EIGHT CYLINDER ENGINE

(348 cu. in.)

INDEX

GENERAL DESCRIPTION

The optional Turbo-Thrust 348 cubic inch displacement V-8 engine is available in five R. P. O. series; Turbo-Thrust (R. P. O. 576), Turbo-Thrust Special (R. P. O. 590), Turbo-Thrust Special (R. P. O. 575), Super Turbo-Thrust (R.P.O. 573A) and Super Turbo-Thrust (R. P. O. 573B). Major engine components can be determined by referring to the "348 cubic inch Engine Identification Chart."

348 Cu. In. ENGINE IDENTIFICATION CHART

MAJOR COMPONENTS	R. P. O.				
	576	573A	575	590	573B
Crankcase (Special)			X		
Cylinder Heads (Standard)	X	X	X		
Cylinder Heads (Special) 1/8" Larger Inlet Valves 1/16" Larger Exhaust Valves Dual Valve Springs				X	X
Inlet Manifold—4 Bbl Cast Iron	X				
Inlet Manifold—3 x 2 Cast Iron		X			X
Inlet Manifold—4 Bbl Cast Iron Special			X		
Inlet Manifold—4 Bbl Aluminum				X	
4 Bbl Carter Carb. (3- and 4-Spd. only)	X				
4 Bbl Carter or Rochester Carb. (Auto. Trans. only)	X				
3 x 2 Bbl—Rochester Carburetors		X			X
4 Bbl—AFB—Carter			X	X	
Camshaft (Low Overlap)			X		
Camshaft (High Overlap)				X	X
Hydraulic Lifters	X	X			
Mechanical Lifters			X	X	X
Pistons (Gabled)	X	X			
Pistons (Notched—High Compression)			X	X	X
Piston Fit	.0006 .0010	.0006 .0010	.0016 .0020	.0026 .0030	.0026 .0030
TRANSMISSIONS Powerglide			X		
Turboglide	X	X			
3-Speed	X	X		X	X
4-Speed	X	X		X	X
Compression ratio	9.5 to 1	9.5 to 1	11.0 to 1	11.25 to 1	11.25 to 1
Horsepower	250	280	305	320	335
Ignition Timer Distributor (Std.) Single Breaker W/Vac. Adv.	X	X	X		
Ignition Timer Distributor (Special) Dual Breaker W/o Vac. Adv.				X	X

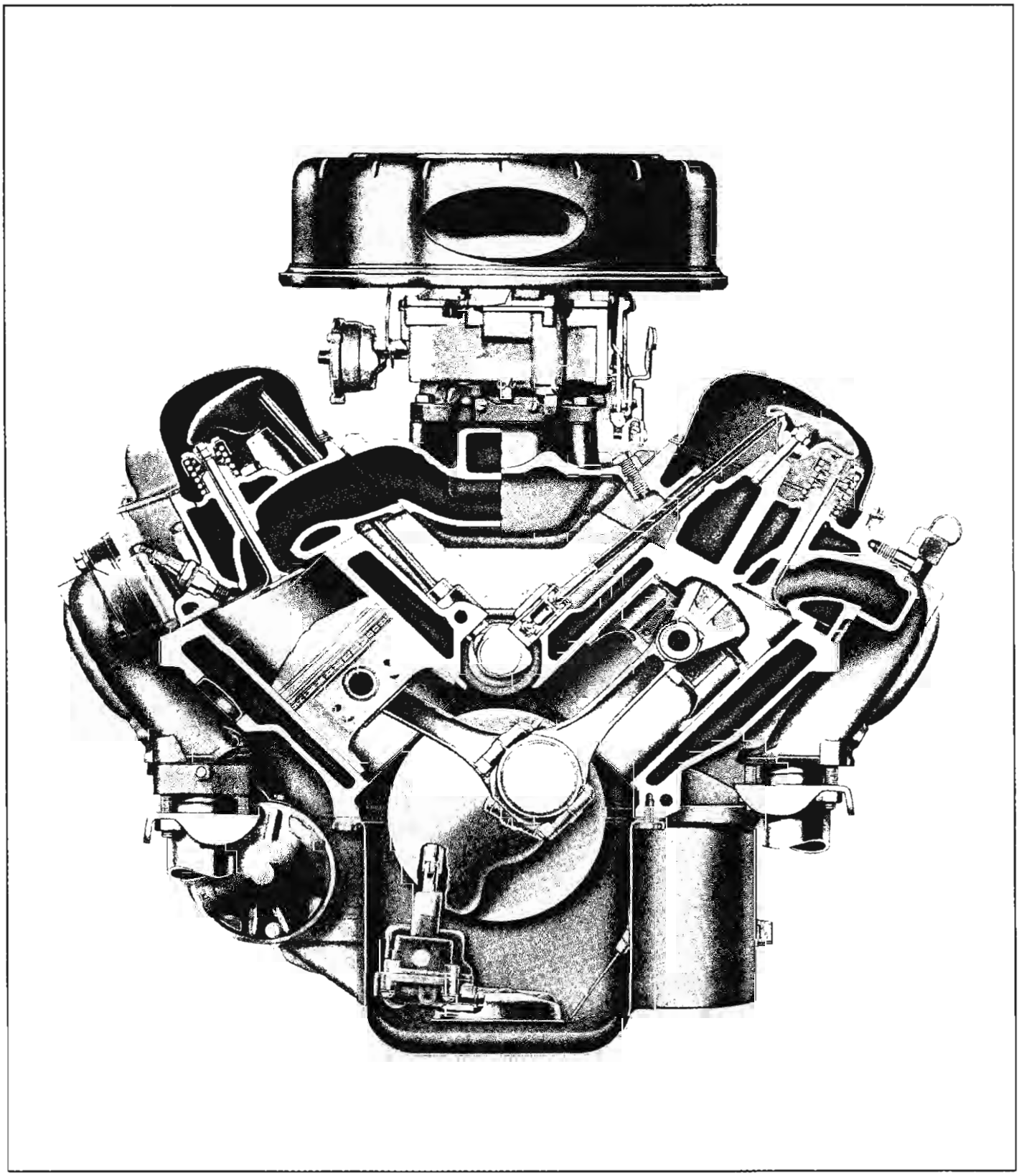

Fig. 112—Engine Cross-Section Across Crankshaft

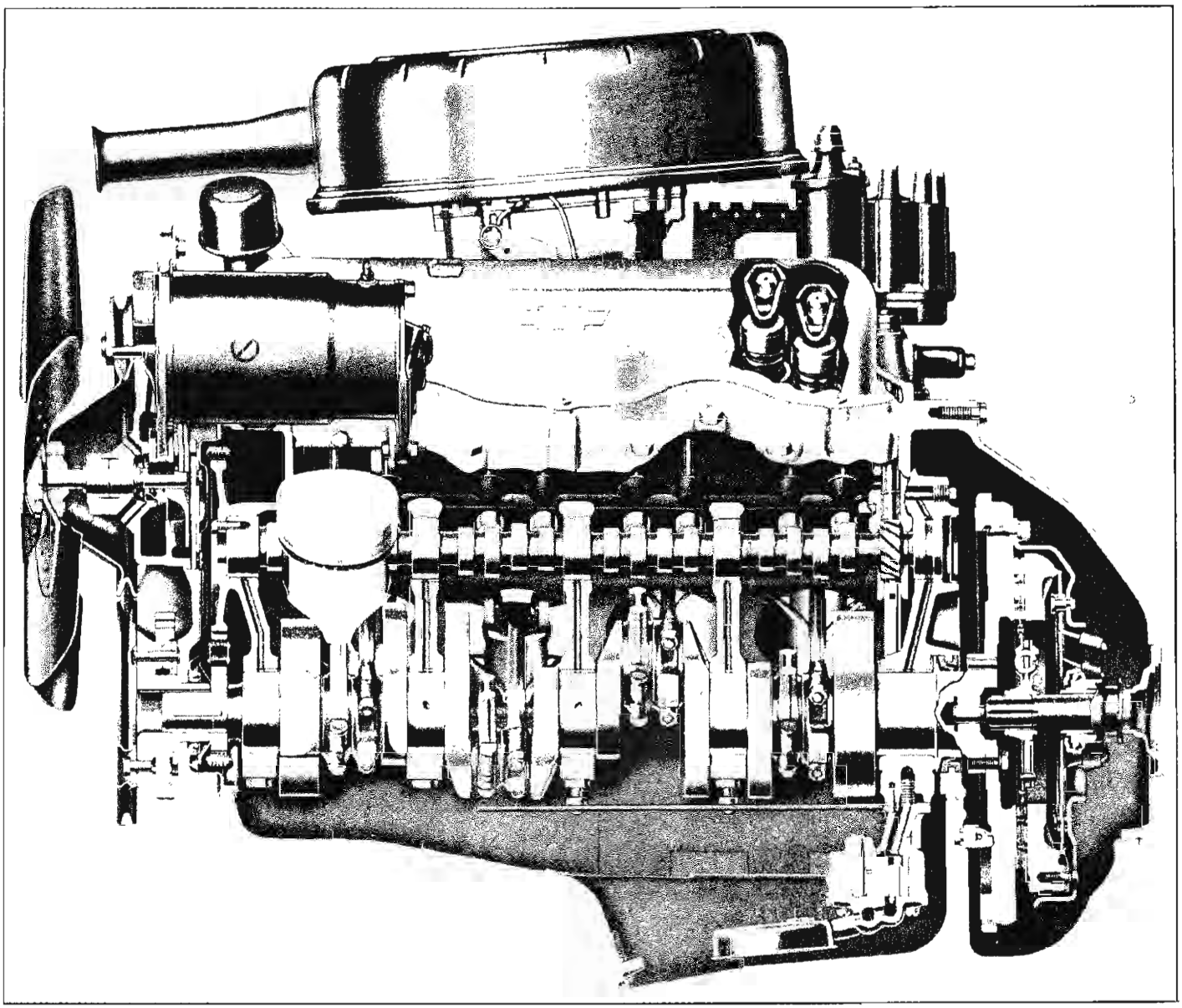

Figure 113—Engine Cross Section Along Crankshaft

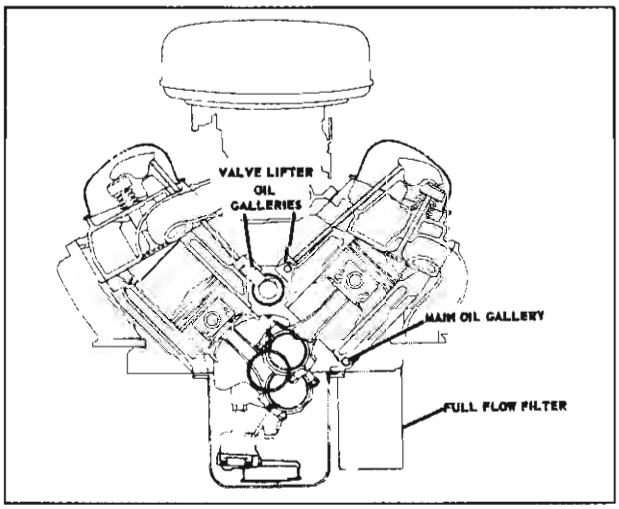

Fig. 114—Engine Lubrication

MAINTENANCE AND ADJUSTMENTS

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 dipstick. *Do not overfill.* Refill capacity 4 quarts, with oil filter 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.

VALVE LASH ADJUSTMENT—ENGINE RUNNING

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

1. After the engine has been normalized, remove valve covers and install a reworked valve cover (cut the top out of a used valve cover) and gasket, on cylinder heads to prevent oil from running out.
2. With the engine running at idle, back off valve rocker arm nuts (one at a time) until the valve rocker arm starts to clatter.
3. Turn rocker arm down until the clatter just stops; continue to turn nut down exactly 1 turn.

   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. Remove reworked covers, install new gaskets and valve covers.

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.

HYDRAULIC VALVE LIFTERS

The 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:

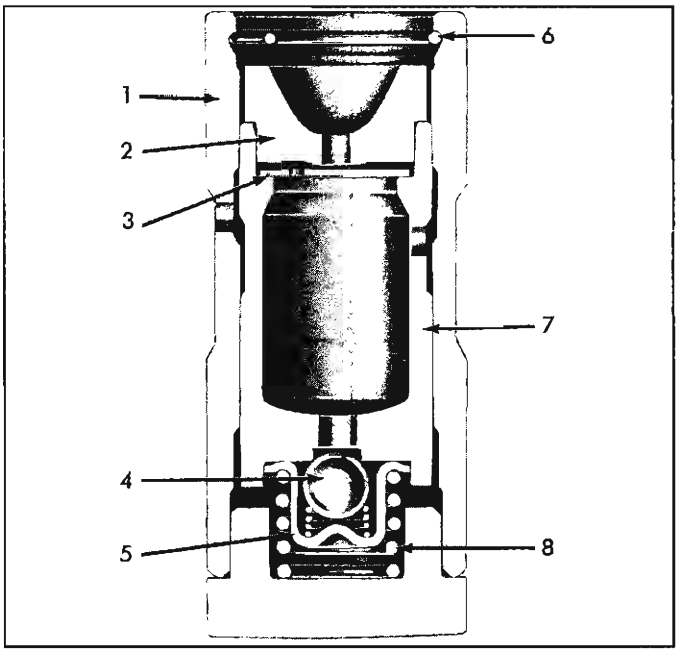

Fig. 115—Hydraulic Valve Lifter

1. Lifter Body
2. Push Rod Seat
3. Metering Valve
4. Check Ball
5. Ball Retainer
6. Push Rod Seat Retainer
7. Plunger
8. Plunger Spring

a. Excessive varnish or carbon deposit causing abnormal wear.
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 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 the 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.

CYLINDER NUMBERING

Cylinder numbering is by arrangement, rather than by firing order.

The cylinders are numbered 1, 3, 5 and 7, on the left bank starting from the front and 2, 4, 6 and 8, on the right bank. This arrangement gives a consecutive order of 1 through 8 to the connecting rods.

The firing order is 1, 8, 4, 3, 6, 5, 7 2.

BOLT TORQUES

The proper torque tightness of the attaching bolts and screws of various engine parts is very important. To avoid both over-tightening and under-tightening with possible distortion a torque specification chart is listed in Section 16 to be used with a torque wrench on the various bolts listed.

SERVICE OPERATIONS

HYDRAULIC VALVE LIFTERS

Removal

1. Remove rocker arm cover attaching screws with reinforcements and remove covers and gaskets.
2. Remove intake manifold as described under Cylinder Head Reconditioning in this section.
3. Back off rocker arm nuts until arms may be pivoted away from push rods. Remove push rods.
4. Remove hydraulic valve lifters.

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

Disassembly and Assembly

Refer to Figure 116.

1. Hold plunger down with a push rod and using a small screwdriver or awl, remove push rod seat retainer.
2. Remove push rod seat, metering valve, plunger and spring from lifter body.
3. Pull check valve ball retainer from plunger and remove ball and spring.
4. Thoroughly clean all parts in cleaning solvent, and inspect them carefully. If any parts are damaged, the entire lifter assembly should be replaced.
5. To reassemble the lifter:
   a. Place check ball on small hole in bottom of plunger.
   b. Insert check ball spring on seat in ball retainer and place retainer over ball so spring rests on ball. Carefully squeeze retainer and press into position by plunger.
   c. Place plunger spring over ball retainer and slide lifter body over spring and plunger.

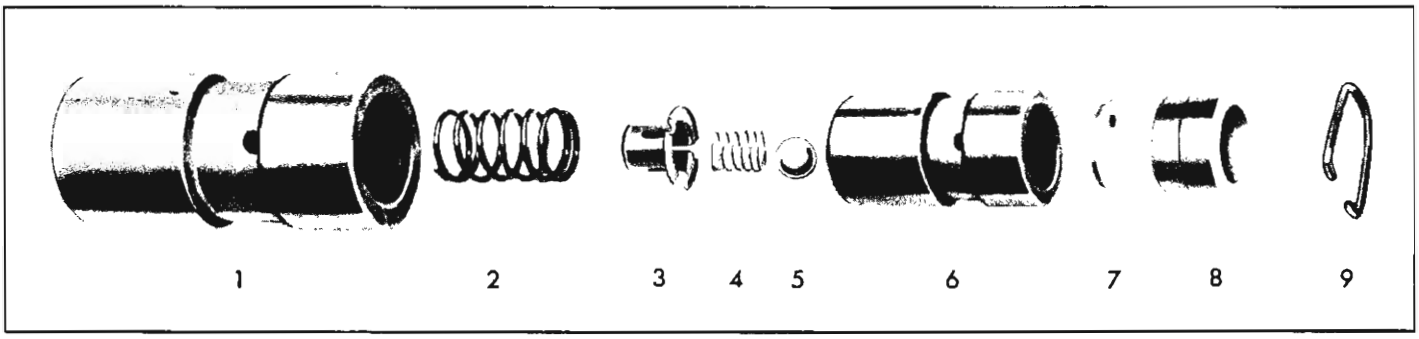

Fig. 116—Hydraulic Lifter Exploded

1. Lifter Body
2. Plunger Spring
3. Ball Retainer
4. Check Ball Spring
5. Check Ball
6. Plunger
7. Metering Valve
8. Push Rod Seat
9. Push Rod Seat Retainer

d. Install push rod seat and metering valve in open end of plunger, push plunger into body and install retainer.

6. Compress plunger to open oil holes and fill plunger with SAE 10 oil. Work plunger up and down and refill.

Installation

1. Install valve lifters.
2. Install intake manifold as described under Cylinder Head Reconditioning in this section.
3. Install push rods.
4. Pivot rocker arms to engage push rods and adjust valves.

VALVE LASH ADJUSTMENT

1. Adjust valve as follows:
   a. Crank engine until mark on harmonic balancer lines up with center or "0" mark on the timing tab fastened to the timing chain cover, with the engine in the Number 1 firing position. This may be determined by placing fingers on the number 1 cylinder valves as the mark on the balancer comes near the "0" mark on the front end cover. If the valves are not moving, the engine is in the number 1 firing position. If the valves move as the mark comes up to the timing tab, the engine is in number 6 firing position and should be turned over one more time to reach the number 1 position.
   b. Valve adjustment is made by backing off the adjusting nut (rocker arm stud nut) until there is play in the valve push rod and then tighten to just remove all push rod to rocker arm clearance. This may be determined by rocking push rod as the nut is tightened. When rod does not readily move in relation to the rocker arm, the clearance has been eliminated. The adjusting nut should then be tightened an additional 1 turn to place the hydraulic lifter plunger in the center of its travel. No further adjustment is required.
   c. With the engine in the number 1 firing position as determined above, the following valves may be adjusted.
      Exhaust—1,3,4,8
      Intake—1,2,5,7
   d. Crank the engine one revolution until the pointer "O" mark and harmonic balancer mark are again in alignment. This is number 6 firing position. With the engine in this position, the following valves may be adjusted.
      Exhaust —2,5,6,7
      Intake—3,4,6,8
2. Install rocker arm covers using new gaskets, and tighten screws up to 2½ ft. lbs., after determining that cover hole reinforcements are in place.
3. Start engine and check for leaks at rocker arm covers.

NOTE: If noisy, refer to valve lash adjustment —engine running.

CYLINDER HEAD AND VALVE CONDITIONING

The condition of the cylinder heads 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 heads and valve to maintain correct valve stem to guide clearance, correctly ground valves, valve seats of correct width and correct valve adjustment.

Removal

NOTE: Removal procedure will vary, depending on whether or not the vehicle is equipped with air conditioning.

1. When removing the right cylinder head on vehicles equipped with air-conditioning, remove air compressor, mounting brackets, and lines as described in Section 15.
2. Drain cooling system and remove air cleaner.

3. Disconnect choke and throttle rod.
4. Disconnect fuel and vacuum lines from carburetor.
5. Disconnect coil primary wires. Disconnect coil to distributor clamp and remove distributor.
6. Remove spark plug wires from spark plugs and remove plugs.
7. Remove water outlet hose and heater hose, if so equipped, from intake manifold.
8. Disconnect temperature indicator sending unit wire at intake manifold.
9. Remove bolts attaching intake manifold to cylinder head. Remove manifold.
10. Remove fan belt.
11. Remove exhaust pipe stud nuts on cylinder head to be removed and remove heat control valve from right bank.
12. Disconnect generator field and armature wires from generator.
13. Remove bolts and french locks from exhaust manifolds. Remove exhaust manifolds. When removing left cylinder head, remove bolts from generator bracket and from brace on cylinder head. Remove bolt from generator mounting bracket on exhaust manifold and remove generator assembly.
14. Remove rocker arm cover screws and remove rocker arm cover.
15. Back off rocker arm nuts, pivot rocker arms to clear push rods and remove push rods.

    NOTE: Exhaust push rods are longer than inlet push rods.

16. Remove cylinder head bolts, cylinder heads and gaskets.

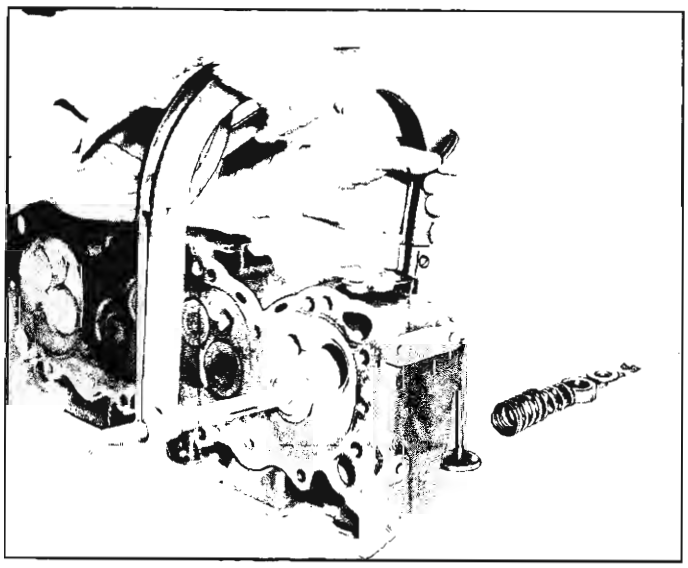

Fig. 117—Removing Valves

Disassembly

1. Place cylinder head assembly on its side on a bench and, using Tool J-8062, compress valve spring and remove valve locks. Release tool and remove cap, shield, spring, dampers and oil seal from valve stem. Repeat this operation on each valve (fig. 117).
2. Remove valves from bottom of cylinder head and keep them in their proper sequence for inspection and assembly.
3. Remove rocker arm nuts, lift rocker arms off studs and remove pivots from rocker arms.

Cleaning

1. Clean all carbon from combustion chambers and valve ports using Tool J-8089 (fig. 118).
2. Thoroughly clean the valve bores, using Tool J-8010 (fig. 119).

   NOTE: Replacement cylinder heads (fig. 120) have a cored water passage around each spark plug and drill spots on the bottom of the cylinder head for locating the cored water passages in the cylinder head. When installing replacement cylinder heads, holes must be drilled into water passages with a ¼" diameter drill.

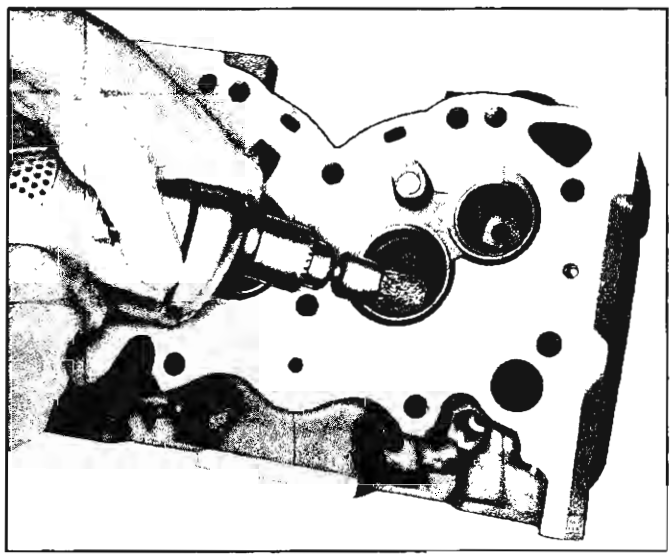

Fig. 118—Removing Carbon from Valve Chambers

3. Thoroughly clean spark plug cooling holes with a small wire or brush and flush out with cleaning solvent before assembly.
4. While cylinder heads are removed from the engine clean all deposits from hollow push rods, inside and outside; disassemble, clean and reassemble all valve lifters.
5. Clean valve stems and heads on a buffing wheel.

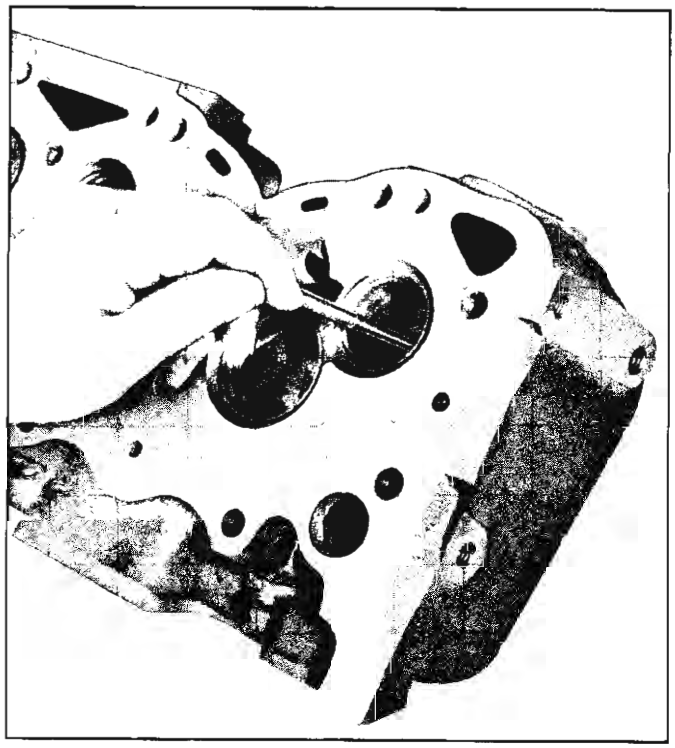

Fig. 119—Cleaning Valve Bores

6. Clean carbon deposits from piston and cylinders.
7. Wash all parts in cleaning solvent and dry them thoroughly.

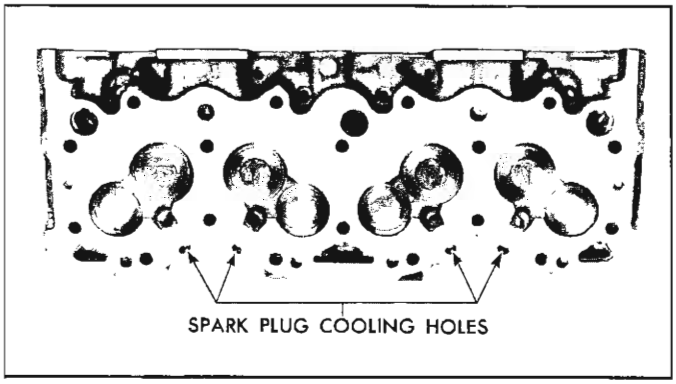

Fig. 120—Cylinder Head Spark Plug Cooling Holes

Inspection

1. Inspect the cylinder heads 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. Inspect exhaust valve seat inserts for cracks or looseness in the cylinder head.
4. Check fit of valve stems in their respective bores.

NOTE: Excessive valve to bore clearance may cause lack of power, oil consumption, rough idling and noisy valves. Insufficient clearance will result in noisy and sticky functioning of the valve and disturb engine smoothness of operation.

Intake valve stem to bore clearance should be .001″ to .003″ while exhaust stem clearance should be .002″ to .004″. Valve stem clearance may be accurately determined 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-valve guide clearance. If clearance is not within .002″ of above limits, use next oversize valve and ream bore to fit using suitable reamer of Tool set J-7049.

5. Check valve spring tension with Tool J-8056 (fig. 121).

NOTE: Spring should be compressed to 1 5/8″ at which height it should check 82 pounds. Weak springs affect power and economy and should be replaced if not within 10 lbs. of the above limits.

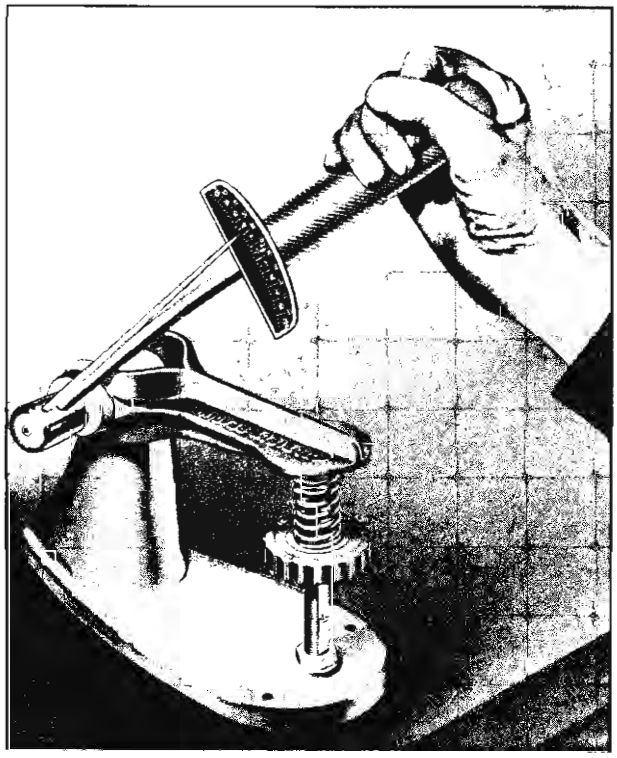

Fig. 121—Checking Valve Spring Tension

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

Repairs

Valve Guide Bore

Valves with oversize stems are available for inlet and exhaust valves in the following sizes, .003", .015", and .030". Use the 3/8" diameter reamer sizes from Reamer Tool Set J-7049, which are: J-7049-7 Standard; J-7049-4, .003" oversize, J-7049-5, .015" oversize and J-7049-6, .030" oversize to ream the bores for new valves (fig. 122).

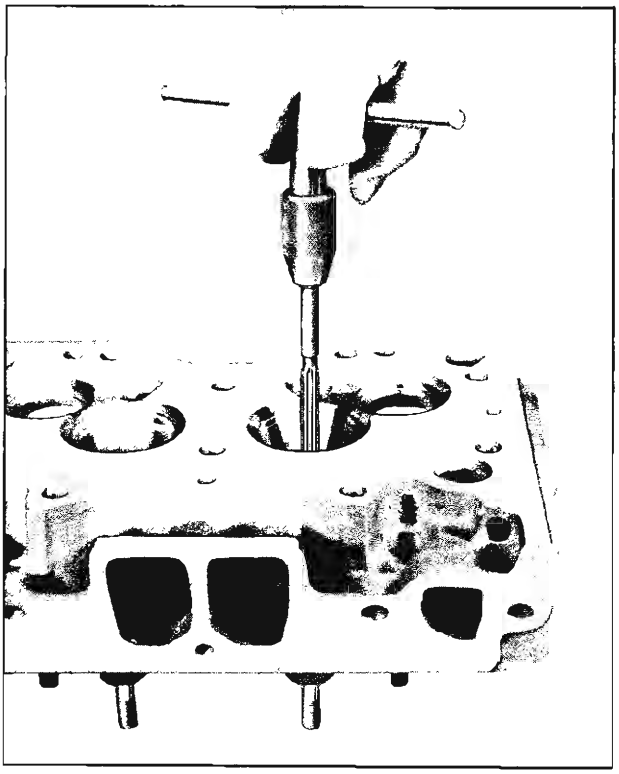

Fig. 122—Reaming Valve Bores

Rocker Arm Studs

Rocker arm studs that have damaged threads may be replaced with standard studs. If the studs are loose in the head oversize studs, available in .003" or .013" oversize, may be installed after reaming the holes with Tool J-5715 or .003" oversize and Tool J-6036 for .013" oversize.

1. Remove old stud by placing Tool J-5802 over the stud, installing nut and flat washer and removing stud by turning nut (fig. 123).
2. Ream hole for oversize stud, using Tool J-5715 for .003" oversize and Tool J-6036 for .013" oversize (fig. 124).
3. Coat press-fit area of stud with hypoid axle lubricant. Install new stud using Tool J-6880. Tool should bottom on head (fig. 125).

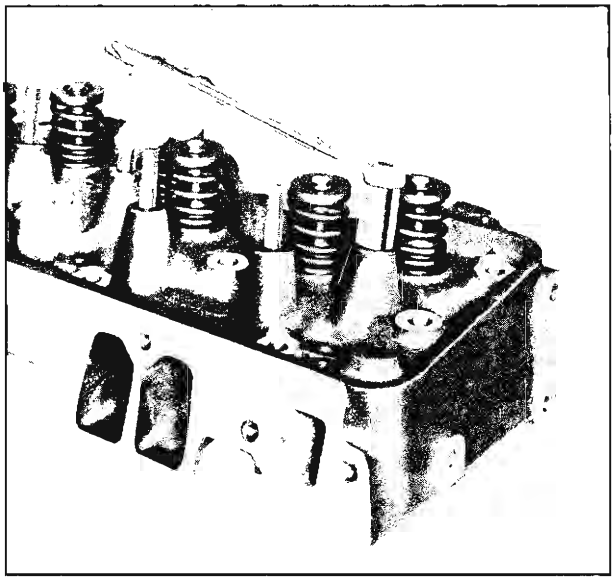

Fig. 123—Removing Valve Rocker Stud

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

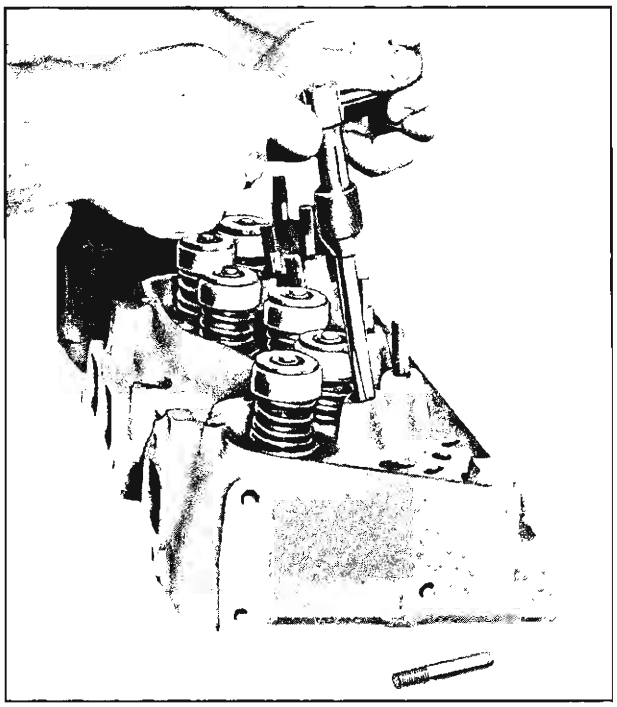

Fig. 124—Reaming Stud Hole

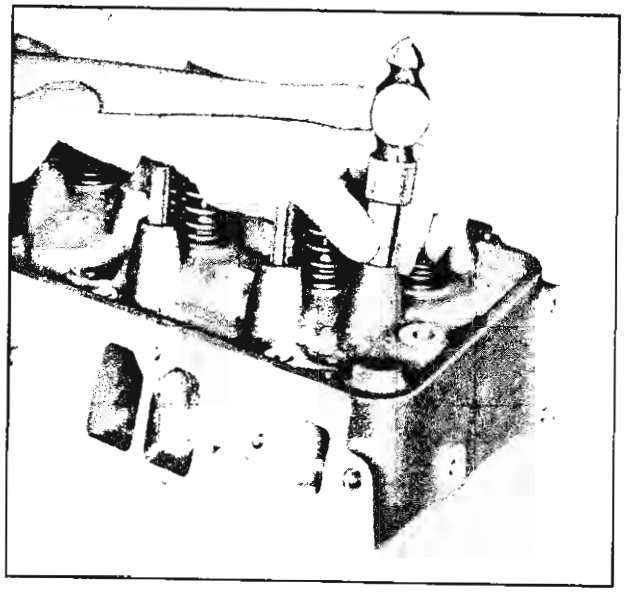

Fig. 125—Installing Valve Rocker Stud

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 the pilot in the guide.

Regardless of the methods used for valve seat repair, the final seat width in cylinder head should be as follows:

Inlet $\frac{3}{64}$" to $\frac{1}{16}$"
Exhaust $\frac{1}{16}$" to $\frac{3}{32}$"

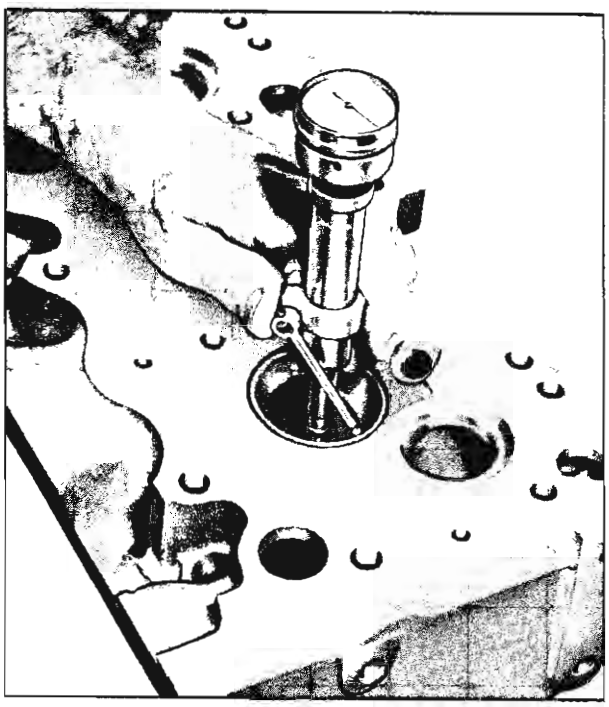

Fig. 126—Checking Valve Seat Concentricity

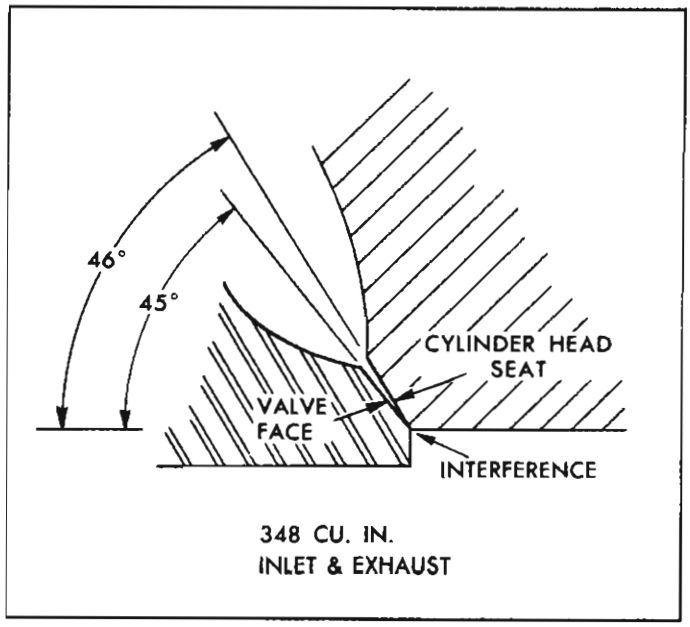

Fig. 127—Relation of Valve and Seat Angles

The seats should be concentric within .002" indicator reading (fig. 126).

Valve seat angle on all 348 cu. in. engines should be 46°. Always dress stones to proper angle before grinding valve seat.

NOTE: Inlet valve face to seat angles have an interference fit as shown in Figure 127.

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 premature breakage, burning and pre-ignition 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.

1. If necessary, dress the valve refacing machine grinding wheel to make sure it is true and smooth.
2. Set chuck angle at 45° mark for grinding valves.
3. After setting chuck angle, insert valve and grind carefully.

Assembly

1. Clean valves, valve seats, valve bores and cylinder heads thoroughly.
2. Insert the valve in the port and set the rotator (if used), valve spring and damper in place with close coiled end of spring against cylinder head and in-

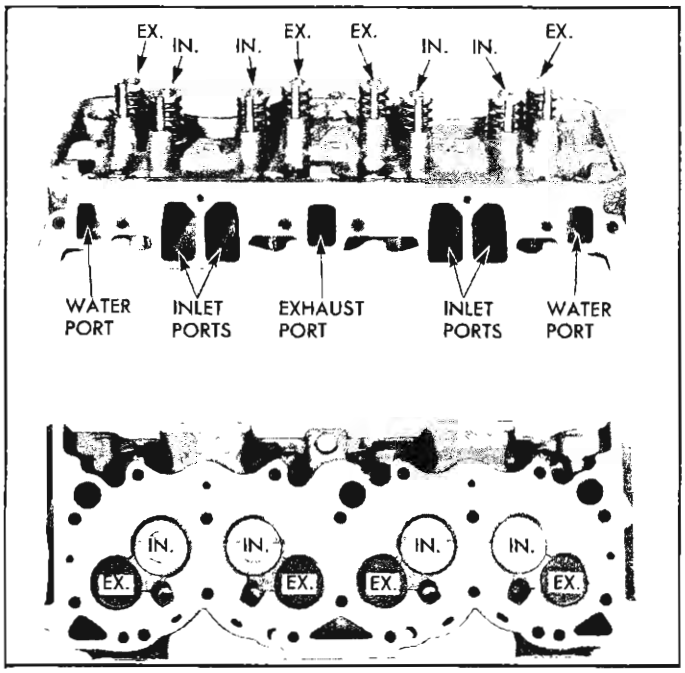

Fig. 128—348 Cu. In. Cylinder Head

stall shield on spring.

3. Install cap and compress the spring with Tool J-8062 (fig. 117).

4. Install oil seal in lower groove on stem, making sure seal is flat and not twisted in groove. Install valve locks and release compressor tool, making sure locks seat properly in upper groove on stem. Check each seal by placing a vacuum cup or similar device over end of valve stem and against cap to make sure no air leaks past oil seal.

   A vacuum cup can be made from a small syringe and a high voltage shield such as (Sun Electric #1578) shown in Figure 129.

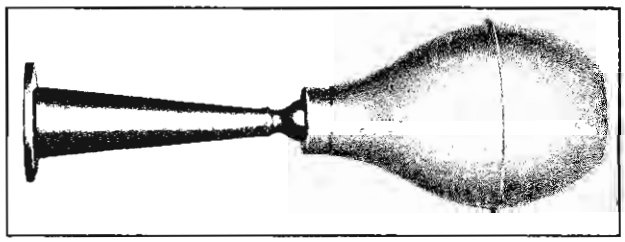

Fig. 129—Vacuum Cup

5. Assemble the remaining valves, valve springs, dampers, spring caps, shields, oil seals and valve locks in the cylinder heads in the same manner.

Installed Height of Valve Springs

Check the installed height of the valve springs, using a narrow, thin scale to measure from the top of the shim or spring seat, in the head to the top of the valve spring shield (fig. 130). If this is found in excess of $1^{23}/_{32}$" (all 348 cu. in. engines) install a valve spring seat shim.

Fig. 130—Checking Installed Height of Valve Springs

Shims are available in $1/16$" thicknesses, and should be used to obtain installed spring heights as follows:

Turbo-Thrust (R.P.O. 576) $1\frac{5}{8}$" to $1^{23}/_{32}$" Exhaust and Inlet

**Turbo-Thrust (R.P.O. 590) $1^{21}/_{32}$" to $1^{23}/_{32}$" Exhaust and Inlet

Super Turbo-Thrust (R.P.O. 573A) $1\frac{5}{8}$" to $1^{23}/_{32}$" Exhaust and Inlet

**Super Turbo-Thrust (R.P.O. 573B) $1^{21}/_{32}$" to $1^{23}/_{32}$" Exhaust and Inlet

Turbo-Thrust (Special R.P.O. 575) $1\frac{5}{8}$" to $1^{23}/_{32}$" Exhaust and Inlet

Spring heights listed are as measured to the top of the valve spring shield which is .030 ($1/32$) thick; thus, the actual operating height of the spring itself is $1/32$ less than the dimensions listed.

**Cylinder Heads with larger valves and dual valve springs (heights are for outer spring).

NOTE: If springs are to be changed with cylinder head installed, J-5892 Spring Compressor may be used to compress springs for removal or installation. Compressed air or a screwdriver may be used to hold the valves in place, used through the spark plug hole.

Installation

NOTE: Long reach spark plugs with copper gaskets shown in Figure 131 must be used with replacement cylinder heads.

1. Thoroughly clean out cylinder head bolt holes in

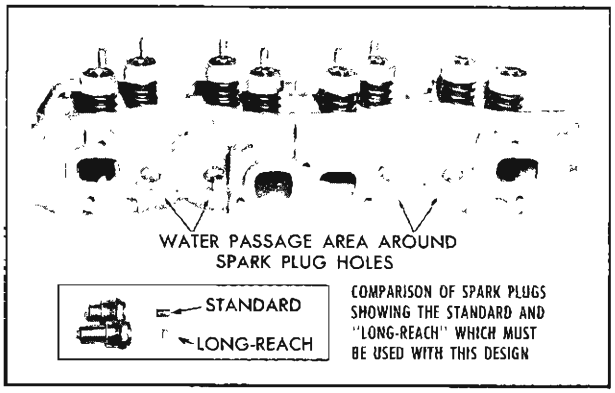

Fig. 131—Cylinder Head Spark Plug (Long Reach)

the block and clean cylinder bolt threads. Then place new cylinder head gaskets in position on cylinder block. Use a good head gasket paste with these steel gaskets.

NOTE: Cylinder head gaskets with spark plug cooling holes Figure 132 must be used on 1961, 348 cu. in. engines.

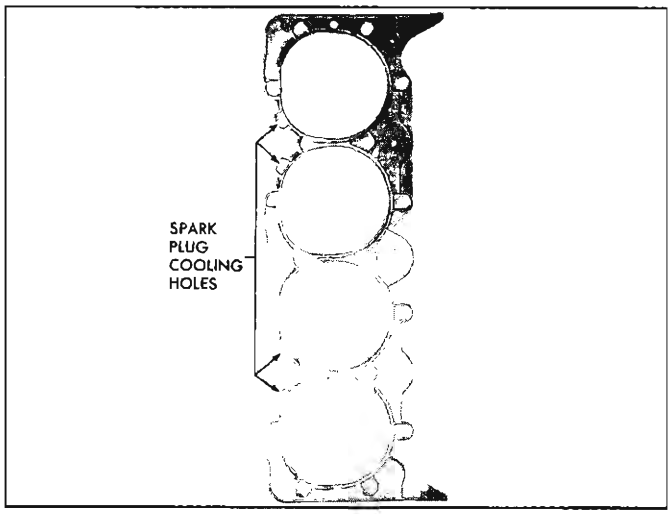

Fig. 132—Cylinder Head Gasket

2. Place the cylinder heads in position over the two dowel pins in the block.
3. Coat threads of all cylinder head bolts with a suitable oil and water thread sealing compound such as G.M. Perfect Seal.
4. Install bolts finger tight.
5. Tighten the cylinder head bolts a little at a time in the order shown (fig. 133). The final tightening should be 60-70 ft. lbs.
6. Install 16 valve lifters and 16 push rods as described below.

   NOTE: Exhaust valve rockers use long push rods, and inlet valve rockers use short push rods.

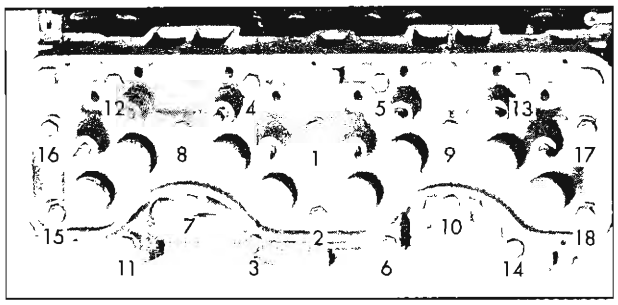

Fig. 133—Head Bolt Torque Sequence

Insert pivots in valve rocker arms, and install rocker arms over studs while engaging push rod end with hardened tip, then install nuts on rocker arm studs.

NOTE: Exhaust valve push rods are longer than inlet valve push rods.

7. Insert pivots in valve rocker arms, install rocker arms over studs and install nuts.

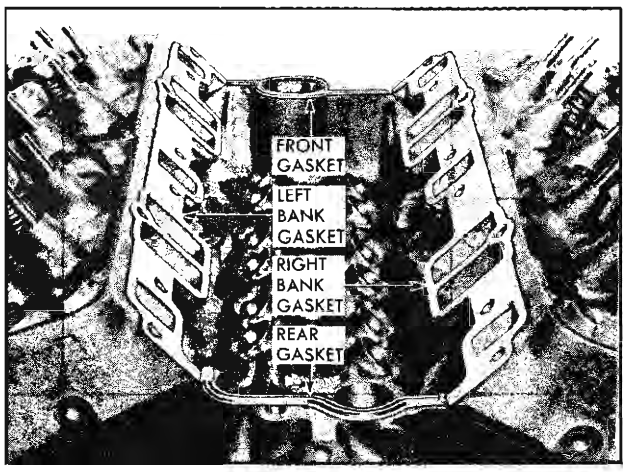

Fig. 134—Intake Manifold Gasket Location

8. Clean gasket faces of manifolds and cylinder heads.
9. Install intake manifold end and side gaskets on cylinder block as shown in Figure 134.
10. Install intake manifold (fig. 136) and install bolts. Tighten finger tight. Tighten bolts a little at a time according to sequence shown in Figure 136. Final bolt torque should be 25-35 ft. lbs.
11. Install temperature indicator element in intake manifold.
12. Install intake manifold hose to radiator core.
13. Install exhaust manifolds, bolts and french locks. Tighten three center bolts 25-30 ft. lbs. torque. Install french locks under the two bolts on each end and torque to 15-20 ft. lbs., bend ends of french locks against bolt heads.
14. Clean mating surfaces and install exhaust pipes using new gaskets.

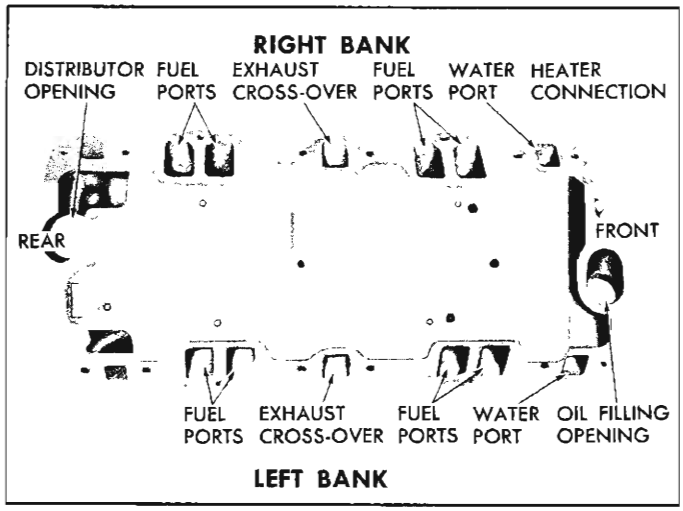

Fig. 135—Intake Manifold

15. Clean all spark plugs with abrasive type cleaner, inspect for damage and set gap at 0.35" using a round feeler gauge. See Section 9 Electrical for spark plug diagnosis chart.
16. Place new gaskets on plugs and install. Tighten to 20-25 ft. lbs. torque. See Figure 131.
17. Install distributor clamp and distributor and coil wiring. Roughly set timing, by adjusting for points just breaking with engine in number 1 firing position.
18. Connect spark plug wires to their respective terminals and install generator field and armature wires.
19. Install carburetor if removed. Connect choke and throttle linkage.
20. Connect gasoline and vacuum lines to carburetor.
21. Clean and install air cleaner and connect air cleaner intake.
22. Fill cooling system and check for leaks.
23. Normalize engine and re-torque cylinder head bolts.
24. Install new rocker arm cover gaskets and rocker arm covers as shown in Figure 137.
25. Check ignition timing as outlined in Section 7.

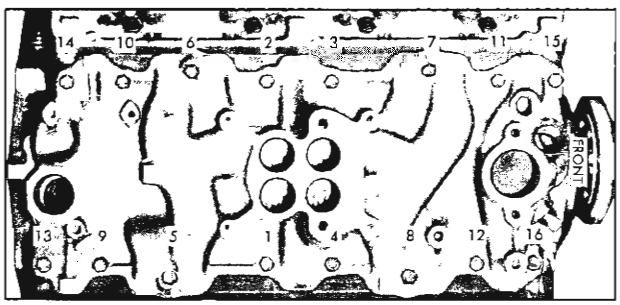

Fig. 136—Intake Manifold Bolt Torque Sequence

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.

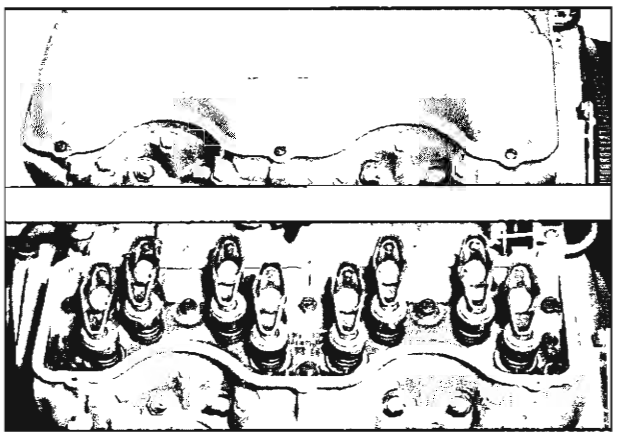

Fig. 137—Rocker Arm Covers and Gaskets

1. Remove valve covers and gaskets.
2. Remove rocker arms and balls.
3. Attach Tool J-8520 to stud as shown in Figure 138.
4. Position clamp on Tool J-8520.
5. Position indicator Tool J-8520 to push rod as shown in Figure 138.

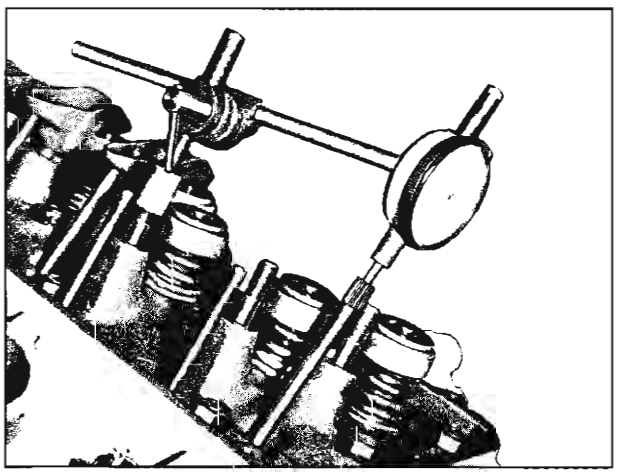

Fig. 138—Checking Camshaft Lobe Lift

NOTE: Make sure push rod is in the lifter socket and in line with the indicator.

6. 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.
7. 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 (lifter on top of cam lobe "toe").

NOTE: Ground primary coil wire when cranking engine.

8. Compare the total lift recorded from the dial indicator Tool J-8520 with specifications.
9. Continue to rotate the engine until the indicator reads zero. This will be a check on the accuracy of the original indicator reading.
10. If camshaft readings for all lobes are within specifications, remove indicator assembly Tool J-8520.
11. Install all push rods and valve rocker arms and balls. Adjust valves as outlined under *Service Operations—Valve Lash Adjustment.*
12. Replace valve rocker covers and gaskets.
13. Start engine and check for leaks.

CAMSHAFT—WEAR LIMIT

1961 348—V8	Turbo Thrust and Super Turbo Thrust		Turbo Thrust—Special Super Turbo Thrust—Special	
	Inlet	Exhaust	Inlet	Exhaust
New	.229" ± .002"	.235" ± .002"	.232" ± .002"	.235" ± .002"
Worn	.224" + .003" — .002"	.230" + .003" — .002"	.227" + .003" — .002"	.230" + .003" — .002"

OIL PAN

348 cubic inch V-8 Engine with Three-Speed, Four-Speed and Automatic Transmissions.

Removal

1. Raise front of vehicle and place on stand jacks or raise vehicle on a hoist.
2. Remove oil pan drain plug and drain crankcase oil.
3. Drain water and disconnect the radiator hoses at radiator.
4. Disconnect battery ground strap at engine.
5. Disconnect clutch pedal push rod (refer to Section 11 of this manual) at clutch pedal control, intermediate lever and shaft assembly.
6. Remove clutch pedal control, intermediate lever and shaft assembly at frame mounting bracket leaving shaft assembly attached to engine.
7. Remove carburetor fuel feed pipe at fuel pump. Remove fuel pump from engine.

NOTE: Hose connected from fuel pump to fuel tank feed pipe, need not be removed.

8. Remove accelerator control rod from accelerator control rod lever.
9. Remove oil level gauge tube.
10. If power brake equipped, remove power brake vacuum hose at valve on engine manifold.
11. Disconnect generator brace and rotate away from engine.
12. Remove transmission lower control rods at transmission shift levers.
13. Remove exhaust pipe flange to exhaust manifold, nuts and gasket. Lower exhaust pipe and muffler assembly.
14. Remove oil filter.
15. Loosen transmission mounting bolts.
16. Remove nut, washer and long bolt from each front engine mounting.

NOTE: Turn crankshaft so harmonic balancer key-way slot is at bottom of engine. This will index crankshaft counterweights so baffle in oil pan will clear counterweights.

17. Engine may be raised from below at harmonic balancer.

NOTE: Engine will have to be raised approximately 2¾" to clear from crossmember for oil pan removal. Raise engine until transmission housing comes in contact with underbody toe pan. Note clearance at fan blade and shroud while lifting engine and adjust for clearance as required.

18. Remove oil pan bolts, using a Universal socket and long extension handle. Tilt oil pan, while removing.

NOTE: Removal of the oil pan with Turboglide transmission, installed, is identical to the procedure above with one exception. Remove the transmission control lever cross-shaft at transmission shifter lever and shaft assembly.

Installation

1. Thoroughly clean all gasket sealing surfaces.
2. Install side gaskets on pan rails, using grease as a retainer. Rear end of side gaskets lap rear end gasket. Tuck front ends of side gaskets into gap between front end cover seal groove and cylinder block.

3. Install rear oil pan seal in groove in rear main bearing cap. Tuck ends into groove openings in cylinder block.
4. Install oil pan front seal in groove in front end cover, with ends butting side gaskets.
5. Install oil pan and pan to cylinder block bolts. Tighten bolts to 10-15 ft. lbs. torque.
6. Install heat valve, and exhaust pipes or pipe.
7. Install oil drain plug.
8. Lower engine on front mounts, insert bolts and tighten nuts. Remove lifting equipment.
9. Fill crankcase with oil, start engine and check for oil pressure and leaks.

OIL PUMP

The oil pump (fig. 139) consists of two gears and a pressure relief valve enclosed in a two-piece housing and driven from the distributor drive which in turn is driven by a helical gear on the camshaft.

NOTE: The oil pump has a baffle incorporated on the intake pipe and screen assembly (9) shown in Figure 139. This baffle eliminates pressure loss due to sudden surging stops.

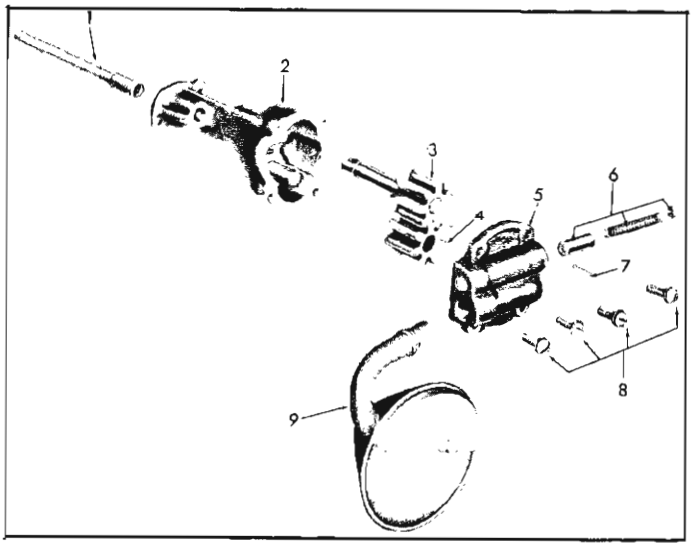

Fig. 139—Oil Pump Exploded

1. Shaft Extension
2. Pump Body
3. Drive Gear and Shaft
4. Idler Gear
5. Pump Cover
6. Regulator Valve
7. Retaining Pin
8. Screws
9. Intake Pipe and Screen

The pump cover is equipped with a pressure regulator valve that regulates oil pressure to approximately 45 psi at 2000 rpm.

The pump intake is of the fixed screen type. The pick-up point is just above the bottom of the oil pan. A mesh screen filters out small particles of dirt and sludge which may be present. In the event that the screen becomes clogged, a valve in the center will allow the pump to pick up oil, by-passing the screen.

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

Removal and Disassembly

1. Remove oil pan.
2. Remove pump to rear main bearing cap bolt and remove pump, extension shaft and collar, as shown in Figure 140.
3. Disconnect pump shaft from extension.
4. Remove pump cover attaching screws, cover idler gear and drive gear and shaft.
5. Mount pump cover in a soft-jawed vise and pull pipe from cover (if screen or pipe needs replacing).
6. Wash all parts in cleaning solvent and dry by using compressed air, if available.

Inspection

Should any of the following conditions be found during inspection operations it is advisable to replace pump assembly.

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 gear.
5. Check the oil pick-up screen for damage to screen, by-pass valve or body. Check for oil in air chamber.

Assembly and Installation

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. Clamp suction pipe and screen assembly in vise, being careful not to collapse pipe, tap cover on pipe with a soft tip hammer (if screen or pipe was removed).
4. Install cover and attaching screws. Tighten screws to 6 to 9 ft. lbs. and check to see that shaft turns freely.
5. Assemble collar end of extension shaft assembly over pump drive shaft, aligning tang of extension shaft with slot in end of pump drive shaft.
6. Assemble pump and extension shaft to rear main bearing cap as shown in Figure 140, aligning slot on top end of extension shaft with drive tang on lower end of distributor drive shaft.

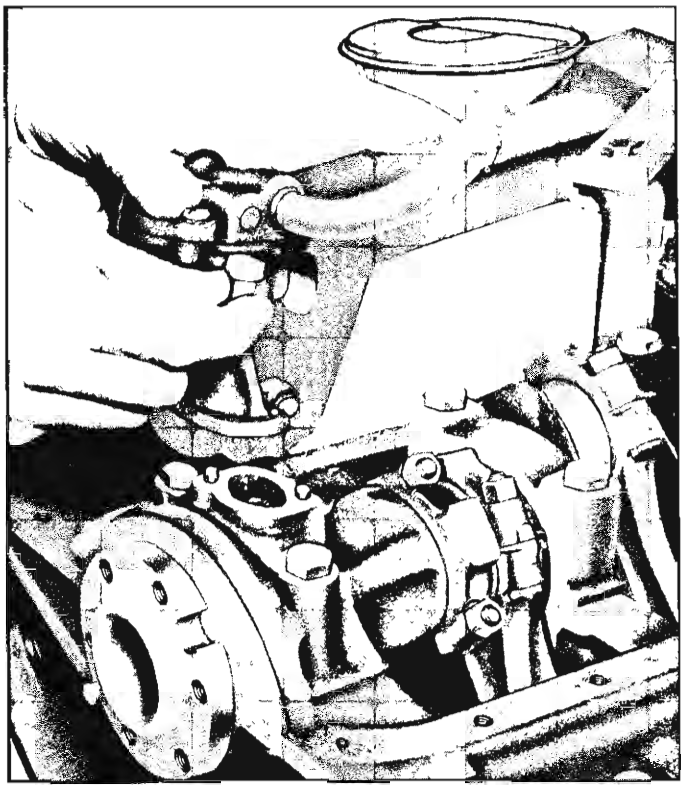

Fig. 140—Oil Pump Removal and Installation

NOTE: Install oil screen with bottom edge of screen pointed toward front of engine at a 5° angle down from oil pan rail line.

7. Install oil splash shield on rear bearing cap if removed then, install pump to rear bearing cap bolt and tighten to 45 to 50 ft. lbs. (fig. 141).
8. Install oil pan.

HARMONIC BALANCER

Removal

1. Drain radiator and disconnect radiator hoses.

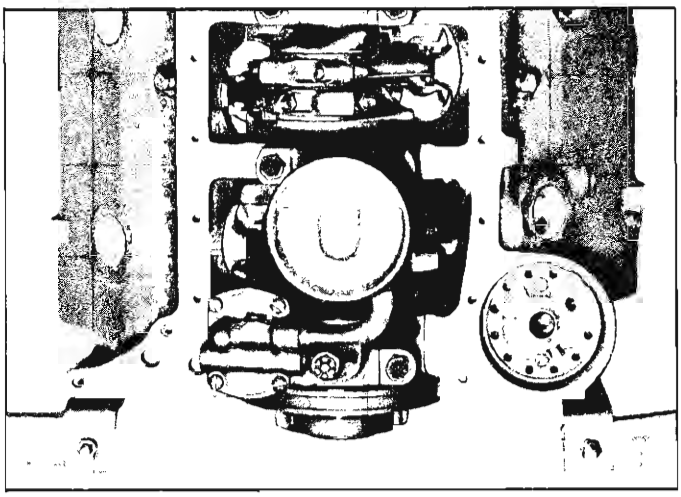

Fig. 141—Oil Pump Installed

2. Remove fan belt, fan and pulley.
3. Remove bolts from fan shroud and remove shroud.
4. Remove radiator core support bolts and remove radiator core. Notice number of spacer shims removed, if any.
5. Remove harmonic balancer pulley bolts and remove pulley.
6. Remove harmonic balancer retaining bolt and washers.
7. Install tool J-6978 to harmonic balancer and turn puller screw to remove balancer from crankshaft (fig. 142).
8. Remove tool from balancer.

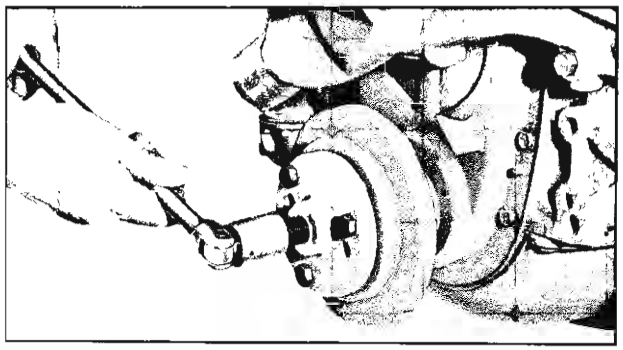

Fig. 142—Removing Balancer

Installation

1. Coat front cover seal contact on balancer with engine oil.
2. Position balancer on crankshaft, aligning the key on the crankshaft with the keyway in balancer.
3. Using Tool J-5990, drive balancer on crankshaft until the hub bottoms on the crankshaft timing sprocket (fig. 143).
4. Install harmonic balancer pulley.
5. Install fan pulley and fan blade to water pump hub and tighten bolts 10-20 ft. lbs.

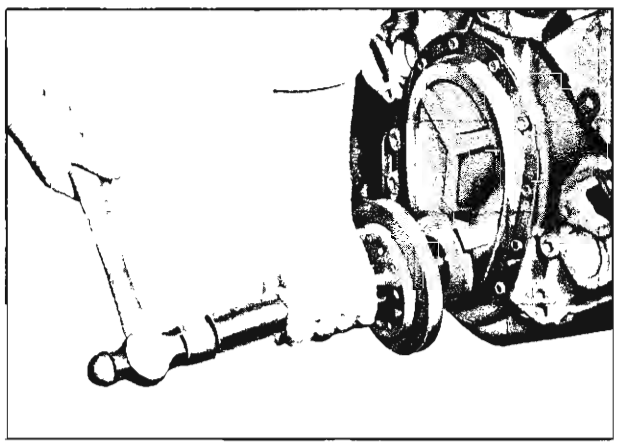

Fig. 143—Installing Harmonic Balancer

6. Lay fan shroud over fan blade and lower radiator into place.
7. Install radiator bolts and install shroud-to-radiator retaining bolts.
8. Install fan belt and adjust as described in Section 7.
9. Install radiator hoses.
10. Fill cooling system, start engine and check for leaks.

CRANKCASE FRONT-END COVER

Removal

1. Remove harmonic balancer.
2. Remove oil pan.
3. Remove heater hose from water pump if so equipped. Remove water pump from cylinder block.
4. Remove crankcase front end cover attaching screws and remove front end cover and gaskets.

Repairs

Crankcase Front End Cover Oil Seal Replacement

1. Pry old 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-0996 (fig. 144).

CAUTION: Support cover at sealing area.

Installation

1. Make certain that cover mounting face and cylinder block front end plate face are clean and flat.
2. Make certain oil slinger is in place against crankshaft timing sprocket.
3. Coat the oil seal with light grease and, using a new cover gasket, install cover and gasket over dowel pins in cylinder block.
4. Install cover screws and tighten to 6-8 ft. lbs. torque.
5. Install oil pan.
6. Install harmonic balancer and water pump.
7. Start engine and check for leaks.

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.

8. Remove harmonic balancer with Tool J-6978.
   a. Pry old seal out of cover from the front with a large screwdriver, being careful not to damage the seal surface on the crankshaft.
   b. 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.

TIMING CHAIN OR SPROCKET REPLACEMENT

1. Remove harmonic balancer and crankcase front end cover as previously described. Remove crankshaft oil slinger.

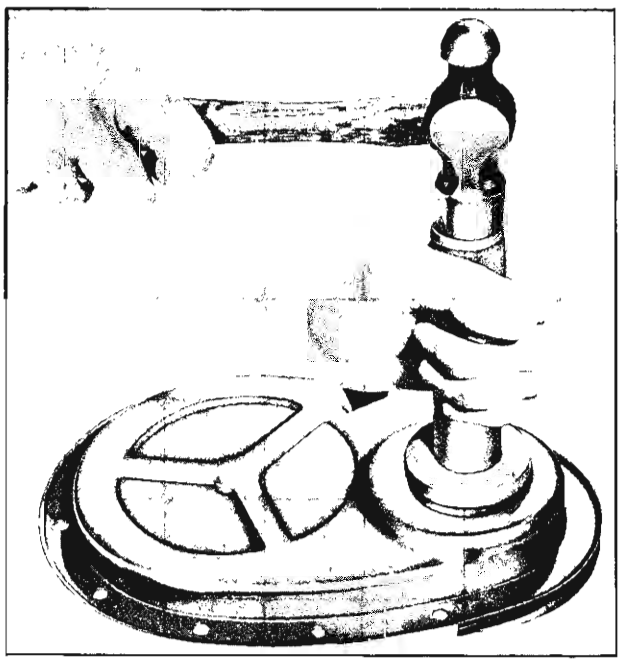

Fig. 144—Installing Oil Seal

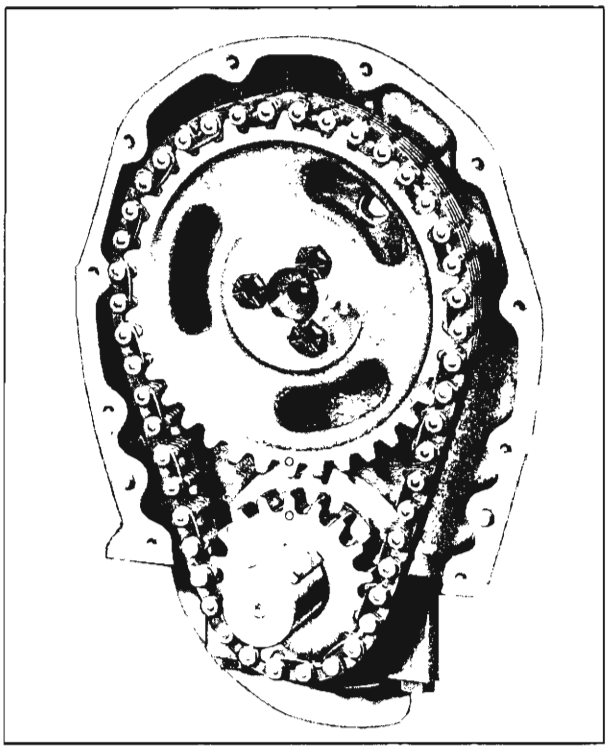

Fig. 145—Timing Sprocket "O" Marks

2. Crank engine until "O" marks on camshaft and crankshaft sprockets are in alignment (fig. 145).
3. Remove three camshaft sprocket-to-camshaft bolts.
4. Remove camshaft sprocket and timing chain together. Sprocket is a light press fit on camshaft for approximately ⅛". If sprocket does not come off easily, a light blow with a plastic-faced hammer on the lower edge of the camshaft sprocket should dislodge the sprocket.
5. If crankshaft sprocket is to be replaced, remove, using Tool J-5825. Install new sprocket, aligning key and keyway, using J-5590.
6. Install timing chain on camshaft sprocket. Hold the sprocket vertical with the chain hanging below, and orient to align "O" marks on camshaft and crankshaft sprockets.
7. Align dowel in camshaft with dowel lobe in camshaft sprocket and install sprocket on camshaft (fig. 146).

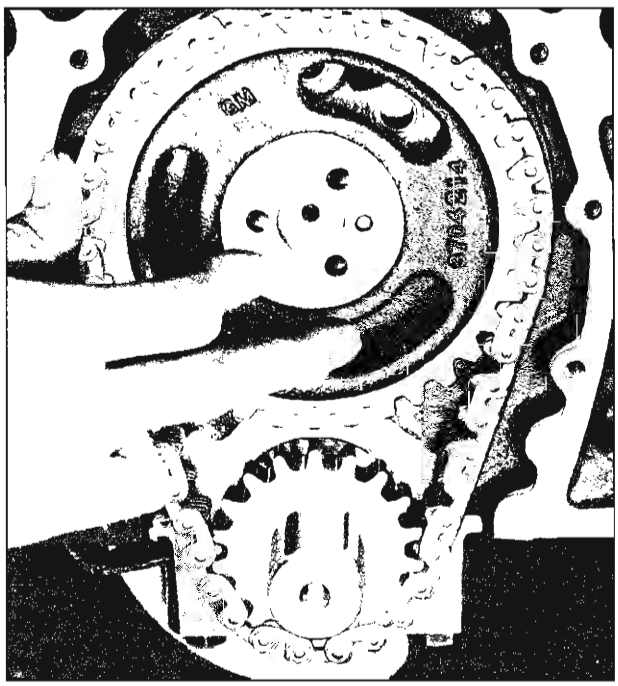

Fig. 146—Installation of Timing Chain

NOTE: Do not attempt to drive cam sprocket on shaft as welsh plug at rear of engine can be dislodged.

8. Draw camshaft sprocket onto camshaft, using the three mounting bolts. Tighten to 15-20 ft. lbs. torque.
9. Lubricate timing chain with engine oil and install crankcase front end cover and gasket.
10. Install harmonic balancer as previously described.

CAMSHAFT

Removal

1. Remove valve lifters as described under Service Operations.
2. Remove fuel pump and fuel pump push rod as described in Section 10.
3. Remove grille assembly. See Front End Sheet Metal, Section 14.
4. Drain and remove radiator.
5. Remove harmonic balancer.
6. Remove timing chain cover and gasket.
7. Remove timing chain and camshaft sprocket as previously described.
8. Install a $\frac{5}{16}$"-18x4" puller bolt (a tee handle can be made by welding two $\frac{5}{16}$"-18x4" bolts together. Remove camshaft from engine (fig. 147).

CAUTION: All camshaft journals are the same diameter and caution must be used in removing camshaft to avoid damage to bearing.

Inspection

The camshaft bearing journals are 1.8682"-1.8692" in diameter. The journals 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. 148). 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

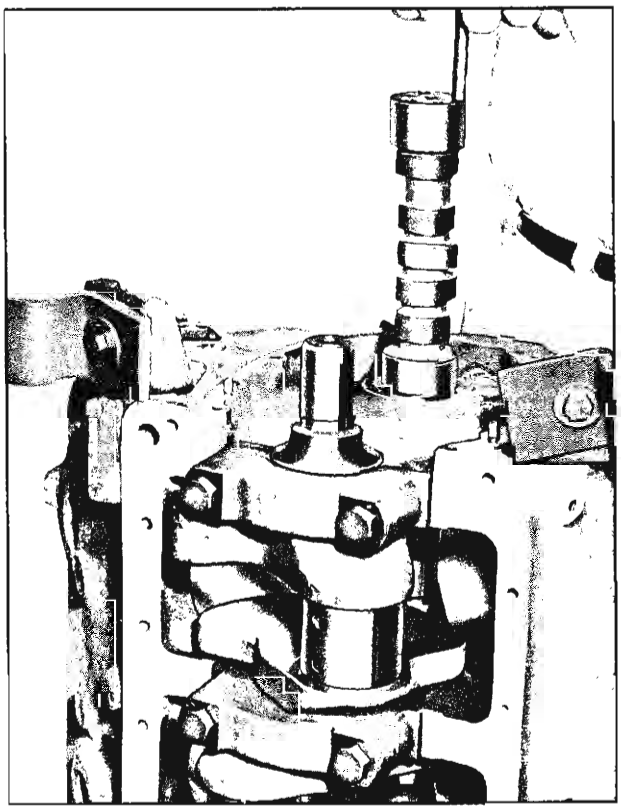

Fig. 147—Removing Camshaft

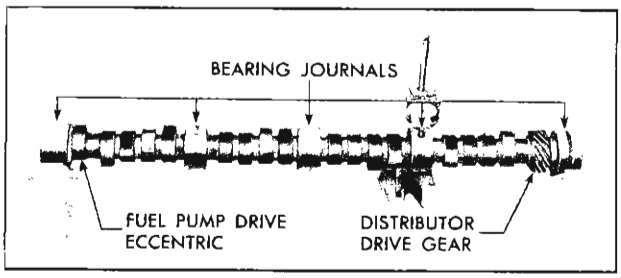

Fig. 148—Checking Camshaft Alignment

should be straightened. Examine the camshaft bearings and if any bearing needs replacement, replace all bearings.

Installation

1. Install 5/16"-18x4" Tee handle bolt (as described in Step 8 of Removal) in camshaft. Lubricate camshaft and install camshaft in engine. Remove 5/16"-18x4" bolt or "Tee handle."
2. Install timing sprocket and chain as previously described.
3. Install timing chain cover and harmonic balancer as previously described.
4. Install grille assembly as described in Section 14.
5. Install radiator and hoses.
6. Install valve lifters, valve mechanism, intake manifold and distributor.
7. Install fuel pump push rod, mounting plate and pump as described in Section 10.

CAMSHAFT BEARINGS

Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul, or without complete disassembly of the engine. To replace bearings without complete disassembly remove the camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Fasten connecting rods against sides of engine so they will not be in way while replacing camshaft bearings.

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.

   NOTE: This procedure is based on removal of the bearing nearest center of the engine first. With this method a minimum amount of turns is necessary to locate the Remover in position to remove next bearing.

2. Install nut on puller screw and turn to end of threads on puller screw using Tool J-6098.
3. Index pilot over screw with open end toward nut on puller screw.
4. Insert Remover with shoulder toward number three bearing, making sure a sufficient amount of threads are engaged on the puller.
5. Using two wrenches, hold screw shaft with one wrench while turning the front nut with the other wrench (fig. 149). After removing bearing from block, repeat operation for number two bearing.
6. Remove tool and reassemble tool to remove number four bearing from rear of engine.
7. Assemble remover on driver handle and remove front and rear bearing.

Installation

Refer to Figures 150 and 151.

1. The number one or front camshaft bearing should be installed first. This gearing will act as a guide for the tool and center the number two and three bearing being pulled in place. Install the front bearing with bearing installer assembled to the drive handle, then drive bearing in.

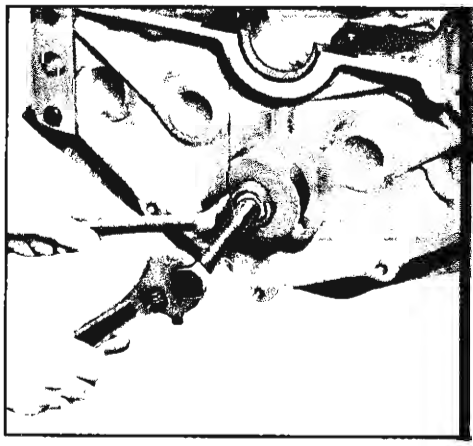

Fig. 149—Removing No. 4 Camshaft Bearing

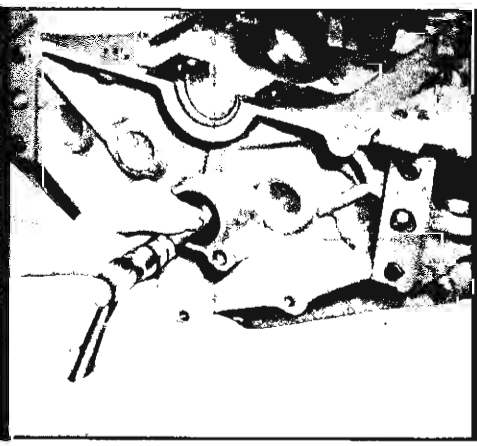

Fig. 150—Installing Rear Camshaft Bearing

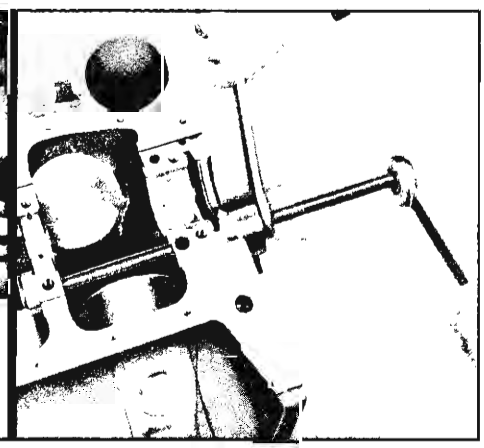

Fig. 151—Installing No. 4 Camshaft Bearing

CAUTION: Align oil holes in bearing with oil holes in block before driving or pulling in place.

2. Install nut on puller screw and turn to end threads on puller screw.
3. Index pilot screw, with open end of pilot toward nut.
4. Index number three camshaft bearing on screw, then turn installer on screw with shoulder toward bearing making sure a sufficient amount of threads are engaged on the puller.
5. Turn nut on puller screw to exert pressure on pilot until bearing is installed.
6. Remove installer and repeat operation 4 and 5 for two and four bearing.
7. Install rear bearing in same manner as number one bearing. Caution should be observed while installing rear bearing due to smaller size of oil pressure holes in rear camshaft bearing. Improper alignment of rear camshaft bearing will result in restricted oil pressure to valve train.
8. Install a new camshaft end plug in back end of the cylinder block at the rear camshaft bearing.

NOTE: Plug should be installed flush to 1/32" deep to maintain level surface on rear of cylinder block.

MAIN BEARINGS

Adjust in Vehicle

The main bearings are of the precision insert type and do not utilize shims for adjustment. If the clearances are found to be excessive, a new standard or oversize bearing insert, both upper and lower halves, will be required.

NOTE: If, for any reason, main bearing caps are replaced, shimming may be necessary. Laminated shims for each cap are available for service. Shim requirement will be determined by bearing clearance.

The clearance may be checked with the engine in the vehicle by the plastigage method as described under *Engine Overhaul*. When one bearing is being checked, all the other main bearing caps must be in place and at required torque. The inspection and end play check should also be made as outlined under *Engine Overhaul*.

Bearing Replacement (Engine in Vehicle)

NOTE: Main bearings may be replaced without removing the crankshaft.

1. Remove oil pan.
2. Remove spark plugs.
3. Remove cap on main bearing requiring replacement and remove bearing from shell.
4. Install a main bearing shell 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 usual 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 plain (unnotched) end of shell between crankshaft and indented or notched side. Rotate the bearing into place.
7. Install new bearing shell in bearing cap.
8. Check bearing clearance as outlined under *Engine Overhaul*.
9. Install oil pan.
10. Install spark plugs.

REAR MAIN BEARING OIL SEAL REPLACEMENT

1. Remove rear bearing cap.
2. Remove old seal from groove, prying from bottom, using a small screwdriver as shown in Figure 152.

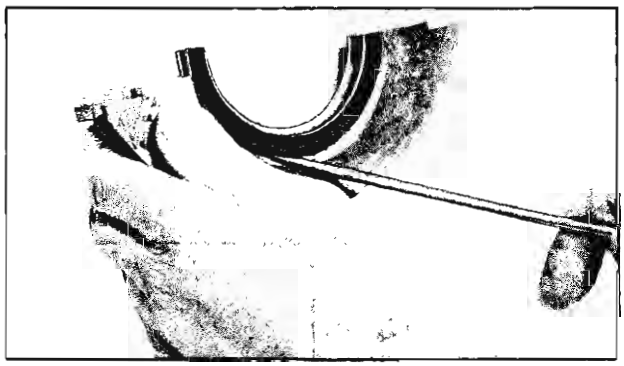

Fig. 152—Removing Seal from Cap

3. Insert a new seal well lubricated on lip only (keep oil off of parting line surface, this is glue treated) with engine oil (lip facing toward the front of engine) with index finger and thumb, roll seal in place.

NOTE: Always replace upper and lower seal as a unit.

4. Engine in Vehicle:
   a. To replace the upper half of the seal, use a small hammer and tap a brass pin punch on one end of seal (fig. 153) until it protrudes far enough to be removed with pliers as shown in Figure 153.
   b. Insert a new seal well lubricated on lip only (keep oil off of parting line surface, this is glue treated) with engine oil in groove, gradually push with a hammer handle until seal is rolled into place and install bearing cap.

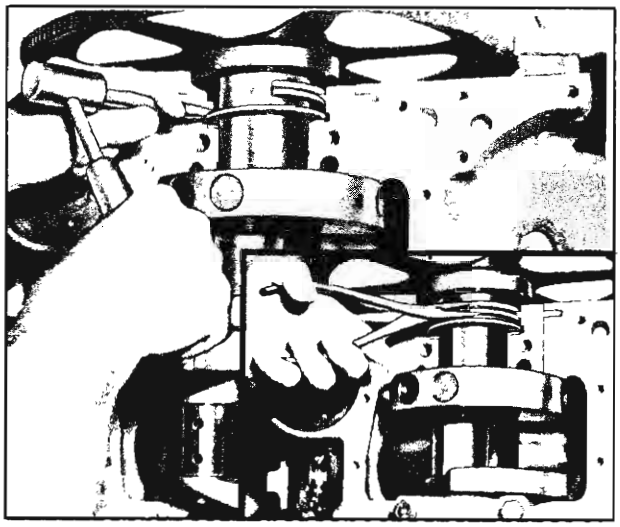

Fig. 153—Removing Oil Seal

FRONT MOUNTS—REPLACE

1. Remove distributor cap.
2. Remove fuel pump and remove nut, bolt and washer at "B" (fig. 154) from mount.
3. Raise engine and remove three bolts and lockwashers at point "A" (fig. 154) bolts may be removed from bottom of vehicle with a universal socket wrench, using a long extension.

   NOTE: Do not remove bolts at "C" location for engine mount removal (fig. 154).

4. Replace mounts and install bolts and lockwashers at point "A" (fig. 154) and lower engine into place.
5. Replace long bolts, washers and locknuts as shown in Figure 154 inset.

OIL FILTER VALVE—REPLACE

1. Remove oil pan drain plug and drain crankcase.
2. Remove oil filter can and cartridge.
3. Remove bolts holding oil filter valve.
4. Remove valve and seal (fig. 155).
5. Check spring and fiber valve for operation.
6. Check valve for cracks, if cracked or broken replace valve.

   NOTE: Clean valve chamber in cylinder block.

7. Install valve assembly with a new seal. Install bolts and tighten 15-18 ft. lbs. torque.

   NOTE: Valve assembly can be installed in two positions. Positioning valve away from engine as shown in Figure 155 is preferable for inspection from beneath the vehicle.

8. Replace oil filter can with a new cartridge and tighten holding bolt 20-30 ft. lbs. torque.
9. Add oil to engine and check for leaks.

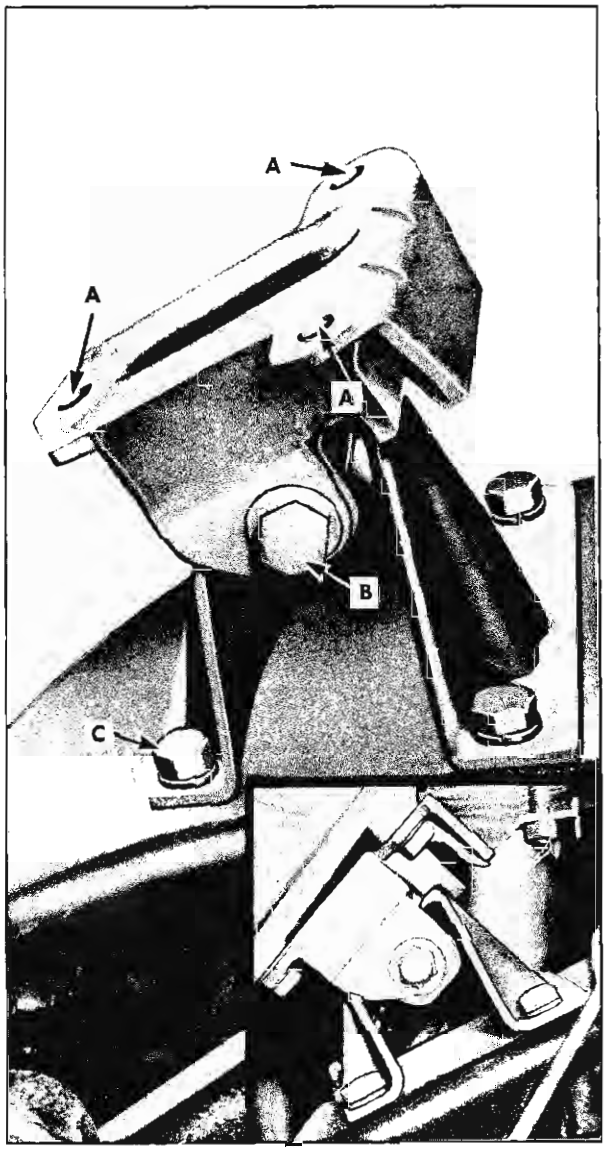

Fig. 154—Front Engine Mounts

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.

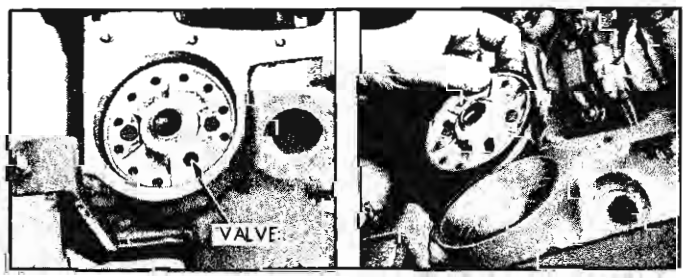

Fig. 155—Oil Filter Valve

3. Remove radiator hoses, heater hoses and oil cooler hoses on models so equipped.
4. Remove battery and battery cables.
5. Remove fan shroud and radiator core bolts. On Powerglide or Turboglide models, remove and plug oil cooler lines. Remove radiator core and fan shroud.
6. Disconnect starter and generator wires, engine to body ground strap, oil pressure indicator wire at sending unit on block and coil primary lead at coil.
7. Remove temperature indicator element wire.
8. Remove oil filter assembly.
9. Remove air cleaner. Remove Air Conditioning if so equipped as outlined in Section 15.
10. Disconnect gasoline feed pipe from fuel pump and disconnect vacuum lines from intake manifold and pump if so equipped.
11. Remove distributor cap.
12. Disconnect carburetor control rod from bell crank and T.V. lever on Transmission if Powerglide or Turboglide equipped.
13. Remove bolt from crankcase ventilator tube through access hole in dash and toe panel. Remove crankcase ventilator tube.
14. Remove exhaust cross-over pipe and manifold heat valve (fig. 156) from right hand exhaust manifold and lower exhaust pipe or pipes.
15. Remove transmission control rods.
16. Remove clutch control bellcrank and control rods on conventional transmission models. On Powerglide or Turboglide models, remove oil filler tube and plug opening. Disconnect oil cooler lines and plug openings.
17. Disconnect speedometer cable at transmission.
18. Remove propeller shaft as outlined in Section 5.
19. Install two eye bolts and spacers from Tool Kit J-4536-A in cylinder head bolt holes.
20. Raise engine slightly. Remove fuel pump and remove front mounting bolts (see figure 154). Remove transmission mounting block to frame crossmember bolts.
21. Remove the engine and transmission from the vehicle as a unit, tilting engine to clear core support and fenders or remove transmission as outlined in Section 12 or 13.

Disassembly

1. On all models equipped with a 3-speed transmission, proceed as follows:
   a. Remove flywheel underpan and extension and bolts attaching transmission to clutch housing. Remove transmission.

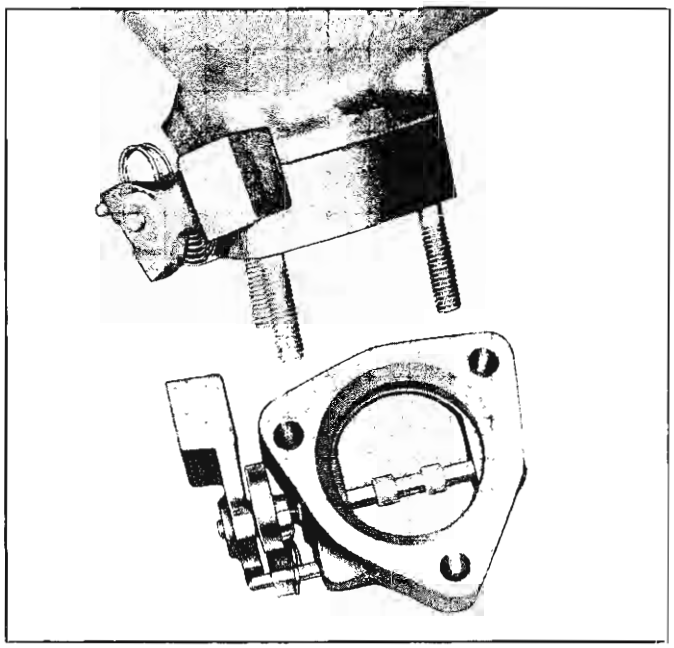

Fig. 156—Manifold Heat Valve

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 throwout bearing from clutch fork and remove fork by forcing it forward and toward the center of the vehicle.
   c. 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 (fig. 157). Remove all bolts, pilot tool, cover assembly and disc.
   d. Remove the flywheel and clutch housing.
2. On models equipped with a POWERGLIDE TRANSMISSION, proceed as follows:
   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, starting motor and flywheel housing cover.
   c. Remove crankcase breather road draft tube from cylinder block.
   d. Remove flywheel to converter bolts, working through bolt access hole on right side of flywheel housing.

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

   e. Remove converter housing to flywheel housing bolts and separate transmission assembly from engine. Install Tool J-5384 to hold converter in position.

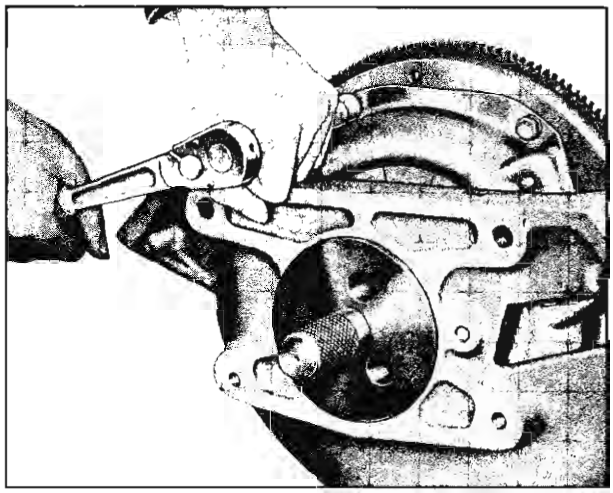

Fig. 157—Removing Clutch

3. On TURBOGLIDE TRANSMISSION, proceed as follows:
   a. Insert the two eye bolts from Tool J-4536 with attaching nuts to the two bosses cast on each side of the front of the transmission. Attach sling and chain fall.
   b. Remove the lower transmission inspection cover.
   c. Disassemble vacuum hose from vacuum diaphragm on right side of transmission.
   d. Loosen converter to flywheel bolts, one turn at a time to avoid distortion of the converter.
   e. Remove transmission case to engine bolts.
   f. Separate transmission from engine.
   g. Install Tool J-5384.

   NOTE: Make sure that converter has not slipped forward.
4. Remove generator from left bank exhaust manifold.
5. Remove exhaust manifold to cylinder head bolts and remove exhaust manifolds.
6. Install engine stand. If Engine Stand Tool J-5856-02 is to be used, Adapater Tool J-5831 or universal mounting Tool J-8690-01 will allow engine to be mounted securely. Remove lifting hooks.
7. Disconnect fuel pump to carburetor pipe and remove fuel pump. Remove fuel pump mounting plate and fuel pump push rod from cylinder block.
8. Remove carburetor.
9. Remove thermostat housing from intake manifold and remove thermostat. Remove water pump.
10. Remove intake manifold to cylinder head bolts and remove pipe clips and intake manifold.
11. Remove spark plug wiring harness and spark plugs.
12. Remove rocker arm covers, rocker arm nuts, rocker arms and pivots, and remove push rods.

    NOTE: Exhaust valve push rods are longer than inlet valve push rods.
13. Remove cylinder head bolts, cylinder heads and gaskets.
14. Place each cylinder head assembly on its side on a bench then, using Tool J-8062 compress valve spring and remove valve locks. Release tool and remove cap, shield and spring, then remove seal from stem. Repeat this operation on each valve (fig. 117).
15. Remove valves from bottom of cylinder head and keep them in their proper sequence for inspection and assembly.
16. Remove valve lifters.

    NOTE: Valve lifters should be placed in a rack in their proper sequence so they can be reinstalled in their same positions in the cylinder block.
17. Remove oil pan retaining bolts and remove oil pan. Remove oil level gauge tube attaching bolt and lockwasher and remove gauge and tube before removing pan.
18. Install Tool J-6978 to harmonic balancer and turn puller screw to remove balancer from crankshaft (fig. 142). Remove tool from balancer.
19. Remove crankcase front end cover attaching screws and remove front end cover and gasket. Remove crankshaft oil slinger.
20. Remove three camshaft sprocket to camshaft bolts.
21. Remove camshaft sprocket and timing chain together. Sprocket is a light press fit on camshaft for approximately ⅛". If sprocket does not come off easily, a light blow with a plastic-faced hammer on the lower edge of the camshaft sprocket should dislodge the sprocket.
22. Remove crankshaft sprocket using Tool J-5825 (fig. 158).
23. Remove camshaft from engine (fig. 147).

    CAUTION: All camshaft journals are the same diameter and caution must be used in removing camshaft to avoid damage to bearings.
24. Remove oil pump to rear main bearing cap bolt

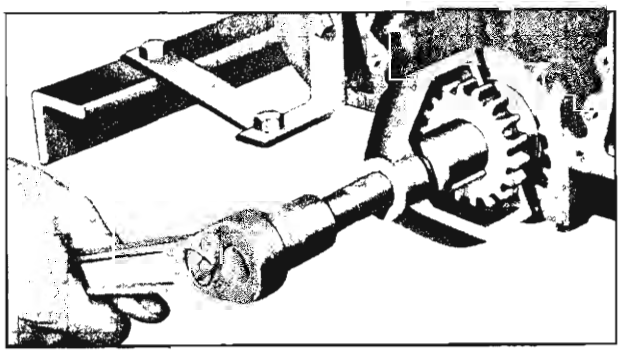

Fig. 158—Removing Crankshaft Sprocket

(fig. 140) and remove pump, extension shaft and collar.

25. Disconnect pump shaft from extension.
26. Remove pump cover attaching screws, cover, idler gear and drive gear and shaft.
27. Remove connecting rod journal bearings caps and install Tool J-5239-3 and 4 on studs. Push piston assemblies out of top of cylinder block (fig. 159). If piston rings strike ridge at top of cylinder, remove ridge to prevent damaging piston ring lands with Tool J-6991 inserted in each cylinder while using Tool J-8089 (fig. 160) or a ridge reamer that pilots in cylinder bore may be necessary.

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

28. Remove piston rings by expanding them and sliding them off the ends of the pistons. Tool J-7117 is available for this purpose.
29. Remove main bearing caps and lift crankshaft out of cylinder block. Lift bearing shells out of block and caps.

Cleaning and Inspection

1. Wash all parts thoroughly in cleaning solvent.
2. Remove four oil gallery plugs located at front and rear of cylinder block, also remove five oil gallery plugs located, four on the lower left side of cylinder block, and one at the front. These oil passages should be thoroughly cleaned either by using compressed air or a wire brush. Plugs may easily be removed with a sharp punch or they may be drilled and pried out.
3. Clean all oil passages in the cylinder block by blowing them out with compressed air. It is good practice to blow them out separately.

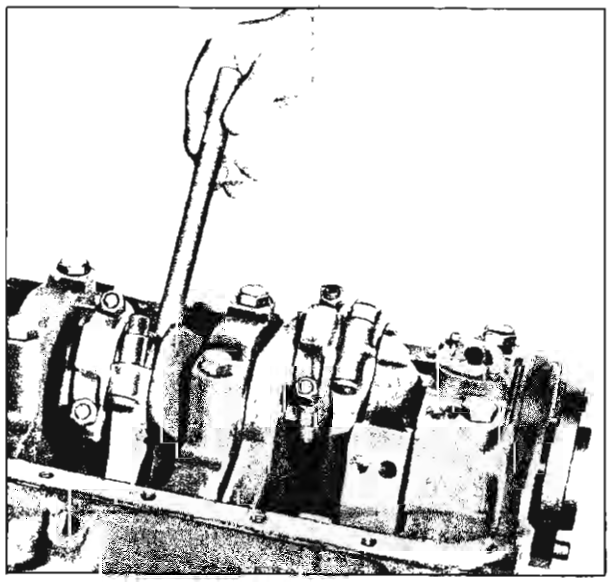

Fig. 159—Removing Piston Assemblies

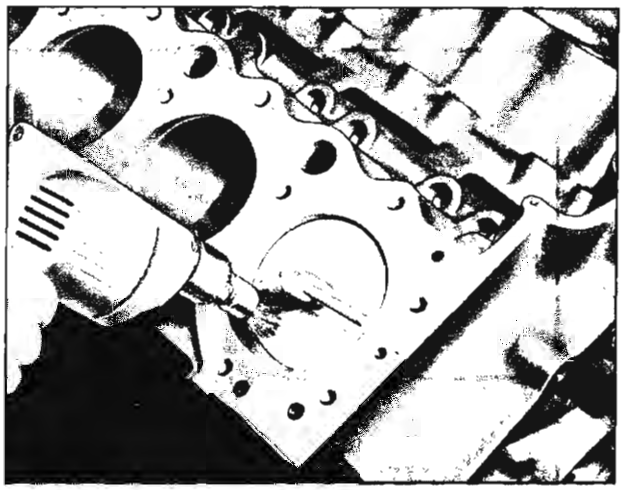

Fig. 160—Removing Carbon from Combustion Chamber

NOTE: All 348 cubic inch V-8 engine cylinder blocks have machined water holes (fig. 161) at each cylinder, which index with spark plug cooling holes in cylinder head.

Thoroughly clean spark plug cooling holes at each cylinder with a length of wire or a small wire brush.

4. Clean out the hollow push rods and the valve lifters. Hydraulic lifters should be disassembled for cleaning as described under "Service Operations."
5. Clean carbon from piston heads, ring grooves and inside of piston head. Clean carbon from cylinder head combustion chambers and valve parts with Tool J-8089. Clean valve guides with Tool J-8101. Clean valve stems and heads on a buffing wheel.
6. Check the cylinder block for cracks in the cylinder walls, water jacket and main bearing webs.
7. 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. 162). Set the gauge so that the thrust pin must be forced in

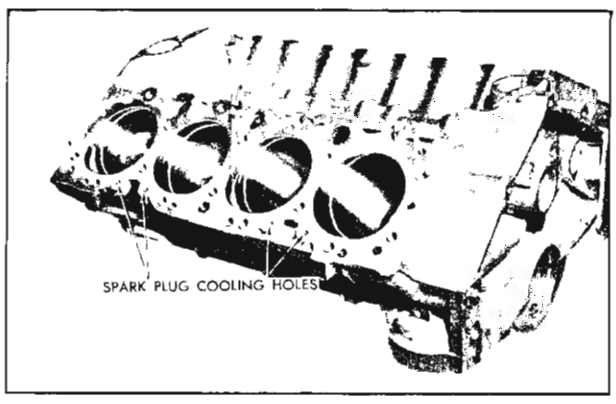

Fig. 161—Cylinder Block Spark Plug Cooling Holes

about ¼" to enter gauge in cylinder bore. Center gauge in cylinder and turn dial to "O". 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.

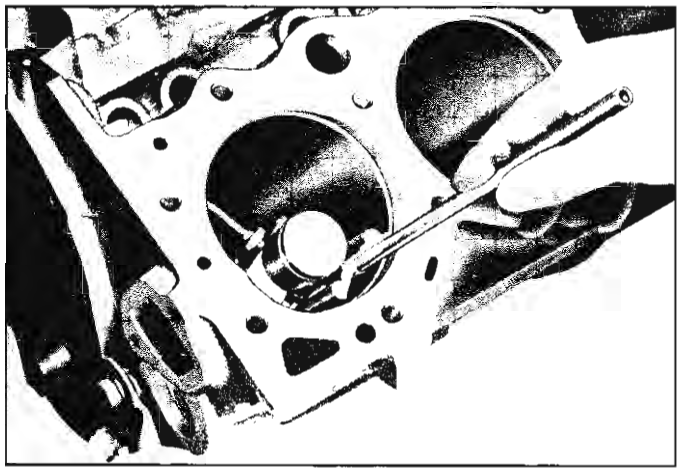

Fig. 162—Checking Cylinder Bores

8. 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.
9. Inspect the main bearings for wear or damage that would make replacement necessary.
10. Inspect camshaft bearings for wear or damage.
11. Inspect the camshaft for damaged cams or bearing journals. If the journals are out-of-round more than .001" the shaft should be replaced. Check the fit of the camshaft in the bearings. Check the camshaft for runout as described under, "Service Operations."
12. Inspect the crankshaft journals and crank pins for roughness and scores. Check them with a micrometer for out-of-round or taper. If out-of-round more than .001" or tapered, the shaft should be replaced or reconditioned. Check the crankshaft thrust faces at the rear main bearing for scoring or excessive wear.
13. Inspect the connecting rod bearings for damage that would make replacement necessary.
14. 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.
15. Inspect the timing chain sprockets for excessive tooth wear. Inspect the chain for signs of wear.
16. Check the cylinder heads for being warped, for having clogged water passages, cracked valve seats or worn valve bores.
17. Inspect the manifolds for excessive carbon in the ports. Clean the carbon deposits from the intake manifold oil splash guard.
18. 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.
19. 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.

Repairs and Assembly

Cylinder Conditioning

The performance of the following operations is contingent upon engine condition at time of overhaul as determined in the inspection.

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 requiring only light honing to clean up the bores. There are four standard size pistons available for service installation. 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 piston. 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.

Cylinder Boring

NOTE: The top of the cylinder block is at a 16° angle to the centerline of the cylinder bore, therefore an adapter plate will be needed to correct for the 16° angle to perform the cylinder boring operation.

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 at the center of the piston skirt and at right angles to the piston pin. The cylinder should be bored to the same diameter as

the piston and honed. Refer to specifications Section 16 for clearance.

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. Follow the hone manufacturers recommendations for the procedure on the use of the hone and cleaning lubrication during honing.
3. Occasionally during the honing operation, the cylinder bore should be thoroughly cleaned and the piston selected for the individual cylinder checked for correct fit.
4. 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.
   b. Insert the feeler ribbon and inverted piston into the cylinder bore so that the center of the piston pin is flush with the counterbore 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 5 and 9 pounds (fig. 163).
   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. This will assure proper installation.
5. Permanently mark the piston for the cylinder to which it has been fitted and 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. Cylinder 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.

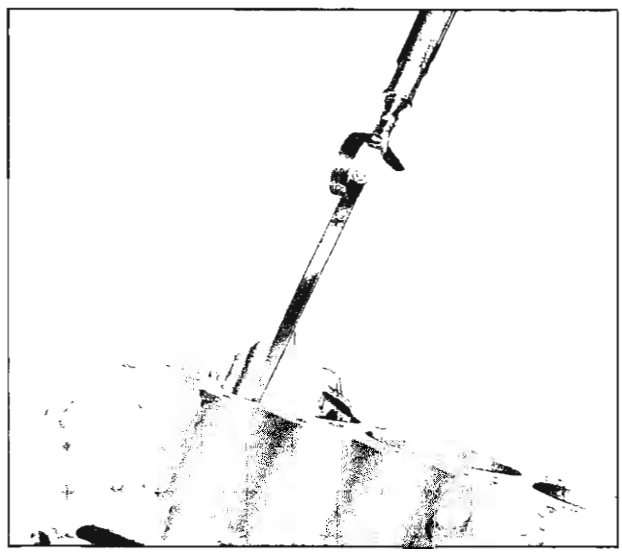

Fig. 163—Checking Piston Fit

Main Bearings

Crankshaft main bearing service may be performed with the engine inverted and oil pan, spark plugs, and oil pump removed. Remove timing chain if front bearing is in need of service. The Plastigage method of measuring bearing clearance is recommended on both main and connecting rod bearings.

Bearing and Journal Inspection

Whenever the bearings are adjusted, the bearing insert and the journal should be inspected.

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 install

both upper and lower bearing halves. Should this become necessary, the crankshaft journal should be checked with a micrometer for out-of-round, taper or undersize. 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.

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.

NOTE: To assure the proper seating of the crankshaft, the rear main bearing oil seal should be removed and all bearing cap bolts should be at their specified torque. 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.
2. Place a piece of Plastigage the full width of the bearing (parallel to the crankshaft on the journal) (fig. 164).
3. Install the bearing cap and evenly tighten the retaining bolts to 100-105 ft. lbs. 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.

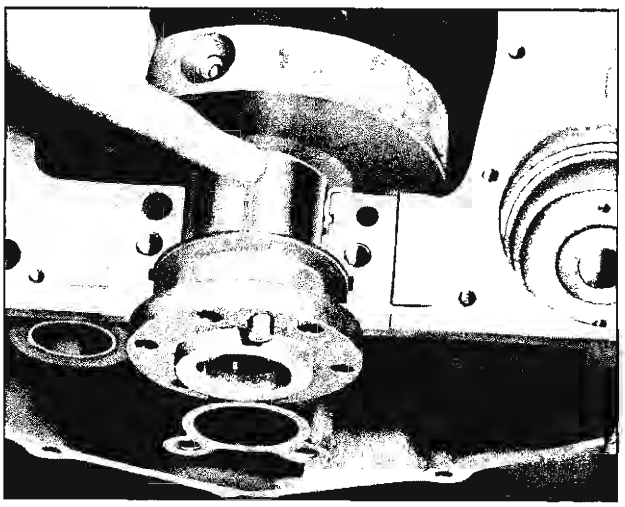

Fig. 164—Plastigage on Journal

5. Without removing the Plastigage, check its compressed width (at the widest point) with the graduations on the Plastigage envelope (fig. 165).

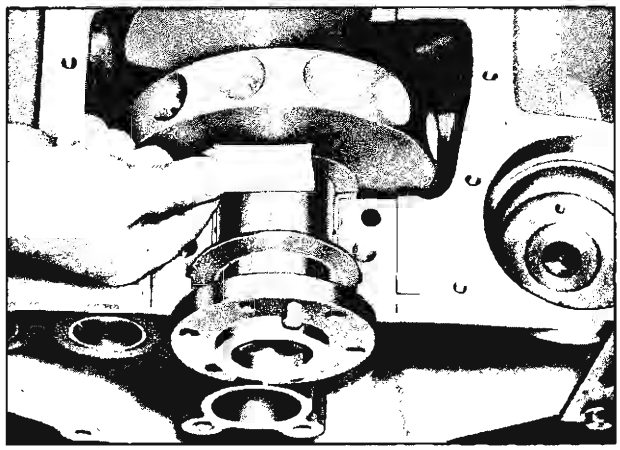

Fig. 165—Measuring Plastigage

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.

6. If the bearing clearance is not over .004" (worn), or .003" (new) or less than .001" the bearing insert is satisfactory. If the clearance is not within these limits replace the insert.

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

7. A .002" undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.

   NOTE: Bearings are available in standard sizes and .002", .010", .020" and .030" undersize.

8. Proceed to next bearing. After all bearings have been checked rotate the crankshaft to see that there is no excessive drag.
9. Check the end play by forcing the crankshaft to

its extreme front position. Check at the front end of the rear main bearing with a feeler gauge (fig. 166) with engine vehicle or if engine is out of vehicle, check with a dial indicator as shown in Figure 167. This clearance should be from .002" to .006" with new bearings. If greater than .009" replace rear main bearing.

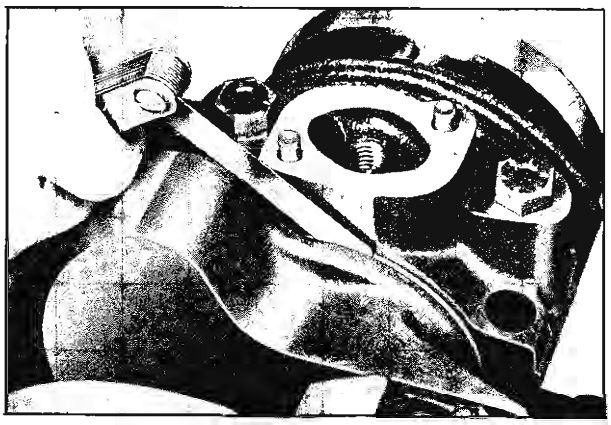

Fig. 166—Checking Crankshaft End Play, Using Feeler Gauge

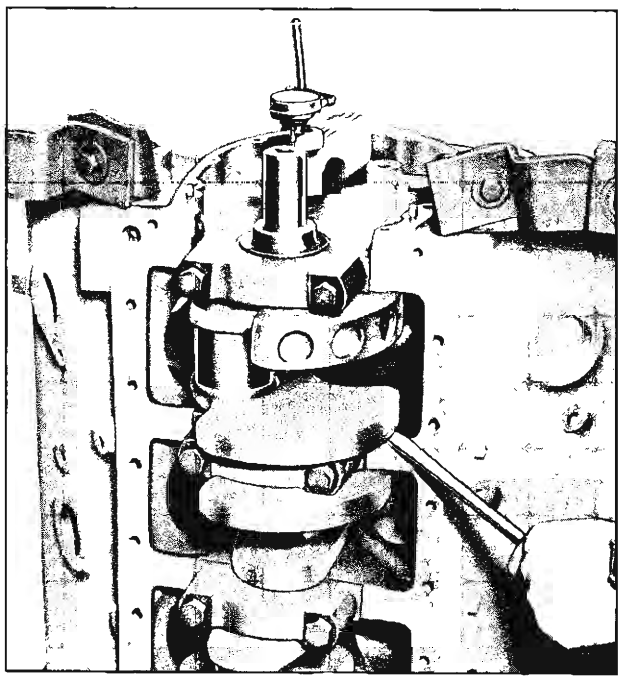

Fig. 167—Checking Crankshaft End Play with Engine Out of Vehicle

10. Install a new rear main bearing oil seal in the cylinder block and main bearing cap. Follow Figures 152 and 153 of this section.

Main Bearings—Replace

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

1. Remove main bearing caps and connecting rod caps and lift crankshaft out of cylinder block. Push pistons to top of bores.
2. Inspect the crankshaft. All main bearings are ground to 2.4980"-2.4990", and crankpin journals to 2.1990"-2.2000".

   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".
3. Remove old bearing shells from cylinder block and caps.
4. Remove rear main bearing oil seal.
5. Install new bearing shells in the cylinder block and caps.

   NOTE: Main bearing shells with oil holes are the upper halves of the bearing shells and are inserted between the crankshaft and cylinder block.
6. Carefully place the crankshaft in the bearings.
7. Install the bearing caps. Tighten bolts to 95 to 105 ft. lbs. torque.
8. When tightening rear main bearing cap, torque bolts 10-12 ft. lbs. first, then rap end of crankshaft rearward with a lead hammer (this will locate bearing cap and bearing). Then rap crankshaft forward (this will line up both upper and lower crankshaft bearing thrust surfaces). Proceed with final tightening of main bearing cap bolts 95-105 ft. lbs. torque.

   NOTE: The caps are marked with an arrow for identification purposes. The caps are to be installed with the arrows pointing to the front of the engine.
9. Check crankshaft end clearance at the rear main bearing. It should be .002" to .006".
10. Check main bearing clearance as previously outlined.
11. Install connecting rod bearings and caps.

Pistons and Connecting Rods

Piston and connecting rod operations may be performed with the engine either in or out of the vehicle. Procedure remains the same in either case.

Removal of Piston and Connecting Rod Assemblies

1. Remove oil pan and oil pump.
2. Remove cylinder heads.
3. Remove ridge in top of cylinder bores.

   CAUTION: Remove ridge only down to the top of piston ring travel.

4. Remove ridge if necessary with a ridge reamer that pilots in cylinder bore.
5. Remove connecting rod journal bearing caps and install Tool J-5239-3 and 4 Connecting Rod Guide Set on studs. Push piston assemblies out of top of cylinder block.

Connecting Rod Alignment

When connecting rod and piston assemblies are removed from an engine the wear pattern on the piston skirts should be symmetrical on each side. Bent or misaligned connecting rods will cause an off angle wear pattern. When this condition exists, the piston, pin, and rod assembly should be replaced.

Disassembly

1. Install pilot of piston pin Removing and Installing Tool J-6994 on piston pin.
2. Install piston and connecting rod assembly on support and place assembly in on arbor press as shown in Figure 168. Press pin out of connecting rod.
3. Remove assembly from press and remove piston pin from support and remove tool from piston and rod.

Checking Piston Pin Fit

Piston pins should be capable of supporting their own weight in either pin boss (fig. 169) when coated with light engine oil and at 60° F. Higher or lower temperatures will cause false indications. Pistons and pins are serviced as assemblies.

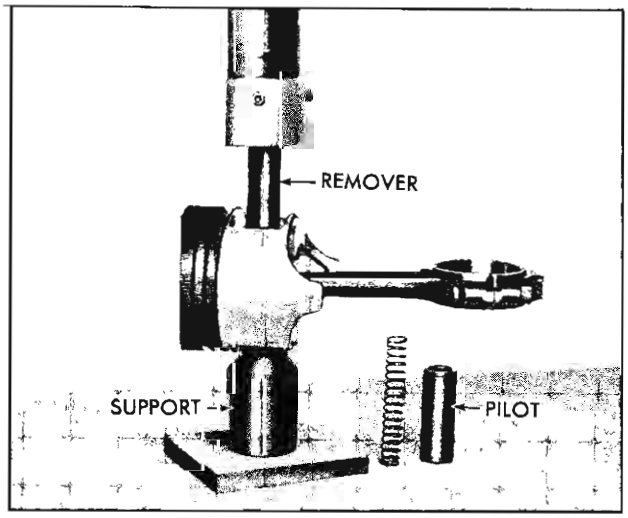

Fig. 168—Removing Piston Pin

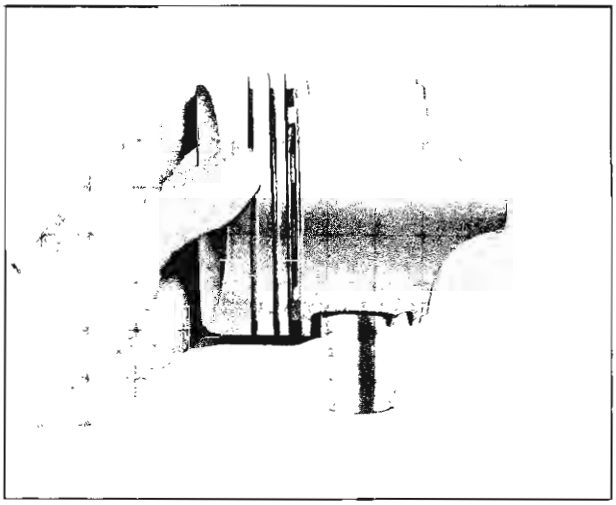

Fig. 169—Checking Piston Pin Fit

Assembly

1. Lubricate piston pin holes in pistons and connecting rod to facilitate installation of pin.
2. Position connecting rod in its respective piston so that flange or heavy side of rod at the bearing end will be towards front of piston (cast depression in top of piston head) on 1, 3, 5 and 7 pistons, and the rod flange to the rear of the piston on 2, 4, 6 and 8 pistons.
3. Install piston pin on installer and pilot spring and pilot in support (fig. 170).

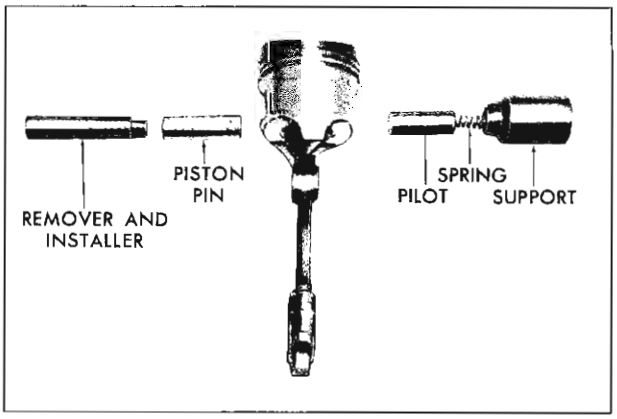

Fig. 170—Piston Pin Assembly Tool

4. Install piston and rod on support, indexing pilot through piston and rod.
5. Place support on arbor press, start pin into piston and press on installer until pin pilot bottoms.
6. Remove installer and support assembly from piston and connecting rod assembly.

7. Check piston pin for freedom of movement in piston bore.

Piston pins are a matched fit to the piston and are not available separately. Piston pins will not become loose enough to cause a knock or tapping until after very high mileages and in such cases a new piston and pin assembly should be installed.

Piston Rings

All compression rings in the V-8 engines are the deep section twist type.

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 I.D. is chamfered or stepped, making the ring unbalanced in cross section.

Upper Compression rings have the chamfer, or step, at the upper edge. The second ring has the step at the lower edge.

All compression rings are marked with the letters "G.M." cast in the upper side of the ring. When installing compression rings, make sure the marked side is toward the top of the piston. The top ring is chromed for maximum life.

The oil control rings used are of the three piece type, consisting of two elements (rails) and a spacer.

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

Piston Ring Installation

1. Select rings comparable in size to the pistons being used.
2. Slip the ring in the cylinder bore, press the ring down into the cylinder bore about two inches and square the ring with the cylinder walls.
3. Check the space or gap between the ends of the ring with a feeler gauge (fig. 171).

Fig. 171—Checking Ring Gap

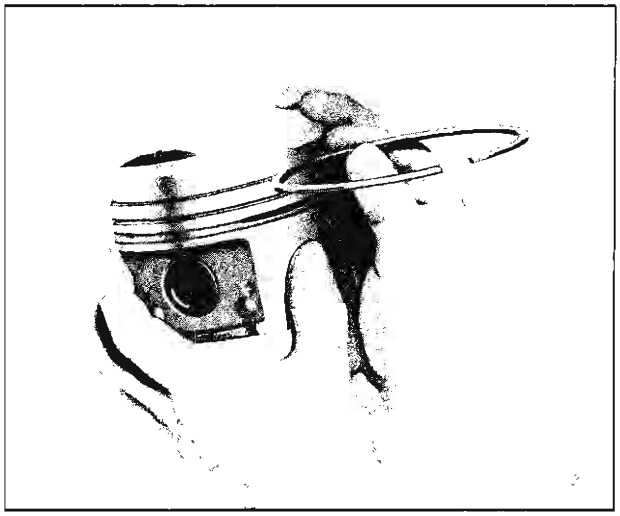

Fig. 172—Rolling Ring in Groove

4. If the gap between the ends of the ring is below specifications (see "Engine Specifications"), remove the ring and try another 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 gap does not become greater than $\frac{1}{32}$".
7. Carefully remove all particles of carbon from the ring grooves in the piston and inspect the grooves carefully for burrs or nicks that might cause the rings to hang up.
8. Slip the outer surface of the compression ring into the piston ring groove and roll the ring entirely around the groove to make sure that the ring is

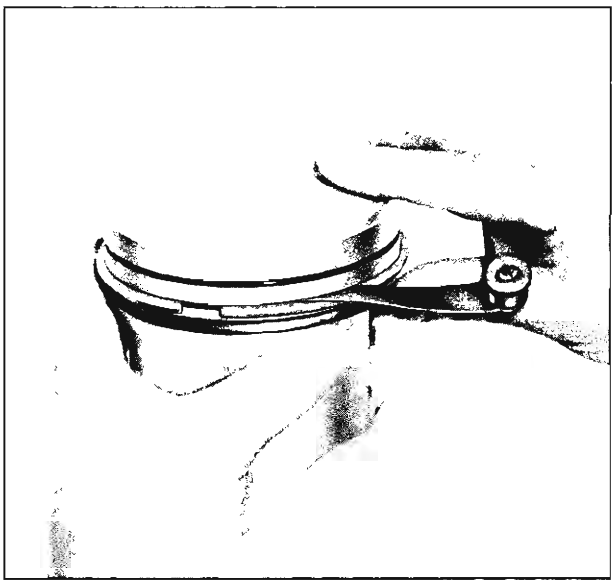

Fig. 173—Checking Groove Clearance

free and does not bind in the groove at any point (fig. 172). 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.

9. 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.
10. 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, install an new ring.
11. 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 clearance between the top and bottom surfaces of the grooves should be inspected (fig. 173). Refer to *Engine Specifications* for correct clearances.

Piston and Connecting Rod Assembly

Installation

1. Lightly coat pistons, rings and cylinder walls with light engine oil.
2. With bearing caps removed, install Tool J-5239 on bearing cap bolts.

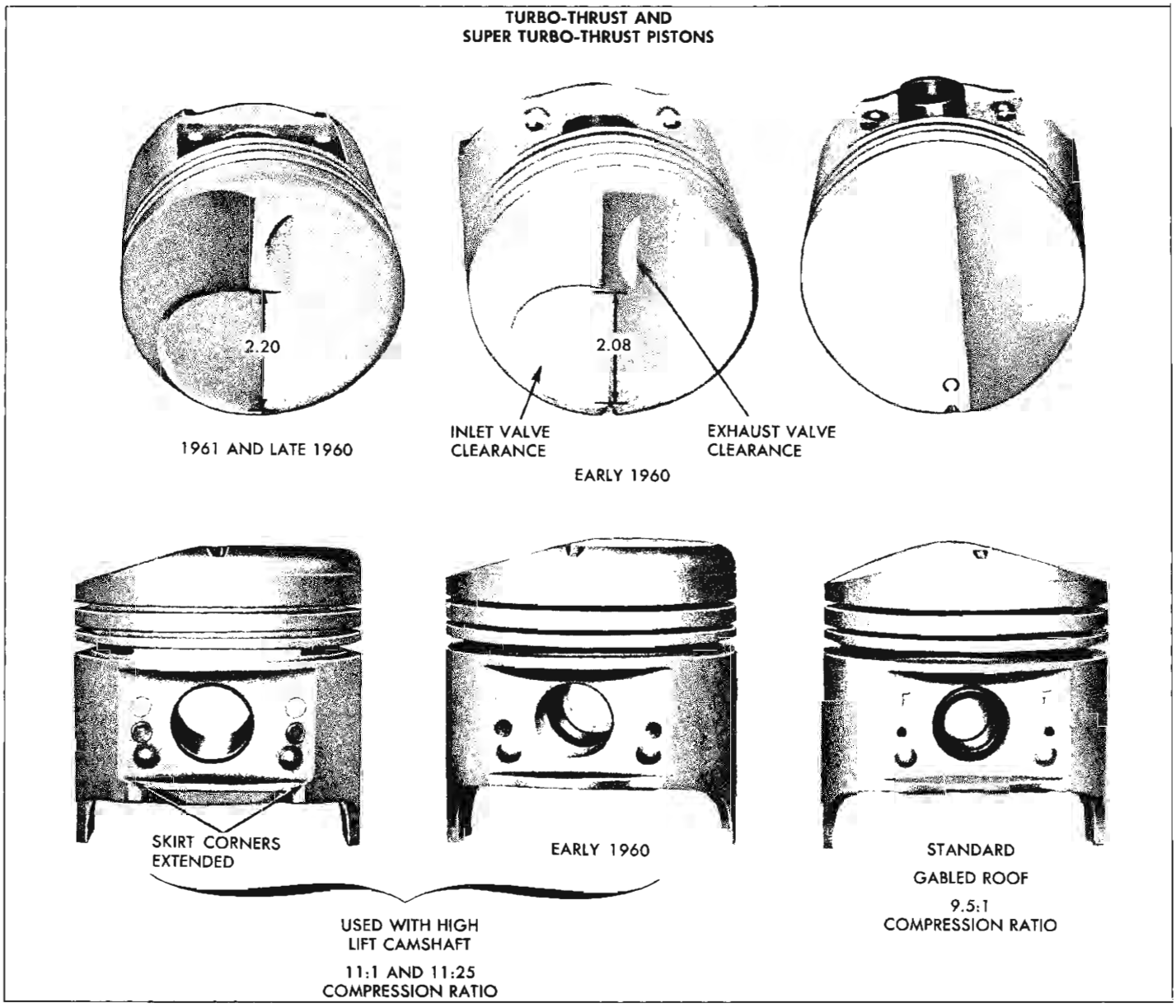

Fig. 174—Piston Identification

NOTE: Pistons used in the 11.0 to 1 and 11.25 to 1 compression ratio engines (fig. 174) eliminate the gabled roof of piston. The piston head extends into the combustion chamber and has cutouts for clearance to inlet and exhaust valves. Pistons used in the 9.5 to 1 compression ratio engine (fig. 174) have a gabled roof which provides for larger combustion chamber volume, for normal compression.

NOTE: When Installing new domed pistons, measure the inlet valve clearance cutout shown in Figure 174. Inlet clearance cutout should measure 2.20″ for late 1960 and 1961, 348 cu. in. high performance V-8 engines.

NOTE: Modified domed pistons must be installed as shown in Figure 175.

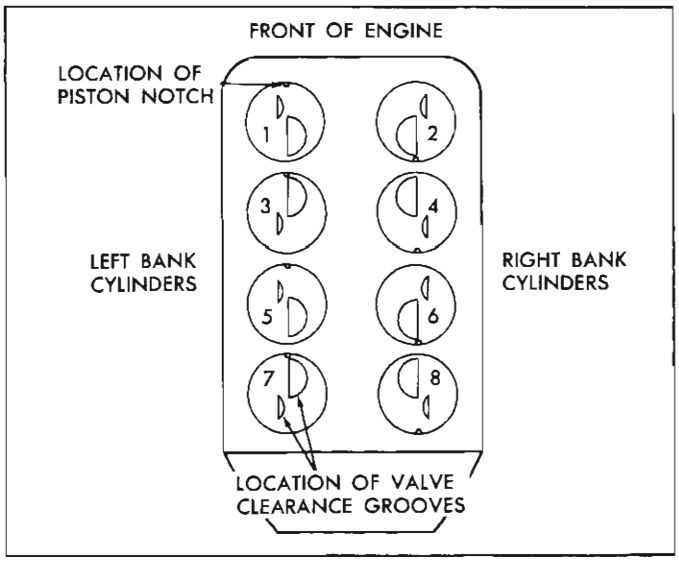

Fig. 175—Piston Installation Diagram

3. Install each piston in its respective bore, using Tool J-5239 on each assembly. The side of the piston with the cast depression in the head should be to the front of the cylinder block (except with high compression pistons—see Figure 175) and the oil hole on connecting rod towards the center of the engine. Use Tool J-8037 upside down (fig. 176) to compress the ring for installation on all 348 engines except, R.P.O. 575 engines. On R.P.O. 575 engines lubricate rings and lower piston and rod assembly into bore. Squeeze piston rings into piston with fingers and slide assembly in bore, one ring at a time. Guide the connecting rod bearing into place on the crankshaft journals with the long detail of Tool J-5239.
4. Install bearing caps and check the bearing clearance as described below.

Connecting Rod Bearing Clearance

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

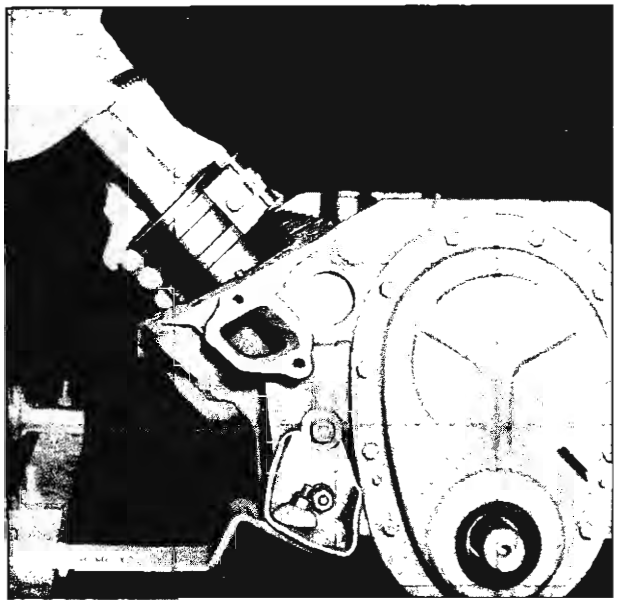

Fig. 176—Installing Piston Assemblies

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. 177).
4. Reinstall the bearing cap and evenly tighten the retaining bolts to 35-45 ft. lbs. torque.

CAUTION: Do not turn crankshaft with the Plastigage installed.

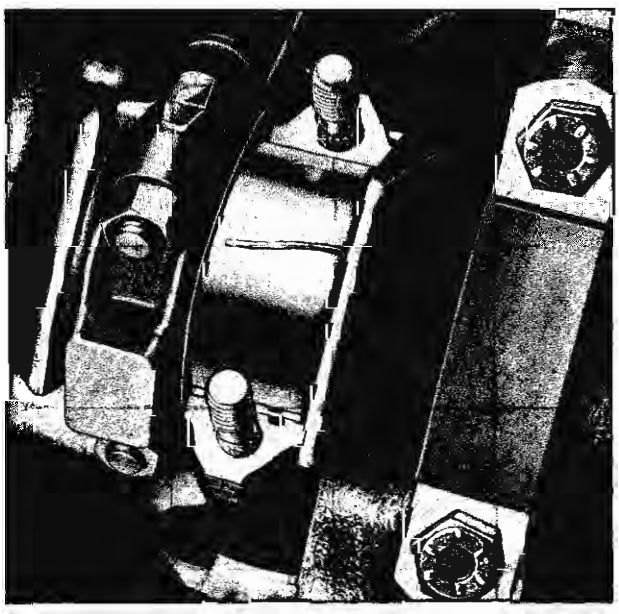

Fig. 177—Plastigage on Crankpin

5. Remove the bearing cap and without removing the Plastigage, check its width at the widest point with the Plastigage scale (fig. 178).

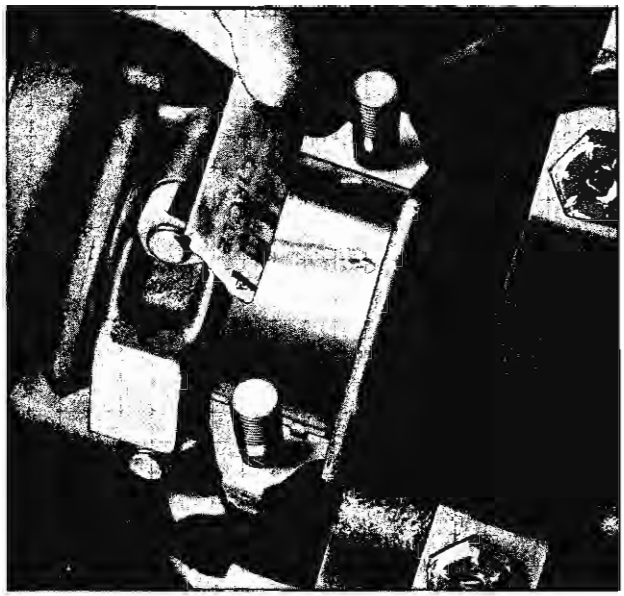

Fig. 178—Measuring Plastigage

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 .003" (worn), or .002" (new) 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.

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

7. Rotate the crankshaft after bearing adjustment to be sure the bearings are not too tight.

8. Check connecting rod clearance between upper half of connecting rod and side of crank pin. This clearance should be .008" to .014" with two rods on each throw of crankshaft (fig. 179).

Clutch or Flywheel Housing Installation, and Alignment Check

1. Install clutch housing (standard shift models) or flywheel housing (Powerglide Models) to cylinder block over dowel pins, install attaching bolts and tighten to 25 to 35 ft. lbs.

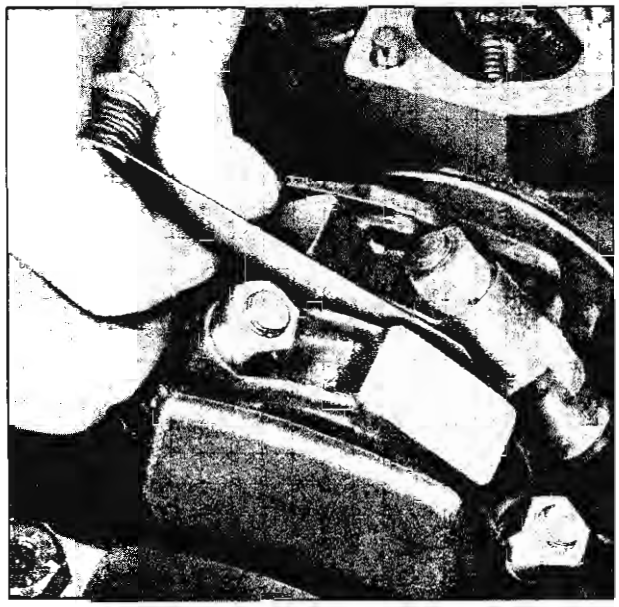

Fig. 179—Connecting Rod Side Clearance

2. Install Tool J-2494 in one of the crankshaft flange bolt holes. On Powerglide models, install Tool J-4656 on indicator post.
3. Install Tool J-8001 and position to read bore runout of the housing (fig. 180). Check runout by rotating crankshaft. On standard shift models, the limit is .008", while Powerglide models have a limit of .005".
4. On Powerglide models only, reposition the dial indicator to read face runout and rotate crankshaft. On Powerglide models, .007" is the maximum allowable runout (fig. 181).
5. Remove indicator and attachments.

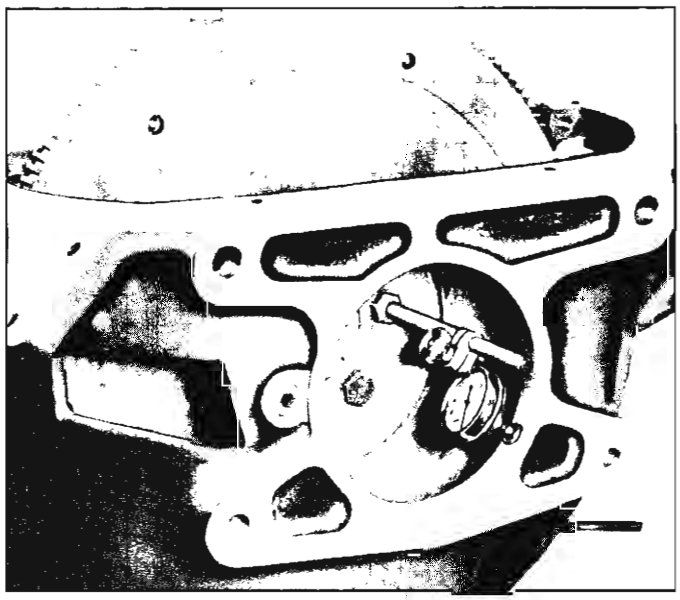

Fig. 180—Checking Bore Runout

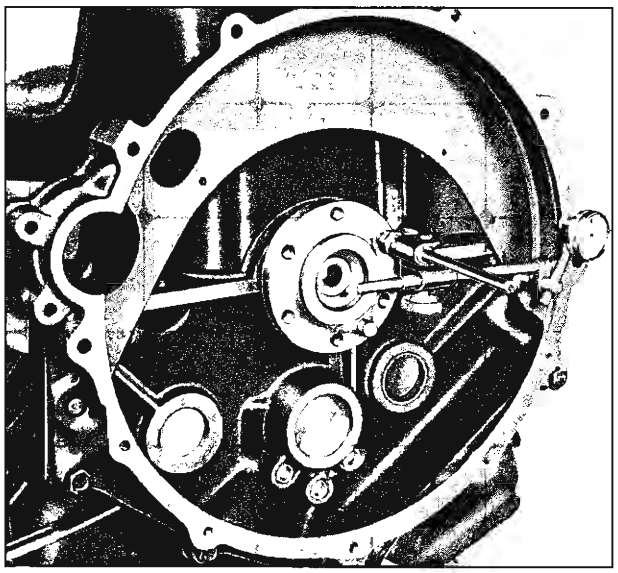

Fig. 181—Checking Face Runout (Powerglide)

Alignment Correction

NOTE: When applying this alignment correction to clutch housing of the three speed transmission models, face parallelism should be disregarded as this alignment check must be made with the transmission case assembled to housing. This alignment correction is covered in the transmission section.

1. If bore runout is in excess of .005" or if housing face parallelism exceeds .007", remove indicator and the housing from engine block.
2. Remove the cylinder block to housing dowel pins.
3. Clean mating faces of housing and engine block and make certain there are no burrs or metal extrusion around dowel or bolt holes.
4. Install flywheel housing and tighten attaching bolts evenly to 25-35 ft. lb. torque.
5. 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.

6. If the face runout exceeds .007", shim as necessary, using a main bearing shim between the housing and block at the attaching bolt locations.
7. After the housing face has been brought within the .007" limit with bolts tightened to 25-35 ft. lb. 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.

8. Check indicator readings at the 9, 12 and 3 o'clock positions, carefully lifting indicator button over each cutaway section of flange on Powerglide models (fig. 182). The runout should not exceed .005".

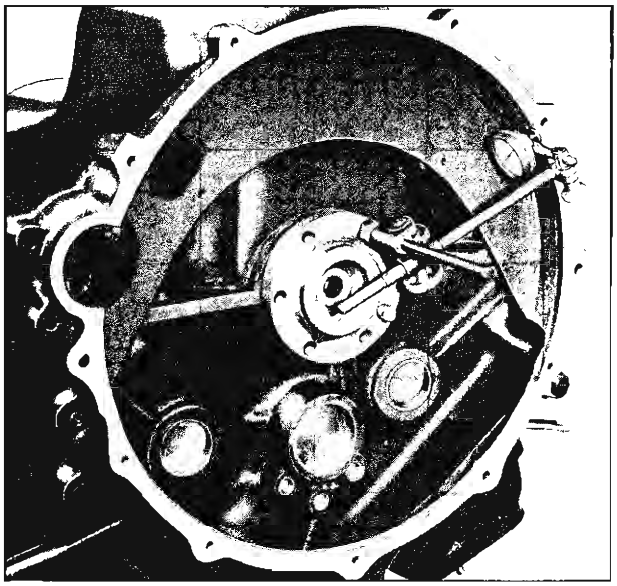

Fig. 182—Checking Bore Runout (Powerglide)

9. 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 25-35 ft. lb. torque and recheck.
10. With housing in proper alignment, carefully ream holes, using a $^{21}/_{32}$" reamer.
11. Blow out holes and then install special oversize dowels.
12. Recheck flywheel housing bore and the face to make sure they still are within proper limits.
13. Remove indicator and attachments.

Flywheel Installation

1. Clean the mating flanges of flywheel and crankshaft carefully and make sure there are no burrs on either mounting face.
2. Place the flywheel in the clutch housing and position it so that the dowel in cranshaft flange will enter the hole in the flywheel.
3. Install the six bolts and lock washers.
4. Tighten bolts to 55-65 foot pounds with a torque wrench.
5. Mount a dial indicator on the clutch or flywheel housing so that the button of the indicator will con-

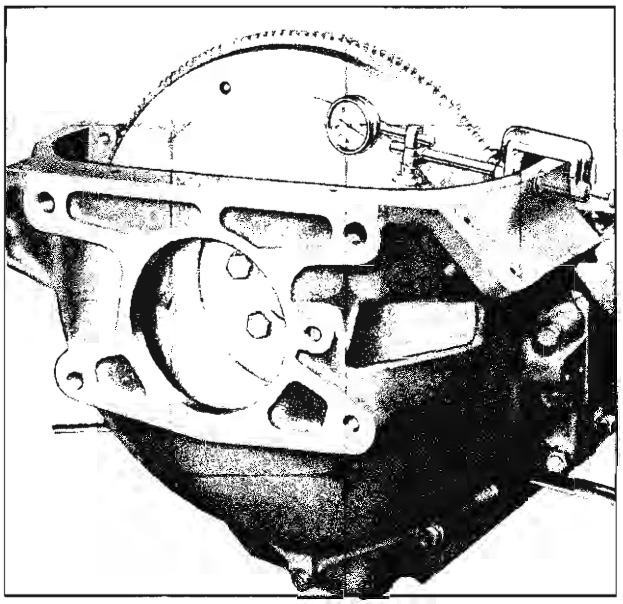

Fig. 183—Checking Flywheel Runout

tact the machined surface of flywheel (fig. 183), and check the flywheel runout.

6. Runout should not exceed .008" on conventional .005" on automatic. If excessive, remove flywheel and recheck for burrs or replace flywheel.

Flywheel Balance Markings

Balance markings are incorporated on all Engines and Automatic Transmissions to provide closer indexing of these components and improve Engine-transmission balance conditions.

Flywheel assemblies used with the Powerglide transmission have been changed to provide six (6) transmission attaching holes instead of three (3).

The three holes have been added to permit more accurate indexing of the converter to flywheel. The actual attachment, however, will remain the same three bolts.

All flywheels used with automatic transmissions will have a "white" paint mark on the outer rim on the transmission side to indicate "heavy" side of engine.

All automatic transmissions will have ¼ to ½" stripe of "Dykem Blue" across the ends of both converter cover and housing to denote the "light" side of the transmission.

These paint markings are to be aligned as closely as possible during assembly of transmission to engine to obtain best balance conditions.

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. Install nine new oil gallery plugs in front, rear and side of cylinder block.
2. Assemble oil pump and extension shaft assembly to rear main bearing cap, aligning slot on top end of extension shaft with drive tang on lower end of distributor drive shaft.
3. Install oil pump to rear main bearing cap bolt and tighten to 45 to 50 ft. lbs.
4. Install two $\frac{5}{16}$-18 x 4" bolts (or Tee handle) in camshaft as outlined under Camshaft Removal. Lubricate camshaft and install camshaft in engine. Remove Tee handle or bolts.
5. Install crankshaft timing sprocket on crankshaft, aligning keyway with key intsalled in crankshaft. Drive in place, using a hammer and Tool J-5590 (fig. 184).

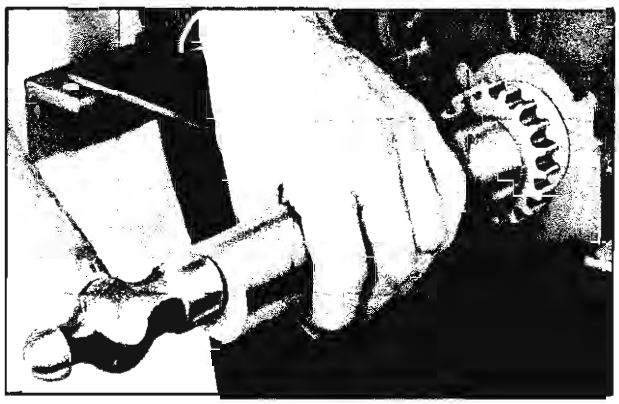

Fig. 184—Installing Crankcase Sprocket

6. Rotate crankshaft until "O" mark on crankshaft sprocket is up toward camshaft.
7. Install timing chain on camshaft sprocket. Hold the sprocket vertical with the chain hanging below, and orient to align "O" marks on camshaft and crankshaft sprockets.
8. Align dowel in camshaft with dowel hole in camshaft sprocket and install sprocket on camshaft.
9. Draw camshaft sprocket onto camshaft, using the three mounting bolts. Do not drive sprocket, as camshaft bore rear plug can be driven out of block. Tighten to 15-20 ft. lbs. torque.
10. Lubricate timing chain with engine oil.
11. Install crankshaft oil slinger on crankshaft.
12. Make certain that cover mounting face and cylinder block front end plate face are clean.
13. Coat the oil seal with light grease and, using a new gasket, install cover and gasket over dowel pins in cylinder block.
14. Install cover screws and tighten to 6-7½ ft. lbs. torque.
15. Install harmonic balancer on crankshaft, aligning the key on the crankshaft with the keyway in the balancer.
16. Using Tool J-5590, drive balancer on crankshaft

until the hub bottoms on the crankshaft timing sprocket (fig. 184).

17. Thoroughly clean all oil pan gasket sealing surfaces.
18. Install rear oil pan seal in groove in rear main bearing cap. Tuck ends into groove openings in cylinder block.
19. Install side gaskets on pan rails, using grease as a retainer. Rear ends lap end gasket. Tuck front ends of side gaskets into gap between front end cover seal groove and cylinder block.
20. Install oil pan front seal in groove in front end cover, with ends butting side gaskets.
21. Install oil pan to cylinder block bolts. Tighten bolts to 10 to 15 ft. lbs. Install oil level gauge tube assembly using a new seal. Secure with bolt and lockwasher. Install oil gauge.
22. Install oil pan drain plug.
23. Install the valve lifters in same bores as removed.
24. Thoroughly clean out cylinder head bolt holes in the block and clean cylinder bolt threads. Then place new cylinder head gaskets in position on cylinder block. Use a good head gasket paste with these steel gaskets.
25. Place the cylinder heads in position over the two dowel pins in the block.
26. Coat threads of all cylinder head bolts with a suitable water and oil thread sealing compound, such as G.M. Perfect Seal. These bolts protrude into the water passages and require this compound to prevent rusting.
27. Install bolts finger tight.
28. Tighten the cylinder head bolts a little at a time in the order shown (fig. 133). The final tightening should be 60-70 ft. lbs.
29. Install 16 push rods in their respective bores.

    NOTE: Exhaust push rods are longer than Inlet push rods.

30. Insert pivots in valve rocker arms, rocker arms over studs, and install nuts.
31. Clean gasket faces of intake manifold and cylinder heads.
32. Install intake manifold end gaskets on cylinder block and side gaskets as shown in Figure 134.
33. Install intake manifold and bolts with pipe clips in place. Tighten finger tight. Tighten bolts a little at a time according to the sequence shown in Figure 136. Final torque should be 25-35 ft. lbs.
34. Clean all spark plugs with abrasive type cleaner, inspect for damage and set gap at .035" using a round feeler gauge.
35. Place new gaskets on plugs and install. Tighten to 20-25 ft. lbs.
36. Install plug wiring harness as outlined in Section 9.

    CAUTION: Plug wire location is extremely important. Numbers stamped on supports show sequence.

37. Install gaskets and valve rocker arm covers.
38. Install thermostat, water outlet gasket and thermostat housing and tighten bolts 18 to 23 ft. lbs. Install water pump. Tighten bolts to 25 to 35 ft. lbs.
39. Install carburetor. On Powerglide or Turboglide models, install transmission throttle control upper rod to carburetor. Install automatic choke heat tube.
40. Install push rod, fuel pump mounting plate gasket, mounting plate, fuel pump gasket and fuel pump. Mounting plate bolts should be tightened to 6 to 9 ft. lbs. Install fuel pump to carburetor feed pipe.
41. Install eye bolts from Tool J-4536-A in appropriate cylinder head bolt holes. Engine may have to be removed from stand for following steps, depending on stand used.
42. Install exhaust manifolds and bolts. Tighten center bolts to 25-30 ft. lbs. torque and tighten end bolts to 15-20 ft. lbs. over french locks.
43. Clean mating surfaces and install new exhaust gaskets and seals.
44. Install generator on left bank exhaust manifold.
45. On all standard shift 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 the Pilot 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 foot pounds torque with a torque wrench 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.
    d. Install clutch throw-out bearing.
    e. Install transmission and tighten attaching bolts securely.
    f. Install flywheel underpan and extension.
46. Install starter and torque bolts 25-35 ft. lbs.
47. On all POWERGLIDE TRANSMISSION MODELS:
    a. Remove Tool J-5384.
    b. Install transmission on flywheel housing and tighten attaching bolts securely.
    c. Install converter to flywheel bolts and tighten to 25 to 30 ft. lbs.
    d. Install flywheel housing cover and starting motor.
    e. Install crankcase breather road draft tube.

48. On all TURBOGLIDE TRANSMISSION MODELS:
    a. Remove the two oil cooler plugs from right side of transmission assembly and apply approximately one thimble-full of petrolatum into each hole with caulking gun or any other suitable applicator. Reinstall plugs finger tight.
    b. Put film of lubriplate in crankshaft bore which pilots converter cover.
    c. Remove converter safety clamp (make sure that converter has not slipped forward).
    d. Align bolt holes in flywheel and converter.
    e. Enter transmission case into dowels on engine and assemble one on right side of center near top.
    f. Assemble throttle bell crank bracket on left side of case and assemble two bolts holding case and bracket to engine.
    g. Tighten transmission case to engine bolts.
    h. Tighten flywheel to converter bolts to 25 to 30 ft. lbs.
    i. Assemble vacuum hose to vacuum diaphragm on right side of transmission.
    j. Assemble converter under pan.
    k. Hook up throttle linkage.

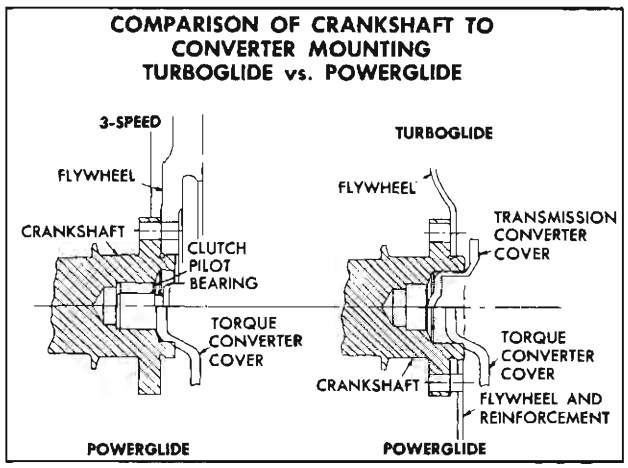

Fig. 185—Comparison of Crankshaft to Converter Mounting

Engine Installation

1. Install lift tool J-4536-A.
2. Tilt and lower engine and transmission assembly into the chassis as a unit, guiding engine to align supports with frame.
3. Install front mounts, and tighten nuts (fig. 154).
4. Remove lifting attachments. Tighten transmission mounting bolts.
5. Install propeller shaft as outlined in Section 5.
6. On all STANDARD TRANSMISSION MODELS:
    a. On conventional transmission models: Install clutch bellcrank, connect clutch pedal adjusting link to clutch fork and adjust. See Section 11.
    b. Connect speedometer cable to speedometer driven gear.
    c. Connect transmission control rods to shifter levers on transmission side cover. Adjust control rods as outlined in "Transmission Section."
    d. Check transmission lubricant level.
    e. If equipped with overdrive, connect associated wires and cables.
7. On all POWERGLIDE OR TURBOGLIDE TRANSMISSION MODELS:
    a. Connect speedometer cable to speedometer driven gear.
    b. Connect transmission control rod to transmission control rod bellcrank and adjust rod as outlined in "Transmission Section."
    c. Install transmission filler tube and dip stick.
    d. Install transmission throttle control rod.
8. Install exhaust manifold heat control valve and gaskets and install exhaust cross-over pipe and packing.
9. Replace exhaust pipe to cross-over pipe and tighten attaching bolts securely.
10. Connect vacuum lines.
11. Connect wire to oil pressure gauge and temperature gauge on intake manifold.
12. Install air cleaner.

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

13. Attach generator and field wires to generator.
14. Attach gasoline line to fuel pump.
15. Install battery. Attach battery cable and voltage regulator wire to large terminal. Install wire to solenoid and install starter switch wire to small terminal and connect coil wire to coil.
16. Install fan pulley and fan blade. Install radiator core and fan shroud.
17. Install oil cooler lines on all Powerglide or Turboglide models, and connect radiator hoses.
18. Refill radiator and crankcase.
19. Install and adjust fan belt to $^{13}/_{16}$" deflection.
20. On all models with automatic transmission use Tool J-4264 and fill transmission as follows:
    a. Fill Turboglide transmission with 3½ quarts and Powerglide with 4½ 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 dipstick. Do not overfill.
21. On Powerglide and Turboglide equipped cars, place selector lever in reverse and check linkage adjustment as outlined in the "Transmission Section."
22. Replace hood assembly, aligning previously scribed marks.

TROUBLES AND REMEDIES

ALL ENGINES

Symptom and Probable Cause	Probable Remedy
Lack of Power	
1. Poor Compression	
a. Incorrect valve lash	a. Adjust valve lash according to instructions under "Valve Adjustment"
b. Leaky valves	b. Remove cylinder head and grind valves
c. Valve stems or lifters sticking	c. Free up or replace
d. Valve springs weak or broken	d. Replace springs
e. Valve timing incorrect	e. Correct valve timing
f. Leaking cylinder head gasket	f. Replace gasket
g. Piston rings broken	g. Replace rings
h. Poor fits between pistons, rings and cylinders	h. Overhaul engine
2. Ignition System Improperly Adjusted	
a. Ignition not properly timed	a. Set ignition according to instructions under "Engine Tune-Up"
b. Spark plugs faulty	b. Replace or clean, adjust and test spark plugs
c. Distributor points not set correctly	c. Set distributor points and time engine
3. Lack of Fuel	
a. Dirt or water in carburetor	a. Clean carburetor and fuel pump
b. Gas lines partly plugged	b. Clean gas lines
c. Dirt in gas tank	c. Clean gas tank
d. Air leaks in gas line	d. Tighten and check gas lines
e. Fuel pump not functioning properly	e. Replace or repair fuel pump
4. Carburetor Air Inlet Restricted	
a. Air cleaner dirty	a. Clean air cleaner
b. Carburetor choke partly closed	b. Adjust or replace choke mechanism
5. Overheating	
a. Lack of water	a. Refill system
b. Fan belt loose	b. Adjust or replace
c. Fan belt worn or oil soaked	c. Replace belt
d. Thermostat sticking closed	d. Replace thermostat
e. Water pump inoperative	e. Replace water pump
f. Cooling system clogged	f. Clean and reverse flush
g. Incorrect ignition or valve timing	g. Retime engine
h. Brakes dragging	h. Adjust brakes
i. Improper grade and viscosity oil being used	i. Change to correct oil
j. Fuel mixture too lean	j. Overhaul or adjust carburetor
k. Valves improperly adjusted	k. Adjust valves
l. Defective ignition system	l. See "Engine Tune-Up"
m. Exhaust system partly restricted	m. Clean or replace
6. Overcooling	
a. Thermostat holding open	a. Replace thermostat

Symptom and Probable Cause	Probable Remedy
Excessive Oil Consumption	
1. Leaking Oil	
a. Oil pan drain plug loose	a. Tighten drain plug
b. Oil pan retainer bolts loose	b. Tighten oil pan bolts
c. Oil pan gaskets damaged	c. Replace pan gaskets
d. Timing gear cover loose or gasket damaged	d. Tighten cover bolts or replace gasket
e. Oil return from timing gear case to block restricted, causing leak at crankshaft fan pulley hub on six cylinder models	e. Remove oil pan and clean oil return passages
f. Rocker arm cover gaskets or, on six cylinder models, push rod cover damaged or loose	f. Tighten covers or replace gaskets
g. Fuel pump loose or gasket damaged	g. Tighten fuel pump or replace gasket
h. Rear main bearing leaking oil into clutch housing or flywheel housing	h. Adjust or replace main bearing or main bearing oil seal
i. Oil drain slots in intake manifold splash guard closed	i. Remove intake manifold and open slots to .100"
2. Burning Oil	
a. Broken piston rings	a. Replace rings
b. Rings not correctly seated to cylinder walls	b. Give sufficient time for rings to seat. Replace if necessary
c. Piston rings worn excessively or stuck in ring grooves	c. Replace rings
d. Piston ring oil return holes clogged with carbon	d. Replace rings
e. Excessive clearance between piston and cylinder wall due to wear or improper fitting	e. Fit new pistons
f. Cylinder walls, scored, tapered or out-of-round	f. Recondition cylinders and fit new pistons
Hard Starting	
1. Slow Cranking	
a. Heavy engine oil	a. Change to lighter oil
b. Partially discharged battery	b. Charge battery
c. Faulty or undercapacity battery	c. Replace battery
d. Poor battery connections	d. Clean and tighten or replace connections
e. Faulty starter switch	e. Replace switch
f. Faulty starting motor or drive	f. Overhaul starting motor
2. Ignition Trouble	
a. Distributor points burned or corroded	a. Clean or replace points
b. Points improperly adjusted	b. Readjust points to .016'" adjust new points to .019"
c. Spark plugs improperly gapped	c. Set plug gap at .035"
d. Spark plug wires loose and corroded in distributor cap	d. Clean wire and cap terminals
e. Loose connections in primary circuit	e. Tighten all connections in primary circuit
f. Series resistance in condenser circuit	f. Clean all connections in condenser circuit
g. Low capacity condenser	g. Install proper condenser
h. Ballast resister faulty or out of circuit	h. Inspect and correct

Symptom and Probable Cause	Probable Remedy
3. Engine Condition	
a. Valves holding open	a. Adjust valves
b. Valves burned	b. Grind valves
c. Leaking manifold gasket	c. Tighten manifold bolts or replace gasket
d. Loose carburetor mounting	d. Tighten carburetor
e. Faulty pistons, rings or cylinders	e. See "Poor Compression"
4. Carburetion	
a. Choke not operating properly	a. Adjust or repair choke mechanism
b. Throttle not set properly	b. Set throttle
c. Carburetor dirty and passages restricted	c. Overhaul carburetor

Popping, Spitting and Detonation

1. Overheated Intake Manifold	
a. Manifold heat control spring not properly installed	a. Check operation under "Engine Tune-Up"
b. Manifold heat control valve sticking	b. Free up heat control valve
2. Ignition Trouble	
a. Loose wiring connections	a. Tighten all wire connections
b. Faulty wiring	b. Replace faulty wiring
c. Faulty spark plugs	c. Clean or replace and adjust plugs
3. Carburetion	
a. Lean combustion mixture	a. Clean and adjust carburetor
b. Dirt in carburetor	b. Clean carburetor
c. Restricted gas supply to carburetor	c. Clean gas lines and check for restrictions
d. Leaking carburetor or intake manifold gaskets	d. Tighten carburetor to manifold and manifold to head bolts or replace gaskets
4. Valves	
a. Valves adjusted too tight	a. Adjust valve lash
b. Valves sticking	b. Lubricate and free up. Grind valves if necessary
c. Exhaust valves thin and heads overheating	c. Replace valves
d. Weak valve springs	d. Replace valve springs
e. Valves timed early	e. Retime
5. Cylinder Head	
a. Excessive carbon deposits in combustion chamber	a. Remove head and clean carbon
b. Cylinder head water passages partly clogged causing hot spot in combustion chamber	b. Remove cylinder head and clean water passages
c. Partly restricted exhaust ports in cylinder head	c. Remove cylinder head and clean exhaust ports
d. Cylinder head gasket blown between cylinders	d. Replace cylinder head gasket
6. Spark Plugs	
a. Spark plugs glazed	a. Clean or replace spark plugs
b. Wrong heat range plug being used	b. Change to correct spark plugs

Symptom and Probable Cause	Probable Remedy
7. Exhaust System	
a. Exhaust manifold or muffler restricted causing back pressure	a. Clean or replace manifold and muffler

Rough Engine Idle

1. Carburetor	
a. Improper idling adjustment	a. Adjust according to instructions
b. Carburetor float needle valve not seating	b. Clean or replace
2. Air Leaks	
a. Carburetor to manifold heat insulator or gasket leaks	a. Tighten carburetor to manifold bolts or replace heat insulator or gasket
b. Manifold to head gasket leaks	b. Tighten manifold to head bolts or replace gaskets
c. Air leaks in windshield wiper vacuum line	c. Check for leaks and repair
3. Valves	
a. Improper lash adjustment	a. Check and adjust valves
b. Valves not seating properly	b. Grind valves
c. Valves loose in guides or bores	c. Condition valves
4. Cylinder Head	
a. Cracks in exhaust ports	a. Replace cylinder head
b. Head gasket leaks	b. Replace cylinder head gasket

Engine Misses On Acceleration

1. Carburetion	
a. Accelerating pump jet misadjusted plugged or vapor vent ball in pump plunger not working	a. Overhaul carburetor or, on eight cylinder models, adjust pump travel
b. Lean fuel mixture	b. Overhaul carburetor
2. Ignition Trouble	
a. Faulty spark plugs	a. Clean, adjust or replace plugs
b. Faulty igntion wiring	b. Replace faulty wiring
c. Improperly adjusted or faulty distributor points	c. Adjust or replace distributor points
d. Weak coil	d. Replace coil
3. Engine	
a. Burned or improperly adjusted valves	a. Adjust, replace or grind valves
b. Leaky manifold gaskets	b. Tighten manifold or replace gaskets
c. Poor compression due to cylinder, piston or ring condition	c. Overhaul engine
d. Leaky cylinder head gasket	d. Replace gasket

Symptom and Probable Cause	Probable Remedy
Engine Noise	
1. Crankshaft Bearings Loose	
a. Bearings improperly fitted	a. Readjust main bearings
b. Crankshaft journals out-of-round	b. Replace or recondition crankshaft
c. Crankshaft journals rough	c. Replace or recondition crankshaft
d. Oil passages in block restricted	d. Clean passages
e. Insufficient oil	e. Adjust or replace bearings. Replenish oil
f. Improper grade and viscosity oil being used	f. Adjust bearings and change to correct oil
g. Oil pump failure	g. Replace oil pump, adjust or replace bearings and damaged parts
h. Contaminated oil	h. Wash motor thoroughly. Adjust or replace bearings and other damaged parts
2. Connecting Rod Bearings Loose	
a. Worn bearings	a. Replace bearings
b. Crankpins rough	b. Polish or replace shaft. Adjust or replace bearings
c. Insufficient oil	c. Adjust or replace bearings and replenish oil
d. Oil pump failure	d. Replace oil pump. Replace or adjust rod bearings
e. Improper grade and viscosity of oil used	e. Replace rod bearings and change to proper oil
3. Pistons or Pins Loose	
a. Excessive cylinder wear	a. Hone cylinders and fit new pistons and rings. Make sure all abrasive that would cause cylinder wear is removed
b. Improperly fitted pistons or pins	b. Replace pistons or pins
c. Contaminated Oil	c. Make necessary replacements, flush oiling system and use new oil
d. Faulty fuel or ignition system causing unburned fuel to flush the oil from cylinder walls	d. Make necessary repairs to fuel or ignition system, replace worn parts and change oil
e. Piston pin or bore wear	e. Ream pin bore and install oversize piston pins on six cylinder models. Replace pistons and pins on eight cylinder models
4. Engine Noise—General	
a. Bent connecting rod	a. Replace rod
b. Excessive end play in camshaft on six cylinder models	b. Replace camshaft thrust plate, or correct end play by pressing gear on further
c. Excessive crankshaft end play	c. Replace main bearings
d. Broken piston ring	d. Replace broken ring and check condition of cylinder wall
e. Loose timing gears or chain	e. Replace timing gears or chain
f. Dry push rod sockets	f. Polish and lubricate push rod sockets
g. Bent oil gauge rod	g. Replace oil gauge rod
h. Improperly adjusted valve lash	h. Adjust valve lash
i. Sticking valves	i. Free sticking valves or grind valves

SPECIFICATIONS

Refer to Section 16 for Engine System Specifications.

SPECIAL TOOLS

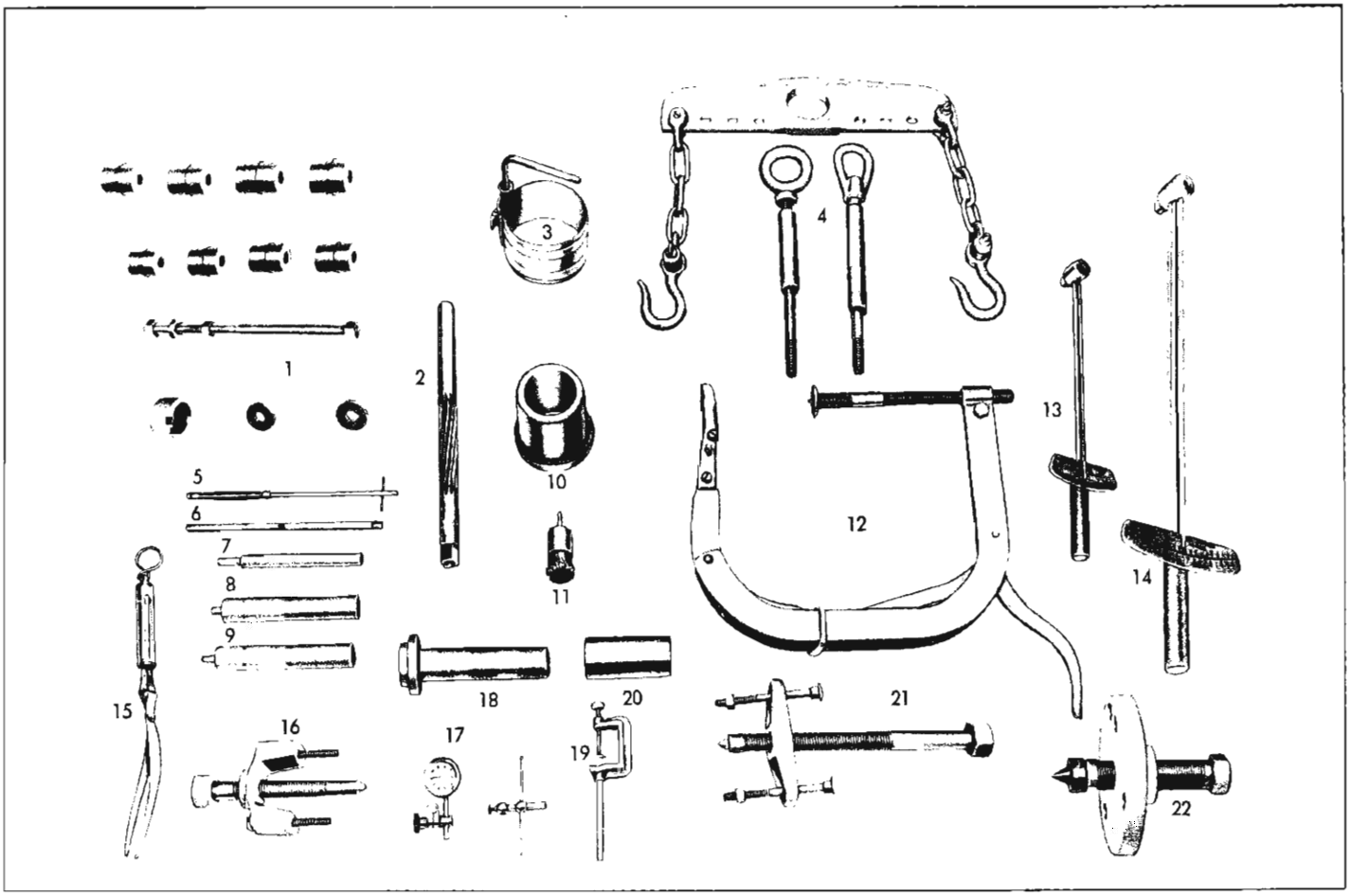

Fig. 186—Engine Special Tools—6 Cyl.

1. J-6356	Camshaft Bearing Remover and Replacer	13. J-8058 (KMO-629)	0-50 ft. lbs. Torque Wrench
2. J-0965	Piston Pin Bore Expansion Reamer	14. J-1264	0-200 ft. lbs. Torque Wrench
3. J-8037 (KMO-357)	Piston Ring Compressor	15. J-5513	Piston Fitting Scale
4. J-4536	Lift Kit	16. J-1287	Harmonic Balancer Puller
5. J-8101	Valve Guide Cleaner	17. J-8001 (KMO-30)	Indicator Set
6. J-4822	Valve Guide Reamer (.343")	18. J-0995	Timing Gear Cover Oil Seal Replacer
7. J-5600	Valve Stem Guide Remover	19. J-4656	Indicator Swivel Set
8. J-5599	Valve Guide Replacer	20. J-0966	Timing Gear Cover Centering Gauge
9. J-5734	Valve Guide Replacer	21. J-8105 (T-126R)	Crankshaft Gear Puller
10. J-0971	Camshaft Gear Remover and Replacer	22. J-6978	Harmonic Balancer Puller
11. J-8089 (KMO-7004)	Carbon Removing Brush	23. J-8520	Camshaft Lobe Indicator
12. J-8062 (KMO-642)	Valve Spring Compressor	24. J-8690-01	Universal Engine Adapter (not shown)

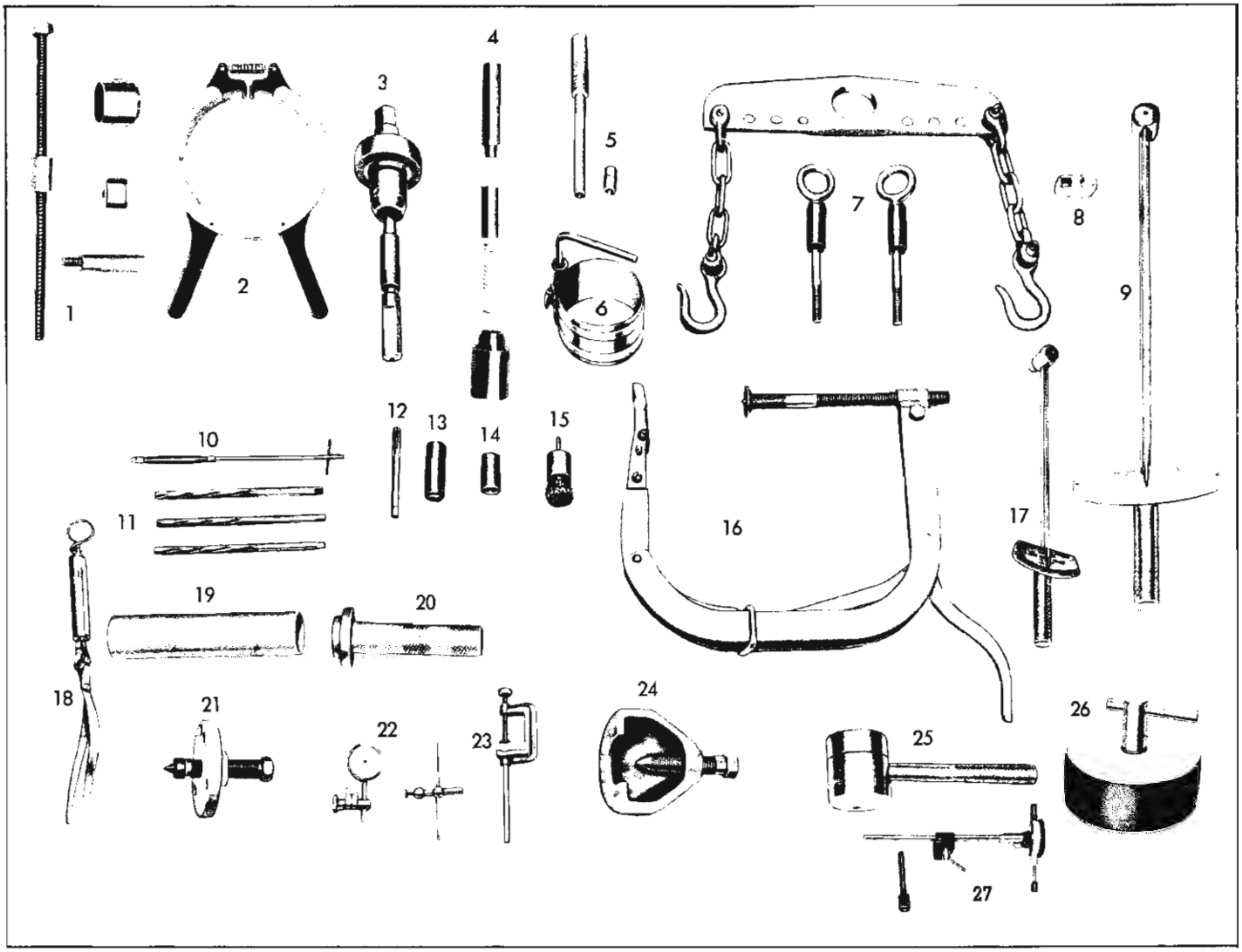

Fig. 187—Engine Special Tools—8 Cyl.

1.	J-6098	Camshaft Bearing Remover and Replacer
2.	J-8021	Piston Ring Expander (283 Engine)
	J-7117	Piston Ring Expander (348 Engine)
3.	J-5538	Piston Pin Assy. Tool (283 Engine)
4.	J-6994	Piston Pin Assy. Tool (348 Engine)
5.	J-6305	Connecting Rod Guide Set (283 Engine)
	J-5239	Connecting Rod Guide Set (348 Engine)
6.	J-8037	Piston Ring Compressor
7.	J-4536	Lift Kit
8.	J-5860	Cylinder Head Bolt Wrench Adapter
9.	J-1264	0-200 ft. lbs. Torque Wrench
10.	J-8101 (KMO-122)	Valve Guide Cleaner
11.	J-5830	Valve Bore Reamer Set (283 Engine)
	J-7049	Valve Bore Reamer Set (348 Engine)
12.	J-5715 (.003")	Rocker Arm Stud Reamer
	J-6036 (.013")	
13.	J-6880	Rocker Arm Stud Installer
14.	J-5802	Rocker Arm Stud Remover
15.	J-8089 (KMO-7004)	Carbon Removing Brush
16.	J-8062	Valve Spring Compressor
17.	J-8058 (KMO-629)	0-0 ft. lbs. Torque Wrench
18.	J-5513	Piston Fitting Scale
19.	J-5590	Transmission Front Bearing Installer
20.	J-0995	Timing Gear Cover Oil Seal Replacer
21.	J-6978	Harmonic Balancer Puller
22.	J-8001 (KMO-30)	Indicator Set
23.	J-4656	Indicator Swivel Set
24.	J-5825	Crankshaft Gear Puller
25.	J-5788	Rear Main Oil Seal Installer (283 Engine)
	J-6988	Rear Main Oil Seal Installer (348 Engine)
26.	J-6991	Cylinder Bore Plug
27.	J-8520	Camshaft Lobe Indicator
28.	J-8690-01	Universal Engine Adapter (not shown)