SECTION 8

ENGINE MECHANICAL

CONTENTS OF THIS SECTION

SIX CYLINDER ENGINE
(235 cu. in.)

INDEX

Fig. 1—Engine Cross Section

GENERAL DESCRIPTION

For 1961, one six cylinder Hi-Thrift economy engine (fig. 1) is provided for all passenger models with either 3 speed, overdrive or Powerglide transmissions. The Hi-Thrift six cylinder engine has a displacement of 235.5 cubic inches, a $3\frac{9}{16}$" bore, $3\frac{15}{16}$" stroke and an 8.25:1 compression ratio. All six cylinder engines are equipped with hydraulic valve lifters and a low lift, high torque camshaft for increased economy and performance.

MAINTENANCE AND ADJUSTMENTS

A routine inspection of items which should be checked at regular intervals is determined by the conditions under which the vehicle operates which may vary.

ENGINE OIL

See "General Lubrication," Section 2.

ENGINE OIL LEVEL

The engine oil level should be maintained between the "Full" and "Add" marks on the oil level gauge. DO NOT OVERFILL. Refill capacity 5 quarts.

RADIATOR

See "Cooling System," in this Section.

IGNITION TIMING

See Section 7.

COMPRESSION CHECK

See Section 7.

CRANKCASE VENTILATION—STANDARD

The breather filter should be cleaned with a solvent every 2000 miles. After cleaning, oil the mesh with light engine oil.

The road-draft tube seldom requires service.

CRANKCASE VENTILATION—POSITIVE

The positive crankcase ventilation system will operate effectively as long as normal maintenance is applied. Due to the nature of the materials carried by the ventilating system, the valve and pipe are subject to fouling with sludge and carbon formation.

At regular intervals of 10,000 miles or less, depending on operating conditions, the metering valve, the pipe running from the valve to the intake manifold and manifold fitting should be removed from the engine, disassembled and cleaned thoroughly.

NOTE: Under cold weather operating conditions, when vehicles are operated at slow speeds with low engine temperatures, more rapid accumulations of harmful fumes may be present in the engine. Under these conditions of operation the valve and tube must be cleaned more frequently than specified above. However, no specific mileage recommendation can be made under these conditions. Frequency of cleaning must be dictated by experience.

VALVE LASH ADJUSTMENT—ENGINE RUNNING

The following procedure, performed with the engine running, supplements the valve lash adjustment as instructed under Service Operations—Valve Lash Adjustment.

1. After the engine has been normalized, remove valve cover and install a new valve cover gasket, on cylinder head to prevent oil from running out.
2. With the engine running at idle, loosen lock nut and back off valve rocker arm adjusting screw (one at a time) until the valve rocker arm starts to clatter.
3. Turn rocker arm adjusting screws down until the clatter just stops; continue to turn screw down exactly 1½ turns and tighten lock nut securely.

   NOTE: The engine will run rough for a few seconds until the lifter plunger adjusts to its normal operating position. Noisy lifters should be replaced.
4. Install rocker cover with existing new gasket.

AIR CLEANER AND CARBURETION

See "Fuel and Exhaust Systems," Section 10.

ENGINE ELECTRICAL SYSTEM COMPONENTS

See "Engine Electrical," Section 9.

ENGINE TUNE-UP

See "Engine Tune-up," Section 7.

INTAKE AND EXHAUST MANIFOLD OR GASKET

Removal

1. Remove air cleaner clamp, remove support bolts and remove air cleaner.
2. Remove cotter pin at lower end of throttle rod and disconnect rod from bell crank and disconnect throttle return spring.

3. Disconnect gas and vacuum lines from carburetor.
4. Remove oil filter and hoses on vehicles so equipped.
5. Remove bolts and clamps that attach manifold assembly to cylinder head and pull manifold assembly off the manifold studs (fig. 2).
6. Remove intake manifold pilot sleeves (fig. 2).

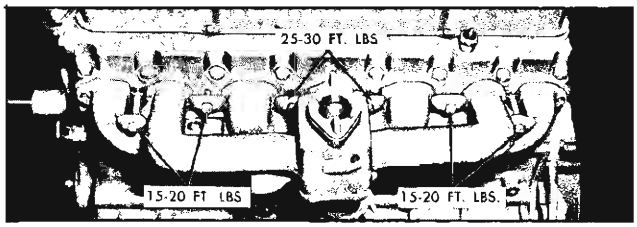

Fig. 2—Intake and Exhaust Manifold Tightening Sequence

Installation

1. Clean gasket flanges on cylinder head and manifold.

   NOTE: Check for cracks on manifold castings.

2. Install new gaskets, intake manifold pilot sleeves and four bolts with clamps loosely to hold gaskets in place.
3. Position the manifold and slide it into place over the end studs and pilot sleeves, making sure it seats against the gaskets.
4. Install the two end bolts with clamps and turn the center clamps into position against manifold.
5. Tighten long clamp bolts to 25-30 ft. lbs. torque and center short clamp bolts 15-20 ft. lbs. torque.
6. Reverse sequence of removal, Steps 1 to 4.

SERVICE OPERATIONS

CHECKING CAMSHAFT LOBE LIFT

NOTE: Procedure is similar to that used for checking valve timing. If improper valve operation is indicated, check the lift of each lobe in consecutive order and record the readings.

1. Remove valve rocker cover and gasket.
2. Remove valve rocker shaft and support assembly.
3. Install 3/8-24-16 stud adapter from Tool J-8520 in rocker shaft support bolt hole.
4. Attach Tool J-8520 to adapter stud and position indicator Tool J-8520 to push rod as shown in Figure 3.

   NOTE: Make sure push rod is in the lifter socket.

5. Rotate the crankshaft balancer slowly in the direction of rotation until the lifter is on the heel of the cam lobe. At this point, the push rod will be in its lowest position.
6. Set dial indicator on zero, then rotate the damper slowly, or attach an auxiliary starter switch and "bump" the engine over until the push rod is in the fully raised position.

   NOTE: Ground primary coil wire when cranking engine.

7. Compare the total lift recorded from the dial indicator Tool J-8520, with specifications.

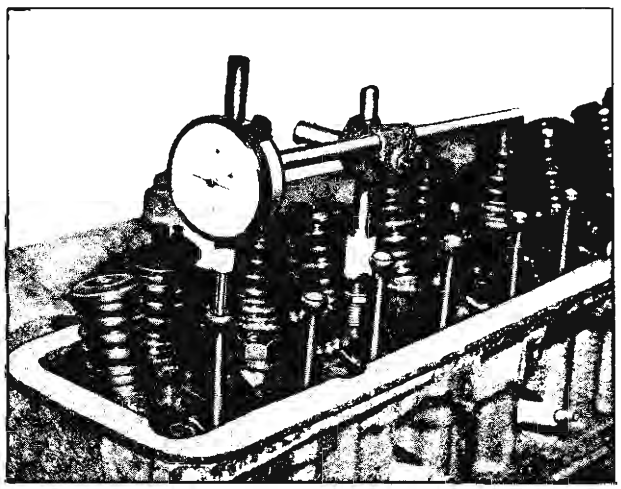

Fig. 3—Checking Camshaft Lobe Lift

CAMSHAFT-WEAR LIMIT

Tappet Lift Should Be:	Inlet and Exhaust
New	.222" ± .002"
Worn	.217" + .003" − .002"

8. Continue to rotate the engine until the indicator reads zero. This will be a check on the accuracy of the original indicator reading.
9. If camshaft readings for all lobes are within specifications, remove dial indicator assembly and Tool J-8520 from stud adapter.
10. Install all push rods and rocker shaft assembly. Refer to "Service Operations"—Valve Lifters for valve adjustment.

CRANKCASE VENTILATION—STANDARD

Effective crankcase ventilation is provided on all engines by a road-draft tube type of system. A venti-

lator tube, leading from the crankcase, is exposed to the air moving underneath the vehicle. The shape and position of the end of the tube is such that a differential of pressure is created between the ends of the tube. Thus, in addition to providing a ready exhaust for any crankcase pressure due to vapor formation, heat expansion or piston blowby, a draft is created through the engine. The path of the draft is from a breather filter in the sealed valve rocker cover on top of the engine, through the valve train section of the engine to the crankcase to the ventilator tube. In this manner, crankcase vapors are drawn from the engine as they are formed, reducing the possibility of harmful acid or sludge formation in the lubricating oil.

The only service required for this system is the cleaning of the breather intake filter and road-draft tube. Refer to "Maintenance and Adjustments" in this section for recommendations.

Driving conditions determine the length of time required to build up a sludge formation in the road-draft tube. If there is evidence of crankcase pressure, such as leaking seals on the crankshaft above and beyond normal conditions, the tube should be checked as a possible source of trouble. The tube should be removed from the vehicle for cleaning, which may be done with solvents or by burning out the sludge formation. This is a good precaution on high mileage engine overhauls.

CRANKCASE VENTILATION—POSITIVE

Positive crankcase ventilating units are available as an option. Installation of this unit will serve:

1. To prevent entrance of dust or dirt into the crankcase on vehicles that are operated in dusty areas. Dust and dirt in the crankcase and oiling system will result in rapid wear of main and connecting rod bearings, piston rings, cylinder walls and other moving parts.

   NOTE: An oil bath air cleaner should also be used in dusty areas.

2. To provide adequately controlled crankcase ventilation on vehicles used continuously in slow speed, door to door delivery and similar type operations by effectively removing harmful vapors which contaminate the oil, also to prevent corrosion and sludge formation in the crankcase.

Operation

Positive crankcase ventilation is accomplished by utilizing the vacuum created in the intake manifold and the system features controlled circulation of clean air through the crankcase and valve chamber at all engine speeds and loads. Clean air is drawn into the engine from the carburetor air cleaner through a ventilation valve which regulates the amount of ventilation to meet changing operation conditions. To assure proper operation of positive crankcase ventilation system it is important that the crankcase oil level be correctly maintained and not over filled.

When the positive crankcase ventilation system is installed on a Chevrolet engine an extra quantity of air is permitted to enter the intake manifold below the carburetor. This may in some instances result in a leaner air-fuel ratio in the engine than is desirable. No change in carburetion should be made unless definite evidence of lean mixture is experienced. If this condition is experienced, one step rich main metering jet may be used in the carburetor.

A section drawing (fig. 4) is shown in order to familiarize servicemen with the air flow through the positive ventilation system. The system is simple yet very effective. The only moving part of the system is the operation of the ventilation valve (fig. 5) which is controlled by engine vacuum.

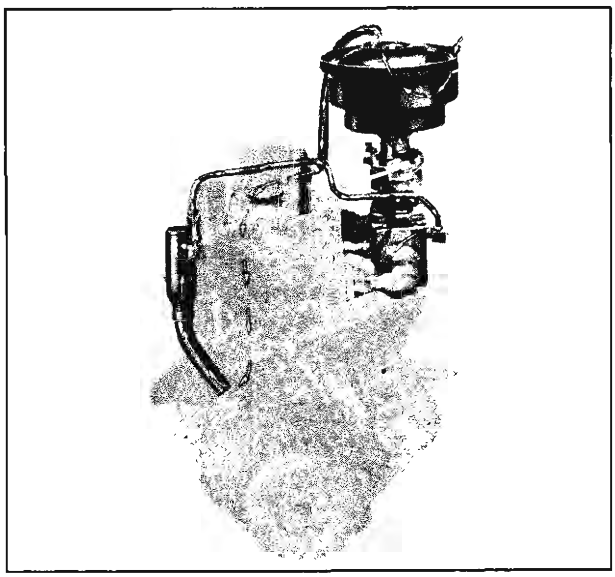

Fig. 4—Positive Ventilation System

Improper functioning of the ventilation valve may cause erratic operation of the engine. This condition may show up as any of the following troubles:

1. Engine stalls frequently after slow or quick stops. After restart of engine, engine runs rough, with typical lean idle fuel mixture.
2. Engine loss of power and surging at speeds above idle.
3. Considerable amount of black smoke at tailpipe, engine has typical rich rolling idle.
4. Idle rpm speed fluctuates but engine does not stall.

POSITIVE VENTILATION

Disassembly

Disassemble the valve (fig. 5) and clean the valve parts with any good solvent cleaner and blow dry with compressed air.

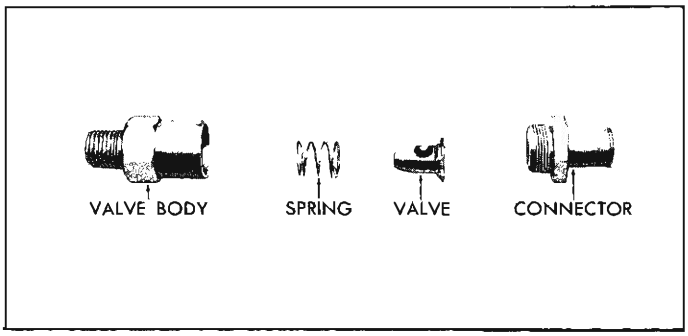

Fig. 5—Positive Ventilation Valve

Assembly

When reassembling the valve parts, be sure to attach the spring on the valve by pushing the end coil over the tapered end of the valve, over the ridge and into the groove machined just under the head of the valve. This is very important. Unless the spring is properly assembled, the valve will not contact the valve seat squarely and will not close properly. Consequently, the engine will not idle properly due to the entrance of too much air into the intake manifold. If the spring has been stretched the same trouble may occur.

If improper action of the spring is suspected due to spring being distorted, bent or etched from corrosive action, the valve assembly should be replaced. Clean the steel ventilator connection tube and intake manifold connector with solvent and blow dry with compressed air.

Remove oil filler tube and inspect for sludge accumulation, if necessary burn clean, make sure all holes in baffle inside of oil filler tube are open. Inspect oil filler cap and gasket for sealing. If necessary replace gasket as ventilating system efficiency depends on a sealed cap at this point.

Inspect for and correct any air leaks at valve rocker cover gasket, valve side cover gasket and ventilator connecting tube and fitting to prevent entrance of air.

VALVE LIFTERS

Hydraulic valve lifters very seldom require attention. The lifters are extremely simple in design, readjustments are not necessary, and servicing of the lifters require only that care and cleanliness be exercised in the handling of parts.

The easiest method for locating a noisy valve lifter is by use of a piece of garden hose approximately four feet in length. Place one end of the hose near the end of each intake and exhaust valve with the other end of the hose to the ear.

In this manner, the sound is localized making it easy to determine which lifter is at fault.

Another method is to place a finger on the face of the valve spring retainer. If the lifter is not functioning properly, a distinct shock will be felt when the valve returns to its seat.

The general types of valve lifter noise are as follows:

1. Hard Rapping Noise – Usually caused by the plunger becoming tight in the bore of the lifter body to such an extent that the return spring can no longer push the plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit causing abnormal stickiness.
   b. Galling or "pick-up" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedging between plunger and lifter body.
2. Moderate Rapping Noise—Probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper lash adjustment.
3. General Noise Throughout the Valve Train—This will, in almost all cases, be a definite indication of insufficient oil supply, or improper lash adjustment.
4. Intermittent Clicking—Probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, the ball itself may be out-of-round or have a flat spot.
   c. Improper lash adjustment.

In most cases where noise exists in one or more lifters, all lifter units should be removed, cleaned in a solvent, reassembled, and reinstalled in the engine. If dirt, varnish, carbon, etc. is shown to exist in one unit, it more than likely exists in all the units, thus it would only be a matter of time before all lifters caused trouble.

In instances where parts are damaged, particularly the plunger or lifter body, the complete lifter unit should be replaced. However, in rare or emergency cases an Arkansas hard stone may be used to remove metal scratches or humps; and if after correcting, the plunger will operate freely in the lifter body, the parts may be thoroughly cleaned and the unit assembled and installed.

A few precautions to follow when servicing the valve lifters are:

1. Plungers are not interchangeable, they are a selective fit at the factory. Should a plunger or lifter body become damaged, it is necessary to replace the whole unit.
2. The plunger must be free in the lifter body. A simple test for this is to be sure the plunger will drop of its own weight in the body.
3. There must be no excessive leakdown and there must be no ball check valve leakage.

Removal

1. Remove rocker arm cover attaching screws and remove cover and gasket.

2. Disconnect spark plug wires and disconnect high tension wire from coil.
3. Remove push rod cover attaching screws and remove cover and gasket.
4. Remove bolts and nuts which retain valve rocker arm assembly to cylinder head and remove rocker arm assembly.
5. Remove the twelve push rods and twelve valve lifters.

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

Disassembly and Assembly

1. Hold plunger down with Tool J-4274 and using the blade of a small screwdriver, remove plunger and push rod seat retainer.
2. Remove push rod seat, plunger and ball check valve assembly and plunger lifter spring. Figure 6 shows a layout of the parts.

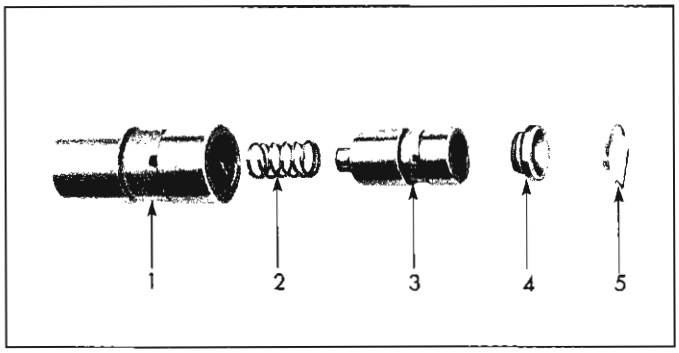

Fig. 6—Valve Lifter, Exploded View

1. Body
2. Spring
3. Plunger & Ball Check Valve
4. Push Rod Seat
5. Retainer

NOTE: It is not necessary to remove ball check valve from plunger for cleaning. Figure 7 shows a cross-section of lifter.

3. Thoroughly clean all parts in cleaning solvent, then inspect them carefully. If any parts are damaged, the entire lifter assembly should be replaced.
4. To reassemble drop lifter spring into lifter body.
5. Install plunger and ball check valve assembly in lifter body, being careful to line up the feed holes in lifter body and plunger.
6. Fill assembly with SAE 10 oil, then insert end of Tool J-4272 into plunger and press down solid, at which point holes in lifter body and plunger assembly will be aligned.
7. Insert pin which is part of Tool J-4274-2 through both holes to hold plunger down against lifter spring tension. Remove tool from top of lifter.
8. Fill assembly with SAE 10 oil, install push rod seat and spring retainer.

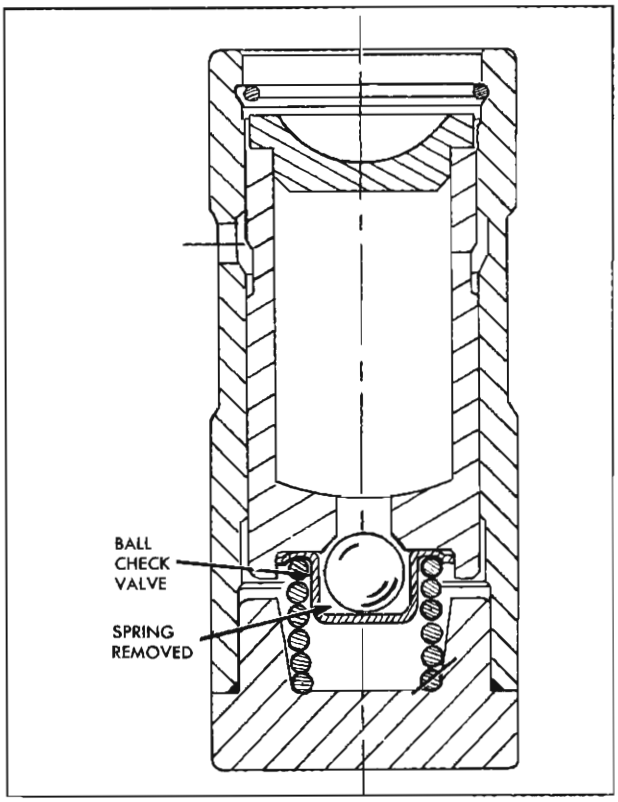

Fig. 7—Hydraulic Valve Lifter Cross-Section

9. Press down on push rod seat and remove pin Tool J-4274-2. The hydraulic lifter is now completely assembled, loaded with oil and ready for installation.

Installation

1. Install valve lifters in cylinder block.
2. Install push rods and valve rocker arm assembly, and install push rod cover and gasket.
3. Replace high tension wire to coil and connect spark plug wires.

VALVE LASH ADJUSTMENT

Any time the rocker arm assemblies or valve lifters are removed from the engine it is necessary to make an initial adjustment for each valve lifter. This adjustment must be made when the lifter is on the base circle of the cam according to the following procedure:

1. Remove distributor cap and crank engine until distributor rotor points to number one (1) cylinder position with the breaker points open. In this position the piston in number one cylinder is at top center on compression stroke with both lifters on the base circle of the cam and both valves can then be adjusted.
2. Turn adjusting screw down until all lash is removed from lifter to valve. This can be determined by checking push rod side play at adjusting screw end while turning the adjusting screw. At the

point where no side play of push rod can be felt, continue turning adjusting screw down 1½ turns and tighten lock nut securely. This places the lifter plunger in center of its travel and no further adjustment is required.

3. Crank engine until the distributor is pointing to number five (5) cylinder position. Then adjust both valves for number five (5) cylinder in the manner described above.
4. The other valves may be adjusted by setting the engine with the distributor as described above. It should be noted that we are following the firing order of the engine which is 1, 5, 3, 6, 2, 4; therefore, both intake and exhaust valves for each cylinder should be adjusted in this order.

CYLINDER HEAD AND VALVE CONDITIONING

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

Removal and Disassembly

1. Drain radiator, raise hood, loosen air cleaner clamp and remove air cleaner. Disconnect choke and throttle wires from carburetor if engine is so equipped.
2. Remove lower end of throttle rod from bell crank and disconnect throttle return spring.
3. Disconnect gas and vacuum lines from carburetor, 2-speed and hydrovac vacuum line from manifold fitting.
4. Remove gas and vacuum line retaining clip from water outlet.
5. Remove bolts, and clamps that attach manifold assembly to cylinder head and pull manifold assembly off the manifold studs. Also remove intake pilot sleeves.
6. Disconnect radiator hose from water outlet, remove outlet to cylinder head bolts and remove outlet and thermostat. Remove battery ground strap to cylinder head bolt.
7. Remove air cleaner attachment to rocker arm cover on positive crankcase ventilation engines.
8. Remove rocker arm cover attaching screws and remove cover and gasket.
9. Disconnect wires and remove all spark plugs.
10. Remove high tension wire from coil, remove coil attaching screws and lay coil down out of the way.
11. Remove temperature indicator element from cylinder head.
12. Remove bolts which retain rocker arm assembly to cylinder head and remove rocker arm assembly.
13. Remove twelve push rods and twelve valve lifters.

NOTE: Valve lifters should be placed in a rack in their proper sequence so they may be reinstalled in the same position in the cylinder block at assembly.

14. Remove the cylinder head bolts, cylinder head and gasket.
15. Using Tool J-8062, compress the valve springs and remove valve keys, spring caps, oil seals and springs (fig. 8). Remove exhaust valve rotators from engines so equipped.

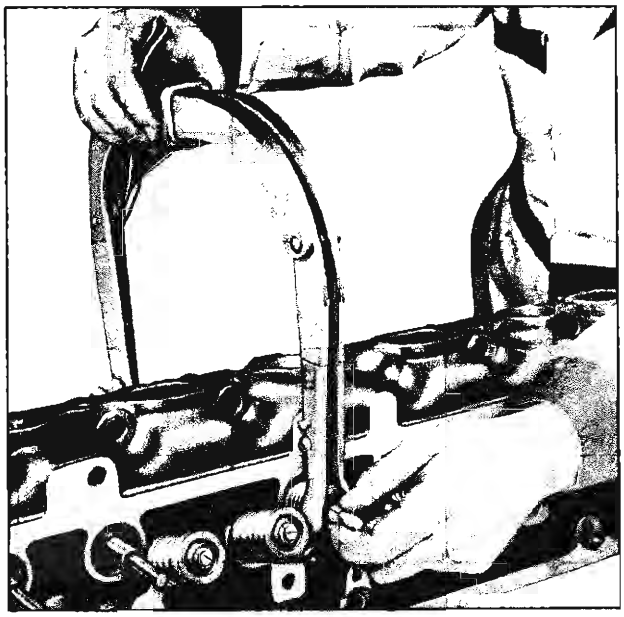

Fig. 8—Using Valve Spring Compressing Tool J-8062

16. Remove valves from cylinder head and keep them in their proper sequence for inspection and assembly.

Cleaning

1. Clean all carbon from combustion chambers and valve ports using Tool J-8089.
2. Thoroughly clean the valve guides using Tool J-8101.
3. Clean all carbon from push rods and valve lifters.
4. Clean valve stems and heads on a buffing wheel.
5. Clean carbon deposits from pistons and cylinders.
6. Wash all parts in cleaning solvent and dry them thoroughly.

Inspection

1. Inspect the cylinder head for cracks in the exhaust ports, combustion chambers, or external cracks to the water chamber.
2. Inspect the valves for burned heads, cracked faces or damaged stems.
3. Check fit of valve stems in their respective guides.

NOTE: Excessive valve to guide clearance will cause lack of power, rough idling and noisy valves, and may cause valve breakage. Insufficient clearance will result in noisy and sticky functioning of the valve and disturb engine smoothness of operation. Intake valve stem to guide clearance should be .001" to .003" while exhaust stem clearance should be .002" to .004". By using a micrometer and a suitable telescope hole gauge check the diameter of the valve stem in three places top, center and bottom. Insert telescope hole gauge in valve guide bore, measuring at the center. Subtract highest reading of valve stem diameter from valve guide bore center diameter to obtain valve to guide clearance. If clearance is not within limits replace valve guide.

4. Check valve spring tension with Tool J-8056 spring tester (fig. 9).

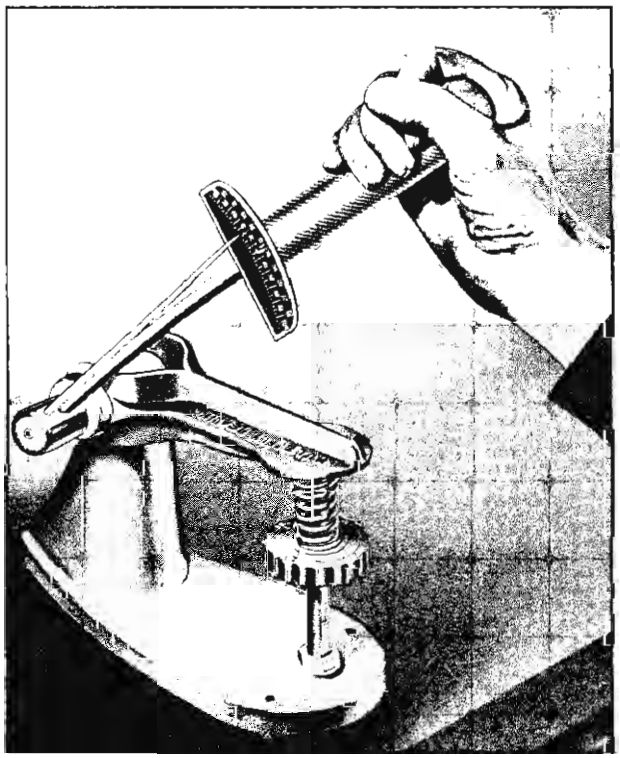

Fig. 9—Valve Spring Tension Gauge

NOTE: On all models, springs should be compressed to 1-27/32" at which height it should check 65 pounds. Weak springs affect power and economy and should be replaced if not within 10 pounds of the above load.

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

REPAIRS

Replace Valve Guides

1. Place the cylinder head on the table of an arbor press and press the old valve guides out using removed Tool J-5600 (fig. 10).

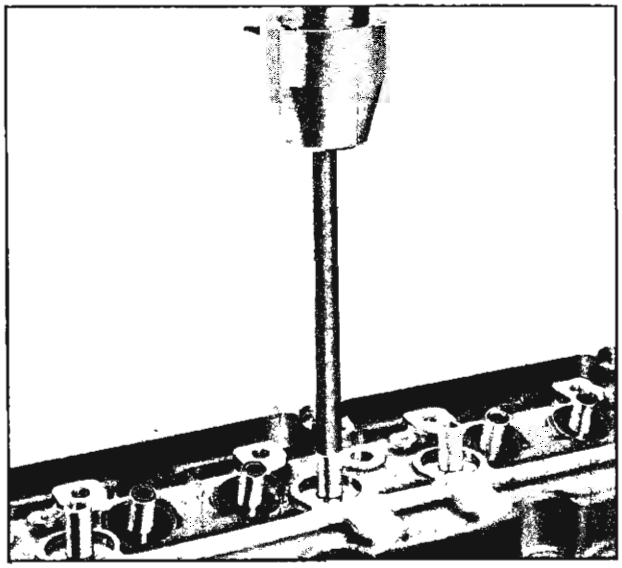

Fig. 10—Removing Valve Guide

2. Press new precision exhaust (short) guides and new precision intake (long) guides into the cylinder head.

NOTE: The guides should be pressed into the cylinder head until the tops of the exhaust guides extend 15/16" above the head and the intake guides extend 1" above the head (fig. 11). Service tool J-5599 may be used on intake guides by placing a 1/16" shim under tool. Service tool J-5734 may be used on exhaust guides also using a 1/16" shim under tool.

3. Finish ream all guides with a .343" hand reamer Tool J-4822.

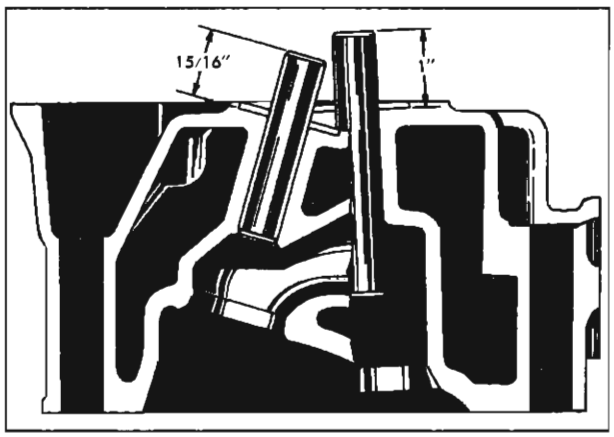

Fig. 11—Valve Guides

Reseating Valve Seats (Cylinder Head)

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

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

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

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

1. Install expanding pilot in the valve guide and expand pilot by tightening nut on top of pilot.
2. Place roughing stone or forming stone over pilot and just clean up the valve seat. Use a 31° stone for the inlet and a 46° stone for the exhaust valve seats.
3. Remove roughing stone or forming stone from pilot, install finishing stone on pilot and cut just enough metal from the seat to provide a smooth finish.
4. Narrow down the valve seats to the proper width of $\frac{1}{16}$" to $\frac{3}{32}$" for the intake and exhaust.

   NOTE: This operation is done by machining both port and top of valve seat.

5. Remove expanding pilot and clean cylinder head carefully to remove all chips and grindings from above operations.

   NOTE: Valve seats should be concentric to within .002" total indicator reading (fig. 12).

Refacing Valves

Valves that are pitted can be refaced to the proper angle, insuring correct relation between the head and stem on a valve refacing machine. Valve stems which show excessive wear, or valves that are warped excessively should be replaced. When a valve head which is warped excessively is refaced, a knife edge will be ground on part or all of the valve head due to the amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or preignition due to head localizing on this knife edge. If the edge of the valve head is less than $\frac{1}{32}$" thick after grinding, replace the valve.

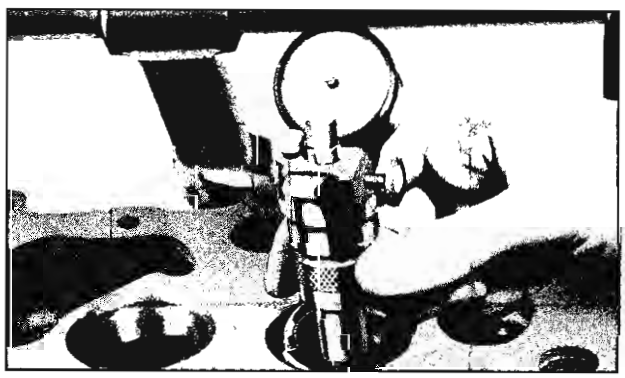

Fig. 12—Checking Valve Seat with Indicator

1. If necessary, dress the valve refacing machine grinding wheel to make sure it is smooth and true. Set the chuck at the 30° mark for grinding intake valves. Set chuck at 45° mark for grinding exhaust valves (fig. 13).

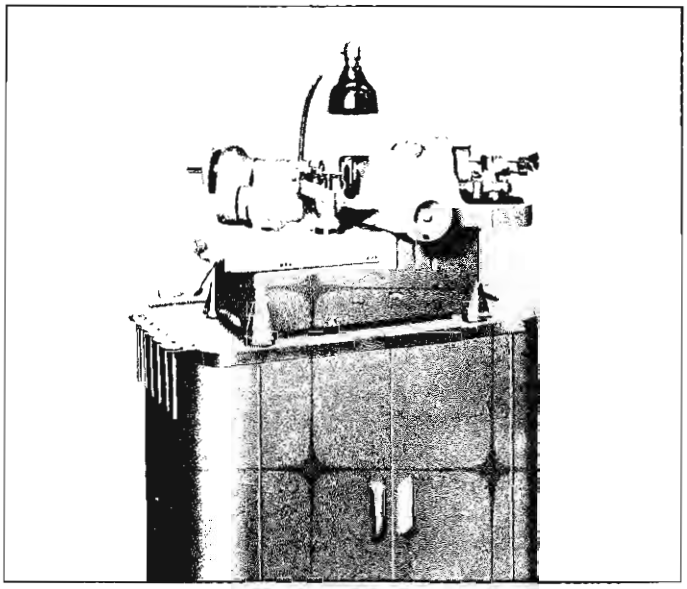

Fig. 13—Valve Refacing Machine

2. Clamp the valve stem in the chuck of the machine.
3. Start the grinder and move the valve head out in line with the grinder wheel by moving the lever to the left.
4. Turn the feed screw until the valve head just contacts wheel. Move valve back and forth across the wheel and regulate the feed screw to provide light valve contact.
5. Continue grinding until the valve face is true and smooth all around valve. If this makes the valve head thin the valve must be replaced as the valve will overheat and burn.
6. Remove valve from chuck and place stem in "V" block. Feed valve squarely against grinding wheel to grind any pit from rocker arm end of stem.

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

7. After cleaning valve face and cylinder head valve seat of grinding particles, make pencil marks

about ¼" apart across the valve face, place the valve in cylinder head and give the valve ½ turn in each direction while exerting firm pressure on face of valve.

8. Remove valve and check face carefully. If all pencil marks have not been removed at the point of contact with the valve seat, it will be necessary to repeat the refacing operation and again recheck for proper seating.
9. Grind and check the remaining valves in the same manner.

Rocker Arms and Shafts

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

1. Remove the support bolts, hairpin locks, springs, rocker arms and supports.
2. Clean all sludge or gum formation from the inside and outside of the shafts and from valve rocker shaft tube.
3. Clean oil holes and passages in the shafts and rocker arms.
4. Clean the rocker arm shaft oil connector assembly.
5. Inspect the shafts for wear. Check the fit of rocker arms on the shafts and check the valve end of rocker arms for excessive wear. Replace all worn parts.
6. There are three each of four different type rocker arms used—right and left hand exhaust and right and left hand intake. They must be installed on the shafts in correct position. For identification each type rocker arm carries a different number stamped on the side.
7. The proper locations of the rocker arms according to number are as follows:

Type Rocker Arm	For Cylinder No.	Number Cast
L.H. Exhaust	1-3-5 Exhaust	87
R.H. Exhaust	2-4-6 Exhaust	88
L.H. Intake	2-4-6 Intake	85
R.H. Intake	1-3-5 Intake	86

8. One end of each rocker arm shaft is plugged; the open end of each shaft must be toward the center.
9. Install the rocker arms, springs, supports, support bolts and locks in their correct position by referring to the above chart and Figure 14. Figure 18 shows the rocker arm and shaft assemblies correctly installed on the cylinder head.

Assembly

1. Clean valves, valve seats, valve guides and cylinder head thoroughly.
2. Starting with No. 1 cylinder, place the exhaust valve in the port and place the valve spring and cap in position. Place spring and rotator on exhaust valves. Then using Tool J-8062, compress the spring and install the oil seal and valve keys (fig. 15). See that the seal is flat and not twisted in the valve stem groove and that the keys seat properly in the valve stem groove.

   NOTE: Place valve springs in position with the closed coil end toward the cylinder head.

3. Assemble the remaining valves, valve springs, rotators, spring caps, oil seals and valve keys in the cylinder head using Tool J-8062. Check seals by placing a vacuum cup shown in Figure 15 inset, over valve stem and cap, squeeze vacuum cup to make sure no air leaks past oil seal.

A vacuum cup can be made from a small syringe and a high voltage rubber shield such as (Sun Electric No. 1578).

Valve Spring Installed Height

Check the installed height of each spring, measuring from the top of the spring to the spring seat of the cylinder head. If this is found in excess of 1⅞", install valve spring seat shim, approximately 1/16" thick. At no time should the spring be shimmed to give an installed height of less than $1\frac{51}{64}$".

Installation

1. Thoroughly clean out cylinder head bolt holes in block and clean cylinder bolt threads. Place a new cylinder head gasket in position on the cylin-

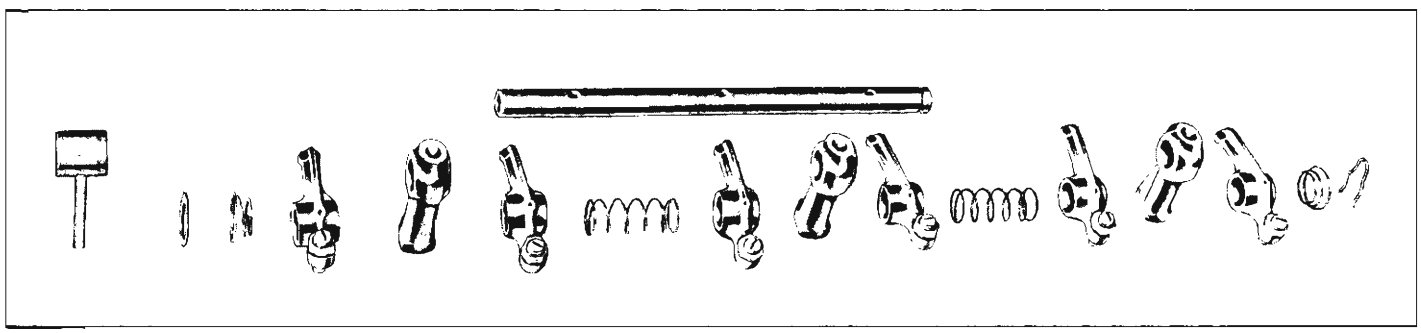

Fig. 14—Layout of Rocker Arm & Shaft Parts

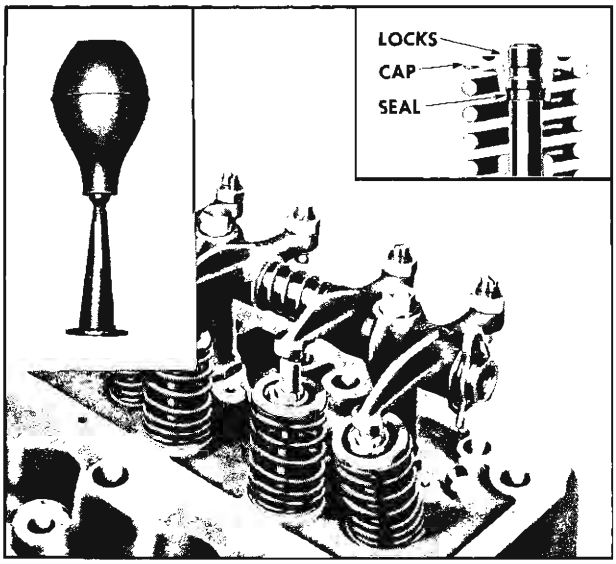

Fig. 15—Correct Installation of Seal, Cap and Lock

der block following the instructions stamped on the gasket. This assures alignment of water passages and bolt holes in the block and head with openings in the gasket.

2. Place two cylinder head guide pins through the gasket and screw them into the cylinder block front and rear holes on the manifold side to hold the gasket in position and guide the cylinder head into place.
3. Place the cylinder head in position over the guide pins, and lower the head into position.
4. Oil thread of cylinder bolts and install cylinder head bolts finger tight. Remove guide pins and install two remaining bolts.
5. Tighten the cylinder head bolts a little at a time in the order shown in Figure 16. The final tightening should be to 90-95 ft. lbs.

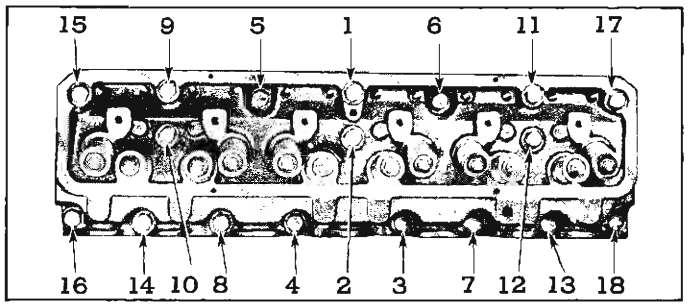

Fig. 16—Cylinder Head Bolt Tightening Diagram

6. Install 12 valve lifters in right side of block and drop the 12 valve push rods down through the openings in the cylinder head and seat them in the lifters.

CAUTION: Mechanical tappets have an annulus around the lifter body for passage of oil to the rocker shaft assembly as shown in Figure 17. The use of a mechanical tappet without the annulus would block the flow of oil to the rocker arm shaft assembly.

7. Place the oil connector over open ends of the two rocker shaft assemblies, install rocker arm assembly retaining bolts in assembly and place shaft assembly on the cylinder head.
8. Tighten retaining bolts evenly to 25-30 ft. lbs. torque. Figure 15 shows rocker arm and shaft assemblies correctly installed on head.
9. Install temperature indicator fitting and tighten to 15-20 ft. lbs. torque.
10. Install thermostat and thermostat housing using a new gasket and connect radiator hose.
11. Place coil in position and install attaching screws, tighten screws to 5-8 ft. lbs. torque.
12. Clean all spark plugs with abrasive type cleaner, inspect for damage and using a round feeler gauge, set the spark gap at .035".

NOTE: The orifice located in the cylinder block shown in Figure 17, is a 11/32" diameter hole. The oil connector is incorporated, to sustain oil pressure in the rocker shaft (fig. 18). The oil groove annulus in each rocker arm has been decreased in depth and relocated ¼" to the side adjacent to each rocker arm shaft support, thus providing full pressure oiling.

13. Place new gaskets on plugs and install. Tighten to 20-25 ft. lbs. If torque wrench is not available, tighten finger tight and ½ turn more.
14. Connect spark plug wires to their respective terminals and the high tension wire to the coil.
15. Clean gasket flanges on cylinder head and manifold, and install new gaskets, intake manifold pilot sleeves, and the four bolts with clamps loosely to hold gaskets in place. Position the manifold and slide it into place over the end studs and pilot sleeves, making sure it seats against the gaskets.
16. Install the two end bolts with clamps and turn the center clamps into position against manifold. Tighten as outlined under Maintenance and Adjustments.
17. Connect choke and throttle wires to the carburetor, where used. Connect lower end of throttle rod and install a new cotter pin.
18. Connect gas and vacuum lines to carburetor and vacuum line to manifold fitting.
19. Attach gas and vacuum line retaining clip to water outlet.
20. Fill cooling system and check for water leaks.
21. Clean air cleaner and install.
22. Roughly set all valve clearances to make sure that all valves have clearance.

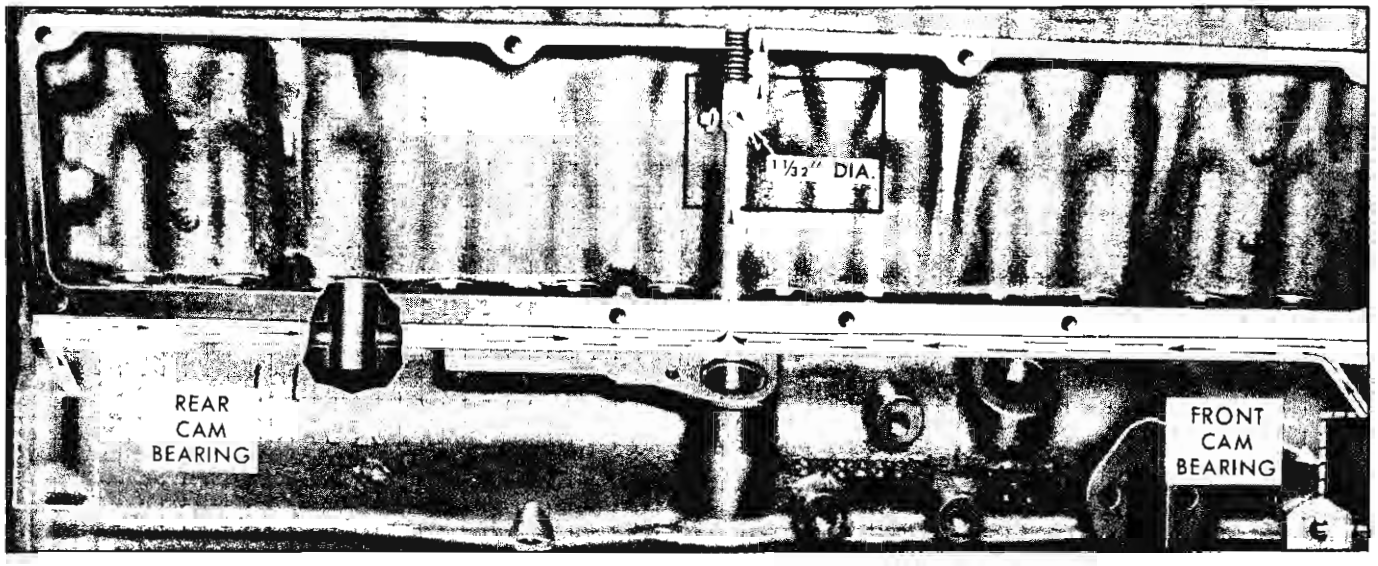

Fig. 17—Oil Passages from Camshaft Bearings to Rocker Arm Assembly

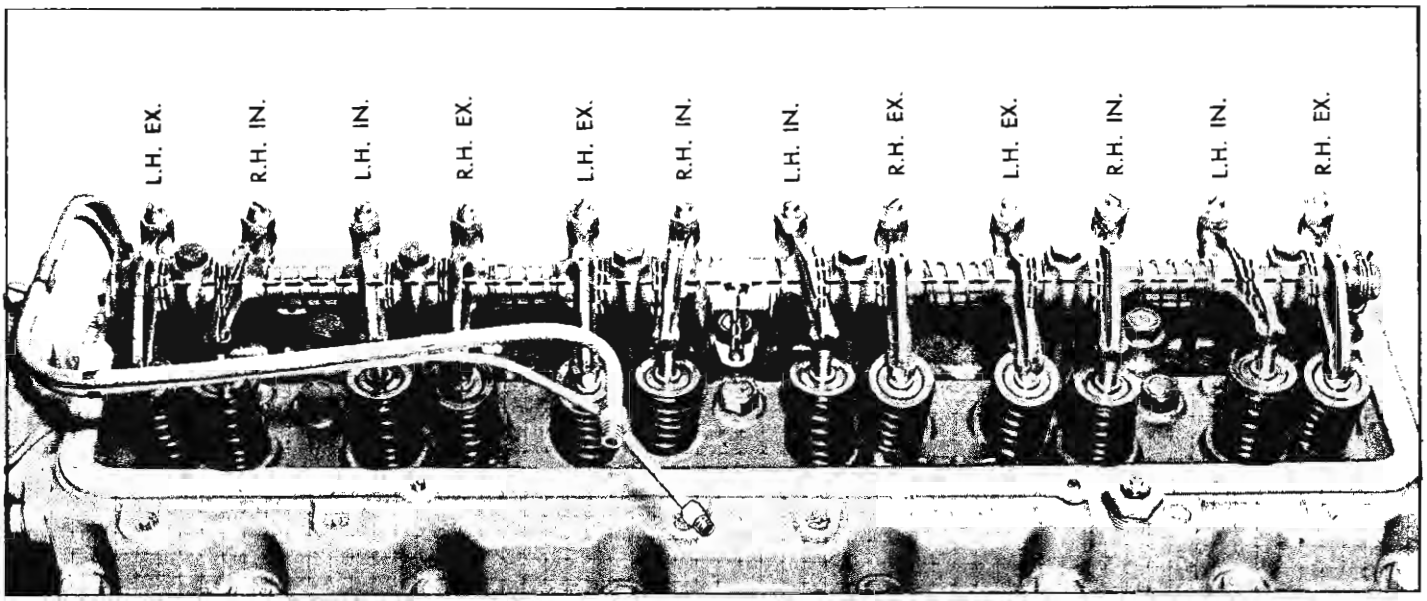

Fig. 18—Oil Passage Through Rocker Arm Assembly

23. Normalize engine and adjust valves as instructed under "Service Operations"—Valve Lash Adjustment.

HARMONIC BALANCER

Removal

1. Drain radiator and disconnect upper and lower radiator hoses. On automatic models, remove oil cooler lines.
2. Remove radiator core to radiator core support bolts and remove radiator core.
3. Remove fan belt.
4. Install Tool J-6978 or Tool J-1287 to harmonic balancer and turn puller screw to remove balancer and pulley assembly (fig. 19).

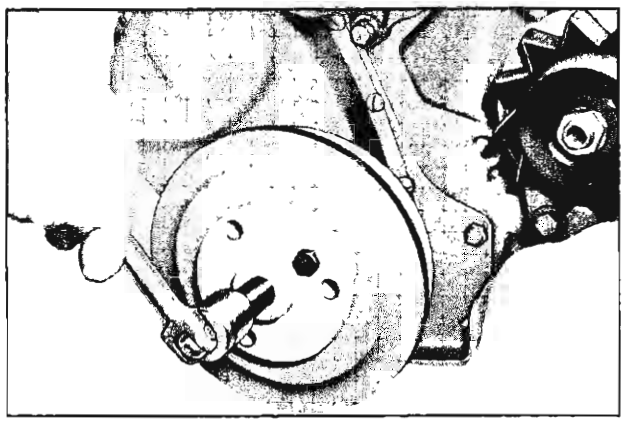

Fig. 19—Removing Harmonic Balancer

Installation

1. Remove puller screw from harmonic balancer. Install two 3/8"-16 x 1" capscrews in balancer to support wheel portion during installation.
2. Coat front cover seal contact area on balancer with engine oil. Position balancer on crankshaft and drive balancer onto shaft using Tool J-5590 until it bottoms against crankshaft gear, using a heavy hammer and a short punch. Use care to obtain a straight installation. Remove two 3/8"-16 bolts previously installed.
3. Adjust the fan belt to obtain a 5/16" deflection with a 15 pound load midway between pulleys.
4. Replace radiator core, and attaching bolts and tighten securely.
5. Replace upper and lower radiator hoses and refill cooling system.

TIMING GEAR COVER

Removal

1. Remove oil pan and radiator.
2. Remove harmonic balancer.
3. Remove timing gear cover attaching screws and two bolts that are installed from the back through the front main bearing cap and remove timing gear cover and gasket.

Repairs

Timing Gear Cover Oil Seal Replacement

1. Pry oil seal out of cover from the front with a large screwdriver.
2. Install new seal so that open end of the seal is toward the inside of cover and drive it into position with Tool J-0995 (fig. 20).

NOTE: The preferred method for timing gear cover oil seal replacement is to remove the cover and replace seal with Tool J-0995 as outlined above, however, an alternate method as outlined below may be used.

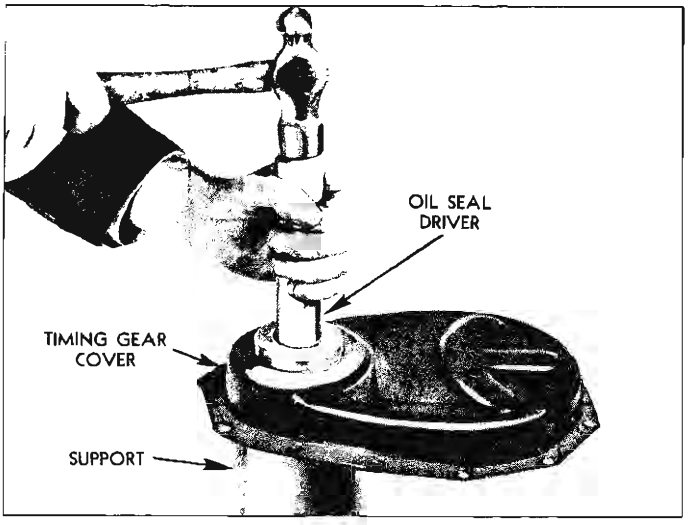

Fig. 20—Installing Oil Seal

Alternate Method:

1. Remove harmonic balancer with Tool J-6978.
2. Pry old seal out of cover from the front with a large screw driver, being careful not to damage the seal surface on the crankshaft.
3. Install new seal so that open end of seal is toward the inside of cover and drive it into position with a hollow piece of pipe or tubing.

Installation

1. Make certain that cover mounting face and cylinder block front end plate face are clean.
2. Install Tool J-0966 over end of crankshaft.
3. Coat the oil seal with light grease and using a new cover gasket install cover and gasket over centering gauge (fig. 21).

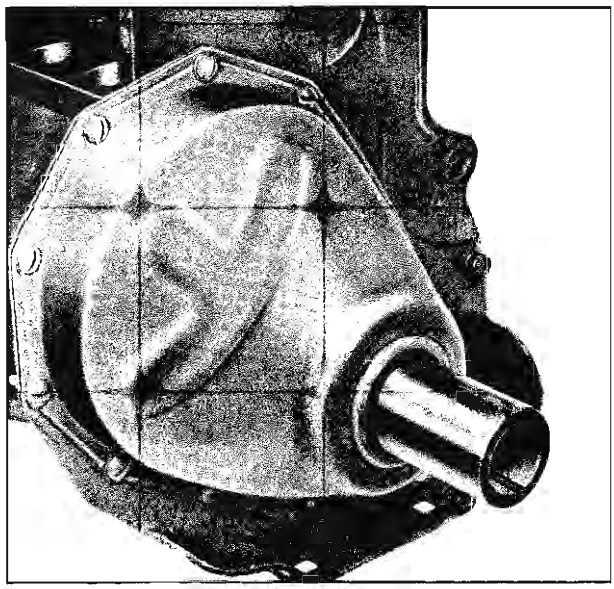

Fig. 21—Timing Gear Cover Installation

4. Install cover screws and two bolts through bearing cap and tighten 6-7½ foot pounds torque. Remove centering gauge.

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

5. Install new oil pan gaskets and end seals. Carefully place the oil pan in position and tighten pan bolts securely.

NOTE: Tighten oil pan corner bolts to 12½-15 foot lbs. Tighten flange bolts to 6-7½ foot lbs.

6. Remove puller screw from harmonic balancer. Install two 3/8"-16 x 1" capscrews in balancer to support wheel portion during installation.
7. Position balancer on crankshaft so that keyway aligns with key in crankshaft and drive balancer onto shaft using Tool J-5590 until it bottoms against crankshaft gear, using a heavy hammer and a short punch. Use care to obtain a straight installation. Remove two 3/8"-16 bolts previously installed.

CYLINDER BLOCK FRONT END PLATE

Removal

1. Remove harmonic balancer and radiator.
2. Drain crankcase and remove oil pan.
3. Remove two bolts through front main bearing cap.
4. Remove timing cover screws and remove cover and gasket.
5. Remove side cover and gasket.
6. Remove valve cover and valve rocker shaft assembly.
7. Remove 12 push rods and valve lifters.
8. Remove the two camshaft thrust plate screws by working through holes in the camshaft gear (fig. 22).

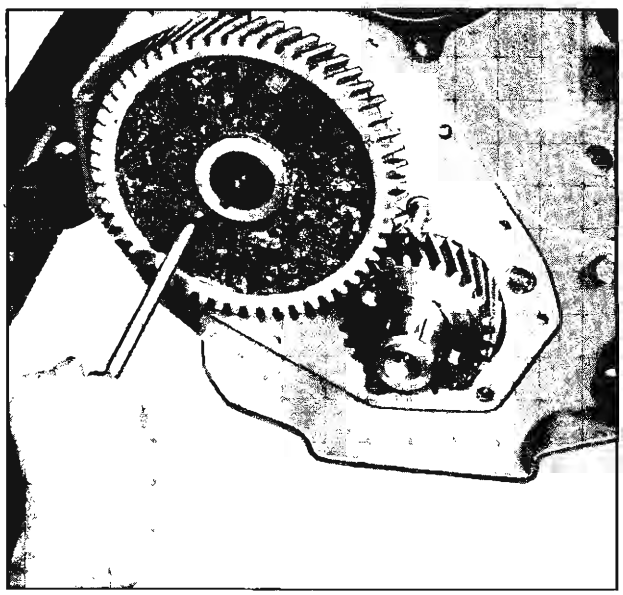

Fig. 22—Removing Camshaft Thrust Plate Screws

9. Remove the camshaft and gear assembly by pulling it out through the front of the block.

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

10. Remove the engine front plate attaching screws and remove plate and gasket.

Installation

1. Make sure gasket surfaces on block and on front end plate are thoroughly cleaned.
2. Install new front end plate gasket and end plate, and hold in position with three screws and two hex head bolts. Tighten screws to 15-20 ft. lbs. and stake securely at bottom of slot.
3. Install camshaft and gear assembly with timing marks aligned, being careful not to damage camshaft bearings. Insert camshaft thrust washer retaining bolts and torque 6-7½ ft. lbs. Install valve lifters and push rods. Install side cover with a new gasket.
4. Install valve rocker shaft assembly.
5. Install oil pan using new gaskets. Install Tool J-0966 over end of crankshaft, coated with engine oil.
6. Install timing gear cover, using a new gasket. Install cover screws and two bolts through bearing cap and tighten 6-7½ ft. lbs. Remove Tool J-0966.
7. Install new oil pan gaskets and end seals. Carefully place oil pan in position and tighten pan bolts securely.
8. Install harmonic balancer, using Tool J-5590.
9. Install crankcase oil, start engine and check for leaks.

TIMING GEAR OIL NOZZLE

Replacement

NOTE: When the timing gear nozzle becomes loose, it can be replaced without removing the engine front plate.

1. Remove harmonic balancer and radiator.
2. Remove oil pan and two bolts through front main bearing cap to timing cover. Remove timing cover screws and remove timing gear cover.
3. Replace timing gear oil nozzle with pliers (providing it is loose).
4. Drill and tap, using a 1/8" dryseal AM.NAT. taper thread in oil nozzle hole in front plate. Install a new timing gear oil nozzle, #3690722 using a suitable screwdriver; install nozzle with exit hole directed between the camshaft gear and crankshaft gear. Install Tool J-0966 over end of crankshaft.
5. Install timing gear cover with a new gasket.
6. Install screws and two bolts through front main bearing into timing gear cover.
7. Install harmonic balancer.

CAMSHAFT

Removal

1. Drain crankcase and radiator.
2. Remove radiator as described under **"Engine Cooling," in this section.**

3. Remove grille assembly. See Front End Sheet Metal, Section 14.
4. Remove valve cover and gasket. Remove valve rocker shaft assembly.
5. Remove coil and side cover and gasket. Remove 12 push rods and 12 valve lifters.
6. Remove harmonic balancer using Tool J-6978. Remove oil pan and timing gear cover.
7. Remove the two camshaft thrust plate screws by working through holes in the camshaft gear (fig. 22).
8. Remove the camshaft and gear assembly by pulling it out through the front of the block.

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

Inspection

The camshaft is cast alloy iron with the following bearing journal sizes: front 2.1537″-2.1547″; front intermediate 2.0912″-2.0922″; rear intermediate 2.0287″-2.0297″; rear 1-9662″-1.9672″.

These dimensions should be checked with a micrometer for an out-of-round condition. If the journals exceed .001″ out-of-round, the camshaft should be replaced.

The camshaft should also be checked for alignment. The best method is by use of "V" blocks and a dial indicator (fig. 23). The dial indicator will indicate the exact amount the camshaft is out of true. If it is out more than .002″ dial indicator reading, the camshaft should be replaced. When checking, the high reading of the dial indicator indicates the high point of the shaft. Examine the camshaft bearings and if any bearing needs replacement, replace all bearings.

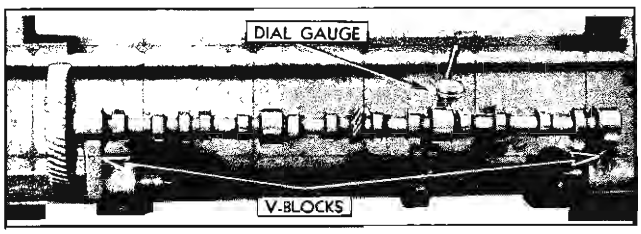

Fig. 23—Checking Camshaft Alignment

CAMSHAFT GEAR AND THRUST PLATE

1. If the inspection indicated that the camshaft, gear and thrust plate were in good condition, the camshaft end play should be checked (fig. 24). This clearance should be .001″ to .005″.
2. If the inspection indicated that the shaft, gear or plate should be replaced, the gear must be removed from the shaft. This operation requires the use of camshaft gear remover Tool J-971.

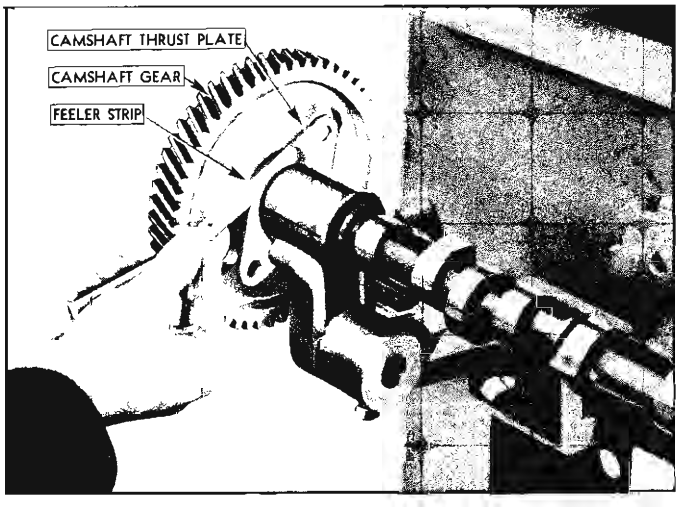

Fig. 24—Checking Camshaft End Play

3. Place the camshaft through the gear remover, place end of remover on table of a press and press shaft out of gear (fig. 25).

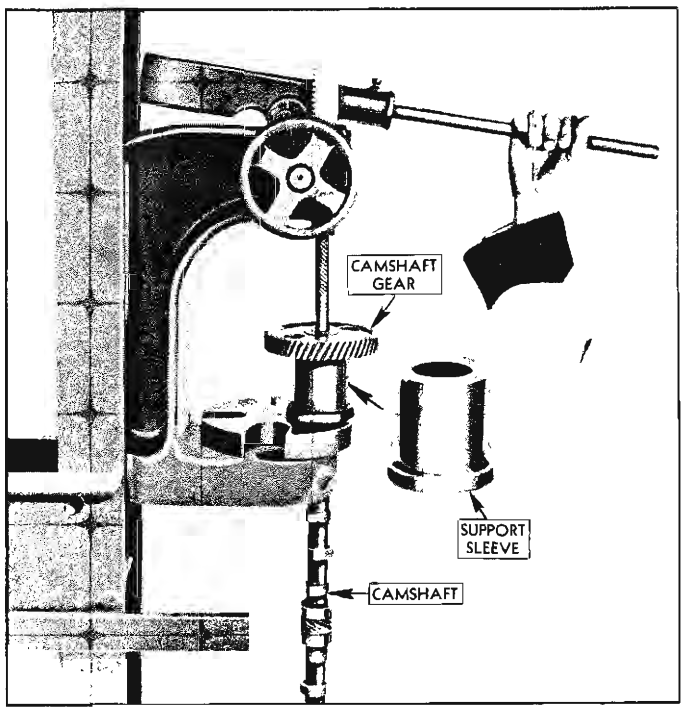

Fig. 25—Removing Camshaft Gear

CAUTION: Thrust plate must be so positioned that woodruff key in shaft does not damage it when the shaft is pressed out of gear. Also, support on the hub of the gear or the gear will be seriously damaged.

4. To assemble camshaft gear, thrust plate and gear spacer ring to camshaft, proceed as follows:
   a. Firmly support shaft at back of the front journal in an arbor press.

b. Place gear spacer ring and thrust plate over end of shaft, and install woodruff key in shaft keyway.
c. Install camshaft gear and press it onto the shaft until it bottoms against the gear spacer ring. The end clearance of the thrust plate should be .001″ to .005″.

Installation

1. Install the camshaft assembly in the engine block, being careful not to damage bearings or cams.
2. Turn crankshaft and camshaft so that the valve timing marks on the gear teeth will line up, push camshaft into position. Install camshaft thrust plate to block screws and tighten 6-7½ ft. lbs.
3. Check camshaft and crankshaft gear runout with a dial indicator (fig. 26). The camshaft gear runout should not exceed .004″ and the crankshaft gear runout should not exceed .003″.

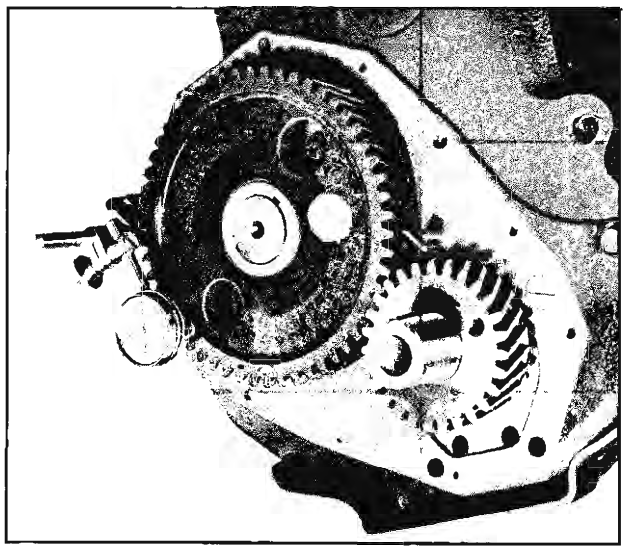

Fig. 26—Checking Camshaft Gear Runout

4. If gear runout is excessive, the gear will have to be removed and any burrs cleaned from the shaft or the gear replaced.
5. Check the backlash between the timing gear teeth with a narrow feeler gauge (fig. 27). The backlash should not be less than .004″ nor more than .006″.
6. Install timing gear cover and gasket.
7. Install the two bolts through front main bearing cap into the timing gear cover.
8. Install oil pan with new gaskets.
9. Install harmonic balancer, using two ⅜″-16 bolts in harmonic balancer.
10. Line up keyway in balancer with key on crankshaft and drive balancer onto shaft until it bottoms against crankshaft gear, using Tool J-5590, then remove two ⅜″-16 bolts.
11. Install 12 valve lifters and 12 push rods. Install

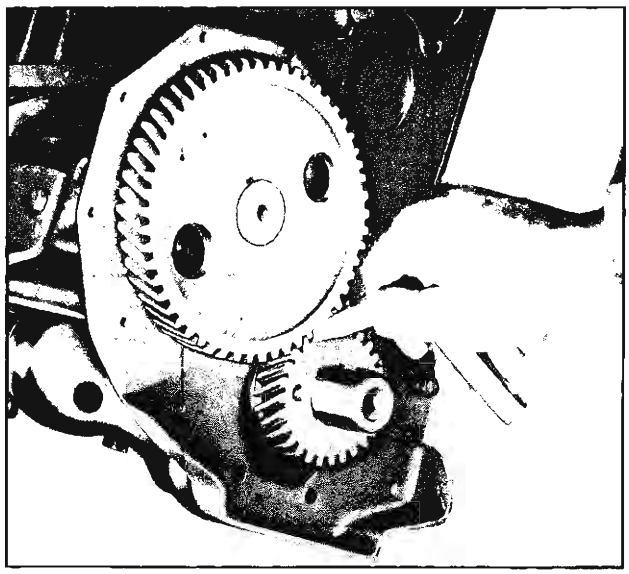

Fig. 27—Checking Timing Gear Backlash

side cover with a new gasket. Attach coil and wires.
12. Install rocker shaft assembly and lash valves as described under **"Service Operations—Valve Lash Adjustment"** in this section.
13. Add oil to engine. Install the fan belt with a 5/16 deflection midway between pulleys with a 15 pound load.
14. Install the radiator as described under "Engine Cooling" in this section.
15. Install grille assembly. See Front End Sheet Metal, Section 14.
16. Add cooling solution to radiator, start engine and check for leaks.

CAMSHAFT BEARINGS

Removal and Installation

All four of the steel backed, babbitt lined camshaft bearings are pressed into the crankcase and are lubricated through holes that line up with oil passages leading from the main bearings.

Replacement of these bearings is seldom necessary; however, if the inspections previously made indicate that replacement is necessary, Tool J-6356 shown in Figure 28 must be used as follows:

1. With camshaft removed, drive out expansion plug from cylinder block at the rear of the rear camshaft bearing, by driving it out from the inside.
2. Install a bearing installer in first and second camshaft bearing with new bearing installed on trailing edge of each installer. Trailing edge of installer should be towards center of engine.
3. Assemble tool with nut and washer on rear of screw shaft.
4. Index assembled tool through camshaft bearing installer in number 2 bearing, then turn nut on

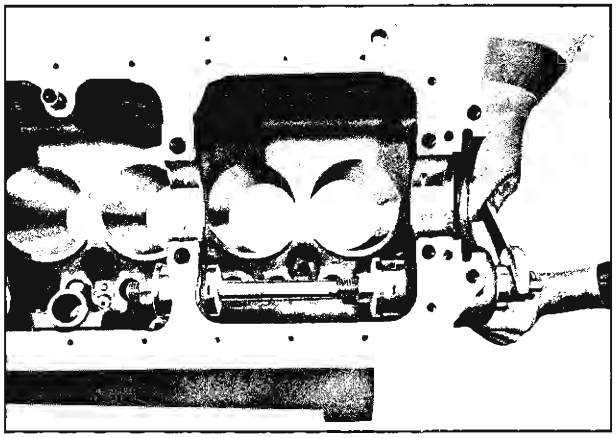

Fig. 28—Replacing Camshaft Bearings

screwshaft to end of threads. While turning nut on screwshaft, install washer on front of shaft and feed screwshaft through installer in number 1 bearing.

5. Install bracket and thrust bearing on front of screwshaft and install remaining nut on screwshaft. Tighten nut until all threads are engaged.
6. Tighten nut behind number 1 bearing installer snugly. Repeat operation for number 2 installer.
7. Using two wrenches, hold screwshaft with one wrench while turning the front nut with the other. Pull new bearing into place, washer will act as bearing stop.

CAUTION: Align oil holes in bearings with oil holes in block before pulling into place.

8. Disassemble tool and repeat operation for rear two camshaft bearings.
9. Install a new camshaft end plug in the back end of the cylinder block at the rear camshaft bearing.

NOTE: Camshaft end plug must be assembled flush to 1/32" deep from clutch housing face of case.

OIL PAN

NOTE: Engine equipped with either Powerglide or 3-Speed synchromesh transmission.

Removal

1. Remove oil pan drain plug and drain crankcase oil.
2. Raise front of vehicle and place on stand jacks.
3. Drain water and disconnect radiator hoses at radiator. Remove radiator.
4. Disconnect battery ground strap at engine.
5. Disconnect gas tank to fuel pump feed pipe, at the fuel pump.
6. Disconnect accelerator control rod at the accelerator control rod lever.
7. Remove overdrive solenoid if overdrive equipped.
8. Disconnect power brake hose at check valve.
9. Remove oil filter and support bracket assembly to clear power brake master cylinder.
10. Remove exhaust pipe flange to exhaust manifold nuts and gasket.
11. Disconnect transmission lower control rods at the transmission shifter levers.
12. Disconnect clutch fork push rod at the clutch fork.
13. Disconnect clutch pedal control, intermediate lever and shaft assembly from the engine.
14. Loosen transmission mounting bolts and remove front engine mounting bolts.
15. Remove hood and lift engine using Tool J-4536. Raise engine (approximately three inches) until valve rocker cover comes in contact with the dash upper panel.
16. Remove oil pan retaining bolts and screws. If synchromesh transmission equipped, remove flywheel under-pan extension and remove oil pan.

NOTE: Crankshaft may have to be turned to allow oil pan to clear counterweights.

Installation

1. Thoroughly clean all gasket sealing surfaces.
2. Install pan side gaskets on cylinder block, using grease as a retainer.
3. Install oil pan end gaskets in grooves in front and rear main bearing caps.
4. Reverse the removal procedure to complete the installation. Corner bolts should be tightened to 12½ to 15 ft. lbs., and side rail screws to 6-7½ ft. lbs.

OIL PUMP

Oil pump (fig. 29), consists of two gears and a pressure relief valve enclosed in a two-piece housing and driven from the distributor drive shaft which in turn is driven by a helix gear on the camshaft.

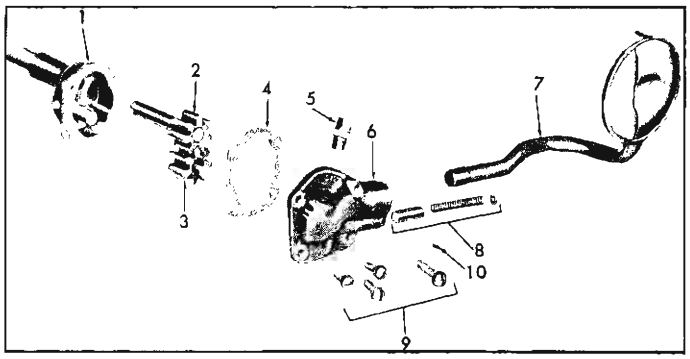

Fig. 29—Layout of Oil Pump Parts

1. Pump Body
2. Drive Gear and Shaft
3. Idler Gear
4. Cover Gasket
5. Discharge Fitting
6. Cover
7. Pick-up Screen and Pipe
8. Pressure Control Valve
9. Screws
10. Retaining Pin

The pump cover is equipped with the pressure regulator valve that regulates oil pressure to approximately 35 psi. @ 2000 rpm.

The pump intake is of the fixed screen type. A mesh screen filters out small particles of dirt and sludge which may be present.

NOTE: A baffle incorporated on the intake screen has been designed to eliminate pressure loss due to sudden surging stops.

In the event that a screen becomes plugged a steel grommet opens and by-passes oil to the pump.

Inasmuch as the oil pump is serviced on an exchange basis, no repair operations other than disassembly and inspection operations are covered in this manual.

Removal and Disassembly

1. Drain oil and remove flywheel housing underpan, flywheel underpan extension and oil pan.
2. Disconnect oil pump to block oil line at the block.
3. Remove oil pump retaining sleeve lock screw and remove oil pump and pump to block oil line.
4. Remove oil line from pump and remove pump cover attaching screws, cover, gasket, idler gear and drive gear and shaft.
5. Remove regulator valve pin and valve parts.
6. Remove oil pump suction pipe and screen by unscrewing from pump cover.

   CAUTION: Do not disturb pick-up pipe on screen. This pipe is located at assembly.

7. Wash all parts in cleaning solvent and dry by using compressed air.

Inspection

Should any of the following conditions be found during inspection operations, the pump assembly should be replaced.

1. Inspect pump body for cracks or excessive wear.
2. Inspect oil pump gears for excessive wear or damage.
3. Check shaft for looseness in the housing.
4. Check inside of cover for wear that would permit oil to leak past the ends of gears.
5. Check the oil pick-up screen for damage to screen, or relief grommet. Check for oil in the air chamber.
6. Check pressure regulator valve plunger for fit in cover.

Assembly and Installation

Should it be necessary to replace the oil pump pipe to case fitting, caution should be exercised. The fitting should be installed finger tight plus one turn to avoid cracking the block.

1. Place drive gear and shaft in pump body.
2. Install idler gear so that smooth side of gear will be toward the cover.
3. Install a new GENUINE Chevrolet gasket to assure correct end clearance of the gears.
4. Install suction pipe and screen assembly to cover and install cover and attaching screws. Tighten screws 6 to 9 ft. lbs. torque and check to see that shaft turns freely.
5. Install regulator valve plunger, spring, retainer and pin and install oil line to pump body loosely.
6. Place oil pump in block fitting, aligning oil lines and adjust bottom of pick-up screen parallel to oil pan rails as shown in Figure 30. Install oil pump retaining sleeve lock screw and tighten it securely.

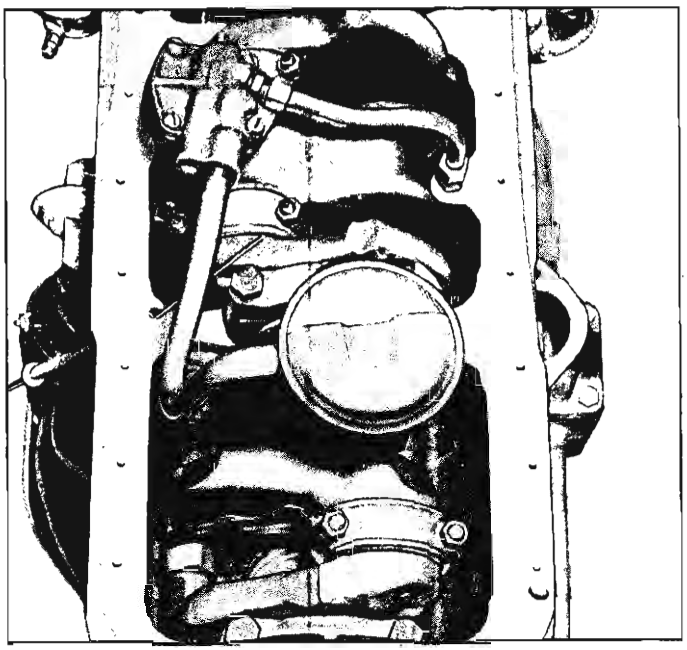

Fig. 30—Oil Pump Installed

NOTE: Make sure that tapered end of lock screw draws down into hole in oil pump body. Tighten lock nut securely.

7. Tighten oil pump to block oil line connector nuts securely.

   CAUTION: Make sure oil lines are properly fitted so as to eliminate the possibility of shaft seizure when tightened.

8. Install oil pan using a new oil pan gasket. Tighten oil pan flange bolts to 6-7½ ft. lbs. and oil pan corner bolts to 12½-15 ft. lbs. torque. Install flywheel underpan extension and flywheel housing underpan. Refill with oil.

CONNECTING RODS, BEARINGS, PISTONS AND RINGS

Piston and Connecting Rod Removal

1. Drain crankcase and remove oil pan.
2. Remove cylinder head and gasket.
3. Remove any ridge and/or deposits from the upper end of the cylinder bores with a ridge reamer.

   NOTE: Move piston to the bottom of its travel and place a cloth on top of piston to collect the cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at the top of its stroke and carefully remove cloth with the cuttings.

4. Check connecting rods and pistons for cylinder number identification and, if necessary, mark them.
5. Remove connecting nuts and rod caps. Push the rods away from the crankshaft and install caps and nuts loosely to their respective rods.
6. Push piston and rod assemblies away from crankshaft and out of the cylinders.

   NOTE: It will be necessary to turn the crankshaft slightly to disconnect some of the rods and to push them out of the cylinder.

7. Remove piston rings by expanding them and sliding them off the ends of the pistons. Tool J-8020 is available for this purpose.

Piston and Connecting Rod Disassembly

1. Clamp the piston in piston vise Tool J-1218 (fig. 31), remove the connecting rod to piston pin clamp bolt and push the piston pin out.

   Remove connecting rod from piston.

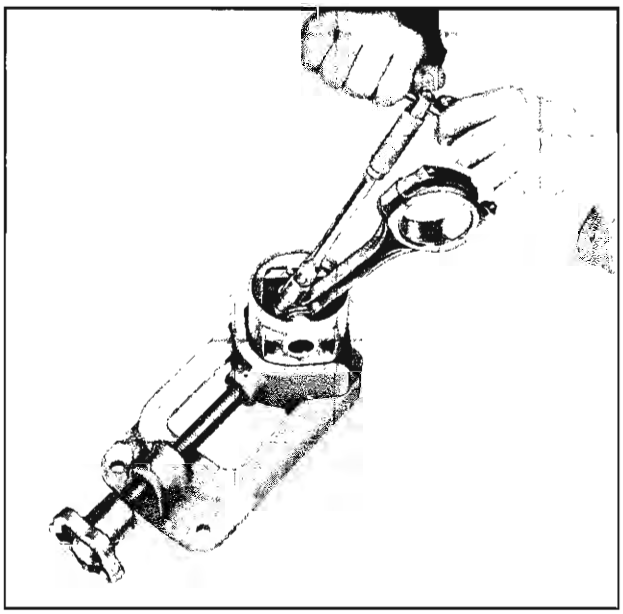

Fig. 31—Piston in Piston Vise

Cylinder Block Inspection

1. Check the cylinder block for cracks in the cylinder walls, water jacket and main bearing webs.
2. Check the cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator (fig. 32). Set the gauge so that the thrust pin must be forced in about ¼" to enter gauge in cylinder bore. Center gauge in cylinder and turn dial to "0." Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine the out-of-round condition. If cylinders were found to have more than .002 out-of-round, boring will be necessary.

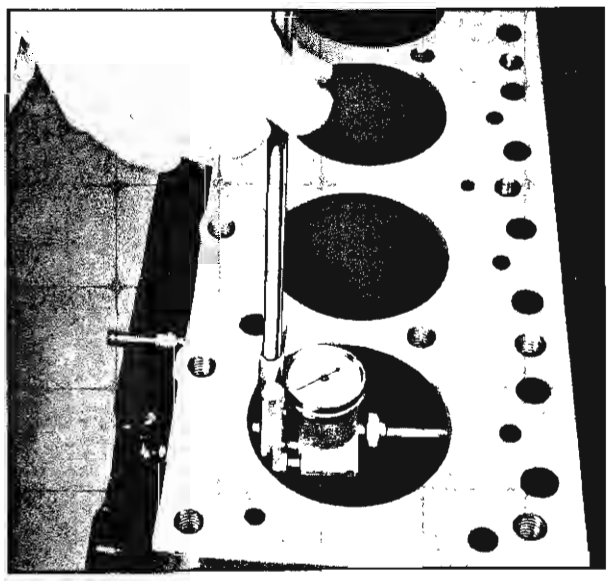

Fig. 32—Checking Cylinder Bore with Dial Gauge

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

Cylinder Conditioning

The performance of the following operations is contingent upon engine condition at time of repair.

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

High limit standard size pistons are available for service use so that proper clearances can be obtained for slightly worn cylinder bores and blocks requiring only light honing to clean up the bores. There are four standard size pistons available for service under two part numbers. These aluminum pistons are selected by size and are unitized in groups of six for service usage. In addition, aluminum pistons are serviced in .020", .030" and .040" oversizes. If the cylinders were found to have less than .005" taper or wear they can

be conditioned with a hone and fitted with the high limit standard size pistons. A cylinder bore of less than .005" wear or taper may not entirely clean up when fitted to a high limit position. If it is desired to entirely clean up the bore in these cases, it will be necessary to rebore for an oversize piston. If more than .005" taper or wear they should be bored and honed to the smallest oversize that will permit complete resurfacing of all cylinders. The use of a dial gauge set up with a pair of micrometers to the standard cylinder bore size as outlined under *"Cylinder Block Inspection,"* will aid in determining the size pistons for which the cylinders must be bored.

Cylinder Boring

1. Before using any type boring bar, the top of the cylinder block should be filed off to remove any dirt or burrs. This is very important. Otherwise, the boring bar may be tilted which would result in the rebored cylinder wall not being at right angles to the crankshaft.
2. The piston to be fitted should be checked with a micrometer, measuring just below the lower ring groove and at right angles to the piston pin. The cylinder should be bored to the same diameter as the piston and honed to give a clearance of .0006" to .0010".
3. The instructions furnished by the manufacturer of the equipment being used should be carefully followed.

Cylinder Honing and Piston Fitting

1. When the cylinders are to be honed only for use of standard high limit piston or for final finishing after they have been rebored to within .002" of the desired size, they should be finished with a hone. Rough stones may be used at first and fine stones for the final operation.
2. Place the hone into a cylinder bore and expand the stones until the hone can just be turned by hand. Connect a ¾" electric drill to the hone and drive hone at drill speed while moving hone up and down entire length of cylinder until hone begins to run free. During this operation a liberal amount of kerosene should be used as a cutting fluid to keep the stones of the hone clean. Move hone slowly up and down with rough stones but move hone up and down as rapidly as possible with the fine stones in the final operation. Final bore finish should show very fine surface scratches in a cross-hatch pattern.
3. Expand the stones against the cylinder bore and repeat the honing operation until the desired bore diameter is obtained.
4. Occasionally during the honing operation, the cylinder bore should be thoroughly cleaned and the piston selected for the individual cylinder checked for correct fit.
5. Check fit of the aluminum pistons in the following manner:
   a. Invert the piston, skirt end up, and place a .0015" by ½" wide feeler ribbon, part of Tool J-5513 on the side of the piston 90° from the piston pin holes.

   NOTE: Thoroughly clean cylinder bores with soap and hot water to remove all grit particles.

   b. Insert the feeler ribbon and inverted piston into the cylinder bore so that the center of the piston pin is flush with the top surface of the cylinder block. Keep the feeler ribbon straight up and down and keep the piston pin parallel with the crankshaft axis.
   c. Pull the feeler gauge straight up and out, noting at the same time the scale reading which should be between 7 and 18 pounds (fig. 33).

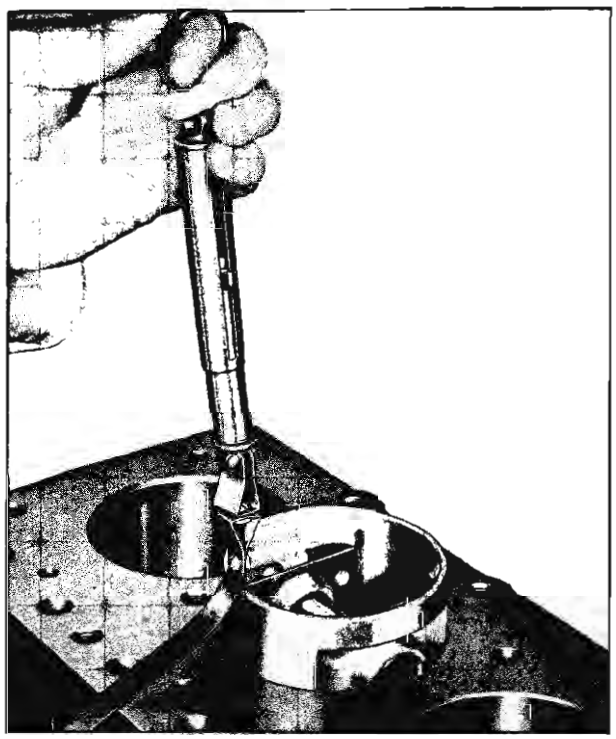

Fig. 33—Fitting Piston

   d. If the scale reading is greater than the maximum allowable pull, try another piston or lightly hone the cylinder bore to obtain the proper fit.
   e. Should the scale reading be less than the minimum allowable pull, try another piston, or if

standard size, try a standard high limit piston. If proper fit cannot be obtained, it will be necessary to rebore the cylinder to the next oversize piston.

f. Mark each piston after fitting to correspond with the cylinder to which it has been fitted.

Proceed to hone cylinders and fit the remaining pistons.

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

6. Thoroughly clean the cylinder bores. It is extremely essential that a good cleaning operation be performed. If any of the abrasive material is allowed to remain in the cylinder bores, it will rapidly wear the new rings and cylinder bores in addition to the bearings lubricated by the contaminated oil. The bores should be swabbed several times with light engine oil and a clean cloth and then wiped with a clean dry cloth. Cylinders should not be cleaned with kerosene or gasoline. Clean the remainder of the cylinder block to remove the excess material spread during the honing operation.

Piston Pin Fitting

All new Chevrolet pistons are serviced with properly fitted piston pins, therefore, pin fitting is unnecessary when new pistons are installed. Where cylinder condition and piston fit justify the use of old pistons, it may be desirable to install new piston pins which are available in .0015″, .003″, .005″, and .010″ oversize. Correct alignment of the pin bores is essential; therefore, the following procedure should be carefully followed.

1. Adjust the expansion reamer for a light cut and clamp square end in bench vise.
2. Place piston over reamer and start reamer pilot in piston pin bores (fig. 34).
3. Turn the piston until the reamer has passed through both bores.
4. Expand the reamer by easy stages and repeat the reamer operation until the piston pin is fitted.
5. Stabilize the temperature of the piston and piston pin by immersion in oil at 60° F.
6. Wipe the piston and pin dry, and lightly coat the pin with an oil film.
7. Place one end of the pin in either boss.
8. The fit must be such that the pin will hold its own weight in either boss and yet permit movement under thumb pressure in its final position (fig. 35).
9. If pin is too tight, lightly hone pin hole.
10. If pin is too loose, ream to next oversize pin. After fitting the first piston pin, the other bores may be reamed quickly by reducing the diameter of the reamer approximately .0005″ (half a thousandth) by backing off the expansion screw. This permits quick roughing out of all bores leaving about half a thousandth for the finish cut.
11. It is good practice to check the diameter of all piston pins with a micrometer. In case there should be a slight variation in diameter, consideration must be taken when adjusting the reamer for the finish cut.

Fig. 34—Reaming Piston Pin Bores

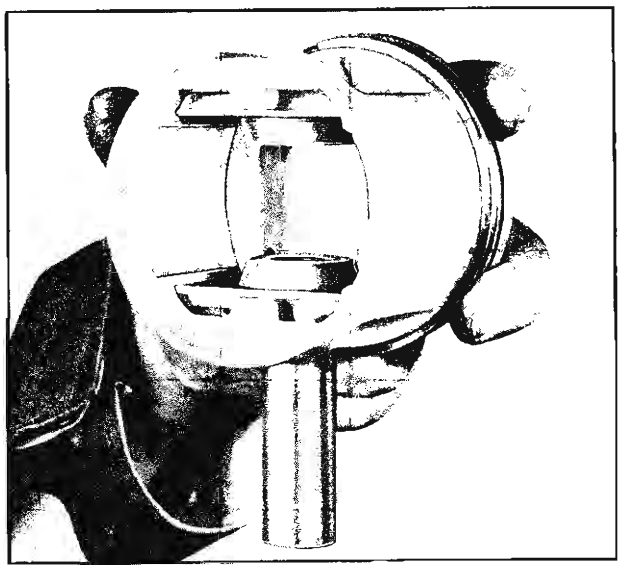

Fig. 35—Fitting Piston Pin

Piston and Connecting Rod Assembly

1. Lubricate piston pin holes in piston and connecting rod to facilitate installation of pin.

2. Clamp the piston in piston vise Tool J-1218 (fig. 31), insert the connecting rod in the piston (so that connecting rod clamp screw and oil hole will be toward right side of engine) and install the piston pin. Center the piston pin in the piston and the connecting rod in the center of the two piston pin bosses.
3. Tighten the clamp screw and move piston on pin from side to side, checking to see that the piston pin does not extend beyond the outside of the piston.

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

Piston Ring Fitting

Compression rings in all engines are the deep section twist type, $^{3}/_{32}$" wide.

This type compression ring takes its name, twist type, from its installed position which is cocked or twisted. It assumes and maintains this position for life because the upper edge of its diameter is chamfered, making the ring unbalanced in cross section.

All compression rings are marked with the letters "GM" cast in the upper side of the ring. When installing compression rings, make sure the side marked "GM" is toward the top of the piston.

The oil control rings used on all engines consist of two segments (rails) and a spacer.

Chevrolet piston rings are furnished in standard sizes as well as .020", .030" and .040" oversizes.

Compression Ring Installation

1. Select rings comparable in size to the pistons being used.
2. Slip the ring in the cylinder bore; then, using the head of a piston, press the ring down with the cylinder bore about two inches.

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

3. Check the space or gap between the ends of the ring with a feeler gauge. (See Engine Specifications in Section 16 for correct gap).
4. If the gap between the ends of the ring is not within specifications, remove the ring and try another for fit.
5. Fit each ring separately to the cylinder in which it is going to be used.
6. New pistons, rings and cylinder bores wear considerably during seating and gaps widen quickly; however, engine operation will not become seriously affected if ring gaps do not become greater than $^{1}/_{32}$".
7. Carefully remove all particles of carbon from the ring grooves in the piston and inspect the ring grooves carefully for burrs or nicks that might cause the rings to hang up.
8. Slip the outer surface of the ring into the piston ring groove and roll the ring entirely around the groove to make sure that the ring is free and does not bind in the groove at any point (fig. 36). If binding occurs, the cause should be determined and removed by carefully dressing with a fine cut file. However, if the binding is caused by a distorted ring, install a new ring.

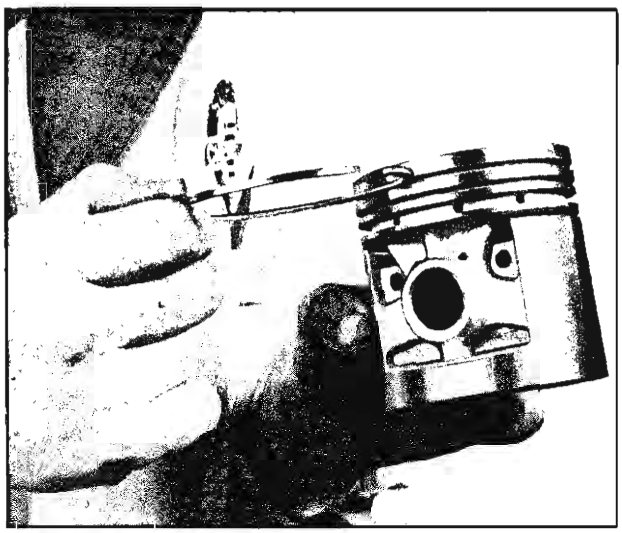

Fig. 36—Rolling Piston Ring in Ring Groove

9. Proper clearance of the piston ring in its piston ring groove is very important in maintaining engine performance and in preventing excessive oil consumption. Therefore, when fitting new rings, the following clearances between the top and bottom surfaces of the ring grooves should be provided.
10. The compression rings should be fitted so that the clearance is .0020" to .0035" (fig. 37).
11. Assemble the rings to the pistons as they are fitted and make a final test of the ring fit in the grooves by repeating the fitting procedure given above.

Expander ends must not align with the ring gap.

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

Oil Control Ring Installation

1. Select rings comparable in size to the pistons being used.
2. Carefully remove all particles of carbon from the ring groove in the piston and inspect the groove carefully for burrs or nicks that might cause the rings to hang up.

Fig. 37—Checking Piston Ring, Groove Clearance

3. Install the oil ring spacer in the oil ring groove and position gap in line with piston pin hole. Hold spacer ends butted and install steel rail on top side of spacer. Position gap at least 1" to left of spacer gap, then install second rail on lower side of spacer. Position gap at least 1" to right of spacer gap.
4. Flex the oil ring assembly in its groove to make sure ring is free and does not bind in the groove at any point. If binding occurs the cause should be determined and removed by carefully dressing with a fine cut file. However, if the binding is caused by a distorted ring, a new ring must be installed.
5. Proper clearance of the piston ring in its piston ring groove is very important in maintaining good engine performance and in preventing excessive oil consumption. Therefore, when fitting new rings, check the clearances between the top and bottom surfaces of the ring grooves. Refer to "Engine Specifications" for correct clearances.

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

Piston and Connecting Rod Installation

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

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

1. Lubricate pistons and cylinder bores, remove bearing caps and install piston and rod essemblies using Tool J-8037 (fig. 38).

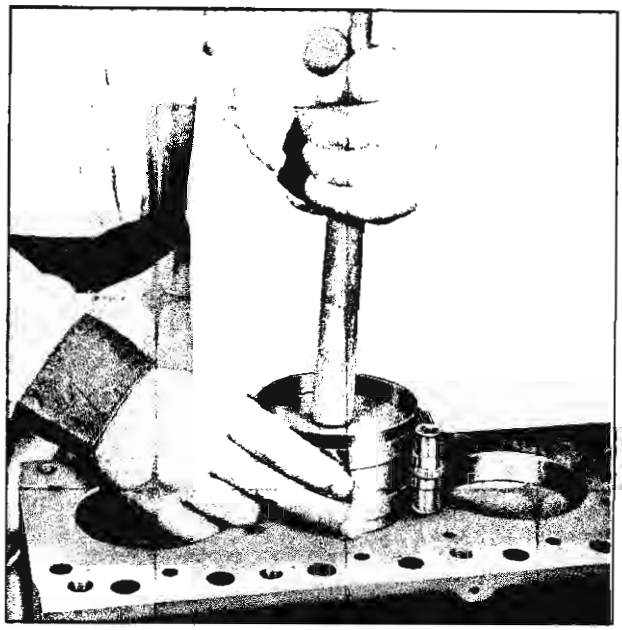

Fig. 38—Installing Piston in Cylinder Bore

NOTE: *Piston and rods must be installed with the piston pin clamp on the camshaft side and notch in piston head towards front of engine.*

2. Lubricate crank pin and pull connecting rod down into it, making sure the numbered side of the rod is toward the camshaft.
3. All engines are equipped with precision interchangeable insert bearings and do not require shims. Install the bearing cap with the numbered side toward the camshaft. Assemble and tighten the bearing cap nuts to 35-45 foot pounds of torque.
4. Install remaining piston and connecting rod assemblies as described above.
5. Adjust connecting rod bearings.

Connecting Rod Bearing Clearance

Connecting rod bearing inserts are available in standard sizes and undersizes of .001", .002", .010" and .020". These bearings are not shimmed and when clearances become excessive the next undersize bearing insert should be used. DO NOT FILE ROD OR ROD CAPS.

1. Remove the connecting rod bearing cap.
2. Wipe bearing insert shell and crankpin clean of oil.
3. Place a piece of Plastigage the full width of the bearing or crankpin (parallel to the crankshaft) (fig. 39).
4. Reinstall the bearing cap and evenly tighten the retaining nuts to 35-45 ft. lbs. torque.

CAUTION: Do not turn crankshaft with the Plastigage installed.

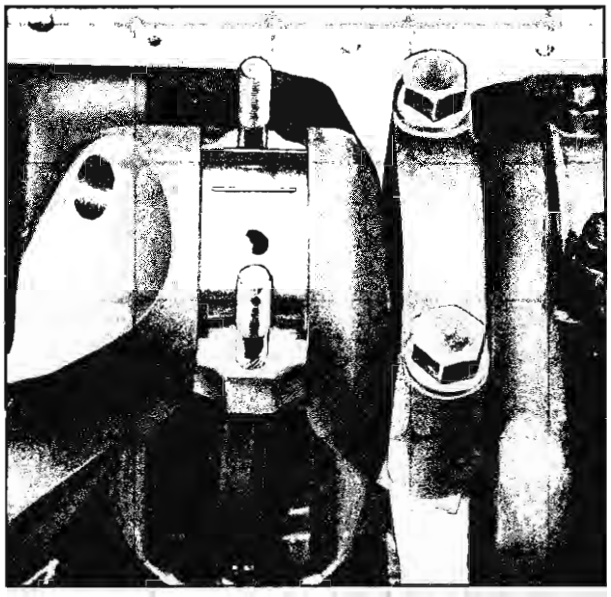

Fig. 39—Plastigage on Crankpin

5. Remove the bearing cap and without removing the Plastigage, check its width at the widest point with the Plastigage scale (fig. 40).

   NOTE: If the crankpin is out-of-round be sure to fit the bearing to the maximum diameter of the crankpin. If the flattened plastic is not uniform from end to end in its width, the crankpin or bearing is tapered, has a low spot or some other irregularity. Check the crankpin with a micrometer for taper if the flattened Plastigage indicates more than a .001" difference.

6. If the reading is not over .004" or not less than .001" the fit is satisfactory. If however, the clearances are not within these limits, replace the bearing with the proper undersize bearing.

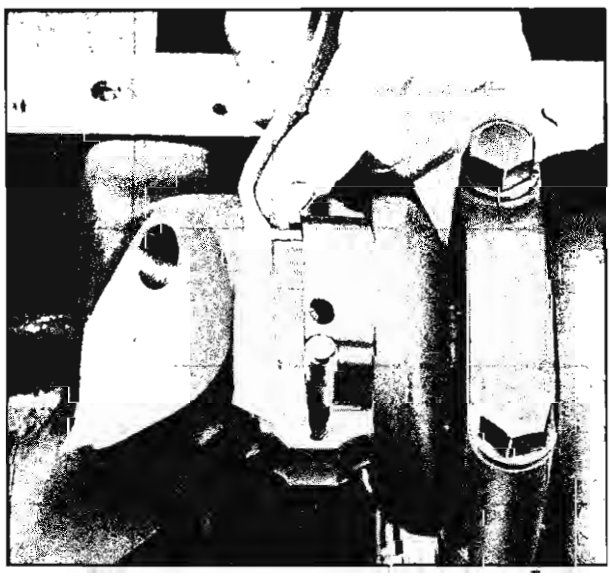

Fig. 40—Measuring Plastigage

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

7. New bearing shell insert clearance should be .003" maximum and .001" minimum.
8. Rotate the crankshaft after bearing adjustment to be sure the bearings are not too tight.
9. Check connecting rod clearance between upper half of connecting rod and side of crank pin (fig. 41). See engine specifications for clearance.

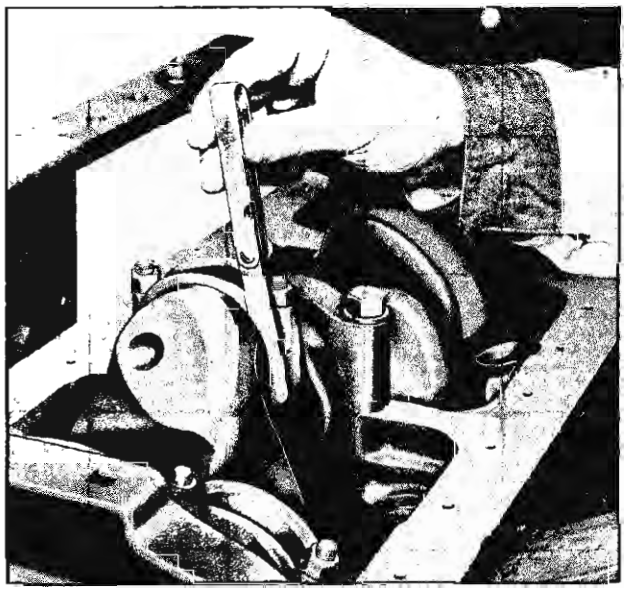

Fig. 41—Checking Connecting Rod Side Clearance

CRANKSHAFT AND MAIN BEARINGS

Crankshaft

Removal

1. Drain the cooling system and the crankcase. Disconnect all radiator hoses.
2. Remove fan blade, radiator, spacer and pulley.
3. Remove engine from chassis and install on engine stand. If Tool J-5856 stand is to be used, Tool J-5891 adapter will allow engine to be mounted securely.
4. Remove the valve rocker cover and gasket and remove the rocker shaft assembly.
5. Remove the engine side cover and gasket. Remove 12 push rods and 12 valve lifters.
6. Remove the harmonic balancer.
7. Remove the oil pan and gasket.
8. Remove the camshaft and gear assembly.
9. Remove the two front bolts from the front main bearing cap to the front plate.

10. Remove the front plate attaching screws, front plate and gasket.
11. Invert the engine on the stand and remove the connecting rod caps and bearings, then push the piston and rod assemblies toward the cylinder head.
12. Remove the crankshaft gear, if necessary with Tool J-8105 by attaching it to the gear and turning the puller handle (fig. 42).

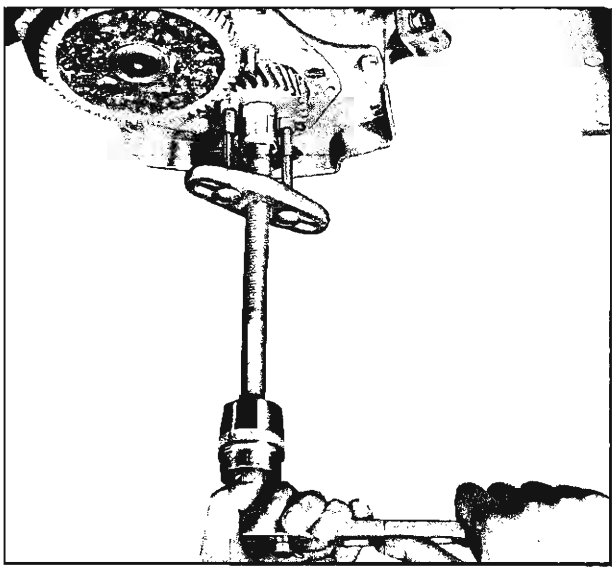

Fig. 42—Removing Crankshaft Gear

13. Remove the oil pump and screen assembly.
14. Remove main bearing caps, bearing inserts and carefully lift the crankshaft out of the cylinder block. Remove rear main bearing oil seal from cylinder block and rear main bearing cap following procedures outlined under *"Rear Main Bearing Oil Seal.*
15. If new main bearings are to be installed, remove the main bearing inserts from the cylinder block. Install new bearings following procedures outlined in this section.

Inspection

The crankshaft main bearing journal and connecting rod journal sizes are as follows: front, 2.6835″-2.6845″; front intermediate, 2.7145″-2.7155″; rear intermediate, 2.7455″-2.7465″; rear, 2.7765″-2.7775″; connecting rod journal, 2.311″-2.312″.

These dimensions should be checked with a micrometer for out-of-round taper or undersize. If the journals exceed .001″ out-of-round or taper the crankshaft should be replaced or reconditioned to an undersize figure that will enable the installation of undersize precision type bearings.

The crankshaft should also be checked for runout. To perform this operation, support the crankshaft at the front and rear main bearing journals in "V" blocks and indicate the runout of both the rear intermediate and front intermediate journals, using a dial indicator. The runout limit of each of these journals is .002″. If the runout exceeds .002″ the crankshaft must be repaired or replaced.

Installation

NOTE: Be sure that all bearings and crankshaft journals are clean.

1. Install a new rear main bearing oil seal in cylinder block and bearing cap.
2. Carefully lower the crankshaft into place. BE CAREFUL NOT TO DAMAGE THE BEARING SURFACES.
3. Check clearance of each main bearing following procedure outlined under *"Main Bearing Clearance"* in this section. If the bearing clearances are satisfactory, apply a light coat of engine oil to the journals and bearings.
4. Install all main bearing caps and bolts. Snug all bearing cap bolts, then tap end of crankshaft rearward with a lead hammer (this will locate bearings and bearing caps). Then tap crankshaft forward (this will line up both upper and lower crankshaft bearing thrust surfaces). Proceed with final tightening of all main bearing cap bolts 100 to 110 ft. lbs. torque.

Crankshaft End Play

5. Check crankshaft end play by forcing the crankshaft to its extreme rear position and check the end clearance at the rear intermediate bearing (fig. 43). This end clearance should be .003″ to .009″.

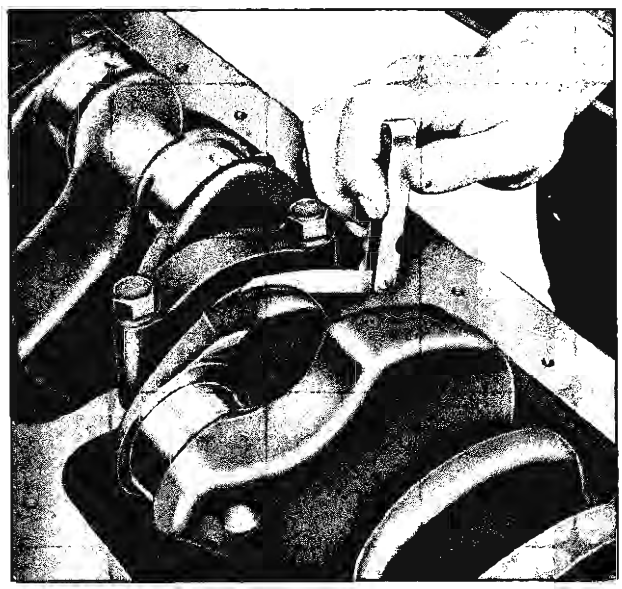

Fig. 43—Checking Crankshaft End Play

6. If the crankshaft gear was removed, install the two woodruff keys in their respective keyways in the crankshaft.
   Place the crankshaft gear on the end of crankshaft with key way in line with key.
   Drive the gear onto the shaft, using a suitable driver until gear bottoms against shoulder on shaft.
7. Install the front plate and gasket and attaching screws. Install the two front main bearing cap-to-front plate bolts.
8. Install the camshaft and gear assembly, while indexing timing marks.
9. Install connecting rod bearings and caps. Torque connecting rod nuts (oiled) 35 to 45 ft. lbs.
10. Install timing gear cover and harmonic balancer.
11. Install the oil pump and screen assembly.
12. Install oil pan and new pan gasket.
13. Install valve lifters and push rods. Install side cover, using a new side cover gasket.
14. Install valve rocker shaft assembly and lash valves as described under "Service Operations," Valve Lash Adjustment.
15. Install valve rocker cover with a new gasket.
16. Remove engine from engine stand and install in vehicle.
17. Install fan blade, spacer and belt. Install radiator and radiator hoses.
18. Fill cooling system and crankcase. Start engine and check for leaks.

MAIN BEARINGS

Precision type main bearings used as service replacement are of high quality with close tolerances of fit and will not require line reaming on installation. The close dimensional tolerances assure an equalized bearing surface at all points on the crankshaft when replaced in sets.

Bearings are available in standard sizes and undersizes of .002", .010", .020" and .030".

Main Bearings and Journal Inspection

In general, the lower half of the bearing shows a greater wear and the most distress from fatigue. If upon inspection the lower half is suitable for use, it can safely be assumed that the upper half is also satisfactory. If the lower half shows evidence of fatigue, distress, abrasion, erosion, scoring or the like, both upper and lower halves should be replaced. Never should one half be replaced without replacing the other half.

If the running clearance of a bearing is too great with the used inserts, it will be necessary to replace both halves. Should this become necessary, the crankshaft journals should be checked for out-of-round, taper or undersize. If out-of-round more than .001" or tapered, the shaft should be replaced or reconditioned. Check crankshaft thrust faces at the rear intermediate bearing surfaces for scoring or excessive wear. Experience has shown that clearance increase from wear in main bearings is not only due to bearing wear, but is also due in part to crankshaft journal wear.

Precision type main bearings may be replaced either with the engine in the vehicle or with the engine removed. With the engine in the vehicle, proceed as outlined below.

Replacement (Engine Installed)

NOTE: If, for any reason, main bearing caps are replaced, shimming may be necessary. Laminated shims for each bearing caps are available for service.

Shim requirements may be determined as outlined under "Bearing Clearance."

1. Remove oil pan.
2. Remove spark plugs.
3. Remove cap on main bearing to be replaced and remove bearing shell from cap.
4. Install a main bearing removing and installing tool in the oil hole in the crankshaft.

   NOTE: If such a tool is not available, a cotter pin may be bent as required to do the job.

5. Rotate the crankshaft in the direction of normal rotation (clockwise as viewed from front of engine). This will roll upper bearing shell out of engine.
6. Oil new upper bearing shell and insert end of shell without tang between crankshaft and block on the indented or notched side. Rotate the bearing shell into position.
7. Install new bearing shell in bearing cap.
8. Check bearing clearance, using Plastigage as outlined under "Bearing Clearance."

Replacement (Engine Removed)

With the engine removed from the vehicle—The procedure for replacing main bearings is as follows:

1. Remove old bearing shells from cylinder block and caps. Make sure that cylinder block and caps are well cleaned.
2. Install the new bearing shells in cylinder block and caps.

   NOTE: The front and front intermediate bearing shells are very similar in appearance and it is possible to get them mixed. The front intermediate shells are identified by the letter "I" in the bottom of the oil groove.

3. Lubricate all four bearings with light engine oil and place the crankshaft in the bearings.
4. Install bearing caps.

NOTE: The intermediate bearing caps are marked "F" and "R" for identification purposes. The front intermediate bearing caps is installed with the "F" mark to the front of the engine and the rear intermediate bearing cap is installed with the "R" mark to the rear of the engine.

5. Force the crankshaft to its extreme rear position and check the end clearance at the rear intermediate bearing (fig. 43). This end clearance should be .003" to .009".

Main Bearing Clearance

Plastigage consists of a wax-like plastic material which will compress evenly between the bearing and journal surfaces without damaging either surface. To obtain the most accurate results with Plastigage, certain precautions should be observed. If the engine is out of the chassis and upside down, the crankshaft will rest on the upper bearings and it can be assumed that the total clearance can be measured between the cap bearing and journal. If the engine is in the chassis, the crankshaft must be supported up against the upper bearings.

NOTE: To assure the proper seating of the crankshaft, remove rear main bearing oil seal. In addition, preparatory to checking fit of bearings the surface of the crankshaft journal and bearing should be wiped clean of oil.

1. Starting with the rear main bearing, remove bearing cap and wipe oil from journal and bearing cap.

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

2. Place a piece of Plastigage the full width of the bearing (parallel to the crankshaft) on the journal (fig. 44).
3. Install the bearing cap and evenly tighten the retaining bolts to 100-110 ft. lb. torque.

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

4. Remove bearing cap. The flattened Plastigage will be found adhering to either the bearing shell or journal. On the edge of Plastigage packing envelope there is a graduated scale which is correlated in thousandths of an inch.
5. Without removing the Plastigage, check its compressed width (at the widest point) with the graduations on the Plastigage envelope (fig. 45).

NOTE: Normally, main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal be sure to fit to the maximum diameter of the journal. If the bearing is fitted to the minimum diameter of the journal and the journal is out-of-round .001" or more, interference between the bearing and journal will result in rapid bearing failure. If the flattened Plastigage tapers toward the middle or ends, there is a difference in clearance indicating a taper, low spot or other irregularity of the bearing or journal. Be sure to check the journal with a micrometer if the flattened Plastigage indicates more than .001" difference.

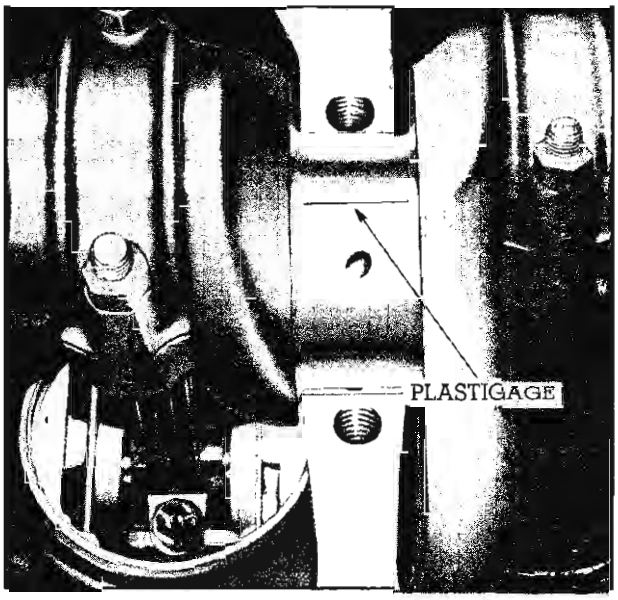

Fig. 44—Plastigage on Journal

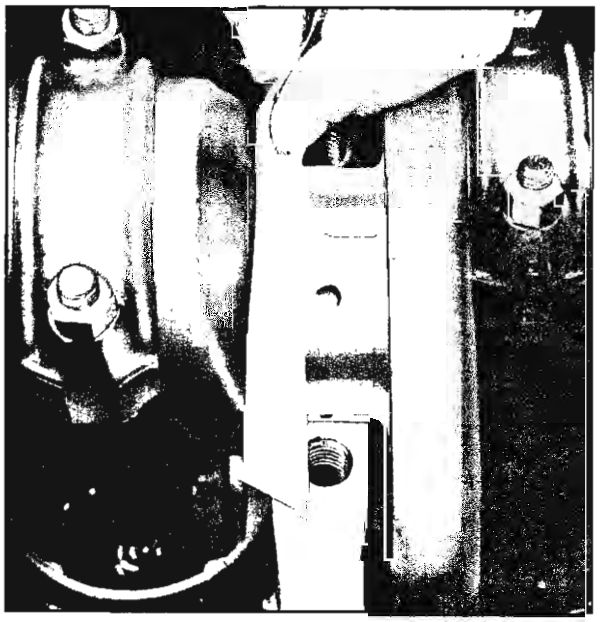

Fig. 45—Measuring Plastigage

6. If the bearing clearance is not over .004" or less than .0005" the bearing insert is satisfactory. If the clearance is not within these limits, bearing replacement is necessary.

NOTE: If new bearing cap is being installed and clearance is less than .001", install shims as required.

7. If replacement bearing does not bring the clearance below .004" it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.
8. New bearing shell clearance should be .003" maximum and .0005" minimum.
9. After checking rear main bearing proceed to next bearing.

NOTE: When installing front main bearing, timing gear cover through-bolts should be tightened before bearing cap bolts to assure seal between cap and front end plate.

10. Install new rear bearing oil seal.
11. Install front end plate and gasket and crankshaft gear, if removed.

REAR MAIN BEARING OIL SEAL—REPLACE

Sealing at the crankshaft rear bearing is made very effective due to machining the rear bearing cap and cylinder block to receive a wick type seal (fig. 46).

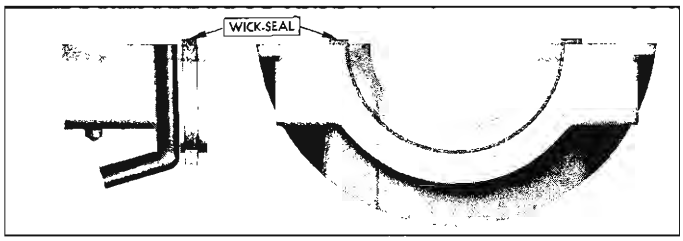

Fig. 46—Rear Main Bearing Oil Seal

The rear main bearing oil seal replacement is outlined below in two methods.

Engine Removed

To install a new wick seal in the rear main bearing cap and cylinder block proceed as outlined below.

1. Remove engine from vehicle and remove bearing caps and crankshaft.
2. Remove old seal from groove and make sure groove is clean.
3. Insert new seal in groove with the fingers.
4. Using a rounded tool, roll the seal into the groove.

NOTE: When rolling the seal start at one end and roll it to the center of the groove. Then starting from the other end, again roll toward the center (fig. 47).

5. Cut the small portion of the seal that protrudes from the groove flush with the surface of the bearing cap.

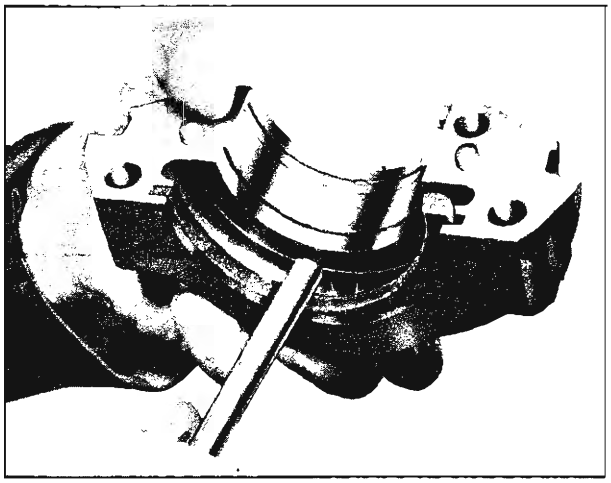

Fig. 47—Rolling Seal Into Groove

NOTE: To prevent possibility of pulling seal out of groove a round block of wood the same diameter as the crankshaft flange may be used to hold packing firmly in place while the ends are being cut off.

6. Install crankshaft, bearing caps. Install all necessary parts, then install engine in vehicle:

Engine In Vehicle

Removal

1. Remove engine oil pan.
2. Remove oil pump assembly.
3. Remove rear bearing cap, discard lower seal.
4. Loosen the remaining bolts in bearing caps to allow crankshaft to drop a slight amount.

NOTE: Due to possible static friction between the pistons and cylinder walls, the crankshaft may not drop sufficiently to allow removal and insertion of the upper seal. It will be necessary, in such cases, to place a lever between the crankshaft and block to force the crankshaft down into the space provided by loosening the bearing caps.

5. Using a screwdriver or similar tool, push seal out of upper bearing sufficiently to permit removal with a pair of pliers. It may be necessary to rotate crankshaft slightly to aid in removal.

Installation

1. Pre-form new upper seal in bearing cap.
2. Insert a piece of soft wire through upper seal, approximately ¼" from the end, then wrap the end with wire as shown in Figure 48.
3. Lubricate entire surface of upper seal with a light coat of silicone lubricant and form seal in the lower cap.
4. Remove upper seal from bearing cap.

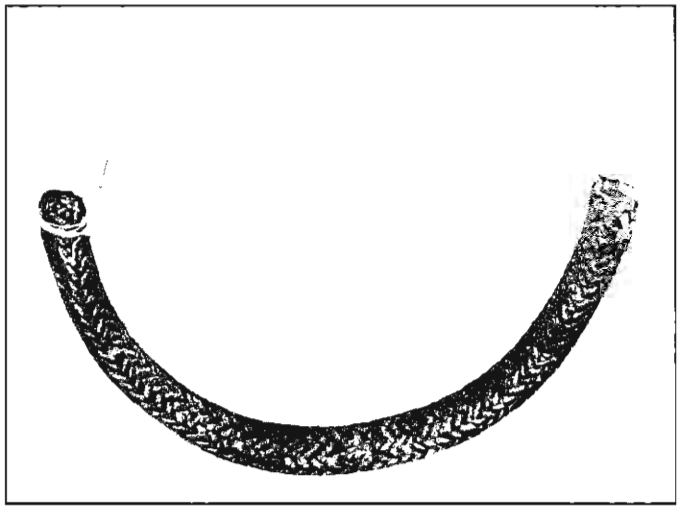

Fig. 48—Wire Attached to Oil Seal

5. Insert wire attached to seal through seal opening in crankcase and around crankshaft.
6. With the aid of a screwdriver or similar tool, start seal into opening.

   NOTE: Be sure seal is started properly before pulling seal into position.

7. Pull seal into position with wire, while working seal back and forth at the point where it contacts the crankcase seal opening, continue working seal until it is in position.

   NOTE: It may be necessary to rotate crankshaft slightly to help position seal.

8. With seal centered in opening, cut ends off $\frac{1}{64}$" below bearing edge.

   To install a new wick in the rear main bearing cap proceed as outlined below.

9. Insert a new seal in groove with the fingers.
10. Using a rounded tool, roll the seal into the groove.

    NOTE: When rolling the seal start at one end and roll it to the center of the groove. Then starting from the other end, again roll toward the center.

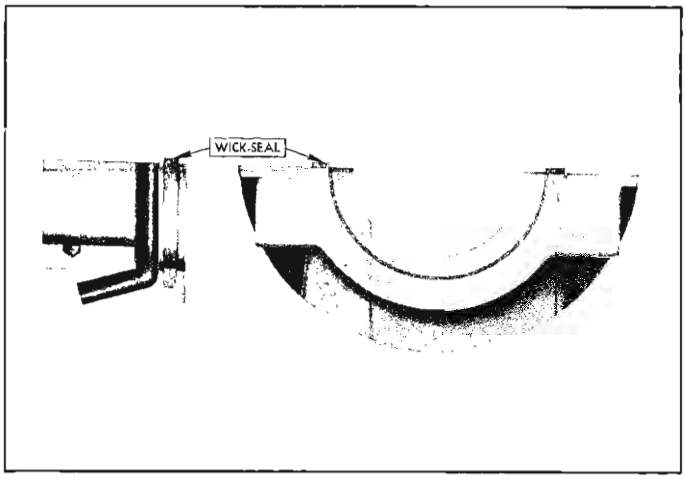

Fig. 49—Rear Main Bearing Oil Seal

11. Cut the small portion of the seal that protrudes from the groove flush with the surface of the bearing cap.

ENGINE MOUNTINGS

Front engine mountings are of the fixed type. Service is seldom required. Broken or deteriorated mounts should be replaced immediately because of the added strain thrown on other mounts and drive line components.

Front Mounts—Replace

1. Remove retaining nuts, bolts and washers.
2. Raise front of engine and remove engine mounts from between cross member mount and engine bracket by removing three retaining bolts (fig. 50).

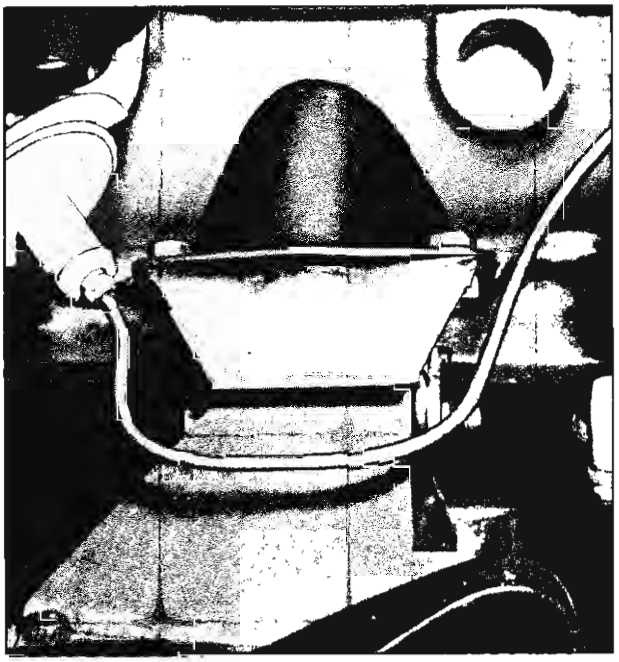

Fig. 50—Engine Front Mount Installation

3. On each engine bracket install bolts to retain engine mounts.
4. Lower engine in place and install engine mount to cross member bracket bolts, washers and nuts. Rear Mount see Section 12 and 13 of this manual.

ENGINE OVERHAUL

Removal from Vehicle

1. Drain cooling system, crankcase and transmission.
2. Scribe alignment marks on hood around hood hinges and remove hood from hinges.
3. Remove radiator hoses and heater hoses on models

so equipped. On Powerglide equipped models, remove and plug oil cooler lines.

4. Remove radiator core support bolts. Remove radiator core.
5. Remove battery, and battery cables.
6. Disconnect starter and generator wires, engine to body ground strap, oil pressure indicator wire at switch on block and coil primary lead at coil.
7. Remove temperature indicator element wire.
8. Remove air cleaner and oil filter.
9. Disconnect gasoline feed pipe from fuel pump and disconnect vacuum lines from intake manifold.
10. Remove exhaust pipe to manifold nuts.
11. Disconnect carburetor control rod from dash panel bell crank.
12. Remove transmission control rods.
13. Remove clutch control bell crank and control rods on conventional transmission models. On overdrive models, disconnect overdrive wires and cables. On Powerglide models, remove oil filler tube and plug opening.
14. Disconnect speedometer cable at transmission.
15. Remove propeller shaft as outlined in section 5.
16. Remove overdrive solenoid if overdrive equipped.
17. Remove rocker arm cover and install lifting hooks from Tool J-4536 in cylinder head bolt holes.
18. Disconnect clutch idler shaft bracket from engine.
19. Raise engine slightly and remove bolt, nut and washer from each engine mount and transmission mount. Remove the engine and transmission from the vehicle as a unit.
20. Attach engine stand adapter Tool J-5831.

Engine Disassembly

1. Mount engine in stand Tool J-5856-02 and clamp it securely so that the engine can be turned over when necessary. Remove the lifting attachment.
2. On CONVENTIONAL TRANSMISSION MODELS:
   a. Remove bolts attaching transmission to clutch housing. Remove transmission.

      NOTE: Support the transmission as the last mounting bolt is removed and as it is being pulled away from the engine to prevent damage to clutch disc.

   b. Remove flywheel underpan extension and clutch release link from clutch fork.
   c. Remove throwout bearing from clutch fork and remove fork.
   d. Install Tool J-5824 to support clutch during disassembly. Loosen clutch to flywheel bolts a turn at a time (to prevent distortion of clutch cover) until the diaphragm spring pressure is released. Remove all bolts, pilot tool, cover assembly and disc.
   e. Remove starter assembly and engine ground strap.
   f. Remove the flywheel and clutch housing.
3. On POWERGLIDE TRANSMISSION MODELS:
   a. Remove two upper transmission to converter housing bolts, install Tool J-4262 and attach chain hoist to lift sling.
   b. Remove spark plugs and wires, and remove flywheel cover and flywheel underpan extension.
   c. Remove three flywheel to converter bolts, working through bolt access hole on left side of flywheel housing adjacent to cylinder block drain cock.

      NOTE: Do not remove converter cover bolts which extend through holes in flywheel.

   d. Remove converter housing to flywheel housing bolts and separate transmission assembly from engine. Install Tool J-5384.
4. Remove octane selector retaining screw and disconnect vacuum line from vacuum spark control. Disconnect spark plug wires from spark plugs and lift the distributor up out of engine.
5. Disconnect gas line and vacuum lines from fuel pump, remove fuel pump bolts and fuel pump.
6. Disconnect fuel and vacuum lines from clip at water outlet and from carburetor and remove lines.
7. Remove spark plugs, push rod cover and oil gauge rod.
8. Remove two bolts attaching water outlet to thermostat housing and remove water outlet and thermostat.
9. Remove two bolts attaching thermostat housing to cylinder head and remove housing.
10. Remove water pump retaining bolts and remove generator brace and pump.
11. Attach Tool J-6978 or Tool J-1287 to balancer and turn puller screw to remove balancer and pulley assembly.
12. Disconnect throttle rod from throttle and accelerator lever and remove throttle rod.
13. Remove throttle and accelerator lever, and accelerator rod from cylinder block.
14. Remove carburetor attaching nuts and carburetor.
15. Remove bolts and clamps attaching manifold to cylinder head and remove manifold assembly and gaskets.
16. Remove rocker arm shaft assembly at cylinder head.
17. Remove push rods.
18. Remove valve lifters.
19. Remove the cylinder head attaching bolts, cylinder head and gasket.
20. Remove the timing gear cover attaching screws and the two bolts that are installed from the back

through the front main bearing cap and remove cover and gasket.

21. Pull the crankshaft gear with Tool J-8105.
22. Remove the two camshaft thrust plate screws by working through holes in the camshaft gear.
23. Remove the camshaft and gear assembly by pulling it out through the front of the block.

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

24. Remove the engine front plate attaching screws and remove plate and gasket.
25. Disconnect oil pump to block oil line from pump and block fitting and remove oil line.
26. Remove oil pump retaining screw and remove oil pump.
27. Remove oil pump suction pipe and screen, cover attaching screws, cover, gasket, idler gear and drive gear and shaft.
28. Check the connecting rods and pistons for cylinder number identification and, if necessary, mark them.
29. Remove connecting rod nuts and rod caps. Push the rods away from the crankshaft and install caps and nuts loosely to their respective rods.
30. Push piston and rod assemblies away from crankshaft and out of the cylinders.

NOTE: It will be necessary to turn the crankshaft slightly to disconnect some of the rods and to push them out of the cylinder.

31. Remove piston rings by expanding them and sliding them off the ends of the pistons.
32. Remove main bearing cap bolts and remove the bearing caps.
33. Lift the crankshaft out of the block and place it where it will not get damaged.
34. Lift bearing shells from block and bearing cap.

Cleaning and Inspection

1. Wash all parts thoroughly in cleaning solvent.
2. Remove oil gallery plugs, located one at front and one at rear face of cylinder block. These plugs may be removed with a sharp punch or they may be drilled and pried out. This oil passage should be thoroughly cleaned either by using compressed air or wire brush.
3. Clean all oil passages in the cylinder block and crankshaft by blowing them out with compressed air. It is good practice to blow them out separately. On the block this can be done by plugging the holes in three of the bearings and placing the nozzle of the air gun in the oil inlet of the cylinder block and blowing through the remaining bearing oil passages. Continue this until all passages are clean. Blow through the pasasge to the camshaft bearings.
4. Run a fine wire through the cylinder wall lubrication holes in each connecting rod.
5. Blow out the rocker arm shaft oil line, and the passage up from the camshaft bearing.
6. Clean carbon from piston heads, ring grooves and inside of piston head.
7. Check the cylinder block for cracks in the cylinder walls, water jacket and main bearing webs.
8. Inspect the connecting rod bearings for fatigue, pitted or damaged.
9. Determine whether or not pistons are to be replaced. New piston assemblies and rings are required when the cylinders are to be honed or rebored. If the pistons are to be used again, check the piston pin fit in the pin bores. Refer to "Connecting Rod, Bearings, Pistons and Rings.
10. Inspect the timing gears for excessive tooth wear and for loose hub in camshaft gear. Inspect the camshaft thrust plate for excessive wear.
11. Check the cylinder head for being warped, for having clogged water passages, cracked valve seats or worn valve guides.
12. Inspect the manifolds for excessive carbon in the ports. Check the operation of the heat control valve and make sure that the gasket between the manifolds is in good condition.
13. Inspect the oil pump gears for wear, check the shaft for looseness in the housing and the inside of cover for wear that would permit oil to leak past end of gears. Check screen for damage.

NOTE: Instructions for inspection and repair of the fuel pump, carburetor, air cleaner, generator, starting motor, distributor, clutch and water pump will be found in their respective sections of this manual.

CLUTCH HOUSING INSTALLATION

(Standard Transmissions)

1. Install clutch housing and attaching bolts and tighten to 44-55 foot pounds with a torque wrench.
2. Install indicator extension in a crankshaft stud hole, attach indicator to extension and check pilot hole runout (fig. 51). This runout should not exceed .008".
3. Should runout exceed .008" the clutch housing should be aligned by removing dowel pins. Loosen bolts and locate housing within limits, tighten to 45-55 pounds with a torque wrench.

FLYWHEEL HOUSING INSTALLATION

(Automatic Transmission)

The flywheel housing used on Powerglide models differs from the regular production clutch housing in

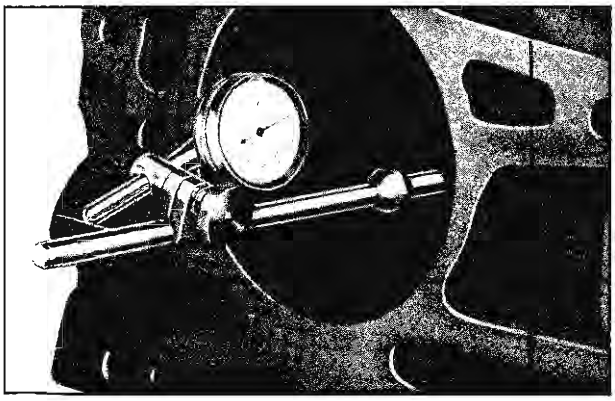

Fig. 51—Transmission Pilot Hole Runout

both design and tolerances. Parallelism of the face must be within .007" and total bore runout must not exceed .005". Special oversize dowel pins are to be used to obtain proper bore runout with respect to the crankshaft bearings.

Procedure for installing this flywheel housing and checking alignment correction is as follows. In addition, this method of alignment correction may be applied to correct bore misalignment, where found, of the clutch housing on standard or overdrive transmission models.

1. Remove old flywheel housing from cylinder block.
2. Carefully clean mating surfaces of block and new housing of dirt, burrs, nicks, etc.
3. Install new flywheel housing to block, install attaching bolts and tighten evenly to 45-55 ft. lbs. torque.
4. Install Tool J-2494 in one of the crankshaft flange stud holes. Attach Tool J-4656 to indicator post.
5. Install Tool J-8001 to indicator extension rod and set indicator to read zero at the six o'clock position on the flywheel housing face (fig. 52).

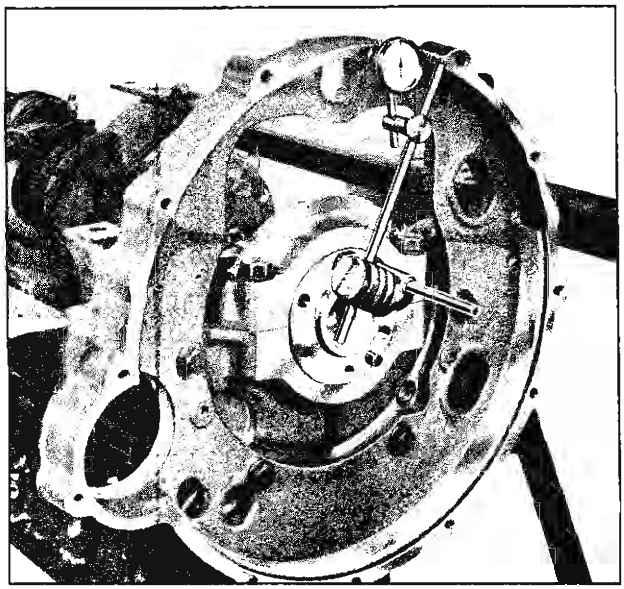

Fig. 52—Checking Face Parallelism

6. Indicate face of housing and take readings at the 9, 12 and 3 o'clock positions. The runout limit is .007".

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

7. Reset the indicator to read zero at the six o'clock position on the machined inside diameter of the flywheel housing bore, being careful that the indicator button is centered on the narrow machined flange and does not touch flange step.
8. Take readings at the 9, 12, and 3 o'clock positions, carefully lifting indicator button over each cutaway section of flange. The runout should not exceed .005" (fig. 53).

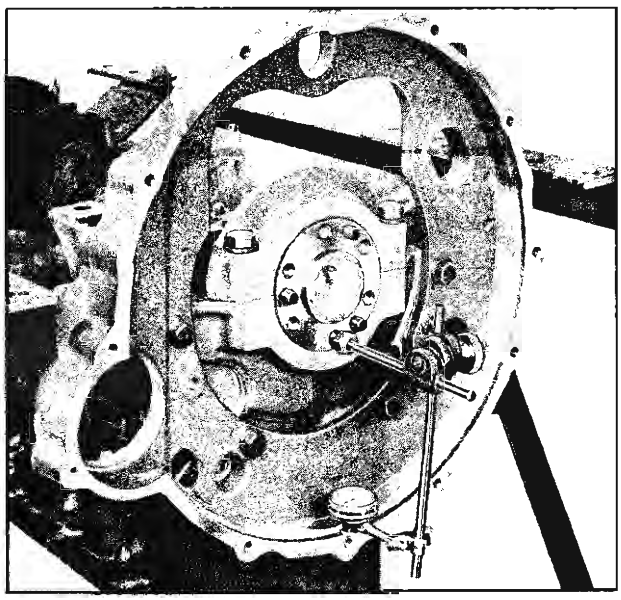

Fig. 53—Checking Bore Runout

Alignment Correction

NOTE: When applying this alignment correction to clutch housing of a standard or overdrive transmission engine, face parallelism should be disregarded as this alignment check must be made with the transmission case assembled to housing in the normal manner. This alignment correction is covered in Section 12.

1. If bore runout is in excess of .005" or if housing face parallelism exceeds .007", remove indicator and the flywheel housing from the engine block.
2. Remove the lower left hand dowel by driving it out, using a drift punch through hole in cylinder block flange.
3. Center punch the other two dowels and then drill through the dowels using a $^{7}/_{32}$" drill.
4. Run a $^{1}/_{4}$"-28 tap through drilled holes in dowels.
5. Install a $^{1}/_{4}$"-28x2" capscrew into each dowel. Tighten capscrew to push dowels out of block.

6. Clean mating faces of flywheel housing and engine block and make certain there are no burrs or metal extrusion around dowel or bolt holes.
7. Install flywheel housing and tighten attaching bolts evenly to 45-55 ft. lbs. torque.
8. Mount indicator on indicator post and indicate flywheel housing face. Set indicator at zero at the six o'clock position and carefully check indicator readings at the 9, 12, and 3 o'clock positions. The runout limit is .007".

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

9. If the face runout exceeds .007", shim as necessary, using main bearing shim No. 3847687 between the housing and block at the attaching bolt locations.
10. After the housing face has been brought within the .007" limit, with bolts tightened to required torque, reset indicator to read zero at the six o'clock position on the machined inside diameter of the flywheel housing bore.

    NOTE: Be careful that the indicator button is centered on the narrow machined flange and does not touch flange step.

11. Check indicator readings at the 9, 12, and 3 o'clock positions, carefully lifting indicator button over each cutaway section of flange. The runout should not exceed .005".
12. If the readings exceed the .005" runout limits, loosen bolts slightly and tap housing with a soft hammer in required direction until runout is within limits. Tighten attaching bolts evenly to 45-55 ft. lbs. torque and recheck.
13. With flywheel housing in proper alignment, carefully drill through dowel holes in housing and into block using a $^{13}/_{32}$" drill.

    CAUTION: When drilling into lower right blind hole in block, be careful not to drill through.

14. Carefully ream holes using Tool 4628 ($^{27}/_{64}$").
15. Recheck flywheel housing bore and the face to make sure they are still within proper limits.

Flywheel Installation

1. Clean the mating flanges of flywheel and crankshaft carefully and make sure there are no burns on either mounting face.
2. Place the flywheel in the clutch housing and position it so that the three evenly spaced dowels in crankshaft flange will enter the holes in the flywheel.
3. Install the six bolts using new external tooth lock washers under each bolt.
4. Tighten bolts to 50-65 foot pounds with a torque wrench.
5. On all except Powerglide models, mount a dial indicator on the clutch housing so that the button of the indicator will contact the machined surface of flywheel (fig. 54), and check the flywheel runout.

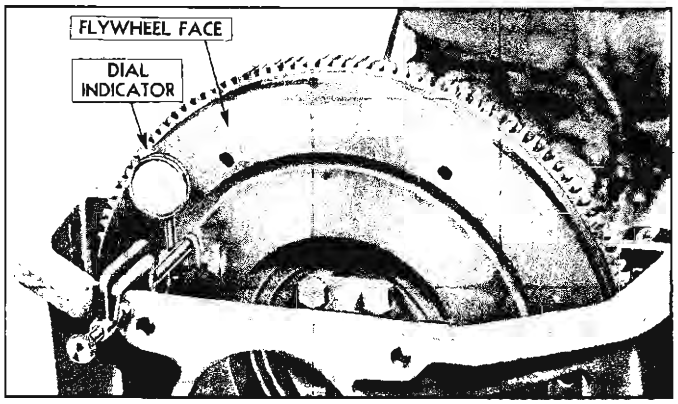

Fig. 54—Checking Flywheel Runout

6. Runout should not exceed .008". If excessive remove flywheel and recheck for burrs or replace flywheel.

Engine Assembly

The following engine assembly is to be performed after the crankshaft, connecting rods and pistons, clutch or flywheel housing and flywheel have been installed as previously outlined.

1. Place the oil pump in position in the block fitting. Install the oil pump retaining screw and tighten securely, being sure that the tapered end of screw draws down into the hole in pump body. Tighten lock nut securely.
2. Install the oil pump to block oil line and tighten the connector nuts securely. Figure 30 shows proper installation.
3. Check to see that the crankcase ventilator baffle (attached to block at crankcase breather hole) is not damaged and is securely bolted in place. Turn the crankshaft to see that the camshaft lobes clear the baffle.
4. Check to see that all connecting rod bolt nuts and main bearing bolts are properly tightened and locked. Check to see that the crankcase is clean.
5. Install new oil pan gaskets and carefully place the oil pan in position and tighten pan bolts securely.

   NOTE: Tighten oil pan corner bolts to 12½-15 ft. lbs. Tighten oil pan flange bolts to 6-7½ ft. lbs.

6. On conventional transmission models:
   a. Lubricate the clutch pilot bearing with a small amount of high melting point grease. Place the clutch disc and clutch cover assembly in position and install Tool J-5824.

b. Turn the clutch cover until the "X" on the cover lines up with the "X" on the flywheel. Install the attaching bolts loosely and then tighten them a turn at a time to take up the spring pressure evenly and prevent clutch distortion. Tighten bolts to 25-30 ft. lbs. torque and then remove pilot tool.

c. Pack the clutch fork ball seat with a small amount of high melting point grease and snap the fork onto the ball with the end extending through opening in clutch housing.

7. Turn engine assembly over in engine stand.
8. Place new cylinder head gasket on the block following the installation instructions stamped on gasket. This assures alignment of water passages and bolt holes in head and block with openings in gasket. Install two guide pins to position gasket and pilot cylinder head.
9. Carefully place cylinder head in position over guide pins and install all cylinder head bolts and tighten them finger tight.
10. Tighten the cylinder head bolts a little at a time in the order shown (fig. 16). The final tightening should be 90-95 ft. lbs. torque.
11. Install the valve lifters and push rods.
12. Install push rod cover using a new gasket and tighten attaching screws evenly to 6-7½ ft. lbs. torque.
13. Install new manifold to cylinder head gaskets, intake manifold sleeves, manifold assembly and attaching part. See Figure 2 under "Maintenance and Adjustments." Check manifold heat control valve, unhook the thermostat spring from its anchor pin and check the adjustment.

    Proper adjustment requires only ½ turn of the spring from its unhooked position to slip it over the anchor pin.

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

    Check valve shaft to make sure it is free in the manifold. If shaft is sticking, free it up with kerosene containing a small amount of baking soda.
14. Install water pump using a new gasket and tighten attaching bolts to 25-30 ft. lbs. Install thermostat housing, place thermostat in housing, install new water outlet gasket and water outlet, and install attaching bolts. Tighten bolts securely.
15. Install carburetor and tighten nuts evenly. Place throttle rod in position and connect it to the bell crank and throttle shaft arm.
16. Install crankcase ventilator tube. Connect tube brace to oil pan flange. Install oil gauge rod.
17. Adjust spark plug gaps to .035". Using new gaskets install spark plugs and tighten to 20-25 ft. lbs. torque.
18. Install the fuel pump using a new gasket and tighten attaching bolts to 15-20 ft. lbs. Place the fuel pump to carburetor gas line and the vacuum spark control line in position and connect them to carburetory and clip at water outlet. Connect the gas line to the fuel pump.
19. Install ignition distributor following instructions in Engine Electrical Section of this manual and connect vacuum line to distributor spark control.
20. On conventional transmission models:

    a. Lubricate the recess on the inside of clutch throwout bearing collar and coat the throwout fork grooves with a small amount of graphite grease and place bearing assembly in position on the throwout fork.

    b. Carefully clean the mating faces on clutch housing and transmission case. Pilot the clutch shaft of transmission through throwout bearing and into clutch disc and pilot bearing. Work the transmission up against the clutch housing until bearing retainer pilots into pilot hole in clutch housing. Install and tighten the transmission mounting bolts securely.

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

    c. Install the clutch housing underpan and retaining bolts.
21. On automatic transmission models:
    See Section 13.
22. Using lift kit Tool J-4536, install the proper lifting Tool. Attach lifting attachments to suitable hoist, release engine from stand and lift engine with hoist.
23. Install starting motor and body ground strip and tighten attaching bolts securely.
24. Install generator loosely and attach slotted brace. Place fan belt over fan and around pump, generator and crankshaft pulley. See Section 7 for fan belt adjustment. Tighten generator to brace bolt securely to secure generator in position.

Engine Installation to Vehicle

1. Install engine lifting device Tool J-4536-A to engine, and lower engine and transmission assembly into chassis as a unit, guiding engine to align supports with frame.
2. Install rear transmission mount, bolts and snug up bolts.
3. Remove lifting attachment, install cylinder head bolts and tighten to 90-95 ft. lbs. Tighten rear transmission bolts and front mounting bolts.
4. Install rocker arm assembly and tighten retaining bolts evenly to 25-30 foot-pounds torque.
5. Install rocker arm cover gasket, cover and screws with reinforcements.
6. Install propeller shaft as outlined in section 5.
7. On CONVENTIONAL TRANSMISSION MODELS:

a. Connect clutch pedal adjusting link to clutch fork and adjust to give ¾″ to 1″ free pedal travel (see Section 11).

b. Connect carburetor linkage.

c. Connect speedometer cable to speedometer driven gear.

d. Connect transmission control rods to shifter levers on transmission side cover. Adjust control rods as outlined in "Transmission Section."

e. Check tranmission lubricant level.

8. On all models having a Powerglide transmission:

a. Connect speedometer cable to speedometer driven gear.

b. Connect transmission control rod to transmission control rod bell crank and adjust rod as outlined in "Transmission Section."

c. Install transmission filler tube and dip stick.

d. Check transmission fluid level.

9. Replace exhaust pipe to manifold annd tighten attaching bolts securely.

10. Connect wire to oil pressure gauge and temperature element in cylinder head.

11. Install air cleaner.

NOTE: If oil bath cleaner is used, disassemble, clean and refill before installing.

12. Attach generator and field wires to generator.

13. Attach gasoline line to fuel pump.

14. Mount coil in position with two coil mounting bolts, tighten bolts to 5-8 ft. lbs. torque.

15. Attach coil wires to distributor.

16. Install battery. Attach battery cable and ammeter wire to large terminal on solenoid and starter switch wire to small terminal and connect coil wire to coil.

17. Install radiator assembly and wiring harness.

18. Install oil cooler lines on all Powerglide models, and connect radiator hoses.

19. Refill radiator and crankcase.

20. Connect vacuum lines.

21. On all models with the POWERGLIDE TRANSMISSION, use Tool J-4264 and fill transmission as follows:

a. Fill transmission with four and one-half quarts of Automatic Transmission Fluid, "Type A."

b. Start engine and let idle with transmission selector lever in "N" position. Check oil level and if necessary add oil to bring fluid level to "Full" mark on the dip stick. Do not overfill.

22. On Powerglide equipped cars, place selector lever in reverse and check linkage adjustment as outlined in the "Transmission Section."

23. Replace hood assembly, aligning previously scribed marks.