Section K

ENGINE

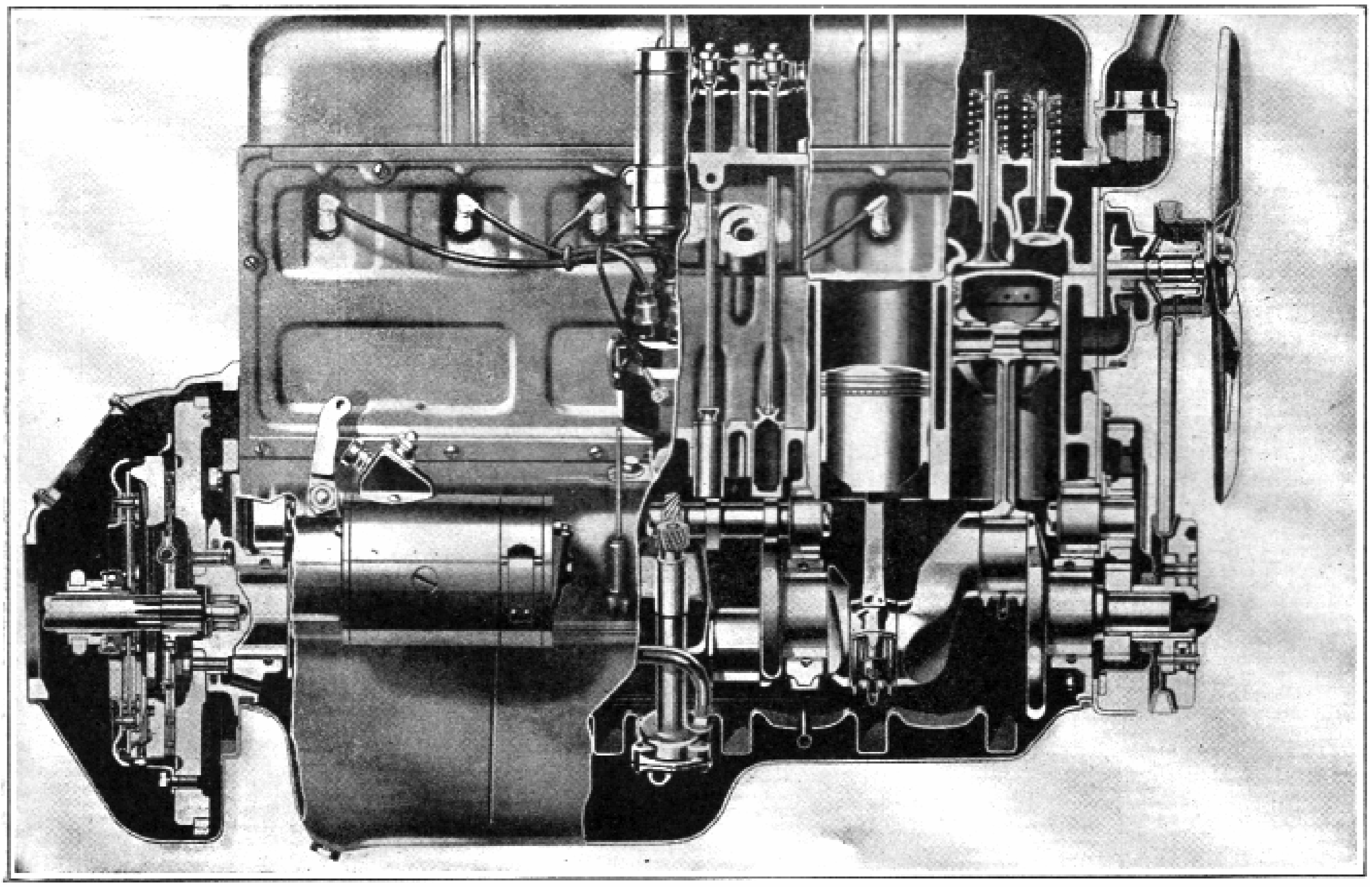


Fig. 1—Engine—Cross Section

The engine used in these vehicles is a six cylinder Valve-in-Head type. The piston displacement is 216.5 cubic inches with a compression ratio of 6.25 to 1.

Engine smoothness is brought about by a combination of factors, rather than by any one feature of engine design. The factors involved are: crankcase rigidity, crankshaft design, weight of the piston and connecting rod assembly and the length of the piston stroke, bearing area, and flywheel and clutch balance. All of these factors are interrelated and must be considered together.

The crankcase of sturdy, heavily ribbed construction, with its thick roof, gives an absolute maximum of rigidity with no surplus weight.

The crankshaft, with four main bearings, together with scientific counter-balancing and short connecting rod throws, increases the crankshaft rigidity and reduces torsional vibration to a minimum.

The connecting rod and the light weight pistons decrease the weight of the piston and connecting rod assembly. This, in conjunction with the lower piston speed due to the $3\frac{3}{4}''$ stroke, decreases the loads on both connecting rod bearings and main bearings. The short stroke also results in a greater overlap of the connecting rod journals on the main bearing journals, increasing crankshaft rigidity which naturally contributes to engine smoothness and quietness.

The clutch is designed so that the pedal pressure decreases as the clutch is disengaged. In providing greater ease of pedal movement, nothing is sacrificed in the engagement characteristics as would be necessary with the conventional coil spring clutch. In fact the engagement pressure is increased and the engagement characteristics improve with use.

Operation:

The engine is a "Four Cycle" which means there are four complete strokes of the piston or two complete revolutions of the flywheel to complete one cycle, or power stroke.

1. As the piston starts downward in the first stroke of the cycle, the intake valve is opened. The motion of the piston creates a vacuum in the cylinder and draws a charge of gas from the carburetor through the valve spring.
2. When the piston reaches the bottom of its stroke and starts upward on the second stroke of the cycle, the intake valve closes and the piston compresses the gas that is drawn in to the combustion chamber in the cylinder head.
3. As the piston reaches the end of its upward stroke, the compressed gas is ignited by an electric spark which occurs at the points of the spark plug and the resulting explosion or expansion pushes the piston downward turning the crankshaft on the third working stroke of the cycle.
4. On the upward stroke of the piston, the exhaust valve is opened and the piston forces the remaining burned gas out through the exhaust port, leaving the cylinder empty and ready for the beginning of a new cycle.

Care:

Like any piece of machinery, the engine of any vehicle needs periodical attention and care. Upon this periodical care depends, to a great extent, the performance and economy of the engine.

The engine should be tuned at specific intervals as well as the valves ground to expect the maximum amount of economy. This procedure is fully covered later on in this section.

The life of the engine, to a great extent, is dependent upon the rapidity at which the moving parts become worn. The minimum amount of wear can be obtained only through the use of correct oils properly applied.

To also increase the engine life, by keeping out grit under extremely dusty operating conditions, the following refinement, known as valve controlled type crankcase ventilation system has been incorporated, which is designed to:—

1. Completely seal the engine against the entry of dust and other foreign material.
2. To insure a constant circulation of clean air through the engine crankcase at all times thereby evacuating gases which might otherwise involve lubrication problems, such as sludge formations, etc.

CRANKCASE VENTILATION SYSTEM TO SEAL THE ENGINE AGAINST DUST

The crankcase ventilation system is a means of circulating fresh air through the crankcase of an engine to help prevent harmful dilution of the engine oil. Dilution may be caused either by unburned fuel or the condensation of water in the crankcase. When an engine is cold a certain amount of unburned fuel and exhaust gases will pass by the piston rings and the unburned fuel mixing with the oil thins it out. Exhaust gases are charged with water vapour and the moment these strike the cold crankcase they condense, forming drops of water. Before the advent of the crankcase ventilation system, frequent changing of oil was the only remedy for crankcase dilution in winter operation.

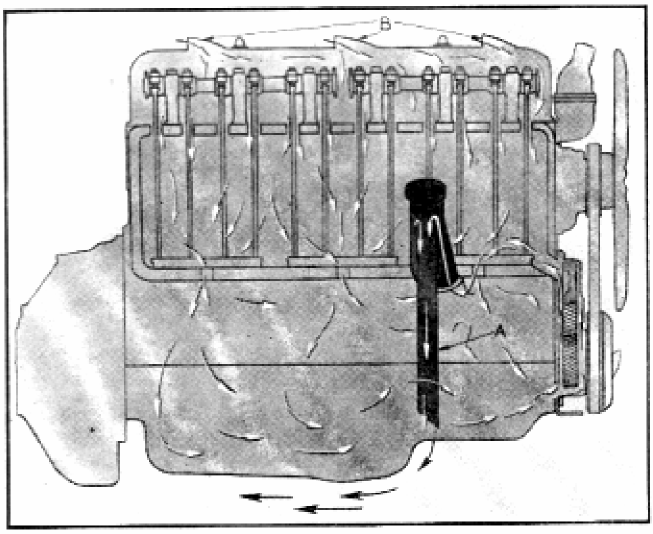


Fig. 2—Crankcase Ventilation System

Ventilation of the crankcase is obtained by drawing the air from the crankcase through a tube, "A", Fig. 2, on the right hand side of the engine. The end of this tube is bevelled and projects into the air stream created by the forward motion of the vehicle. The air passing the end of the crankcase ventilator outlet tube creates a vacuum drawing the air out of the crankcase. Fresh air enters the crankcase through the louvres, "B", Fig. 2, on top of the valve rocker arm cover.

When the engine reaches normal operating temperature, exhaust gases which may pass by the piston rings, are caught in the air stream of the crankcase ventilation system and emitted through the outlet tube.

This system works very satisfactorily where there is no dust to contend with. In dusty sections, however, provision has to be made to prevent dust entering the engine through the inlet louvres on top of the valve rocker arm cover and through the crankcase ventilator outlet tube.

Sealing of the Crankcase Ventilator Inlet in the Valve Rocker Arm Cover

The rocker arm cover has been sealed to eliminate dust by closing the original louvres, "B", Fig. 2, through which fresh air was admitted to the crankcase ventilating system. In their place an air cleaner, and tube have been added to the rocker arm cover so that the dust is removed from the air by means of the cleaner before it enters the crankcase ventilation system.

An "oil wetted" type of air cleaner, Fig. 3, has been used on the rocker arm cover so far in production. This consists of copper gauze, "E", Fig. 3, fitted inside a metal shell, "F", Fig. 3. The cleaner should be dipped in oil before installation, oil-coating the surface of the copper gauze. Air enters the cleaner through openings, "G" Fig. 3, in the bottom of the cap and passes up through the copper gauze, entering the crankcase ventilation system through the passage in the centre of the cap, "H", Fig. 3.

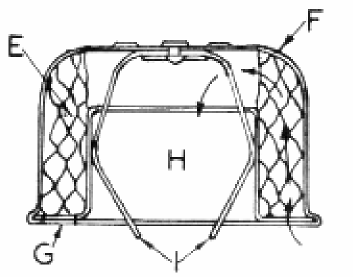


Fig. 3—Oil Wetted Air Cleaner

As the air passes up through the copper gauze, dust and dirt is deposited on the oil covered surface of the gauze, thus cleaning the air before it enters the system. The air cleaner assembly is held in place on the tube by means of expanding clips, "I", Fig. 3. To remove, simply pull upwards on the cap assembly.

Later vehicles will use an oil bath type air cleaner, Fig. 4, on top of the valve rocker arm cover, which has a larger capacity for collecting dust than the "oil wetted" type.

Fig. 4—Oil Bath Air Cleaner

The oil bath type cleaner consists of copper gauze, "J", Fig. 5, inside a metal shell similar to the "oil wetted" type, but in addition, oil is carried in the sump, "K", Fig. 5, below the copper gauze. In operation, air enters the cleaner through the louvres, "L", Fig. 5, connected with the passage, "M", which is restricted by the bead T and gives the air high velocity before it strikes the oil in the chamber "K". The air then turns upward through the copper gauze, "J" and passes into the crankcase ventilation system through the centre of the cap, "N", Fig. 5. Thus air is cleaned in the following manner:—

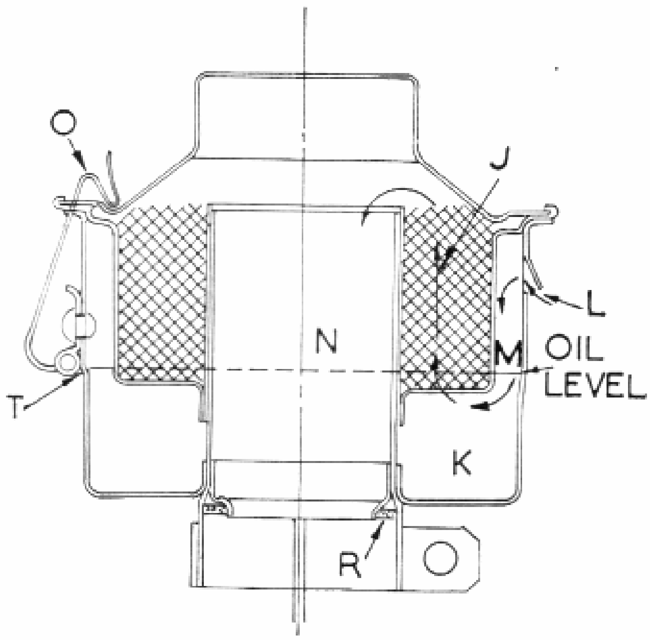


Fig. 5—Cross Section of Oil Bath Air Cleaner

1. Due to the high velocity of the air in the passage, "M", and the sudden change in the direction of the air flow, the heavier particles of dust are thrown out of the air stream by centrifugal force and caught by the oil bath.
2. Some of the air passes through the oil where it is washed free of dust.
3. In its passage the air stream picks up some oil in the form of a spray and carries it into the copper gauze, "J", keeping the surface of the gauze oil covered. As the air passes through the copper gauze, dust and dirt adhere to the oil covered surface, leaving the air clean as it enters the crankcase ventilation system.

While the vehicle is being driven, a certain amount of oil splashes onto the copper gauze, "J", Fig. 5, from the oil sump, "K". As this oil drains back into the sump it carries the accumulated dust on the copper gauze with it, permitting a continued washing action.

The cover of the oil bath type cleaner is held on by means of spring clips, "O", Fig. 5. The cleaner assembly, itself, is clamped to the tube in the rocker arm cover. The neck of the cleaner, where it attaches to the rocker arm cover, is made up of an inner and outer tube, Fig. 5, with a gasket, "R", Fig. 5, at the top junction of the tubes. When installing, always make sure the cleaner is well down into position so that the gasket seats properly on top of the tube in the rocker arm cover.

Cleaning the Crankcase Ventilator Intake Air Cleaner

1. The "Oil Wetted" Cleaner:—

The "oil wetted" type air cleaner can be cleaned by removing the cleaner assembly from the valve rocker arm cover and rinsing it thoroughly in a container of gasoline.

Allow excess gasoline to drain off the copper gauze, then dip the assembly in engine oil (S.A.E. 50 in Summer, 20-W in Winter). Wipe excess oil from the outside of the cap and allow some of the oil to drain from the copper gauze before re-installing the assembly on the rocker arm cover. This operation must be completed at least every 2,000 miles, even under ideal operating conditions and oftener, as required, where the vehicle is operating under extreme dusty conditions.

2. The Oil Bath Type Cleaner:—

Without removing the cleaner from the valve rocker arm cover, undo the clips, "O", Fig. 5, holding the cover of the oil bath type cleaner in place. Lift off the cover and copper gauze element as an assembly. Rinse the copper gauze element thoroughly in a container of gasoline and allow it to drain, then dip in engine oil (S.A.E. 50 in Summer, 20-W in Winter), and leave to drain. Wipe the oil and dirt out of the oil sump, "K", Fig. 5, in the bottom of the cleaner. Clean the sump with a gasoline soaked rag. Where the dirt has caked in the sump, it may be necessary to remove the lower half of the cleaner from the valve rocker arm cover and clean it thoroughly in a container of gasoline, then re-install on the rocker arm cover. Fill the oil sump to the level indicated on the cleaner, (also shown in Fig. 5), using 2½ ounces or 1/3 cup of engine oil (S.A.E. 50 in Summer, 20-W in Winter). Re-assemble the cover and copper gauze element to the cleaner. This operation must be completed at least every 5,000 miles, even under ideal operating conditions and oftener, as required, when the vehicle is operating under extreme dusty conditions.

NOTE—Daily cleaning of the "oil wetted" or oil bath type cleaner may be advisable under severe dust conditions.

Oil bath type cleaner is to be substituted for the "oil wetted" type when available.

Sealing the Crankcase Ventilator Outlet

In order to eliminate the open end of the crankcase ventilator outlet tube, "A", Fig. 6, and prevent dust entering the crankcase at this point, the tube has been omitted and the suction necessary to draw air out of the crankcase provided from the manifold. A pipe, "S", Fig. 6, connects the crankcase outlet, "T", Fig. 6, with the manifold. An automatic valve "U", Fig. 6, is inserted in the line between the manifold and the crankcase outlet, to control the suction to the crankcase under various driving conditions.

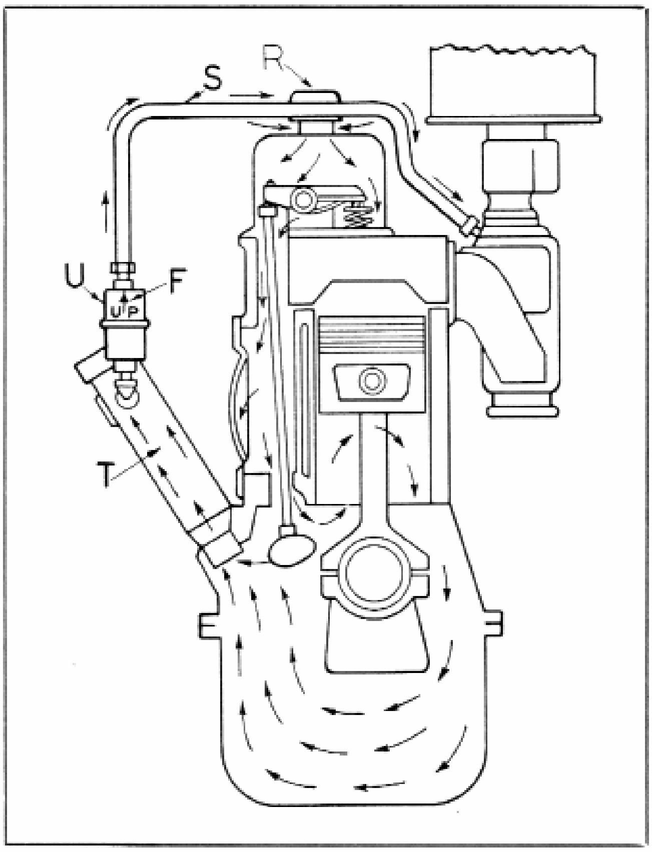


Fig. 6

The automatic valve assembly consists of a small weight, "A", Fig. 7, which moves quite freely in an outer shell, "B", Fig. 7. The upper end of the weight is formed into a pin with a small diameter "C" at the top and a larger diameter, "D" lower down. The top end of the pin fits loosely in the passage or orifice "E", in the outer shell, while the larger diameter, "D" almost completely fills the orifice. The valve assembly should be installed in a verticle position with the arrow, "F", Fig. 6, pointing upward.

In operation, the high vacuum in the intake manifold at low engine speeds lifts the weight, "A", Fig. 7, so that the larger diameter, "D" of the pin at the top of the weight fits into the passage, "E", Fig. 7, restricting the orifice. As the engine speed increases and the manifold vacuum decreases, the weight drops and the small diameter of the pin, "C", Fig. 7, enters the passage "E", Fig. 7, increasing the orifice. The automatic valve thus restricts the flow of air from the crankcase to the manifold when the engine is idling and the vacuum in the manifold is high. This prevents excessive oil vapour being drawn into the manifold from the crankcase, which would result in high oil consumption. As the engine speed increases and the orifice in the valve is opened, due to the weight

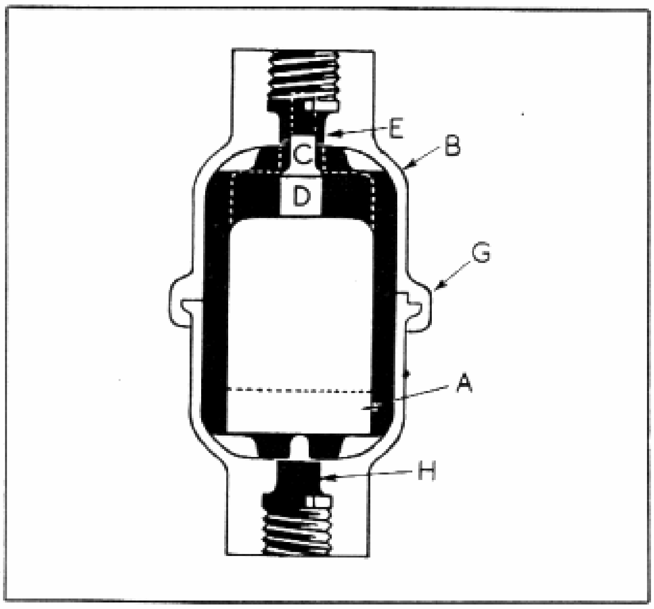


Fig. 7—Crankcase Ventilator Valve

dropping, the flow of air from the crankcase is still controlled, due to the vacuum in the manifold dropping.

NOTE:—The first valves used consisted of a die-cast weight in a die-cast (aluminum) shell, the two halves of which are "spun" together and cannot be "taken apart".

The second type of valve, is of the same design and material, except that a steel reinforcing ring, "G", Fig. 7, has been added at the junction of the two halves. The unit cannot be taken apart.

A third type exists (not yet in use) of the same design, but with a steel shell, in two halves, threaded together. This can be taken apart for a major cleaning operation.

Servicing the Automotive Valve

The movable weight may, under some operating conditions, tend to gum up due to oil laden fumes being drawn past it. If it should stick in the raised position, with the large portion of the top in the orifice, the flow of air would be stopped, and ventilation of the crankcase cease.

If it should stick in the down position, with the small portion of the pin in the orifice, there would be too much suction in the crankcase at closed throttle, resulting in excessive use of oil and a tendency to "gum up" the automatic valve still further.

Operation of the valve can be checked by holding the hand on the outside of the valve while the engine is idling. It should be possible to feel the weight drop when the throttle is opened quickly.

Where it is impossible to feel the weight drop when the throttle is opened, first check to make sure that all pipe connections are tight. If the weight still does not drop when the test is repeated, remove the automatic valve and rinse it thoroughly in a container of gum solvent. The third design of valve should be taken apart and thoroughly cleaned in a gum solvent.

Occasionally the copper tubing should be filled with a gum solvent and shaken to loosen any accumulation of oil, then a "pull through" soaked in gum solvent, used and then the tube blown out. The various fittings should also be similarly cleaned. Where necessary, the holes in these fittings, particularly the one at the intake manifold, should be cleaned by passing the necessary sized rods through them.

The frequency for such attention will depend on the type of crankcase oil in use (its viscosity, volatility and tendency to gum), operating temperatures, etc. As a starting point—THOROUGH CLEANING AFTER EACH 2,000 MILES OF OPERATION IS RECOMMENDED. If fittings are replaced at any time, always make sure that the correct part is installed. It is important that the hole in the fitting be at least as large or larger than the passages, "E" and "H", Fig. 7, at the top and bottom of the automatic valve.

ENGINE MOUNTINGS

Front Mounting

The front engine mounting assembly is made up of a shield, bushing and rubber cushion assembly and a metal retainer.

When installing the mounting, the shield is installed next to the engine front end plate. Then install the bolts through the end holes in the rubber mounting, starting the bolts through from the side having the large diameter hubs on the bushings, thread the mounting over the bolts staked into the engine front end plate, install the washers and nuts. Tighten the nuts and install cotter pins. Install the mounting cover. The complete engine mounting is attached to the frame front cross member by the two bolts which were installed in the ends of the rubber mounting. After these bolts are inserted through the cross member, install the washers and nuts and tighten. Should the mounting become oil soaked, it will be necessary to replace it, as oil deteriorates the rubber.

Rear Mountings

The rear mountings are spring loaded construction. This type of mounting is for use on vehicles operating under extreme conditions, where the vehicle is subjected to considerable frame distortion, due to heavy loading under bad road conditions.

The method of installation is shown in Fig. 8. When installing, make sure that the washer underneath the spring is pulled up to the shoulder on the long bolt, as this determines the amount of spring load placed on the mounting.

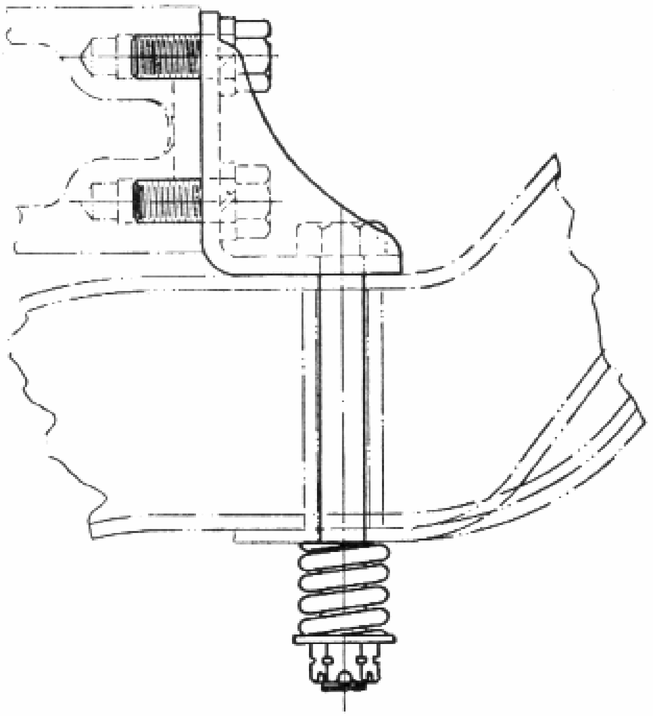


Fig. 8—Rear Engine Mounting

REMOVE ENGINE ASSEMBLY FROM CHASSIS

1. Drain the radiator and cylinder block.
2. Remove the upper hood panel, hood side panels and upper radiator shell.
3. Disconnect the radiator hoses and radiator support bolts, then lift the radiator assembly from the chassis.
4. Remove the starter cable at the starter and at the battery to prevent short circuiting during the engine removal.
5. Disconnect the generator, distributor, horn, coil and temperature gauge wires.
6. Disconnect the gasoline line from the fuel pump. Disconnect the throttle and choke controls from the carburetor and the accelerator rod from the bell crank.
7. Disconnect the exhaust pipe from the exhaust manifold.
8. Disconnect the vacuum booster line from the manifold on models which are equipped with vacuum brakes.
9. Remove the bolts holding the universal joint flange to the transmission and separate the two.
10. Remove the clutch pedal link.
11. Remove the front and side engine mountings.
12. Attach a suitable chain to the centrally balanced points on the engine assembly. Attach a chain hoist, raise the engine clear of its mountings, then pull it forward. Again raise the engine until the chassis may be rolled away from beneath it, or if an engine lifting eye bolt is available, remove the third cylinder head bolt from the rear on the left side and install the engine lifting eye bolt.

To replace the engine in the chassis, the removal operations are just reversed.

REPAIR OPERATIONS

CYLINDER BLOCK

The cylinder block used in these engines is a grey iron casting. It is heavily ribbed at the points of maximum stress to prevent deflection under loads, and machined on modern machines, all operations being located from two master holes, assuring perfect alignment of all operations.

The cylinder walls are bored and honed to a mirror like finish and held to within .001″ out-of-round and taper.

Checking Cylinders

By far the best method to be used in determining the condition of the cylinder walls in an engine, preparatory to reconditioning, is the use of a dial gauge as is shown in Fig. 9.

The dial gauge hand will instantly and automatically indicate the slightest variation in the cylinder bores. It completely eliminates unceritainty and mistakes in judgment.

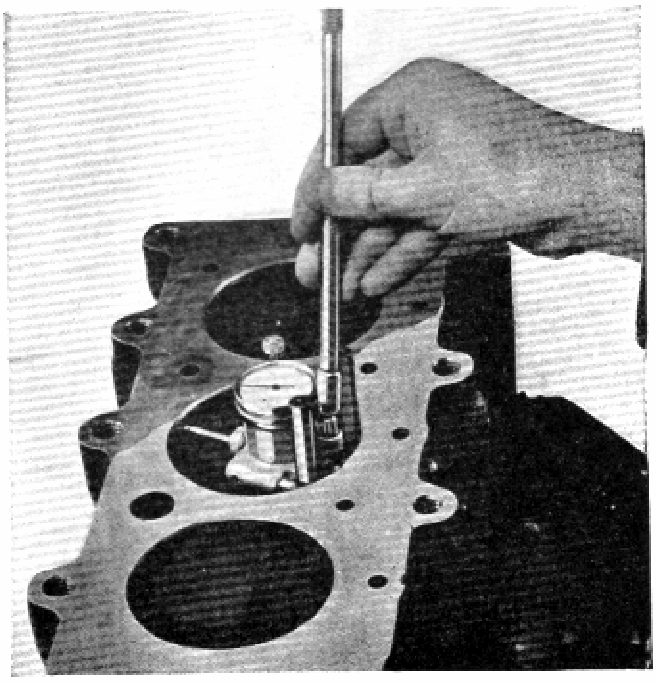


Fig. 9—Dial Cylinder Gauge

In use, the dial gauge is simply inserted in the cylinder bore, and moved up and down its full length. It is then turned spirally or completely rotated at as many points as may be desired, taking readings at each point. In this manner, all variations in the cylinder walls from top to bottom may be determined.

If a master gauge, corresponding with the exact diameter of a standard cylinder bore, is used to set the dial gauge, it is easy to determine the oversize piston to use as well as the amount of metal which must be removed from the cylinder walls to make them true.

Cylinder Boring:

When it becomes necessary to rebore the cylinders of an engine to fit oversize pistons, the instructions furnished by the manufacturer of the equipment being used should be very carefully followed.

Before using any 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 angle to the crankshaft.

In these engines, the piston clearance is provided for on the piston and this must be taken into consideration when setting the cutter in the boring bar. The piston to be fitted should be checked with a micrometer, measuring just below the lower ring groove and at right angles to the piston pin. The cylinder should be bored to the same diameter as the piston.

If a micrometer is not available to measure the piston, the cylinder should be bored .002″ less than the oversize piston to be fitted. For example, when fitting a .020″ oversize piston, the cylinder should be bored .018″ oversize.

Cylinder Hone:

After the cylinder bores have been rebored within .002″ of the size desired, they should be finished or polished with a hone similar to the one shown in Fig. 10.

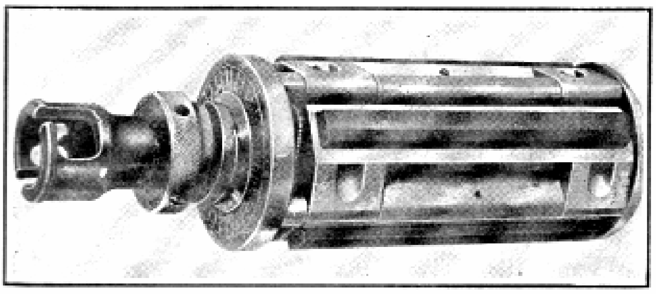


Fig. 10—Cylinder Hone

This is an expanding type hone, with the blades or stones expanding when the nut on the top of the hone is turned. Tool No. KMO-1000.

In operation, the hone is placed into the cylinder bore and expanded until it can just be turned by hand. The hone is then operated up and down in the bore until it begins to run free. Then the expanding nut on the top of the hone is tightened and the hone passed up and down in the bore until it again runs free. During this operation kerosene should be used as a cutting fluid to keep the stones of the hone cleaned. If the crankshaft is not removed—cover the crankshaft journals to prevent cuttings getting onto the shaft.

PISTONS

The pistons used in these engines are cast iron electroplated, with a slipper skirt. Three ring grooves are located above the piston pin. The pistons are cam ground out-of-round. This out-of-round piston compensates for heat expansion along the line of the piston pin bosses.

The lower piston ring in the piston is an oil control ring with ports to allow excess oil, scrapped from the sides of the cylinder wall, to be returned to the inside of the pistons and then to the crankcase by means of holes drilled in the ring grooves of the piston.

Pistons are furnished in standard sizes as well as .003″, .010″, .020″, .030″, and .040″ oversizes.

If it is necessary to replace pistons due to wear, the cylinder walls should be honed for .003″ oversize or rebored and honed for .010″, .020″, .030″ and .040″ oversize pistons.

NOTE: Any time a piston is removed from the cylinder it should be examined for carbon on the inside. Although Pistons do not carbon up excessively, however, it is a good practice to inspect them and remove any carbon that is present. This helps to keep the engine oil clean.

Piston Fitting:

Pistons should be fitted in the following manner:

1. Cylinders and pistons should be thoroughly cleaned with compressed air and wiped dry with a clean cloth.
2. Pistons are tapered to provide for greater expansion at the upper end of the piston. The diameter below the lower ring groove is less than at the extreme lower end of the skirt.
3. The pistons must be fitted in their running position in the cylinder. A proper size feeler should be inserted between the cylinder wall and thrust side of the piston. The feeler gauge should be at right angles to the piston pin and in line with the thrust surface of the piston. See Fig. 11.

The correct fit for the piston in this engine is a 25 lb. pull on a .0015″ feeler ½″ wide.

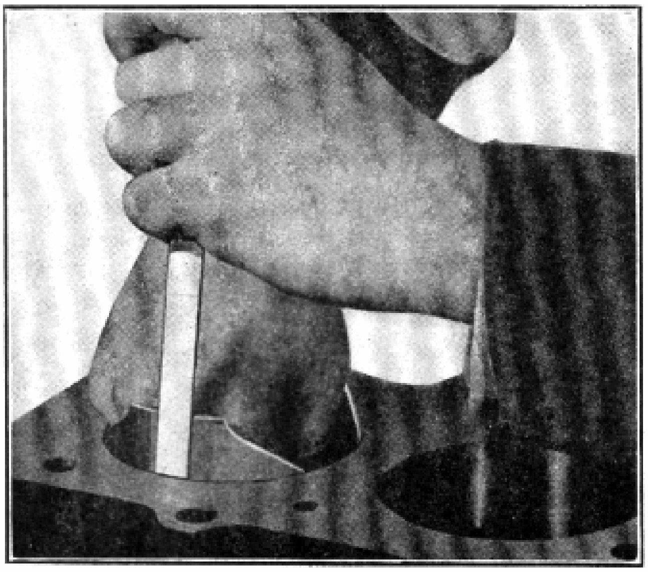


Fig. 11—Determining Piston Clearance—Tool No. HM-593

This clearance has been carefully worked out in tests at the factory and in actual service. Do not attempt to fit the pistons with clearance other than recommended as .0015" is the minimum.

CAUTION: Great care must be exercised when fitting this type of piston because they can easily be damaged by careless handling.

Do not exert heavy pressure on the piston when pusing it into the cylinder bore to check the fit with a feeler gauge.

Fitting Piston Pins:

Very seldom will it be found necessary to replace the piston pins due to the bushing becoming excessively worn, but should this operation become necessary, the following procedure should be carefully followed.

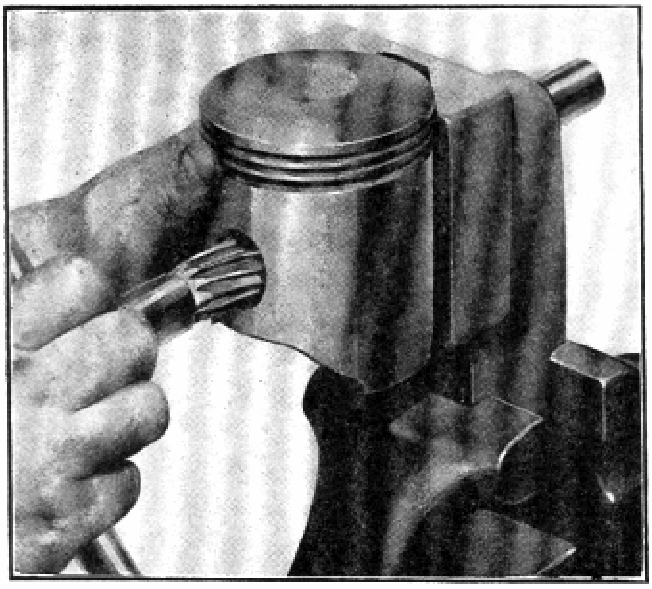


Fig. 12 —Piston Pin Bushing Reamer

1. Place the piston pin bushing reaming fixture Tool No. J965 in a bench vise.
2. Adjust the expansion reamer for a light cut.
3. Insert the reamer in the piston bushing and start the reamer pilot into the guide in the fixture.
4. Hold the piston in the V-block of the fixture with one hand and turn the reamer handle with the other hand until the reamer has passed through both bushings as shown in Fig. 12.
5. Expand the reamer by easy stages and repeat the reaming operation until the piston pin is fitted.

The proper fit of the Piston Pin is a "thumb push" fit as illustrated in Fig. 13.

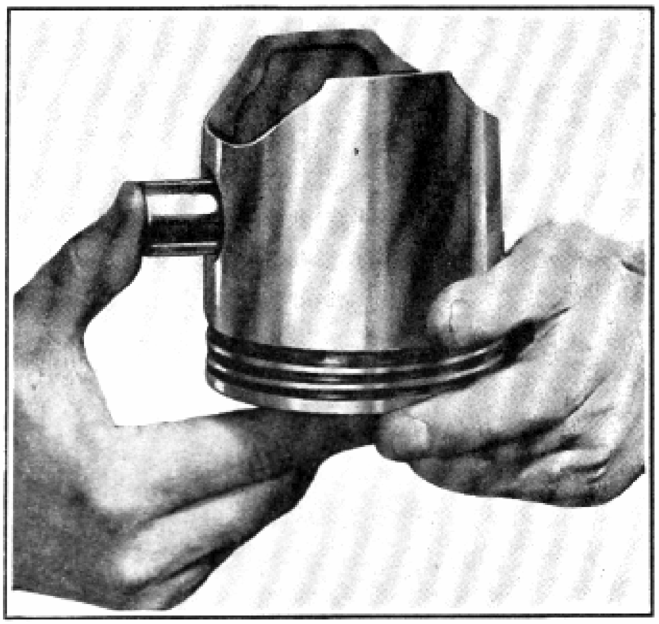


Fig. 13—Fitting Piston Pin

After fitting the first piston pin, the other piston bushings may be reamed quickly by reducing the diameter of the reamer by approximately .0005" (half a thousandth) by backing off the expansion screw. This permits a quick roughing-out of all bushings leaving about half a thousandth for the finish cut.

It is good practice to check the diameter of all piston pins with a micrometer in case there should be a slight variation in diameter. Should a variation exist, this must be taken into consideration when adjusting the reamer for the finish cut.

The purpose of the reaming fixture is to make sure that the piston pin bushings will be reamed at right angles to the skirt of the piston, assuring proper alignment of the piston in the cylinder.

Piston pins are serviced in standard sizes as well as .003", .005", and .010" oversizes.

PISTON RINGS

The purpose of a piston ring is to fill up the space between the cylinder walls and the piston, so as to prevent leakage of gases and oil.

As these gases are under considerable pressure, it is therefore necessary that the rings not only fit snugly around the cylinder walls, but in the grooves of the pistons as well, otherwise the gases and oil will work behind the rings.

The compression ring used in these engines is designed to control oil consumption during the break-in period. The face of the ring is tapered one thousandth of an inch. With this design the lower edge of the ring tends to scrape the excess oil from the cylinder wall and acts as an oil control ring until the regular oil control ring is seated (broken-in) in the cylinder. These compression rings are marked with the word "TOP" cast in the upper side of the ring. When installing them, make sure the marked side ("TOP") is toward the top of the piston.

Piston rings are furnished in standard sizes as well as .005, .010″, .015″, .020″, .030″ and .040″ oversizes.

Removing Piston Rings

The best method is to clamp the piston and connecting rod assembly in a bench vise.

Do not place the skirt of the piston in the piston vise when removing or replacing the rings, as the pressure of the jaws will distort the piston skirt.

Remove the piston rings over the top of the piston, using a proper ring removing tool.

If piston ring removing tool is not available, insert a table knife or hack saw blade under the ring. As the knife is slipped back of the ring and guided around the piston with one hand, the ring is forced out of the groove with the other hand.

It will be found easier to remove the top ring first, then the center and lastly the bottom.

NOTE: Do not remove rings over skirt of piston as this scratches the piston skirt.

Fitting Piston Rings

To properly fit new piston rings, proceed as follows:

Slip the ring into the cylinder, pressing it down about two inches into the bore with a piston. This will square the ring in the cylinder wall. Measure the gap between the ring ends. (See Fig. 14.)

This clearance should be .005″ to .015″ for all three rings. If the space between the ends of the ring is less than this remove the ring and try another ring for fit, or the gap in the tight fitting ring may be enlarged by the following method: Remove the ring from the cylinder. Clamp a fine cut file in the vise. Grasping each end of the ring firmly between thumbs 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 space 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.

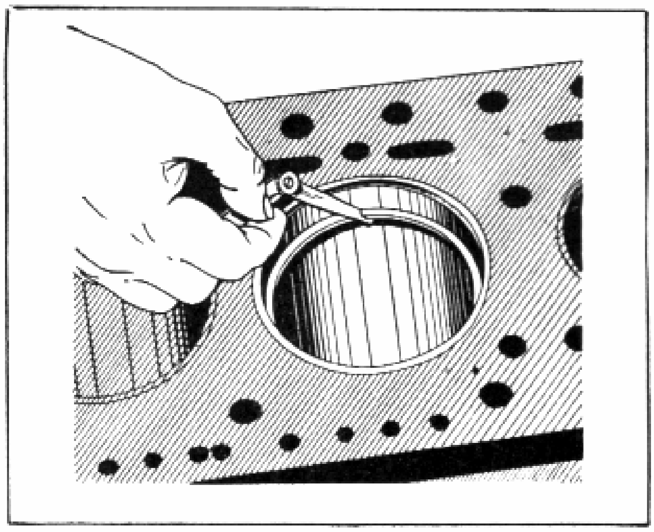


Fig. 14—Measure Piston Ring End Gap and Vertical Clearance as Shown

New rings and bores wear considerably during seating and gaps quickly get wider. No operating defects will be noted if gaps do not get greater than 1/32″.

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

Slip the back side of the ring into the groove, and roll it entirely around the groove, to make sure that the ring is free and does not bind in the groove at any point.

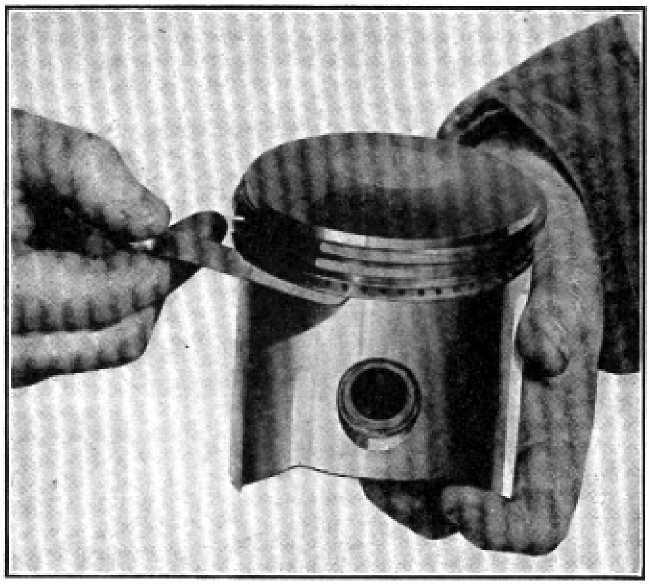


Fig. 15—Piston Ring Fit in Groove

Rings should be selectively fit to each individual bore and piston groove. When the piston and ring assembly is installed in the cylinder, the gaps in the rings should not be in a vertical position, nor should there be any gaps over the piston pins. Stagger the gaps so that they will be equal distance apart around the circumference of the piston.

Piston Ring to Ring Groove Clearance:

At the top ring a .002" feeler should be very free, but a .003" should cause a rather heavy drag.

At the center ring, the .002" feeler should be just free and the use of a .003" feeler should cause the ring to lock in the groove.

At the bottom, or oil control groove, the .002" feeler should also be free and can have as much as .003" clearance.

It is of the utmost importance that the rings be selectively fitted to each individual bore and each ring groove of the piston. A final test of the ring fit in the groove is to repeat the fitting procedure given above, after the rings are assembled in the grooves of the pistons, Figure 15.

Inserting Pistons

In slipping the pistons back into the cylinders, use extreme care and do not force the rings into the bore. Compress the rings with the Piston Inserter KMO-357 as shown in Figure 16, until they enter the cylinder freely. In using this Piston Inserter the chamfer on the bottom of the inserter must fit into the chamfer at the top of the cylinder.

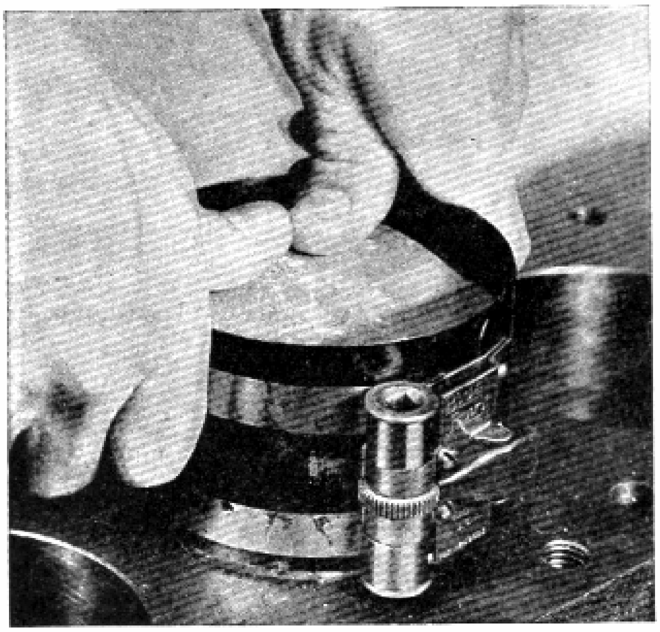


Fig. 12—Piston Inserter

MAIN BEARINGS

The main bearings are steel back babbitt-lined. The babbitt is centrifugally cast or "spun-in" into the steel lining. This method assures a positive bond between the steel and the babbitt and prevents the formation of air pockets in the babbitt metal.

The advantage of this type of bearing is that the expansion characteristics are similar to those of the parts with which they come in contact. This prevents loosening of the bearings. The thin wall of the bearing permits it to conform to both the crankshaft and the bearing bore in the cylinder block, assuring a snug fit at all times. These features of the main bearings make for long life.

Bearings for Service are available in two sizes, (1.) For Line Reaming. (2.) For Hand Scraping.

When it is necessary to replace main bearings, the clutch housing should not be removed from the cylinder block. This is very important, as the transmission pilot hole in the clutch housing is used in the alignment of the boring bar. In case it is necessary to replace the clutch housing, the new part must be assembled to the block and checked before main bearings are installed. The housings furnished for service are selected and are interchangeable with the production part.

CRANKSHAFT

The following is a list of the sizes of the main bearing and connecting rod journals of the crankshaft:—front, 2.6855"-2.6865"; front intermediate, 2.7165"-2.7175"; rear intermediate, 2.7475"-2.7485"; rear, 2.7785"-2.7795"; connecting rod journal, 2.311"-2.312".

Whenever a crankshaft has been removed from an engine, it is important that these dimensions be checked with a micrometer for out of round, taper and undersize. If the journals exceed .001" out of round or taper, the crankshaft should be replaced. Slightly undersize journals can be used providing that they are within the above limits for out of round or taper.

Any time the crankshaft is removed from the engine it should also be checked for runout. To perform this operation, support the crankshaft at the front and rear main bearing journals and indicate the runout of both the rear intermediate and front intermediate journals, using a dial indicator. The runout limit of each of these journals is .002".

Main Bearing Boring Machine

Any reliable type of boring bar may be used. The operating instructions issued by the manufacturer of the tool should be followed explicitly. The Boring Bar operations described in this manual are for use with Tool J-1000.

The unit consists of the following parts, Fig. 17.

A—Support Bracket and Clamps.
B—Universal Clamp Bolts.
C—Boring Bar Supports and Ball Bearings.
D—Boring Bar Centering Bushings.
E—Clutch Housing Centering Bushing.
F—Boring Bar.
G—Boring Bar Feed Support Bracket.
H—Feed Nut Yoke.
I—Feed Screw.
J—Turning Handle.
K—Boring Bar Cutters.

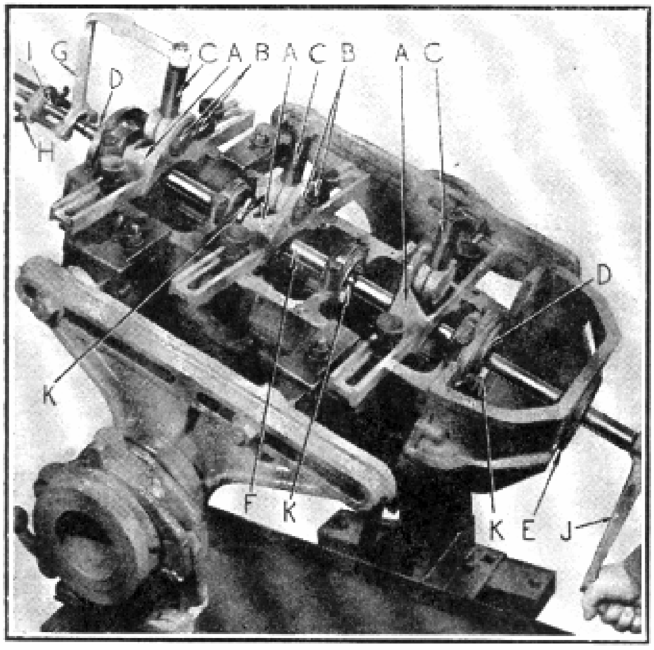


Fig. 17—Main Bearing Boring Machine

The operations for replacing main bearings are as follows:

1. Support the crankcase in a motor stand with the bearing side of the case up.
2. Remove the old bearings and see that the case is well cleaned.
3. Install the centering bushings "D" in the front and rear bearing bores and install the bearing caps without shims.
4. Thread the boring bar "F" through the bushings from the rear to the front. Then mount the dial gauge on the boring bar and check the alignment of the transmission pilot hole in the clutch housing, Fig. 18. The run-out must not exceed .015". If it does, it will be necessary to replace the clutch housing before proceeding with the job of installing new main bearings.
5. Remove the boring bar and the centering bushing in the rear bearing. Then install the clutch housing centering bushing "E" in the transmission pilot hole of the clutch housing.
6. Install the boring bar through the rear centering bushing and thread the boring bar support bearings "C" over the bar, locating one support in the space between each two bearings. Be sure to push the boring bar through the front centering bushing beyond the reduced diameter portion.
7. Install the boring bar support brackets "A" and line them up so there will be clearance between the bearing cap and support bracket for the installation and removal of the cutters. Clamp the support brackets firmly to the pan rail of the cylinder block.
8. Tighten the Universal clamp bolts "B" on each support bracket evenly. As the bolts are being tightened, the boring bar should be turned by hand to make sure that it is free to turn without any indication of a bind. Remove the boring bar and the front centering bushing.
9. Install the bearing shells in the cylinder block and caps.

NOTE: The front and front intermediate bearing shells are very similar in appearance and it is possible to get them mixed. The front intermediate shells are identified by the letter "I" in the bottom of the oil groove. Should the intermediate bearing shell be installed in the front bearing bore, the sides of the bearing would be too high and would not permit the cap to seat firmly on the shims.

10. Place four .002" shims on each side of each bearing and install the caps. The intermediate bearing caps are marked "front" and "rear" for identification purposes. The front intermediate bearing cap is installed with the "FRONT" mark to the front of the engine and the rear intermediate bearing cap is installed with the "REAR" mark to the rear of the engine.

    The rear intermediate bearing shell is flanged because it takes the end thrust of the crankshaft.

    Tighten the bearing cap bolts evenly and make sure they are drawn down tight.

11. Examine the boring bar to make sure the cutter seats are clean; then install the bar through the rear centering bushings and bearing supports. Examine the cutters to make sure they are clean and install them in the slots in the cutter bar. The cutters are lettered F-FC-RC-R to designate front, front center, rear center, and rear.

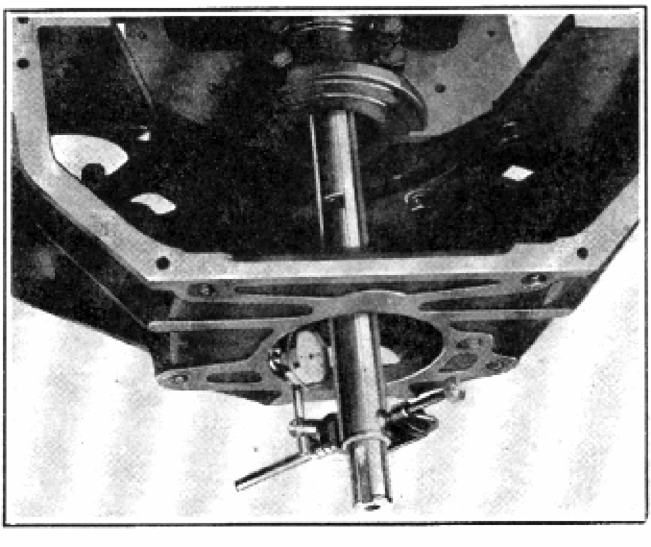


Fig. 18—Checking Clutch Housing

12. Mount the feed screw support bracket "G" on the front boring bar support. Mount the feed screw "I" in its U-shaped yoke and install the screw in the end of the boring bar. Adjust the bar so that the cutters are just about to enter the bearings; then tighten the two feed screw support thumb screws.

13. Install the turning handle on the end of the boring bar and proceed with the boring operation. During this operation, use a liberal supply of kerosene to keep the cuttings washed out of the bearings.

14. After the cutters have passed through the bearings, remove the turning handle and feed screw. Blow all cuttings out of the bearings with compressed air, being careful not to blow the cuttings into the boring bar support bearings.

15. Slide the boring bar back until the cutters have passed through the bearings; then again install the feed screw and bore through the bearing a second time. This is very important in order to obtain a perfectly smooth true bearing.

16. Remove the turning handle, feed screw, cutters and boring bar. Do not disturb the boring bar supports because they will be used when facing the rear-intermediate bearing for crankshaft end clearance.

Rear Intermediate Bearing

The rear intermediate main bearing carries the crankshaft end thrust. Therefore it becomes absolutely necessary when replacing main bearings to use an accurate tool to face the flanges of the rear intermediate bearing to the correct width so that the crankshaft will have the proper end clearance.

Facing the Rear Intermediate Bearing:

1. Install the boring bar through the centering bushing and the rear bearing support. Slip the facing cutters on the boring bar, one on each side of the rear intermediate bearing.

2. Place the feed screw sleeve in the front intermediate bearing and push the boring bar through the sleeve. Install the feed screw drive key through the hole in the sleeve and into No. 2 cutter hole in the boring bar, locking the key in place with its screw.

3. Adjust the feed screws for equal feed range on each side of the front intermediate bearing. Adjust the facing cutters to provide about .015" clearance between the cutter face and the flange of the bearing. Lock the cutters to the boring bar with the clamp screws.

4. Caliper the width of the rear intermediate bearing journal on the crankshaft with the special inside and outside calipers, KMO-964.

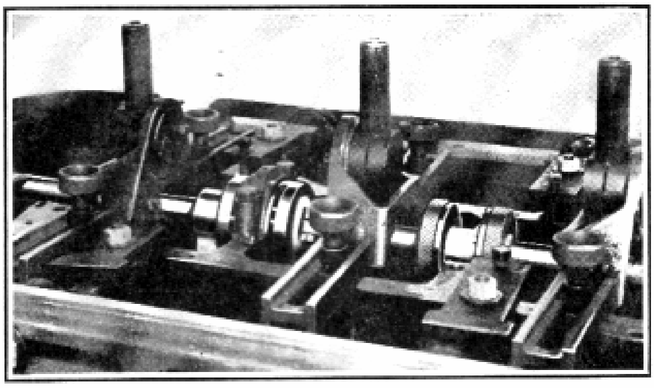


Fig. 19—Facing Rear Intermediate Bearing

5. Install the turn.ng handle on the end of the boring bar. Bac'k off the front feed screw collar several turns and tighten the rear feed screw collar until the front facing cutter contacts the bearing flange. Then proceed with the facing operation, tightening the feed screw as necessary to keep the cutter in contact with the bearing flange.

The front flange of the bearing should be machined just enough to thoroughly clean up the face. The proper installation of this tool is shown in Fig. 19.

6. Back off the rear feed screw collar and tighten the front collar until the rear cutter engages the bearing rear flange. Then continue with the facing operation, checking the progress of the job every few turns with the special caliper that was set for the width of the crankshaft journal. Continue facing the bearing until the special caliper will pass over the bearing and a .004" feeler laid alongside the bearing flange.

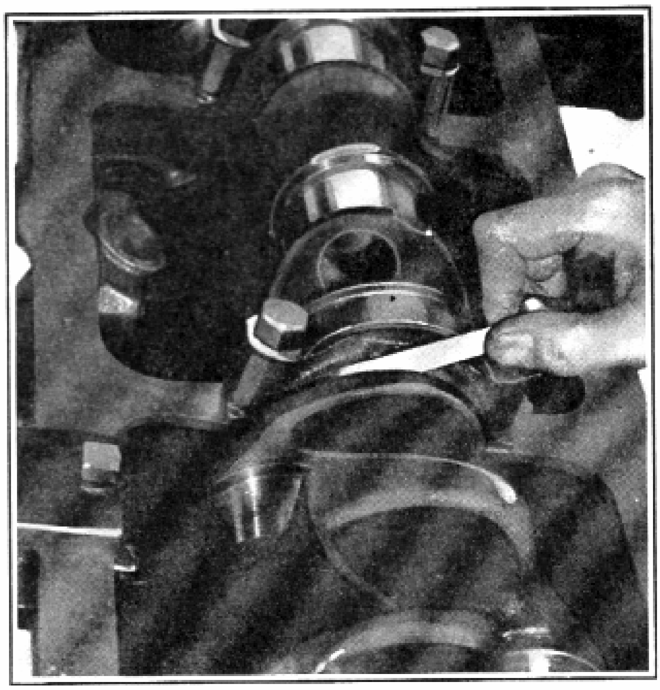


Fig. 20—Crankshaft End Play

Remove the bearing cap and place it on the rear intermediate journal of the crankshaft. Check the end clearance with a feeler gauge; the correct clearance is .004" to .007".

7. Disassemble the facing cutters and boring bar from the cylinder block. All parts of this tool should be thoroughly cleaned and oiled to prevent rusting, and put away in the special boxes provided for this purpose.

Installing Crankshaft

Blow out all cutting from the bearings.

Clean out all oil passages by blowing them out with compressed air. It is a good practice to blow out each oil passage separately—this can be done by placing the fingers on the oil hole in three of the bearings while the nozzle of the air gun is placed in the oil inlet of the cylinder block. After blowing out the oil passages of all four bearings, then blow through each of the oil passages from the main bearings to the camshaft bearings.

Proper cleaning of all oil passages is very important and must be done thoroughly.

Lubricate all four bearings and carefully place the crankshaft in the bearings.

Check the end play by forcing the crankshaft to its extreme rear position. Check at the rear side of the rear intermediate bearing with a feeler gauge. See Fig. 20. This clearance should be from 0 04" to .007".

Install the bearing caps with four .002" shims on each side and pull the bolts down snugly. Check to see the crankshaft rolls freely.

Adjusting Main Bearings

Starting with the rear bearing, remove shims evenly until there is a slight drag on the crankshaft (turning it by hand) with the bolts pulled down tight. Then replace one .002" shim for clearance, again tighten the bolts and check for drag. The crankshaft should now roll freely without any indication of a drag.

Loosen the bolts on the bearing that has just been adjusted and proceed to adjust the next one in the same nanner and so on until all bearings have been adjusted.

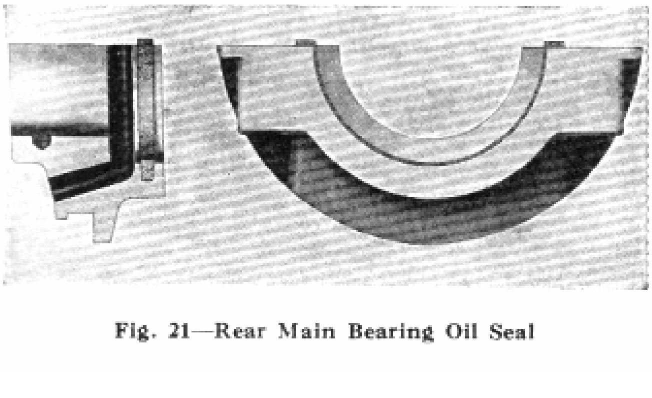


Fig. 21—Rear Main Bearing Oil Seal

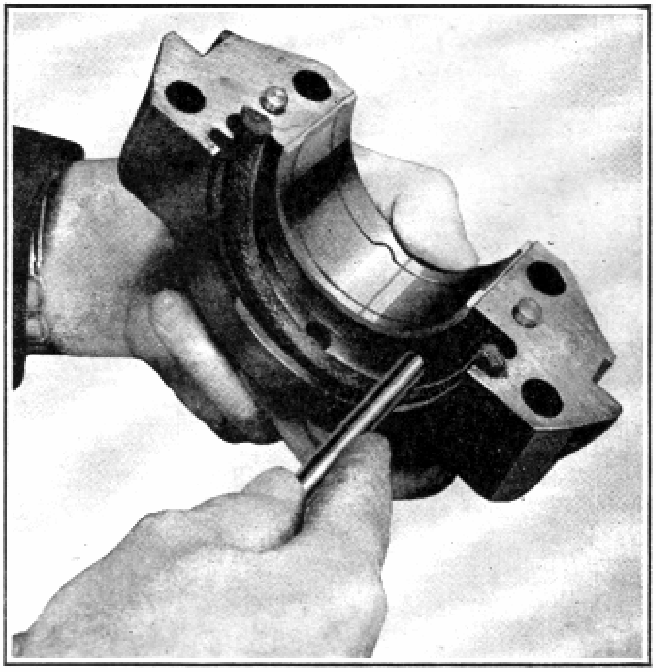


Fig. 22—Rolling Rear Bearing Oil Seal into Cap Groove

When adjusting the bearings, shims should be removed evenly. If an uneven number of shims have to be used, it is good practice to have the greater number of shims on the same side of all bearings.

By following the procedure of removing shims to check and then replacing one .002" shim, there will be no possibility that the bearing will be too loose. Then if the crankshaft may be turned freely by hand, it is certain that the bearing is not too tight.

If the shaft turns freely by hand, after all bolts have been tightened, you know the bearings are properly adjusted.

Crankshaft Rear Bearing Seal

Sealing at the crankshaft rear bearing has been improved by machining the rear bearing cap and crankcase to receive a wick-type seal. Fig. 21.

To install a new wick seal at the rear main bearing cap, insert the packing in the groove with the fingers. Then using a rounded tool, roll the packing into the groove. When rolling the packing start at one end and roll the packing to the center of the groove. Then starting from the other end, again roll toward the center. Fig. 22.

By following this procedure you are assured that the wick is firmly pressed into the bottom of the groove.

The small portion of the wick which protrudes from the groove at each end should be cut flush with the surface of the bearing cap. To prevent the possibility of pulling the wick out of the groove while cutting off the ends, it is recommended that a round block of wood the same diameter as the crankshaft flange be used to hold the packing firmly in position while the ends are being cut off.

If it should become necessary to replace the upper half of the wick seal, it will be necessary to remove the engine from the chassis and remove the crankshaft.

The procedure for installing the wick in the cylinder block is exactly the same as for installing it in the bearing cap.

CAMSHAFT

The camshaft is designed to assure quiet operation, combined with accurate valve timing. The contour of the cams is carefully worked out to take up the valve clearance gradually. The valve lifters are located slightly off the center line of the cams. This design results in spinning the lifter so the cams do not engage the same point on the lifters, each time the valves open, resulting in long valve lifter life and quiet operation.

The following is a list of the sizes of the camshaft bearing journals: front, 2.0282″-2.0292″; front intermediate, 1.9657″-1.9667″; rear intermediate, 1.9032″-1.9042″; rear, 1.8407″-1.8417″.

Whenever a camshaft is removed from an engine it is important that these dimensions be checked with a micrometer for out of round. If the journals exceed .001″ out of round, the camshaft should be replaced.

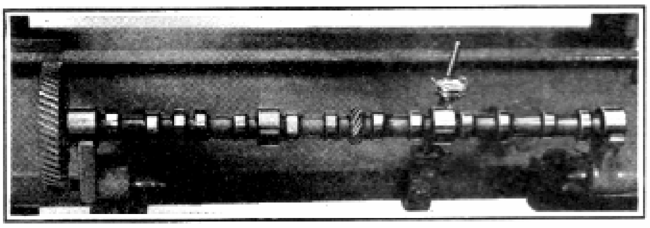


Fig. 23—Checking Camshaft Alignment

Another very important inspection operation, when the camshaft is removed from the engine, is to check it for alignment. The best method is by use of "V" blocks and a dial indicator as shown in Fig. 23. The dial indicator will indicate the exact amount that the camshaft is out of true. If it is out more than .002″ 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 so you can tell exactly where to apply pressure when straightening.

NOTE: During the straightening operation care should be taken to protect the center bearing journal to prevent damage to its surface.

After the camshaft has been straightened, it should be re-checked to be sure that it is within .002″ dial indicator reading for alignment.

CAMSHAFT BEARINGS

All four of the camshaft bearings are steel backed, babbitt lined bearings. They are pressed into the crankcase and staked into place to prevent rotation and endwise movement. They are accurately line reamed at the time of assembly, assuring proper alignment of the camshaft. These bearings are lubricated through holes which line up with the oil passages from the main bearings.

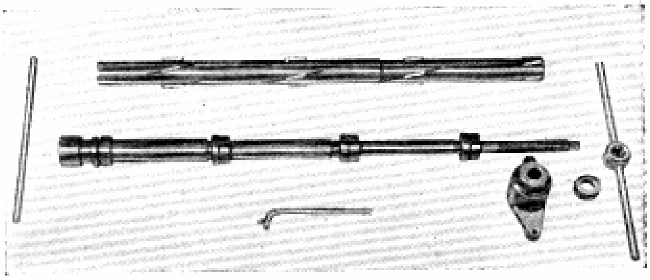


Fig. 24—Camshaft Bearing Removing and Replacing Tools

To remove, replace, and line ream the camshaft bearings in service; a special set of tools J-946 is necessary. This set consists of a removing and replacing bar, four removing and replacing sleeves, a bracket which is attached to the rear of the cylinder block and a special camshaft bearing reamer. Fig. 24.

Removal

1. Drive out the expansion plug at the rear of the rear camshaft bearing.
2. Assemble the camshaft bearing remover bracket loosely to the rear of the cylinder block.
3. Start the bearing puller bar through the front bearing and install the puller sleeve for each bearing over the bar before the bar has passed through that particular bearing. Then pass the bar through the hole in the bracket. Tighten the bolts that hold the bracket to the crankcase. Then install the thrust bearing and puller handle on the end of the bar.
4. Turning the puller handle will now remove all four bearings at one time. An extension handle is provided to aid in starting bearings that may have corroded in the case.

Replacement

1. To make sure that the oil holes in the camshaft bearing bores will line up with the oil holes in the camshaft bearings after the bearings have been installed, mark the position of the oil hole in the bore on the front face of the bearing bore.
2. Place a new front camshaft bearing over the puller bar and start the bar through the front bearing bore. Place the puller sleeve with a new bearing over the bar before passing the bar through the bearing bore in the cylinder block. Pass the end of the bar through the puller bracket and install the thrust bearing and turning handle.

3. Line up the oil holes in each bearing with the oil hole location marks previously made. All four bearings can now be pulled into place simultaneously.

4. Remove the puller bar and bracket and then stake each bearing into the hole provided in the bore for that purpose.

Reaming Camshaft Bearings

The special camshaft bearing line reamer has all four cutters mounted on one bar so that all of the camshaft bearings will be in perfect alignment after the reaming operation.

1. Pass the reamer through the first, second, and third bearings. Then start the reamer cutters into all four bearings and turn the reamer slowly until the cutters have passed through the bearings. While the bearings are being reamed, a liberal supply of kerosene should be used.

2. Remove the reamer by pulling it back through the bearings, at the same time turning the reamer slowly in the same direction as when reaming the bearings.

3. Blow all cuttings from the bearings with compressed air. Install the camshaft and check all bearing clearances with a narrow feeler gauge. The proper clearance is from .002″ to .004″. Install the expansion plug in the cylinder block at the back of the rear camshaft bearing.

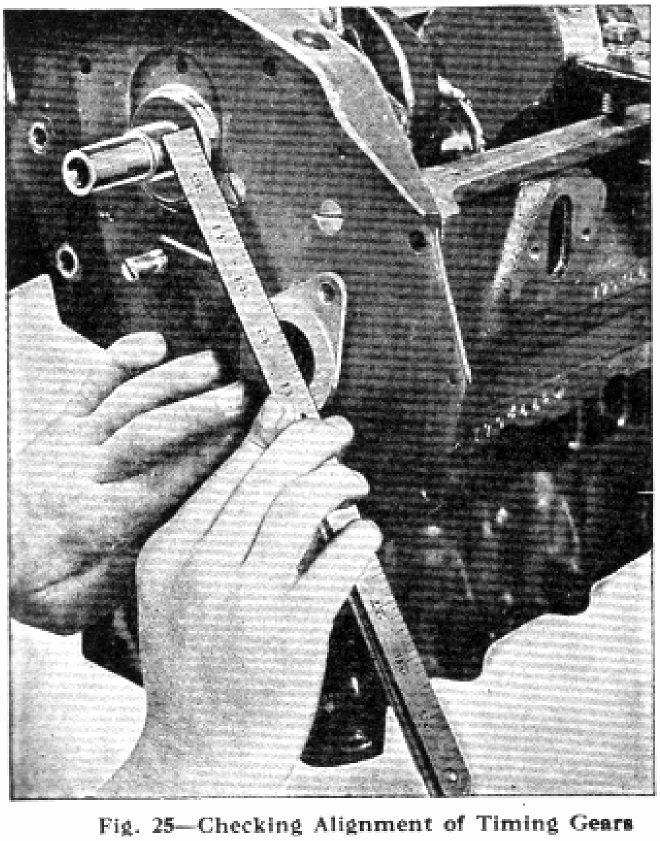


Fig. 25—Checking Alignment of Timing Gears

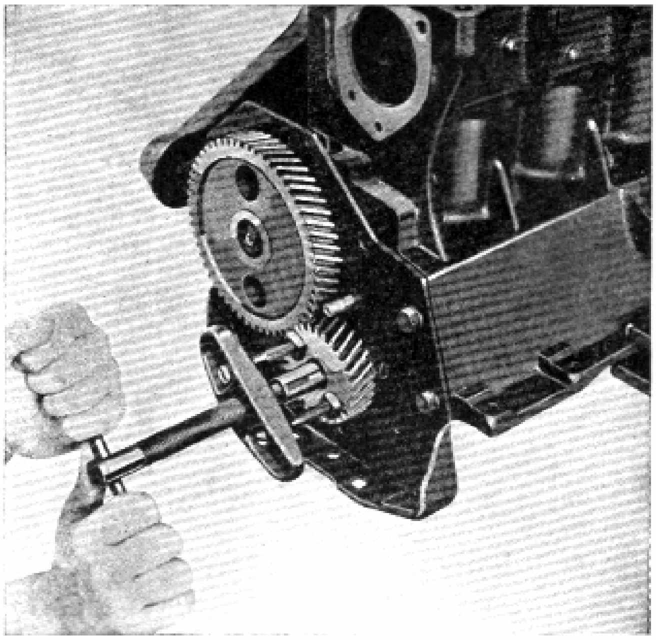


Fig. 26—Crankshaft Gear Puller

CRANKCASE FRONT END PLATE

This part is assembled to the cylinder block with from one to three gaskets. The reason for the various number of gaskets is to give the correct alignment to the timing gears.

In assembling this part to the cylinder block, first use two gaskets and hold in place with three screws. Then place a new camshaft thrust plate over the camshaft hole in the end plate. Using a scale laid against the thrust plate and over to the shoulder on the crankshaft for the timing gear, check to see whether or not these two surfaces are flush. Fig. 25. If scale strikes the shoulder, on the crankshaft, add another gasket. If there is space between the scale and the shoulder on the crankshaft, remove one gasket.

After the proper number of gaskets have been installed between the plate and the crankcase, assemble the screws and bolts, setting the screws with a center punch.

CRANKSHAFT AND CAMSHAFT GEARS
(Timing Gears)

The gear on the end of the crankshaft, or the crankshaft timing gear, is cut from a solid piece of steel. It is a drive fit on the end of the crankshaft as well as being held in place with a key.

To properly remove this gear, without damage to it, a gear puller, such as is shown in Fig. 26, is necessary. To replace this gear, a driver is essential so that the gear can be driven straight back on its seat accurately.

The camshaft gear, or camshaft timing gear, is a composition gear which has been pressed into gear blanks under enormous pressure. After this blank has been made, the teeth and the inside hole of the gear is machined, the timing mark punched on it and the keyway cut. This gear together with the steel crankshaft gear gives long, quiet, trouble-free life.

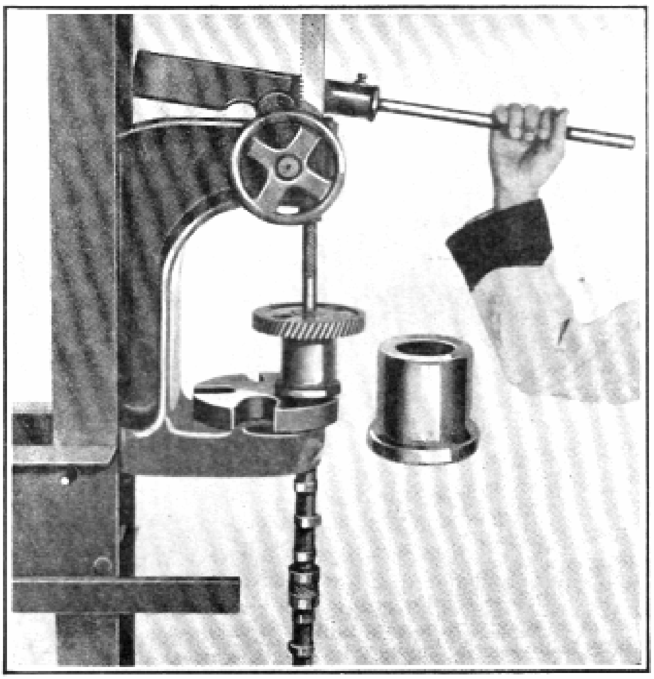


Fig. 27—Camshaft Gear Removing Sleeve

If it becomes necessary to replace the camshaft gear, a sleeve to properly support the gear on its hub is necessary.

This sleeve, shown in Fig. 27, removes the gear, but it so damages the thrust plate that it is very important that every time a gear is removed from the camshaft, a new thrust plate must be used.

In replacing the gear on the camshaft, the back of the front journal of the camshaft must be firmly supported in an arbor press and the camshaft thrust plate assembled to the camshaft, after which the gear is pressed on the shaft far enough so that the camshaft thrust plate has no clearance, yet is free to revolve. The correct clearance is—a free fit to a maximum of .003″. It is very important that the gear be pressed on the camshaft using the hub of the gear as a pressing medium and not the outside of the gear. Serious damage will be done to the gear if it is pressed on the shaft using the outside of the gear.

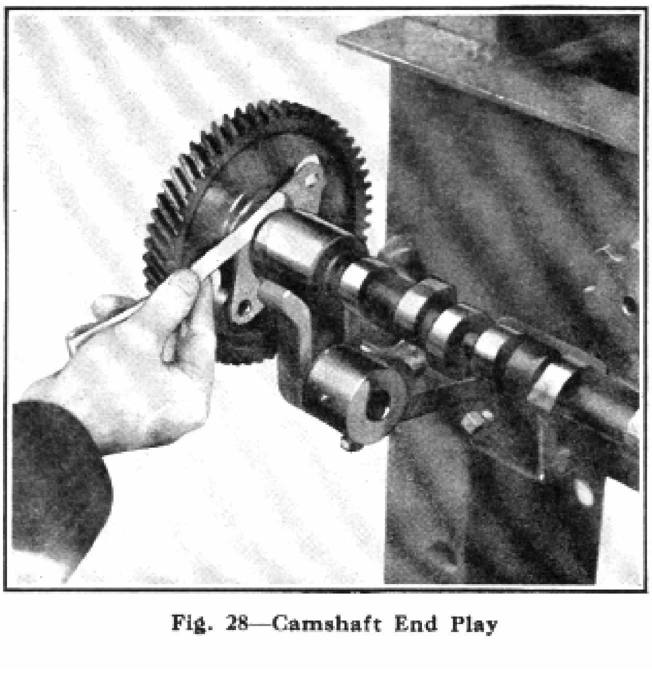


Fig. 28—Camshaft End Play

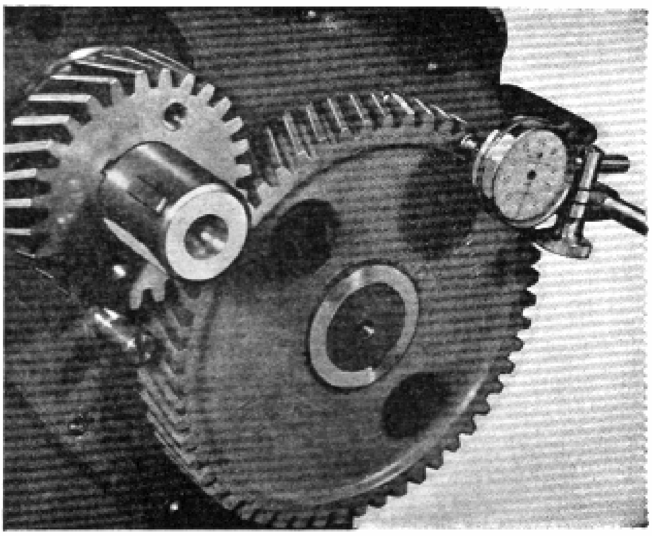


Fig. 29—Checking Run-Out of Timing Gears

The thrust bearing, on the inside of the camshaft gear, when it is assembled to the camshaft, determines the amount of camshaft end play.

If there is an excessive amount of end play in the camshaft, it is necessary to remove the gear and shaft assembly and press the gear further on the shaft so that the thrust plate is tight, yet free to revolve, to a maximum of .003″ clearance. See Fig. 28.

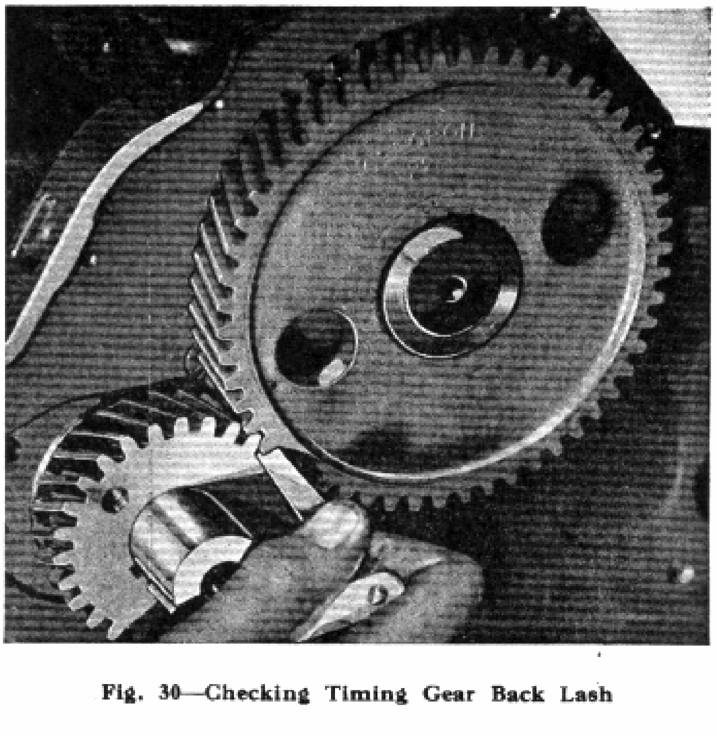


Fig. 30—Checking Timing Gear Back Lash

When the camshaft and gear are assembled to the engine, it is important that the punch marks on both the camshaft and the crankshaft gear be opposite each other.

The camshaft will then be in its proper position so that the valves will open and close in the proper relation to the movement of the piston.

After the camshaft and crankshaft gears are in their proper places, check the crankshaft timing gear for run-out with a dial indicator. This should not exceed .003". Then check the run-out of the camshaft gear. This should not exceed .004". Fig. 29.

If these run-outs are excessive, remove gears to be sure that burrs on the shaft or gears are not causing run-out. If necessary replace with new gears. The back lash should be checked. This check is made with a feeler gauge placed between the teeth of the gears. This should be from .002" to .005". Fig. 30.

Timing Gear Oil Nozzle

In order to properly lubricate the timing gears, a timing gear oil nozzle is screwed into the crankcase front end plate.

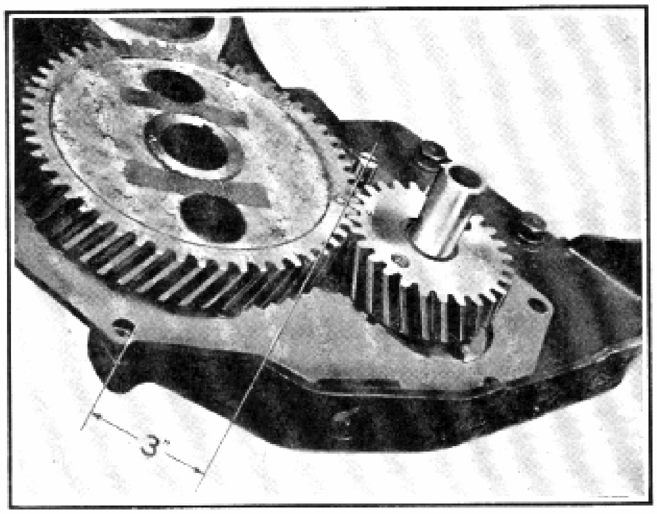


Fig. 31—Timing Gear Oil Nozzle

This oil nozzle receives the oil from the crankcase and delivers it to the timing gears through a small outlet hole drilled in the nozzle. The position of the hole determines whether or not the timing gears will receive the correct amount of lubrication.

Fig. 31 shows the position that the oil hole in the nozzle must be in to properly perform its function. The outlet hole in the nozzle must be from straight down to in line with a point three inches from the flanged edge on the bottom left hand side of the crankcase end plate as indicated in Fig. 31.

TIMING GEAR COVER

The timing gear cover is a pressed steel stamping, heavily ribbed for strength. A spring loaded leather seal is assembled into the crankshaft opening to prevent oil leakage around the hub of the harmonic balancer. The seal is pressed into a pocket in the cover by the use of Oil Seal Replacer J-995.

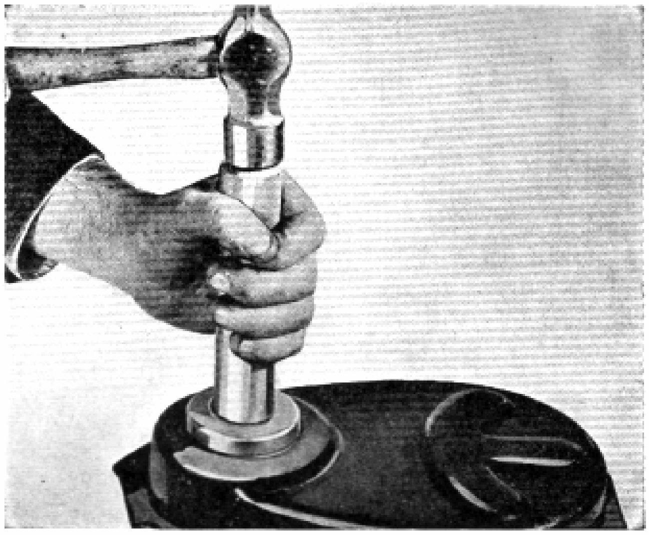


Fig. 32—Installing Timing Gear Cover Oil Seal

When it becomes necessary to replace the leather seal, the special tool, illustrated in Fig. 32, should be used. Place a new oil seal on the driver with the free end of the leather towards the end of the tool. The seal can then be driven into place in the cover with a few light blows of a hammer.

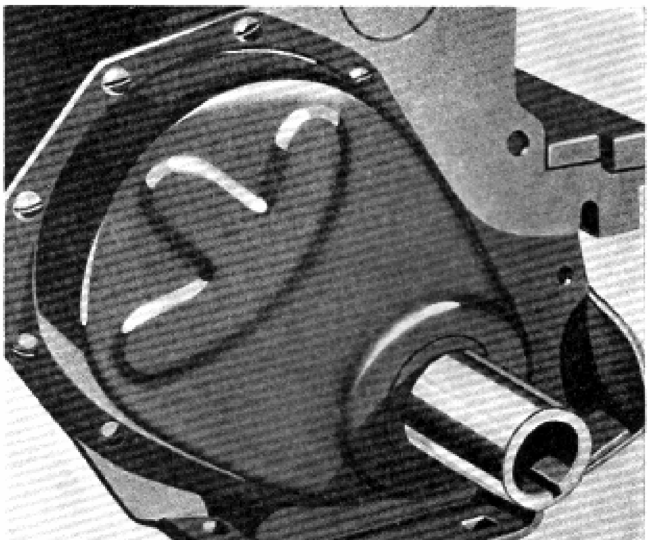


Fig. 33—Timing Gear Cover Centering Gauge

When installing a timing gear cover, it is essential that it be centered so that the harmonic balancer is installed without damage to the oil seal.

The guide J-966 illustrated in Fig. 33, fits over the crankshaft and, when in position, guides and holds the timing gear cover in its correct position, so when the balancer is installed it will not damage the oil seal. A coating of grease around the inside surface of the leather, will aid in preventing damage to the seal during this operation.

HARMONIC BALANCER

The Harmonic Balancer consists of a small flyweight attached to and driven by the crankshaft through two rubber annular rings mounted over six studs which are riveted to the hub.

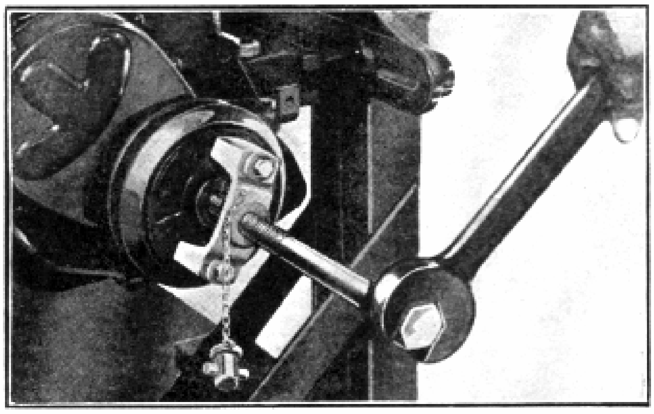


Fig. 34—Harmonic Balancer Puller and Driver

When the engine is running, any change in the speed of the crankshaft, which would cause vibration, will be resisted by the action of the balancer. This resistance is produced by a floating action between the rubber annular rings and the six driving studs. The flyweight moves back and forth on the rubber mounted studs in the opposite direction to that of the crankshaft, and thereby dampens out or absorbs crankshaft vibrations.

Due to the construction of the balancer the component parts will not be serviced separately.

The puller (Fig. 34) is made in three parts, a drop forged puller body, a puller screw and a driver head. The driver head is made of tool steel with a drill rod pin which is replaceable.

In operation the puller body is attached to the balancer by means of the two cap screws in the puller, which screw into the tapped holes in the balancer. This insures the puller body being held firmly against the balancer and helps to hold the balancer together while it is being removed. Next turn the puller screw into the body until the balancer is removed. This puller provides a steady pull on the balancer allowing its removal without damage.

In installing this part the puller body is removed and the driver placed in the starting crank jaws and the puller body reassembled to the balancer. Next line up the key in the crankshaft and the keyway in the balancer and drive the balancer in position using the puller screw as a driver. If the puller is assembled in any other than this way serious damage will be done to the balancer.

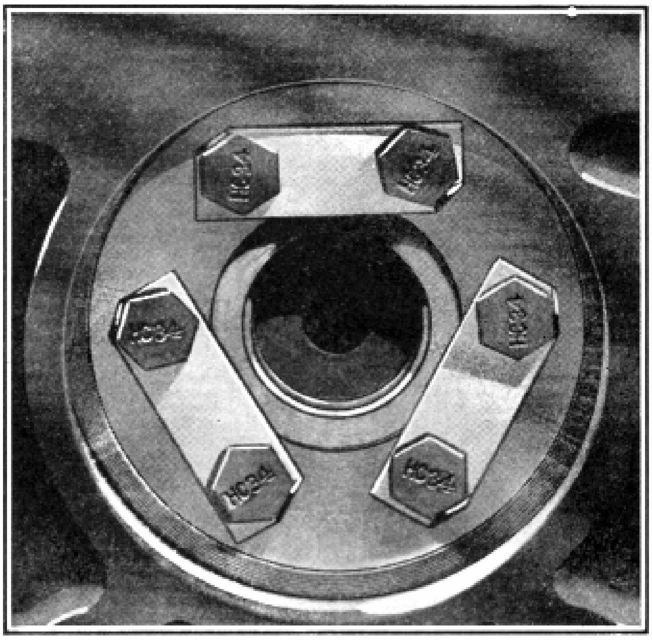


Fig.35 —Method of Locking Flywheel Bolts

FLYWHEEL

The flywheel is properly located on the crankshaft flange by three dowels and is retained by six special large head cap screws. These bolts are locked by lock plates as shown in Fig. 35.

After the flywheel has been assembled to the crankshaft, it is necessary that the face and the rim of the flywheel be checked for run-out.

This can be done with the dial indicator as shown in Fig. 36. The face and rim of the flywheel should not exceed .008″ run-out.

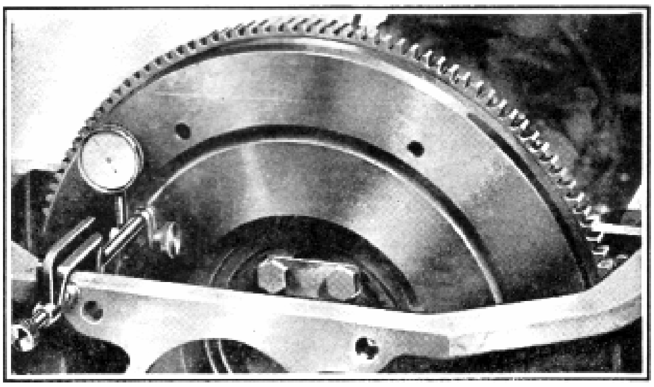


Fig. 36—Checking Flywheel Run-Out

CONNECTING RODS

The connecting rods are made of special steel, drop forged and of unusual strength. The connecting rod crankshaft bearings are of the "spun-in" type. By this is meant that the babbitt lining or bearing part is an integral part of the rod assembly. The metal is not simply poured or die cast into place. Instead, the rod and cap forgings are clamped to a special face plate which revolves at a high rate of speed. The centrifugal action set up causes the molten metal to be forced out towards the walls of the rod, and, in cooling becomes a very dense mass integral with the connecting rod.

The connecting rods are then checked for alignment and weighed as well as other important dimensions checked. The rods that pass this very careful inspection are then placed in new engines or sent out for service.

Connecting Rod Alignment

The connecting rod alignment fixture, illustrated in Fig. 37, is used to accurately check the alignment of the piston and pin with the connecting rod bearing.

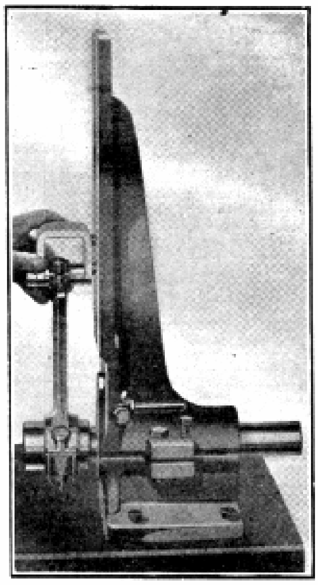


Fig. 37

Connecting Rod Alignment Fixture

The connecting rod is clamped on the arbor, as shown in the illustration, and by use of the "V" block resting against either the piston or the piston pin, the amount of misalignment will be shown between the pins on the "V" block and the face plate on the fixture.

To check the rod on this fixture, place the pin in the rod and assemble the rod and pin to the arbor on the fixture. Place the "V" block on the piston pin, and move the rod and arbor towards the face plate. The vertical pins will indicate a cocked or bent rod, by that is meant that if the two top pins rest against the face plate and the two bottom pins are away from the face plate, the rod is cocked or bent. The same is true if the two bottom pins rest against the face plate and the two top pins are away from it.

If the two horizontal pins, on the front side, rest against the face plate and the two back pins are away from it, the rod is twisted. The same is true if the two back pins rest against the face plate and the two front pins are away from the face plate.

The fixture is sufficiently strong to hold the connecting rod, if straightening is necessary, which can be done with a bending bar.

After this check has been made and the rod straightened, if necessary, so that all four pins touch the face plate, the "V" block should be placed on the piston pin so that the "V" block rests against the outside edge of the connecting rod and then the rod and "V" block is moved towards the face plate until all four pins touch. The index, on the bottom of the fixture, is then placed so that it touches the large end of the connecting rod bearing. Remove the rod from the arbor and turn it around. Assemble it again to the arbor and place the "V" block on the piston pin in the same place as when you checked the other side. Move rod and "V" block towards the face plate until either the index touches the bearing or the pins touch the face plate. If the index does not touch the rod bearing with the four pins touching the face plate, the distance between the rod bearing and the index should be checked with a feeler gauge. If this distance is more than .025″ the rod should be straightened until both the pins touch the face plate and the index touches the rod bearing, within .025″.

If the index touches the rod bearing and the four pins do not touch the face plate, the distance between the pins and the face plate should also be checked with a feeler gauge. If this distance is more than .025″ the rod should be straightened until the pins, on the "V" block, touch the face plate and the index touches the rod bearing within .025″.

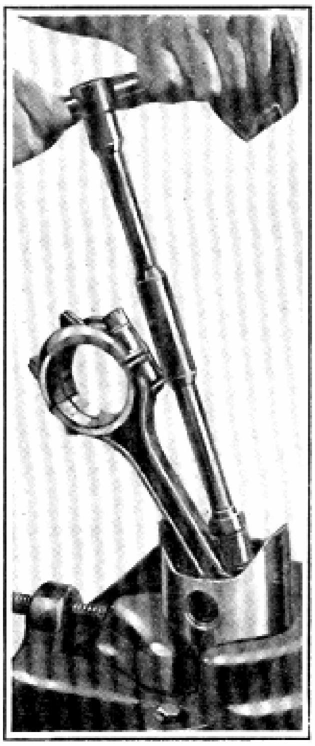


Fig. 38

Assembling Connecting Rod to Piston

Assembling Connecting Rod to Piston

Place the piston in a piston vise as shown in Fig. 38. Assemble the rod to the piston and install the pin. Before tightening the clamp screw, center the piston pin in the piston and the rod in the center of the two piston pin bosses. Tighten the clamp screw and move piston on the pin from side to side, checking to see that the piston pin does not extend over the outside of the piston.

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

Fig. 39

Checking Piston and Connecting Rod Assembly

Assemble the piston and connecting rod assembly to the alignment fixture, shown in Fig. 39, and check with the "V" block resting against the piston skirt to see that the rod and piston are in alignment.

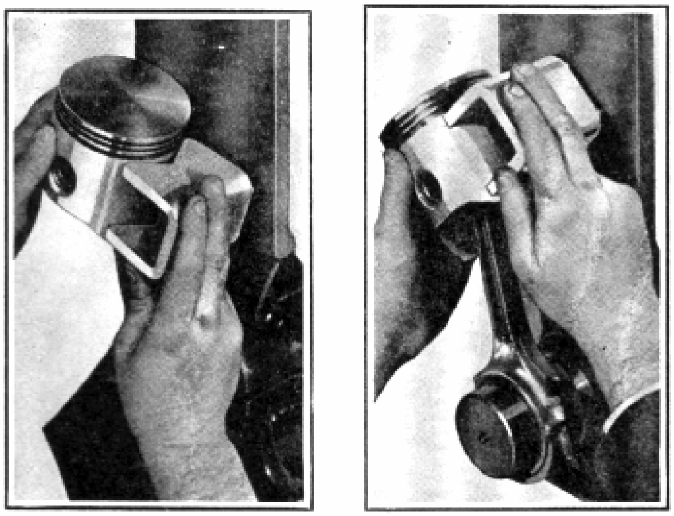


Fig. 40—Checking Piston and Connecting Rod Assembly for Twisted Connecting Rod

Both pins on the "V" block should rest against the face of the plate on the fixture. The piston should be in the same alignment as the connecting rod when this check is made.

A quick check of a piston and connecting rod assembly for both cock or twist can be made without disassembling the rod from the piston. This method saves considerable time on any repair operation that does not normally require the removal of the rod from the piston. To make this check, the connecting rod and piston assembly is mounted on the alignment fixture and the piston is set in line with the connecting rod. Then place the "V" block on the piston skirt, and if both pins on the block contact the face plate the rod is not cocked. See Fig. 39. Then, with the "V" block on the piston skirt and the pins against the face plate, tip the piston first in one direction and then in the other, Fig. 40. If the pins on the block follow the face plate, there is no twist in the connecting rod. But if one pin leaves the face plate while the piston is being tipped in one direction and the other pin leaves the face plate while the piston is in the other direction, the connecting rod is twisted and should be straightened until both pins follow the face plate.

Assembling Piston and Connecting Rod to Engine

In production, both the rod and the cap are stamped with the number of the cylinder to which they are to be assembled. The numbers are stamped on the camshaft side. When the rods are being reassembled they should be placed back into the same cylinder from which they were removed and the stamped numbers should be placed on the camshaft side.

The condition of the crank pins, on the crankshaft, should be checked when installing new rods. Damaged crankpins can only be corrected by the installation of a new shaft, as it is impossible to maintain rod bearings on a damaged crankpin.

Lubricate either the piston or the cylinder bore and slip the pistons back into the bores, using extreme care. Do not force the rings into the bore. Compress the rings with the piston inserter, J-975, and slip the assembly into the bore until the chamfer on the inserter enters the chamfer at the top of the cylinder bore. With the inserter in this position, the piston rings will readily enter the bore.

The gaps in the three rings should not be in a vertical line, neither should there be any ring gap over the piston pin, as the gases could leak by more easily at this point. Therefore, it is desirable to stagger the gaps so that they will be equally distant around the circumference of the piston.

The connecting rod should be assembled in the cylinder bore with the piston pin clamp bolt to the camshaft side of the engine.

Lubricate the cap and assemble it to the connecting rod with the number of the cylinder, which is stamped on it, toward the camshaft side and the

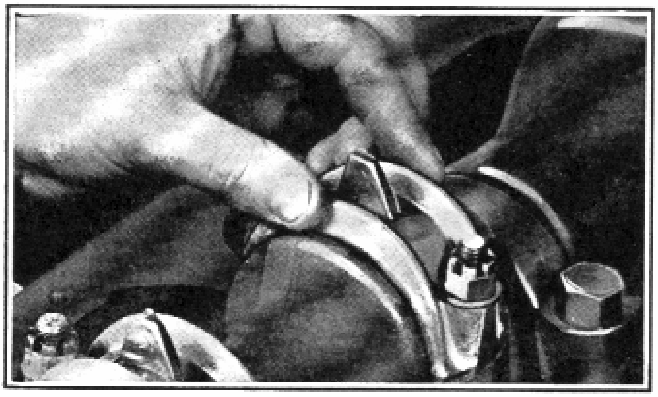


Fig. 41—Checking Connecting Rod Bearing Fit

oil hole, in the cap, away from the camshaft side. Three .002" shims should be used on each side of the cap.

The connecting rod dipper should be placed over the bolts with the mouth of the dipper toward the camshaft. Assemble and tighten the nuts.

Adjusting Connecting Rod Bearings

Remove shims, an equal number from each side of the bearing, until the rod cannot be snapped back and forth on the crank pin by hand, but can be tapped back and forth with a light blow of an 8 ounce hammer. Then replace one .002" shim, being careful to keep the number of shims on each side equal, if possible. When the bearing is properly fitted, it should be possible to snap the rod back and forth on the crank pin with one hand, Fig. 41.

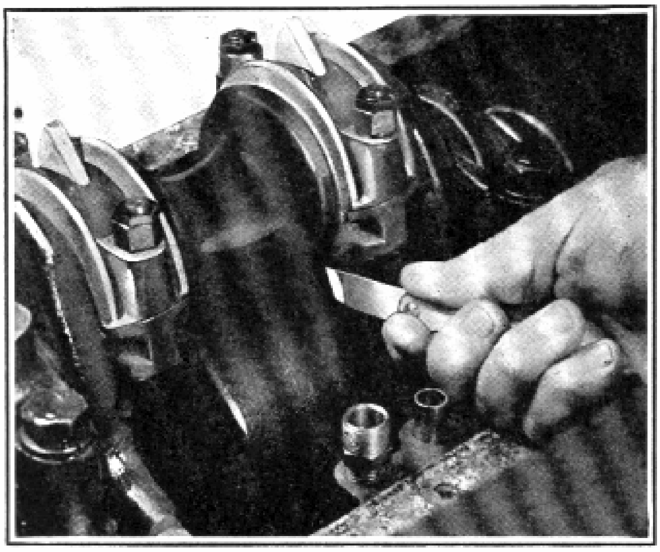


Fig. 42—Checking Connecting Rod End Clearance

If it is not possible to keep the number of shims on each side equal for all bearings, it is preferable to have the greater number of shims on the camshaft side.

Check connecting rod end clearance, using a feeler gauge. This should be from .004" to .011". Fig. 42.

Lock the connecting rod bolt nuts by installing new "pal" nuts. The "pal" nuts must be installed with the open side of the nut toward the end of the bolt. Turn the "pal" nut up finger tight and then ½ turn more.

As a final and last check to be sure that the assembly will travel true with the bore, check the clearance between the piston pin end of the connecting rod and the piston pin bosses on the piston with a feeler gauge. This should not be less than .025".

ENGINE OILING SYSTEM

Lubrication for the above series engine is supplied by a positively driven gear pump that is equipped with a spring loaded by-pass valve which controls the maximum pressure at high speeds and when the engine oil is apt to be heavy and sluggish during cold weather starting.

The engine oiling system provides positive pressure lubrication to the main bearings, camshaft bearings, and the valve rocker arm bushings.

Main and Camshaft Bearing Lubrication

The oil flow is from the pan, through the pump screen and oil pump to the block fitting pipe, and then to the oil manifold, thence through drilled passages in the bearing support webs in the cylinder block, to the four main bearings. The oil then passes through grooves in the bearings to the drilled passages in the cylinder block webs and to the camshaft bearings. In this manner full pressure feed lubrication is supplied to all main and camshaft bearings.

Timing Gear Lubrication

Lubrication for the timing gears is supplied by conducting the oil from the front camshaft bearing, through a milled slot in the back of the engine front end plate, to a drilled screw. The nozzle of this screw is so aimed that the oil stream effectively lubricates the timing gears.

Connecting Rod Bearing Lubrication

Oil for the connecting rods passes from the cylinder block fitting to the oil manifold, through a drilled passage in the cylinder block and to the oil distributor. As the oil pressure builds up, the oil distributor valve opens and releases the oil into a drilled passage in the block, this passage connecting with the short pipe that fits into the main supply pipe in the oil pan. From the main supply pipe the oil passes to the oil manifold in the oil pan, where it is distributed to the six oil nozzle pipes.

The six oil troughs in the oil pan are adjusted to the proper height so that the connecting rod dippers will dip into the oil and supply lubrication for the lower speeds.

As the engine speed is increased and the oil pressure is built up, the oil streams from the nozzles rise, and are intercepted by the dippers, forcing

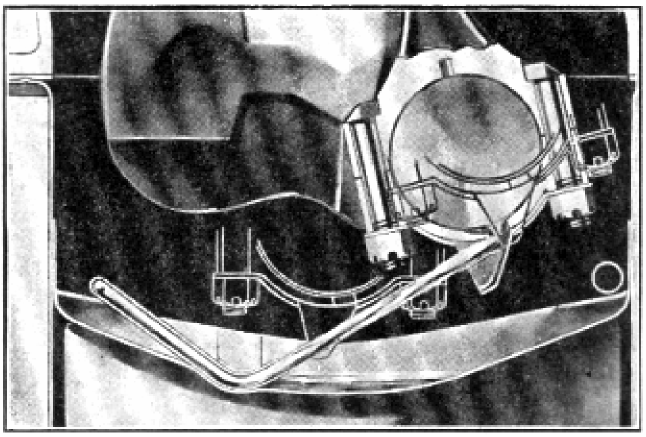


Fig. 43—Connecting Rod Bearing Lubrication

the oil into the connecting rod bearings under high pressure, Fig. 43. The cylinder walls, pistons, and piston pins are lubricated by the oil spray thrown off by the connecting rods.

Valve Mechanism Lubrication

Oil for lubrication of the valve mechanism is tapped off at the oil manifold and is carried by a pipe which passes through the water jacket to a fitting between the two hollow rocker arm shafts where it is distributed to all rocker arm bushings. A bleeder hole in each rocker arm supplies oil for lubrication of the valve stems and push rod sockets.

SERVICING THE OILING SYSTEM

Proper functioning of the oiling system is dependent upon the proper adjustment of connecting rod dippers, oil troughs, and oil nozzles.

IT IS VERY IMPORTANT THAT THESE ADJUSTMENTS BE CHECKED AND ADJUSTED EVERY TIME AN OIL PAN IS REMOVED.

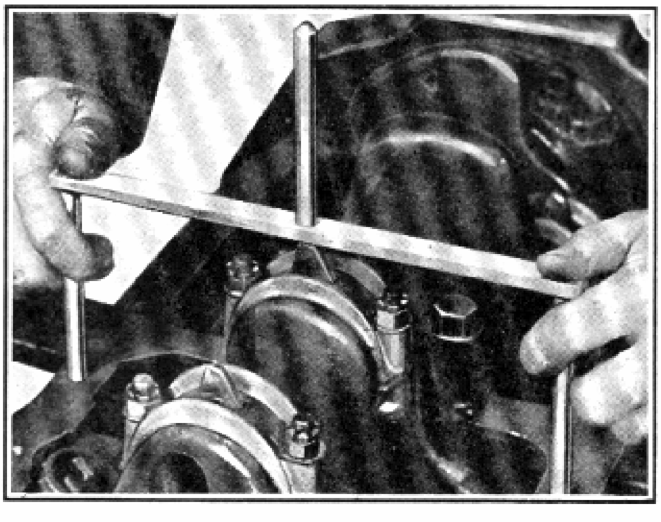


Fig. 44—Checking Connecting Rod Dipper Height

Connecting Rod Dippers

The height of the connecting rod dippers is very important to insure proper lubrication of connecting rod bearings.

The oil trough depth and connecting rod dipper height gauge, J-969-2, is used to check the height of the dipper from the machined surface of the crankcase. With the two side pins of the gauge resting on the crankcase flange, Fig. 44, the end of the dipper should just touch the bottom of the cross bar on the gauge.

If the dipper is lower than the gauge, a new dipper must be installed.

If the dipper is higher than the gauge, it may be bent down to the correct position.

NOTE—The oil pan gasket must be removed during this operation.

Checking the Oil Pan

To check the oil pan proceed as follows:

1. Check the oil nozzle height for connecting rod dipper clearance, using the oil nozzle depth gauge, J-969-3, Fig. 45. Remove the oil pan gasket and hook the edge of the gauge over the pan rail, with the side of the gauge marked "FRONT" toward the front of the oil pan.

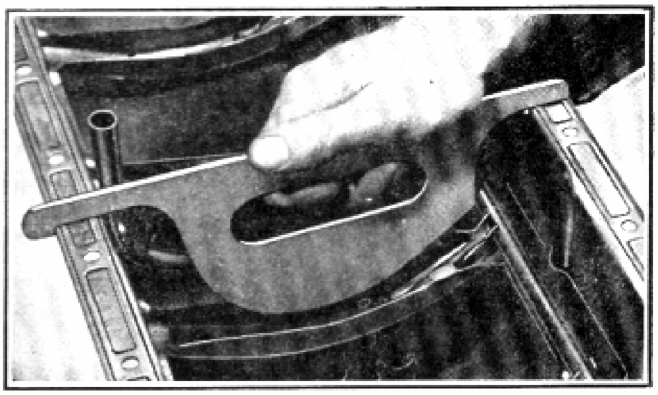


Fig. 45—Checking Oil Nozzle Height

   With the gauge resting flat on the pan, move it from one oil trough to the other, making sure that the open end of each nozzle is below the gauge.

2. Check the oil trough height with the oil trough depth gauge, J-969-2, by placing the bar of the gauge on the pan rail. The stem of the gauge should just touch the edge of each of the six oil troughs, Fig. 46.

3. To check the aiming of the oil nozzles, install the oil pan target gauge, J-969-1, on the oil pan by locating the dowels of the gauge in the screw holes in the oil pan. Insert the water nozzle, J-793-3, in the main oil pipe. Tip the oil pan about 45 degrees to prevent the water from covering the ends of the nozzles. Open the water nozzle just enough to straighten the

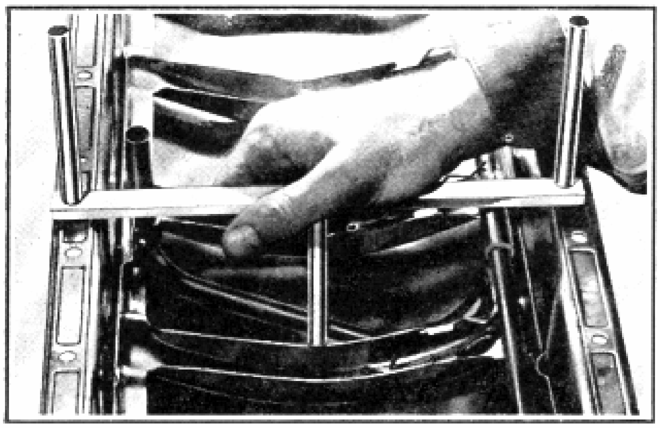


Fig. 46—Checking Oil Trough Depth

water streams. If the oil nozzles are properly adjusted, the water streams will pass through the centers of the target holes. Both the correct and incorrect aiming of the water nozzles is shown in Fig. 47.

The oil nozzles may be adjusted by using the oil nozzle wrench, J-793-2, as shown in Fig. 48 Continue adjusting and checking the oil nozzles until each water stream passes through the center of its target hole.

4. Re-check the oil nozzle height with the oil nozzle depth gauge, J-969-3. This is important because the oil nozzle height may be upset during the adjustment of the aiming.

OIL PUMP ASSEMBLY

The oil pump is a positive gear type. It consists of two spur gears enclosed in a one-piece housing, and is provided with a relief valve to control maximum oil pressure. In operation, oil

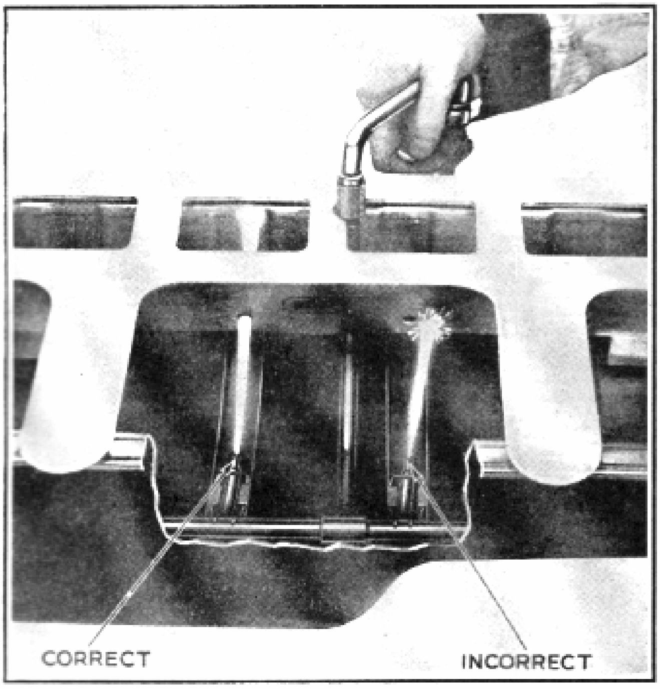


Fig. 47—Checking Aim of Oil Nozzles

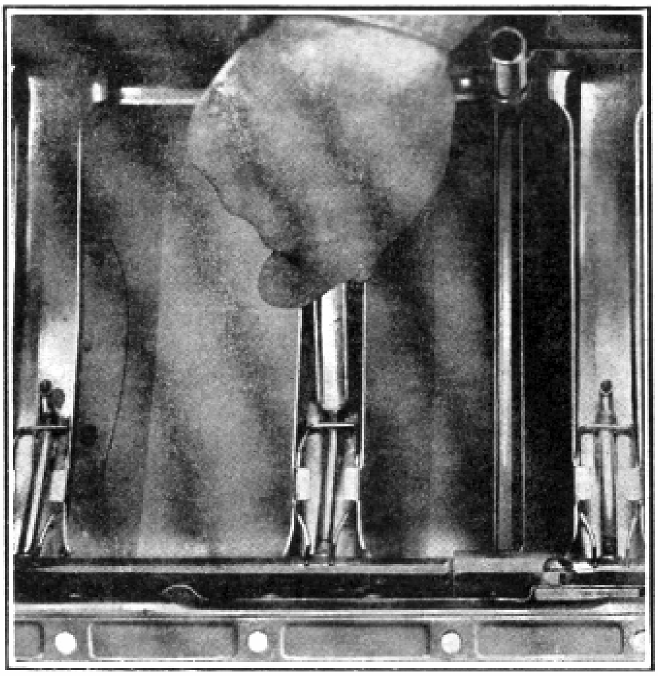


Fig. 48—Adjusting Aim of Nozzles

is drawn from the crankcase through a fine mesh screen which is mounted on the rear intermediate bearing. The oil then passes through a pipe to the oil pump, from which is passes to the oil distribution system as previously described.

To disassemble the oil pump remove the cover screws and cover. Then remove the drive gear and shaft and the idler gear.

The fit of the shaft should be checked in the pump housing. Also check the spur gears for wear. If the pump parts are badly worn it is good policy to replace the oil pump assembly. Fig. 49.

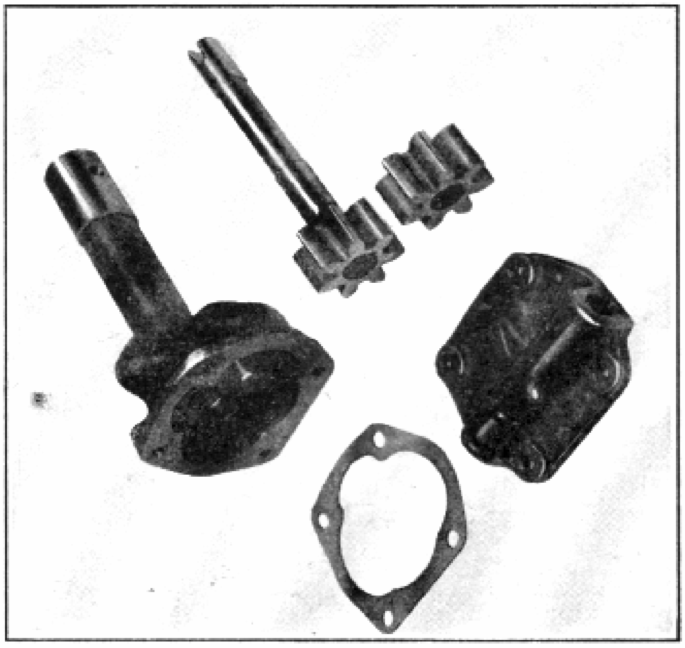


Fig. 49—Oil Pump Parts

When reassembling an oil pump make sure that the ground side of the idler gear is toward the cover. It is also important that only a Genuine Gasket be used as this gasket controls the clearance in the pump.

When securing the oil pump assembly to the cylinder block, be sure that the tapered oil pump set screw is fully seated in the tapered hole located in the neck of the oil pump housing, then lock the set screw with the lock nut.

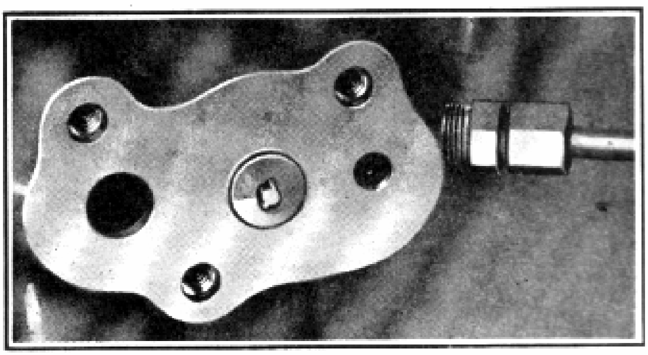


Fig. 50—Oil Distributor Mounting

OIL DISTRIBUTOR

The Oil Distributor Valve Assembly is mounted in the side of the cylinder block as shown in Fig. 50. When assembling the oil distributor valve assembly a cork gasket must be installed between the valve assembly and the block, and then another cork gasket between the valve assembly and the oil distributor cover.

NOTE—Care must be used not to get these gaskets mixed. The gasket indicated by the number "I" in Fig. 52 must be assembled between the valve and the block and gasket numbered "2" between the valve and cover.

Oil Distributor to Rocker Arm Pipe

The pipe leading from the oil distributor to the rocker arm shaft passes directly through the water

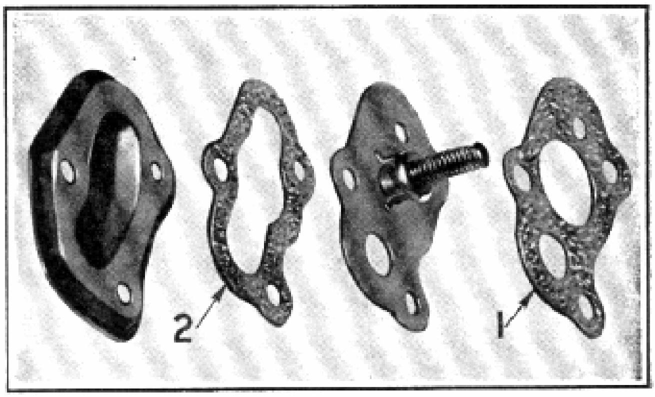


Fig. 51—Oil Distributor Parts

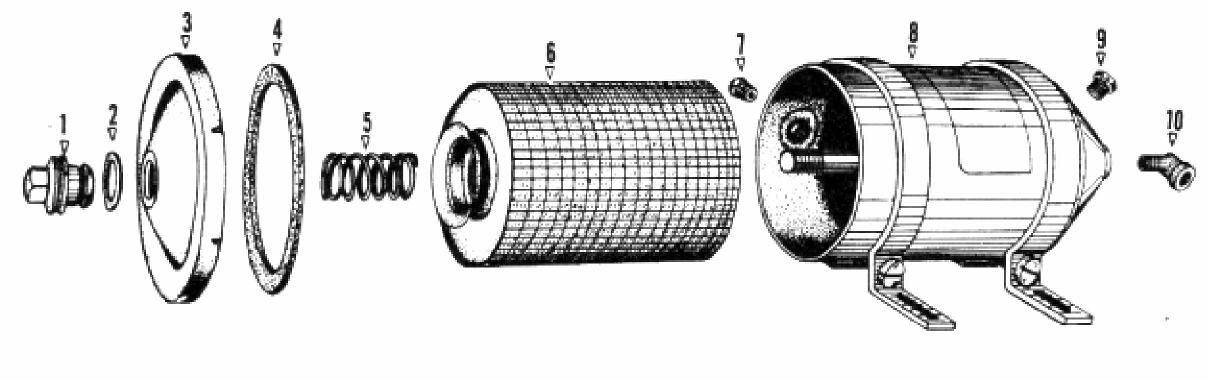
jacket of the cylinder block. This construction serves to stabilize the oil temperature.

If the oil distributor to valve rocker oil pipe is removed for any reason, it must be discarded and a new nipple and pipe assembly, Part No. 839186, installed according to the following instructions:

Coat the threads of the nipple with white lead, thread the pipe through the block and screw the nipple securely into the block. Install nipple and sleeve nut at the lower end of pipe, on left side of block, coating threads of nipple with white lead and tighten securely. Make bend in lower end of pipe and connect to fitting at oil distributor location. Bend pipe on right side of block so as to clear the push rod cover. Then bend the upper portion of pipe to pass through the hole in the cylinder head. Connect the pipe to the valve rocker shaft coupling. Fill the cooling system with water, start the engine and check all connections for both oil and water leaks.

OIL FILTER

The oiling system of these vehicles are equipped with an oil filter (Fig. 52) as a further means of keeping the oil being pumped to the bearing surfaces of the engine from becoming contaminated.



1. Oil Filter Cover Nut
2. Cover Nut Gasket
3. Filter Cover
4. Filter Cover Gasket
5. Oil Filter Spring
6. Oil Filter Element
7. Inlet Fitting
8. Oil Filter Body
9. Drain Plug
10. Outlet Fitting

Fig. 52—Oil Filter Parts

The inlet line to the filter is connected to the oil pressure gauge fitting, this fitting taps the oil manifold which extends the full length of the cylinder block. The return line from the filter is connected with the drilled passage from the oil distributor valve. This passage connects with the oil manifold in the oil pan which feeds the oil nozzles for the connecting rods.

The drain plug on the bottom of the filter should be removed periodically to drain off any water or sludge deposit trapped in the filter.

Operation:

Unfiltered oil from the crankcase enters the filter through the inlet and flows into the space between the case and the filter element. The oil is then forced through the "Igneonite" filtering element into the collector tube into the annular passage which connects with the outlet fitting and is returned to the crankcase.

Maintenance:

Oil filter element changing periods are directly related to oil changing periods, type and quality of oil used, severity of and the type of engine operation. Therefore, it is impossible to recommend a definite mileage period that will meet all types of service.

In view of the foregoing it is recommended that frequent inspections be made of oil to determine advisable intervals between engine oil and oil filter element changes. In some types of service, where operating conditions are severe, laboratory tests of oil drained from engine conducted by the oil supplier, or by another suitable means, may be helpful in determining greatest advisable intervals between oil and oil filter element changes for your operation.

NOTE:—Use only Genuine Element when Replacement is Necessary

Solid matter and water settle to the sump in the bottom of the filter. If the filter is drained completely, as when the element is renewed, add sufficient oil to the crankcase to bring the oil to the correct level. About one quart of oil remains in the filter.

While the oil filter will adequately remove dust and dirt entering the oil stream, the element must be renewed whenever clogged with these substances, regardless of mileage. Vehicles operating in dusty areas require renewals more often than those which do not encounter such conditions.

To replace the element, remove the top cover and remove the old element. Remove the drain plug and drain the basin in the bottom of filter. Install a new filter element and replace the cover and drain plug.

Changing Oil:

When placing a new or overhauled engine in operation, it is recommended that oil be changed at 500 mile intervals for the first 2,000 miles of service. Thereafter, regular oil changing periods are dependent upon the type of service to which engines are subjected. Periodic inspection of the condition of oil should be made, and oil changed whenever it is thin or dirty regardless of mileage. Oil should be maintained at proper level at all times. Determine level of oil with the dip-stick at the side of the oil pan.

When the engine oil is changed at the same time the filter element is replaced, it is necessary to use 5½ quarts of oil for the crankcase oil refill in order to have the oil up to the "full" mark on the oil level gauge after the filter has become filled and the element saturated.

CYLINDER HEAD ASSEMBLY

One of the most important units of any overhead valve engine is the cylinder head. It contains not only the combustion chambers and spark plugs, but the valves, inlets ports, exhaust ports and the necessary water passages to maintain the proper temperature of these important parts.

The Blue Flame cylinder head, provides for larger valves and higher compression ratio without detonation. The valves are so located that they permit the incoming charge of fuel mixture to enter the combustion chamber, do its work, and leave the chamber after its work is done, without restriction, making use of the volume of mixture efficiently with the least possible disturbance.

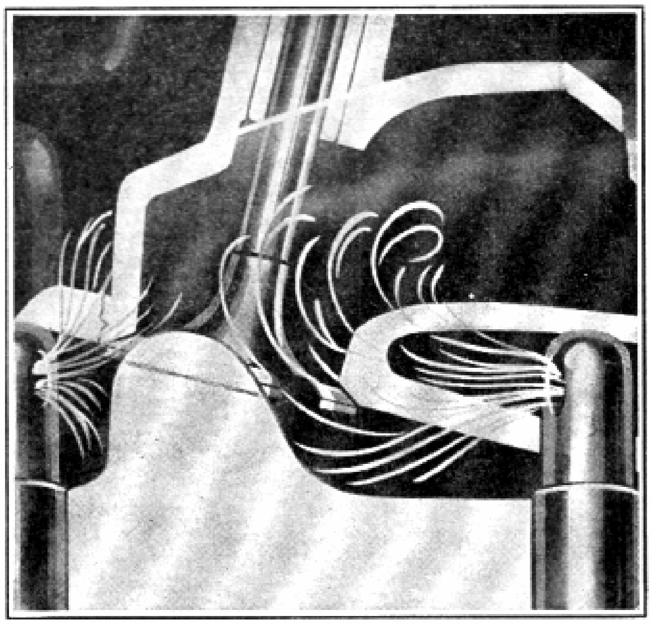


Fig. 53—Cylinder Head Water Nozzles

This type cylinder head also has the results of many years' experience in providing ample water space around the valves and spark plugs in addition to a means for most effective distribution of water. The coldest water is taken into the cylinder head and directed toward the valve seats by means of eight small copper nozzles which are pressed into the lower part of the head. There are two kinds of these nozzles—one with a single opening which is used to direct a single stream of water to the single exhaust valves at the end cylinders and the other with two openings which direct two streams of water to the other exhaust valves. See Fig. 53.

GRINDING VALVES

There is no operation, in the maintenance of an automobile that is more important than the valve grinding operation from the standpoint of engine economy and performance.

Extreme care should therefore be used whenever valves are ground to maintain factory limits and clearances, as only by maintaining these limits and clearances can one expect to get good engine economy and performance.

Cylinder Head Holding Fixture

The valve heads set down in pockets in the cylinder head, and this construction necessitates the use of a cylinder head holding fixture combined with a valve spring compressor, see Fig. 54, for the removal of valve springs and the grinding of valves.

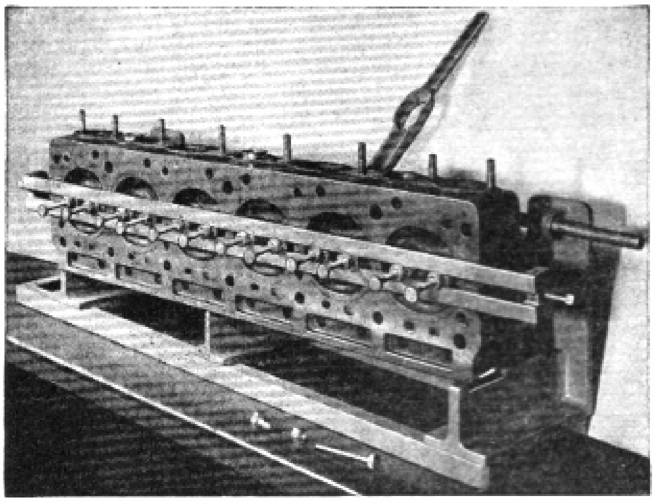


Fig. 54—Cylinder Head Holding Fixture

After the cylinder head has been removed from the engine, and all of the parts disassembled from it, all carbon should be thoroughly cleaned from the combustion chamber, valve ports and guides, and the head thoroughly washed.

Valve Guides

The clearance between the valve guides and the valve stems is very important. Lack of power and noisy valves, in many instances, can be traced to worn valve guides.

The intake valve guides should be checked with a new intake valve and the exhaust valve guides should be checked with a new exhaust valve, because the diameters of the stems are different on these parts.

The exhaust valve guide is designed to bring the inner end of the guide flush with the inside of the valve port. With this design the heat dissipating properties are increased and aids in eliminating valve sticking.

The clearances that must be maintained between the intake valve stem and their guides is .001" to .003" and the clearance between the exhaust valve stems and their guides is .002" to .004".

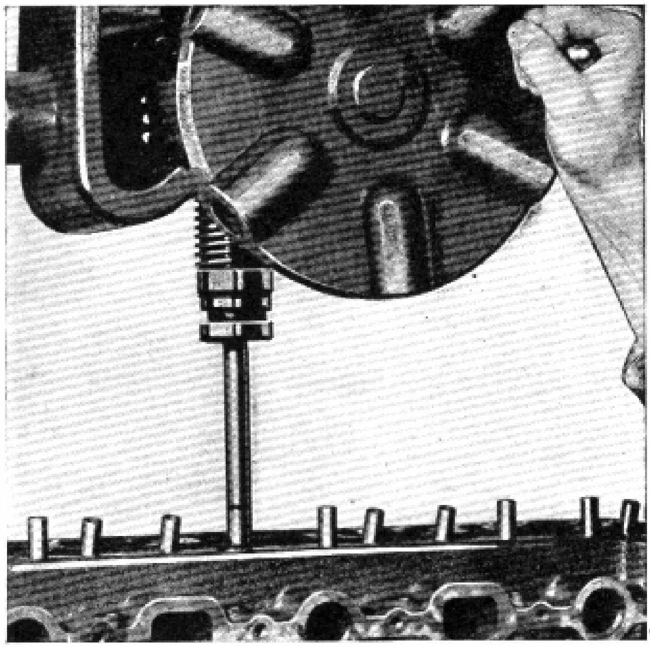


Fig. 55—Removing Valve Guide

Quite naturally, if the valve guides are worn, they should be replaced. To remove them from the cylinder head, the driver shown in Fig. 55, must be used. The cylinder head is placed in an arbor press and the guide pressed from it, using this tool.

The valve guides do not have a shoulder to determine the distance they should be pressed into the cylinder head. The intake guides should extend above the cylinder head 1 1/16" while the exhaust guide extends above the head 61/64". These dimensions are very important. See Fig. 56.

To simplify this operation and make sure the valve guides are pressed in the proper distance, two valve guide drivers are available. These drivers have stop collars on the driver body to automatically stop the guides at the proper height.

After the guides have been pressed into the cylinder head, they should be rough reamed with a .341" reamer and then finish reamed with a .343" reamer.

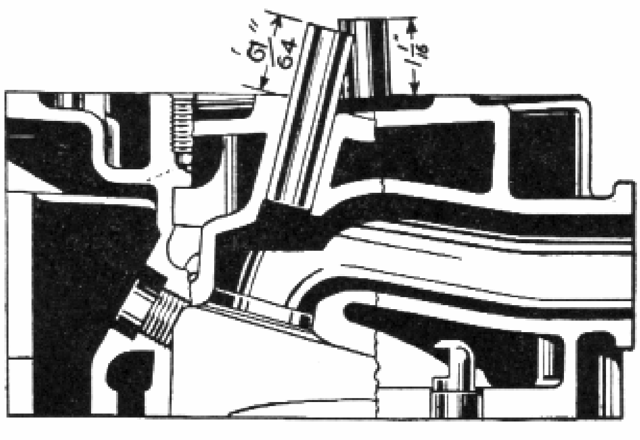


Fig. 56—Valve Guides

Reseating Cylinder Head

Reconditioning of the valve seats on modern high compression engines is becoming more and more important, because the seating of the valves must be in perfect condition in order for the engine to deliver the power and performance that has been built into it.

Another important factor is the cooling of the valve heads, good contact between the valve and its seat is imperative if the heat in the valve head is to be properly dissipated.

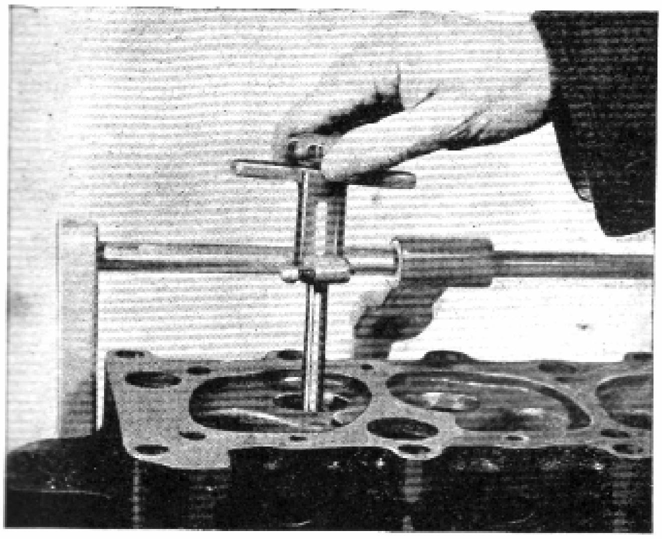


Fig. 57—Installing Expanding Pilot

We are recommending the use of a grinder of the eccentric type for the reconditioning of valve seats, the use of which we will describe in the following paragraphs.

Before attempting to grind any seat, clean carbon thoroughly from the valve port, wipe seat with gasoline, cleaning it of any grease or foreign matter. Great care should be taken to clean the guide with a wire brush and make sure it is free from carbon and dirt. These precautions permit proper centering of the pilot in the guide.

Install the expanding pilot in the guide, using the special handling wrench; expand the pilot with the knurled knob on the top of the wrench, Fig. 57, and remove the handling wrench.

Dressing the Grinding Wheel

The grinding wheel should be dressed before commencing any valve regrind job. Set the grinder over the two top pilots of the dresser stand. When the grinder is seated on these pilots, the wheel will pass over the stud projecting through "A" and the grinder will be in position ready to dress the wheel, Fig. 58. Set the diamond dressing tool at the proper angle. Turn on the switch and dress the grinding wheel.

NOTE—Never let the grinding wheel become glazed or loaded, as it will not grind freely and do accurate work.

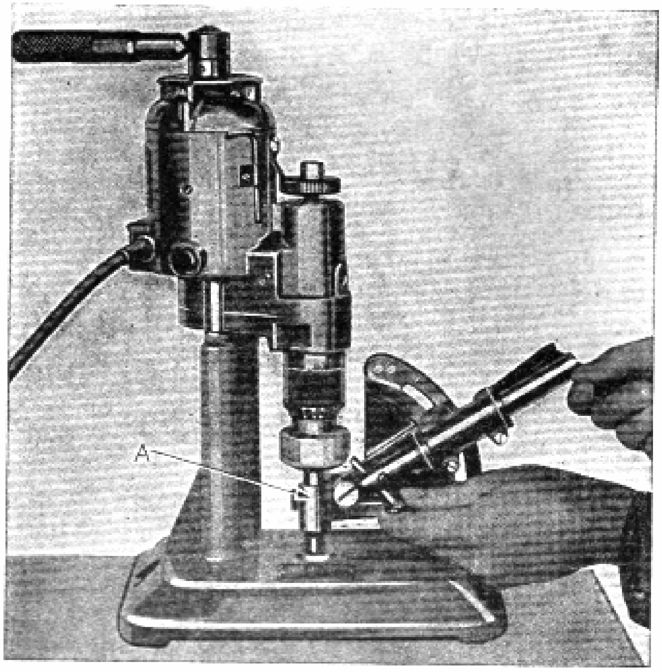


Fig. 58—Dressing Valve Seat Grinder

Place the grinder over the expanding pilot, then loosen the Allen set screw "B", and push down the adjusting rod "C" against the top of the pilot, Fig. 59. Then lock the set screw "B" tightly.

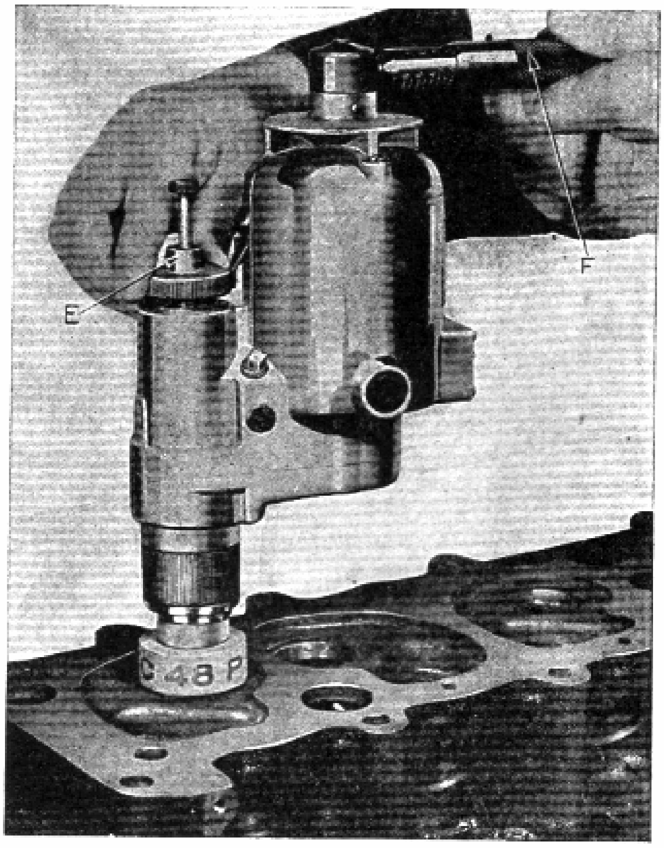


Fig. 59—Grinding Valve Seat

Turn the feed screw "E" to the right until the grinding wheel just clears the seat. Balance the grinder with the compensating handle "F", Fig. 60. Start the motor and feed the grinding wheel into the seat by turning the feed screw "E" to the left one notch at a time until the wheel is grinding all round the face of the valve seat. Before shutting off the grinder, stop feeding the wheel into the seat and give it time to grind itself free. Turn off the switch and allow the grinder to come to a stop before lifting it from the pilot.

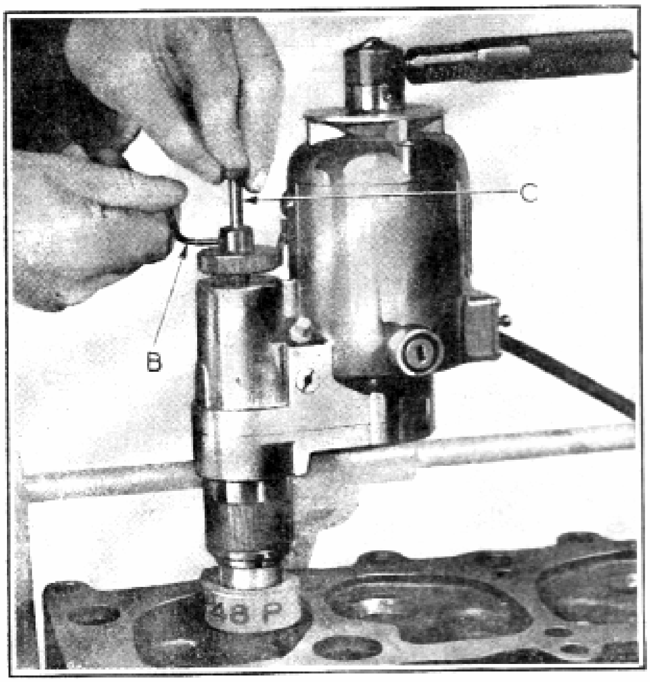


Fig. 60—Setting Adjusting Rod

Mount the valve seat dial indicator on the stationary pilot, set the indicator at zero and turn the sleeve of the indicator with thumb and finger. When the seat is properly ground, the indicator reading will be within .001", Fig. 61.

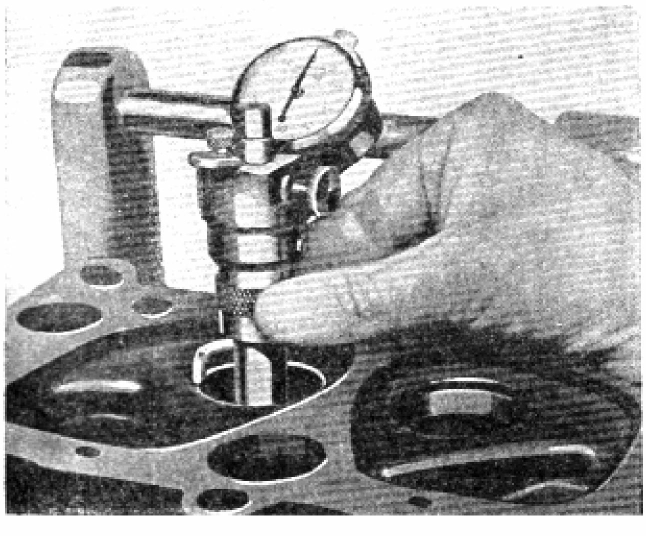


Fig. 61—Indicating Valve Seat

The valve seat may now be ground to the proper width, using a 20 degree grinding wheel on top and a 70 degree grinding wheel in the port. Good judgment must be used when narrowing a valve seat to make sure the seat contacts the center of the valve. The width of the intake valve seat should be from 3/64" to 1/16" and the exhaust valve seat from 1/16" to 3/32". This is very important because the life of a valve grind job depends to a great extent upon the width of the valve and seat contact.

If the valve is too narrow, heat cannot be dissipated from the valve head fast enough. If the valve seat is too wide, carbon particles can be readily caught between the valve and seat causing blow-by, that will soon burn both the valve and the seat.

VALVES

When valves are removed, the valve stems and heads should be cleaned on a buffing wheel to remove all carbon and other foreign matter.

The condition of the valves and valve stems can then be checked.

Refacing Valves

Valves that are pitted or burred can be refaced to the proper angle, insuring the correct relation between the head and the stem, on the valve facing machine shown in Fig. 62.

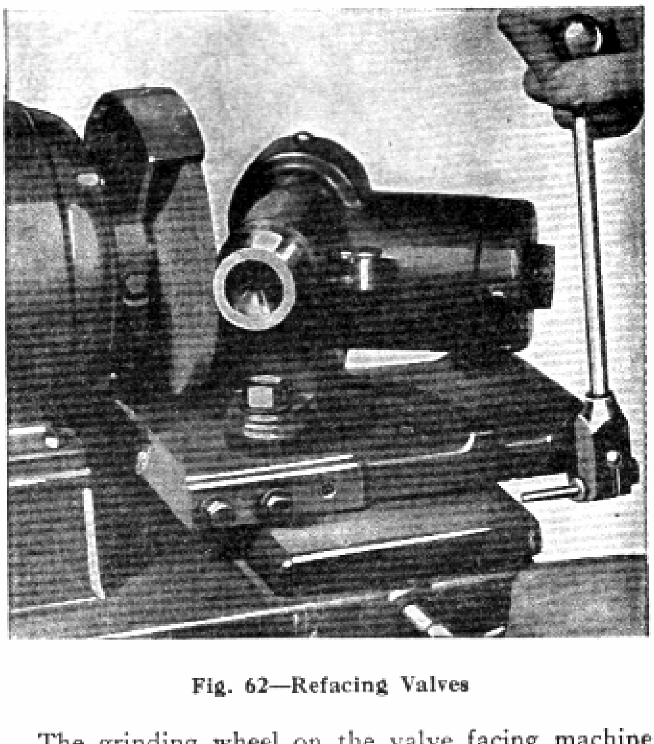


Fig. 62—Refacing Valves

The grinding wheel on the valve facing machine should be properly dressed to be sure that it is true and smooth. The valve stem is then placed in the chuck and passed across the face of the grinding wheel until the valve face is true and smooth. Care should be taken, in grinding, to prevent removing too much stock from the angle of the valve. This is important to prevent burning of valves.

For quiet operation, it is important that the end of the valve stem be free from pits. The valve should be placed in the "V" block, on the facing machine, and the end of the valve stem ground until it is true and smooth.

To test for perfect contact, mark lines with a lead pencil about ¼" apart on the beveled edge of the valve head or apply a little Prussian Blue and replace the valve.

Give the valve one-half turn to the right and one-half turn to the left, using a little extra pressure on the valve. If all the marks are removed the grinding is perfect. If, on the other hand part of the marking remains untouched, this fact indicates an uneven spot, and the valve must be reground until it seats properly.

Before replacing the valves in the cylinder head, clean the valves and the cylinder head. A good valve job is frequently ruined by failure to properly clean all of the parts.

Valve Lifters and Push Rods

The Valve Lifters in the above series are made in two parts. The lower part of the lifter is machined from a casting, the bottom of which is chilled during the casting operation to produce a hard wearing surface. The upper part of the lifter which incorporates the push rod seat is machined and hardened to produce a smooth, long-wearing seat. The lifter unit is completed by brazing the steel seat into the cast part of the lifter. Fig. 63 shows the construction of the lifter in cross section.

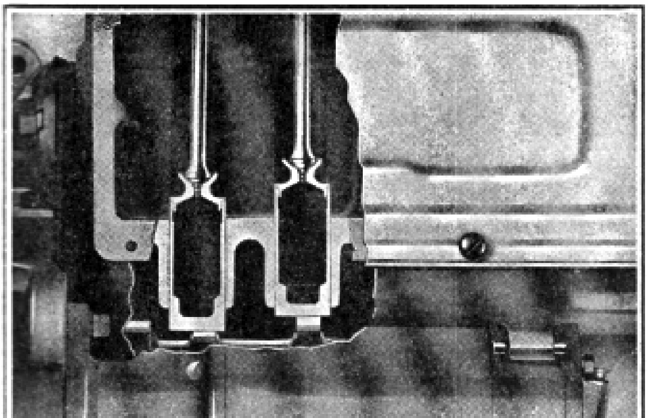


Fig. 63—Valve Lifters

The Push Rods are made from a solid piece of steel with the two ends forged to form the contacts with the lifter and rocker arm adjusting screw. These ends are carefully machined and hardened to produce a smooth hard surface that will give thousands of miles of service with the minimum amount of wear.

When assembling the valve lifter to the engine, it should be a free fit, and the end that contacts the camshaft should be smooth. If the end shows signs of wear or roughness it is good practice to replace it.

Valve Springs

The valve springs are made from a special analysis steel wire. They are accurately coiled, and, after being made, each spring is checked to be sure that it comes within the limits for tension. Any springs that fail to pass this inspection are immediately scrapped.

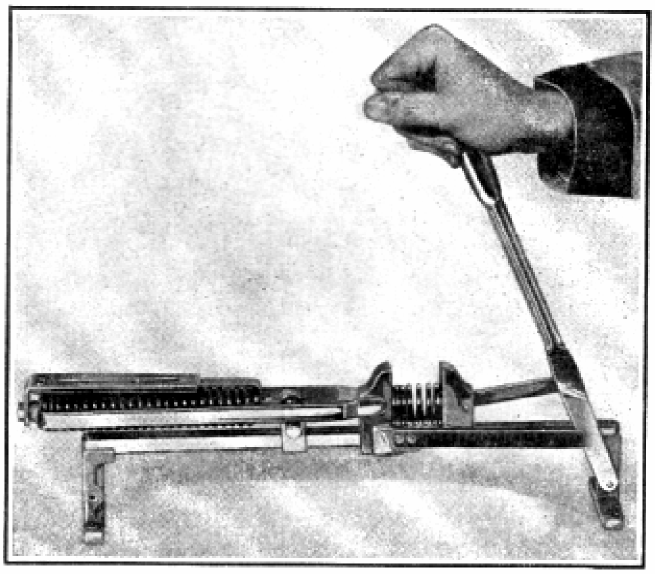


Fig. 64—Spring Tension Gauge

Weak valve springs affect the economy and power of the engine; therefore, each time the valves of an engine are ground, the valve springs should be checked to be sure they have not been weakened from the heat of the engine. This can easily be done by placing the valve spring in the Valve Spring

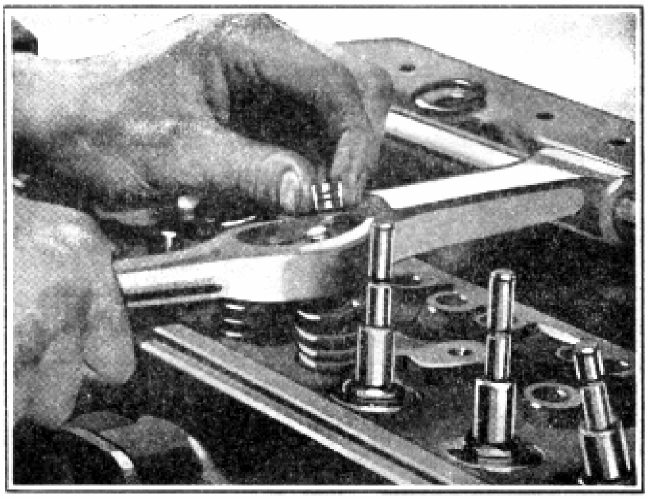


Fig. 65—Valve Spring Compressor

Tester—U15 (Fig. 64) and compressing it to a length of 1½". At this length the spring tension should be from 125 to 133 pounds. Any springs that do not test within these limits should be replaced with new genuine GM Valve Springs.

The valve spring is retained to the valve with a cap and a key. It is necessary to compress the spring with the spring compressor shown in Fig. 65, which is a part of the cylinder head holding fixture, far enough to allow the keys to be inserted in the valve stem.

The valve springs are assembled with the close coiled end towards the cylinder head.

NOTE—The round valve caps must be installed on the intake valves and the hexagonal caps on the exhaust valves.

INSTALLING CYLINDER HEAD ASSEMBLY

It is good practice to install a new cylinder head gasket each time the cylinder head is removed.

CAUTION—The cylinder head gasket must be installed with the side marked "This side up" on top, Fig. 66.

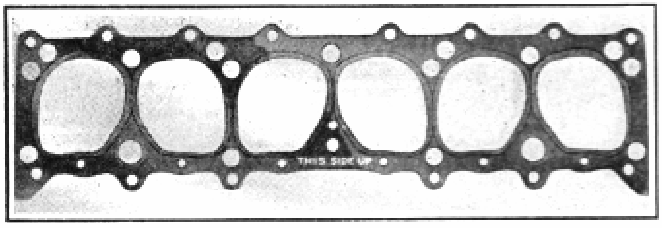


Fig. 66—Cylinder Head Gasket

To properly align the cylinder head to the cylinder block and keep the cylinder head gasket in place and free from damage, cylinder head guide pins should be used. They screw into the cylinder block at the front and rear holes on the manifold side and guide the head into position.

After the head has been properly aligned, insert and tighten the cylinder head bolts with a wrench, tightening each one evenly a little at a time in the order shown in the cylinder head bolt tightening diagram, Fig. 67. The order in which the bolts are tightened is important, as many water leaks between the cylinders are caused by other than this method.

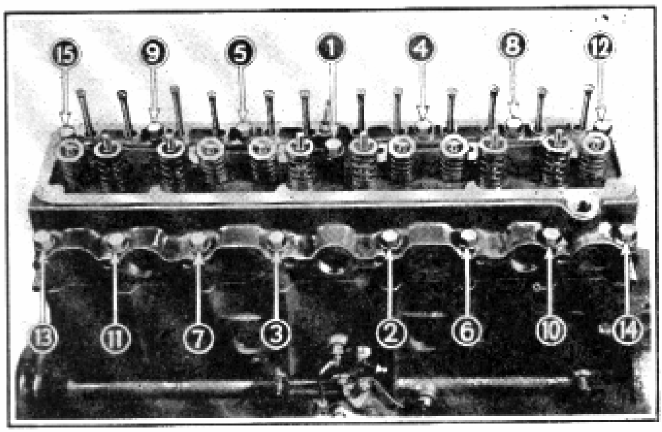


Fig. 67—Cylinder Head Bolt Tightening Diagram

When torque wrenches are used to tighten cylinder head bolts to secure uniform tension on all bolts, the recommended tension is from 75 to 80 foot pounds.

ROCKER ARMS AND SHAFTS

There are three different rocker arms used in this new improved engine. One for the exhaust valves and two for the intake valves. These two different arms for the intake valves have right and left hand angles. Right hand angle intake rocker arms are assembled to cylinders number 1, 3, and 5. Left hand angle intake arms are assembled to cylinders number 2, 4, and 6. Neither of these parts are interchangeable one with the other. They must be assembled as shown in Fig. 68.

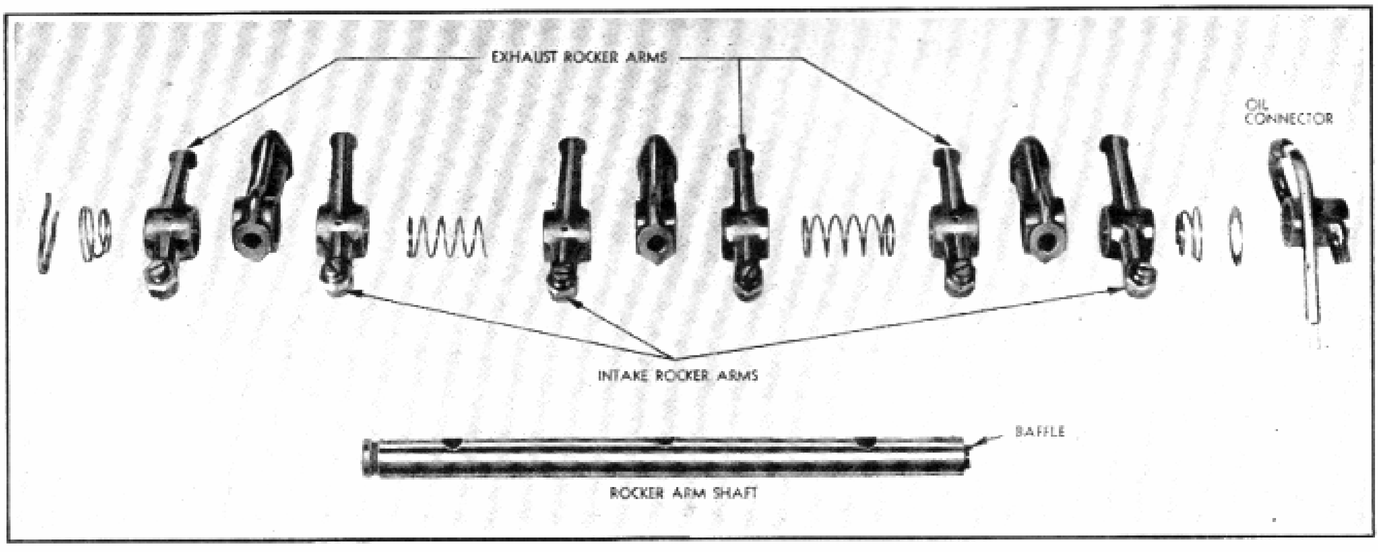


Fig. 68—Rocker Arm and Shaft

The rocker arms supplied through the Parts Department come with the bushings installed and diamond bored ready for assembly. Worn rocker arm bushings necessitate the replacement of the rocker arms.

The rocker arm shafts are hollow and have holes drilled in them to allow oil to pass into the rocker arm bushings. Worn rocker arms shafts should be replaced.

The rocker arms, springs and shaft supports are assembled to the rocker arm shafts and locked in place with hair pin springs, in the order shown in Fig. 68.

One end of these shafts is plugged and they must be installed to the cylinder head with the open ends to the center. A stamped steel baffle is pressed into the open end of the rear rocker arm shaft. This baffle must be installed in the vertical plane. The rocker arm shafts are connected for oil feed at the center by the brass oil connector which slips over the end of each shaft. Therefore, when removing or replacing the rocker assemblies they must be handled as one unit.

VALVE ADJUSTMENT PROCEDURE

Before adjusting Valve Clearance, the engine must be thoroughly warmed up to normalize the expansion of all parts and stabilize the oil temperature. This is very important because during the warm-up period, the valve clearance varies considerably.

Tests have shown that during the warm-up period, when starting with a cold engine and running idle, the following variations in valve clearance take place until the engine is normalized. These tests were made with the valve clearance adjusted at a base setting of—Intake .006″ and Exhaust .013″.

Time Minutes	Valve Clearance Change		Oil Temperature	Water Temperature
	Intake	Exhaust	Degrees F.	Degrees F.
0	.006″	.013″	70°	70°
3	.009″	.010″	95°	125°
5	.011″	.012″	115°	155°
10	.010″	.012″	160°	185°
15	.0075″	.0095″	180°	185°
20	.0065″	.008″	190°	185°
25	.006″	.012″	185°	185°
30	.006″	.013″	185°	185°

Covering the radiator with a blanket will not materially hasten this process because, even with the water temperature quickly raised to 185°, it does not change the rate at which the oil temperature increases.

The actual temperature of the oil is not as important as the stabilization of the oil temperature. The expansion or contraction of the valves, rocker arm supports, push rods, cylinder head and cylinder block are relative to this oil temperature. Hence, after the oil temperature is stabilized, these parts have stopped expanding and no valve adjustment change takes place as shown in the above table.

In order to obtain correct performance of the engine, it is essential that correct valve clearance exists.

Valve clearance is adjustable by means of adjusting screws on the rocker arms. It is very important, when checking this clearance, that the engine be at road operating temperature. In other words; the engine should have been running for at least half an hour and should have been operated on the road for a mile or two, so that the engine heat will be normalized before the adjustment is checked.

When the correct operating temperature has been established, adjust the valves with the engine running.

Intake Valves	.010″
Exhaust Valves	.020″

Engine performance, to a great extent, will depend on the above adjustments being correct. When quietness of operation is desired and the vehicle is not to be used in high engine speed service or heavy going, the Exhaust Valves may be adjusted to .015″.

VALVE TIMING

The valve timing is illustrated in Fig. 69. The reader will note that the inlet valve starts to open 3 degrees before upper dead center and continues open for 218 degrees, closing 35 degrees past lower dead center.

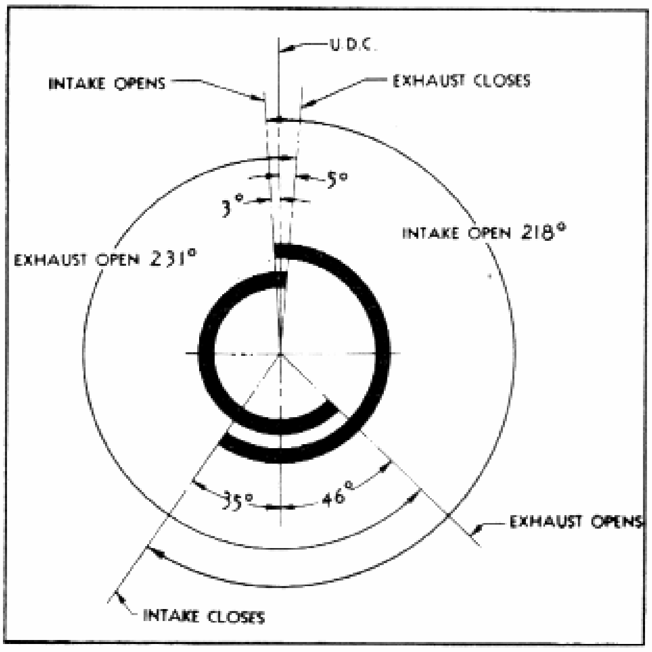


Fig. 69—Valve Timing

The exhaust valve starts to open 46 degrees before lower dead center and continues open for 231 degrees, closing 5 degrees past upper dead center.

To check the valve timing use Number 1 cylinder exhaust valve.

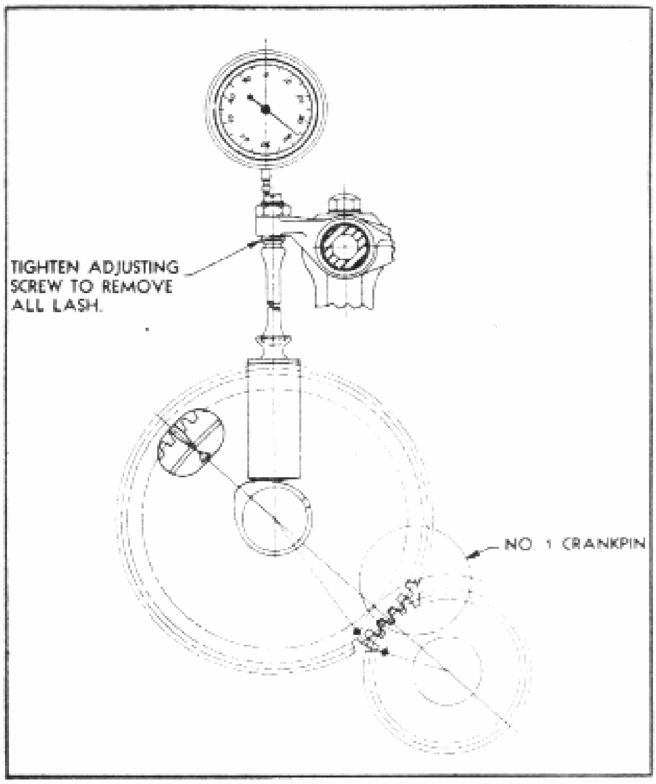


Fig. 70—Checking Valve Timing

1. Tighten the adjusting screw to just remove all tappet clearance.
2. Hand crank the engine until the Number 1 cylinder exhaust valve starts to close. Continue cranking the engine until the triangular mark on the flywheel lines up with the pointer in the flywheel housing.
3. Mount a dial gauge on the rocker arm shaft support with the spindle of the indicator on top of Number 1 cylinder exhaust valve adjusting screw. Set the indicator at .036".
4. Continue to hand crank the engine until the indicator hand just stops moving. At this point the indicator should read zero plus or minus .003".

Fig. 70 illustrates checking the valve timing.

INTAKE AND EXHAUST MANIFOLDS

The intake manifold is a "D' shape which results in better atomizing and more even distribution of the fuel to each of the six cylinders. This is another contribution to smooth engine performance.

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

The thermostatically controlled heat valve in the exhaust manifold directs the hot exhaust gases against the center of the intake manifold when the engine is cold (Fig. 71). As the engine warms up, the thermostatic spring closes the valve and directs the exhaust gases away from the intake manifold (Fig. 72). This thermostatic control results in the proper temperature of the incoming gases under all operating conditions. The tension of the thermostatic spring is very important—if it is too tight, the exhaust manifold heat will not be turned off the intake heat riser as the engine warms up, with the result that the incoming gases are expanded several volumes and a full charge cannot be forced into the cylinders. This, of course, reduces power and top speed, makes the vehicle lazy on acceleration, etc. Therefore, it is most important that the thermostatic spring be wound up just enough to slip it over the anchor pin in the manifold and no more. This is approximately ½ turn of the spring.

Whenever the manifolds are removed from an engine, the gaskets should be examined to be sure that they are in good condition, as leaky gaskets will make the engine miss. Worn gaskets should be replaced with genuine G.M. gaskets. This type of gasket assures a positive seal between the manifolds and the cylinder head.

In assembling the manifolds to the cylinder head, the bolts should be drawn up evenly until they are all tight. A special wrench is necessary to properly tighten these bolts.

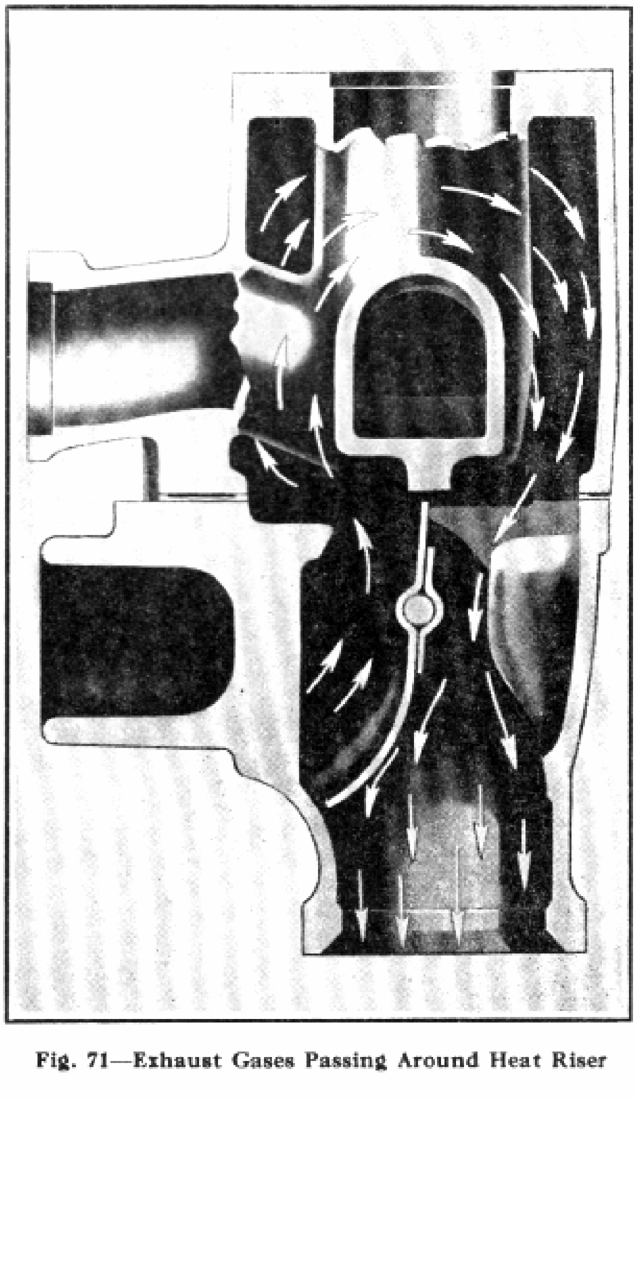


Fig. 71—Exhaust Gases Passing Around Heat Riser

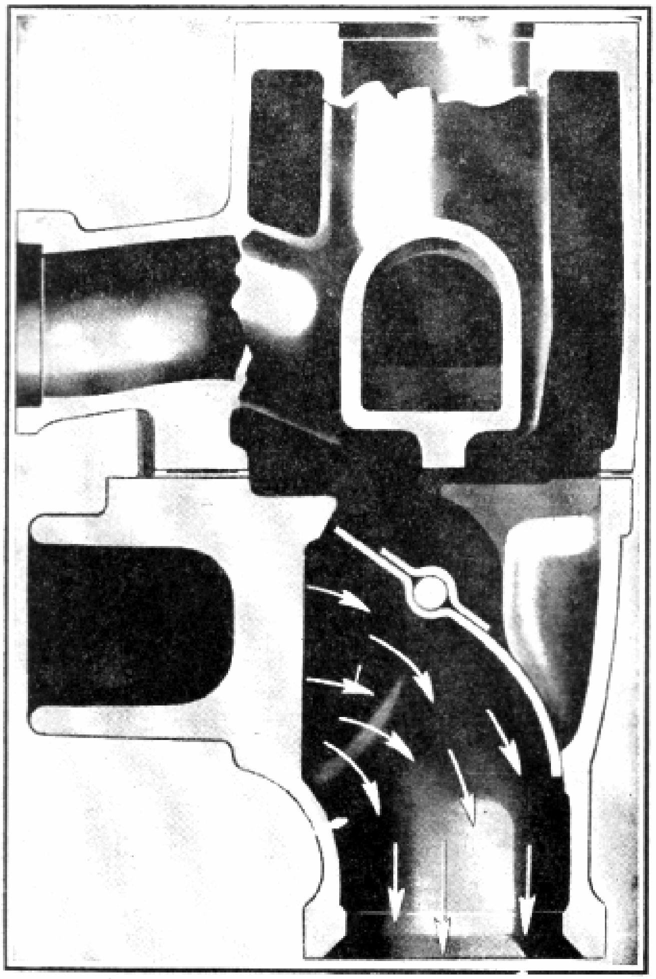


Fig. 72—Manifold Heat Valve Closed

ENGINE TUNE-UP

One of the most important operations in proper engine maintenance, is the tuning of engines. This operation, more than any other, determines whether or not the maximum amount of performance with the greatest amount of economy will be received.

Only by performing these operations and adhering to limits, clearances and specifications are you able to get the performance and economy that has been built into the engine.

Engine Tune-up Procedure.

Before an Engine Tune-up, the mechanic must determine whether or not the engine can be successfully tuned. Therefore, the first operation, as shown in Fig. 73 is a careful check of the compression—**An Engine without fairly even compression cannot be tuned.**

Compression

Before making any checks on an engine it should be run for several minutes to warm it up and lubricate the valve mechanism. The compression of the engine should be checked first because an engine with uneven compression cannot be tuned successfully.

1. Remove all spark plugs from the engine. The ignition should be turned off and the throttle valve in the open position.
2. Insert the compression gauge KMO-213 in a spark plug hole and hold it tightly. Crank the engine with the starting motor until the gauge reaches its highest reading, which requires only a few turns of the engine. Repeat the same test on all cylinders and make a note of the compression on each cylinder.

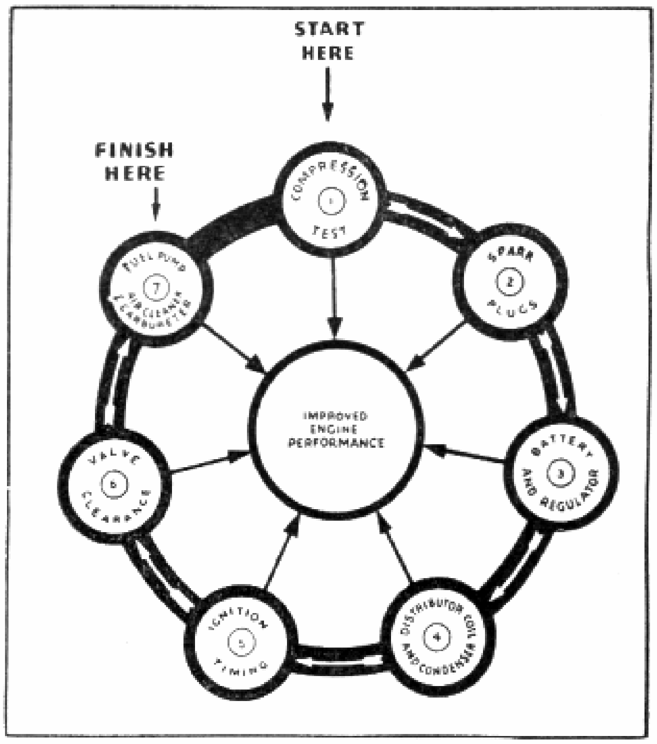


Fig. 73—Engine Tune-up Procedure

All cylinders should read alike within 5 to 10 pounds for satisfactory engine performance.

The compression on all cylinders should be 90 pounds or better.

Should you have a low compression reading on two adjacent cylinders, it indicates an inter-cylinder leak, usually caused by a leak at a 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 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 reading on the low reading cylinders is about uniform with the other cylinders, it indicates compression loss past the pistons and rings.

Naturally, the cause of low or uneven compression would have to be corrected before proceeding with an Engine Tune-Up Job.

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 heat range.

Adjust the spark plug gaps, using a round feeler gauge, to .040".

CAUTION—Do not bend the center electrode. Replace the spark plugs in the engine, using new gaskets wherever necessary.

Battery Test

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

Close the starting motor switch and crank the engine for 15 seconds. If the starting motor cranks the engine over at a good rate of speed with the voltmeter reading 5 volts ior better, it indicates a satisfactory starting circu t, which includes the condition of the battery terminals and cables. However, if the cranking speed is slow, or the voltmeter reading is under 5 volts, the starting motor, battery, and battery cable terminals should be checked individually to locate the source of the trouble.

Distributor

Remove the spark plug wires from the distributor cap and examine the terminals for corrosion. The wires should also be checked for damaged insulation and the wires being oil soaked.

Remove the distributor cap and check the cap and distributor rotor for cracks or burned contacts.

Check the 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.

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.

Hand-crank the engine until the cam follower rests on the peak of the cam. Adjust the point gap to .018", using a feeler gauge. This operation must be performed very accurately because it affects point dwell. Hand-crank the engine until the cam follower is located between the cams. Hook the end of a 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 17 and 21 ounces.

Check to see that the vacuum spark control operates freely by turning the distributor body counter clockwise and see that the spring returns it to the retarded position. Any stiffness in the operation of the vacuum spark control will affect the ignition timing.

Set the octane selector at "Zero" on the scale. Reassemble distributor cap and spark plug wires. Make sure that the terminals of the primary wire from the ignition coil to the distributor are clean and tight.

Coil and Condenser

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

Fuel Pump

Remove the filter bowl and screen and wash them thoroughly in clean gasoline. When reassembling make sure that the cork gasket is in good condition and properly seated. Tighten all fuel pump connections.

Air Cleaner

Remove the air cleaner and wash the copper filter element in clean gasoline. Dry the element and dip in engine oil. Allow excess oil to drain from the filter before replacing.

Carburetor

Remove the carburetor from the engine. Disassemble and clean all parts thoroughly. Refer to carburetor section for disassembly instructions.

Manifold Heat Valve

Unhook the thermostatic spring from its anchor pin and check the adjustment. Proper adjustment requires only ½ turn of the spring to slip it over its anchor pin. Should the thermostatic spring be distorted in any way it should be replaced.

Ignition Timing

With the octane selector set at "Zero," attach Neon Timing Light to No. 1 spark plug. Start the engine and run it at idling speed. Loosen distributor clamp and rotate distributor body clockwise or counter-clockwise until the steel ball in the flywheel lines up with the pointer on the flywheel housing. Tighten the distributor clamp screw.

Valve Adjustment

Start the engine and while it is warming up the cylinder head bolts, rocker arm shaft support bolts and nuts and the manifold bolts and nuts should be tightened. Where torque wrenches are available the cylinder head bolts should be tightened to 75 to 80 foot pounds, and the rocker arm shaft support bolts to 25 to 30 foot pounds.

Normalize the engine and adjust the valves according to the procedure given in this section of the manual under the heading "Valve Adjustment Procedure".

Install the rocker arm cover, using a new gasket and check for oil leaks.

Idling Adjustment

Adjust the carburetor idle and throttle stop screws in combination with each other to secure the best idling performance. Idling speed should be set at 450 to 500 R.P.M.

NOTE—To determine approximate engine revolutions per minute, pick out one valve or tappet noise. While concentrating on this one noise, count the number of times it can be heard in 15 seconds. Multiplying this by 8 will give the approximate revolutions per minute.

Cooling System

Tighten all hose connections and examine for any indications of water leaks. Check the fan belt for proper tension and adjust it if necessary.

Current and Voltage Regulator

Check the adjustment of the Current and Voltage Regulator according to the instructions given in Section R of this Manual.

Road Test

After the completion of the above operations, the vehicle should be road-tested for performance. During this time the octane selector should be adjusted for the grade of fuel being used. For peak performance and maximum gasoline economy, the octane selector should be set to produce a slight "ping" upon accelerating at wide-open throttle.

SERVICE DIAGNOSIS AND CORRECTIVE METHODS

SYMPTOM AND PROBABLE CAUSE	REMEDY
Lack of Power—	
1. Low or poor compression.	1. Reface Valves and clean carbon.
2. Ignition system defective.	2. See "Distributor" Section.
3. Carburetor or Fuel Pump not functioning properly.	3. See "Fuel System" Section.
4. Air Cleaner restricted.	4. Clean Air Cleaner and refill.
5. Exhaust Manifold heat valve seized.	5. Free up heat valve.
6. Overheating.	6. See "Cooling System" Section.
7. Improper grade and viscosity of oil.	7. Change to correct grade of oil.
Poor Compression—	
1. Incorrect Valve lash.	1. Adjust Valves (hot)— Intake—.010". Exhaust—.020".
2. Leaky Valves.	2. Reface Valves.
3. Valve stems or lifters sticking.	3. Reface valves, clean guides, polish stems and lifters.
4. Valve stems or guides worn.	4. Replace worn parts.
5. Valve springs weak or broken.	5. Replace springs.
6. Valve timing incorrect.	6. Set valve timing to specifications.
7. Cylinder head gasket leaking.	7. Replace cylinder head gasket.
8. Piston rings broken, worn or stuck.	8. Replace piston rings.
9. Pistons or rings improperly fitted.	9. Fit pistons or rings.
10. Piston ring grooves worn.	10. Replace pistons.
11. Cylinder scored or worn excessively.	11. Hone cylinders and fit pistons and rings.
Excessive Cylinder and Piston Wear—	
1. Improper grade and viscosity of oil.	1. Adhere to correct grade and viscosity of oil
2. Lack of oil.	2. Keep oil at proper level.
3. Dirty oil.	3. Change oil as specified and clean filter.
4. Overheating.	4. See "Cooling System" Section.
5. Piston improperly installed and fitted.	5. Fit pistons and rings as specified.
6. Piston rings not properly fitted to piston grove and cylinder wall.	6. Fit piston rings.
7. Piston rings stuck in piston grooves, or broken.	7. Replace piston rings.
8. Air cleaner not clean, allowing dirt to enter combustion chamber.	8. Keep air cleaner clean and maintain correct level.
9. Carburetor fuel mixture too rich.	9. Adjust float level and idle adjustment screw.