

# **Workshop Manual**

**Group 21-26**

**D2-50/55, D2-60, D2-75**



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# 00-0 General

## General Information

The product designation and the serial number and specification are shown on the engine decal or type plate. This information must be included in all correspondence concerning the product.

Volvo Penta is constantly developing its products. All information in this Manual is based on product data that was available at the time the Manual was published.

The working methods described in this manual are based on a workshop scenario where the product is mounted in a work fixture. Maintenance work is often carried out in situ, in which case - if nothing else is indicated - using the same working methods as the workshop.

The service manual describes work operations carried out with the aid of Volvo Penta Special Tools, where such have been developed. Volvo Penta Special Tools are designed to ensure the safest and most rational working methods possible.

In some cases local safety regulations and user instructions may be applicable regarding the use of tools and chemicals mentioned in the service manual. These rules must always be observed, so there are no special instructions about this in the workshop manual.

Above all, when working on fuel systems, hydraulic systems, lubrication systems, turbochargers, inlet systems, bearings and seals, it is of the utmost importance that dirt and foreign objects are kept away, as malfunctions or shortened service intervals may otherwise result.

## Replacement parts

Volvo Penta Original Replacement Parts meet national safety requirements. No damage of any kind caused by the use of replacement parts not approved by Volvo Penta will be compensated by any warranty undertaking.

## About this Workshop manual

### Certified engines

**When performing service and repairs on emission certified engines, it is important to be aware of the following:**

Certification means that an engine type has been checked and approved by the relevant authority. The engine manufacturer guarantees that all engines of the same type are manufactured to correspond to the certified engine.

This places special demands on service and repair work, namely:

- Maintenance and service intervals recommended by Volvo Penta must be complied with.
- Only replacement parts approved by Volvo Penta may be used.
- All fuel injection service must always be carried out by an authorised Volvo Penta workshop.
- The engine must not be converted or modified, except with accessories and service kits which Volvo Penta has approved for the engine.
- No changes to the exhaust pipe and engine air inlet duct installations may be made.
- No warranty seals (where present on the product) may be broken by unauthorized persons.

### IMPORTANT!

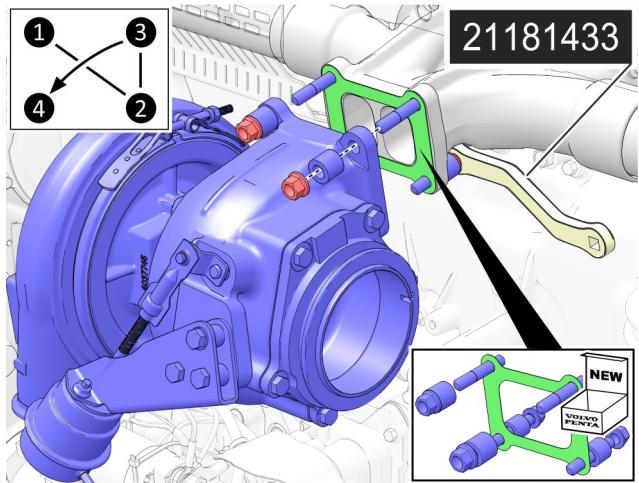
Neglected or poorly-performed maintenance or service and the use of replacement parts not approved by Volvo Penta, will mean that AB Volvo Penta no longer guarantees that the engine conforms to the certified model.

Volvo Penta accepts no responsibility for damage or costs arising as a result of failure to follow the above mentioned standards.

## Colours used in images

Most images include a highlighted component which is secured by a screw or similar as part of a (light gray) engine transmission.

**NOTICE!** Because the images in the maintenance literature are used for different engine variants, certain details may vary compared to the actual model concerned. The essential information is always correct, however.



P0030543

- 1 Component emphasized (blue)
- 2 Attachment fasteners (red)
- 3 Chassis (light grey)
- 4 Background (white)
- 5 Special tool (yellow)
- 6 Seals (green)  
(as from June 2018)

**Other types of symbols used in the images are divided into the following categories:**

- Safety
- Important
- Cleanliness
- Position
- Movement
- Measured value
- Tools
- Chemicals
- Sealant
- Units

## Safety information

Read the safety information below carefully before you start repair or service work.



This symbol is used on the product to let you know that this concerns safety information. Always read such information very carefully.

**Warnings take the following priority:**



Indicates a dangerous situation which, if not avoided, will lead to death or serious injury.



Indicates a dangerous situation which, if not avoided, could lead to death or serious personal injury.



Indicates a dangerous situation which, if not avoided, will lead to minor or significant injury.

**IMPORTANT:**

Is used to make you aware of something that may cause minor injury or a minor malfunction to the product or property.

**NOTICE!** Is used to make you aware of important information that will facilitate the work or operation in progress.



This symbol is used on certain functions to indicate the following:

Performance of this operation requires prior theoretical and/or instructor-led training. Contact your local training organization for further information.



This symbol informs you that supplemental information needs to be read. And where necessary information can be found.



This symbol means **Dangerous electrical voltage / General electrical danger**.



This symbol is used when a VODIA computer is needed, either for troubleshooting, testing or programming.



This symbol is used for facilitation tips when repairing.

**A compilation of safety precautions that must be taken and risks which you must be aware of is presented in the following pages.**

	Immobilize the engine by turning off the power supply with the main switch(es) and lock it (them) in the off position before work is begun. Place a warning notice at the main switch.		Avoid opening the coolant filler cap when the engine is hot. Steam or hot coolant may spray out and with a resultant system pressure loss.
	All maintenance and service must be carried out on when the engine is stopped. Approaching a running engine is a safety risk.		Never start the engine without the air filter in place. The rotating compressor turbine in the turbocharger can cause severe injury. Install all protective covers before starting the engine.
	Beware of hot surfaces and hot liquids in pipes and hoses on an engine that is running or has just been switched off.		When operating in a confined space, exhaust pipe fumes and crankcase gases must be led away from the engine compartment or workshop area. Ensure good ventilation.
	Make sure that all warning and information decals on the product are always visible. Replace decals that have been damaged or painted over.		Only make connection adjustments with the engine switched off.
	Avoid getting oil on the skin! Use protective gloves and avoid oil-soaked clothes and rags.		Never start the engine with the valve cover removed. There is a risk of personal injury.
	Switch off the engine and disconnect the power at the main switches before starting work on the electrical system.		Stop the engine before working on the cooling system. Marine engines: Close the sea cock/cooling water inlet valve before starting work on the cooling system.
	Always wear protective goggles if there is a risk of splinters, sparks and splashes from acid or other chemicals.		Check that rags soaked in oil or fuel and used fuel and oil filters are stored safely. Oil-soaked rags may ignite spontaneously in certain conditions.
	Never use start gas or similar products as a starting aid.		Never work alone when dismantling heavy components, even if you use lifting equipment.
	Never allow open flames or electrical sparks in the vicinity of fuel. Always ensure that there are fire extinguishers close at hand in the operating area.		Take extreme care when searching for fuel system leaks and testing fuel injector nozzles. Wear safety goggles.
	Batteries must never be exposed to open flames or electrical sparks.		Never use a high-pressure washer to clean the engine. Pay attention to the following when using a high-pressure washer on components other than the actual engine: Never aim the water jet at seals, rubber hoses or electrical components.



Always wear protective goggles when charging or handling the batteries. Rinse immediately with plenty of water and soap if battery electrolyte comes into contact with unprotected skin.

If you get battery acid in your eyes, flush at once with a generous amount of water, and get medical assistance at once.



The engine must not be operated in areas where there are explosive materials or gases.



Only use fuels and lubricating oils as recommended by Volvo Penta.

# 03-2 Specifications, Engine

## Wear Tolerances

### General

Compression pressure at starter motor speed (min. 200 rpm).	Min. 25 Bar (363 PSI)
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### Pistons

Piston clearance	Max. 0.25 mm (0.0098")
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### Piston rings

Piston ring clearance in groove	
Compression rings	Max. 0.25 mm (0.0098")
Oil ring	Max. 0.15 mm (0.0059")
Piston ring gap in cylinder	Max. 1.0 mm (0.0394")

### Gudgeon pins

Piston pin diameter	Min. 27.996–28.000 mm (1.10220–1.10236")
Clearance, piston pin - connecting rod bush	Max. 0.08 mm (0.0031")
Clearance, piston pin - piston pin hole	Max. 0.02 mm (0.0008")

### Cylinder head

Warping	Max. 0.12 mm (0.0047")
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### Cylinder block

Warping (head plane)	Max. 0.12 mm (0.0047")
Bore	Max. 84.2 mm (3.31")
0.5 mm (0.02") TDC	Max. 84.7 mm (3.33")
1.0 mm (0.04") TDC.	Max. 85.2 mm (3.35")

### Crankshaft

Out of straightness	Max. 0.06 mm (0.0024")
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### Con rods

Straightness, max. deviation on 100 mm (3.94") measured length	0.15 mm (0.0059")
Twist, max. deviation on 100 mm (3.94") measured length	0.20 mm (0.0079")
End float, connecting rod - crankshaft	Max. 0.70 mm (0.0276")

### Bearing clearance

Main bearing	Max. 0.20 mm (0.0079")
Big end bearing	Max. 0.20 mm (0.0079")

## Tightening torques

Cylinder head*:	100 Nm (73.8 lbf.ft.)
<b>Main bearing</b>	
Upper to lower bearing cap	52 Nm (38.4 lbf.ft.)
Main bearing caps to cylinder block (hex bolts)	52 Nm (38.4 lbf.ft.)
Rear cap (Allen bolt)	27 Nm (19.9 lbf.ft.)
Big end bearing	52 Nm (38.4 lbf.ft.)
End plate / flywheel housing	25 Nm (18.4 lbf.ft.)
Flywheel Housing	25 Nm (18.4 lbf.ft.)
Flywheel	74 Nm (54.6 lbf.ft.)
Elastic coupling	22 Nm (16.2 lbf.ft.)
Adapter plate to flywheel housing	22 Nm (16.2 lbf.ft.)
Suction strainer, oil pump	10 Nm (7.4 lbf.ft.)
Oil Sump	10 Nm (7.4 lbf.ft.)
Drain plug, sump	35 Nm (25.8 lbf.ft.)
Transmission gear casing	10 Nm (7.4 lbf.ft.)
Crankshaft belt pulley	300 Nm (221.3 lbf.ft.)
Injection Pump	15 Nm (11.1 lbf.ft.)
Bearing bracket, rocker arm shaft	33 Nm (24.3 lbf.ft.)
Valve Cover	14 Nm (10.3 lbf.ft.)
Delivery pipe (cylinder block - cylinder head)	12 Nm (8.9 lbf.ft.)
Injectors	64 Nm (47.2 lbf.ft.)
Delivery pipes	23 Nm (17.2 lbf.ft.)
Pressure valve retainer	42 Nm (31.0 lbf.ft.)
Reducing Valve	64 Nm (47.2 lbf.ft.)
Locking screw (max. fuel volume)	15 Nm (11.1 lbf.ft.)
Lock screw (rpm)	15 Nm (11.1 lbf.ft.)
Glowplugs	18 Nm (13.3 lbf.ft.)
Oil pressure monitor	18 Nm (13.3 lbf.ft.)
Coolant temperature monitor	27 Nm (19.9 lbf.ft.)
Oil pressure sensor	18 Nm (13.3 lbf.ft.)
Coolant temperature sensor	18 Nm (13.3 lbf.ft.)

**NOTICE!** \* The final tightening torque is indicated. The cylinder head must be tightened in three stages and in the correct order: refer to the tightening procedure. Lubricate the cylinder head mounting bolts with oil on installation.

**General tightening torque values**

M5	5 Nm (3.7 lbf.ft.)
M6	10 Nm (7.4 lbf.ft.)
M7	17 Nm (12.5 lbf.ft.)
M8	24 Nm (17.7 lbf.ft.)
M10	50 Nm (36.9 lbf.ft.)
M12	80 Nm (59.0 lbf.ft.)
M14	130 Nm (95.9 lbf.ft.)

**Conversion table**

	To convert:		Multiply by	To convert:		Multiply by
	From	To		From	To	
<b>Length</b>	mm	inch	0,03937	inch	mm	25,40
	cm	inch	0,3937	inch	cm	2,540
	m	foot	3,2808	foot	m	0,3048
<b>Area</b>	mm <sup>2</sup>	sq.in.	0,00155	sq.in.	mm <sup>2</sup>	645,2
	m <sup>2</sup>	sq.ft.	10,76	sq.ft.	m <sup>2</sup>	0,093
<b>Volume</b>	cm <sup>3</sup>	cu.in.	0,06102	cu.in.	cm <sup>3</sup>	16,388
	liter, dm <sup>3</sup>	cu.ft.	0,03531	cu.ft.	liter, dm <sup>3</sup>	28,320
	liter, dm <sup>3</sup>	cu.in.	61,023	cu.in.	liter, dm <sup>3</sup>	0,01639
	liter, dm <sup>3</sup>	imp. gallon	0,220	imp. gallon	liter, dm <sup>3</sup>	4,545
	liter, dm <sup>3</sup>	US gallon	0,2642	US gallon	liter, dm <sup>3</sup>	3,785
	m <sup>3</sup>	cu.ft.	35,315	cu.ft.	m <sup>3</sup>	0,0283
<b>Power</b>	N	lbf	0,2248	lbf	N	4,448
<b>Weight</b>	kg	lb.	2,205	lb.	kg	0,454
<b>Power</b>	kW	hp (metric) <sup>1)</sup>	1,36	hp (metric) <sup>1)</sup>	kW	0,735
	kW	bhp	1,341	bhp	kW	0,7457
	kW	BTU/min	56,87	BTU/min	kW	0,0176
<b>Torque</b>	Nm	lbf.ft.	0,738	lbf.ft.	Nm	1,356
<b>Pressure</b>	Bar	PSI	14,5038	PSI	Bar	0,06895
	MPa	PSI	145,038	PSI	MPa	0,006895
	Pa	mm Wg	0,102	mm Wg	Pa	9,807
	Pa	in Wg	0,004	in Wg	Pa	249,098
	kPa	in Wg	4,0	in Wg	kPa	0,24908
	mWg	in Wg	39,37	in Wg	mWg	0,0254
<b>Energy</b>	kJ/kWh	BTU/hph	0,697	BTU/hph	kJ/kWh	1,435
<b>Work</b>	kJ/kg	BTU/lb	0,430	BTU/lb	kJ/kg	2,326
	MJ/kg	BTU/lb	430	BTU/lb	MJ/kg	0,00233
	kJ/kg	kcal/kg	0,239	kcal/kg	kJ/kg	4,184
<b>Fuel consumption</b>	g/kWh	g/hph	0,736	g/hph	g/kWh	1,36
	g/kWh	lb/hph	0,00162	lb/hph	g/kWh	616,78
<b>Inertia</b>	kgm <sup>2</sup>	lbft <sup>2</sup>	23,734	lbft <sup>2</sup>	kgm <sup>2</sup>	0,042
<b>Flow, gas</b>	m <sup>3</sup> /h	cu.ft./min.	0,5886	cu.ft./min.	m <sup>3</sup> /h	1,699
<b>Flow, fluid</b>	m <sup>3</sup> /h	US gal/min.	4,403	US gal/min.	m <sup>3</sup> /h	0,2271
<b>Speed</b>	m/s	ft./s	3,281	ft./s	m/s	0,3048
	mph	knot	0,869	knot	mph	1,1508
<b>Temperature</b>	$^{\circ}\text{F}=9/5 \times ^{\circ}\text{C}+32$			$^{\circ}\text{C}=5/9 \times (^{\circ}\text{F}-32)$		

<sup>1)</sup> All power noted in the catalogue refers to metric horsepower.

## Technical Data

Type Designation	D2-55-A/B/C/D/E/F	D2-75-A/B/C/F
No. of cylinders	4	4
Induction System	Atmospheric pressure	Turbo charge with charge air cooler
Bore	84 mm (3.31")	84 mm (3.31")
Stroke	100 mm (3.94")	100 mm (3.94")
Cylinder volume	2.2 dm <sup>3</sup> (134.3 in <sup>3</sup> )	2.2 dm <sup>3</sup> (134.3 in <sup>3</sup> )
Power	Refer to the sales literature	
Idle rpm	850 ±25 rpm	850 ±25 rpm
Rated rpm	3,185 ±15 rpm	3,185 ±15 rpm
Compression ratio	23,3:1	23,3:1
Compression pressure at starter motor speed	>27 Bar (392 PSI)	>27 Bar (392 PSI)
Firing sequence (highest cyl. # next to flywheel)	1-3-4-2	1-3-4-2
Direction of rotation seen from front	Clockwise	
Max. permissible rearward incline in operation	20°	20°
Max. lateral incline in operation	30°	30°
Valve clearance, idle, cold engine: inlet and exhaust	0,20 (0.008")	0,20 (0.008")
Weight, dry engine	225 kg (496 lbs)	250.6 kg (552 lbs)
Max. permitted back-pressure in exhaust line	20 kPa (2.9 PSI)	20 kPa (2.9 PSI)

## Engine

### Group 21 - Engine

#### Pistons

Materials	Aluminum alloy
Height, total	87.66–87.74 mm (3.4512–3.4543")
Height from piston pin center to piston crown	47.66–47.74 mm (1.8764–1.8795")
Piston clearance	0.038–0.072 mm (0.0015–0.0028")
Front marking	The designation "SHIBAURA" on the inside of the piston must face the fuel pump on installation.

**Piston rings**

<b>Compression rings</b>	
Quantity	2
Upper compression ring, height	1,97–1,99 (0.0776–0.0783")
2nd compression ring, height	1,47–1,49 (0.0579–0.0587")
<b>Oil ring</b>	
Quantity	1
Height	3.90–3.98 mm (0.1535–0.1567")
<b>Piston ring gap in cylinder</b>	
Upper compression ring	0.20–0.35 mm (0.0079–0.0138")
2nd compression ring	0.20–0.40 mm (0.0079–0.0157")
<b>Piston ring clearance in groove</b>	
Upper compression ring	0.07–0.11 mm (0.0028–0.0043")
2nd compression ring	0.04–0.08 mm (0.0016–0.0031")
Oil ring	0.02–0.06 mm (0.0008–0.0024")

**Piston pins**

Clearance, piston pin - connecting rod bush	0.010–0.027 mm (0.00039–0.00106")
Piston pin - piston pin hole	-0.001–0.011 mm (-0.000039–0.000433")
Piston pin diameter	27.996–28.000 mm (1.1022–0.01024")
Connecting rod bush int. diameter	28.010–28.021 mm (1.1028–1.1032")
Piston pin hole diameter in piston	27.999–28.005 mm (1.1023–1.1026")

**Cylinder head**

Height	69.7–70.3 mm (2.744–2.768")
<b>Valve seats (inlet and exhaust)</b>	
Inlet, diameter	36.35–36.45 mm (1.431–1.435")
Exhaust, diameter	32.35–32.45 (1.274–1.278")
Inlet, width	1.5–2.0 mm (0.059–0.079")
Exhaust, width	1.9–2.2 mm (0.075–0.087")

**Crankshaft with bearings**

(Replaceable bearing shells for main and big-end bearings)	
Crankshaft, end float	0.1–0.4 mm (0.0039–0.0157")
<b>Main bearings, radial clearance</b>	
# 1, 2, 3 and 4	0.044–0.102 mm (0.0017–0.0040")

**Main bearing journals**

<b>Diameter, standard, journal</b>	
#. 1, 2, 3 and 4	67.957–67.970 mm (2.6755–2.6760")

**Big-end journals**

Big-end bearing, radial clearance	0.035–0.085 mm (0.0014–0.0033")
Journal length	17.70–20.60 mm (0.699–0.811")
Diameter, standard	51.964–51.975 mm (2.0458–2.0463")

**Big end journal shells**

Thickness, standard	1.482–1.495 mm (0.0583–0.0589")
---------------------	---------------------------------

**Con rods**

Fitted with replaceable bearing shells.	
<b>Diameter</b>	
Connecting rod bush bearing position	
Bearing shell bearing position	
Piston pin bush	28.010–28.021 mm (1.1028–1.1032")
End float, connecting rod - crankshaft	
	0.035–0.085 mm (0.0014–0.0033")

**Camshaft**

Drive	Gear wheel
No. of bearings	3

**Valve timing**

Inlet valves	opens before TDC	13°
	closes after BDC	43°
Exhaust valves	opens before BDC	43°
	closes after TDC	13°

## Valves

<b>Inlet</b>	
Valve stem diameter	6.955–6.970 mm (0.27382–0.27441")
Valve disc	0.925–1.075 mm (0.03642–0.04232")
Clearance, valve stem - valve guide	0.03–0.06 mm (0.0012–0.0024")
Seat angle in cylinder head	45°
Valve clearance, cold engine	0.20 mm (0.0079")

<b>Exhaust</b>	
Valve stem diameter	6.94–6.95 mm (0.27323–0.27362")
Valve disc	0.925–1.075 mm (0.03642–0.04232")
Clearance, valve stem - valve guide	0.050–0.075 mm (0.0020–0.0030")
Seat angle in cylinder head	45°
Valve clearance, cold engine	0.20 mm (0.0079")

## Valve springs

Length, uncompressed	35.0 mm (1.377")
Length at 79.4 Nm (58.56 lbf.ft) compression	30.4 mm (1.196")

## Pushrods

Length, total	226 mm (8.9")
Outer diameter	6.35 mm (0.25")

## Rocker arm mechanism

Rocker arm shaft, diameter	14.95–14.97 mm (0.0098")
Clearance, rocker arm shaft - rocker arm bush	0.030–0.093 mm (0.0012–0.0037")

# Lubrication System

## Group 22 - Lubrication System

Oil pressure, hot engine at operating speed	150–500 kPa (21.8–72.5 PSI)
Oil pressure, idle	50–150 kPa (7.3–21.8 PSI)
Oil pressure relief valve, opening pressure:	245–345 kPa (35.5–50.0 PSI)
<b>Oil pump</b>	
Clearance between inner and outer rotors	0.010–0.015 mm (0.0004–0.0006")
End float between rotor and cover	0.010–0.015 mm (0.0004–0.0006")
Oil grade according to API system	VDS-2 ACEA E7 API CH-4
Viscosity at –5 to +50°C (23°F to 122°F)*	SAE 15W/40 SAE 20W/50
Max. oil volume incl. oil filter, no engine inclination, approx.	10.6 l (2.80 US gals)
Min. oil volume incl. oil filter, no engine inclination, approx.	8.9 l (2.35 US gals)
<b>NOTICE!</b> * Temperatures at stable ambient temperature.	

# Fuel System

## Group 23 - Fuel System

Injection sequence	1-3-4-2
Feed pump maximum suction height	0.8 m (2.62 ft)
Feed pressure	15–25 kPa (2.2–3.6 PSI)

### Fuel injection pump

Injection start, crankshaft position	22.0° ±1° before TDC
Pump element diameter	6 mm (0.236")
Stroke	7 mm (0.276")

### Injectors

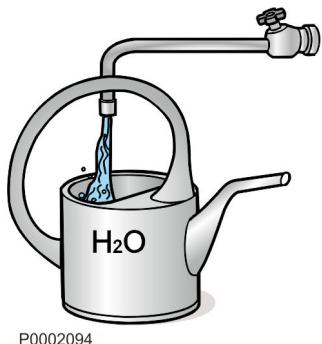
Opening pressure (at checks)	14,7 MPa (2132 PSI)
Needle valve, diameter	4 mm (0.157")
Pin diameter	1 mm (0.039")
Jet angle	4°

# Cooling System

## Group 26 - Cooling System

Type	Positive pressure, sealed cooling system
<b>Freshwater system volume, approx.</b>	
D2-55 A/B/C/D/E/F	9.5 l (2.51 US gals)
D2-75 A/B/C/F	9.8 l (2.59 US gals)
Thermostat, quantity	1
Thermostat starts opening at	82°C (179.6°F) ±4°C (39.2°F)
Thermostat fully open at	95°C (203°F)
Thermostat valve lifting height	8 mm (0.31")

## Water Quality



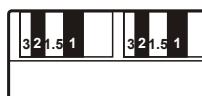
### ASTM D4985:

Total solid particles	<340 ppm
Total hardness	<9.5° dH
Chloride	<40 ppm
Sulfate	<100 ppm
pH value	5.5–9
Silica (acc. ASTM D859)	<20 mg SiO <sub>2</sub> /l
Iron (acc. ASTM D1068)	<0.10 ppm
Manganese (acc. ASTM D858)	<0.05 ppm
Conductivity (acc. ASTM D1125)	<500 µS/cm
Organic content, COD <sub>Mn</sub> (acc. ISO8467)	<15 mg KMnO <sub>4</sub> /l



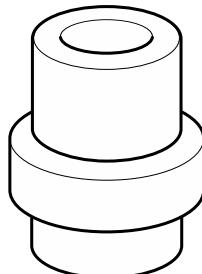
## 08-2 Special Service Tools

The following special tools are used when working on the engine. The tools can be ordered from AB Volvo Penta by specifying the number indicated.



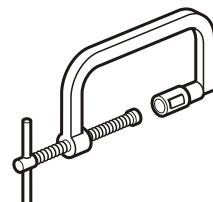
**856927 Plastigauge**

For measuring main and big end bearing clearance.



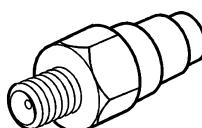
**884283 Sleeve**

Seawater pump, overhaul.



**885023 Valve spring compressor**

Used for compressing valve springs.



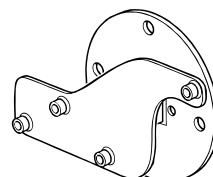
**885252 Adapter**

Used for compression testing.



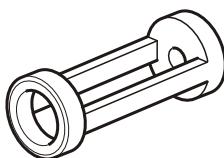
**885484 Adapter**

Used for compression testing.



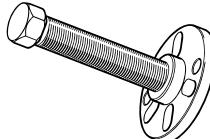
**885485 Fixture**

Engine fixture for unit stand.



**885498 Adapter**

Floor lock (used together with 885023 Valve spring compressor)



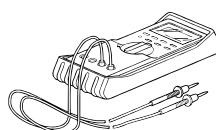
**885820 Puller**

Puller, for pulley.



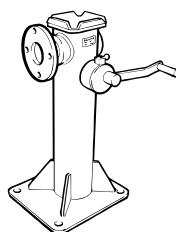
**885822 Magnetic pen**

Used for removing valve lifters.



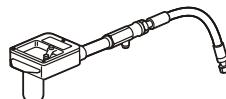
**88890074 Multimeter**

Used for measuring.



**9986485 Stand**

For use with 885485 Fixture.

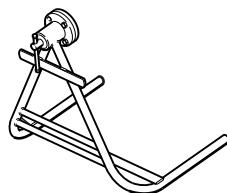


**9988539 Compression meter**

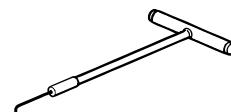
Used for compression tests.



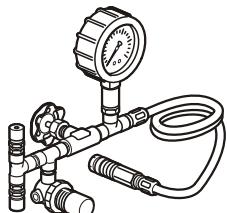
**9989876 Dial indicator**  
Used when checking end float.



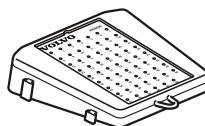
**9992520 Stand**  
For use with 885485 Fixture.



**9995919 Extractor**  
Used when removing seals.



**9996662 Pressure testing kit**  
Used for checking pressure valve in filler cap.



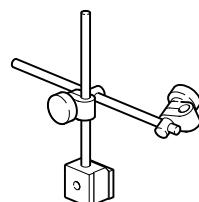
**9998699 Break-out box**  
Used for measurements.



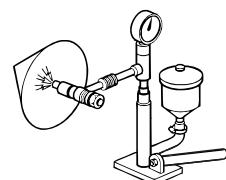
**9999179 Extractor oil filter**  
Wrench for removing fuel and oil filters.



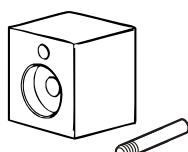
**9999683 Dial indicator (short probe)**  
Used e.g. when checking drive transmission.



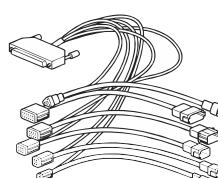
**9999696 Magnetic stand**  
Used e.g. for checking end float.



**9999772 Pressure testing kit**  
Used for checking injectors.



**3849641 Mounting tool**  
Installation tool for oil pump shaft.



**88890016 Break-out cable**  
For use with 9998699 Break-out box.

# 20-0 Engine Information, General

## Design and Function

### Identification Numbers

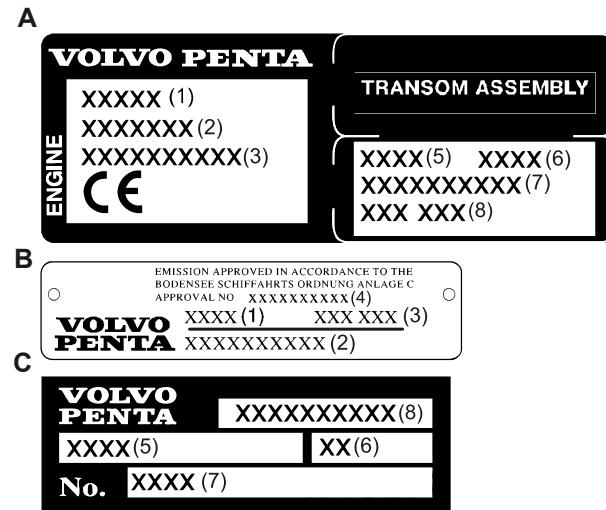
There are type plates on the engine and timing cover, marked with identification numbers. This information must always be used a reference when spare parts are ordered. The appearance and location of the type plates is shown below. The figures in brackets refer to the location of the identification number on the type plate.

#### Engine

Product designation (1): .....  
 Product number (2): .....  
 Serial number (3): .....  
 Certification number (4) .....

#### Timing

Product designation (5): .....  
 Gear ratio (6): .....  
 Serial number (7): .....  
 Product number (8): .....

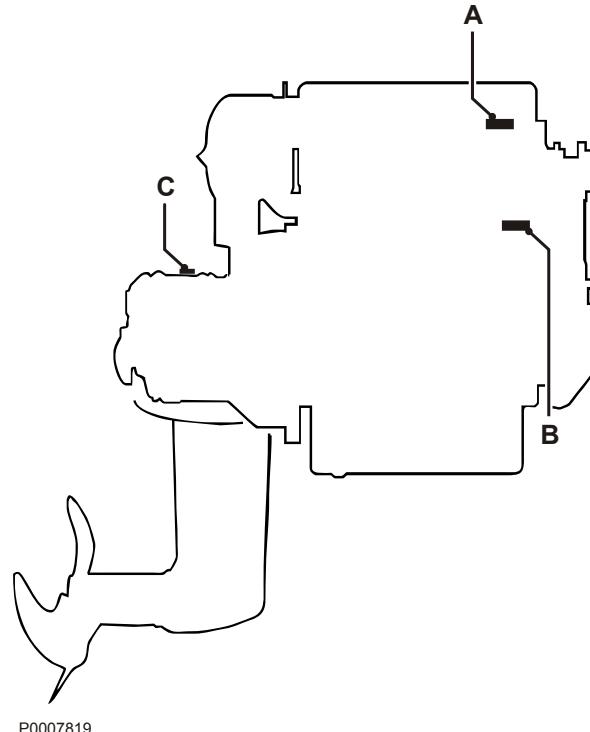


P0007817

A Engine and transmission decal

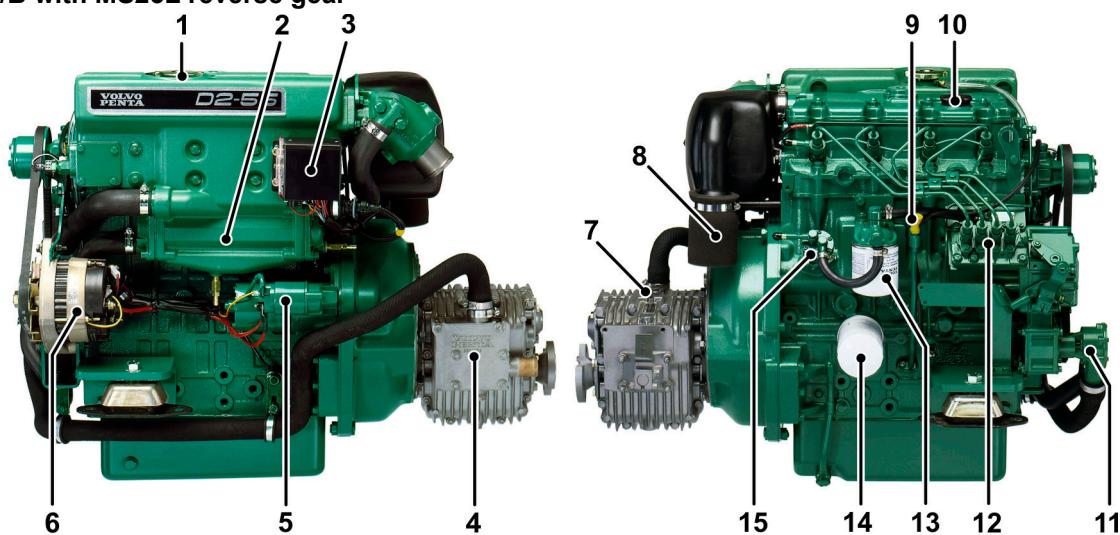
B Engine plate

C Transmission plate



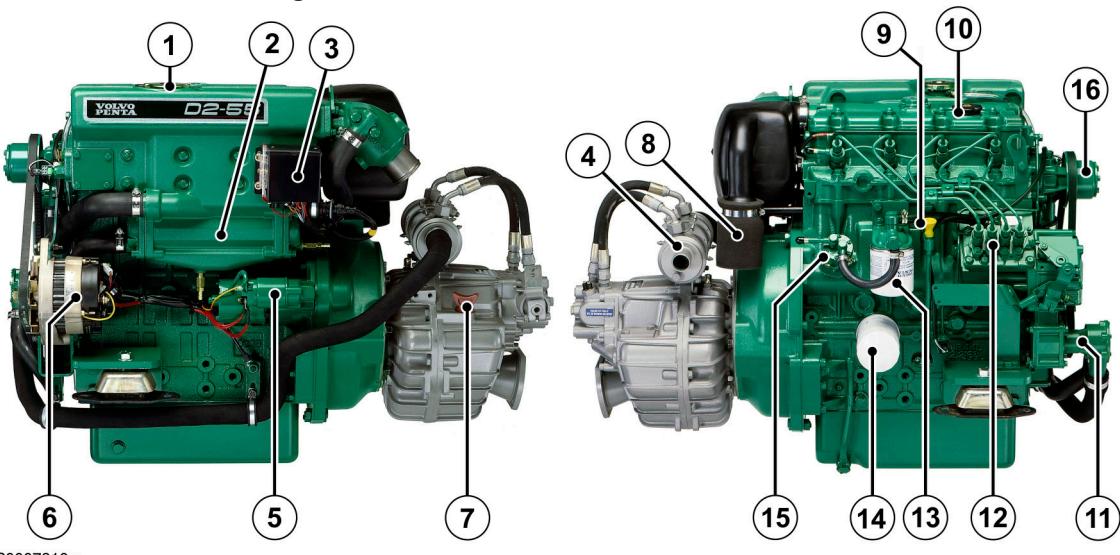
## Engine Introduction

**D2-55-A/B with MS25L reverse gear**



P0007716

**D2-55-A/B with HS25A reverse gear**

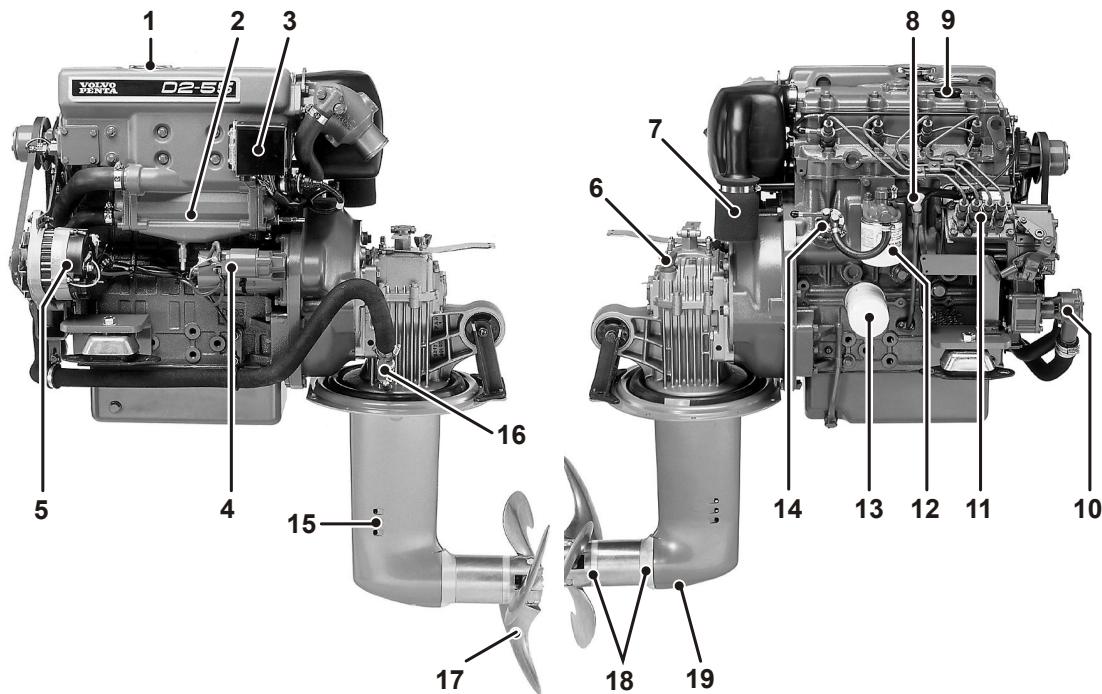


P0007810

- 1. Coolant filling
- 2. Heat exchanger
- 3. Relay box with fuses
- 4. Oil cooler, reverse gear
- 5. Start motor

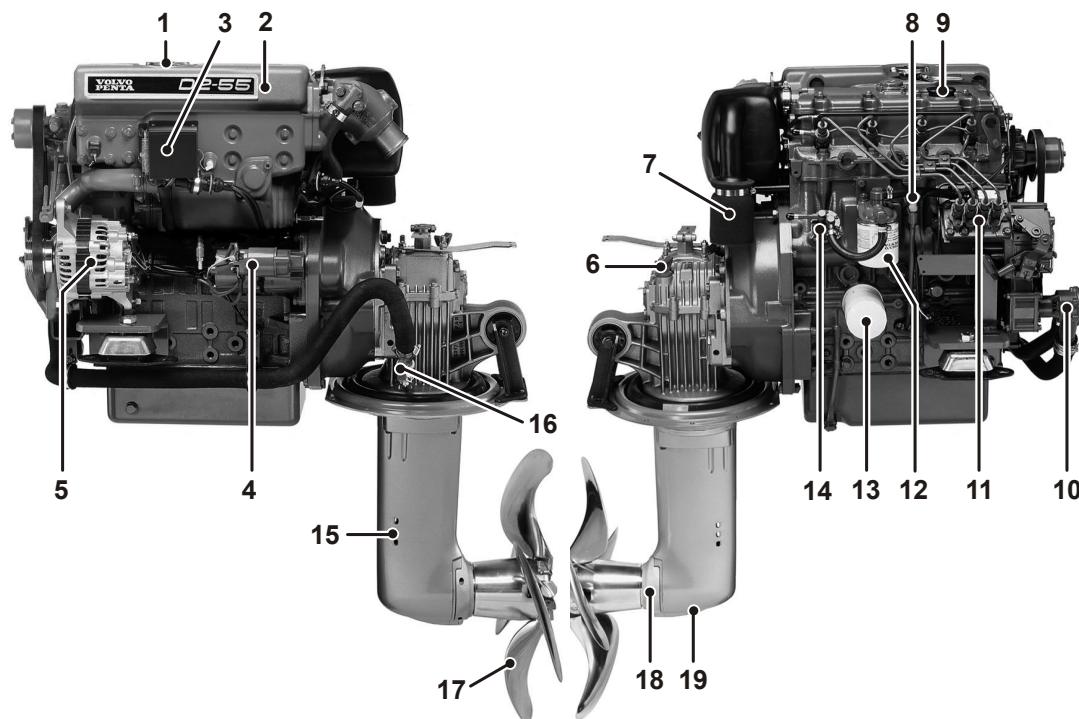
- 6. Alternator
- 7. Oil dipstick, reverse gear
- 8. Air filter / air intake
- 9. Oil dipstick, engine
- 10. Oil filler, engine

- 11. Raw water pump
- 12. Injection pump
- 13. Fuel filter
- 14. Oil filter
- 15. Fuel pump

**S2-55-A/B with MS25S sail-drive**

P0007820

- |                            |                         |                                  |
|----------------------------|-------------------------|----------------------------------|
| 1. Coolant filling         | 8. Oil dipstick, engine | 14. Fuel pump                    |
| 2. Heat exchanger          | 9. Oil filler, engine   | 15. Cooling water inlet, S-drive |
| 3. Relay box with fuses    | 10. Raw water pump      | 16. Sea cock, S-drive            |
| 4. Start motor             | 11. Injection pump      | 17. Folding propeller            |
| 5. Alternator              | 12. Fuel filter         | 18. Sacrificial anodes           |
| 6. Oil dipstick, S-drive   | 13. Oil filter          | 19. Oil drain, S-drive           |
| 7. Air filter / air intake |                         |                                  |

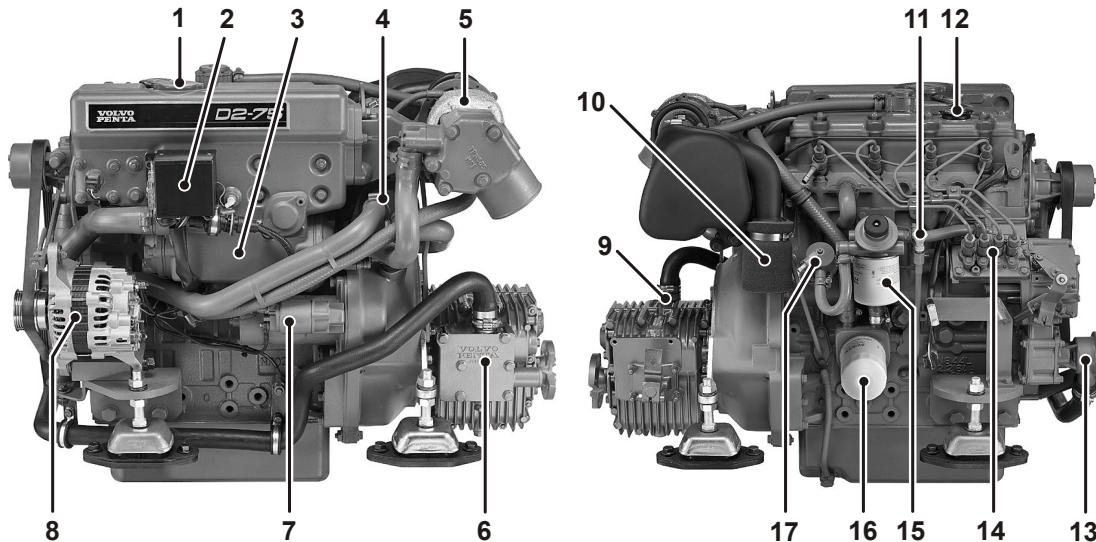
**S2-55-C with 130S sail-drive**

P0007821

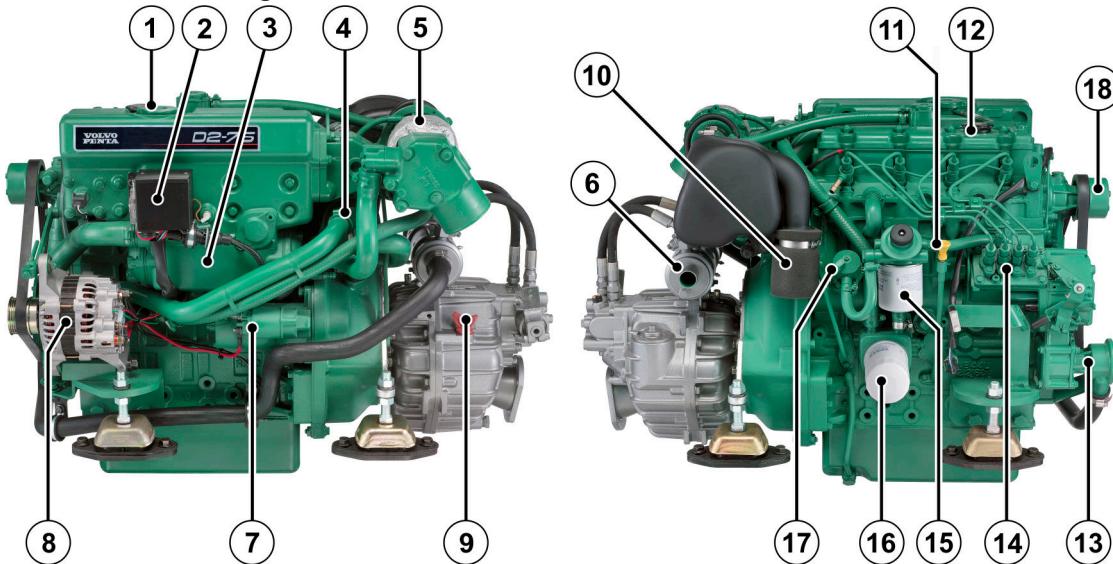
1. Coolant filling
2. Heat exchanger
3. Relay box with fuses
4. Start motor
5. Alternator
6. Oil dipstick, S-drive
7. Air filter / air intake

8. Oil dipstick, engine
9. Oil filler, engine
10. Raw water pump
11. Injection pump
12. Fuel filter
13. Oil filter

14. Fuel pump
15. Cooling water inlet, S-drive
16. Sea cock, S-drive
17. Folding propeller
18. Sacrificial anodes
19. Oil drain, S-drive

**S2-75-A with MS25L reverse gear**

P0007822

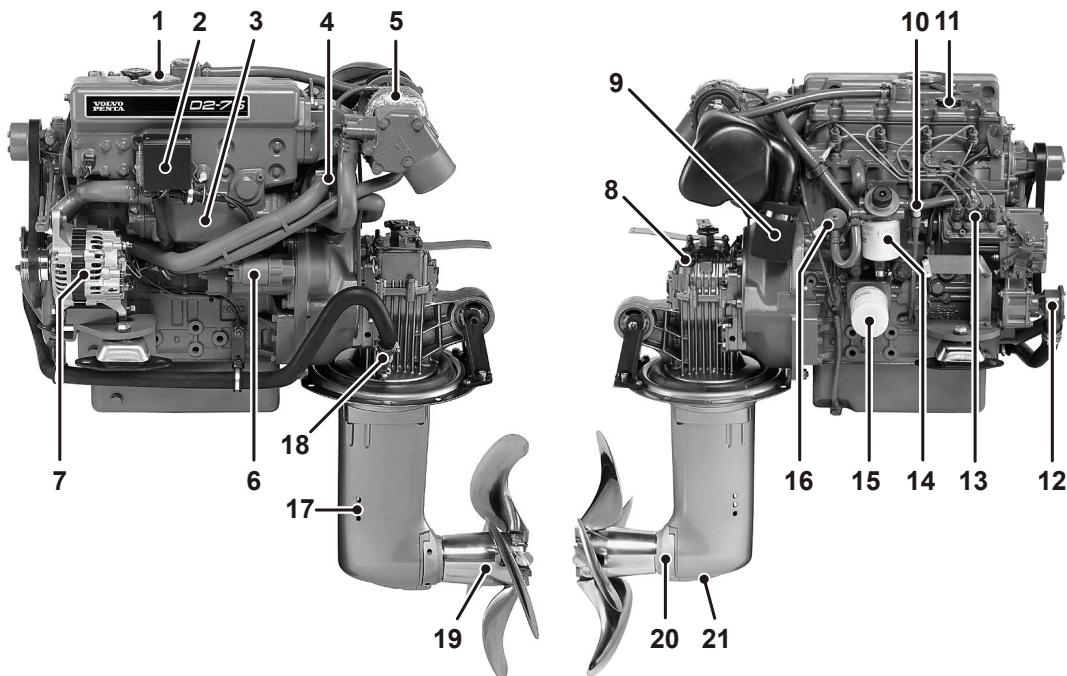
**S2-75-A with HS25A reverse gear**

P0007823

- 1. Coolant filling
- 2. Relay box with fuses
- 3. Heat exchanger
- 4. Charge air cooler
- 5. Turbocharger
- 6. Oil cooler, reverse gear

- 7. Start motor
- 8. Alternator
- 9. Oil dipstick, reverse gear
- 10. Air filter / air intake
- 11. Oil dipstick, engine
- 12. Oil filler, engine

- 13. Raw water pump
- 14. Injection pump
- 15. Fuel filter
- 16. Oil filter
- 17. Fuel pump

**S2-75-A with 150S sail-drive**

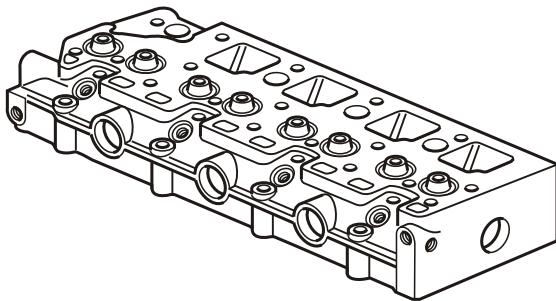
P0007824

- 1. Coolant filling
- 2. Relay box with fuses
- 3. Heat exchanger
- 4. Charge air cooler
- 5. Turbocharger
- 6. Start motor
- 7. Alternator

- 8. Oil dipstick, S-drive
- 9. Air filter / air intake
- 10. Oil dipstick, engine
- 11. Oil filler, engine
- 12. Raw water pump
- 13. Injection pump
- 14. Fuel filter

- 15. Oil filter
- 16. Fuel pump
- 17. Cooling water inlet, S-drive
- 18. Sea cock, S-drive
- 19. Folding propeller
- 20. Sacrificial anodes
- 21. Oil drain, S-drive

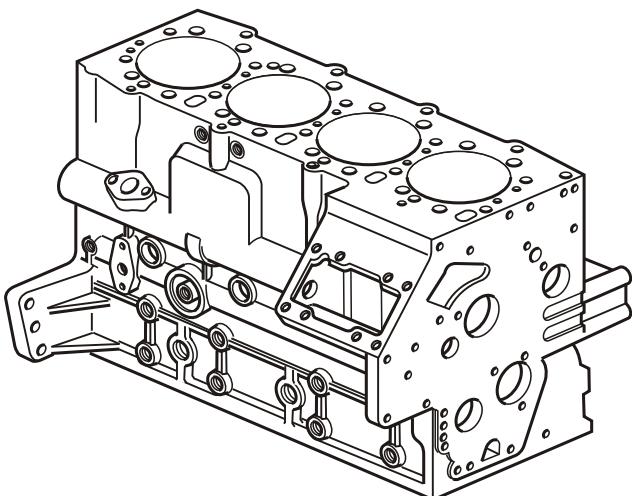
## Component description



P0007837

### Cylinder head

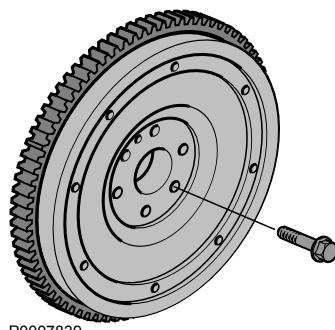
The cylinder head is made from special cast iron alloy. It has replaceable valve seats for inlet and exhaust valves on D2-55-A/B/C and for exhaust valves on D2-75-A.



P0007838

### Cylinder block

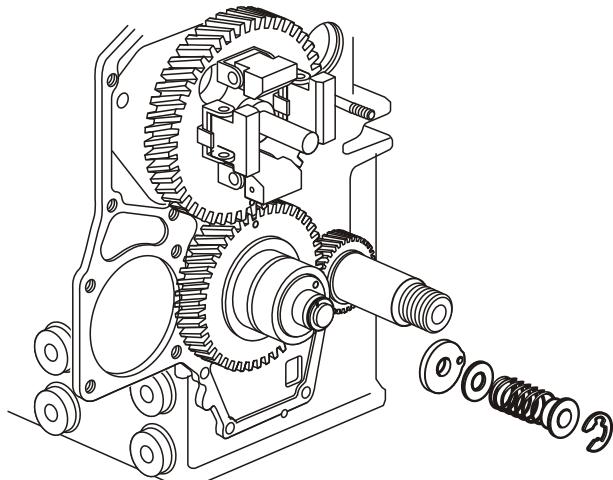
The cylinder block is cast in one piece from special cast iron alloy.



P0007839

### Flywheel

An elastic coupling with a rubber damping element is bolted to the flywheel. The coupling transfers power to the reverse gear / S-drive.

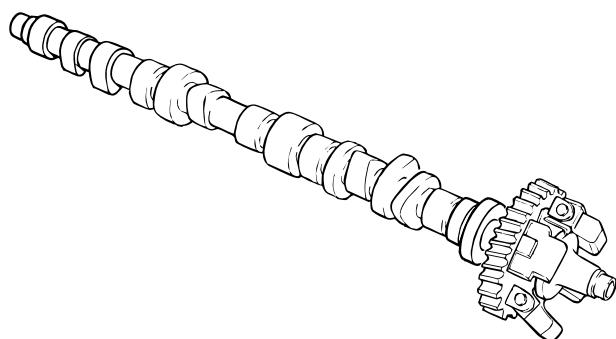


P0007840

## Transmission

The timing gears comprise both straight-cut and helical gears.

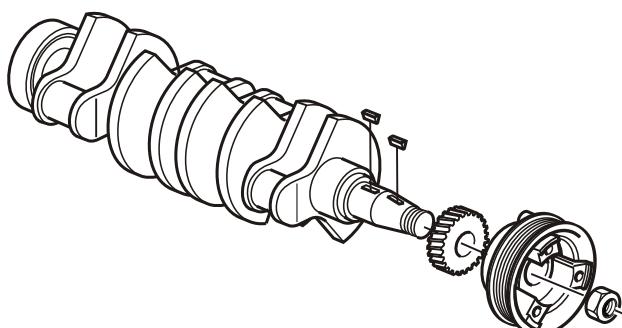
The camshaft and raw water pump are driven from the crankshaft gear via an idler gear. The engine lubrication pump is integral with the idler gear, and is driven by it. Governor weights are suspended on the front of the camshaft gear.



P0007841

## Camshaft

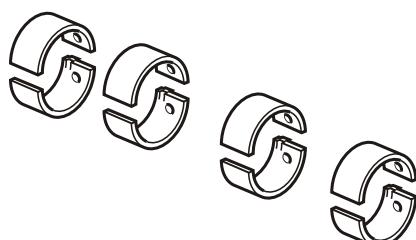
The camshaft is of conventional design with eight lobes that operate the pushrods and valves.



P0007842

## Crankshaft

The crankshaft is suspended in five main bearings. Axial thrust is taken up by separate thrust washers placed on the rear main bearing. The crankshaft is statically and dynamically balanced, and has induction hardened bearing surfaces. The front end of the crankshaft has a Woodruff key and the rear end has a flange upon which the flywheel is mounted.

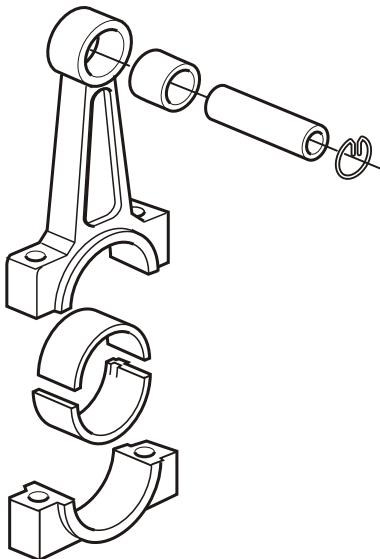


P0007843

## Main and big-end bearings

The main and big-end bearings comprise steel shells lined with bearing metal. The bearings are precision made and are ready to be installed.

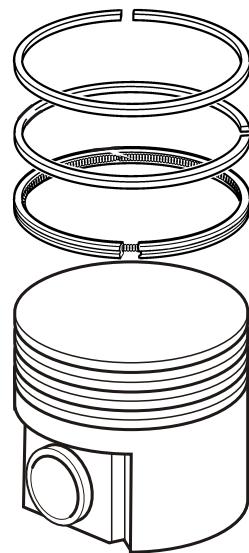
The thrust washers for the crankshaft axial bearings are not available in oversize.



P0007844

## Con rods

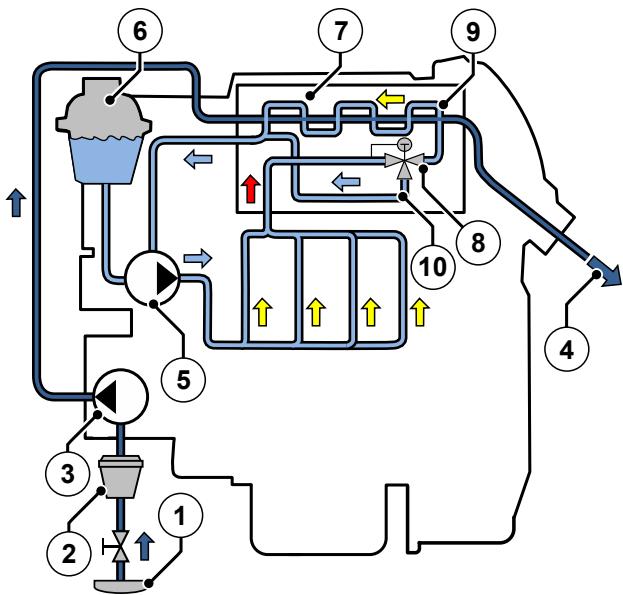
The connecting rods are of I-section. The small end is drilled for piston pin lubrication.



P0007845

## Pistons, piston rings

The pistons are made from aluminum alloy. They are fitted with three piston rings (chrome plated) - two compression rings and an oil ring.



P0007846

- 1 Raw water, inlet
- 2 Raw water filter
- 3 Raw water pump
- 4 Raw water, outlet
- 5 Coolant pump
- 6 Expansion tank
- 7 Heat exchanger / exhaust manifold
- 8 Thermostat
- 9 Open thermostat - circulation
- 10 Closed thermostat - circulation

## Cooling System

The engine is fresh water cooled with a closed cooling system. The system is divided into two circuits. In the inner circuit, the freshwater system, coolant is pumped around by a circulation pump, driven via a belt from the crankshaft pulley.

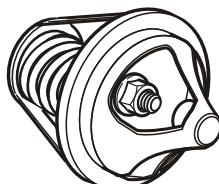
The fresh water system works under pressure, thus reducing the risk of boiling if the temperature becomes high. If the pressure becomes excessive, a pressure valve opens in the filler cap.

The coolant temperature is regulated by a thermostat.

Raw water system flow is achieved by means of a gear-driven impeller pump.

The heat exchanger transfers heat from the coolant to the raw water.

As extra equipment, the engine can be equipped with a separate expansion tank.



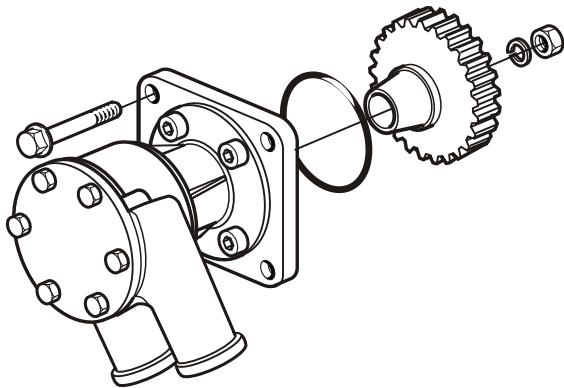
P0007847

## Thermostat

The engine is equipped with a thermostat whose sensor body contains wax.

When the engine is cold the thermostat keeps the route to the heat exchanger closed. Coolant then passes through a by-pass line, directly back to the suction side of the pump. As the engine warms up, the volume of the wax increases and the thermostat progressively opens the passage to the heat exchanger, at the same time as the by-pass line is closed.

Refer to 03-25, *Technical Data* for opening temperatures.

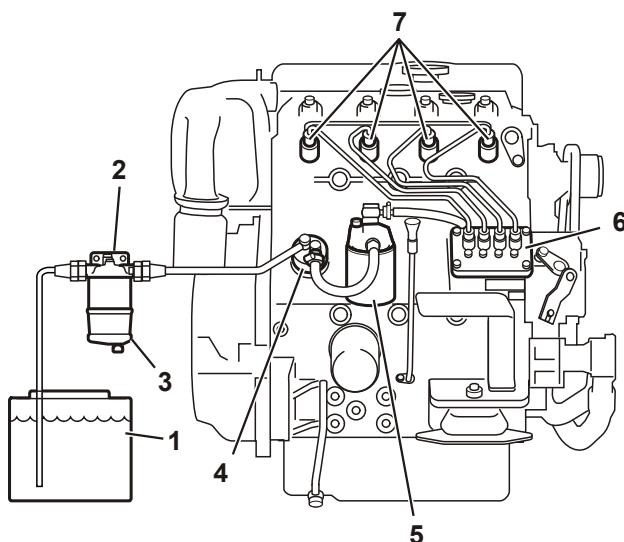


P0007848

## Seawater Pump

The raw water pump is driven by the gears in the timing gear. The impeller (pump wheel) is made from rubber and is replaceable.

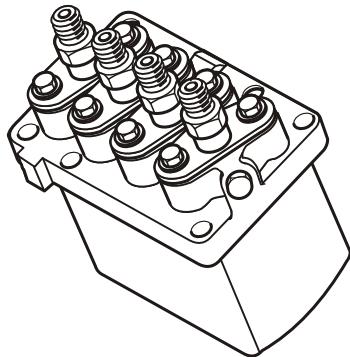
**NOTICE!** The impeller will be damaged if the pump is run dry.



P0007849

## Fuel System

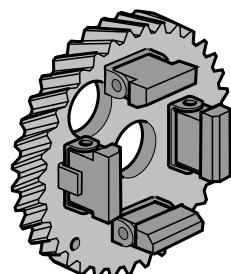
Fuel is drawn from the fuel tank by the feed pump, through a water separator / pre-filter (extra equip.) and is forced through a fine filter to the injection pump. Return fuel from the injectors is led through return fuel lines, back to the tank.



P0007850

## Injection Pump

The injection pump is an in-line flange mounted pump. The pump is driven by cams on the engine camshaft, that operate the pump chambers directly.

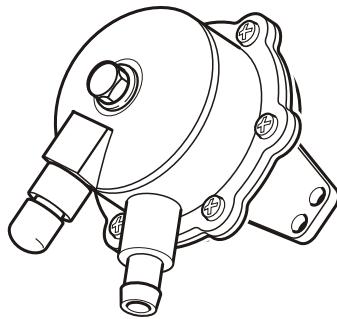


P0007851

## Centrifugal Regulator

The governor is mechanical and works with speed-sensitive governor weights. It is mounted on the front of the camshaft gear, from where it is also driven.

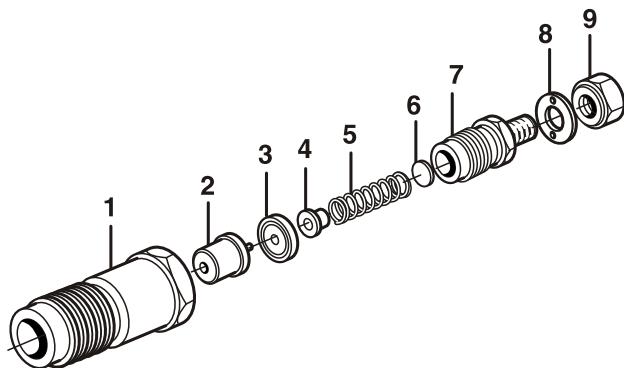
The governor weights operate the injector pump control rod via the governor sleeve, a lever and a governor arm. Engine speed is governed throughout the entire range, from low idle to high idle (all-speed type).



P0007852

## Feed pump

The feed pump is driven by an eccentric on the camshaft rear end. The pump on D2-55 A/B is also equipped with a manual hand pump.



P0007853

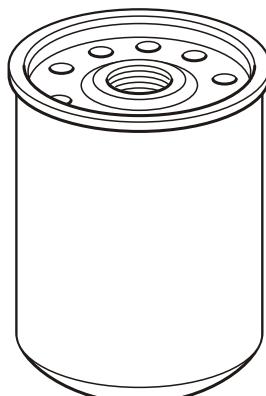
- 1 Injector nut
- 2 Injectors
- 3 Joining piece
- 4 Compression screw
- 5 Spring
- 6 Adjustment shims
- 7 Injector holder
- 8 Washer
- 9 Nut

## Injectors

The engine is provided with pintle-type injectors. Each injector basically consists of a nozzle retainer and a nozzle.

When the fuel pressure increases to the set value (opening pressure) the injector needle, which is held pressed against its seat by the compression spring, is lifted and atomized fuel is injected into the precombustion chamber of the engine.

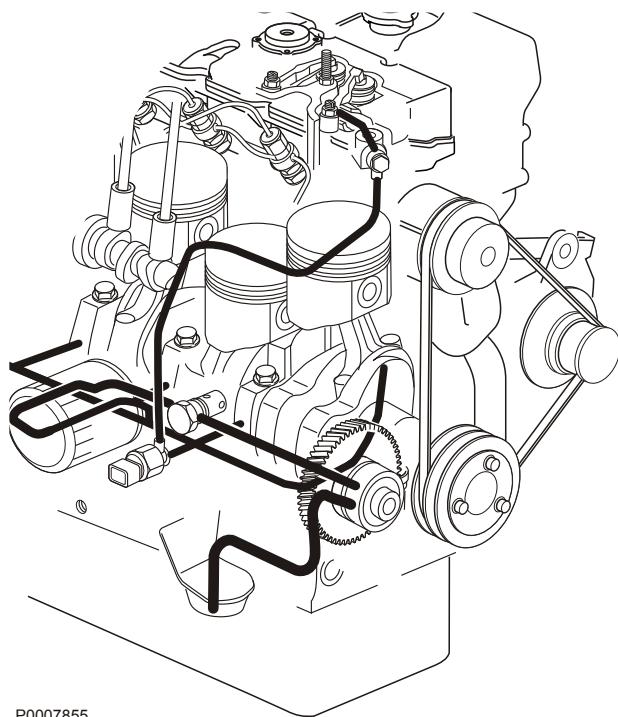
Injector opening pressure is determined by the compression spring which is adjustable with shims.



P0007854

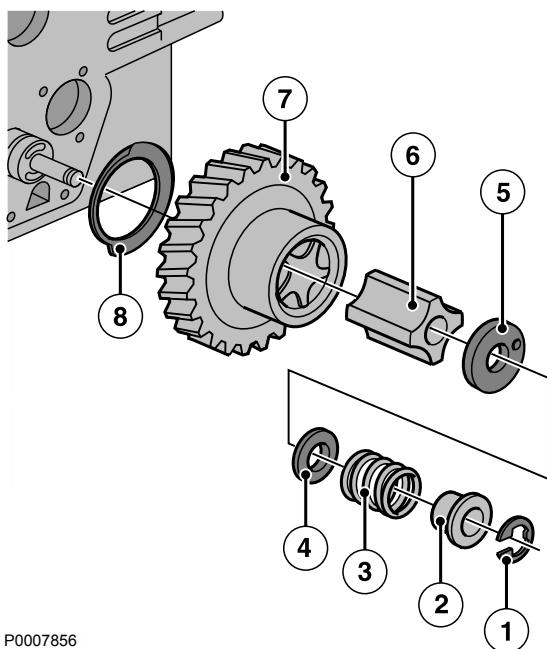
## Fuel Filter

The fuel filter is discardable. The filter insert is a paper filter.



## Lubrication System

The engine has a pressurized lubrication system with full-flow oil filter.



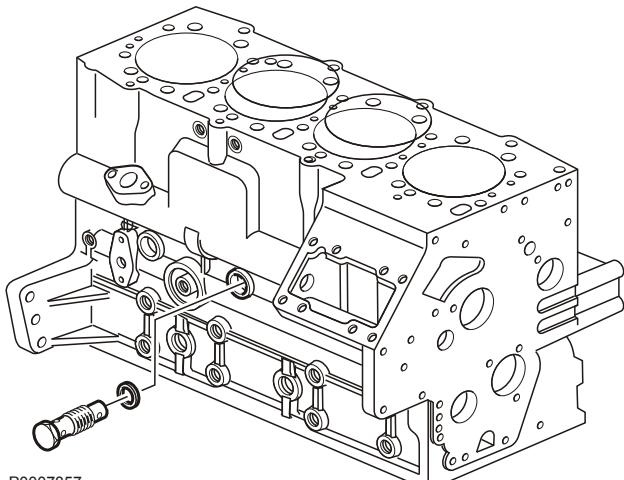
## Oil pump

The lubrication pump is located within the idler gear on the timing gears, by which it is also driven.

The pump is a rotor pump with an inner rotor and an outer rotor mounted eccentrically in relation to each other. The inner rotor has one "tooth" less than the outer rotor.

Pump function results from the space between the inner and outer gear wheels increasing and decreasing. During the first section of the rotation of the inner rotor, the volume increases, a partial vacuum occurs and oil is drawn into the inlet. After about a half revolution volume is reduced, pressure increases and oil is forced out through the outlet.

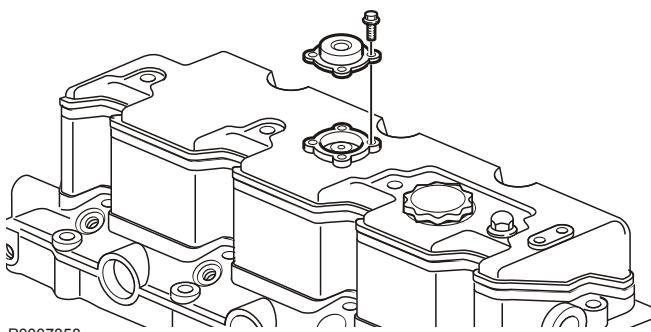
- 1 Retainer ring
- 2 Spring washer
- 3 Spring
- 4 Shim
- 5 Oil pump cover
- 6 Inner rotor
- 7 Idler wheel with outer rotor
- 8 Thrust washer



## Reducing Valve

Lubricating oil pressure is limited by a relief valve. The valve is located in the lubrication system just before the oil filter. The valve opens with high pressure and allows the oil to flow back into the sump.

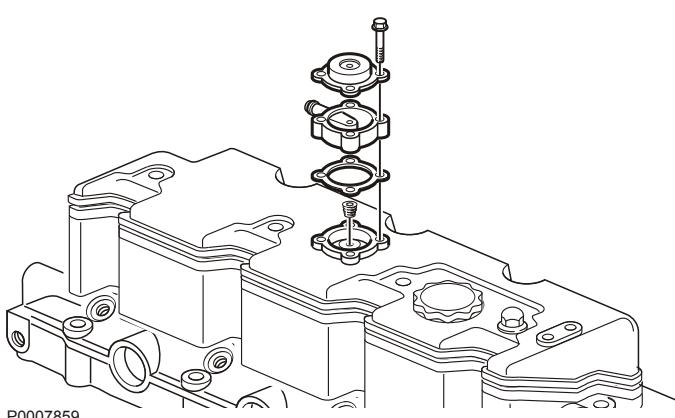
**D2-55**



## Crankcase ventilation

To prevent over-pressure and to separate fuel vapor, water vapor and other gaseous combustion products, the engine is fitted with closed crankcase ventilation.

**D2-75**

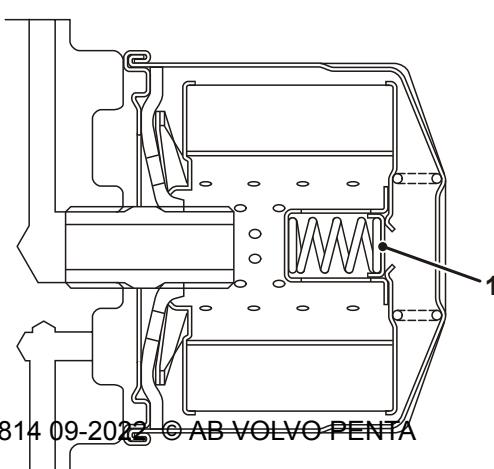


## Oil filter

The filter is a full flow filter, which means that all the oil is filtered before it is forced out into the lubrication system.

The filter element consists of folded filter paper.

There is a bypass valve (1) at the base of the filter, which opens and allows oil to flow past the filter if the filter insert should become blocked.



# Test and Adjustments

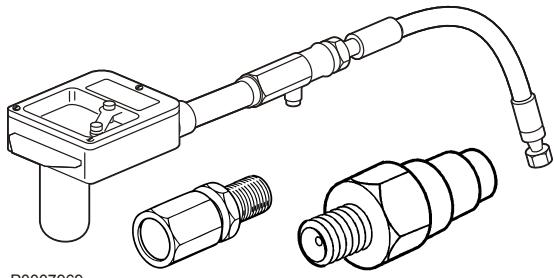
## Compression Test

**Tools:**

885252 Adapter

885484 Adapter

9988539 Compression meter



In order to assess engine condition in a simple, reliable manner, a compression test is carried out to show cylinder and valve sealing.

- Warm the engine up, then stop it.
- Remove all the injectors and test each of the cylinders in turn.

**IMPORTANT!**

Avoid getting dirt in the fuel system, observe the greatest possible cleanliness.

Plug the connections for the disassembled injectors and fuel pipes.

The compression pressure must be read at normal starter motor speed.

Low combustion pressure in all cylinders indicates worn cylinder bores and piston rings. If one cylinder has lower compression than the others, the reason can be poor valve sealing, broken piston rings or a damaged cylinder head gasket.

Place the adapters 885484 Adapter and 885252 Adapter in the injector sockets.

Place 9988539 Compression meter in the adapter and carry out the compression test.

# Repair Instructions

## General

If possible, a condition test should be performed before each major service activity to determine the general condition of the engine and discover any concurrent fault causes. A condition test requires the engine to be run, so it should be performed before the engine or engine components are removed.

Refer to *Compression Test, page 34*.

## When working with chemicals, fuel and lubricating oil

### CAUTION!

Always use protective gloves for work including contact with oil, fuel etc.

Constant skin contact with engine oil can be very harmful.

- 1 Disconnect battery power.
- 2 Clean the outside of the engine.

**NOTICE!** Make sure that wash residue is collected for destruction and does not inadvertently end up in the environment.

### **IMPORTANT!**

Remember the following when washing with a power washer: Be extremely careful when cleaning, to avoid getting water inside engine components. When a power washer is used, the water jet must never be aimed at seals, such as shaft seals, joints with gaskets, rubber hoses or electrical components.

- 3 For work that includes dismantlement of the cooling system: Close the sea cocks and drain the coolant from the raw water and fresh water systems.

### **IMPORTANT!**

Make sure that all sea water inlets are securely closed, so that water can not find its way in during disassembly of cooling system sub-components.

# 21-0 Engine Complete, General

## Exposing the Engine

### Before lifting the engine

#### Boat removed from the water

- 1 Turn the battery isolator off, and undo the battery connections on the starter motor.
- 2 Remove the harness terminal for the engine instrumentation harness.
- 3 Remove the raw water connections / keel cooling connection.
- 4 Remove the exhaust line.
- 5 Close the fuel taps. Remove the fuel connections.
- 6 Remove the throttle and gear shift cables.
- 7 Undo the propeller shaft from the reversing gear. Undo the engine mounting pads from the bed and lift the engine out.

### Actions after lifting the engine

- 1 Clean the engine.

#### IMPORTANT!

Remember the following when washing with a power washer: Be extremely careful when cleaning, to avoid getting water inside engine components. When a power washer is used, the water jet must never be aimed at seals, such as shaft seals, joints with gaskets, rubber hoses or electrical components.

- 2 Drain the engine oil
- 3 Remove the reverse gear (as necessary)

## Fitting the Fixture

**Tools:**

856927 Plastigauge

885485 Fixture

9986485 Stand

Use 885485 Fixture to secure the engine in 9986485 Stand or 856927 Plastigauge.

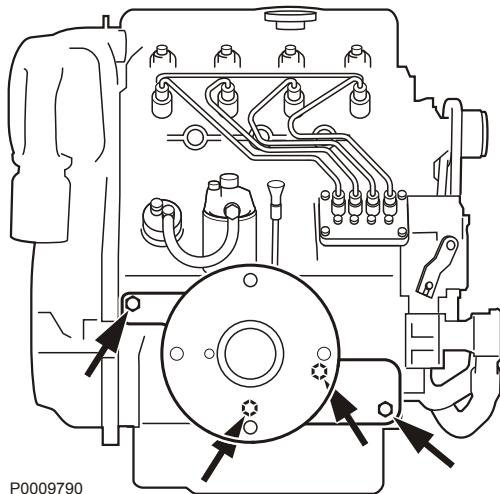
The fixture is bolted to the right side of the engine as illustrated below.

**NOTICE!** It is important that the instructions regarding the number and sizes of attachment bolts are followed to ensure secure engine attachment.

**Bolts required:**

1 pc	M10 x 35 mm (1.38")
3 pcs	M14 x 1.5 x 35 mm (1.38")

Before the engine fixture can be positioned and the engine attached to the overhaul stand, the right front engine mounting, oil dipstick tube, oil cooler with oil filter and turbo oil pipe (D2-75), must be removed from the engine.



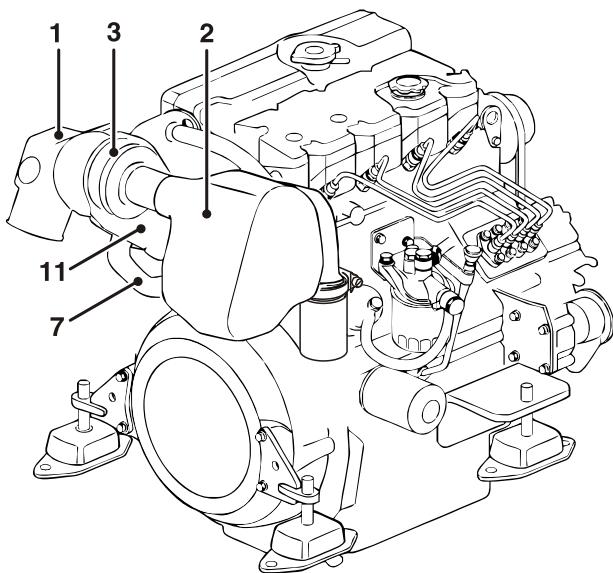
# Engine Disassembly

## Tools:

885510 Plugs  
885820 Puller  
885822 Magnetic pen

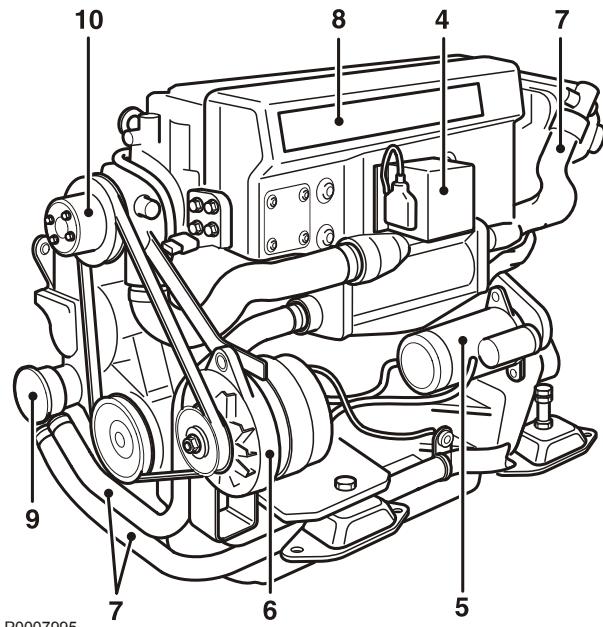
Empty the oil and water from the engine.

Lift the engine with a suitable lifting device. Install the engine fixture: Refer to *Engine with mounting and equipment, page 37*.

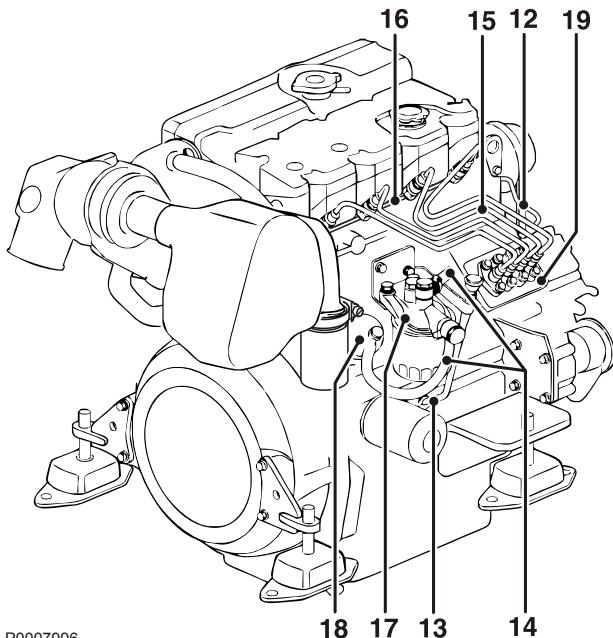


P0007994

- 1 Remove the exhaust bend (1).
- 2 Remove the inlet muffler(2).
- 3 Remove the turbo (3) with associated oil return pipe (only D2-75).
- 4 Remove the electronics box (4) together with the cable harness.
- 5 Remove the starter motor (5) and alternator (6) and front left engine mounting.
- 6 Remove the cooling water hoses (7), heat exchanger (8), raw water pump (9) and the circulation pump (10).
- 7 Remove the charge air cooler (11) and oil pipe to the turbo (only D2-75).



P0007995



8 Remove (13) the oil pressure monitor and the oil pressure pipe (12) to the cylinder head.

9 Remove the fuel lines (14) between the injection pump, fuel filter and feed pump.

#### **IMPORTANT!**

Avoid getting dirt in the fuel system, observe the greatest possible cleanliness.

#### **CAUTION!**

Always use protective gloves for work including contact with oil, fuel etc.

10 Remove the fuel supply pipes (15) between the fuel pump and injector; use the nut underneath the fuel return pipe as a counterhold to avoid kinking the pipe. Remove the fuel supply pipes and put them on a clean, dry surface.

11 Remove the fuel return pipe (16) and the injectors.

#### **IMPORTANT!**

Avoid getting dirt in the fuel system, observe the greatest possible cleanliness.

Plug the fuel pump and injector connections with suitable plugs, for example kit number 885510 Plugs.

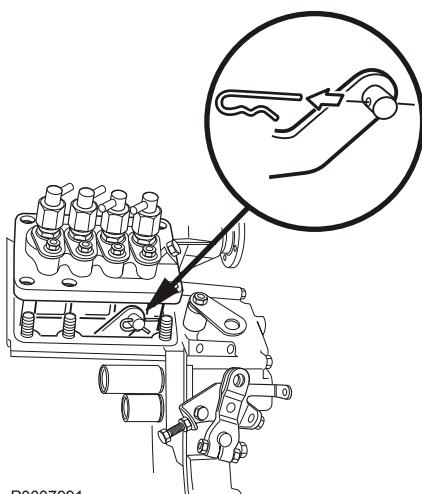
12 Remove the fuel filter and bracket (17), feed pump (18) and the nipple to the injection pump.

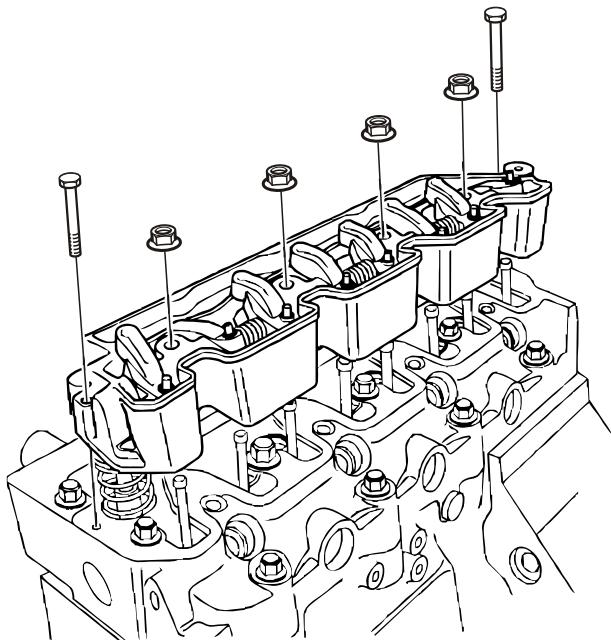
13 Remove the injection pump (19). Remove the pump retaining nuts and bolts. Turn the stop lever clockwise and carefully lift the pump, to make the lock clip on the regulator arm accessible. Remove the lock clip and free the regulator arm.

#### **IMPORTANT!**

Be careful when disassembling the injection pump, avoid damaging or bending its lever.

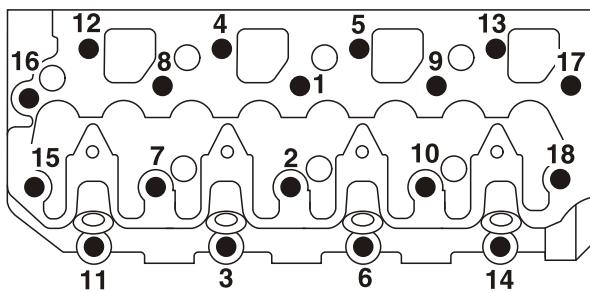
**NOTICE!** Retain any shims from beneath the injection pump flange. Use the same thickness of shims when re-installing.





P0007997

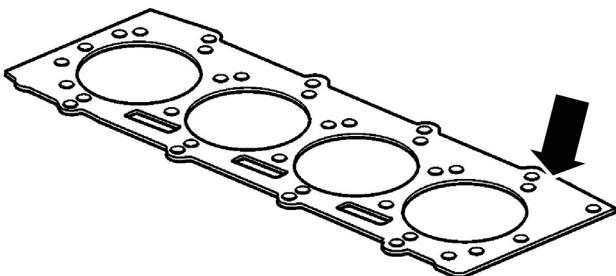
- 14 Remove the rocker cover, current bar and glow plugs.
- 15 Remove the lower part of the valve cover with the integrated rocker arm bridge. Start by unscrewing the two M6 bolts at the outer edge, then loosen the rocker arm bridge nuts half a turn at a time, until the rocker arms are no longer under load.
- 16 Prepare a stand, marked with cylinder numbers. If the rocker arms, valve caps, pushrods and valve lifters are to be re-used, these **must** be fitted in their original positions.  
Lift the push rods and valve caps out and put in them in number sequence in the marked stand.

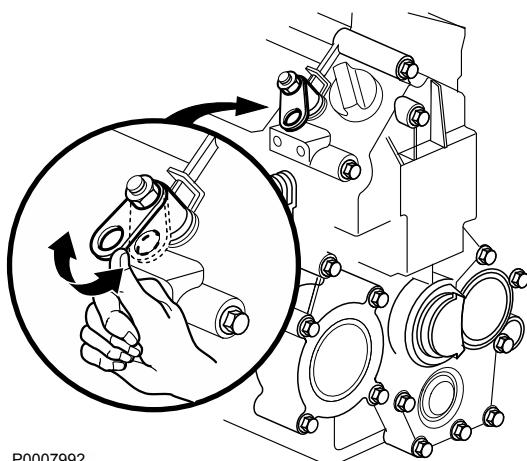


P0007998

- 17 Undo the bolts in reverse tightening sequence (refer to *Cylinder Head, Installation, page 45*). Remove the cylinder head.  
**NOTICE!** Note the marking of the cylinderhead gasket.
- 18 Remove the valves lifters; if these are to be re-used, they **must** be fitted in their original positions. Use special tool 885822 Magnetic pen.
- 19 Remove the crankshaft sensor, flywheel housing and oscillation damper.  
**NOTICE!** In order to reduce the risk of damage to the crankshaft sensor, it should be removed before the flywheel housing is removed.
- 20 Mark the position of the flywheel on the crankshaft. Remove the flywheel.
- 21 Remove the inner flywheel housing and the rear shaft seal.

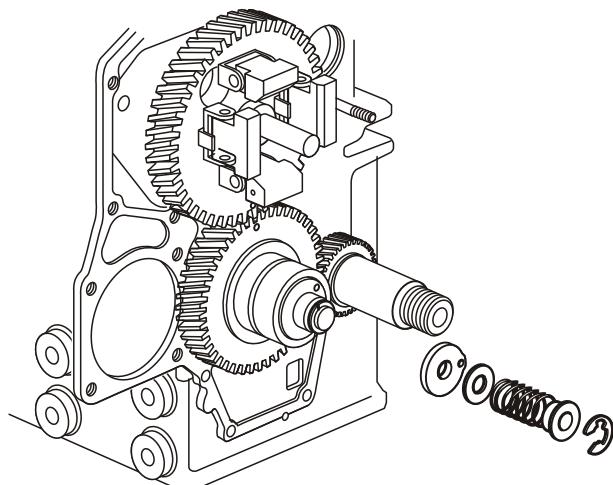
P0017560





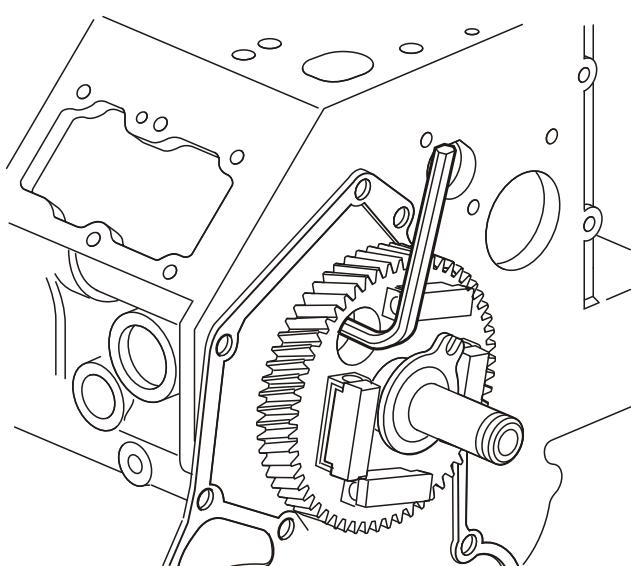
P0007992

- 22 Remove the belt pulley; use special tool 885820 Puller and 3 pcs. M10x40 mm bolts. Remove the timing gear casing. Load the stop arm so that the springs on the inside of the housing do not come out of position or spring out.



P0007840

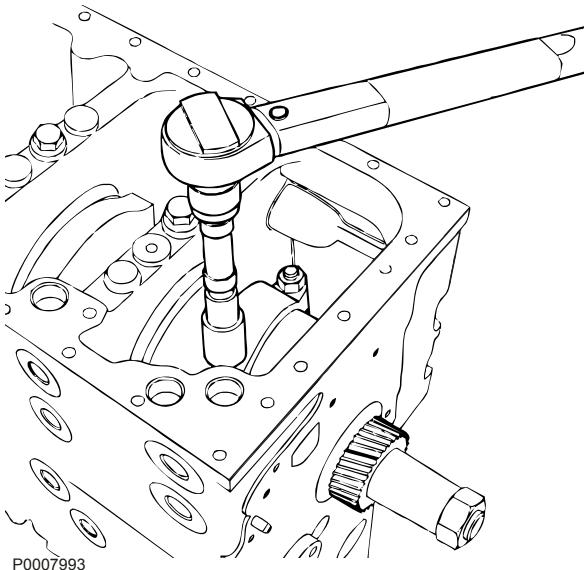
- 23 Remove the idler retainer ring. Retain the sleeve washer, spring and shims. Lift away the idler gear complete with cover and oil pump. Note the thrust washer behind the oil pump.



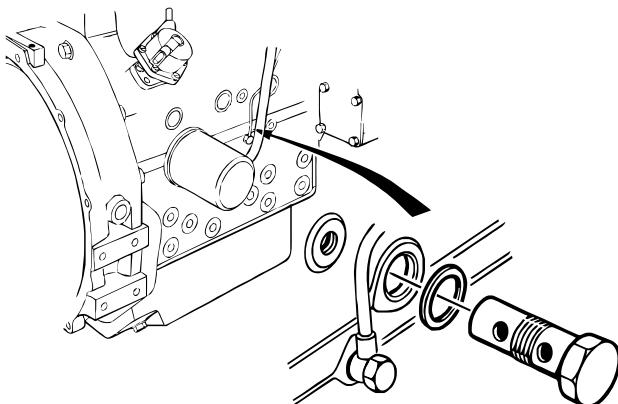
P0008000

- 24 Remove the camshaft and camshaft gear. Remove the screws from the locking plate; the screws are accessible through a hole in the camshaft gear. Lift out the camshaft complete with gear and regulator weights.

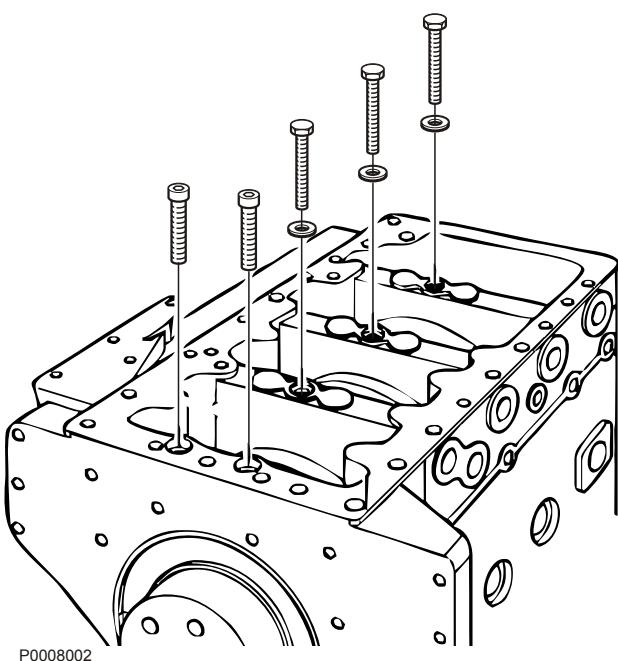
**NOTICE!** Be careful to avoid damaging the bearings, bearing tracks and camshaft lobes.



- 25 Remove the timing gear plate.
- 26 Turn the engine upside down and remove the sump, together with the external oil pipe. Remove the oil strainer and oil suction pipe.
- 27 Scrape away the line of carbon at the top of the cylinders, to facilitate removal. Check that the big end bearing caps are marked so that they may be replaced later in the right manner. Remove the big end bearing caps and press the pistons out.



- 28 Remove the oil pressure valve to allow removal of the crankshaft and facilitate flushing of the oil channels.
- NOTICE!** Check that the oil pressure valve on the right side of the block is removed before removing the crankshaft.
- NOTICE!** Tape the crankshaft gear to protect the bearing surfaces in the block during removal.
- 29 Remove the locking screws which hold the main bearing caps. Carefully lift the crankshaft out backwards, complete with caps.

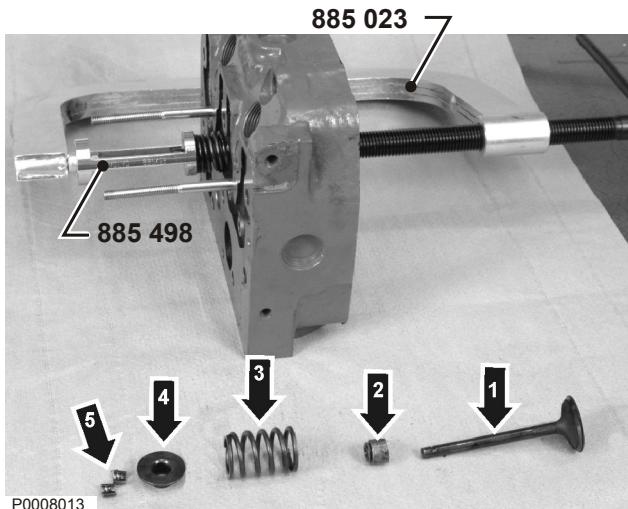


# 21-1 Cylinder Head

## Cylinder Head, Disassembly

### Tools:

885023 Valve spring compressor  
885498 Adapter



P0008013

- 1 Remove the valves (1), valve springs (3) and valve spring washers (4). Compress the springs with compressor 885023 together with pressure foot 885498 and remove the valve cotters (5). Place the valves in order in a marked valve holder, so they can be refitted in their original positions. Remove the valve stem seals (2).
- 2 Clean all components. Be especially careful with the cylinder head channels for oil and coolant.
- 3 Remove any remaining carbon and deposits from the cylinder head sealing surface.

**NOTICE!** A wire brush may not be used for cleaning the cylinder head bolt threads or the underside of the bolt heads.

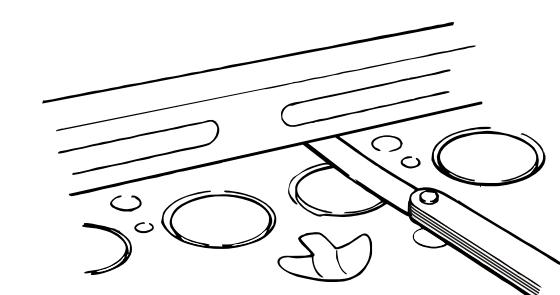
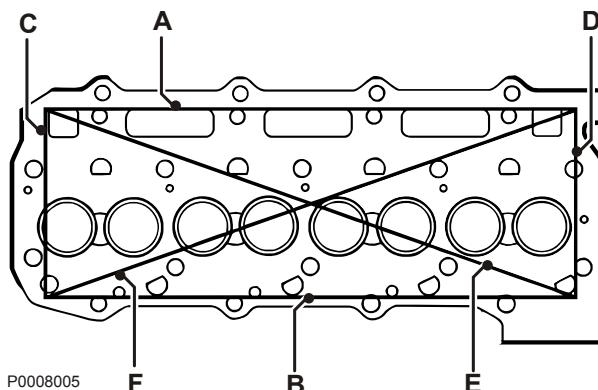
## Cylinder Head, Inspection

Cylinder head warping must not exceed the value given in *Group 21 - Engine, page 11*. The check should be done with a feeler gauge and a straight edge. Measurement is done at six positions (A - F).

If warpage above the permissible level is found, the cylinder head must be changed. If leakage is found, or if the cylinder head has blow lines, no special measurement is needed since such a cylinder head will have to be attended to in any case.

Check the valve seats and check that the studs are firmly seated.

Inspect the cylinder head for cracks. Carefully check the areas around the valve seats and the holes for the injector nozzles.

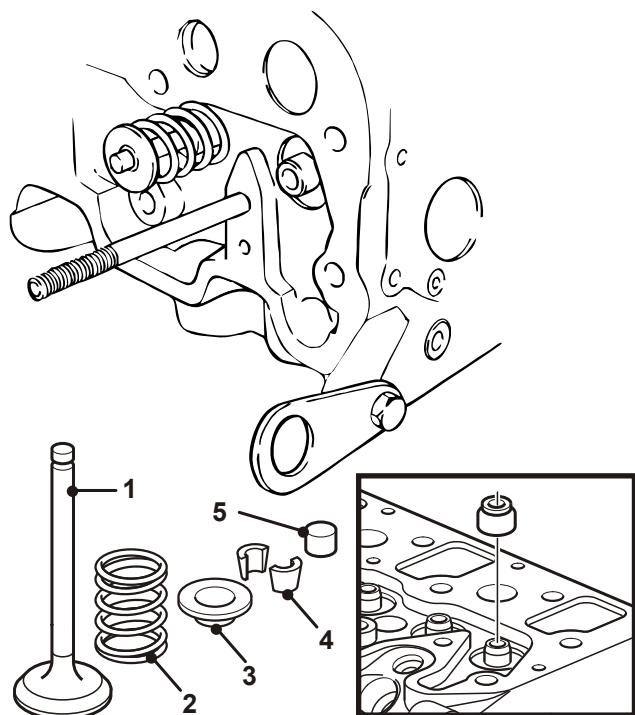


P0008006

## Cylinder Head, Assembly

### Tools:

885023 Valve spring compressor  
885498 Adapter



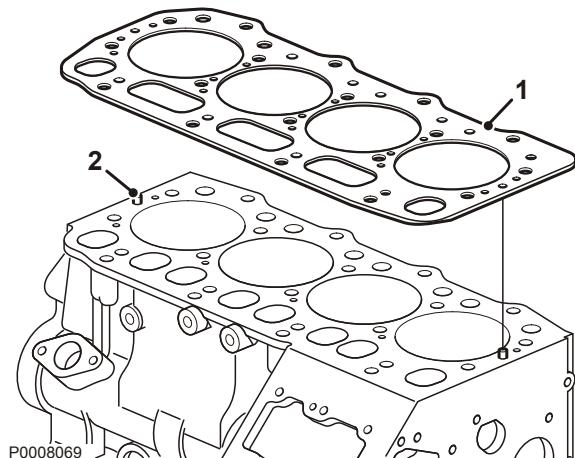
P0008011

- 1 Press the new valve stem seals onto the valve guides.

**NOTICE!** The seals for the inlet and exhaust valve guides are different. The inlet valve seal has a silver spring while the exhaust valve seal spring is black.

- 2 The valves must be installed in the correct order. Oil the valve stems and install one valve (1) in its guide. Put the valve spring (2) and valve spring washer (3) in position and compress the spring using 885023 Valve spring compressor and 885498 Adapter. Install the valve cotters (4). Be careful when installing the valves and compressing the springs, so that the valve stem seals are not damaged. Check that the valve cotters are properly seated.
- 3 Install the valve caps (5) once all the valves have been installed.
- 4 Install new core plugs if these have been removed.
- 5 Install the glowplugs. For tightening torque, refer to *Tightening torques, page 8*. Install the current bar.

## Cylinder Head, Installation



- 1 Clean the cylinder head and engine block mating planes. Remove any rust and carbon from bolt holes and from the threads on the cylinder head bolts.

### 2 Only when installing spare parts head

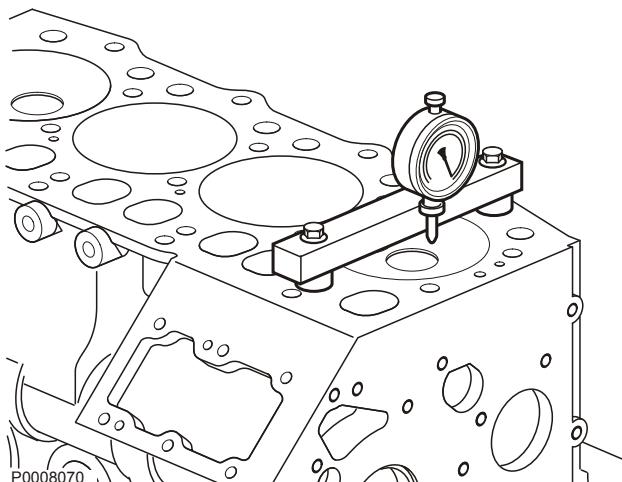
**NOTICE!** When inserting the spare parts head, the guide pins (2) must be removed from the cylinder block and discarded. Use two cylinder head screws (with the heads removed and notches made at the top) as guide pins. Insert the cylinder head gasket and then the cylinder head. Insert the remaining cylinder head screws.

Remove the guide pins, use a screwdriver in the notches cut into the top of the guide pins. Install the remaining two bolts and tighten according to step 6.

- 3 Fit the new cylinder head gasket in place with the marking (1) upwards.

**NOTICE!** The new gasket must be of the same thickness as the old one.

If a piston, connecting rod, the crankshaft or engine block has been changed, new measurements must be taken.

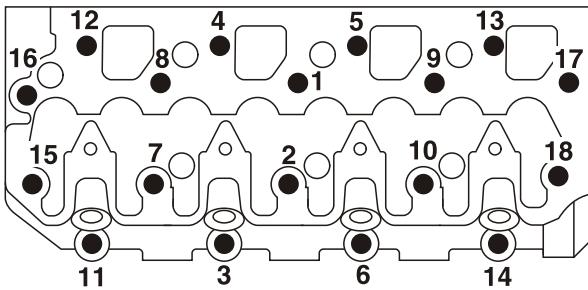


Engine	Piston height below (-) and above (+) cylinder block upper plane.	Gasket thickness	Gasket marking
D2-55 A/B/C/D/E	-0.45 to -0.30 mm (-0.0177 to -0.0118 inches) -0.29 to -0.20 mm (-0.0114 to -0.0078 inches)	0.4 mm (0.0157 in) 0.5 mm (0.0196 in)	7711 7721
D2-75 A/B/C	-0.29 to -0.20 mm (-0.0114 to -0.0078 inches)	0.5 mm (0.0196 in)	7711
D2-50 F, D2-55 F, D2-60 F, D2-75 F	-0.30 to -0.40 mm (-0.0118 to -0.0157 inches) -0.41 to -0.50 mm (-0.0161 to -0.0196 inches) -0.51 to -0.60 mm (-0.0200 to -0.0236 inches)	1.1 mm (0.0433 in) 1.2 mm (0.0472 in) 1.3 mm (0.0511 in)	7751 7761 7771

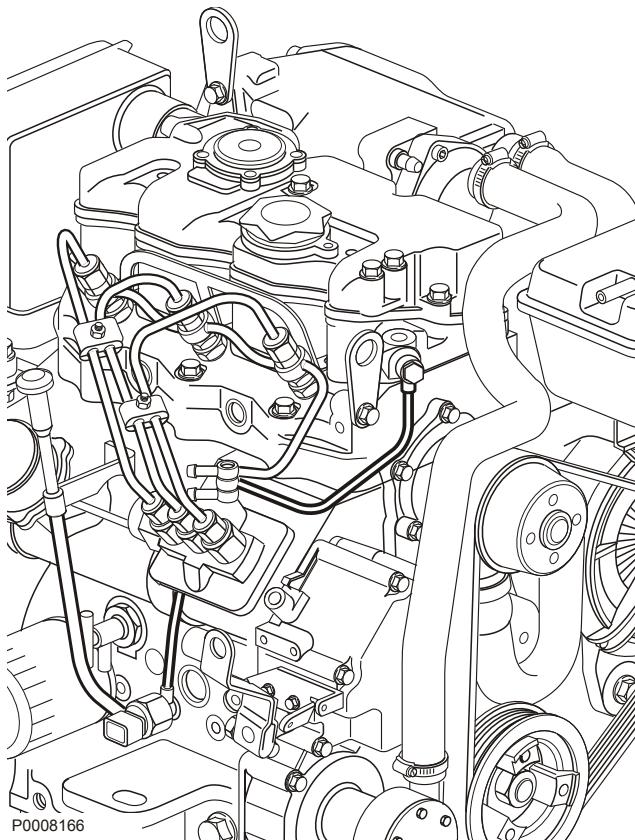
- 4 Dip them completely (also the bolt heads) in rust preventative product 116 1346 and let them run off on a net. The bolts should be drip free upon installation (otherwise cold oil may be forced up and be mistaken for leakage).

### IMPORTANT!

The screws are phosphated and must not be cleaned with a steel wire brush. If the cylinder head is painted, the contact surfaces for the cylinder head bolts must be free from paint. The clamping force in the joint could otherwise be very poor.



P0007998

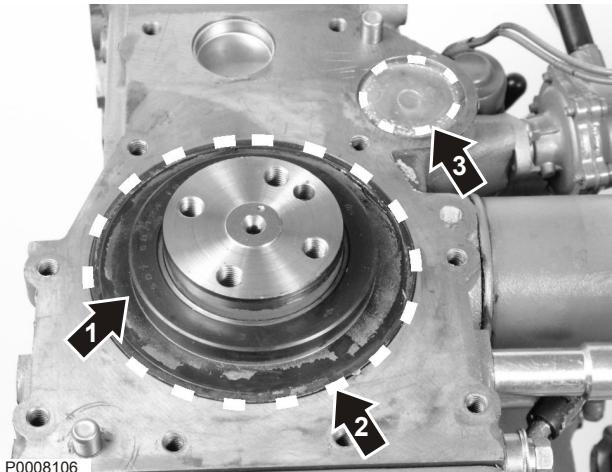


P0008166

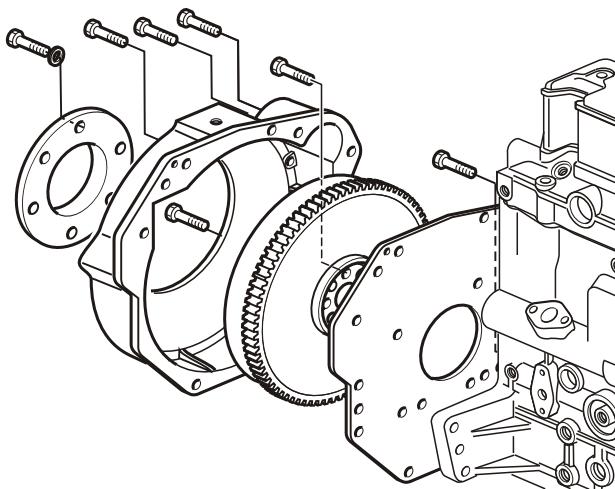
- 5 Check that the hollow pins are installed in the block.
- 6 Tighten the cylinder head bolts in three stages as follows. Refer to tightening sequence.

<b>1st tightening</b>	30 Nm (22 lbf ft)
<b>2nd tightening</b>	70 Nm (52 lbf ft)
<b>Final tightening</b>	100±2.5 Nm (74±1,8 lbf ft)

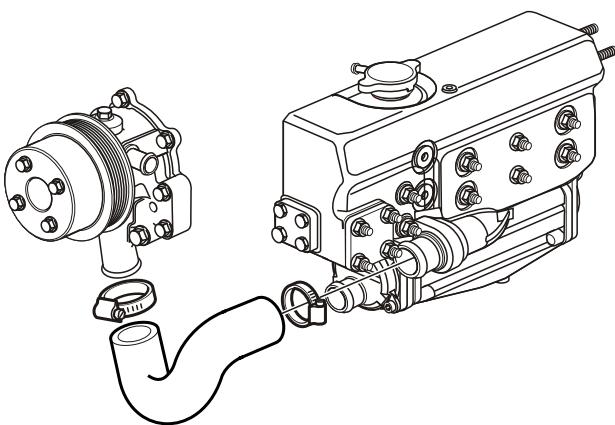
- 7 Install the copper gaskets for the injectors. Install the injectors.  
For tightening torque, refer to *Tightening torques, page 8*.
- 8 Install the pushrods, valve caps and rocker arm mechanism with gasket. For tightening torque, refer to *Tightening torques, page 8*.
- 9 Install the oil supply pipe between the block and rocker arm mechanism together with the oil pressure sensor. Install the oil pressure valve. For tightening torque, refer to *Tightening torques, page 8*.  
Crank the crankshaft a couple of revolutions.
- 10 Adjust the valve play. For tightening torque, refer to *Tightening torques, page 8*.
- 11 Install the valve cover.
- 12 Install the injection pump hollow bolt and banjo union with new copper washers.
- 13 Install new copper gaskets and the return fuel line. Tighten the nuts and connect the return line.
- 14 Install the supply pipes: For tightening torques, refer to *Tightening torques, page 8*.
- 15 Install the glow plugs and bus bar.
- 16 Install the circulation pump: For tightening torques, refer to *Tightening torques, page 8*.
- 17 Clean the sealing ring seat in the cylinder block and the plate contact surface. Install the rear crankshaft seal.



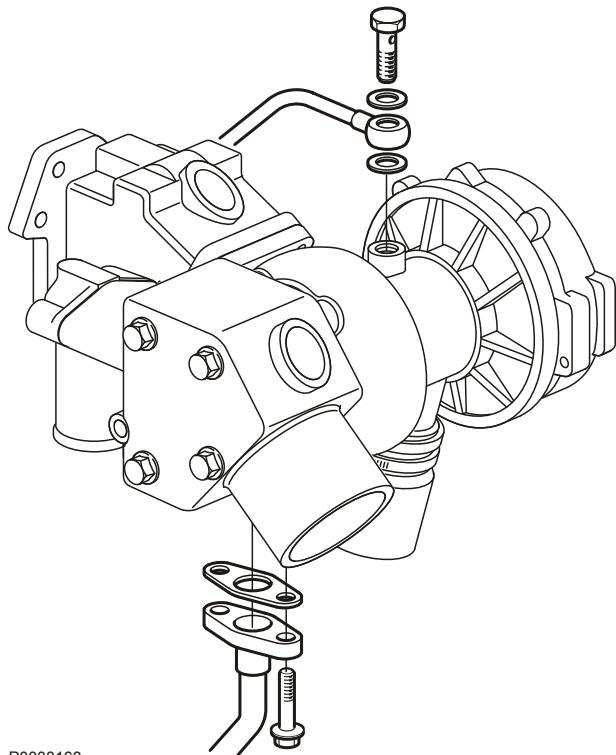
- 18 Check that the spaces for the seal on the engine block and crankshaft are clean. Apply grease to the sealing edges and fit the seal (1). Apply an even layer of sealant 840 879 around the stuffing box (2) and camshaft (3).



- 19 Install the plate, the flywheel according to previous markings, the elastic coupling and the flywheel housing; for tightening torques refer to *Tightening torques, page 8*.



- 20 Install the heat exchanger. Connect the hoses to the heat exchanger and coolant pump. Tighten the hose clamps.

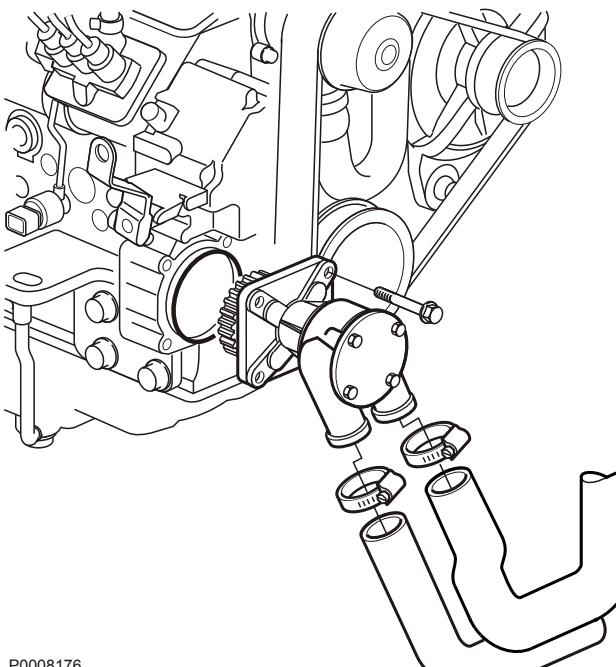


P0008168

D2-60, D2-75

Install the oil pipe to the turbocharger and charge air cooler (only D2-60, D2-75).

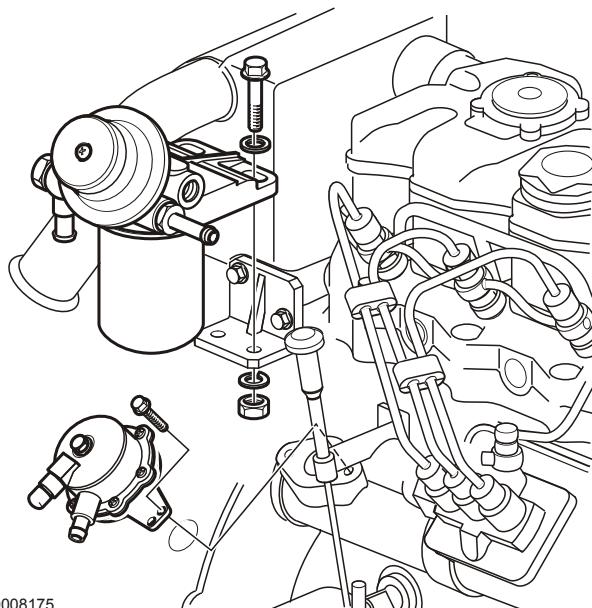
Install the turbocharger (only D2-60, D2-75).



P0008176

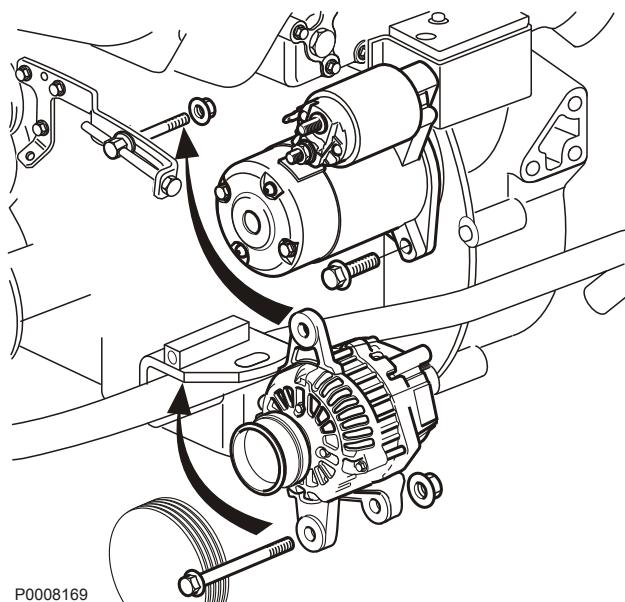
21 Install the seawater pump.

Connect the hose to the seawater pump and tighten the hose clamp. Install the exhaust pipe.



P0008175

- 22 Install the fuel filter bracket and feed pump; for tightening torques refer to *Tightening torques, page 8*. Connect the hoses and tighten hose clamps.

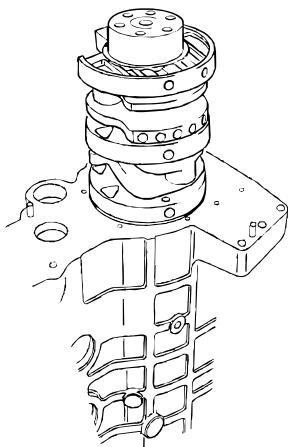


P0008169

- 23 Install the starter motor and alternator together with the front engine mounting.
- 24 Install the electronics box; install the connectors and other electrical connections.
- 25 Install the induction silencer.
- 26 Fill with oil; refer to *Group 22 - Lubrication System, page 15*. Refill with coolant: Refer to *Coolant Level, Checking and Topping Up, page 97*.
- 27 Connect the battery cables. Open the fuel taps and the sea cock. Start the engine and check that no leaks are present.

# 21-2 Cylinder Block

## Cylinder Block, Inspection

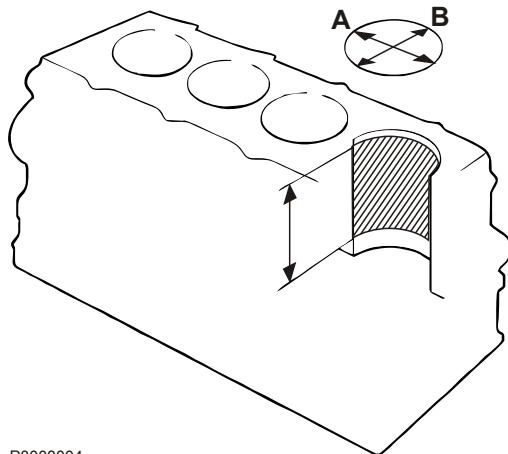


P0008003

### Upper block plane

Check that the upper engine block plane does not have any cracks or other damage. Also check that it is not warped (in the same way as for the cylinder head).

For max. warpage, refer to *Group 21 - Engine, page 11*. Change the engine block if it is outside the tolerances.



P0008004

### Cylinder bore

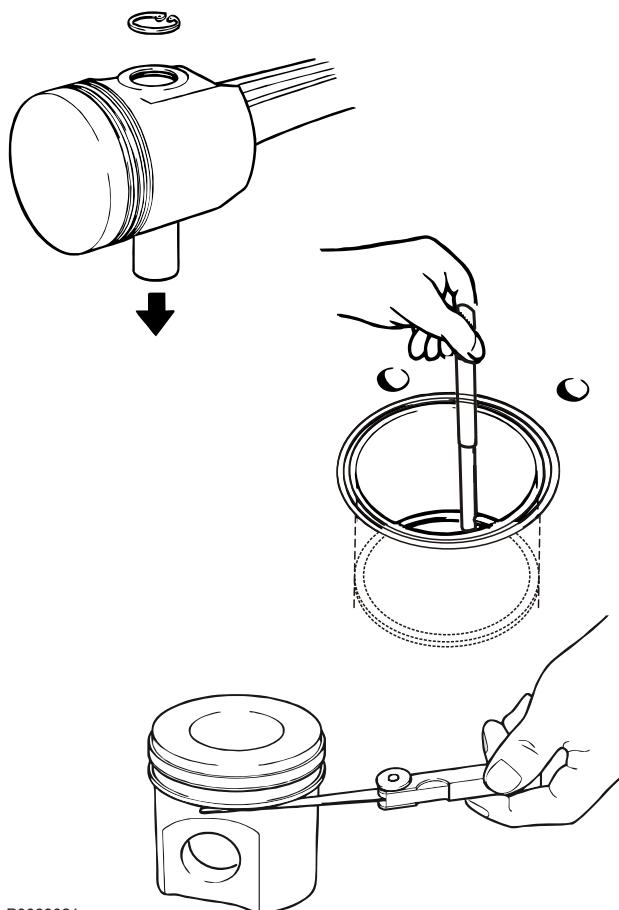
Check that the cylinder bores are not scored or damaged in other ways.

Measure the cylinder bores at the piston ring top and bottom dead center positions (approx. 10 mm (0.39") and 100 mm (3.94") below the engine block plane) and also in between. Measurement should be done with an internal dial gauge both longitudinally and transversely to the engine block (**A** and **B**).

Concerning max. permitted cylinder diameter, refer to "Wear tolerances" in *Group 21 - Engine, page 11*.

## 21-3 Cylinder Liner, Pistons

### Piston Rings, Measurement and Inspection



P0008021

- 1 Remove the piston rings with piston ring pliers.
- 2 Remove the piston pin retainer rings and remove the piston pin carefully, using a suitable mandrel.
- 3 Check that the rings do not bind in the piston ring grooves.
- 4 Check the piston ring gap. Push the ring down below bottom dead center with a piston. Change the piston ring if the gap exceeds 1.0 mm (0.04").

Also check the piston ring gap on new rings. Refer to *Group 21 - Engine, page 11* for measurements.

In general, piston rings should be changed if there is any noticeable wear or out-of-roundness in the cylinders, since piston rings frequently do not end up in the same positions as they had before removal.

Oil consumption is also of decisive importance for the point in time when a piston ring change should be done.

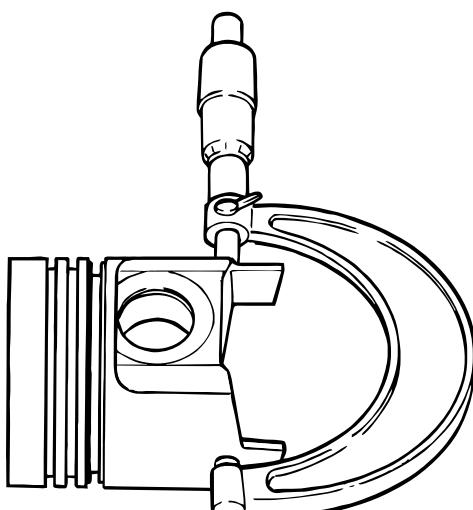
- 5 Check the clearance in the piston ring grooves. Rotate the ring in its piston groove and measure the clearance at several points with a feeler gauge. Refer to *Group 21 - Engine, page 11* for measurements.

### Piston and Cylinder Bore, Inspection and Measurement

Check the pistons for cracks and worn piston ring grooves. Change the piston if it has deep lines in the skirt surface. Also if the piston has one or more cracks in the piston pin hole. If any such damage is found, the injection equipment must also be checked.

Measure the piston diameter with a micrometer at right angles to the piston pin hole and 10 mm (0.4") from the bottom edge of the piston. Then measure the cylinder bore and calculate the clearance between the cylinder and piston.

Replace the piston if the clearance exceeds permitted values or if the piston diameter is lower than the permitted value.



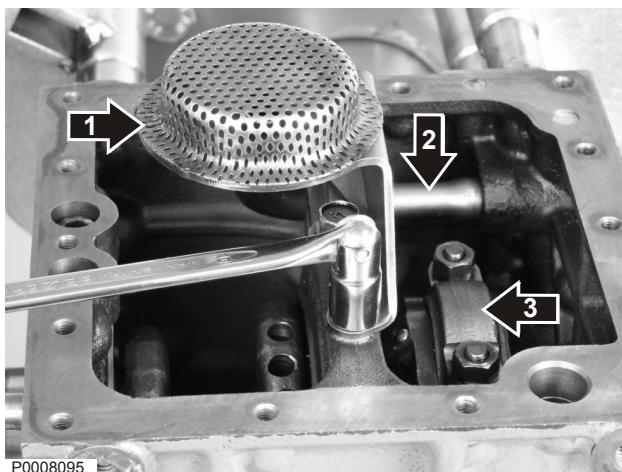
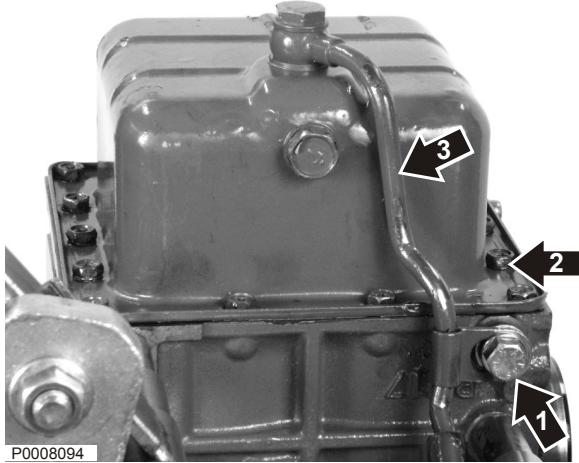
P0008022

## Pistons, Removal

D2-50F, D2-60F

**Engine oil drained. Cylinder head removed.**

- 1 Turn the engine upside down. Undo the oil drain pipe attachment fitting (1) on the cylinder head. Unscrew the oil pan (2) and remove it together with the oil drain pipe (3).



- 2 Unscrew the oil suction strainer (1). Remove the suction pipe (2) with its O-ring. Unscrew the connecting rod bearing caps (3).

**IMPORTANT!**

Note the markings on the bearing caps and their locations.

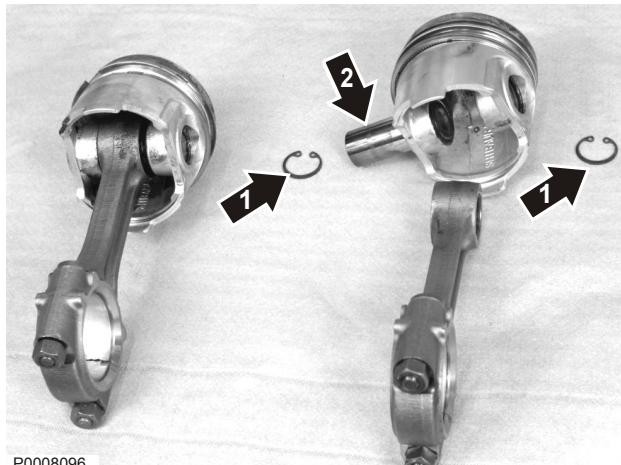
- 3 Press the pistons out.

**NOTICE!** There may be a soot deposit on the top of the cylinder bores. Remove the deposit to facilitate pressing the pistons out.

## Pistons, Replace

D2-50F, D2-60F

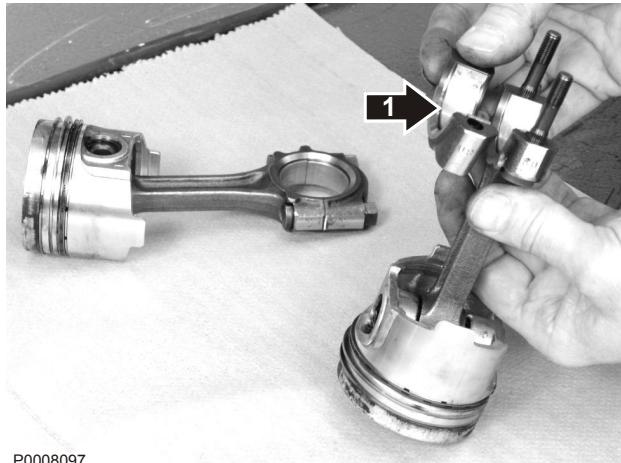
- 1 Note the positions of the pistons in relation to the crankshaft.  
Remove the retainer rings (1) and press the piston pin out (2).
- 2 Clean the piston pin bushing and check it.
- 3 Install a new piston in the correct position.  
Press the piston pin in.  
Install the retainer rings with the lugs facing upwards.



## Big end bearing, change

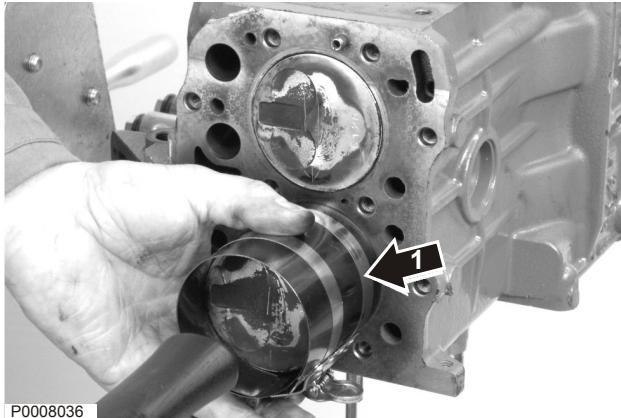
Pistons, removed

- 1 Remove the big end bearings (1) and put the new ones in position.



## Pistons, Installation

D2-50F, D2-60F



P0008036

- 1 For piston ring positioning, refer to *Assembling Piston, Piston Rings and Con Rod, page 68.*  
Fit a piston ring compressor on the piston.  
Lubricate the connecting rod bearing shells and studs with engine oil.
- 2 Crank the crankshaft so that the big end bearing is in the lowest position for the piston to be installed.  
Insert the piston (1) in the bore and carefully tap it down. The piston marking " SHIBAURA " must face the injection pump side.
- 3 Install the big end bearing cap according to the mark. Tighten with 23 Nm of torque (17.0 lbf.ft) (D1-13, D1-20), or 32 Nm (23.6 lbf.ft) (D1-30, D2-40).  
Check the movement of the big end bearing.  
Repeat the procedure to install the remaining pistons.

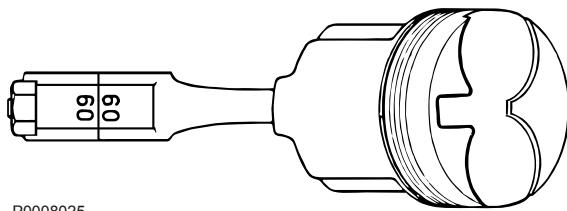
### **IMPORTANT!**

Make sure that the connecting rod studs do not strike the crankshaft when tapping down the piston.

## Pistons in Cylinders, Installation

**NOTICE!** After replacing the crankshaft, piston or piston pin, the weight difference between connecting rods with piston and piston rings must not exceed 10 g (0.0022 lbs) between cylinders.

- 1 Lubricate the pistons and piston rings with engine oil and rotate the rings so that the oil finds its way into the piston ring grooves. Rotate the piston rings so that the ring gaps are staggered 90° from each other.  
Make sure that no piston ring gap is placed in line with the piston pin.
- 2 Put the bearing shells in their places in the connecting rods and caps. Oil the bearing journals with engine oil.
- 3 Check that the markings on the piston crown or inside the piston tally with those on the connecting rod.  
Use a piston ring compressor and install the piston with connecting rod in its cylinder, starting with cylinder no. 1 (front).  
The connecting rod with the **lowest number** must be installed at the front (in cyl. no. 1) and the connecting rod with the highest number closest to the flywheel.  
The connecting rods must be turned so that the mark (number / color mark) is facing towards the injection pump (camshaft side).
- 4 Install the bearing caps and tighten the connecting rod bolts. For tightening torque, refer to *Tightening torques, page 8*. Big end bearing caps must be installed so that the number markings / paint marks on the connecting rod and cap tally. Undamaged connecting rod bolts do not need to be changed, but may be reinstalled.
- 5 Install the oil suction pipe and oil strainer. For tightening torque, refer to *Tightening torques, page 8*. Use a new O-ring.
- 6 Install the oil pan together with a new gasket. For tightening torque, refer to *Group 21 - Engine, page 11*.



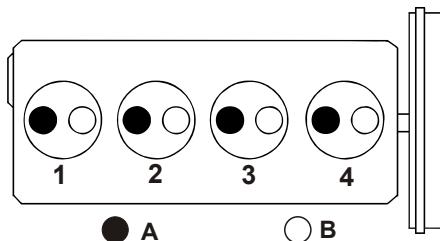
P0008025

# 21-4 Valve Mechanism

## Valves, Adjustment

**NOTICE!** The clearance must never be checked while the engine is running, but on a stopped, cold engine.

**Valve clearances:** Inlet and exhaust: 0.2 mm.



P0008170

A Inlet

B Exhaust

Firing sequence: 1-3-4-2

Corresponding cylinder whose valves overlap:  
4-2-1-3

- 1 Remove the valve cover.
- 2 Crank the engine in the normal direction of rotation until no.1 piston is at TDC after the compression stroke. At this point the valves on cylinder 4 overlap.
- 3 Check and adjust the valve clearances for cyl. no. 1. Crank the engine in the normal direction of rotation a half turn and check the clearances for cyl. no. 3; the valves on cylinder 2 overlap. Check the clearances for the remaining cylinders in firing order.
- 4 Replace the seal. Clean the valve cover and install it. Test run the engine and check that no oil leakage occurs.

## Valves, Removal

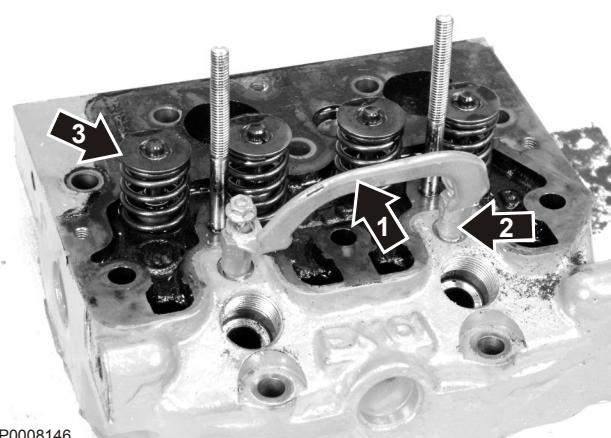
D2-50F, D2-60F

### Cylinder head removed

#### Tools:

885023 Valve spring compressor  
885498 Adapter

- 1 Remove the busbar (1) and glow plugs (2). Remove the valves (3) with the aid of 885023 Valve spring compressor and 885498 Adapter. Mark the valves. Remove the valve seals.



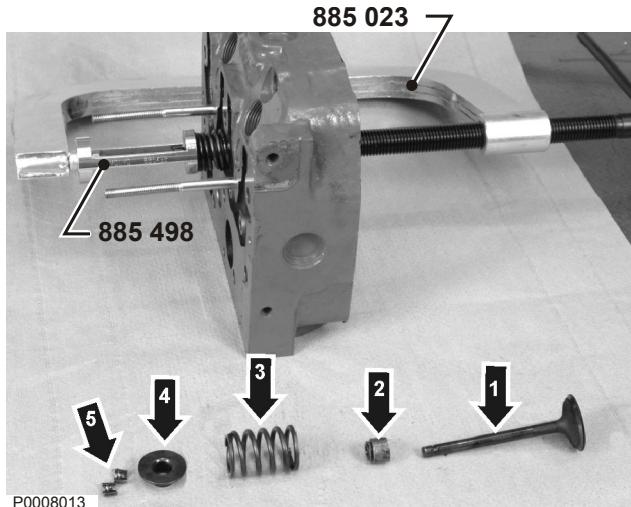
P0008146

## Valves, Installation

D2-50F, D2-60F

#### Tools:

885023 Valve spring compressor  
885498 Adapter



- 1 Install the valve (1) in the cylinder head as marked. Install a new valve seal (2), spring (3) and valve spring washer (4). Compress the valve spring with the spring clamp and install the collets (5).
- 2 Install the glowplugs and tighten to the specified torque: refer to *Tightening torques, page 8*. Install the busbar.

## Valve Guides, Inspection

**Tools:**

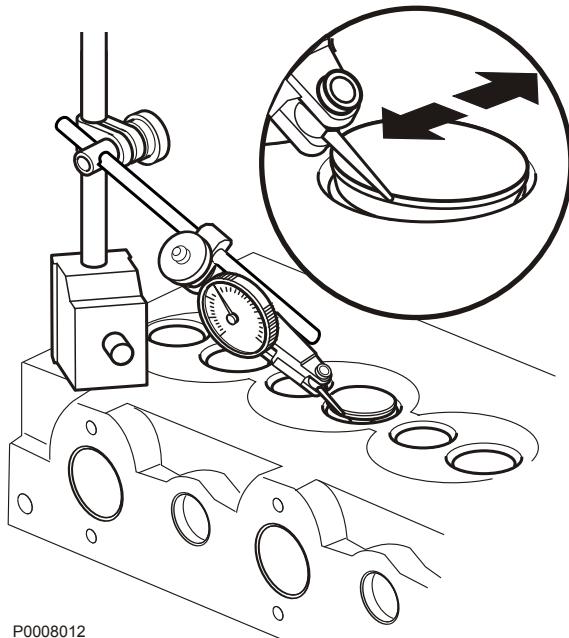
9999683 Dial indicator (short probe)  
9999696 Magnetic stand

- 1 Put the cylinder head on the bench, and put the valves in the valve guides.
- 2 Measure the wear with 9999683 Dial indicator (short probe) and 9999696 Magnetic stand. Lift each valve about 2 mm (0.08") from its seat, put the measurement tip on the valve seat rim and check the wear.

**Permissible clearance between valve and valve guide:**

Inlet valve, max clearance 0.20 mm (0.008")  
Exhaust valve, max clearance 0.25 mm (0.010")

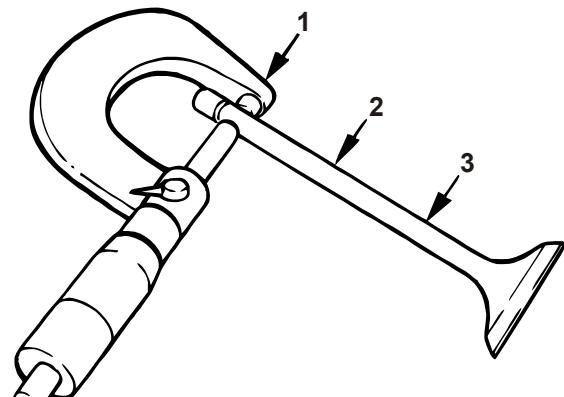
**NOTICE!** Since the valve guides are machined directly in the cylinder head, the cylinder head must be changed when the clearance is too great, even when the valve is new.



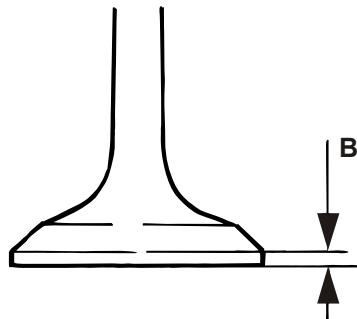
## Valve Seats and Valve, Grinding

### Tools:

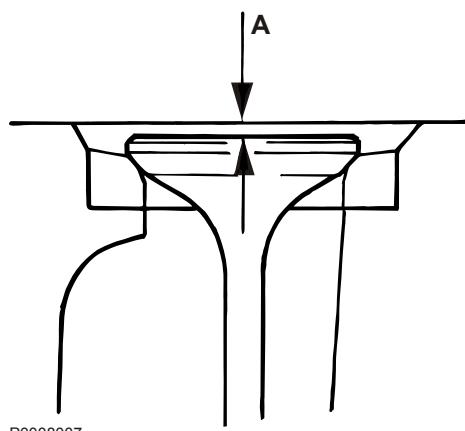
885023 Valve spring compressor  
885498 Adapter



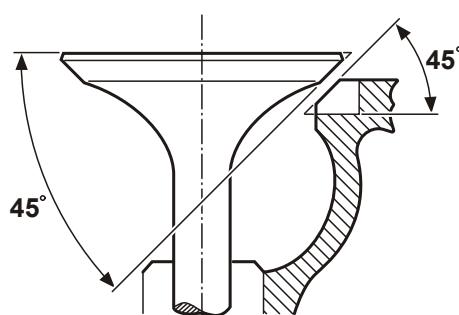
P0008008



P0008010



P0008007



- 1 Use 885023 Valve spring compressor and 885498 Adapter to remove the collet. Remove the valve washers, springs and valves. Place the parts in the correct order in a valve holder. Remove the valve stem seals.

- 2 Clean the components.

- 3 Check the valve stems for wear. Measure the diameter with a micrometer at points I, II and III. Diameter, min, inlet: 6.89 mm (0.271")  
Diameter, min, exhaust: 6.84 mm (0.269")

- 4 Grind the valves in a valve grinder. Grind the seat for the minimum necessary to clean it. Scrap the valve if valve head rim thickness (**B**) is less than 0.5 mm (0.020") after grinding. Likewise, scrap valves with bent stems.

- 5 Check valve guide wear (refer *Valve Guides, Inspection, page 58*) before machining the valve seats.

- 6 Mill the valve guides. When machining, only remove enough material to provide the valve seat with the correct shape and a proper surface.

**NOTICE!** Do not grind away so much that valve depth exceeds the permissible value. Refer to *Valve Seat, Replace, page 60*.

New valve seats must be milled away enough for the clearance between the cylinder head plane and the valve head surface (**A**) to be 0.65-0.95 mm (0.026–0.037").

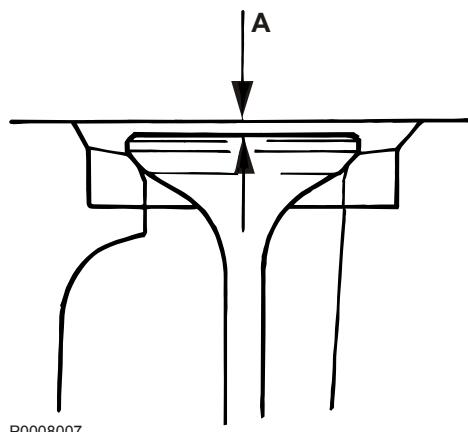
- 7 Lap in the valves using grinding paste, and check contact with marker dye.

- 8 Install the seals, valves, valve springs, spring washers, valve cotters and valve caps. Refer to *Cylinder Head, Installation, page 45*.

## Valve Seat, Replace

**NOTICE!** Only the inlet valve seat can be replaced on D2-60 D2-75 engines. On D2-50 D2-55 engines, both the inlet and exhaust valve seats can be replaced.

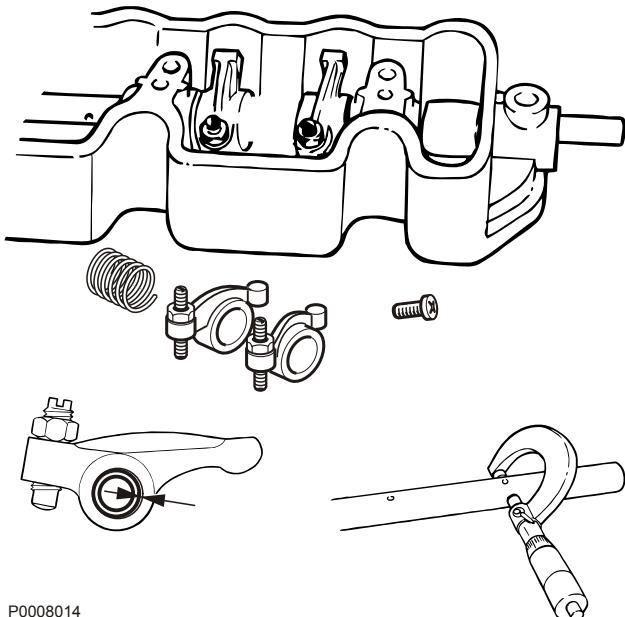
The valve seat should be changed when the clearance **A** measured with a new valve exceeds 1.8 mm (0.071").



- 1 Remove the old valve seat with the aid of gas-flame heating to 600–700 °C (1112–1292 °F) diagonally across the seat. Allow the cylinderhead to cool for 3 - 5 min in air. Then carefully tap the seat out with a drift (make sure the cylinder head is not damaged). The valve seat may also be milled away (make sure the cylinder head is not damaged).
- 2 Thoroughly clean the valve seat bed in the cylinder head. Check the cylinder head for cracks.
- 3 Cool the new seat with dry ice or similar to minus 60–70 °C (minus 140–158 °F) and then, where necessary, heat the cylinderhead to +60–100 °C (+140–212 °F).
- 4 Press the seat into the cylinder head. Use a hydraulic press and a suitable drift.
- 5 Machine the seats to the correct angle and width.

## Rocker Arm Mechanism, Overhaul

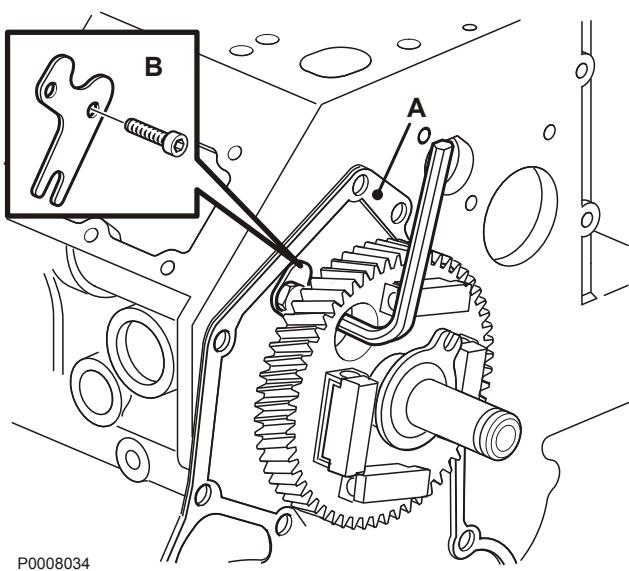
Special Tools: 9996400.



- 1 Remove the screw from the front edge of the rocker arm shaft. Screw an M8 bolt into the rocker arm shaft. Grab the bolt with e.g. a pair of pliers and pull the rocker arm shaft out.
- 2 Disassemble the rocker arm mechanism. Remove the rocker arms, springs and washers.
- 3 Clean the components. Be especially careful with the rocker arm shaft oil channels and the oil holes in the rocker arms.
- 4 Check the wear of the rocker arm shaft with a micrometer.
- 5 Check that the rocker arm bearing surfaces are not worn oval. Check the clearance between rocker arm and shaft. Check that the spherical part of the adjustment screw is not deformed or worn. The threads on the pin and lock nut must be undamaged. The lock nut must be in good condition.
- 6 Oil the rocker arm shaft and disassemble the other components.

## 21-5 Timing Gears and Shaft

### Camshaft, Installation

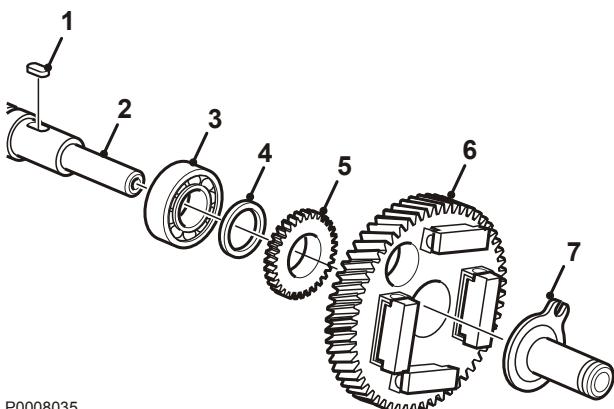


1 Install the front plate (**A**) with a new gasket. For tightening torque, refer to *Tightening torques, page 8*.

2 Oil the camshaft bearing surfaces and carefully lift the camshaft into place, complete with drive gear and regulator weights.

**NOTICE!** Be careful to avoid damaging the bearings, bearing races and camshaft lobes.

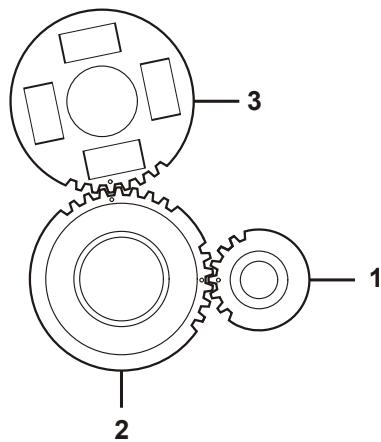
3 Install the camshaft lock washer (**B**) in the correct position and tighten it. For tightening torque, refer to *Tightening torques, page 8*.



The parts of the camshaft are installed as illustrated.

- |   |                  |
|---|------------------|
| 1 | Woodruff key     |
| 2 | Camshaft         |
| 3 | Bearing          |
| 4 | Spacer           |
| 5 | Gear wheel       |
| 6 | Camshaft gear    |
| 7 | Regulator sleeve |

## Timing Gear, Installation



P0008164

### Installation and settings, timing gear and injector pump

Timing gears that are of importance for setting timing are marked as follows:

Crankshaft gear (1) and idler gear (2) are marked with a punch mark.

The idler gear (2) and camshaft gear (3) with a punched line in front of a tooth and its respective tooth groove.

- 1 Fit the key into the crankshaft and install the crankshaft gear.

#### **IMPORTANT!**

The components must be oiled before installation.

#### **IMPORTANT!**

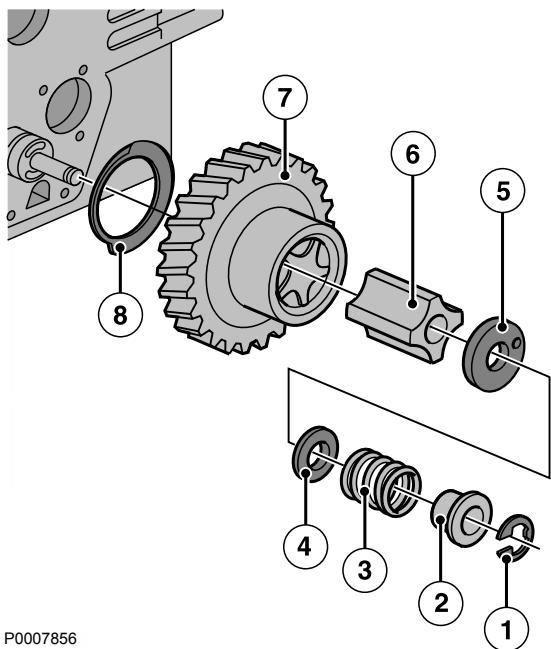
Make sure that the gear wheel markings coincide.

- 2 Install the thrust washer (8) on the idler wheel shaft stub. Install the idler gear according to the marking.

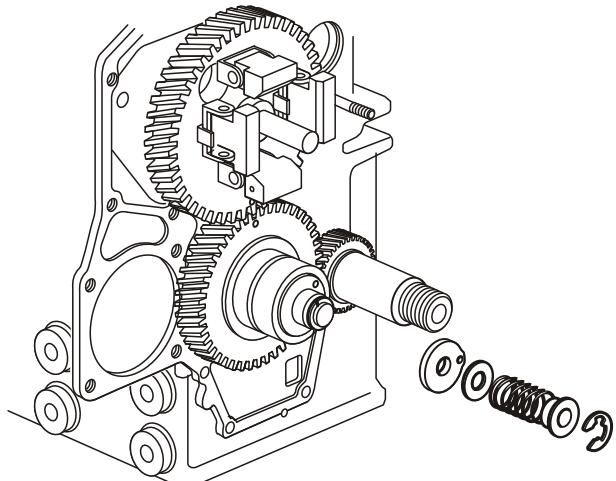
**NOTICE!** Do not turn the crankshaft before the timing gear cover has been installed.

- 3 Install the inner rotor and cover on the oil pump. Install shims, spring, spring washer and lock washer.

- 1 Retainer ring
- 2 Spring washer
- 3 Spring
- 4 Shim
- 5 Oil pump cover
- 6 Inner rotor
- 7 Idler wheel with outer rotor
- 8 Thrust washer

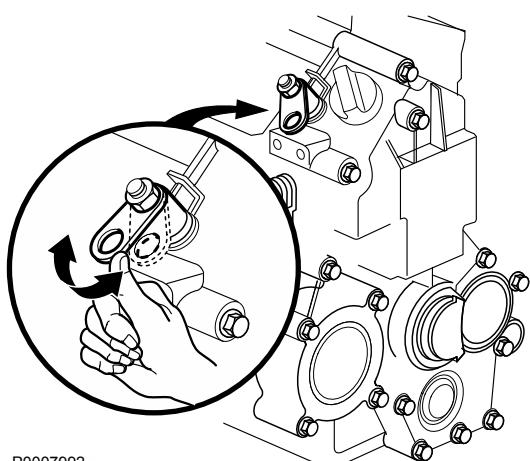


P0007856



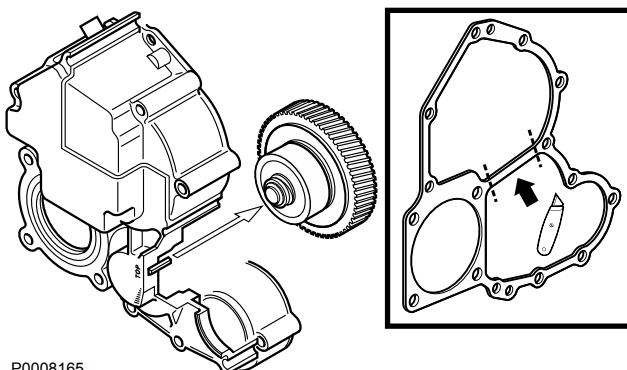
P0007840

- 4 Adjust the oil pump end float to 0.10-0.15 mm (0.0039–0.0059"). Shims are available in thicknesses 0.10, 0.15, 0.20 and 0.50 mm (0.0039, 0.0059, 0.0079, 0.0197").
- 5 Install a new crankshaft seal.
- 6 Center the cover in front of the oil pump.



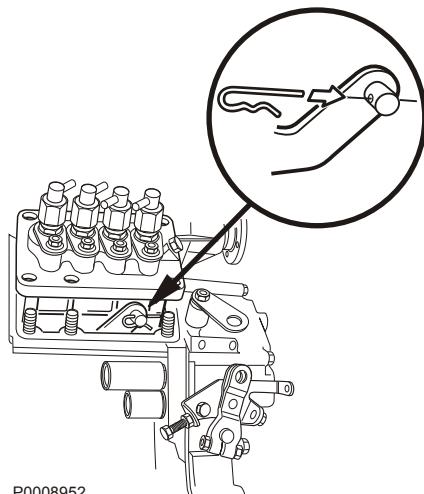
P0007992

**NOTICE!** Check that the spring pin in the timing gear cover engages in the hole in the oil pump cover. Turn the cover backwards and forwards, and center it in the mid position. The stop arm must be turned and held in place while the timing gear cover is positioned.



P0008165

- 7 Install a new gasket on the timing cover.
- NOTICE!** If the gasket has a center part, this must be cut away.
- Install the timing gear cover with the new gasket. Check that the start spring is in position in the timing gear cover and is connected to the regulator arm (link arm). Insert the regulator arm through the hole in the cylinder block. Bolt on the timing gear cover.
- 8 Turn the stop arm clockwise and connect it to the injection pump. Install the clip.
- NOTICE!** Be careful to ensure that the shim that was placed underneath the injection pump flange is put back before the pump is placed in the cylinder block (applies when the pump has been removed).

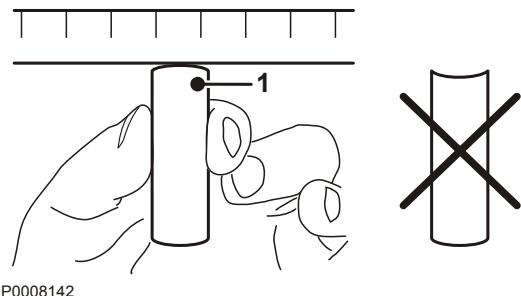


P0008952

- 9 Fasten the injection pump; for tightening torque refer to *Tightening torques, page 8*.
- 10 Fit the key into the crankshaft and install the crankshaft pulley. For tightening torque, refer to *Tightening torques, page 8*.
- 11 Connect the fuel hose to the injection pump.
- 12 Check the injection timing (crankshaft position) in those cases where a new complete camshaft has been installed or if a new cylinder block is used.

## Camshaft, Inspection

### Camshafts and valve lifters, inspection



P0008142

Using a steel ruler, check that valve lifter (1) contact surfaces facing the camshaft are convex or flat. If the surface is concave, change the valve lifter.

If the valve lifter is worn right across the lifting surface, the valve lifter must be scrapped. The "depression" shows that the lifter has not been turning.

On the other hand, a dark line outermost on the valve lifter shows that the surface is not worn. It is valve lifter condition that determines whether it is necessary to check for camshaft wear.

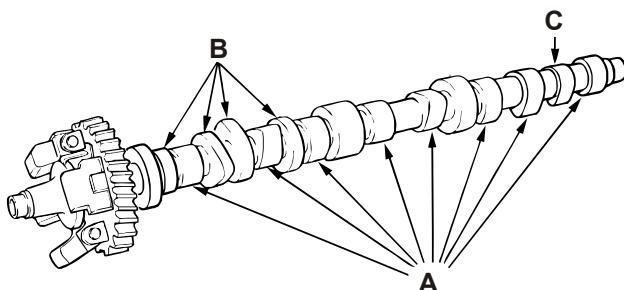
Check that the lifting surfaces on the camshaft and valve lifters do not have large pitting defects. Pitting defects can occur for various reasons. The defects are caused when small pieces of metal loosen from the hardened surface. Lifters and camshafts with minor pitting defects may be used. Pitting defects seldom becomes worse.

Check that the camshaft bearing surfaces and cam curves are not abnormally worn.

Change the camshaft if major damage or wear is evident.

**NOTICE!** When the camshaft is changed, all the valve lifters must also be changed.

### Measuring the camshaft



P0008028

Cam height **A** (inlet and exhaust) 33.7 mm (1.33")

Cam height **B** (for injection pump) 41.8 mm (1.65")

Cam height **C** (for feed pump) 30.0 mm (1.18")

Change the camshaft if the wear limits have been exceeded.

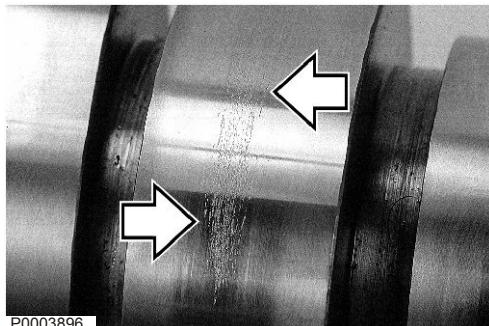
## Guidelines for replacement

In normal conditions, unevenness may occur on the surface of engine camshaft lobes. This does not mean that the camshaft has to be changed. These marks do not have any negative influence on either engine performance or the durability of the engine and its components.

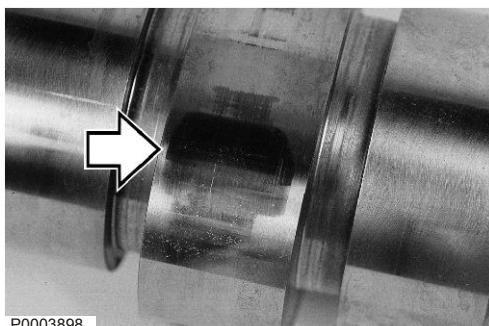
Examples of acceptable wear and **unacceptable** wear are shown below.

### Acceptable wear

The camshaft does not need to be changed.



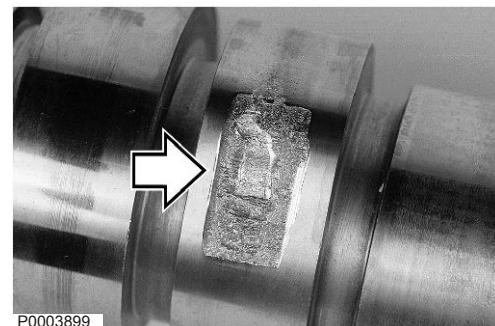
P0003896



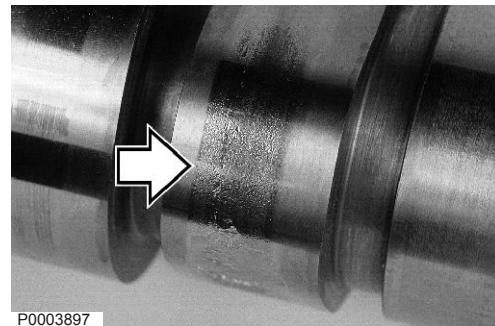
P0003898

### Unacceptable wear

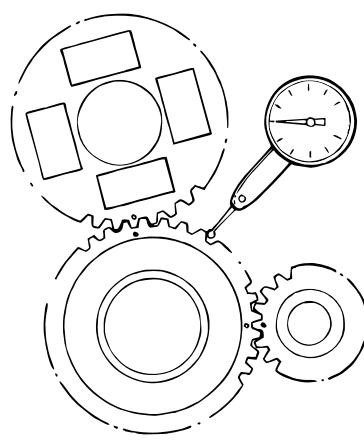
**NOTICE!** The camshaft and associated rocker arms must be changed.



P0003899



P0003897



P0008033

## Timing Gears, Inspection

### Tools:

9999683 Dial indicator (short probe)

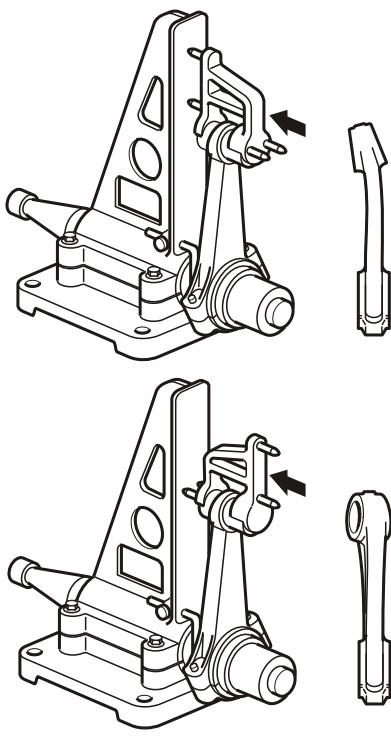
Clean the gears and other parts of the timing system and check them carefully. Replace gears that are badly worn or damaged.

Check the gear flank play with feeler gauges or a dial gauge, special tool 9999683 Dial indicator (short probe).

Max. permitted gear flank play: 0.25 mm (0.01"). If the gear flank play exceeds the permitted value, then all timing gears must be replaced.

# 21-6 Crank Mechanism

## Con Rods, Inspection

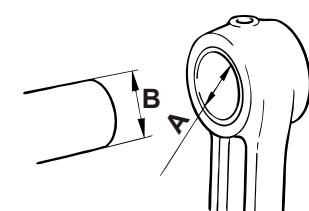


- 1 Check the connecting rods for cracking, straightness and twist before any piston pin bush replacement.

Scrap the connecting rod if it is cracked, bent or twisted.

Check the wear in the "small end" with a piston pin. When the clearance is correct, an oiled piston pin should slowly slide through the bush under its own weight.

- 2 Use a new piston pin and measure connecting rod straightness in a fixture. Max. deviation: 0.15 mm (0.0059") per 100 mm (3.9") measured length.
- 3 Measure connecting rod twist. Max. deviation: 0.20 mm (0.0079") per 100 mm (3.9") measured length.



- 4 Check the end float between the connecting rod and crankshaft. Change the connecting rod if the end float exceeds 0.035 - 0.085 mm (0.0014–0.0033").

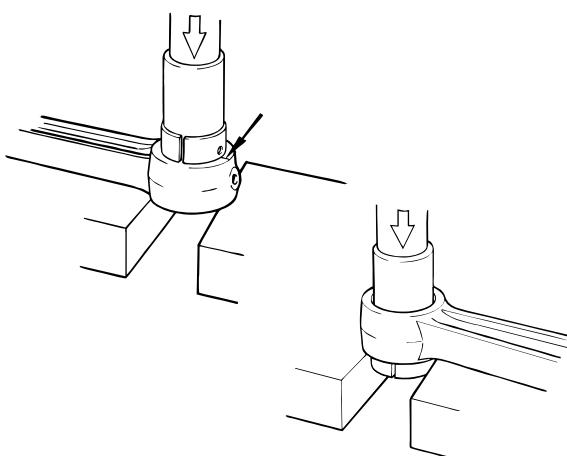
Also check the connecting rod bushes. For permissible clearance between the piston pin (**A**) and the connecting rod bush (**B**), refer to *Group 21 - Engine, page 11*.

## Changing the piston pin bushing

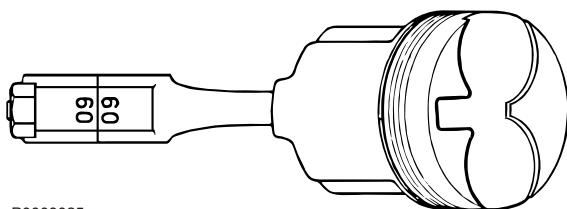
- 1 Press the old bush out.
- 2 Press the new bush in.

**NOTICE!** Make sure that the oil hole in the bush lines up with the drilling in the connecting rod. Using a felt tip pen, draw a line across the hole in the connecting rod and the bush. Check that the oil duct is open after pressing in the new bush.

- 3 Ream the bush and measure the connecting rod with an internal dial gauge.



## Assembling Piston, Piston Rings and Con Rod



P0008025

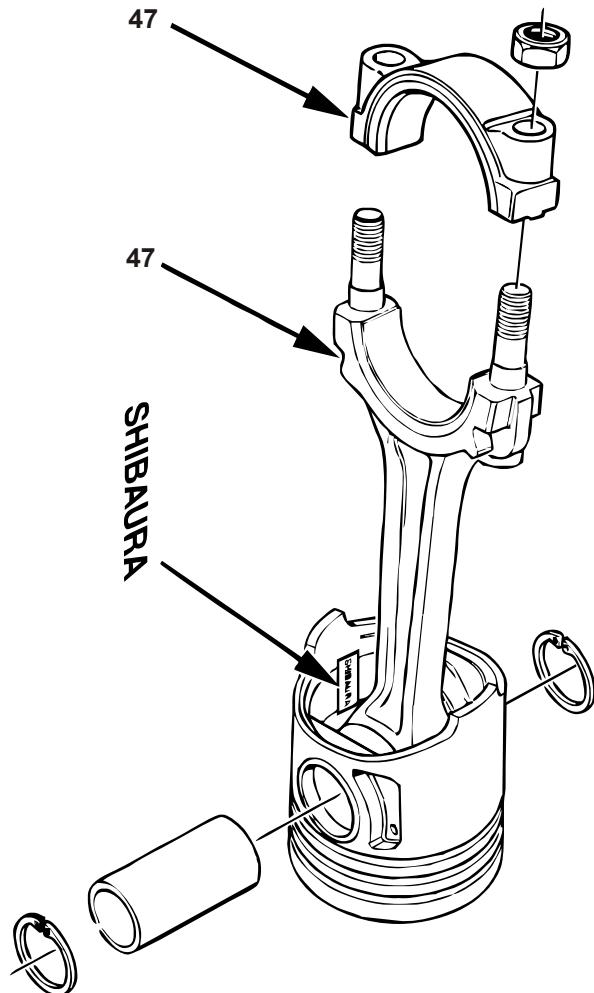
- 1 Install one of the retainer rings in the piston.
- 2 Oil the piston pin and connecting rod bush.
- 3 Heat the piston to approx. 100°C (212 °F). Position the piston and connecting rod so that the markings line up.

The marking on the connecting rod and the "SHIBAURA" marking inside the piston must face the same direction.

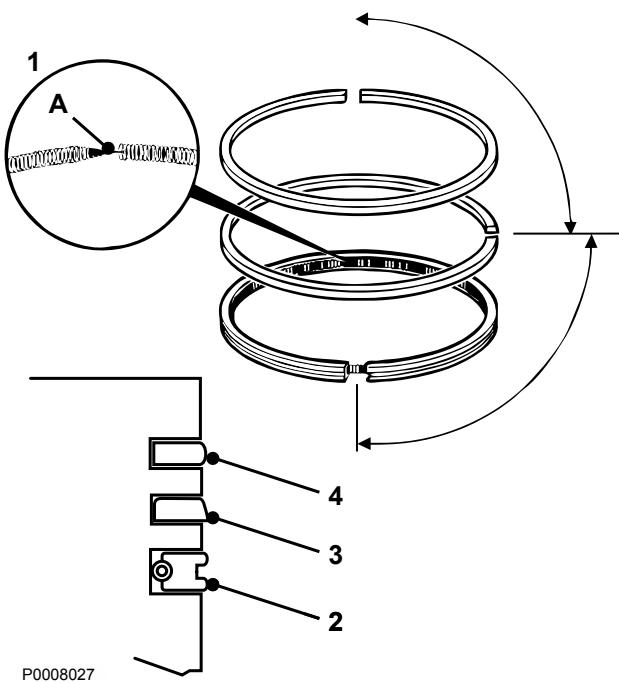
Slide the piston pin in.

**NOTICE!** It should be possible to press the piston pin in easily. It must not be driven in.

- 4 Install the other retainer ring.
- 5 Check that the connecting rod is not tight on the piston pin bearing.
- 6 Check the big end bearing clearances. Refer to *Crankshaft and Bearings, Inspection, page 69*.
- 7 Check the piston ring gap in the cylinder bore and that the rings do not bind in the piston ring grooves.



P0008026



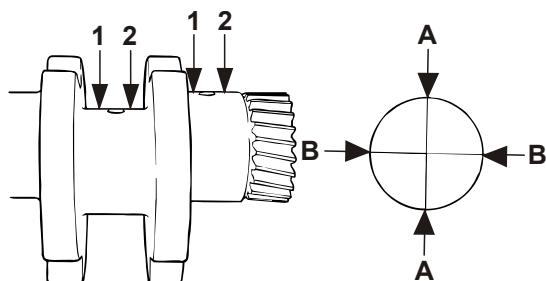
- 8 Install the piston rings on the pistons, using piston ring pliers. Letters or markings on ring surfaces must always be turned so that the marking faces upwards.

Install the oil scraper ring first. Put the expansion spring (1) for the oil scraper ring in the lower piston ring groove, with the guide pin (A) inside both ends of the spring. Check that the ends of the expansion spring do not overlap. Install the oil scraper ring (2) above the expansion spring. Check that the ring gap is staggered 180° (356 °F) from the guide pin.

Install the ring with the tapered surface (3) in the center piston ring groove so that the marking faces the piston crown.

Install the upper ring (4) with the marking upwards.

Check that the ring openings are staggered 90° (194 °F) from each other.



## Crankshaft and Bearings, Inspection

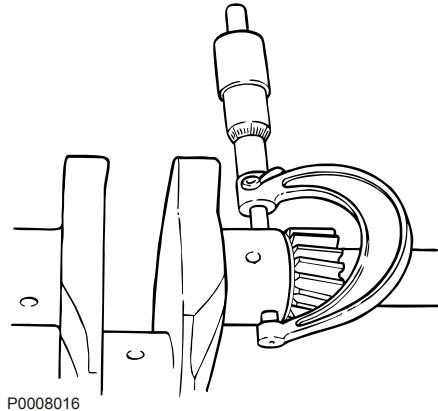
Clean the crankshaft carefully in all channels after disassembly and inspect the crankshaft thoroughly to determine if overhaul is really necessary.

- 1 Check wear and ovality with a micrometer. Measure the diameters A-A and B-B at points 1 and 2. Max. permissible taper and ovality in the main and big-end journals is 0.05 mm\* (0.002"). Grind the crankshaft to a suitable undersize dimension, if these values are exceeded. Bearing shells are available in two oversizes.
- NOTICE!** First check which oversize bearing shells are available for the engine type concerned.
- 2 Measure longitudinal crankshaft crookedness (runout). Lay the crankshaft on a pair of V-blocks placed under the front and rear main bearing journals. Alternatively, the crankshaft can be suspended between centers. The measurement must be performed on the center main bearing journal(s). For max. longitudinal crookedness (runout) refer to *Group 21 - Engine, page 11*. If these values are exceeded, the crankshaft must be straightened or changed.
- 3 Check that the crankshaft seal mating surfaces on the crankshaft are not worn or damaged.

\* Max. wear; refer to *Group 21 - Engine, page 11*.

## Inspection of the crankshaft bushing and crankshaft journal

Check the bearing clearance between the crankshaft journal and the crankshaft bushing. Use both internal and external micrometers.

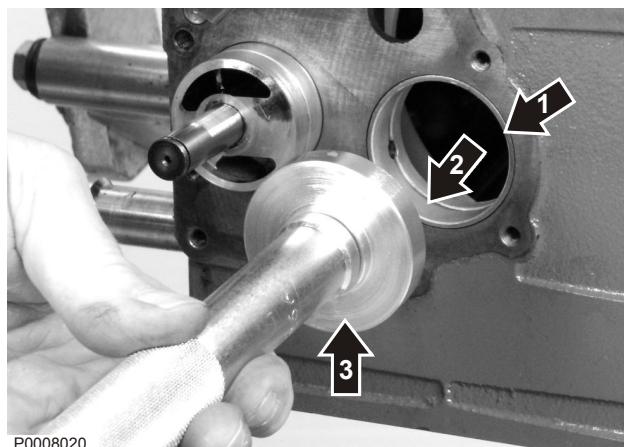


- 1 Measure the inner diameter of the bushing at points **1** and **2**. Measure in two directions (**A** and **B**) at each point.
- 2 Measure the bearing journal outer diameter and calculate the bearing play (difference between previous measurement and max. diameter of the bearing journal).  
For max. bearing play, refer to *Group 21 - Engine, page 11*.  
Change the bush if the clearance exceeds the permissible value. If necessary, the crankshaft can be ground to a suitable undersize and the bush replaced with a corresponding oversize.  
Check the bearing play again before the crankshaft is installed, if grinding has been performed.

### Inspection of main and big end bearings

Check the main and big end bearing shells, and the front main bearing bushing. Change worn bearing shells, or any with damaged bearing surfaces.

### Front Crankshaft Bush, Replacement



- 1 Remove the bush from the cylinder block.
- 2 Check that the bush contact surface in the housing has no burrs or deformities.
- 3 Mark a line across the hole in the housing and the bush with a marker pen. Oil the outside of the bush and the contact surface in the housing.
- 4 Place the bush (1) in the cylinder housing.

#### **IMPORTANT!**

Position the bush so that its oil hole is correctly aligned in the cylinder block. The oil groove (2) in the bush must be furthest in.

Tap the bush in with a suitable mandrel (3) until it lines up with the engine block.

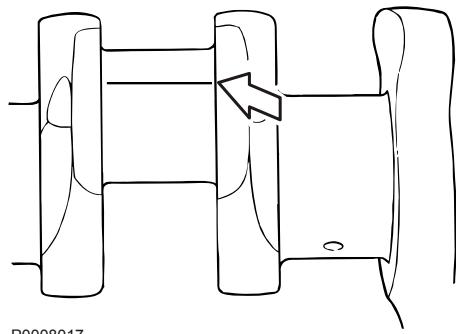
- 5 Check that the oil duct is open after pressing in the new bush. Also check that the inner diameter of the bush is the same as the crankshaft diameter.

## Big End Bearing Clearance, Check

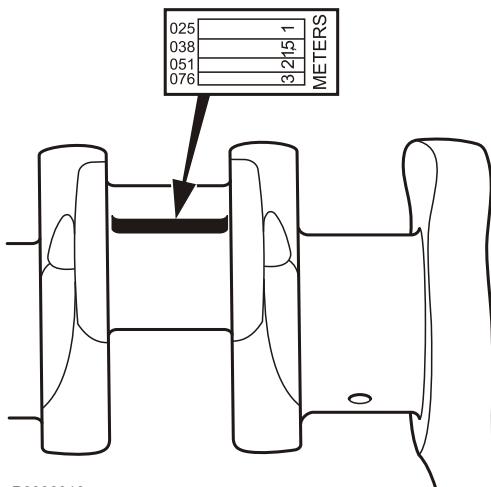
### Tools:

856927 Plastigauge

Big-end bearing radial play can be checked with the aid of 856927 Plastigauge as follows:



P0008017



P0008018

- 1 Wipe off any oil from the big end bearing and big end journal. Apply a piece of plastigauge the same length as the width of the bearing along the big-end journal. Avoid the oil hole.

- 2 Install the connecting rod and bearing cap (observe the markings) and tighten the connecting rod bolts.

For tightening torques, refer to *Tightening torques, page 8*.

**NOTICE!** Do not rotate the connecting rod or crankshaft during measurement, as this will destroy the measurement strip.

- 3 Remove the big end cap and measure the width of the compressed plastigauge at the widest point. Use the scale supplied with the plastigauge.

For max. permissible big-end bearing play, refer to *Group 21 - Engine, page 11*.

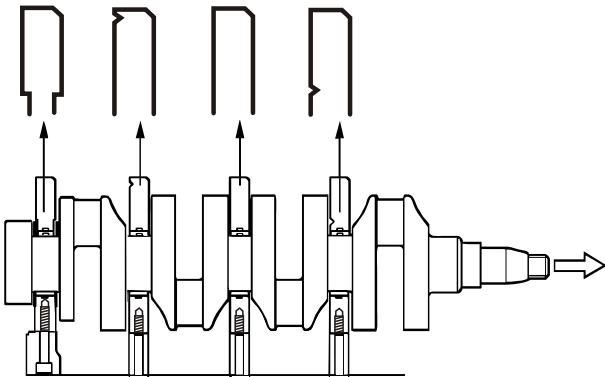
Change the big-end bearing if bearing clearance exceeds the permissible value. The big-end journal can be ground to an undersize if required and a corresponding oversize bearing shell fitted. Big-end bearings are available in two oversizes.

**NOTICE!** After grinding the bearing journals, check the bearing clearance again before assembly.

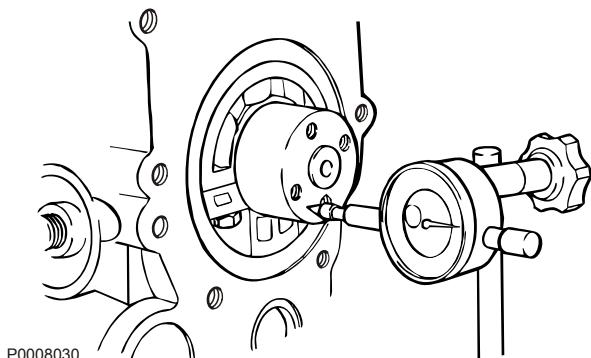
## Crankshaft, Installation

### Tools:

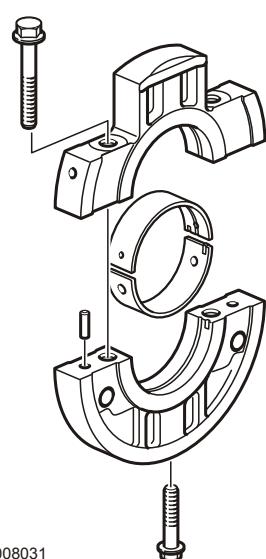
9989876 Dial indicator  
9999696 Magnetic stand



P0008029



P0008030



P0008031

- 1 Check the cleanliness of the crankshaft ducts, bearing surfaces, engine block and bearing caps. Check that the bearing shells and their beds do not have any burrs or deformities.

- 2 Place the main bearing shell in position in the bearing cap. The bearing shells equipped with an oil groove must be placed in the **upper** bearing cap.

**NOTICE!** Check that the lubrication holes in the upper bearing shells are centered on the oil ducts.

- 3 Oil the bearings and main bearing journals and install the bearing caps in their respective positions. The chamfered edge must face forwards on all bearing caps.

- 4 Place the thrust washers in the rearmost bearing cap (flywheel side) with the oil groove towards the crankshaft. Bolt the bearing caps together; for tightening torque refer to *Tightening torques, page 8*.

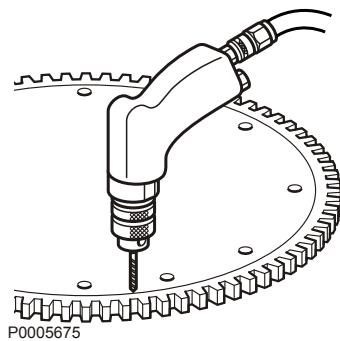
- 5 Carefully lift the crankshaft into place in the cylinder block.

**NOTICE!** Tape the crankshaft gear before lifting the crankshaft into place, to prevent the gear teeth from damaging the front bearing seat.

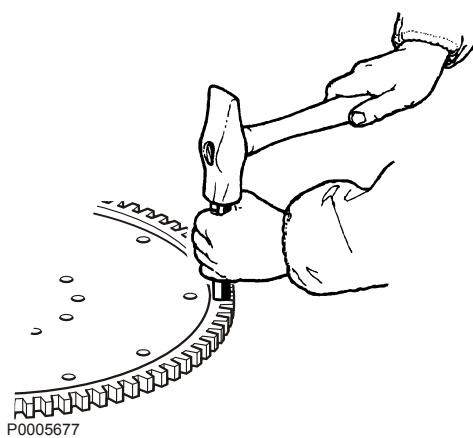
- 6 Torque the main bearing caps in the engine block. For tightening torque, refer to *Tightening torques, page 8*.

- 7 Using special tools 9999696 Magnetic stand and 9989876 Dial indicator, check that end float does not exceed 0.5 mm (0.020").

## Gear Ring, Flywheel: Replace



- 1 Mark the flywheel position in relation to the crankshaft (facilitates installation). Remove the flywheel.
- 2 Drill a hole or two in a tooth root on the ring gear. Crack the ring gear with a chisel at the drilled holes and remove it.
- 3 Clean the ring gear contact surface on the flywheel with a wire brush.
- 4 Heat up the new ring gear in an oven to 120-150 °C (248–302 °F) so that the ring gear is heated evenly.
- 5 Place the heated ring gear on the flywheel and drive it into position with a hammer and soft mandrel. The ring gear must then cool in open air.
- 6 Clean the contact surfaces on the flywheel and crankshaft. Check the rear crankshaft seal. Change as necessary.
- 7 Install the flywheel in the correct position. For tightening torque, refer to *Tightening torques, page 8*.



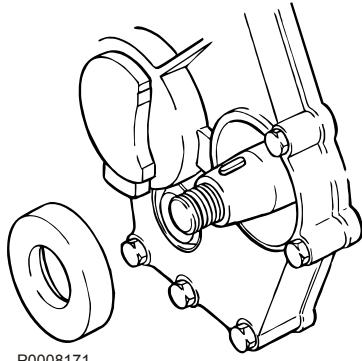
## Crankshaft Seal, Replace (front)

**Tools:**

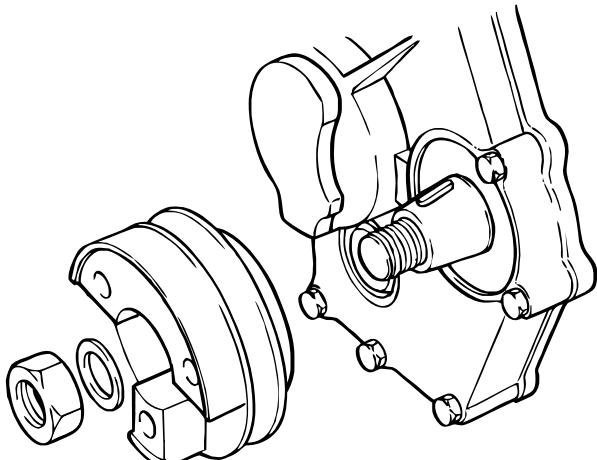
9995919 Extractor

The seal consists of a rubber ring and can be replaced once the crankshaft pulley has been removed. Use 9995919 Extractor to remove the seal.

- 1 Remove the key and tape over the keyway.
- 2 Apply grease to the new seal and install it using a suitable socket.
- 3 Remove the tape. Install the key and crankshaft pulley. For tightening torque, refer to *Tightening torques, page 8*.



P0008171



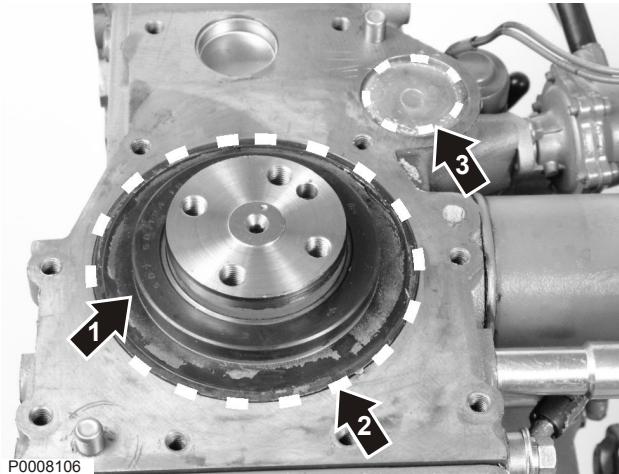
P0008172

## Crankshaft Seal, Replace (rear)

The seal consists of a rubber ring and is accessible once the plate behind the flywheel housing and the elastic coupling, flywheel\* and flywheel housing have been removed.

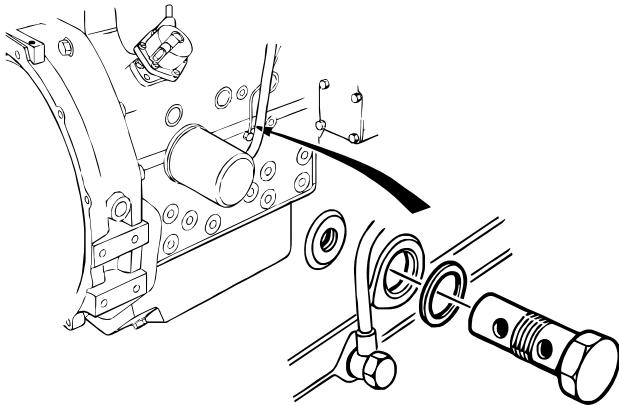
**NOTICE!** \* Mark the flywheel position in relation to the crankshaft (facilitates installation).

- 1 Remove the rear stuffing box (1). Check that the spaces for the stuffing box on the engine block and crankshaft are clean. Apply grease to the sealing edges and install the seal.
- 2 Apply an even layer of sealant 840 879 around the stuffing box (2) and camshaft (3).
- 3 Install the flywheel, the elastic coupling, the adapter plate and the flywheel housing. For tightening torque, refer to *Tightening torques, page 8*.



## 22-0 Lubricating and Oil System, General

### Engine Oil Pressure, Check



P0008001

The lubrication oil pressure can be checked by connecting a manometer with a hose to the connection for the oil pressure switch (thread size in cylinder block = 1/8").

For the correct pressure at operating speed and temperature, refer to *Group 22 - Lubrication System, page 15*.

If the oil pressure is too high or too low, first try changing the relief valve and then check the oil pressure again.

## 22-1 Oil pump and Line

### Lube Oil Pump, Removal

**Tools:**

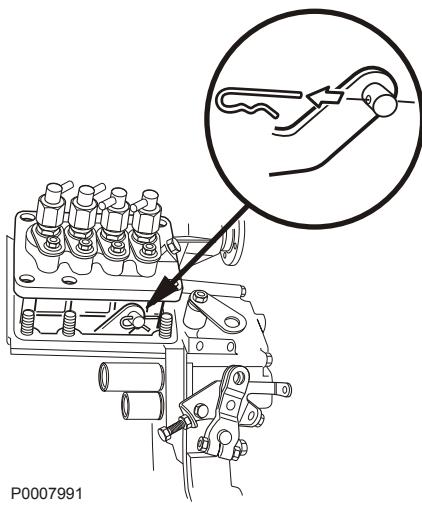
885820 Puller

- 1 Remove the injection pump. Remove the pump retaining nuts and bolts. Turn the stop lever clockwise and carefully lift the pump, to make the lock clip on the regulator arm accessible. Remove the lock clip and free the regulator arm.

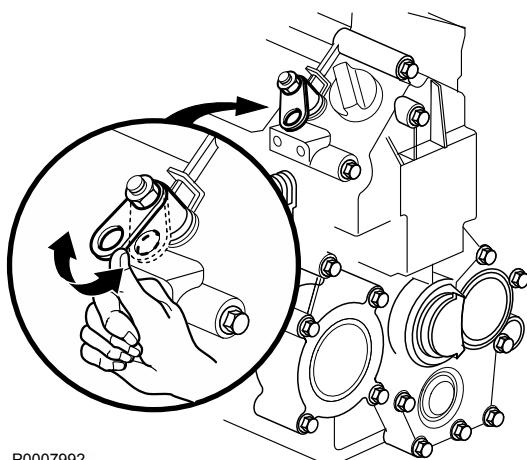
**IMPORTANT!**

Be careful when disassembling the injection pump, so that its lever is not bent or damaged.

**NOTICE!** Retain any shims from beneath the injection pump flange. Use the same thickness of shims when re-installing, unless the camshaft, block or injection pump have been changed.

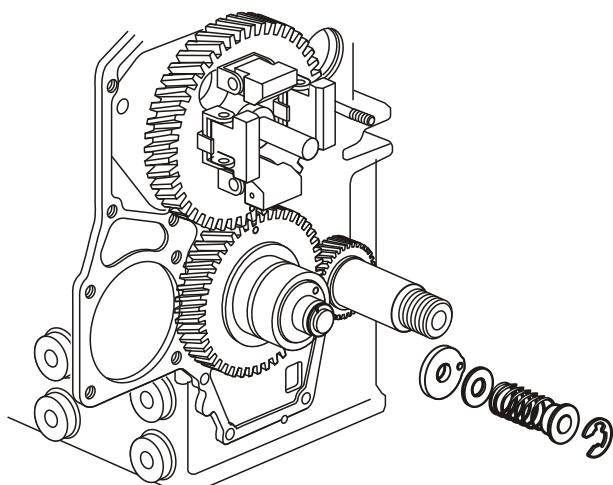


P0007991



P0007992

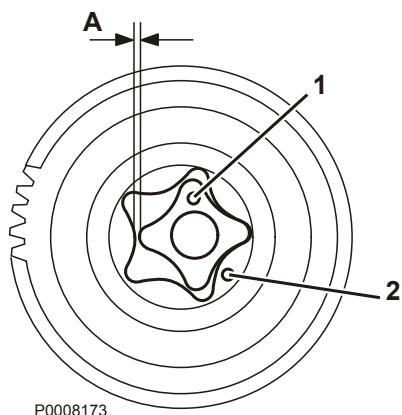
- 2 Remove the belt pulley; use special tool 885820 Puller and 3 pcs. M10x40 mm (1.57") bolts. Remove the timing gear casing. Load the stop arm so that the springs on the inside of the housing do not come out of position or spring out.



P0007840

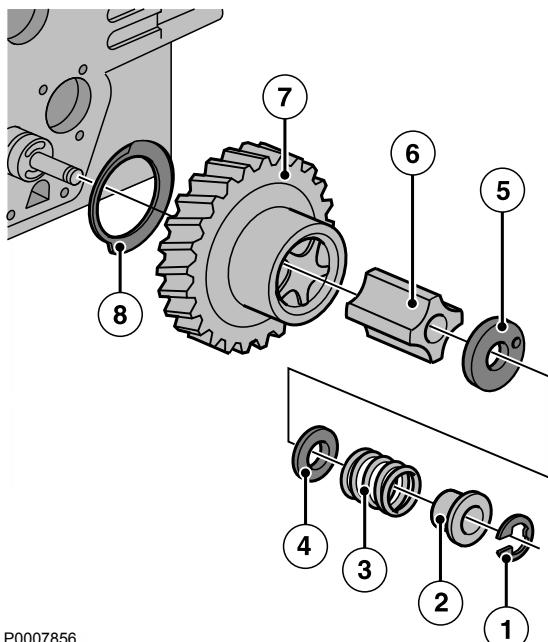
- 3 Remove the idler retainer ring. Retain the sleeve washer, spring and shims. Lift away the idler gear complete with cover and oil pump. Note the thrust washer behind the oil pump.

## Lube Oil Pump, Inspection



- 1 Check that the oil pump cover and the outer and inner rotors are not worn or damaged.
- 2 Check the clearance (A) between the inner (1) and outer (2) rotors. Max. permitted clearance 0.25 mm.
- 3 Check the idler gear bearings and stub axle. If necessary these must be replaced. Refer to *Oil Pump Bearing, Replace, page 81*.

## Lube Oil Pump, Installation



P0007856

- 1 Retainer ring
- 2 Spring washer
- 3 Spring
- 4 Shim
- 5 Oil pump cover
- 6 Inner rotor
- 7 Idler wheel with outer rotor
- 8 Thrust washer

Timing gears that are of importance for setting timing are marked as follows:

Crankshaft gear (1) and idler gear (2) are marked with a punch mark.

The idler gear (2) and camshaft gear (3) with a punched line in front of a tooth and its respective tooth groove.

### IMPORTANT!

The components must be oiled before installation.

### IMPORTANT!

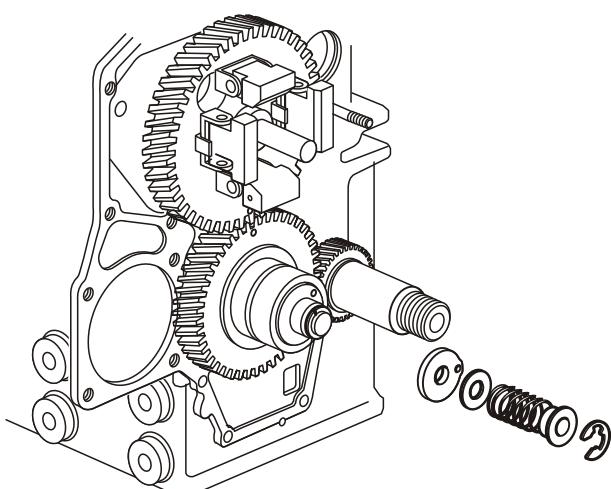
Make sure that the gear wheel markings coincide.

- 1 Install the thrust washer (8) on the idler wheel shaft stub. Install the idler gear so that the marks align.

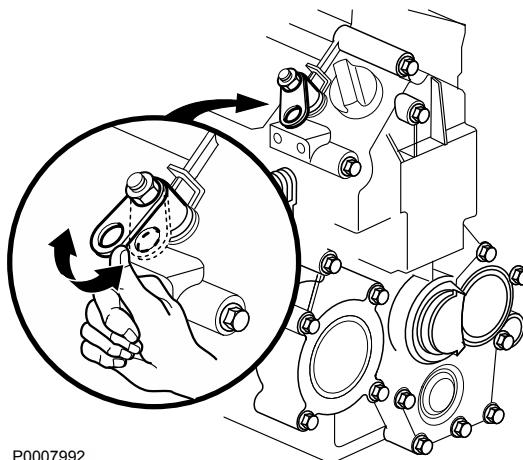
**NOTICE!** Do not turn the crankshaft before the timing gear cover has been installed.

- 2 Install the inner rotor and oil pump cover. Install shim, spring, spring washer and lock washer.

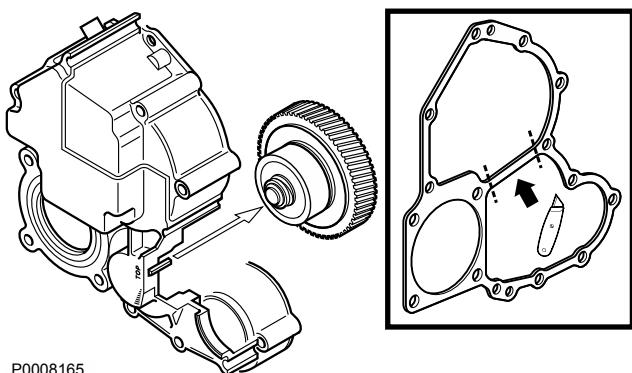
- 3 Adjust the oil pump end float to 0.10–0.15 mm (0.0039–0.0059"). Shims are available in thicknesses 0.10, 0.15, 0.20 and 0.50 mm (0.0039, 0.0059, 0.0079, 0.0197").
- 4 Install a new crankshaft seal.



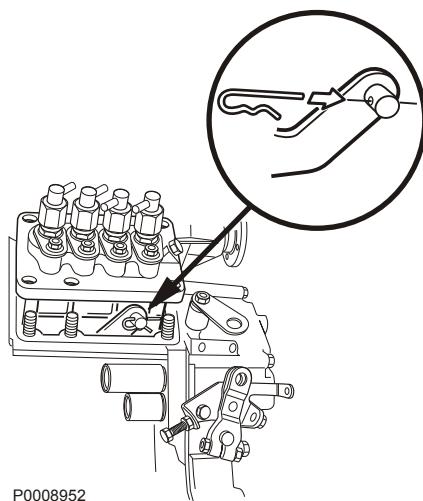
P0007840



P0007992



P0008165



P0008952

- 5 Center the cover in front of the oil pump.

**NOTICE!** Check that the spring pin in the timing gear cover engages in the hole in the oil pump cover. Turn the cover backwards and forwards, and center it in the mid position. The stop arm must be turned and held in place while the timing gear cover is positioned.

- 6 Install a new gasket on the timing cover.

**NOTICE!** If the gasket has a center part, this must be cut away.

Install the timing gear cover with the new gasket. Check that the start spring is in position in the timing gear cover and is connected to the regulator arm (link arm). Insert the regulator arm through the hole in the cylinder block. Bolt on the timing gear cover.

- 7 Turn the stop arm clockwise and connect it to the injection pump. Fit the clip.

**NOTICE!** Be careful to ensure that the shim that was placed underneath the injection pump flange is put back before the pump is placed in the cylinder block (applies when the pump has been removed).

- 8 Fasten the injection pump; for tightening torque refer to *Tightening torques, page 8*.

- 9 Fit the key into the crankshaft and install the crankshaft pulley. For tightening torque, refer to *Tightening torques, page 8*.

- 10 Connect the fuel hose to the injection pump.

- 11 Check the injection timing (crankshaft position) in cases where a new complete camshaft has been installed or if a new cylinder block is used.

### Oil channels

Clean and flush the oil channels in the engine with cleaning liquid and then with steam or rinsing oil at a pressure of 300–400 kPa (44–58 psi) in conjunction with a larger engine overhaul. Clean the oil pressure pipe between the cylinder block and cylinder head.

Clean the drilled oil ducts in the cylinder block, crankshaft and connecting rods with a cleaning brush.

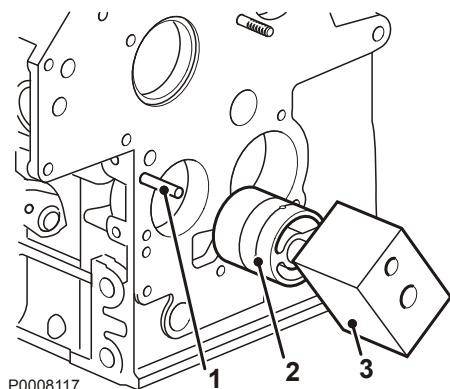
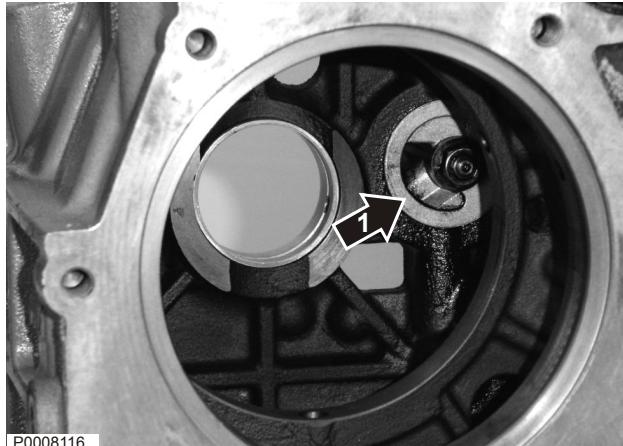
## Oil Pump Bearing, Replace

### Tools:

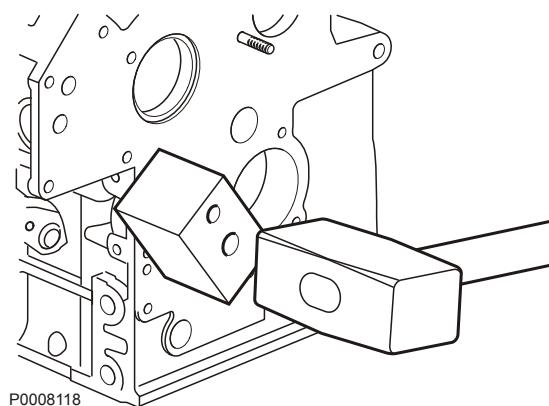
3849641 Mounting tool

In order to remove the oil pump, the timing gear and crankshaft must be removed.

- 1 Drive out the oil pump bearing section (1) located in the engine block. Tap it out from inside the crankcase.



- 2 Use special tool 3849641 Mounting tool. First screw the tool guide pin (1) into the engine block. Then put the new oil pump bearing (2) into the tool block (3).



- 3 Position the tool block with the bearing in place, using the guide pin. Tap in the bearing until the tool bottoms on the engine block.

**NOTICE!** It is important that the engine block surface towards the tool is clean and smooth.

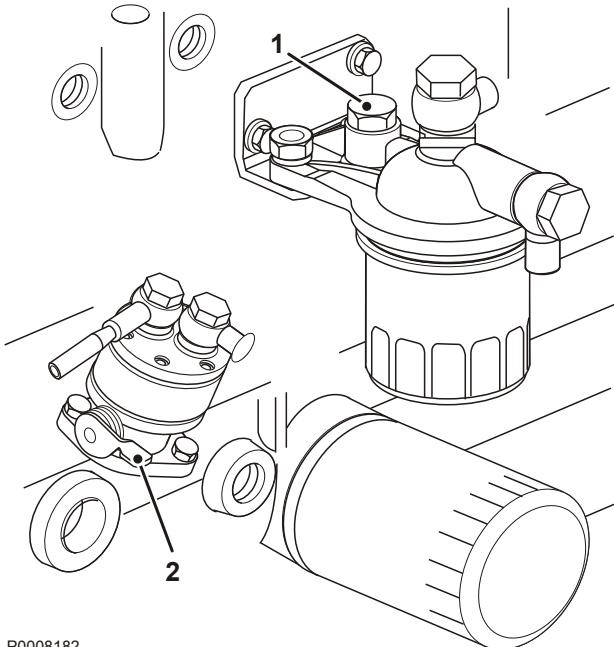
# 23-0 Fuel System, General

## Fuel system, bleeding

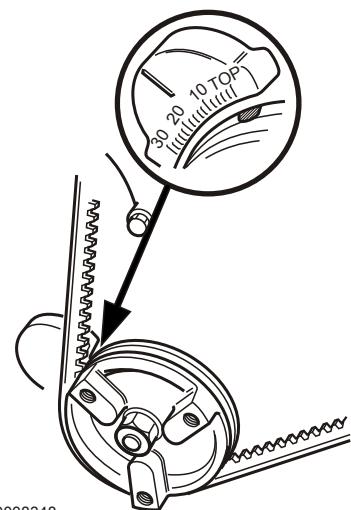
The fuel system must be primed after a filter change, if the fuel tank has been run dry and after a long-term stoppage.

### D2-55-A/B

- 1 Open the bleed screw (1) on the fuel filter. Avoid fuel spillage. Use e.g. rags at the bleed point.
- 2 Pump fuel up with the hand pump (2) until fuel without air bubbles can be seen. Continue pumping and tighten the bleed screw at the same time.
- NOTICE!** If the pump works poorly, crank the engine so that the mark on the pulley is at "TOP"; if it is still poor, crank the engine another revolution to "TOP".
- 3 Normally, additional bleeding is not required. Start the engine and check for leaks.



P0008182

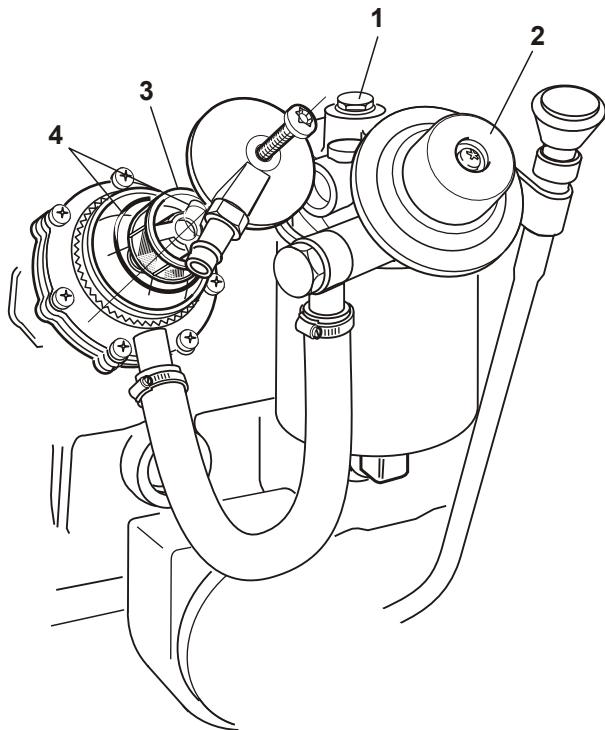


P0008348

### D2-55-A/B

- 4 If the engine does not start after a short attempt, loosen the delivery pipes at the injectors a turn or so. Hold the injection pump actuator arm in its max. position and crank the engine with the starter motor until fuel leaks from the pipes. Tighten the delivery pipe nuts. For tightening torque, refer to *Tightening torques, page 8*.

The glow plugs are activated at the same time as the starter motor. Save the batteries by only using the starter motor for short periods when bleeding.

**D2-55C/D/E/F and D2-75A/B/C/F**

P0007532

- 1 Open the bleed screw (1) on the fuel filter. Avoid fuel spillage. Use e.g. rags at the bleed point.
- 2 Pump fuel up with the hand pump (2) until fuel without air bubbles can be seen. Continue pumping and tighten the bleed screw at the same time. The pump inlet pipe contains a strainer (3) which normally does not need to be cleaned since the engine has a fuel pre-filter. If a fuel pre-filter is not fitted, poor feed flow can be due to a blocked strainer.

**NOTICE!** If either of the two O-rings (4) are damaged, they must be changed.

- 3 Normally, additional bleeding is not required. Start the engine and check for leaks.
- 4 If the engine does not start after a short attempt, loosen the delivery pipes at the injectors a turn or so. Hold the injection pump actuator arm in its max. position and crank the engine with the starter motor until fuel leaks from the pipes. Tighten the delivery pipe nuts. For tightening torque, refer to *Tightening torques, page 8*.

**D2-55C/D/E/F and D2-75A/B/C/F**

The glow plugs are activated at the same time as the starter motor. Save the batteries by only using the starter motor for short periods when bleeding.

## 23-3 Fuel Feed Pump and Filter

### Fuel Pre-filter, Replace

#### Draining and change of filter insert

##### Draining

The fuel pre-filter is extra equipment.

Position a suitable vessel underneath the filter. Drain off water and contaminants through the tap / plug in the bottom of the filter bowl.

##### IMPORTANT!

Draining must be performed after the engine has been stopped a few hours.

##### Changing filter insert

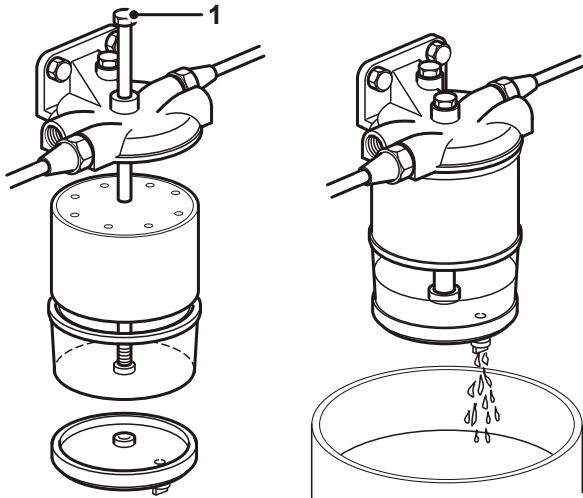
Close the fuel tap on the tank. Position a suitable vessel underneath the filter.

Remove the filter bowl by loosening screw (1). Empty and clean the filter bowl. Replace the insert and install the bowl. Open the fuel tap. Bleed the fuel system. Hand in the old filter to a re-cycling station.

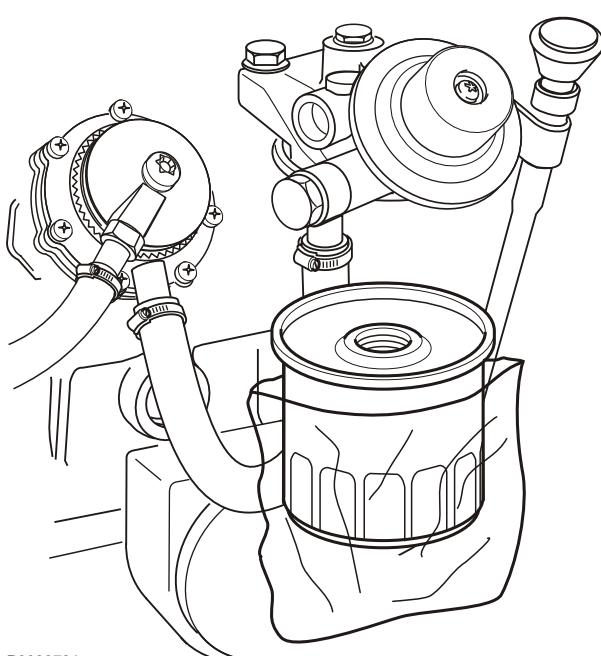
Start the engine and check for leaks.

##### **WARNING!**

Working with or approaching a running engine is a safety risk. Watch out for rotating components and hot surfaces.



P0008349



P0003731

### Engine Fuel Filter Replacement

Clean the filter bracket. To prevent fuel spill, a plastic bag can be pulled over the filter. Unscrew the filter. Apply a film of oil on the new filter gasket. Screw the filter on by hand until it touches the contact surface. Then tighten an extra half turn, no more. Bleed the fuel system. Hand in the old filter to a re-cycling station. Start the engine and check for leaks.

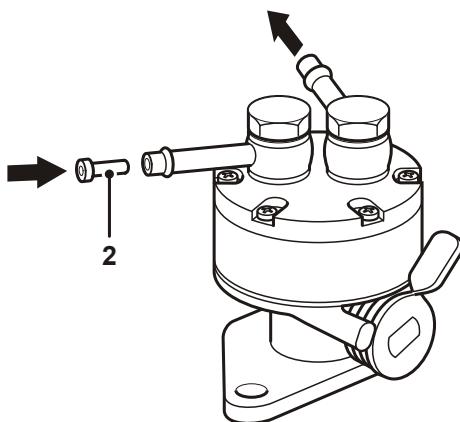
##### **WARNING!**

Working with or approaching a running engine is a safety risk. Watch out for rotating components and hot surfaces.

## Fuel Feed Pump, Replace

### Removal of feed pump

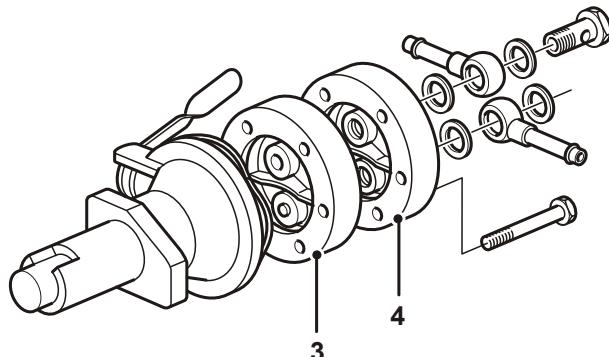
- 1 Wash clean around the pump.
- 2 Close the fuel taps. Undo the fuel connections from the pump.
- 3 Remove the feed pump from the cylinder block. Empty the pump of fuel.



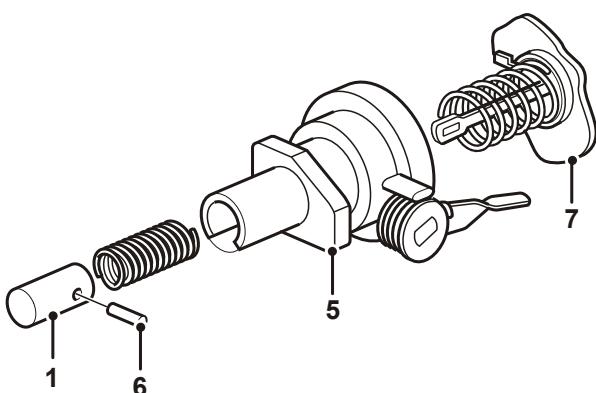
P0008179

### Disassembly and inspection of the feed pump

- 1 Check that the piston (1) does not bind in the pump housing.
- NOTICE!** The feed pump hand pump only functions when the piston is depressed.
- 2 Remove the strainer (2) from the fuel pump inlet pipe and check that it is not blocked by dirt. Re-install the strainer by pressing it in until a "click" is heard.
- 3 Check the function in the valve housing (3) before disassembly as follows:  
Suck in the inlet (IN), and blow in the outlet (OUT). The function is normal if they seal in both cases.
- 4 Mark the position of the cover (4), valve housing and pump housing (5) with alignment marks.
- 5 Remove the screws holding the cover. Remove the cover and valve housing.
- 6 Turn the diaphragm and piston until the pin (6) in the piston is in front of the groove in the pump housing.
- 7 Press in the piston and diaphragm (7). Press the pin out of the piston and remove the piston, diaphragm and springs from the pump housing.
- 8 Check that the diaphragm is undamaged and shows no cracks.



P0008180



P0008181

- 1 Piston
- 2 Strainer
- 3 Valve housing
- 4 Cover
- 5 Pump housing
- 6 Pin
- 7 Diaphragm

### Assembling the feed pump

- 1 Assemble the piston (1), diaphragm (7) and springs in the pump housing (5). Press the piston and diaphragm together and press the pin (6) into the piston.
- 2 Turn the diaphragm and piston so that the pin (6) in the piston is not aligned with the groove in the pump housing.
- 3 Install the valve housing (3) and cover (4) according to the previously made marks. Tighten the bolts.

# 23-6 Injection Pump, Regulator

## Injection Pump, Replace

### **IMPORTANT!**

Avoid getting dirt in the fuel system, observe the greatest possible cleanliness.

### **IMPORTANT!**

Be careful when disassembling the injection pump, avoid damaging or bending its lever.

### Removal of injection pump

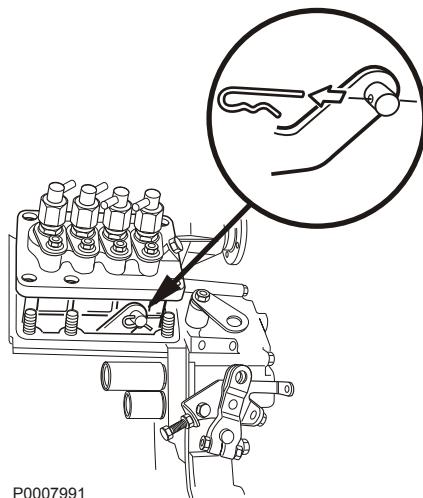
**NOTICE!** Repairs that requires work on the injection pump and which may change its settings may only be performed by specially trained mechanics who have the necessary equipment at their disposal.

All warranties for the engine are forfeit if the seals are broken by unauthorized personnel.

- 1 Wash the injection pump, injection pipes and the engine area closest to the pump thoroughly clean.
- 2 Close the fuel taps. Remove the delivery pipes completely. Release the fuel hose from the pump. Fit protective plugs to all connections.
- 3 Remove the pump retaining nuts and bolts. Turn the stop lever clockwise and carefully lift the pump, to make the lock clip on the regulator arm accessible.  
Remove the lock clip and free the regulator arm.

**NOTICE!** Retain the shim / gasket beneath the injection pump flange when the pump is lifted from the cylinder block.

- 4 Send the pump to an authorized diesel workshop for repair if the current workshop does not have specially trained personnel with the necessary testing equipment.



P0007991

## Injection pump installation

Check that the pump is free from faults and where necessary has also been tested and approved before installation.

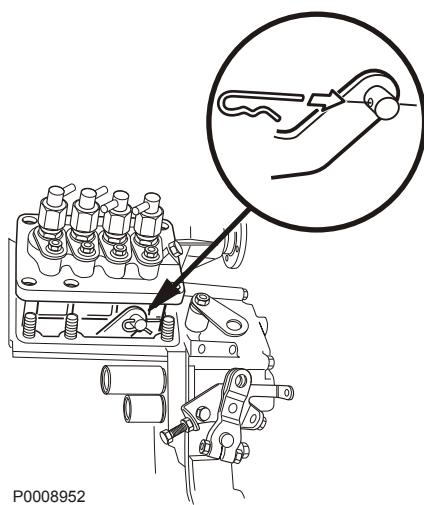
Do not remove the protective plugs before the pipes are connected.

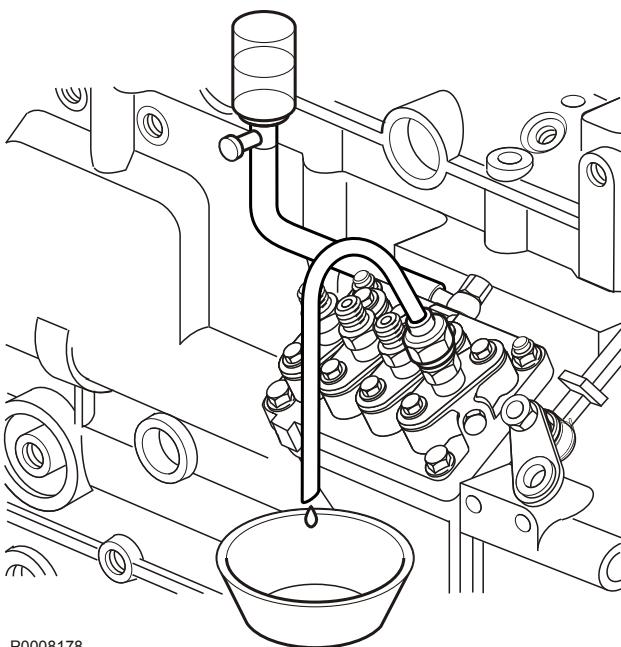
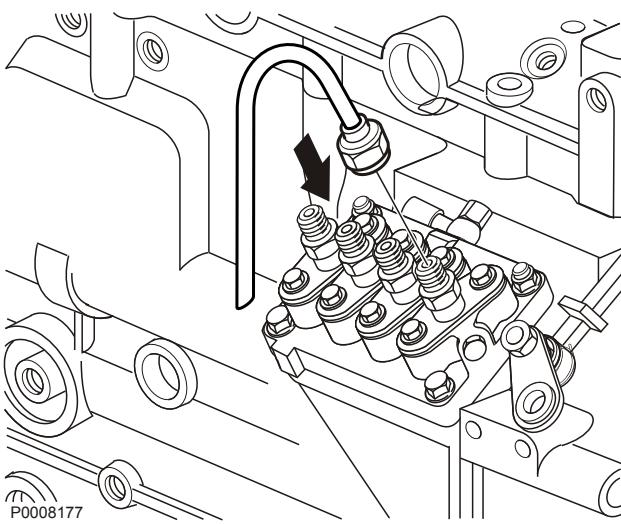
- 1 Insert the injection pump into the cylinder block.

**NOTICE!** Make sure that the shim that was placed under the injection pump flange is replaced the right way up, before the pump is installed on the block.

The correct pump setting is usually regained with this method. However, if the camshaft complete or the cylinder block have been replaced, injection pump settings must be adjusted. Refer to the next paragraph "Setting injection timing".

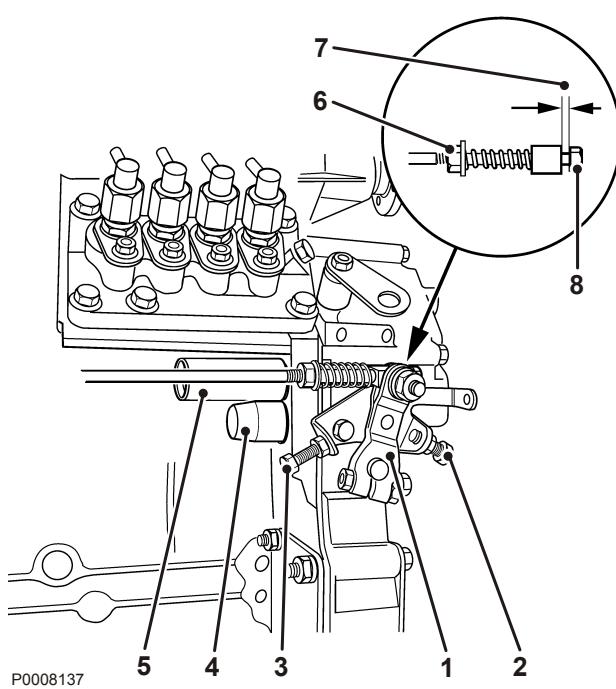
- 2 Turn the stop arm clockwise and connect the regulator arm to the regulator rod on the pump. Fit the clip. Bolt the pump in place.
- 3 Connect the fuel hose and return fuel line to the pump. Install the delivery pipes.
- 4 Bleed the fuel system and test run the engine.





## Setting injection timing

- 1 Remove the delivery pipes and return line. If the block or the camshaft have been replaced, a 0.5 mm (0.02") shim must be placed under the injection pump flange at installation.
- 2 Remove the front (1st) pressure valve holder. Remove the pressure valve and refit the pressure valve holder.  
It is recommended to remove the pump and hold it in an upright position when installing the pressure valve holder.
- NOTICE!** Be aware of the pump element so as not to damage it.
- 3 Make a drop pipe from e.g. a scrapped delivery pipe and install it on the pressure valve holder. Place a fuel container under the pressure valve holder drop pipe.
- 4 Connect a fuel container and tap to the injection pump inlet. The container should hold about 0.7 liters (0.18 US gals). Use the hose between the fuel filter and the injection pump to connect the fuel container. If everything is correctly arranged, fuel should start to run out of the drop pipe.
- 5 Turn the crankshaft in the direction of rotation until the piston in cylinder 1 is at TDC; the rocker arms on cylinder 1 should overlap.  
Turn the crankshaft another half turn (180°) in the direction of rotation.
- 6 Move the actuator arm to maximum position.
- 7 Turn the crankshaft slowly in the direction of rotation until the flow is 7 drops/minute, then read off the number of degrees on the crankshaft belt pulley. If the value noted deviates from the value in Technical data, the injection timing must be adjusted.  
A 0.1 mm (0.004") shim alters the injection timing approx. 1°. Thicker shims retard timing and thinner shims advance timing.
- 8 Refit the pressure valve.



- 1 Actuator arm
- 2 Adjustment screw, low idle
- 3 Stop screw, full throttle
- 4 Adjustment screw, race revolutions
- 5 Adjustment screw, max. fuel volume
- 6 Lock nut

## Setting engine rpm

Check that the accelerator control functions normally, i.e. the actuator arm (1) is pressed against the low idle stop (2) when the accelerator control is at idle, and is pressed against the full throttle screw (3) when the accelerator control is at full throttle. Adjust the control as necessary. Also check that the air filter is not blocked, and that the air inlet is not blocked.

### IMPORTANT!

The engine's fuel volume and speed are set at the factory to give highest power and least environmental impact. These settings must not be disturbed.

**NOTICE!** Seals on injection equipment may only be broken by authorized personnel. Seals which have been broken must be re-sealed.

### Low idle

- 1 Check that the gap (7) is about 3 mm (0.118") when the accelerator is in the idle position. If necessary: Undo locknut (6) and adjust screw (8) to give the correct gap.
- 2 Warm the engine up and check the idle speed with a tachometer (refer to *Technical Data, page 11* for correct idle speed).
- 3 Use adjustment screw (2) as necessary to give the correct idling speed.
- 4 Check the gap (3) again as in item 1.

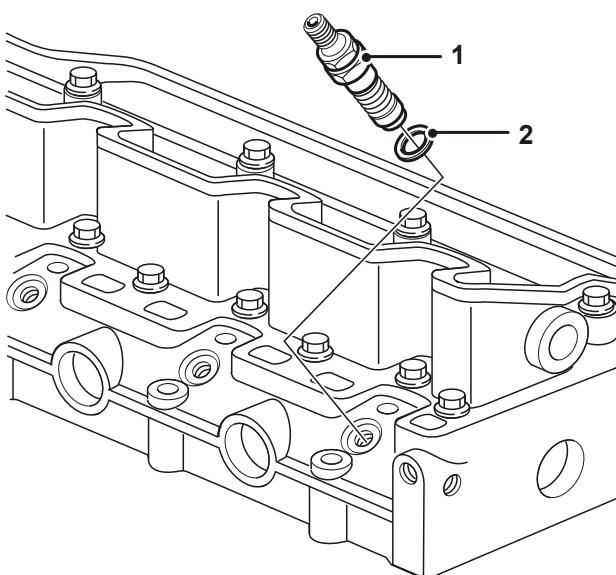
### Race revolutions (high idle)

Warm the engine up and check the race revolutions with a workshop tachometer when the engine is unloaded at full throttle (refer to *Technical Data, page 11* for correct race revolutions).

### Adjust the following as necessary

- 1 Loosen the stop screw (3) so that it does not limit the movement of the actuator arm (1).
- 2 Run the engine unloaded at full throttle and adjust to the correct race revolutions with adjuster screw (4) (remember to re-seal the screw).
- 3 Adjust stop screw (3) to give a clearance of 0.1 mm (0.004") between the stop screw (3) and the actuator arm (1) when the throttle control is in the full throttle position.

# 23-7 Injectors and Delivery Pipes



P0008350

## Injector, Replace

- 1 Wash clean around the injectors.
- 2 Undo the delivery pipes at the injection pump and at the injectors. Lift the fuel delivery pipes away together.
- 3 Undo the nut at the top of each injector, use the nuts beneath the return fuel line as counterholds so that the pipes are not bent. Lift the return fuel pipe away.
- 4 Unscrew the injectors (1). Use socket L=80 mm (3.15"). Remove the copper washers (2) beneath the injectors.
- 5 Fit a protective plug to the injector pipe connection and over the injector nozzle if it is not to be installed immediately.
- 6 Install the new injector. For tightening torque, refer to *Tightening torques, page 8*.
- 7 Install the return fuel pipe, use the nut underneath the fuel return pipe as a counterhold to avoid kinking the pipe.
- 8 Install the delivery pipes. Check that they do not come out of alignment, and tighten the nuts. For tightening torque, refer to *Tightening torques, page 8*.
- 9 Start the engine and check for leaks.

## Testing injectors

Testing is done in an injector tester. During the test, opening pressure and sealing are most important. The spray pattern is more difficult to evaluate and does not fully indicate the condition of the nozzle.

### **⚠ WARNING!**

Be careful when testing injectors, avoid getting the fuel jet from an injector on un-protected parts of your body. The jet has such powerful penetration ability that it can force its way in under your skin and cause blood poisoning (septicemia).

## Opening pressure

With the pressure gauge connected, press the injector tester lever down slowly until the injector opens and releases fuel. Read off the opening pressure at the opening instant.

If the value noted does not coincide with the prescribed value, the setting must be changed. This is done with washers.

**NOTICE!** The opening pressure increases or decreases by about 1 MPa (145 psi) with a change of shim thickness of 0.1 mm (0.004").

## Checking injectors

### Spray pattern

#### Tools:

9999772 Pressure testing kit

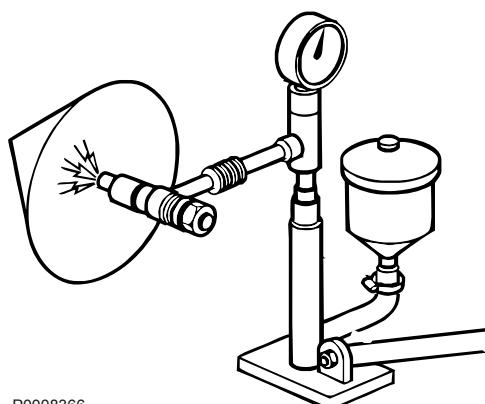
- 1 Pump using 9999772 Pressure testing kit and check the injector spray pattern. The fuel spray should be cone shaped and aligned with the injector center line. Fuel drops must not occur in the spray.
- 2 Check that the fuel jet has a circular cross section.

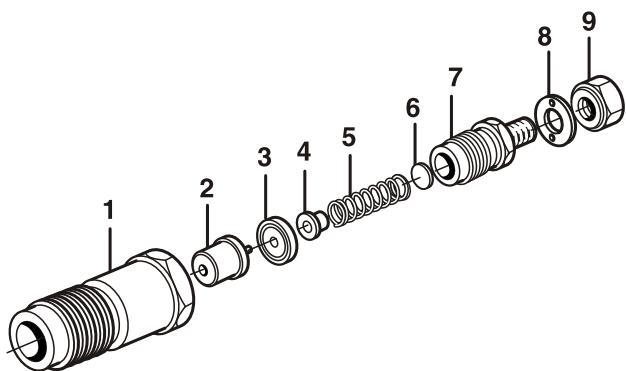
### Sealing

When sealing is checked, investigate any fuel leakage that may occur between the injector nozzle seat and the tapered sealing surface in the injector sleeve.

- 1 Wipe the injector nozzle tip dry.
- 2 Pump the pressure up to about 2 MPa (290 psi) below the injector opening pressure (refer to *Group 23 - Fuel System, page 16*). Keep the pressure constant for about 10 sec. and check that no fuel drips out from the tip of the injector. Damp injectors may be approved.

Fit a protectives plug to the injector pipe connections and over the injector nozzles if they are not to be installed immediately.





P0007853

- 1 Injector nut
- 2 Injectors
- 3 Joining piece
- 4 Compression screw
- 5 Spring
- 6 Adjustment shims
- 7 Injector holder
- 8 Washer
- 9 Nut

## Overhauling injectors

- 1 Clean the outside of the injector.
- 2 Fix the injector (holder) in a vise. Unscrew the injector nut and disassemble the injector.
- NOTICE!** Be careful that the injector nozzle does not fall out during disassembly.
- 3 Pull the injector nozzle out of the injector sleeve and put the components in white benzene.
- NOTICE!** Make sure that the injector needles and injector sleeves which belong with each other, and fit together, are not mixed up if several injectors are cleaned at the same time. To avoid mix-ups, the injectors should be put in an injector stand or in different compartments.
- 4 Check each injector carefully with an illuminated magnifier or an injector microscope. Also check the other components.
- 5 When installing a **new nozzle** it is important that the conserving oil is cleaned off the injector needle and sleeve before the injector is assembled (avoid skin contact with the needle's sliding surface). Clean the components in chemically pure white benzene. Check that the needle slides in the sleeve with no tendency to bind.
- 6 Dip the injector components in pure Diesel or testing oil, and fit the components together. Use the original thickness of adjustment washer(s) to set the opening pressure.
- 7 Check the opening pressure, jet pattern and sealing in an injector tester.

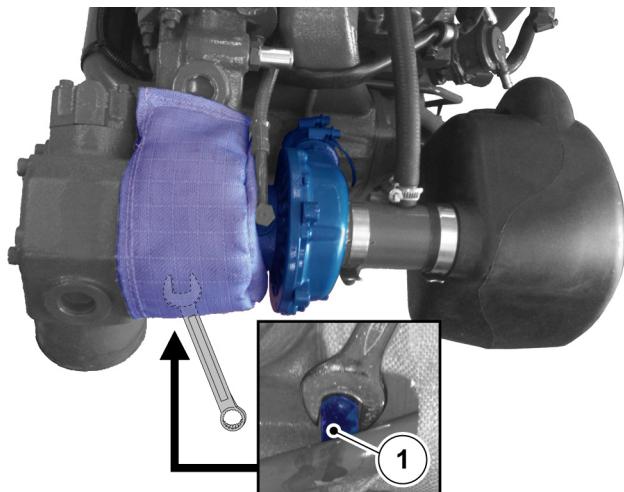
## 25-5 Turbo and supercharger

### Turbo, Check and Cleaning

D2-60F, D2-75A, D2-75B, D2-75C, D2-75F

#### Checks

Make sure the wastegate valve is working by checking that the valve lever (1) underneath the turbo is easy to turn.

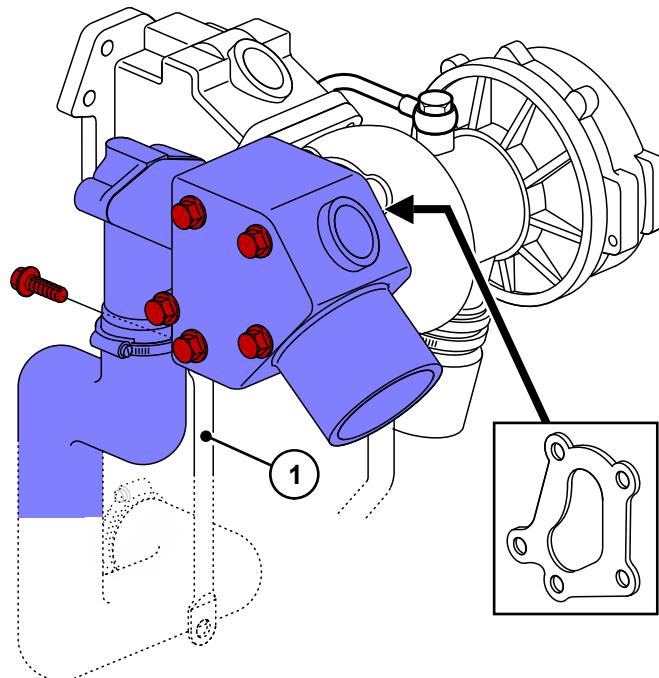


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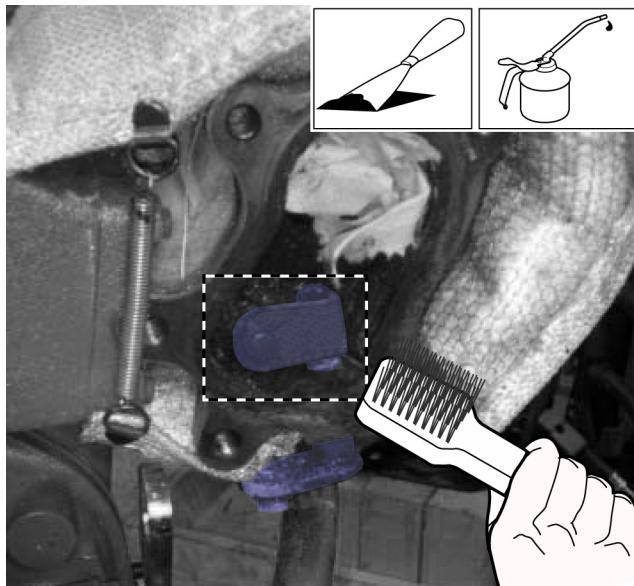
#### Cleaning

If the wastegate valve lever is stiff it must be cleaned and greased.

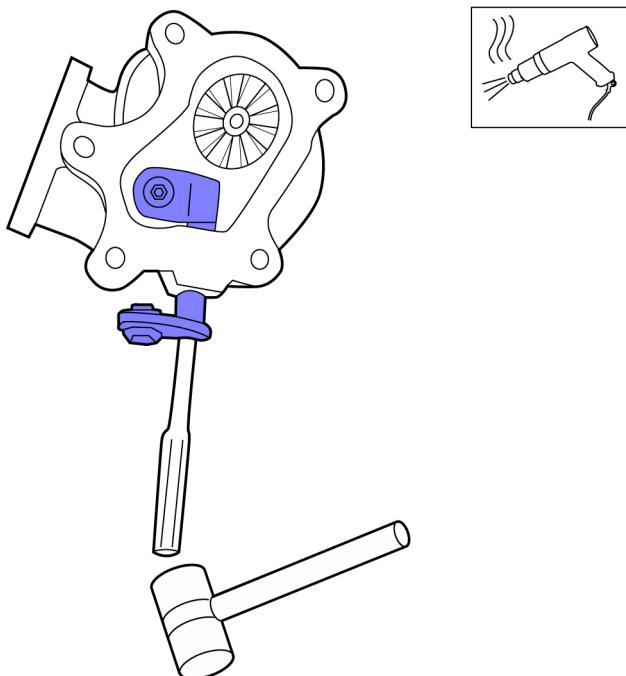
- 1 Remove the stay (1) from the exhaust elbow. Remove the exhaust elbow from the turbocharger.



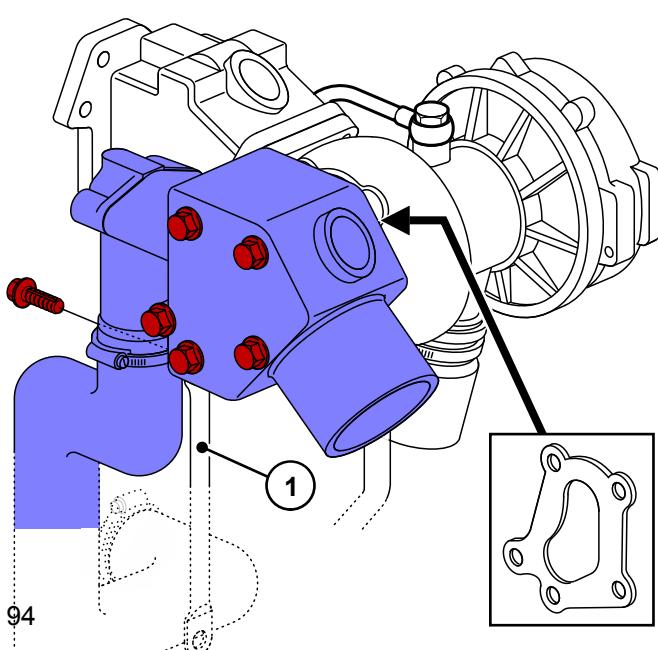
P0017092



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P0017106



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**2    IMPORTANT!**

Protect the turbine rotor with paper.

Clean around the wastegate valve.  
Use a wire brush.

**3** Spray with universal oil, part # 85110720 on the wastegate valve spindle.

Wait a couple of minutes. Test by turning the valve carefully.

**4    If the wastegate valve spindle is still stiff:**

- Heat the area around the wastegate valve spindle.
- Carefully tap it with a drift and rubber mallet.

**5    Install the exhaust elbow.**

Attach the stay (1) to the exhaust elbow.

# 26-0 Cooling System, General

The engine's internal cooling system makes sure the engine works at the right temperature. It is a closed system that must always be filled with a mixture of concentrated coolant and water in order to protect the engine against internal corrosion, cavitation and bursts due to freezing.

## **IMPORTANT!**

Coolant of a suitable chemical composition must be used all year round. This also applies in areas where there is never any risk of freezing, to provide the engine with full corrosion protection.

The corrosion protection additives become less effective over time, which means that the coolant must be changed at regular intervals; refer to the *Maintenance Schedule*. The cooling system must be flushed whenever the coolant is changed; refer to the *Cooling System, Cleaning* section.



P0013077

Volvo Penta engines are delivered with either "Volvo Penta Coolant" (green) or "Volvo Penta Coolant VCS" (yellow); both are available as concentrates and "Ready Mixed".

Volvo Penta coolants have been prepared to work best with Volvo Penta engines and offer excellent protection against corrosion, cavitation damage, and bursts due to freezing. Only coolants of this quality are adapted to, and approved by, Volvo Penta.

We recommend that the coolant supplied with the engine on delivery be used. Future warranty claims related to engine and accessories may be declined if an unsuitable coolant has been used, or if the instructions for coolant mixture have not been followed.

The use of anti-corrosion agents alone is not permitted in Volvo Penta engines. Never use water alone as a substitute for coolant.

## **IMPORTANT!**

- The two types of Volvo Penta coolant may **never** be mixed with each other as this will affect the anti-corrosion properties.
- Coolant filters may not be used together with Volvo Penta Coolant VCS.
- Engines using yellow Volvo Penta Coolant VCS must have a yellow decal with the text VOLVO COOLANT VCS on the expansion tank.

## **Ready Mixed**

Ready mixed coolant contains 40% Volvo Penta Coolant / Volvo Penta Coolant VCS and 60% water. This mixture protects the engine against internal corrosion, cavitation and bursts due to freezing down to -28°C (-18 F).

## Coolant, Mixing

The concentrated coolant must be mixed with pure water (distilled or de-ionized water) according to specifications; refer to *Water Quality*.

### **WARNING!**

All coolant is hazardous and harmful to the environment. Do not consume. Coolant is flammable.

### **IMPORTANT!**

Different kinds of coolant must not be mixed with each other!

### **Mix: 40% concentrated coolant and 60% water**

This mixture protects against internal corrosion, cavitation and bursts due to freezing down to  $-28^{\circ}\text{C}$  ( $-18^{\circ}\text{F}$ ). A 60% glycol admix lowers the freezing point to  $-54^{\circ}\text{C}$  ( $-65^{\circ}\text{F}$ ).

Never mix more than 60% concentrate in the coolant. A greater concentration provides reduced cooling effect with the risk for overheating and reduced anti-freeze protection.

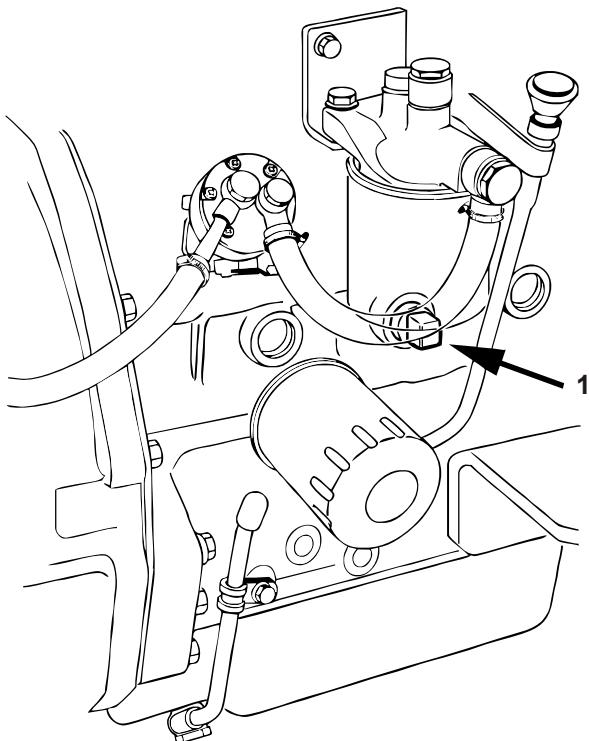
It is extremely important that the system be filled with the correct coolant concentration. Mix in a separate clean vessel before filling the cooling system. Make sure that the liquids mix.



P0002463

## Coolant, Draining

Stop the engine before draining the cooling system.



P0008351

### Freshwater system

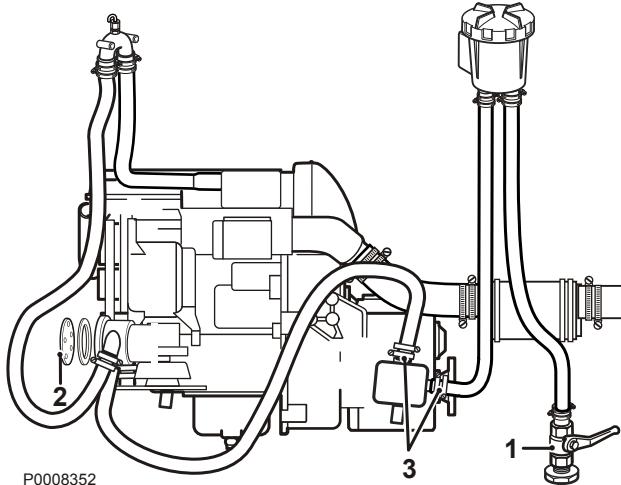
#### **⚠ WARNING!**

All coolant is hazardous and harmful to the environment. Do not consume. Coolant is flammable.

#### **⚠ WARNING!**

Do not open the coolant filler cap when the engine is hot, except in emergencies, as this could cause serious personal injury. Steam or hot fluid could spray out.

- 1 Place a suitable collection vessel beneath the engine block drain plug (1) and at the heat exchanger drain tap.
- 2 Open the drain plug (1) and drain tap and drain all coolant.
- 3 Collect the old coolant and hand it to a recycling depot for disposal.



P0008352

### Raw water system

#### **⚠ WARNING!**

Risk of water entry. Close the seawater cocks before doing any work on the seawater system.

- 1 Close the sea cock (1) or the valve on the S-drive. Remove the raw water pump cover (2) and let the water run out.
- 2 Undo the hoses (3) from the raw water pump and raw water filter at the reverse gear / drive and angle them downwards so the water runs out.
- 3 Check if there are extra taps or plugs at the lowest points of the cooling and exhaust lines. Check carefully that all the water runs out.
- 4 Tighten the hoses and the raw water pump cover. Pump out the bilges.

#### **IMPORTANT!**

Check that no leakage occurs.

## Coolant Level, Checking and Topping Up

### Filling

Flush the cooling system clean before new coolant is added.

Close all drain points and fill up with coolant to the correct level.

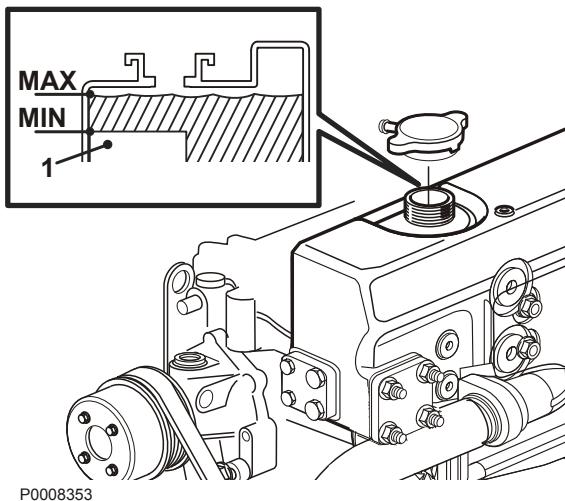
**The engine must be stopped when the cooling system is filled, and must not be started until the system is vented and completely filled.** If a heating installation is connected to the engine cooling system, the heat control valve must be fully open and the installation vented during filling.

Check the hoses and joints and rectify any leaks.

Fill the system slowly! Filling must not be done so fast that air locks are formed in the system. Air must be allowed to flow out through the filler opening. Check the coolant level after the engine has been run for about an hour. Top up with coolant as necessary.

**NOTICE!** It is okey to lift off and heighten the expansion tank to ease the filling.

Check and top up as necessary after the engine has been running warm (open thermostat).



## Checks

### **⚠ WARNING!**

Do not open the coolant filler cap when the engine is hot, except in emergencies, as this could cause serious personal injury. Steam or hot fluid could spray out.

Turn the filler cap to the first stop and allow any excess pressure to hiss out before removing the cap completely. Top up with coolant as necessary. The level should be between the filler opening and the lower edge of the level marker (1). Fit the filler cap.

If a separate expansion tank is fitted (extra equipment), the coolant level must be between the MIN and MAX marks.

## Fault cause

### Coolant temperature too low

Low coolant temperature can be caused by:

- Faulty thermostat
- Faulty temperature sensor or gauge
- Low engine loading

### Excessive coolant temperature

Excessive coolant temperature (warning lamp lights up) can be caused by:

- Blocked raw water inlet or raw water filter
- Defective impeller in the raw water pump
- Too low coolant level; air in the fresh water system
- Slipping or broken circulation pump drive belt
- Faulty thermostat, temperature sensor or gauge
- Blocked cooling system
- Incorrectly set injection timing on the injection pump
- Filler cap gasket does not seal

## Coolant losses

There are two types of coolant losses

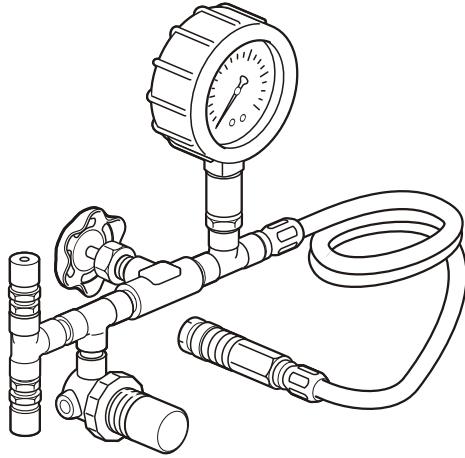
- Coolant losses during operation
- Coolant losses after stopping a hot engine

Coolant losses during operation can be due to a leaking cooling system or air or combustion gases being forced into the cooling system.

## Pressure Valve in Filler Cap, Check

**Tools:**

9996662 Pressure testing kit



- 1 Drain some of the coolant and connect 9996662 Pressure testing kit to a nipple or other plugged hole in the cooling system.
- 2 Extend the drain hose from the filler pipe with a hose that discharges into a water-filled vessel.
- 3 Increase the pressure and read the pressure gauge when the valve opens (water bubbles into the vessel with the drain hose). The valve should open at 0.09 MPa (13 PSI).
- 4 Remove the test equipment. Install the plug and fill the engine with coolant.

# 26-1 Radiator, Heat Exchanger

## Heat exchanger, cleaning

Clean the heat exchanger insert at any sign of blockage (slowly increasing coolant temperature).

**NOTICE!** First check / clean the raw water filter. Also check the raw water pump impeller wheel and the raw water intake.

### IMPORTANT!

Close the sea cock before working on the cooling system.

- 1 Drain the water from the raw water and freshwater systems.
- 2 Disassemble the exhaust manifold together with the heat exchanger.
- 3 Undo the bolts and covers at the front and rear of the heat exchanger. Pull out the insert.
- 4 Flush and clean the insert, both internally and externally. Also clean the housing.  
If there are loose deposits in the insert, cleaning can be performed by passing a suitable steel rod through the tubes in the opposite direction to the water flow.

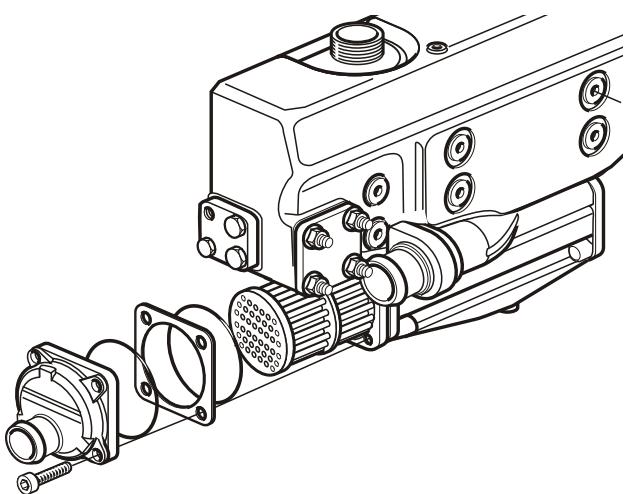
**NOTICE!** Check that the rod does not damage the tubes.

- 5 Install the insert in the heat exchanger.

**NOTICE!** Be careful to install the insert in the correct position.

Make sure the hole in the insert aligns with the hole in the housing and that the venting hole is upwards. The insert is marked "UP".

- 6 Install the covers on the front and rear ends of the heat exchanger. Connect the hose from the raw water pump and tighten the clamp.
- 7 Install the exhaust manifold together with the heat exchanger.
- 8 Fill the engine with coolant.
- 9 Open the sea cock or S-drive tap and start the engine. Check that no leakage occurs.



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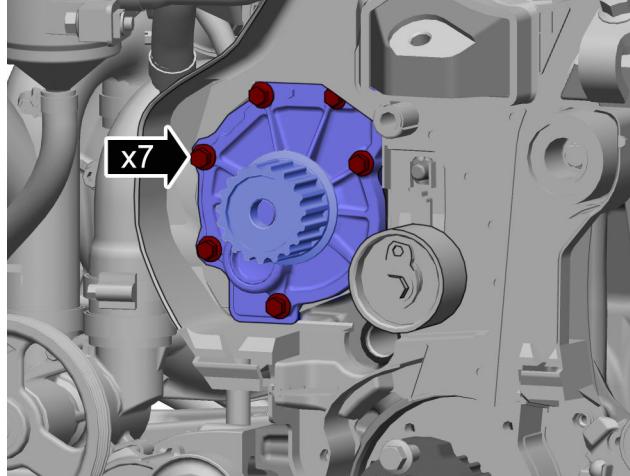
## 26-2 Coolant Pump, Thermostat

### Coolant Pump, Replace

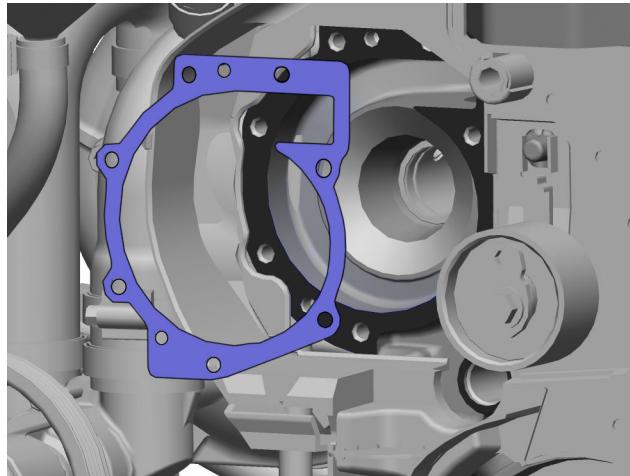
#### Removal

Drain the coolant according to 26-0, *Coolant, Replace*. Remove the camshaft belt according to 21-5, *Camshaft Belt, Replace*.

- 1 Remove the coolant pump.  
**Tightening torque: M6, 10 Nm (7.4 lbf.ft.)**



P0010727



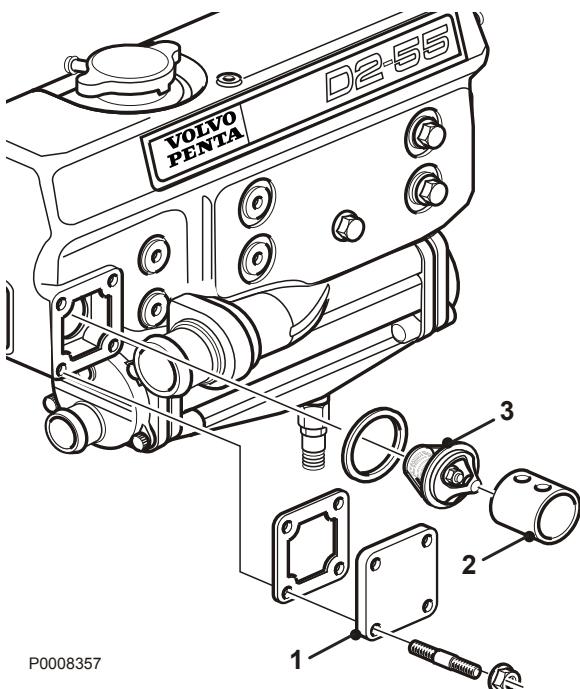
P0010728

- 2 **NOTICE!** Make sure the surface is clean before application.

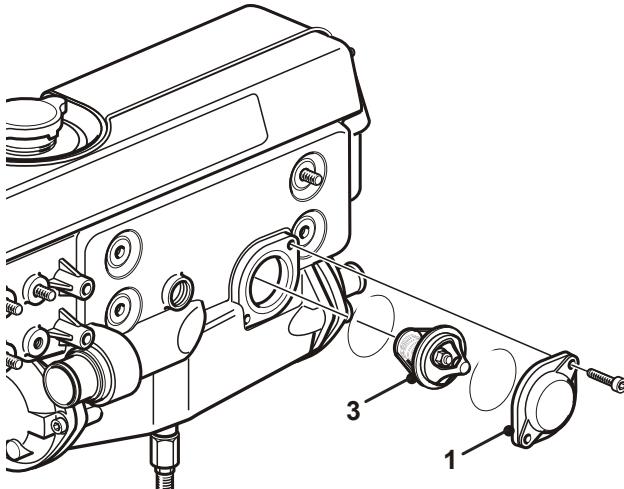
Remove and discard the gasket.

#### Installation

Install in reverse order.



D2-55-A/B



D2-55-C/D/E/F and D2-75

## Thermostat, Replace

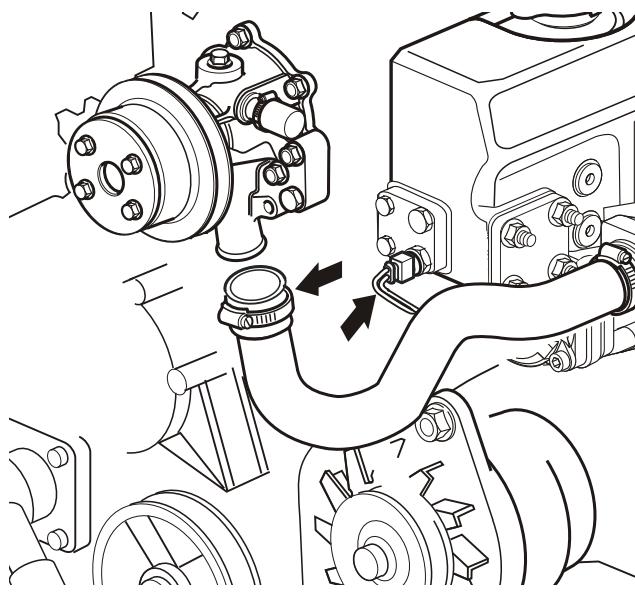
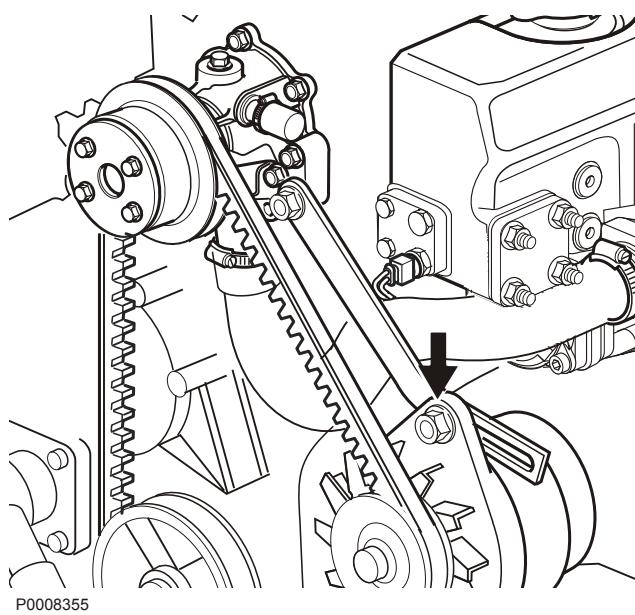
- 1 Disconnect battery power. Drain the water from the freshwater system.
- 2 Remove the cover (1), the spacer (2) and lift out the thermostat (3). Remove the rubber ring.

### Thermostat checks

- 1 Check that the thermostat closes completely.
- 2 heat water in a vessel to 75°C (167°F).
- 3 Immerse the thermostat in the water. Check that the thermostat is still closed after 3-5 minutes.
- 4 Raise the temperature to boiling point (100°C = 212°F). Check that the thermostat has opened at least 8 mm (0.31") after 3-5 minutes. Change the thermostat if it does not fulfill the requirements.

**NOTICE!** If the thermostat does not close completely, the engine will run with too low a temperature.

## Circulation Pump, Replace



### Removal

- 1 Drain the coolant from the engine (freshwater system).
- 2 Undo the alternator and remove the drive belt. Remove the alternator tensioner.

- 3 Remove the rubber hoses to and from the pump.
- 4 Remove the electrical connection from the temperature monitor.
- 5 Remove the pump retaining bolts and lift out the pump.

### Installation

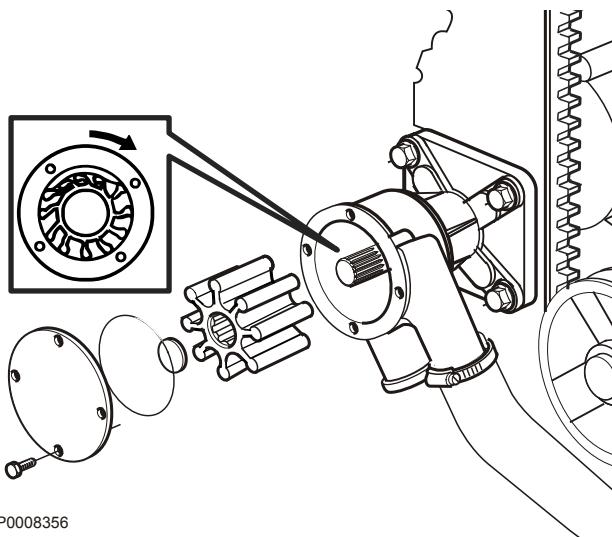
- 1 Clean the contact surfaces on the pump and cylinder block.
- 2 Install the coolant pump with a new gasket.
- 3 Install the alternator tensioner.
- 4 Connect the rubber hoses to the pump inlet and outlet. Tighten the hose clamps.
- 5 Install the drive belt. It should be possible to depress the belt approx. 10 mm (0.4") between the pulleys.
- 6 Reconnect the temperature monitor.
- 7 Fill the engine with coolant. Start the engine and check that no leakage occurs.

# 26-6 Sea Water System, Sea Water Pump

## Seawater Pump, Impeller, Change

Close the sea cock or the S-drive tap before working on the cooling system.

- 1 Remove the pump end cover and drain the water from the raw water system.
- 2 Pull and twist out the impeller with pliers.
- 3 Clean inside the housing. Grease the pump housing and the inside of the cover with a little water-resistant grease intended for rubber.
- 4 Push in the new impeller with a twisting motion (clockwise). Install a **new** O-ring at the outer impeller center.
- 5 Install the cover with a new gasket.
- 6 Open the sea cock, or S-drive tap. Start the engine and check that no leakage occurs.



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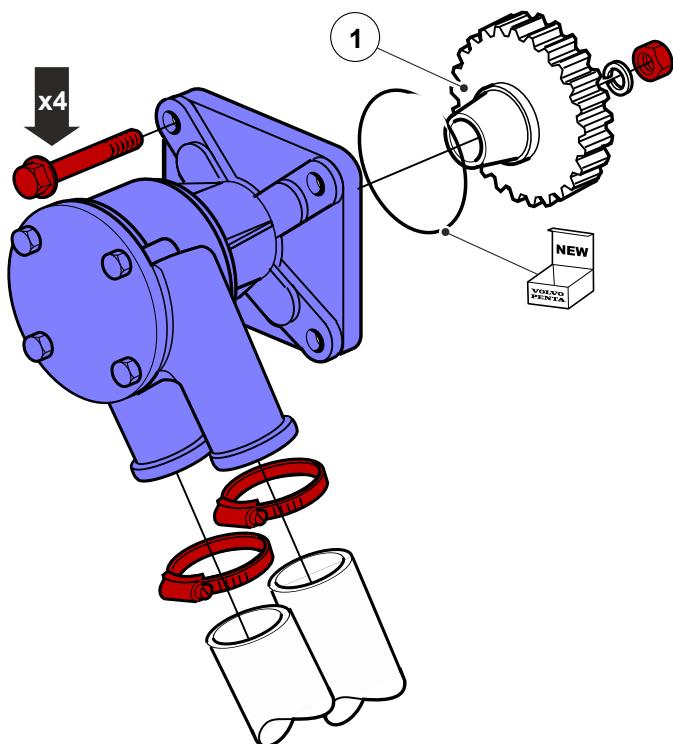
## Seawater Pump, Overhaul

### Tools:

884283 Sleeve

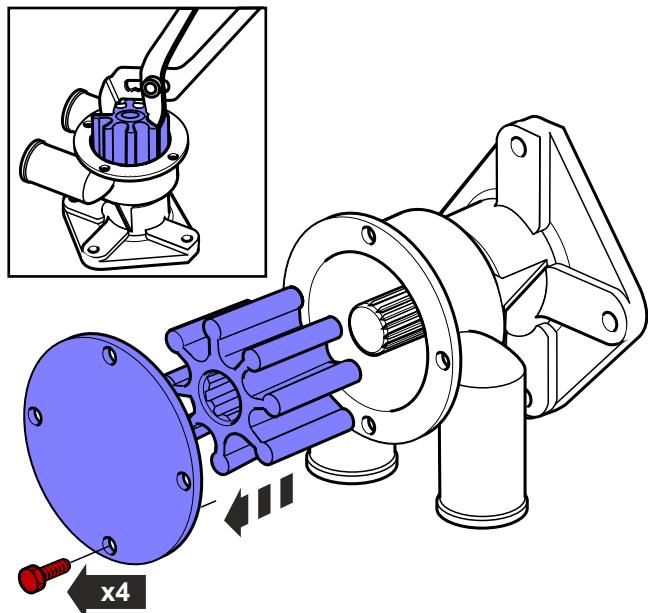
**NOTICE!** Close the sea cock or the valve on the S-drive before working on the cooling system.

### Disassemble



P0017511

- 1 Remove the seawater pump.  
Remove the gearwheel (1) from the seawater pump shaft.

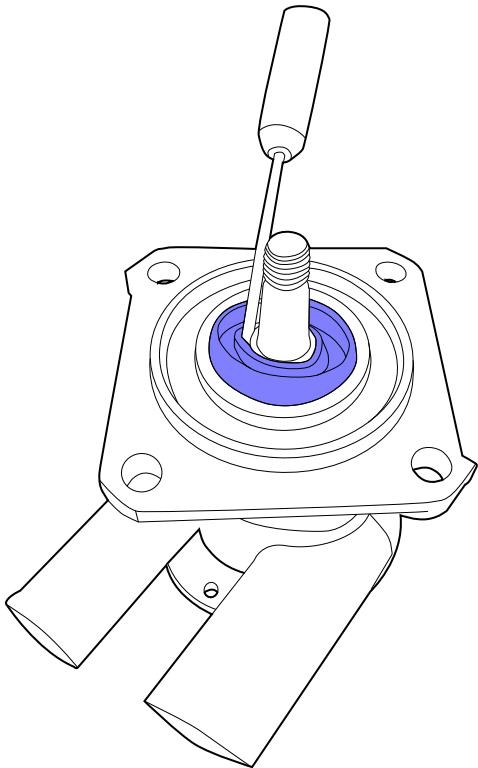


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- 2 Remove the impeller cover.  
Pull out the impeller with the aid of polygrip pliers.

- 3 Remove the seal ring.

**NOTICE!** Because the seal ring must be scrapped it is permissible to damage it.

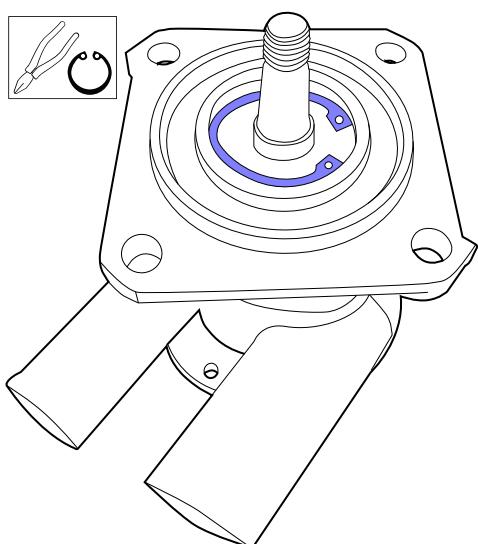


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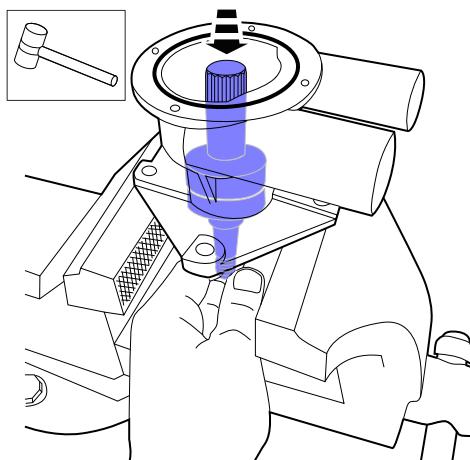
- 4 Remove the retainer ring.

**⚠ CAUTION!**

Risk of eye injury. Eye protection required.

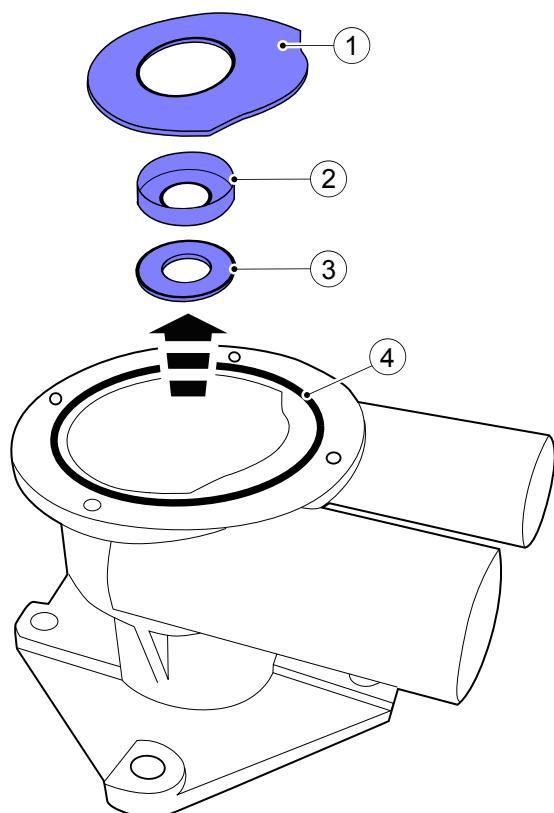


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- 5 Carefully tap out the shaft with the two ball bearings, one retainer ring and the installed O-ring.

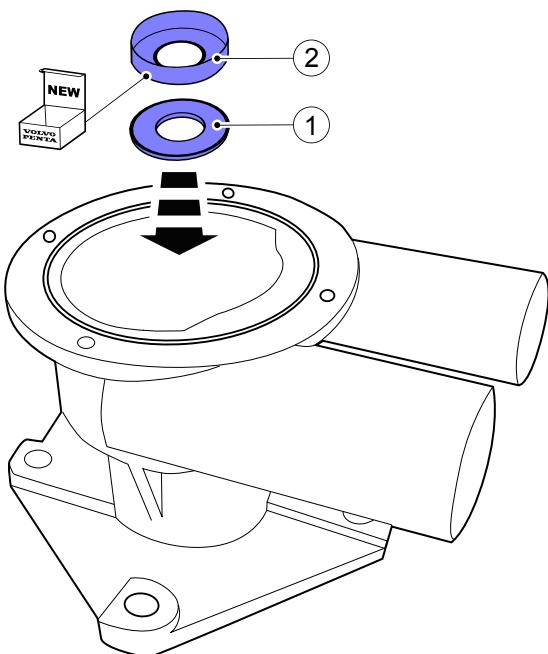


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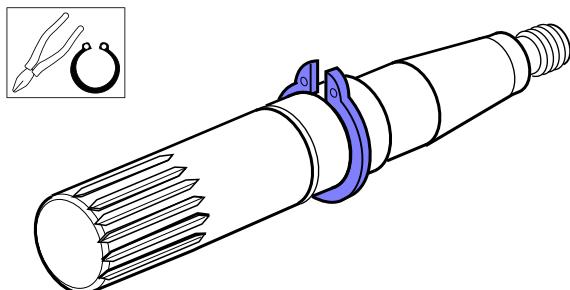
- 6 Remove the wear washer (1), the seal ring (2), washer (3) and the O-ring (4).

**Reassemble**

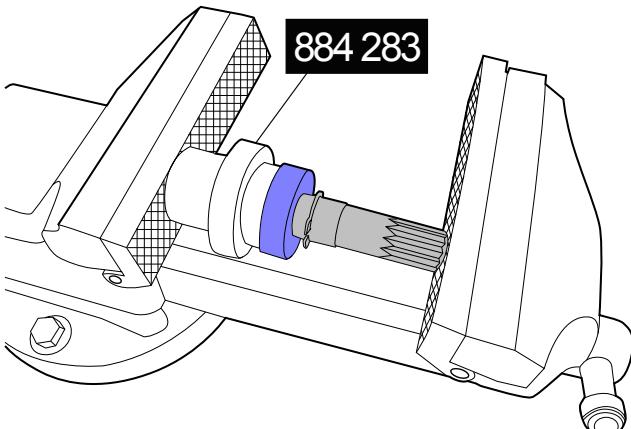
- 7 Install the washer (1) and the seal ring (2).



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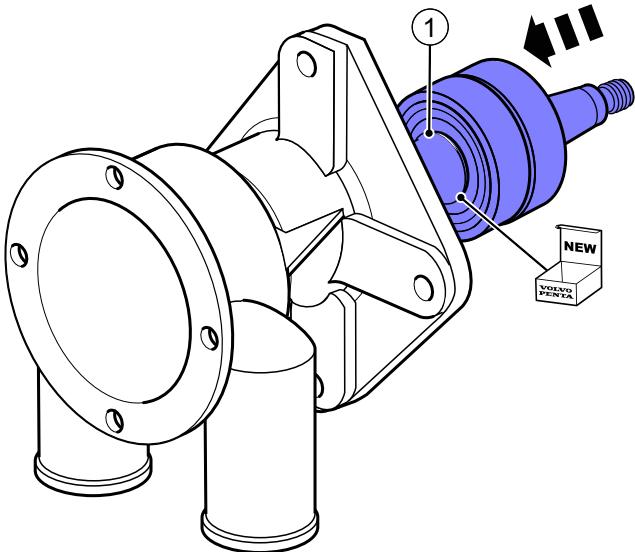
- 8 Install the retainer ring on the shaft.

**CAUTION!**

Risk of eye injury. Eye protection required.

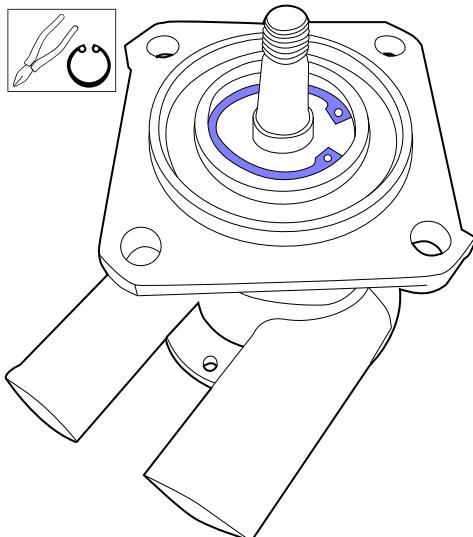
- 9 Carefully press on a ball bearing either side of the retainer ring.

**NOTICE!** Use a suitable sleeve, e.g. 884283 Sleeve to avoid damage to the ball bearings.



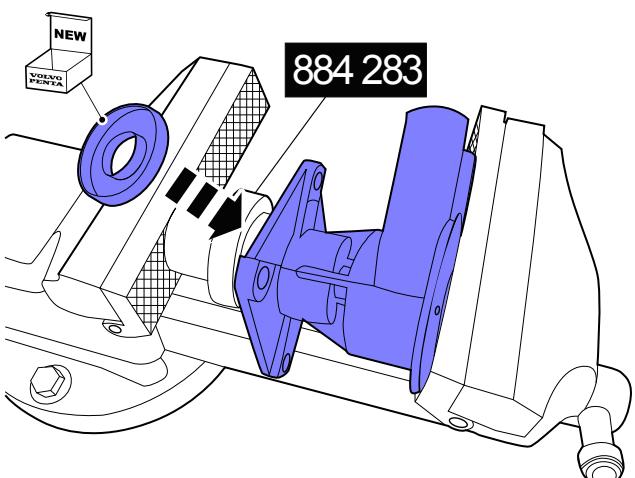
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- 10 Fit the O-ring (1) onto the shaft.  
Press the shaft into the seawater pump housing, preferably with the aid of a vise.



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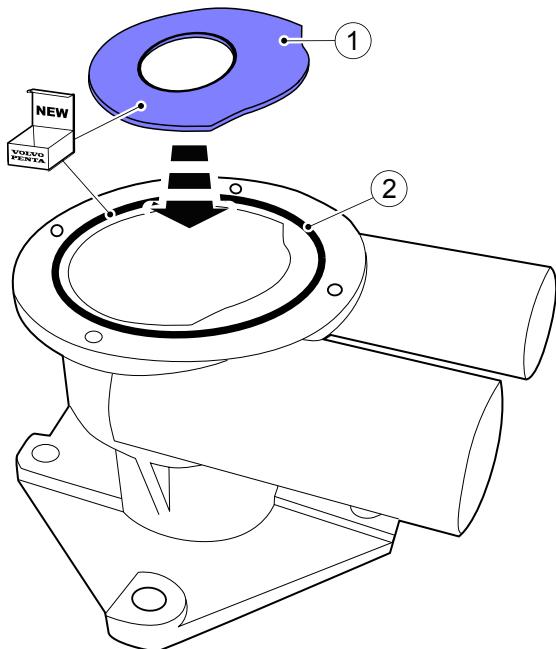
- 11 Fit the retainer ring into the groove in the seawater pump housing.



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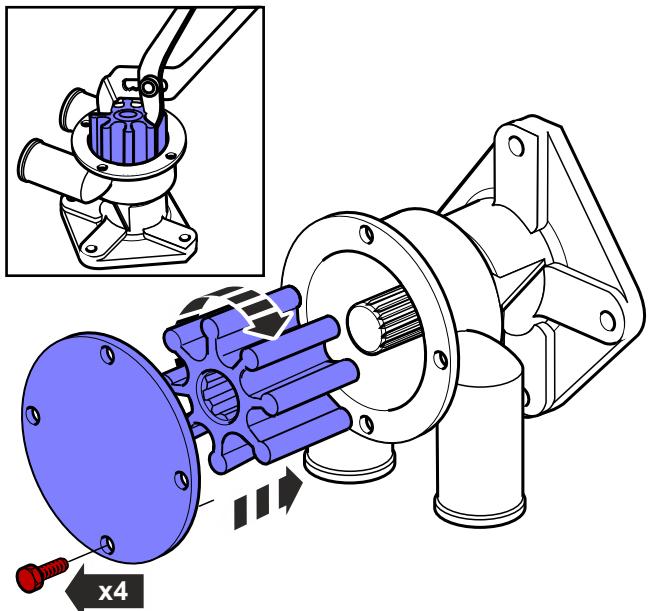
- 12 Press on the seal ring.

**NOTICE!** Use a suitable sleeve, e.g.  
884283 Sleeve.



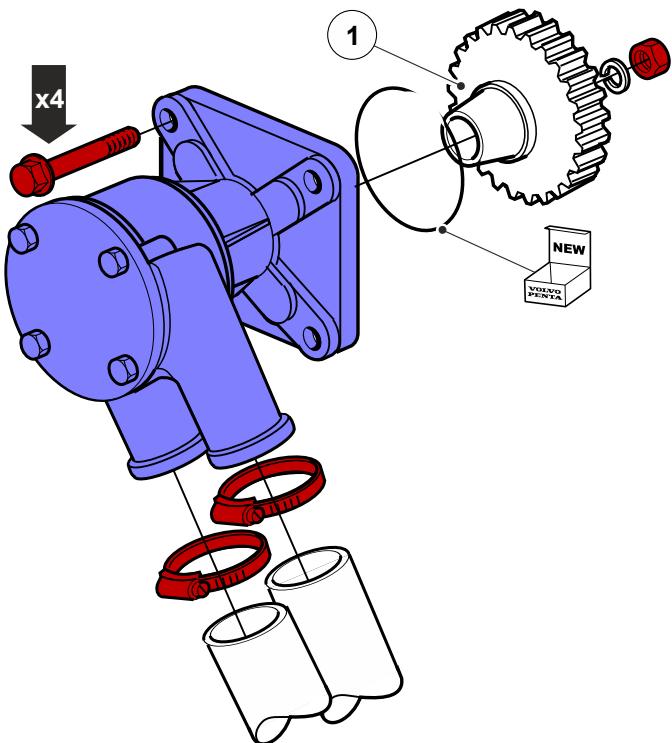
- 13 Install the wear washer (1).  
Install the O-ring (2).

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- 14 Press in the impeller with a rotating movement (clockwise).  
Install the impeller cover.

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- 15 Fit a new O-ring and the gearwheel (1) with a washer and nut on the seawater pump shaft. Install the seawater pump.

#### Finishing off

- 16 Open the sea cock, or S-drive valve. Start the engine and check that no leakage occurs.

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## **References to Service Bulletins**

**Group No.**

Date

## Refers to



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Do you have any comments or other viewpoints concerning this manual? Make a copy of this page, and write down your comments and send them to us. The address is at the bottom of the page. We would prefer you to write in Swedish or English.

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