

Workshop Manual

Engine

B
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**AQD40, AQAD40,
MD40, TMD40, TAMD40**

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Safety Precautions

Introduction

This Workshop Manual contains technical data, descriptions and repair instructions for Volvo Penta products or product versions contained in the contents list. Ensure that the correct workshop literature is being used.

Read the safety information and the Workshop Manual “General Information” and “Repair Instructions” carefully before starting work.

Important

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



WARNING! If these instructions are not followed there is a danger of personal injury, extensive damage to the product or serious mechanical malfunction.



IMPORTANT! Used to draw your attention to something that can cause damage, product malfunction or damage to property.

NOTE! Used to draw your attention to important information that will facilitate work or operations.

Below is a summary of the risks 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.



Generally, all servicing should be carried out with the engine switched off. Some work (carrying out certain adjustments for example) requires the engine to be running. Approaching a running engine is dangerous. Loose clothing or long hair can fasten in rotating parts and cause serious personal injury.

If working in proximity to a running engine, careless movements or a dropped tool can result in personal injury. Avoid burns. Take precautions to avoid hot surfaces (exhausts, turbochargers, charge air pipes and starter elements etc.) and liquids in supply lines and hoses when the engine is running or has been turned off immediately prior to starting work on it. Reinstall all protective parts removed during service operations before starting the engine.



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



Engine with turbocharger: Never start the engine without installing the air cleaner (ACL). 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 or similar to start the engine. The starter element 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 coolant filler cap carefully and slowly to release pressure before removing the cap completely. Take great care if a cock, plug or engine coolant line must be removed from a hot engine. It is difficult to anticipate in which direction steam or hot coolant can spray out.



Hot oil can cause burns. Avoid skin contact with hot oil. Ensure that the lubrication system is not under pressure before commencing work on it. 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 space, ensure that exhaust gases and crankcase ventilation emissions are ventilated out of the working area.


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- ⚠ Always use protective goggles where there is a danger of pieces of metal, sparks from grinding, acid or other chemicals being thrown into your eyes. Your eyes are very sensitive, injury can lead to loss of sight!
 - ⚠ Avoid skin contact with oil. Long-term or repeated contact with oil can remove the natural oils from your skin. The result can be irritation, dry skin, eczema and other skin problems. Used oil is more dangerous to health than new oil. Use protective gloves and avoid using oil-soaked clothes and rags. Wash regularly, especially before meals. Use the correct barrier cream to prevent dry skin and to make cleaning your skin easier.
 - ⚠ Most chemicals used in products (engine and transmission oils, glycol, petrol and diesel oil) and workshop chemicals (solvents and paints) are hazardous to health. Read the instructions on the product packaging carefully! Always follow safety instructions (using breathing apparatus, protective goggles and gloves for example). Ensure that other personnel are not unwittingly exposed to hazardous substances (by breathing them in for example). Ensure that ventilation is good. Handle used and excess chemicals according to instructions.
 - ⚠ Be extremely careful when tracing leaks in the fuel system and testing fuel injection nozzles. Use protective goggles! The jet ejected from a fuel injection nozzle is under very high pressure, it can penetrate body tissue and cause serious injury. There is a danger of blood poisoning.
 - ⚠ All fuels and many chemicals are inflammable. Ensure that a naked flame or sparks cannot ignite fuel or chemicals. Combined with air in certain ratios, petrol, some solvents and hydrogen from batteries are easily inflammable and explosive. Smoking is prohibited! Ensure that ventilation is good and that the necessary safety precautions have been taken before carrying out welding or grinding work. Always have a fire extinguisher to hand in the workplace.
 - ⚠ Store oil and fuel-soaked rags and fuel and oil filters safely. In certain conditions oil-soaked rags can spontaneously ignite. 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 allow a naked flame or electric sparks near the batteries. 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 spark which is sufficient to cause an explosion with resulting damage. Do not disturb battery connections when starting the engine (spark risk) and do not lean over batteries.
 - ⚠ Never mix up the positive and negative battery terminals when installing. Incorrect installation can result in serious damage to electrical equipment. Refer to wiring diagrams.
 - ⚠ Always use protective goggles when charging and handling batteries. The battery electrolyte contains extremely corrosive sulfuric acid. If this comes into contact with the skin, wash immediately with soap and plenty of water. If battery acid comes into contact with the eyes, immediately flush with copious amounts of water and obtain medical assistance.
 - ⚠ Turn off the engine and turn off power at main switch(es) before carrying out work on the electrical system.
 - ⚠ Clutch adjustments must be carried out with the engine turned off.

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


To ensure safe handling and to avoid damaging engine components on top of the engine, use a lifting beam to raise 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 altering its center of gravity, a special lifting device is required to achieve the correct balance for safe handling.

Never carry out work on an engine suspended on a hoist.

 Never remove heavy components alone, even where secure lifting equipment such as secured blocks are being used. Even where lifting equipment is being used it is best to carry out the work with two people; one to operate the lifting equipment and the other to ensure that components are not trapped and damaged when being lifted.

When working on-board ensure that there is sufficient space to remove components without danger of injury or damage.

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

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

General information

About the workshop manual

This workshop manual contains technical specification, descriptions and instructions for repairing the standard versions of the following engines AQD40, AQAD40, MD40, TMD40, TAM40. The product designation and number should be given in all correspondence about the product.

This Workshop Manual has been developed primarily for Volvo Penta service workshops and qualified personnel. Persons using this book are assumed to have a grounding in marine drive systems and be able to carry out related mechanical and electrical work.

Volvo Penta is continuously developing their products. We therefore reserve the right to make changes. All the information contained in this book is based on product data available at the time of going to print. 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 electrical and fuel systems are subject to statutory requirements (US Coast Guard Safety Regulations for example). Volvo Penta Genuine parts meet these requirements. Any type of damage which results from the use of non-original Volvo Penta replacement parts for the product will not be covered under any warranty provided by Volvo Penta.

Repair instructions

The working methods described in the Service 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 occurring in the Workshop Manual (for their meaning see *Safety information*)



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. For this reason we can only highlight the risks that can arise when work is carried out incorrectly in a well-equipped workshop using working methods and tools developed by us.

All procedures for which there are Volvo Penta special tools in this Workshop Manual are carried out using these. Special tools are developed to rationalize working methods and make procedures as safe as possible. It is therefore the responsibility of any person using tools or working methods other than the ones recommended by us to ensure that there is no danger of injury, damage or malfunction resulting from these.

In some cases there may be special safety precautions and instructions for the use of tools and chemicals contained in this Workshop Manual. These special instructions should always be followed if there are no separate instructions in the Workshop Manual.

Certain elementary precautions and common sense can prevent most risks arising. A clean workplace and engine eliminates much of the danger of injury and malfunction.

It is of the greatest importance that no dirt or foreign particles get into the fuel system, lubrication system, intake system, turbocharger, bearings and seals when they are being worked on. The result can be malfunction or a shorter operational life.

Our joint responsibility

Each engine consists of many connected systems and components. If a component deviates from its technical specification the environmental impact of an otherwise good engine may be increased significantly. It is therefore vital that wear tolerances are maintained, that systems that can be adjusted are adjusted properly and that Volvo Penta Genuine Parts as used. The engine 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 sealed at the factory for environmental reasons. No work should be carried out on sealed components except by authorized personnel.

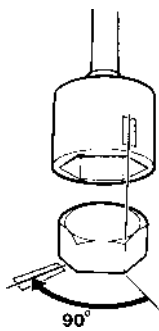
Bear in mind that most chemicals used on boats are harmful to the environment if used incorrectly. Volvo Penta recommends the use of biodegradable degreasing agents for cleaning engine components, unless otherwise stated in a workshop manual. Take special care when working on-board, that oil and waste is taken for destruction and is not accidentally pumped into the environment with bilge water.

Tightening torques

Tightening torques for vital joints that must be tightened with a torque wrench are listed in workshop manual "Technical Data": "Tightening Torques" and are contained in work descriptions in this Manual. All torques apply for cleaned threads, screw heads and mating surfaces. Torques apply for lightly oiled or dry threads. If lubricants, locking fluid or sealing compound are required for a screwed joint this information will be contained in the work 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 Torques	
	Nm	lbt.ft
M5	6	4.4
M6	10	7.4
M8	25	18.4
M10	50	36.9
M12	80	59.0
M14	140	103.3

Tightening torques-protractor (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.

Locknuts

Do not re-use lock nuts that have been removed during dismantling as they 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.

Tolerance classes

Screws and nuts are divided into different strength classes, 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 tolerance 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.

Sealants

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 Service 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). Use for gaskets, sealing gasket joints or coating gaskets. RTV agent is clearly visible when a component has been dismantled; old RTV must be removed before the joint is resealed.

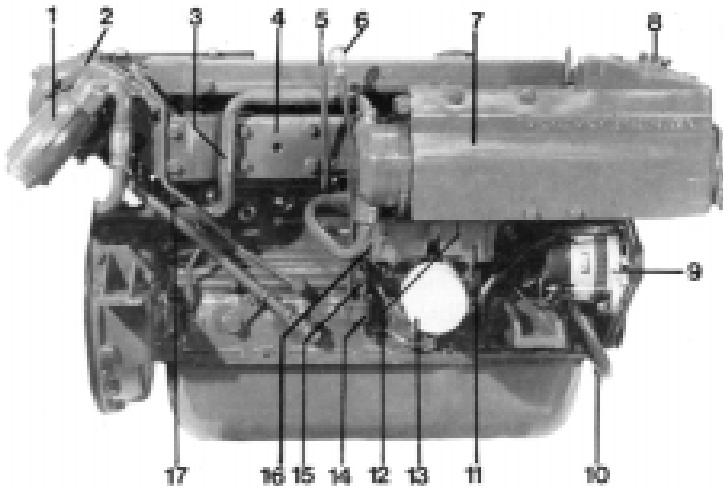
The following RTV agents are mentioned in the Service Manual: Loctite® 574, Volvo Penta 840879-1, Permatex® No. 3, Volvo Penta P/N 1161099-5, Permatex® No. 77. Old sealant can be removed using methylated spirits in all cases.

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.

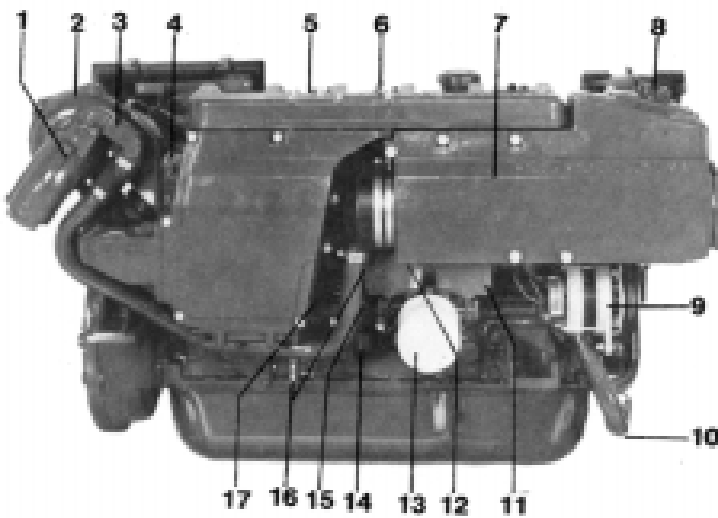
The following anaerobic agents are mentioned in the Service Manual: Loctite® 572 (white), Loctite® 241 (blue).

NOTE! Loctite® is the registered trademark of Loctite Corporation, Permatex® is the registered trademark of the Permatex Corporation.

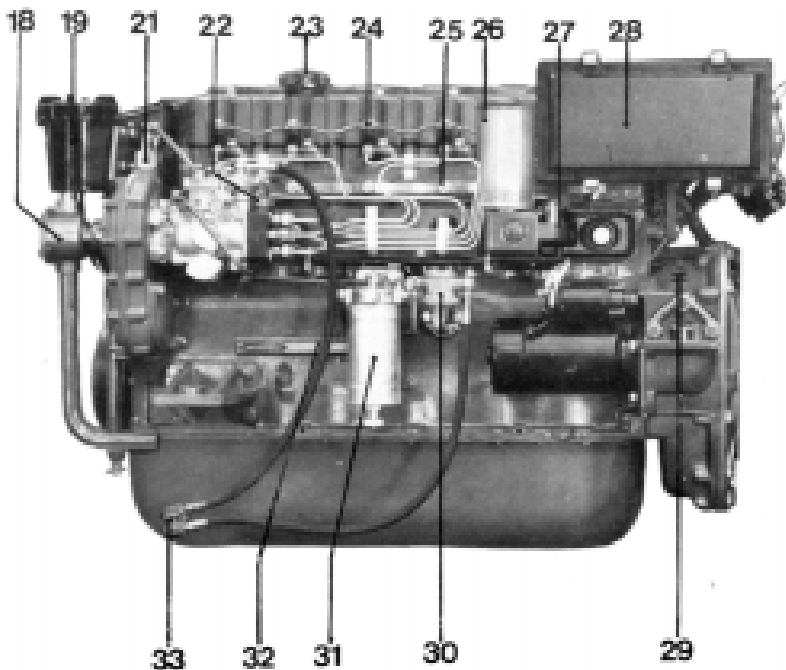
Component Guide



TMD40



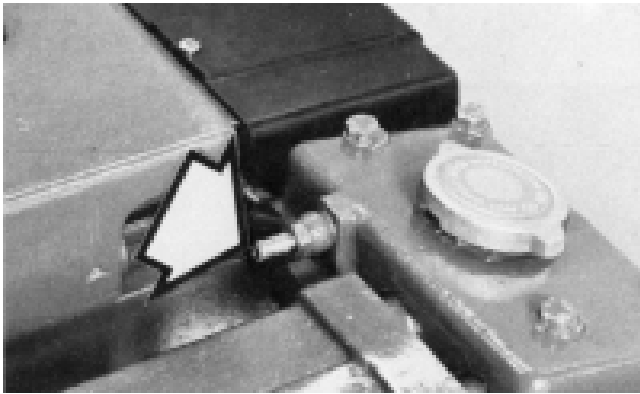
TAMD40



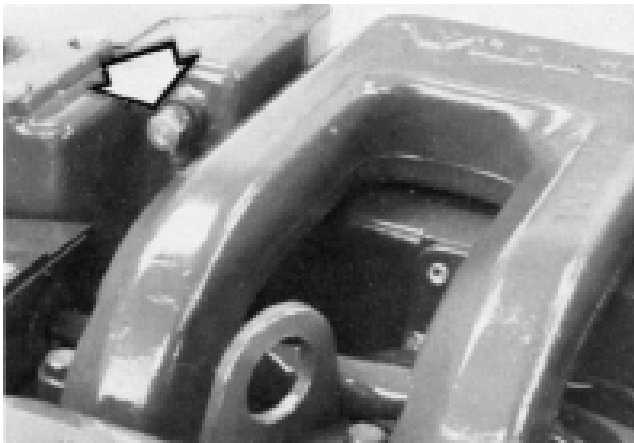
1. Exhaust bend, sea-water cooled
2. Turbo-compressor
3. Coolant pipe
4. Exhaust manifold, fresh-water cooled
5. Pipe for oil discharge pump
6. Oil dipstick
7. Heat exchanger
8. Filling, fresh-water
9. Alternator
10. Draincock, sea-water
11. Oil cooler
12. Draincock, fresh-water
13. Oil filter
14. Oil pressure sender
15. Oil pressure warner
16. Draincock, sea-water
17. Draincock, fresh-water
18. Sea-water pump
19. Sea-water filter
20. Engine speed sender
21. Injection pump
22. Stop solenoid
23. Oil filler cap
24. Injector
25. Glow plug
26. Filter for crankcase ventilation
27. Positive pressure valve for crankcase ventilation
28. Air cleaner
29. Inspection cover, injection timing
30. Feed pump
31. Fuel filter
32. Engine number plate
33. Fuel pipe connection for suction and return pipes

Dismantling

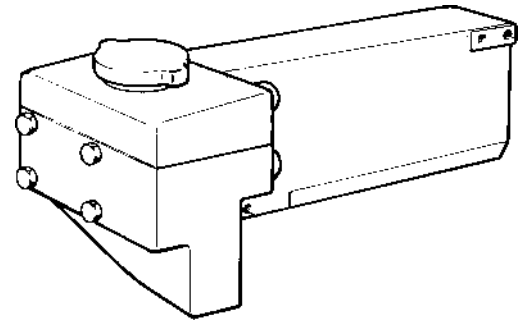
Drain off the cooling water and lubricating oil together with any fuel in the fuel filter and injection pump. Clean the engine externally.



1. AQD40, TMD40, MD40: Take off the alternator drive belts. Remove the hose nipple and the ventilation pipe from the thermostat housing cover.



2. AQAD40, TAMD40: Take off the alternator drive belts. Remove the ventilation pipe from the thermostat housing.

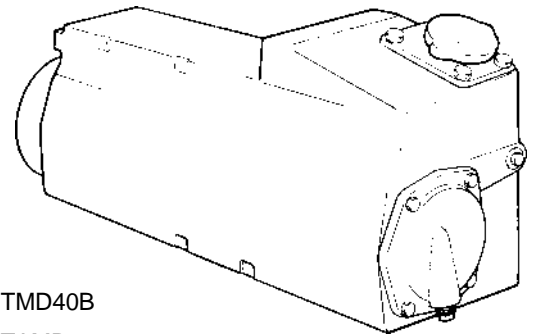


AQD40A, TMD40A, MD40A

- 3a. TMD40, MD40: Take off the coolant pipes between the engine and the reversing gear.

AQD40. Take off the pipe between the heat exchanger and the turbo-compressor.

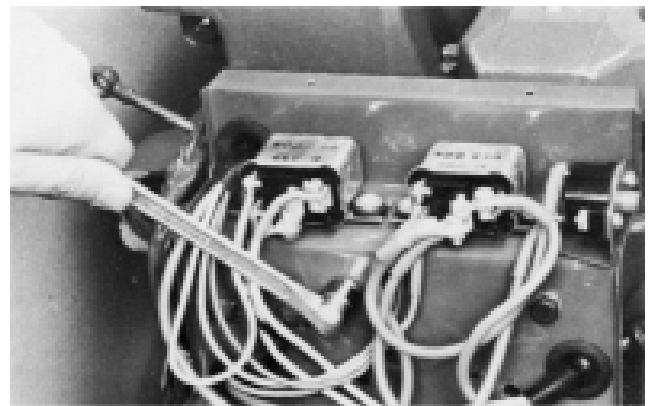
Remove the screws holding the heat exchanger and remove the heat exchanger by drawing it forward.



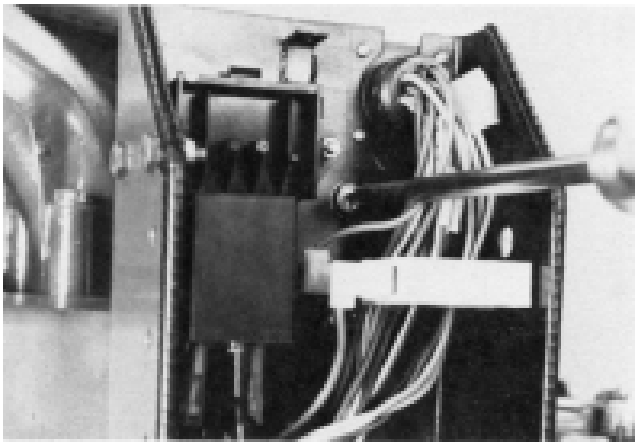
AQD40B, TMD40B

AQAD40, TAMD40

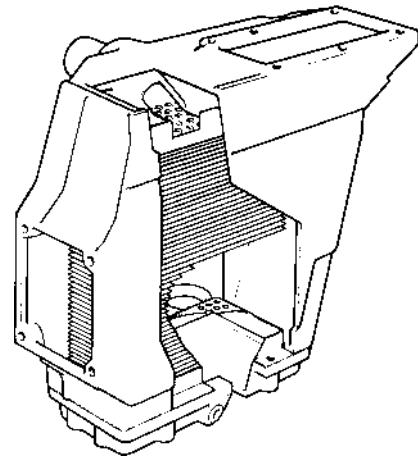
- 3b. Take off the coolant pipes. Remove the screws holding the heat exchanger and remove the heat exchanger by drawing it forward.



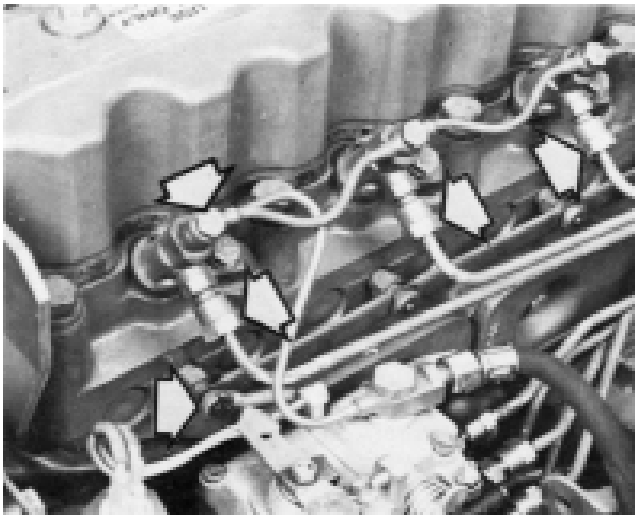
- 4a. Early prod. Remove the plastic cover from the front of the engine. Unscrew the plate on which the relays are mounted and remove the cooling water pipe which is located at the back of the plate.



4b. Late prod. Remove all the connections of the cable harness and remove the electrical distribution box. Also remove the water pipe behind the distribution box.



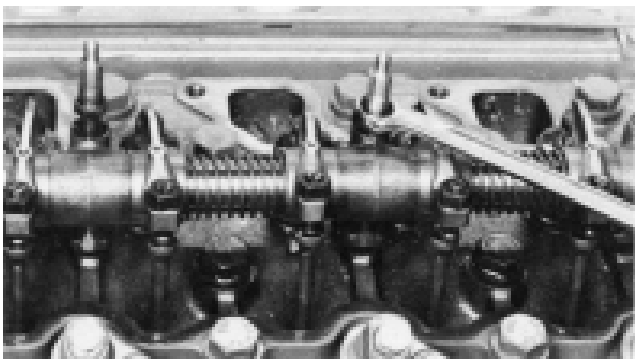
7. AQAD40, TAMD40: Remove the pipe between the turbo and the after cooler. Loosen the bracket under the after cooler and remove the after cooler.



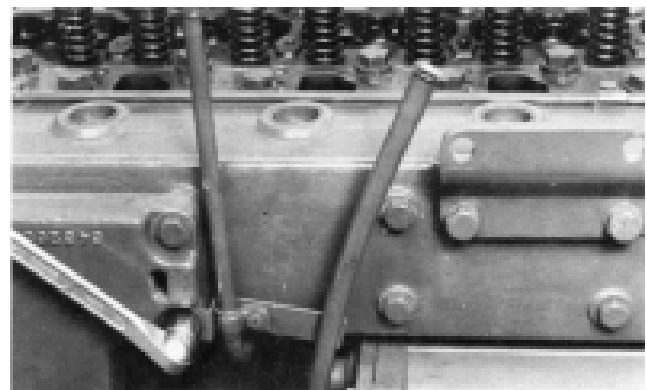
5. Disconnect the cables from the front and back glow plug. Disconnect the fuel leak-off line from the front injector. Disconnect the delivery lines from the injectors.



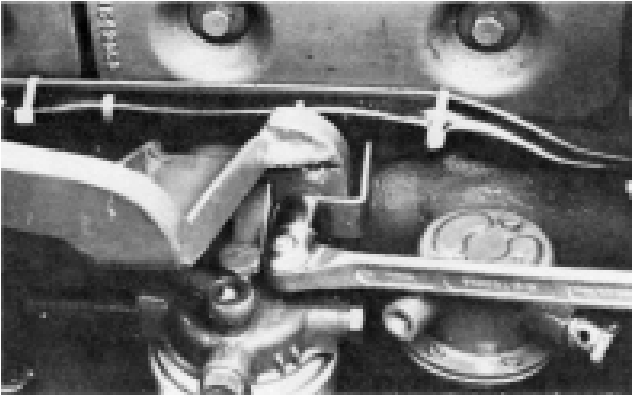
8. Remove the oil pipes between the turbo-compressor and the engine block, also the coolant pipe between the exhaust manifold and the engine block.



6. Remove the inlet manifold, the rocker arm casing, the rocker arm bearing bracket and the pushrods.

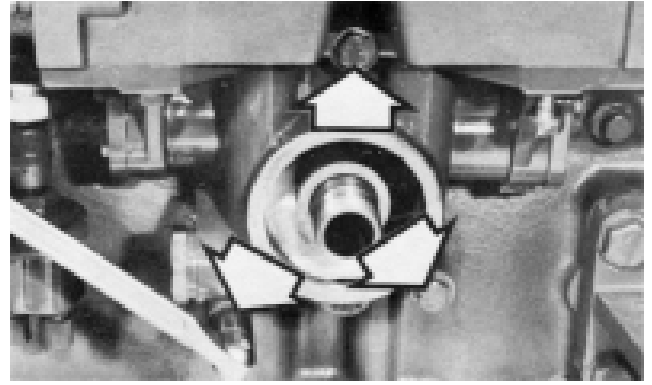


9. Remove the exhaust manifold together with the turbo-compressor. Pull out the tube for the oil dipstick and the oil discharge pipe. Unscrew the front lifting eye. Take off the cylinder head.

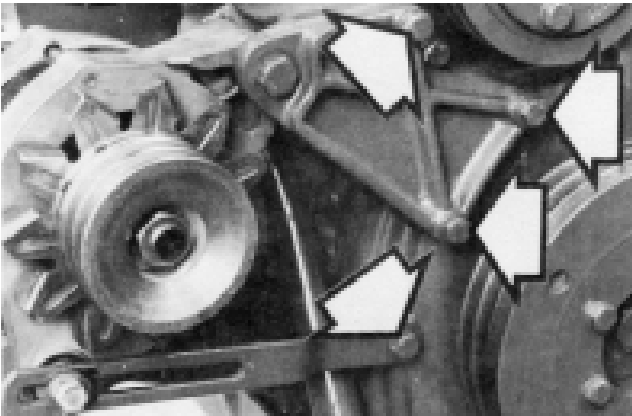


Fuel Pipes, Electrical Equipment

10. Remove the fuel pipes and fuel hoses, the fuel filters with cover and the feed pump. Fit protective caps.

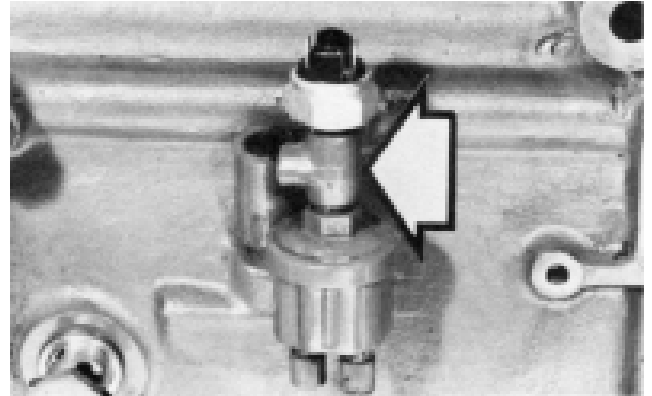


13. Remove the sea-water filter, the sea-water pump and the air cleaner together with the bracket. Remove the pipe between the sea-water filter and oil cooler. Unscrew the oil filter and discard it. Unscrew the bracket for the oil filter and lift it off together with the oil cooler.

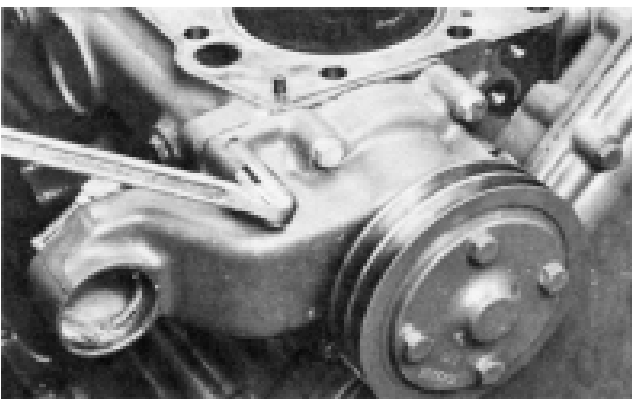


11. Disconnect the cables from the generator, the starter motor, the stop solenoid, senders and warners. Unscrew the generator bracket and the tensioning device and lift out the generator. Remove the starter motor.

12. Unscrew the cable support which is fixed in the injection pump and the oil trap for the crankcase ventilation. Take off the plate holding the relays together with the cable forms.

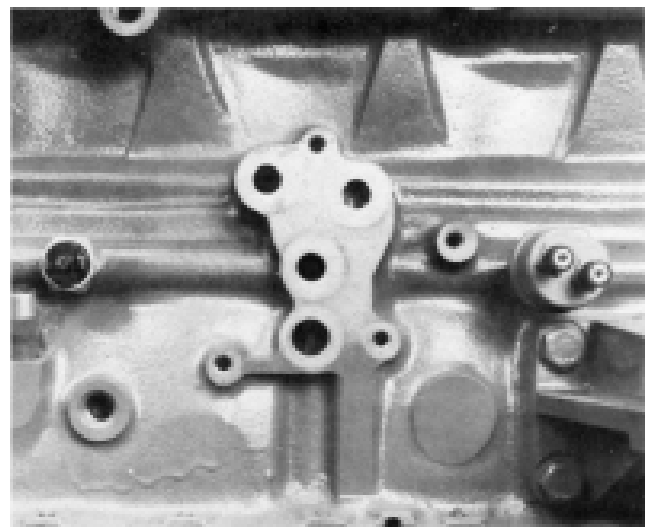


14a. Early prod. Unscrew the T-pipe holding the oil pressure warner and sender.

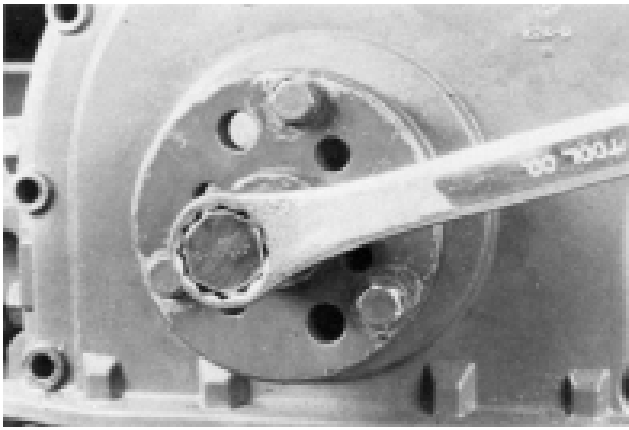


Circulation Pump

Remove the circulation pump.

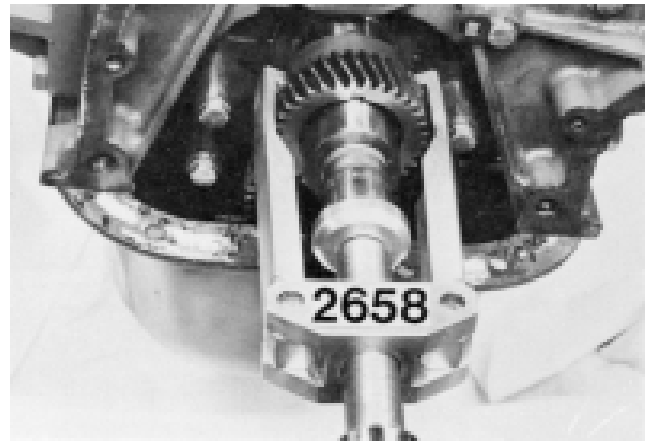


14b. Late prod. Remove the oil pressure sensor and the oil pressure sender.



Auxiliary Drive Gears

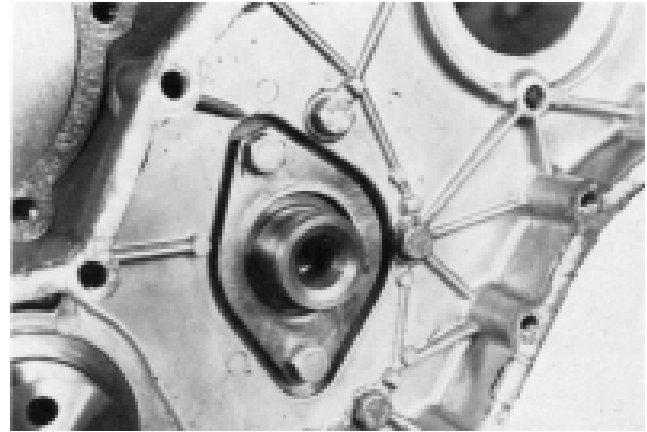
15. Remove the belt pulley which is fitted on the crankshaft polygon hub. Release the polygon hub centre bolt and pull the hub off using puller 884533.



18. Remove the idler gear and its bearing journal after loosening the 3 attaching bolts. Remove the crankshaft gear with puller 2658.



16. Remove the cover over the auxiliary drive gear casing. Release the 4 bolts in the injection pump lifter. Remove the sea-water pump driver and the injection pump drive gear.

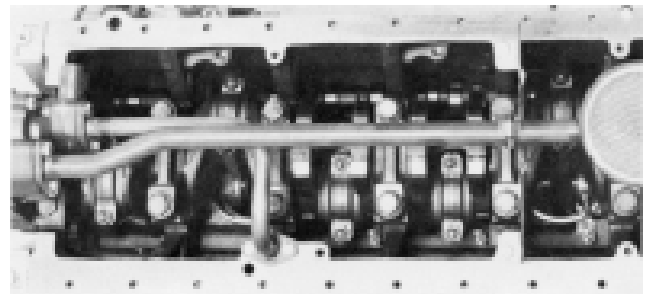


Camshaft

19. Remove the inspection covers and take out the valve tappets. Release the camshaft thrust washer and lift the camshaft out.



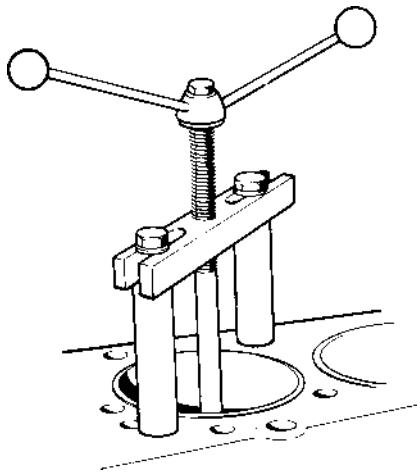
17. Release the 3 bolts fastening the injection pump and lift the pump off. Release the centre bolt and pull off the camshaft drive gear with puller 2679.



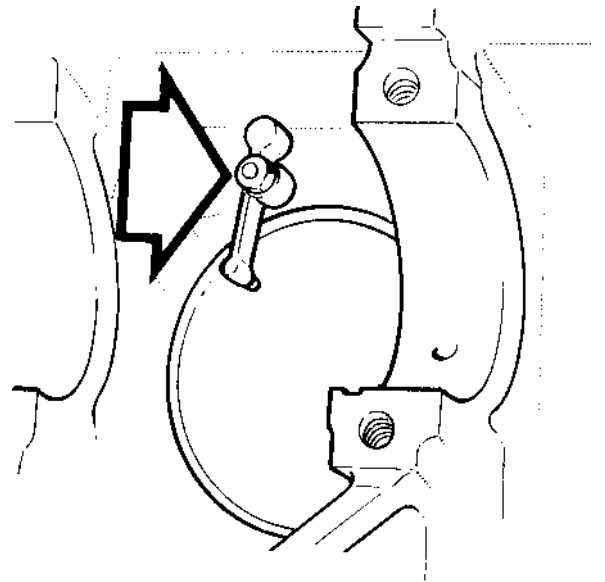
Pistons, Connecting Rods

20. Remove the sump, the oil pump with pipe and bracket. Remove the reinforcement plate, if fitted. Remove the pistons and connecting rods.

NOTE! Be careful not to damage the piston cooling nozzles.

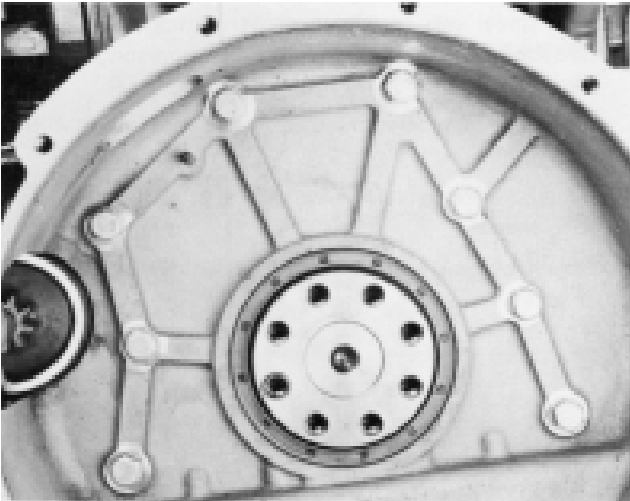


21. Extract the cylinder liners with the aid of a cylinder liner puller.



Crankshaft

23. Remove the crankshaft, noting that the main bearing caps are numbered. Remove the piston cooling nozzles.

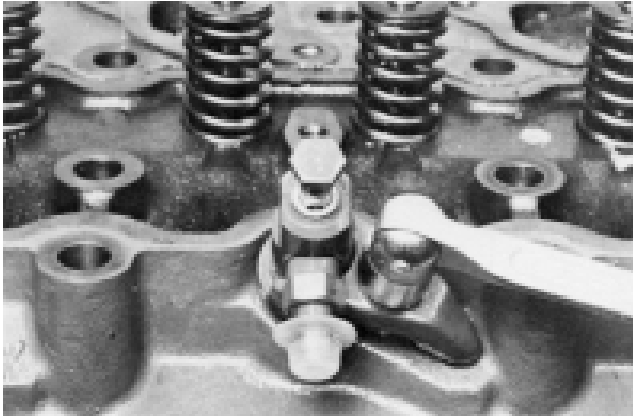


Flywheel

22. Remove the auxiliary drive gear casing, the connecting ring (for reversing gear or AQ-gear), the driving disc and the flywheel casing.

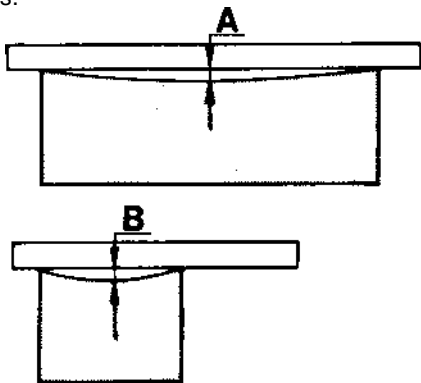
Overhaul

Cylinder Head



1. Disassembling

- A. Remove the electric wiring plate and the glow plugs. Remove the injectors and fit protective caps to the tips of the injector nozzles.
- B. Remove the valve springs and valves with the aid of a valve spring clamp. Place the valves in order in a valve stand. Remove and discard the rubber seals for the inlet valves.



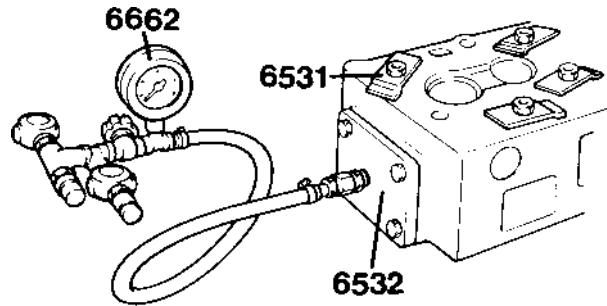
2. Cleaning and Inspection

Clean all the parts. Pay particular attention to the oil and coolant channels. Check for leakages by pressure testing. Check the plane of the cylinder head with a steel rule. Should the cylinder head be out of plane in excess of 0,10 mm within a measuring length of 100 mm or 0,20 mm within the total length of the cylinder head, the cylinder head must be ground to plane.

Grinding Flat

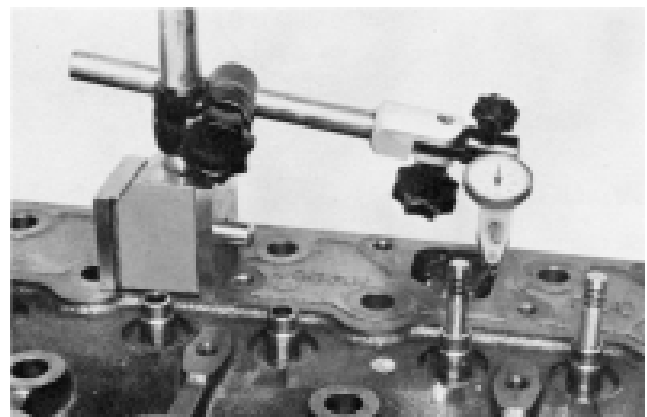
(Early prod. engines with removable inserts).

Remove the inserts from the chambers and turn down the lower ends (surface nearest the piston) by the same amount as the cylinder head is ground down. After being ground down flat, the height of the cylinder head must not be less than 86.7 (3.41339 in). Check that the inserts are flush with respect to the surface of the cylinder head within ± 0.05 mm (0.00197 in). Check the dimension A, see point 5.



3. Cylinder Head – Pressure Testing

- A. Plug all coolant holes with sealing washers part-no 6531. Use bolt part-no 955353 and nut part-no 955784 19 pcs of each, to tighten the sealing washers.
- B. Attach the connection washer part-no 6532 to the end of the cylinder head and connect the pressure testing device part-no 6662. Use the gasket of the water pipe plus 4 bolts part-no 955295 for the connection washer.
- C. Tighten the reduction valve until the pressure gauge indicates 100 kPa (1 kp/cm²).
- D. Lower the cylinder head in water to facilitate the finding of possible leakages.
- E. After the pressure testing, the cylinder head should be dried with compressed air.

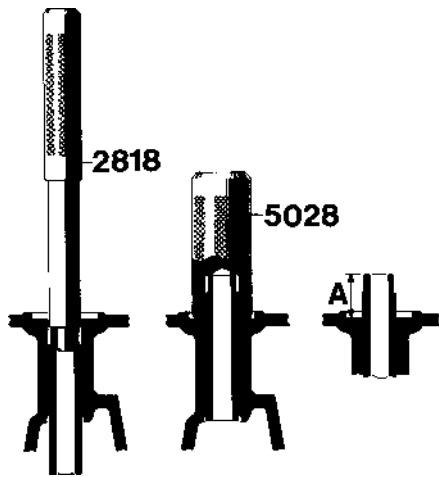


4. Valve Guides

- A. Check the valve guides for wear by inserting a new valve. Measure the clearance with the aid of a dial gauge. Change the guides if necessary.

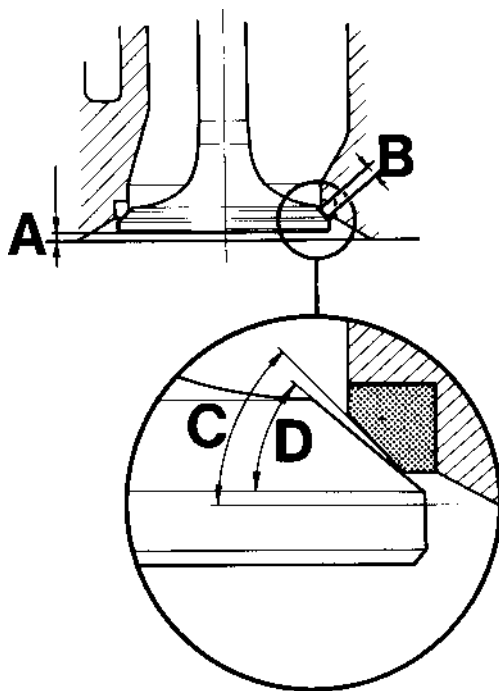
Wear Limits

Inlet valve, max. clearance 0.15 mm 0.00951 in
Exhaust valve, max. clearance 0.17 mm 0.00669 in



A = 18 mm (0.70866 in)

- B. Press out the valve guides using drift 2818. Oil the new guides externally and press them into position with tool 5028. The tool should be pressed right down against the cylinder head. Ream the guides if necessary.



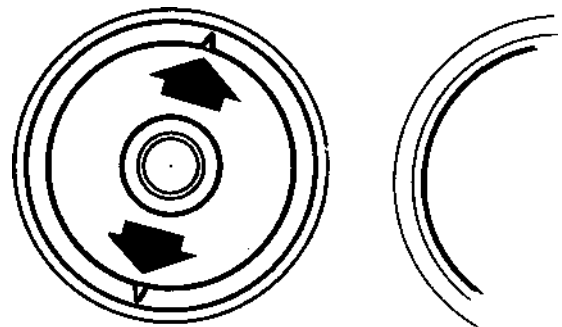
5. Valves

Grind the valves on the valve grinding machine. The angle (D) should be 29.5° for the inlet valve and 44.5° for the exhaust valve. If the thickness of the edge of the disc after grinding is less than 1.5 mm (0.05906 in) for an inlet valve or 1.3 mm (0.05118 in) for an exhaust valve, the valve should be rejected. Valves with bent stems should also be rejected. If necessary, grind the surface on which the rocker arm bears.

- A (New valve)
 in: min. 1.1 mm (0.04331 in)
 max. 1.8 mm (0.07087 in)
 out: min. 0.85 mm (0.03346 in)
 max. 1.55 mm (0.06092 in)
- B in: 1.38–2.8 mm (0.0543–0.11024 in)
 out: 1.3–2.6 mm (0.05118–0.10236 in).
- C in: 30°, out 45°
- D in: 29.5°, out 44.5°

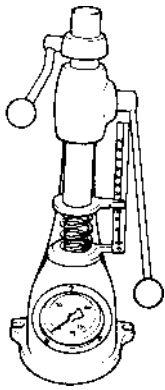
6. Valve Seats

Mill or ream the valve seats. The angle (C) should be 30° for the inlet and 45° for the exhaust. (Check the valve guides before machining the seats, and replace them if necessary). The width of the sealing surface should be 1.3–2.8 mm (0.05118–0.11024 in) for the inlet and 1.3–2.6 mm (0.05118–0.10236 in) for the exhaust. Replace the valve seats when the dimension (A), measured with a new valve, exceeds 1.8 mm (0.07087) for the inlet or 1.55 mm (0.06102 in) for the exhaust. A new seat should be ground down so that the dimension (A) is min. 1.1 mm (0.04331 in) for the inlet or 0.85 mm (0.03346 in) for the exhaust.



Replacing Valve Seats

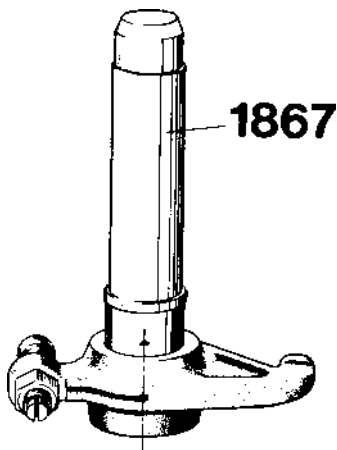
- A. Remove the old seat by grinding two notches as shown in the diagram. Crack the seat with a chisel.
- B. Machine the seat recess to the correct dimension, see "Technical Data". Cool the new seat down in CO₂ snow to about 140°F (60°C), and warm up the cylinder head by rinsing it with hot water. Press the seat in with a drift. Machine the seat so that the height, angle and width are correct.



7. Valve Springs

Check the valve spring lengths, both unloaded and loaded.

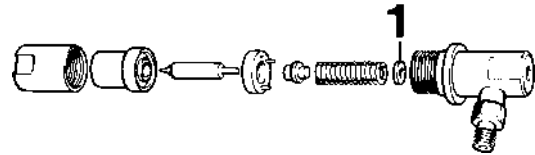
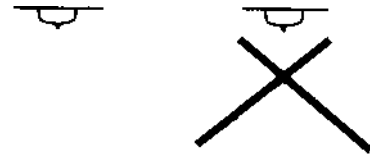
Length without load	46 mm 1.81102 in
Length with load	
267–312 N (27.2–31.8 kp)	40 mm 1.5748 in
Length with load	
766–851 N (78.2–86.8 kp)	30 mm 1.18110 in



8. Rocker Arm Mechanism

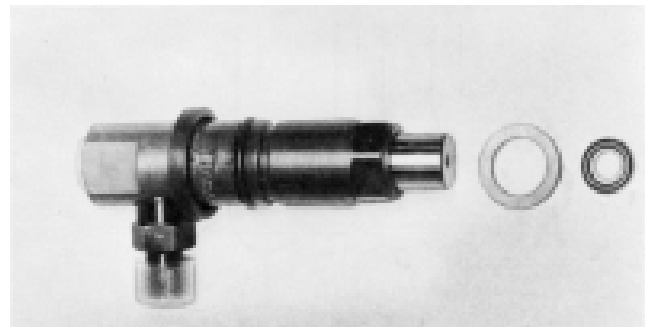
Dismantle the rocker arm mechanism and clear the parts. Check the shaft & the bushes for wear. If the bushes need to be changed, the tool 1867 is used for pressing out and in. (Ensure that the oil hole in the bush coincides with the hole in the rocker arm). After having been pressed in, the bushes should be reamed to give an accurate running fit.

Check whether the rocker arm surface which bears on the valve is worn concave. Minor adjustments can be made with the valve gripping machine. Oil the shaft and fit the parts.



9. Injectors

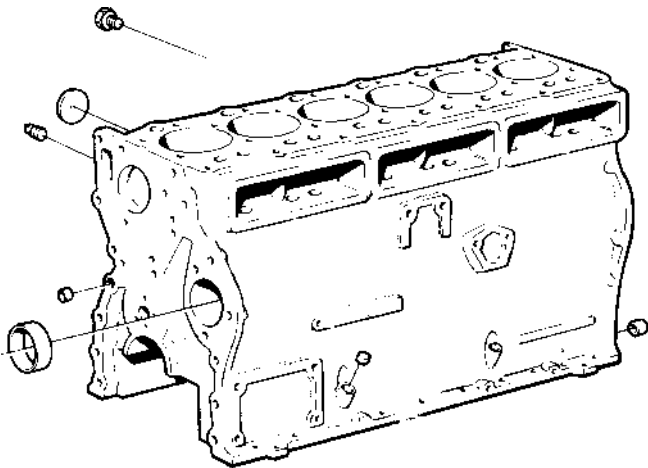
When an injector is tested, the fuel should come out as a properly directed mist, see the illustration. The opening pressure is adjusted by unscrewing the injector and taking it apart, when the adjusting washer (1) can be replaced by a washer of suitable thickness.



10. Assembling the Cylinder Head

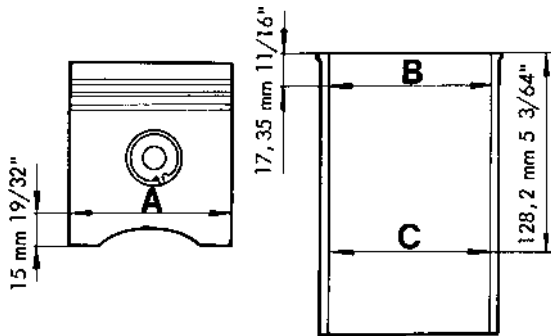
Clean the cylinder head. Oil the valve stems and fit the valves, not forgetting the sealing rings for the inlet valves. Fit the glow plugs and the plate for the electrical wiring. Fit the injectors together with new steel and copper washers. Do not tighten the injectors.

Cylinder Block



11. Cleaning, Inspection

Remove all core plugs and clean the cylinder block thoroughly. Check that all channels are free from deposits and that there are no cracks in the block. Refit the core plugs using a sealing compound.



12. Pistons, cylinder liners

The pistons and liners are classified and marked with a letter. A piston which is marked with a D must thus only be fitted into a liner with the same letter. Check the pistons and liners for damage before making any measurements.

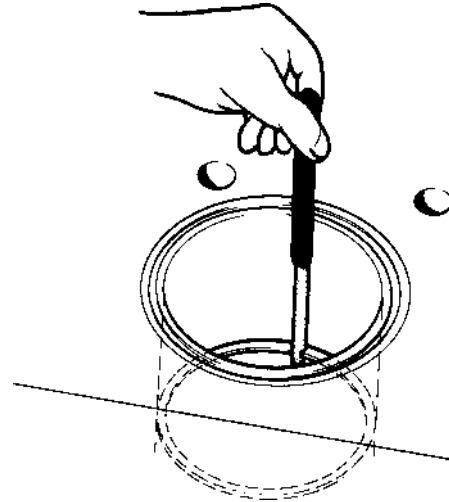
Class	Cylinder diameter
C	92.00–92.01
	3.54331–3.54370 in
D	92.01–92.02
	3.54370–3.54409 in
E	92.02–92.03
	3.54409–3.54448 in

- B. Measure the cylinder liner diameter at a number of points round the circumference and at a number of different heights between the top and bottom dead-centre positions (B and C).

Change the piston and the liner if the wear is as much as 0.25–0.30 mm (0.00984–0.01181 in).

Measure the piston diameter (A) at right angles to the gudgeon pin and 15 mm (0.59055 in.) from the bottom of the piston. Calculate the maximum and minimum piston clearance (the max. and min. liner diameter minus the piston diameter).

Piston clearance (new parts): 0.08–0.12 mm. 0.00315–0.00472 in.

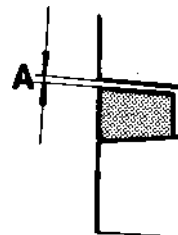


- C. Measure the piston ring gap on the new rings. If the liner is not new, the check should be made with the ring in the bottom dead-centre position.

The gap should be:

Compression rings: 0.40–0.65 mm 0.01515–0.02559 in

Scraper rings: 0.25–0.40 mm 0.00984–0.01575 in



- D. Measure the clearance of the piston rings in their grooves.

NOTE! The upper ring should be flush with the surface of the piston at the point of measurement, see illustration.

The clearance should be:

Upper compression rings:

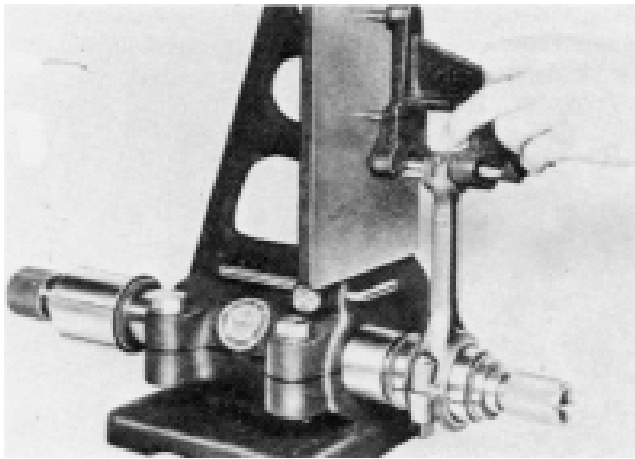
0.08–0.13 mm 0.00315–0.00512 in

Lower compression rings:

0.07–0.10 mm 0.00276–0.00394 in

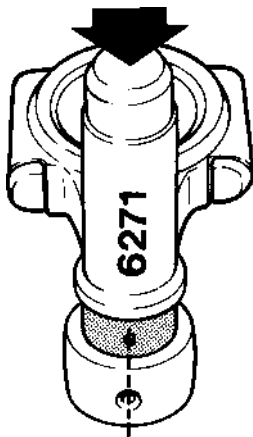
Scraper rings:

0.04–0.07 mm 0.00157–0.00276 in

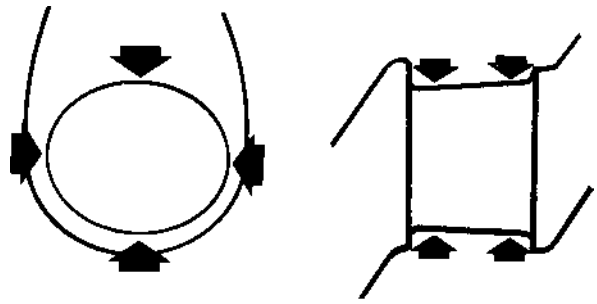


13. Connecting Rods

- A. Check the connecting rods for straightness and twist.

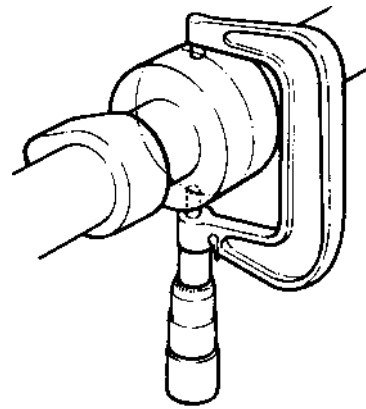


- B. Check the connecting rod bushings, using the gudgeon pins as gauges. There should be no noticeable play. If it is necessary to replace the bushings, drift 6271 should be used for pressing out and in. Ensure that the oil hole in the bushing lines up with that in the connecting rod.
Ream the new bushings. When the fit is correct, an oiled gudgeon pin should slide slowly through the bushing under its own weight.



14. Crankshaft

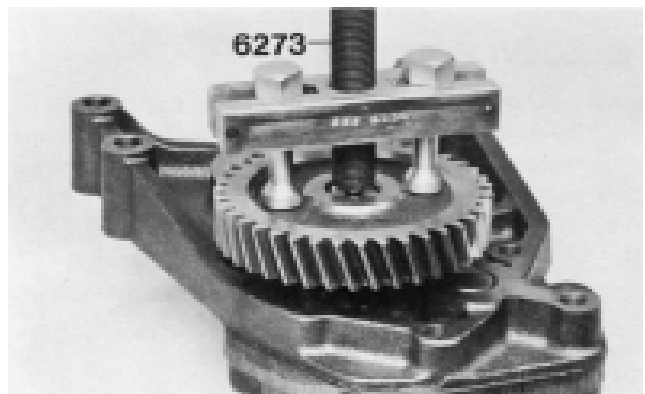
Measure the big-end journals and the main bearing journals. The out-of-round must not exceed 0.04 mm (0.00157 in) and the taper should not exceed 0.05 mm (0.00197 in). If these values are exceeded, the crankshaft should be ground to a suitable undersize. (See "Technical Data").



15. Camshaft

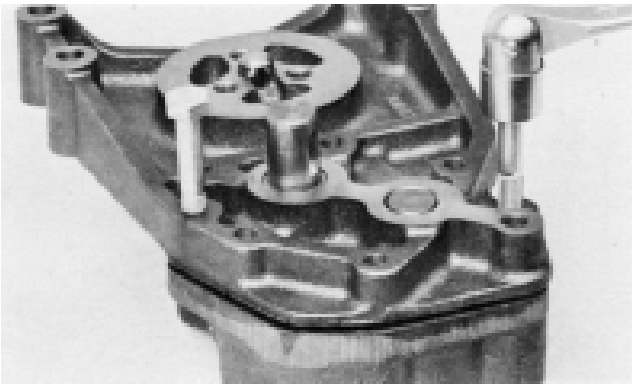
Check the camshaft for wear on the cams and bearing races. Also check the wear on the bearing. The bearings are pressed into their recesses and must be line milled after pressing in.

Max. allowable wear on races or bearings 0.05 mm (0.00197 in).

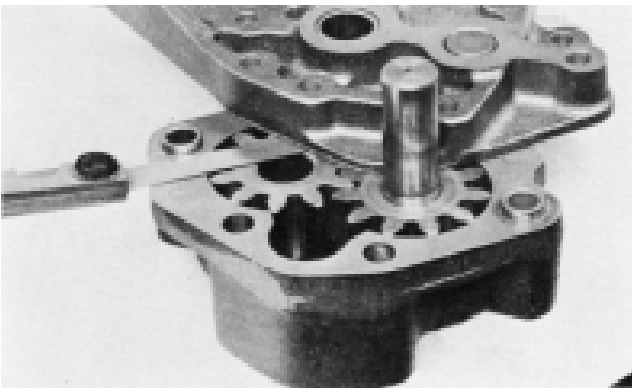


16. Oil Pump

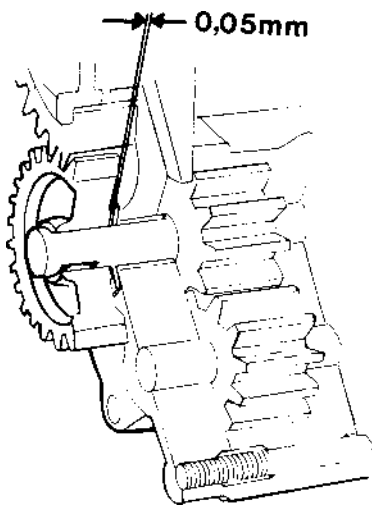
- A. Remove the idler. Pull off the drive gear with puller 6273. Remove the key and the brass washer.



- B. Unscrew the bolts holding the pump housing. Press the housing loose by screwing the bolts in from the front side. Remove the pump gear.

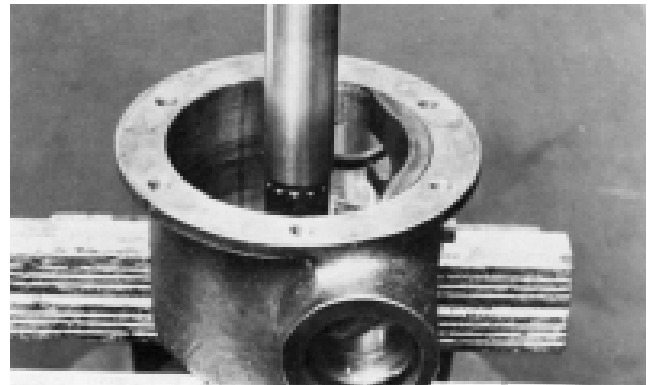


- C. Check the housing for scoring and wear. Check the seal between the bracket and the pump housing. If leakage has occurred, the surfaces will be blackened. The bushings should be changed if the radial play between the shaft and the bushing is 0.15 mm (0.00591 in) or more. The new bushings should be reamed to give an accurate running fit with the housing bolted tightly onto bracket. The idler should be replaced if the radial clearance exceeds 0.20 mm (0.00787 in). Check the pump gear for wear on the tooth flanks, external diameter and end faces. Check the end play and the tooth flank clearance.



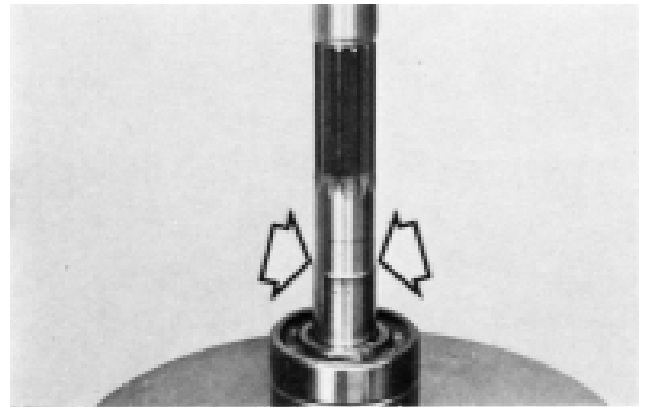
- D. Oil the parts. Fit the pump gear and bolt the housing on. Fit the brass washer and the key.

Press the drive wheel on so that a 0.05 mm (0.00197 in) feeler gauge fits accurately and evenly between the wheel and the brass washer.



17. Sea-Water Pump

- A. Remove the cover and prise out the impeller using two screwdrivers. (Place some kind of protection under the screwdrivers so that the housing is not damaged). Turn the pump over and remove the lock ring. Turn the pump back again and press out the shaft, the bearings and the sealings.



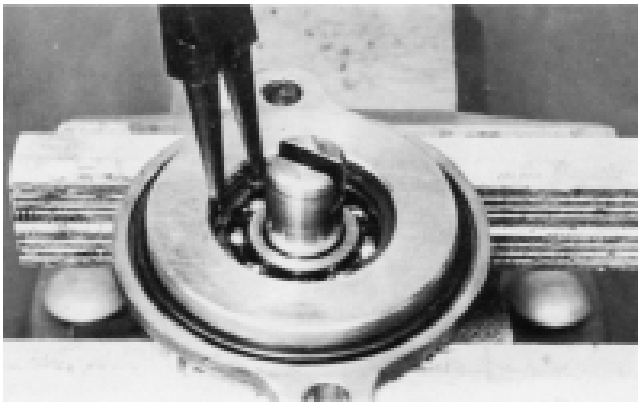
- B. Grease the new bearings and press them into the shaft so that they fit right over the thickest part of the shaft.



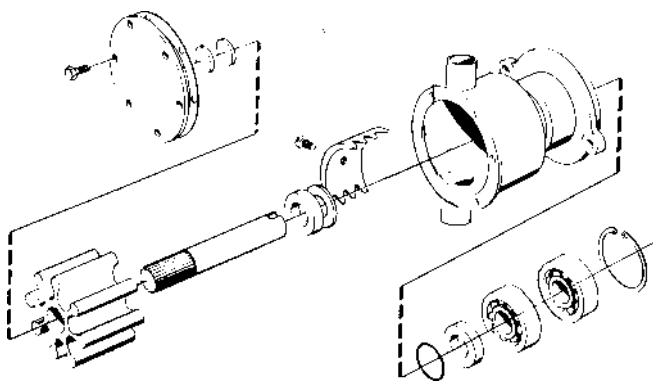
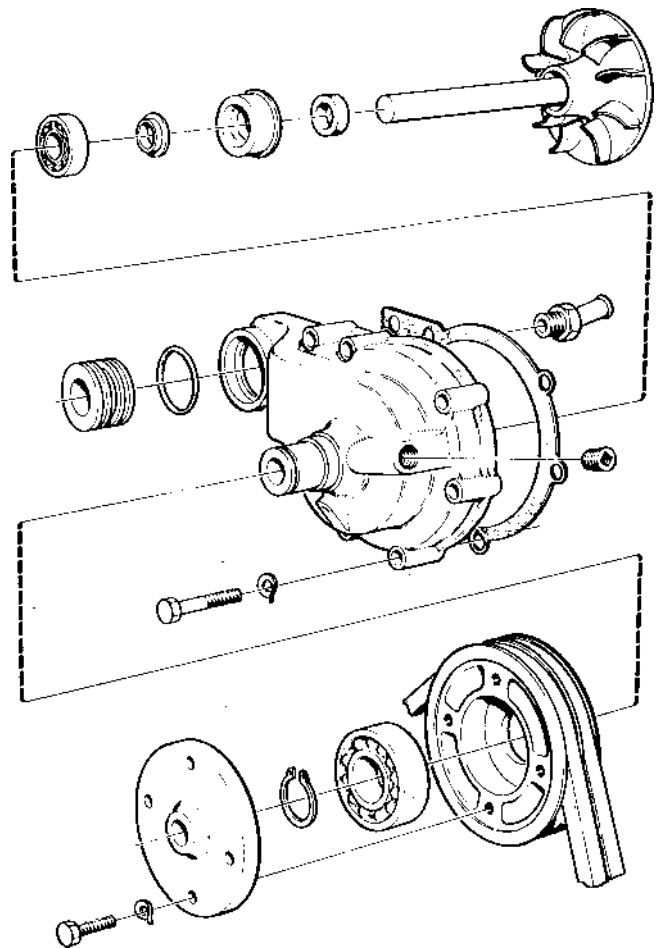
- C. Replace the old cam disc by the new one. (MD40, AQD40, TMD40) Fig. 17E. Grease the sealing rings and press them into the housing with the lips pointing in opposite directions; use tool 884347. Place the O-ring between the two sealing rings.

Pass the shaft down into the housing ensuring that the O-ring fits onto the shaft. Press the shaft and the bearings into the housing with tool 884347.

(AQAD40, TAMD40), Fig. 17F. Mount the sealings in the housing. Press the shaft and the bearings into the housing with tool 884347.



D. Fit the lock ring, the impeller and the sealing washers. Fit the cover together with a new gasket.



E. MD40, TMD40, AQD40

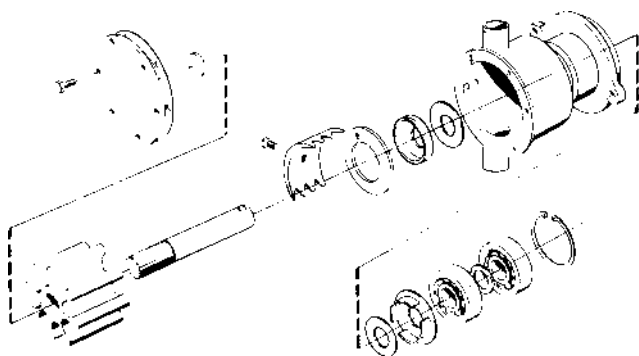
18. Circulation Pump

A. Press the complete shaft including the impeller out of the pump housing. Loosen the 4 bolts and take off the driver.

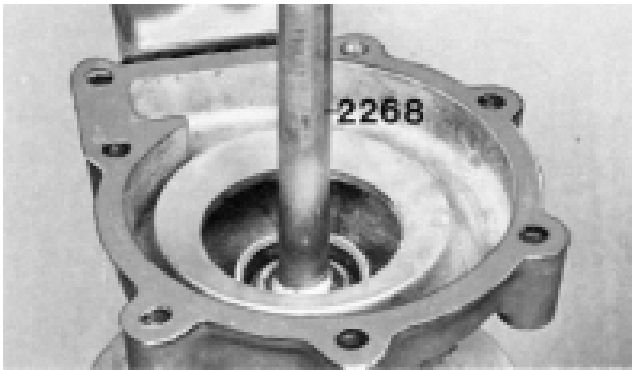
Take off the lock ring and prise the belt pulley loose with two screwdrivers.

Knock out the inner bearing and the shaft seal with the aid of a small drift.

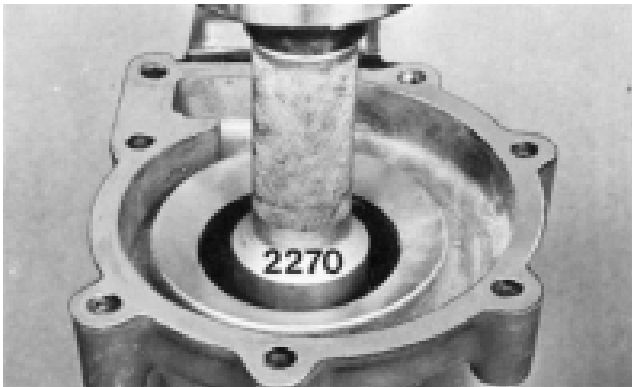
Clean the housing and the belt pulley. Knock the bearing out of the belt pulley.



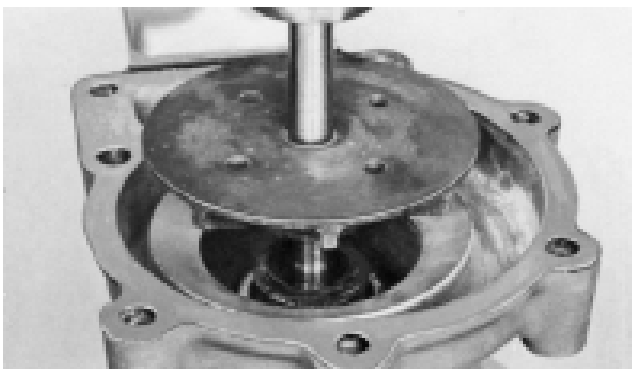
F. TAMD40, AQAD40



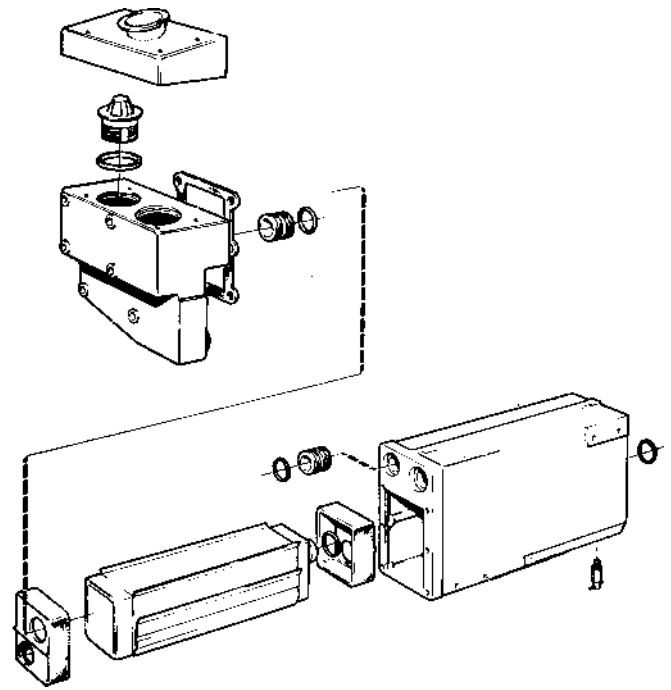
- B. Pack the bearings with heat-resistant ball-bearing grease. Fill the space with the bearing with grease. Press the bearing into the belt pulley. Press the bearing into the pump housing with the aid of tool 2268 (turn the sealed side of the bearing towards the water).



- C. Place the deflector ring on the bearing and press the shaft seal on with tool 2270.
NOTE! The carbon ring and the ceramic ring in the seal must not come into contact with grease or be touched with the fingers.



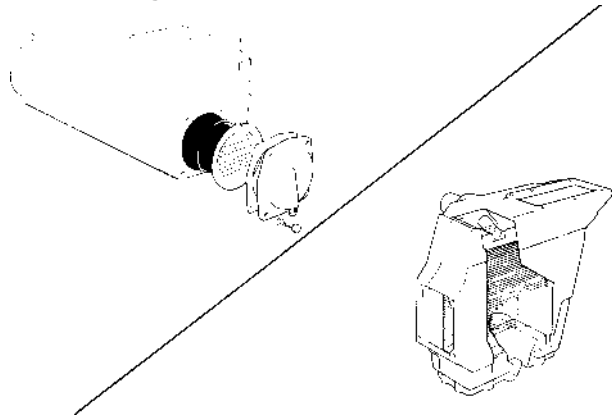
- D. Place the ceramic seal ring on the impeller and insert the shaft through the seal. Make sure that the deflector ring is correct. Press the shaft in so that there is a clearance of 0.8 mm (0.3150 in) between the impeller blades and the pump housing.



19. Heat Exchanger, Aftercooler

AQD40A, TMD40A, MD40A. Remove the cover of the thermostat housing. Remove the housing and pull out the heat exchanger insets.

Heat exchanger



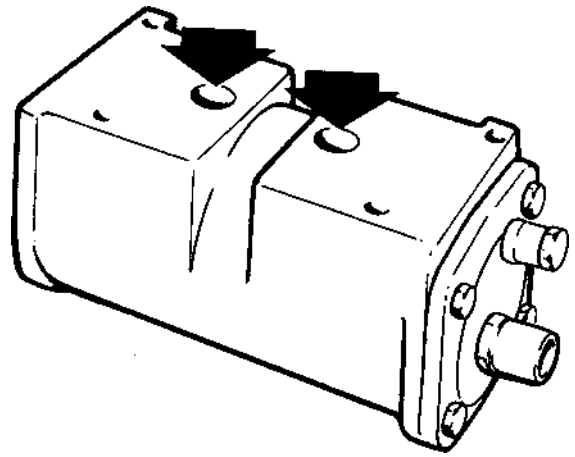
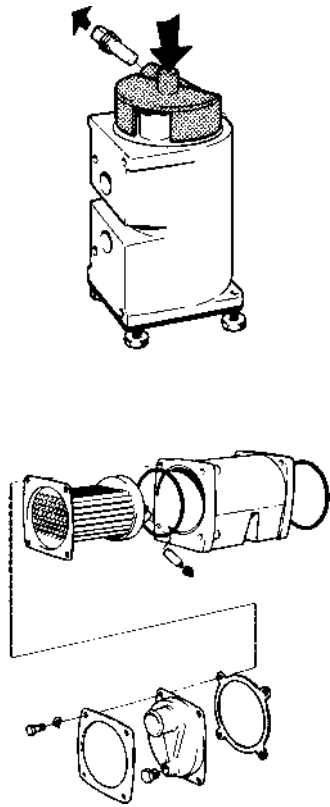
After cooler

AQAD40, TAMD40: Remove the cover and pull out the insert.

Rinse and thoroughly clean the parts. If leakage is suspected, the insert can be pressure tested with i.e. air or kerosene, pressure: 0,2 MPa (2 kp/cm²). (28.4 lbf/in²).

NOTE! Follow valid safety regulations.

Check that the thermostats open at the correct temperature. Fit the parts in the reverse order, using new O-rings and a new gasket. Grease the insert connections with water resistant grease before re-assembling.



Pressure Testing

Remove the oil cooler from the filter bracket. Make a plate to cover the two holes in the housing. Provide the plate with a connection for compressed air or similar. Bolt the plate into the housing, using sealing rings. Make a pressure test with approx. 0.7 MPa (7 kp/cm²) 100 lbf/in².

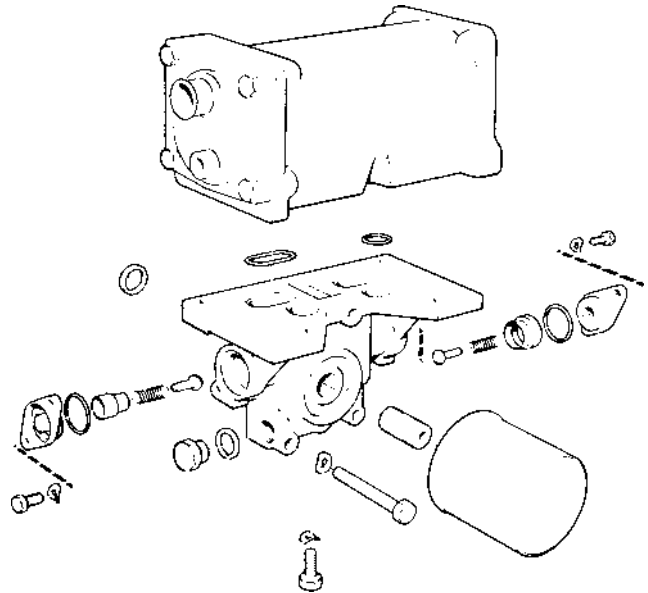
NOTE! Follow valid safety regulations.

20. Oil Cooler

From and including engine no. 1070, the oil cooler insert can be removed for cleaning. Removing the end cover, replace the screws and screw in approx 5 mm (0.2"). Dismantle the zinc electrode. Stand the oil-cooler on the screws, ensure that it rests upon all the screws. Tap with the help of the tool 884635 to loosen the insert.

Remove the insert and take off the two O-rings. Wash the insert, use a brush which can be pushed into the tubes. Also clean the housing. Check the zinc electrode and if the length is less than 20 mm (0.7874 in) this should be replaced. Fit new O-rings and push the insert into the housing. Fit the end cover using a new gasket.

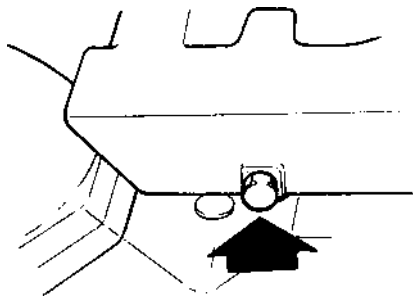
Engines with lower number than 1070: Remove the end cover and wash the insert with a brush which can be pushed into the tubes. Flush water side and oil side respectively.



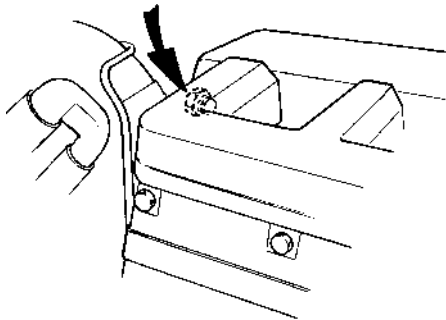
There are two positive pressure valves installed in the oilfilter bracket. The rear for the piston cooling (opening pressure 2,2–3,0 kp/cm²/31–42 psi.) and the forward for the engine oil pressure 4,2–5,0 kp/cm²/60–71 psi.)

Turbo-Compressor

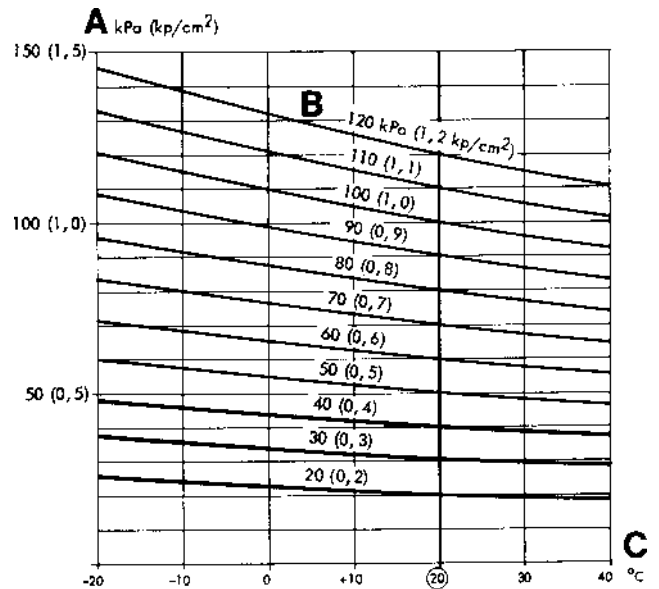
In the event of excessive exhaust smoke or loss of engine power, faulty action of the turbo-compressor is to be suspected. The supercharging pressure should then be checked. When speed slowly decreases the bottom of the boat should also be examined and, if necessary, cleaned.



AQD40, TMD40



AQAD40, TAM40



Supercharging pressure at different temperatures.

- A. Supercharging pressure measured
- B. Correction curves
- C. Temperature of intake air

- B. Measure the supercharging pressure under full load and at full throttle whilst the engine speed passes relatively slowly through a suitable speed, e.g. 56.7 r/s (3.400 r/m) for B-power engines or 46.6 r/s (2.800 r/m) for C-power engines, see the Supercharging Pressure Diagram under "Technical Data". The supercharging pressure should not be less than the specified minimum value. Check the engine speed with a hand tachometer.

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. Example: A measured pressure of 80 kPa (0.8 kp/cm² = 11.3 lbf/in²) measured at -10°C (14°F) corresponds to 70 kPa (0.7 kp/cm² = 9.9 lbf/in²) at +20°C (68°F), i.e. the pressure decreases as the temperature rises, due to reduced air density.

22. Checking the Supercharging Pressure

- A. Connect a pressure gauge to the measuring connection on the intake manifold (see illustration).

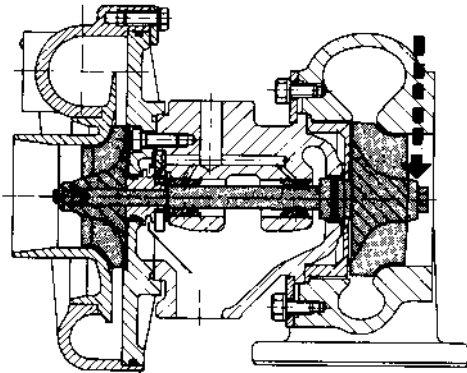
23. Measures to be carried out when the Supercharging Pressure is too low

A. Air intake, air cleaner

Check that the air intake is not blocked. Check the air cleaner and replace it if necessary.

B. Leakage

Check for leakage between the turbo housing and bearing housing or between the compressor housing and the bearing housing. Also check the joint between the turbo compressor and the inlet manifold.



C. Turbo-compressor

Remove the air cleaner. Check that the compressor rotor is at rest and then see whether the rotor is stiff when turned by hand. If the rotor is difficult to turn, the compressor should be replaced or reconditioned.

Measure the axial and radial clearances of the rotor unit. The radial clearance is measured on the turbine side (at the outer edge of the hub, see illustration).

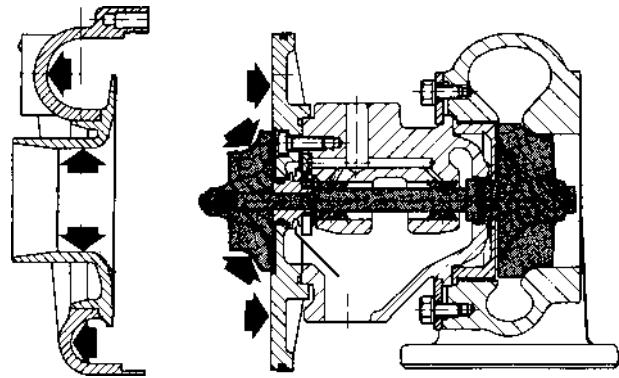
Max. allowable axial clearance: 0.16 mm (0.00630 in).

Max. allowable radial clearance: 0.42 mm (0.01654 in).

If the wear limits are reached, the turbo-compressor should be replaced or reconditioned.

If no faults are found:

Check whether the compressor section requires cleaning, see point D. Deposits of soot and oil can cause low supercharging pressure.



D. Cleaning

The compressor section can be cleaned with the unit still on the engine, as follows:

Remove the compressor housing. Clean the compressor housing, the compressor rotor and the bearing shield with an agent such as white spirit. Fit the compressor housing and remeasure the supercharging pressure.

If the supercharging pressure is still too low the following checks should be made:

E. Throttle Control

Check that the throttle control can move the injection pump throttle arm to the maximum position.

F. Injection Pump

Check the injection angle and the high idle speed.

If necessary, check the entire pump on a pump test bench.

G. Feed Pressure

If necessary, replace the fuel fine filter and clean the pre-filter. There must be no fuel leakage.

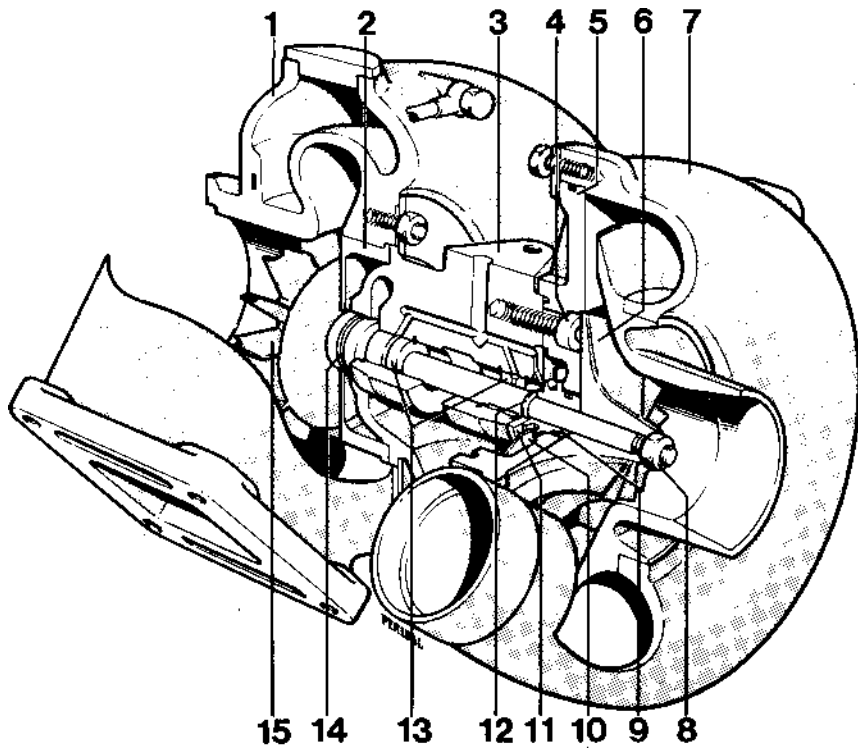
H. Injectors

Check the opening pressure and the spray pattern.

I. Condition of engine

Check the valve clearances and the compression pressure.

If the supercharging pressure is still unsatisfactory, the compressor must be reconditioned or replaced.



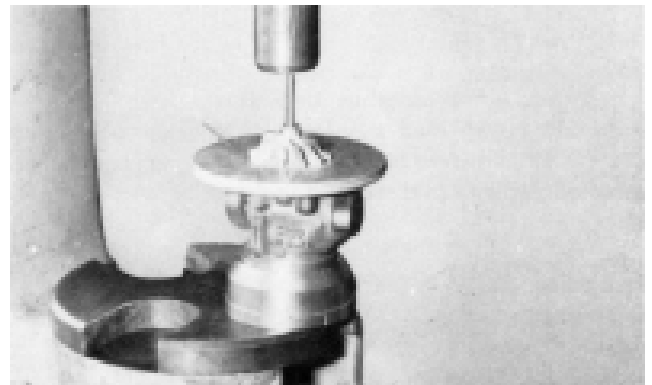
Reconditioning

All moving parts of the turbo compressor are separately balanced. This also applies to spare parts. A joint balancing after reconditioning may however be advantageous from the viewpoint of life time length.



24. Disassembling

- A. Make line-up marks between the turbine housing (1), the compressor housing (7) and the bearing housing (3). Remove the turbine housing and the compressor housing. Clamp the turbine rotor and remove the compressor rotor lock nut (8). The position of the wheel should be marked in relation to the shaft.

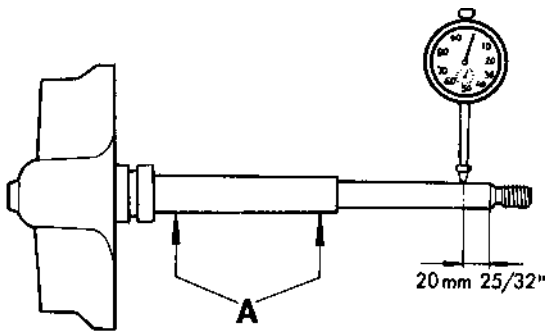


- B. Remove the compressor rotor. Press the shaft out if the rotor is stuck.



- C. Remove the bearing end head (5) and press out the piston ring retainers (9). Remove the piston rings, the oil deflector plate (10), the thrust bearing (11) and the thrust washer (12). Lift the bearing housing (1) and the heat shield (2) from the shaft. Remove the piston rings (14) and the bushings (13).

Clean the components thoroughly, take care not to damage them.



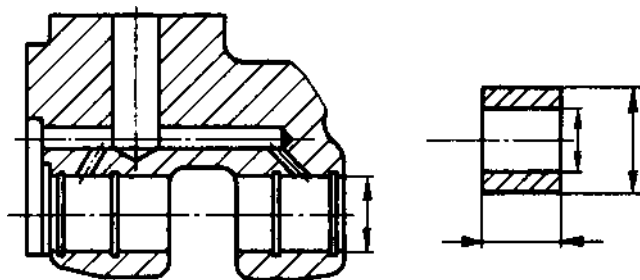
25. Measuring, Inspection

A. Turbine Rotor with Shaft, Compressor Rotor

Check that the rotors and the shaft are free from mechanical defects. The blades must not be worn or deformed. Blades must never be straightened, and any damaged parts must be replaced by new or reconditioned parts.

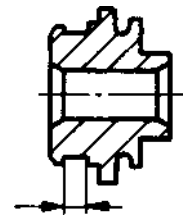
Place the shaft on two supports located under the bearing positions, see illustration. Measure the out-of-truth of the shaft at about 20 mm (0.7874 in) from the threaded portion. Max. allowable out-of-truth: 0.007 mm (0.00028 in).

Check the diameters at the shaft bearing positions. Min. dia. 9.95 mm (0.39173 in). Check the width of the piston ring grooves in the shaft. The width should be max. 3.0 mm (0.11811 in).



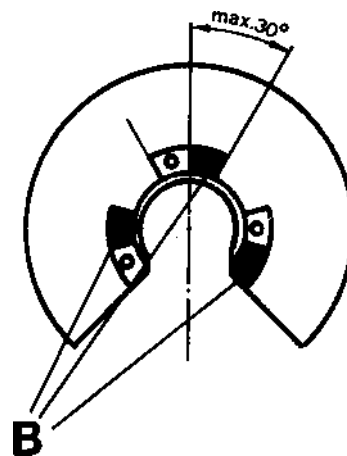
B. Bearing housing, Compressor housing, Turbine housing

Check the housing for cracks and other damage. Measure the diameters of the bushing recesses in the bearing housing. The diameter should be max. 16.064 mm (0.63244 in).



C. Bushings

Check the bearing surfaces for damage. Measure the internal and external diameters. Internal diameter, max: 10.00 mm (0.3937 in). External diameter, min: 15.975 mm (0.62895 in). Measure the lengths of the bushings. These should be min: 11 mm (0.43307 in). Note that the bushings should have a push fit in the bearing housing.



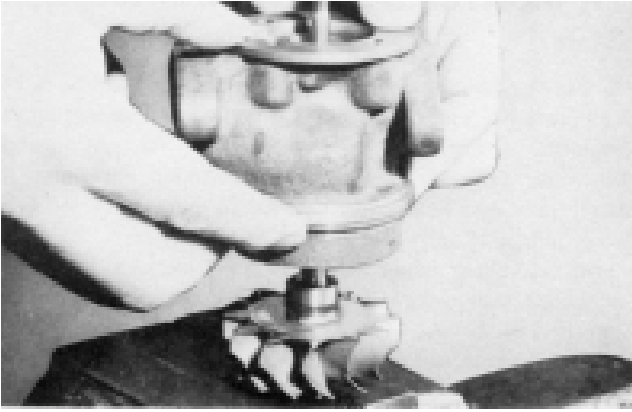
B = Wearing Surfaces

D. Piston Rings, Piston Ring Retainers

Measure the width of the piston rings. This should be min: 1.2 mm (0.04724 in). Measure the width of the piston ring grooves in the piston ring retainer. The width must not exceed 3.0 mm (0.11811).

E. Thrust Washer, Thrust Bearing

Measure the thickness of the thrust washer. This should be min. 1.47 mm (0.5787 in). Check the wearing surfaces of the thrust bearing. The angle, as shown in the illustration, should not exceed 30°.



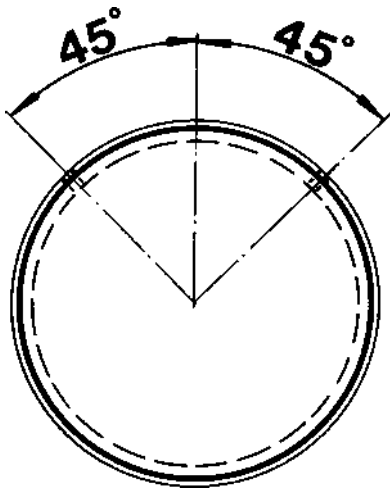
26. Assembling

Lubricate all moving parts involved in the assembly process.

- A. Fit the bushing and lock rings on the turbine side of the bearing housing. Also fit the inner lock ring on the compressor side.

Fit the heat shield (2) on the bearing housing.

Clamp the hub of the turbine rotor (15) in a vice. Fit the piston rings (14) and carefully fit the bearing housing over the shaft.



- B. Fit the piston ring gaps 90° apart and at 45° with respect to the oil inlet (see illustration). Compress the rings so that they can be inserted in the bearing housing. After this, check that the heat shield turns easily.

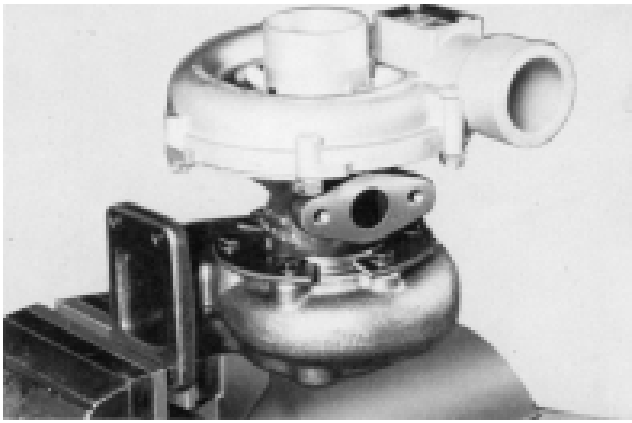


- C. Fit the bushing and the external lock ring on the compressor side of the bearing housing. Fit the thrust washer (12), the thrust bearing (11) and the oil deflector plate (10). Fit the piston rings on the piston ring retainer (9). Arrange the piston ring gaps in the same way as on the turbine side and fit the retainer in the bearing end head (5).



- D. Apply Curil T to the sealing surfaces of the bearing end head and screw the head into the bearing housing.
NOTE! The self-locking bolts (4) should be replaced by new ones. (If the old bolts are used, they should be secured with Loctite). Tightening Torque: 8 Nm (0.8 kpm) (5.8 ft/lbs).

Heat the compressor rotor up to about 100°C and fit it into the shaft. Tighten nut (8), torque 10 Nm (1 kpm) (7.233 ft/lbs). Check the torque after the parts have cooled down.



- E. Fit the O-ring on the bearing end head and fit the compressor housing (7). Torque 7 Nm (0.7 kpm) (5.0 ft/lbs). Fit the turbine housing (1). Tightening torque: 8 Nm (0.8 kpm) (5.8 ft/lbs).

27. Fitting the turbo-compressor

- A. Change the engine oil and the lubricating oil filter. Bearing damage in the turbo-compressor is almost always caused by sludge deposits in the engine lubricating system. The presence of sludge deposits can be checked by lifting off the rocker arm casing. If deposits are found, the complete lubrication system must be thoroughly cleaned before a new or reconditioned turbo-compressor is fitted.

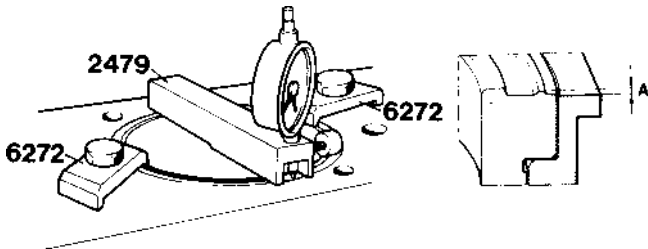
The correct grade of oil must be used (see "Technical Data"), and oil changes must be carried out in accordance with the instruction book in order to keep the engine clean.

Also check the delivery and return lines to the turbo-compressor.

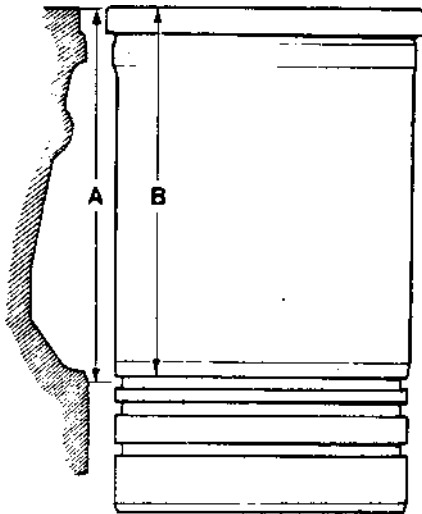
- B. Clean the intake line between the turbine and the air cleaner. If the compressor rotor has been damaged, pieces may still remain which can damage the new compressor rotor.
- C. Fit the turbo-compressor on the engine. After this, inject lubricating oil into the compressor bearing system before fitting the delivery oil line.
- D. Turn the engine over, with the stop button pushed in, until oil pressure is obtained. Then disconnect the upper oil pipe on the turbo-compressor and check that oil is coming out of it.

Assembling

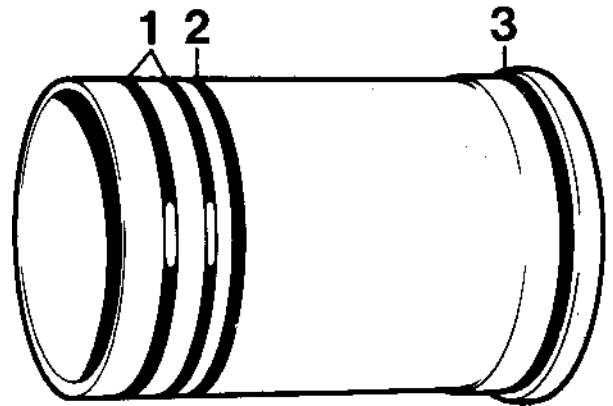
Use new gaskets, sealing rings, sealing washers and lock washers. Apply grease or oil to the sealing rings. (The cylinder liner sealing rings should be smeared with soap). Also oil the movable parts before fitting.



1. Fit the cylinder liners into the block without sealing rings. Measure the liner height, dimension A in the illustration. The measurement should be made at four points on each liner. The height should be: 0.26–0.31 mm (0.01024–0.01220 in), but the difference between two adjacent liners should not exceed 0.02 mm (0.00079 in). Mark the liners so that they come in the same position in the final assembly.

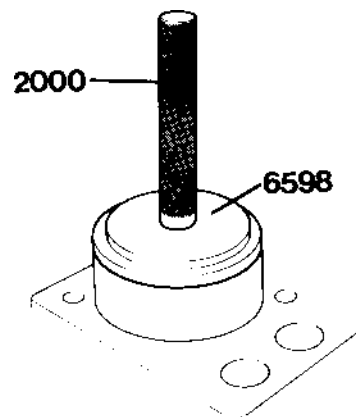


	Early prod.	Late prod.
A =	133.0 mm	134.5 mm
B =	131.0 mm	141.0 mm



- 1 = Black with violet marking
- 2 = Black
- 3 = Black (this ring and ring groove has been introduced with engine no 2201)

3. Lift the cylinder liners and fit the sealing rings as shown in the illustration. Smear the sealing rings and the lower guides in the block with soapy water. Fit the liner into the block. (Center the liners so that the upper guides enter).

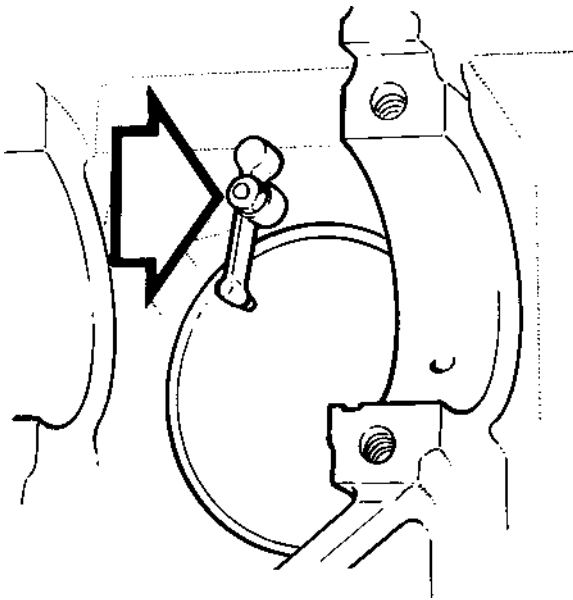


Pistons, Liners

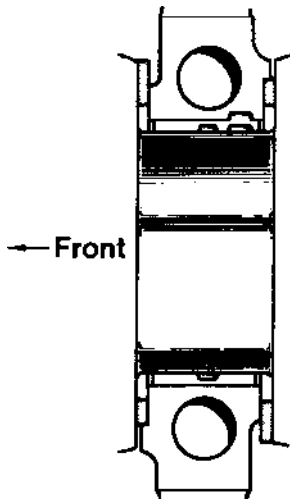
2. With effect from engine number 11900 altered cylinder liners and cylinder block have been introduced in production. These alterations have been made so that the liner can be installed more easily and also to reduce the risk of damage to the sealing rings.

The new liners can be used on earlier engines but the earlier liners cannot be used on later engines.

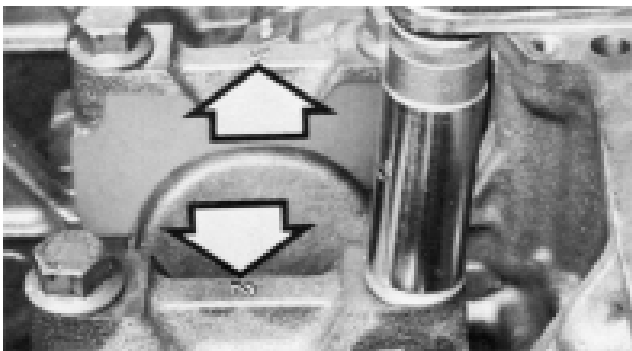
4. Install the cylinder liners, using mandrel part-no 6598 and standard shaft part-no 2000.



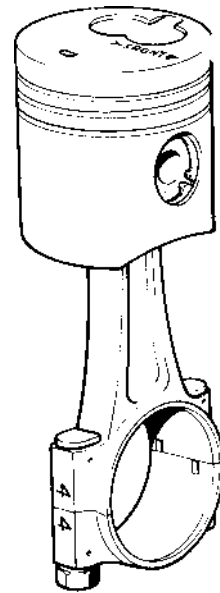
5. Fit all piston cooling nozzles.



6. Fit the main bearings and the crankshaft (lubricate bearing surfaces with engine oil. Fit the two thrust washers in the engine block, one on either side of the middle main bearing. Check the axial clearance. It should be 0.10–0.31 mm (0.00394–0.01220 in).



7. Fit the main bearing caps so that their numbering is correct. (No. 1 at the front). Tightening torque: See "Technical Data". Oil the threads.



8. Heat the pistons up to about 100°C (212°F). Fit the pistons and connecting rods so that the front markings on the pistons and the numbers on the connecting rods are as shown in the illustration.

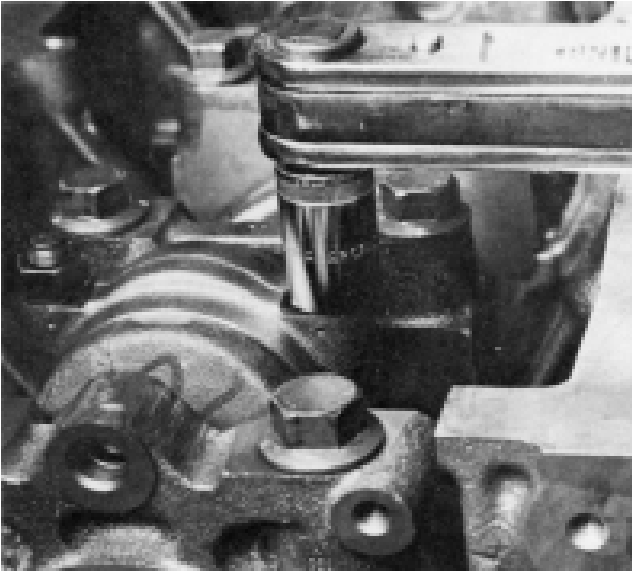


9. Fit the piston rings with the aid of piston pliers. The compression rings are marked "Top". The oil scraper ring can be fitted either side up. Fit the big-end bearing shells.

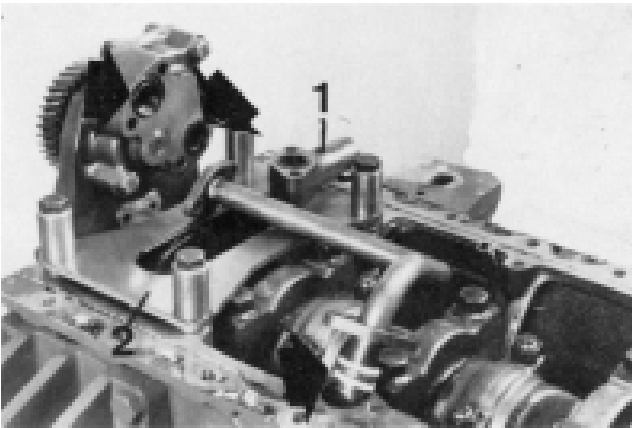
Oil the pistons, the piston rings and the big-end bearings. Arrange the piston rings so that the gaps are about 120° apart.

Fit the pistons so that the front markings point forward. Use assembly tool 5031.

NOTE! If the pistons are pushed down too far, the cooling nozzles may be damaged.



10. Fit the big-end bearing caps so that their markings agree with those on the connecting rod. Oil the threads. Tightening torque: 113 Nm (11.3 kpm) (81.73 ft/lbs).

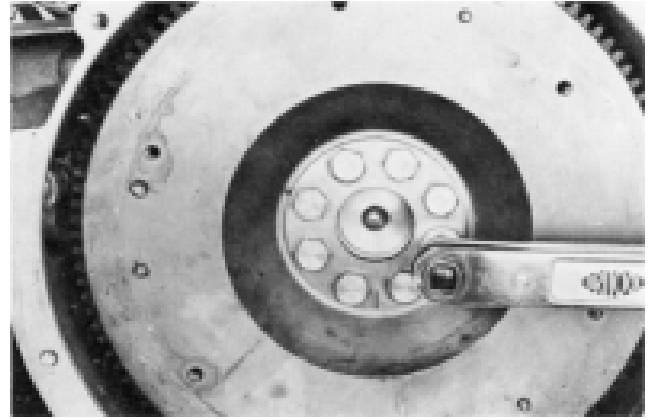


Oil Pump

11. If the engine has a reinforcement plate (2) the threads of the bolts must be dipped in anti-rust medium, part no. 598177, 24 hours max before assembling. At assembling the bolts must be dripfree. Clean the mating surfaces carefully. Tightening torque 46 ± 5 Nm.

Screw the oil pump tight to the front main bearing. Fit new sealing rings in accordance with the illustration.

NOTE! Two yellow sealing rings should be fitted to the end of the delivery pipe which is connected to the block. Screw the bracket for the suction pipe to main bearing No. 5. Screw tight the oil pipes. The reducing valve (1) is fitted between the suction pipe and the pump.

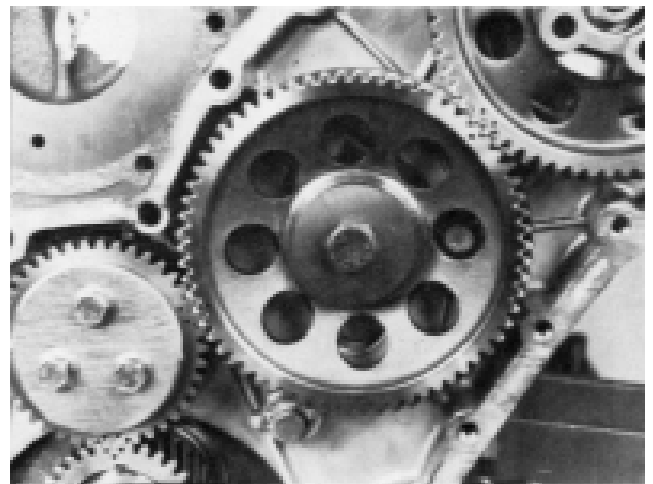


Flywheel

12. Fit a new sealing ring in the flywheel casing (grease the ring before the casing is fitted). Fit the flywheel casing and the auxiliary drive gear casing.

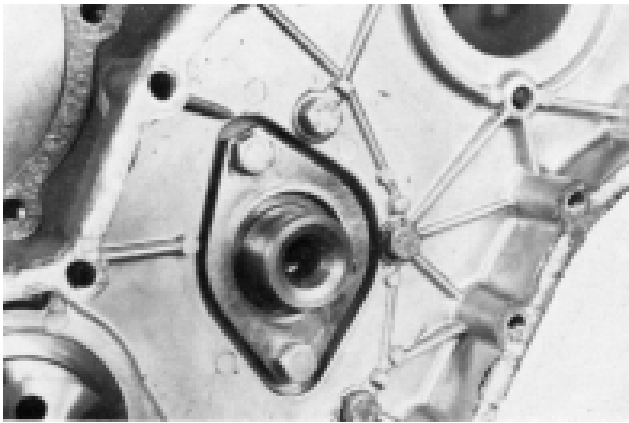
Fit the flywheel. Tightening torque 105 Nm (10,5 kpm), 75,95 ft/lbs. With effect from engine number 31816, 115 Nm (11,5 kpm) 82 ft/lbs.

NOTE! The flywheel is provided with a guide-sleeve, which must match the crankshaft. Fit the driving disc and the connecting flange. Fit the oil sump.



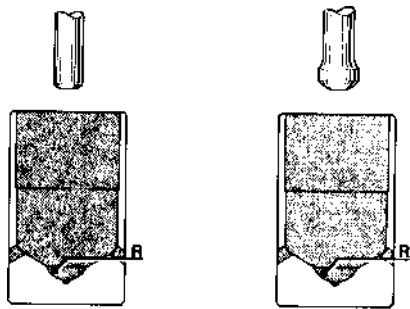
Auxiliary Drive Gears

All the gearwheels in the auxiliary drive which affect the timing are marked with punch marks.



12a. Oil the camshaft bearings. Fit the camshaft, the distance ring and the thrust washer. Check the axial clearance. This should be 0.04–0.12 mm (0.00157–0.00472 in).

Clean carefully each valve tappet and apply molybdenum disulphide on the surface against the camshaft. Oil the holes in the cylinder block. Fit the valve tappets and the inspection covers.



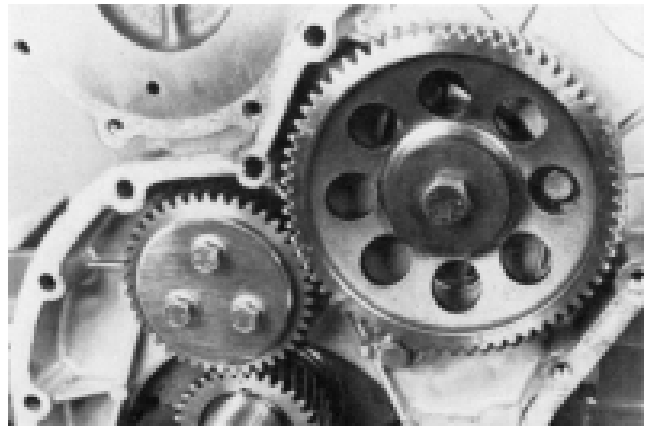
Earlier prod. R = 4.7 mm

Later prod. R = 6 mm

12b. NOTE! Later production of engines have altered valve tappets and push rods. These may not be mixed with earlier production.

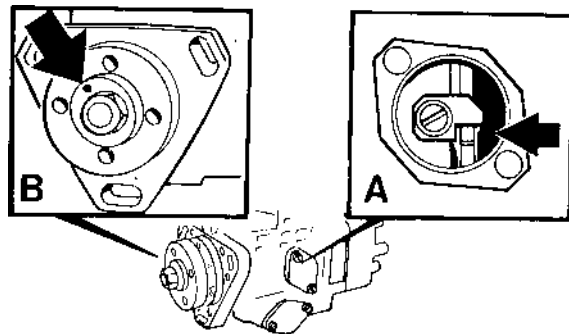


13. Check that the key is fitted in the crankshaft. Fit the crankshaft gear using tool 6404.
NOTE! Ensure that the gearwheel meshes with the oil pump gear.

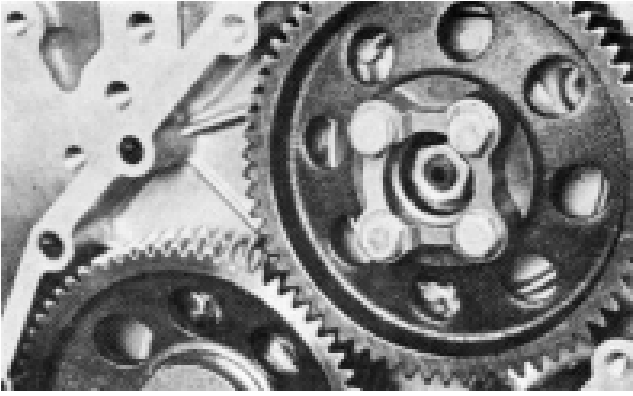


14. Fit the key into the camshaft. Heat the camshaft gear to about 100°C (212°F) and fit it on the shaft.

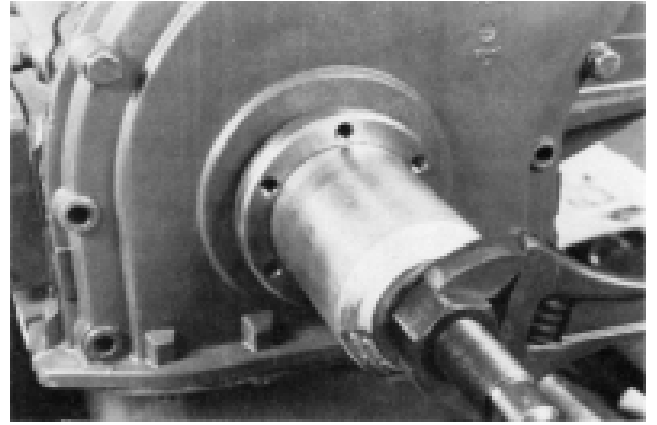
Fit the idler gear with its bearing journal so that the markings agree. The angular position of the bearing journal is immaterial. Tightening torque: Idler gear 23 Nm (2,3 kpm) (16.636 ft/lbs). Secure the bolts with the lock washer, (only early prod.). Tighten the camshaft drive gear. Tightening torque: 80 Nm (8 kpm) (5.8 ft/lbs).



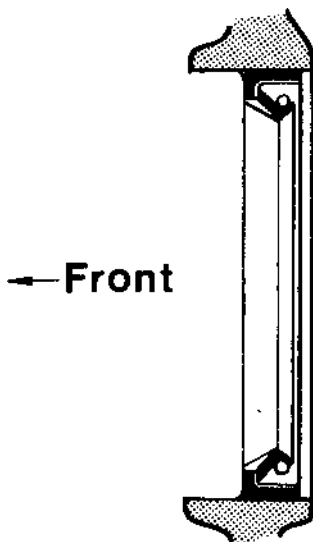
15. Remove the cover from the side of the injection pump. Turn the pump so that the line-up marking is visible (A). Later production of engines have a marking on the carrier (B). Position the carrier marking in a way that it points obliquely upwards to the left (the marking then points towards number 1 pressure line connection). Fit the pump on the engine, not forgetting the O-ring on the flange. Do not tighten the nuts.



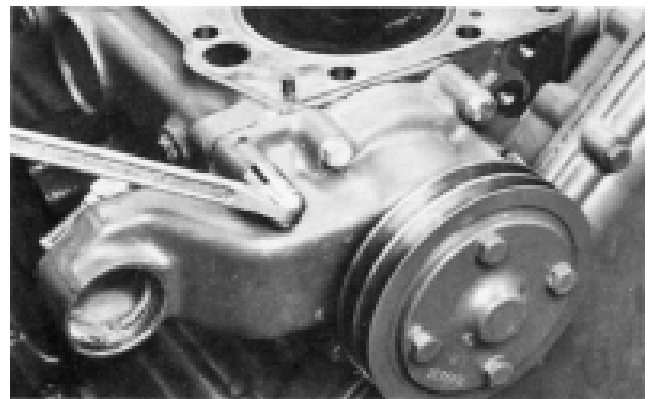
16. Fit the pump gear so that the markings agree.
NOTE! Later production of the pump gear wheel carries markings for the 6-cylinder engine as well as for the 4-cylinder one. Screw the pump gear tight together with the driver.
NOTE! The bolts are unevenly spaced so that the driver can only be fitted in one position. Tightening torque: 23 Nm (2.3 kpm) (16.636 ft/lbs). Fit the driver for the sea-water pump.



18. Apply molybdenum disulphide to the end of the crankshaft. Heat the polygon hub up to about 100°C (212°F) and fit it into the shaft. If necessary, the hub can be pressed on with tool 6404. Fit the washer and the centre bolt. Tightening torque: 180 Nm (18 kpm) (130.2 ft/lbs). Fit the belt pulley. Tightening torque: 25 Nm (2.5 kpm) (18.00 ft/lbs).

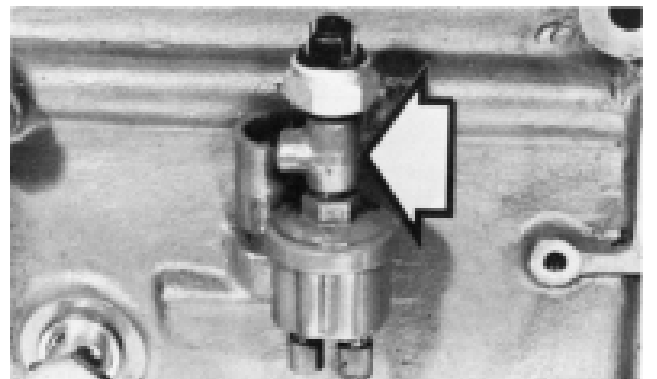


17. Fit a new sealing ring in the auxiliary drive gear casing cover. Saturate the sealing ring with oil and fit the cover together with a new gasket.

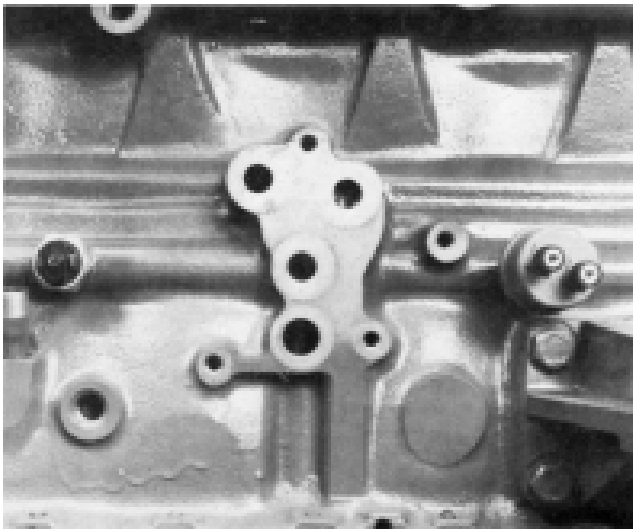


Circulation Pump

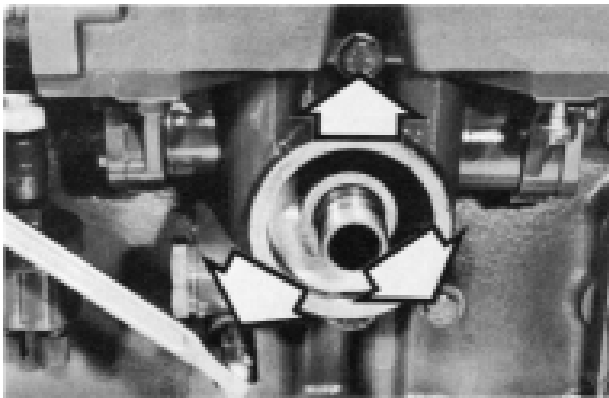
19. Fit the circulation pump and the front lifting eye.



- 20a. Early prod. Fit the T-tube which holds the oil pressure warner and sender.



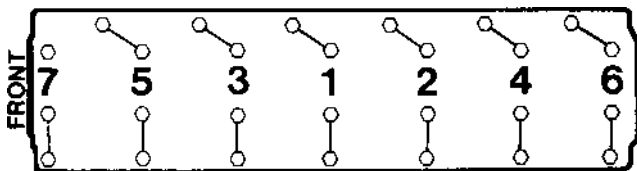
20b. Later prod. Install the oil pressure sensor and the oil pressure sender.



Oil Cooler

21. Fit the oil filter bracket and the oil cooler. Fit a new oil filter, see the instructions for the filter.

Cylinder Head

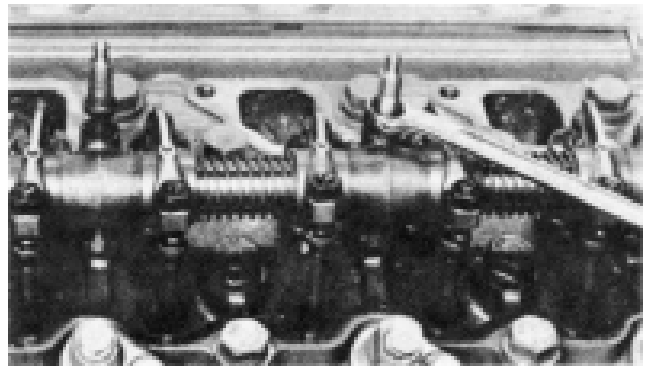


22. Place the cylinder head gasket and the cylinder head on the cylinder block. Moisten the cylinder head bolts with rust protecting medium. Item No. 282036 (or a mixture of 75% Tectyl 511 and 25% kerosene). The bolts should be free from drip when fitted.

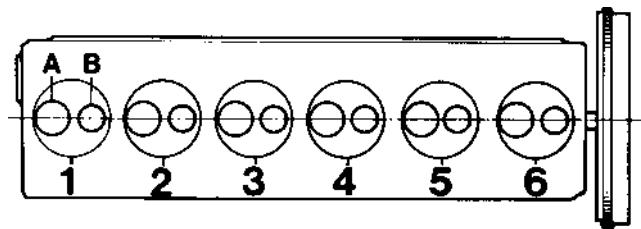
NOTE! The bolts are phosphated and must not be cleaned with a wire brush.

Tighten the cylinder head bolts in accordance with the tightening diagram in the following stages: 30, 90 and 130 Nm (3, 9, 13 kpm), (21.7, 65.1, 94.0 ft/lbs).

NOTE! The cylinder head bolts shall be tightened after the engine has been run for approx. 1 h. (warm or cold engine).



23. Fit the push rods and the rocker arm bearing bracket. Tightening torque: 23 Nm (2,3 kpm) (16.636 ft/lbs).



A = Inlet B = Outlet

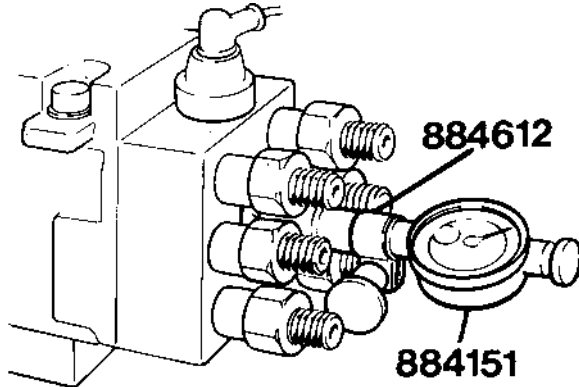
24. Valve Adjustment

- A. **NOTE!** The valve clearance must not be adjusted with the engine running. Valve clearance for all valves, engine hot or cold: 0.40 mm (0.01575 in). Adjust the valve clearance for Cylinder No. 1 with the piston in the firing position. The valves on Cylinder No. 6 will then "Rock".
- B. Turn the engine over one third of a revolution on its correct direction of rotation and adjust the clearance on No. 5 cylinder. (The valves in cylinder No. 2 will then "Rock"). Adjust the clearances for the other cylinders in the order of firing.

Order of Firing	1	5	3	6	2	4
Corresponding cylinder whose valves "Rock"	6	2	4	1	5	3

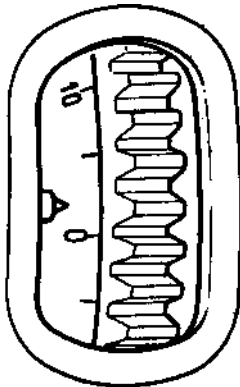
26. Adjustment of Injection Angle

(The rocker arm casing, pressure pipes and the cover of the flywheel casing should be removed).

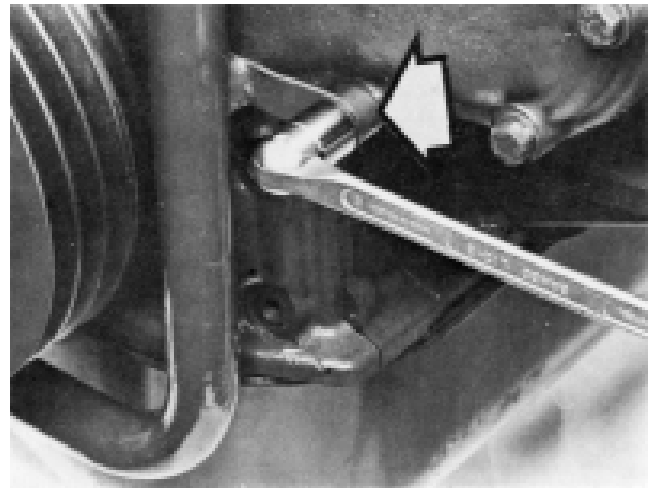


- A. Turn the engine in the correct direction of rotation until both the valves in cylinder No. 6 are "rocking". Rotate the engine backwards (against the direction of rotation) to 30° b.t.d.c.

Remove the center bolt on the rear end of the injection pump, and fit the tool 884612 and an indicator instrument 884151. Set the instrument to zero.



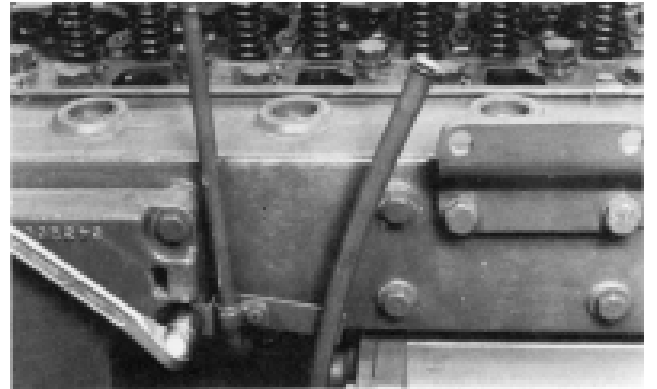
- B. Turn the engine in the direction of rotation until the reading of the indicators is 1 mm. Then the grading of the flywheel will show: MD40 0-1°, TMD40 2-3°, TAMD40 1-2° after TDC. If the injection angle requires altering: Rotate the engine back to 30° b.t.d.c. Unscrew the pump attachment nuts and rotate the pump clockwise (as seen from the front), if the injection is too retarded. If the injection is too advanced, rotate the pump anti-clockwise. Tighten the pump and repeat the measurement.



Exterior Details

26. Fit the pipe between the oil cooler and the sea-water filter. Note the spacer sleeve on the left hand fastening.

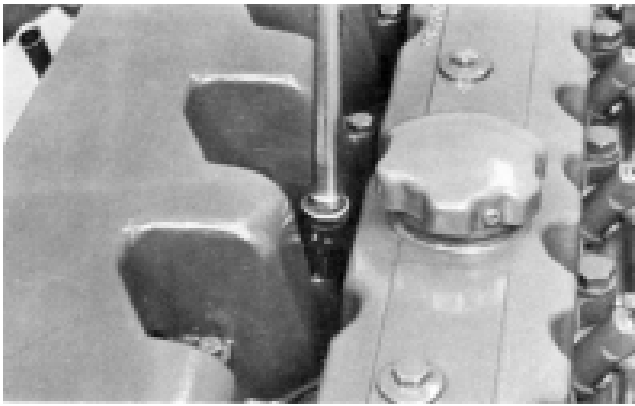
Later production of engines have a bracket with clamp to hold the pipe.



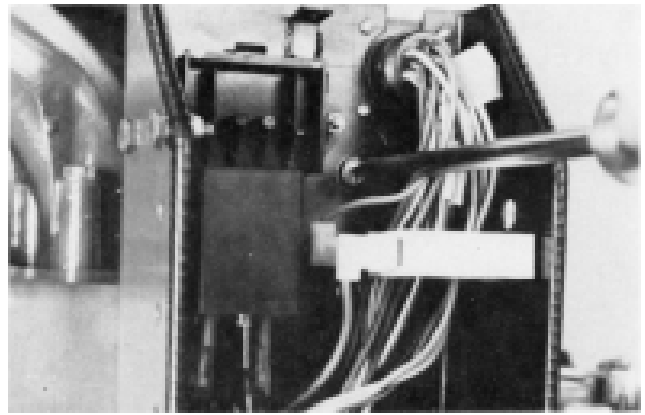
27. Fit the tube for the oil dipstick and the oil discharge pipe. Fit the exhaust manifold. Fit the turbo-compressor (Not MD40).



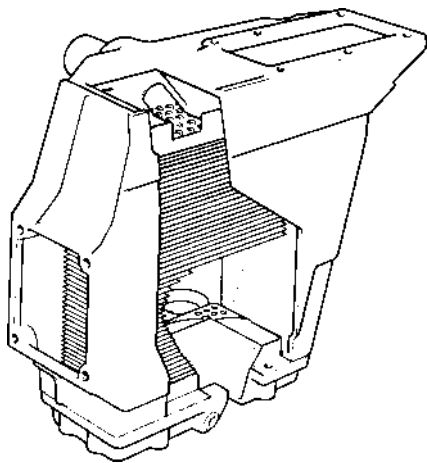
28. Fit the coolant pipe between the exhaust manifold and the cylinder block. Fit the oil pipe between the turbo-compressor and the cylinder block (Not MD40).



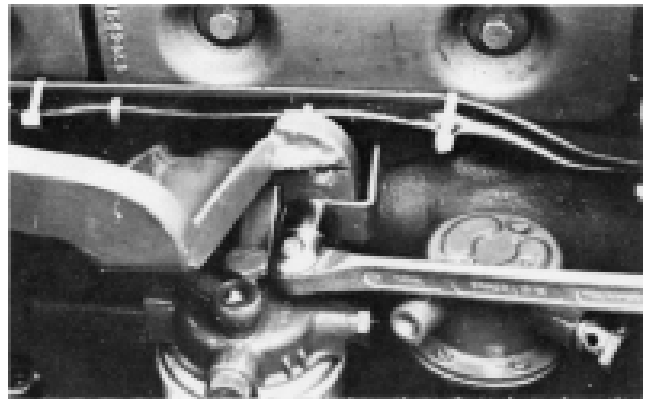
29. Fit the rocker arm cover, the inlet manifold, the generator and the starter motor.



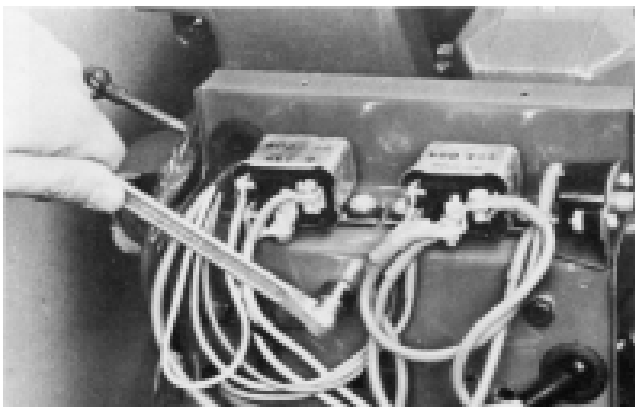
31b. Late prod. Install the coolant pipe between the cylinder head and the exhaust manifold (at the front end of the engine). Install the electrical distribution box and connect the cables.



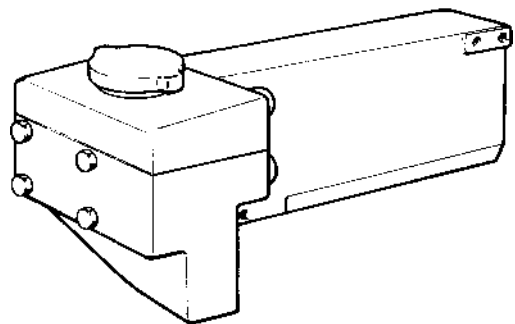
30. AQAD40, TAMD40: Fit the aftercooler and the pipe between the turbo and the aftercooler.



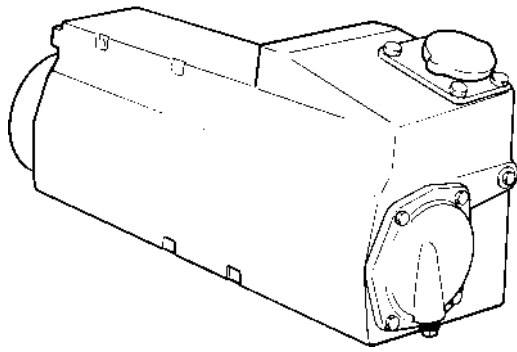
32. Fit the filter bracket together with a new fuel filter. Fit the feed pump and all fuel pipes. Tighten the injectors. Tightening torque: 23 Nm (2.3 kpm), (16.630 ft/lbs).



31a. Early prod. Fit the cooling water pipe between the cylinder head and the exhaust manifold (on the engine in the front.) Screw the pipe fast, also the plate which holds the relays. Fit the plastic casing. Screw the cable support fast and connect the cables.

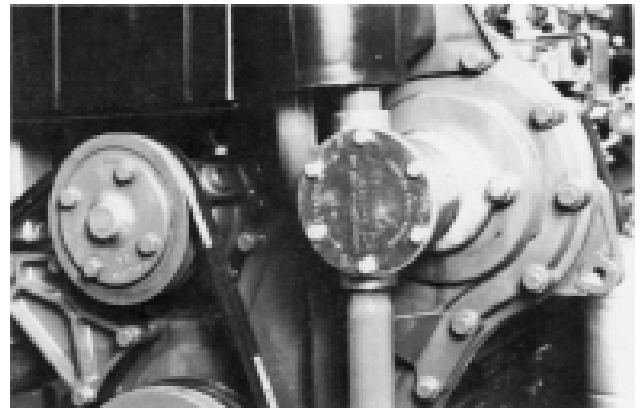


AQD40A, TMD40A, MD40A

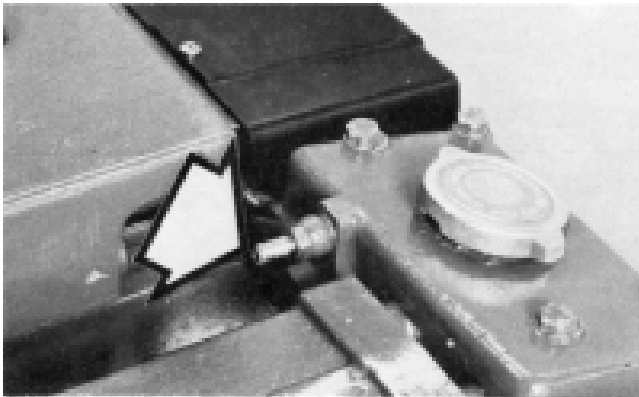


AQAD40, TAMD40A, AQD40B, TMD40B

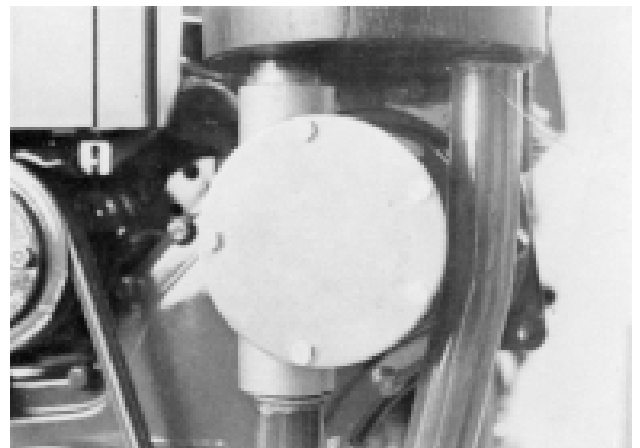
33. Fit the heat exchanger.



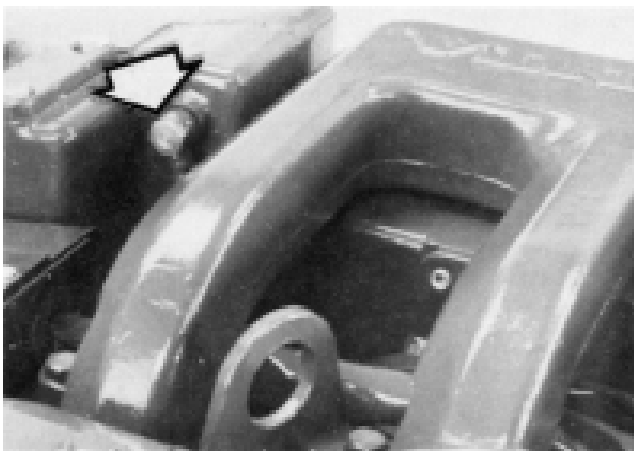
36. (AQD40, TMD40, MD40.) Fit the air cleaner, the sea-water pump and the sea-water filter.



34. (AQD40, TMD40, MD40.) Fit and tension the alternator driving belts. Fit the hose between the heat exchanger and the oil cooler. Screw the ventilation pipe fast into the thermostat housing cover. Fit the coolant hoses and the coolant pipes.



37. (AQAD40, TAMD40.) Fit the air cleaner, the sea-water pump and the sea-water filter.

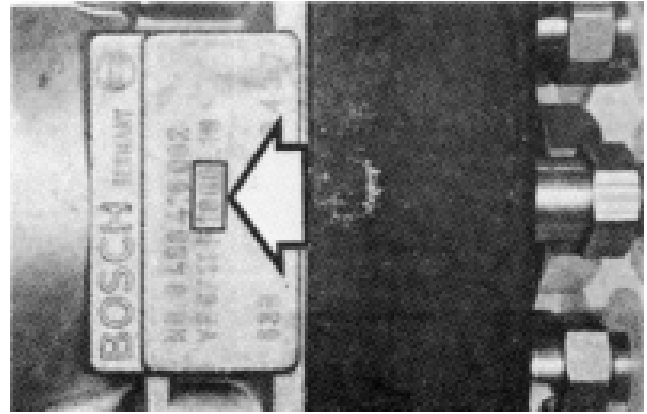
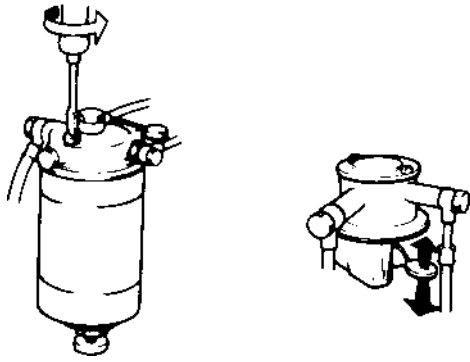


35. (AQAD40, TAMD40.) Fit and tension the alternator driving belts. Fit the hose between the aftercooler and the oil cooler. Screw the ventilation pipe fast into the thermostat housing. Fit the coolant hoses and the coolant pipes.

38. Close all draincocks. Refill with oil and water. See "Technical Data" for the grade and viscosity of the oil. Vent the fuel system, see point 39.

Make a trial run on the engine and check all the points specified under delivery Service on the Guarantee Certificate.

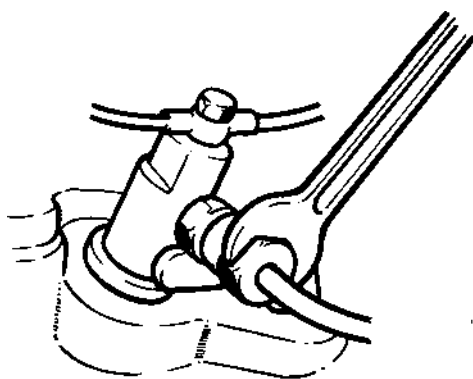
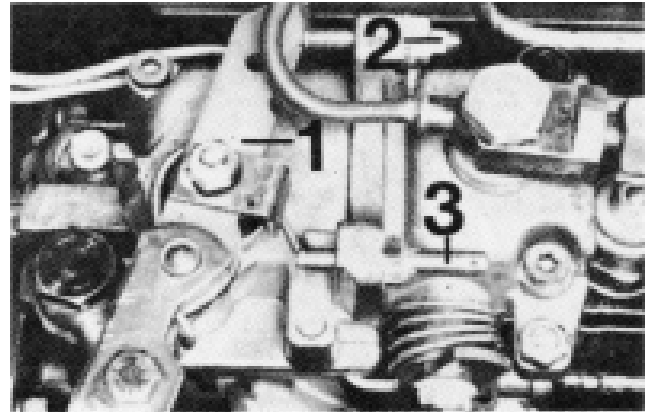
NOTE! The cylinder head bolts shall be tightened after the engine has been run for approx. 1 h. (warm or cold engine).



39. Venting the Fuel System

NOTE! Be on the lookout for fuel spillage. Exercise special care at the venting point.

- A. Open the vent screw on the fuel filter by about 4 turns. Pump fuel on with the aid of the hand pump until fuel comes out free from air bubbles. If the pump does not work properly, turn the engine over slightly so that the pump driving cam changes position. Close the vent screw.



- B. If the injection pump has been removed, this must also be vented. Pump with the hand pump for about half a minute; this automatically removes any air from the injection pump.

Loosen the delivery pipe nuts on the injectors. Set the governor to full revolutions and turn the engine over with the starter motor until fuel comes out of the delivery pipes. Tighten up the delivery pipe nuts.

40. Adjusting the speed

NOTE! The lead seals may only be broken by specially trained personnel.

Max unloaded speed

Warm the engine up. Then run the engine light at the maximum speed. Check that the throttle arm (1) pressed up against the adjusting screw (3). Check with the pump speed given in technical data.

Low Idle

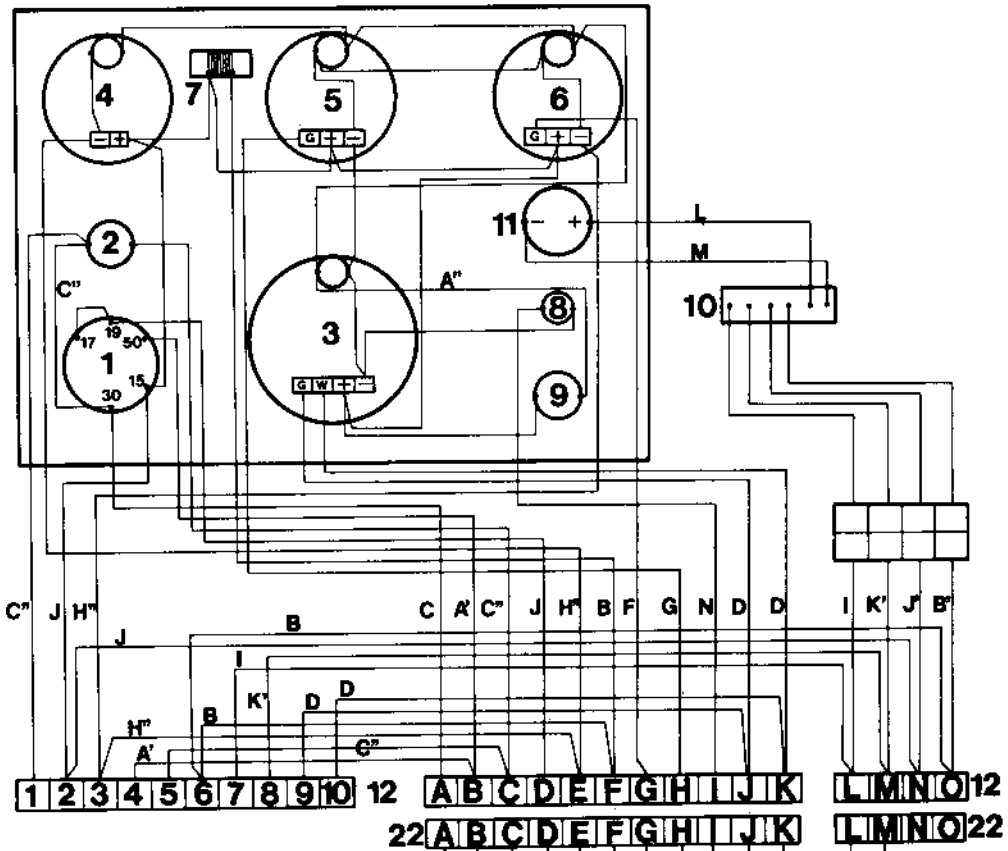
Warm the engine up. Check the speed when the engine is running light at the lowest speed. The speed should be 600–700 r/m. If necessary, adjust with adjusting screw (2).

In order to secure the attachment of the front engine supports to the engine block, we recommend that the four screws on each support are checked using a torque of 7.3 kpm (73 Nm) (54 ft. lb).

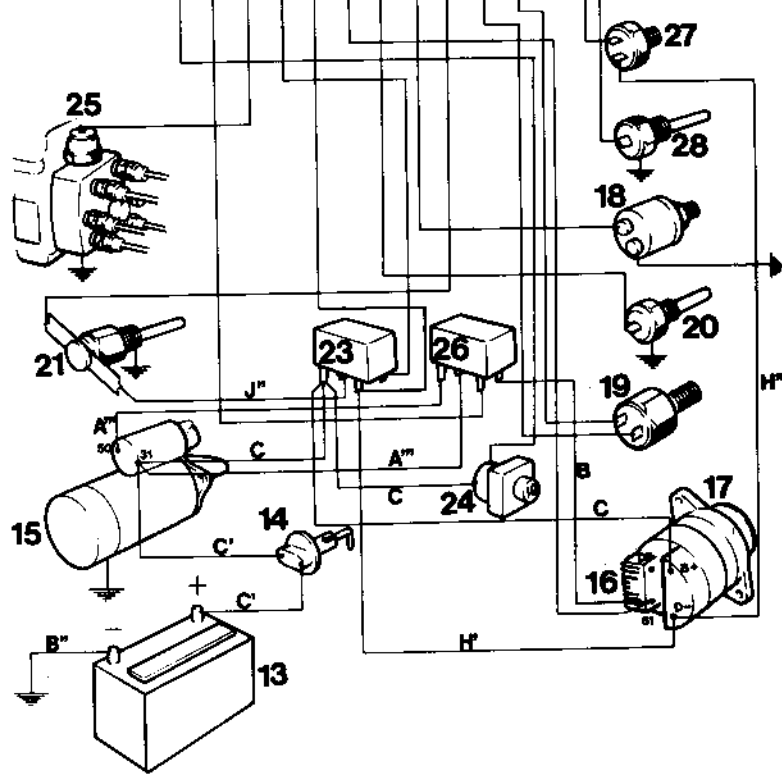
Wiring Diagram

(Early Prod.)

INSTRUMENTPANEL



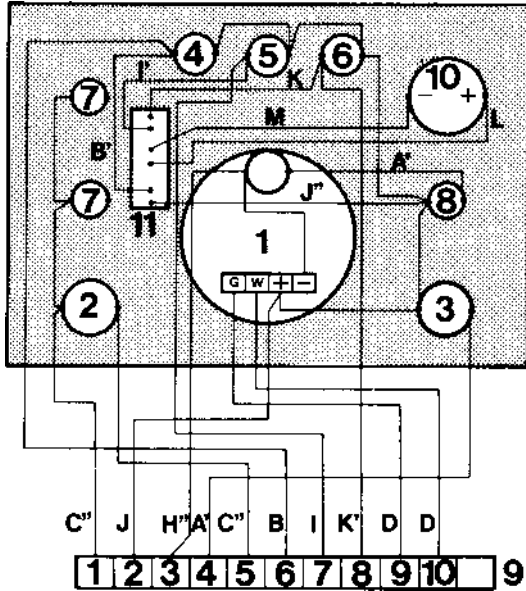
ENGINE



Wiring Diagram

(Early Prod.)

Flying bridge



Cable Marking

Designation	Colour	mm ²	AWG
A'	White	1.5	15
A''	Ivory	1.5	15
A'''	White	2.5	13
B	Black	1.5	15
B'	Black	0.75	18
B''	Black	70	00
C	Red	6	9
C'	Red	70	00
C**	Red	2.5	13
D	Grey	1.5	15
F	Yellow	1.5	15
G	Brown	1.5	15
H'	Blue	2.5	13
H''	Blue	1.5	15
H'''	Blue	4	11
I	Green/Red	1.5	15
I'	Green/Red	0.75	18
J	Green	1.5	15
J'	Green	0.75	18
J''	Green	0.75	18
J'''	Green	6	9
K	Yellow/Blue	0.75	18
K'	Yellow/Blue	1.5	15
L	Red/White	0.75	18
M	Blue/Red	0.75	18
N	White/Red	1.5	15

Instrument Panel

1. Key switch
2. Stop button
3. Rev. counter
4. Voltmeter
5. Oil pressure gauge
6. Temperature gauge
7. Protective resistor
8. Warning lamp, (glow plugs)
9. Instrument lighting
10. Alarm analyser
11. Alarm
12. Connector

Engine

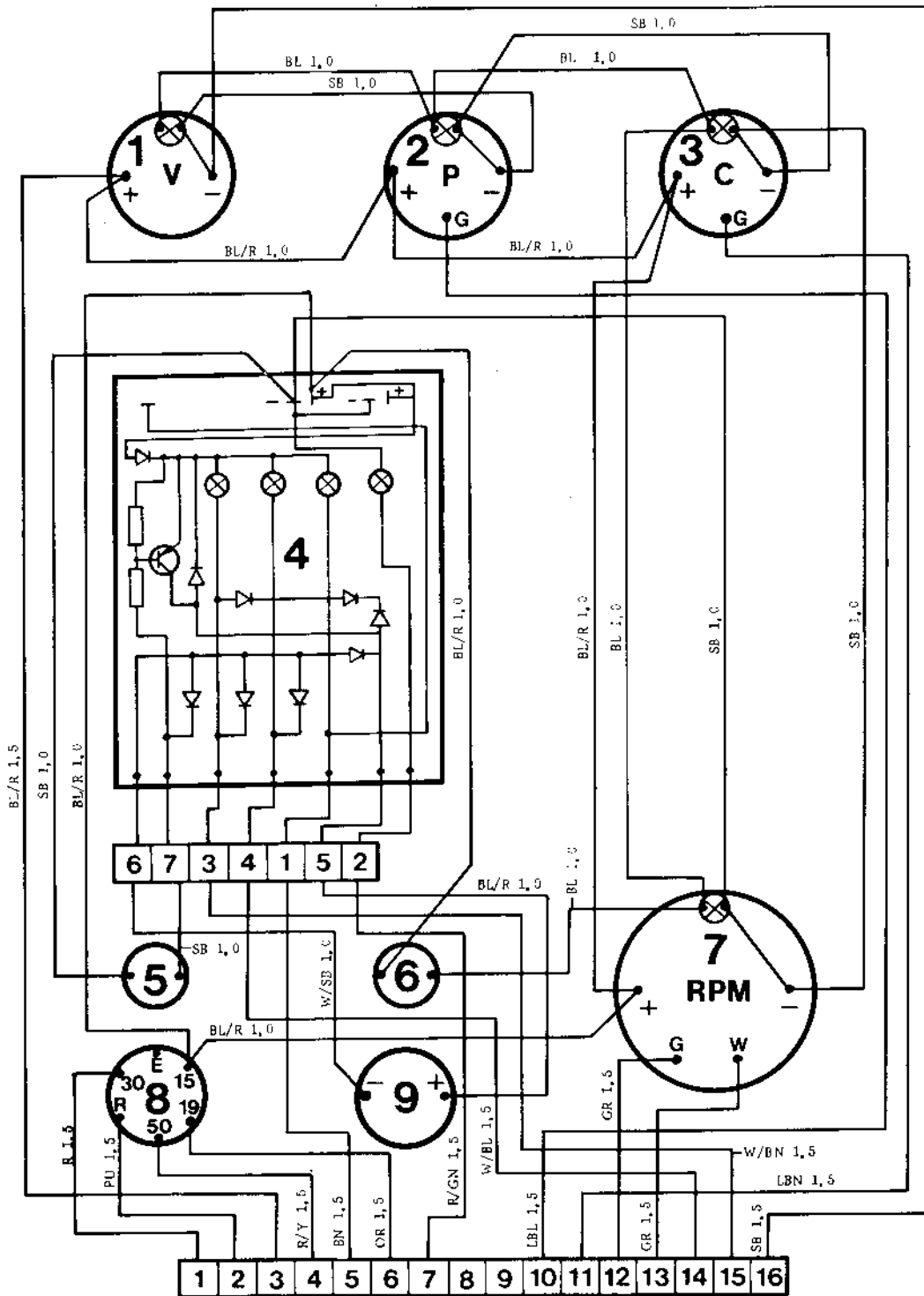
13. Battery
14. Main switch
15. Starter motor
16. Charging regulator
17. Alternator
18. Oil pressure sender
19. Rev. sender
20. Temperature sender
21. Glow plug
22. Connector
23. Glow current relay
24. Fuse
25. Stop solenoid
26. Start relay
27. Temperature warner (for alarm)
28. Oil pressure warner (for alarm)

Flying bridge

1. Rev. counter
2. Stop button
3. Start button
4. Warning lamp, charging
5. Warning lamp, oil pressure
6. Warning lamp, temperature
7. Pull switch (spare)
8. Instrument lighting
9. Connector
10. Electronic signal equipment
11. Alarm analyser

Electrical Wiring Diagram

(Late Prod.)

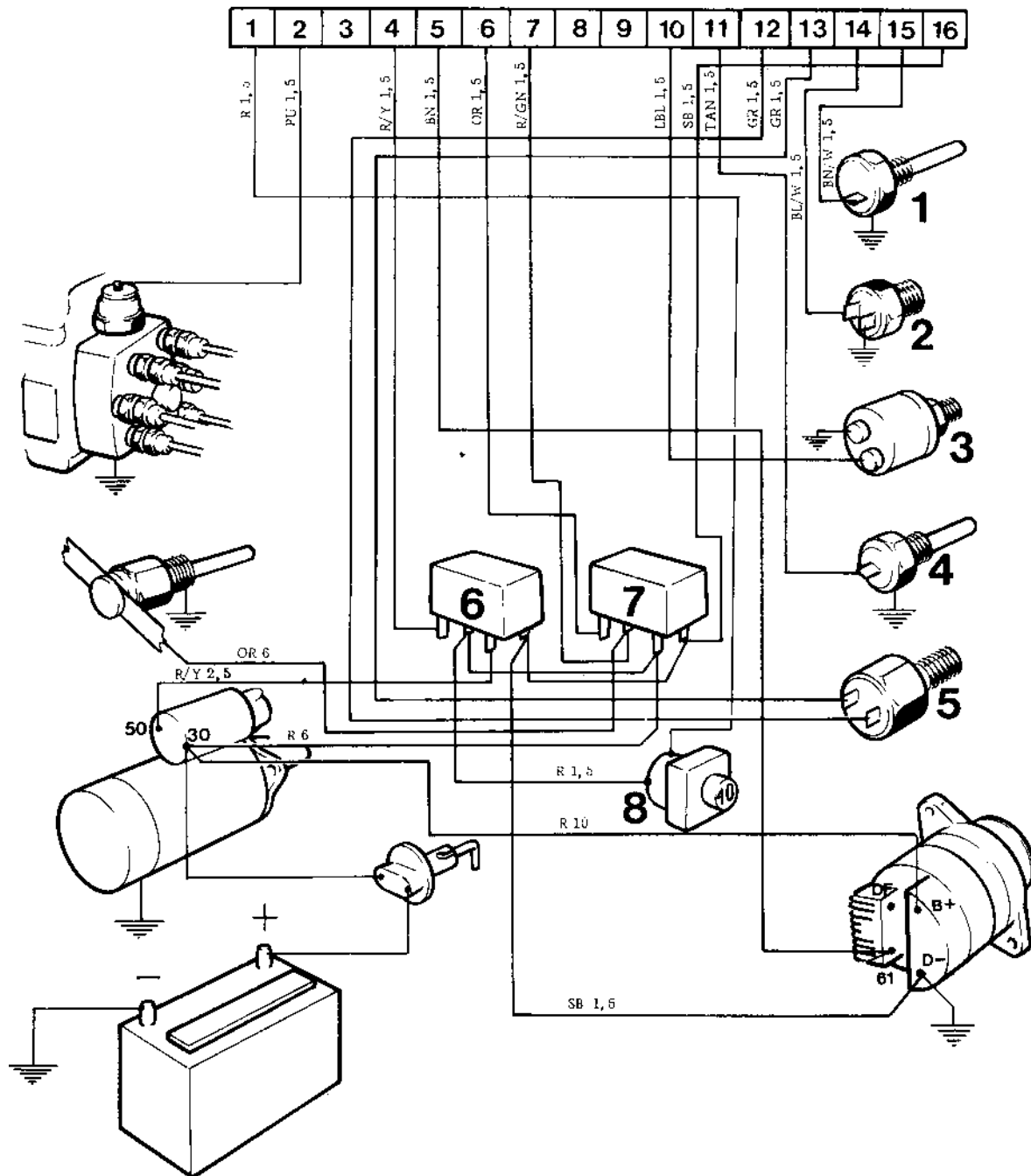


Instrument Panel

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

Electrical Wiring Diagram

(Late Prod.)



Engine

1. Temp.
2. Oil pressure-guard
3. Oil pressure sender
4. Temp. sender
5. Sender rev. counter
6. Start-relay
7. Relay, glow-current
8. Fuse

Cable colour

GR = Grey
 SB = Black
 BN = Brown
 LBN = Light brown
 R = Red
 PU = Purple

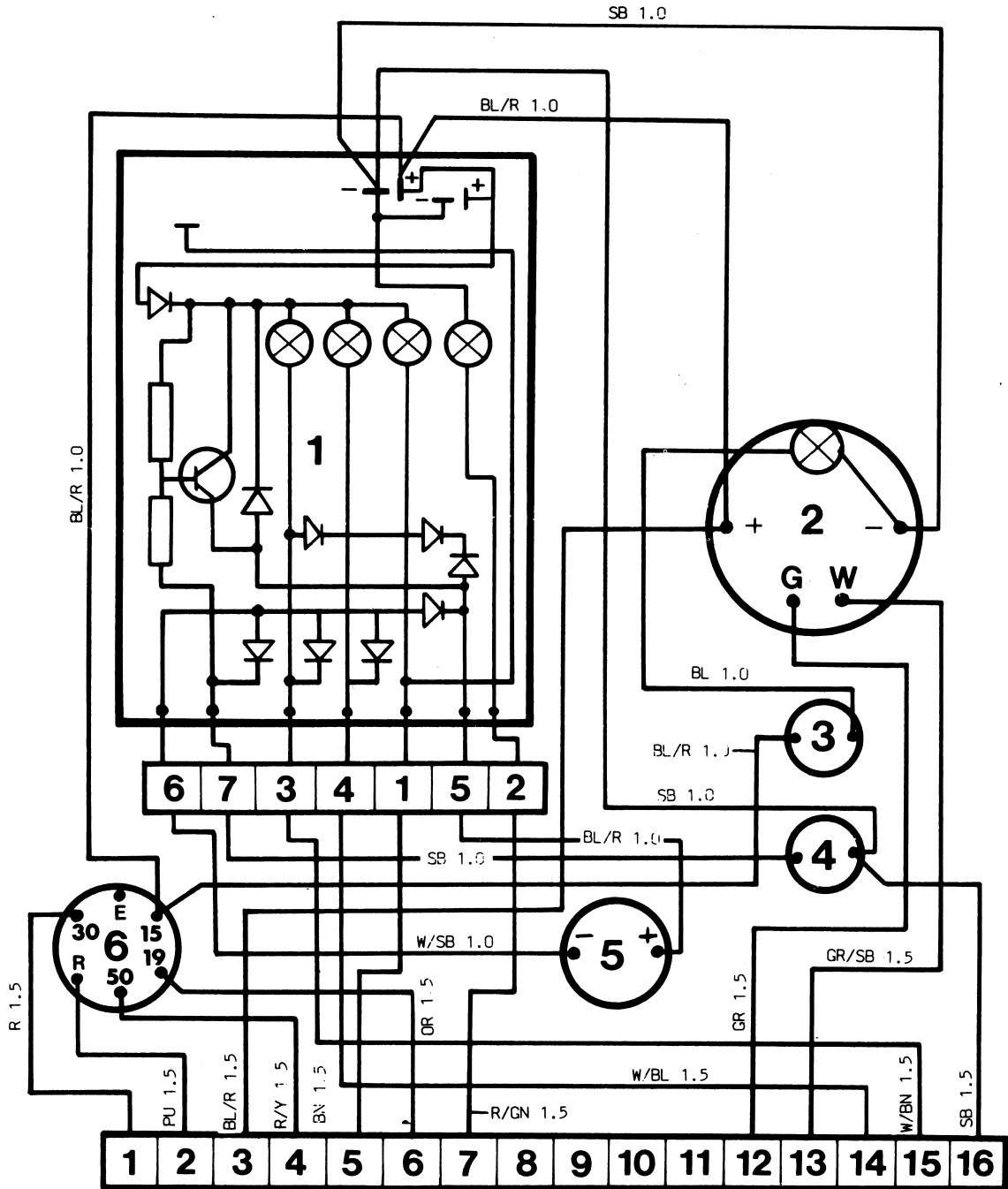
GN = Green
 Y = Yellow
 W = White
 BL = Blue
 LBL = Light blue

Wire areas in mm²

Electrical wiring diagram

(Late. Prod)

Flying bridge


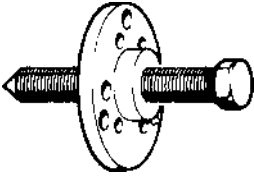
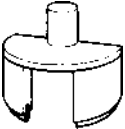


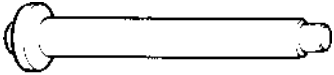
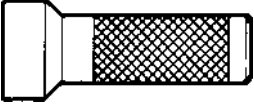
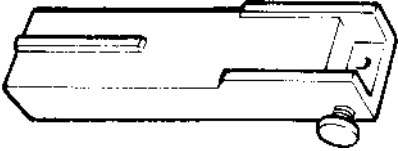
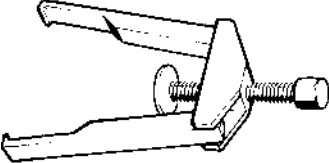

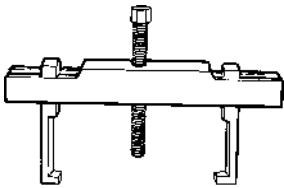



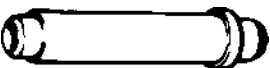
1. Printed circuit card
2. Rev. counter
3. Switch for instrument lighting
4. Push button
5. Alarm
6. Key switch

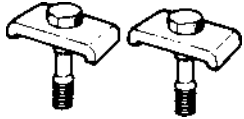
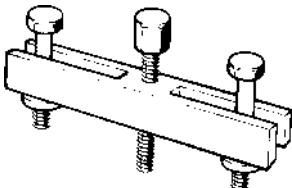

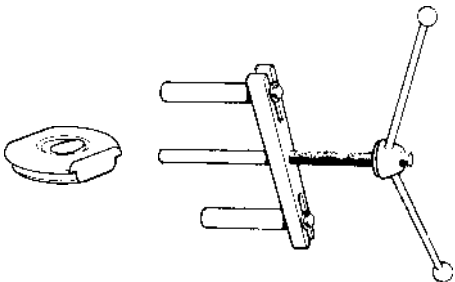
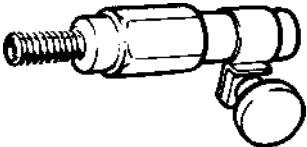
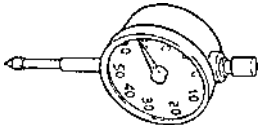
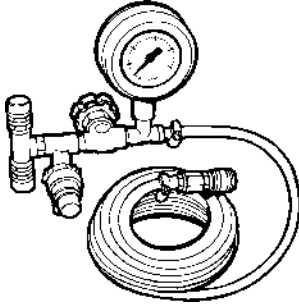
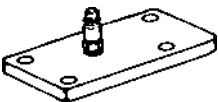

Fault Finding Table

Engine does not start	Engine stops	Engine does not reach correct working speed on full throttle	Engine runs irregularly or vibrates abnormally	Engine becomes abnormally hot	CAUSE OF TROUBLE
X					Main switch not closed. Battery discharged. Break in cable or main fuse block. Faulty glow plugs.
X	X				Fuel tank empty. Fuel cock closed. Fuel filter blocked.
X	X		X		Water or impurities in fuel. Faulty injectors. Air in fuel system.
		X			Faulty rev. counter. Boat loaded abnormally. Air cleaner blocked. Fouling on boat bottom or outboard mechanism.
		X	X		Propeller damaged.
				X	Coolant level too low, V-belts broken or slipping. Obstruction in sea-water filter, cooling water intake, oil cooler, cooling jackets or heat exchanger. Sea-water pump impeller fault. Thermostats faulty.

Special Tools

9991867		Drift for removing and fitting bushing in rocker lever
884533		Puller for polygon hub on crankshaft
884635		Tool for removing oil cooler insert (from and including engine no 1070)

9992268		Drift for fitting bearing in circulation pump
9992270		Drift for fitting seal in circulation pump
9992479		Retainer for dial indicator when checking height of liner flanges above cylinder block face
9992658		Puller for crankshaft gear
9996404		Press tool for fitting crankshaft gear and polygon
9992679		Puller for camshaft gear
9992818		Drift for removing valve guides
9995028		Drift for fitting valve guides
9995031		Installing ring for piston
9996271		Drift for removing and fitting gudgeon pin bushings

9996272		Press tools (two) for cylinder liners when measuring height of cylinder liners
9996273		Puller for oil pump drive gear
884347		Drift for fitting bearings and seal rings in seawater pump
884602+ 884551+ 884231		Plate for cylinder liner puller. Should be supplemented with yoke from 884551 (MD5) and screw and nut from 884231 (MD21 -32)
884612		Holder for indicator instrument for injection angle measurement
884151		Indicator gauge
9996662		Test pressure device for cylinder head
9996532		Connection washer for test pressure cylinder head
9996531		Sealing washers for test pressure cylinder head (19 pcs)

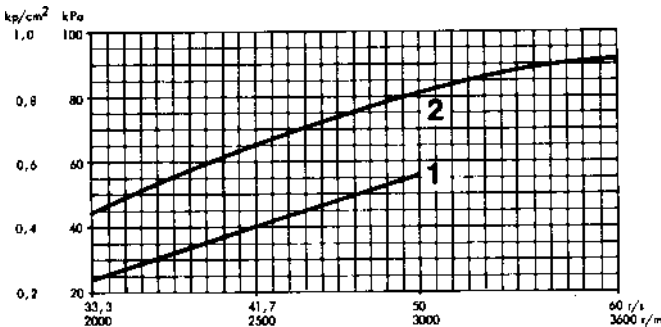
Technical Data

General

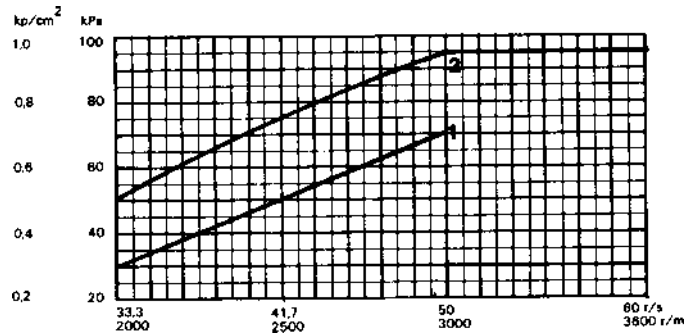
Type designation	AQD40, AQAD40, TAMD40 TMD40, MD40,
Number of cylinders	6
Cylinder diameter	92.015 mm, 3.62264 in
Stroke	90 mm, 3.54331 in
Displacement, total	3.59 dm ³ , 220 in ³
Compression ratio	21:1
Compression pressure at starter motor speed, 4 r/s (240 r/min)	2.5 MPa (25 kp/cm ²) 355 lbs/in ²
Order of firing (No. 6 cylinder nearest flywheel)	1-5-3-6-2-4
Direction of rotation (viewed from front)	Clockwise
Output	See applicable engine diagram
Torque	See applicable engine diagram

	Engine	Power lever	Governor overrun speed r/m	Max unloaded speed r/m
Pump settings	MD40A	C-output	3000	3190-3290
	MD40A	B-output	3600	3980-4080
	MD40A	C-output	3000	3190-3290
	MD40A	B-output	3600	3980-4080
	TMD40A	B-output	3600	4000-4050
	TMD40A	B-output	3600	3980-4080
	TMD40A	B-output	3600	3900-4080
	TMD40A	C-output	3000	3190-3290
	TMD40B	B-output	3600	3980-4080
	TAMD40A	B-output	3600	3980-4080
	TAMD40A	C-output	3000	3190-3290
	TAMD40B	B-output	3600	3980-4080
TAMD40B	C-output	3250	3730-3830	

Low idling 10-11.6 r/s (600-700 r/m)
 Weight, engine without outboard drive or reversing gear about 400 kg 881.6 lbs (TAMD40, 440 kg, 968 lbs).



AQD40, TMD40



AQAD40, TAMD40

Supercharger Pressure

Supercharging pressure (measured in the inlet manifold) at 100 % load and full throttle and with an air temperature of plus 20°C. If the measurement is made at some other temperature, the measured pressure must be corrected in accordance with the diagram on page 23.

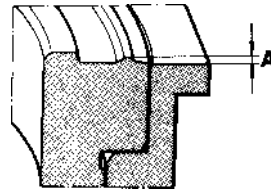
Curve 1 = Lowest supercharging pressure at an output in accordance with Curve C of the engine diagram.

Curve 2 = Lowest supercharging pressure at an output in accordance with Curve B of the engine diagram.

A considerably lower pressure is obtained at less than full output.

Turbo-Compressor

Make and type (AQD40, TMD40)	KKK K26-2470/10.7
Make and type (AQAD40, TAMD40)	KKK K26-2664 GA 12.71
Lubrication system	Pressure lubrication
Cooling system	Fresh-water cooling
Axial clearance, max	0.16 mm (0.00630 in)
Radial clearance, max. (compressor side)	0.42 mm (0.01654 in)

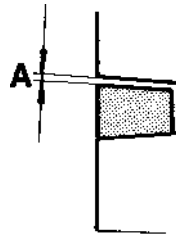


Cylinder Liners

Type	Wet, replaceable
Cylinder diameter (no oversizes available)	92.015 mm, 3.54390 in
Collar thickness	9.20–9.23 mm, 0.36622–0.36740 in
Depth of liner recess from cylinder block face	8.920–8.940 mm, 0.35118–0.35197 in
Height of liner above cylinder block face, see illustration	0.26–0.31 mm, 0.01024–0.01220 in
Max. difference in height between adjacent liners	0.02 mm, 0.00079 in

Pistons

Material	Light alloy with cast iron ring carriers
Overall height	101.375–101.825 mm, 3.99114–4.00885 in
Height from gudgeon pin centre to top of piston	66.575–66.625 mm, 2.62106–2.62303 in
Piston clearance	0.08–0.12 mm, 0.00315–0.00472 in
Piston fitted in engine, height above cylinder block surface	0.035–0.650 mm, 0.00137–0.02559 in
Front marking	Arrow pointing towards front end



Piston Rings

Compression rings, number	2
Upper compression ring, height	2,5 mm, 0.09843 in
Lower compression ring, height	2.478–2.490 mm, 0.94794–0.94844 in
Oil scraper ring, number	1
Height	3.978–3.990 mm, 0.15661–0.15708 in
Piston ring clearance in groove, axial:	
Upper compression ring, see diagram	0.08–0.13 mm, 0.00315–0.00512 in
Lower pressure ring	0.07–0.10 mm, 0.00276–0.00394 in
Oil scraper ring	0.04–0.07 mm, 0.00157–0.00276 in
Piston ring gap measured in cylinder liner:	
Compression rings	0.40–0.65 mm, 0.0157–0.0256 in
Oil ring	0.25–0.40 mm, 0.0098–0.0157 in

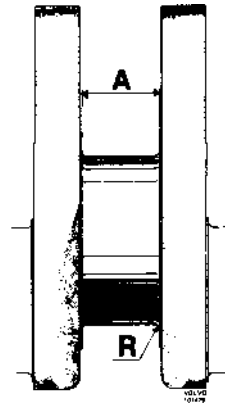
Gudgeon Pins

Clearance, gudgeon pin-connecting rod bushing	0.014–0.022 mm, 0.00055–0.00087 in
Clearance, gudgeon pin-gudgeon pin hole	max. 0.008 mm, 0.00035 in
Grip fit, gudgeon pin-gudgeon pin hole	max. 0.002 mm, 0.00008 in
Gudgeon pin diameter	35.000–35.004 mm, 1.37795–1.37811 in
Connecting rod bushing, internal dia	35.018–35.022 mm, 1.37866–1.37882 in
Gudgeon pin hole dia. in piston	35.002–35.008 mm, 1.37803–1.37826 in

Cylinder Head

Height	86.9–87.1 mm, 3.42136–3.42914 in
--------------	----------------------------------

R = 3.9 mm



Crankshaft with Bearings

Crankshaft end float	0.10–0.31 mm, 0.00394–0.01220 in
Main bearings, radial clearance	0.04–0.09 mm, 0.00157–0.00354 in

Main Bearing Journals

Diameter, standard	69.987–70.000 mm, 2.74788–1.75591 in
Undersize 0.25 mm, 0.01 in	69.737–69.750 mm, 2.74204–2.74607 in
0.50 mm, 0.02 in	69.487–69.500 mm, 2.73220–2.73623 in
0.75 mm, 0.03 in	69.237–69.250 mm, 2.72586–2.72639 in
With (A in figure) on crankshaft for pilot bearing with separate thrust washers:	
Standard	35.975–36.025 mm, 1.41634–1.418230 in
Oversize 0.2 mm 0.00787 in (thrust washers 0.1 mm 0.00394 in oversize)	36.175–36.225 mm, 1.42421–1.42617 in
Oversize 0.4 mm, 0.01575 in (thrust washers 0.2 mm 0.00787 in oversize)	36.375–36.425 mm, 1.43208–1.43403 in

Big-End Journals

Big-end bearings, radial clearance	0.034–0.078 mm, 0.00134–0.00307 in
Length of bearing journals	38.95–39.05 mm, 1.53346–1.53740 in
Diameter, standard	56.487–56.500 mm, 2.22390–2.22441 in
Undersize, 0.25 mm 0,01 in	56.237–56.250 mm, 2.21012–2.21063 in
0.50 mm, 0.02 in	55.987–56.000 mm, 2.19685–2.20472 in
0.75 mm, 0.03 in	55.737–55.750 mm, 2.18307–2.19094 in

Main and Big-End Bearing Shells

	Main bearing shells	Big-End bearing shells
Thickness, standard	2.970–2.979 mm, 0.11683–0.11728 in	1.724–1.733 mm, 0.06787–0.06819 in
Undersize, 0.25 mm, 0.01 in	3.095–3.104 mm, 0.12185–0.12221 in	1.849–1.858 mm, 0.07280–0.07315 in
0.50 mm, 0.02 in	3.220–3.229 mm, 0.12677–0.12712 in	1.974–1.983 mm, 0.07771–0.07797 in
0.75 mm, 0.03 in	3.345–3.354 mm, 0.13169–0.13205 in	2.099–2.108 mm, 0.08264–0.08299 in

Connecting Rods

Marked 1 to 6.

End float, connecting rod – crankshaft	0.15–0.30 mm, 0.00591–0.01181 in
Dia. Big-end bearing shell recess	60.00–60.013 mm, 2.36220–2.36271 in
Dia. Connecting rod bearing bushing recess	39.000–39.039 mm, 1.53543–1.53697 in
Dia. Gudgeon pin bushing	See "Gudgeon Pins"

Flywheel

Flywheel ring gear 115 teeth

Camshaft

Drive Gear
 Number of bearings 7
 Dia. of bearing journals 52.981–53.000 mm, 2.08586–2.08661 in
 End float 0.04–0.12 mm, 0.00157–0.00433 in
 Radial clearance 0.025–0.063 mm, 0.00098–0.00248 in

Checking camshaft setting (cold engine and valve clearance = 0)

With flywheel at 10° after TDC, the inlet valve for

No. 1 cylinder should have opened 2.1 mm, 0.08267 in
 Lift, inlet 7.26 mm, 0.28583 in
 exhaust 7.54 mm, 0.29685 in

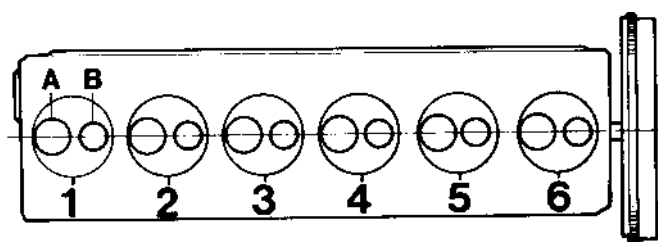
Camshaft Bearings

Bearing diameter 53.025–53.044 mm, 2.08759–2.08834 in

Auxiliary Drive Gears

Backlash 0.03–0.17 mm, 0.00118–0.00669 in
 Radial clearance of idler gear 0.03–0.09 mm, 0.00118–0.00354 in
 End float for idler gear 0.03–0.15 mm, 0.00118–0.00591 in
 Shaft for idler gear, dia. 54.940–54.970 mm, 2.16299–2.16417 in
 Bushing for idler gear, dia 55.000–55.030 mm, 2.16535–2.16653 in
 Number of Teeth: Crankshaft Gear 33
 Idler Gear 41
 Camshaft Gear 66
 Drive gear for injection/sea-water pump 66

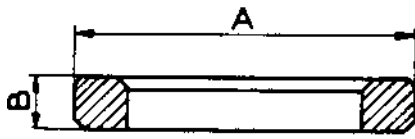
Valve Lay-Out and Cylinder Numbering
 Valves, A = INLET, B = EXHAUST



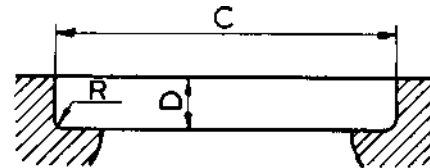
Valve System

Valves	Inlet	Exhaust
Disc diameter	41.8 mm, 1.64567 in	35.7 mm, 1.40551 in
Stem diameter	7.955–7.970 mm, 0.31319–0.31378 in	7.925–7.940 mm, 0.31200–0.31259 in
Valve seat angle	29.5°	44 5°
Seat angle in cylinder head	30°	45°
Clearance, (cold engine or at working temperature)	0.40 mm, 0.01575 in	0.40 mm, 0.01575 in

Valve seats



Valve seat



Valve seat Recess

	Inlet	Exhaust
Diameter, standard (measurement A)	43.064–43.080 mm 1.69543–1.69606 in	37.064–37.080 mm 1.45921–1.45984 in
Oversize	43.264–43.280 mm 1.70370–1.70393 in	37.264–37.280 mm 1.46709–1.46771 in
Height (measurement B)	7.3–7.35 mm 0.28740–0.28937 in	7.5–7.55 mm 0.29528–0.29725 in

Valve Seat Recess:

Dia. standard (measurement C)	43.000–43.025 mm 1.69291–1.69350 in	37.000–37.025 mm 1.45669–1.45767 in
Oversize	43.200–43.225 mm 1.70078–1.70137 in	37.200–37.225 mm 1.46456–1.46554 in
Depth (measurement D)	10.5–10.8 mm 0.4134–0.4254 in	10.25–10.5 mm 0.40354–0.4134 in
Bottom radius of recess (measurement R)	0.4–0.5 mm 0.01575–0.01969 in	0.4–0.5 mm 0.01575–0.01969 in
The distance between the valve disc and the cylinder head face should be	1.1–1.6 mm 0.04331–0.06299 in	0.85–1.35 mm 0.03346–0.04348 in

Valve Guides

Length	59 mm 2.32283 in
Internal dia. (fitted)	8.000–8.015 mm, 0.31496–0.31555 in
Replacement type	8.000–8.022 mm, 0.31496–0.32362 in
Height above cyl. head spring plane	18 mm, 0.70866 in
Clearance, valve stem - valve guide:	
Inlet valves	0.030–0.060 mm, 0.00012–0.00024 in
Exhaust valves	0.060–0.090 mm, 0.00024–0.00035 in

Valve Springs

Length unloaded	46 mm, 1.81102 in
Length with loading of: 267–312 N (27.2–31.8 kp) 60–70 lbs	40 mm, 1.57480 in
Length with loading of: 767–852 N (78.2–86.2 kp) 170–190 lbs	30 mm, 1.18110 in
Length fully compressed, max	28.8 mm, 1.13386 in

Rocker Arm Mechanism

Rocker arm bushing, dia. after pressing in and machining	22.020–22.041 mm, 0.86732–0.86775 in
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Lubricating System

Oil pressure, hot engine, operating speed, lubricating oil	0.42–0.5 MPa (4.2–5 kp/cm ²) 59.7–71.1 lbf/in
Oil pressure, hot engine, operating speed, piston; cooling oil	0.22–0.3 MPa (2.2–3 kp/cm ²) 31.3–42.6 lbf/in ²
Oil quality in accordance with API-system	CD (For Service DS)
Oil viscosity, above +10°C 50°F	SAE 20W/30 ¹⁾
under +10°C 50°F	SAE 10W ²⁾

¹⁾ Volvo Penta CD Oil, Double Grade.

²⁾ Volvo Penta CD Oil, Single Grade

Oil capacity, including oil cleaner:

No engine inclination	11 dm ³ (litre) 2.42 imp.gal, 2.9 US gal
15° engine inclination	10.5 dm ³ (litre) 2.3 imp.gal. 2.77 US gal
Lubricating oil pump, type	Gear
End float, pump gear	0.07–0.15 mm 0.00276–0.00591 in
Backlash, pump gear	0.15–0.35 mm 0.00591–0.01378 in
Dia., idler gear bearing sleeve	55.03–55.06 mm, 2.1665–2.1677 in
Bushing for idler gear	54.07–55.00 mm, 2.12874–2.16535 in
Radial clearance for idler gear	0.03–0.09 mm, 0.00118–0.00354 in
Dia., oil pump bushings	16.016–16.034 mm, 0.63055–0.63126 in
Clearance, thrust washer – oil pump drive gear	0.02–0.08 mm, 0.00079–0.00315 in
Number of teeth on oil pump drive gear	39
Oil pump idler	36
Crankcase ventilation	
Valve opens at	0,8 kPa (0.008 kp/cm ²), 0.114 lbf/in ²

Fuel System

Direction of rotation of injection pump, seen from the front	Anti-clockwise
Order of injection	1-5-3-6-2-4
Low idling	10–11.6 r/s (600–700 r/m)
High idling B-output	66.6–67.5 r/s (4000–4050 r/m)
C-output	53.2–54.8 r/s (3200–3300 r/m)
Feed Pressure	14.7–27.5 kPa (0.15–0.28 kp/cm ²) 2.13-4.98 lbf/in ²

Injection Pump

Make, type	Bosch EP/VE 6/11 F
Setting	MD40 0-1°, TMD40 2-3°, TAMD40 1-2° after TDC with 1 mm plunger lift
Feed Pump	S.E.V. 70 VE

Fuel Filter

Type designation	FJ/DBR 1 W6/225
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Injectors

Nozzle Holders, make and type	KBE 36 S 2/13
Nozzles	DN 0 SD 193
Type of Nozzle	Pintle Nozzle
Injector compl. number marking	0 432 297 032
Opening pressure	17.7 MPa (175 kp/cm ² , 2489 lbf/in ²)
Adjusting pressure (new spring)	18.0–18.8 MPa (183–192 kp/cm ²) 2602.8-2730.8 lbf/in ²

Cooling system

Type	Overpressure
Capacity, including heat exchanger and separate expansion tank, about (AQ40, TMD40, MD40)	21 dm ³ 4.6 imp.gal. 5.5 US gal.
Capacity, including heat exchanger and separate expansion tank, about (AQAD40, TAMD40)	23 dm ³ 5.0 imp.gal. 6.6 US gal.

Thermostats

Type	Wax
Number	2
The thermostat with an air valve should open at	68–72°C, 154.4–161.6°F
Fully open at	78–82°C, 172.4–179.6°F
The thermostat without an air valve should open at	74–78°C, 165.2–172.4°F
Fully open at	84–88°C, 183.2–190.4°F

Electrical System

System voltage	12 V
Battery capacity	114 Ah
Density of battery electrolyte:	
Fully charged battery	1.275–1.285
Battery to be recharged at	1.230
Alternator	
Voltage/max. current	14 V/50 A
Output	700 W
Starter Motor	
Output	2.5 kW (3.4 hp)
Brush length	min. 10 mm 0.3937 in
Brush spring force	20–25 N (2–2.5 kp) 4.41–5.51 lb
Glow plug Bosch	RSK

Wear Tolerances

Cylinder Head

Height	min. 86.7 mm, 3.4134 in
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Cylinders

Cylinder liners and pistons must be replaced when wear amounts to	0.25–0.30 mm, 0.0098–0.0118 in.
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Crankshaft

Permissible out-of-round on main and big-end bearing journals, max. .	0.04 mm, 0.001575 in
Max. permissible taper on main and big-end journals	0.05 mm, 0.00197 in
Max. end float on crankshaft	0.40 mm, 0.01575 in

Valves

Valve stems, max. permissible wear	0.02 mm, 0.00079 in
Max. permissible clearance between valve stem and valve guide	
Inlet valves	0.15 mm, 0.00591 in
Exhaust valves	0.17 mm, 0.00669 in
The valve edge should be, min. inlet	1.5 mm, 0.05906 in
exhaust	1.3 mm, 0.05118 in
The valve seat may be ground until the distance from the valve disc (new valve) to the cylinder head surface is:	
Inlet	1.8 mm, 0.07087 in
Exhaust	1.55 mm, 0.06103 in

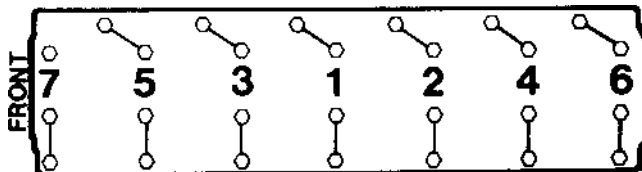
Camshaft

Max. permissible wear	0.05 mm, 0.00197 in
Bearings, max. permissible wear	0.05 mm, 0.00197 in

Tightening Torques

Cylinder head bolts*	Nm 130	(kpm) (13)	ft lbs 94.0
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Tightening diagram, Cylinder Head Bolts.



* Note! The bolt threads should be moistened with rust proofing medium (detail number 282036) before being fitted. The bolts should be tightened in accordance with the diagram in stages, the tightening torques for these stages being 30, 90 and 130 Nm (3, 9, 13 kpm) 22, 65, 94 ft/lbs.

NOTE! The bolts should be re-tightened after 1 h test run (warm or cold engine).

	Nm	(kpm)	ft lbs
Main bearings	180, 140*	(18) (14)*	130.2 (101.2)*
Big-end bearings	113	(11.3)	81.7
Rocker arm shaft	23	(2.3)	16.6
Thrust washer, camshaft bearings	23	(2.3)	16.6
Camshaft gear	80	(8)	57.8
Bearing journal for idler gear, auxiliary drive gears	23	(2.3)	16.6
Engine speed sender	40	(4)	28.9
Oil filter with oiled sealing ring	25	(2.5)	18.0
Lubricating oil pump bracket	23	(2.3)	16.6
Rocker arm cover	10	(1)	7.2
Auxiliary drive gear casing	20	(2)	14.5
Oil sump	15	(1.5)	11.0
Drain plug, oil sump	60	(6)	43.5
Flywheel casing	46	(4.6)	33.3
Flywheel	105 115**	(10.5) (11.5)**	76 (82)**
Vibration damper, attaching bolts	25	(2.5)	18
Centre bolt for hub	180	(18)	130
Injection pump, hub for drive	65	(6.5)	47
Gearwheel/driver	25	(2.5)	18
Pressure valve retainers	40	(4)	29
Stop solenoid	43	(4.3)	31
Injector, attaching nut	23	(2.3)	16.5
Glow plug	20	(2)	14.5

* The low value is current for engines with no 2201 and following.

** The high value is current for engines with no 31816 and following.

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