SECTION 9

ENGINE

SERVICE BULLETIN REFERENCE

NUMBER	DATE	SUBJECT	CHANGES

NOTES

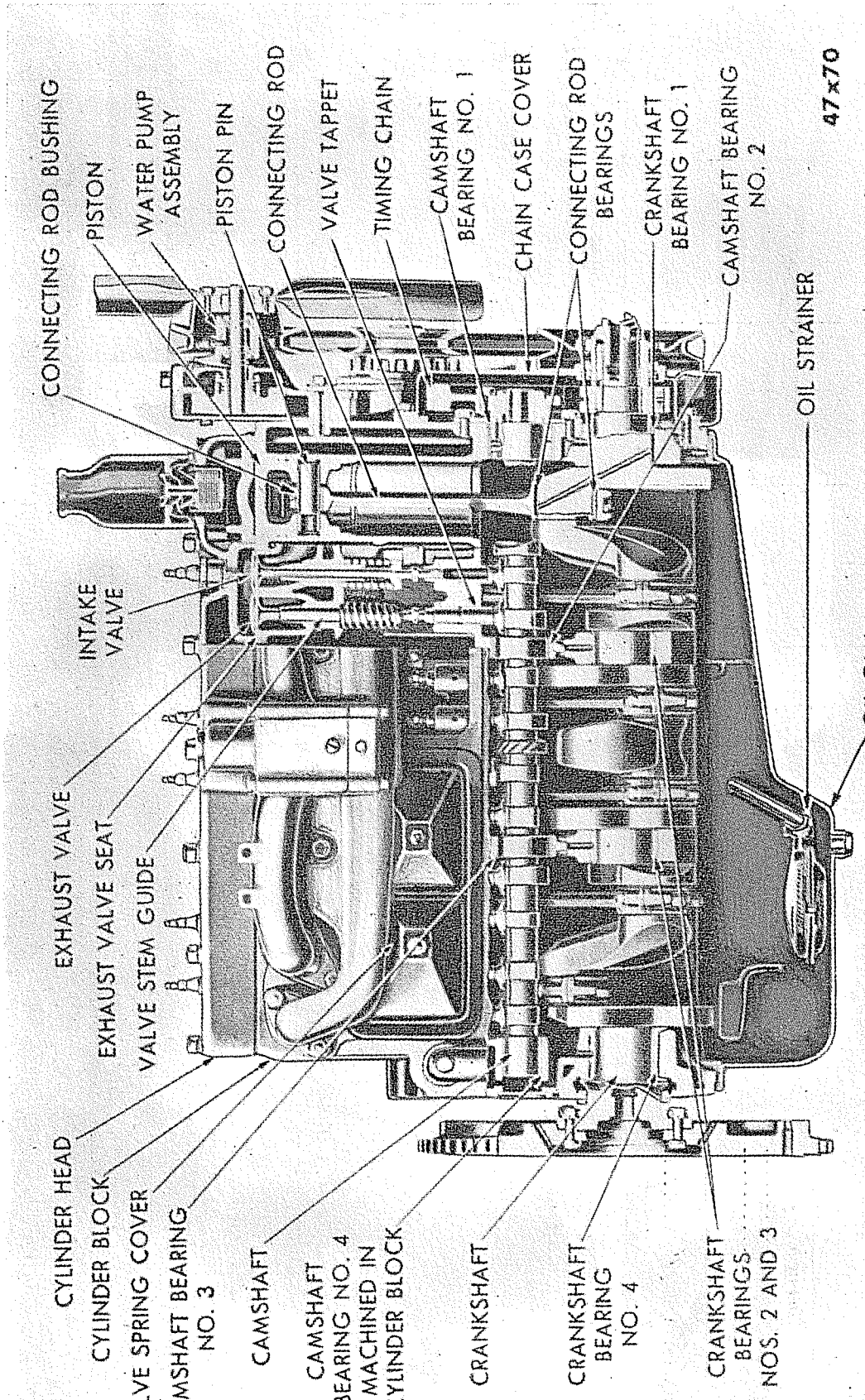

Fig. 1. ENGINE — TYPICAL SIDE SECTIONAL VIEW

SERVICE STANDARDS

Model Designation →	1-08AD 1-08AF 1-08AS	2-26AD 2-26AF 2-26AS	2-33AD 2-33AF 2-33AS	3-59AD 3-59AF 3-59AS	6-71AD 6-71AF 6-71AS	8-65AD 8-65AF 8-65AS	8-71AD 8-71AF 8-71AS
Maximum Torque:							
Ft./Lbs.	195	195	195	195	195	195	195
At R.P.M.	1400	1400	1400	1400	1400	1400	1400
Compression Ratio	6.25 to 1	6.25 to 1	6.25 to 1	6.25 to 1	6.25 to 1	6.25 to 1	6.25 to 1
Camshaft:							
Bearing Clearance	.002 to .004	.002 to .004	.002 to .004	.002 to .004	.002 to .004	.002 to .004	.002 to .004
End Play	.002 to .006	.002 to .006	.002 to .006	.002 to .006	.002 to .006	.002 to .006	.002 to .006
Connecting Rod:							
Big End Bearing Clearance	.001 to .003	.001 to .003	.001 to .003	.001 to .003	.001 to .003	.001 to .003	.001 to .003
End Play	.005 to .011	.005 to .011	.005 to .011	.005 to .011	.005 to .011	.005 to .011	.005 to .011
Crankshaft:							
Con Rod Journal Diameter	$2\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{1}{8}$	$2\frac{1}{8}$
Main Journal Diameter ..	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$
Main Bearing Clearance ..	.0015 to .003	.0015 to .003	.0015 to .003	.0015 to .003	.0015 to .003	.0015 to .003	.0015 to .003
End Play at Rear Main Bearing	.003 to .008	.003 to .008	.003 to .008	.003 to .008	.003 to .008	.003 to .008	.003 to .008
Cylinders:							
Max. Allowable Taper ...	.0015	.0015	.0015	.0015	.0015	.0015	.0015
Max. Allowable Out of Round	.002	.002	.002	.002	.002	.002	.002
Reconditioning Working Limits	.0005	.0005	.0005	.0005	.0005	.0005	.0005
Oil Pressure ..... at	40 lbs. 800 r.p.m.	40 lbs. 800 r.p.m.	40 lbs. 800 r.p.m.	40 lbs. 800 r.p.m.	40 lbs. 800 r.p.m.	40 lbs. 800 r.p.m.	40 lbs. 800 r.p.m.
Piston Ring to Groove Side Clearance:							
Compression Ring Upper	.0025 to .004	.0025 to .004	.0025 to .004	.0025 to .004	.0025 to .004	.0025 to .004	.0025 to .004
Compression Ring Lower	.002 to .0035	.002 to .0035	.002 to .0035	.002 to .0035	.002 to .0035	.002 to .0035	.002 to .0035
Oil Control Rings	.001 to .0025	.001 to .0025	.001 to .0025	.001 to .0025	.001 to .0025	.001 to .0025	.001 to .0025

SERVICE STANDARDS

(CONTINUED)

Model Designation →	1-08AD 1-08AF 1-08AS	2-26AD 2-26AF 2-26AS	2-33AD 2-33AF 2-33AS	3-59AD 3-59AF 3-59AS	6-71AD 6-71AF 6-71AS	8-65AD 8-65AF 8-65AS	8-71AD 8-71AF 8-71AS
Piston Skirt Clearance for .002″ x ½″ Feeler Gauge (on Thrust Side of Piston)	4 to 6 lbs. pull on scale at 70°F.						
Piston Pin Service Fit in Piston and Connecting Rod	All Models: Thumb Press fit when both Piston and Pin at normal room temperature 70°F.						
Piston Ring Gap Clearance..	.007 to .015	.007 to .015	.007 to .015	.007 to .015	.007 to .015	.007 to .015	.007 to .015
Valve Inlet Stem Clearance in Guide	.001 to .003	.001 to .003	.001 to .003	.001 to .003	.001 to .003	.001 to .003	.001 to .003
Valve Exhaust Stem Clearance in Guide	.003 to .005	.003 to .005	.003 to .005	.003 to .005	.003 to .005	.003 to .005	.003 to .005
Valve Seat Angle	45°	45°	45°	45°	45°	45°	45°
Valve Guide Depth from Top of Cylinder Block	$\frac{7}{8}$″	$\frac{7}{8}$″	$\frac{7}{8}$″	$\frac{7}{8}$″	$\frac{7}{8}$″	$\frac{7}{8}$″	$\frac{7}{8}$″
Valve Seat Width	.090″	.090″	.090″	.090″	.090″	.090″	.090″
Valve Spring:							
Valve Spring Pressure:							
Compressed to $1\frac{3}{8}$″	107 to 115 lbs.	107 to 115 lbs.	107 to 115 lbs.	107 to 115 lbs.	107 to 115 lbs.	107 to 115 lbs.	107 to 115 lbs.
Compressed to $1\frac{3}{4}$″	40 to 45 lbs.	40 to 45 lbs.	40 to 45 lbs.	40 to 45 lbs.	40 to 45 lbs.	40 to 45 lbs.	40 to 45 lbs.
Valve Tappets:							
Clearance (Hot):							
Intake	.010	.010	.010	.010	.010	.010	.010
Exhaust	.014	.014	.014	.014	.014	.014	.014
Clearance to Check Timing (Cold)	.014	.014	.014	.014	.014	.014	.014
Intake Valve Opens for Correct Timing	12° B.T.D.C.	12° B.T.D.C.	12° B.T.D.C.	12° B.T.D.C.	12° B.T.D.C.	12° B.T.D.C.	12° B.T.D.C.
Exhaust Valve Closes for Correct Timing	6° A.T.D.C.	6° A.T.D.C.	6° A.T.D.C.	6° A.T.D.C.	6° A.T.D.C.	6° A.T.D.C.	6° A.T.D.C.

ENGINE

ENGINE TUNE-UP.

Engine performance can be kept at a high standard of efficiency by maintaining a few simple adjustments. High compression engines and high speed demand accurate setting of the ignition and fuel systems for maximum performance. The following tune-up and inspection operations are provided as a guide to easily maintain peak engine performance.

The vehicle owner should be convinced of the importance of frequent tune-up, particularly that outlined under "Minor Tune-up".

1. MINOR TUNE-UP.

The tune-up procedure should be performed frequently in order to maintain the standard of performance the engine is designed to produce.

If the engine performance indicates the need for further inspection or adjustment, after doing the following operations, "Performance Inspections" should be made, and the work done as indicated by these inspections.

(1) Clean the spark plugs by sand blasting and adjust the points to .030 in. gap. Use a round feeler gauge. Too wide a gap reduces speed and power; too narrow a gap causes uneven engine idling.

(2) Adjust breaker points to correct clearance to open .014" to .016". Refer to Service Standards, Electrical Section.

(3) Check distributor cap and rotor for cracks and corrosion. Inspect the small lead wires for breakage or damaged insulation.

(4) Use the timing marks on the crankshaft pulley, or a timing indicator over Number 6 cylinder, and set timing so that the breaker points open at the proper time.

5) Clean and oil the carburettor air cleaner. Clean the fuel filter and bowl. Inspect the filter and replace if necessary. Then set the carburettor idle mixture using a vacuum gauge. Adjust the throttle stop screw so that the engine idles at not less than 6 m.p.h. On engines fitted with Carter carburettor set accelerator pump linkage according to the season of the year, as follows:

Hot weather—short stroke hole.
Normal summer driving—centre hole.
Cold weather—long stroke hole.

(6) Inspect primary and high tension wires for poor insulation or connections, and tighten as required.

TIGHTENING REFERENCE

PART NAME	TORQUE (foot pounds)
Timing chain cover screws	12 to 17
Connecting rod nuts $\frac{3}{8}$"	45 to 50
Connecting rod nuts $\frac{7}{16}$"	50 to 75
Starting crankjaw	108 minimum
Oil pump cover plate screw	15 to 23
Fuel pump attaching screw	12 to 17
Camshaft sprocket screw	15 to 20
Oil pump body screws	20 to 25
Cylinder head nuts $\frac{7}{16}$"	52.5 to 57.5
Cylinder head nuts $\frac{1}{2}$"	85 to 90
Cylinder head cap screws plain head	65 to 70
Cylinder head cap screws cupped head	67.5 to 72.5
Main bearing cap screws	80 to 85
Main bearing nuts	75 to 80
Rear main bearing oil seal retainer screw	5 to 10
Connecting rod nuts and cap screws $\frac{3}{8}$"	45 to 50
Connecting rod nuts and cap screws $\frac{7}{16}$"	50 to 75
Counterweight attaching screws	65 to 70
Flywheel nuts	55 to 60
Manifold stud nuts	15 to 20

2. PERFORMANCE INSPECTION.

When making a complete engine analysis in order to determine the cause of improper engine performance, and when performing a Major Tune-up, the following inspection should be made, using suitable testing equipment:

(a) Check battery and line voltage. The battery is a source of electrical energy for starting the engine. The amount of charge to the battery is governed by the regulator unit which functions according to the state of charge of the battery. Excessive voltage will cause distributor points to burn, hard starting and headlights to burn out. The voltage should be checked at the battery terminal of the voltage regulator with an accurate voltmeter.

(b) **Vacuum Test.**

The vacuum test will reveal many causes of unsatisfactory engine performance. The following conditions affect vacuum readings:

Improper carburettor adjustment.
Improper valve timing.
Burned, riding or sticky valves.
Loose valve guides and weak springs.
Leaky intake manifold and carburettor gaskets.
Piston Ring Seal.

A steady reading of 18 to 21 pounds of vacuum indicates normal performance at idling speeds. Proper interpretation of the needle fluctuation will indicate whether something is wrong within or outside the engine—such as carburettor idle adjustment or ignition timing. At sea level the vacuum gauge should read 18-21 pounds of vacuum, and vary one point for every 1,000 ft. above sea level, when everything is in order.

Listed below are five examples of vacuum reading and their interpretation which will be of assistance:

(1) Low and steady needle indicates low compression, air leaks or late ignition timing.
(2) Rapid vibration of needle when engine is accelerated indicates weak valve springs.
(3) Rapid vibration of needle while the engine is idling indicates worn intake valve guides.
(4) Three or four point intermittent drop of needle indicates sticky valves.
(5) Floating motion of needle from right to left indicates rich mixture.

(c) **Compression Test.**

Before testing compression, remove all spark plugs. Perform the test while cranking the engine with the starter with throttle wide open. Compression pressures depend upon cranking speed, engine temperature and compression ratio. If the reading is reasonably high and uniform (not varying more than 10 lbs. between cylinders) compression pressure may be considered normal. If the compression test indicates an abnormal condition, the cylinder head should be removed for an examination of the valves and condition of the pistons, rings, etc. An extremely low reading obtained in two adjacent cylinders might result from the head gasket leaking between the affected cylinders.

(d) **Condensor Test.**

The condensor may easily be tested without removing it from the truck by using an accurate condensor tester. A defective condensor may cause burning of the contact points, which in turn will affect the performance of the engine.

(3) **Coil Test.**

The ignition coil transforms battery voltage into high voltage for the spark plugs. In order to test the coil, an accurate tester is required.

3. MAJOR TUNE-UP.

The following operations should be performed in addition to the performance inspection and minor tune-up when performing a major tune-up.

(1) Clean and tighten battery connections and add water if necessary. Tighten all primary and high tension wire connections, particularly at the ignition switch, ammeter and fuel gauge behind the instrument panel.
(2) Tighten cylinder head and manifold nuts to proper torque while engine is warm.
(3) Adjust valve clearance with engine at normal running temperature. See Service Standards for valve tappet clearances.
(4) Disconnect the main fuel line at fuel pump and tank. Then clear the line with compressed air.
(5) Check the float level. See Fuel Section for detailed instructions. While the carburettor air horn is off, clean dirt and all foreign material from body.
(6) Road test the vehicle to check for other mechanical irregular conditions which might affect performance such as dragging brakes, slipping clutch, etc.

REMOVAL, INSTALLATION AND MAINTENANCE.

4. CYLINDER BLOCK.

When the engine is overhauled and the cylinder block is stripped, the block should be thoroughly cleaned and inspected for any condition that may render it unfit for further service. The use of live steam, or a suitable degreasing tank, for cleaning the block is recommended. When cleaning a cylinder block, be sure to blow out all passages with compressed air. Inspect particularly the core hole plugs and replace as necessary. When installing new plugs, coat edges of core holes and plugs with a suitable sealer. Then, drive into place.

5. REMOVAL AND INSTALLATION OF ENGINE ASSEMBLY.

(1) Remove the hood.
(2) Drain water from radiator and cylinder block.
(3) Disconnect headlights and parking lights.
(4) Remove radiator inlet and outlet hoses.
(5) Remove radiator, grill and both front fenders as an assembly.
(6) Remove mat and toe board from inside cabin.
(7) Disconnect the propellor shaft.
(8) Remove the transmission (Refer to Transmission Section).
(9) Remove the clutch pedal bracket and brake pedal.
(10) Disconnect the following:
Fuel pump flexible line at fuel pump.
Exhaust pipe at manifold.
Throttle and choke controls.
Heat indicator tube and bulb at cylinder head.
Oil gauge line at the oil line flexible tube.
Starter cable at starter.
High and low tension wires at ignition coil.
Generator wires.
Vacuum brake line at manifold if so equipped.
(11) Remove carburettor air cleaner, horn, breather pipe, ignition coil and brake master cylinder.
(12) Remove the front and rear engine support bolts.

When installation is completed, be sure to bleed the brake lines, aim the headlights, and align the hood. The exhaust pipe support bracket should be loosened and the engine allowed to run a few seconds before tightening engine mounting bolts and exhaust pipe support brackets. This is extremely important, for correct engine alignment.

6. REMOVAL AND INSTALLATION OF CRANKSHAFT (ENGINE REMOVED).

(1) Remove carburettor, spark plugs, etc., and any accessory that will interfere when the engine is turned upside down in a stand. Invert engine..
(2) Remove the fan belt and fan drive pulley.
(3) Remove timing chain case and the cylinder block end plate.
(4) Remove the clutch pan, clutch assembly.
(5) Remove oil pan.
(6) Remove oil pump and strainer assembly and pump outlet pipe.
(7) Remove the connecting rod bearing caps.
(8) Remove the main bearing caps. Use Tool C.305 on the rear cap (Figure 2). Remove crankshaft.
(9) Remove the crankshaft sprocket from the crankshaft using Puller Tool DD-888.
(10) Remove the clutch pilot shaft bearing from the end of the crankshaft.

Before installation, inspect the surface of the shaft or other parts where contact is made with the seal, and make certain the surface is smooth.

Roughness of the contact surface (of parts mentioned above) will cause rapid wear of the seal and result in oil leakage.

When installing the crankshaft, use new cotter pins, lock washers, gaskets and oil seals.

7. REMOVAL AND INSTALLATION OF MAIN BEARINGS (ENGINE REMOVED).

Drain oil pan and place engine upside down in an engine stand (Figure 3) and proceed as follows:

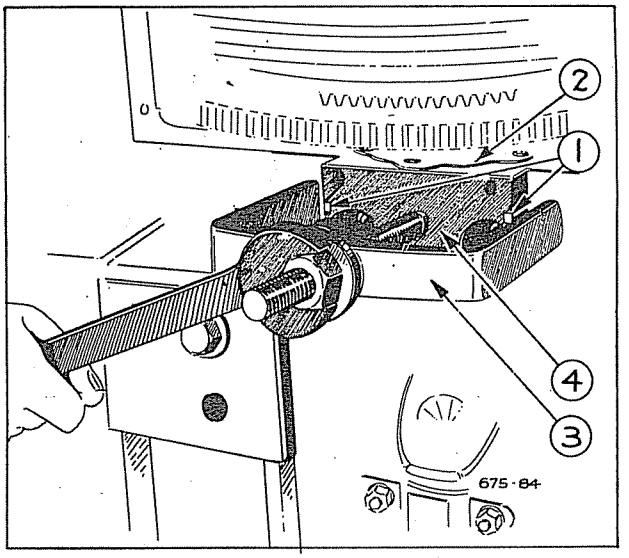

Fig. 2—Removing Rear Main Bearing Cap with Tool C-305.
1 — Crankshaft rear bearing cap oil seals.
2 — Crankshaft rear bearing oil seal and retainer.
3 — Tool C-305.
4 — Crankshaft rear bearing cap.

(1) Remove the oil pan.
(2) Remove the oil pump assembly and outlet pipe.
(3) Remove the main bearing caps.
With tool C.305, remove the rear main bearing cap (Figure 2).

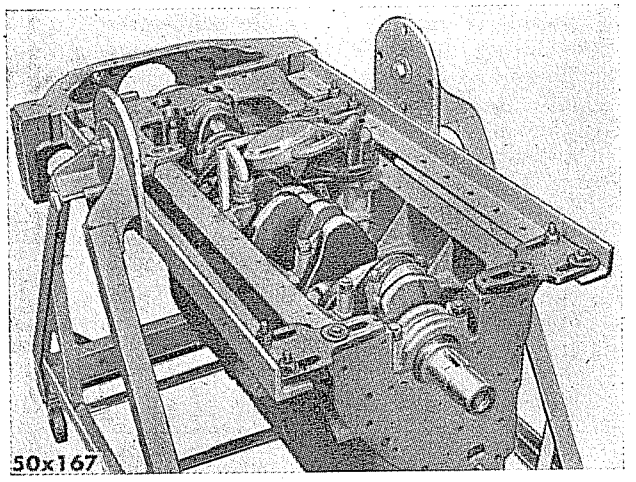

Fig. 3—Engine Mounted in Stand.

(4) Remove and instal the upper bearing shells, one at a time, with tool C.584. Insert the pin of the tool in the oil hole of the crankshaft (Figure 4). Slowly rotate the crankshaft clockwise, forcing out the bearing.

NOTE.—When installing a new upper bearing shell, slightly chamfer the sharp edges from the plain side.

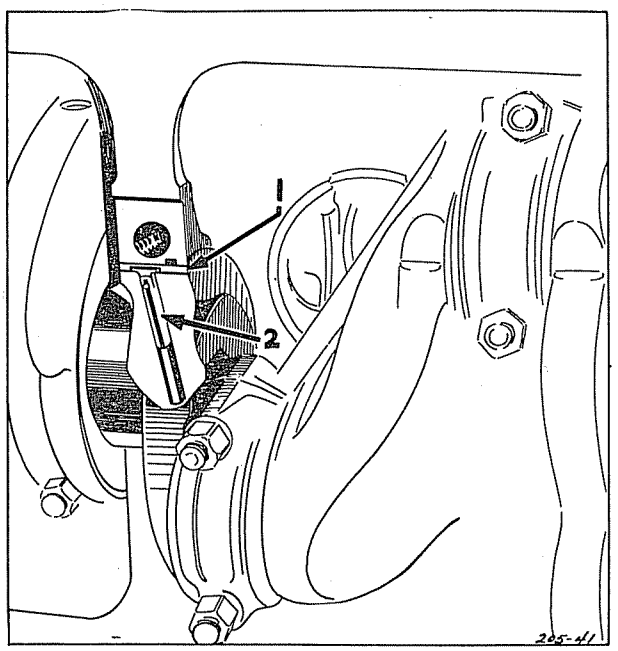

Fig. 4—Removing Upper Main Bearings.
1—Main Bearing 2—Tool C-584

Start the new bearing in place. Then insert tool C.584 in the oil hole in the crankshaft and slide the bearing into place. Slowly rotate the crankshaft counter clockwise, as in Figure 5.

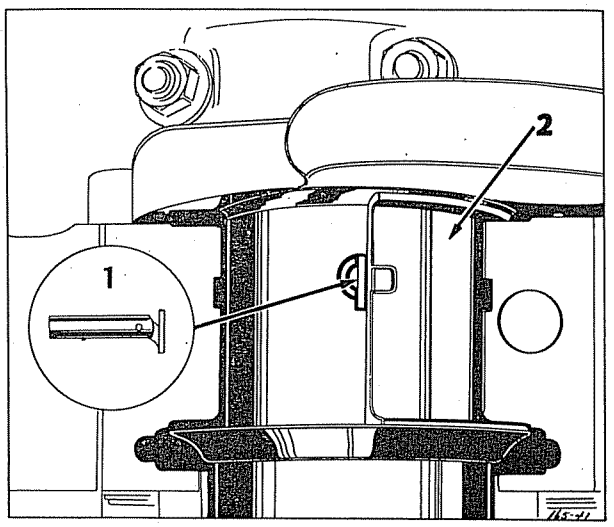

Fig. 5—Removing or Installing Upper Bearing Shells with Tool C-584.
1—Tool C-584 2—Main Bearing

8. CHECKING MAIN BEARING CLEARANCE.

(a) **Inspection.**

Check each bearing carefully. If bearing is scored, chipped or etched, replacement is necessary. If the bearing is in good condition, check its clearance as outlined below.

(b) **Main Bearing Clearance.**

The desired main bearing clearance is from .0015 to .003. To determine if the bearing clearance is within the above limits, proceed as follows:

To see if fit is too tight:

With all bearings in place and bolted up tight, crankshaft must be free enough to turn by hand. If crankshaft can be turned by hand (all the way round one complete revolution) the clearance is adequate.

If the crankshaft cannot be turned (all the way over by hand) the fit is too tight.

To see if fit is too loose:

Check each main bearing one at a time. Remove cap. Use a piece of .0015 inch feeler stock ½in. wide and 1in. long, as shown in Figure 6. Oil stock well and place it between the bearing and the crankshaft journal. Fit the cap and tighten nuts evenly with a torque wrench to 80-85 foot pounds.

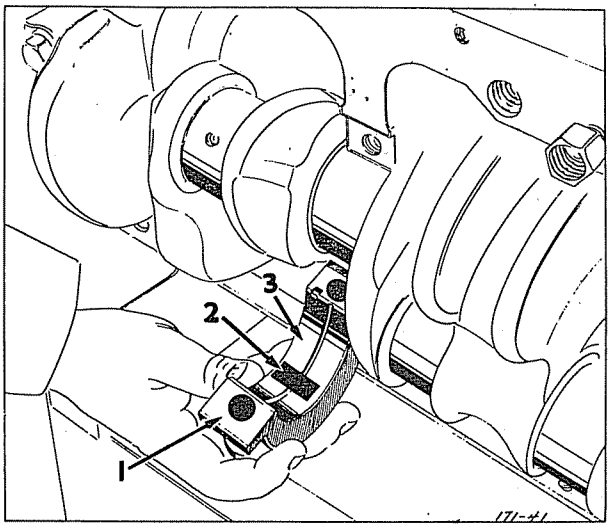

Fig. 6—Checking Main Bearing Clearance with Feeler
1—Main bearing cap 2—Feeler stock 3—Bearing

If a drag is present when turning the crankshaft a full revolution by hand (or if it cannot be turned by hand) with the feeler stock in any one main bearing, the clearance is less than .001 inch. If no drag is felt, the main bearing (which has the feeler in it) is too loose. If the main bearing clearance is excessive, the crankshaft journals should be checked for out of round and taper. Both out of round and taper should not exceed .001 inch.

UNDER NO CIRCUMSTANCES MUST THE BEARING CAPS BE FILED IN ORDER TO TAKE UP WEAR.

9. CHECKING CRANKSHAFT END PLAY.

End play on the crankshaft can be checked by measuring the space between the end of the crankshaft rear main bearing and the adjacent crank throw (Figure 7) or by mounting a dial indicator so that it rests against the flywheel or some vertical surface of the crankshaft. (Figure 8.) End play can be determined by prying the crankshaft back and forth. Refer to Service Standards for end play limits.

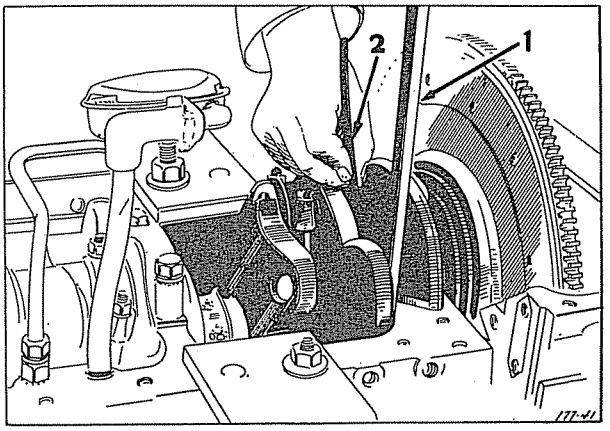

Fig. 7—Checking Crankshaft End Play.
1 — Pry bar 2 — Feeler stock.

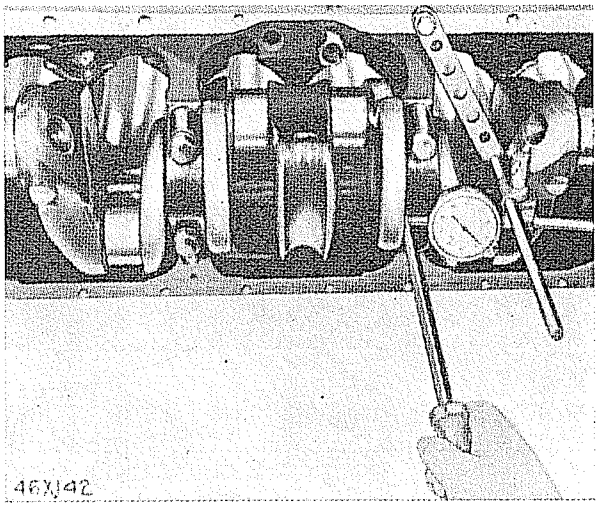

Fig. 8—Checking Crankshaft End Play Using Dial Indicator.

10. ADJUSTMENT OF MAIN BEARING CAPS.

Replace main bearing caps that have become damaged or broken in service. MoPar main bearing caps are available from Chrysler Australia Limited's Parts Division, Distributors and Dealers. A main or connecting rod bearing cap should never be filed, dressed down or shimmed, except when a replacement cap is installed, and then, only for its original installation.

Replacement caps are similar to the original caps with these exceptions: stud holes are 1/64 in. larger and the bearing cap length is $\frac{1}{16}$ in. shorter. These features permit the fitting of bearing caps by shimming or filing in order to obtain proper bearing clearance. Fitting is necessary. Bearing caps, originally installed on the engine are line reamed in place on the cylinder block. However, replacements caps are reamed in a master fixture, resulting in unavoidable variations that will affect bearing clearance.

11. MAINTENANCE, INSPECTION AND INSTALLATION OF CRANKSHAFT.

When the crankshaft has been removed for reconditioning, or for any other reason, clean and inspect it as follows before installation:

a. **Cleaning and Inspection.**

(1) Clean crankshaft thoroughly and blow out all oil passages with compressed air.
(2) Inspect journals for scoring, wear or cracks. If necessary, regrind and instal undersize bearings.
(3) Measure the main and connecting rod journals at several places to determine if the journals have become worn.
(4) If it is necessary to replace main bearing shells before setting the crankshaft in place, make sure the oil holes in the shells register with the oil holes in the cylinder block.
(5) After the upper bearing shells have been placed in the crankcase, apply clean engine oil to all journals and bearings. Instal the crankshaft.

(b) **Installation.**

When setting the crankshaft in place with the timing chain installed, be sure that the timing marks align (Figure 9). Continue to assemble as follows:

(1) Instal the transmission mainshaft pilot bearing in the end of the crankshaft.
(2) Instal crankshaft sprocket on the shaft using tool DD-888.
(3) Instal main bearing caps, lock washers and nuts. To seat caps, tap with a hide mallet. Tighten the caps to the specified torque (Refer to Tightening Section).
(4) Instal connecting rod bearing cap nuts and cotter pins. Tighten to torque specified in Tightening Section.
(5) Instal oil pump and strainer assembly and outlet pipe.
(6) Instal oil pan with new gasket.
(7) Instal flywheel, clutch assembly and clutch lower pan.
(8) Instal cylinder block end plate, timing chain cover, using new gaskets.

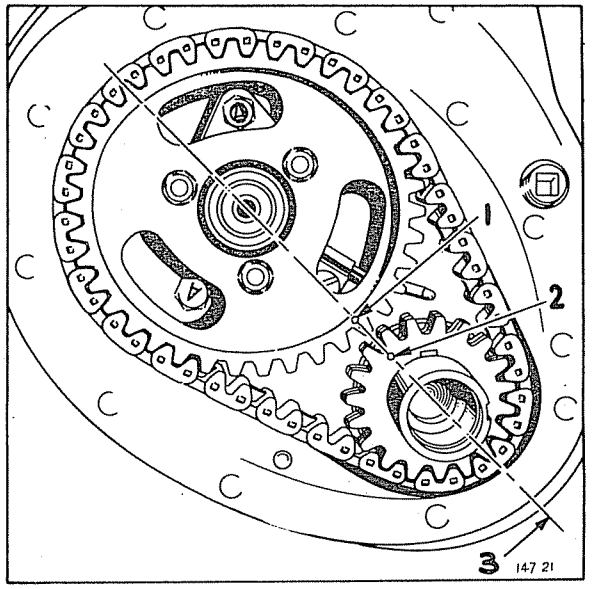

Fig. 9—Marks on Timing Sprockets.
1 — Mark on camshaft sprockets.
2 — Mark on crankshaft sprocket.
3 — Centre line.

(9) Instal fan drive pulley and fan belt. Tighten starting crankjaw nut to a torque of 108 foot pounds minimum.
Always use new cotter pins, lock washers, gaskets and oil seals when installing the crankshaft.

11A. INSTALLATION OF MAIN BEARING OIL SEALS.

The rear main bearing contains oil seals and gaskets which prevent leakage of oil at this point. These oil seals should be carefully located in the cap, before the cap is installed. Figures 10 and 11 illustrate the construction and location of these seals.

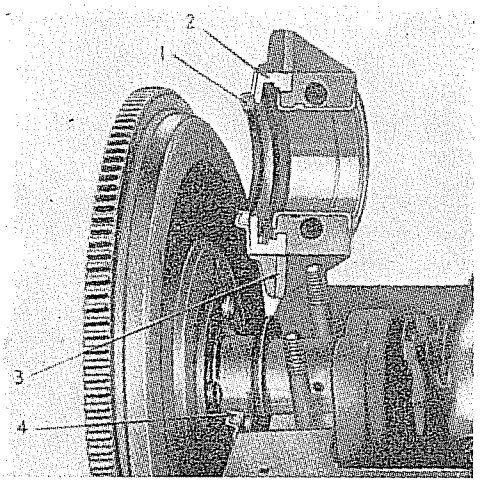

Fig. 10—Crankshaft Rear Bearing Cap Oil Seals, (Assembled view).

1 — Bearing oil seal.
2 — Cap gasket—left.
3 — Cap gasket—right.
4 — Bearing oil seal.

12. CAMSHAFT BEARINGS.

All camshaft bearings (except the rear which is machined in the cylinder casting) are removable and seldom require replacement. If the bearing clearance is excessive, new bearings can be installed. Replacement bearings during manufacture are finished to such close limits that they do not require reaming, scraping or burnishing.

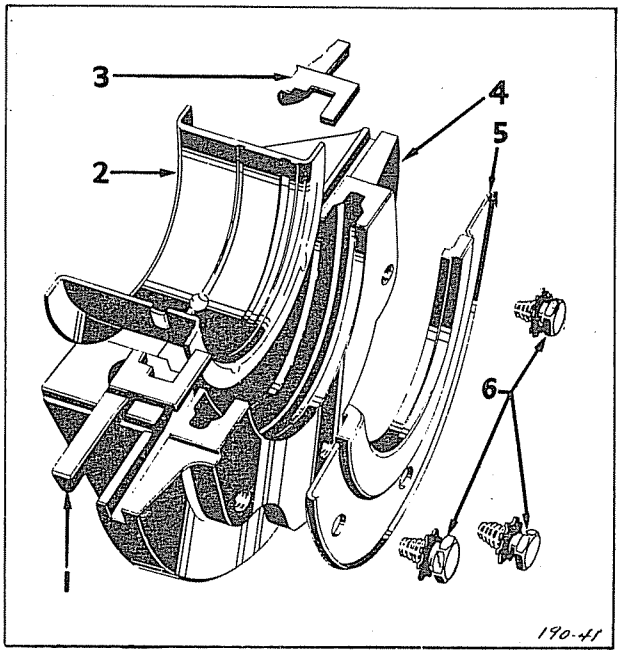

Fig. 11—Crankshaft Rear Bearing Cap Oil Seals (Exploded view).

1 — Cap gasket—left.
2 — Bearing.
3 — Cap gasket—right.
4 — Cap.
5 — Oil seal.
6 — Oil seal screws.

(a) Measuring camshaft bearing wear.

The desired camshaft bearing clearance is .002 to .004 inch. To measure bearing wear, attach a dial indicator to the block with a plunger of the indicator resting on the back of the nearest bearing. Pry the shaft to and from the indicater so that this movement will be shown on the indicator. Check all bearings in the same manner. If the clearance exceeds .004 inch instal a new camshaft (for test purposes only) and recheck the clearance. With the new camshaft installed, clearance should not exceed .002 inch. If clearance exceeds this dimension, replace the bearings.

(b) Removal of camshaft.

If bearing replacement is necessary remove the camshaft as follows:

(1) Remove the fan drive pulley.
(2) Remove the timing chain case cover.
(3) Remove the valve tappets and guides. Remove camshaft and timing gear.
(4) Replace all of the puller bushings of tool C-536 into the bearings. Slide the puller bar across

the puller bushings. Remove the bearings one at a time—and place the slotted washer in the slot provided in the bar at the back of the bearing to be removed. Strike the nut end of the puller with the sliding weight to remove the bearing, as shown in Figure 12.

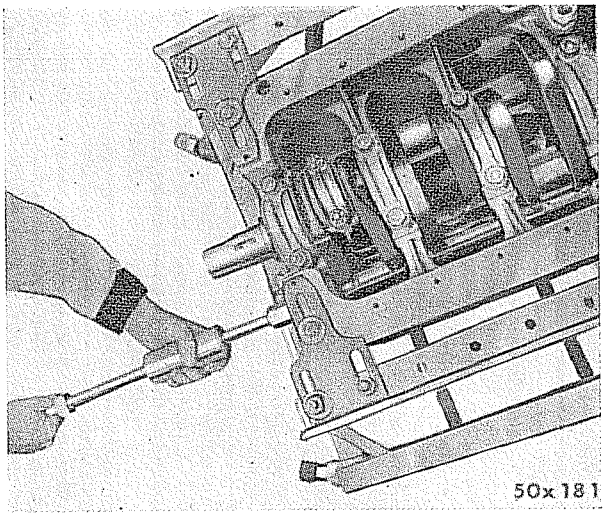

Fig. 12—Removing Camshaft Bearings.

Inspect the cam lobes, and the oil pump drive gear for excessive wear. Measure the camshaft journals with a micrometer. If the journals are worn more than .002 or if the cam lobes and oil pump drive gear are worn, or damaged, intal a new camshaft. Measure the end play as shown in Figure 13. If the end play exceeds .006 in., instal a new thrust plate or other parts as necessary.

13. INSTALLING CAMSHAFT BEARINGS.

Instal camshaft bearings so that the oil hole in each bearing lines up with the oil hole in the cylinder block. The front bearing has an additional oil hole. This must line up with the hole that supplies oil to the timing chain. Instal the correct size adaptor in each of the two intermediate bores. Instal the correct adaptor in the front bearings and start the front bearing in its bore with the additional oil hole (mentioned above) to the rear.

Insert the bar through all three adaptors and instal the horse shoe washer forward of the front adaptor. With the sliding hammer of the tool, drive the front bearing into place and make certain the oil holes are lined up. Remove the bar and leave the front and rear adaptors in the bore in order to guide the bar when installing Number 2 bearing.

Place the adaptor in Number 2 bearing and start the bearing in its bore. Instal the horse shoe washer forward of the Number 2 bearing and drive the bearing into place. Remove the bar adaptor. Place the Number 3 bearing in the adaptor and drive it into place, following the installation procedure for the other bearings.

Camshaft bearings are manufactured to such close limits that no finishing or burnishing is required.

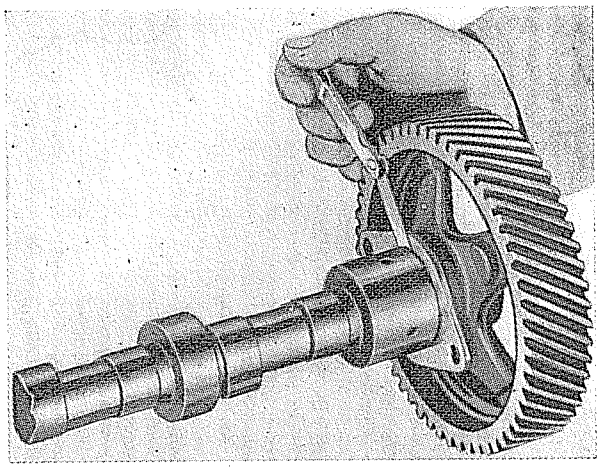

Fig. 13.—Typical Illustration, Measuring Camshaft End Play.

14. INSTALLATION OF CAMSHAFT.

Make certain the camshaft is thoroughly clean and that all oil holes are open. Installation is as follows:

(1) Place the thrust plate over the end of the camshaft.
(2) Instal the timing sprocket on the shaft.
(3) Check camshaft end play.
(4) Slide the camshaft through the bearings, being careful not to damage the bearings. Align the timing marks on the sprockets as shown in Figure 9. Instal the thrust plate bolts and washers. Tighten securely.
(5) Instal case cover. Tighten with a torque wrench to 12 to 17 foot pounds.
(6) Instal the distributor lower drive shaft assembly in the block, meshing it with the camshaft. When meshing the drive gear with the camshaft, be sure that the slot in the coupling is in position.
(7) Instal the set screw from the side of the block, locking the lower drive shaft in the block.

15. REMOVAL OF CAMSHAFT OR THRUST PLATE

To remove the camshaft or thrust plate (without removing the engine assembly) proceed as folllows:

(1) Remove the hood.
(2) Drain water from radiator on cylinder block.
(3) Disconnect headlights and parking lights.
(4) Remove radiator inlet and outlet hoses.
(5) Remove radiator, grill and both front fenders as an assembly.
(6) Remove cylinder head.
(7) Remove the fuel pump, oil pump and valve tappet cover plates.
(8) Remove crankshaft pulley.
(9) Support the front end of the engine. Remove the front motor support and timing chain case cover, being careful not to damage the oil seal.

Remove the camshaft sprocket and timing chain.

(10) Raise the valves. Hold them in position by inserting two wooden wedges, under each valve head (at opposite points) to prevent cocking or warping of the valve head. This operation is not required if the valves are being ground, since the valves and springs will be removed.

(11) Lift the valve tappets and hold them in place with spring type clothes pegs (Figure 14) or similar tools.

(12) Then remove the camshaft, rotating it as it is drawn out so that the cams will clear any obstacles. Press off the sprocket hub and thrust plate in an arbour press.

If the valve tappets are to be replaced, remove the oil pan. Then remove the clothes pegs and the tappets will drop down and out.

When installing, use centering tool, as shown in Figure 15.

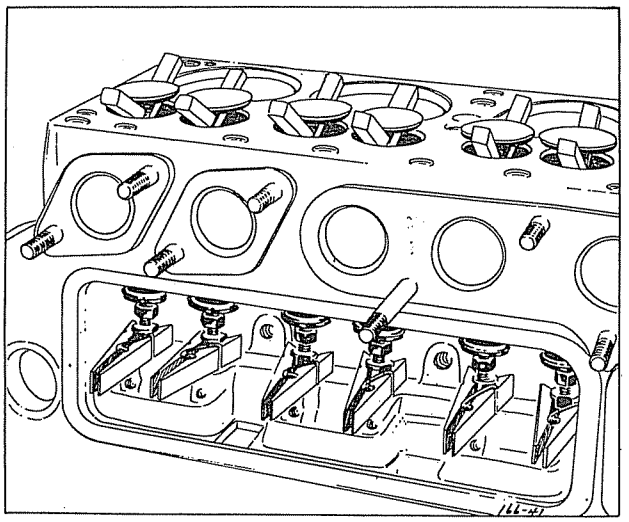

Fig. 14—Holding up Valves and Tappets for Camshaft Removal.

16. INSTALLING CONNECTING RODS.

Connecting rods should always be installed with the oil metering hole (8), Figure 16, in the connecting rod towards the valve mechanism.

Always check rods for alignment each time they are installed (especially when installing new piston pins or bushings).

17. REPLACING CONNECTING ROD BEARINGS.

Connecting rod bearings can easily be replaced by removing bearing caps and bearing shells.

Replacement bearings require no reaming or shaping.

Connecting rod bearing inserts must always be installed so the small boss on the insert lines up with the machined grooves in the connecting rod. This applies to both bearing halves.

Connecting rod bearings should always be replaced in pairs. Never use a new half bearing with an old half.

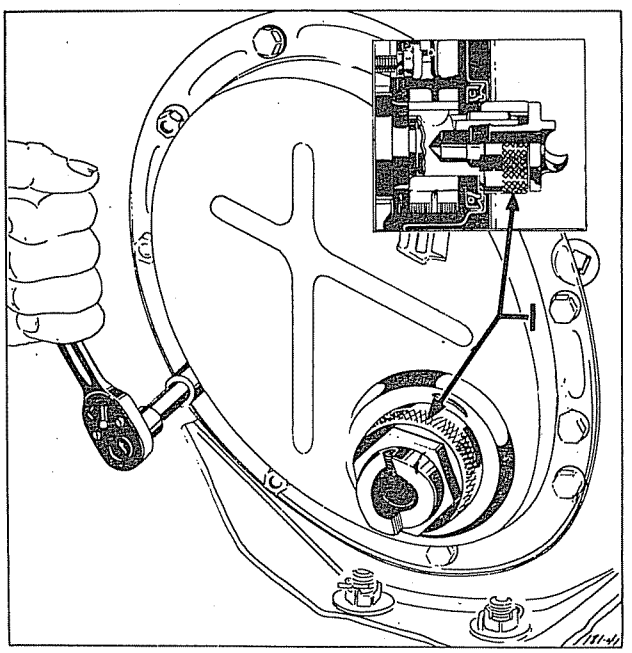

Fig. 15—Chain Case Cover Oil Seal Centering Tool.

1 — Centering tool (C-522) is to be held in place by crankshaft starting jaw while tightening cover in place. Tighten jaw with fingers only.

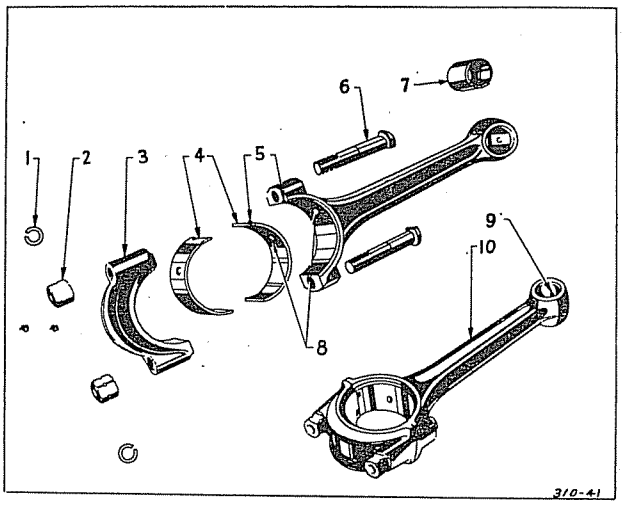

Fig. 16—Connecting Rod.

1 — Cap bolt nut lock washer.	6 — Cap bolt.
2 — Cap bolt nut.	7 — Rod bushing.
3 — Cap.	8 — Oil holes.
4 — Rod bearings.	9 — Oil hole.
5 — Torque and groove.	10 — Rod assembly.

18. UNDERSIZE MAIN AND CONNECTING ROD BEARINGS

Main and connecting rod bearings are furnished in .001, .002, .010, .012, .020, .030, .040, .050 and .060 inch undersizes.

Bearing inserts should be replaced in pairs, never use a new bearing half with an old half.

When checking bearing clearance, always check one pair of halves at a time.

Checking connecting rod clearance.

When checking connecting rod clearance, follow the procedure used in checking main bearing clearance.

19. REPLACEMENT OF WELCH PLUGS.

Welch plugs are installed in various parts of an engine assembly. If a leak occurs at a welch plug installation, replace the plug.

To remove the plug, use a centre punch or a similar tool. Drive in the centre of the plug so that it will collapse and fall out. Be extremely careful when installing a welch plug. Observe the following precautions:

(1) The plug seat should be clean, smooth, even and free from rust and dirt.
(2) The plug should be free from burrs and irregularities.
(3) The convex side of the plug should face outwards. Expand the plug by flattening with a blunt drift and a hammer.

NOTE

White lead, or a similar sealing compound, may be used in the plug seat before installation.

20. SERVICING THE CYLINDER HEAD.

When fitting the cylinder head, always use a new gasket, coat both sides of the gasket with a light, high temperature, non-fibre grease, or with a suitable sealing compound. Make sure the cylinder head and block are clean and free from carbon and dirt.

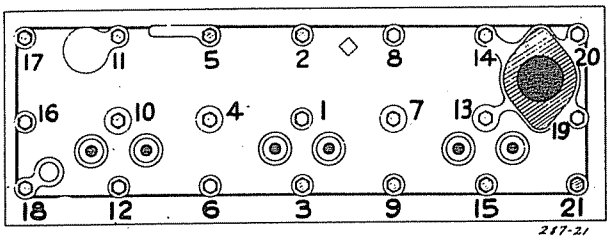

Fig. 17—Sequence for Tightening Cylinder Head Nuts.

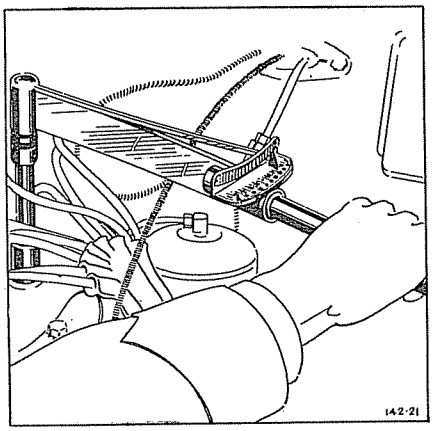

Fig. 18—Tightening Cylinder Head Nuts.

Tighten cylinder head nuts in sequence as shown in Figure 17. Draw all nuts down evenly with a torque wrench as specified in the Tightening Reference and as shown in Figure 18. Finally check the tension of the cylinder head nuts after the engine has reached its normal operating temperature. Also check for internal and external leaks.

21. REMOVAL AND INSTALLATION OF OIL PAN.

(1) Drain the engine oil, instal drain plug and tighten securely.
(2) Remove clutch housing pan to prevent damaging the oil pan gaskets on the clutch housing pan dust seal.
(3) Remove the oil level indicator and oil pan.
(4) Before installing the oil pan, clean it thoroughly and instal new gaskets. The end gaskets A and B, Figure 19, should protrude $\frac{1}{8}$" to $\frac{1}{4}$" above the oil pan. These ends must not be cut off. They should be allowed to protrude while the pan is being installed. The pan will compress them into place when the pan screws are tightened.

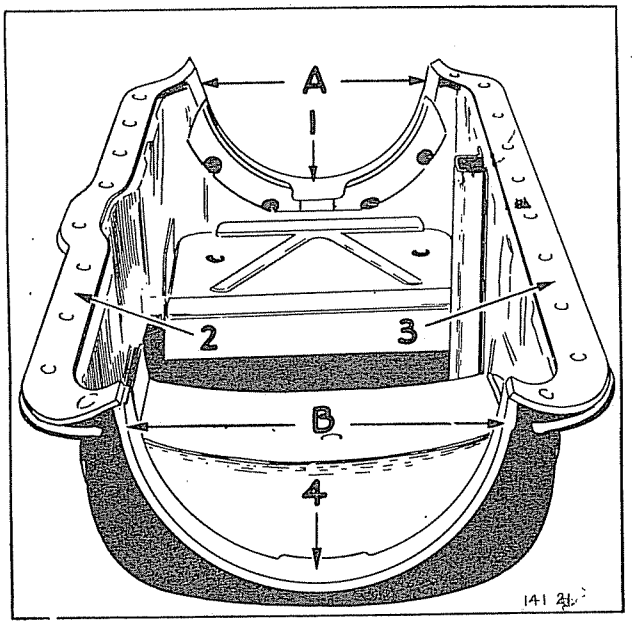

Fig. 19—Oil Pan Gaskets

1 — Gasket—rear.
2 — Gasket—right.
3 — Gasket—left.
4 — Gasket—front.
A — Rear gasket lips.
B — Front gasket lips.

22. RECONDITIONING CYLINDER WALLS (ENGINE DISASSEMBLED).

Cylinder walls which are not badly scored, yet need "cleaning up" to bring them within satisfactory working limits may be reconditioned with a hone.

The cylinder bore should be checked with an accurate gauge, Figure 20, to determine whether or not the bore is out of round or tapered. A good cylinder wall job should show measurements of not more than .001 in. out of round and .0015 in. taper. Maximum allowable out of round is .002 in.

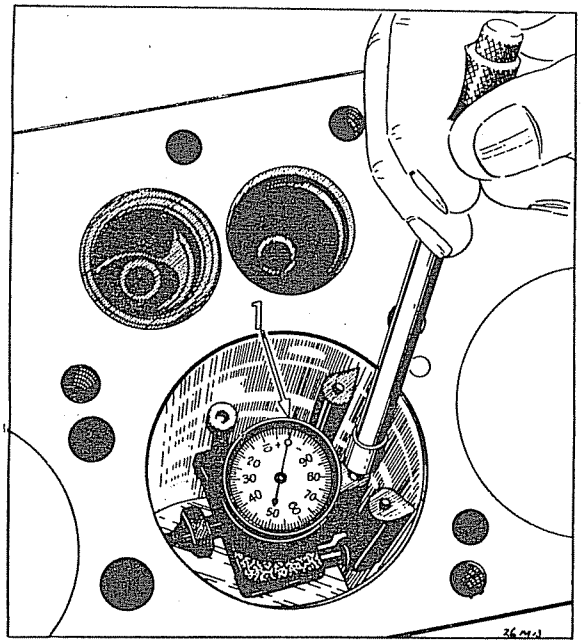

Fig. 20—Checking Cylinder Bore.
1 — Tool C-119.

If cylinder walls are badly scored, tapered or out of round, they should be bored with a reliable boring tool and polished with a hone.

When reconditioning cylinder walls, cover the crankshaft and main bearings to prevent cuttings and abrasives from getting into the engine. After reconditioning the cylinder walls, the engine should be thoroughly cleaned before fitting pistons.

23. FITTING PISTONS.

a. Fitting piston in bore.

Fit the piston with the pin removed. Make sure that the cylinder walls and pistons are clean and dry and all parts are at normal room temperature, 70° F.

To check the piston clearance, use .002 in. feeler stock ½ in. wide and long enough to extend into the cylinder bore the full length of the piston.

Insert the piston upside down in the cylinder bore with the feeler stock placed between the highest point on the piston contour and the cylinder wall. If this is not done a true reading cannot be obtained, due to the taper of the piston.

Attach a spring scale and withdraw the feeler stock (Figure 21). The scale will indicate the pull required to withdraw the feeler stock.

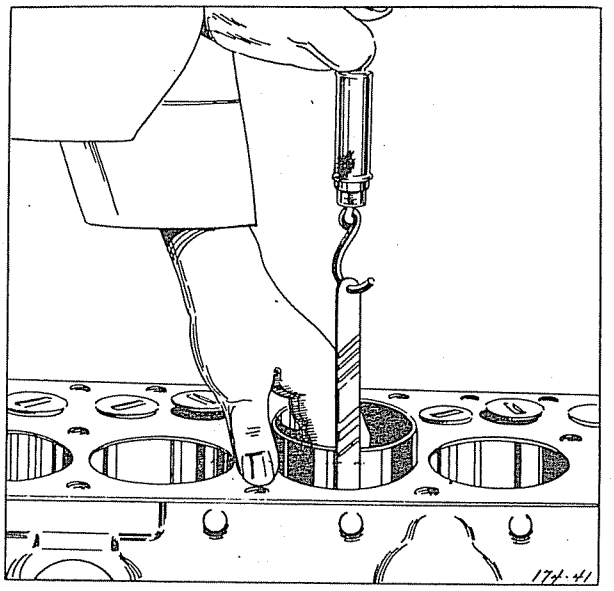

Fig. 21—Inserting Piston with Feeler Stock Attached to Spring Scale Tool C-690.

If the piston clearance is correct, it will require to 4 to 6 lbs. pull to withdraw the feeler stock.

Aluminium pistons will contract at low temperatures. Consequently, some piston and valve noise heard when the cold engine is started, is normal. This noise is not an indication of damaged parts, nor does it indicate improper piston fit, provided the noise is not heard after the engine reaches normal operating temperature.

b. Checking Piston Size.

New pistons should be fitted to the cylinder bores with great accuracy and care. Check the measurements of stock pistons with a micrometer across the high spots of the piston skirt contour (Figure 22).

Pistons are available through Chrysler Australia Limited's Parts Division, Distributors and Dealers, in standard and the following oversizes: .020 in., .030 in., .040 in., .050 in. and .060 in.

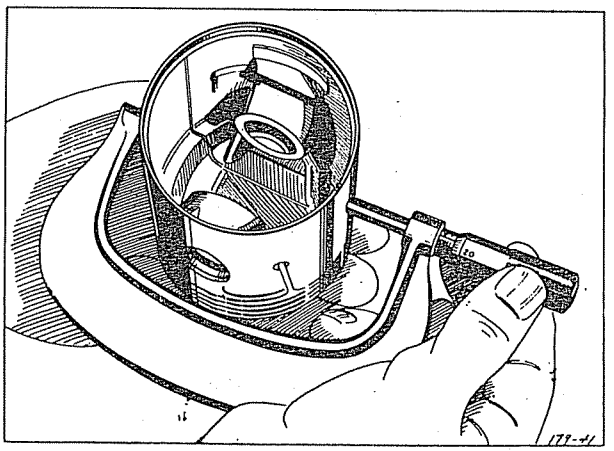

Fig. 22—Measuring Piston with Micrometer

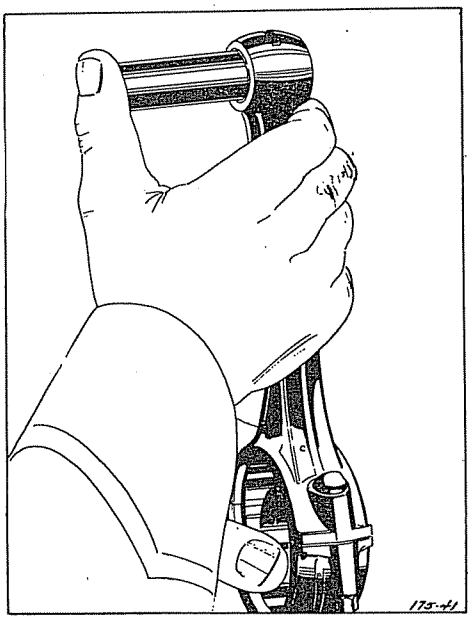

Fig. 23—Fitting Piston Pin in Connecting Rod.

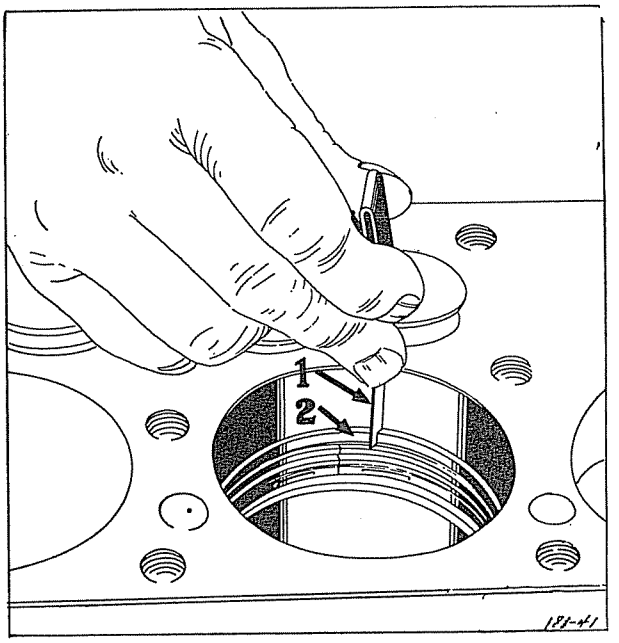

Fig. 25—Fitting Piston Rings.
1 — Feeler gauge. 2 — Piston ring.

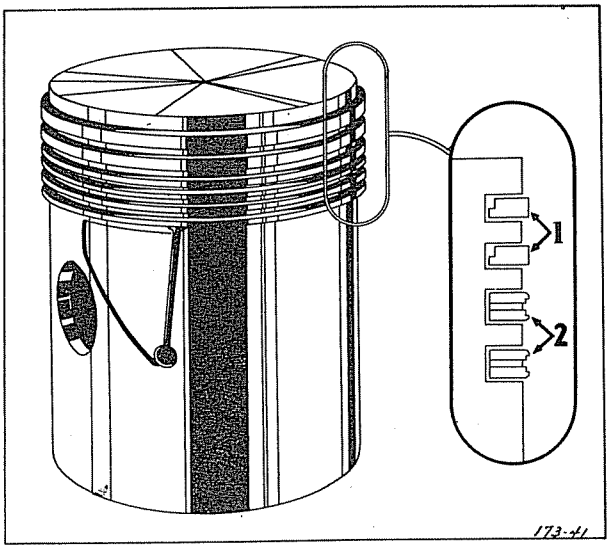

Fig. 24—Piston Rings.
1 — Piston rings—upper. 2 — Piston rings—lower.

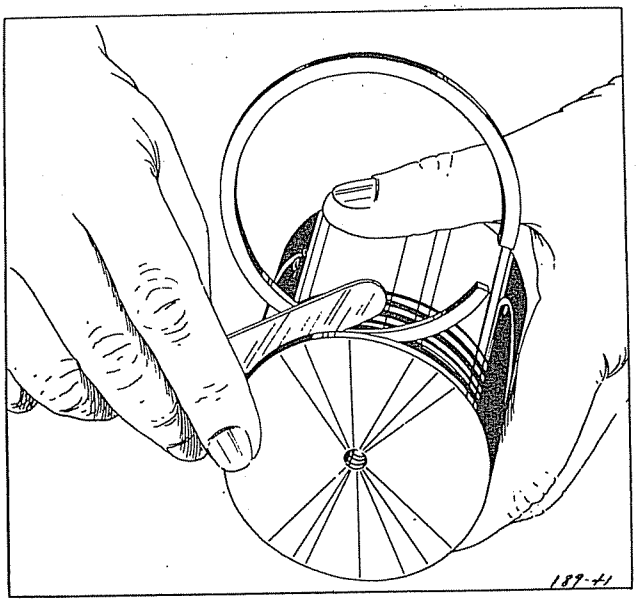

Fig. 26—Checking Side Clearance in Piston Groove.

24. FITTING PISTON PINS.

Piston pins should be installed in the piston and connecting rod with a thumb press fit at 70° F. (Figure 23).

Piston pins are available in standard and the following oversizes: .003 in., .005 in. and .008 in.

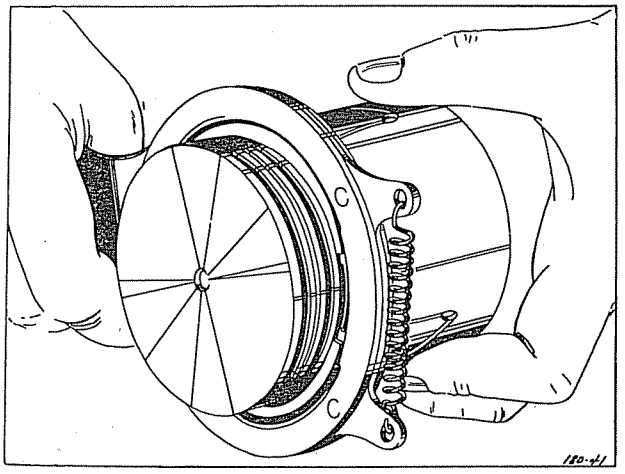

Fig. 27—Installing Piston Rings.

25. FITTING PISTON RINGS. (Refer to Figure 27.)

Measure piston ring gap with the ring about 1 in. below the top face of the cylinder bore (Figure 25). Be sure the ring is square in the cylinder bore. Measure the gap with the proper thickness feeler gauge. Piston rings should be fitted with a gap clearance of .007 to .015 in. Measure ring side clearance as shown in Figure 26 with feeler gauge. (Refer Service Standards for side clearances.) Piston rings should be installed on the piston with a piston ring installing tool (Figure 27).

26. SEMI-FINISHED PISTONS.

Pistons are available from Chrysler Australia Limited's Parts Division, Distributors and Dealers, with the skirts semi-finished, so with proper equipment they may be finished to fit any cylinder bore.

These pistons are available in two sizes: for cylinder bores from standard to .023 in. oversize, and for cylinder bores from .025 in. to .090 in. oversize.

The piston ring grooves and the heads of the semi-finished pistons are completely finished so that only the skirts require finishing.

However, do not attempt to use a .025 in. to .090 in. oversize semi-finished piston to make a finished piston below .025 in. oversize, because the heads and ring grooves which are finished are of a different size than on the .023 in. oversize pistons.

When installing a new set of rings (Figure 28) without reconditioning the cylinder bores, always remove the ridge in the top of the bore with a reliable ridge reamer. Be careful not to cut below the top of the upper ring position in the bore. Cut the ridge before removing the piston assemblies, and cover the tops of the pistons to prevent cuttings from reaching the bearings, crankshaft, etc.

Piston rings are available through Chrysler Australia Limited's Parts Division, Distributors and Dealers in standard and the following oversizes: .020, .030, .040, .050 and .060 in.

27. VALVE ARRANGEMENT.

The valves can be readily indentified. The inlet valve having a flat head while the exhaust valve is slightly coned and has a shallow recess machined below the head.

28. REMOVAL AND INSTALLATION OF VALVES.

(1) Drain water from radiator.

(2) Remove cylinder head and gasket.

(3) Remove right front wheel and lower wheel housing panel.

(4) Remove valve cover plates. Be careful when removing valve locks in order to make sure they do not fall into oil pan through the drain holes in the cylinder block around the valve tappets.

(5) Remove valve locks after compressing the valve springs with the valve spring compressor. Then lift out valves. The valve locks can easily be installed with a valve lock installing tool, C-486, after compressing springs. When installing cylinder head, refer to "Cylinder Head".

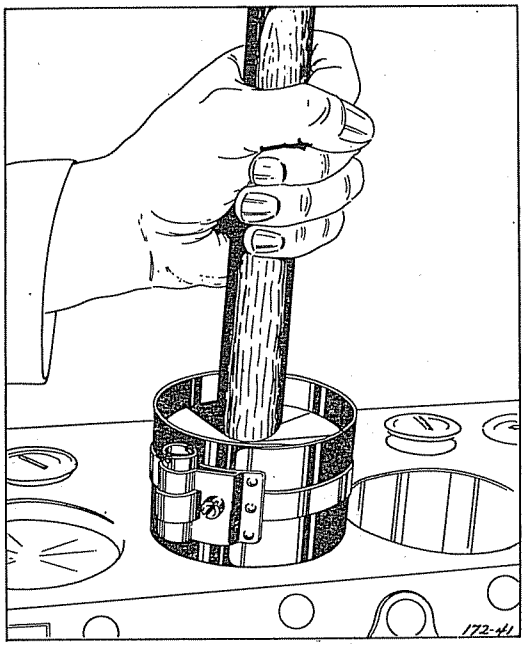

Fig. 28—Installing Piston and Rings, Tool C-385.

29. VALVE SPRINGS.

Whenever valve springs are removed they should be checked for pressure before installation. If they are not within the limits specified in the Service Standards, they should be replaced. When installing springs, the closely coiled ends must be to the top against the cylinder block.

30. REMOVAL AND INSTALLATION OF VALVE GUIDES (VALVES AND SPRINGS REMOVED).

(1) Insert valve guide removing and installing tool through guide and screw nut on extension screw.
(2) Turn the screw handle to left and the guide will move up and out.

To instal, reverse operations. Finish new guides by reaming after installation. See Service Standards for valve guide specifications.

IMPORTANT.

Valve guides are available through Chrysler Australia Limited's Parts Division, Distributors and Dealers, and are counterbored at one end. When installing, the counterbore must be at the top of the exhaust valve and the counterbore must be at the bottom of the intake valve.

31. REPLACING VALVE TAPPETS.

To remove valve tappets it is necessary to remove the camshaft. Take the tappets out through the bottom of the engine. When reaming tappet guides, remove the cylinder head and valves in order to instal the reamer pilot.

If the valve tappet guides are excessively worn, the tappets may be removed, the guides reamed and oversize tappets installed. Oversize tappets are available in .001 and .008 in. oversize.

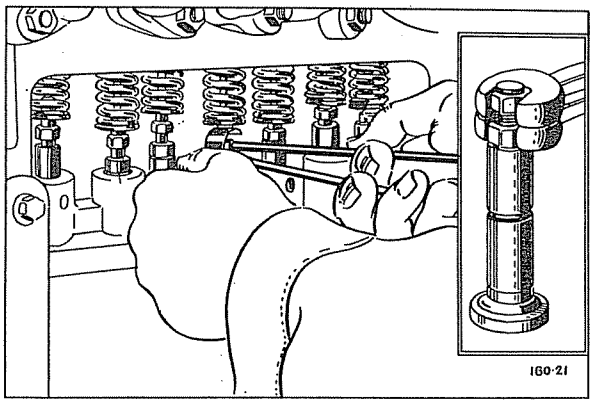

Fig. 29—Adjusting Self-Locking Type Valve Tappets.

32. ADJUSTING VALVE TAPPETS.

Valve tappets should be adjusted (Figure 29) with the engine running at normal operating temperature. Adjust valve to the clearance specified in the Service Standards.

It is important that the proper clearance be maintained at all times to ensure satisfactory engine performance.

33. RECONDITIONING VALVE SEAT INSERTS.

Because of the hardness of the special valve seat inserts used in the exhaust valve ports (Figure 30), it is impossible to recut these seats. They must be reground (Figure 31) using tool number MH-JB-41. The following should be considered when using equipment for reconditioning valve inserts.

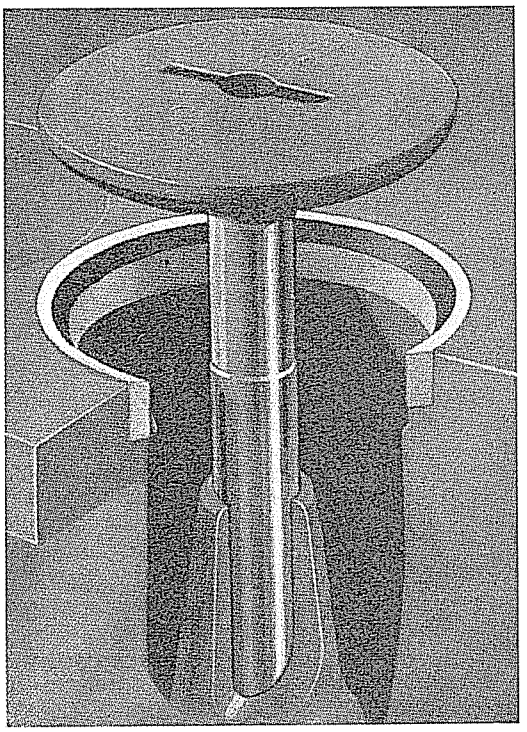

Fig. 30—Exhaust Valve and Valve Seat Insert.

(1) Valve guides must be clean.
(2) The upper end of the valve guide must be chamfered.
(3) The valve guide pilot must fit snugly in the valve guide and be tightened securely into place.
(4) The grinding stone must be trued for concentricity.
(5) The grind stone must be operated dry to maintain proper grinding speeds.
(6) The finished seats should not exceed .0005 in. run out, check with indicator.

Only sufficient material should be ground away to remove pits or other depressions.

(7) Do not use valve grinding compound on seat inserts. Inlet valves are not equipped with valve seat inserts and therefore may be reconditioned with valve seat cutting tools. Valve seat inserts of .010 in. oversize are available for service replacement.

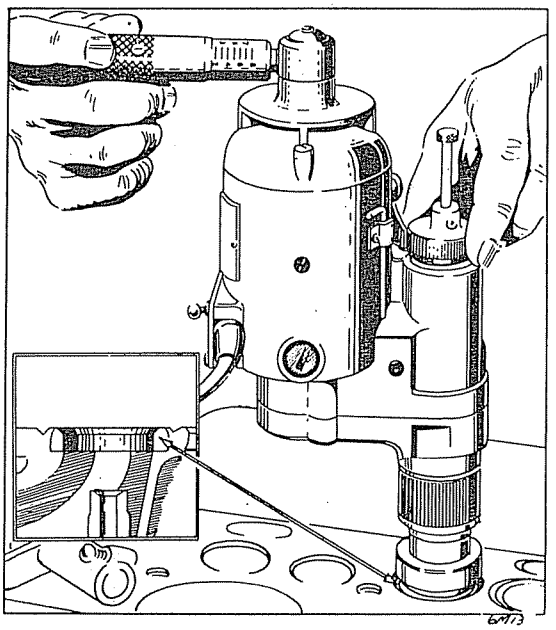

Fig. 31—Grinding Exhaust Valve Seat Inserts.
1 — Tool MH-JB-41.

34. GRINDING INTAKE VALVES.

The intake valve seats in the cylinder block should be recut with a suitable valve seat cutter.

The seats should be cut only enough to remove pits or other depressions in the seat. Then grind a new seat surface on the valve head with a valve grinding machine. When new seats are finished, the valves and seats in the cylinder block should be lapped together with a suitable valve grinding compound to ensure a tight seat. Considerable care must be taken to make certain that all grinding compound is removed from the valve, valve seat, intake port and cylinder block.

35. REPLACE EXHAUST VALVE INSERTS. VALVES REMOVED.

The valve seat inserts may be removed with tool C.732 (Figure 32).

To remove, force the jaws of tool C.732 beneath the insert (about $\frac{1}{8}$ inch). Then tighten the main puller nut. Best results will be obtained by tightening the main puller nut slightly while forcing the jaws under the inserts. Continue to turn the puller nut until the valve seat insert has been pulled out of the block.

Be particularly careful when replacing valve seat inserts. The inserts are installed in the block with a .002 to .004 inch press fit and must be started into place true with the counterbore in the block.

The following procedure is recommended:

(1) Chill the inserts with ice to obtain maximum contraction.
(2) Make certain the counterbore is clean and free from burrs and rough edges.

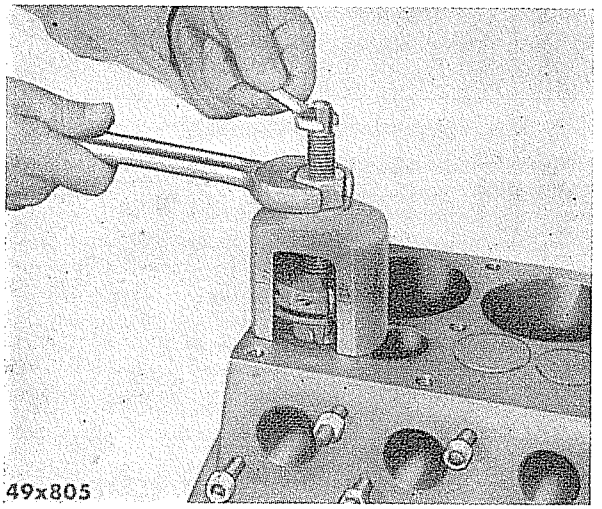

Fig. 32—Removing Exhaust and Intake Valve Seat Inserts.

(3) Place a chilled insert in the counterbore—valve side up.
(4) Instal valve seat using tool No. C.767, drive insert tightly into counterbore (Figure 33).

NOTE: This operation must be done quickly while insert is cold.

(5) Regrind valve seat.

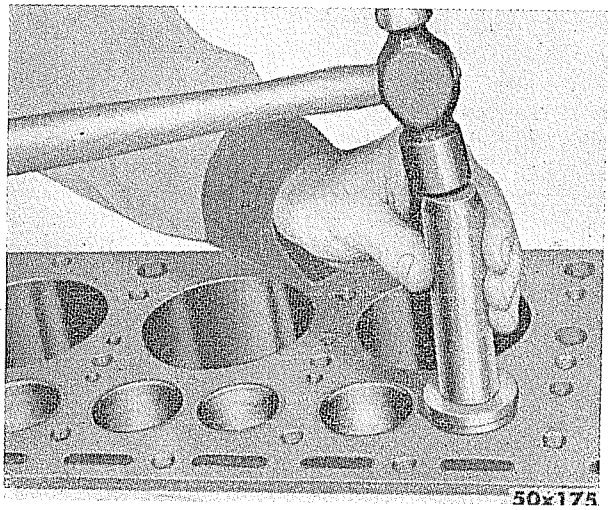

Fig. 33—Installing Valve Seat Insert.

If a standard seat insert is too loose, a .010 inch oversize insert is available in which case the cylinder block will have to be recut to fit oversize valve seat insert. Be sure to clean cuttings from the counterbore and the valve port. Then instal the seat inserts as described previously.

36. TO CHECK VALVE TIMING (CYLINDER HEAD INSTALLED).

To check valve timing, first adjust No. 6 inlet and exhaust valve tappets to .014 in. with the engine cold.

With these tappet clearances the valves should open and close as follows: Inlet opens 12 degrees or .058 in. B.T.D.C. Exhaust valve closes 6 degrees or .014 in. A.T.D.C. Locate top dead centre position of the No. 6 piston.

Rotate the crankshaft until the rear intake valve tappets just make contact with the valve stem. At this point the piston should be within specified range, before T.D.C. Position of the piston and crankshaft can be taken from the fan drive pulley and pointer. If a timing indicator is available, it may be used in the hole above No. 6 piston.

If the timing chain or sprockets have been removed, they should be assembled as shown in Figure 9.

37. FIRING ORDER (ALL MODELS).

1 - 5 - 3 - 6 - 2 - 4.

38. VALVE MAINTENANCE.

If valve tappets with proper clearance are noisy, the following should be checked.

(1) Tappets loose in their guides.
(2) Tappets not properly rotating, causing uneven wear on tappet faces.
(3) Weak valve springs.
(4) Valves sticking in valve guides.
(5) Valves loose in valve guides.
(6) Valve spring cocked or not seating properly.
(7) Warped valve.
(8) Valve seat or guide not in alignment.

ENGINE OIL SYSTEM.

39. REMOVAL AND INSTALLATION OF OIL PUMP.

All petrol engines are equipped with a "Rotor" gearless type oil pump being mounted on the off side of the engine at the base of the cylinder casting and may be identified by the cast webs on the face of the pump cover.

The rotor type pump is driven by a gear from the camshaft and oil pressure is obtained by the rotation of an inner and outer rotor housed in the pump body. The inner rotor is pinned to and driven by the oil pump drive shaft.

To remove and instal the oil pump, proceed as follows:

(1) Lift off the distributor cap and rotate crankshaft until the distributor rotor is in the firing position for No. 1 cylinder. Keep crankshaft in this position while the oil pump is removed from the engine, as this will avoid the resetting of the ignition timing when the pump is installed.
(2) Remove cap screws securing oil pump to cylinder block and withdraw the oil pump.

Use a new gasket when installing pump. If the engine crankshaft was moved while the pump was off, rotate the engine until No. 1 cylinder is in the firing position. Then set distributor rotor in No. 1 firing position and instal oil pump. Be sure the distributor rotor remains in correct position. Reset ignition timing.

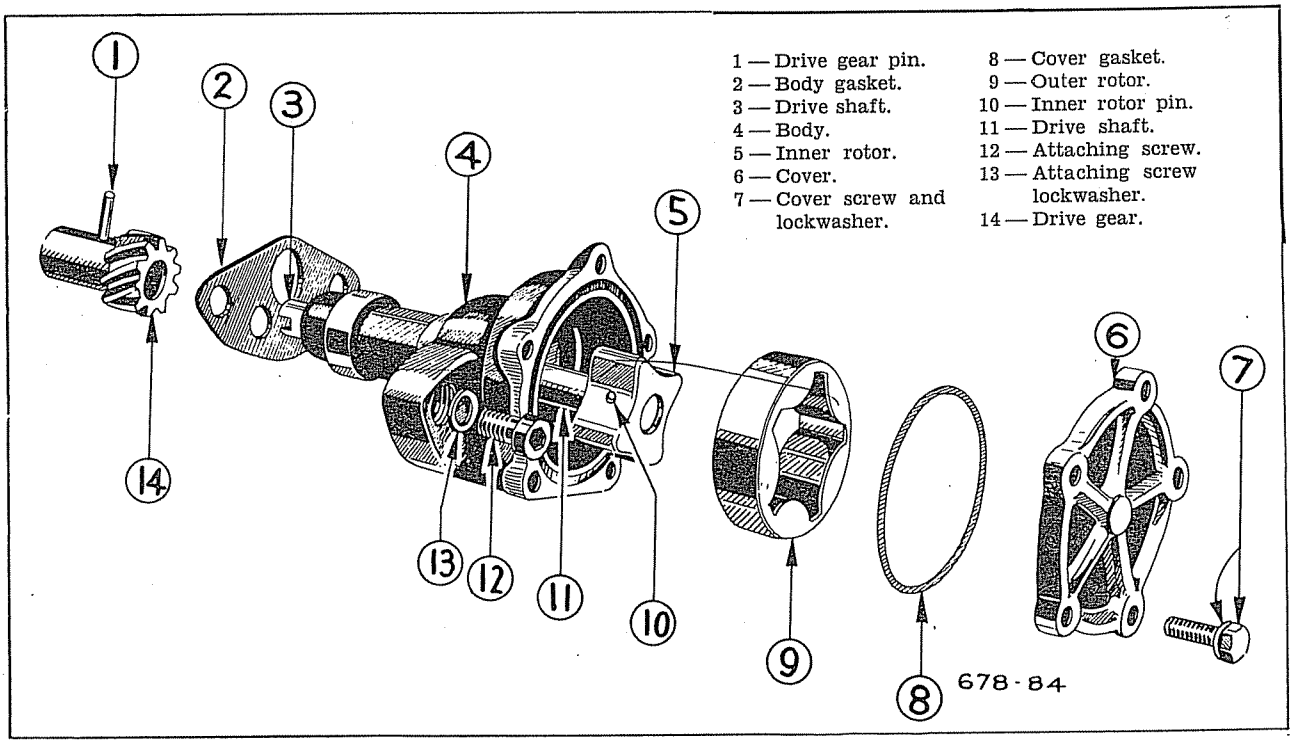

Fig. 34—Rotor Type Oil Pump.

40. DISASSEMBLY AND INSPECTION OF OIL PUMP.

(1) Remove cover and gasket.
(2) Hold hand over cover opening, invert the pump and turn drive shaft until the outer rotor slides out.
(3) Drive out the pin which secures the drive gear to the pump shaft.
(4) Press the shaft from the drive gear and remove shaft and inner rotor assembly from the pump body.
(5) Wash all parts in dry cleaning solvent and dry with compressed air.
(6) Match the rotors together similar to the way they would be if in the pump with one lobe of the inner rotor pushed as far as possible into a corresponding recess in the outer rotor. (Figure 35) and if more than .010 inch, replace both rotors.

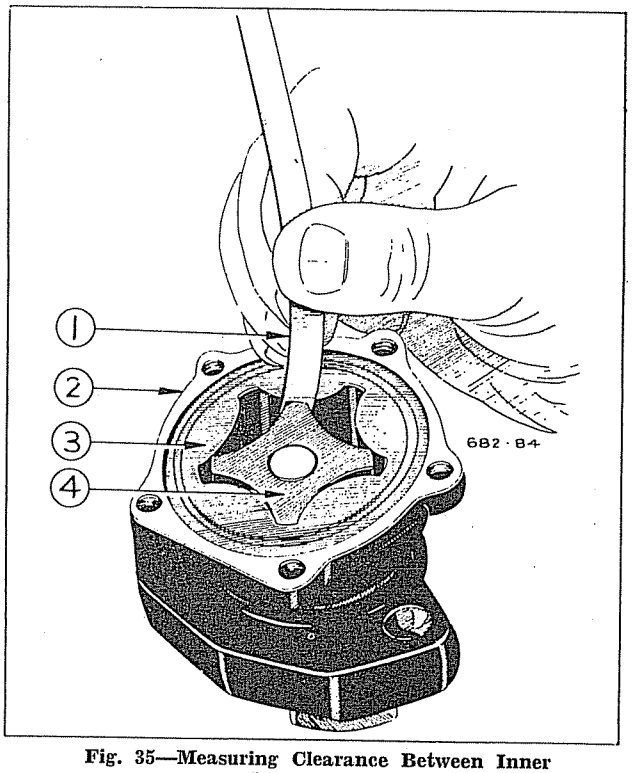

Fig. 35—Measuring Clearance Between Inner and Outer Rotors.

1 — Feeler gauge.
2 — Pump body.
3 — Outer rotor.
4 — Inner rotor.

(7) Measure thickness and diameter of outer rotor with a micrometer. If the thickness is less than .748 inch and if diameter is less than 2.245 inch, replace the rotor.
(8) Measure thickness of the inner rotor with a micrometer. If thickness is less than .748 inch remove rotor from the shaft, discard it and assemble new rotor to shaft.
(9) Slide rotors into pump body.
(10) Place a straight edge across the pump body between the screw holes and with a feeler gauge measure the clearance between the top of rotors and straight edge (Figure 37). If clearance exceeds .004 inch, renew pump body.

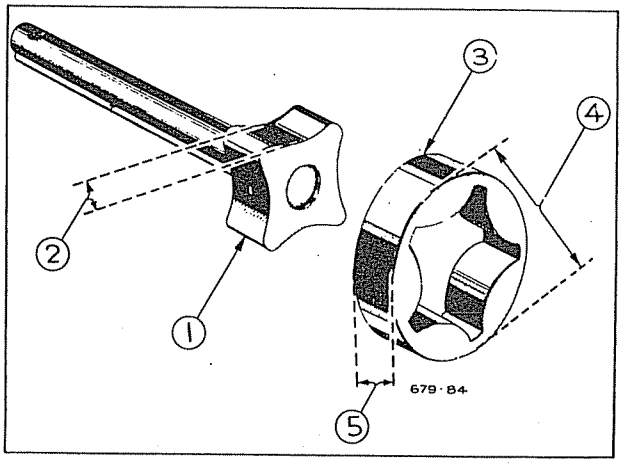

Fig. 36—Measuring Oil Pump Rotors.

1 — Inner rotor.
2 — Inner rotor thickness.
3 — Outer rotor.
4 — Outer rotor diameter.
5 — Outer rotor thickness.

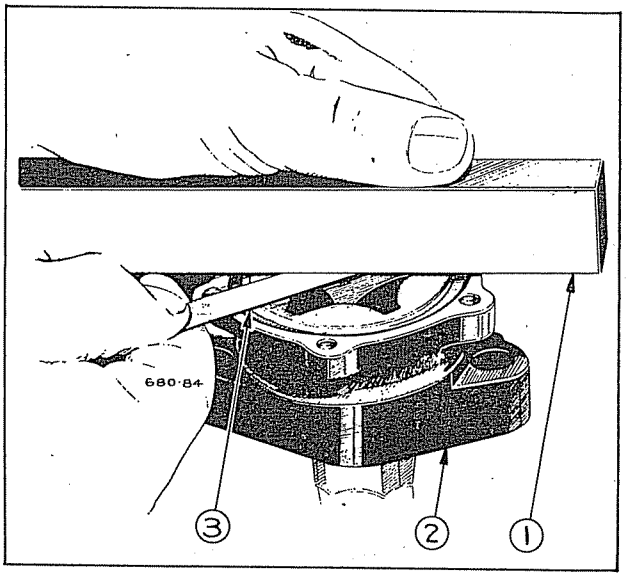

Fig. 37—Measuring Clearance Over Rotors

1 — Straight edge.
2 — Pump body.
3 — Feeler Gauge.

(11) Press the outer rotor against the pump body and measure clearance at opposite side with feeler gauge (Figure 38). If clearance exceeds .008 inch, replace pump body. (This inspection is not necessary if a new pump body is being used.)
(12) The cover should be smooth, if scratched or grooved, replace it. Lay a straight edge across the inner surface as shown in Figure 39. If a .001 inch feeler gauge can be inserted between the cover and the straight edge, replace cover.

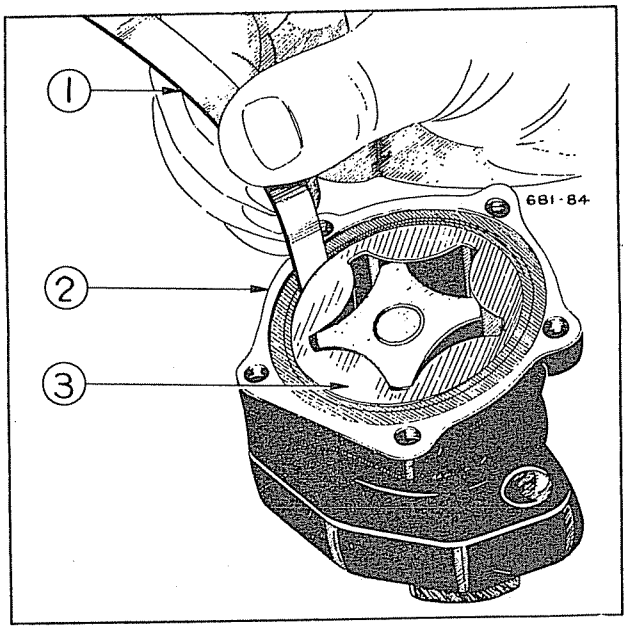

Fig. 38—Measuring Clearance Between Outer Rotor and Body.
1—Feeler gauge. 2—Pump body.
3—Outer rotor.

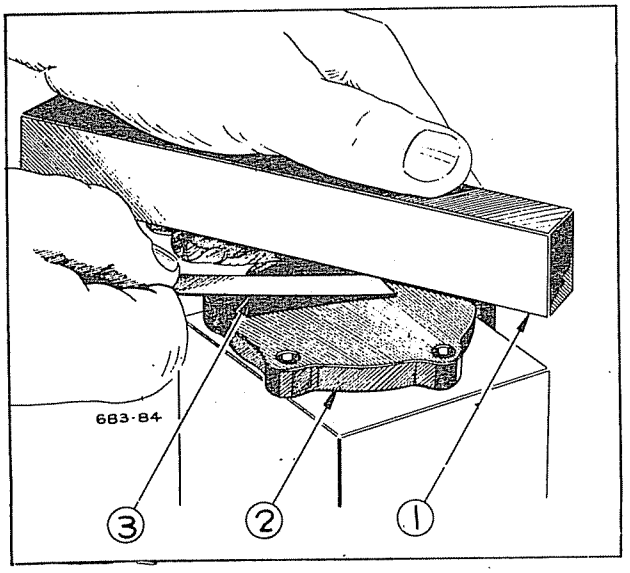

Fig. 39—Checking Body Cover.
1—Straight Edge 2—Cover.
3—Feeler gauge.

41. ASSEMBLY OF OIL PUMP.

(1) When assembling a new rotor on the drive shaft, press the rotor on to the shaft until the end of the shaft is flush with the face of the rotor. When pressing rotor on shaft make sure it is square with the shaft. Drill a $\frac{5}{32}$ inch hole and instal pin, making certain the pin does not protrude at other end above the surface of the rotor.

(2) Slide shaft and rotor into pump body.

(3) Press the drive gear on to the shaft until end play is from .005 to .010 inch (Figure 40). If the pin holes do not line up, drill a new $\frac{5}{32}$ inch hole at right angles to the other hole, instal pin and peen over both ends.

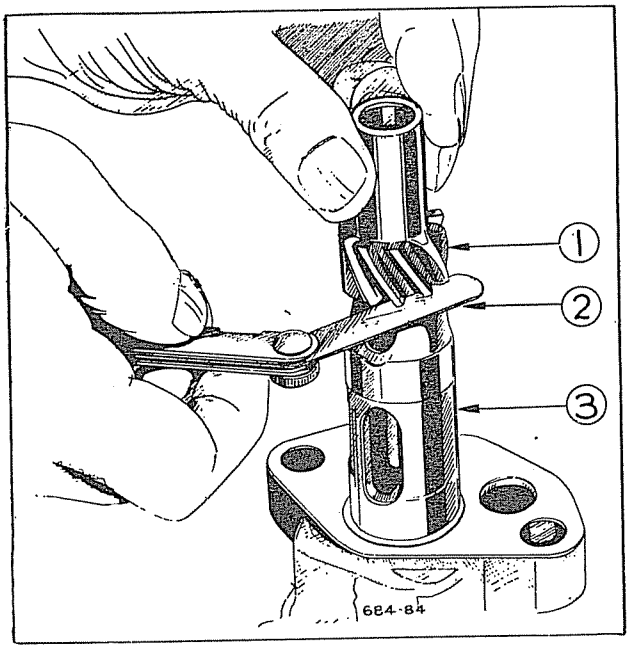

Fig. 40—Measuring End Play.
1—Drive gear. 2—Feeler gauge.
3—Pump body.

(4) Instal the outer rotor in pump body.

(5) Instal a new cover gasket.

(6) Instal the cover and tighten screws evenly.

42. OIL PRESSURE.

Oil pressure should be checked with the proper viscosity oil in the crankcase and with the engine at normal operating temperature. The correct pressure is from 30 to 45 lbs. at speeds above 30 m.p.h. On all models different coloured springs are used in the oil pressure relief valve (Figure 41). The standard spring is not painted, springs lighter than standard are painted red, heavier than standard are painted green. If for any reason the springs have to be replaced, the same colour spring should be used. Should the oil pressure indicate high or low on the gauge, remove the relief valve assembly and carefully clean the plunger. If this does not correct the pressure to normal, the sump should be removed and the cause of the trouble investigated.

Incorrect oil pressure can be caused by any of the following:

(1) Leaking or broken oil pipes.

(2) Leaking oil pipes connection.

(3) Defective oil gauge.

(4) Clogged oil pump or oil screen.

(5) Worn oil pump rotors.
(6) Loose main or connecting rod bearings.
(7) Worn camshaft bearings.
(8) Improper viscosity of oil.

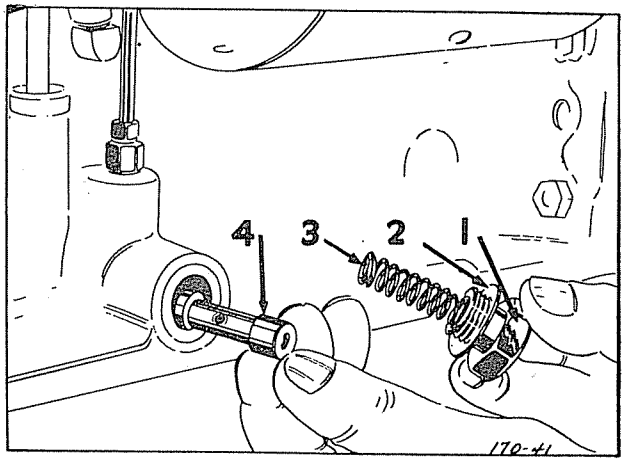

Fig. 41—Oil Pressure Relief Valve.

1 — Cap.
2 — Cap gasket.
3 — Spring.
4 — Plunger.

43. OIL FILTER.

The oil filter is designed to remove solid particles from the oil, but is not intended to remove fluids of the crankcase such as water, acid or petrol.

The filter cartridge which is replaceable, will continue to separate foreign matter from the engine oil until it becomes clogged. In the event of the filter becoming clogged, the oil will by pass around the filter so that the oil will always circulate to the bearings, but it will not be filtered. It is advisable to inspect the filter periodically and replace the cartridge when the oil becomes black and dirty usually about every 10,000 miles and at the time of an oil change.

To replace the cartridge, remove the filter cover by unscrewing the large hexagon nut and lift out the old cartridge. Replace the drain plug and tighten securely. Make sure that the cover gaskets are in good condition and that the cartridge and gaskets are correctly positioned before finally tightening the cover nut.

The oil passage through the filter may be checked in the following manner:

(1) Run engine at idling speed.
(2) Remove return pipe connection.
(3) A steady stream of clean oil should pass from the filter at this point. If there is not a steady flow of oil, the filter is probably clogged, this being so, proceed to replace filter cartridge as stated above.

44. OIL PRESSURE GAUGE.

An accumulation of oxide sometimes plugs the small hole in the oil gauge connection. This may be opened with a fine wire to restore gauge to its original state of efficiency. The gauge line should be free from oil when installed.

45. CRANKCASE VENTILATION.

The crankcase ventilation system is designed to remove harmful fumes from the crankcase and to prevent condensation of these fumes which may cause excessive dilution of crankcase oil.

Ventilation is accomplished by drawing off the fumes or vapours through the crankcase ventilator pipe at the rear of the engine. Fresh air enters through the oil filler pipe, which is equipped with an air cleaner which removes dirt and dust from the air.

The oil filler cap air cleaner should be removed every recommended oil change or more frequently in dusty areas. Cleaning is accomplished by washing the air cleaner in kerosene, draining, and lubricating with fresh engine oil and refitted.

46. LUBRICATION.

Oil used in engines should always be a high grade, well refined oil. The recommendations made in the Lubrication Section of this manual are based on the SAE viscosity numbering system. The numbers used indicate the viscosity of the oil only and do not take into consideration the quality of the oil. The oil level in the oil pan can be checked with the dip stick situated adjacent to the filler tube. When checking the oil level, care should be taken to see that the vehicle is standing on level ground and that the engine has been stopped.

The dip stick should be removed and wiped clean, and then re-inserted so that a true reading of the level can be obtained.

The dip stick has two markings, "ADD OIL" and "FULL". The level should be checked immediately after the engine has been run and before the oil has drained from the circulation system and filter back into the oil pan. If the oil level indicated on the dip stick is between the "ADD OIL" mark and the "FULL" mark, it is not necessary to replenish the oil pan. Should the level be slightly below or at the "ADD OIL" mark, add sufficient quantity of the correct viscosity oil to raise the level to the correct height. A quantity of oil is in suspension while the engine is in operation, and this oil remains in the system until the engine is stopped, and it drains normally back to the oil pan.

Therefore, if the oil level is checked after the engine has been stationary for a period, sufficient oil should be added to bring the level to "FULL".

Under no circumstances should the oil level be allowed to remain below the "ADD OIL" mark.

SERVICE DIAGNOSIS

Conditions — Possible Causes — Remedies

ENGINE PERFORMANCE

47. ENGINE WILL NOT START.

Possible Causes.

(a) Weak battery.
(b) Corroded or loose battery terminal connections.
(c) Dirty or corroded distributor contact points.
(d) Weak coil.
(e) Broken or loose ignition wires.
(f) Moisture on ignition wires, cap or plugs.
(g) Fouled spark plugs.
(h) Improper spark plug gap.
(i) Improper timing (ignition).
(j) Dirt or water in gas line or carburettor.
(k) Carburettor flooded.
(l) Fuel level in carburettor bowl not correct.
(m) Supply of fuel insufficient.
(n) Defective fuel pump.
(o) Vapour lock.
(p) Defective starting motor.

Remedies.

(a) Recharge and test battery, using Open Circuit Battery Tester. Refer to Electrical Section. If necessary replace battery.
(b) Clean, inspect and tighten battery terminals and clamps. Replace battery cables and clamps if badly corroded.
(c) Clean and inspect contact points. If badly burned or pitted, replace points and condenser. Adjust gap to .014 to .016 inch and check timing.
(d) Replace weak coil. Then, check condition of contact points and replace if necessary. See "c" above.
(e) Replace broken ignition wires, or those with cracked insulation. Tighten all connections at distributor, coil, ammeter and ignition switch. Be sure the spark plug wires are secure in distributor cap and coil tower.
(f) Dry the wet ignition system with compressed air, or with a clean dry cloth. Remove the individual spark plug wires from cap. Dry cavity and wire ends thoroughly. Inspect inside of cap and remove all traces of moisture and dirt.
(g) Clean and tighten spark plugs. Adjust gaps to .030 inch.
(h) Clean spark plugs and adjust gaps to .030 inch.
(i) Check ignition timing. Replace parts as necessary.
(j) Disconnect lines and clear with compressed air. Remove and clean carburettor. Drain tank and refill.
(k) Check carburettor float level and needle seat assembly. Check float for leaks and replace parts as necessary.
(l) Refer to Fuel System Section for correction of this condition.
(m) Refill fuel tank and then check gauge.
(n) Replace defective fuel pump.
(o) Check for air and fuel restrictions around fuel pump and check for misplacement of heat shield. Repair as necessary.
(p) Repair or replace defective starting motor. If repairing, test as outlined in Electrical System Section. Replace worn or damaged parts as required.

48. ENGINE STALLS.

Possible Causes.

(a) Idling speed too low.
(b) Idle mixture too lean or too rich.
(c) Dirt or water in gas line or carburettor.
(d) Incorrect carburettor float level.
(e) Leak in intake manifold.
(f) Defective accelerator pump. (Stalls on acceleration.
(g) Improper choke adjustment.
(h) Carburettor icing (cold wet weather).
(i) Dash pot ineffective.
(j) Corroded battery terminals.
(k) Weak battery.
(l) Spark plugs dirty, damp, or gaps incorrectly set.
(m) Coil or condenser defective.
(n) Distributor points dirty, burned or incorrectly spaced.
(o) Trailing edge of rotor worn.
(p) Leaks in ignition wiring.
(q) Incorrect valve tappet clearance.
(r) Burned or pitted valves.
(s) Engine overheating.

Remedies.

(a) Reset throttle adjustment screw until engine idles at approximately 450 to 500 r.p.m.
(b) Reset idle adjustment screw $\frac{1}{2}$ to $1\frac{1}{2}$ turns open for correct idle mixture. For richer mixture, turn screw out.
(c) Disconnect lines and clear with compressed air. Remove and clean carburettor, as outlined in Fuel System Section. Drain tank and refill.
(d) Refer to Fuel System Section for correction of this condition.
(e) Check intake manifold, gasket and heat riser gasket. Replace parts as required. Tighten manifold stud nuts to proper torque.
(f) Replace or repair defective accelerator pump. Refer to Fuel System Section. Replace parts as required.
(g) Readjust choke, as outlined in the Fuel System Section.
(h) Open throttle by pressing against accelerator pedal as engine starts to stall. Keep motor at fast idle until condition clears.

(i) Check carburettor dash pot piston, leather and valve. Replace parts as required. Check piston travel. Make sure it comes within specifications. Refer to Fuel System Section.
(j) Clean, inspect and tighten battery terminal posts and clamps. Replace battery cables and clamps if badly corroded.
(k) Recharge and test battery. If necessary instal a new battery of the same type and capacity.
(l) Clean and tighten spark plugs. Adjust plug gaps to .030 inch.
(m) Replace defective coil and condenser. Then, check condition of distributor points and replace if necessary. Adjust gap to .014 to .016 inch.
(n) Replace distributor points and condenser. Set gap at .014 to .016 inch.
(o) Replace worn rotor. Check contacts in cap for burning or pitting. If necessary, replace cap.
(p) Replace broken ignition wires or wires with cracked insulation. Tighten all connections at coil, distributor, ammeter and ignition switch. Be sure the spark plug wires are secure in distributor cap and coil tower.
(q) Adjust valve tappet clearance. Refer to Service Standards for proper clearances.
(r) Replace or reface and grind valves.
(s) Refer to Cooling System Section for various causes of engine overheating. Correct as indicated in remedies.

49. ENGINE HAS NO POWER.

Possible Causes.

(a) Incorrect ignition timing.
(b) Coil or condenser defective.
(c) Trailing edge of rotor worn.
(d) Defective mechanical advance (distributor).
(e) Excessive play in distributor shaft.
(f) Distributor cam worn.
(g) Spark plugs dirty or gap incorrectly set.
(h) Low grade of fuel.
(i) Carburettor in poor condition.
(j) Dirt or water in gas line or carburettor.
(k) Improper carburettor float level.
(l) Defective fuel pump.
(m) Valve timing incorrect.
(n) Incorrect valve tappet clearance.
(o) Blown cylinder head gasket.
(p) Low compression.
(q) Burned, warped, or pitted valves.
(r) Plugged or restricted muffler or tail pipe.
(s) Brakes dragging.
(t) Clutch slipping.
(u) Engine overheating.

Remedies.

(a) Check and reset ignition timing, as outlined in Electric System Section. Replace parts as necessary.
(b) Replace defective coil and condenser. Check condition of contact points and replace if necessary. Adjust gap to .014 to .016 inch.
(c) Replace worn rotor. Check contacts in cap for burning or pitting. If necessary, replace distributor cap.
(d) Check advance mechanism. Make adjustments or replace parts as necessary.
(e) Check distributor shaft play. Replace parts as required.
(f) Replace worn distributor cam.
(g) Clean and tighten spark plugs. Adjust plug gaps to .030 inch.
(h) Drain fuel tank and refill with a fuel that will give more complete combustion.
(i) Remove and recondition carburettor. Replace parts as required.
(j) Disconnect lines and clear with compressed air. Remove and clean carburettor. Drain tank and refill.
(k) Refer to Fuel System Section for correction of this condition.
(l) Replace defective fuel pump. Fuel pump pressure should be from 3½ to 4½ lbs.
(m) Reset valve timing.
(n) Adjust valve tappet clearance. Refer to Service Standards for proper clearance.
(o) Replace blown cylinder head gasket. Tighten cylinder head stud nuts to proper torque.
(p) Perform a vacuum test or a compression test to determine mechanical condition of engine.
(q) Replace, or reface and grind valves.
(r) Remove plugged or restricted muffler or tail pipe and replace. Check for excessive carbon in combustion chamber.
(s) Refer to Brake Section for possible causes and remedies. Correct as indicated.
(t) Refer to Clutch Section for possible causes and remedies. Correct as indicated.
(u) Refer to Cooling System Section for possible causes and remedies. Correct as indicated.

50. ENGINE "LOPES" OR MISSES.

Possible Causes.

(a) Incorrect carburettor idle adjustment.
(b) Dirt or water in gas line or carburettor.
(c) Dirty jets or plugged passages in carburettor.
(d) Incorrect valve tappet clearance.
(e) Burned, warped or pitted valves.
(f) Incorrect ignition timing.
(g) Leaks in ignition wiring.
(h) Moisture on ignition wires, cap or plugs.
(i) Excessive play in distributor shaft.
(j) Defective spark advance mechanism.
(k) Distributor cam worn.
(l) Spark plugs dirty, damp, or gaps set too close.
(m) Weak battery.
(n) Uneven compression.
(o) Low grade of fuel.

Remedies.

(a) Reset idle adjustment screw ½ to 1½ turns open for correct idle mixture. For richer mixture, turn screw out.
(b) Disconnect lines and clear with compressed air, Remove and clean carburettor. Drain tank and refill.

(c) Remove carburettor and recondition. Replace parts as necessary.
(d) Adjust valve tappet clearance. Refer to Service Standards for proper clearance.
(e) Replace, or reface and grind valves.
(f) Check and reset ignition timing.
(g) Replace broken ignition wires or wires with cracked insulation. Tighten all connections at distributor, coil, ammeter and ignition switch. Be sure the spark plug wires are secure in distributor cap and coil tower.
(h) Dry the wet ignition system with compressed air or with a clean dry cloth. Remove each spark plug wire from cap. Dry the cavity and wire ends thoroughly. Inspect inside of cap and remove all traces of moisture and dirt.
(i) Check distributor shaft play. Replace parts as required.
(j) Check advance mechanism. Make adjustments or replace parts as required.
(k) Replace worn distributor cam. Replace parts as required.
(l) Clean and tighten spark plugs. Adjust plug gaps to .030 inch.
(m) Recharge and test battery. If necessary, instal a new battery of the same type and capacity.
(n) Perform a vacuum test or a compression test to determine the mechanical condition of the engine.
(o) Drain fuel tank and refill with fuel that will give more complete combustion.

51. ENGINE MISSES WHILE IDLING.

Possible Causes.

(a) Spark plugs dirty, damp, or gap incorrectly set.
(b) Broken or loose ignition wires.
(c) Burned or pitted contact points, or set with insufficient gap.
(d) Coil or condenser defective.
(e) Weak battery.
(f) Distributor cap cracked.
(g) Trailing edge of rotor worn.
(h) Moisture on ignition wires, cap or plugs.
(i) Excessive play in distributor shaft.
(j) Distributor shaft cam worn.
(k) Burned, warped or pitted valves.
(l) Incorrect valve tappet clearance.
(m) Incorrect carburettor idle adjustment.
(n) Improper carburettor float level.
(o) Low compression.

Remedies.

(a) Clean and tighten spark plugs. Adjust plug gaps to .030 inch.
(b) Replace broken ignition wires or wires with cracked insulation. Tighten all connections at distributor, coil, ammeter and ignition switch. Be sure the spark plug wires are secure in distributor cap and coil tower.
(c) Clean and inspect contact points. If badly burned or pitted, replace points and condensor. Adjust gap to .014 to .016 inch and check timing.
(d) Replace defective coil and condensor. Check the condition of contact points and replace if necessary. Adjust gap to .014 to .016 inch.
(e) Recharge and test battery. If necessary instal a new battery of the same type and capacity.
(f) Replace cracked distributor cap. Then, check rotor for burned conductor. Replace if necessary.
(g) Replace worn rotor. Check contacts in cap for burning or pitting. If necessary, replace distributor cap.
(h) Dry the wet ignition system with compressed air or a clean dry cloth. Remove each spark plug wire from cap. Dry the cavity and wire ends thoroughly. Inspect inside of cap and remove all traces of moisture and dirt.
(i) Check distributor cam play. Replace parts as required.
(j) Replace worn distributor shaft.
(k) Replace, or reface and grind valves.
(l) Adjust valve tappet clearance. Refer to Service Standards for proper clearance.
(m) Reset idle adjustment screw $\frac{1}{2}$ to $1\frac{1}{2}$ turns open for correct idle mixture. For richer mixture, turn screw out.
(n) Refer to Fuel System Section for correction of this condition.
(o) Perform a vacuum test or a compression test to determine the mechanical condition of the engine.

52. ENGINE MISSES ON ACCELERATION.

Possible Causes.

(a) Distributor points dirty or incorrectly spaced.
(b) Incorrect ignition timing.
(c) Coil or condensor defective.
(d) Spark plugs dirty, damp, or gap set too wide.
(e) Abnormal resistance in spark plugs.
(f) Dirty jets in carburettor, especially economizer jet or accelerator pump operating improperly.
(g) Burned or pitted valves.
(h) Low grade of fuel.

Remedies.

(a) Clean and inspect contact points. If badly burned or pitted, replace points and condensor. Adjust point gap to .014 to .016 inch and then check timing.
(b) Check and reset ignition timing.
(c) Replace defective coil and condensor. Check condition of contact points and replace if necessary. Adjust gap to .014 to .016 inch.
(d) Clean and tighten spark plugs. Adjust plug gaps to .030 inch.
(e) Instal new spark plugs. Before installing, check gaps and if necessary adjust to .030 inch. Clean seats, instal new gaskets, and tighten with a torque wrench to 30 to 32 foot pounds.
(f) Remove carburettor and recondition. Replace parts as required.
(g) Replace, or reface and grind valves.
(h) Drain fuel tank and refill with a fuel that will give more complete combustion.

53. ENGINE MISSES AT HIGH SPEED.

Possible Causes.

(a) Dirt or water in gas line or carburettor.
(b) Dirty jets in carburettor, especially the economiser jet.
(c) Coil or condensor defective.
(d) Incorrect ignition timing.
(e) Distributor points dirty or incorrectly spaced.
(f) Trailing edge of rotor worn.
(g) Loose ignition wiring.
(h) Excessive play in distributor shaft.
(i) Spark plugs dirty, damp, or gaps too wide.
(j) Abnormal resistance in spark plugs.
(k) Distributor shaft cam worn.
(l) Engine overheating.
(m) Low grade of fuel.

Remedies.

(a) Disconnect lines and clear with compressed air. Remove and clean carburettor. Drain tank and refill.
(b) Remove carburettor and recondition. Replace parts as necessary.
(c) Replace defective coil and condensor. Check condition of contact points and replace if necessary. Adjust gap to .014 to .016 inch.
(d) Check and reset ignition timing.
(e) Clean and inspect contact points. If badly burned or pitted, replace points and condensor. Adjust point gap to .014 to .016 inch and then check timing.
(f) Replace worn rotor. Check contacts in cap for burning or pitting. If necessary, replace distributor cap.
(g) Replace broken ignition wires or wires with cracked insulation. Tighten all connections and be sure the spark plug wires are secure in distributor cap.
(h) Check distributor shaft play. Replace as required.
(i) Clean and tighten spark plugs. Adjust plug gaps to .030 inch.
(j) Instal new spark plugs. Before installing, check gaps and if necessary adjust to .030 inch. Clean seats, instal new gaskets and tighten with a torque wrench to 30 to 32 foot pounds.
(k) Replace worn distributor shaft and/or bushings. Replace parts as required.
(l) Refer to Cooling System section for possible causes and remedies. Correct as indicated.
(m) Drain fuel tank and refill with a fuel that will give more complete combustion.

HIGH OIL CONSUMPTION

54. EXTERNAL OIL LEAKAGE.

Possible Causes.

(a) Outside oil lines.
(b) Timing gear case cover oil seal.
(c) Rear main bearing oil seal.
(d) Oil pan gaskets.
(e) Oil pan drain plug.
(f) Oil filter gasket.
(g) Clogged rear camshaft bearing drain hole.
(h) Tappet cover gaskets.
(i) Fuel pump or gasket.
(j) Timing chain cover gasket.

Remedies.

(a) Check for oil leaks at filter tubes and oil gauge lines. Replace tubing or fittings as necessary. Be sure filter mounting bracket is fastened directly next to the cylinder head.
(b) Replace chain case cover oil seal. Use a new cover gasket.
(c) Replace rear main bearing oil seal. Be sure seal and gaskets are in correct location in the cap before installation.
(d) Replace faulty oil pan gaskets.
(e) Replace worn oil pan plug and use new gasket.
(f) Clean filter and cover, removing all traces of old gasket. Instal new gasket and make sure gasket is centred. Tighten and run engine for five minutes. Inspect for leakage.
(g) Remove rear tappet chamber cover and open drain hole. Check gasket on cover and replace if necessary.
(h) Remove gaskets from tappet chamber covers and replace. Before installing, be sure all traces of old gaskets have been removed from the machined faces of block. Wipe surfaces dry and instal covers.
(i) Replace fuel pump to block gasket. Check fuel pump for oil leaks. Correct as necessary.
(j) Replace timing chain cover gasket. Inspect oil seal and if necessary replace.

55. OIL PUMPING AT RINGS.

Possible Causes.

(a) Worn, scuffed or broken rings.
(b) Incorrect size rings.
(c) Out-of-round rings.
(d) Rings fitted too tight in groove.
(e) Carbon in oil ring slots.
(f) Insufficient tension in rings.
(g) Stuck rings.
(h) Compression rings installed incorrectly.

Remedies.

(a) Replace worn or scuffed rings after a careful inspection of cylinder walls. Worn, wavy or scored walls are a contributing factor to high

oil consumption. Recondition walls as necessary.
(b) Replace incorrect size rings with new rings of proper type.
(c) Replace out-of-bound rings, after checking cylinder bore.
(d) Replace improperly fitted rings. Refer to Service Standards for clearance of oil ring in groove.
(e) Remove rings and clean piston ring slots with a suitable cleaning tool. Check cylinder bore and if necessary recondition before installing new rings.
(f) Replace weak rings after checking condition of cylinder walls.
(g) Free up sticking rings by disassembly or with a suitable "upper lubricant". If necessary, replace rings.
(h) Remove and replace incorrectly installed rings.

56. OIL PUMPING AT VALVES.

Possible Causes.

(a) Worn valve stems or guides.
(b) Too much oil spray in tappet chamber.
(c) Intake valve stem guide in inverted position.

Remedies.

(a) Replace worn valves and guides as necessary.
(b) Reduce main and connecting rod clearances.
(c) Replace valve guide if condition is evident.

57. HIGH OIL CONSUMPTION DUE TO LUBRICATING OIL CONDITIONS.

Possible Causes.

(a) Oil level too high.
(b) Contaminated oil.
(c) Poor grade of oil.
(d) Thin, diluted oil.
(e) Oil pressure too high.
(f) Sludge in engine.

Remedies.

(a) Add oil only when level reaches "add oil" mark. If oil level is above the "full" mark, drain sufficient oil to obtain correct level.
(b) Drain and refill crankcase with a good quality oil of the proper type and grade. Refer to Lubrication Section. Replace cartridge in filter after thoroughly cleaning filter can.
(c) Drain and refill crankcase with a good quality oil. Replace cartridge in filter after thoroughly cleaning filter can.
(d) Drain and refill crankcase with a good quality oil. Replace cartridge in filter after thoroughly cleaning filter can.
(e) Replace oil pressure relief valve spring.
(f) Drain and refill crankcase with a good quality oil. Replace cartridge in filter after thoroughly cleaning filter can. Check thermostat. A thermostat that remains in the open position allows the engine to operate below normal temperatures. This promotes sludge formation.

58. HIGH OIL CONSUMPTION—MISCELLANEOUS.

Possible Causes.

(a) Overheated engine.
(b) Sustained high speeds.
(c) Misadjusted breather cap, causing excessive crankcase ventilation.

Remedies.

(a) Refer to the Cooling System Section for correction of this condition.
(b) Avoid sustained high speeds at wide open throttle whenever possible.
(c) Check breather for correct position and readjust if necessary. Inspect crankcase ventilator outlet tube and oil drain passage in block for restriction correction. Clean or repair as required.

VALVE TROUBLES.

59. BROKEN VALVES.

Possible Causes.

(a) Weak valve springs.
(b) Worn valve guides.
(c) Excessive tappet clearance.
(d) Cocked springs or retainers.
(e) Out-of-round block seats.
(f) Defective valve forgings.
(g) Excessive engine speeds.

Remedies.

(a) Remove valves and springs and test springs. Discard springs that do not have the proper tension. Refer to Service Standards.
(b) Remove valves, springs and guides and instal new guides. Check valve seat faces for burning or pitting. Recondition as required.
(c) Replace valves as needed. Readjust valves with engine hot. Refer to Service Standards for proper clearances.
(d) Remove valves as needed. Then, test valve springs. At reassembly, be sure springs and retainers are in correct positions.
(e) Replace broken valves after reconditioning valve seat faces.
(f) Replace broken valves.
(g) Avoid sustained high speeds at wide open throttle whenever possible.

60. BURNED OR STICKING VALVES.

Possible Causes.

(a) Close tappet clearance.
(b) Weak valve springs.
(c) Gum formations on stem or guide.
(d) Eccentric valve face.
(e) Deposits on valve seats.
(f) Incorrect valve seat width.
(g) Improper valve guide clearance.
(h) Warped valves.

(i) Improper block cooling.
(j) Exhaust back pressure.
(k) Improper spark timing.
(l) Out-of-round valve seat.

Remedies.

(a) Replace valves as required. Readjust tappets with engine hot. Refer to Service Standards for proper clearance.
(b) Remove valves as required. Then test valve springs. Refer to Service Standards for tension specifications.
(c) Remove valves as required. Clean valves and guides with suitable tool to remove gum and carbon deposits.
(d) Replace valves as required after reconditioning valve seats.
(e) Remove valves as required. Clean or reface valve seats and valves as necessary. See "f" below.
(f) Replace valves as required.
(g) Remove valves as required. Replace, clean or ream guides to required specifications.

Note.—When replacing valve guides, be sure the counterbore in guide is up for exhaust and down for intake.

(h) Replace valves as required. Clean and reface valve seats.
(i) Replace valves as required. Refer to Cooling System Section for correction of this condition.
(j) Replace valves as required. Check exhaust system for restrictions. Replace parts as necessary.
(k) Replace valves as required. Check ignition timing as outlined in Electrical System Section. Make adjustments or repairs as necessary.
(l) Replace valves as required. Grind valve seats.

61. NOISY VALVES.

Possible Causes.

(a) Incorrect tappet clearance.
(b) Worn tappets or adjusting screws.
(c) Wear in cam lobes.
(d) Worn valve guides.
(e) Excessive runout of valve seat or valve face.

Remedies.

(a) Readjust valve tappets with engine hot.
(b) Replace worn tappets and adjusting screws as required.
(c) Replace camshaft. Check tappets for excessive wear and replace as required.
(d) Replace worn valve guides as required. Be sure and instal guide with counterbore DOWN on intake and UP on exhaust. Then, "mike" the valve stem diameter and ream guides to fit.
(e) Reface valve seat and valve face as required.

62. BROKEN VALVE SPRINGS.

Possible Causes.

(a) Valve flutter at high speed.
(b) Improper crankcase ventilation.
(c) Worn timing gears or chain.
(d) Cold engine operation due to defective thermostat.

Remedies.

(a) Replace valve spring as required. Test remaining springs. Refer to Service Standards for tension specifications.
(b) Check crankcase breather tubes and filters for restrictions. Clean or replace parts as required.
(c) Replace valve springs as required. Check timing chain and gears for excessive wear and backlash. Replace parts as needed.
(d) Test thermostat. Replace thermostat if required.

63. VALVE DEPOSITS.

Possible Causes.

(a) Quality of fuel.
(b) Quality of lubricating oil.
(c) Valve stem wear.
(d) Improper cooling of block.
(e) Sludged engine.
(f) Worn valve guides.
(g) Improper lubrication of valve stem.
(h) Excessive engine idling.
(i) Rich carburettor setting.

Remedies.

(a) Clean valves, stems, guides and scrape carbon from internal parts of engine. Use only a good "regular" grade of fuel.
(b) Clean valves, stems, guides and scrape carbon from the internal parts of engine. Drain crankcase and refill with a good quality of oil of the proper type and grade. Refer to Lubrication Section.
(c) Clean valves and guides as required. Then, check for excessive wear in guides. Replace parts as necessary.
(d) Clean valves and guides as required. Then, refer to Cooling System Section for correction of this condition.
(e) Clean valves and guides as required. Then, test thermostat.
(f) Clean valves and stems. Then replace worn valve guides as required.
(g) Clean valves and guides as required. Coat valve stems with engine oil before installation. Check for restriction of oil spray in valve tappets chamber and correct as necessary.
(h) Clean valves and guides as required and avoid excessive engine idling when possible.
(i) Readjust carburettor. Clean valves and guides as required.

ENGINE NOISES.

64. PISTON RING NOISE.

Possible Causes.

(a) Broken ring.
(b) Top ring striking cylinder ridge.
(c) Broken ring lands.

Remedies.

(a) Replace broken ring as required. Check to determine cause of breakage and correct as necessary.
(b) Remove ridge at top of cylinders as required, using suitable ridge reamer. Check rings and piston for possible damage and replace parts as necessary.
(c) Replace pistons as needed. Check for ridge at top of cylinder wall and remove, using suitable ridge reamer. Replace parts as required.

65. PISTON NOISE.

Possible Causes.

(a) Piston pin fit too tight.
(b) Excessive piston to bore clearance.
(c) Carbon accumulations in head.
(d) Collapsed piston skirt.
(e) Insufficient clearance at top ring land.
(f) Broken piston, skirt or ring land.

Remedies.

(a) Refit piston pins as required. Fit pins at normal room temperature 70° F. Use a thumb press fit.
(b) Replace pistons as required. Check cylinder walls for excessive wear. If necessary, recondition cylinder walls and instal new pistons and rings.
(c) Remove cylinder head and clean carbon from chamber, pistons and valves. Drain and refill crankcase with a good grade of lubricating oil.
(d) Replace pistons as required. Check cylinder walls for possible scoring, and recondition as necessary.
(e) Check piston clearance. If necessary, refit pistons.
(f) Remove pistons as required. Check cylinder walls for possible scoring or damage. Recondition walls if necessary and instal new pistons.

66. NOISY VALVES.

Possible Causes.

(a) Incorrect tappet clearance.
(b) Worn tappets or adjusting screws.
(c) Wear in cam lobes.
(d) Worn valve guides.
(e) Excessive runout of valve seat or valve face.

Remedies.

Refer to Paragraph 61 of this section for noisy valve remedies.

67. CONNECTING ROD NOISE.

Possible Causes.

(a) Low oil pressure.
(b) Insufficient oil supply.
(c) Thin or diluted oil.
(d) Misaligned rods.
(e) Excessive bearing clearance.
(f) Eccentric or out-of-round crank pin journal.

Remedies.

(a) Refer to Paragraph 71 for possible causes of low oil pressure. Correct as indicated in remedies.
(b) Check oil level in crankcase. If necessary, add oil to obtain correct level, or drain and refill. Test for possible loose or damaged rod bearings.
(c) Drain and refill crankcase. Then, test for possible loose or damaged rod bearings.
(d) Check rods for alignment. If necessary, straighten rod or instal new one. Check bearing and journal for excessive wear. Replace parts as required.
(e) Replace worn bearings as required. Fit connecting rod bearings to the desired clearance. Refer to Service Standards.
(f) Replace or regrind crankshaft as necessary. Replace with new undersize bearings after grinding operation is completed.

68. MAIN BEARING NOISE.

Possible Causes.

(a) Low oil pressure.
(b) Insufficient oil supply.
(c) Thin or diluted oil.
(d) Loose flywheel.
(e) Excessive bearing clearance.
(f) Excessive end play.
(g) Eccentric or out-of-round journals.
(h) Sprung crankshaft.

Remedies.

(a) Refer to Paragraph 71 for possible causes for low oil pressure. Correct as indicated in Remedies.
(b) Check oil level in crankcase. If necessary, add oil to obtain correct level, or drain and refill. Test for possible loose or damaged main bearings.
(c) Drain and refill crankcase. Then, test for possible loose or damaged main bearings.
(d) Tighten flywheel to specified torque.
(e) Replace worn bearings as required. Fit main bearings to the desired clearance. Refer Service Standards.
(f) Refer to remedy "e" above for correction of this condition.
(g) Replace crankshaft or regrind journals as necessary. Replace with new undersize bearings when grinding operation is completed.
(h) Replace or straighten crankshaft as necessary. Then, check condition of bearings and replace as required.

69. BROKEN PISTON RINGS.

Possible Causes.

(a) Wrong type or size.
(b) Undersize pistons.
(c) Ring striking top ridge.
(d) Worn ring grooves.
(e) Broken ring lands.

(f) Insufficient gap clearance.
(g) Excessive side clearance in groove.
(h) Uneven cylinder walls (particularly due to a previous ring breakage in same cylinder).

Remedies.

(a) Replace rings as required, after checking cylinder walls for possible scoring or grooving. When replacing rings, use only those that are of the correct type and size for the particular truck.
(b) Fit new pistons and rings. Check cylinder walls for possible scoring or grooving. Recondition walls as required.
(c) Replace rings as required, after checking cylinder walls for possible scoring or grooving. Remove ridge and recondition walls, if necessary.
(d) Fit new pistons and rings, after checking cylinder walls for possible scoring or grooving. Recondition cylinder walls as required.
(e) Fit new pistons and rings as required, after checking cylinder walls for possible scoring or grooving. Recondition cylinder walls if necessary.
(f) Replace rings as required. Check walls for damage and recondition if necessary.
(g) Replace broken rings as required. Inspect cylinder walls for damage and recondition if necessary.
(h) Fit new pistons and rings, after reconditioning cylinder walls.

70. BROKEN PISTONS.

Possible Causes.

(a) Undersize pistons.
(b) Eccentric or tapered cylinders.
(c) Misaligned connecting rods.
(d) Engine overheating.
(e) Cracks at expansion slots (excess engine speed with no load).
(f) Water or fuel leakage into combustion chamber.
(g) Detonation.
(h) Resizing of pistons.

Remedies.

(a) Recondition cylinder walls if necessary. Then, "mike" walls and fit new pistons and rings.
(b) Recondition cylinder walls and fit new pistons and rings.
(c) Recondition cylinder walls if necessary. Then, fit new pistons and rings. Realign connecting rods.
(d) Recondition cylinder walls if necessary. Then, fit new pistons and rings. Refer to Cooling System Section for possible causes and remedies of engine overheating.
(e) Recondition cylinder walls if necessary. Then, fit new pistons and rings. Avoid the practice of "racing" the engine during the warm-up period or afterwards.
(f) Recondition cylinder walls if necessary. Then, fit new pistons and rings. Check cylinder head, gasket and cylinder block for leaks. Repair as necessary.
(g) Recondition cylinder walls if necessary. Then, fit new pistons and rings. Check for excessive spark knock and pre-ignition, or detonation. Then, adjust as required.
(h) Recondition cylinder walls if necessary. Then, fit new pistons and rings. Avoid the use of resized pistons when possible.

71. LOW OIL PRESSURE.

Possible Causes.

(a) Thin or diluted oil.
(b) Worn or damaged oil pump rotors.
(c) Inaccurate oil pressure gauge.
(d) Loose oil pump cover.
(e) Oil relief valve spring broken or weak.
(f) Plugged oil pump screen.
(g) Excessive clearance at main bearings.
(h) Excessive clearance at rod bearings.
(i) Excessive clearance at camshaft bearings.
(j) Low oil level.
(k) Loose connections or restricted lines.

Remedies.

(a) Drain and refill crankcase, using a good grade of motor oil of the correct viscosity. Check for cause of dilution and correct as necessary.
(b) Remove oil pump and recondition as necessary.
(c) Test oil pressure gauge and replace if it does not meet specifications.
(d) Remove oil pump cover and replace cover gasket. Replace cover and tighten cover bolts securely.
(e) Replace broken or damaged relief valve spring.
(f) Check oil strainer for freeness. Then, remove and clean with a suitable solvent. Refill crankcase with a good grade of motor oil of the correct viscosity.
(g) Check amount of oil leakage at main bearings. Replace rod bearings as required.
(h) Check amount of oil leakage at rod bearings. Replace rod bearings as required.
(i) Check amount of oil leakage at camshaft bearings. Replace camshaft bearings as required.
(j) Drain and refill crankcase, using a good grade of motor oil of the correct viscosity.
(k) Clear all lines with air pressure. Then, tighten connections securely. Replace parts as necessary.

72. HIGH OIL PRESSURE.

Possible Causes.

(a) Heavy engine oil.
(b) Relief valve stuck.
(c) Stiff relief valve spring.
(d) Inaccurate pressure gauge.
(e) Restricted or partially clogged passage at relief valve.

Remedies.

(a) Drain and refill crankcase, using a good grade of motor oil of the correct viscosity.
(b) Service the relief valve to eliminate sticking.
(c) Replace relief valve spring.
(d) Test oil pressure gauge and replace if it does not meet specifications.
(e) Remove relief valve plug, spring and valve plunger. Then, clear passage with air pressure.

73. OIL PUMP NOISE.

Possible Causes.

(a) End play in pump shaft.
(b) Damaged or worn driven gear.
(c) Damaged or worn camshaft gear.
(d) Improper mesh of driving and driven gears.
(e) Oil pump not securely mounted.

Remedies.

(a) Refer to Oil Pump Section for proper end play specifications. Recondition as necessary to correct this condition.
(b) Replace worn or damaged driven gear. Check mating gear on camshaft. If necessary, replace camshaft.
(c) Refer to "b" above for correction of this condition.
(d) Check for burrs, dirt or buckled gasket where oil pump seats in block. Check driving and driven gears for excessive wear or damage. Replace parts as necessary.
(e) Remove pump and inspect for possible damage. Tighten oil pump mounting bolts to proper torque.

74. CONTAMINATED OIL.

Possible Causes.

(a) Infrequent oil change.
(b) Failure to service oil filter.
(c) Incomplete combustion.
(d) Low engine temperature.
(e) Poor grade of oil.
(f) Internal leak in cooling system.
(g) Frequent stop and go service.

Remedies.

(a) Drain and refill crankcase, at the proper time or mileage, using a good grade of motor oil of the correct viscosity. Refer to Lubrication Section.
(b) Oil filter should be changed every 10,000 miles, or more often, depending upon conditions. Refer to Lubrication Section.
(c) Drain and refill crankcase, using a good grade of motor oil of the correct viscosity. Check ignition system as outlined in Electrical System Section.
(d) Drain and refill crankcase, using a good grade of motor oil of the correct viscosity. Check and test thermostat as outlined in Cooling System Section. Replace parts as required.
(e) Drain and refill crankcase, using a good grade of motor oil of the correct viscosity. Refer to Lubrication Section. Check and determine cause of contamination and correct as required.
(f) Drain and refill crankcase, using a good grade of motor oil of the correct viscosity. Check cooling system as outlined in Cooling System Section.
(g) Drain and refill crankcase, using a good grade of motor oil of the correct viscosity. Frequent stop and go driving does not allow the engine to operate at the proper operating temperature that will permit vaporization of moisture accumulated in the crankcase.