VOLVO

Construction Equipment

Service Information

Document Title:	Function Group:	Information Type:	Date:
Engine, description	**200**	**Service Information**	**2015/3/16**
Profile: **EXC, EC135B LC [GB]**			

Engine, description

The engine is a 4-cylinder, 4-stroke, direct injected, turbocharged, aftercooled with a cast iron block and cylinder head.
Gears in the engine gear case are hardened helical type for strength and reduced noise, arranged to provide quiet, smooth transmission of power.
The cylinder block and head are designed with internal passages forming galleries for both lubricating oil and coolant.
The fan belt is a poly type V-belt for improved performance and an auto tension adjuster maintains belt tension.

Starter side view

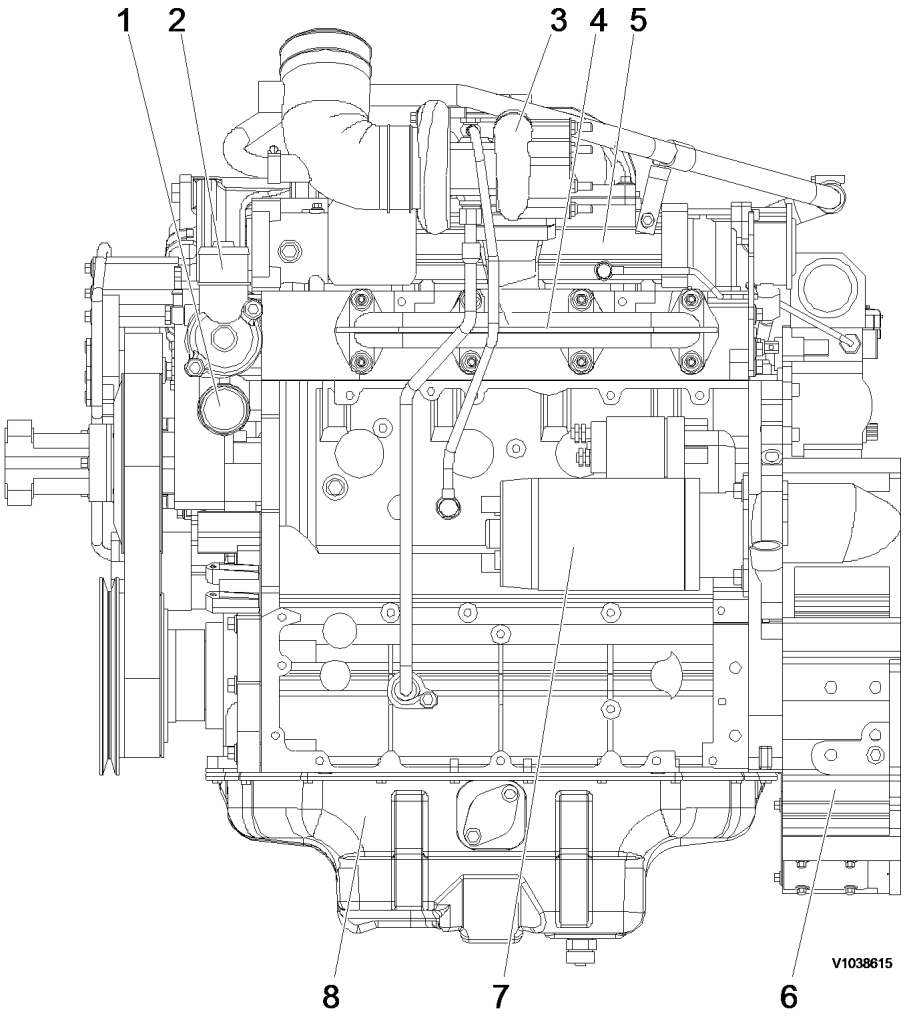

Figure 1
Engine, starter side view

1. Coolant inlet
2. Coolant outlet
3. Exhaust turbocharger
4. Exhaust manifold
5. Air intake manifold
6. Flywheel housing
7. Starter

8. Oil pan

Alternator side view

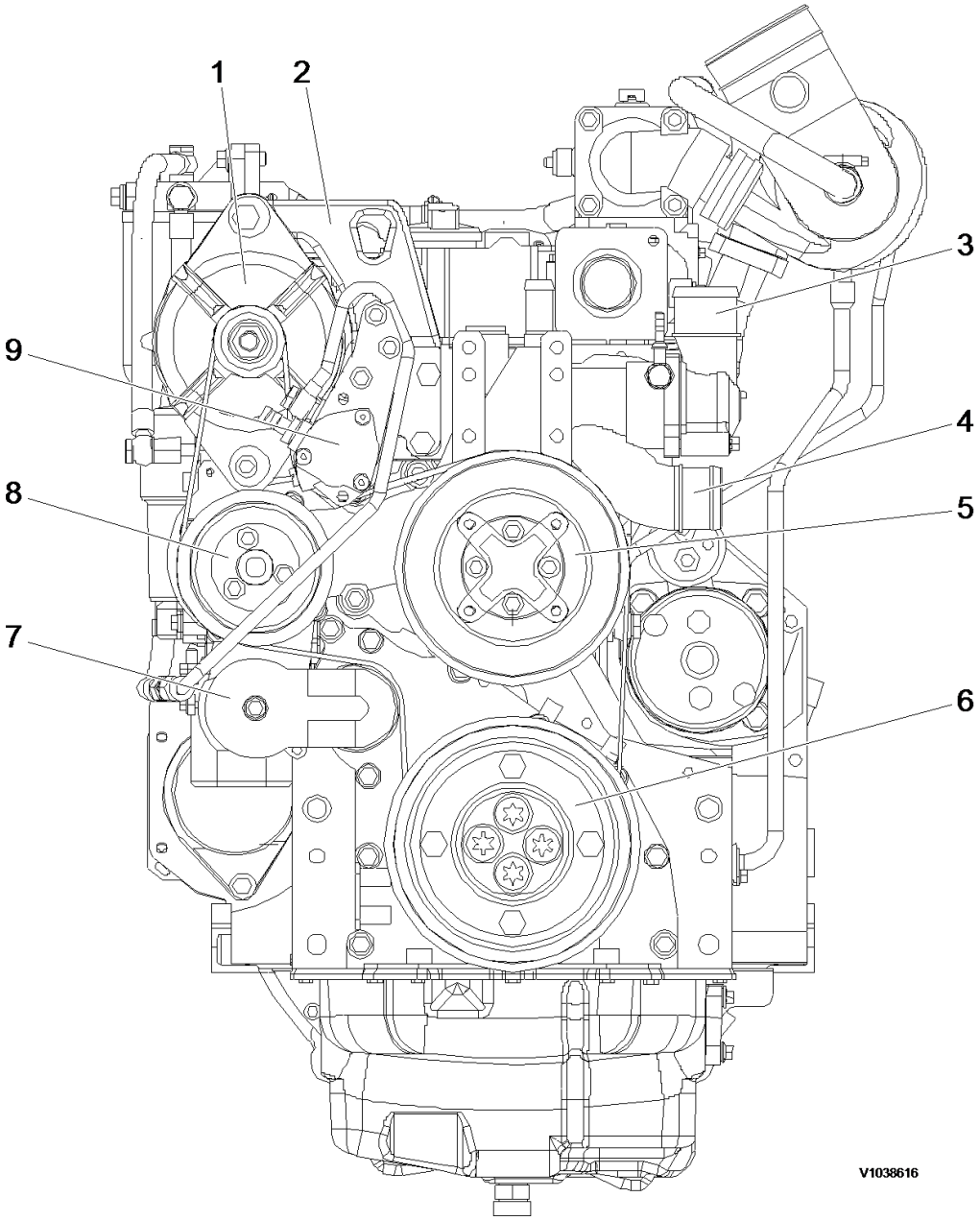

Figure 2
Engine, Alternator side view

1. Alternator
2. Engine lifting bracket
3. Coolant outlet
4. Coolant inlet
5. Fan pulley
6. Poly - V-pulley with vibration damper
7. Poly - V-belt tension pulley
8. Coolant pump
9. Fuel pump

Top view

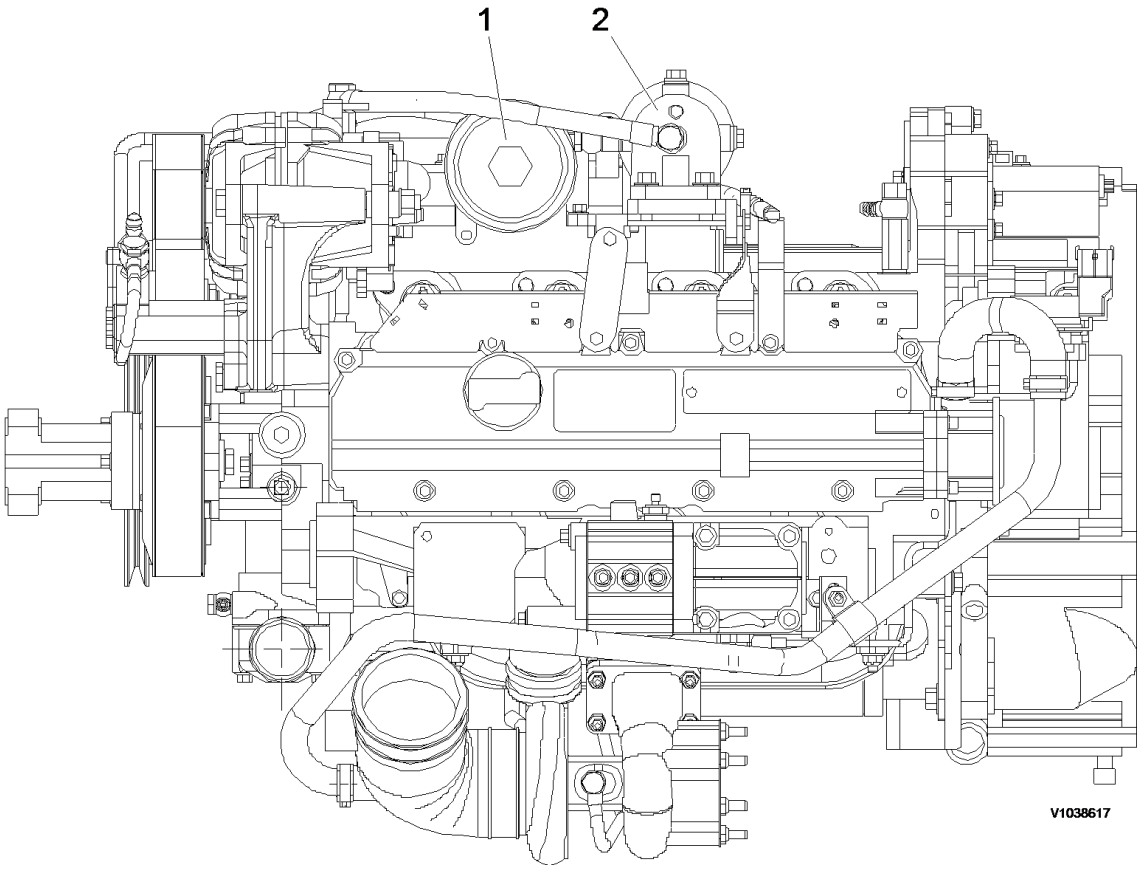

Figure 3
Engine, top view

1. Engine oil filter
2. Fuel filter

Fuel filter side view

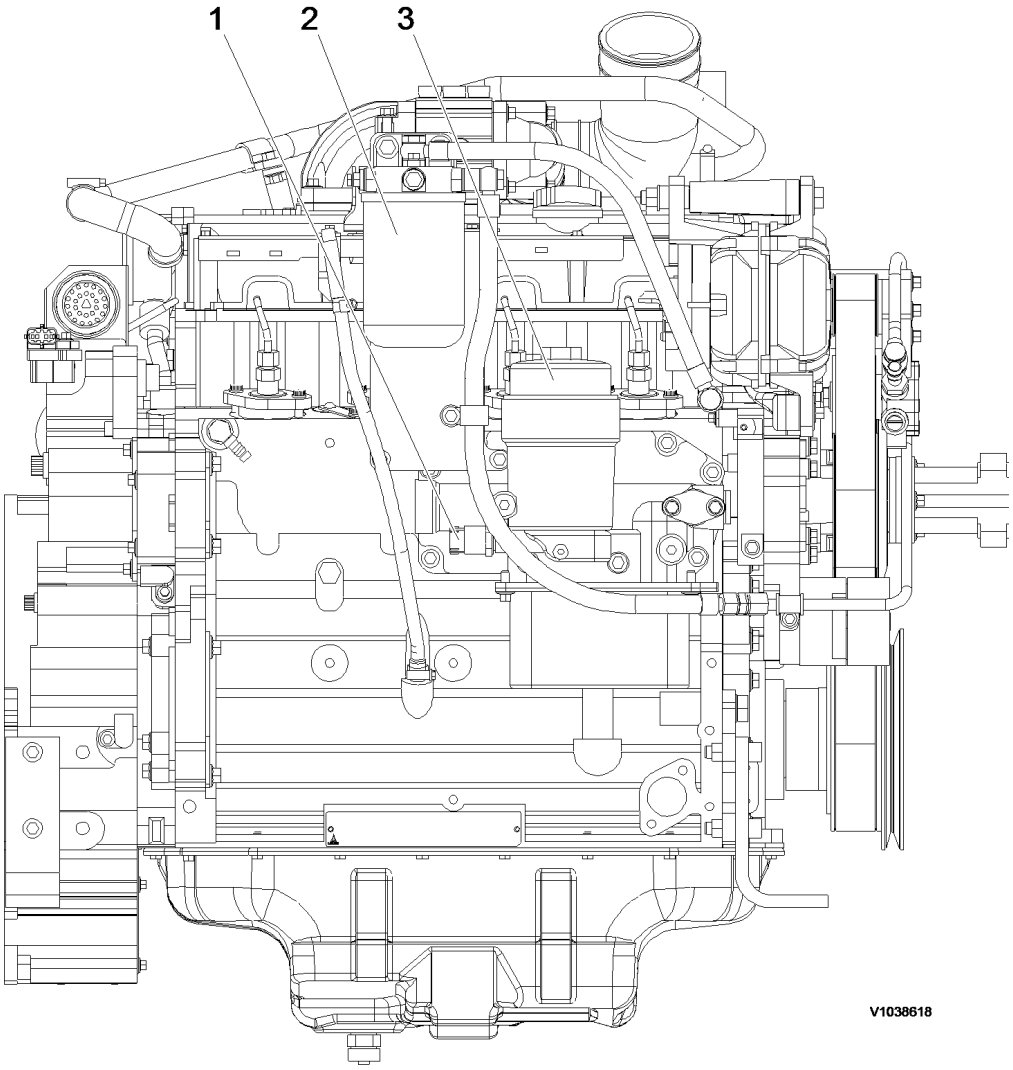

Figure 4
Engine, fuel filter side view

1. Lube oil pressure port (M14 × 1.5)
2. Fuel filter
3. Engine oil filter

Flywheel end view

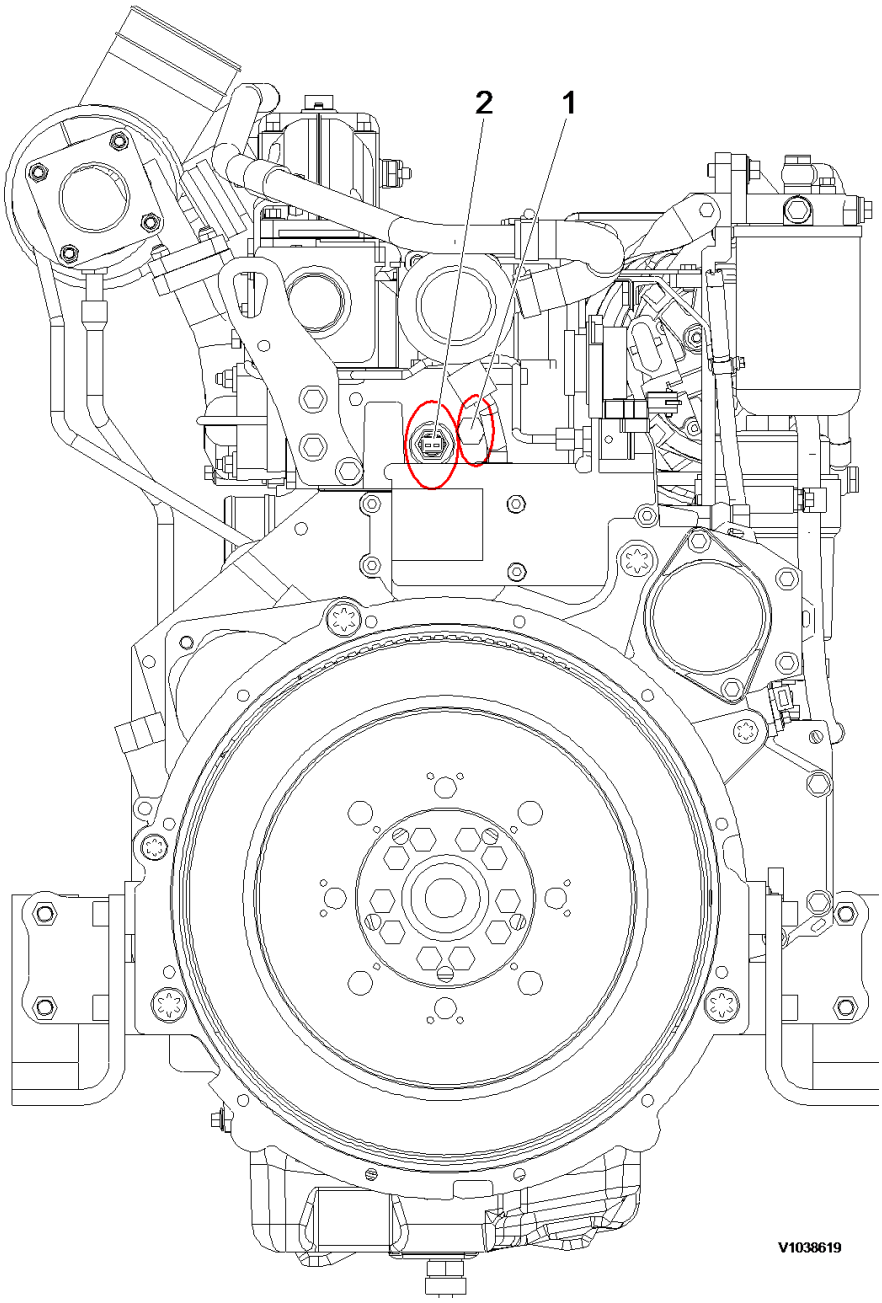

Figure 5
Engine, flywheel end view

1. Coolant temperature check port
2. Coolant temperature sensor port

Document Title: **Valves, adjusting**	Function Group: **214**	Information Type: **Service Information**	Date: **2015/3/16**
Profile: **EXC, EC135B LC [GB]**			

Valves, adjusting

Op nbr 21412

The valve clearance must be checked and adjusted at specified intervals. To do this, the engine oil temperature must be between 20 °C (68 °F) and 80 °C (176 °F).

Valve clearance adjustment

Item	mm	inch
Inlet valve	0.3	0.012
Exhaust valve	0.5	0.020

Adjustment

1. Remove rocker cover.

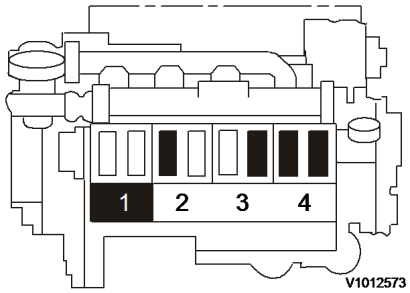

Figure 1
Adjustment, valve clearance

2. Turn crankshaft until both valves in cylinder 1 overlap (exhaust valve about to close, inlet valve about to open).

3. Adjust clearance of valves marked in black in figure. Mark respective rocker arm with chalk to show that adjustment has been done.

4. Turn crankshaft one full revolution (360°). Now adjust clearance of valves marked black in figure.

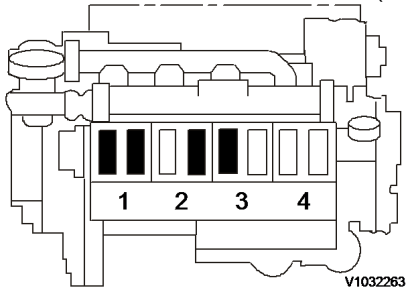

Figure 2
Adjustment, valve clearance

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Construction Equipment

Service Information

Document Title: **Camshaft and timing gears, description**	Function Group: **215**	Information Type: **Service Information**	Date: **2015/3/16**
Profile: **EXC, EC135B LC [GB]**			

Camshaft and timing gears, description

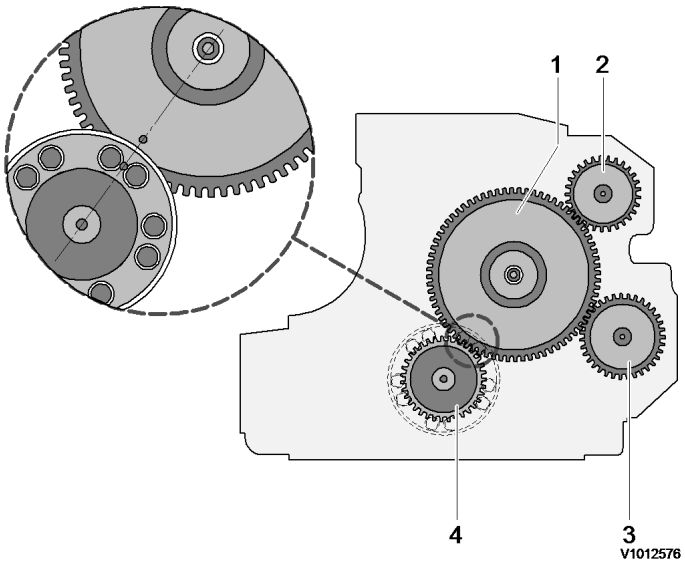

Figure 1
Camshaft and timing gears

1. Camshaft gear with marking
2. PTO, e.g. hydraulic pump
3. PTO, e.g. air compressor
4. Crankshaft gear with markings

Camshaft

- The camshaft is mounted on 5 bearings. The running surfaces of bearings and cams are induction-hardened.
- Each bearing runs in a bearing bushing pressed into the crankcase. There is one inlet, exhaust and injection pump cam per cylinder. The axial stop for the camshaft is located in the timing chest cover.

Timing gears

- The timing gears are arranged on the flywheel end. Gears for the auxiliary drive of the air compressor are clearance-optimized. The drive:
    - Camshaft (injection pumps and valve gear)
    - 1st PTO (hydraulic pumps)
    - 2nd PTO (air compressor)

Crankshaft flange and camshaft gear are marked for setting the engine timing.
Marking on the crankshaft flange in the tooth gap.
Marking on the camshaft gear on the tooth.

As already mentioned, the balancing shafts are located by pins (special tool) in the crankcase for assembly.

Document Title:	Function Group:	Information Type:	Date:
Crankshaft, description	**216**	**Service Information**	**2015/3/16**
Profile: **EXC, EC135B LC [GB]**			

Crankshaft, description

- The forged crankshaft of the D4D engine is provided with integrated balance weights. The drive gear for the timing gears and the flywheel flange are shrunk on.

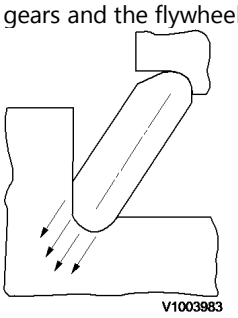

Figure 2
Fillet radii on the bearing journal

- The material microstructure of the fillet radii on the bearing journals is strengthened by rolling.
- Remachining of the fillet radii is therefore not permissible.

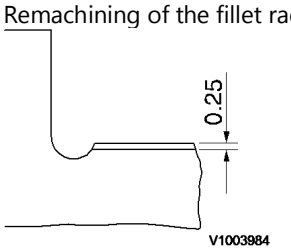

Figure 3
Allowable repair limit

- In case of repair, there is available one undersize of 0.25 mm (referred to the diameter) for the crank pins and main bearing journals.

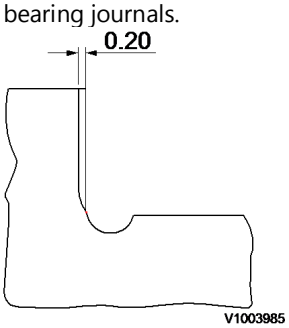

Figure 4
Allowable thrust bearing face repair limit

- The thrust bearing face can only be remachined once (oversize: 0.4 mm, 0.2 mm each side).
  Thrust bearing clearance of the crankshaft in installed condition: 0.1 to 0.28 mm (0.004 to 0.011 in).

Document Title: **Connecting rod, description**	Function Group: **216**	Information Type: **Service Information**	Date: **2015/3/16**
Profile: **EXC, EC135B LC [GB]**			

Connecting rod, description

- The connecting rod of forged steel is fitted at the big end bearing bore with a balance weight (1) in order to compensate the manufacturing tolerances with regard to weight and position of the center of gravity.
- The number markings (A) on the big end eye and the bearing cap must be on one side and identical.
- Locating lugs (2) are provided in the lower and upper bearing shells to prevent the bearing shells from rotating in their seat; these lugs engage in oblong shaped grooves in the big end eye and big end bearing cap.
- The piston must be so installed that the flywheel symbol (B) on the piston top faces the flywheel.
- When assembling connecting rod and piston, the centering pins (3) for locating the connecting rod bearing cap must be fitted on the upper face of the piston on the side of the flywheel symbol (B).

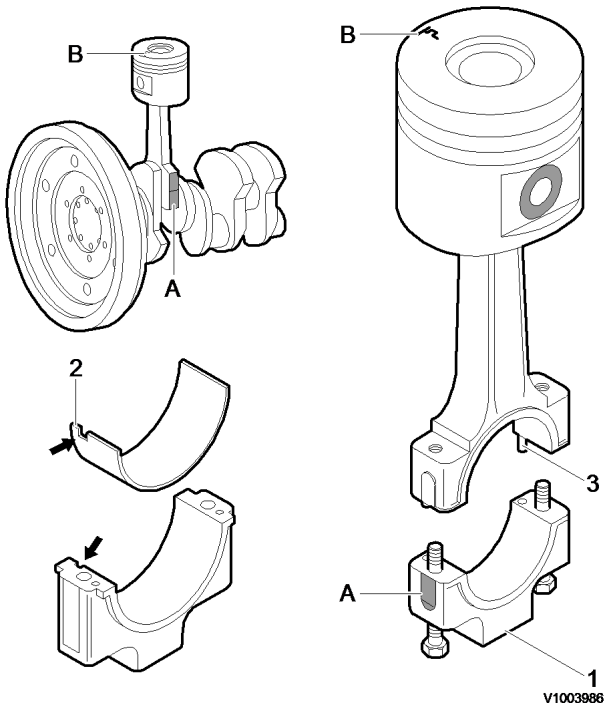

Figure 1
Connecting rod

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Service Information

Document Title:	Function Group:	Information Type:	Date:
Engine mounting	**218**	**Service Information**	**2015/3/16**
Profile: **EXC, EC135B LC [GB]**			

Engine mounting

Front fan end view

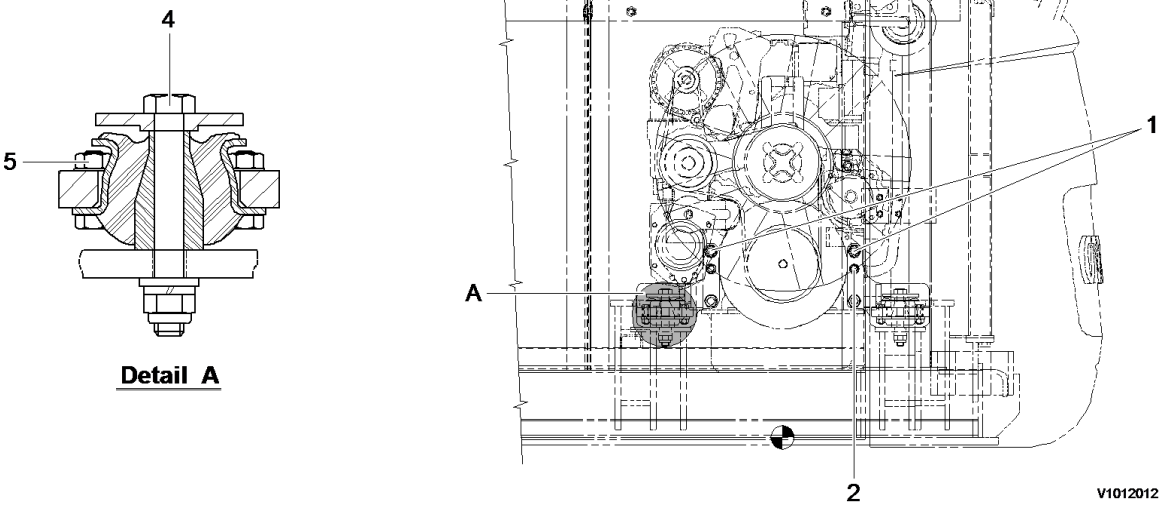

Figure 1
Engine mounting, front-fan end view

Flywheel end view

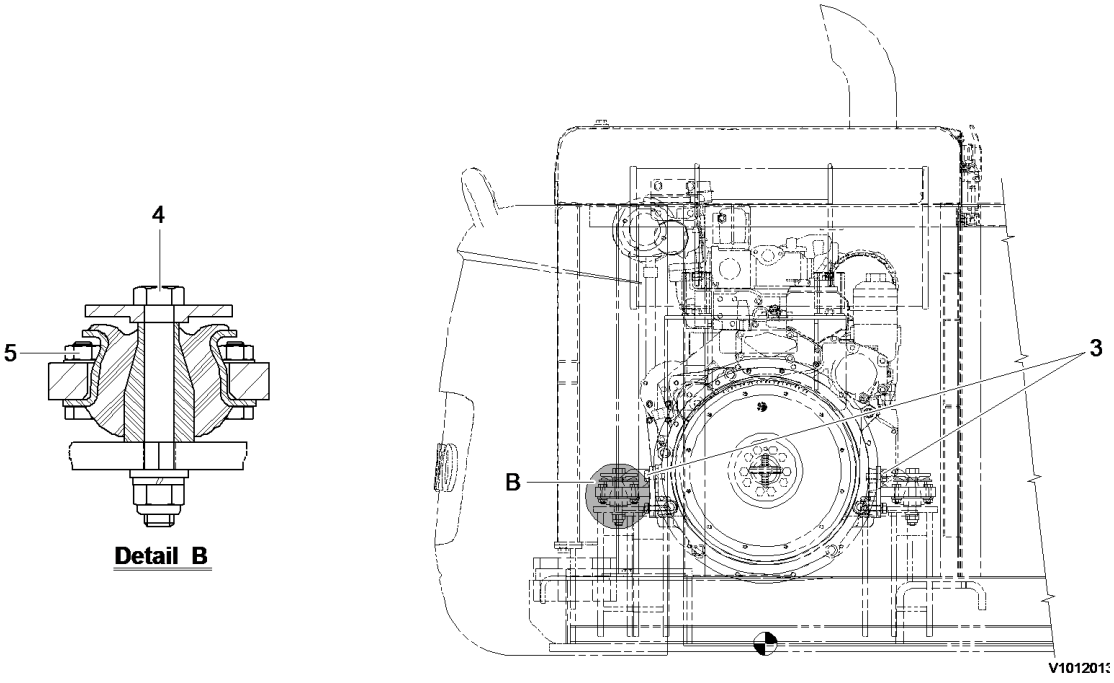

Figure 2

Engine mounting, rear-flywheel end view

NOTE!
Check the color markings for cushion installation.

Front (fan end) – Blue marking
Rear (flywheel end) – Beige marking

Tightening torque, unit: kgf·m (lbf·ft)

No.	Mounting position	Tightening torque
1	Engine mounting bracket (front)	26 ± 2 (188 ± 14)
2		11.5 ± 0.5 (83 ± 4)
3	Engine mounting bracket (rear)	11.5 ± 0.5 (83 ± 4)
4	Engine mounting cushion	14 ~ 15 (101 ~ 108)
5		6 ~ 7 (43 ~ 51)

NOTE!
Apply loctite to engine mounting bracket screws (front, rear).

Document Title: **Lubrication system, description**	Function Group: **220**	Information Type: **Service Information**	Date: **2015/3/16**
Profile: **EXC, EC135B LC [GB]**			

Lubrication system, description

- Engine lubricating oil is supplied to the contact faces of rotating components such as turbocharger, crankshaft, camshaft, piston, inlet/exhaust valve, rocker arm and timing gear by means of forced lubrication from the oil pump.

Lubrication oil flow diagram

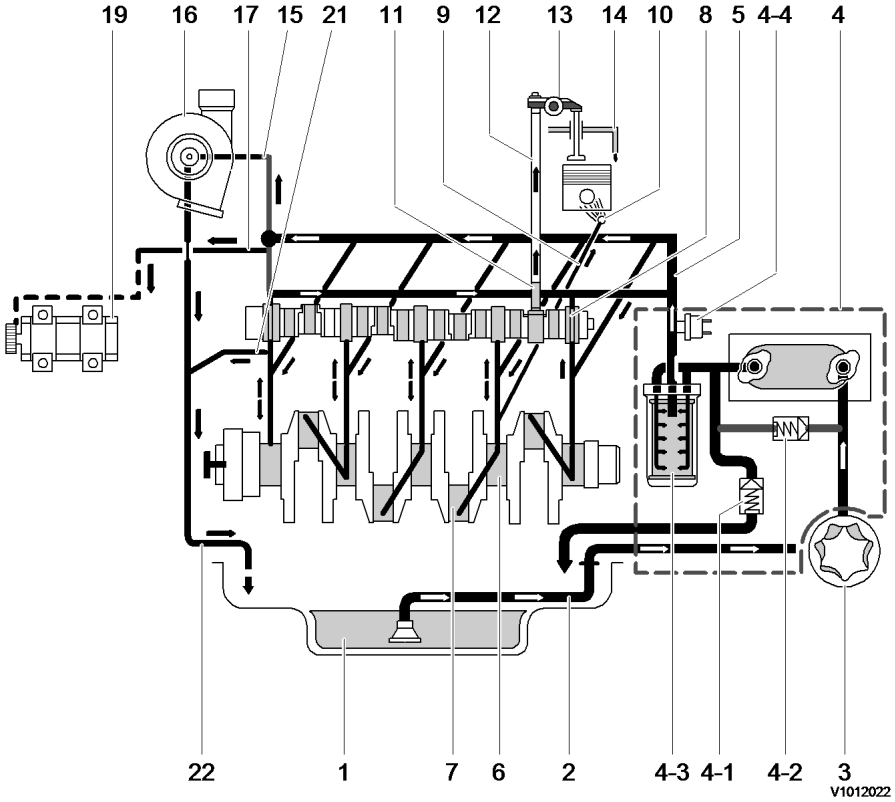

Figure 1
Lubrication oil flow

1	Oil pan	11	Tappet control bore for lubrication of rocker arms
2	Intake pipe	12	Push rod, oil supply for rocker arm
3	Lube oil pump	13	Rocker arm
4	Lube oil cooler housing	14	Return line to oil pan
4-1	Pressure regulator valve: 4.1 ± 0.4 kgf/cm2 (58 ± 6 psi)	15	Oil line to exhaust turbocharger
4-2	Cooler bypass valve: 2.1 ± 0.35 kgf/cm2 (30 ± 5 psi)	16	Exhaust turbocharger
4-3	Lube oil filter with bypass valve: 2.5 ± 0.5 kgf/cm2 (36 ± 7 psi)	17	Oil line to compressor or to hydraulic pump
4-4	Oil pressure sensor	19	Hydraulic pump
5	Main oil passage	21	Return to oil pan
6	Crankshaft bearing	22	Return line from turbocharger

7	Big end bearing		
8	Camshaft bearing		
9	Bore for piston cooling spray nozzle		
10	Spray nozzle for piston cooling		

Schematic, lube oil circuit

Specifications

Item	Description	Remark
1	Lube oil pump	Rotary pump: Volume flow at n = 2500 min—1: 65 l/min
2	Oil cooler	
3	Bypass valve	Opening pressure: p = 2.1 ± 0.35 kgf/cm2 (30 ± 5 psi)
4	Oil filter	With bypass valve (5)
5	Bypass valve	Opening pressure: p = 2.5 ± 0.5 kgf/cm2 (36 ± 7 psi)
6	Pressure regulating valve	Opening pressure: p = 4.0 ± 0.4 kgf/cm2 (57 ± 6 psi)
7	Exhaust turbocharger	

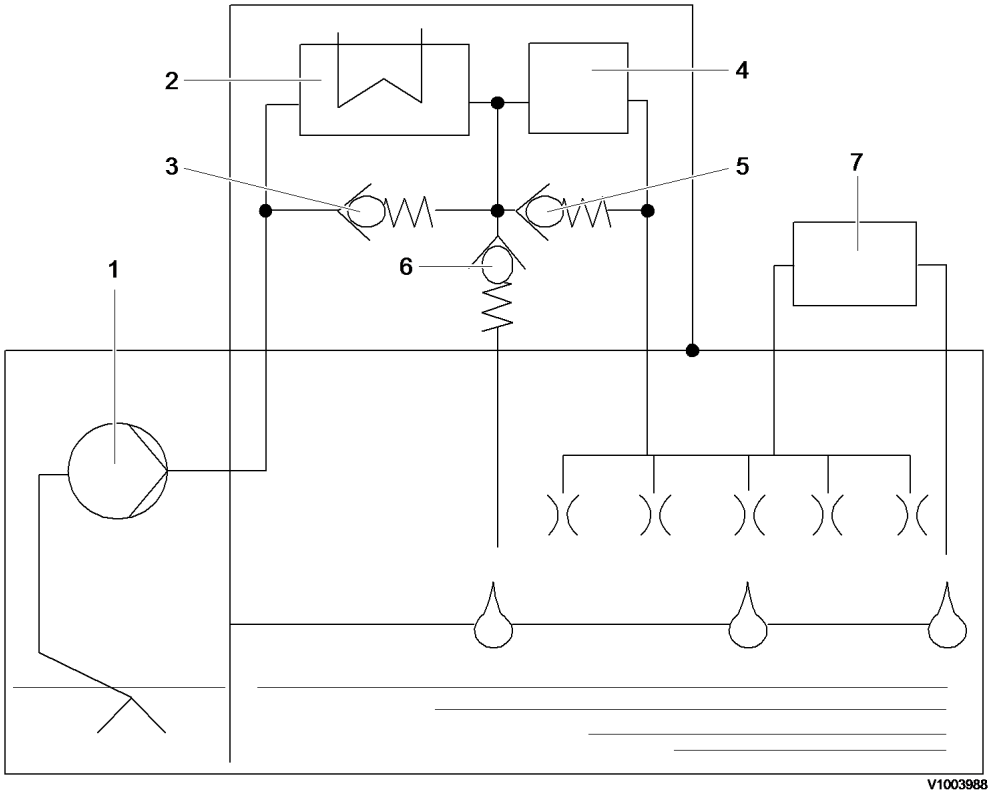

Figure 2
Schematic, lube oil circuit

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Service Information

Document Title: **Lubrication system, principle of operation**	Function Group: **220**	Information Type: **Service Information**	Date: **2015/3/16**
Profile: **EXC, EC135B LC [GB]**			

Lubrication system, principle of operation

Lube oil ducts

The D4D engine is provided with forced-fed circulation lubrication with lube oil cooler and lube oil filter arranged in full flow. The lube oil is supplied by the lube oil pump through the oil cooler to the oil filter. Both components are mounted to the lube oil cooler housing which is flanged to the crankcase. Downstream of the filter the lube oil flows into the main oil passage and secondary oil passage. From here the oil is ducted to the lubricating points.

The main oil passage supplies:
– Crankshaft
– Camshaft
– Valve tappets
– Roller tappets

The secondary oil gallery supplies:
– Exhaust turbocharger
– Compressor

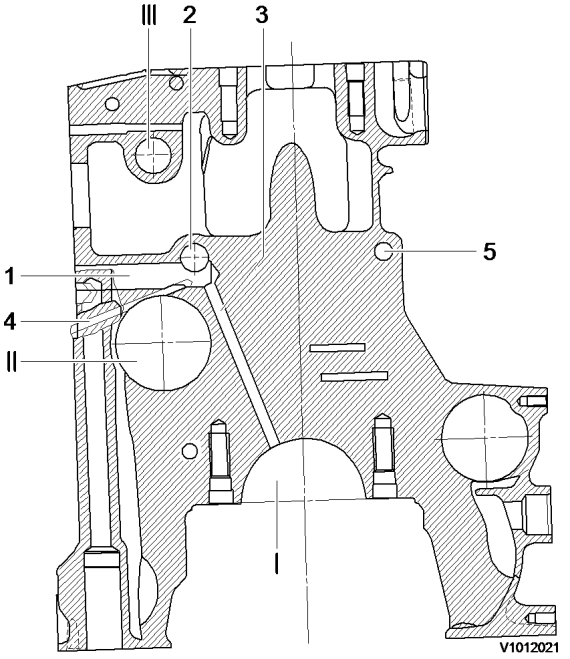

Figure 1
Lube oil duct, sectional view

1	From oil filter	I	Crankshaft bearing
2	Main oil passage	II	Camshaft bearing
3	Oil duct to crankshaft	III	Fuel rack guide
4	Oil duct to camshaft		
5	Secondary oil passage		

Lubrication of the rockers is effected via the tappets and the push rods.

Lube oil pump

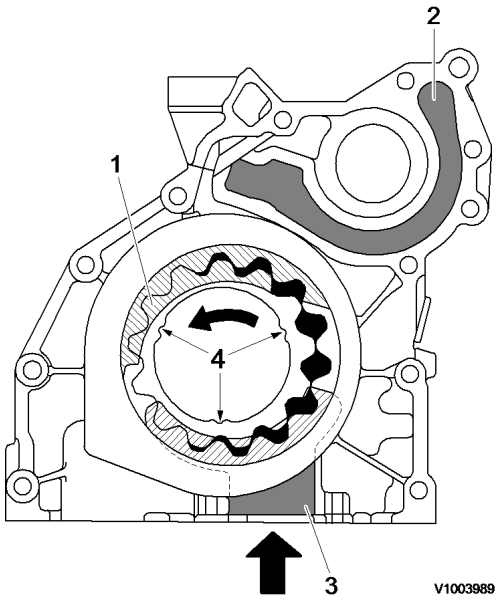

Figure 2
Lube oil pump, sectional view

1. Inner rotor
2. Delivery chamber towards crankcase
3. Suction chamber
4. Driver contour

The lube oil pump rotary pump is installed in the front cover. The inner rotor (1) is seated on the crankshaft and is driven by same.
Its driver contour (4) has no 120° partition, i.e. the rotor can only be slid onto the crankshaft in a specific position.
This is attributable to deviating rotor widths.

	Unit	**Specification**
Rotor width	mm (in)	12.3 (0.48)
Volume flow	l/min	65 at 2500 rpm

Minimum oil pressure at 120°C (248°F) oil temperature, measured at oil filter bracket.

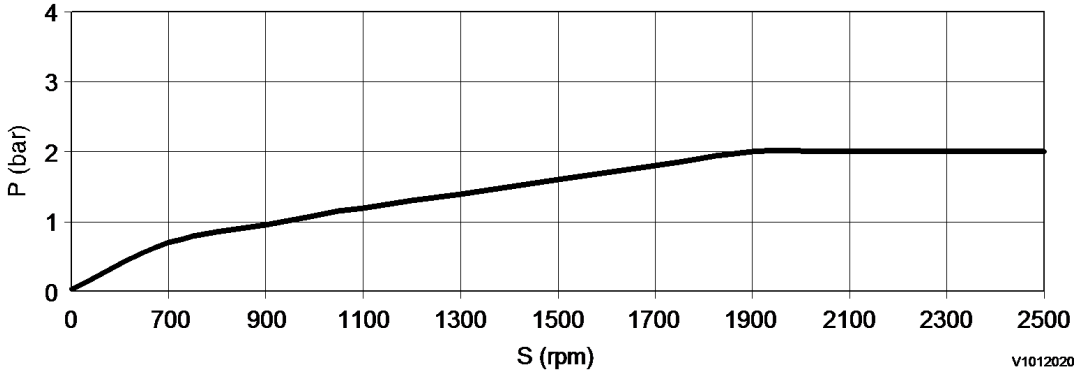

Figure 3
Lube oil pump, characteristic curve

P	Oil pressure
S	Speed

Lube oil cooler housing

The oil cooler housing incorporates the oil cooler, the oil filter and the pressure relief valve of the lube oil circuit.

Lube oil cooler housing

Item	Description	Remark
1	Oil filter	Consisting of: filter housing, filter cover, filter element. Tightening torque of cover = 25 N·m
2	Bypass valve	Opening pressure: p = 2.5 ± 0.5 bar
3	Drain valve	Opens when filter cover is loosened by 1 to 2 turns. The oil in the filter housing drains into the oil pan.
4	Bypass valve	Protects cooler from pressure peaks. Opening pressure: p = 2.1 ± 0.35 bar
5	Pressure regulating valve	Opening pressure: p = 4.0 ± 0.4 bar
6	Non-return valve	Prevents draining of the oil circuit when engine is not running. Opening pressure max. 0.12 bar
7	Oil cooler	Aluminium shell-type cooler
8	Passage water	Between oil cooler housing and oil cooler
9	Passage oil	Between oil cooler housing and oil cooler

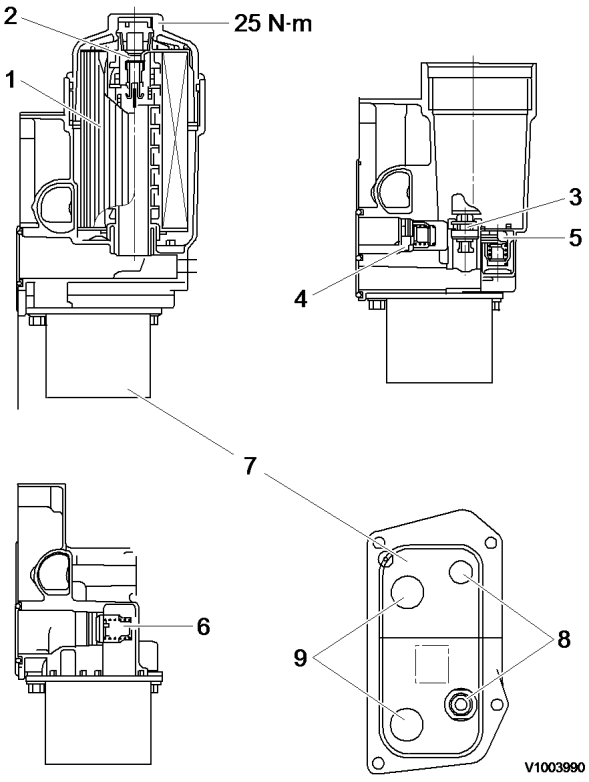

Figure 4
Lube oil cooler housing

Document Title: **Fuel injection system, description**	Function Group: **230**	Information Type: **Service Information**	Date: **2015/3/16**
Profile: **EXC, EC135B LC [GB]**			

Fuel injection system, description

- The D4D engine operates according to the direct injection principle.
- The piston bowl has a small amount of eccentricity to the piston axis. The fuel is injected via four single-cylinder injection pumps. The maximum injection pressure reaches up to 1350 bar. This results in good exhaust emission values which meet the requirements of EURO I to III.

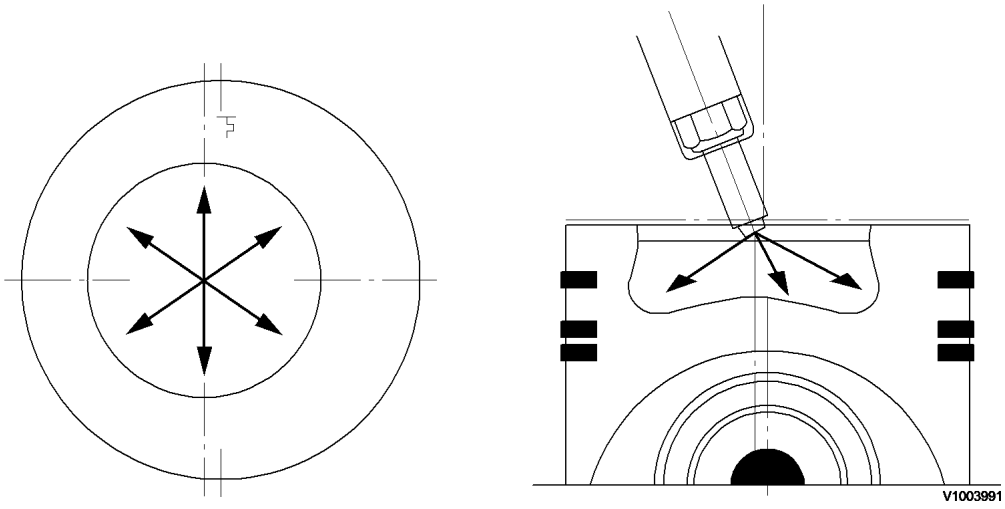

Figure 1
Diagram, fuel injection system

Fuel flow system diagram

The fuel is delivered by fuel feed pump (3) from tank (1) via filter (5) to the supply duct of the single-cylinder injection pumps integrated in the crankcase. From the four single injection pumps the fuel is supplied through the injection lines (8) to the injectors (9). The end of the supply duct is fitted a pressure holding valve (10).

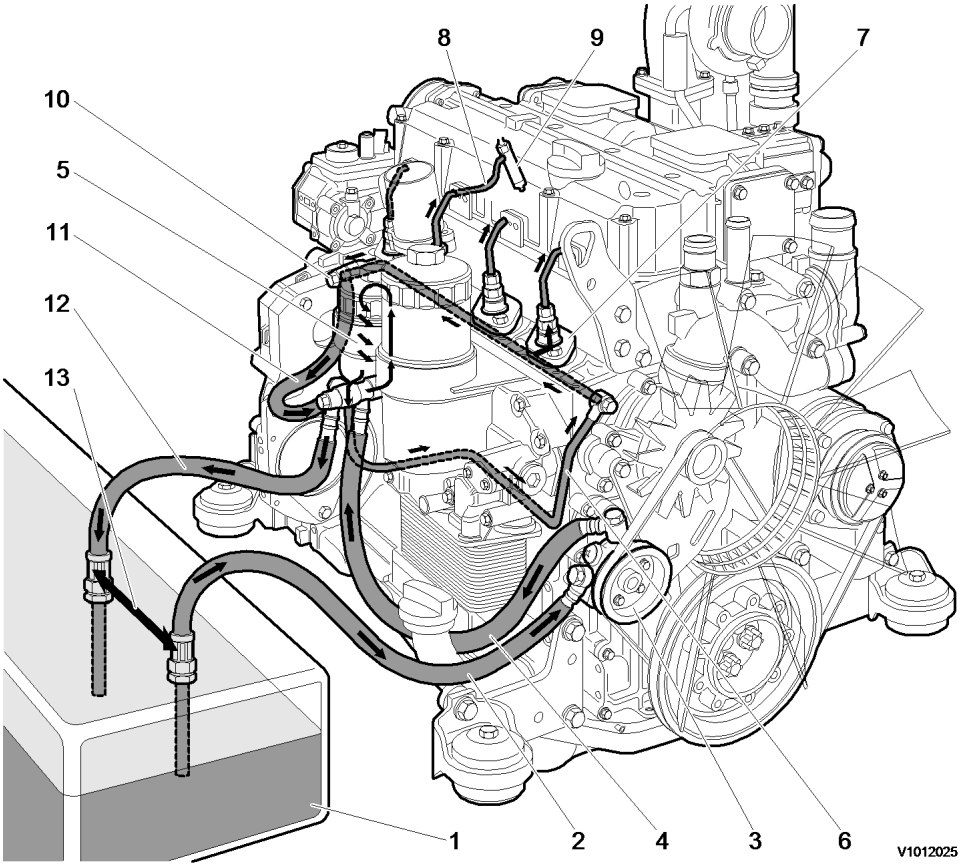

Figure 2
Diagram, fuel flow system

1	Fuel tank	8	Line to injector
2	Line to fuel pump	9	Injector
3	Fuel pump	10	Pressure holding valve (5 bar)
4	Line to fuel filter	11	Return line to fuel filter housing
5	Fuel filter	12	Return line to fuel tank
6	Line to single injection pumps	13	Minimum distance 300 mm
7	Single-cylinder injection pump		

Fuel feed pump

- The fuel feed pump is a rotary pump which is driven via the Poly V-belt.
- The pump is provided with a two-way valve (item 1 Pop. 6 ± 0.5 bar, item 2 Pop.: 0.5 bar).
- The overpressure relief valve (1) is a plunger valve and opens at 5.5 bar. This valve simultaneously limits the system pressure to 9.5 bar.
- The bypass valve (2) is a ball valve. When the fuel lines have run empty, the fuel system can be primed with a hand pump. This prevents an excessive engine starting procedure. (starter protection).

NOTE!
Do not reduce the line cross section and connection to the fuel feed pump (see installation directions), as this may result in engine power loss.

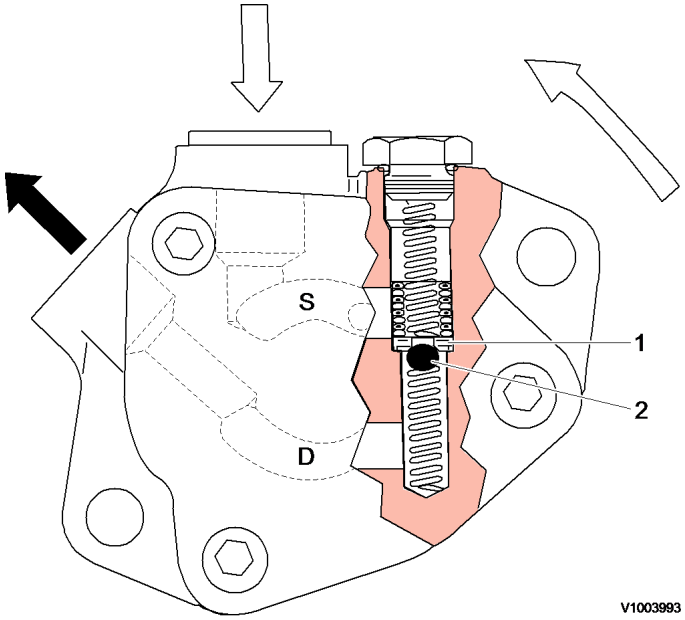

Figure 3
Fuel feed pump

1. Relief valve
2. Bypass valve

Injection system

The D4D engine is provided with BOSCH single-cylinder injection pumps (1). In combination with a high hydraulic stiffness due to extremely short injection lines (2), very high injection pressures are realized with this concept. This again forms the basis for achieving low exhaust emission values together with low fuel consumption.

Commencement of delivery

The setting of the commencement of delivery (COD) influences:

- fuel consumption,
- power and
- exhaust emissions of the engine.

The commencement of delivery is set without tolerance. It is indicated in C/A degrees BTDC of the piston (see nameplate) and is dependent on application, power and speed setting respectively for optimization of the engine.

The single injection pump is in COD position when plunger (7) is just closing fuel inlet port (8) in plunger barrel (9).

On engines with in-line injection pumps the crankshaft assembly is turned in COD position, and the closing of the fuel inlet port in the injection pump plunger is determined with a high pressure pump. Any occurring tolerances are compensated at the coupling of the injection pump drive, with the injection pump camshaft being turned to COD position relative to the stationary crankshaft assembly.

This method for setting the commencement of delivery is not applicable in the case of the D4D as the injection pump cams are fitted on engine camshaft (6).

The commencement of delivery is therefore set according to a new method, with the conventional method being subdivided into length measurements of individual components and arithmetic steps.

The permissible manufacturing tolerances of the following components are determined and eliminated with shim (4).

Injection system

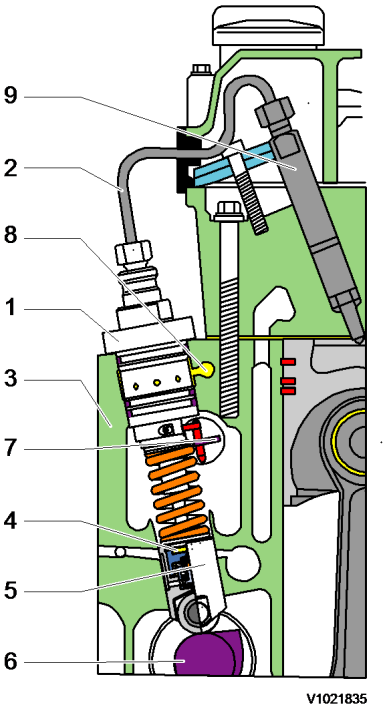

Figure 4
Injection pump and injector

1. **Injection pump (new)**
2. Delivery pipe
3. Engine block
4. **Shim (new)**
5. **Roller tappet (new)**
   Cold engine, injection timing : approx. 9 deg. BTDC
   Hot engine (over 50 ~ 60 °C), injection timing : 3 deg. BTDC
   Selp-regulated by memory spring concept.
6. **Camshaft (new)**
   Injection timing : 3 deg. BTDC
7. Fuel rack
8. Fuel duct
9. **Injector (new)**
   HC reduction

Determining shim thickness in case of engine repair

- To begin with, the TDC of the relevant piston is determined with a protractor disc fitted to the flywheel.
- The injection pump standard dimension "L" represents the reference dimension for setting the commencement of injection pump delivery. It is required to connect the crankshaft assembly and the injection pump in COD position.
- It is measured between the contact surface of the single-cylinder injection pump flange on the crankcase and the contact surface of the tappet foot seated on the roller tappet, with the roller tappet being on the base circle of the injection pump cam (pre-stroke Vh = 0 mm).

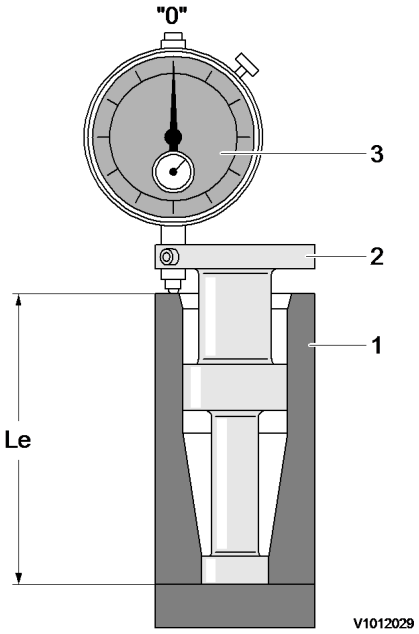

Figure 6
Measurement, dimension "L"

1. Hollow cylinder (Le = 124 mm)
2. Depth gauge
3. Dial gauge

- For determining the standard dimension (L), a special tool is used which consists of three individual components.

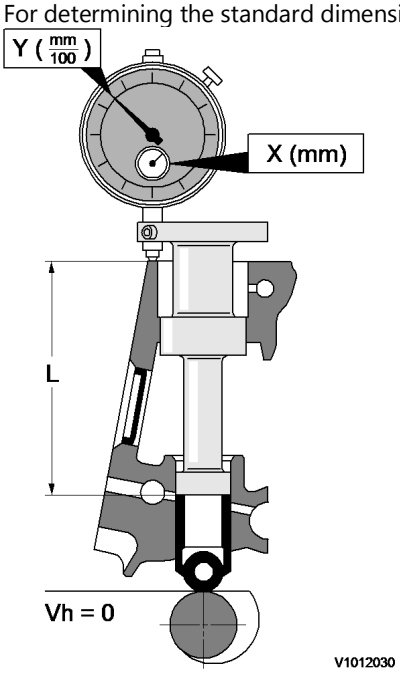

Figure 7
Determination, dimension "L"

- After completing the basic setting the special depth gauge is inserted in the injection pump seat, and the dial gauge readings (X, Y) are taken. When adding the standard measure (Le) to the reading, the standard dimension (L) has been determined and should be written down.

  L = Le + X + Y (mm)

  NOTE!
  During this measurement the roller tappet must be positioned on the base circle of the camshaft!

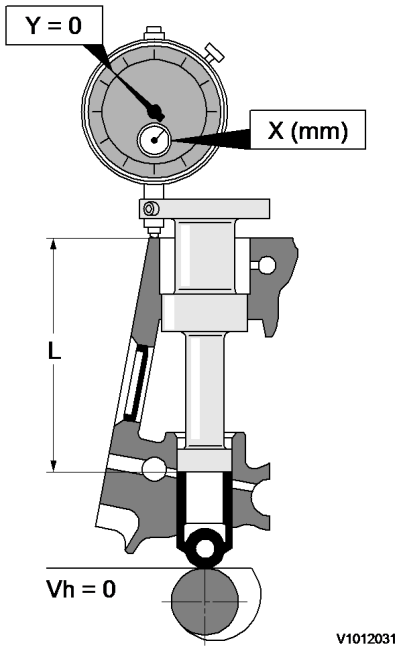

Figure 8
Setting, zero position

- After the standard dimension (L) has been determined, the gauge fitted in the crankcase is set to zero position, with the roller tappet positioned on the camshaft base circle.

Table for commencement of delivery, pre-stroke, basic dimension Lo

From the following table the "Vh" value is determined for the pre-stroke according to the commencement of delivery to be set - see nameplate. It is determined depending on engine type and installed camshaft.

"Vh" value

Commencement of delivery (FB)	Camshaft type	Pre-stroke (Vh)	Pre-stroke correction factor	Standard dimension (Lo) injection pump
	[°C/A BTDC]	[mm]	[mm/°C/A]	[mm]
2.0	L	5.14	0.14	117.5
3.0		4.97		
4.0		4.80		
5.0		4.62		
6.0		4.44		
7.0		4.26		
8.0		4.11		
9.0		3.95		

NOTE!
Commencement of delivery and camshaft type are indicated on the nameplate.

- The crankshaft is turned in direction of engine rotation until the dial gauge precisely indicates the "Vh" value given in the table. The crankshaft assembly is now in commencement of delivery position for the cylinder to be set. On the fitted protractor disc (exact TDC position of the piston had to be determined before), the actual commencement of delivery "FB_{actual}" is now compared with commencement of delivery "Fb_{nom}.". Each deviation is corrected.