ENGINE

(NEVER RUN ENGINE IN CLOSED GARAGE)

Due to the presence of carbon monoxide (a poisonous gas in the exhaust of the engine) never run the engine for any length of time while this vehicle is in a small closed garage. Opening the doors and windows lessens the danger considerably, but it is safest, if adjustments are being made that require operation of engine, to run the vehicle out of doors.

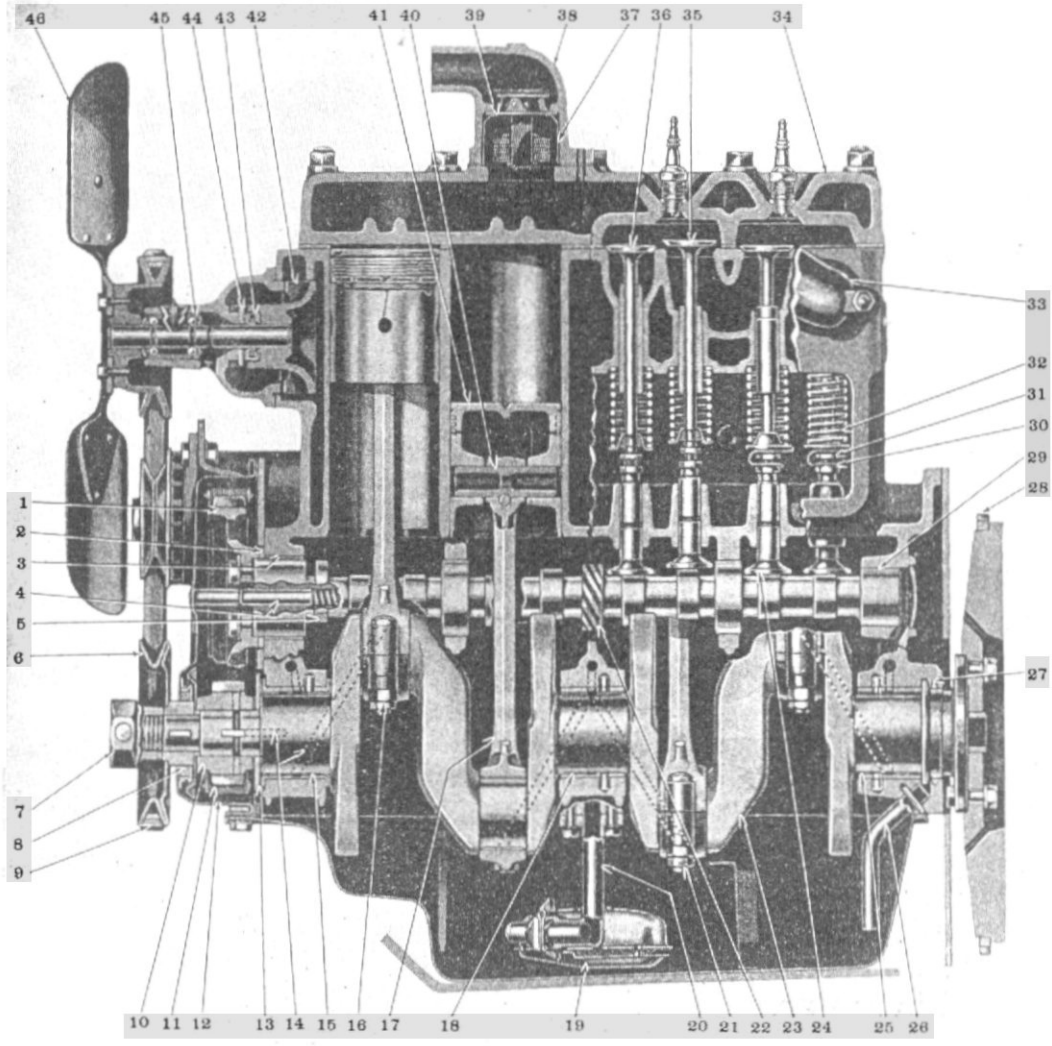


FIG. 1—SIDE SECTIONAL OF ENGINE

The engine is a Four-Cylinder L head type unit equipped with a counter-balanced crankshaft.

At end of this section will be found the Engine specifications. When adjustments are necessary we recommend that reference be made to these specifications for proper running tolerances and clearances of all component parts. On Page 34 headed "Engine Troubles and Causes" are listed many reasons for engine failure or poor performance. For correction of these difficulties you will find the procedure to follow under separate headings in this section.

FIG. 1—SIDE SECTIONAL VIEW OF ENGINE

No.	Willys Part No.	Ford Part No.	Name
1	638458	GPW-6256	Camshaft Sprocket
2	375900	GPW-6245	Camshaft Thrust Washer
3	639051	GPW-6262	Camshaft Front Bushing
4	375907	GPW-6243	Camshaft Thrust Plunger
5			Fuel Pump Eccentric
6	638113	GPW-6312	Fan and Generator Drive Pulley
7	387633	GPW-6319	Starting Crank Nut Assembly
8	637098	GPW-6700	Crankshaft Packing—Front End
9	A-1495	GPW-8620	Fan and Generator Drive Belt
10	638459	GPW-6306	Crankshaft Sprocket
11	638457	GPW-6260	Camshaft Drive Chain
12	A-1190	GPW-6016	Chain Cover Assembly
13	634796	GPW-6308	Crankshaft Thrust Washer
14			Crankshaft Oil Passages
15	637008	GPW-6338-A	Crankshaft Bearing Front—Lower
16	52825	356028-S	Connecting Rod Bolt Nut Lock
17	639859		Connecting Rod Assembly No. 2
18	638731	GPW-6341-A	Crankshaft Bearing Center—Lower
19	630396	GPW-6615	Oil Float Assembly
20	630397	GPW-6617	Oil Float Support
21	637020		Connecting Rod Cap Bolt
22			Oil Pump and Distributor Drive Gear
23	638121	GPW-6303-A1	Crankshaft
24	637047	GPW-6500	Valve Tappet
25	638783	GPW-6337-A	Crankshaft Bearing Rear—Lower
26	630294	GPW-6326	Crankshaft Bearing Rear Drain Pipe
27	637237	GPW-6702	Crankshaft Packing—Rear End
28	635394	GPW-6384	Flywheel Ring Gear
29	637065	GPW-6250	Camshaft
30	637704	GPW-6550	Valve Tappet Clearance Spring
31	637048	GPW-6549	Valve Tappet Adjusting Screw
32	638636	GPW-6513	Valve Spring
33	A-912		Exhaust Manifold Assembly
34	A-1534	GPW-6050	Cylinder Head
35	637182	GPW-6507	Inlet Valve
36	637183	GPW-6505	Exhaust Valve
37	639661	GPW-8578	Thermostat Retainer
38	A-1192	GPW-8250	Water Outlet Elbow
39	637646	GPW-8575	Thermostat Assembly
40	636961	GPW-6135-A	Piston Pin
41	636957	GPW-6110-A	Piston
42	639993	GPW-8512	Water Pump Impeller
43	639663	GPW-8524	Water Pump Seal Assembly
44	639994	GPW-8557	Water Pump Seal Washer
45	636297	GPW-8530	Water Pump Bearing and Shaft Assembly
46	A-447	GPW-8600	Fan Assembly

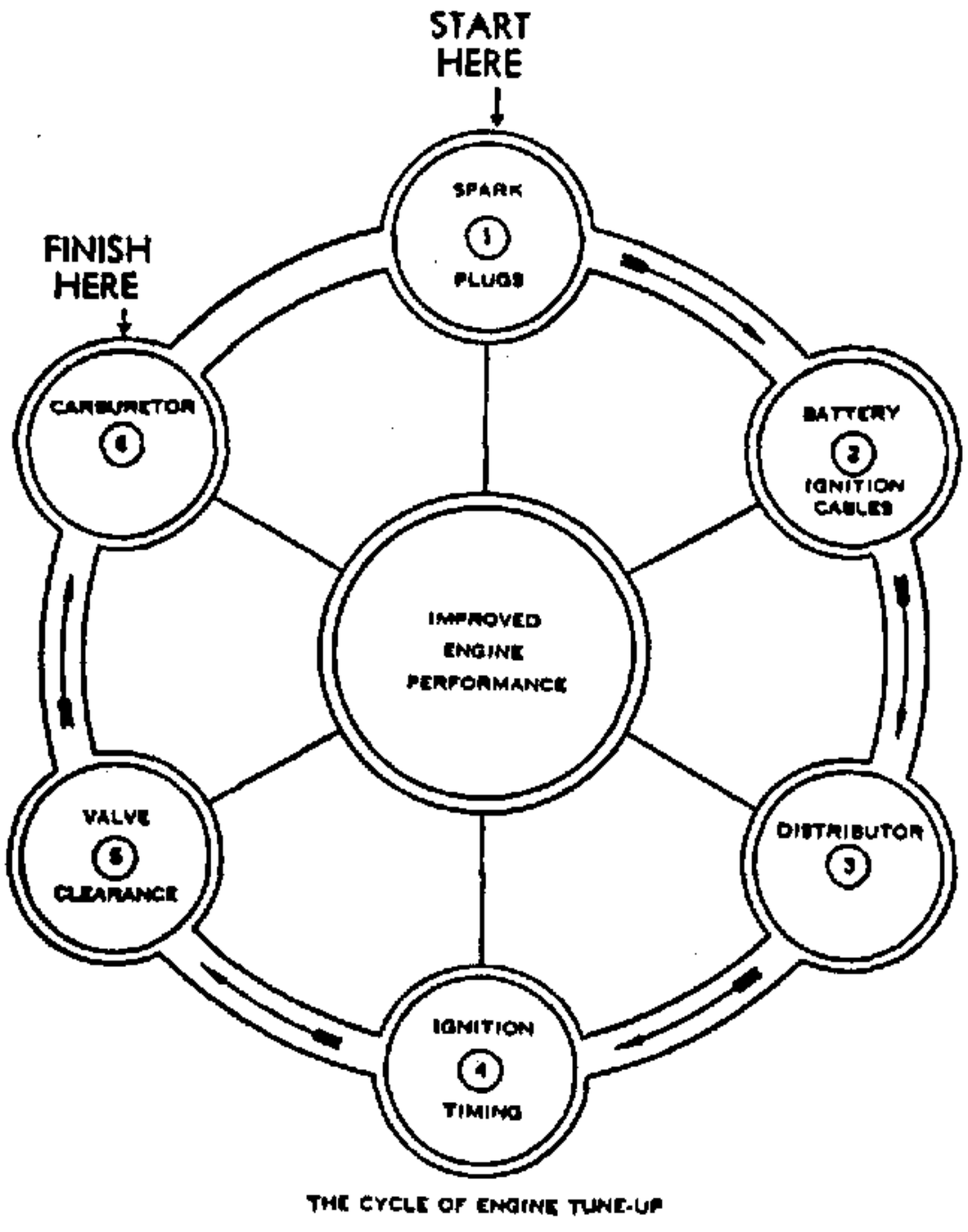


FIG. 2

Engine Tune-Up

For best performance and dependability, the engine should have a periodic tune-up every 6,000 miles, see Fig. 2. The following procedure is recommended when performing this operation:

1. Remove spark plugs and clean. Adjust the Electrodes to .030" gap.
2. Check Battery Terminals, ground cable and ground straps on left side of engine at front engine support and cylinder head for clean and tight connections.
3. Remove distributor cap and inspect points.
4. Check ignition timing.
5. Check valve tappet clearance-set .014" cold.
6. Set carburetor float level, accelerator pump travel, and metering rod as covered under heading "Carburetor".
7. Start engine and allow to run until thoroughly warmed up, then set carburetor idle screw so the engine will idle at 600 R.P.M. (vehicle speed approximately 8 miles per hour).
8. Adjust low speed idling screw so that engine will idle smoothly.

Carburetor

Complete information regarding dismantling, cleaning and adjusting will be found in the Fuel section, under heading "Carburetor".

Distributor

For complete information regarding cleaning, adjusting and setting ignition timing refer to Electrical section under heading "Distributor".

Grinding Valves

Lack of power in an engine is sometimes caused by poor seating of the valves in the valve seats which allows the gases in the cómpression chamber to escape into the intake or exhaust manifold.

Through the use of a cylinder compression gauge one can readily determine which valves are not properly seating.

Compression gauge readings should all be within 10 pounds of each other and not less than 70 lbs.

If no gauge is available, remove all spark plugs, hand crank engine and have mechanic place thumb over one spark plug hole at a time. When no compression is experienced that particular cylinder is at fault.

The valve grinding operation from the standpoint of engine power and performance is very important. Extreme care should be used whenever valves are ground to maintain factory limits and clearances, as only by maintaining these can one expect to get good engine performance.

When it is necessary to perform a valve job, it will be best to follow the procedure as outlined in the next few paragraphs.

1. Drain radiator by opening drain cock at the bottom left corner of the radiator.
2. Remove oil filter and bracket by removing the nuts on the cylinder studs and lay filter on generator.
3. Remove fuel line from fuel pump to carburetor.
4. Remove carburetor air cleaner and accelerator rod.
5. Remove choke and throttle control wires.

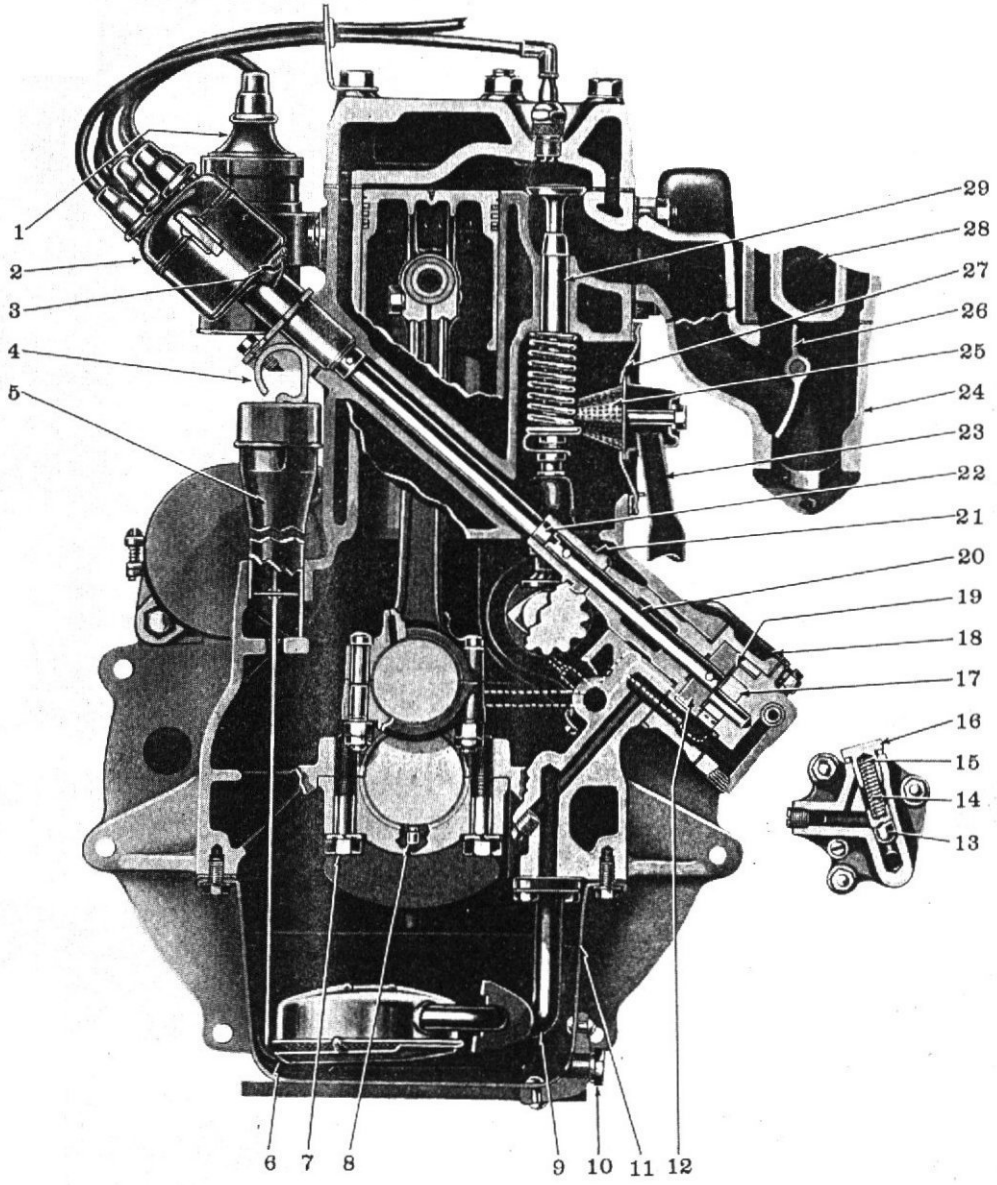


FIG. 3—FRONT SECTIONAL OF ENGINE

No.	Willys Part No.	Ford Part No.	Name
1	A-1527	GPW-12000	Ignition Coil
2	A-1244	GPW-12100	Ignition Distributor
3	107128	B-10141	Distributor Oiler
4	A-5168	GPW-6766-B	Oil Filler Cap and Level Indicator
5	A-5165	GPW-6763-B	Oil Filler Tube
6	630396	GPW-6615	Oil Float Assembly
7	381519	GPW-6345	Crankshaft Bearing Cap to Crankcase Screw
8	635377	GPW-6369	Crankshaft Bearing Dowel
9	630397	GPW-6617	Oil Float Support
10	639979	GPW-6727	Oil Pan Drain Plug
11	A-1167	GPW-6675	Oil Pan Assembly
12	636599	GPW-6608	Oil Pump Shaft and Rotor Assembly
13	630518	GPW-6663	Oil Relief Plunger
14	356155	GPW-6654	Oil Relief Plunger Spring
15	630389	GPW-6628	Oil Relief Plunger Spring Shims
16	630390	GPW-6644	Oil Relief Plunger Spring Retainer
17	343306	GPW-6614	Oil Pump Pinion
18	637636	GPW-6600	Oil Pump Assembly
19	636600	GPW-6673	Oil Pump Rotor Disc
20	630386	GPW-6609	Oil Pump Shaft
21	630394	GPW-6630	Oil Pump Body to Cylinder Block Gasket
22	637615	GPW-12083	Distributor Shaft Friction Spring
23	A-1061	GPW-6758	Crankcase Ventilator Assembly
24	A-912		Exhaust Manifold Assembly
25	630298	GPW-6762	Crankcase Ventilator Baffle
26	636439	GPW-9460	Heat Control Valve
27	656554	GPW-6519	Valve Spring Cover Assembly
28	A-1166		Intake Manifold Assembly
29	375811	GPW-6510	Exhaust Valve Guide

6. Remove nuts holding carburetor to manifold and remove carburetor.
7. Remove bolt and nuts holding exhaust pipe to manifold.
8. Remove manifold stud nuts and manifolds.
9. Remove the upper radiator hose. Remove all spark plugs by using the socket wrench furnished in the tool kit. Remove the cylinder head cap screws, stud nuts and the temperature gauge bulb, then lift head from engine block. Removal is made easy by using lifting hooks screwed in No. 1 and 4 spark plug holes. CAUTION—Do not use screw driver or any other sharp instrument to drive in between the cylinder head and the block to break the head loose from the gasket.
10. Remove the valve cover plate screws and the valve cover. Care should be taken when removing the valve cover breather tube not to lose the copper gasket on each screw as well as the screen and gasket. With a piece of cloth or cotton waste cover the three holes in the valve chambers to prevent the valve keys dropping into crankcase upon removal.
11. Remove valve tappet clearance springs by placing screw driver on top edge and snapping out. With valve spring compressor inserted between valve tappet and spring retainer raise springs on those valves which are in closed position and remove valve locks. Turn crankshaft with crank or by fan belt until those valves which are open become closed and repeat the operation.
12. Remove valves and place them in a valve carrying board, so that they can be identified as to cylinders from which they were removed. Remove valve springs. The valve springs should be tested for pressure which should show 116 lbs. when valves are open (Length 1¾") or 50 lbs. pressure when closed (Length 2 7/64"). The free length of the valve spring is 2½" inches. Any springs which are distorted or do not fall within these specifications should be replaced with new springs.
13. Clean carbon from cylinder head, top of pistons, valve seats and cylinder block, clean valve guides with guide brush. Clean valves on a wire wheel brush making sure that all carbon is removed from the top and bottom of the heads, as well as the gum which might have accumulated on the stems. The valve heads should then be refaced at an angle of 45°. If valve seats in block show signs of excessive pitting it is advisable to reface the seats and check with dial gauge—Fig. 4. Then by hand, touch up the valves to the valve seats with fine valve grinding compound.

The clearance between the intake valve stem and the valve guide is .0015" to .00325", the exhaust valve stem clearance to guide is .002" to .00375". Excessive clearance between the valve stem and the valve guide will cause improperly seating and burned valves. If there is too much clearance between the inlet valve stem and the valve guide, on the suction stroke there will be a tendency to draw oil vapors up the guide into the combustion chamber causing excessive oil consumption, fouled spark plugs and poor low speed performance.

To check the clearance of the valve stem to the valve guide, take new valve and place in each valve guide and feel the clearance by moving the valve stem back and forth. If this tolerance is excessive it will be necessary to replace the valve guide, otherwise the valve stem is worn.

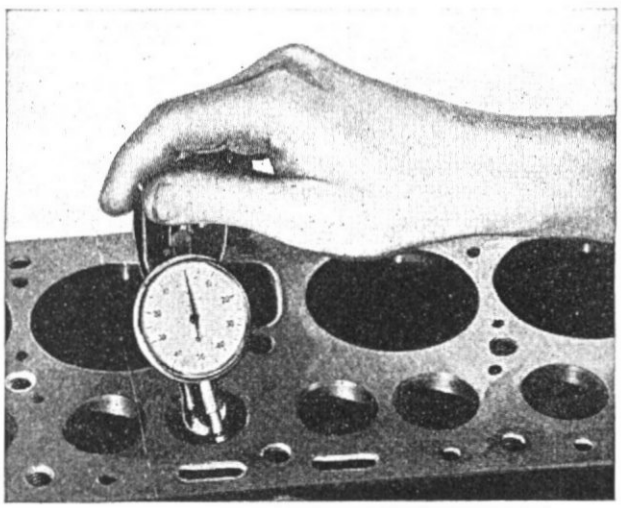


FIG. 4—GAUGING VALVE SEATS

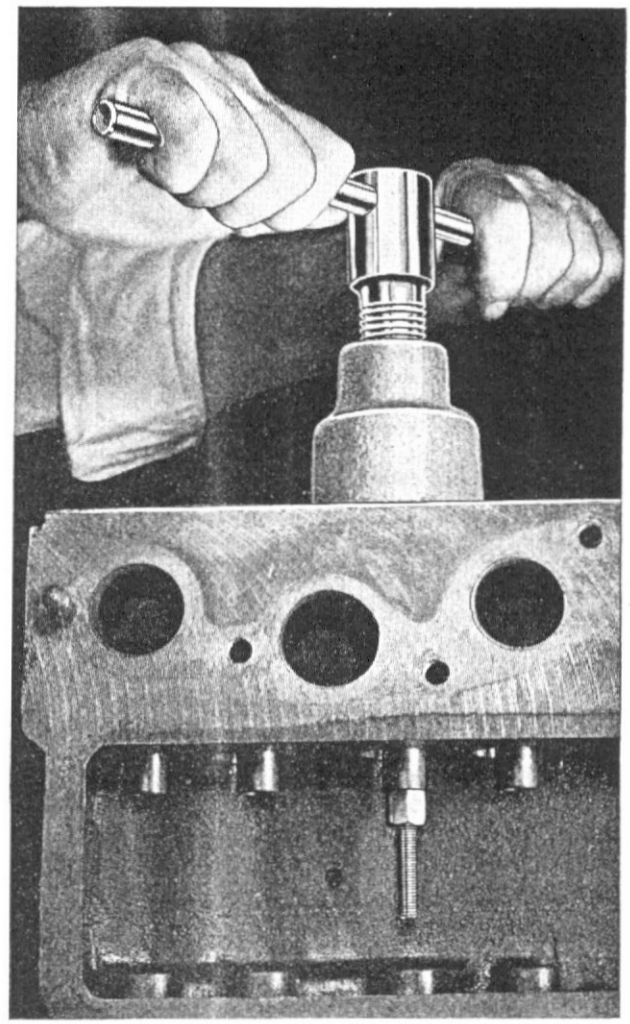


FIG. 5—PULLING VALVE GUIDE

Removing and Replacing of Valve Guide

When removing the valve guides use a valve guide puller such as shown in Fig. 5 to prevent damage to cylinder block. If a regular puller is not available, a suitable tool can be made from a 2" pipe, 6" long and a ⅜" bolt 10" to 12" long with a long threaded end, a small hexagon nut which will pass through the hole in the cylinder block and a 2" washer with a ⅜" hole in it.

The valve guides are installed with a replacer or a driver as shown in Fig. 6. Taking a piece of half inch round stock 6" long and turning down one end to ⅜" diameter 2" long will make a suitable driver.

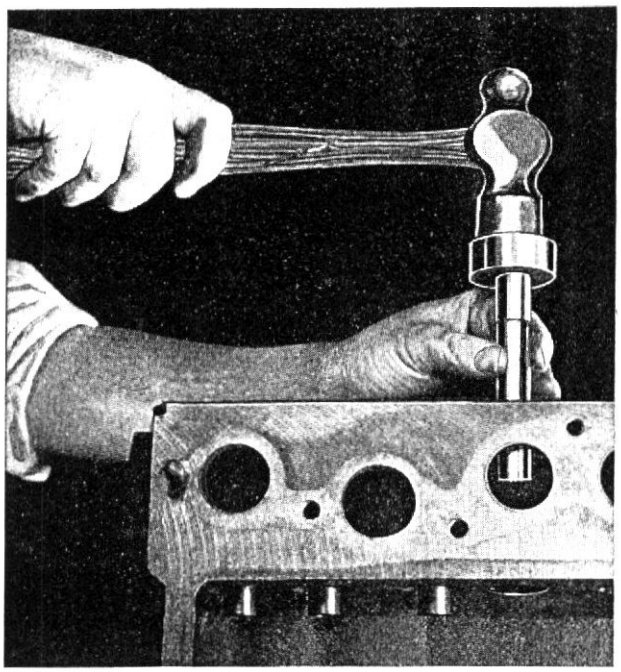


FIG. 6—INSTALLING VALVE GUIDE

The exhaust valve guide is installed in the cylinder block so that there will be a distance of 1" from the top of the guide to the top of the block. The intake valve guide is set at 15/16" from top of valve guide to the top of block. Fig. 7.

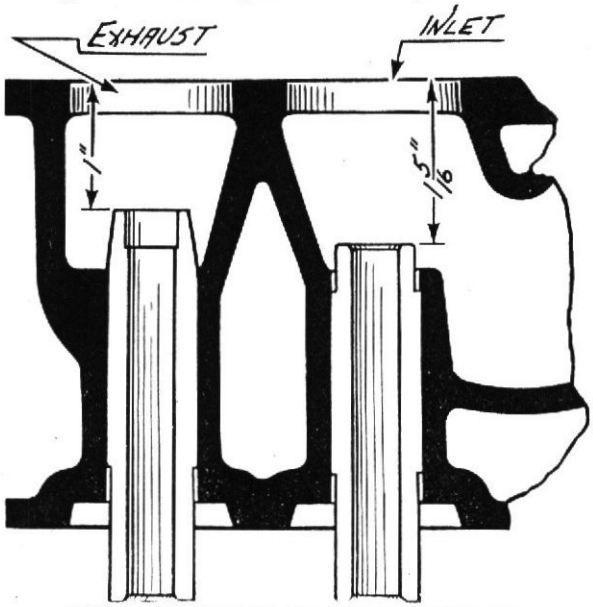


FIG. 7—POSITION OF VALVE GUIDES

The valve tappet clearance in the guide should be .0005" to .002". It is advisable to check the clearance of the valve tappet by moving it back and forth in the guide. If the clearance seems to be excessive it might be necessary to install a new valve tappet. This operation is covered in this section under "Camshaft and Valve Tappet".

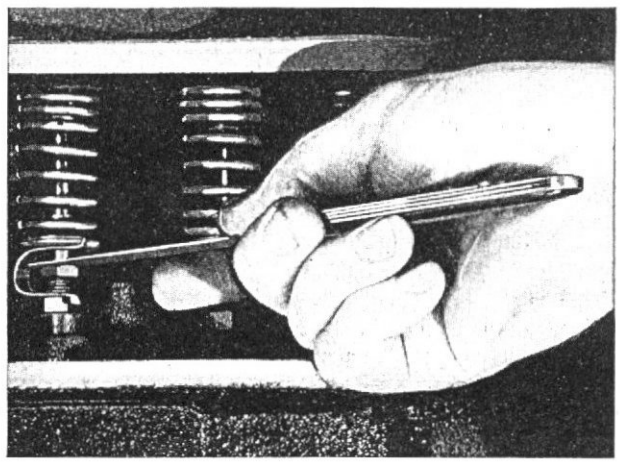


FIG. 8—VALVE TAPPETS AND SPRINGS

When assembling valve springs and retainers in engine make sure that the closed coils are up against cylinder block. See Fig. 8. Then make installation of the valves in their respective positions as they were disassembled. Through the use of a valve spring compressor raise valve springs on those valves which are in the closed position, and with valve key inserting tool, insert the valve spring locks. If no tool is available, hold keys in place by sticking them to valve stem with grease.

Adjust the valve tappet to valve stem clearance to .014". Fig. 8. Remove cloth or waste from valve chamber.

Clean top of block and pistons of all foreign matter and install cylinder head gasket. Clean carbon from cylinder head and wipe off all foreign matter then install over studs on cylinder block.

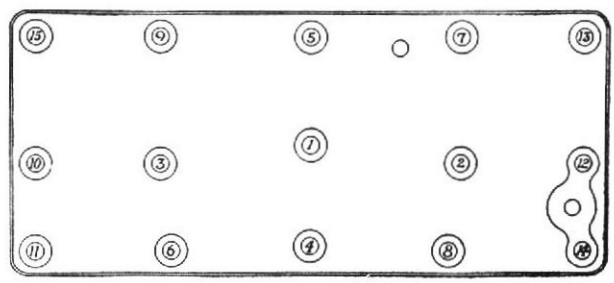


FIG. 9—CYLINDER HEAD TIGHTENING

Install oil filter and air cleaner bracket and tube assembly. Install cylinder head cap screws and nuts bringing them down finger tight, then with a tension wrench tighten cylinder head screws and nuts in sequence as shown on Fig. 9, tightening screws to 65 to 75 foot pounds or 780 to 920 inch pounds and the nuts to 60 to 65 foot pounds or 720 to 780 inch pounds.

Clean and adjust spark plugs, setting the electrode gaps at .030", Fig. 10. Install spark plugs in cylinder head to prevent any foreign matter from entering the combustion chamber during the remaining operations.

Install manifold with new gaskets. Install manifold clamp washers with convex surface toward manifold. Install manifold nuts drawing them up tight. Install exhaust pipe to manifold with new gasket.

Overhaul and recondition carburetor as per instructions given under the heading "Carburetor". Install carburetor to manifold and attach controls.

Recondition distributor and set ignition timing in accordance with instructions given under "Distributor".

NOTE—Make sure when installing distributor assembly in crankcase that it fits down in the crankcase properly.

Install upper radiator hose, and all line connections and fill radiator with water. Start engine and allow it to idle for a period of five or ten minutes, then recheck tappet clearance.

If necessary, install new valve cover plate gasket (shellac to cover). Install cover plate to engine block. Clean valve chamber ventilator tube and screen and reinstall with gaskets.

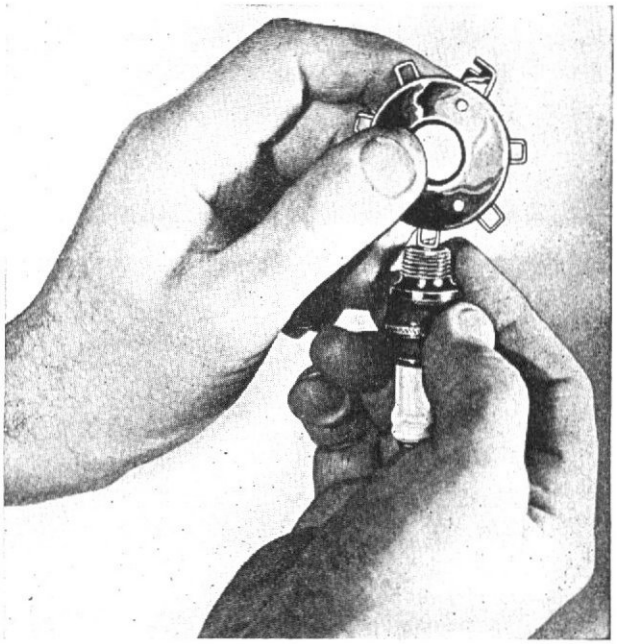
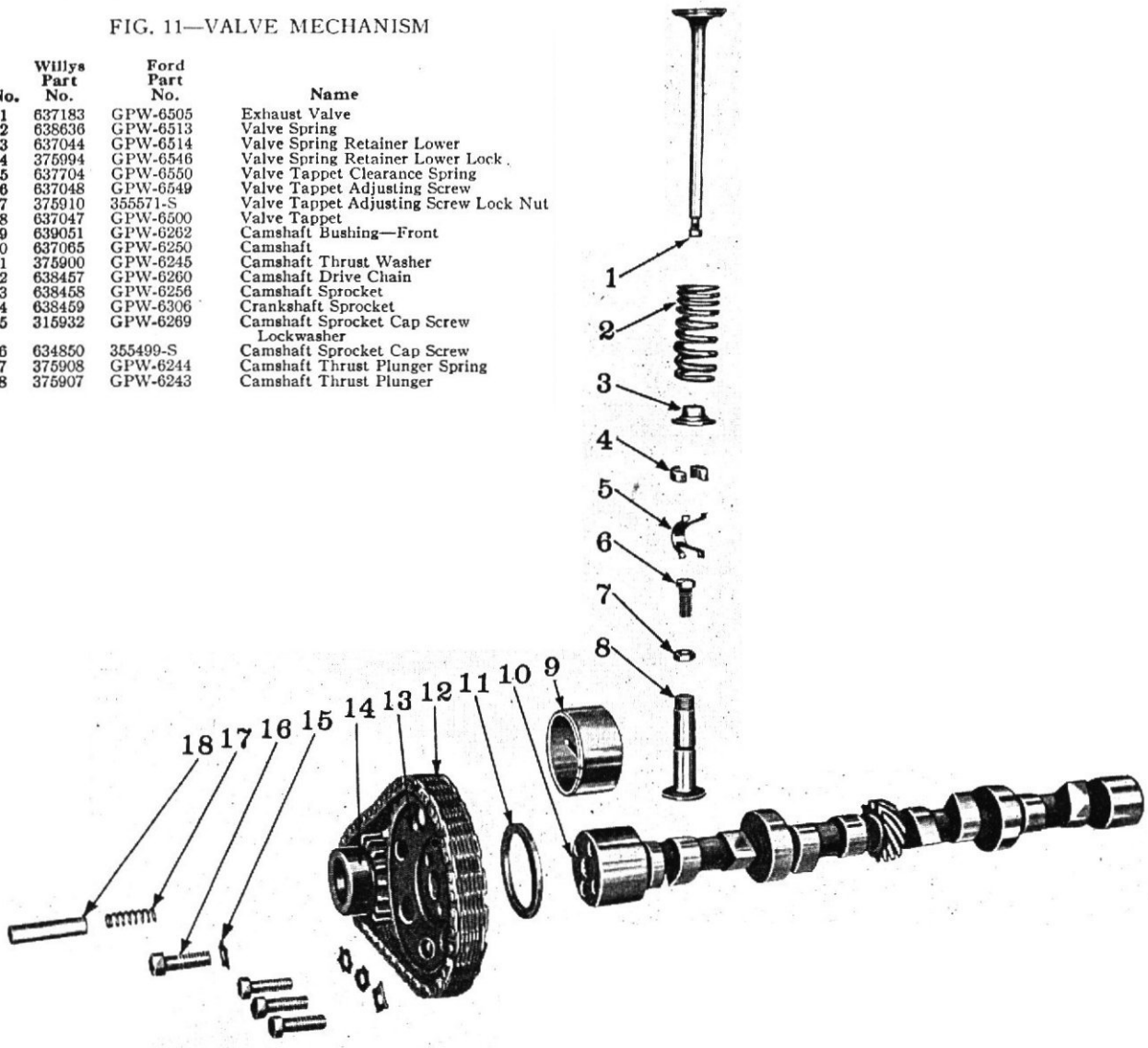


FIG. 10—SETTING SPARK PLUG

FIG. 11—VALVE MECHANISM

No.	Willys Part No.	Ford Part No.	Name
1	637183	GPW-6505	Exhaust Valve
2	638636	GPW-6513	Valve Spring
3	637044	GPW-6514	Valve Spring Retainer Lower
4	375994	GPW-6546	Valve Spring Retainer Lower Lock
5	637704	GPW-6550	Valve Tappet Clearance Spring
6	637048	GPW-6549	Valve Tappet Adjusting Screw
7	375910	355571-S	Valve Tappet Adjusting Screw Lock Nut
8	637047	GPW-6500	Valve Tappet
9	639051	GPW-6262	Camshaft Bushing—Front
10	637065	GPW-6250	Camshaft
11	375900	GPW-6245	Camshaft Thrust Washer
12	638457	GPW-6260	Camshaft Drive Chain
13	638458	GPW-6256	Camshaft Sprocket
14	638459	GPW-6306	Crankshaft Sprocket
15	315932	GPW-6269	Camshaft Sprocket Cap Screw Lockwasher
16	634850	355499-S	Camshaft Sprocket Cap Screw
17	375908	GPW-6244	Camshaft Thrust Plunger Spring
18	375907	GPW-6243	Camshaft Thrust Plunger



Camshaft and Valve Tappets

The alloy cast steel camshaft Fig. 11 rotates on four bearings which are lubricated under oil pressure through drilled passages in the crankcase. The front bearing carries the thrust and is a steel back babbitt-lined shell. This bearing is staked in place to prevent rotation and endwise movement. See Fig. 12.

The valve tappets are lubricated through oil troughs cast in crankcase and drilled passages to valve tappet guides. The oil troughs are filled from oil spray holes at connecting rod bearing ends. A groove cut in center of valve tappet shank carries the oil up and down in guides.

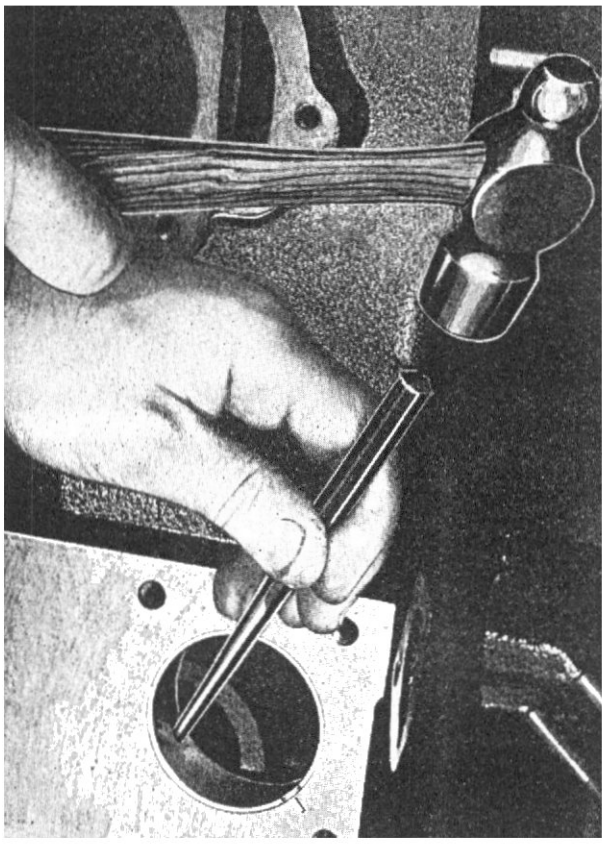


FIG. 12—STAKING CAMSHAFT BEARING

Removal of Camshaft or Valve Tappet

Drain water from radiator, remove radiator and grille, cylinder head, manifold, valves and valve springs. Follow instructions given under subheading "Grinding Valves" Page 18.

Remove oil pump and fuel pump assemblies.

Remove oil pan, crankshaft pulley, fan belt and fan assembly.

Remove nuts holding front engine supports to rubber insulators.

Remove timing chain cover, camshaft sprocket screws and timing chain.

Tie all valve tappets up with a string wrapped around heads of screws and attach to manifold studs.

Place jack with block under crankcase and raise front end of engine until camshaft will clear front frame cross member. Remove camshaft and valve tappets.

Carefully inspect camshaft for scores, roughness of cams and bearings. Examine valve tappet faces where they contact cams and replace if found to be scored, rough or cracked. Check clearance of tappets to guides, renewing those which have worn excessively. Oversize available .004".

Replacing Camshaft or Valve Tappets

Install valve tappets and tie up in place with string. Install camshaft. Install camshaft thrust washer.

To set the valve timing, see instructions given under heading "Valve Timing" Page 24.

For installation of oil pump see section under heading "Oil Pump" Page 29.

Install the plunger and spring in the front end of camshaft with round end out. Inspect pin in timing chain cover to see that it stands perpendicular to the cover face. Put a light smear of cup grease on end of pin and on the end of plunger, then assemble cover to the engine.

Balance of the assembly is the same operations used in removal of camshaft only in the reverse order.

NOTE—On earlier engines, when replacing oil pan, the four short cap screws are used across front end.

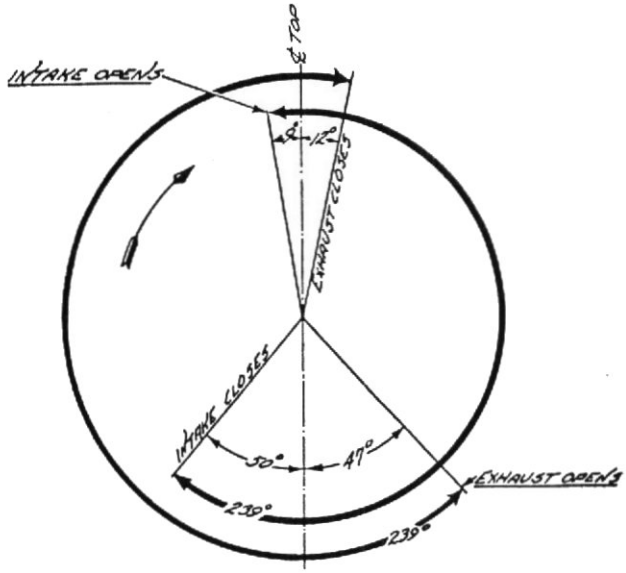


FIG. 13—VALVE TIMING

TIMING CHAIN AND SPROCKETS

The silent type timing chain is non-adjustable. The lubrication is positive through drilled passages in the crankshaft and sprocket from the front main bearing and oil filter return. These should be checked whenever the chain or sprockets are replaced.

To replace timing chain, it is necessary to remove fan blades, radiator, fan belt, crankshaft pulley and timing case cover. Remove screws holding camshaft sprocket to camshaft and remove chain.

When chain has been removed, for any purpose, it will be necessary to set the valve timing when chain is replaced.

VALVE TIMING

To set the valve timing turn the crankshaft so No. 1 and No. 4 pistons are at top dead center.

Place camshaft sprocket on camshaft, turn camshaft so punch mark faces punch mark on crankshaft sprocket.

Remove sprocket and place the timing chain on, then place timing chain over crankshaft sprocket, changing position of camshaft sprocket within chain until the cap screw holes in sprocket and camshaft are in line.

Timing is correct when a line drawn between sprocket centers cuts through timing marks on both sprockets. See Fig. 14.

Inlet opens 9° before top center measured on flywheel or .039" piston travel from top center.

To check valve timing, Fig. 13 adjust inlet valve tappet No. 1 cylinder to .020". Rotate crankshaft clockwise until piston in No. 1 cylinder is ready for the intake stroke, at which time the tappet should just be tight against end of valve stem and mark on flywheel "I O" is in center of timing hole in flywheel housing, see Fig. 15.

TIMING CHAIN COVER AND SEAL

The timing chain cover is a pressed steel stamping heavily ribbed for strength.

The stationary pin in cover is so located as to bear against the plunger in the end of camshaft which controls the end play of camshaft.

The crankshaft oil seal is woven asbestos impregnated with graphite and oil. When necessary to install new oil seal, the steel retainer should also be renewed.

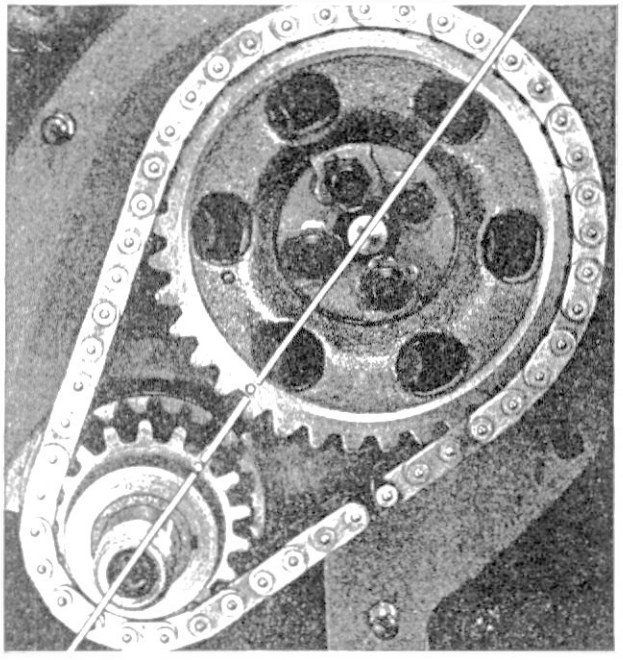


FIG. 14—TIMING SPROCKETS

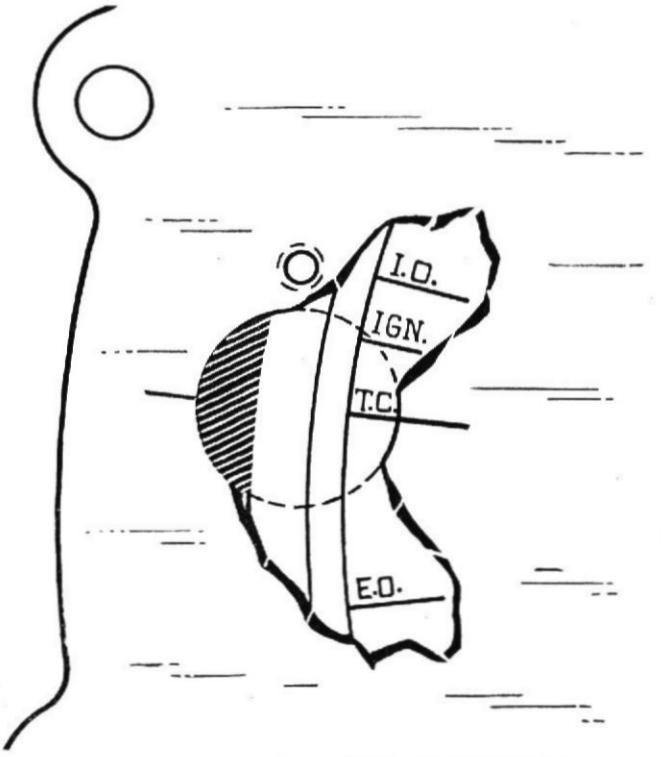


FIG. 15—TIMING MARKS (FLYWHEEL)

Crankshaft

The crankshaft Fig. 16 is of drop forged steel, grain direction following shape of crankshaft with four integral counterweights. This short shaft is rugged and reduces torsional vibration, weight 41½ lbs. After machining, the crankshaft is balanced statically and dynamically, and then dynamically balanced with clutch and flywheel as an assembly. It rotates on three steel back babbitt lined bearings, the front bearing taking the thrust. The packing at the rear bearing prevents oil getting into clutch and loss when parked on steep inclines.

The main bearing journal diameter and length dimensions are as follows:

Front—2.3340"—1.920"
Center—2.3340"—1 13/16"
Rear—2.3340"—1¾"

The steel back babbitt lined bearings are made to size and are interchangeable without line reaming. The running tolerance of the bearing is established at .001". No adjustment is provided on the main bearings. Should they require attention they should be replaced to maintain proper control of oil. Main bearing cap screw torque wrench reading 65-70 ft. lbs.

The end play of the crankshaft is .004" to .006" and adjusted by shims between the crankshaft sprocket thrust washer and end of Main Bearing, Fig. 17.

To adjust end play the crankshaft sprocket must be removed with gear puller, Fig. 18.

Whenever it is necessary to remove the crankshaft or install new crankshaft bearings, the engine has to be removed from the frame. See Note under "Flywheel" Page 32.

Undersize main bearings are available in .010"; .020" and .030".

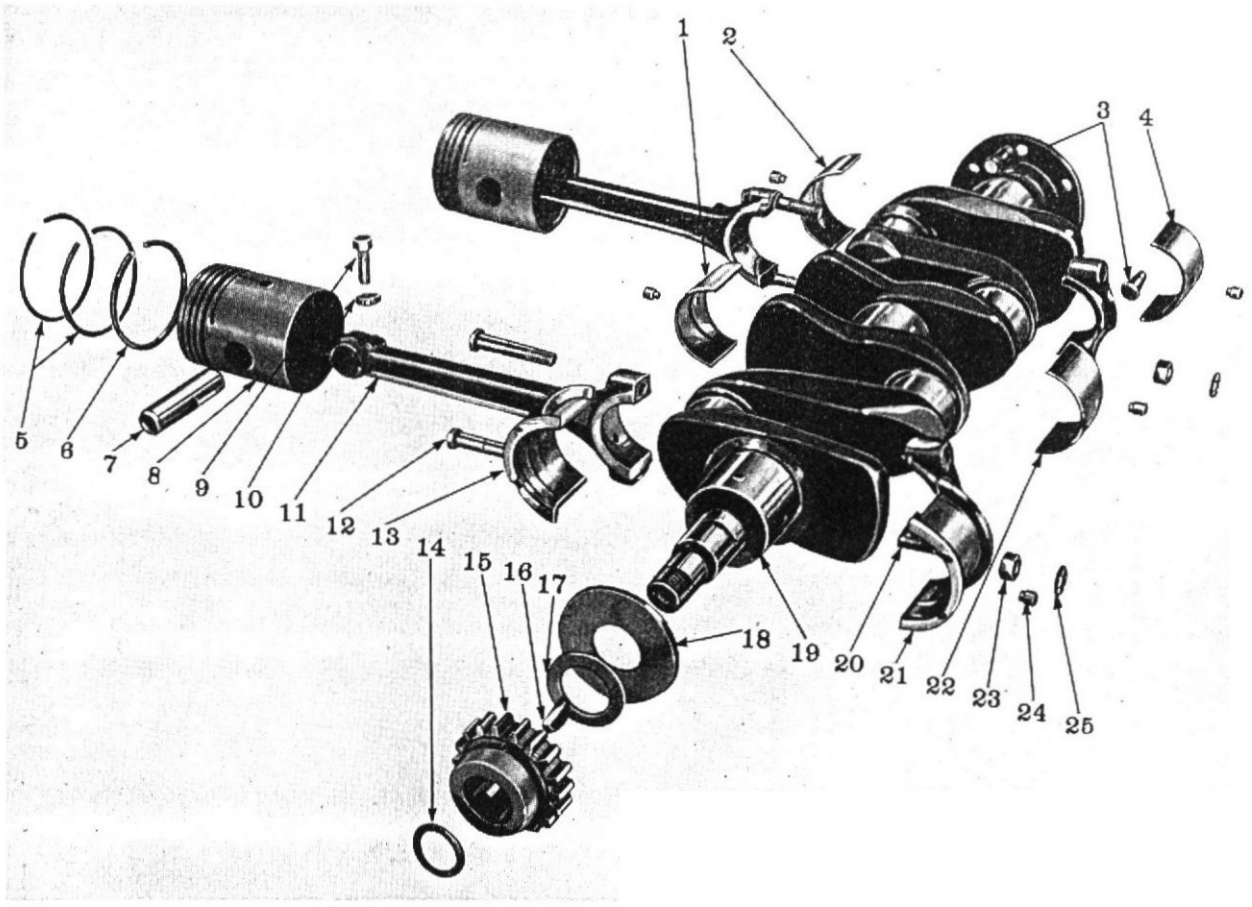


FIG. 16—CRANKSHAFT AND PISTONS

No.	Willys Part No.	Ford Part No.	Name
1	638730	GPW-6339-A	Crankshaft Bearing Center—Upper
2	638732	GPW-6331-A	Crankshaft Bearing Rear—Upper
3	632156	GPW-6387	Flywheel Crankshaft Dowel
4	638733	GPW-6337-A	Crankshaft Bearing Rear—Lower
5	116562	GPW-6155-A	Piston Ring—Compression (Lower)
	639864	GPW-6150	Piston Ring—Compression (Upper)
6	116566	GPW-6156-A	Piston Ring—Oil Regulating
7	636961	GPW-6135-A	Piston Pin
8	636957	GPW-6110-A	Piston—Grade "D"
9	632157	355497-S	Piston Pin Lock Screw
10	5010	34807-S	Piston Pin Lock Screw Lockwasher
11	639858	GPW-6200	Connecting Rod Assembly (No. 1 and No. 3 Cylinders)
12	637020		Connecting Rod Cap Bolt
13	637007	GPW-6333-A	Crankshaft Bearing Front—Upper
14	334103	GPW-6353	Crankshaft Oil Slinger Gasket
15	638459	GPW-6306	Crankshaft Sprocket
16	50917	74182-S	Crankshaft Sprocket Key
17	630727	GPW-6342-A	Crankshaft Sprocket Spacer
18	634796	GPW-6308	Crankshaft Thrust Washer
19	638121	GPW-6303-A1	Crankshaft
20	639862	GPW-6211-A	Connecting Rod Bearing (Upper and Lower)
21	637008	GPW-6338-A	Crankshaft Bearing Front—Lower
22	638731	GPW-6341-A	Crankshaft Bearing Center—Lower
23	636962	356021-S	Connecting Rod Cap Bolt Nut
24	635377	GPW-6369	Crankshaft Bearing Dowel
25	52825	356028-S	Connecting Rod Cap Bolt Nut Lock

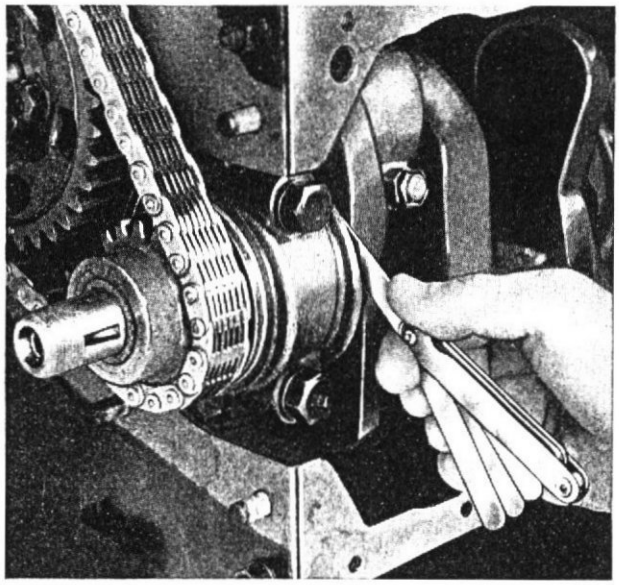


FIG. 17—CRANKSHAFT END PLAY

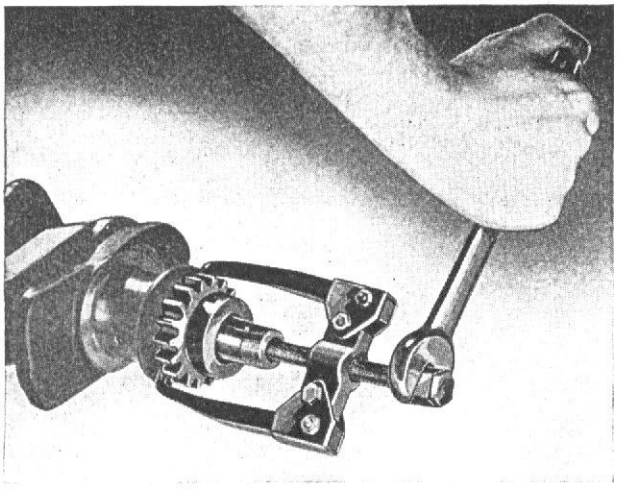


FIG. 18—CRANKSHAFT SPROCKET

CRANKSHAFT REAR BEARING SEAL

The rear main bearing is sealed by a wick type packing, installed in the groove machined in the crankcase, and rear main bearing cap, Fig. 19.

To install a new seal at the rear main bearing cap, insert the packing in the groove with the fingers. Then using a round piece of wood or steel, 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 towards the center. By following the above procedure you are sure that the wick is firmly pressed into the bottom of the groove.

The small portion of the packing 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 packing out of the groove while cutting off the ends it is recommended that a round block of wood, the same diameter as the crankshaft be used to hold the packing firmly in position while the ends are being cut off.

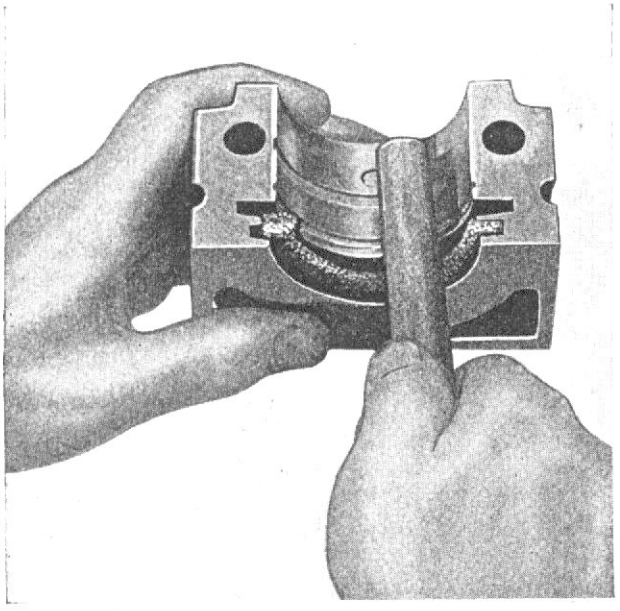


FIG. 19—REAR MAIN BEARING

Should it be necessary to install a new seal in the crankcase, it will require the removal of the engine from the frame and the removal of the crankshaft.

The same procedure should be followed when installing a crankcase seal as when installing a seal in the bearing cap.

When installing rear main bearing cap to case a little sealer should be put on the faces of cap where it fits against the case. The rubber seal packing that goes between the main bearing cap and the case is cut to a given length and will protrude down from the case approximately ¼". When the oil pan is installed it will force this seal tightly into the holes and prevent any oil from leaking from the engine into the clutch housing. See Fig. 20.

If new crankshaft bearings are installed care should be taken to see that the drilled passages line up with drilled passages in the crankcase, and that the bearings set snugly over the dowel pins.

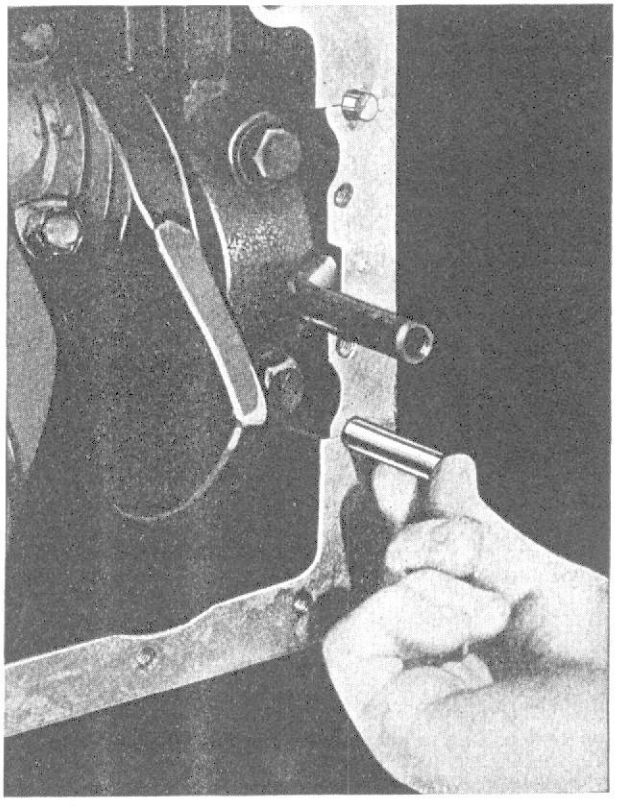


FIG. 20—REAR BEARING CAP SEAL

CONNECTING ROD

The connecting rods are drop forged and are of unusual length, measuring 9 3/16" from center to center. The babbitt bearings are of the replaceable type, steel-backed, babbitt lined, precision cut to size and no fitting is required.

When installing the upper half of rod bearing be sure that the oil spray hole lines up with the spray hole in the connecting rod. Undersize rod bearings are available in .010"; .020" and .030".

The connecting rod and piston assembly is removed and installed from the top of the engine.

When the rod is installed in the engine, the offset is away from the nearest main bearing. The oil spray hole in bearing end of rod should be on the follow side or away from camshaft, toward right side of vehicle. Torque wrench reading, 50-55 ft. lbs.

Clearance on crankshaft .0008" to .0023". Total side clearance .005" to .009". See Fig. 21.

Every time a connecting rod is removed from an engine or a new rod is to be installed, it should be checked for alignment on a connecting rod aligning fixture as shown in Fig. 22.

There are different types of connecting rod aligners. Follow the instructions issued by the manufacturer, when checking the connecting rod for twist or bend.

When straightening the rod, twist or bend in the opposite direction more than the original twist or bend then return the rod to true alignment. The rod will then retain correct alignment.

PISTON

The piston is aluminum alloy, "T" slotted, cam ground, tin plated, double ribbed at piston pin

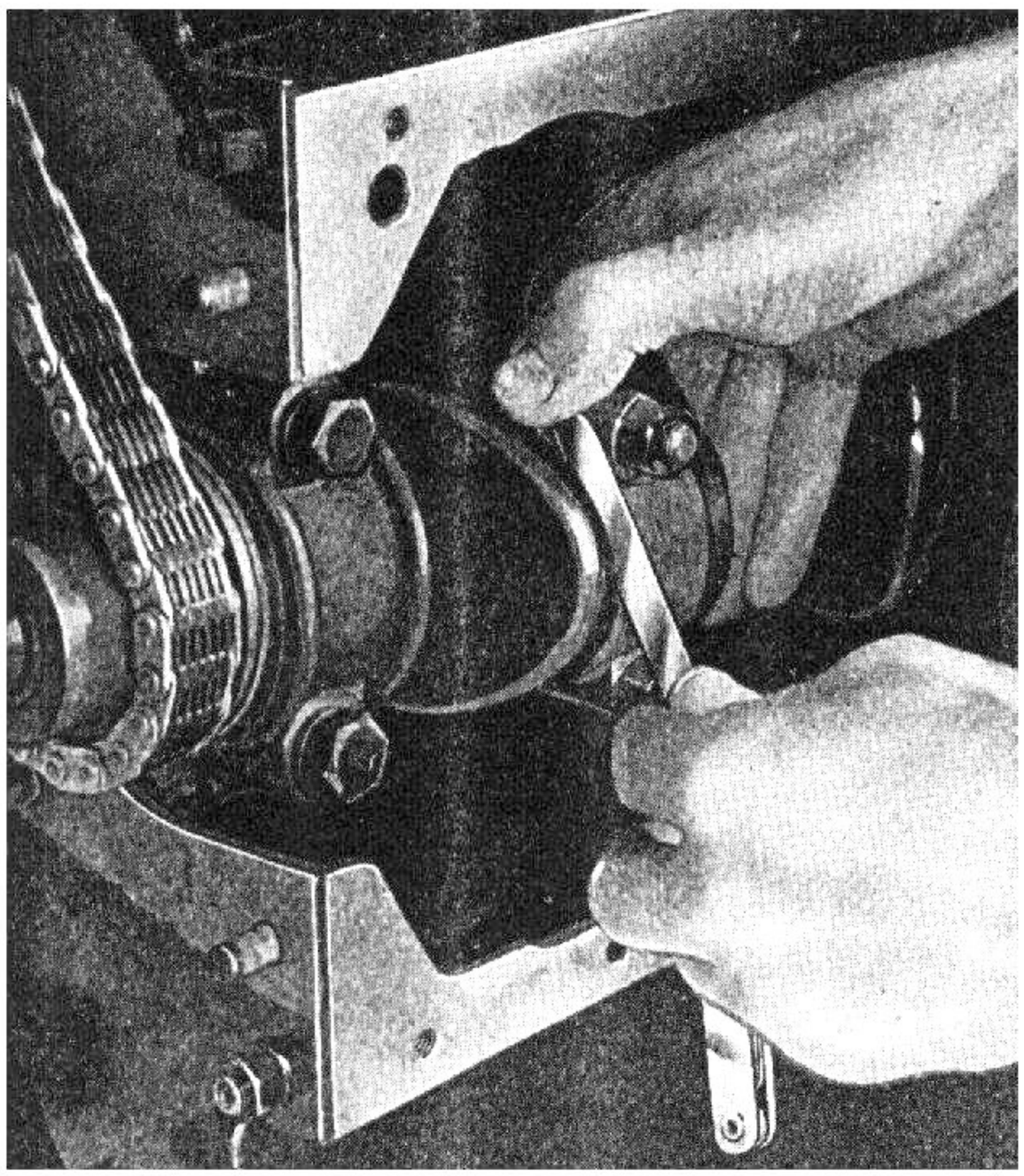


FIG. 21—CONNECTING ROD SIDE PLAY

bosses with a heat insulation groove above top ring. The clearance of the piston to the cylinder bore is .003". Check clearance with .003" feeler gauge ¾ wide; feeler gauge should have from 5 to 10 lbs. pull when being removed, see Fig. 23. The gauge should extend the entire length of the piston on the thrust side which is the opposite side from the "T" slot in the skirt.

Pistons are available in the following over-sizes: .010"; .020" and .030".

If it is ever found necessary to install an oversize piston, the cylinder bore must be honed with a regular cylinder honing tool and the manufacturers instructions should be carefully followed to get a true straight cylinder. Do not try to lap

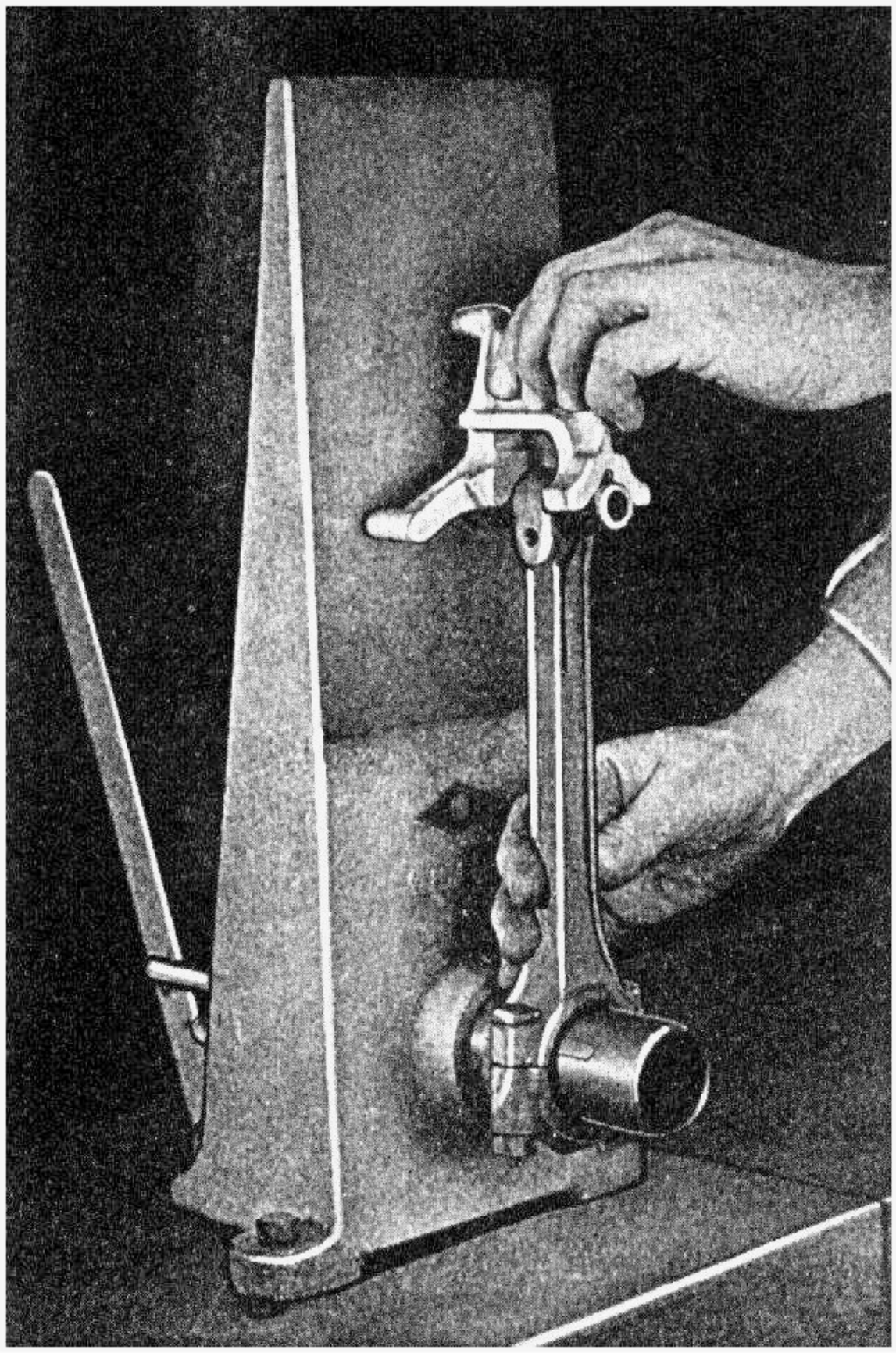


FIG. 22—CONNECTING ROD ALIGNER

in a new piston using compound, as in so doing it will ruin the tin plating on the piston and cause a scoring or wiping condition of both the piston and cylinder walls. See "Checking Cylinder Bores" and "Cylinder Boring", Pages 28 and 29.

PISTON RINGS

Width of compression rings 3/32". Width of oil control ring 3/16". The upper compression ring is installed with the inside beveled edge up. The face of the lower compression ring is tapered .005". The letters "T-O-P" on the upper edge of the ring indicates how the ring is installed, Fig. 24.

When fitting the rings to the cylinder bores, the end gap is .008"—.013". Fig. 25.

Fitting rings to piston grooves, Fig. 26 and 27. Compression rings .0005"—.001". Oil rings .001"—.0015".

Oversize rings are available in the following sizes: .010"; .020"; .030". Use standard rings up to .010" oversize cylinder bores.

PISTON PIN

The piston pin is anchored in the rod with a lock screw and fitted with a clearance of .0001" to .0009" in piston which is equivalent to a light thumb push fit at room temperature of 70°; pin diameter 13/16" (.8117"). See Fig. 28.

Piston pins are available in oversizes .001"; .002"; .003".

ASSEMBLING CONNECTING ROD TO PISTON

Clamp connecting rod in vise using vise jaw protector shields of a soft metal or two pieces of hardwood on each side of connecting rod three inches from piston pin end.

Start piston pin in piston with groove facing down. Assemble piston to connecting rod with the slot in piston, No. 2, Fig. 29 opposite oil spray hole in bearing end of connecting rod, No. 1. Install piston pin clamp screw.

Center piston on pin and place assembly on connecting rod aligning fixture. Tilt piston to left with piston resting against surface plate. With feeler gauge measure clearance between piston skirt and surface plate. See Fig. 30. Tilt piston to right and check clearance. See Fig. 32. If clearance is within .003" on both left and right positions connecting rod is in alignment. A difference greater than .003" indicates connecting rod is twisted.

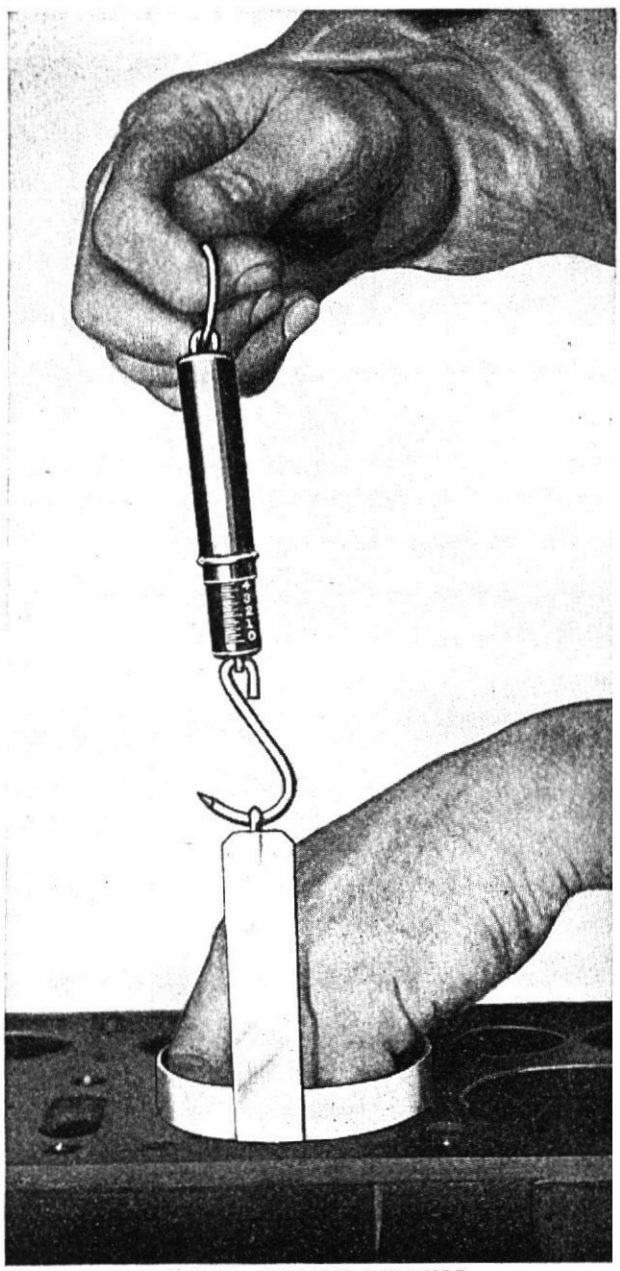


FIG. 23—PISTON FITTING

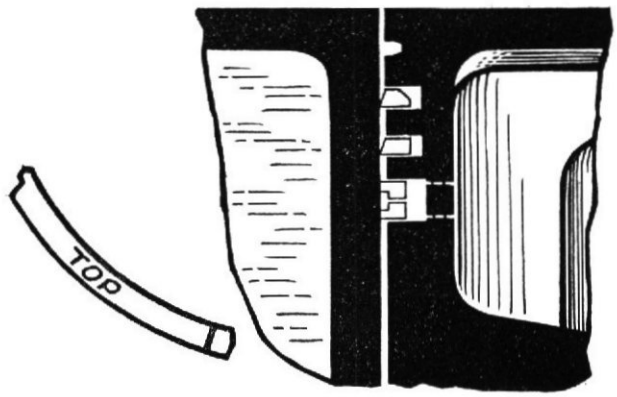


FIG. 24—PISTON RINGS

CHECKING CYLINDER BORES

The best method to be used in determining the condition of the cylinder bores preparatory to reconditioning is the use of a dial gauge such as shown in Fig. 31.

The dial gauge hand will instantly and automatically indicate the slightest variation of the cylinder bores.

To use the dial gauge simply insert in the cylinder bores and move up and down its full length. It is then turned spirally or completely rotated at different points, taking readings at each point. In this manner all variations in the cylinder bores from top to bottom may be determined.

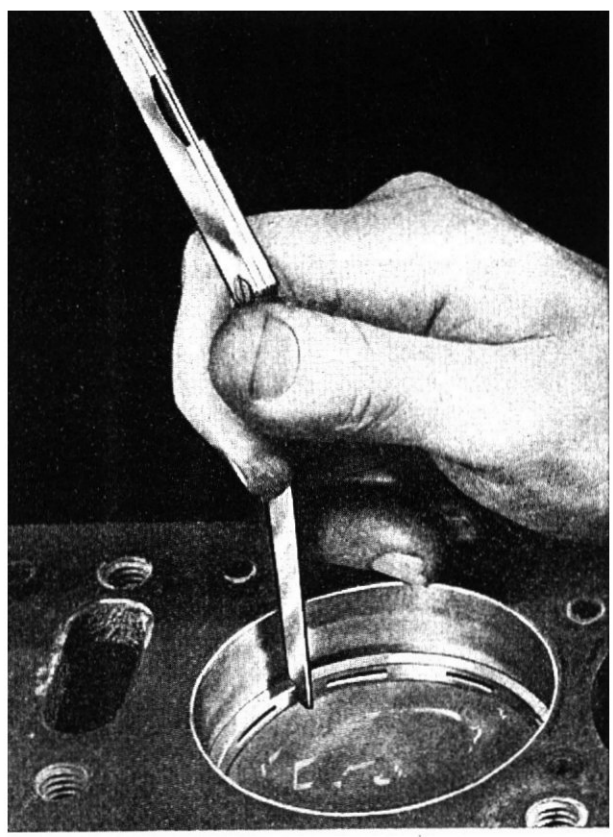


FIG. 25—PISTON RING GAP

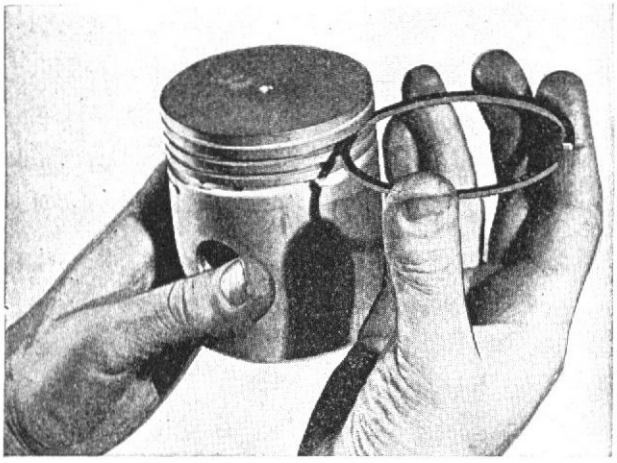


FIG. 26—COMPRESSION RING FITTING

CYLINDER BORING

When cylinders are more than .005" out of true it is best to rebore the cylinders. The instructions furnished by the manufacturer of the equipment should be carefully followed.

After the cylinder has been rebored within .002" of the size desired it should be finished or polished with a cylinder hone. Do not use a piston as a hone. In operating, the hone is placed in the cylinder bore and run up and down the full length of the cylinder wall. This procedure should be followed until the piston can be forced through the bores with a .003" feeler gauge ¾" wide on the thrust side and show a pull on the feeler gauge of five to ten pounds. See Fig. 23.

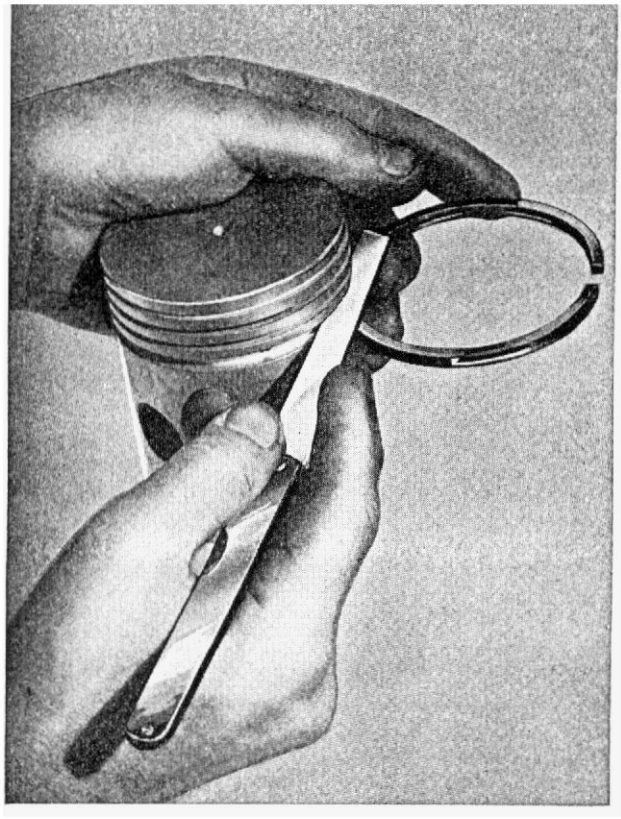


FIG. 27—OIL RING FITTING

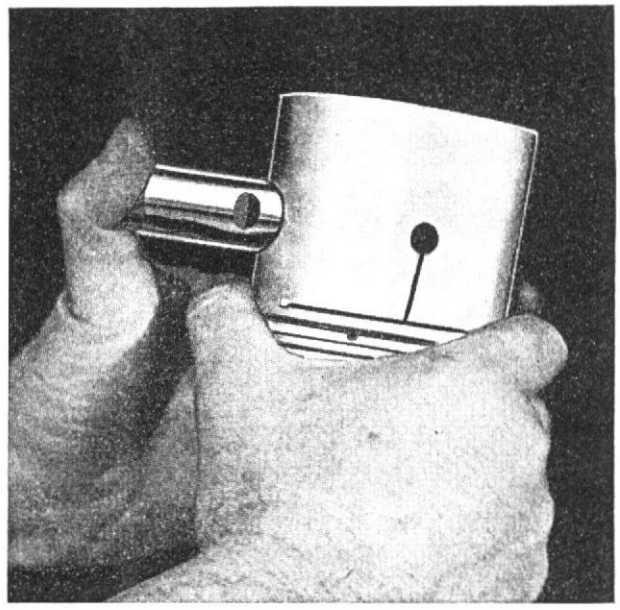


FIG. 28—PISTON PIN FITTING

OIL PUMP ASSEMBLY

The oil pump is the planetary gear type. It consists of two spur gears enclosed in a one piece housing. It is provided with a relief valve to control maximum oil pressure at all speeds. In operation the oil is drawn from the crankcase through the floating oil intake, Fig. 33. The oil then passes through a drilled passage in crankcase to the oil pump from which it passes to the oil distribution system or drilled passages in crankcase to crankshaft and camshaft bearings.

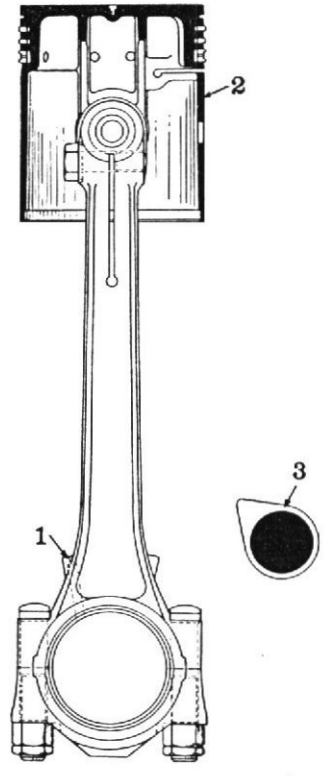


FIG. 29—CONNECTING ROD AND PISTON

The oil pump is driven from a spiral gear on the camshaft which is located at the center of the engine block on left hand side. See No. 22, Fig. 1.

To remove oil pump from engine for dismantling; remove the three nuts on studs holding oil pump to crankcase. Slide oil pump from studs. Remove screw No. 6, Fig. 34, in oil pump cover plate which will allow cover to be removed from housing.

To remove driven gear No. 16, file off one end of straight pin No. 17, with a small drift drive pin through the shaft. The oil pump shaft and rotor No. 12 can be removed from the body in an assembly.

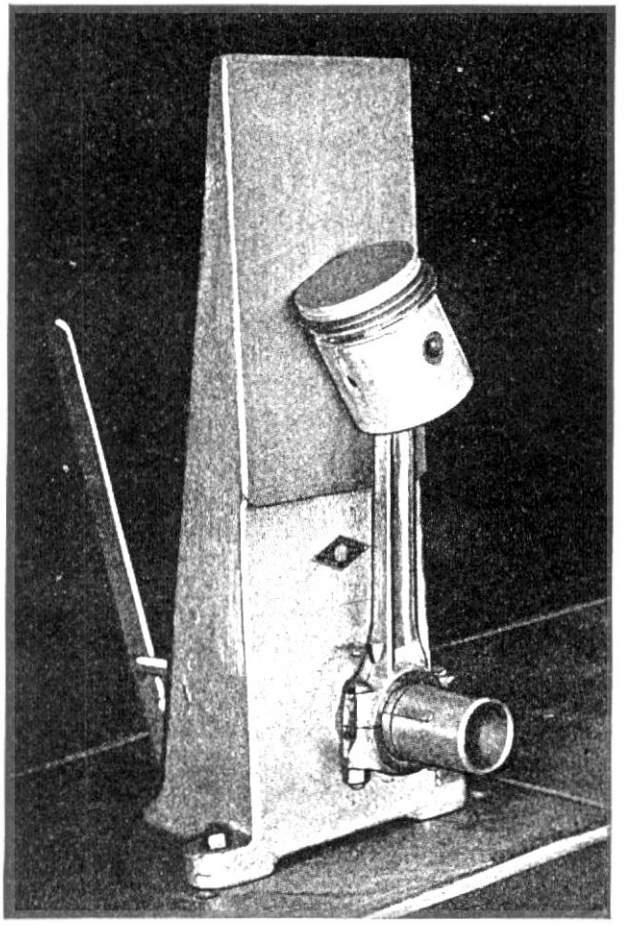


FIG. 30—CONNECTING ROD TWIST-RIGHT

When removing spring retainer No. 1, care must be taken not to lose the small shims No. 3 which govern the spring tension of the relief valve No. 5. Adding shims increases the oil pressure, removing of shims decreases the pressure. The pressure at which the relief valve opens is 40 lbs. actual, however, on instrument panel gauge it will register between 75 and 80. The idle reading should not be less than 10.

When replacing the oil pump on engine the following procedure should be followed in order to have correct timing for the ignition.

Set No. 1 piston coming up on the compression stroke, then turn flywheel so that the timing mark "IGN" appears on the flywheel in the center of the hole in the flywheel housing on the right hand side, Fig. 15.

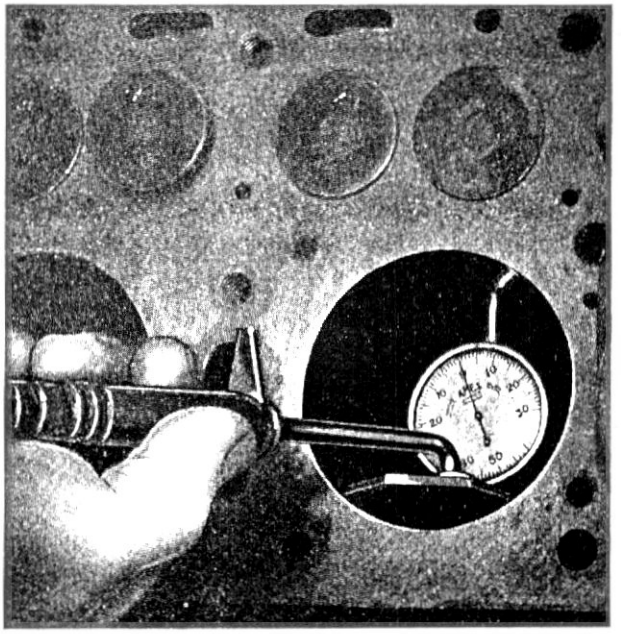


FIG. 31—CYLINDER BORE GAUGE

Set distributor rotor at No. 1 terminal tower in distributor cap and with the points just breaking.

Hold the oil pump in one hand with the oil relief valve retainer in the same position as it

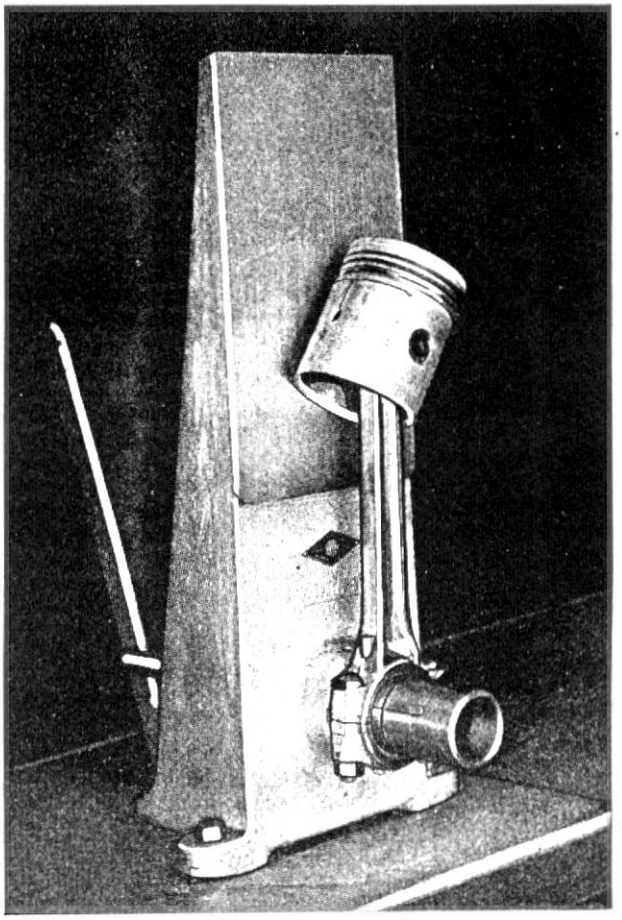


FIG. 32—CONNECTING ROD TWIST-LEFT

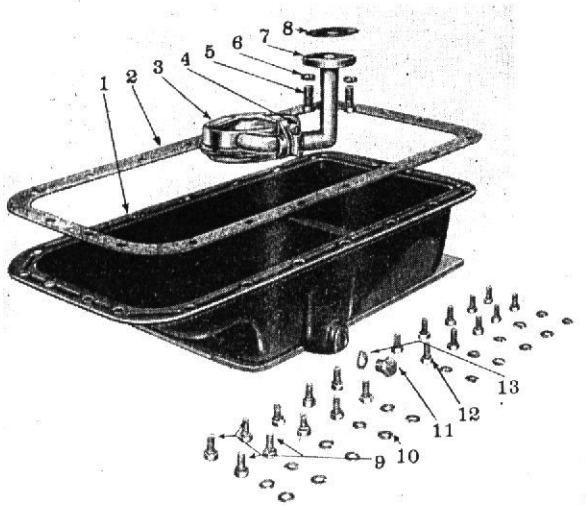


FIG. 33—FLOATING OIL INTAKE AND PAN

No.	Willys Part No.	Ford Part No.	Name
1	A-1167	GPW-6675	Oil Pan Assembly
2	639980	GPW-6710	Oil Pan Gasket
3	630396	GPW-6615	Oil Float Assembly
4	5108	72053-S	Oil Float to Support Cotter Pin
5	636796	355396-S	Oil Float Support to Crankcase Screw
6	51833	34806-S	Oil Float Support to Crankcase—Screw Lockwasher
7	630397	GPW-6617	Oil Float Support
8	630398	GPW-6627	Oil Float Support Gasket
9	51485	20326-S	Oil Pan to Front Engine—Cover Screw
10	51833	34806-S	Oil Pan Screw Lockwasher
11	639979	GPW-6727	Oil Pan Drain Plug
12	51485	20326-S	Oil Pan to Cylinder Block Screw
13	314338	GPW-6734	Oil Pan Drain Plug Gasket

would be when installed in the engine; turn shaft so that the narrow side of slot in driven gear end is toward you, then line up the pin holding driven gear to shaft so that it will fall in line with the right hand side of the slot in pump body. Slide the assembly on studs in the crankcase, feed gear slowly into cam shaft gear, noting when fully set, if the rotor on distributor has moved from its original setting. If so remove oil pump and turn one tooth to obtain the correct setting.

FLOATING OIL INTAKE

The floating oil intake, Fig. 33 is attached to the crankcase with two cap screws. The construction of the float and screen cause it to float on top of the oil, raising and lowering in relation to the amount of oil in the crankcase.

This construction does not permit water or dirt to circulate, which may have accumulated in the bottom of the oil pan, because the oil is drawn horizontally from the top surface.

Whenever removed the float, screen and tube should be cleaned thoroughly in a suitable cleaning fluid to remove any accumulation of dirt.

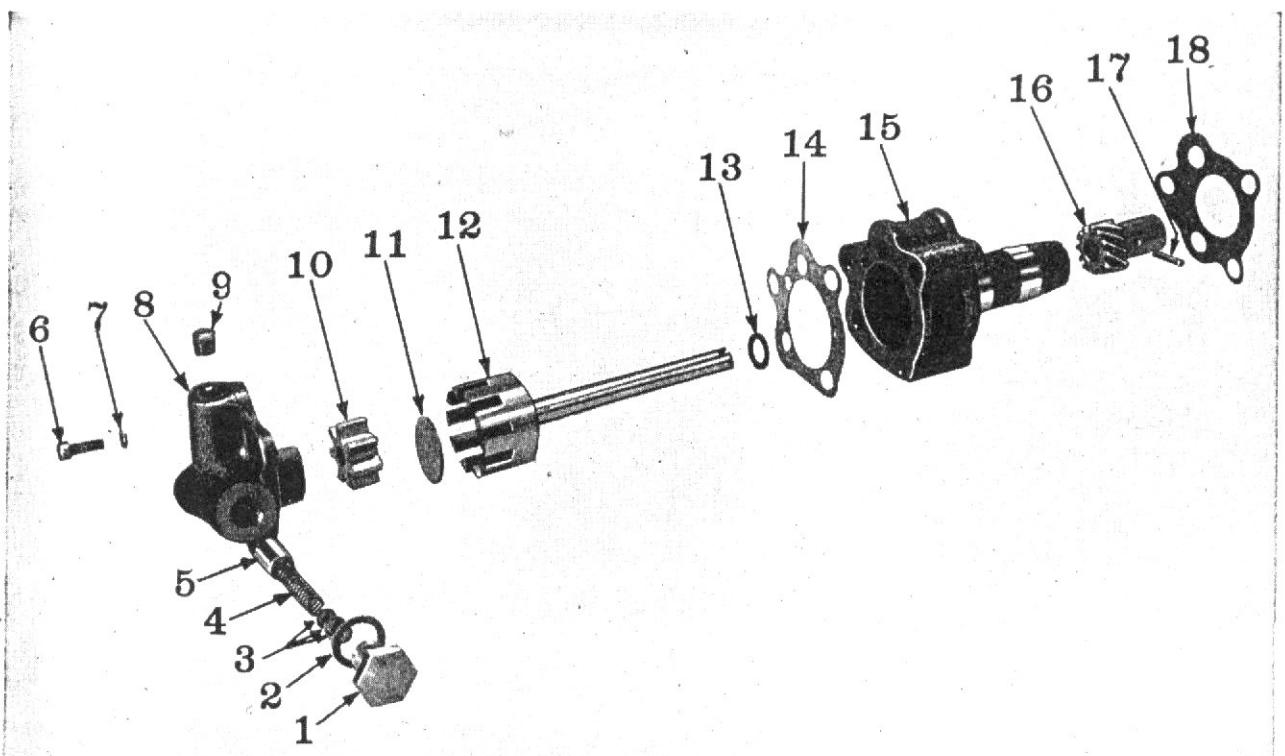


FIG. 34—OIL PUMP

No.	Willys Part No.	Ford Part No.	Name
1	630390	GPW-6644	Oil Pump Oil Relief Spring Retainer
2	634813	GPW-6642	Oil Pump Oil Relief Spring Retainer Gasket
3	630389	GPW-6628	Oil Pump Relief Spring Shim
4	356155	GPW-6651	Oil Pump Relief Plunger Spring
5	630518	GPW-6663	Oil Pump Oil Relief Plunger
6	51819	31079-S	Oil Pump Cover to Body Screw
7	380197		Oil Pump Cover to Body Screw Lockwasher
8	630387	GPW-6664	Oil Pump Cover Assembly
9	52525	353052-S	Oil Pump Cover Plug
10	343306	GPW-6614	Oil Pump Pinion
11	636600	GPW-6673	Oil Pump Rotor Disc
12	636599	GPW-6608	Oil Pump Shaft Assembly
13	375927	GPW-6625	Oil Pump Shaft Gasket
14	639870	GPW-6659	Oil Pump Cover Gasket
15	630384	GPW-6604	Oil Pump Body
16	637425	GPW-6610	Oil Pump Driven Gear
17	330964	GPW-6684	Oil Pump Driven Gear Pin
18	630394	GPW-6630	Oil Pump to Cylinder Block Gasket

FLYWHEEL

The flywheel is made of cast steel, machined all over and balanced to insure smooth engine performance. A steel ring gear is shrunk on the outer edge to mesh with the starter Bendix gear when starting engine.

The flywheel is attached to the crankshaft flange by two dowel bolts and four special head cap screws. When assembling the flywheel to crankshaft, be sure it is properly installed in relation to No. 1 crank throw and that it fits properly to crankshaft flange, to avoid runout or looseness. To check runout use dial indicator attached to the rear engine plate. The runout should not exceed .008" on the rear face near the rim. Torque wrench reading 36-40 ft. lbs.

When installing a new crankshaft or flywheel in service, it is the general practice to replace the tapered dowel bolts with straight snug fitting bolts. The crankshaft and flywheel should be assembled in proper relation, then install the straight bolts previously used and tighten securely. Next use a $^{35}/_{64}$" drill to enlarge the tapered bolt holes and then ream the holes with a $^{9}/_{16}$" (.5625") straight reamer and install two flywheel to crankshaft bolts No. 116295 with nut No. 52804 and lockwasher No. 52330, instead of the two dowel bolts formerly used. This procedure overcomes the difficulty in correctly tapering holes in the field.

OIL FILTER

The oil filter, No. 35 is so designed that it will effectively control contamination of engine oil. The filter element removes particles of dust, carbon and other foreign material from the oil which cause discoloration and sludge.

The inlet line to the filter is connected to the oil distribution line at the front plug on left hand side of engine. The outlet or oil return line to engine connects to the timing chain cover.

When the oil on the level indicator in the engine filler tube becomes dark, remove the oil filter cover; remove the drain plug and drain out the sludge after which replace the drain plug. Next, remove the element and install a new element. Install new cover gasket; reinstall cover, start engine and check for leaks; then check oil level; add to oil supply if necessary.

OIL PRESSURE GAUGE

The oil pressure gauge is of the Bourdon or hydraulic type and measures the pressure of the oil applied to the engine bearings. It does not indicate the amount of oil in the engine crankcase or the need for changing of the engine oil.

A pressure tube connects the gauge unit to the engine. It requires no special attention other than to see that the connection to the engine is tight.

If the unit becomes inoperative, it should be replaced as its construction does not permit repair or adjustment.

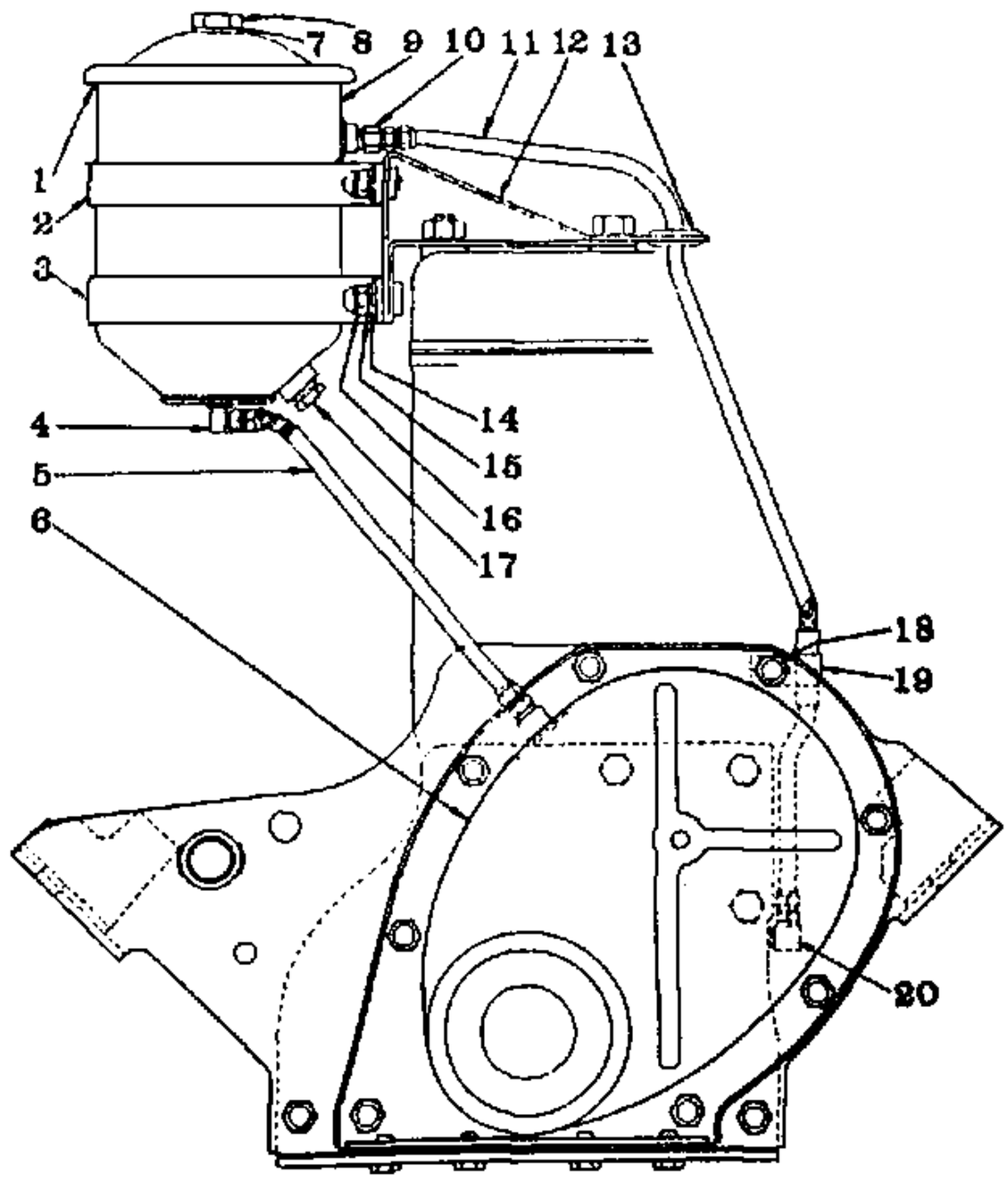


FIG. 35—OIL FILTER

No.	Willys Part No.	Ford Part No.	Name
1	A-1235	GPW-18688	Cover Gasket
2	A-1251	GPW-18658	Clamp Assembly
3	A-1251	GPW-18658	Clamp Assembly
4	384569	GPW-9628	Inverted Flared Tube Ell
5	A-1198	GPW-18666	Oil Filter Outlet Tube
6	A-1190		Chain Cover Assembly
7	A-1233	GPW-18675	Cover Bolt Gasket
8	A-1232	GPW-18691	Cover Bolt
9	A-1230	GPW-18660	Oil Filter Assembly
10	387891	9N-18679	Inverted Flared Tube Connector
11	A-1197	GPW-18667	Oil Filter Inlet Tube
12	A-1247	GPW-18663	Oil Filter Bracket Assembly
13	345961	GPW-13434-A2	Rubber Grommet
14	52274	34746-S2	Plain Washer
15	51833	34806-S	Lockwasher
16	51396	24347-S2	Screw (Filter to Bracket)
17	A-1237	358040-S	Drain Plug
18	5919	24389-S2	Screw (Timing Chain Cover)
19	A-1289	GPW-14585	Inlet Tube Clip
20	384569	GPW-9628	Inverted Flared Tube Ell
—	A-1236	GPW-18632	Filter Element Assembly

ENGINE SUPPORT PLATE AND MOUNTING

The front engine support plate is bolted to the front face of the cylinder block and forms the back panel for the attachment of the timing chain cover.

The rubber engine mountings, which are attached to the frame side rail brackets and to the support plate, prevent fore-and-aft motion of engine yet allow free side wise and vertical oscillation which has the effect of neutralizing vibration at its source, No. 9, Fig. 36.

The rear engine plate is attached to the rear of the cylinder block and provides a means for attaching the flywheel bell housing.

The engine is attached to the center cross member of the frame on a mounting which attaches to the bottom of the transmission. Torque wrench reading, 38-42 ft. lbs.

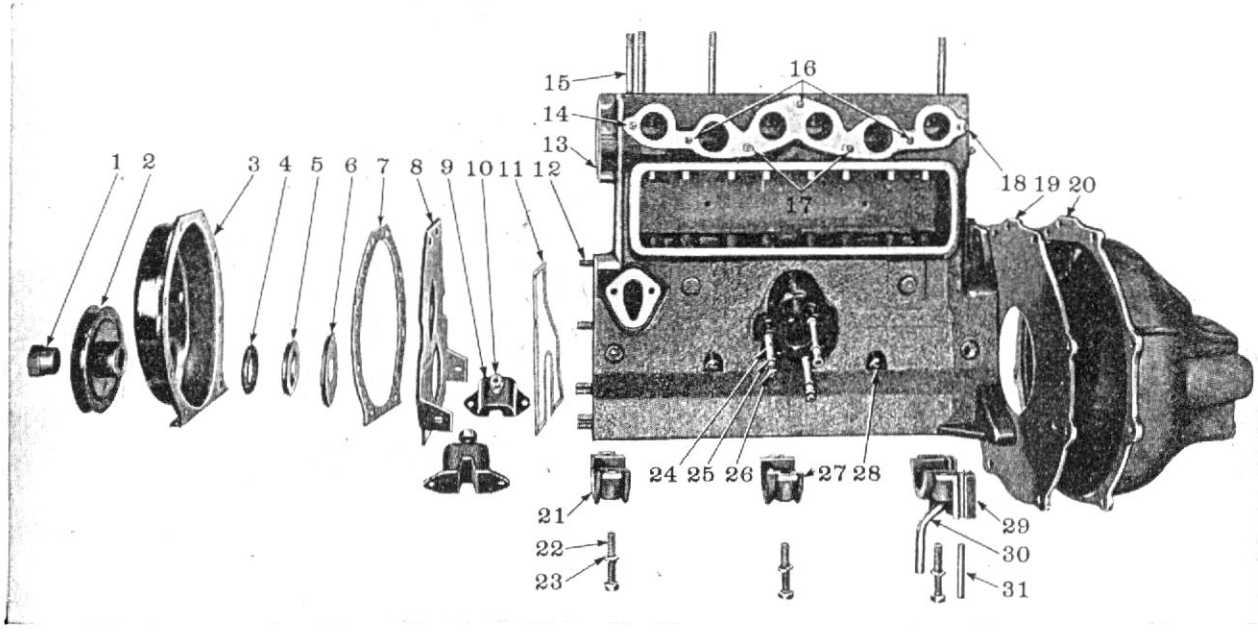


FIG. 36—TIMING CHAIN COVER, CYLINDER BLOCK AND BELL HOUSING

No.	Willys Part No.	Ford Part No.	Name
1	387633	GPW-6319	Starting Crank Nut Assembly
2	638113	GPW-6312	Fan Drive Pulley
3	A-1190		Chain Cover Assembly
4	637098	GPW-6700	Crankshaft Packing—Front End
5	375920	GPW-6287	Crankshaft Packing Retainer
6	375877	GPW-6310	Crankshaft Oil Slinger
7	630365	GPW-6288	Chain Cover Gasket
8	A-1463	GPW-6031	Engine Plate Front Assembly
9	A-542	GPW-6038	Engine Support Insulator—Front
10	5916	33846-S	Engine Support Insulator Nut—to Engine Plate
11	630359	GPW-6020	Cylinder Block Gasket—Front
12	384958	88032-S	Chain Cover and Front Plate Stud
13	A-1272		Cylinder Block and Bearings Assembly
14	349712	88082-S	Inlet and Exhaust Manifold Stud—1 15/16"
15	349368	GPW-6066	Cylinder Head Stud
16	300143	88042-S	Inlet and Exhaust Manifold Stud—1½"
17	632159	88057-S7	Inlet and Exhaust Manifold Stud—1 11/16"
18	349712	88082-S	Inlet and Exhaust Manifold Stud—1 15/16"
19	A-5121	GPW-7007	Engine Plate—Rear
20	A-439	GPW-6392	Transmission Bell Housing Assembly
21	630285	GPW-6329	Crankshaft Bearing Cap—Front
22	381519	GPW-6345	Bearing Caps to Crankcase Screw
23	5009	34809-S	Bearing Cap to Crankcase Screw Lockwasher
24	375981	88141-S	Oil Pump to Cylinder Block Stud
25	51833	34806-S	Oil Pump Stud Nut Lockwasher
26	5910	33798-S	Oil Pump Stud Nut
27	630288	GPW-6330	Crankcase Bearing Cap—Center
28	5085		Oil Passage Plug
29	637236	GPW-6325	Crankshaft Bearing Cap—Rear
30	630294	GPW-6326	Crankshaft Rear Bearing Drain Pipe
31	637790	GPW-6701	Crankshaft Rear Bearing Cap Packing

ENGINE TROUBLES AND CAUSES

Poor Fuel Economy

Ignition Timing Slow or Spark Advance Stuck
Carburetor Float High
Accelerator Pump Not Properly Adjusted
Gasoline Leakage
Leaky Fuel Pump Diaphragm
Loose Engine Mounting causing high gasoline level in Carburetor.
Low Compression
Valves Sticking
Spark Plugs Bad
Weak Coil or Condenser
Improper Valve Tappet Clearance
Carburetor Air Cleaner Dirty
Clogged Muffler or bent Exhaust Pipe

Lack of Power

Low Compression
Ignition System (Timing Late)
Improper Functioning Carburetor or Fuel Pump
Gasoline Lines Clogged
Air Cleaner Restricted
Engine Temperature High
Improper Tappet Clearance
Sticking Valves—Valve Timing
Leaky Gaskets
Muffler Clogged
Bent Exhaust Pipe
Old Gasoline

Low Compression

Leaky Valves
Poor Piston Ring Seal
Sticking Valves
Valve Spring Weak or Broken
Cylinder Scored or Worn
Tappet Clearance Incorrect
Piston Clearance too Large
Leaky Cylinder Head Gasket

Burned Valves and Seats

Sticking Valves or too loose in Guides
Improper Timing
Excessive Carbon around Valve Head and Seat
Overheating
Valve Spring Weak or Broken
Valve Tappet Sticking or not set to .014"
Clogged Exhaust System

Valves Sticking

Warped Valve
Improper Tappet Clearance
Carbonize or scored Valve Stems
Insufficient Clearance Valve Stem to Guide
Weak or Broken Valve Spring
Valve Spring Cocked
Contaminated Oil

Overheating

Defective Cooling
Thermostat Inoperative
Improper Ignition Timing
Improper Valve Timing
Excessive Carbon Accumulation
Fan Belt too Loose
Clogged Muffler or Bent Exhaust Pipe
Oiling System Failure
Scored or Leaky Piston Rings

Popping-Spitting-Detonation

Improper Ignition
Improper Carburetion
Excessive Carbon Deposit in Combustion Chamber
Poor Valve Seating
Sticking Valves—Broken Valve Spring
Tappets Adjusted too Close
Spark Plug Electrodes Burnt
Water or Dirt in Fuel—Clogged Lines
Improper Valve Timing

Excessive Oil Consumption

Piston Rings Stuck in Groove, Worn or Broken
Piston Rings Improperly fitted or Weak
Piston Ring Oil Return Holes Clogged
Excessive Clearance Main and Connecting Rod Bearings
Oil Leaks at Gasket or Oil Seals
Excessive Clearance Valve Stem to Valve Guide (Intake)
Cylinder Bores Scored-Out-of-Round or Tapered
Too Much Clearance Piston to Cylinder Bore
Misaligned Connecting Rods
High Road Speeds or Temperature

Bearing Failure

Crankshaft Bearing Journal Out of Round
Crankshaft Bearing Journals Rough
Lack of Oil—Oil Leakage
Dirty Oil
Low Oil Pressure or Oil Pump Failure
Drilled Passages in Crankcase or Crankshaft Restricted
Oil Screen Dirty
Connecting Rod Bent

ENGINE SPECIFICATIONS

Type	L. Head
Number of Cylinders	4
Bore	3 1/8"
Stroke	4 3/8"
Piston Displacement	134.2 cu. in.
Compression Ratio	6.48 to 1
Horse Power Max. Brake	60 @ 4000
Compression	111 lbs. @ 185 R.P.M.
S.A.E. Horse Power	15.63
Maximum Torque	105 Lbs.-Ft. @ 2000 R.P.M.
Firing Order	1-3-4-2
Cylinder Block:	
Bore Size	3.125"—3.127"
Cylinder Head:	
Torque Wrench Pull	
Cylinder Head Screw	65-75 Lbs.-Ft.
Cylinder Head Stud Nut	60-65 Lbs.-Ft.
Crankshaft:	
Counter Weights	4
Crankshaft Main Bearings:	
Bearing Journals	3
Front	2.3340"x1.920"
Center	2.3340"x1 13/16"
Rear	2.3340"x1 3/4"
Thrust	Front
End-play	.004"-.006"
Bearing Clearance	.001"
Type	Steel back, babbitt lined
Non-Adjustable	Replaceable Without Reaming
Torque Wrench Pull	65-70 Lbs.-Ft.
Connecting Rod:	
Center to Center Length	9 3/16"
Upper End	Piston Pin Locked in Rod
Lower Bearing Type	Steel back, babbitt lined, replaceable
Lower Bearing Diameter and Length	1 15/16"-x1 5/16"
Clearance on Crankshaft	.0008"-.0023"
Side Clearance	.005"-.009"
Torque Wrench Pull	50-55 Lbs.-Ft.
Installation	From Top Offset away from nearest main bearing Oil spray hole away from camshaft
Piston:	
Lo-Ex Lynite T-Slot—Oval Ground—Tin Plated—Heat dam	
Length	3 3/4"
Clearance Top Land	.0205"-.0225"
Clearance Skirt	.003"
Oversize pistons Available	.010", .020", .030"
Number Rings	3
Compression Ring	2-Width 5/32"
Oil Ring	1-Width 3/16"
Ring Gap	.008"-.013"
Ring to Groove Clearance	.0005"-.0015"
Piston Pin Hole	
Diamond Bored	15/16" (.8007"-.8119")
Piston Pin:	
Length	2 25/32"
Diameter	13/16"
Type	Locked in Rod
Clearance in Piston	.0001"-.0009"
Oversize Pins Available	.001", .002", .003"

Engine Specifications—Continued

Camshaft:
- Number of Bearings: 4
- Bearing Journal Diameter:
  - Front: 2 5/16"
  - Front Intermediate: 2 1/4"
  - Rear Intermediate: 2 3/16"
  - Rear: 1 3/4"
- Thrust Taken: Front
- End Play Control: Plunger and Spring

Camshaft Bearings:
- Front: Steel Back Babbitt Lined
- Clearance: .002"-.0035"

Intake Valve:
- Tappet Clearance Cold: .014"
- Seat Angle: 45°
- Diameter Head: 1 17/32"
- Length Over-all: 5 3/4"
- Stem Diameter: .373"
- Stem to Guide Clearance: .0015" to .00325"
- Intake Opens: 9° BTC Flywheel (.039" Piston travel)
- Intake Closes: 50° ABC Flywheel (3.772" Piston travel)
- Lift: 23/64"

Exhaust Valve:
- Tappet Clearance Cold: .014"
- Seat Angle: 45°
- Diameter Head: 1 15/32"
- Length Over-all: 5 3/4"
- Stem Diameter: .3725"
- Stem to Guide Clearance: .002"-.00375"
- Exhaust Opens: 47° BBC Flywheel (3.799" Piston travel)
- Exhaust Closes: 12° ATC Flywheel (.054" Piston travel)
- Lift: 23/64"

Valve Spring:
- Free Length: 2 1/2"
- Spring Pressure Valve Closed: 50 lbs. length 2 7/64"
- Spring Pressure Valve Open: 116 lbs. length 1 3/4"
- Closed Coil End of Spring: Installed Up against Block

Valve Tappet:
- Overall Length: 2 7/8"
- Stem Diameter: .6240"-.6245"
- Clearance To Guide: .0005"-.002"
- Adjusting Screw: 3/8"-24 thd. x 1 1/32"

Timing Chain:
- Link-Belt
- Number Links: 47
- Width: 1"
- Pitch: 1/2"
- Type: Non-adjustable

Fan Belt:
- Type: "V"
- Angle of Vee: 42°
- Length outside: 44 1/8"
- Width: 11/16"

Oil Pump:
- Type: Planetary Gear
- Driven from Camshaft: Gear

Oil Pressure Relief:
- Pressure 40 lbs. actual—75 gauge at 30 miles per hour.
- Adjustable: Shims in Spring Retainer.

Oil Filter: Purolator No. 27078

Spark Plugs: Champion QM-2