PART TWO

ENGINE AND ELECTRICAL

ENGINES

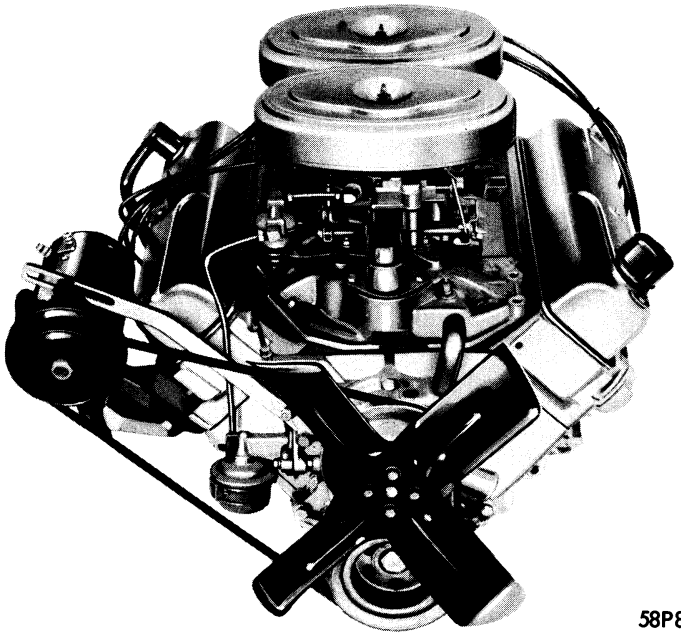
IGNITION SYSTEM

STARTING SYSTEM

GENERATING SYSTEM

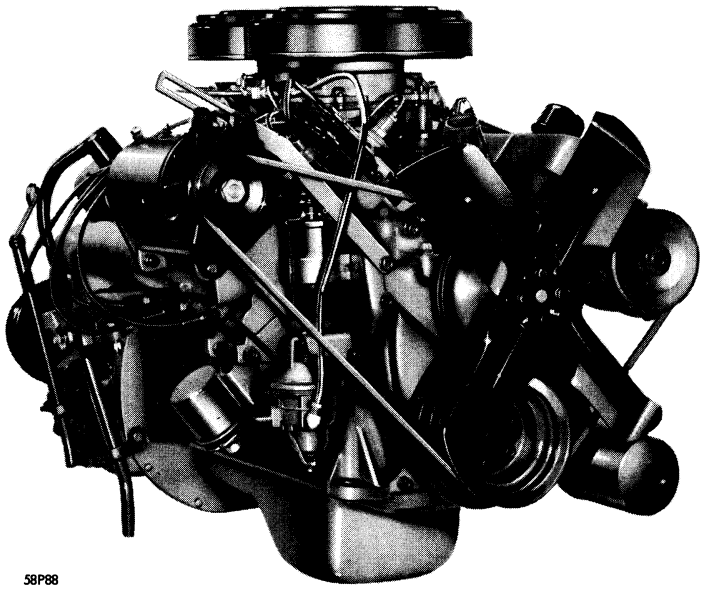
COOLING SYSTEM

FUEL AND EXHAUST SYSTEM



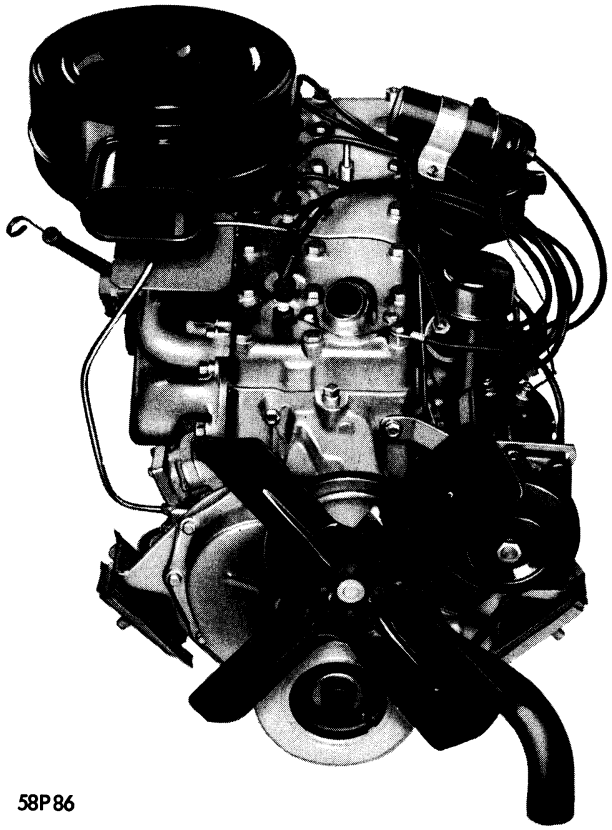
58P87

Dual Fury V-800—318 Cubic Inch V-8 Engine



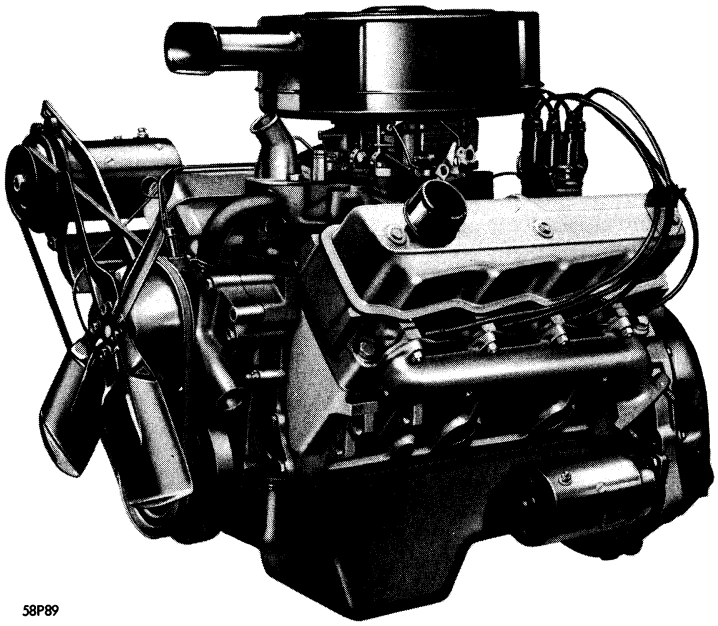
58P88

Golden Commando—350 Cubic Inch Engine



58P86

Power Flow 6—230 Cubic Inch Engine



58P89

Fury V-800—Typical of 301 and 318 Cubic Inch Engine

PART TWO—ENGINE AND ELECTRICAL

SECTION 1—ENGINES

1. CYLINDER HEAD AND GASKET

When a cylinder head is removed, exercise care to prevent damage to the mating surfaces of the cylinder head and cylinder block. Clean the machined surfaces and inspect for nicks or scratches. Inspect all cored passages. Check surfaces for parallelism with a quality straight edge.

A new gasket should always be installed whenever a cylinder head is removed. Inspect the new gasket to make certain all holes are punched out and that sealing ridges are not creased. This is important to insure a positive seal around each opening. Coat the new gasket on both sides with a light application of a suitable sealer.

REPLACEMENT

V-8 ENGINE—Drain cooling system, remove intake manifold, exhaust manifolds, and rocker covers. To remove the push rod on the 277, 301 or 318 cubic inch engines, back out all tappet adjusting screws until the screw is clear of the push rod socket. Slide the arm to one side, compressing the rocker shaft spring, and lift out the push rod. See Figure 1.

When working on the 350 cubic engine, remove the rocker shaft assembly and slide out push rods. Refer to Figure 2. It is important that push rods be placed in a suitable rock in order that each rod can be reinstalled in its original position. Remove the cylinder head bolts and carefully lift off the cylinder head. Note the two dowel guide pins in the cylinder block.

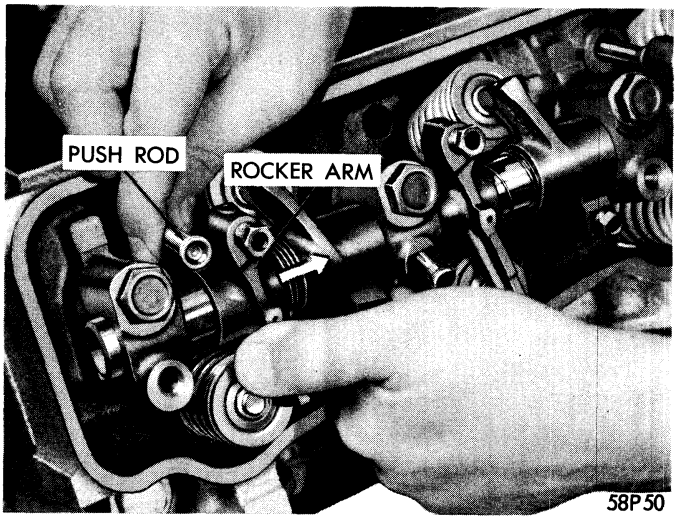


Figure 1—Removing Push Rods from V-8 Engine—277, 301 and 318 Cubic Inch Engine

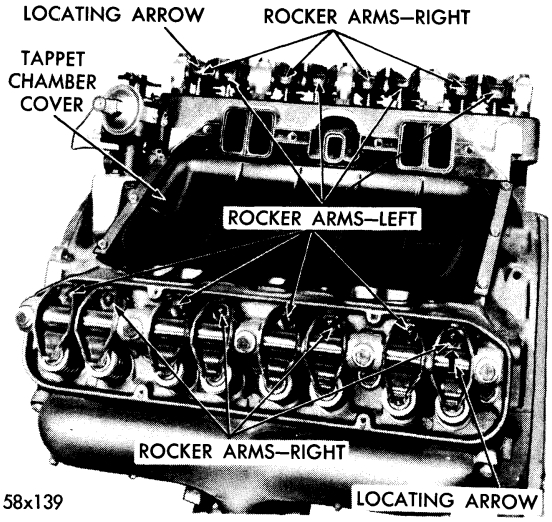


Figure 2—Rocker Arms and Tappet Chamber Cover—350 Cubic Inch Engine

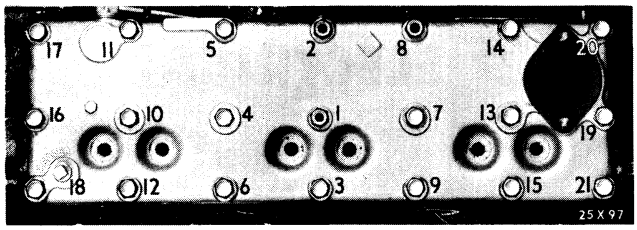


Figure 3—Sequence for Tightening Cylinder Head—6 Cylinder Engine

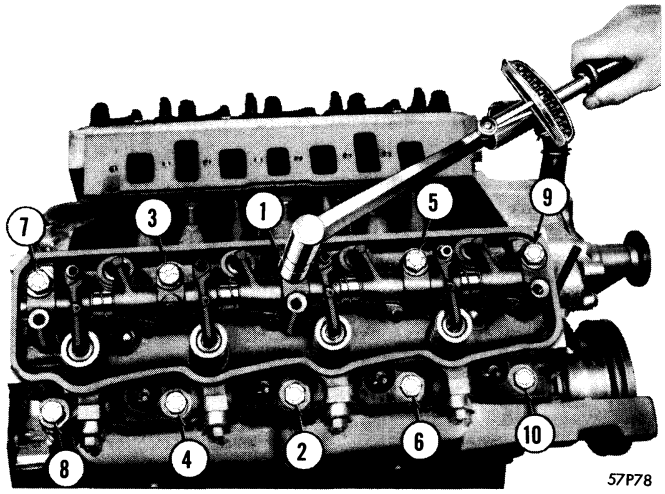


Figure 4—Sequence for Tightening Cylinder Head—V-8 Engine—277, 301 and 318 Cubic Inch Engine

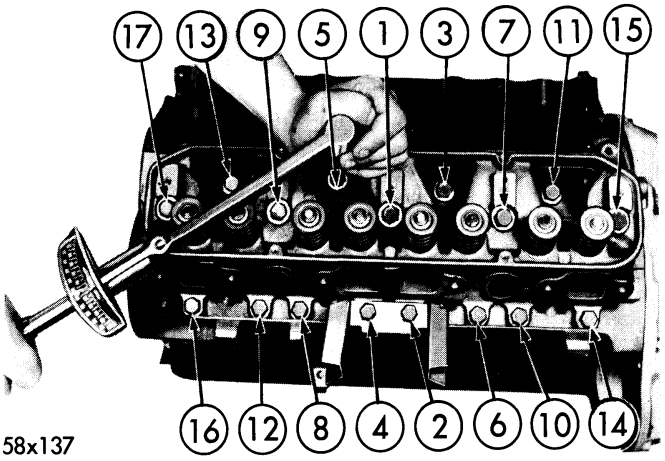


Figure 5—Sequence for Tightening Cylinder Head—V-8 Engine—350 Cubic Inch Engine

CAUTION

(350 cubic inch engine)

Extreme caution must be exercised when tightening the rocker shaft bolts so that the hydraulic tappets have sufficient time to bleed down to their operating length. If tappets are forced down too rapidly when tightening the bolts, damage to the push rods, tappet bodies, or rocker arms will result.

SIX CYLINDER ENGINE—When installing the cylinder head, always use a new gasket. Coat the threads of the cap screws with sealer except the three screws that lead into the intake manifold ports. If a sealer is used on these cap screws, there is a possibility that it will be drawn into the valves.

TORQUING SEQUENCE

Cylinder head bolts should be tightened in sequence. See Figures 3, 4 and 5. Tighten all bolts evenly the first time around to a torque of 35 foot-pounds. Repeat the tightening procedure and tighten the bolt in sequence to the specified torque. Run the engine until normal operating temperature is reached. Then recheck all cylinder head bolts and tighten to specified torque.

V-8 Engine (350 cu. in.).....70 ft. lbs.
V-8 Engine (277, 301, 318 cu. in.).....85 ft. lbs.
6 Cylinder Engine.....70 ft. lbs.

2. OIL PAN AND GASKET

To remove the oil pan from either the 6 cylinder or V-8 engines, drain oil, remove steering and idler arms, dust shield, and starter motor. In addition, on V-8 engines, remove the exhaust cross-over pipe, distributor cap (except 350 cu. in. engines) and the crankcase outlet breather pipe.

Disconnect the motor mounts and raise engine approximately two inches. Support the engine by placing wooden blocks under the motor mounts. Then remove the oil pan.

Before installing the oil pan clean the pan and pan rail of the cylinder block. The cork end seals on the 6 cylinder engine oil pan should be installed so that the ends protrude above the oil pan about ⅛ inch. Do not cut off the ends. The ends will compress against the block and form a better seal. See Figure 6. Gaskets may be installed with a suitable sealer applied to both sides.

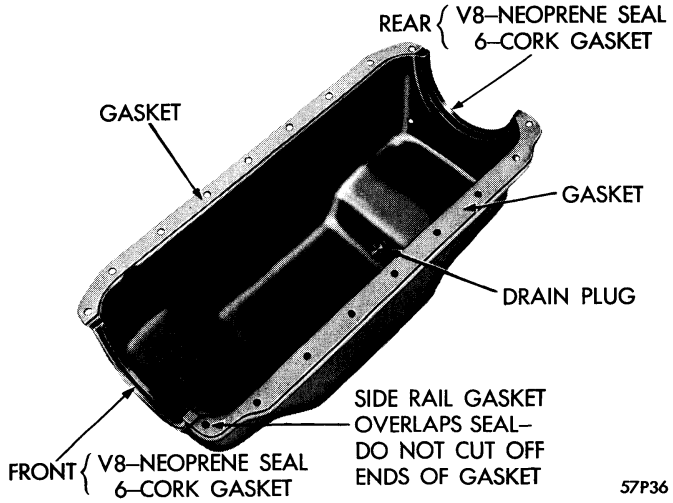


Figure 6—Oil Pan Gaskets and Seals Installed

Typical of 6 Cylinder and 277, 301 and 318 Cubic Inch V-8 Engines

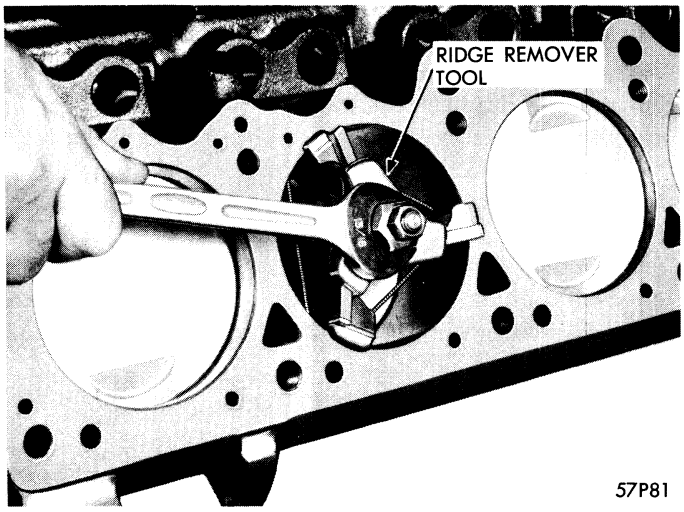


Figure 7—Removing Cylinder Bore Ridge
Typical of all Engines

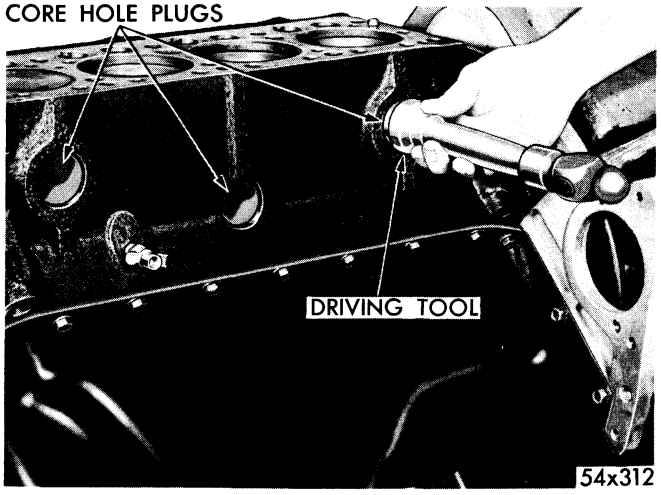


Figure 9—Installing Cylinder Block Core Hole Plug
Typical of all Engines

3. CYLINDER BLOCK

When reconditioning cylinder bores, it is important to remove the top ridge before pistons are removed from the cylinder block. Use a reliable ridge reamer for this operation. See Figure 7. Care must be exercised so as not to cut below the top of the upper piston ring position in the bore. Cover pistons to catch cuttings. Clean cylinder bores after removing ridge. Pistons and connecting rod assemblies must be removed from the top. Rotate crankshaft until piston is at bottom dead center. Then remove cap and push out piston. Always reinstall connecting rod cap to prevent mixing.

CHECKING CYLINDER BORES

Cylinder bores should be checked for taper or out-of-round. See Figure 8. Check each bore at the top, bottom, crosswise, and lengthwise to determine what variation exists. If the cylinder bores are more than .005 inch out of round, or have a taper of more than .020 inch, the bores should be rebored and new pistons fitted.

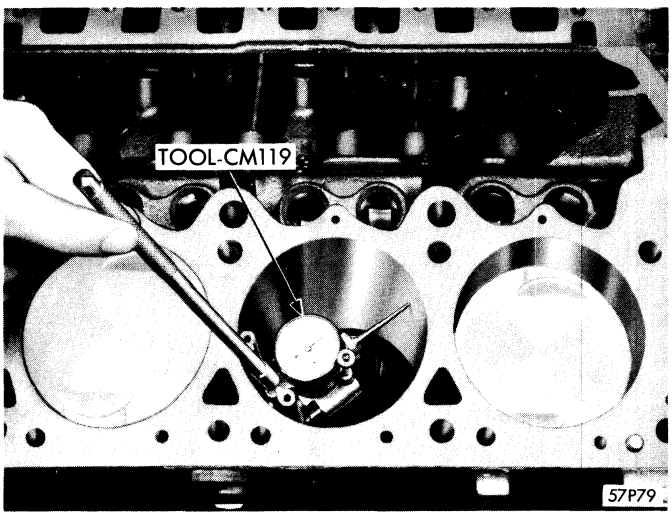


Figure 8—Checking Cylinder Bore for Out-of-Round or Taper
Typical of all Engines

HONING CYLINDER BORES

To remove light scratches, scoring or scuffing, cylinder bores can be satisfactorily honed. Honing limits should not exceed .005 inch removal of metal. If only one or two cylinder bores have light scratches or scores, hone the cylinders up to .005 oversize and use new .005 inch oversize pistons. It is important that cylinder bores are absolutely clean before fitting pistons.

BORING CYLINDER BORES

Cylinder bores that are badly scuffed, scored, over .005 inch out of round or exceed .020 inch taper, should be rebored. Working operation should be closely coordinated with fitting of pistons so that specifications can be maintained. Clean bores thoroughly before fitting pistons.

CLEANING CYLINDER WALLS

After honing, clean the cylinder walls with a brush, using soap and water. Wipe the walls dry with a clean rag.

Be sure to lubricate the piston and rings with a coating of oil before installing them in the cylinder block when assembling the engine.

4. CORE HOLE PLUGS

To remove a core hole plug, use a center punch or similar tool to drive in the center of the plug. Before installing the new plug, make sure seat is clean, smooth and even. Apply a suitable sealer and install plugs with curved side out. See Figure 9.

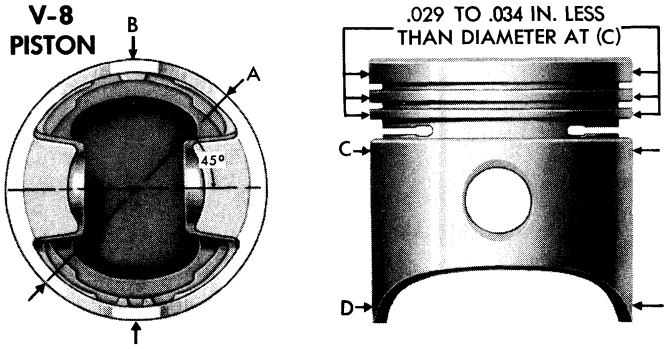


Figure 10—Piston—V-8 Engine—277, 301 and 318 Cubic Inch Engine

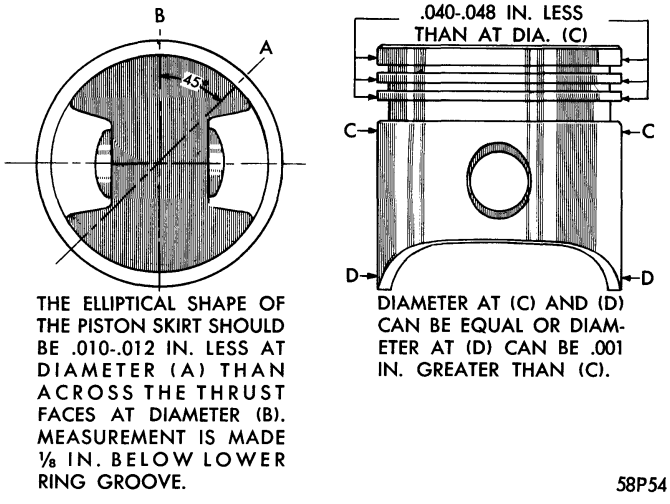


Figure 11—Piston—V-8 Engine—350 Cubic Inch Engine

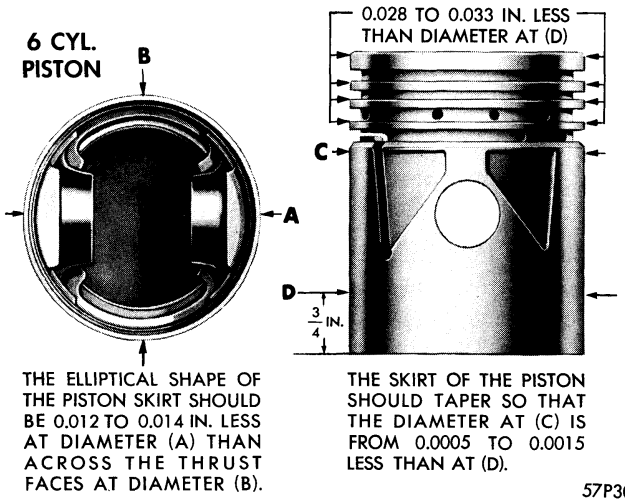


Figure 12—Piston—6 Cylinder Engine

5. PISTONS

The pistons used in Plymouth engines are cam ground so that the diameter at the pin boss is less than its diameter across the thrust face. This allows for expansion under normal operating conditions. Under operating temperatures, expansion forces the pin bosses away from each other, thus, causing the piston to assume a more nearly round shape. It is important that pistons be checked for taper and elliptical shape before they are fitted into the cylinder bore. See Figures 10, 11 and 12.

FINISHED PISTONS

All pistons are machined to the same weight in grams, regardless of oversize to maintain piston balance. For cylinder bores which have been honed or rebored, pistons are available in standard and the following oversizes: .005, .020, .030, .040, and .060 inch.

SEMI-FINISHED PISTONS

Semi-finished pistons are available for the 6 cylinder engines only. If the measurement of a reconditioned bore is such that standard finished piston is not available for the particular size, a semi-finished piston can be used. They are available in two sizes:—(1) for cylinder bores from standard to .023 inch oversize, and (2) for cylinder bores from .025 inch to .060 inch oversize. Only the skirt and lands of a semi-finished piston reqnire finishing. Do not use a .025 inch to .060 inch oversize piston to make a piston below .025 inch oversize because the finished ring grooves will be too shallow, causing ring failure. A semi-finished piston should be finished elliptical in shape and tapered to correct measurements with cam grinding equipment. These pistons must not be finished to a circular shape.

IMPORTANT

When a piston is finished to proper size, its weight should be brought to the average weight of the old pistons. If all new pistons are installed, the difference in weight should not exceed plus or minus 2 grams.

FITTING PISTONS

6 CYLINDER AND 277, 301, AND 318 CUBIC INCH V-8 ENGINES—Piston fitting should be done at normal room temperature, 70° F, with the use of a spring scale and a strip of ½ inch wide feeler stock of a specified thickness. Use .002 inch thick feeler stock for 6 cylinder engines and .0015 inch for V-8 engines. The feeler stock should be long enough to extend into the bore to the full length of piston travel.

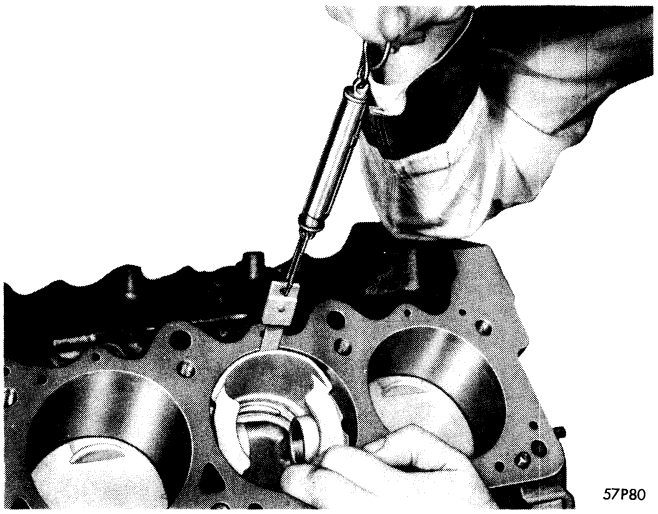


Figure 13—Fitting Pistons in Cylinder Bore
Typical of 6 Cylinder and 277, 301 and 318 Cubic Inch V-8 Engines

Before fitting the piston, make sure cylinder bore and piston are absolutely clean. Coat the cylinder bore lightly with SAE 10W engine oil. Insert the piston in the bore upside down, with the feeler stock between the thrust face of the piston and cylinder wall. Hold the piston and draw the feeler stock out straight with the spring scale as shown in Figure 13. The amount of pull to withdraw the feeler stock should be from 5 to 10 pounds.

350 CUBIC INCH V-8 ENGINE—Piston and cylinder bores must be clean and dry and should be measured at normal room temperature, 70° F. The piston diameter should be measured at the top of the skirt 90° to the piston pin axis. The cylinder bores should be measured halfway down the cylinder bore and crosswise to the centerline of the engine. The specified clearance between the piston and cylinder bore is .005 to .0015 inch.

Figure 14—Fitting Piston Pin in Connecting Rod
Typical of 6 Cylinder and 277, 301 and 318 Cubic Inch V-8 Engines

Figure 15—Fitting Piston Pin in Piston

IMPORTANT

Do not fit the piston in the cylinder bore with the piston pin installed. The pin may distort the piston and a false fit may be indicated.

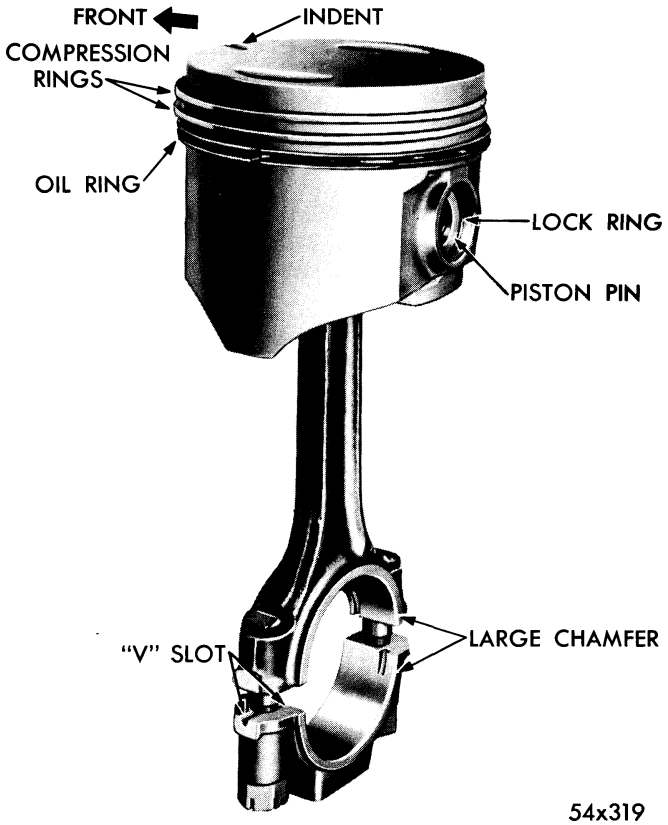


Figure 16—Piston and Connecting Rod Assembly—V-8 Engine—Right Bank
Typical of V-8 Engines

ENGINE

DATA AND SPECIFICATIONS

MODEL		P-30 and LP-1	P-31			LP-2			
			277 cu. in.	301 cu. in.		318 cu. in.			350 cu. in.
Number of Cylinders		6		8					
Taxable Horsepower		25.4	45.0	48.9					52.8
Piston Displacement (cu. in.)		230	277	301		318			350
Bore		3¼	3¾	$3\frac{29}{32}$					$4\frac{1}{16}$
Stroke		4⅝	$3\frac{1}{8}$			$3\frac{5}{16}$			3⅜
Compression Ratio		8.0 to 1		8.5 to 1		9.25 to 1	9.0 to 1	9.25 to 1	10.0 to 1
Maximum Brake Horsepower (At specified engine r.p.m.)		132 at 3600	197 at 4400	215 at 4400	*235 at 4400	†290 at 5400	225 at 4400	*250 at 4400	†290 at 5200	☆305 at 5000
Maximum Torque (Ft. Lbs.) (At specified engine r.p.m.)		205 at 1600	270 at 2400	285 at 2800	305 at 2800	325 at 4000	330 at 2800	340 at 2800	330 at 3600	370 at 3600
Compression Pressure at min. cranking speed of 150 RPM, plugs removed, and wide open throttle		120-150 P.S.I.	125-165 P.S.I.							150-180 P.S.I.
Maximum Variation Between Cylinders		10 P.S.I.	15 P.S.I.							25 P.S.I.
Cylinder Numbering (From Front of Engine)		1-2-3-4-5-6	Left Bank 1-3-5-7 Right Bank 2-4-6-8							
Firing Order		1-5-3-6-2-4	1-8-4-3-6-5-7-2							
Connecting Rod Bearings	Type	Replaceable—Steel Backed Babbitt								
	Diameter and Length	$2\frac{1}{16}$x1 in.	$2\frac{1}{8}$ x $1\frac{3}{16}$ in.							$2\frac{3}{8}$x$\frac{59}{64}$
	Clearance Desired	.0005 in. to .0015 in.								
	Side Clearance	.006-.011 in.	.006-.014 in.							.009-.017
Main Bearings	Type	Replaceable—Steel Backed Babbitt								
	Number of Bearings	4	5							
	Clearance Desired	.0005 in. to .0015 in.								
	Diameter (Nominal)	$2\frac{1}{2}$ in.								$2\frac{5}{8}$ in.
	Effective Length No. 1— No. 2— No. 3— No. 4— No. 5—	 1.09 in. .89 in. .89 in. 1.43 in.	 .750 in. .750 in. .780 in. .750 in. 1.190 in.							 .9375 in. .9375 in. 1.250 in. .9375 in. .9375 in.

*Super-Pak †Fury ☆Golden Commando

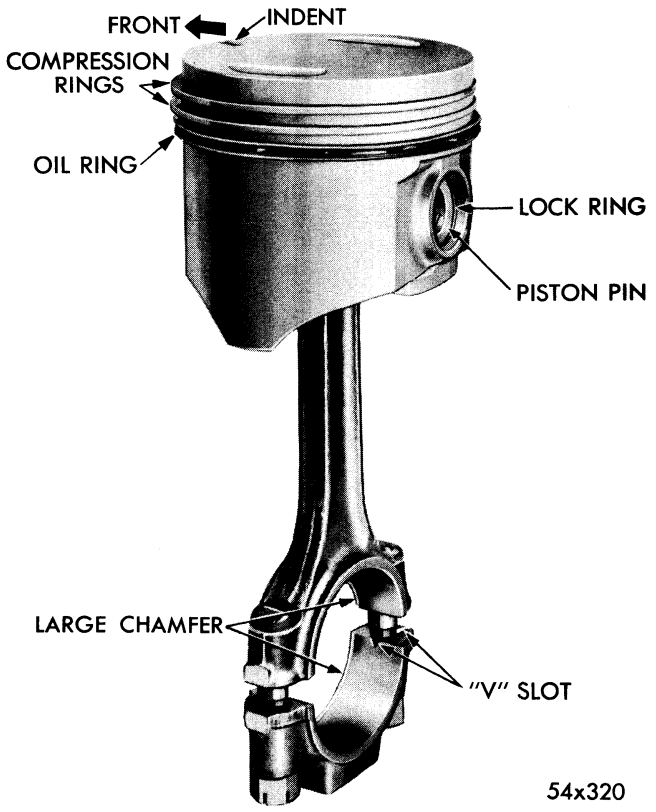


Figure 17—Piston and Connecting Rod Assembly—V-8 Engine—Left Bank
Typical of V-8 Engines

6. PISTON PINS

FITTING PISTON PINS

6 CYLINDER AND 277, 301, AND 318 CUBIC INCH V-8 ENGINES—Test the piston pin fit in the connecting rod as illustrated in Figure 14. This should be a tight thumb press fit at normal room temperature, 70° F.

Test the piston pin fit in the piston as shown in Figure 15. This should be a tight double thumb press fit at normal room temperature, 70° F.

If the pin cannot be installed as explained, use an expansion reamer to enlarge the hole. Use extreme care and take very light cuts, alternately reaming and fitting. This will prevent cutting too much of the metal at one time and will insure a better fit.

ASSEMBLING PISTONS TO CONNECTING ROD

V-8 ENGINE, 277, 301, AND 318 CUBIC INCH—Assemble pistons to the connecting rods on the right hand cylinder bank (Nos. 2, 4, 6 and 8) with the indent on the top of the piston on the side opposite to the large chamfer at the insert end of the connecting rod. See Figure 16.

Assemble pistons and rods on the left bank (Nos. 1, 3, 5 and 7) with the indent on the same side as the large chamfer at the insert end of the connecting rod. See Figure 17.

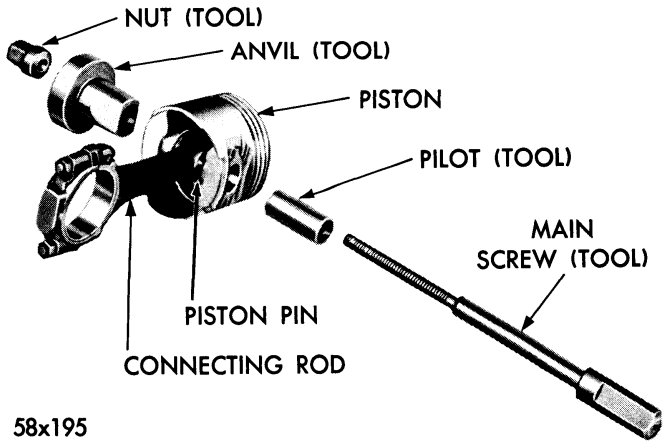


Figure 18—Tool Arrangement for Removal of Piston Pin—350 Cubic Inch V-8 Engine

6 CYLINDER ENGINE—Assemble piston to the rod with the slot in piston on the side opposite to the marking on the machined bolt boss of the connecting rod.

PISTON PIN REMOVAL
(350 Cubic Inch V-8)

The piston pin is held in place in the connecting rod by an interference fit between the rod and the pin. To

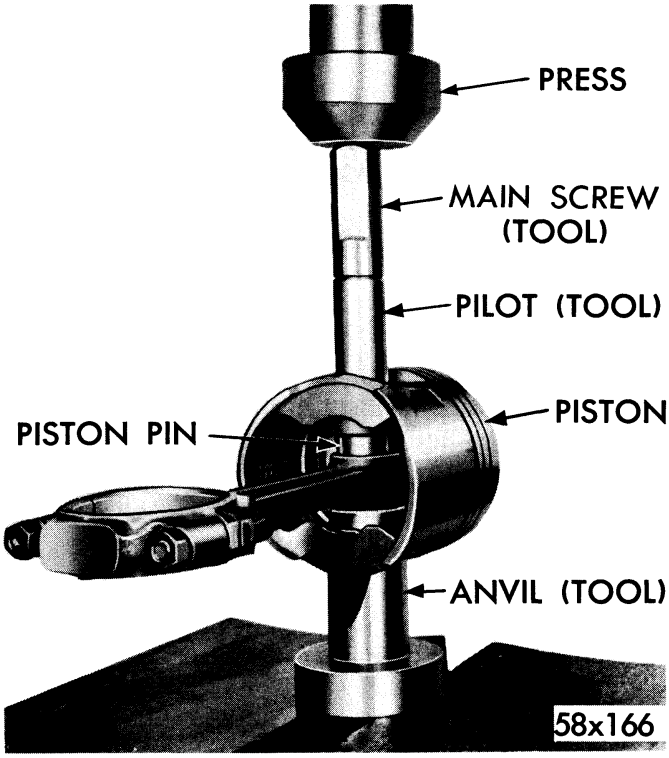


Figure 19—Removing Piston Pin—350 Cubic Inch Engine

ENGINE DATA AND SPECIFICATIONS (Continued)

MODEL		P-30 and LP-1	P-31	LP-2	
			277-301-318 cu. in.	318 cu. in.	350 cu. in.
Crankshaft	Type	Counter-Balanced			
	End Thrust Taken By	Rear Main Bearing	No. 3 Main Bearing		
	End Play	.003 in. to .007 in.	.002 in. to .007 in.		
Camshaft and Bearings	Drive	Silent Chain			
	Bearing Type	Replaceable—Steel Backed Babbitt			
	Number of Bearings	3	5		
	Thrust Taken By	Thrust Plate			Cylinder Block
	End Play		.002 in. to .006 in.		
	Bearing Clearance		.001 in. to .003 in.		
	Diameter and Length No. 1—	2 in. x $1\frac{3}{32}$ in.	2 in. x $\frac{7}{8}$ in.		2 in.
	No. 2—	$1\frac{31}{32}$ in. x $\frac{7}{8}$ in.	$1\frac{63}{64}$ in. x $\frac{3}{4}$ in.		$1\frac{63}{64}$ in.
	No. 3—	$1\frac{15}{16}$ in. x $\frac{7}{8}$ in.	$1\frac{31}{32}$ in. x $\frac{3}{4}$ in.		$1\frac{31}{32}$ in.
	No. 4—	Bored in Block	$1\frac{61}{64}$ in. x $\frac{3}{4}$ in.		$1\frac{61}{64}$ in.
	No. 5—	—	$1\frac{9}{16}$ in. x $1\frac{5}{16}$ in.		$1\frac{3}{4}$ in.
Chain	Adjustment		None		
	Number of Links	48	68		50
	Width		1.02 in.		.875 in.
Intake Valves	Stem Diameter	.340 in. to .341 in.	.372 in. x .373 in. (Std.)		
	Head Diameter	1.53 in.	1.84 in.		1.95 in.
	Length	4.84 in.	4.60 in.		4.84
	Stem to Guide Clearance		.002 in.		
	Face Angle		45°		
Exhaust Valves	Stem Diameter	.340 in. to .341 in.	.371 in. to .372 in.		
	Head Diameter	1.41 in.	1.56 in.		1.600 in.
	Length	4.89 in.	4.58 in.		4.82 in.
	Stem to Guide Clearance	.004 in.	.003 in.		.002-.004 in.
	Face Angle		45°		
Valve Springs	Number	12	16		
	Free Length	2 in.	$1\frac{15}{16}$ in.		$2\frac{5}{16}$ in.
	Pressure (Valve Open)	107 to 115 lbs. at $1\frac{3}{8}$ in.	160-172 lbs. at $1\frac{5}{16}$ in.		173-187 lbs. at $1\frac{15}{32}$ in.
	Pressure (Valve Closed)	40 to 45 lbs. $1\frac{3}{4}$ in.	68-76 lbs. at $1\frac{11}{16}$ in.		75-85 lbs. at $1\frac{55}{64}$ in.

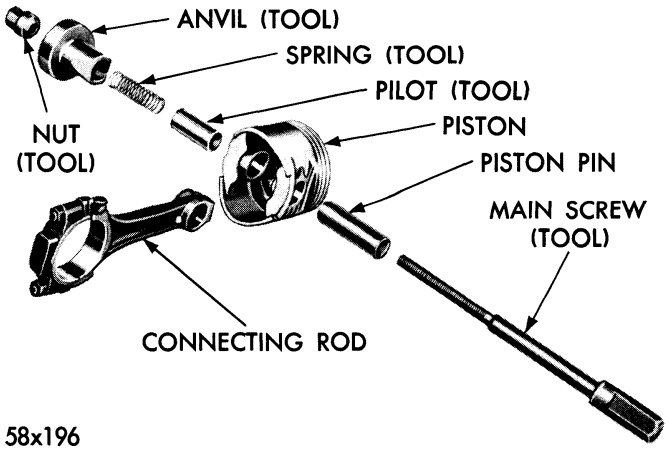


Figure 20—Tool Arrangement for Installation of Piston Pin—350 Cubic Inch Engine

remove the pin, arrange the parts of special Tool C-3624 as shown in Figure 18. Install the pilot on main screw and install screw through piston pin. Install anvil over threaded end of main screw with the small end of the anvil against the piston boss. Install the nut loosely on the main screw and place assembly in the press. Press out pin as shown in Figure 19.

PISTON PIN INSTALLATION (350 Cubic Inch V-8)

Before installing the piston pin in the connecting rod, check the pin fit in the piston. Pin should be a thumb press fit at normal room temperature, 70° F.

Lubricate the piston pin holes in the piston and connecting rod. Arrange the parts of Tool C-3624 as shown in Figure 20. Insert the spring inside the pilot and install the assembly in the anvil. Install the piston pin over the main screw. Place the piston, with "front" up, over the pilot so that the pilot extends through the piston pin hole. Then position the rod over the pilot. Insert main screw and pin assembly through piston and install puller nut. Install assembly in press and press pin into piston until it bottoms on the pilot. See Figure 21.

Assemble pistons and rods on the left bank (Numbers 1, 3, 5, and 7) with the indent in the piston on the same side as the large chamfer at the insert end of the connecting rod. Refer to Figure 17.

Assemble pistons and rods on the right bank Numbers 2, 4, 6, and 8, with the indent in the top of the piston on the side opposite to the large chamfer at the insert end of the connecting rod. Refer to Figure 16.

CHECKING PISTON PIN FIT (350 Cubic Inch V-8)

Assemble the parts of Tool C-3624 to the piston and connecting rod assembly as shown in Figure 18. Place the assembly in a vise as shown in Figure 22 and attach torque wrench. Apply up to 25 foot-pounds torque. If the connecting rod moves downward on the piston pin, reject the connecting rod and piston pin. Obtain a new rod and pin and repeat installation and checking procedure.

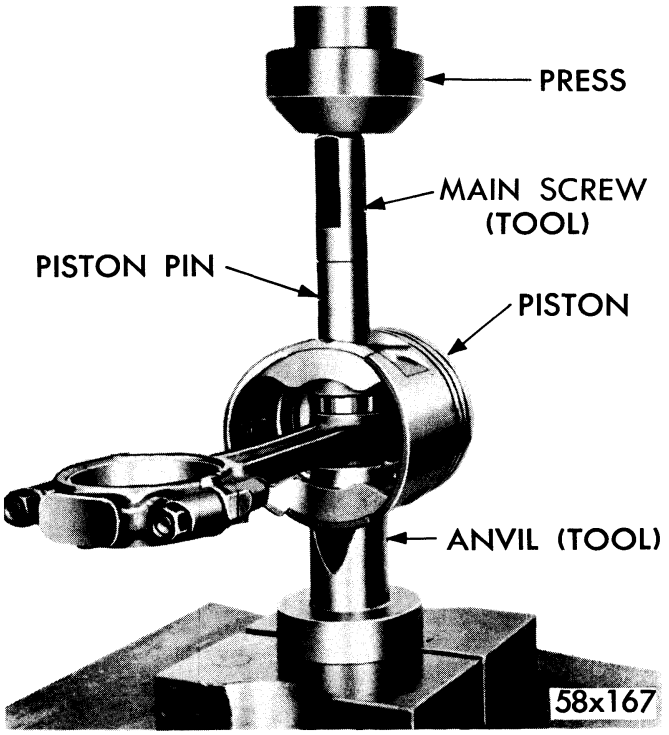


Figure 21—Installing Piston Pin—350 Cubic Inch Engine

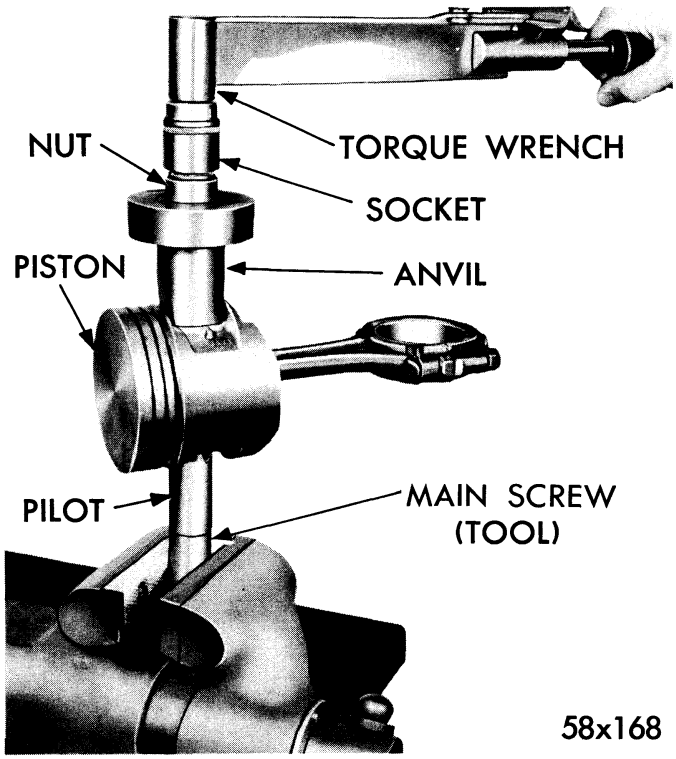


Figure 22—Testing Piston Pin Fit—350 Cubic Inch Engine

ENGINE DATA AND SPECIFICATIONS (Continued)

MODEL		P-30 and LP-1	P-31			LP-2			
			277 cu. in.	301 cu. in.	318 cu. in.				350 cu. in.
Valve Seat Width (Intake) (Exhaust)		5/64 in.	.060 in to .085 in. .040 in. to .060 in.						
Valve Guides		Replaceable	Reamed in Cylinder Heads						
Tappets	Type	Self-locking adjusting screw							Hydraulic
	Body Diameter	5/8 in.	.9040 in. to .9045 in. (Std.)						
	Radial Clearance	.0002 to .001 in.	.0005 in. to .0015 in.						
Valve Timing	Marks Located On	Pulley							
	Intake Opens (°B.T.C.)	12°	14°	8°	17°	8°	17°	21°	15°
	Exhaust Closes (°A.T.C.)	6°	12°	8°	21°	8°	9°	17°	15°
	Exhaust Opens (°B.B.C.)	50°	52°	52°	55°	52°	55°	55°	57°
	Intake Closes (°A.B.C.)	44°	47°	52°	59°	52°	47°	59°	57°
	Running Clearance (Intake) (Exhaust)	.010 (Hot) .010 (Hot)	.008 in. (Hot) .018 in. (Hot)						—
Pistons	Type	U-Slot Cam Ground	Slotted-Cam Ground with Steel Belt						
	Material	Aluminum Alloy							
	Clearance	5-10 Pounds Pull .002 x ½ in. Feeler Stock	With .0015 in. x ½ in. feeler stock 5-10 pounds pull						Hand Fit
	Weight (ounces)	15.8	19.2	20.9	21.0				24.5
	Piston Length	3 11/16 in.	3 9/32 in.		3 7/32 in.				3 7/16 in.
Piston Pins	Type	Floating							Press Fit in Rod
	Length	2.738 in. to 2.753 in.	2.990 to 3.000 in.						3.44 in.
	Diameter	.8591 in. to .8593 in.	.9841 to .9843 in.						1.094 in.
	Fit in Piston	.0000 in. to .0005 in.							.00015 to .00065
Piston Rings	Compression Rings	2							
	Oil Rings	2	1						
	Width—Compression —Oil	.093 in. .150 in.	.0775 in. to .0780 in. .1860 in. to .1865 in.						
	Piston Ring Gap	.010 in. to .020 in.							.013 in. to .025 in.
	Side Clearance: No. 1 Comp.	.0025 to .004	.0015 in. to .003 in.						.002 to .0035
	Side Clearance: No. 2 Comp.	.002 to .0035	.001 in. to .0025 in.						.002 to .0035
	Side Clearance: Oil Ring	.001 to .0025	.001 in. to .003 in.						.0012 to .0025

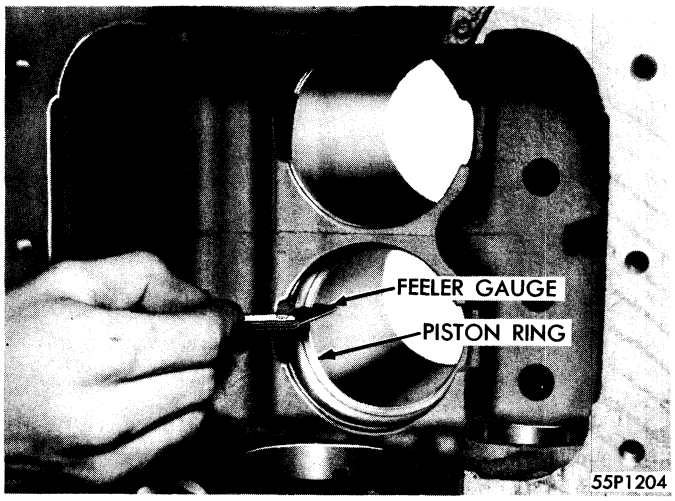


Figure 23—Measuring Piston Ring Gap—6 Cylinder Engine
Typical of V-8 Engines

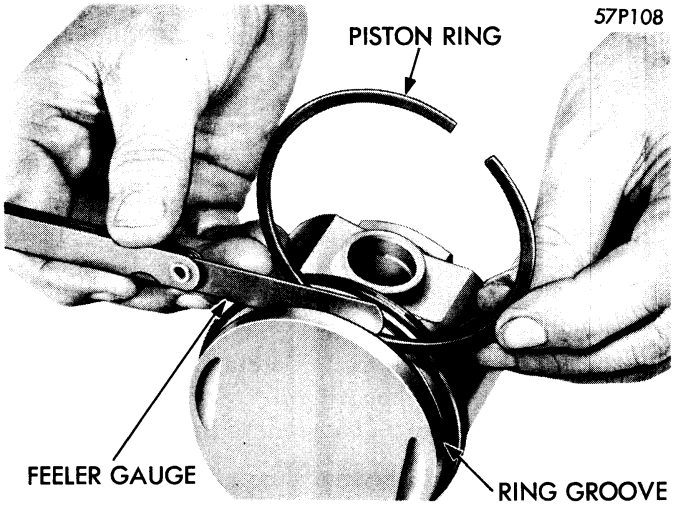


Figure 24—Checking Piston Ring Groove Clearance

7. PISTON RINGS

PISTON RING GAP

Measure the piston ring gap with the ring about two inches from the bottom of the cylinder bore to which it is fitted. Use an inverted piston to push the piston ring down squarely in the cylinder bore. Refer to Data and Specifications for allowable clearance. See Figure 23.

PISTON RING SIDE CLEARANCE

Make sure piston ring grooves are clean. Measure the clearance between the piston ring and land as shown in Figure 24. See Data and Specifications for allowable clearances.

Install piston rings on piston with a suitable piston ring applier. It is important that piston rings be installed correctly as shown in Figure 25.

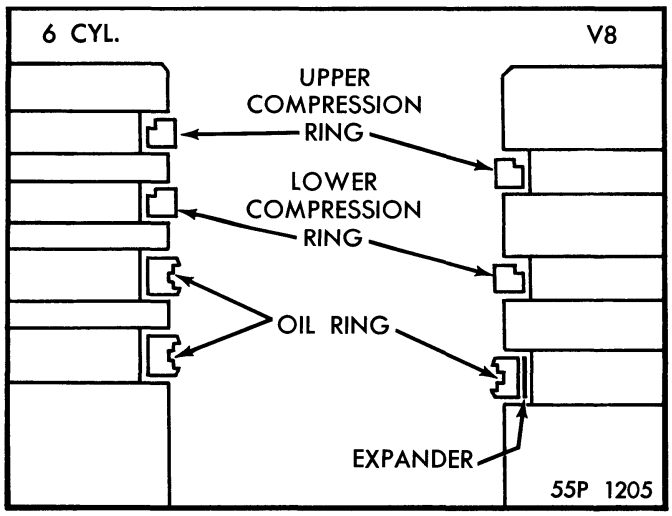


Figure 25—Piston Rings Assembled to Piston

8. CRANKSHAFT

When removing the crankshaft pulley from the 6 cylinder and 350 cubic inch V-8 engines use puller C-3033. No puller is required to remove the pulley or sprocket on 277, 301, or 318 cubic inch V-8 engines. Tap the pulley or sprocket lightly with a soft rubber hammer if necessary.

MAIN BEARING CAPS

V-8 ENGINE—Main bearing caps Nos. 1, 2, 3 and 4 are marked at the bottom. Make sure they are installed correctly and in their proper position.

6 CYLINDER ENGINE—Before removing the No. 2 and No. 3 main bearing caps punch mark the caps and the block so that the caps may be reinstalled in their original position and location. Failure to reinstall the caps in their original position may result in a broken cap.

The crankshaft journals should be examined for scoring, cracks, excessive wear or overheating. Scored or badly worn journals should be reground and undersize bearings installed. Journal of an overheated crankshaft will have a bluish tinge, in which case, a new crankshaft should be installed. Main bearing and connecting rod journals should be checked for out of round and taper. Allowable limit is .001 inch before regrinding.

V-8 ENGINE—When regrinding crankshaft journals, use extra caution to prevent grinding the undercut fillets of the journals. These fillets are formed by a shot peening method to provide maximum strength at the fillet area. Do not grind the thrust faces of the No. 3 main bearing.

Grinding limits of journals should not exceed .012 inch reduction of the original journal diameter. The smallest undersize replacement bearing is .012 inch undersize.

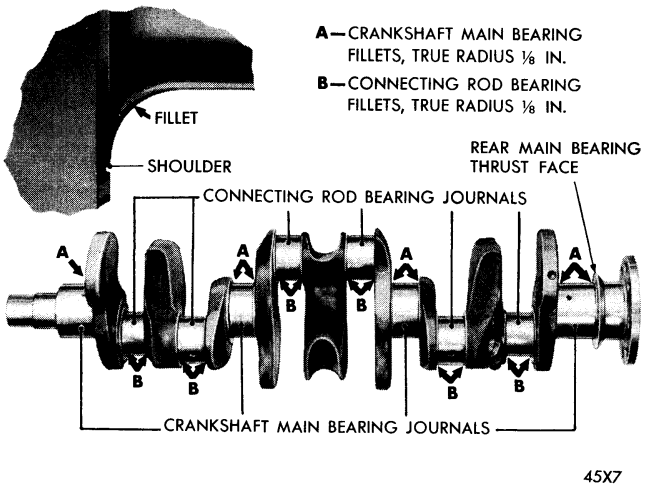


Figure 26—Crankshaft and Connecting Rod Bearing Fillets—6 Cylinder Engine

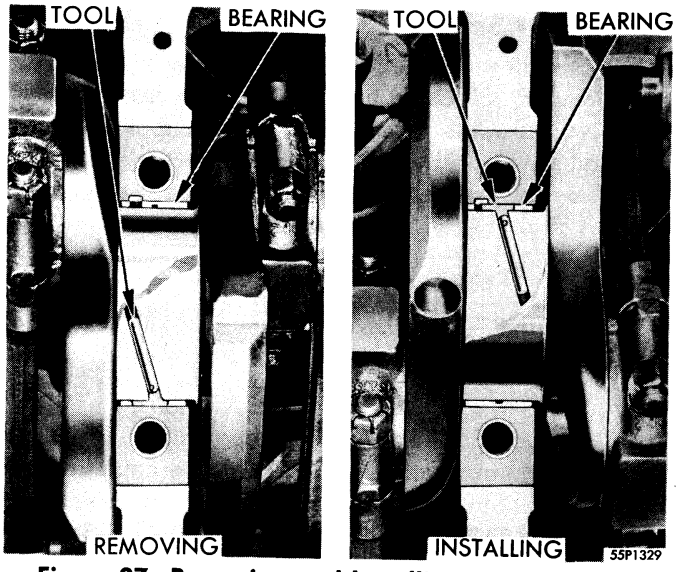


Figure 27—Removing and Installing Main Bearing Upper Insert with Special Tool

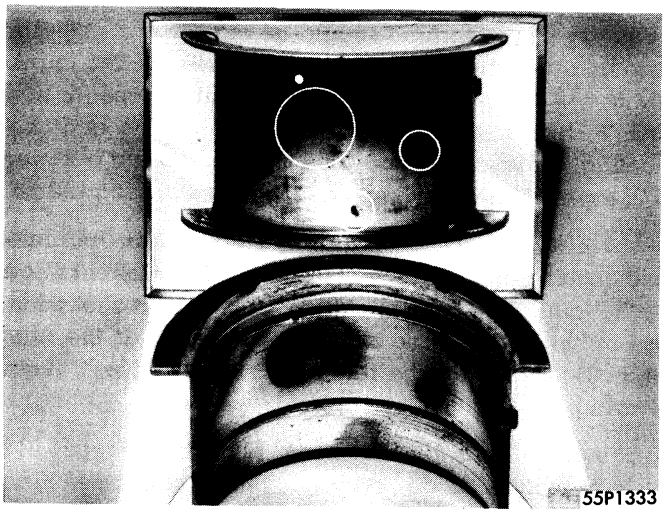


Figure 28—Result of Dirt on Back of Bearing Insert

6 CYLINDER ENGINE—When regrinding be sure to maintain crankshaft bearing fillets. See Figure 26. To avoid damaging polished surface, do not touch shoulder with grinding wheel. The fillet radius must be ⅛ inch (plus 0, minus $\frac{1}{32}$ inch). Too great a fillet radius will permit the bearing to ride the fillet, resulting in bearing failure.

After regrinding, use hand grinder to remove rough edges from all crankshaft oil holes. Clean out all oil passages. Do not grind thrust face of rear bearing journal. The width of this journal controls end play.

END PLAY

To determine crankshaft end play, attach a suitable dial indicator to the engine pan rail with the dial indicator plunger bearing on the crankshaft flange. Pry the crankshaft fore and aft and record readings. Allowable limits are .003 to .007 inches for 6 cylinder engines and .002 to .007 inches for V-8 engine. Thrust is taken up by the number four rear main bearing on 6 cylinder engines and the number three main bearing on V-8 engines.

9. CRANKSHAFT BEARINGS

REPLACEMENT BEARINGS

When .001 inch thicker wall (undersize) crankshaft main bearings are used for production engines an identification mark is stamped on the machined surface of the crankshaft center counterweight for 6 cylinder engines and the No. 3 counterweight on V-8 engines. When the thicker crankshaft main bearings are used, the crankshaft will be marked M1, M2, etc.; depending upon which journal has the .001 undersize bearing.

A .001 thicker wall bearing has an inside diameter .001 inch less than a standard bearing. Each half of the bearing is only .0005 thicker. Replacement crankshaft main bearings are available in the following undersizes:

V-8 Engines—.001, .002, .003, and .012 inch.

6 Cylinder Engines—.001, .002, .003, .010, .012, .020, .030 and .040 inch.

MAIN BEARING REMOVAL

Main bearing inserts can be removed with the engine installed if extreme caution is exercised when removing the upper insert. A special tool is available for this operation. Never remove bearings with a screw driver or similar tool. This usually results in damage to the bearing journal or bearing bore. Use tool C-3059 when removing upper inserts in V-8 engines and use Tool C-584 when working on 6 cylinder engines. Replace one bearing at a time. Insert the pin of the tool in the crankshaft oil hole as shown in Figure 27. Then remove the insert by slowly rotating the crankshaft.

INSPECTION OF BEARING HALVES

The appearance of the babbitt lining of a bearing insert cannot be used as an indication of its running clearance. Before checking bearing clearance, however, a visual inspection can be made to determine whether the bearing is suitable for further use.

Discoloration or dull appearance does not affect the good quality or usefulness of the bearing insert. Look for excessive grooving, scoring or too much foreign material embedded in the babbitt. Shiny spots on the babbitt indicating wiping action are a sign of too little clearance brought about by crankshaft journal taper or out-of-round, damage to back of insert or dirt behind the insert. See Figure 28.

If the bearing clearance is correct, all other factors, such as dull or varnished appearance, dark gray color, lack of brightness and similar minor irregularities can be disregarded. Such a bearing can give satisfactory service for many additional thousands of miles, provided the clearance is satisfactory.

MEASURING BEARING CLEARANCE

Bearing life and quiet engine operation depend upon the establishment of the proper clearance between the babbitt lining of the bearing insert and crankshaft journal.

Excessive clearance will result in bearing noise, while insufficient clearance results in lack of lubrication and may cause a wiping action resulting in damage to the bearing insert or crankshaft journal. Excessive crankshaft journal taper, or an out-of-round condition will prevent proper fitting of the bearing insert, causing premature bearing failure. If crankshaft does not meet specifications, regrind the crankshaft journals.

When checking the clearance of a bearing, do not loosen the other bearing caps. This would disturb crankshaft alignment, cause binding and result in false indication of clearance. Remove spark plugs to relieve compression.

PLASTIGAGE METHOD—Fitting bearings by the Plastigage method consists of compressing a plastic like material between the crankshaft journal and bearing insert. The flattened material is then measured by a graduated scale on the packing envelope, thus indicating bearing clearance. Accuracy depends on cleanliness of the journal and bearing cap and ability of the individual to accurately read the graduated scale. Check one bearing at a time leaving other caps tightened to their specified torques.

Remove the bearing cap and wipe the crankshaft journal and bearing cap to remove oil. Place the plastigage strip parallel with the crankshaft on the bearing insert or crankshaft journal. See Figure 29.

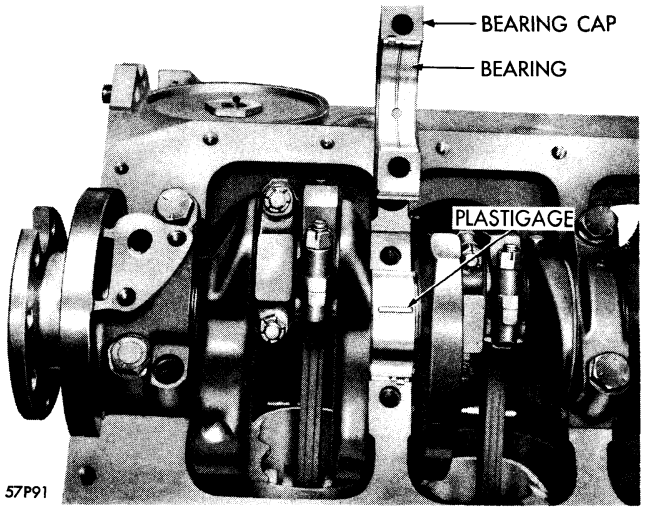


Figure 29—Checking Main Bearing Clearance with Plastigage

Install the bearing cap and tighten the cap bolts alternately to the specified torque.

Remove the bearing cap and measure the compressed material across the widest flattened width with the graduated scale. Allowable bearing clearance is from .005 to .0015 inches. If the compressed plastigage tapers at any point, and differs more than .001 inches as measured with the graduated scale, the journal should be checked with micrometers.

IMPORTANT

If bearings are measured with the engine in the chassis, the crankshaft must be supported in order to take up clearance between the upper bearing insert and crankshaft journal. Use extreme caution when this is done to avoid unnecessary strain on the crankshaft or bearings or false reading may be obtained. Do not rotate crankshaft while plastigage is installed.

INSTALLATION OF BEARING INSERTS

When installing new upper main bearing inserts, remove the sharp edges from the back side of bearings by chamfering slightly. This will permit ease of rotation of the bearing in the shells. Start the bearing insert in place with tool inserted in the oil hole of the crankshaft. Rotate crankshaft counter-clockwise, sliding insert into place. See Figure 27. Use Tool C-548 on 6 cylinder engines and Tool C-3059 on V-8 engines.

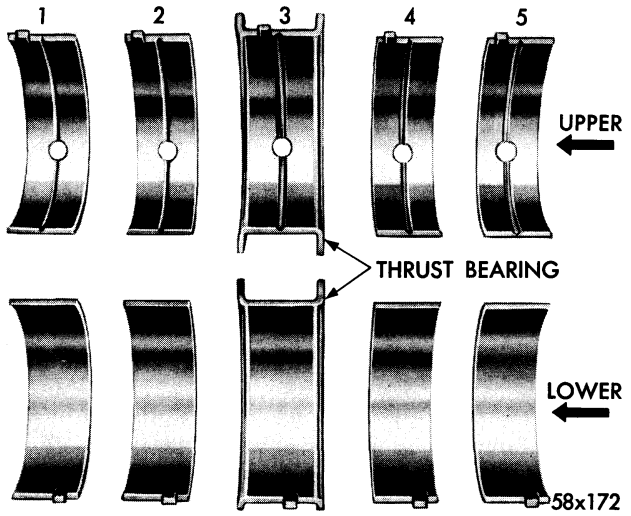


Figure 30—Upper and Lower Bearing Inserts—350 Cubic Inch V-8 Engine

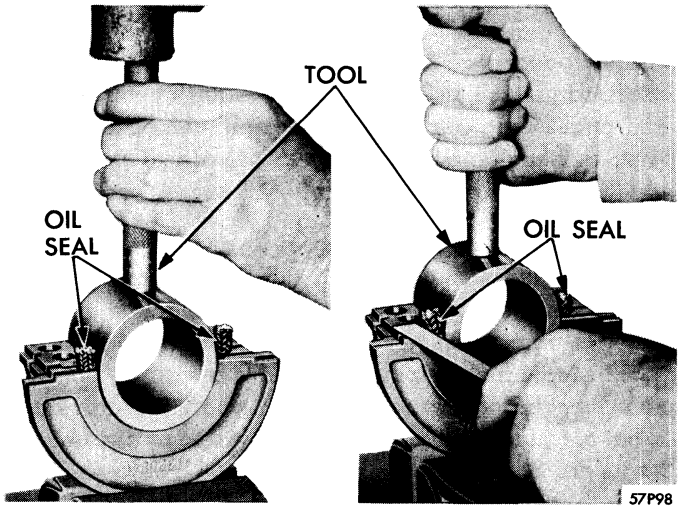


Figure 31—Installing Rear Main Bearing Oil Seal—277, 301 and 318 Cubic Inch V-8 Engine

When installing the lower half of the main bearing, draw the cap down evenly. ALWAYS use a torque wrench and tighten nuts or cap screws to 80 to 85 foot-pounds. Tightening to this specified torque is extremely important.

NOTE

One-half of a .001 inch thicker wall bearing can be used with one-half of a standard bearing. One-half of a .002 inch thicker wall bearing can be used with one-half of a .001 inch bearing. Never use one-half of a .002 inch thicker wall bearing with one-half of a standard bearing. Never use one-half of an old bearing with one-half of a new bearing.

GENERAL INSTALLATION PRECAUTIONS

Use proper tools and make sure tools, equipment and hands are clean. Dust or dirt must be prevented from reaching engine parts.

1. BEARING INSERTS—Never use an old bearing half with a new bearing half. Replace inserts in pairs. When installing, do not allow oil to get between back of the bearing and the bearing cap or the insert may not transfer heat to the cylinder block.

2. INTERCHANGEABILITY OF BEARING INSERTS—350 Cubic Inch V-8 Engine—The upper halves of bearings 1, 2, 4, and 5 are interchangeable. The lower halves of bearings 1, 2, 4, and 5 are also interchangeable. An upper halve of an insert is not interchangeable with a lower halve. See Figure 30.

3. INTERCHANGEABILITY OF BEARING INSERTS—277, 301 and 318 Cubic Inch V-8 Engine—The upper halves of bearings 1, 2, and 4 are interchangeable. The lower halves of bearing 1, 2, and 4 are also interchangeable. On 1957 and some 1958 engines the upper halves of bearings 1, 2, and 4 are interchangeable with the lower halves. However, on later model engines, none of the upper halves are interchangeable with the lower halves.

4. 6 CYLINDER ENGINE—Upper inserts of number 1 and number 4 main bearing inserts are not interchangeable. Make sure that the bearing insert with the oil feed hole is in the upper position.

5. BEARING CAPS—Never file, dress down or shim a main bearing cap except when installing a replacement cap. On replacement caps, stud holes are $\frac{1}{64}$ inch larger than production caps and bearing cap length is $\frac{1}{16}$ inch shorter. This permits fitting of the replacement cap by shimming or filing.

REAR MAIN BEARING OIL SEAL AND CAP SEALS

V-8 ENGINE, 277, 301, AND 318 CUBIC INCH—The rear main bearing oil seal is a rope type seal of braided asbestos. Whenever it is necessary to replace the upper half of the seal, the crankshaft must be removed.

To replace the lower seal and cap seals, remove the rear main bearing cap. Remove all seals, clean the cap and dry with compressed air. Install the rope seal with the ends protruding out. Tap the seal in position with Tool C-3511 as shown in Figure 31, until the tool is seated in the bore. Hold tool down and cut off protruding ends flush with cap. Install bearing insert and both cap seals. See Figure 32. The long cap seal should be installed so that when cap is in position, the seal is on the oil filter side of engine.

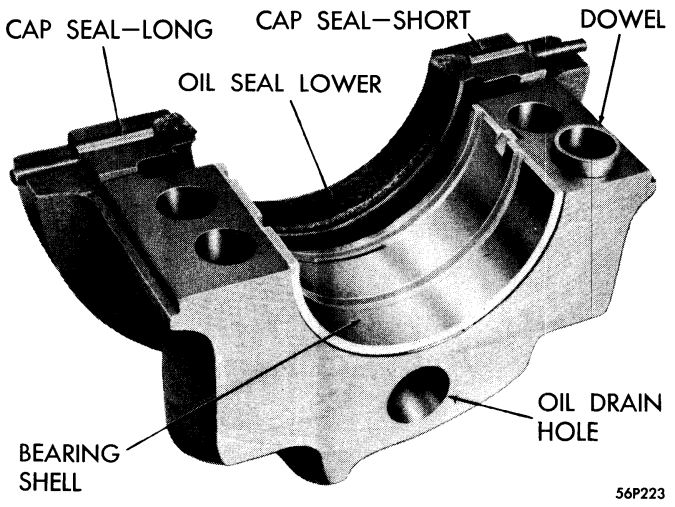


Figure 32—Rear Main Bearing Cap and Seals—277, 301 and 318 Cubic Inch V-8 Engine

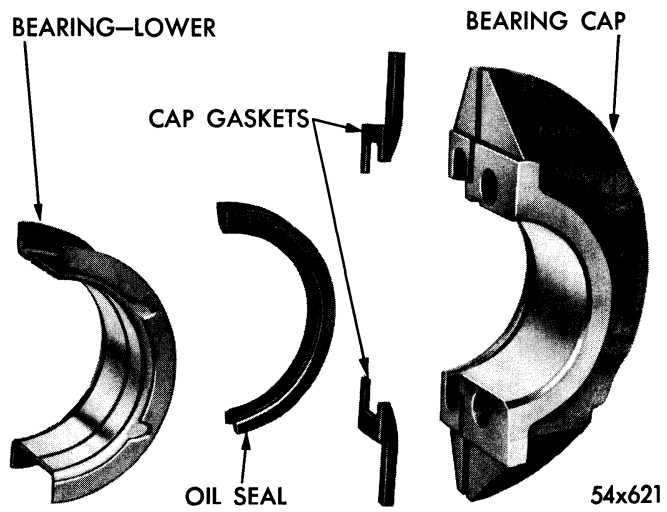


Figure 34—Rear Main Bearing and Cap Seals—6 Cylinder Engine

V-8 ENGINE, 350 CUBIC INCH—When installing the upper seal, tap the seal into position using Tool C-3625 until tool is seated in bearing bore. Hold tool in position and cut off the projecting ends flush with the block.

Tap the seal in the seal retainer until tool bottoms and cut off the projecting ends as shown in Figure 33. When installing the retainer, tighten the screws to 30 foot-pounds.

6 CYLINDER ENGINES—The rear main bearing oil seal is a neoprene lip type seal with a steel insert. See Figure 34. When replacing the rear oil seal, replace both the upper and lower halves. With the cap removed the upper seal can easily be removed with a pair of long nose pliers. Clean the groove in the block of any foreign matter. Insert one end of the seal in the block and push it into place with a rolling motion. Make sure ends are flush with block. See Figure 35.

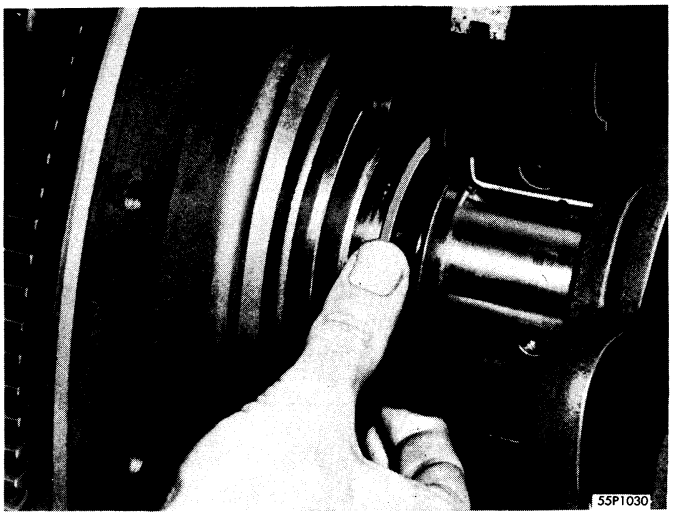


Figure 35—Installing Upper Seal—6 Cylinder Engine

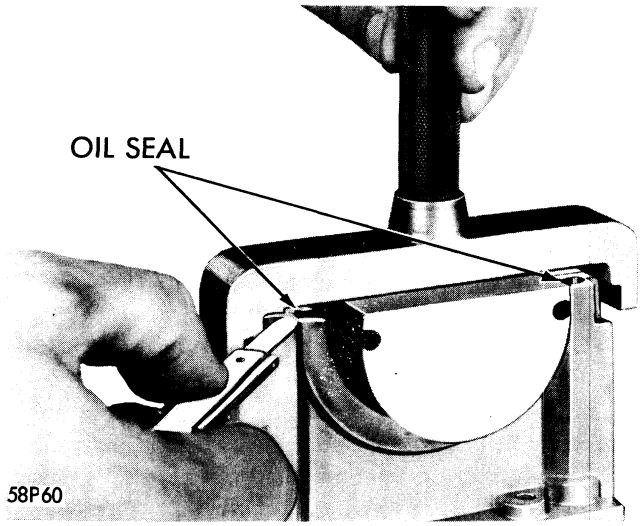


Figure 33—Trimming Rear Main Bearing Oil Seal—350 Cubic Inch V-8 Engine

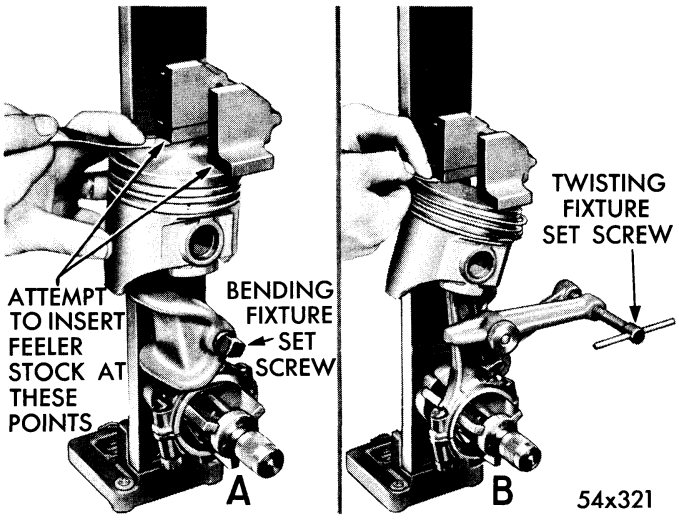


Figure 36—Checking Connecting Rod and Piston for Alignment

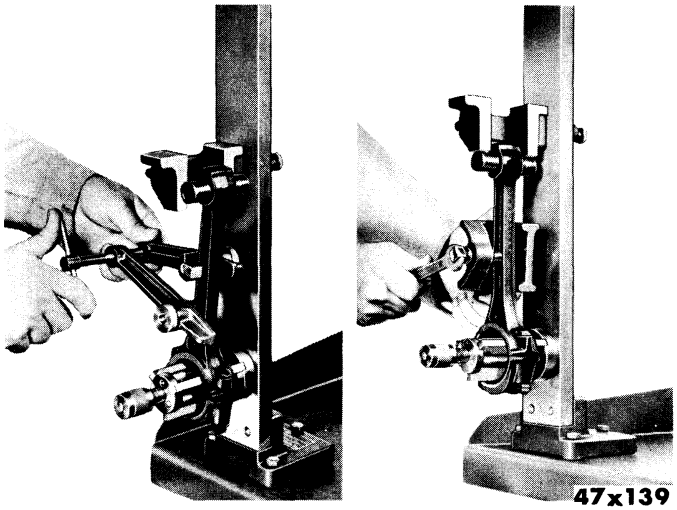


Figure 37—Correcting Connecting Rod for Bend or Twist

After installing the oil seal in the cap, install cap seals in position, making sure that the tabs of the cap seals fit in the cap seal channel.

CAUTION

PowerFlow 6 — Coat the contacting lip of the rear main bearing oil seal with a light application of grease to assure initial lubrication. Install the upper and lower seals so that the contacting lip points toward the front of the engine.

10. CONNECTING RODS AND BEARINGS

CONNECTING ROD ALIGNMENT

CHECKING FOR BEND—Install the connecting rod and piston assembly in Fixture C-481 as shown in Figure 36. The top of the piston should be flush with the tool. The clearance between the piston and the tool shown in (A) of Figure 36 should be zero (0), however, a .002 inch variation is allowable. If more than .002 inch feeler stock can be inserted, the rod should be disassembled and checked and straightened as shown in Figure 37.

CHECKING FOR TWIST—Use Tool C-481 for checking for twist as shown in (B) of Figure 36. Tilt the piston and if more than .002 inch feeler stock can be inserted between piston and tool, disassemble rod and correct as shown in Figure 37.

REPLACEMENT BEARINGS

When .001 inch thicker wall (undersize) bearings are used on production engines, an identification mark will be stamped on the machined surface of the center counterweight for 6 cylinder engines and the number 3 counterweight on V-8 engines. When the thicker bearings are used the markings will be R1, R2, etc., depending what rod uses the .001 inch thicker insert. Replacement bearings are available in the following undersizes:

V-8 Engines—.001, .002, .003, .010, .012 inches.

6 Cylinder Engines—.001, .002, .003, .010, .012, .020, .030, .040 inches.

CONNECTING ROD BEARING CLEARANCE

Install bearings in pairs. Never use a new bearing half with an old bearing half. When fitting bearings do not file the connecting rod or cap to fit bearings but use the proper size insert. When an engine is completely overhauled the shim method can be used to advantage. The Plastigage method has advantages when the bearings alone are to be checked or replaced.

PLASTIGAGE METHOD—The measurement of connecting rod bearing clearance can be done with the use of Plastigage with the engine in the chassis. After removing the connecting rod cap, wipe off oil from the journal and inserts. Place the Plastigage on bearing, parallel with crankshaft. Reinstall cap and tighten attaching nuts alternately to specified torque.

Remove cap and measure the width of the compressed material with the graduated scale to determine bearing clearance. Allowable clearance is from .0005 to .0015 inches. If taper of compressed material is evident, measure with the graduated scale. If difference exceeds .001 inch, journal should be checked with micrometers.

INSTALLING CONNECTING ROD, PISTON AND RINGS ASSEMBLY

V-8 ENGINE—Before installing the pistons, rings and rod assemblies in the bore, be sure that the compression ring gaps are opposite one another and not in line with the oil ring gap. The oil ring expander gap should be toward the *outside* of the "V" of the engine. The oil ring gap should be turned toward the *inside* of the "V" of the engine.

Immerse the piston head and rings in clean engine oil, then slide ring compressor Tool C-385 over piston and tighten with the special wrench (part of Tool C-385). Be sure the position of the rings does not change during this operation. Screw the connecting rod bolt protector (part of Tool C-3221) on one rod bolt, then insert rod and piston into cylinder bore. Affix the puller part of Tool C-3221 on the other bolt, then guide the rod over the crankshaft journal, as shown in Figure 38.

Tap the piston down into the cylinder bore, using the handle of a hammer, as shown in Figure 39, and at the

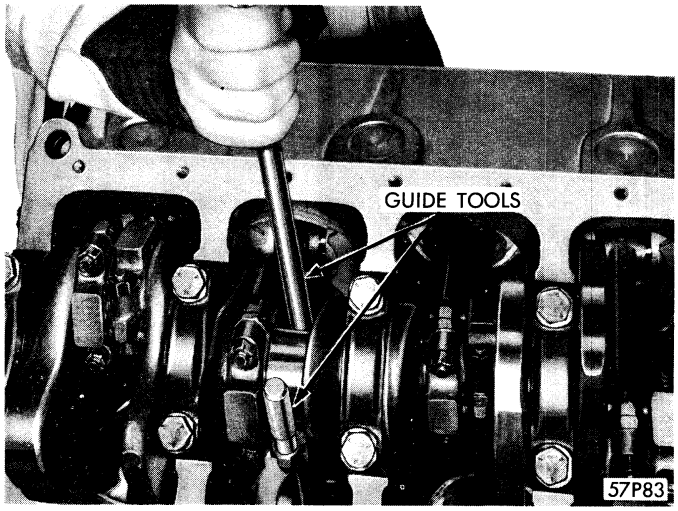


Figure 38—Guiding Connecting Rod on Crankshaft Journal—V-8 Engine

same time, guide the connecting rod into position on the crankshaft journal. The indent in the top of the piston must be pointing toward the front of engine. The connecting rod bores are chamfered more on one side than the other and the larger chamfer must be installed toward the crankshaft journal fillet.

It should be noted that each bearing cap has a small "v" groove across the parting face. When installing the lower bearing insert, make certain that the "v" groove in the insert is in line with the "v" groove in the cap. This is to allow lubrication of the cylinder wall. Install bearing caps and nuts and tighten to 45 foot-pounds.

6 CYLINDER ENGINE—Position each ring so that no two ring gaps are in line. Immerse the piston head in light engine oil and install ring compressor. Position the piston in place and tap it into the bore. The slot in the piston should be away from valve side of the engine.

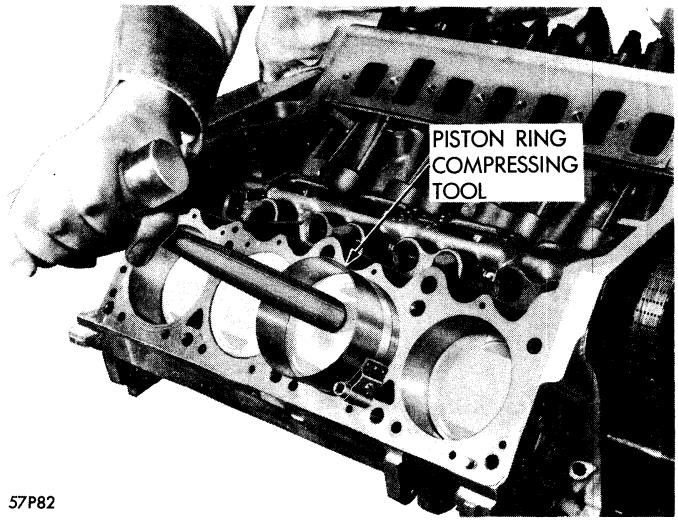


Figure 39—Installing Piston, Ring and Connecting Rod Assembly—V-8 Engine
Typical of 6 Cylinder Engine

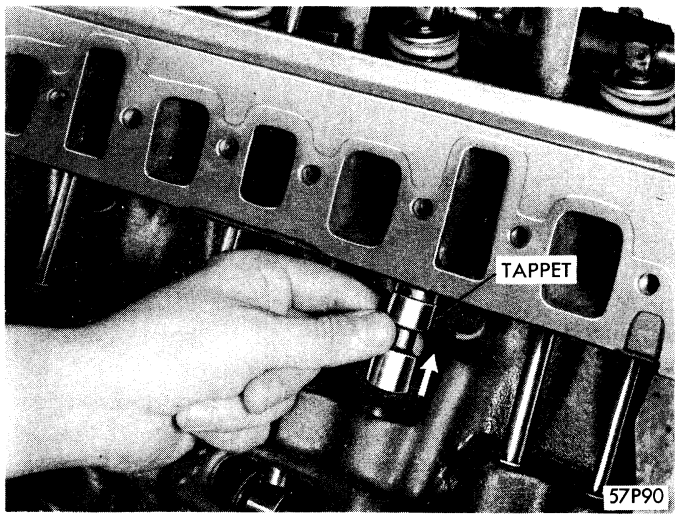


Figure 40—Removing Mechanical Tappet—V-8 Engine
Typical of 350 Cubic Inch V-8 Engine

The number marking on the connecting rod should be on the valve side of the engine. Note that the rods have two oil metering holes. Insert the bearing into the connecting rod so that oil metering hole in the bearing is on the valve side of the engine. Install the connecting rod cap and tighten to 45 foot-pounds torque.

11. CAMSHAFT AND BEARINGS

REMOVAL AND INSPECTION

V-8 ENGINE—Drain coolant and remove radiator and crankshaft pulley.

Remove fan, water pump, and water pump housing assembly. Loosen oil pan bolts sufficiently in order that oil pan clears chain case cover. Remove fuel pump, chain case cover, camshaft gear and timing chain. Remove intake manifold, distributor, distributor drive gear, rocker cover, and valve push rods.

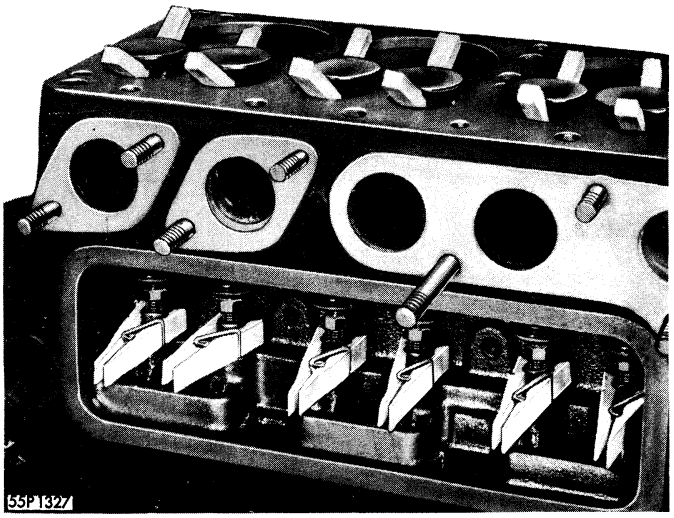


Figure 41—Holding up Valves and Tappets for Camshaft Removal—6 Cylinder Engine

Pull out tappets as shown in Figure 40. On 277, 301, and 318 cubic inch engines end play should be .002-.006 in. Due to the design of the 350 cubic inch engine end play is not measured. Camshaft can now be removed. Carefully inspect camshaft lobes and distributor and oil pump drive gears for excessive wear or damage.

6 CYLINDER ENGINE—Drain coolant and remove radiator core. Remove cylinder head, wheel and splash shield. Support front end of engine and remove front engine support, timing chain case cover, camshaft sprocket and timing chain. If the valves are not being removed, hold them up by inserting two wooden wedges at each valve head at opposite points. See Figure 41. Lift valve tappets up and hold them in place with spring type clothes pins. Remove thrust plate bolts. Camshaft can now be removed. Measure clearance between thrust plate and front bearing journal as shown in Figure 42. The end play should be .002 to .006 inches. Carefully inspect camshaft lobes and distributor and oil pump drive gears for excessive wear or damage.

MEASURING CAMSHAFT BEARING CLEARANCE

Attach a dial indicator to the block with the plunger of the indicator resting on the back of cam nearest a bearing. Pry the shaft "to" and "from" the indicator so that the movement will be shown on the indicator. Check all bearings in the same manner. If the clearance exceeds .005 inch, install a new camshaft for test purpose only. Then recheck the clearance. See Figure 44. If the clearance with the new camshaft exceeds .0035 inch, a new camshaft bearing shell should be installed.

All the camshaft bearing shells are replaceable but seldom, if ever, have to be replaced. If bearing is excessive, new bearing shells may be pressed in place.

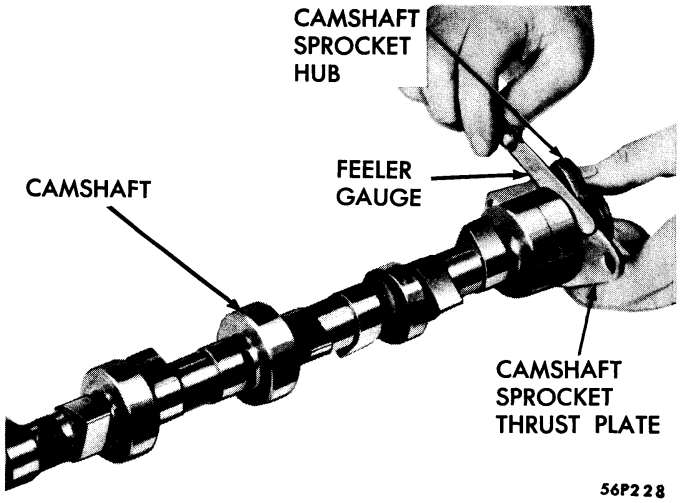


Figure 42—Measuring Camshaft End Play—6 Cylinder Engine

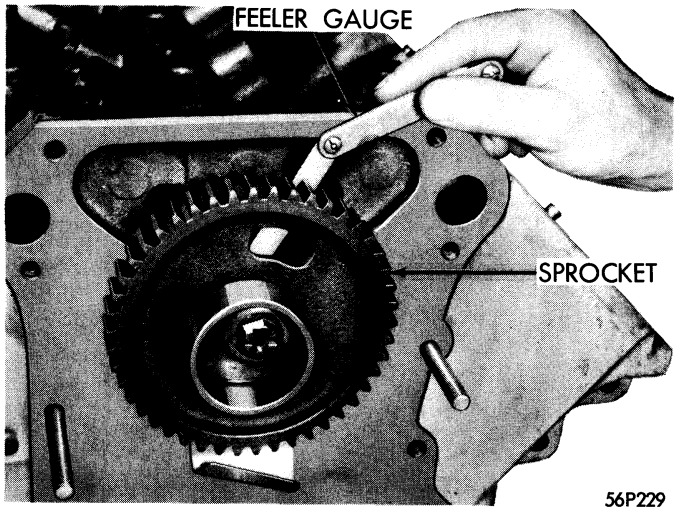


Figure 43—Measuring Camshaft End Play—V-8 Engine—277, 301 and 318 Cubic Inch Engine

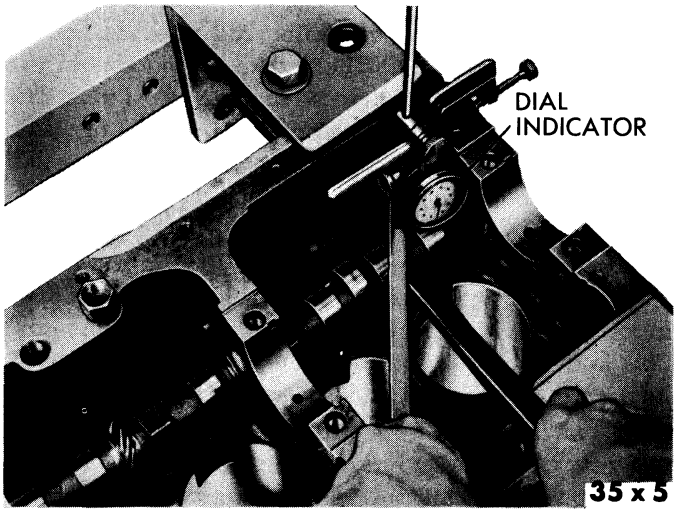


Figure 44—Measuring Camshaft Bearing Clearance—6 Cylinder Engine

Typical of V-8 Engines

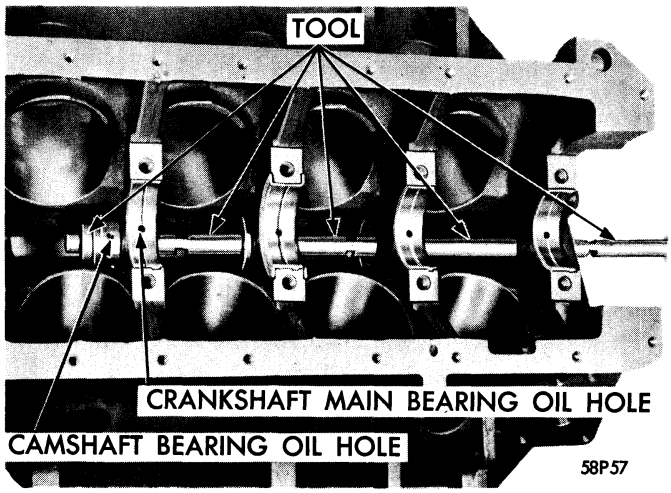


Figure 45—Installing Camshaft Bearings—350 Cubic Inch V-8 Engine

Typical of 277, 301 and 318 Cubic Inch Engine

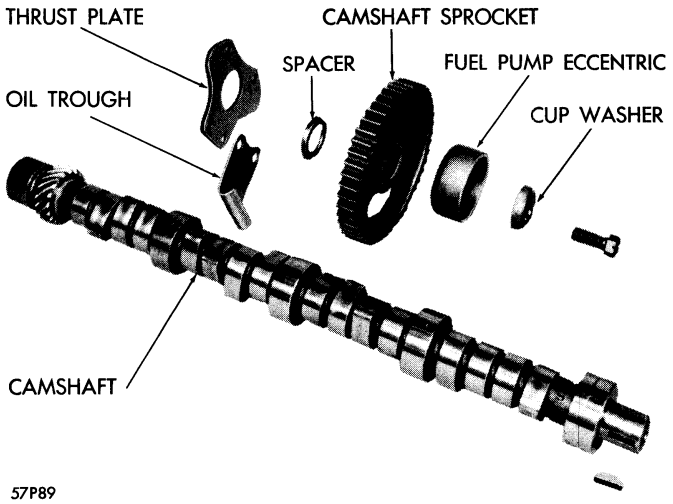


Figure 46—Camshaft and Related Parts—V-8 Engine —277, 301 and 318 Cubic Inch Engine

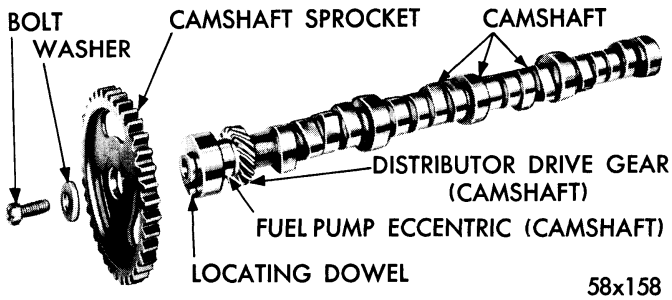


Figure 47—Camshaft and Related Parts—V-8 Engine— 350 Cubic Inch Engine

IMPORTANT

Use care so as not to burr or damage the camshaft bearing bores in the cylinder block, as such damage will interfere with the installation of new camshaft bearings. Use care when installing the camshaft so as not to damage the bearing surface.

REPLACING CAMSHAFT BEARINGS

V-8 ENGINE—When it is necessary to replace camshaft bearings the engine should be removed from the chassis. The rear camshaft welch plug can be removed at the same time. Bearings are removed using special bearing removal and installing Tool C-3132 when working on 277, 301, and 318 cubic inch engines. When working on the 350 cubic inch V-8 engine use adapter SP-3006 with Tool 3132. Coat a new welch plug with suitable sealer and install in cylinder block at rear cam bearing with Tool C-897. Slide new bearing on adaptor and insert in position as shown in Figure 45. Install horseshoe lock and drive in place. Be sure the oil holes in the cam bearing shell and cylinder block are in exact alignment.

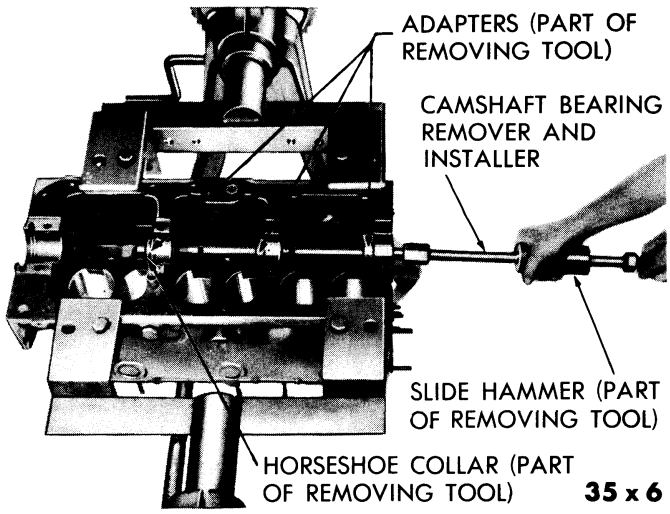


Figure 48—Removing Camshaft Bearings— 6 Cylinder Engine

To check after each bearing shell has been installed, insert light in shell. The complete circumference of the camshaft bearing oil hole should be visible by looking through the main bearing drilled oil passage. If camshaft bearing oil hole is not in exact alignment, reinstall.

6 CYLINDER ENGINE—Camshaft bearings can be removed with the engine in the chassis. Use special removing and installing Tool C-536. See Figure 48. When installing the bearings, it is important that the oil hole in the bearing is in line with the lubricating oil hole in the block.

12. CHAIN CASE COVER OIL SEAL

V-8 ENGINE—Remove crankshaft pulley and water pump housing. Loosen oil pan bolts sufficiently until pan clears chain case cover. Install Tool C-3506 and remove seal. Discard seal and retainer. Position new seal and retainer assembly in housing and press into place using Tool C-3506. Seal must be tight against seat surface.

Be sure mating surfaces of chain case cover and cylinder block are clean and free of burrs. Install a new gasket and position cover over locating dowels. Coat screws with suitable sealer. Tighten to torque of 35 foot-pounds.

6 CYLINDER ENGINE—Drain coolant and remove radiator. Support engine at front and disconnect front engine support. Remove pulley and hub. Remove chain case cover and discard gasket. Clean mating surface of chain case cover and support plate. Drive oil seal out with suitable drift.

When installing seal, make sure seal is driven into place evenly to insure a tight fit. Use a new gasket and position cover in place. Install screws, but do not tighten.

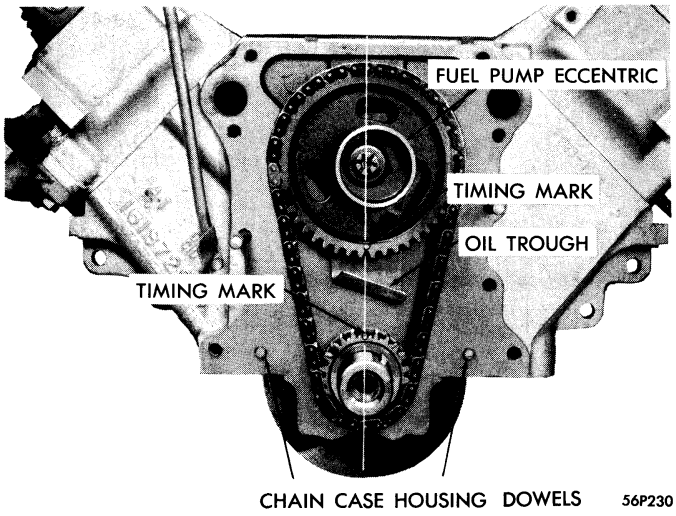


Figure 49—Timing Marks—V-8 Engine
Typical of 277, 301 and 318 Cubic Inch Engine

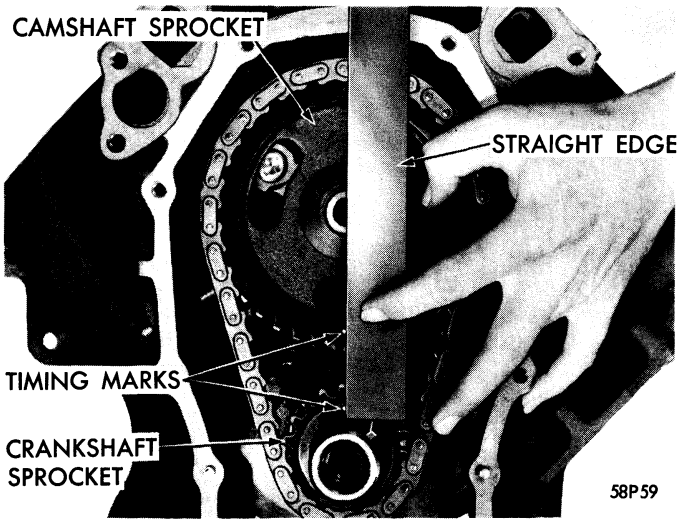


Figure 50—Timing Marks—V-8 Engine—350 Cubic Inch Engine

Install the pulley and hub on crankshaft far enough so that seal can be evenly positioned on crankshaft. Tighten the two screws on right side lightly. Then tighten remainder of screws in like manner. Repeat tightening procedure and torque screws to 15 foot-pounds. This procedure will insure an even seal around the hub.

13. TIMING CHAIN AND SPROCKETS
INSTALLATION

V-8 ENGINE—Rotate the crankshaft until the zero mark on the timing gear is exactly in line with the center of the camshaft. Temporarily install the camshaft gear and line up the dowel pin holes in the hub and the gear, while at the same time positioning the camshaft gear zero mark exactly in line with the center of the crankshaft. See Figures 49 and 50. A straight edge should be used to check the accuracy of this alignment.

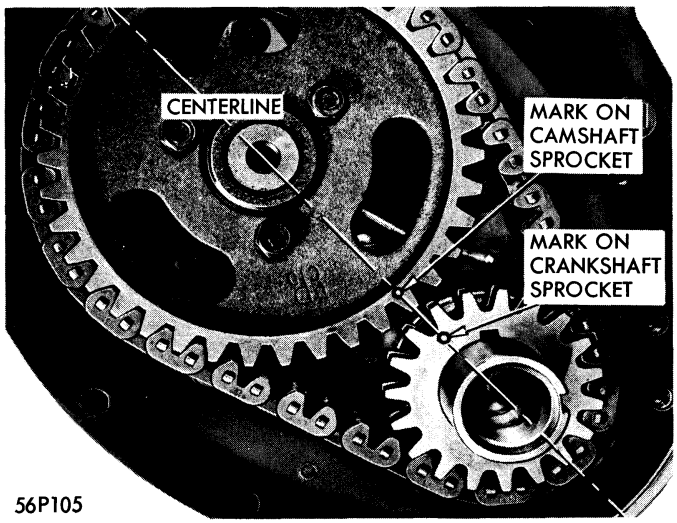


Figure 51—Timing Marks—6 Cylinder Engine

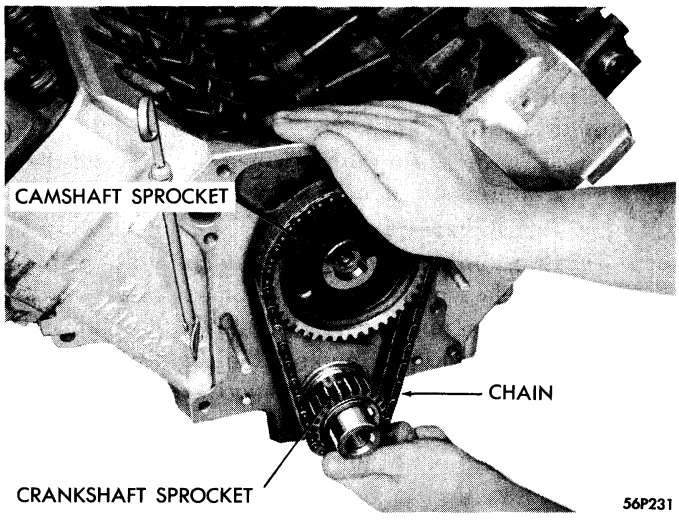


Figure 52—Installing Timing Chain, Sprocket and Crankshaft Gear—277, 301 and 318 Cubic Inch V-8 Engine
Typical of 350 Cubic Inch Engine

Remove the camshaft gear and engage with timing chain. Place chain over crankshaft gear and at the same time, slide the camshaft gear over the end of camshaft, keeping the timing mark in position. See Figure 52. Check the timing chain for stretch or wear.

Block the camshaft to prevent rearward movement. If the shaft is allowed to move back, there is a possibility of striking the rear camshaft plug.

6 CYLINDER ENGINE—Rotate crankshaft until zero mark is in line with center of camshaft. Match the sprocket mounting holes with camshaft hub mounting holes. Rotate camshaft so that zero mark is in line with zero mark on crankshaft timing gear. Remove sprocket and install timing chain. See Figure 51.

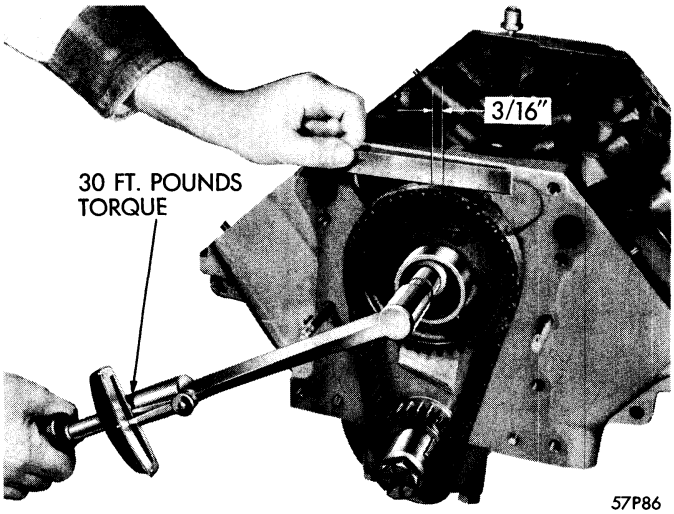


Figure 53—Measuring Timing Chain Stretch—277, 301 and 318 Cubic Inch Engine
Typical of 350 Cubic Inch Engine

CHECKING TIMING CHAIN

V-8 ENGINE—To check the timing chain for stretch or wear, place a scale across the top of camshaft gear with the edge close to the chain. Apply a 30 foot-pound torque in the direction of the crankshaft rotation to take up slack. Holding the scale with the dimensional reading even with the edge of a chain link, apply the 30 foot-pound torque in the reverse direction and note the amount of chain rotation. See Figure 53.

If the movement of the chain is greater than $\frac{3}{16}$ inch, as indicated by the scale, install a new timing chain. With a 30 foot-pound torque applied to the camshaft gear nut, the crankshaft should not move during this check. However, if there is any question, the crankshaft should be blocked to prevent rotation.

6 CYLINDER ENGINE—Turn crankshaft clockwise so that the top span of chain is tight. If the amount of deflection in the lower span of chain is greater than ¾ inch, from a straight line, replace the timing chain.

14. VALVES, SPRINGS, SEATS, AND TAPPETS—V-8 ENGINE

REMOVAL AND INSPECTION

With cylinder head mounted in holding fixtures C-3209, compress the spring with Tool C-3428 and remove valve locks, Figure 54. Release tool and remove valve spring, retainer and valves. Remove all carbon and varnish from valves and cylinder head. Discard any that are burned, warped or cracked.

Measure valve stem diameter at various points. Diameter should be .372 to .373 inch for standard intake

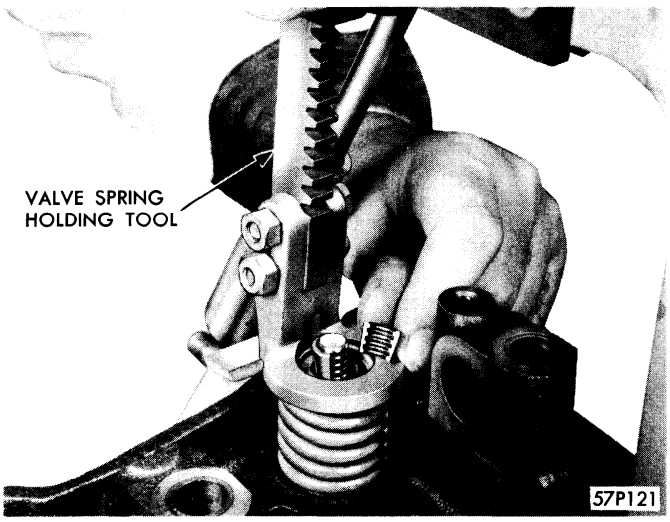


Figure 54—Installing or Removing Valve Locks

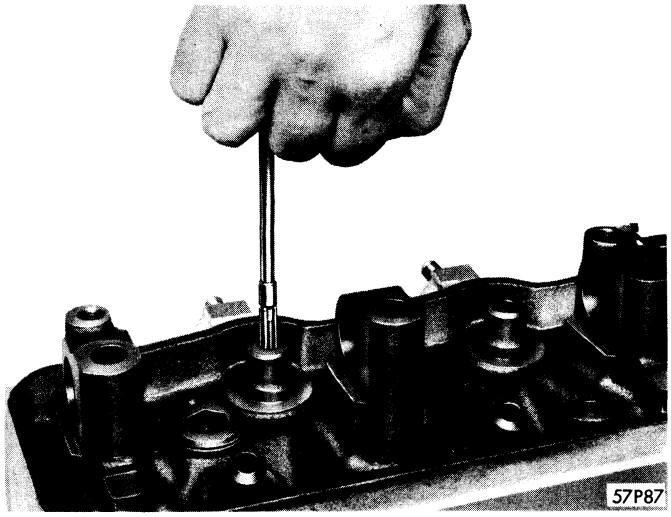


Figure 55—Cleaning Valve Guide—277, 301 and 318 Cubic Inch V-8 Engine
Typical of 350 Cubic Inch Engine

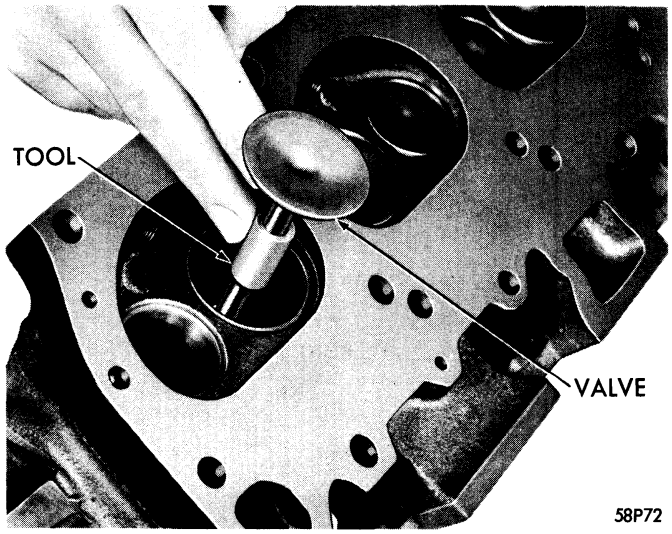


Figure 56—Installing Valve Guide Sleeves for Checking Guide Clearance—350 Cubic Inch V-8 Engine
Typical of 277, 301 and 318 Cubic Inch Engine

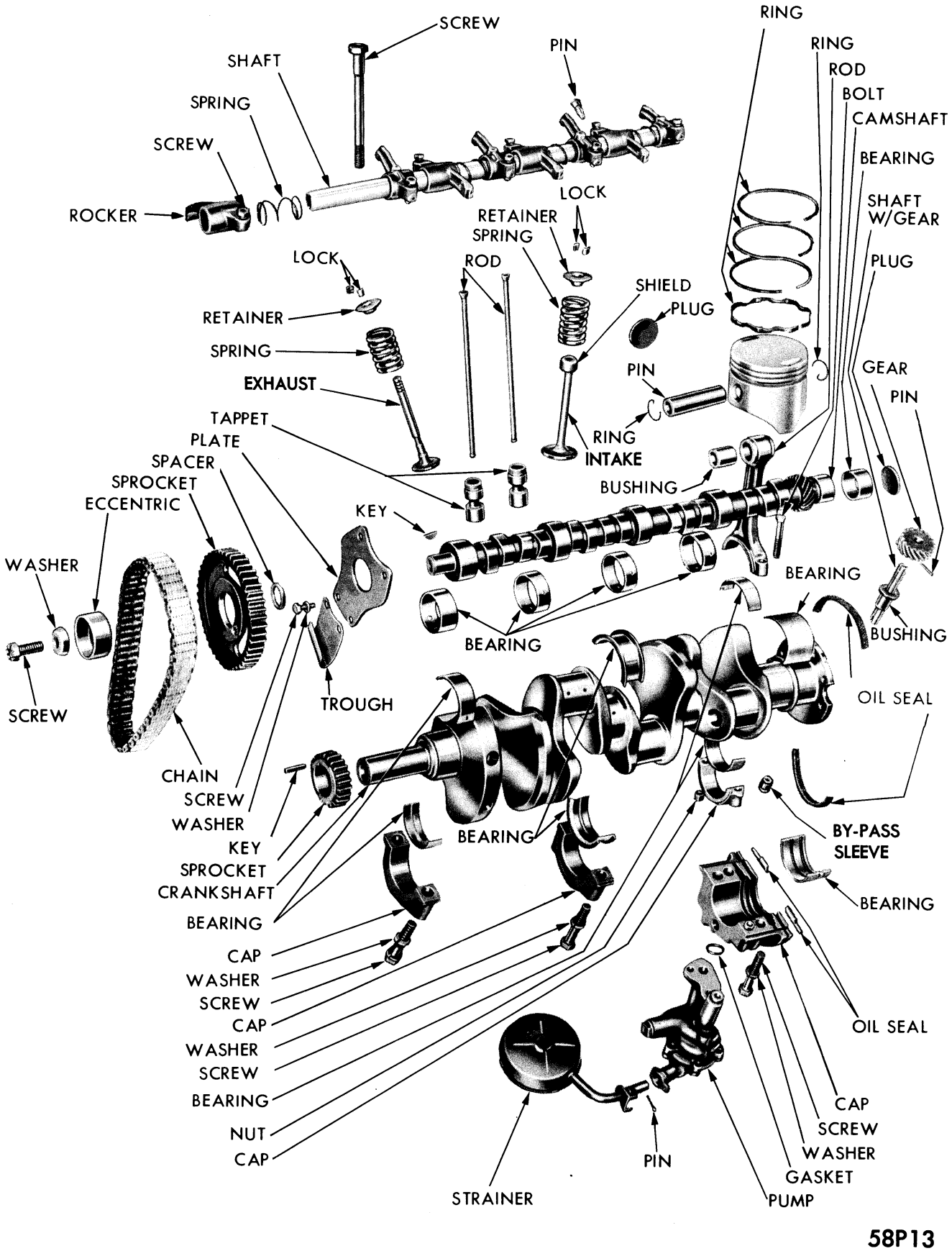


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Figure 57—Crankshaft and Related Parts—V-8 Engine—277, 301 and 318 Cubic Inch Engine

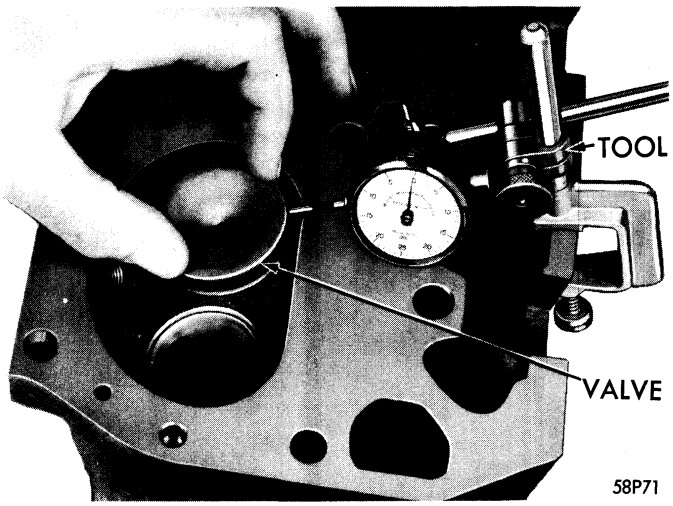

Figure 58—Checking Valve Guide Clearance—350 Cubic Inch V-8 Engine
Typical of 277, 301 and 318 Cubic Inch Engine

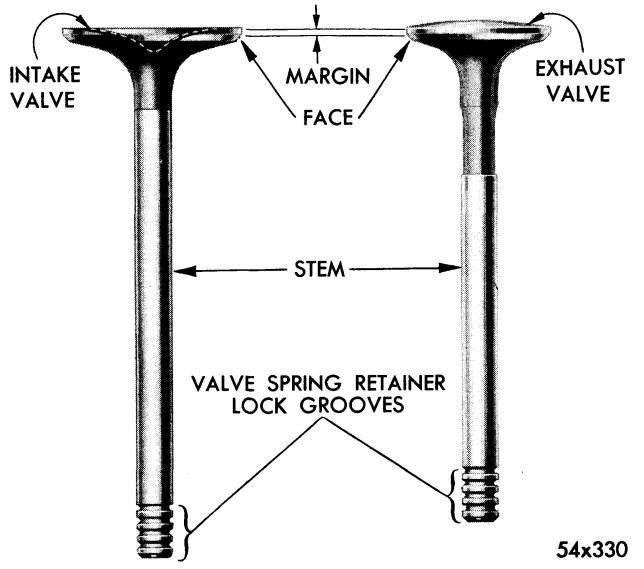

Figure 59—Intake and Exhaust Valve Nomenclature

valves and .371 to .372 inch for standard exhaust valves. If wear exceeds .002 inch ream guide and install an oversize valve.

Remove carbon and varnish from valve guide with Tool C-756 as shown in Figure 55. Measure amount of valve stem to guide clearance with dial indicator. Install sleeve C-3025 on intake valve and C-3026 on exhaust valve. Then install valve in guide as shown in Figure 56. Attach dial indicator and move valve to and from the indicator as shown in Figure 57. Total clearance should not exceed .008 inch on intake valves and .014 inch on exhaust valves. If these clearances are exceeded replace valves and ream guides.

REAMING VALVE GUIDES

Standard production reaming of both intake and exhaust valve guides is .374 to .375 inch. When reaming guides for oversize valve stems do not attempt to ream from standard to .030 inch oversize. If necessary to ream to that size, use the step procedure of .005, .015, and then .030 inch. This must be done in order to maintain a true relationship of the guide to the valve seat. The following chart indicates reamer size and valve stem size:

Reamer Tool No.	Reamer Oversize	Valve Stem Size
C-3433	.005 in.	.379-.380 in.
C-3430	.015 in.	.389-.390 in.
C-3427	.030 in.	.404-.405 in.

IMPORTANT

Valve guides are cast integral in the cylinder head. Valves with oversize valve stems are available for service when it is necessary to ream guides.

REFACING VALVES AND VALVE SEATS

When refacing a valve, remove only enough metal to insure a smooth, accurate surface of the valve face. After refacing the valve, check the valve head margin. See Figure 59. If margin is less than $\frac{3}{64}$ inch, replace the valve.

When refacing valve seats, it is important to use the correct size valve guide pilot. Remove only enough metal to obtain a smooth accurate seat. After grinding, check concentricity of seat with a dial indicator. Total run-out should not exceed .002 inch.

Check the valve seat with Prussian Blue to determine where the valve contacts the seat. It is important that this contact be centralized on the valve face. If this contact surface is not properly centralized, the seat should be relocated by using a 20° stone at the top, or a 60° stone at the bottom, whichever is necessary. Refer to Figure 60. When the seat is properly positioned, the width of the intake seats should be a liberal $\frac{1}{16}$ inch, but not more than $\frac{3}{32}$ inch in any case. The width of the exhaust seats should be $\frac{3}{64}$ inch to a liberal $\frac{1}{16}$ inch.

350 CUBIC INCH ENGINES—When valves and seats are reground, the position of the valve in the head is changed so as to shorten the operating length of the hydraulic tappet. This means that the plunger is operating closer to its bottom position, and less clearance is available for the thermal expansion of the valve mechanism during high sped driving. Design of plunger travel includes a safety factor for normal wear and refacing of valves and seats. However, if face and seat grinding is carried to the point where the valve position is changed

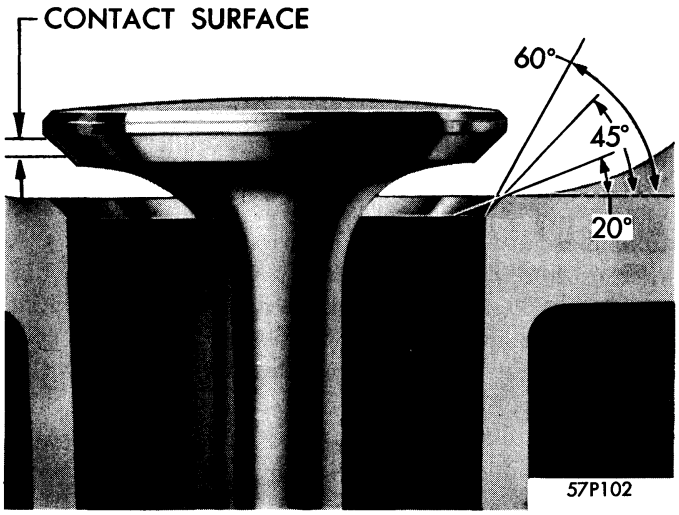

Figure 60—Valve Seat Reconditioning Angles

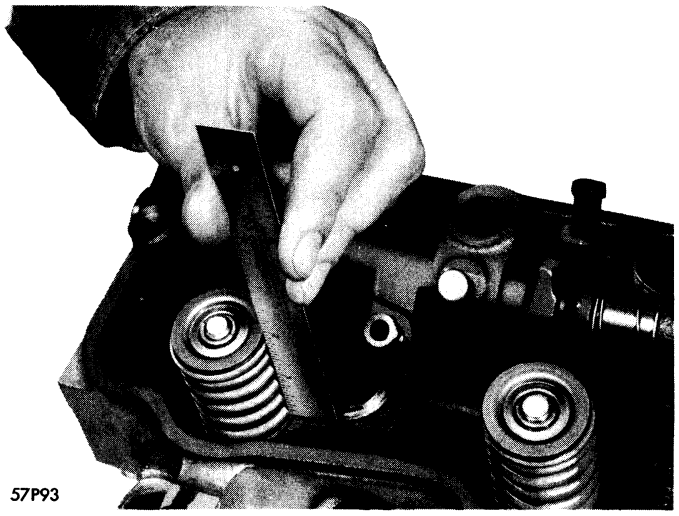

Figure 63—Checking Installed Height of Spring—277, 301 or 318 Cubic Inch Engine

Typical of 350 Cubic Inch Engine

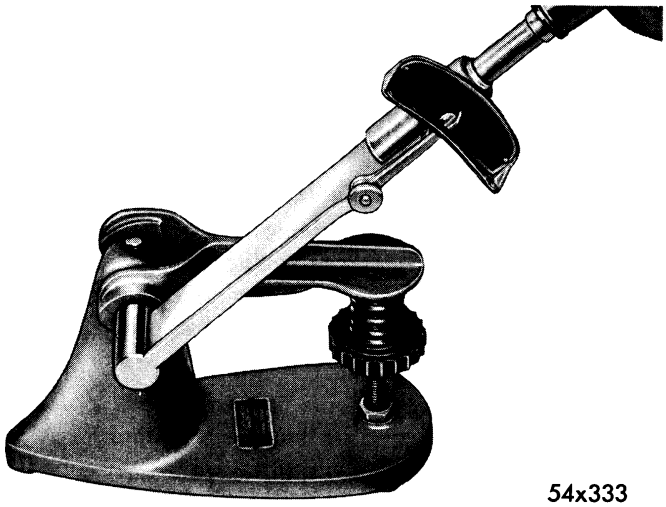

Figure 61—Testing Valve Springs

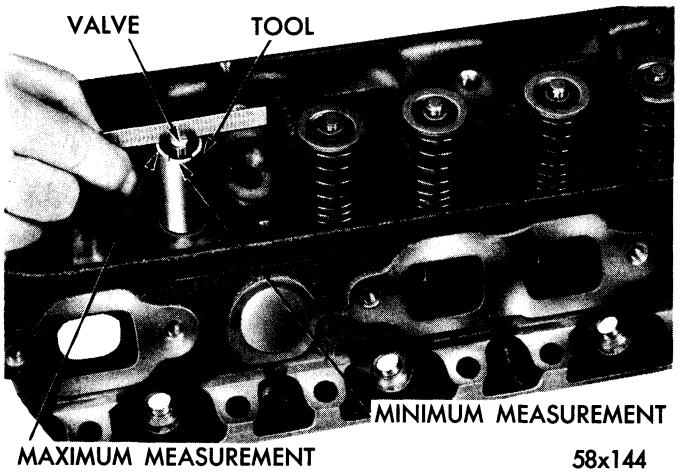

Figure 64—Checking Installed Height of Valve—350 Cubic Inch Engine

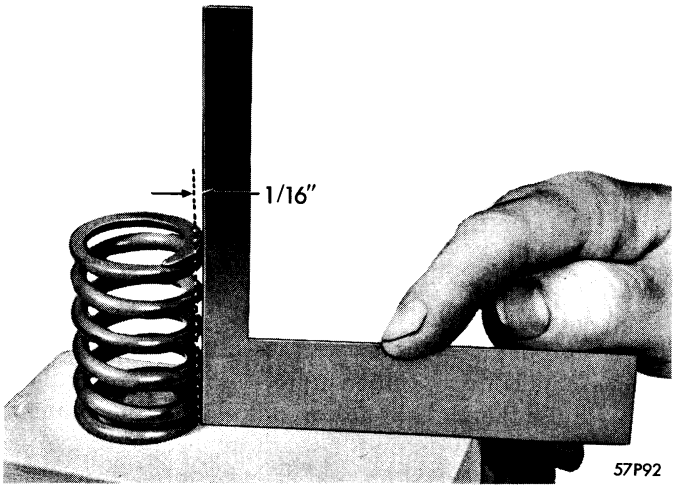

Figure 62—Checking Trueness of Valve Springs

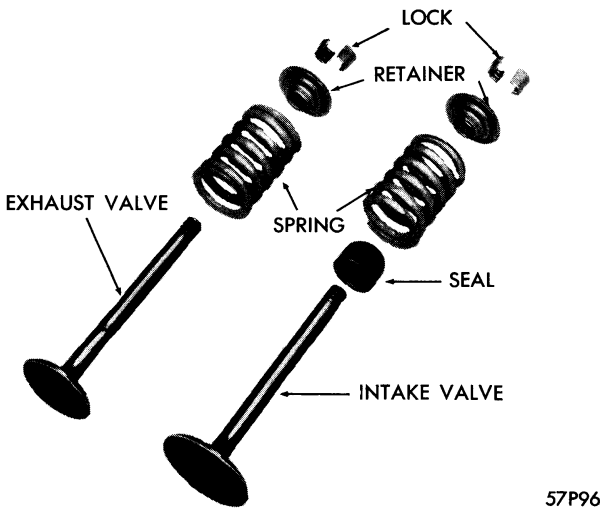

Figure 65—Intake and Exhaust Valve and Related Parts—V-8 Engine

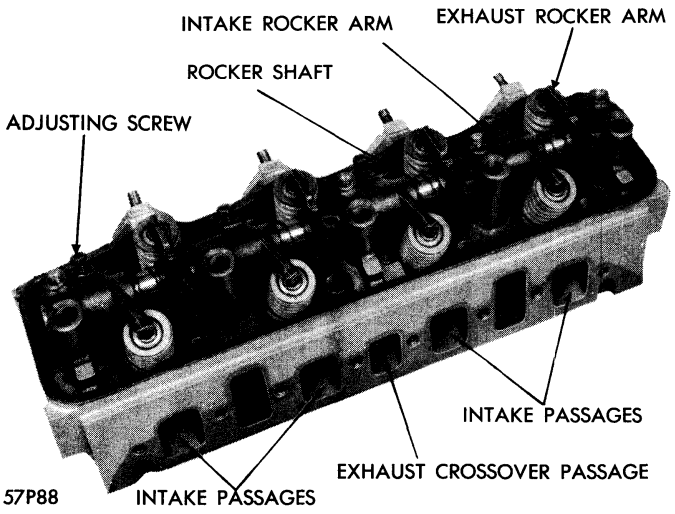

Figure 66—Cylinder Head Assembly
Typical of 277, 301 and 318 Cubic Inch Engine

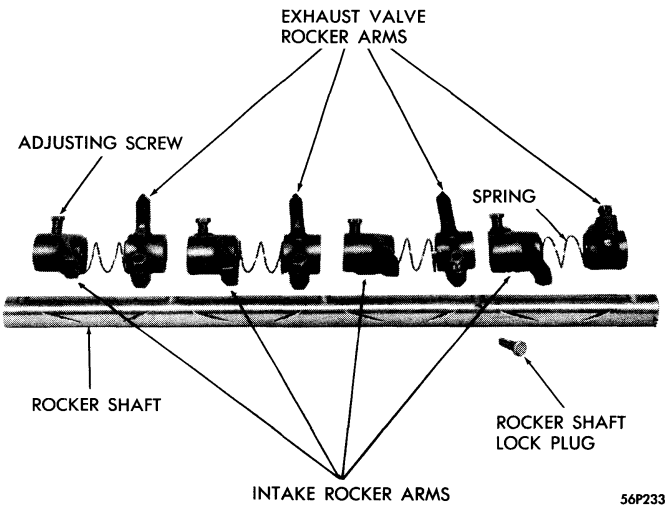

Figure 67—Rocker Shaft Assembly
Typical of 277, 301 and 318 Cubic Inch Engine

$\frac{1}{32}$ inch or more from its factory installed position, the dimension from the valve spring seat in the head to the valve tip should be checked with gauge C-3648, as shown in Figure 64.

The end of the cylindrical gauge and the bottom of the slotted area represent the maximum and minimum allowable extension of the valve stem tip beyond the spring seat. If the tip exceeds the maximum, grind to approach but do not go below the minimum allowable on the gauge. Clean tappets if tip grinding is required.

If necessary the valves may be lapped to obtain a perfect gas seal. See Lapping Valves on Page 303 for additional details.

VALVE SPRINGS

When valves are removed, always check valve springs for trueness and tension. See Figure 61. Both intake and exhaust valves should test at specifications given in chart on page 282.

Check trueness of spring by placing it on a surface plate and using a square. If distance from top coil to square is more than $\frac{1}{16}$ inch, replace spring, Figure 62.

If valves and/or seats are reground, check the installed height of the springs. A thin metal scale may be used. Make sure that scale is inserted to the full depth of counterbore in cylinder head. Measure to spring seat surface of retainer. If the height on a 277, 301 or 318 cubic inch engine is over $1\frac{11}{16}$ inch, install a $\frac{1}{16}$ inch spacer in the head counterbore to bring the spring height back to normal $1\frac{5}{8}$ to $1\frac{11}{16}$ inches. See Figure 63. If the height on a 350 cubic inch engine is over $1\frac{55}{64}$ inch, install a spacer in the head counterbore to bring the spring height back to a normal of $1\frac{51}{64}$ to $1\frac{55}{64}$ inches.

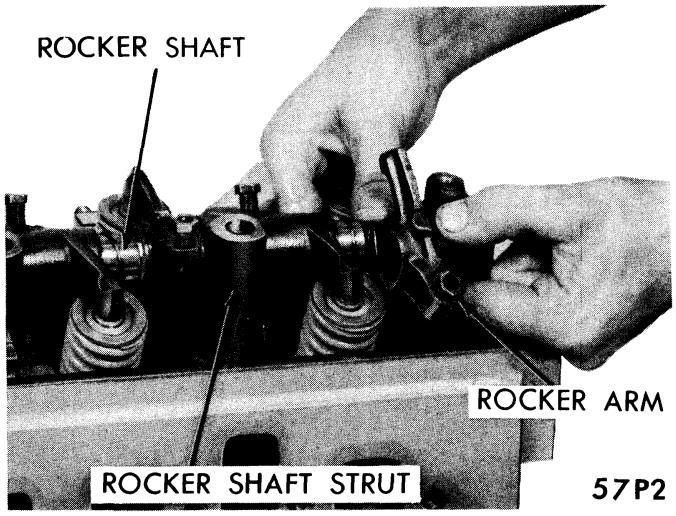

Figure 68—Installing Rocker Arms
Typical of 277, 301 and 318 Cubic Inch Engine

ROCKER ARM ASSEMBLY
(277, 301 and 318 Cubic Inch Engine)

Slide rocker shaft into bore of strut and at same time engage intake rocker arm. Install spring and engage exhaust rocker arm. Install remainder of rocker arms in same sequence. Make sure that rocker shaft head bolt grooves line up with head bolt holes in rocker shaft strut. In addition the plug hole in strut must also line up with hole in rocker shaft. Then tap in new rocker shaft plug. Refer to Figures 66, 67 and 68.

ROCKER ARM ASSEMBLY
(350 Cubic Inch Engine)

The right and left rocker arms must be assembled on the rocker shaft as shown in Figure 2 and 70. The stamped arrow on the rocker shaft must be on top and pointing toward the inside of the engine. The two wide

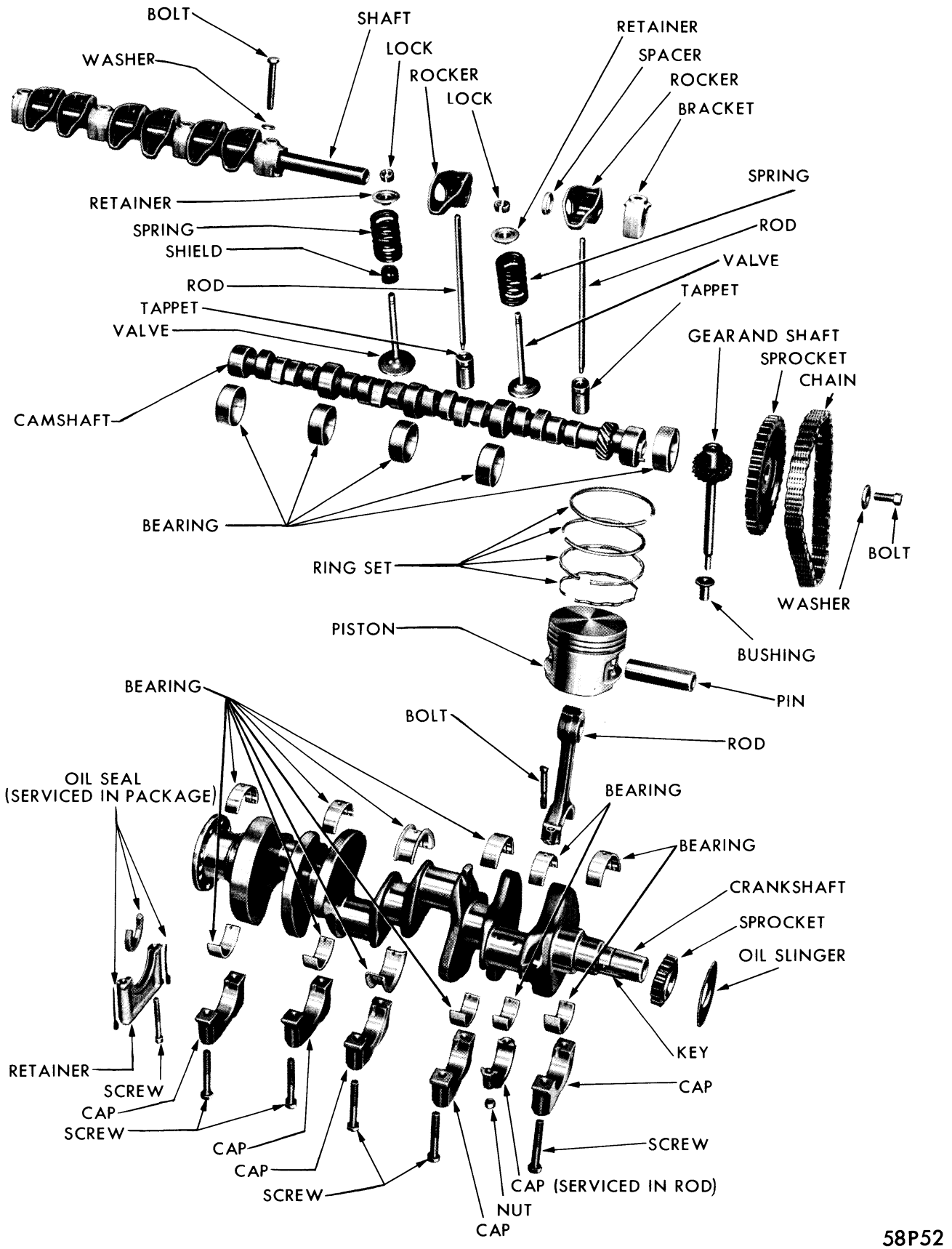

Figure 69—Crankshaft and Related Parts—V-8 Engine—350 Cubic Inch Engine

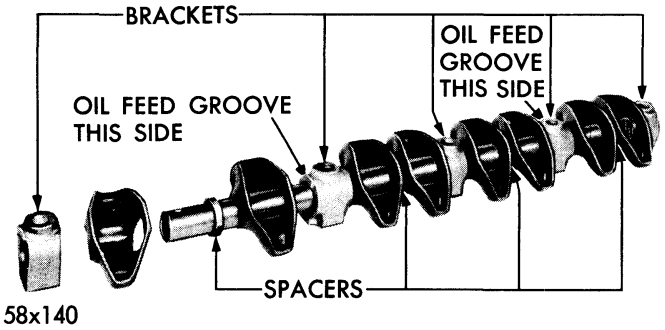

Figure 70—Rocker Shaft Assembly—350 Cubic Inch Engine

brackets must be installed with the oil feed grooves facing the push rod side of the rocker arm.

Tighten bracket bolts evenly and allow sufficient time for the tappets to bleed down. Failure to do this will result in a bulged tappet or damaged push rod.

TAPPETS
(277, 301 and 318 Cubic Inch Engine)

Tappet adjustments should be made after engine reaches normal operating temperature. Adjust intake rocker arms to have .008 inches clearance and the exhaust rocker arms to have .018 inches clearance. See Figure 71. The adjustment is made at the self-locking rocker arm adjusting screw. The screw should have a minimum of 3 ft. lbs. tension as it is turned. If less than this, replace the adjustment screw and if necessary, the rocker arm.

TAPPETS
(350 Cubic Inch Engine)

It is not necessary to remove the cylinder heads or intake manifold when removing the hydraulic tappets for service. Remove tappet cover and rocker shaft assembly.

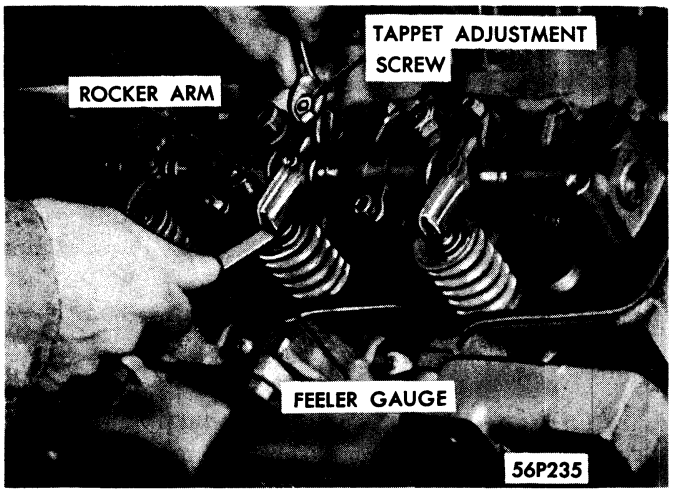

Figure 71—Adjusting Mechanical Tappets—277, 301 and 318 Cubic Inch Engine

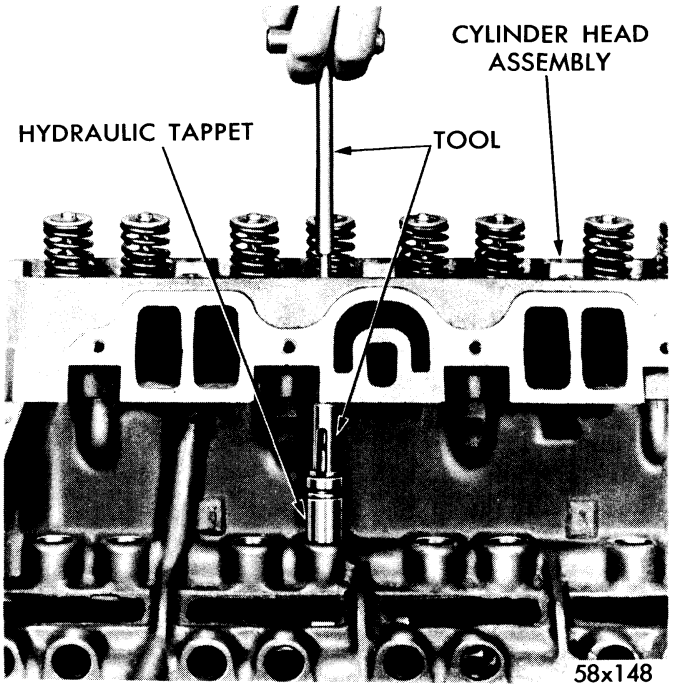

Figure 72—Removing Hydraulic Tappet—350 Cubic Inch Engine

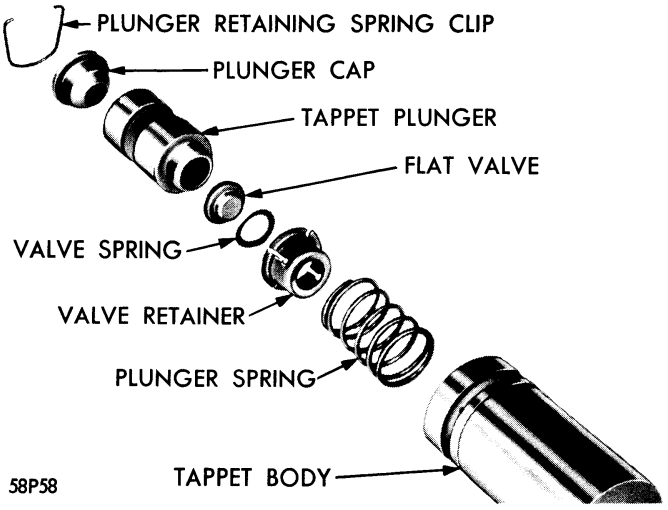

Figure 73—Hydraulic Tappet—Disassembled—350 Cubic Inch Engine

Insert tool into tappet through opening in cylinder as shown in Figure 72 and withdraw tappet.

HYDRAULIC TAPPET TEST—Completely immerse tappet, in upright position, in a clean container filled with kerosene until tappet is filled. Remove tappet and install the plunger cap.

Hold the tappet in an upright position and insert the lower jaw of pliers Tool C 3160 in the groove in the tappet body. Engage the upper jaw of pliers with the top of tappet plunger cap.

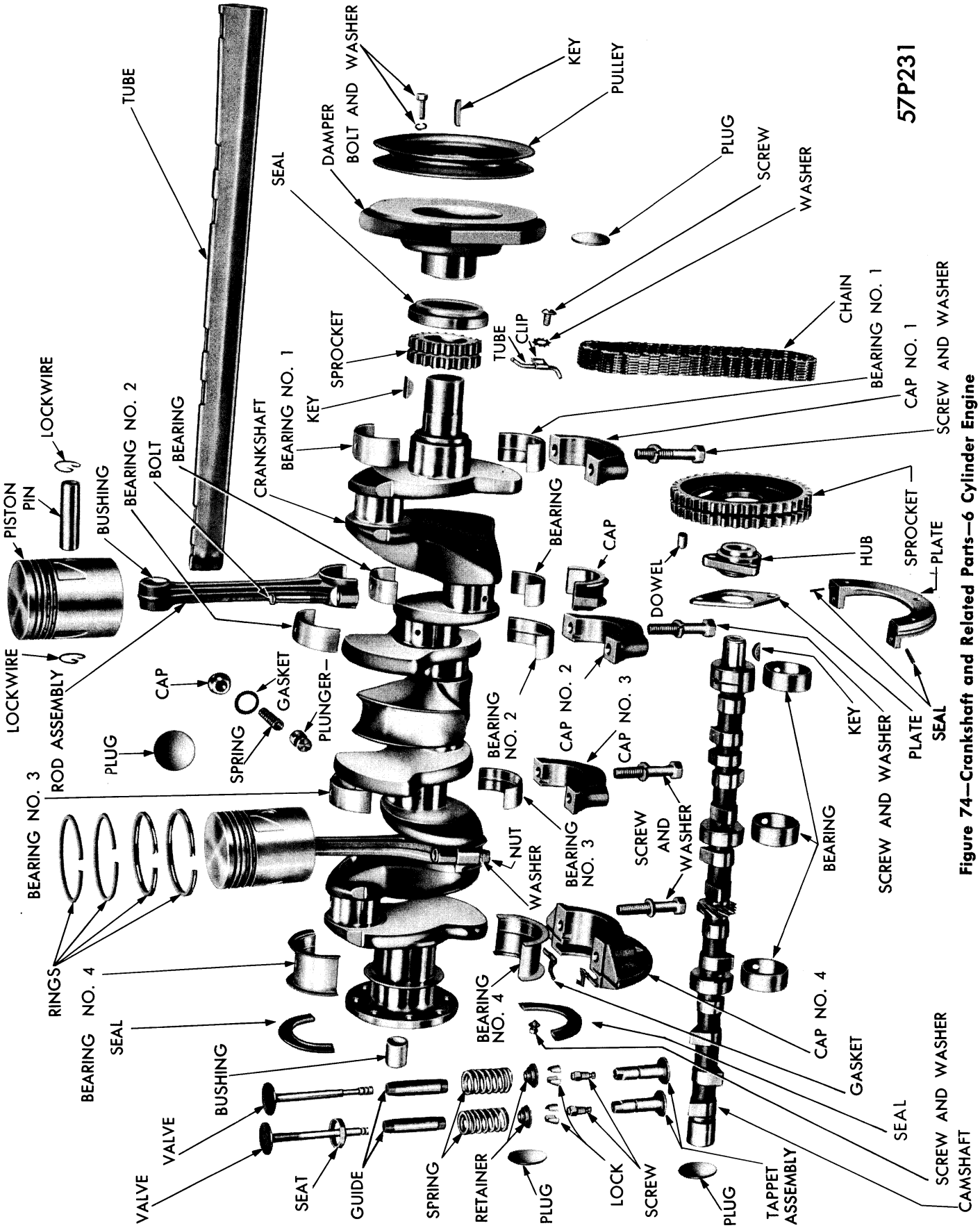

Figure 74—Crankshaft and Related Parts—6 Cylinder Engine

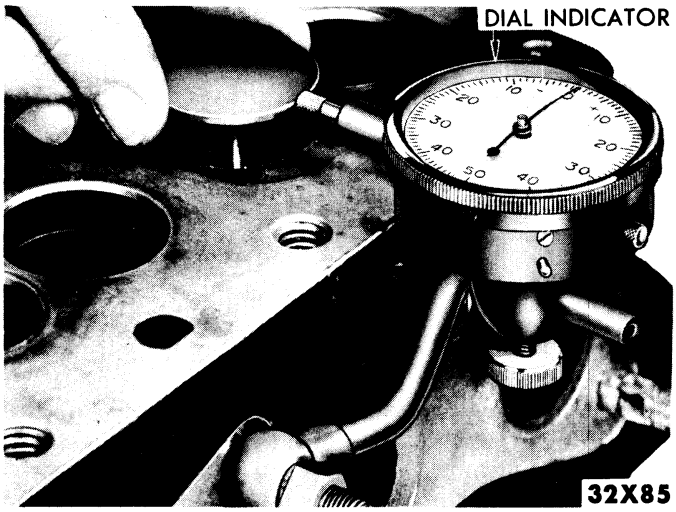

Figure 75—Measuring Valve Stem to Guide Clearance

Check the leak down by compressing the pliers. If the plunger collapses almost instantly, as pressure is applied, disassemble tappet assembly and reclean. Test tappet again. If the tappet still does not operate satisfactorily after cleaning, install a new tappet assembly. If the tappet shows the least sign of not meeting the leak-down test, the tappet should be discarded.

After the hydraulic tappets have been cleaned, inspected and tested, reassemble and install in the engine. See Figure 73. It is important that each tappet serviced be reinstalled in its original bore in the engine block.

TAPPET BORE

If the tappet bore shows evidence of scuffing, scores or sticking, ream the bore to the next oversize, using Tool C-3028 and install a new tappet. Tappets are available in standard and oversizes: .001, .008 and .030 inch. A diamond mark on the engine serial number pad indicates that .008 inch oversize tappets are used.

If the operation is to be done with the engine in the chassis, remove the camshaft. It is vitally important the cuttings from the reaming operation do not get on any internal parts of the engine. The crankshaft must be completely covered to prevent accumulation of cuttings.

15. VALVES, SPRINGS, SEATS AND TAPPETS—6 CYLINDER ENGINE

REMOVAL AND INSPECTION

Remove the valves and brush all carbon from the cylinder head, heads of the pistons, valves and valve seats with a wire brush. A wooden rack containing 12 holes can be used to keep the valves in correct order.

Check the valve stems and guides for wear by placing each valve stem in its respective guide and measuring the amount of side-to-side movement of the valve stem in the guide with a dial indicator. Make this measurement with the valve at its fully-opened position (approx. $\frac{5}{16}$ in.). See Figure 74. The dial indicator reading will be twice the actual clearance between the valve stem and the guide. Check for scuffed valve stems which might damage new valve guides. Install new valves if necessary.

REFACING VALVES

Replace valves that are badly burned, cracked or warped. When refacing valves, make sure that the grinding equipment is in good condition and that the wheel is square, true and clean. The valve must run true in the grinder chuck. If a dull wheel is used, the valve face may become scratched.

When refacing a valve, remove enough metal to clean up all pits and burned spots to obtain a smooth surface so that the valve will make a good seal with its seat. Do not grind so that a knife edge is left at top of valve. The valve should be at least $\frac{1}{32}$ inch thick, measured between the upper edge of the face and the top of the valve. If the valve will not clean up and leave that amount of thickness, install a new valve.

Before installing a reground valve in the engine block, remove carbon and varnish from the valve stem. Oil the valve stem to provide the initial lubrication.

CAUTION

Do not pound the valve against the valve seat. This would damage the valve seat and the valve face.

LAPPING VALVES

If it is necessary to lap the valves to obtain a perfect gas seal, use a fine lapping compound and apply light pressure. Control the lapping operation by installing a light coil spring under the valve head. Valves and seals may be lightly lapped together (to assure a tight seal) with a suitable compound. Valve heads may be rotated by means of a rod fitted with a vacuum cap which can be operated by hand or by a machine. When the lapping operation is completed, make sure all of the compound is removed from the valve, the valve seat, the intake port and the cylinder block.

REFACING VALVE SEATS

Clean all carbon from the valve guides with a valve guide reamer. Exert light pressure on the grinder to obtain the desired smooth surface. Do not cause the stone to chatter by bearing down too hard. Be sure the stone is clean and true so that the cut will be clean.

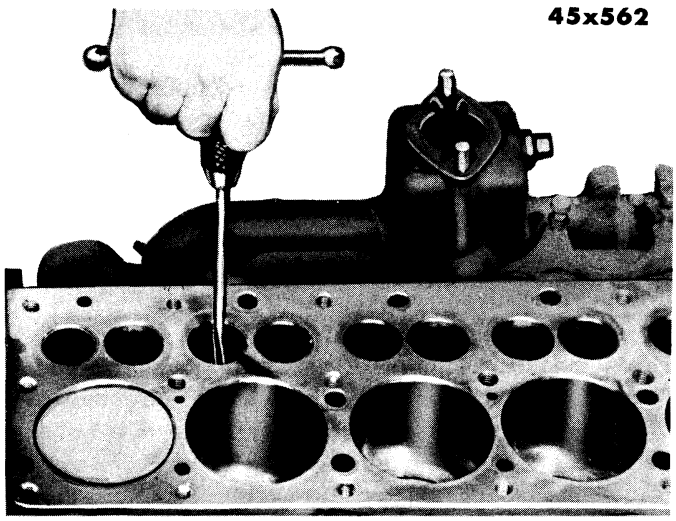

Figure 76—Reaming Valve Guide

Keep the width of the valve seat within specified limits —1/16 inch to 3/32 inch. If the seat is too wide it is difficult to obtain proper gas seal. Trim down a wide seat by relieving the edge with a 20° finishing stone. Then check the seat for run-out with a dial indicator. Run-out should not be greater than .0015 inch.

CAUTION

Make sure the indicator pilot fits snugly inside the valve guide so that the indicator will not wobble and give a false reading. Remove only enough metal to remove pits or other depressions in the seat.

EXHAUST VALVE SEAT INSERTS

Replace inserts that are cracked, burned or pitted. Remove old inserts with special Tool C-732. Remove all burrs and rough edges. If the insert is loose in the block, install a .010 inch oversize insert. A perfect fit can be obtained by boring out the counterbore from .002 inch to .004 inch smaller than the oversize insert. Install the new valve seat using special Tool C-767. Regrind the valve seat.

NOTE

Valve seat inserts are fitted tightly and can be installed by first chilling the inserts with dry ice to obtain maximum contraction. Do not handle a chilled insert with bare hands.

Drive the insert in to its full depth. Make certain the upper edge of the insert does not stick up above the block by boring out the counterbore .002 inch to .004 inch deeper than the height of the insert. Tool kit, MH-M-1 can be used, if .010 inch oversize insert is used and it is necessary to cut the block in order to fit insert. Inserts of .010 inch oversize are available.

VALVE GUIDES

Replacement guides are supplied with undersize bores. Check the valve stem with a micrometer and lightly ream the valve guide to fit. Do not remove too much metal with one cut. The clearances for the valve stems and guides are Intake—.001 to .003 inch; Exhaust —.003 to .005 inch.

For intake valves, install the valve guides with the counterbored ends downward. For exhaust valves, install the valve guides with the counterbored ends upward. This installation provides better heat shielding. Drive the valve guides in to full depth 7/8 inch below cylinder block top edge. Tool DD-849 is available for removing and installing valve guides.

When installing new guides, ream to the following specifications as necessary: Intake—.342 to .343 inch; Exhaust—.344 to .345 inch. Use reamer C-249 for this operation. See Figure 76.

VALVE SPRINGS

When valves are removed for reconditioning or replacement, test springs for proper tension. Exhaust and intake valve spring tension should be 110-120 foot-pounds when compressed to 1 3/8 inches.

VALVE TAPPETS

Remove the oil pan and head so the tappets can be lifted away from the camshaft lobes. The tappets can be held up with spring type clothes pins or other types of holders. Then remove the camshaft, rotating it to clear the tappets.

If new tappets fit too loosely in the block, ream the tappet bore oversize and install oversize tappets. Special Tool C-265 can be used for this operation. Oversize tappets are available in the following sizes: .001 inch, .008 inch, and .030 inch. If a reaming tool is used, remove the valves and springs so that a reamer pilot can be installed.

To check tappet clearance, clean and dry the tappets and tappet guide. Attach a dial indicator to a manifold stud. Raise tappet slightly above the lower end of its normal travel and place the plunger of the dial indicator against the upper end of the tappet as shown in Figure 77. Move tappet back and forth. Clearance should not exceed .002 inch.

Check the mushroom faces of the tappets for pitting or scratches that might damage the cams. Make sure the tappets have been rotating in operation. Replace the tappets that are pitted or scratched.

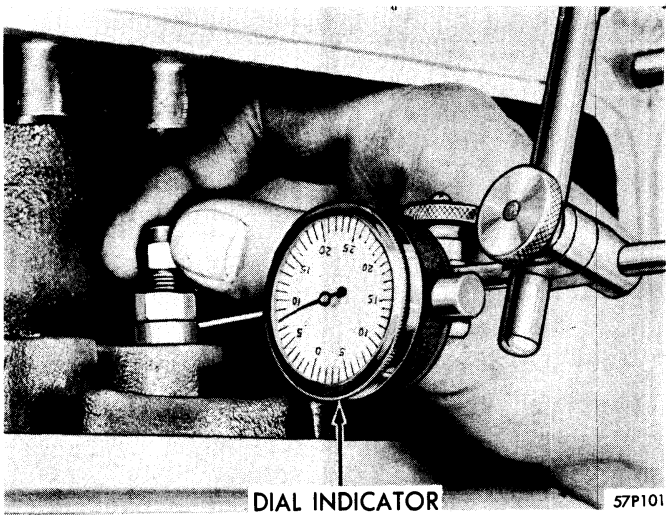

Figure 77—Measuring Tappet Clearance

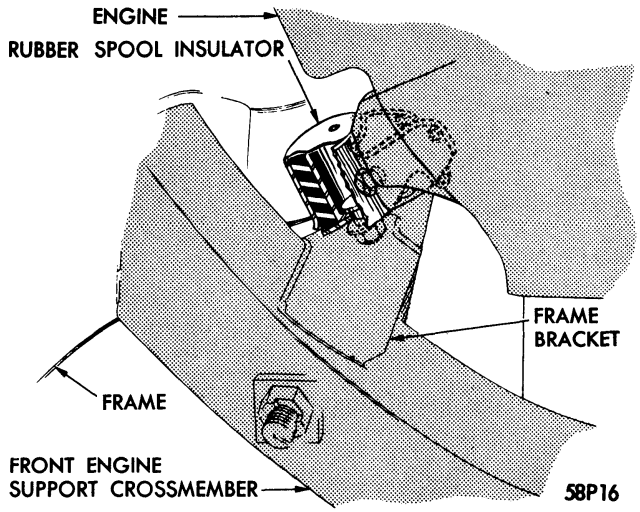

Figure 79—V-8 Engine Mount—Front

TAPPET ADJUSTMENT

At a preliminary cold setting, adjust valve tappets to .010 inch for intakes and .013 inch for exhausts. To obtain an accurate cold setting, adjust each tappet when the cam nose is down. If clearance is set when the tappet is part way up the quieting ramp on the cam, excessive clearance will result when the cam comes down.

When adjusting, be sure the feeler stock is flat and of the correct thickness. The use of old feeler stock that is bent or torn can result in an improper valve tappet adjustment.

Finish checking the tappet clearance when the engine is at normal operating temperature and running at normal idling speed. Tappet clearance (hot setting) should be .010 inch for intake valves and .010 inch for exhaust valves. If the car is to operate at high speeds for long periods, set the exhaust tappet clearance at .012 inch with the engine hot and running. Valve tappet screws are self-locking. See Figure 78.

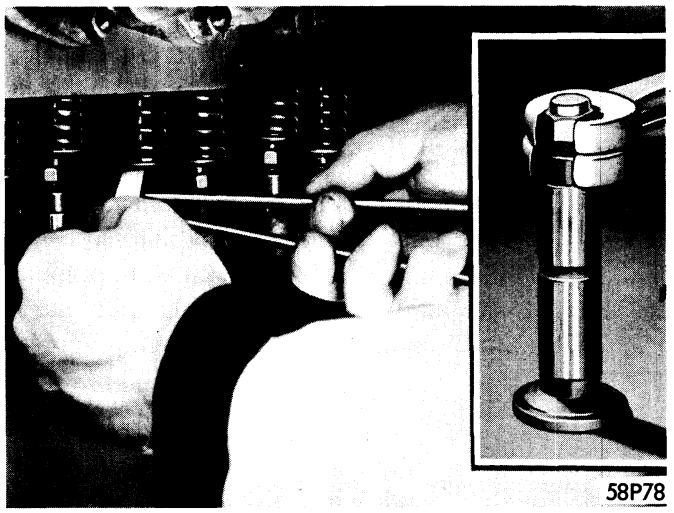

Figure 78—Adjusting Valve Tappets

16. FLYWHEEL

To remove the flywheel, remove the propeller shaft, the transmission, the clutch housing pan, the clutch assembly and the oil pan. Remove the flywheel nuts and the two lower bolts so that the flywheel can be turned to make the upper bolts accessible.

Before installing the flywheel, check for face run-out. Run-out should not exceed .005 inch. The face of the flywheel should be free from scores and scratches. Tighten the flywheel nuts to a torque of 55 to 60 foot-pounds.

17. ENGINE MOUNTINGS

FRONT ENGINE MOUNTS

V-8 ENGINE—Spool type front engine mounts, used on V-8 engines, consist of a cylinder of rubber encased inside and out. The rubber is not bonded to either shell, but is free to move within the confines of the steel shells. Right and left mounts are not interchangeable. See Figure 79.

6 CYLINDER ENGINE—Shear type mountings used on 6-cylinder engines consist of a rubber block bonded between two metal plates so that the engine movement forces act through the rubber in a direction parallel to the plates. The front engine mount is attached to a bracket which is integral with the engine block. See Figure 80. Support the engine weight at the oil pan whenever it is necessary to service the mounts.

TORQUE SPECIFICATIONS

Name	6 Cyl.	V-8	
	230 cu. in.	277-301-318 cu. in.	350 cu. in.
Connecting Rod Nut	45 ft. lbs.		
Cylinder Head Bolt	70 ft. lbs.	85 ft. lbs.	70 ft. lbs.
Camshaft Lock Bolt	.....	35 ft. lbs.	
Camshaft Thrust Plate Bolt	15 ft. lbs.		
Camshaft Sprocket Bolt	20 ft. lbs.	.....	
Carburetor to Manifold Nut	7 ft. lbs.		
Chain Case Cover Bolt	15 ft. lbs.	35 ft. lbs.	15 ft. lbs.
Cylinder Head Cover Screw and Nut	.....	36 in. lbs.—end 20-25 in lbs.—center	40 in. lbs.
Crankshaft Bolt	135 ft. lbs.		
Engine Front Mounting to Frame Nut	85 ft. lbs.		
Engine Front Mounting to Block Nut	45 ft. lbs.		
Exhaust Manifold Nut	25 ft. lbs.		30 ft. lbs.
Intake to Exhaust Manifold Bolt Nut	25 ft. lbs.	.....	
Fan to Hub Bolt	17 ft. lbs.		15-18 ft. lbs.
Flywheel Nut	60 ft. lbs.		
Exhaust Pipe Flange Nut	40 ft. lbs.		
Fuel Pump Mounting Bolt	30 ft. lbs.		
Intake Manifold Bolt	.....	30 ft. lbs.	
Intake to Exhaust Manifold Nut	25 ft. lbs.	.....	
Oil Pump Cover Bolt	15 ft. lbs.	10 ft. lbs.	15 ft. lbs.
Oil Pump Attaching Bolt	.....	35 ft. lbs.	30 ft. lbs.
Oil Pump Body Bolt	25 ft. lbs.	.....	
Oil Pan Drain Plug	35 ft. lbs.		
Oil Pan Bolt	15 ft. lbs.		
Main Bearing Cap Bolt	85 ft. lbs.		
Rear Engine Mounting Nut	25 ft. lbs.		
Water Outlet Elbow Bolt	30 ft. lbs.		
Water Pump Body Bolt	30 ft. lbs.		

CAUTION

The connecting rod nuts, bearing cap bolts, cylinder head bolts and spark plugs must be carefully tightened to specifications shown with a torque wrench.

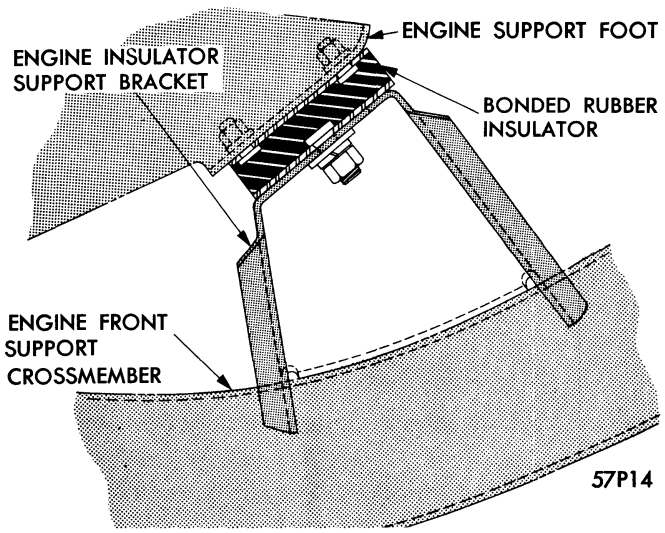

Figure 80—6 Cylinder Engine Mount—Front

REAR ENGINE MOUNTS

A compression type engine mount is used to support the engine at the rear engine crossmember. Do not overtighten the mounting bolts, since this may collapse the insulator spacer.

18. REPLACEMENT ENGINES

New, factory-built replacement engines are available. As in the production engines for Plymouth cars, all factory standards are carefully maintained in the assembly of the replacement engines.

If the engine serial number is followed by a letter A, it indicates that the engine is equipped with a special cylinder block having .020 inch larger bores than the standard production engine. If serial number is followed by a letter B, it indicates that the replacement engine has .010 inch thicker wall bearings for the main and connecting rod journals.

CAUTION

Before installing a replacement engine, check the clutch housing alignment.

Always check the torque of the cylinder head bolts before starting the engine.

Crank the engine with the starter a short time before running the engine on its own power. This is necessary to provide initial lubrication.

Clean and inspect or replace the spark plugs. Clean the distributor breaker points and reset the gap, if necessary. Test distributor in a tester and recondition as necessary. On the generator and starting motor, clean the armatures and replace the brushes, if necessary.

Carburetor and fuel pump should be inspected and reconditioned if necessary. The carburetor air cleaner should be drained, cleaned, and refilled. Clean the crankcase breather pipe inlet air cleaner and the crankcase ventilator outlet pipe air cleaner if so equipped.

19. ENGINE OILING SYSTEM

OIL PUMP

REMOVAL—V-8 ENGINE—On 277, 301 and 318 cubic inch engines, drain engine oil and remove oil pan. Remove oil pump mounting bolts and lower pump straight down.

On 350 cubic inch engines, pump is removed from eternal left front side of the engine.

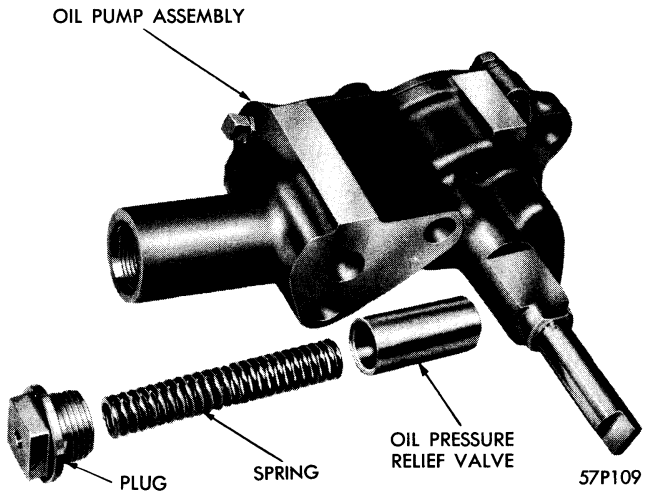

Figure 81—Oil Pump—V-8 Engine
Typical of 277, 301 and 318 Cubic Inch V-8 Engine

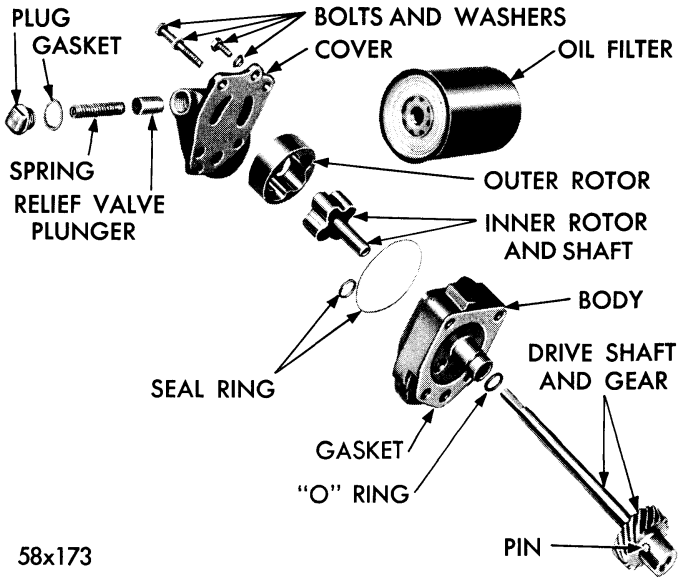

Figure 82—Oil Pump—V-8 Engine—350 Cubic Inch Engine

REMOVAL—6 CYLINDER ENGINE—Before removing the oil pump, rotate the crankshaft and make sure the DC mark on the crankshaft pulley lines up with the pointer on the chain case cover and the rotor is ready to fire the No. 1 spark plug. After pump is removed, do not bump the starter or let the engine turn, as this will change the ignition timing.

OIL PUMP—DISASSEMBLY

V-8 ENGINE—Before disassembling of pump refer to Figures 81 and 82. Remove the cotter pin holding the oil strainer to the oil pump suction pipe, then remove the pipe. Remove cover bolts and cover. Discard oil seal ring. Remove pump rotor shaft and lift out pump outer rotor. Remove the oil pressure relief valve plug and lift out spring and plunger. Wash all parts in a suitable solvent and inspect for damage or excessive wear.

6-CYLINDER ENGINE—Before disassembly, see Figure 83. Remove the oil pump cover and gasket. Hold the hand over the cover opening and with the pump upside down, turn the drive shaft until the outer rotor slips out. Drive out the straight pin which holds the pump drive gear to the shaft.

Press the shaft out of the drive gear and slide the shaft and the inner rotor assembly out of the pump body. Wash all parts in cleaning solvent and dry with compressed air. Inspect all parts for damage or excessive wear.

INSPECTION OF PARTS

PUMP COVER—Check for excessive cover to rotor wear. Cover should be smooth. If there are scratches or grooves, replace it. Check the cover by placing a straight edge across the inner surface of the cover and try to insert a feeler gauge between the straight edge and inner surface of the cover. See Figure 84. If clearance is in excess of limit shown below replace the pump cover.

V-8 Engine—Allowable maximum limit .0015 in.

6-Cylinder Engine—Allowable maximum limit .001 in.

OUTER ROTOR—Measure the diameter and thickness of the rotor with micro-calipers. If measurements are less than the limits shown below, replace both the inner and outer rotor. See Figure 87.

V-8 Engine—(277, 301 and 318 cubic inch)—Diameter—Allowable minimum limit—2.244 in.

V-8 Engine—(277, 301 and 318 cubic inch)—Thickness—Allowable minimum limit—.998 in.

V-8 Engine—(350 cubic inch)—Diameter—Allowable minimum limit—2.469 in.

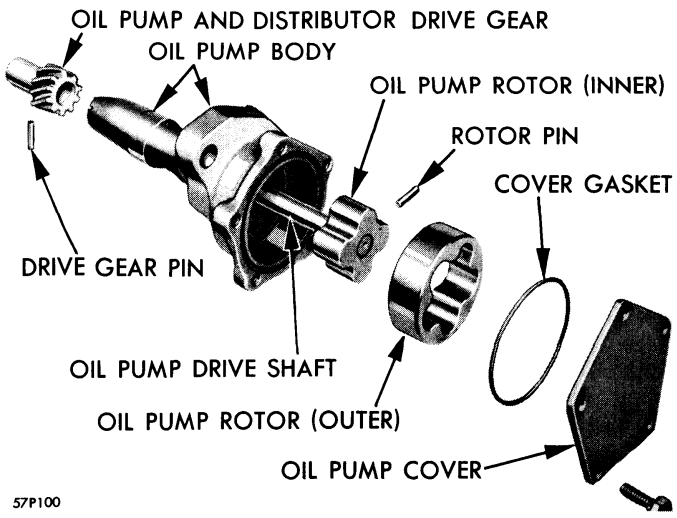

Figure 83—Oil Pump—6 Cylinder Engine

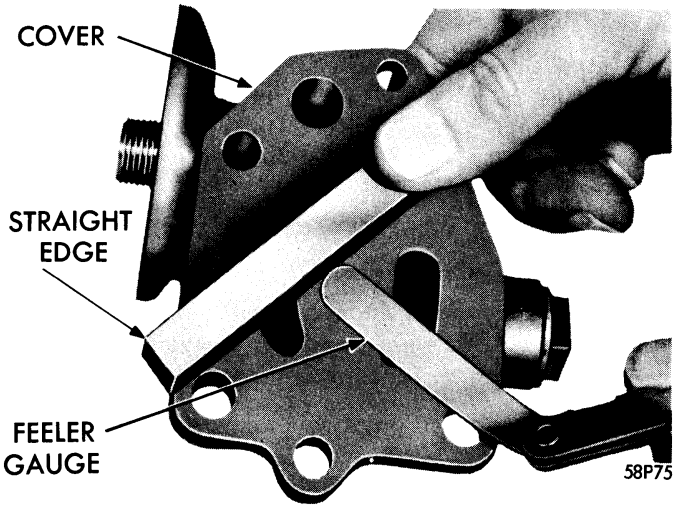

Figure 84—Checking Oil Pump Cover—350 Cubic Inch Engine
Typical of V-8 Engines

V-8 Engine—(350 cubic inch)—Thickness—Allowable minimum limit—.943 in.

6 Cylinder Engine—Diameter—Allowable minimum limit—2.245 in.

6 Cylinder Engine—Thickness—Allowable minimum limit—.748 in.

INNER ROTOR—Measure thickness of inner rotor with micro-calipers as shown in Figure 88. If the thickness measures less than allowable limits listed below, replace both inner and outer rotor.

V-8 Engine—(277, 301 and 318 cubic inch)—Allowable minimum limit—.998 in.

V-8 Engine—(350 cubic inch)—Allowable minimum limit—.943 in.

6 Cylinder Engine—Allowable minimum limit—.74 in.

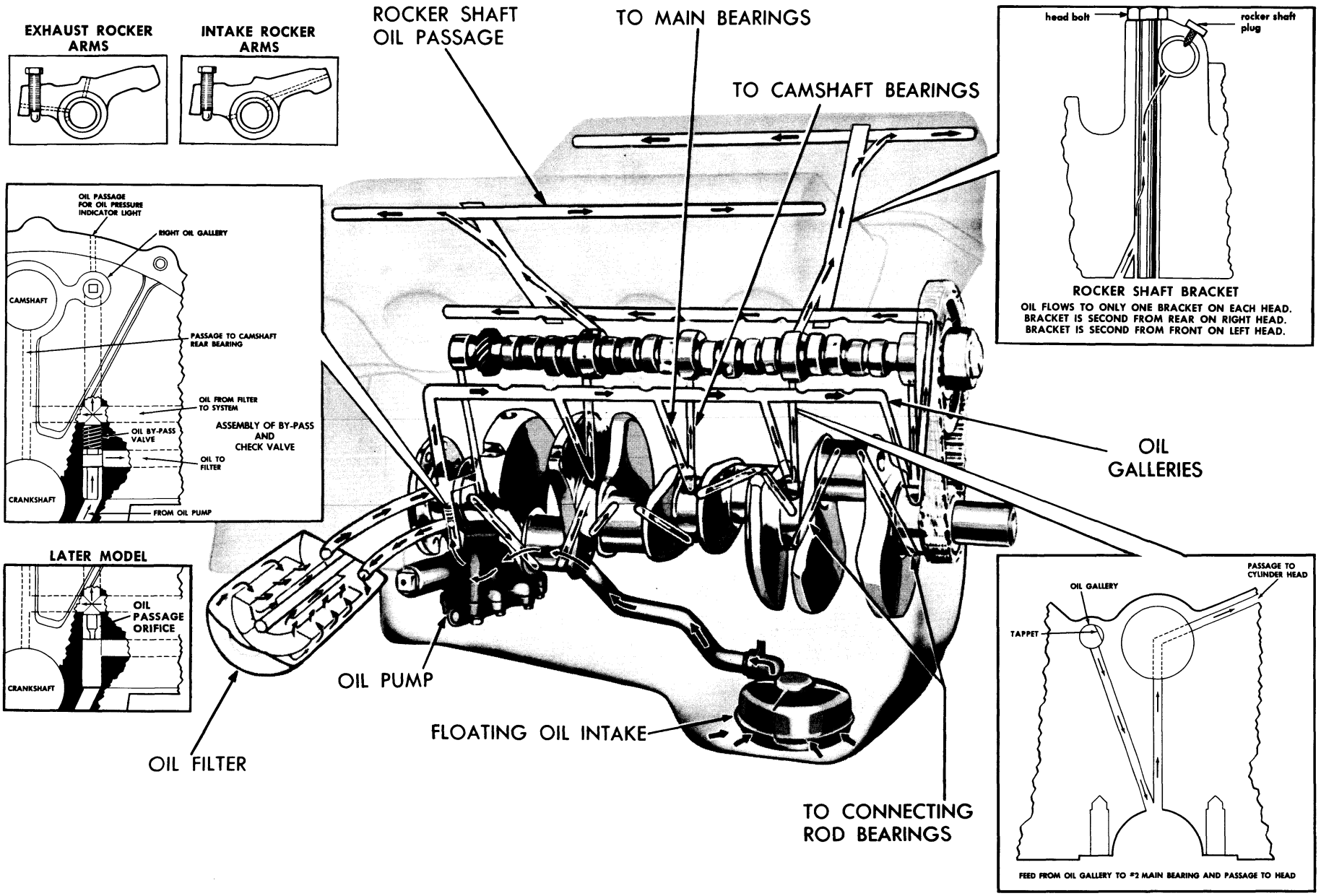

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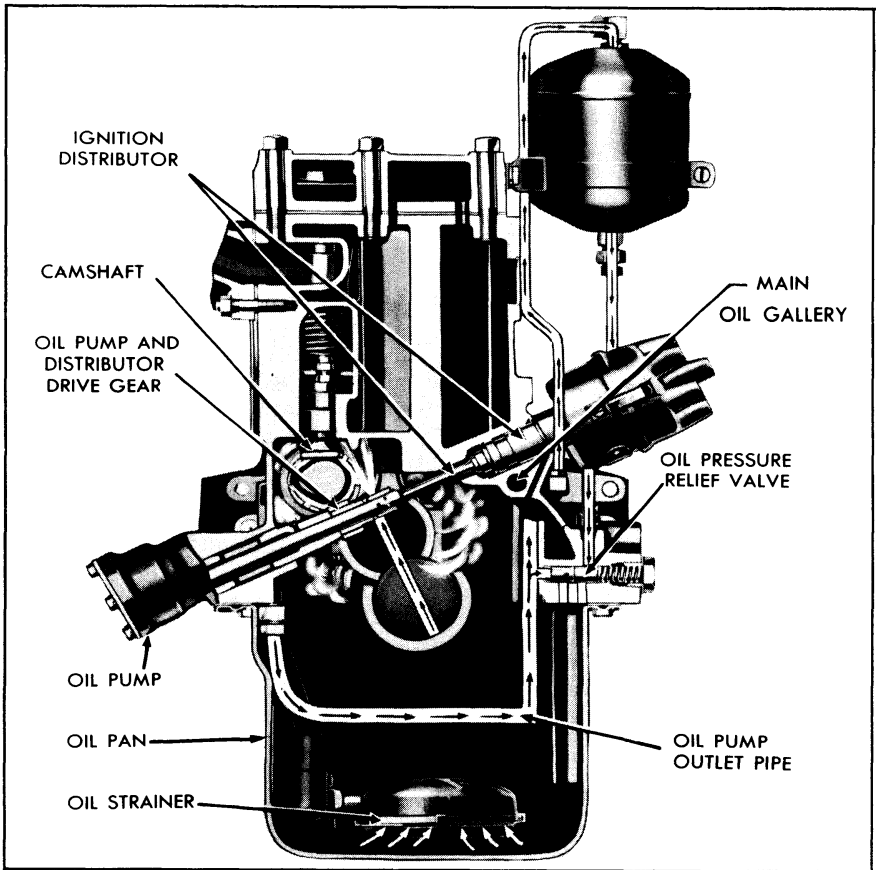
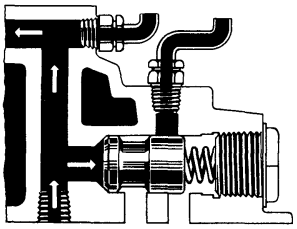
Figure 85—Engine Oiling System—V-8 Engine—277, 301 and 318 Cubic Inch Engine



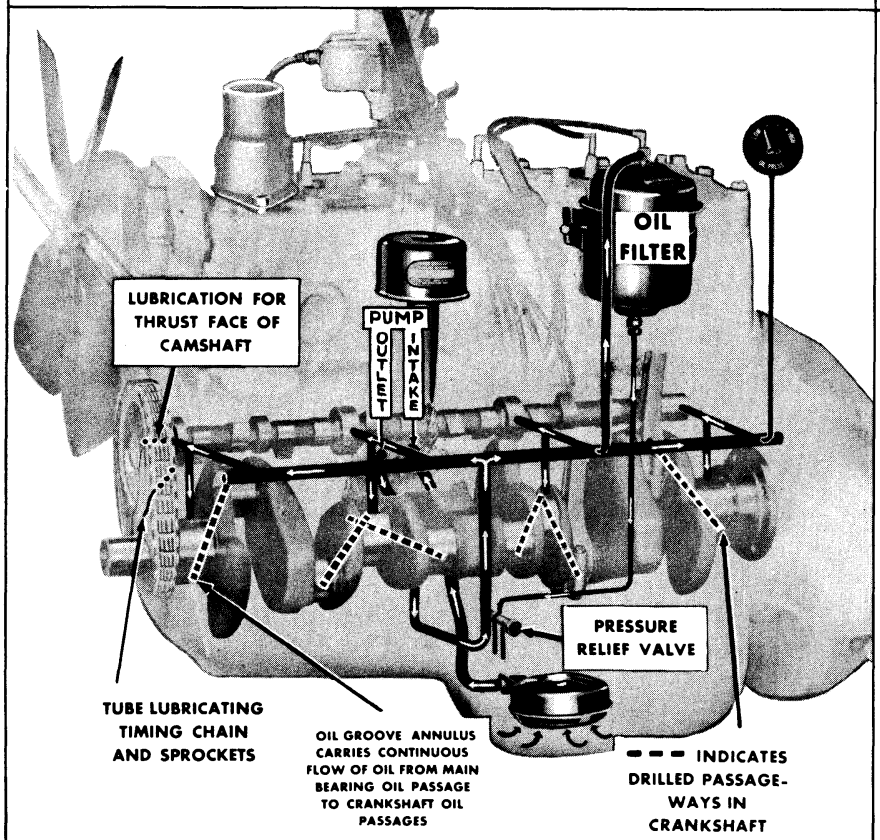
Pressure relief valve used with *by-pass type* oil filter

TO OIL FILTER FROM OIL FILTER

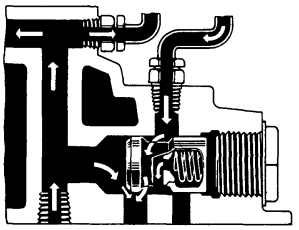


CLOSED

When valve is closed oil pump fills passages and oil filter. Relief valve blocks oil flow from filter to crankcase.



TO OIL FILTER FROM OIL FILTER



OPEN

When oil pressure is greater than relief valve spring tension, valve starts to open. Excess oil returns to crankcase.

Relief valve opens passage to permit oil flow from filter to crankcase.

55P1307

Figure 86—Engine Oiling System—6 Cylinder Engine

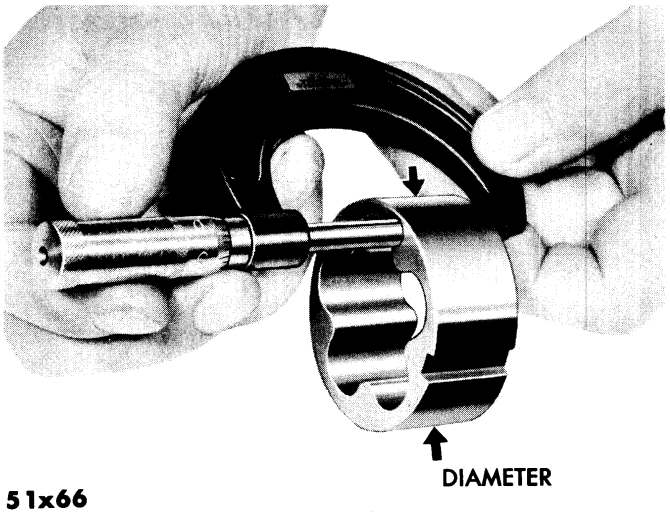


Figure 87—Measuring Outer Rotor

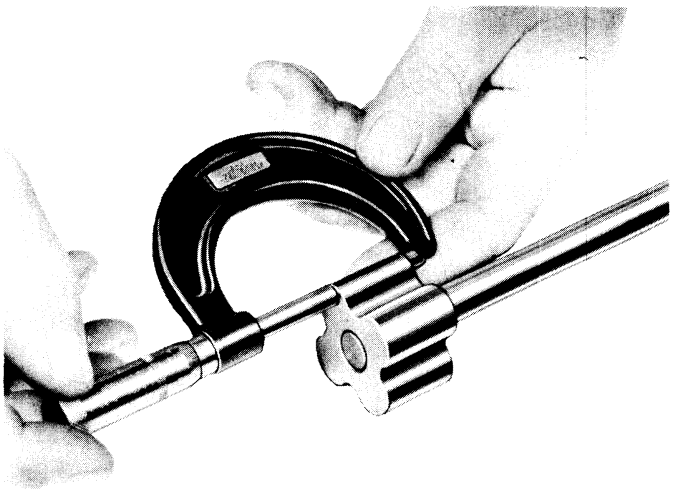


Figure 88—Measuring Inner Rotor

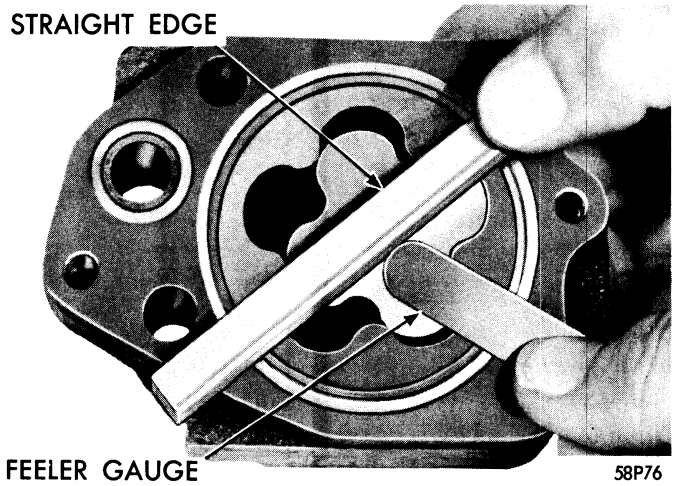


Figure 89—Measuring Clearance Over Pump Rotors—350 Cubic Inch V-8 Engine
Typical of All Engines

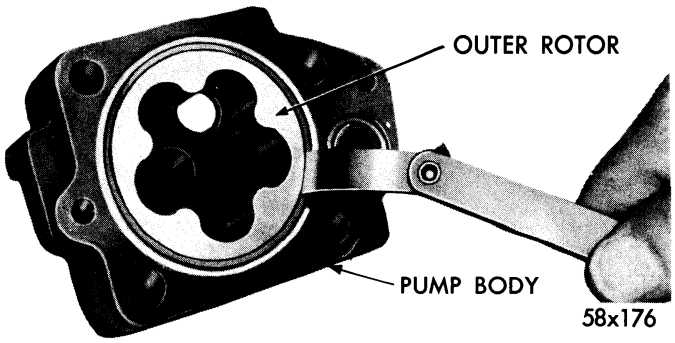


Figure 90—Measuring Clearance Between Outer Rotor and Pump Body—350 Cubic Inch V-8 Engine
Typical of All Engines

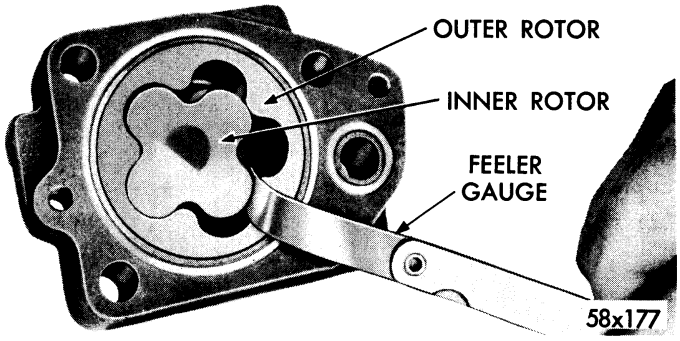


Figure 91—Measuring Clearance Between Pump Rotors—350 Cubic Inch Engine
Typical of All Engines

ROTOR DEPTH—Slide rotors in pump body. Place a straight edge across the pump body. Use a feeler gauge and measure clearance between the top of rotors and straight edge as shown in Figure 89. If clearance is in excess of .004 inch, replace the pump body.

OUTER ROTOR TO PUMP BODY CLEARANCE—Move rotors to one side and measure the clearance outer rotor and pump body with a feeler gauge as shown in Figure 90. If clearance is in excess of limits shown below, replace the pump body.

V-8 Engine—Allowable limit—.012 inch
6 Cylinder Engine—Allowable limit—.008 inch

INNER TO OUTER ROTOR CLEARANCE—To check rotors for excessive wear, measure the clearance between the lobes of the inner and outer rotors as shown in Figure 91. If clearance is in excess of .010 inch, replace both inner and outer rotor.

OIL PUMP—ASSEMBLY AND INSTALLATION

V-8 ENGINE—When assembling oil pump, use a new oil seal ring between the cover and body. Tighten cover bolts 10 to 15 foot-pounds. Prime the pump and then install a new oil seal ring in the pump mounting face. Install the pump assembly, being careful to align the drive slot in the pump shaft with the shaft. Tighten bolts to 30 foot-pounds.

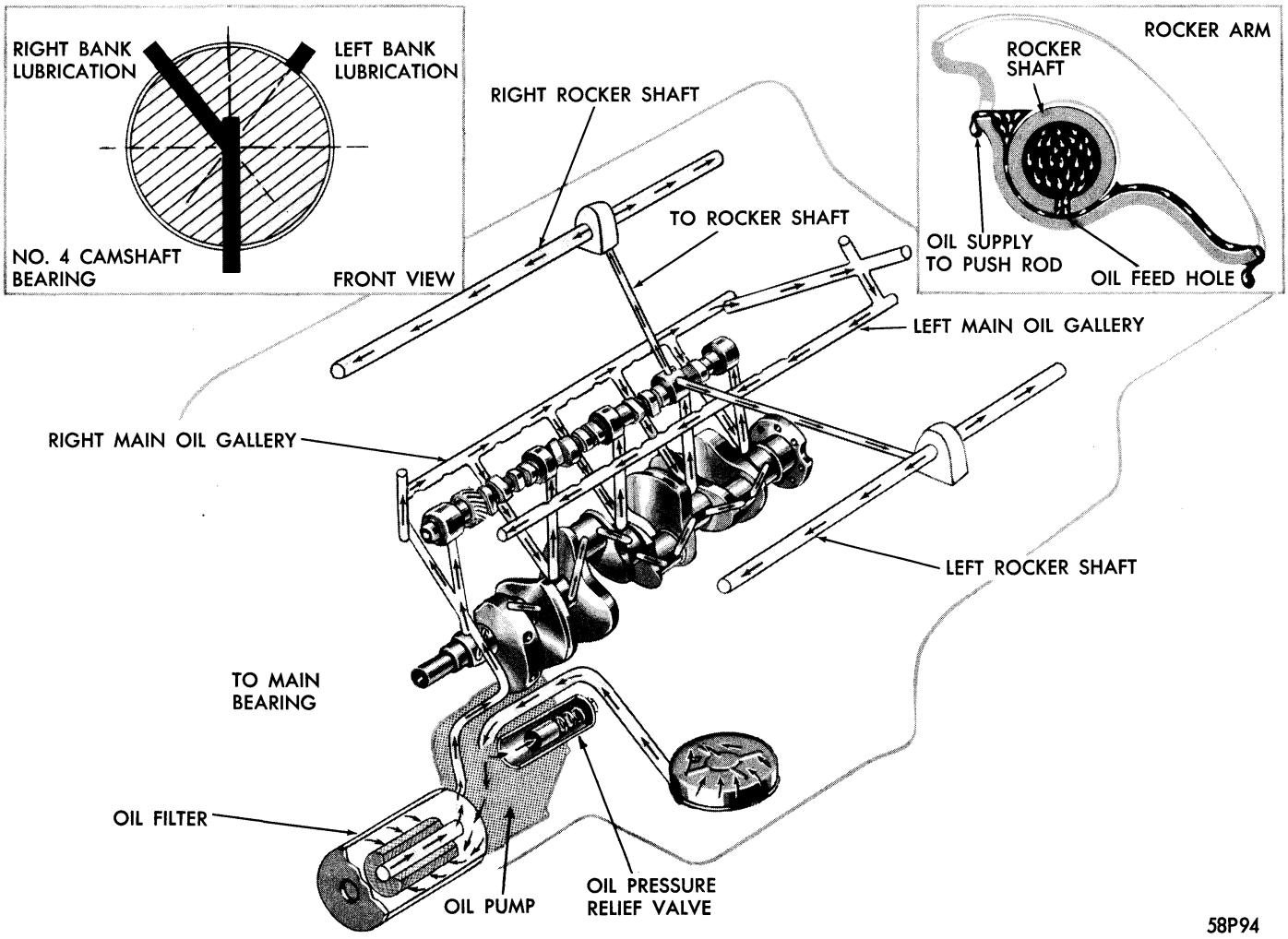


Figure 92—Engine Oiling System—V-8 Engine—350 Cubic Inch Engine

ENGINE OILING SYSTEM — DATA AND SPECIFICATIONS

MODEL	6 Cylinder Engine	V-8 Engine	
	230 cu. in.	301-318 cu. in.	350 cu. in.
Engine Lubrication—Type	Pressure		
Oil Pump—Type	Rotary		
Oil Pump Driven By	Camshaft		
Oil Pressure	40-50 lbs. at 1500 r.p.m.		50-65 lbs. at 1500 r.p.m.
Engine Oil Refill Capacity	5 quarts (6 quarts with filter)		4 quarts (5 quarts with filter)
Type of Filter	By Pass	Shunt	Full Flow
Oil Pressure Relief Valve Location	Left Side in Block	In Oil Pump Body	
Oil Pump Location	Right Side Exterior of Block	In Crankcase	Lower Left Front Exterior of Block

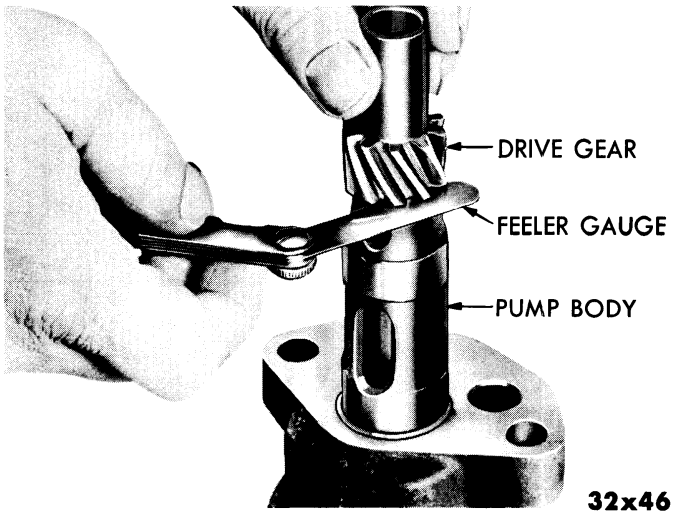


Figure 93—Measuring End Play of Oil Pump Drive Shaft—6 Cylinder Engine

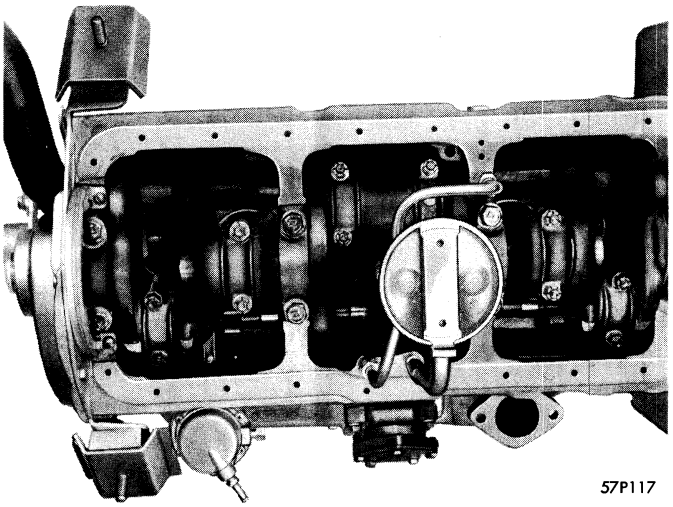


Figure 94—Oil Strainer—6 Cylinder Engine

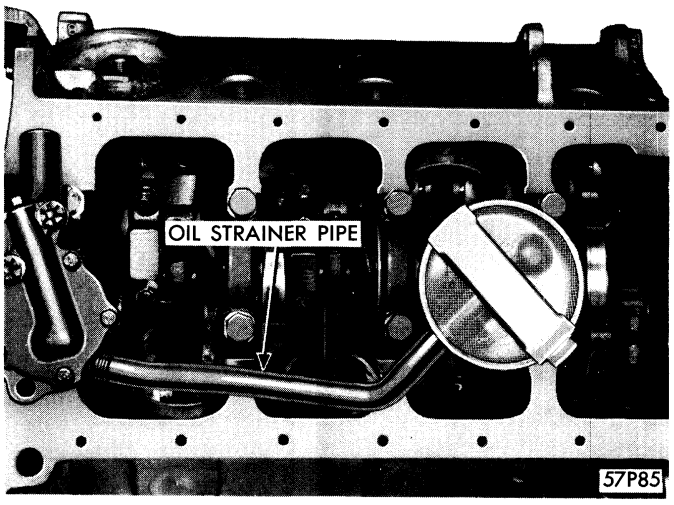


Figure 95—Oil Strainer—V-8 Engine—277, 301 and 318 Cubic Inch Engine

6 CYLINDER ENGINE—Slide the drive shaft and the rotor assembly into the pump body. Press the drive gear on the shaft until the end play of the shaft is from .003 inch to .010 inch. Press the rotor down in the body with the hand and measure the clearance with a feeler gauge. See Figure 93.

Install the pin and peen over both ends. If the pin holes do not line up, drill a new pin hole through the gear and the shaft (at right angles to the other hole) with $\frac{5}{32}$ inch drill. Slide the outer rotor into place in the pump body. Install a new cover gasket. Install the cover and tighten the screws evenly.

Use a new gasket when installing the oil pump. Line up the slots on the end of the pump shaft with the mounting holes in pump flange. Turn the drive gear counterclockwise one tooth and slip the oil pump into position. Check the position of the rotor in the distributor cap. It should be ready to fire the No. 1 spark plug (rotor in "seven o'clock" position).

If the position of the No. 1 piston was accidentally changed while the oil pump was removed, take out the spark plug. Rotate the crankshaft and check the compression of the No. 1 cylinder. Do this by holding the thumb tightly over the spark plug hole. When the compression is felt by the thumb, turn the crankshaft until the piston is at top dead center, as indicated when pointer points to the DC mark on the crankshaft.

Turn pump drive shaft until the slot in end of drive shaft lines up with the cap screw holes in the mounting flange. Then turn the drive gear one tooth, counterclockwise, and carefully install the oil pump. Do not turn the drive gear while installing the pump.

OIL STRAINER

Clean oil is drawn near the top of the oil in crankcase through the strainer and foreign material settles to the bottom of the oil pan.

The oil strainer screen can be cleaned by removing the bottom plate on the oil strainer float. If the screen becomes clogged, oil will by-pass around the screen to the oil pump.

OIL PRESSURE RELIEF VALVE

V-8 ENGINE—The oil pressure relief valve is located in the oil pump body and consists of a plunger spring and valve. See Figures 81 and 82.

6 CYLINDER ENGINE—The oil pressure relief valve is located on the left side of the cylinder block below the starter motor and consists of a valve, spring, gasket and plug. See Figure 96.

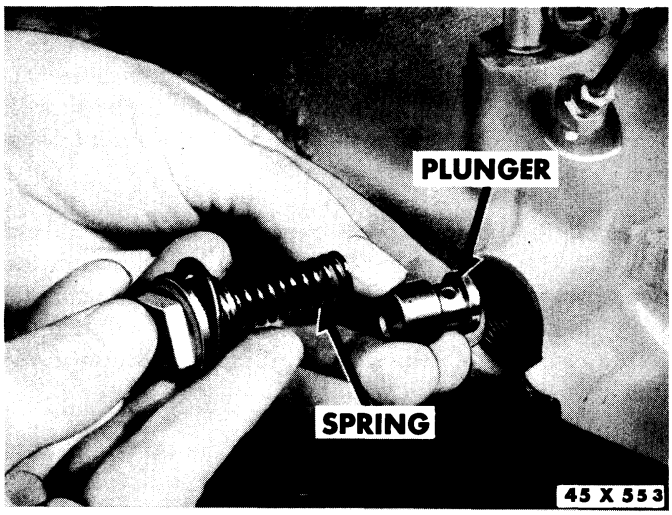


Figure 96—Oil Pressure Relief Valve—6 Cylinder Engine

SERVICING OIL PRESSURE RELIEF VALVE

Inspect the relief valve plunger and the spring after removing the valve cap and the gasket. If the plunger is scratched, remove the scratches by polishing, or install a new plunger. If the old plunger is to be reinstalled, clean it and flush out the bore with engine oil.

If the spring is to be replaced, use a new one of the same type. Do not use a heavier spring or a steel ball or washers behind the spring to raise the oil pressure. If oil pressure is low, check bearing fit or look for other causes of possible loss of oil pressure. Different colored springs are used in the oil pressure relief valve. The same colored spring should be installed. See oil pressure relief valve spring chart.

OIL FILTER REPLACEMENT

V-8 ENGINE, 277, 301, and 318 Cubic Inch—To remove the filter from the engine, it will be necessary to remove the filter shell. Loosen the shell retaining nut and lift off shell. Remove filter element by grasping wire handle. This will expose mounting bolts. Remove bolts and lift off filter base. Always use new gaskets when installing filter.

V-8 ENGINE, 350 CUBIC INCH—Unscrew filter from front of engine with tool C-3654 and discard. Clean face and install new filter using a new gasket. Start engine and check filter for leakage.

6 CYLINDER ENGINE—When replacing a complete oil filter, disconnect both the inlet and the outlet lines, and loosen the clamp bolt so that the body can be lifted out. Avoid damaging the brass fittings in the filter. These fittings can be used when installing a new filter. When installing a new filter, tighten all connections firmly. Start the engine and inspect the oil line connections for possible leaks. Operate the engine approximately 5 minutes and recheck the oil level.

IMPORTANT

Oil lines should be installed as near to the cylinder block as possible. When installing a filter bracket, make sure the legs of the bracket fit against the cylinder head and the block to prevent vibration damage to lines.

BEARING LEAK DETECTOR SET

When using a bearing leak detector, shown in Figure 97, raise the car and drain the oil. Attach the hose fitting of the bearing leak detector to the oil gallery at a pipe plug or the oil gauge line fitting. Pour three quarts of No. 10 engine oil in the tank of the bearing leak detector and charge the tank with approximately 25 pounds of compressed air. Remove the valve chamber covers and the oil pan.

Open the valve from the tank to the engine. Watch as oil flows from the main, connecting rod and camshaft bearings. Slowly turn the crankshaft. If engine oil escapes from a bearing at a rate of about two drops a second, the clearance can be considered to be satisfactory. But, if the oil flows from a bearing in a steady stream, the bearing clearance should be checked.

NOTE

If oil flow is excessive from the front main bearing, when making a bearing leak detector test, turn the crankshaft about 90° because the hole in the crankshaft may be lined up with the oil passage way to the timing chain.

Oil for the connecting rod bearings is supplied through passageways from the main bearing. If oil does not

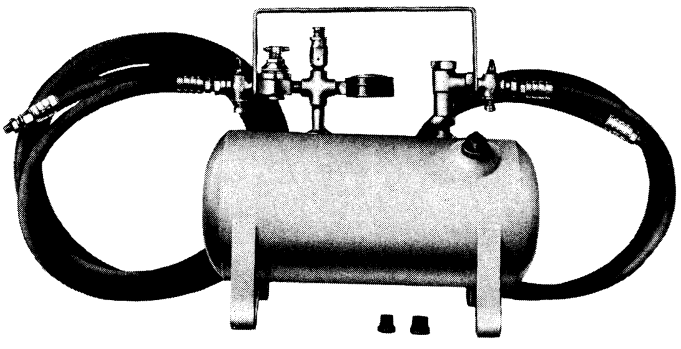


Figure 97—Bearing Leak Detector

OIL PRESSURE RELIEF VALVE SPRING CHART

Model	Color	Free Height	Spring Pressure and Checking Height
6 Cylinder Engine	Black (std.)	1⅞ in.	14.250-15.75 lbs. @ 1¼ in.
V-8 Engine—277, 301, and 318 cubic inch	Gray (lt.) Red (std.) Brown (hvy.)	3 1/32 in. 2 27/32 in. 2 31/32 in.	16.1-17.1 lbs. @ 2 1/16 in. 19.5-20.5 lbs. @ 2 1/16 in. 22.9-23.9 lbs. @ 2 1/16 in.
V-8 Engine—350 cubic inch	Gray (lt.) Red (std.) Brown (hvy.)	2 3/16 in. 2 9/32 in. 2 11/32 in.	11.85-12.85 lbs. @ 1 19/32 in. 14.85-15.85 lbs. @ 1 19/32 in. 17.9 -18.9 lbs. @ 1 19/32 in.

escape from a connecting rod bearing, the passageway may be blocked.

Check for this condition by removing the connecting rod and main bearing. Clean out the oil passage. To make sure it is open, blow it out with compressed air. Hold a cloth over one end of passage to catch possible foreign material which may have blocked the passage.

If oil fails to flow from a main bearing, the oil passage in the cylinder block is probably blocked and the main bearing supplied by this main bearing oil passage, take out the main bearing and connecting rod bearings fed by that main bearing. Remove the fitting in oil gallery opposite the blocked passage. Blow out the passage with a continuous stream of compressed air and make certain it is open. If this method fails to clear the passage, remove the crankshaft, clean out the oil passage with a wire and blow out passage with compressed air. Whenever a bearing job is performed make certain the oil passages are clear.

20. ENGINE TUNE-UP PROCEDURES

Engine performance depends upon correct ignition, carburetion and compression. In order to maintain engine performance at is peak, and to assure economical operation, a minor or major engine tune up should be performed when engine performance or economy is below standard.

Detailed information for performing each step in the tune-up procedures will be found in the section of this manual covering the unit involved.

MINOR TUNE UP

BATTERY—Test for weak or discharged battery. Inspect cables in the charging circuit for looseness and the battery terminals for corrosion.

SPARK PLUGS—Remove, inspect and clean. Adjust spark plug gap to .035 inch. Reinstall, using new gaskets.

DISTRIBUTOR—Adjust breaker points. Inspect distributor cap and rotor for cracks and corrosion. Inspect small lead wires for breaks or damaged insulation. Inspect distributor advance plate bearing for excessive play.

IGNITION TIMING—Check and set the ignition timing for brand of gasoline generally used by the owner. The engine will give its best performance if timed according to procedure outlined in the Ignition Section.

CARBURETOR—Set idle mixture adjustments using a vacuum gauge. Set accelerator pump linkage according to the season of the year.

AIR CLEANER—Remove and tap out dirt from filter element.

PRIMARY AND HIGH TENSION WIRES — Inspect wires for frayed or worn insulation or poor connections. Repair or replace wires, and tighten connections as necessary.

FAN BELT—Inspect for a frayed or worn fan belt. Replace if necessary.

MAJOR TUNE UP

BATTERY—Clean and tighten connections. Test for weak or discharged battery. Make a voltage test of the battery cells. Add water if necessary. Tighten all primary and high tension wire connections, particularly at the ignition-starter switch, ammeter and fuel gauge behind the instrument panel.

COMPRESSION TEST—Warm up engine to normal operating temperature. Remove all spark plugs and block throttle wide open. Insert compression gauge in first spark plug hole and hold it firmly. Crank engine and take reading. If readings are low in two adjacent cylinders, the cylinder head gasket may be blown out.

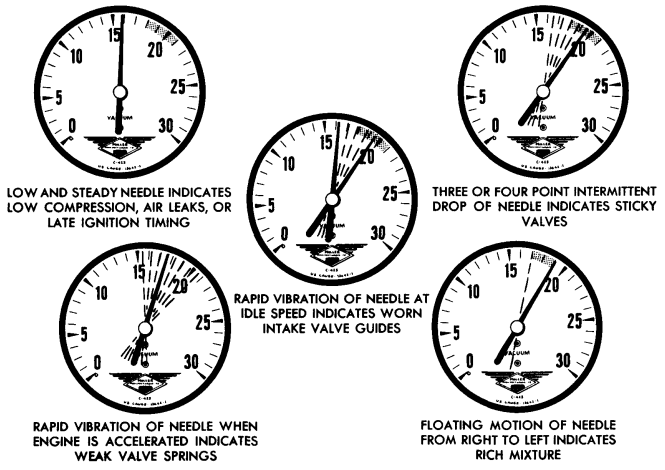


Figure 98—Vacuum Gauge Indications

If readings are low and vary widely (more than 10 p.s.i. on 6 cylinder engines and 15 p.s.i. on V-8 engines), pressure is being lost either at the pistons, rings or valves. To determine where loss is occurring, insert about one tablespoon of SAE 30 engine oil through the spark plug hole. Take a new reading. If this reading is higher than the initial reading, the piston rings are faulty. If reading is the same as the initial reading, the valves may be leaking or the cylinder head gasket is damaged.

VACUUM TEST—Use the vacuum gauge to test engine operation. Connect the vacuum gauge directly to the intake manifold. If this is not done, a true reading cannot be obtained. An accurate interpretation of needle movements will often indicate whether the cause of poor engine performance is due to internal conditions, or due to improper adjustment of the carburetor or ignition timing. Check vacuum gauge readings with compression gauge readings to determine the exact cause of an internal engine condition. See Figure 98.

A steady reading of 18 to 21 inches of vacuum up to 1,000 feet altitude indicates normal engine performance at idling speed. The vacuum reading will fall off one inch for each 1,000 feet of altitude above sea level. If, for example, there is a steady needle reading of 18 inches at 1,000 feet altitude, the same engine will give a vacuum reading of about 16 inches at 3,000 feet altitude.

When reading a vacuum gauge, a steady needle indicates good performance. A lower than normal reading indicates poor compression or late timing or air leaks at carburetor mounting flange or at the intake manifold gaskets. If timing is late, the needle will be steady, but low. With poor compression, the needle will be low and unsteady. This is because compression pressure will vary between cylinders. Vacuum will vary also because the same leaks which cause low compression pressure will also prevent the cylinder from developing its maximum vacuum.

If the vacuum gauge needle shows a steady drop of three or four inches each time that a particular cylinder is firing, it is an indication that the valve is sticking or is burned so it does not make a tight seal against its seat.

When the vacuum gauge needle vibrates rapidly while the engine is idling, it usually indicates worn intake valve stem guides. If the needle is fairly steady at idle speed but vibrates rapidly when engine speed is increased, the valve springs may be weak.

A floating action of the vacuum gauge needle probably means the air fuel mixture is too rich to burn completely.

STARTING MOTOR—Inspect brushes, commutator, and switch. Check tension of brush spring by comparing old spring with a new one. Test voltage and amperage draw at cranking speed.

DISTRIBUTOR—In a testing fixture, check distributor performance at various speeds. Check the automatic governor advance and the vacuum advance. Test condenser in suitable testing equipment if available.

COIL—Test with coil tester for output at high and low speeds, and for shorts or open-circuits. Test coil at normal operating temperature since a cold coil may appear to be satisfactory under test and yet may not be operating properly when warmed up to its normal working temperature.

GENERATOR—Test generator and voltage regulator with voltmeter and ammeter.

FUEL PUMP—Check the fuel pump pressure with a low-reading pressure gauge. Replace diaphragm, check valves or entire pump assembly as necessary.

MUFFLER AND TAIL PIPE—Inspect for clogged or choked muffler, damaged baffles, kinks in tail pipe or other conditions which may affect engine performance.

CYLINDER HEAD AND MANIFOLD—Tighten cylinder head cap screws and manifold nuts to specified torque while engine is at normal operating temperature.

CARBURETOR—Check float level. While carburetor cover is removed, clean out the bowl.

VALVES—Adjust tappet clearance with engine at normal operating temperature.

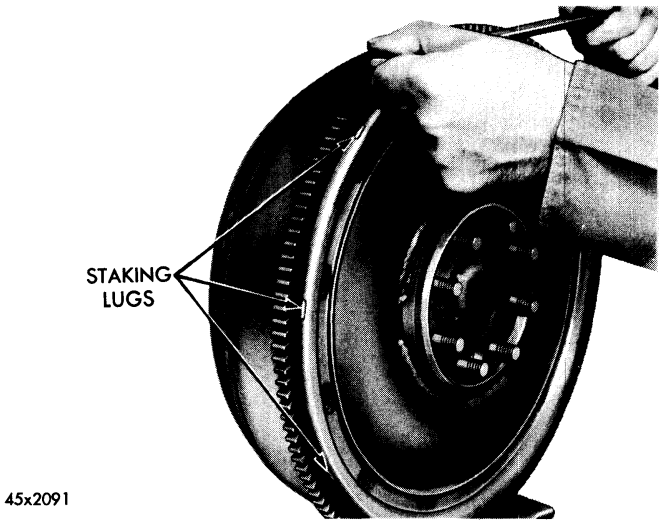


Figure 99—Filing Staking Lugs to Remove Ring Gear

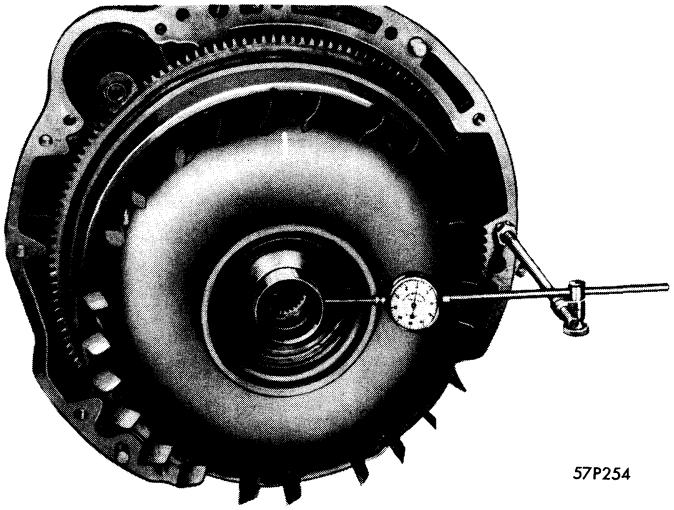


Figure 101—Checking Converter Hub Runout

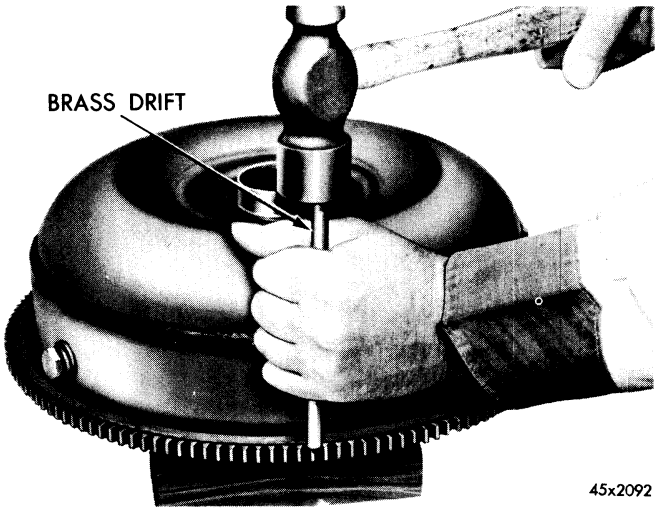


Figure 100—Removing Ring Gear With Drift

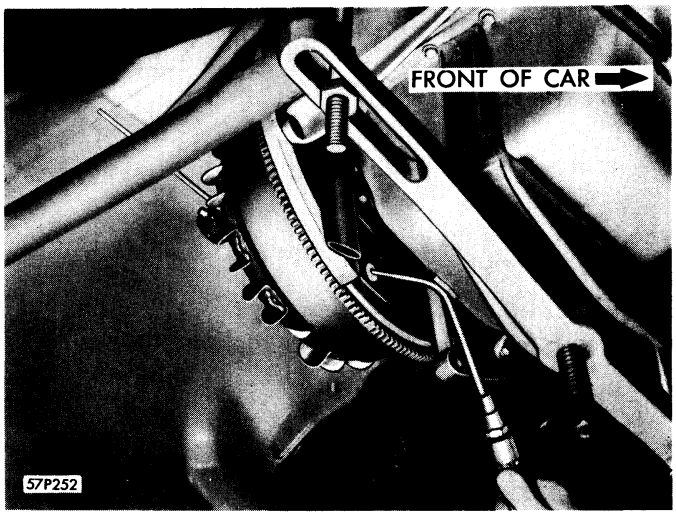


Figure 102—Correcting Converter Hub Runout

21. TORQUE CONVERTER AND HOUSING

Whenever the transmission or torque converter is serviced for repair it is important to check the torque converter hub runout, housing bore runout and housing face runout. Excessive runout at any one of the three can cause premature wear of the converter hub seal or transmission front pump.

TORQUE CONVERTER HOUSING REMOVAL

Install engine support fixture and remove intermediate crossmember. Disconnect propellor shaft, brake cable, wiring, and oil cooler lines if so equipped. A doweled and bolted adapter plate is used between the torque converter housing and engine block on the 277, 301 and 318 cubic inch V-8 engines and the 6 cylnder engine. The converter housing on the 350 cubic inch engine is doweled and bolted directly to the engine block.

Do not hammer or pry between the flanges to loosen the housing since this will distort the metal and result in misalignment. Carefully move the housing straight back to avoid damage to the torque converter.

Inspect all mating surfaces and remove any burrs or rough spots with emery cloth.

TORQUE CONVERTER UNIT REMOVAL

Remove the metal dust shield. Remove the eight nuts and lockwashers that hold the converter unit to the crankshaft using special wrench C-811. The torque converter assembly is a welded unit and cannot be serviced except as an assembly.

RING GEAR REMOVAL

To replace the ring gear it will first be necessary to remove the torque converter from the crankshaft. Carefully remove the staking lugs which retain the ring gear

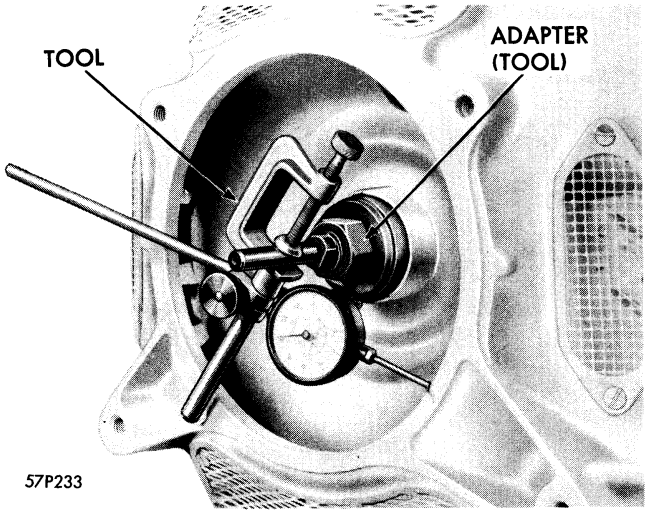


Figure 103—Checking Converter Housing Bore Runout

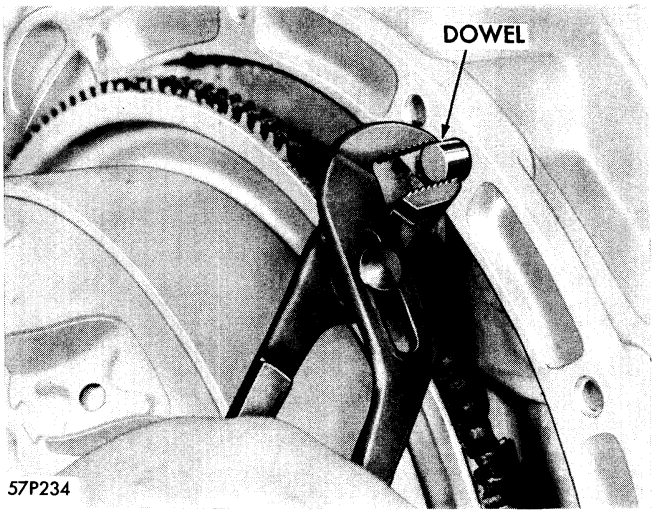


Figure 105—Removing Dowel Pin

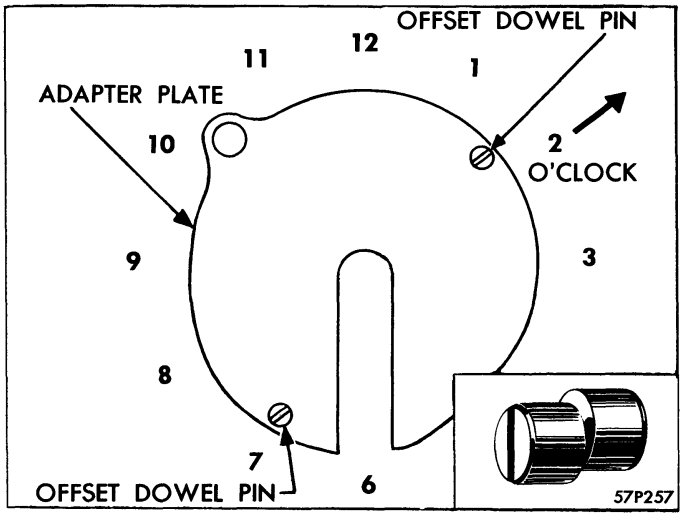


Figure 104—Adapter Plate and Inset of Offset Dowel

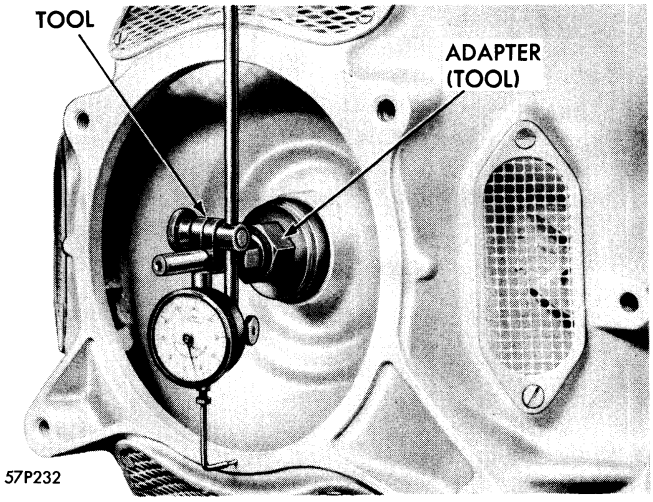


Figure 106—Checking Converter Housing Face Runout

to the converter with a file. Using a blunt drift, tap around the ring gear until the gear is free of the converter. Remove any burrs or rough spots from the gear contact surface of the converter with a file. See Figures 99 and 100.

RING GEAR INSTALLATION

Listed below are three recommended methods which may be used to heat the starter ring gear for installation on the torque converter.

1. *OVEN*—When available, use Oven C-794. Set the temperature at 150° F. Allow the ring to remain in the oven approximately 15 to 20 minutes.

2. *BOILING WATER*—If boiling water is used, place the ring gear in a shallow container and heat for approximately 8 minutes after the water starts to boil.

3. *STEAM*—When steam is to be used, place the ring gear on a flat surface and direct the steam flow around the ring gear for approximately two minutes.

Place the starter ring gear over the gear surface of the converter. Make certain that the rear face of the gear contacts the flange on the converter evenly around the entire circumference. Weld the gear to the converter. space the welds evenly and use approximately the same amount of metal at each weld.

CONVERTER HUB RUNOUT

To check hub runout, remove the transmission, the torque converter housing and the dust shield. Install the hub alignment indicator on the torque converter adapter plate or engine and rotate the converter. See Figure 101. Converter hub runout should not exceed .004 inch. The

indicator plunger should bear on the hub of the converter ¼ inch forward of the rear edge.

To correct excessive hub runout, rotate the converter through 360 degrees, marking the high point on the converter with chalk. Rotate the high point to the top. See Figure 101. Then, using an acetylene torch with a number 3 burner, apply heat about the size of a dime at a spot exactly 180 degrees from the high point at the opposite side of the converter shell, at the radius high point. See Figure 102.

Apply heat to the spot in a circular motion. When it begins to redden, remove the flame and quench it with a water-soaked cloth. Change cloths several times to cool the spot quickly, to effect a greater drawing on the metal.

Extreme caution must be used while heating to prevent burning the metal and damaging the unit.

When both sides of the converter are the same temperature, check hub runout again. If it still exceeds .004 inch at the same point, or if the metal has been drawn excessively, causing excessive runout on the opposite side of the converter, it will be necessary to repeat the operation. With the heat application method, it is possible to reduce total runout to the near-zero point.

HOUSING BORE RUNOUT

Check bore runout using fixture C-3461 and a suitable dial indicator. Runout must not exceed .010 inch total indicator reading. See Figure 103.

As an example, assume the total indicator reading is .016 inch in a direction which approximates 2 o'clock, on the adapter plate. See Figure 104. In this case the housing is off the crankshaft centerline .008 inch (½ total indicator reading) which is .003 inch greater than the allowable limit of .005 inch (½ total reading).

To correct an off center condition, three offset dowel pins, are available from the Parts Division. See inset of Figure 104.

OFFSET DOWEL PINS

Amount of Offset (in)	Part Number
.007	1736347
.014	1736348
.021	1736353

In the example above, using the .007-inch offset dowel pin will bring the runout well within the allowable limit of .005 inch, or: .008-.007 (offset pin) =.001-inch runout.

To install the offset dowel pins, remove the housing and remove both dowel pins. See Figure 105. Install the offset dowels to the shoulder. Avoid damage to the adapter plate by supporting it when installing the lower dowel pin. Install the housing and torque the screws 20-25 ft. lbs. Mount the indicator and recheck bore runout. If necessary, loosen housing screws and turn the dowels with a screwdriver to shift the housing and align the bore within limits.

HOUSING FACE RUNOUT

Check the housing face runout with a dial indicator before installing the transmission and locate the lowest point of the indicator reading. See Figure 106. Face runout should not exceed .008-inch total indicator reading. Shims for correcting excessive face runout are available from the Parts Division as follows:

HOUSING FACE RUNOUT SHIMS

Thickness (in.)	Part Number
.002	1610442
.003	1610443
.005	1610444

22. DIAGNOSIS PROCEDURES

ENGINE DIFFICULT TO START OR FAILS TO START

Generally, the causes of hard starting can be classified as Mechanical or Non-Mechanical. A Mechanical condition indicates that corrective measures, such as, adjustment, repair, or replacement of parts are necessary.

1. HARD STARTING—MECHANICAL CAUSES

(a) Fuel System

Carburetor—Determine if fuel is reaching the carburetor by removing the air cleaner and working the accelerator linkage by hand. If fuel is not being sprayed into the carburetor when the accelerator linkage is moved, there may be a restriction in the fuel line from the tank to the carburetor, or the fuel pump may be faulty. Disconnect the fuel line at the carburetor and crank the engine. If no fuel flows from the line, the line is clogged or the fuel pump is at fault.

Fuel Pump—At the pump, disconnect the line which leads to the fuel tank and apply compressed air carefully at reduced pressure. Reconnect the line and crank the engine. The fuel pump is at fault if no fuel flows from the cleaned out line. Inspect the pump and recondition as necessary.

Fuel Lines—Inspect for clogging by disconnecting the fuel lines at the carburetor and fuel pump and blowing out the line carefully with compressed air at reduced pressure. Check the lines for possible air leaks on the vacuum side of the pump especially the flexible hose and connections.

Automatic Choke—Inspect the choke for proper adjustment. Remove the air cleaner and observe the position of the choke valve in carburetor. The choke should be completely closed when a cold engine is cranked.

Intake Manifold Leaks—Inspect for loose manifold or defective intake manifold gasket which might result in air leakage. Inspect carburetor gasket for damage or air leaks.

(b) Electrical

Battery—Inspect for weak or discharged battery. Inspect cables for looseness and the battery terminals for corrosion.

Spark Plugs—Check for fouling, cracked porcelain or improper gap.

Wiring and Connections—Inspect wiring for breaks, frayed or worn insulation. Inspect connections for tightness and corrosion.

Distributor—Inspect for wet or cracked distributor cap, poor connections or corroded terminals in cap towers. Also check for worn, dirty, corroded, burned, or improperly adjusted contact points, or for a defective condenser.

Coil—Inspect for a weak coil.

Ignition Timing—Set ignition timing as recommended in Ignition Section of this manual.

Starter Solenoid and Switch—If the solenoid switch fails to "click" when the ignition key is turned to the starting position, connect a jumper wire from the positive battery post to the small terminal on the solenoid. If this causes the solenoid to "click", check for loose connections on the small terminal on the solenoid switch, the ignition-starter switch or fuel gauge. If the solenoid switch fails to "click" when energized with the jumper wire, install a new solenoid.

Starting Motor — Test starter for proper cranking speed. A slow turning starter may not start engine. Check the amperage draw to make sure it is not excessive. If the test indicates that the starting motor is not up to specifications, it should be removed, inspected and the necessary repairs performed.

(c) Compression

Perform compression test to determine if compression is being lost due to worn or leaking valves, worn piston rings or leaking cylinder head gasket.

2. HARD STARTING—NON-MECHANICAL CAUSES

Dampness—When high humidity prevails, moisture may collect in the distributor cap, on the spark plugs and spark plug wires and connectors. This may result in the engine failing to start. Dry the spark plugs, wires, connectors, and distributor caps.

Engine Oil—In extremely cold weather, use the recommended engine oil in the crankcase. Use of excessively heavy oil may cause a heavy drag on the engine, preventing proper cranking speed.

Improper Starting Methods—Flooding of the carburetor may result if the accelerator pedal is pumped when cranking the engine. If the throttle is not held opened approximately $\frac{1}{3}$ when cranking the engine, gasoline may not reach the manifolds in sufficient quantity to start the engine.

Depress the clutch pedal when starting the engine, especially in cold weather. When this is done, the transmission is disengaged from the engine, thereby reducing the heavy drag of transmission lubricant.

ENGINE LACKS POWER

1. FUEL SYSTEM—Inspect the fuel lines for obstructions or leaks. Inspect the carburetor for the presence of dirt or water. Test the fuel pump by connecting a low pressure liquid gauge in the line between the fuel pump and the carburetor. Fuel pump pressure should be checked. Check the carburetor float level.

2. IGNITION SYSTEM—Inspect the spark plugs for fouling, improper gap or cracked porcelains. Check the ignition timing and inspect the distributor.

3. COMPRESSION—Perform a vacuum or compression test to determine the condition of the engine.

4. CHASSIS FRICTION—Check for dragging brakes, tight wheel bearings or under-inflated tires.

"FLAT SPOT" ON ACCELERATION

The term "flat spot" is commonly accepted to mean that engine operation is interrupted momentarily when being accelerated in high gear at low speeds. If such a condition occurs, check the operation of the accelerator pump system in the carburetor.

This is done by removing the air cleaner and working the throttle by hand. A stream of fuel should flow from the accelerator pump jet. If this jet is not operating properly, the fuel stream will be thin, deflected to one side, or the fuel will merely dribble out of the jet. If such is the case, the carburetor should be cleaned and reconditioned.

ENGINE WILL NOT IDLE SMOOTHLY

1. FUEL SYSTEM—If it is difficult to obtain smooth engine idle, determine whether or not the carburetor is at fault by trying to make the engine roll. Do this by turning the idle mixture screw out (counter-clockwise) to obtain an over-rich mixture. Also, try to make the engine stall by turning the idle mixture screw in (clockwise) to provide too lean a mixture. If either of these fuel-air mixture extremes cannot be obtained, perform a vacuum test, checking for air leaks or poor valve conditions. If the vacuum test does not disclose any mechanical conditions, it is an indication that the carburetor is at fault.

The engine idle should be set according to the specifications shown in Section VI—Fuel and Exhaust Systems.

2. IGNITION SYSTEM—Inspect the spark plugs for fouling, cracked porcelains or improper gap. Check high tension wires for frayed or worn insulation or loose connections.

Check the distributor shaft for wear. Inspect for a cracked distributor cap, loose or corroded terminals in the cap towers, burned, pitted or improperly adjusted contact points, corroded or worn rotor. Also, test coil and condenser with testing equipment.

ENGINE MISSES ON ACCELERATION

1. IGNITION SYSTEM—Inspect the spark plugs for fouling, improper gap or cracked porcelain. Check the distributor for a cracked cap, loose or corroded terminals in cap towers, pitted or improperly adjusted contact points, or a worn rotor. Check the distributor vacuum advance, condenser and coil with testing equipment. Inspect high tension wires for frayed or worn insulation.

2. VALVE SPRINGS—Weak valve springs may cause the engine to miss on acceleration or at high speeds.

OIL LEAKAGE

1. EXTERNAL LEAKS—Traces of oil on the underside of the oil pan or the clutch housing, or oil that has dripped under a car that has been standing for a short time may indicate oil leakage.

(a) Oil Pan and Gaskets—Make sure the oil pan and gaskets have been correctly installed and are not damaged.

(b) Drain Plug—Inspect the oil pan drain plug for tightness.

(c) Rear Main Bearing Oil Seal—Inspect the underside of the clutch housing for traces of oil. Oil at this point usually indicates leakage at the rear main bearing oil seal.

(d) Fuel Pump—Oil drippage on the cylinder block below the fuel pump or the underside of the oil pan at this point, is an indication that the fuel pump mounting is loose or the gasket is at fault.

(e) Timing Gear Cover Gasket—Make sure the cover is tight and that the gasket is correctly positioned. Also, inspect front crankshaft pulley seal.

(f) Valve Cover Gaskets—Make certain the covers are tight and the gaskets are correctly positioned.

OIL CONSUMPTION

Blue smoke escaping from the tail pipe immediately after the engine is accelerated or decelerated is an indication that oil is being drawn past the piston rings or past the valves in the guides and into the combustion chambers. If no smoke escapes from the tail pipe when the engine is running, yet oil consumption exists, check for external leakage.

NOTE

When new rings are installed in an engine, there may be more than normal oil consumption until the rings are seated.

To determine if the piston rings or valves are faulty, perform a compression or vacuum test.

LOW OIL PRESSURE

1. EXTERNAL LEAKS—Inspect for possible leakage. Wipe the oil lines and fittings clean, run the engine at a fast idle and look for traces of oil at the points cleaned.

NOTE

Low oil pressure at engine idling speed is not an indication of lack of oil circulation, provided the oil pressure increases with engine speed. When the engine is operated at speeds equivalent to a car speed of over 30 miles per hour, the indicated oil pressure should be 30 to 50 pounds.

2. OIL PRESSURE RELIEF VALVE—Inspect for a broken or distorted oil pressure relief valve spring. Check the plunger for dirt, nicks, or burrs.

3. OIL PRESSURE SWITCH — Inspect the oil switch for accuracy, by connecting an accurate gauge in the line with a "T" fitting.

4. OIL—Make certain that oil of the recommended viscosity is used in the crankcase.

5. *EXCESSIVE BEARING CLEARANCE*—Check flow of oil at the bearings by using a Bearing Leak Detector. See page 314.

6. *OIL PUMP*—Inspect the oil pump parts for excessive clearance.

HIGH OIL PRESSURE

1. *OIL PRESSURE RELIEF VALVE*—Make sure the plunger is not sticking in the closed position. The spring should not be backed up with washers or other such material. Also a spring heavier than specified should not be used.

2. *ENGINE OIL*—Make sure that the recommended oil is used in the crankcase. A heavy oil will not flow as rapidly as a light oil and high oil pressure may result.

ENGINE NOISES

The noises described here are only those which could originate inside the engine. No attempt has been made to describe other noises coming from other parts of the car.

1. *MAIN BEARINGS*—A main bearing noise (usually a deep-toned knock) is more noticeable when the engine is under load. Check for this noise by shorting out the spark plugs one at a time when the engine is under load; approximately 35 MPH (1700 RPM). If the noise is more noticeable when the spark plugs are shorted out on either side of a main bearing, that main bearing may be at fault.

2. *CONNECTING ROD BEARINGS*—A loose connecting rod bearing usually produces a rapid metallic knock which is most noticeable when the accelerator pedal is released immediately following acceleration of engine. Find the faulty bearing by shorting out the spark plugs —one at a time. If the noise quiets down or disappears, when a particular spark plug is shorted out, the connecting rod bearing at that point is probably responsible for the noise.

3. *PISTON*—A piston noise is generally referred to as a piston "slap" and may be classified as a hot or cold slap. A cold slap noise should leave the engine when the heat indicator pointer starts to move away from the pin. Noise caused by a cold piston is not harmful. If a hot piston slap continues after the engine reaches operating temperature, it is an indication that some corrective action is necessary. Check piston fit in bore and piston pin fit. Check piston for collapsed skirt, scored wall and proper taper.

4. *VALVES*—Inspect rocker arm and push rod for excessive wear. Inspect for sticking valves or for a binding condition of the rocker arm on the shaft. If valve noise is evident, check valve tappet clearance. Valve tappet noise cannot be controlled by setting the clearance less than recommended. After checking the tappet clearance, inspect the valve stem ends, the valve guides, the valve tappet adjusting screw, and the cam lobes for wear. Also, inspect for weak or broken valve spring.

5. *FUEL PUMP*—An air leak on the intake side of the fuel pump will increase diaphragm movement and result in noise. Inspect the inlet lines for tightness.

EXCESSIVE FUEL CONSUMPTION

When excessive fuel consumption is suspected, a fuel test should be made to determine whether a mechanical condition in the engine is responsible, or whether the condition is due to driving habits.

Fuel tests should be made under controlled conditions with a suitable fuel mileage tester. Make two test runs (one with, and one against the wind) at a constant speed of 30 miles an hour over a level road. An average of these two test runs will indicate the mileage the car is capable of delivering under these controlled conditions.

NOTE

A gas mileage test under controlled conditions will reveal the maximum fuel mileage the car is capable of delivering. Under normal driving conditions, the fuel mileage will be less because of operating conditions generally beyond the control of the driver. These conditions are explained in the following paragraphs under the heading "Driving Methods and Weather Conditions."

If the results of the fuel test indicates excessive fuel consumption under controlled conditions based on tests made on similar model cars known to be in good mechanical condition, the following units should be checked.

1. *IGNITION TIMING*—Check ignition timing at various operating speeds. Check vacuum advance unit.

2. *SPARK PLUGS*—Check for fouled electrodes, cracked porcelain and improper gap.

3. *CARBURETOR*—Make sure the step-up piston is operating properly. Check for high float level and for dirt in the air cleaner which might restrict the passage of air. Test for excessive fuel pump pressure.

4. *CHOKE*—If the choke is not wide open with engine at operating temperature, an over-rich fuel air mixture will be delivered to the carburetor and fuel consumption will be increased.

5. CHASSIS FRICTION—The slightest amount of brake drag will tend to increase fuel consumption. Inspect for tight wheel bearings. Check front wheel toe-in. Inflate tires to the recommended pressure. Check lubrication of universal joints, rear axle and transmission.

If the fuel test indicates that the car condition is not the cause of excessive fuel consumption, the operator should be informed of the following good driving practices which promote fuel economy.

DRIVING METHODS AND WEATHER CONDITIONS

1. CITY DRIVING—To obtain maximum fuel mileage in city traffic, it is advisable to avoid frequent use of low gears when possible. Fast starts and resulting excessive brake applications will greatly increase fuel consumption.

2. HIGHWAY DRIVING—It requires more fuel per mile to operate car at 70 miles an hour than at 35 miles an hour. At 70 miles an hour, the engine develops about 60 horsepower and only approximately 10 horsepower at 35 miles an hour. As more horsepower is developed, more fuel will be required. At high speeds, wind resistance must be overcome. As speed increases, friction on the moving parts of the engine increases. More fuel must be consumed by the engine to overcome the drag imposed under these conditions.

At freezing temperatures, tests show that a car must be driven approximately 8 miles before maximum fuel mileage can be obtained. At lower temperatures, the car must be driven even greater distances to secure maximum fuel mileage.

Not only does the engine have to be warmed up during cold weather, but also the units of the drive train, to reduce chassis friction.