INTRODUCTION

GENERAL

This section has the description and the repair instructions for the engine. Disassembly, cleaning, assembly, specifications and troubleshooting are included.

⚠ WARNING

Some gaskets used in this engine can contain dangerous fibers. Breathing dust from these fibers is a cancer or lung disease hazard. Do not create dust! Use vacuum equipment for asbestos or follow the cleaning procedure described below.

- **Make sure the gasket material is wet with water or oil to prevent particles in the air.**
- **Use a hand scraper to remove old gasket material. Do not use a power tool or compressed air.**
- **Discard all asbestos material in a closed container while it is still wet.**

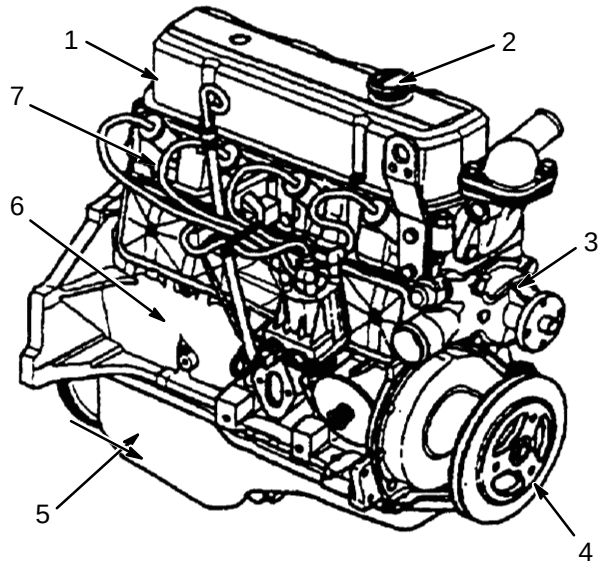
Put a "DANGEROUS FIBERS" warning label on the container. Discard dangerous fiber material safely.

⚠ CAUTION

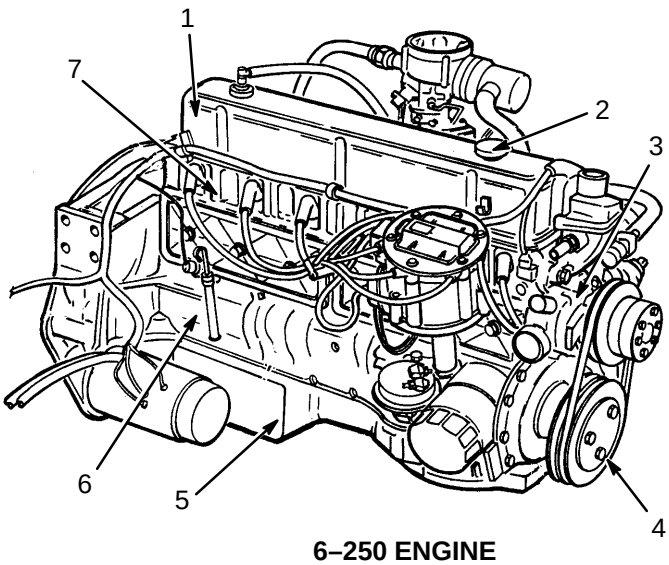
Disconnect the battery cables before doing any disassembly and repair to the engine or parts of the electrical system.

The diodes and resistors in the electrical system can be damaged if the following cautions are not followed:

- **Do not disconnect the battery when the engine is running. The voltage surge can damage the diodes and resistors.**
- **Do not disconnect an electric wire before the engine is stopped and the switches are "OFF".**
- **Do not cause a short circuit by connection of the electric wires to the wrong terminals. Make sure a correct identification is made of the wire before it is connected.**
- **Make sure a battery is the correct voltage and polarity before it is connected.**
- **Do not check for current flow by making a spark because the electronic components can be damaged.**



4–153, 4–181 AND 3.0L ENGINES



6–250 ENGINE

1. ROCKER ARM COVER
2. FILL CAP FOR ENGINE OIL
3. WATER PUMP
4. VIBRATION DAMPENER
5. OIL SUMP
6. ENGINE BLOCK
7. CYLINDER HEAD ASSEMBLY

10569

FIGURE 1. GM ENGINES

DESCRIPTION

The GM engines described in this section are the four cylinder and six cylinder models that have the arrangement of the cylinders in a straight line. These engines have a similar design. The number one cylinder for these engines is toward the cooling fan. These engines can have either a gasoline or a LPG fuel system.

The GM 4–153 engine is used in some models of 2.00 to 3.00 ton (4000 to 6000 lb) capacity lift trucks from June 1975 until June 1990. During 1990, production of the GM 4–153 engine was stopped and it was replaced with variations of the GM 4–181 engine. The GM 4–181 engine is also used in some models of 2.00 to 3.00 ton (4000 to 6000 lb) capacity lift trucks beginning in 1978. The two engines are the same design except for different displacements. The GM 4–181 engines installed in the lift trucks with serial code B187 [S2.00–3.00XL (S40–60XL)] beginning in 1990 have a different camshaft than the GM 4–181 engines used in the lift trucks with other serial codes.

The GM 4–181 engines installed in the lift trucks with serial codes C187 [S2.00–3.00XL (S40–60XL)] and serial codes B177 and C177 [H2.00–3.00XL (H40–60XL)] are the same engine.

The GM 3.0L engine is a later model of the 4–181 engine. It is used in the S/H2.00–3.20XM (S/H40–65XM) lift trucks.

The GM 6–250 engine is used in some models of 3.00 to 7.50 ton (6000 to 15 000 lb) capacity lift trucks from 1975 until 1988.

A camshaft in the engine block operates the overhead valves with push rods. A cast iron crankshaft gear drives a camshaft gear. The cam lobes are hardened and have a taper with the high side toward the rear of the engine. The valve lifters have a rounded surface where they contact the cam lobes. This combination of surfaces causes the valve lifters to rotate during engine operation. All of the engines have hydraulic valve lifters.

Each rocker arm rotates on a pivot ball stud fastened to the cylinder head. The valve guides and valve seats are part of the cylinder head. The exhaust valve seats are induction hardened.

The crankshaft in the four cylinder engines has five main bearings. The crankshaft in the six cylinder engine has seven main bearings. The rear main bearing in all engines is the thrust bearing.

The pistons are aluminum alloy and have three piston rings. The two compression rings each have a different design. Some oil control rings have three parts that must be assembled when the oil control ring is installed on the piston.

The specifications for engine repair are shown in ENGINE SPECIFICATIONS at the end of this section.

REMOVAL AND INSTALLATION OF THE ENGINE

NOTE: The removal and installation procedures for the engine and transmission are not included in this section. See the section, **THE FRAME** for the model of lift truck for these procedures.

CYLINDER HEAD AND VALVE MECHANISM

Cylinder Head, Removal

1. Disconnect the battery cables at the battery.

2. Drain the cooling system.

3. Disconnect and remove the coolant hose from the housing for the thermostat.

4. Remove or disconnect the air filter.

5. Disconnect the PCV valve.

6. Disconnect the wires and hoses fastened to brackets on the rocker arm cover.

7. Disconnect the spark plug wires.

8. Disconnect the linkages, fuel lines, and hoses for the fuel system.

9. Disconnect the exhaust pipe at the exhaust manifold and remove the intake and exhaust manifolds.

10. If necessary, remove the alternator and bracket.

11. Remove the dipstick tube for engine oil.

12. Remove the rocker arm cover.

NOTE: Keep the rocker arm assemblies and the push rods in order so that they will be installed in the same position.

(More Content includes: Brake system, Capacities, and specifications, Frame, Hydraulic, System, Industrial battery, Main control, Valve, Mast repair, Fasteners, Schematics diagrams, Steering axle, Steering system, Wire harness repair And more)

13. Remove the rocker arms and the push rods.

14. Loosen the cylinder head bolts in two or three steps. Do not completely loosen the cylinder head bolts during the first sequence. Remove the cylinder head bolts. Remove the cylinder head and the gasket.

Cylinder Head, Disassembly

1. Use a compressor tool to compress the valve springs and remove the retainers. See FIGURE 2. and FIGURE 3. Release the compressor tool and remove the spring cap, (rotators, when used), oil shield, and valve springs. Remove the oil seal and any shims from the springs.

2. Remove the valves from the cylinder head and put them in a rack so that the valves can be installed again in their same positions in the cylinder head.

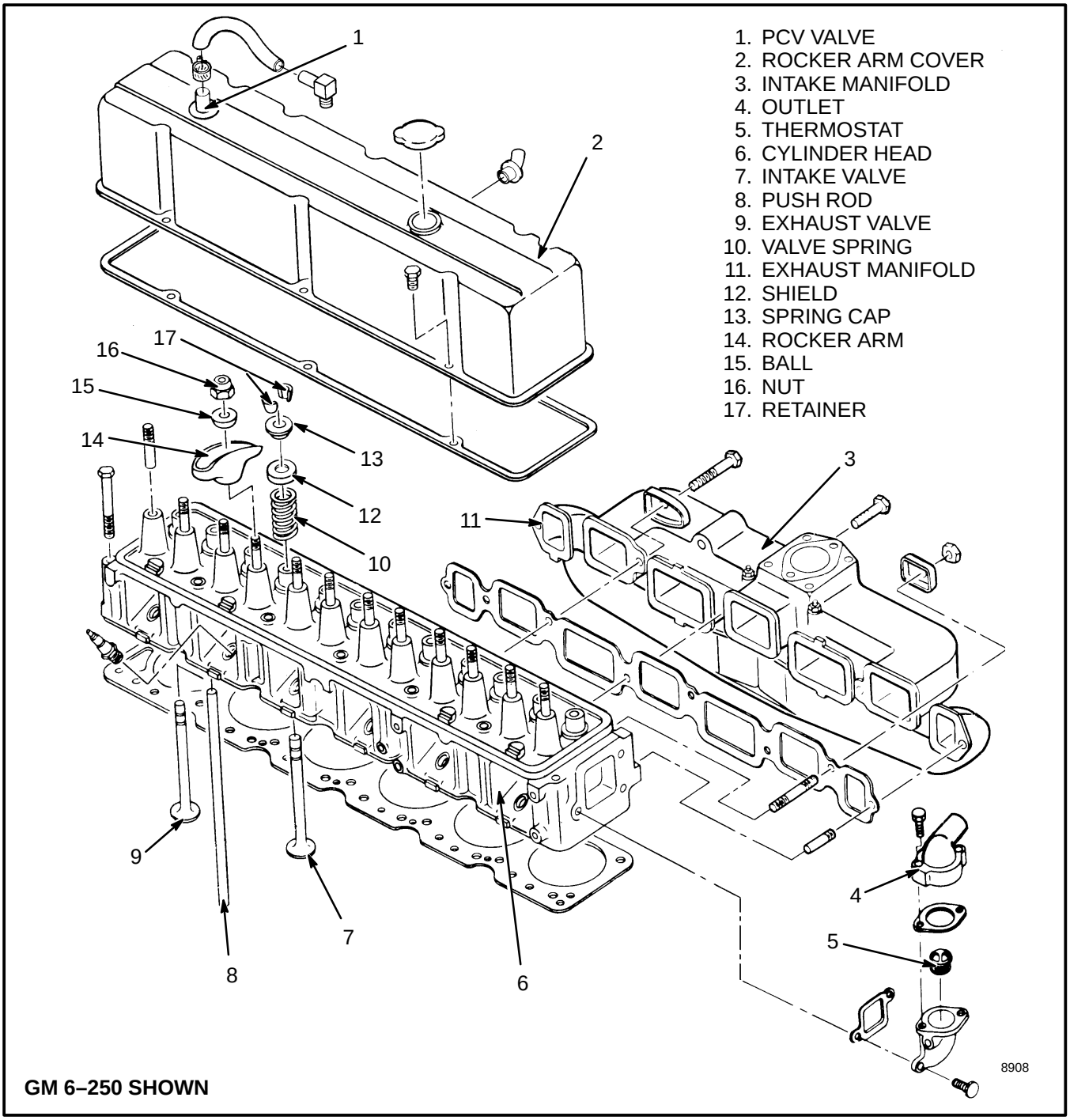


FIGURE 2. CYLINDER HEAD

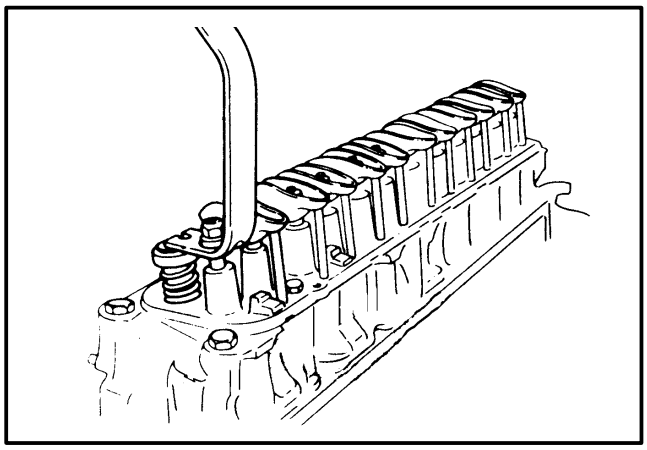


FIGURE 3. COMPRESS THE VALVE SPRINGS

Cleaning And Inspection

1. Clean the carbon from the combustion chambers and the valve ports.

2. Clean the valve guides. Use a tool as shown in the example in FIGURE 4.

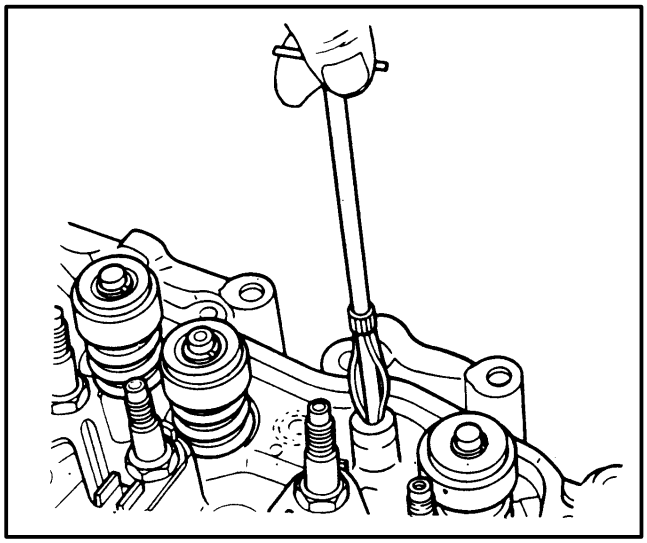


FIGURE 4. TOOL FOR CLEANING THE VALVE GUIDES

3. Clean the push rods and rocker arms.

4. Clean the surfaces of the cylinder head where the gaskets fit.

6. Inspect the cylinder head for cracks in the exhaust ports, combustion chambers, and external surfaces.

7. Inspect the valves for burned or damaged areas in the seat surfaces. Inspect for cracks and damaged or worn valve stems.

8. Check the clearance of each valve stem in its valve guide. Use the following procedure:

a. Use a micrometer to measure the diameter of the valve stem in three places: top, center, and bottom. The stems of exhaust valves have a small taper. The end of the valve stem near the spring is approximately 0.0025 mm (0.001 in) larger than the diameter near the valve head. Use a hole gauge to measure the bore in the valve guide.

b. Another method of measuring the clearance of the valve stem in its valve guide is to use a dial indicator as shown in FIGURE 5. Put the dial indicator so that it can measure the side–to–side movement of the valve stem. Lower the valve away from its valve seat approximately 3 mm (0.1 in). Move the valve stem from side–to–side and check the measurement on the dial indicator.

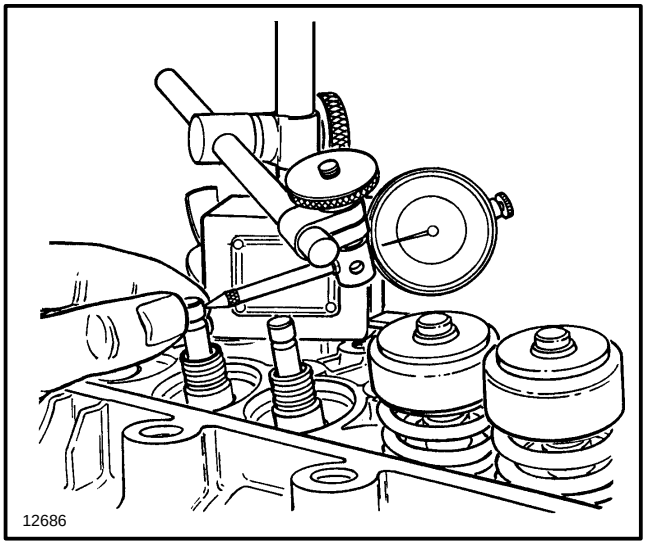


FIGURE 5. CHECK THE CLEARANCE BETWEEN VALVE GUIDE AND VALVE

c. The maximum clearance between the valve stems and their valve guides is shown in the ENGINE SPECIFICATIONS.

d. If the clearance between the valve stem and its valve guide is greater than the specification, a valve with an oversize stem must be installed. Use a reamer to make the bore the correct diameter for the next oversize valve. See the Parts Manual for oversize valves.

9. Use a valve spring tester to check the valve springs. A typical tester is shown in FIGURE 48. The specifica-

tions for the valve springs are shown in the ENGINE SPECIFICATIONS.

10. Inspect the rocker arm bolts for wear and damage.

Valves And Valve Seats

The condition and alignment of the valves to their valve seats is important so that the engine will operate correctly. Before any work is done on the valve seats, make sure the clearance of the valve stems in their valve guides is within specifications.

A correction for minimum wear and damage to the valve and seat can be done by a process called “lapping”. When the valve seats are “lapped”, keep the valve seats within the specifications. Make sure all of the lapping compound is removed from the valve and valve seat when the process is completed.

NOTE: Some engines have valve seats that can be replaced. If the valve seats cannot be repaired or replaced, install a new cylinder head.

Damaged valve seats can be repaired with a cutter tool. If the valve seat can not be repaired so that the valve depth is within specifications, the cylinder head must be replaced. The specifications for the valve seats are shown in FIGURE 6.

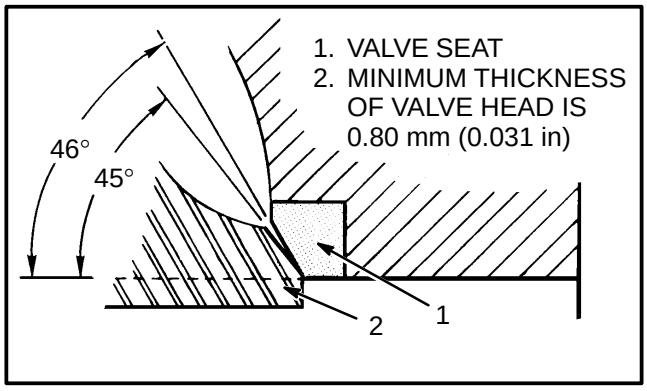


FIGURE 6. VALVE SEAT SPECIFICATIONS FOR INTAKE AND EXHAUST VALVES

Studs For The Rocker Arms

Replace a stud that has damaged threads or is loose in the cylinder head. See the Parts Manual for oversize studs.

1. Remove the old stud. Install a spacer, flat washer, and nut to the damaged stud. Use a wrench to remove the damaged stud. See FIGURE 7.

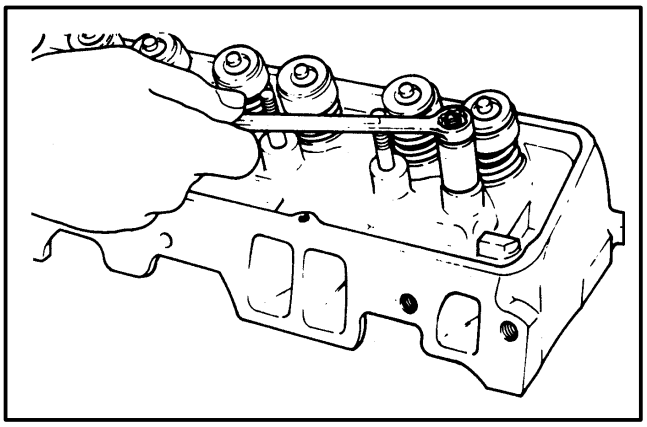


FIGURE 7. REMOVE A STUD FOR A ROCKER ARM

⚠ CAUTION

Do not try to install an oversize stud without reaming the stud hole to the new size. Installation of an oversize stud without reaming the stud hole can cause cracks in the cylinder head.

2. Use a reamer of the correct size for the new oversize stud. Apply SAE 90 lubricant to the new stud during installation. Install the new stud as shown in FIGURE 8.

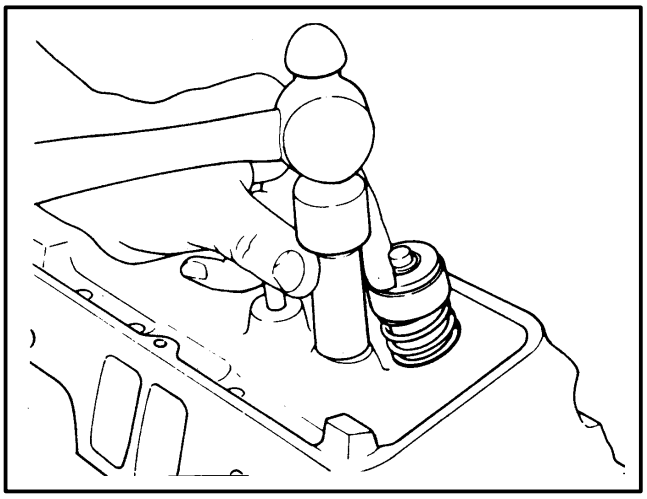


FIGURE 8. INSTALLATION OF A STUD FOR A ROCKER ARM

Hydraulic Valve Lifters, Replacement

The hydraulic valve lifters normally do not need service unless they are dirty or damaged. The hydraulic valve lifters must be clean to operate correctly. If the lifters make noise or do not operate correctly, replace them. The lifters can be removed with a flexible magnet after the push rods are removed.

Hydraulic Valve Lifters, Cleaning And Inspection

⚠ WARNING

Cleaning solvents can be flammable and toxic, and can cause skin irritation. When using cleaning solvents, always follow the solvent manufacturer's recommended safety precautions.

Clean all parts in a cleaning solvent and inspect them carefully. If any parts are damaged or worn, the complete hydraulic valve lifter must be replaced. If the body of the hydraulic valve lifter is worn, also inspect the bore in the engine block. If the bottom of the hydraulic valve lifter is worn or damaged, inspect the camshaft lobe for wear and damage. The bottom of the lifter must be convex for correct rotation during engine operation.

Cylinder Head, Assembly (See FIGURE 2.)

1. Install the valves in their correct ports. If a spring shim is used, install it on the valve stem. Install the valve spring, oil shield, and valve cap or rotator (exhaust valves) in position on each valve.

2. Use a valve spring compressor to compress the valve spring. Install a new oil seal on each valve stem. Make sure the oil seal is not twisted on the valve stem.

3. Install the retainers for the valve spring assembly. Make sure the retainers fit correctly in the upper groove of the valve stem. Release the spring compressor tool.

Cylinder Head, Installation

1. Clean the surface of the cylinder head and the top of the engine block. The surfaces for the gaskets must be clean. The threads for the head bolts must be clean so that the correct torque is applied during installation.

2. Install a new gasket for the cylinder head to the engine block. Do not use a sealant on the gasket.

3. Carefully install the cylinder head to the engine block. Use a sealant on the capscrews during installation. Tighten the head bolts evenly in a minimum of three steps. Tighten the head bolts evenly to a final torque of 130 N.m (95 lbf ft) in the sequence shown in FIGURE 9.

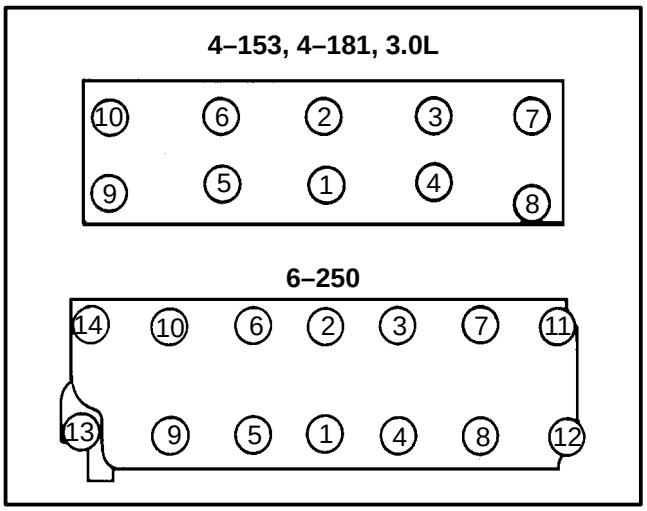


FIGURE 9. TIGHTENING SEQUENCE FOR THE CYLINDER HEAD

4. If the hydraulic valve lifters (cam followers) were removed, install them in their positions in the engine block. Install the side cover for the hydraulic valve lifters.

5. Install the push rods in their positions in the engine. Make sure each push rod fits in its socket in its hydraulic valve lifter.

6. Lubricate the rocker arms and rocker arm balls with engine oil during installation. Install the rocker arms, rocker arm balls, and rocker arm nuts. Tighten the rocker arm nuts until there is zero clearance.

7. Install the intake manifold and exhaust manifold. Connect the exhaust pipe at the exhaust manifold.

8. Install the carburetor. Connect the carburetor linkage, fuel line and hoses.

9. Install the alternator and bracket.

10. Install the dipstick tube for engine oil.

11. Connect the coolant hose to the housing for the thermostat.

12. Adjust the clearance of the rocker arm assemblies as described in "Valve Clearance Adjustment".

NOTE: If performing repair on the GM 3.0 liter engine got to step 14.

13. When the valve clearances are adjusted correctly, install the rocker arm cover. Use a new gasket between the cylinder head and the rocker arm cover. Install the retaining bolts and tighten them to 6 Nm (50 lbf in).

14. Install the rocker arm cover as described in “Rocker Arm Cover, Installation”.

15. Install and connect the PCV valve.

16. If the distributor cap was removed, install it. Connect the spark plug wires. Connect the wires and hoses fastened to brackets on the rocker arm cover.

17. Install the air cleaner, and component parts.

18. Fill the cooling system with the correct coolant. See the **PERIODIC MAINTENANCE** section for your unit.

19. Connect the battery cables at the battery.

20. When the engine can be operated, adjust the ignition timing and carburetor as necessary. See the **PERIODIC MAINTENANCE** section for additional information:

Valve Clearance Adjustment

1. Remove the cover for the rocker arm assembly.

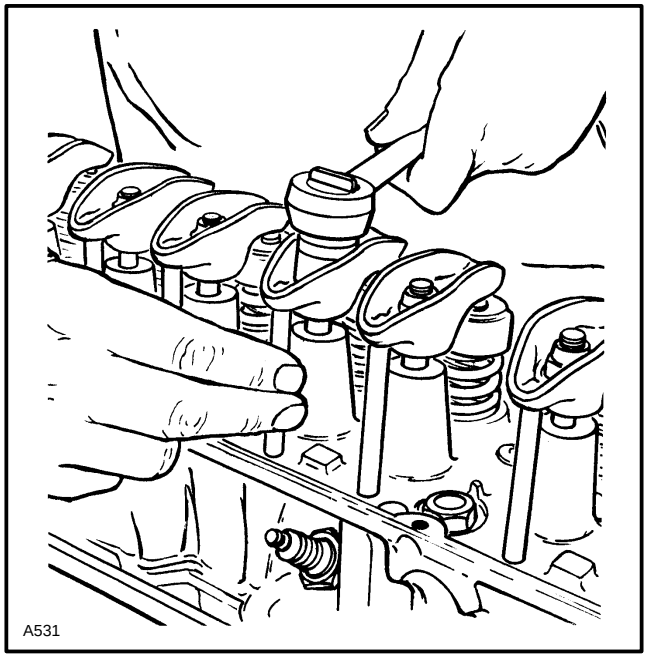


FIGURE 10. VALVE CLEARANCE ADJUSTMENTS

2. Adjust the valves for each cylinder when the piston is at top dead center on the compression stroke. Use the rotor in the distributor to find top dead center for each piston. Make an identification mark for each cylinder on the distributor housing. Make the marks directly under the connections of the spark plug wires.

3. Remove the distributor cap. Turn the crankshaft until the rotor is aligned over the mark for the number one cylinder. Now adjust both valves for the number one cylinder. Tighten the nut for the rocker arm while turning the push rod with your fingers as shown in FIGURE 10. Tighten the nut just until the movement of the push rod stops. This condition is zero clearance. Now tighten the nut one more turn.

4. Turn the crankshaft in the normal direction of rotation until the rotor aligns over the next mark. (For the six cylinder engine, the valves for the number five cylinder can now be adjusted. For the four cylinder engine, the valves for the number three cylinder can now be adjusted.) Adjust the valves as described in step 3.

5. Follow the same procedure as described in step 4 until all the valves are adjusted.

6. Install the distributor cap and the cover for the rocker arms.

Rocker Arm Cover, Installation

1. Remove all gasket material from the cylinder head and the rocker arm cover.

2. Coat the cylinder head rail with Loctite Flange Sealant.

3. Install a new gasket onto the cylinder head rail.

4. Apply Loctite Flange Sealant around the bolt holes of the gasket, and install the rocker arm cover.

5. Tighten the rocker arm cover bolts to 6 Nm (50 lbf in) in the sequence shown in FIGURE 11.

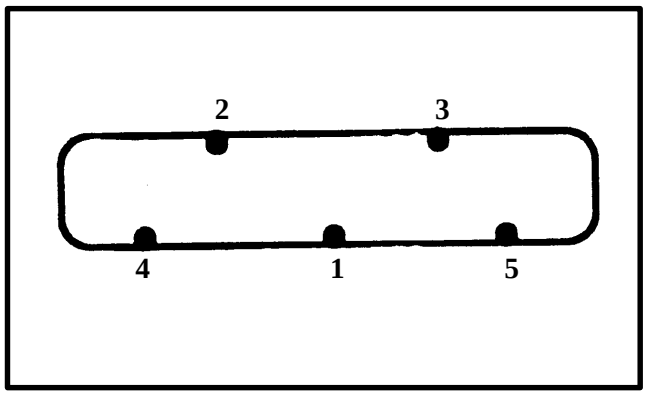


FIGURE 11. ROCKER ARM COVER TIGHTENING SEQUENCE

TIMING GEAR COVER

Removal

NOTE: The oil seal can be replaced without removing the timing gear cover. The crankshaft pulley and vibration dampener must be removed. The oil seal can be removed with a prybar. Work carefully so that the the sheet metal of the timing gear cover is not bent or damaged during removal or installation of the oil seal. The replacement of the oil seal is easier if the timing gear cover is removed from the engine.

1. Drain the coolant system. Remove the radiator.

2. Remove the drive belts. Remove the pulley from the vibration dampener.

NOTE: The vibration dampener on the 3.0L engine is pressed on to the crankshaft. It must be pulled off with a puller.

3. Remove the vibration dampener. Use a tool that pulls on the center of the vibration dampener. (A special tool, GM Part No. J–23523 is available.) See FIGURE 13. Do not use a puller that pulls on the outside diameter of the vibration dampener.

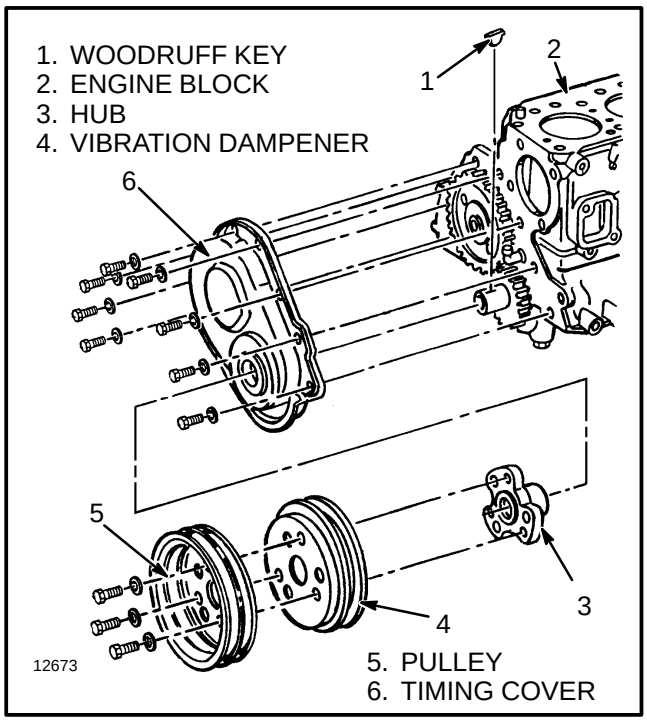


FIGURE 12. TIMING GEAR COVER AND PULLEYS

4. Remove the screws that hold the oil sump to the timing gear cover. Remove the screws that hold the timing gear cover to the engine block.

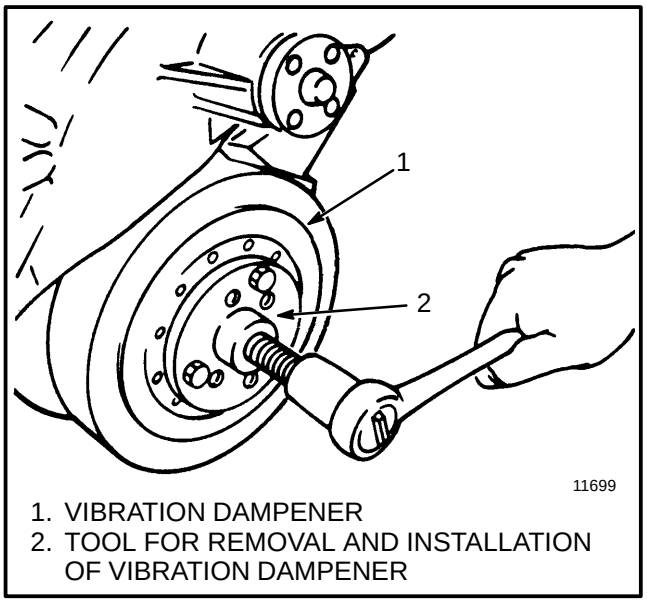


FIGURE 13. VIBRATION DAMPENER

GM 4–153, 4–181 and 3.0L. Remove the timing gear cover.

GM 6–250. Pull the timing gear away from the engine block only enough to cut the front gasket of the oil sump. Use a sharp knife and cut the gasket even with the edge of the engine block. Remove the timing gear cover.

5. Remove the oil seal from the timing gear cover. Do not bend or damage the sheet metal of the timing gear cover when removing the oil seal.

Installation

1. Make sure the gasket surfaces on the engine block, timing gear cover, and oil sump are clean.

2. Install a new oil seal. Carefully press the oil seal into the timing gear cover. Make sure the lip of the oil seal is toward the engine.

3. Install a new gasket if your engine uses a gasket between the timing gear cover and engine block. Apply a thin coat of sealant to both sides of the gasket.

4. Install a centering tool in the oil seal. See FIGURE 14. (A special tool, GM Part No. J–34995 is available for GM 4–153, 4–181 and 3.0L and GM Part No. 23042 is available for GM 6–250.) The oil seal must be aligned so that it is evenly in position around the hub. An oil seal

that is not correctly aligned with the hub will be damaged and will leak oil.

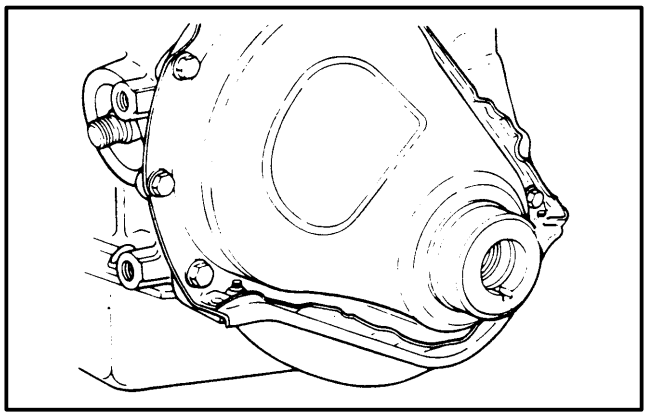


FIGURE 14. CENTERING TOOL, TIMING GEAR COVER

5. **GM 4–153, 4–181 and 3.0L**. Install the timing gear cover. Install the two screws for the oil sump and the screws for the timing gear cover and tighten the screws with your fingers. Make sure the oil seal is correctly aligned. Tighten the screws to 10 N.m (90 lbf in).

GM 6–250. Cut the tabs from the oil seal for the front of the oil sump as shown in FIGURE 15. Apply a thin coat of sealant to both side of the gasket and put it in position. Apply a 3 mm ($^1/_8$ in) bead of RTV sealant at the joint between the gaskets at the edge of the engine block. Install the timing gear cover. Install the screws for the oil sump and the screws for the timing gear cover and tighten the screws with your fingers. Make sure the oil seal is correctly aligned. Tighten the screws to 9 N.m (80 lbf in).

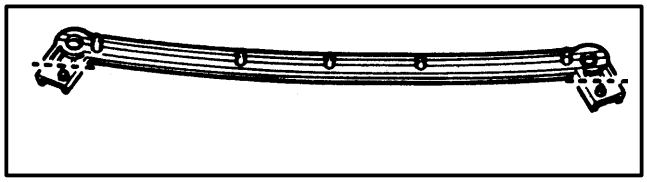


FIGURE 15. SEAL MODIFICATION FOR THE FRONT OF THE OIL SUMP, GM 6–250

6. Remove the centering tool.

NOTE: The vibration dampener on the 3.0L engine is pressed on to the crankshaft and does not use a capscrew.

7. Install the vibration dampener. Use a tool that presses on the center of the vibration dampener. (A special tool, GM Part No. J–23523 is available.) See FIGURE 13. Do not use a tool that pushes on the outside diameter of the vibration dampener. Make sure the hub of the vibration dampener is against the crankshaft gear. Tighten the capscrew for the vibration dampener. See TORQUE SPECIFICATIONS.

8. When used, install the pulley on the vibration dampener. Tighten the capscrews to 44 N.m (35 lbf ft). Install the drive belts.

9. If the coolant system is complete, fill the system with coolant and check for leaks.

CAMSHAFT

Removal

NOTE. The engine is removed from the lift truck for this procedure.

1. Remove the drive belts, fan, and pulley.

2. Remove the timing gear cover. See the procedure under TIMING GEAR COVER, Removal.

3. Remove the rocker arms and push rods as described in "Cylinder Head, Disassembly". Put the parts in a rack so that they will be installed again in the same position.

4. Remove the side cover for access to the hydraulic valve lifters. Remove the hydraulic valve lifters and put them in a rack so that they will be installed again in the same position in the engine block.

5. Remove the fuel pump.

6. Align the timing marks on the timing gears as shown in FIGURE 16. On engines with holes in the timing gear, remove the two capscrews that hold the thrust plate to the engine block. On engines with a capscrew for the timing gear, remove the capscrew and the gear. Remove the two capscrews for the thrust plate.

7. Carefully pull the camshaft from the engine block. Give enough support to the camshaft so that the bearings are not damaged.

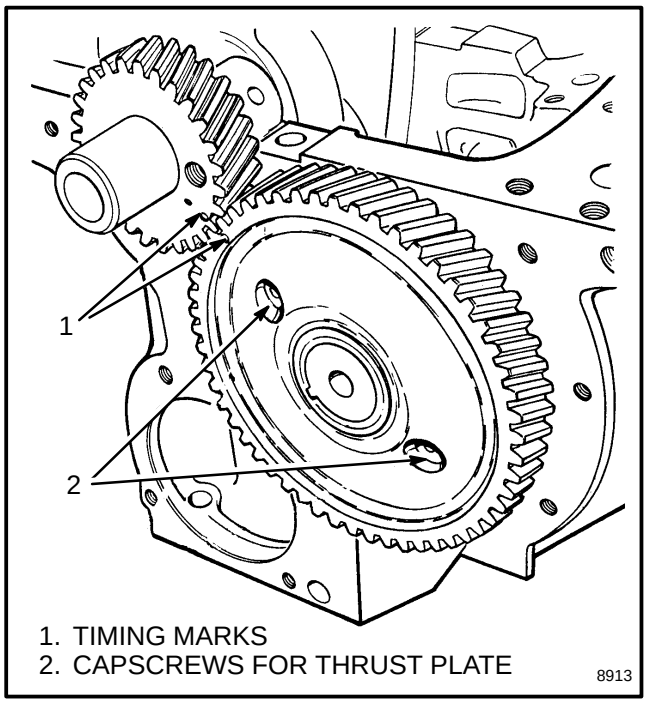


FIGURE 16. TIMING GEARS

Inspection

1. Measure the amount of clearance between the thrust plate and the camshaft as shown in FIGURE 17. If the clearance is greater than 0.203 mm (0.008 in), replace the thrust plate.

If the camshaft gear or the thrust plate must be replaced, the camshaft gear must be removed. A press must be used to remove and install the camshaft gear on the camshaft.

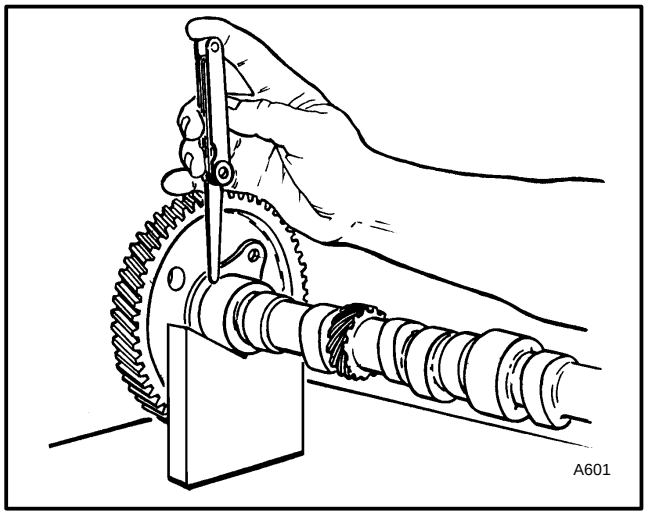


FIGURE 17. CHECK THE CLEARANCE BETWEEN THRUST PLATE AND THE CAMSHAFT

⚠ CAUTION

Make sure the force is applied to the hub of the camshaft gear or the camshaft gear will be damaged. Make sure the woodruff key does not damage the thrust plate during removal or installation.

Check the surfaces of the camshaft for wear and damage. See the ENGINE SPECIFICATIONS, Camshaft.

Camshaft Bearings, Removal

Special tools are required to remove and install the camshaft bearings. See FIGURE 18. Remove the front and rear bearings last.

1. Remove the plug in the bore for the camshaft at the rear of the engine block.

2. Install the removal and installation tool as shown in FIGURE 18. Remove the intermediate bearings.

3. Install the head of the special tool on the end of a driver. Remove the front and rear bearings by pushing them toward the center of the engine block. See FIGURE 19.

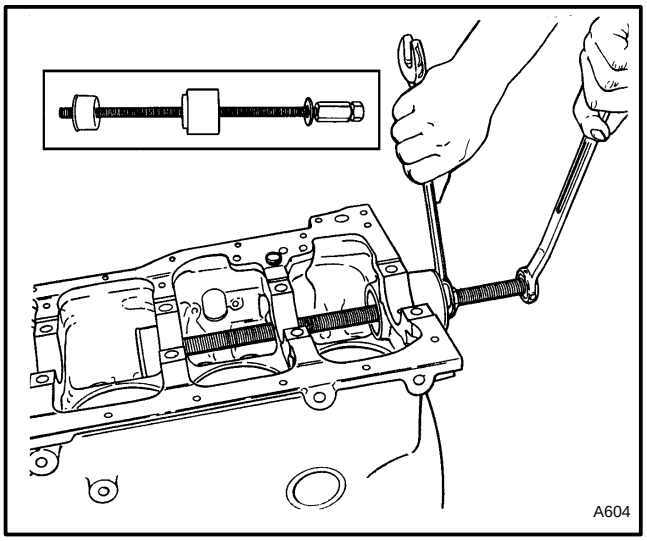


FIGURE 18. CAMSHAFT BEARINGS, REMOVAL AND INSTALLATION

Camshaft Bearings, Installation

⚠ CAUTION

The holes for the oil passages in the camshaft bearings must be aligned with the oil passages in the bore of the engine block. If the oil passages are not aligned correctly, the loss of lubrication will cause a failure of the camshaft bearings or other parts of the engine.

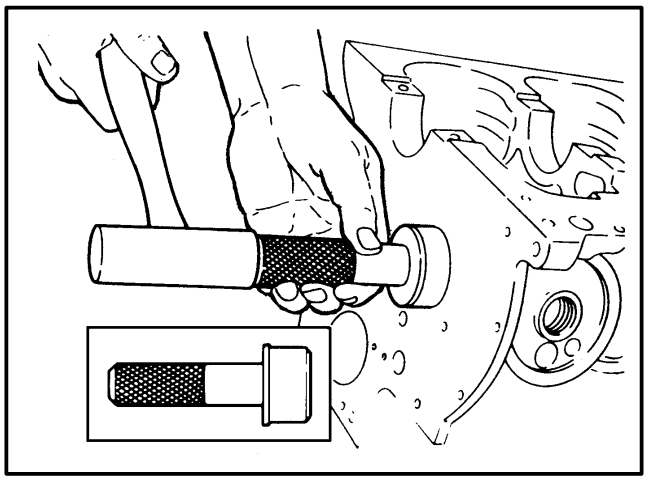


FIGURE 19. CAMSHAFT BEARINGS, REMOVAL AND INSTALLATION

1. Install the front and rear camshaft bearings first. These bearings will be guides for installation of the intermediate bearings. See FIGURE 19. Use the special tool to install the front and rear camshaft bearings.

GM 4–153, 4–181 and 3.0L. The front camshaft bearing must be 3.0 mm (0.12 in) below the surface of the engine block so that the oil passage to the nozzle for the timing gears is open.

2. Install the intermediate camshaft bearings. Use the special tool as shown in FIGURE 18.

3. Install a new plug in the bore in the rear end of the engine block. The surface of the plug must be even with the surface of the engine block or not greater than 0.80 mm (0.03 in) below the surface.

DISTRIBUTOR

NOTE: This section has only the removal and installation procedures for the distributor. The service procedures for the ignition system are found in the following sections:

THE HIGH ENERGY IGNITION SYSTEM, 2200 SRM 107.

THE MICROPROCESSOR SPARK TIMING SYSTEM (MSTS), 2200 SRM 463

Removal

⚠ CAUTION

Carefully lift and release the lock tabs on the connectors to the distributor. The lock tabs can be easily broken if too much force is applied with a screwdriver or other tool.

Never let the TACH CONN. terminal to touch a ground. The HEI module or the ignition coil will be damaged.

1. Disconnect the battery negative (ground) cable.

2. If removal of the spark plug wires are not required for the repairs, leave them connected to the distributor cap. Remove the two capscrews that fasten the distributor cap to the distributor. Move the distributor cap away from the work area.

3. Disconnect the distributor 4–terminal connector.

4. Disconnect the ignition coil connector.

5. Remove the bolt and clamp that hold the distributor in the engine. Make a note of the positions of the rotor to distributor housing and the distributor to the engine. Slowly pull the distributor from the engine until the rotor just stops turning counterclockwise and make a note of the position of the rotor. This position must be used when the distributor is installed again.

If the engine has been rotated after the distributor was removed, the following procedure must be used before the distributor is installed again:

a. Remove the No. 1 spark plug.

b. Put a finger over the No. 1 spark plug hole and slowly rotate the engine until pressure is felt on the compression stroke.

c. Align the timing mark on the crankshaft pulley to 0° (TDC) on the engine timing indicator.

d. Turn the distributor rotor to point between the positions on the distributor cap for No. 1 and No. 4 (or No. 1 and No. 6 for six cylinders) spark plug wires.

e. Install the distributor in the engine. The rotor and shaft will rotate a few degrees when the gear on the distributor shaft engages the drive gear on the engine cam. The timing is correct if the rotor points at the position on the distributor cap for the No. 1 spark plug wire.

f. Continue with the installation of the distributor as described in “Installation”.

Installation

1. Put the rotor and distributor in the same position as it was removed from the engine.

2. Install the clamp and bolt. Tighten the bolt with your hand.

3. Install the distributor connector(s) at the distributor..

4. Install the ignition coil connector.

5. Install the distributor cap and the two capscrews. If the spark plug wires were removed. install them in the correct sequence.

6. Connect the battery negative cable.

7. Start the engine and check the engine timing. See the section for **PERIODIC MAINTENANCE** for your lift truck for procedures on Ignition Timing.

8. Tighten the bolt for the distributor clamp. See TORQUE SPECIFICATIONS.

LUBRICATION SYSTEM

Oil Sump, Removal

1. Disconnect the battery negative cable.

2. Remove the dipstick. Drain the engine oil.

3. Remove the starter.

4. Remove the bolts that fasten the oil sump to the engine block. Remove the oil sump.

Oil Sump, Installation

1. Clean the sealing surfaces on the oil sump and the engine block. Remove old gasket material or sealant.

NOTE: Some engines use a gasket to seal the joint between the oil sump and the engine block. Earlier production engines use a two–piece gasket and separate rear oil seal for the crankshaft. Some later production engines use a one–piece gasket. If a gasket is used in your engine, apply a thin coat of liquid sealant to the gasket surfaces to hold it in position on the oil sump during installation. Other later production engines use an RTV sealant between the oil sump and the engine block. If your engine uses only an RTV sealant, apply a 3.0 mm (0.13 in) bead of sealant around the sealing surfaces of the oil sump.

2. Apply RTV sealant or install the gasket on the oil sump.

3. Install the capscrews that fasten the oil sump to the engine block. Tighten the $^{1}/_{4}$ – 20 capscrews to 10 N.m (7 lbf ft). Tighten the $^{5}/_{16}$ – 18 capscrews to 19 N.m (14 lbf ft).

Oil Pump, Removal

1. Remove the oil sump.

2. Remove the mount bolts and remove the oil pump and screen assembly.

Oil Pump, Disassembly and Repair (See FIGURE 20.)

1. Disassemble the oil pump as necessary for cleaning and inspection. Remove the four screws that fasten the cover (4) to the pump body (8). Remove the cover and gasket.

2. Make an index mark on the gears so that they can be installed again in the same position to each other. Remove the gears. Do not remove the screen and tube assembly (9) unless it is damaged.

⚠ WARNING

The relief valve has a compressed spring. When the pin is removed, do not permit a sudden release of the spring and cause an injury.

3. Remove the pin (3), spring (2), and the relief valve (1).

4. Inspect the gears and the pump body for wear and damage. If the parts are worn or damaged, replace the oil pump. Parts are not available for repairs.

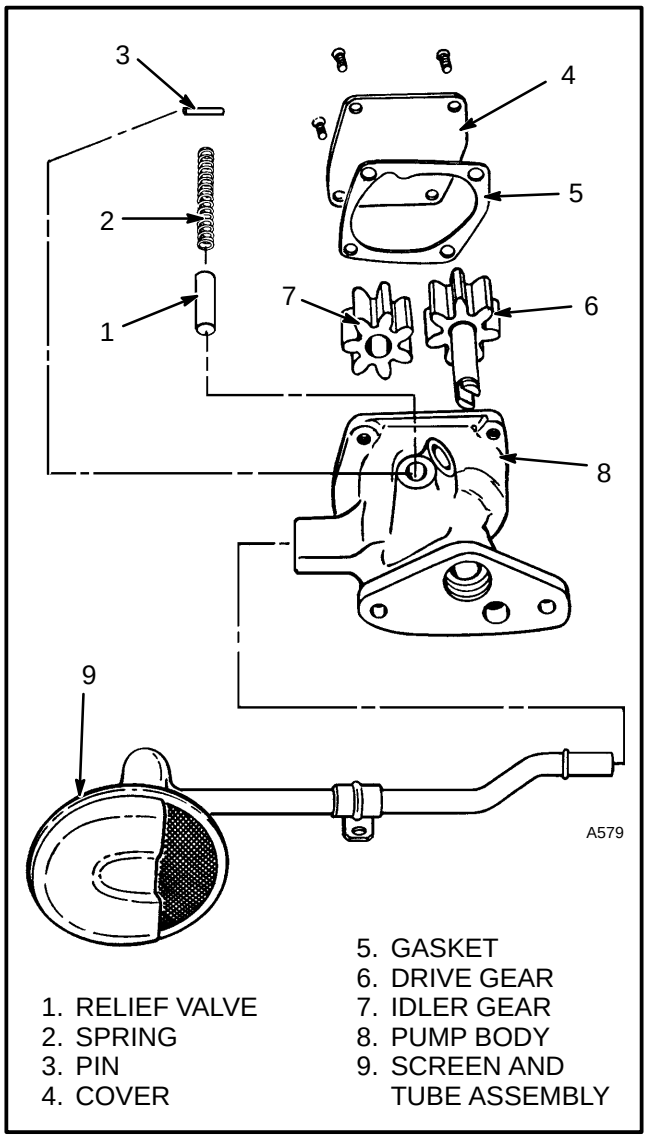


FIGURE 20. OIL PUMP

Oil Pump, Assembly (See FIGURE 20.)

1. Use a sealant when replacement of the screen and tube assembly is necessary. Do not damage the tube during installation. Make sure that the surface of the screen assembly is parallel to the bottom surface of the engine block.

2. If the relief valve was disassembled, install the relief valve (1), spring (2), and pin (3).

3. Install the gears in the pump body. Align the identification marks. Make sure that the smooth side of the idler gear (7) is toward the cover (4).

4. Use a new gasket and install the cover (4). Tighten the screws to 8 N.m (70 lbf in). Turn the drive shaft with your hand to check for a smooth operation.

Oil Pump, Installation

1. Install the oil pump and screen assembly. Make sure the screen is parallel to the bottom of the oil sum when the oil pump is installed.

2. Install the oil sump.

PISTON AND CONNECTING ROD ASSEMBLIES

Connecting Rod Bearings, Replacement

NOTE: The connecting rod bearings are available in a standard size and several undersizes. See the Parts Manual for bearing sizes. If a bearing on a journal is worn, both the upper and lower half of the bearing must be replaced.

1. Remove the oil sump and the oil pump.

2. Before the cap for the connecting rod is removed, mark the connecting rod and cap with the cylinder number so that the parts will be installed again in their original positions. Remove the cap for the connecting rod bearing and the lower bearing half.

3. Push the connecting rod away from the crankshaft and remove the upper bearing half. Wipe the oil from the bearing halves and the bearing journal.

4. Use a micrometer to measure the bearing journal. The bearing journal must be within the following specifications:

Four Cylinder Engines:
Out–of–round less than 0.0127 mm (0.0005 in)
Taper less than 0.0127 mm (0.0005 in)

Six Cylinder Engines
Out–of–round less than 0.0254 mm (0.001 in)
Taper less than 0.0254 mm (0.001 in)

If the bearing journals are not within specifications, the crankshaft must be removed and the bearing journal ground to an undersize. If the bearing journal can not be repaired so that the bearing journal is a correct undersize, the crankshaft must be replaced. See the ENGINE SPECIFICATIONS, Crankshaft.

5. If the bearing journal is within specifications, measure the clearance between the new bearing and the

crankshaft. Use Plastigage® or equivalent to check the clearance:

a. Put a piece of Plastigage across the full width of the bearing journal as shown in FIGURE 21. Do not rotate the crankshaft when the Plastigage is between the bearing and its journal.

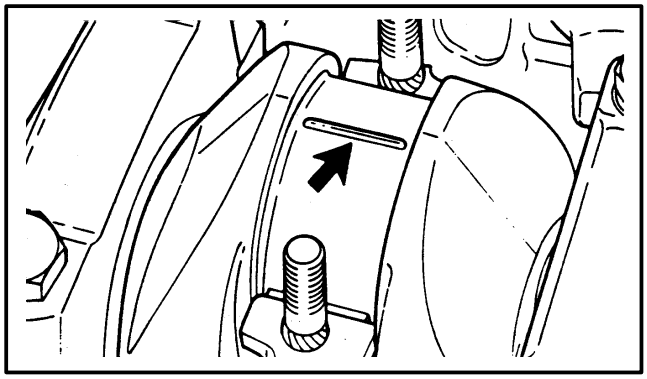


FIGURE 21. PLASTIGAGE® ON A BEARING JOURNAL

b. Remove the bearing cap. The Plastigage will be compressed and wider and will adhere to either the bearing or its journal. Use the scale on the envelope for the Plastigage to measure the width of the plastic at its widest point. The scale will indicate the clearance in millimetres or thousandths of an inch. See FIGURE 22.

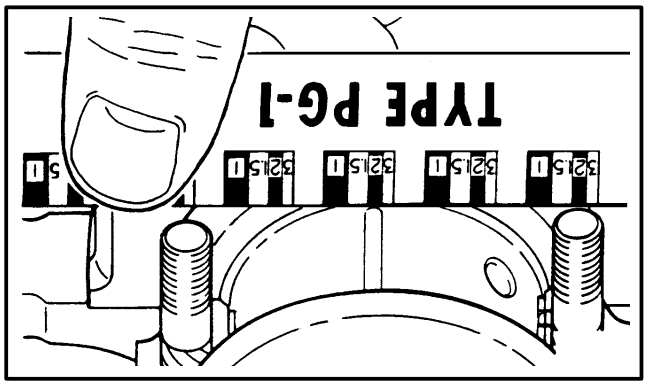


FIGURE 22. MEASURE THE PLASTIGAGE® ON A BEARING JOURNAL

c. If the clearance is greater than the specifications, select a new undersize bearing set and install it. Measure the clearance again. If the clearance can not meet specifications with the available undersize bearings, the bearing journal must be ground to a new undersize. If the bearing journal is already at the maximum undersize, the crankshaft must be replaced.

d. If the clearance is within specifications, lubricate the bearing with engine oil and install the bearing and bearing cap. Tighten the nuts on the bearing cap. See TORQUE SPECIFICATIONS.

6. When all of the rod bearings have been replaced, use the following procedure to check the side clearances between the connecting rods and the crankshaft:

a. Use a hammer to lightly hit the connecting rod parallel to the crankshaft journal to make sure there is a clearance.

b. Measure the clearance between the caps for the connecting rods and the crankshaft. See FIGURE 23.

Piston And Connecting Rod Assemblies, Removal

1. Remove the oil sump and the oil pump.

2. Remove the cylinder head as described in Cylinder Head, Removal.

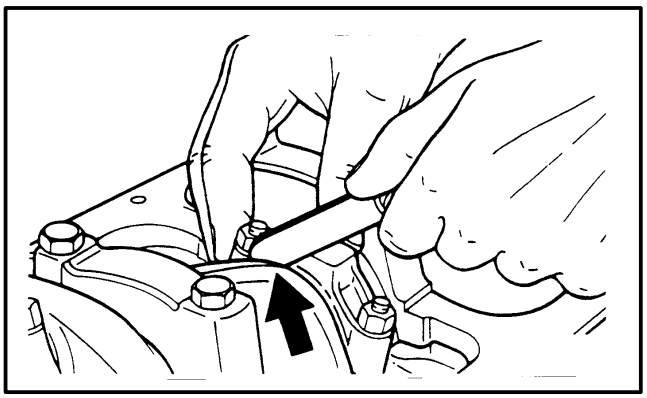


FIGURE 23. MEASURE THE SIDE CLEARANCE, CONNECTING RODS

3. If the engine has been in service for many hours, a ridge can be worn in the top of the cylinder. This ridge can be removed with a ridge reamer tool. Turn the crankshaft to lower the piston to the bottom of the stroke in its cylinder. Put a cloth on top of the piston for a collector of metal particles. Remove the ridge at the top of the cylinder.

4. Clean the carbon from the top of each cylinder.

5. Put an identification mark on the top of each piston.

6. Remove the caps and bearings from each connecting rod. Keep the caps and bearings with their original piston assemblies. Mark the caps so that they will be in-

stalled again in their original positions. Do not mix the parts.

7. Push the connecting rod and piston from the cylinder. Temporarily install the bearing cap on the connecting rod to keep the parts together.

Disassembly

⚠ CAUTION

The pistons are aluminum alloy and can be damaged if they are hit with a hard object. The grooves for the piston rings are machined to close tolerances. Use a tool made to clean the grooves of the piston rings. Do not use a wire brush to clean a piston.

1. Remove the piston rings from the pistons. Use a press to remove the piston pins from the piston. See FIGURE 24.

2. Use solvent to clean the pistons and connecting rods. Use compressed air to dry the parts. Make sure that the holes for oil passages are clean.

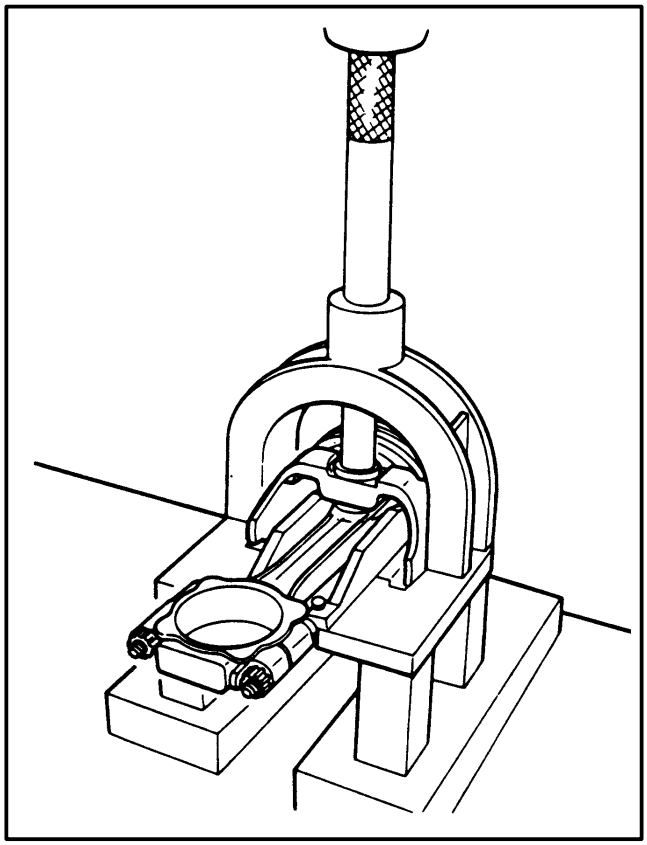


FIGURE 24. PISTON PIN REMOVAL

Piston, Cleaning And Inspection

Inspect the pistons for wear, cracks, and damage. Replace a piston that is worn or damaged.

NOTE: If the cylinder bore must be repaired the piston must be changed to the correct oversize. Check the clearance of the piston in its cylinder after the surface of the cylinder bore has been finished with a hone.

Check the clearance of the piston pin in the piston. The normal clearance is shown in the ENGINE SPECIFICATIONS. The piston pin will normally fall from the hole in the piston by its own weight. The piston pin is a press fit in the connecting rod. The piston and piston pin are a matched set and must be replaced as a unit if the clearances are greater than the specifications.

Cylinder Bores, Inspection And Repair

Inspect the cylinder bores for wear and damage. Measure the cylinder bores in several positions as shown in FIGURE 25. Measure the cylinder bore at right angles to the centerline to find any distortion from wear. A cylinder that is out–of–round greater than 0.05 mm (0.002 in) must be repaired.

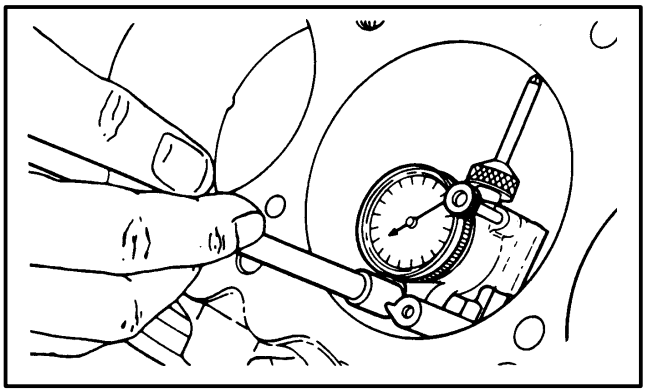


FIGURE 25. MEASURE THE CYLINDER BORE

Measure the cylinder bore in positions from top to bottom to find any taper from wear. A normal wear pattern for a cylinder bore is shown in FIGURE 26. A cylinder that has a taper [measurement “A” that is 0.127 mm (0.005 in) greater than measurement “B”] must have a new bore. A tool called a hone can be used to remove a small amount of taper from a cylinder bore. Use a boring machine to repair a badly worn cylinder. The boring machine will make a more accurate cylinder bore. The hone is then used to finish the surface of the cylinder bore.

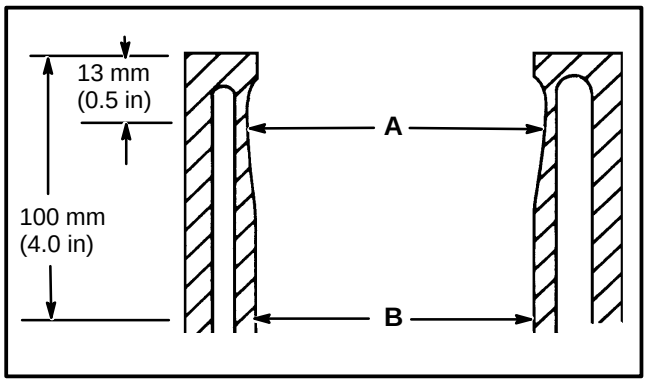


FIGURE 26. PATTERN FOR NORMAL CYLINDER WEAR

A cylinder bore that has been repaired with a hone or a boring machine must be fitted with a piston that is the correct size. Measure the outer diameter of the piston and the inner diameter of the cylinder bore as shown in FIGURE 27. Using different oversize pistons in the engine does not affect the dynamic balance of the engine. Replacement pistons from standard size to 0.030 in oversize normally have the same weight. The clearance specifications between a piston and its cylinder bore is shown in the ENGINE SPECIFICATIONS.

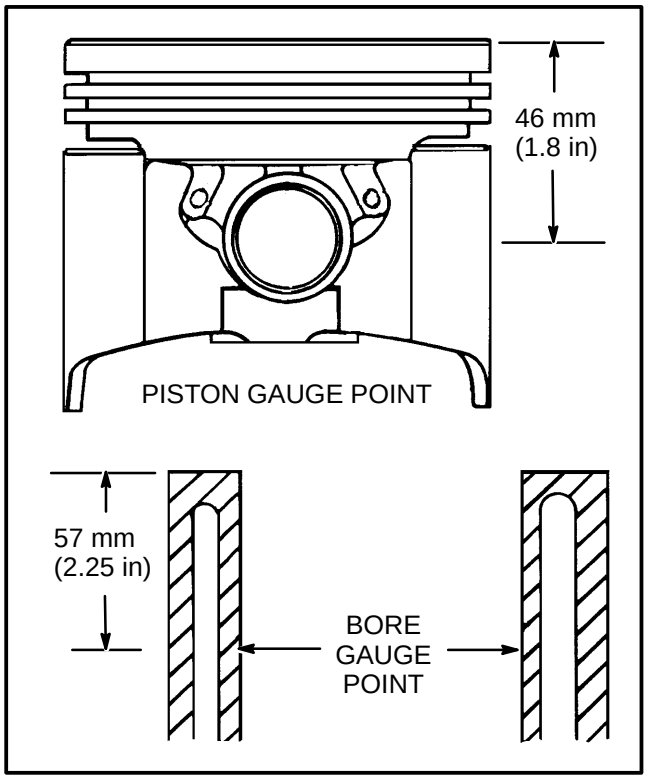


FIGURE 27. GAUGE POINTS FOR PISTON AND CYLINDER BORE

Piston Rings

NOTE: Check the clearance of the piston rings in the cylinder after the surface of the cylinder has been finished with a hone. New piston rings are available for the several piston size. See the Parts Manual for sizes. The piston rings must match the size of the piston on which they are installed. Check the side clearance and the end clearance of the piston rings as described in the following paragraphs.

Each compression ring has a mark on one surface. This mark must be toward the top of the cylinder when the piston ring is installed. The No. 1 compression ring normally has a chrome or molybdenum surface.

The oil control ring has three pieces. There are two thin steel rings separated by a spacer.

1. Measure the clearance between the piston ring and the groove in the piston as shown in FIGURE 28. The clearances are shown in the ENGINE SPECIFICATIONS. Replace the piston if the clearances are greater than the specifications.

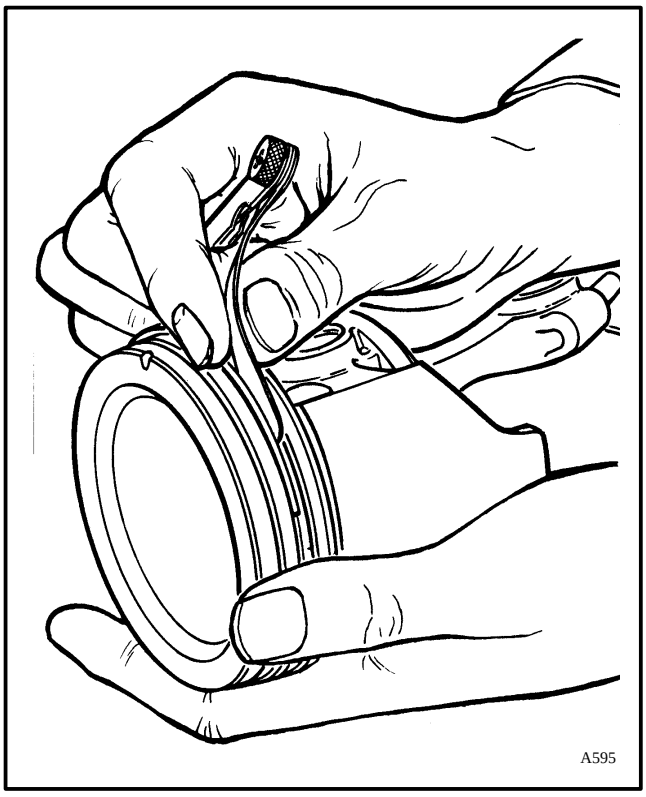


FIGURE 28. CHECK THE CLEARANCE BETWEEN THE PISTON RING AND THE GROOVE

2. Measure the end clearance of each piston ring as shown in FIGURE 29. The end clearances are shown in the ENGINE SPECIFICATIONS. Install the piston ring into the cylinder where it will be used. Use a thickness gauge to measure the amount of end clearance. Replace the piston if the clearances are greater than the specifications.

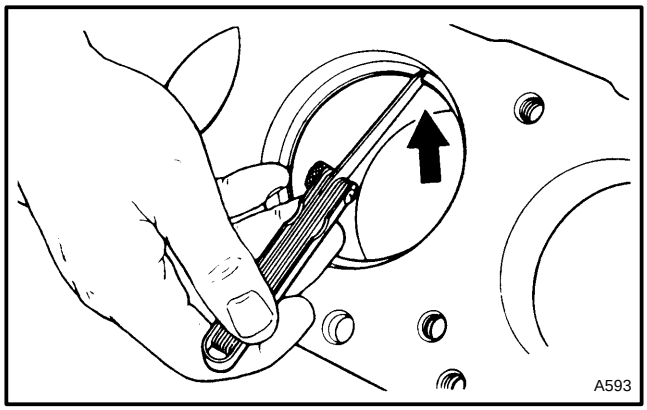


FIGURE 29. CHECK THE END CLEARANCE OF THE PISTON RINGS

Assembly

NOTE: There are notches cast in the top of all pistons to indicate the correct assembly and installation. The pistons must always be installed with this notch toward the fan end of the engine. See FIGURE 33.

The connecting rods have a notch cast in the bearing journal as shown in FIGURE 30. This notch must be opposite the notch on the top of the piston when the piston and connecting rod are assembled.

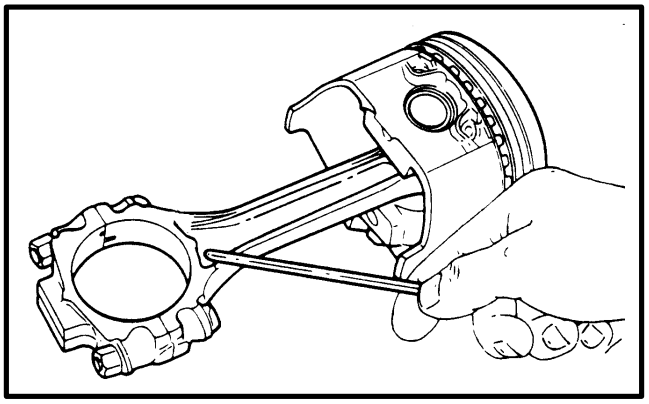


FIGURE 30. CONNECTING ROD IDENTIFICATION

1. Assemble the connecting rod to the piston. Make sure the orientation of the connecting rod and piston are correct as described in the NOTE above. Use a press to install the piston pin into the piston and connecting rod. Lubricate the piston pin with engine oil during installation.

2. Check the clearances of the piston rings as described in “Piston Rings”. Install the piston rings on the piston as shown in FIGURE 31.

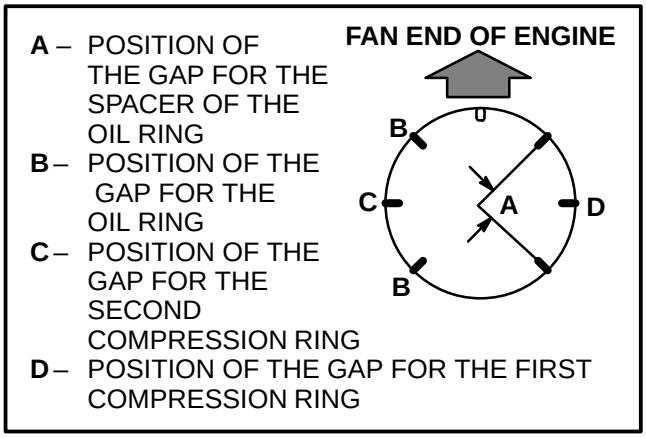


FIGURE 31. ARRANGEMENT OF THE PISTON RINGS ON THE PISTON

Piston And Connecting Rod Assemblies, Installation

1. Lubricate the assembly with engine oil during installation. Arrange the piston rings on the piston as shown in FIGURE 31. Install a ring compressor on the piston as shown in FIGURE 32.

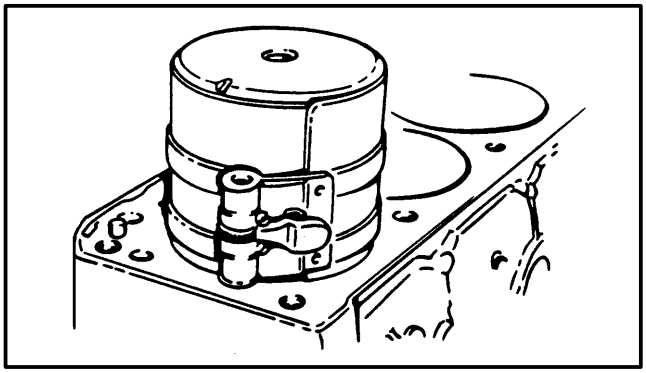


FIGURE 32. INSTALL A RING COMPRESSOR

2. Make sure that the notch in the piston is toward the fan end of the engine as shown in FIGURE 33. Install the piston and connecting rod assemblies in the cylinder bores.

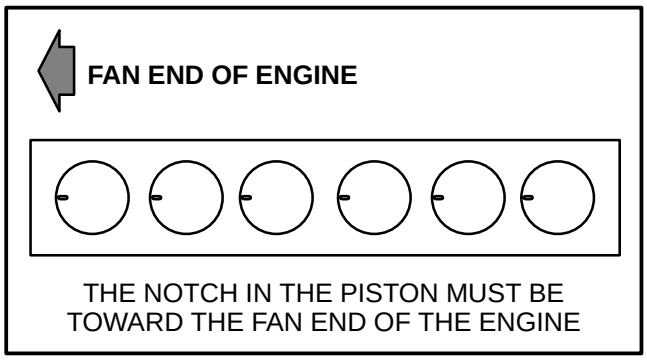


FIGURE 33. POSITION OF THE PISTON IN THE CYLINDER

3. Install the bearings and the caps for the connecting rods. Tighten the nuts. See TORQUE SPECIFICATIONS. Check the side clearance of each connecting rod after the bearing cap is installed. See the procedure in the paragraphs under "Connecting Rod Bearings, Replacement".

4. Install the cylinder head as described in "Cylinder Head, Installation".

5. Install the oil sump and the oil pump.

CRANKSHAFT

Main Bearings, Replacement

NOTE: The following procedure is for replacement of the main bearings without removing the crankshaft from the engine.

1. Remove the oil sump and the oil pump as described in the procedures under LUBRICATION SYSTEM.

2. Remove the cap on the main bearing that needs replacement. Remove the bearing half from the cap.

3. The rear main bearing does not have an oil hole. Use the following procedure to replace the upper half of the rear main bearing:

a. Use a small drift punch and a hammer to start the bearing half from the engine block.

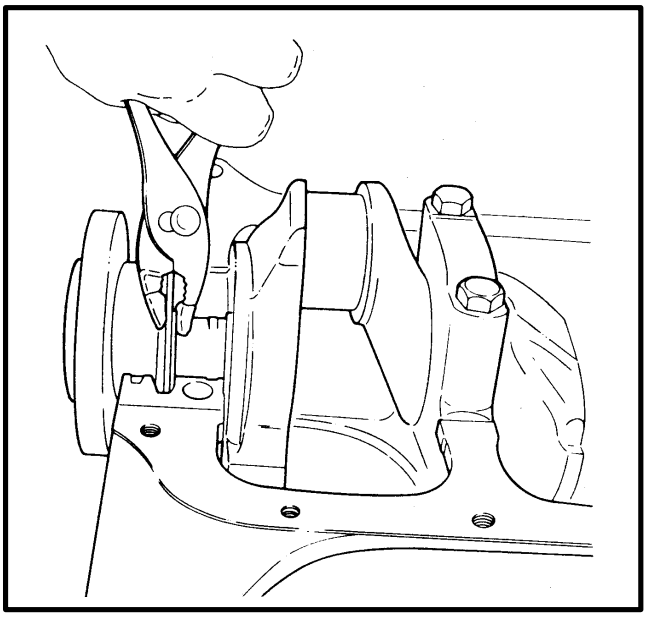


FIGURE 34. REAR MAIN BEARING REPLACEMENT

b. Put some tape on a pair of pliers to make soft jaws. Use the pliers to hold the thrust surface of the bearing to the oil control ring of the crankshaft. See FIGURE 34. Turn the crankshaft to remove the upper bearing half.

c. Lubricate a new bearing half of the correct size with engine oil. Insert the end of the bearing without the notch between the crankshaft and the side of the engine block with the notch.

d. Use the pliers described in step b to rotate the bearing half into position.

4. The other crankshaft journals have oil holes. Use the following procedure to replace the upper half of the main bearing:

a. Put a thin rod or a bent cotter pin through the oil hole in the crankshaft to contact the main bearing half.

b. Rotate the crankshaft clockwise as seen from the fan end of the engine. This movement will rotate the main bearing half from the engine block.

c. Lubricate a new bearing half of the correct size with engine oil. Insert the end of the bearing without the notch between the crankshaft and the side of the engine block with the notch.

d. Rotate the main bearing half into position in the engine block.

Oil Seal For The Rear Main Bearing, Replacement (GM 4–181 and 3.0L Only)

The oil seal is a one–piece unit that can be replaced without removal of the oil sump or the crankshaft. See FIGURE 36. The transmission must be disconnected from the engine.

1. Remove the flywheel.

2. Use a screwdriver or small prybar to carefully remove the oil seal from the engine.

3. Clean the surface of the engine block area for the oil seal.

4. Lubricate the oil seal with engine oil and carefully install it.

5. Install the flywheel and tighten the bolts. See TORQUE SPECIFICATIONS.

Oil Seal For The Rear Main Bearing, Replacement (Engines That Have A Two–Piece Oil Seal)

NOTE: The following procedure is for replacement of the oil seal for the rear main bearing without removing the crankshaft from the engine. Always replace both halves of the oil seal as a unit.

This procedure requires careful work so that the oil seal is not damaged during installation. The seal bead in the channel on the outside diameter of the oil seal must be protected during installation. An oil seal installation tool can be made from a piece of 0.10 mm (0.004 in) shim stock. See FIGURE 35.

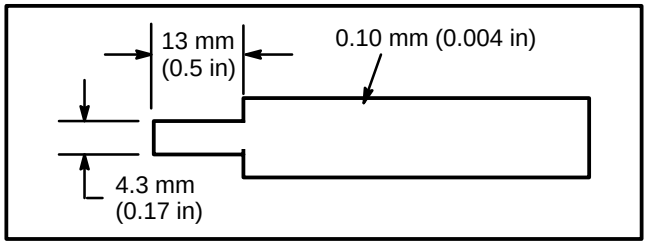
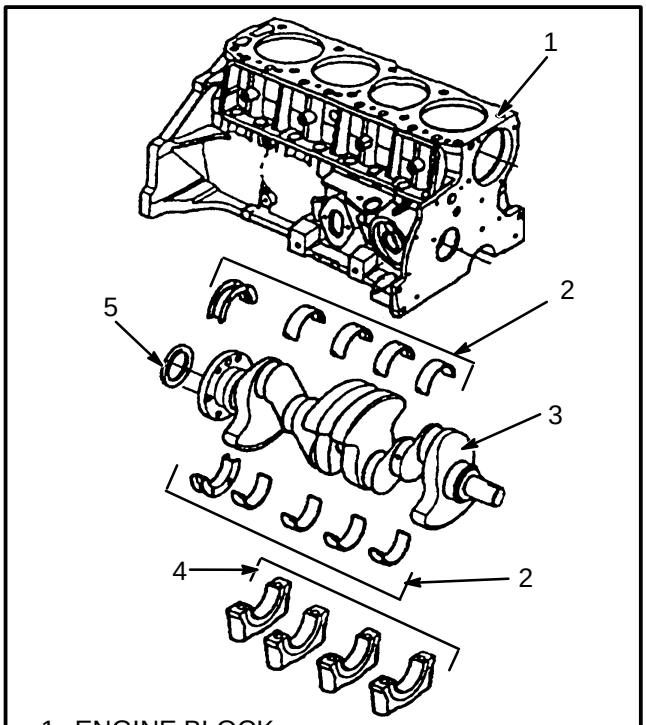


FIGURE 35. INSTALLATION TOOL FOR REAR OIL SEAL

1. The oil sump and the oil pump must be removed. Remove the cap for the rear main bearing.

2. Use a small screwdriver to remove the lower half of the oil seal from the main bearing cap. See FIGURE 37.



1. ENGINE BLOCK
2. MAIN BEARINGS
3. CRANKSHAFT
4. MAIN BEARING CAPS
5. REAR OIL SEAL

FIGURE 36. GM 3.0L, CRANKSHAFT, MAIN BEARINGS, AND OIL SEAL

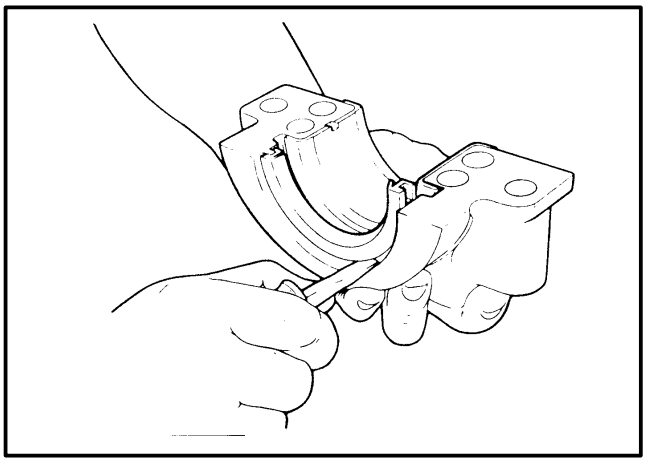


FIGURE 37. OIL SEAL, REMOVAL OF LOWER HALF

3. Use a hammer and a small punch. Lightly hit one end of the upper oil seal half to rotate it until it can be removed with a pair of pliers. See FIGURE 38.

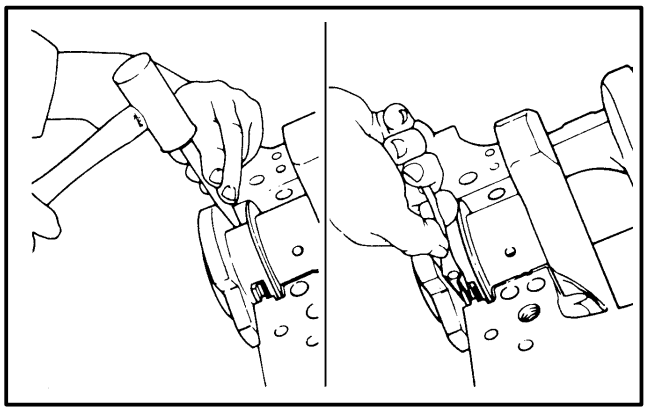


FIGURE 38. OIL SEAL, REMOVAL OF UPPER HALF

4. Clean the area for the oil seal in the engine block and main bearing cap.

5. Lubricate the lips and bead of the oil seal with engine oil. Keep oil from the end surfaces of the oil seal.

6. Put the tip of the tool shown in FIGURE 35. in position between the crankshaft and the cavity for the oil seal in the engine block. Put the oil seal between the engine block and the tip of the tool so that the bead on the oil seal is against the tip of the tool. Make sure the lip of the oil seal is toward the fan end of the engine. See FIGURE 39.

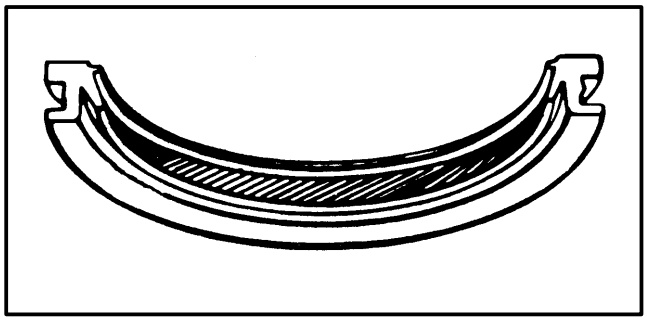


FIGURE 39. OIL SEAL HALF, REAR MAIN BEARING

7. Carefully rotate the oil seal around the crankshaft until both ends are even with the surface of the engine block. Use the tool to protect the bead on the oil seal from the sharp edge of the engine block.

8. Carefully remove the tool. Make sure the bead is not damaged.

9. Install the lower half of the oil seal in the cap for the main bearing. Make sure the ends of the oil seal are even with the surfaces of the main bearing cap.

10. Remove any engine oil from the ends of the oil seal, both upper and lower halves. Apply a thin coat of sealant ONLY to the ends of the oil seal. Do not permit any sealant on the surfaces where the main bearing cap joins the engine block. See FIGURE 40.

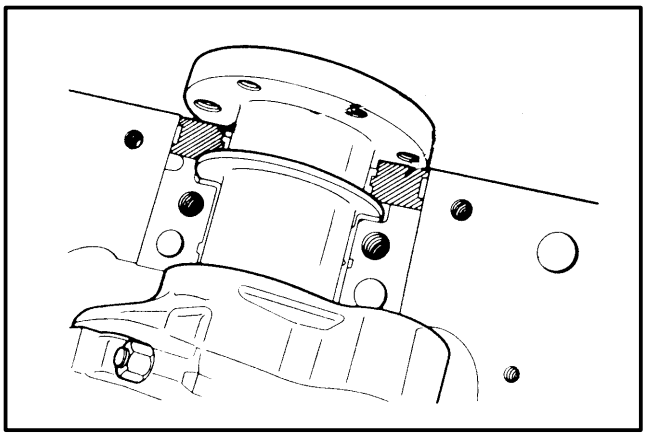


FIGURE 40. APPLY SEALANT TO ENDS OF THE OIL SEAL

11. Install the cap for the rear main bearing. and tighten the capscrews to an initial torque of 14 N.m (10 lbf ft). Use a hammer to lightly hit the crankshaft and move it forward against the rear main bearing. Then use the hammer to lightly hit the crankshaft and move it backward against the rear main bearing. This procedure is to align the thrust surfaces on the rear main bearing. Tighten the capscrews for the main bearing cap. See TORQUE SPECIFICATIONS.

Crankshaft, Removal

1. Remove the flywheel housing and the flywheel.

2. Remove the oil sump and the oil pump as described in the procedures under LUBRICATION SYSTEM.

3. Remove the crankshaft pulley or vibration dampener and timing gear cover as described in the procedures under TIMING GEAR COVER.

4. Remove the bearing caps for the connecting rods as described in the procedures under PISTON AND CONNECTING ROD ASSEMBLIES. If the piston and connecting rod assemblies will not be removed for repair, push them to the top of their bores so that they are away from the crankshaft.

5. Remove the caps for the main bearings. Make sure that there are identification marks on the caps so that they can be installed again in the same position.

6. Carefully remove the crankshaft from the engine block.

7. Remove the oil seal for the rear main bearing. Remove the main bearings from the crank case and the main bearing caps.

Inspection and Repair

1. Clean the crankshaft with solvent and dry it with compressed air.

2. Inspect the crankshaft for cracks or other damage.

3. Inspect the crankshaft for wear and damage. See FIGURE 41. Use a micrometer to measure the journals for the bearings of the crankshaft. Do the measurement at different positions to see if the surface of the bearing is round. The correct sizes are given in the ENGINE SPECIFICATIONS.

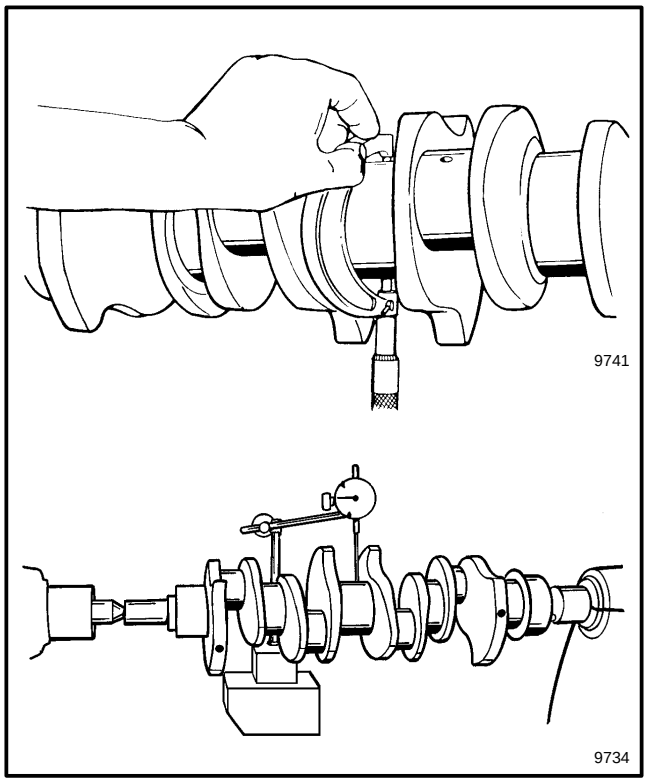


FIGURE 41. CRANKSHAFT INSPECTION

4. If the crankshaft journals must be repaired, they can be ground to a smaller (undersize) than the original size. See the **PARTS MANUAL** for available bearing sizes**.**

When the crankshaft is assembled by the manufacturer, the main bearings are specially selected to obtain close tolerances. For this reason, you can find one–half of a standard size insert with one–half of a 0.001 in undersize insert. This combination will decrease the clearance 0.0005 in from using a full standard bearing.

When a production crankshaft can not be fitted with this method, the main journal is then ground 0.009 in undersize. Only those main bearing journals that can not be fitted with standard, 0.001 in or 0.002 in undersize main bearing will be ground. A 0.009 in and a 0.010 in undersize bearings will be selected as described to obtain close tolerances.

A production crankshaft that has been ground will have the following identification:

- The crankshaft journal that has been ground will have a “9” marked in the metal of the crankshaft next to the journal. A spot of light green paint is also added to the crankshaft.
- The main bearing cap is also marked with green paint.

How To Check The Clearance Between The Main Bearings And Their Journals

1. Use Plastigage or equivalent to check the clearance. The procedure is similar for both connecting rod bearings and main bearings. If the engine has been removed from the lift truck put the engine so that the crankshaft is up. The weight of the crankshaft is against the upper bearing half and the total clearance can be measured correctly. If the engine is still in the lift truck, the crankshaft must have a support to remove any additional clearance between the upper bearing half and its journal.

2. All main bearing caps must be installed and their capscrews tightened to the specifications.

3. Check the rear main bearing first. Remove the cap for the rear main bearing. The procedure for checking the clearance of the other bearings is similar.

4. Clean the oil from the bearing half and journal to be checked. Put a piece of Plastigage across the full width of the bearing journal as shown in FIGURE 21. Do not rotate the crankshaft when the Plastigage is between the main bearing and its journal.

5. Install the main bearing cap and tighten the capscrews. See TORQUE SPECIFICATIONS. The capscrews must be tightened to their final torque or there will be an error in the measurement.

6. Remove the main bearing cap. The Plastigage will be compressed and wider and will adhere to either the bearing or its journal. Use the scale on the envelope for the Plastigage to measure the width of the plastic at its widest point. The scale will indicate the clearance in millimetres or thousandths of an inch. See FIGURE 22.

7. If the clearance is greater than the specifications, select a new undersize bearing set and install it. Measure the clearance again. If the clearance can not meet specifications with the available undersize bearings, the bearing journal must be ground to a new undersize. If the bearing journal is already at the maximum undersize, the crankshaft must be replaced.

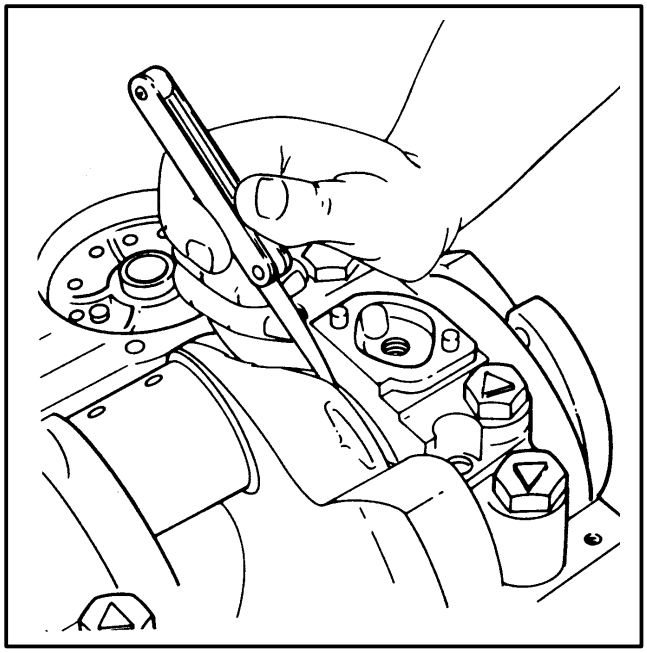


FIGURE 42. MEASURE THE AXIAL CLEARANCE OF THE CRANKSHAFT

8. If the clearance is within specifications, lubricate the bearing with engine oil and install the main bearing and bearing cap. Tighten the capscrews on the main bearing cap to the correct specifications.

9. Turn the crankshaft to make sure it rotates smoothly.

10. Check the axial clearance between the rear main bearing and the thrust surface. Push the crankshaft forward. See FIGURE 42. Measure the clearance between the crankshaft and the thrust surface of the rear bearing. The correct clearance is 0.05 to 0.15 mm (0.002 to 0.006 in).

Installation

1. If the engine has a two–piece oil seal, install a new oil seal for the crankshaft. Apply engine oil to the oil seal during installation. Do not permit any oil on the ends of the oil seal. See FIGURE 40. Install the oil seal so that the lip is toward the fan end of the engine. See “Oil Seal For The Rear Main Bearing, Replacement (Engines That Have A Two–Piece Oil Seal)” for additional information about the rear oil seal.

2. Lubricate new main bearing halves with engine oil and install them in the bearing housing of the engine block.

3. Carefully install the crankshaft in the engine block.

4. Lubricate the lower halves of the main bearings and install them in their caps. Install each main bearing cap in its position on the engine block. Make sure each main bearing cap is installed in its original position. If a main bearing cap is not installed correctly, there can be an alignment problem which will cause rapid wear and possible damage to the engine.

5. Use the following procedure to install the cap for the rear main bearing:

a. Install the cap for the rear main bearing. and tighten the capscrews to an initial torque of 14 N.m (10 lbf ft). Use a hammer to lightly hit the crankshaft and move it forward against the rear main bearing. Then use the hammer to lightly hit the crankshaft and move it backward against the rear main bearing. This procedure is to align the thrust surfaces on the rear main bearing. Tighten the capscrews for the main bearing cap. See TORQUE SPECIFICATIONS.

b. Check the clearance between the rear main bearing and the thrust surface. Push the crankshaft forward. Measure the axial clearance between the crankshaft and the thrust surface of the rear bearing. See FIGURE 42.

6. Check the clearance between the main bearing and its crankshaft journal. See “How To Check The Clearance Between The Main Bearings And Their Journals”.

7. Install the piston assemblies as described in “Piston And Connecting Rod Assemblies, Installation”.

8. Install the oil pump and the oil sump as described in the LUBRICATION SYSTEM.

FLYWHEEL AND FLYWHEEL HOUSING

Some models of lift trucks have an oil clutch. Before the flywheel is removed, check for an even surface on the face of the flywheel. Fasten a dial indicator to the engine as shown in FIGURE 43. Turn the flywheel and check the variations indicated by the dial indicator. Make a note of the high indication and the low indication. If the difference between the indications are more than 0.20 mm (0.008 in), replace the flywheel.

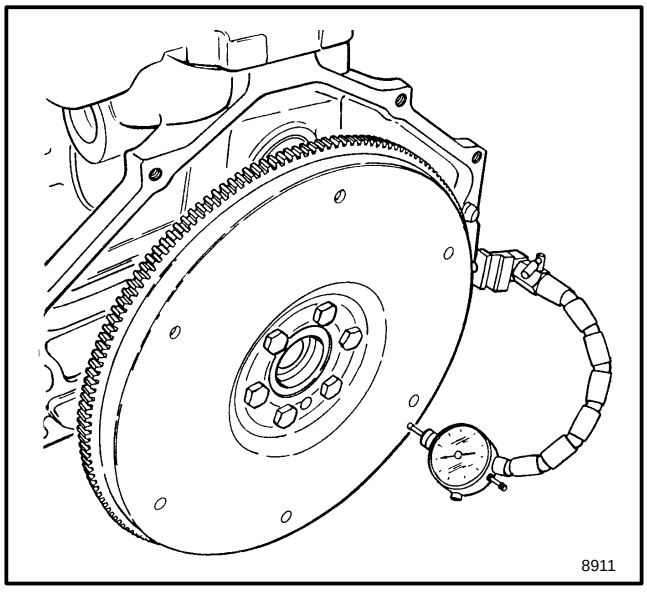


FIGURE 43. CHECK THE SURFACE OF THE FLYWHEEL

Some lift trucks have a hydraulic pump drive assembly that is part of the flywheel and flywheel housing. See **THE HYDRAULIC PUMP DRIVE ASSEMBLY, 1900 SRM 64** for additional information on the S30–120E, S40–50F, H30–60H, H40–60J, H60JS, and H60–110E lift trucks. See **THE HYDRAULIC PUMP DRIVE ASSEMBLY, 1900 SRM 339** for additional information on the S/H2.00–3.00XL (S/H40–60XL) lift trucks.

MODEL	DIMENSION "X"
S/H 2.00–3.00XL (S/H40–60XL)	28.4 to 28.6 mm (1.118 to 1.125 in)

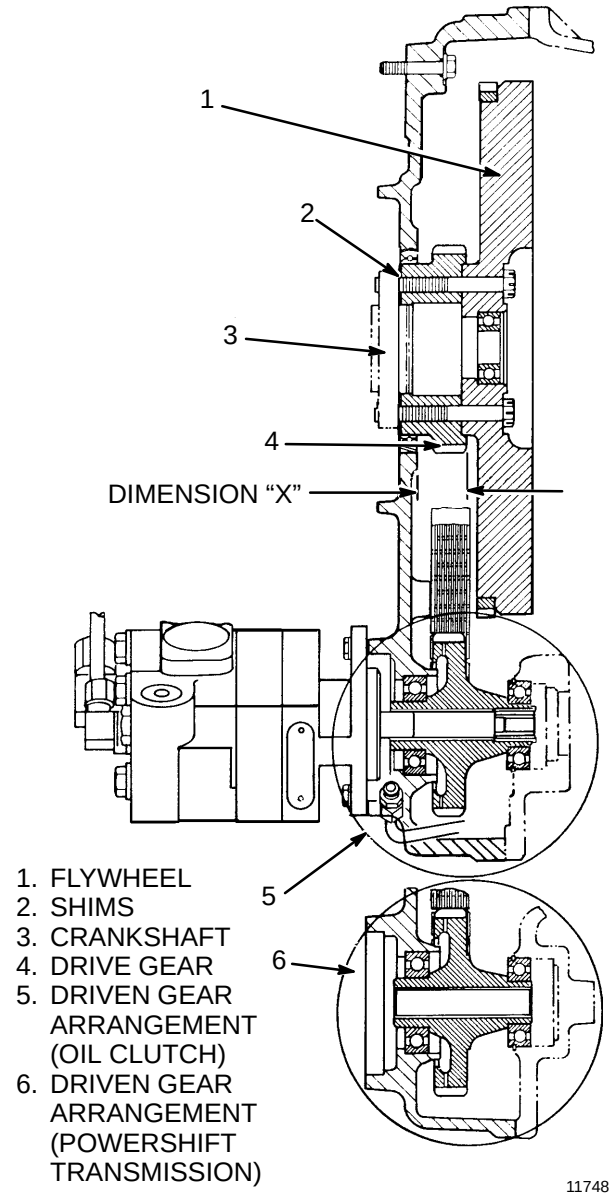


FIGURE 44. FLYWHEEL ARRANGEMENT WITH HYDRAULIC PUMP DRIVE ASSEMBLY

Flywheel, Removal (See FIGURE 45.)

1. Remove the engine from the lift truck and separate the engine from the transmission.

2. Make alignment marks between the flywheel and the crankshaft so the parts will be assembled again in their original positions.

3. Remove the oil sump and the rear main bearing cap from the engine.

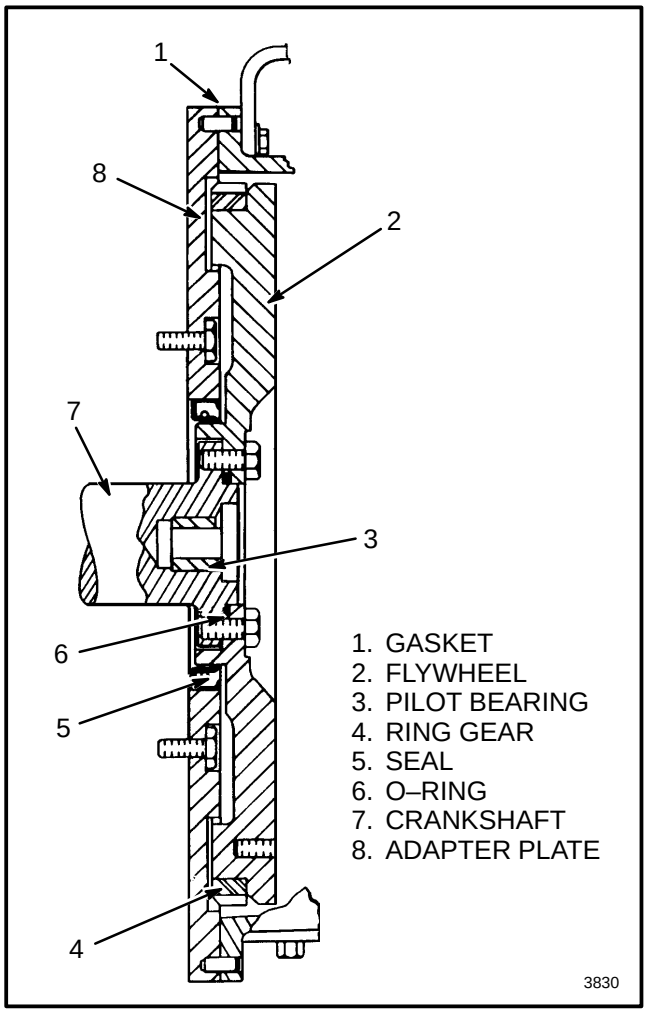


FIGURE 45. FLYWHEEL ARRANGEMENT FOR A TYPICAL OIL CLUTCH

4. Remove the capscrews that fasten the flywheel to the crankshaft. If there are dowel pins installed, use a hammer and driver to remove the dowel pins from the flywheel and crankshaft. Rotate the crankshaft as necessary so that the dowel pins will not hit the engine block as they are removed.

5. Remove the flywheel. Discard the dowel pins on the GM 6–250.

Ring Gear, Replacement

⚠ WARNING

Wear eye protection for this operation to prevent eye injury from metal chips. You will be using a hammer and driver to remove the ring gear.

1. Use the following procedure to remove the ring gear on the flywheel:

a. During removal or installation, do not heat the ring gear greater than 230°C (450°F). Heat the circumference of the ring gear evenly and carefully remove it from the flywheel with a hammer and driver.

⚠ WARNING

Hot parts. Wear protective clothing and gloves to prevent burns.

b. Heat the new ring gear to 200°C (395°F) in an oven and install the ring gear on the flywheel. Push the ring gear fully against the shoulder of the flywheel.

c. The pilot bearing in the flywheel can be replaced. Push the old bearing from the flywheel and push in a new bearing.

Flywheel, Installation

1. Install a new oil seal in the adapter plate on lift trucks that have an oil clutch. Use a sealant on the outside of the seal during installation.

2. Apply a sealant to the flange of the adapter plate. Install the adapter plate to the engine.

3. Install a new O–ring to the flywheel for lift trucks that have an oil clutch transmission.

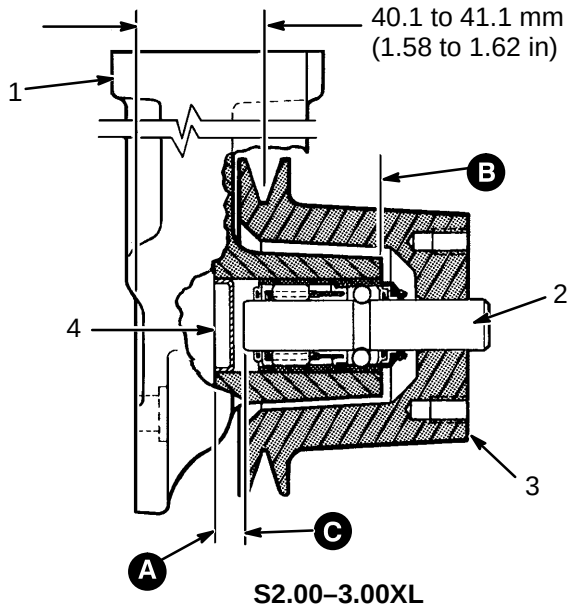
4. Install the flywheel to the crankshaft. Apply a sealant to the capscrews that hold the flywheel to the crankshaft.

5. Tighten the capscrews. See TORQUE SPECIFICATIONS.

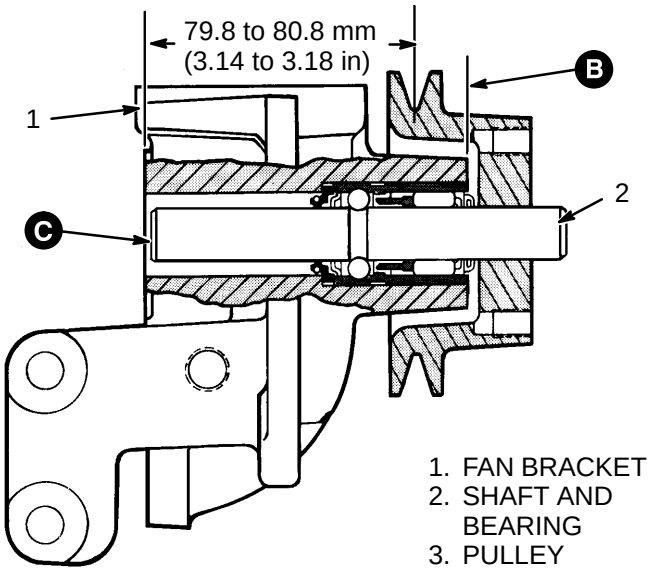
COOLING SYSTEM

Coolant Pump

If any parts of the coolant pump are worn, replace the coolant pump. Parts for the coolant pump are not available separately. During installation, apply a sealant to the gasket for the coolant pump. Adjust the tension of the drive belt as described in the section **PERIODIC MAINTENANCE**.



S2.00–3.00XL
(S40–60XL)



1. FAN BRACKET
2. SHAFT AND BEARING
3. PULLEY
4. PLUG

S40–50F, H40–50J–60JS,
H30–60H (E3), H30–60H (D3)

A HOLD THE BRACKET ON THIS SURFACE WHEN THE BEARING IS PRESSED INTO THE BRACKET.

B PRESS THE BEARING INTO THE BRACKET UNTIL THE BEARING AND BRACKET ARE EVEN.

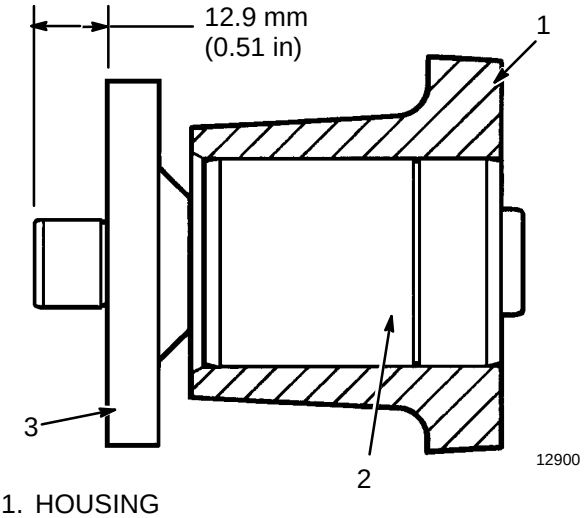
C USE A SUPPORT ON THE SHAFT WHEN YOU PRESS THE PULLEY ONTO THE SHAFT.

12588

FIGURE 46. ASSEMBLY, FAN DRIVE

Fan Drive

See FIGURE 47. and FIGURE 46. for the correct assembly procedures for the fan drive.



1. HOUSING
2. SHAFT AND BEARING
3. HUB

FIGURE 47. FAN DRIVE, 3.0L ENGINE

Viscous Fan Drive

Some lift trucks have a viscous fan drive. The viscous fan drive is a fluid coupling between the cooling fan and a pulley on the engine. The fluid coupling permits the cooling fan to rotate at a different speed than the engine speed. The fluid coupling also controls the maximum speed of the cooling fan. The cooling fan can be rotated by hand when the engine is not running. If the engine temperature is above normal, check the following parts of the cooling system:

- coolant level
- damaged hose or restrictions to coolant flow
- operation of the thermostat
- restriction to the rotation of the cooling fan
- restrictions that stop the air from flowing freely through the radiator

If these parts of the cooling system are normal when the engine temperature is above normal, check the viscous fan drive.

Do the following procedure to check the viscous fan drive:

Stop the engine. Rotate the cooling fan and fan drive by hand. The rotation must be smooth with some resistance. A small amount of movement side–to–side will occur at the tips of the fan blades because of bearing clearance. Approximately 5 mm (0.2 in) maximum of side–to–side movement at the tips of the fan blades is permitted. If the cooling fan can not be rotated by hand or has a rough rotation, the fan drive must be replaced. A very small leakage of oil around the bearing is normal. If oil has leaked from the fan drive, the cooling fan will turn too easily. If the cooling fan will turn more than three revolutions when pushed by the hand and released, the viscous fan drive must be replaced.

ENGINE SPECIFICATIONS

ENGINE DATA

GM 4–153

Number of cylinders 4

Firing order 1–3–4–2

Bore and stroke 98.45 x 82.5 mm (3.876 x 3.25 in)

Displacement 2512 cm^3 (153 in^3)

Compression Ratio 8.25:1

Governor speed See the **PERIODIC MAINTENANCE** section for each model of lift truck

GM 4–181

Number of cylinders 4

Firing order 1–3–4–2

Bore and stroke 101.6 x 91.44 mm (4.00 x 3.60 in)

Displacement 2965 cm^3 (181 in^3)

Compression Ratio 8.25:1

Governor speed See the **PERIODIC MAINTENANCE** section for each model of lift truck

GM 3.0L

Number of cylinders 4

Firing order 1–3–4–2

Bore and stroke 101.6 x 91.44 mm (4.00 x 3.60 in)

Displacement 2965 cm^3 (181 in^3)

Compression Ratio 8.25:1

Governor speed See the **PERIODIC MAINTENANCE** section for each model of lift truck

GM 6–260

Number of cylinders 6

Firing order 1–5–3–6–2–4

Bore and stroke 98.45 x 89.66 mm (3.88 x 3.53 in)

Displacement 4095 cm^3 (250 in^3)

Compression Ratio 8.25:1

Governor speed See the **PERIODIC MAINTENANCE** section for each model of lift truck

CYLINDER HEAD

Valve seat specifications See FIGURE 6.

Valve seat width, intake valves
0.896 to 1.897 mm (0.035 to 0.074 in)

Valve seat width, exhaust valves
1.468 to 2.468 mm (0.058 to 0.0971 in)

Clearance between intake valve and guide
– Production Limit
0.0254 to 0.0686 mm (0.0010 to 0.0027 in)

– Service Limit 0.094 mm (0.0037 in)

Clearance between exhaust valve and guide
[**NOTE:** The valve stems for the exhaust valves have a taper of 0.0025 mm (0.001 in)]

– Production Limit (top of taper)
0.0254 to 0.0686 mm (0.0010 to 0.0027 in)

– Service Limit 0.119 mm (0.0047 in)

– Production Limit (bottom of taper)
0.0508 to 0.0939 mm (0.0020 to 0.0037 in)

– Service Limit 0.145 mm (0.0057 in)

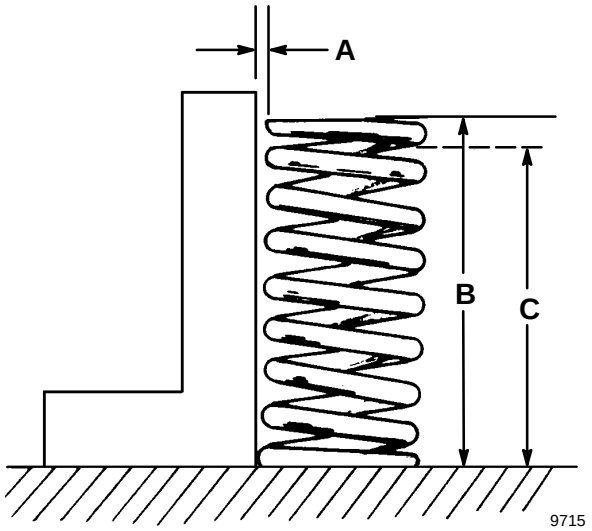
Diameter of exhaust valve stem
8.6817 to 8.9665 mm (0.3418 to 0.3425 in)

Diameter of intake valve stem
8.6995 to 8.6817 mm (0.3425 to 0.3418 in)

Valve head diameter (all)
8.6817 to 8.6995 mm 0.3418 to 0.3425 in)

Valve installed height (all)
42.926 mm (1.69 in)

Valve spring, free length (See FIGURE 48.)
52.8 mm (2.08 in)



A. VARIATION FROM VERTICAL:
– Production less than 1.5 mm (0.06 in)
– Service limit 2.5 mm (0.984 in)

B. FREE LENGTH:
– Standard 49.7 mm (1.96 in)
– Service Limit 48.2 mm (1.90 in)

C. INSTALLATION HEIGHT:
THE VALVE SPRINGS NEED A MINIMUM FORCE OF 347 to 383 N (76 to 86 lbf) TO COMPRESS THEM TO A HEIGHT OF 43 mm (1.69 in)

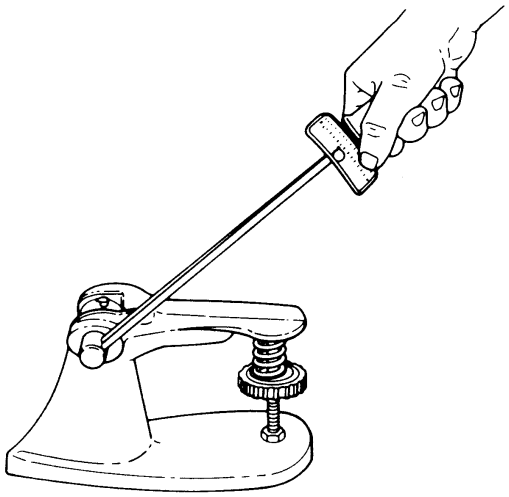


FIGURE 48. VALVE SPRING SPECIFICATIONS

Valve spring force (installed and valve is closed)
347 to 383 N @ 43 mm
(78 to 86 pounds @ 1.69 in)

Valve spring force (installed and valve is open)
756 to 800 N @ 32 mm
(170 to 180 pounds @ 1.26 in)

HYDRAULIC VALVE LIFTER

Leak rate 12 to 90 seconds with 50 lb load

Body diameter
21.3868 to 21.4046 mm (0.8420 to 0.8427 in)

Plunger travel 3.175 mm (0.125 in)

Clearance in bore 0.0635 mm (0.0025 in)

Lifter bore diameter
21.425 to 21.450 mm (0.8435 to 0.8445 in)

CAMSHAFT

Variation from front to rear of a cam lobe
– Taper with larger dimension away from No. 1 piston

Bearing journals, diameter
47.44 to 47.49 mm (1.8677 to 1.8697 in)

Bearing journals, clearance
0.01778 to 0.9685 mm (0.0007 to 0.0027 in)

Variation of a bearing journal in either diameter or axial direction 0.03 mm (0.001 in)

Axial Clearance (see FIGURE 17.)
– Production Limit
0.020 to 0.120 mm (0.001 to 0.005 in)
– Service Limit 0.2 mm (0.008 in)

PISTONS

Piston diameter (see gauge points in FIGURE 27.)

Clearance at top of cylinder
– Production Limit
0.0635 to 0.0838 mm (0.0025 to 0.0033 in)

Clearance at bottom of cylinder
– Production Limit
0.043 to 0.104 mm (0.0017 to 0.0041 in)

Clearance in cylinder (service limit for top and bottom of cylinder) 0.76 mm (0.030 in)

Piston ring to groove clearance for piston rings (see FIGURE 28.)

Compression rings No. 1 and No. 2
– Production Limit
0.0381 to 0.0889 mm (0.0015 to 0.0035 in)

ENGINE SPECIFICATIONS

– Service Limit 0.1143 mm (0.0045 in)

Oil ring to groove clearance
– Production Limit
0.127 to 0.1397 mm (0.005 to 0.0055 in)

– Service Limit 0.1651 mm (0.0065 in)

Piston ring end clearance (see FIGURE 29.)
– Piston ring No. 1 and No. 2
– Production Limit
0.254 to 0.559 mm (0.010 to 0.022 in)

– Service Limit 0.813 mm (0.032 in)

– Oil control ring
0.381 to 1.397 mm (0.015 to 0.055 in)

– Service Limit 1.65 mm (0.065 in)

Piston pin to piston clearance
– Production Limit
0.0076 to 0.0127 mm (0.0003 to 0.0005 in)

– Service Limit 0.0254 mm (0.001 in)

Piston pin to connecting rod clearance Press fit

CYLINDER BORE

Out–of– round (see FIGURE 25.)
– Production Limit 0.254 mm (0.001 in)

– Service Limit 0.0508 mm (0.002 in)

Taper (see FIGURE 26.)
– Production Limit 0.0127 mm (0.0005 in)

– Service Limit 0.127 mm (0.005 in)

CRANKSHAFT

Diameter of main bearing journal
– Production Limit
58.367 to 58.405 mm (2.2979 to 2.2994 in)

– Grinding Limit 57.859 mm (2.278 in)

Out–of–round of main bearing journal (maximum)
– Production Limit 0.0127 mm (0.0005 in)

– Service Limit 0.0254 mm (0.001 in)

Taper of main bearing journal (maximum)
– Production Limit 0.0127 mm (0.0005 in)

– Service Limit 0.0254 mm (0.001 in)

Clearance between journals and main bearings (except for rear main bearing of GM 6–250)
– Production Limit
0.0127 to 0.061 mm (0.0005 to 0.0024 in)

– Service Limit 0.064 mm (0.0025 in)

Clearance between journal and rear main bearing for GM 6–250
– Production Limit
0.0127 to 0.061 mm (0.0016 to 0.0035 in)

– Service Limit 0.089 mm (0.0035 in)

Available undersize main bearings
– See **PARTS MANUAL**

Axial Clearance (crankshaft to thrust surface of rear main bearing)
– Production Limit
0.0508 to 0.1524 mm (0.002 to 0.006 in)

– Service Limit 0.1524 mm (0.006 in)

CONNECTING RODS

Diameter of connecting rod journals for earlier production engines
– Production limit
50.775 to 50.800 mm (1.999 to 2.000 in)

– Grinding Limit 50.27 mm (1.979 in)

Diameter of connecting rod journals for later production engines
– Production limit
58.369 to 58.420 mm (2.298 to 2.300 in)

– Grinding Limit 57.86 mm (2.278 in)

Out–of–round of bearing journal (maximum)
– Production Limit 0.0127 mm (0.0005 in)

– Service Limit 0.0254 mm (0.001 in)

Taper of bearing journal (maximum)
– Production Limit 0.0127 mm (0.0005 in)

– Service Limit 0.0254 mm (0.001 in)

Clearance between crankshaft journals and connecting rod bearings
– Production Limit
0.0127 to 0.066 mm (0.0005 to 0.0026 in)

– Service Limit 0.762 mm (0.003 in)

ENGINE SPECIFICATIONS

Available undersize connecting rod bearings
– See **PARTS MANUAL**

Side clearance of connecting rod to crankshaft
– Production limit
0.1524 to 0.4318 mm (0.006 to 0.017 in)
– Service Limit 0.5588 mm (0.022 in)

COOLING SYSTEM

Thermostat 82°C (180°F)

LUBRICATION SYSTEM

Oil pressure @ 2500 rpm
170 to 241 kPa (25 to 35 psi)

Minimum oil pressure @ idle rpm 48 kPa (7 psi)

Oil pressure switch “ON” @
20 to 39 kPa (2.9 to 5.7 psi)

TORQUE SPECIFICATIONS

ITEM	SPECIFICATION
ADAPTER PLATE FOR TORQUE CONVERTER HOUSING	
3.0L	44 N.m (35 lbf ft)
ALTERNATOR PULLEY	61 N.m (45 lbf ft)
CAMSHAFT THRUST PLATE	10 N.m (7 lbf ft)
CHAIN BLOCK FOR HYDRAULIC PUMP DRIVE	19 N.m (14 lbf ft) with adhesive sealant
CONNECTING ROD CAP NUTS	44 N.m (35 lbf ft)
COOLANT PUMP TO BLOCK	10 N.m (7 lbf ft)
COOLING FAN TO HUB	19 N.m (14 lbf ft)
CYLINDER HEAD	130 N.m (95 lbf ft)
ENGINE MOUNT TO BLOCK	44 N.m (35 lbf ft)
EXHAUST MANIFOLD	41 N.m (30 lbf in)
EXHAUST MANIFOLD TO INTAKE MANIFOLD	61 N.m (45 lbf ft)
FAN BELT PULLEY TO VIBRATION DAMPENER	44 N.m (35 lbf ft)
FLYWHEEL CAPSCREWS	
4–153, 4–181	80 N.m (60 lbf ft) with adhesive sealant
3.0L	107 N.m (79 lbf ft) with adhesive sealant
6–250	100 N.m (75 lbf ft) with adhesive sealant
FLYWHEEL HOUSING	44 N.m (35 lbf ft)
INSPECTION COVER (Lifters)	10 N.m (7 lbf ft)
INTAKE MANIFOLD TO CYLINDER HEAD	54 N.m (40 lbf ft)
MAIN BEARING CAP	95 N.m (70 lbf ft)
OIL SUMP	
1/4–20 Capscrews	10 N.m (7 lbf ft)
5/15–18 Capscrews	19 N.m (14 lbf ft)
OIL SUMP TO TIMING COVER	8 N.m (6 lbf ft)
OIL PUMP TO ENGINE BLOCK	30 N.m (22 lbf ft)
OIL PUMP COVER	14 N.m (10 lbf ft)
ROCKER COVER	8 N.m (6 lbf ft)
STARTER	44 N.m (35 lbf ft)
TIMING COVER	11 N.m (97 lbf in)
VIBRATION DAMPENER	80 N.m (60 lbf ft)

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
When the ignition switch is in the “START” position, the starter does not operate.	The battery has a problem.	Install a new battery.
	The battery is not fully charged.	Charge the battery.
	The connections at the battery are loose or they have corrosion.	Clean and tighten the battery connections.
	The ignition switch has a problem.	Repair or install an ignition switch.
	The starter system has a problem.	Check and repair the starter circuit.
	There are damaged parts in the engine.	Repair the engine.
The engine will not start.	The fuel tank is empty.	Fill the fuel tank.
	The battery is not fully charged.	Charge the battery.
	The valves are worn or damaged.	Repair the valves.
	The piston rings are worn or have damage.	Install new piston rings.
	The ignition system has a problem.	Check and repair the ignition system.
	The fuel system has a problem.	Check and repair the fuel system.
The engine does not run smoothly.	The valve mechanism does not operate correctly.	Repair the valve mechanism.
	The head gasket has a leak.	Install a new head gasket.
	The cylinder head has cracks.	Install a new cylinder head.
	There is a leak in the intake system.	Install new gaskets at the intake manifold.
	The spark plugs have a problem.	Install new spark plugs.
	The ignition system has problems. (See the sections for the electrical components in the **SERVICE MANUAL** for more information.	Repair the ignition system.
The engine does not have enough power.	The air filter is dirty.	Clean or install a new air cleaner.
	The fuel is the wrong type.	Drain and fill fuel tank.
	The ignition timing is not correct.	Check timing.
	The valve mechanism does not operate correctly.	Repair parts of valve mechanism.
	The piston assemblies are worn or damaged.	Install new pistons.
	The spark plugs are the wrong type or they are not installed correctly.	Install new spark plugs.
	The valve timing is not correct.	Check valve mechanism.
	The exhaust system has restrictions.	Clean or repair exhaust system.

TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
There is noise inside the engine.	The main bearings are worn or damaged.	Install new bearings.
	The bearings for the connecting rods are worn or damaged.	Install new bearings.
	The pistons are worn or damaged.	Install new pistons.
	The engine is too hot.	Check the cooling system.
	There is not enough oil in the engine.	Fill the engine to the correct level.
	The flywheel is loose.	Tighten the capscrews for the flywheel.
	A connecting rod is bent.	Repair the engine.
	There is a leak in the exhaust system.	Repair the exhaust system.
	A valve lifter has a problem.	Check the valve lifters.
	The valve mechanism does not operate correctly.	Repair the valve mechanism.
There is noise in the engine during acceleration.	The spark plugs are dirty.	Install new spark plugs.
	The spark plugs are the wrong type.	Install the correct spark plugs.
	The ignition timing is not correct.	Check the timing.
	The fuel is the wrong type.	Fill the tank with the correct fuel.
	There is too much carbon in the combustion chamber.	Clean the cylinder head and pistons.
	The engine is too hot.	Check the cooling system.
The engine gets too hot.	There is not enough coolant in the cooling system.	Fill cooling system with coolant.
	The belt for the water pump is worn or not adjusted correctly.	Adjust drive belts.
	The thermostat has damage.	Install a new thermostat.
	The cooling system has restrictions.	Clean the cooling system parts.
	The water pump has damage.	Install a new water pump.
	The radiator is dirty.	Clean the radiator.
	The exhaust system has restrictions.	Clean or replace the parts of the exhaust system.
The bearings in the engine are damaged.	There is not enough oil in the engine.	Fill engine with correct oil.
	The oil in the engine is the wrong type.	Fill engine with correct oil.
	The oil pump has damage.	Install a new oil pump.
	The connecting rods have damage.	Install new connecting rods.
	The camshaft is worn or damaged.	Install a new camshaft.
	The passages for oil have restrictions.	Clean oil passages.
	The bearings are not installed correctly.	Install new bearings.
	The oil in the engine is dirty.	Install a new oil filter and oil.