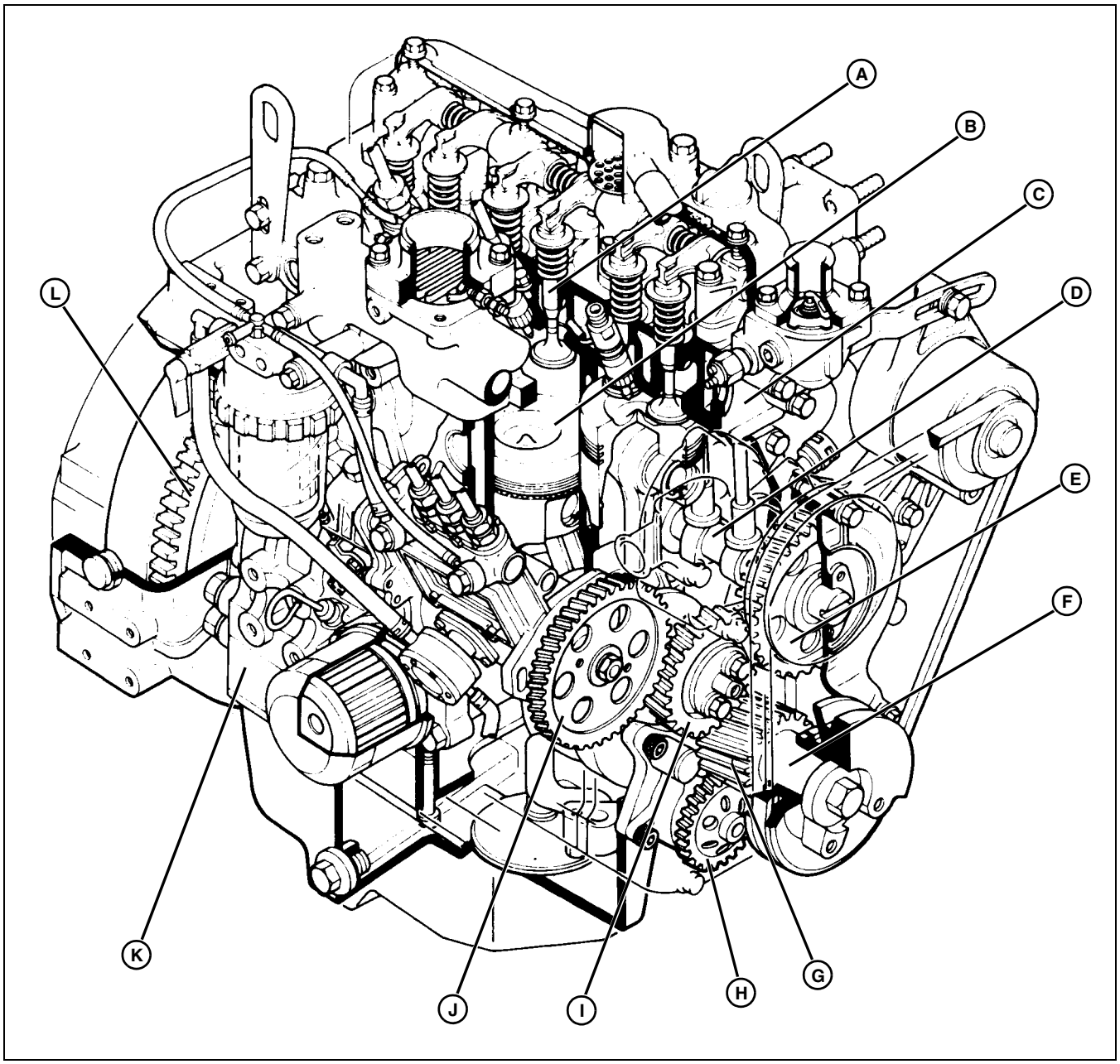
Component Location

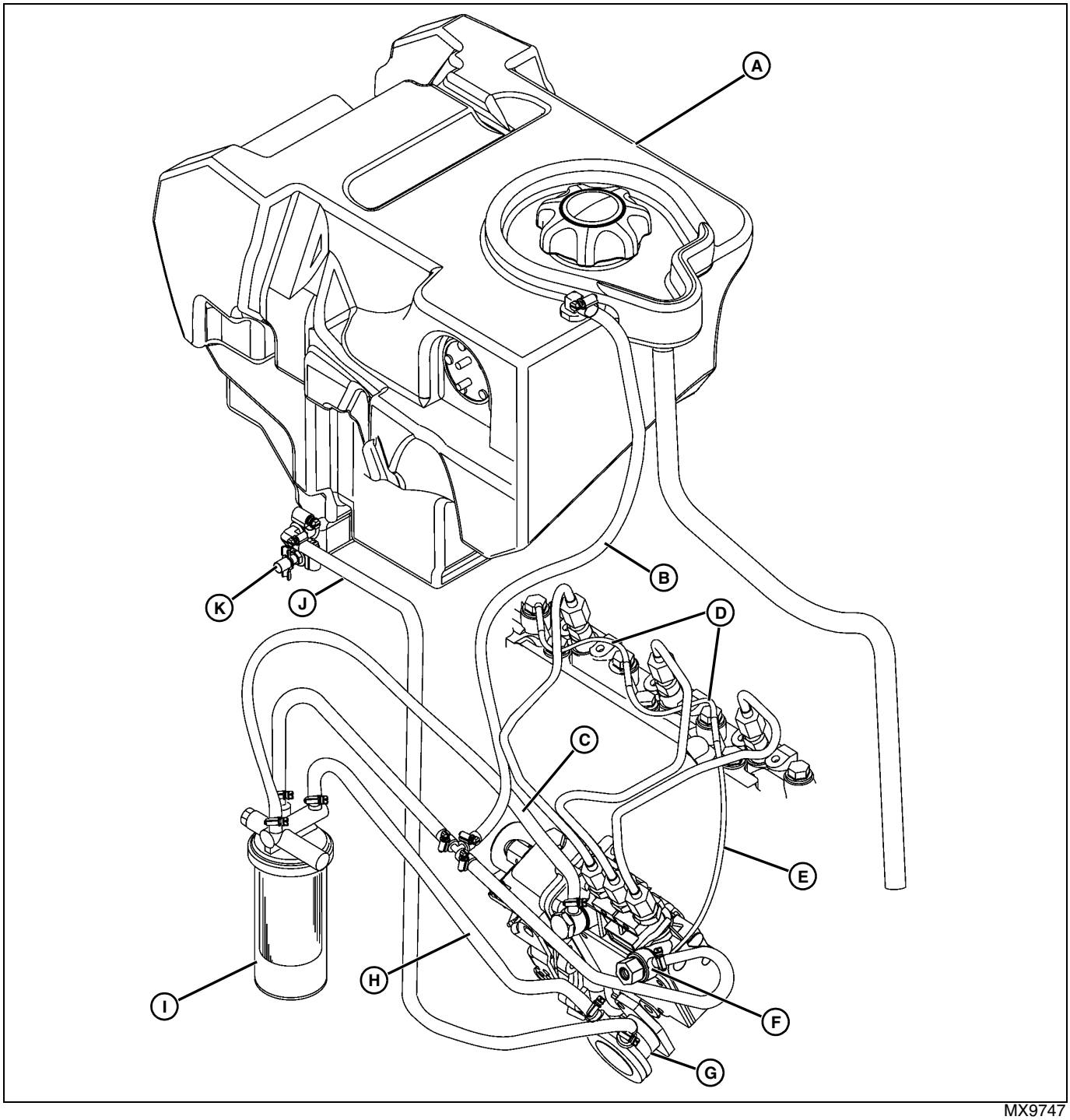
Engine



MX19735

A - Valves
B - Pistons
C - Cylinder Head
D - Camshaft
E - Camshaft Gear
F - Crankshaft
G - Crankshaft Gear
H - Oil Pump Gear
I - Idler Gear
J - Injection Pump Gear
K - Cylinder Block
L - Flywheel

Fuel Supply



MX9747

A - Fuel Tank
B - Return Fuel Hose
C - Fuel Filter-to-Injection Pump Hose
D - Nozzle Leak-Off Hose (Short)
E - Nozzle Leak-Off Hose (Long)
F - Air Vent Check Valve
G - Transfer Pump
H - Transfer Pump-to-Filter Hose
I - Fuel Filter
J - Fuel Tank-to-Transfer Pump Hose
K - Drain Valve

Theory of Operation

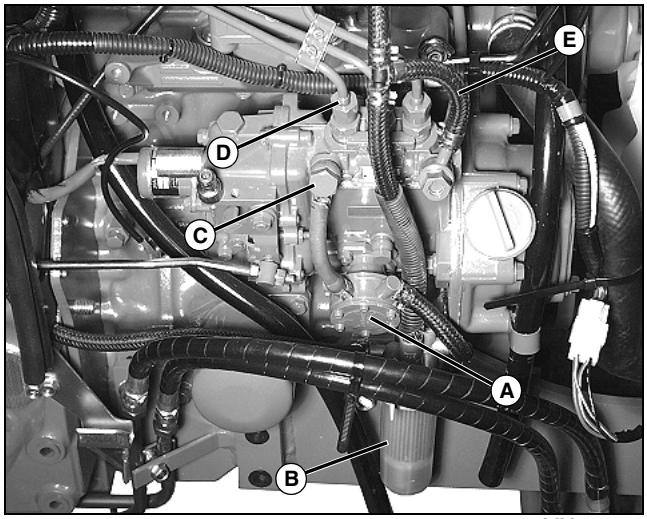
Fuel and Air System Operation

Function:

Fuel system supplies fuel to injection nozzles.

The air intake system filters and supplies air needed for combustion.

Theory of Operation:



MX19843

Fuel System:

A mechanical fuel transfer pump (A) draws fuel from the tank outlet. The low pressure fuel from the fuel pump flows through the filter/water separator (B) to the fuel the injector pump inlet (C). The injection pump then directs high pressure fuel through the injector lines (D) for combustion. Excess fuel is returned, along with fuel from the injectors, through the return line (E) to the fuel tank.

If the machine runs out of fuel, there are two air bleed lines that allow air to escape from the top of the filter and the injection pump. These two lines allow the system to be self bleeding.

The engine speed is controlled by the throttle lever and rod. The rod is connected to the injection pump governor control lever. The fuel shutoff solenoid controls the injection pump shutoff shaft. When the solenoid is retracted (key in the START or ON position), the engine can be started. When the key is turned off, return springs on the shutoff shaft, extend the solenoid, moving the shutoff linkage to the shutoff position. The solenoid also closes if the machine is operated in an unsafe condition. See “Engine Shutoff Circuit Operation” in the Electrical section.

The injection pump meters fuel as determined by the governor and delivers it at high pressure to the injection nozzles.

The injection nozzle prevents flow until high pressure is reached, opening the valve and spraying atomized fuel into the combustion chamber. Injection lines contain trapped fuel whenever injection is not taking place.

A small amount of fuel leaks past the nozzle valve to lubricate the fuel injection nozzle. This leakage combines with excess fuel from the injection pump and is returned to tank. Any air in the fuel system is bled out with return fuel to the fuel tank.

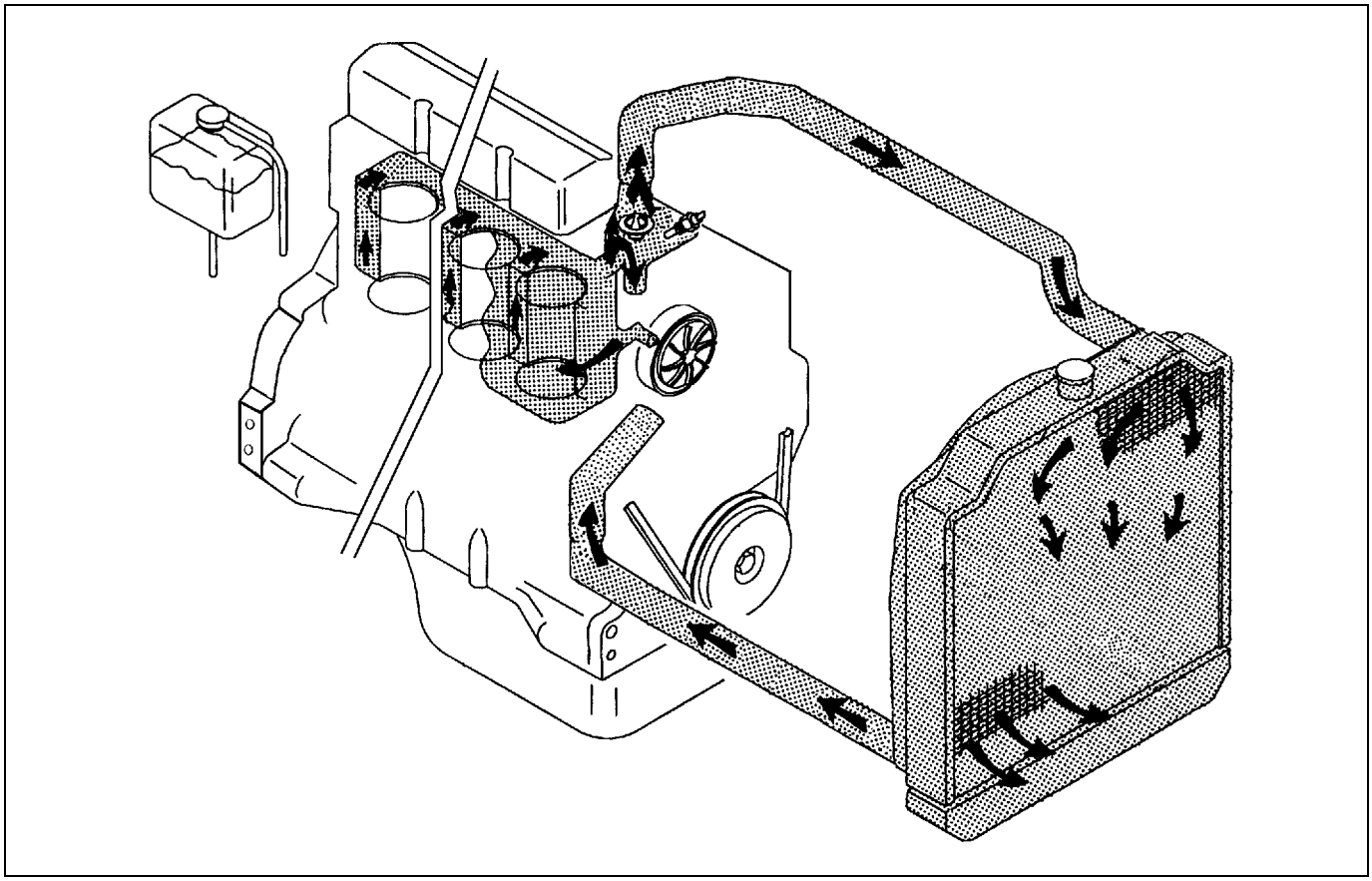
A fuel level sensor mounted in the fuel tank informs the operator of the fuel level.

Air Intake System:

Engine intake air enters the inlet hose (A) behind the grille, and flows into the air filter body (B). The air cleaner also has a rubber, one way, unloading valve (C), that ejects heavy dirt particles from the air stream during engine operation before they reach the filters. The operator can squeeze the valve to remove the large particles. The air cleaner elements filter the air, which then flows through hose (D) to the intake manifold.

An air filter restriction indicator (E) at the rear of the air cleaner informs the operator when the air filter needs servicing.

Cooling System Operation



MX1026

Function:

The coolant pump circulates coolant through the cooling system, drawing hot coolant from the engine block, circulating it through the radiator for cooling.

Theory of Operation:

The pressurized cooling system includes the radiator, water pump, fan and thermostat.

During the warm-up period, the thermostat remains closed and the impeller type coolant pump draws coolant from the bypass tube. Coolant from the pump flows to the cylinder block water jacket and up through the cylinder head providing a fast warm-up.

Once the engine has reached operating temperature, the thermostat opens and coolant is pumped from the bottom of the radiator via the lower radiator hose into the cylinder block. Here it circulates through the block and around the cylinders.

From the block, coolant is then directed through the cylinder head, and into thermostat housing. With the thermostat open, warm engine coolant passes through the housing into the top of the radiator where it is circulated to dissipate heat.

When coolant system pressure exceeds 88.3 kPa (12.8 psi), a valve in the radiator cap opens to allow coolant to discharge into the coolant recovery tank.

When temperature is reduced, a vacuum is produced in the radiator and coolant is drawn back out of the coolant recovery tank through a valve in the radiator cap.

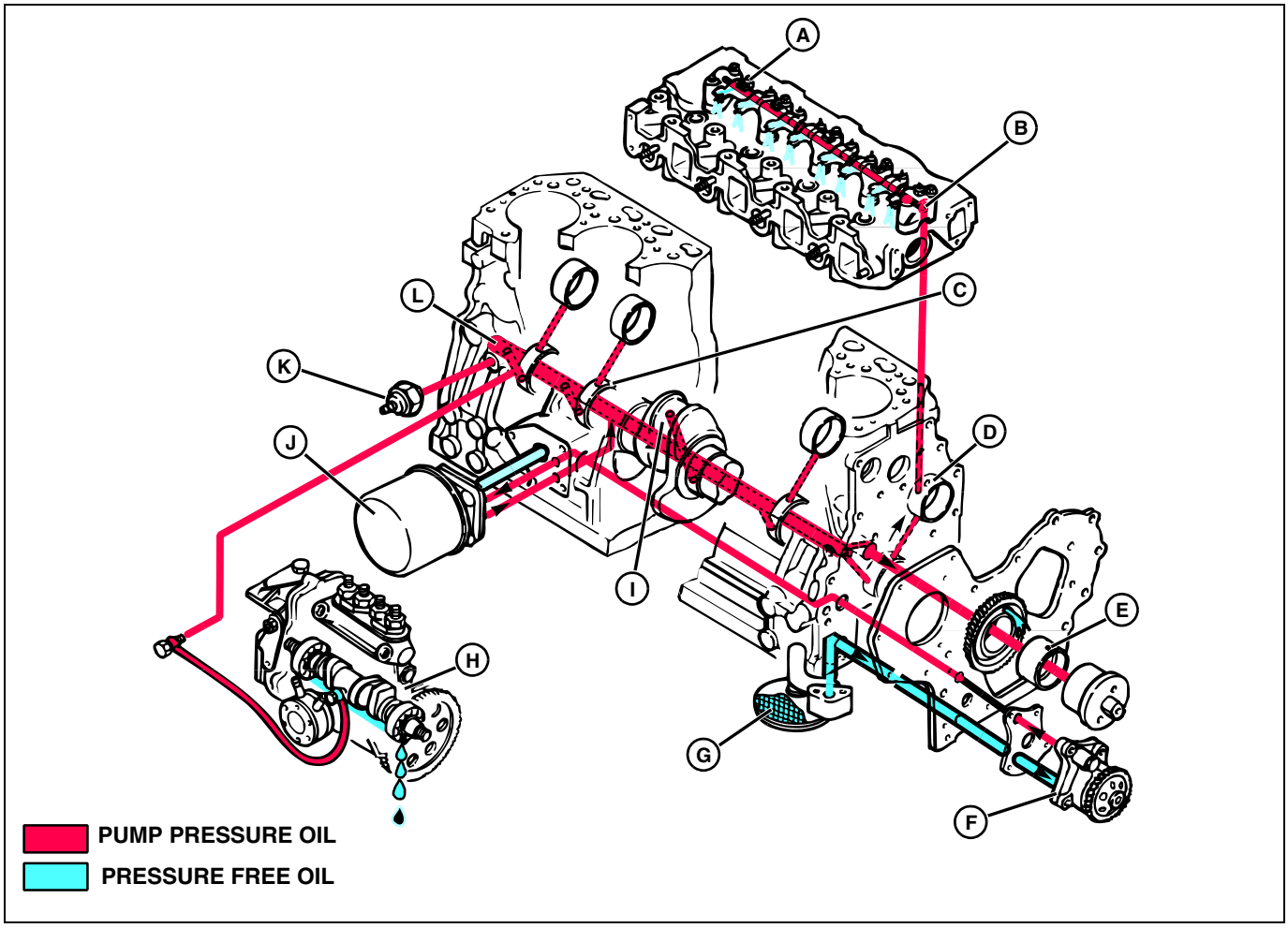
A coolant temperature sensor informs the operator of the engine coolant temperature and warns of a high temperature condition by lighting a lamp.

Thermostat Settings:

Start To Open . . . . . 69.5 - 72.5° C (157 - 163° F)

Fully Opened . . . . . 85° C (185° F)

Lubrication System Operation



MIF

Function:

A full pressure system lubricates engine parts with filtered oil.

Theory of Operation:

The pressure lubrication system consists of a positive displacement gear-driven pump (F), oil strainer (G), full flow oil filter (J), oil pressure regulating valve and an electrical pressure warning switch. (K)

The pump draws lubrication oil from the oil pan through a strainer and a suction tube. The oil is then pumped through an oil passage to the oil filter and through the engine block main oil galley (L).

From the main oil galley, oil is forwarded under pressure to the crankshaft main bearing journals (C) and idler gear bushing (E). Drilled cross-passages in the crankshaft (I) distribute the oil from the main bearings to connecting rod bearings.

Lube oil holes in main bearing oil grooves direct oil to the camshaft bearings (D).

A drilled passage from the rear camshaft bearing through the cylinder block and cylinder head supplies lubricating oil to the rocker arm shaft (B). The hollow shaft distributes oil to the rocker arms (A), cam followers and valves.

Lubrication oil is supplied to the fuel injection pump (H) from the main oil galley through external oil lines.

An oil pressure sensor (K) activates an indicator light to alert the operator to shut down the engine if oil pressure drops below specification.

Test/Check Point	Normal Condition	If Not Normal
Injection pump fast idle speed (engine running)	Engine runs at 2850 ± 25 rpm.	See “Injection Pump Static Timing Adjustment” on page 47 in this section.
Governor	Engine runs smoothly through out rpm range with low smoke and good power.	Have governor torque capsule adjusted by a certified CARB/EPA service center.
Oil pressure sender port	Oil pressure to specification.	Test engine oil pressure. See “Tests and Adjustments” in this section.
Thermostat	Opening temperature within specification.	Perform thermostat opening test. See “Tests and Adjustments” in this section.
Muffler	Not restricted.	Replace muffler.

Tests and Adjustments

Cylinder Compression Test

Reason:

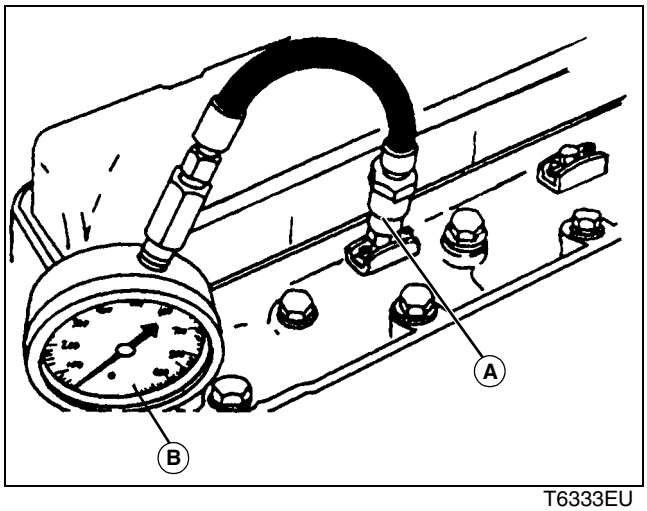
To determine the condition of the pistons, rings, cylinder walls and valves.

Equipment:

- JT01682 Compression Gauge Assembly
- JDG560 Adapter

Procedure:

1. Remove the injection nozzles.



T6333EU

2. Install the heat protector from end of injector and install JDG560 adapter (A).

3. Install JT01682 Compression Gauge Assembly (B) and JDG560 Adapter.

4. Disconnect the fuel control solenoid connector.

IMPORTANT: Avoid damage! DO NOT overheat starting motor during test.

5. Crank the engine for five seconds with the starting motor. Minimum cranking speed is 250 rpm.

6. Record the pressure reading for each cylinder.

Specifications:

Cylinder Compression. . . . . 3334 kPa (483 psi)

(Minimum) . . . . . 3138 kPa (455 psi)

Difference Between Cylinders (Maximum) . . . . . 294 kPa (42 psi)

Results:

- If the pressure reading is below specification, perform “Radiator Bubble Test” to help determine the cause of compression loss.

Slow Idle Adjustment

IMPORTANT: Avoid damage! The slow idle adjustment is the only adjustment that can be made on this engine.

The fast idle and torque capsule adjustments are pre-set by the engine manufacturer to comply with strict EPA/CARB emissions requirements, and are adjustable ONLY by authorized diesel service facilities.

Reason:

To achieve proper slow idle rpm setting. Provides adequate rpm to keep the engine running smoothly without stalling.

Equipment:

- JT05719 Hand Held Digital Tachometer

NOTE: Make sure the air cleaner is clean and not restricted. Replace the air cleaner element as necessary.

Procedure:

1. Place a small piece of reflective tape on the crankshaft pulley.

2. Start the engine and run for 5 minutes to attain operating temperature.

3. Move the throttle lever to slow idle position.

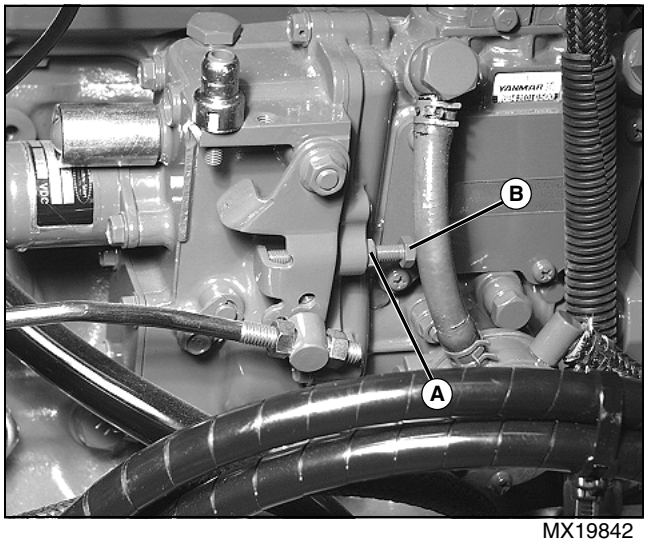
4. Use JT05719 Hand Held Digital Tachometer to check engine speed at the crankshaft pulley.

5. Visually check that the injection pump throttle lever is against slow idle stop screw. Slow idle speed is set to specification.

Specifications:

Low Idle . . . . . 925 ± 25 rpm

Results:



MX19842

- If the slow idle rpm is not according to specifications, loosen the nut (A) and turn the slow idle stop screw (B) clockwise to increase the engine speed, or counterclockwise to decrease the engine speed until the slow idle speed is correct. After adjustment, tighten the nut.

Valve Clearance Adjustment

Reason:

To be sure the valves are fully opening and closing at the correct time, and not wearing the valve train unnecessarily.

Equipment:

- Feeler Gauge
- 10 mm End Wrench
- Flat Blade Screwdriver
- 17 mm Wrench

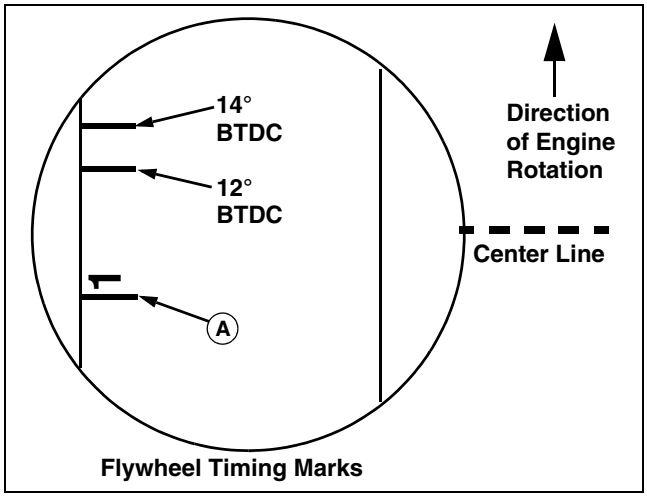
Procedure:

1. The engine must be cool (room temperature) before the valve clearance is checked.

2. Be sure ignition key is OFF before attempting to turn engine by hand.

3. Open the hood and remove the engine side covers.

4. Remove the rocker arm cover. See “Rocker Cover Removal and Installation” on page 54.



MIF

5. Locate the inspection hole in right side of the transmission tunnel. The flywheel can be seen inside the inspection hole.

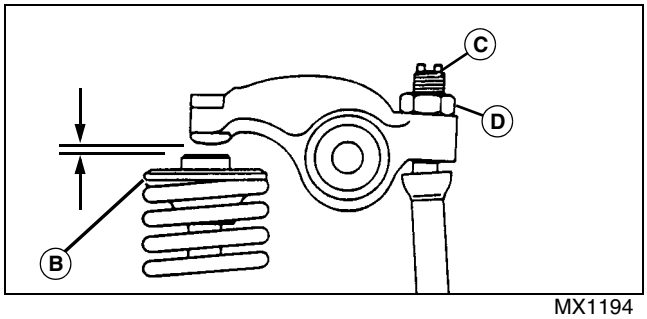
NOTE: "Top dead center (TDC)" is when the piston is at its' highest point of travel in the cylinder on the compression stroke.
Number one cylinder is located at rear of engine (flywheel side).

6. Turn the crankshaft pulley while watching the flywheel inside the inspection hole. Align the number one TDC mark (A) on the flywheel with the pointer on the tunnel.

NOTE: When top dead center is reached, the rocker arms for that cylinder will be motionless as the crankshaft if rotated. If rocker arms are still moving when TDC is approached, rotate crankshaft one full revolution and try again.

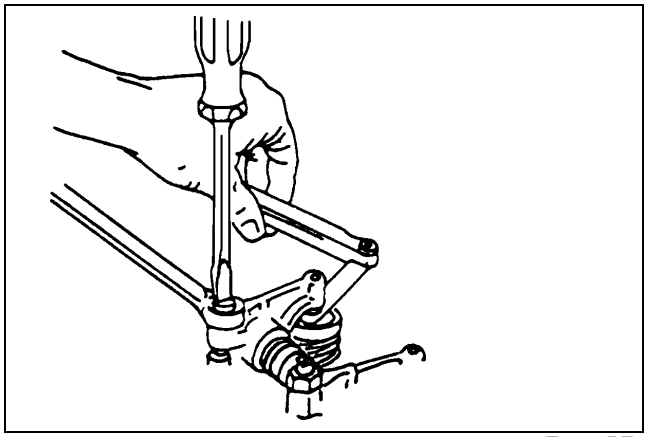
7. Try to move rocker arms and/or push rods for No. 1 cylinder:

- If the rocker arms and push rods are loose, the piston is at TDC on the compression stroke. Go to step 8.
- If the rocker arms and/or push rods are not loose, rotate the flywheel one revolution (360°), and recheck the rocker arms and push rods.



MX1194

8. Slide a feeler gauge between the valve cap (B) and rocker arm to measure the clearance.



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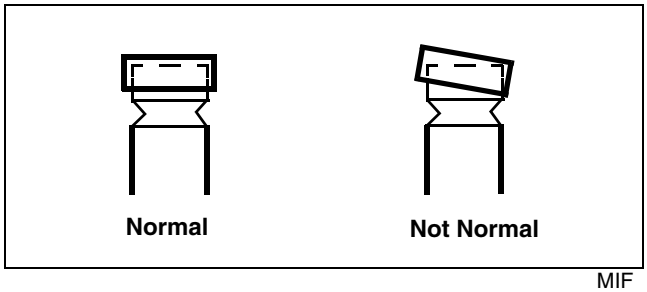
9. To adjust the valves, loosen the lock nut (D) and turn the adjusting screw (C) until the blade of the feeler gauge can be inserted between the rocker arm and valve cap. Hold the adjusting screw while tightening the lock nut.

10. Recheck the valve clearance after tightening the lock nut.

Specification:

Valve Clearance . . . . . **0.15 - 0.25 mm (0.006 - 0.010 in.)**



MIF

11. Check that the valve cap on the valve stem remained seated on the valve and inside the valve spring retainer.

12. Turn the crankshaft pulley counter clockwise (as viewed from operator's seat or flywheel end) approximately 2/3 of a revolution (240°) while watching the observation hole for the number three timing mark.

13. Check that the rocker arms and push rods for cylinder number three are loose.

14. Repeat steps 7 - 13 for number three cylinder.

15. Repeat steps 7 - 11 for number two cylinder.

16. Replace the rocker arm cover, air cleaner bracket and housing, and the muffler.

17. Replace the engine side covers and hood.

Connecting Rod Side Play Check

Reason:

To determine proper side clearance between the crankshaft and the connecting rod.

Equipment:

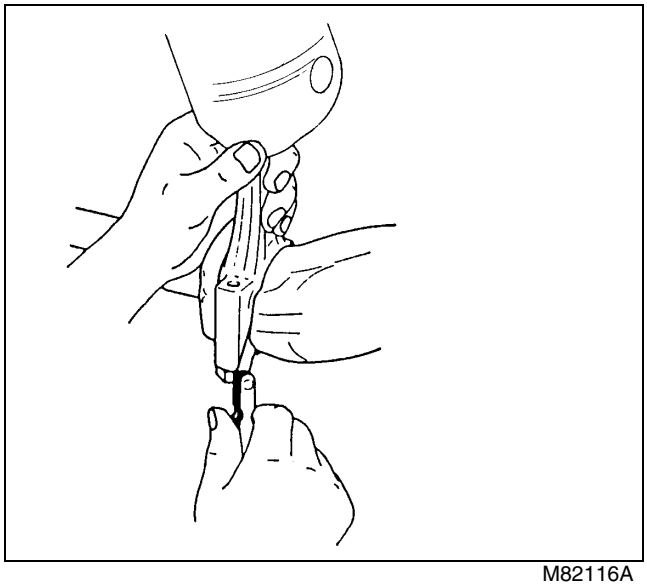
- Feeler Gauge

NOTE: The engine must be removed from the machine to perform this test.

Procedure:

1. Remove the oil pan, crankcase extension, oil pick-up, and balancer assembly.

2. Insert a feeler gauge, according to specifications, between the connecting rod cap and the crankshaft.



M82116A

3. Connecting rod side play is 0.2 - 0.4 mm (0.008 - 0.016 in.

Results:

- If the side play exceeds specification, replace the bearing inserts or the connecting rod.

Connecting Rod Bearing Clearance Check

Reason:

To measure oil clearance between connecting rod bearing and crankshaft journal.

Equipment:

- PLASTIGAGE®

NOTE: The engine must be removed from the machine to perform this procedure.

Procedure:

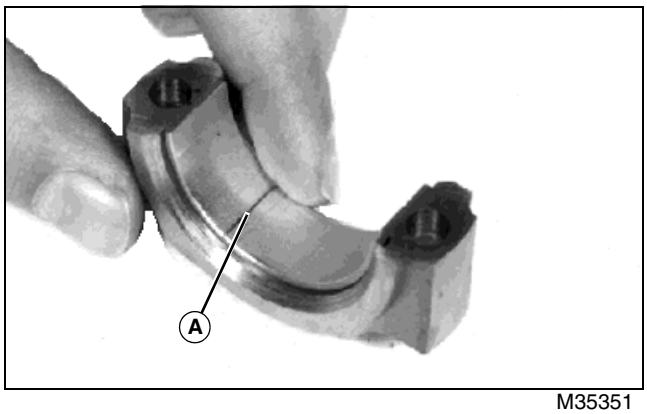
1. Remove the oil pan, and oil pickup.

IMPORTANT: Avoid damage! The connecting rod caps must be installed on the same connecting rod and in the same direction to prevent crankshaft and connecting rod damage.

2. Remove the connecting rod cap.

3. Wipe oil from the bearing insert and the crankshaft journal.

4. Put a piece of PLASTIGAGE® (A), or an equivalent, along the full length of the bearing insert approximately 6 mm (0.25 in.) off center.



M35351

5. Turn the crankshaft approximately 30° from bottom dead center.

6. Install the connecting rod end cap and original rod bolts. Tighten the rod bolts to specification.

Specifications:

Connecting Rod Bolt Torque. 44 - 54 N•m (33 - 40 lb-ft)

7. Remove the rod bolts and the connecting rod cap.

NOTE: The flattened PLASTIGAGE® (A) will be found on either the bearing insert or crankshaft journal.

8. Use the graduation marks on the envelope (C) to compare the width of the flattened PLASTIGAGE at its widest point. The number within the graduation marks indicates the bearing clearance in inches or millimeters depending on which side of the envelope is used.

Suggest:

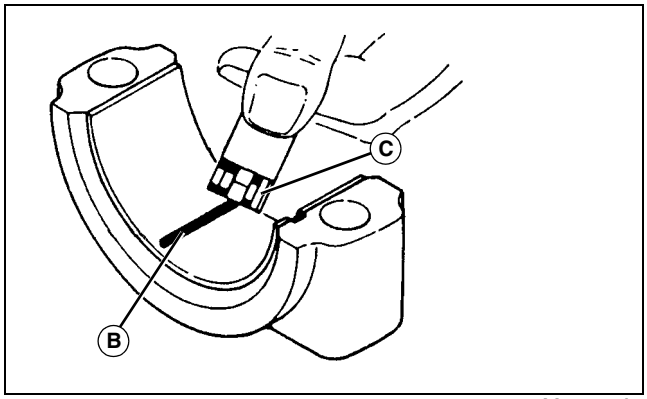
If the above button click is invalid.

Please download this document

first, and then click the above link

to download the complete manual.

Thank you so much for reading



M82117A

9. Measure the connecting rod bearing oil clearance.

Specification:

Connecting Rod Bearing Oil Clearance
. . . . . 0.04 - 0.07 mm (0.002 - 0.003 in.)

Wear Limit . . . . . 0.16 mm (0.006 in.)

Results:

- If the clearance exceeds the wear limit specification, replace the bearing inserts.
- Remove the PLASTIGAGE®.

Crankshaft End Play Check

Reason:

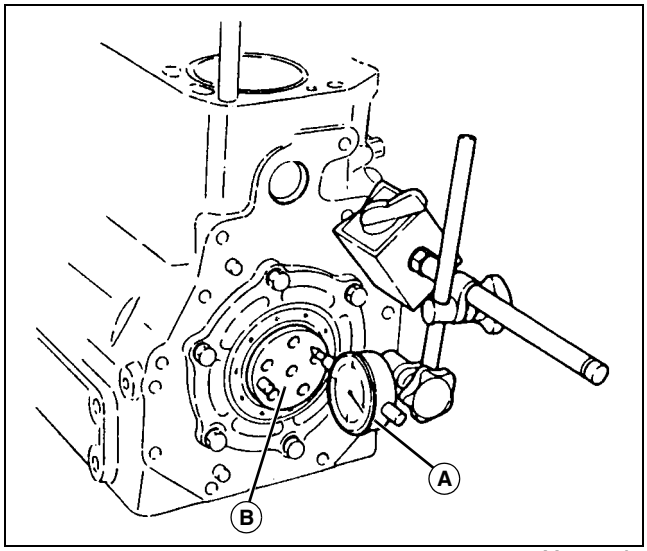
To determine proper side clearance between the crankshaft and the engine block.

Equipment:

- Dial Indicator

Procedure:

NOTE: Crankshaft end play can be measured at front end or rear end of crankshaft. Procedure is performed from the rear end. The flywheel is removed to show detail.



M82118A

1. Fasten the dial indicator (B) to engine and position indicator tip on end of crankshaft (A).

IMPORTANT: Avoid damage! Do not use excessive force when moving crankshaft to avoid damaging bearings.

2. Push the crankshaft toward rear as far as possible.
3. Zero the dial indicator.
4. Using a bar, gently pry the crankshaft as far forward as possible.
5. Crankshaft end play is 0.09 - 0.27 mm (0.004 - 0.011 in.).

Results:

- If the end play exceeds 0.27 mm (0.011 in.), replace the thrust bearings.

Crankshaft Main Bearing Clearance Check

Reason:

To measure oil clearance between main bearing and crankshaft journal.

Equipment:

- PLASTIGAGE®

NOTE: The engine must be removed from the machine to perform this test.

Procedure:

1. Remove the oil pan, and oil pickup.