SERVICE REPAIR

MANUAL

Hyster F006 (H6.00XL H7.00XL) Forklift

HYSTER

INTRODUCTION

GENERAL

This section has descriptions and repair instructions for the Perkins 4.236 and the Perkins 4.2482 diesel engines. Checks and Adjustments and Troubleshooting procedures are included in this section.

DESCRIPTION

The 4.2482 engine is a modification of the 4.236 design to give decreased exhaust emissions and smoke. Some parts are not common to the two engines, but the repair procedures are similar. When the procedures or parts are different, a description is given for each engine.

The cylinder block is cast–iron and has cylinder liners that can be replaced. The 4.236 engine is available with two types of cylinder liners: either with a flange or without a flange. Both Perkins engines made for Hyster Company normally have a flange on the cylinder liner.

The cylinder head is cast–iron and has an intake valve and an exhaust valve for each cylinder. The injectors are in the cylinder head. The overhead valve assembly is actuated by the camshaft found on the right side of the cylinder block.

The crankshaft has five main bearings. Number three main bearing is the thrust bearing and has thrust washers on each side of the main bearing.

The pistons are aluminum alloy castings. The piston for the 4.236 engine has five piston rings and a combustion chamber in the top of the piston. The piston for the 4.2482 engine has three piston rings. The combustion chamber in the 4.2482 engine is a modification of the 4.236 engine and is called a “squish lip” by the manufacturer.

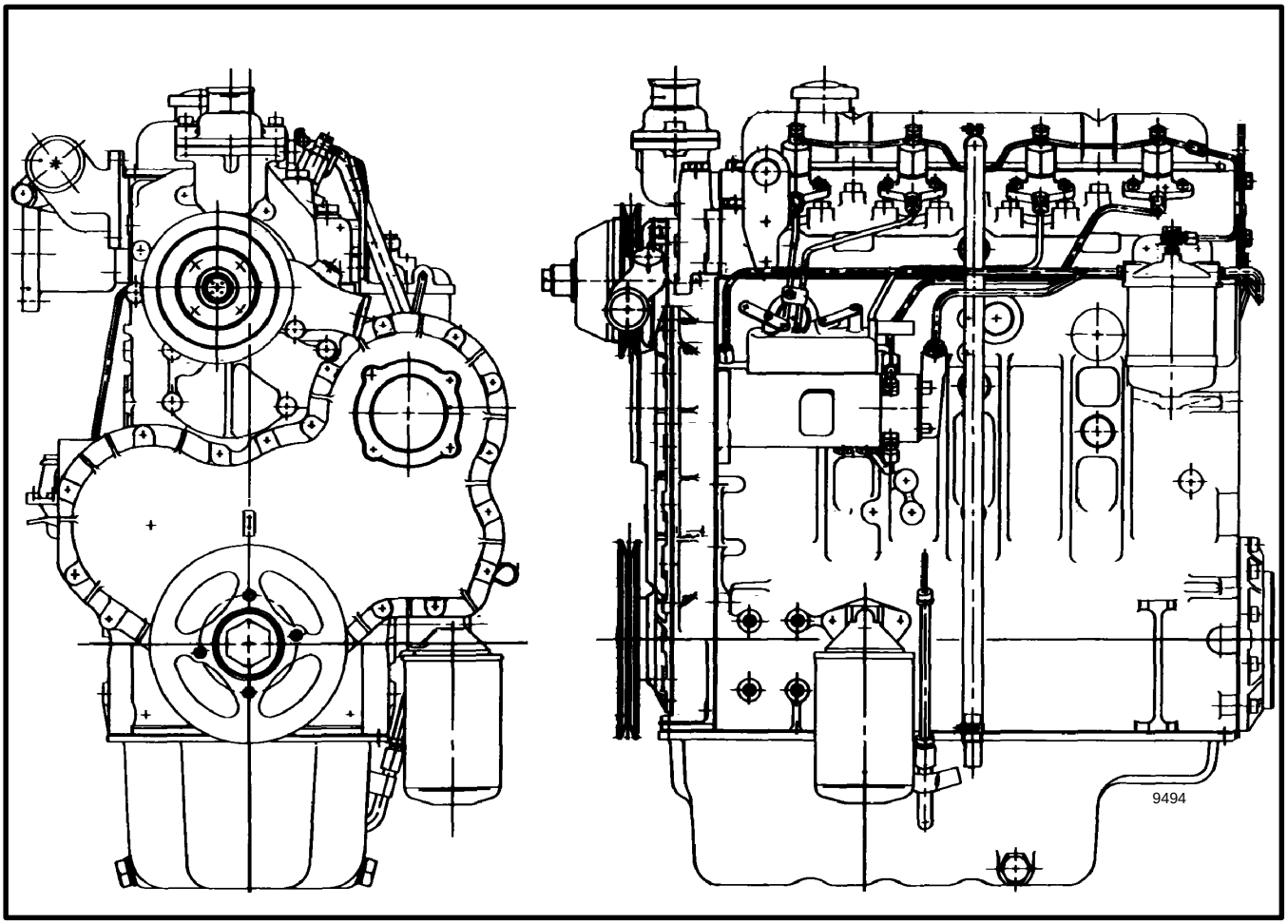


FIGURE 1. PERKINS 4.2482 ENGINE

The timing and quantity of fuel sent to the injectors is controlled by a throttle and governor in the fuel injection pump. The static timing is set by the position of the injection pump when it is installed. The throttle linkage must be correctly adjusted to control the quantity of fuel sent to the injectors.

Special tools are needed to repair the injection pump. The injection pump must be sent to an authorized dealer if repairs are necessary.

ENGINE SERIAL NUMBER CODES

Serial numbers before 1974 were as follows:

236 U 470028 A
① ② ③ ④

① Type of engine 4.236

② Manufactured in the United Kingdom

③ Serial number

④ The letter "A" after the serial number indicates the engine has 0.5 in diameter cylinder head studs. The letter "C" after the serial number indicates the engine has chrome cylinder liners.

This serial number is found above the tappet cover on the blocks of early engines. The serial number is found above the generator of later engines.

During the middle 1970's, the introduction of a new serial number system was made in the different Perkins plants.

Serial number beginning in 1974 are as follows:

LD 21498 U 510256 D
① ② ③ ④ ⑤

① Type of engine LD = 4.236, LF = 4.248, LG = 4.2482

② Parts list number

③ Country of manufacture

④ Serial number

⑤ Year of manufacture. The letter indicates the year of manufacture starting with "A" in 1974 (D = 1977). The letters I, O, Q, R and Z will not be used. Not all of the manufacturer's plants started the newer serial number sequence in 1974. Some engines made after 1974 can have the earlier serial number sequence.

REMOVAL AND INSTALLATION

See the section for **THE FRAME** for the specific model of interest for the procedure for removing and installing the engine and transmission. See the sections for **THE TRANSMISSION** to separate the transmission from the engine.

ENGINE

⚠ WARNING

Always disconnect the connections at the battery before making repairs to the engine. (Disconnect the negative cable first.)

CYLINDER HEAD

Removal

1. Disconnect the negative battery cable at the battery. Remove the brackets for the wires to the alternator. Remove the wire to the cold start aid. Clean the cylinder head so that dirt cannot enter the cylinder head or fuel system.

2. Drain the cooling system. Remove the hoses.

3. Disconnect and remove the air cleaner, hose bracket and hose. Disconnect the lines–the secondary filter and remove the air cleaner bracket. Remove the inlet and exhaust manifolds.

4. Make sure the area around the fittings is clean. Remove the fuel line to the cold start aid. Disconnect the

high pressure and drain lines at the fuel injectors and at the fuel injection pump. Remove the injectors. Remove the brackets and tubes.

⚠ CAUTION

DO NOT bend the tubes.

5. Remove the hose for the crankcase ventilation valve. Remove the rocker arm cover. Remove the rocker arm assembly. Remove the push rods.

NOTE: Keep the push rods in order so that they can be installed in the same positions.

6. Remove the cylinder head nuts and capscrews in opposite order of the tightening sequence shown in FIGURE 2. Remove the cylinder head.

Installation

1. Clean the threads of all the studs and capscrews. Use a tap to clean threads of the holes in the block. Put a small amount of oil on the threads.

2. Make sure the surfaces of the engine block and cylinder head are clean. Install the cylinder head gasket with the words “TOP FRONT” in view on the fan end of the engine block. Use only the HYSTER APPROVED cylinder head gasket. Do not use sealant on the gasket.

3. Put the cylinder head on the engine block. See FIGURE 2. for the correct location of studs and capscrews. Tighten the nuts and capscrews to 27 N.m (20 lbf ft) in the sequence shown in FIGURE 2. Tighten the nuts and capscrews again the same sequence to 102 N.m (75 lbf ft). Tighten the nuts and capscrews in the same sequence to a final torque of 136 N.m (100 lbf ft). Repeat the final tightening procedure.

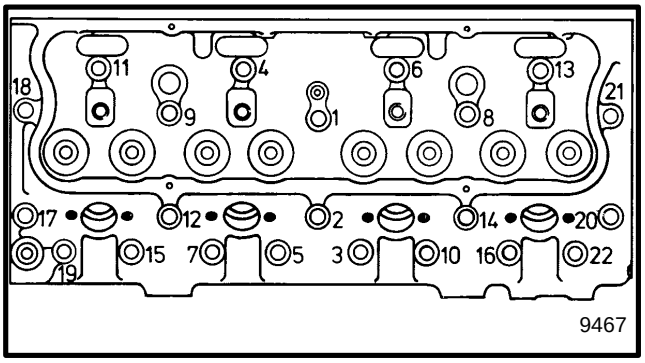


FIGURE 2. CYLINDER HEAD TIGHTENING SEQUENCE

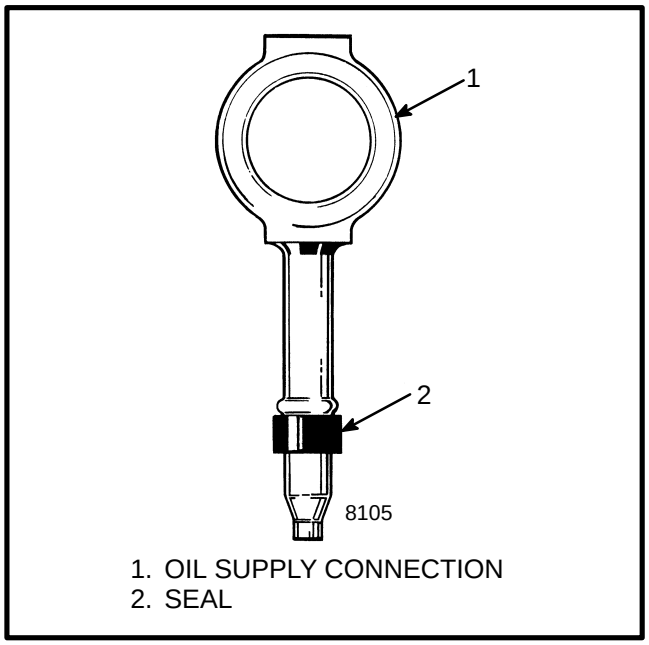


FIGURE 3. OIL FEED CONNECTION

4. Install the push rods in the same positions from which they were removed. Put a new O–ring for the oil tube in the correct hole in the cylinder head.

5. Install the rocker arm assembly on the cylinder head. Make sure each push rod is in position in the rocker arm before tightening the capscrews. Tighten the capscrews to 43 N.m (32 lbf ft).

6. Adjust the clearance between the valves and the rocker arm as described in CHECKS AND ADJUSTMENTS in this section.

7. Install new copper washers on the injectors. Install the injectors and brackets. Connect the lines to the injectors and to the fuel injection pump. Tighten the capscrews for the injector bracket 16 N.m (12 lbf ft).

8. Install a new gasket for the rocker arm cover. Put a steel washer and a rubber washer on each rocker arm capscrew. Install the cover, rubber washers, steel washers and capscrews.

9. Make sure the surfaces of the inlet and exhaust manifolds are clean and smooth. Install new gaskets and install the manifolds. Connect the hose for the crankcase ventilation valve.

10. Connect the fuel line and wire to the cold start aid. Connect the wire to the temperature sender. Connect the hose to the radiator. Install the bracket for the air cleaner. Connect the lines to the secondary filter. Install the air cleaner, hose and clamp.

11. Fill the cooling system with coolant. Check for leaks. Connect the negative battery terminal.

12. Remove the air from the fuel system as described in CHECKS AND ADJUSTMENTS in this section. Remove the air from the cold start aid before starting the engine.

13. Run the engine until the normal operating temperature is reached. The cylinder head nuts and bolts must be tightened to the final torque again when the engine has reached operating temperature. After the engine has been run for 25 to 50 hours, the nuts and capscrews must be tightened again. Use the sequence shown in FIGURE 2. and tighten to 136 N.m (100 lbf ft). If the nut or capscrews does not turn when tightened to the final torque, loosen it 30° to 60°. Tighten it to 136 N.m (100 lbf ft). After all the capscrews or nuts have been tightened, again tighten the first ten capscrews or nuts to the final torque.

⚠ CAUTION

It is very important that the nuts and capscrews for the cylinder head be tightened after the engine has been operated for 25 to 50 hours.

Cylinder Head Repairs

The maximum clearance along the length of the surface of the cylinder head is 0.15 mm (0.006 in). The maximum clearance across the width of the surface of the cylinder head is 0.08 mm (0.003 in). See FIGURE 4.

The surface of the cylinder head can be machined to a maximum of 0.030 mm (0.012 in). The nozzles of the injectors must not extend more than 4.44 mm (0.175 in) below the surface of the cylinder head. Use only one washer for each injector. The correct thickness for the washers is 2.13 mm (0.084 in).

VALVE SEATS

NOTE: Perkins 4.236 and 4.2482 engines made for Hyster Company do not have separate valve guides nor valve seats. Valves are available with oversize valve stems of 0.08, 0.038 and 0.76 mm (0.003, 0.015 and 0.030 in) valve seats can be installed if necessary when a cylinder head is repaired.

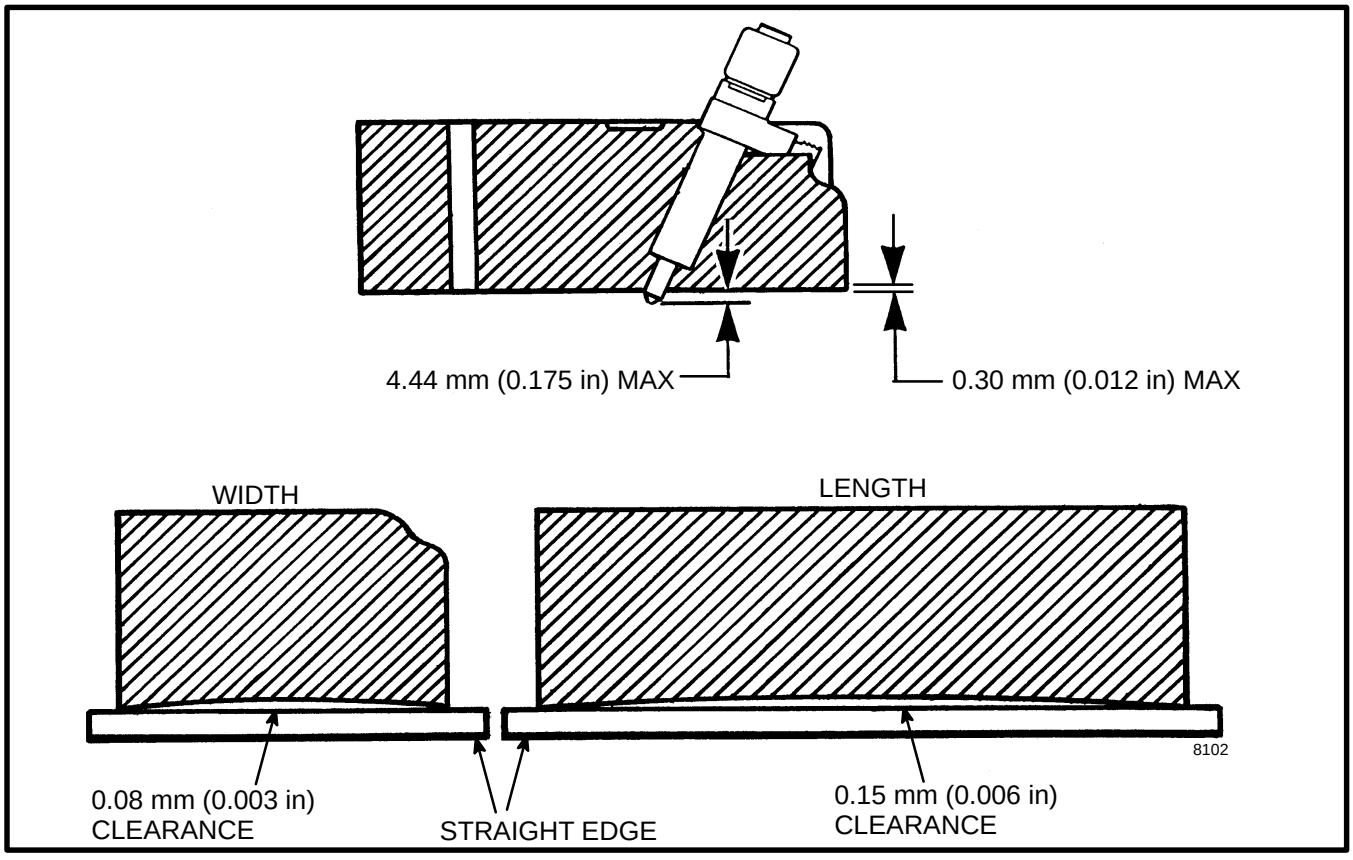


FIGURE 4. CYLINDER HEAD DIMENSIONS

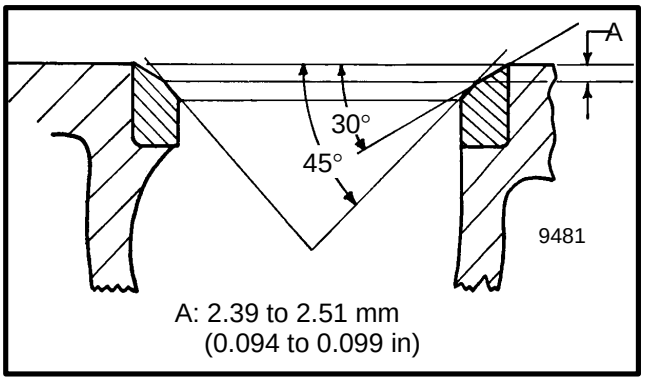


FIGURE 5. VALVE SEAT ANGLES

1. If the surface of the valve seat is not smooth, the seat must be cut or ground. The seat must ground at two angles so that the surface for the valve is not too wide. Grind the seat with the 45° stone until the surface is smooth. Use the 30° stone to make the seat narrow. See FIGURE 5.

2. Check the depth of a new valve head below the surface of the cylinder head after the seat is machined. See FIGURE 6. The exhaust valve head must not be more than 1.4 mm (0.055 in) below the surface of the cylinder head. The inlet valve head must not be more than 1.5 mm (0.061 in) below the surface of the cylinder head. If the depth of the valve head is more than the specification, the valve seat or valve must be replaced.

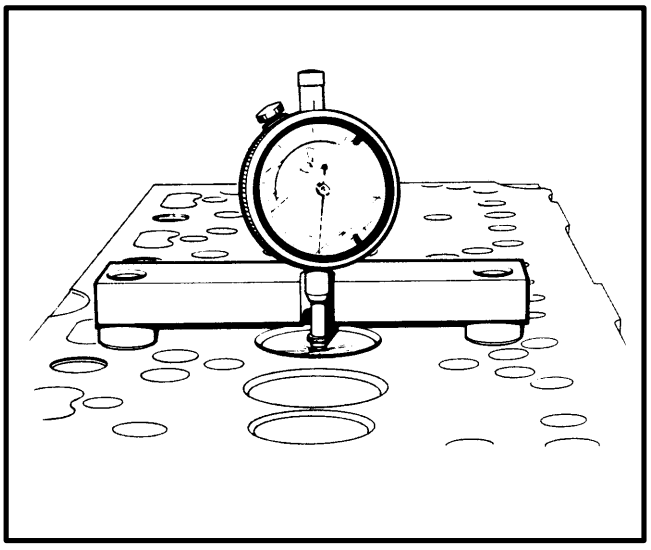


FIGURE 6. CHECKING THE DEPTH OF THE VALVE HEAD

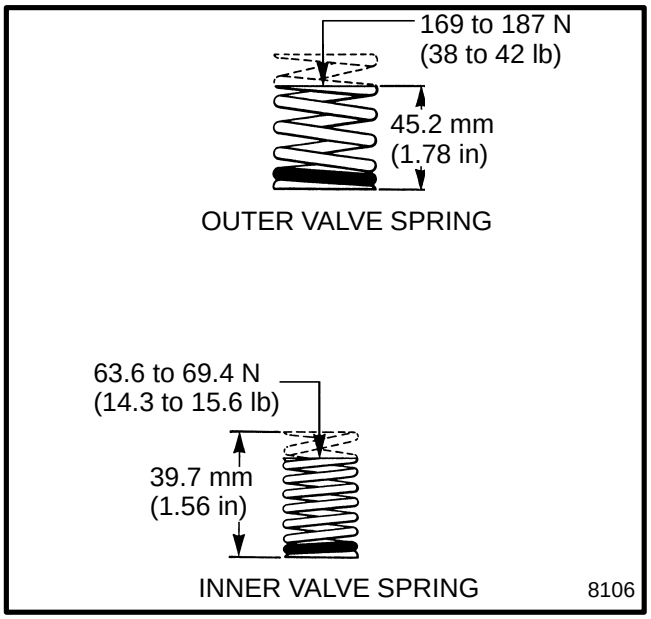


FIGURE 7. VALVE SPRINGS

3. Do not lubricate the valve seats before installation. Grind or cut the valve seats after installation as described above.

VALVE SPRINGS

Check the pressure of the valve springs when the cylinder head is disassembled. The springs must be square. The height of an inner spring that is compressed by a load of 63.6 to 69.4 N (14.3 to 15.6 lb) must be 39.7 mm (1.56 in). A load of 169 to 187 N (38 to 42 lb) is needed to compress the outside spring to a height of 45.2 mm (1.78 in). If the springs are not at the correct height when the specified load is applied, they must be replaced. See FIGURE 7.

The correct height for the inner springs when they are installed is 39.7 mm (1.56 in). The correct height for the outer springs is 45.2 mm (1.78 in).

The spring coils that are together must be installed toward the cylinder head.

VALVES

The valves must be checked for wear on the stems. The valve head must not be bent or have cracks. The valve face must be ground to a 45° angle. Do not grind too much metal from the valve or the valve head will be too far below the surface of the cylinder head.

Lubricate the valve with engine oil before installing the valve in the valve guide. Use new valve seals when assembling the valve mechanism.

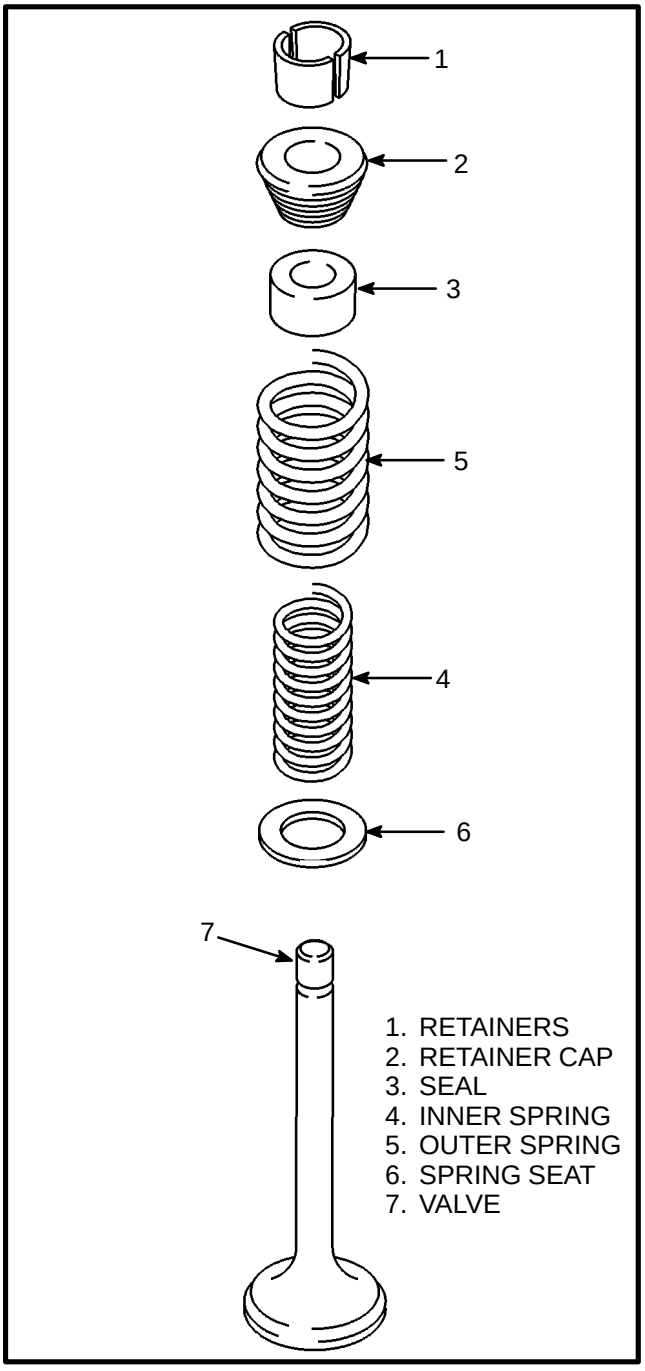


FIGURE 8. VALVE ASSEMBLY

ROCKER ARM SHAFT

Disassembly

Remove the rocker arms from the shaft by removing the snap rings on the ends of the shaft. Remove the washers, rocker arms, springs and support brackets. Remove the screw from the oil tube fitting and slide the fitting from the shaft. If the clearance between the rocker arm bushings and the shaft is more than 0.127 mm (0.005 in) the bushings must be replaced. The correct clearance between the rocker arm bushings and the shaft is 0.025 to 0.075 mm (0.001 to 0.003 in).

Assembly

If new bushings are needed, make sure the oil holes are aligned. Slide the oil tube fitting on the shaft. Align the hole for the screw in the shaft with the hole in the fitting. Install the screw. Install the support brackets, springs and rocker arms in the correct order. Install the washers and snap rings on the shaft.

OIL PUMP

Removal

1. Remove the sump. Remove the screen assembly and inlet tube.

2. Remove the tube between the pump and the relief valve.

3. Remove the crankshaft pulley, timing gear cover, timing gears and timing gear case.

Disassembly

1. Remove the snap ring for the drive gear for the pump. Remove the Woodruff key from the drive shaft.

2. Remove the end plate. Remove the drive and driven rotors from the pump body. Remove the O–ring.

Inspection (See FIGURE 11. and FIGURE 12.)

1. Check the rotors and plate and body for grooves or cracks.

2. Check the clearance between the inner rotor and the outer rotor. See FIGURE 11.

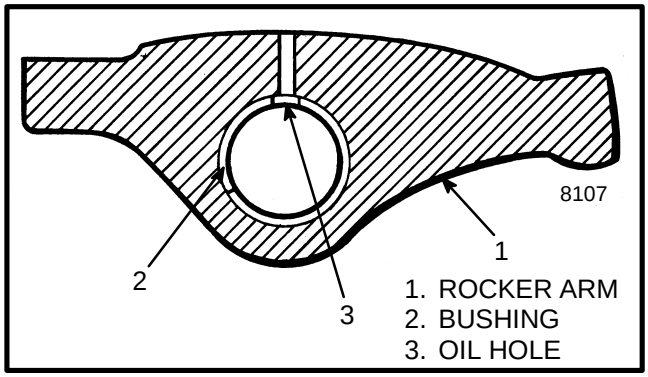


FIGURE 9. ROCKER ARM

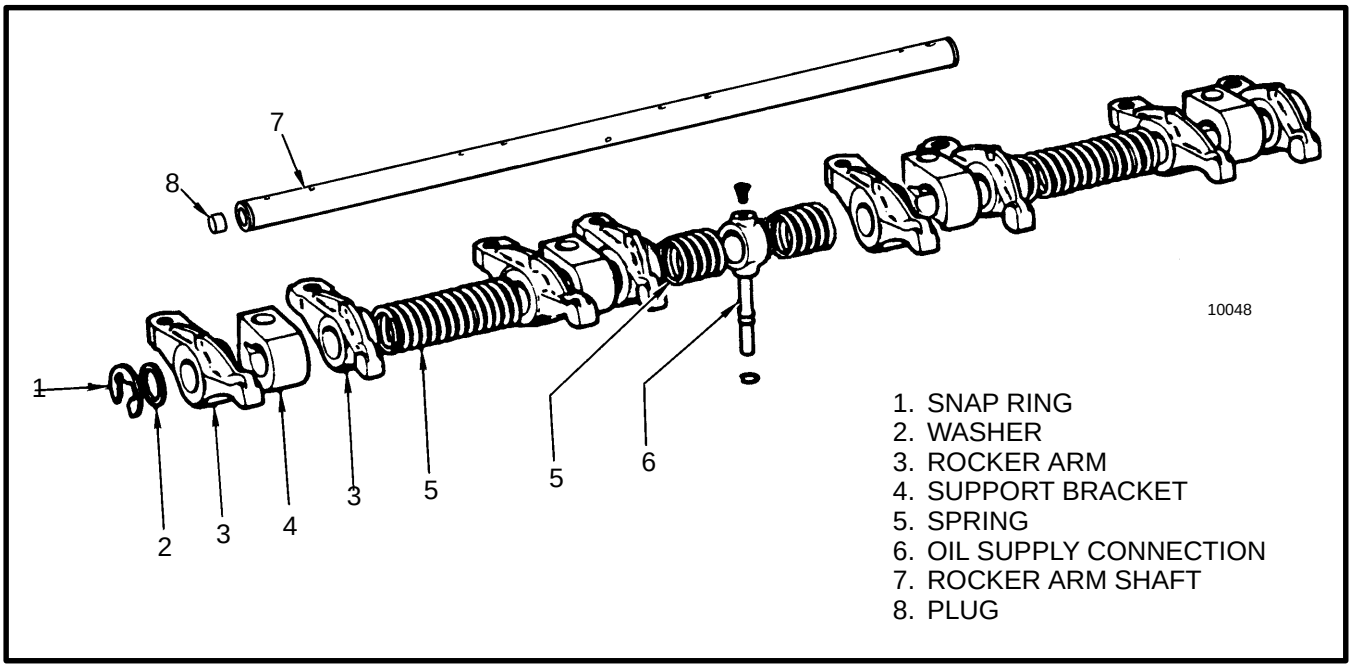


FIGURE 10. ARRANGEMENT OF THE ROCKER ARM SHAFT

3. Check the clearance between the outer rotor and the pump body. See FIGURE 12.

4. Check the clearance between a straight edge across the pump body and the driven rotor. See FIGURE 13.

5. Check the clearance between a straight edge and the inner rotor. See FIGURE 13.

If any parts of the pump are damaged or worn, the oil pump must be replaced. The parts are not available separately.

Assembly

1. Install the inner and outer rotors into the oil pump body. The ends of the rotors with the chamfer must be installed first. Install a new O–ring and the end plate.

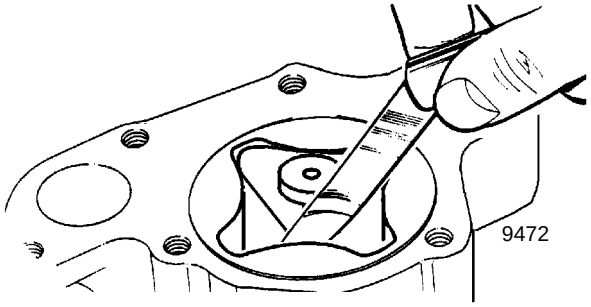
2. Install the Woodruff key on the shaft. Install the drive gear with the boss toward the snap ring groove. Install the snap ring.

3. Put the inlet tube in a container of clean engine oil. Turn the drive gear until oil flows from the oil pump.

Installation

1. Install the oil pump on the main bearing cap.

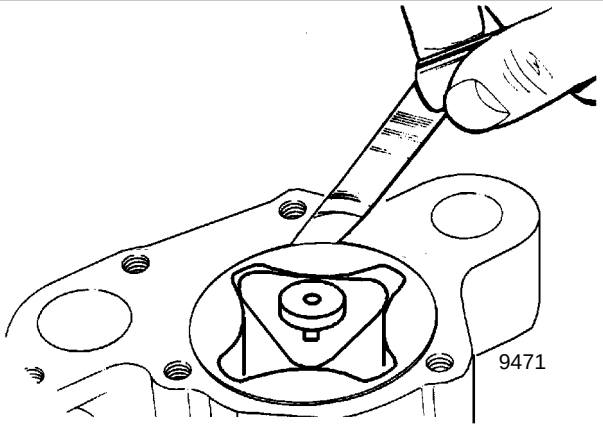
2. Install the idler gear with the boss toward the oil pump. Install the snap ring. The clearance between the idler gear and the mount flange must be 0.05 to 0.41 mm (0.002 to 0.016 in). The clearance between the idler gear and the oil pump gear must be 0.15 to 0.23 mm (0.006 to 0.009 in).



CLEARANCE

OUTER ROTOR HAS 4 LOBES:
0.025 to 0.076 mm (0.001 to 0.003 in)
OUTER ROTOR HAS 5 LOBES:
0.025 to 0.152 mm (0.001 to 0.006 in)

FIGURE 11. CHECK THE CLEARANCE BETWEEN ROTORS



CLEARANCE

OUTER ROTOR HAS 4 LOBES:
0.28 to 0.033 mm (0.011 to 0.013 in)
OUTER ROTOR HAS 5 LOBES:
0.139 to 0.254 mm (0.0055 to 0.010 in)

FIGURE 12. CHECK THE CLEARANCE BETWEEN ROTOR AND BODY

3. Install the timing case, timing gears, timing case cover, and crankshaft pulley.

4. Install the oil tube between the oil pump and relief valve.

5. Install the inlet tube and screen. Install the sump.

6. Before starting the engine fill the sump with oil to the correct level. Run the starter with the stop cable pulled until the warning light for oil pressure does not illuminate.

RELIEF VALVE

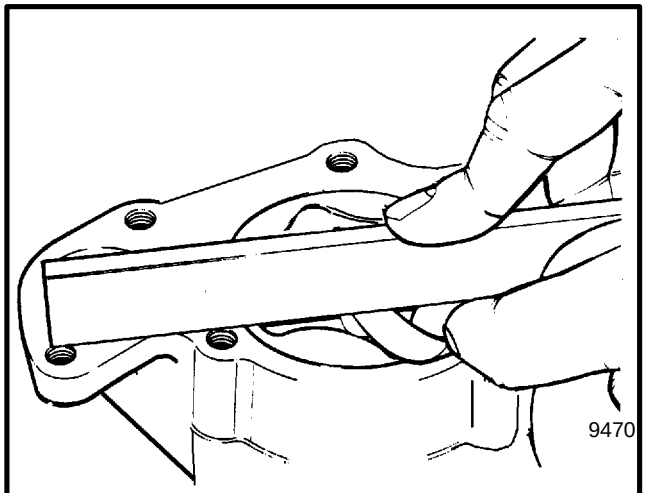
1. Remove the sump. Remove the tube to the oil pump.

2. Remove the capscrew and remove the relief valve body from the crankcase.

3. Remove the cotter pin from the body.

⚠ WARNING

The cotter pin holds a compressed spring in the relief valve body.



CLEARANCE

3 LOBE INNER ROTOR:
0.008 to 0.076 mm (0.0015 to 0.003 in)
4 LOBE INNER ROTOR:
0.025 to 0.127 mm (0.001 to 0.005 in)
4 LOBE OUTER ROTOR:
0.013 to 0.063 mm (0.0005 to 0.0025 in)
5 LOBE OUTER ROTOR:
0.025 to 0.127 mm (0.001 to 0.005 in)

FIGURE 13. CHECK END CLEARANCE OF THE ROTORS

Remove the cap, spring and plunger.

4. Clean all the parts. Inspect the spring for damage. The length of the spring must be 32.51 mm (1.28 in) with a 34.5 to 36.7 N (7.76 to 8.24 lb) load. Inspect the bore and plunger for scratches or wear. There must be 0.03 to 0.10 mm (0.001 to 0.004 in) clearance between plunger and bore.

5. Lubricate the parts with engine oil. Install the plunger and spring in the bore. Install the cap and cotter pin.

6. Install the relief valve body on the crankcase. Install the capscrew and lock washer.

7. Connect the tube to the oil pump. Install the sump. Make sure there is oil in the sump before starting the engine.

8. The relief valve must open at 345 to 415 kPa (50 to 60 psi).

TIMING GEAR CASE AND TIMING GEARS

Removal

1. Remove the crankshaft pulley.

2. Remove the capscrews that hold the cover to the timing gear case. Remove the cover. Do not damage the oil seal.

NOTE: Each drive gear for the crankshaft, camshaft and fuel injection pump has timing marks that must be aligned with the idler gear so that the engine will operate. See FIGURE 13. See also that each drive gear and shaft has marks that must be correctly aligned during assembly.

3. Rotate the crankshaft until the timing marks on the timing marks on the timing gears are aligned. See FIGURE 14. Remove the nuts for the retainer for the idler gear. Remove the idler gear and hub assembly.

⚠ CAUTION

Do not rotate the crankshaft or camshaft when the idler gear is removed. You will damage the pistons and/or the valves.

4. Remove the capscrew, lock washer and lock plate for the camshaft gear. Use a puller to remove the camshaft gear.

5. Remove the three capscrews for the gear for the fuel injection pump. Remove the gear.

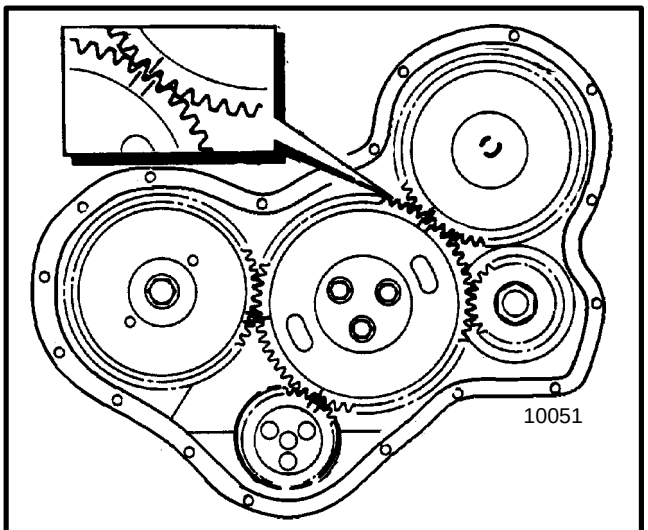


FIGURE 14. TIMING GEARS

6. Remove the fuel injection pump. Remove the nine capscrews and washers that hold the timing gear case to the crankcase. Remove the four capscrews and washers that hold the timing gear case to the sump. Remove the timing gear case.

Installation

1. Install a new gasket and install the timing gear case on the crankcase. Make sure the thrust washer is on the camshaft. Install the capscrews to the crankcase and sump.

2. If the crankshaft gear was removed, install it on the crankshaft.

3. Install the Woodruff key and camshaft gear with the mark away from the engine. Install the retainer plate, lock plate, lock washer and capscrew. Tighten the capscrew to 68 N.m (50 lbf ft). Bend the lock plate over the nut.

4. Install the fuel injection pump on the timing gear case. Make sure the mark on the fuel injector pump aligns with the mark on the timing gear case. Install the gear for the fuel injection pump. Install the three capscrews and lock washers. Make sure the mark on the gear is toward the idler gear.

5. Lubricate the thrust washers and bushing for the idler gear. Install the hub and thrust washer. Put the idler gear on the hub with the marks for the camshaft, crankshaft and fuel injection pump gears aligned. If the marks are not aligned within three teeth, remove the idler gear and turn the gear that is not aligned. If the gears are not aligned more than three teeth, the rocker arm assembly must be removed. This action prevents damage to the valve mechanism when the camshaft or crankshaft is rotated. Install the idler gear so that the marks are in alignment. Install the other thrust washer, the plate and nuts. Tighten the nuts to 41 N.m (30 lbf ft).

6. Check the clearance between the thrust washer and the idler gear. The correct clearance is 0.25 to 0.41 mm (0.010 to 0.016 in).

7. Check the clearance between the teeth of the gears. The minimum is 0.08 mm (0.003 in). There is no maximum clearance, but the gears can be replaced if they are worn and make too much noise. The maximum clearance on new engines is 0.24 mm (0.009 in).

8. Install a new seal in the cover for the timing gear case. Press the seal in from the front until the seal is 9.73 to 9.97 mm (0.38 to 0.39 in) from the front face of the cover. See FIGURE 15.

9. Put the spacer on the crankshaft. Install the cover for the timing gear case. The three capscrews for the bottom of the cover must have aluminum washers on them.

⚠ CAUTION

The cover must be installed so that the crankshaft is exactly in the center of the bore for the seal.

10. Install the crankshaft pulley. Tighten the capscrew and washer to 406 N.m (300 lbf ft).

PISTONS AND CONNECTING RODS

Removal

1. Remove the cylinder head. See Cylinder Head Removal.

2. Drain the oil and remove the sump.

3. Remove the nuts for the connecting rod caps. Remove the caps and bearings. Make sure the caps have a number on them before removal. See FIGURE 16. Each connecting rod cap and connecting rod are a machined assembly and must not be mixed with another assembly.

4. Push the piston and connecting rod away from the crankshaft. See FIGURE 17. Be careful so that the bolts for the connecting rods do not touch the crankshaft and damage the bearing surface.

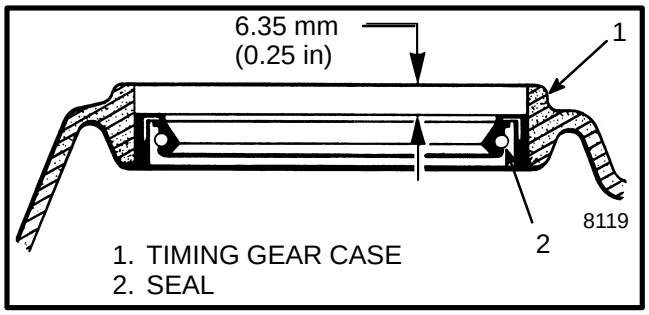


FIGURE 15. CRANKSHAFT SEAL FOR TIMING GEAR CASE

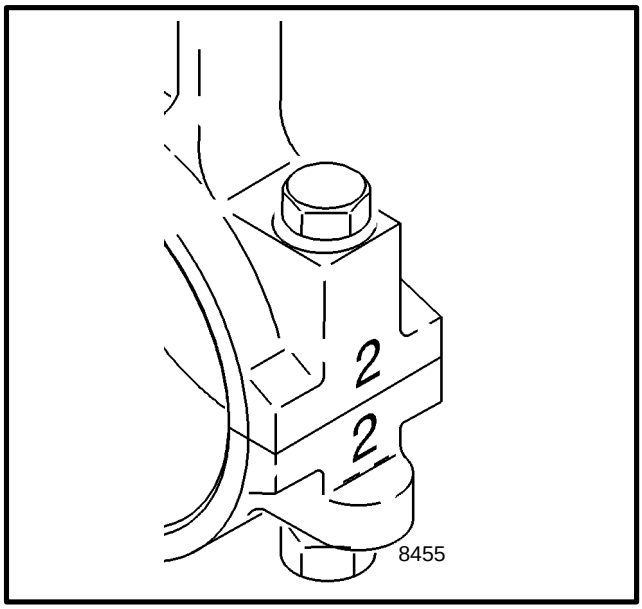


FIGURE 16. CONNECTING ROD

⚠ CAUTION

If the cylinder liners are worn, use a ridge reamer to cut the ridges before removing the pistons.

NOTE: The 4.236 engine has five piston rings on each piston. See FIGURE 19.

NOTE: The 4.2482 engine has three piston rings on each piston. See FIGURE 20.

Disassembly

1. Remove the rings from the pistons.

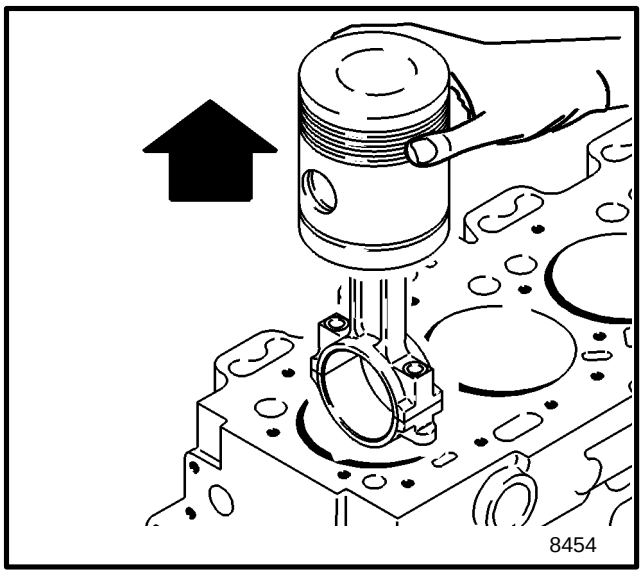


FIGURE 17. REMOVING THE PISTON AND CONNECTING ROD

2. Remove the snap rings from the piston.

3. Push out the piston pin. If necessary, heat the piston in warm water 40°C (120°F) to remove the pin.

Inspection

1. Clean the carbon from the grooves for the piston rings. Check the clearance of a new ring in its groove. If the clearance is more than 0.20 mm (0.008 in) replace the piston.

2. Check the fit of the piston pin in the connecting rod and piston. Measure the piston pin. Measure the diameter of the holes in the piston and connecting rod. The piston pin diameter must be 34.92 to 34.93 mm 1.3748 to 1.3750 in). The inside diameter of the bushing in the connecting rod must be 34.94 to 34.96 mm (1.3757 to 1.3765 in). The clearance between the piston pin and the connecting rod bushing must be 0.02 to 0.04 mm (0.0007 to 0.0017 in). If the bushing is replaced, use a reamer to make the bushing the correct size. The diameter of the bores in the piston must be 34.92 to 34.93 mm (1.3748 to 1.3750 in).

3. Check the alignment of the connecting rod bores. The bores must be parallel to within 0.06 mm (0.0025 in) with the bushing installed when measured at 127 mm (5 in) from the center of the connecting rod. See FIGURE 16. When the bushing is removed the bores must be parallel to 0.25 mm (0.010 in).

4. Check the pistons for wear or scratches on the sides of the pistons. Clean the carbon from the top of the pistons.

NOTE: The pistons for the Perkins 4.2482 are special. Do not remove any metal from the top of the piston.

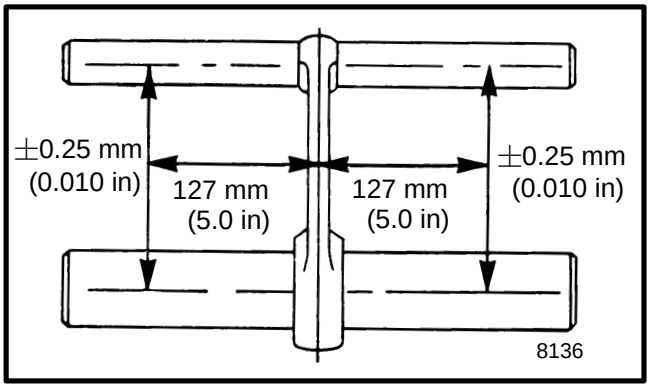
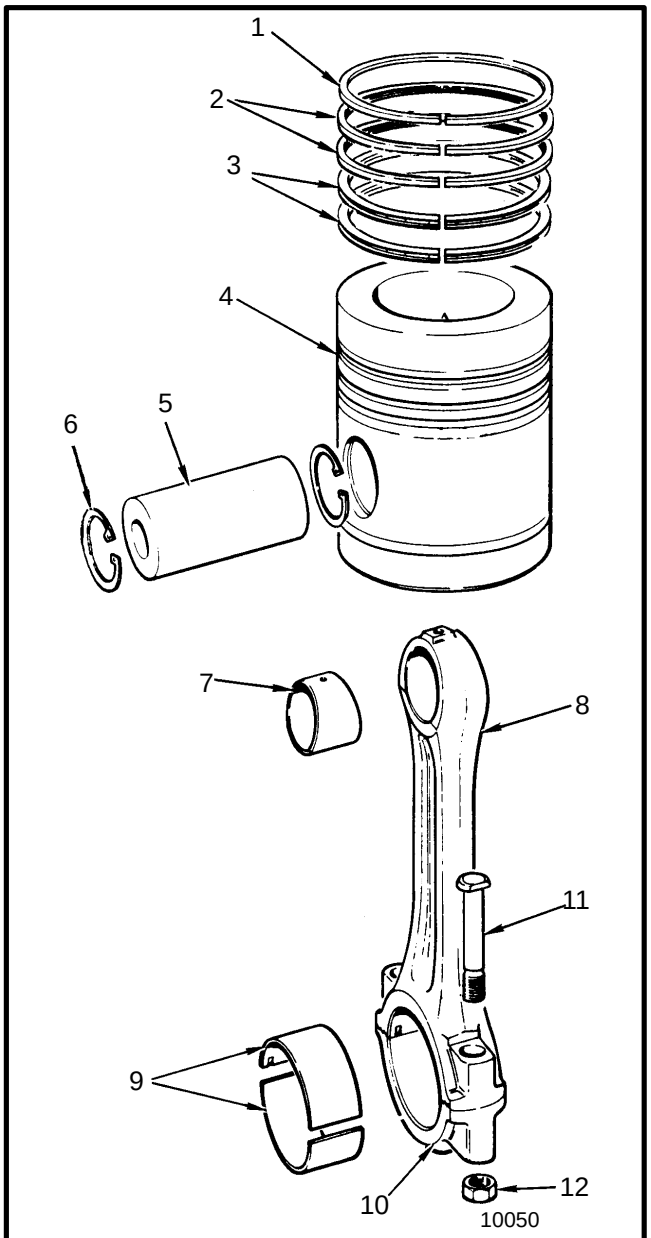


FIGURE 18. ALIGNMENT OF CONNECTING ROD BORES WITH BUSHING REMOVED



1. TOP COMPRESSION RING
2. COMPRESSION RING
3. OIL CONTROL RING
4. PISTON (4.236)
5. PISTON PIN
6. SNAP RING
7. BUSHING
8. CONNECTING ROD
9. CONNECTING ROD BEARINGS
10. CONNECTING ROD CAP
11. BOLT
12. NUT

FIGURE 19. PISTON AND CONNECTING ROD ASSEMBLY

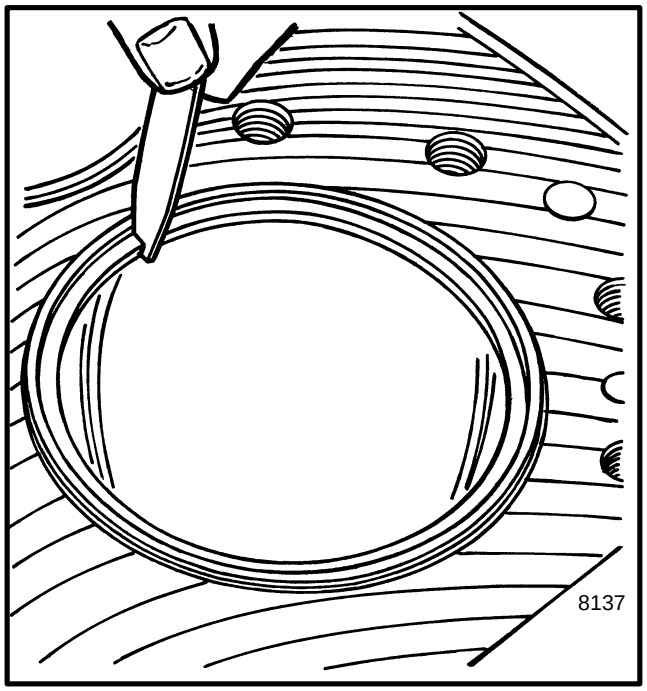


FIGURE 20. CHECKING THE CLEARANCE AT THE ENDS OF THE PISTON RINGS

5. Check the bore for the crankshaft in the connecting rod to make sure it is round.

6. Check the clearance of the ends of the rings in the cylinder bore. See FIGURE 20. See SPECIFICATIONS in this section for correct dimensions.

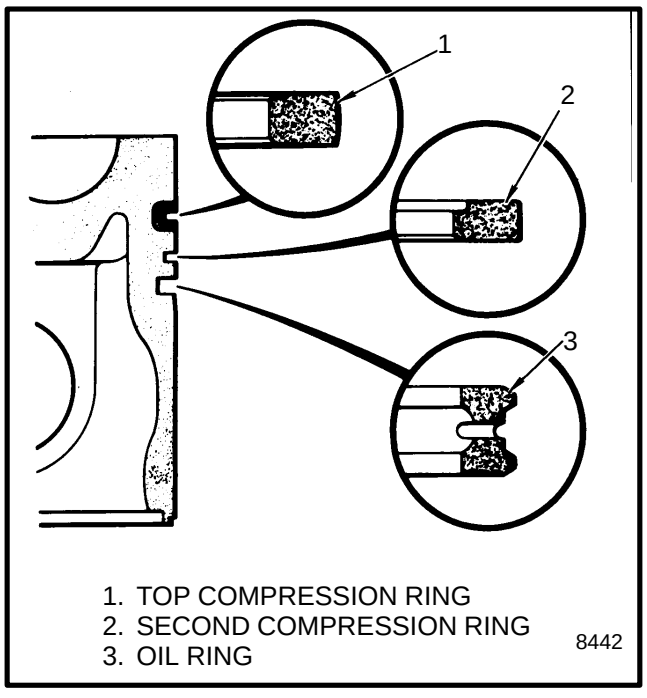


FIGURE 21. PISTON RINGS (4.2482 ENGINE)

Assembly

4.2482 ENGINE (See FIGURE 21.)

1. Install the oil control ring on the the number “1” piston. Install the spring so that both ends of the spring are in the pin. Install the oil control ring so that the space is opposite the pin. Make sure the spring is in the inner groove of the oil control ring.

2. Install the second ring into the groove with the step toward the top of the piston. The ring for the second groove has a tapered face. Move the second ring so that the space does not align with the space of the oil control ring. See FIGURE 21.

3. Install the top compression ring in the top groove with the step toward the top of the piston. The gap for the top ring must not be aligned with the gap of the second ring. See FIGURE 21.

4.236 ENGINE (See FIGURE 19.)

1. Install an oil control ring below the bore for the piston pin (number five groove). Install an oil control ring above the bore for the piston pin (number four groove).

2. Install an iron compression ring in the second and third grooves. These rings have a step on the inside diameter. This step must be towards the top of the piston.

3. Install the top compression ring. This ring normally has a chrome finish.

BOTH ENGINES

4. Lubricate the bores with oil for the piston pin in the connecting rod and piston. Put the connecting rod in between the piston bores. The letter “F” on the piston must be toward the fan end of the engine when the number on the connecting rod is away from the camshaft. See FIGURE 22. Push the piston pin into the piston and connecting rod. Heat the piston in warm water if the piston pin will not enter the piston. Install the snap rings.

5. Install the connecting rod bearings in the connecting rods and caps. Do not touch the bearing surface with your fingers.

Installation

1. Lubricate the piston, rings and bearings with engine oil. Install the piston in their cylinders with the letter

"F" toward the fan end of the engine. Use a ring compressor so that the pistons will fit in the cylinders. Use a wood handle to push the pistons into the cylinders. Make sure the bolts of the connecting rod do not touch the crankshaft.

2. Install the caps for the connecting rods. Install the nuts. Tighten the nuts to 102 N.m (75 lbf ft). Bend the lock plates over the nuts (4.2482 engines). 4.236 engines do not have lock plates. Use new nuts on the bolts for the connecting rods on the 4.236 engine.

NOTE: If new pistons are installed in a 4.236 engine, check the piston height. Measure the difference between the top face of the cylinder block and the top of a piston installed in the engine. The piston will normally extend 0.08 to 0.25 mm (0.003 to 0.010 in) above the top face of the cylinder block. A maximum limit is 0.41 to 0.61 mm (0.016 to 0.024 in) for the piston to extend above the top face of the cylinder block. Remove metal from the top of the piston if necessary to make the correct clearance.

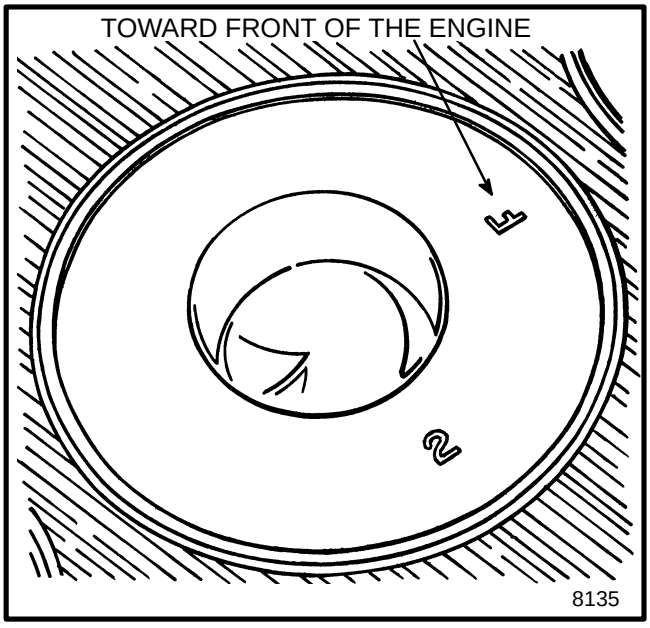


FIGURE 22. IDENTIFICATION OF THE PISTON

NOTE: DO NOT remove the metal from the tops of the pistons for the 4.2482 engine. This action will change the special combustion chamber and decrease the performance of the engine.

3. Install the oil sump. Install the cylinder head as described in Cylinder Head Installation in this section.

CRANKSHAFT AND MAIN BEARINGS

Removal

1. Remove the sump, the screen for the oil pump, the relief valve and the oil pump.

2. Remove the timing gears and case. See TIMING GEAR CASE AND TIMING GEARS, Removal for the procedures.

3. Remove the flywheel and flywheel housing. See Flywheel and Flywheel Housing.

4. Remove the connecting rod caps.

5. Remove the housing for the rear oil seal. Remove the support from the rear main bearing.

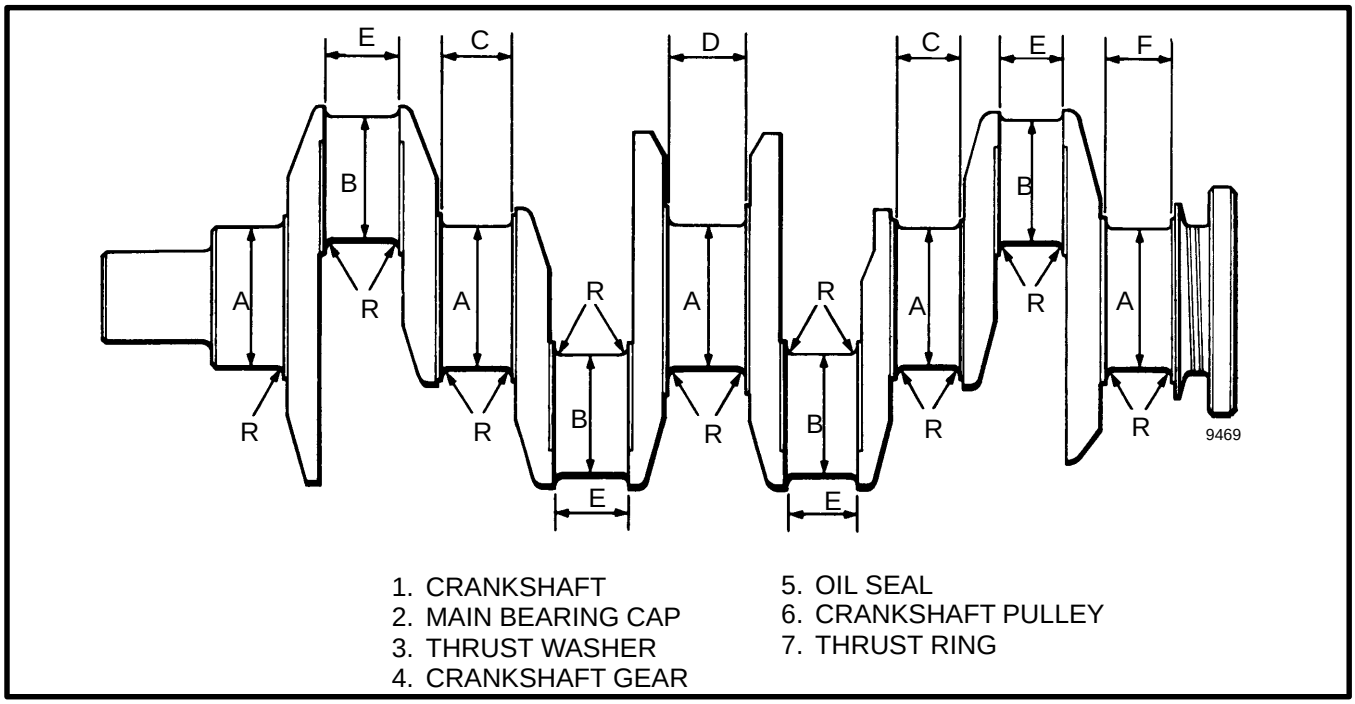
6. Remove the capscrews from the main bearings. Remove the caps for the main bearings.

7. Remove the crankshaft. Remove the bearings and thrust washers.

Inspection

1. Inspect the bearing surfaces of the crankshaft for grooves or damage.

2. Measure the bearing surfaces of the crankshaft. Each bearing surface must be measured four times. Measure at each end of the bearing surface and then measure at positions 90° from the first positions. The bearing surfaces must not be worn more than 0.04 mm (0.0015 in). See FIGURE 23. for the specifications.



1. CRANKSHAFT
2. MAIN BEARING CAP
3. THRUST WASHER
4. CRANKSHAFT GEAR
5. OIL SEAL
6. CRANKSHAFT PULLEY
7. THRUST RING

FIGURE 23. CRANKSHAFT SPECIFICATIONS

3. Check the surface for the rear seal on the crankshaft. If the surface has a groove, the new seal must be installed in a different position. The surface for the seal can be machined when the surface has too many grooves. The diameter of the flange must not be less than 133.17 mm (5.234 in).

4. The surfaces for the bearings can be ground to diameters that are 0.25, 0.51 or 0.76 mm (0.010, 0.020 or 0.030 in) smaller than the original size. The crankshaft must be replaced if the surface must be ground more than 0.76 mm (0.030 in).

5. Clean the oil passages in the crankshaft. Clean the bearing caps.

6. Check the capscrews for the main bearings for damage. Use only capscrews for the main bearings that are HYSTER APPROVED.

7. The thrust washers are found in the support for the center main bearing. Check the thrust surfaces of the crankshaft for wear. The correct total clearance between the crankshaft and the thrust washers is 0.10 to 0.38 mm (0.004 to 0.015 in). Thrust washers are available that are 0.19 mm (0.0075 in) thicker than the standard thrust bearings. A pair of thick thrust washers can be used on one side of the main bearing with a pair of standard thrust washers on the other side.

Assembly

1. Install the new main bearings in the crankcase and main bearing caps. Lubricate all the main bearings with oil. Install and lubricate the thrust washers.

2. Put the crankshaft in the crankcase. Install the main bearing caps in the correct positions. The number “1” main bearing cap is toward the timing gears.

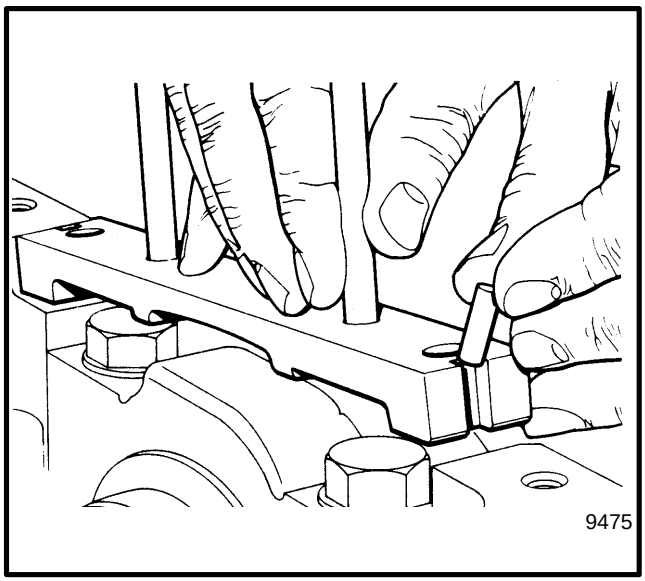


FIGURE 24. MAKE SURE SUPPORT IS EVEN WITH CRANKCASE

3. Install and tighten the capscrews to 44 N.m (180 lbf ft).

4. Check the clearance between the crankshaft and the thrust washers. The clearance must be 0.010 to 0.38 mm (0.004 to 0.015 in). Install thicker thrust washers if the clearance is more than 0.38 mm (0.015 in).

5. Install the connecting rod bearings in the connecting rods and caps. Lubricate the bearings and install the caps on the connecting rods. Tighten the nuts to 102 N.m (75 lbf ft).

6. Install the support for the rear main bearing. Use new seals when installing the support. Make sure the rear surface of the support is even with the rear surface of the crankcase. See FIGURE 24.

7. Install the new seal in the seal housing as shown in FIGURE 25. The seal must be installed so that the lip does not touch a groove in the crankshaft flange. Install a new gasket with sealant. Lubricate the seal and install the seal housing. Make sure the flange of the crankshaft is in the center of the seal.

⚠ CAUTION

Do not damage the seal when installing the seal housing.

8. Install the flywheel housing and flywheel. Tighten the place bolts in the flywheel 122 N.m (90 lbf ft).

9. Install the oil pump and relief valve. Install the timing gear case and timing gears. Install the crankshaft pulley.

10. Install the oil pump screen and tube. Install the sump.

CAMSHAFT AND CAM FOLLOWERS

Removal

The engine must be on an engine stand to remove the camshaft and cam followers.

1. Remove the crankshaft pulley, timing case cover, timing gears and timing case. See TIMING GEAR CASE AND TIMING GEARS, Removal.

2. Rotate the engine so that the cylinder head is toward the floor.

3. Remove the sump. Remove the fuel pump.

4. Remove the thrust ring for the camshaft. Remove the camshaft.

5. Remove the cam followers as shown in FIGURE 27.

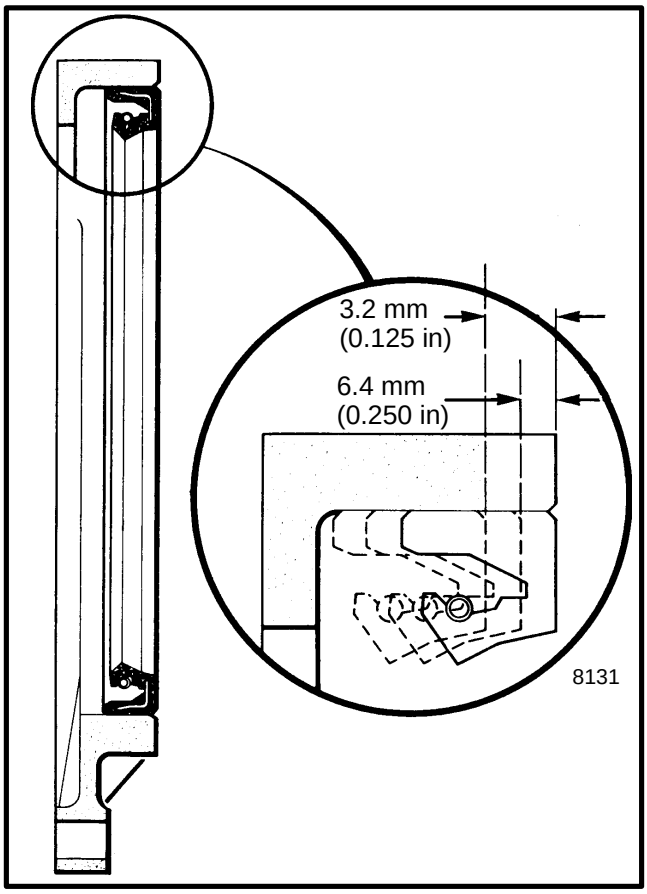


FIGURE 25. REAR OIL SEAL AND HOUSING

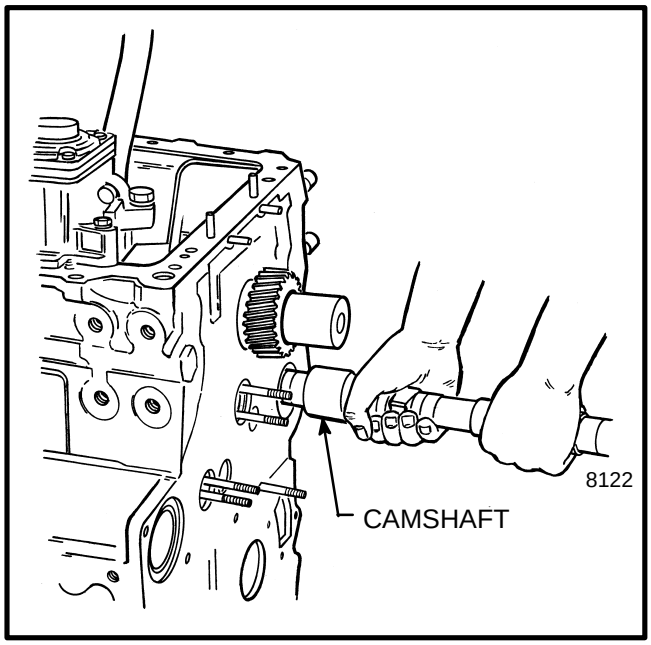


FIGURE 26. REMOVING THE CAMSHAFT

Inspection

1. Inspect the cams of the camshaft for wear or damage. The cam lift must be 7.62 to 7.70 mm (0.300 to 0.303 in).

2. Check the thrust surfaces for wear or damage.

3. Inspect the bearing surface for wear or damage. Measure the bearing surfaces of the camshaft. The diameter of the bearing surface next to the camshaft gear must be 50.71 to 50.74 mm (1.9965 to 1.9975 in). The diameter of the middle bearing surface must be 50.46 to 50.48 mm (1.9865 to 1.9875 in). The diameter of the rear bearing surface must be 49.95 to 49.98 mm (1.9665 to 1.9675 in). The clearance between the front bearing surface and the bore must be 0.06 to 0.11 mm (0.0025 to 0.0045 in). The clearance for the other two bearing surfaces must be 0.06 to 0.14 mm (0.0025 to 0.0053 in).

4. Check the cam followers for wear or damage. The clearance between the cam followers and the bores must be 0.04 to 0.10 mm (0.0015 to 0.0038 in).

Assembly

1. Lubricate the cam followers with oil. Install the cam followers in their bores.

2. Lubricate and install the camshaft. Install the sump.

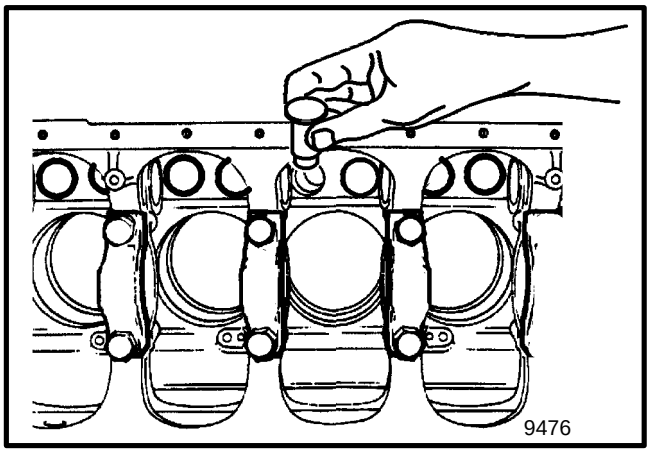


FIGURE 27. REMOVING THE CAM FOLLOWERS

3. Install the thrust washer. Check that the thrust washer extends beyond the front face of the cylinder block surface by 0.66 to 0.79 mm (0.026 to 0.031 in).

4. Install the timing gear case. Check that the clearance between the thrust washer and the camshaft is 0.10 to 0.41 mm (0.004 to 0.016 in).

5. Install the timing gears as described in TIMING GEAR CASE AND TIMING GEARS, Installation. Install the cover for the timing gears and the crankshaft pulley.

6. Install the push rods and rocker arm assembly. Adjust the valve clearances to 0.030 mm (0.012 in) (cold).

7. Install the cover for the rocker arms.

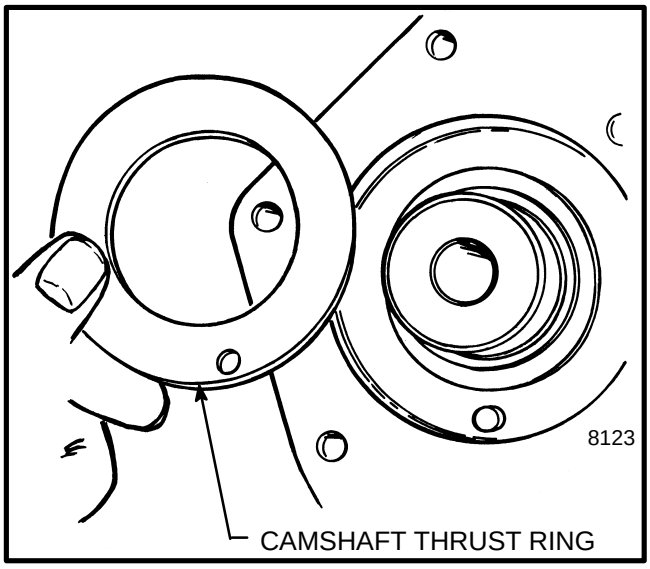


FIGURE 28. CAMSHAFT THRUST RING

FLYWHEEL AND FLYWHEEL HOUSING

Removal

1. Remove all but two of the place bolts that hold the flywheel to the crankshaft. Install two long studs into the crankshaft with your fingers. Remove the two place bolts.

2. Pull the flywheel away from the crankshaft. If the engine has a hydraulic chain drive, remove the gear, chain and shims as described in the **HYDRAULIC PUMP DRIVE ASSEMBLY, 1900 SRM 64**. Remove the flywheel housing and the two studs.

Repairs

1. Replace the ring gear on the flywheel as follows:

   a. During removal or installation, do not heat the gear to more than 230°C (450°F).

   b. During installation, push the ring gear fully against the shoulder of the flywheel.

2. The pilot bearing in the flywheel can be replaced. Push out the old bearing and push in a new bearing. Apply the force only on the outer bearing.

Installation

1. Install a new seal in the flywheel housing. If equipped, install the flywheel housing and pump drive assembly as described in the **HYDRAULIC PUMP DRIVE ASSEMBLY** for the model of interest.

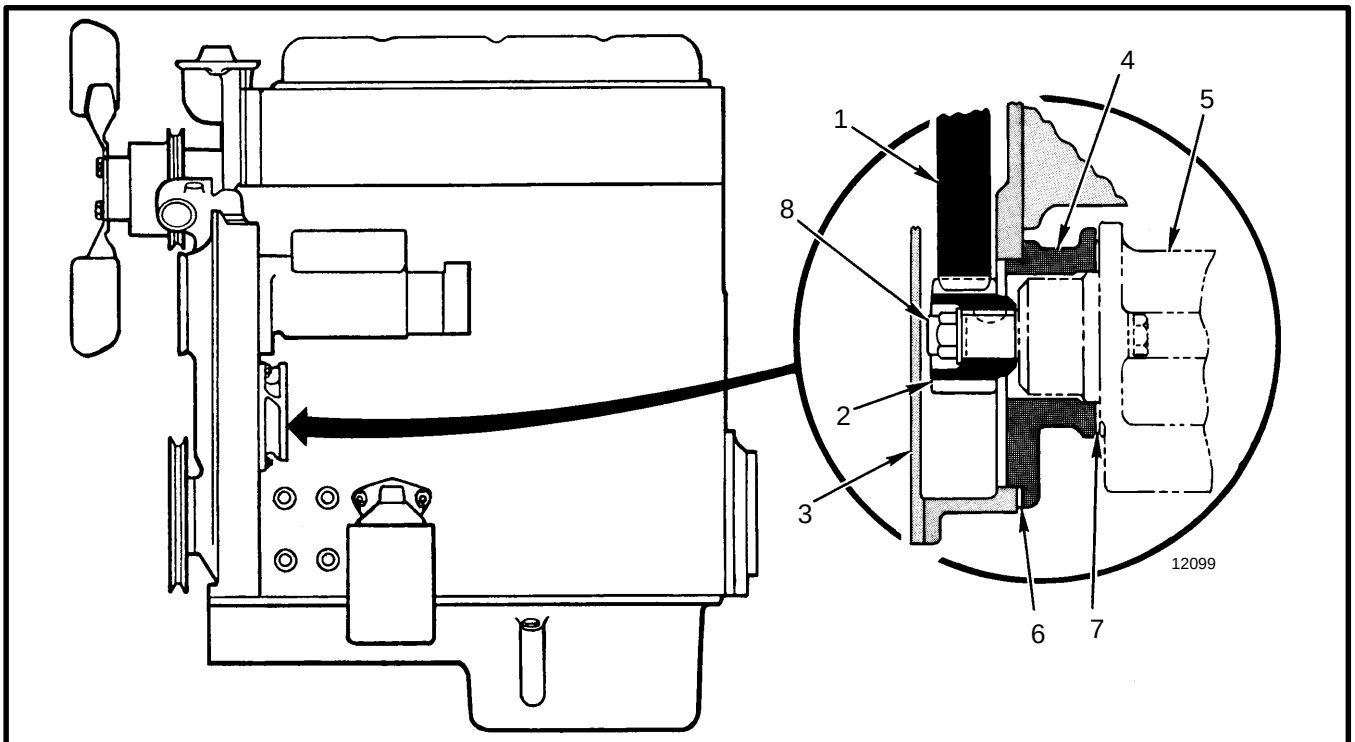
2. Install to studs into the flywheel. Slide the flywheel on the studs. Install the place bolts and tighten the caps-crews to 122 N.m (90 lbf ft). Remove the studs and install the place bolts. Tighten the place bolts to 122 N.m (90 lbf ft).

STEERING PUMP DRIVE (See FIGURE 29.)

Removal

1. Removing the steering pump (5)

2. Remove the four adapter mount nuts and the adapter (4).



1. IDLER GEAR
2. PUMP DRIVE GEAR
3. TIMING GEAR COVER
4. ADAPTER
5. STEERING PUMP (REFERENCE)
6. GASKET
7. GASKET
8. NUT

FIGURE 29. STEERING PUMP DRIVE

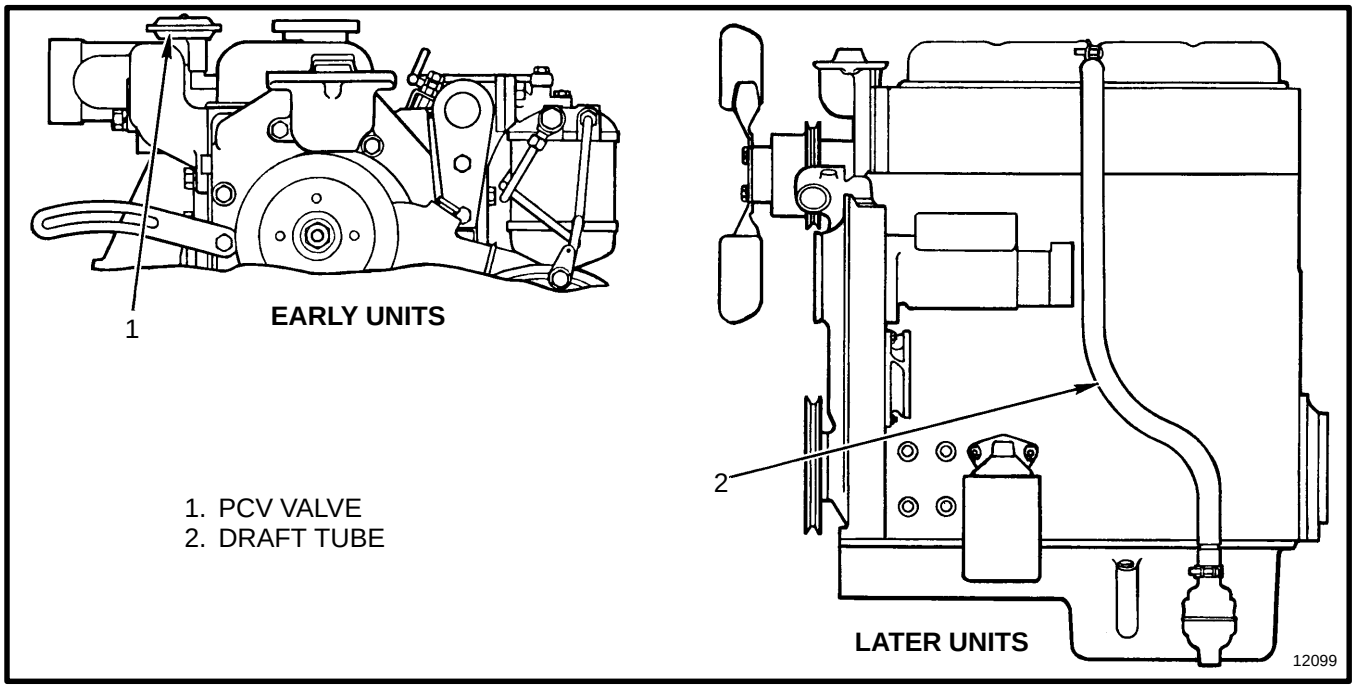


FIGURE 30. CRANKCASE VENTILATION

Installation

1. Install the adapter gasket (6) and adapter 4. Tighten the adapter mount nuts to 20 Nm (15 lbf ft).

2. If the steering pump gear (2) was removed, reinstall the gear and tighten the nut (8) to 45 Nm (33 lbf ft).

3. Install the steering pump (5).

PCV VALVE (See FIGURE 30.)

Early units used a PCV valve for crankcase ventilation. Later units use an open draft tube. See the Periodic Maintenance Section for the maintenance procedures.

FUEL SYSTEM

FUEL PUMP (See Figure 31)

Removal

1. Disconnect and remove the fuel lines at the fuel pump.

2. Remove the nuts and washers that hold the fuel pump to the engine. Remove the fuel pump.

Disassembly

1. Clean the outside of the fuel pump. Make a mark between the flanges of the fuel pump.

2. Remove the cover on the top of the fuel pump. Remove the screws on the housing and separate the parts.

3. Remove the diaphragm assembly by rotating it 90° in either direction.

4. Remove all other parts as necessary.

Assembly

1. Install the lever and spring into the lower half of the fuel pump body.

2. Install the spring and diaphragm. Push on the diaphragm and rotate it 90° in either direction. This action engages the diaphragm and the lever.

3. Align the marks and assemble the housings of the fuel pump. Tighten the screws evenly.

4. Install the cover on top of the fuel pump.

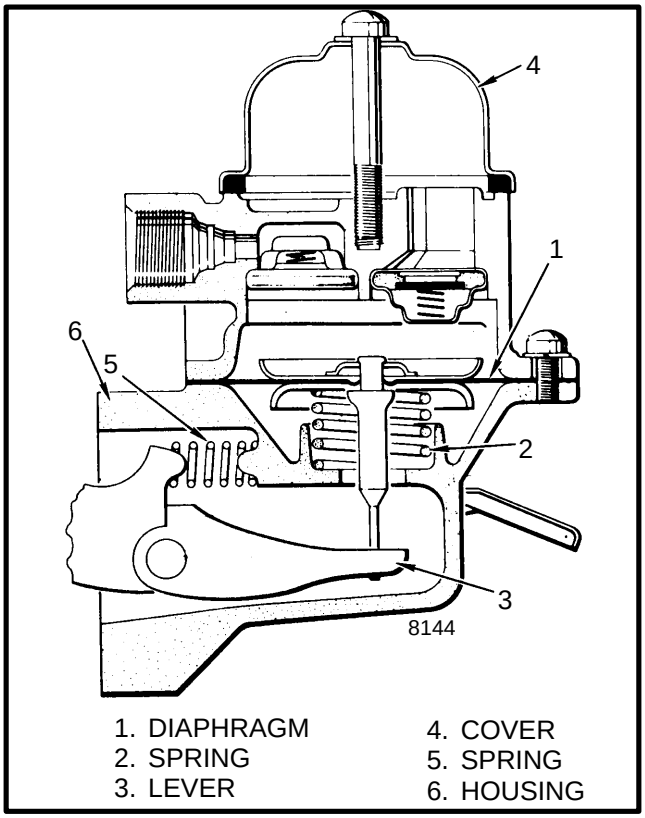


FIGURE 31. FUEL PUMP

Installation

1. Use a new gasket and install the fuel pump on the engine. Tighten the capscrews to 27 N.m (20 lbf ft). Tighten the capscrews again after the engine is hot.

2. Connect the inlet and outlet fuel lines. Remove air from the fuel system as described in Checks and Adjustments.

FUEL INJECTION PUMP

Removal

1. Clean the outside of the fuel injection pump and the fuel lines.

2. Disconnect and remove all the fuel lines to the fuel injection pump. Remove the lines carefully. Do not bend the fuel lines. When removing the fuel lines make sure to disconnect the lines at each end. Put caps on the lines that are disconnected.

3. Remove the throttle cable and the engine stop cable.

4. Remove the inspection plate for the fuel pump on the timing case cover.

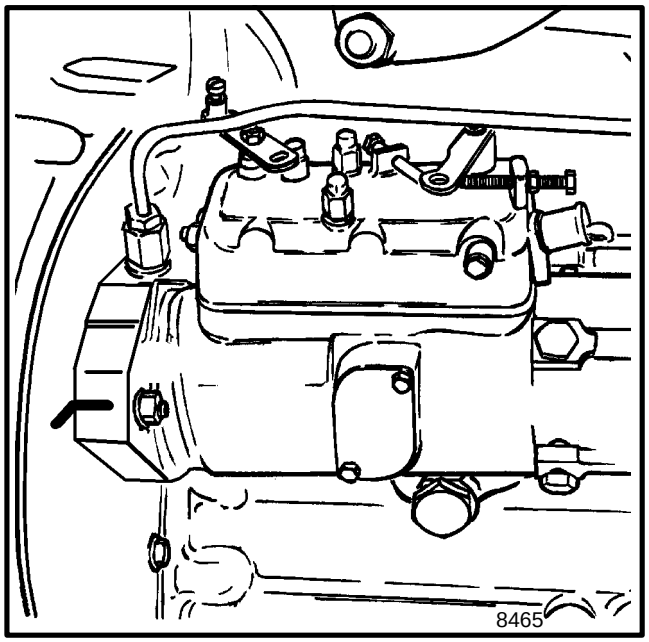


FIGURE 32. FUEL INJECTION PUMP

5. Remove the fuel pump gear as described in TIMING GEAR CASE AND TIMING GEARS, Removal.

6. Remove the nuts that hold the pump on the timing gear case.

7. Remove the fuel injection pump.

Repairs

Repairs to the fuel injection pump cannot be made without special tools. Any necessary repairs must be made by a dealer.

Installation

1. Check the timing for the fuel injection pump as described in CHECKS AND ADJUSTMENTS. Install the fuel injection pump to the timing gear case. Tighten the nuts.

2. Connect the throttle cable and the engine stop cable.

3. Connect all the fuel lines to the fuel injection pump.

⚠ CAUTION

Do not bend the fuel lines.

4. Remove the air from the system as described in Checks and Adjustments.

FUEL INJECTORS

Removal

1. Clean the outside of the fuel injectors.