

Document Title: Description	Function Group: 200	Information Type: Service Information	Date: 2014/4/16
Profile: CEX, EC45 [GB]			

Description

Engine, description and external views

The EC45 is powered by a 4-cylinder four-stroke diesel in line engine with water cooling.

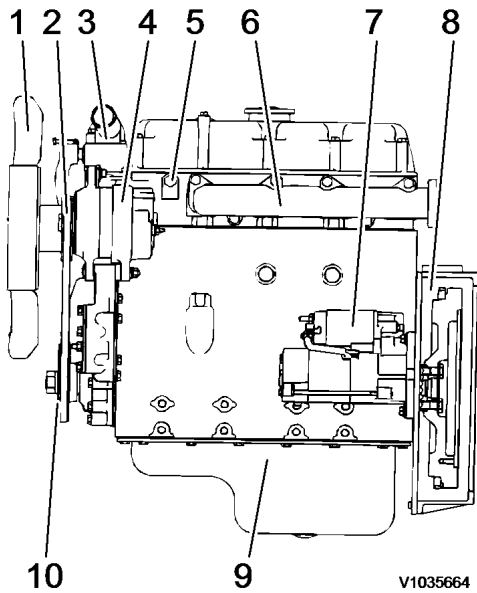


Figure 1
Engine, left side

1. Fan
2. V-belt
3. Thermostat
4. Alternator
5. Engine hanger
6. Exhaust manifold
7. Starter
8. Flywheel
9. Oil pan
10. Crankshaft pulley

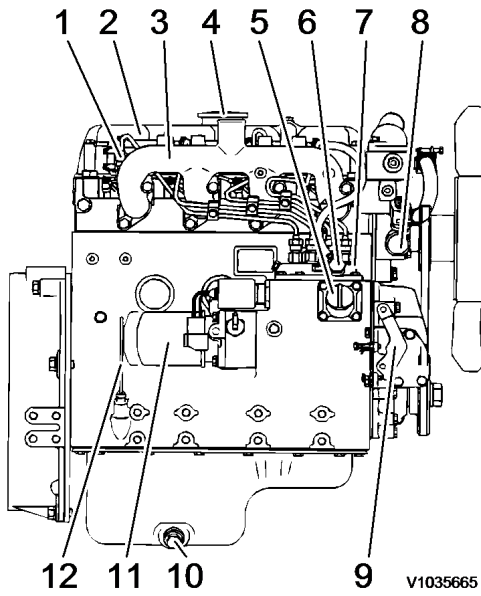


Figure 2
Engine, right side

1. Fuel injection nozzle
2. Fuel return
3. Intake manifold
4. Oil filler
5. Oil filter
6. Fuel inlet
7. Injection pump
8. Water pump
9. Governor
10. Oil drain plug
11. Oil filter
12. Disptick

Document Title: Precautions	Function Group: 200	Information Type: Service Information	Date: 2014/4/16
Profile: CEX, EC45 [GB]			

Precautions

Make preparation as follows before starting engine inspection and service.

- Fix the engine on a horizontal base.
- Remove the coolant hoses, fuel oil pipes, wire harness, control wires etc. connecting the driven machine and engine, and drain coolant, lubricating oil and fuel.
- Remove soil, oil, dust, etc. from the engine by washing with solvent, air, steam, etc. Carefully operate so as not to let any foreign matter enter the engine.
- Any part which is found defective as a result of inspection or any part whose measured value does not satisfy the standard or limit shall be replaced.
- Any part predicted to dissatisfy the standard or limit before the next service as estimated from the state of use should be replaced even when the measured value then satisfies the standard or limit.

Document Title: Troubleshooting chart	Function Group: 200	Information Type: Service Information	Date: 2014/4/16
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Troubleshooting chart

The following table summarizes the general trouble symptoms and their causes. If any trouble symptom occurs, take corrective action before it develops into a serious problem so as not to shorten the engine service life.

Engine troubleshooting chart

Trouble symptoms	Causes	Corrective actions
Engine does not start	Improper clearance of inlet/exhaust valve	Adjust the valve clearance
	Seizure of inlet/exhaust valve	Correct or replace
	Seized or broken piston ring	Replace the piston ring
	Worn piston ring, piston or cylinder	Perform honing and use oversize parts
	Seized crankpin metal or bearing	Repair or replace
	Foreign matter trapped in combustion chamber	Disassemble and repair
	Improper open/close timing of intake/exhaust valves	Adjust the valve clearance
	Improper properties of lubricating oil	Use proper lubricating oil
	Water entrance in fuel system	Perform draining from the fuel filter
	Clogged fuel filter	Clean or replace
	Air entrance in fuel system	Perform air bleeding
	Clogged or cracked fuel pipe	Clean or replace
	Insufficient fuel supply to fuel injection pump	Check the fuel tank cock, fuel tank, fuel pipe and fuel feed pump
	Priming failure (foreign matter trapped in the valve inside the priming pump)	Disassemble and clean
	Starting motor defect	Repair or replace
	Alternator defect	Repair or replace
Open circuit in wiring harness	Repair	
Battery voltage drop	Inspect and charge the battery	
Engine starts, but stops soon. Exhaust smoke none.	Improper clearance of inlet/exhaust valve	Adjust the valve clearance
	Seized crankpin metal or bearing	Repair or replace
	Improper arrangement of piston rings joint	Correct the ring joint positions
	Defective governor	Make adjustment
	Improper properties of lubricating oil	Use proper lubricating oil
	Insufficient lubricating oil level	Add proper lubricating oil
	Clogged fuel filter	Clean or replace
	Air entrance in fuel system	Perform air bleeding
	Clogged or cracked fuel pipe	Clean or replace
Insufficient fuel supply to fuel injection pump	Check the fuel tank cock, fuel tank, fuel pipe and fuel feed pump	
Engine starts, but stops soon. Exhaust smoke excessive.	Seizure of inlet/exhaust valve	Correct or replace
	Seized or broken piston ring	Replace the piston ring
	Worn piston ring, piston or cylinder	Perform honing and use oversize parts
	Water entrance in fuel system	Perform draining from the fuel filter

Insufficient engine output. Exhaust color : ordinary	Clogged air filter	Clean
	Improper clearance of inlet/exhaust valve	Adjust the valve clearance
	Compression leakage from valve seat	Lap the valve seat
	Seizure of inlet/exhaust valve	Correct or replace
	Blowout from cylinder head gasket	Replace the gasket
	Worn crankpin and journal bearing	Measure and replace
	Improper properties of lubricating oil	Use proper lubricating oil
	Improper properties of fuel oil	Use proper fuel oil
	Clogged fuel filter	Clean or replace
	Air entrance in fuel system	Perform air bleeding
	Clogged or cracked fuel pipe	Clean or replace
	Insufficient fuel supply to fuel injection pump	Check the fuel tank cock, fuel tank, fuel pipe and fuel feed pump
	Clogged strainer at fuel feed pump inlet	Clean the strainer
Insufficient engine output. (Exhaust color : white)	Seized or broken piston ring	Replace the piston ring
	Worn piston ring, piston or cylinder	Perform honing and use oversize parts
	Improper arrangement of piston rings joint	Correct the ring joint positions
	Reverse assembly of piston ring	Reassemble correctly
	Worn inlet/exhaust valve guide	Measure and replace
	Improper open/close timing of intake/exhaust valves	Adjust the valve clearance
	Timing of fuel injection pump too late	Check and adjust
	Improper properties of fuel oil	Use proper fuel oil
	Water entrance in fuel system	Perform draining from the fuel filter
	Uneven injection volume of fuel injection pump	Check and adjust
	Poor spray pattern from fuel injection nozzle	Check and adjust
Insufficient engine output. (Exhaust color : black)	Compression leakage from valve seat	Lap the valve seat
	Seizure of inlet/exhaust valve	Correct or replace
	Improper open/close timing of intake/exhaust valves	Adjust the valve clearance
	Insufficient cooling effect of radiator, Defective thermostat (kept opened) or slipping fan belt	Repair or replace thermostat and fan belt
	Insufficient coolant level	Check leakage from cooling system
	Slackened fan belt	Adjust the belt tension
	Defective thermostat	Check or replace
	Timing of fuel injection pump too late	Check and adjust
	Improper properties of fuel oil	Use proper fuel oil
	Uneven injection volume of fuel injection pump	Check and adjust
	Poor spray pattern from fuel injection nozzle	Check and adjust
	Clogged air filter	Clean
	Engine used at high temperature or at high altitude	Study output drop and load matching
	Clogged exhaust pipe	Clean
Poor exhaust color : white (During work)	Seized or broken piston ring	Replace the piston ring
	Worn piston ring, piston or cylinder	Perform honing and use oversize parts
	Reverse assembly of piston ring	Reassemble correctly
	Improper open/close timing of intake/exhaust valves	Adjust the valve clearance
	Excessive cooling effect of radiator,	Repair or replace

Poor exhaust color : black (During work)	Defective thermostat (kept closed)	
	Defective thermostat	Check or replace
	Timing of fuel injection pump too early	Check and adjust
	Timing of fuel injection pump too late	Check and adjust
	Improper properties of fuel oil	Use proper fuel oil
	Water entrance in fuel system	Perform draining from the fuel filter
	Uneven injection volume of fuel injection pump	Check and adjust
	Poor spray pattern from fuel injection nozzle	Check and adjust
	Compression leakage from valve seat	Lap the valve seat
	Seizure of inlet/exhaust valve	Correct or replace
	Improper open/close timing of intake/exhaust valves	Adjust the valve clearance
	Timing of fuel injection pump too early	Check and adjust
	Timing of fuel injection pump too late	Check and adjust
	Improper properties of fuel oil	Use proper fuel oil
	Uneven injection volume of fuel injection pump	Check and adjust
	Excessive fuel injection volume	Check and adjust
	Poor spray pattern from fuel injection nozzle	Check and adjust
	Clogged air filter	Clean
	Engine used at high temperature or at high altitude	Study output drop and load matching
	Clogged exhaust pipe	Clean
High knocking sound during compression	Timing of fuel injection pump too early	Check and adjust
Abnormal engine sound	Improper clearance of inlet/exhaust valve	Adjust the valve clearance
	Compression leakage from valve seat	Lap the valve seat
	Seizure of inlet/exhaust valve	Correct or replace
	Seized or broken piston ring	Replace the piston ring
	Seized crankpin metal or bearing	Repair or replace
	Worn crankpin and journal bearing	Measure and replace
	Loosened connecting rod screw	Tighten to specified torque
	Foreign matter trapped in combustion chamber	Disassemble and repair
	Excessive gear backlash	Adjust gear and repair
Improper open/close timing of intake/exhaust valves	Adjust the valve clearance	
Uneven combustion sound	Improper properties of fuel oil	Use proper fuel oil
	Water entrance in fuel system	Perform draining from the fuel filter
	Uneven injection volume of fuel injection pump	Check and adjust
	Poor spray pattern from fuel injection nozzle	Check and adjust
	Clogged air filter	Clean
	Clogged exhaust pipe	Clean
Hunting during idling	Seized or broken piston ring	Replace the piston ring
	Seized crankpin metal or bearing	Repair or replace
	Worn crankpin and journal bearing	Measure and replace
	Defective governor	Make adjustment
	Water entrance in fuel system	Perform draining from the fuel filter
	Uneven injection volume of fuel injection pump	Check and adjust
	Poor spray pattern from fuel injection nozzle	Check and adjust
Hunting during work	Seizure of inlet/exhaust valve	Correct or replace

Large engine vibration	Seized crankpin metal or bearing	Repair or replace
	Worn crankpin and journal bearing	Measure and replace
	Defective governor	Make adjustment
	Water entrance in fuel system	Perform draining from the fuel filter
	Uneven injection volume of fuel injection pump	Check and adjust
	Poor spray pattern from fuel injection nozzle	Check and adjust
	Seizure of inlet/exhaust valve	Correct or replace
	Seized or broken piston ring	Replace the piston ring
	Seized crankpin metal or bearing	Repair or replace
	Worn crankpin and journal bearing	Measure and replace
	Loosened connecting rod screw	Tighten to specified torque
	Defective governor	Make adjustment
	Timing of fuel injection pump too early	Check and adjust
	Uneven injection volume of fuel injection pump	Check and adjust
	Poor spray pattern from fuel injection nozzle	Check and adjust
	Difficulty in returning to low speed	Defective governor
Excessive fuel consumption	Compression leakage from valve seat	Lap the valve seat
	Excessive cooling effect of radiator, Defective thermostat (kept closed)	Repair or replace
	Timing of fuel injection pump too late	Check and adjust
	Excessive fuel injection volume	Check and adjust
	Poor spray pattern from fuel injection nozzle	Check and adjust
	Engine used at high temperature or at high altitude	Study output drop and load matching
Excessive lubricating oil consumption	Seized or broken piston ring	Replace the piston ring
	Worn piston ring, piston or cylinder	Perform honing and use oversize parts
	Improper arrangement of piston rings joint	Correct the ring joint positions
	Reverse assembly of piston ring	Reassemble correctly
	Foreign matter trapped in combustion chamber	Disassemble and repair
	Worn inlet/exhaust valve guide	Measure and replace
	Improper properties of lubricating oil	Use proper lubricating oil
	Leakage from lubricating oil piping system	Repair
	Excessive fuel injection volume	Check and adjust
Lubricating oil diluted by fuel	Seizure of inlet/exhaust valve	Correct or replace
	Seized or broken piston ring	Replace the piston ring
	Worn piston ring, piston or cylinder	Perform honing and use oversize parts
Lubricating oil mixed with water	Blowout from cylinder head gasket	Replace the gasket
	Cracked water jacket	Repair or replace
Low lubricating oil pressure	Worn crankpin and journal bearing	Measure and replace
	Loosened connecting rod screw	Tighten to specified torque
	Cracked water jacket	Repair or replace
	Improper properties of lubricating oil	Use proper lubricating oil
	Leakage from lubricating oil piping system	Repair
	Insufficient delivery capacity of trochoid pump	Check and repair
	Clogged lubricating oil filter	Clean or replace
	Defective pressure regulating valve	Check, adjust or replace
	Insufficient lubricating oil level	Add proper lubricating oil
Excessive blow-by gas	Compression leakage from valve seat	Lap the valve seat

	Seizure of inlet/exhaust valve	Correct or replace
	Seized or broken piston ring	Replace the piston ring
	Worn piston ring, piston or cylinder	Perform honing and use oversize parts
	Seized crankpin metal or bearing	Repair or replace
	Improper arrangement of piston rings joint	Correct the ring joint positions
	Reverse assembly of piston ring	Reassemble correctly
	Foreign matter trapped in combustion chamber	Disassemble and repair
	Worn inlet/exhaust valve guide	Measure and replace
	Improper properties of lubricating oil	Use proper lubricating oil
	Clogged lubricating oil filter	Clean or replace
	Excessive fuel injection volume	Check and adjust
Overheating of coolant	Blowout from cylinder head gasket	Replace the gasket
	Seized or broken piston ring	Replace the piston ring
	Insufficient cooling effect of radiator, Defective thermostat (kept opened) or slipping fan belt	Repair or replace thermostat and fan belt
	Insufficient coolant level	Check leakage from cooling system
	Cracked water jacket	Repair or replace
	Slackened fan belt	Adjust the belt tension
	Defective thermostat	Check or replace
	Excessive fuel injection volume	Check and adjust
	Engine used at high temperature or at high altitude	Study output drop and load matching
Low coolant temperature	Excessive cooling effect of radiator, Defective thermostat (kept closed)	Repair or replace
	Defective thermostat	Check or replace
Air inlet pressure drop	Improper clearance of inlet/exhaust valve	Adjust the valve clearance
	Compression leakage from valve seat	Lap the valve seat
	Seizure of inlet/exhaust valve	Correct or replace
	Clogged air filter	Clean
	Engine used at high temperature or at high altitude	Study output drop and load matching
Air inlet pressure rise	Excessive fuel injection volume	Check and adjust
Exhaust temperature rise	Improper clearance of inlet/exhaust valve	Adjust the valve clearance
	Compression leakage from valve seat	Lap the valve seat
	Seized or broken piston ring	Replace the piston ring
	Insufficient cooling effect of radiator, Defective thermostat (kept opened) or slipping fan belt	Repair or replace thermostat and fan belt
	Insufficient coolant level	Check leakage from cooling system
	Slackened fan belt	Adjust the belt tension
	Timing of fuel injection pump too late	Check and adjust
	Uneven injection volume of fuel injection pump	Check and adjust
	Excessive fuel injection volume	Check and adjust
Clogged exhaust pipe	Clean	

Document Title: Engine trouble shooting	Function Group: 210	Information Type: Service Information	Date: 2014/4/16
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Engine trouble shooting

Engine faults must be detected and rectified as quickly as possible in order to avoid more expensive repairs. The following table summarizes the most important faults and their rectification.

Problem/fault	Possible cause of fault	Fault remedy
Engine does not start	Starter switch defective	Tighten connections. Replace the switch.
	Starter power too low	If the starter is OK, check condition of battery and electric connections.
	Air in fuel system	Bleed the system.
	Air filter dirty	Replace the air filter.
	Wrong oil viscosity	Check viscosity and fill in correct oil.
	Engine too cold	Check the function of the preheater plug.
	Injection valves defective	Check and adjust the injection valves Replace defective valves.
	Incorrect injection timing	Adjust the injection timing. Check the valve clearance.
Engine shuts down automatically	Compression pressure too low	Check condition of cylinder head gasket, valves and piston rings.
	Fuel tank empty	Fill in fuel.
	Air in fuel system	Bleed the fuel system.
	Fuel filter dirty	Clean or replace the fuel filter.
	Fuel pump defective	Check connection of fuel pump or replace fuel pump.
Erratic running of engine	Exhaust system clogged	Clear or replace the exhaust system.
	Fuel pump defective	Replace the pump.
	Fuel filter dirty	Clean or replace the fuel filter. Bleed the fuel system.
	Air filter dirty	Clean the air filter. Check the intake air.
Engine overheating	Injection valves defective	Check and adjust the injection valves Replace defective valves.
	Cooling system elements defective	Check elements (water pump, radiator, thermostat, cylinder head gasket, coolant hoses).
	Fan not running	Check presence, tension and cleanliness of V-belt.
Engine overheating	Lubrication system elements defective	Check elements (oil filter, oil pump, suction filter) and replace defective parts.
	Incorrect injection timing	Adjust the injection timing. Check the valve clearance.
	Oil level too low	Fill in oil. Check whether the oil in the engine meets the operating conditions.
	Governor incorrectly adjusted	Adjust the governor.
Engine develops black smoke	Coolant level not correct	Correct the coolant level. Check whether the coolant meets the operating conditions.
	Air cleaner soiled	Clean or replace the air filter.
	Poor fuel quality	Check quality of fuel and suitability for climatic

		conditions.	
	Valve clearance and injection timing not correct	Adjust valve clearance and injection timing.	
	Compression pressure not O.K.	Check condition of cylinder head gasket, valves and piston rings.	
	Injection pressure not O.K.	Check and adjust the injection valves	
	Injection pump defective	Check injection pump, replace if necessary.	
Irregular idle speed	Engine control cable incorrectly adjusted	Adjust the control cable.	
	Poor engine oil quality	Fill in oil as required for the operating conditions.	
	Poor fuel quality	Check quality of fuel and suitability for climatic conditions.	
	Valve clearance and injection timing not correct	Adjust valve clearance and injection timing.	
	Opening pressure of injection valves not correct	Check opening pressure and injection valves.	
	Compression pressure not O.K.	Check condition of cylinder head gasket, valves and piston rings.	
	Injection pump defective	Check injection pump, replace if necessary.	
Unusual engine noise	Poor fuel quality	Check quality of fuel and suitability for climatic conditions.	
	Air cleaner soiled	Clean or replace the air filter.	
	Incorrect injection timing	Adjust the injection timing.	
	Engine shut-down solenoid not O.K.	Check the engine shut-down solenoid.	
	Injection pressure not O.K.	Adjust the injection valves.	
	Compression pressure not O.K.	Check condition of cylinder head gasket, valves and piston rings.	
	Injection pump defective	Replace the injection pump.	
Oil pressure too low	Oil level and oil quality not correct	Check oil level and oil quality and fill in specified oil.	
	Oil pressure switch defective	Check and replace the oil pressure switch.	
Battery charge condition too low	Fan V-belt too loose	Tighten the V-belt or replace, if defective.	
	Generator defective	Check and replace the generator.	
	Battery defective	Replace the battery.	
	Wiring not O.K.	Check correct connection of cables.	
	Regulator defective	Check regulator, replace if necessary.	
Engine cannot be shut down	Starter switch defective	Tighten connections. Replace the switch.	
	Engine shut-down solenoid not O.K.	Check engine shut-down solenoid, replace if necessary.	

Document Title: Compression pressure inspection	Function Group:	Information Type: Service Information	Date: 2014/4/16
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Compression pressure inspection

Compression pressure drop is one of major causes of increasing blow-by gas (lubricating oil contamination or increased lubricating oil consumption as a resultant phenomenon) or starting failure. The compression pressure is affected by the following factors:

1. Degree of clearance between piston and cylinder
2. Degree of clearance at intake/exhaust valve seat
3. Gas leak from nozzle gasket or cylinder head gasket

In other words, the pressure drops due to increased parts wear and reduced durability resulting from long use of the engine. A pressure drop may also be caused by scratched cylinder or piston by dust entrance from the dirty air cleaner element or worn or broken piston ring. Measure the compression pressure to diagnose presence of any abnormality in the engine.

Compression pressure measurement method

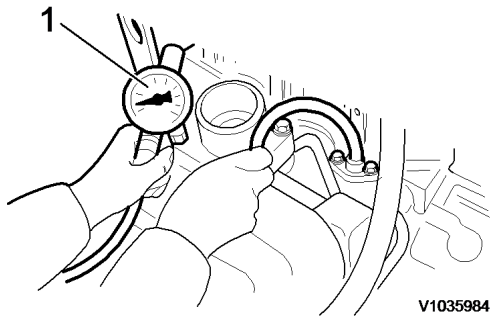


Figure 1
Measurement, compression pressure

1. Compression gauge
1. After warming up the engine, remove the fuel injection nozzle from the cylinder to be measured.
2. Crank the engine before installing the compression gauge adapter.
 - Perform cranking with the stop handle at the stop position (no injection state).
3. Install the compression gauge and compression gauge adapter at the cylinder to be measured.
NOTE!
Do not forget to install a gasket at the tip end of the adapter.
4. Crank the engine by the starting motor until the compression gage reading is stabilized.

Standard compression pressure

- Standard: 30 kgf/cm² (427 psi)
- Limit: 26 kgf/cm² (370 psi)
- Dispersion among cylinders: 3 kgf/cm² (43 psi)

Document Title: Valves, adjusting	Function Group:	Information Type: Service Information	Date: 2014/4/16
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Valves, adjusting

Adjusting the valves

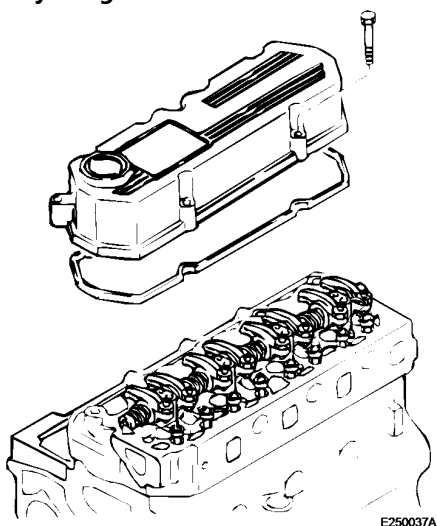


Figure 1

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NOTE!

Clean the area around the rocker cover before starting adjustment work.

1. Pull off the hose for crankcase ventilation.
2. Remove the cylinder head cover.
3. Crank the engine until the valves are overlapping.

NOTE!

Overlapping of valves means: Exhaust valve not yet closed, intake valve starts to open. In this situation the push rods cannot be turned.

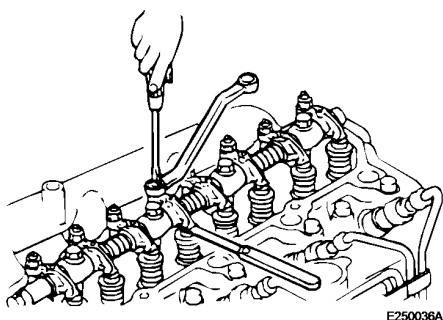


Figure 2

4. Adjust the valve clearance on the respective cylinder using a feeler gauge.
5. Tighten the counter nut. Check the adjustment again with the feeler gauge.
6. Attach the gasket to the rocker cover.
7. Install the rocker cover. Tighten the screws with a torque of 11.3 Nm.
8. Push on the crankcase ventilation hose.
 - Intake: 0.25 mm (0.01 in)
 - Exhaust: 0.25 mm (0.01 in)

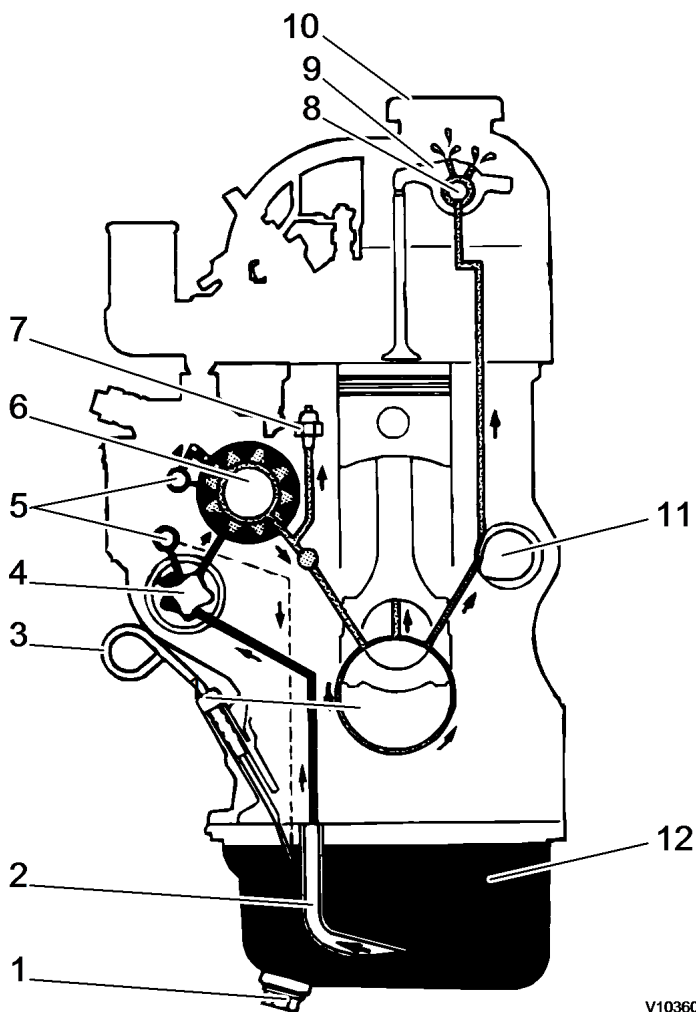
Valve clearance values

Document Title: Lubricating description	system, 220	Function Group: 220	Information Type: Service Information	Date: 2014/4/16
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Lubricating system, description

- The oil pump delivers pressurized engine oil to lubricate the contact faces of moving parts, such as crankshaft, camshaft, intake/exhaust valves, rockers and engine timing gears.

Schematic flow of lubrication oil



V1036004

Figure 1

1. Drain plug
2. Oil screen
3. Dipstick
4. Oil pump
5. Check valve
6. Oil filter
7. Oil pressure switch

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