

(17) Install engine under covers, right and left.

(18) Install clutch fork pull rod to clutch fork and install return spring from clutch fork to bracket.

(19) Connect oil cleaner inlet pipe to oil distributor and outlet pipe to nipple of block. Connect outlet pipe clamp at steering gear box.

(20) Connect exhaust pipe to manifold and tighten attaching nuts securely.

(21) Connect accelerator link rod to accelerator link shaft.

(22) Connect oil pressure gage pipe to union of block and install water thermal unit in cylinder head.

(23) Attach wiring to generator and install bond strap to generator adjusting bar.

(24) Connect choke and throttle rods to carburetor.

(25) Connect gas inlet line to fuel pump.

(26) Mount coil in position at the right side of cylinder head with two coil mounting bolts and tighten bolts to 10 to 15 foot pounds. Connect ignition coil primary lead. Install ignition coil wire from coil to distributor cap.

(27) Connect battery starter cable to starter motor and connect engine ground cable to engine under cover right.

(28) Connect battery starter cable to battery terminal. Install ground cable from battery to frame.

(29) Place radiator in position at the first crossmember and install supporting bolt nuts through two holes of first crossmember using socket wrench. Connect bond strap to radiator. Install two brace rods from radiator to cowl, and then connect hoses to radiator.

(30) Install radiator grille and side wind guides as an assembly.

(31) Install air cleaner.

(32) Refill radiator, crankcase and transmission.

(33) Start engine and allow to run until properly normalized and adjust valves as outlined under "Valve Adjustment". Replace valve rocker arm cover and connect bond strap to each side of rocker arm cover. Install ventilating rubber hose from air cleaner cap to rocker arm cover.

(34) Replace engine hood and connect engine hood hinges and bond straps. Lower engine hood.

SECTION IV

TROUBLE SHOOTING

18. TROUBLE SHOOTING.

SYMPTOM AND PROBABLE CAUSE	PROBABLE REMEDY
Lack of Power	
1. Poor Compression	
a. Incorrect valve lash	a. Adjust valve lash according to instructions
b. Leaky valves	b. Remove cylinder head and grind valves
c. Valve stems or lifters sticking	c. Free up or replace
d. Valve springs weak or broken	d. Replace springs
e. Valve timing incorrect	e. Retime valves
f. Leaking cylinder head gasket	f. Replace gaskets
g. Piston rings broken	g. Replace rings
h. Poor fits between pistons, rings and cylinders	h. Overhaul engine
2. Ignition System Improperly Adjusted	
a. Ignition not properly timed	a. Set ignition according to instructions
b. Octane selector not adjusted for grade of fuel being used	b. Set octane selector. See "Engine Tune-Up"
c. Spark plugs faulty	c. Replace or clean, adjust and test spark plugs
d. Distributor points not set	d. Set distributor points and time engine
3. Lack of Fuel	
a. Dirt or water in carburetor	a. Clean carburetor
b. Gas lines partly plugged	b. Clean gas lines
c. Dirt in fuel tank	c. Clean fuel tank
d. Air leaks in gas line	d. Tighten and check gas lines
e. Fuel pump not functioning properly	e. Replace or repair fuel pump
4. Carburetor Air Inlet Restricted	
a. Air cleaner dirty	a. Clean air cleaner
b. Carburetor choke partly closed	b. Adjust or replace choke mechanism

SYMPTOM AND PROBABLE CAUSE	PROBABLE REMEDY
5. Overheating	
a. Lack of water	a. Refill system
b. Fan belt loose	b. Adjust or replace
c. Fan belt worn or oil soaked	c. Replace belt
d. Thermostat sticking closed	d. Replace thermostat
e. Water pump inoperative	e. Replace water pump
f. Cooling system clogged	f. Clean and reverse flush
g. Incorrect ignition or valve timing	g. Retime engine
h. Brakes dragging	h. Adjust brakes
i. Improper grade and viscosity oil being used	i. Change to correct oil
j. Fuel mixture too lean	j. Overhaul or adjust carburetor
k. Restricted air cleaner	k. Clean air cleaner
l. Valves improperly adjusted	l. Adjust valves
m. Defective ignition system	m. See "Engine Tune-Up"
n. Exhaust system partly restricted	n. Clean or replace
6. Overcooling	
a. Thermostat holding open	a. Replace thermostat
Excessive Oil Consumption	
1. Leaking Oil	
a. Oil pan drain plug loose	a. Tighten drain plug
b. Oil pan retainer bolts loose	b. Tighten oil pan bolts
c. Oil pan gaskets damaged	c. Replace pan gaskets
d. Timing gear cover loose or gasket damaged	d. Tighten cover bolts or replace gasket
e. Oil return from timing gear cover to block restricted, causing leak at crankshaft pulley hub	e. Remove oil pan and clean oil return passages
f. Push rod or rocker arm cover gaskets damaged or covers loose	f. Tighten covers or replace gaskets
g. Fuel pump loose or gasket damaged	g. Tighten fuel pump or replace gasket
h. Rear main bearing leaking oil into clutch housing	h. Adjust or replace main bearing or main bearing rear oil seal
2. Burning Oil	
a. Broken piston rings	a. Replace rings
b. Rings not correctly seated to cylinder walls	b. Give sufficient time for rings to seat. Replace if necessary.

SYMPTOM AND PROBABLE CAUSE	PROBABLE REMEDY
c. Piston rings worn excessively or stuck in ring grooves	c. Replace rings
d. Piston ring oil return holes clogged with carbon	d. Replace rings
e. Excessive clearance between piston and cylinder wall due to wear or improper fitting	e. Fit new pistons
f. Cylinder walls scored, tapered or out-of-round	f. Recondition cylinders and fit new pistons
g. Valve stem oil seals broken or missing	g. Install new valve stem oil seals
Hard Starting	
1. Slow Cranking	
a. Heavy engine oil	a. Change to lighter oil
b. Partially discharged battery	b. Charge battery
c. Faulty or undercapacity battery	c. Replace battery
d. Poor battery connections	d. Clean and tighten or replace connections
e. Faulty starter and ignition switch	e. Replace switch
f. Faulty starter motor or drive	f. Overhaul starter motor
2. Ignition Trouble	
a. Distributor points burned or corroded	a. Clean or replace points
b. Points improperly adjusted	b. Adjust points to 0.45 mm or 0.50 mm
c. Spark plugs improperly gapped	c. Set plug gap at 0.9 mm
d. Spark plug wires loose and corroded in distributor cap	d. Clean wires and cap terminals
e. Loose connections in primary circuit	e. Tighten all connections in primary circuit
f. Series resistance in condenser circuit.	f. Clean all connections in condenser circuit
g. Low capacity condenser	g. Install proper condenser
3. Engine Condition	
a. Valves holding open	a. Adjust valves. See "Poor Compression"
b. Valves burned	b. Grind valves
c. Leaking manifold gasket	c. Tighten manifold bolts or replace gasket
d. Loose carburetor mounting	d. Tighten carburetor
e. Faulty pistons, rings or cylinders	e. See "Poor Compression"

SYMPTOM AND PROBABLE CAUSE	PROBABLE REMEDY
4. Carburetion	
a. Choke not operating properly	a. Adjust or repair choke mechanism
b. Throttle not set properly	b. Set throttle
c. Carburetor dirty and passages restricted	c. Overhaul carburetor
Popping, Spitting and Detonation	
1. Overheated Intake Manifold	
a. Manifold heat control valve coil not properly installed	a. Adjust according to instructions under "Engine Tune-Up"
b. Manifold heat control valve sticking	b. Free up heat control valve
2. Ignition Trouble	
a. Loose wire connections	a. Tighten all wire connections
b. Faulty wiring	b. Replace faulty wiring
c. Faulty spark plugs	c. Clean or replace and adjust plugs
3. Carburetion	
a. Lean combustion mixture	a. Clean and adjust carburetor
b. Dirt in carburetor	b. Clean carburetor
c. Restricted gas supply to carburetor	c. Clean gas lines and check for restrictions
d. Leaking carburetor or intake manifold gaskets	d. Tighten carburetor to manifold and manifold to head bolts or replace gaskets
4. Valves	
a. Valves adjusted too tight	a. Adjust valve lash
b. Valves sticking	b. Lubricate and free up. Grind valves if necessary
c. Exhaust valves thin and heads overheating	c. Replace valves
d. Weak valve springs	d. Replace valve springs
e. Valves timed early	e. Retime. See "Timing Gear Installation"
5. Cylinder Head	
a. Excessive carbon deposits in combustion chamber	a. Remove head and clean carbon
b. Cylinder head water passages partly clogged causing hot spot in combustion chamber	b. Remove cylinder head and clean water passages
c. Partly restricted exhaust ports	c. Remove cylinder head and clean

SYMPTOM AND PROBABLE CAUSE	PROBABLE REMEDY
in cylinder head	exhaust ports
d. Cylinder head gasket blown between cylinders	d. Replace cylinder head gasket
6. Spark Plugs	
a. Spark plugs glazed	a. Clean or replace spark plugs
b. Wrong heat range plug being used	b. Change to correct spark plugs
7. Exhaust System	
a. Exhaust manifold or muffler restricted causing back pressure	a. Clean or replace manifold and muffler
Rough Engine Idle	
1. Carburetor	
a. Improper idling adjustment	a. Adjust according to instructions
b. Carburetor needle valve not seating	b. Clean or replace
2. Air Leaks	
a. Carburetor to manifold gasket leaks	a. Tighten carburetor to manifold bolts or replace gasket
b. Manifold to head gasket leaks	b. Tighten manifold to head bolts or replace gasket
3. Valves	
a. Improper lash adjustment	a. Check and adjust valves
b. Valves not seating properly	b. Grind valves
c. Valves loose in guides	c. Condition valves
4. Cylinder Head	
a. Cracks in exhaust ports	a. Replace cylinder head
b. Head gasket leaks	b. Replace cylinder head gasket
Engine Misses on Acceleration	
1. Carburetion	
a. Accelerating pump jet plugged or pump sticking or not working	a. Overhaul carburetor
b. Lean fuel mixture	b. Overhaul carburetor
2. Ignition Trouble	
a. Faulty spark plugs	a. Clean, adjust or replace plugs
b. Faulty spark plug wire	b. Replace faulty wire
c. Improperly adjusted or faulty distributor points	c. Adjust or replace distributor points
d. Weak coil	d. Replace coil

SYMPTOM AND PROBABLE CAUSE	PROBABLE REMEDY
3. Engine	
a. Burned or improperly adjusted valves	a. Adjust, replace or grind valves
b. Leaky manifold gaskets	b. Tighten manifold or replace gaskets
c. Poor compression due to cylinder, piston or ring condition	c. Overhaul engine
d. Leaking cylinder head gasket	d. Replace gasket
Engine noise	
1. Crankshaft Bearings Loose	
a. Bearings improperly fitted	a. Readjust main bearings
b. Crankshaft journals out-of-round	b. Replace or recondition crankshaft
c. Crankshaft journals rough	c. Replace or recondition crankshaft
d. Oil passages in block restricted	d. Clean passages
e. Insufficient oil	e. Adjust or replace bearings. Replenish oil
f. Improper grade and viscosity oil being used	f. Adjust bearings and change to correct oil
g. Oil pump failure	g. Replace oil pump. Adjust or replace bearings and other damaged parts
h. Contaminated oil	h. Wash motor thoroughly. Adjust or replace bearings and other damaged parts
2. Connecting Rod Bearings Loose	
a. Improperly adjusted bearings	a. Adjust bearings
b. Crankpins rough	b. Polish or replace shaft. Adjust or replace rods
c. Insufficient oil	c. Adjust or replace rods and replenish oil
d. Oil pump failure	d. Replace oil pump. Replace or adjust rod bearings
e. Improper grade and viscosity of oil used	e. Adjust or replace rod bearings and change to proper oil
3. Pistons or Pins Loose	
a. Excessive cylinder wear	a. Hone cylinders and fit new pistons and rings. Make sure all abrasive that would cause cylinder wear is removed
b. Improperly fitted pistons or pins	b. Replace pistons or pins
c. Contaminated oil	c. Make necessary replacements, flush oiling system and use new oil

SYMPTOM AND PROBABLE CAUSE	PROBABLE REMEDY
d. Faulty fuel or ignition system causing unburned fuel to flush oil from cylinder walls	d. Make necessary repairs to fuel or ignition system, replace worn parts and change oil
e. Piston pin or pin hole wear	e. Regrind pin holes and install over-size piston pins
4. Engine Noise–General	
a. Bent connecting rod	a. Replace rod
b. Excessive end play in camshaft	b. Replace camshaft thrust plate, or correct end play by pressing gear on further
c. Excessive crankshaft end play	c. Replace main bearings
d. Broken piston ring	d. Replace broken ring and check condition of cylinder wall
e. Loose camshaft and crankshaft gears	e. Replace camshaft and crankshaft gears
f. Bent oil level gage rod	f. Replace oil level gage rod
g. Improperly adjusted valve lash	g. Adjust valve lash
h. Sticking valves	h. Free or grind valves

M E M O

SECTION V

ENGINE FITS AND TOLERANCES

19. ENGINE FITS AND TOLERANCES.

Type . . . . . Over-Head-Valve
Number of Cylinders 6
Bore . . . . . 90.0 mm
Stroke . . . . . 101.6 mm
Piston Displacement . . . . . 3878 cc
Compression Ratio . . . . . 7.2 : 1
Horsepower . . . . . 110 at 3400 rpm
Firing Order 1-5-3-6-2-4
Cylinder Block
  Cylinder Block Bore
    STD . . . . . 90.000 – 90.040 mm
    0.010″ O/S . . . . . 90.254 – 90.294 mm
    0.020″ O/S . . . . . 90.508 – 90.548 mm
    0.030″ O/S . . . . . 90.762 – 90.802 mm
    0.040″ O/S . . . . . 91.016 – 91.056 mm
    Allowable Out of Round . . . . . 0.05 mm max.
    Allowable Taper . . . . . 0.05 mm max.
  Main Bearing Bores and Caps
    I. D. of Bearing Bore
      Front . . . . . 72.000 – 72.035 mm
      Second . . . . . 73.500 – 73.535 mm
      Third . . . . . 75.000 – 75.035 mm
      Rear . . . . . 76.500 – 76.535 mm
      Wear Limit . . . . . 0.05 mm
  Camshaft Bearing Bore
    I. D. of Bore
      Front . . . . . 52.000 – 52.035 mm
      Second . . . . . 50.500 – 50.535 mm
      Third . . . . . 49.000 – 49.030 mm
      Rear . . . . . 47.500 – 47.530 mm
      Wear Limit . . . . . 0.05 mm

Valve Lifter Bore
- STD . . . . . 25.147 – 25.172 mm
- Wear Limit . . . . . 0.5 mm

Crankshaft
- Number of Bearings 4
- O. D. of Main Bearing Journals
  - STD
    - Front . . . . . 66.970 – 67.000 mm
    - Second . . . . . 68.470 – 68.500 mm
    - Third . . . . . 39.970 – 70.000 mm
    - Rear . . . . . 71.470 – 71.500 mm
  - 0.010″ U/S
    - Front . . . . . 66.716 – 66.746 mm
    - Second . . . . . 68.216 – 68.246 mm
    - Third . . . . . 69.716 – 69.746 mm
    - Rear . . . . . 71.216 – 71.246 mm
  - 0.020″ U/S
    - Front . . . . . 66.462 – 66.492 mm
    - Second . . . . . 67.962 – 67.992 mm
    - Third . . . . . 69.462 – 69.492 mm
    - Rear . . . . . 70.962 – 70.992 mm
  - 0.030″ U/S
    - Front . . . . . 66.206 – 66.236 mm
    - Second . . . . . 67.706 – 67.736 mm
    - Third . . . . . 69.206 – 69.236 mm
    - Rear . . . . . 70.706 – 70.736 mm
  - 0.040″ U/S
    - Front . . . . . 65.952 – 65.982 mm
    - Second . . . . . 67.452 – 67.482 mm
    - Third . . . . . 68.952 – 68.982 mm
    - Rear . . . . . 70.452 – 70.482 mm
- Journal Out of Round . . . . . 0.025 mm max.
- Runout at Second & Third Journal . . . . . 0.05 mm
- Thrust Taken . . . . . Third Bearing Rear Side
- End Play (Clearance)
  - STD . . . . . 0.03 – 0.13 mm
  - Allowable Clearance . . . . . 0.15 mm max.
- Crankpin Journal Diameters
  - STD . . . . . 53.980 – 54.000 mm
  - 0.010″ U/S . . . . . 53.726 – 53.746 mm
  - 0.020″ U/S . . . . . 53.472 – 53.492 mm
  - 0.030″ U/S . . . . . 53.218 – 53.238 mm
  - 0.040″ U/S . . . . . 52.964 – 52.984 mm
- I. D. of Rear Oil Seal Bore
  - STD . . . . . 120.000 – 120.054 mm

Wear Limit .. .. 0.10 mm

I. D. of Pilot Bearing Bore

STD .. .. 34.970 – 34.987 mm

Wear Limit .. .. 0.15 mm

Crankshaft Main Bearing Clearance

STD .. .. 0.03 – 0.05 mm

Allowable Clearance .. .. 0.10 mm max.

Undersize Bearings

Semi-undersize .. .. 0.000″ – 0.030″ ; 0.040″

Shim .. .. 0.20 mm (0.05,0.10 mm)

Connecting Rod

Center to Center Length .. .. 190.45 – 190.55 mm

Allowable Twist of Rod .. .. 0.05 mm max. to 100 mm

Allowable Bent .. .. 0.025 mm max.

Upper Bearing

Type .. .. Locked on Pin

Bore

STD .. .. 25.150 – 25.192 mm

Wear Limit .. .. 1.0 mm

Lower Bearing

Type .. .. Precision Interchangeable Insert (Steel Backed, Babbitt)

I. D. of Bore

Con-rod Marks A .. .. 56.80 – 56.81 mm

Con-rod Marks B .. .. 56.81 – 56.82 mm

Wear Limit .. .. 0.025 mm

Bearing Thickness

Marks A .. .. 2.80 – 2.82 mm

Marks B .. .. 2.82 – 2.84 mm

Bearing Clearance

New .. .. 0.02 – 0.05 mm

Used .. .. 0.02 – 0.06 mm (Selective Fit Marks A to A ,B to B)

Allowable clearance .. .. 0.08 mm max.

Undersize Bearings

Available .. .. 0.010″, 0.020″, 0.030″ 0.040″ U/S

Side Clearance Rod to Crankpin

STD .. .. 0.11 – 0.23 mm

Allowable Side Clearance .. .. 0.30 mm max.

Piston

Diameter Clearance at Skirt .. .. 2 lbs to 5 lbs Pull with 0.015″ Feeler ; 0.04 mm at 20 °C (Selective Fit)

Oversize Pistons
- Available ..... 0.010″, 0.020″, 0.030″, 0.040″ O/S

O. D. of Pistons at Skirt
- STD ..... 89.960 – 90.000 mm
- 0.010″ O/S ..... 90.214 – 90.254 mm
- 0.020″ O/S ..... 90.468 – 90.508 mm
- 0.030″ O/S ..... 90.722 – 90.762 mm
- 0.040″ O/S ..... 90.976 – 91.016 mm

Piston Pin Bore
- STD ..... 25.147 – 25.172 mm
- 0.005″ O/S ..... 25.274 – 25.299 mm
- Wear Limit ..... 0.05 mm

Piston Pin
- Diameter
  - STD ..... 25.145 – 25.170 mm
  - 0.005″ O/S ..... 25.272 – 25.297 mm
  - Wear Limit ..... 0.05 mm
- Piston Pin Fit
  - STD ..... Thumb Push Fit ; 0.002 mm at 20 °C
  - Allowable Limit ..... 0.010 mm max.
- Width of Ring Grooves
  - Top ..... 3.000 – 3.025 mm
  - Second ..... 3.000 – 3.025 mm
  - Oil Top ..... 4.000 – 4.025 mm
  - Oil Second ..... 4.000 – 4.025 mm

Piston Rings
- Compression Ring
  - Quantity 2
  - Type
    - Top ..... Without Taper, Cr-plated
    - Second ..... 1°Taper, Unplated
  - Width
    - Top ..... 3.58 – 3.82 mm
    - Second ..... 3.58 – 3.82 mm
  - Ring Groove Clearance (Installed)
    - Top ..... 0.040 – 0.085 mm
    - Second ..... 0.040 – 0.085 mm
    - Wear Limit ..... 0.02 mm
  - Gap Clearance (Installed)
    - Top ..... 0.15 – 0.45 mm
    - Second ..... 0.15 – 0.40 mm

Wear Limit .. .. 0.1 mm

Oil Ring

Quantity 2

Type

Top .. .. Without Taper, Cr-plated

Second .. .. Without Taper, Unplated

Width

Top .. .. 3.58 – 3.82 mm

Second .. .. 3.58 – 3.82 mm

Ring Groove Clearance (Installed)

Top .. .. 0.040 – 0.085 mm

Second .. .. 0.040 – 0.085 mm

Wear Limit .. .. 0.02 mm

Gap Clearance (Installed)

Top .. .. 0.15 – 0.45 mm

Second .. .. 0.15 – 0.40 mm

Wear Limit .. .. 0.1 mm

Ring Gap Spacing .. .. Not in Line

Camshaft

Number of Bearing 4

Bearing Journal Diameter

STD

Front .. .. 47.955 – 47.975 mm

Second .. .. 46.455 – 46.475 mm

Third .. .. 44.955 – 44.975 mm

Rear .. .. 43.455 – 43.475 mm

0.010″ U/S

Front .. .. 47.701 – 47.721 mm

Second .. .. 46.201 – 46.221 mm

Third .. .. 44.701 – 44.721 mm

Rear .. .. 43.201 – 43.221 mm

0.020″ U/S

Front .. .. 47.447 – 47.467 mm

Second .. .. 45.947 – 45.967 mm

Third .. .. 44.447 – 44.467 mm

Rear .. .. 42·947 – 42.967 mm

0.030″ U/S

Front .. .. 47.193 – 47.213 mm

Second .. .. 45.693 – 45.713 mm

Third .. .. 44.193 – 44.213 mm

Rear .. .. 42.693 – 42.713 mm

0.040″ U/S

Front .. .. 46.939 – 46.959 mm

Second .. .. 45.439 – 45.459 mm

Third .. .. 43.939 – 43.959 mm

Rear	42.439 – 42.459 mm
Runout at Second & Third Bearings	0.05 mm max.
Thrust Taken	By Thrust Plate
Thickness of Thrust Plate	
STD	3.978 – 4.000 mm
Wear Limit	0.35 mm
Camshaft End Play	
STD	0.085 – 0.110 mm
Allowable	0.15 mm max.
Camshaft bearings	
Type	Steel Backed Babbitt Lined
I. D. of Camshaft Bearing	
STD	
Front	48.000 – 48.030 mm
Second	46.500 – 46.530 mm
Third	45.000 – 45.030 mm
Rear	43.500 – 43.530 mm
0.010″ U/S	
Front	47.746 – 47.776 mm
Second	46.246 – 46.276 mm
Third	44.746 – 44.776 mm
Rear	43.246 – 43.276 mm
0.020″ U/S	
Front	47.492 – 47.522 mm
Second	45.992 – 46.022 mm
Third	44.492 – 44.522 mm
Rear	42.992 – 43.022 mm
0.030″ U/S	
Front	47.238 – 47.268 mm
Second	45.738 – 45.768 mm
Third	44.238 – 44.268 mm
Rear	42.738 – 42.768 mm
0.040″ U/S	
Front	46.984 – 47.014 mm
Second	45.484 – 45.514 mm
Third	43.984 – 44.014 mm
Rear	42.484 – 42.514 mm
Bearing Clearance	
STD	0.025 – 0.075 mm
Allowable Clearance	0.15 mm max.
Camshaft End Plug	
Assembly in Cylinder Block	Flush to 6 mm Deep
Intake Valve	
Seat Angle	45°
Diameter-Head	

STD ..... 43.9 – 44.1 mm
Wear Limit ..... 0.2 mm
Length Overall
STD ..... 151.9 – 152.6 mm
Wear Limit ..... 0.5 mm
O. D. of Stem
STD ..... 7.978 – 7.985 mm
Wear Limit ..... 0.08 mm
I.D. of Guide Ream
STD ..... 8.01 – 8.02 mm
Wear Limit ..... 0.20 mm
Stem to Guide Clearance
STD ..... 0.025 – 0.042 mm
Wear Limit ..... 0.020 mm
Valve Clearance with Engine Hot ..... 0.254 mm (0.010″)
Intake Opens ..... 6° B. T. D. C.
Closes ..... 42° A. B. D. C.
Period ..... 228°
Width of Seat in Head
STD ..... 1.8 – 1.9 mm
Allowable Min. Limit ..... 0.8 mm

Exhaust Valve
Seat Angle ..... 45°
Diameter-Head
STD ..... 37.4 – 37.5 mm
Wear Limit ..... 0.2 mm
Length-Overall
STD ..... 120.7 – 121.4 mm
Wear Limit ..... 0.5 mm
O.D. of Stem
STD ..... 7.96 – 7.97 mm
Wear Limit ..... 0.08 mm
I.D. of Guide Ream
STD ..... 8.01 – 8.02 mm
Wear Limit ..... 0.20 mm
Stem to Guide Clearance
STD ..... 0.04 – 0.06 mm
Wear Limit ..... 0.25 mm
Valve Clearance with Engine Hot ..... 0.356 mm (0.014″)
Exhanst Opens ..... 45° B. B. D. C.
Closes ..... 6° A. T. D. C.
Period ..... 231°
Width of Seat in Head
STD ..... 2.7 – 2.1 mm
Allowable Limit ..... 1.0 mm min.

Valve Guide
- Extend above Head
  - Intake ..... 20 mm
  - Exhaust ..... 20 mm

Valve Lifter
- Bore of Cylinder Block ..... 25.147 – 25.172 mm
- O. D. of Lifter
  - STD ..... 25.103 – 25.128 mm
  - Wear Limit ..... 0.08 mm
- Clearance Block to Lifter
  - STD ..... 0.019 – 0.769 mm (Selective Fit)
  - Wear Limit ..... 0.08 mm

Valve Spring
- Free Length
  - STD ..... 52.3 mm
  - Wear Limit ..... 1.6 mm
- Installed Height
  - STD
    - Intake ..... 43.4 mm
    - Exhaust ..... 43.7 mm
- Installed Load
  - STD
    - Intake ..... 24.6 – 28.6 kg
    - Exhaust ..... 23.9 – 27.9 kg
  - Wear Limit ..... 4.0 kg

Valve Rocker Shaft
- O. D. of Rocker Shaft
  - STD ..... 18.475 – 18.493 mm
  - Wear Limit ..... 0.12 mm
- I.D. of Rocker Arm Bore
  - STD ..... 18.500 – 18.528 mm
  - Wear Limit ..... 0.12 mm
- Total Backlash of Crankshaft and Camshaft Gears
  - STD ..... 0.08 – 0.16 mm
  - Allowable Limit ..... 0.25 mm max.
- Camshaft Gear
  - Material ..... Bakelite with Steel Hub
  - Teeth 54
  - Runout ..... 0.10 mm max.
- Crankshaft Gear
  - Material ..... Steel
  - Teeth 27
  - Runout ..... 0.08 mm

Oil Pump
- Type and Drive ..... Gear Pump Driven by Tang on Distributor
- Capacity ..... 10 ltr/min
- Pressure to open Valve ..... 5 – 10 kg/cm²
- O. D. of Pump Shaft
  - STD ..... 13.985 – 14.000 mm
  - Wear Limit ..... 0.100 mm
- I. D. of Pump Shaft Bore
  - STD ..... 14.014 – 14.042 mm
  - Wear Limit ..... 0.08 mm
- Backlash Between Main and Idler Gears
  - STD .....
  - Wear Limit ..... 0.2 mm
- Height of Gear ..... 23.48 – 23.50 mm
- Clearance Gear to Body (Radial)
  - STD ..... 0.025 – 0.085 mm
  - Wear Limit ..... 0.2 mm
- Clearance Gear to Cover
  - STD ..... 0.01 – 0.05 mm
  - Allowable Limit ..... 0.15 mm max.
- O. D. of Idler Gear Shaft
  - STD ..... 13.950 – 13.968 mm
  - Wear Limit ..... 0.10 mm

Oil Distributor
- Pressure ..... 2.8 – 3.5 kg/cm² at 2400 rpm

Spark Plug
- Make, Model Size ..... N-F 27630, 14 mm
- Type ..... Medium Type
- Spark Plug Gap ..... 0.9 mm

Distributor
- Point Gap ..... 0.4 – 0.5 mm
- Point Spring Tension ..... 450 – 650 gm
- Idling Speed ..... 450 – 500 rpm
- Vacuum Reading at Idling Speed ..... 17 – 21 inches

Fan Belt Adjustment
- Deflection Midway between Pulleys ..... 13 mm

Clutch Housing
- Bore
  - STD ..... 128.000 – 128.046 mm
  - Runout ..... 0.13 mm max.
- Parallelism of Face ..... 0.18 mm

Flywheel
- Teeth 136
- Runout ..... 0.20 mm max.

M E M O

SECTION VI

TORQUE WRENCH SPECIFICATIONS

20. TORQUE WRENCH SPECIFICATIONS.

Engine Bolts and Nuts	Foot—pounds
Cylinder head bolts	85—95
Valve rocker shaft support bolts	30—45
Manifold attaching bolts	25—45
Connecting rod bolt nuts	40—55
Piston pin bolts	45—60
Main bearing cap bolts: Front	95—110
Second	95—110
Third	95—110
Rear	75—90
Timing gear cover set bolts	12—20
Timing gear cover bolts	17—15
Clutch housing attaching bolts	45—60
Flywheel mounting bolts	40—55
Oil pan bolts	4—8
Clutch cover to flywheel bolts	18—22
Valve lifter cover bolts	2—4
Camshaft thrust plate bolts	10—15
Carburetor stud bolt nuts	20—25
Water pump attaching bolts	10—15
Fuel pump attaching bolts	10—15
Starter motor attaching bolt nuts	35—50
Generator bracket attaching bolts	20—35
Generator adjusting bar attaching bolts	10—15
Oil pump attaching bolts	10—15
Oil distributor attaching bolts	10—15
Distributor attaching bolts	10—15
Spark plugs	12—18
Coil attaching bolts	10—15

M E M O

SECTION VII

FUEL SYSTEM

21. CARBURETOR.

a. General Description.

(1) Glass bowl cover provided on float chamber to enable observing fuel level from the outside.

The cover on the float chamber is made in two layers with gasoline flowing in between making it possible to see the fluid level from the outside. This makes it very convenient as the gasoline supply condition can readily be observed.

(2) Body made into 3-body type.

The carburetor body is made into 3 parts, i. e., air horn, main body, and flange to increase precision during manufacture and facilitate overhauling and adjustments.

With this change in construction, air tightness has been improved to increase the effectiveness of the air vent system.

(3) Lifter rod and metering rod adjusting piece provided to make action of accelerating pump and metering rod smoother.

Because of this action, pump is subject only to vertical force by lifter rod, and no thrust is received to any other relative parts.

Moreover, metering-rod is installed to metering-rod-adjusting-piece, and it also is subject only to vertical force.

(4) Oversize metering rod provided inside the carburetor to enable its use to conform to operating conditions.

This oversize metering rod is carried as spare in the hole in operating block.

b. Construction Parts.

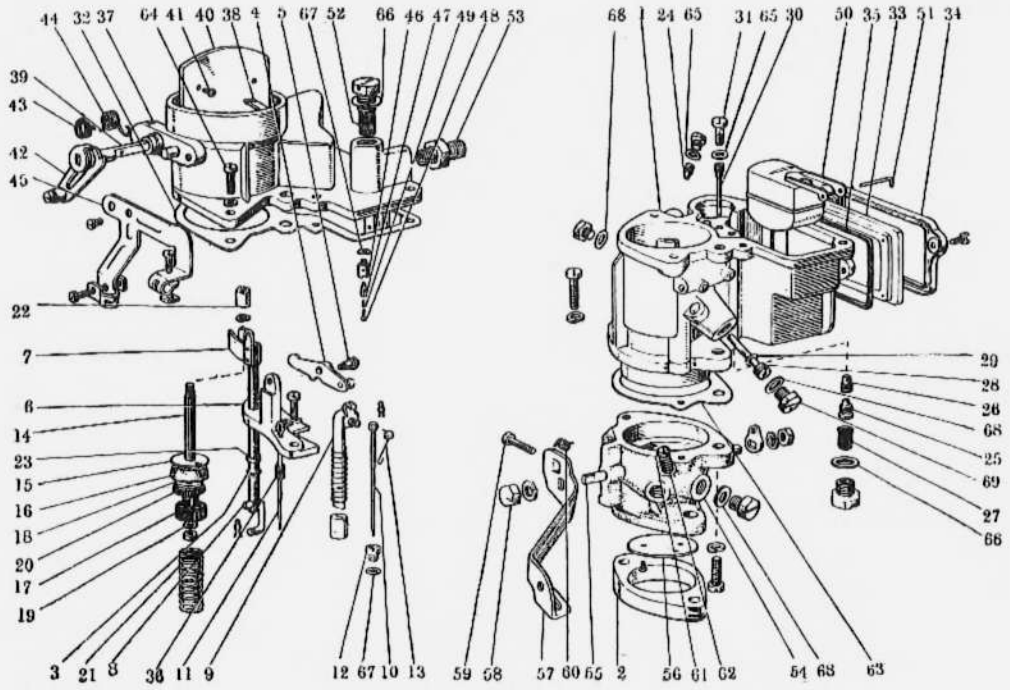


Figure 106 – Exploded View of Carburetor

1 MAIN BODY
2 CARBURETOR GASKET
3 "O" RING
4 COUNTER ARM
5 SUPPORTING SCREW
6 OPERATING BLOCK
7 LIFTER ROD
8 THROTTLE CONNECTOR LINK
9 METERING ROD ADJUSTING PIECE
10 METERING ROD (STD)
11 METERING ROD (O/S)
12 METERING ROD JET
13 ROD SPRING
14 PUMP ROD
15 LEATHER RETAINER (OUTSIDE)
16 PLUNGER LEATHER
17 PLUNGER CAP
18 LEATHER RETAINER (INSIDE)
19 LOCK WASHER
20 PLUNGER SPRING
21 PUMP SPRING
22 ROD LOCK NUT
23 "O" RING SET SPACER
24 PUMP JET
25 INTAKE BOWL CHECK
26 DISCHARGE BOWL CHECK
27 STRAINER SCREEN
28 HIGH SPEED NOZZLE
29 NOZZLE WASHER
30 SLOW JET
31 PASSAGE SCREW
32 BODY GASKET
33 FUEL LEVEL GAGE
34 LEVEL GAGE HOLDER PLATE

35 LEVEL GAGE GASKET
36 ROD HOLDER RUBBER
37 AIR HORN
38 AIR VENT TUBE
39 CHOKE VALVE SHAFT
40 CHOKE VALVE
41 CHOKE VALVE SET SCREW
42 CHOKE VALVE LEVER
43 VALVE LEVER SPRING
44 SHAFT LEVER SPRING
45 TUBE CLAMP
46 NEEDLE SEAT
47 NEEDLE VALVE
48 VALVE PUSH PIN
49 NEEDLE VALVE SPRING
50 FLOAT
51 FLOAT PIN
52 INLET STRAINER SCREEN
53 UNION NIPPLE
54 CARBURETOR FLANGE
55 THROTTLE SHAFT
56 THROTTLE VALVE
57 THROTTLE VALVE LEVER
58 LOCK NUT
59 VALVE ADJUSTING SCREW
60 ADJUSTING SPRING
61 IDLE ADJUST SCREW
62 IDLE ADJUSTING SCREW SPRING
63 FLANGE GASKET
64 BODY SET SCREW
65 GASKET (For 6 mm diam.)
66 GASKET (For 11 mm diam.)
67 GASKET (For 7 mm diam.)
68 GASKET (For 8 mm diam.)
69 NUT PLUG

c. Carburetor Specifications.

Venturi	First	8.73 mm (0.344″)
	Second	14.75 mm (0.581″)
	Main	35.00 mm (1.380″)
Fuel Level		22.5 mm (0.886″)
Float Raised		6 mm (0.236″)
Lowered		20 mm (0.787″)
Needle Valve Seat Hole Diameter		2.0 mm (0.080″)
Low Speed System		
Low Speed Jet		0.62 mm (0.0244″)
Air By-pass	First	1.0 mm (0.040″)
	Second	1.61 mm (0.063″)
Economizer		1.8 mm (0.031″)
Idle Port		
Length		4.75 mm (0.187″)
Width		0.75 mm (0.030″)
Upper Orifice Diameter		1.7 mm (0.067″)
Lower Orifice Diameter		1.4 mm (0.055″)
Idle Adjustment Screw Seat		1.7 mm (0.067″)
High Speed System		

Angle with Horizontal		30°
High Speed Nozzle		3.0 mm (0.118″)
Metering Rod Stroke		12.05 mm (0.474″)
Standard Metering Rod	First Step	2.0 mm (0.080″)
	Second Step	1.7 mm (0.067″)
	Power Step	1.3 mm (0.051″)
	Overall Length	59.4 mm (2.339″)
Oversize Metering Rod	First Step	2.1 mm (0.082″)
	Second Step	1.9 mm (0.075″)
	Power Step	1.5 mm (0.059″)
	Overall Length	59.4 mm (2.339″)
Metering Rod Jet		2.8 mm (0.110″)
Metering Rod Height		44.05 mm (1.734″)
Accelerating Pump Jet		0.75 mm (0.0295″)
Accelerating Pump Stroke		10.0 mm (0.394″)
Weight of Float		12.5 gm (0.438oz)

d. Construction and Operation.

Carburetor is made as a 3-body type comprising of the air horn part, main body part, and flange part.

The fuel supply relations are divided into the following systems:

(1) Float System
(2) Low Speed System
(3) High Speed System
(4) Accelerating System
(5) Choke System
(6) Air Vent System

(1) Float System.

The principal parts of the float system are the inlet strainer screen, needle valve, valve seat, valve push pin, valve spring, float, float pin, etc.

The gasoline flowing through the carburetor should not be subjected to any force other than the suction force of the air flowing through the carburetor.

Consequently this makes it necessary to maintain a constant fuel level in the float chamber. This is accomplished in the following manner.

The fuel delivered from the fuel tank by the fuel pump under pressure flows through the needle valve into the float chamber. As the fuel accumulates in the float chamber, the float rises and when it reaches to a specified fluid level, the float lip closes the needle valve to stop the incoming flow of gasoline.

The lifting force of the float at this state is from 1.5 to 2 times the fuel pressure of 0.32 kg/cm² (4.5psi). As the fuel is drawn out and the amount in the float chamber becomes less, the float drops to open the needle valve and allow gasoline to flow in again.

The height of fuel level will vary slightly with the specific gravity of the fuel used, a lighter fuel making the fuel level higher. Also, if the fuel inlet pressure becomes higher, that is, a higher pump discharge pressure, the fuel level becomes higher.

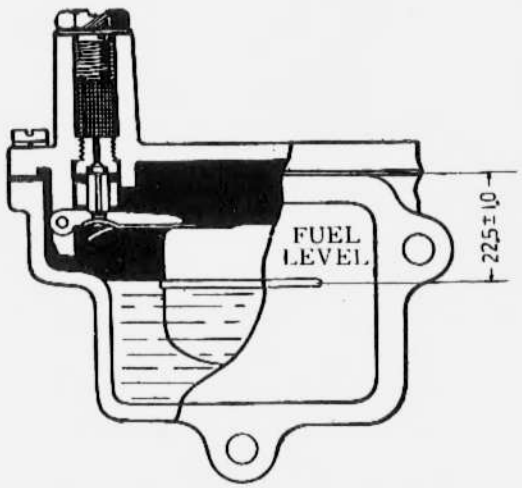


Figure 107 – Float System

(2) Low Speed System.

The low speed system is made up of the low speed jet, first by-pass, second by-pass, idle adjustment screw, throttle valve, and idle port.

This low speed system supplies fuel from 400 rpm up to around 1100 to 1200 rpm. It also supplies part of the fuel together with the main nozzle at no-load speed of from 1200 rpm to 1800 rpm.

In this low speed system, the fuel from the float chamber flows out between the metering rod and jet into the low speed jet where the vacuum draws the fuel upwards. As it passes by the first by-pass, the fuel mixes with the air coming in through the first by-pass and flows toward the second by-pass.

The passage to the second by-pass is made with sudden constriction so that the fuel and air passing through increases speed suddenly and mixes completely with the air coming in from the second by-pass to form a fine gasoline mist. The air-fuel mixture in this fine mist form then flows through the passage to be discharged out of the idle port.

This air-fuel mixture flowing through the passage, however, is too rich for idling mixture demands in this state so that upon discharging it mixes with the air flowing down the through throttle valve to form an air-fuel mixture properly suited for idling speed.

The idle port is made elongated so that the shape or area of the hole will change as the throttle valve is opened. This hole is shaped such that as the throttle valve is opened, the proper amount of air-fuel mixture to

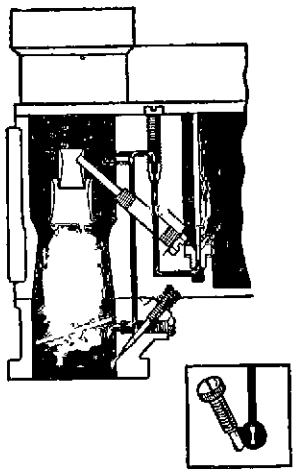


Figure 108 Slow Speed and Idle System

conform to the variation in the amount of air will be supplied through the opening to increase the speed

(3) High Speed System.

The high speed system is made up of the metering rod, high speed nozzle, main venturi,and second venturi.

As the throttle valve is gradually opened, the air pressure at the tip of the high speed nozzle becomes low. The difference between the pressure at the tip of the high speed nozzle and that in the float chamber draws the gasoline from the float chamber through the metering rod and jet and discharge it out through the high speed nozzle.

When gasoline is first discharged out from the high speed nozzle, it also is being supplied from the low speed system. As the throttle valve is opened wider, the high speed system increases its action while the low speed system becomes unable to draw up gasoline because of the reduction in vacuum and ceases to function, leaving only the high speed system in operation.

As the speed increases, the balance between the incoming air flow and the gasoline flow becomes disrupted and more air flows through to make the air-fuel mixture lean. For this reason, the metering rod is provided with steps with the stepped parts sized such that the gap area between the rod and jet increase to allow more gasoline to flow through to maintain a proper air-fuel mixture.

The metering rod is provided with metering rod spring to keep the rod constantly on one side of the jet orifice.

(4) Accelerating System.

The accelerating system is made up of the pump cylinder, pump assembly, intake ball check, discharge ball check, and strainer screen.

When the throttle valve is suddenly opened to accelerate the engine from

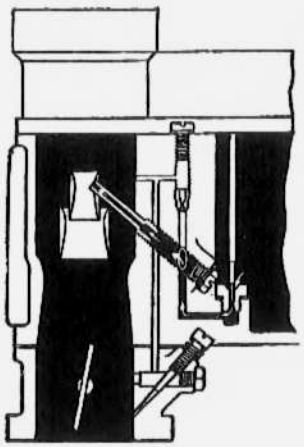


Figure 109 – High Speed System

low speed, the air having low density will immediately adapt itself to the new condition and flow, but gasoline being much heavier than air will take some time before it adapts itself to the new condition and flow because of the higher inertia.

If sudden acceleration, that is, a richer mixture is required, this time lag will cause a mixture leaner than that demanded to flow and in extreme cases may cause the engine to stop.

To help out this difficulty, the accelerator pump is provided to supply extra

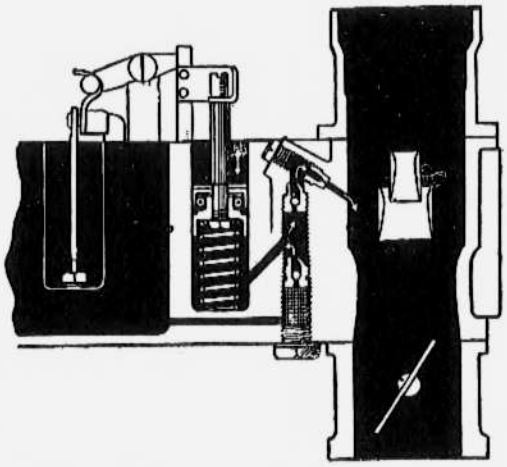


Figure 110 – Accelerating System

gasoline temporarily from a different jet when the throttle valve is suddenly opened and give ample acceleration.

The piston on the accelerator pump is at the top of the pump cylinder when

the accelerator pedal is released.

In this state, the gasoline in the float chamber lifts up the ball in the intake ball check and fills the pump cylinder. When the accelerator pedal is depressed, the pump piston is forced down into the cylinder to cause the gasoline in the cylinder to close the intake ball check and open the discharge out into the venturi.

This gasoline discharge does not end instantaneously but is made to continue for a fixed period of time (1 to 1.2 seconds).

(5) Choke System.

The choke system is made up of the choke valve, choke valve shaft, and choke valve lever.

The choke system is used in starting the engine, that is, until the engine warms up or when temporary increase in engine power is required through richer mixture.

When the engine is cold, the gasoline vapor contained in the air-fuel mixture supplied by the carburetor condenses on the cold intake manifold and cylinder walls. Thus the air-fuel mixture entering the combustion chambers will be exceedingly lean to make its ignition difficult and even if ignited will have low detonating power so that the engine will have inadequate power. This action is especially pronounced during cold weather starting.

In operation, closing the choke valve speeds up the flow of air to raise the vacuum around the high speed nozzle and causing gasoline to be discharged from this point also to form a richer air-fuel mixture.

(6) Air Vent System.

The air vent system comprises of the air vent tube provided on the air horn.

The air vent system is provided to equalize the pressure in the float chamber with that of the air flowing past the tip of the air vent inlet.

Since the gasoline discharged from the high speed jet is effected by the difference in pressures between that at the tip of the high speed jet and that inside the float chamber, a rise in pressure inside the float chamber will cause that much more gasoline to be discharged out.

Similarly, if a clogged air cleaner or other causes should restrict the flow of incoming air, the vacuum at the tip of the high speed jet will become higher to make the air-fuel mixture richer.

This defect can be prevented if the pressure inside the float chamber can be varied to conform to that at the venturi part to allow a proper amount of gasoline to be discharged from the high speed jet.

For this purpose, the air vent is provided in the air horn part to equalize the pressure in the air horn with than in the float chamber to limit the differences in pressures between these parts.

e. Disassembly.

The carburetor is disassembled in the following order.

(1) Unloosen 6 screws attaching air horn and separate air horn from carburetor (Figs. 111—112).

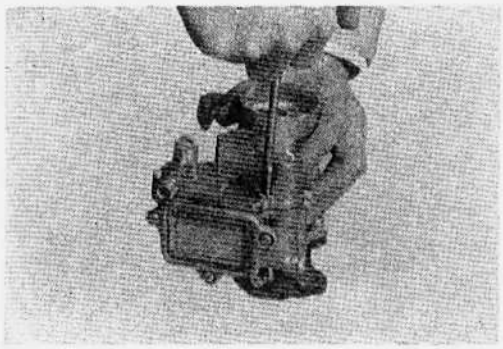


Figure 111

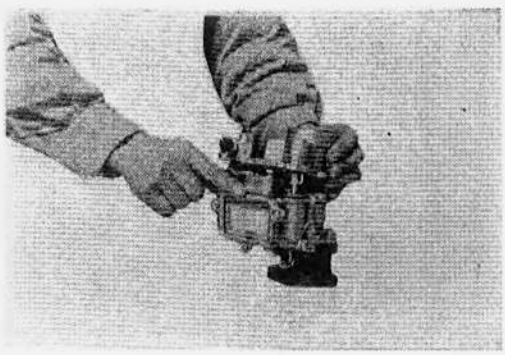


Figure 112

Among the 6 screws, the one over the high speed system passage is larger than the other 5 screws. Also, it uses a brass washer.

(2) Pull out spare metering rod (Fig. 113).

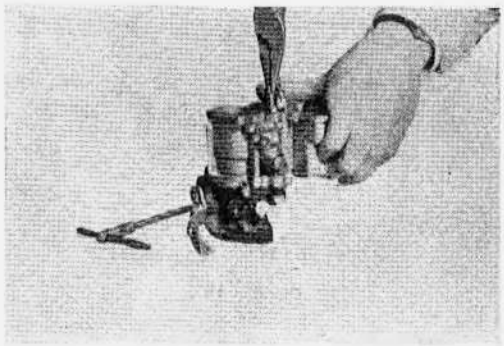


Figure 113

(3) Unloosen pump rod lock nut from accelerating pump (Fig. 114).

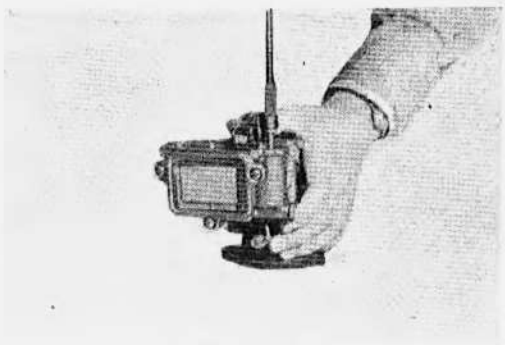


Figure 114

(4) Disconnect throttle connector link from lifter rod and remove lifter rod (Figs. 115–116).

Figure 115

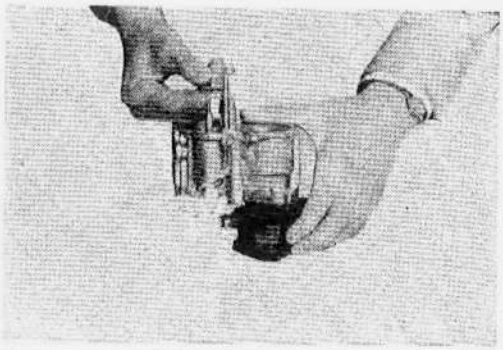


Figure 116

(5) Remove counter arm by unloosening supporting screw (Fig. 117).

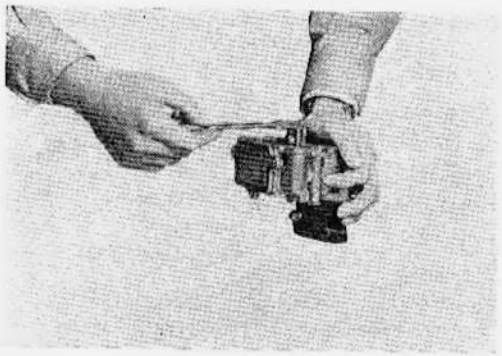


Figure 117

(6) Remove metering rod from metering rod adjusting piece.
(7) Remove operating block (Figs. 118–119).

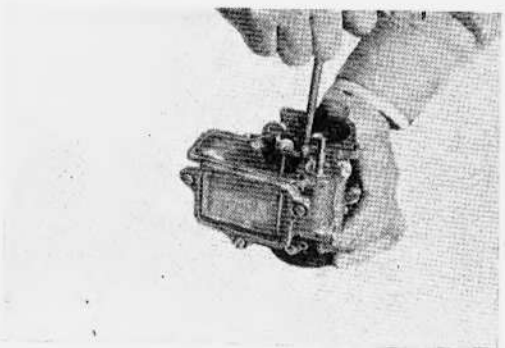


Figure 118

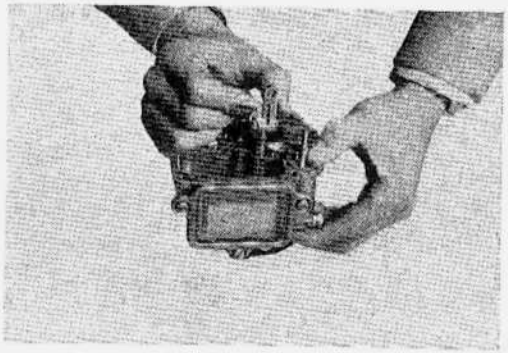


Figure 119

(8) Take out accelerating pump (Fig. 120).
(9) Unloosen and remove metering rod jet (Fig. 121).

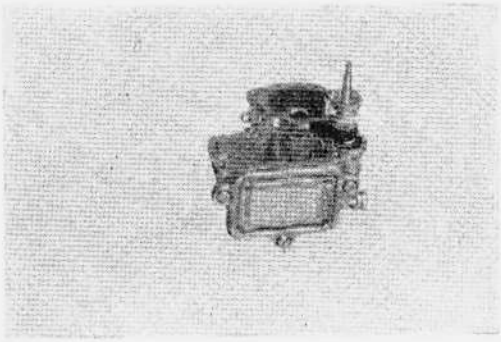


Figure 120

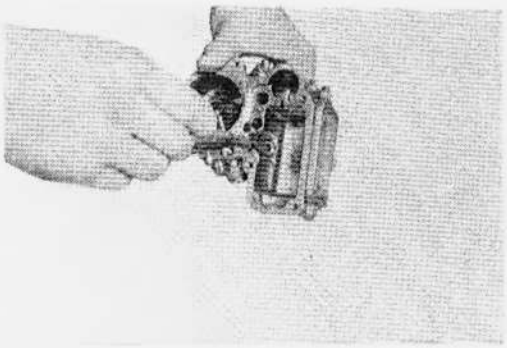


Figure 121

(10) Remove carburetor flange (Fig. 122).

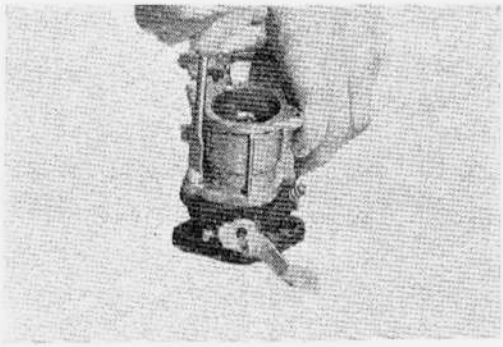


Figure 122

Disassemble carburetor main body in following order: low speed system, accelerating system, high speed system.
(11) Remove low speed jet (Fig. 123).

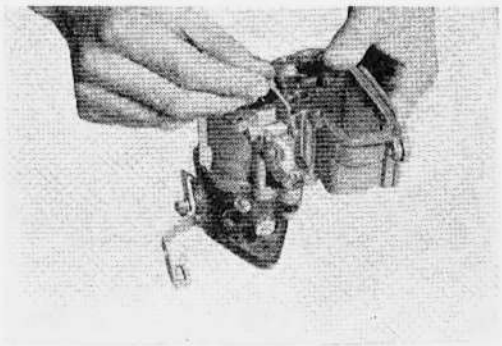


Figure 123

(12) Unloosen and remove nut plug at lower part of pump cylinder (Fig. 124).

(13) Unloosen nut plug and take out pump intake strainer screen (Fig. 125).

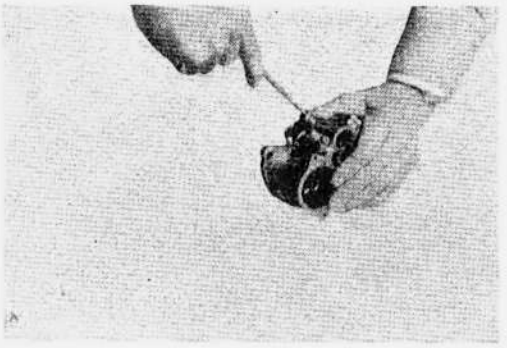


Figure 124

Figure 125

(14) Also, remove intake ball check in the inside by unscrewing it out (Fig. 126).

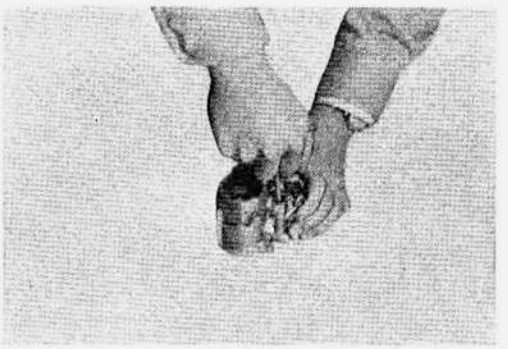


Figure 126

(15) The discharge ball check is also inside so remove by unscrewing it out (Fig. 127).

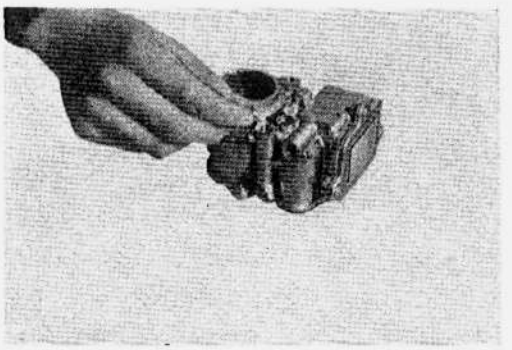


Figure 127

(16) Unloosen accelerating jet passage screw and remove accelerating jet (Fig. 128).

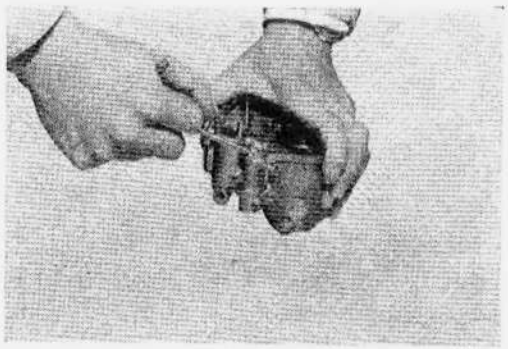


Figure 128

Next disassemble high speed system.

(17) Remove nut plug.

(18) Take out high speed nozzle (Fig. 129).

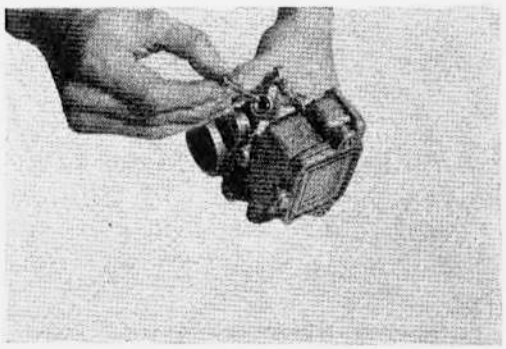


Figure 129

(19) Take out float and needle valve from air horn (Fig. 130).

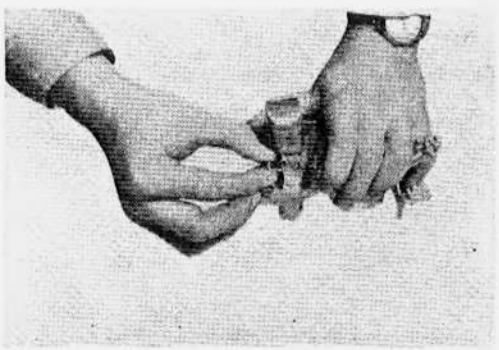


Figure 130

f. Inspection.

(1) Check needle valve contact.

The end of needle valve should show good contact all around.

If the contact is poor, the needle valve and seat should be replaced as a set with new parts.

If valve seats poorly, gasoline leakage will occur at this part to cause over-flowing.

(2) Check float for air tightness.

If gasoline leaks into the float, the float level will be deranged to cause poor engine performance. Float found with gasoline inside should be replaced. Check float pin for wear and other defects and if found worn badly replace with new pin.

(3) Check pump plunger leather for condition of wear and deterioration.

Leather found worn or deteriorated should be replaced.

Check plunger spring for tension.

If spring is weakened so that contact between leather and cylinder is poor, the spring should be replaced.

(4) Check action of intake ball check and discharge ball check.

If the intake ball check fails to close tight, the accelerating pump on its down stroke will force gasoline to return back to the float chamber and shorten discharge time, and also the discharge amount will become smaller.

If the ball in the discharge ball check has poor contact, the gasoline will be discharged out in a mist.

(5) Check point of idle adjust screw for contact.

If the end of idle adjust screw shows poor contact or is worn excessively, it should be repaired or replaced.

(6) Check slow speed jet for contact.

The slow jet is made up of two parts, the upper half and the lower half, which are force-fitted together. The tapered part of the upper half contacts the carburetor main body so that this part is checked and if the contact is found poor, the jet should be replaced.

Poor contact at the tapered part will cause extra gasoline to be drawn in to make slow speed performance bad and result in poor fuel economy so that special care should be taken in checking this part.

g. Reassembly.

The carburetor is reassembled in the following order.

(1) Assemble needle valve seat in air horn. Then fit on needle valve, valve spring, and valve push pin (Fig. 131).

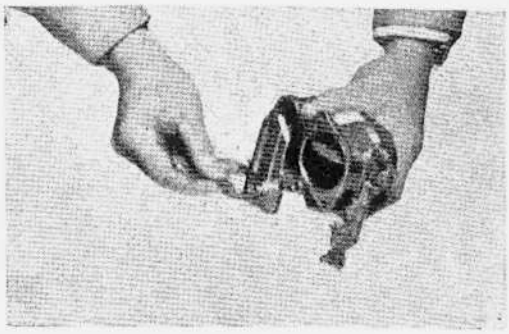


Figure 131

(2) Assemble on float.

After assembling on float, always make sure to adjust its positions when raised and lowered.

(3) Assemble on high speed nozzle.

Screw down nozzle tightly over the copper high speed nozzle washer after which screw on nut plug over gasket (Fig. 132).

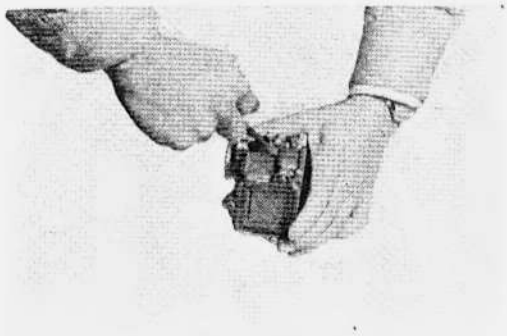


Figure 132

(4) Tighten pump jet, and then pump jet passage screw (Fig. 133).

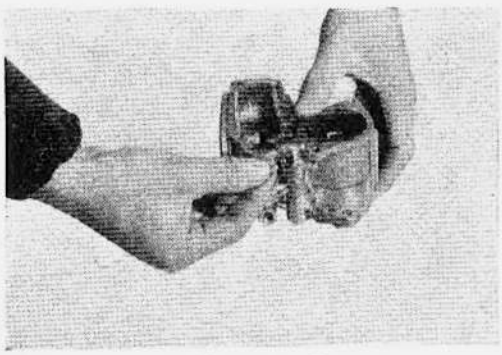


Figure 133

(5) Screw on intake ball check and then screw on discharge ball check (Fig. 134).

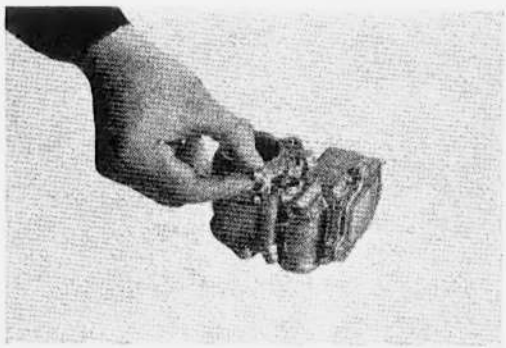


Figure 134

(6) Then insert pump intake strainer screen and screw on nut plug over gasket.
(7) Screw on nut plug at lower part of pump cylinder over gasket.
(8) Assemble on slow jet.
(9) Assemble on carburetor flange to carburetor main body (Fig. 135).

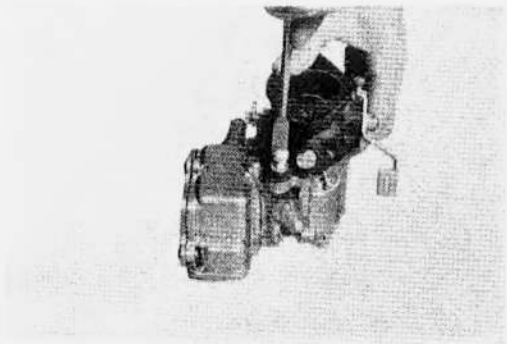


Figure 135

(10) Assemble on metering rod jet (Fig. 136).

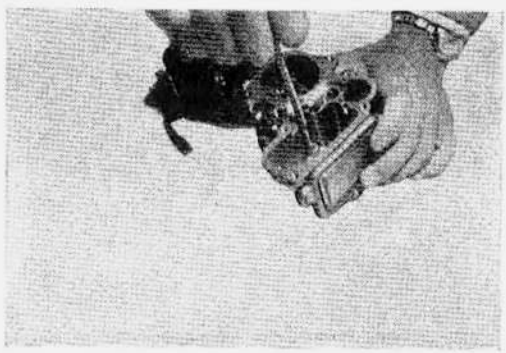


Figure 136

(11) Assemble on accelerating pump (Fig. 137).
(12) Assemble on operating block (Fig. 138).

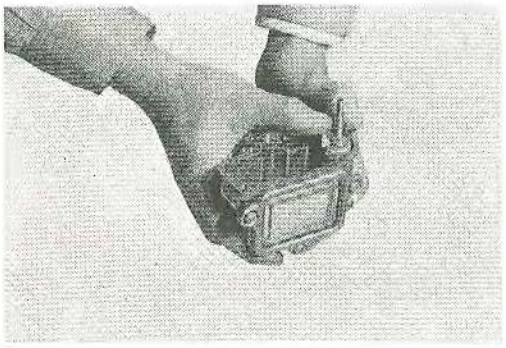


Figure 137

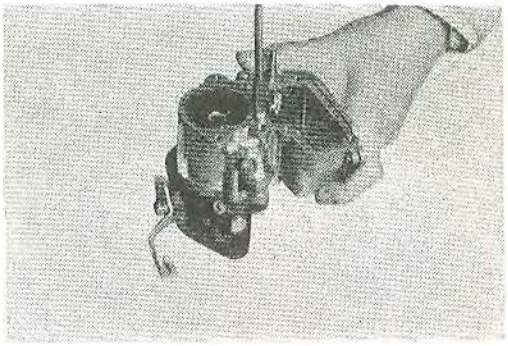


Figure 138

(13) Assemble on metering rod to metering rod adjusting piece.
(14) Screw on counter arm to operating block with counter arm supporting screw (Fig. 139).

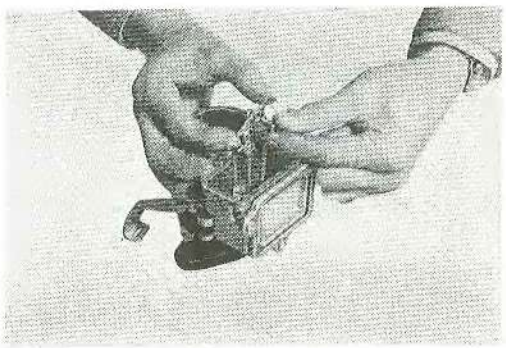


Figure 139

(15) Assemble on lifter rod (Fig. 140).

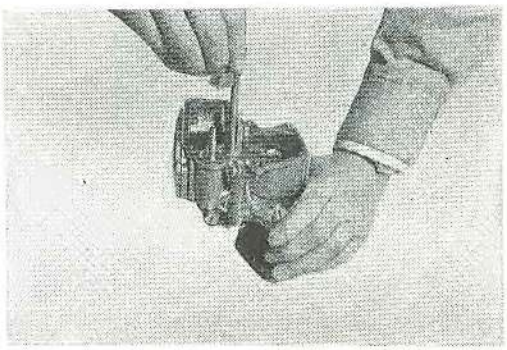


Figure 140

(16) Connect up throttle connector link on the lifter rod and hook on snap ring (Fig. 141).

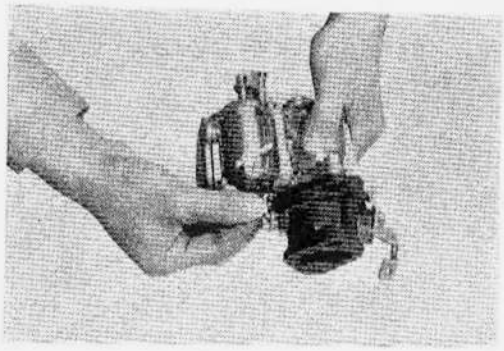


Figure 141

(17) Screw on pump rod locknut on to accelerating pump (Fig. 142).

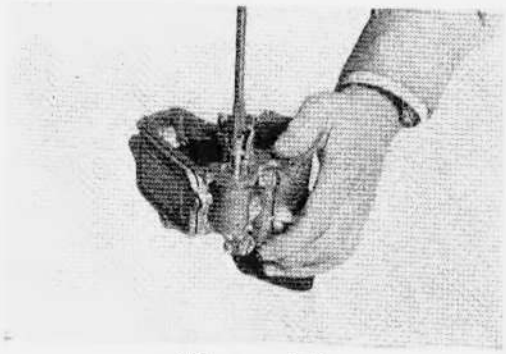


Figure 142

(18) Insert spare metering rod into hole in operating block (Fig. 143).

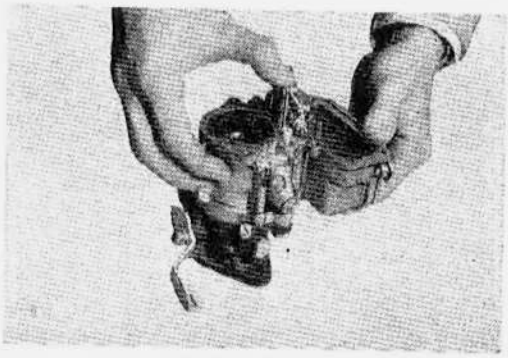


Figure 143

(19) Assemble on air horn (Fig. 144).

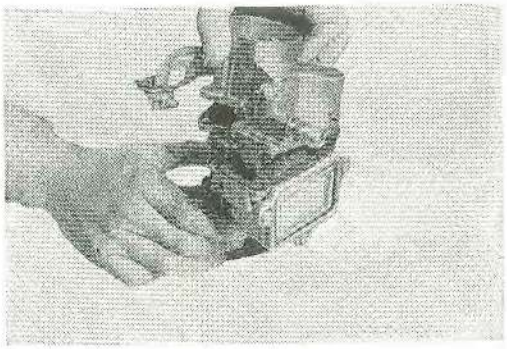


Figure 144

h. Adjustment.

(1) Testing Accelerating Pump.

To test accelerating pump, fill float chamber full of gasoline and by moving throttle lever, check condition of gasoline discharge from pump jet.

If the gasoline discharges out in a steady steam for a period of 1 to 1.2 seconds, the action of the pump can be considered satisfactory.

If the gasoline fails to discharge or the amount discharged is small, the cause is probably due to the check valves being defective or the leather on the pump plunger being badly worn out so that these points should be checked and necessary repairs made.

When the gasoline discharges out in a form of a mist, the cause is due to faulty ball checks and when the discharge time is too short, the cause is due to defective intake ball check.

Faulty discharge can also be caused by the passages being clogged and also by sediment collecting in the pump cylinder so that for this kind of trouble, a thorough check should be made on all parts.

(2) Adjusting Float Level.

The float level is adjusted by the following procedure.

Adjust height of float by bending part of float lever which contacts needle valve (Fig. 145).

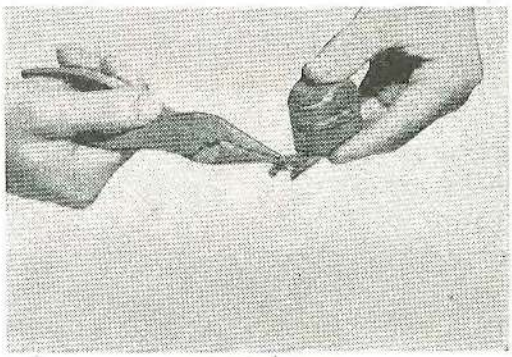


Figure 145

For raised position of float, turn carburetor upside down and adjust clearance between end of float body to 6 mm (Fig. 146).

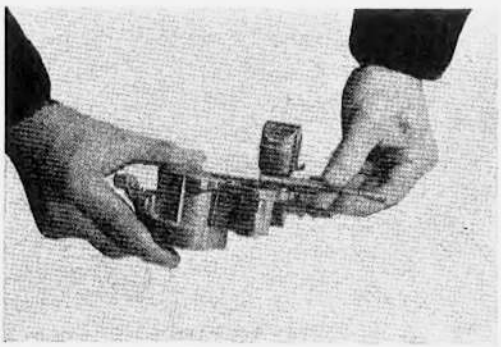


Figure 146

In this case, the needle valve spring will deflect by amount equal to weight of float. This 6 mm clearance includes this deflection of the spring.

For lowered position of float, adjust clearance between float upper surface to 20 mm (Fig. 147).

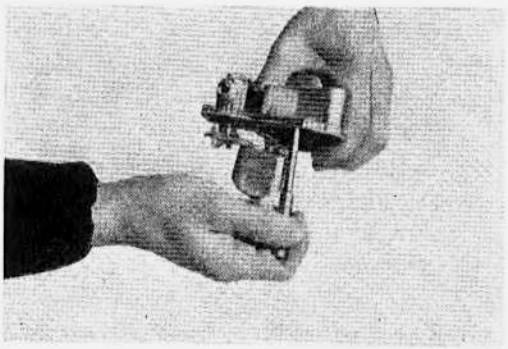


Figure 147

The float level is correct if the surface of the fuel is within the level line marked on the bowl cover when viewed from outside of the carburetor.

(3) Adjusting Metering Rod.

To adjust the installed height of the metering rod, vary the amount of bend of the adjusting piece attached on the upper end of the metering rod (Fig. 148).

The height of metering rod is adjusted to make the distance from the bottom surface of rod attaching pin to bottom surface of tapered hole in jet 44.05 mm.

If this measurement is taken from the top surface of the jet, it should be 41.05 mm.

(4) Adjusting Idling.

Adjustments for the air-fuel mixture for low speed system is made through

the idle adjusting screw.

To adjust, warm up the engine to 75° to 85°C and have the check valve wide open. Adjust engine speed with throttle lever adjusting screw to give speed equivalent to that when truck is running about 10 km per hour on level road at top gear. Then screw in idle adjusting screw carefully to throttle down the fuel supply until the engine is just turning over smoothly.

Everything is in good condition if this adjustment can be made by screwing the idle adjusting screw in tightly and then unscrewing back about 1¼ to 1¾ turn.

Idling adjustment can be made more accurately by using a vacuum gage. In this method, a vacuum gage is installed on the intake manifold and the idle adjusting screw varied until the pointer on the vacuum gage shows a steady reading between 17 and 21 inches.

After this idle adjustment is made, push the throttle button in fully and adjust with throttle lever adjusting screw to give engine speed of from 400 to 600 rpm.

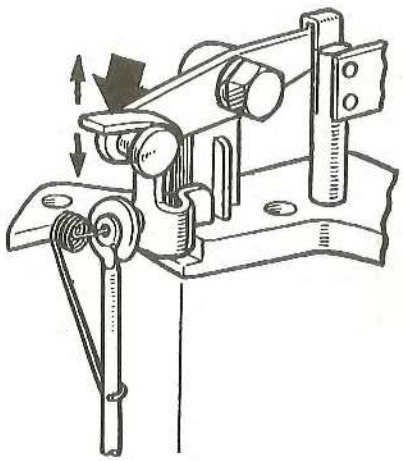


Figure 148 – Adjusting Metering Rod

i. Trouble Shooting.

(1) FLOAT SYSTEM (FUEL LEVEL)

Trouble-Fuel Overflows or Leak

Cause	Effect	Repairs
Fuel pump pressure is too high	Fuel level in bowl becomes too high due to needle seat being pushed open and extra fuel flowing in	Check strength of diaphragm spring and also link and arm. Replace all defective parts.
Float level is too high	Fuel level becomes too high and extra fuel flows in	Adjust float to specified height
Air vent tube is clogged	Pressure inside bowl rises to force fuel into carburetor	Clean thoroughly
Float chamber is not air tight due to defective gasket, etc.		Replace defective gasket or cover with new part
Needle valve seating is loose due to foreign particles or defective gasket	Fuel leaks around needle valve seat	Replace defective part. Tighten needle seat
Needle and seat are worn	Shoulder becomes formed on needle to prevent it being tight	Replace needle and seat together as set with new parts
Gap between needle and seat is clogged	Needle valve is prevented from closing tight to allow overflowing	Disassemble and clean. Check needle valve and seat
Shoulder formed on float lip due to wear and causes needle to stick	Needle action prevented to cause overflowing	Dress down float lip smooth with #00 sandpaper
Float pin is worn or pin hole in bracket is enlarged.	Float becomes unstable and fluid level does not remain constant	Replace with new parts
Float lowering angle is incorrect	Float becomes stuck	Adjust to specifications
Body and passage plugs and other parts are damaged	Parts begin to leak	Replace defective parts.

Dirt or paint is under copper washers	Fuel begins to leak from nozzles and plugs	Clean and replace washers

(2) LOW SPEED SYSTEM

Trouble (A) Mixture Too Lean At Idling

Cause	Effect	Repairs
Metering hole in low speed jet is plugged	Fuel flow becomes inadequate	Replace jet if defective. Clean if dirty
Air passage or bleed hole is enlarged	Air flow becomes too large	Repair to specified size or replace with new part
Economizer hole is plugged	Prevents flow of air-fuel mixture	Clean with gasoline and air or remove plug and clean out with wire
Passage between low speed jet and port hole and to idle screw is plugged	Prevents flow of air-fuel mixture	Same as above. If rubber is present, wash off with thinner
Port hole is too small	Flow of air-fuel mixture becomes too small	Clean if plugged with foreign matter but if due to defective casting, enlarge hole to specified size
Port at end of idle screw is plugged	Prevents adjustment of idle screw	Remove idle screw and clean out hole
Carbon accumulated on tapped holes in casting	Makes adjustment with idle screw impossible	Clean out threads with gasoline or thinner
Air leaks out from flange gasket	Surplus air infiltrates to thin air-fuel mixture	If gasket is defective, replace with new part and tighten securely
Idle screw is damaged	Makes adjustment impossible	Replace with new part
Nut plug is loose or improperly installed	Surplus air infiltrates	Retighten plug or reinstall correctly
Throttle shaft is worn	Surplus air infiltrates around the shaft	Replace with new part as repairs are difficult

Trouble—(B) Mixture Too Rich At Idling

Cause	Effect	Repairs
Metering hole for low speed jet is worn or enlarged	Fuel flow becomes too large	Replace jet and washer with new parts

Cause	Effect	Repairs
Upper end of low speed jet fails to contact body tightly	Surplus fuel flow through clearance formed	Replace jet and washer with new parts
Low speed jet washer is defective or lost	Jet will fail to fit tightly to allow fuel to flow through	Replace with new washer
Air bleed hole or by-pass is plugged with carbon.	Air in air-fuel mixture becomes too small	Remove carbon with wire, clean with gasoline and air
Economizer is too large	Too much fuel passes through	Replace carburetor body
Idle port is damaged	Makes adjustment with idle screw impossible	Replace carburetor body
Fuel leaks from high speed nozzle seat	Surplus fuel flows in	Check high speed jet washer or tighten jet
Idle screw is damaged	Makes adjustment impossible	Replace with new part
Carbon accumulated around throttle valve	Air flow becomes inadequate	Clean carbon
Throttle valve installed incorrectly	Angle with port or clearance becomes incorrect	Place marked side toward idle port and install with mark pointing downward

(3) HIGH SPEED SYSTEM

Trouble—(A) Mixture Too Lean

Cause	Effect	Repairs
Fuel pump pressure is too low	Inadequate supply of fuel causes fuel level to drop	Replace pump diaphragm spring or replace worn parts in link
Fuel passage to needle seat is clogged	Inadequate supply of fuel causes fuel level to drop	Clean fuel line from fuel tank to carburetor
Float level is too low	Fuel level in float chamber becomes too low	Adjust height of float to specifications
Opening in needle seat is too small	Fuel supply becomes inadequate	(a) Replace needle and seat with specified types (b) Adjust lowered position of float

Vent hole on outer side is plugged	Fuel supply becomes inadequate	Clean out vent hole
Gap between metering rod and jet is closed	Prevents flow of fuel	Clean and remove all foreign matter
Height of metering rod is incorrect	Deranges mixture ratio	Adjust height of rod
Parts actuating metering rod are worn	Prevents accurate movement of metering rod	Replace worn parts
Metering rod is too large in diameter	Makes fuel passage smaller	Replace rod with specified size
Metering rod jet is too small	Makes fuel passage smaller	Replace with specified size jet
Passage through body from metering jet to nozzle is clogged	Prevents flow of fuel	Remove jet and nozzle and clean out passage
Nozzle is damaged	Prevents discharge of fuel	Replace with new part
Air horn is loose from body	Surplus air infiltrates into body	Tighten down uniformally
Throttle shaft is worn	Surplus air infiltrates around shaft and also prevents proper movement of metering rod	Replace with new part

Trouble- (B) Mixture Is Too Rich

Cause	Effect	Repairs
Fuel pump pressure is too high	Needle valve is pushed open to raise fuel level inside bowl	Replace diaphragm spring if too strong and repair link and arm if defective
Float level is too high	Fuel level inside bowl becomes too high	Adjust float to specified height
Air infiltrates through gasket	Disrupts position of float and height of fuel level	Replace with new part or correct back to former shape if repairable

Metering rod spring is loose from the rod	Rod becomes unstable to allow surplus fuel to flow in	Hook spring back to rod and replace any part found worn
Diameter of metering rod is incorrect	If too small, surplus fuel will flow in	Replace with proper size rod
Metering rod and jet are worn	Clearance between rod and jet becomes too large to allow surplus fuel to flow in	Use oversize rod or replace jet and rod
Metering rod jet is loose	Surplus fuel will flow in between jet and body	Use standard gasket and tighten down securely
Metering rod is bent	Correct balance with jet will be lost	Repair or replace with new part
High speed nozzle is damaged	Amount of fuel discharge will be deranged	Replace with new part
Nozzle is installed without gasket	Surplus fuel will flow in between nozzle and body	Use gasket and tighten securely
Hinge on choke valve is stuck	Choke will be in half-choked state	Repair choke hinge or its spring
Air cleaner is dirty	Carburetor will be in half-choked state to limit air flow	Clean out with compressed air

(4) ACCELERATING PUMP SYSTEM

Trouble—Fuel Mixture Too Lean During Acceleration

Cause	Effect	Repairs
Plunger spring is too weak	Pump cylinder will not be filled with adequate amount of fuel	Replace with new part
Plunger leather is worn or dried out	Acceleration becomes poor	Replace with new part
Leather is loose from the plunger	Acceleration becomes poor	Tighten down securely

Leather is damaged or torn	Acceleration becomes poor	Replace with new part
Plunger is incorrectly installed	Accceleration becomes poor	Reassemble correctly
Intake or discharge valve is not fitted tightly into body	Fuel will flow through clearances form to make action of pump poor	Remove foreign matter and retighten securely
Intake or discharge valve leaks or is stuck	Flow of fuel into pump becomes poor	Clean if dirty and replace if defective
Passages from pump to body is clogged	Prevents flow of fuel into and out of pump	Disassemble and clean out passages with gasoline and air
Pump jet is clogged or is not fitted tightly into body	Prevents proper discharge of fuel	Clean with gasoline and air and fit securely into body
Wrong parts were used in assembling	Prevents proper action of pump	Replace with correct parts
Pump spring is weak	Prevents fast action of pump	Replace with new part
Throttle to pump connections are worn	Due to play, pump will not actuate as soon as throttle valve is opened	Replace worn parts

(5) CHOKE SYSTEM

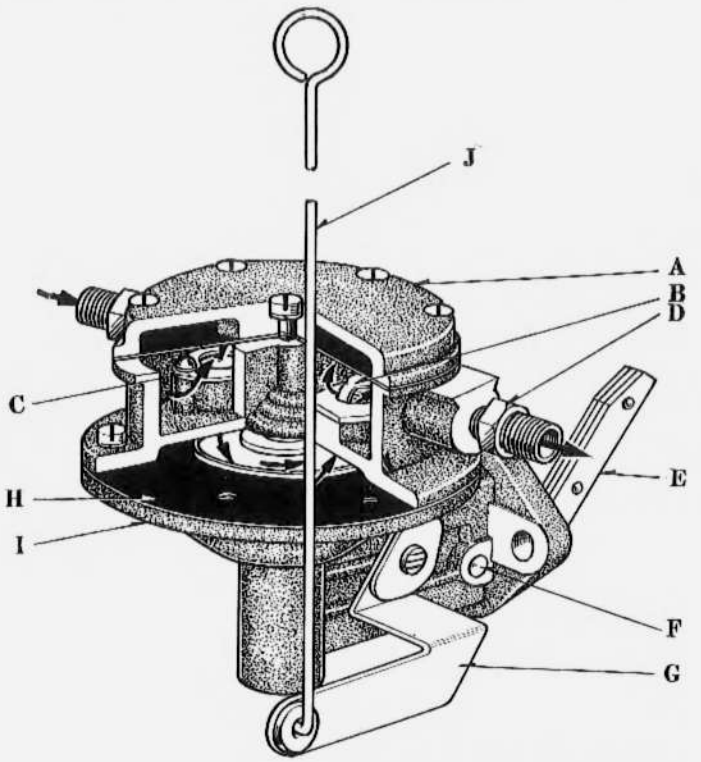
Trouble—Mixture Is Too Rich

Cause	Effect	Repairs
Choke shaft is sticking	Failure to return properly places choke in half opened state	Disassemble and clean, and replace defective parts
Choke button wire is improperly installed	Choke will fail to return properly	Reinstall to make choke return properly

22. FUEL PUMP.

a. General Description.

The diaphragm type fuel pump (Fig. 149) used on this vehicle mounts on the right side of the crankcase near the front of the engine (Fig. 150). It is operated by a rocker arm that reaches through the side of the crankcase and rides on a special cam on the engine camshaft.



A BODY COVER
B VALVE
C VALVE RETAINER
D FUEL PUMP UNION NIPPLE
E ROCKER ARM
F ROCKER ARM PIN
G HAND LEVER
H DIAPHRAGM
I FUEL PUMP BODY
J HAND LEVER ROD

Figure 149 – Fuel Pump

The fuel pump consists of a body, rocker arm and link assembly, hand lever, diaphragm, diaphragm spring, inlet and outlet valves.

The diaphragm consists of several layers of specially treated cloth, which are not affected by gasoline or benzol, held together by two metal discs and a diaphragm shaft.

b. Operation.

In operation the diaphragm is pulled down against the tension of the diaphragm spring by the action of the cam and rocker arm. This causes a partial vacuum in the pump chamber which opens the inlet valve and applies this vacuum to inlet line from the fuel filter. Further movement of the camshaft releases the rocker arm and the diaphragm spring pushes the diaphragm up, the inlet valve closes and the outlet valve is forced open permitting the

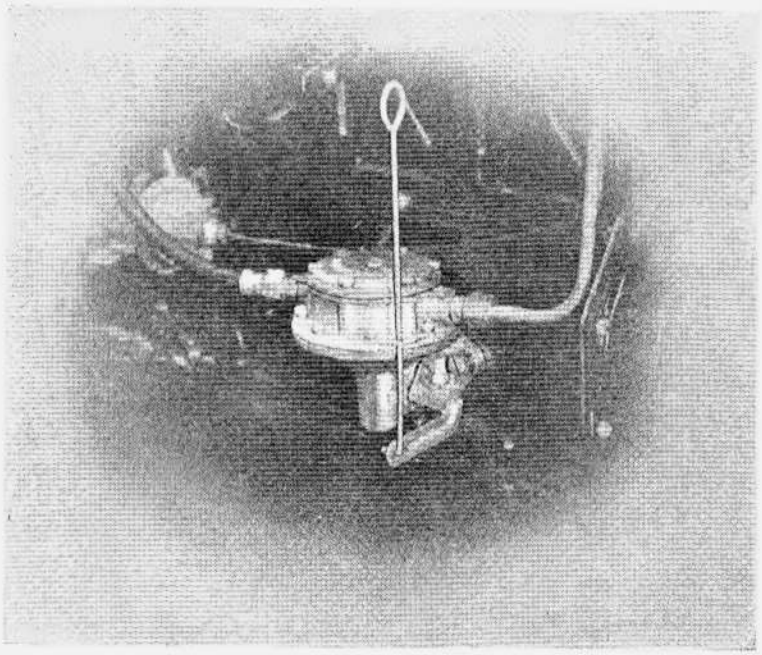


Figure 150 Mounting Fuel Pump

fuel to be forced into the outlet line and up to the carburetor. Each revolution of the camshaft repeats this operation bringing additional fuel in through the inlet and outlet valves, and up to the carburetor.

Hand lever rod is equipped on fuel pump for manual pumping of fuel into carburetor float chamber when this chamber is empty such as after removing carburetor. Moving this rod up and down several times will fill the chamber to facilitate starting engine. If at this time, the pump diaphragm is at its uppermost position, the pump will not work effectively so that it will be necessary to rotate the engine crankshaft slightly to change the position of fuel pump cam.

c. Minor Service Operations.

The fuel pump should be checked regularily to make sure that mounting bolts, cover to body bolts, pump upper to lower body attaching bolts, and inlet and outlet connections are tight.

d. Major Service Operations.

(1) Removal and Disassembly.

(a) Disconnect fuel inlet and outlet pipes from fuel pump.

(b) Remove two mounting bolts and remove pump and gasket.

(c) Remove bolts attaching pump upper body and remove upper body.

(d) Remove cover attaching bolts and disassemble body cover from pump upper body.

(e) Removing valve retainer from upper body enables removing inlet and outlet valves.

(f) Pry off edge of diaphragm if adhering to pump body. Press down center of diaphragm with thumb and disconnect end of diaphragm shaft from rocker arm link, and take out diaphragm complete from pump body.

(g) Push out rocker arm pin and take out rocker arm complete and rocker arm spring.

(2) Inspection.

(a) Wash all parts thoroughly in cleaning solvent.

(b) Inspect rocker arm and link for excessive wear and for loose pin.

(c) Inspect body and cover for cracks or damaged flanges.

(d) Inspect diaphragm for cracks or wear that would cause leaks.

(e) Make sure the valves are clean and that they seat properly under normal spring tension.

(f) Inspect rocker arm spring and diaphragm spring for weakened tension.

(3) Assembly.

(a) Install rocker arm spring, rocker arm complete, and rocker arm pin.

(b) Place on diaphragm spring, oil seal spring retainer, oil seal gasket and oil seal retainer over diaphragm shaft. In similar as for disassembling diaphragm, press down the center of diaphragm with thumb and connect end of diaphragm shaft on to rocker arm link (Fig. 151).

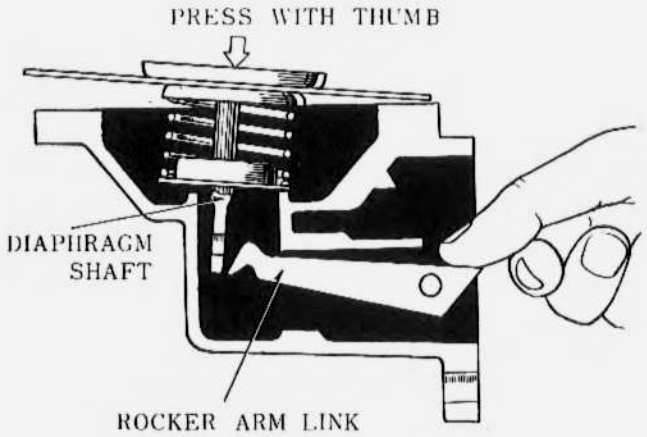


Figure 151 – Installing Diaphragm

(c) Install valves over valve gaskets to pump upper body. Install valve retainer.

(d) Install body cover to upper body over gasket.

(e) Install pump upper body assembly to lower body, holding down diaphragm.

(f) Replace pump to block using new gasket. Tighten the two mounting bolts.

(g) Connect fuel inlet and outlet pipes to fuel pump.

(4) Specifications.

Model	Diaphragm Type
Pressure	0.27 – 0.37 kg/cm²
Capacity	2.1 ltr/min
O. D. of Rocker Arm Pin	
STD	6.472 – 6.500 mm
Wear Limit	0.025 mm
I. D. of Rocker Arm for Rocker Arm Pin	
STD	6.511 – 6.545 mm
Wear Limit	0.025 mm
I. D. of Rocker Arm Link for Rocker Arm Pin	
STD	6.511 – 6.545 mm
Wear Limit	0.025 mm
Rocker Arm Spring	
Free Length	7.1 mm
Wear Limit	0.2 mm
Diaphragm Spring	
Free Length	61 mm
Wear Limit	2 mm

23. FUEL FILTER.

a. General Description.

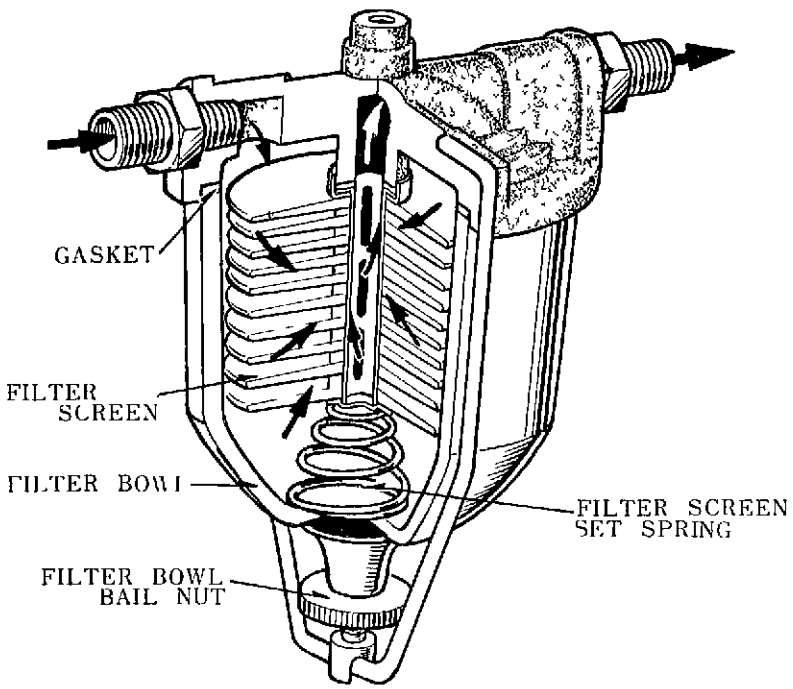


Figure 152 – Fuel Filter

Fuel filter(Fig. 152) is the type employing paper filter element. This serves to prevent carburetor clogging by filtering out all particles of dirt or other foreign matter which may be contained in the fuel. If this filter is allowed to clog up, engine performance will be impaired. Thus, at frequent intervals, disassemble and take out the filter element, cleaning it with gasoline. Replace with new filter screen **every 5,000 km.**

b. Disassembly.

(1) Loosen the filter bowl bail nut.

(2) Remove filter bowl, spring, filter screen and gasket.

c. Inspection.

(1) Wash all parts throughly in cleaning solvent.

(2) Check the bowl for chips around the rim that would make a good seal difficult.

(3) Inspect the filter screen for rust or restriction.

d. Reassembly.

(1) Install a new gasket, filter screen set spring and bowl.

(2) Tighten filter bowl bail nut to create a little tension and turn bowl slightly to make sure it seats.

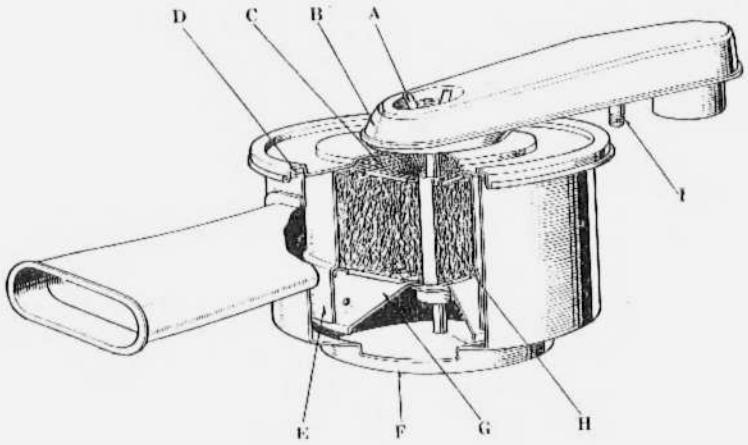
(3) Tighten bail nut securely.

NOTE : Start engine and check to see that fuel filter fills with fuel and that there is no indication of leaks.

24. AIR CLEANER.

a. Description.

Air cleaner (Fig. 153) operates primarily to remove dust and dirt from the air that is taken into the carburetor and engine. The cleaner has an strainer consisting of a non-metalic gauze. As air filters through this strainer, dirt and dust are deposited on the oily surfaces of the strainer. Air entering this cleaner must go directly down in a narrow space around the cleaner to the oil level in the cleaner case. The air must then turn and go up through the strainer and then down into the carburetor. As the direction of air flow is reversed, heavy particles in the air are thrown into the oil in the cleaner case, greatly reducing the amount of dirt to be desposited in the non-metallic gauze. This type of cleaner should be disassembled and cleaned every 2000 km (Fig 154).



A AIR CLEANER CAP NUT
B AIR CLEANER CAP
C AIR CLEANER WIRE NET
D AIR CLEANER CAP GASKET
E AIR CLEANER STRAINER CASE DRUM
F AIR CLEANER CASE COMPLETE
G AIR CLEANER BAFFLE PLATE
H AIR CLEANER STRAINER
I PLUG

Figure 153 – Oil Bath Type Air Cleaner

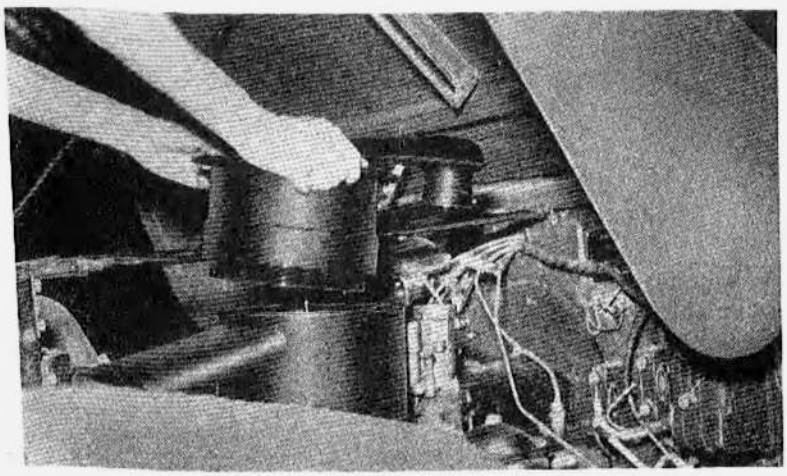


Figure 154 – Air Cleaner Disassembly

b. Removal.

Loosen cap bolt, and remove four attaching bolt nuts from air cleaner bracket.

Remove air cleaner assembly.

c. Disassembly.

Remove cap nut, cap and strainer assembly from air cleaner case.

d. Cleaning.

(1) Empty oil out of cleaner and clean out all oil and accumulated dirt.
(2) Wash case with cleaning solvent and wipe dry.
(3) Wash strainer by slushing up and down in cleaning solvent.
(4) Dry strainer with an air hose or let stand until dry.
(5) Fill the cleaner case with engine oil up to the oil level.

e. Installation.

(1) Install strainer assembly to drum welded cleaner cap (Fig. 155). Install baffle plate to drum.

(2) Install cleaner case to cleaner bracket and four attaching bolt nuts.

(3) Install cap and strainer assembly to cleaner case (Fig. 156). Tighten cap clamp bolt to carburetor and cap nut securely.

(4) Make sure air cleaner fits tight and is set down securely.

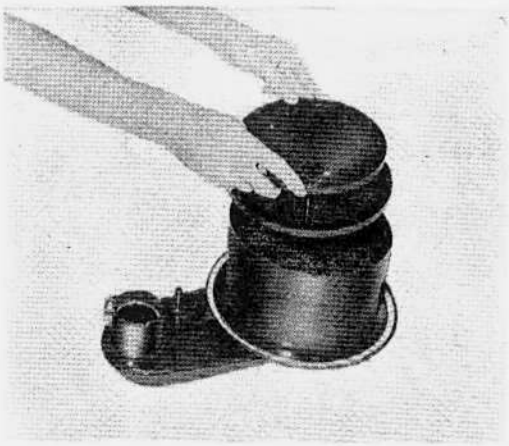


Figure 155 – Installing Wire Net and Baffle Plate

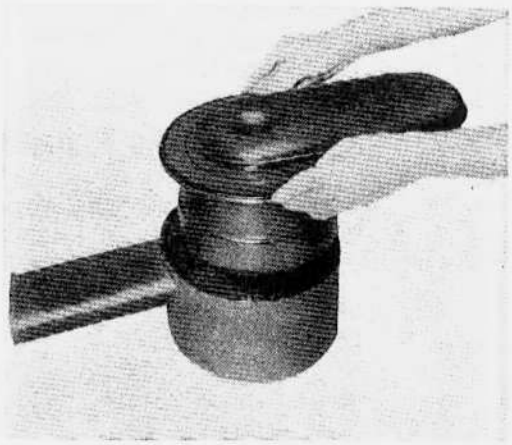


Figure 156 – Installing Cap and Strainer Assembly

SECTION VIII

COOLING SYSTEM

25. GENERAL DESCRIPTION.

The cooling system of engine is designed with two purposes in mind; first, to carry off a certain amount of the heat created in the engine so it will not

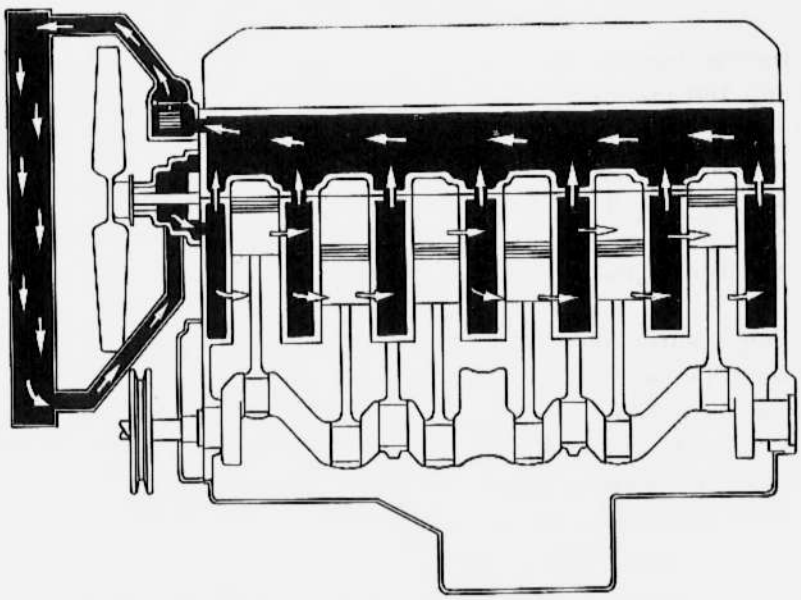


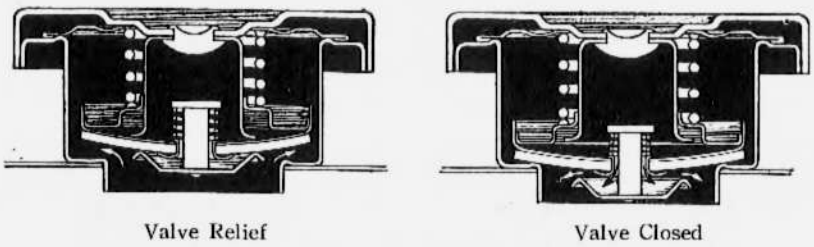
Figure 157 – Cross Section of Cooling System

operate at too high a temperature; and second, to maintain the engine heat at the temperature which will produce the most efficient and economical operation of the engine. Figure 157 shows a cross-section view of the cooling system.

The radiator is of fin and tube construction. The water passages are wide and straight with smooth interior, permitting maximum cooling liquid flow and efficient cleaning of the radiator. A water by-pass is included in the cooling system. This provides some circulation of coolant even though the thermostat is closed and results in a faster engine warm-up and more uniform coolant temperature throughout the engine.

The radiator is equipped with a pressure type radiator cap which seals the cooling system (Fig. 158).

The pressure type radiator cap used is designed to hold a pressure up to approximately four pounds per square inch above atmospheric pressure. Above four pounds per square inch, the pressure is relieved by a valve within the cap that opens to radiator overflow. As the pressure is reduced to atmospheric upon cooling, a "reverse" valve in the cap allows air to re-enter the radiator, preventing the formation of a vacuum in the cooling system.



Valve Relief Valve Closed

Figure 158 – Pressure Type Radiator Cap

The pressure type radiator cap helps to prevent coolant loss from boiling, for by raising the pressure on the coolant above atmospheric, the coolant will not boil until a higher temperature is reached. This increases the margin of safety between the coolant operating temperature and the boiling point, and is advantageous in that it permits the engine to operate at higher temperature without having the coolant overflowing. Thus, may operate at slightly higher engine temperatures, and may do so with a minimum of coolant loss from overflowing.

The water pump driven by a belt circulates the coolant from the radiator through the engine water passages and back to the radiator where it is cooled by the action of the fan.

The thermostat, mounted in the cylinder head water outlet, restricts the flow of water to the radiator until a predetermined temperature is reached, thus minimizing the length of time required to reach efficient operating temperature.

Since the action of the cooling system controls the operating temperature of the engine it is essential that systematic inspection of units in the system be made periodically to maintain the efficiency of the system.

26. ANTI-FREEZE.

In selecting an anti-freeze solution for winter operation, the local conditions and the type of service must be considered. In any event it is very essential to make certain checks and do certain things to at least insure the anti-freeze remaining in the cooling system. To be certain that the solution will not leak out and be lost entirely, resulting in little or no protection against freezing, or seep into the working parts of the engine, the following procedure should be followed in conditioning the system.

(1) Drain the entire cooling system including the cylinder block.

NOTE: If considerable rust, scale, oil or grease is present in the water drained out it is advisable to flush and clean the system.

(2) Tighten all cylinder head bolts in sequence as shown in Figure 27 of Engine Chapter.

(3) Check the water pump for leaks, excessive end play or looseness of the shaft in the pump.

NOTE: Should the water pump leak or indicate that leakage would occur with anti-freeze in the system, it should be replaced.

(4) Inspect fan belt Replace if badly worn. Adjust belt to proper tension. See Fan Belt Adjustment in this section (Fig. 159).

(5) Inspect all radiator hoses. If hoses are collapsed, cracked or in any way indicate a rotted condition on the inside, replacement should be made. Carefully check and tighten all hose clamps.

(6) Check the thermostat. Make sure it does not stick open or closed.

(7) Fill the cooling system with the proper quantity of anti-freeze and water according to instructions of manufacturer of anti-freeze.

NOTE: Be sure to allow for additional amount of anti-freeze solution when vehicle is equipped with a hot water heater.

(8) Warm up engine and recheck radiator, water pump and all hose connections for leaks with ENGINE HOT.

(9) Check and adjust valves when necessary. See Engine Section.

NOTE: Tightening of cylinder head bolts will affect valve clearance adjustment.

27. FAN BELT ADJUSTMENT.

(1) Loosen bolts at generator adjusting bar and bracket.

(2) Pull generator away from engine until desired belt tension is obtained.

NOTE: With correct adjustment, a light pressure on the belt at a point midway between pulleys should cause 13 mm deflection of the belt.

(3) Tighten all generator bolts securely.

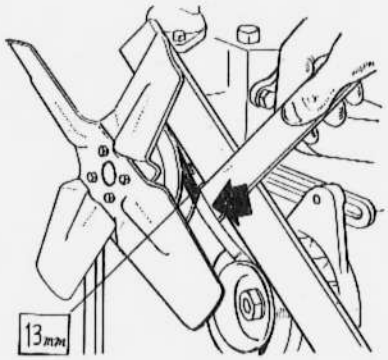


Figure 159 – Fan Belt Adjustment

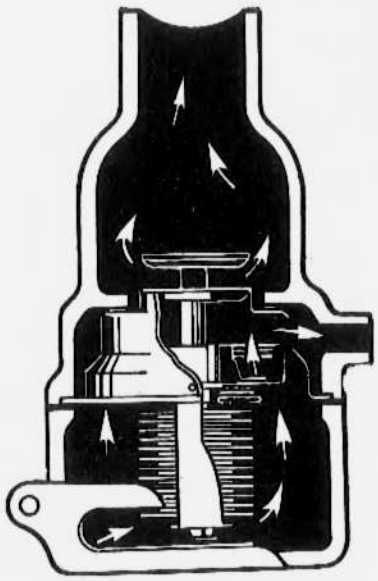


Figure 160 – Thermostat

28. THERMOSTAT.

The thermostat consists of a restriction valve actuated by a thermostatic element (Fig. 160). This unit is mounted in the case at the cylinder head water outlet above the water pump.

Thermostats are designed to open and close at predetermined temperatures, the thermometer should register from 61.5° to 64.5°C when the valve begins to open and from 71.5° to 74.5°C when the valve is fully open. (10 mm travel when measured from seat face). And if not operating properly should be removed and tested.

(1) Remove radiator to thermostat case hose, and disconnect by-pass hose at thermostat case.

(2) Remove thermostat case to water outlet bolt nuts and remove, thermostat case, gasket and thermostat.

(3) Inspect thermostat bellows and valve to make sure they are in good condition.

(4) Place thermostat in hot water about 80° to 85°C.

(5) Submerge the bellows completely and agitate the water thoroughly. Under this condition the valve should open fully.

(6) Remove the thermostat and place in water about 50° to 55°C.

(7) With bellows completely submerged and water agitated thoroughly, the valve should close completely.

(8) If thermostat checks satisfactorily, replace using a new case gasket.

29. CLEANING.

Unless water in the cooling system is treated with a corrosion preventive,

rust and scale may eventually clog water passages in the radiator and water jackets. This rust accumulation will result in inefficient operation of the cooling system vitally affecting engine performance and economy of operation.

Two common causes of corrosion are: (1) air suction air may be drawn into the system due to low liquid level in the radiator, leaky water pump or loose hose connections; (2) exhaust gas leakage—exhaust gas may be blown into the cooling system past the cylinder head gasket or through cracks in the cylinder head and block.

Periodic service must be performed to the engine cooling system to keep it inefficient operating condition. These services should include a complete cleaning as well as a reconditioning service as explained under "Anti-Freeze."

A good cleaning solution should be used to loosen the rust and scale. There are a number of cleaning solutions available and the manufacturer's instructions with the particular cleaner being used should always be followed.

An excellent preparation to use for this purpose is Radiator Cleaner No. 20. The following directions for cleaning the system applies only when this type cleaner is used.

(1) Drain the cooling system including the cylinder block and then close both drain cocks.

(2) Remove thermostat and replace thermostat case.

(3) Add the cleaner portion of the radiator cleaner.

(4) Fill the cooling system with water to a level of about 3 inches below the top of the overflow pipe.

(5) Cover the radiator and run the engine at moderate speed until the heat indicator reaches 85° C.

(6) Remove cover from radiator and continue to run the engine for 20 minutes. AVOID BOILING.

(7) While the engine is still running add the rust inhibitory portion of the radiator cleaner and continue to run the engine for 10 minutes.

(8) At the end of this time, stop the engine, wait a few minutes and then open the drain cocks and lower hose connection.

CAUTION: Be careful not to scald your hands.

30. WATER PUMP AND FAN.

The water pump (Fig. 161) is of the grease filled, sealed ball bearing type so that there is no necessity of daily greasing. This pump has been made completely water-proof by using material which are heat and oil resistant and can be immersed in hot water or oil for a long period of time without deformation, deterioration, or damage, and will withstand long usage. This pump has been made leak proof, the construction being such that as the pump revolution increases, the bakelite thrust washer is pressed against the pump body side face by the action of the spring and centrifugal force of the pump. This automatically maintains the water seal and prevents leakage.

Any small amount of water which may leak through the shaft clearance is prevented from entering the bearing by means of a deflector on the rotor shaft which deflects the water into the hole in pump body to drain outside.

All fans are of the four blade type with blades spaced so as to dampen out vibrations and of a size to provide adequate cooling.

The fan blades are bolted directly to the water pump pulley which is driven by the crankshaft pulley by means of a "V" type endless fan belt.

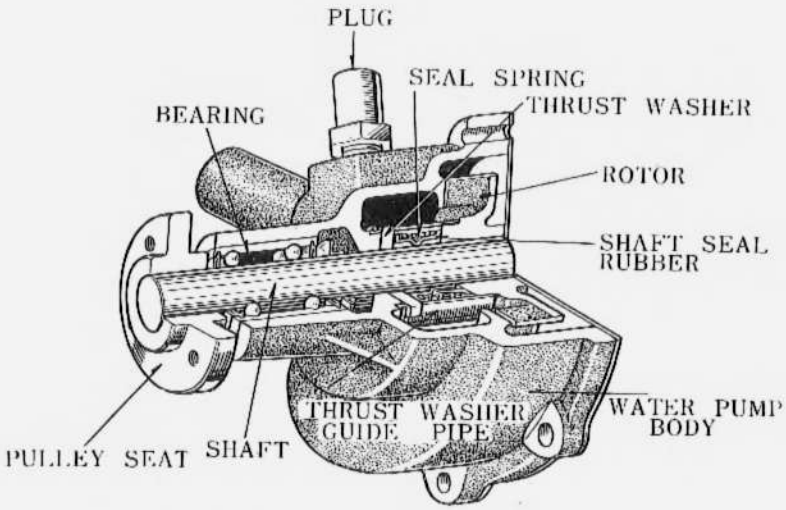


Figure 161 – Cross Section of Water Pump

31. WATER PUMP SEAL RUBBER AND THRUST WASHER.

Water pump pulley seat puller (BX SST–1051) has been developed for use in removing the water pump pulley seat. Repairs to replace the water pump seal rubber and thrust washer should be performed in the following manner.

a. Disassembly.

(1) Remove pump seat plate attaching bolts. Remove pump seat plate and gasket.

(2) If necessary to remove pump pulley seat, install water pump pulley seat puller (BX SST – 1051) to pulley seat.

CAUTION: Make sure tool is installed with puller plate square with pulley seat face.

Place pump body in a vise (Fig. 162) and tighten puller screw to remove pulley seat. Remove puller from pulley seat. Remove pump body from vise.

NOTE: Removal of pulley seat is not necessary when replacing seal rubber or thrust washer. It is only necessary to remove pulley seat when bearing is to be replaced. Bearing replacement is necessary when

bearing is worn to cause excessive noise or excessive end play in bearing shaft.

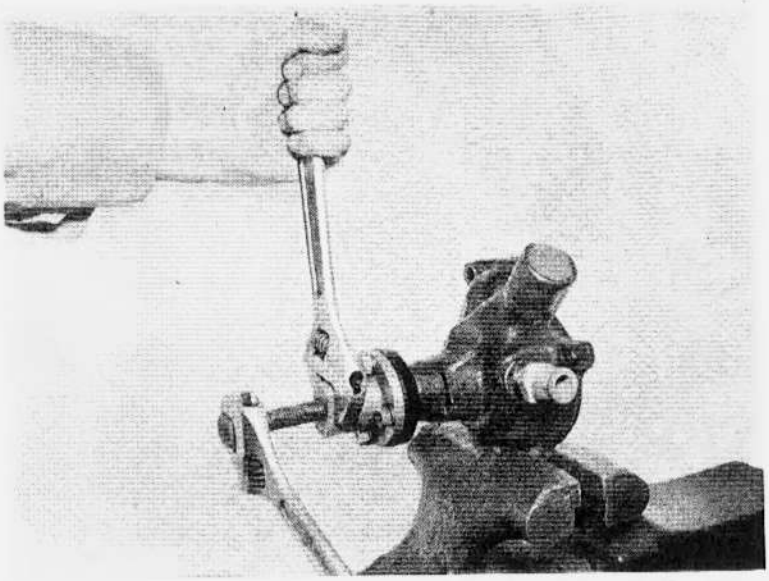


Figure 162 – Removing Pump Pulley Seat

(3) Remove bearing retaining wire from pump body using long nose pliers.

(4) Support pump on milled shoulder of body in a hand arbor press or a press plate in arbor press. Press shaft and bearing assembly out of pump body. Remove rotor assembly (Fig. 163).

(5) Remove thrust washer guide pipe, and then remove thrust washer and seal from rotor, and discard.

b. Inspection.

(1) Wash all parts except pump bearing in cleaning solvent.

NOTE: Pump bearing is a permanently sealed and lubricated bearing and should not be washed in cleaning solvent.

(2) Inspect shaft and bearing assembly for roughness or excessive end play. Remove any rust or scale from shaft with fine emery cloth. The bearing should be wrapped in cloth while this operation is performed to prevent emery dust from entering bearing.

(3) Inspect seat for thrust washer in pump body for pit marks or scoring. If seat for thrust washer is scored or pitted the pump should be replaced.

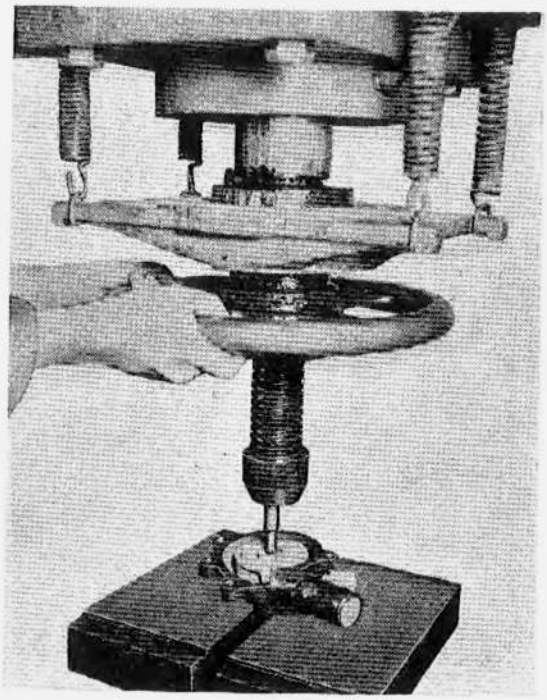


Figure 163 – Removing Water Pump Shaft and Bearing Assembly

c. Assembly.

(1) If pulley seat is removed, install pulley seat to shaft and bearing assembly using an arbor press. Force in pulley seat until seat face is within 11.5 mm to end of shaft (Fig. 164).

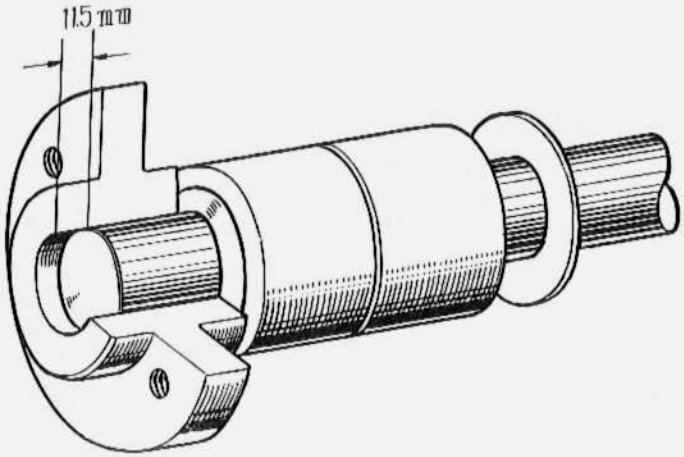


Figure 164 – Installing Pulley Seat to Shaft

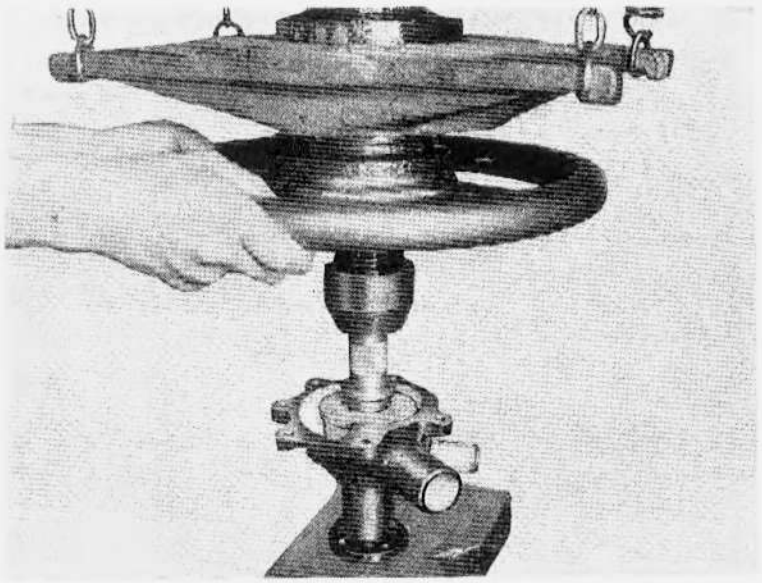


Figure 165 – Installing Rotor and Seal Assembly onto Shaft

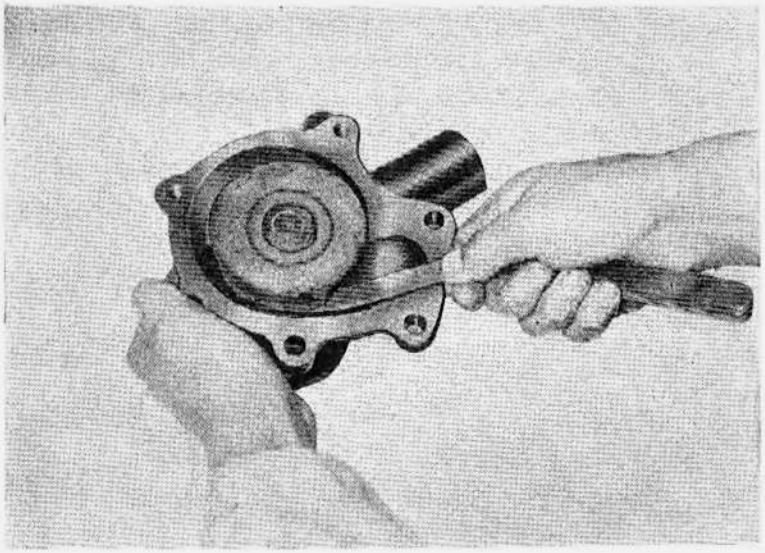


Figure 166 – Checking Clearance between Face of Rotor and Pump Body

(2) Install pump bearing assembly into pump body bearing bore applying pressure to outer race until it bottoms.

(3) Press shaft and bearing retaining wire into pump body using pliers.

(4) Assemble seal spring, spring seat, seal rubber and thrust washer into pump rotor. Thrust washer is installed on the top of seal assembly so that two lugs index with slots in the thrust washer guide pipe.

(5) Lay the rotor and seal assembly onto the shaft until the rotor and seal assembly is flush with end of shaft (Fig. 165).

(6) Check clearance between face of rotor and pump body (Fig. 166). This clearance should be 0.5mm.

(7) Install pump plate to pump body using a new gasket, install screws, tighten securely and stake in place.

32. RADIATOR REPLACEMENT.

(1) Remove drain cock and drain radiator.

(2) Raise engine hood sufficiently and disconnect engine hood stand stay at radiator.

(3) Remove radiator grille and side wind guides as an assembly.

(4) Remove radiator inlet and outlet pipes.

(5) Remove radiator lower supporting bolt nuts through two holes of the first crossmember using socket wrench. Disconnect bond strap at radiator. Disconnect two brace rods at radiator.

(6) Lift radiator straight up to remove. Remove radiator from the vehicle.

(7) To re-install, place radiator in position at the first crossmember and install supporting bolt nuts through two holes of first crossmember using socket wrench. Connect bond strap at radiator. Connect two brace rods at radiator.

(8) Install radiator hoses and replace radiator drain cock.

(9) Install radiator grille and side wind guides as an assembly.

(10) Fill cooling system and check for leaks. Connect engine hood stand stay at radiator and lower engine hood.

33. TROUBLE SHOOTING.

COOLING SYSTEM

SYMPTOM AND PROBABLE CAUSE	PROBABLE REMEDY
Overheating	
a. Lack of coolant	a. Refill system and check for leaks
d. Fan belt loose	b. Adjust
c. Fan belt oil soaked	c. Replace fan belt
d. Thermostat sticks closed	d. Replace thermostat
e. Water pump inoperative	e. Replace water pump
f. Cooling system clogged	f. Clean entire system
g. Incorrect ignition timing	g. Retime engine
h. Brakes dragging	h. Adjust brakes
i. Manifold heat control valve coil damaged	i. Replace coil
j. Manifold heat control valve stuck due to seized shaft	j. Free manifold heat control valve shaft
Overcooling	
a. Themostat remains open	a. Replace thermostat
b. Extremely cold climate	b. Cover part of radiator area
Loss of Coolant	
a. Leaking radiator	a. Replace or repair
b. Loose or damaged hose connection	b. Tighten or replace hose connections
c. Leaking water pump	c. Replace water pump
d. Leak at cylinder head gasket	d. Replace gasket and tighten bolts securely and evenly
e. Cracked cylinder head	e. Replace cylinder head
f. Cracked cylinder or block expansion plug loose	f. Make necessary repairs or replacements
g. Engine operating at too high temperature	g. See overheating causes
Circulation System Noisy	
a. Pump bearings rough	a. Replace pump
b. Fan blades loose or bent	b. Tighten or replace fan blades
c. Fan belt noisy in pulley	c. Dress belt with belt dressing or soap and adjust
d. Fan belt inner plies loose	d. Replace fan belt

34. FITS AND TOLERANCES.

Cooling Capacity	20.0 ltr
Water Pump	
Type and Drive	Centrifugel by Fan Belt
Location	Front of Cylinder Block
Capacity	100 ltr/mn at 2500 rpm
Bearing and Shaft Assembly	
Type	Permanently Sealed and Lubricated Ball
O. D. of Bearing	
STD	29.887 – 3.000 mm
Wear Limit	0.025 mm
O. D. of Shaft at short end	
STD	15.905 – 15.918 mm
Wear Limit	0.025 mm
O. D. of Shaft at long end	
STD	15.905 – 15.918 mm
Wear Limit	0.025 mm
End Play of Shaft in Bearing	0.008 0.015 mm
Fitting Bearing to Bore in Body	0.014 0.018 mm (tight)
End Play of Shaft when assembled	
STD	0.015 0.040 mm
Wear Limit	0.05 mm
Impeller	
Location	Pump Body
I. D. of Bore	15.837 – 15.855 mm
Fitting Impeller to Shaft	0.050 – 0.081 mm (tight)
Body	
I. D. of Bearing Bore	29.885 – 30.005 mm
Fitting Bearing to Bearing Bore	0.014 – 0.018 mm (tight)
Washer	
Type	Bakelite
Thickness	
STD	4.4 – 4.6 mm
Wear Limit	2.0 mm
Seal	Molded Rubber Automatically Adjusted by Spring Tension
Spring	
Free Height	
STD	16.5 mm
Wear Limit	0.5 mm
Installed Height	9.5 mm

Installed Load	
STD	2.68 kg
Wear Limit	0.3 kg
Pulley Seat	
I. D. of Hub Bore	15.855 – 15.837 mm
Fitting Hub Bore to Shaft	0.050 – 0.081 mm (tight)
Pulley	
Run-out	0.8 mm
Fan	
Diameter	450 mm
Number of Blades	4
Fan Belt	
Deflection	13 mm
Adjustment	By Moving Generator
Thermostat	
Starts to open	61.5° – 64.5°C
Fully opened	71.5° – 74.5°C
Location	In Cylinder Head Outlet
Radiator	
Make and type	Toyo, Fin & Tube
Front Area	2930 cm^2

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SECTION IX

LUBRICATING SYSTEM

35. GENERAL DESCRIPTION.

It is necessary that all the moving parts of the engine be lubricated in order to attain smooth motion and prevent wear and burning out. No matter how precise the finish may have been made, there are still minute irregularities remaining on the surfaces. When such metallic surfaces are contacting and in motion without lubrication, the frictional resistance will be greatly increased and will cause large losses in the generated power of the engine. Such contacting surfaces will produce heat, cause excessive wear and burning out with consequent damage to the engine.

This frictional resistance will be greatly decreased by applying a thin film of oil to the contacting surfaces. Thus, for the prevention of power loss and wear, a lubrication system is absolutely necessary. The lubricating method on this engine is an all force feed type insuring positive lubrication.

The high pressure oil discharged from the oil pump is divided into two parts, one part entering the oil hole in the cylinder while the other parts after passing through the oil distributor, flows through the oil cleaner where it is cleaned and returns to the oil pan. The oil stream entering the oil hole lubricates the main bearings and is again divided into two parts, one part lubricating the camshaft bearings. The other part passes through the crankshaft hole and lubricates the connecting rod bearings and in addition lubricates the pistons and cylinders through the holes in the connecting rods. The oil stream lubricating the camshaft bearings is again divided, the part lubricating the second bearing after passing through a pipe passes through the rocker arm shaft and lubricates the push rods and lifters. The part lubricating the front bearing on the camshaft passes through the oil passage in the front end plate

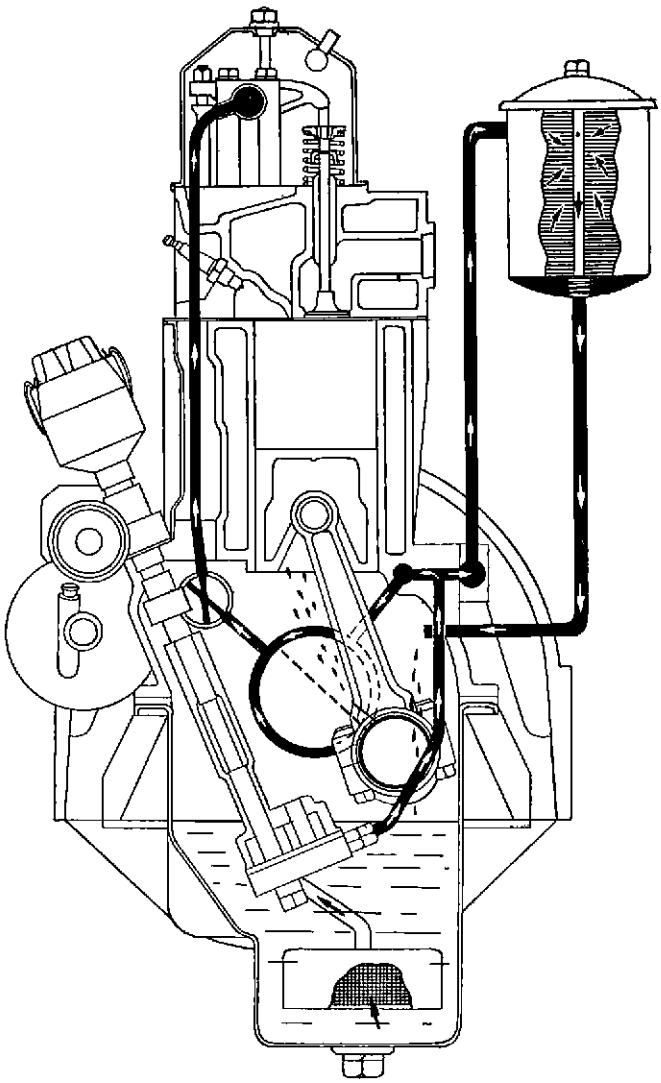

Figure 167 – Lubricating System

gasket is discharged the timing gear oil nozzle and lubricates the crankshaft and camshaft gears.

The oil pressure in the lubricating system is maintained within the specified pressure of 3 kg/cm² by means of a safety valve in the oil distributor. When the pressure rises above this value, the oil is by-passed to the oil pan to reduce the pressure.

63. OIL DISTRIBUTOR.

a. General Description.

The oil distributor is installed on the left side of the engine near the

center part and is mounted on to the upper half of the crankcase with two bolts. A cross-sectional view of the oil distributor is shown in the illustration. The oil distributor serves as a safety valve preventing the high pressure oil discharged from the oil pump to rise above a specified value (3 kg/cm²) by means of the adjusting valve.

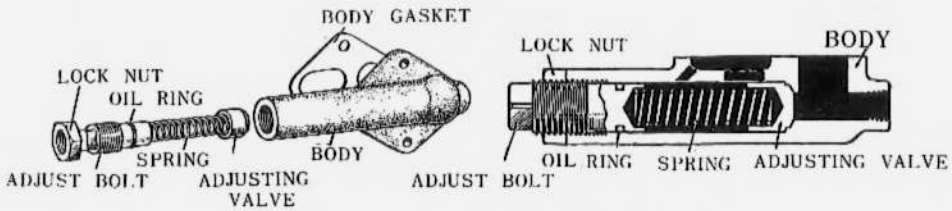

Figure 168 – Oil Distributor

b. Service Operation.

When the valve spring becomes weakened or when valve fails to close tight, the pressure of the oil being sent to the crankshaft bearings falls off and may cause the bearings to burn up. In such cases, remove the oil distributor, disassemble by unscrewing the plug and clean the inside thoroughly. If the valve spring is found to be weakened, replace the spring together with the valve with new parts.

37. OIL PUMP.

a. General Description.

This engine is equipped with a gear type oil pump. As shown in the illustration this pump consists of two gears encased in a one piece body. It is driven by the camshaft.

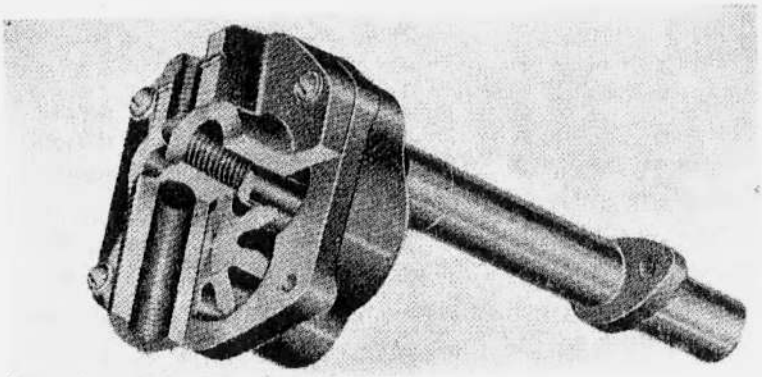

Figure 169 – Oil Pump

b. Disassembly.

(a) Remove pump cover attaching screws, cover, gasket, idler gear and main gear and shaft.

(b) Wash all parts in cleaning solvent and dry by using compressed air, if available.

c. Inspection.

See "Oil pump" in Minor Service Operation of Engine.

d. Assembly.

(a) Oil main gear and idler gear.

(b) Install main gear and shaft in pump body.

(c) Install idler gear to idler gear shaft and fill gear clearance with oil.

(d) Install a new gasket to assure correct end clearance of the gears.

(e) Install cover and attaching screws. Tighten screws securely and check to see that shaft turns freely.

38. OIL CLEANER.

a. General Description.

While the engine is in operation, carbon formed from oil entering the combustion chamber of the engine, burned out oil, metallic particles worn down from bearings, and other foreign matter enters into the crankcase contaminating the oil. Thus, no matter how excellent the oil may have been, in time, it will be unable to serve the lubricating purposes for which it was originally intended.

In order to continuously clean and recondition this contaminated oil while the engine is in operation, the vehicle is equipped with an oil cleaner. The inlet pipe is connected to the upper part of the cleaner and the outlet pipe connected to the bottom of the cleaner returns the oil back to the oil pan.

This cleaner utilizes a special paper filter element with high filtering performance. The filter element is made up in cartridge form to facilitate easy removal and replacement when the life of the filtering element is gone.

The main advantages of this type of filter are:

(1) As the pores of the filter paper are exceedingly small, the minute particles of sludge can be cleaned out completely.

(2) Due to the large filtering surface, the filtering life is considerably prolonged. (Cleaner is slow in plugging up).

(3) A large oil volume can pass through.

(4) A water removal provision is made so that the water can be separated out.

(5) Low cost. (Low maintenance cost due to low cost of element)

(6) Does not require cleaning.

b. Operation.

The high pressure oil discharged from the oil pump to the oil distributor enters the case through the inlet pipe without reduction in pressure. It then passes through the filter paper and is led to the outlet pipe by the basket guide. The cleaned oil again returns to the oil pan. During this passage, the filter paper filters and cleans out all forms of contaminating matter maintaining the oil to have performance as good as new. By the use of this cleaner, the wear in the cylinders, bearings, and other engine parts are reduced from ¼ to ⅕ and assures long life to the engine.

c. Disassembling and Maintenance.

(1) Remove cleaner assembly from intake manifold, loosing inlet and outlet pipe.

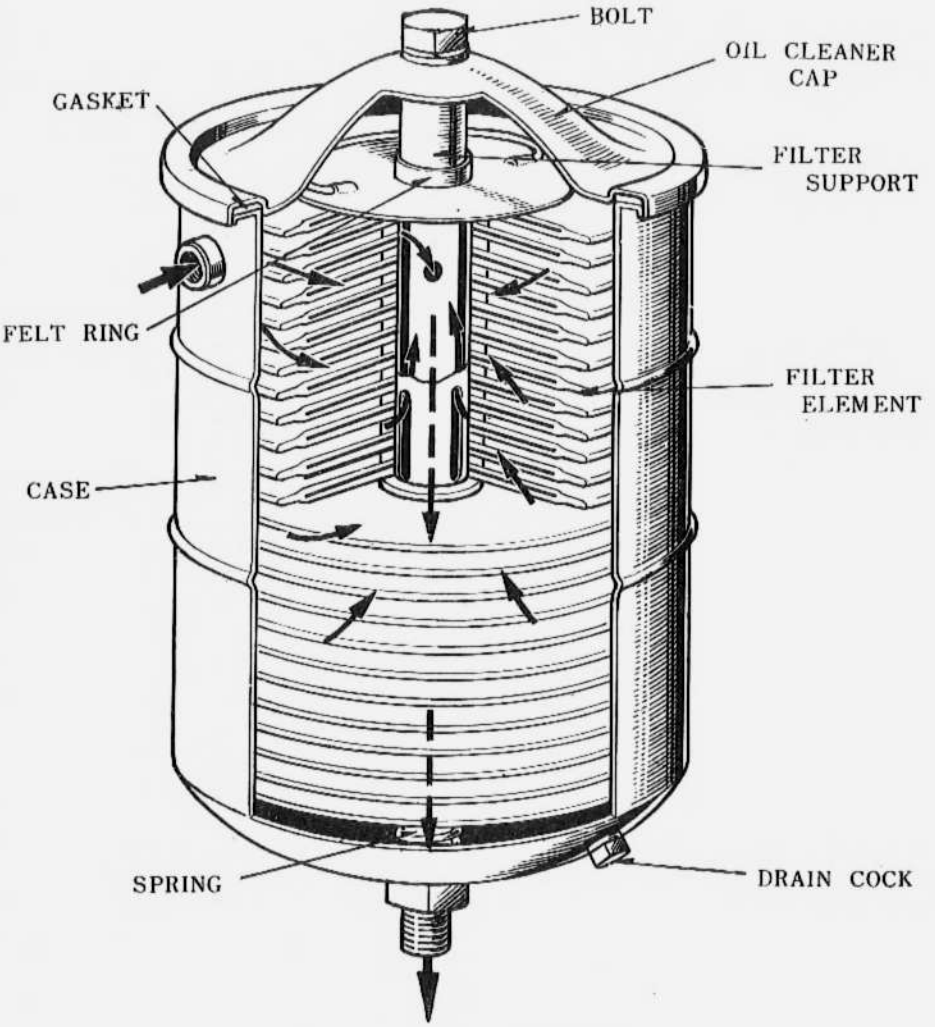

Figure 170 - Oil Cleaner

(2) The cartridge can be taken out by removing the center bolt.

(3) Wash out the sludge contained in the bottom of the cleaner case.

If the filter element is found to be exceedingly dirty, it is more economical to replace with new element due to its low cost than to try washing it with gasoline.

The cleaner should be checked every 2000kms.

39. AMOUNT OF OIL IN OIL PAN.

The amount of oil contained in the oil pan is measured by the gradations marked on the oil level gage installed on the right side of the engine. To measure, stop the engine and pull out the oil level gage rod illustrated in the Figure 171 and wipe clean with a piece of waste. Then insert back full ways and pull out again. If the oil adhering to the gage is between the upper and lower lines of the marks, the amount of oil is satisfactory. If below the lower line of the marks, oil should be replenished without fail. The capacity of this engine is 5.0 liters.

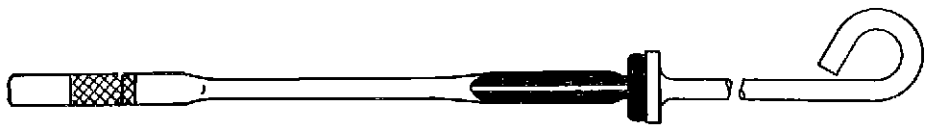

Figure 171 – Oil Level Gage Rod

40. ENGINE OIL.

The object of lubricating the engine is, as previously explained, to form a oil film in all the frictional surfaces of the moving parts in order to prevent a direct metal to metal contact while in motion. Its effect is in the reduction of friction in all of the moving parts of the engine and not only prolongs the life of the engine but prevents it from over-heating.

Thus, in selecting the oil to be used in the engine, the oil must be high grade with the correct viscosity. It is no exaggeration to say that the life of the engine depends on the quality of oil and the method of lubrication.

High consumption of oil and gasoline, and low power caused by poor engine condition can mostly be traced back to the usage of cheap, low grade oil. Therefore, it is absolutely necessary that a high grade oil from a reputable firm be used.

The oil should first be changed after 500 kms. After this, it is recommended to be changed every 2,000 kms. This should be done taking into consideration the amount of dilution and contamination found.

In changing oil drain out the old oil while the engine is still warm, and refill with new engine oil up to the upper line of the marks on the oil level gage. The oil used should conform to the atmospheric temperature as follows :

When above 0°C.. .. .. SAE No. 30
When between 0° to −18°C .. .. SAE No. 10
When below −18°C .. .. OES

The amount of engine oil required for replacement is 5.0 liters.

41. CAUTION.

(1) In extremely cold weather, never accelerate the engine until about 5 to 10 minutes after starting the engine.

The reason for this is because at low temperature, the oil is very viscous and does not reach the moving parts sufficiently until the engine is warmed up. Consequently, there will be rapid wear in all the moving parts, especially the cylinders.

(2) Never race the engine recklessly. (Racing means to run the engine at high speed without load).

This is a very poor practice and should always be avoided since it not only wastes oil and gasoline, loosens up the various parts of the engine but causes the engine to overheat.

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