250 CU. IN. IN-LINE ENGINE

CONTENTS

DESCRIPTION AND OPERATION:
- Engine Construction 6A- 1
- Engine Mounting 6A- 1

DIAGNOSIS:
- Excessive Oil Consumption 6A- 1

MAINTENANCE AND ADJUSTMENTS:
- Valve Adjustment 6A- 3

MAJOR REPAIR:
- Engine Assembly Removal and Installation 6A- 3
- Exhaust Manifold, Cylinder Head, Valve Train and Lifters 6A- 4
- Connecting Rod Bearings 6A- 8
- Crankshaft Bearing and Seals 6A-10
- Camshaft and Crankcase Front Cover 6A-13
- Pistons, Rings, and Connecting Rods 6A-15
- Removal and Inspection of Oil Pump, Pick-Up Screen and Pipe Assembly 6A-19

SPECIFICATIONS:
- Bolt Torque Specifications 6A-21
- General Specifications 6A-21
- Engine Dimension and Fits 6A-22

DESCRIPTION AND OPERATION

ENGINE CONSTRUCTION

The 250 cu. in. is an in-line 6 cylinder engine with the valves in head arrangement.

The 250 engine cylinders are numbered from front to rear, 1-2-3-4-5-6 and the firing order is 1-5-3-6-2-4. Crankshaft rotation as viewed from the rear is counterclockwise.

The crankshaft has 7 main bearings and the camshaft is supported by 4 bearings.

Full pressure lubrication, through a full flow oil filter is accomplished by a gear-type oil pump. The main oil gallery feeds oil, through drilled passages to the camshaft and crankshaft to lubricate the bearings. The main oil gallery also feeds the valve lifters which, through hollow push rods, feed the individually mounted rocker arms. See Figure 6A-1.

ENGINE MOUNTING

The mounting of the 250 cu. in. engine is covered in the illustrations at the end of this section.

DIAGNOSIS

EXCESSIVE OIL CONSUMPTION

Possible Cause	Correction
1. External Oil Leaks at: Rocker Arm Covers Timing Chain Cover Oil Pan and Gasket Between Oil Pan and Flywheel Housing Intake Manifold Gasket	1. Tighten attaching bolts. If leaks persist, remove cover (or pan), check sealing surfaces for burrs, scoring or distorted cover flanges, replace gasket and seal attaching bolts with silastic sealer, or equivalent. Make sure oil level is not overfull.
2. Improper Reading of Dip Stick	1. 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 may be bent.

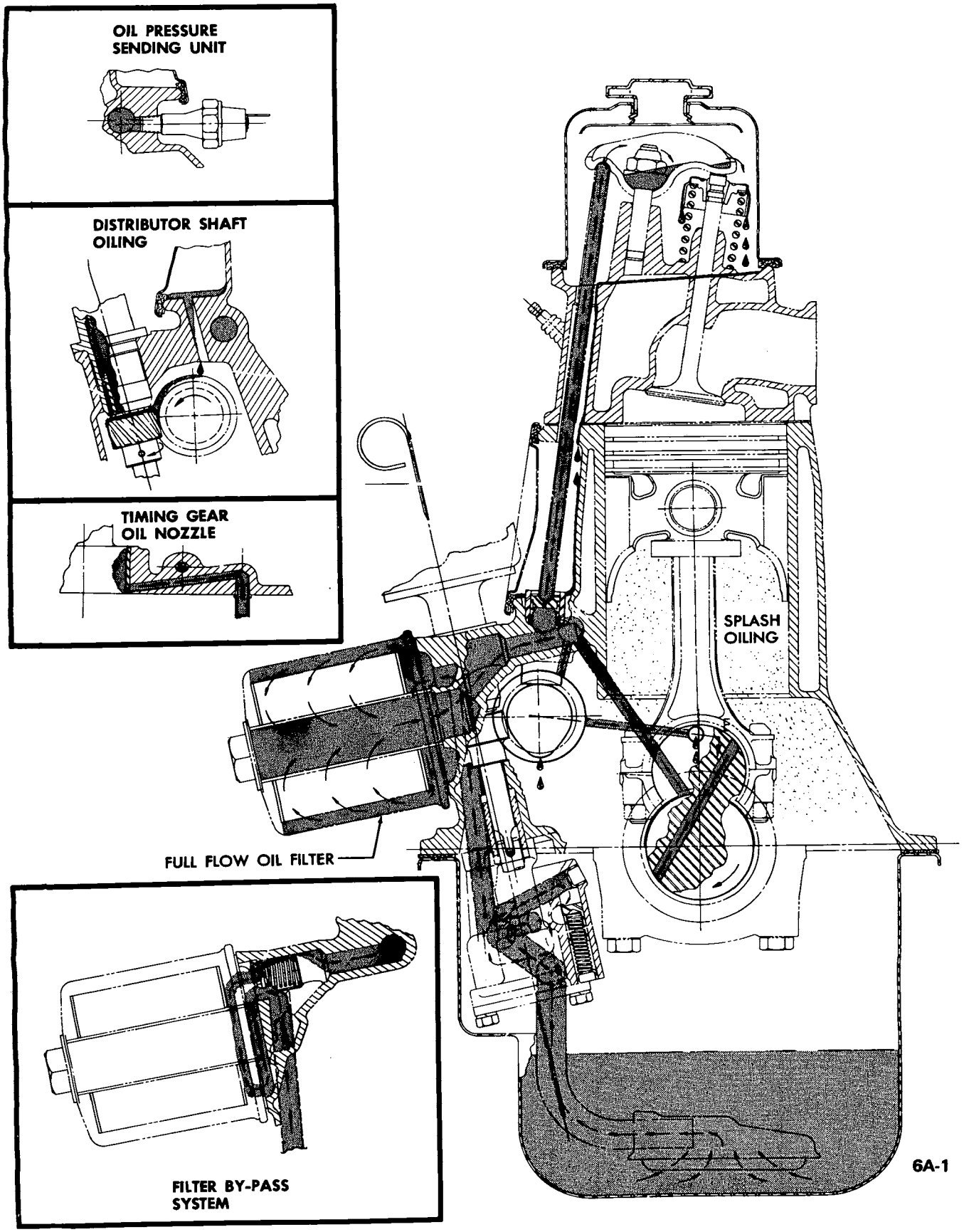


Figure 6A-1 Lubrication System

Possible Cause	Correction
3. Oil Viscosity Too Light	1. Use recommended SAE viscosity for prevailing temperatures.
4. Continuous High Speed	1. At speeds above 60 MPH, increased oil consumption can be expected with any engine. Inform customer of this fact.
5. High-Speed Driving Following Normal Slow-Speed City Driving	1. 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.
6. Piston Rings Not "Broken In"	1. Allow engine to accumulate at least 5,000 miles before attempting any engine disassembly to correct for oil consumption.
7. Valve Guides And/Or Valve Stem Seals Worn	1. Ream out guides and install service valves with oversize stems and new valve stem seals.

MAINTENANCE AND ADJUSTMENTS

VALVE ADJUSTMENT

1. Adjust valves when lifter is on base circle of camshaft lobe as follows: a. Mark distributor housing, with chalk, at at each cylinder position (plug wire), then disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly.

b. Crank engine until distributor rotor points to number one cylinder position. Both valves on number one cylinder may now be adjusted.

c. Back out adjusting nut until lash is felt at the push rod, then turn in adjusting nut until all lash is removed. This can be determined by checking push rod side play while turning adjusting nut. See Figure 6A-2. When play has been removed, turn adjusting nut in one full additional turn (to center lifting plunger).

2. Adjust the remaining valves, one cylinder at a time, in the same manner, in firing order.

3. Install distributor cap and spark plug wires.

4. Install rocker arm cover.

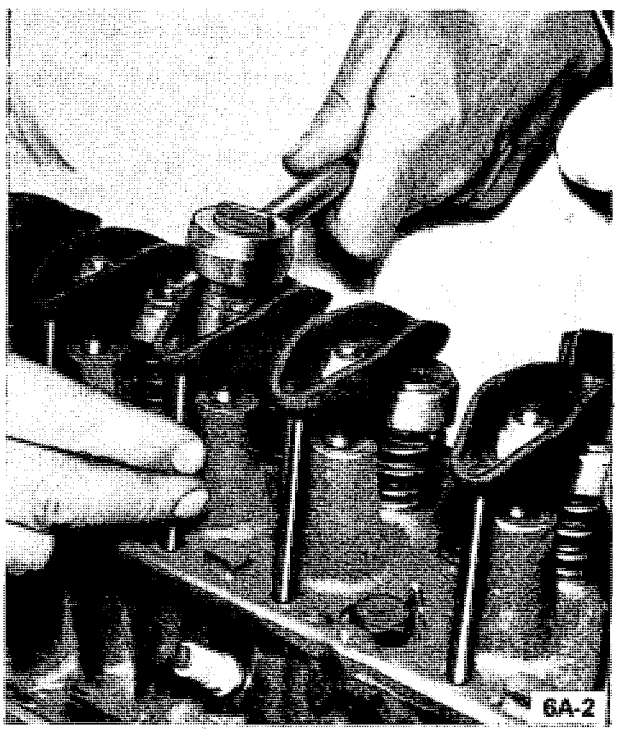


Figure 6A-2 Valve adjustment

MAJOR REPAIR

ENGINE REMOVAL AND INSTALLATION

Removal

1. Remove hood, and mark hinges for ease in installation.

2. Remove air cleaner, and disconnect battery cables at battery.

3. Drain radiator.

4. Remove fan shroud and radiator.

5. Remove fan blade and pulley.

6. Disconnect wires at:

a. Starter solenoid.

b. Delcotron.

c. Temperature switch.

d. Oil pressure switch.

e. Coil.

7. Disconnect:

a. Accelerator linkage at manifold bellcrank.

b. Exhaust pipe at manifold flange.

c. Fuel line (from fuel tank) at pump.

d. Vacuum line to power brake unit at manifold (if so equipped).

e. Power steering pump and position out of the way (if so equipped).

8. Raise vehicle.

9. Remove propeller shaft and plug extension housing.

10. Disconnect:

a. Shift linkage at transmission.

b. Speedometer cable at transmission.

11. On synchromesh equipped vehicles, disconnect clutch linkage at cross-shaft then remove cross-shaft engine bracket.

12. Connect a suitable lifting device to the engine and raise engine just enough to take the weight off the front mounts and remove front mount thru bolts.

13. Remove rear mount to crossmember bolts.

14. Remove engine-transmission assembly from vehicle as a unit.

15. Remove transmission and mount engine to a stand.

INSTALLATION

1. Remove engine from stand and install transmission to engine.

2. Tilt and lower engine and transmission assembly into chassis as a unit, guiding engine to align front mounts with frame supports.

3. Install front mount through bolts and rear mount bolts (torque to specifications).

4. On synchromesh equipped vehicles, install clutch cross shaft engine bracket, then adjust and connect clutch as outlined in transmission section.

5. Connect:

a. Speedometer cable.

b. Shift linkage at transmission.

6. Install propeller shaft.

7. Lower vehicle.

8. Install fan blade and pulley.

9. Install radiator and fan shroud.

10. Connect:

a. Power steering pump (if disconnected).

b. Vacuum line to power brake unit (if disconnected).

c. Fuel line.

d. Hoses to vapor storage cannister.

e. Exhaust pipe at manifold flange.

f. Accelerator linkage at manifold bellcrank.

11. Connect wires at:

a. Coil.

b. Oil pressure switch.

c. Temperature switch.

d. Delcotron.

e.. Starter solenoid.

12. Install hood using marks made in removal for alignment.

13. Connect battery cables.

14. Fill cooling system, lubrication system and transmission oil if drained.

15. Start engine and check for leaks.

16. Install air cleaner and perform necessary adjustments.

EXHAUST MANIFOLD, CYLINDER HEAD, VALVE TRAIN AND LIFTERS

Exhaust Manifold Removal

1. Remove air cleaner.

2. Remove power steering pump and/or A.I.R. pump brackets (if so equipped).

3. Remove EFE valve bracket.

4. Disconnect throttle controls and throttle return spring.

5. Disconnect exhaust pipe at manifold flange.

6. Remove manifold attaching bolts; then, remove manifold and discard gasket.

7. Check for cracks in manifold assembly.

Exhaust Manifold Installation

1. Clean gasket surfaces on cylinder head and manifold.

2. Position new gasket on exhaust manifold.

3. Install manifold assembly bolts, while holding manifold assembly in place.

4. Clean, oil and torque all manifold to cylinder head bolts and nuts to specifications.

5. Connect exhaust pipe to manifold.

6. Connect throttle controls and throttles return spring.

7. Install air cleaner, start engine and check for leaks.

Cylinder Head Removal

1. Drain coolant from radiator.

2. Remove exhaust manifold as outlined.

3. Disconnect A.I.R. injection hose at check valve if equipped.

4. Disconnect spark plug wires from spark plugs.

5. Remove fuel and vacuum line from retaining clip at water outlet, then disconnect wires from temperature sending units.

6. Disconnect upper radiator hose at water outlet housing, and battery ground strap at cylinder head.

7. Remove coil.

8. Remove rocker arm cover.

Do not pry rocker arm cover loose. Gaskets adhering to cylinder head and rocker arm cover may be sheared by bumping end of rocker arm cover rearward with palm of hand or a rubber mallet.

9. Remove rocker arm nuts, rocker arm balls, rocker arms and pushrods.

Place rocker arms, rocker arm balls, and pushrods in a rack so they may be reinstalled in the same location.

10. Remove cylinder head bolts, cylinder head, and gaskets. Place cylinder head on two blocks of wood to prevent damage.

Cylinder Head Installation

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

2. Place new head gasket on cylinder block with the head up. Dowels in the block will hold the gasket in place.

Do not use gasket sealer on composition steel asbestos gasket.

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.

Damage to the cylinder block threads can result if bolts are not lubricated 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 consumption.

5. Install head bolts. Tighten the bolts a little at a time about three times around in the sequence shown in Figure 6A-3. Give bolts a final torque in the same sequence. Torque to 95 lb. ft.

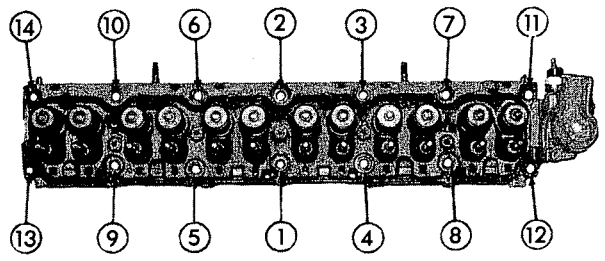


Figure 6A-3 Cylinder Head Bolt Tightening Sequence

6. Install coil.

7. Connect upper radiator hose and engine ground strap.

8. Connect temperature sending unit wires and *install fuel* and vacuum lines in clip at water outlet.

9. Install exhaust manifold as outlined.

10. Connect vapor hose at canister.

11. Fill cooling system.

12. Install and adjust rocker arm assembly in the following manner.

Whenever new rocker arms and/or rocker arm balls are being installed, coat bearing surfaces of rocker arms and rocker arm balls with Molykote or its equivalent.

a. Install push rods. Be sure push rods seat in lifter socket.

b. Install rocker arms, rocker arm balls and rocker arm nuts. Tighten rocker arm nuts until all lash is eliminated.

13. Adjust valves when lifter is on base circle of camshaft as follows:

a. Mark distributor housing, with chalk, at each cylinder position (plug wire), then disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly (if not previously done).

b. Crank engine until distributor rotor points to number one cylinder position. Both valves on number one cylinder may now be adjusted.

c. Back out adjusting nut until lash is felt at the push rod, then turn in adjusting nut until all lash is removed. This can be determined by checking push rod side play while turning adjusting nut. When play has been removed, turn adjusting nut in one full additional turn (to center lifter plunger).

d. Adjsut the remaining valves, one cylinder at a time, in the same manner.

14. Connect A.I.R. injection pipe if equipped.

15. Install distributor cap and spark plug wire assembly.

16. Install rocker arm cover using a new gasket. Torque bolts to specification.

17. Adjust carburetor idle speed.

Valve Stem Oil Seal and/or Valve Spring Replacement (on car)

1. Remove rocker arm cover.

2. Remove spark plug, rocker arm and push rod on the cylinder(s) to be serviced.

3. Apply compressed air to the spark plug hole to hold the valves in place using applicable air adapter.

4. Using a suitable compressor, such as J-22891, compress valve spring and remove valve spring cap keys. Release tool and remove shield spring and cap. See Figure 6A-4.

5. Remove valve stem oil seal.

6. To replace, set the valve spring and damper, valve shield and valve cap in place. THE CLOSE COILED END OF

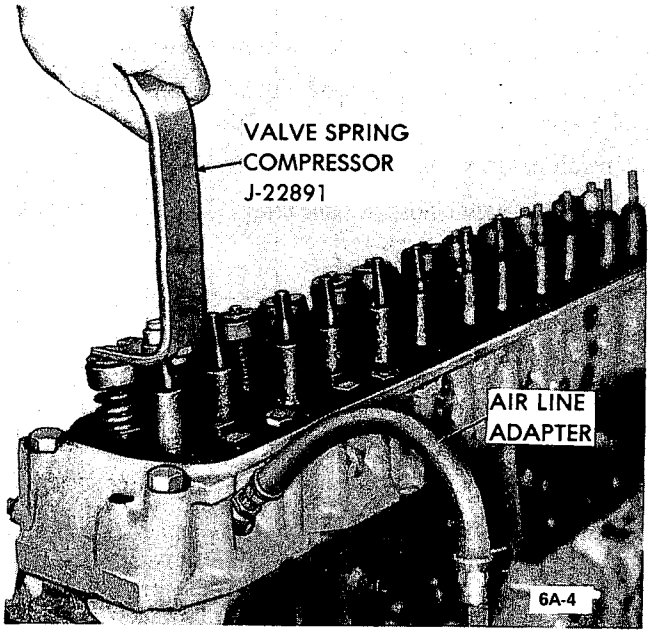


Figure 6A-4 Removing Valve Cap Retainers

THE SPRING IS INSTALLED AGAINST THE CYLINDER HEAD. See Figure 6A-5. Compress the spring with J-22891 and install oil seal in the lower groove of the stem, making sure the seal is flat and not twisted.

A light coat of oil on the seal will help prevent twisting.

7. Install the valve locks and release the compressor tool, making sure the locks seat properly in the upper groove of the valve stem.

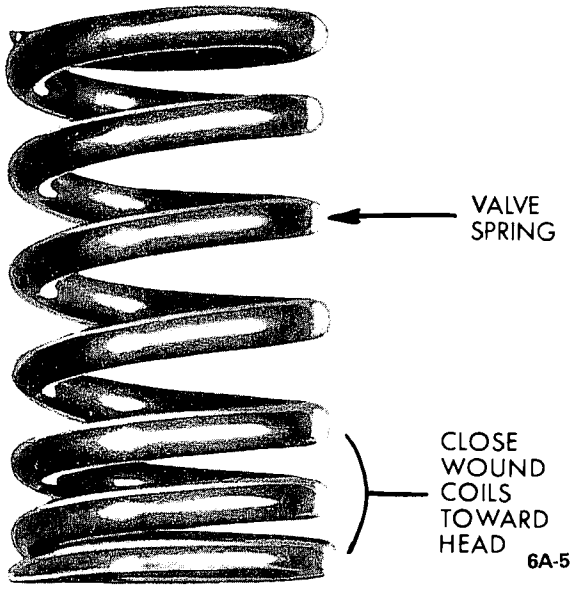


Figure 6A-5 Valve Spring

Grease may be used to hold the locks in place while releasing the compressor tool.

8. Install spark plug, and torque to specifications.

9. Install and adjust valve mechanism.

Reconditioning Valves and Guides

1. Remove cylinder head and place cylinder head on clean, smooth surface.

2. Using a suitable spring compressor, such as J-8062, compress valve spring and remove valve spring cap keys. Release tool and remove spring and cap then, remove oil seal. See Figure 6A-6.

3. Remove valves. Place valves in numerical order so that they can be reinstalled in original locations.

4. Remove carbon from combustion chamber of heads. Be careful when performing this operation so that valve seats are not scratched.

A soft wire brush, such as J-8358 is suitable for this purpose.

5. Clean carbon and gum deposits from valve guide bores.

6. Clean valves. Inspect valve faces and seats for pitting, burned spots, or other conditions that could cause poor seating.

7. Grind or replace valves as necessary. If a valve head must be ground to a knife edge to obtain a true face, the valve should be replaced, as a sharp edge will run too hot. 45 degrees in the correct angle for valve faces.

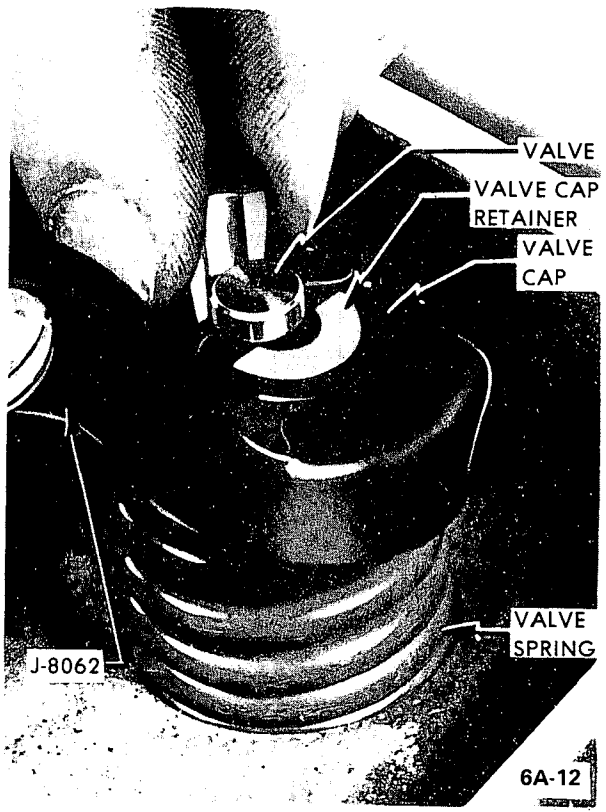


Figure 6A-6 Removing Valve Stem Keys

8. If a valve stem has excessive clearance in its guide, the guide must be reamed overside. See Figure 6A-7. Oversize valves of .003", .015" and .030" are available through the Parts Department.

9. True up valve seats to 46°. Cutting a valve seat results in lowering the valve spring pressure and increases the width of the seat. The nominal width of the valve seat is

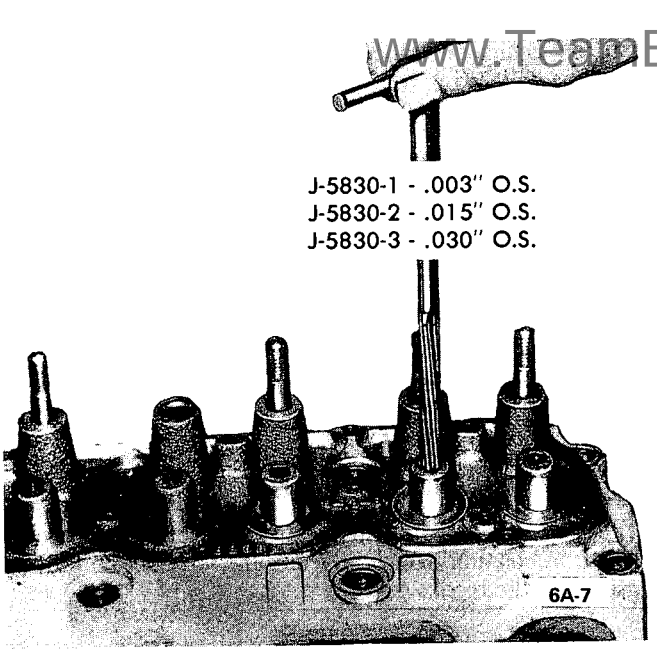


Figure 6A-7 Reaming Valve Guides

1/16". If a valve seat is over 5/64" wide after truing up, it should be narrowed to specified width by use of 20 degree and 70 degree stones.

10. 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.

11. Test valves for concentricity with seats and to tight seating. The usual test is to coat the valve face lightly with Prussion Blue or equivalent 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.

12. Lube with engine oil and reinstall valves, valve springs, cap, oil seal, and cap retainer, using same equipment used for removal. Install valve spring with closely wound coil toward the cylinder head. See Figure 6A-5.

13. Install cylinder head as outlined.

Removal and Installation of Rocker Arm Stud

1. If rocker arm stud is loose or pulled out of head it will be necessary to ream stud hole to next largest size. See Figure 6A-8.

Oversize studs have the size marked on the bottom. Example: A1.001" O.S., A3.003" O.S. and A13.013" O.S.

2. Install new O.S. stud as shown in Figure 6A-9, tool should bottom on head.

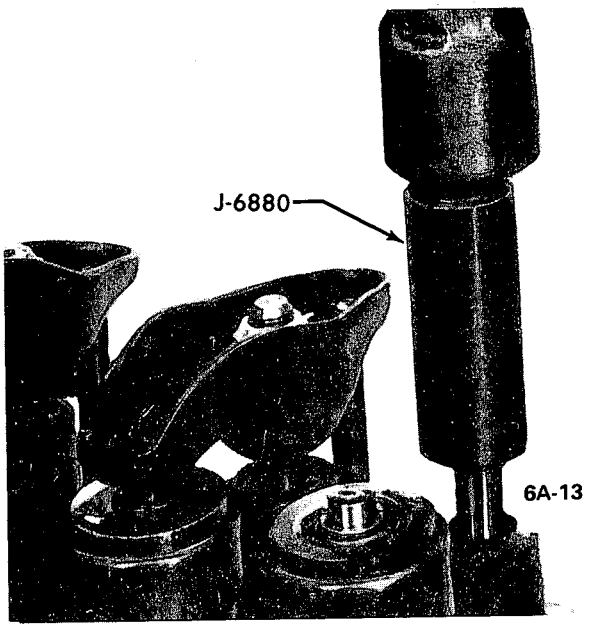


Figure 6A-9 - Installing Rocker Arm Stud

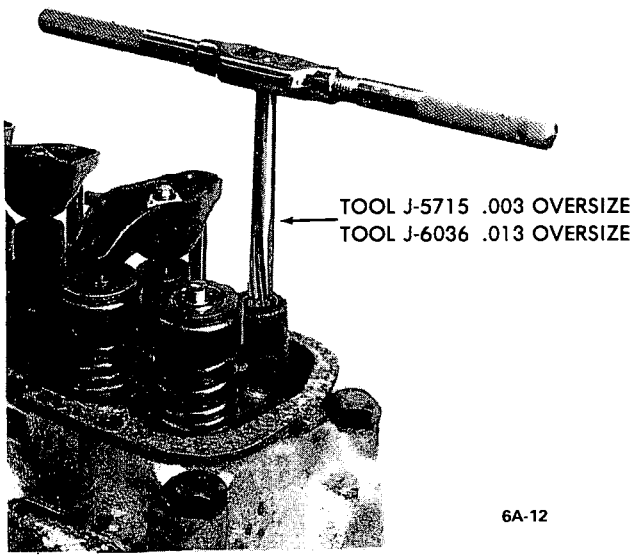


Figure 6A-8 - Reaming Rocker Arm Stud Hole

ORIGINAL ROCKER ARM STUD IS 3/8" - 24 N. F. IF STUD IS STRIPPED, USE 3/8" - 16 N.C. DIE TO RETHREAD STUD THEN PULL THE STUD AS SHOWN.

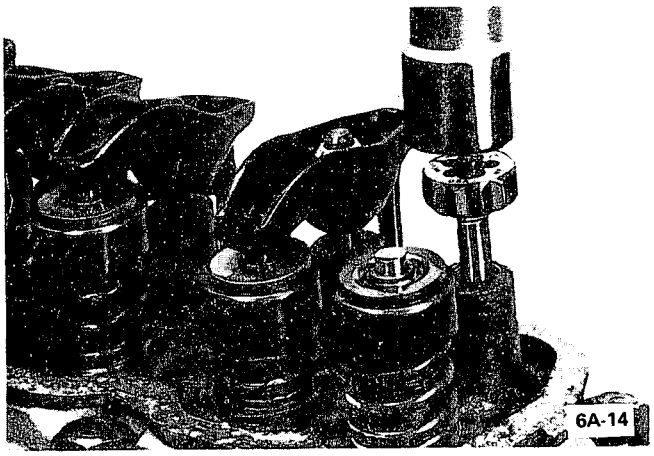


Figure 6A-10 - Removing Stripped Rocker Arm Stud

3. If rocker arm stud is stripped refer to Figure 6A-10 for rethreading and Figure 6A-11 for pulling the stud.

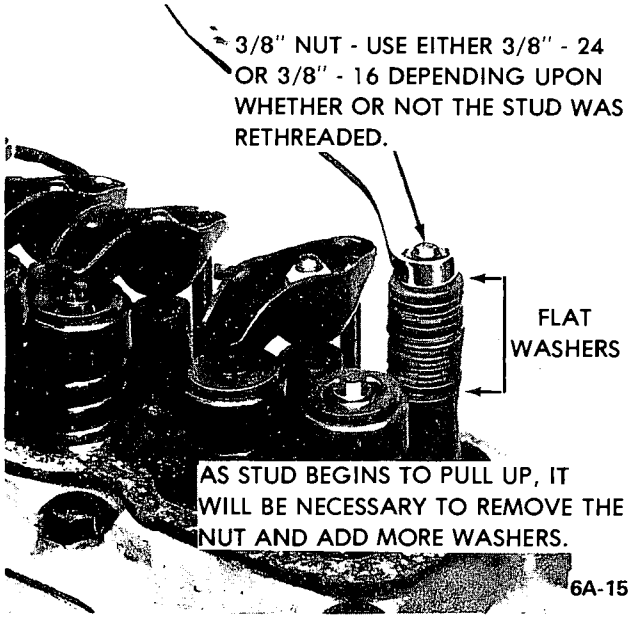


Figure 6A-11 - Removing Rocker Arm Stud

Distributor Lower Bearing and Thrust Washer Replacement

The distributor lower bearing is a bronze bushing pressed into the lower side of the engine block. Its upper inside diameter pilots the distributor shaft and the outside diameter extending below the block pilots the oil pump.

The lower bushing will ordinarily require only a clearance or wear check during engine overhaul. When distributor shaft-to-bushing clearance exceeds .0035", the bushing should be replaced as follows with oil pump and distributor removed. See Figure 6A-12.

1. Install Tool J-9534-01 into bushing and using a slide hammer, remove the bushing.

2. Using a drift up through bushing bore, drive thrust washer (if installed) out of bore and remove from block.

3. Clean bushing bore in block and check for burrs or damage.

4. If thrust washer was removed start new washer in position in bore and drive into place.

5. Position bushing and drive the bushing into position until 3/16" is extended below the crankcase rail.

6. Position bushing and driver to block and drive the bushing in position, which is determined by tool bottoming against the block.

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. *The ends of shells must never be filled flush with parting surface of rod or cap.*

If a precision type connecting rod bearing becomes noisy or 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.*

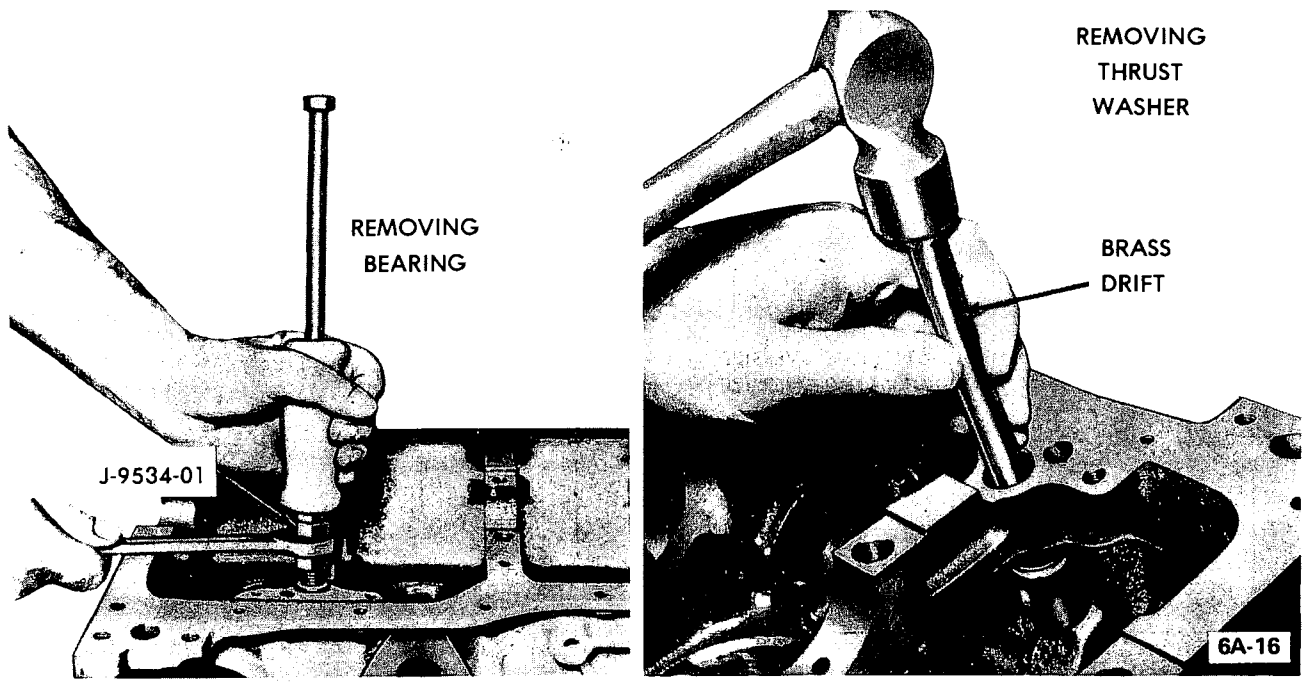


Figure 6A-12 - Replacement of Distributor Bearing and Thrust Washer

Removal

1. Disconnect battery positive cable.

2. Remove radiator upper mounting panel or side mount bolts.

3. Place a piece of heavy cardboard between fan and radiator.

4. Disconnect fuel suction line at the fuel pump.

5. Raise vehicle on hoist and drain engine oil.

6. Disconnect and remove starter.

7. Remove either flywheel underpan or converter housing underpan and splash shield.

8. Disconnect steering rod at idler lever, then position steering linkage to one side for oil pan clearance.

9. Rotate crankshaft until timing mark on torsional damper is at 6:00 o'clock position.

10. Remove bolts attaching brake line to front crossmember and move brake line away from crossmember.

11. Remove "through" bolts from engine front mounts.

12. Remove oil pan bolts.

13. Remove left engine mount and frame bracket. Remove oil pan by lowering it slightly and then rolling it into opening created by removal of left engine mount until oil pan is clear. Tilt front of pan upward and remove by pulling pan down and to the rear of vehicle.

Installation

1. Thoroughly clean all gasket sealing surfaces.

2. Using a new gasket set, install rear seal in rear main bearing cap.

3. Install front seal on crankcase front cover, pressing tips into holes provided in cover. See Figure 6A-13.

4. Install side gaskets to engine block, using a gasket sealer with sufficient body to act as a retainer.

5. Install pan by tilting front end upward on its side and inserting into the space on the left of engine. Roll pan under engine and then upward and install pan bolts. Torque pan bolts to specifications. Install left engine mount and bracket. Torque to specifications.

6. Install engine mount, lower engine and install engine mount "through" bolts. Torque bolts to specifications.

7. Reinstall and secure brake line to front crossmember.

8. Connect and secure steering rod at idler lever. Torque to specifications.

9. Install flywheel underpan or converter housing underpan and splash shield as applicable.

10. Install and connect starter.

11. Install radiator upper mounting panel or side mount bolts as applicable.

12. Remove cardboard previously placed between fan and radiator.

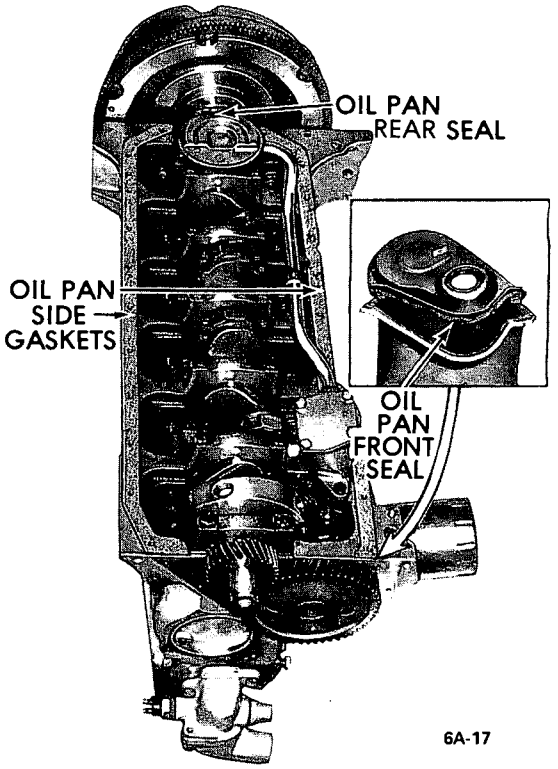


Figure 6A-13 Pan Gasket and Seals

13. Connect fuel suction line at fuel pump and connect battery positive cable.

14. Refill crankcase with engine oil, start engine and check for leaks.

Inspection of Connecting Rod Bearings and Crankpin Journals

After removal of engine oil pan, 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.

Do not interchange rod caps with 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 crankpin as described below.

If crankpin journals are scored or ridged, the crankshaft must be replaced or reground for undersize 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 .001" out-of-round, satisfactory life of new bearings cannot be expected.

Checking Clearance and Selecting Replacement Bearings

Service bearings are furnished in standard size and several undersizes.

The clearance of connecting rod (and crankshaft) bearings may be checked by use of plastic-type guage which has a *range* of .001" to .003".

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

Plastic-type guage is soluble in oil.

2. Place a piece of plastic-type guage lengthwise along the bottom center of the lower bearing shell (Figure 6A-14, View A). Install cap with shell and tighten bolt nuts to 35 lb. ft. torque.

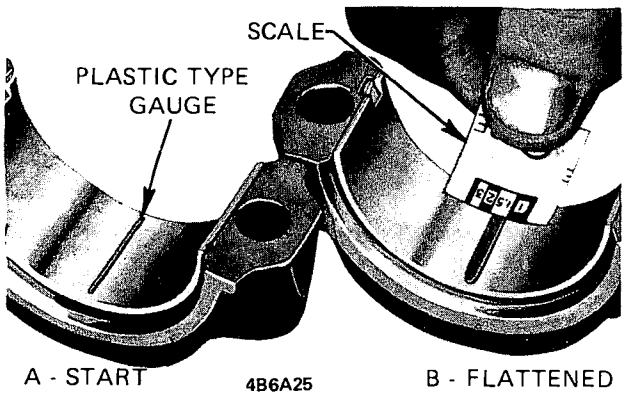


Figure 6A-14 Checking Bearings with Plastic-Type Gage

3. DO NOT TURN CRANKSHAFT with plastic-type guage in bearing.

4. Remove bearing cap with bearing shell, the flattened plastic-type guage will be found adhering to either the bearing shell or the crankpin. *Do not remove it.*

5. Using the scale printed on the plastic-type guage envelope, measure the flattened plastic-type guage at its widest point. The number within the graduation which most closely corresponds to the width of plastic-type guage indicates the bearing clearance in thousandths of an inch. See Figure 6A-14, View B.

6. The desired clearance with a new bearing is .0007" to .0027". If bearing has been in service, it is advisable to install a new bearing if the clearance exceeds .004"; 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 plastic-type guage.

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

8. After the proper size bearing has been selected, clean off the plastic-type guage, oil the bearing thoroughly, reinstall cap with bearing shell and tighten bolt nuts. Torque to 35 lb. ft.

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.

10. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to make sure they have clearance.

11. Measure all connecting rod side clearances (see specifications), between the connecting rod cap and side of crankpin. See Figure 6A-15.

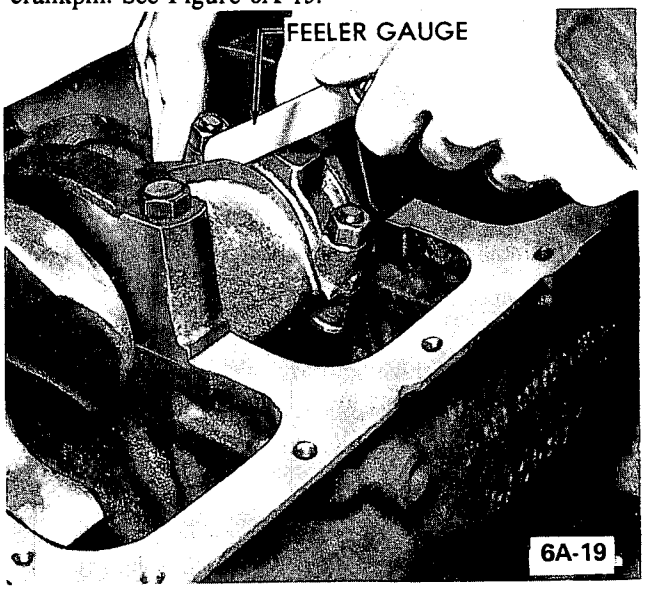


Figure 6A-15 Measuring Connecting Rod Side Clearance

CRANKSHAFT BEARINGS AND SEALS

Replacement of Crankshaft Bearings

A crankshaft bearing consists of two halves or shells which are not alike and not interchangeable between 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. All crankshaft bearings except the rear main bearings are identical. The thrust bearing (No. 7) is flanged to take end thrust. When the shells are placed in crankcase and bearing cap, the ends extend slightly beyond the parting surfaces. 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.*

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.

The following procedure is suggested when checking crankshaft for distortion.

Rest crankshaft on "V-blocks" at No. 1 and No. 7 main bearing journals. Check indicator runout at No. 2 and 6 main bearing journals. Total indicator readings at each journal should not exceed .001".

When checking runout at each journal, note relation of "high" spot (or maximum eccentricity on ecah 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 affects 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.

If replacement of cylinder block or crankshaft is required, always check main bearing clearance with plastic-type guage 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 plastic-type guage as described for connecting rod bearings.

4. When checking a crankshaft bearing with plastic-type guage, turn crankshaft so that oil hole is up to avoid dripping oil on plastic-type guage. 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.*

5. If bearing clearance exceeds .004", 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 rotate crankshaft so that tool rotates the shell out of place by pushing against end without tang. See Figure 6A-16.

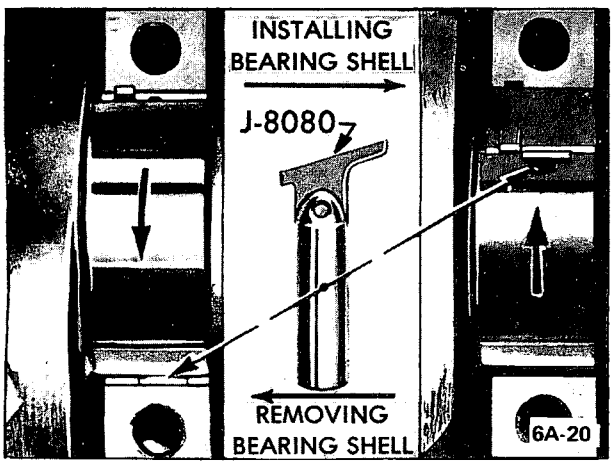


Figure 6A-16 Removal and Installation of Crankshaft Bearing (Upper Shell)

The rear main journal has no oil hole. Replace the rear main bearing upper half as follows:

a. Use a small drift punch and hammer to start the upper bearing half rotating out of block.

b. Use a pair of pliers (with taped jaws) to hold the bearing thrust surface to the oil slinger and rotate the crankshaft to remove bearing. See Figure 6A-17.

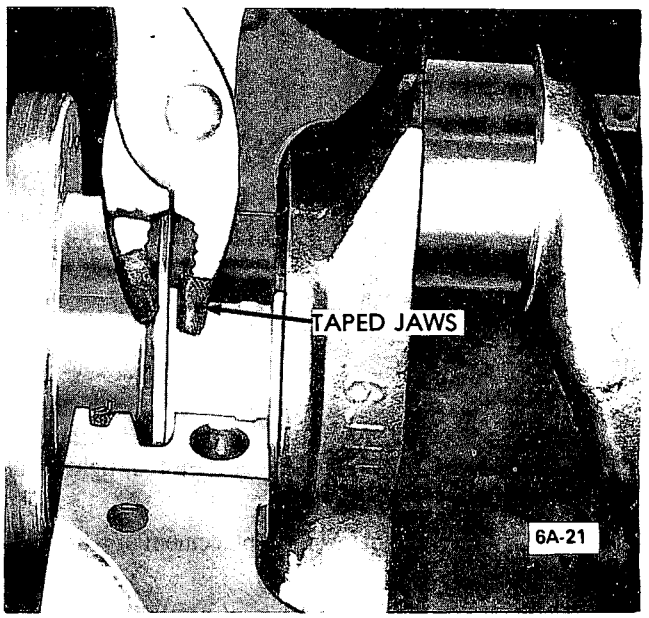


Figure 6A-17 (Rear) Main Bearing Replacement

c. Oil new selected size upper bearing and insert plain (unnotched) end between crankshaft and indented or notched side of block.

d. Use pliers as in removing to rotate bearing into place. The last 1/4" movement may be done by holding just the slinger with the pliers or tap in place with a drift punch.

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-or-round by using a special crankshaft caliper and inside micrometer. The caliper should not be applied to journal in line with oil hole.

If crankshaft journal is more than .001" out-of-round, the crankshaft should be replaced since satisfactory service cannot be expected from bearings used with an excessively out-or-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.

IMPORTANT: *Upper bearing shells have an oil groove in their center, while lower shells are plain. They must not be interchanged.*

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. See Figure 6A-16.

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

12. Place lower bearing shell in bearing cap, then check clearance with plastic-type guage as previously described.

13. The desired clearance with a new bearing is .0029" to .003". If this clearance cannot be obtained with a standard size bearing, insert an undersize bearing and check again with plastic-type guage.

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 plastic-type guage, oil the lower shell and reinstall bearing cap. Clean the bolt holes and lube bolts, then torque cap bolts to 65 lb. ft. The crankshaft should turn freely at flywheel rim; however, a very slight drag is permissible.

15. After bearing is installed and tested, loosen all bearing cap bolts 1/2 turn and continue to install other bearings. When bearings have been installed and tested, tighten all bearing cap bolts to 65 lb. ft.

16. Refer to paragraph below for replacement of rear bearing oil seals.

17. Install oil pump, pipe and screen assembly.

18. Thoroughly clean lower crankcase and flywheel housing and bell housing cover before installation.

19. Install oil pan.

Installation of Rear Bearing Oil Seals

The rear main bearing oil seal can be replaced (both halves) without removal of the crankshaft.

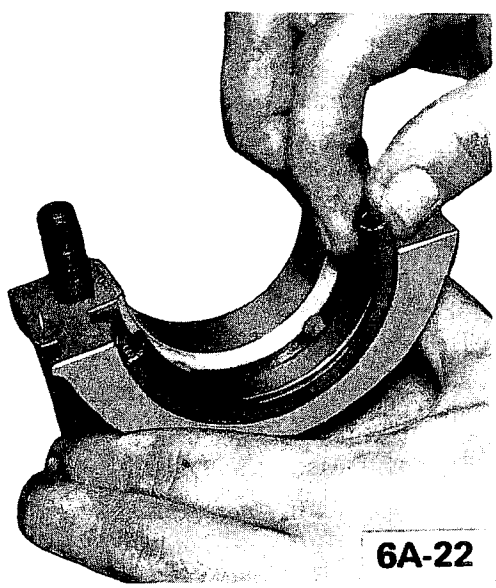


Figure 6A-18 Removing Rear Main Oil Seal (Lower)

Always replace the upper and lower seal as a unit. Install with the lip facing toward the front of the engine.

1. With the oil pan removed, remove the rear main bearing cap.

2. Remove oil seal from the groove by lifting the end tab then clean seal groove. See Figure 6A-18.

3. Lubricate the lip and O.D. of a new seal with engine oil. Keep oil off the parting Line surface. Insert seal in cap and roll it into place with finger and thumb, using light pressure so beads on seal O.D. are not cut by seal groove at cap parting line. Be sure tabs on seal are properly located in cross grooves.

4. To remove the upper half of the seal, use a small hammer to tap a brass pin punch on one end of seal until it protrudes far enough to be removed with pliers. See Figure 6A-19.

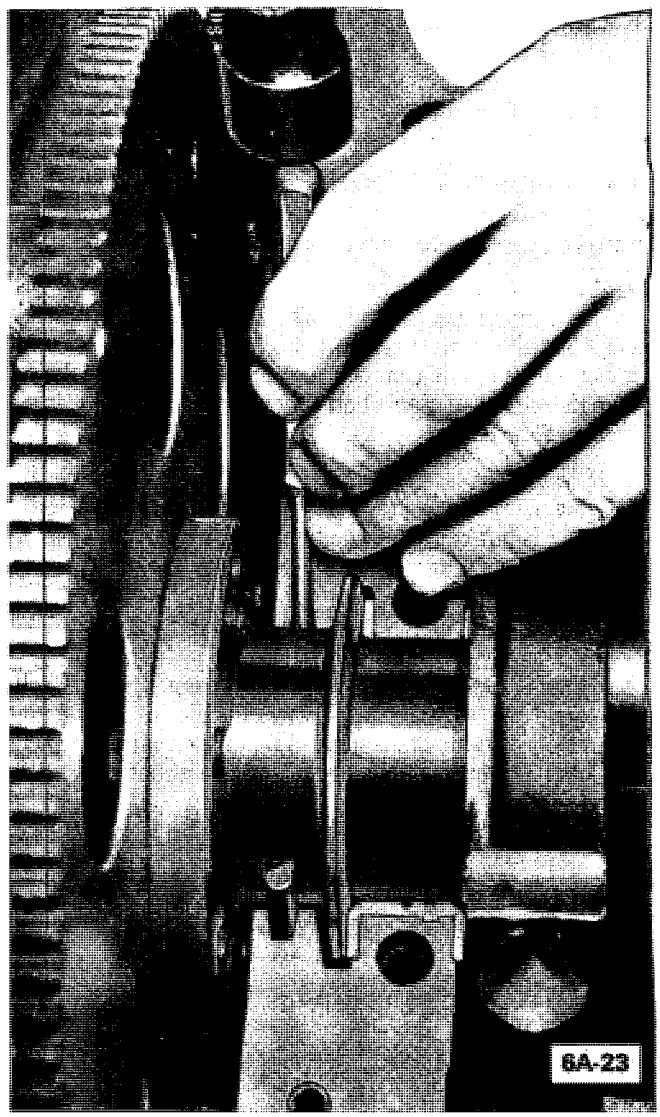


Figure 6A-19 Removing Rear Main Oil Seal Upper

Always clean crankshaft surface removing *all* foreign deposits before installing a new seal. Also clean seal grooves.

5. Lubricate the lip and O.D. of a new seal with engine oil. Keep oil off the parting Line surface. Gradually push with a hammer handle, while turning crankshaft, until seal is

rolled into place (similar to installing a main bearing). Be careful that seal bead on O.D. is not cut. Compress seal towards crankshaft as much as possible.

6. Install the rear main bearing cap (with new seal) and torque to specifications. Be sure cross seal tabs are in place and properly seated.

CAMSHAFT AND CRANKCASE FRONT COVER

Crankcase Front Cover Removal

1. Remove engine from vehicle as outlined.

2. Remove oil pan.

3. Install Tool J-6978 to torsional damper and turn puller screw to remove damper. See Figure 6A-20.

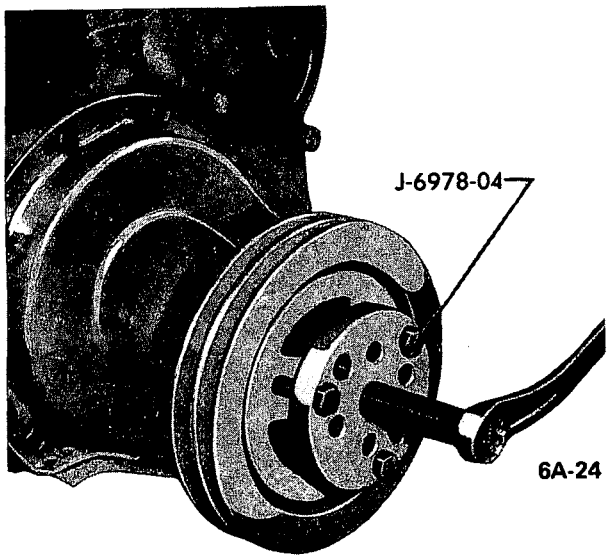


Figure 6A-20 Removing Torsional Damper

4. Remove crankcase front cover attaching bolts and remove cover and discard gasket. Thoroughly clean the cover, taking care to avoid damage to the gasket surfaces.

Crankcase Front Cover Installation

1. Clean gasket surfaces on block and crankcase front cover.

2. Install centering Tool J-21742 in crankcase front cover seal. See Figure 6A-21.

3. Coat the gasket with gasket sealer and place in position on cover, then install crankcase front cover to block and torque bolts to 7 lb. ft.

4. Remove centering Tool.

It is important that centering tool be used to align front cover so that torsional damper installation will not damage seal and to position seal evenly around the balancer or hub surface.

5. Coat front cover seal contact area of damper with engine oil.

6. Install torsional damper as follows:

CAUTION: *The inertia weight section of the torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight section on the*

CENTERING TOOL MUST BE INSTALLED AS SHOWN BEFORE TIGHTENING TIMING COVER TO CENTER SEAL SURFACE AROUND C/S.

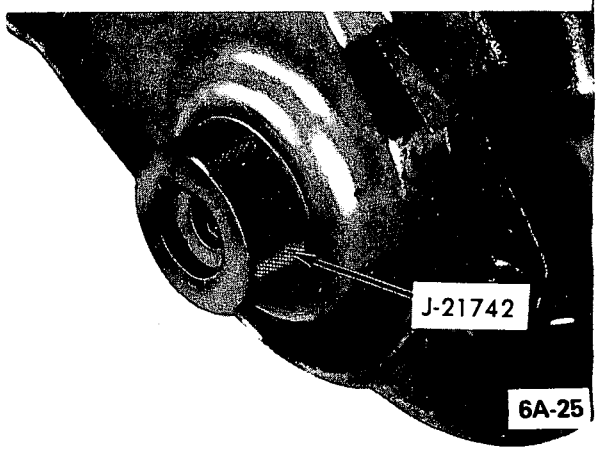


Figure 6A-21 Installing Centering Tool in Cover

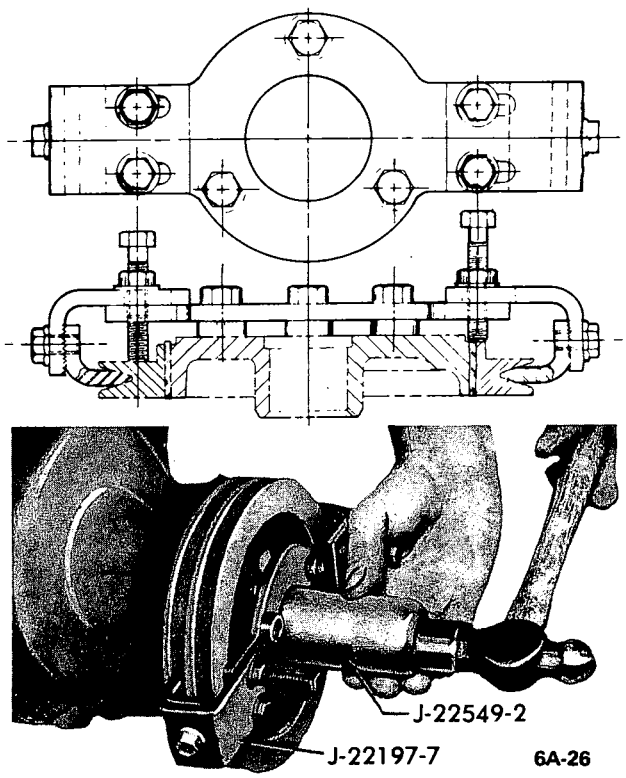


Figure 6A-22 Installing Torsional Damper

hub will destroy the tuning of the torsional damper.

a. Coat front cover seal area (on damper) with engine oil.

b. Attach damper Installer Tool J-22197 to damper. Tighten fingers of tool to prevent weight from moving. See Figure 6A-22.

Crankshaft Front Oil Seal Replacement

1. With cover removed, pry old seal out of cover from the front with screwdriver being careful not to distort cover.

2. Install new seal so that open end of the seal is toward the inside of cover and drive it into position with Tool J-21426. See Figure 6A-23.

Support cover at sealing area.

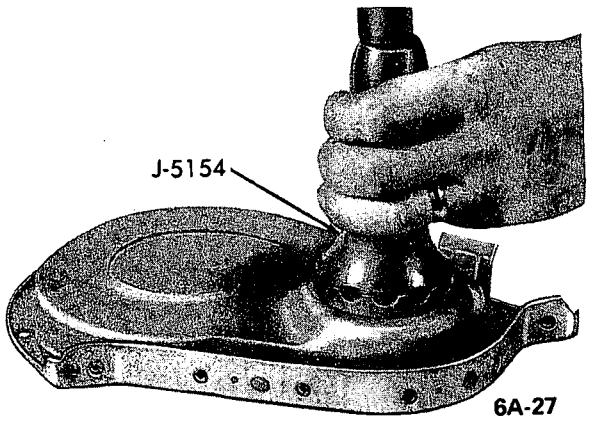


Figure 6A-23 Installing Oil Seal

Camshaft Removal

1. Remove front cover.

2. Remove valve lifters.

3. Remove fuel pump.

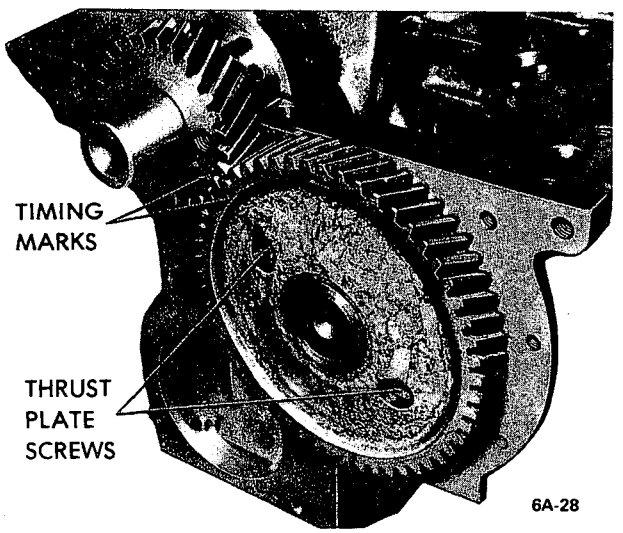


Figure 6A-24 Timing Gear Marks

4. Align timing gear marks then remove the two camshaft thrust plate bolts by working through holes in the camshaft gear. See Figure 6A-24.

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

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

Camshaft Gear Replacement

1. If the inspection indicates that the shaft, gear, or thrust plate should be replaced, the gear should be removed from the shaft. Refer to Figure 6A-25 for gear removal.

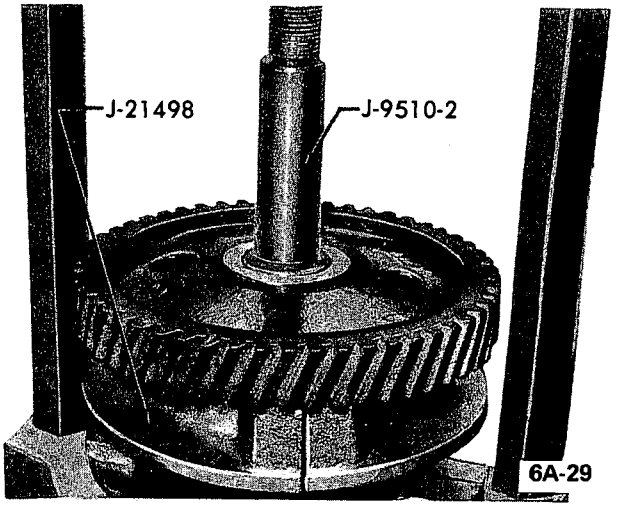


Figure 6A-25 Removing Camshaft Gear

Thrust plate must be positioned so that Woodruff key and shaft does not damage it when the shaft is pressed out of gear.

2. To assemble camshaft gear and thrust plate, use a hydraulic press to press gear onto camshaft.

3. Place the gear on the shaft until the correct clearance (.001" to .005") is obtained between the thrust plate and bearing.

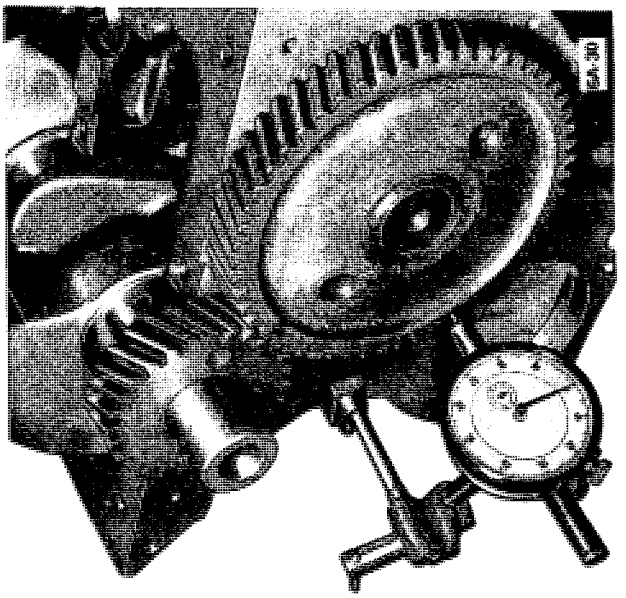


Figure 6A-26 Checking Camshaft Gear Runout

1. Install the camshaft and gear assembly in the engine block, being careful not to damage camshaft bearings or camshaft.

2. Turn crankshaft and camshaft so that the valve timing marks on the gear teeth will line up. See Figure 6A-24. Push camshaft into position. Install camshaft thrust plate to block bolts and torque to specifications.

3. Check camshaft and crankshaft gear runout with a dial indicator. The camshaft gear runout should not exceed .004" and the crankshaft gear runout should not exceed .003". See Figure 6A-26.

4. If gear runout is excessive, the gear will have to be removed and any burns cleaned from the shaft or the gear will have to be replaced.

5. Check the backlash between the timing gear teeth with a dial indicator. The backlash should not be less than .004" nor more than .006". See Figure 6A-27.

less than .004" nor more than .006". See Figure 6A-31.

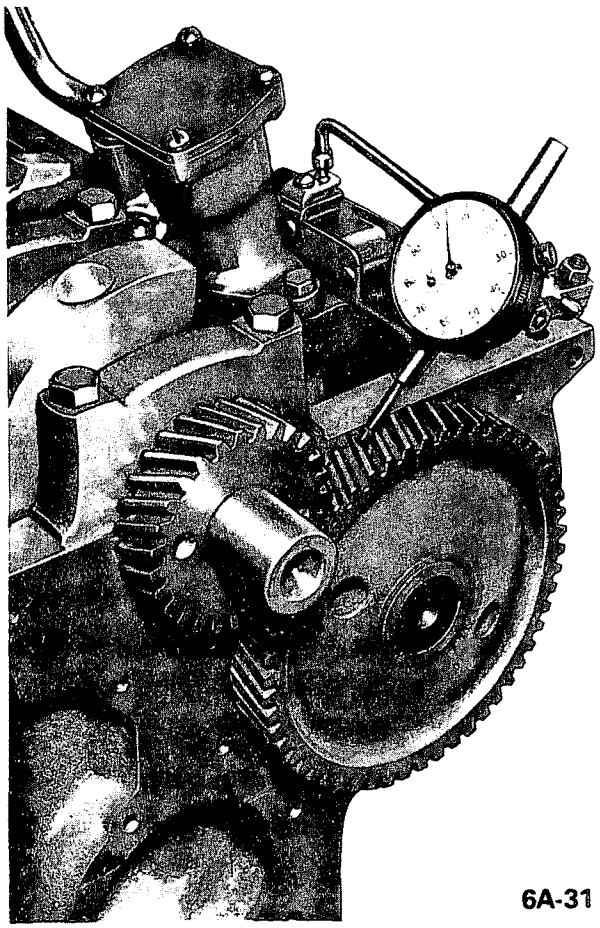


Figure 6A-27 Checking Timing Gear Backlash

Crankshaft Gear Removal and Installation

1. With camshaft removed, crankshaft gear may be removed using Tool J-6978. See Figure 6A-28. To install crankshaft gear use Tools shown in Figure 6A-29.

To install crankshaft gear use Tools shown in Figure 6A-33.

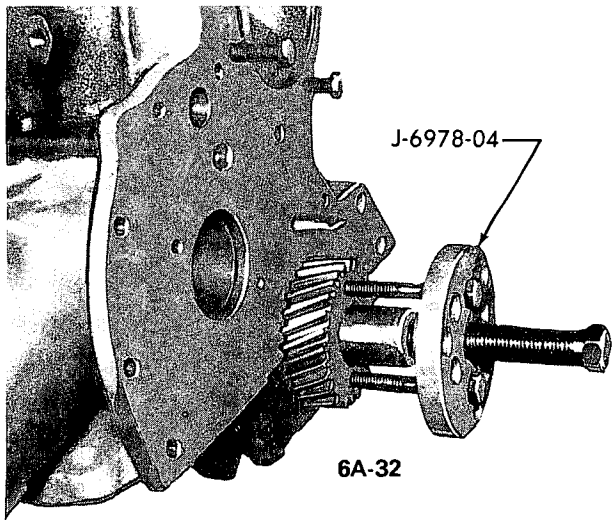


Figure 6A-28 Removing Crankshaft Gear

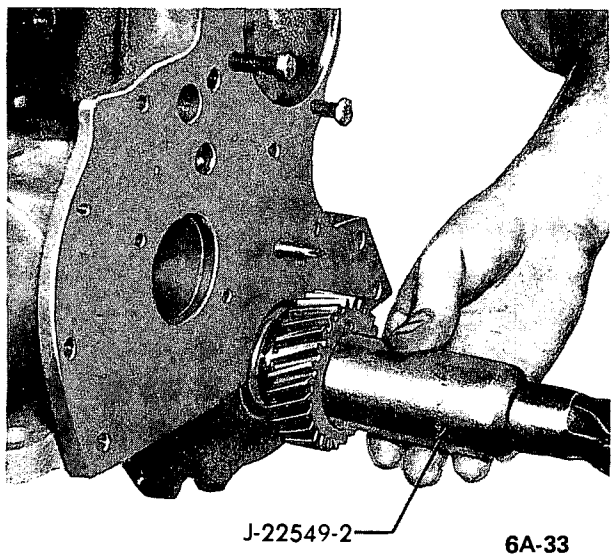


Figure 6A-29 Installing Crankshaft Gear

PISTON, RINGS, AND CONNECTING RODS

Disassembly, Inspection, and Replacement of Piston and Rod Assemblies Engine Removed

1. Remove oil pan, cylinder head and oil pump.

2. Examine the cylinder bores above the ring travel. If bores are worn so a shoulder or ridge exists at this point, remove the ridges with a ridge reamer to avoid damaging rings or cracking ring lands in pistons during removal. See Figure 6A-30.

3. Use a silver pencil or quick drying paint; mark the cylinder number on all pistons, connecting rods, and caps.

4. Remove cap and bearing shell from No. 1 connecting rod. Install connecting rod bolt guides on the bolts to hold the upper half of the bearing shell in place. See Figure 6A-31.

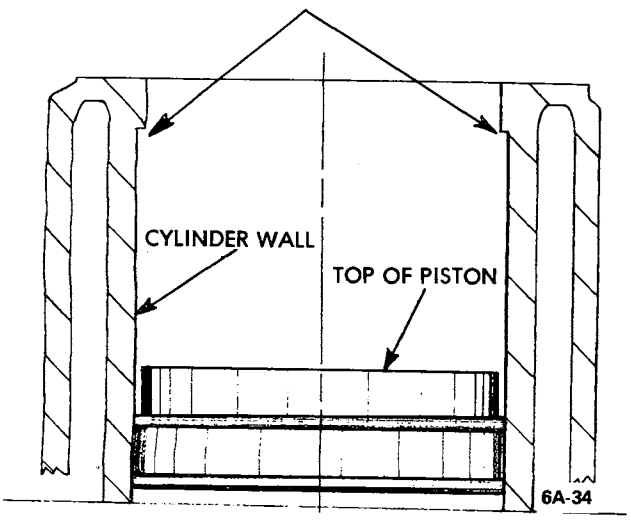


Figure 6A-30 Ridges Worn by Ring Travel

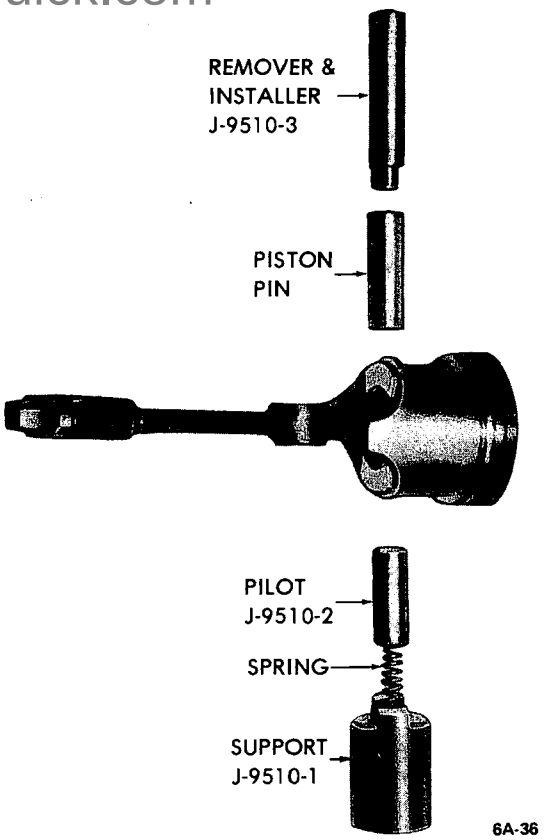


Figure 6A-32 Piston Pin and Tool Layout

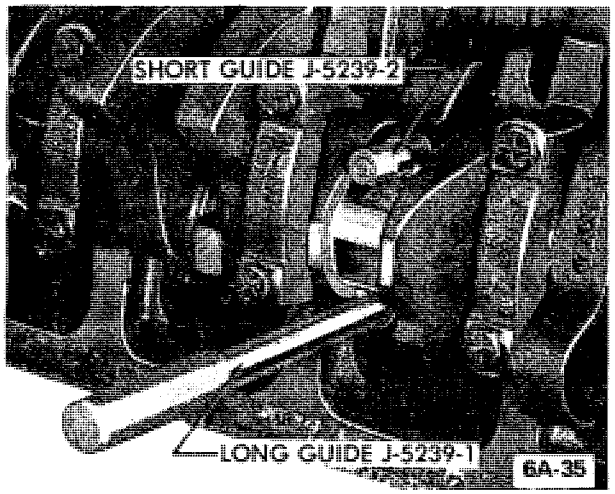


Figure 6A-31 Connecting Rod Bolt Guides Installed

5. Push the piston and rod assembly up out of the cylinder. Remove guides and reinstall cap and bearing shell on rod.

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

7. Remove compression rings. Remove expander and oil ring by removing the two rails and spacer-expander.

8. Remove piston pin in following manner:

(a) Place connecting rod and piston assembly in a hydraulic press with piston on support (J-9510-1), then using remover (J-9510-3) press piston pin out. See Figure 6A-32.

9. Inspect pistons and cylinder bores in the following manner:

(a) Inspect cylinder walls for scoring, roughness, or ridges which indicate excessive wear. Check cylinder bores for taper and out-of-round using an accurate cylinder gage at top, middle and bottom of bore, both parallel and at right angles to the centerline of the engine. The diameter of the cylinder bores at any point may be measured with an inside micrometer or by setting the cylinder gage dial at "O" and measuring across the gage contact points with outside micrometer while the gage is at same "O" setting.

(b) If a cylinder bore is moderately rough or slightly scored but is not out-of-round or tapered, it is possible to repair the bore by honing to accept a standard service piston. If cylinder bore is very rough or deeply scored, it may be necessary to rebore the cylinder to fit an oversize piston in order to insure satisfactory results.

(c) If cylinder bore is tapered .005" or more, is out-of-round .002" or more, it is advisable to rebore for the smallest possible oversize piston 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 solvent.

11. Carefully examine pistons for rough or scored bearing surfaces, cracks in skirt, head cracked or broken ring lands, and chipping or uneven wear which would cause rings 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 the right angle to the piston pin is greater than the diameter parallel to the piston pin. When a piston is checked for size, it must be measured with micrometers applied to the skirt at points 90 degrees to the piston pin.

See Figure 6A-33. The piston should be measured (for fitting purposes) 1/2" below the top of piston.

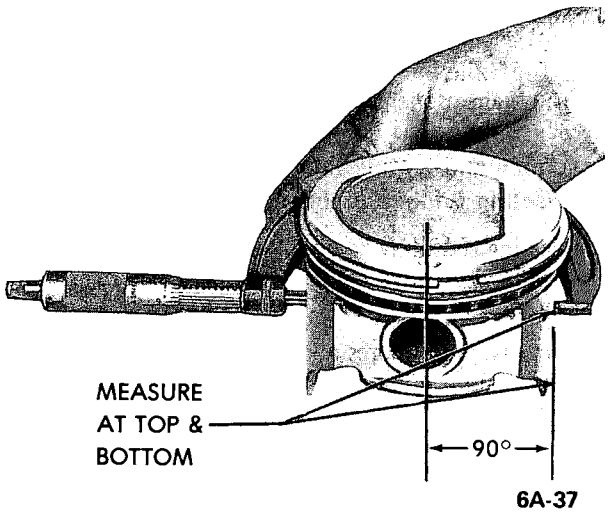


Figure 6A-33 Measuring Piston

12. Inspect bearing surfaces of piston pins. Check for wear by measuring worn and unworn surfaces with micrometers. Rough or worn pins should be replaced. Check fit of piston pins in piston bosses. Occasionally 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 overside, the piston and pin assembly must be replaced. Oversize pins are not practical because the pin is a press fit in the connecting rod. Piston pins must fit the piston with .0004" to .0007" clearance.

13. Examine all piston rings for scores, chips or cracks. Check compression rings for tension by comparing with new rings. Check gap of compression rings by placing rings in bore at bottom of ring travel. Measure gap with feeler gage. Gap should be between .010" and .020". If gaps are excessive (over .020") it indicates the rings have worn considerably and should be replaced.

Reboring Cylinder and Fitting New Pistons

If one or more cylinder bores are rough, scored, or worn beyond limits, it will be necessary to refinish 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. All oversize service pistons are held to the same weights as standard size pistons. If conditions justify replacement of all pistons, however, new pistons should all 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. All service pistons are diamond bored and selectively fitted with piston pins; pistons cannot be purchased without pins.

No attempt should be made to cut down oversize pistons to fit cylinder bores. This practice will destroy the surface treatment and affect the weight. The smallest possible oversize service pistons should be used and the cylinder bores should be honed to size for proper clearance.

Before the honing or reboring operation is started, measure all new pistons with micrometer contacting at points exactly 90 degrees to piston pin then select the smallest piston for the first fitting. The slight variation usually found between pistons in a set may provide for correction if the first piston has excessive clearance.

If wear of cylinder does not exceed .005" honing is recommended for truing the bore. If wear or out-of-round exceeds these limits, the bore should be trued up with a fly cutter boring bar, and 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 certain the crankshaft is out of the way of the boring cutter when boring each cylinder. When making 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 required amount of metal to be removed, in accordance with instructions of the hone manufacturer. 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 in order to maintain 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 have not over .005" 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. The dry bore should then be brushed clean with a power-driven fibre brush. If

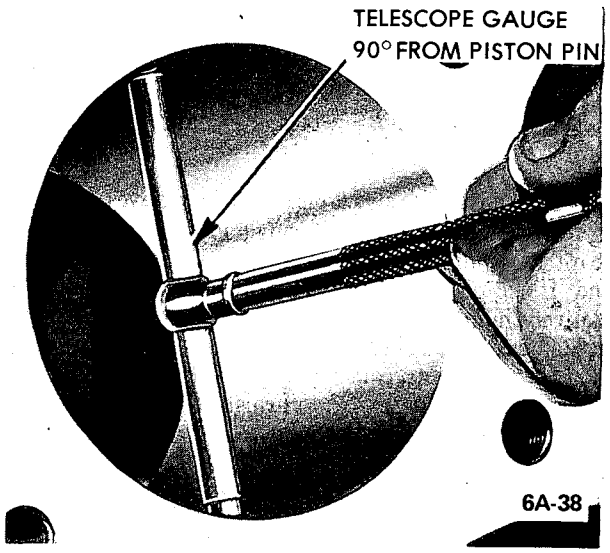


Figure 6A-34 Checking Cylinder Bore

all traces of abrasive are not removed, rapid wear of new pistons and rings will result. Fit new pistons in the following manner:

1. Expand a telescope gage to fit the cylinder bore at right angles to the piston pin 2-1/2" from top. See Figure 6A-34.

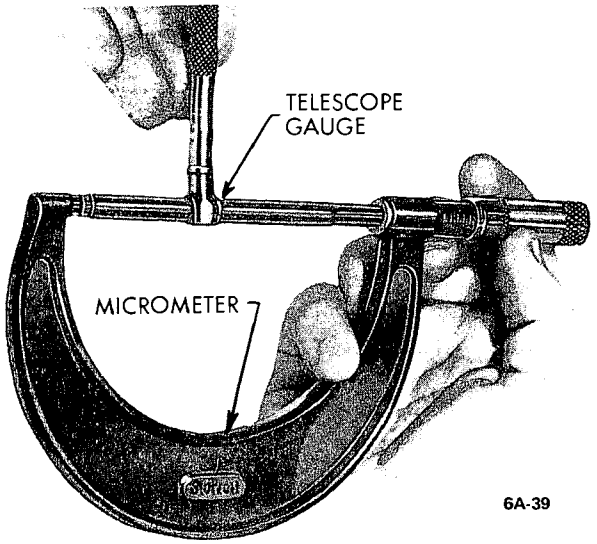


Figure 6A-35 Measuring Telescope Gage

2. Measure the piston to be installed. See Figure 6A-33. The piston must be measured at right angles to the piston pin 2-1/2" below the top of piston. The piston must be between .0005" and .0011" smaller than the cylinder bore.

Both block and piston must be at approximately the same temperature when measurements are made or expansion errors will occur. A difference of 10 degrees F. between parts is sufficient to produce a variation of .0005".

Fitting New Piston Rings

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

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. 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 since steps will interfere with the operation of new rings causing ring clearances to become excessive. Piston 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 .0012" - .0027" (top) and .0012"-.0032" (2nd) and the oil ring clearance should be .000"-.005".

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

Assembly and Installation of Piston and Connecting Rod Assemblies

Connecting rods may be out of alignment due to shipping or handling. Always check a new rod before installing piston and pin.

Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish or scuffing when being measured. The piston pin should be measured with a micrometer and the piston pin bore should be measured with a dial bore gage or an inside micrometer. If clearance is in excess of the .001" wear limit, the piston and piston pin assembly should be replaced.

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

2. Using Tool J-9510, place support (J-9510-1) with spring and pilot (J-9510-2) in place on an arbor press. See Figure 6A-32.

3. Connecting rod can be installed either way. See Figure 6A-36.

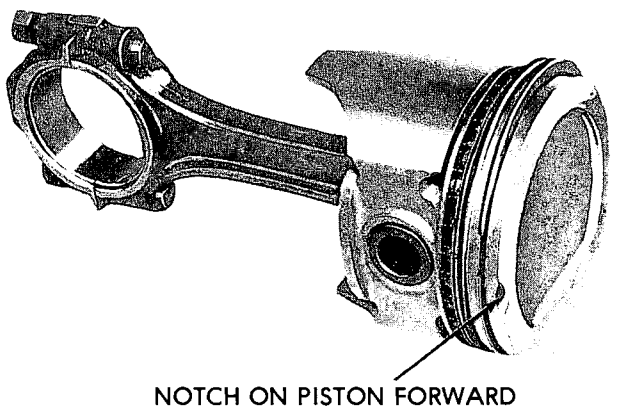


Figure 6A-36 Piston and Rod Assembly

4. Place piston on support, indexing pilot through piston and rod.

5. Place installer (J-9510-3) on piston pin, start piston pin into piston and press on installer until pilot bottoms in support.

6. Remove installer from connecting rod and piston assembly and check piston for freedom of movement on piston pin.

7. Install piston rings as shown in Figure 6A-37.

8. *All compression rings are marked with a dimple, a letter "T", a letter "O" or word "TOP" to identify the side of*

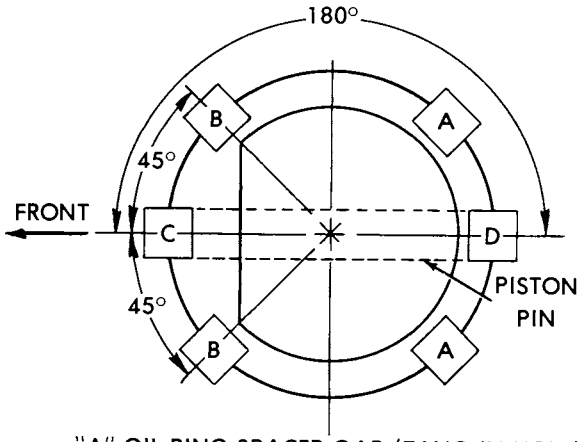


Figure 6A-37 Ring Gap Positioning

the ring which must be assembled toward the top of the piston.

9. Make sure 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 bore, position the crankpin straight down.

11. Remove connecting rod cap, and with bearing upper shell seated in rod; install connecting rod guides. These guides hold the upper bearing shell in place and prevent damage to the crankpin during installation of the connecting rod and piston assembly.

12. Make sure the gap in the oil ring rails and the gaps of the compression rings are positioned as shown in Figure 6A-37.

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 6A-38.

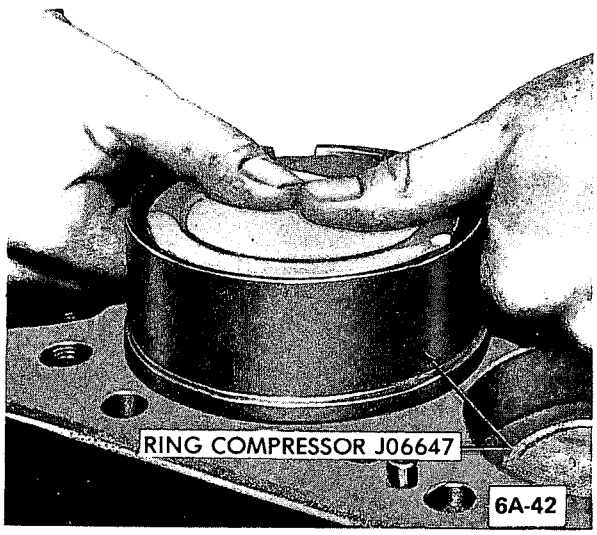


Figure 6A-38 Installing Piston with Ring Compressor

14. Select a new connecting rod bearing, if necessary. Otherwise install cap with bearing lower shell on rod and tighten bolt nuts to 35 lb. ft. torque.

15. Install all other piston and rod assemblies in same manner.

16. Check end clearance between connecting rods in each crankpin using feeler gages. Clearance should be between .009" and .014".

IMPORTANT: *After installation of new pistons and rings care should be used in starting the engine and running it for the first hour. Avoid high speeds until the parts have had a reasonable amount of "break-in" time. This practice will avoid unnecessary "scuffing" of new parts.*

REMOVAL AND INSPECTION OF OIL PUMP AND PICKUP SCREEN AND PIPE ASSEMBLY

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. The oil pump is driven by the distributor shaft which is driven by the helical gear on the camshaft.

1. Remove oil pan as outlined.

2. Remove two flange mounting bolts, pickup pipe bolt, then remove pump and screen as an assembly.

3. Remove the pump cover attaching screws, the pump cover and the pump cover gasket.

Mark gear teeth so they may be reassembled with the same teeth indexing.

4. Remove the idler gear and the drive gear and shaft from the pump body.

5. Remove the pressure regulator valve retaining pin, pressure regulator valve and related parts.

6. If the pickup screen and pipe assembly need replacing, mount the pump in a soft-jawed vise and extract pipe from pump.

NOTE: *Do not disturb the pickup screen on the pipe. This is serviced as an assembly.*

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

8. Inspect the pump body and cover for cracks or excessive wear.

9. Inspect pump gears for damage or excessive wear.

10. Check the drive gear shaft for looseness in the pump body.

11. Inspect inside of pump cover for wear that would permit oil to leak past the ends of the gears.

12. Inspect the pickup screen and pipe assembly for damage to screen, pipe or relief grommet.

13. Check the pressure regulator valve for fit.

The pump gears and body are not serviced separately. If the pump gears on body are damaged or worn, replacement of the entire oil pump assembly is necessary.

Oil Pump Assembly and Installation

Assembly

1. If the pickup screen and pipe assembly was removed, mount the pump in a soft-jawed vise, apply sealer to end of pipe and tap pipe in place. See Figure 6A-39.

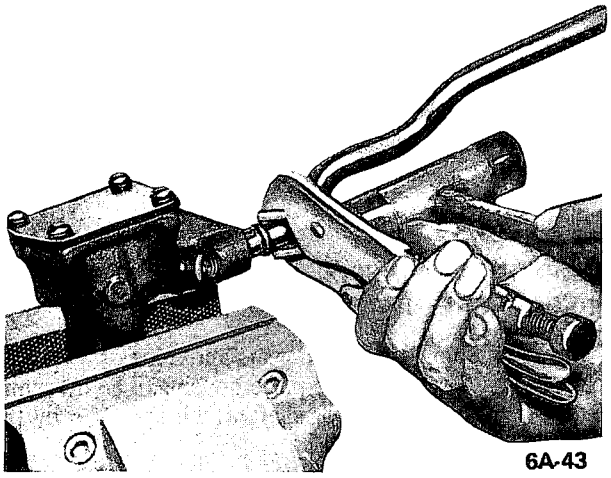


Figure 6A-39 Installing Pick-Up Screen and Pipe Assembly

Be careful of twisting, shearing or collapsing pipe while installing pump. Pickup screen must be parallel to bottom of oil pan.

2. Install the pressure regulator valve and related parts.

3. Install the drive gear and shaft in the pump body.

4. Install the idler gear in the pump body with the smooth side of gear towards pump cover opening.

5. Install the pump cover with new gasket and torque attaching screws to specifications.

6. Align oil pump drive shafts to match with distributor tang, then install oil pump to block positioning flange over distributor lower bushing. Use no gasket.

7. Install oil pan using new gaskets and seal as outlined.

Oil Filter Bypass Valve Inspection and Replacement

With the oil filter removed, check the spring and fibre valve for operation. Inspect for a cracked or broken valve. If replacement is necessary, remove valve by prying it out with a screw driver. Install and seat a new valve by taping it in place, using a 9/16 thin-wall deep socket. See Figure 6A-40.

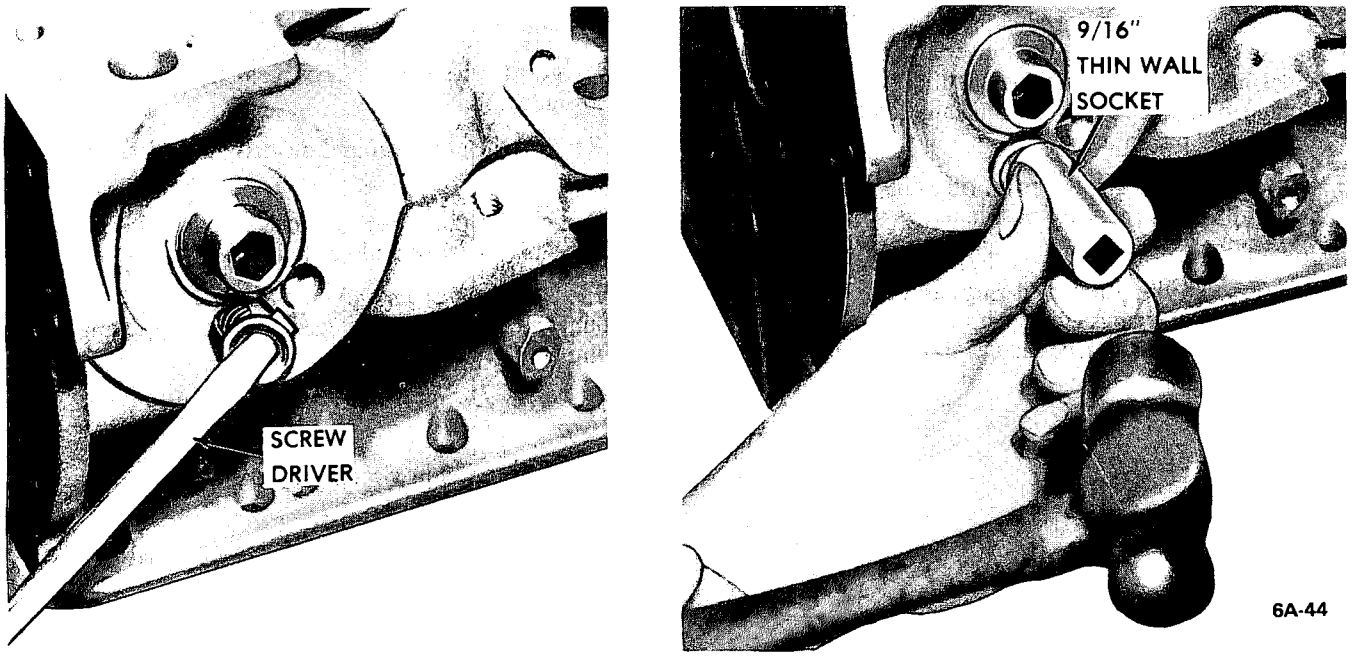


Figure 6A-40 Oil Filter By-Pass Valve

SPECIFICATIONS

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 measurements 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	Lb. Ft.
Spark Plugs	15
Oil Filter	Hand Tight
Fuel Pump	20
Carburetor to Intake Manifold	15
Distributor Clamp	20
Starting Motor to Block	30
Motor Mount to Block	35
Oil Pressure Sending Unit	10
Oil Pan Drain Plug	20
Oil Pump	9
Oil Pump Cover	6
Oil Pan to Cylinder Block	7
Oil Pan to Front Cover	4
Rocker Arm Cover	4
Push Rod Cover	4
Temperature Sending Unit	20
Thermostat Housing	30
Water Outlet	20
Water Pump	15
Exhaust Manifold to Intake Manifold	30
Intake Manifold to Head	35
Camshaft Thrust Plate	7
Crankcase Front Cover	7
Lower Flywheel Housing Cover	7
Flywheel Housing to Cylinder Block	30
Flywheel	60
Clutch Pressure Plate	35
Harmonic Balancer	60
Cylinder Head to Block	95
Main Bearing Cap	65
Connecting Rod Cap	35

General Specifications

Engine Type	In-Line L-6
Bore and Stroke	3.875 x 3.53
Piston Displacement	250
Carburetor Type-1 Bbl. Roch.	
Compression Ratio	8.25:1
Gasoline Requirements	Unleaded
Octane Requirement - Motor	83
Octane Requirement - Research	91
Cylinder Numbers - Front to Rear	1-2-3-4-5-6
Firing Order	1-5-3-6-2-4

Piston and Pin Specifications

Piston	
Material	Cast Aluminum Alloy
Type	Slipper
Piston Pins	
Material	Chromium Steel
Type	Pressed in Rod

Connecting Rods

Material	Drop Forged Steel
Rod Bearing	Copper Lead Alloy or Sintered Copper Nickel Backed Babbit on Steel

Ring Specifications

#1 Compression	Cast Alloy Iron
#2 Compression	Cast Alloy Iron
Oil Control Rings	Chrome Plated
Type	Multi-Piece (Two Rails and One Spacer)
Material	
Rails	Steel
Spacer	Alloy Steel
Ring Locations	Above Pin

Crankshaft Specifications

Material	Cast Nodular Iron
Bearings	Replaceable Steel, Backed Insert
Bearing Taking End Thrust	#7

Camshaft Specifications

Material	Cast Alloy Iron
Bearings	Steel Backed Babbit
Number of Bearings	4
Drive	Gear
Camshaft Sprocket	Bakelite and Fabric Composition with Steel Hub
Crankshaft Sprocket	Steel, Helical Gut

Valve Specifications

Intake Valve Material	Steel Alloy, Aluminized Face and Chrome Flashed Stem
Exhaust Valve Material	High Alloy Steel, Aluminized Face and Chrome Flashed Stem
Valve Lifter Mechanism	Hydraulic
Valve Spring	Single Spring

Lubrication System Specifications

Type of Lubrication	
Main Bearing	Pressure
Connecting Rods	Pressure
Piston Pins	Splash
Camshaft Bearing	Pressure
Timing Gears	Nozzle Sprayed
Cylinder Walls	Main and Connecting Rod Bearing Throw Off
Oil Pump Type	Gear
Normal Oil Pressure	40 psi @ 2000 rpm
Oil Pressure Sending Unit	Electric
Oil Intake	Stationary
Oil Filter System	Full Flow
Filter Type	Throwaway Canister
Crankcase Capacity - With Filter	4.5 Quarts
Crankcase Capacity - Less Filter	4 Quarts

Engine Dimensions and Fits

All measurements in inches, unless otherwise specified.

Piston Clearance Limits	
Top Land	.0245-.0335
Skirt Clearance	.0005-.0015
Ring Groove Depth	
#1 Compression Ring	.2153-.2218
#2 Compression Ring	.2153-.2218
#3 Oil Ring	.2093-.2158

Ring Width	
#1 Compression Ring	.0775-.0780
#2 Compression Ring	.0775-.0780
#3 Oil Ring (Assembled)	.1870-.1890
Ring Gap	
#1 Compression Ring	.010-.020
#2 Compression Ring	.010-.020
#3 Oil Ring	.015-.055
Piston Pin Length	2.990-3.010
Piston Pin Diameter	.9270-.9273
Clearance in Piston	.00015-.00025

Connecting Rod Specifications

Bearing Length	.807
Bearing Clearance Limits	.0007-.0027
End Play	.009-.014

Crankshaft Specifications

End Play at Thrust Bearing	.002-.006
Main Bearing Journal Diameter	2.3004
Crankpin Journal Diameter	1.999-2.000
Main Bearing Overall Length	
#1 - #6	.752
#7	.760
Main Bearing to Journal Clearance	.0003-.0029

Camshaft Specifications

Bearing Journal Diameter	1.8682-1.8692
Journal Clearance in Bearings	.0015-.0035

Valve System Specifications

Rocker Arm Ratio	1.75:1
Valve Lifter Diameter	.8427-.8422
Valve Lifter Clearance in Bore	.0005-.002
Intake Valve	
Overall Length	4.902-4.922
Head Diameter	1.715-1.725
Seat Angle	46°
Stem Diameter	.3410-.3417
Guide Diameter	.3427-.3437
Valve Spring	
Valve Closed	56# - 64# @ 1.66
Valve Opened	180# - 192# @ 1.27
Exhaust Valve	
Overall Length	4.913-4.933
Head Diameter	1.495-1.505
Seat Angle	46°
Stem Diameter	.3410-.3417
Guide Diameter	.3427-.3437
Valve Spring	
Valve Closed	56# - 64# @ 1.66
Valve Opened	180# - 192# @ 1.27

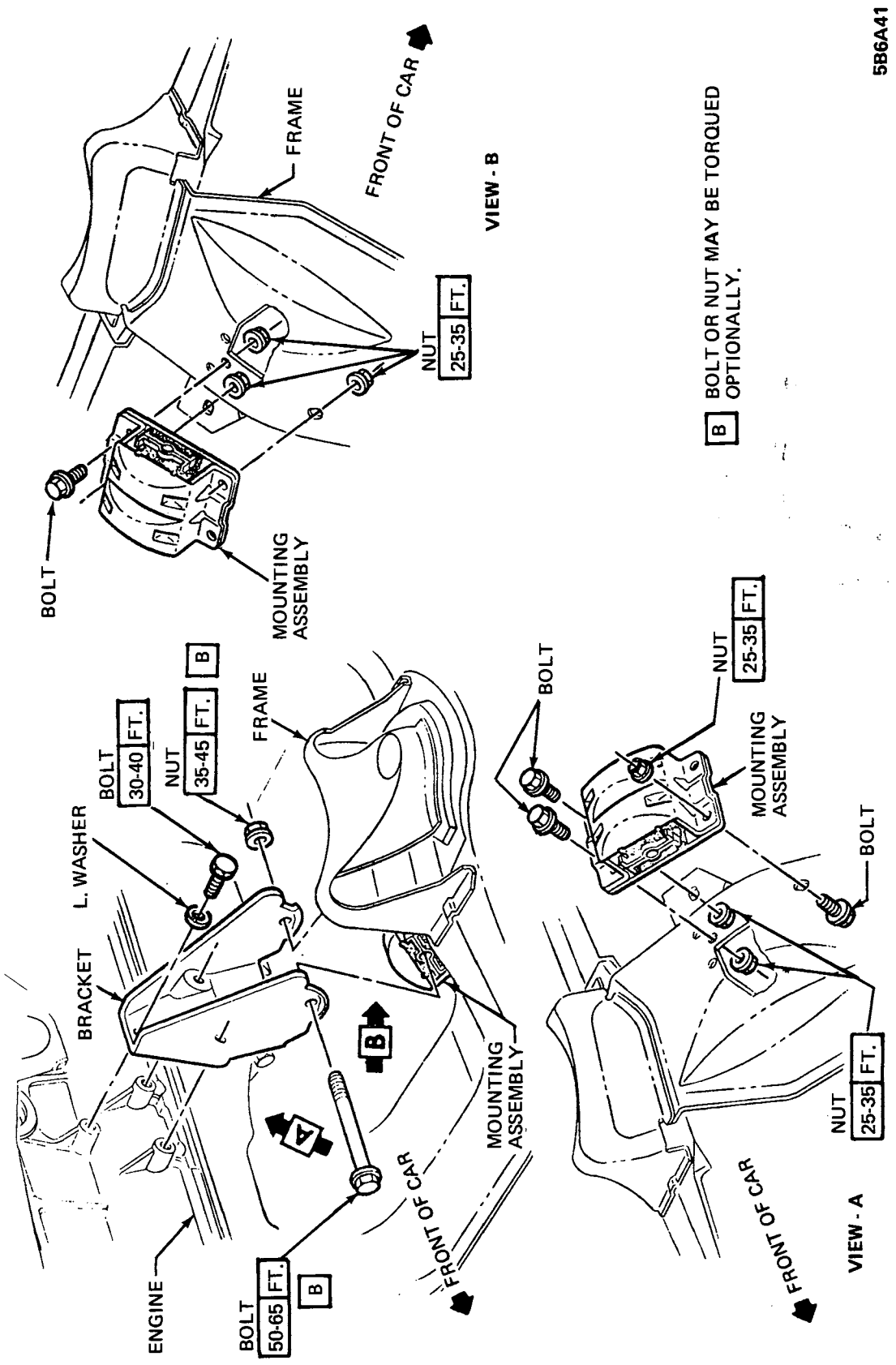


Figure 6A-41 L-6 Engine Mounting X Series

231, 350 AND 455 CU. IN. ENGINES

CONTENTS

DESCRIPTION AND OPERATION:
Engine Construction 6A-25
Lubrication System and Oil Pump 6A-26
DIAGNOSIS:
Excessive Oil Consumption 6A-28
Noisy Valves and Lifters 6A-29
MAINTENANCE AND ADJUSTMENTS: (Not Applicable)
MAJOR REPAIR:
231, 350 and 455 Cu. In. Engine Removal and Installation 6A-29
Exhaust and Intake Manifold, Cylinder Head, Valve Train and Lifters and Oil Pan 6A-30
Connecting Rod Bearings 6A-36
Crankshaft Bearings and Seals 6A-38
Pistons, Rings and Connecting Rods 6A-41
Camshaft and Timing Chain Inspection and Test 6A-46
Testing Oil Pressure 6A-49
Priming the Oil Pump 6A-49
Removal and Inspection of Oil Pump Cover and Gears 6A-49
Engine Mounting, Flywheel and Engine Balancing 6A-50
SPECIFICATIONS:
Bolt Torque Specifications 6A-52
General Specifications 6A-52
Engine Dimension and Fits 6A-54

DESCRIPTION AND OPERATION

ENGINE CONSTRUCTION

Engine Mounting

For details of engine and transmission mounts refer to illustrations at end of section.

Engine Construction

The 231, 350 and 455 cu. in. engines 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 of the engine, cylinders in the *left* bank are numbered 1-3-5-7 V-8 (1-3-5 V-6) and cylinders in the *right* bank are numbered 2-4-6-8 V-8 (2-4-6 V-6).

The *crankshaft,* nodular cast iron, is supported in the crankcase by five bearings V-8 (4 V-6) which are identical except number three V-8 and number 2 V-6, which takes end thrust and the rear main which has a different width and material. See Figure 6A-50 and 6A-51.

The *crankshaft* is counterbalanced by weights cast integral with the crankshaft. Additional counterbalancing is

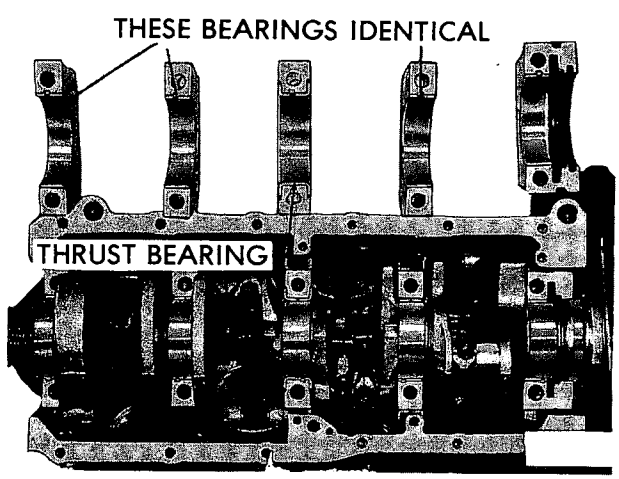


Figure 6A-50 - Engine Crankshaft and Bearings 350 and 455

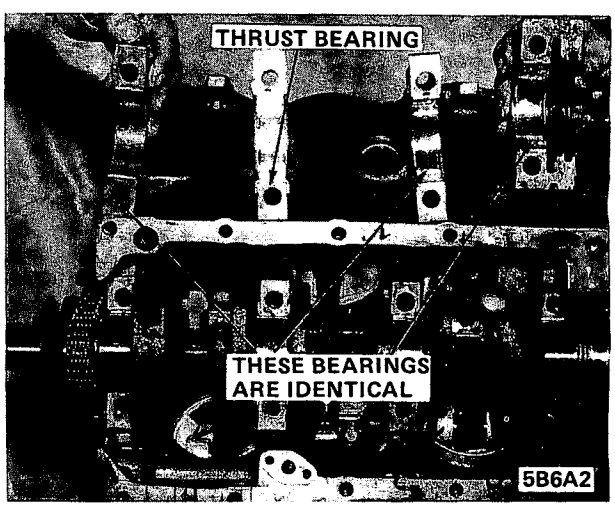


Figure 6A-51 - Engine Crankshaft and Bearings 231 Engine

obtained from the flywheel and harmonic balancer.

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 incorporate integral valve stem guides and rocker arm shaft pedestals. Right and left cylinder heads are identical and interchangeable, although in service, it is good practice to reinstall the cylinder heads on the side from which they are removed.

The intake manifold on all three engines 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.

Some 1975 engines have especially-designed intake manifolds for use with Air Injection Reactor and all engines use an Exhaust Gas Recirculation System.

The E.G.R. System, used on all engines has a cast passage from the exhaust heat passage to the E.G.R. valve and from the valve to a hole in the floor of the intake manifold under the carburetor.

Each *exhaust and intake valve* has a spring of ample capacity to insure positive seating throughout the operating speed range.

The valve rocker arms for each bank of cylinders are mounted on a tubular steel shaft supported on the cylinder head by four pedestals V-8's and three V-6. The rocker arms are stamped steel.

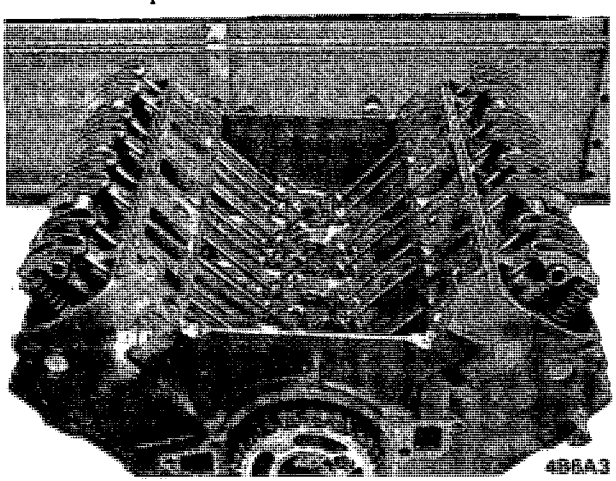
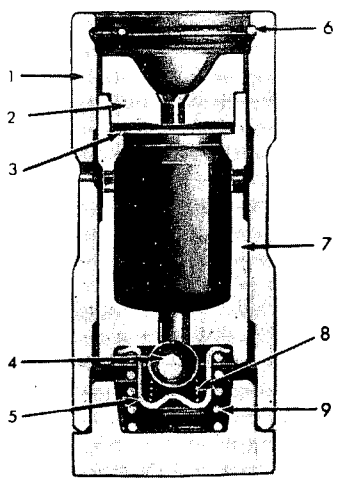


Figure 6A-52 - Engine Valve Mechanism (455 Shown)

Hydraulic valve lifters and tubular push rods are used to operate overhead rocker arms and valves of both banks of cylinders from a single camshaft. This system requires no lash adjustment at time of assembly or in service. Construction and operation of hydraulic valve lifters are described below.

In addition to its normal function of a cam follower, each hydraulic valve lifter also serves as an automatic adjuster which maintains zero lash in the valve train under all operating conditions. By eliminating all lash in the valve train and also providing a cushion of oil to absorb operating shocks, the hydraulic valve lifter promotes quiet valve operation. It also eliminates the need for periodic valve adjustment to compensate for wear of parts.

As shown in Figure 6A-53 all parts of a hydraulic lifter are housed in the lifter body, which is the cam follower.



1. LIFTER BODY
2. PUSH ROD SEAT
3. METERING VALVE
4. CHECK BALL
5. CHECK BALL RETAINER
6. PUSH ROD SEAT RETAINER
7. PLUNGER
8. CHECK BALL SPRING
9. PLUNGER SPRING

Figure 6A-53 - Hydraulic Valve Lifter

Oil is fed to all lifters through galleries in the crankcase. Oil enters each lifter through grooves and oil holes in the lifter body and plunger, flows down into the chamber below the plunger through the feed hole and around the check ball. The first few cycles of operation after the engine is started forces out all air and completely fills the plunger and lower chamber of each lifter with oil.

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 arms, and push rods. All other moving parts are lubricated by gravity flow or splash. See Figure 6A-54.

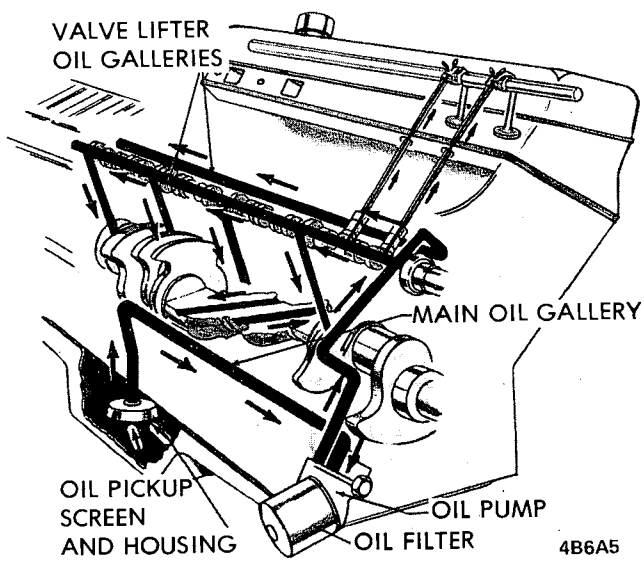


Figure 6A-54 - Schematic Diagram of Engine Oil Flow V-8 Shown

The supply of oil is carried in the lower crankcase (oil pan) which is filled through a filler opening in the left rocker arm cover. A removable oil gauge 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. The oil filter by-pass valve opens when the filter The oil filter by-pass valve opens when the filter has has become clogged, to the extent that approximately 10-15 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.

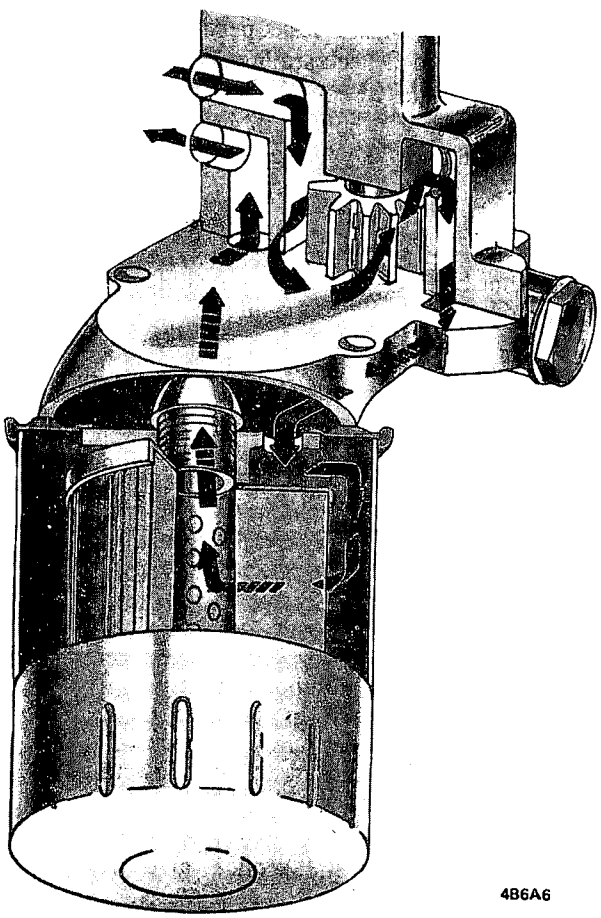


Figure 6A-55 - Oil Pump and Filter Assembly

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. Holes drilled from the crankshaft bearings to the main gallery intersect the cam bearing bores to supply oil to the cam 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 thrown off the crankshaft and connecting rod splash. Piston pins are lubricated by splash.

In the *231 and 350 engine,* a drilled hole in the camshaft connects the front camshaft bearing journal to the keyslot in the front of the camshaft. Oil flows from the journal

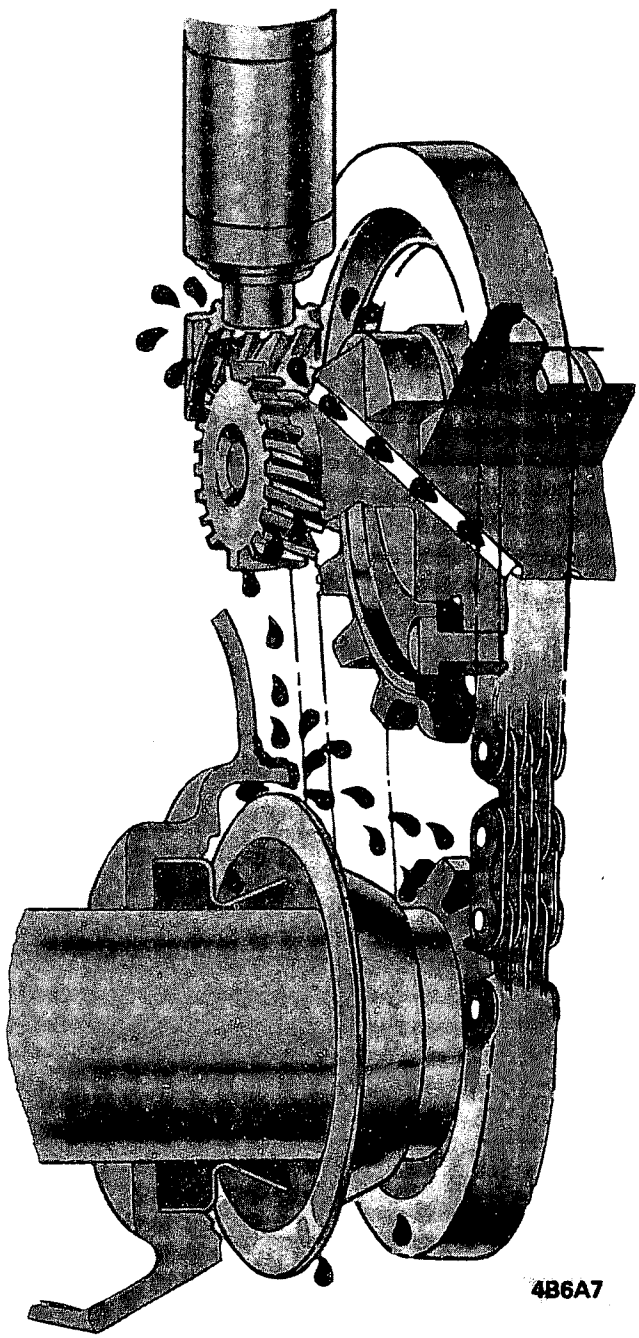


Figure 6A-56 - Front End Lubrication (455 Shown)

into the keyslot over the woodruff key in the space between the key and the camshaft sprocket and fuel pump eccentric.

In the *455 engine,* a drilled hole in the camshaft connects the front camshaft bearing journal to the front of the camshaft. Oil flows from the journal through a passage to an outlet between the camshaft sprocket and distributor gear.

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

Each rocker arm and valve is supplied with oil through the tubular push rod. This oil comes from the inside of the lifter, passing around the metering valve and through a hole in the lifter push rod seat. Oil from the push rod passes through a hole in the rocker arm push rod seat, and emerges on top of the push rod seat boss. See Figure 6A-57.

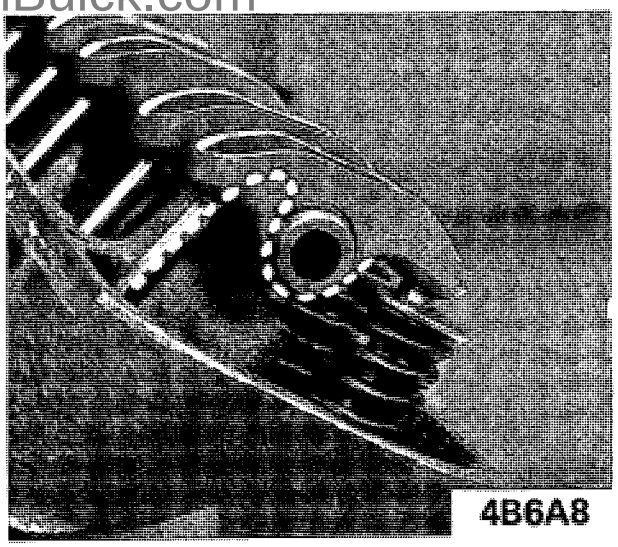


Figure 6A-57 - Overhead Lubrication

DIAGNOSIS

EXCESSIVE OIL CONSUMPTION

Possible Cause	Correction
1. External Oil Leaks at: Rocker Arm Covers Timing Chain Cover Oil Pan and Gasket Between Oil Pan and Flywheel Housing Intake Manifold Gasket	1. Tighten attaching bolts. If leaks persist, remove cover (or pan), check sealing surfaces for burrs, scoring or distorted cover flanges, replace gasket and seal attaching bolts with silastic sealer, or equivalent. Make sure oil level is not overfull.
2. Improper Reading of Dip Stick	1. 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 may be bent.
3. Oil Viscosity Too Light	1. Use recommended SAE viscosity for prevailing temperatures.
4. Continuous High Speed Operation	1. At speeds above 60 MPH, increased oil consumption can be expected with any engine. Inform customer of this fact.
5. High Speed Driving Following Normal Slow-Speed City Driving	1. 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 rapid lowering of oil level. Inform customer ofthis fact.
6. Valve Guides And/Or Valve Stem Seals Worn	1. Ream out guides and install service valves with oversize stems and new valve stem seals.
7. Piston Rings Not "Broken In"	1. Allow engine to accumulate at least 5,000 miles before attempting any engine disassembly to correct for oil consumption.

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 10 minutes of operation at 1200 to 1500 RPM) to stabilize oil and coolant temperatures and bring all engine parts 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 mechanism 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 train components 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 that is high enough to allow the crankshaft 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 train. 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 valve 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, rocker arm shaft and push rod ends for scoring. Check for bent push rods. Check 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. The normal height of the valve stem above the valve spring seat is 1.933 inches, for 231, 350 cu. in. engines and 2.082 inches for 455 cu.in. engines.

(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 the following paragraph.

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 0. The engine oil must be heavy-duty type (SE marked on container) and must also conform to General Motors Specification 6136-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 prevailing 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 at idle and low speed.* If one or more valve lifters are noisy at 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 idling, 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. With engine idling, strike each rocker arm above push rod several sharp blows with a mallet; if noise disappears, it indicates that foreign material was keeping check ball from seating. Stop engine and place lifters on camshaft base circle. If there is lash in any valve train, it indicates a stuck lifter plunger, worn lifter body lower end, or worn camshaft lobe.

(5) *Loud noise at normal operating temperature only.* If 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.

MAJOR REPAIR

ENGINE REMOVAL AND INSTALLATION

Removal

1. Remove hood; for easier installation, scribe marks should be made at hood hinge and the hinge bracket.

2. Disconnect battery.

3. Drain coolant into a suitable container.

4. Remove air cleaner.

5. On cars equipped with air conditioning, disconnect compressor ground wire from the mounting bracket. Remove the electrical connector from the compressor clutch, remove the compressor to mounting bracket attaching bolts, and position the compressor out of the way.

6. Remove fan blade, pulleys, and belts.

7. Disconnect radiator and heater hoses from engine and fasten them out of the way.

8. Remove fan shroud assembly.

9. Remove power steering pump to mounting bracket bolts and position pump assembly out of the way.

10. Remove fuel pump hoses and plug hoses.

11. Disconnect battery ground cable from engine.

12. Disconnect the vacuum supply hose from carburetor to the vacuum manifold. On cars so equipped, the vacuum modulator, load leveler, and power brake vacuum hoses should all be disconnected at the engine.

13. Disconnect throttle control cable at carburetor.

14. Disconnect oil and coolant sending unit switch connections at the engine.

15. Disconnect engine to body ground strap(s) at engine.

16. Raise car, disconnect starter cables, and disconnect the cable shield from the engine.

17. Disconnect exhaust pipes from exhaust manifolds.

18. Remove lower flywheel or converter cover.

19. Remove flywheel to converter attaching bolts. Scribe chalk mark on the flywheel and converter for reassembly alignment (this is not necessary on manual transmissions. Remove manual transmission with engine).

20. Remove transmission to engine attaching bolts. On automatic transmissions and on manual transmissions disconnect propeller shaft, shift linkage, clutch equalizer shaft and transmission mount.

21. Remove motor mount fasteners.

22. Lower the car and support the transmission, automatic transmission only.

23. Attach a lifting device to the engine and raise the engine enough so mounting through-bolts can be removed. Make certain wiring harness, vacuum hoses, and other parts are free and clear before lifting engine out of car.

24. Raise engine far enough to clear engine mounts, raise transmission support accordingly and alternately until engine can be disengaged from the transmission and removed.

Installation

1. Slowly lower engine into car until engine and transmission are engaged and scribe marks are aligned.

2. It may be necessary to alternately raise and lower transmission to fit motor mount through-bolts into position. Install through-bolt nuts and torque to 63 lb.ft.

3. Raise car and install transmission to engine attaching bolts. Torque flywheel housing to engine bolts to 35 lb.ft. Install flywheel cover and torque bolts to 4 lb.ft.

4. Connect crossover pipe to exhaust manifold and torque bolts to 10-18 lb.ft.

5. Connect the starter cables to the starter and cable shield to the engine block.

6. Lower the car and reconnect the body ground strap to the engine, the coolant and oil switch sending unit connectors, the throttle control cable, all vacuum and water hoses, and the emission control line from the canister to the air cleaner.

7. Connect the battery ground cable to the engine.

8. Connect the fuel lines to the fuel pump.

9. Reposition the power steering pump into the pump brackets and secure.

10. Install fan shroud.

11. Install pulley, fan, and belts. Adjust belt tension as specified in the Cooling System Section.

12. Reinstall air conditioning compressor to bracket.

13. Reinstall air cleaner.

14. Reinstall coolant and check to make certain proper level is attained.

After complete engine assembly, start engine and recheck for proper fill.

15. Reinstall hood, noting proper alignment of scribe marks.

16. Connect battery.

EXHAUST AND INTAKE MANIFOLD, CYLINDER HEAD, VALVE TRAIN AND LIFTERS AND ENGINE OIL PAN REMOVAL AND INSTALLATION

Intake Manifold Removal

1. Disconnect battery.

2. Drain radiator.

3. Remove air cleaner.

4. Disconnect:

a. Upper radiator hose at manifold.

b. Accelerator linkage at carburetor and linkage bracket at manifold.

c. Booster vacuum pipe at manifold.

d. Fuel line at carburetor.

e. Choke pipe at choke housing.

f. Transmission vacuum modulator line.

g. Idle stop solenoid wire (if equipped).

h. Distributor wires.

i. Temperature sending unit wire.

j. Vacuum hoses from distributor T.V.S. and EFE valve pipe, and vacuum tank hose.

k. Disconnect coolant by-pass hose at manifold.

5. Remove distributor cap and rotor (V-6 only) to gain access to left intake manifold torx head bolt. (Use Tool J-24394) to remove torx head bolt.

6. Remove plug wires V-6 only.

7. Remove accelerator linkage springs.

8. Remove intake manifold.

Intake Manifold Installation

1. Place new intake manifold gasket and rubber manifold seals in position at front and rear rails of cylinder block. Be sure pointed end of seal fits snugly against block and head. Before installing intake manifold seals apply Silastic Sealer or equivalent to ends of seals. See Figure 6A-58.

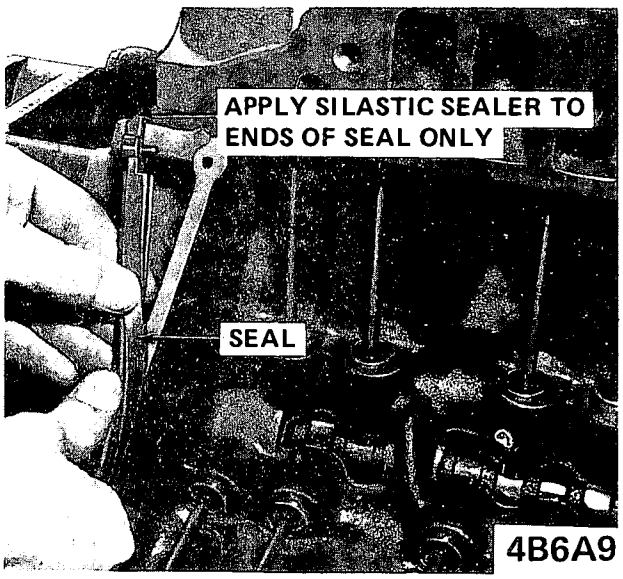


Figure 6A-58 - Intake Manifold Seal Installation

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

3. Install manifold to cylinder head bolts.

New intake manifold gasket and seals must be used whenever a manifold is removed.

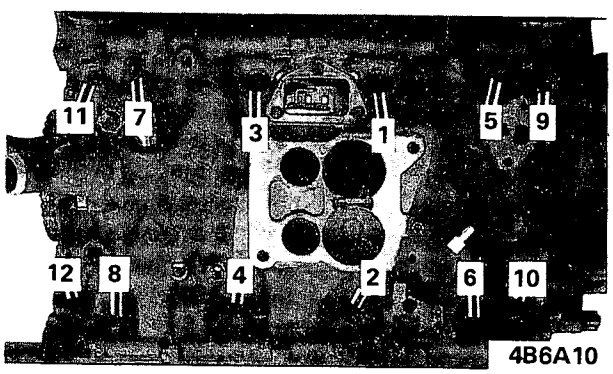


Figure 6A-59 - Intake Manifold Bolt Tightening Sequence 350 and 455

When installing manifold, start with the No. 1 and No. 2 bolts. See Figure 6A-59. Gradually tighten both bolts until snug. Then continue with the rest of the bolts in the sequence shown in Figure 6A-59 or 6A-60. Torque bolts to 45 lb. ft.

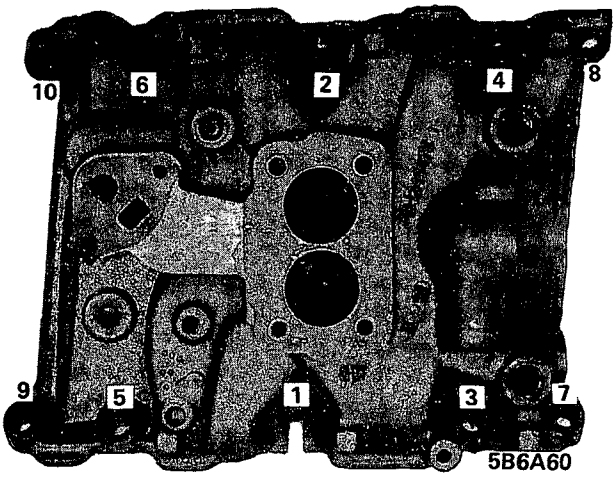


Figure 6A-60 - Intake Manifold Bolt Tightening Sequence 231 Engine

4. Reverse removal procedure for installation.

5. Connect battery.

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

Cylinder Head Removal

1. Remove intake manifold.

2. When removing RIGHT cylinder head:

H-X-A-B-C-E Series

(a) Loosen and remove belt (s).

(b) Remove wires from Delcotron.

(c) If equipped with air conditioning compressor, remove compressor from mounting bracket and position it out of the way with hoses connected, then remove Delcotron with mounting bracket.

3. When removing LEFT cylinder head;

H-A-B-C-E Series

(a) Remove oil gauge rod.

(b) Remove power steering gear pump with mounting bracket if present, and move it out of the way with hoses attached.

(c) Remove A.I.R. pump if equipped.

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

5. Remove exhaust manifold bolts from head being 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 hydraulic valve lifters.*

8. Remove rocker arm cover and rocker arm and shaft assembly from cylinder head. Lift out push rods.

If lifters are to be serviced, remove them at this time. Otherwise, protect lifters and camshaft from dirt by covering area with a clean cloth. 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. Loosen all cylinder head bolts, then remove bolts and lift off the cylinder head.

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

Left Cylinder Head Removal

X-Series

1. Remove intake manifold.

2. Remove oil gauge rod.

3. Remove power steering pump with hoses connected and swing out of way.

4. Remove power steering pump bracket if equipped.

5. Disconnect spark plug wires and swing out of the way.

6. Remove rocker arm cover, rocker arm and shaft assembly from cylidner head. Lift out push rods.

If lifters are to be serviced, remove them at this time. Otherwise, protect lifters and camshaft from dirt by covering area with a clean cloth. 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.

7. Disconnect power brake unit hose at rear of cylinder head.

8. Raise vehicle and place on jack stands, disconnect exhaust crossover pipes and support.

9. Remove left front engine mount thru bolt and "loosen" right front engine mount thru bolt.

10. Raise the engine (if chain fall is used hood will have to be removed).

11. Remove cylinder head bolts and remove cylinder head.

If exhaust manifold does not clear steering gear, engine may have to be raised further.

Cylinder Head Installation

All Series

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 of the gasket.

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 engine oil.

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 6A-61 or 6A-62. Give bolts a final torque in the same sequence. Torque to 75 lb. ft. (231 engine), 80 lb.ft. (350 Cu. In.) and 100 lb. ft. (455 Cu. In.).

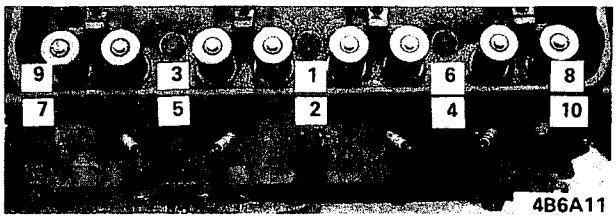


Figure 6A-61 - Cylinder Head Bolt Tightening Sequence (350 and 455)

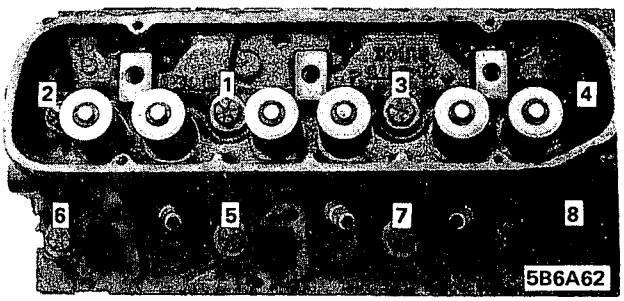


Figure 6A-62 - Cylinder Head Bolt Tightening Sequence 231 Engine

6. Assemble exhaust manifolds to heads. Torque bolts to 28 lb. ft.

7. Wipe rocker arm shaft 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.

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

11. Place spark plug wires in position on rocker arm cover studs and connect spark plug wires.

12. Install intake manifold.

13. Replace components removed in cylinder head removal and tighten belt(s). See cooling system Specifications section.

14. After installation is completed and engine has been warmed up to operating temperature, recheck cylinder head bolt torque.

15. Install rocker arm cover and new gasket torque bolts to 4 lb.ft.

1. Remove cylinder head. Place on a clean surface.

2. Using suitable spring compressor, such as J-8062, compress valve spring and remove valve spring cap key. Release tool and remove spring and cap. See Figure 6A-63.

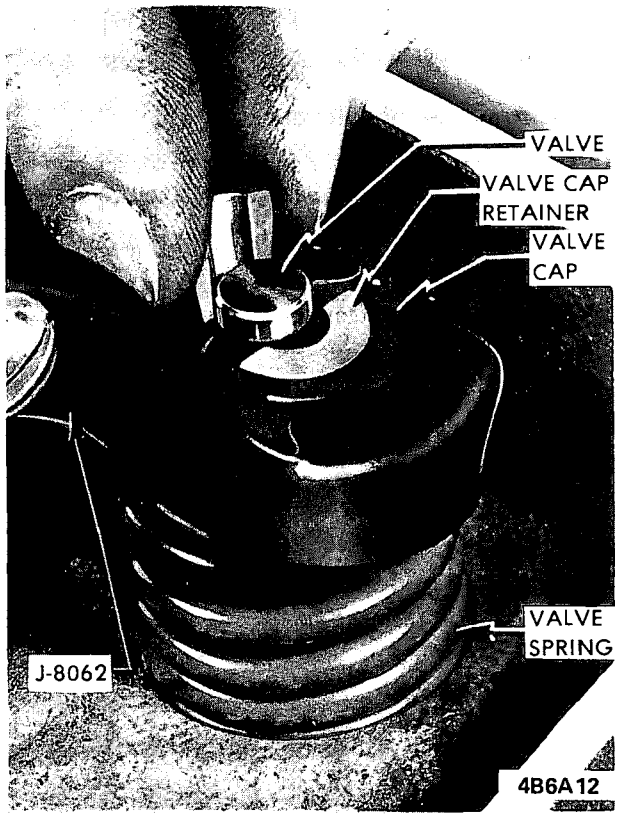


Figure 6A-63 - Removing Valve Cap Retainers.

3. Remove valve seals from intake 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 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-8101.

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. 45 degrees is the correct angle for valve faces.

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 6A-64.

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

The Parts Department stocks .010" oversize valves for replacement purposes. See Figure 6A-65.

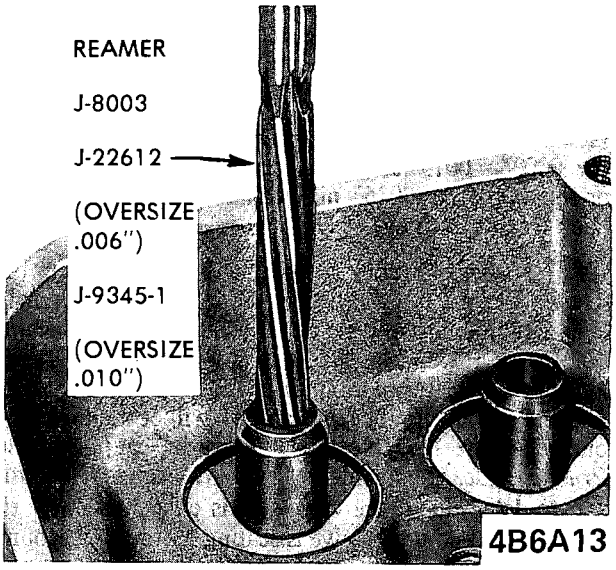


Figure 6A-64 - Reaming Valve Guide

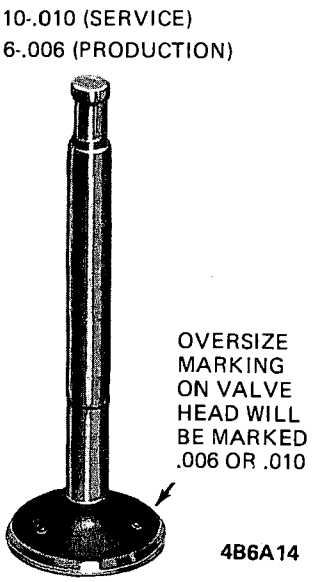


Figure 6A-65 - Oversize Valve Identification

8. True up valve seats to 45 degrees. Cutting a valve seat results in lowering the valve spring pressure and increases the width of the seat. The nominal width of the intake valve seat is 1/16". If the intake valve seat is over 5/64" wide after truing up it should be narrowed to specified width by the use of 20 degrees and 70 degrees stones. The nominal width of the exhaust valve seat is 3/32". If the exhaust valve is over 7/64" wide after truing it should be narrowed to the specified width. Use 20 degree and 70 degree stones to narrow the valve seats to the specified widths.

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.

9. Lightly lap the valves into seats with the 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.

New valves should not be lapped under any condition as the .0002" - .0015" aluminum alloy surface on the intakes or the .0004" to .0015" nickel-plated surface on the exhausts will be removed.

10. Test valves for concentricity with seats and for tight seating. *The usual* test is to coat the valve face lightly with Prussian blue, or equivalanet, and turn the valve against seat. If the valve face is concentric with the valve stem a mark will be made all around the face, while if the face is not concentric with the stem, a mark will be made on only one side of the *face.* Next, coat the valve seat lightly with Prussian blue, or equivalent, Rotate the valve against the seat to determine if the valve seat is concentric with the valve guide, 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 and polish with crocus cloth.

12. Lubricate valve stems and guides with engine oil and reinstall valves.

13. Install new intake valve seals.

Do not install exhaust valve guide seals.

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.

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

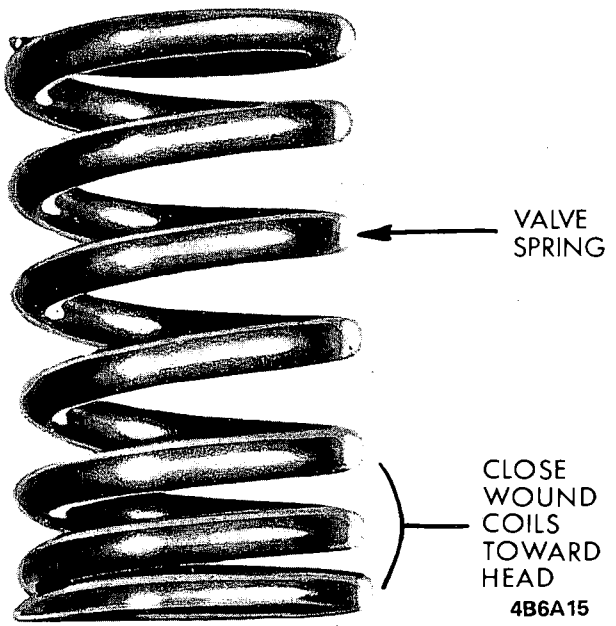


Figure 6A-66 - Valve Spring (350 cu.in.)

14. Install intake valve springs on the 350 cu. in. with closely-wound coil toward the cylinder head. Exhaust valve springs on the 350 engine and all valve springs for 231 and 455 cu. in. engines, may be installed with either end up. See Figure 6A-66.

15. Reinstall valve spring, cap and cap retainer, using same equipment used for removal.

16. Install cylinder head.

Rocker Arm Assembly Removal

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

2. Place assembly on a clean surface.

3. Remove nylon arm retainers by prying them out using a pair of channel locks. See Figure 6A-67.

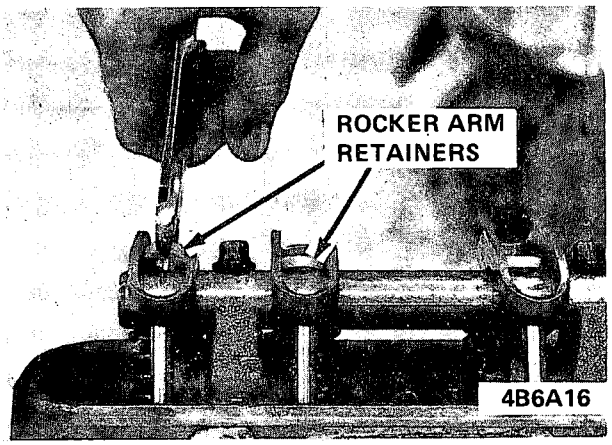


Figure 6A-67 - Removing Nylon Retainer

4. Remove rocker arms and clean in suitable solution. Inspect for wear. Remove retainer pieces from inside shaft.

Rocker Arm Assembly Installation

1. Install rocker arms on shaft lubricating all parts as they are assembled with engine oil. One common rocker arm

Figure 6A-68 Service Rocker Arms

is used in all locations on all 1975 production V-8 engines, and therefore can be installed in any sequence on the rocker arm shaft. V-6 engine rocker arms are installed in production with rights and lefts and must never be interchanged.

Should it become necessary to replace one or more rocker arms, it must be noted that all service rocker arms are stamped (R) right (L) left. See Figure 6A-68 .

When installing service rocker arms care must be taken to insure rocker arms are installed on the rocker arm shaft in the correct sequence. See Figure 6A-69.

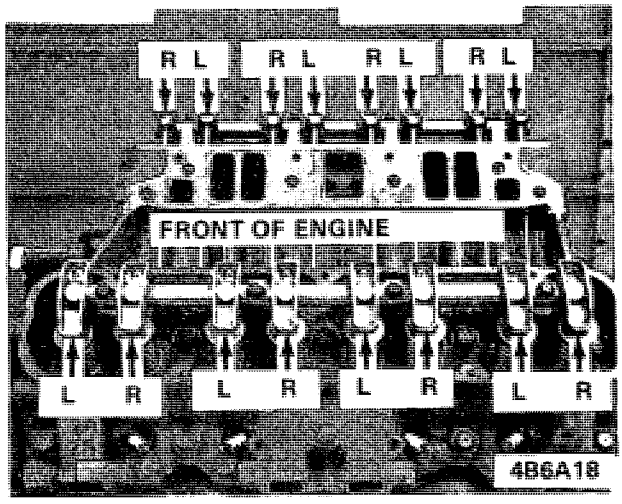


Figure 6A-69 Position of Service Rocker Arms on Shaft

2. Center each arm on the 1/4" hole in the shaft. Install new nylon rocker arm retainers in the 1/4" holes using a drift of at least 1/2" dia.

3. Install rocker arm assembly.

Exhaust Manifold Removal Right and Left

A-B-C-E Series and X-Series Right Side 350 and 455 Engines

1. Raise front of car and support on stands.

2. Disconnect exhaust pipe from exhaust manifolds both sides of engine and lower.

3. If manual transmission remove equalizer shaft.

4. Remove exhaust manifold to cylinder head bolts.

5. Remove exhaust manifold from beneath the car.

X-Series Left Side 350 Engine

1. Raise vehicle.

2. Disconnect crossover pipe (if dual exhaust disconnect left exhaust pipe only).

3. Remove left front engine mount thru bolt and "loosen" right front engine mount thru bolt.

4. Raise engine.

5. Remove exhaust manifold bolts and exhaust manifold.

H-X-A Right and Left 231 Engine

1. Support vehicle on stands.

2. Remove crossover pipe.

3. Right side-disconnect choke pipe.

Left side-disconnect EFE pipe.

4. Remove exhaust manifold.

Exhaust Manifold Installation Right and Left

All Series

1. Install manifold by reversing above procedures.

2. Torque exhaust manifold bolts to 28 lb. ft.

Oil Pan Removal

A-B-C-E Series 350 and 455 Engines

1. Disconnect battery.

2. Remove fan shroud to radiator tie bar screws.

3. Remove air cleaner and disconnect throttle linakge.

4. Raise car and support on stands.

5. Drain oil.

6. Disconnect exhaust crossover pipe at engine.

7. Remove lower flywheel housing.

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

9. Remove front engine mounting bolts.

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

At this point, on A/C equipped cars, it will be necessary to place a support under the right side of the transmission prior to raising engine. This is necessary to prevent the engine transmission assembly from cocking to the right when being raised.

11. Remove oil pan bolts and remove pan.

It may be necessary to position crankshaft so No. 1 and 2 crankpin and counterweight will not interfere with front of oil pan.

12. Remove rear seal (455 cu.in. engines only).

X-Series 350 Engine Only

1. Disconnect battery.

2. Remove fan shroud to radiator tie bar screws.

3. Remove air cleaner and disconnect throttle linkage at intake manifold.

4. Raise vehicle and place on jack stands.

5. Drain oil.

6. Remove lower flywheel housing cover.

7. Remove shift linkage attaching bolt and swing out of the way.

8. Disconnect exhaust crossover pipe at engine.

9. Remove front engine mount thru bolts.

10. Disconnect idler arm at frame and swing assembly downward.

11. Raise engine (if chain fall is used hood must be removed).

12. Remove oil pan bolts and remove oil pan.

It may be necessary to position crankshaft so No. 1 and 2 crank pin and counter weight will not interfere with front of oil pan.

H-X-A 231 Engine Only

1. Raise vehicle.
2. Drain oil.
3. Remove flywheel cover.
4. Remove crossover pipe.
5. Remove oil pan.

Oil Pan Installation

All Series

1. For installation, reverse procedures of oil pan removal observing the following:

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

3. Install rear seal (455 cubic inch engines only).

4. Apply silastic sealer to a few spots on a new pan gasket and install on block. *Make sure seal and gasket are properly fitted.* See Figure 6A-70. (455 cu.in. only).

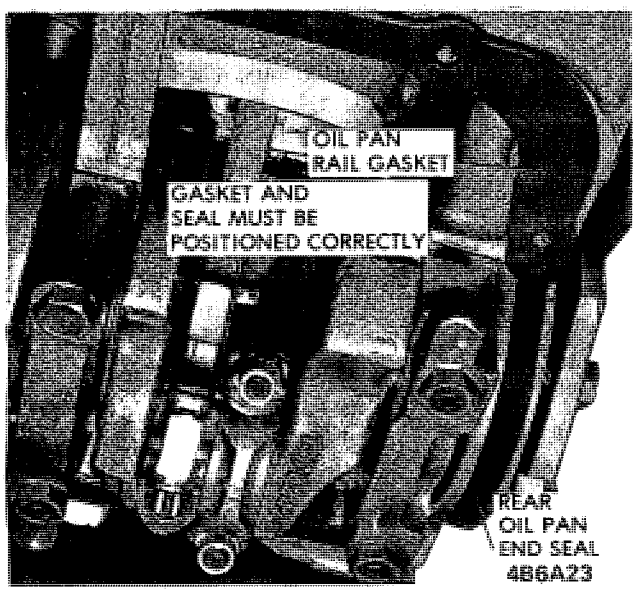


Figure 6A-70 - Oil Pan Gasket and Seal Installation

5. Install oil pan. Torque bolts to specifications Do not overtighten.

Removal and Inspection of Oil Pump Pipe and Screen Assembly

1. Remove oil pan.

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

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

Installation of Oil Pump Pipe 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 new gasket and tighten bolts to specifications. See Figure 6A-71.

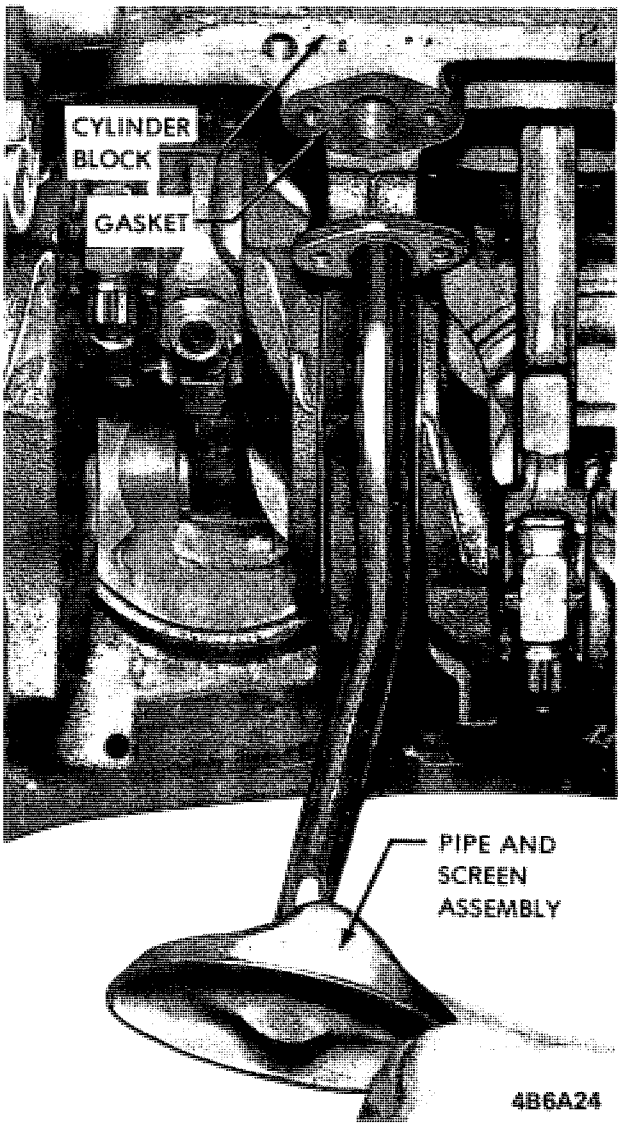


Figure 6A-71 - Oil Pickup Pipe and Screen

3. Install oil pan.

CONNECTING ROD BEARINGS

A connecting rod bearing consists of two halves or shells which are interchangeable in rod and cap. When the shells are placed in position, the ends extend slightly beyond the parting surfaces so that when the rod bolts are tightened the shells will be clamped tightly in place to insure positive seating and to prevent turning. *The ends of the bearing*

shells must never be filed flush with parting surface of rod or cap.

If a rod bearing becomes noisy or is worn so that clearance on the 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.*

Inspection of Connecting Rod Bearings and Crankpin Journals

After removal of engine oil pan, 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 crankpin to avoid possibility of damaging the journals through contact with loose rods. Do not interchange rod caps with rods.

If connecting rod bearings are scored or show flaking, they should be replaced. If bearings are in good physical condition check for proper clearance on crankpin.

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.

Checking Clearance and Selecting Replacement 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 checked by use of Plastic-Type Gauge 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. Plastic-type gauge is soluble in oil.

2. Place a piece of plastic-type gauge lengthwise along the bottom center of the lower bearing shell (Figure 6A-72, View A), then install cap with shell and torque bolt nuts to specifications.

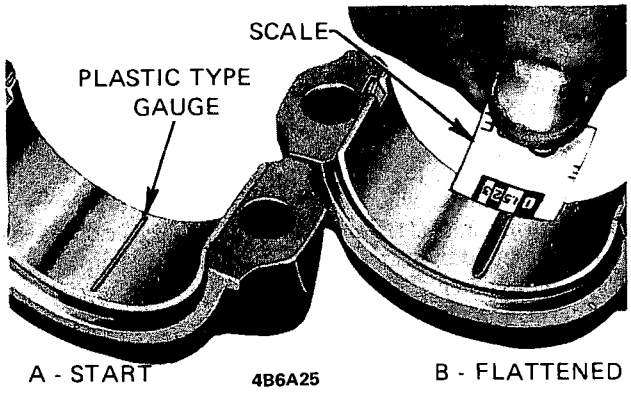


Figure 6A-72 - Checking Bearing Clearance With Plastic-Type Gauge

Conical boss on web of rod (231, 350 and 455) and rib on edge of 455 cap must be toward rear of engine on all rods in left bank and toward front of engine in right bank. Cap installation on 350 rod can be in only one direction since it is dictated by bolt centerline offset.

3. DO NOT TURN CRANKSHAFT with plastic-type gauge in bearing.

4. Remove bearing cap with bearing shell, the flattened plastic-type gauge will be found adhering to either the bearing shell or the crankpin. *Do not remove it.*

5. Using the scale printed on the plastic-type gauge envelope, measure the flattened plastic-type gauge at its widest point. The number within the graduation which most closely corresponds to the width of plastic-type gauge indicates the bearing clearance in thousandths of an inch. See Figure 6A-72, View B.

6. The desired clearance with a new bearing is .0005" to .0026". 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 plastic-type gauge. Each undersize bearing shell has a number stamped on the outer surface to indicate amount of undersize. See Figure 6A-73.

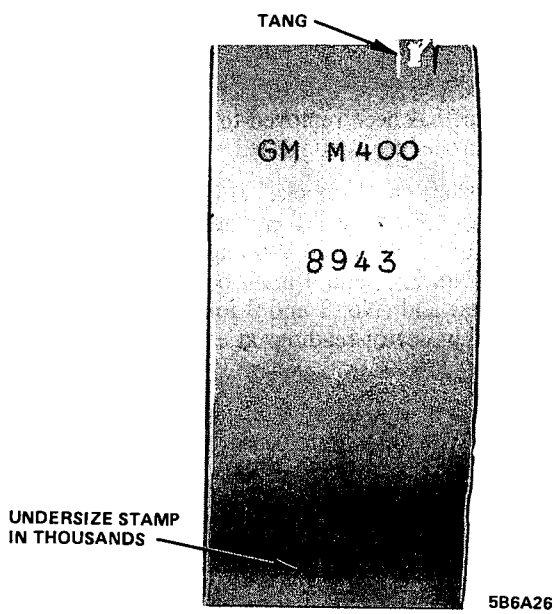


Figure 6A-73 - Location of Undersize Mark on Bearing Shell

8. After the proper size bearing has been selected, clean off the plastic-type gauge, oil the bearing thoroughly, reinstall cap with bearing shell and torque bolt nuts to specifications. See 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.

CRANKSHAFT BEARINGS AND SEALS

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 and rear main upper are identical. The thrust bearing (No. 3) (No. 2 bearing for V-6 engines) is flanged to take end thrust and the rear main upper bearing groove does not extend the full length of the bearing. 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. 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, pipe and screen assembly, and oil pan baffle, 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

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 for the V-8 engines) and (No. 1 and No. 4 bearing journals for the V-6 engine). Check indicator runout at (No. 2, 3, and 4 main bearing journals for the V-8 Engines) and (No. 2 and 3 journals for the V-6 engine). Total indicator readings at each journal should not exceed .0015.

While checking runout at each journal note relation of "high" spot (for 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 affects 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. If replacement of cylinder block or crankshaft is required, always check main bearing clearance with plastic-type gauge 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 plastic-type gauge as described for the connecting rod bearing.

4. When checking a crankshaft bearing with plastic-type gauge, turn crankshaft so that oil hole is up to avoid dripping of oil on plastic-type gauge. 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.* Arrow on cap must point to front of engine.

5. If bearing clearance exceeds .003", 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 6A-74.

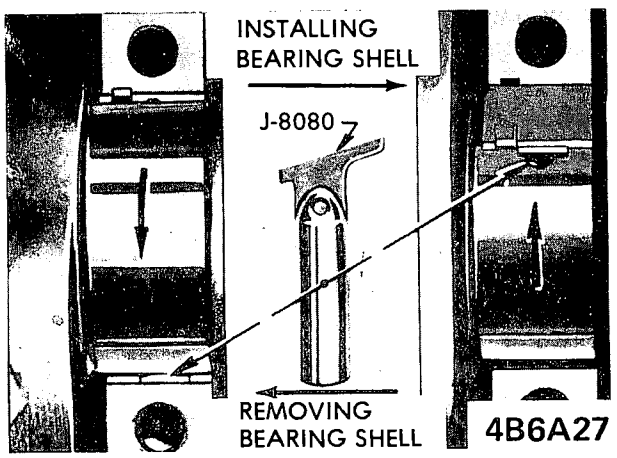


Figure 6A-74 - Removal and Installation of Crankshaft Bearing Upper Shell

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 oil hole.

If crankshaft journal is more than .0015" out-of-round, the crankshaft 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. Upper bearing shells have an oil groove in their center, while lower shells are not grooved. They must not be interchanged.

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. Bearing shells 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 plastic-type gauge, as previously described.

13. The desired clearance with a new bearing is .0004" to .0015" (231 and 350 Cu. In.) and .0007" to .0018" (455 cu. in). If this clearance cannot be obtained with a standard size bearing, insert an undersize bearing and check again with plastic-type gauge.

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 plastic-type gauges, oil the lower shell and reinstall bearing cap. Clean the bolt holes and lube bolts, then torque cap bolts to specification.

The crankshaft should turn freely at flywheel rim; however, a very slight drag is permissible.

15. If the *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 serveral times (last movement fore) 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 other bearings. When bearings have been installed and tested, tighten all bearing cap bolts to specified torque.

17. Replace rear main bearing oil seals.

18. Install oil pan baffle, pipe and screen assembly, and oil pan.

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. See Figure 6A-75 or 6A-76.

A new braided fabric seal can be installed in crankcase only when crankshaft is removed, but it can be repaired while crankshaft is installed, as outlined under Rear Main Bearing Upper Oil Seal Repair. The seal can be replaced in cap whenever the 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 6A-75 or 6A-76.

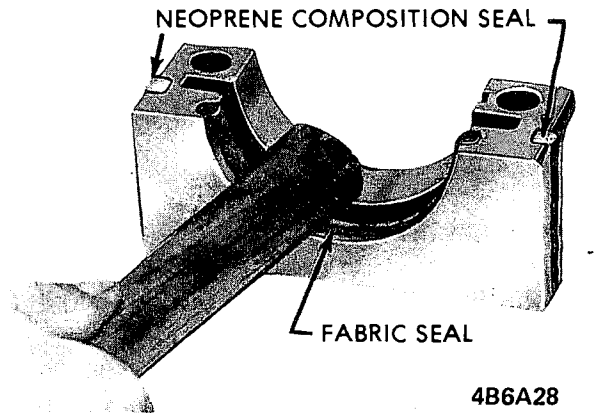


Figure 6A-75 - Installing Rear Bearing Oil Seals (231 and 350 Cu. In.)

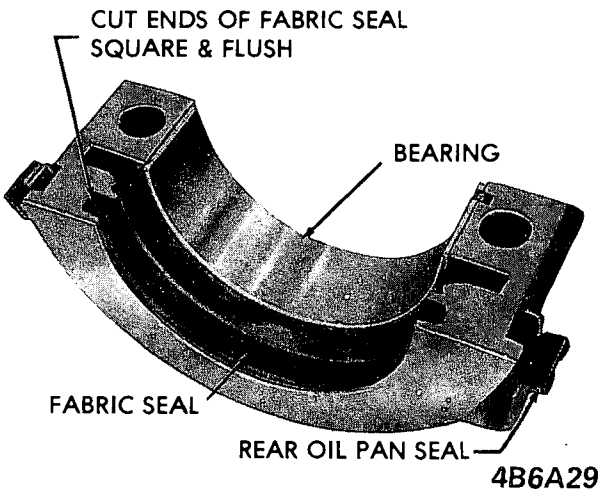


Figure 6A-76 - Rear Bearing Oil Seal (455 Cu. In.)

The engine must be operated at slow speed when first started after a new braided seal is installed.

Neoprene composition seals (231 and 350 cu.in. only) are placed in grooves in the sides of bearing cap to seal against leakage in the joints between cap and crankcase. The neoprene composition swells in the presence of oil and heat. The seals are undersize when newly installed and may even leak for a short time until the seals have had time to swell and seal the opening. See Figure 6A-75.

The neoprene seals are slightly longer than the grooves in the bearing cap. The seals must not be cut to length. Before installation of seals, soak for 1 to 2 minutes in light oil or kerosene. After installation of bearing cap in crankcase, install seal in bearing cap.

To help eliminate oil leakage at the joint where the cap meets the crankcase, apply silastic sealer to the rear main bearing cap split line. When applying sealer, use only a thin coat as an over abundance will not allow the cap to seat properly. See Figure 6A-77.

After seal is installed, force seals up into the cap with a blunt instrument to be sure of a seal at the upper parting line between the cap and case.

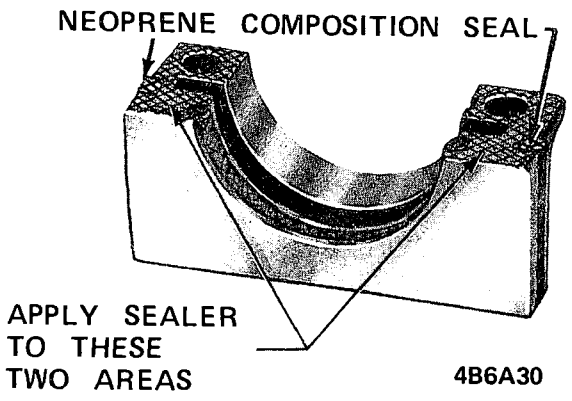


Figure 6A-79 (231 and 350 Engine) Sealer Applied to Split Line

Rear Main Bearing Upper Oil Seal Repair

1. Remove oil pan.

2. Insert packing tool (J-21526-2) against one end of the seal in the cylinder block. Drive the old seal gently into the groove until it is packed tight. This varies from 1/4" to 3/4" depending on the amount of pack required. See Figure 6A-78.

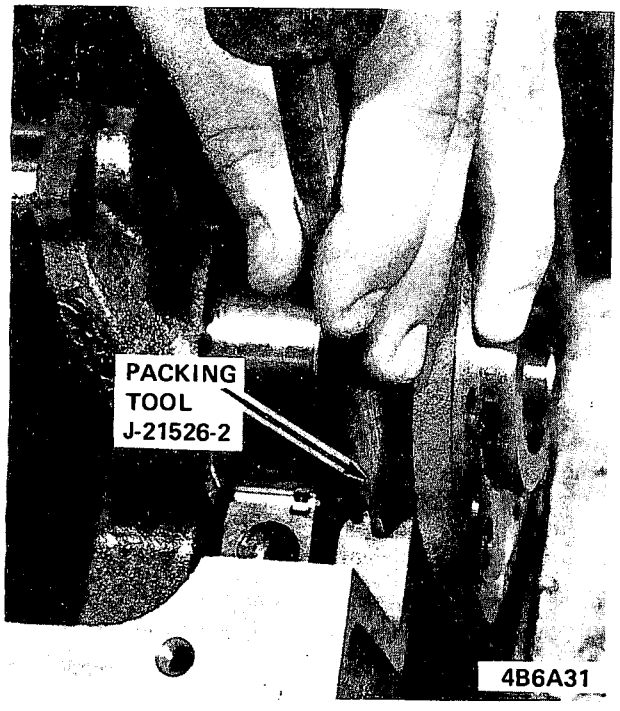


Figure 6A-78 Packing Seal into Cylinder Block

3. Repeat Step 2 on the other end of the seal in the cylinder block.

4. Measure the amount the seal was driven up on one side and add 1/16", using a single edge razor blade cut that length from the old seal removed from the rear main bearing cap. Repeat the procedure for the other side. Use the rear main bearing cap as a holding fixture when cutting the seal.

5. Install Guide Tool (J-21526-1) onto cylinder block. See Figure 6A-79.

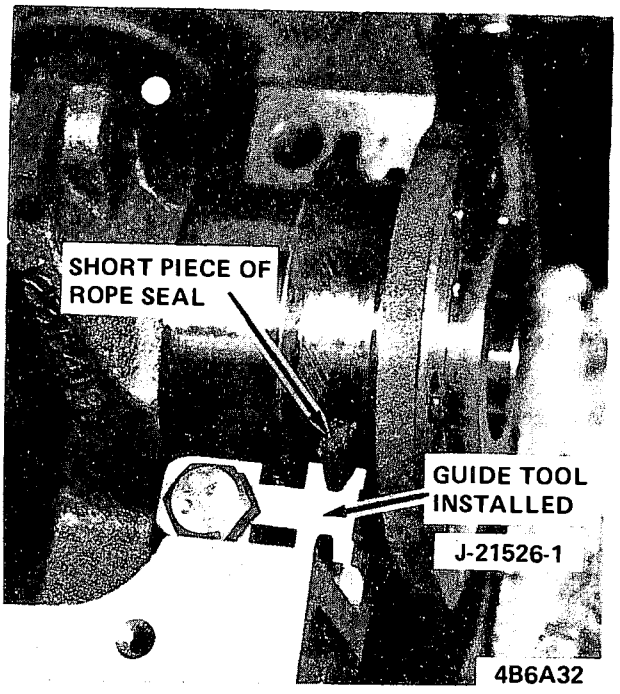


Figure 6A-79 Guide Tool Installed

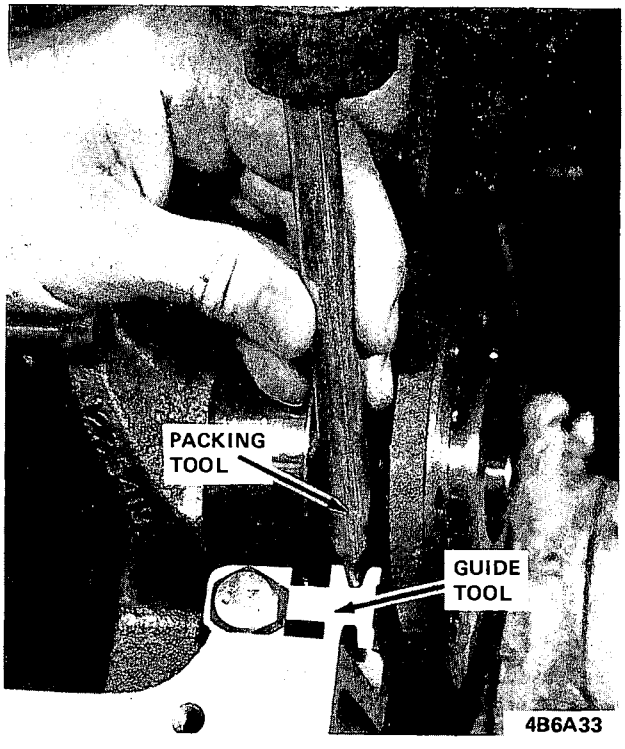


Figure 6A-80 Packing Short Pieces of Rope Seal into Guide Tool and Cylinder Block

6. Using packing tool, work the short pieces cut in Step 4 into the guide tool and then pack into cylinder block. The guide tool and packing tool have been machined to provide a built-in stop. Use this procedure for both sides. See Figures 6A-79 and 6A-80.

It may help to use oil on the short pieces of the rope seal when packing into the cylinder block.

7. Remove the guide tool.

8. Install a new fabric seal in the rear main bearing cap. Install cap and torque to specifications.

9. Install oil pan.

PISTONS, RINGS, AND CONNECTING RODS

Replacement, Disassembly, and Inspection of Piston and Rod Assemblies

1. Remove cylinder heads.

2. Examine the cylinder bores above the ring travel. If bores are worn so that a shoulder or ridge exists at the top of the cylinder, remove the ridges with a ridge reamer to avoid damaging rings or cracking ring lands in pistons during removal. See Figure 6A-81.

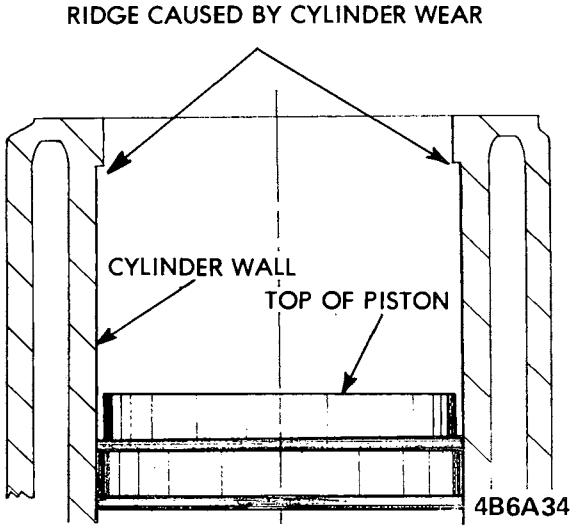


Figure 6A-81 - Ridge Formed by Rings at Top of Travel

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

4. To remove piston and rod assemblies:

455 Cu. In.

With No. 1 crankpin straight down, remove the cap with bearing shell from No. 1 connecting rod, install the *short* Connecting Rod Bolt Guide J-5239-1 on the connecting rod bolt, above crankpin. Install the *long* Connecting Rod Bolt Guide J-5239-2 on remaining stud. Turn guides down fully to hold the upper bearing shell in place while removing piston and rod assembly. See Figure 6A-82.

231 and 350 Cu. In.

With No. 1 crankpin straight down, remove the cap with bearing shell from No. 1 connecting rod, install the "short" connecting rod guide Tool J-24567-1 in the connecting rod hole above the crankpin. Install the "long" connecting rod guide Tool J-24567-2 in remaining hole. Turn guides down fully to hold the upper bearing shell in place while removing the piston and rod assembly.

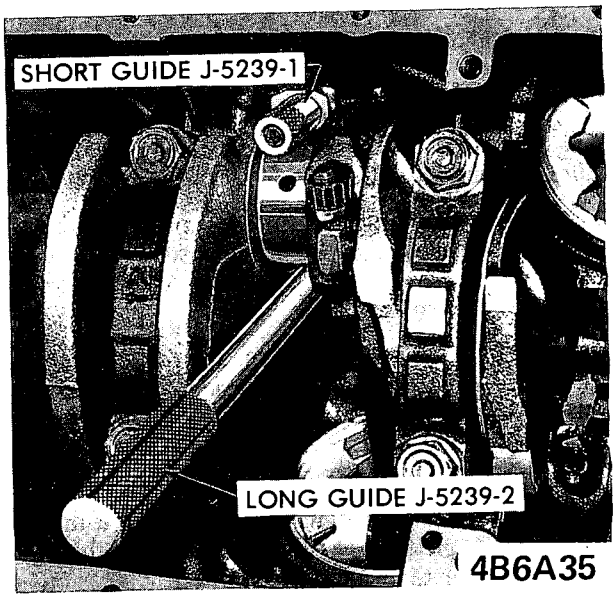


Figure 6A-82 - Connecting Rod Bolt Guides Installed

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 and remove oil ring.

8. To remove piston pin:

455 Engine

(a) Place piston and rod assembly in press, using Piston Support J-6047-17 (with full radial face up) under the piston.

(b) Place Drive Pin J-6047-4 in upper end of piston pin.

(c) Press pin from rod and piston.

231 and 350 Engine

(a) Place piston and rod assembly in press, using Piston Support J-6047-5 (with full radial face up) under the piston.

(b) Place Drive Pin J-6047-4 in upper end of piston.

(c) Press pin from rod and piston.

9 (a) Inspect cylinder walls for scoring, roughness, or ridges which indicate excessive wear. Check cylinder bores for taper and out-out-round with an accurate cylinder gauge at top, middle and bottom of bore, both parallel and at right angles to the centerline of the engine. The diameter of the cylinder bores at any point may be measured with an inside micrometer or setting the cylinder gauge dial at "O" and measuring across the gauge contact points with outside micrometer while the gauge is at same "O" setting.

(b) If a cylinder bore is moderately rough or slightly

scored but is not out-of-round or tapered, it is usually possible to remedy the situation by honing the bore to fit a standard service piston since standard service pistons are high limit production pistons. If cylinder bore is very rough or deeply scored, however, it may be necessary to rebore the cylinder to 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 piston 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 rings 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 the piston pin is greater than the diameter parallel to the piston pin. When a piston is checked for size, it must be measured with micrometers applied to the skirt at points 90 degrees to the piston pin. See Figure 6A-83. The piston should be measured (for fitting purposes) 1/4" below the bottom of the oil ring groove.

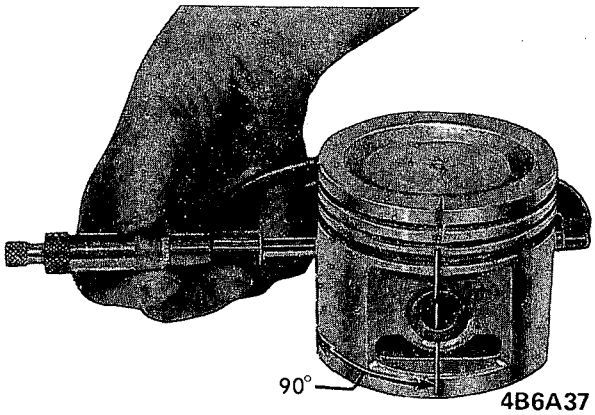


Figure 6A-83 - Measuring Piston

12. Inspect bearing surfaces of piston pins and check for wear by measuring worn or unworn surfaces with micrometers. Rough or worn pins should be replaced. Test fit piston pins in piston bosses. Occasionally 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 due to the pin being a press fit in the connecting rod. Piston pins must fit the piston with an easy finger push at 70 degrees F (.0004" to .0007" clearance).

13. Examine all piston rings for scores, chips or cracks. Check compression rings for tension by comparing with new rings. Check gap of compression rings by placing rings in bore at bottom of ring travel. Measure gap with feeler gauge. Gap should be between .010" and .020". If gaps are excessive (over .020") it indicates the rings have worn considerably and should be replaced. Bore wear should be checked before rings are replaced, .005" bore wear will result in .015" increase in ring gap.

Reboring Cylinder and Fitting New Pistons

If one or more cylinder bores are rough, scored, or worn beyond limits, 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 oversize 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 piston pins; pistons are not furnished without pins.

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. 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 6A-85 then select the smalles. 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 manufacturer. 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. A satisfactory method of fitting pistons is as follows:

1. Expand a telescope gauge to fit the cylinder bore at right angles to the piston pin and between 1-1/2″ and 2″ from the top. See Figure 6A-84.

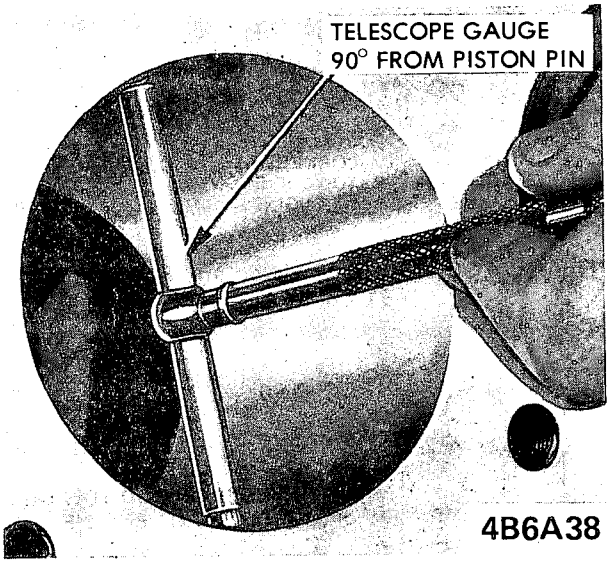


Figure 6A-84 - Checking Cylinder Bore

2. Measure the telescope gauge. See Figure 6A-85.

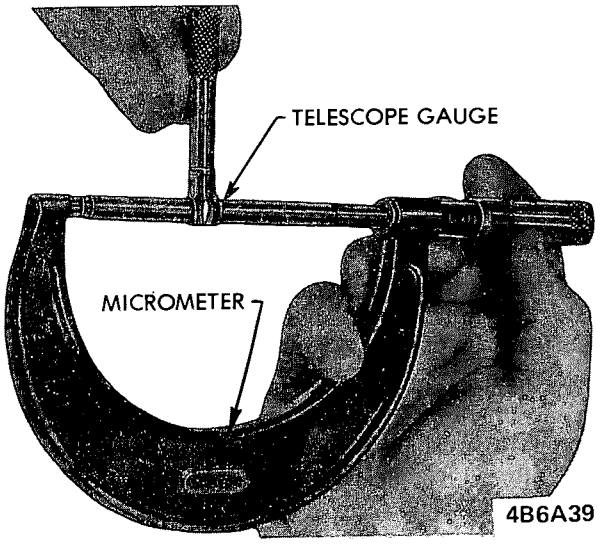


Figure 6A-85 - Measuring Telescope Gauge

3. Measure the piston to be installed. See Figure 6A-83. The piston must be measured at right angles to the piston pin 1/4″ below the oil ring groove. The piston must be between .0008″ and .0020″ (231 and 350 Cu. In.) and .0007″ to .0013″ (455 Cu. In.) smaller than the cylinder bore.

Measurements should be made at 70°F ± 15°.

Both block and piston must be at very nearly the same temperature when measurements are made or errors due to expansion will occur. A difference of 10 degrees F. between parts is sufficient to produce a variation of .0005″.

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.

New piston rings must be checked for clearance in piston grooves and for gap in cylinder bores. 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 gauges 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. Piston 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 not exceed .0035″.

To check the end 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 gap with feeler gauges. Piston rings should not have less than .010″ (231 and 350 Cu. In.) and .013″ (455 Cu. In.)(compression rings) and .015″ (oil ring) gap when placed in cylinder bores. If gap is less than specified, file the ends of rings carefully with a smooth file to obtain proper gap.

Assembly and Installation of Piston and Connecting Rod Assemblies

Connecting rods may be sprung out of alignment in shipping or handling. Always check a new rod before installing piston and pin.

Check bend and twist on an accurate rod aligning fixture using Guide Pin J-6047-16 for 455 engines, J-6047-20 for 231 and 350 engines, 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 .00125″ tight on pin.

1. To assemble piston and pin to connecting rod, first place Piston Pin Spacer, J-6047-21, and Piston Support, J-6047-17, or J-6047-5 whichever applies, in base plate of press.

2. If the piston and rod assembly is to be installed in the

left bank, the assembly must be made as shown in Figures 6A-86, 6A-89 or 6A-90.

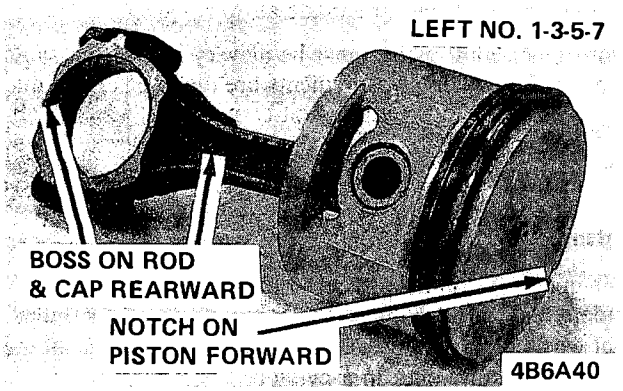


Figure 6A-86 Left Bank Piston and Rod Assembly (455 Cu. In. Engine)

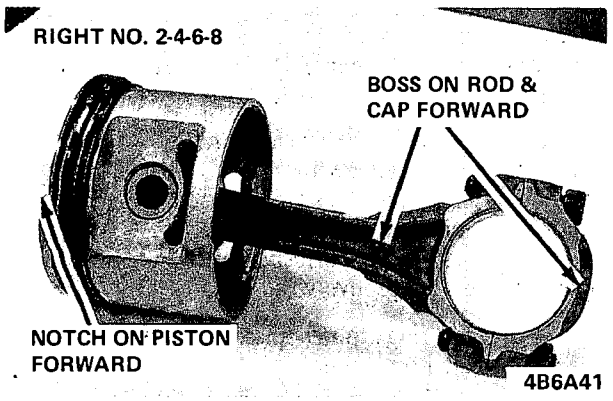


Figure 6A-87 - Right Bank Piston and Rod Assembly (455 Cu. In. Engine)

3. If the piston and rod assembly is to be installed in the *right* bank, the assembly must be made as shown in Figures 6A-87, 6A-89 or 6A-91.

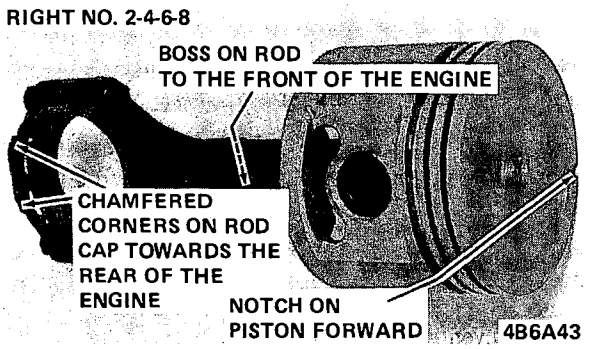


Figure 6A-88 - Right Bank Piston and Rod Assembly (350 Cu. In. Engine)

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

5. Assemble piston and rod on spring loaded guide pin.

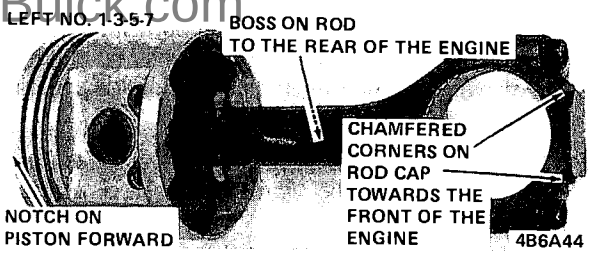


Figure 6A-89 - Left Bank Piston and Rod Assembly (350 Cu. In. Engine)

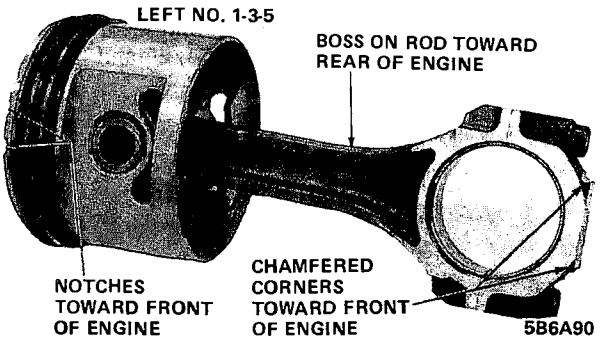


Figure 6A-90 - Left Bank Piston and Rod Assembly (231 Cu. In. Engine)

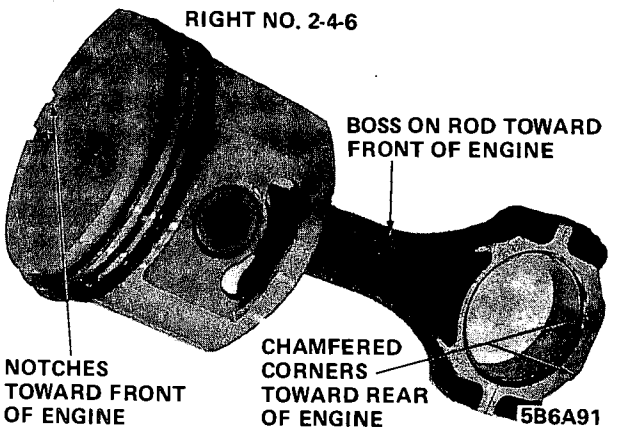


Figure 6A-91 - Right Bank Piston and Rod Assembly (231 Cu. In. Engine)

6. Install drive pin in upper end of piston pin. Press on drive pin till piston pin bottoms.

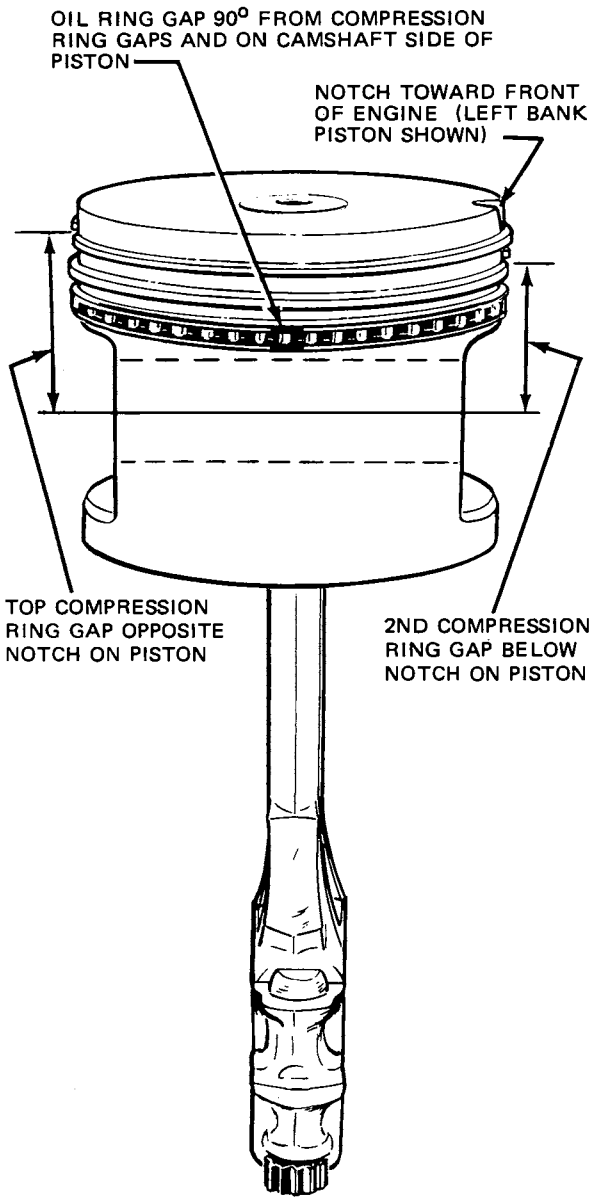
7. Remove piston and rod assembly from press. Rotate piston on pin to be sure pin was not damaged during the pressing operation.

8. Install piston rings as shown in Figures 6A-92. Position expander ends over piston pin. Install oil ring rail spacer, and oil ring rails. Position gaps in rails so that when piston is installed in its bore the gap will point toward the camshaft. Install compression rings in upper two grooves.

a. Top compressing ring - When installed, the manufacturer's indentification mark ("O", "DOT" or "TOP") facing up.

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

c. Oil ring - Can be installed with either rail facing up. Some engines have a 2 piece oil ring, which has only one rail. The rail must be installed at the top of the oil ring groove.



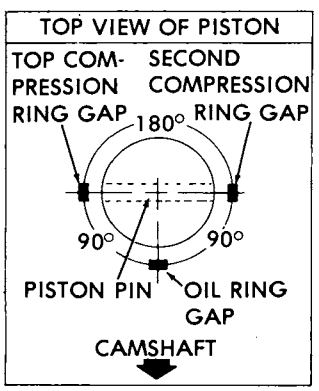


Figure 6A-92 - Piston Ring Gap Positioning

d. Ring gaps - All three ring gaps must be 90 degrees apart. See Figure 6A-92.

9. Make sure 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 bore, position the crankpin straight down.

11. Remove cap, and with bearing upper shell seated in connecting rod, install the *long* Guide J-5239-2 or (J-24567-1 for capscrew rods) on bolt for 455 and in bolt hole 231 and 350 engines which is on same side of rod as the notch for the tang of the bearing insert. Install short Guide J-5239-1 or (J-24567-2 for capscrew rods) on the other connecting rod bolt. 455 and in the bolt hole for 231 and 350 engines.

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" position toward center of engine and the gaps of the compression rings are positioned as shown in Figure 6A- 93.

13. Lubricate the piston and rings and install in bore by compressing the rings either with a "wrap around" compressor or a ring type such as shown in Figure 6A- 93.

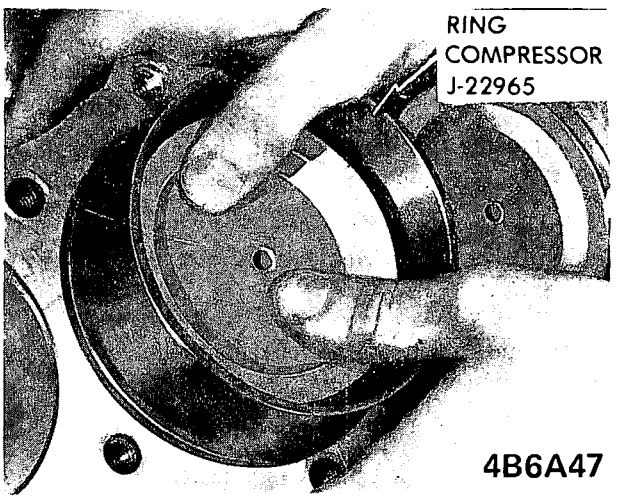


Figure 6A-93 - Installing Piston with Ring Compressor Installed (350 Shown)

14. Select new connecting rod bearing, if necessary. Otherwise install cap with bearing lower shell on rod and tighten bolt nuts to specifications.

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

455 Cu. In.

When piston and rod assemblies are properly installed, all notches on the pistons will point towards the front of the engine and the boss on the connecting rod and caps will point towards the front of the engine for the right bank and towards the rear of the engine for the left bank. See Figures 6A-86 and 6A-87.

b. *231 and 350 Cu. In.*

When piston and rod assemblies are properly installed, the notches on "all" the pistons will point towards the front of the engine. The boss on the connecting rods in the "right bank" will point towards the front of the engine and the chamfers on the rod caps will point towards the rear of the engine. The boss on the connecting rods in the "left bank" will point towards the rear of the engine and the chamfers on the rod caps will point towards the front of the engine. See Figures 6A-88 and 6A-89 for the 350 and Figures 6A-90 and 6A-91 for the 231 engine.

16. Check end clearance between connecting rods on each crankpin using feeler gauges. Clearance should be between .005" and .026" for the 455 engine and between .006 - .027 for the 350 engine and between .006" and .020" for the 231 engine.

17. Install cylinder head. Install oil screen and engine oil pan.

After installation of new pistons and rings, care should be used in starting the engine and running it for the first hour. Avoid high speeds until the parts have had a reasonable amount of "break in" time. This practice will avoid unnecessary "scuffing" of new parts.

CAMSHAFT AND TIMING CHAIN

Timing Chain Inspection and Test

The timing chain should be replaced when the overall "in and out" chain movement, midway between the two sprockets on the slack side of the chain, exceeds one inch.

Before making this measurement, the engine should be cranked to get all the slack on one side of the chain.

Timing Chain Cover Removal

1. Drain radiator.

2. Disconnect upper and lower radiator hose and heater return hose at water pump.

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

4. Remove fan driving pulley (crankshaft).

5. Disconnect fuel lines and remove fuel pump.

6. Remove Delcotron generator and brackets.

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 harmonic balancer bolt and washer and remove harmonic balancer.

10. Remove bolts attaching timing chain cover to cylinder block. See Figures 6A-94, 6A-95 and 6A-96. Remove two oil pan to timing chain cover bolts 350 Cu. In. and 4 bolts on the 455 Cu. In. Remove timing chain cover assembly and gasket. Thoroughly clean the cover, taking care to avoid damage to the gasket surface.

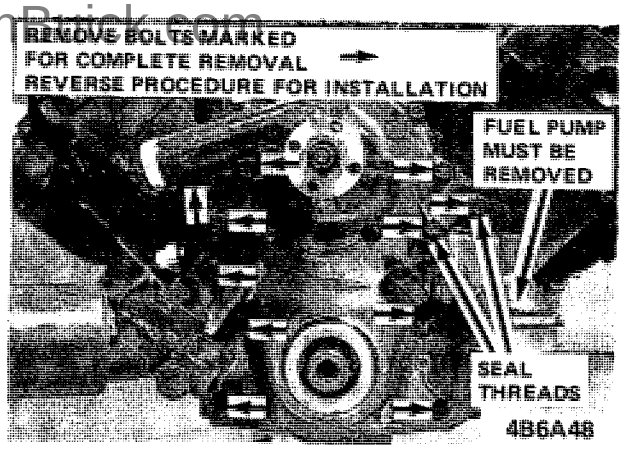


Figure 6A-94 - Timing Chain Cover Removal and Installation (350 cu.in.)

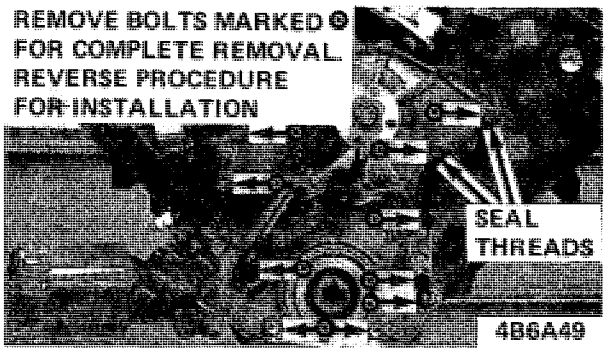


Figure 6A-95 - Timing Chain Cover Removal and Installation (455 cu.in.)

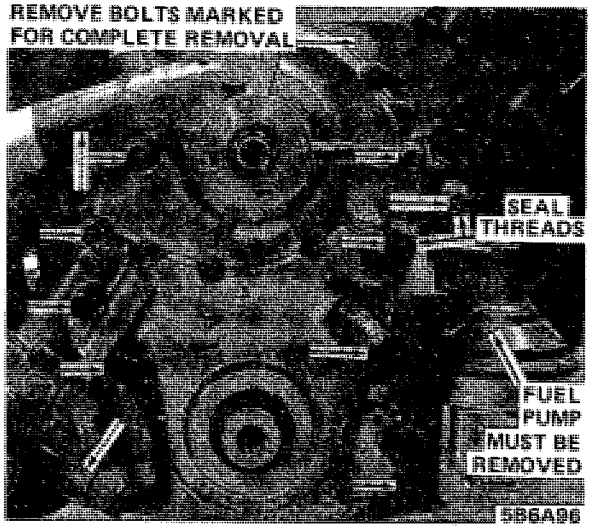


Figure 6A-96 - Timing Chain Cover Removal and Installation (231 Cu. In.)

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, 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. Apply sealer to bolt threads as shown in Figures 6A-94, 6A-95 and 6A-96.

5. Install harmonic balancer, bolt and washer. By using a screwdriver or other suitable tool, lock flywheel and torque bolt to specification. See Figure 6A-97.

Figure 6A-97 - Locking Flywheel to Torque Harmonic Balancer Bolt.(350 cu.in. Shown)

Front Crankshaft Oil Seal Replacement

1. Use a punch to drive out old seal and shedder. Drive from the front toward the rear of the timing chain cover.

2. Coil new packing around opening so ends of packing are at top. Drive in shedder using suitable punch. Stake the shedder in place in at least three places.

3. Size the packing by rotating a hammer handle or similar tool around the packing until the balancer hub can be inserted through the opening.

Timing Chain and Sprocket Removal

231 and 350 Cu. In.

1. With timing chain cover removed temporarily install harmonic balancer bolt and washer in end of crankshaft. Turn crankshaft so sprockets are positioned as shown in Figure 6A-98. Remove harmonic balancer 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 front crankshaft oil slinger.

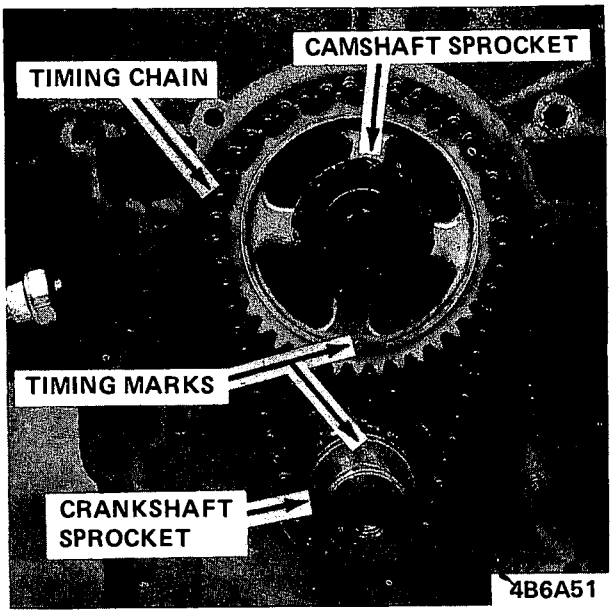


Figure 6A-98 - Installation of Timing Chain and Sprocket - 231 and 350 Cu. In.

3. Remove bolt and special washer retaining camshaft distributor drive gear and fuel pump eccentric to camshaft forward end. Slide gear and eccentric off camshaft. See Figure 6A-99.

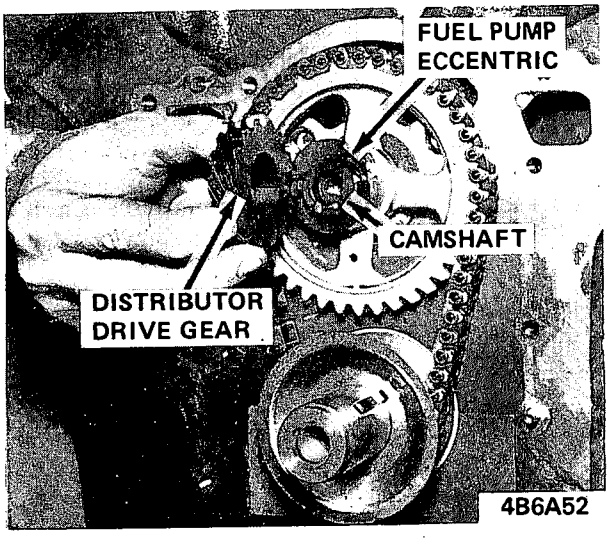


Figure 6A-99 - Fuel Pump and Distributor Drive Gear Installation - 231 and 350 Cu. In.

4. 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.

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

455 Cu. In.

1. With timing chain cover removed, temporarily install harmonic balancer bolt and washer in end of crankshaft.

Turn crankshaft so sprockets are positioned as shown in Figure 6A-100. Remove harmonic balancer bolt and washer using a sharp blow on the wrench handle, so that the bolt can be started out without changing position of sprockets.

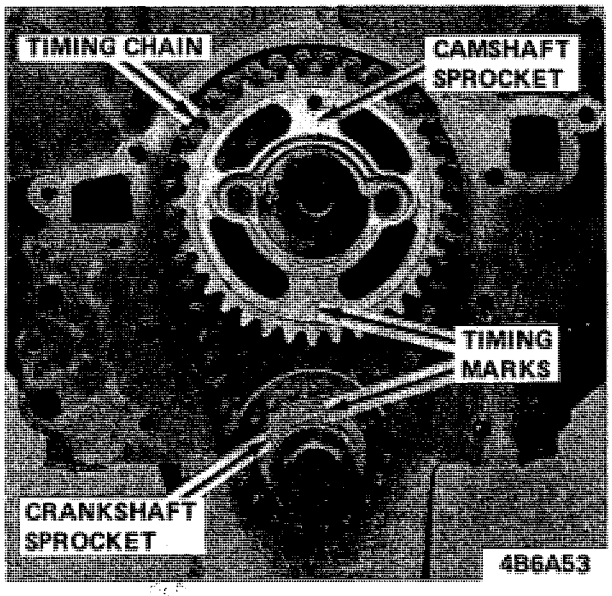


Figure 6A-100 - Installation of Timing Chain and Sprocket (455 Cu. In.)

2. Remove oil pan.

3. Remove front crankshaft oil slinger.

4. Remove camshaft sprocket bolts.

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.

Timing Chain and Sprocket Installation

231 and 350 Cu. In.

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

2. Turn camshaft so with sprocket temporarily installed, timing mark is straight down. See Figure 6A-98. 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 6A-98.

4. Assemble slinger on crankshaft with I.D. against sprocket (concave side toward front of engine). See Figure 6A-101.

5. Slide fuel pump eccentric on camshaft with oil groove out board of keyway towards front of engine. See Figure 6A-99.

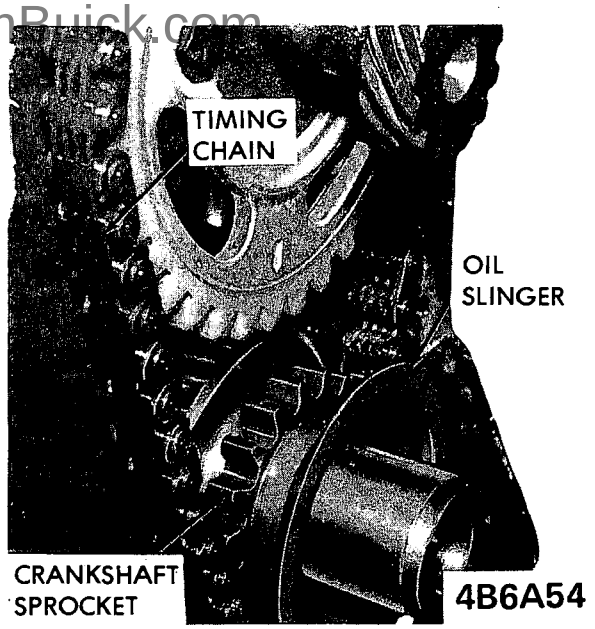


Figure 6A-101 - Oil Slinger Installation

6. Install distributor drive gear. See Figure 6A-99.

7. Install drive gear and eccentric bolt and retaining washer. Torque to specifications.

8. Reinstall timing chain cover.

455 Cu. In.

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

2. Turn camshaft so with sprocket temporarily installed, timing mark is straight down. See Figure 6A-100. 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 6A-100.

4. Assemble slinger on crankshaft with I.D. against sprocket (concave side toward front of engine). See Figure 6A-101.

5. Reinstall oil pan using a new gasket.

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

7. Reinstall timing chain cover.

Camshaft Removal and Installation

1. Remove intake manifold.

2. Remove rocker arm covers.

3. Remove rocker arm and shaft assemblies, push rods and valve lifters.

4. Remove timing chain cover, timing chain and sprocket.

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

6. When replacing camshaft, take particular care to avoid marring the bearing surfaces.

7. Install valve mechanism.

8. Install intake manifold.

If low oil pressure is suspected, the pressure can be checked on the car with tool set J-25087.

1. Check oil level.

2. Raise vehicle and remove oil filter.

3. Assemble plunger valve in the large hole of the tester base and the hose in the small hole of the tester base. Connect guage to the end of the hose.

4. Insert the flat side of the rubber plug, for ease of installation, in the by-pass valve without depressing the by-pass valve itself.

5. Install the tester on filter mounting pad.

6. Start engine to check overall pressure, sender switch, or noisy lifters. Pressure should be as follows:

(NOTE: Engine should be at operating temperature before checking oil pressure.)

231 Cu. In. V-6 37 psi @ 2600 rpm

250 Cu. In. L-6 40 psi @ 2000 rpm

260 Cu. In. V-8 35 psi @ 2000 rpm

350 Cu. In. V-8 37 psi @ 2600 rpm

400 Cu. In. V-8 55-60 psi @ 2600 rpm

455 Cu. In. V-8 40 psi @ 2500 rpm

7. If adequate oil pressure is indicated, check pressure sending switch.

8. If a low reading is indicated, depress the valve on tester base to isolate the oil pump and/or its components from the lubricating system. An adequate reading at this time would indicate a good pump and the previous low pressure was due to worn bearings etc. A low reading while depressing the valve would indicate a faulty pump.

PRIMING THE OIL PUMP WITH TOOL J-25087

1. Assemble plunger valve in the large hole of the tester base and the hose in the small hole of the tester base. Connect guage to the end of the hose.

2. Insert the flat side of the rubber plug, for ease of installation, in the by-pass valve without depressing the by-pass valve itself.

3. Install the tool on filter mounting pad.

6. Connect a pressurized air supply to the primer attachment.

7. Depress lever on primer attachment while at the same time holding valve on tester base down to assure that oil will be lifted instead of air being drqwn from bearings etc. Hold these positions until a light spray of oil emits from the nozzle verifying that the oil pump has been primed.

8. Remove primer assembly, install filter and start engine.

(NOTE: In the event of failure to raise oil during priming operation, check for vented system, such as a cracked or broken pump body or relief valve in open position.

If oil can be lifted during priming operation, but pump fails to function, check for worn or broken pump drives. A broken or twisted pump drive may indicate a lock-up (frozen) oil pump. Inspect and replace as necessary.)

OIL PUMP AND RELIEF VALVE CLEANING

At times an oil pump or oil pump relief valve may be stuck due to the presence of foreign particles. They may be cleaned in the following manner:

1. Blow compressed air through the oil channel (between the pump and filter pad), with short blasts this will further open the relief valve allowing these particles to be forced from the pump. If this operation is successful, the oil pump will once again be able to deliver pressure.

2. Follow procedure for priming oil pump.

(NOTE: Failure to prime at this time will necessitate oil pump overhaul or replacement.)

REMOVAL AND INSPECTION OF OIL PUMP COVER AND GEARS

Removal

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 6A-103. Oil filter by-pass valve and spring are staked in place and should not be removed.

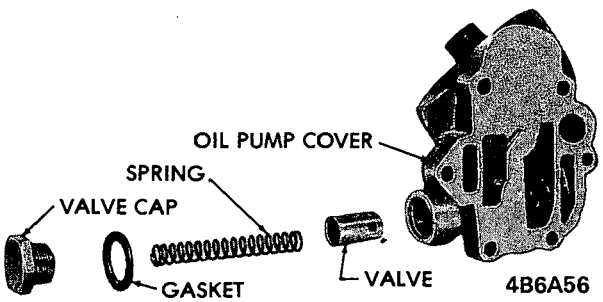


Figure 6A-103 - Oil Pump Cover and Pressure-Relief Valve

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.

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.

Installation

1. Lubricate and install pressure relief valve and spring in

bore of oil pump cover. See Figure 6A- 103. 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 6A-104. Clearance should be between .0023" and .0058". If clearance is less than .0018" check timing chain cover gear pocket for evidence of wear.

Figure 6A-104 - Checking Oil Pump End Clearance

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

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

ENGINE MOUNTING, FLYWHEEL, AND ENGINE BALANCING

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.

Installation of Front Mount

1. Install mount to engine block bolts and torque to specification.

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

3. Remove frame support and lower car.

Removal of Rear (transmission) Mount

For details of engine and transmission mounts and transmission support installation refer to illustrations at end of this section.

Removal and Replacement of Automatic Transmission Flywheel

1. Remove transmission (refer to Transmission Group).

2. Remove six bolts attaching flywheel to crankshaft flange.

3. Inspect flywheel; if cracked, 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 so all flywheel bolts can be installed with flywheel in correct position. 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". 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.

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. Flywheel is located in a predetermined location on crankshaft by attaching bolts, which are unevenly spaced.

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 degrees F.). Heating the ring in excess of 800 degrees 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.

Automatic Transmission Flywheel Balance

Clips are available from the Parts Department that will serve as balance weights for automatic transmission fly-

wheels. These clips are secured by their clamping pressure to the flywheel. See Figure 6A-105 for clip installation locations.

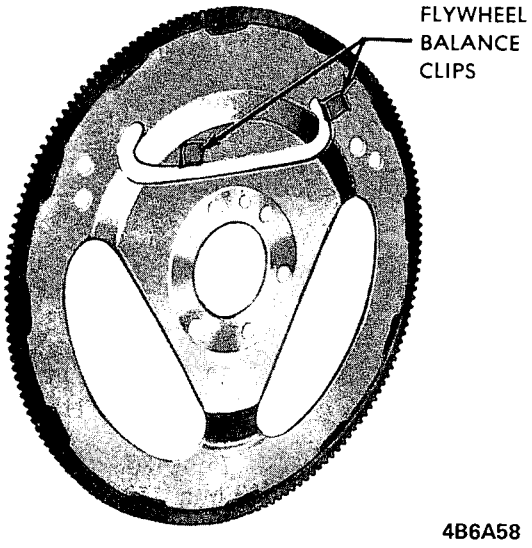


Figure 6A-105 - Automatic Transmission Flywheel Balance Clip Location (350 cu.in. Shown)

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 degrees 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 degrees from original location.

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

(c) If no change is noted, move clip 90 degrees 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. Be certain that the tangs on the clip are set in the flywheel. Otherwise, the clip(s) may shift when the flywheel is turned at high speeds.

Manual Transmission Flywheel Balance

All manual transmission flywheels are balanced at the factory by drilling holes at various points on the flywheel surface. *No attempt should be made to balance a flywheel after the initial factory balance.*

Harmonic Balancer

If the 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. Run engine at critical speed and note vibration.

c. Repeat Step a above using varying amounts 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" iron rod approximately 1/2" long. Use a chisel, upset a small amount of material on the side of the piece of rod. See Figure 6A-106.

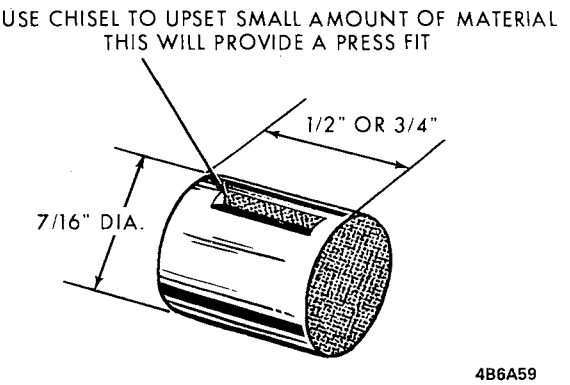


Figure 6A-106 - Harmonic Balancer - Balance Weight Details

f. Install iron rod into hole marked in Step 4.

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

SPECIFICATIONS

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 measurements 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		
	231	350	455
	Lb. Ft.		
Spark Plugs	30	15	15
Crankshaft Bearing Caps to Cylinder Block	115	115	115
Connecting Rods	40	40	45
Cylinder Head to Cylinder Block	75	80	100
Harmonic Balancer to Crankshaft	150 Min.	150	200
Fan Driving Pulley to Harmonic Balancer	20	23	23
Flywheel to Crankshaft (Auto. and Manual)	55	60	60
Oil Pan to Cylinder Block	15	14	14
Oil Pan Drain Plug	30	30	30
Oil Pump Cover to Timing Chain Cover	10	10	10
Oil Pump Pressure Regulator Retainer	35	35	35
Oil Screen Housing to Cylinder Block	7	8	8
Oil Pan Baffle to Cylinder Block	–	–	8
Oil Gallery Plugs	25	25	25
Oil Pressure Switch to Cylinder Block	23	23	23
Filter Assembly to Pump Cover	12	13	13
Timing Chain Cover to Block	30	30	30
Water Pump Cover to Timing Chain Cover	7	7	7
Fan Driven Pulley	20	20	20
Thermostat Housing to Intake Manifold	20	20	20
Automatic Choke Cover to Intake Manifold	–	8	8
Intake Manifold to Cylinder Head	45	45	45
Exhaust Manifold to Cylinder Head	25	28	28
Carburetor to Intake Manifold	15	15	15
Fuel Pump to Cylinder Block	20	20	20
Motor Mount to Cylinder Block	55	63	63
Fuel Pump Eccentric and Timing Chain Sprocket to Camshaft	45	48	22
Rocker Arm Cover to Cylinder Head	5	4	4
Rocker Arm Shaft to Cylinder Head	30	30	30
Delcotron Bracket to Cylinder Head	35	35	35
Delcotron Adjusting Bracket to Water Pump	20	22	22
Delcotron Mounting Bracket Through Delcotron to Cylinder Head at Pivot Location	35	35	35
Starting Motor to Block	35	35	35
Distributor Hold-Down Clamp	12	13	13
Lower Flywheel Housing Cover Manual	10	4	4
Flywheel Housing or Automatic Transmission Cylinder Block	35	35	35
Timing Chain Dampener to Cylinder Block Bolt	7	–	–
Bolt - Special Moveable Timing Chain Dampener	12	–	–

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

ENGINE	231-2	350-2	350-4	455-4
CODE LETTER PREFIX	AD	AB	AM	AF
ENGINE TYPE	90° V-6	90° V-8	90° V-8	90° V-8
BORE AND STROKE	3.800 x 3.400	3.800 x 3.850	3.800 x 3.850	4.312 x 3.900
PISTON DISPLACEMENT	231 CU. IN.	350 CU. IN.	350 CU. IN.	455 CU. IN.
CARBURETOR TYPE	2 BBL-ROCH	2 BBL-ROCH	4 BBL-ROCH	4 BBL-ROCH
COMPRESSION RATIO	8.0:1	8.1:1	8.0:1	8.0:1
FUEL REQUIREMENTS	UNLEADED	UNLEADED	UNLEADED	UNLEADED
OCTANE REQUIREMENTS - MOTOR	82	82	82	82
OCTANE REQUIREMENTS - RESEARCH	91	91	91	91
CYLINDER NUMBERS - FRONT TO REAR - RIGHT BANK	2-4-6	2-4-6-8	2-4-6-8	2-4-6-8
CYLINDER NUMBERS - FRONT TO REAR - LEFT BANK	1-3-5	1-3-5-7	1-3-5-7	1-3-5-7
FIRING ORDER	1-6-5-4-3-2	1-8-4-3-6-5-7-2	1-8-4-3-6-5-7-2	1-8-4-3-6-5-7-2
CYLINDER BLOCK MATERIAL	CAST IRON	CAST IRON	CAST IRON	CAST IRON
CYLINDER HEAD MATERIAL	CAST IRON	CAST IRON	CAST IRON	CAST IRON
INTAKE MANIFOLD MATERIAL	CAST IRON	CAST IRON	CAST IRON	CAST IRON

5B6A106A

Figure 6A-106A

Connecting Rods

Material ..... (231 and 350) Pearlite Malleable Cast Iron (455) SAE-1053 Steel Forged
Rod Bearing ..... Removable Steel Backed M/400 Aluminum

Ring Specifications

#1 Compression ..... Cast Iron Molybdenum Coated
#2 Compression ..... Cast Iron - Lubrited
Oil Control ..... (231 and 350) Uncoated Steel (455) SAE-1070 Steel (Chrome Plated)
Oil Ring Expander ..... Abutment Type
Ring Locations ..... Above Pin

Crankshaft Specifications

Material ..... Nodular Iron
Bearings ..... Replaceable Steel Backed
Bearing Material 350 and 455 #1,#2,#3 and #4 M/400 #5-M/100A Durex (231 All M/100 Durex)
Bearing Taking End Thrust ..... No. 3 350 and 455 - No. 2 231 Engine

Camshaft Specifications

Material ..... Cast Alloy Iron
Bearings ..... Steel Backed Babbitt
Number of Bearings ..... 350 and 455 5 231 Engine 4
Drive ..... Chain
Number of Links ..... (231 and 350) 54 (455) 48
Crankshaft Sprocket ..... Sintered Iron
Camshaft Sprocket ..... Nylon-Coated Aluminum

Valve Specifications

231 and 350 Cu.In.
- Intake Valve Material ..... SAE 1041 Steel - Aluminized Face and Chrome Flashed Stem
- Exhaust Valve Material ..... 21-2 Nickel-Plated Face and Chrome Flashed Stem
- Valve Lifter Mechanism ..... Hydraulic
- Valve Springs ..... Intake - Single Helical
- Valve Springs ..... Exhaust - Helical with Dampener

455 Cu.In.
- Intake Valve Material ..... Aluminized Face and Chrome Flash Stem SAE 1041 Steel
- Exhaust Valve Material ..... 21-2 Nickel-Plated Face and Chrome Flash Stem
- Valve Lifter Mechanism ..... Hydraulic
- Valve Springs ..... Intake - Single Helical
- Valve Springs ..... Exhaust - Helical with Dampener

Lubrication System Specifications

Type of Lubrication
- Main Bearings ..... Pressure
- Connecting Rods ..... Pressure
- Piston Pins ..... Splash
- Camshaft Bearing ..... Pressure
- Timing Chain ..... Drop From Front Cam Bearing
- Cylinder Walls ..... Splash

Oil Pump Type ..... Gear Driven
Normal Oil Pressure ..... (231 and 350) 37 Lbs. at 2600 RPM (455) 40 Lbs. at 2400 RPM
Oil Pressure Sending Unit ..... Electrical
Oil Intake ..... Stationary
Oil Filter System ..... Full Flow
Filter Type ..... Throw-Away Element and Can
Crankcase Capacity - With Filter ..... 5 Quarts
Crankcase Capacity - Less Filter ..... 4 Quarts

ENGINE DIMENSIONS AND FITS

General

	231 and 350 Cu.In.	455 Cu.In.
Piston Clearance Limits*		
Top Land	.026-.034	.036-.044
Skirt Top	.0008-.0020	.0007-.0013
Skirt Bottom	.0013-.0035	.0020-.0036
Ring Groove Depth		
#1 - Compression Ring	.184-.194	.212-.222
#2 - Compression Ring	.186-.194	.215-.222
#3 - Oil Ring	.188-.196	.181-.222
Ring Width		
#1 - Compression Ring	168-.178	.191-.201
#2 - Compression Ring	.168-.178	.191-.201
#3 - Oil Ring (3 Piece Ring)	.150-.156	.150-.156
#4 - Oil Ring (2 Piece Ring)	.135-.142	.135-.142
Ring Gap		
#1 - Compression Ring	.010-.020	.013-.023
#2 - Compression Ring	.010-.020	.013-.023
#3 - Oil Ring	.015-.035	.015-.035
Piston Pin Length	3.060	3.520
Diameter of Pin	.9391-.9394	.9991-.9994
Clearance		
In Piston (Selected)	.0004-.0007	.0004-.0007
Press Fit in Rod	.0007-.0017	.0006-.00016
Direction and Amount Offset in Piston	.040 Major Thrust Side	.060 Major Thrust Side

*All measurements in inches, unless otherwise specified.

Connecting Rod Specifications

	231 and 350 Cu.In.	455 Cu.In.
Bearing Length	.737	.820
Bearing Clearance (Limits)	.0005-.0026	.0005-.0026
End Play - Total for Both Rods	.006-.027	.005-.026

Crankshaft Specifications

	231 Cu. In.	350 Cu. In.	455 Cu. In.
End Play at Thrust Bearing	.004-.008	.003-.009	.003-.009
Main Bearing Journal Diameter	2.4995	3.0000	3.2500
Crankpin Journal Diameter	1.991-2.0000	1.991-2.000	2.2487-2.2495
Main Bearing Overall Length			
#1	.864	.864	.865
#2	.1057	.864	.865
#3	.864	1.057	1.057
#4	.864	.864	.865
#5		.864	1.143
Main Bearing to Journal Clearance	.0004-.0015	.0004-.0015	.0007-.0018

Camshaft Specifications

Bearing Journal Diameter
- #1 ..... 1.785-1.786
- #2 ..... 1.785-1.786
- #3 ..... 1.785-1.786
- #4 ..... 1.785-1.786
- #5 ..... 1.785-1.786

Journal Clearance in Bearings ..... .0005-.0025 (#1) .0005-.0035 (#2,#3,#4, and #5)

Valve System Specifications

231 Cu. In.
- Rocker Arm Ratio ..... 1.55 to 1
- Valve Lifter Diameter ..... .8420" - .8427"
- Valve Lifter Clearance in Crankcase ..... .0008" - .0025"
- Intake Valve
  - Head Diameter ..... 1.630" - 1.620"
  - Seat Angle ..... 45°
  - Stem Diameter ..... .3412" - .3405"
  - Clearance in Guide ..... .0015" - .0032"
- Exhaust Valve
  - Head Diameter ..... 1.430" - 1.420"
  - Seat Angle ..... 45°
  - Stem Diameter ..... .3412" - 3405"
  - Clearance in Guide ..... .0015" - .0032"
- Valve Spring
  - Valve Closed - Pounds @ Length Not Including Dampener ..... 64 ± 5 @ 1.727"
  - Valve Open - Pounds @ Length Not Including Dampener ..... 168 ± 6 @ 1.327"

350 Cu.In.
- Rocker Arm Ratio 1.55:1
- Valve Lifter Diameter ..... .8420-.8427
- Valve Lifter Clearance in Crankcase ..... .0008-.0025
- Intake Valve
  - Overall Length 5.024-4.994
  - Head Diameter 1.880-1.870
  - Seat Angle ..... 45°
  - Stem Diameter ..... .3730 – .3720
  - Clearance in Guide ..... .0015-.0035
- Valve Spring
  - Valve Closed - Lbs. at Length ..... 75 ± 5# at 1.727
  - Valve Open - Lbs. at Length ..... 180 ± 7# at 1.340
- Exhaust Valve
  - Overall Length 4.908-4.893
  - Head Diameter 1.555-1.545

Seat Angle ..... 45°
Stem Diameter ..... .3723 Min. and .3730 Max.
Clearance in Guide ..... .0015-.0032
Valve Spring
Valve Closed - Lbs. at Length Not Including Dampener ..... 72 ± 5# at 1.727
Valve Open - Lbs. at Length ..... 177 ± 7# at 1.450

455 Cu.In.
Rocker Arm Ratio 1.60:1
Valve Lifter Diameter ..... .8427-.8420
Valve Lifter Clearance in Crankcase ..... .0008-.0025
Intake Valve
Head Diameter 2.005-1.995
Seat Angle ..... 45°
Stem Diameter ..... .3730 – .3720
Clearance in Guide ..... .0015-.0035
Valve Spring
Valve Closed - Lbs. at Length ..... 72 ± 5# at 1.890
Valve Open - Lbs. at Length ..... 177 ± 7# at 1.450
Exhaust Valve
Head Diameter 1.692-1.682
Seat Angle ..... 45°
Stem Diameter ..... .3723 Min. and .3730 Max.
Clearance in Guide ..... .0015 - .0032
Valve Spring
Valve Closed - Lbs. at Length Not Including Dampener ..... 72 ± 5# at 1.890
Valve Open - Lbs. at Length Not Including Dampener ..... 177 ± 7# at 1.450

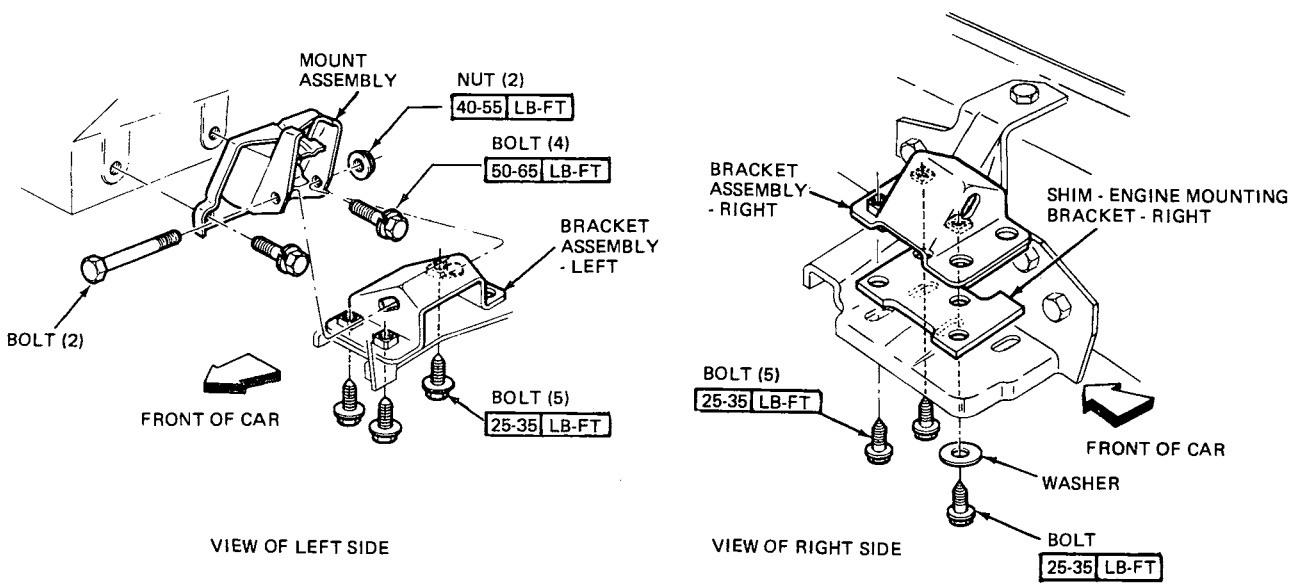


Figure 6A-107 Engine Mounting 231 H Series

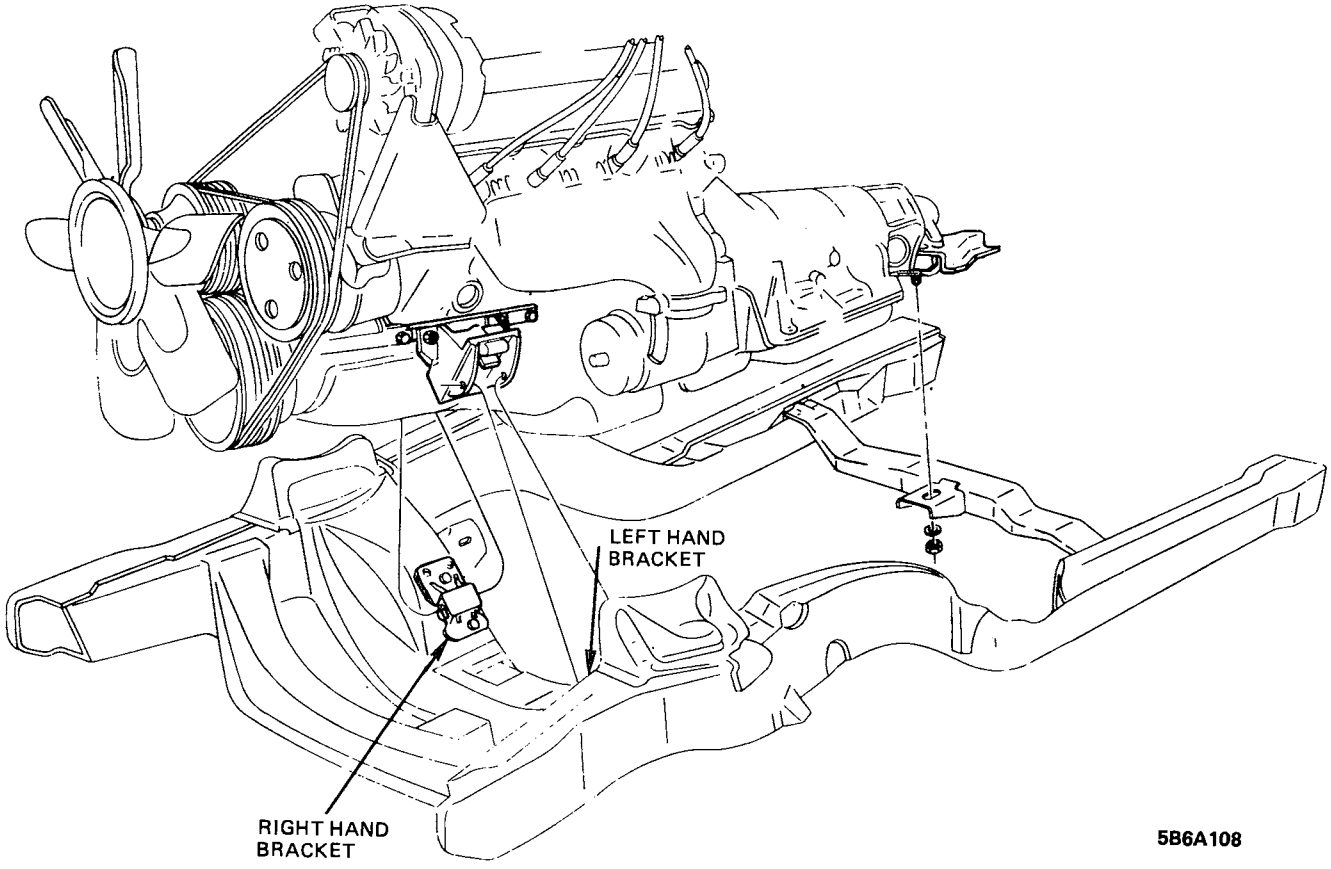


Figure 6A-108 Engine Mounting 260 "X" Series

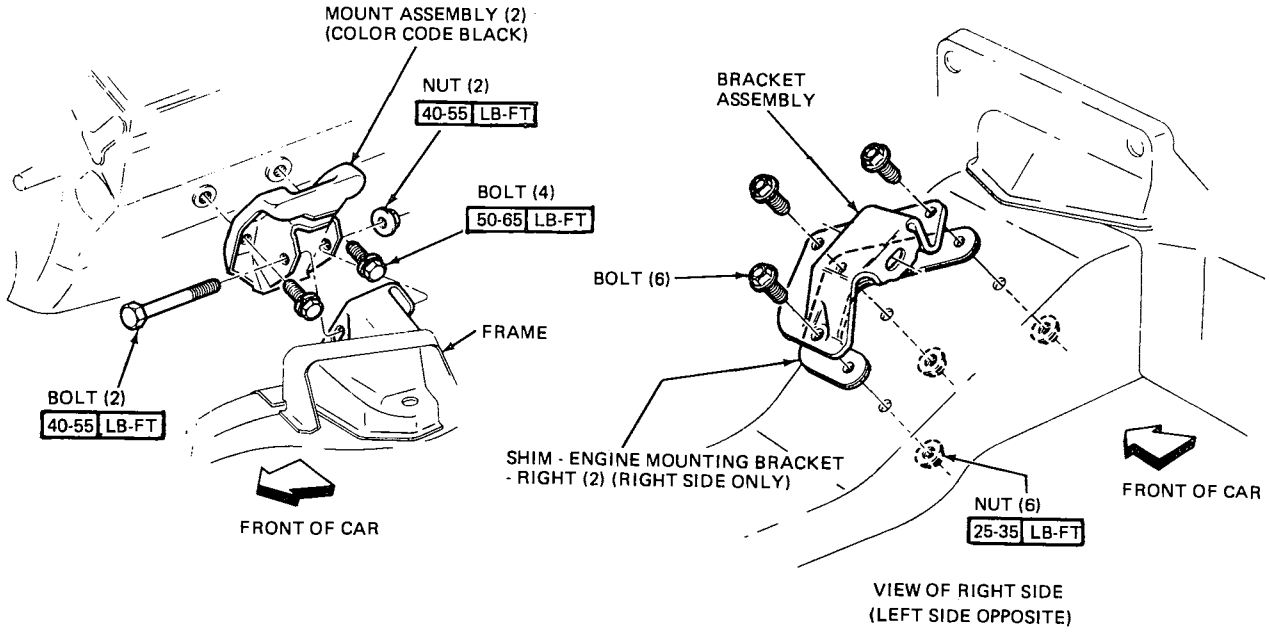


Figure 6A-109 Engine Mounting 350 "X" Series

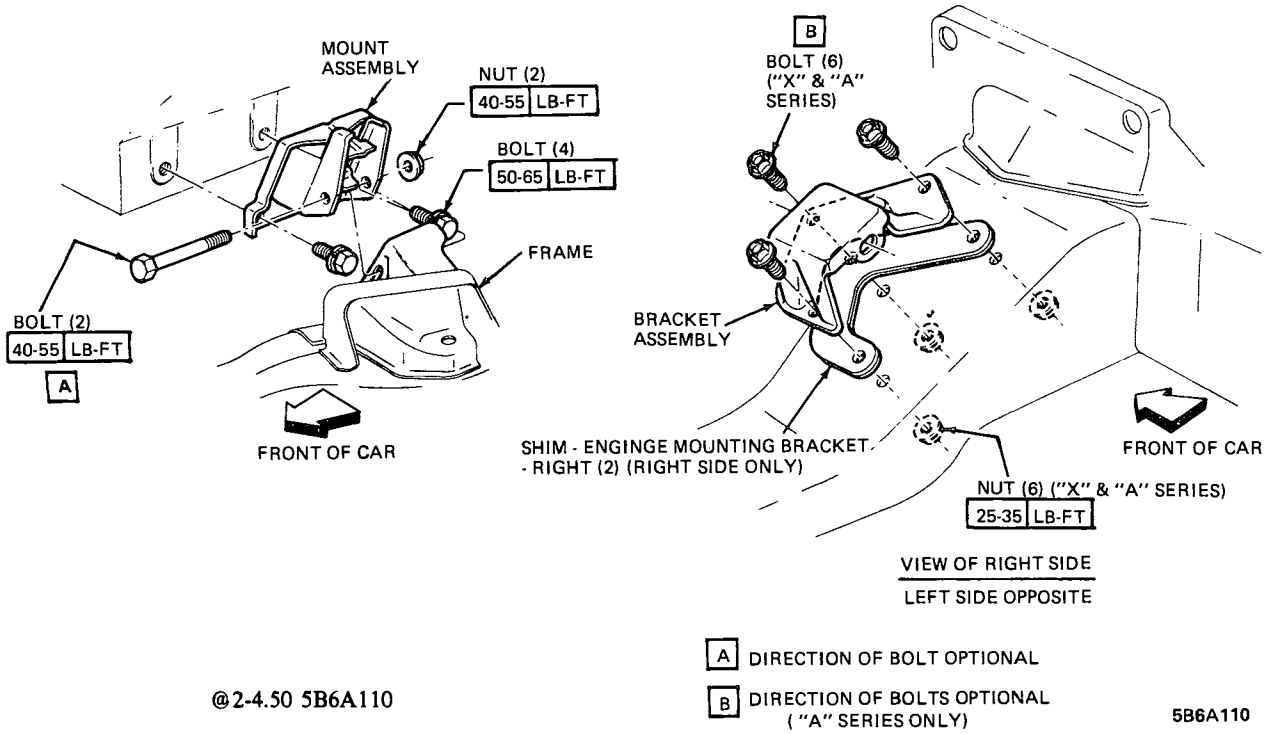


Figure 6A-110 Engine Mounting 231 "A and X" Series

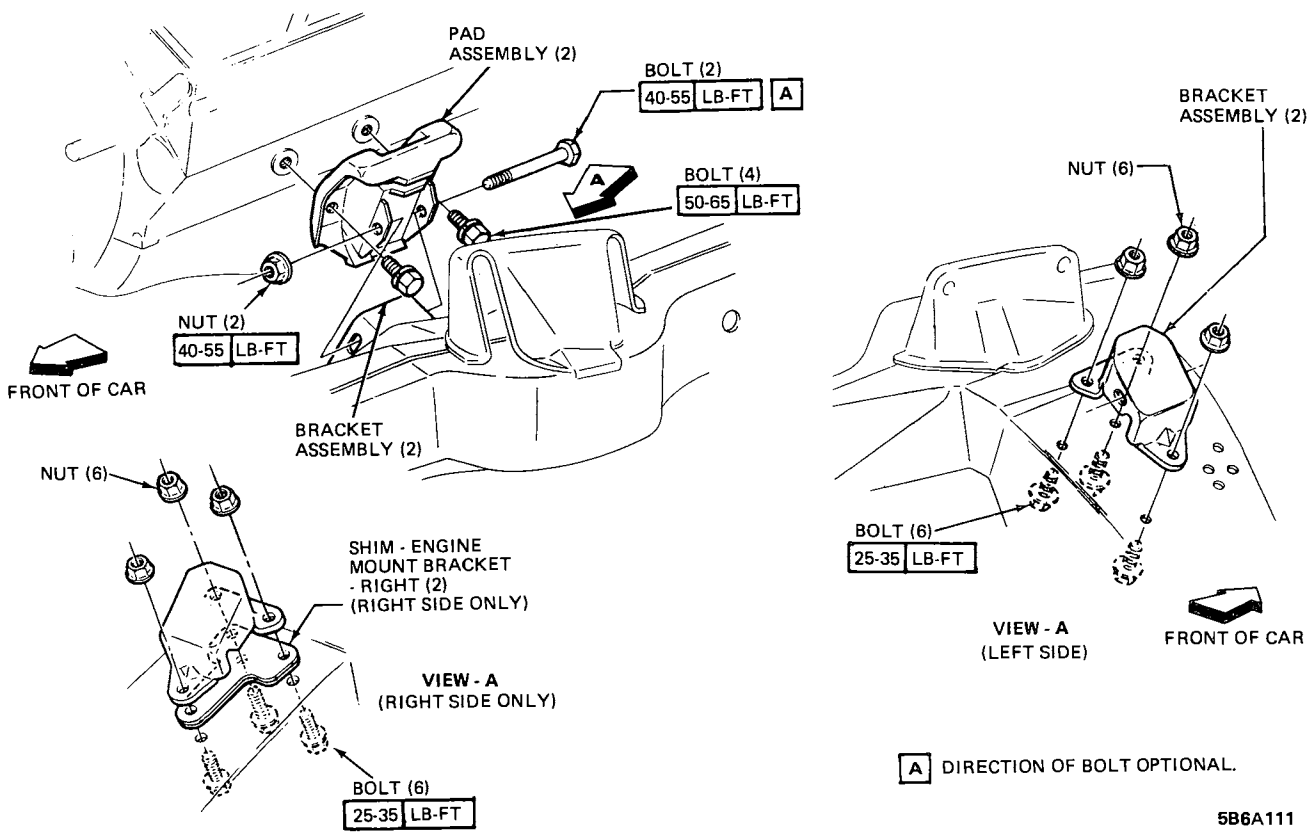


Figure 6A-111 Engine Mounting 350 "A" Series

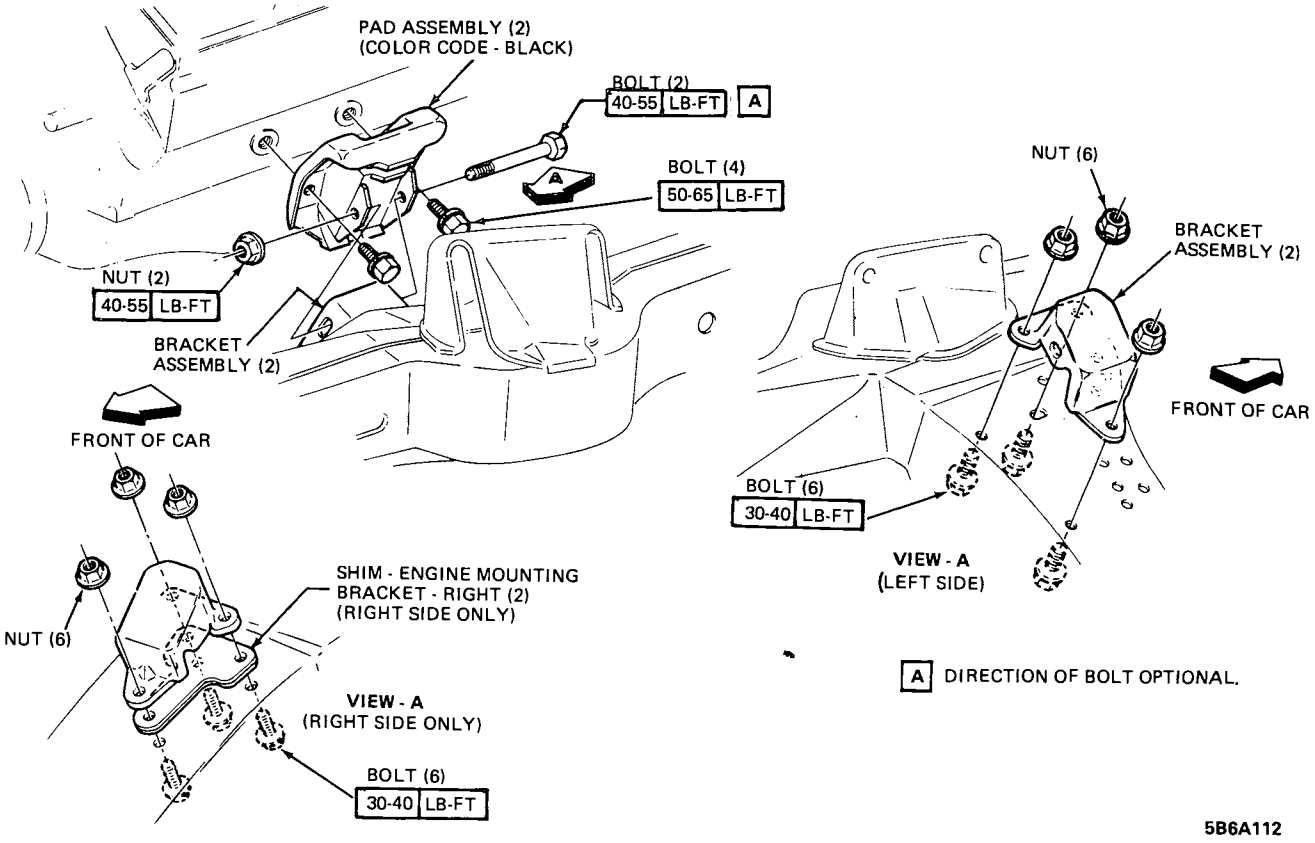


Figure 6A-112 Engine Mounting 350 Engine "B" Series

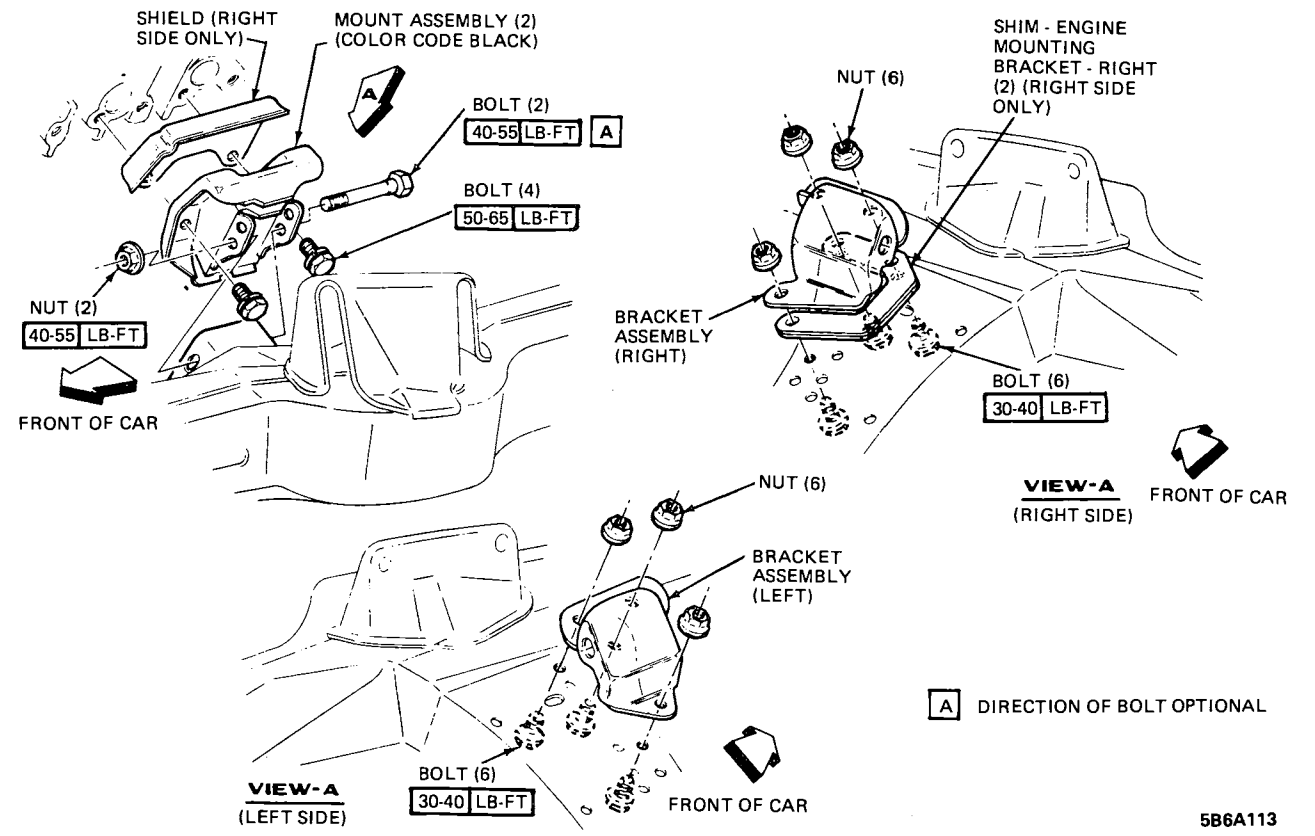


Figure 6A-113 Engine Mounting 455 Engine B-C-E Series

400 V-8 ENGINE

CONTENTS

GENERAL DESCRIPTION:
Cylinder Block 6A-60
Cylinder Head 6A-60
Crankshaft and Bearings 6A-60
Camshaft and Bearings 6A-61
Pistons and Connecting Rods 6A-61
Valve Train 6A-61
Hydraulic Valve Lifters 6A-61
GENERAL INFORMATION ON ENGINE SERVICE:
PERIODIC SERVICE:
SERVICE OPERATIONS ON CAR:
Engine Mounts-Remove and Replace 6A-62
Engine Assembly-Remove and Replace 6A-63
Exhaust Manifold-Remove and Replace 6A-63
Intake Manifold or Gasket-Remove and Replace 6A-64
Push Rod Cover or Gasket-Remove and Replace 6A-65
Valve Springs, Shield or Seal-Remove and Replace 6A-65
Push Rod or Valve Lifter-Remove and Replace 6A-65
Cylinder Head or Gasket-Remove and Replace 6A-66
Rocker Arm Studs-Remove and Replace 6A-66
Cylinder Head and Valves-Recondition 6A-67
Harmonic Balancer-Remove and Replace 6A-68
Timing Chain Cover Seal-Remove and Replace 6A-69
Timing Chain Cover, Gasket or Fuel Pump Eccentric-Remove and Replace 6A-69
Timing Chain and Sprockets-Remove and Replace 6A-70
Camshaft-Remove and Replace 6A-70
Oil Pan and/or Oil Pan Gasket-Remove and Replace 6A-72
Oil Pump-Remove and Replace 6A-72
Rear Main Bearing Oil Seal-Remove and Replace 6A-73
Main Bearings-Remove and Replace 6A-74
Connecting Rod Bearings-Remove and Replace 6A-75
Connecting Rod and Piston Assembly-Remove and Replace 6A-76
Cylinder Bores-Inspect 6A-78
Honing or Boring 6A-79
Fit and Replace Piston 6A-79
Fitting Pin in Piston 6A-80
Piston Rings-Remove and Replace 6A-80
Crankshaft-Remove and Replace 6A-81
Engine Block Core Hole Plugs and Oil Passage Plugs-Inspect and Replace 6A-82
Fitted Block Assembly-Replace 6A-83

GENERAL DESCRIPTION

IDENTIFICATION

Engines may be identified by first noting the engine code on the front of the block, stamped on a machined pad on the right bank of cylinders and then referring to the engine charts.

CYLINDER BLOCK

The cylinder block has two banks of four cylinders each, cast at 90° to each other. Left bank cylinders are numbered 1-3-5-7 from front to back and right bank cylinders are numbered 2-4-6-8.

All main bearing caps are doweled to the cylinder block to assure accurate alignment and facilitate assembly.

CYLINDER HEAD

Cylinder heads have fully machined compustion chambers. In addition, all exhaust valve seats are induction hardened, making them more resistant to wear. Valve guides are cast integral with the cylinder head and valve heads are surrounded by water jackets. A.I.R. provisions on all cyl. heads.

CRANKSHAFT AND BEARINGS

The crankshaft is cast nodular iron and is supported by

five main bearings. The rear main bearing shells have two oil grooves. When replacing main bearings, it is very important that bearings are installed with the recommended material (M100-A or M400-A) located in the proper position on the crankshaft (upper & lower). Refer to engine specifications for detailed bearing usage. Torsional vibration is dampened by the harmonic balancer mounted on the front end of the crankshaft. The harmonic balancer consists of a hub and a rubber mounted inertia member. The accessory pulleys are bolted to the harmonic balancer and may be changed independently of each other.

The rear main bearing is sealed by a packing seated in a chamfered groove in the block and bearing cap. A slinger on the crankshaft in front of the seal and the drain groove in the rear main bearing prevent an excess of oil from getting to the seal.

Two cavities are drilled in the cylinder block and cap seal groove to prevent seal rotation.

CAMSHAFT AND DRIVE

The engine chart shows the application of camshafts which can be identified by a letter stamped on the front end of the shaft.

Camshafts are cast from alloy iron and cam lobes are ground, hardened and tapered with the high side toward the rear. This, coupled with a spherical face on the lifter, causes valve lifters to rotate. The camshaft is supported by five bearings.

A 7/8" wide, 60-link timing chain is used to drive the camshaft. The 42-tooth camshaft drive sprocket is made from hardened cast iron while the 21-tooth crankshaft sprocket is made from hardened sintered iron.

PISTONS AND CONNECTING RODS

Pistons are of a light weight cast all aluminum slipper skirt type. Their light weight results in reduced inertia forces. These pistons maintain thermal control through contour grinding. The taper cam grind provides quiet piston operation and adds to overall engine smoothness. Two compression rings and one oil control ring are used, all of which are located above the piston pin. Machined reliefs on the top of the piston contribute to the determination of compression ratio and provide for valve clearance.

Piston pins are offset toward thrust side (right-hand side) to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. This feature provides quieter engine operation. Pins are hardened steel and have a floating fit in the pistons. They are retained in the connecting rods by a press fit.

VALVE TRAIN

A very simple ball pivot-type valve train is used. Motion is transmitted from the camshaft through the hydraulic lifter and push rod to the rocker arm. The rocker arm pivots on its ball and transmits the camshaft motion to the valve. The rocker arm ball is retained by a nut which locks against a chamfer on the stud.

The maximum in durability is assured by the use of carburized and cyanide-hardened stamped steel rocker arms. In addition, all friction points in the valve train are positively lubricated.

The cylinder head has straight valve guides cast integrally. External shields are used on both intake and exhaust valve springs to reduct the amount of oil splashed against stems..

Valve stem seals are used on exhaust as well as intake valves to prevent excessive oil from entering the valve guides.

HYDRAULIC VALVE LIFTERS

Hydraulic lifters are used to keep all parts of the valve train in constant contact. Each lifter is an automatic adjuster maintaining zero lash under all conditions. This insures precision valve timing and silent operation, increases valve life, and eliminates the need for tappet adjustment.

The hydraulic lifter assembly includes; the cast iron body which rides in the cylinder block boss, the plunger, push rod seat, plunger spring, ball check valve and spring, ball check valve retainer, rocker feed metering valve and retainer ring.

The hydraulic valve lifter functions as follows: When the lifter is riding on the low point of the cam the plunger spring keeps the plunger and push rod seat in contact with the push rod.

When the lifter body begins to ride up the cam lobe, the ball check valve cuts off the transfer of oil from the reservoir below the plunger. The plunger and lifter body then rise as a unit, pushing up the push rod and opening the valve.

As the lifter body rides down the other side of the cam, the plunger follows with it, until the valve closes. The lifter body continues to follow the cam to its low point, but the plunger spring keeps the plunger in contact with the push rod. The ball check valve will then move off its seat and the lifter reservoir will remain full.

Oil is supplied to the lifter by the cylinder block oil gallery to replace that lost through leak down. The annular groove around the outside of the lifter body indexes with the passage drilled from the gallery to the lifter boss. Oil then enters the lifter from this groove and passes into the plunger cavity. From the plunger cavity, oil under pressure is also fed up the push rod to lubricate the friction area between the upper end of the push rod and the rocker arm.

The hydraulic valve lifter used incorporates a restricted orifice plate installed in the plunger counter bore between the plunger cavity and push rod seat. Its function is to meter the oil supplied under pressure through the push rod to the drilled rockers in the engine, using the push rod and drilled rockers for lubricating the upper valve train.

GENERAL INFORMATION ON ENGINE SERVICE

THE FOLLOWING INFORMATION ON ENGINE SERVICE SHOULD BE NOTED CAREFULLY, AS IT IS IMPORTANT IN PREVENTING DAMAGE AND CONTRIBUTING TO RELIABLE ENGINE PERFORMANCE.

Cleanliness is a primary factor when servicing the V-8 engine. The slightest particle of dirt that finds its way into a hydraulic lifter may cause a malfunction.

Since any dirt which may enter the oil galleries or passages in the engine could eventually get to a lifter, cleanliness should be exercised when any part of the engine is removed or disassembled. When a cylinder head is removed for any purpose, it is necessary to remove the push rod cover. This exposes the lifters to any dirt which may fall from the upper portion of the block or which may be carried in the air. Thus it is wise to cover the lifter galleries until ready to reassemble the engine.

When lifters are removed for any reason, they should immediately be placed in a valve lifter storage box in the order in shich they were removed. It is important for two reasons. First, it is the easiest way to keep lifters clean. Second, lifters should always be replaced in the same boses from which they were removed.

Valves, valve lifters, push rods, rocker arms, rocker arm balls, and rocker arm ball nuts should always be kept in sets and returned to their original positions. These parts will tend to mate as the engine operates and will provide more satisfactory operation when kept together. By storing lifters in a storage box and valves, push rods, rocker arms, balls and nuts in a holding stand whenever they are removed, they can easily be kept in sets for identification during assembly. In addition to keeping the parts in sets, the push rods should be replaced with the same end up. In other words, replace push rods so that the same end contacts the rocker arm as before the engine was disassembled.

Push rods will be polished somewhat in the area where the rod passes through the head.

When hydraulic valve lifters are disassembled, the various parts of each lifter must be kept together. This is especially important since the lifter body and plunger are selectively fitted.

Cylinder head bolts should be installed without thread sealer of any kind.

When raising or supporting the engine for any reason, do not use a jack under the oil pan or crankshaft pulley. Due to the small clearance between the oil pan and the oil pump, jacking against the oil pan may cause it to be bent against the pump. The result would be a telegraphed noise which would be difficult to trace. The crankshaft pulley is sheet steel and will not support engine weight.

When performing any work where electrical terminals could possibly be grounded, the ground cable of the battery should be disconnected at the battery and taped.

Never reverse battery leads, even for an instant, as reverse polarity current flow will damage diodes in the generator.

Any time the carburetor or air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material which could follow the intake passage to the cylinder and cause extensive damage when the engine is started.

IN THE MECHANICAL PROCEDURES DESCRIBED IN THIS SECTION, GENERALLY NO REFERENCES WILL BE MADE TO THE REMOVAL OF OPTIONAL EQUIPMENT SUCH AS POWER STEERING PUMP, AIR CONDITIONING COMPRESSOR, ETC. SHOULD IT BECOME NECESSARY TO REMOVE ANY SUCH ITEM TO PERFORM OTHER SERVICE REFER TO THE APPROPRIATE SECTION OF THE MANUAL FOR SPECIFIC INFORMATION.

PERIODIC SERVICE

There are no periodic services required on the mechanical portions of the engine. Periodic services connected with the engine consist of tune-up, lubrication, replacing oil filter, etc. Procedures and recommendations for these services will be found in appropriate sections of this manual, and the Owner's Manual.

SERVICE OPERATIONS ON CAR

ENGINE MOUNTS

FRONT MOUNTS

Remove and Replace

If a new rear mount is also to be installed, it should be installed first since the engine locates from the rear mount.

> **CAUTION:** *Disconnect battery ground strap before raising engine. (When engine is raised, the starting motor solenoid terminals may contact the steering gear which could energize the starting motor if ground cable is not disconnected).*

1. Remove thermal feed switch from rear of left cylinder head. Lift engine and support.
2. Remove bolt which fastens mounts to frame.
3. Remove bolts fastening engine mount to engine.
4. Raise engine just clear of mount.
5. Remove mount.
6. Position new mount against engine and install attaching screws and washers. Tighten to 70 lb. ft.
7. Lower engine.
8. Install frame to mount bolt (with lockwasher and plain washer, if equipped) and tighten to 50 lb. ft.

REAR MOUNT

Remove and Replace

1. Support transmission at rear to remove engine weight from rear mount, using suitable lifting equipment.
2. Remove attaching nuts or bolts at mount/crossmember, and raise transmission until mount is clear of lower crossmember support.
3. Remove mount upper retainer bolts from transmission extension.
4. Remove mount assembly.
5. Install by reversing above procedure, torquing all nuts and bolts to 30 lb. ft.

Remove

1. Disconnect battery cables at battery.
2. Drain cooling system.
3. Scribe alignment marks on hood around hood hinges and remove hood from hinges.
4. Disconnect engine wire harness and engine to body ground straps.
5. Remove thermal feed switch from rear of left cylinder head.
6. Remove air cleaner.
7. Disconnect radiator and heater hoses at engine.
8. If equipped with power steering or air conditioning, remove pump and compressor from mounting brackets and set aside. Do not disconnect hoses.
9. Remove engine fan and pulley.
10. Disconnect accelerator control linkage and move cable to one side.
11. Disconnect transmission vacuum modulator line (automatic) and power brake vacuum line at carburetor.

CAUTION: *Do not bend the metal transmission modulator line.*

12. Raise vehicle and drain crankcase.
13. Disconnect fuel lines at fuel pump.
14. Disconnect exhaust pipes from manifolds.
15. Disconnect starter wires.
16. If equipped with automatic transmission, remove converter cover, remove three converter retaining bolts and slide converter to rear.
17. Remove four lower transmission to engine bolts (two each side).
18. Disconnect transmission filler tube support (automatic) and starter wire harness shield from cylinder heads.
19. Remove two front motor mount bolts at frame.
20. Lower vehicle.
21. Using jack and block of wood, support transmission (automatic transmission).
22. Remove remaining transmission to engine bolts.
23. Raise transmission slightly.
24. Using suitable lifting equipment, remove engine.

Install

1. Install engine lifting equipment to engine and lower engine into chassis, guiding engine to align with transmission.
2. With engine supported by lifting equipment, install two upper transmission bolts.

CAUTION: *Do not lower engine completely while jack is supporting transmission.*

3. Remove transmission support jack.
4. Lower engine and remove lifting equipment.
5. Raise vehicle.
6. Install remaining transmission bolts.
7. Replace two front motor mount to frame bolts.
8. For remaining installation procedures, reverse steps 1 thru 16.

MANIFOLD - VALVE TRAIN - CYLINDER HEADS

RIGHT SIDE EXHAUSE MANIFOLD OR GASKET

Remove

1. Disconnect exhaust pipe from manifold.
2. Straighten tabs on manifold front and rear individual bolt locks and remove manifold attaching bolts, manifold, and gaskets. (Locks are used on front and rear pairs of bolts only).

Replace

1. Thoroughly clean gasket surfaces of cylinder head and exhaust manifold.
2. Replace exhaust manifold gasket. Use new individual manifold bolt locks on front and rear pairs of bolts.
3. Place manifold outlet in position over end of exhaust pipe but do not permit weight of manifold to rest on exhaust pipe. Since the end holes of gasket are slotted, installation of gasket may be simplified by first installing manifold, using only the front and rear bolts to retain manifold. Allow clearance of about 3/16" between cylinder head and exhaust manifold. After inserting gasket between head and manifold, the remaining bolts may be installed.
4. Tighten all bolts evenly and securely to 30 lb. ft. Bend tab of screw locks against bolt heads.

Be sure tabs are bent against sides of bolt heads, not on top of bolt heads.

5. Attach exhaust pipe to manifold with bolts and tighten to 30 lb. ft.

LEFT SIDE EXHAUST MANIFOLD OR GASKET

Remove

1. Remove generator belt and remove generator and mounting bracket as an assembly.
2. Disconnect exhaust pipe from manifold.
3. Remove carburetor air pre-heater shroud.
4. Straighten tabs on manifold individual bolt locks. Tabs can be straightened from beneath car by using long-handled screwdriver. (Locks are used on front and rear pairs of bolts only.)
5. Remove manifold attaching bolts and remove manifold.

Replace

1. Thoroughly clean gasket surfaces of cylinder head and exhaust manifold.

2. Place manifold in position against cylinder head and install two end bolts, leaving about 1/8" clearance between head and manifold.

3. Slide gasket between manifold and cylinder head.

4. Install remaining bolts and new bolt locks.

5. Tighten all bolts evenly and securely to 30 lb. ft. Bend tabs of bolt locks against bolt heads.

6. Install carburetor air pre-heater shroud.

7. Attach exhaust pipe to manifold and tighten to 30 lb. ft.

ROCKER ARM COVER OR GASKET

Remove

1. Remove air cleaner.

2. Disconnect crankcase ventilation hoses (as required).

3. Disconnect electrical wire(s) from rocker arm cover clips (remove rear compressor bracket and front adjustment bolt on A/C compressor and swing compressor out of way).

4. Remove rocker cover.

CAUTION: *DO NOT pry rocker arm cover loose. Gaskets adhering to cylinder head and rocker arm cover may be sheared by bumping end of rocker arm cover rearward with palm of hand or a rubber mallet.*

Replace

1. Clean gasket surfaces on cylinder head and rocker arm cover with degreaser then, using a new gasket, install rocker arm cover and torque bolts to 4 lb. ft.

2. Connect crankcase ventilation hoses (if disconnected).

3. Connect electrical wire(s) at rocker arm cover clips.

4. Install air cleaner.

INTAKE MANIFOLD OR GASKET

Remove

1. Drain water from radiator and from each side of cylinder block. (Most water can be drained from the block through radiator drain by raising rear end of car approximately 15" to 18" off floor).

2. Remove air cleaner and disconnect closed ventilation pipe at air cleaner, air cleaner vacuum source at manifold and hot air duct by loosening clamp holding elbow to snorkel.

3. Remove water outlet fitting bolts and position fitting out of way, leaving radiator hose attached.

(EGR valve removal is necessary before removal of the intake manifold can be accomplished.)

4. Disconnect electrical wires and vacuum hoses from emission switches and solenoids.

5. Remove spark plug wire brackets from manifold.

6. On cars equipped with power brakes, remove power brake vacuum hose from carburetor.

7. Disconnect distributor solenoid to carburetor vacuum hose.

8. Disconnect fuel line connecting carburetor and fuel pump.

9. Disconnect crankcase vent hose from intake manifold.

10. Disconnect throttle cable from carburetor.

11. Remove screws retaining throttle control bracket assembly.

CAUTION: *Make certain O-ring seal between intake manifold and timing chain cover is retained and installed during assembly if not damaged.*

Replace

When a new manifold is to be installed, transfer carburetor, thermostat, choke stove, stove to carburetor pipes, and distributor spark and EGR thermal vacuum valve. Use new gaskets on those units requiring gaskets and new O-ring seal between manifold and timing chain cover.

1. Install new gaskets on cylinder heads, positioning them with plastic retainers. See Figure 6A-120.

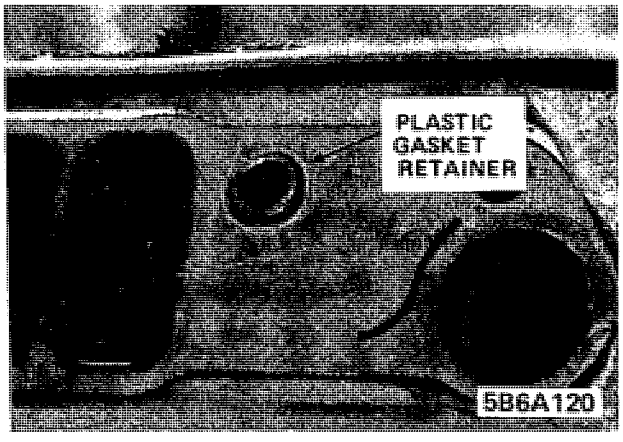


Figure 6A-120 - Intake Manifold Gasket Retainers

2. Install intake manifold on engine.

3. Install O-ring seal.

4. Install cap bolts loosely.

5. Position throttle control bracket assembly on manifold and install cap bolts.

6. Tighten timing chain cover to intake manifold bolt until both units are metal-to-metal (15 lb. ft.)

7. Tighten all bolts evenly to 40 lb. ft.

8. Connect throttle cable to carburetor.

9. On cars equipped with power brakes, install vacuum hose to carburetor.

10. Install fuel pipe connecting carburetor to fuel pump.

11. Install crankcase vent hose to intake manifold fitting.

12. Install water outlet fitting.

13. Connect electrical wires and vacuum hoses to emission switches and solenoids.

14. Install vacuum hoses, connecting distributor solenoid to carburetor.

15. Install spark plug wire bracket.

16. Replace air cleaner, attaching closed ventilation pipe, vacuum source and hot air duct.

17. Close drain plugs and fill radiator to proper level.

PUSH ROD COVER OR GASKET

Remove

1. Remove intake manifold, retaining O-ring seal.

2. Remove crankcase ventilator hose.

3. Remove screws from push rod cover and remove cover.

Replace

1. Cement new gasket on push rod cover.

2. Install neoprene tabs at 4 corners of cover.

3. Replace push rod cover and tighten screws.

4. Replace positive crankcase ventilation hose.

5. Install intake manifold and O-ring seal.

VALVE SPRINGS, SHIELD OR SEAL

Remove

1. Remove rocker arm cover, spark plug and distributor cap. (Remove rear compressor bracket on right side on cars equipped with A/C).

2. Crank engine until distributor rotor is in position to fire cylinder being serviced.

3. Install air fitting J-22278 in spark plug hole and attach air line.

4. Remove rocker arm.

5. After removing rocker arm, thread valve spring compressor stud J-8929-1 on rocker arm stud and compress valve spring, using compressor J-6384-1 and nut J-8929-2. See Figure 6A-121. Remove valve spring retainer cup locks and then remove valve spring compressor, valve spring retainer cup shield and valve stem seal.

Replace

1. Install new part or parts, compress springs with valve spring compressor J-6384-1 and nut J-8929-2. Install valve stem seal (Figure 6A-122) and retainer cup locks. Remove spring compressor and valve holder, then test valve stem seal using suction cup end of Tool J-22330. See Figure 6A-123.

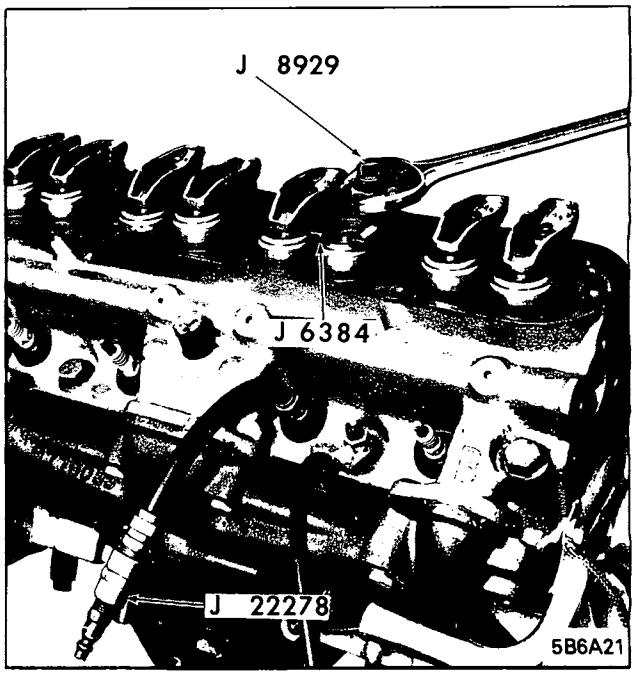


Figure 6A-121 - Compressing Valve Spring

2. Install rocker arm, tighten rocker arm ball retaining nut to 20 lb. ft.

3. Remova air fitting J-22278.

4. Replace rocker arm cover, spark plug, distributor cap and connect spark plug wire.

PUSH ROD OR VALVE LIFTER

Remove

1. Remove intake manifold, making sure timing cover to intake manifold O-ring is saved.

2. Remove push rod cover.

3. Remove rocker arm cover.

4. Loosen rocker arm ball nut and move rocker arm off push rod.

5. Remove push rod.

6. Remove lifter. Hydraulic valve lifter remover J-3049 may facilitate removal of lifter.

If move than one lifter is to be replaced, store push rods in a stand and lifters in a lifter box so they can be re-installed in exactly the same place and position. See General Information on Engine Service.

Replace

If new lifter is to be installed be sure to remove all sealer coating from inside of new lifter.

1. Place new lifter in lifter boss.

2. Replace push rod exactly as removed (same end against rocket arm).

Whenever rocker arms and/or rocker arm balls are being installed, coat bearing surfaces of rocker arms and rocker arm balls with "Molykote" or its equivalent.

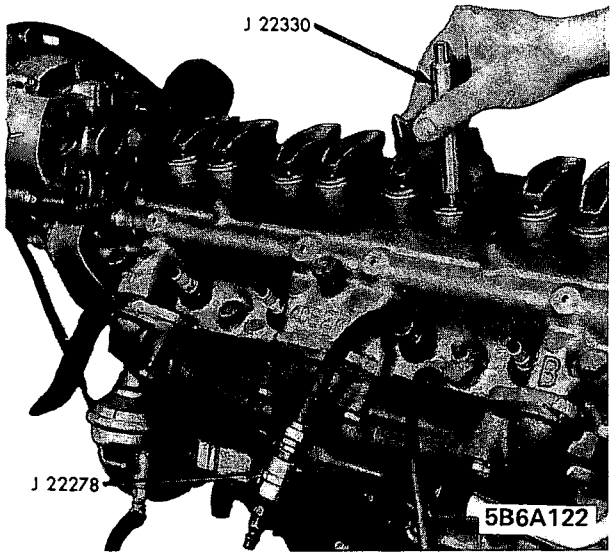


Figure 6A-122 - Installing Valve Stem Seal

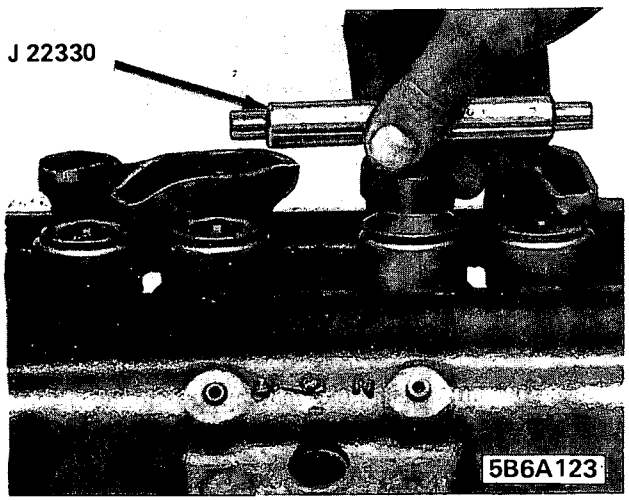


Figure 6A-123 - Checking Valve Stem Seal

3. Position rocker arm on push rod and tighten rocker arm ball retaining nut to 20 lb. ft.

4. Replace rocker arm cover.

5. Inspect condition of push rod cover gasket and replace if necessary; replace push rod cover and tighten screws. New gasket must be cemented securely to push rod cover before installation.

6. Replace intake manifold using new gaskets and replace O-ring seal.

CYLINDER HEAD OR GASKET

Remove

1. Drain cooling system, including block.

2. Remove intake manifold, push rod cover, and rocker arm cover.

3. Loosen all rocker arm retaining nuts and move rocker arms off push rods.

4. Remove push rods and place in a support stand so they can be replaced in exactly the same position from which they were removed.

5. Remove exhaust pipe to manifold attaching bolts.

6. Remove battery ground cable and engine ground strap or engine ground strap and automatic transmission oil level indicator tube bracket on head to be removed.

7. Remove cylinder head bolts (dowel pins will hold head in place) and remove head with exhaust manifold attached, using lifting hooks J-4266. (If left head is being removed, it will be necessary to raise head off dowel pins, move it forward and maneuver the head in order to clear the power steering and power brake equipment if car is so equipped).

> **CAUTION:** *Extreme care should be taken when handling or storing cylinder heads as the rocker arm studs are hardened and may crack if struck.*

10. Remove cylinder head gasket.

Replace

Right and left cylinder heads are the same. When installing new head, transfer all serviceable parts to new head, using new seals on intake and exhaust valve stems, and new exhaust manifold gasket. Install new intake manifold gasket plastic retainers.

1. Thoroughly clean gasket surfaces of head and block. Place new gasket on block, and replace cylinder head.

2. Start all bolts.

Bolts are three different lengths. When inserted in proper holes all bolts will project an equal distance from the head. Do not use sealer of any kind on the threads.

3. Tighten bolts evenly to 95 lb. ft.

4. Install push rods in same location from which they were removed and with the same end up against rocker arm.

5. Reposition rocker arms and tighten rocker arm ball retaining nuts to 20 lb. ft.

6. Replace rocker arm cover and tighten screws.

7. Replace push rod cover and tighten screws.

8. Replace battery ground strap and engine ground strap or engine ground strap and automatic transmission oil level indicator tube bracket. Also replace the engine oil level indicator.

9. Replace intake manifold using new gaskets.

10. Install exhaust-pipe-to-manifold attaching nuts.

11. Refill cooling system.

ROCKER ARM STUDS

Remove and Replace

1. Remove rocker arm cover.

2. Remove rocker arm and nut.

3. Using a deep well socket, remove rocker stud.

4. Install new stud and tighten to 50 lb. ft.

5. Install rocker arm and tighten nut to 20 lb. ft.

6. Install rocker arm cover using new gasket.

CYLINDER HEAD AND VALVES

Disassemble

1. Remove valve spring retainer cup locks (keepers), valve stem oil seals, valve spring retainer cups, valve stem shields, valve springs, and valves, using valve spring compressor J-8062. VALVE STEM OIL SEALS MUST BE DISCARDED AND REPLACED WITH NEW SEALS any time they are removed.

2. Place valves in valve and valve train holding stand.

CYLINDER HEAD AND VALVES

Clean and Inspect

Efficient engine performance depends to a great degree upon the condition of engine valves. Close inspection of intake valves is especially important as excessive clearance of valve stems in guides will permit oil to be pulled into the combustion chamber, causing fouled spark plugs and clogged piston rings. Oil deposited on valve heads will carbonize and burn, causing valves to leak with resultant loss of engine power. Therefore, valves must operate properly and if inspection discloses any malfunction of valves, the trouble must be corrected to avoid future damage to valves or related engine parts.

1. Inspect valves and seats to determine condition before cleaning. Also examine water passage plugs for evidence of leakage.

2. Clean valves thoroughly to remove deposits from head and stem.

3. Clean and inspect cylinder head as follows:

a. Clean carbon deposits from combustion chambers and all sludge or foreign matter from other areas of cylinder head. If a scraper or wire brush is used for cleaning, use care to prevent damage to valve seats (by staying clear of seat area with tool).

b. Clean cylinder head thoroughly, using suitable cleaning equipment.

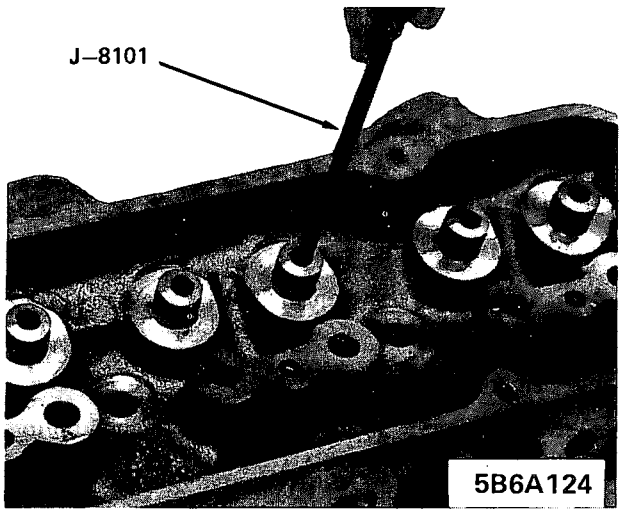


Figure 6A-124 - Cleaning Valve Guide

4. Clean valve guides thoroughly, using valve guide cleaner J-8101. Figure 6A-124.

5. Visually inspect valve guides for evidence of wear, especially the end toward the spring seat. If a guide is scored or galled, install valve with proper oversize stem according to procedure.

6. Clean valve springs and inspect for damage.

7. Clean push rods and thoroughly clean out oil passage through center of rod. Inspect to see that the rod is straight.

8. Clean rocker arms and rocker arm balls, and visually inspect for evidence of wear.

9. Clean spark plugs as outlined in ENGINE ELECTRICAL SECTION.

10. Clean and inspect valve lifters.

VALVES AND SEATS

Recondition

1. Reface valves and seats as follows:

Valves should be ground on a special bench grinder designed specifically for this purpose. Valve seats should be ground with power grinding equipment having stones of the correct seat angle and a suitable pilot which pilots in the valve stem guide. To ensure positive sealing of the valve face to its seat, the grinding stones should be carefully refaced before any grinding is done. Intake valve seat angle is 30°, and exhaust valve seat angle is 45° on all cylinder heads. Intake valve face angle is 29° large valve and exhaust valve face angle is 44° on all valves. This will provide hairline contact between valve and seat to provide positive sealing and reduce build-up of deposits on seating surfaces. Figure 6A-125.

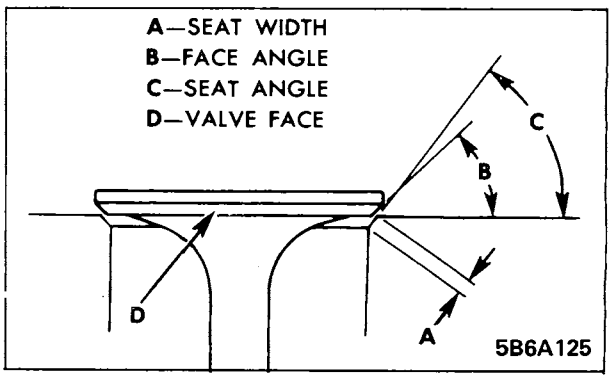


Figure 6A-125 - Valve Seat and Face Angles

DO NOT USE REFACING EQUIPMENT EXCESSIVELY; only enough material should be removed to true up surfaces and remove pits. The valve head will run hotter as its thickness is diminished; therefore, if the valve face cannot be cleaned up without grinding to a point where the outside diameter of the valve has a sharp edge, the valve should be replaced. Whenever it is necessary to replace a valve, the new valve should be of the same stem diameter as the valve removed (unless the valve guide is reamed to provide proper fit).

Width of exhaust valve seats should be 1/16" (.048"-.070"). Intake valve seat should be between 3/64" and 1/16" (.045"-.071"). If seat width is excessive, it should be narrowed by grinding with a flat stone (Figure 6A-125). This is the only method that should be used to narrow the seat.

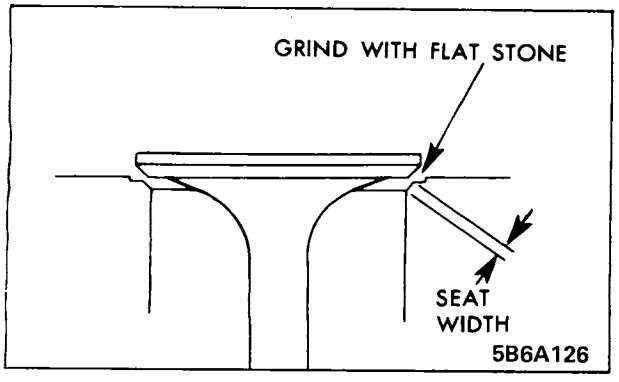


Figure 6A-126 - Valve Seat After Grinding with Flat Stone

Lapping of valve seats is not required nor recommended.

2. Concentricity of valve seat and valve guide can be checked by using a suitable dial indicator or prussian blue. When using a dial indicator, total runout should not exceed .002".

When prussian blue or its equivalent is used, a light coat should be applied to the face of the valve only and the valve rotated in its seat. If blue appears all the way around valve seat, the valve seat and valve guide are concentric with one another.

3. After cleaning prussian blue from valve and seat following preceding check, lightly coat valve seat with prussian blue and rotate valve in guide. If blue appears all the way around valve, the valve stem and valve face are concentric with one another.

Both tests in steps 2 and 3 are necessary to insure proper valve seating.

FITTING VALVE STEMS TO GUIDES

Correct valve stem clearance for valve guides is .0016" to .0033" for intake valve and .0021" to .0038" for exhaust valve.

Valves with oversize stems are available in .003" and .005" larger than standard. (Valves are marked .003 or .005 with colored ink).

The same valve stem to guide clearance applies for oversize stems.

Oversize reamers are required to enlarge valve guide holes to fit the oversize stems. When the reamer is turned through the valve guide, it will size hole to fit valve stem according to above limits.

Carefully ream valve guide using valve guide reamer J-5830-1 for .003" oversize stems and valve guide reamer J-6617 for .005" oversize stems (Figure 6A-127). For best results when installing .005" oversize valve stem, use .003" oversize reamer first and then ream to .005" oversize. Always reface valve seat after reaming valve guide.

CYLINDER HEAD AND VALVES

Assemble

1. Install valves, valve springs, valve stem shields, valve spring retainer cups, valve stem seals and retainer cup locks, using suitable spring compressor. The valve stem seals must be installed in the second groove (from end of stem). Valve stem seal installer and tester J-22330 can be used to install this seal. Where necessary, install new umbrella type seal using suitable plastic protector over end of valve stem.

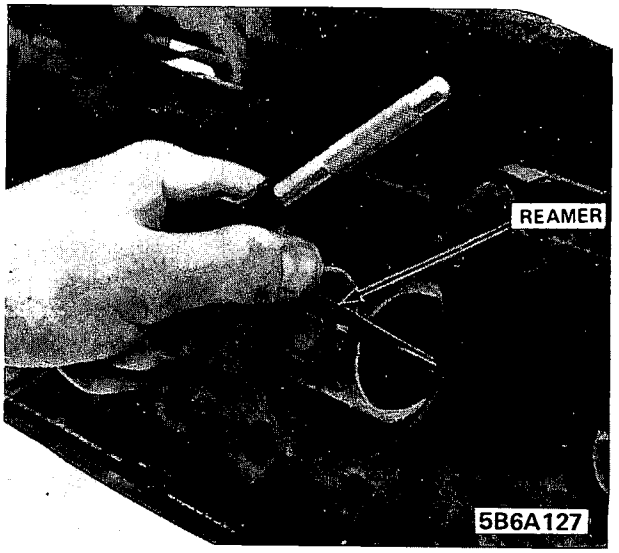


Figure 6A-127 - Reaming Valve Guide

After valves have been installed, the suction cup end of special Tool J-22330 should be used to test for leaks between the valve spring retainer cup and valve stem seal. The suction cup will tend to be held to the valve spring retainer cup by suction when seal is satisfactory. If a leak is detected, replace seal or valve spring retainer cup as necessary. It is important to have a positive seal between the valve spring retainer cup and valve stem seal to prevent excessive amounts of oil from being drawn down the valve stem which will cause exhaust smoke and oil consumption.

2. Install spark plugs.

HARMONIC BALANCER

Remove and Replace

1. Loosen generator at adjusting strap and lower pivot bolt and remove fan belt from harmonic balancer. On cars equipped with power steering, also remove power steering pump belt from harmonic balancer.

2. Position fan so wide angles will be at top and bottom allowing access to balancer.

3. Remove harmonic balancer attaching bolt and retainer washer.

4. Remove harmonic balancer by sliding it off end of crankshaft.

5. Remove crank pulleys and reinforcing plate.

CAUTION: *Do not pry on O.D. of harmonic balancer. Harmonic balancer is a rubber mounted inertia member and balance could be affected.*

6. Install new harmonic balancer by reversing above steps, lining up keyway in balancer with key on crankshaft.

7. Tighten harmonic balancer attaching bolt to 160 lb. ft. (Remove flywheel cover and lock flywheel before tightening balancer bolt).

8. Install fan belt and adjust to specifications.

TIMING CHAIN COVER SEAL

Remove and Replace

1. Loosen generator adjusting bolts.

2. Remove fan and accessory drive belts.

3. Remove harmonic balancer.

4. Remove timing chain cover seal by prying out of bore with a pry bar (Figure 6A-128).

Figure 6A-128 - Timing Chain Cover Seal

5. Install new seal with lip of seal inward, using seal installer J-21147.

6. Replace harmonic balancer.

7. Install drive belts and adjust to proper tension.

TIMING CHAIN COVER, GASKET, OR FUEL PUMP ECCENTRIC

Remove and Replace

1. Drain radiator and cylinder block.

2. Loosen generator adjusting bolts.

3. Remove fan belt and accessory drive belt.

4. Remove fan and pulley from hub of water pump.

5. Remove water pump.

6. Disconnect lower radiator hose.

7. Remove fuel pump.

8. Remove harmonic balancer.

9. Remove front four oil pan-to-timing chain cover screws.

10. Remove timing chain cover to block attaching bolts and nuts and timing chain cover to intake manifold bolt.

11. Pull timing chain cover forward to clear studs and remove.

12. Remove O-ring seal from recess in intake manifold water recirculation passage.

13. Remove timing chain cover gasket and thoroughly clean gasket surfaces on block and cover. Use care to prevent gasket particles and other foreign material from falling into oil pan.

14. Inspect front oil pan gasket and replace if damaged. If new gasket is installed, it should be cemented to oil pan.

15. If new fuel pump eccentric and bushing are to be installed, remove camshaft sprocket retainer bolt and retaining washer and remove the eccentric and bushing. Place fuel pump bushing over eccentric with rolled flange toward camshaft sprocket. Figure 6A-129.

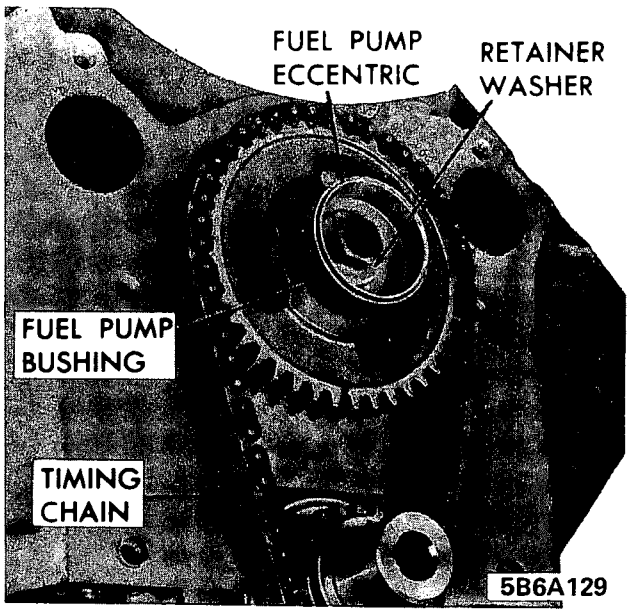


Figure 6A-129 - Fuel Pump Drive

CAUTION: *Bushing retaining flange should be between eccentric and sprocket for retention of bushing during operation.*

Install bushing and eccentric, indexing tang on eccentric with hole in camshaft sprocket. Insert retaining screw with retainer washer and tighten securely.

16. Position new timing chain cover gasket over studs against block.

17. Transfer water pump to new timing chain cover if new cover is to be installed.

18. Install new O-ring seal in water recirculation passage of intake manifold.

19. Install four oil pan to timing chain cover screws and tighten to 12 lb. ft.

21. Install harmonic balancer, retainer bolt with retainer, and tighten to 160 lb. ft.

22. Connect lower radiator hose to pump inlet.

23. Position pulley and fan on water pump hub and install attaching bolts. Tighten to 20 lb. ft.

24. Install power steering pump and belt on cars so equipped.

25. Install generator adjusting strap.

26. Install fan belt and accessory drive belts. Adjust to proper tension.

27. Install fuel pump.

28. Refill cooling system and check for leaks.

TIMING CHAIN AND SPROCKETS

Remove and Replace

1. Remove timing chain cover, making certain O-ring seal is retained for installation at assembly.

2. Remove fuel pump eccentric and bushing and timing chain cover oil seal.

3. Align timing marks to simplify proper positioning of sprockets during reassembly (Figure 6A-130).

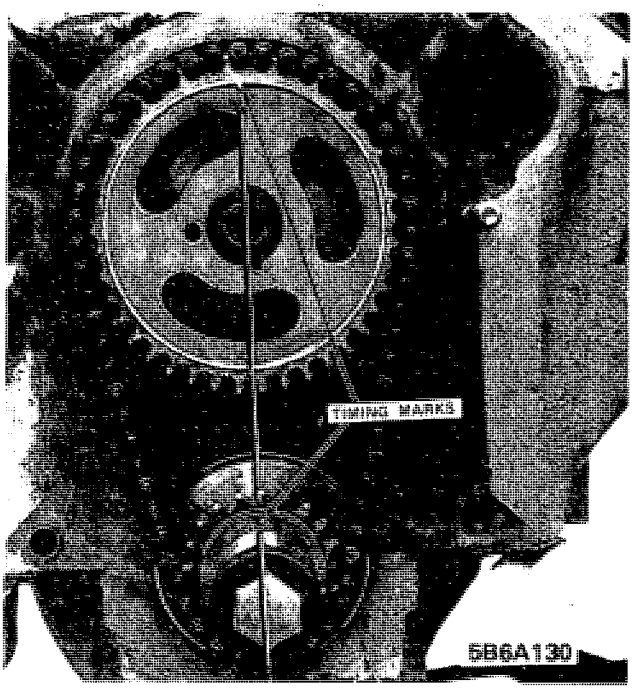


Figure 6A-130 - Timing Marks Aligned with No. 1 at T.D.C.

4. If crankshaft sprocket is to be replaced, remove sprocket using Tool J-22888 (Figure 6A-131). Refer to Figure 6A-132 for correct installation procedure.

5. Slide timing chain and sprockets off ends of crankshaft and camshaft.

6. Install new timing chain and/or sprockets, making sure marks on timing sprockets are aligned exactly on a straight line passing through the shaft centers (Figure 6A-130). Camshaft should extend through sprocket so that hole in fuel pump eccentric will locate on shaft.

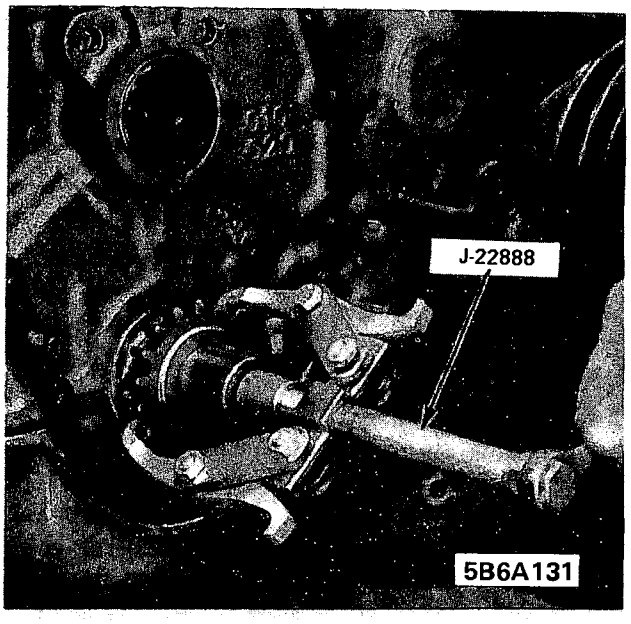


Figure 6A-131 - Removing Crankshaft Sprocket - Typical

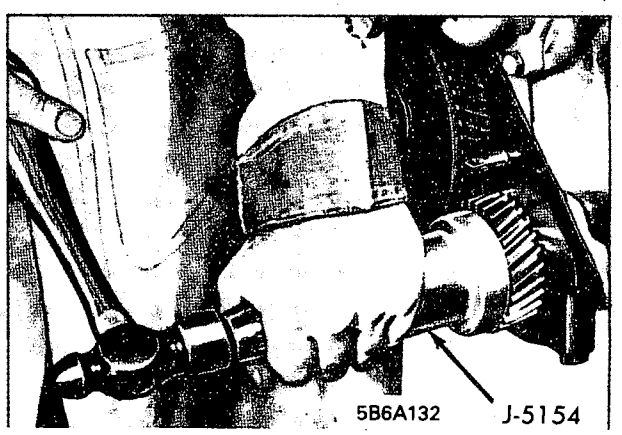


Figure 6A-132 - Installing Crankshaft Sprocket - Typical

7. Install fuel pump eccentric and bushing, indexing tang on eccentric with hole in sprocket. Install retainer bolt with retainer washer and tighten securely.

8. Place timing chain cover gasket over studs and dowels.

9. Install timing chain cover, water pump and harmonic balancer making sure O-ring seal is in place.

CAMSHAFT

The camshaft can be replaced with engine installed in car or with engine removed and disassembled for overhaul. To

replace the camshaft without removing and completely disassembling the engine, proceed as follows:

Remove

1. Drain radiator.

2. Remove carburetor air cleaner.

3. Disconnect all water hoses, vacuum hose and spark plug wires.

4. Disconnect carburetor linkage, fuel lines and wires to thermogauge unit.

5. Remove hood latch brace.

6. Remove radiator.

7. On air-conditioned cars, remove generator mounting bracket and generator.

8. Remove crankcase ventilator hose, and remove both rocker arm covers and gaskets.

9. Remove distributor hold-down clamp and remove distributor.

10. Remove intake manifold and gaskets.

Make certain O-ring seal between intake manifold and timing chain cover is retained and re-installed during assembly.

11. Remove push rod cover.

12. Loosen rocker arm ball retaining nuts so that rocker arms can be disengaged from push rods and turned sideways.

13. Remove push rods and hydraulic lifters. Store push rods in stand and lifters in a lifter box so they can be reinstalled in original positions.

14. Remove harmonic balancer.

15. Remove fuel pump.

16. Remove four oil-pan-to-timing-chain-cover screws.

17. Remove timing chain cover and gasket.

18. Remove fuel pump eccentric and fuel pump bushing.

19. Align timing marks on timing chain sprockets and remove timing chain and sprockets. Refer to Figure 6A-130.

20. Remove camshaft thrust plate.

21. Carefully pull camshaft from engine, exercising caution so as not to damage bearings in block.

The clearance for camshaft removal is very limited and, in cases where engine mounts are worn excessively, it may be necessary to raise the front of the engine to permit removal.

CAMSHAFT

Replace

1. Coat inner diameters of all camshaft bearings with oil. Coat camshaft lobes with heavy oil. Carefully install camshaft. Rotate camshaft through several revolutions to make sure it is completely free. If any tight spots are found, remove camshaft and very carefully polish down the center journal slightly. If still not free, polish the front and rear journals slightly. If any particular bearing causes binding of the camshaft, replace that bearing also.

Front center and rear center journals should not be polished except to remove slight roughness or scratches. Slight warpage of the camshaft is not harmful, provided the journals are polished down until the camshaft rotates freely in its bearings.

2. With camshaft properly seated, install camshaft thrust plate and tighten bolts to 20 lb. ft.

3. Install timing chain sprockets and timing chain, making sure marks on sprockets are aligned properly. Refer to Figure 6A-130.

4. Install fuel pump eccentric and bushing. Insert tang on eccentric into hole in camshaft sprocket. *Tighten* camshaft sprocket retaining bolt to 40 lb. ft.

5. Install timing chain cover dowels and new gasket and tighten bolts and nuts to 30 lb. ft.

6. Insert four oil-pan-to-timing-chain-cover screws and tighten to 12 lb. ft.

7. Install fuel pump and tighten bolts to 25 lb. ft.

8. Install harmonic balancer. Tighten bolt to 160 lb. ft.

9. Coat base of lifters with heavy oil. Install hydraulic lifters and push rods, making certain they are replaced in their original positions.

10. Engage rocker arms on push rods and tighten rocker arm ball retaining nuts to 20 lb. ft.

11. Install push rod cover.

12. Install intake manifold and gasket. Tighten bolts to 40 lb. ft.

> **CAUTION:** *O-ring seal must be installed between intake manifold and timing chain cover before manifold is securely positioned.*

13. Install distributor, positioning rotor to fire number one cylinder, and install distributor hold-down clamp. (Distributor housing will be properly positioned when vacuum advance unit is at right angles, facing L.H. side, to centerline of crankshaft). Tighten clamp retaining screw to 30 lb. ft. after ignition timing has been set.

14. Install crankcase ventilator outlet pipe and both rocker arm covers and gaskets. Tighten cover bolts to 65 lb. in.

15. Install fan and pulleys.

16. Install radiator, tightening all bolts securely.

17. Install hood latch bracket and tighten bolts.

18. Connect carburetor linkage, fuel lines and thermogauge unit.

19. Connect all water hoses, vacuum hose and spark plug wires.

20. Install carburetor air rilter.

21. Refill cooling system and check for leaks.

OIL PAN AND/OR OIL PAN GASKET

Remove

1. Disconnect battery cable at battery.

2. If equipped with power steering remove power steering adjusting bolt, remove drive belt and tilt pump upward.

3. Remove the two (2) fan shroud screws and position shroud so it will swing up with engine.

4. Remove fan.

5. Inspect all water hoses and wiring harnesses for proper routing to avoid excessive bind when engine is raised.

6. Remove thermal feed switch from rear of left cylinder head.

7. Raise vehicle and drain crankcase.

8. Disconnect exhaust pipes from manifolds.

9. Remove starter assembly (and set to one side with wires attached), starter motor bracket and flywheel inspection cover.

10. Lift and suitably support engine.

11. Remove oil pan bolts and remove oil pan.

WARNING: WHENEVER ENGINE IS RAISED OFF ENGINE MOUNTS, SUPPORT ENGINE BLOCK WITH SUITABLE BLOCKS OF WOOD.

Replace

1. Thoroughly clean all gasket sealing surfaces.

2. Clean sludge from oil pan and oil pump pick-up screen.

3. Install new gaskets on oil pan (Figures 6A-136, 6A-137 and 6A-138).

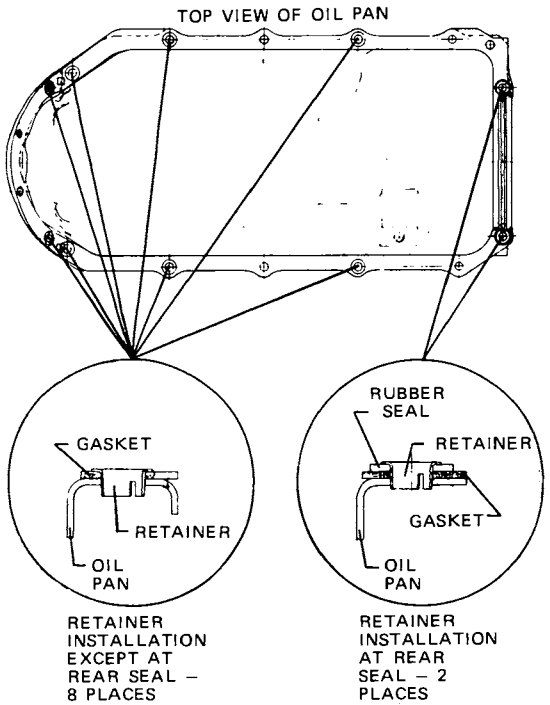


Figure 6A-136 - Oil Pan Gasket Retainers

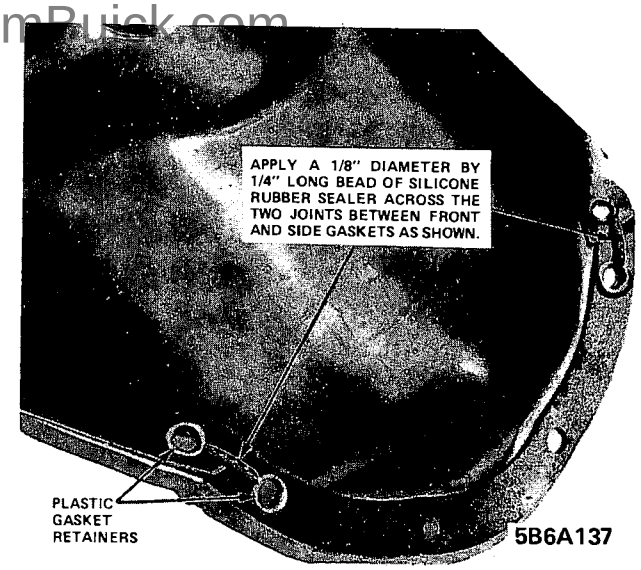


Figure 6A-137 - Front Oil Pan Gasket Installation

Figure 6A-138 - Rear Oil Pan Gasket Installation

4. Apply 1/8" diameter of silicone rubber sealer as shown in Figures 6A-137 and 6A-138.

5. Replace oil pan. Tighten retaining bolts to 12 lb. ft.

Rear bolts (through reinforcement straps) should be tightened to 18 lb. ft.

6. Lower engine and install frame bracket-to-motor mount through bolts.

7. Lower vehicle.

8. Replace fan.

9. Replace thermal feed switch.

10. Connect battery cable.

11. Refill engine crankcase.

OIL PUMP

Remove

1. Remove engine oil pan (see OIL PAN - REMOVE AND REPLACE). Remove splash baffle.

2. Remove oil pump attaching bolts while holding oil pump in place. Carefully lower oil pump away from block with one hand while removing oil pump drive shaft with other hand. Figure 6A-139.

Replace

1. Position drive shaft in distributor and oil pump drive gears. Place pump against block, using new gasket between pump and block. Index drive shaft with pump drive gear shaft. Install two attaching screws with lockwashers and tighten securely. (Removal and installation of pump does not affect ignition timing, since the oil pump and distributor drive gear is mounted on the distributor shaft).

2. Install oil pan.

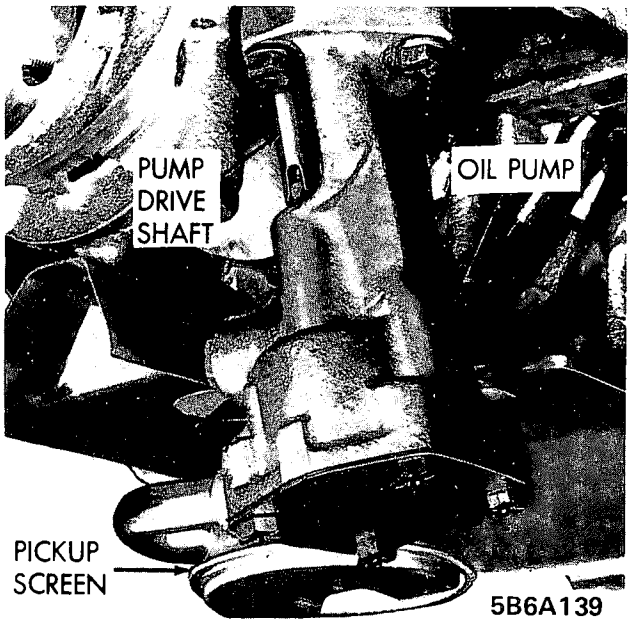


Figure 6A-139 - Oil Pump and Oil Pump Drive Shaft

OIL PUMP

Disassemble

1. Remove pressure regulator spring retainer, spring, and pressure regulator ball or valve.

2. Remove screws retaining cover to oil pump body and remove cover.

3. Remove driven gear and drive gear with shaft.

CAUTION: *Oil pump screen should not be removed from pump body. Be careful not to loosen screen.*

Clean and Inspect

1. Clean all parts thoroughly. Screen must be thoroughly cleaned by using a fluid such as used for carburetor cleaning.

2. Inspect pressure regulator spring (Fighre 6A-140) for distortion, cracks, and wear on sides.

3. Inspect pressure regulator ball or valve to see that it is not nicked or otherwise damaged.

4. Inspect pump body, driven gear shaft and cover for evidence of wear.

5. Inspect pump gears and end of drive gear shaft for wear (Figure 6A-140).

6. Inspect oil pump drive shaft (distributor to pump shaft) for evidence of wear and cracks.

Assemble

1. Install drive and driven gears.

2. Install cover and turn drive shaft by hand to ensure that it turns freely.

3. Install pressure regulator ball or valve, spring and retainer.

CAUTION: *Do not attempt to change oil pressure by varying length of pressure regulator valve spring.*

REAR MAIN BEARING OIL SEAL

Remove

1. Remove oil pan (see OIL PAN - REMOVE AND REPLACE).

2. Remove oil pump and baffle.

3. Remove rear main bearing cap.

4. Use Tool shown in Figure 6A-141 made from brass bar stock to pack upper seal as follows:

a. Insert tool against one end of the oil seal in the cylinder block and drive the seal gently into the groove until the tool bottoms.

b. Remove the tool and repeat at the other end of the seal in the cylinder block.

c. Clean the block and bearing cap parting line thoroughly.

d. Form a new seal in the cap (Figure 6A-142).

e. Remove the newly formed seal from the cap and cut four (4) pieces approximately 3/8″ long from this seal.

f. Work two 3/8″ pieces into each of the gaps which have been made at the end of the seal in the cylinder block. Without cutting off the ends, work these seal pieces in until flush with the parting line and until no fibers are protruding over the metal adjacent to the groove.

g. Form another new seal in the cap (Figure 6A-142).

h. Assemble the cap to the block and tighten to 120 lb. ft.

i. Remove the cap and inspect the parting line to insure that no seal material has been compressed between the block and the cap. Clean as necessary.

j. Apply a 1/16″ bead of silicone rubber sealer to cap parting line. Extend sealer continuously from center of seal (packing) to the outer gasket groove (Figure 6A-142).

k. Reassemble the cap. Tighten to 120 lb. ft.

5. Install baffle and oil pump.

6. Install oil pan (see OIL PAN - REMOVE AND REPLACE).

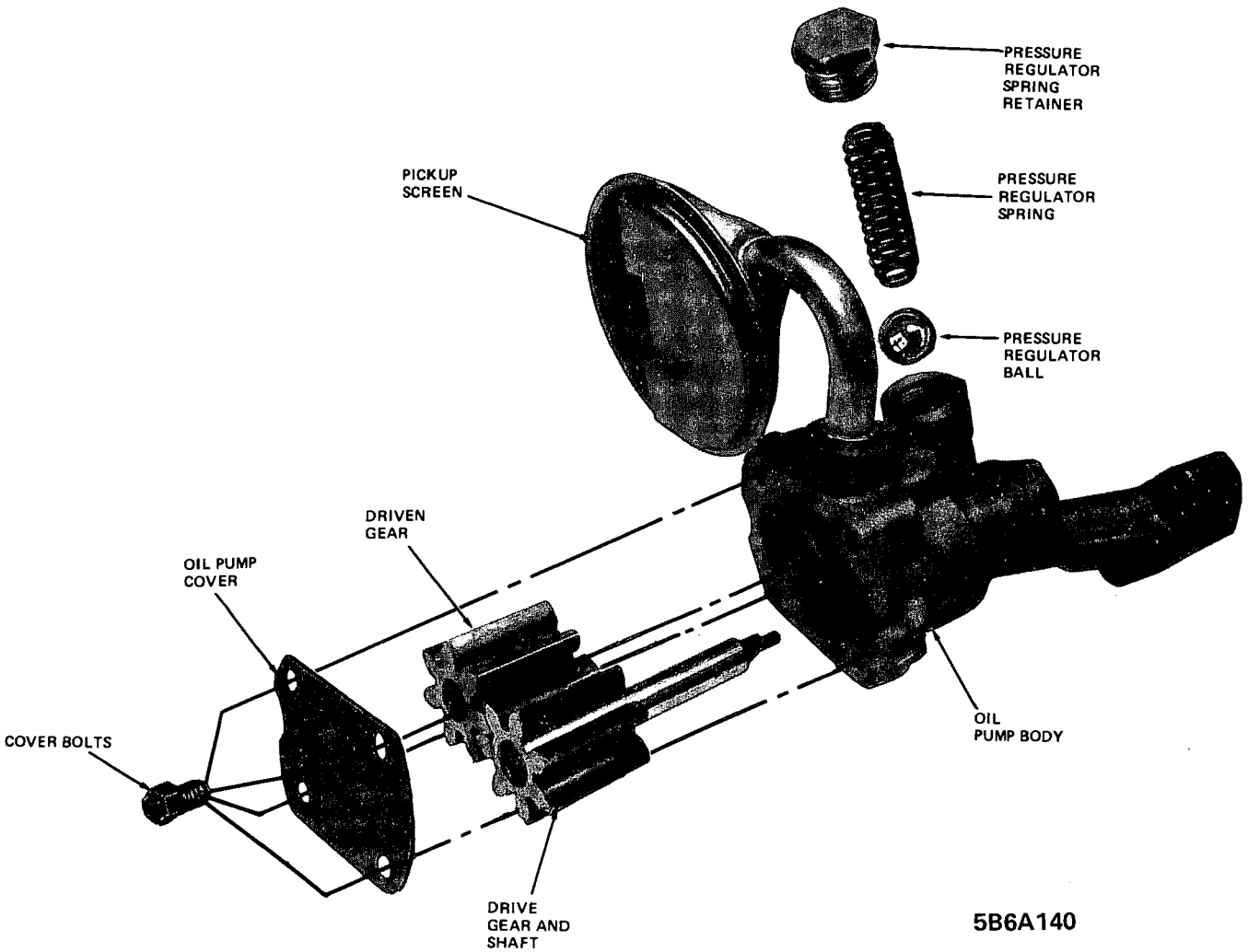


Figure 6A-140 - Oil Pump - Exploded View

MAIN BEARINGS

Remove

1. Remove oil pan (see OIL PAN - REMOVE AND REPLACE).

2. To gain access to bearing caps, remove oil baffle. To gain access to rear main, remove oil pump in addition to oil baffle.

3. Remove bearing cap of main bearing to be replaced.

4. Make a tool for removing upper half of bearing shell as shown in Figure 6A-143.

5. Insert tool in oil hole of crankshaft and rotate crankshaft in usual direction of rotation. This will cause bearing to be moved from between shaft and bearing seat (Figure 6A-144).

6. Oil bearing surface of shell and install by inserting plain end of bearing shell at indented side of bearing seat and gently rotating shell into place by turning shaft.

7. Install new bearing lower half by inserting in bearing cap so indentation in shell and cap coincide.

8. Install bearing cap and check fit of bearing, using a plastic-type gage as outlined below.

CAUTION: *Under no circumstances should bearing caps be filed or shimmed in an effort to effect a fit.*

PLASTIC TYPE GAGE METHOD FOR DETERMINING MAIN BEARING CLEARANCE

When checking main bearing clearance with engine in the car, place a .002" brass shim between the crankshaft journal and the lower bearing in each bearing cap next to the one being checked. Figure 6A-145.

Tighten all cap bolts to proper torque as follows: rear - 120 lb. ft., all others - 100 lb. ft.

This causes the crankshaft to be forced against the upper bearing and insures an accurate measurement of the total clearance.

1. Remove the bearing cap of the bearing to be checked. Wipe the bearing and the journal free of oil.

2. Place a piece of plastic type gage the width of the

bearing on the journal or bearing surface. Install the cap and tighten cap bolts to proper torque. (Do not turn crankshaft with plastic type gage in-place).

3. Remove bearing cap and using plastic type gage scale on envelope (Figure 6A-146), measure width of plastic type gage before removing it from the bearing or journal. If the bearing clearance is between the specifications listed below, the clearance is satisfactory. If the clearance is more than the upper limit shown, replace the bearing with the next undersize bearing and recheck clearance. Bearings are available in standard size, .001" and .002" undersize.

ENGINE	BEARING CLEARANCE
All	.0002"-.0017"

4. Install a new rear main bearing oil seal in the cylinder block and main bearing cap if the rear main bearing was checked and/or replaced.

5. Replace oil pump, cylinder block to oil baffle tube, and oil baffle if they were previously removed.

6. Replace oil pan, using new gaskets.

CONNECTING ROD BEARINGS

Remove

1. Remove oil pan (see OIL PAN - REMOVE AND REPLACE).

2. To gain access to numbers 5, 6, 7 or 8 connecting rod caps, it will be necessary to remove oil pump and oil baffle. Pump must be removed as an assembly. Screen tube is a press fit in pump body and must not be rotated or removed.

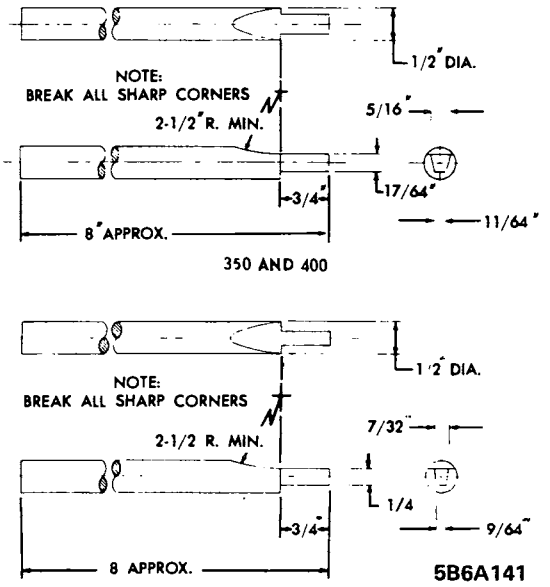


Figure 6A-141 - Upper Rear Main Bearing Seal Tool

3. Rotate crankshaft as necessary to bring crank pin carrying bearing to be replaced straight down (Figure 6A-147).

4. Remove bearing cap of bearing to be replaced.

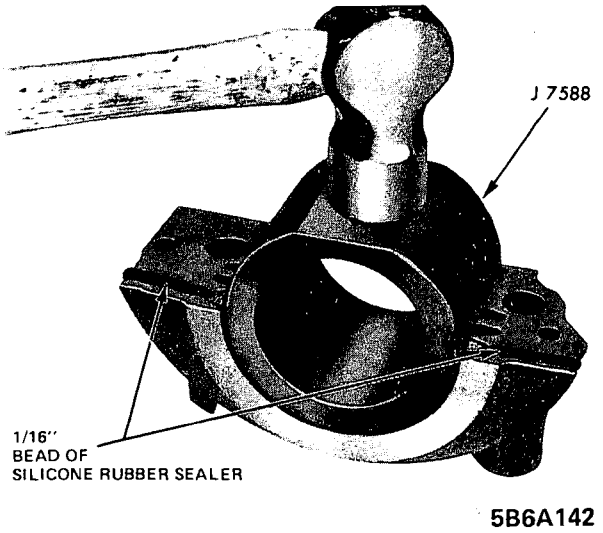


Figure 6A-142 - Forming New Seal in Cap

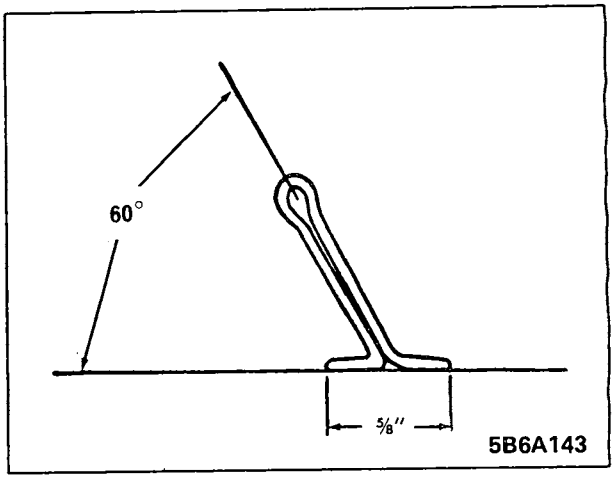


Figure 6A-143 Tool for Removing Upper Half of Main Bearing

5. Install rubber hose on connecting rod bolts (Figure 6A-148).

6. Push piston and rod assembly up far enough to allow removal of bearing shell. Remove bearing shells from rod and cap.

7. Inspect crank pin for damage, out-of-round, and taper.

8. Reassemble cap and rod with new bearing shells and check fit, using plastic type gage as outlined below.

CAUTION: *Under no circumstances should a bearing cap be filed or shimmed in an effort to effect a fit.*

PLASTIC TYPE GAGE METHOD FOR DETERMINING CONNECTING ROD BEARING

Clearance

1. Remove the cap of the bearing to be checked. Wipe the bearing and the crankpin free of oil.

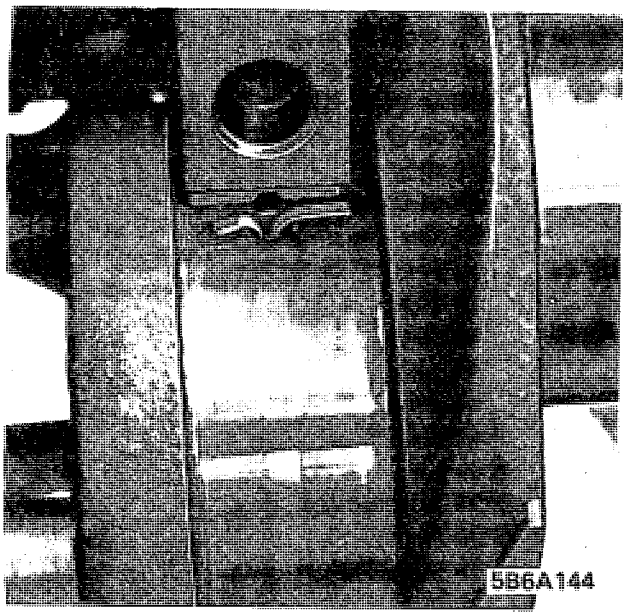


Figure 6A-144 - Tool Installed for Removing Upper Half of Main Bearing

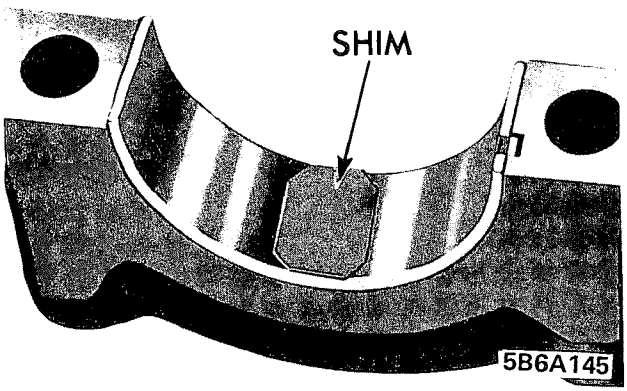


Figure 6A-145 - .002" Shim Positioned in Adjacent Caps to Check Main Bearing Clearance with Engine in Car

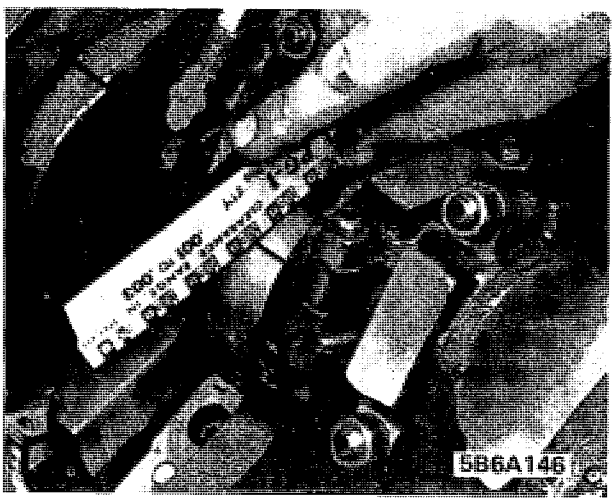


Figure 6A-146 - Measuring Plastic Type Gage

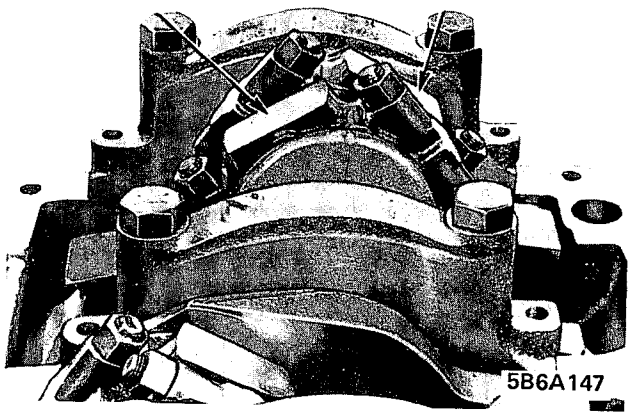


Figure 6A-147 - Crankshaft Positioned for Removal of No. 1 and 2 Connecting Rod Caps

2. Place a piece of plastic type gage the width of the bearing (parallel to the crankshaft) on the crankpin or bearing surface. Install the cap and tighten cap bolts to 43 lb. ft. (Do not turn crankshaft with plastic type gage in place).

3. Remove bearing cap and using plastic type gage scale on envelope, measure width of compressed plastic type gage before removing it from the crankpin or bearing. If the bearing clearance is between .0005" and .0025", the clearance is satisfactory. If clearance is more than .0025", replace bearing with the next undersize bearing and re-check clearance. Bearings are available in .001" and .002" undersize.

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

CONNECTING ROD AND PISTON ASSEMBLY

Remove

1. Remove oil pan, oil baffle and oil pump (see OIL PAN - REMOVE AND REPLACE).

2. Remove intake manifold and cylinder head on bank from which piston is to be removed.

3. Rotate crankshaft so crank pin carrying assembly to be replaced projects straight downward (Figure 6A-147).

4. Remove ring ridge (Figure 6A-149) using suitable ring ridge remover.

5. Remove bearing cap and install rubber hoses on connecting rod bolts.

6. Carefully remove connecting rod and piston assembly by pushing out with hoses. Figure 6A-148.

Replace

1. Install rubber hoses on connecting rod bolts.

2. Using ring compressor, insert piston connecting rod assembly into cylinder so that notch in top of piston is toward front of engine. Connecting rods are assembled with the thrust faces of the two rods on the same crank

Figure 6A-148 - Installing Connecting Rod

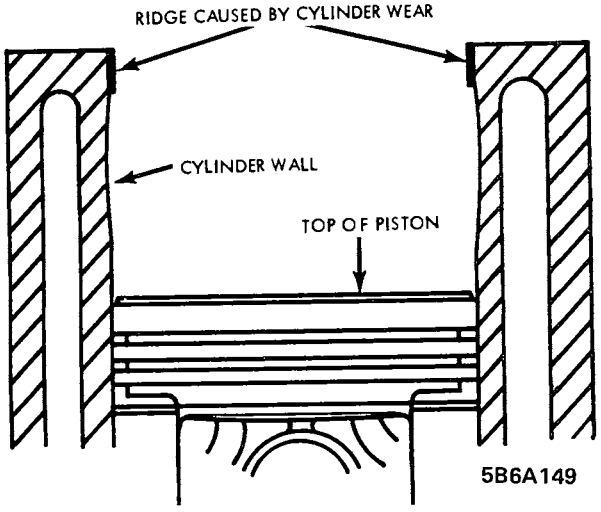


Figure 6A-149 - Cylinder Ring Ridge

journal facing each other. The thrust face of the rod has dimples on the machine surface of the big end. See Figure 6A-150. Rods are assembled on the crank with dimples facing rear on the right bank and forward on the left bank.

3. From beneath engine, pull connecting rod, with bearing shell in place, into position against crankpin.

4. Remove rubber hoses. Install bearing cap and cap nuts and tighten to 43 lb. ft.

5. Replace oil pump and oil baffle, if they were removed.

6. Install cylinder head and intake manifold.

CONNECTING ROD AND PISTON ASSEMBLY

CAUTION: *Use care at all times when handling and servicing connecting rods and pistons. To prevent possible damage to these units, do not clamp rod or piston in vise since they may become distorted. Do not allow pistons to strike against one another, against hard objects or bench surfaces, since distortion of piston contour or nicks in soft aluminum material may result.*

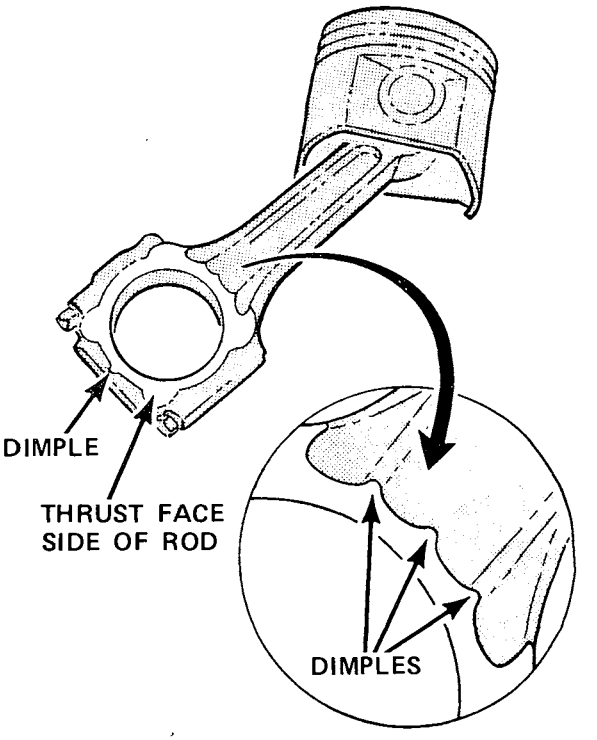


Figure 6A-150 - Connecting Rod Installation

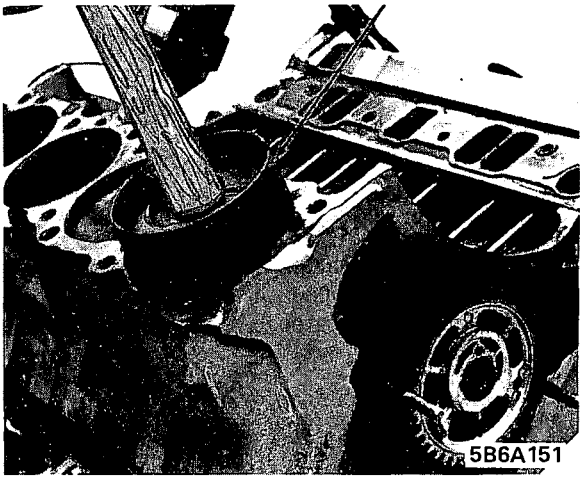


Figure 6A-151 - Installing Piston Assembly

Disassemble

1. Remove piston rings, using proper piston ring remover. (It is important that rings be removed carefully to prevent scratching or burring of ring grooves and lands).

2. Using a suitable arbor press, place the spring and plunger into the bore of the base support and position on

an arbor press with the pilot plunger indexed in the bottom of piston pin bore. See insert in Figure 6A-152 for correct base support and pilot plunger for the type pistons being serviced.

3. Using the pilot plunger (or plate) indicated in Figure 6A-152 the pin may be pressed out far enough to index with the bore in the base.

4. Remove pilot plunger and spring from base.

5. Complete removal of pin using pin driver J-6901-3 and vase along.

6. Remove bearing cap and bearings.

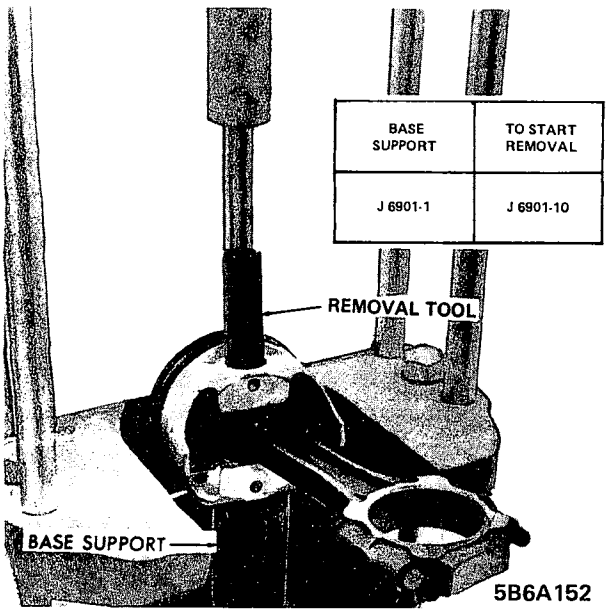


Figure 6A-152 - Removing Piston Pin

Clean and Inspect

1. Clean carbon, varnish, and gum from piston surfaces, including underside of piston head. Clean ring grooves, and oil slots in oil ring groove, using suitable cleaning tools and solvent.

2. Clean piston pin, rod, cap, bolts and nuts in suitable solvent. Reinstall cap on connecting rod to insure against subsequent mixing of caps and connecting rods.

3. Carefully examine piston for rough or scored bearing surfaces; cracks in skirt or head; cracked, broken, or worn ring lands; scored, galled, or worn piston bosses. Damaged or faulty pistons should be replaced.

If piston pin bosses are rough or worn out-of-round and the piston is otherwise serviceable, the pin bosses may be hones for oversize pins. Before fitting oversize pins, however, it is advisable to check fit of piston in bore.

4. Inspect piston pin for scoring, roughness, or uneven wear.

5. Inspect bearing shells to see that they are serviceable. Fit of bearings should be checked when engine is being assembled.

CYLINDER BORES

Inspect

Inspect cylinder bores for out-of-round or excessive taper with an accurate cylinder gauge (J-8087 or comparable) at top, middle and bottom of bore. Measure cylinder bore parallel and at right angles to the centerline of engine to determine out-of-round. Variation in measure from top to bottom of cylinder indicates taper in cylinder.

Figure 6A-149 illustrates area in cylinder where normal wear occurs. Cylinder bore can be measured (Figure 6A-154) by setting cylinder gauge dial at zero in cylinder at the point of desired measurement. Lock dial indicator at zero before removing from cylinder, and measure across the gauge contact points with outside micrometer with gauge at the same zero setting when removed from cylinder (Figure 6A-155).

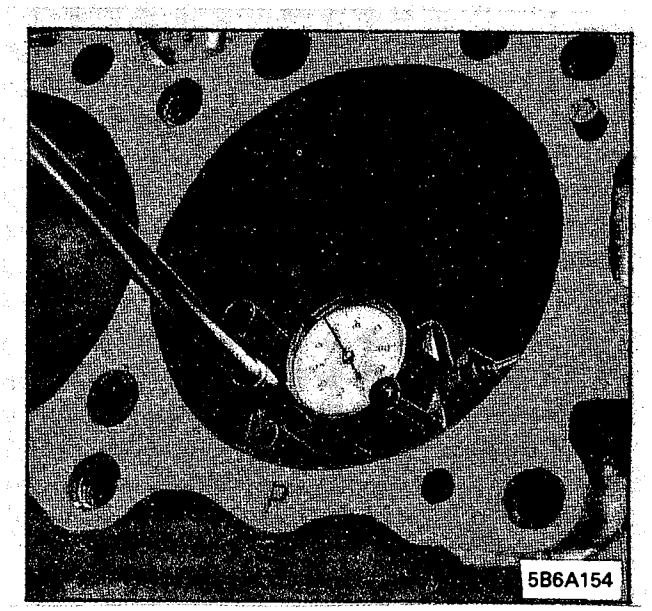


Figure 6A-154 - Measuring Cylinder Bore

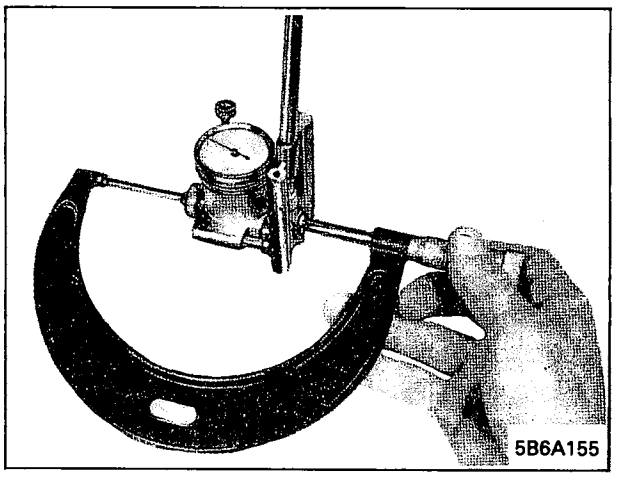


Figure 6A-155 - Measuring Cylinder Gauge

Take several measurements parallel and at right angles to the crankshaft, between 1/2" and 4" from the top of the

cylinder. Subtract the smallest measurement found from the largest. If this figure exceeds .0006", a piston cannot be fitted properly, and the cylinder must be honed. New rings and a new oversized piston must then be fitted.

Fine vertical scratches made by ring ends will not cause excessive oil consumption, therefore, honing to remove these scratches is unnecessary.

HONING OR BORING

If a piston other than standard is to be installed, the cylinder should be bored, rather than honed, to effect a true bore.

To eliminate the possibility of honing taper into the cylinder, full strokes of the hone should be made in addition to checking measurement at top, middle and bottom of bore repeatedly.

Always be sure the crankshaft is out of way of boring cutter when boring each cylinder. Crankshaft bearings and other internal parts must be covered or taped to protect them during boring or honing operation. When taking final cut with a boring bar, leave .001" on the diameter for finish honing to give required piston-to-cylinder clearance specifications. (Honing or boring operation must be done under close supervision so that specified clearance between pistons, rings, and cylinder bores is maintained).

By measuring the piston to be installed at the sizing points (Figure 6A-156) and adding the mean of the clearance specification, the finish hone cylinder measurement can be determined. It is important that both block and piston be measured at normal room temperature, 60° - 90°F.

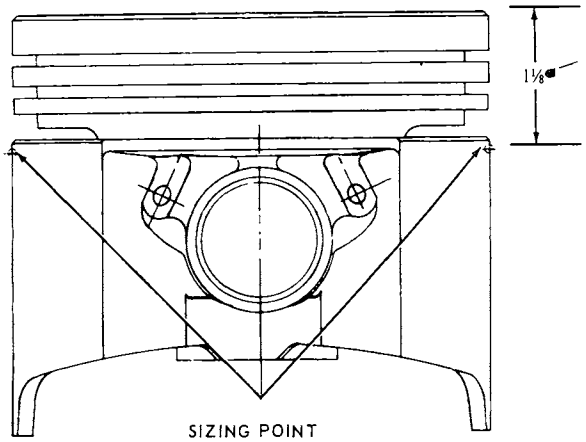


Figure 6A-156 - Piston Sizing Points

After final honing and before the piston is checked for fit, each cylinder bore must be thoroughly cleaned. Use soapy water solution and wipe dry to remove all traces of abrasive. If all traces of abrasive are not removed, rapid wear of new rings and piston will result.

Intermixing different size pistons has no effect on engine balance as all pistons from standard size up to .030" oversize weigh exactly the same. Boring beyond .010" during warranty period is not recommended so that if necessary, engine can be serviced at high mileage without cylinder block replacement.

FIT AND REPLACE PISTON

Pistons should be fitted in the bores by actually measuring the fit. Clearance between the piston and the cylinder bore should be .0025" to .0033" on all engines.

If cylinder bores have been reconditioned, or if pistons are being replaced, reconditioning of bores and fitting of pistons should be closely coordinated. If bore has been hones, it should be washed thoroughly with hot soapy water and a stiff bristle brush.

Using a cylinder checking gauge, measure the cylinder bore crosswise to the block to find the smallest diameter. Record the smallest diameter of each bore.

> **CAUTION:** *When measuring cylinder bores and pistons, it is very important that the block and pistons be at room temperature. If any or all of the parts are hotter or colder than normal room temperature, improper fitting will result.*

Measure the piston skirt perpendicular to the piston pin boss (piston pin removed) and at sizing point indicated in Figure 6A-156.

Make sure the micrometer is in full contact (Figure 6A-157).

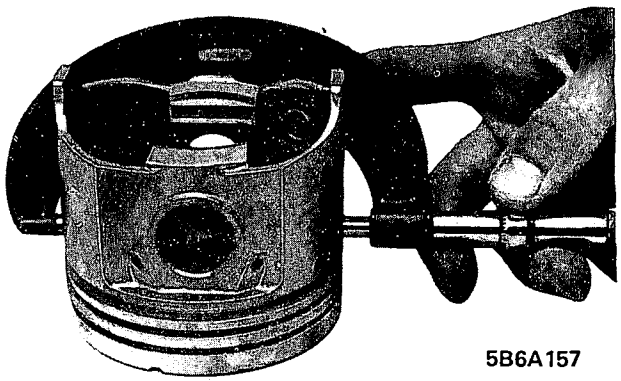


Figure 6A-157 - Measuring Piston

As the pistons are measured, they should be marked for size identification and the measurements recorded.

If there is excessive clearance between a cylinder bore and the piston which was installed in that bore, a new piston should be used.

New pistons are serviced in standard size and .001", .002", .010" and .030" oversize.

Since these are nominal or basic sizes, it is important that new pistons be measured to ensure proper fit. All new pistons are serviced with selectively fitted piston pins.

After all measurements have been made, match the new pistons with cylinders where they will fit with proper clearance. Honing of cylinder bore may be necessary to effect a proper fit. When properly mated, mark pistons with cylinder numbers they fit so they will not become mixed.

FITTING PIN IN PISTON

The piston pin fit in the piston is .0005" to .0007" loose with pin and bosses clean and dry.

Piston and pin must be at room temperature when checking fit and pin must be able to fall from piston by its own weight.

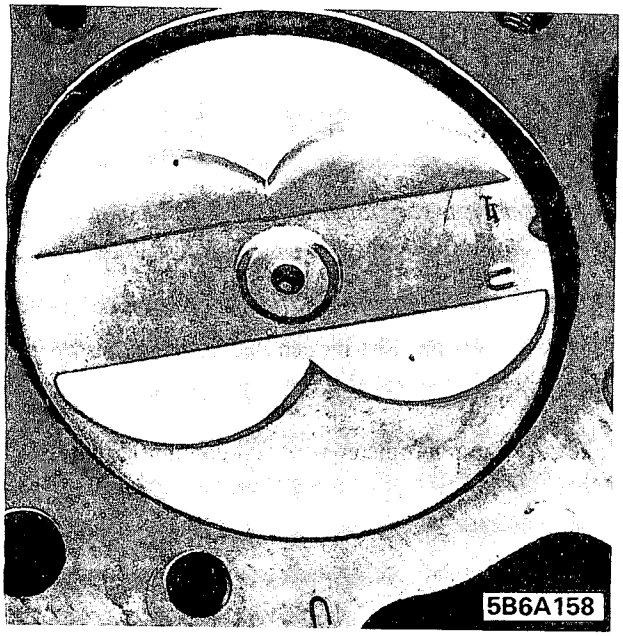


Figure 6A-158 - Cylinder Bore and Piston Identification

FITTING OVERSIZE PINS IN PISTONS AND CONNECTING ROD PIN BORES

In case the standard size piston pin does not fit properly in the piston, an oversize piston pin must be fitted. Piston pins are available in .001" and .003" oversize.

When oversize pins are used, the piston pin bosses must be honed to give required fit. It will also be necessary to hone the connecting rod pin bore to fit the oversize pin, using a precision hone.

> **CAUTION:** *A special grit hone is used for honing the connecting rod pin bore. The piston pin size should be .0008" to .0016" larger than connecting rod pin bore for proper press fit. The piston pin should not show any movement under 1500 lb. minimum load after assembly in rod.*

Assemble Connecting Rod to Piston

There is a notch cast in the top of all piston heads to facilitate proper installation. The piston assemblies should always be installed with notch toward front of engine (Figure 6A-159).

PISTON PIN

Replace

1. Place pilot plunger and spring in the support base to be used as a pilot end stop. See Figure 6A-160 insert for correct base support and pilot plunger for type pistons being serviced.

2. Place pilot plunger of Tool J-6901 in piston pin bore and place on arbor press.

3. Coat piston pin and rod lightly with graphite lubricant.

4. Place Tool J-6901-3 in piston pin and press pin into piston and connecting rod (Figure 6A-160) until piston pin bottoms against plunger of Tool J-6901. Piston must turn freely on pin. If piston binds on pin, disassemble, hone piston pin bosses slightly and reassemble.

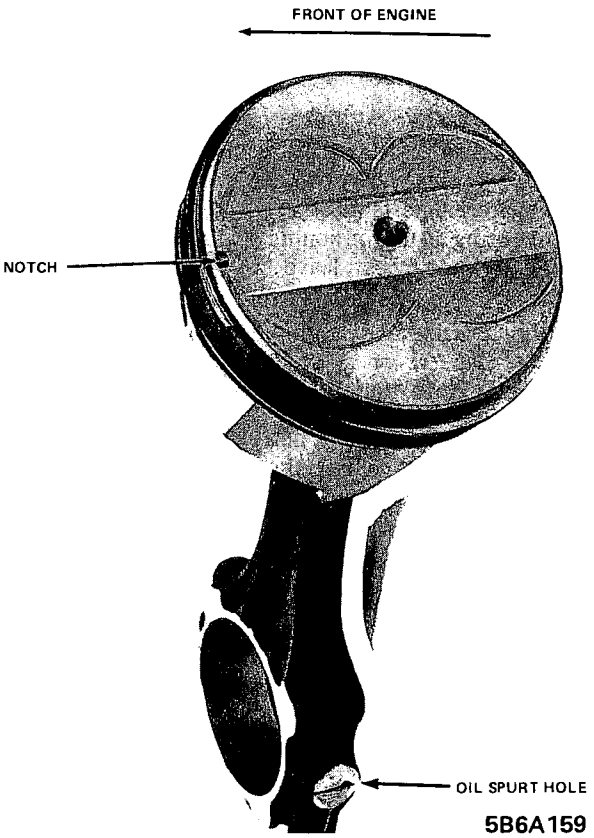


Figure 6A-159 - Piston and Rod Assembly

PISTON RINGS

Remove

1. Remove piston and rod assembly. See CONNECTING ROD AND PISTON ASSEMBLY - REMOVE AND REPLACE.

2. Remove piston rings using proper tool.

3. Clean carbon, varnish, and gum from piston surfaces, including underside of piston head. Clean ring grooves, and oil holes in oil ring groove, using suitable cleaning tools and solvent.

4. Carefully examine piston for rough or scored bearing surfaces; cracks in skirt or head; cracked, broken, or worn ring lands; scored, galled, or worn piston bosses. Damaged or faulty pistons should be replaced.

5. Inspect bearing shells to see that they are serviceable. Fit of bearings should be checked when engine is being assembled.

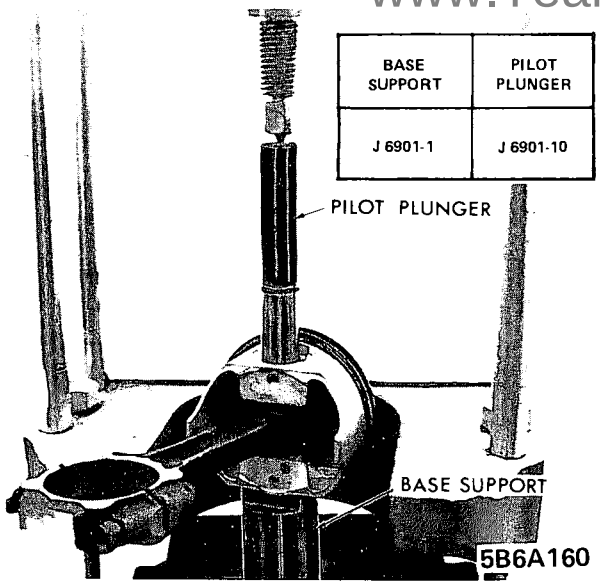


Figure 6A-160 - Installing Piston Pin

6. Inspect cylinder bores for out-of-round or excessive taper. See CYLINDER BORES-INSPECT.

PISTON RING CHECK AND INSTALL ON PISTON

Two compression rings and one 3-piece oil control ring, all above the piston pin, are used on pistons for all engines. The compression rings are taper faced and also have either a step or chamfer on the inside diameter of the bottom side. The top compression ring is molybedenum filled, which results in the center section of ring sealing edge appearing porous or grainy. The lower compression ring varies depending upon the engine. See specifications at the end of this section.

Regardless of engine type, always install compression rings with the stamped markings toward the top of piston.

New rings are serviced for the standard size pistons, and for .010" and .030" oversize pistons. When selecting rings, be sure they match the size of the piston on which they are to be installed, i.e., standard rings for standard pistons, .010" oversize rings for .010" oversize pistons, etc. Ring gap and side clearance should be checked while installing as follows:

1. Check pistons to see that ring grooves and oil return holes have been properly cleaned.

2. Place ring down at the bottom of the ring traveled part of the cylinder bore in which it will be used. Square ring in bore by pushing it into position with head of piston.

3. Measure gap between ends of ring with feeler gauge (Figure 6A-161). Gaps should be as follows:

Compression Ring ..... .010"-.030"
Oil Ring ..... .015"-.055"

Incorrect ring gap indicates that wrong size rings are being used. If rings are selected according to the size of the bore (standard, .010" oversize, etc.), they should have the proper gap. It should not be necessary to alter ring gap by filing.

4. Install rings on piston, using J-8021 or J-7117 to prevent breakage or fracture of rings, or damage to pistons.

5. Measure side clearance of rings in ring groove as each ring is installed (Figure 6A-162). Clearance with new pistons and rings should be .0015"-.005".

If side clearance is excessive, piston should be replaced.

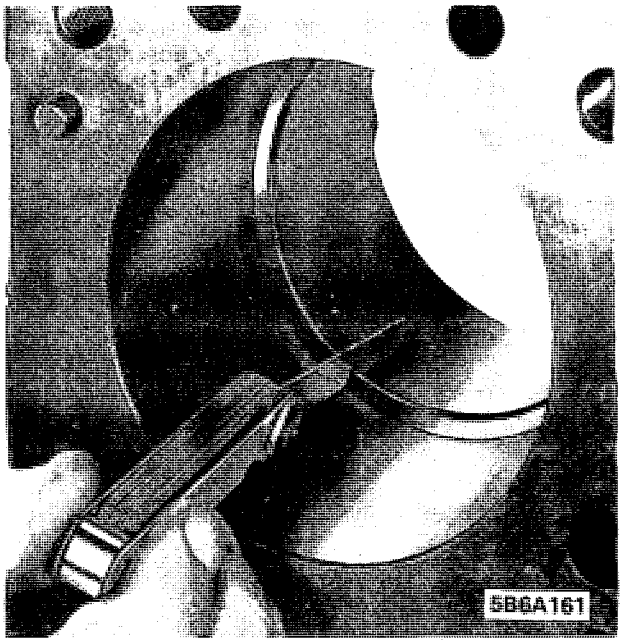


Figure 6A-161 - Checking Ring Gap

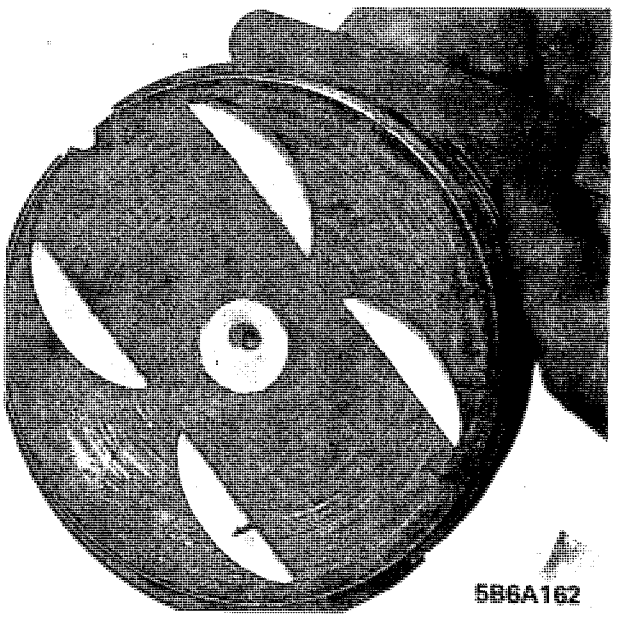


Figure 6A-162 - Measuring Side Clearance of Ring in Groove

CRANKSHAFT

Check

These checks are to be made with oil pan and baffle removed and with all main caps and rods installed and properly torqued.

1. Check end play (Figure 6A-163). Using hammer, tap

end of crankshaft at rear until it is tight against front of thrust bearing (No. 4 main bearing). Measure clearance between crankshaft counterweight and thrust bearing. Proper clearance is .003" to .009". If clearance is outside these limits, a new thrust bearing is required.

2. Check connecting rod side clearance. Using hammer, gently tap lower end of connecting rod (rod most rearward) toward front of engine. Measure clearance between rear of connecting rod and counterweight. Proper clearance is .012" to .017" total for both rods. If clearance is outside these limits, a new rod or rods is required.

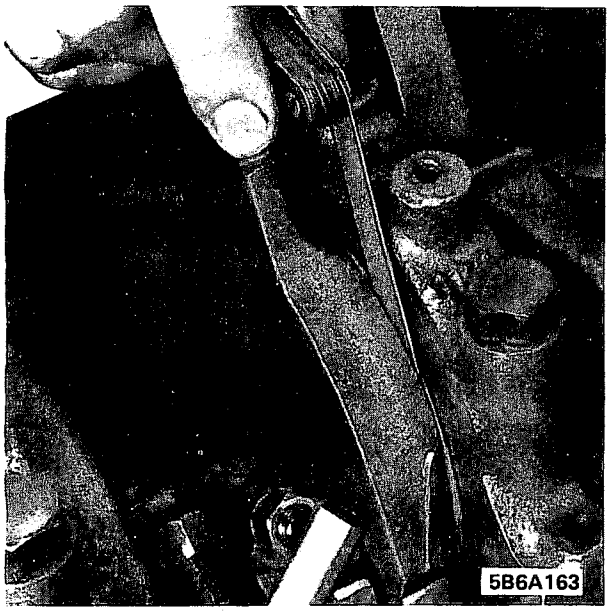


Figure 6A-163 - Measuring Crankshaft End Play

Remove

In order to remove the crankshaft, the engine assembly must be removed from the vehicle.

The crankshaft can then be removed and replaced with cylinder heads, pistons, rods, manifolds and other upper engine components installed, but the flywheel, and transmission assemblies must be removed.

1. Remove engine assembly. See ENGINE - REMOVE AND INSTALL.
2. Install engine on suitable stand.
3. Remove spark plugs.
4. Remove engine oil pan.
5. Remove oil pump assembly and oil pump drive shaft (Figure 6A-139).
6. Remove oil baffle and oil baffle tube.
7. Remove harmonic balancer.
8. Remove fuel pump.
9. Remove timing chain cover, gasket and O-ring seal.
10. Remove fuel pump eccentric and bushing (Figure 6A-129).
11. Remove sprockets and timing chain (Figure 6A-130).
12. Remove connecting rod caps.

    CAUTION: *Mark connecting rod caps for proper reinstallation.*

13. Remove main bearing caps from block.

    CAUTION: *Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Depress pistons until connecting rods are free of crankshaft.*

14. Lift crankshaft from block.

Replace

1. With upper bearings installed, position crankshaft in block.
2. Install main bearing caps (with bearing shells in place) but do not tighten retaining bolts.
3. Pull connecting rods and piston assemblies into place, rotating crankshaft as necessary to properly seat rods. (Make sure upper bearings remain in proper position).
4. Remove tape from connecting rod threads and install connecting rod caps (with bearings) and retaining nuts, but do not tighten.
5. Check fit of all main and rod bearings with plastic type gage and install proper sized new bearings.
6. Tighten rear main bearing cap to 120 lb. ft. and all remaining bearing caps to 100 lb. ft. Tighten connecting rod bearing cap retaining nuts to 43 lb. ft.
7. Install sprockets and timing chain, making sure timing marks on sprockets are aligned properly (Figure 6A-130).
8. Install fuel pump eccentric and bushing and insert sprocket retaining bolt with washer. Tighten securely.
9. Install timing chain cover, new cover gasket and new O-ring seal.
10. Install fuel pump.
11. Install harmonic balancer.
12. Install oil baffle and oil baffle tube.
13. Install oil pump drive shaft and oil pump assembly.
14. Install engine oil pan.
15. Install spark plugs.
16. Remove engine from stand and install flywheel.
17. Install complete assembly in vehicle.

ENGINE BLOCK CORE HOLE PLUGS AND OIL PASSAGE PLUGS

Inspect and Replace

Engine moving part failures may be caused by lack of proper lubrication. In such case it may be necessary to trace oil supply in the block to determine area of obstruction. Oil pressure drop may be caused by leaking oil passage plugs. For these reasons the following procedures and block illustrations are provided.

1. With cylinder block inverted, use pen light to see that passage from oil pump to filter is open (Figure 6A-167).

2. Check passage from filter outlet to rear main bearing by inserting wire in oil filter outlet passage and using pen light to see that wire is visible in passage to rear main bearing (Figure 6A-166).

3. Visually check passage from each main bearing to corresponding camshaft bearing (Fighre 6A-157).

4. Check passage from filter outlet (through left oil gallery) to main bearings. Use rubber hose to blow smoke in oil filter outlet while observing to see that smoke passes out passages leading to all main bearings.

5. With cylinder block right side up, check oil passages to left bank lifter bosses. Use rubber hose to blow smoke in oil filter outlet while observing for smoke passing out oil passages from left main oil gallery to lifter bosses (Figure 6A-165).

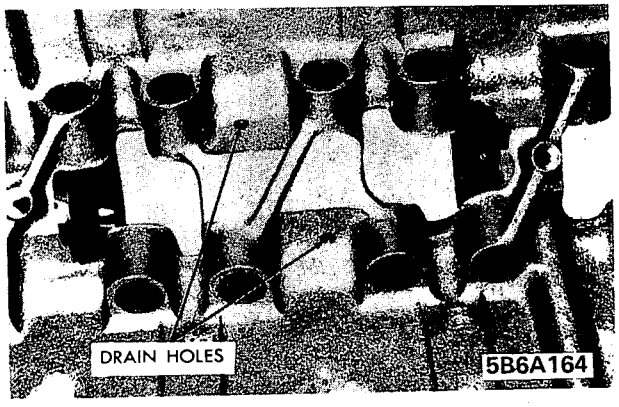


Figure 6A-164 - Drain Holes in Lifter Gallery

6. Check oil passages to right bank lifter bosses. Use rubber hose to blow smoke in passage from front main bearing to right main oil gallery while observing for smoke passing out passages from right gallery to lifter bosses (Figure 6A-166).

7. Use wire to check two drain holes in lifter gallery (Figure 6A-164).

INSTALL NEW PLUGS

The following plugs can be installed by driving into place using a flat piece of metal or hard wood, bearing against the outer surface: Camshaft plug, water jacket plugs, rear oil gallery plug in block, cylinder head and core hole plugs.

Front oil gallery plugs in the block must be driven into place using a tool which bears against the bottom of the plug. A 1/2" x 3" bolt will make satisfactory tool for this purpose.

The camshaft rear plug should be driven in to a depth of 3/10" from the rear surface of the block.

All other plugs should be driven in until the outer edge is flush with the surrounding surface.

FITTED BLOCK ASSEMBLY

Fitted block contains pistons, rings, pins and camshaft bearings.

Disassemble

1. Remove flysheel housing and clutch assembly.

2. Remove flywheel and mount engine in holding stand.

3. Remove motor mounts and linkage bracket.

4. Remove generator and mounting bracket.

5. Remove fuel pump.

6. Remove harmonic balancer.

7. Remove timing chain cover, fan and pulley. Remove timing cover mounting studs.

8. Remove fuel pump eccentric and bushing.

9. Slide timing chain and sprockets off end of camshaft and crankshaft.

10. Remove camshaft thrust plate.

11. Remove distributor and high tension wires.

12. Remove coil.

13. Remove starter assembly.

14. Remove intake manifold.

15. Remove push rod cover.

16. Remove oil level indicator.

17. Remove rocker arm covers.

18. Loosen rocker arm nuts, rotate rocker arms and remove push rods. Store push rods so that they may be reinstalled in the same position as removed.

19. Remove cylinder heads and exhaust manifolds.

20. Remove cylinder head gaskets.

21. Remove oil filter assembly.

22. Remove valve lifters; use J-3049 if necessary.

Place valve lifters in a storage box so lifters can be reinstalled in original location.

23. Remove camshaft.

24. Invert engine and remove oil pan and flywheel inspection cover.

25. Remove oil pump assembly and drive shaft.

26. Remove baffle and oil indicator tube extension.

27. Remove crankshaft.

28. Remove all connecting rod and piston assemblies.

29. Remove connecting rods from pistons and identify rods for installation in original location.

30. Remove old block from stand and mount new fitted block on stand.

31. Remove each piston and pin assembly from new block and identify for installation in original position.

This completes disassembly for fitted block replacement. Proceed with assembly operations. Use new gaskets throughout and pay special attention to torque requirements.

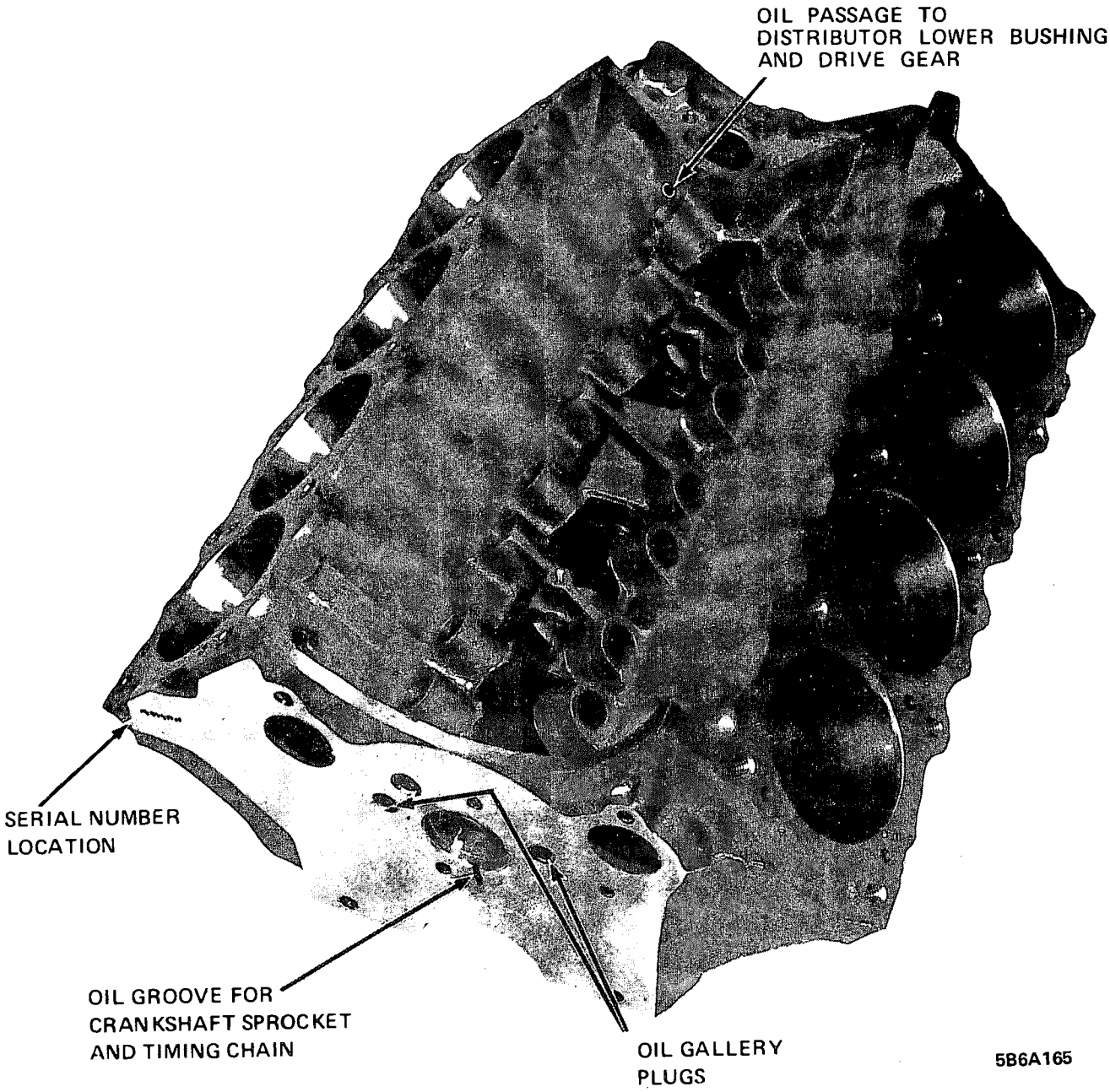


Figure 6A-165 - Cylinder Block - View from Left Front

Assemble

1. Install old connecting rods to proper new piston and pin assemblies and install in cylinders from which pistons were removed.

2. Install crankshaft and measure bearing clearances.

3. Install two timing cover mounting studs.

4. Install camshaft, using care not to damage bearings.

5. Install camshaft thrust plate indexing oiling slot in plate with oil groove in block.

6. Make sure keys are in place in crankshaft and camshaft. Insatll timing chain and sprockets, making sure marks in sprockets are aligned exactly on a straight line passing through shaft centers (Figure 6A-130). (Number one cylinder is now at T.D.C. in its firing position).

Alignment can be simplified by first installing sprockets without chain to align timing marks. If timing chain is excessively loose, new chain or new chain and sprockets should be used.

When installing distributor, position so that rotor is in position to fire number one cylinder.

7. Position fuel pump eccentric bushing over eccentric with flange toward camshaft sprocket.

8. Install fuel pump eccentric and bushing on camshaft sprocket, indexing tang on eccentric with keyway cut-out in camshaft sprocket.

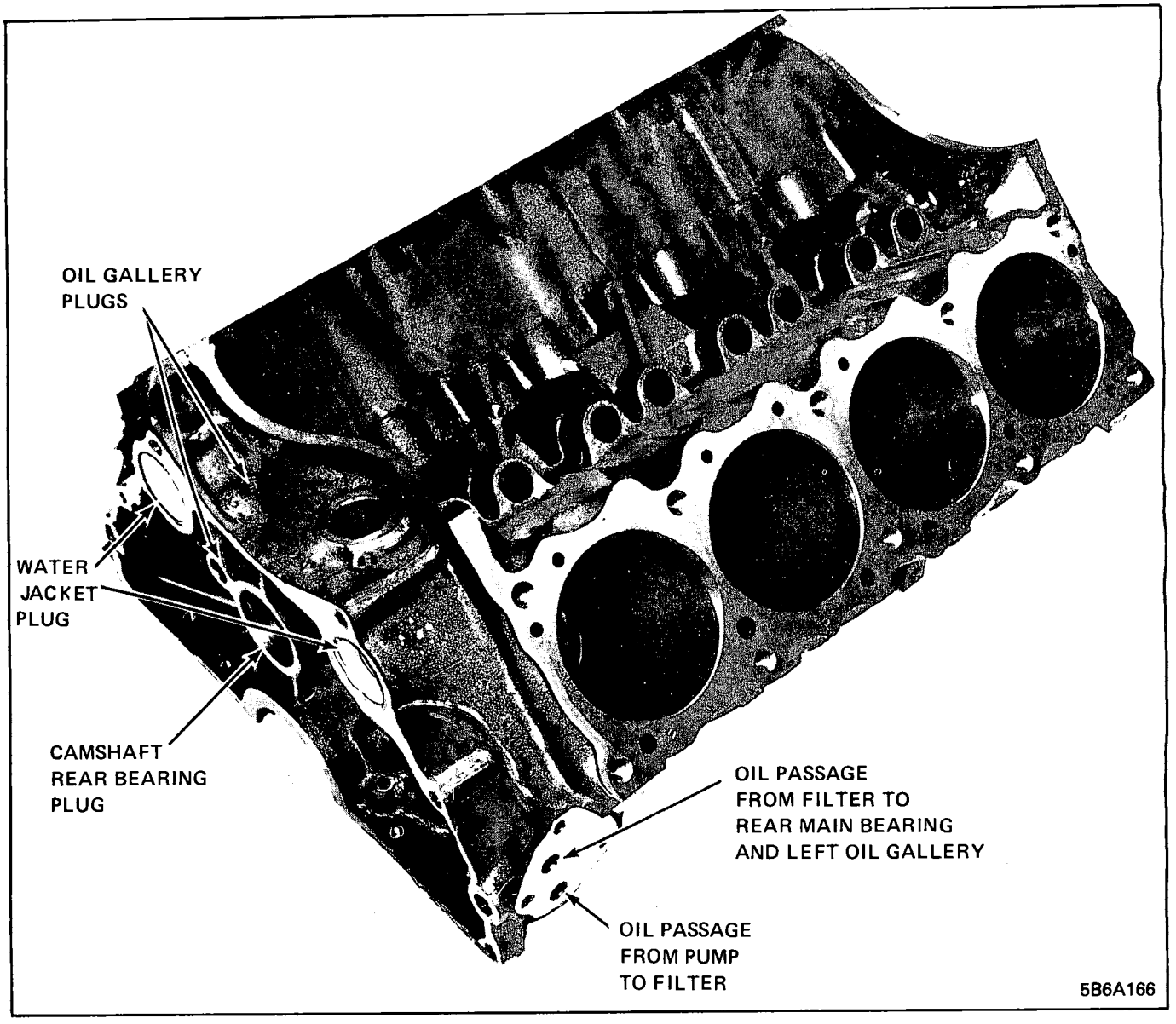


Figure 6A-166 - Cylinder Block - View from Right Rear

9. Position timing cover gasket over mounting studs and dowels on block.

10. Install timing cover, water pump, fan and pulley. Do not install stud nuts at this time.

11. Slide harmonic balancer onto crankshaft, and install harmonic balancer to crankshaft bolt and washer. Place hammer handle between block and crankshaft counterweight to keep crankshaft from turning and tighten harmonic balancer to crankshaft bolt to 160 lb. ft.

12. Install baffle and oil indicator tube extension.

13. Insert oil pump drive shaft with dimpled end towards block.

14. Install oil pump gasket and oil pump.

15. Cement new gaskets to oil pan and rear main bearing cap; use retainers to hold gasket. Install oil pan and tighten pan bolts to 12 lb. ft. Tighten four rear bolts (through reinforcement straps) to 18 lb. ft. Position flywheel housing inspection cover in place and secure with bolts.

16. Position new cylinder head gasket on block.

17. Position cylinder heads and exhause manifolds on locating pins. Install head bolts and torque to 95 lb. ft.

Three different length bolts are used. When inserted in proper holes, all will project an equal amount from their respective bosses.

18. Install lifters in bosses from which they were removed.

19. Install push rods in same location as originally removed and with same end facing valve lifter.

20. Tighten rocker arm ball retaining nuts to 20 lb. ft.

21. Install distributor as follows:

a. If not already done as explained in Step number 6, turn crankshaft to firing position of number one cylinder (number one exhaust and intake valve lifters both on base cir-

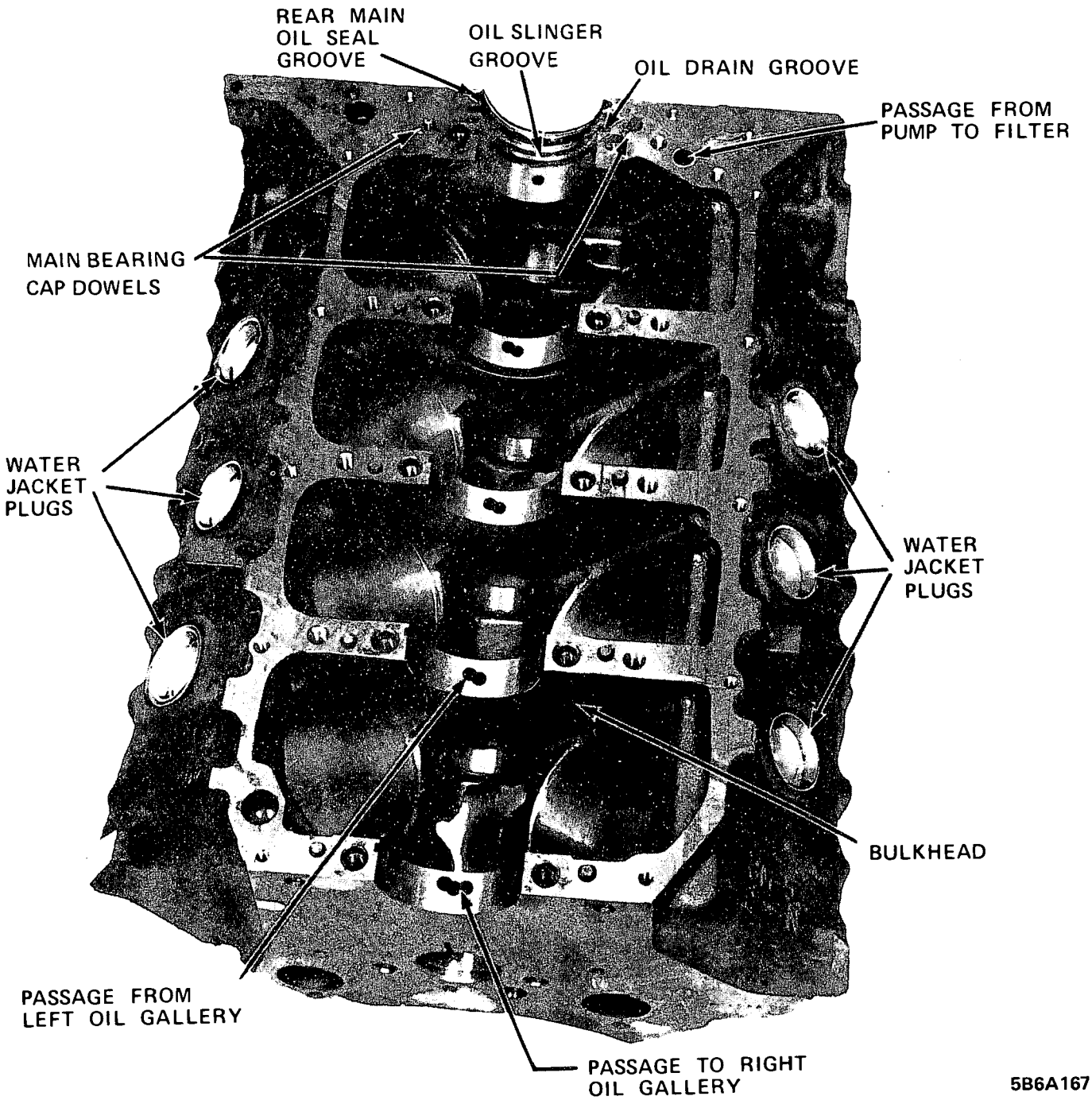


Figure 6A-167 - Cylinder Block - View from Bottom

cles of their cam lobes and timing mark on harmonic balancer indexed with pointer (number one intake must have just closed).

b. Position new distributor to block gasket on block.

c. Install distributor (without cap and wires) so that vacuum diaphragm faces left side of engine and rotor arm points toward contact in cap for number one cylinder. It will also be necessary to turn the oil pump drive shaft so it will index with distributor shaft.

22. Insttall distributor hold-down clamp and special bolt and tighten enough to hold distributor in place.

23. Install coil.

24. Cement new gasket to push rod cover and install push rod cover.

25. Cement new gaskets to rocker arm covers and install covers.

26. Install intake manifold gasket with plastic locating sleeves in cylinder head as shown in Figure 6A-120.

27. Start intake manifold to timing cover draw bolt into intake manifold, making sure rubber "O" ring is in place.

28. Position intake manifold and install retaining screws finger- tight.

29. Tighten draw bolt to 15 lb. ft. to obtain metal to metal contact between manifold and timing cover.
30. Tighten manifold screws to 40 lb. ft.
31. Install oil filter assembly and gasket.
32. Install oil level indicator.
33. Install starter assembly.
34. Install fuel pump.
35. Install generator and bracket.
36. Install fan belt and adjust belt tension.

V-8 ENGINE TORQUE SPECIFICATIONS

Torque in lb. ft. unless otherwise specified.

APPLICATION	TORQUE
Bolt-Main Bearing Cap to Block	100
Bolt-Rear Main Bearing Cap to Block	120
Bolt-Cylinder Head	95
Bolt-Flywheel to Crankshaft	95
Nut-Connecting Rod Bearing Cap	43
Bolt-Oil Pan to Block	
Front Bolts	12
Rear Bolts (Through Reinforcement Straps)	18
Bolt-Oil Pump to Block	30
Bolt-Harmonic Balancer to Crankshaft	160
Bolt-Exhaust Manifold to Head	30
Bolt-Intake Manifold to Head	40
Bolt-Camshaft to Sprocket	40
Nut-Rocker Arm to Stud	20
Stud-Rocker Arm	50
Spark Plug to Head	15
Bolt-Rocker Cover	8

SPECIFICATIONS V-8 ENGINE

Type	90° V-8 O.H. Valve
Bore and Stroke	
400 Cu. In.	4.12" x 3.75"
Compression Ratio	
400 Cu. In., Q'Jet	8.0
Compression Pressure at Cranking Speed	
Wide Open Throttle)	120-160 PSI @ 155-175 RPM
Car-Engine Serial No.	
Location	Front Face of Right Cylinder Bank
Production Engine	
No. Location	Front Face of Right Cylinder Bank
Cylinder Nos.-Front to Rear	
Left Bank	1-3-5-7
Right Bank	2-4-6-8
Firing Order	1-8-4-3-6-5-7-2

Cylinder Block

Material	Alloy Cast Iron

Cylinder Heads

Material	Alloy Cast Iron
Combustion Chamber	Quench Type Fully Machined
Material	Cast Aluminum Alloy
Type	Cam and Contour Ground-Slipper Skirt
Measurement Taken At	Top of Skirt
Clearance in Cylinder	.0029"-.0037"

Cylinder block and pistons must be at 70° to 80° F. at time of fitting pistons to cylinder.

Piston Rings

Compression Rings	Two - Cast Iron Reverse Twist
Barrel Face (Upper), and Taper Face (Lower)	
Material	
Upper	Channel Moly Filled
Lower	Channel Moly Filled
Ring Gap	
Upper	.019"
Lower	.015"
Side Clearance	.0015"-.005"
Oil Ring	Three Piece
Material	
Rails (2)	Chrome-Plated Steel
Expander	Stainless Steel
Ring Gap	.035"
Side Clearance	.0015"-.005"

Piston Pin

Material	Extruded SAE 1016 Steel
Diameter	.9802"
Wall Thickness	.38"
Length	3.25"
Fit in Piston	.0003"-.0005"
Fit in Rod	Press

Connecting Rod

Material	Arma Steel
Weight (Oz.)	31.7
Length (Center to Center)	6.625"
Bearings	
Length	.88"
Clearance	.0005"-.0025"
Material	Moraine 400-A
Eng Play on Crankshaft (Total for Two)	.012"-.017"

Valves

Material	
Intake	GM 8440 Steel with Aluminized Face and Flash Chrome Plate Stem
Exhaust	21-2 Steel with Aluminized Face and Flash Chrome Plated Stem
Diameter of Head	
Intake	2.11"
Exhaust	1.66"
Overall Length	
Intake	4.960"
Exhaust	4.949"
Diameter of Stem	.34"
Stem to Guide Clearance	
Intake	.0016"-.0033"
Exhaust	.0021"-.0038"
Valve Seat Angle	
Intake	30°
Exhaust	45°
Valve Face Angle	
Intake	29°
Exhaust	44°

Crankshaft

Material	Nodular Iron
No. of Bearings	5
Main Bearing Type	
400 4 Bbl.	
All Uppers	Moraine 100-A
All Lowers exc. #5	Moraine 400-A
#5 Lower	Moraine 100-A
Thrust Taken On	No. 4
Crankshaft Endplay	.003"-.009"
Journal Diameter	3.00"
Main Bearing Length	
Nos. 1, 2, 3	.94"
No. 4	1.13"
No. 5	1.59"
Main Bearing Clearance	.0002"-.0017"
Crankpin Diameter	2.25"

Flywheel and Sprockets

Flywheel	
Material	
Manual	Cast Iron
Automatic	Stamped Steel
No. of Teeth	166
Starter Motor Drive	
No. of Teeth	9
Crankshaft Sprocket	
Material	Hardened Sintered Iron
No. of Teeth	21
Camshaft Sprocket	
Material	Hardened Cast Iron
No. of Teeth	42
Timing Chain	Link Type - Single Side Guide
No. of Links	60
Harmonic Balancer	Cast Iron

Camshaft

Material	Hardened Alloy Cast Iron
Bearings	
Number	5
Type	Steel Backed Babbitt
Diameter - All	1.9"

Valve System

Valve Lifter	
Type	Hydraulic
Plunger Travel (For Gaging Purposes)	125"
Pushrod	
Material	Ball Ended - Steel Tubing
Length	9.17"
Rocker Arm	
Material	Stamped Steel
Ratio	1.5 to 1
Rocker Arm Stud	Screwed into Head

Lubrication System

Type of Lubrication
- Main Bearings ..... Pressure
- Connecting Rods ..... Pressure
- Piston Pins ..... Splash
- Camshaft Bearings ..... Pressure
- Lifters and Rocker Arms ..... Pressure
- Timing Gears and Chain ..... Metered Jet
- Cylinder Walls ..... Splash

Oil Pump

Type ..... Spur Gear
- Oil Pickup ..... Stationary Screen

Pressure
- All ..... 55-60 PSI @ 2600 RPM

Oil Capacity ..... 5 Qts.
- With Filter ..... 6 Qts.

Fuel System

Fuel Pump Pressure (PSI) 5.0-6.5

Pleated Paper

Carburetor

Type
- 4 Bbl. ..... Rochester Quadrajet

Barrel Size
- Q'Jet ..... 1.375″ Primary, 2.250″ Secondary

Cooling System

Radiator Cap Pressure (PSI) 14-17
- Thermostat Opens At ..... 195°
- Water Pump Rate (GPM) 17

Valve Timing (In Crankshaft Degrees)

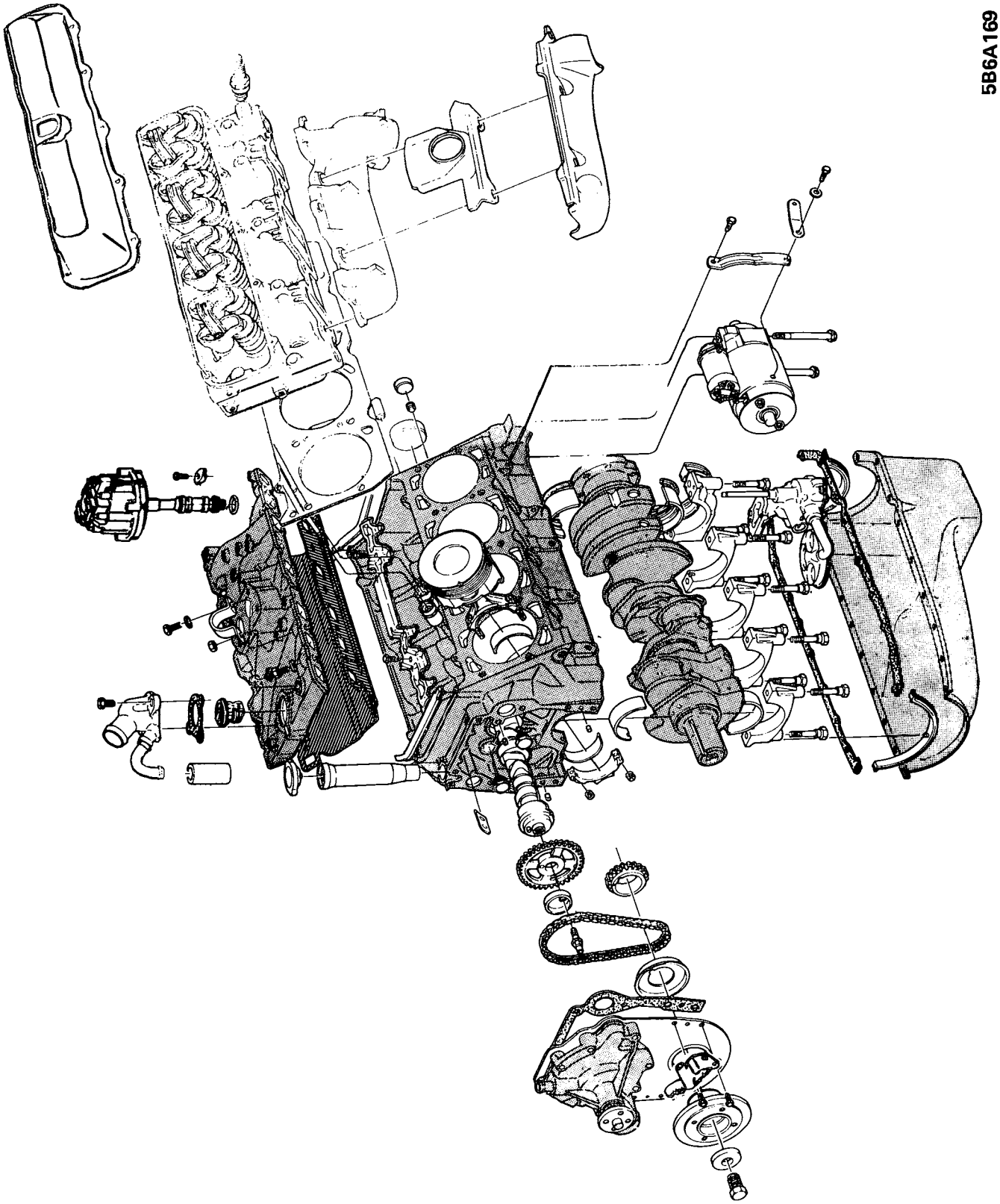
Camshaft 9779067
- Intake
  - Opens (BTC) ..... 23°
  - Closes (ABC) ..... 70°
  - Duration ..... 273°
  - Lift (@ Zero Lash) ..... .403″
- Exhaust
  - Opens (BBC) 78°
  - Closes (ATC) ..... 31°
  - Duration ..... 209°
  - Lift (@ Zero Lash) ..... .406″

Valve Overlap ..... 54°

260 CU. IN. V-8 ENGINE

CONTENTS

Camshaft 6A-111
Camshaft and Oil Gallery Plugs 6A-111
Crankshaft 6A-112
Crankshaft Pulley 6A-108
Main Bearings 6A-113
Rear Main Oil Seal 6A-114
Connecting Rod and Piston Assembly 6A-103
Rod Assembly 6A-104
Rod Bearings 6A-104
Cylinder Head and Gasket 6A- 99
Measuring Valve Stem Height 6A-100
Valve and Springs (Heads Removed) 6A- 99
Reaming Procedure 6A-101
Valve Spring (Head on Engine) 6A-101
Description 6A- 94
Engine Assembly 6A- 94
Installation 6A- 95
Removal 6A- 94
Front Cover
Oil Seal 6A-110
Harmonic Balancer 6A-108
Lubrication System 6A- 94
Manifold
Exhaust 6A- 97
Intake 6A- 96
Oil Filter Base 6A- 94
Oil Pan 6A-102
Oil Pump 6A-103
Piston
Checking Cylinder Bore 6A-106
Cleaning Piston 6A-106
Measuring Piston 6A-105
Pistons Pins 6A-108
Piston Information Chart 6A-119
Rings
Piston Ring and Rail Gap 6A-106
Ring Ident. and Installation 6A-107
Ring Tolerance 6A-106
Side Clearance 6A-106
Specifications 6A-115
Torque Specifications 6A-118
Valve Covers 6A- 97
Valves and Springs (Heads Removed) 6A- 99
Valve Guides
Reaming Procedure 6A-101
Valve Spring (Head on Engine) 6A-101
Valve Lifters
Checking Valve Rotators 6A-102
Diagnosis 6A- 98
Operation 6A- 97



@2-9.00 5B6A169

Figure 6A-169 - V-8 Engine Exploded View

The left bank of cylinders (as viewed from the driver's seat) are numbered (from front to rear) 1-3-5-7. Cylinders in the right bank are numbered (from front to rear) 2-4-6-8. Figure 6A-170.

The required engine maintenance, engine unit numbers and engine identification is outlined in Section O of this manual. The engine specifications are listed at the back of this section.

ENGINE LUBRICATION SYSTEM (Figure 6A-171)

The engine oil pan forms a reservoir for engine oil to provide lubrication and also hydraulic fluid to operate the valve lifters. Oil pressure for lubrication is furnished by a gear type oil pump that is bolted to the rear main bearing cap and driven by the camshaft gear through a hexagonal drive shaft.

Oil enters the pump through a screened inlet located near the bottom rear of the oil pan. The pressurized oil from the pump passes through the oil filter located on the right rear side of the engine block. The oil filter base has a by-pass valve which in the event of filter restriction will open at 5.3 to 6.3 psi. Oil then enters the right oil gallery where it is distributed to the five main bearings. The right bank valve lifters receive oil from this gallery from eight feed holes that intersect the gallery.

The five camshaft bearings are lubricated from vertical passages intersecting the main bearing oil passages. At the front main bearing a third passage connects the right main oil gallery to the left gallery which then feeds the left bank of valve lifters.

The engine oil pressure warning light switch is connected to the front of the left oil gallery. The switch is calibrated to turn on the instrument panel warning light when engine oil pressure is too low. The switch, normally closed, is set to open at 2-6 psi. The rear oil gallery plug has a .040" orifice to help purge contaminants from the gallery.

At the front end of the right gallery, a small orifice sprays oil to lubricate the fuel pump eccentric cam and the timing chain.

The distributor drive gear is lubricated by oil from the left rear oil gallery.

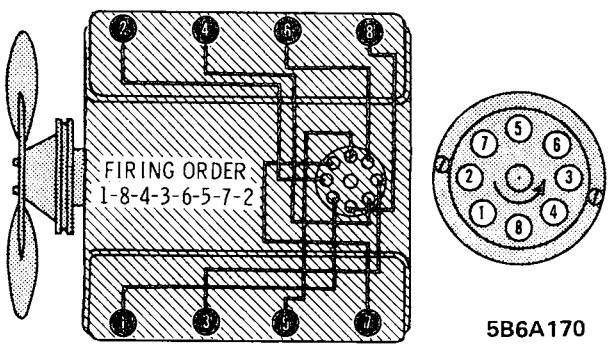


Figure 6A-170 - Cylinder Numbers

The rocker arms and valve tips are lubricated by means of oil furnished through the hydraulic lifters and hollow push-rods. A disc valve in the lifter meters oil to the push rods.

The connecting rod bearings are oiled by constant oil flow from passages drilled through the crankshaft *connecting* the main journals to the rod journals. A groove around each main bearing furnishes oil to the drilled crankshaft passages.

Oil returns to the oil pan reservoir from the rocker arms through passages at each end of the cylinder heads. Oil from the valve lifter compartment returns through clearance holes in the chain compartment drains directly into the oil pan.

(NOTE: To check engine oil pressure, see procedure outlined in 231, 350 and 455 section.)

OIL FILTER BASE (Figure 6A-172)

Removal

1. Hoist car and remove R.F. Wheel.
2. Disconnect exhaust crossover and exhaust pipe from right exhaust manifold.
3. Straighten lock tab on bolts, then remove exhaust manifold attaching bolts.
4. Remove exhaust manifold.
5. Remove bolts securing oil filter base and remove base and gasket.

Installation

Clean manifold and oil filter base sealing surfaces. Bend all lock tabs to retain exhaust manifold bolts after installation. Torque oil filter base bolts to 35 ft. lbs. and exhaust manifold bolts to 25 ft. lbs. Start engine, check for possible leaks. Check for proper engine oil level.

ENGINE ASSEMBLY

Removal

1. Drain cooling system.
2. Remove air cleaner and hot air pipe.
3. Remove hood from hinges, mark hood for reassembly.
4. Disconnect battery negative cable at battery and ground wire at inner fender panel. Disconnect engine ground strap, right head to cowl.
5. Disconnect radiator hoses, automatic transmission cooler lines, heater hoses, vacuum hoses, power steering pump with hoses attached, power steering hose bracket from engine air conditioning compressor with brackets and hoses attached, fuel hose from fuel line, wiring and throttle cable.
6. Remove upper radiator support and radiator.
7. Raise car.
8. Disconnect exhaust pipes at manifold.
9. Remove torque converter cover and three bolts holding converter to flywheel.

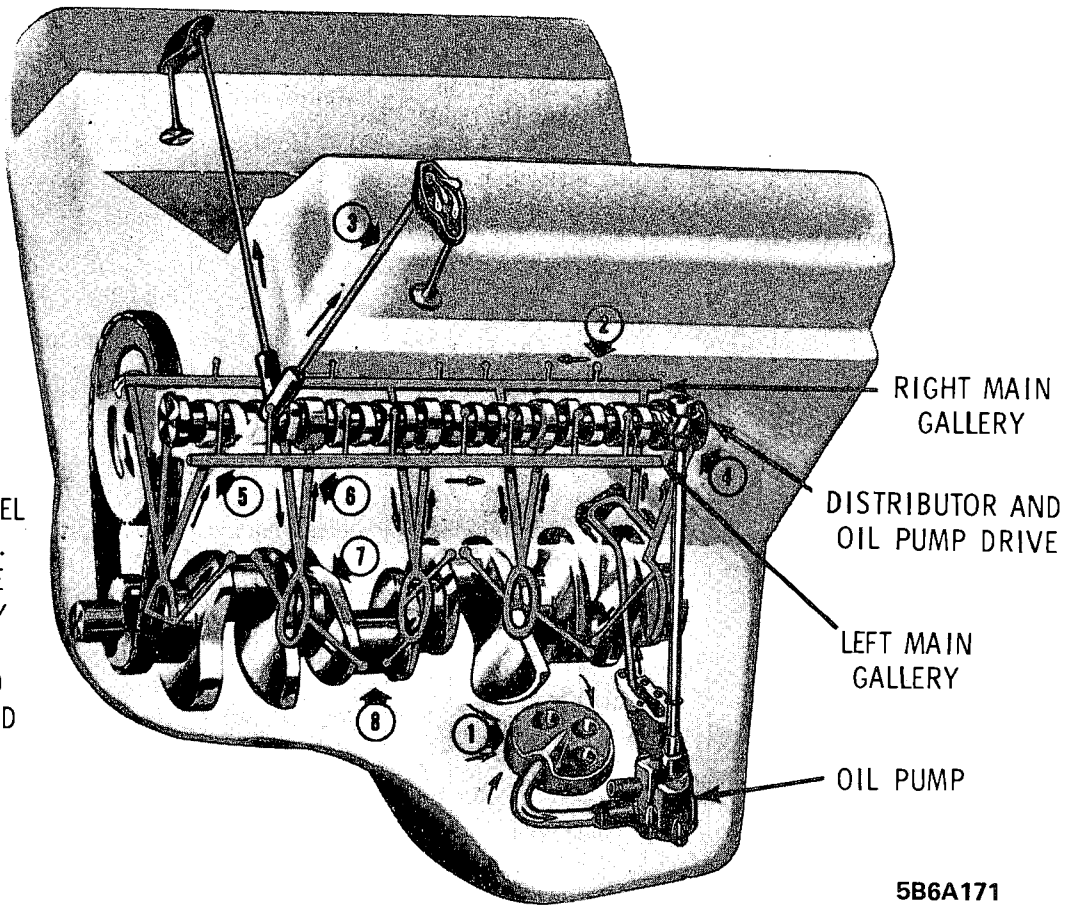


Figure 6A-171 - Engine Lubrication

10. Remove engine mount bolts or nuts.

11. Remove three bolts, transmission to engine on the right side. Remove starter with wires attached and attach to frame to support it.

12. Lower car.

13. Place board on top of jack and slightly raise transmission. Remove three left transmission to engine bolts. Remove engine.

14. If car is to be moved, install converter holding Tool J-21654 and support transmission with chain.

Installation

1. Install engine in place. Locate engine dowels into transmission and position through bolts into mounts and tighten. Replace three left transmission to engine bolts. Remove jack.

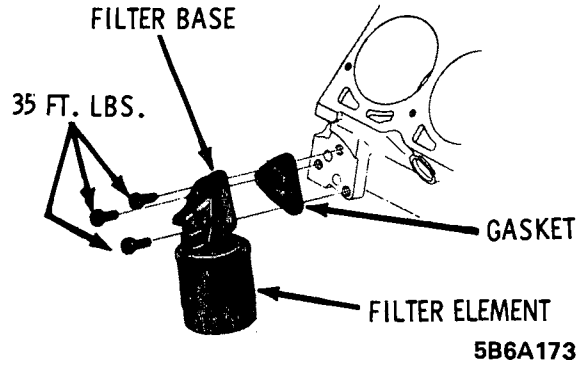


Figure 6A-172 - Oil Filter Base

2. Raise car. Replace three bolts, transmission to engine on the right side. Replace starter and attaching bolts.

3. Replace three bolts converter to flywheel and torque converter cover.

4. Connect exhaust pipes and lower car.

5. Replace radiator and upper radiator support.

6. Connect radiator hoses, automatic transmission cooler lines, heater hoses, vacuum hoses, power steering pump hoses at pump, power steering hose bracket to engine, air conditioning compressor, fuel hose to fuel line, wiring and accelerator linkage.

7. Replace air cleaner and hot air pipe.

8. Replace and align hood with scribe marks.

9. Connect battery cable and ground wires.

10. Add engine oil and coolant.

INTAKE MANIFOLD

Removal

1. Remove air cleaner assembly.

2. Drain radiator, then disconnect upper radiator hose and thermostat bypass hose from water outlet. Also, disconnect heater hose at rear of manifold.

3. Disconnect throttle cable.

4. Remove fuel and all vacuum lines.

5. Disconnect and/or remove generator and air conditioning compressor brackets as necessary.

6. Disconnect temperature gauge wire.

7. Remove intake manifold bolts; then remove manifold with carburetor attached.

8. Clean machined surfaces of cylinder head and intake manifold with a putty knive. Use care not to gouge or scratch machined surface.

Installation

1. Coat both sides of gasket sealing surface that seal the intake manifold to the head with sealer position intake manifold gasket.

2. Install end seals, making sure that ends are positioned under cylinder heads as shown in Figure 6A-173.

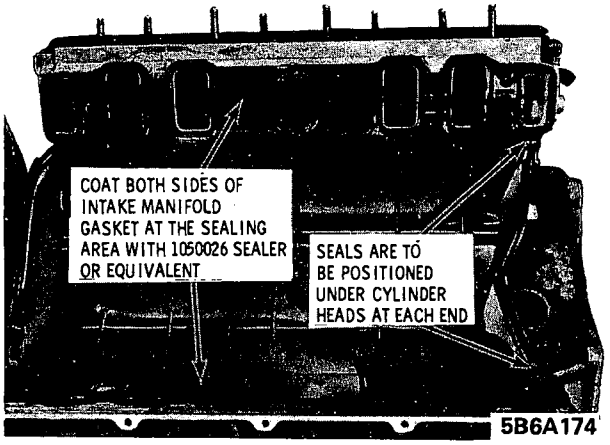


Figure 6A-173 - Intake Manifold Gasket

3. Position intake manifold on engine and connect thermostat bypass hose to water pump.

4. Dip intake manifold bolts in engine oil and torque in sequence shown to 15 ft. lbs. Then retorque to 40 ft. lbs. Figure 6A-174.

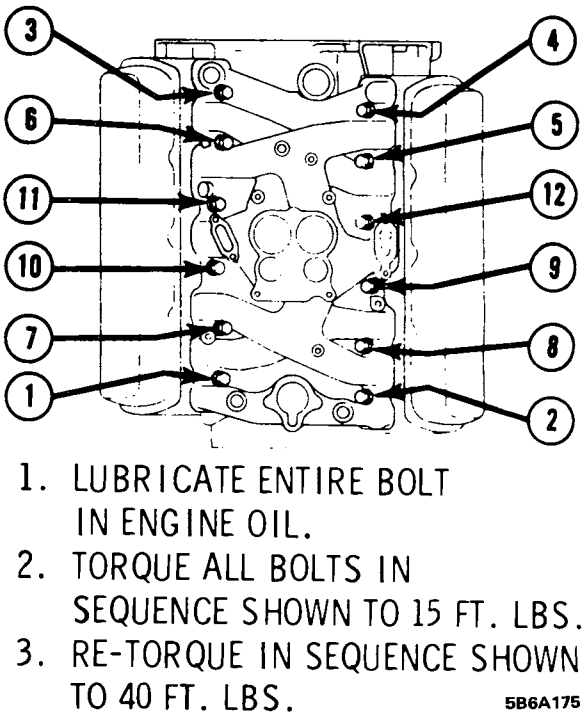


Figure 6A-174 - Intake Manifold Torque Sequence

5. Position E.G.R. gasket on intake manifold. Install E.G.R. valve or adapter and torque bolts to 25 ft. lbs.

6. Connect temperature gauge wire.

7. Install fuel and vacuum lines.

8. Connect upper radiator hose, spark plug wires, heater hose, throttle linkage and install air cleaner assembly.

9. Fill cooling system.

R. H. EXHAUST MANIFOLD

1. Hoist car.
2. Remove exhaust crossover pipe.
3. Disconnect exhaust pipe.
4. Remove exhaust manifold.

To install, reverse removal procedure. Refer to Torque Chart for proper bolt torque.

L. H. EXHAUST MANIFOLD

1. Remove generator lower bracket.
2. Remove hot air shroud attaching nuts.
3. Hoist car.
4. Remove exhaust crossover pipe.
5. Remove manifold hot air shrouds.
6. Remove manifold attaching bolts and manifold.

To install, reverse removal procedure. Refer to Torque Chart for proper bolt torque.

VALVE COVER

Removal

1. Disconnect positive crankcase ventilation from valve cover.
2. Disconnect spark plug wires and move away from valve cover.
3. Remove valve cover to cylinder head attaching screws. Remove accessory mounting brackets as necessary and remove valve cover.

Installation

1. Apply sealer to the valve cover side of the gasket and install the gasket in the cover.
2. Replace valve cover and torque attaching screws to 7 ft. lbs.
3. Connect spark plug wires and replace accessory mounting brackets previously removed. Torque attaching bolts to specification.
4. Connect positive crankcase ventilation to valve cover.

ROCKER ARM ASSEMBLIES

Removal

1. Remove valve cover.
2. Remove rocker arm, flanged bolts, pivot and rocker arms.

(NOTE: Remove each set (one set per cylinder) as a unit.)

Installation

1. Position a set of rocker arms (for one cylinder) in the proper location.
2. Lubricate wear points and install the pivots.
3. Install the hardened flanged bolts and tighten alternately. Torque bolts to 25 ft. lbs.

VALVE LIFTERS

Operation

Oil is supplied to the lifter through a hole in the side of the lifter body which indexes with a groove and hole in the lifter plunger. Oil is then metered past the oil metering valve in the lifter, through the push-rods to the rocker arms.

When the lifter begins to ride up the cam lobe, the ball check is held against its seat in the plunger by the ball check spring which traps the oil in the base of the lifter body below the plunger. The plunger and lifter body then raise as a unit, pushing up the push-rod to open the valve. The force of the valve spring which is exerted on the plunger through the rocker arm and push-rod causes a slight amount of leakage between the plunger and lifter body.

This "leak-down" allows a slow escape of trapped oil in the base of the lifter body. As the lifter rides down the other side of the cam lobe and reaches the base circle or "valve closed" position, the plunger spring quickly moves the plunger back (up) to its original position. This movement causes the ball check to open against the ball spring and oil from within the plunger is drawn into the base of the lifter. This restores the lifter to zero lash.

Removal

(NOTE: Valve lifters and push-rods should be kept in order so they can be reinstalled in their original position. Some engines will have both standard and .010" oversize valve lifters, the .010" oversize lifter is etched "O" on the side of the lifter. The cylinder block will also be marked if the overside lifter is used.) Figure 6A.175.

1. Remove intake manifold and gasket.
2. Remove valve covers, rocker arm assemblies and push-rods.

(NOTE: In order to remove bolt, remove R.H. engine

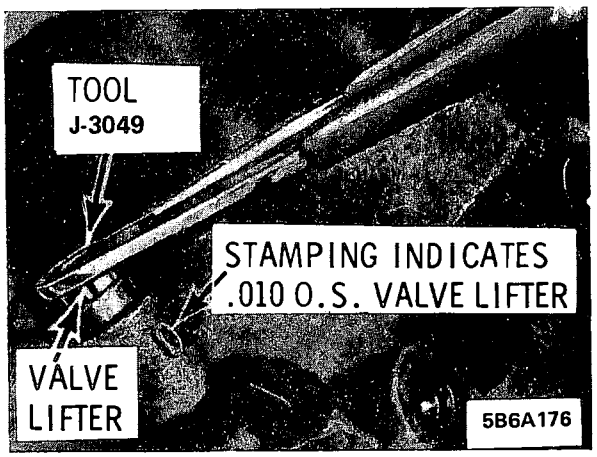


Figure 6A-175 - Removing Valve Lifter

mount through bolt, then jack right side of engine until push rods may be removed.)

3. If lifters are varnished, apply carburetor cleaning solution to lifter body. Allow five minutes for solution to remove varnich.

CAUTION: *Carburetor cleaning solvent should be used in a well ventilated room. Avoid contact with skin and prolonged breathing of fumes.*

4. Remove lifter.

Valve Lifter Diagnosis

1. Momentarily Noisy When Car Is Started:

This condition is normal. Oil drains from the lifters which are holding the valves open when the engine is not running. It will take a few seconds for the lifter to fill after the engine is started.

2. Intermittently Noisy on Idle Only, Disappearing When Engine Speed is Increased:

Intermittent clicking may be an indication of a flat or pitted ball, or it may be caused by dirt.

Correction: Replace lifter.

3. Noisy At Slow Idle or With Hot Oil, Quiet With Cold Oil or As Engine Speed is Increased:

Insert a .015" feeler gauge between the rocker arm and valve stem. If noise mementarily disappears and then reappears after a few seconds with the feeler still inserted, it is an indication that the lifter leak-down rate is too fast.

Correction: The lifter must be replaced.

4. Noisy at High Car Speeds and Quiet at Low Speeds.

a. High oil level - Oil level above the "Full" mark allows crankshaft counterweights to churn the oil into foam. When foam is pumped into the lifters, they will become noisy since a solid column of oil is required for proper operation.

Correction: Drain oil until proper level is obtained.

b. Low oil level - Oil level below the "Add" mark allows the pump to pump air at high speeds which results in noisy lifters.

Correction: Fill until proper oil level is obtained.

c. Oil pan bent on bottom or pump screen cocked, replace or repair as necessary.

5. Noisy at Idle Becoming Louder as Engine Speed is Increased to 1500 rpm.

a. This noise is not connected with lifter malfunction. It becomes most noticeable in the car at 10 to 15 mph "L" range, or 30 to 35 mph "D" range and is best described as a hashy sound. At slow idle, it may be entirely gone or appear as a light ticking noise in one or more valves. It is caused by one or more of the following:

1. Badly worn or scuffed valve tip and rocker arm pad.

3. Excessive valve seat runout.

4. Off square valve spring.

5. Excessive valve face runout.

6. Valve spring damper clicking on rotator.

Correction:

Remove valve covers and while listening with a stethoscope, locate noisy valves by increasing engine speed slightly above idle, about 1500 rmp. With gloved hand, push side-ways on valve spring. Noise will change, either becoming louder or disappearing completely. Some noise will be present in all valve locations. It is necessary to determine which are actually responsible for the noise.

a. Occasionally this noise can be eliminated by rotating the valve spring and valve. Crank engine until noisy valve is off its seat. Rotate spring. This will also rotate valve. Repeat until valve becomes quiet. If correction is obtained, check for an off square valve spring. If spring is off square more than 1/16" in free position, replace spring. Figure 6A-176.

b. Check for excessive valve stem to guide clearance. If necessary, correct as required.

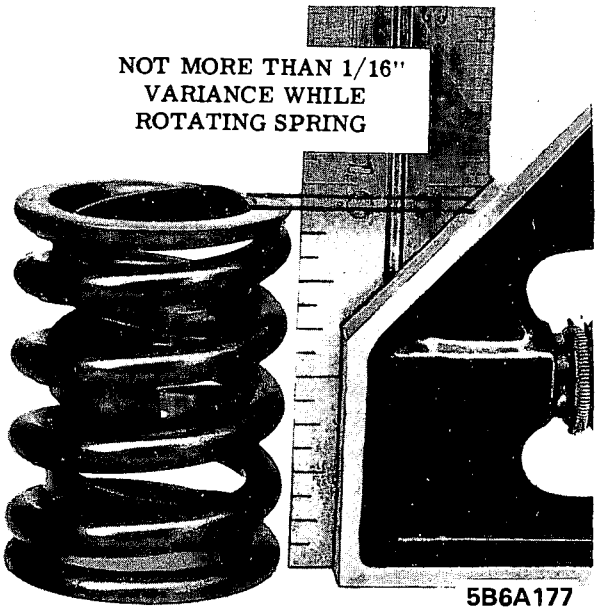


Figure 6A-176 - Checking Valve Spring

6. Valves Noisy Regardless of Engine Speed.

This condition can be caused by foreign particles or excessive valve lash.

Correction:

a. With transmission in Park and parking brake on, run the engine at a moderate speed.

If this method does not quiet the lifter, strike the rocker

arm above the push-rod with a mallet while the engine is idling. This method of correction has proven successful for dislodging a foreign particle which is preventing the ball from seating properly.

b. Check for valve lash by turning engine so the piston in that cylinder is on top dead center of firing stroke. If valve lash is present, the push-rod can be freely moved up and down a certain amount with rocker arm held against valve.

Valve lash indicates one of the following:

1. Worn push-rod.

3. Lifter plunger stuck in down position due to dirt or varnish.

4. Malfunctioning lifter.

Checking of the above four items:

1. Observe upper end of push rod. Excessive wear of the spherical surface indicates one of the following conditions.

a. Improper hardness of the push-rod ball. The push-rod and rocker arm must be replaced.

b. Improper lubrication of the push-rod. The push-rod and rocker arm must be replaced. The oiling system to the push-rod should be checked.

2. If push-rod appears in good condition and has been properly lubricated, replace rocker arm and recheck valve lash.

3. If valve lash exists and push-rod and rocker arm are okay, trouble is in the lifter. Lifter should be replaced.

Installation

(NOTE: Prime new lifters by working lifter plunger while submerged in new engine oil. Lifter could be damaged when starting engine if dry.)

1. Install lifters and push-rods into original position in cylinder block. See note under Removal.

2. Install manifold gaskets and manifold.

3. Position rocker arms, pivots and bolts on cylinder head as shown in Figure 6A-177.

4. Install valve covers, connect spark plug wires and install air cleaner.

CYLINDER HEAD AND GASKET

Removal

1. Drain radiator. By raising the rear wheels at least 24", the block will drain enough coolant to remove the heads.

2. Remove intake manifold.

3. Remove exhaust manifold, see "EXHAUST MANIFOLD REMOVAL".

4. Remove valve cover.

(NOTE: Loosen or remove any accessory brackets which interfere.)

5. Remove ground strap from right cylinder head.

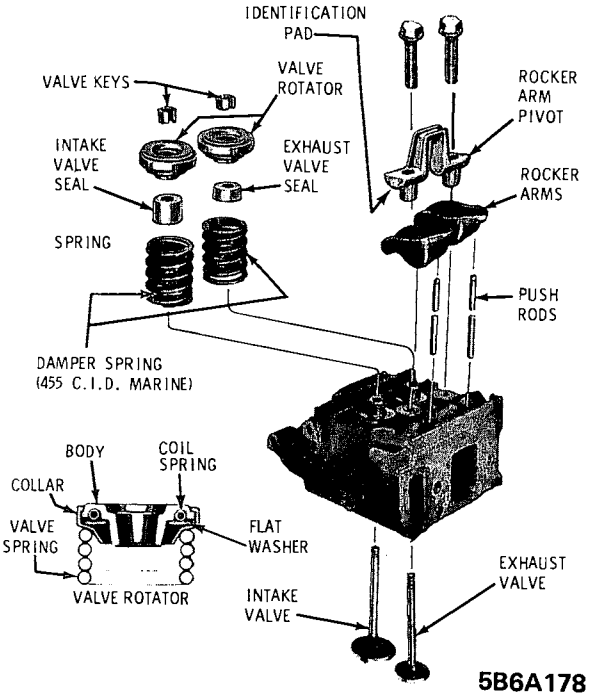


Figure 6A-177 - Cylinder Head - Exploded View

6. Remove rocker arm bolts, pivots, rocker arms and push rods.

(NOTE: Scribe pivots and keep rocker arms separated so they can be installed in their original locations.)

7. Remove cylinder head bolts and remove cylinder head.

Installation

Head gasket should be coated on both sides with No. 1050026 Sealer or equivalent before installation.

Clean and dip cylinder head bolts in engine oil, torque bolts to 60 ft. lbs. in sequence shown, then re-torque in sequence to 85 ft. lbs. Figure 6A-178.

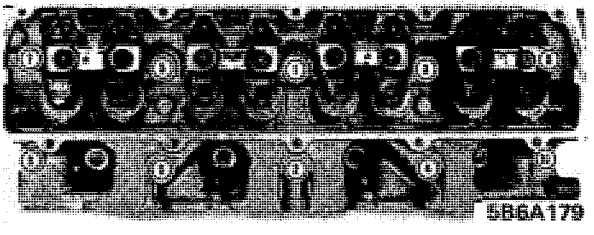


Figure 6A-178 - Cylinder Head Torque Sequence

VALVES AND SPRINGS WITH HEAD REMOVED

Removal

1. Remove spark plugs.

2. Remove valve keys by compressing valve spring with a tool such as J-8062.

3. Remove valve spring rotators or retainers and springs.

4. Remove oil seals from valve stems.

5. Remove valves. Keep valves separated so they can be installed in their original locations.

Installation

1. Install valves in their respective guides reversing removal procedure.

VALVE SEAL IDENTIFICATION

Intake

Std. - .005" O.S.	Gray Colored
.010" - .013" O.S.	Orange Colored

Exhaust

Std. - .005" O.S.	Ivory Colored
.010" - .013" O.S.	Blue Colored

2. Install new oil seals over valve stem.

Position seals down as far as possible on valve stem. The seals will correctly position themselves when the engine is started.

(NOTE: Inspect seal for cracks after installation.)

3. Position valve springs over valve stems.

4. Install valve rotators then compress springs with a tool such as J-8062 and install valve stem keys.

5. Check valve springs and keys to be sure they are properly seated.

6. Install exhaust manifold and shroud. Torque bolts and nuts to 25 ft. lbs. Bend exhaust manifold bolt lock tabs.

7. Set spark plug gap. Lubricate plug threads with one drop of engine oil and re-install plugs. Torque to 35 ft. lbs.

Reconditioning Valves

When reconditioning valves and valve seats, clean carbon from cylinder heads and valves using care not to gouge or scratch machined surfaces. A soft wire brush is suitable for this purpose. Whenever valves are replaced or new valves installed, the valve seats must be reconditioned.

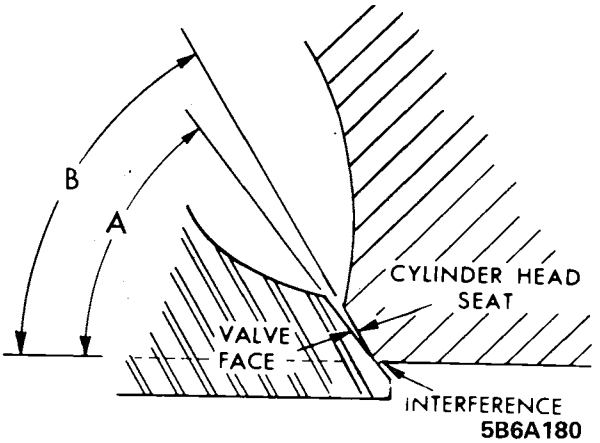


Figure 6A-179 - Relation of Valve and Seat Angles

Figure 6A-179.

a. Narrow the valve seats to the specified width.

(NOTE: This operation is done by grinding the portside with a 30° sone to lower the seat and a 60° stone to raise the seat.)

See "Engine Specification" chart for valve seat width.

(NOTE: Exhaust valve seats are either induction hardened and must be ground, not cut.)

If valve guide bores are worn excessively, they can be reamed oversize. This will require replacement of the valves with oversize valves (stems). The guide bores should be reamed before grinding the valve seats. Valve clearance in guide bore should be .001" to .004".

Measuring Valve Stem Height

Whenever a new valve is installed, or after grinding valves, it will be necessary to measure valve stem height as follows:

Install Gauge J-25289 as shown in Figure 6A-180.

There should be at least .035" clearance between gauge surface and end of valve stem. (Valve stem can be gauged with or without the valve rotator on the valve). If clearance is less than specifications, remove valve and grind tip of valve stems as required on a valve refacing machine using the "Vee" block attachment to insure a smooth 90° end. Also be certain to break shafp edge on ground valve tip. Observe an original valve to determine chamver.

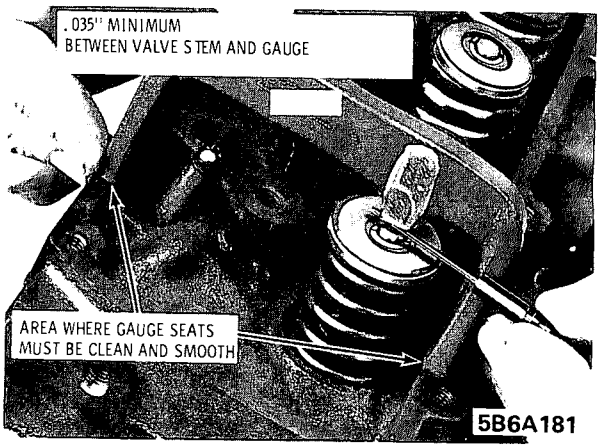


Figure 6A-180 - Measuring Valve Stem Height

After all valve keys have been installed on valves, tap each valve stem end with a hammer to seat valve rotators or retainers and keys. Using Gauge J-25289 as shown in Figures 6A-180 and Figure 6A-181, re-gauge all valves between valve stem and gauge and valve rotator and gauge. If any valve stem end is less than .005" above rotator or .030" above retainer, the valve is too short and an new valve must be installed.

EXAMPLE:

Valve Rotator to Gauge Clearance	.038"
Minus Valve Stem to Gauge Clearance	–.035"
	.003"

This is less than .005" and a new valve should be installed.

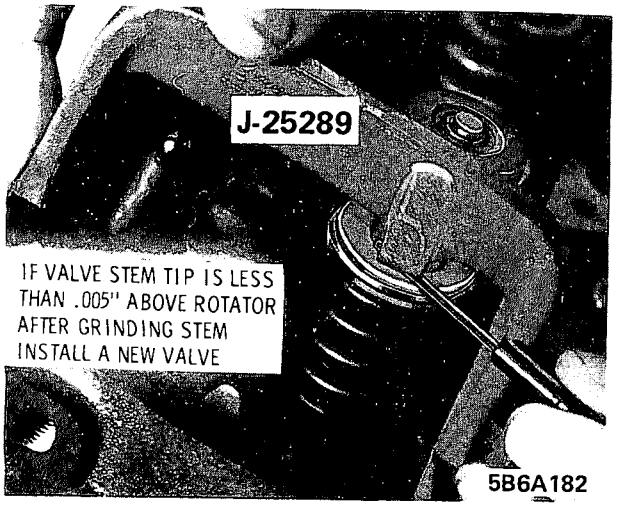


Figure 6A-181 - Measuring Rotator Height

VALVE GUIDE BORES

As previously stated, if the valve guide bores are worn excessively, they can be reamed oversize. The following reamers are available.

J-5830-1 .003" Oversize Valve Guide Reamer

J-6621 .005" Oversize Valve Guide Reamer

J-5830-7 .013" Oversize Valve Guide Reamer

If a standard valve guide bore is being reamed, use the .003" or .005" oversize reamer. For the .010" oversize valve guide bore, use the .013" oversize reamer. If too large a reamer is used and the spiraling is removed, it is probable that the valve will not receive the proper lubrication.

Occasionally a valve guide bore will be oversize as manufactured. These are marked on the inboard side of the cylinder heads on the machined surface just above the intake manifold surface, Figure 6A-182. These markings are visible without removing any aprts other than the air cleaner assembly. Before removing the cylinder heads to perform service to either the valves or valve guide bores, the cylinder heads should be inspected to determine if these parkings are present. If no markings are present, the guide bores are standard. If oversize markings are present, any valve replacement will require an oversize valve. If the oversize marking is present, only that particular bore would be oversize, not all bores in that cylinder head. Service valves are available in five different stem diameters: Standard, .003" oversize, .005" oversize, .010" oversize, and .013" oversize.

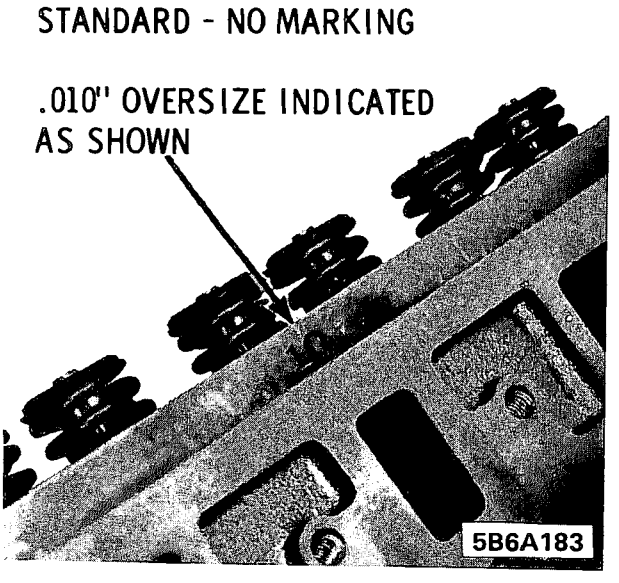


Figure 6A-182 - Valve Guide Bore Marking

REAMING PROCEDURE

Before attempting to ream the valve guide bores they should be cleaned using Tool J-8101 as shown in Figure 6A-183.

This procedure to ream valve guide bores using Tool J-5830 is shown in Figure 6A-184. Use care to hold reamer straight in valve guide bore.

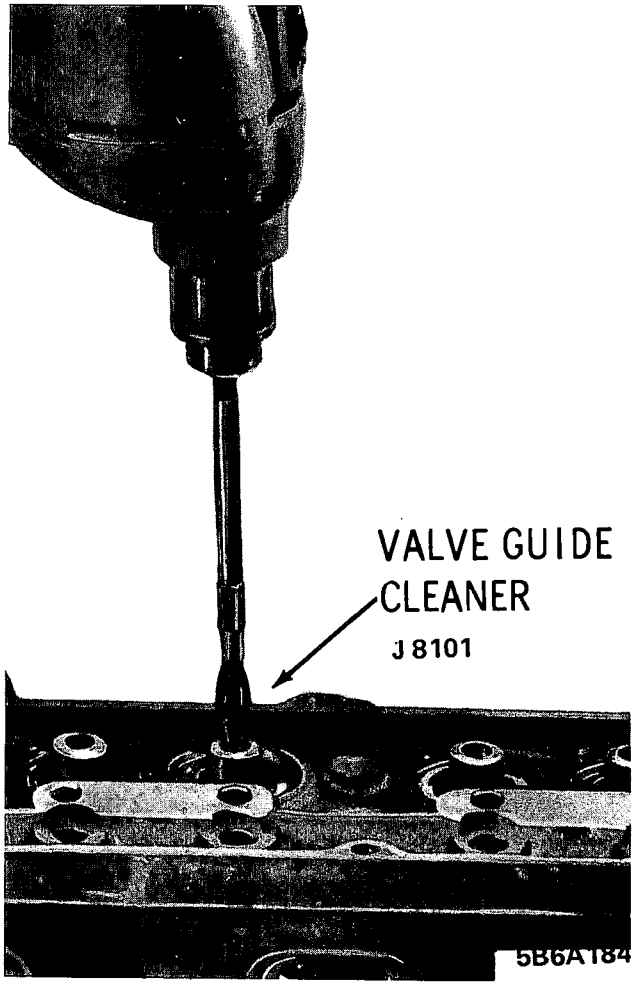


Figure 6A-183 - Cleaning Valve Guide Bores

REPLACING VALVE SPRING (HEAD ON ENGINE)

To replace a worn or broken valve spring without removing the cylinder head proceed as follows:

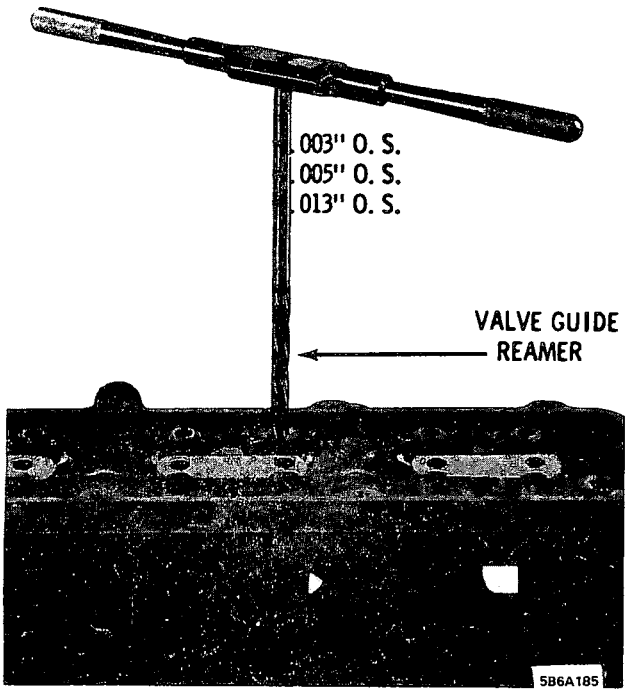


Figure 6A-184 - Reaming Valve Guide Bores

Removal

1. Remove rocker arm assemblies.

2. Remove spark plug and install a suitable adapter into spark plug hole and attach to an air hose to hold the valve against its seat.

3. Install Tool J-22891. Compress the valve spring until valve keys are accessible, then remove keys valve rotators and springs.

(NOTE: If valve spring does not compress, tap tool with a hammer to break bind at rotator and keys.)

CHECKING ROTATORS

The rotators cannot be disassembled and require replacement only when they fail to rotate the valve.

Rotator action can be checked by applying a daub of paint across the top of the body and down the collar. Run engine approximately 1500 rpm, there should appear to be motion between the body and collar, the body will appear to "walk" around the collar. Rotator action can be either clockwise or counterclockwise, sometimes on removal and reinstallation; the direction of rotation will change but this does not matter so long as it rotates.

Anytime the valves are removed fro service the tips should be inspected for improper pattern which could indicate valve rotator malfunction. Figure 6A-186.

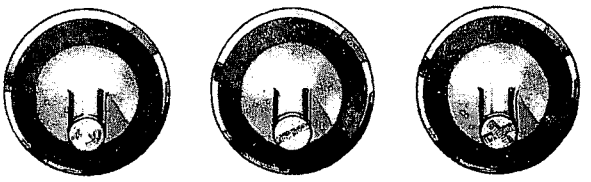


Figure 6A-186 - Valve Stem Wear

Installation

1. Install valve spring and rotator. Using Tool J-22891 compress the valve spring until the valve keys can be installed.

2. Install spark plugs. Torque 35 ft. lbs.

3. Install rocker arm assemblies.

OIL PAN

Removal

1. Remove distributor cap and align rotor in the number one firing position.

2. Disconnect battery cable. Remove the dipstick.

3. Hoist the car and drain oil.

4. Remove flywheel cover.

5. Remove starter assembly.

6. Disconnect exhaust pipes and crossover pipe (single exhaust).

7. Disconnect engine mounts and raise front of engine up as far as possible.

8. Remove oil pan attaching bolts and remove oil pan.

Installation (Figure 6A-187)

1. Apply Sealer to both sides of pan gaskets and install on block.

2. Install front and rear seal (rubber).

3. Wipe lube on seal area and install pan. Torque bolts to 10 ft. lbs. Reverse the removal procedure. Fill crankcase.

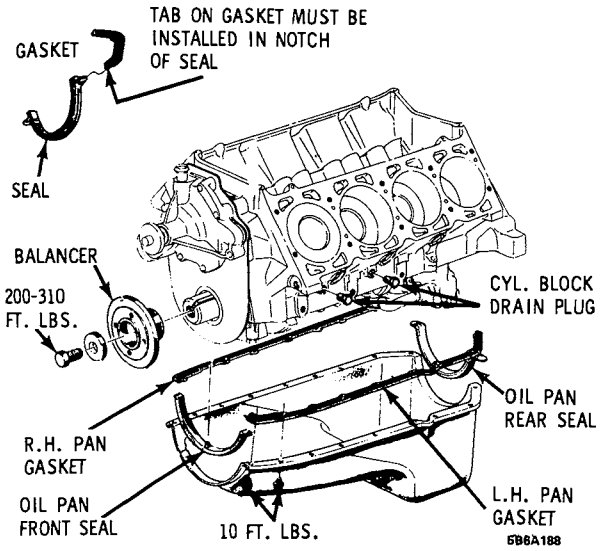


Figure 6A-187 - Oil Pan Assembly

OIL PUMP

Removal

1. Remove oil pan.

2. Remove the oil pump to rear main bearing cap attaching colts, then remove pump and drive shaft extension.

Disassembly (Figure 6A-188)

1. Remove the oil pump drive shaft extension.

(NOTE: Do not attempt to remove the washers from the drive shaft extension. The drive shaft extension and washers must be serviced as an assembly. Figure 6A-189.

2. Remove the cotter pin, spring and the pressure regulator valve.

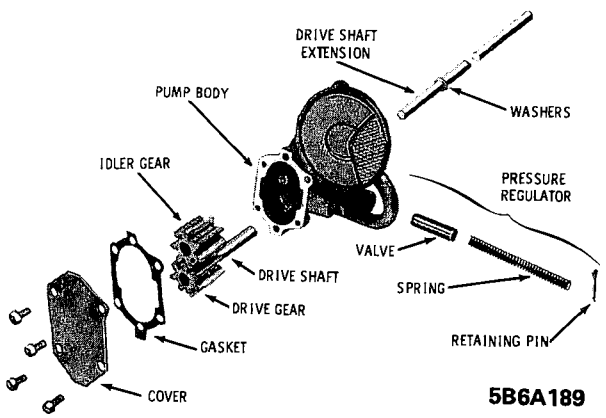


Figure 6A-188 - Oil Pump Exploded View

(NOTE: Position thumb over pressure regulator bore before removing cotter pin, as the spring is under pressure.)

3. Remove the oil pump cover attaching screws and remove the oil pump cover and gasket.

4. Remove the drive gear and idler gear from the pump body.

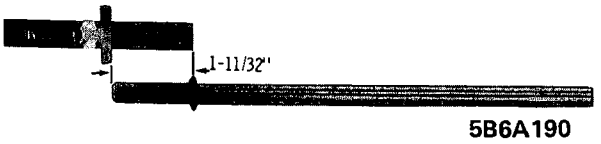


Figure 6A-189 - Oil Pump Drive Shaft Extension

Inspection

Check the gears for scoring or other damage. If they are damaged, new gears should be installed. During assembly, the gear end clearance should be gauged. Proper end clearance is .0025" to .0065". Also check the pressure regulator valve, valve spring and bore for damage. Proper valve to bore clearance is .0025" to .0050".

Assembly

1. Install the drive gear into the pump with the hex ID of the drive shaft toward the oil pump mounting pad, then install the idler gear.

2. Position a new gasket on the pump body and install the oil pump cover. Tighten the cover screws to 8 ft. lbs.

3. Position the pressure regulator valve into the pump cover, closed end first, then install the spring and retaining pin.

(NOTE: When assembling the drive shaft extension to the drive shaft, the END OF THE EXTENSION NEAREST THE WASHERS MUST BE INSERTED INTO THE DRIVE SHAFT.)

Installation

1. Insert the drive shaft extension through the opening in the main bearing cap and block until the shaft mates into the distributor drive gear.

2. Position pump onto the rear main bearing cap and install attaching bolts. Torque bolts to 35 ft. lbs. Figure 6A-190.

3. Install the oil pan.

CONNECTING ROD AND PISTON ASSEMBLY

Removal

1. Remove intake manifold, head or heads.

2. Remove oil pan.

3. Remove oil pump assembly.

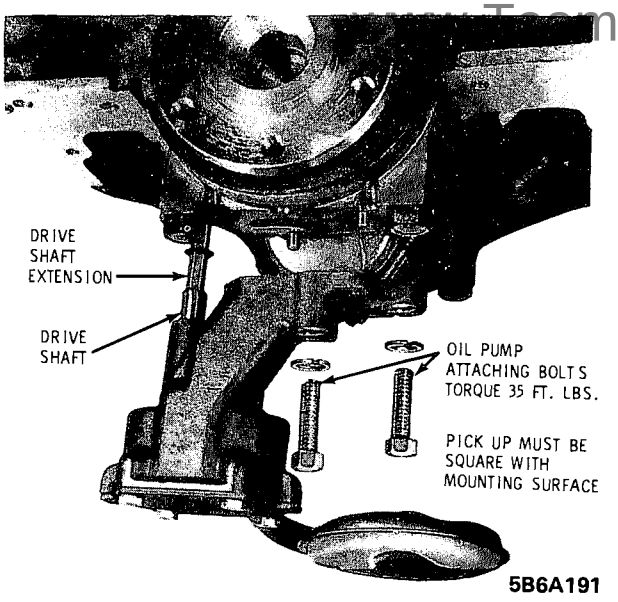


Figure 6A-190 - Oil Pump Installation

(NOTE: Stamp cylinder number on the machined surfaces of the bolt bosses of the connecting rod and cap for identification when reinstalling. If the pistons are to be removed from the connecting rod, mark cylinder number on piston with a silver pencil or quick drying paint for proper cylinder identification and cap to rod location. The right bank is numbered 2-4-6-8, left bank 1-3-5-7.)

Examine the cylinder bore above ring travel. If ridge exists, remove ridge with ridge reamer before attempting to remove the piston and rod assembly.

4. Remove rod bearing cap and bearing.

5. Install guide hose over threads of rod bolts. This is to prevent damage to bearing journal and rod bolt threads. Figure 6A-191.

Figure 6A-191 - Connecting Rod Bolt Guide

6. Remove rod and piston assembly through the top of the cylinder bore.

7. Remove other rod and piston assemblies in the same manner.

ROD BEARINGS

The connecting rod bearings are designed to have a slight projection above the rod and cap faces to insure a positive contact.

Connecting rod bearings can be replaced without removing the rod and piston assembly from the engine.

1. Remove oil pan.

(NOTE: It may be necessary to remove oil pump to provide access to rear connecting rod bearings.)

2. With connecting rod journal at the bottom, stamp cylinder number on machined surfaces of connecting rod and cap for identification when reinstalling, then remove caps.

3. Inspect journals for roughness and wear. Slight roughness may be removed with a fine grit polishing cloth saturated with engine oil. Burrs may be removed with a fine oil stone by moving the stone on the journal circumference. Do not move the stone back and forth across the journal. If the jorurnals are scored or ridged, the crankshaft must be replaced.

4. The connecting rod journals should be checked for out-of-round and correct size with a micrometer. Maximum out-of-round must not exceed .0015".

(NOTE: Refer to ENGINE SPECIFICATIONS Chart at the back of this section.)

If plastic-type gage is to be used:

5. Clean oil from journal bearing cap, connecting rod and outer and inner surface of bearing inserts. Position insert so that tang is properly aligned with notch in rod and cap. Figure 6A-191.

6. Place a piece of plastic-type gage in the center of lower bearing shell.

7. Reinstall bearing cap and torque to 42 ft. lbs.

8. Remove bearing cap and determine bearing clearances by comparing the width of the flattened plastic-type gage at its widest point with the graduation on the plastic-type gage container. The number within the the graduation on the envelope indicates the clearance in thousandths of an inch. If this clearance is greater than .0035", replace the bearing and recheck clearance with plastic-type gage.

(NOTE: Lubricate bearing with engine oil before installation. Repeat Steps 2 through 8 on remaining connecting rod bearings. All rods must be connected to their journals when rotating the crankshaft to prevent engine damage.)

(NOTE: Bearings are identified as shown in Figure 6A-193.)

9. Measure the rod side clearance shown in Figure 6A-194.

Rod Assembly

If a rod is twisted or bent, a new rod must be installed. NO ATTEMPT SHOULD BE MADE TO STRAIGHTEN CONNECTING RODS.

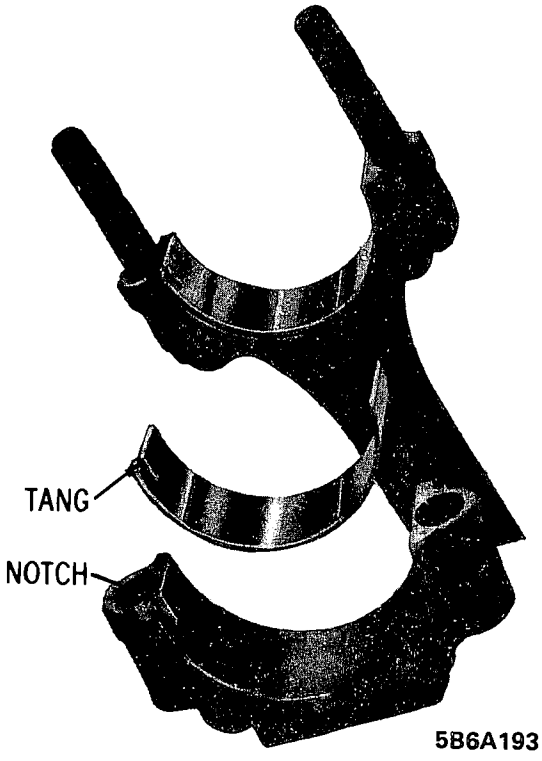


Figure 6A-192 - Bearing Tang and Notch

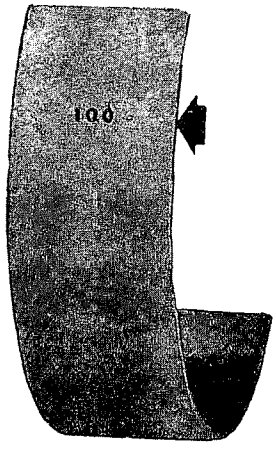


Figure 6A-193 - Bearing Identification

MEASURING PISTON

(NOTE: Refer to Piston Information chart at end of section.)

When replacing pistons, the original cylinder size is stamped with a code letter on the block near each cylinder on the cylinder head surface. Figure 6A-195.

When measuring piston for size or taper, measurement must be made on skirt 90° from piston pin hole (with the piston pin removed). Figure 6A-196.

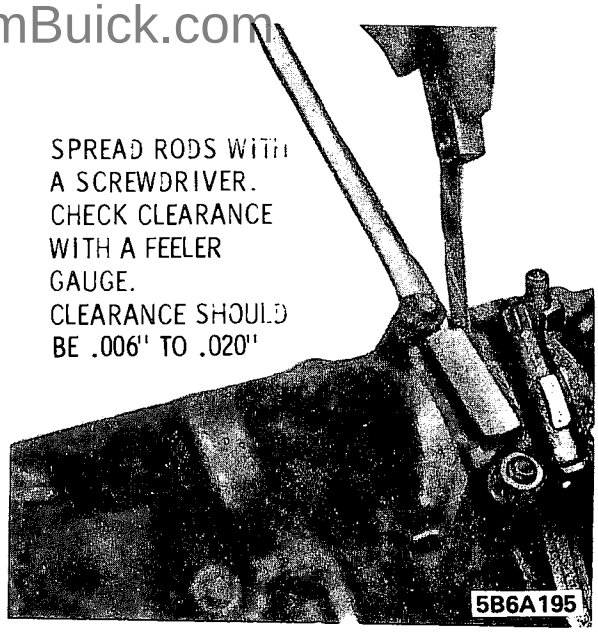


Figure 6A-194 - Connecting Rod Side Clearance

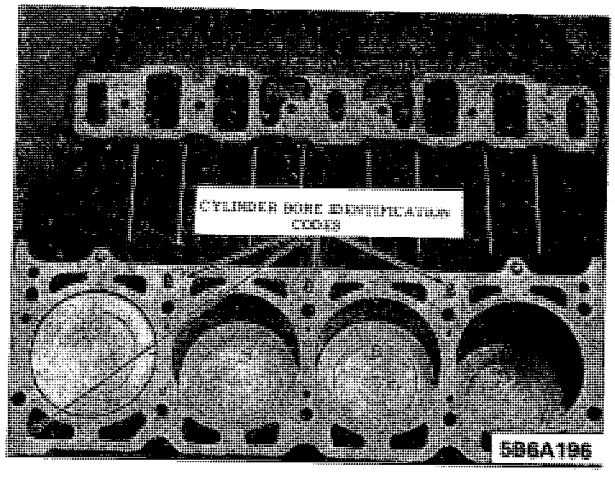


Figure 6A-195 - Cylinder Bore Marking

When measuring taper, the largest reading must be at the bottom of the skirt. Allowable taper is .000" to .0001".

The piston and cylinder bore must be free of oil and at the same temperature.

(NOTE: On some cars, oversize pistons may be found. These pistons will be .010" oversize.)

1. Place a strip of .0015" feeler gauge against the upper side of the bore, at 90° to the normal piston pin location. Attach Scale J-5515 to feeler gauge. Figure 6A-197.

2. Insert piston upside down with pin and rings removed, into bore.

3. While holding the piston on the center of its normal travel, slowly pull the scale in a straight line and note the reading on the scale. The reading should be between 3 to 12 pounds while pulling the feeler gauge out of the bore. Each piston should be fitted to its individual cylinder and marked for that cylinder.

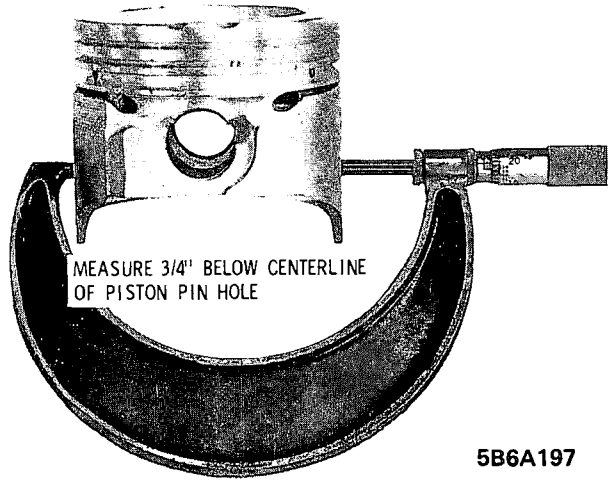


Figure 6A-196 - Measuring Piston

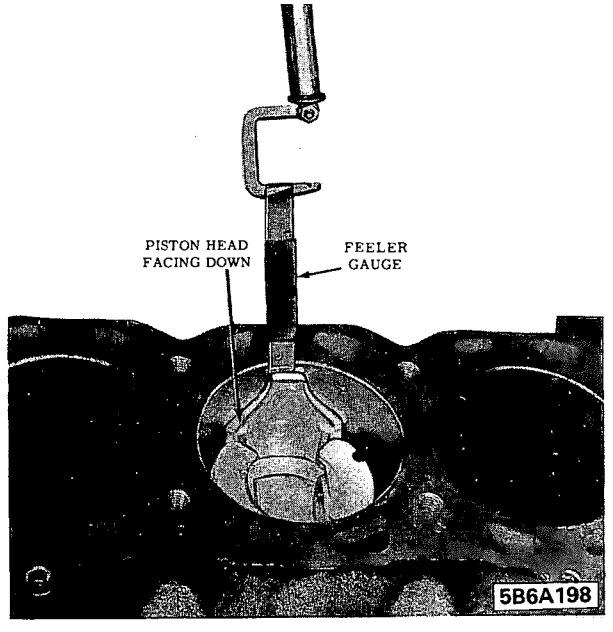


Figure 6A-197 - Checking Piston Clearance

CHECKING CYLINDER BORE

(NOTE: Refer to PISTON INFORMATION chart at end of section.)

Cylinder bore size can be measured with inside micrometers or a cylinder gauge. Maximum allowable taper of the cylinder bore is .001". The most wear will occur at the top of the ring travel.

Reconditioned cylinder bores should be held to not more than .001" out-of-round and .001" taper.

If the cylinder bores are smooth, the cylinder walls should not be deglazed. If the cylinder walls are scored, the walls may have to be honed before installing new rings. It is important that reconditioned cylinder bores be thoroughly washed with a soap and water solution to remove all traces of abrasive material to eliminate premature wear.

CLEANING PISTON

Clean the pistons by scraping carbon off the top of the piston. Deposits in the ring grooves should be removed with a suitable ring groove cleaning tool. It is important that the ring grooves be completely free of deposits.

RINGS (Figure 6A-198)

The pistons have three rings (two compression rings and one oil ring). The oil ring consists of two rails and an expander.

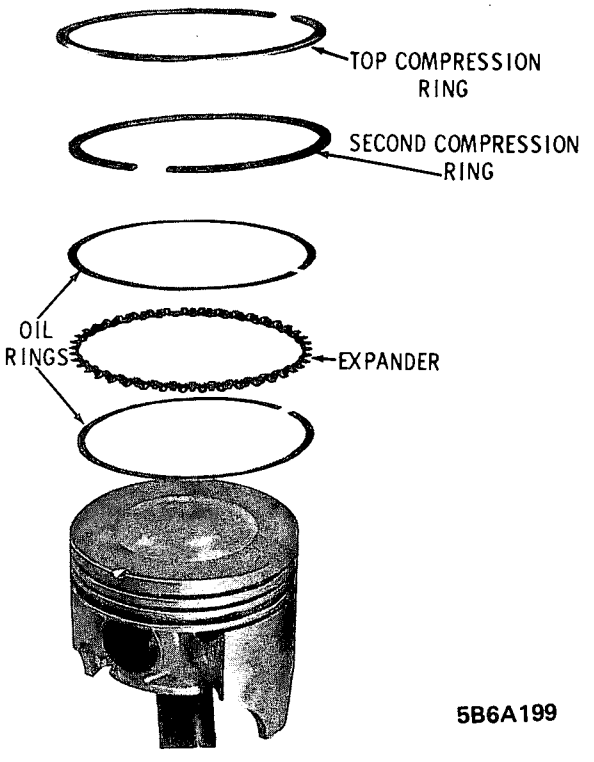


Figure 6A-198 - Piston Rings

Ring Tolerances

When installing new rings, ring gap and side clearance should be checked as follows:

Piston Ring and Rail Gap

Each ring and rail gap must be measured with the ring or rail positioned squarely and at the bottom of the ring-travel area of the bore. Figure 6A-199.

The gap measurement should be .013" to .023" for compression rings and .015" to .055" for oil rings.

Side Clearance

Each ring must be checked for side clearance (see chart) in its respective piston groove by inserting a feeler gauge between the ring and its upper land. (Figure 6A-200) The Piston grooves must be cleaned before checking ring for side clearance.

(NOTE: To check oil ring side clearance, the oil rings must be installed on the piston.)

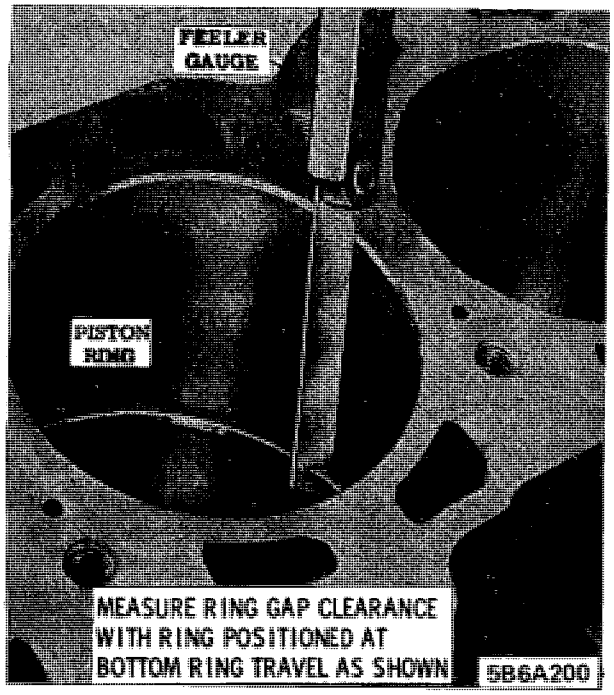


Figure 6A-199 - Measuring Piston Ring Gap

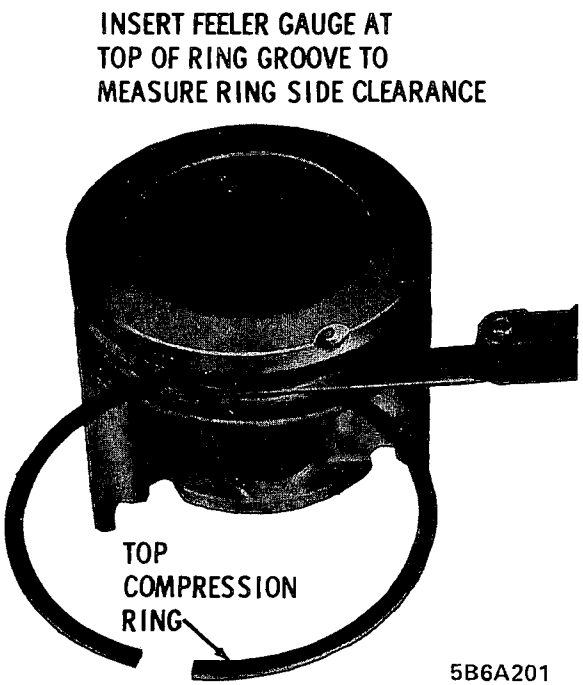


Figure 6A-200 - Piston Ring Side Clearance

ALLOWABLE SIDE CLEARANCE

Compression Rings	.002" to .004"
Oil Ring	.001" to .005"

RING IDENTIFICATION AND INSTALLATION

(NOTE: For service ring specifications and detailed installation instructions, refer to the instructions furnished with the parts package.)

Installation

1. Install connecting rod bolt guide hose over rod bolt threads. Figure 6A-201.

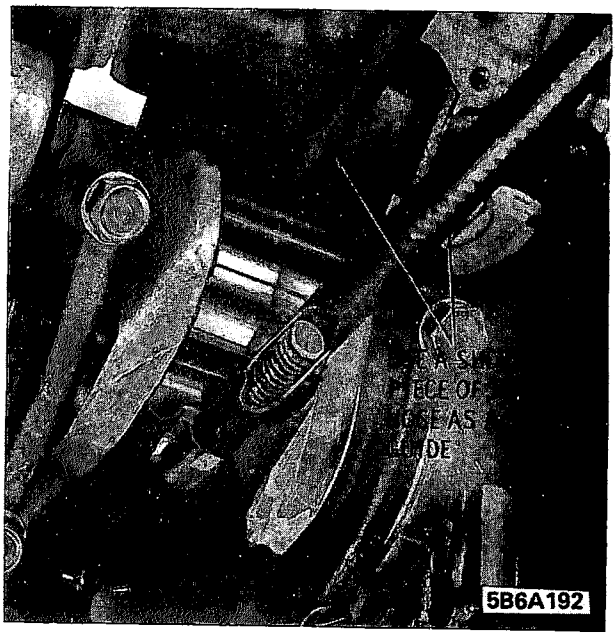


Figure 6A-201 - Connecting Rod Bolt Guide

2. Apply engine oil to rings and piston, then install piston ring compressing tool on piston Tool J-8037 or J-8910. Figure 6A-202.

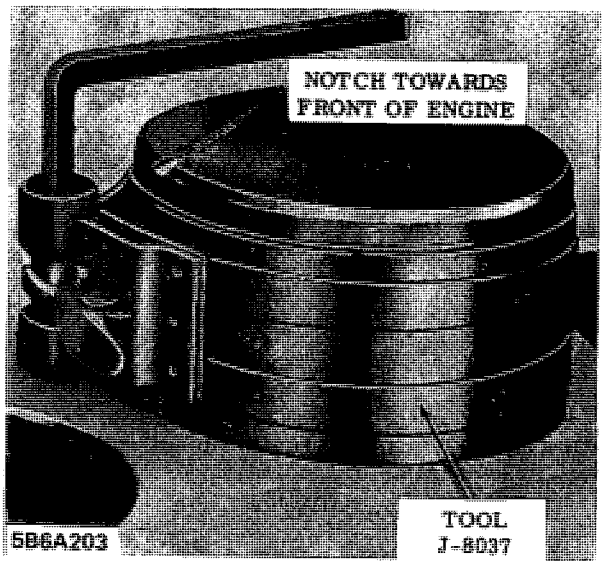


Figure 6A-202 - Piston Ring Compressor

3. Install assembly in its respective cylinder bore so notch cast in top of piston is towards the front of engine.

4. Lubricate the crankshaft journal with engine oil and install connecting rod bearing and cap, with bearing index tang in rod and cap on same side.

(NOTE: When more than one rod and piston assembly is being installed, the connecting rod cap attaching nuts should only be tightened enough to keep each rod in position until all have been installed. This will facilitate installation of remaining piston assemblies.)

The clearance between the adjacent rods, when checked with a feeler gauge on each crankpin, should be from .006" to .020". Figure 6A-203.

5. Torque rod bolt nuts to 42 ft. lbs.

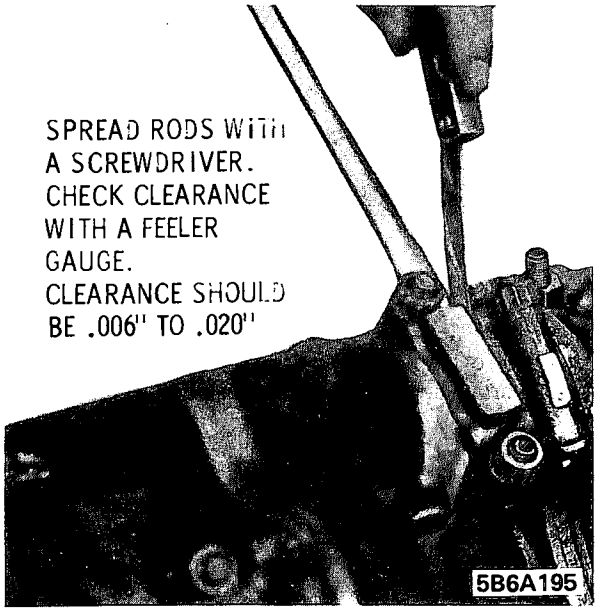


Figure 6A-203 - Connecting Rod Side Clearance

PISTON PINS

The correct piston pin fit in the piston is .0003" to .0005" loose. If the pin to piston clearance is to the high limit (.0005"), the pin can be inserted in the piston with very little hand pressure and will fall through the piston by its own weight. If the clearance is .0003", the pin will not fall through. It is important that the piston pin hole be clean and free of oil when checking pin fit. The pin is a press fit in the connecting rod.

Whenever the replacement of a piston pin is necessary, use the following procedure.

Removal

1. Place Tool J-6047-27 on Tool J-6047-1.

2. Place piston on piston pin remover Tool J-6047-27 with the notch on piston facing up.

3. Place Remover Tool J-6047-28 in piston pin.

Installation

1. Place Tool J-6047-27 on Tool J-6047-1, the place spring J-6047-3 inside Tool J-6047-26 and put assembly inside Tool J-6047-27.

2. Place piston on pilot J-6047-26.

3. Using driver J-6047-28 press piston into place.

CRANKSHAFT PULLEY

Removal

1. Remove belt(s).

2. Hoist car.

3. Remove four pulley bolts and pulley.

Installation

1. Install pulley, and four bolts. Torque to 10 ft. lbs.

2. Install belt(s). Adjust belts to specifications.

HARMONIC BALANCER

Removal

1. Remove belt and crankshaft pulley.

2. Remove harmonic balancer hub bolt and washer.

3. Using abalancer pulley, remove balancer as shown in Figure 6A-204.

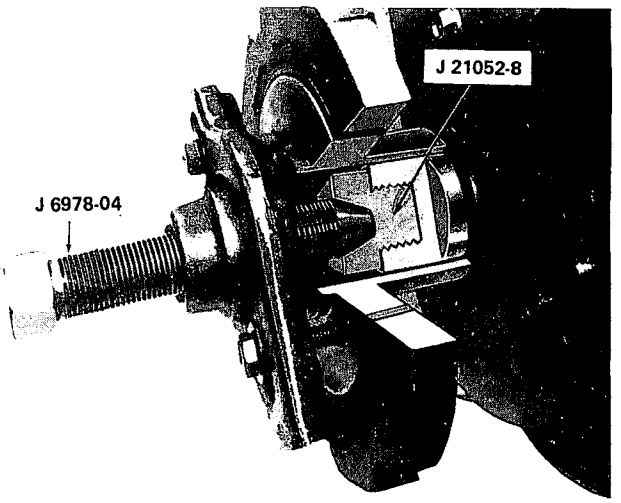


Figure 6A-204 - Removing Harmonic Balancer

Installation

1. Apply sealer to inside diameter of pulley hub and to crankshaft key to prevent possible oil leakage. Coat outside area of crankshaft pulley hub which enters seal with Special Seal Lubricant No. 1050169, or equivalent.

2. Install harmonic balancer on crankshaft. Figure 6A-205.

(NOTE: Balancer to crankshaft fit is .001" tight to .007" loose.)

3. Install washer and bolt. Torque 200 - 310 ft. lbs.

4. Install pulley and belt(s). Adjust belts to specifications.

Removal

1. Drain cooling system. Disconnect radiator hoses, heater hose and bypass hose.

2. Remove radiator upper support and radiator.

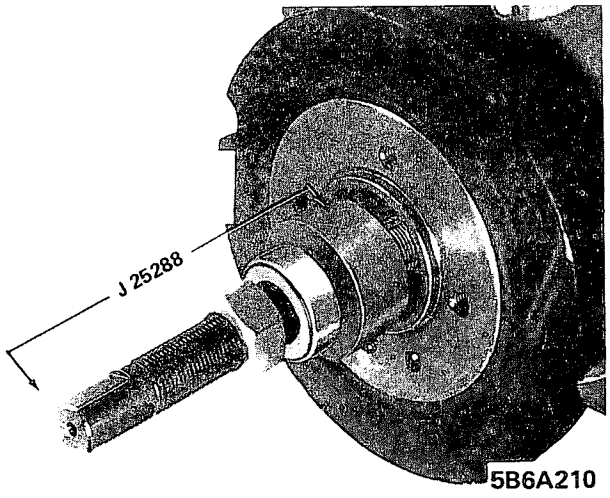


Figure 6A-205 - Installing Harmonic Balancer

3. Remove all belts, fan and fan pulley, crankshaft pulley and harmonic balancer.

4. Drain oil and remove oil pan.

5. Remove cover to block attaching bolts and remove cover, timing indicator and water pump assembly. Figure 6A-206.

Installation

1. Install new cover gasket. Apply sealer to gasket around water holes and place on block.

2. Install front cover, timing indicator and water pump assembly.

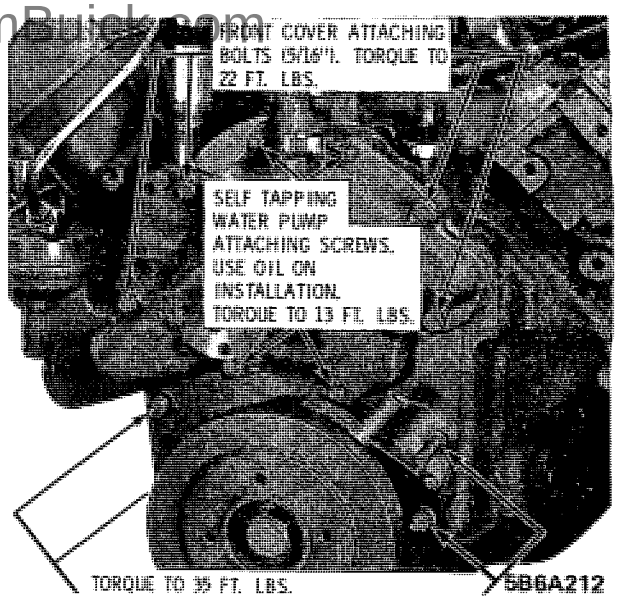


Figure 6A-207 - Engine Front Cover Bolts

3. Apply engine oil to bolts (Thrads and heads) and install. Torque bolts evenly as indicated in Figure 6A-207.

4. Apply lubricant on pulley hub seal surface.

5. Install oil pan.

6. Install pulley hub and pulley hub bolt. Torque to 200-310 ft. lbs.

7. Connect heater hose, bypass hose and radiator hoses.

8. Install crankshaft pulley and four attaching bolts. Torque to 10 ft. lbs.

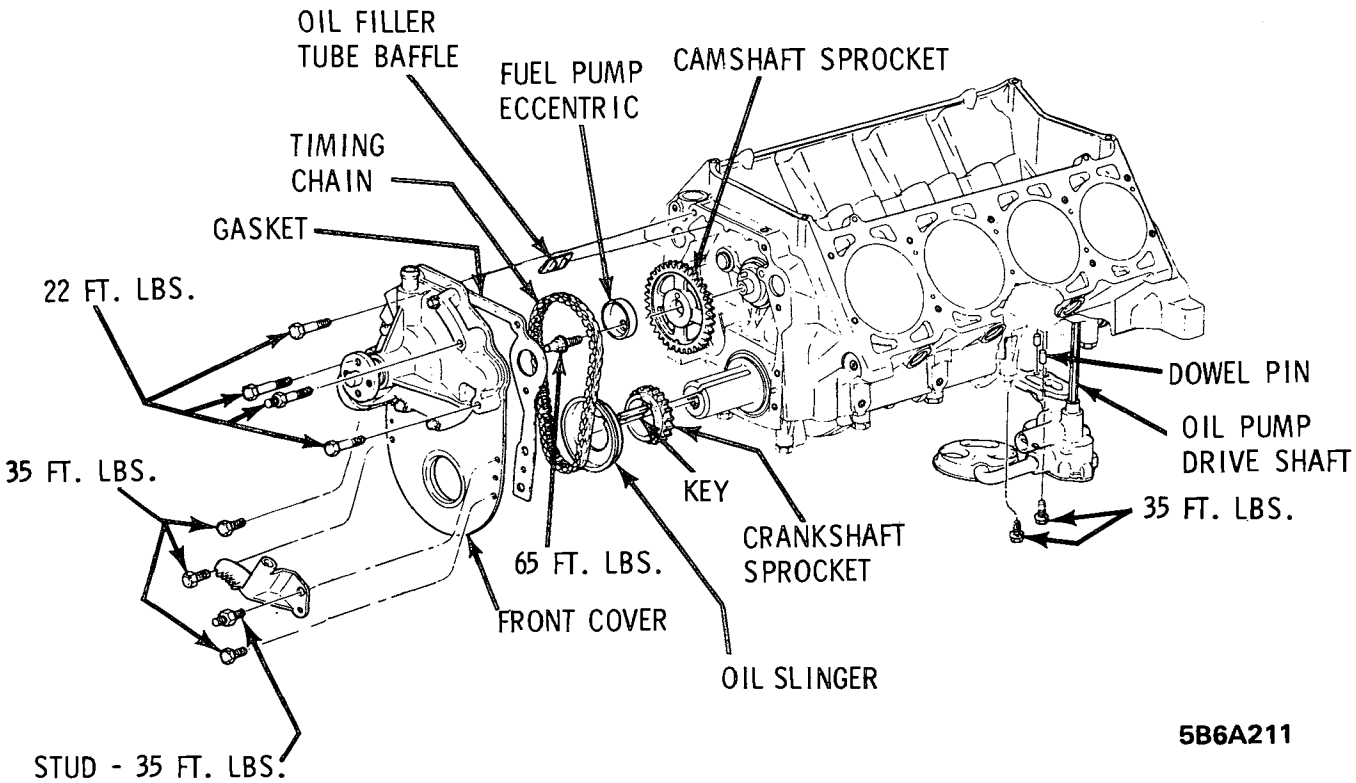


Figure 6A-206 - Engine Front Cover

9. Install fan pulley, fan and four attaching bolts. Torque bolts to 20 ft. lbs.

10. Install belts and adjust to specifications.

11. Fill radiator and crankcase.

OIL SEAL REPLACEMENT

1. Remove oil seal.
2. Apply sealer to outside diameter of seal.
3. Using Tool J-25264, install oil seal.
4. Install the pulley hub and crankshaft pulley.
5. Install and adjust belts.

TIMING CHAIN AND GEARS (WITH FRONT COVER REMOVED)

Removal

1. Remove fuel pump eccentric.
2. Remove oil slinger, cam gear and timing chain.
3. Remove key than crankshft geat.

(NOTE: Gear to crankshaft fit tolerances may be such that a pulley is necessary. Use J-25287 Puller and J-21052 Adapter for removal.

Installation

1. Install camshaft gear, crankshaft gear and timing chain together, and align timing marks. Figure 6A-208.

(NOTE: When the two marks are in alignment (Figure 6A-208). Number six is at T.D.C. To obtain T.D.C. for number one cylinder slowly rotate crankshaft one rotation, this will bring the cam mark to the top, number one then will be in firing position.)

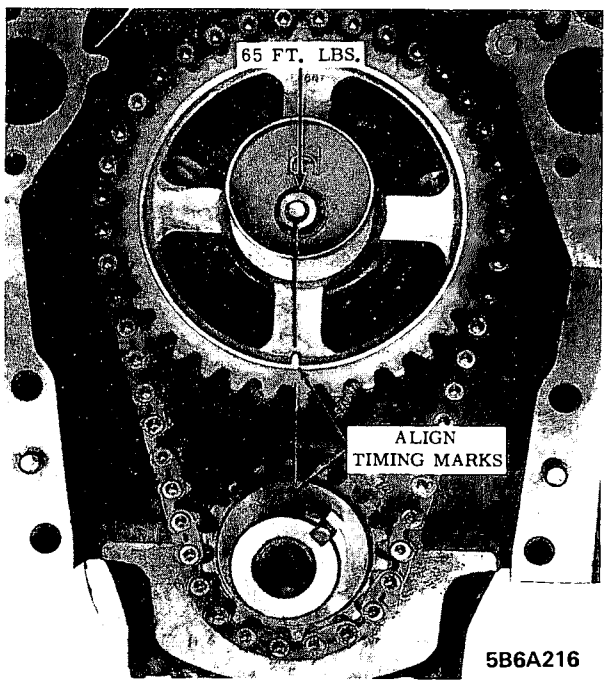


Figure 6A-208 - Aligning Timing Marks

2. Install fuel pump eccentric with flat side rearward. Figure 6A-209.

3. Drive key in with a brass hammer until it bottoms in gear.

4. Install oil slinger.

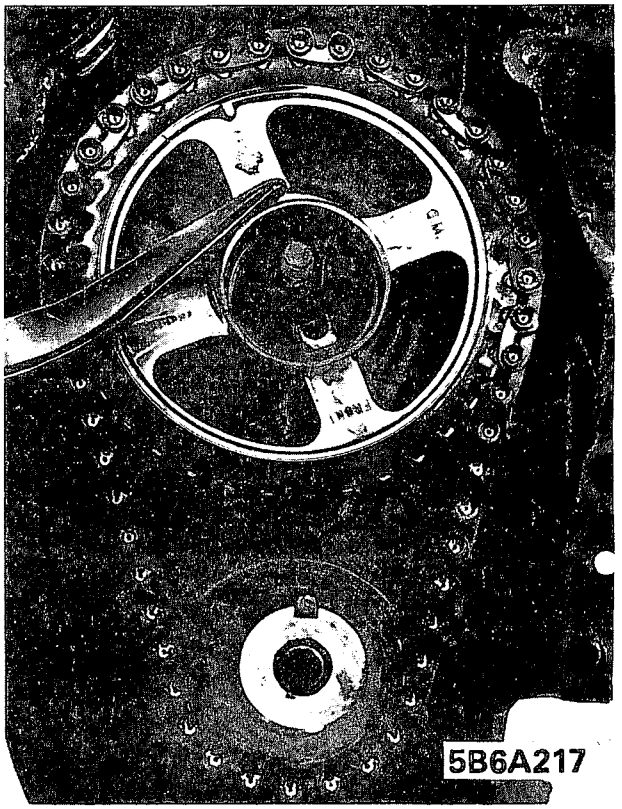


Figure 6A-209 - Fuel Pump Accentric

CHECKING VALVE TIMING WITHOUT REMOVING FRONT COVER

1. Remove distributor cap, right valve cover, No. 4 cylinder intake and exhaust rocker arms and pivot.

2. Remove wire from "Bat." terminal of H.E.I. distributor.

3. Turn ignition switch on. Crank engine until rotor is in line with No. 4 spark plug wire position. No. 4 piston will be approximately at the top of the cylinder.

4. Measure from pivot boss on head surface to top of No. 4 intake push-rod. Record measurement. Figure 6A-210.

5. Slowly turn engine 1-1/2 revolutions until rotor approaches No. 1 spark plug wire position. Continue to turn engine until timing mark on crank pulley is aligned with O on indicator. This is top dead center of No. 1 piston.

6. Again measure from pivot boss surface to top of No. 4 cylinder intake push-rod. Figure 6A-210.

7. Measurement should increase over the first measurement as shown on chart. Figure 6A-210.

8. If measurement increase is not within 1/32" of that shown on chart, camshaft is advanced or retarded.

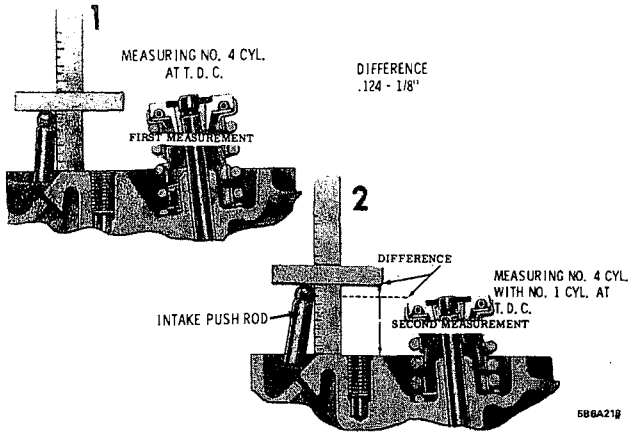


Figure 6A-210 - Checking Valve Timing

CAMSHAFT

Removal

1. Disconnect battery.
2. Drain radiator coolant.
3. Remove upper radiator baffle.
4. Disconnect upper radiator hose at water outlet.
5. Disconnect upper radiator hose support clamp.
6. Disconnect transmission cooler lines at radiator.
7. Remove radiator fan shroud.
8. Remove radiator.
9. Disconnect fuel line at fuel pump.
10. Remove air cleaner and disconnect throttle cable.
11. Loosen generator belt adjusting bolt, remove belt.
12. Remove generator bracket attaching bolts, move generator to one side for access.
13. Remove power steering pump bracket attaching bolts and remove pump, support pump to the side for access.
14. Remove air conditioning compressor mounting bracket attaching bolts and support compressor to side for access.

(NOTE: The air conditioning lines at the compressor are flexible and should be left attached to the compressor.)

15. Disconnect thermostat bypass hose and heater hose at water pump.
16. Disconnect electrical and vacuum connections.
17. Remove distributor with cap and wiring intact.
18. Hoist car, drain engine oil.
19. Remove exhaust crossover pipe.
20. Remove starter.
21. Disconnect exhaust pipe at manifold.
22. Remove harmonic balancer pulley.
23. Remove harmonic balancer attaching bolt.
24. Remove balancer. Figure 6A-210.
25. Remove flywheel inspection cover.
26. Remove engine oil pan.
27. Lower car.
28. Remove engine front cover.
29. Remove bolt valve covers.
30. Remove intake manifold and gasket, front and rear seal.
31. Remove oil filler pipe and water temperature switch.
32. Remove rocker arms, push rods and valve lifters.

(NOTE: Parts position should be noted so they will be installed in their original position.)

33. If equipped with air conditioning, remove condenser attaching bolts and move condenser to one side.
34. Remove bolt securing fuel pump eccentric, remove eccentric, camshaft gear, oil slinger and timing chain.
35. Raise and suitably support engine.
36. Remove camshaft by carefully sliding it out the front of the engine.

(NOTE: Do not force shaft as damage can occur to camshaft bearings.)

Installation

Coat camshaft and bearings liberally with No. 1051396 or equivalent before installing. Camshaft gear and crankshaft gear must be aligned as shown in Figure 6A-208. Before installing distributor, refer to ELECTRICAL Section.

Timing indicator attaching stud must be installed and properly torqued before installing power steering pump bracket. Install flywheel inspection cover after installing starter. Refill engine oil, start engine, recharge A/C system, check for possible leaks.

The left hand rear oil gallery plug is not shown. It is a threaded plug in the end of the left gallery just rearward of the distributor. A small hole is provided in the plug for distributor lubrication. The cup plug shown provides access to the threaded plug.

The front oil gallery plugs (not shown) are threaded. The

plug on the right side has a small hole which provides lubrication for the timing chain and gears.

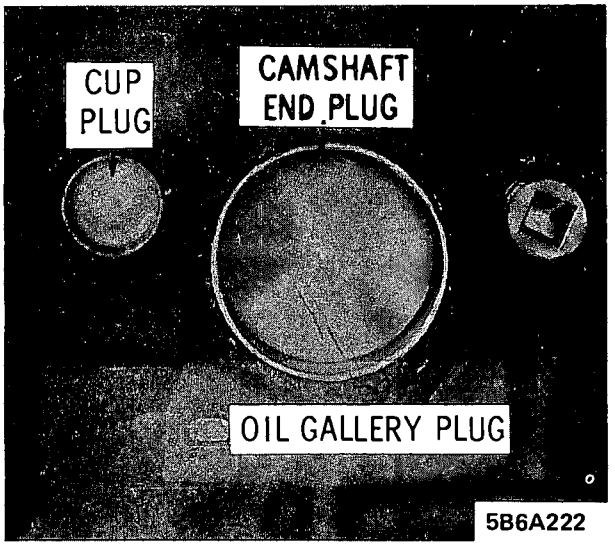


Figure 6A-211 - Camshaft and Oil Gallery Plug

CRANKSHAFT

Removal (Cylinder Heads On)

1. With engine on stand and oil pan, oil pump and front cover removed, rotate crankshaft to the position where the connecting rod nuts are most accessible. Figure 6A-212 shows a V-8 Engine with the No. 3 and No. 4 rods in the fully extended position.

2. Remove main bearing caps.

3. Remove connecting rod caps and install thread protectors.

4. Note position of keyway in crankshaft so it can be installed in the same position.

5. Lift crankshaft out of block. Rods will pivot to the center of the engine when the crankshaft is removed.

Do not allow pistons to move in their bore during or after crankshaft removal.

Installation

1. Install sufficient oil pan bolts in pan rails to align rods with rubber bands as shown in Figure 6A-212.

Align rods so that the inner thread protectors of adjacent rods overlap approximately one inch as shown. Alignment can be adjusted by increasing tension on rubber bands with additional turns around the pan bolts or thread protectors.

2. Position crankshaft keyway in the same position as removed and lower into block. The connecting rods will follow the crank pins into the correct position as the crankshaft is lowered.

3. Remove rubber bands, thread protectors and pan bolts and assemble engine.

Removal (Cylinder Heads Removed)

1. With engine on stand, remove oil pan, front cover, connecting rods, and oil pump.

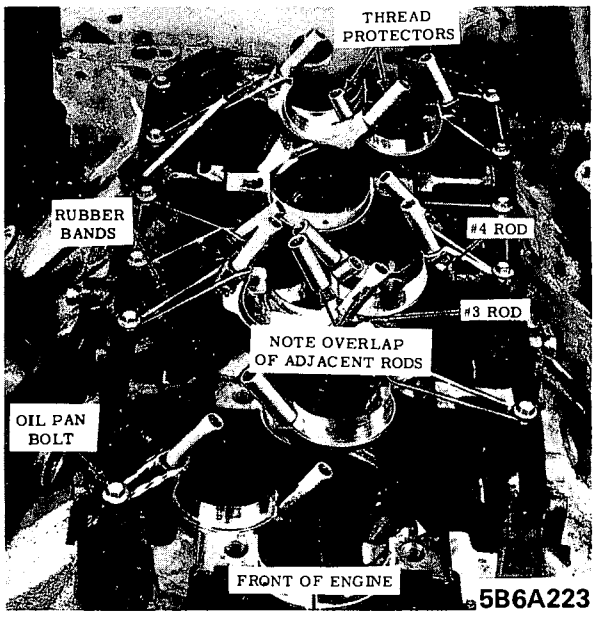


Figure 6A-212 - Crankshaft Removed

2. Remove main bearing caps and lift crankshft out of block. Figure 6A-213.

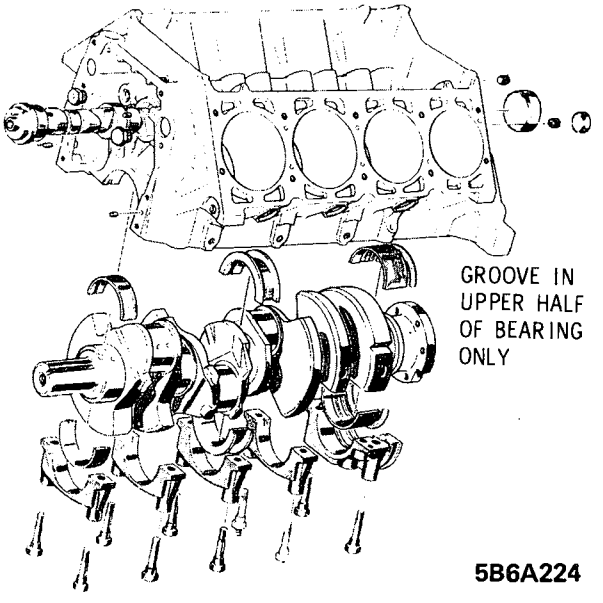


Figure 6A-213 - Crankshaft - Exploded View

Installation

1. Measure the crankshaft journals with a micrometer to determine the correct size rod and main bearings to be used.

(NOTE: Whenever a new or reconditioned crankshaft is installed, new connecting rod bearings and main bearings should be installed.)

2. Position upper half of main bearings in block and lubricate with engine oil.

3. Install a new rear main bearing cap seal as follows:

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.

A new braided fabric seal can be installed in crankcase only when crankshaft is removed, but it can be repaired while crankshaft is installed, as outlined under Rear Main Bearing Upper Oil Seal Repair.

The seal can be replaced in cap whenever the 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.

The engine must be operated at slow speed when first started after a new braided seal is installed.

To help eliminate oil leakage at the joint where the cap meets the crankcase, apply silastic sealer or equivalent to the rear main bearing cap split line. When applying sealer, use only a thin coat as an over abundance will not allow the cap to seat properly. After installation of seal in crankcase, install seal in bearing cap.

After seal is installed, force seals up into the cap with a blunt instrument to be sure of a seal at the upper parting line between the cap and case.

4. After oil passages in crankshaft have been checked for being open and shaft is clean, place shaft in block. Lubricate thrust flanges of the center bearing with 1050169 Lubricant or equivalent. Install caps wit hlower half of bearing lubricated with engine oil. Lubricate cap bolts with No. 1050125 or equivalent, and install, but do not tighten.

5. With a block of wood (Figure 6A-214) bump shaft in each direction to align thrust flanges of center main bearing.

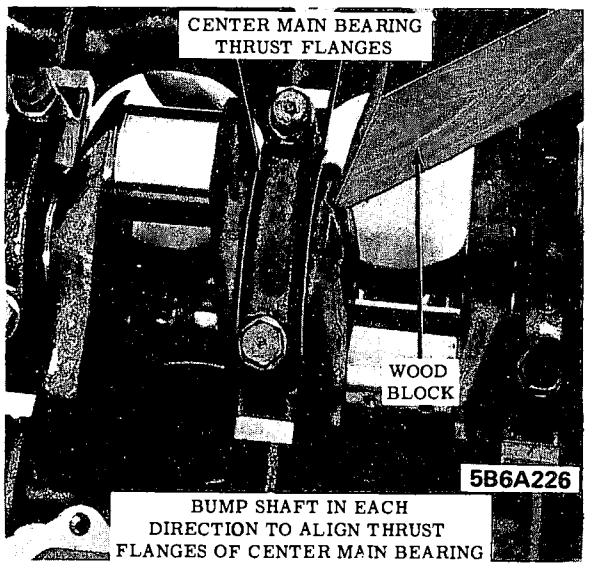


Figure 6A-214 - Aligning Center Main Bearing Flanges

(NOTE: After bumping shaft in each direction, wedge the shaft to the front and hold it while torquing No. 3 cap bolts.)

6. Torque No's. 1, 2, 3 and 4 main bearing cap bolts to 80 ft. lbs. and No. 5 bolt to 120 ft. lbs.

7. Reassemble engine and install in chassis.

MAIN BEARINGS

Main bearing clearance must not exceed .0035" on all bearings. The .0035" clearance is permissible only if the engine is disassembled for other than a bearing noise condition. If bearings are noisy or if a visual inspection indicates worn bearings, new bearings must be installed within the specififcations outlined under MAIN BEARINGS - REPLACE.

Bearings which fall within the .0035" specifications should not be rejected if the bearings show a normal wear pattern or slight radial grooves, unless it has been established to be worn excessively.

Checking Bearing Clearances

1. Remove bearing cap and wipe oil from crankshaft journal and outer and inner surfaces of bearing shell.

2. Place a piece of plastic-type gage in the center of bearing.

3. Use a floor jack or other means to hold crankshaft against upper bearing shell. This is necessary to obtain accurate clearance readings when using plastic-type gage.

4. Reinstall bearing cap and bearing. Place Lubricant No. 1050125 or equivalent on cap bolts and install.

Torque Nos. 1, 2, 3 and 4 bolts to 80 ft. lbs. and No. 5 bolt to 120 ft. lbs.

5. Remove bearing cap and determine bearing clearance by comparing the width of the flattened plastic-type gage at its widest point with graduation on the plastic-type gage container. The number within the graduation on the envelope indicates the clearance in thousandths of an inch. Figure 6A-215. If this clearance is greater than .0035", REPLACE BOTH BEARING SHELLS AS A SET. Recheck blearance after replacing shells. (Refer to MAIN BEARINGS - REPLACE)

(NOTE: Main bearing end thrust clearance should be .004" to .008" as checked with a dial indicator.)

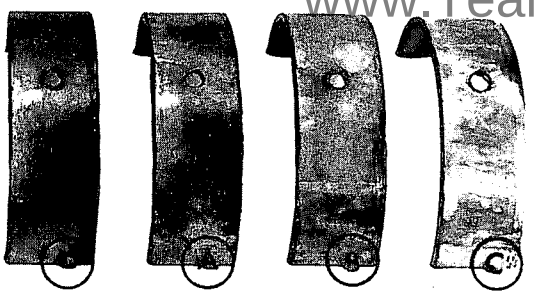
Main Bearings- Replace

Main bearing clearances must be corrected by the use of selective upper and lower shells. UNDER NO CIRCUMSTANCES should the use of shims behind the shells, to compensate for wear, be attempted.

(NOTE: The upper and lower shells must be installed in pairs. Sizes of the bearings are located on the tang. Figure 6A-216. It is possible to have more than one bearing size in the same engine.)

To install main bearing shells, proceed as follows:

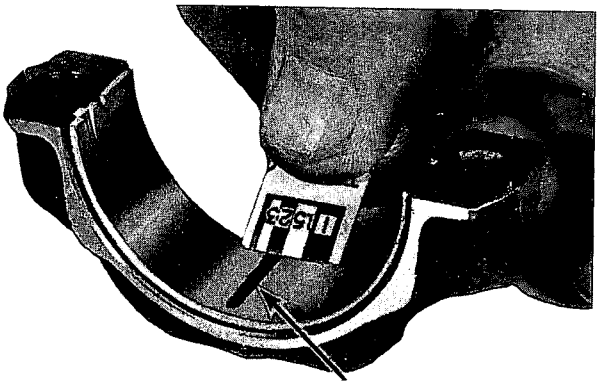
1. Loosen all main bearing caps.



NO LETTER--STD
LETTER "A"-.0005
LETTER "B"-.0010
LETTER "C"-.0015

5B6A228

Figure 6A-216 - Main Bearing Identification



FLATTENED
PLASTIC-TYPE GAUGE

5B6A227

Figure 6A215 - Checking Bearing Clearance

2. Remove bearing cap and remove lower shell.

3. Insert a flattened cotter pin or roll out pin in the oil passage hole in the crankshaft, then rotate the crankshaft in the direction opposite to cranking rotation. The pin will contact the upper shell and roll it out.

4. The main bearing journals should be checked for roughness and wear. Slight roughness may be removed with a fine grit polishing cloth saturated with engine oil. Burrs may be removed with a fine oil stone. If the journals are scored or ridged, the crankshaft must be replaced.

(NOTE: The journals can be measured for out-of-round with the crankshaft installed by using a crankshaft caliper and inside micrometer or a main bearing micrometer. The upper bearing shell must be removed when measuring the crankshaft journals. Maximum out-of-round of the crankshaft journals must not exceed .0015".)

5. Clean crankshaft journals and bearing caps thoroughly before installing new main bearings.

6. Apply special Lubricant, No. 1050169 or equivalent to the thrust flanges of bearing shells on No. 3 bearing.

7. Place new upper shell on crankshaft journal with locating tang in correct position and rotate shaft to turn it into place using cotter pin or roll out pin as during removal.

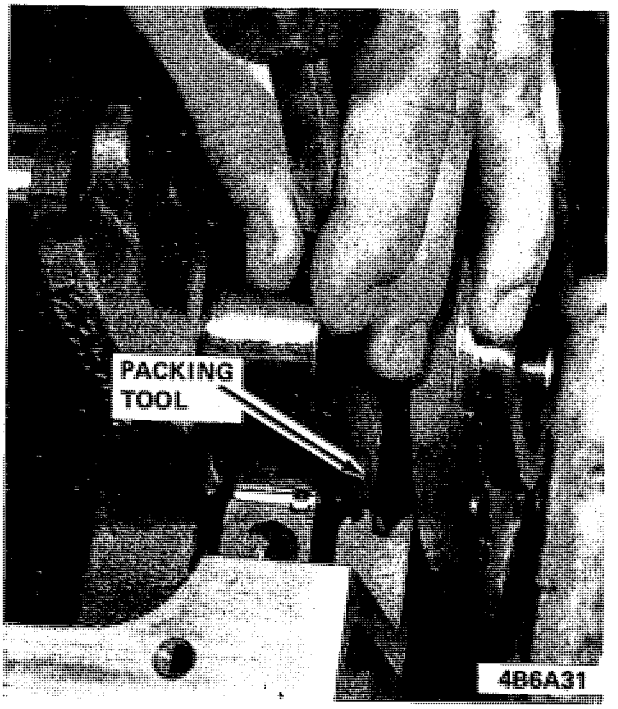


Figure 6A-217 - Packing Seal into Cylinder Block

8. Place new bearing shell in bearing cap.

9. No. 5 bearing - Install new oil seal in the rear main bearing cap. (REAR MAIN BEARING OIL SEAL). Install sealer on cap.

10. Install bearing caps, lubricate bolt threads with No. 1050125 Lubricant or equivalent, and install.

Torque Nos. 1 through 4 to 80 ft. lbs. and No. 5 to 120 ft. lbs.

Rear Main Bearing Upper Oil Seal Repair

1. Remove oil pan.

2. Insert packing Tool J-25286-2 against one end of the seal in the cylinder block. Drive the old seal gently into the groove until it is packed tight. This varies from 1/4" to 3/4" depending on the amount of pack required. See Figure 6A-217.

3. Repeat Step 2 on the other end of the seal in the cylinder block.

4. Measure the amount the seal was driven up on one side and add 1/16", using a single edge razor blade cut that length from the old seal removed from the rear main bearing cap. Repeat the procedure for the other side. Use the rear main bearing cap as a holding fixture when cutting the seal.

5. Install Guide Tool J-25286-1 onto cylinder block. See Figure 6A-218.

6. Using packing tool, work the short pieces cut in Step 4 into the guide tool and then pack into cylinder block. The guide tool and packing tool have been machined to provide a built-in stop. Use this procedure for both sides. See Figures 6A-218 and 6A-219.

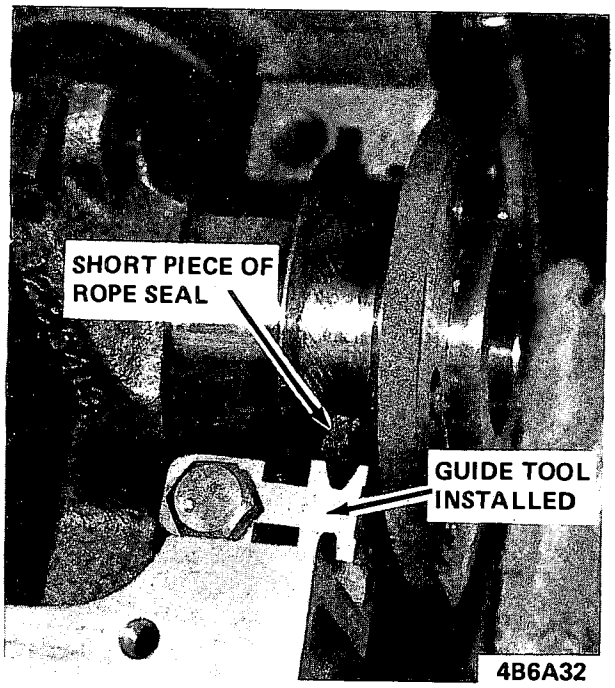


Figure 6A-218 - Guide Tool Installed

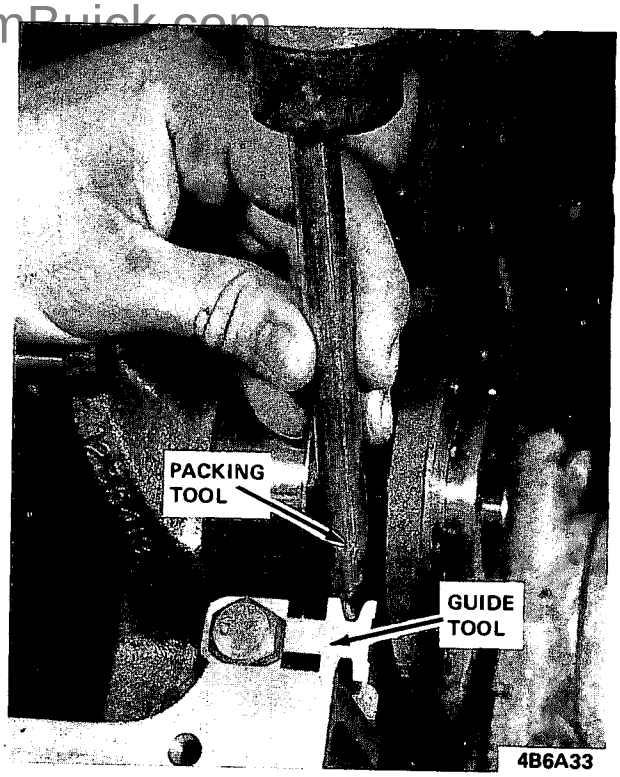


Figure 6A-219 - Packing Short Pieces of Rope Seal into Guide and Cylinder Block

(NOTE: It may help to use oil on the short pieces of the rope seal when packing into the cylinder block.)

7. Remove the guide tool.

8. Install a new fabric seal in the rear main bearing cap. Install cap and torque to specifications.

9. Install oil pan.

ENGINE SPECIFICATIONS

Lubrication System

Crankcase Capacity Drain and Refill	4 Qts.
Drain Refill with Filter Change	5 Qts.
Oil Pump	
Clearance Pressure Relief Valve in Bore	.0025"-.0050"
End Clearance-Gear	.0025"-.0065"
Oil Pump Pressure	35 PSI at 2000 RPM

GENERAL SPECIFICATION

Cylinder Block

Engine Type	90° V-Type
No. of Cylinders	8
Bore and Stroke	3.500" x 3.385"
Piston Displacement	260 Cu. In.
Compression Ratio	8.5:1
Firing Order	1-8-4-3-6-5-7-2
Main Bearing Bore (I.D.)	2.687"-2.688"

ENGINE DIMENSIONS AND FITS

Crankshaft

Diameter	
Main Bearing Journal	2.4995"-2.4985" (2, 3, 4, 5) 2.4998"-2.4998" (1)
Width-Main Bearing Journal (With Fillets)	
No. 1	1.185"
No. 2 4	1.156"-1.166"
No. 3	1.199"-2.001"
No. 5	1.882"

Diameter
Connecting Rod Bearing Journal ..... 2.1248"-2.1238"
Width
Connecting Rod Bearing (With Fillets) ..... 1.877"-1.887"
Length-Overall Crankshaft ..... 26.470"
Diameter-Oil Holes in Crankchaft ..... .201"-.223"
Clearance-Crankshaft End ..... .004"-.008"

Main Bearings

Bearing Clearance
Crankshaft 1, 2, 3 & 4 ..... .0005"-.0021"
(Vertical) 5 ..... .0015"-.0031"
Width-Bearing Shell
No. 1, 2, and 4 ..... .970"-.980"
No. 3 ..... 1.193"-1.195"
No. 5 ..... 1.624"

Connecting Rods

Length-Center to Center ..... 5.998/6.002"
Diameter-Connecting Rod Bore ..... 2.2495"-2.2500"
Diameter-Pin Bore ..... .9789"-.9795"
Bearing Clearance-(Vertical) ..... .0004"-.0033"
Side Clearance - Big End ..... .006"-.020"

Piston

Diameter Nominal Outside 3.49975-3.4997
Length Overall ..... 3.620"
Top of Piston to Center of Pin ..... 1.617/1.613"
Clearance at Thrust Surface (selective) ..... .001"-.002"
Weight Less Pin Rings (All) ..... 22.60 Oz.
Skirt Taper ..... .0005"-.0015" Larger at Bottom
Ring Width (2 Compression) ..... .0798"-.0808"
Ring Width (1 Oil) ..... .1881"-.1891"

Piston Pins

Diameter ..... .9803"-.9807"
Length Overall ..... 2.980"
Pin to Piston Clearance ..... .0003"-.0005"
Pin to Rod Fit ..... .0008"-.0018" Press

Piston Rings

No. of Compression Rings (Per Piston) 2
Width of Compression Rings (Top Bottom) ..... .0780"-.0770"
Gap Clearance Compression Rings ..... .010"-.023"
Clearance in Groove Compression Rings
Upper ..... .0020"-.0040"
Lower ..... .0020"-.0040"
No. of Oil Rings (Per Piston) 1
Gap Clearance, Oil Ring ..... .015"-.055"

Camshaft

Bearing Journal Diameters
No. 1 ..... 2.0365"-2.0357"
No. 2 ..... 2.0165"-2.0157"
No. 3 ..... 1.9965"-1.9957"
No. 4 ..... 1.9765"-1.9757"
No. 5 ..... 1.9565"-1.9557"
Width (Including Chamfers)
No. 1 ..... .810"
No. 2, 3 and 4 ..... .741"
No. 5 ..... .788"
Journal Clearance in Bearing (All) ..... .0020"-.0058"
End Clearance ..... .011"-.077"
Push Rod - Length ..... 8.265"

Valve - Intake

Diameter Head	1.517″-1.527″
Diameter - Stem	.3425″-.3432″
Angle - Valve (A°) See Figure 6A-180	44°
Angle - Valve Seat (B°) See Figure 6A-180	45°
Width - Valve Seat (Cylinger Head)	.037″-.075″
Overall Length	4.667″
Clearance in Guide	.0010″-.0027″
Lash	Hydraulic

Valve Exhaust

Diameter - Head	1.295″-1.305″
Diameter - Stem	.3420″-.3427″
Angle - Valve (A°) Figure 6A-180	30°
Angle - Valve Seat (B°) Figure 6A-180	31°
Width - Valve Seat Cylinder Head)	.050″-.090″
Overall Length	4.675″
Clearance in Guide	.0015″-.0032″
Lash	Hydraulic

Valve Springs

Length	1.96″
Diameter - Wire	.192″
Inside Diameter	1.065″-1.041″
Load	76-84 Lbs. @ 1.670″
Load @ 1.270″	180-194 Lbs.

Valve Lifters

Diameter - Body	.8422″-.8427″
Length - Overall	2.000″
Clearance in Boss	.0005″-.0020″

Also Available in .010″ Oversize

Camshaft Sprocket

Width of Sprocket	.420″-.400″
Pitch	.500″
No. of Teeth	36

Crankshaft Sprocket

Width of Sprocket	.410″-.400″
Overall Width of Gear	1.001″-.991″
Pitch	.500″
No. of Teeth	18

Timing Chain

Width	Morse - .627, Link Belt - .720″-.750″
No. of Links	48
Pitch	.500″
Flywheel	
No. of Teeth on Starter Gear	166
No. of Teeth on Starter Pinion	9

TORQUE SPECIFICATIONS

Specified torque is for installation of parts only. Checking of torque during inspection may be 10% below specification.

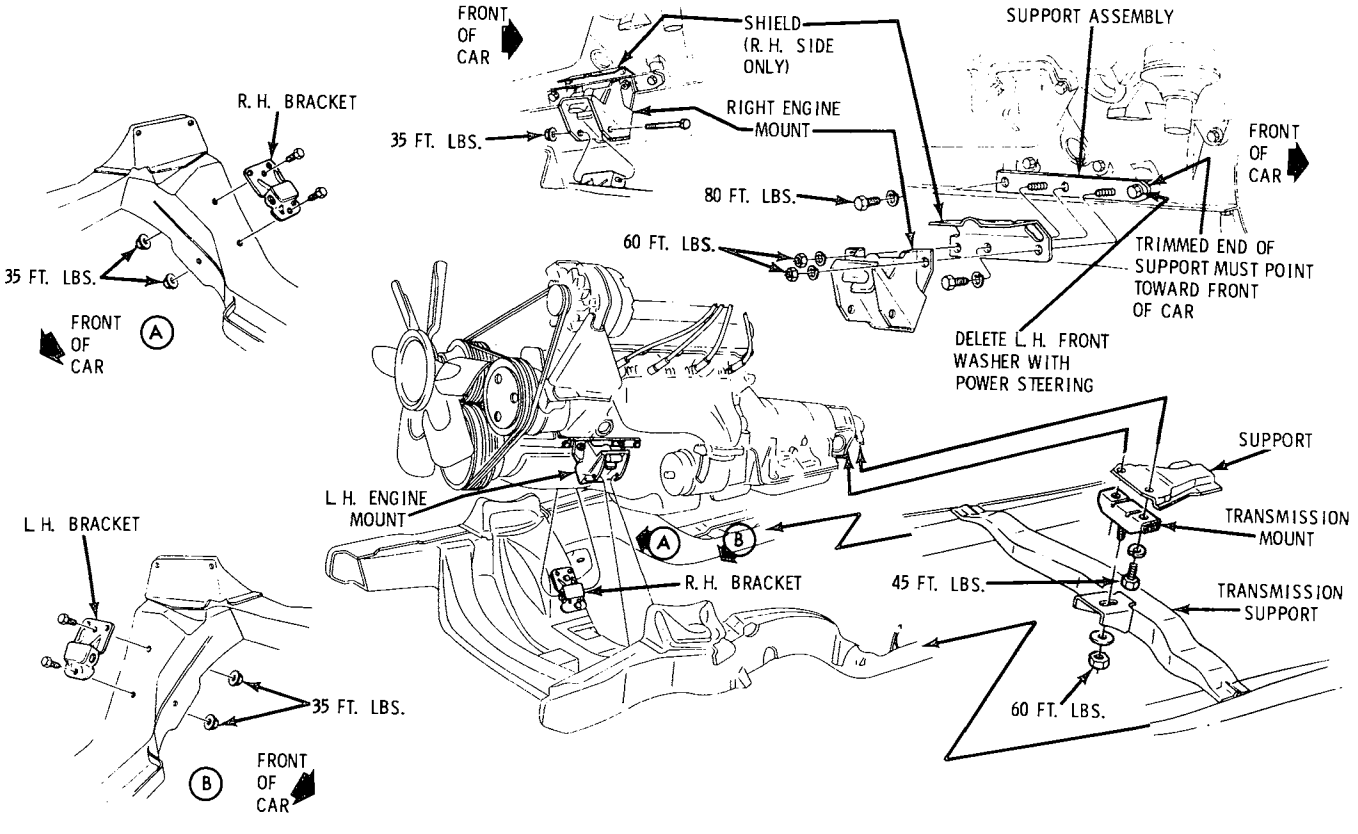
Application	Lb. Ft.
Fuel Pump	
Fuel Pump to Block Bolt and Nut	25
Fuel Pump to Eccentric to Camshaft	65
Engine	
Crankshaft Bearing Cap Bolts Nos. 1, 2, 3 & 4-80	
Crankshaft Bearing No. 5	120
E.G.R. Valve to Intake Manifold	25
Flywheel to Crankshaft	60
Oil Pump to Bearing Cap Bolts	35
Oil Pump Cover to Pump Bolts	8
Rocker Arm Pivot Bolt to Head	25
Valve Cover Bolts	7
Oil Pan Bolts	10
Oil Pan Drain Plug	30
Crankshaft Balancer or Hub to Crankshaft Bolt	200-310
Oil Filter Element to Base	20
Oil Filter Assembly to Cylinder Block Bolts	35
Support/Front Cover to Cylinder Block Bolts 3/8"	35
Fan Driven Pulley to Hub Bolts	20
Fan Driving Pulley to Balancer Bolts	20
Water Pump to Front Cover Bolts	13
Water Outlet to Manifold Bolts	20
*Intake Manifold to Cylinder Head Bolts	40
Exhaust Manifold to Cylinder Head Bolts	25
Carburetor to Intake Manifold Bolts	10
Choke Tube and Plate to Intake Manifold Bolts	15
Air Cleaner to Carburetor Stud	5
Engine Mount to Cylinder Block Bolts	75
Engine Mount to Frame Mount	50
Starter to Cylinder Block Bolts	35
Starter Brace to Cylinder Block Bolts	25
Starter Brace to Starter Bolt	15
Starter Brace to Starter Stud	8
Distributor Clamp to Cylinder Block Bolt	17
Spark Plugs	15
*Cylinder Head Bolts	85
Connecting Rod Nuts	42

*Clean and dip entire bolt in engine oil before tightening to obtain a correct torque reading.

ENGINE	BORE DIAMETER	CYLINDER BORE SELECTION	BORE-SIZES	PISTON SELECTION	PISTON SIZES	PISTON DIAMETER	PISTON TO CYLINDER BORE CLEARANCE
260 CU. IN.	3.499 3.501 STANDARD	A	3.4990-3.4995	A	3.49825-3.49775	3.49975 3.49775 STANDARD	.00075 TO .00175
		B	3.4995-3.5000	B	3.49875-3.49825		
		C	3.5000-3.5005	C	3.49925-3.49875		
		D	3.5005-3.5010	D	3.49975-3.49925		
	3.509 3.511 .010 OVER SIZE	J	3.5090-3.5095	J	3.50825-3.50775	3.50975- 3.50775 .010" OVER SIZE	
		K	3.5095-3.5100	K	3.50875-3.50825		
		L	3.5100-3.5105	L	3.50925-3.50875		
		M	3.5105-3.5110	M	3.50975-3.50925		

5B6A232A

Figure 6A-220 - Piston Information Chart



5B6A233

Figure 6A-221 - 260 Cu. In. Engine Mounting