

# **Workshop Manual**

**Engine unit**

<b>A</b>
<b>2(0)</b>

**2001, 2002, 2003, 2003T**



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# *Engine unit*

*2001, 2002, 2003, 2003T*

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# Safety Precautions


## Introduction


This Workshop Manual contains technical specifications, descriptions and instructions for the repair of the Volvo Penta products or product types described in the Table of Contents. Check that you have the correct Workshop Manual for your engine.

**Before starting work on the engine read the "Safety Precautions", "General Information" and "Repair Instruction" sections of this Workshop Manual carefully.**

## Important


In this book and on the product you will find the following special warning symbols.


 **WARNING!** Possible danger of personal injury, extensive damage to property or serious mechanical malfunction if the instructions are not followed.


 **IMPORTANT!** Used to draw your attention to something that can cause damage or malfunctions on a product or damage to property.


**Note!** Used to draw your attention to important information that will facilitate the work or operation in progress.


Below is a summary of the risks involved and safety precautions you should always observe or carry out when operating or servicing the engine.


 Immobilize the engine by turning off the power supply to the engine at the main switch (switches) and lock it (them) in the OFF position before starting work. Set up a warning notice at the engine control point or helm.


 As a general rule all service operations must be carried out with the engine stopped. However, some work, for example certain adjustments require that the engine is running when they are carried out. Approaching an engine which is operating is a safety risk. Loose clothing or long hair can fasten in rotating parts and cause serious personal injury. If working in proximity of an engine which is operating, careless movements or a dropped tool can result in personal injury. Take care to avoid contact with hot surfaces (exhaust pipes, Turbocharger (TC), air intake pipe, start element etc.) and hot liquids in lines and hoses on an engine which is running or which has just been stopped. Reinstall all protective parts removed during service operations before starting the engine.


 Check that the warning or information labels on the product are always clearly visible. Replace labels which have been damaged or painted over.


 Engines with turbocharger (TC): Never start the engine without installing the air cleaner (ACL) filter. The rotating compressor in the Turbo can cause serious personal injury. Foreign objects entering the intake ducts can also cause mechanical damage.



 Never use start spray products or similar when starting the engine. They may cause an explosion in the inlet manifold. Danger of personal injury.

 Avoid opening the filler cap for engine coolant system (freshwater cooled engines) when the engine is still hot. Steam or hot coolant can spray out. Open the filler cap slowly and release the pressure in the system. Take great care if a cock, plug or engine coolant line must be removed from a hot engine. Steam or hot coolant can spray out in any direction.

 Hot oil can cause burns. Avoid getting hot oil on the skin. Ensure that the lubrication system is not under pressure before carrying out any work. Never start or operate the engine with the oil filler cap removed, otherwise oil could be ejected.

 Stop the engine and close the sea cock before carrying out operations on the engine cooling system.

 Only start the engine in a well-ventilated area. If operating the engine in an enclosed area ensure that there is exhaust ventilation leading out of the engine compartment or workshop area to remove exhaust gases and crankcase ventilation emissions.

-  Always use protective glasses or goggles when carrying out work where there is a risk of splinters, grinding sparks, acid splashes or where other chemicals are used. The eyes are extremely sensitive, an injury could result in blindness!
-  Avoid getting oil on the skin! Repeated exposure to oil or exposure over a long period can result in the skin becoming dry. Irritation, dryness and eczema and other skin problems can then occur. Used oil is more dangerous than fresh oil from a health aspect. Use protective gloves and avoid oil soaked clothes and shop rags. Wash regularly, especially before eating. There are special skin creams which counteract drying out of the skin and make it easier to clean off dirt after work is completed.
-  Many chemicals used on the product (for example engine and transmission oils, glycol, gasoline and diesel oil), or chemicals used in the workshop (for example degreasing agents, paint and solvents) are dangerous to health. Read the instructions on the product packaging carefully! Always follow the safety precautions for the product (for example use of protective mask, glasses, gloves etc.). Make sure that other personnel are not exposed to hazardous chemicals, for example in the air. Ensure good ventilation in the work place. Follow the instructions provided when disposing of used or leftover chemicals.
-  Exercise extreme care when leak detecting on the fuel system and testing the fuel injector jets. Use eye protection. The jet from a fuel injector nozzle is under extremely high pressure and has great penetrative energy, so the fuel can penetrate deep into the body tissue and cause serious personal injury. Danger of blood poisoning.
-  All fuels and many chemical substances are flammable. Do not allow naked flame or sparks in the vicinity. Fuel, certain thinner products and hydrogen from batteries can be extremely flammable and explosive when mixed with air. Smoking is not to be permitted in the vicinity! Ensure that the work area is well ventilated and take the necessary safety precautions before starting welding or grinding work. Always ensure that there are fire extinguishers at hand when work is being carried out.
-  Ensure that rags soaked in oil or fuel and used fuel or oil filters are stored safely. Rags soaked in oil can spontaneously ignite under certain circumstances. Used fuel and oil filters are environmentally dangerous waste and must be deposited at an approved site for destruction together with used lubricating oil, contaminated fuel, paint remnants, solvent, degreasing agents and waste from washing parts.
-  Never expose a battery to naked flame or electrical sparks. Never smoke in proximity to the batteries. The batteries give off hydrogen gas during charging which when mixed with air can form an explosive gas - oxyhydrogen. This gas is easily ignited and highly volatile. Incorrect connection of the battery can cause a single spark which is sufficient to cause an explosion with resulting damage. Do not shift the connections when attempting to start the engine (spark risk) and do not lean over any of the batteries.
-  Always ensure that the Plus (positive) and Minus (negative) battery leads are correctly installed on the corresponding terminal posts on the batteries. Incorrect installation can result in serious damage to the electrical equipment. Refer to the wiring diagrams.
-  Always use protective goggles when charging and handling the batteries. Battery electrolyte contains sulfuric acid which is highly corrosive. Should the battery electrolyte come into contact with unprotected skin wash off immediately using plenty of water and soap. If battery acid comes in contact with the eyes, immediately flush with plenty of water and obtain medical assistance at once.
-  Turn the engine off and turn off the power at the main switch(es) before carrying out work on the electrical system.
-  Clutch adjustments must be carried out with the engine stopped.



Use the lifting eyes fitted on the engine/reverse gear when lifting the drive unit. Always check that the lifting equipment used is in good condition and has the load capacity to lift the engine (engine weight including reverse gear and any extra equipment installed).

Use an adjustable lifting beam or lifting beam specifically for the engine to raise the engine to ensure safe handling and to avoid damaging engine parts installed on the top of the engine. All chains and cables should run parallel to each other and as perpendicular as possible in relation to the top of the engine.

If extra equipment is installed on the engine which alters its center of gravity a special lifting device is required to obtain the correct balance for safe handling.

Never carry out work on an engine suspended on a hoist without other supporting equipment attached.



Never work alone when removing heavy engine components, even when using lifting devices such as locking tackle lifts. When using a lifting device two people are usually required to do the work, one to take care of the lifting device and another to ensure that components are lifted clear and not damaged during the lifting operations. If working onboard a boat check before starting work if there is enough room to carry out removal work without risking personal injury or damage to the engine or parts.



The components in the electrical system, in the ignition system (gasoline engines) and in the fuel system on Volvo Penta products are designed and manufactured to minimize the risk of fire and explosion. The engine must not be run in areas where there are explosive materials.



Always use the fuels recommended by Volvo Penta. Refer to the Instruction manual. Use of fuels that are of a lower quality can damage the engine. On a diesel engine poor quality fuel can cause the actuating rod to seize and the engine to overrev with resulting risk of damage to the engine and personal injury. Poor fuel quality can also lead to higher maintenance costs.

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# General Information

## About this Workshop Manual

This Workshop Manual contains technical specifications, descriptions and instructions for the repair of the following engines in standard format: 2001, 2002, 2003, 2003T. This Workshop Manual can show operations carried out on any of the engines listed above. As a result the illustrations and pictures in the manual that show certain parts on the engines, do not in some cases apply to all the engines listed. However the repair and service operations described are in all essential details the same. Where they are not the same this is stated in the manual and where the difference is considerable the operations are described separately. The Engine Designations and Engine Number can be found on the product plate (refer to page 14). Please always include both the engine designation and the engine number in all correspondence.

The Workshop Manual is produced primarily for the use of Volvo Penta workshops and service technicians. For this reason the manual presupposes a certain basic knowledge of marine propulsion systems and that the user can carry out the mechanical/electrical work described to a general standard of engineering competence.

Volvo Penta products are under a continual process of development and we therefore reserve all rights regarding changes and modifications. All the information in this manual is based on product specifications available at the time the book was published. Any essential changes or modifications introduced into production or updated or revised service methods introduced after the date of publication will be provided in the form of Service Bulletins.

## Replacement parts

Replacement parts for the electrical and fuel systems are subject to various national safety requirements, for example the United States Coast Guard Safety Regulations. Volvo Penta Original Spare Parts meet these specifications. Any type of damage which is the result of using replacement parts that are not original Volvo Penta replacement parts for the product in question will not be covered under any warranty or guarantee provided by AB Volvo Penta.

## Certificated engines

Engines certificated to meet national and regional environmental legislation (for example Lake Constance) carry with them an undertaking from the manufacturer that both new and existing engines in use meet the environmental demands of the legislation. The product must correspond to the validated example that was granted certification. In order for Volvo Penta as the manufacturer to take responsibility for engines in use, certain requirements regarding service and spare parts must be met by the user according to the following:

- The Service Intervals and maintenance operations recommended by Volvo Penta must be followed.
- Only Volvo Penta Original Spare Parts intended for the certificated engine may be used.
- Service work on the ignition system, timing and fuel injection system (gasoline) or injection pump and injectors (diesel) must always be carried out by an authorized Volvo Penta workshop.
- The engine may not be altered or modified in any way, with the exception of accessories and service kits developed by Volvo Penta for that engine.
- No modifications to the exhaust pipes and air supply ducts for the engine room (ventilation ducts) may be undertaken as this may effect exhaust emissions.
- Any seals on the engine may not be broken other than by authorized persons.



**IMPORTANT!** If replacement parts are required use only Volvo Penta Original Parts. **Use of replacement parts other than AB Volvo Penta Original Parts will result in AB Volvo Penta being unable to assume any liability that the engine corresponds to the certificated engine variant.** Volvo Penta AB excludes any liability for all and any type of damage or costs caused by the use of replacement parts that are not Volvo Penta Original Parts for the product in question.

# Repair instructions and methods

The working methods described in the Workshop Manual apply to work carried out in a workshop. The engine has been removed from the boat and is installed in an engine fixture. Unless otherwise stated reconditioning work which can be carried out with the engine in place follows the same working method.

Warning symbols used in this Workshop Manual (for full explanation of the symbols refer to the section; "Safety Precautions")



**WARNING!**



**IMPORTANT!**

**Note!**

are not in any way comprehensive since it is impossible to predict every circumstance under which service work or repairs may be carried out. Volvo Penta AB can only indicate the risks considered likely to occur as a result of incorrect working methods in a well-equipped workshop using working methods and tools tested by Volvo Penta AB.

All operations described in the Workshop Manual for which there are Volvo Penta Special Tools available assume that these tools are used by the service technician or person carrying out the repair. Volvo Penta Special Tools have been specifically developed to ensure as safe and rational working methods as possible. It is therefore the responsibility of the person or persons using other than Volvo Penta Special Tools or approved Volvo Penta working methods (as described in a Workshop Manual or Service Bulletin), to acquaint themselves of the risk of personal injury or actual mechanical damage or malfunction that can result from failing to use the prescribed tools or working method.

In some cases special safety precautions and user instructions may be required in order to use the tools and chemicals mentioned in the Workshop Manual. Always follow these precautions as there are no specific instructions given in the Workshop Manual.

By following these basic recommendations and using common sense it is possible to avoid most of the risks involved in the work. A clean work place and a clean engine will eliminate many risks of personal injury and engine malfunction.

Above all when working on the fuel system, engine lubrication system, air intake system, Turbocharger unit, bearing seals and seals it is extremely important to observe the highest standards of cleanliness and avoid dirt or foreign objects entering the parts or systems, since this can result in reduced service life or malfunctions.

## Our joint responsibility

Every engine consists of many systems and components that work together. If one component deviates from the technical specifications this can have dramatic consequences on the environmental impact of the engine even if it is otherwise in good running order. It is therefore critical that the stated wear tolerances are observed, that systems which can be adjusted are correctly set up and that only Volvo Penta Original Parts are used on the engine. The stated service intervals in the Maintenance Schedule must be followed.

Some systems, such as the components in the fuel system, require special expertise and special testing equipment for service and maintenance. Some components are factory sealed for environmental and product specific reasons. Under no circumstances attempt to service or repair a sealed component unless the service technician carrying out the work is authorized to do so.

Bear in mind that most of the chemicals used around boats are harmful to the environment if used incorrectly. Volvo Penta recommends the use of bio-degradable degreasing agents for all cleaning of engine components unless otherwise stated in the Workshop Manual. When working onboard a boat make a special point of preventing oil, waste water from washing components entering the bilges; instead remove all such waste for safe disposal at an approved site for destruction.

## Tightening torques

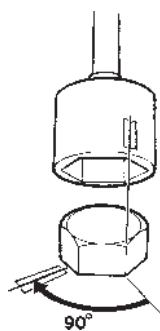
The correct tightening torques for critical joints which must be tightened using a torque wrench are listed under "Technical Specifications -Tightening Torques" and stated in the method descriptions in the Workshop Manual. All tightening torques apply to cleaned threads, bolt heads and mating surfaces. Tightening torques stated are for lightly oiled or dry threads. Where grease, locking or sealing agents are required for screwed joints this is stated in both the operation description and in "Tightening Torques". Where no tightening torque is stated for a joint use the general tightening torques according to the tables below. The tightening torques stated are a guide and the joint does not have to be tightened using a torque wrench.

### Dimension Tightening torque

	Nm	ft.lbs
M5 .....	5	3.6
M6 .....	10	7.3
M8 .....	20	14.7
M10 .....	40	29.5
M12 .....	70	51.6
M14 .....	115	84.8



## Tightening torque with Protractor tightening (angle tightening)



Tightening using both a torque setting and a protractor angle requires that first the recommended torque is applied using a torque wrench and then the recommended angle is added according to the protractor scale. Example: a 90° protractor tightening means that the joint is tightened a further 1/4 turn in one operation after the stated tightening torque has been applied.

## Lock nuts

Do not re-use lock nuts that have been removed during disassembly operations as these have reduced service life when re-used - use new nuts when assembling or reinstalling. For lock nuts with a plastic insert such as Nylock® the tightening torque stated in the table is reduced if the Nylock® nut has the same head height as a standard hexagonal nut without plastic insert. Reduce the tightening torque by 25% for bolt size 8 mm or larger. Where Nylock® nuts are higher, or of the same height as a standard hexagonal nut, the tightening torques given in the table apply.

## Strength classes

Bolts and nuts are divided up into different classes of strength; the class is indicated by the number on the bolt head. A high number indicates stronger material, for example a bolt marked 10-9 indicates a higher strength than one marked 8-8. It is therefore important that bolts removed during the disassembly of a bolted joint must be reinstalled in their original position when assembling the joint. If a bolt must be replaced check in the replacement parts catalogue to make sure the correct bolt is used.

## Sealant

A number of sealants and locking liquids are used on the engines. The agents have varying properties and are used for different types of jointing strengths, operating temperature ranges, resistance to oil and other chemicals and for the different materials and gap sizes in the engines.

To ensure service work is correctly carried out it is important that the correct sealant and locking fluid type is used on the joint where the agents are required.

In this Volvo Penta Workshop Manual the user will find that each section where these agents are applied in production states which type was used on the engine.

During service operations use the same agent or an alternative from a different manufacturer.

Make sure that mating surfaces are dry and free from oil, grease, paint and anti-corrosion agent before applying sealant or locking fluid. Always follow the manufacturer's instructions for use regarding temperature range, curing time and any other instructions for the product.

Two different basic types of agent are used on the engine and these are:

RTV agent (Room temperature vulcanizing). Used for gaskets, sealing gasket joints or coating gaskets. RTV is visible when a part has been disassembled; old RTV must be removed before resealing the joint.

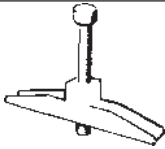




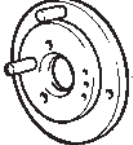
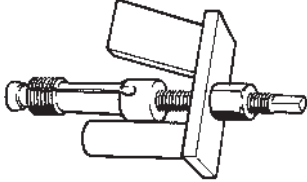

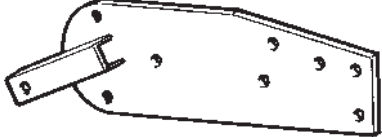

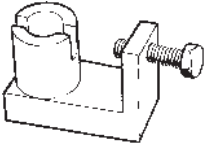

The following RTV agents are mentioned in the Service Manual: Loctite® 574, Volvo Penta P/N 840879-1, Permatex® No. 3, Volvo Penta P/N 1161099-5, Permatex® Nr 77. Old sealant can be removed using methylated spirits in all cases.

Anaerobic agents. These agents cure in an absence of air. They are used when two solid parts, for example cast components, are installed face-to-face without a gasket. They are also commonly used to secure plugs, threads in stud bolts, cocks, oil pressure switches and so on. The cured material is glass-like and it is therefore colored to make it visible. Cured anaerobic agents are extremely resistant to solvents and the old agent cannot be removed. When reinstalling the part is carefully degreased and then new sealant is applied.

The following anaerobic agents are mentioned in the Workshop Manual: Loctite® 572 (white), Loctite® 241 (blue).

**Note:** Loctite® is the registered trademark of Loctite Corporation, Permatex® the registered trademark of the Permatex Corporation.

## *Special tools*

9992265-0		Pulley puller
884813-7		Installation ring for piston
9995218-6		Mandrel for valve guide removal
884557-0		Mandrel for installation of injector sleeve
884559-6		Mandrel for installation of valve guide
884787-3		Setting-disc for injection pump seeing
884811-1		Puller for injector sleeve
884823-6		Flaring tool for injector sleeve
884837-6		Flange for engine cradle
884838-4		Mandrel for installation of sealing ring in transmission
884839-2		Assembly and disassembly tool for camshaft pin
884840-0		Guide pin for cylinder head. <b>NOTE!</b> Two tools are required.

# Technical data

## General

	2001	2002	2003
Type designation .....			
Output <sup>1)</sup> at 53 r/s (3200 rpm) .....	6.6 kW (9.0 hp)	13.2 kW (18.0 hp)	20.6 kW (28.0 hp)
Output <sup>1)</sup> at 53 r/s (3200 rpm) 2003T .....			33.1 kW (45.0 hp)
Number of cylinders .....	1	2	3
Displacement .....	0.43 dm <sup>3</sup> (26.2 cu.in)	0.852 dm <sup>3</sup> (51.9 cu.in)	1.278 dm <sup>3</sup> (77.99 cu.in)
Cylinder bore .....		79 mm (3.11024 in)	
Stroke .....		87 mm (3.4252 in)	
Compression ratio .....		17.5:1	
Compression ratio at starter motor speed .....		2 – 2.5 MPa (290 – 362 psi)	
Direction of rotation (seen from the front end) .....		Clockwise	
Idling speed .....		13 – 14 r/s (775 – 825 rpm)	
Oil pressure at full speed and warm engine .....		0.35 – 0.40 MPa (50 – 58 psi)	
Oil pressure at idling and warm engine .....		0.08 – 0.15 MPa (11 – 22 psi)	

## Cylinder block

Material .....	Special alloy cast iron
Cylinder diameter, standard .....	79.00 – 79.03 (3.11025 – 3.11142 in.)
0.25 mm over-size .....	79.25 – 79.28 (3.12008 – 3.12126 in.)
0.50 mm over-size .....	79.50 – 79.53 (3.12992 – 3.13110 in.)

## Pistons

Material .....	Light-alloy
Total height .....	78.3 mm (3.08268 in.)
Height from gudgeon pin center to piston top .....	50.3 mm (1.98031 in.)
Piston clearance in cylinder .....	0.09 mm (.00354 in.)
Piston in standard dimension .....	78.903 – 78.917 mm (3.10642 – 3.10697 in.)
0.25 mm over-size .....	79.153 – 79.167 mm (3.11626 – 3.11681 in.)
0.50 mm over-size .....	79.403 – 79.417 mm (3.12610 – 3.12665 in.)

## Gudgeon pins

Diameter .....	25.995 – 26.000 mm (1.02343 – 1.02362 in.)
Gudgeon pin bushing, diameter .....	26.005 – 26.011 mm (1.02382 – 1.02406 in.)
Clearance gudgeon pin – bushing .....	0.0050 – 0.0160 mm (0.00020 – 0.0063 in.)

## Piston rings

Compression ring, number .....	2
Oil ring, number .....	1
The upper compression ring has an inlay of chrome.	
The piston rings are available for standard dimension and for 0.25 mm (0.00984 in.) and 0.50 mm (0.01969 in.) over-size	

## Piston ring clearance in the groove

Upper compression ring .....	0.070 – 0.102 mm (0.00276 – 0.00402 in.)
Lower compression ring .....	0.050 – 0.082 mm (0.00197 – 0.00323 in.)
Oil ring .....	0.030 – 0.062 mm (0.00118 – 0.00244 in.)

<sup>1)</sup> Propeller shaft output in accordance with DIN 6270B.

**Piston ring gap in the cylinder**

Upper compression ring .....	0.30 – 0.50 mm (0.001181 – 0.00197 in.)
Lower compression ring .....	0.30 – 0.50 mm (0.001181 – 0.00197 in.)
Oil ring .....	0.25 – 0.50 mm (0.009842 – 0.00197 in.)

**Crankshaft**

Material .....	Nodular iron
Crankshaft axial clearance .....	0.040 – 0.221 mm (0.00157 – 0.00870 in.)
Main bearing radial clearance .....	0.040 – 0.092 mm (0.00157 – 0.00362 in.)
Big-end bearing, radial clearance .....	0.024 – 0.068 mm (0.00094 – 0.00268 in.)

**Main bearing journals**

Diameter, standard .....	59.987 – 60.000 mm (2.36169 – 2.36220 in.)
0.250 mm over-size .....	59.737 – 59.750 mm (2.35185 – 2.35236 in.)
0.500 mm over-size .....	59.487 – 59.500 mm (2.34200 – 2.34252 in.)

**Main bearing shells**

Thickness, standard .....	2.987 – 2.997 mm (0.11760 – 0.11799 in.)
0.250 mm over-size .....	3.112 – 3.122 mm (0.12252 – 0.12291 in.)
0.500 mm over-size .....	3.237 – 3.247 mm (0.12744 – 0.12783 in.)

**Big-end journals**

Diameter, standard .....	47.989 – 48.000 mm (1.88933 – 1.88976 in.)
0.250 mm over-size .....	47.739 – 47.750 mm (1.87949 – 1.87992 in.)
0.500 mm over-size .....	47.489 – 47.500 mm (1.86965 – 1.87008 in.)

**Big-end bearing shells**

Thickness, standard .....	1.478 – 1.488 mm (0.05819 – 0.05858 in.)
0.250 mm over-size .....	1.603 – 1.613 mm (0.06311 – 0.06350 in.)
0.500 mm over-size .....	1.728 – 1.738 mm (0.06803 – 0.06843 in.)

**Connecting rods**

Axial clearance at the crankshaft .....	0.15 – 0.35 mm (0.00590 – 0.01378 in.)
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**Camshaft**

Axial clearance .....	0.160 – 0.300 mm (0.0063 – 0.01181 in.)
Radial clearance in bearings .....	0.020 – 0.075 mm (0.000787 – 0.00295 in.)
Camshaft diameter .....	46.975 – 47.000 mm (1.8494 – 1.85039 in.)
Lifting height of cams .....	5.48 – 5.52 mm (0.21575 – 0.21732 in.)
Bushing diameter .....	47.02 – 47.05 mm (1.85118 – 1.85236 in.)

**Cylinder head**

Material .....	Special alloy cast iron
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**Inlet valves**

Disc diameter .....	34.4 – 34.6 mm (1.35433 – 1.36220 in.)
Stem diameter .....	7.955 – 7.970 mm (0.31319 – 0.31378 in.)
Valve seat angle .....	44°55' – 44°85'
Cylinder head seat angle .....	45°
Seat width in the cylinder head .....	appr. 1 mm (0.03937 in.)
Clearance, cold/warm engine .....	0.3 mm (0.011811 in.)

**Exhaust valves**

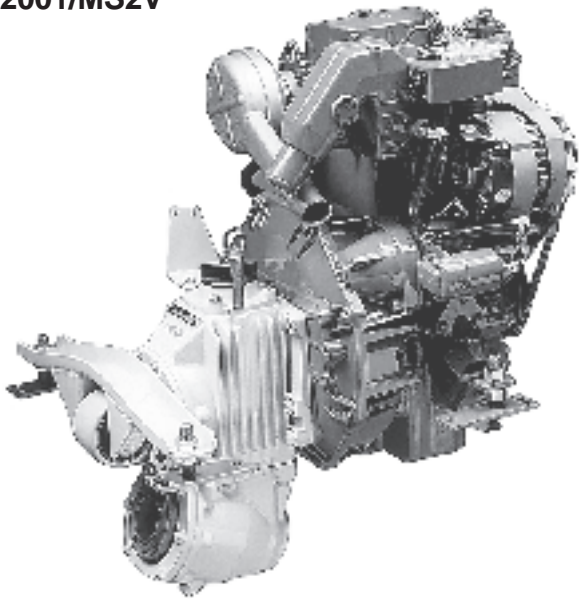
Disc diameter 2001, 2002, 2003 .....	29.9 – 30.1 mm (1.14716 – 1.18504 in.)
Disc diameter 2003T .....	35.8 – 36.0 mm (1.40944 – 1.41732 in.)
Stem diameter .....	7.950 – 7.965 mm (0.31319 – 0.31378 in.)
Valve seat angle 2001, 2002, 2003 .....	44°55' – 44°85'
Valve seat angle 2003T .....	29°45' – 30°15'
Cylinder head seat angle 2001, 2002, 2003 .....	45°
Cylinder head seat angle 2003T .....	30°
Seat width in the cylinder head .....	appr. 1 mm (0.03937 in.)
Clearance, cold/warm engine .....	0.3 mm (0.011811 in.)



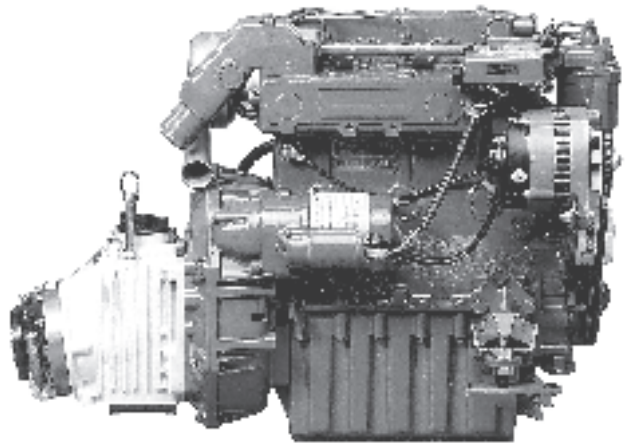
Injected quantity .....	25±1,5 mm <sup>3</sup> /stroke at 40±5°C (104°F ±10.6°F) and at 1500 rpm pump revs
Governor overrun .....	3250 rpm
<b>Turbo charger (2003T)</b>	
Boost pressure at full load / 3200 rpm, 20°C (68°F) .....	100 – 120 kPa (14.5 – 17.4 psi)
<b>Feed pump</b>	
Feed pressure at 2500 rpm .....	0.65 – 0.85 kp/cm <sup>2</sup> (9.20 – 12.10 psi)
<b>Electrical system</b>	
Battery voltage .....	12V
Battery capacity .....	Max. 70 Ah
Starter motor output 2001 .....	0.8 kW (1.1 Hp)
Starter motor output 2002 and 2003 .....	1.4 kW (1.9 Hp)
Alternator output, voltage/current .....	14V/50A
output .....	700 W
Electrolyte spec. gravity:	
Fully loaded battery .....	1.275 – 1.285
To be charged at .....	1.230
<b>Cooling system</b>	
Thermostat (sea water cooling) .....	Wax thermostat
Starts opening at .....	60± 2°C (140 ± 4°F)
Fully open at .....	75°C (165°F)
With fresh water cooling (2002, 2003, 2003T)	
Starts opening at .....	74±1°C (± 2°F)
Fully open at .....	87°C (189°F)
Fresh-water system, volume 2002 .....	4.0 L (4.2 US qts)
2003 .....	5.5 L (5.8 US qts)
2003T .....	7.0 L (7.4 US qts)
<b>Wear Tolerances</b>	
<b>Cylinders</b> .....	To be bored at 0.25 mm (0.00984 in.) wear.
<b>Crankshaft</b>	
Main- and big-end journals:	
Permitted out of round .....	0.06 mm (0.00236 in.)
Permitted taper .....	0.05 mm (0.00197 in.)
Max. axial clearance on crankshaft .....	0.40 mm (0.01575 in.)
<b>Camshaft</b>	
Bearing journals, permitted out of round .....	0.03 mm (0.00118 in.)
Max. clearance between camshaft and bushings .....	0.15 mm (0.00590 in.)
<b>Valves</b>	
Max. clearance between valve stem and valve guide ...	0.15 mm (0.00590 in.)
Min. thickness of valve disc edge .....	1.5 mm (0.05906 in.)
<b>Tightening torques</b>	
Main bearing bolts, 1st tightening .....	20 Nm (14.7 ft. lbs.)
2nd tightening .....	60 Nm (44.2 ft. lbs.)
Big-end bearing bolts, 1st tightening .....	25 Nm (18 ft. lbs.)
2nd tightening .....	70 Nm (53 ft. lbs.)
Flywheel housing bolts .....	25 Nm (18 ft. lbs.)
Flywheel bolts .....	65 Nm (47.9 ft. lbs.)
Cylinder head bolts, 1st tightening .....	20 Nm (14.7 ft. lbs.)
2nd tightening .....	70 Nm (51.6 ft. lbs.)
Rocker arm bridge .....	25 Nm (18.4 ft. lbs.)
Fuel injection pumps .....	25 Nm (18.4 ft. lbs.)
Pulley .....	40 Nm (29.5 ft. lbs.)
Injectors .....	20 Nm (14.7 ft. lbs.)

# Presentation

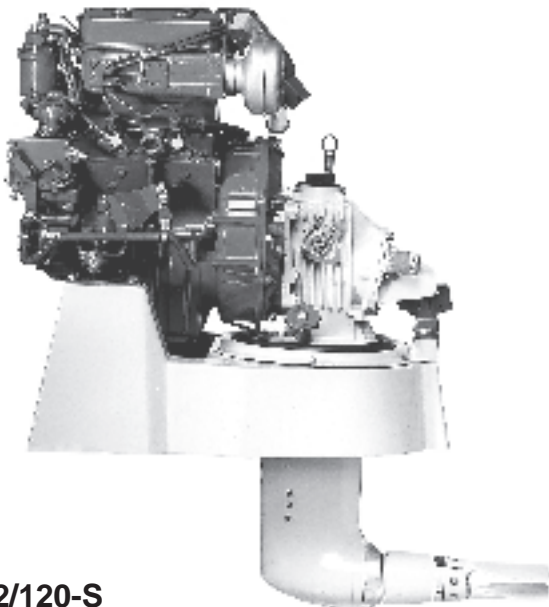
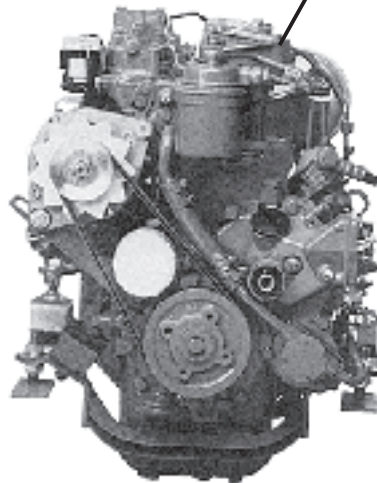
2001/MS2V



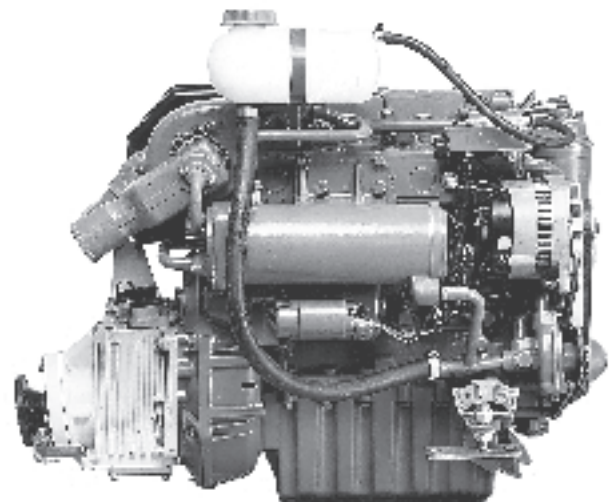
2003/MS2B-R



Type plate



2002/120-S



2003T/MS2B-R



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All engines in the 2000 range are four stroke diesels with direct injection and separate injection pumps for each cylinder. In the 2000 range, the 2001 has a single cylinder, the 2002 has twin cylinders, and the 2003 has three cylinders. The 2003 is also available with turbocharging, and then has the designation 2003T. The engines are of modular construction, with many common components, so in most cases they have the same repair data and service methods.

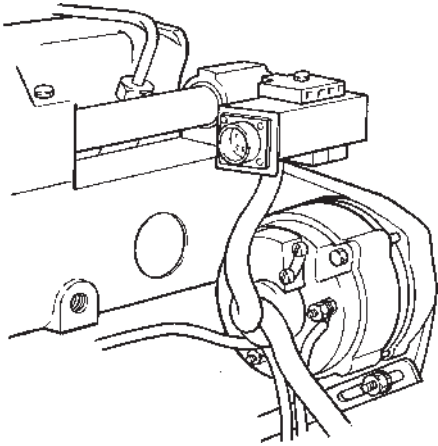
The 2001, 2002 and 2003 are sea-water cooled as standard. The 2002 and 2003 can be provided with optional fresh water cooling. The turbo-charged engine 2003T also has fresh water cooling as standard.

The engines were built in an earlier A version and a later B version. The main changes introduced on the B versions were :

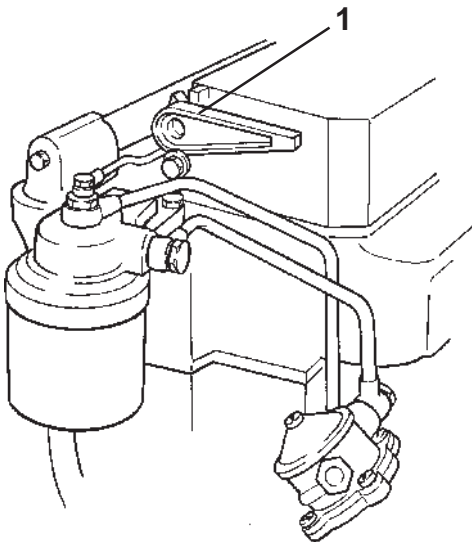
- Modified combustion chamber and 5-hole injector nozzle with no sack hole.
- Changed injector opening pressure.
- New injection pumps (not 2003T) with increased plunger diameter.
- Smoke limiter added to 2003T.
- Decompressor omitted from 2001 and 2003 (was omitted during ongoing production of 2002A).
- Changed cooling system hose run (fresh water system) on 2003T.

# Disassembly

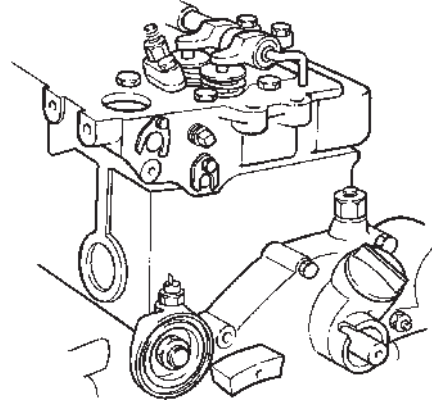
Drain off the cooling water and the lubricating oil from the engine. Clean the engine and fit it on engine cradle p/n 9992520 and fixture p/n 884837.



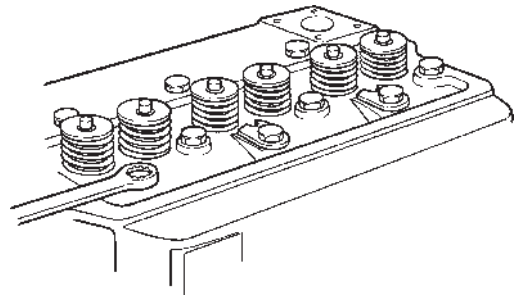
1. Remove the alternator, the tensioner bracket and the starter motor. Remove the connections from the electrical distribution box from the engine and remove the box and the wire harness.



2. Remove the return fuel line, the fuel pressure lines and the inlet air silencer. Install protection caps on the fuel injection pumps and injectors. Remove the screw holding the lever of the decompression device (1) and pull out the lever. Remove the valve cover.

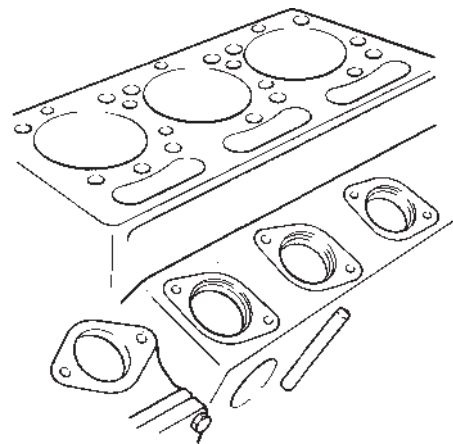


3. Remove the fuel filter, the oil filter, the feed-pump, the thermostat housing and the exhaust elbow. Also remove the sea-water pump with its attachment tubes.

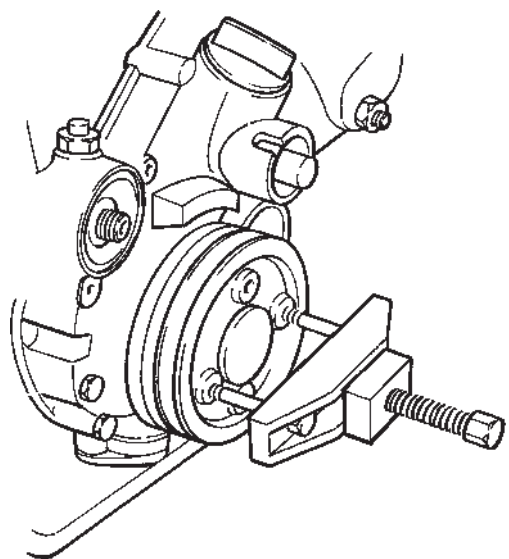


4. Remove the valve bridge and lift out the push rods. Remove the rubber rings for the oil pipe. Remove the cylinder head and the valve lifters. Put the lifters on a rack in consecutive order.

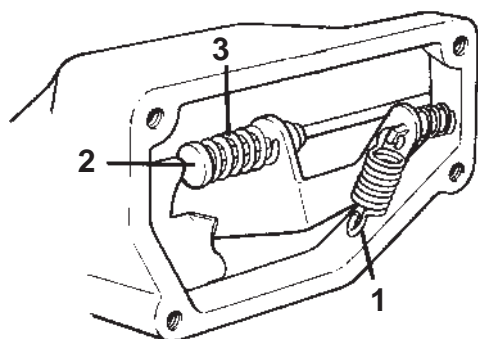
**NOTE!** The cylinder head bolts are phosphatised and must not be cleaned with a steel brush.



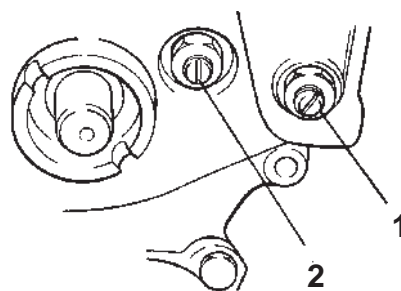
5. Remove the fuel injection pumps. **Mark the pumps to ensure installation in the same cylinders from which they were removed.** Take care of the shims. Remove the screws on the side of the engine block and lift out the pump lifters. Put the lifters on a rack in consecutive order. See also illustration on page 28.



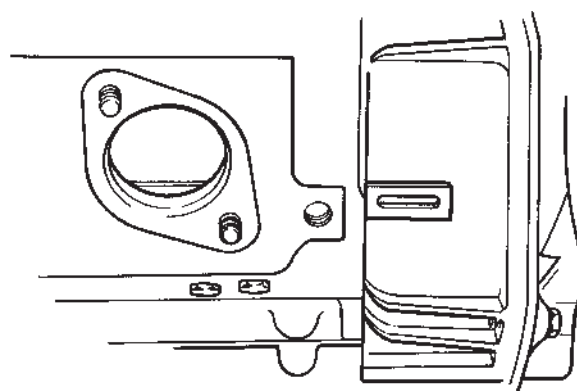
6. Remove the pulley center bolt and pull off the pulley using puller p/n 9992265. Place a protection pad between the puller and the crankshaft to avoid the crankshaft being damaged.



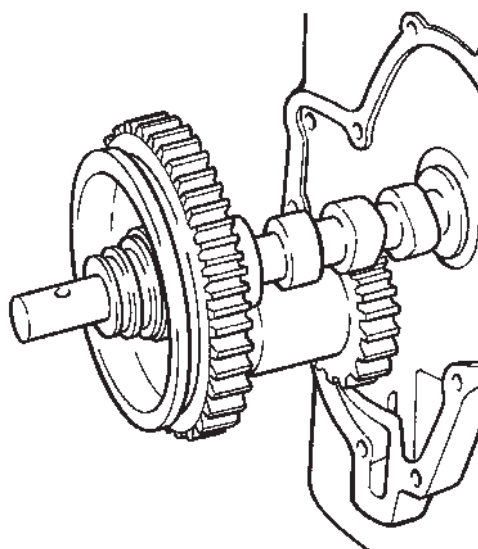
7. Remove the transmission cover: Start by removing the throttle control cover. Use a suitable type of pliers to remove the spring (1). Then remove the end-nipple (2) and the spring (3). Remove the oil pump cover and **mark the gear wheels with a colour pen before removing them.** (When installing the gear wheels, the marked side must be facing outwards). Remove the bracing pin of the camshaft using the special tool p/n 884839. Never remove the bracing pin by punching it out, this can very well bend the camshaft. Remove the screws on the transmission cover and pull it straight outwards.



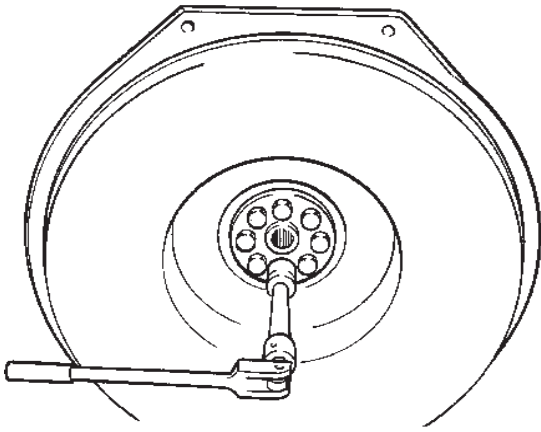
8. The max.-volume-screw (1) and the max.-rev-screw (2) are set by Volvo Penta and must never be changed since this will affect the engine output.



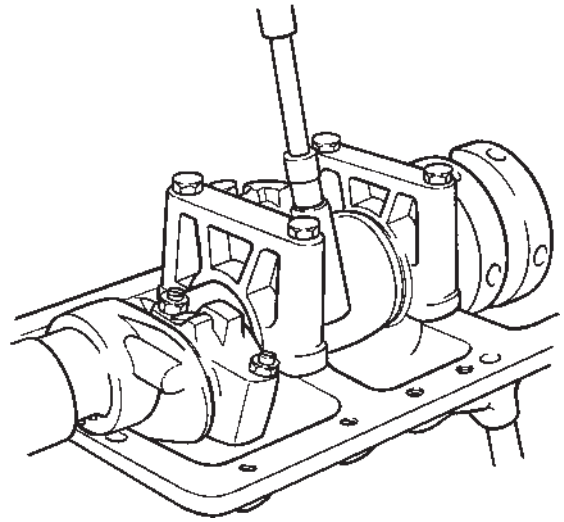
9. Remove the control rod. Start by removing the plug at the rear of the block and the two screws on the pump plane, holding the control rod.



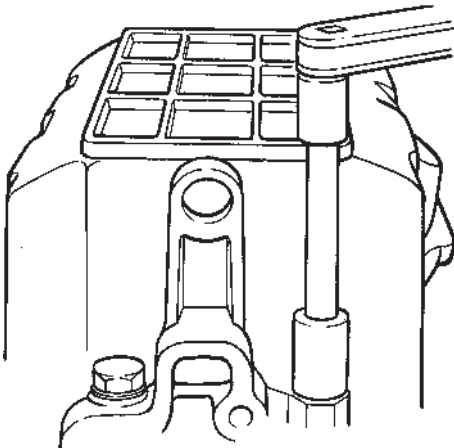
10. Pull out the camshaft.



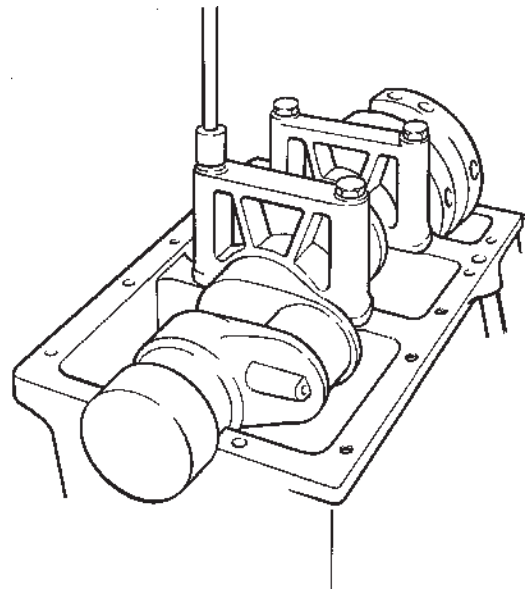
11. Remove the outer flywheel housing, the flywheel and the inner flywheel housing.



13. Remove the connecting rod bolts and remove the connecting rods and the pistons. The connecting rod and the connecting rod cap are marked with figures.

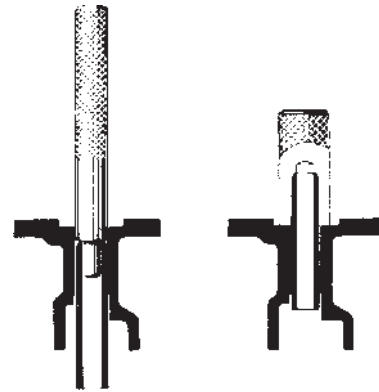
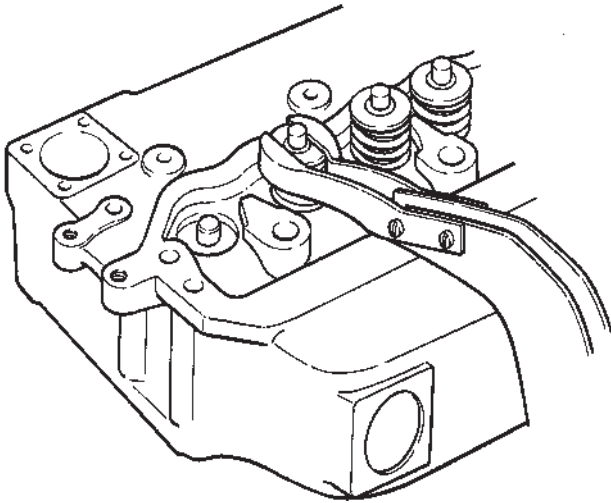


12. Turn the engine upside down and remove the oil pan. Be careful as the pan is glued.  
**NOTE!** The oil pan ends also function as main bearings.



14. Remove the main bearing caps. The main bearing caps are marked with a figure. The corresponding figure is punched into the block. Lift out the crankshaft. On later engine versions an arrow is cast in the separate main bearing caps (2002, 2003). The arrow is to point towards the dipstick.

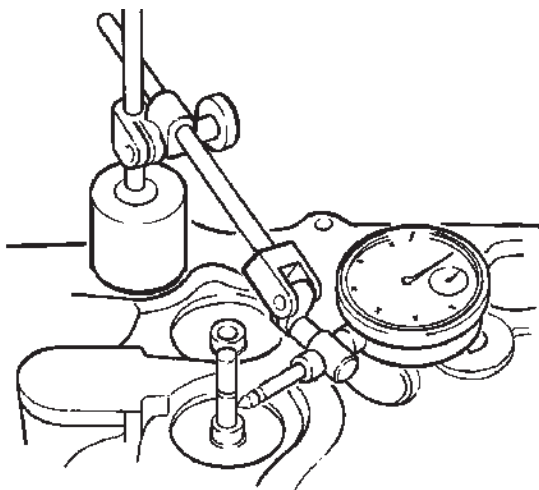
# Overhaul



3. Use mandrel p/n 9995218 to press out the valve guides. Oil the new valve guides externally and use mandrel p/n 884559 to install them. Press down the mandrel all the way down to the cylinder head. Ream the valve guides if necessary.

## The cylinder head

1. Remove the “collets” and valve springs using a valve bow. Remove the valves. Remove the valve stem seals. Place the valves in the proper sequence in a valve stand.

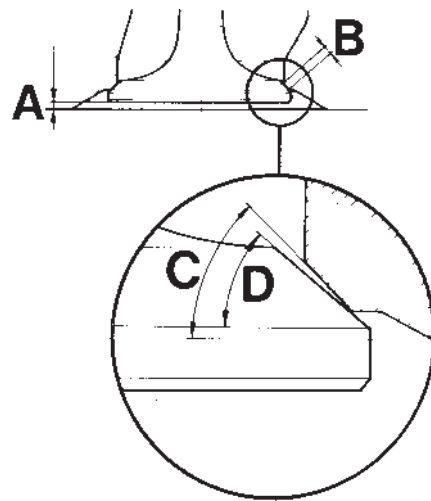


## Valve guides

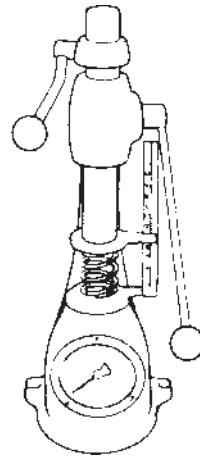
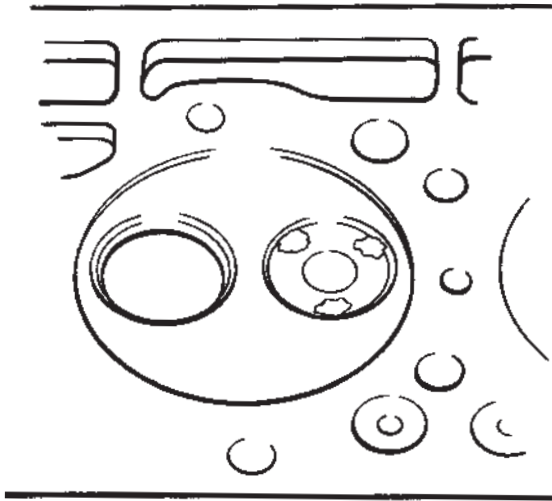
2. Check the wear of the valve guides by placing a new valve in the guide. Use an indicator gauge and measure the clearance. Replace the guides if necessary.

Wear limits:

Inlet valve, max. clearance ..... 0.15 mm (.0059 in)  
Outlet valve, max. clearance ..... 0.15 mm (.0059 in)



4. Mill or ream the valve seats. The angle (C) should be 45° (for 2003T, 30° for the inlet valve). The sealing surface width (B) should be  $1 \pm 0.1$  mm ( $0.039 \pm 0.0039$  in.) Grind the valves in a valve grinding machine. The angle (D), see Technical data. If the disc thickness after grinding is less than 1.0 mm (0.039 in.) for 2001, 2002, 2003 or 0.8 mm (0.031 in.) for 2003T, the valves must be scrapped. Valves with bent stems, or if the measurement (A) exceeds 2.5 mm (0.098 in.) must also be scrapped. Grind the valve tip towards the rockers if necessary. Lap in the valves using valve grinding paste and check the contact area with marking dye.



**Replacing the valve seat, exhaust port \***

Grind down the valve disc of a discarded valve to just below 27 mm (1.063 in) diameter. Push the valve stem through the guide.

Do not push in too far - the valve disc should be just below the edge of the seat. Spot weld the disc in place at three points using a MAG electric welder. Knock out the seat by hitting the valve guide with a plastic-headed hammer.

**⚠ IMPORTANT!** Cover the cylinder head surface so that it is protected from any welding spray.

Cool the new seat to approx. -20° C (-4° F); the cylinder head should be at room temperature (+20° C / 68° F). Place the cooled seat on tool 884961 and knock it down until it bottoms.

**NOTE!** Turn the seat with the valve face towards the tool.

\* Replaceable exhaust valve seats was introduced from engine numbers:

Model	Product No	Engine No
2001	868212	46683
2002	868213	46980
	868214	46912
	868215	46740
	868216	46760
	868217	47495
2003	868219	47947
	868220	46922
	868221	46897
	868222	47500
2003T	868223	47214
	868224	46775
	868226	46807

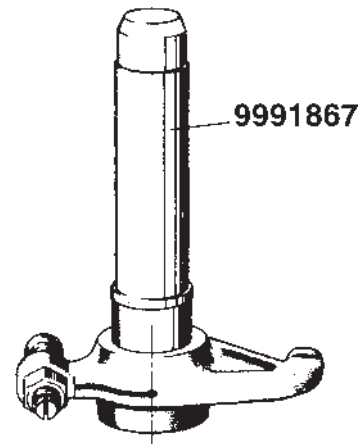
**Valve springs**

5. Check the free length of the valve springs and the length when loaded.

L = Length, unloaded 42.5 mm (1.67323 in.)

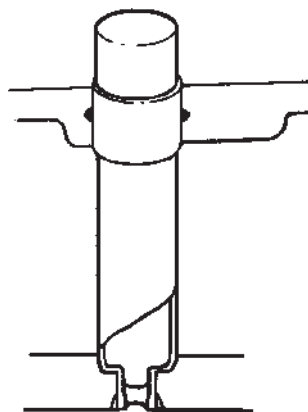
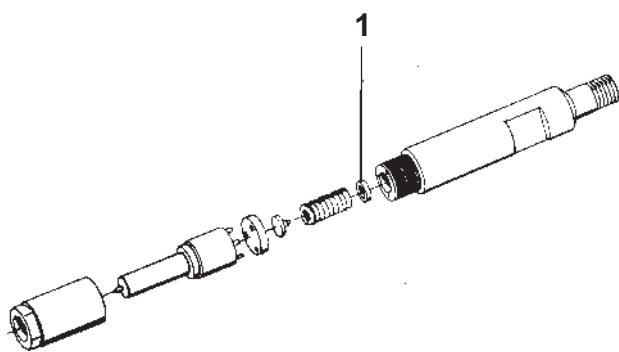
L<sub>1</sub> = Length, loaded with 170±10 N (17±1 kp) 32 mm (1.25984 in.)

L<sub>2</sub> = Length, loaded with 300±20 N (30±3 kp) 24 mm (0.94488 in.)



**Rocker arm mechanism**

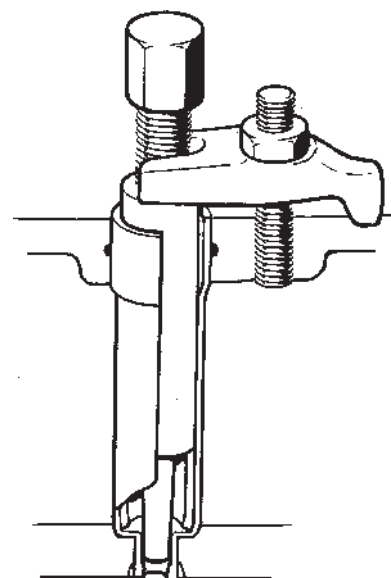
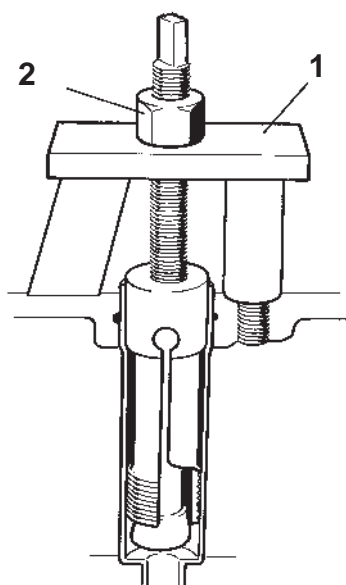
6. Disassemble the rocker arm mechanism and clean the parts. Check the wear of the shaft and rocker arm bushings. Should the bushings need to be replaced, use the mandrel p/n 9991867 for the removal and installation, (make sure that the oil hole in the bushing coincides with the one in the rocker arm). After the installation the bushings are reamed to a close running fit. When installing the rocker arm shaft, it must be turned so that the lubrication holes are facing the valve-side. Check to make sure that the rocker arm contact surface against the valve is concave. Minor adjustment are made in a valve grinding machine. Oil the shaft and install the parts.



### Pressure testing the nozzles

7. Check the nozzle's spray pattern at the correct opening pressure (see Technical Data). Check also that the fuel sprays stop simultaneously and no dripping occurs. Adjust the opening-pressure with adjustment-washers (1) being available in different thicknesses from 1 mm (.03937 in.) to 1.95 mm (.076772 in.) in steps of 0.05 mm (.001969 in.). Disassemble the injector and replace the adjustment-washer against a thinner one or a thicker one depending on whether the pressure must be reduced or increased. Assemble the injector and check the opening-pressure and the spray-pattern.

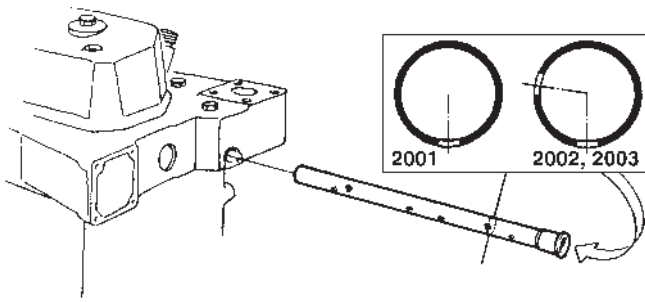
9. Replace the O-ring, sealing off between the sleeve and the cylinder head. Dip the new O-ring in soap-water in order to facilitate the installation. Oil the new injector sleeve and install it, using special tool p/n 884557. Knock down the sleeve until it bottoms.



### Injector-sleeve

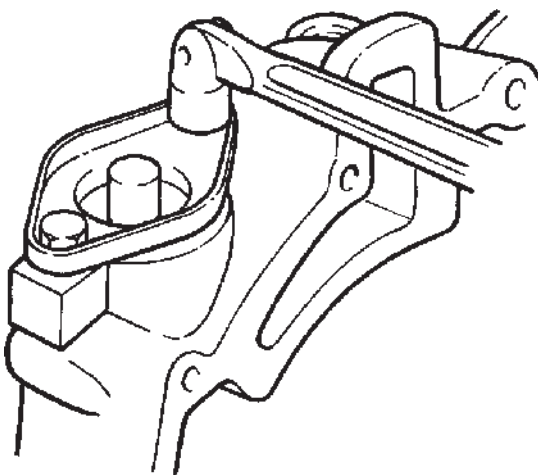
8. Insert the expanding screw on the special tool p/n 884811 into the copper sleeve and turn the screw anti-clockwise until the screw has stuck in the sleeve. Tighten the screw hard to allow the threads to work themselves into the copper material. Then install the yoke (1) on the stud bolt of the injector. Put a cylinder head screw in the cylinder head as a support for the leg of the yoke. Install the nut (2) and tighten it until the sleeve is removed.

10. Oil the flare-tool p/n 884823 and insert it into the sleeve (make sure that the dowel is properly retracted). Brace the tool with the injector yoke. Screw down the flare-tool as far as the shoulder in the injector sleeve allows, thereby flaring the sleeve. Remove the tool. Adjust the length of the sleeve outside the plane of the cylinder head to maximum 1 mm (.03937 in.).



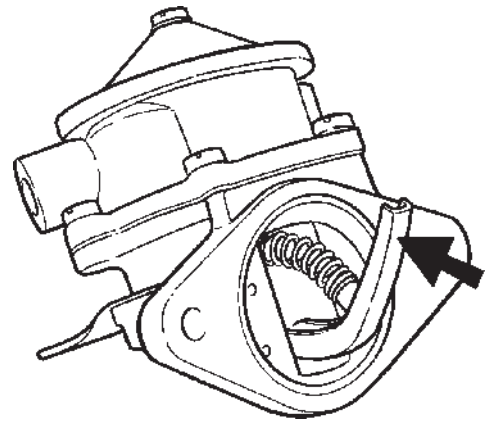
**Assembling the cylinder head**

11. Clean the cylinder head. If the water distribution pipe has been disassembled, it must be installed with the holes turned as indicated in the picture. Install new valve stem sealings. Oil the valve stems and install the valves. Make sure to install the valves and the valve springs in their respective original positions. Install the valve springs and the “collets”. Use a valve-bow.



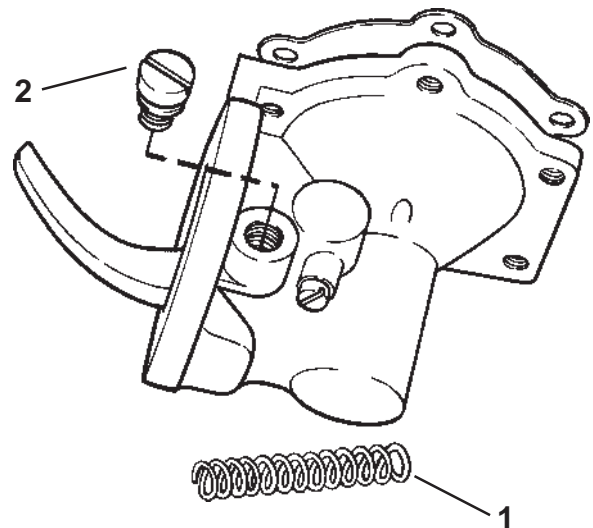
**Reduction valve**

12. Remove the cover of the reduction valve and check to make sure that the spring and the piston are faultless. If there are reasons to suspect a fault in the opening pressure of the reduction valve, then check the data of the spring. See under “Technical Data” - reduction valve.



**Feed-pump**

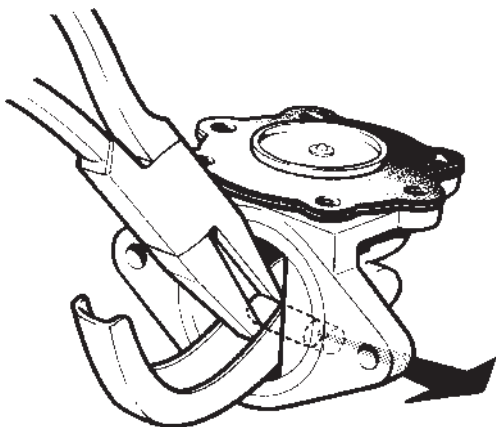
13. Depress the pump lever. If the diaphragm of the pump sounds squeaky, the diaphragm is faultless.



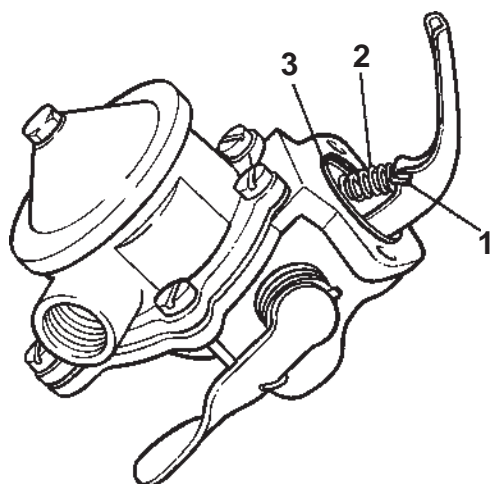
**Changing the diaphragm**

14. Remove the six screws, holding the upper and lower pump housings together. Remove the pump lever spring (1) and remove the screw (2) holding the pump lever shaft.





15. Use a suitable pair of pliers and remove the pump lever shaft. Pull out the lever and the diaphragm.

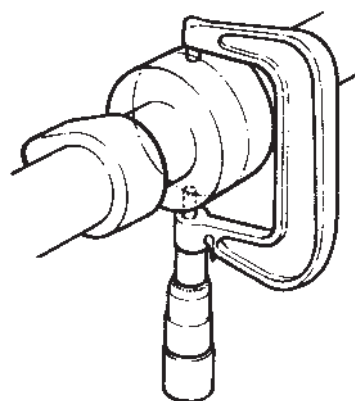


16. Clean the pump housing carefully and replace worn parts. Install the diaphragm and the lever on the diaphragm shaft. Then insert the shaft and tighten it with the screw. Assemble the two housing halves and install the attachment plate (1). Then install the spring (2) and the O-ring (3).



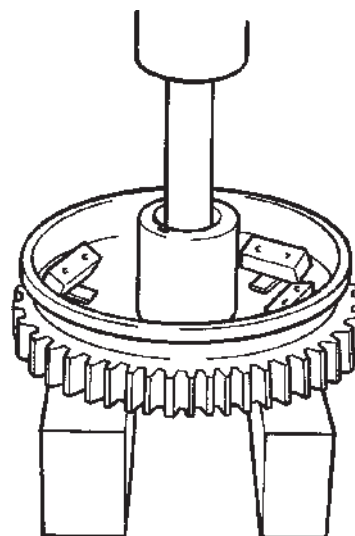
#### Valve lifters

17. Check the valve lifters for wear. Replace them if necessary.

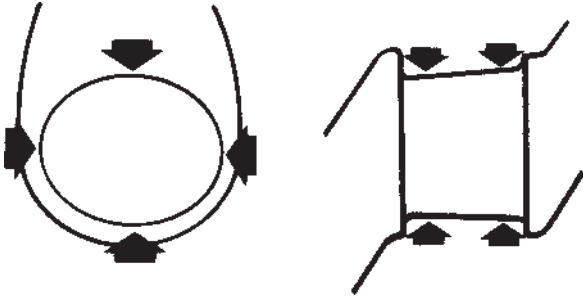


#### Camshaft

18. Check the camshaft for wear on cams and bearing races. Also check the wear of the bearings. The bearings are pressed into their locations and must be line bored after the installation.

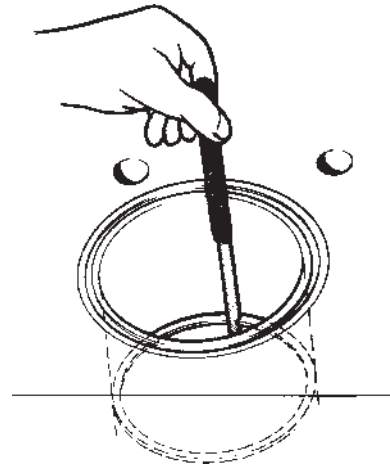


19. Place a support under the camshaft gear and use a hydraulic press to remove the gear.

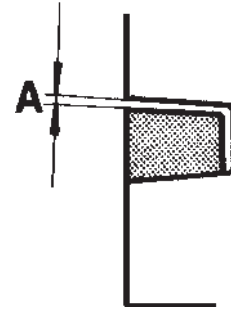
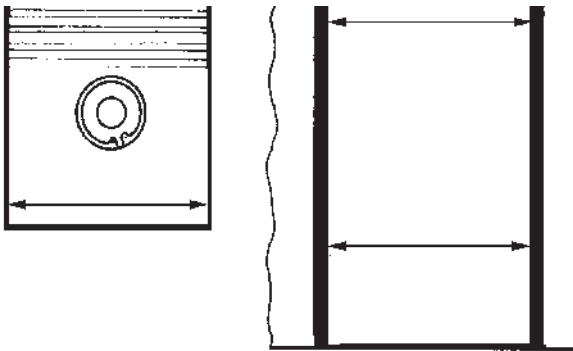


**Crankshaft**

**20.** Remove the gear wheel. Use a prong puller. Clean the crankshaft. Measure the crank- and main bearing pins. The eccentricity must not exceed 0.06 mm (.002362 in.) and the taper 0.05 mm (.001969 in.). Should these values be exceeded, the crankshaft must be ground to a suitable underdimension, see under "Technical Data".



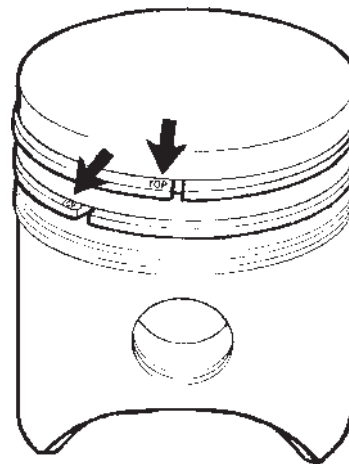
**22.** Insert a new piston ring into the cylinder and measure the piston ring gap. As to the measurement, see under "Technical Data". If necessary increase the gap, using a special file.



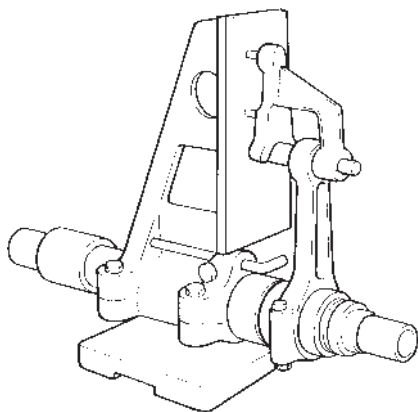
**23.** Measure the clearance of the piston rings in the piston ring grooves. Regarding the measurement, see under "Technical Data".

**Pistons, cylinders**

**21.** Check the wear on pistons, piston rings and gudgeon pins. Replace these if necessary. Use a cylinder indicator gauge to measure the cylinder bores. The measurement of the biggest wear is made immediately beneath the edge of the upper dead center and crosswise the engine. The measurement of the smallest wear is made at the lower dead center. As to the cylinder diameter, see "Technical Data". Use a micrometer to measure the pistons. Piston diameter, see under "Technical Data".

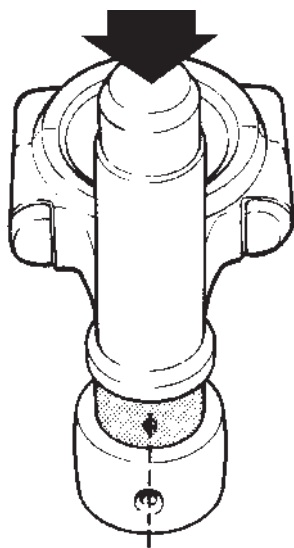


**24.** Use piston ring pliers to install the piston rings. The marking of the rings (TOP or the mark of the manufacturer) must be turned upwards. The height of the upper compression ring: 1.75 mm (.068898 in.) The height of the lower compression ring: 2.00 mm (.07874 in.). Turn the piston rings so that the gaps are turned 120° from each other.

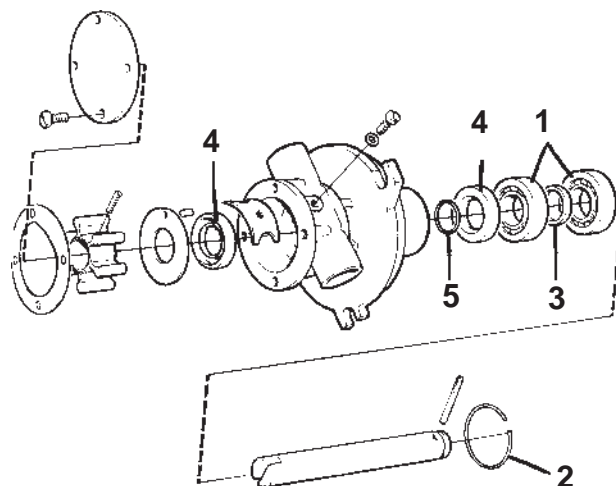


### Connecting rods

25. Check the connecting rods for straightness and twisting.



26. Check the connecting rod bushings by using the gudgeon pin as a gauge. There must be no play. If the bushings must be replaced, use a suitable mandrel for the removal and installation. **Make sure to install the bushing with the oil hole coinciding with that of the connecting rod.** Ream the new bushings. The fit is correct when an oiled gudgeon pin by its own weight can slowly slide through the bushing.

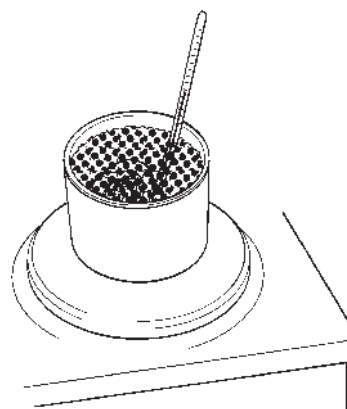


### Sea-water pump

27. The pump is equipped with two ball-bearings (1). When disassembling, remove the locking-ring (2) in the housing and push out the shaft, whereby the bearings are following. Use a suitable mandrel to remove the bearings from the shaft.

**NOTE!** Do not forget the spacer sleeve (3). Replace the sealings (4).

**NOTE!** Turn the sealings correctly and make sure that they do not block the drainage hole in the pump-housing. Replace the O-ring (5). Install the ball-bearings and the spacer sleeve onto the shaft and leave a distance of 39.5 mm (1.55512 in.) from the shaft end to the ball-bearing. Coat the shaft with grease and "screw" it through the sealings and the O-ring and take care not to damage them. Push in the shaft as far as to allow the bearings to bottom and then install the locking-ring (2).

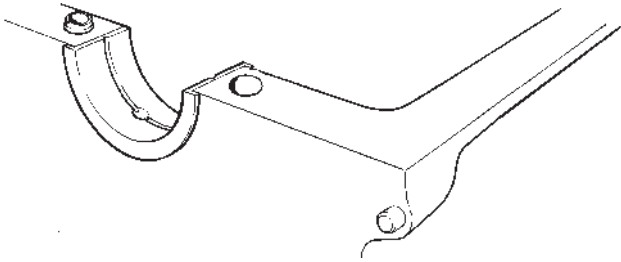


### Checking the thermostat

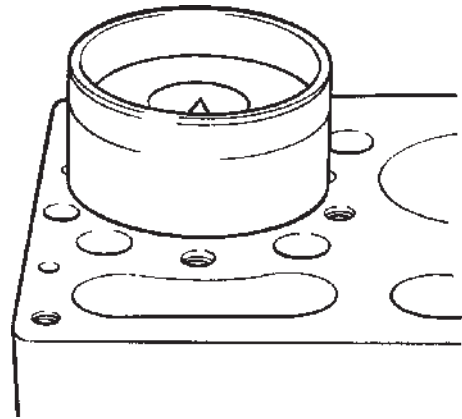
28. Lower the thermostat into water and check when heating with a thermometer if the thermostat opens at the correct temperature. It should start opening at  $60\pm 2^{\circ}\text{C}$  ( $140\pm 4^{\circ}\text{F}$ ) and be fully open at  $75^{\circ}\text{C}$  ( $165^{\circ}\text{F}$ ). With freshwater cooling (2002, 2003, 2003T). Starts opening at  $74\pm 1^{\circ}\text{C}$  ( $164\pm 2^{\circ}\text{F}$ ), fully open at  $87^{\circ}\text{C}$  ( $189^{\circ}\text{F}$ ). A faulty thermostat must be replaced.

# Assembly

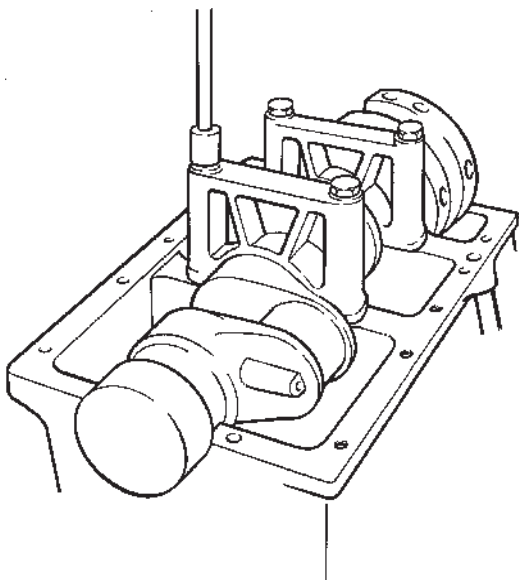
Always use new gaskets, sealing rings, sealing washers and lock-washers. Coat the sealings with grease or oil them and also oil all moving parts prior to installing them.



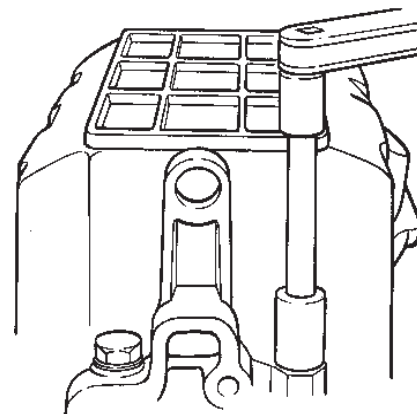
1. Heat the crankshaft gear wheel to approx. 150°C (302°F) prior to the installation. Place the key in the key-way of the crankshaft and press on the gear wheel. Oil the new main bearing halves (with oil hole) and install them in the block. Put in the crankshaft. **NOTE!** The main bearing shell at the flywheel also functions as a thrust-bearing.



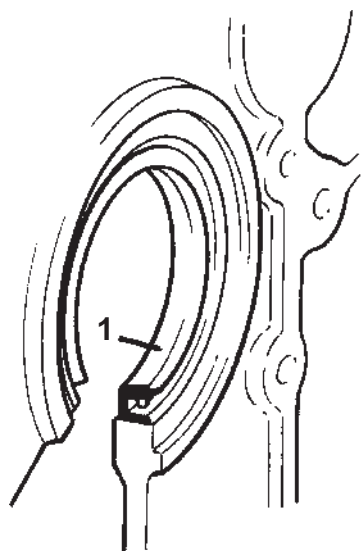
3. Turn the piston rings so that the piston ring gaps are displaced in relation to each other. The top of the piston is marked with an arrow, which is to be directed towards the front of the engine. Use installation ring p/n 884813. Install the caps with the marking coinciding with that of the connecting rod. The connecting rod can be turned on the piston at your own discretion. Tightening torque: 70 Nm (51.6 ft.lbs).



2. Oil the cap bearing halves and install them. Install the caps in accordance with the marking in the block (2001 has no intermediate bearing). If an arrow is cast, it shall point towards the oil dipstick. Tightening torque for the main bearings: 1st tightening 20 Nm (14.7 ft.lbs), 2nd tightening 60 Nm (44.2 ft.lbs). Turn the engine.

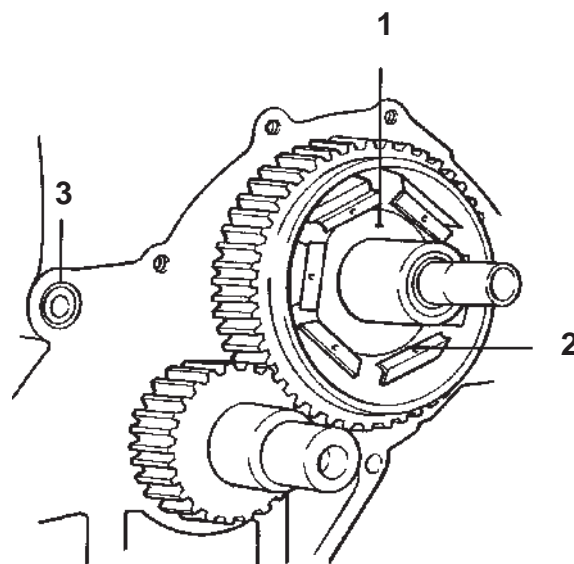


4. Install the main bearing halves in the oil pan and coat the edge of the oil pan with thin layer of sealing compound p/n 840879. Install the oil pan and tighten the oil pan screws and the main bearing screws alternately to 20 Nm (14.7 ft.lbs.) and then the main bearing screws to 60 Nm (44.2 ft.lbs.).

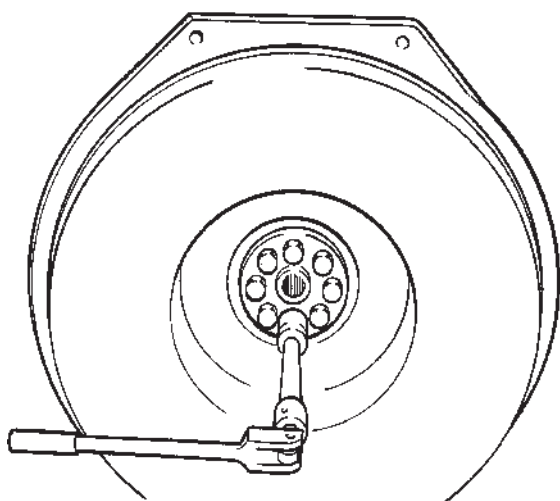


5. Replace the flywheel housing sealing (1). Smear sealing compound (p/n 840879) on the edge between the flywheel housing and the sealing.

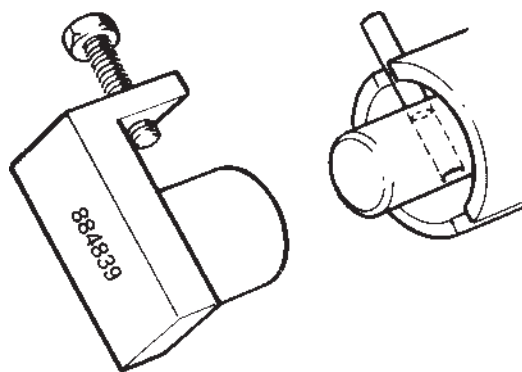
**NOTE!** The sealing lip with a spring shall be turned towards the engine. Make sure that the sealing is installed in accordance with the picture.



7A. Heat the camshaft gear wheel to a temperature of approx. 150°C (302°F) and use a suitable sleeve to install it. Check to make sure that the gear wheel “bottoms” on the camshaft. Install the camshaft and make sure that the markings on the camshaft gear wheel and on the crankshaft gear wheel coincide. Put the washer (1) on the hub of the camshaft gear wheel. Check that all weights are pressed in so that the tabs (2) are inside the washer.

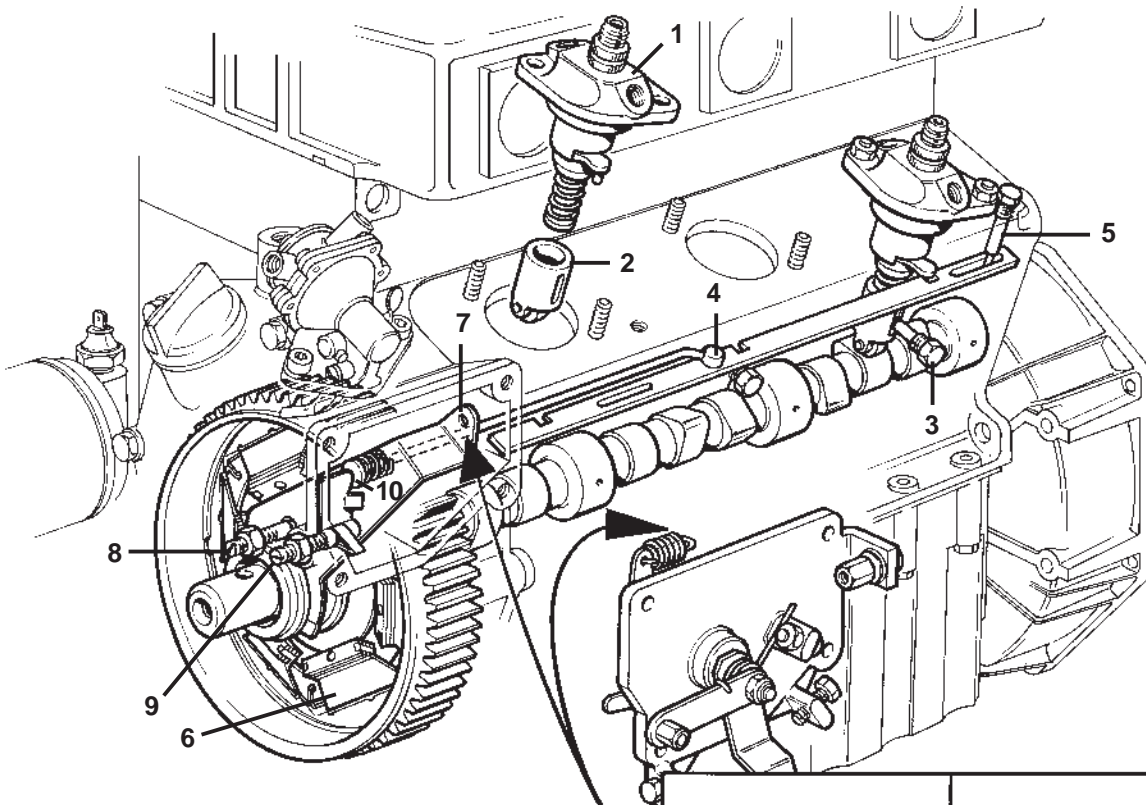


6. Replace the O-rings and install the flywheel housing. Tightening torque 25 Nm (18.4 ft.lbs). Install the flywheel. Tightening torque 65 Nm (48.0 ft.lbs).



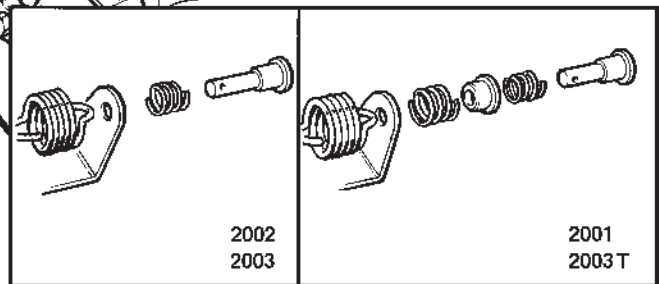
7B. Install a new sealing ring for the camshaft in the transmission housing, using mandrel p/n 884838. The sealing lip with the spring is to be turned towards the engine. Press in the sealing ring from the outside until the mandrel “bottoms” against the housing. Install a new O-ring in the oil channel in the block (3 fig. 7A). Use a new gasket and install the timing gear cover.

Place the pressure sleeve (with the bearing towards the pressure washer) in the control arm lever. Hold the sleeve in place by pressing the lever to its bottom position where the sleeve is pressed against the housing. Install the pin of the camshaft, using special tool p/n 884839. The pin must protrude equally much on both sides. Under no circumstances are you to use a hammer or some such tool to punch the pin into its location with the aid of a mandrel. The camshaft will then be bent.

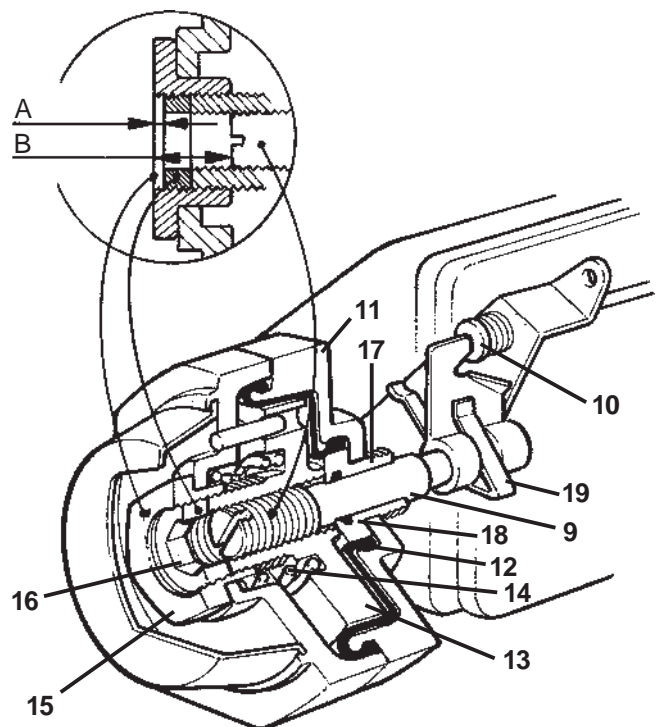


**Control mechanism, injection pumps**

- 8. Control mechanism, design
- 1. Injection pumps
- 2. Roller lifter
- 3. Control screw, roller lifter
- 4. Control rod
- 5. Control screw, control rod
- 6. Centrifugal weights, fuel volume control
- 7. Control arm
- 8. Max. engine speed screw
- 9. Max. volume screw
- 10. End nipple, control rod



The 2003T-B has a smoke limiter, which maximises the fuel volume to suit the turbo boost pressure. Quick acceleration does not give full fuel volume until the turbocharger has speeded up and gives more than enough air to burn the amount of fuel required by the throttle opening. The smoke limiter consists of a pressure chest (11) and diaphragm (12) which is at turbo boost pressure. The diaphragm (boost pressure) bears on piston (13) which is screwed onto the maximum volume screw (9). The piston movement is counteracted by spring (14). The smoke limiter is adjusted individually on each engine. If it is removed, it must be adjusted again when it is put back. Please refer to "adjustment, smoke limiter". The diaphragm (12) and O-ring (18) can be changed without affecting adjustment, however.



2003T-B

**Diaphragm replacement**

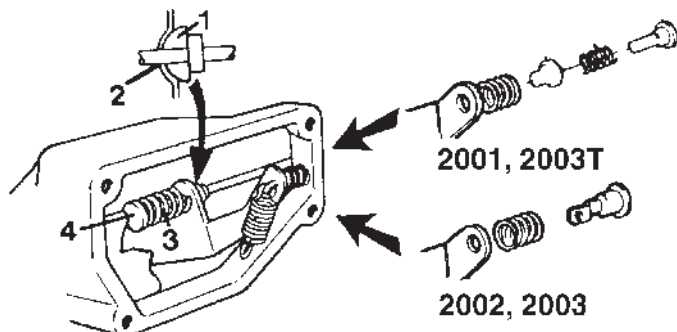
Undo the lid with the throttle opening and stop arms. Unhook the regulator spring and the inner section of the throttle opening arm. Unscrew the four arms which keep the smoke limiter housing together, force the

housing apart using a screwdriver in the groove provided, at the same time as you hold the leaf spring (19) out to allow the full load limiter to loosen from the volume screw (9). The outer part of the smoke limiter housing, including the spring, piston and volume screw, can now be removed. Unscrew the holder (17) (internal 8 mm socket) and press it out of the smoke limiter housing, after which the diaphragm (12) can be undone and can be changed. It is good practice to change the O-ring (18) at the same time. On re-assembly, coat the contact face of the volume screw (9) against the O-ring (18) and the holder (17), and the surface of the holder against the diaphragm with silicone grease, such as MOLYKOTE® PG 54 Plastislip.

### Adjustment, smoke limiter

Screw in the maximum volume screw (9) to make the dimension (B) from adjustment nut (15) 7 mm and dimension (A) between adjustment nut (15) and stop nut (16) 0.3 mm. These dimensions are default values, which correspond to the median values of adjustments made in production. If dimension (A) is increased, i.e. adjustment nut (15) is screwed out, the amount of visible smoke is reduced.

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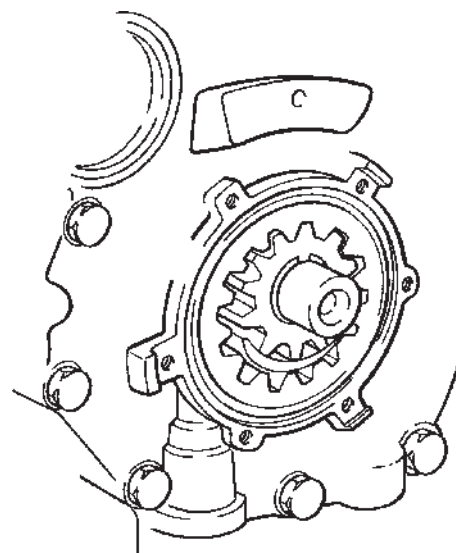


**8A.** Insert the control rod through the block and into the transmission housing. Install the bearing ball (1) onto the control rod and insert the control rod through the hole in the control arm (2). Install the spring (3) which guides the control rod. Models 2001 and 2003T have two springs and a washer, see fig. Screw on the end nipple (4) until it bottoms.

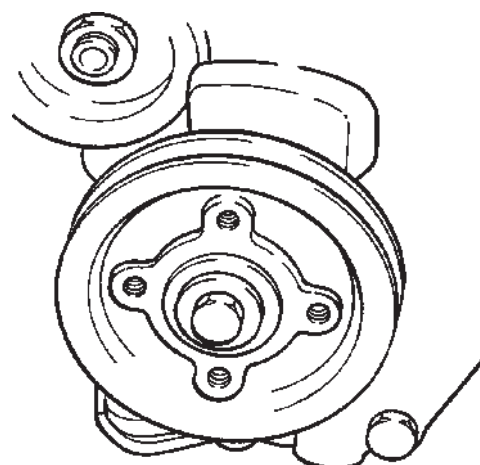
**NOTE!** Do not use any tools.

Screw in the upper bolts (with their copper sealing washers) that guide the control rod. Then, screw the lower bolts that hold the control rod in place in the engine block.

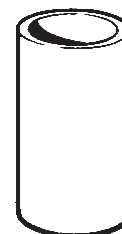
**NOTE!** The lower bolts should not have sealing washers. Apply Permatex to the threads. Check that the control rod moves freely.



**9.** Install the oil pump's gearwheel according to the marks (from the disassembly). Insert a new O-ring in the timing gear cover. Oil the gear wheel and fit the cover using a new sealing ring.

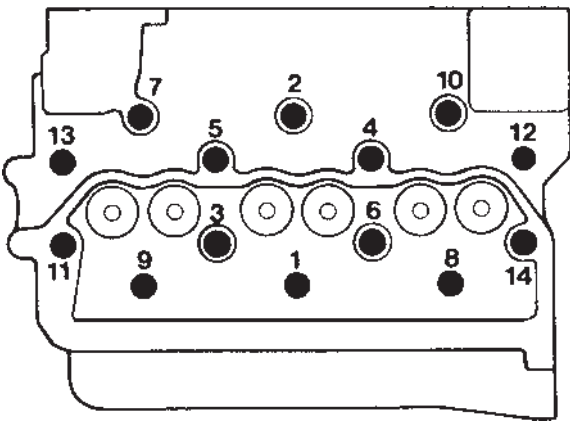
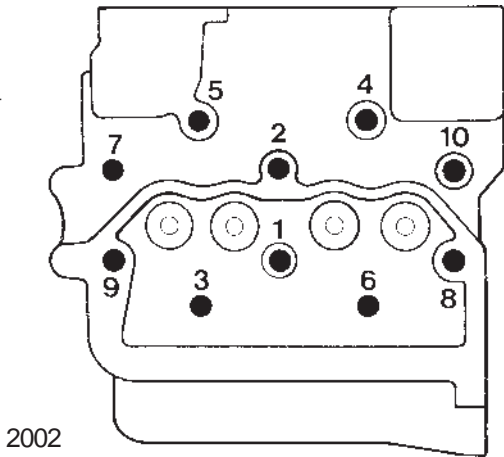
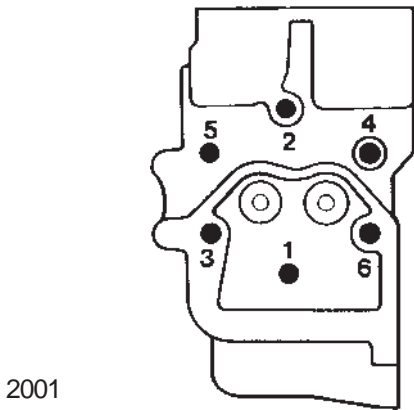


**10.** Insert the key for the pulley in the crankshaft and install the pulley. Tightening torque 40 Nm (4,0 kpm) (29.5 ft.lbs).



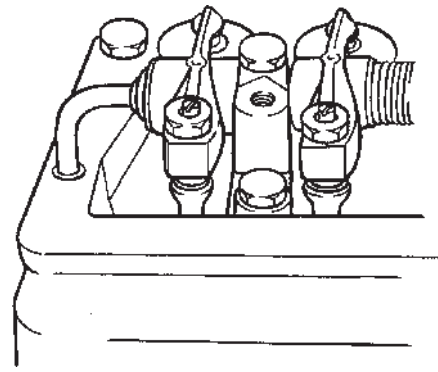
**11.** Clean the valve lifters carefully and coat the contact surface against the camshaft with molybdenum disulphide. Oil the valve guides in the block and install the lifters. Clean the roller lifters of the fuel injection pumps and install them in the block. Lock the roller lifters with screws through the block after the installation (apply Permatex to the threads). Check carefully to make sure that the lifters are correctly installed and that they are running easily in the groove.

## Mounting the cylinder head

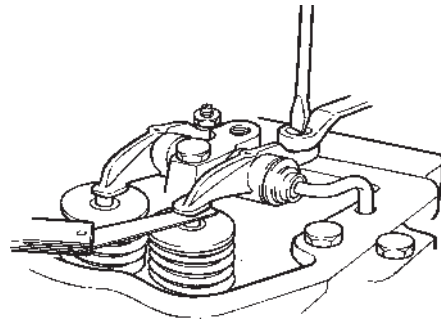


12. Tighten the two guide screws p/n 884840 in the block and install the cylinder head gasket with the marking "Top" facing upwards. Install the cylinder head. Make sure that the contact surface for the cylinder head bolts are free from paint. Should there be paint on the bolts, there is always the risk of having an insufficient tightening force in the bolt joint with subsequent leakages as a result.

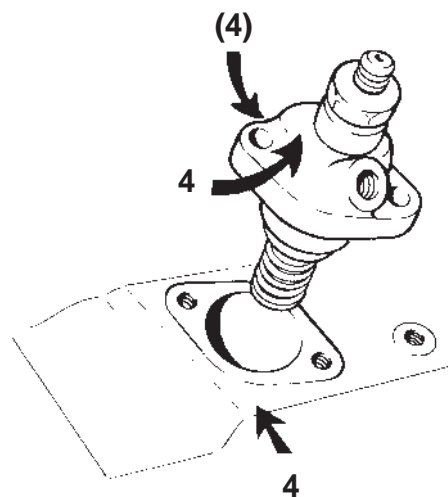
**NOTE!** The bolts are phosphated, therefore do not clean them with a steel-brush. Coat the cylinder head bolts with molybdenum disulphide and tighten them in accordance with the diagram, first to 20 Nm (14.7 ft.lbs) and then to 70 Nm (51.6 ft.lbs).



13. Install the push rods and the rocker arm bridge, push on new rubber rings to the oil pipe which is fitted at the same time as the rocker arm bridge.



14. Valve clearance cold/warm engine should be 0.30 mm (.01181 in.). Turn the engine in the direction of rotation until the valves in one cylinder are "rocking". Then turn the engine one turn more and adjust the valves for this cylinder. Repeat the procedure for the remaining cylinders.



### Shimming the fuel injection pump

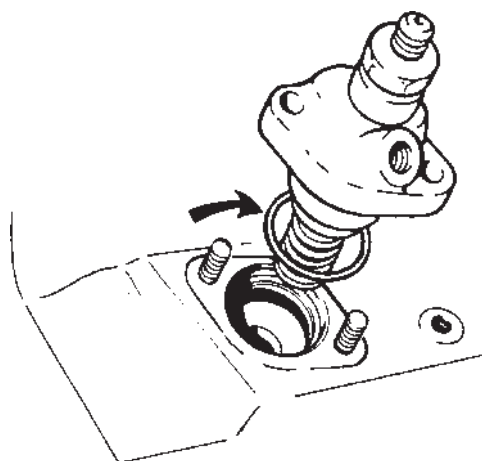
15. If the same block, camshaft and fuel injection pumps are used when assembling, the fuel injection pumps must be installed in their original positions and with the same shim thickness as earlier. The so



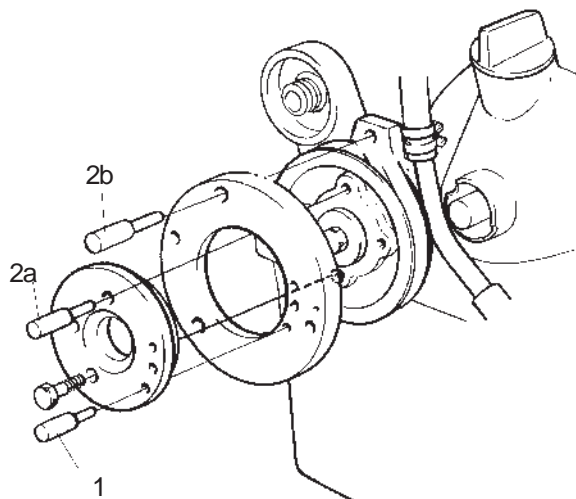
called soft shims, always being installed against the block, must be replaced against new ones. Carefully clean the contact surfaces between the block and the fuel injection pumps and install shims with thickness equal to the sum of the marking on the block and that on the fuel injection pump, (4) earlier marking. Example: The block has the marking 4 (= 4 tenths of a millimeter / .015748 in.) The pump marking is 4 (= 4 tenths of a millimeter / .015748 in.) Total amount of shims = 0.8 mm (.031496 in.) In this case select two soft shims 0.2 and 0.3 mm (.011811 in.). Place the hard shim between the two soft ones and install the pump.

**NOTE!** Never install a hard shim together with another hard shim or against the block or the fuel injection pump.

Hard shims are available in thicknesses 0.3, 0.6 and 0.9 mm (.011811, .02362, .035433 in. respectively). Soft shims are available in thicknesses 0.2 and 0.3 mm (.007874 and .011811 in.).



On later version engines an O-ring has been introduced as a seal between the injection pump and the block. Only so-called hard shims may be used on these engines when shimming. Hard shims are available in thickness of 0.2 mm (0.0079 in), 0.3 mm (0.0118 in), 0.6 mm (0.0024 in) and 0.9 mm (0.0354 in).



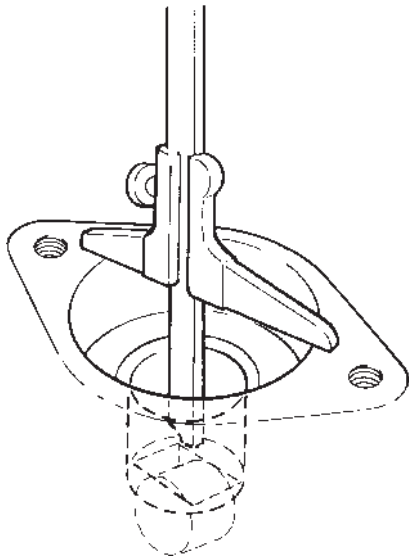
### Injection setting in connection with new block or camshaft

**16.** If the block or the camshaft are replaced the block must be measured and marked, using the setting disc p/n 884787 and a sliding calmer.

A. The setting-disc consists of two rings, an inner and an outer. The inner ring determines the injection angle and has markings (holes) for 20°, 22° and 23°. The injection angle is fixed with a pin (1). When the injection angle is set after block or camshaft replacement, **the setting tool should always be set to 22°**. Using the tool set to 22°, all injection angles can be adjusted, including 16° and 18°, where there is no setting hole on the tool.

B. Mount the setting-disc on the pulley with two bolts, do not tighten the bolts. Turn the setting-disc so that the guide pin (2a) comes in the largest of the four holes in the pulley. Press in the guide pin (2a) so that the disc is centered and tighten the bolts. The setting-disc is marked for each respective cylinder:

Marking	Denotes
Cylinder 1	Cylinder 1 (1, 2 and 3 cylinder engines)
Cylinder 2/2	Cylinder 2 (2 cylinder engine)
Cylinder 2/3	Cylinder 2 (3 cylinder engine)
Cylinder 3/3	Cylinder 3 (3 cylinder engine)



C. Turn cylinder no. 1 to its injection position. Place the guide pin (2b) in the setting-disc's hole marked cyl. 1. Turn the crankshaft a little against the normal direction of rotation and thereafter in the normal rotation direction until the setting-disc's guide pin (2b) goes in the timing cover's hole. Measure using a caliper the distance between the cylinder block and the roller lifter's edge (do not measure on the roller).

Based on the dimension measured, shims shall be selected so that: Measured dimension + shim = reference dimension. When the reference dimension has been achieved, this gives the correct injection angle for the engine.

Please refer to Technical Data, page 12, for reference dimensions.

**Example:** The injection angle for a 2003-D is to be set after camshaft replacement. Using tool no. 884787 set to 22°, the measured dimension is 55.0 mm (2.16535"). The reference dimension for 2003-D is 55.4 mm (2.18110").

The pump is marked 2.

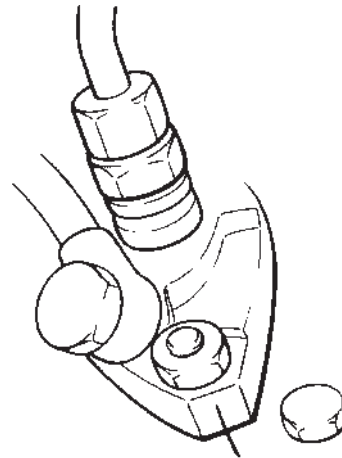
The shim thickness then becomes:

The reference measurement	55.4	(2.181102 in.)
The measured distance	- 55.0	(2.165354 in.)
	= 0.4	(0.015748 in.)
The pump marking 2	- 0.2	(0.007874 in.)
(= 0.2 mm / 0.007874 in.)		
Shim thickness required	0.2	(0.007874 in.)

In this case, use one soft 0.2 mm (0.007874") shim. Mark the block "4" and install the pump with the selected shim(s). Cylinder no. 1 is now set to 16°.

**NOTE!** A hard shim must always be fitted between two soft ones, never together with another hard shim or directly against the block or pump. Hard shims are available in thicknesses 0.3, 0.6 and 0.9 mm (0.011811, 0.02362 and 0.035433 in). Soft shims are available in thicknesses 0.2 and 0.3 mm (0.007874 and 0.011811 in).

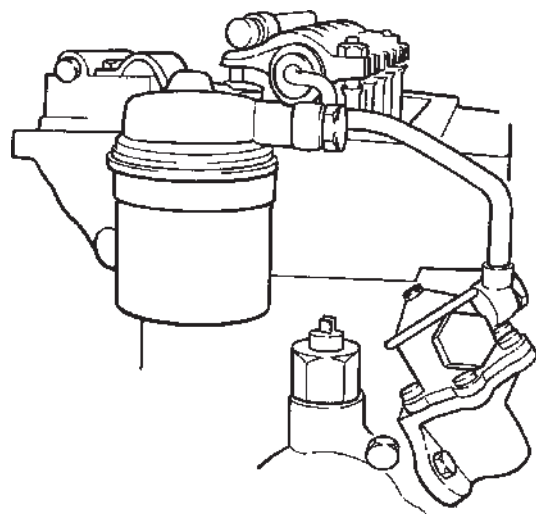
D. Repeat the procedure for the other pumps (2002, 2003) in the same way as for cylinder 1. The setting-disc's marking is explained under point B.



**17.** Fit the injection pump(s) together with the calculated shim thickness. Turn the engine so that the cam for the pump is not in the lifting position. Check that the pump's pin locates in the control rod's groove and that the pump(s) and the locks markings coincide (see figure). Check after fitting each pump that the control rod operates easily.

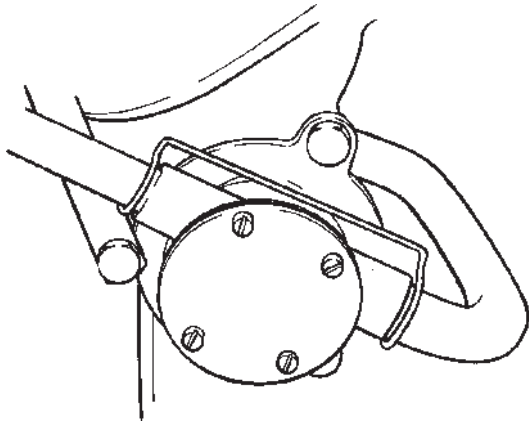
Tightening torque for the nuts is 20 Nm (14.7 ft.lbs). Connect the fuel pipe between the pumps and the pipe from the fuel filter to the injection pump.

**NOTE!** The hole bolt for the return hose has a smaller through-flow channel than the others (on later versions it is marked "Out")

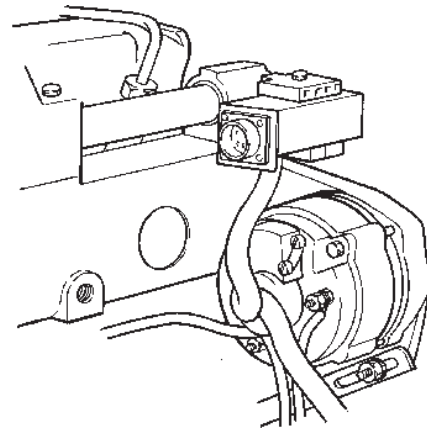


**18.** Install the feed pump and the fuel filter. Also install the thermostat housing with the thermostat.

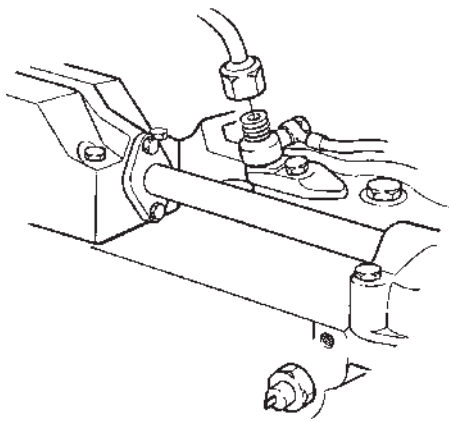
**NOTE!** Do not forget the lifting eyelet between the fuel filter and the thermostat housing.



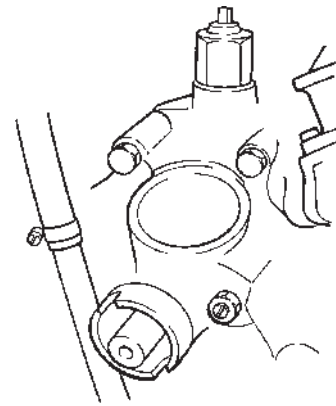
**19.** Install the sea-water pump and the cooling water pipes.



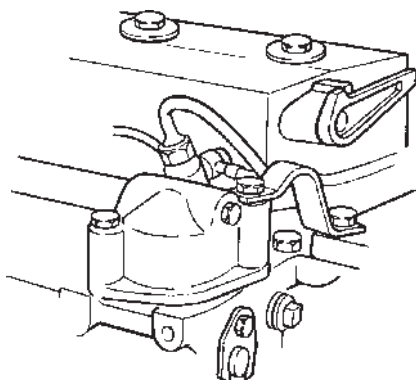
**22.** Install the starter motor, the alternator and the alternator V-belt. Also install the electrical distribution box and hook-up the cable harness.



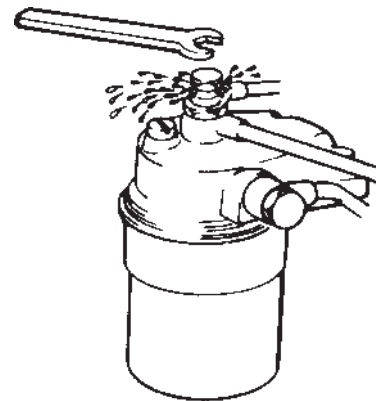
**20.** Install the injectors and the return fuel pipe. Tightening torque for the injectors 20 Nm (14.7 ft.lbs.). Also install the exhaust elbow and the water pipe between the thermostat housing and the exhaust elbow.



**23.** Fill up with lubricating oil to the correct level. Regarding quantity and quality, see under "Technical Data".



**21.** Fit the valve cover using a new gasket. Make sure that the round hole for the crankcase ventilation is in the right position. Fit the decompression device lever. Fit the pressure pipes between the injectors and the injection pumps. Also refit the inlet air silencer.



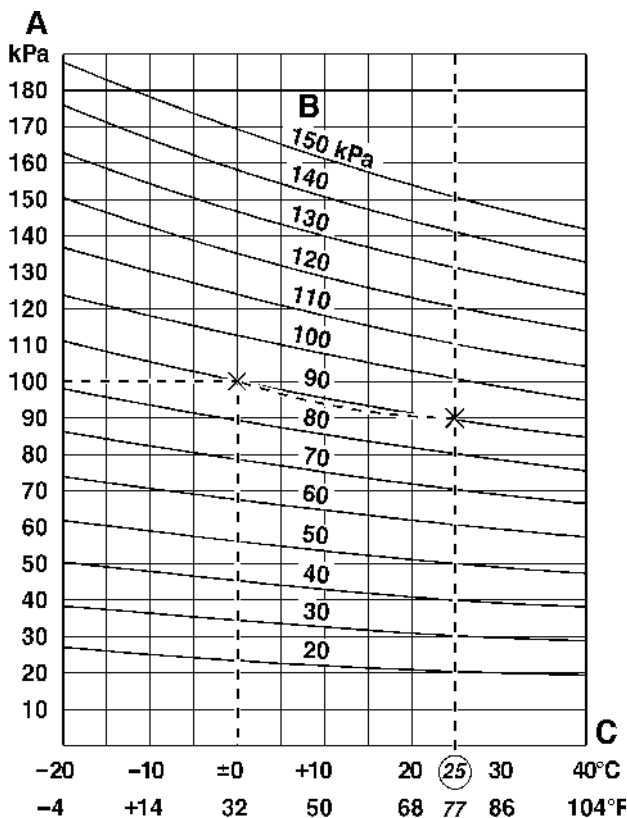
**24. Venting the fuel system**

- A. Open the venting screw on the fuel filter approx. 4 turns. Watch out for fuel-splashes.
- B. Use the hand-pump to pump fuel until fuel free from air bubbles is coming out. Close the venting screw.
- C. Ease off the fuel pressure pipe nuts at the injectors. Position the throttle control in the position for full speed and turn the engine with the starter motor until fuel comes out of the fuel pressure pipes. Tighten the fuel pressure pipe nuts.

## 2003T Turbo Compressor

Where there is an excessive amount of smoke in the exhaust fumes or the engine output is particularly low it may be that the turbo is not functioning properly. If the boat's speed through the water is gradually decreasing, the boat's bottom should also be inspected, and cleaned where necessary. Check that the air intake has not become clogged, and clean the intake silencer. Measure the supercharging pressure under full load at 3200 rpm. The boost pressure should be 100 kPa – 120 kPa (14.5 – 17.4 psi) at 20°C (68°F).

**NOTE!** It is important to maintain full loading long enough to enable the pressure to stabilise if results are to be correct. Also note that the pressure varies with the temperature of the intake air, as shown in the diagram below. The supercharging pressure is given at +20° (68°F), which implies that the measured pressure must be corrected as shown in the diagram if the intake air is not at this temperature when the measurement is made.



Boost pressure at various pressures

- A. Boost pressure measured
- B. Correction graphs
- C. Intake air temperature (IAT)

Example:

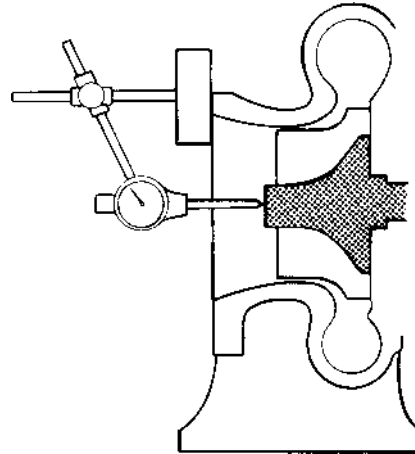
A pressure of 100 kPa recorded at 0°C is the equivalent of 92 kPa at +25°C.

### 1. Inspecting the Seals

Check the joints between the turbine housing and the compressor bearing housing, and between the compressor bearing housing and the compressor housing.

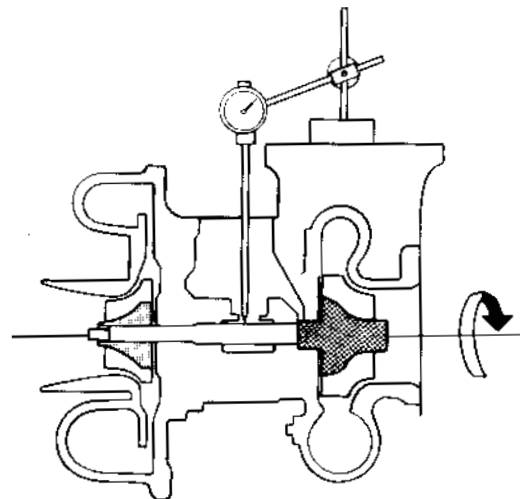
### 2. Checks

Check the pre-injection angle, the injector's opening pressure and the spray pattern. The valve clearance and compression should also be checked.



### 3. Checking axial and radial clearance

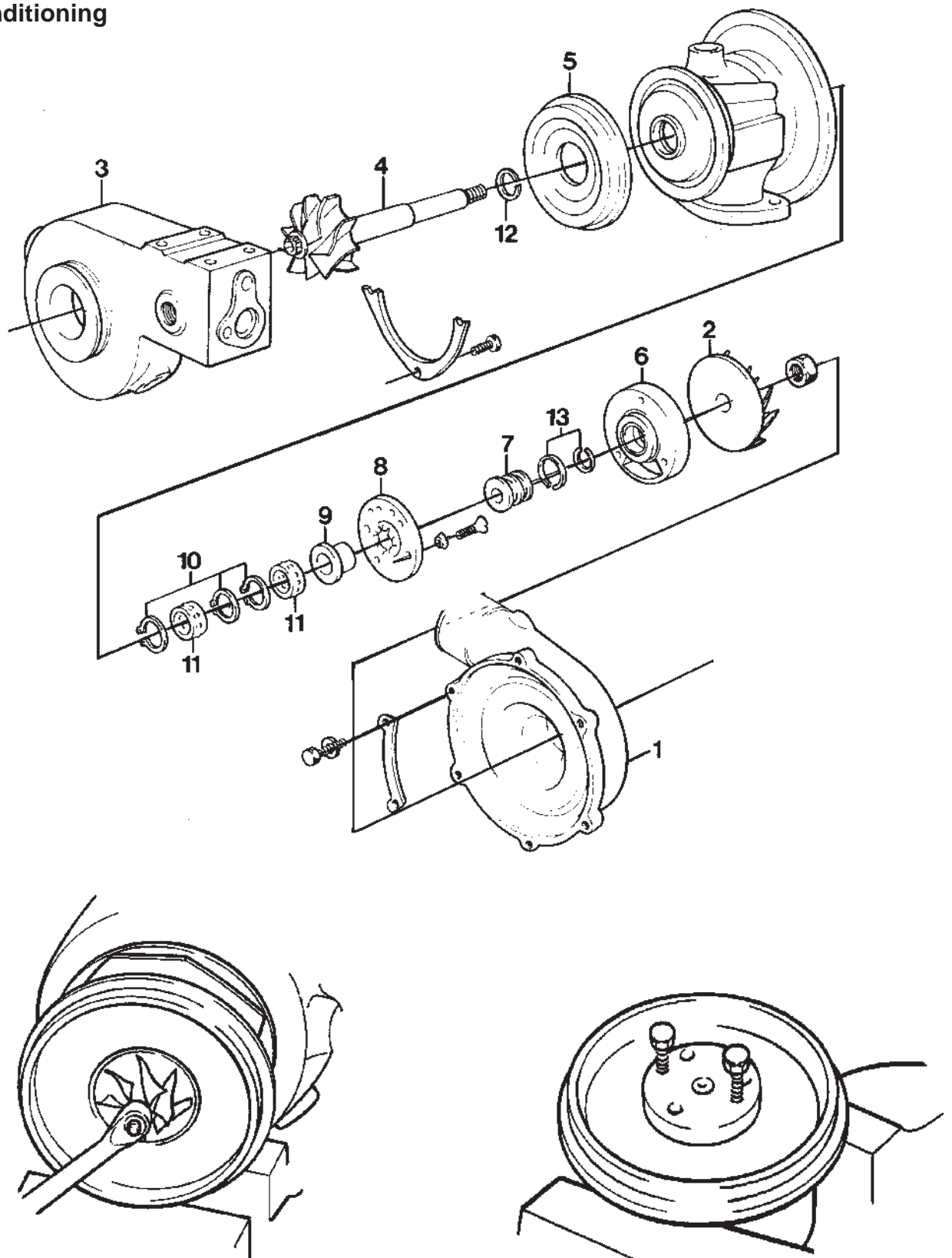
Dismount the turbo-compressor from the engine, and measure the rotor unit's axial and radial clearance. Maximum permissible axial clearance: 0.09 mm (0.00354 in)



Maximum permissible radial clearance: 0.17 mm (0.00669 in).

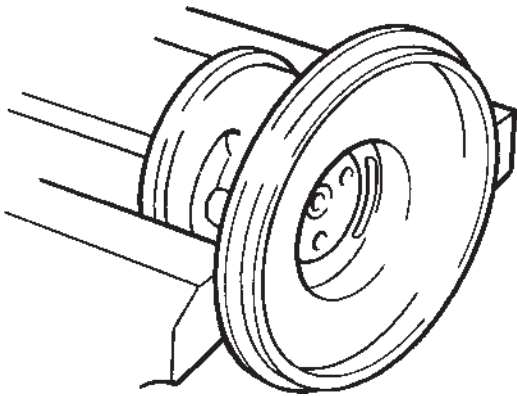
If wear and tear has reached the maximum permissible the turbo-compressor should be reconditioned or replaced.

## Reconditioning



**4.** Make line-up marks between the turbine housing, the bearing housing and the compressor housing. Dismantle the compressor housing (1). Unscrew the left-hand threaded nut which holds the compressor wheel, using dollies on the turbine shaft. Remove the compressor wheel (2) and dismantle the turbine housing (3).

**5.** Dismantle the turbine shaft (4) and the heat shield. If the turbine shaft sticks, tap the end gently with a wooden hammer. Unfasten the three screws which hold the cover (3) and screw two M5 screws into the cover. Then lift it up. Take the oil deflector (7) out of the cover.

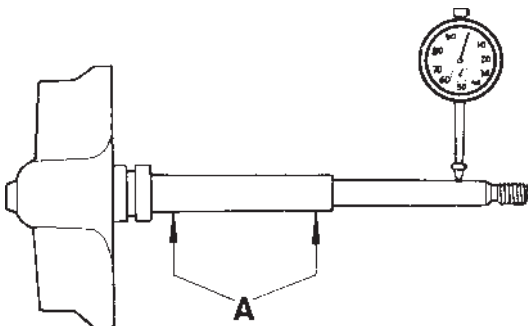


6. Unfasten the four screws which hold the compression bearing (8). Using a small copper mandrel, tap out the compression bearing and the bushing (9). Then remove the circlips (10) inside the bearing housing and remove the two bearings (11). Remove the packing ring (12) on the turbine shaft and the two packing rings (13) on the oil deflector. Clean the parts carefully.

## Measuring and Inspection

### Turbine Wheel and Shaft

7. Check that the turbine wheel and shaft are free from mechanical damage. The vanes must not be worn or out of shape. Do not try to realign the vanes. Damaged parts should be replaced.



8. Place the shaft on two supports, which should be under the bearing recesses, and check the throw at the end of the shaft. The maximum permissible throw is 0.011 mm (0.00043 in).

9. Check the diameter of the shaft bearing recesses. The minimum permissible diameter is 7.98 mm (0.3141 in). Check the width of the shaft piston ring groove. Maximum permissible width is 1.29 mm (0.0507 in).

### Compressor Housing, Turbine Housing

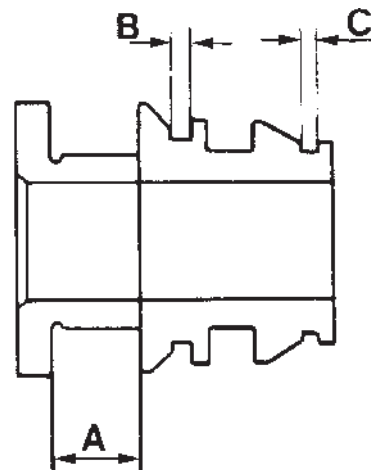
10. Check that the housings are free from cracks or other damage caused by excessive wear and tear. Damaged parts should be replaced.

### Heat Shield

11. Check that the heat shield is free from damage caused by wear and tear, heat or corrosion, and replace it if necessary.

### Bushing, Oil Deflector, Compressor Bearing

12. Check that the parts are free from wear and tear and discoloration. Damaged parts should be replaced even if the amount of wear and tear is within the permitted tolerances.



### Bushing

13. Check measurement (A), which should not be less than 4.07 mm (0.16023 in).

### Oil Deflector

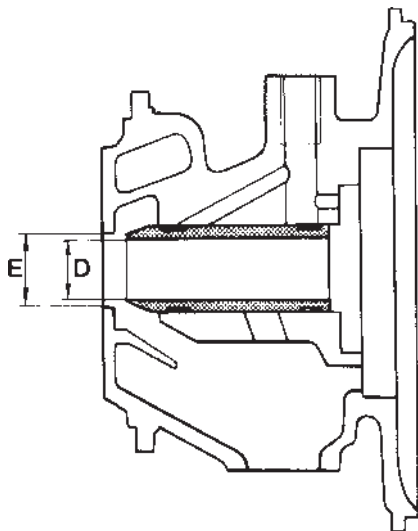
14. Check measurements (B) and (C). (B) should not be more than 1.31 mm (0.05157 in) (C) should not be more than 1.11 mm (0.04370 in).

### Compressor Bearing

15. Check the width of the bearing, and replace it if the amount of wear and tear is in excess of the permitted tolerance. Minimum permissible width is 3.98 mm (0.15669 in).

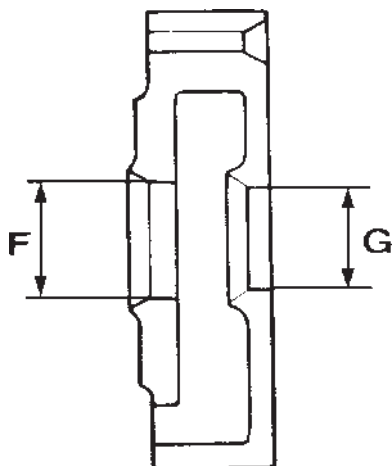
## Bearings

16. Check the bearings for abnormal wear and tear or discoloration, and replace them where necessary. Check the internal and external diameters of all bearings. The external diameter should not be less than 12.31 mm (0.48464 in), the internal diameter should not be more than 8.04 mm (0.31653 in).



## Bearing Housing

17. Check the housing for corrosion or cracks. Check measurements (D) and (E), and replace the housing where necessary. Measurement (D) should not be more than 12.42 mm (0.48897 in), measurement (E) should not be more than 15.05 mm (0.59251 in).



## Cover

18. Check measurements (F) and (G), and replace the cover where necessary. Measurement (F) should not be more than 12.45 mm (0.49015 in), measurement (G) should not be more than 10.05 mm (0.39566 in).

## Packing Rings

19. Check the packing rings to see if they are worn or out of shape, and replace them with new ones where necessary.

## Reassembly

Grease all removable parts when reassembling them. Position the circlips in the bearing housing so that the openings in them are facing towards the oil outlet. Mount the packing ring on the turbine shaft. Turn the opening in the ring so that it is facing towards the oil intake. Position the heat shield on the bearing casing, and then place the turbine axle in the bearing housing. Mount the bushing on the turbine shaft. Grease in the compressor bearing with engine oil, and mount it on the bearing casing, using new screws and washers to fasten it. The torque should be  $1.3 \text{ Nm} \pm 0.1$  (0.95 ft.lbs). Tighten the screws to the above torque, then loosen them a quarter turn before tightening them up to the correct torque again. Position the two packing rings on the oil deflector.

**NOTE!** The opening in the inner ring should be facing the oil outlet, that in the outer ring should be facing the oil intake.

The thickness of the sealant should be about 0.1-0.2mm (0.0039-0.0078 in). Fit the cover on the bearing housing, and fasten it with new screws and washers. The torque should be  $1.3 \text{ Nm} \pm 0.1$  (0.95 ft.lbs). Position the oil deflector in the cover. Smear the edges of the bearing housing which come in touch with the cover, using Permatex for the purpose. Tighten the screws to the above torque, then loosen them a quarter turn before tightening them up to the correct torque again. Position the compressor wheel on the turbine shaft and fasten it with the left-hand thread nut. The torque should be  $2.0 \text{ Nm} \pm 0.1$  (1.47 ft.lbs).

Mount the turbine housing on the bearing housing according to the line-up marks. Screw the locking cover into position, making sure that the screws used are not those for the compressor housing. The torque should be  $11.0 \text{ Nm} \pm 0.5$  (M6),  $26.0 \pm 1.0$  (M8). Smear the edges of the bearing housing where it comes in touch with the compressor housing, using Permatex for the purpose. The thickness of the sealant should be about 0.1-0.2 mm (0.0039-0.0078 in). Then mount the compressor housing according to the line-up marks, and screw the locking cover into position. The torque should be  $4.5 \text{ Nm} \pm 0.5$  (3.32 ft.lbs). Check the axial and radial clearance. Maximum permissible axial clearance is 0.09 mm (0.00354 in), maximum permissible radial clearance is 0.17 mm (0.00669 in).

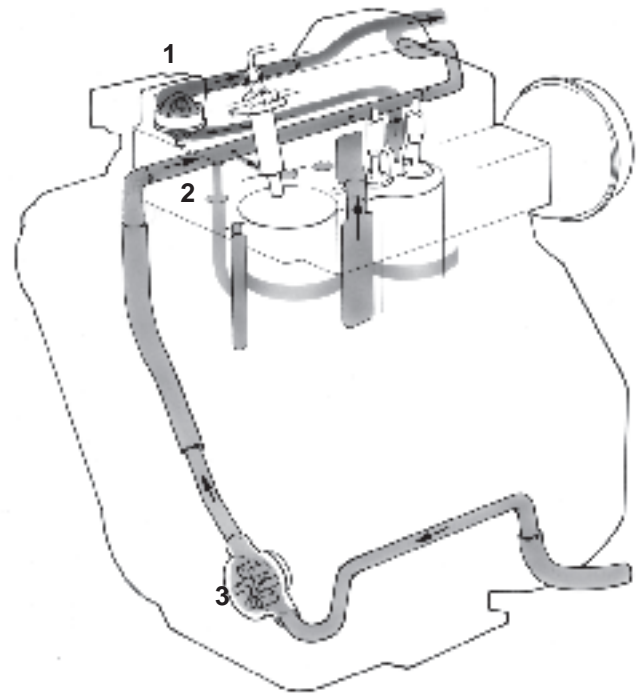
## Fitting the Turbo-Compressor

Before fitting the turbo-compressor on the engine, spray clean engine oil into the oil intake, and turn the turbine shaft so that the oil is evenly distributed. Clean the turbo-compressor's delivery and return oil lines. Change the engine oil and the filter for the lubricant. Be sure to use the correct quality of oil (see under "Technical Data"). Oil changes should be carried out in accordance with the instructions in the Manual, in order to keep the engine clean. Clean the air filter.

### Cooling system 2001, 2002, 2003

#### Sea water cooled (standard)

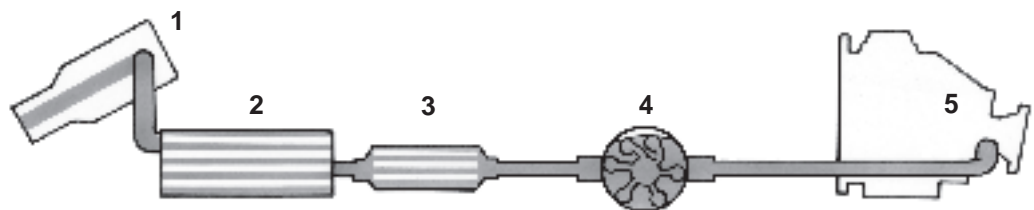
1. Thermostat
2. Distribution manifold
3. Sea water pump



### Cooling system 2003T

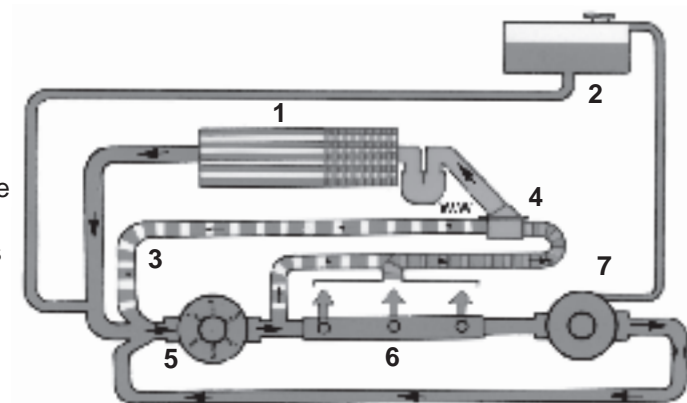
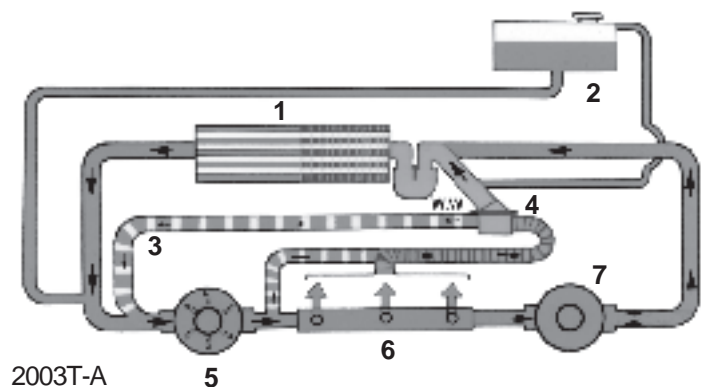
#### Sea water system

1. Exhaust pipe
2. Heat exchanger
3. Oil cooler
4. Sea water pump
5. Reversing gear



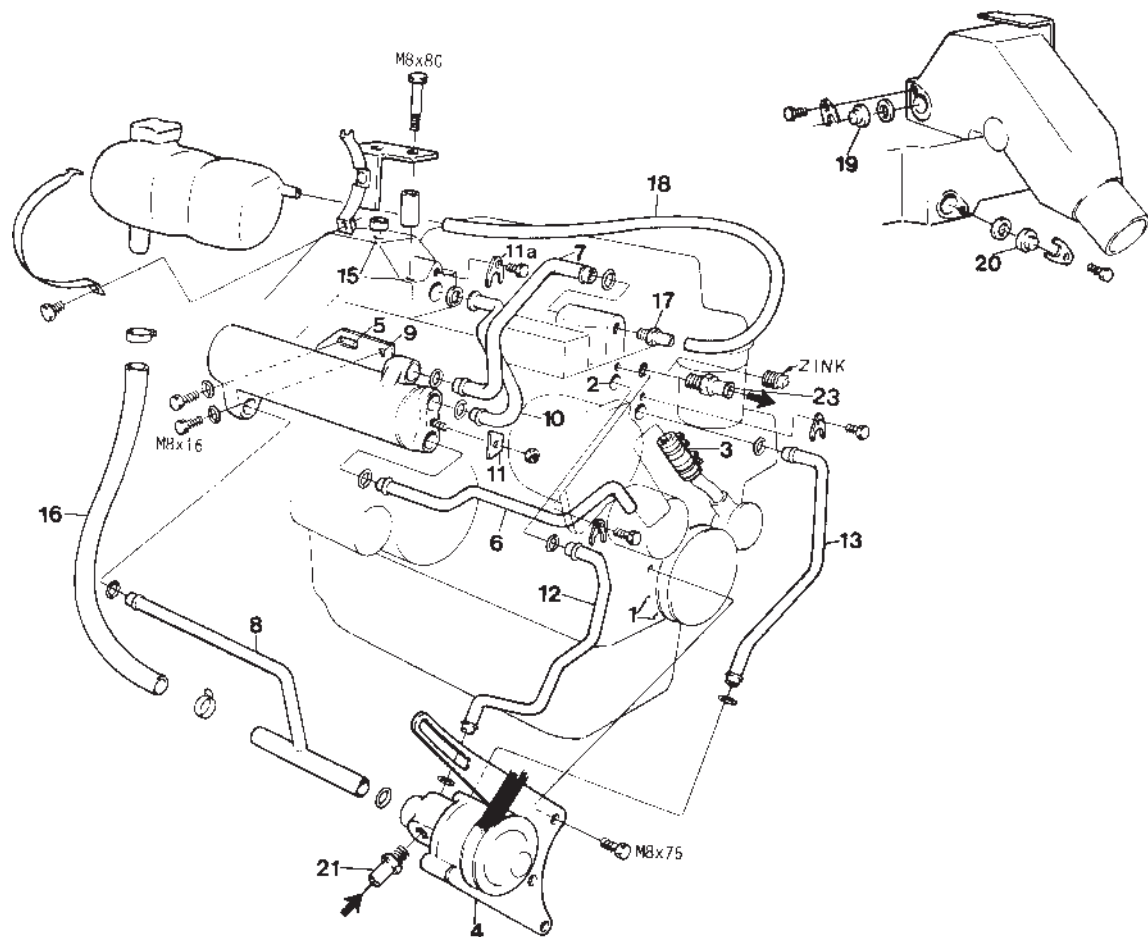
#### Fresh water system

1. Heat exchanger
2. Expansion tank
3. "By-pass" pipe (water flow with closed thermostat)
4. Thermostat
5. Circulation pump
6. Distribution manifold
7. Turbo\*



\* On the 2003T-B, the hose run for water outlet from the turbocharger was changed. Outgoing coolant on the B version is taken to the circulation pump, whereas it was taken to the heat exchanger on the A version. This allows the engine to come up to working temperature faster, and also gives it a higher working temperature, which reduces exhaust emissions.





## Fresh water cooling

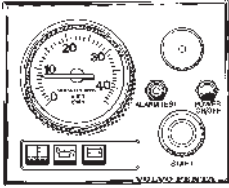
### Accessory 2002, 2003

1. Fit the circulation pump (complete with tensioner bracket and spacer sleeve, position 4). Tighten the bolts (M8x75) to 20 Nm (14.7 ft.lbs), position 1.
2. Suspend the heat exchanger loosely by the rear bolt (M8x16 and spring washer), position 5.
  - a) Fit the pipe (position 6) and the hose (position 3) between the heat exchanger and the sea-water pump, using double hose clamps (apply soapy water to the rubber rings, applies for all rubber rings).
  - b) Fit the pipe between the heat-exchanger and thermostat housing, position 7.
  - c) Fit the pipe between the heat-exchanger and the circulation pump, position 8.
3. Locate the pipes in the heat-exchanger and draw it forward tightening it with the two bolts (M8x16 and spring washers), positions 5 and 9.
4. Fit the pipe between the heat-exchanger and the exhaust elbow, position 10.
 

**NOTE!** The holder for the pipe, (position 11) and the lock (position 11a).
5. Fit the pipe between the circulation pump (lower outlet) and the cylinder head, position 12.
6. Fit the pipe between the circulation pump (upper outlet) and the cylinder head, position 13.
7. Fit the alternator, place the bolt for the tensioner bracket with the head forwards. Put on and tension the V-belt.
8. Fit the expansion tank to the exhaust elbow, position 15.
9. Fit the hose between the tank and the circulation pump (double pipe) 2002 = 450 mm (17.7 in), 2003 = 550 mm (21.7 in) (only single hose clamps are used on the fresh-water system), position 16.
10. Fit the nipple, position 17.
11. Fit the hose between the tank and the thermostat housing (nipple 17): 2002 = 350 mm (13.8 in), 2003 = 450 mm (17.7 in), position 18.
12. Fit the plugs in the exhaust elbow and the cylinder head, positions 19 and 20.
13. Fill the system to the right level with a mixture of fresh water (50 %) and anti-freeze (50 %), alternatively rust-protection additive (VP accessory). The fresh-water system volumes: 2002 = 4.0 dm<sup>3</sup> (litre) (1.1 US gals), 2003 = 5.5 dm<sup>3</sup> (litre) (1.45 US gals).

Pos 21 and 23 are for hot water outlet.

### Instrument panel, alternative «A»



**Instrument panel**

1. Printed circuit card
2. Rev. counter (accessory)
3. Start button
4. Instrument panel switch
5. Alarm test
6. Alarm

Max. output from the panel : 5 Amp

**Cable color**

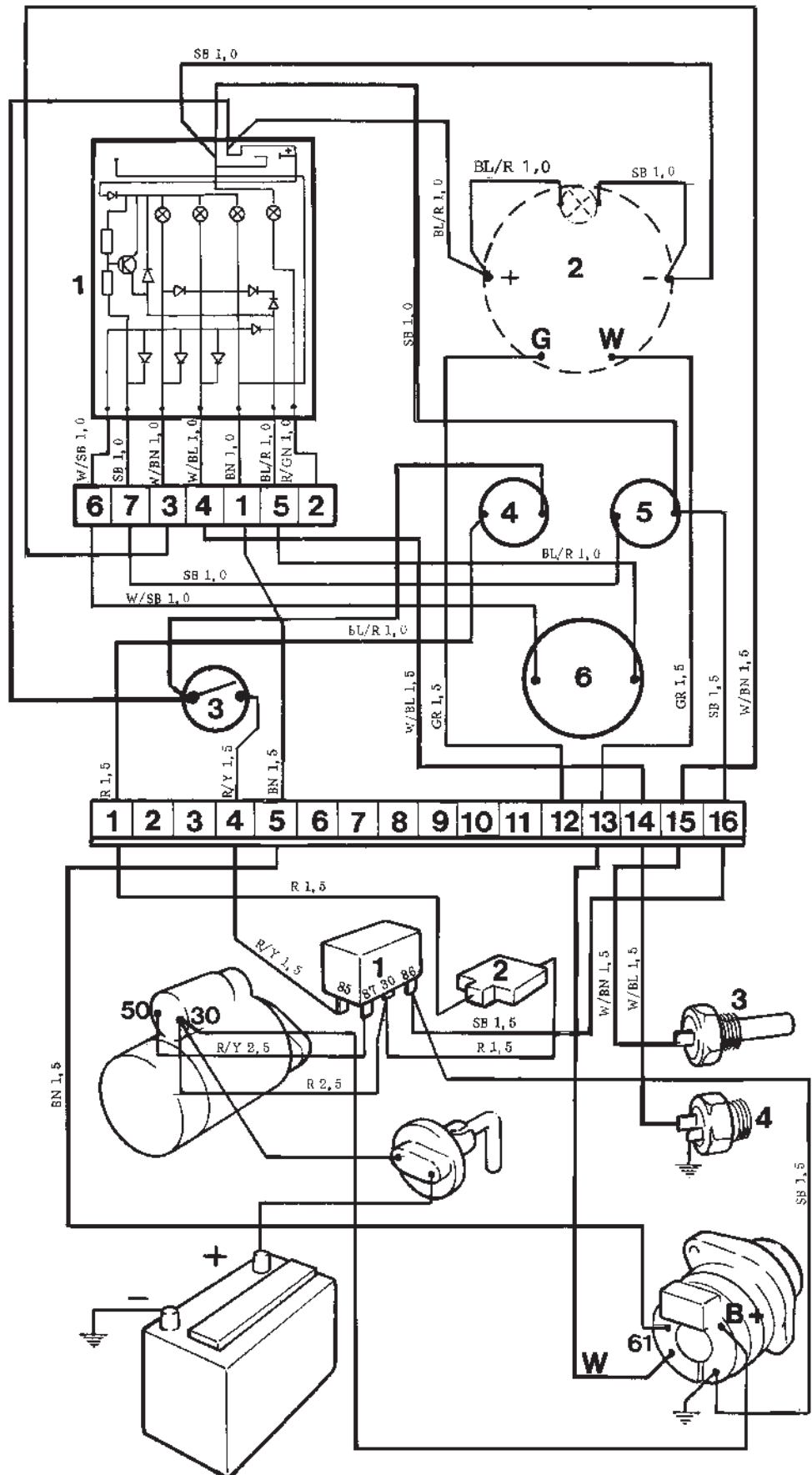
- GR = Grey
- SB = Black
- BN = Brown
- LBN = Light brown
- R = Red
- PU = Purple
- GN = Green
- Y = Yellow
- W = White
- BL = Blue
- LBL = Light blue

**Wire areas**

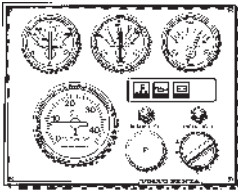
mm <sup>2</sup>	AWG
1,0	17
1,5	15
2,5	13
10	7

**Engine**

1. Relay
2. Fuse
3. Coolant temp. alarm switch
4. Oil pressure alarm switch



Instrument panel, alternative «B»



Instrument panel

1. Voltmeter
2. Oil pressure gauge
3. Coolant temperature gauge
4. Printed circuit card
5. Alarm test
6. Switch for instrument lightning
7. Rev. counter
8. Key switch
9. Alarm

Max. output from the panel : 5 Amp

Cable color

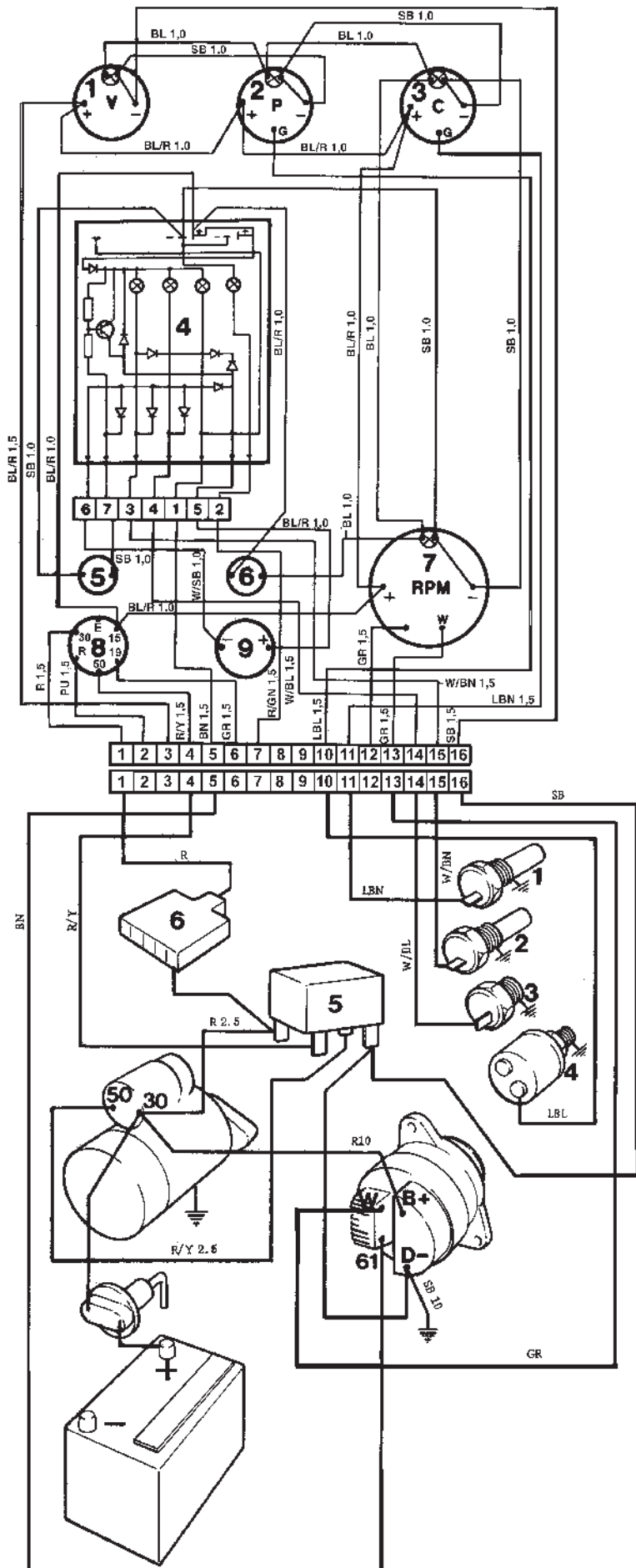
- GR = Grey
- SB = Black
- BN = Brown
- LBN = Light brown
- R = Red
- PU = Purple
- GN = Green
- Y = Yellow
- W = White
- BL = Blue
- LBL = Light blue

Wire areas

mm <sup>2</sup>	AWG
1,0	17
1,5	15
2,5	13
10	7

Engine

1. Coolant temperature sender
2. Oil pressure alarm switch
3. Coolant temperature alarm switch
4. Oil pressure sender
5. Relay
6. Fuse



## ***Fault tracing***

<b>Engine does not start</b>	<b>Engine stops</b>	<b>Engine not reaching full rpm</b>	<b>Engine runs roughly or vibrates abnormally</b>	<b>Engine becomes abnormally hot</b>	<b>Fault</b>
●					Stop control not fully pushed back. Main switch not switched on. Flat battery. Broken electric wires. Main fuse blown.
●	●				Empty fuel tank, closed fuel cock or clogged fuel filter.
●	●		●		Water or impurities in the fuel. Faulty injectors or air in the fuel system.
		●	●		Boat abnormally loaded, clogged intake air filter or marine growth on the boat bottom.
			●		Engine not properly aligned. Propeller damaged.
				●	Clogged cooling water intake or water jackets in the exhaust manifold. Faulty impeller in sea-water pump. Faulty thermostat. Clogged cooling water pipe in the cylinder head.



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**Notes**

Ruled lines for writing notes.

# Report form

Do you have any complaints or other comments about this manual? Please make a copy of this page, write your comments down and post it to us. The address is at the bottom of the page. We would prefer you to write in English or Swedish.

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AB Volvo Penta  
Market Communication  
SE-405 08 Göteborg  
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