SECTION C

400 AND 430 CUBIC INCH V-8 ENGINES

CONTENTS

DIVISION I SPECIFICATIONS AND ADJUSTMENTS

60-1 BOLT TORQUE SPECIFICATIONS

Use a reliable torque wrench to obtain the figures listed below. This will prevent straining or distorting the parts as well as preventing thread damage. These specifications are for clean and lightly lubricated threads only. Dry or dirty threads produce friction which prevents accurate measurement of the actual torque. It is important that these specifications be strictly observed. Overtightening can damage threads. This will prevent attainment of the proper torque and will require replacement of the damaged part.

Area	Torque Lbs. Ft.
Spark Plug	15
Crankshaft Bearing Caps to Cylinder Block	110
Connecting Rods	45
Cylinder Head to Cylinder Block	100
Harmonic Balancer to Crankshaft	200 Minimum
Fan Driving Pulley to Harmonic Balancer	22
Flywheel to Crankshaft (Auto. & Manual)	60
Oil Pan Baffle to Cylinder Block	8

60-1 BOLT TORQUE SPECIFICATIONS (Cont'd.)

Oil Pan to Cylinder Block	14
Oil Pan Drain Plug	30
Oil Pump Cover to Timing Chain	10
Oil Pick-Up Tube & Screen Housing Assembly to Cylinder Block	8
Oil Pump Pressure Regulator Retainer	35
Oil Gallery Plugs	25
Oil Filter to Cylinder Block	12
Timing Chain Cover to Block	30
Water Pump Cover to Timing Chain Cover	8
Fan Driven Pulley	20
Thermostat Housing to Intake Manifold	20
Intake Manifold to Cylinder Head	50
Exhaust Manifold to Cylinder Head	18
Carburetor to Intake Manifold	12
Automatic Choke Cover to Intake Manifold	8
Fuel Pump to Cylinder Block	20
Motor Mount to Cylinder Block	70
Timing Chain Sprocket to Camshaft	22
Rocker Arm Cover to Cylinder Head	4
Rocker Arm Shaft Bracket to Cylinder Head	30
Delcotron Mounting Bracket to Cylinder Head	35
Delcotron Adjustable Mounting Bracket to Cylinder Head	22
Delcotron Mounting Bracket Thru Delcotron	35
Starting Motor to Block	35
Starting Motor Bracket to Block	11
Distributor Hold-Down Clamp	12
Synchromesh Lower Flywheel Housing Plate	11
Flywheel Housing to Cylinder Block	35
Oil Pressure Switch to Cylinder Block	25

60-2 GENERAL SPECIFICATIONS

a. General

	400-4	430-4
Code Number Prefix	PR	PD
Export Code Number Prefix	Not Available	PE
Engine Type	90° V-8	90° V-8
Bore and Stroke	4.040 x 3.900	4.1875 x 3.90
Piston Displacement	400 Cu. In.	430 Cu. In.
Carburetor Type	4 Bbl.	4 Bbl.
Compression Ratio	10.25:1	10.25:1
Gasoline Requirements	Premium	Premium
Brake Horsepower @ RPM	340 @ 5000	360 @ 5000
Maximum Torque @ RPM	440 @ 3200	475 @ 3200
Taxable Horsepower	51.91	56.1
Octane Requirements - Motor	90	90
Octane Requirements - Research	99	99
Cylinders Numbers - Front to Rear - Left Bank	1-3-5-7	1-3-5-7
Cylinders Numbers - Front to Rear - Right Bank	2-4-6-8	2-4-6-8
Firing Order	1-8-4-3-6-5-7-2	1-8-4-3-6-5-7-2

b. Piston and Pin Specifications

Piston	
Material	Cast Aluminum Alloy
Type	Divorced Skirt
Finish	Cam Ground
Piston Pins	
Material	Extruded SAE-1018
Type	Pressed in Rod

c. Connecting Rods

Material	Forged - SAE-1141 Steel
Rod Bearing	Removable Steel Backed M/400 Aluminum

60-2 GENERAL SPECIFICATIONS (Cont'd.)

d. Ring Specifications

#1 Compression	Cast Iron Molybdenum Coated
#2 Compression	Cast Iron-Lubrited
Oil Ring Rail	SAE-1070 Steel-Chrome Plated
Oil Ring Expander	Abutment Type
Ring Locations	Above Pin

e. Crankshaft Specifications

Material	Nodular Iron
Bearings Material	Steel Backed M/400 Aluminum - #5 Durex M/100A Removable
Bearing Taking End Thrust	#3

f. Camshaft Specifications

Material	Cast Alloy Iron
Bearings	Steel Backed Babbitt
Number of Bearings	5
Drive	Chain
Number of Links	48
Crankshaft Sprocket	Sintered Iron
Camshaft Sprocket	Nylon Coated Aluminum

g. Valve Specifications

Intake Valve Material	Aluminized Face and Chrome Flash Stem SAE 1041 Steel
Exhaust Valve Material	Aluminized Face and Chrome Flash Stem GM-N82152 (21-4N)
Valve Lifter Mechanism	Hydraulic
Valve Spring	Single Spring With Damper

h. Lubrication System Specifications

Type of Lubrication	
Main Bearings	Pressure
Connecting Rods	Pressure
Piston Pins	Splash
Camshaft Bearing	Pressure
Timing Chain	Drip From Front Cam Bearing
Cylinder Walls	Splash & Nozzle
Oil Pump Type	Gear Driven
Normal Oil Pressure	40 lbs. @ 2400 RPM
Oil Pressure Sending Unit	Electrical
Oil Intake	Stationary
Oil Filter System	Full Flow
Filler Type	Throw-Away Element & Can
Crankcase Capacity	
Less Filter	4 qts.
With Filter	5 qts.

i. Cooling System Specifications

System Type	Pressure
Radiator Cap Relief Pressure	15 psi
Thermostat	Poppet-Pellet Type Opening at 190°
Water Pump	
Type	Centrifugal
GPM @ RPM	15 @ 1000 Pump RPM
Drive	V-Belt
Bearings	Double Row
By-Pass Recirculation Type	Internal

60-2 GENERAL SPECIFICATIONS (Cont'd)

i. Cooling System Specifications (Cont'd)

Cooling System Capacities	400 Cu. In.	430 Cu. In.
With Heater	16.2 Qts.	16.7 Qts.
W/O Heater	15.3 Qts.	16.0 Qts.
With Air Conditioning	16.7 Qts.	17.0 Qts.

Fan Diameter and Number of Blades

G.S. 400	18" x 4 Less AC 18" x 7 With AC	Wildcat and Electra 225	18" x 4 Less AC 20" x 5 With AC
Riviera	18" x 7 Less AC 20" x 5 With AC		

Fan Drive

Less AC	Water Pump Shaft
With AC	Thermostatic Controlled Clutch

60-3 ENGINE DIMENSIONS AND FITS

a. General

Piston Clearance Limits*	400 Cu. In.	430 Cu. In.
Top Land	.034 - .042	.0343 - .0423
Skirt - Top	.0007 - .0013	.0007 - .0013
Skirt - Bottom	.0017 - .0033	.0017 - .0033
Ring Groove Depth		
#1 - Compression Ring	.2090 - .2165	.2090 - .2165
#2 - Compression Ring	.2115 - .2190	.2215 - .2190
#3 - Oil Ring	.1815 - .1890	.1815 - .1890
Ring Width		
#1 - Compression Ring	.077 - .078	.077 - .078
#2 - Compression Ring	.077 - .078	.077 - .078
#3 - Oil Ring	.023 - .025	.023 - .025
Ring Gap		
#1 - Compression Ring	.013 - .023	.013 - .023
#2 - Compression Ring	.013 - .023	.013 - .023
#3 - Oil Ring	.015 - .055	.015 - .055
Piston Pin Length	3.520	3.520
Diameter of Pin	.9994 - .9997	.9994 - .9997
Clearance		
In Piston	.0001 - .0004	.0001 - .0004
In Rod	.00075 - .00125	.00075 - .00125
	Press	Press
Direction & Amount Offset in Piston	.060 Offset Major Thrust Side	.060 Offset Major Thrust Side

*All Measurements in Inches Unless Otherwise Specified.

b. Connecting Rod Specifications

Bearing Length	.821	.821
Bearing Clearance (Limits)	.0002 - .0023	.0002 - .0023
End Play-Total for Both Rods	.005 - .012	.005 - .012

c. Crankshaft Specifications

End Play at Thrust Bearing	.003 - .009	.003 - .009
Main Bearing Journal Diameter	3.2500	3.2500
Crankpin Journal Diameter	2.249 - 2.250	2.249 - 2.250
Main Bearing Overall Length		
#1	.865	.865
#2	.865	.865
#3	1.057	1.057
#4	.865	.865
#5	1.143	1.143
Main Bearing to Journal Clearance	.0007 - .0018	.0007 - .0018

60-3 ENGINE DIMENSIONS AND FITS (Cont'd.)

d. Camshaft Specifications

	400 cu. in.	430 cu. in.
Bearing Journal Diameter		
#1	1.785 - 1.786	1.785 - 1.786
#2	1.785 - 1.786	1.785 - 1.786
#3	1.785 - 1.786	1.785 - 1.786
#4	1.785 - 1.786	1.785 - 1.786
#5	1.785 - 1.786	1.785 - 1.786

e. Valve System Specifications

Rocker Arm Ratio	1.59 to 1
Rocker Arm Clearance on Shaft	.0015" - .003"
Valve Lifter Diameter	.8427 - .8422
Valve Lifter Clearance in Crankcase	.0008 - .0023
Valve Lifter Leakdown Rate	12 to 60 Sec. in Test Fixture
Intake Valve	
Head Diameter	2.000
Seat Angle	45°
Stem Diameter	.3725 ± .0005 - Max. Allowable Taper to be .0003 with Smallest Dia. @ Valve Head End
Clearance in Guide	.0015 - .0035 and .0003 Max. Taper
Valve Spring	
Valve Closed - Pounds @ Length	72 ± 5 @ 1.890
Valve Open - Pounds @ Length	177 ± 7 @ 1.450
Exhaust Valve	
Head Diameter	1.625
Seat Angle	45°
Stem Diameter	.3725 ± .0005 Top - .3715 ± .0005 Bottom
Clearance in Guide	.0015 - .0035 Top - .0025 - .0045 Bottom
Valve Spring	
Valve Closed - Pounds @ Length	72 ± 5 @ 1.890
Valve Open - Pounds @ Length	177 ± 7 @ 1.450

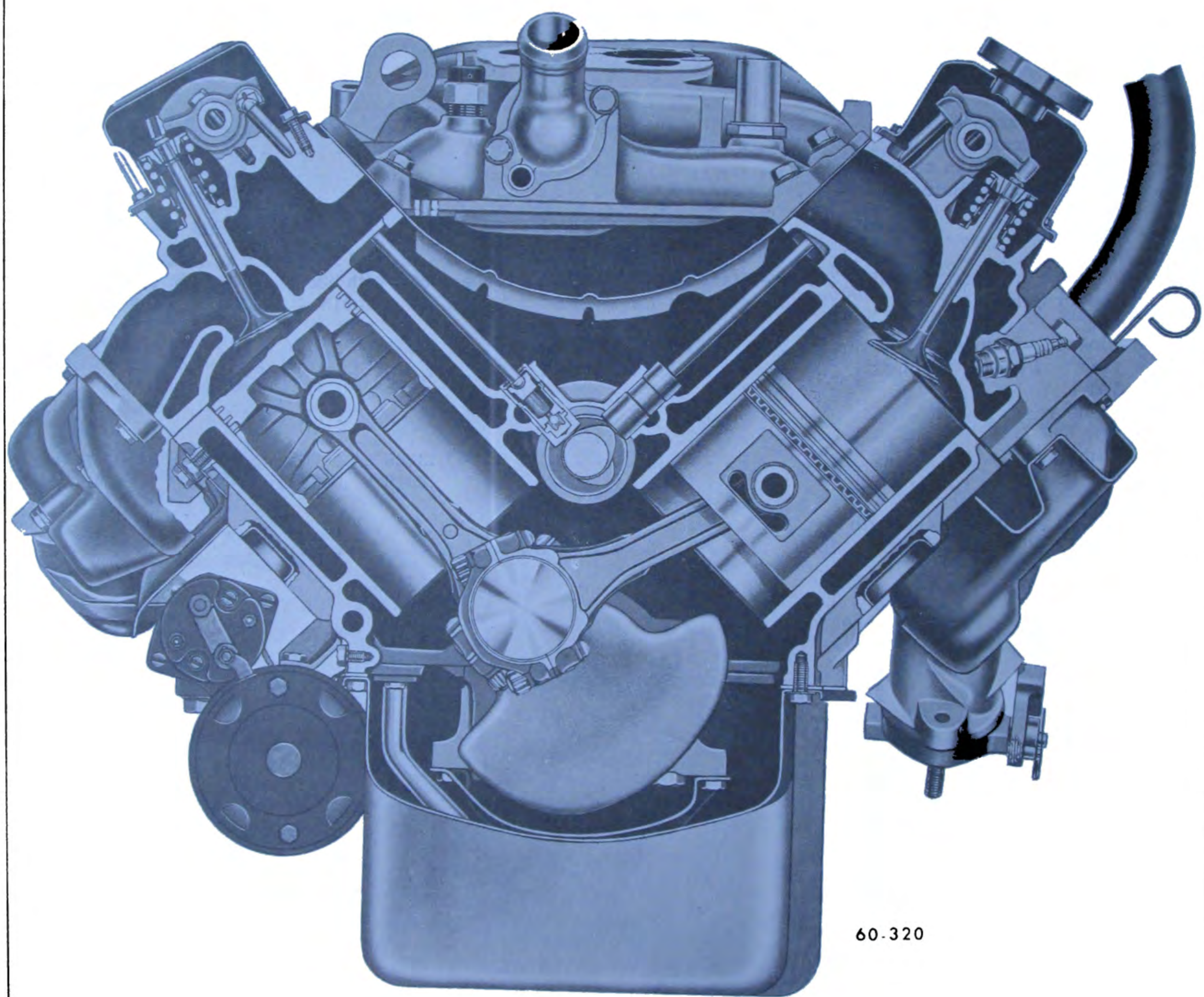


Figure 60-300—400 and 430 Cubic Inch - End Sectional View

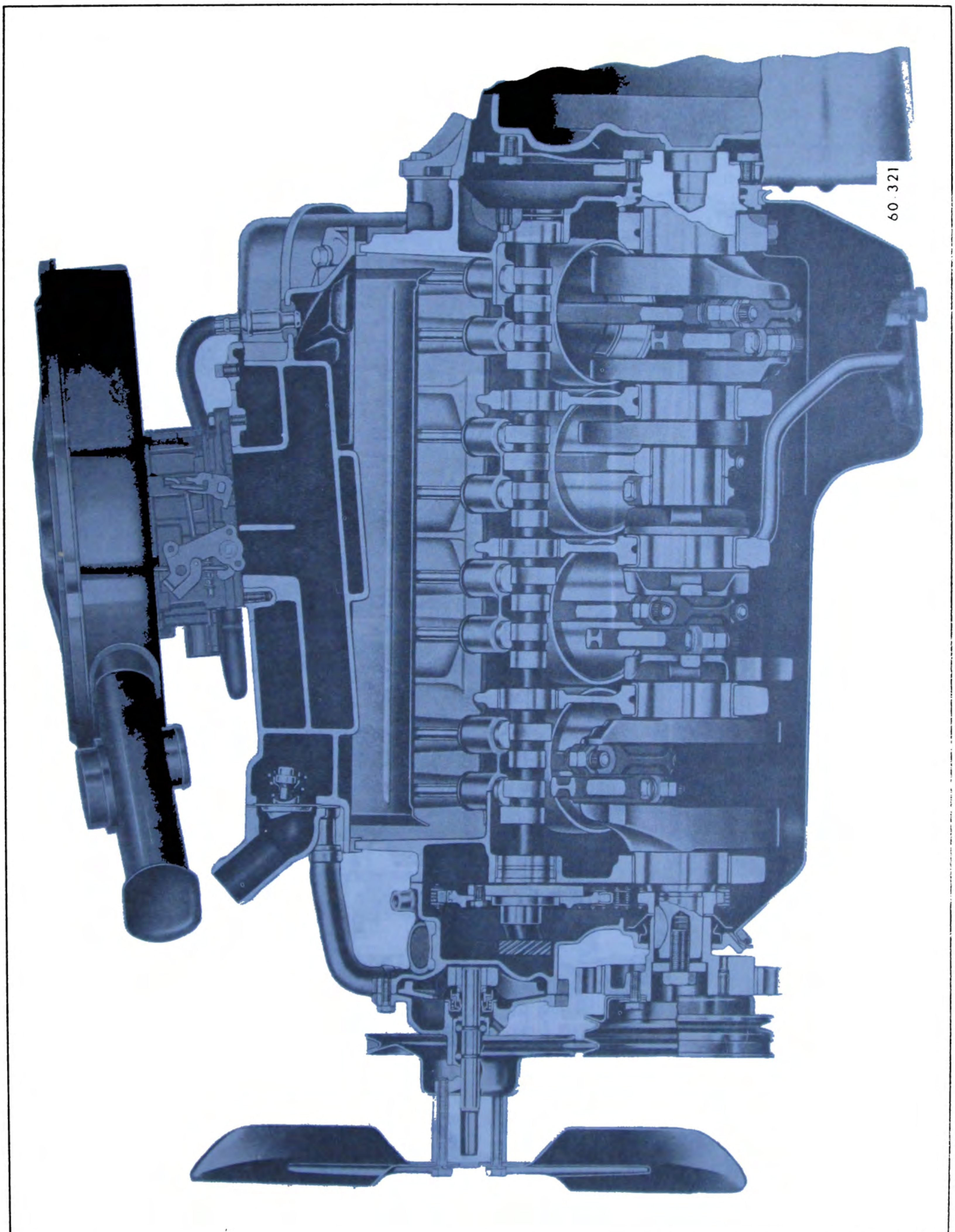


Figure 60-301 - 400 Cubic Inch - Side Sectional View

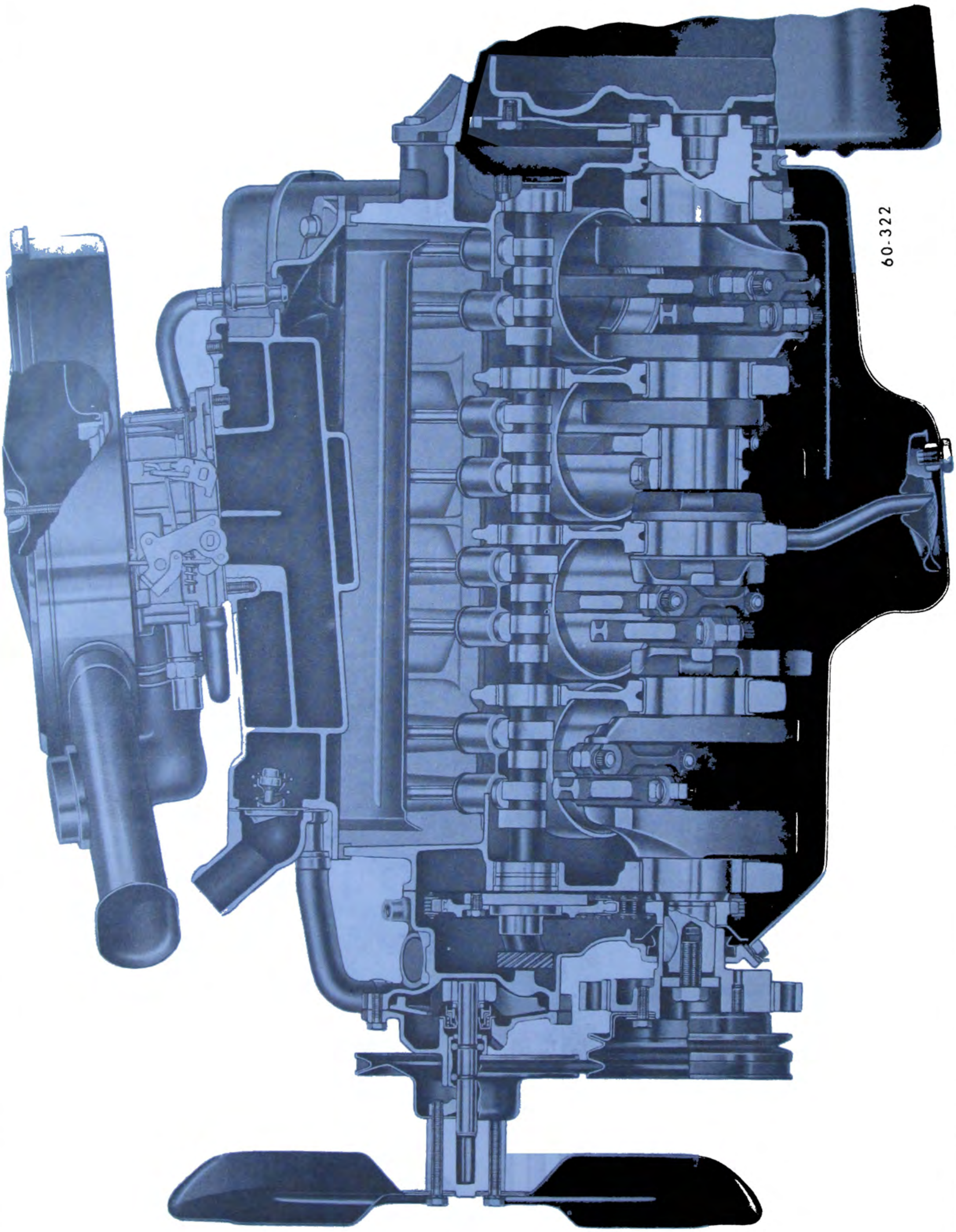


Figure 60-302—430 Cubic Inch - Side Sectional View

DIVISION II—DESCRIPTION AND OPERATION

60-4 ENGINE CONSTRUCTION

a. Engine Usage

Series	Engine Code No. Prefix	Cu. In. Displacement	Use	Compression Ratio	Carburetor
44600	PR	400	Standard	10.25:1	4 Bbl.
46000	PD	430	Standard	10.25:1	4 Bbl.
48000 49000	PE	430	Export	8.75:1	4 Bbl.

b. Engine Mounting

For details of engine and transmission mounts refer to Figures 60-352 and 60-353.

c. Engine Construction

The 400 and 430 cu. in. engines, with the exception of cylinder bore size, are very similar. Because of the similarity between the two engines, the service procedures, unless otherwise specified will be combined.

The left bank of cylinders (as viewed from rear) is set slightly forward of the right bank so that connecting rods of opposite sides can be connected to the same crankpin. Starting at the front end cylinders in the left bank are numbered 1-3-5-7 and cylinders in the right bank are numbered 2-4-6-8.

The crankshaft, cast nodular iron, is supported in the crankcase by five bearings which are identical except number three, which takes end thrust and rear main which has a different width and material.

The crankshaft is counterbalanced by weights cast integral with crankshaft. Additional counterbalancing is obtained by an offset flywheel flange.

The tin plated aluminum alloy pistons have full skirts and are cam ground. Two transverse slots in the oil ring grooves extend through the piston wall and permits drain back of oil collected by the oil ring.

The camshaft is supported in the crankcase by five steel-backed, babbitt-lined bearings. It is driven from the crankshaft by sprockets and chain.

The cylinder heads are cast iron and incorporates cast-in valve guides and rocker arm shaft pedestals. Right and left cylinder heads are identical and interchangeable, although in service, it is good practice to replace the cylinder heads on the side from which they are removed.

The intake manifold on the V-8 engine utilizes a low restriction, dual intake manifold. It is bolted to the inner edges of both cylinder heads so that it connects with all inlet ports. Since the intake manifold is cast iron, as is the carburetor throttle body, the manifold incorporates a special exhaust heat passage to warm the throttle body. Fuel/air mixture distribution to each intake port is shown in Figure 60-304.

The manifold heat control valve, located on the right exhaust manifold, regulates the amount of exhaust gas passing through the intake manifold. A bi-metallic spring attached to the control valve shaft tends to gradually open and reduce the amount of exhaust gas warming the intake manifold and throttle body by slowly opening the valve. When engine operating temperature is reached, a small quantity of exhaust gas continues to warm the throttle body.

Intake manifold heat is necessary when operating the engine in cold temperatures. Better fuel mixture vaporization, with resulting improved combustion is achieved.

Each valve has one concentric spring and damper to insure positive seating throughout the

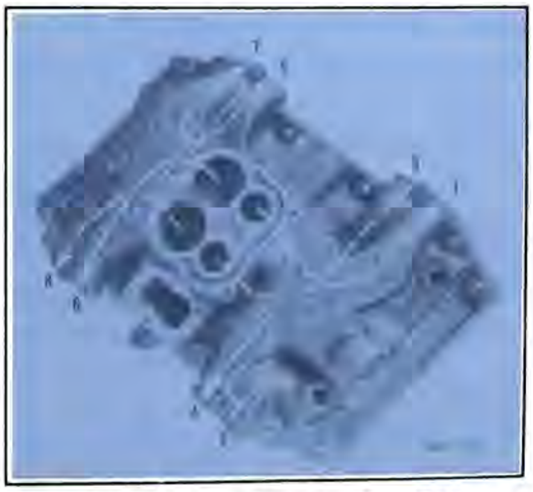


Figure 60-304—Intake Manifold Distribution

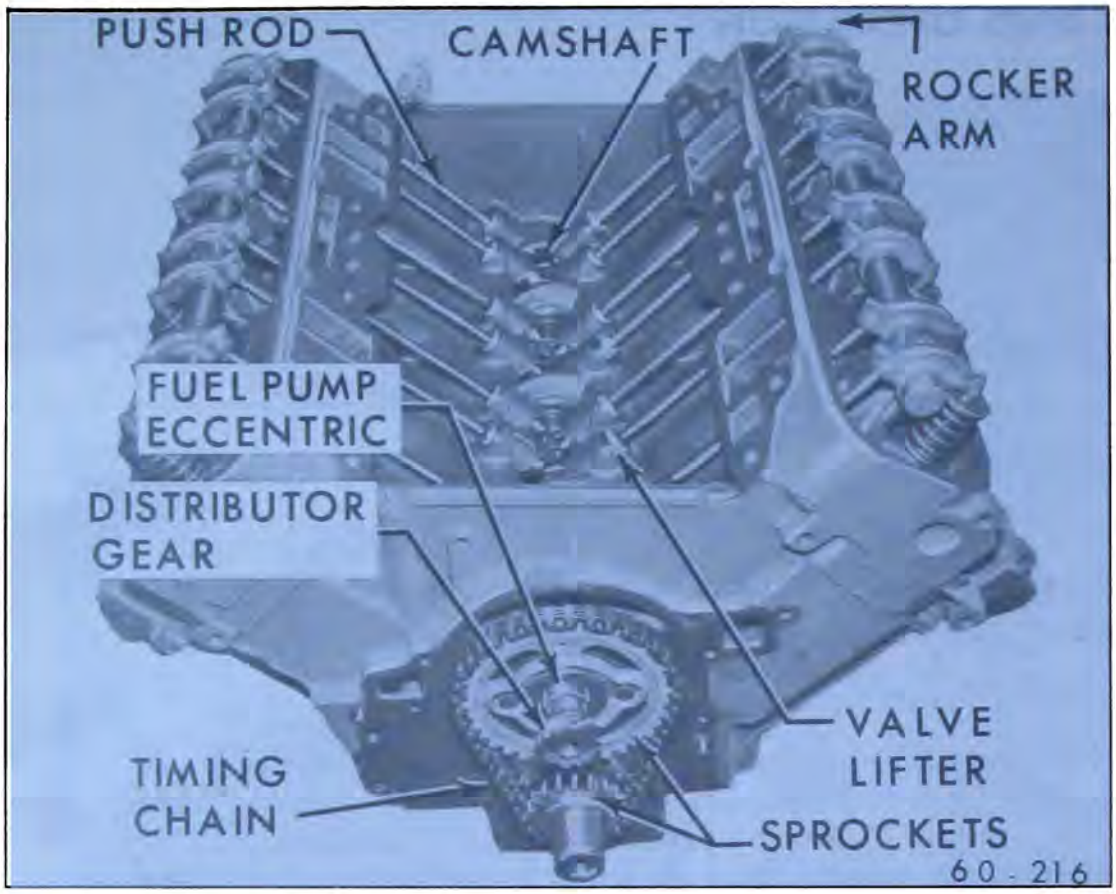


Figure 60-305—Valve Mechanism

operating speed range. Intake valve heads are 2" and exhaust valves heads are 1 5/8" in diameter.

The valve rocker arms for each bank of cylinders are mounted on a tubular steel shaft supported on the cylinder head by four pedestals. The rocker arms are die cast aluminum with inserts at the push rod sockets and the valve stem contact face. The rocker arm sockets are offset to accommodate the different planes of movement of the valves and the push rods which pass through the cylinder head to one side of the valves.

Hydraulic valve lifters and solid one-piece steel push rods are used to operate the overhead rocker arms and valves of both banks of cylinders from the single camshaft. This system requires no lash adjustment at times of assembly or in service; therefore, no adjusting studs or screws are provided in the valve train. Construction and operation of the hydraulic valve lifters are described in paragraph 60-4 of the 350 Cu. In. Engine Section.

DIVISION III SERVICE PROCEDURES

61-1 INTAKE MANIFOLD, CYLINDER HEAD, VALVE TRAIN AND LIFTERS

a. Intake Manifold Removal

1. Disconnect battery.

2. Drain coolant from radiator.

3. Remove air cleaner.

a. Disconnect breather tube at air cleaner.

b. Disconnect heat air pipe at top end of pipe.

c. Disconnect air cleaner sensor hose at tee (Auto. only).

d. Disconnect hose at elbow from carburetor to air cleaner (Manual only).

4. Remove air conditioning mounting bracket bolt (if equipped). Loosen two brackets to compressor bolts and slide bracket outboard.

5. Disconnect water temperature indicator wire from switch.

6. Disconnect throttle linkage at carburetor.

7. Disconnect fuel line at carburetor inlet.

8. Slide front thermostat by-pass hose clamp back on hose. Disconnect by-pass hose at timing chain cover to allow coolant to drain from manifold. Disconnect upper radiator hose at outlet.

9. Disconnect heater hose at intake manifold.

10. Remove bolts attaching manifold to cylinder heads.

11. Remove intake manifold and carburetor as an assembly. Remove gasket and seals.

b. Intake Manifold Installation

1. Place new rubber manifold seal in position at front and rear rails of cylinder block. Be sure pointed ends of seal fit snugly against block and head.

NOTE: Before installing intake manifold seals, apply Sealer Scotch-Grip EC971 or equivalent to underside of seals. See Figure 60-306.

Figure 60-306—Intake Manifold Seal Installation

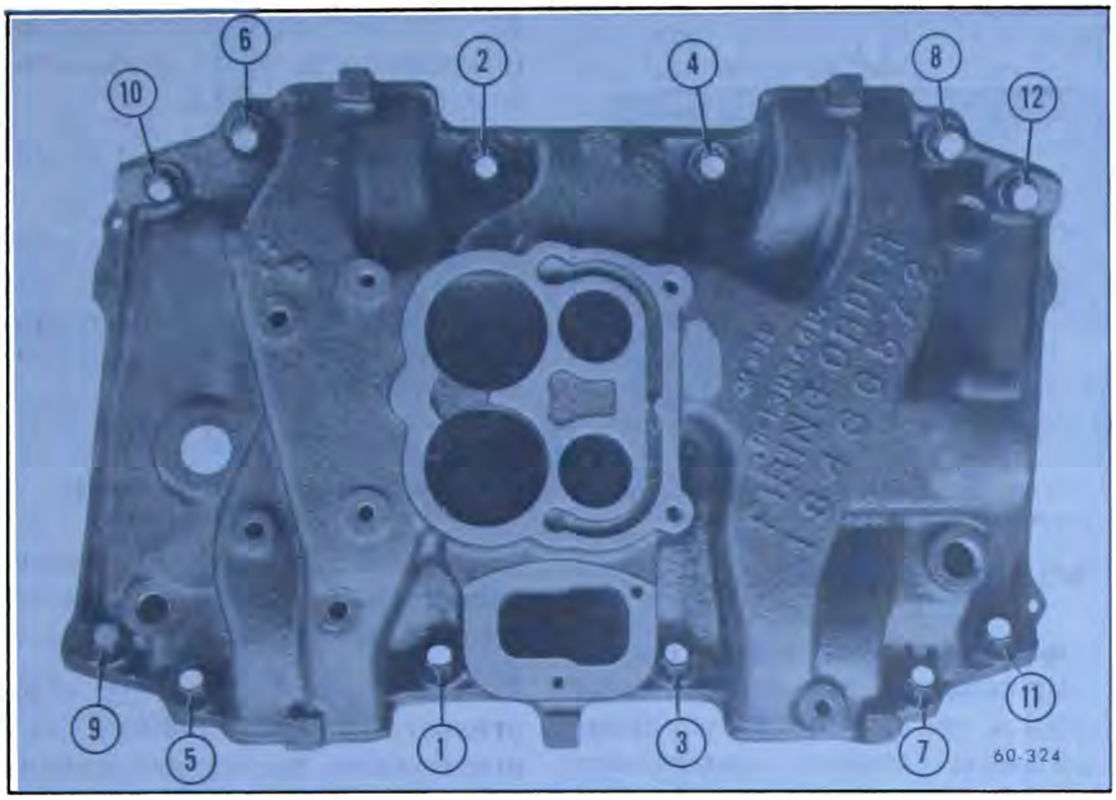


Figure 60-307—Intake Manifold Bolt Tightening Sequence

2. Install one piece manifold gasket and carefully set intake manifold on the engine block dowel pins.

3. Install manifold bolts.

NOTE: New intake manifold gasket and seals must be obtained whenever a manifold is removed.

When installing the intake manifold start with the #1 and #2 bolts. See Figure 60-307. Gradually tighten both bolts until snug. Then continue with the rest of the bolts in the sequence illustrated in Figure 60-307. Torque bolts to 50 lb. ft.

4. Connect parts removed in Steps 3 thru 9 in subpar. a.

5. Connect battery.

6. Close drain plug and fill radiator to proper level.

c. Cylinder Head Removal

1. Remove intake manifold as outlined in subparagraph a.

2. When removing RIGHT cylinder head:

a. Loosen delcotron and/or air compressor and remove bolt(s).

b. Remove wires from delcotron.

c. Remove delcotron with mounting bracket; if equipped with air conditioning compressor, remove compressor from mounting bracket and move it out of the way with hoses connected, then remove delcotron with mounting bracket.

3. When removing LEFT cylinder head:

a. Remove oil gage rod.

b. Remove power steering pump with mounting bracket and move it out of the way with hoses attached.

4. Disconnect wires from spark plugs, and remove the spark plug wire clips from the rocker arm cover studs.

5. Remove exhaust manifold to exhaust pipe bolts.

6. Disconnect exhaust manifold from head to be removed.

7. With air hose and cloths, clean dirt off cylinder head and adjacent area to avoid getting dirt into engine. It is extremely important to avoid getting dirt into the hydryulic valve lifters.

8. Remove rocker arm cover and remove four rocker arm and shaft assembly to cylinder head bolts. Remove shaft assembly. Lift out push rods.

NOTE: Whenever lifters or push rods are removed, place in a wooden block with numbered holes or similar device to keep them identified as to position in engine.

9. Slightly loosen all cylinder head bolts, then remove bolts and lift off the cylinder head. Remove gasket.

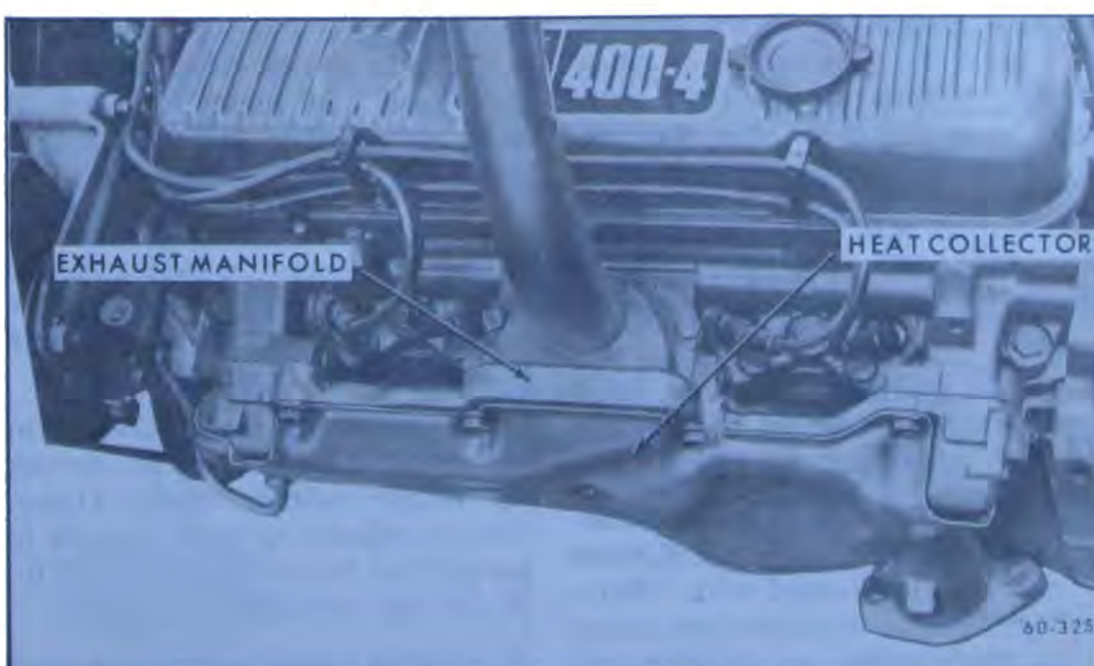


Figure 60-308—Exhaust Manifold Installation (Left Side)

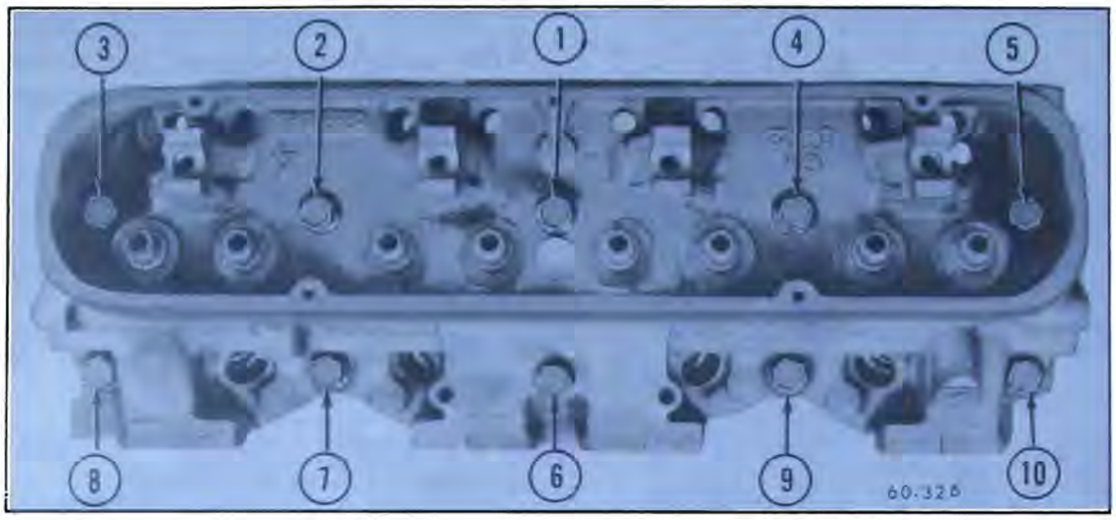


Figure 60-310—Cylinder Head Bolt Tightening Sequence

10. With cylinder head on bench, remove all spark plugs for cleaning and to avoid damage during work on the head.

d. Cylinder Head Installation

1. Thoroughly clean off engine block gasket surface and be certain no foreign material has fallen in the cylinder bores, bolt holes, or in the valve lifter area. It is good practice to clean out bolt holes with an air hose.

2. Install new head gasket on cylinder block. Dowels in the block will hold the gasket in place. Always handle gaskets carefully to avoid kinking or damage to the surface treatment of the gasket. The gaskets are coated with a special lacquer to provide a good seal, once the parts have warmed up.

3. Clean gasket surface of cylinder head and carefully set in place on the engine block dowel pins.

4. Clean and lubricate the head bolts with "Perfect Seal" or equivalent sealing compound.

NOTE: Damage to the cylinder block threads can result if bolts are not lubricated with "Perfect Seal" or equivalent prior to installation or if bolts are tightened excessively. Use an accurate torque wrench when installing head bolts. Uneven tightening of the cylinder head bolts can distort the cylinder bores, causing compression loss and excessive oil comsumption.

5. Install head bolts. Tighten the bolts a little at a time about three times around in the sequence shown in Figure 60-310. Give bolts a final torque in the same sequence. Torque to 100 lb. ft.

6. Assemble exhaust manifold to heads. Torque bolts to 18 lb. ft.

7. Wipe bases of rocker arm shaft brackets and bosses on cylinder head with a clean cloth.

8. Install push rods.

9. Tilt the rocker arm toward the push rod and locate the top of each push rod in its rocker arm seat.

NOTE: Drill mark on rocker arm shaft must be facing up and in the rear on the left cylinder head and toward the front on the left cylinder head.

10. Draw down the rocker arm and shaft assembly by tightening the bracket bolts a little at a time. Use a reliable torque wrench to torque the bracket bolts to 30 lb. ft. Do not overtighten.

11. Install rocker arm cover and new gasket. Torque bolts to 4 lb. ft.

12. Connect spark plug wire clips to rocker arm cover studs, connect spark plug wires.

13. Install intake manifold as outlined in subpar. b.

14. After installation is completed and engine has been warmed up to operating temperature, recheck cylinder head bolts for 100 lb. ft. torque.

e. Reconditioning Valves and Guides

1. Remove cylinder head per subparagraph c above. Place on clean surface.

2. Using suitable spring compressor, such as J-8062, compress valve spring and remove cap retainers. Release tool and remove spring and cap. See Figure 60-311.

3. Remove valve seals from intake and exhaust valve guides. Seals must be discarded. Remove valves. Place valves in numerical order so that they can be reinstalled in original location.

4. Remove all carbon from combustion chambers, piston heads, and valves. When using scrapers

Figure 60-311—Removing Valve Cap Retainers

Figure 60-312—Reaming Valve Guide

or wire brushes for removing carbon, avoid scratching valve seats and valve faces. A soft wire brush such as J-8358 is suitable for this purpose.

5. Clean carbon and gum deposits from valve guide bores. Use Reamer J-8003.

6. Inspect valve faces and seats for pits, burned spots or other evidences of poor seating. If a valve head must be ground until the outer edge is sharp in order to true up the face, discard the valve because the sharp edge will run too hot.

7. If valve stem has too much clearance in its guide, the guide should be reamed to .006" oversize using J-22612, and then to .010" oversize using Reamer J-9345-1. See Figure 60-312.

> **NOTE:** .006" oversize valve are occasionally used in production. If clearance in the valve guide exceeds .006" the guide should be reamed to .010" oversize by using J-9345-1. Oversize valves are identified by the oversize marking stamped on the valve head. See Figure 60-313.

The Parts Department stocks .010" oversize valves for replacement purposes.

8. True up valve seats to 45°. Cutting a valve seat result in lowering the valve spring pressure and increases the width of the seat. The nominal width of the valve seat is 1/16". If a valve seat is over 5/64" wide after truing up it should be narrowed to specified width by the use of 20° to 70° stones.

Improper hydraulic valve lifter operation may result if valve and seat have been refinished enough to allow the end of valve stem to raise approximately .050" above normal position. In this case it will be necessary to grind off end of valve stem or replace parts. The normal height of the valve stem above the valve spring seat is 2.275".

9. Lightly lap the valves into seats with fine grinding compound. The refacing and reseating operations should leave the refinished surfaces smooth and true so that a minimum of lapping is required. Excessive lapping will groove the valve face preventing a good seat when hot.

> **IMPORTANT:** New valves should not be lapped under any condition as the .0002"-.0015" aluminum alloy surface will be removed.

Figure 60-313—Oversize Valve Identification

Figure 60-314—Valve Spring

10. Test valves for concentricity with seats and for tight seating. The usual test is to coat the valve face lightly with Prussian blue and turn the valve against seat. If the valve seat is concentric with the valve guide a mark will be made all around the seat, while if the seat is not concentric with the guide, a mark will be made on only one side of the seat. Next, coat the valve seat lightly with Prussian blue. Rotate the valve against the seat to determine if the valve face is concentric with the valve stem, and if the valve is seating all the way around. Both of these tests are necessary to prove that a proper seat is being obtained.

11. Remove any burrs from valve stem with a fine stone or crocus cloth.

12. Lubricate with "Service MS" engine oil and reinstall valves.

13. Install valve seal.

a. Start valve seal carefully over valve stem. Push seal down until it touches top of guide.

b. Use Installation Tool J-22509 to push seal over valve guide until upper inside surface of seal touches top of guide.

NOTE: COMPRESS SPRINGS ONLY ENOUGH TO INSTALL KEEPERS. EXCESS COMPRESSION CAN CAUSE SPRING RETAINER TO DAMAGE VALVE SEAL.

14. Reinstall valve springs, cap and cap retainer, using same equipment used for removal. The valve spring may be installed with either end up.

15. Install cylinder head as described in Subparagraph d above.

Figure 60-316—Rocker Arm Positioned on Shaft

f. Rocker Arm Assembly Removal

1. Remove rocker arm cover and remove four rocker arm and shaft assembly to cylinder head bolts. Remove shaft assembly.

2. Place assembly on clean surface.

3. Remove shaft end cap by splitting side of cap with chisel. See Figure 60-315.

4. Remove rocker arms and springs and clean in suitable solution. Inspect for wear.

g. Rocker Arm Assembly Installation

NOTE: When installing rocker arm shaft be sure that the drill mark is facing up and toward the rear on the left cylinder head and toward the front on the right cylinder head.

Figure 60-315—Removing Rocker Arm Shaft End Cap

1. Install rocker arms and springs on shaft using engine oil to lubricate mating surfaces. Each set of rocker arms must be offset to each other. See Figure 60-316.

2. Install new end cap on shaft.

3. Install rocker arm assembly as outlined in Subparagraph d.

h. Valve Lifter Service

1. Refer to procedure outlined under "Cylinder Head Removal" (par. 61-1 sub par. c, Steps 1-9) for lifter removal.

2. Since the valve lifters for the 400 & 430 cu. in. are serviced the same as the 350 cu. in. refer to paragraph 61-1g (valve lifter service) and 61-1h (checking valve lifter leakdown rate) in the 350 cu. in. engine section.

3. Following the procedure outlined in paragraph 61-1, subparagraph d, reassemble engine.

i. Exhaust Manifold Removal (Left Side)

1. Raise front of car and support on stands.

2. Disconnect exhaust pipe from exhaust manifold on both sides of engine and lower. If dual exhaust, disconnect left exhaust pipe and lower.

3. If manual transmission, remove equalizer shift.

4. Remove pitman arm from pitman shaft using Tool J-5504. Swing steering linkage forward.

NOTE: Mark location of pitman arm to pitman shaft for reinstallation.

5. Remove exhaust manifold to cylinder head bolts.

6. Remove exhaust manifold from beneath the car.

j. Exhaust Manifold Installation

1. Install exhaust manifold by reversing above procedures.

2. Torque exhaust manifold bolts to 18 lb. ft.

3. Torque pitman shaft nut to 140 lb. ft.

61-2 REPLACEMENT OF CONNECTING ROD BEARINGS

A connecting rod bearing consists of two halves or shells which are alike and interchangeable in rod and cap. When the shells are placed in rod and cap the ends extend slightly beyond the parting surfaces so that when rod bolts are tightened the shells will be clamped tightly in place to insure positive seating and to prevent turning. <u>The ends of shells must never be filed flush with parting surface of rod or cap.</u>

If a precision type connecting rod bearing becomes noisy or is worn so that clearance on crankpin is excessive, a new bearing of proper size must be selected and installed since no provision is made for adjustment. Under no circumstances should the connecting rod or cap be filed to adjust the bearing clearance.

a. Inspection of Connecting Rod Bearings and Crankpin Journals

After removal of lower crankcase Paragraph 62-1, disconnect two connecting rods at a time from crankshaft and inspect the bearings and crankpin journals. While turning crankshaft it is necessary to temporarily reconnect the rods to crankshaft to avoid possibility of damaging the journals through contact with loose rods.

If connecting rod bearings are chipped or scored they should be replaced. If bearings are in good physical condition check for proper clearance on crankpins as described in subparagraph b, below.

If crankpin journals are scored or ridged the crankshaft must be replaced, or reground for undersize bearings, to insure satisfactory life of connecting rod bearings. Slight roughness may be polished out with fine grit polishing cloth thoroughly wetted with engine oil. Burrs may be honed off with a fine oil stone.

Use an outside micrometer to check crankpins for out-of-round. If crankpins are more than .0015" out-of-round, satisfactory life of new bearings cannot be expected.

b. Checking Clearance and Selecting Replacement Connecting Rod Bearings

Service bearings are furnished in standard size and several undersizes (including undersizes for reground crankpins).

The clearance of connecting rod (and crankshaft) bearings may be

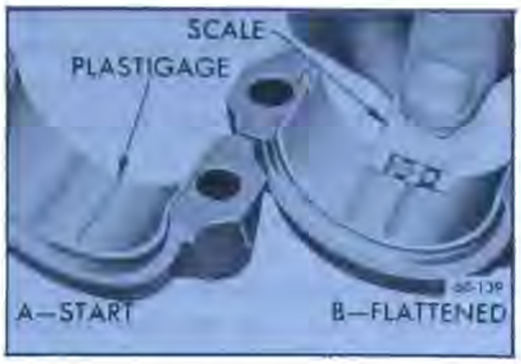


Figure 60-317—Checking Bearing Clearance with Plastigage

checked by use of Plastigage, Type PG-1 (green) or equivalent, which has a range of .001" to .003".

1. Remove connecting rod cap with bearing shell. Wipe oil from bearing and crankpin journal, also blow oil out of hole in crankshaft.

> **NOTE:** Plastigage is soluble in oil.

2. Place a piece of Plastigage lengthwise along the bottom center of the lower bearing shell (Figure 60-317, View A), then install cap with shell and tighten bolt nuts to 45 lb. ft. torque.

> **NOTE:** The rib on edge of cap and the conical boss on web of rod must be toward rear of engine on all rods in left bank or toward front of engine in right bank.

3. DO NOT TURN CRANKSHAFT with Plastigage in bearing.

4. Remove bearing cap with bearing shell, the flattened Plastigage will be found adhering to either the bearing shell or the crankpin. Do not remove it.

5. Using the scale printed on the Plastigage envelope, measure the flattened Plastigage at its widest point. The number within the graduation which most closely corresponds to the width of Plastigage indicates the bearing clearance in thousandths of an inch. See Figure 60-317, View B.

6. The desired clearance with a new bearing is .0002" to .0023". If bearing has been in service it is advisable to install a new bearing if the clearance exceeds .003"; however, if bearing is in good condition and is not being checked because of bearing noise, it is not necessary to replace the bearing.

7. If a new bearing is being selected, try a standard size, then each undersize bearing in turn until one is found that is within the specified limits when checked for clearance with Plastigage.

> **NOTE:** Each undersize bearing shell has a number stamped on outer surface on or near the tant to indicate amount of undersize. See Figure 60-318.

8. After the proper size bearing has been selected, clean off the Plastigage, oil the bearing thoroughly, reinstall cap with bearing shell and tighten bolt nuts to 45 lb. ft. torque. See NOTE in Step 2.

9. With selected bearing installed and bolts tightened, it should be possible to move connecting rod freely back and forth on crankpin as allowed by end clearance. If rod cannot be moved, either the bearing is too much undersize or a misaligned rod is indicated.

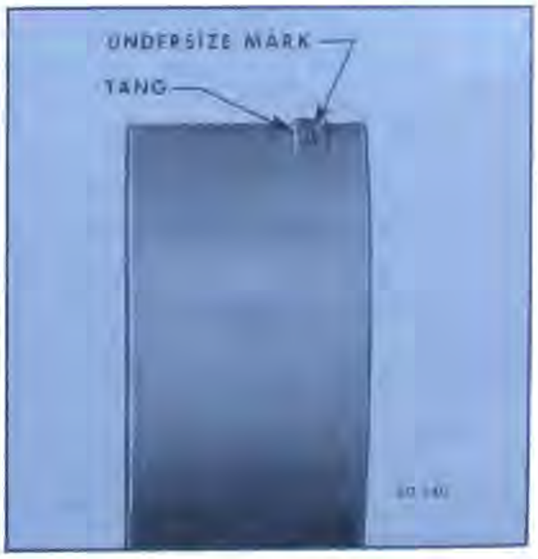


Figure 60-318—Location of Undersize Mark on Bearing Shell

61-3 CRANKSHAFT BEARINGS AND SEALS

a. Replacement of Crankshaft Bearings

A crankshaft bearing consists of two halves or shells which are not alike and not interchangeable in cap and crankcase. The upper (crankcase) half of the bearing is grooved to supply oil to the connecting rod bearings while the lower (bearing cap) half of the shell is not grooved. The two bearing halves must not be interchanged. All crankshaft bearings except the thrust bearing are identical. The thrust bearing is flanged to take end thrust. When the shells are placed in crankcase and bearing cap, the ends extend slightly beyond the parting surfaces so that when cap bolts are tightened the shells will be clamped tightly in place to insure positive seating and to prevent turning. The ends of shells must never be filed flush with parting surface of crankcase or bearing cap.

Crankshaft bearings are the precision type which do not require reaming to size or other fitting. Shims are not provided for adjustment since worn bearings are readily replaced with new bearings of proper size. Bearings for service replacement are furnished in standard size and undersizes. Under no circumstances should crankshaft bearing caps be filed to adjust for wear in old bearings.

After removal of oil pan, paragraph 62-1 and oil pump perform the following removal, inspection and installation operations on each crankshaft bearing in turn so that the crankshaft will be well supported by the other bearings.

NOTE: If crankshaft has been removed to check straightness the following procedure is suggested.

Rest crankshaft on "V-blocks" at No. 1 and No. 5 main bearing journals. Check indicator runout at No. 2, 3 and 4 main bearing journals. Total indicator readings at each journal should not exceed .003".

While checking runout at each journal note relation of "high" spot (or maximum eccentricity) on each journal to the others. "High" spot on all journals should come at the same angular location. If "high" spots do not come at nearly the same angular location, crankshaft has a "crook" or "dogleg" in it and is unsatisfactory for service.

1. Since any service condition which affect the crankshaft bearings may also affect the connecting rod bearings,, it is advisable to inspect connecting rod bearings first. If crankpins are worn to the extent that crankshaft should be replaced or reground, replacement of crankshaft bearings only will not be satisfactory.

NOTE: If replacement of cylinder block or crankshaft is required, always check main bearing clearance with plastigage to obtain specified limits.

2. Remove one bearing cap, then clean and inspect lower bearing shell and the crankshaft journal. If journal surface is scored or ridged, the crankshaft must be replaced or reground to insure satisfactory operation with new bearings. Slight roughness may be polished out with fine grit polishing cloth, thoroughly wetted with engine oil, and burrs may be honed off with a fine stone.

3. If condition of lower bearing shell and crankshaft journal is satisfactory, check the bearing clearance with Plastigage as described for connecting rod bearings in paragraph 61-2.

4. When checking a crankshaft bearing with Plastigage, turn crankshaft so that oil hole is up to avoid dripping of oil on Plastigage. Place paper shims in lower halves of adjacent bearings and tighten cap bolts to take the weight of crankshaft off the lower shell of bearing being checked.

NOTE: Arrow on cap must point to front of engine.

5. If bearing clearance exceeds .0036", it is advisable to install a new bearing; however, if bearing is in good condition and is not being checked because of bearing noise, it is not necessary to replace the bearing.

6. Loosen all crankshaft bearing cap bolts 1/2 turn, and remove cap of bearing to be replaced.

7. Remove upper bearing shell by inserting Bearing Shell Remover and Installer J-8080 in oil hole in crankshaft, then slowly turning crankshaft so that the tool rotates the shell out of place by pushing against the end without the tang. See Figure 60-320.

CAUTION: When turning crankshaft with rear bearing cap removed hold oil seal to prevent it from rotating out of position in crankcase.

8. The crankshaft journal cannot be measured with an outside micrometer when shaft is in place; however, when upper bearing shell is removed the journal may be checked for out-of-round by using a special crankshaft caliper and inside micrometer. The caliper should not be applied to journal in line with the oil hole.

If crankshaft journal is more than .0015" out-of-round, the crank-

Figure 60-320—Removing and Installing Crankshaft Bearing Upper Shell

shaft should be replaced since the full mileage cannot be expected from bearings used with an excessively out-of-round crankshaft.

9. Before installation of bearing shells make sure that crankshaft journal and the bearing seats in crankcase and cap are thoroughly cleaned.

10. Coat inside surface of upper bearing shell with engine oil and place shell against crankshaft journal so that tang on shell will engage notch in crankcase when shell is rotated into place.

11. Rotate bearing shell into place as far as possible by hand, then insert Installer J-8080 in crankshaft oil hole and rotate crankshaft to push shell into place.

> **CAUTION**: Bearing shell should move into place with very little pressure. If heavy pressure is required, shell was not started squarely and will be distorted if forced into place.

12. Place lower bearing shell in bearing cap, then check clearance with Plastigage as previously described.

13. The described clearance with a new bearing is .0007" to .0018". If this clearance cannot be obtained with a standard size bearing, insert an undersize bearing and check again with Plastigage.

> **NOTE**: Each undersize shell has a number stamped on outer surface on or near the tang to indicate amount of undersize.

14. When the proper size bearing has been selected, clean out all Plastigage, oil the lower shell and reinstall bearing cap. Tighten cap bolts to 110 lb. ft. The crankshaft should turn freely at flywheel rim; however, a very slight drag is permissible if an undersize bearing is used.

15. If a thrust bearing shell is disturbed or replaced it is necessary to line up the thrust surfaces of the bearing shell before the cap bolts are tightened. To do this, move the crankshaft fore and aft the limit of its travel several times with the thrust bearing cap bolts finger tight.

16. After bearing is installed and tested, loosen all bearing cap bolts 1/2 turn and continue with outer bearings. When bearings have been installed and tested, tighten all bearing cap bolts to 110 ft. lb. torque.

17. Refer to subparagraph b for replacement of rear bearing oil seal.

18. Install oil pan baffle, pipe and screen assembly and oil pan, following procedures outlined in paragraph 62-1c.

b. Installation of Rear Bearing Oil Seals

Braided fabric seals are pressed into grooves formed in crankcase and rear bearing cap to rear of the oil collecting groove, to seal against leakage of oil around the crankshaft.

The braided fabric seal can be installed in crankcase only when crankshaft is removed; however, the seal can be replaced in cap whenever cap is removed. Remove old seal and place new seal in groove with both ends projecting above parting surface of cap. Force seal into groove by rubbing down with hammer handle or smooth stick until seal projects above the groove not more than 1/16". Cut ends off flush with surface of cap, using sharp knife or razor blade. See Figure 60-321.

Figure 60-321—Rear Bearing Oil Seal

> **CAUTION**: The engine must be operated at slow speed when first started after new braided seal is installed.

61-4 PISTONS, RINGS, AND CONNECTING RODS

a. Replacement, Disassembly, and Inspection of Piston and Rod Assemblies

1. Remove cylinder heads (par. 61-1, c), and oil pan. (par. 62-1).

2. Examine the cylinder bores above the ring travel. If bores are worn so that a shoulder or ridge exists at this point, remove ridges with a ridge reamer to avoid damaging rings or cracking ring lands in pistons during removal. See Figure 60-322.

3. Use a silver pencil or quick drying paint to mark the cylinder number on all pistons, connecting rods and caps. Starting at front end of crankcase, the cylinders in left hand bank are numbered 1, 3, 5, 7 and in right bank are numbered 2, 4, 6, 8.

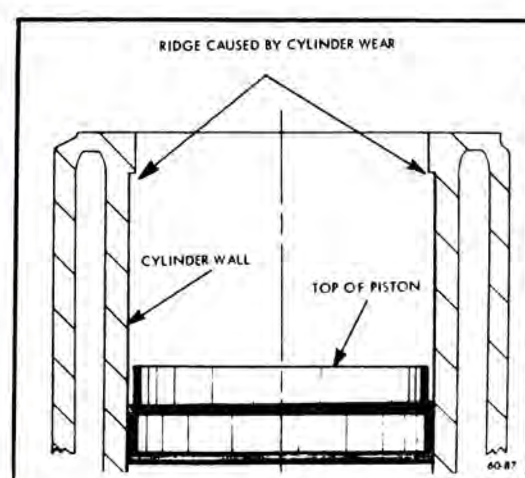


Figure 60-322—Ridge Formed by Rings At Top of Travel

Figure 60-323—Connecting Rod Bolt Guides Installed

4. With No. 1 crankpin straight down, remove the cap with bearing shell from No. 1 connecting rod, then install the short Connecting Rod Bolt Guide J-5239-1 on the lower connecting rod bolt, and install the long Guide J-5239-2 on the opposite bolt, above crankpin. Turn guides down to hold the bearing upper shell in place. See Figure 60-323.

5. Use the long guide to push the piston and rod assembly out of the cylinder, then remove guides and reinstall cap with bearing shell on rod.

6. Remove all other piston and rod assemblies in the same manner.

7. Remove compression rings. Then remove oil ring by removing the two rails, spacer, and expander which are separate pieces in each piston third groove. See Figure 60-331.

8. Place piston and rod assembly in press. Using Piston Support J-6047-17 (with full radial face up) under the piston, place Drive Pin J-6047-4 in upper end of piston pin and press pin from rod and piston. Guide Pin J-6047-16 is not used during pin removal.

9a. Inspect cylinder walls for scoring, roughness, or ridges which indicate excessive wear. Check cylinder bores for taper and out-of-round with an accurate cylinder gage at top, middle, and bottom of bore, both parallel and at right angles to centerline of engine. The diameter of cylinder bore at any point may be measured with an inside micrometer, or Telescope Gage and measuring across the gage contact points with outiside micrometer.

b. If a cylinder bore is moderately rough or slightly scored but is not out-of-round or tapered, it usually is possible to remedy the condition by honing the bore to fit a standard service piston, since standard service pistons are of high limit diameters. If cylinder bore is very rough or deeply scored, however, it may be necessary to rebore the cylinder and fit an oversize piston in order to insure satisfactory results.

c. If cylinder bore is tapered .005" or more, or is out-of-round .003" or more, it is advisable to rebore for the smallest possible oversize pistons and rings.

10. Clean carbon from piston surfaces and under side of piston heads. Clean carbon from ring grooves with suitable tool and remove any gum or varnish from piston skirts with suitable solvent.

11. Carefully examine pistons for rough or scored bearing surfaces, cracks in skirt or head, cracked or broken ring lands, chipping or uneven wear which would cause ring to seat improperly or have excessive clearance in ring grooves. Damaged or faulty pistons should be replaced.

The pistons are cam ground, which means that the diameter at a right angle to piston pin is greater than the diameter parallel to piston pin. When a piston is checked for size it must be measured with a micrometer applied to skirt at points exactly 90 degrees to piston pin. See Figure 60-324. Measurements should be made at top and bottom ends of skirt; the diameter at top end will normally be very slightly less than at bottom end after a piston has been in service in an engine.

12. Inspect bearing surfaces of piston pins and check for wear by measuring worn and unworn surfaces with micrometers. Rough or worn pins should be replaced. Test fit of piston pins in piston bosses. Sometimes pins will be found tight due to gum or varnish deposits. This may be corrected by removing the deposit with a suitable solvent.

If piston bosses are worn out of round or oversize, the piston and pin assembly must be replaced. Oversize pins are not practical with the pressed pin and rod assemblies. Piston pins must fit pistons with an easy finger push fit at 70°F (.0004"-.0001").

Examine all piston rings for scores, chips, or cracks, and for tension as compared with new rings. Place all compression rings in cylinder bores at lower end of ring travel and check gaps, which are normally .010" to .020". If gaps are excessive it indicates that rings have worn considerably and should be replaced.

b. Reboring Cylinders and Fitting New Pistons

If one or more cylinder bores are rough, scored, or worn beyond limits prescribed under Inspection of cylinder bores

Figure 60-324—Measuring Piston with Micrometer

(subpar. a), it will be necessary to smooth or true up such bores to fit new pistons.

If relatively few bores require correction it will not be necessary to rebore all cylinders to the same oversize in order to maintain engine balance, since all over-size service pistons are held to the same weights as standard size pistons. If conditions justify replacement of all pistons, however, all new pistons should be the same nominal size.

Standard size service pistons are high limit or maximum diameter; therefore, they can usually be used with a slight amount of honing to correct slight scoring or excessive clearances in engines having relatively low mileage. All service pistons are diamond bored and selectively fitted with pistons pins; pistons are not furnished without pins.

<u>No attempt should be made to cut down oversize pistons to fit cylinder bores as this will destroy the surface treatment and affect the weight.</u> The smallest possible oversize service pistons should be used and the cylinder bores should be honed to size for proper clearances.

Before the honing or reboring operation is started, measure all new pistons with micrometer contacting at points exactly 90 degrees to piston pin (Figure 60-324) then select the smallest piston for the first fitting. The slight variation usually found between pistons in a set may provide for correction in case the first piston is fitted too free.

If wear at top of cylinder does not exceed .005" on the diameter or exceed .003" out-of-round, honing is recommended for truing the bore. If wear or out-of-round exceeds these limits, the bore should be trued up with a boring bar of the fly cutter type, then finish honed.

When reboring cylinders, all crankshaft bearing caps must be in place and tightened to proper torque to avoid distortion of bores in final assembly. Always be sure the crankshaft is out of the way of the boring cutter when boring each cylinder. When taking the final cut with boring bar leave .001" on the diameter for finish honing to give the required clearance specified below.

When honing cylinders use clean sharp stones of proper grade for the amount of metal to be removed, in accordance with instructions of the hone manufacturere. Dull or dirty stones cut unevenly and generate excessive heat. When using coarse or medium grade stones use care to leave sufficient metal so that all stone marks may be removed with the fine stones used for finishing to provide proper clearance.

When finish honing, pass the hone through the entire length of cylinder at the rate of approximately 60 cycles per minute. This should produce the desired 45 degree cross hatch pattern on cylinder walls which will insure maximum ring life and minimum oil consumption.

It is of the greatest importance that refinished cylinder bores are trued up to have not over .0005" out-of-round or taper. Each bore must be final honed to remove all stone or cutter marks and provide a smooth surface. During final honing, each piston must be fitted individually to the bore in which it will be installed and should be marked to insure correct installation.

After final honing and before the piston is checked for fit, each cylinder bore must be thoroughly washed to remove all traces of abrasive and then dried thoroughly. The dry bore should then be brushed clean with a power-driven fibre brush. If all traces of abrasive are not removed, rapid wear of new pistons and rings will result.

Pistons must be fitted with the use of accurate micrometers capable of reading to one ten thousandths of an inch.

A satisfactory method of fitting pistons is as follows:

1. Expand a telescope gage to fit the cylinder bore at right angles to the piston pin and between 1-1/2" and 2" from the top of the bore. See Figure 60-325.

2. Measure the telescope gage. See Figure 60-326.

3. Measure the piston to be installed. See Figure 60-324. The piston must be measured at right angles to the piston pin below the oil ring groove.

4. The tolerance of piston clearance is .0007" to .0013".

> **NOTE:** Both block and piston must be at very nearly the same temperature when measurements are taken or errors due to expansion will occur. A difference of 10°F between parts is sufficient to produce a variation of .0005".

c. Fitting New Piston Rings

When new piston rings are installed without reboring cylinders, the glazed cylinder walls should be slightly dulled, but without increasing the bore diameter, by means of the finest grade of stones in a cylinder hone.

Figure 60-325—Using Telescope Gage in Cylinder Bore

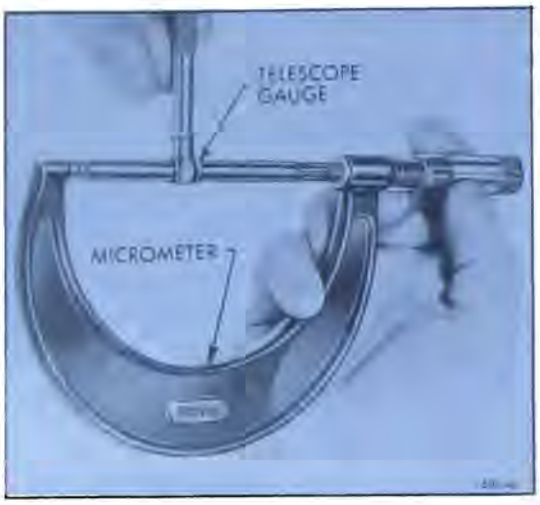


Figure 60-326—Measuring Telescope Gage

New piston rings must be checked for clearance in piston grooves and for gap in cylinder bores; however, the flexible oil rings are not checked for gap. The cylinder bores and piston grooves must be clean, dry and free of carbon and burrs.

With rings installed, check clearance in grooves by inserting feeler gages between each ring and its lower land because any wear that occurs forms a step at inner portion of the lower land. If the piston grooves have worn to the extent that relatively high steps exist on the lower lands, the piston should be replaced because the steps will interfere with the operation of new rings and the ring clearances will be excessive. Pistons rings are not furnished in oversize widths to compensate for ring groove wear.

When fitting new rings to new pistons the side clearance of the compression rings should be .003" to .005" and side clearance of the oil ring should be .0035" to .0095".

To check the gap of compression rings, place the ring in the cylinder in which it will be used, square it in the bore by tapping with the lower end of a piston, then measure the gap with feeler gages. Piston rings should not have less than .013" gap (compression rings) and .015" (oil ring) when placed in cylinder bores. If gap is less then specified, file the ends of rings carefully with a smooth file to obtain proper gap.

d. Assembly and Installation of Piston and Connecting Rod Assemblies

NOTE: Connecting rods may be sprung out of alignment in shipping or handling; therefore, they must be checked before pistons and pins are installed.

Check bend and twist on an accurate rod aligning fixture using Guide Pin J-6047-16 (from wrist pin press) in place of wrist pin. Press V-block firmly and evenly against guide pin to prevent cocking pin in eye of rod which may be up to .0015" larger diameter than pin.

1. To assemble piston, pin, and rod, first place Piston Pin Spacer J-6047-21 and Piston Support J-6047-18 in base plate of press. Use the piston support with the full radial face upward.

2. If the piston and rod assembly is to be installed in the left bank, the assembly must be made as shown in Figure 60-327.

3. If the piston and rod assembly is to be installed in the right bank, the assembly must be made as shown in Figure 60-328.

4. Lubricate piston pin to avoid damage when pressing through connecting rod.

5. Place small end of Drive Pin J-6047-4 in hole in upper (protruding) end of piston pin and position the assembly in the press.

6. Make certain that all units are in alignment, then apply pressure and force pin through rod until Guide Pin J-6047-18 stops downward travel.

7. Release pressure and remove piston and rod assembly from press. Rotate piston on pin to check on fit between piston and pin.

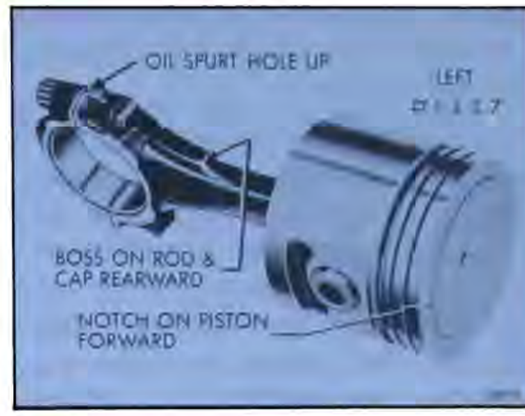


Figure 60-327—Left Bank Piston and Rod Assembly

8. Install piston rings as shown in Figure 60-330.

a. Top compression ring. When installed the manufacture's identification mark ("O", "DOT" or "TOP") is facing up.

b. Second compression ring-When installed the manufacture's identification mark ("O", "DOT" or "TOP") is facing up.

c. Oil ring - can be installed with either rail facing up.

d. Ring gaps - all three ring gaps must be 90° apart. See Figure 60-330.

NOTE: To make certain expander ring does not overlap a red and blue mark will be visible on ring. See Figure 60-331.

NOTE: The rails and spacer of the oil ring are lightly held together with an oil soluble cement. If parts have separated

Figure 60-328—Right Bank Piston and Rod Assembly

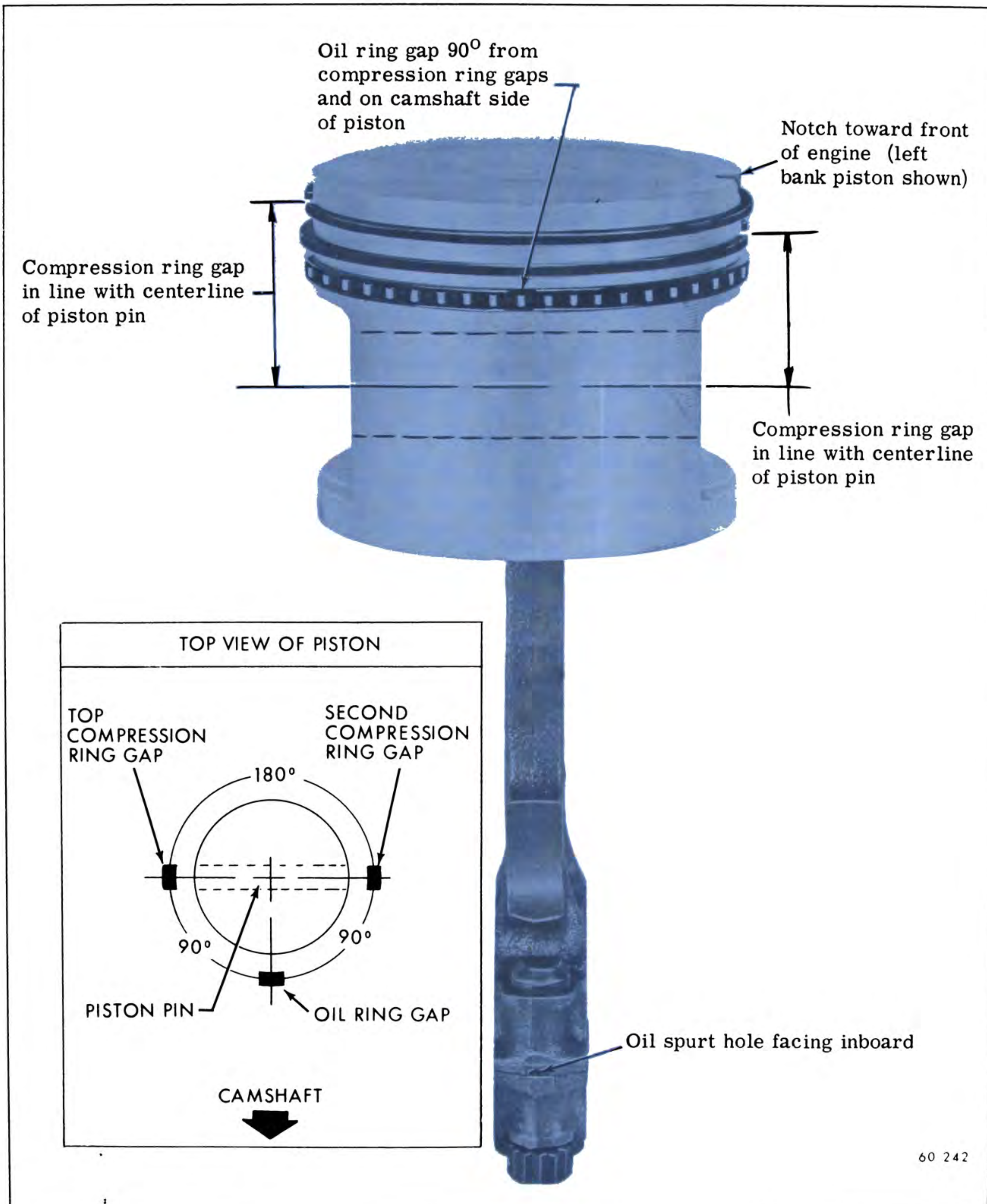


Figure 60-330—Piston Ring Gap Positioning

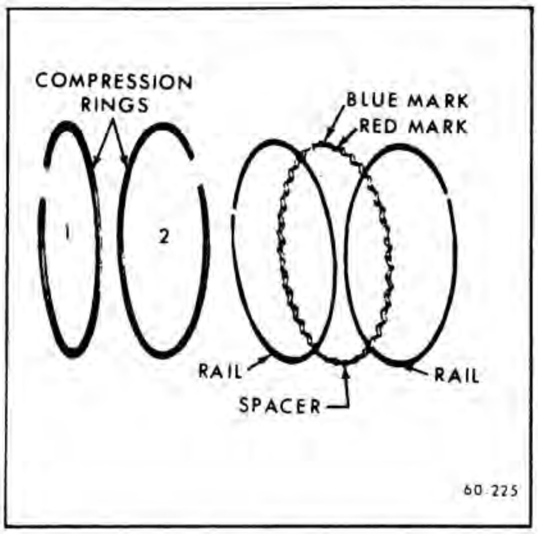


Figure 60-331—Piston Rings

they may be installed as individual pieces.

9. Make sure that cylinder bores, pistons, connecting rod bearings and crankshaft journals are absolutely clean, then coat all bearing surfaces with engine oil.

10. Before installation of a piston and rod assembly in its cylinder bore, turn crankshaft to place the crankpin straight down.

11. Remove cap, and with bearing upper shell seated in connecting rod, install the long Guide J-5239-2 on bolt which is on same side of rod as the oil spurt notch in the bearing parting surface. Install short Guide J-5239-1 on the other connecting rod bolt.

These guides hold the upper bearing shell in place and protect the crankpin journal from damage during installation of connecting rod and piston assembly.

12. Make sure the gap in the oil ring rails is "up" toward center of engine and the gaps of the compression rings are positioned as shown in Figure 60-330.

13. Lubricate the piston and rings and install in bore by compressing the rings either with a "wrap around" compressor or a split ring type such as shown in Figure 60-332.

14. Insert piston and rod assembly into its cylinder bore with the long guide pin placed above the crankpin. Push the assembly down until the rod bearing seats on crankpin.

Figure 60-332—Installing Piston with Compressor Installed

15. Select new connecting rod bearing, if necessary, as described in paragraph 61-3. Otherwise, install cap with bearing lower shell on rod and tighten bolt nuts to 45 lb. ft. torque.

16. Install all other piston and rod assemblies in the same manner.

17. Check end clearance between connecting rods on each crankpin using feeler gages. Clearance should be .005"-.012".

18. Install cylinder heads (par. 61-1,d) oil pump and oil pan (par. 62-1).

IMPORTANT: After installation of new pistons and rings, care should be used in starting the engine and in running it for the first hour. Avoid high speeds until the parts have had a reasonable amount of break-in so that scuffing will not occur.

61-5 CAMSHAFT AND TIMING CHAIN

a. Timing Chain Cover Removal

1. Drain radiator and block.

2. Disconnect upper radiator hose and heater return hose at water pump, disconnect lower bolts and brackets and remove radiator core.

3. Remove fan, fan pulleys and belt(s).

4. Remove fan driving pulley (crankshaft) and pulley reinforcement.

5. Disconnect fuel lines and remove fuel pump.

6. Remove distributor cap, coil and pull spark plug wire retainers off rocker arm cover. Swing distributor cap with wires attached out of the way. Disconnect distrubtor primary lead.

7. Remove distributor. If timing chain and sprockets are not going to be disturbed, note position of distributor rotor for reinstallation in same position.

8. Loosen and slide front clamp on thermostat by-pass hose rearward.

9. Remove crankshaft pulley bolt and washer. Remove harmonic balancer.

10. Remove bolts attaching timing chain cover to cylinder block. Remove four oil pan to timing chain cover bolts. Do not remove five bolts attaching water pump to timing chain cover. Remove timing chain cover assembly using extreme care to avoid damaging lower crankcase (oil pan) gasket. Thoroughly clean the cover, taking care to avoid damage to the gasket surfaces.

b. Timing Chain Cover Replacement

Reinstall timing chain cover by reversing removal procedure, paying particular attention to the following points.

1. Remove oil pump cover and pack the space around the oil pump gears completely full of petroleum jelly. There must be no air space left inside the pump. Reinstall cover using new gasket. This step is very important as the oil pump may "lose its prime" whenever the pump, pump cover or timing chain cover is disturbed. If the pump is not packed,

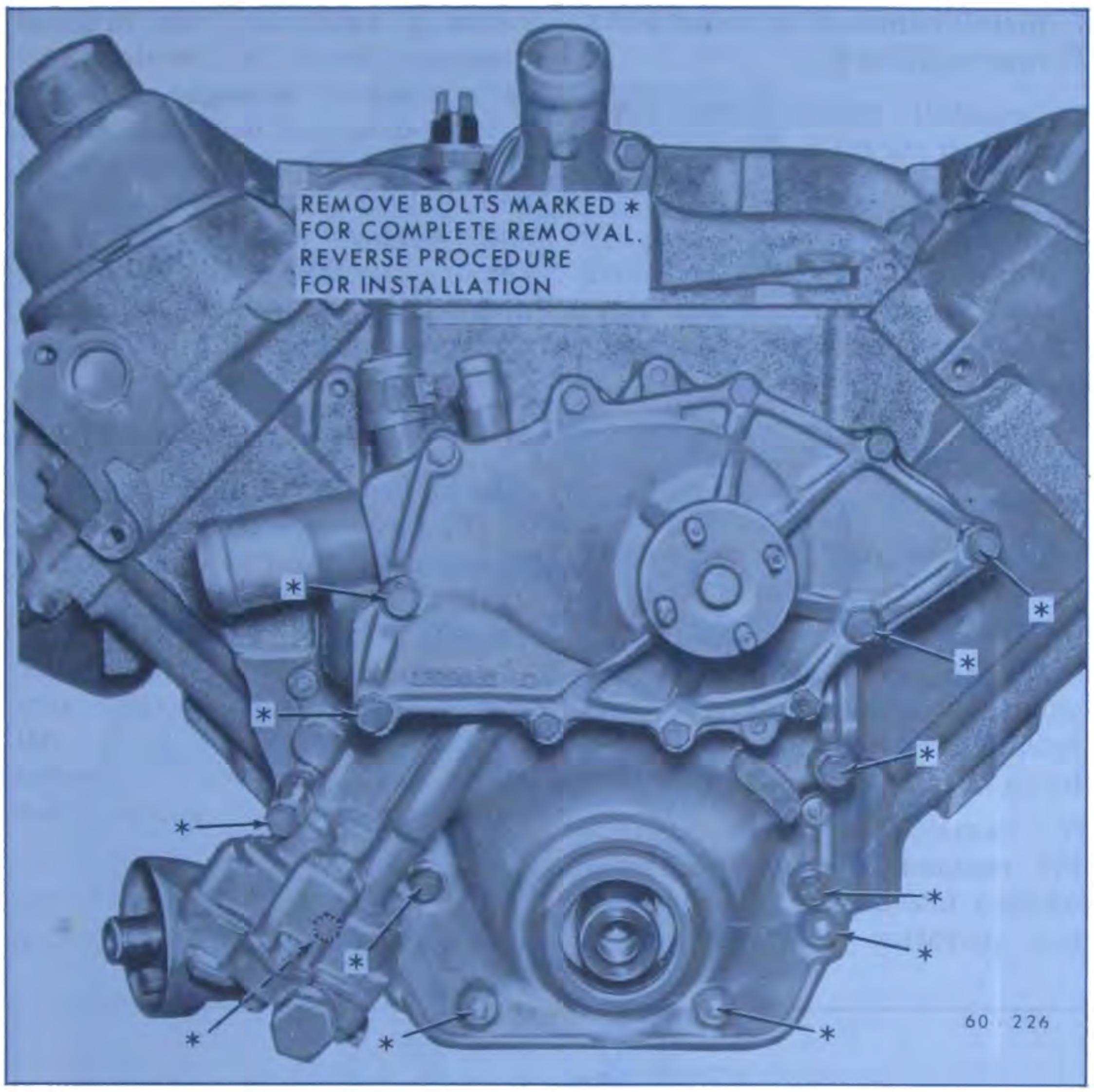


Figure 60-333—Timing Chain Cover Installation

it may not begin to pump oil as soon as the engine is started.

2. The gasket surface of the block and timing chain cover must be smooth and clean. Use a new gasket and be certain it is positioned correctly.

3. Position timing chain cover against block and be certain dowel pins engage dowel pin holes before starting bolts.

4. Lubricate the bolt threads before installation and install as shown in Figure 60-333. Torque bolts to 30 lb. ft.

5. Install harmonic balancer, bolt and washer and torque to 200 lb. ft minimum.

c. Crankshaft Oil Seal Replacement

1. With timing chain cover on bench, remove the braided fabric packing with a screwdriver and then tap the pressed steel shedder out of the cover.

2. Work new packing into the shedder, then drive shedder into recess in timing chain cover, using Installer J-5250-1. See Figire 60-334, View A.

3. Push Packing Expander J-5250-2 through the seal to expand the packing into place and size the opening for the crankshaft. See Figure 60-334, View B. Apply a light coat of vaseline to the packing.

d. Timing Chain and Sprocket Removal

1. With timing chain cover removed (subpar. a above) temporarily install crankshaft pulley bolt and washer in end of crankshaft. Turn crankshaft so sprockets are positioned as shown in Figure 60-335. Remove crankshaft pulley bolt and washer using a sharp blow on the wrench handle, so that the bolt can be started out without changing position of sprockets.

2. Remove oil pan per paragraph 62-1c.

3. Remove front crankshaft oil slinger.

4. Remove camshaft sprocket bolts.

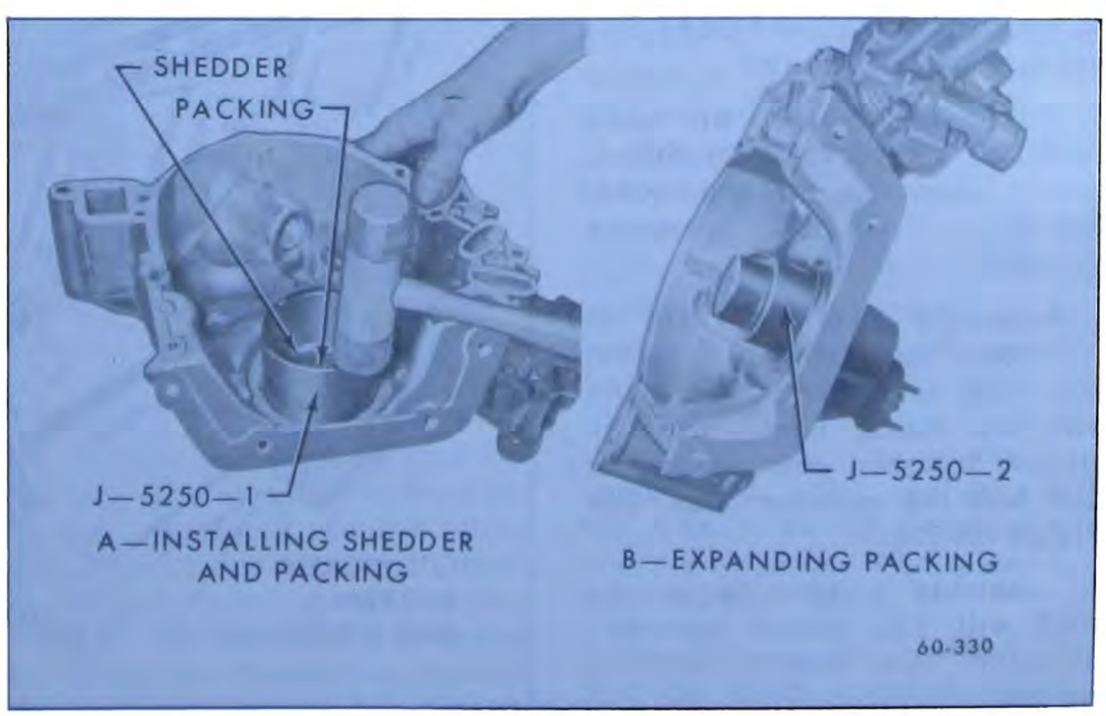


Figure 60-334—Installing Crankshaft Oil Seal

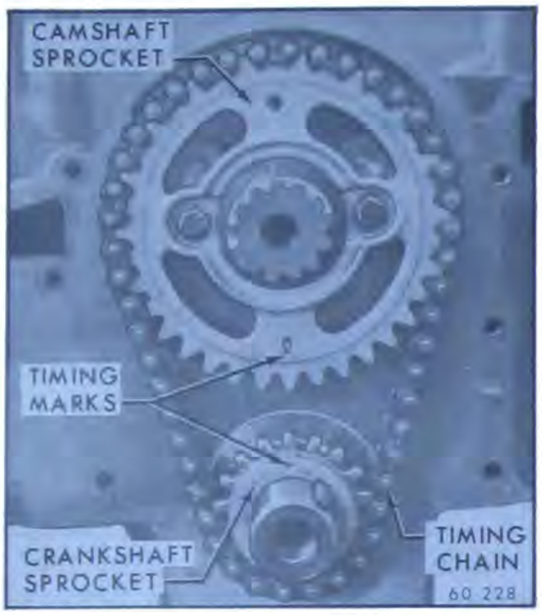


Figure 60-335—Installation of Timing Chain and Sprocket

5. Use two large screwdrivers to alternately pry the camshaft sprocket then the crankshaft sprocket forward until the camshaft sprocket is free, then remove the camshaft sprocket and chain and finish working crankshaft sprocket off crankshaft.

6. Thoroughly clean the timing chain, sprockets, distributor drive gear, fuel pump eccentric and crankshaft oil slinger.

e. Timing Chain and Sprocket Installation

1. Turn crankshaft so that #1 piston is at top dead center.

2. Turn camshaft so with sprocket temporarily installed, timing mark is straight down. See Figure 60-335. Remove sprocket.

3. Assemble timing chain on sprockets and slide the sprocket and chain assembly on the shafts with the timing marks in their closest together position and in line with the sprocket hubs. See Figure 60-335.

4. Assemble slinger on crankshaft with I.D. against sprocket. (Concave side toward front of engine).

5. Reinstall oil pan.

6. Install camshaft sprocket bolts. Torque to 22 lb ft.

7. Reinstall timing chain cover (subpar. b above).

f. Camshaft Service

1. Remove rocker arm and shaft assemblies, push rods and valve lifters as outlined in paragraph 61-1.

2. Remove timing chain cover, timing chain and sprocket, subparagraph d above.

3. Slide camshaft forward out of bearing bores carefully to avoid marring the bearing surfaces.

4. Replace camshaft by reversing removal procedure, taking particular care to avoid damage to the camshaft bearings.

The camshaft bearings must be line reamed to size after being pressed into the crankcase. Since this operation requires special reaming equipment the original bearings should be retained unless severely damaged. Slightly scored camshaft bearings will be satisfactory if the surfaces of camshaft journals are polished and bearings are cleaned up to remove burrs, and the fit of shaft in bearings is free and within the clearance limits of .0015" to .004".

62-1 LUBRICATION SYSTEM AND OIL PUMP

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to crankshaft, connecting rods, and camshaft bearings, and is supplied under controlled volume to the valve lifters, rocker arm bearings, and push rods. All other moving parts are lubricated by gravity flow or splash. See Figure 60-336.

The supply of oil is carried in the lower crankcase (oil pan) which

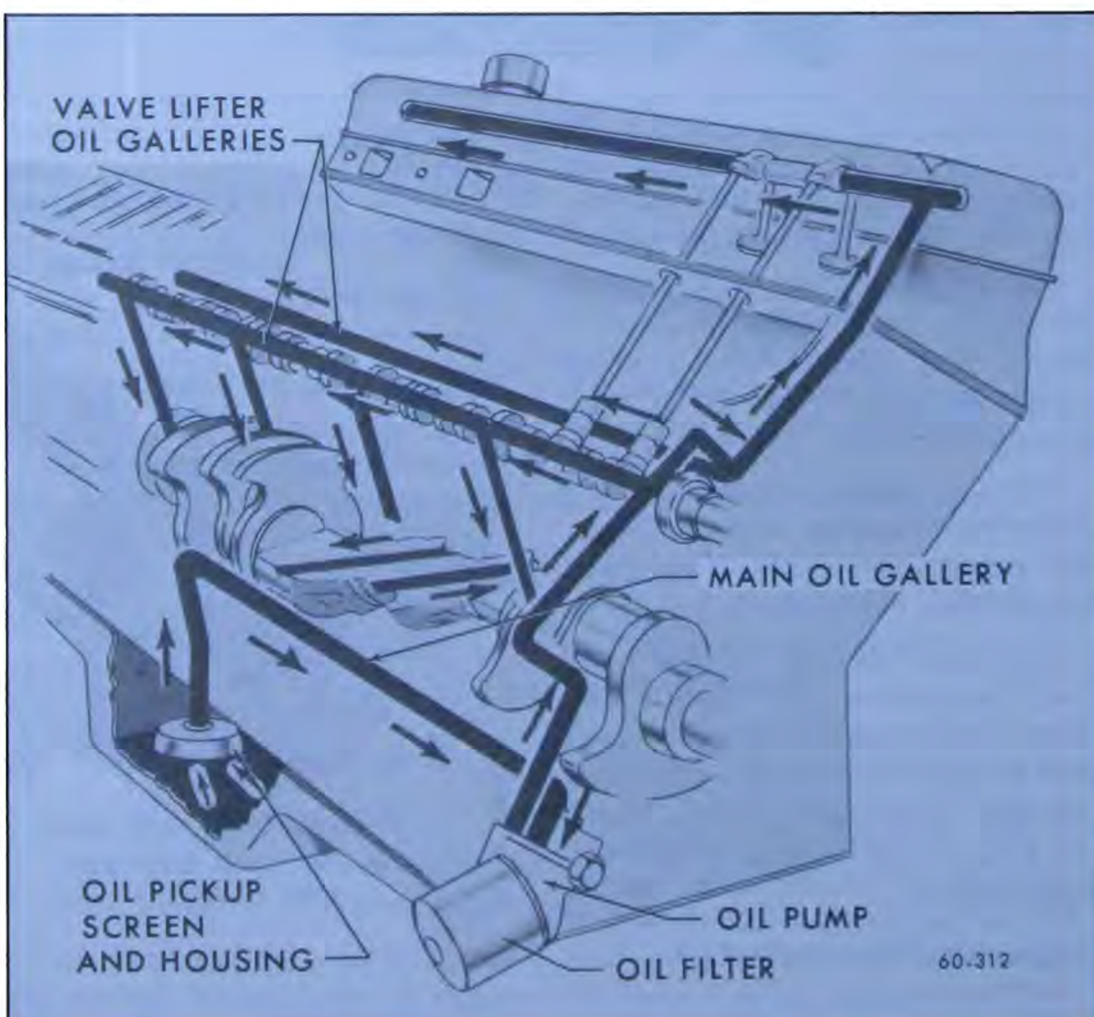


Figure 60-336—Schematic Diagram of Engine Oil Flow

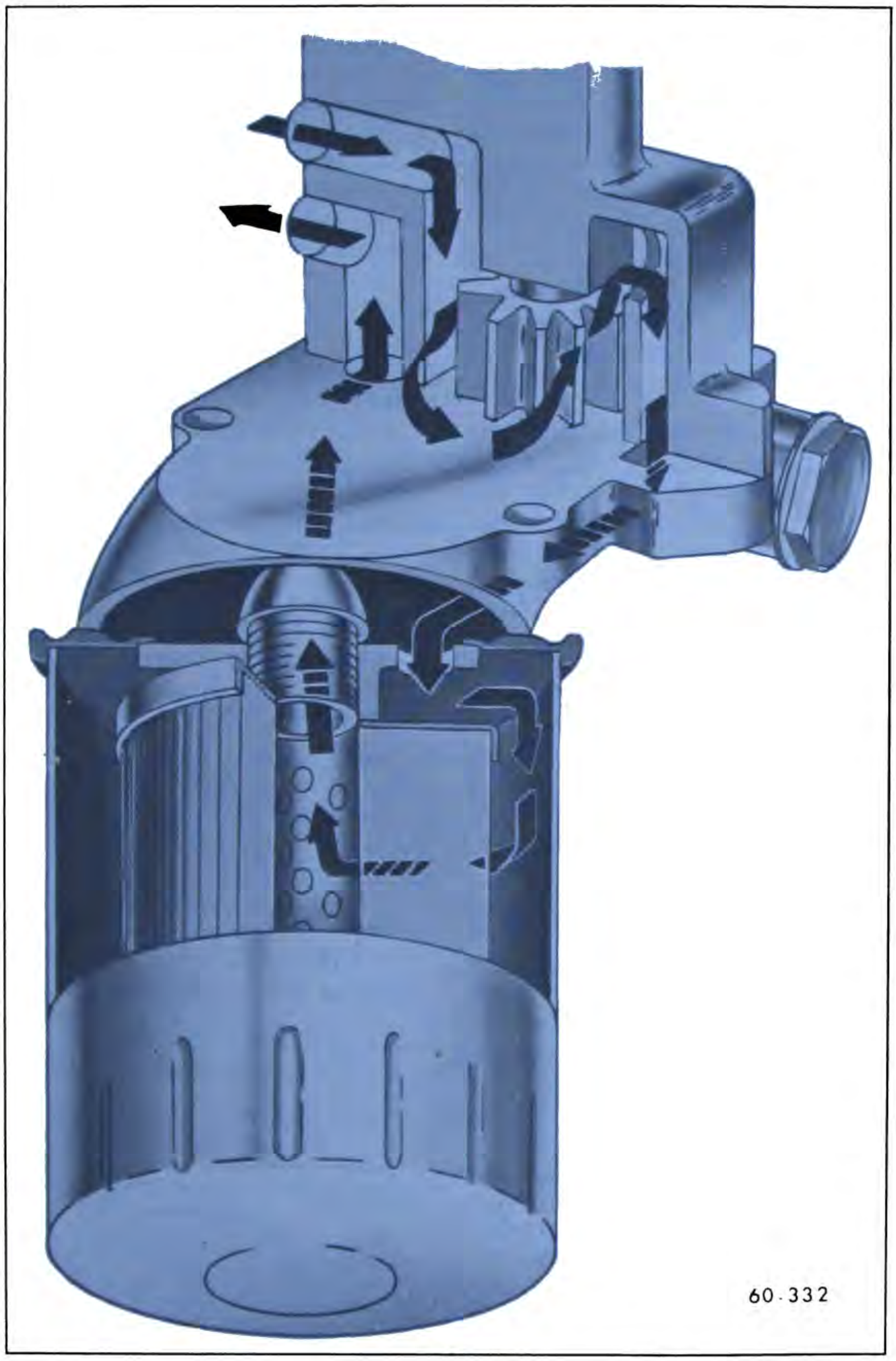


Figure 60-337—Oil Pump and Filter Assembly

is filled through a filler opening in the left rocker arm cover. A removable oil gage rod on the left side of the crankcase is provided to check oil level.

The oil pump is located in the timing chain cover where it is connected by a drilled passage in the cylinder crankcase to an oil screen housing and pipe assembly. The screen is submerged in the oil supply and has ample area for all operating conditions. If the screen should become clogged for any reason, oil may be drawn into the system through the relief valve in the screen.

Oil is drawn into the pump through the screen and pipe assembly and a drilled passage in the crankcase which connects to drilled passages in the timing chain cover. All oil is discharged from the pump to the oil pump cover assembly. The cover assembly consists of an oil pressure relief valve, an oil filter by-pass valve and a nipple for installation of an oil filter. The spring loaded oil pressure relief valve limits the oil pressure to approximate 40 pounds per square inch. The oil filter by-pass valve opens when the filter has become clogged to the extent that approximate 15 pounds pressure difference exists between the filter inlet and discharge to by-pass the oil filter and channel unfiltered oil directly to the main oil galleries of the engine.

An AC full flow oil filter is externally mounted to the oil filter cover nipple on the lower right front side of the engine. Normally, all engine oil passes through the filter element, however, if the element becomes restricted, a spring loaded by-pass valve opens as mentioned above.

The main oil galleries run the full length of the crankcase and cut into the valve lifter guide holes to supply oil at full pressure to the lifters. Connecting passages drilled in the crankcase permit delivery of oil at full pressure to all crankshaft and camshaft bearings.

Holes drilled in the crankshaft carry oil from the crankshaft bearings to the connecting rod bearings. Pistons and cylinder walls are lubricated by oil forced through a small notch in the bearing parting surface on the connecting rod, which registers with the hole in the crankpin once in every revolution. Piston pins are lubricated by splash.

Drilled holes in the camshaft connect the front cmashaft bearing journal to the front of the camshaft. Oil flows from the journal

Figure 60-338—Front End Lubrication

through a passage to an outlet between the crankshaft sprocket and distributor gear.

The oil stream strikes the distributor gear and provided ample lubrication of the timing chain and sprockets by splash.

The rocker arms and valves on each cylinder head are supplied with oil from oil galleries through holes drilled in the front of the cylinder head and cylinder block.

Oversize bolt holes in the rocker arm shaft pedestals allow the oil to flow up inside the pedestals to the hollow rocker arm shaft which is plugged at both ends. Each rocker arm receives oil through a hole in the underside of the shaft.

Grooves in the rocker arm provide lubrication of the bearing surface. Oil is metered to the push rod seat and valve stem through holes drilled in the rocker arm. Excess oil drains off and returns to the oil pan through passages in the cylinder head and block.

a. Removal and Inspection of Oil Pump Cover and Gears

1. Remove oil filter.

2. Remove screws attaching oil pump cover assembly to timing chain cover. Remove cover assembly and slide out oil pump gears.

3. Wash off gears and inspect for wear, scoring, etc. Replace any gears not found serviceable.

4. Remove the oil pressure relief valve cap, spring and valve. See figure 60-341. Oil filter by-pass valve and spring are staked in place and should not be removed.

5. Wash the parts thoroughly and inspect the relief valve for wear or scoring. Check the relief valve spring to see that it is not worn on its side or collapsed. Replace any relief valve spring that is questionable. Thoroughly clean the screen staked in the cover.

6. Check the relief valve in its bore in the cover. The valve should have no more clearance than an easy slip fit. If any perceptible side shake can be felt the valve and/or cover should be replaced.

7. Check filter by-pass valve for cracks, nicks, or warping. The valve should be flat and free of nicks or scratches.

b. Oil Pump Assembly and Installation

1. Lubricate and install pressure relief valve and spring in bore of oil pump cover. See Figure 60-341. Install cap and gasket. Torque cap to 35 lb. ft. with a reliable torque wrench. Do not over-tighten.

2. Install oil pump gears and shaft in oil pump body section of timing chain cover to check gear end clearance.

3. Place a straight edge over the gears and measure the clearance between the straight edge and the gasket surface. See Figure 60-343. Clearance should be between .0023" and .0058". If clearance is less than .0018" check timing chain cover gear pocket for evidence of wear.

4. If gear end clearance is satisfactory, remove gears and pack gear pocket <u>full</u> of petroleum jelly. <u>Do not use chassis lube!</u>

5. Reinstall gears so petroleum jelly is forced into every cavity of the gear pocket and between the teeth of the gears. Place new gasket in position.

NOTE: This step is very important. Unless the pump is packed with petroleum jelly it

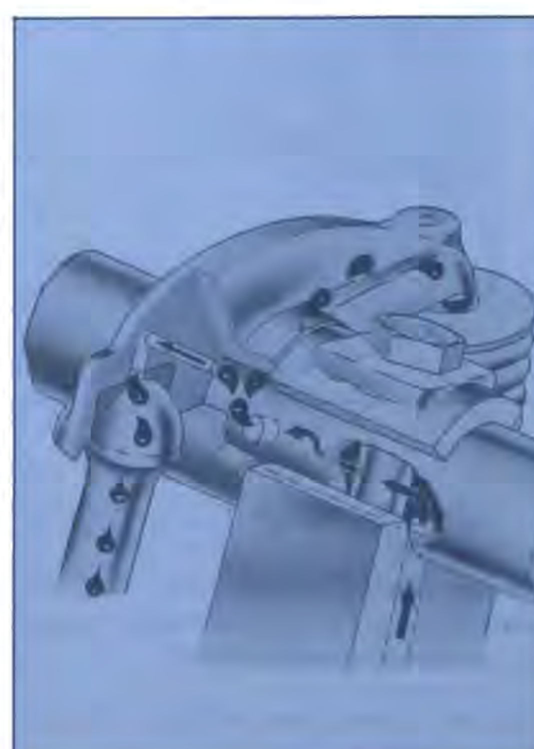


Figure 60-340—Overhead Lubrication

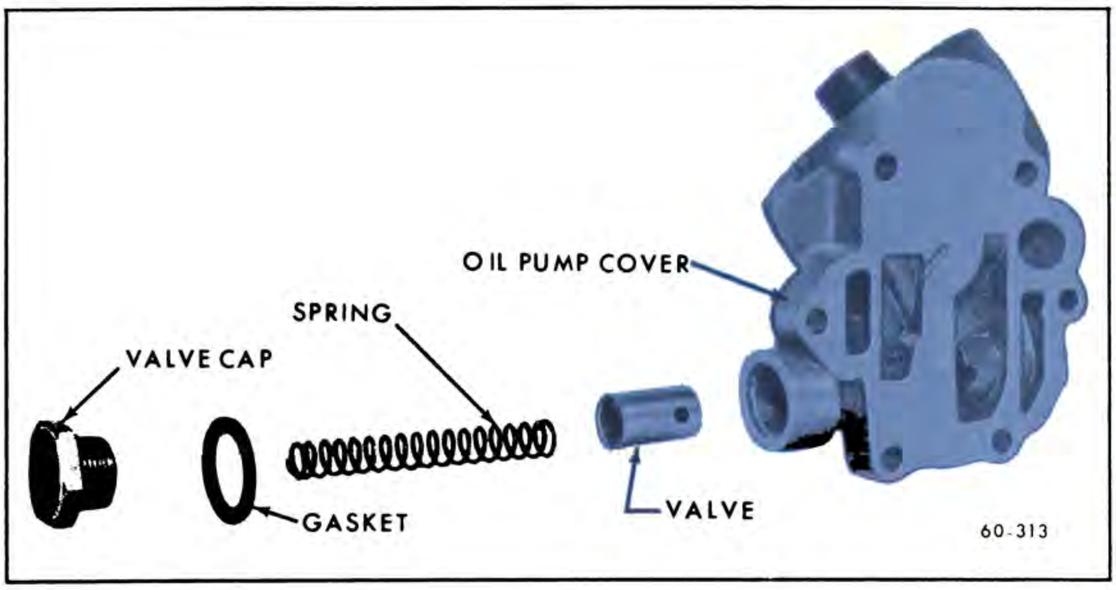


Figure 60-341—Oil Pump Cover and By-Pass Valve

may not prime itself when the engine is started.

6. Install cover assembly screws. Tighten alternately and evenly. The torque specification is 10 lb. ft.

7. Install filter on nipple.

c. Oil Pan Removal

1. Disconnect battery.

2. Raise car and support on stands.

3. Drain oil.

4. If manual equipped:

a. Loosen clutch equalizer bracket to frame attaching bolts.

b. Remove exhaust crossover pipe.

c. Remove front engine mounting bolts.

d. Remove fan shroud to radiator tie bar screws.

5. If automatic equipped:

a. Remove lower flywheel housing.

b. Remove shift linkage attaching bolt and swing out of way.

c. Remove front engine mounting bolts.

d. Remove fan shroud to radiator tie bar screws.

6. Raise engine by placing jack under crankshaft pulley mounting.

7. Remove oil pan bolts and remove pan.

8. Clean oil pan. Make sure the gasket surfaces on pan and block are clean.

d. Oil Pan Installation

1. Install rear seal.

2. Apply non-hardening Permatex to a few spots on a new pan gasket (cork) and install on block. Make sure seal and gasket are properly fitted. See Figure 60-344.

3. Install oil pan. Torque bolts to 14 lb. ft. Do not overtighten.

4. Reverse procedures in subparagraph c.

e. Removal and Inspection of Oil Pump Pipe and Screen Assembly

1. Remove oil pan (subpar. c).

2. Remove oil pump pipe and screen assembly to cylinder block bolts.

3. Clean the screen and housing thoroughly in solvent and blow dry with air stream.

Figure 60-342—Installation of Pipe and Screen Assembly

f. Installation of Oil Pump and Screen Assembly

Install by reversing removal procedure, paying particular attention to the following points.

1. Make sure oil pump pipe flange gasket surface of block is smooth and free of dirt.

2. Use a new gasket and tighten bolts to 8 lb. ft. torque.

3. Install oil pan (subpar. d).

Figure 60-343—Checking Oil Pump End Clearance

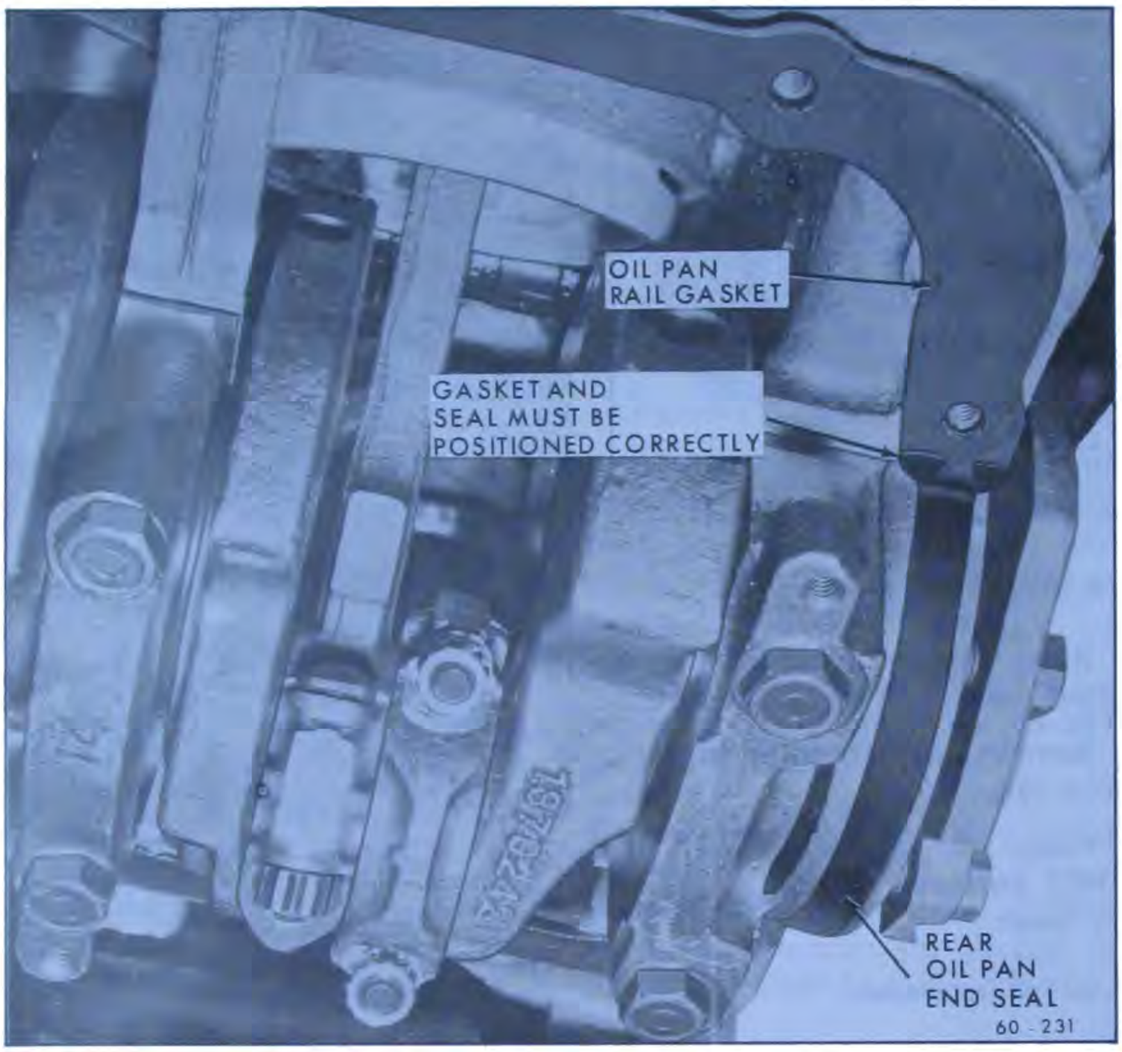


Figure 60-344—Oil Pan Gasket and Seal Installation

63-1 COOLING SYSTEM AND WATER PUMP

The engine cooling system is the pressure type, with thermostatic coolant temperature control and water pump circulation.

A double contact temperature sensitive switch (430 cu. in.) is located in the intake manifold. The switch closes one set of contacts to light a green signal on the instrument panel when engine water temperature is below 110°F. If engine water temperature is between 110° and 246° (approximately) neither contact is closed. Engine water temperature above 246° causes the second set of contacts to close and light a red signal on the instrument panel.

A Harrison tube and center type of radiator core of brass and copper is used on all models. The outlet radiator tank houses the transmission oil cooler.

All engines without air conditioning are equipped with an 18" fan. Air conditioned and heavy duty cooling cars are equipped with an 18" fan (400 cu. in.) 20" fan (430 cu. in.) driven by a torque and temperature sensitive clutch. See Figure 60-345.

The torque sensitive fan clutch is equipped with a temperature sensitive coil which controls the flow of silicone through the clutch.

During periods of operation when radiator discharge air temperature is low, the fan clutch limits the fan speed to a maximum speed of 1200 RPM.

Operating conditions that produce high radiator discharge air temperatures cause the temperature sensitive coil to turn a shaft

Figure 60-345—Fan Clutch

which opens a port inside the clutch. This open port allows a greater flow of silicone providing a maximum fan speed of approximately 2600 RPM.

The clutch coil is calibrated so that at road load with an ambient temperature of approximately 80°F the clutch is just at the point of shift between high and low fan speed.

The cooling system is sealed by a pressure type radiator filler cap which causes the system to operate at higher than atmospheric pressure. The higher pressure raises the boiling point of coolant and increases the cooling efficiency of the radiator. The fifteen pound pressure cap used on all series permits a possible increase of approximately 38°F in boiling point of coolant.

The pressure type radiator filler cap contains a blow off or pressure valve and a vacuum or atmospheric valve. See Figure 60-346. The pressure valve is

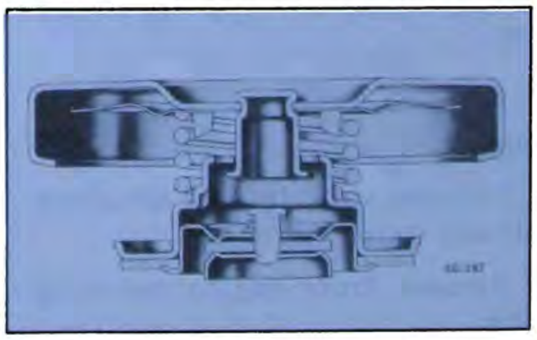


Figure 60-346—Pressure Type Radiator Cap

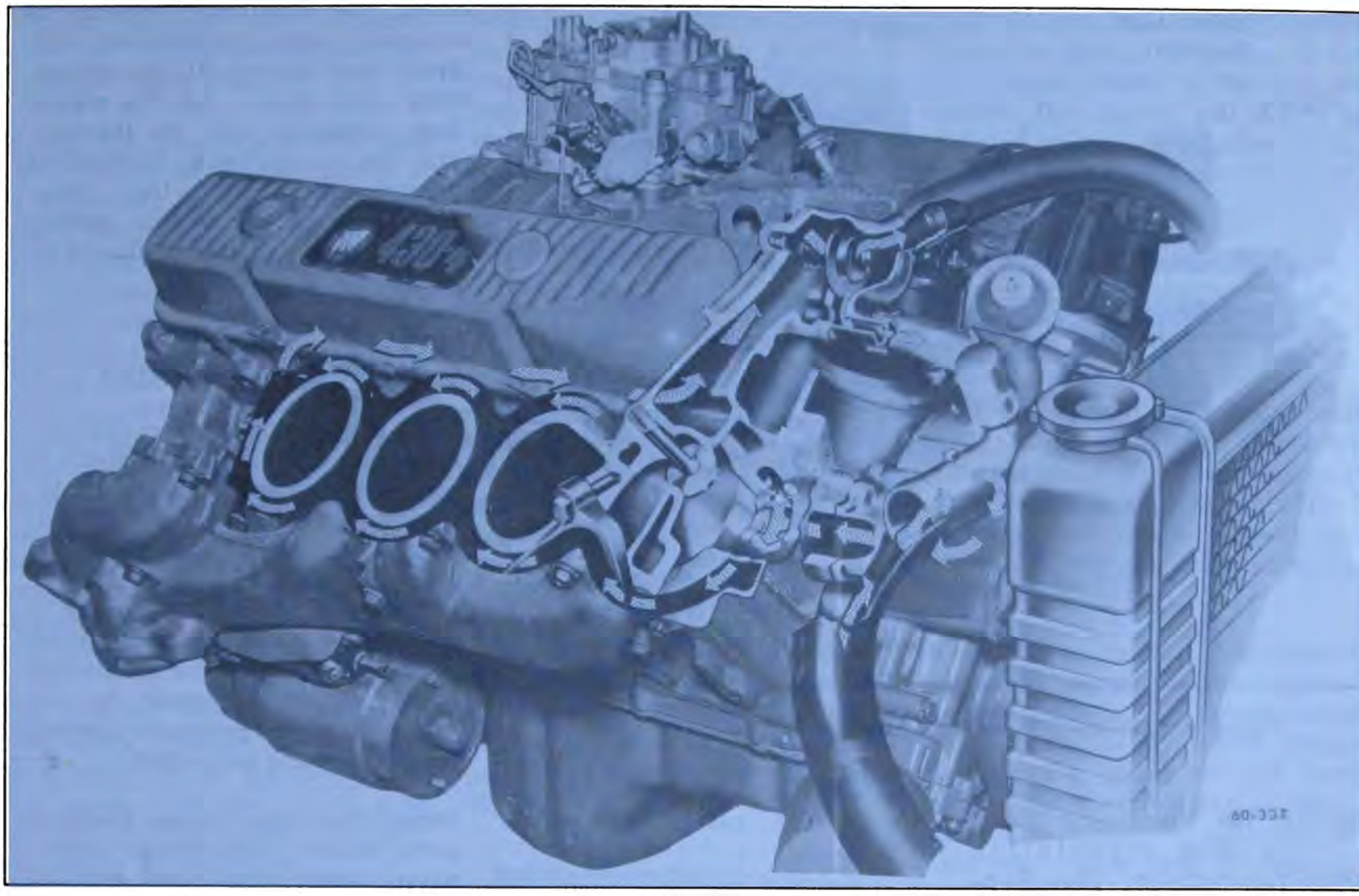


Figure 60-347—Coolant Flow

held against its seat by a spring of pre-determined strength which protects the radiator by relieving the pressure if an extreme case of internal pressure should exceed that for which the cooling system is designed. The vacuum valve is held against its seat by a light spring which permits opening of the valve to relieve vacuum created in the system when it cools off and which otherwise might cause the coolant hoses to collapse.

The coolant is circulated by a centrifugal pump mounted on the timing chain cover which forms the outlet side of the pump. The fan and pulley(s) are bolted to the forward end of the pump shaft. In this manner both the fan and pump are belt driven by a crankshaft driven pulley integral with the harmonic balancer.

The pump shaft is supported on a double row ball bearing shrunk fit in the aluminum water pump cover. The bearings are permanently lubricated during manufacture and sealed to prevent loss of lubricant and entry of dirt.

The pump is sealed against coolant leakage by a packless non-adjustable seal assembly mounted in the pump cover in position to bear against a ceramic in the impeller hub. See Figure 60-348.

The inlet pipe cast on the timing chain cover feeds into the passage formed by the cover and the front face of the impeller, which is mounted on the bearing shaft with the vanes facing rearward. Coolant flows through the inlet passage to the low pressure area at the center, where it then flows rearward through 5 (for air conditioning) and 6 (non-air conditioning) holes in the impeller. Vanes on the rotating impeller cause the coolant to flow radially outward into two discharge passages cast in the timing chain cover, and these passages deliver an equal quantity of coolant to each cylinder bank water jacket.

Cylinder water jackets extend down below the lower limits of piston ring travel and the coolant completely surrounds each cylinder barrel to provide uniform cooling.

The coolant leaves the cylinder heads through the intake manifold that provides a common connection between both heads and the radiator. The intake manifold also houses the "pellet" type radiator thermostat and outlet provides the by-pass passage through which coolant returns to the water pump for recirculation

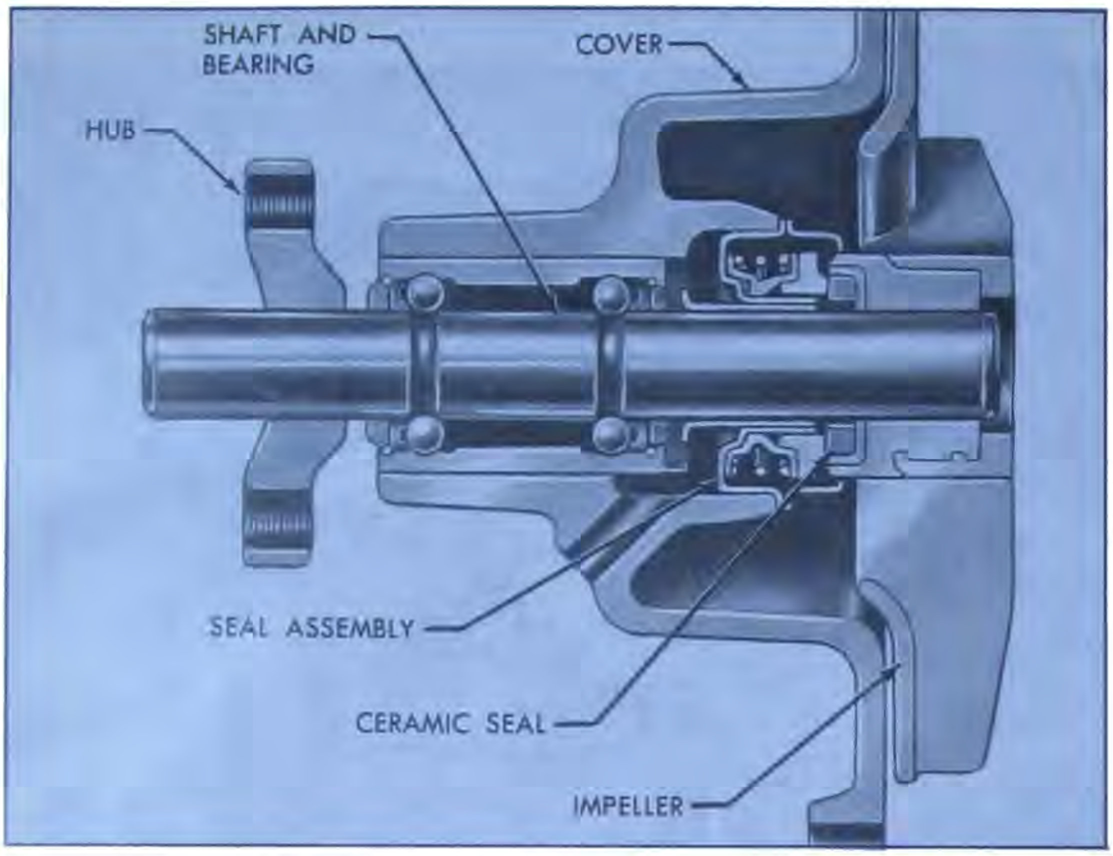


Figure 60-348—Water Pump Cover Assembly (Cross Section)

whenever the thermostat valve closes to block circulation through the radiator. This thermostatically operated by-pass type of water temperature control permits the engine to reach its normal operating temperature quickly. The thermostat valve opens at 190°F.

a. Checking and Filling Cooling System

The engine coolant level should be checked only when the engine is cold. Enough coolant should be added to bring the level to the tip of the "FILL COLD" arrow on the backside of the filler tank. It is unnecessary and undesirable to remove the radiator cap and check the coolant level each time the car stops at a filling station for gasoline or oil, since the engine is usually hot at such times.

CAUTION: Never remove the radiator cap quickly when the radiator is HOT. Sudden release of cooling system pressure may cause the coolant to boil and escape with some force.

If it becomes necessary to remove the radiator cap when the radiator is hot, rotate the cap slowly counterclockwise until a stop is reached. When all system pressure is released, then remove cap.

b. Draining and Flushing the Cooling System

When the cooling system has been drained, reinstall a ethylene glycol type corrosion and anti-freeze cooling system protection solution developed for year around use (General Motors Specification GM 1899-M). Water alone, methanol, or alcohol type anti-freeze is definitely not recommended. To drain the cooling system, remove radiator cap, open the drain at the bottom of the radiator and remove the drain plugs on both sides of cylinder block. If car is heater equipped, set heater temperature control valve at "HOT" position.

After the cooling system is drained, plugs reinstalled, and drain cock closed, fill the system with clean water. Run the engine long enough to open the thermostat for complete circulation through the system then completely drain the cooling system before sediment has a chance to settle.

c. Conditioning the Cooling System

It is very important to make certain that the cooling system is properly prepared before an anti-freeze solution is installed; otherwise, loss of solution through leakage may occur or seepage may result in damage to the engine. The cooling system should be drained and flushed as described above (subpar. b). All joints should be pressure checked for leakage and corrected.

Inspect the water pump, radiator core, heater core, drain cocks, water jacket plugs, and edge of cylinder head gaskets for evidence of leaks. Tighten all hose clamps in the cooling and heating systems and replace any deteriorated hoses.

d. Using and Testing Anti-Freeze Solutions

Inhibited year around (ethylene glycol type) engine coolant solution which is formulated to withstand two full calendar year of normal operation without draining or adding inhibitors should be used at all times (not less than 0°F. to freeze protection should be provided to protect against corrosion). When adding solution due to loss of coolant for any reason or in areas where temperatures lower than -20°F. may be encountered, a sufficient amount of any of the several brands of year around coolant (Ethylene Glycol base) compatible to GM Specification 1899-M available on the market should be used.

NOTE: Alcohol base coolants are not recommended for this vehicle at any time.

If for any reason water is used as a coolant in an emergency, it is extremely important that Buick Heavy Duty Cooling System Protector and Water Pump Lubricant or equivalent be added to the cooling system as soon as possible. If any other cooling system protector is used, be certain it is labeled to indicate that it meets General Motors Specifications GM 1894-M. It should be recognized that this is only a temporary measure. The manufacturer intends that permanent type coolant solution be used year around in the cooling system of your Buick.

The cooling system should be completely drained and the recommended coolant installed every two years. At this time, also add GM cooling system inhibitor and sealer or equivalent.

It is advisable to check the anti-freeze solution at intervals during the winter to make certain that the solution has not been weakened by evaporation or leakage. Use only hydrometers which are calibrated to read both the specific gravity and the temperature. Obtain a table or similar means of converting the freezing point at various temperatures of the solution. Disregarding the temperature of the solution when making the test may cause an error as large as 30°F. Care must be exercised to use the correct float or table for the particular type of anti-freeze being tested.

e. Fan Belt Adjustment and Replacement

A tight fan belt will cause rapid wear of the Delcotron generator and water pump bearings. A loose belt will slip and wear excessively causing noise, engine overheating, and unsteady generator output. A fan belt which is cracked or frayed, or is worn so that it bottoms in the pulleys should be replaced.

The fan belt may be replaced by slightly loosening the generator mounting bolts, and moving generator inward to provide maximum slack in the belt.

The Delcotron generator must be moved outboard to adjust the fan belt. After the Delcotron generator mounting bolts are securely tightened, the fan belt tension should be checked as shown in Figure 60-349.

If the power steering oil pump belt is removed it should be adjusted to tension specified, in Figure 60-349.

If the air conditioner compressor belt is disturbed it should be adjusted as specified, in Figure 60-349.

f. Radiator Thermostat Inspection and Test

A sticking radiator thermostat will prevent the cooling system from functioning properly. If the thermostat sticks in the open position, the engine will warm up very slowly. If the thermostat sticks in the closed position overheating will result.

The thermostat may be removed for inspection by partially draining the cooling system and removing the thermostat housing.

If the thermostat valve does not fully close when cold, check for the presence of foreign material that could hold it open. If no foreign material is present and valve still does not close, replace the thermostat.

Test the thermostat for correct opening temperature by immersing the unit and a thermometer in a container of water. While heating the water do not rest either the thermometer or thermostat on bottom of container as this will cause them to register a higher temperature than the water. Agitate the water to insure uniform temperature of water,

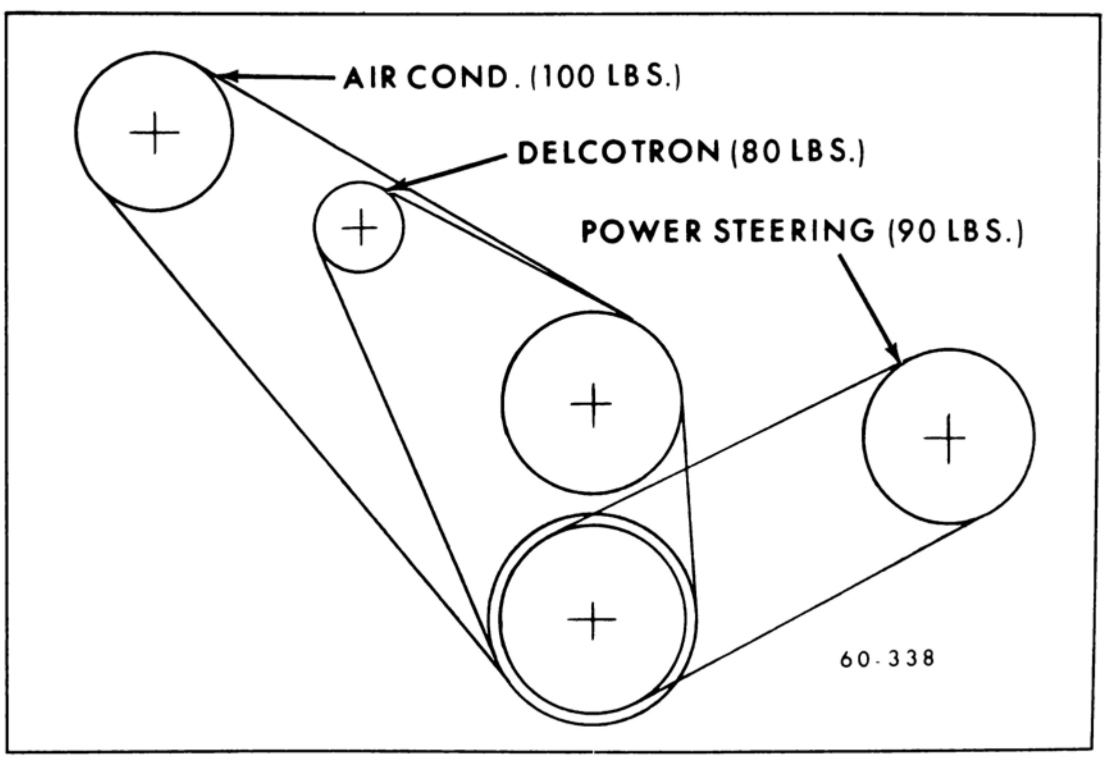


Figure 60-349—Engine Belt Tension Chart - 400 and 430 Cu. In. Engines

thermostat and thermometer.

The standard thermostat (190°F) valve should start to open at approximately 190°F and should be fully open at approximately 212° F. If thermostat does not operate at specified temperatures it must be replaced as it cannot be adjusted.

g. Water Pump Removal

The water pump cover is die cast aluminum into which the water pump bearing outer race is shrunk fit. For this reason the cover, shaft bearing, and hub are not replaceable.

1. Drain coolant into a clean container.

2. Loosen belt or belts, then remove fan blade, and pulley or pulleys from hub on water pump shaft. Remove belts.

3. Disconnect hose from water pump inlet and heater hose from nipple. Remove bolts, pump assembly, and gasket from timing chain cover.

4. Check pump shaft bearings for end play or roughness in operation. If bearings are not in serviceable condition, the assembly must be replaced.

h. Installation of Water Pump

1. Make sure the gasket surfaces on pump and timing chain covers are clean. Install pump assembly with new gasket. Bolts must be tightened uniformly.

2. Connect radiator hose to pump inlet and heater hose to nipple. Fill cooling system and check for leaks at pump and hose joints.

3. Install fan pulley or pulleys and fan blade, tighten attaching bolts securely. Install belts and adjust for proper tension. See Figure 60-349.

63-2 ENGINE MOUNTING, FLYWHEEL, AND ENGINE BALANCING

a. Removal of Front Mounts

1. Raise car and provide frame support at front of car.

2. Support weight of engine at forward edge of oil pan.

3. Remove mount to engine block bolts. Raise engine slightly and remove mount to mount bracket bolt and nut. Remove mount.

b. Installation of Front Mount

1. Install mount to engine block bolts and torque to 70 lb. ft.

2. Lower engine so mounts rest on frame cross member in normal manner. Install mount to bracket bolt and torque to 55 lb. ft.

3. Remove frame support and lower car.

c. Removal of Rear (Transmission) Mount

For details of engine and transmission mounts and transmission support installation refer to Figures 60-352 and 60-353.

d. Removal and Replacement of Automatic Transmission Flywheel

1. Remove transmission (GROUP 74).

2. Remove six bolts attaching flywheel to crankshaft flange.

3. Inspect flywheel; if cracked at flywheel bolt holes, replace flywheel.

4. Inspect crankshaft flange and flywheel for burrs. Remove any burrs with a mill file.

5. Install flywheel. Bolt holes are unevenly spaced. Install bolts and torque evenly to 60 lb. ft.

6. Mount dial indicator on engine block and check flywheel run-out at three attaching bosses. Run-out should not exceed .015".

NOTE: The crankshaft end play must be held in one direction during this check.

7. If run-out exceeds .015", attempt to correct by tapping high side with mallet. If this does not correct, remove flywheel and check for burrs between flywheel and crankshaft mounting flange.

e. Replacement of Flywheel or Ring Gear on Manual Transmission Engine

1. Remove transmission and clutch assembly, being certain to mark clutch cover and flywheel so clutch may be reinstalled in original position.

2. Remove flywheel. Bolt holes are located by lining up the small hole in the flywheel with the drill mark on the crankshaft.

3. If ring gear is to be replaced, drill a hole between two teeth and split gear with a cold chisel.

4. Heat and shrink a new gear in place as follows:

a. Polish several spots on ring with emery cloth.

b. Use a hot plate or slowly moving torch to heat the ring until the polished spots turn blue (approximately 600°F.).

CAUTION: Heating the ring in excess of 600°F will destroy the heat treatment.

c. Quickly place ring in position against shoulder of flywheel with chamfered inner edge of ring gear toward flywheel shoulder. Allow ring to cool slowly until it contracts and is firmly held in place.

5. Make certain the flywheel and crankshaft flange are free from burrs that would cause run-out. Install flywheel.

f. Manual Transmission Flywheel Balance

All manual transmission flywheels are balanced at the factory by drilling holes at various points

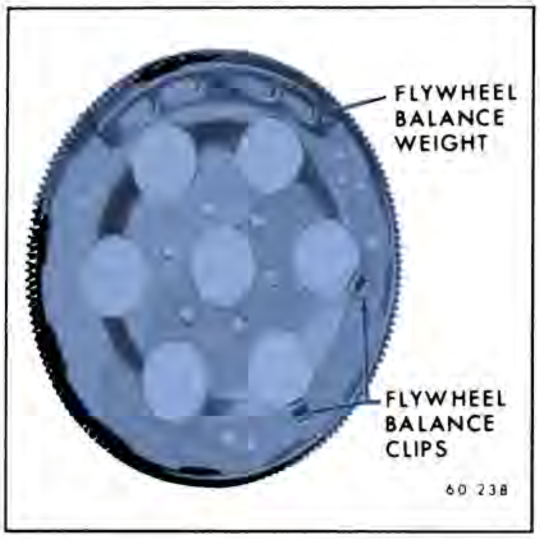


Figure 60-350—Automatic Transmission Flywheel Balance Clip Locations

on the flywheel surface. No attempt should be made to balance a flywheel after the initial factory balance.

g. Automatic Transmission Flywheel Balance

Clips are available from the Parts Department that will serve as balance weights for automatic transmission flywheels. These clips are secured by their clamping pressure and a series of indentations stamped into the flywheels. See Figure 60-350 for clip installation locations.

If a flywheel is found to be out of balance, it can be corrected in the following manner.

1. Remove lower flywheel housing. Mark the flywheel at four locations, 90° apart.

2. Install one clip at one of the marked locations. Run engine with transmission in neutral and note vibration.

(a) If vibration increases, remove clip and relocate 180° from original location.

(b) If vibration decreases, install another clip next to the original.

(c) If no change is noted, move clip 90° and recheck.

3. Continue this procedure until a reduction in vibration is noted. Fine adjustments can be made by moving the clips, by small increments, to different locations.

> **CAUTION:** Be certain that the tangs on the clip are setting in the stamped grooves on the flywheel. Otherwise, the clip(s) may shift when the flywheel is turned at high speeds.

h. Harmonic Balancer

If a harmonic balancer is suspected of being a cause of vibration, it can be checked and/or balanced by following the outline below:

(a) Using a tachometer, determine the engine speed at which the greatest amount of vibration occurs.

(b) Place an amount of body putty or similar material on the inside surface of the fan driving pulley.

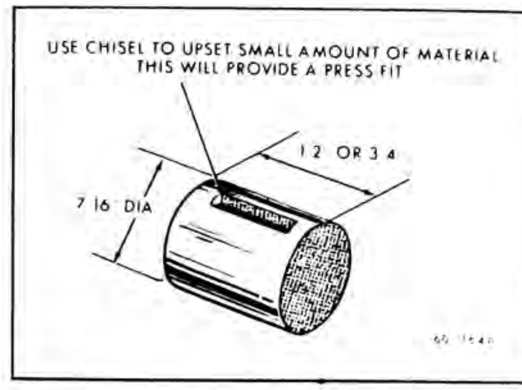


Figure 60-351—Harmonic Balancer Balance Weight

Run engine at critical speed and note vibration.

(c) Repeat Step 2 above using varying amount of putty at different locations until the vibration is diminished to a minimum.

(d) When point of minimum vibration is found, mark the nearest hole drilled in the balancer at that point.

(e) Cut a piece of 7/16" drill rod approximately 1/2" long. Using a chisel, upset a small amount of material on the side of the piece of drill rod. See Figure 60-351.

(f) Install weight into hole marked in Step d.

> **CAUTION:** Do not hammer weight into balancer. Squeeze in with pliers or back up outer ring of balancer if hammering is necessary.

(g) Additional weights should be added (if necessary) in adjoining holes.

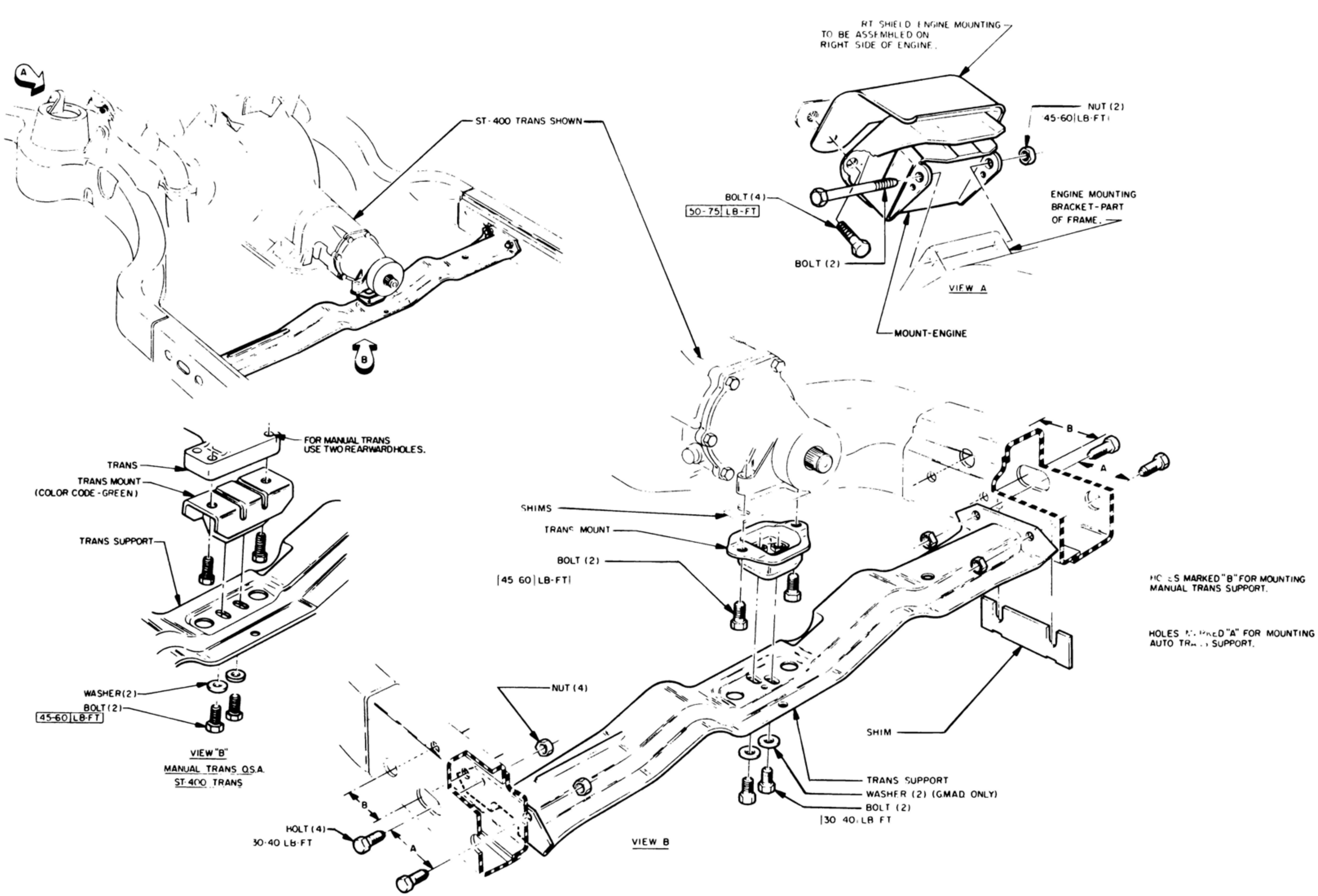


Figure 60-352—Engine and Transmission Mounting - Wildcat and Electra

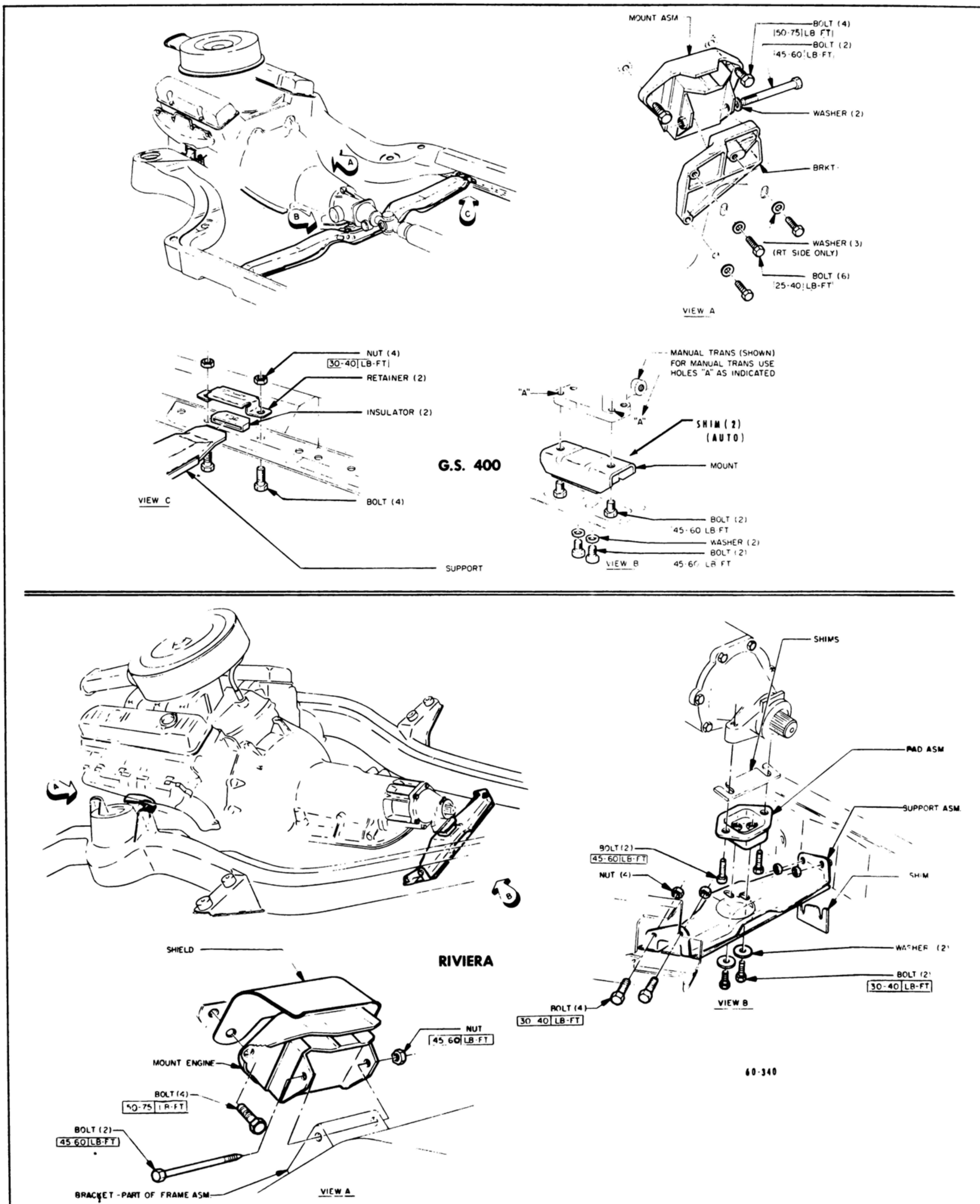


Figure 60-353—Engine and Transmission Mounting - G.S. 400 and Riviera

DIVISION IV—TROUBLE DIAGNOSIS

63-9 EXCESSIVE OIL CONSUMPTION

POSSIBLE CAUSE	CORRECTION
External Oil Leaks at: Intake manifold gaskets Rocker Arm Covers Timing Chain Cover Oil Pan and Gasket Around Starter Bolts Between Oil Pan and Flywheel Housing	Tighten attaching bolts. If leaks persist, remove cover (or pan), check sealing surfaces for burrs or scoring, replace with new gasket, and seal attaching bolts with Permatex #2 or equivalent. Make sure oil level is not overfull.
Improper Reading of Dip Stick	Car may not be level when taking reading. Insufficient oil "drain-back" time allowed after stopping engine (three minutes must be allowed). Dip stick may not be completely pushed down against stop. Dip stick bent.
Oil Viscosity too Light	Use recommended S.A.E. viscosity for prevaling temperatures.
Continuous High Speed Driving	At speeds above 60 MPH, increased oil consumption can be expected with any engine. Inform customer of this fact.
High Speed Driving following Normal Slow Speed City Driving	When principal use of automobile is city driving, crankcase dilution from condensation occurs. High speed and temperatures will remove water, resulting in what appears to be rapid lowering of oil level. Inform customer of this fact.
Valve Guides Worn-Excessive Clearance	Ream out guides and install service valves with oversize stems and new seals. Refer to Par. 61-1.
Piston Rings not "broken in"	Allow engine to accumulate at least 4,000 miles before attempting any engine disassembly to correct for oil consumption.

63-10 NOISY VALVES AND LIFTERS

a. Noisy Valve Train

The noise level of the valve mechanism cannot be properly judged when the engine is below operating temperature, when the hood is raised, or when the valve rocker arm covers are removed.

Before attempting to judge valve noise level, the engine must be thoroughly warmed up (at least 20 minutes of operation at 1200 to 1500 RPM) to stabilize oil and coolant temperatures and bring all engine qarts to a normal state of expansion. When the engine is warmed up, listen for engine noise while sitting in the drivers seat with the hood closed. Run the engine at idle and at various higher speeds. It is advisable to observe the noise level in several engines that have been properly broken in, in order to develop good judgment for checking the noise level in any given engine.

If the preceding check indicates the valve mchanism is abnormally noisy, remove the rocker arm covers so that the various conditions that cause noise may be checked. A piece of heater hose of convenient length may be used to pick out the particular valves or valve linkages that are causing abnormal noise. With the engine running at a speed where the noise is pronounced, hold one end of hose to an ear and hold other end about 1/2" from point of contact between rocker arm and valve stem. Mark or record the noisy valves for investigation of following causes.

(1) Excessive Oil In Crankcase. Crankcase oil level high enough to allow the crankcase to churn the oil will cause air bubbles in the lubricating system. Air bubbles entering the hydraulic lifters will cause erratic operation resulting in excessive lash in the valve linkage. Locate and correct cause of high oil level, then run engine long enough to expel air from system.

(2) Sticking, Warped or Eccentric Valves, Worn Guides. Sticking valves will cause irregular engine operation or missing on a low speed pull and will usually cause intermittent noise.

Pour penetrating oil over the valve spring cap and allow it to drain down the valve stem. Apply pressure to the one side of the valve spring and then the other, and then rotate the vavle spring about 1/2 turn . If these operations affect the valve noise, it may be assumed that valves should be reconditioned.

(3) Worn or scored parts in the valve train. Inspect rocker arms, push rod ends for scoring. Check push rods for bends, valve lifters and camshaft surfaces for scoring. Replace faulty parts.

(4) Valves and seats cut down excessively. Noisy and improper valve action will result if a valve and its seat have been refinished enough to raise the end of the valve stem approximately .050" above normal position. In this case it will be necessary to grind off the end of the valve stem or replace parts.

(5) Faulty Hydraulic Valve Lifters. If the preceding suggestions do not reveal the cause of noisy valve action, check operation of valve lifters as described in paragraph 61-1, subparagraph e.

b. Noisy Valve Lifters

When checking hydraulic valve lifters, remember that grit, sludge, varnish or other foreign matter will seriously affect operation of these lifters. If any foreign substance is found in the lifters or engine where it may be circulated by the lubrication system, a thorough cleaning job must be done to avoid a repetition of lifter trouble.

To help prevent lifter trouble, the engine oil and oil filter must be changed as recommended in Group 00. The engine oil must be heavy-duty type (MS marked on container) and must also conform to General Motors Specification 6041-M to avoid detrimental formation of sludge and varnish. A car owner should be specifically advised of these requirements when the car is delivered. Faulty valve lifter operation usually appears under one of the following conditions:

(1) Rapping noise only when engine is started. When engine is stopped, any lifter on a camshaft lobe is under pressure of the valve spring; therefore, leak down or escape of oil from the lower chamber can occur. When the engine is started a few seconds may be required to fill the lifter, particularly in cold weather. If noise occurs only occasionally, it may be considered normal requiring no correction. If noise occurs daily, however, check for (a) oil too heavy for prevaling temperatures (b) excessive varnish in lifter.

(2) Intermittent Rapping Noise. An intermittent rapping noise that appears and disappears every few seconds indicates leakage at check ball seat due to foreign particles, varnish, or defective surface of check ball or seat. Recondition, clean, and/or replace lifters as necessary.

(3) Noise on idle and low speed. If one or more valve lifters are noisy on idle and up to approximately 25 MPH but quiet at higher speeds, it indicates excessive leakdown rate or faulty check ball seat on plunger. With engine igling, lifters with excessive leakdown rate may be spotted by pressing down on each rocker arm above the push rod with equal pressure. Recondition or replace noisy lifters.

(4) Generally noisy at all speeds. Check for high oil level in crankcase. See subparagraph a (1) above. With engine idling, strike each rocker arm above push rod several sharp blows with a mallet; if noise disappears, it indicates that foreing material was keeping check ball from seating. Stop engine and place lifters on camshaft base circle. If there is lash clearance in any valve linkage, it indicates a stuck lifter plunger, worn lifter body lower end, or worn camshaft lobe.

(5) Loud noise at normal operating temperature only. A lifter develops a loud noise when engine is at normal operating temperature, but is quiet when engine is below normal temperature, it indicates an excessively fast leakdown rate or scored lifter plunger. Recondition or replace lifter.

63-11 COOLING SYSTEM TROUBLE

a. Cooling System Trouble Diagnosis

If the radiator is filled too full when cold, expansion when hot will overfill the radiator and coolant will be lost through the overflow pipe. Adding unnecessary water will weaken the anti-freeze solution and raise the temperature at which freezing may occur.

If the cooling system requires frequent addition of water in order to maintain the proper level in the radiator, check all units and connections in the cooling system for evidence of leakage. Inspection should be made with cooling system cold. Small leaks which may show dampness or dripping can easily escape detection when the engine is hot, due to the rapid evaporation of coolant. Tell-tale stains of grayish white or rusty color, or dye stains from anti-freeze, at joints in cooling system are almost always sure signs of small leaks even though there appears to be no dampness.

Air or gas entrained in the coolant system may raise the level in radiator and cause loss of coolant through the overflow pipe. air may be drawn into the cooling system through leakage at the water pump seal. Gas may be forced into the cooling system through leakage at the cylinder head gasket even though the leakage is not sufficient to allow water to enter the combustion chamber. The following quick check for air leaks in suction side of pump or gas leakage from engine may be made with a piece of rubber tubing and a glass bottle containing water.

1. With cooling system cold, add water to bring coolant to proper level.

2. Block open the radiator cap pressure valve, or use a plain cap, and be sure radiator cap is on tight. Attach a suitable length of rubber hose to overflow pipe.

3. Run engine in neutral at a safe high speed until the engine reaches a constant operating temperature.

4. Without changing engine speed, put the free end of rubber hose into a bottle of water, avoiding kinks or low bends that might block the flow of air.

5. Watch for air bubbles in water bottle. A continuous flow of bubbles indicates that air is being sucked into the cooling system, or exhaust gas is leaking into the cooling system past the cylinder head gasket.

b. Cooling System Overheating

It must be remembered that the Buick pressure system operates at higher temperatures than systems operating at atmospheric pressure. Depending on the pressure in cooling system, the temperature of permanent type anti-freeze may go considerably above 212°F without danger of boiling.

In cases of actual overheating the following conditions should be checked:

1. Excessive water loss.

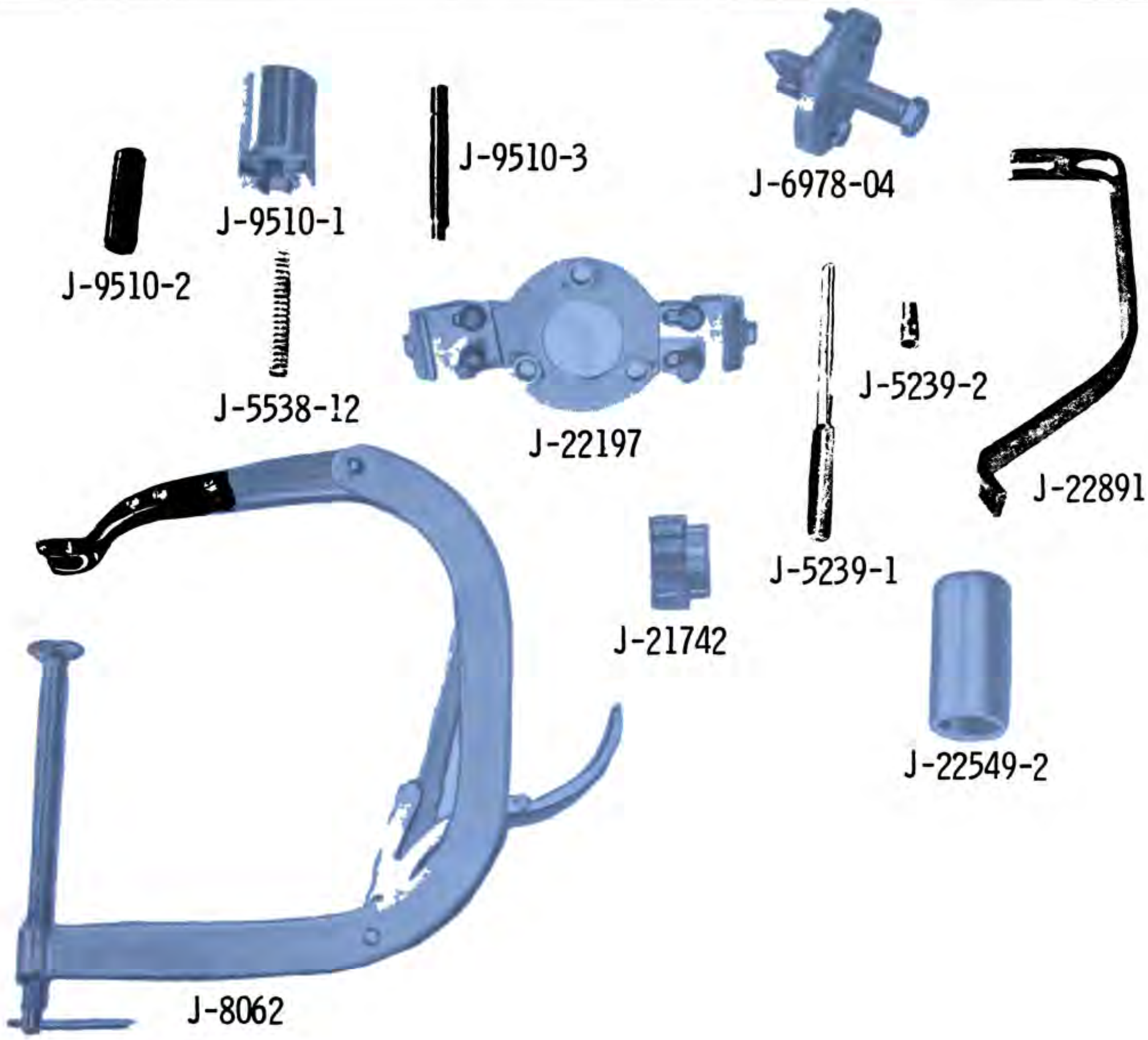
2. Slipping or broken fan belt.

3. Radiator thermostat stuck, radiator air passages clogged, restriction in radiator core, hoses, or water jacket passages.

4. Improper ignition timing.

5. Shortage of engine oil or improper lubrication due to internal conditons.

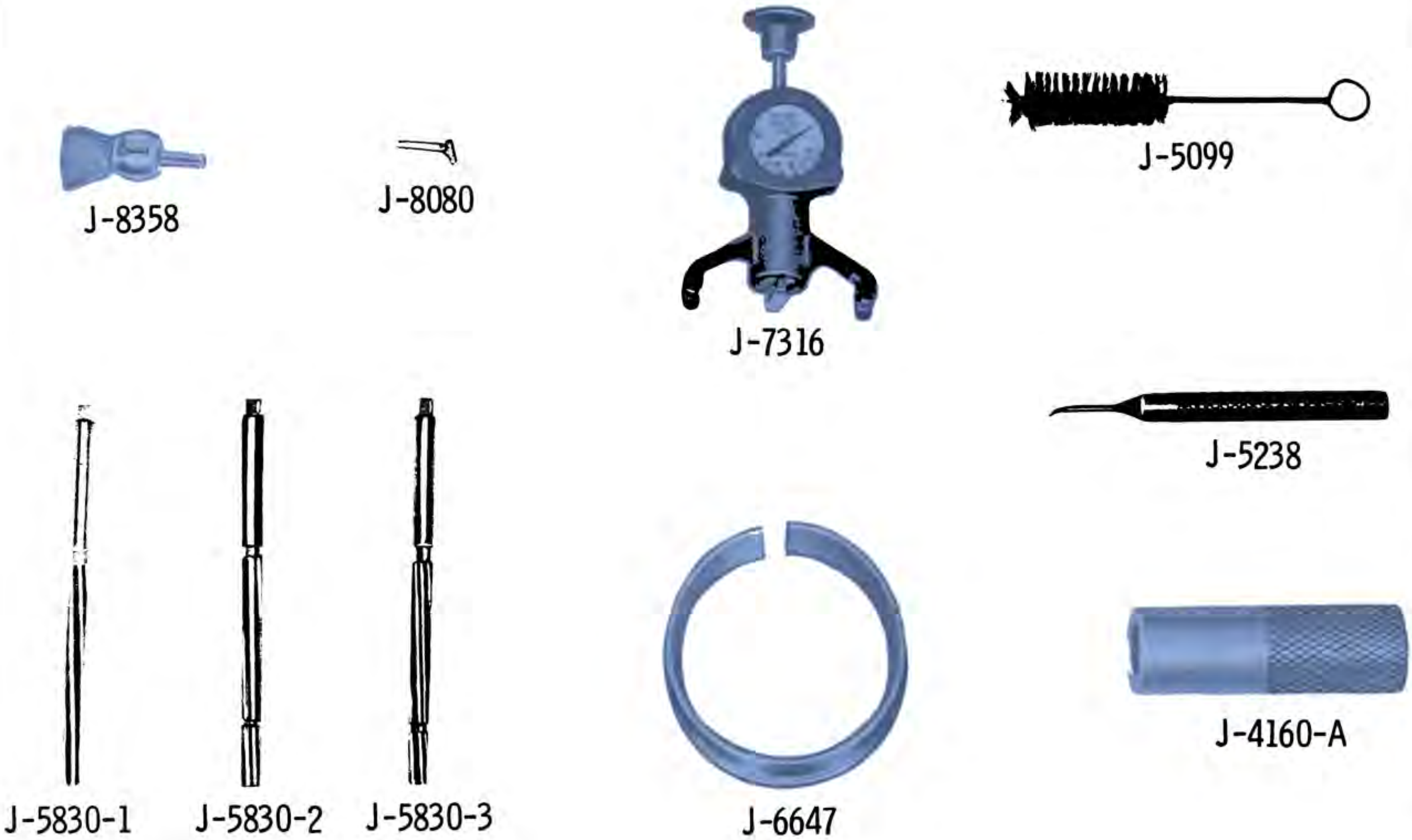
6. Dragging brakes.



J-9510-1	PISTON PIN REMOVER AND INSTALLER SUPPORT
J-9510-2	PISTON PIN REMOVER AND INSTALLER PILOT
J-9510-3	PISTON PIN REMOVER AND INSTALLER
J-5538-12	PISTON PIN REMOVER AND INSTALLER SPRING
J-8062	VALVE SPRING COMPRESSOR
J-22197	VIBRATION DAMPER INSTALLER
J-21742	ENGINE FRONT COVER ALIGNMENT GAUGE
J-6978-04	VIBRATION DAMPER & CRANKSHAFT GEAR INSTALLER
J-5239-1 & 2	CONNECTING ROD BOLT GUIDE SET
J-22891	VALVE SPRING COMPRESSOR
J-22549-2	SHIFT TUBE INSTALLER

60-343

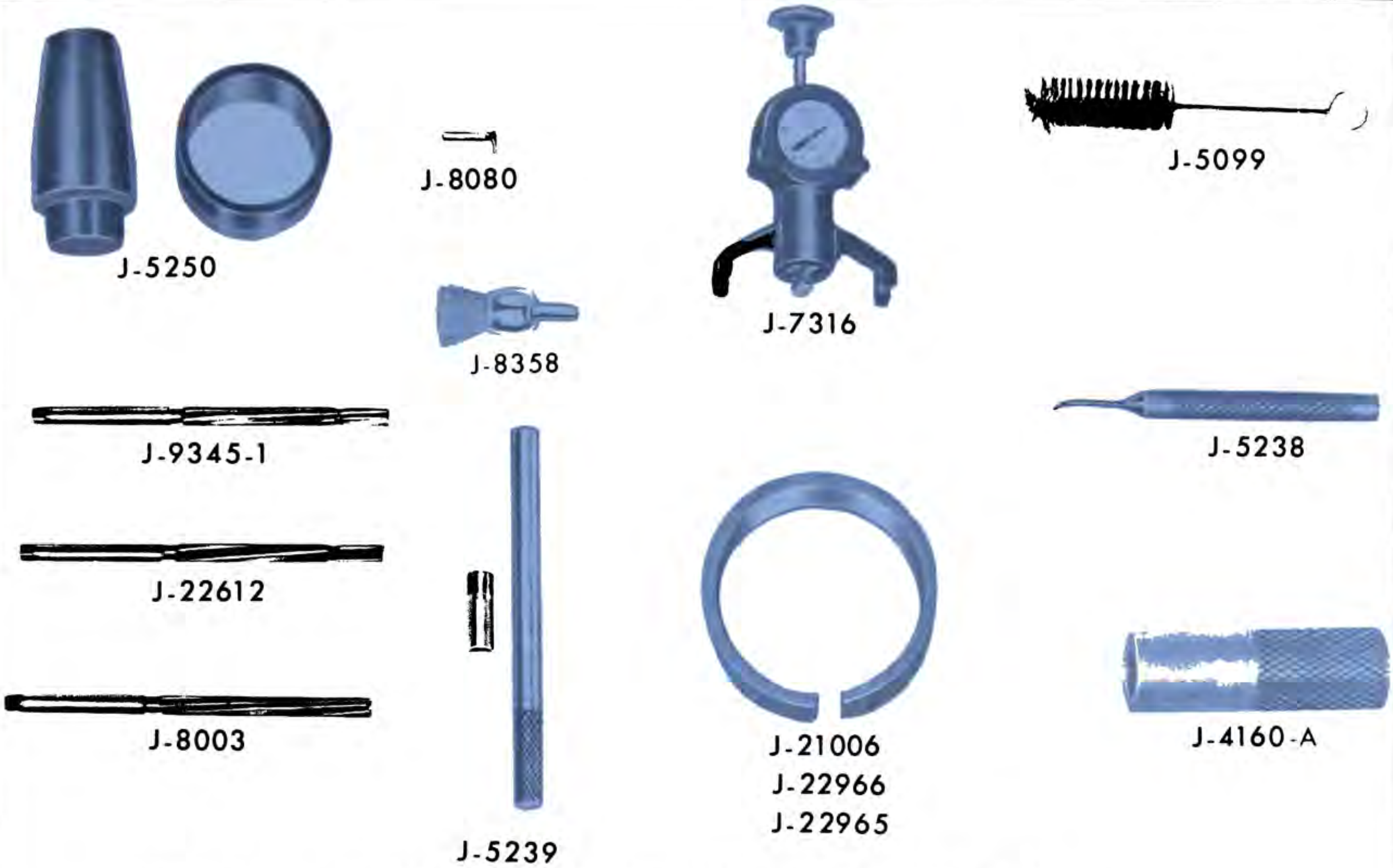
Figure 60-354—Special Tools - 250 Cu. In. L-6



J 4160-A	HYDRAULIC VALVE LIFTER PLUNGER REMOVER
J 5099	HYDRAULIC VALVE LIFTER BODY CLEANING BRUSH
J 5238	HYDRAULIC VALVE LIFTER PLUNGER RETAINER REMOVER & INSTALLER
J 6647	PISTON RING COMPRESSOR 3-7/8
J 5830-1	VALVE GUIDE REAMER .003 OVERSIZE
J 5830-2	VALVE GUIDE REAMER .015 OVERSIZE
J-5830-3	VALVE GUIDE REAMER .030 OVERSIZE
J 7316	BELT TENSION GAUGE
J 8080	MAIN BEARING SHELL REMOVER
J 8358	CARBON REMOVING BRUSH

60-168B

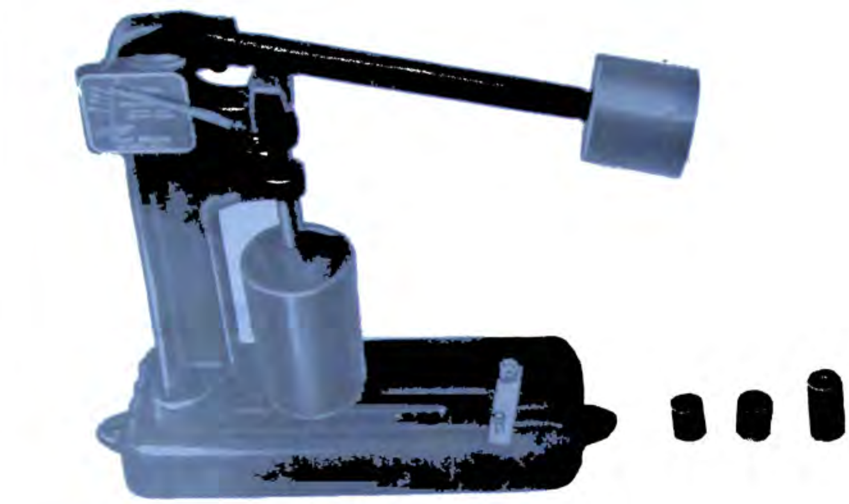
Figure 60-355—Special Tools - 250 Cu. In. L-6



J 4160-A	HYDRAULIC VALVE LIFTER PLUNGER REMOVER
J 5099	HYDRAULIC VALVE LIFTER BODY CLEANING BRUSH
J 5238	HYDRAULIC VALVE LIFTER PLUNGER RETAINER REMOVER & INSTALLER
J 5601	PISTON RING COMPRESSOR 3-3/4"
J 5250	TIMING CHAIN COVER OIL SEAL INSTALLER
J 22612	VALVE GUIDE REAMER .006 OVERSIZE
J 9345-1	BELT TENSION GAUGE
J 8080	MAIN BEARING SHELL REMOVER
J 8358	CARBON REMOVING BRUSH
J-8003	VALVE GUIDE REAMER 11/32"
J 5239	CONNECTING ROD BOLT GUIDE SET
J 21006	PISTON RING COMPRESSOR (430 CU. IN.)
J 22965	PISTON RING COMPRESSOR (350 CU. IN.)
J 22966	PISTON RING COMPRESSOR (400 CU. IN.)

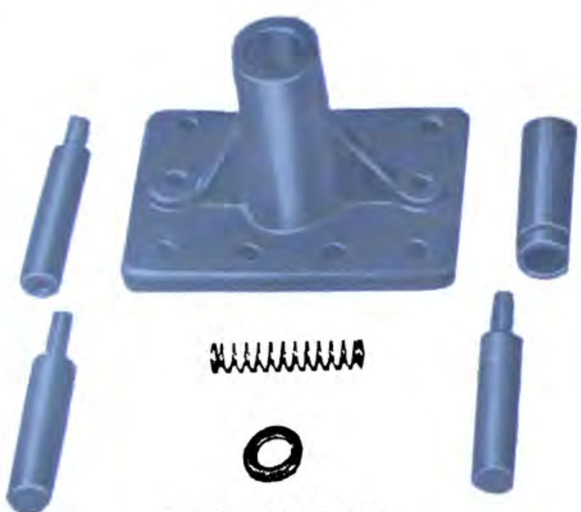
60-1708

Figure 60-356—Special Tools - 350, 400 and 430 Cubic Inch



J-5790

J-5268



J-6047-1-5-20

J-8062

J 5268	HYDRAULIC VALVE LIFTER TESTER OIL - ONE GALLON
J 5790	HYDRAULIC VALVE LIFTER LEAKDOWN TESTER
J 6047	PISTON PIN ASSEMBLY TOOL SET
	Details J 6047-1, J 6047-5 and J 6047-20
J 8062	VALVE SPRING COMPRESSOR

60-169A

Figure 60-357—Special Tools - 350, 400 and 430 Cubic Inch