ENGINE REPAIR • • • • • SECTION 1-B

CONTENTS

GENERAL DESCRIPTION

All Henry J models use either a four or a six cylinder L-head engine to produce ample power for operation of the vehicle and still provide exceptional economy.

The engine is mounted on two rubber shock damping insulators on the front crossmember (Fig. 16), and one rubber mounting insulator between the transmission case and the number 2 crossmember.

The cylinder block and crankcase are cast integrally forming a rigidly reinforced unit. The cylinder heads, while being different in size, have the same compression ratio of 7.01 to 1. Both type heads are provided with fins which help dissipate engine heat.

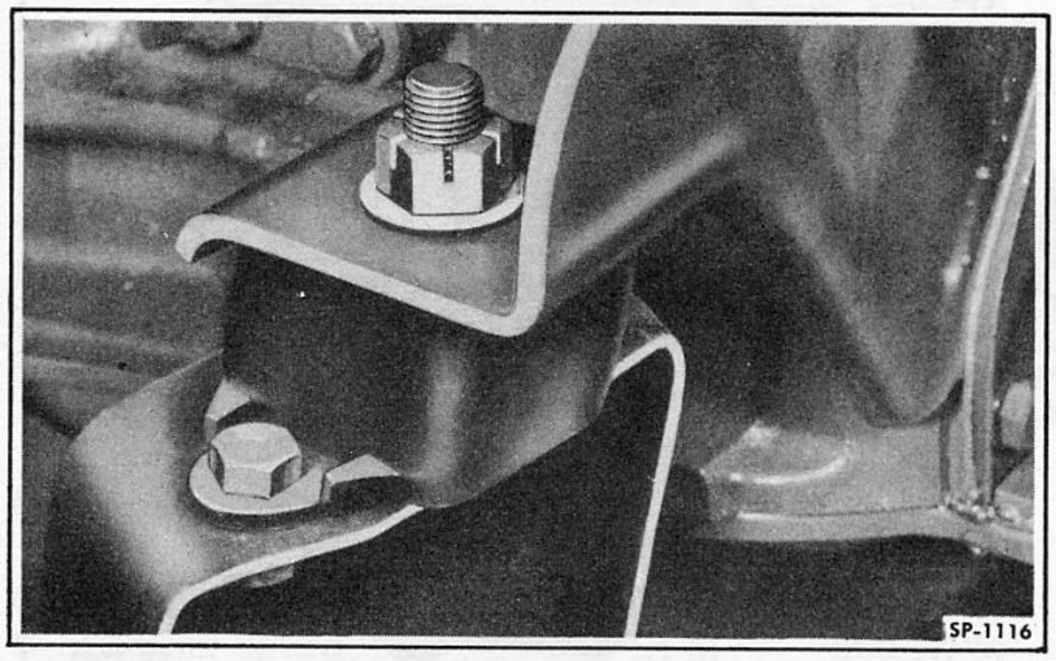


Fig. 16—Forward Engine Mounting

The connecting rods (Fig. 17) are drop forged and are the split type to clamp the piston pin in the rod. The four cylinder engine rods differ from each other due to an offset in the rod which makes the No. 1 and 3 rods interchangeable and the No. 2 and 4 rods interchangeable.

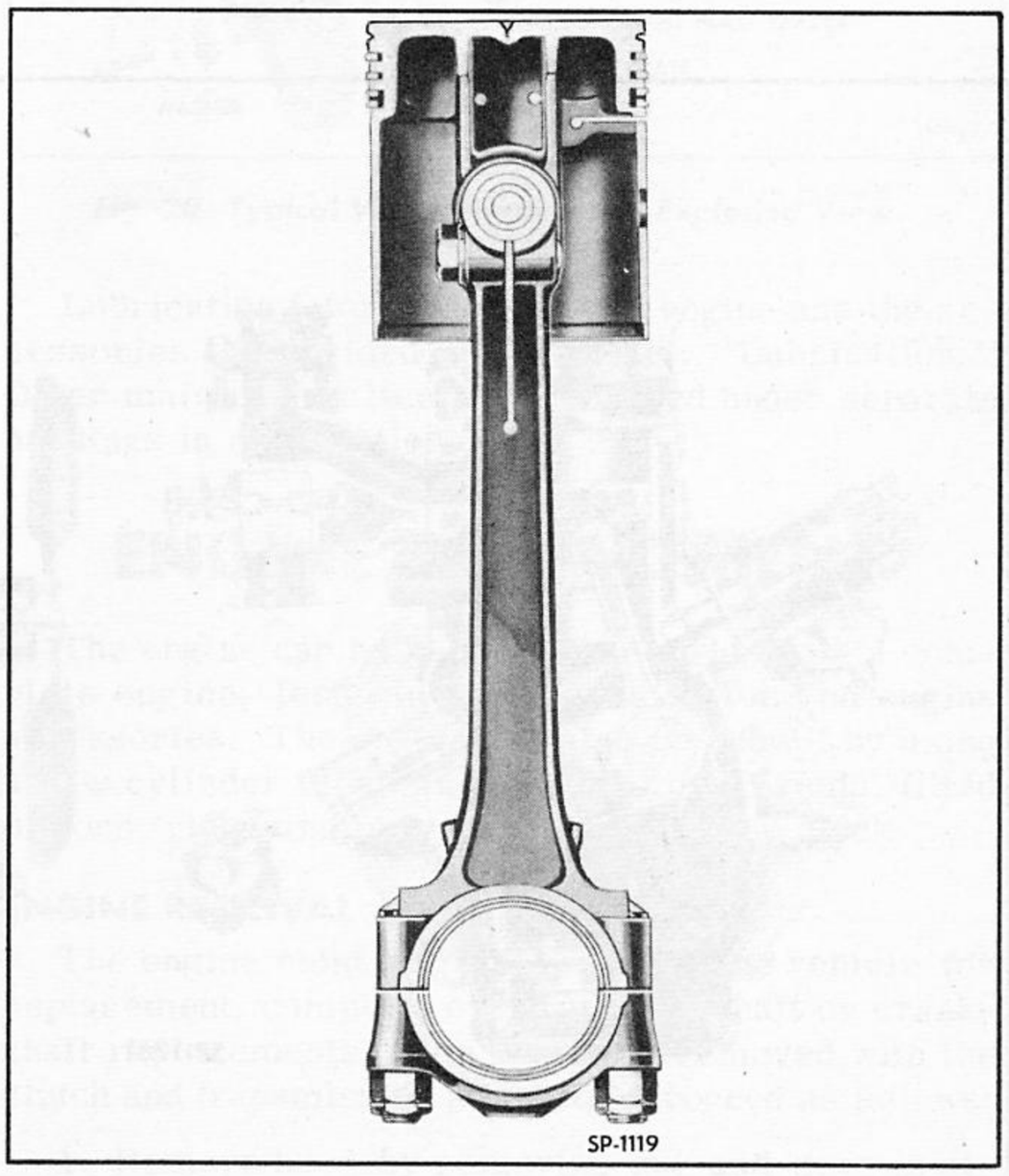


Fig. 17—Piston and Connecting Rod

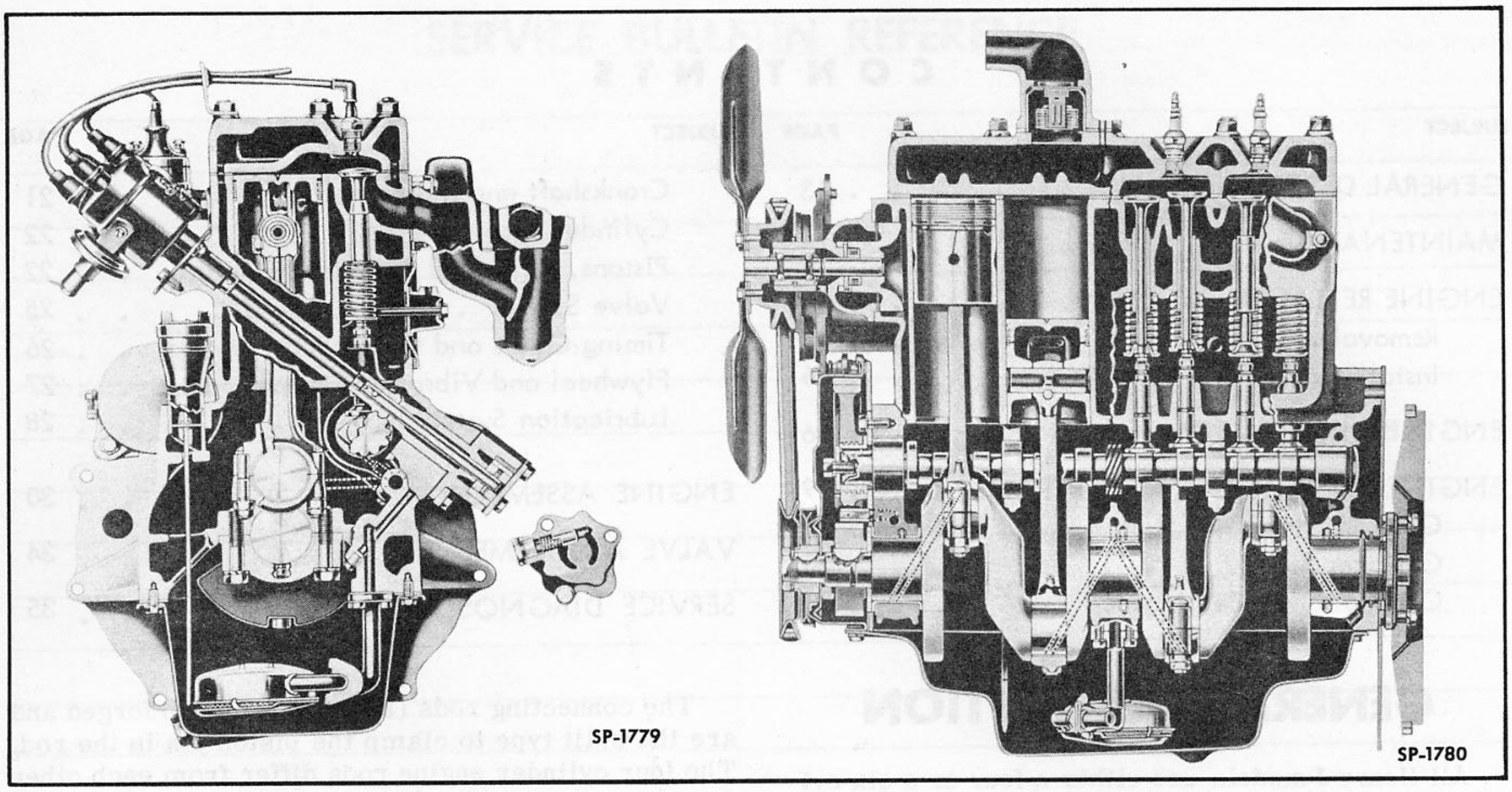


Fig. 18—4 Cylinder Engine—Side and End Section View

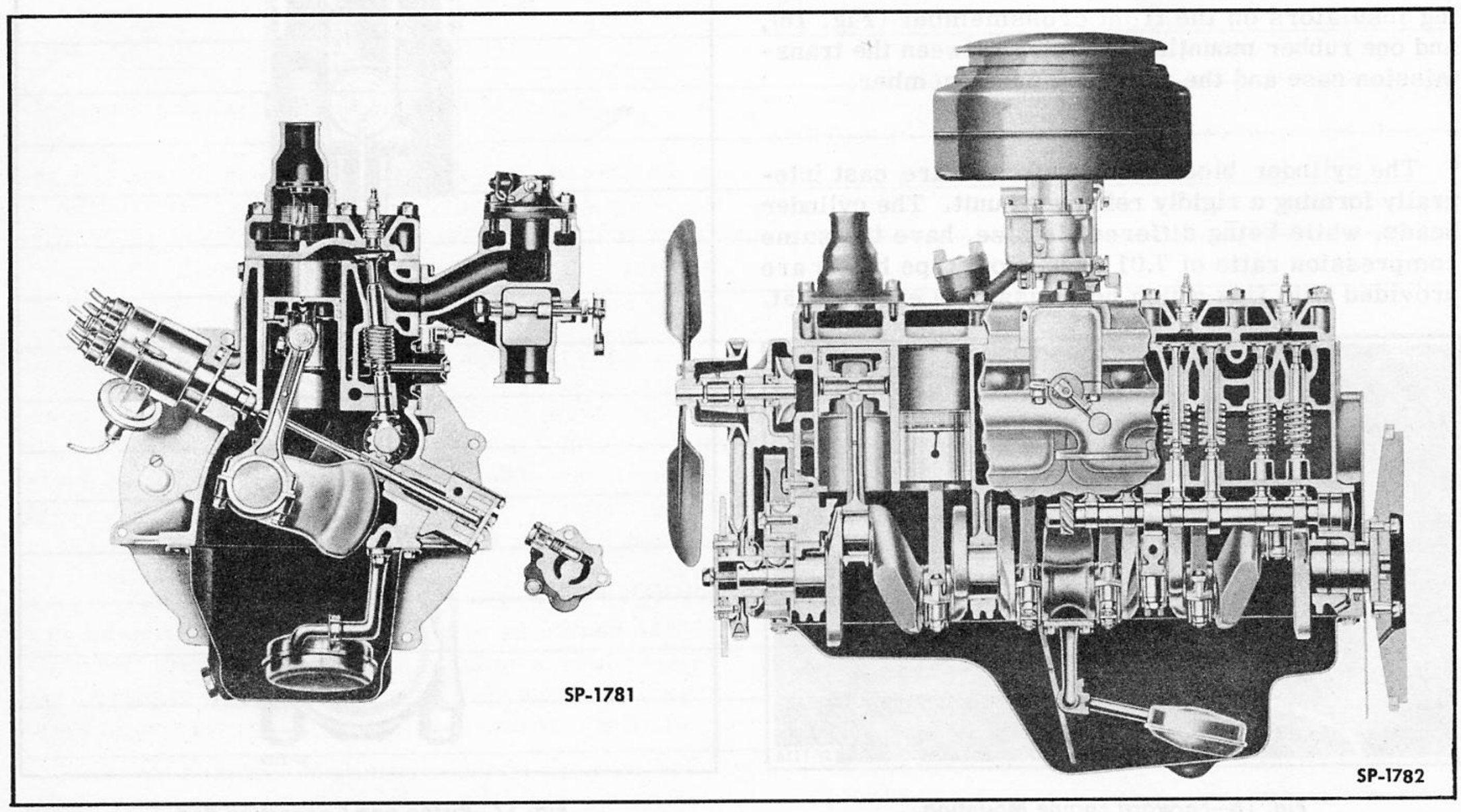


Fig. 19—6 Cylinder Engine—Side and End Section View

The six cylinder rods can be interchanged with each other but must be installed with the oil spurt holes away from the camshaft.

Three piston rings are used on each piston, all rings being located above the piston pin. The two top rings are compression rings and the lower ring is the oil control ring.

The counterbalanced crankshafts for both engines are of drop forged steel. The four cylinder crankshaft has removable counterweights while the counterweights are an integral part of the shaft for the six cylinder engine.

The four cylinder engine crankshaft has three main bearing journals while the larger, six cylinder engine crankshaft, is supported by four main bearings.

The camshaft (Fig. 20) is supported in the block on four bearings and is driven by a pressed on type fiber gear, driven off the crankshaft.

The engine is pressure lubricated. An oil pump, driven from the camshaft, forces the lubricant through the drilled passages in the crankshaft to efficiently lubricate the main and connecting rod bearings. Lubricant is also force fed to the camshaft bearings and timing gears. Cylinder walls and piston pins are lubricated from connecting rod spurt holes.

The engine is provided with full length water jackets. The areas around the valves, cylinders and throughout the cylinder head are provided with passages, through which the coolant is circulated by a belt-driven pump. Circulation of the coolant is controlled by a thermostat in the cylinder head water outlet elbow.

ENGINE DATA

	4-CYLINDER ENGINE	6-CYLINDER ENGINE
Model	4L-134	6L-161
Type	L-Head	L-Head
Number of Cylinders	4	6
Bore	3-1/8 in.	3-1/8 in.
Stroke	4-3/8 in.	3-1/2 in.
Piston Displacement	134.2 cu. in.	161 cu. in.
Taxable Horsepower	15.63	23.4
Maximum Brake Horsepower	68 @ 4000 RPM	80 @ 3800 RPM
Maximum Torque	109 ft. lbs. @1800 RPM	133 ft. lbs. @1600 RPM
Compression Ratio	7.0 to 1	7.0 to 1
Best Idling Speed	550 RPM	500 RPM
Ignition Timing	5° B.T.D.C.	T.D.C.
Firing Order	1-3-4-2	1-5-3-6-2-4

MAINTENANCE

In addition to periodic engine tune-up which is required to maintain the engine in good operating condition, various other parts should be given regular attention. The maintenance of engine accessories as described in other Sections of this manual is important. Items which pertain to the engine proper and which require special attention are: Checking and changing engine oil, checking tightness of cylinder head and manifold bolts, inspecting engine mountings, and general checking for fuel, oil and water leakage.

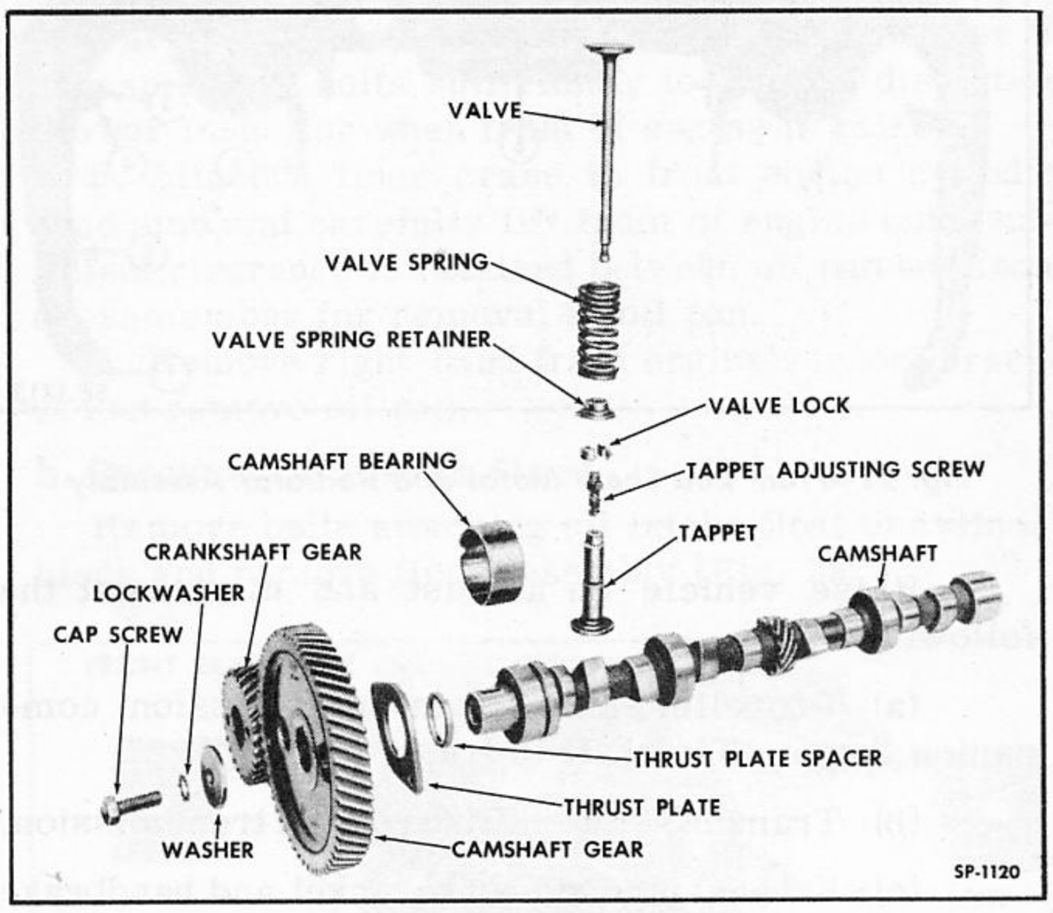


Fig. 20—Typical Valve Mechanism—Exploded View

Lubrication information for the engine and the accessories is provided in Section 17, "Lubrication." Other maintenance items are covered under separate headings in this section.

ENGINE REPLACEMENT

The engine can be replaced in service with a complete engine, less clutch, transmission and engine accessories. The engine can also be rebuilt by using a new cylinder block and new bearings, studs, fitted pistons, rings and pins furnished with the block.

ENGINE REMOVAL

The engine must be removed from the vehicle for replacement, complete overhaul, camshaft or crankshaft replacements. The engine is removed with the clutch and transmission attached. Proceed as follows:

1. Remove hood by removing nut and screws attaching hood to hinge at each side. Remove front bumper and supports from frame.

2. Drain cooling system, disconnect radiator hoses at engine, disconnect headlamp wiring at junction block near hood latch, disconnect and remove battery and disconnect fresh air ducts at cowl (if so equipped).

3. Remove bolts from both sides at locations indicated in Fig. 21 and lift off complete front end sheet metal and radiator assembly.

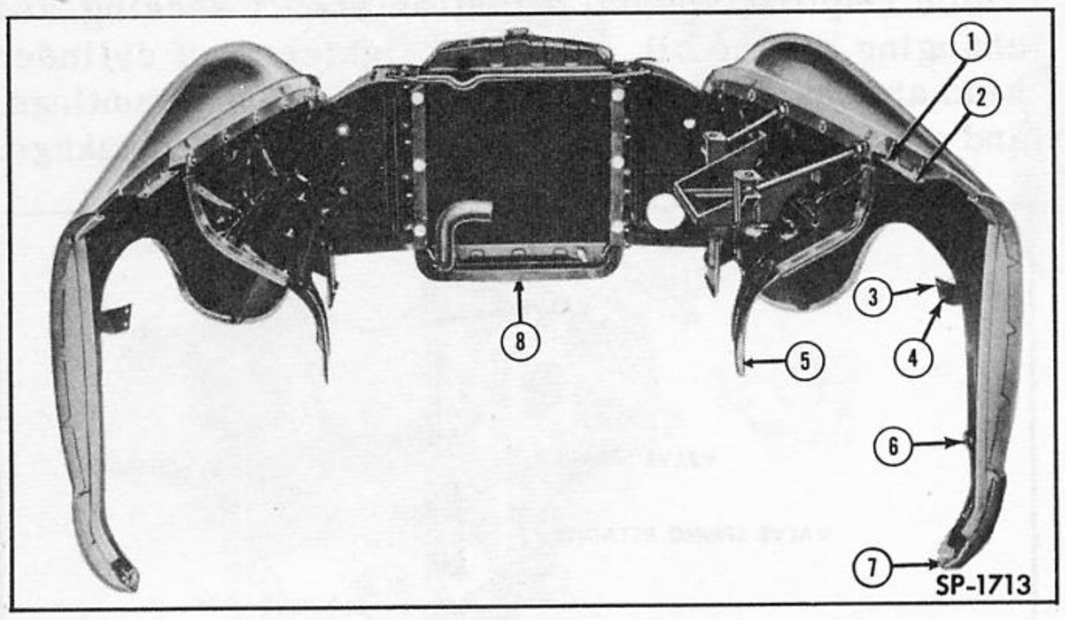


Fig. 21—Front End Sheet Metal and Radiator Assembly

4. Raise vehicle on a hoist and disconnect the following:

(a) Propeller shaft from transmission companion flange. Tie shaft to frame side rail.

(b) Transmission shifting rods at transmission.

(c) Exhaust pipe support bracket and handbrake cable from clutch housing.

(d) Overdrive control cable and wiring (if so equipped) and speedometer cable.

(e) Clutch cross shaft and bell crank. Remove cross shaft to avoid damage.

(f) Remove rear engine mount (at transmission) to frame crossmember bolts.

5. Lower vehicle and disconnect the following:

(a) Heater hoses (if so equipped).

(b) Electrical wiring at ignition coil, generator, starter, oil pressure gauge engine unit and temperature gauge engine unit.

(c) Exhaust pipe from manifold.

(d) Throttle linkage to carburetor and remove bell crank.

6. Remove nuts and washers at forward engine mountings (Fig. 18). Attach a sling or lifting hook approximately in center of block so front of engine is tilted upward when lifting transmission out of vehicle. Place engine in Engine Repair Stand KF-24 with Adapter Set KF-131 or their equivalent and remove sling from engine.

7. If engine is to be completely disassembled or replaced, the carburetor, fuel pump, coil, distributor, spark plugs and wires, generator, starting motor, fan, fan belt, oil filter (if so equipped), transmission and clutch should be removed. Refer to the following sections in this manual for detailed removal procedures on the above items:

Carburetor . . . . . Fuel -- Section 2
Fuel Pump . . . . . Fuel -- Section 2
Fan and Fan Belt . . . . . Cooling -- Section 4
Distributor . . . . . Electrical -- Section 15
Ignition Coil . . . . . Electrical -- Section 15
Generator . . . . . Electrical -- Section 15
Starting Motor . . . . . Electrical -- Section 15
Transmission . . . . Transmission and Overdrive -- Section 6
Clutch . . . . . Clutch -- Section 5

ENGINE INSTALLATION

When the engine is completely assembled and ready for installation, proceed as follows:

1. Install clutch, transmission, oil filter (if so equipped), generator, fan, fan belt, starting motor, distributor, spark plugs and wires, coil, fuel pump and carburetor. Make adjustments as necessary when installing various units. Refer to proper sections in this manual for detailed procedures.

2. Carefully lift engine off repair stand and lower into position on vehicle. Install washers and nuts on front mounting studs. Remove lifting sling or hook from engine.

3. Raise vehicle on a hoist and install rear engine mounting bolts at transmission. Connect propeller shaft, transmission shifting rods, overdrive control cable and wiring (if so equipped), speedometer cable, exhaust pipe support bracket and hand brake cable at clutch housing, clutch cross shaft and bell crank.

4. Lower vehicle and connect exhaust pipe to manifold, throttle linkage, electrical wiring to coil, generator, starter, oil pressure and temperature gauge engine units, and connect heater hoses (if so equipped).

5. Install front end sheet metal and radiator assembly, connect radiator hoses, headlamp wiring, fresh air ducts (if so equipped), install battery and install hood.

6. Fill cooling system and crankcase as necessary.

ENGINE DISASSEMBLY

Engine disassembly is presented in the sequence to be followed when the engine is to be completely

overhauled after removal from the vehicle and after clutch, transmission and engine accessories are removed (Fig. 22). Most of the operations in the procedure are also applicable separately with the engine in the vehicle, provided the part of the engine to be worked on is first made accessible by removal of engine accessories or other engine parts.

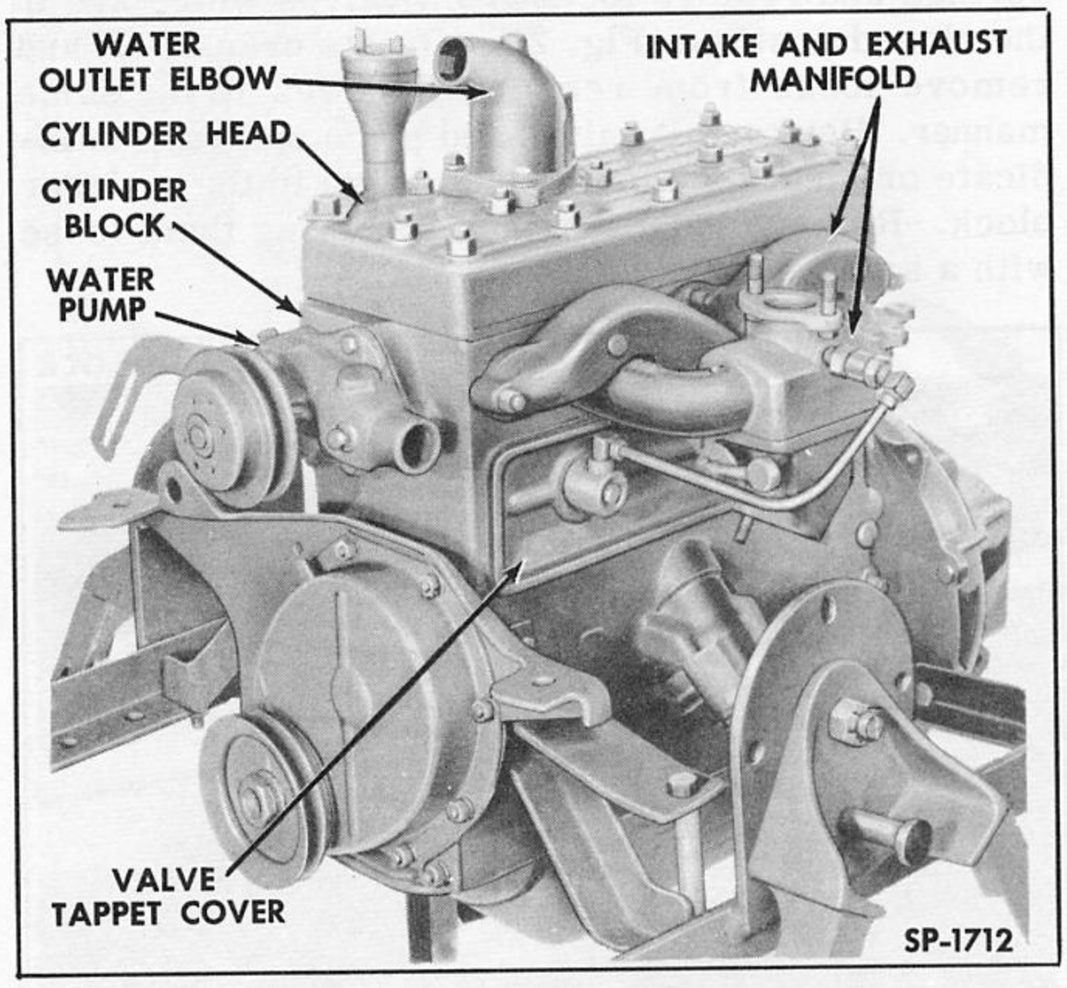


Fig. 22—Engine Ready for Disassembly—4 Cylinder Shown

Proceed as follows:

a. Remove Intake and Exhaust Manifolds

Remove crankcase ventilation check-valve and line to valve tappet cover. Remove nuts and washers that attach manifolds to cylinder block. Lift manifolds off cylinder block as an assembly.

b. Remove Water Pump

Remove screws that attach water pump to cylinder block and remove pump and gasket.

c. Remove Water Outlet Elbow

Remove cap screws and lockwashers from water outlet elbow and remove elbow and gasket from cylinder head.

d. Remove Flywheel

Remove six nuts and washers that attach flywheel to crankshaft. Support flywheel and tap it lightly with a rawhide hammer to loosen it from doweled bolts. Remove flywheel and lift rear end plate off end of crankshaft.

e. Remove Cylinder Head

Remove all nuts attaching cylinder head to cylinder block and remove head.

f. Remove Oil Pump

Remove bolts attaching oil pump to cylinder block. Pull pump out of block.

g. Remove Oil Pan

Remove all bolts attaching oil pan to cylinder block and remove oil pan and gasket. NOTE: Oil pan can be removed with engine in vehicle as follows:

1. Drain radiator and remove upper and lower radiator hoses.
2. Remove the nuts and washers from engine front mounts.
3. Raise and support front of vehicle in a suitable manner.
4. Drain engine oil, disconnect tie rod from pitman arm, and loosen rear engine support insulator to crossmember bolts sufficiently to prevent distortion of rear insulator when front of engine is raised.
5. Attach a floor crane to front engine cylinder head stud and carefully lift front of engine until sufficient clearance is obtained between oil pan and front crossmember for removal of oil pan.
6. Remove right-hand front engine support bracket and remove oil pan.

h. Remove Oil Intake Float

Remove bolts attaching oil intake float to cylinder block and remove float assembly (Fig. 23).

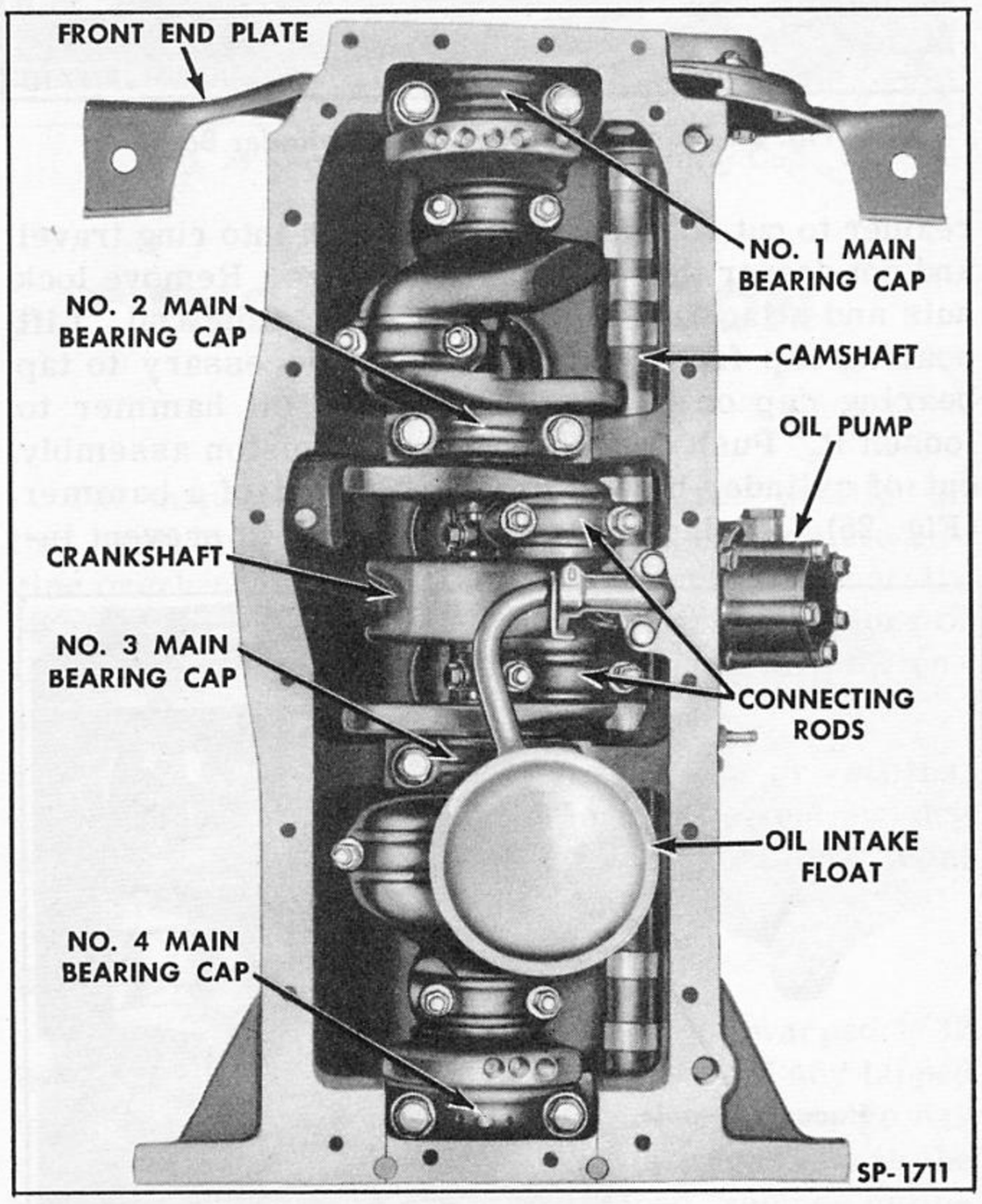


Fig. 23—Underside of Engine with Oil Pan Removed—6 Cylinder Shown

i. Remove Piston and Connecting Rod Assemblies

To prevent damage to pistons, the ridge at the top of each cylinder bore must be eliminated before removing pistons. Remove ridge using Cylinder Ridge Reamer C-3012 or its equivalent (Fig. 24). Adjust

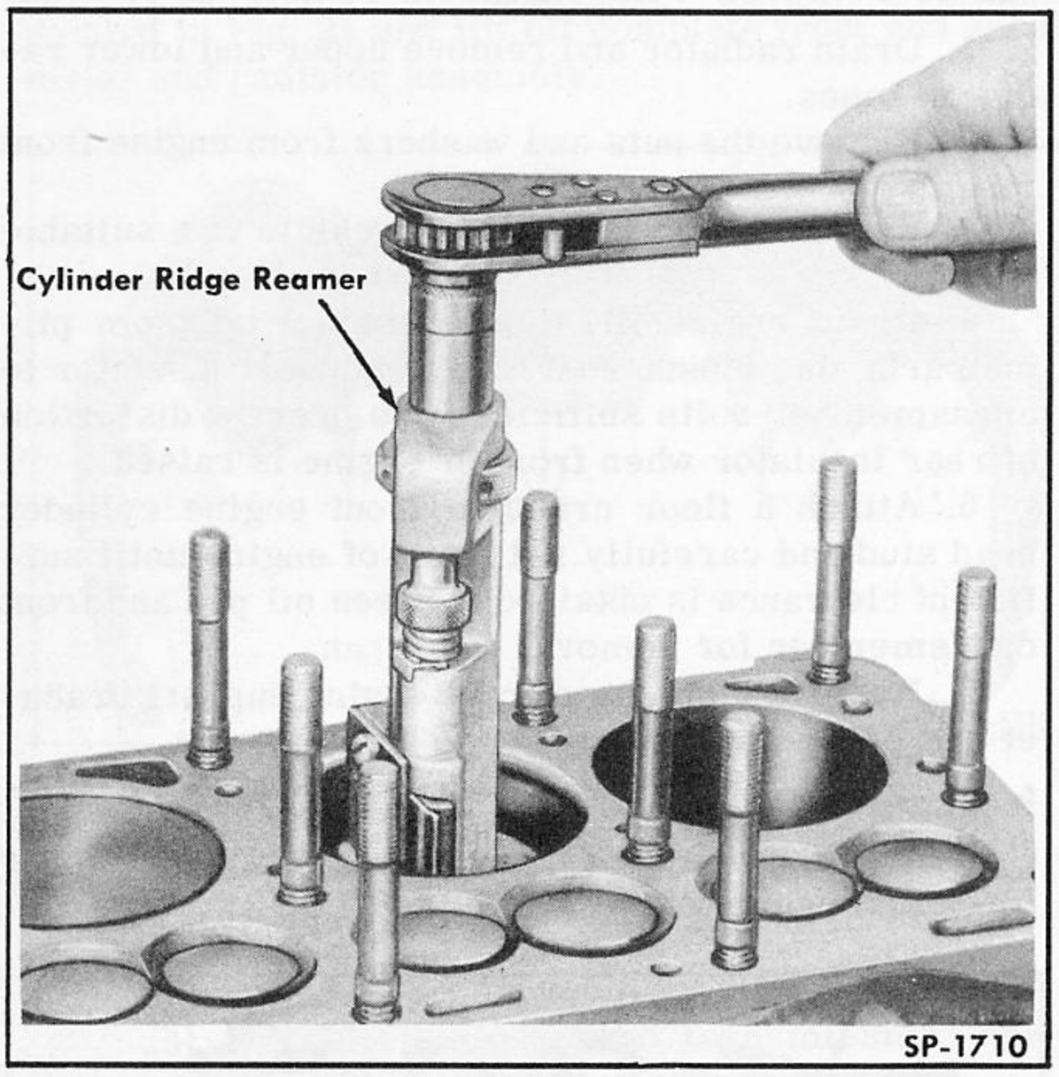


Fig. 24—Removing Ridge from Cylinder Bore

reamer to cut not more than 1/64 inch into ring travel and not deeper than worn cylinder size. Remove lock nuts and attaching nuts from a connecting rod. Lift bearing cap from rod. It may be necessary to tap bearing cap on either side with a soft hammer to loosen it. Push connecting rod and piston assembly out of cylinder block with handle end of a hammer (Fig. 25). Replace bearing cap on rod to prevent inter-mixing caps. Remove remaining connecting rod and piston assemblies in the same manner.

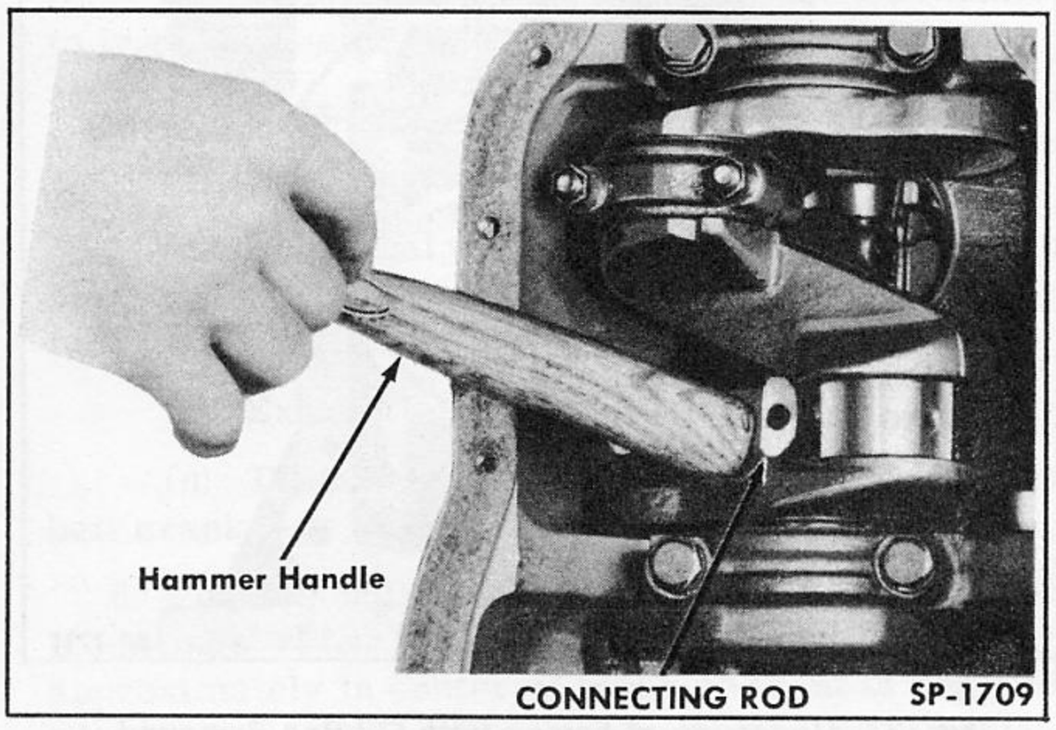


Fig. 25—Removing Piston and Connecting Rod Assembly

j. Remove Valve and Springs

Remove valve tappet cover. With Valve Spring Lifter C-482, or its equivalent, compress valve springs and remove locks from valves which are in the closed position (Fig. 26). Rotate crankshaft and remove locks from remaining valves in the same manner. Remove all valves and place in a rack to indicate original location of each valve in the cylinder block. Remove valve springs by prying them loose with a screwdriver.

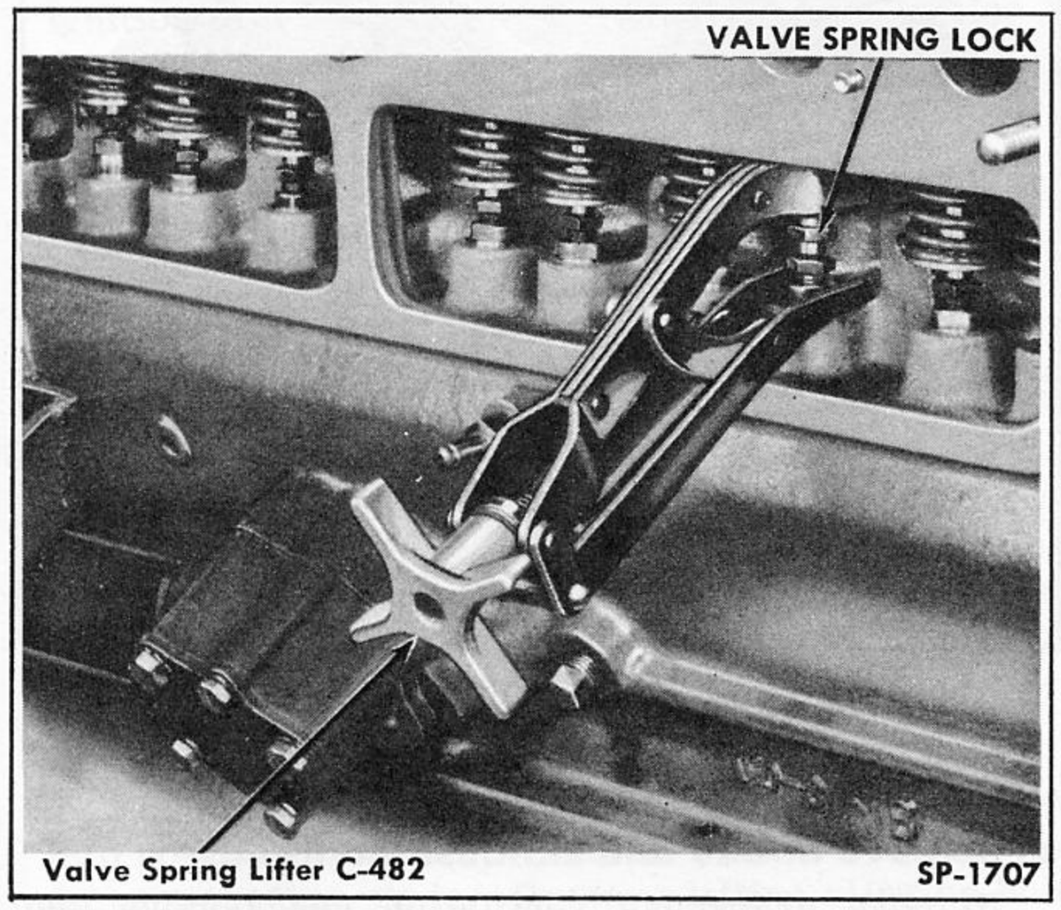


Fig. 26—Removing Valve Spring Locks

k. Remove Vibration Damper or Pulley

On four cylinder engines, remove nut from end of crankshaft and remove crankshaft pulley, using Crankshaft Pulley Puller W-175 (Fig. 27). On six cylinder engines, remove cap screw in end of crankshaft and remove vibration damper and insulators from crankshaft before removing pulley.

l. Remove Timing Gears

Remove cap screws and bolts, attaching timing gear cover to engine and remove cover. Remove timing gears from crankshaft and from camshaft using Crankshaft and Camshaft Gear Puller W-172. On six cylinder engines, remove crankshaft gear with Puller KF-31. NOTE: Timing gears can be left on and removed with the shafts if desired.

m. Remove Cylinder Block End Plates

The cylinder block rear end plate is loosened after clutch housing is removed and can be lifted off crank-

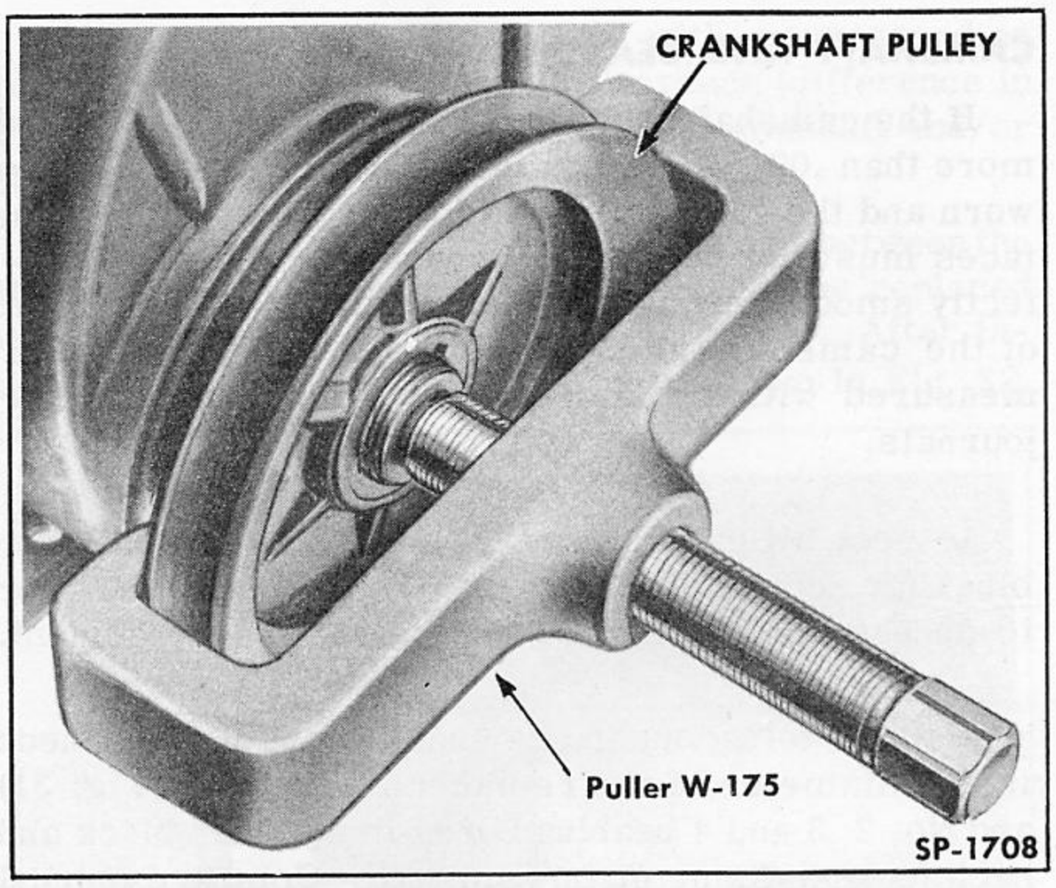


Fig. 27—Removing Crankshaft Pulley—4 Cylinder Engine

shaft after flywheel is removed. The front end plate can be removed from cylinder block by removing its attaching bolts. NOTE: It is not necessary to remove front end plate unless block is to be replaced.

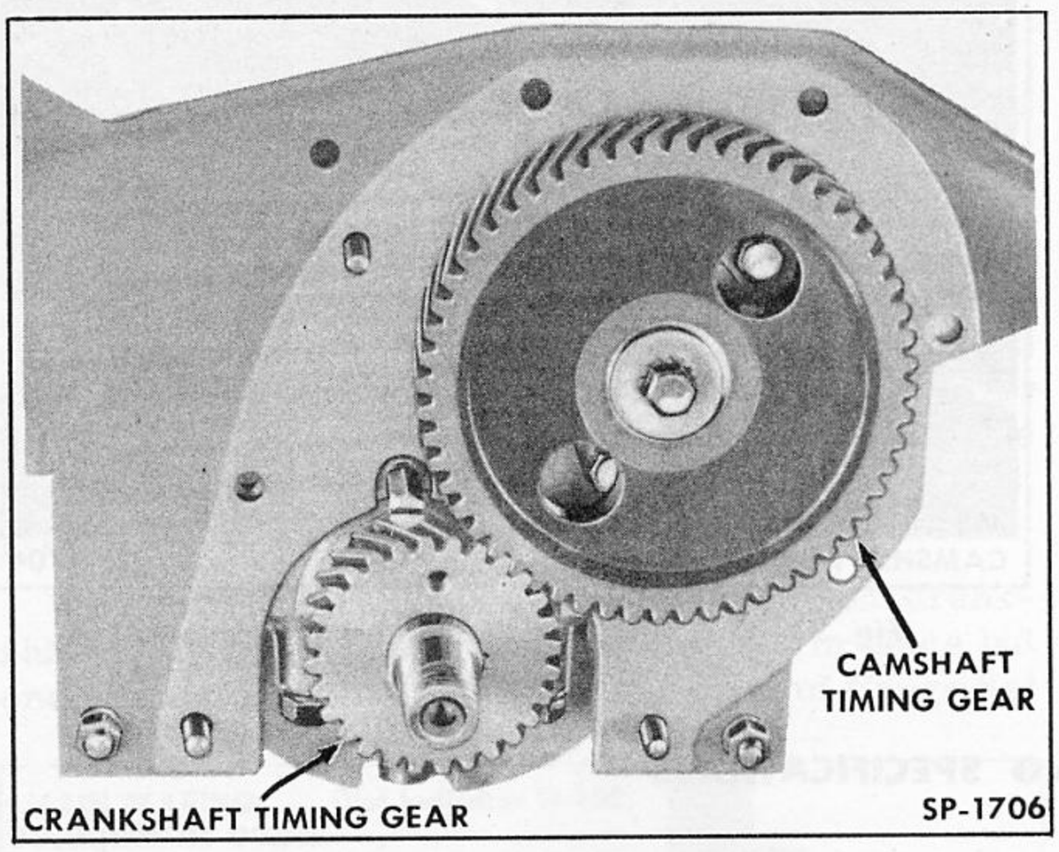


Fig. 28—Timing Gears

n. Remove Crankshaft and Main Bearings

Crankshaft may be removed with timing gear still attached if desired. (See paragraph l.) Remove main bearing cap bolts and remove caps and lower half of bearings.

The rear main bearing cap is easily removed by prying it up as shown in Fig. 29. Lift crankshaft from cylinder block. Remove upper half of main bearings from cylinder block. NOTE: On four cylinder engines, the main bearings are held in place with dowels, therefore main bearings can be replaced only after engine is removed from vehicle and crankshaft is removed from engine. On six cylinder engines, the bearings can be replaced without removing engine from vehicle or removing crankshaft from engine, by using Main Bearing Upper Shell Removing Tool KF-8 to rotate the upper half of bearing out from between crankshaft and block.

o. Remove Camshaft and Tappets

If camshaft timing gear was not removed in paragraph 1., turn gear until two thrust plate attaching screws (see Fig. 28) are visible through holes in timing gear. Remove screws from thrust plate. With all tappets in the up position, carefully remove camshaft. Lift tappets from cylinder block and place in a rack so they may be installed in their original position.

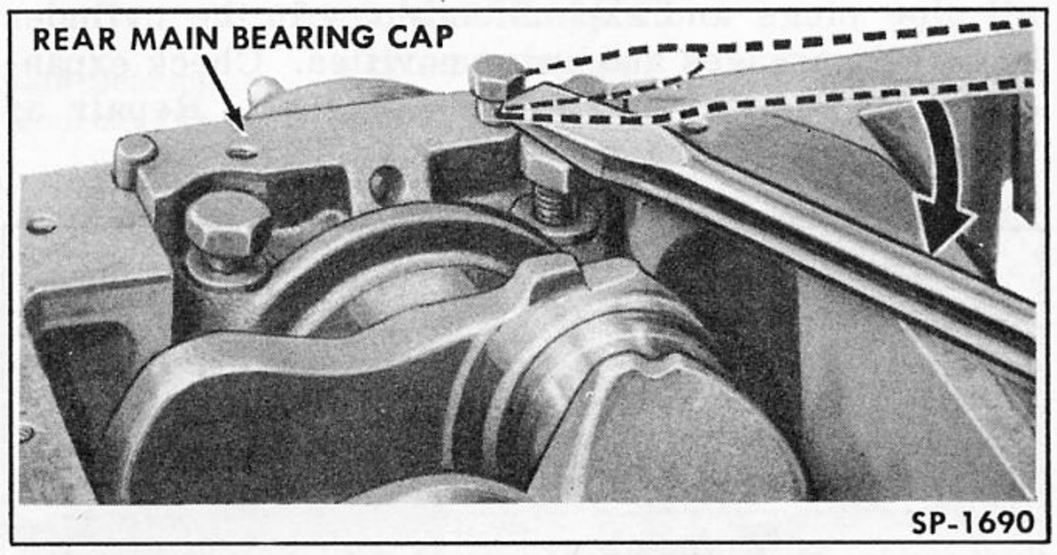


Fig. 29—Removing Rear Main Bearing Cap

ENGINE INSPECTION AND REPAIR

The inspection and repair procedures detailed in this section are recommended when a complete engine overhaul is made. The instructions can generally be applied to inspection repair of separate portions of the engine when minor repairs are made with the engine in the vehicle.

Before proceeding with the inspection or repairs, clean all parts with a suitable cleaning solvent and dry with compressed air. Strip off all old gaskets from all surfaces.

CYLINDER HEAD

Replace cylinder head if cracked, or warped 1/32 inch or more over the full length of head. If any tapped hole for spark plugs or water temperature gauge has damaged threads which cannot be cleaned up with the proper tap, or if threads are stripped, replace cylinder head. Be sure that all water passages are open and that all carbon is removed.

CYLINDER BLOCK

Examine the cylinder block for minute cracks and fractures. Rusted valve springs or evidence of rust in tappet chamber or on cylinder walls indicates a possible crack in the block. Replace cylinder block if cracked.

Examine all machined surfaces of cylinder block for burrs and scores. Remove plugs and clean all crankcase oil passages. Check cylinder block distortion by placing a straight edge on cylinder head surface of block. With a feeler gauge check for clearance between straight edge and block, particularly between adjacent cylinders (Fig. 30). Manufacturing tolerance on the finished surface is .010 of an inch.

Check threads of all studs and tapped holes in block. Replace any damaged or broken studs. Check all pipe plugs and expansion plugs in the cylinder block oil passages and water cavities. Check expansion plug in block at rear of camshaft. Repair as required if evidence of a leak is found.

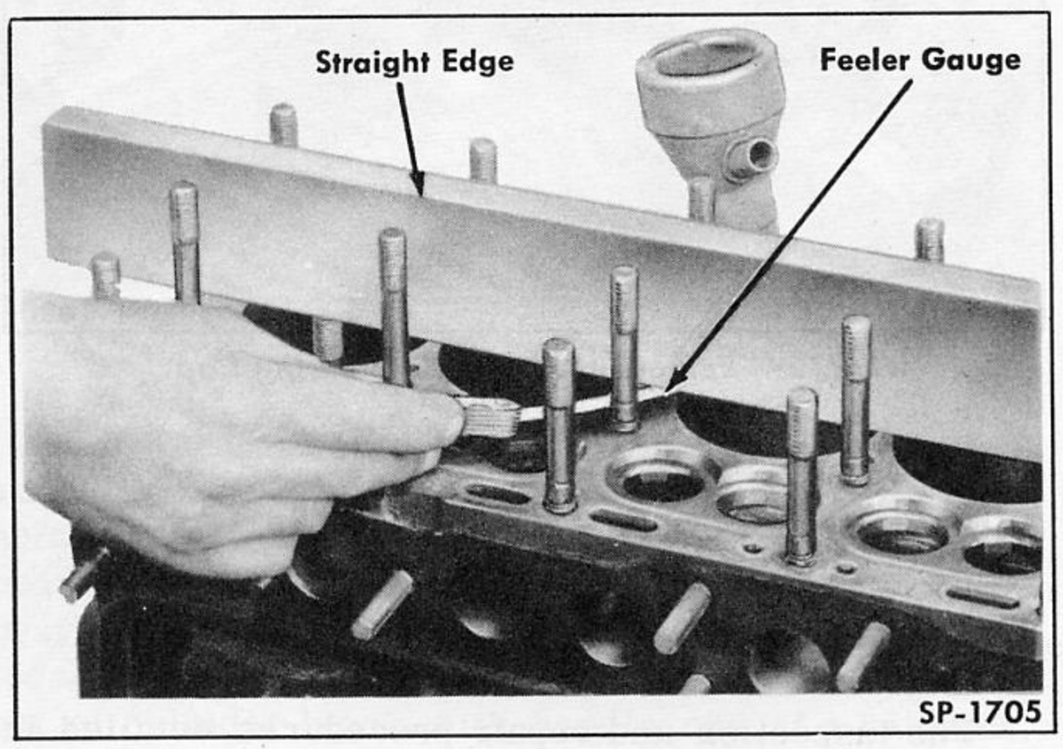


Fig. 30—Checking Cylinder Block for Distortion

CAMSHAFT AND BEARINGS

If the camshaft journals are worn or out-of-round more than .001 of an inch the cams are probably also worn and the camshaft should be replaced. The cam faces must not be scored or worn and must be perfectly smooth throughout their contact face. Run-out of the camshaft must not exceed .002 of an inch, measured with a dial indicator at the intermediate journals.

Inspect all camshaft bearing surfaces in cylinder block for scoring. Check replaceable front bearing for looseness in cylinder block and for oil hole alignment.

Using a telescope gauge and a micrometer, check inside diameter of the replaceable bearing (Fig. 31) and No. 2, 3 and 4 bearing bores in cylinder block and each journal diameter on camshaft. Compare journal diameters with corresponding bearing diameters. The specified diameters are as follows:

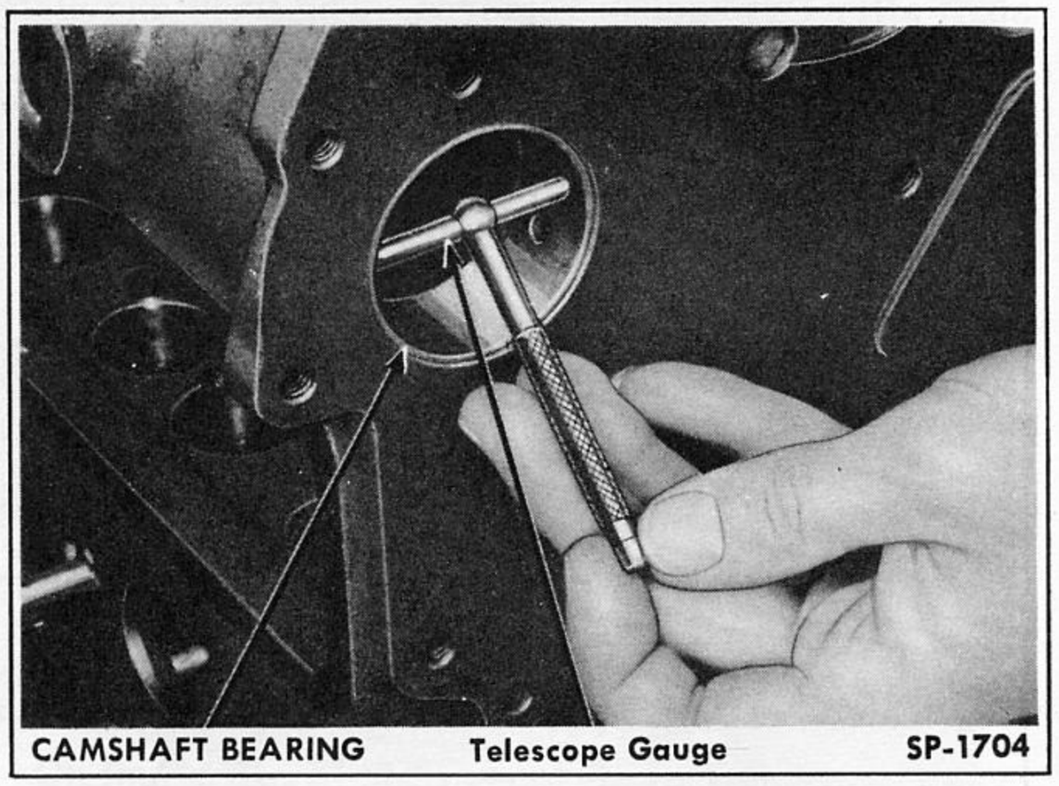


Fig. 31—Checking Camshaft Bearing Diameter

CAMSHAFT BEARING SPECIFICATIONS

	Journal Diameter	Bore in Block	Bore in Replaceable Bearing
4-CYLINDER ENGINE			
No. 1, Front	2.1855" - 2.1860"	2.3165" - 2.3175"	2.1870" - 2.1880"
No. 2, Front Intermediate	2.1215" - 2.1225"	2.1250" - 2.1260"	None
No. 3, Rear Intermediate	2.0590" - 2.0600"	2.0625" - 2.0635"	None
No. 4, Rear	1.6225" - 1.6230"	1.6250" - 1.6260"	None
6-CYLINDER ENGINE			
No. 1, Front	1.8755" - 1.8760"	2.0055" - 2.0065"	1.8770" - 1.8780"
No. 2, Front Intermediate	1.8425" - 1.8435"	1.8460" - 1.8470"	None
No. 3, Rear Intermediate	1.8110" - 1.8120"	1.8145" - 1.8155"	None
No. 4, Rear	1.6245" - 1.6250"	1.6270" - 1.6280"	None

Compare journal diameters with corresponding bearing diameters. If running clearance (difference in diameters) is over .003 of an inch, the camshaft and/or the cylinder block must be replaced.

If excessive running clearance is found between the No. 1 bearing and journal, the bearing can be replaced with a new bearing, using a suitable driver. After installation, stake bearing in place as shown in Fig. 32.

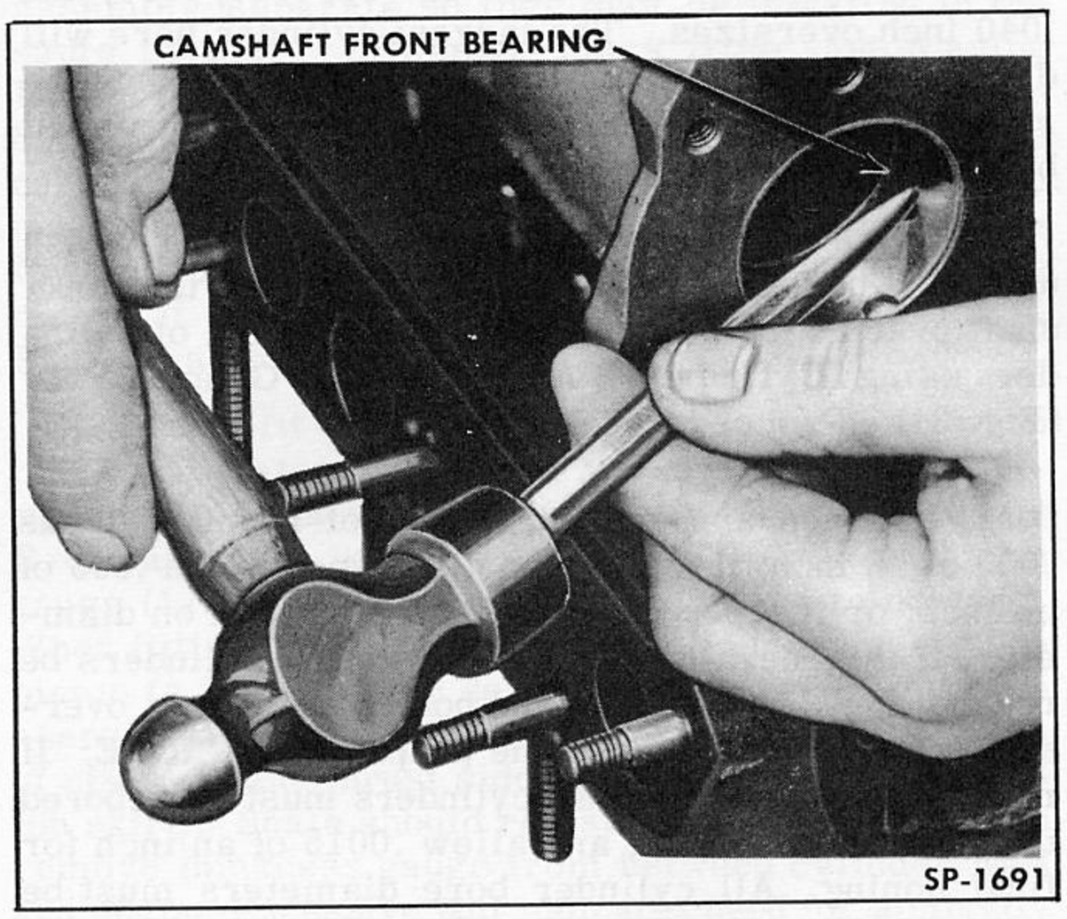


Fig. 32—Staking Camshaft Front Bearing

CRANKSHAFT AND MAIN BEARINGS

The crankshaft must be cleaned and inspected carefully for cracks, misalignment or badly scored or worn journals and crankpins, all of which necessitate replacement of the crankshaft. If it is not cracked, proceed as follows:

1. To check crankshaft alignment, mount crankshaft in cylinder block with all bearings in place but one. Mount Dial Indicator W-102, (part of Gauge Set W-99) on the crankcase with indicator button resting on bearing journal which had bearing removed. Slowly rotate crankshaft and note reading on indicator dial (Fig. 33). Install the bearing and remove another bearing. Repeat the operation with dial indicator until all journals are checked. The maximum allowable run-out is .002 of an inch.

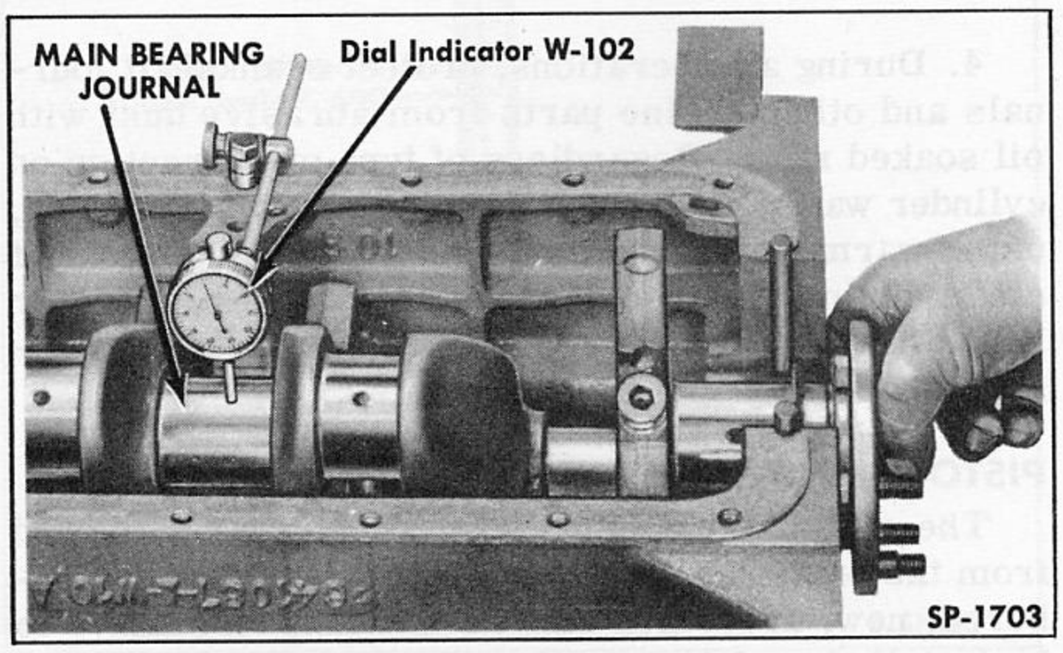


Fig. 33—Checking Crankshaft Run-Out

2. Main bearing journal diameters may be checked with an ordinary three inch micrometer.

Measure each journal diameter at four different places to determine amount of out-of-round or taper. Machine any journals that are out-of-round and/or taper more than .001 inch. Journals that are worn evenly with less than .001 inch out-of-round or taper need not be reground if .001 or .002 inch undersize bearings can be fitted to the tolerances given below.

CRANKSHAFT ORIGINAL DIAMETER AND CLEARANCES

	4-CYLINDER ENGINE	6-CYLINDER ENGINE
Main Bearing Journal Dia.	2.3331" - 2.3341"	2.2490" - 2.2500"
Crankshaft to Main Bearing Clearance	.0009" - .0029"	.0009" - .0030"
Crankpin Dia.	1.9375" - 1.9385"	1.8740" - 1.8750"
Crankshaft to Rod Bearing Clearance	.0005" - .0025"	.0005" - .0025"

3. If crankshaft journals are worn excessively, they can be ground and polished to .010 of an inch undersized (from original diameter shown in above list) and installed with bearings that are .010 undersized.

On six cylinder engines, the crankshaft journals can be checked without removing engine from vehicle. Remove bearing cap and upper and lower bearings from each journal, one at a time. Use a special journal micrometer to obtain diameter.

4. Install main bearing caps to cylinder block without the bearings. Measure main bearing bores using a telescope gauge and micrometer. Measure bores at right angles to split line and at 45 degrees to split line. The standard bore diameter is shown in chart below. The bores should not be over .001 of an inch out-of-round or .001 of an inch in taper from end to end.

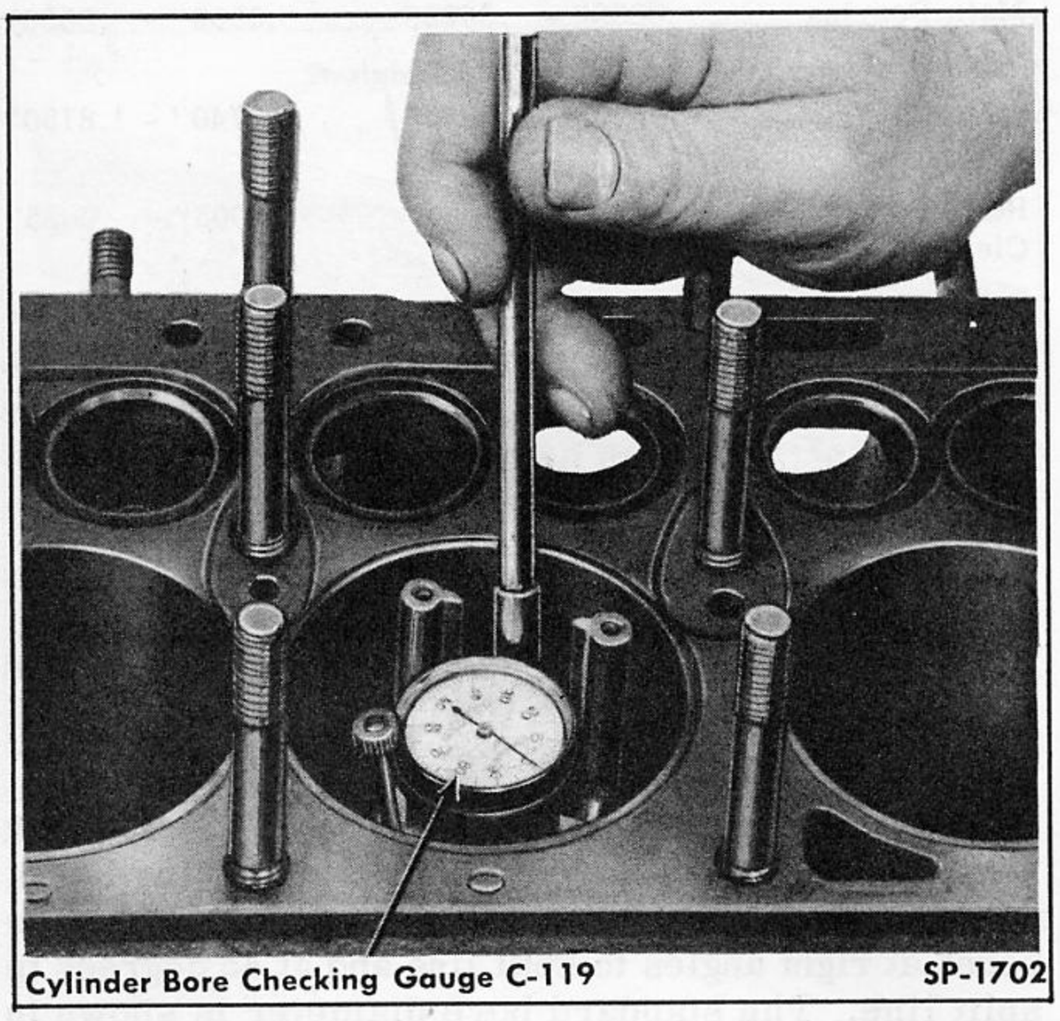
CRANKSHAFT MAIN BEARING DATA

	Diameter of Bearing Bore in Block	Original Bearing Thickness
4-CYLINDER ENGINE		
No. 1, Front	2.4995" - 2.5000"	.08200" - .08225"
No. 2, Intermediate	2.4895" - 2.4900"	.07700" - .07725"
No. 3, Rear	2.4795" - 2.4800"	.07200" - .07225"
6-CYLINDER ENGINE		
All Four Bearings	2.4065" - 2.4070"	.0775" - .0778"

5. Old main bearings must be replaced if they are scored, flaked, worn, or if crankshaft journals were ground undersized. Main bearing sizes can be estimated by comparing the crankshaft journal diameter and the corresponding main bearing bore. Proper crankshaft to main bearing clearance must also be considered. Actual fitting and final selection of bearings is best performed at time of installation as described under "Engine Assembly" in this section.

6. Check crankpins with a micrometer to determine if they are out-of-round or tapered more than .001 of an inch. If crankpins are worn excessively, they can be ground and polished to .010 of an inch undersize (from original diameter shown in above list) and used with .010 undersize connecting rod bearings. Actual fit to connecting rods can be obtained by selectively fitting connecting rod bearings at time of installation.

7. On four cylinder engines, check tightness of crankshaft counterweight attaching bolts.



Cylinder Bore Checking Gauge C-119 SP-1702

Fig. 34—Checking Cylinder Bore

CYLINDER BORES

The cylinder bores may be reconditioned by honing or reboring. A special tool is used to determine the out-of-round or taper condition of the cylinder and necessity for reconditioning.

Both honing and reboring of the cylinders must be closely coordinated with fitting the pistons in order that specified tolerances may be maintained.

Reboring the cylinders may only be accomplished when adequate facilities, and trained or experienced mechanics are available. The engine must be removed from the vehicle and mounted in a suitable level holding fixture.

The amount of material to be removed is determined from the original diameter of the cylinder bores (3.125 - 3.127 inches diameter) plus the amount of oversize in diameter of the oversize pistons to be fitted. Pistons are available in .010, .020, .030, and .040 inch oversizes. The largest cylinder bore will determine the oversize to which all cylinders must be rebored, since the size and weight of all pistons must be uniform to maintain proper engine balance.

Measure the cylinder diameters by making measurements both parallel to and at right angles to crankshaft over entire piston travel and at bottom of cylinder using Cylinder Bore Checking Gauge C-119 (Fig. 34). Proceed as follows:

1. If bores are scored; if out-of-round exceeds .005 of an inch; if diameters differ more than .005 of an inch; or if taper exceeds .015 of an inch on diameter, it is generally recommended that cylinders be reconditioned by reboring and honing to the next oversize, using new pistons of the proper size. NOTE: If reboring is performed, all cylinders must be rebored to the same oversize, and allow .0015 of an inch for final honing. All cylinder bore diameters must be within .002 of an inch after reconditioning.

2. If bore measurements are within the above limits, but indicate hollows or waviness, cylinders should be honed with 250 grit stones. Pump hone up and down in cylinder while it is rotating to produce a satin-finish, diamond cross-hatched pattern approximately 30^{o} with horizontal. Hone only enough to correct waviness.

3. If cylinder bore correction is unnecessary, break the glaze on cylinder walls with a hone with 250 grit stones or with a suitable deglazing tool. Operate the hone or deglazer to obtain diamond cross-hatched pattern same as above.

4. During all operations, protect crankshaft journals and other engine parts from abrasive dust with oil soaked rags. Regardless of type of correction on cylinder walls, wash out bores thoroughly afterwards, using warm water and soap and apply a light coat of clean engine oil. If cylinders have been rebored or honed heavily, remeasure cylinder diameters to assure proper selection of piston size.

PISTONS, RINGS AND CONNECTING RODS

The pistons and connecting rods were removed from the engine as assemblies. If cylinders were rebored, new, oversized pistons and rings will have to be installed as determined at the time cylinders were rebored.

Use standard size pistons in cylinder bores up to .009 inch oversize (measured at bottom of bore), .010 oversize in bores .010 to .019 oversize, .020 oversize in bores .020 to .029 oversize, .030 oversize in bores .040 oversize and up.

If cylinders were not rebored, disassemble pistons and rods by removing piston pin retaining bolt and pressing pin out of piston. Keep the parts of each assembly separate so they may be installed in the same cylinder. Remove rings from piston using Piston Ring Tool C-259. Clean carbon from piston head and clean ring grooves and drain holes. Use care not to scrape metal from side of grooves nor to make burrs on ring groove surfaces. Check pistons for broken lands, cracks, or worn grooves. Replace piston if necessary using same size as old piston. Proceed as follows:

1. Check fit of each piston to cylinder bore, when block and pistons are clean and dry and at approximately 70° F, by using Piston Fitting Gauge and Scale C-690 as shown in Fig. 35. Use a .004 inch thickness gauge (1/2 inch wide) if old pistons are to be used. When fitting new pistons, use .0015 inch gauge. The piston is fitted upside down in block to facilitate the operation, and the gauge must extend the full length of piston on the thrust side (side opposite slot in piston skirt). Scale should register 5-10 pounds pull to remove thickness gauge from between cylinder wall and piston. Excessive pull indicates need for a slightly smaller piston or additional honing of cylinder. Insufficient pull indicates need for fitting a larger piston.

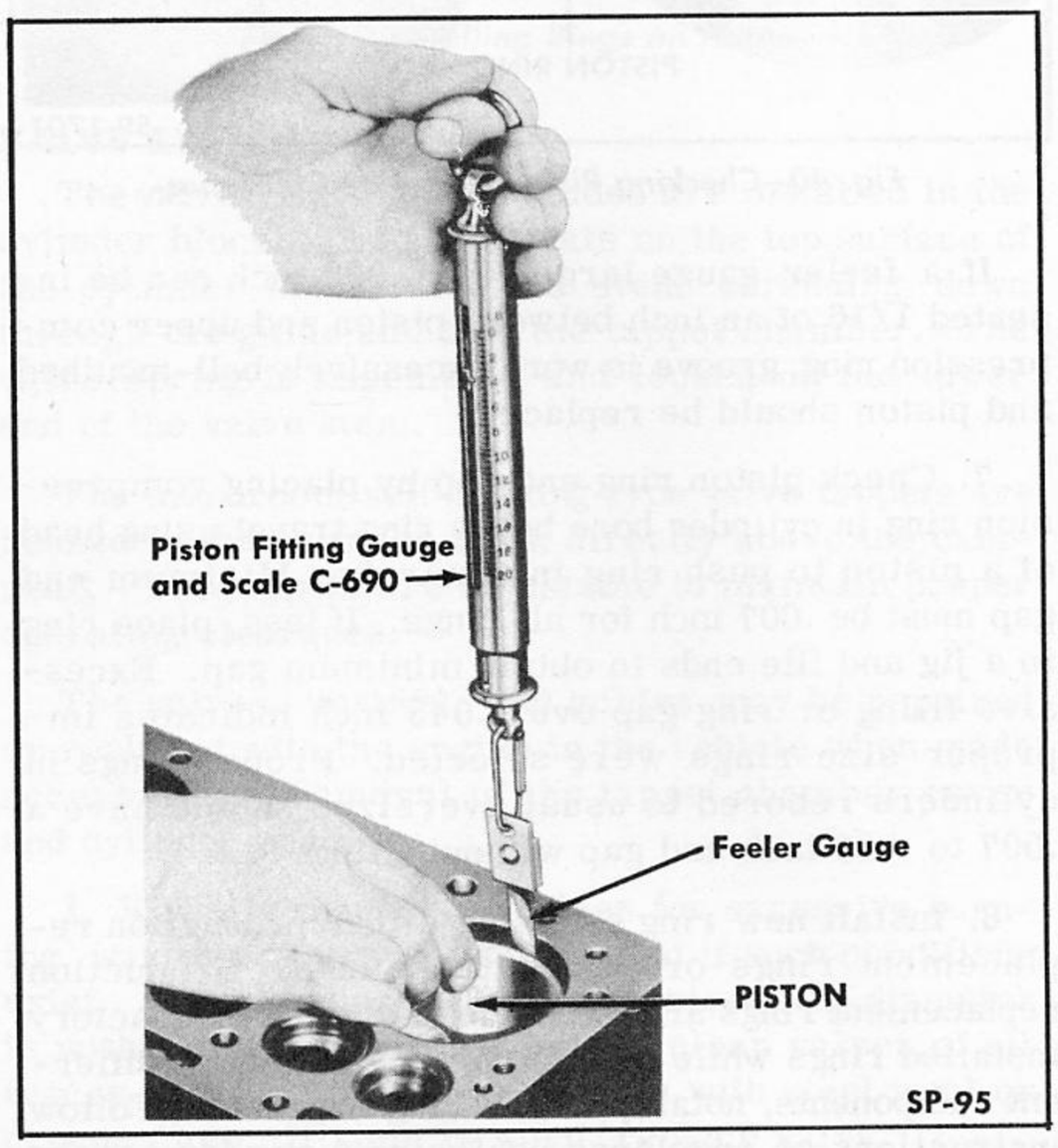


Fig. 35—Fitting Piston in Cylinder Bore

2. Check piston pin fit in piston. If pin falls through by its own weight, pin bore must be reamed to accommodate an oversize piston pin (Fig. 36). Use Piston Pin Reamer DD-82-1 on four cylinder models and C-26 on six cylinder models.

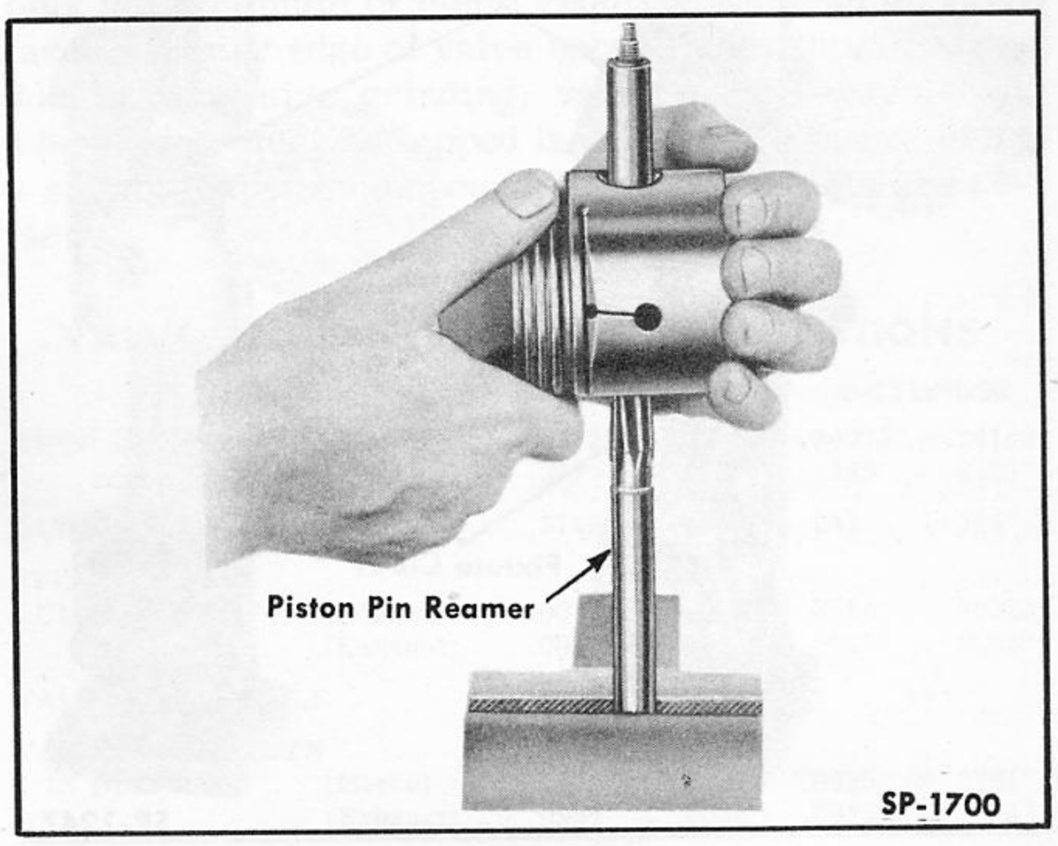


Fig. 36—Reaming Piston Pin Bore

3. Check and correct connecting rod alignment, using Connecting Rod Aligning Fixture C-841 in accordance with instructions furnished with the fixture (Fig. 37).

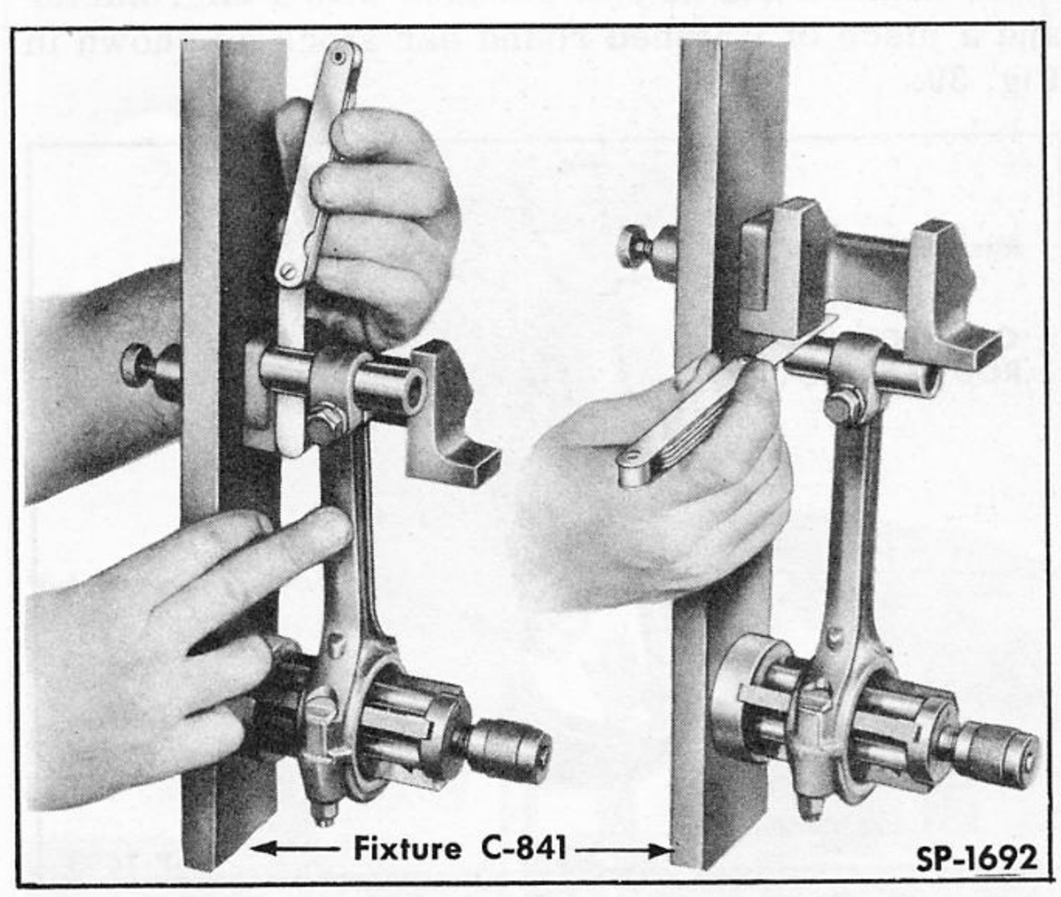


Fig. 37—Checking Connecting Rod Alignment

4. Assemble piston and rod with piston pin so that oil spurt hole in rod is on the opposite side from the T slot in piston. Install and tighten piston pin retaining bolt, then place piston and rod assembly in Fixture

C-841 and check alignment of assembly as shown in Fig. 38. Follow instructions furnished with fixture.

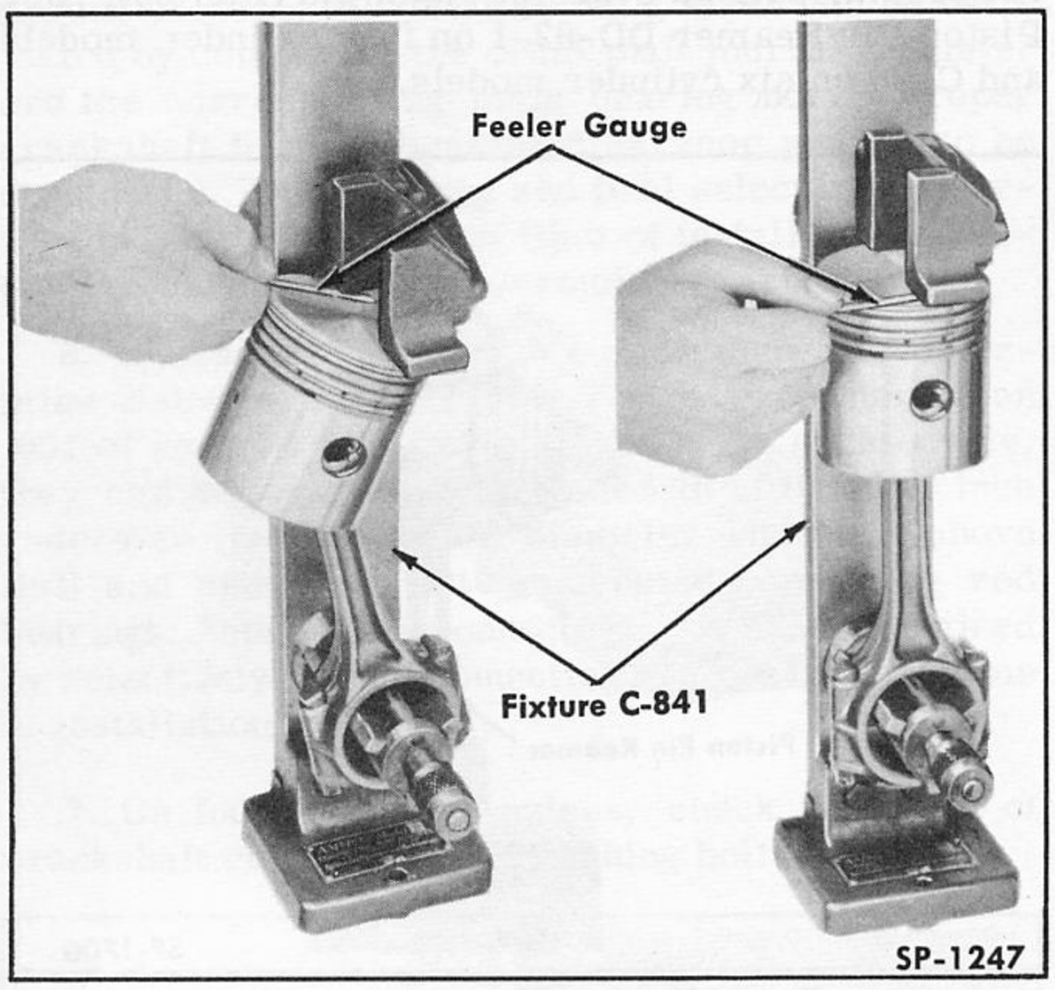


Fig. 38—Checking Piston and Connecting Rod Alignment

5. If connecting rod bearings are worn, cracked, flaked, or scored, they should be replaced. The thickness of the standard bearing is .0520-.05225 inch on four cylinder engines and .0520-.0523 inch on six cylinder engines and may be checked with a micrometer and a piece of finished round bar stock as shown in Fig. 39.

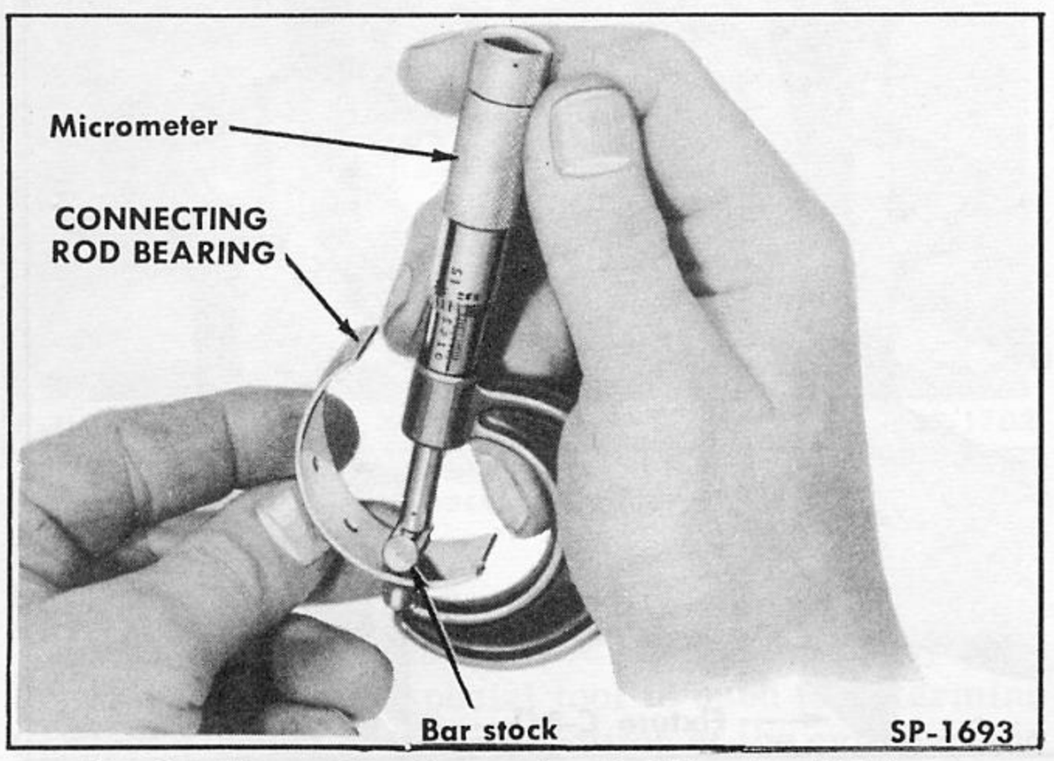


Fig. 39—Measuring Connecting Rod Bearing Thickness

Deduct diameter of bar stock from total measurement to determine thickness of bearing. Replace bearings that vary more than .002 inch from specified thickness. If crankpins were ground down, the proper undersize connecting rod bearing should be obtained. Bearings must be selectively fitted at time of installation to crankshaft as described under "Engine Assembly" in this section.

6. Check width of piston ring grooves using a new piston ring and a feeler gauge as shown in Fig. 40. Insert feeler gauge between ring and piston to bottom of groove. Replace piston if ring grooves are not within allowable tolerances.

RING TO GROOVE CLEARANCES

Upper Compression Ring	.002" - .004"
Lower Compression Ring	.003" - .007"
Oil Control Ring	.006" - .010"

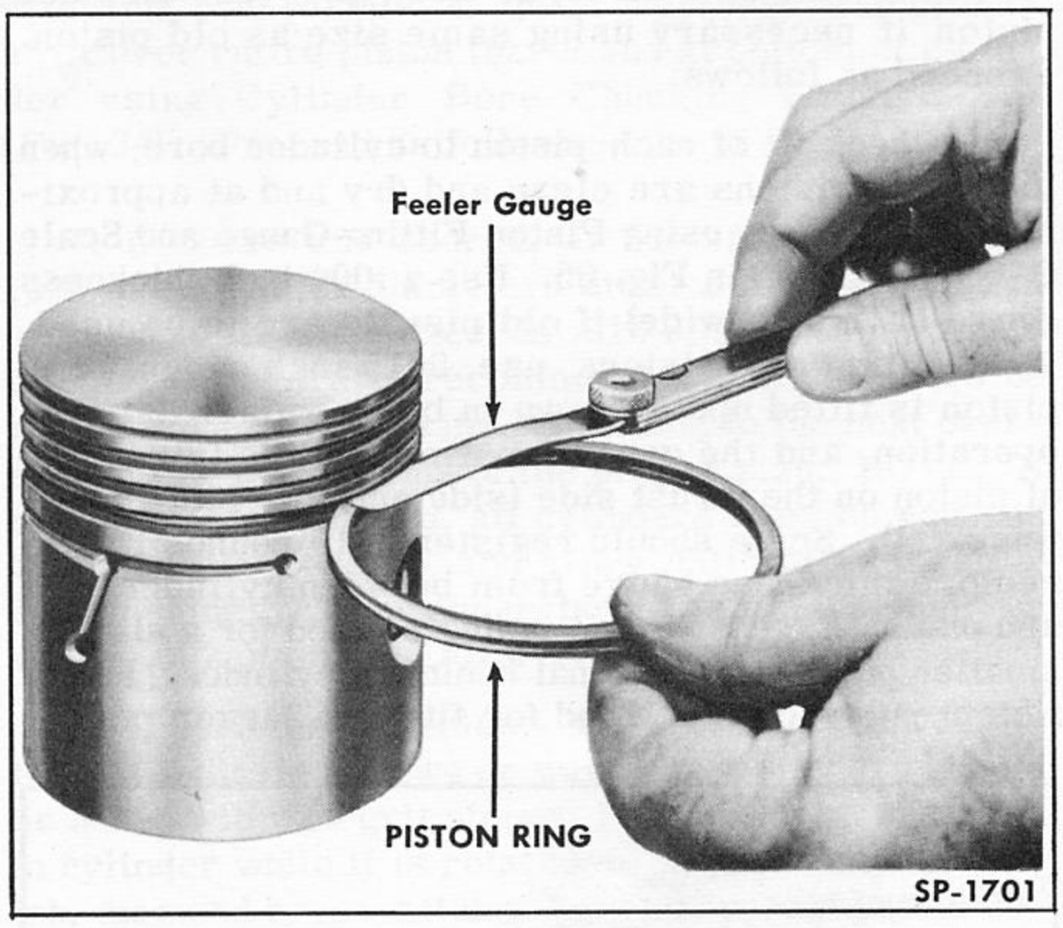


Fig. 40—Checking Piston Ring Side Clearance

If a feeler gauge larger than .006 inch can be inserted 1/16 of an inch between piston and upper compression ring, groove is worn excessively bell-mouthed and piston should be replaced.

7. Check piston ring end gap by placing compression ring in cylinder bore below ring travel using head of a piston to push ring in squarely. Minimum end gap must be .007 inch for all rings. If less, place ring in a jig and file ends to obtain minimum gap. Excessive filing or ring gap over .045 inch indicates improper size rings were selected. Proper rings in cylinders rebored to usual oversizes should have a .007 to .020 inch end gap without filing.

8. Install new ring set using either production replacement rings or oil control rings. Production replacement rings are the same as the original factory installed rings while oil control ring sets have different components, notably the oil ring expander. Follow instructions on envelopes enclosing rings for proper installation. Use Piston Ring Tool C-259 to install

rings on pistons (Fig. 41). Do not expand rings farther than necessary to install, also be careful not to burr the piston with ends of rings. Make sure upper compression ring is installed in groove with correct side up. Position rings so gaps are staggered according to instructions on the envelope.

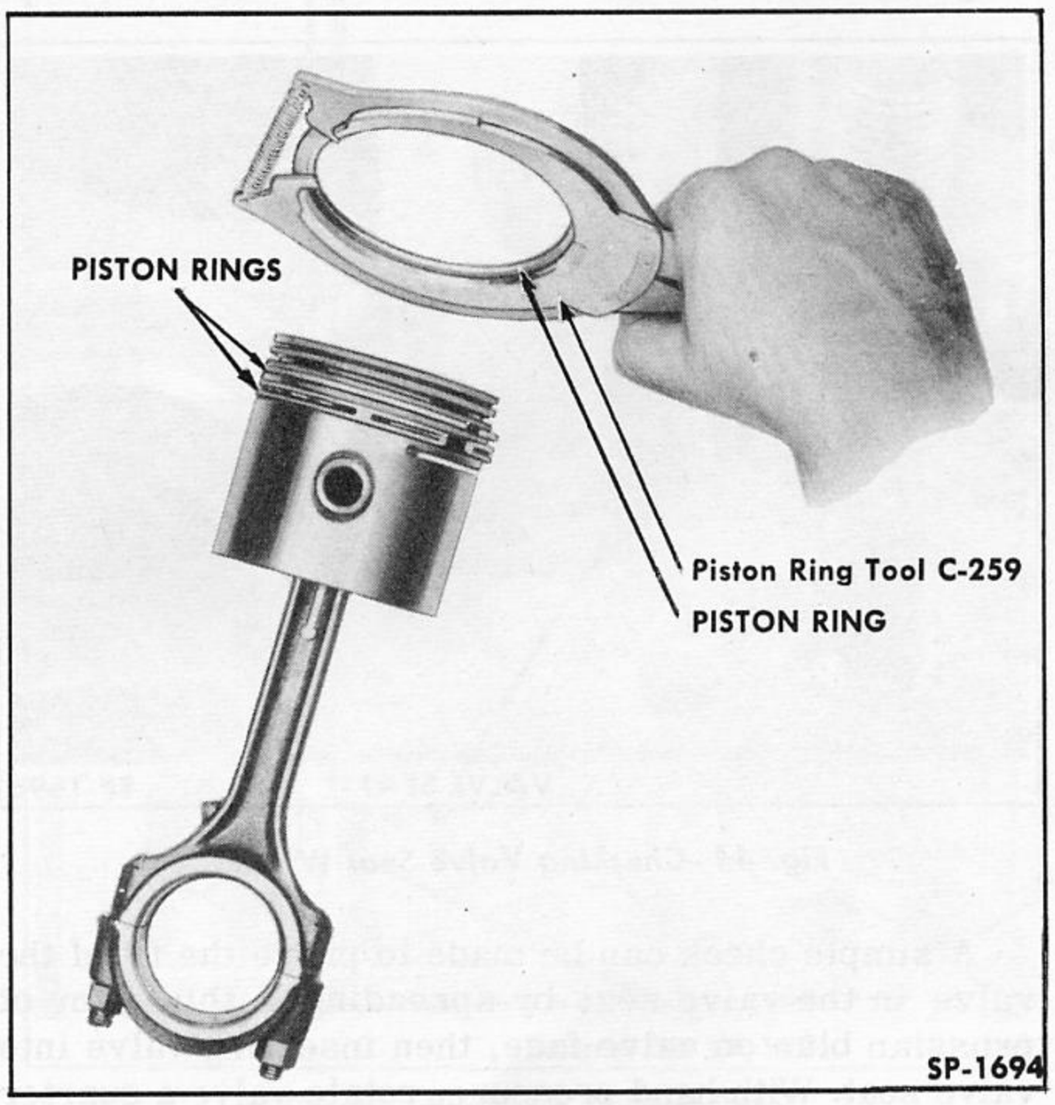


Fig. 41—Installing Rings on Piston

VALVE SYSTEM

The valves, springs and guides are installed in the cylinder block. The valve seats on the top surface of the cylinder block with the stem extending down through the guide and into the tappet chamber. The valve spring is assembled and locked on the lower end of the valve stem.

The mushroom self-locking type valve tappets are housed in the cylinder block directly above the camshaft. The tappets are adjustable to maintain proper operating clearance.

The valves, springs, and guides may be repaired or replaced with the engine in the vehicle when made accessible by removal of the tappet chamber cover and cylinder head.

1. Visually inspect all valves for excessive burning, warpage or cracks and discard if such conditions exist. Measure diameter of valve stems. If diameter is within limits specified below, clean valves of all traces of carbon and polish stems with steel wool or crocus cloth. If stem is worn, replace valve.

2. Refacing valves may be accomplished with Valve Refacer MH-80, or equivalent precision equipment. The manufacturer's instructions should be followed when using refacing equipment.

Reface valves to an angle of 45 degrees. Take off only the minimum of metal required to clean up valve faces. If outer edge of valve becomes too thin or sharp due to excessive grinding, valve must be replaced. The valves must be lapped into the valve seats, using a suitable lapping compound, after valve seats are refaced.

VALVE AND VALVE GUIDE SPECIFICATIONS

		4-CYLINDER	6-CYLINDER
STEM DIAMETER	(Intake)	.37225" - .37300"	.34075" - .34150"
	(Exhaust)	.371" - .372"	.3395" - .3405"
GUIDE DIAMETER		.3745" - .3755"	.343" - .344"
STEM TO GUIDE CLEARANCE	(Intake)	.0015" - .00325"	.0015" - .00325"
	(Exhaust)	.0025" - .0045"	.0025" - .0045"
VALVE SEAT ANGLE		45°	45°
VALVE SEAT WIDTH IN BLOCK	(Intake)	.0625" - .0781"	.0625" - .0781"
	(Exhaust)	.0937" - .1094"	.0937" - .1094"
SPRING PRESSURE	(Valve Closed)	53# 2.109"	50# 1.625"
	(Valve Open)	120# 1.750"	105# 1.328"

3. Check valve guides in cylinder block with a "go" and "no go" gauge if available, or a proper sized valve guide pilot. Any valve guide which is broken or has worn enough to cause excessive valve stem

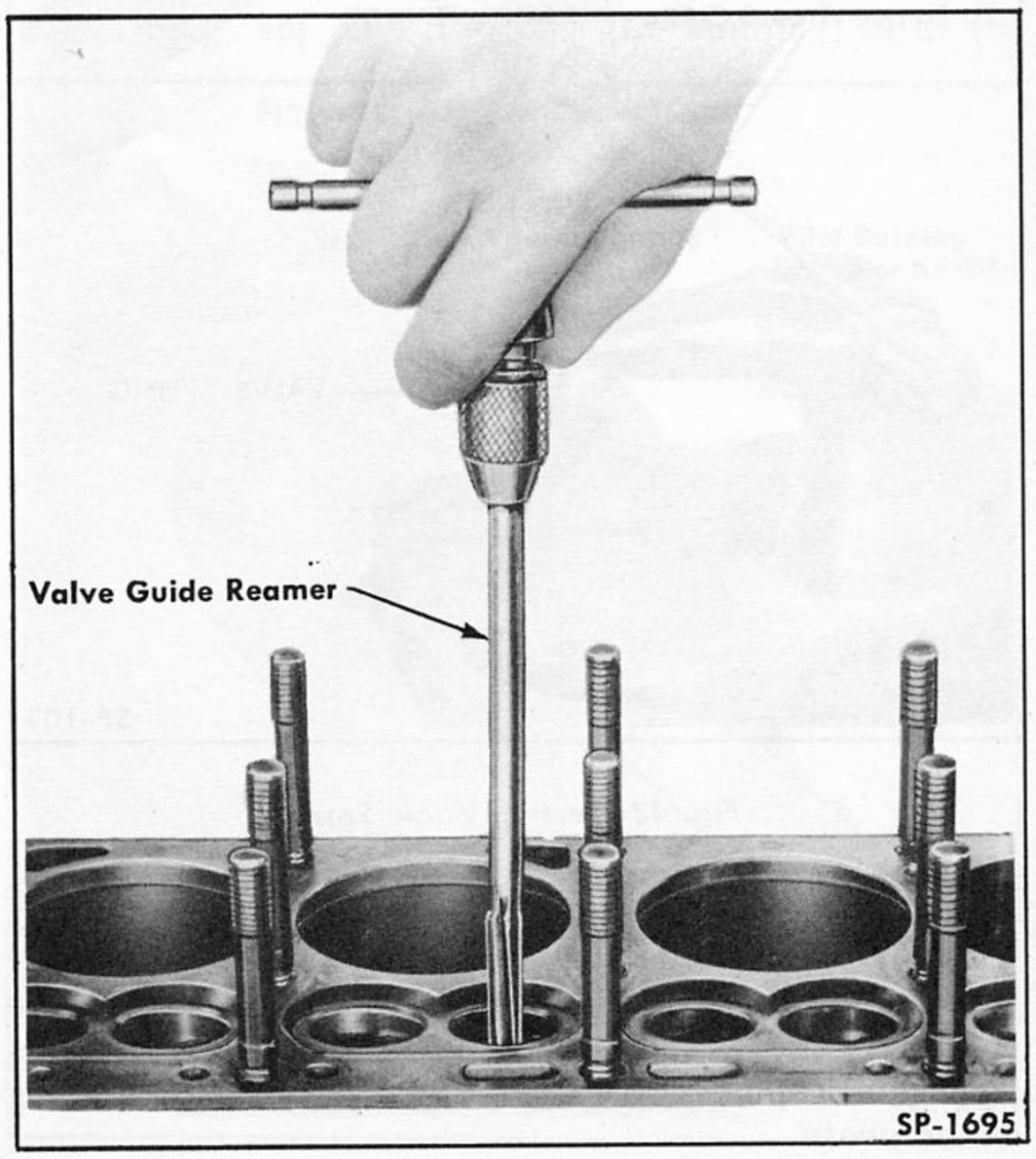


Fig. 42—Reaming Valve Guide

to guide clearance must be replaced. Use Valve Guide Driver W-177 on four cylinder models and W-215 on six cylinder models to drive out old guide and to install new guide. The upper (tapered) end of all valve guides on six cylinder models should be 7/8 of an inch below top surface of cylinder block. On four cylinder models, intake valve guides should be 1-5/16 inch below top surface of block while exhaust valve guides should be 1 inch below surface of block. Use Valve Guide Reamer C-38 on four cylinder engines and C-249 on six cylinder engines after new guides are installed (Fig. 42).

4. Valve springs must be thoroughly cleaned and tested, using Spring Testing Fixture C-647 and Torque Indicating Wrench C-524 (Fig. 43). Check pressure of spring both at the open and the closed lengths as specified in the above chart. When using the recommended spring checking fixture, the "pounds" pressure is obtained by multiplying torque wrench reading (in "foot-pounds") by two. Replace springs that are not within specifications.

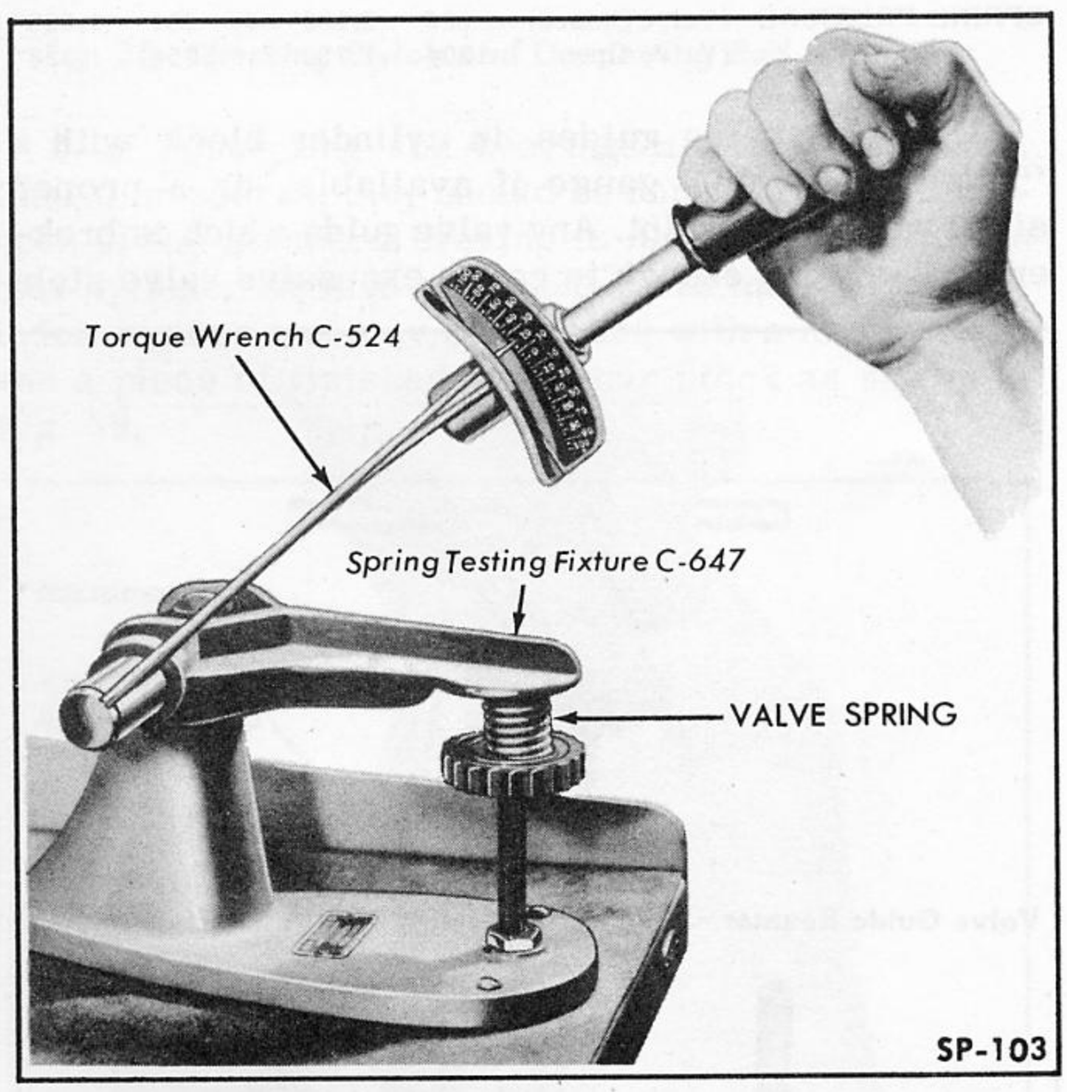


Fig. 43—Testing Valve Spring

5. Inspect valve seats for cracks, burns, pitting, ridges, or improper angle and reface. During any general engine overhaul it is advisable to reface valve seats regardless of their condition. If valve guides are to be replaced, this must be done before refacing valve seats.

Refacing valve seats may be accomplished with Valve Seat Grinder KF-102, or equivalent precision equipment, in accordance with manufacturer's instructions.

The valve seat width after refacing should be checked by placing a scale across the face of the seat (Fig. 44). Do not remove more stock than necessary.

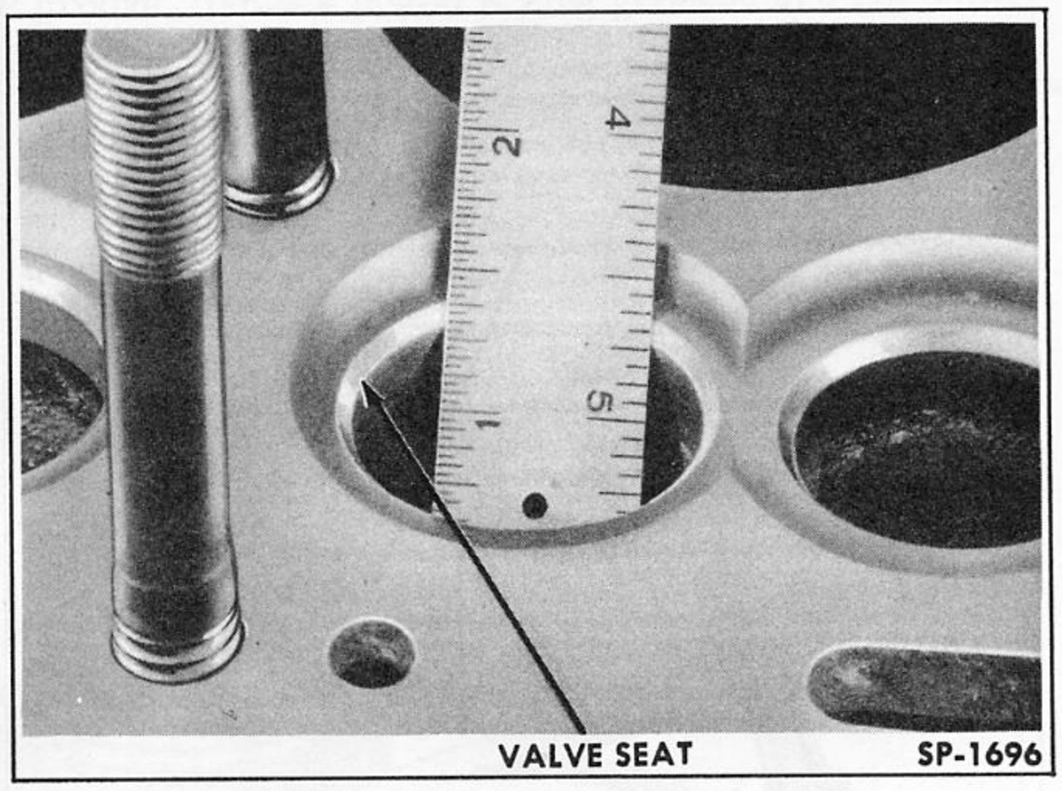


Fig. 44—Checking Valve Seat Width

A simple check can be made to prove the fit of the valve in the valve seat by spreading a thin film of prussian blue on valve face, then inserting valve into valve seat. With hand pressure, rotate valve a quarter of a turn, then remove valve and observe transfer of prussian blue to valve seat. An uneven transfer will indicate an inaccurate valve and valve seat refacing operation.

6. Inspect each tappet carefully. Worn, scored or damaged tappets must be replaced. Standard tappet diameter is .6240 - .6245 of an inch. Tappets are also available in .001, .002 and .005 inch oversize. Proper tappet fit may be determined by rotating tappet in bore; if properly fitted, a slight drag should be evident. If tappet is loose, selectively fit another standard or an oversize tappet, or use Valve Tappet Reamer Set KF-142 to ream the bores to accommodate the next oversize tappet (Fig. 45).

TIMING GEARS AND COVER

Check the general condition of both timing gears and inspect for evidence of excessive wear. Replace excessively worn or damaged gears. Inspect timing gear cover and replace if bent or damaged. It is recommended that the crankshaft oil seal in the cover be replaced while the cover is removed, to assure a good seal around the crankshaft. Drive out the old seal and replace with a new seal, using a suitable driver.

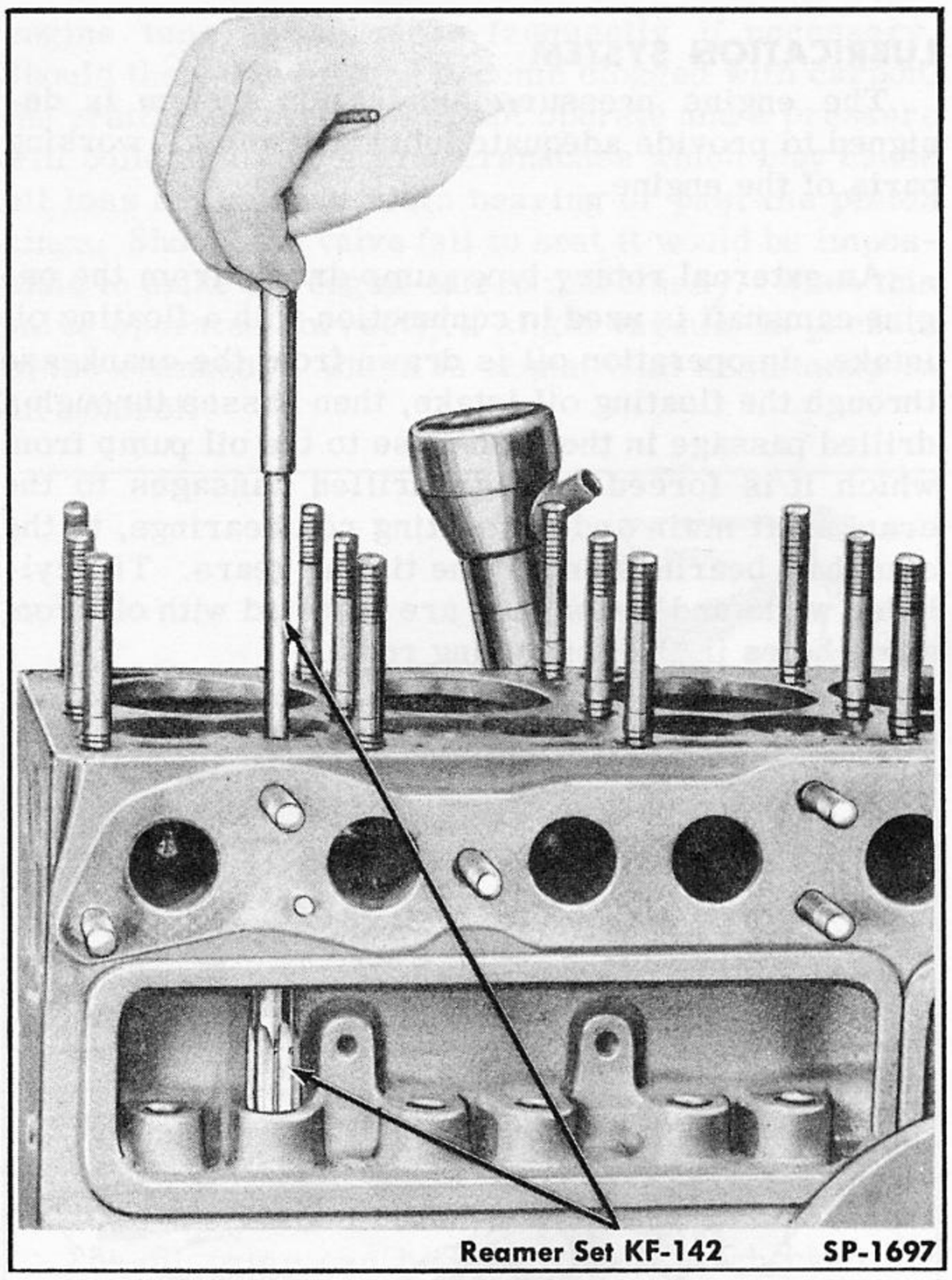


Fig. 45—Reaming Tappet Bores

FLYWHEEL AND VIBRATION DAMPER

The flywheel is mounted to the rear flange of the crankshaft. The crankshaft, flywheel, and clutch assembly are statically and dynamically balanced separately and as a unit; therefore, the components should be assembled in their original relative positions to maintain this balance, if possible. The flywheel and crankshaft each have an arrow stamped on their attaching surfaces to indicate their original position. The clutch pressure plate cover position on the flywheel must be marked at time of removal by a prick punch.

1. Inspection of the flywheel should be done when installing flywheel to crankshaft when engine is being assembled. Clean flywheel with a suitable cleaning solvent and wipe dry. Inspect clutch face of flywheel for burned condition, rivet grooves or scuffed condition.

To check flywheel for run-out, warping or wear, mount flywheel on crankshaft, with crankshaft in cylinder block. Mount Dial Indicator W-102 with contact button of indicator resting against clutch face of flywheel. Set indicator dial at zero and rotate flywheel. Maximum allowable run-out from center of flywheel out to holes where clutch pressure plate cover attaches should not exceed .005 of an inch.

Excessive run-out at clutch attaching bolt holes on flywheel face will seriously affect clutch action; therefore, it is recommended that the flywheel be replaced if run-out exceeds specified limits.

2. Inspect for worn, broken or chipped ring gear teeth and replace the ring gear if necessary. Stripped threads in tapped holes for pressure plate cover attaching bolts will require replacement of flywheel.

To remove ring gear from flywheel, drill a 3/8 inch hole through ring gear and cut through any remaining metal with a cold chisel. Remove ring gear from flywheel. Thoroughly clean ring gear surface of flywheel. Heat new ring gear evenly to 650° - 700° F, and place it on cold flywheel, making certain that the chamfer on the teeth is on engine side of flywheel. Be sure that ring gear is firmly seated on flywheel. Allow ring gear to cool slowly to shrink it onto the flywheel.

3. Inspect transmission drive pinion shaft pilot bushing which is pressed into center of flywheel. If bushing is worn or damaged, it should be removed, using Pilot Bushing Remover KF-5. Bushing can also be replaced with engine in vehicle after transmission and clutch are removed. Screw tapered end of tool into damaged bushing, allowing tool to cut its own threads until a solid grip is obtained. Insert puller screw and rotate it until bushing is forced out of flywheel (Fig. 46). To install a new bushing, slide the

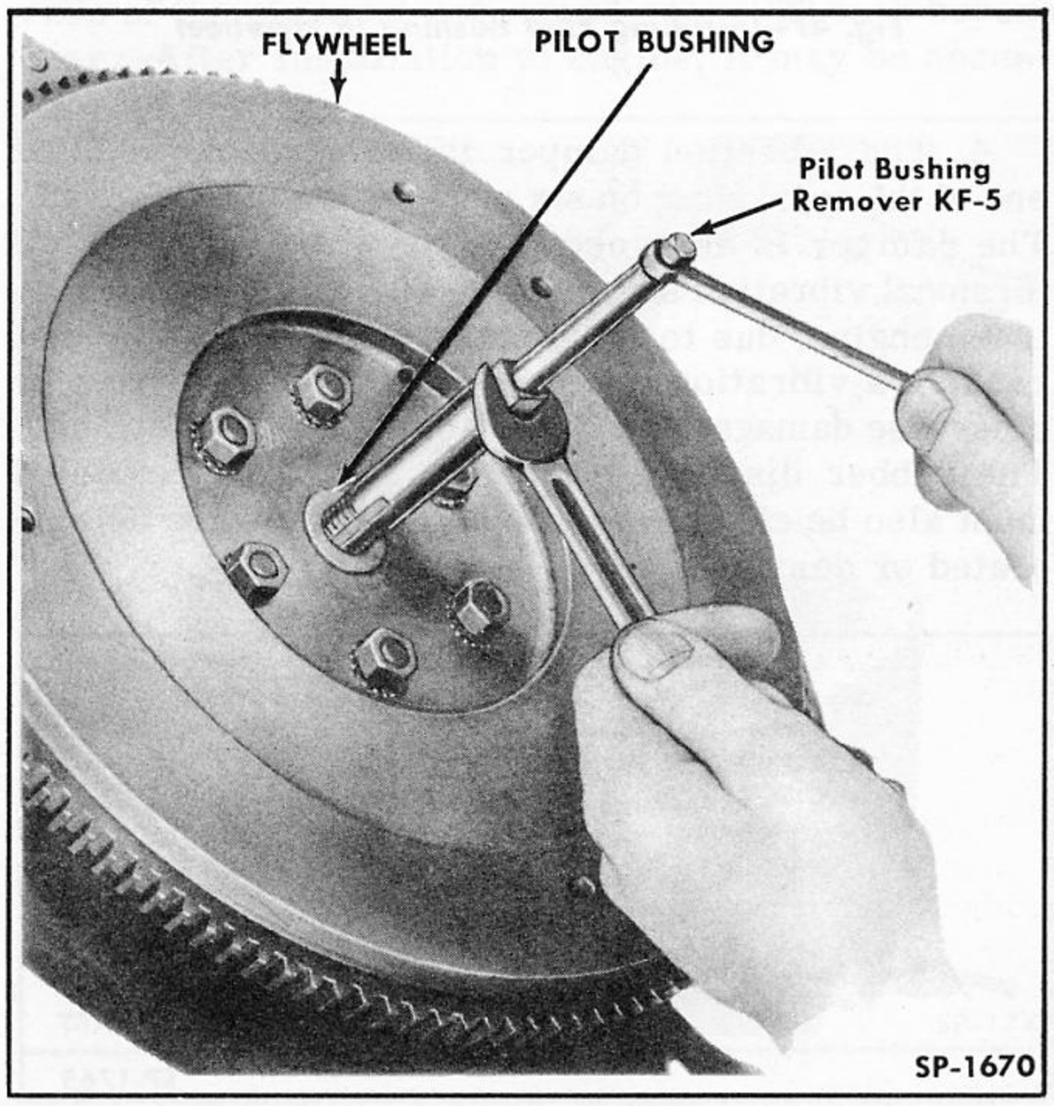


Fig. 46—Removing Pilot Bushing from Flywheel

bushing onto the end of Pilot Bushing Installing and Burnishing Tool KF-6 and insert bushing into flywheel. A soft hammer can be used against the tool to help drive bushing in place. When tool is removed (by tightening cap and pressure nut as shown in Fig. 47), the bushing will be burnished to correct size. Apply a small amount of lubricant to the bushing bore.

Fig. 47—Installing Pilot Bushing to Flywheel

4. The vibration damper is mounted on the front end of the crankshaft on six cylinder engines (Fig. 48). The damper is designed to reduce the amplitude of torsional vibration set up in the engine. The four cylinder engine, due to its shorter crankshaft, does not require a vibration damper. A distorted, broken or otherwise damaged vibration damper must be replaced. The rubber discs on which the damper is mounted must also be checked and replaced if they are deteriorated or damaged.

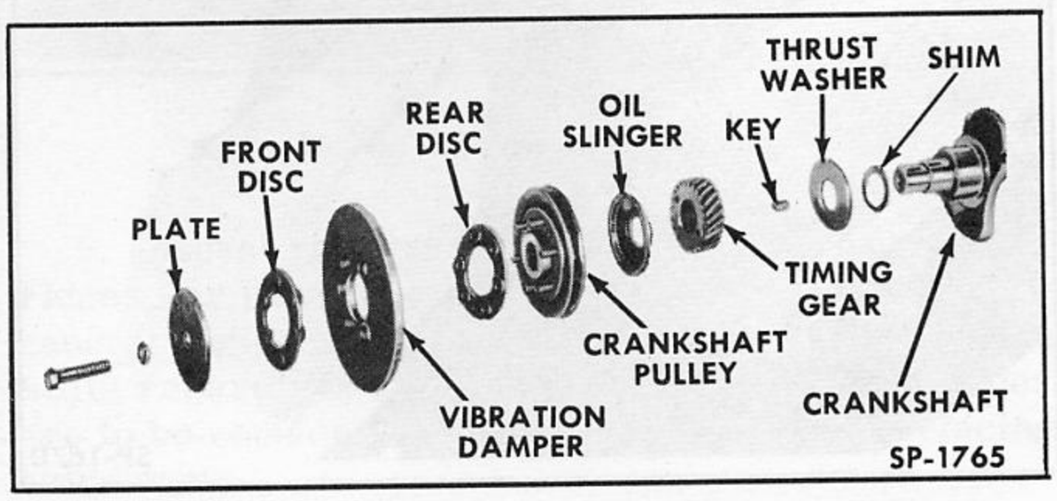


Fig. 48—Vibration Damper—6 Cylinder—Exploded View

LUBRICATION SYSTEM

The engine pressure lubrication system is designed to provide adequate lubrication to all working parts of the engine.

An external rotary type pump driven from the engine camshaft is used in conjunction with a floating oil intake. In operation oil is drawn from the crankcase through the floating oil intake, then passes through a drilled passage in the crankcase to the oil pump from which it is forced through drilled passages to the crankshaft main and connecting rod bearings, to the camshaft bearings and to the timing gears. The cylinder walls and piston pins are supplied with oil from spurt holes in the connecting rods.

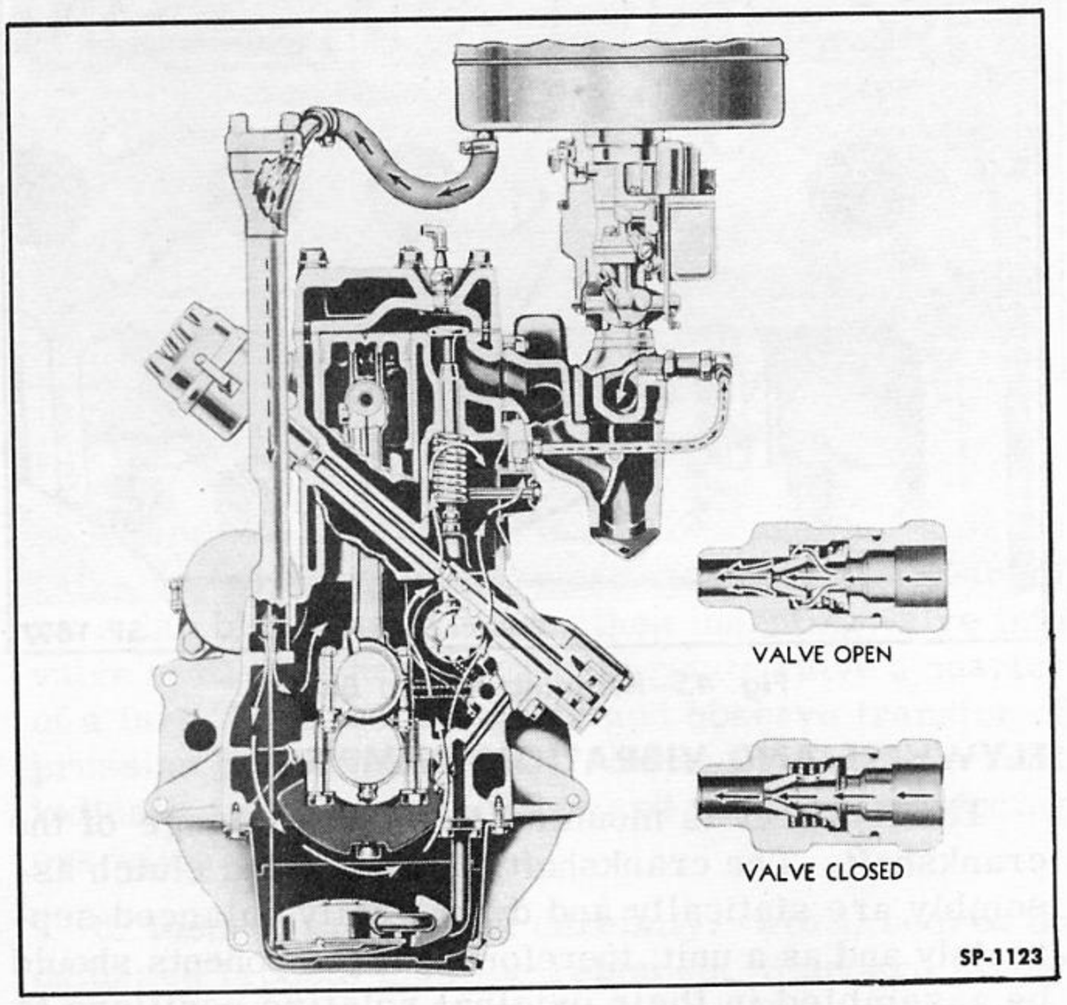


Fig. 49—Crankcase Ventilation System

a. Crankcase Ventilation

Both engines are equipped with a positive, sealed type crankcase ventilation system. This type of ventilation system reduces condensation and sludge formation to a minimum. The correct operation of the system depends upon a free flow of air from the air cleaner, through a hose to the oil filler tube and into the engine, to a control valve mounted on the intake manifold (Fig. 49).

For proper operation, make sure there is no air leakage at the hose connections between the air cleaner and the oil filler tube, and that the oil filler tube cap gasket is in good condition. Always make sure the cap is locked securely in position.

Be sure that the ventilator valve, mounted on the intake manifold, is checked and cleaned at the time of

engine tune-up or more frequently if necessary. Should the valve or tube become clogged with carbon, the ventilating system will not operate and a pressure will build up in the engine crankcase which may cause oil loss at the rear main bearing or past the piston rings. Should the valve fail to seat it would be impossible to make the engine idle satisfactorily. When this valve operates correctly a slight vacuum is present in the crankcase which is of material assistance in oil control.

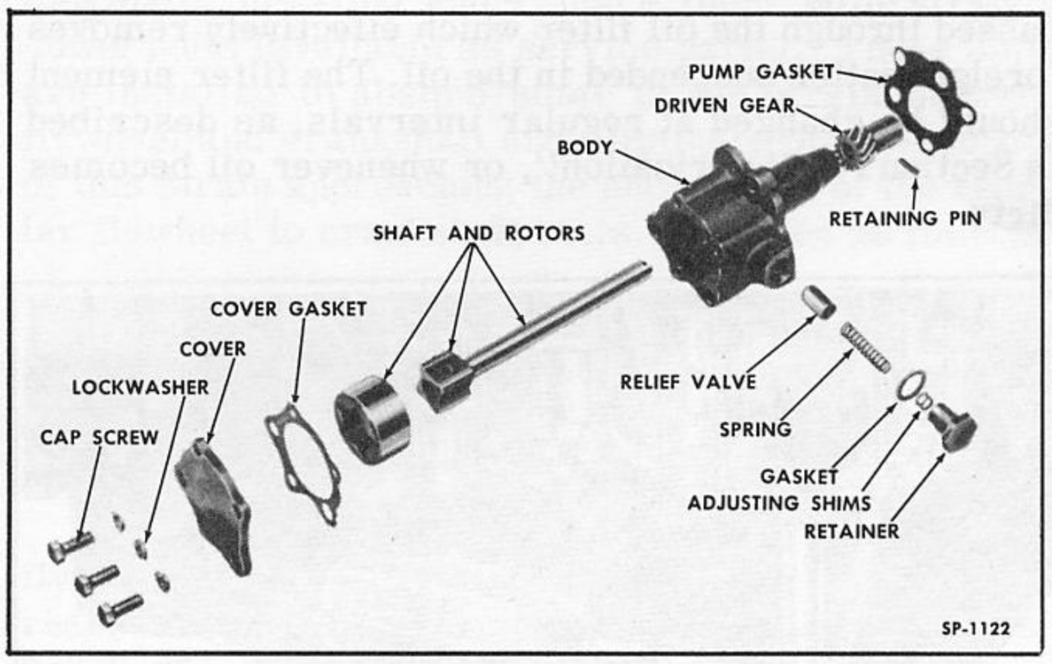


Fig. 50—Oil Pump—Exploded View

b. Oil Pump

The oil pump can be disassembled, checked and repaired as follows:

1. To disassemble oil pump, file one of the peened ends of pin that attaches driven gear to shaft. Drive the pin out of gear with a small drift and pull driven gear off shaft. Remove cap screws and lockwashers that attach cover to pump body and remove cover. Remove shaft and rotors from body. Remove relief valve retainer, gasket, shims (if used), spring and valve from body (Fig. 50).

2. Check inner side of pump cover with a .001 inch feeler gauge and straight edge. If feeler gauge can be withdrawn without disturbing straight edge, cover must be replaced.

3. Measure thickness of each rotor with a micrometer. If thickness varies more than .001 inch between the two rotors replace rotors and shaft. Install rotors in pump body. Measure clearance between lobes of rotors as shown in Fig. 51. This clearance should be .010 inch or less. If more than .010 inch replace both rotors and shaft.

Measure clearance between outer rotor and body (Fig. 52). If this clearance exceeds .012 inch replace rotors and shaft or body, whichever is defective.

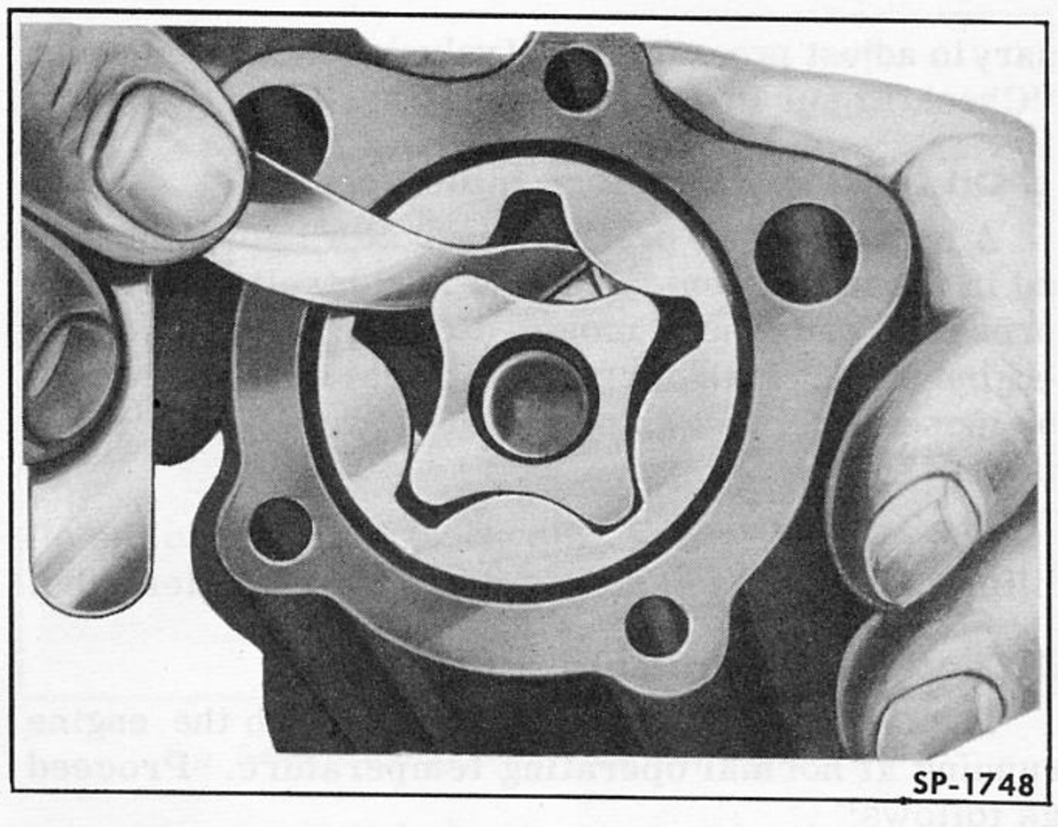


Fig. 51—Checking Clearance Between Oil Pump Rotors

4. Replace body if cracked or damaged. Install rotors and shaft in body and install cover without the gasket. If the shaft can be rotated by hand, the body is worn and should be replaced. If the shaft cannot be rotated, remove cover and position a new gasket on body. Re-install pump cover and tighten attaching screws. The shaft should now turn freely.

5. Replace driven gear and relief valve parts if they appear to be worn or damaged.

6. Assemble the various parts of the pump to the body and peen ends of the pin to lock it in place. The ends of the pin must not extend over .020 inch beyond gear. After installation to engine, it may be neces-

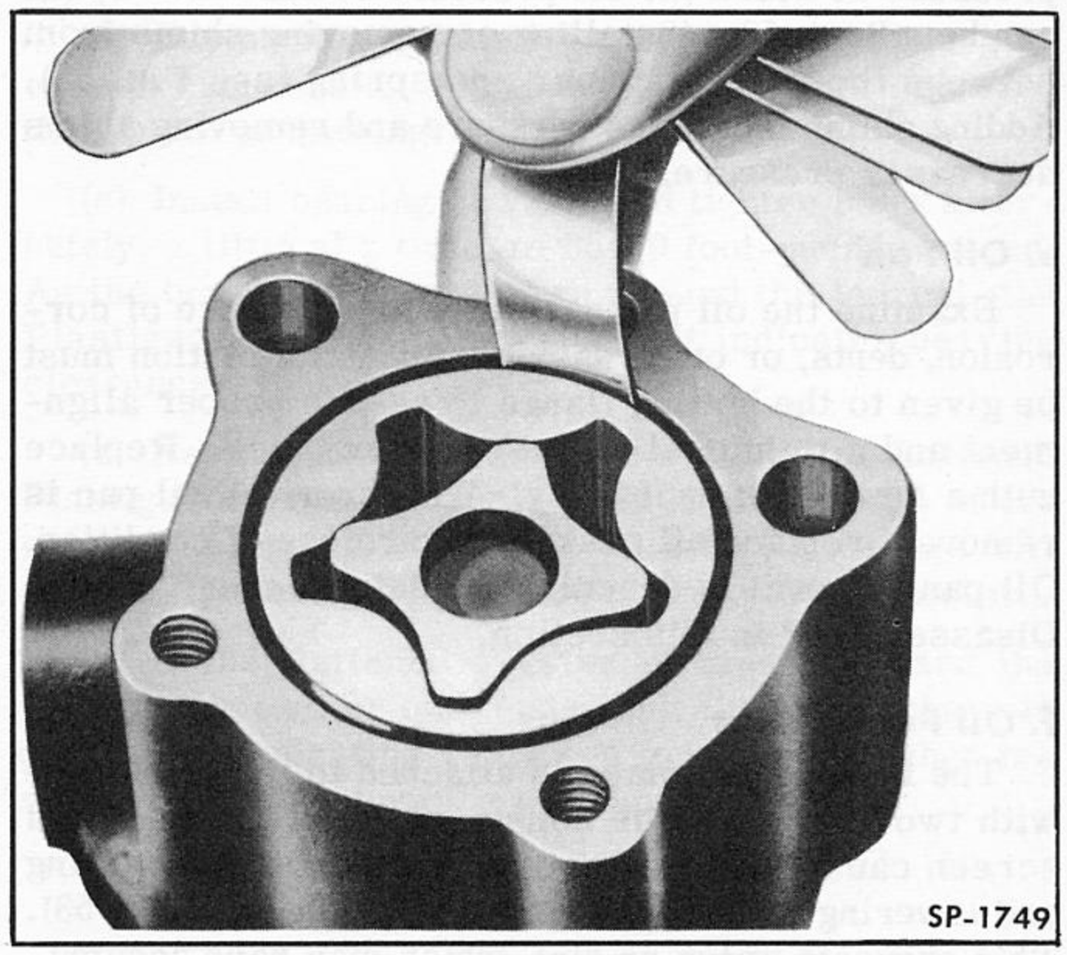


Fig. 52—Checking Clearance Between Outer Rotor and Pump Body

sary to adjust pressure relief valve as described under "Checking Oil Pressure" in this section.

c. Oil Level and Pressure Indicators

A convenient oil pressure indicator light is mounted in the instrument panel and is controlled by an oil pressure gauge unit mounted on the left side of the engine block. If the pressure indicator is believed to be inoperative, test as specified in Section 15, "Electrical."

The oil depth gauge (dip stick) attaches to the oil filler tube cap and extends down the oil filler tube.

d. Checking Oil Pressure

The oil pressure can be checked with the engine running at normal operating temperature. Proceed as follows:

1. Remove a plug from drilled oil passage in crankcase (near oil pump) and install a suitable oil pressure indicating gauge with the proper fitting for the threaded hole in crankcase.
2. With engine running at idle speed, oil pressure should be approximately 10 psi. Oil pressure indicator light on instrument panel should be "on".
3. With engine speed increased slightly to raise pressure to approximately 13 psi, the oil pressure indicator light should go "off".
4. With engine speed increased to the equivalent of 30 MPH, oil pressure should reach approximately 30 to 40 psi pressure. At this pressure, the relief valve should open and keep oil pressure constant even though engine speed is increased to maximum. The pressure at which the oil pressure relief valve opens can be adjusted by installing or removing shims from between the valve retainer and spring (see Fig. 50). Adding shims increases pressure and removing shims decreases pressure.

e. Oil Pan

Examine the oil pan carefully for evidence of corrosion, dents, or other damage. Special attention must be given to the bolting flange to assure proper alignment and a tight seal at the cylinder block. Replace with a new pan if necessary. Whenever the oil pan is removed, replace all gaskets regardless of condition. Oil pan removal is described in detail under "Engine Disassembly" in this section.

f. Oil Pump Float

The floating oil intake is attached to the crankcase with two screws. The construction of the float and screen causes it to remain on top of the oil, raising and lowering with the amount of oil in the pan (Fig. 53). This prevents water or dirt, which may have accumulated in the bottom of the oil pan, from circulating with the oil.

The oil pump float assembly consists of a support and a float which can be disassembled by removing a cotter pin from the support. Clean float assembly thoroughly and blow out with compressed air. Replace float if air chamber or screen is damaged.

g. Oil Filter

An oil filter is available as an accessory for both the four and six cylinder engines. With an oil filter installed, a portion of the engine oil is continually bypassed through the oil filter which effectively removes foreign matter suspended in the oil. The filter element should be changed at regular intervals, as described in Section 17, "Lubrication", or whenever oil becomes dirty.

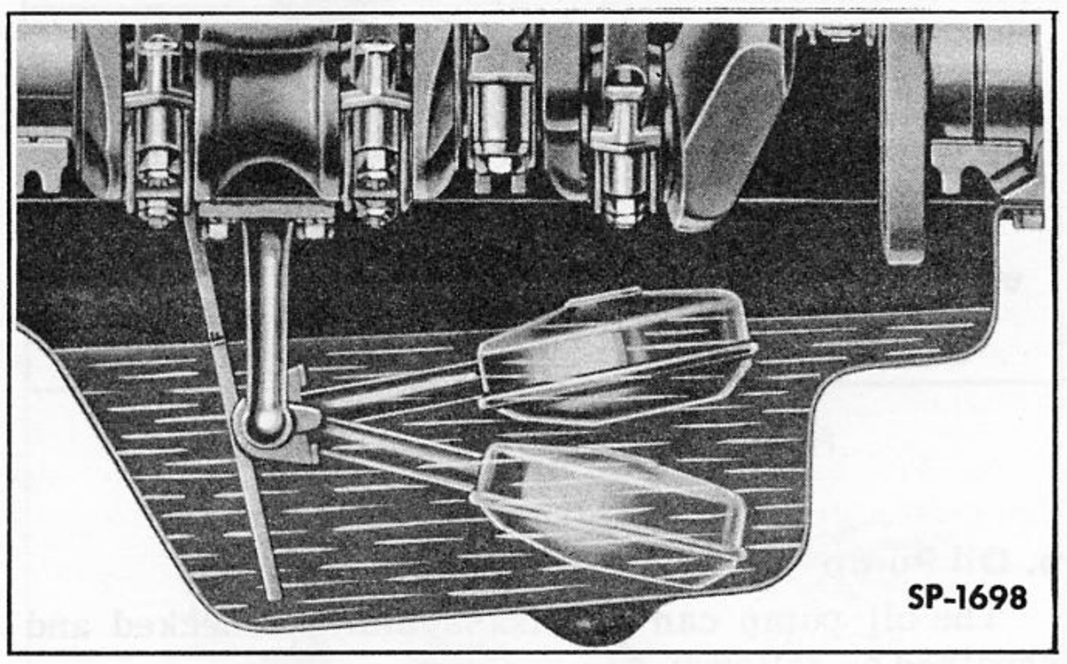


Fig. 53—Oil Pump Float

ENGINE ASSEMBLY

The engine is assembled in the reverse order of its disassembly procedure with special care taken for fitting various parts to the cylinder block. Always use new gaskets and lockwashers to replace the ones removed. Use a thin film of Perfect Seal Gasket Paste to hold gaskets in place wherever desired. Proceed as follows:

a. Install Camshaft and Tappets

Lubricate each tappet with light engine oil and install in same bores to which they were previously fitted. Carefully install camshaft in cylinder block and place spacer and thrust plate on end of camshaft. Install cap screws and lockwashers that attach thrust plate to cylinder block.

Mount Dial Indicator W-102 on block with indicator button against a cam and check camshaft end-play. The end-play should be .003 - .0055 inch. To reduce end-play, add a shim between spacer and shoulder of camshaft. End-play may be increased by dressing off spacer the desired amount.

b. Assemble Crankshaft and Flywheel

Before the crankshaft is installed in the engine, the cylinder block rear end plate should be placed on the crankshaft flange and the flywheel should be attached to the crankshaft. Be sure to line up locating arrows on flywheel and crankshaft to maintain balance of the assembly. Use original bolts and tapered dowels ONLY if crankshaft and flywheel were not replaced. If either the crankshaft or the flywheel were replaced, it is necessary to discard the two tapered dowels originally installed and replace them with straight dowel bolts (available as service parts). These bolts are installed to absorb some of the strain between flywheel and crankshaft and eliminate the possibility of this strain approaching the shear point of the regular flywheel to crankshaft bolts. Proceed as follows:

1. Place rear end plate on crankshaft flange.

2. Install flywheel to crankshaft with regular bolts. Be sure locating arrows on flywheel and crankshaft are aligned to maintain proper balance.

3. Drill through tapered holes in crankshaft and flywheel with a 35/64" diameter drill and straight ream to .5625". Use Flywheel Dowel Drill and Reamer Set W-231.

4. Place new straight dowel bolts through the reamed holes in flywheel and crankshaft and install lockwashers and nuts. Tighten to 36-40 foot-pounds torque.

c. Install Crankshaft, Main Bearings and Rear Oil Seal

Before installing the crankshaft, always install a new rear oil seal. The main bearings should all be carefully fitted and installed. Two methods of fitting main bearings are detailed in the following procedure:

1. Press a new rear main bearing oil seal in groove of rear main bearing cap with the fingers. Then seat seal firmly in groove by rolling with a mandrel (Fig. 54). Roll from ends toward center of seal. Cut off each end of seal so they are flush or slightly protruding from flat surface of bearing cap. Install upper half of seal to cylinder block in same manner.

2. Install the upper main bearings that were previously selected (see "Crankshaft and Main Bearings" in this section) to cylinder block. On four cylinder engines, insert dowels to hold bearings in place. On six cylinder engines, a notch in bearing fits into a notch in block to hold bearing in place. Make sure all holes in bearings register with all holes in block. Lubricate bearings and rear oil seal with light engine oil.

3. Place crankshaft and flywheel assembly in block, with cylinder block rear end plate hanging loosely from crankshaft flange. NOTE: If timing gear

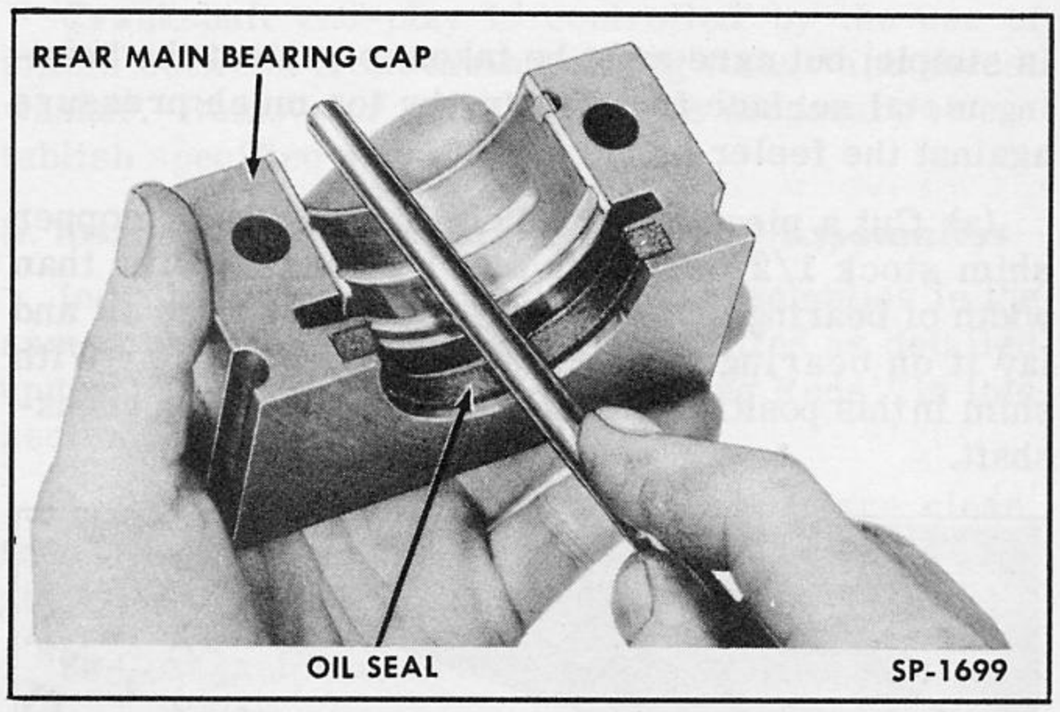


Fig. 54—Installing Rear Main Bearing Oil Seal

was left on crankshaft, the timing marks on crankshaft and camshaft timing gears must be in alignment.

4. Fit main bearings by the "Plastigage" method or the shim stock method. When fitting main bearings, all bearings should be installed and tightened except the one being checked. Proceed as follows:

Plastigage Method

The use of Plastigage of the proper size to measure .001 of an inch, is recommended to measure crankshaft main bearing clearance. Make sure Plastigage is fresh, as it may become brittle with age. Plastigage is available in a package under service part No. 204460. Proceed as follows:

(a) Remove bearing cap and carefully wipe all oil from bearing and journal.

(b) Lay a piece of Plastigage across journal lengthwise of crankshaft. Piece should be 1/8 inch shorter than width of bearing.

(c) Install bearing and cap and tighten bolts alternately, a little at a time, to 65-70 foot-pounds torque. As the bearing tightens down around the journal, the Plastigage flattens to a width that indicates bearing clearance.

(d) Remove cap and measure width of the flattened Plastigage, using the scale printed on the edge of the envelope (Fig. 55). The proper size Plastigage will accurately measure clearance down to .001 of an inch.

(e) If the flattened Plastigage tapers toward the middle, the end, or both ends, there is a difference in clearance, indicating a taper, a low spot, or other irregularity of the bearing or journal.

Shim Stock Method

Thin feeler or shim stock may be used instead of Plastigage to check bearing clearances. The method

is simple, but care must be taken to protect the bearing metal surface from injury by too much pressure against the feeler stock.

(a) Cut a piece of .001 inch thick brass or copper shim stock 1/2 inch wide and 1/8 inch shorter than width of bearing. Coat feeler with light engine oil and lay it on bearing in cap, as shown in Fig. 56. With shim in this position, install bearing and cap on crankshaft.

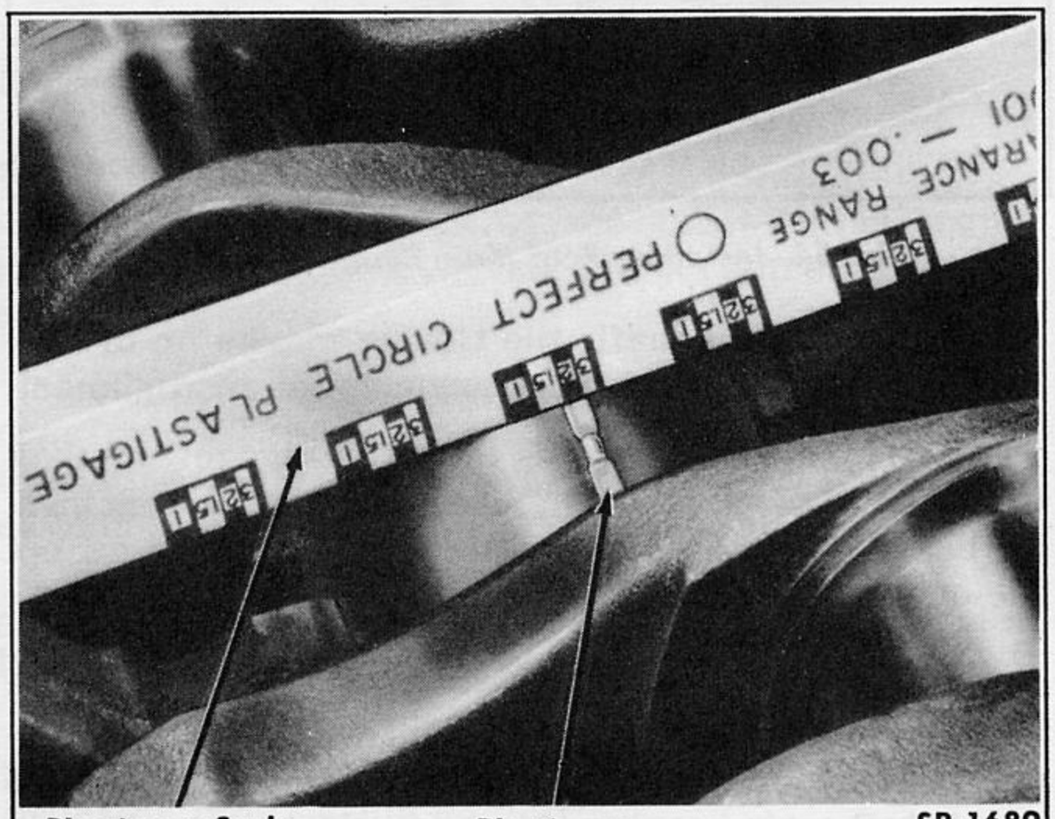


Fig. 55—Checking Main Bearing Clearance with Plastigage

(b) Tighten bearing cap bolts alternately a little at a time, to 65-70 foot-pounds torque.

(c) Turn crankshaft by hand not more than four or five degrees in either direction. CAUTION: Turning the crankshaft more may imbed feeler in bearing, giving a false indication of fit and damaging bearing. If bearing clearance is correct, the .001 inch feeler stock should produce a light to heavy drag. If there is little or no drag, the bearing fit is too loose. If crankshaft will not turn, there is not enough clearance. In either case, another bearing must be selected to provide proper fit.

5. After bearing has been correctly fitted, remove shim stock, or flattened Plastigage, wipe bearing and journal carefully and apply clean engine oil to both surfaces. Replace cap and tighten bolts alternately, a little at a time, to 65-70 foot-pounds torque.

When installing rear main bearing cap, coat face of cap with a thin layer of Perfect Seal Gasket Paste to prevent oil leakage at this point. The crankshaft should now turn freely without drag. Insert the two rubber packings between rear main bearing cap and cylinder block. When packings are properly installed they will extend approximately 1/4 inch above cylinder block; this amount will compress and form a tight seal when oil pan is installed.

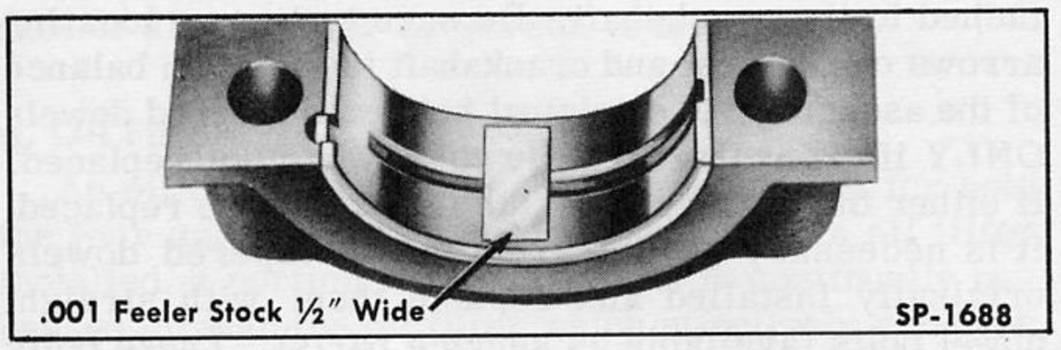


Fig. 56—Feeler in Position on Main Bearing

d. Install Valves and Springs

Install the intake and exhaust valves and springs as follows:

1. Install valve springs and retainers by slipping top end of spring onto bottom end of valve guide and, with a large screwdriver, pry the spring and washer over the tappet adjusting screw. If working on a 4 cylinder engine, make certain that the close wound coils of each spring are at the top.

2. Install Valve Spring Lifter C-482 to compress the springs.

3. Insert all intake and exhaust valves in their proper location and hold valves down, so each valve stem extends through the valve spring retainer far enough to permit installation of valve spring locks. Heavy lubricating oil or grease placed on the inside of valve locks will help hold locks on the valve stem until the valve spring lifter can be removed.

4. Install valve tappet cover and new gasket (two covers and gaskets are used on six cylinder engines) after tappets are adjusted as detailed under "Valve Adjustment" in this section.

e. Install Front End Plate and Timing Gears

If cylinder block front end plate was removed from block and if timing gears were removed from crankshaft and camshaft, proceed as follows:

1. Install front end plate to cylinder block with bolts, using a new gasket.

2. Place timing gear and key on camshaft and install flatwasher, lockwasher and bolt to end of camshaft.

3. Place spacer, thrustwasher, key and timing gear on crankshaft. Timing gear teeth must be meshed so timing marks will align as shown in Fig. 57.

f. Install Timing Gear Cover, Crankshaft Pulley and Vibration Damper

On a four cylinder engine, proceed as follows:

1. If timing gear oil jet was removed, install it so oil stream hits crankshaft gear.

2. Place spacer and oil slinger on crankshaft.

3. Install timing gear cover to block, using a new gasket. Be sure new oil seal was installed in cover as detailed under inspection and repair of "Timing Gears and Cover" in this section.

4. Install pulley and hub assembly to crankshaft with key and nut. Tighten nut to 140 foot-pounds torque.

On a six cylinder engine, proceed as follows:

1. If timing gear oil jet was removed, install it so oil stream hits crankshaft gear (see Fig. 57).

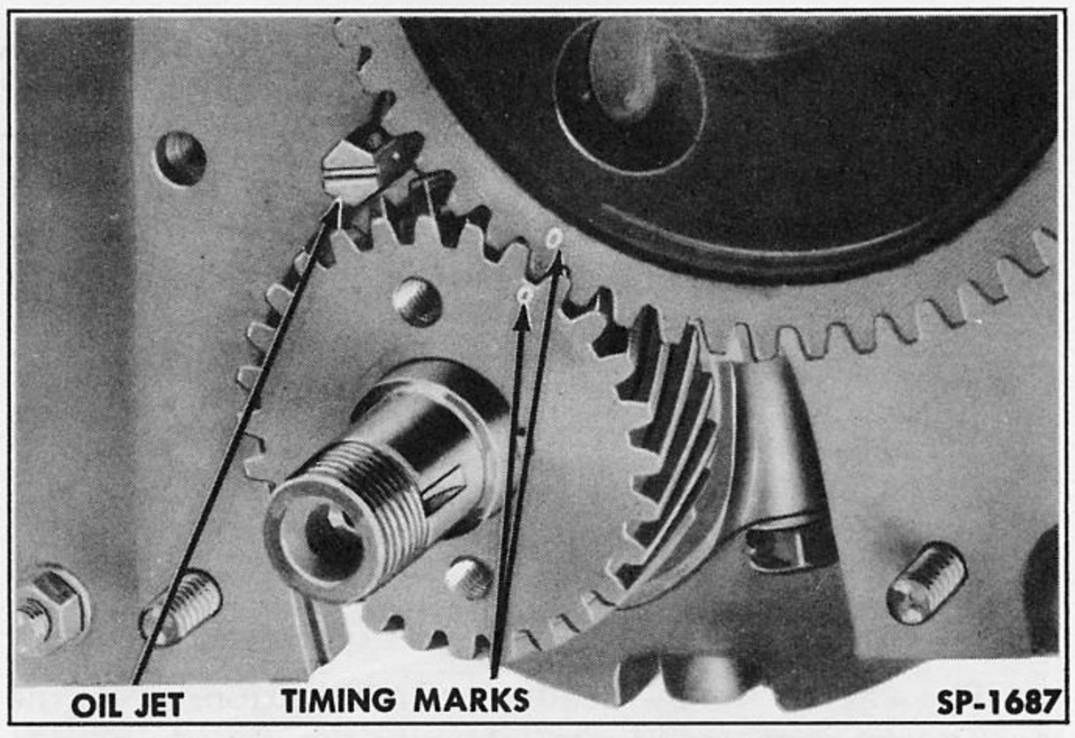


Fig. 57—Valve Timing—6 Cylinder Shown

2. Place oil slinger on crankshaft and install timing gear cover to block, using a new gasket. Be sure new oil seal was installed in cover as detailed under inspection and repair of "Timing Gears and Cover" in this section.

3. Place pulley and key on crankshaft, then install vibration damper and insulator discs, clamp plate, lockwasher and bolt. Tighten bolt to 25-30 foot-pounds torque.

g. Check Crankshaft End-Play

After all component parts are assembled to front end of crankshaft and bolt or nut is tightened to specified torque, crankshaft end-play must be checked.

Mount Dial Indicator W-102 on cylinder block with indicator button against bolt or nut on end of crankshaft and check crankshaft end-play.

The crankshaft end-play should be between .004 and .008 of an inch on both four cylinder engines and six cylinder engines.

Crankshaft end-play is controlled by the use of shims between front main bearing flange and thrust washer. Remove or install shims as necessary to establish specified end-play.

h. Install Piston and Connecting Rod Assemblies

Install piston and connecting rod assemblies in the same cylinders to which they were fitted as detailed under "Pistons, Rings and Connecting Rods" in this section. Proceed as follows:

1. Check pistons to make sure they are clean, free from burrs and all ring gaps are staggered correctly.

2. Coat piston and rings with clean engine oil.

3. Fit Piston Ring Compressor C-385 tightly around piston. Be sure rings are compressed sufficiently to enter block without fracturing rings or piston lands.

4. Install piston in cylinder as shown in Fig. 58. Gently tap piston with wooden hammer handle. Make sure oil hole in connecting rod is on the side away from camshaft. On four cylinder engines, also make sure offset side of connecting rods is placed away from nearest main bearing.

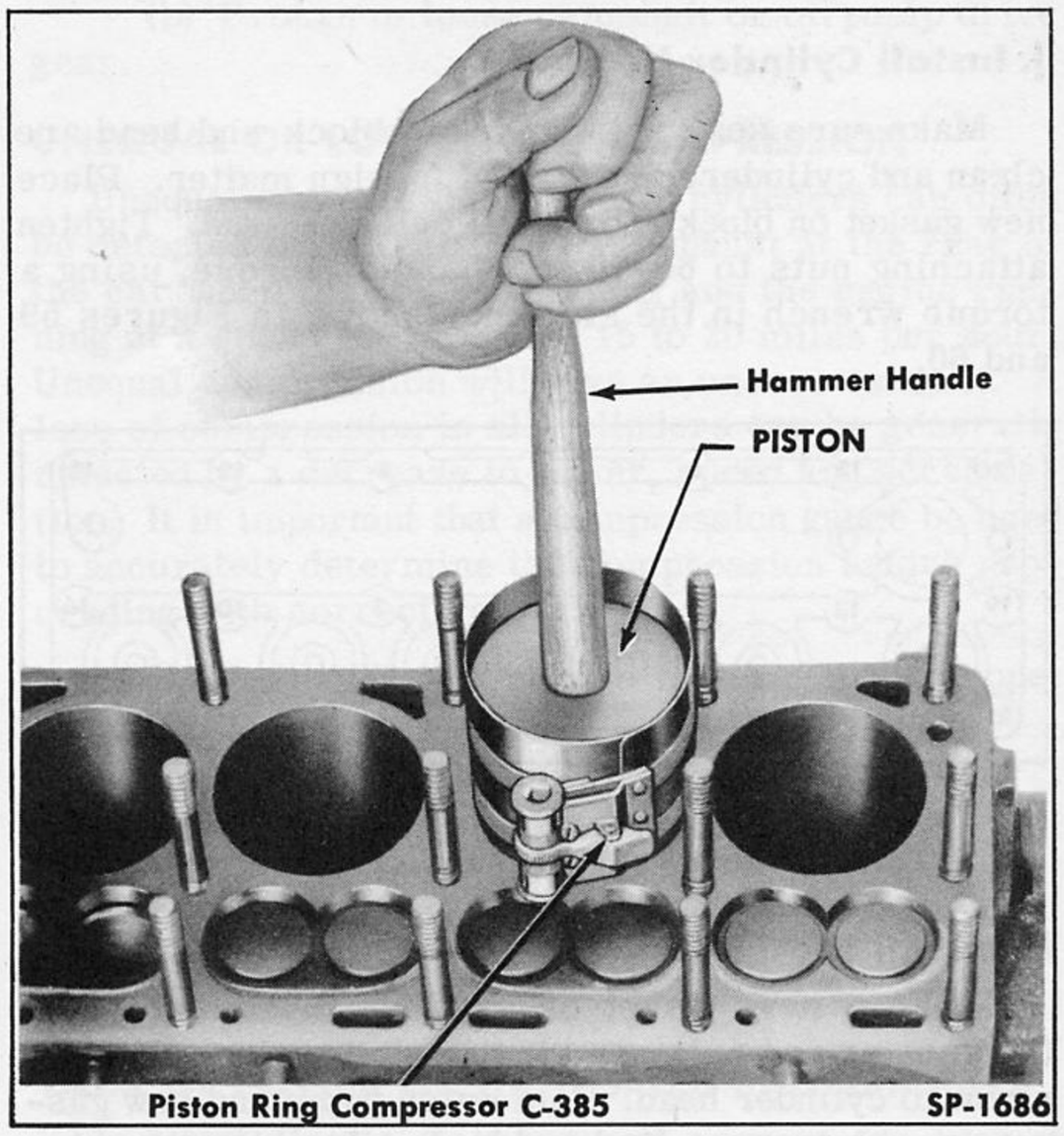


Fig. 58—Installing Piston and Connecting Rod Assembly

5. Selectively fit connecting rod bearings by the Plastigage method or the shim stock method, in same manner used to fit crankshaft main bearings as detailed in this section.

6. After proper fitting, tighten connecting rod cap nuts to 35-45 foot-pounds torque on four cylinder engines and 30-38 foot-pounds on six cylinder engines. Install new lock nuts finger tight against regular nuts, then turn locknut 1/2 turn more to lock them.

i. Install Oil Intake Float and Oil Pan

Install the oil intake float assembly to bottom of block using a new gasket. Install new oil pan gasket to bottom of cylinder block with gasket paste and install oil pan. Tighten oil pan screws to 10-14 foot-pounds torque.

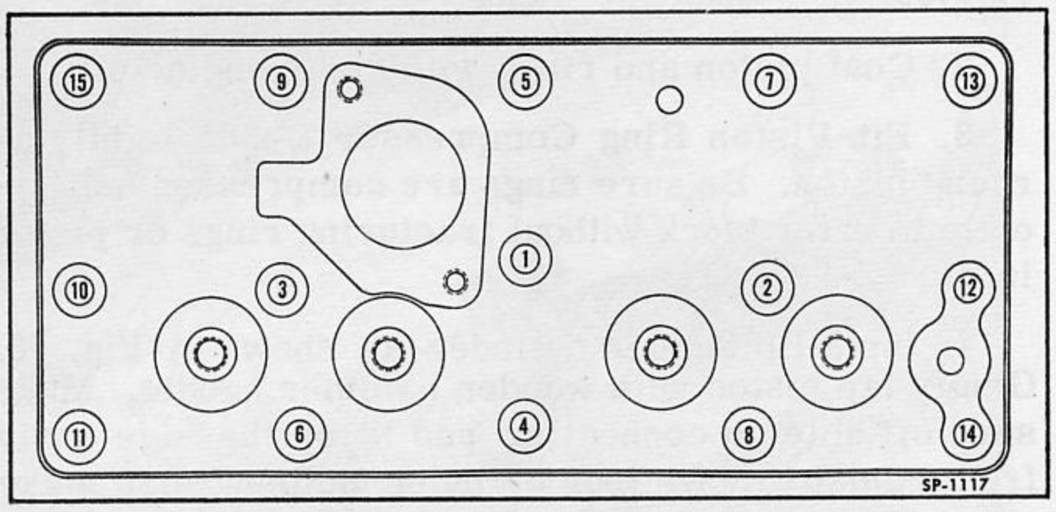


Fig. 59—Cylinder Head Nut Tightening Sequence—4 Cylinder Engine

j. Install Cylinder Head

Make sure sealing surfaces of block and head are clean and cylinders are free of foreign matter. Place new gasket on block and install cylinder head. Tighten attaching nuts to 60-70 foot-pounds torque, using a torque wrench in the sequence shown in Figures 59 and 60.

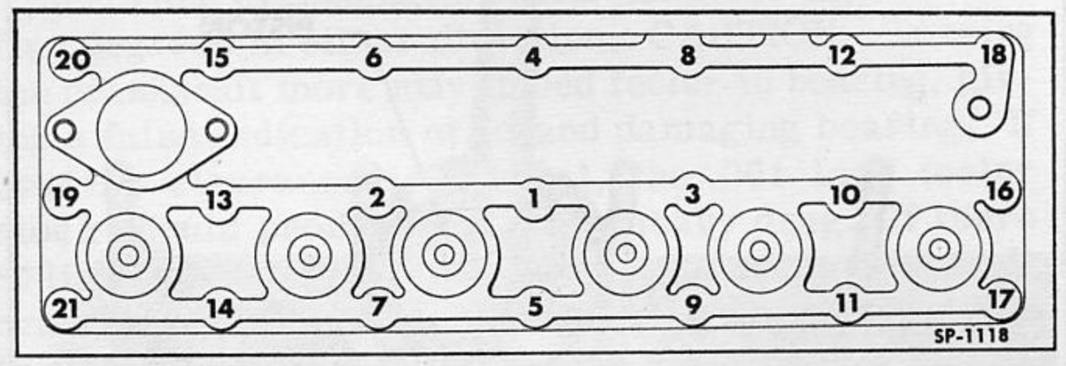


Fig. 60—Cylinder Head Nut Tightening Sequence—6 Cylinder Engine

k. Install Water Outlet Elbow and Water Pump

Place a new gasket on cylinder head and place thermostat and retainer ring in elbow. Install outlet elbow to cylinder head. Hold water pump and new gasket in place on cylinder block. Install attaching screws, placing generator adjusting link under one of the screws.

l. Install Oil Pump

The oil pump must be installed in proper mesh with the camshaft gear and the distributor to obtain correct ignition timing. Proceed as follows:

1. Turn flywheel until No. 1 piston is coming up on compression stroke. Continue turning flywheel until the 0 mark on the vibration damper is opposite timing pointer on a 6 cylinder engine or the mark TC appears opposite index mark on rear end plate on early 4 cylinder engines or the V-notch on the crankshaft pulley appears opposite the 0^{O} mark on the timing gear cover on later 4 cylinder engines.

2. Set distributor rotor at No. 1 firing position and note position of slot in end of distributor shaft. Hold oil pump in same position it would be if installed on engine and turn shaft in a position to engage the distributor shaft.

3. Insert distributor shaft in cylinder block.

4. Slide oil pump into cylinder block slowly to engage oil pump drive gear with gear on camshaft. If oil pump will not engage distributor without moving the distributor rotor 1/8 inch either way remove the oil pump and turn its shaft until it will engage the distributor shaft properly.

5. Install oil pump and distributor attaching bolts.

m. Install Intake and Exhaust Manifolds

Place new manifold gasket on studs in cylinder block. Install intake and exhaust manifold assembly with attaching washers and nuts. Install crankcase ventilation check valve and line to valve tappet cover.

The engine is now ready for installation of engine accessory parts and installation to the vehicle as described under "Engine Installation" in this section.

VALVE ADJUSTMENT

Proper adjustment of the intake and exhaust valve tappets is important to prevent burning of valves and poor engine performance. This adjustment consists of obtaining a specified clearance between the tappet adjusting screw and the bottom of the valve stem. The tappets should be adjusted to .016 inch clearance with the engine cold (at room temperature) and without starting the engine. Each valve tappet can be properly adjusted only when the tappet is on the heel or "low" portion of the cam.

For accessibility when adjusting valves with engine in vehicle, remove right front wheel, splash shield access hole cover and tappet chamber cover.

Crank the engine over to close the valve and check clearance with a feeler gauge (Fig. 61). To adjust clearance, hold tappet from turning with a tappet wrench (such as Valve Tappet Wrenches DD-29) and turn tappet adjusting screw with another tappet wrench

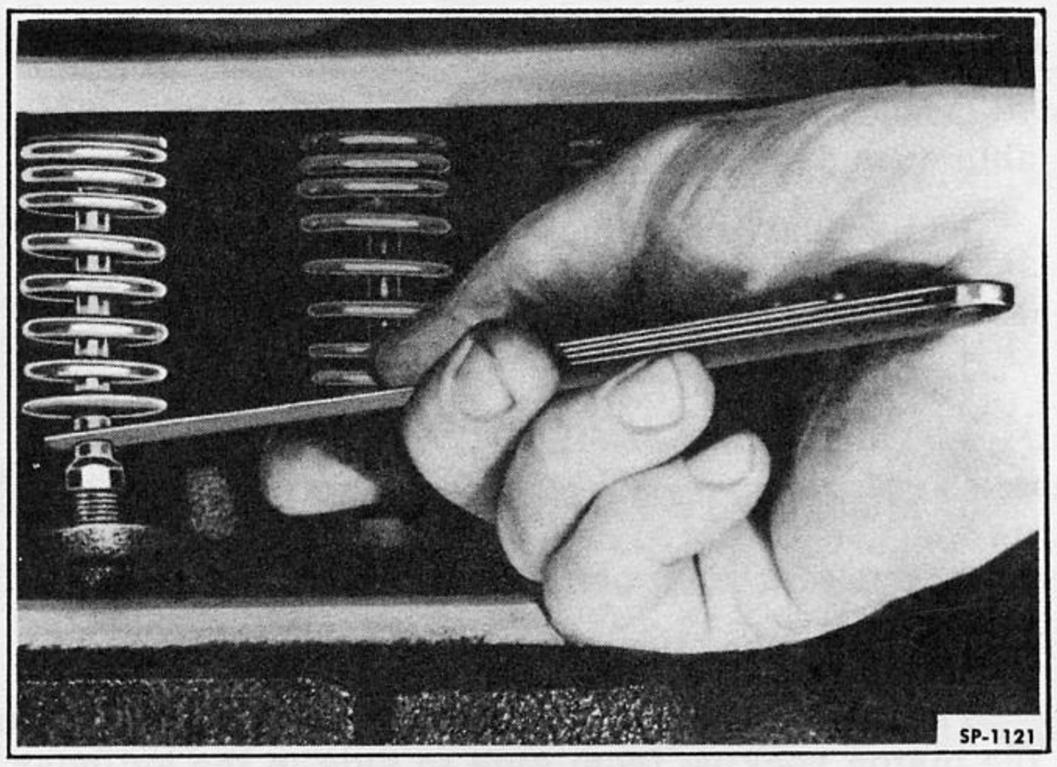


Fig. 61—Checking Valve Clearance

(Fig. 62) to obtain proper clearance of .016 inch. Remove wrenches and recheck clearance. Readjust if necessary. Check and adjust each of the tappets in this manner.

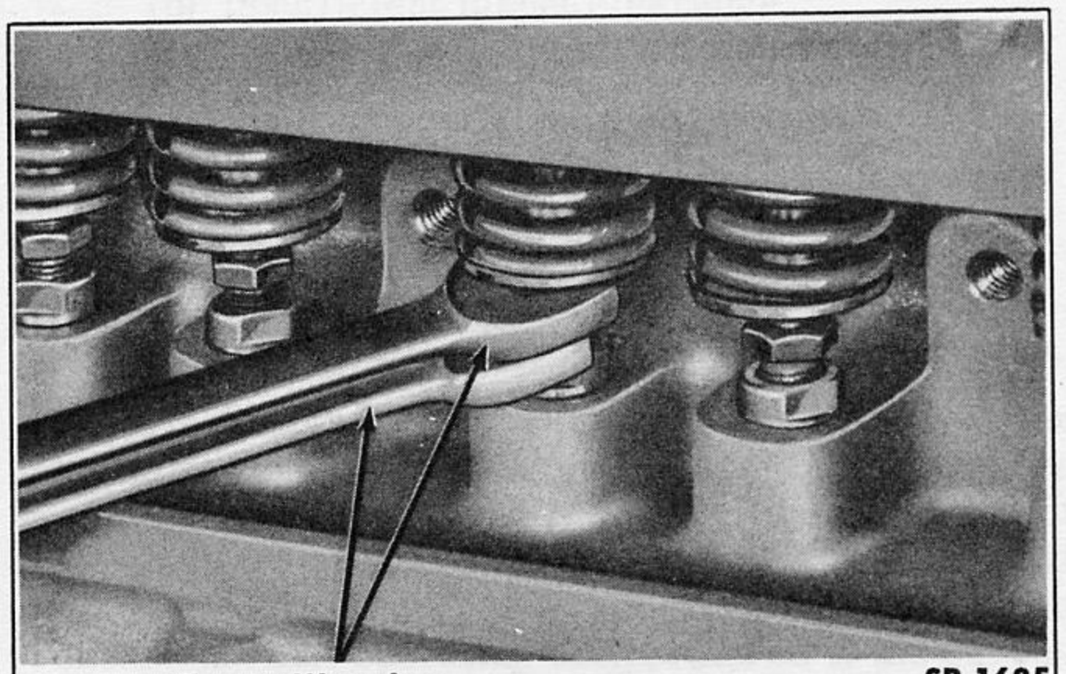


Fig. 62—Adjusting Valve Tappets

SERVICE DIAGNOSIS

The trouble symptoms which follow pertain only to engine operations. Symptoms which affect operation or "running" of the engine can often be attributed to faulty related units or systems such as ignition, cooling, and fuel system rather than the mechanical components of the engine. This diagnosis includes all symptoms which might affect actual engine operation.

Reference should be made to the various sections of the manual for corrective measures as required by the diagnosis.

ENGINE STARTS HARD OR WILL NOT START

1. Improper carburetion.
2. Electrical difficulties.
   (a) Battery.
   (b) Ignition.
   (c) Starting motor.
3. Poor engine compression resulting from:
   (a) Loose cylinder head stud nuts.
   (b) Spark plugs loose in head.
   (c) Improperly installed or damaged cylinder head gasket.
   (d) Poorly seating valves.
   (e) Weak or broken valve springs.
   (f) Valves holding open due to insufficient tappet clearance.
   (g) Valves holding open due to stems being bent, corroded or gummed.
   (h) Badly worn, broken, weak or stuck piston rings.
4. Unusual possibilities.
   (a) Valves improperly timed.
   (b) Broken or loose camshaft or oil pump drive gear.

UNEQUAL OR LOW ENGINE COMPRESSION

Unequal compression between cylinders can often be detected by listening to the exhaust at the rear of the car when the car is standing and the engine running at a speed equivalent to 15 to 20 miles per hour. Unequal compression will give an uneven exhaust. A loss of compression in all cylinders can be generally detected by a decrease in power, speed and acceleration. It is important that a compression gauge be used to accurately determine the compression before proceeding with corrective work.

1. Valves holding open due to insufficient tappet clearance.
2. Sticking valves.
3. Compression loss past pistons and rings.
4. Cylinder head gasket leakage.

LACK OF POWER OR HIGH SPEED PERFORMANCE

In attempting to diagnose and correct for lack of power or high speed performance, first determine whether the trouble is in the engine, brakes or power train. The following should be checked:

1. Insufficient or unequal engine cylinder compression.

2. Improper ignition timing.

3. Manifold heat control valve stuck in closed position.

4. Improper carburetion.

5. Fuel pump defective.

6. Partially restricted exhaust pipe, muffler or tail pipe.

7. Excessive engine temperatures.

8. Pre-ignition.

9. Excessive engine friction resulting from tight bearings or pistons too tight in cylinder bores.

10. Improper clutch adjustment.

11. Excessive rolling resistance resulting from:

(a) Dragging brakes.

(b) Tight wheel bearings.

(c) Misalignment of rear axle.

(d) Under-inflated tires.

12. Improper rear axle ratio.

13. Incorrect valve timing.

14. Inaccurate speedometer. (Gives impression of lack of performance.)

15. Automatic spark advance not operating properly.

ENGINE MISFIRES WHEN IDLING AND AT LOW SPEEDS

1. Improper carburetion.

2. Uneven compression.

3. Improper ignition.

MAIN BEARING KNOCKS

Main bearing knocks are usually heavy, metallic knocks which are easily noticed upon acceleration under load. Check for:

1. Excessive bearing clearance.

2. Excessive crankshaft end-play.

3. Out-of-round journals.

4. Sprung crankshaft.

5. Bearing misalignment.

6. Insufficient oil supply.

7. Low oil pressure.

8. Thin or diluted oil.

9. Loose flywheel.

CONNECTING ROD KNOCKS

Connecting rod knocks are usually more noticeable upon deceleration. Check for:

1. Excessive bearing clearance on crankpin.

2. Insufficient oil supply.

3. Low oil pressure.

4. Thin or diluted oil.

5. Misaligned connecting rod.

6. Out-of-round, or tapered crankpin journal.

PISTON NOISES

The most common piston noise is "slap", due to the piston rocking from side to side in the cylinder. Slight piston noises that occur with a cold engine and disappear after the engine is warm, ordinarily are not harmful. Piston ring noises generally cause a click, snap, or sharp rattle on acceleration. Check for:

1. Excessive piston to cylinder bore clearance.

2. Insufficient piston pin clearance.

3. Connecting rod misalignment.

4. Piston or rings striking ridge at top of cylinder bore.

5. Piston striking carbon accumulation on cylinder head.

6. Piston striking cylinder head gasket.

7. Broken piston rings.

8. Excessive side clearance of ring in ring groove.

9. Pin hole out-of-square with piston.

PISTON PIN NOISES

The most common piston pin noise is the result of excessive piston pin clearance. A piston pin knock is generally noticeable when the engine is idling. Check for:

1. Excessive piston pin clearance.

2. Piston pin rubbing cylinder wall.

3. Insufficient piston pin clearance. (Causes piston slap).

VALVE AND TAPPET NOISES

Noisy valve action has a characteristic clicking noise occurring usually at regular intervals if the valve stem to tappet clearance is too great. If the noise is intermittent, it is usually caused by the tappet adjustment screw surface not being square with the valve stem. Common causes are:

1. Excessive valve stem to tappet clearance.

2. Excessive clearance of valve stem in the guide.

3. Tappet adjustment screws not square with valve stem.

4. Weak valve springs.

SPARK KNOCK (PRE-IGNITION OR DETONATION)

Spark knock and pre-ignition or detonation causes a metallic ringing sound which is often described as a "ping" and is usually encountered when the engine is laboring, accelerating rapidly or is overheated. Possible causes are:

1. Large carbon deposits in combustion chamber.

2. Ignition timed too early.

3. Faulty automatic distributor advance.

4. Overheated valves resulting from:

(a) Incorrect width of valve seats.

(b) Insufficient tappet clearance.

(c) Use of wrong type of valve.

(d) Thin edged valves.

5. Improper operation of cooling system.

6. Use of poor quality or low octane fuel.

ENGINE BACK-FIRING THROUGH CARBURETOR

Engine back-firing through the carburetor, when starting a cold engine, is unavoidable in many cases and should be considered normal. It is the result of incorrect air-gasoline mixture entering the engine and will automatically correct itself after the engine reaches normal operating temperatures if the carburetor and choke adjustments are correct. Continued back-firing after the engine has become warm, or back-firing after considerable operation, should be checked for the following causes:

1. Improper ignition timing.

2. Improperly seating valves, especially intake valves.

3. Incorrect valve timing.

4. Pre-ignition.

5. Excessively lean or abnormally rich carburetor mixture.

6. Intake manifold air leaks.

7. Defective cylinder head gasket.

8. Poor quality of fuel.

9. Spark plug wires improperly installed (crossed).

ENGINE VIBRATION

1. Unequal compression of engine cylinders.

2. Unbalanced fan or loose fan blade.

3. Loose engine mountings.

4. Unbalanced or sprung crankshaft.

EXCESSIVE ENGINE OIL CONSUMPTION

1. Loss from external leaks:

(a) Oil pan gasket damaged or improperly installed.

(b) Oil pan gasket flange distorted or cap screws loose.

(c) Oil pan drain plug loose or gasket damaged.

(d) Rear main bearing oil seal leaking.

(e) Timing gear cover gasket leaking.

(f) Timing gear cover flange distorted.

(g) Valve cover gasket leaking.

(h) Loose fuel pump.

2. Thin or diluted engine oil.

3. More than recommended amount of oil in engine pan.

4. Piston to cylinder wall clearance too great:

(a) Worn piston rings.

(b) Broken piston rings.

(c) Piston rings stuck in ring grooves.

(d) Improper piston ring combination.

5. Excessive clearance between intake valve stems and guides.

6. Damaged vacuum booster pump diaphragm.

7. Piston ring gaps lined up.

OIL PRESSURE

1. Low oil pressure.

(a) Use of very light or diluted engine oil.

(b) Water, sludge, ice or dirt restricting oil pump intake screen.

(c) Oil relief valve not properly seating.

(d) Worn or damaged oil pump rotors.

(e) Excessive clearance of pump rotors in pump body.

(f) Excessive clearance of main, connecting rod or camshaft bearings.

(g) Inaccurate oil pressure indicator.

2. High oil pressure.
   (a) Use of heavy engine oil.
   (b) Relief valve not opening.
   (c) Restricted or partially clogged oil passage.

OIL PUMP AND DISTRIBUTOR DRIVE NOISES

1. Worn or damaged camshaft drive gear.
2. Improper mesh of drive and driven gears.
3. Excessive clearance of shaft in oil pump body.
4. Oil pump not rigidly mounted.
5. Damaged oil pump rotors.

SERVICE BULLETIN REFERENCE