250 CU. IN. IN-LINE ENGINE

CONTENTS

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.

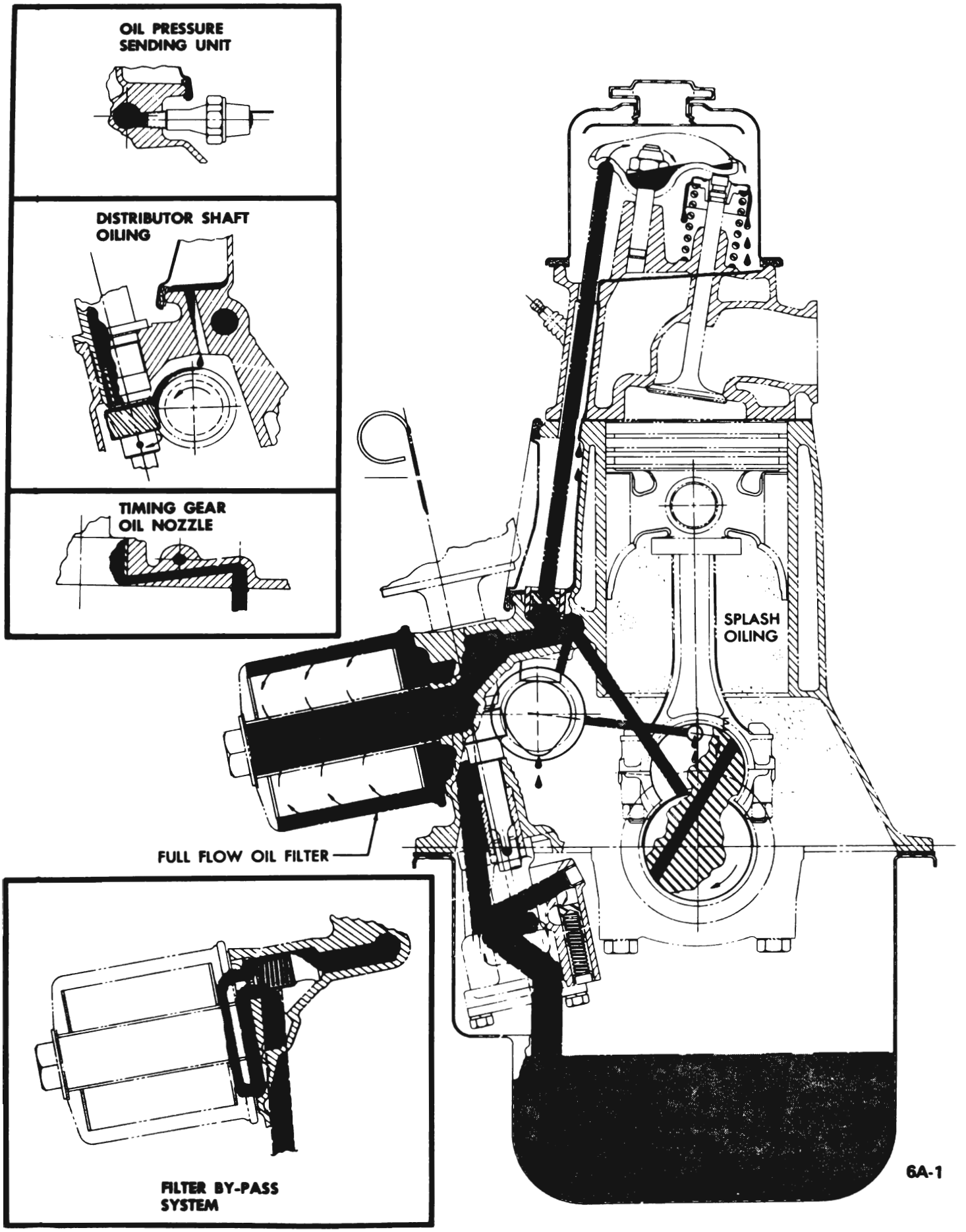


Figure 6A-1 Lubrication System

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	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 4,000 miles before attempting any engine disassembly to correct for oil comsumption.
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 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 and breaker points are open. 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 lifter plunger).

2. Adjust the remaining valves, one cylinder at a time, in the 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. TCS switch at transmission (if equipped).

c. 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. TCS switch at transmission (if equipped).

c. 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.

INTAKE MANIFOLD, CYLINDER HEAD, VALVE TRAIN AND LIFTERS

Intake Manifold Removal

1. Disconnect battery.

2. Remove air cleaner.

3. Remove power steering pump and bracket if equipped.

4. Disconnect both throttle rods at bellcrank and remove throttle return spring.

5. Disconnect fuel and vacuum lines at carburetor, and vapor hose at canister.

6. Disconnect crankcase ventilation hose at rocker arm cover.

7. Disconnect exhaust pipe at manifold flange and discard packing.

8. Remove manifold attaching bolts and clamps, then remove manifold assembly and discard gaskets.

9. Check for cracks in manifold castings.

10. If necessary to replace either intake or exhaust manifolds, separate them by removing one bolt and two nuts at center of assembly. Reassemble manifolds using a new gasket. Tighten finger tight and torque to specifications after assembly to cylinder head. Transfer all necessary parts.

Intake Manifold Installation

1. Clean gasket surfaces on cylinder head and manifolds.

2. Position new gasket over manifold end studs on head and carefully install the manifold in position making sure the gaskets are in place.

3. Install bolts and clamps while holding manifold in place with hand.

4. Torque bolts to specifications.

5. Connect exhaust pipe to manifold using a new packing.

6. Install power steering pump and bracket if equipped and adjust for proper belt tension.

7. Connect crankcase ventilation hose at rocker arm cover.

8. Connect fuel and vacuum lines at carburetor, and connect vapor hose to canister.

9. Connect throttle rods at bellcrank and install throttle return spring.

10. Connect battery.

11. Install air cleaner, start engine, check for leaks and adjust carburetor idle speed.

Cylinder Head Removal

1. Drain coolant from radiator.

2. Remove manifold assembly as outlined.

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

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.

NOTE: *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.

NOTE: *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.

NOTE: *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 with "Perfect Seal" sealing compound.

NOTE: *Damage to the cylinder block threads can result if bolts are not lubricated with "Perfect Seal" 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.

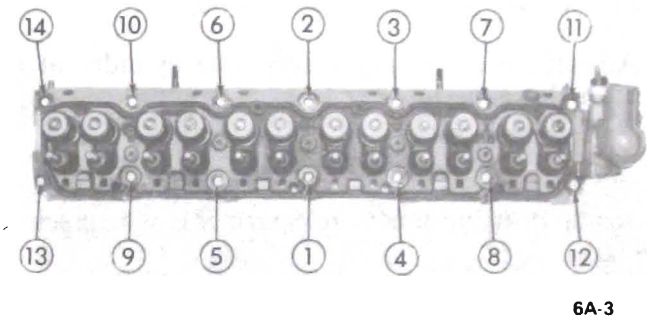


Figure 6A-3 Cylinder Head Bolt Tightening Sequence

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 manifold assembly as outlined.

10. Connect vapor hose at canister.

11. Fill cooling system.

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

NOTE: *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 and breaker points are

open. 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.

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.

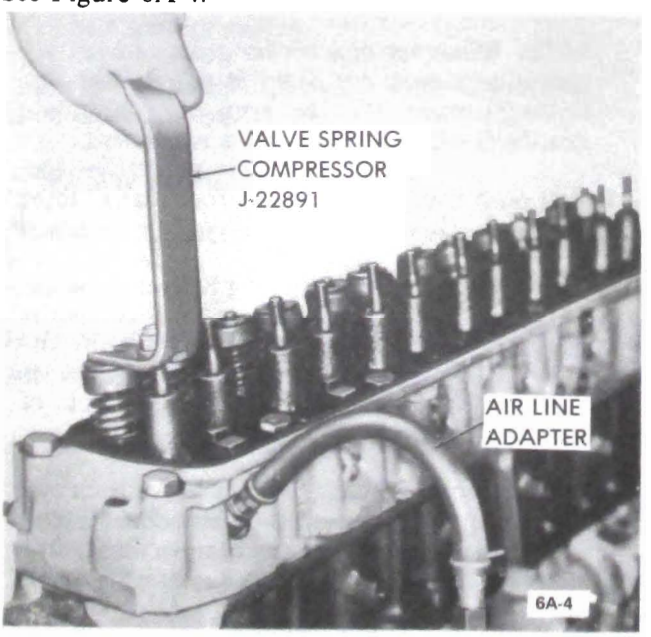


Figure 6A-4 Removing Valve Cap Retainers

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 THE SPRING IS INSTALLED AGAINST THE CYLINDER HEAD. See Figure 6A-5. Compress the spring with J-22891 and install

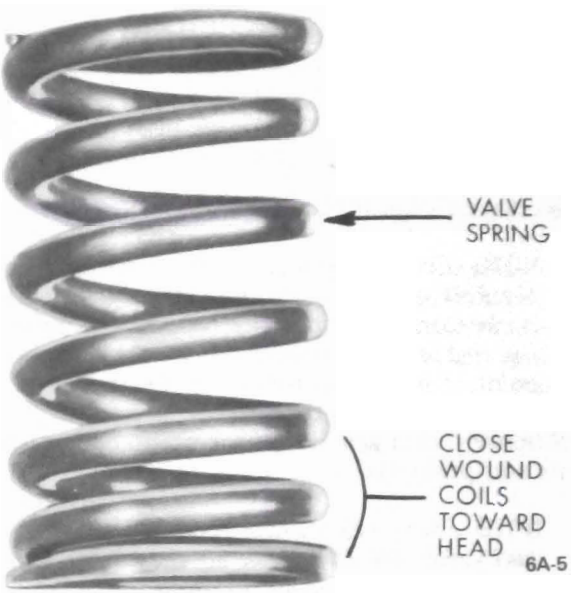


Figure 6A-5 Valve Spring

oil seal in the lower groove of the stem, making sure the seal is flat and not twisted.

> **NOTE:** *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.

> **NOTE:** *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.

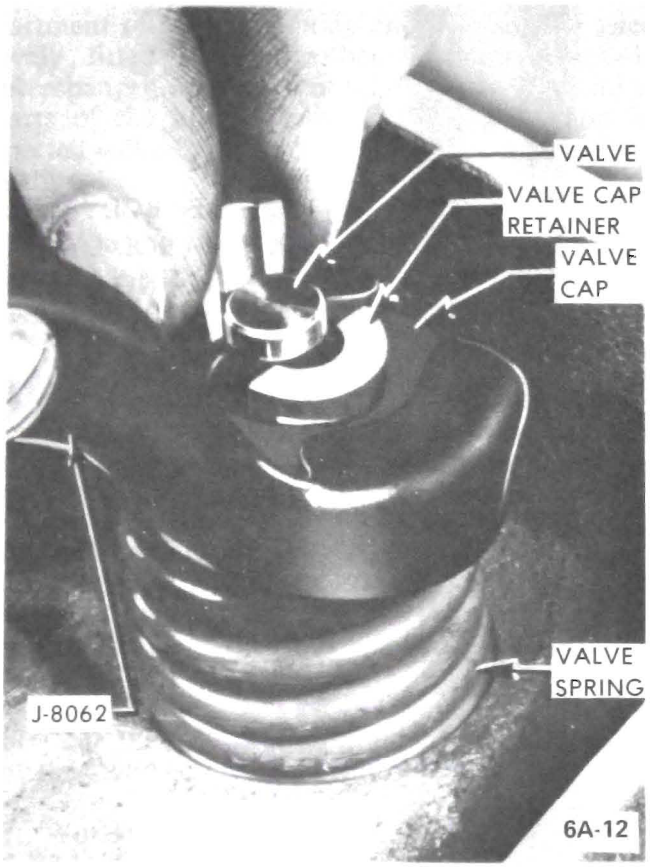


Figure 6A-6 Removing Valve Stem Keys

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

NOTE: *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 defects 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 is the correct angle for valve faces.

8. If a valve stem has excessive clearance in its guide, the guide must be reamed oversize. 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 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.

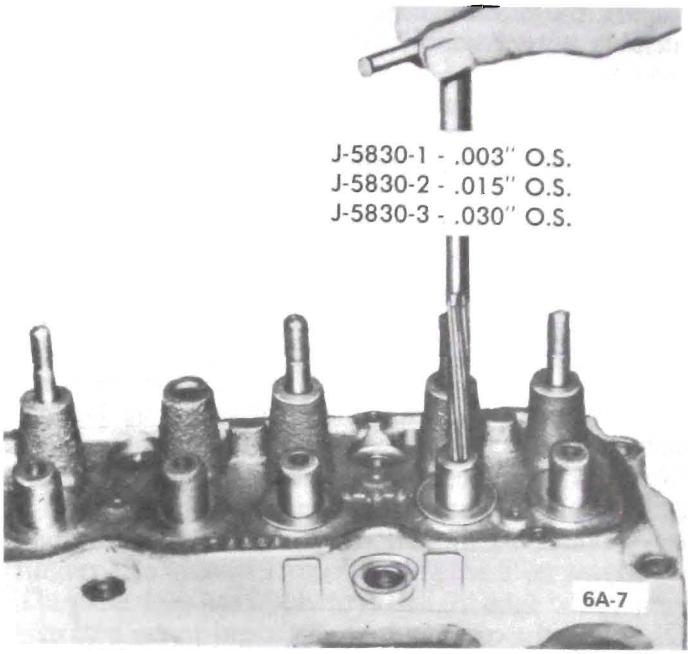


Figure 6A-7 Reaming Valve Guides

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 Prussian Blue and turn the valve against seat. If the valve seat is concentric with the valve guide, a mark will be made all around the seat; while if the seat is not concentric with the guide, a mark will be made on only one side of the seat. Next, coat the valve seat lightly with Prussian Blue. Rotate the valve against the seat to determine if the valve face is concentric with the valve stem and if the valve is seating all the way around. Both of these tests are necessary to prove that a proper seat is being obtained.

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.

Valve Lifter Service

1. Remove valve mechanism as outlined.

2. 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.

3. Crank engine until distributor rotor points to number one position, then disconnect distributor primary lead at coil and remove distributor.

4. Remove push rod covers. (discard gaskets)

5. Remove lifters and place in a wooden block with numbered holes or similar devise to keep them identified as to position in engine.

6. If less than a complete set of lifters is being removed, disassemble one or two and check for dirt or varnish. If this condition exists, it is advisable to remove all lifters for cleaning and inspection. Otherwise, service only those lifters that are not operating properly.

7. Examine the cam contact surface at lower end of lifter body. If this surface is excessively worn, galled, or otherwise damaged, discard the lifter assembly. In this case, also examine the mating camshaft lobe for excessive wear or damage.

8. Disassemble valve lifter by using a push rod to hold down the push rod seat while removing the plunger retainer from the lifter body using Retainer Remover J-5238. See Figure 6A-8.

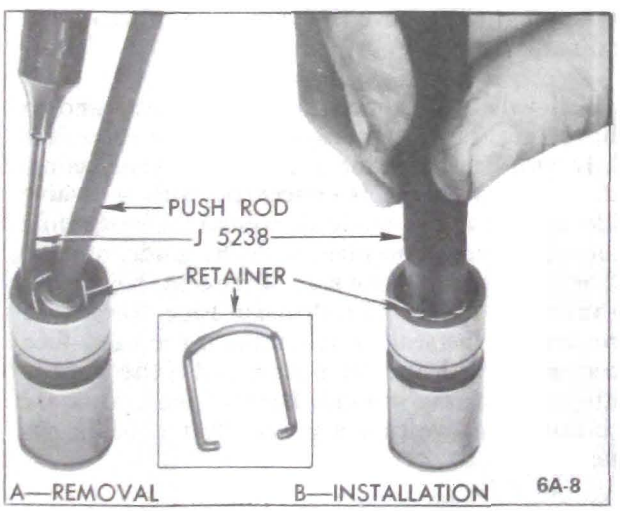
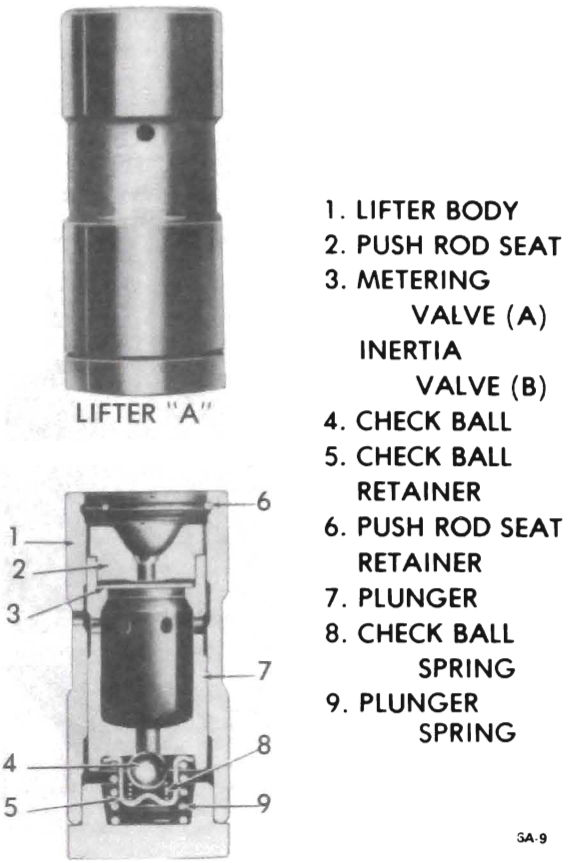


Figure 6A-8 Plunger Retainer

9. Remove the push rod seat and metering valve. See Figure 6A-9.

10. If a plunger sticks in the lifter body, place lifter in large end of Plunger Remover J-4160-A, with plunger inward. While holding lifter with thumb, rap the open end of remover against a block of wood with just enough force to jar the plunger from body. See Figure 6A-10.



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

Figure 6A-9 Lifter Parts

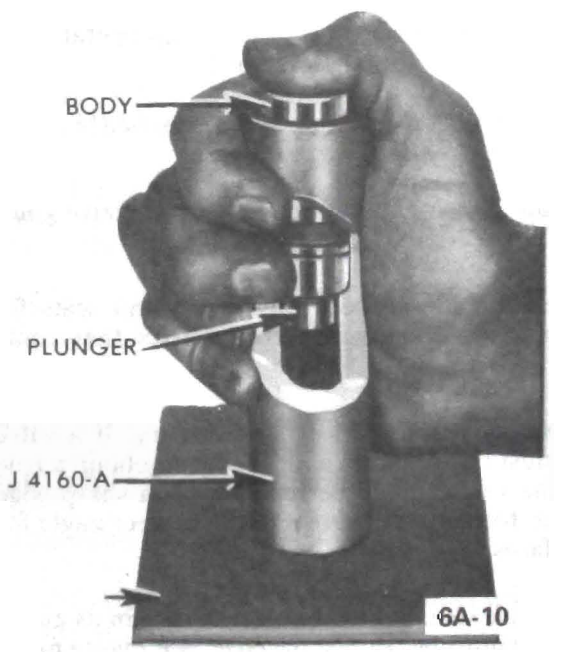


Figure 6A-10 Removing Stuck Plunger

11. Drain oil out of body into waste can and remove the ball retainer, ball, ball spring, and plunger spring. A strainer placed over waste can will prevent dropping these parts into can.

12. Place all parts of each lifter in a separate compartment of tray. The body and plunger are selectively fitted to each other and must not be interchanged with parts of other lifters. Keeping all parts of the lifter together until cleaned and inspected will aid in diagnosing cause of improper operation.

13. Rinse the tray full of lifter parts in a pan of kerosene to remove as much oil as possible. This will reduce contamination of the cleaning solvent and extend its effective life.

14. Submerge the tray and parts in the cleaning solvent and soak for approximately one hour. The time required will depend on the varnish on lifter parts and the effectiveness of the solvent.

15. After the varnish has dissolved or has softened sufficiently to permit removal by wiping, raise the tray and suspend it above the solvent by means of the hooks on tray handles. Allow tray and parts to drain so that solvent will be saved.

16. Rinse the tray of parts in the pan of kerosene to cut the solvent and avoid injury to hands.

17. Working on one lifter at a time and using CLEAN lint-free cloths, thoroughly wipe off all parts. Clean the plunger and the external and internal surfaces of the body with a hard wiping action to remove any varnish deposits. Rinse the parts in kerosene using Cleaning Brush J-5099 to clean the bore of lifter body.

> **NOTE:** *To insure absolute cleanliness of a reconditioned lifter assembly, it is advisable to inspect and assemble each lifter before cleaning the next lifter.*

18. The following list outlines the inspection of lifter parts. An inspection should be made at this point to determine whether or not a lifter is in need of replacement.

> **NOTE:** *The hydraulic valve lifter is serviced as a complete assembly only. If one or more of the valve lifter components are faulty, the complete lifter must be replaced.*

(a) *Lifter Body.* Inspect inner and outer surfaces of body for scoring. Replace lifter assembly if body is roughly scored or grooved. The prominent wear pattern just above lower end of body should not be considered an unusual condition unless it is definitely grooved or scored; it is caused by side thrust of cam against body while the lifter is moving vertically in its guide.

Inspect the cam contact surface on lower end of lifter body. Replace the lifter assembly if this surface is excessively worn, galled, or otherwise damaged. A lifter body that has been rotating will have a round wear pattern and a non-rotating lifter body will have spalling on the lifter base.

> **NOTE:** *The L-6 engine has valve lifters with a slight spherical shaped base that induces lifter rotation, which is caused by the tapered lobes on the camshaft producing camshaft thrust rearward, inducing lifter rotation.*

(b) *Lifter Plunger.* Using a magnifying glass, inspect the check ball seat for wear. Inspect outer surface of plunger for scratches or scores. Small score marks with a rough, satiny finish will cause the plunger to seize when hot but operate normally when cool. Roughness in check ball seat or scores or scratches on outer suface of plunger which may be felt with a fingernail are causes for replacing the lifter assembly. This rule does not apply to the slight edge which may sometimes be present where the lower end of plunger extends below the ground inner surface of the body. This edge is not detrimental unless it is sharp or burred.

A blackened appearance is not a malfunctioning condition. Sometimes the discoloration serves to highlight slight grinder chatter marks and give the outer surface of plunger a ridged or fluted appearance. This condition will not cause improper operation, therefore it may be disregarded.

(c) *Push Rod and Seat.* Replace lifter if the area where the push rod contacts the push rod seat is rough, or otherwise damaged. Replace any push rod having a rough or damaged ball end.

(d) *Check Ball.* Using a magnifying glass, carefully examine the check ball for nicks, imbedded material or other roughness which would prevent proper seating. Such conditions would indicate the cause of intermittently noisy lifter operation.

(e) *Check Ball Spring.* Examine check ball spring for wear or damage. Replace lifter if any spring is distorted or shows evidence of wear.

(f) *Ball Retainer.* Replace lifter if a retainer is cracked or which has a heavily worn area. A small bright spot where the ball contacts the retainer is the normal condition.

(g) *Plunger Spring.* Replace lifter if the plunger spring is distorted or damaged. Exhaustive tests have shown that plunger springs seldom break down in service.

19. Rinse lifter plunger in the kerosene in middle compartment of cleaning tank and then give it a thorough final rinsing in the kerosene in right compartment.

20. Hold plunger in vertical position with feed hole up, then rinse and install the check ball, check ball spring, ball retainer, spring, and body over the plunger. See parts in Figure 6A-9.

21. Rinse push rod seat and plunger retainer, place these parts in end of body and depress with handle of Remover J-5238 until retainer engages groove in body. See Figure 6A-8.

22. Wrap the lifter in clean paper or otherwise protect it from dirt while reconditioning the other valve lifters.

23. Make certain that valve lifter guide holes and adjacent area of cylinder block are clean. Liberally lubricate the camshaft and lifter bores with engine oil and install lifters. Each lifter must slide freely in its guide hole.

24. Reassemble engine.

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-12.

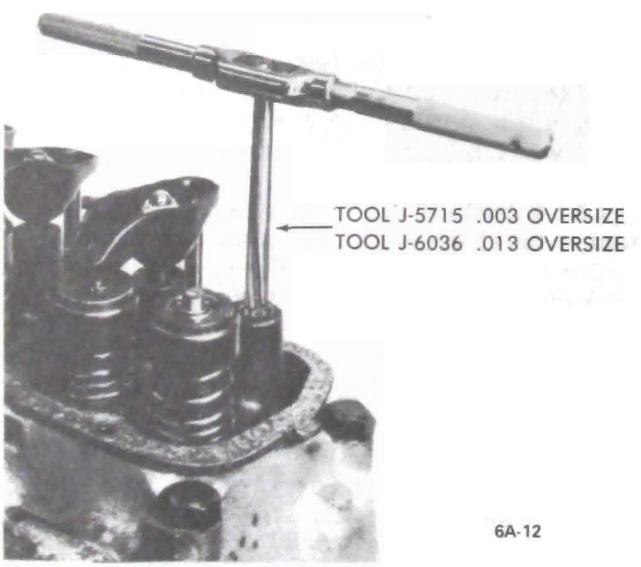


Figure 6A-12 Reaming Rocker Arm Stud Hole

NOTE: *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-13, tool should bottom on head.

3. If rocker arm stud is stripped refer to Figure 6A-14 for rethreading and Figure 6A-15 for pulling the stud.

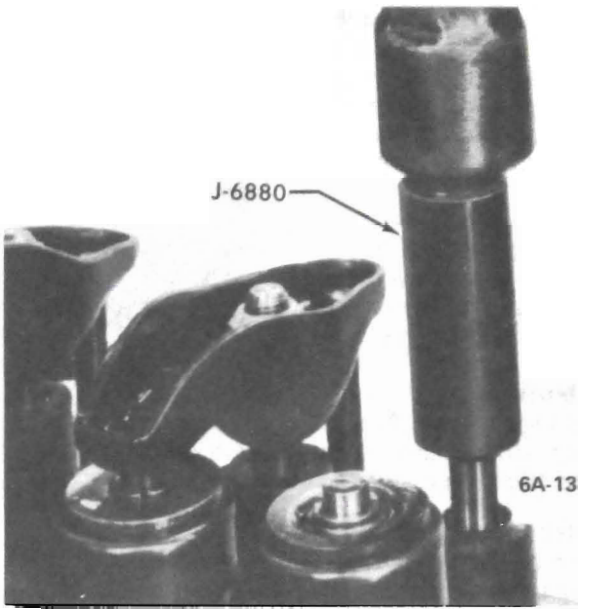


Figure 6A-13 Installing Rocker Arm Stud

Figure 6A-14 Removing Stripped 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

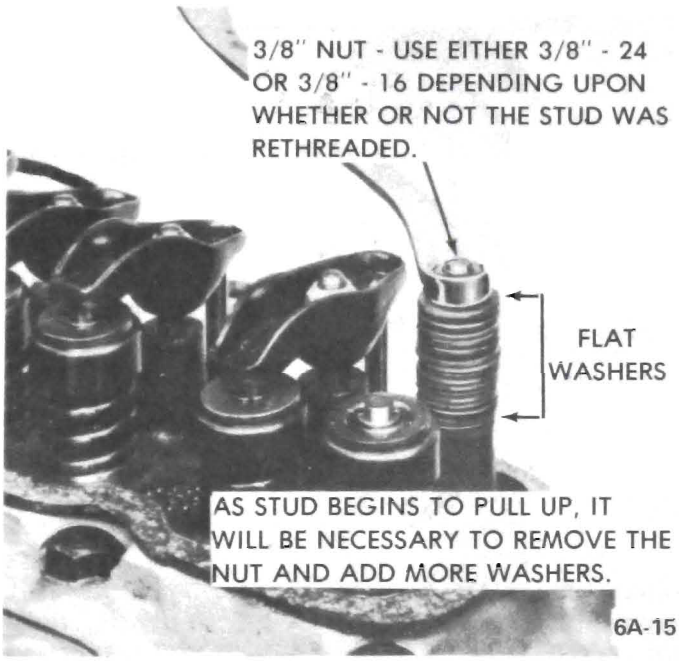


Figure 6A-15 Removing Rocker Arm Stud

with oil pump and distributor removed. See Figure 6A-16.

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 filed 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.*

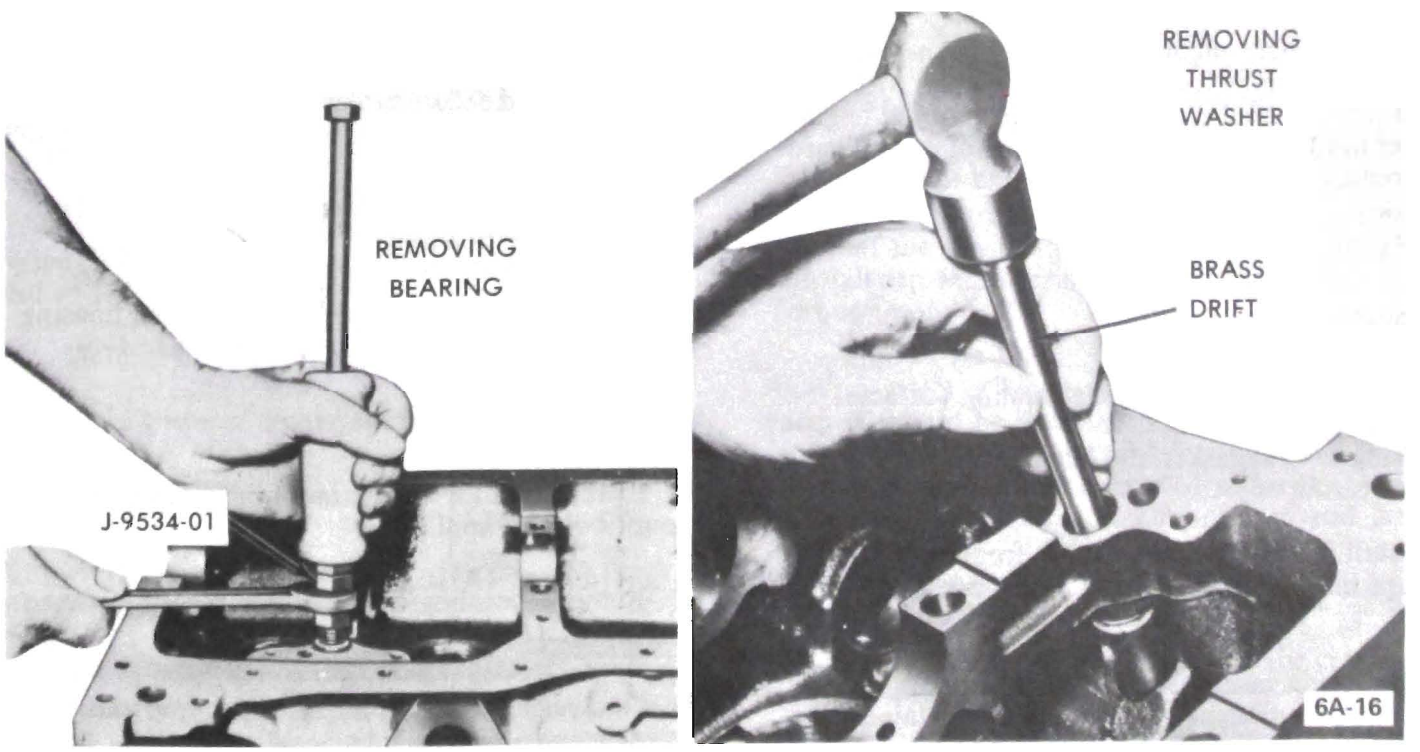


Figure 6A-16 Replacement of Distributor Bearing and Thrust Washer

OIL PAN REMOVAL AND INSTALLATION

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-17.

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

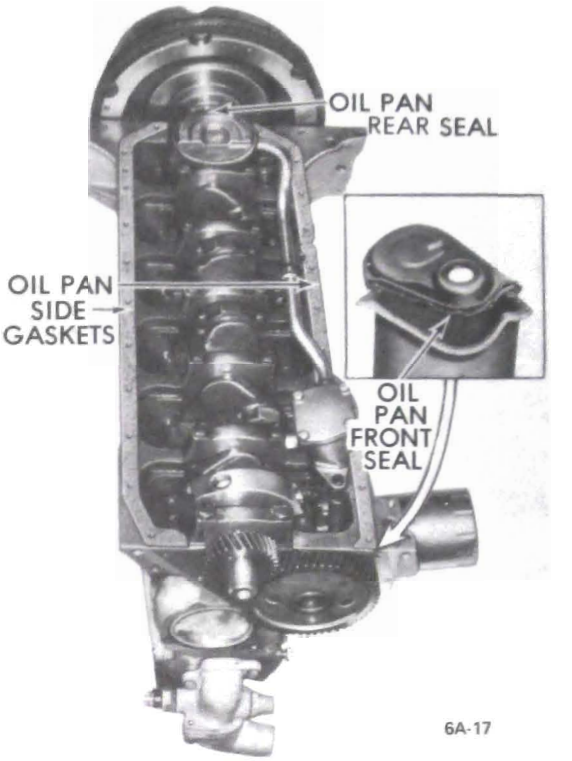


Figure 6A-17 Pan Gasket and Seals

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.

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.

NOTE: *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 Plastigage, Type PG-1 (green) or equivalent which has a range of .001″ to .003″.

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

NOTE: *Plastigage is soluble in oil.*

2. Place a piece of Plastigage lengthwise along the bottom center of the lower bearing shell (Figure 6A-18, View A). Install cap with shell and tighten bolt nuts to 35 lb. ft. torque.

3. DO NOT TURN CRANKSHAFT with Plastigage in bearing.

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

5. Using the scale printed on the Plastigage envelope, measure the flattened Plastigage at its widest point.

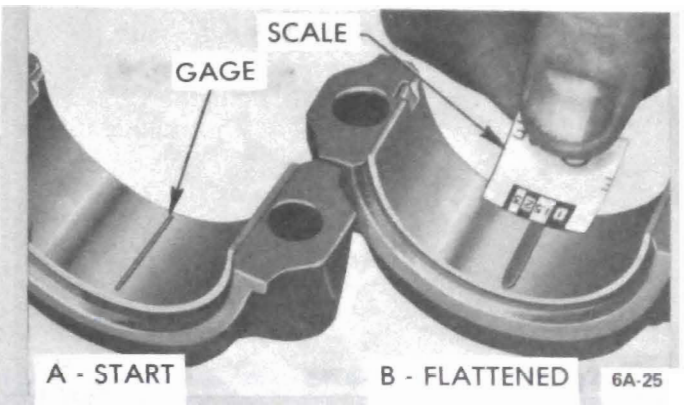


Figure 6A-18 Checking Bearings with Plastic-Type Gage

The number within the graduation which most closely corresponds to the width of Plastigage indicates the bearing clearance in thousandths of an inch. See Figure 6A-18, 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 Plastigage.

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 Plastigage, 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-19.

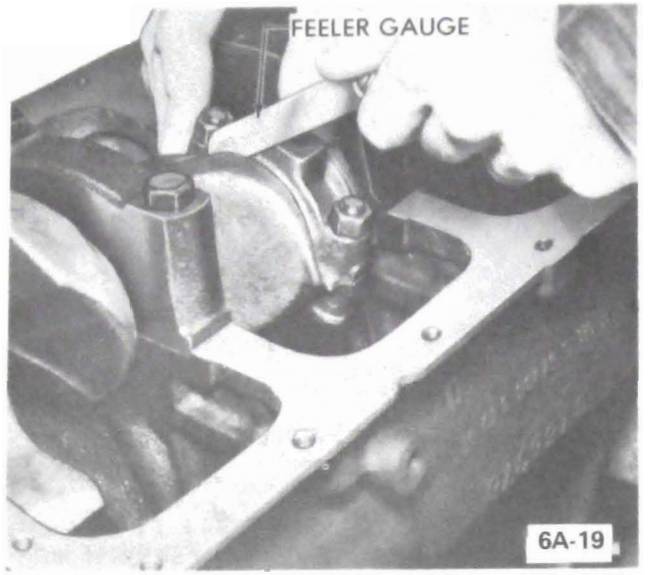


Figure 6A-19 Measuring Connecting Rod Side Clearance

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.

NOTE: *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 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.

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

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

3. If condition of lower bearing shell and crankshaft journal is satisfactory, check the bearing clearance with Pladtigage as described for connecting rod bearings.

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

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-20.

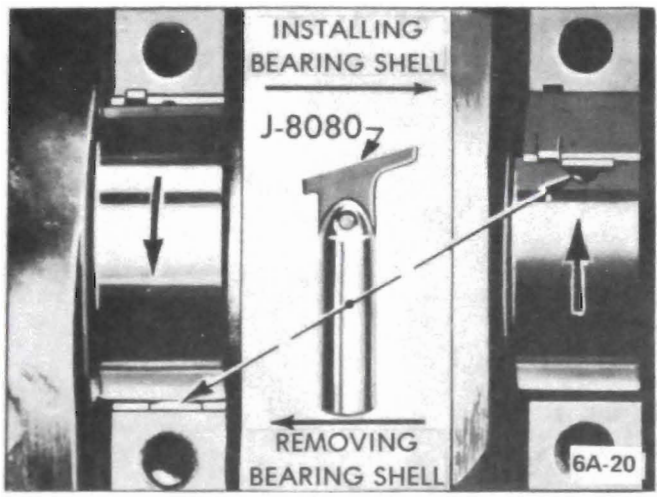


Figure 6A-20 Removal and Installation of Crankshaft Bearing (Upper Shell)

NOTE: *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-21.

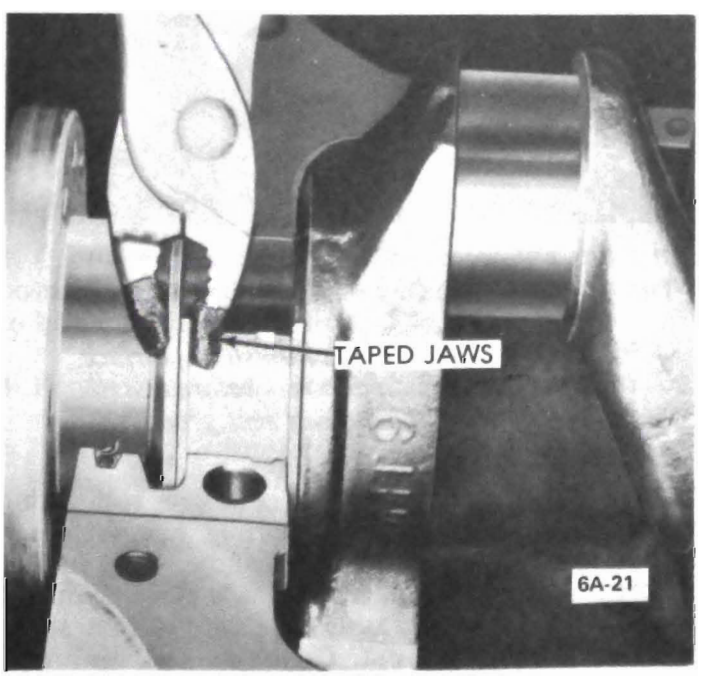


Figure 6A-21 (Rear) Main Bearing Replacement

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-20.

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 Plastigage 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 Plastigage.

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

14. When the proper size bearing has been selected, clean out all Plastigage, oil the lower shell and reinstall bearing cap. 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.

> NOTE: *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-22.

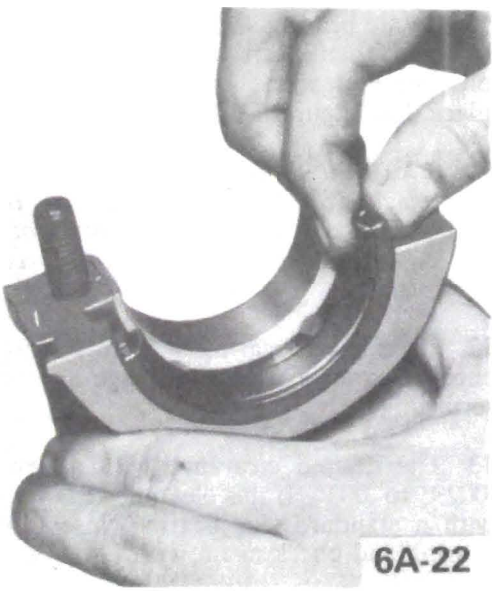


Figure 6A-22 Removing Rear Main Oil Seal (Lower)

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-23.

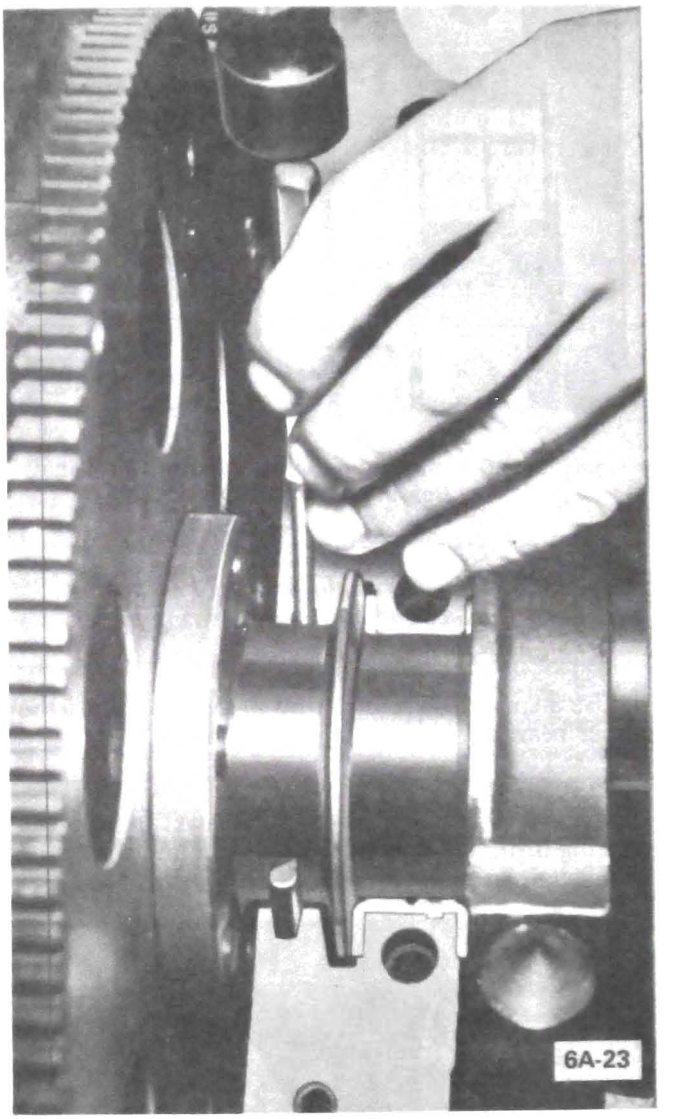


Figure 6A-23 Removing Rear Main Oil Seal Upper

> NOTE: *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-24.

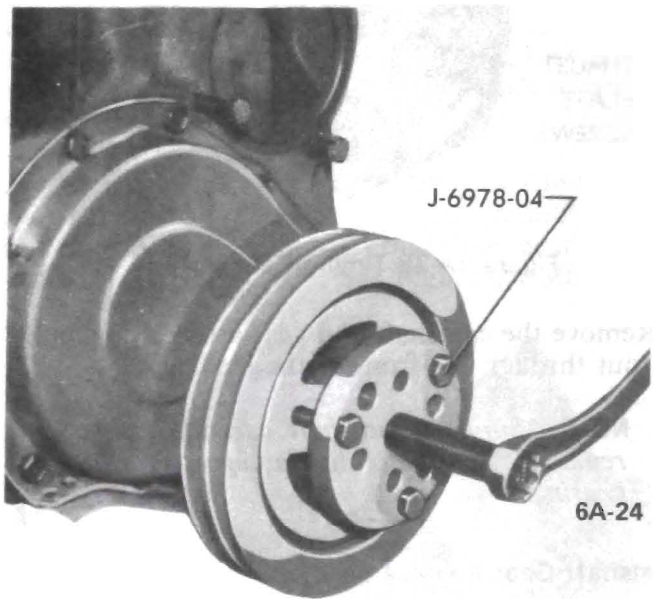


Figure 6A-24 Removing Torsional Damper

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-25.

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.

NOTE: *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*

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

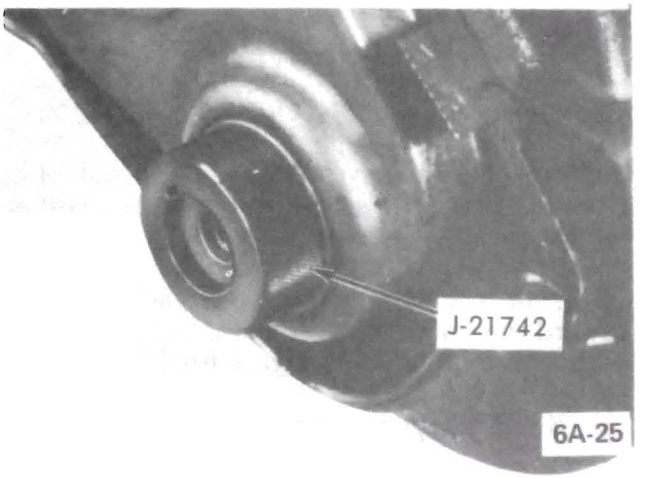


Figure 6A-25 Installing Centering Tool in Cover

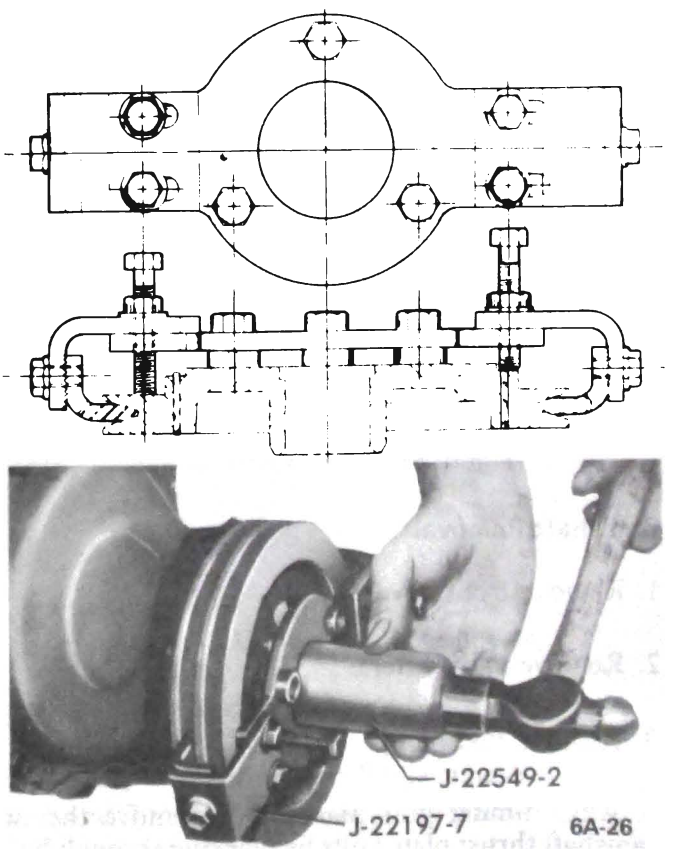


Figure 6A-26 Installing Torsional Damper

with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight section on the 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-26.

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.

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-27.

NOTE: *Support cover at sealing area.*

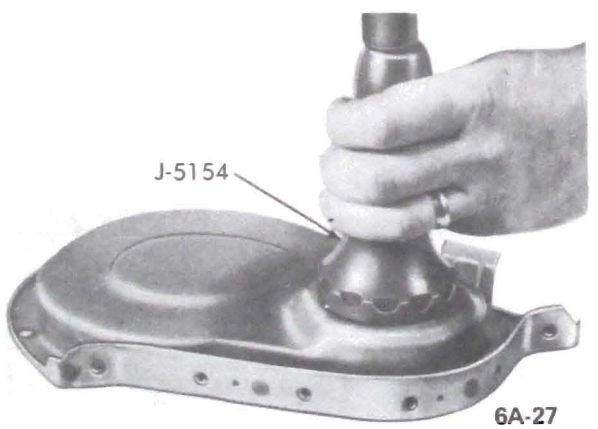


Figure 6A-27 Installing Oil Seal

Camshaft Removal

1. Remove front cover.

2. Remove valve lifters.

3. Remove fuel pump.

4. Align timing gear marks then remove the two camshaft thrust plate bolts by working through holes in the camshaft gear. See Figure 6A-28.

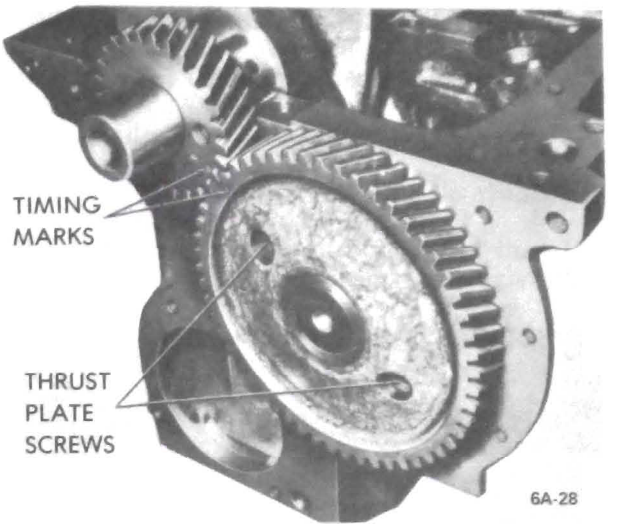


Figure 6A-28 Timing Gear Marks

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

NOTE: *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-29 for gear removal.

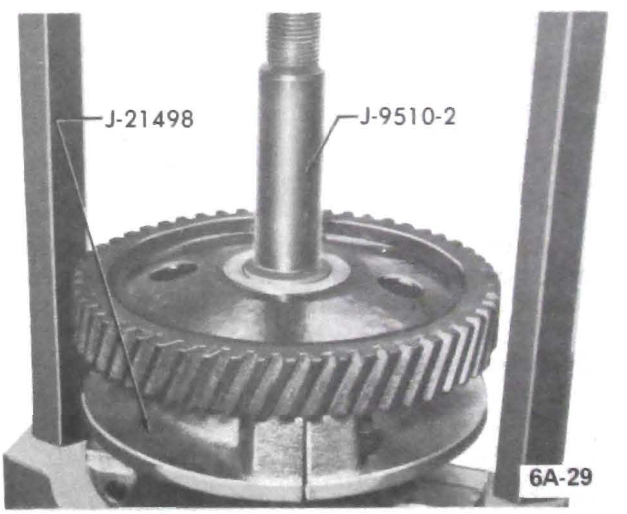


Figure 6A-29 Removing Camshaft Gear

NOTE: *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.

Camshaft Installation

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-28. 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-30.

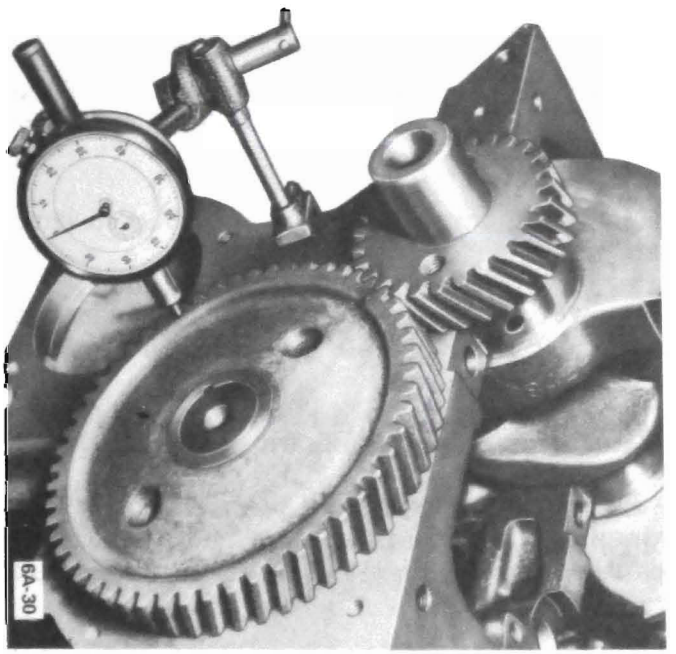


Figure 6A-30 Checking Camshaft Gear Runout

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-31.

Crankshaft Gear Removal and Installation

1. With camshaft removed, crankshaft gear may be removed using Tool J-6978. See Figure 6A-32. To install crankshaft gear use Tools shown in Figure 6A-33.

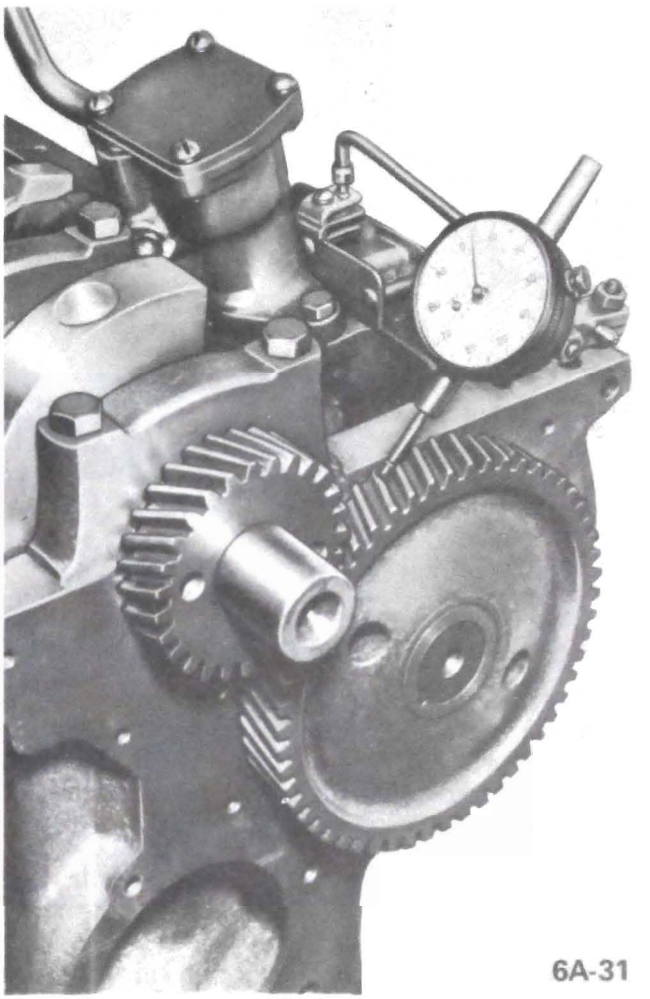


Figure 6A-31 Checking Timing Gear Backlash

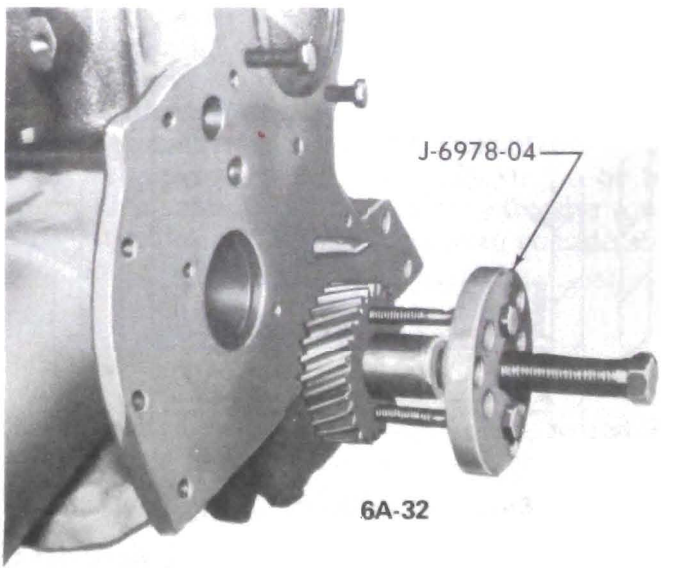


Figure 6A-32 Removing Crankshaft Gear

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.

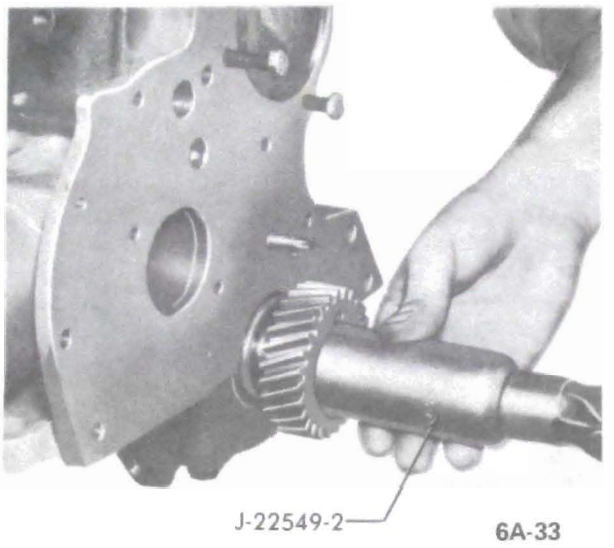


Figure 6A-33 Installing Crankshaft Gear

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-34.

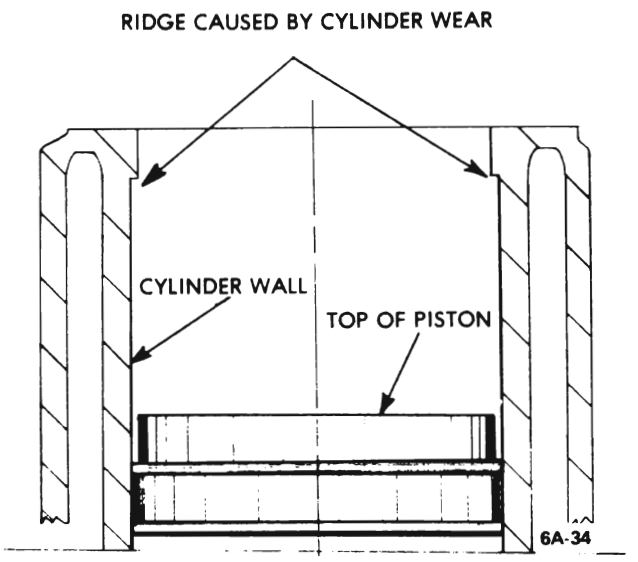


Figure 6A-34 Ridges Worn by Ring Travel

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-35.

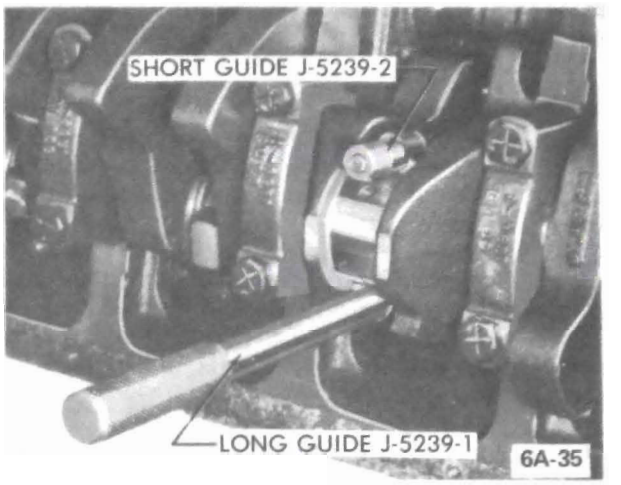


Figure 6A-35 Connecting Rod Bolt Guides Installed

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-35.

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 cyl-

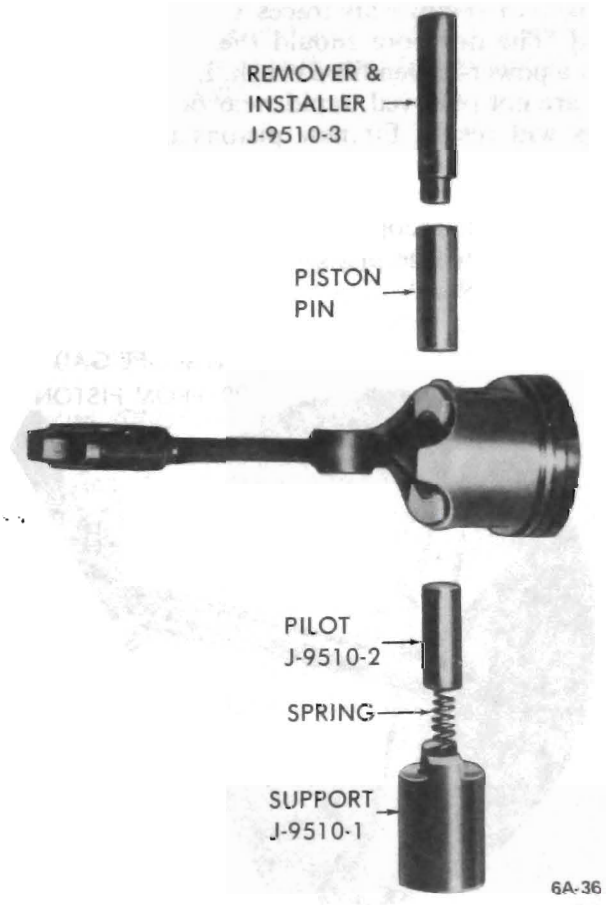


Figure 6A-36 Piston Pin and Tool Layout

inder 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-37. The piston should be measured (for fitting purposes) 1/2" below the top of piston.

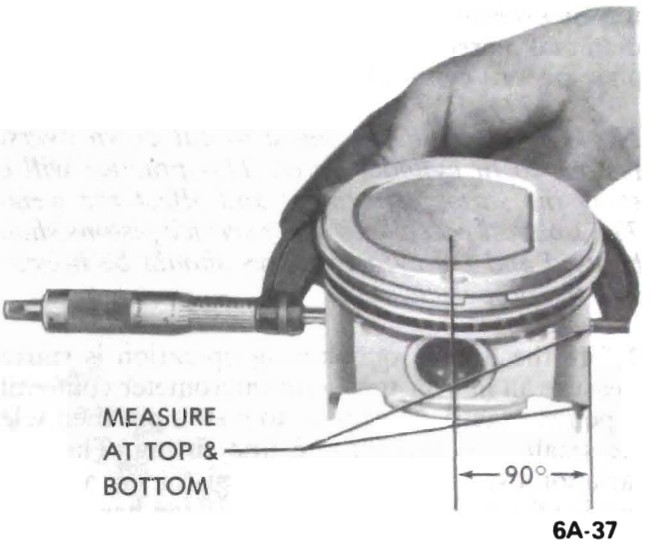


Figure 6A-37 Measuring Piston

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 oversize, 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 scor-

ing 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 .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. 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. 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-38.

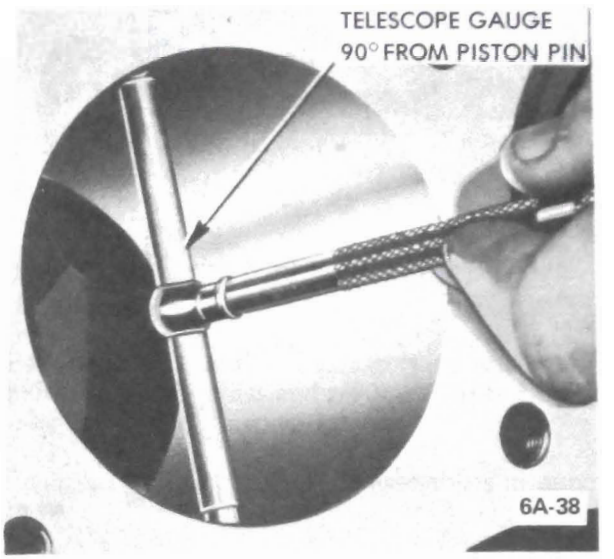


Figure 6A-38 Checking Cylinder Bore

2. Measure the piston to be installed. See Figure 6A-37. 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.

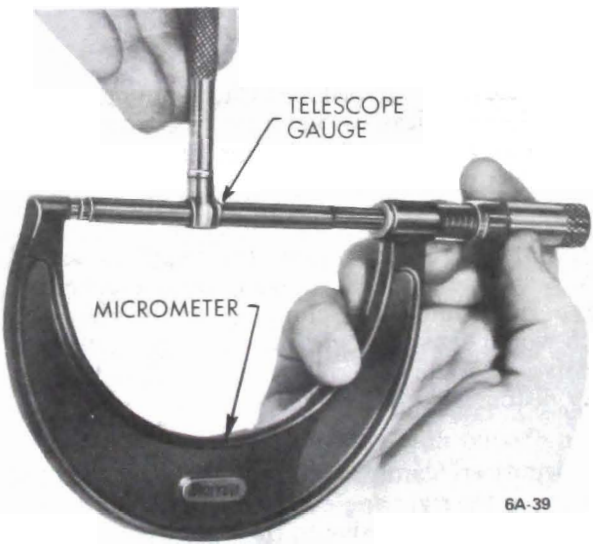


Figure 6A-39 Measuring Telescope Gage

NOTE: *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

NOTE: *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-36.

3. Connecting rod can be installed either way. See Figure 6A-40.

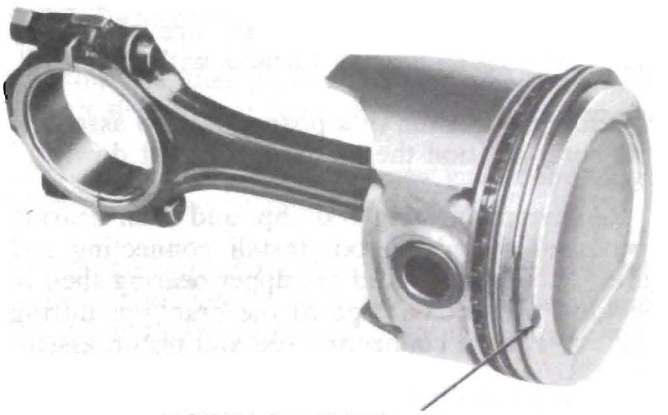


Figure 6A-40 Piston and Rod Assembly

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.

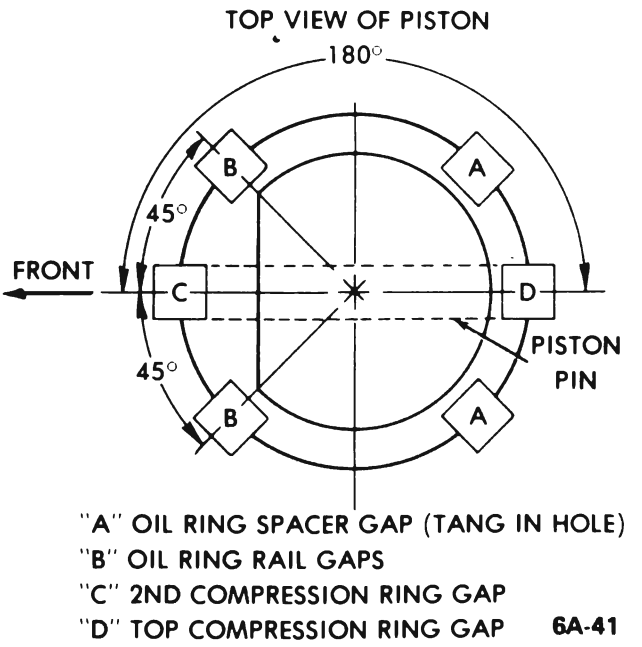


Figure 6A-41 Ring Gap Positioning

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-41.

8. *All compression rings are marked with a dimple, a letter "T", a letter "O" or word "TOP" to identify the side of 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-41.

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-42.

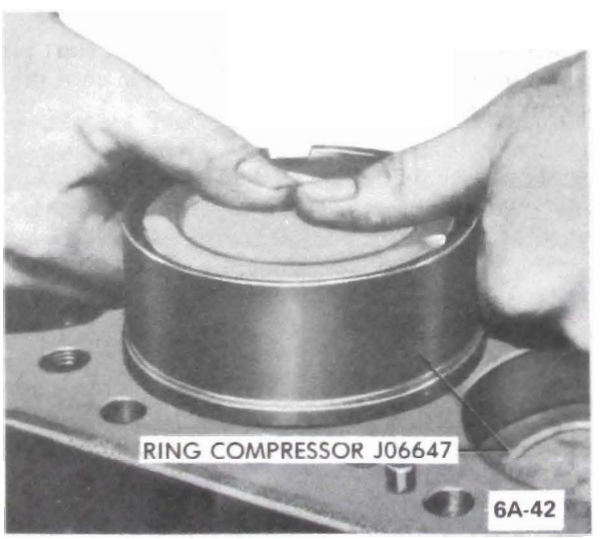


Figure 6A-42 Installing Piston with Ring Compressor

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.

NOTE: *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.

NOTE: *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-43.

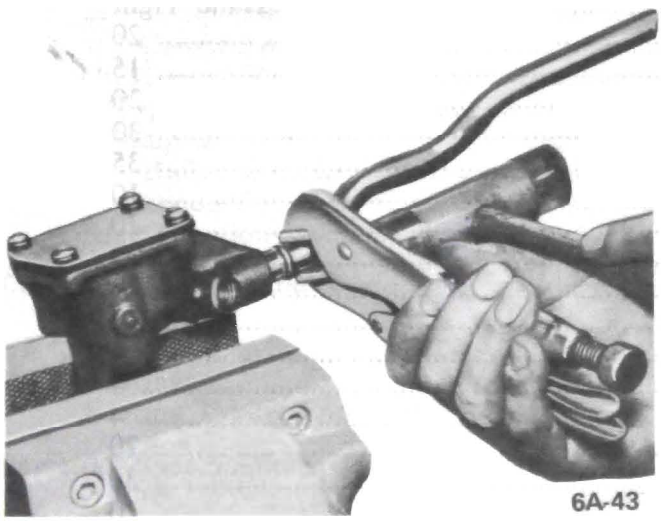


Figure 6A-43 Installing Pick-Up Screen and Pipe Assembly

NOTE: *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-44.

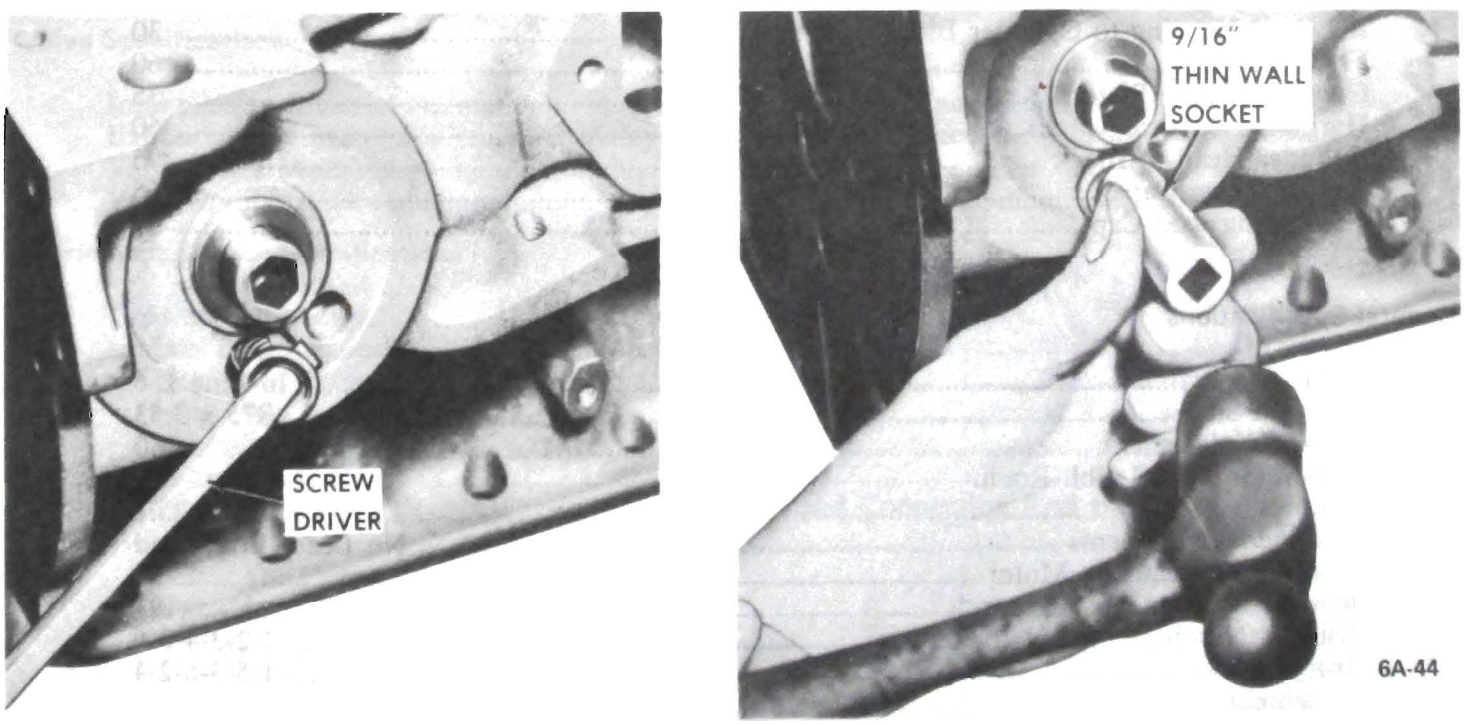


Figure 6A-44 Oil Filter By-Pass Valve

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	No Lead, Low Lead
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

Cooling System Specifications

System Type	Pressure
Radiator Cap Relief Pressure	15 psi
Thermostat	Pellet Type Opening at 190
Water Pump	
Type	Centrifugal
GPM at RPM	20.4 GPM at 2300 Engine RPM
Drive	Fan Belt
Bearings	Double Row Ball
By-Pass Recirculation	Internal

Cooling System Capacities

With Heater (Standard)	14 Quarts
Fan Diameter and Number of Blades	19-1/2" x 4

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

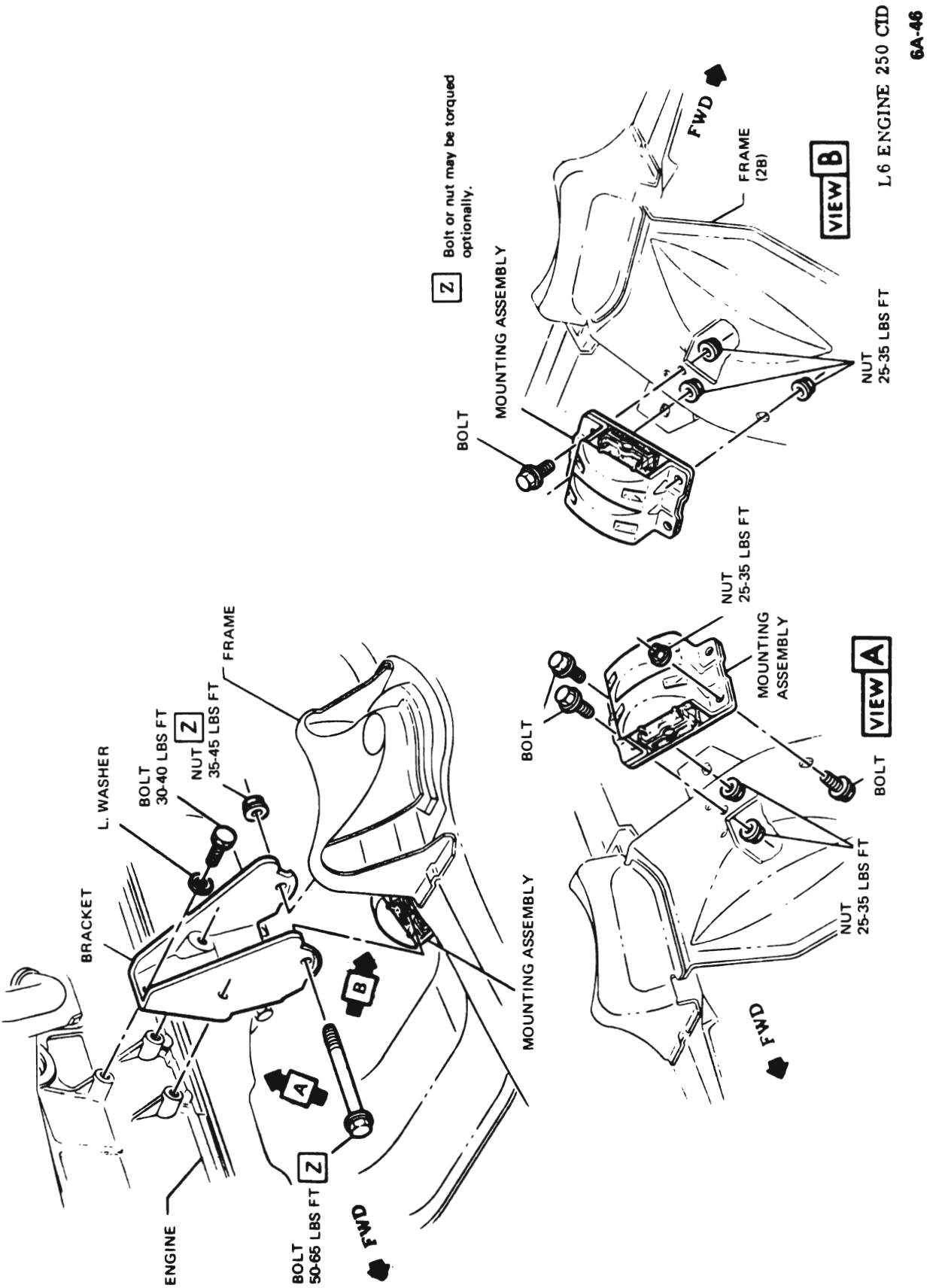
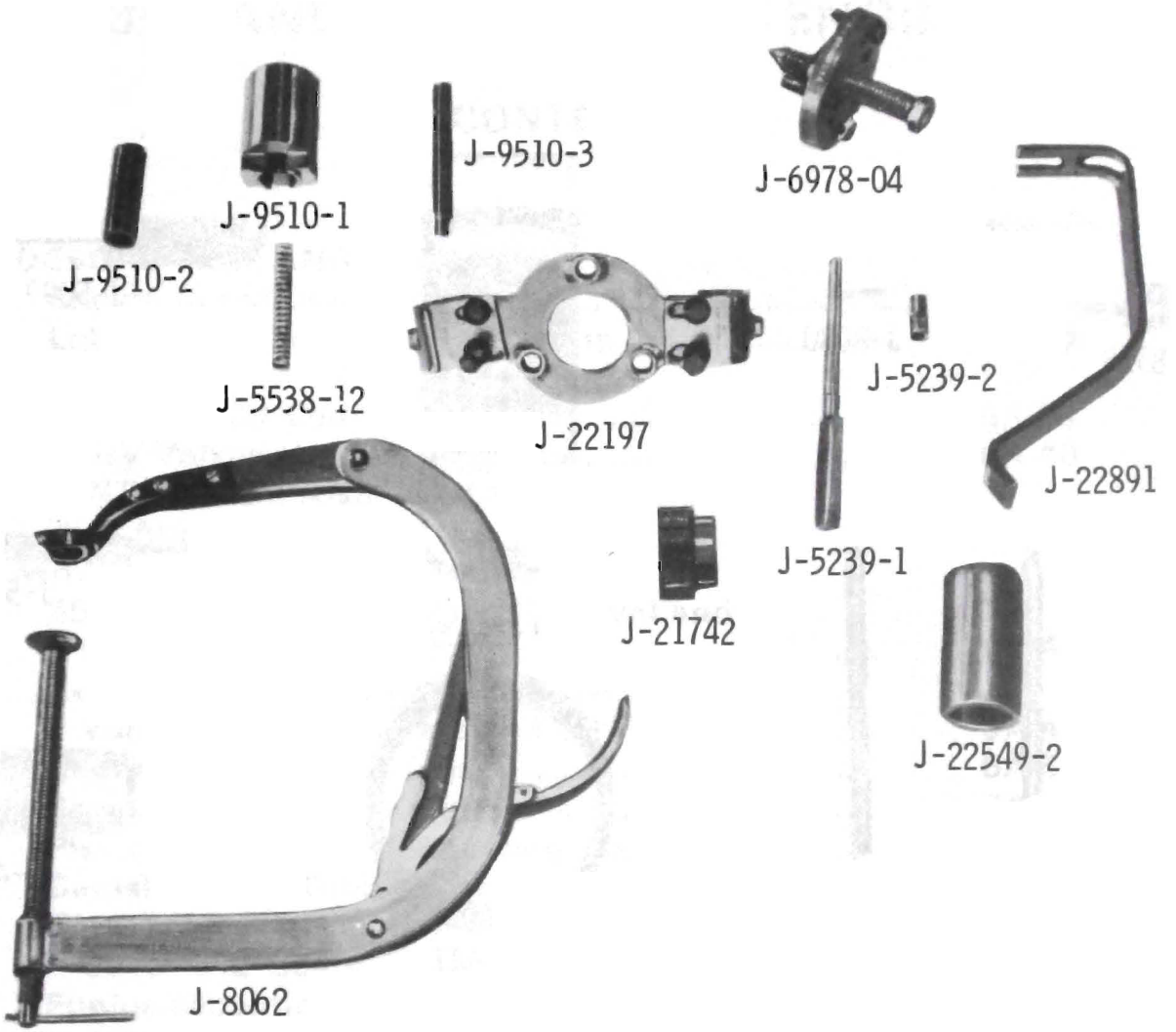


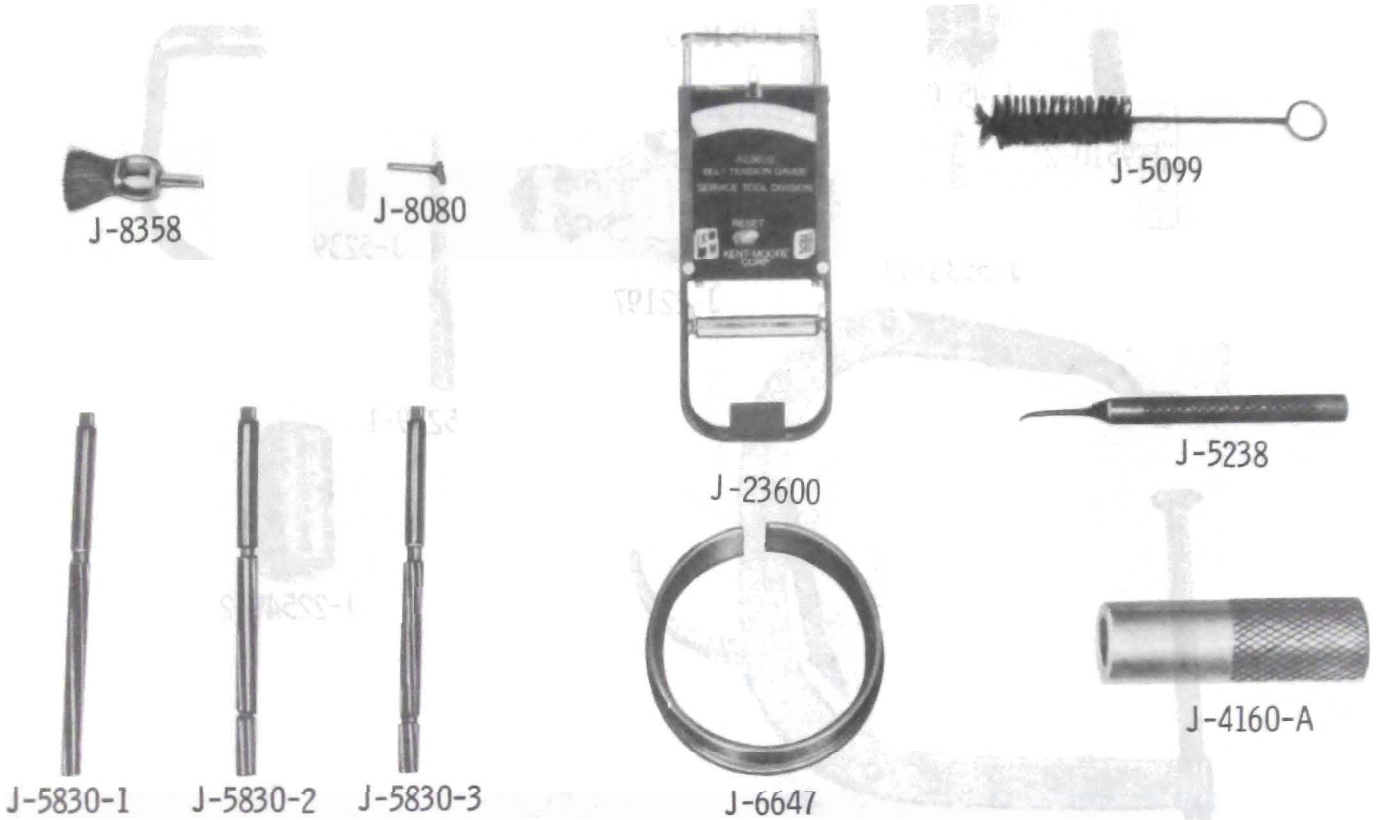
Figure 6A-46 250 Cu. In. Engine Mounting X-Series



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

6A-47

Figure 6A-47 Special Tools



J 4160-A	HYDRAULIC VALVE LIFTER PLUNGER REMOVER
J 5099	HYDRAULIC VALVE LIFTER BODY CLEANING BRUSH
J 5238	HYDRAULIC VALVE LIFTER PLUNGER RETAINER REMOVER & INSTALLER
J 6647	PISTON RING COMPRESSOR 3-7/8
J 5830-1	VALVE GUIDE REAMER .003 OVERSIZE
J 5830-2	VALVE GUIDE REAMER .015 OVERSIZE
J-5830-3	VALVE GUIDE REAMER .030 OVERSIZE
J-23600	BELT TENSION GAUGE
J 8080	MAIN BEARING SHELL REMOVER
J 8358	CARBON REMOVING BRUSH

Figure 6A-48 Special Tools