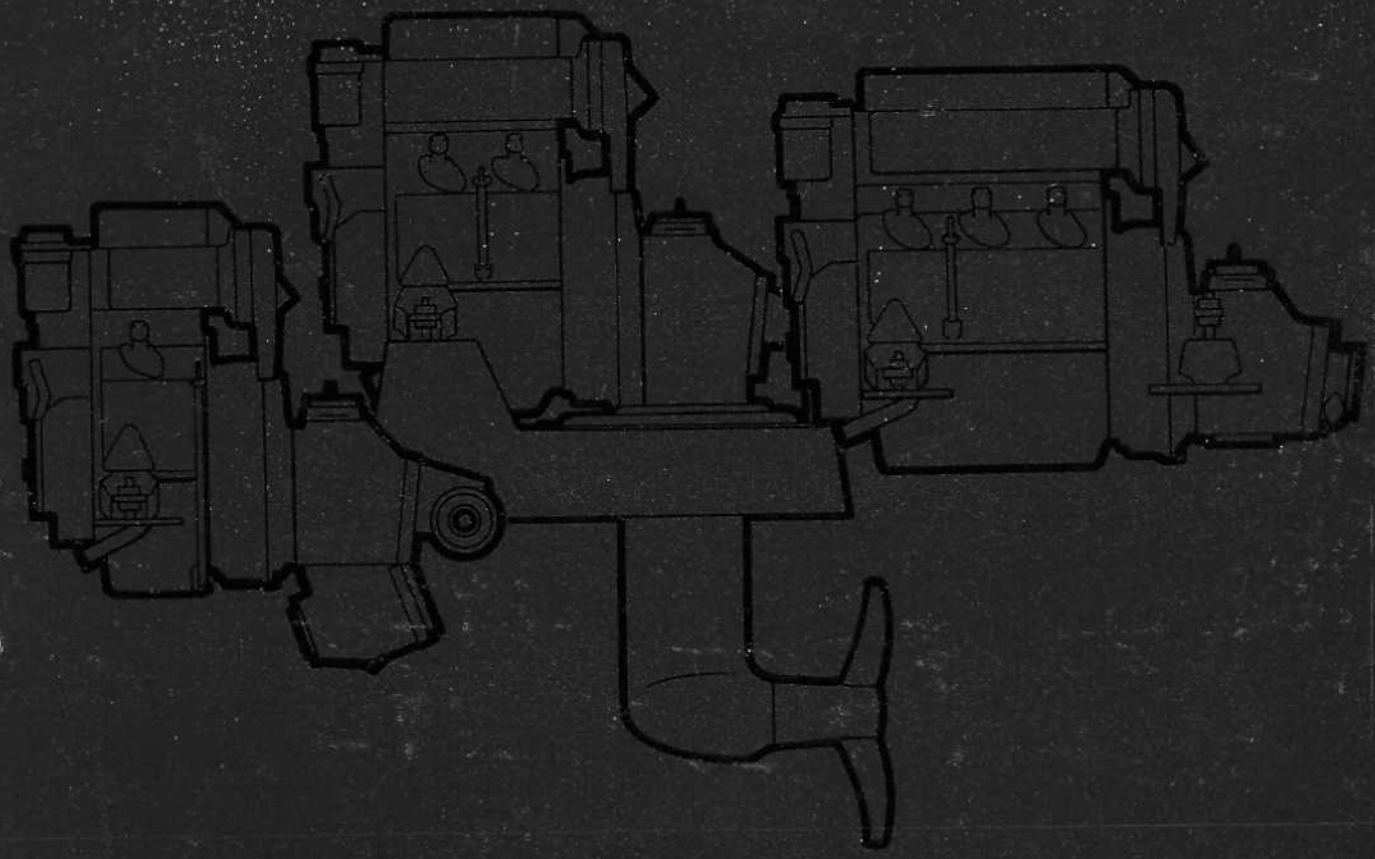
VP7730974-8
14.40
*FREIGHT
3,43

Publ. nr 7730974-8
4—1990

WORKSHOP MANUAL

2001, 2002, 2003, 2003T

ENGINE UNIT



VOLVO PENTA®

FOREWORD

This workshop manual contains repair instructions for the 2001, 2002 and 2003 engines.
The instructions concerning overhauling describe the most suitable working method using the special tools listed under the heading "Special tools".
Both the engine designation and its serial number must be clearly stated in all correspondence concerning the engine and when ordering parts.
We reserve the right carry out design modifications and, for this reason, the contents of this manual cannot be regarded as binding.

AB VOLVO PENTA
Technical Publications Department

SI UNIT SYSTEM

Units according to the international SI system have been used in this book. The earlier units are given after the SI units.

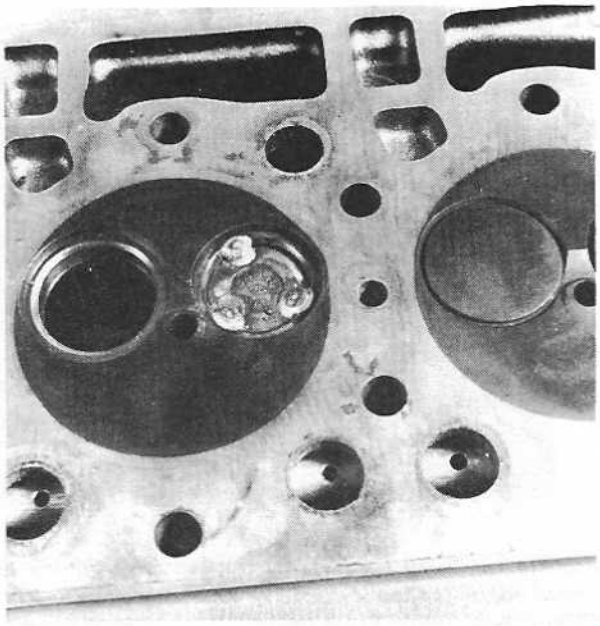
Power is given in kW (kilowatt)
earlier unit hp (horse-power)

Torque is given in Nm (newton metre)
earlier unit kpm (kilopond metre)
earlier unit lbf ft (poundfoot)

Pressure is given in Pa (Pascal)
earlier unit kp/cm^2 (kiloponds per square centimetre)
earlier unit lbf/in^2 (pounds per square inch)

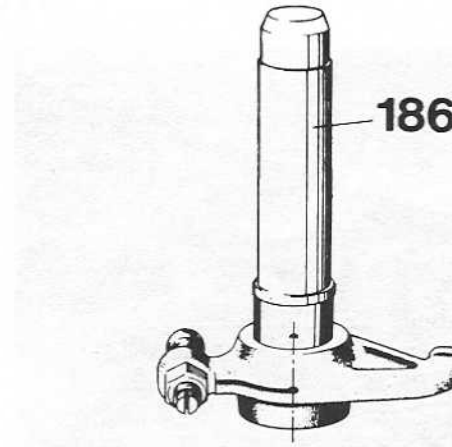
Speed is given in rev/s (revolutions per second)
earlier unit rev/min (revolutions per minute)

Volume is given in dm^3 (cubic decimetre)
earlier unit l (litre)
earlier unit Imp. gal (Imperial gallon)
earlier unit US gal (United States gallon)

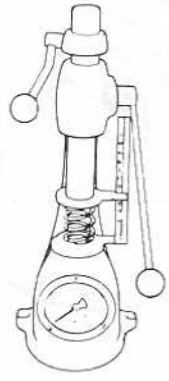


Replacing the valve seat exhaust port 2003T
Grind down the valve disc of a discarded valve to just below 27 mm (1.063 in) diameter. Push the valve stem through the guide. NOTE! Do no push in too far — the valve disc should be just below the edge of the seat. Spot weld the disc in place at three points using a electric welder. Knock out the seat by hitting the valve guide with a plastic-headed hammer.

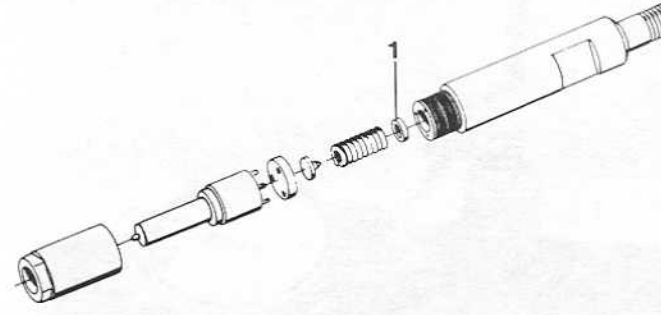
Cool the new seat to approx. —20°C (—4°F); the cylinder head should be at room temperature (+20°C/68°F). Place the cooled seat on tool 884961-4 and knock it down until it bottoms. NOTE! Turn the seat with the valve face towards the tool.



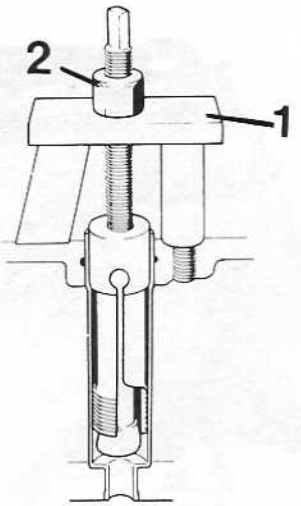
Rocker arm mechanism
6. Disassemble the rocker arm mechanism and clean the parts. Check the wear of the shaft and rocker arm bushings. Should the bushings need to be replaced, use the mandrel p/n 9991867 for the removal and installation, (make sure that the oil hole in the bushing coincides with the 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.



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_1 = Length, loaded with 170±10 N (17±1 kp) 32 mm (1.25984 in.)
L_2 = Length, loaded with 300±20 N (30±3 kp) 24 mm (0.94488 in.)

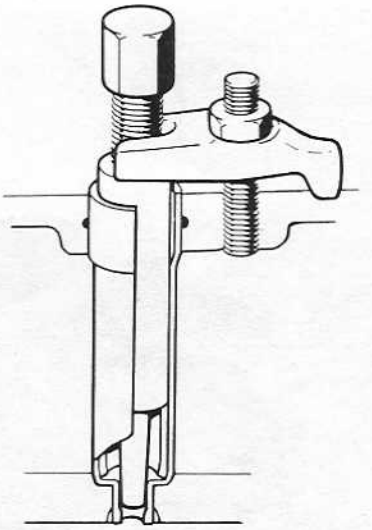


Pressure testing the nozzles
7. Check the nozzle's spray pattern at the correct opening pressure (see Technical Data). Check also that the fuel sprays stop simultaneously and no dripping occurs.
Adjust the opening-pressure with adjustment-washers (1) being available in different thicknesses from 1 mm (.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.

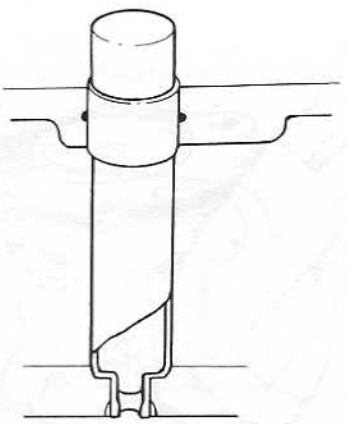


Injector-sleeve

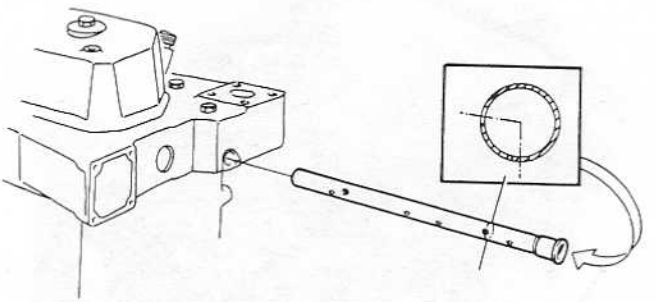
8. Insert the expanding screw on the special tool p/n 884811 into the copper sleeve and turn the screw anti-clockwise until the screw has stuck in the sleeve. Tighten the screw hard to allow the threads to work themselves into the copper material. Then install the yoke (1) on the stud bolt of the injector. 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 884283 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.).

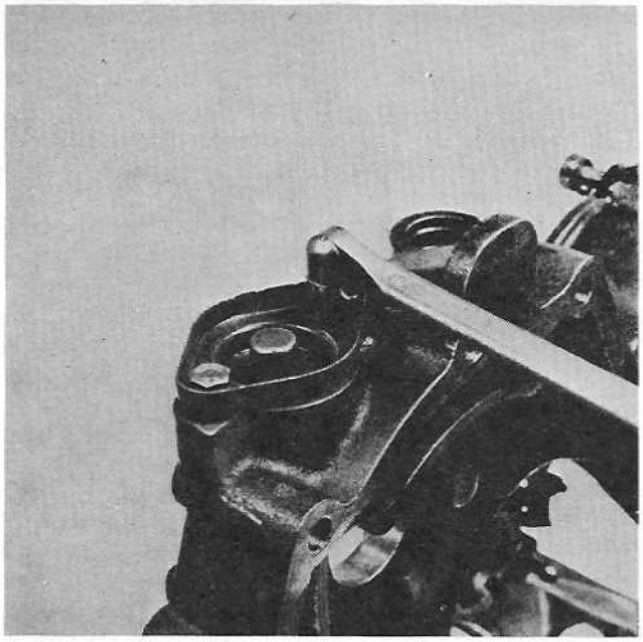


9. Replace the O-ring, sealing off between the sleeve and the cylinder head. Dip the new O-ring in soap-water in order to facilitate the installation. Oil the new injector sleeve and install it, using special tool p/n 884557. Knock down the sleeve until it bottoms.



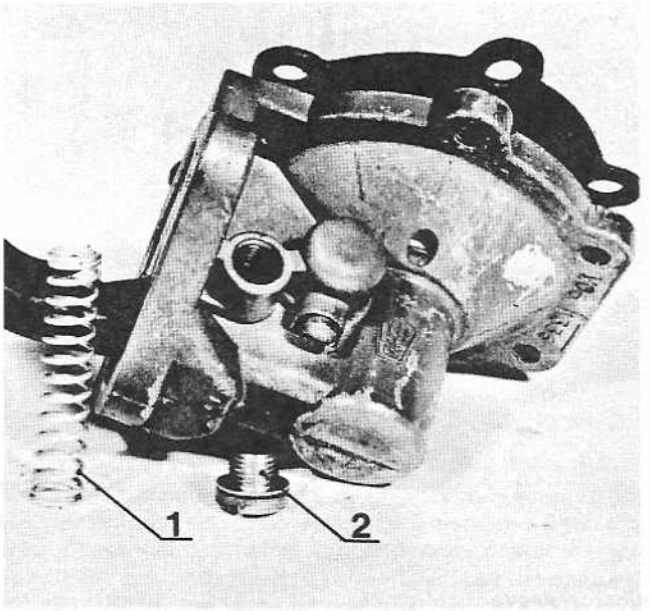
Assembling the cylinder head

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.



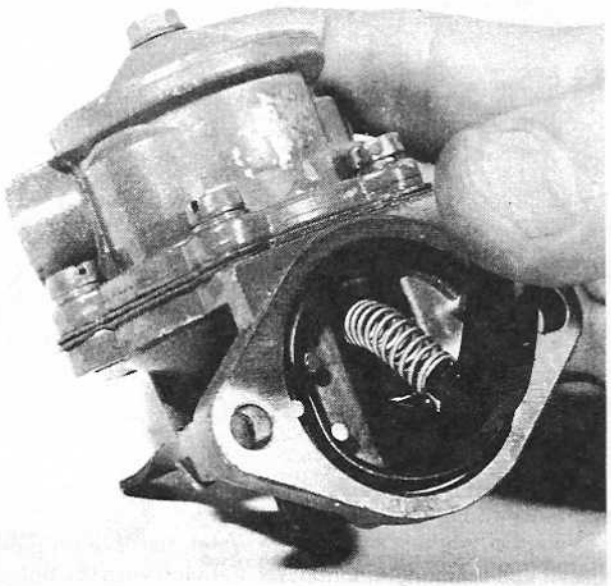
Reduction valve

12. Remove the cover of the reduction valve and check t make sure that the spring and the piston are faultless. I 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.



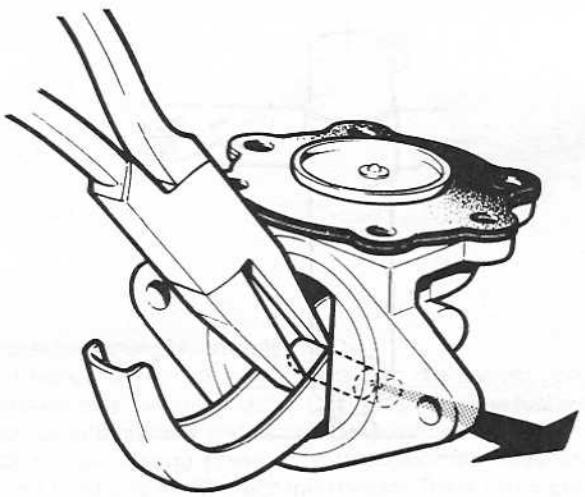
Changing the diaphragm

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.

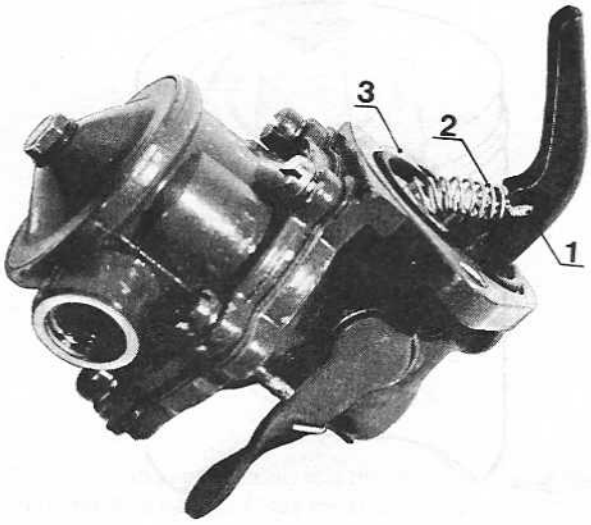


Feed-pump

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



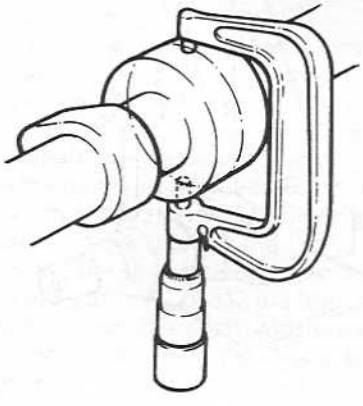
15. Use a suitable pair of pliers and remove the pump lever shaft. Pull out the lever and the diaphragm.



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).

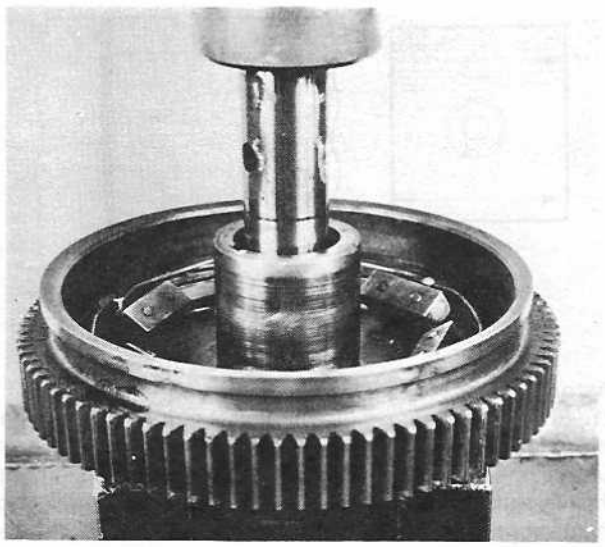
Valve lifters

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

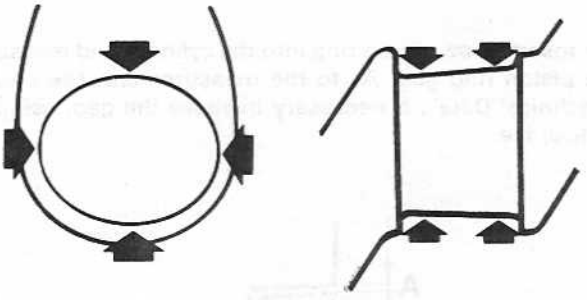


Camshaft

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.

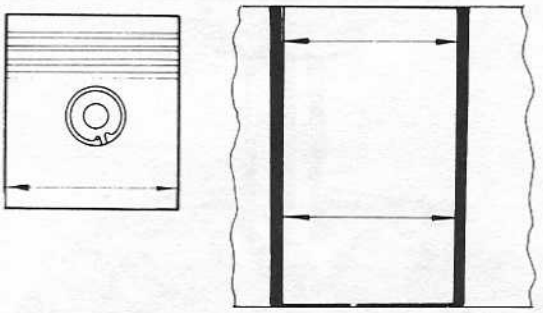


19. Place a support under the camshaft gear and use a hydraulic press to remove the gear.



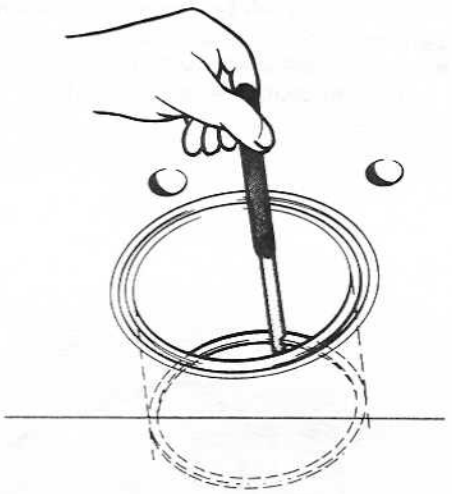
Crankshaft

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".

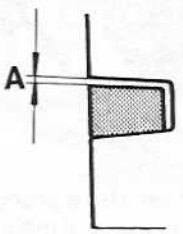


Pistons, cylinders

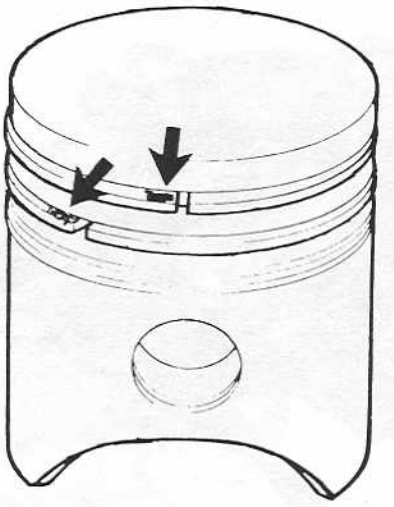
21. Check the wear on pistons, piston rings and gudgeon pins. Replace these if necessary. Use a cylinder indicator gauge to measure the cylinder bores. The measurement of the biggest wear is made immediately beneath the edge of the upper dead center and crosswise the engine. The measurement of the smallest 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".



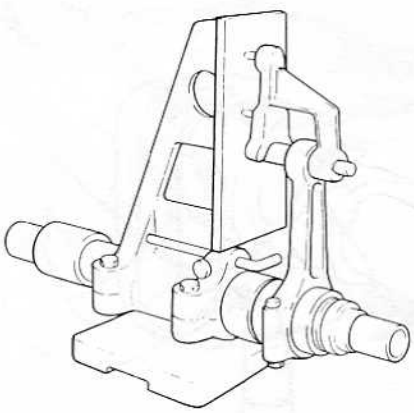
22. Insert a new piston ring into the cylinder and measure the piston ring gap. As to the measurement, see under "Technical Data". If necessary increase the gap, using a special file.



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

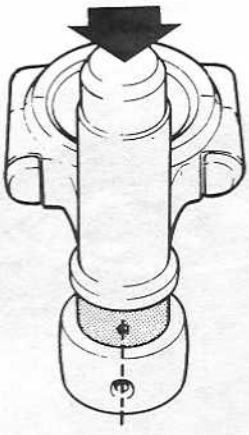


24. Use piston ring pliers to install the piston rings. The marking of the rings (TOP or the mark of the manufacturer) must be turned upwards. The height of the upper compression ring: 1,75 mm (.068898 in.) The height of the lower compression ring: 2,00 mm (.07874 in.). Turn the piston rings so that the gaps are turned 120° from each other.

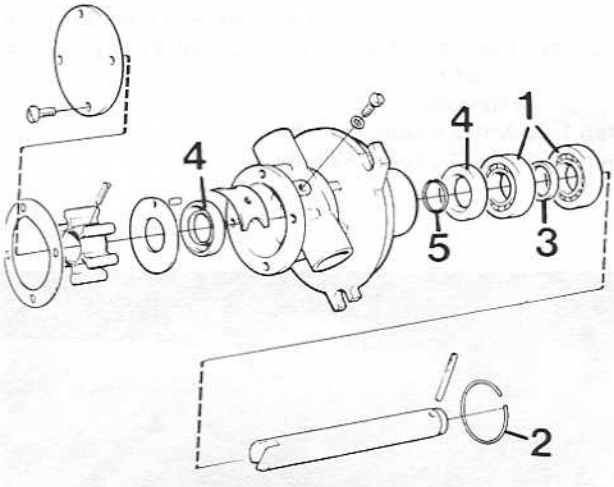


Connecting rods

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

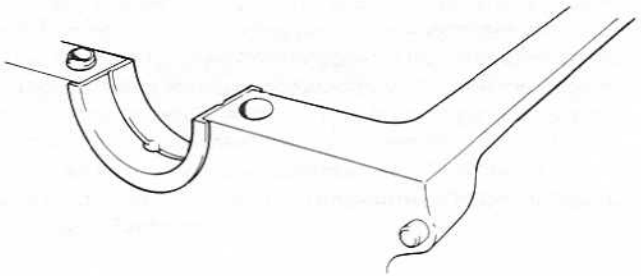
27. The pump is equipped with two ball-bearings (1). When disassembling, remove the locking-ring (2) in the housing and push out the shaft, whereby the bearings are following. Use a suitable mandrel to remove the bearings from the shaft. NOTE! Do not forget the spacer sleeve (3). Replace the sealings (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 thermostats

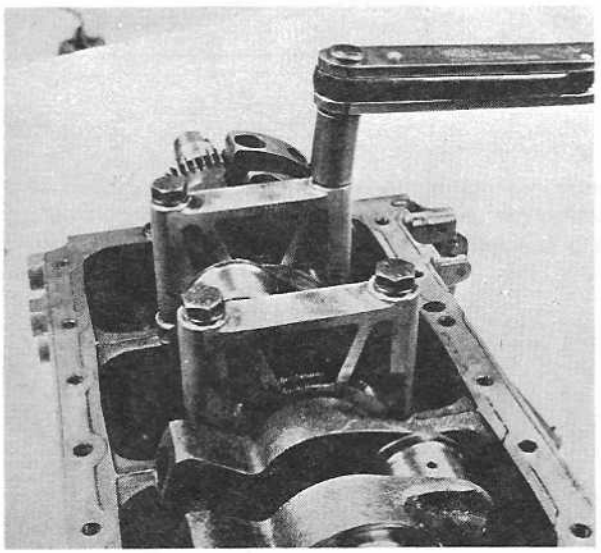
28. Immerse the thermostat in water and, using a thermometer, check if it opens at the correct temperature. See Technical Data for opening temperatures. If the thermostat is faulty, it must be replaced.

ASSEMBLY

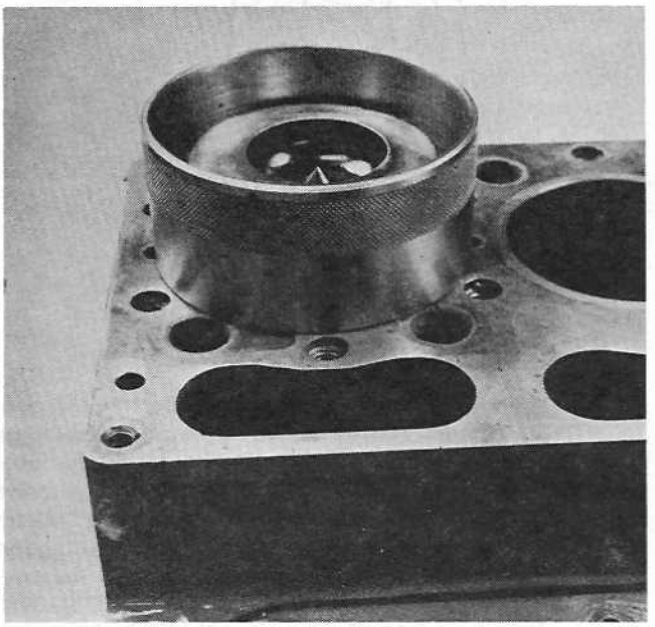
Always use new gaskets, sealing rings, sealing washers and lock-washers. Coat the sealings with grease or oil them and also oil all moving parts prior to installing them. If the engine is fresh-water cooled, see page 21.



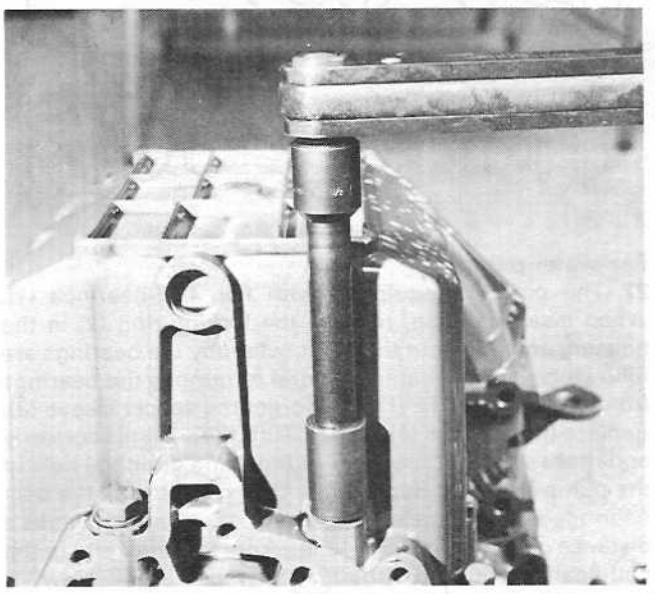
1. Heat the crankshaft gear wheel to approx. 150°C (302°F) prior to the installation. Place the key in the key-way of the crankshaft and press on the gear wheel. Oil the new main bearing halves (with oil hole) and install them in the block. Put in the crankshaft. NOTE! The main bearing shell at the flywheel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



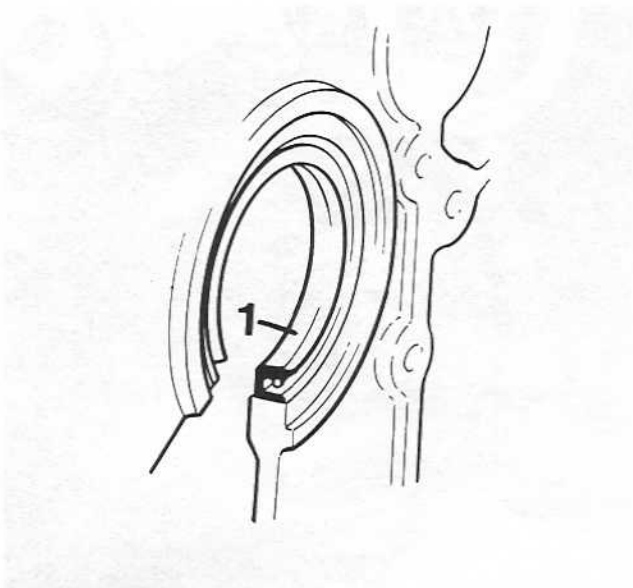
2. Oil the cap bearing halves and install them. Install the caps in accordance with the marking in the block (2001 has no intermediate bearing). If an arrow is cast, it shall point towards the oil dipstick. Tightening torque for the main bearings: 1st tightening 20 Nm (2 kpm) (14.7 ft.lbs), 2nd tightening 60 Nm (6 kpm) (44.2 ft.lbs). Turn the engine.



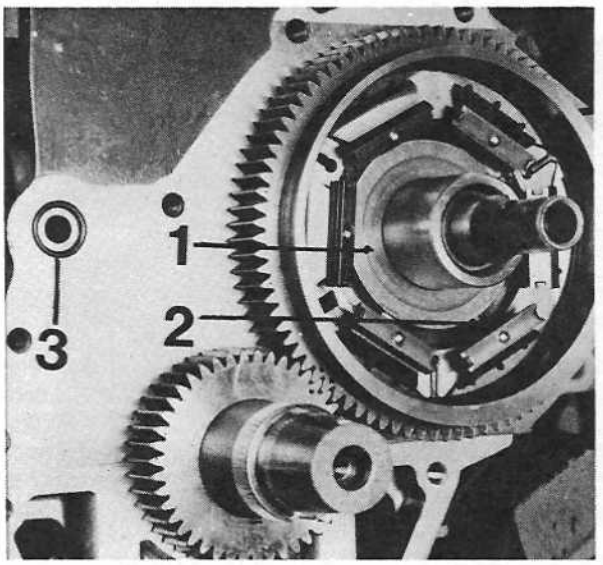
3. Turn the piston rings so that the gaps are offset in relation to each other. The piston crown is marked with an arrow that points towards the belt pulley. Use installation ring 884813-7. Fit the caps with the marking aligned with the crankshaft's marking. The crankshaft can be turned in any direction towards the piston.
Tightening torques:
Step 1: 25 Nm (2.5 kpm) (18 ft/lb)
Step 2: 70 Nm (7.0 kpm) (53 ft/lb)



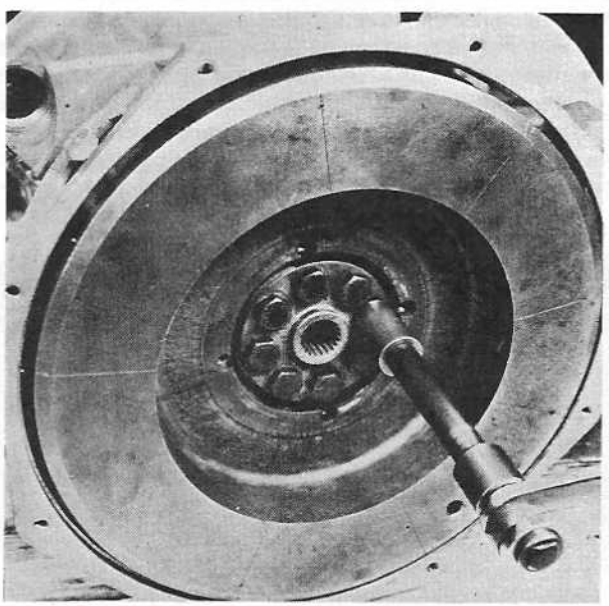
4. Install the main bearing halves in the oil pan and coat the edge of the oil pan with thin layer of sealing compound p/n 840879. Install the oil pan and tighten the oil pan screws and the main bearing screws alternatingly to 20 Nm (2,0 kpm) (14.7 ft.lbs.) and then the main bearing screws to 60 Nm (6,0 kpm) (44.2 ft.lbs.).



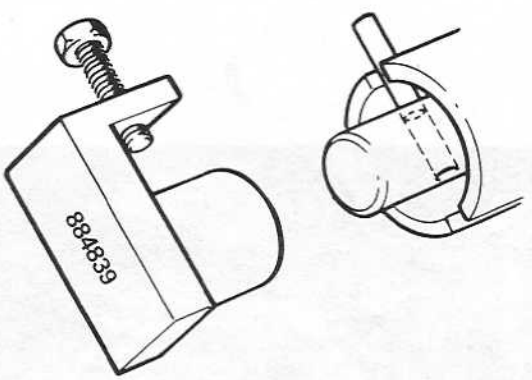
5. Replace the flywheel housing sealing (1). Smear sealing compound (p/n 840879) on the edge between the flywheel housing and the sealing. NOTE! The sealing lip with a spring shall be turned towards the engine. Make sure that the sealing is installed in accordance with the picture.



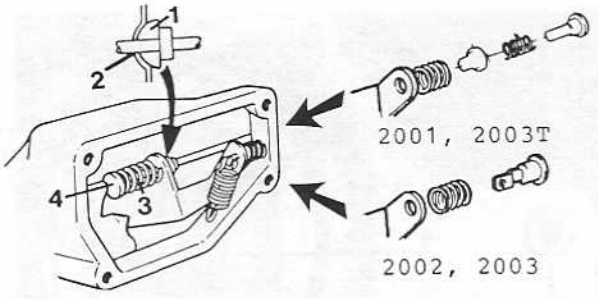
7A. Heat the camshaft gear wheel to a temperature of approx. 150°C (302°F) and use a suitable sleeve to install it. Check to make sure that the gear wheel "bottoms" on the camshaft. Install the camshaft and make sure that the markings on the camshaft gear wheel and on the crankshaft gear wheel coincide. 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.



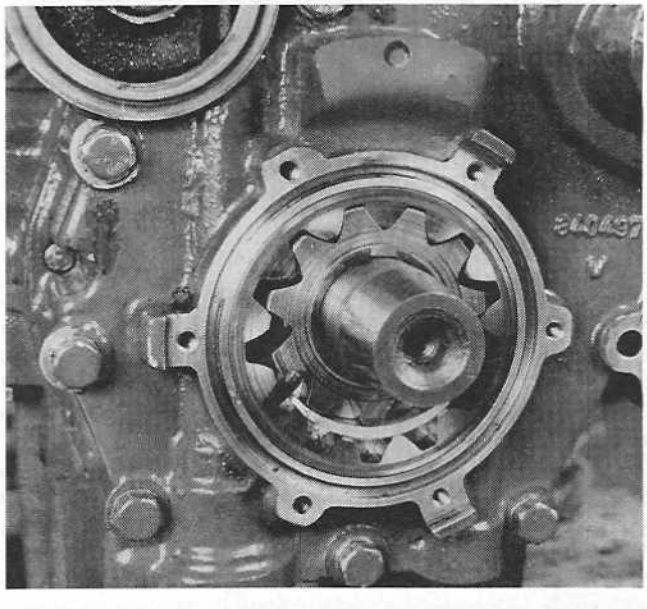
6. Replace the O-rings and install the flywheel housing. Tightening torque 25 Nm (2,5 kpm) (18.4 ft.lbs).
Install the flywheel. Tightening torque 65 Nm (6,5 kpm) (48.0 ft.lbs).



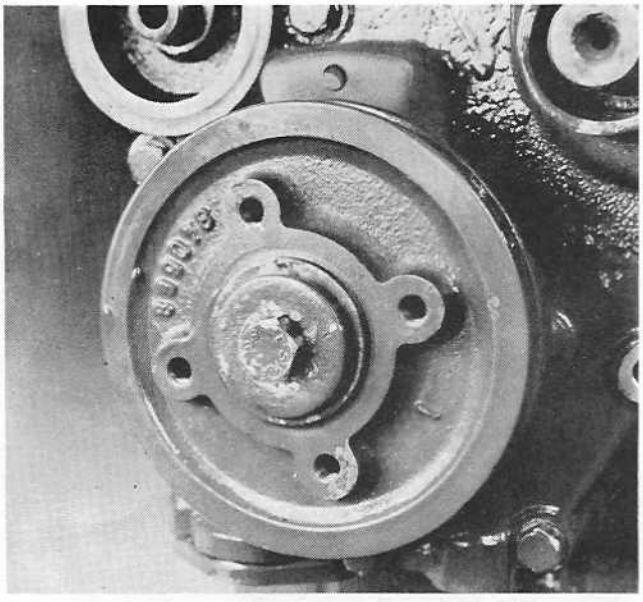
7B. Install a new sealing ring for the camshaft in the transmission housing, using mandrel p/n 884838. The sealing lip with the spring is to be turned towards the engine. Press in the sealing ring from the outside until the mandrel "bottoms" against the housing. Install a new O-ring in the oil channel 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.



8. Insert the control rod through the block and into the timing gear casing. Install the bearing ball (1) into the control rod and push the control rod through the hole in the control lever (2). Fit the spring (3) and screw on the end nipple (4) until it bottoms (Note! Do not use any tools). Screw in the upper bolts (with 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.

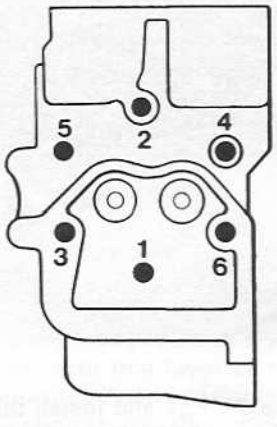


9. Install the oil pump's gear wheel according to the marks (from the disassembly). Insert a new O-ring in the timing gear cover. Oil the gear wheel and fit the cover using a new sealing ring.



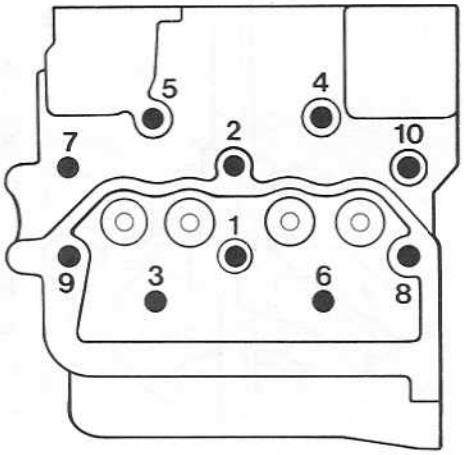
10. Insert the key for the pulley in the crankshaft and install the pulley. Tightening torque 40 Nm (4,0 kpm) (29.5 ft.lbs).

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 then 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.

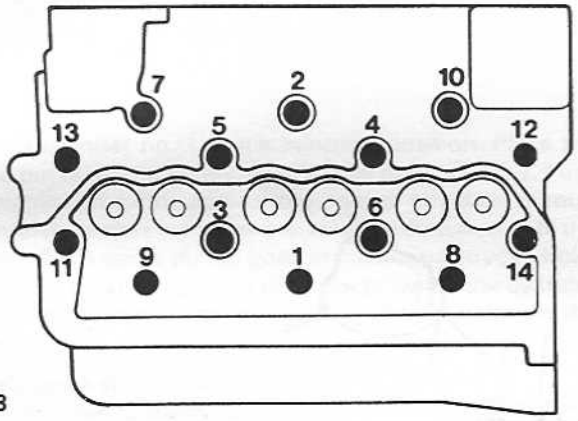


2001

Regarding the installation of the cylinder head, see the following page.

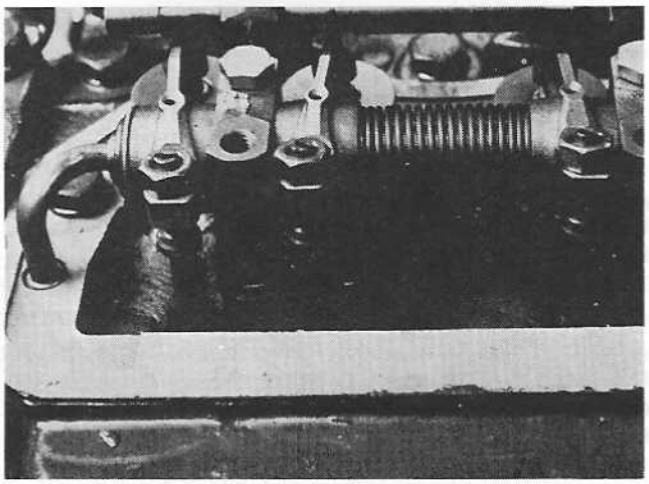


2002

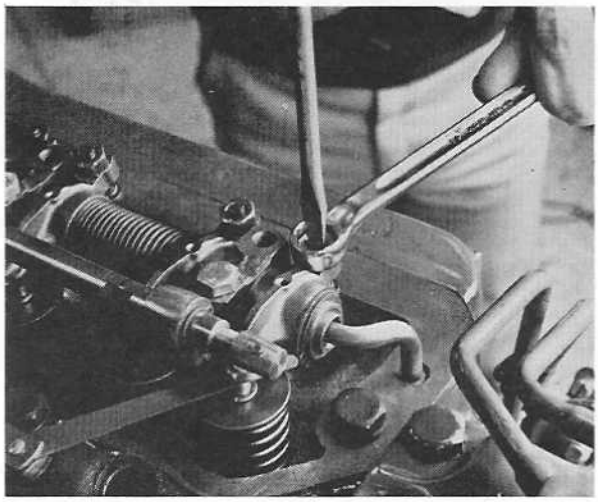


2003

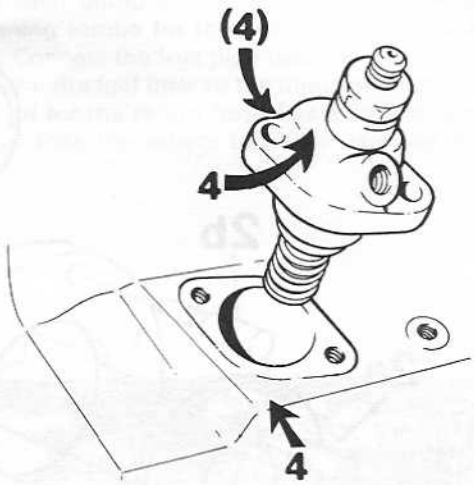
12. Tighten the two guide screws p/n 884840 in the block and install the cylinder head gasket with the marking "Top" facing upwards. Install the cylinder head.
Make sure that the contact surface for the cylinder head bolts are free from paint. Should there be paint on the bolts, there is always the risk of having an insufficient tightening force in the bolt joint with subsequent leakages as a result. NOTE! The bolts are phospated, 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 (2.0 kpm/14.7 ft.lbs) and then to 70 Nm (7.0 kpm/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.

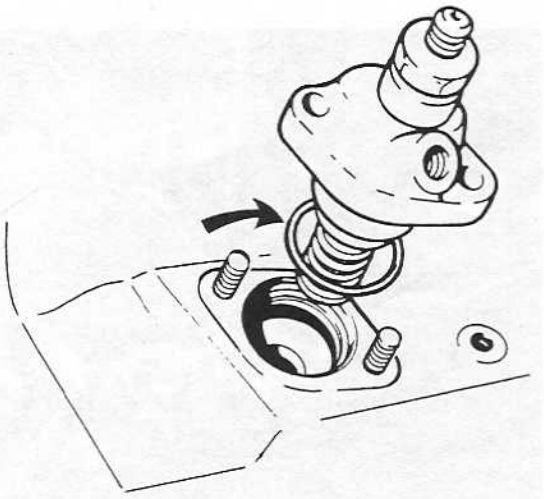


14. Valve clearance cold/warm engine 0.30 mm (.01181 in.). Turn the engine in the direction of rotation until the valves in one cylinder are "rocking". Then turn the engine one turn more and adjust the valves for this cylinder. Repeat the procedure for the remaining cylinders.

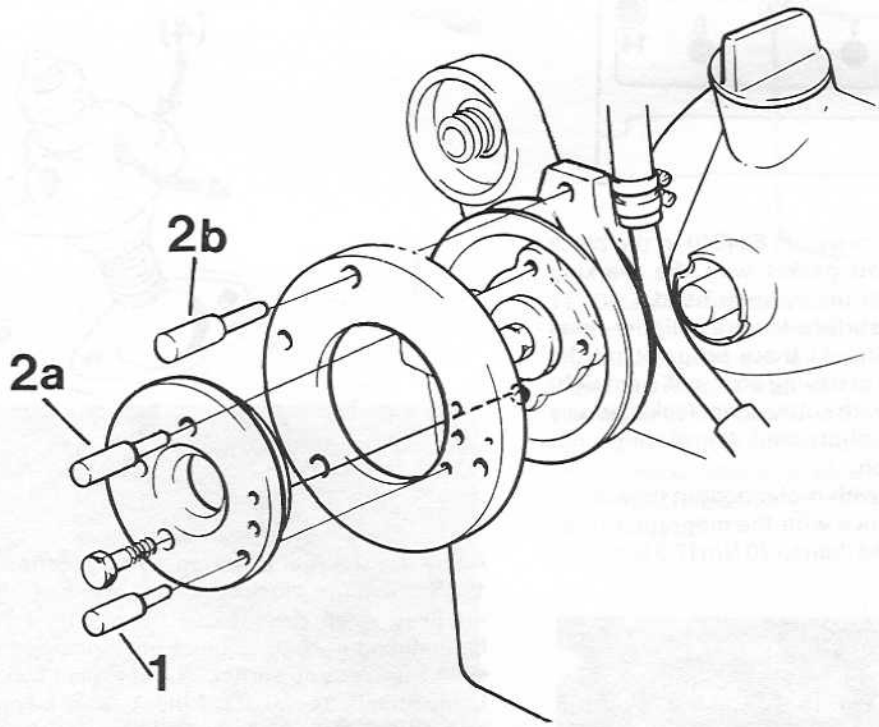


Adjusting the fuel injection pump location with shims

15. If the same block camshaft and fuel injection pumps are used when assembling, the fuel injection pump 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 marking 4 (= 4 tenths of a millimeter) (.015748 in.)
The pump marking 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 thicknesses 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).



16. New block or camshaft

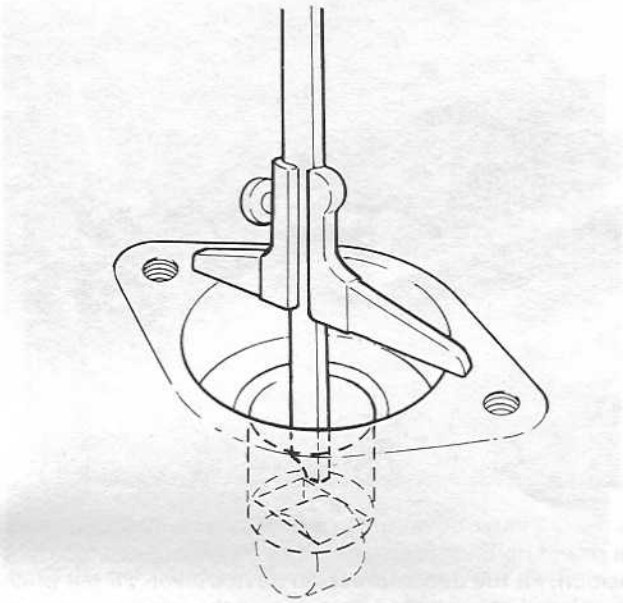
If the block or the camshaft are replaced the block must be measured and marked, using the setting-disc p/n 884787 and a sliding caliper.

A. The setting-disc consists of two rings, an inner and an outer. The inner ring determines the injection angle for each respective engine type, see Technical Data (page 25). The injection angle is stamped in degrees and is fixed with a pin (1).

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 (2) comes in the largest of the four holes in the pulley. Press in the guide pin (2) 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, 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 it's injection position. Place the guide pin (2) 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 (2) 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).

The distance should be:
2001: 55.8 mm (2.19685 in)
2002, 2003: 55,6 mm (2.18504 in)
2003T: 55.9 mm (2.2007 in)

Example:
2001. If the measured distance is 55.2 mm (2.17323 in) this means that a shim with thickness 0.6 mm (0.02362 in) is to be placed between the caliper and the block.

2002, 2003. If the measured distance is 55.0 mm (2.16535 in) this means that a shim with thickness 0.6 mm (0.02362 in) is to be placed between the caliper and the block.

The measured shims thickness (in this example 0.6 mm) is to be stamped into the block as in fig. 15.

The total shim thickness is found by adding the block's measurements and the pump's marking.

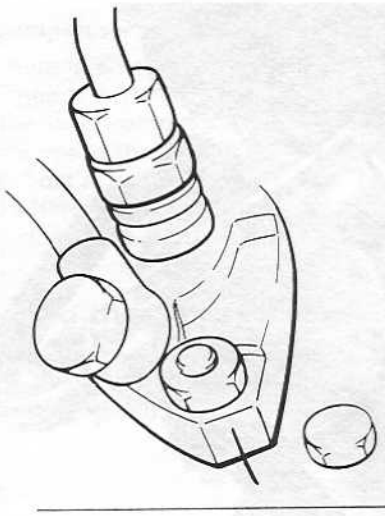
Example

The block's measurements	6 (= 0.6 mm/0.02362 in)
The pump's marking	2 (= 0.2 mm/0.007874 in)
No. of shims	0.8 mm

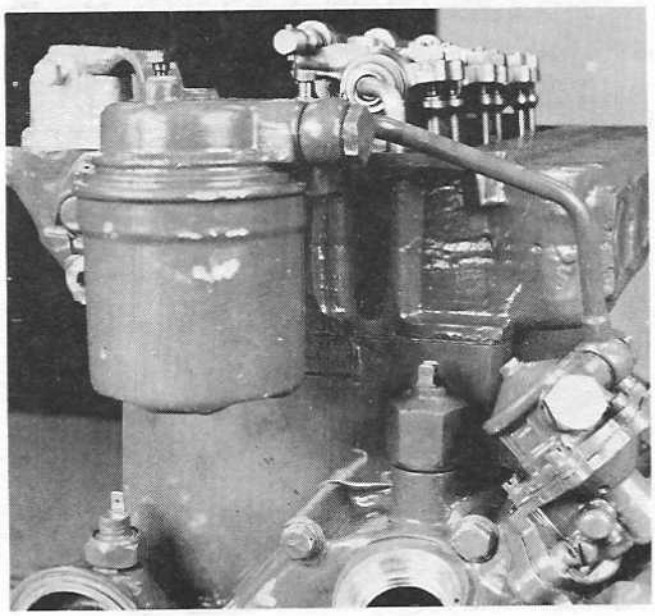
In this case choose two soft shims 0.2 and 0.3 mm (0.007874 and 0.011811 in) and one hard shim of 0.3 mm (0.011811 in). Place the hard shim between the two soft ones and refit the pump. **NOTE! A hard shim must never be fitted together with another hard shim or directly against the block or pump.**

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).

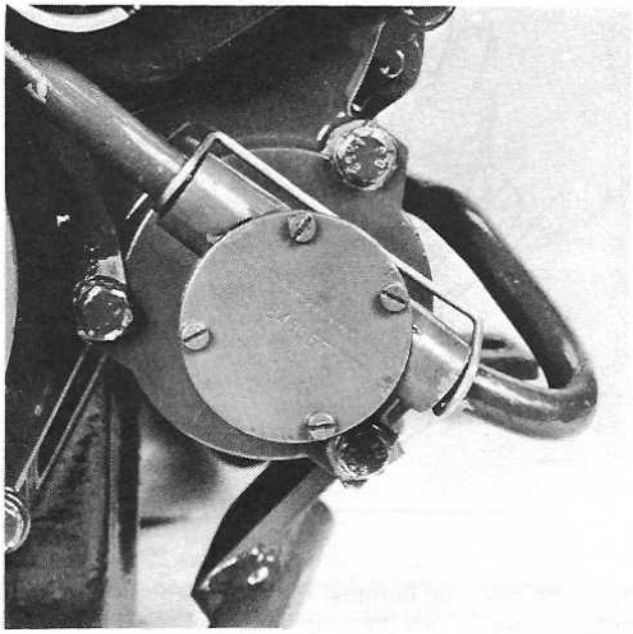
D. Repeat the procedure for the other pumps (2002, 2003) in the same way as for cylinder 1.
The setting-disc's marking is explained under point B.



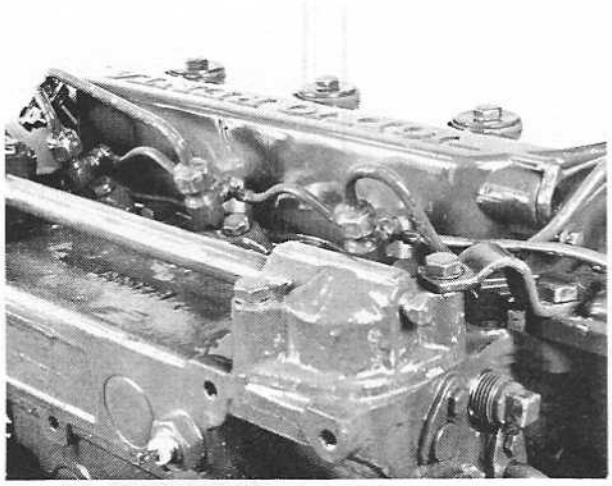
17. Fit the injection pump(s) together with the calculated shim thickness. Turn the engine so that the cam for the pump is not in the lifting position. Check that the pump's pin locates in the control rod's groove and that the pump(s) and the locks markings coincide (see figure). Check after fitting each pump that the control rod operates easily. Tightening torque for the nuts is 20 Nm (2,0 kpm) (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").



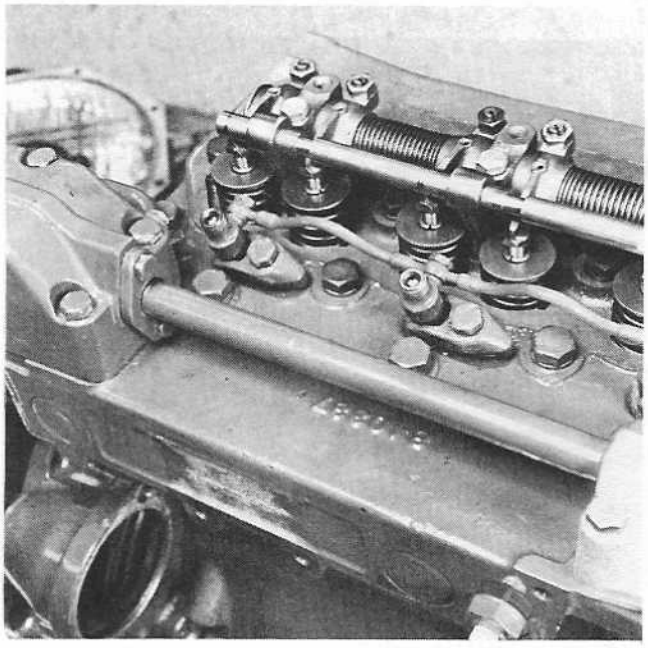
18. Install the feed pump and the fuel filter. Also install the thermostat housing with the thermostat. NOTE! Do not forget the lifting eyelet between the fuel filter and the thermostat housing.



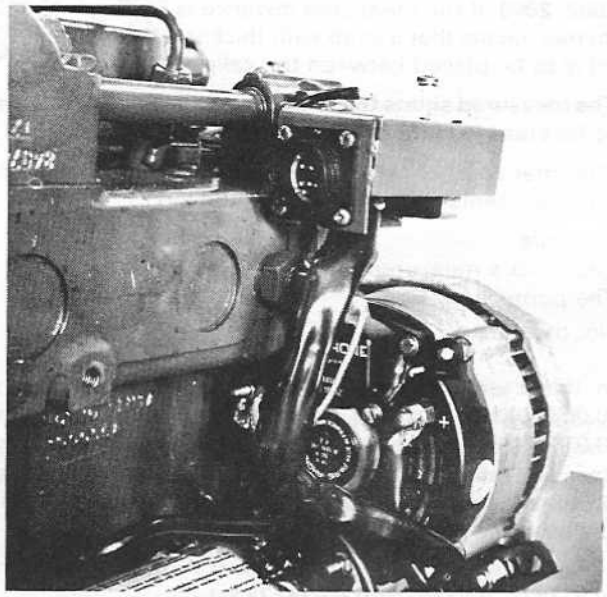
19. Install the sea-water pump and the cooling water pipes.



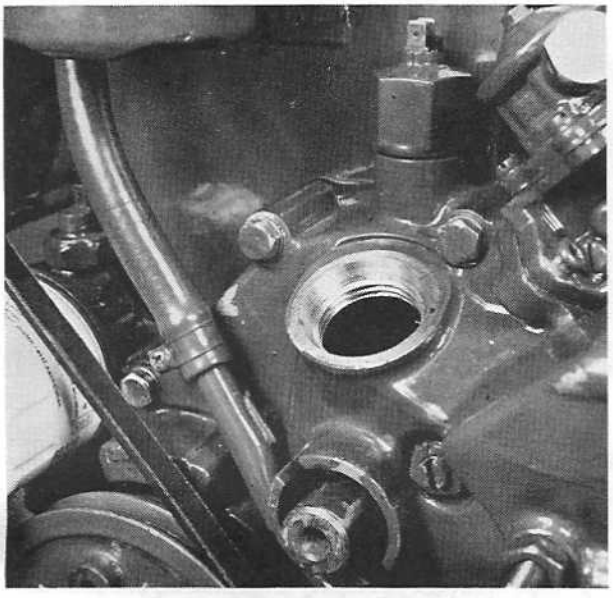
21. Fit the valve cover using a new gasket. Make sure that the round hole for the crankcase ventilation is in the right position. Fit the decompression device lever. Fit the pressure pipes between the injectors and the injection pumps. Also refit the inlet air silencer.



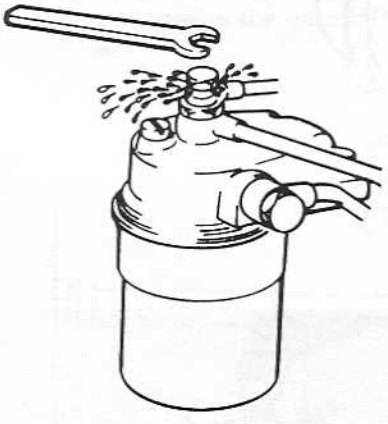
20. Install the injectors and the return fuel pipe. Tightening torque for the injectors 20 Nm (2,0 kpm) (14.7 ft.lbs.). Also install the exhaust elbow and the water pipe between the thermostat housing and the exhaust elbow.



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



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



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

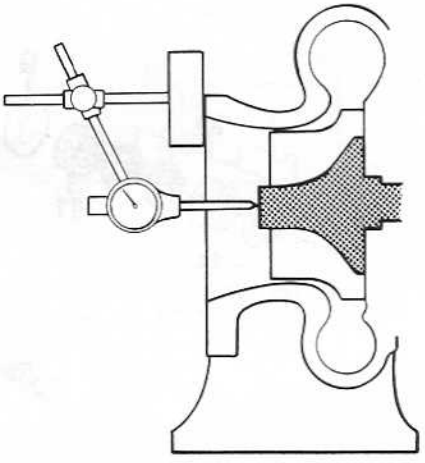
Where there is an excessive amount of smoke in the exhaust fumes or the engine output is particularly low it may be that the turbo-compressor is not functioning properly. If the boat's speed through the water is gradually decreasing, the boat's bottom should also be inspected, and cleaned where necessary. Check that the air intake has not become clogged, and clean the intake silender.

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.

Checks

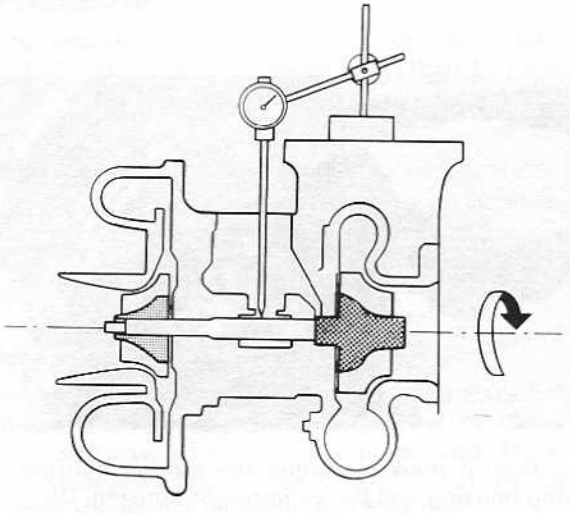
Check the pre-injection angle, the injector's opening pressure and the spray pattern. The valve clearance and compression should also be checked.



Checking axial and radial clearance

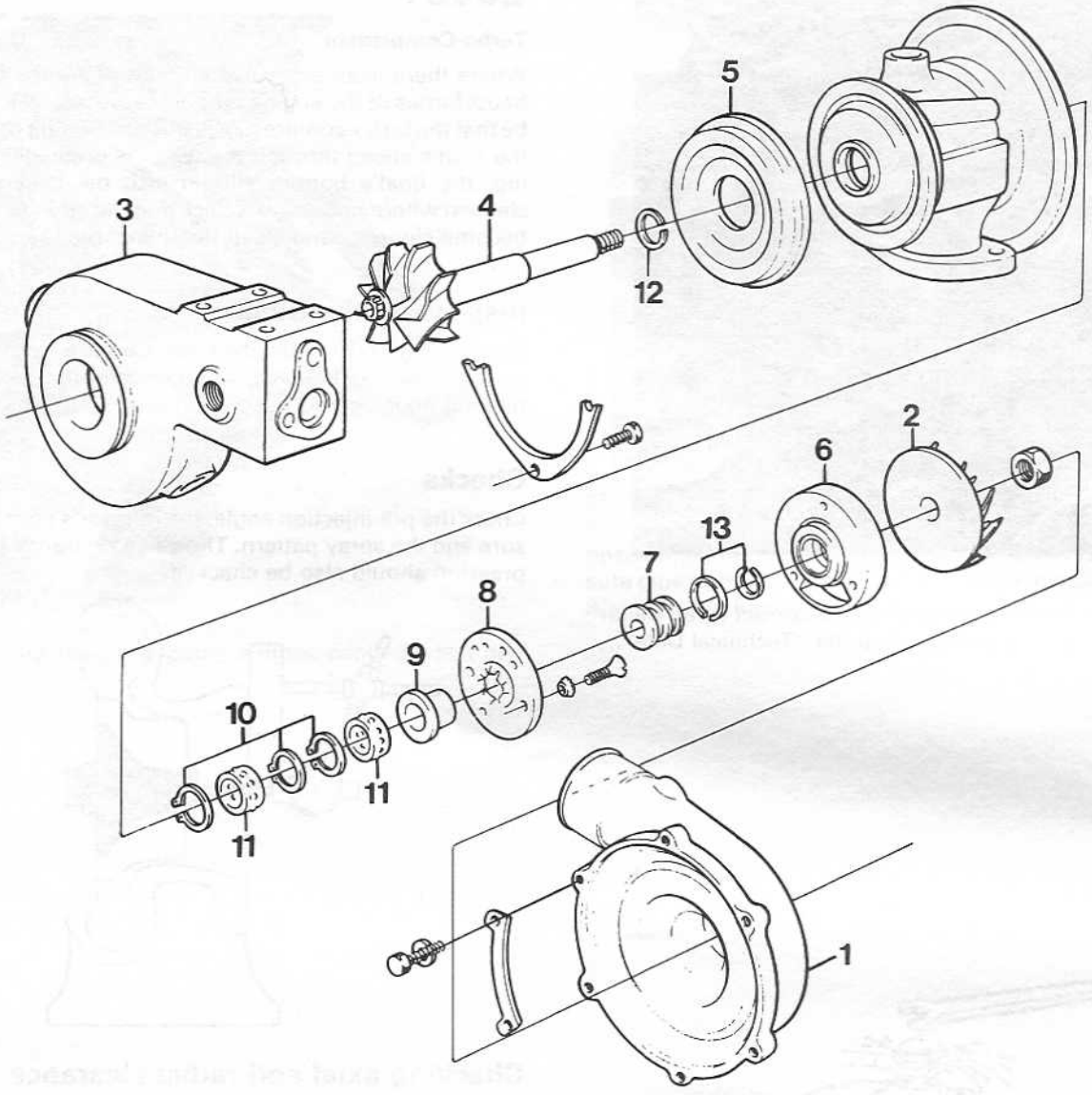
Dismount the turbo-compressor from the engine, and measure the rotor unit's axial and radial clearance.

Maximum permissible axial clearance 0.09 mm

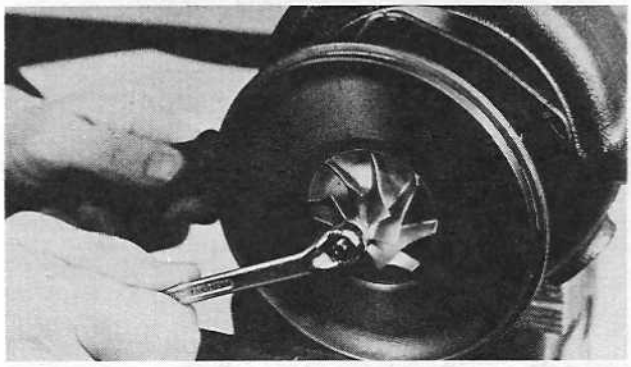


Maximum permissible radial clearance 0.17 mm

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

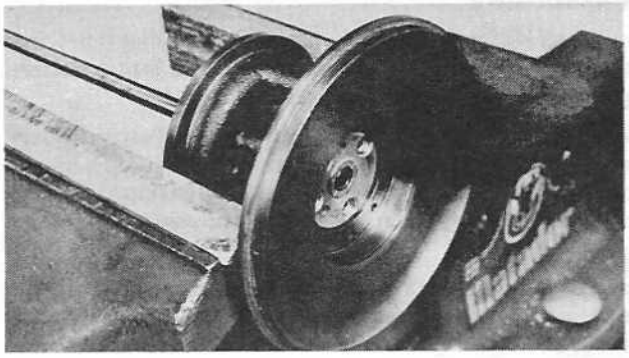


RECONDITIONING



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).

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.



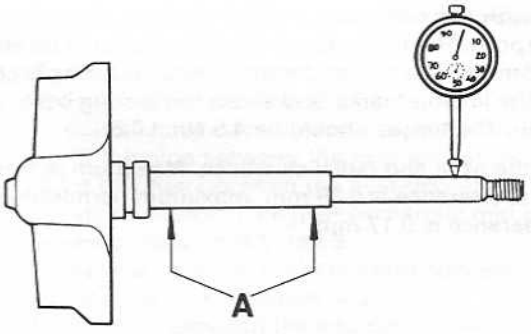
Unfasten the four screws which hold the compression bearing (8). Using a small copper mandrel, tap out the compression bearing and the bushing (9). Then remove the circlips (10) inside the bearing housing and remove the two bearings (11).

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

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.



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.

Check the diameter of the shaft bearing recesses. The minimum permissible diameter is 7.98 mm. Check the width of the shaft piston ring groove. Maximum permissible width is 1.29 mm.

Compressor Housing, Turbine Housing

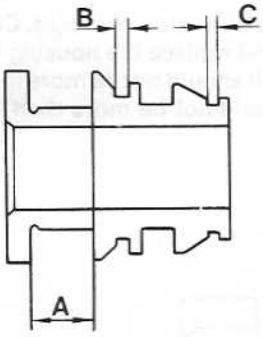
Check that the housings are free from cracks or other damage caused by excessive wear and tear. Damaged parts should be replaced.

Heat Shield

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

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



Bushing

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

Oil Deflector

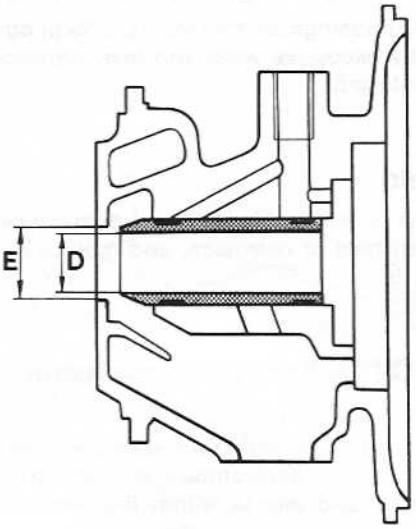
Check measurements (B) and (C). (B) should not be more than 1.31 mm, (C) should not be more than 1.11 mm.

Compressor Bearing

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.

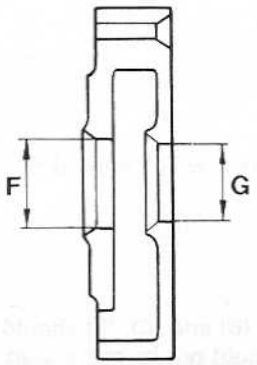
Bearings

Check the bearings for abnormal wear and tear or discolouration, 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, the internal diameter should not be more than 8.04 mm.



Bearing Housing

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, measurement (E) should not be more than 15.05 mm.



Cover

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

Packing Rings

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 Nm±0.1.

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.

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.

The thickness of the sealant should be about 0.1–0.2 mm. Fit the cover on the bearing housing, and fasten it with new screws and washers. The torque should be 1.3 Nm±0.1.

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 Nm±0.1.

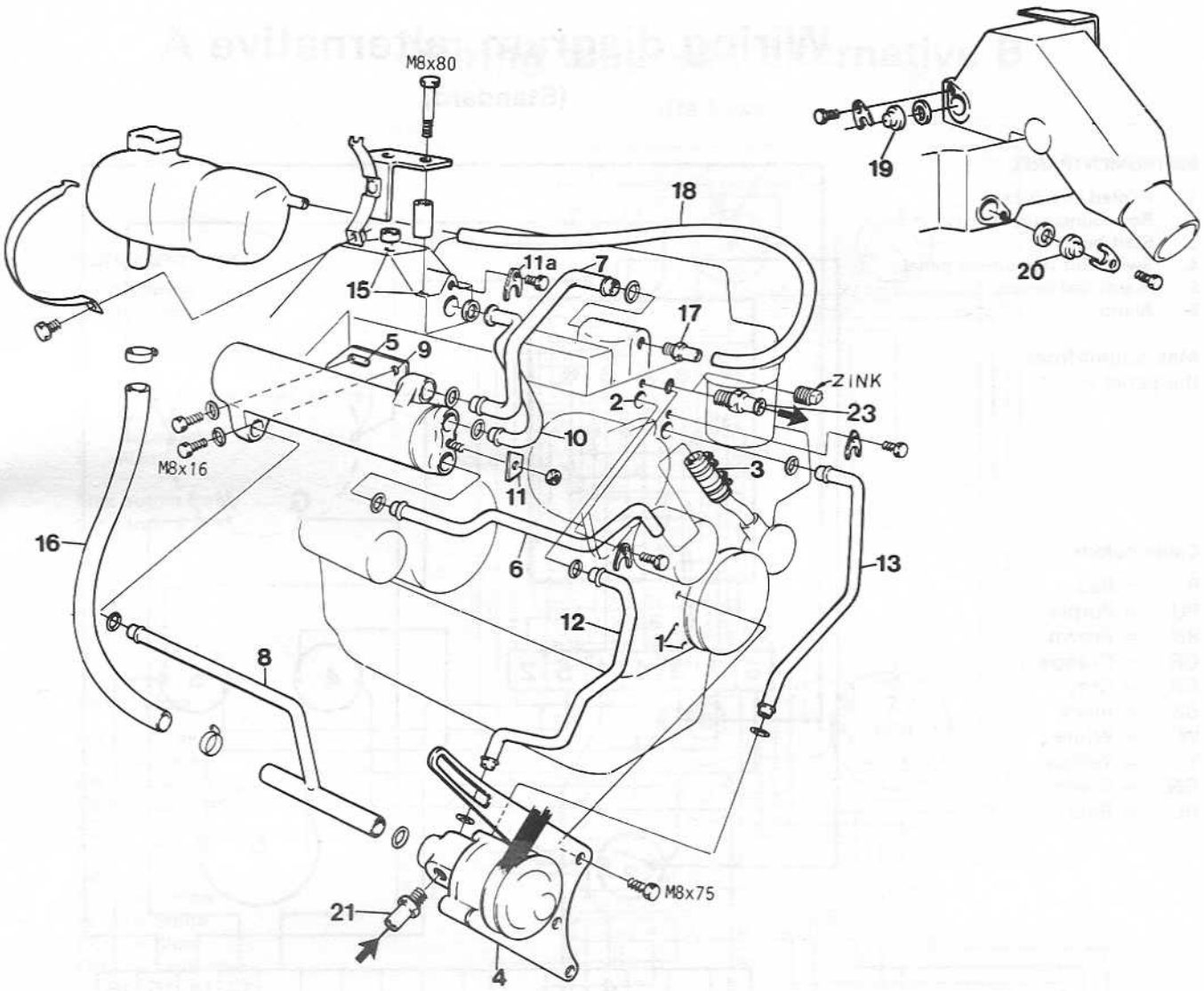
Mount the turbine housing on the bearing housing according to the line-up marks. Screw the locking cover into position, making sure that the screws used are not those for the compressor housing. The torque should be 11.0 Nm±0.5 (M6), 26.0±1.0 (M8).

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. Then mount the compressor housing according to the line-up marks, and screw the locking cover into position. The torque should be 4.5 Nm±0.5.

Check the axial and radial clearance. Maximum permissible axial clearance is 0.09 mm, maximum permissible radial clearance is 0.17 mm.

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.



FRESH-WATER COOLING 2002, 2003

1. Fit the circulation pump (complete with tensioner bracket and spacer sleeve, position 4). Tighten the bolts (M8x75) to 20 Nm (2,0 kpm) (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 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^2 (litre) (0.88 Imp. gals) (1.1 US gals), 2003 = 5.5 dm^3 (litre) (1.2 Imp. gals) (1.45 US gals).

Pos 21 and 23 are for hot water outlet.

Wiring diagram, alternative A

(Standard)

INSTRUMENTPANEL

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

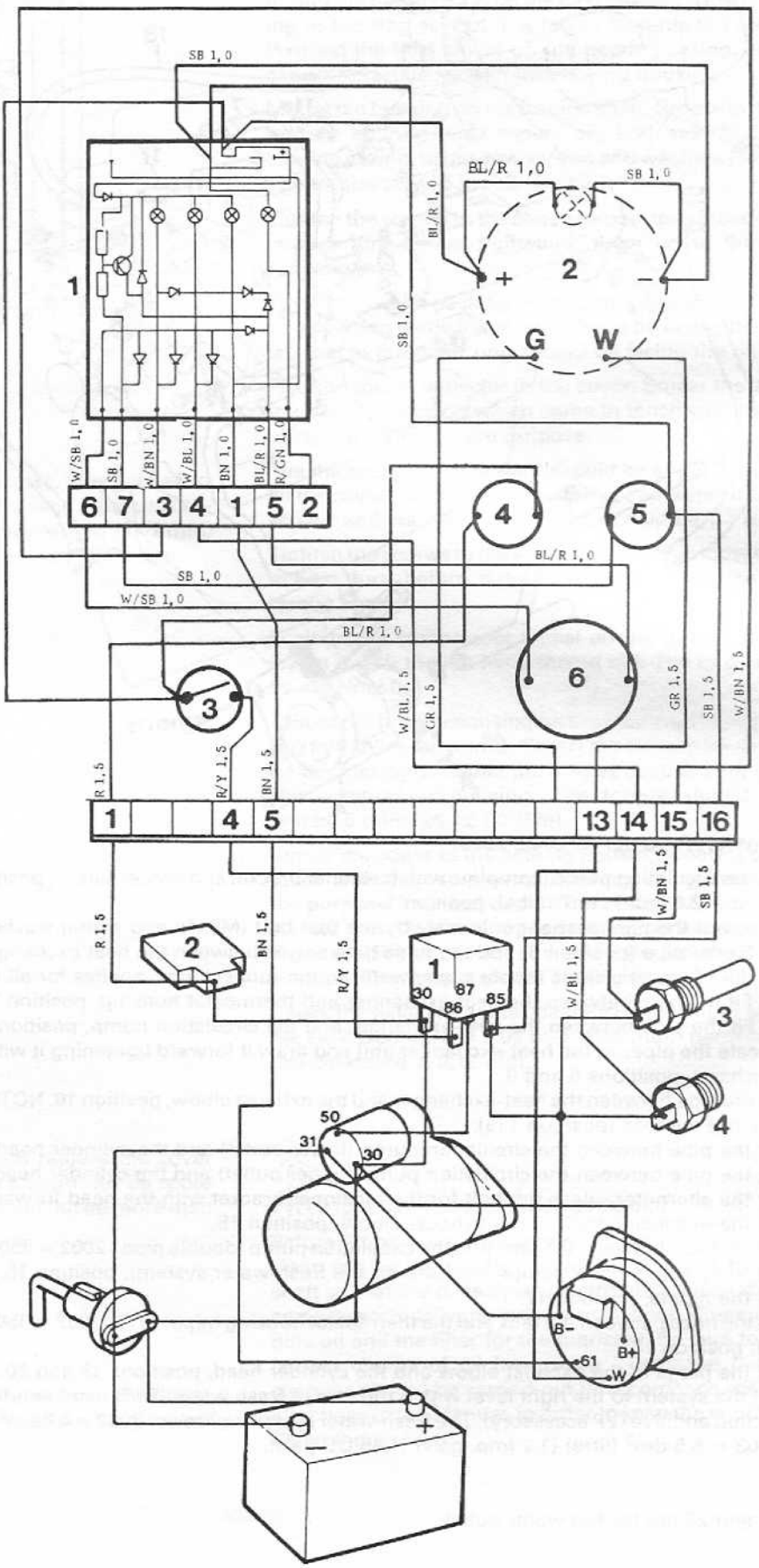
Max output from the panel = 5 A

Cable colour

R	= Red
PU	= Purple
BN	= Brown
OR	= Orange
GR	= Grey
SB	= Black
W	= White
Y	= Yellow
GN	= Green
BL	= Blue

ENGINE

1. Relay
2. Fuse
3. Temp. alarm sender
4. Oil pressure alarm sender



Wire areas in mm^2

Wire area mm^2	AWG
1,0	16
1,5	14
2,5	12
10	6

Wiring diagram, alternative B

(De Luxe)

INSTRUMENT PANEL

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

Max output from the panel: 5 A

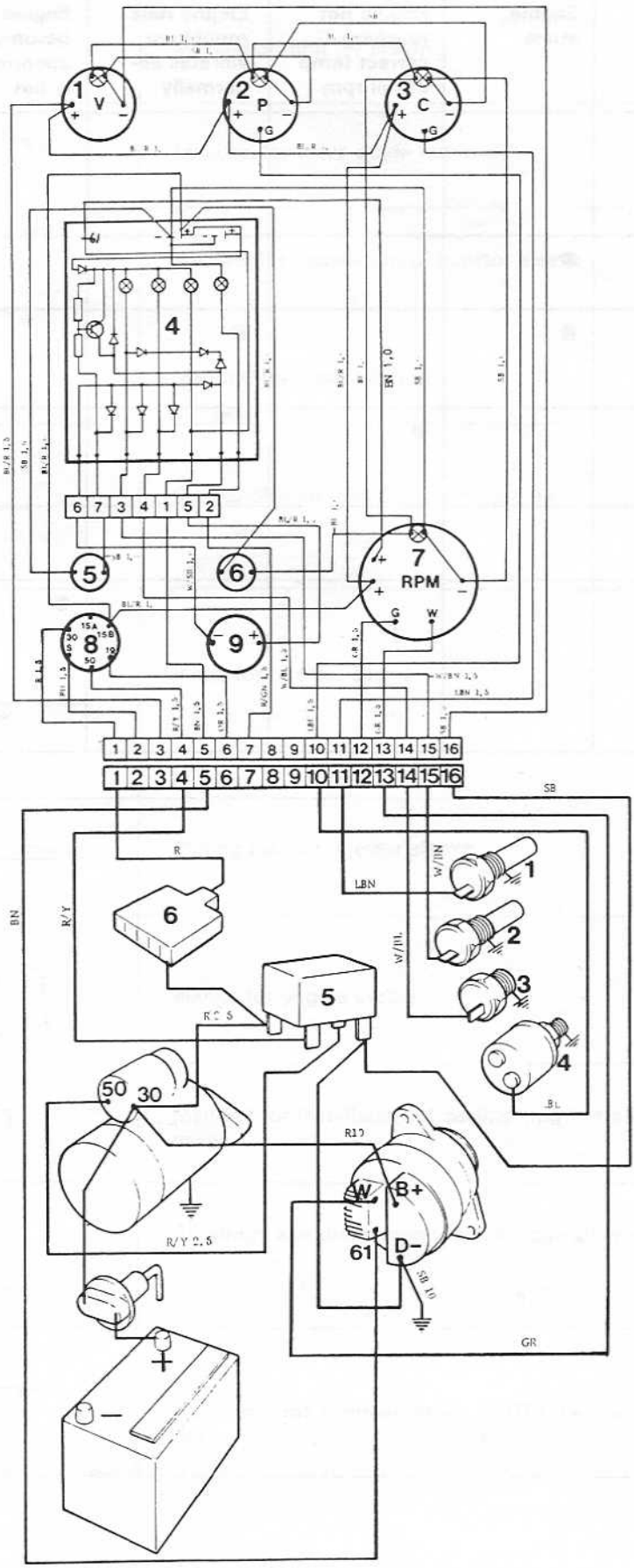
Cable colour

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

ENGINE

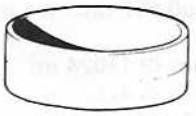
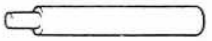
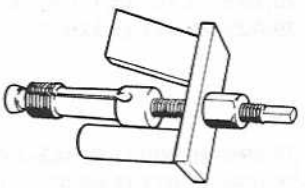
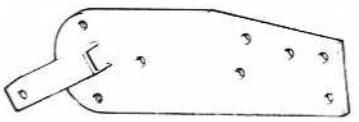
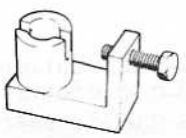
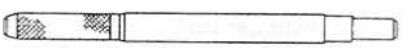
1. Coolant temperature sender
2. Oil pressure alarm sender
3. Coolant temperature alarm sender
4. Oil pressure sender
5. Relay
6. Fuse

Wire areas in mm^2



FAULT TRACING

Engine does not start	Engine stops	Engine not reaching correct temp at full rpm	Engine runs roughly or vibrates abnormally	Engine becomes abnormally hot	Fault
●					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.

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 setting
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 cover
884839-2		Assembly and disassembly tool for camshaft pin
884840-0		Guide pin for cylinder head. NOTE! Two are required.

TECHNICAL DATA

General

Type designation	2001	2002	2003, 2003T
Number of cylinders	1	2	3
Displacement	0.43 dm^3 (26.2 cu in)	0.852 dm^3 (51.9 cu in)	1.278 m^3 (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 (20–25 kp/cm^2)		
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 (3,5–4,0 kp/cm^2)		
Oil pressure at idling and warm engine	0,08–0,15 MPa (0,8–1,5 kp/cm^2)		

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 (3.12992–3.1311 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 (3,10642–3,10697 in.)
0,25 mm over-size	79,153–79,167 (3,11626–3,11681 in.)
0,50 mm over-size	79,403–79,417 (3,12610–3,12665 in.)

Gudgeon pins

Diameter	25,995–26,000 (1,02343–1,02362 in.)
Gudgeon pin bushing, diameter	26,005–26,011 (1,02382–1,02406 in.9
Clearance gudgeon pin – bushing	0,0050–0,0160 (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 0,250 and 0,500 mm oversize (0,00984 and 0,01969 in.)

Piston ring axial clearance in the groove

Upper compression ring	0,070–0,102 (0.00276–0,00402 in.)
Lower compression ring	0,050–0,082 (0,00197–0,00323 in.)
Oil ring	0,030–0,062 (0,00118–0,00244 in.)

Piston ring gap in the cylinder

Upper compression ring	0,30–0,50 (0,001181–0,00197 in.)
Lower compression ring	0,30–0,50 (0,001181–0,00197 in.)
Oil ring	0,25–0,50 (0,009842–0,00197 in.)

Crankshaft

Material	Nodular iron
Crankshaft axial clearance	0,040–0,221 (0,00157–0,00870 in.)
Main bearing radial clearance	0,040–0,092 (0,00157–0,00362 in.)
Big-end bearing, radial clearance	0,024–0,068 (0,00094–0,00268 in.)

[1] Propeller shaft output in accordance with DIN 6270B.

Main bearing journals

Diameter, standard	59,987–60,000 (2,36169–2,36220 in.)
0,250 mm under-size	59,737–59,750 (2,35185–2,35236 in.)
0,500 mm under-size	59,487–59,500 (2,34200–2,34252 in.9

Main bearing shells

Thickness, standard	2,987–2,997 (0,11760–0,11799 in.)
0,250 mm over-size	3,112–3,122 (0,12252–0,12291 in.)
0,500 mm over-size	3,237–3,247 (0,12744–0,12783 in.)

Big-end journals

Diameter, standard	47,989–48,000 (1,88933–1,88976 in.)
0,250 mm over-size	47,739–47,750 (1,87949–1,87992 in.)
0,500 mm over-size	47,489–47,500 (1,86965–1,87008 in.)

Big-end bearing shells

Thickness, standard	1,478–1,488 (0,05819–0,05858 in.)
0,250 mm over-size	1,603–1,613 (0,06311–0,06350 in.)
0,500 mm over-size	1,728–1,738 (0,06803–0,06843 in.)

Connecting rods

Axial clearance at the crankshaft	0,15–0,35 mm (0,00590–0,01378 in.)

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 (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

Inlet valves

		2003T
Disc diameter	34,4–34,6 mm (1,35433–1,36220 in.)	35,8—36,0 mm
Stem diameter	7,955–7,970 mm (0,31319–0,31378 in.)	7,995—7,970 mm
Valve seat angle	44°55′–44°85′	29°45′—30°15′
Cylinder head seat angle	45°	30°
Seat width in the cylinder head	appr. 1 mm (0,03937 in.)	appr. 1 mm (0.03937 in.
Clearance, cold/warm engine	0,3 mm (0,011811 in.)	0.3 mm (0,011811 in.)

Exhaust valves

Disc diameter	29,9–30,1 mm (1,14716–1,18504 in.)
Stem diameter	7,950–7,465 mm (0,31299–0,31339 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.)

Valve guides

Length, inlet valve	38 mm (1,49606 in.)
Length, outlet valve	38 mm (1,49606 in.)
Inner diameter	8,000–8,015 (0,31496–0,31555 in.)
Height above spring-plane of cylinder head	8,70–9,30 mm (0,34252–0,36614 in.)

Valve springs

Length, unloaded	42,5 mm (1,67323 in.)
Loaded with 170±10 N (17±1 kp)	32 mm (1.25984 in.)
Loaded with 300±20 N (30±2 kp)	24 mm (0,94488 in.)

Lubricating system

ENGINE

Oil quantity model 2001	1,40 dm^3 (1.2 quarts)
Oil quantity model 2002	2.75 dm^3 (2.42 quarts)
Oil quantity model 2003	4,10 dm^3 (3.6 quarts)
Oil quality according to the API-system	CD (DS)
Viscosity	15 W/40
Oil pressure, warm engine, idling speed	0,8—1,5 kp/cm^2 (11.37—21.33 lbft/in^2)
Oil pressure, warm engine, full rpm	3,5–4,0 kp/cm^2 (49.78–56.89 lbft/in^2)

Lubricating oil pump

Type	Gear wheel pump
Gear wheel axial clearance	0,025–0,065 (0,00098–0,00256 in.)
Spring for reduction valve, length unloaded	49 mm (1,92913 in.)
Loaded with 35 Nm (3,5 kp) (25.8 ft.lbs.)	40 mm (1,57480 in.)

Fuel System

Opening pressure, injectors	180–190 kp/cm^2 (2560–2702 lbft/in^2)[1]
Spray angle	150°
Injection angle 2001	22±1° B.T.D.C
Injection angle 2002, 2003	20+1°C B.T.D.C.
Injection angle 2003T	23±1° B.T.D.C.
Injection quantity	25+1.5 mm^3/stroke at 40±5°C (104°F±10.6°F) and at 25 r/s (1500 rpm) pump revs
Governor overrun	54 r/s (3250 rpm)

Feed pump

Feed pressure 42 r/s (2500 rpm)	0,65–0,85 kp/cm^2 (9.20–12.10 lbf/in^2)

Electrical system

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/max. current	14V/50 Amp
Output	700 Watts
Electrolyte spec. gravity: Fully loaded battery	1,275–1,285
To be charged at	1,230
Thermostat	Wax thermostat
Begins to open at	60±2°C (140±4°F)
Fully open at	75°C (165°F)

Cooling system

With fresh-water cooling (2002, 2003)	
Starts opening at	74±1°C (164±2°F)
Fully open at	87°C (189°F)
Fresh-water system, volume 2002	4.0 dm^3 (litre) (0.88 Imp. gals) (1.1 US gals)
2003	5.5 dm^3 (litre) (1.2 Imp. gals) (1.45 US gals)

WEAR TOLERANCES

Cylinders

To be bored at 0,25 mm wear (0,00984 in.)

Crankshaft

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.)

[1] 2003T = 204–212 kp/cm^2 (2900–3015 lbf/in^2)

Camshaft

Bearing journals, permitted out-of-round	0,03 mm (0,00118 in.)
Max. clearance between camshaft and bushings	0,15 mm (0,00590 in.)

Valves

Max. clearance between valve stem and valve guide	0,15 mm (0,00590 in.)
The valve disc edge must be at least	1,5 mm (0,05906 in.)

Tightening torques

Main bearing bolts, 1st tightening	20 Nm (2,0 kpm) (14.7 ft.lbs.)
2nd tightening	60 Nm (6,0 kpm) (44.2 ft.lbs.)
Big-end bearing bolts	70 Nm (7,0 kpm) (51.6 ft.lbs.)
Flywheel housing bolts	25 Nm (2,5 kpm) (18.4 ft.lbs.)
Flywheel bolts	65 Nm (6,5 kpm) (47.9 ft.lbs.)
Cylinder head bolts, 1st tightening	20 Nm (2,0 kpm) (14.7 ft.lbs.)
2nd tightening	70 Nm (7,0 kpm) (51.6 ft.lbs.)
Rocker arm bridge	25 Nm (2,5 kpm) (18.4 ft.lbs.)
Fuel injection pumps	25 Nm (2,5 kpm) (18.4 ft.lbs.)
Pulley	40 Nm (4,0 kpm) (29.5 ft.lbs.)
Injectors	20 Nm (2,0 kpm) (14.7 ft.lbs.)