

Workshop Manual

Engine

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|------|
| A |
| 2(0) |

MD2010, MD2020, MD2030, MD2040

Workshop Manual

Marine engines

MD2010A/B/C/D • MD2020A/B/C/D • MD2030A/B/C/D • MD2040A/B/C/D

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Note!

The data given in this Workshop Manual refers in general to engines in both A, B, C and D versions unless otherwise stated.

Safety Precautions

Introduction

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

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

Important

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



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



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

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

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



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



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



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



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



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



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



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



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



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

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



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

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

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

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



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



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



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

General Information

About this Workshop Manual

This Workshop Manual contains technical specifications, descriptions and instructions for the repair of the following engines in standard format: MD2010, MD2020, MD2030, MD2040. This Workshop Manual can show operations carried out on any of the engines listed above. As a result the illustrations and pictures in the manual that show certain parts on the engines, do not in some cases apply to all the engines listed. However the repair and service operations described are in all essential details the same. Where they are not the same this is stated in the manual and where the difference is considerable the operations are described separately. The Engine Designations and Engine Number can be found on the product plate. Please always include both the engine designation and the engine number in all correspondence.

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

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

Replacement parts

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

Certified engines

When service or repairs are done to an emission certified engine, it is important to be aware of the following:

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

This put special demands on service and repair work, as follows:

- Maintenance and service intervals recommended by Volvo Penta must be complied with.
- Only Volvo Penta original spares may be used.
- Service to injection pumps, pump settings and injectors must always be done by an authorized Volvo Penta workshop.
- The engine must not be converted or modified, except for the accessories and service kits which Volvo Penta has approved for the engine.
- No installation changes to the exhaust pipe and engine air inlet ducts may be done.
- No seals may be broken by unauthorized personnel.

The general advice in the instruction book about operation, care and maintenance apply.



IMPORTANT! Delayed or inferior care/maintenance, and the use of non-original spares, mean that AB Volvo Penta can no longer be responsible for guaranteeing that the engine complies with the certified version.

Damage, injury and/or costs which arise from this will not be compensated by Volvo Penta.

Repair instructions and methods

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

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



WARNING!



IMPORTANT!

Note!

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

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

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

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

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

Our joint responsibility

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

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

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

Tightening torques

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

| Dimension | Tightening torque | |
|-----------|-------------------|--------|
| | Nm | ft.lbs |
| M5 | 6 | 4 |
| M6 | 10 | 7 |
| M8 | 25 | 18 |
| M10 | 50 | 37 |
| M12 | 80 | 59 |
| M14 | 140 | 103 |

Tightening torque with Protractor tightening (angle tightening)

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

Lock nuts

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

Strength classes

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

Sealant

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

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

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

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

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

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

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

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

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

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

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

Safety rules for fluorocarbon rubber

Fluorocarbon rubber is a common material in seal rings for shafts, and in O-rings, for example.

When fluorocarbon rubber is subjected to high temperatures (above 300°C/572°F), **hydrofluoric acid** can be formed, which is highly corrosive. Skin contact can give severe chemical burns. Splashes in your eyes can give severe chemical burns. If you breathe in the fumes, your lungs can be permanently damaged.



WARNING! Be very careful when working on engines which have been exposed to high temperatures, e.g. overheating during a seizure or fire. Seals must never be cut with an oxy-acetylene torch, or be burned up afterwards in an uncontrolled manner.

- Always use gloves made of chloroprene rubber (gloves for handling chemicals) and protective goggles.
- Handle the removed seal in the same way as corrosive acid. All residue, including ash, can be highly corrosive. Never use compressed air to blow anything clean.
- Put the remains in a plastic box which is sealed and provided with a warning label. Wash the gloves under running water before removing them.

The following seals are probably made from fluorocarbon rubber:

Seal rings for the crankshaft, camshaft, intermediate shafts.

O-rings irrespective of where they are installed.

O-rings for cylinder liner sealing are almost always made from fluorocarbon rubber.

Note that seals which have not been subjected to high temperature can be handled normally.

Technical data

General

| | MD2010 | MD2020 | MD2030 | MD2040 |
|--|------------------------------|------------------------------|------------------------------|------------------------------|
| Engine designation | MD2010 | MD2020 | MD2030 | MD2040 |
| Number of cylinders | 2 | 3 | 3 | 3 |
| Cylinder diameter | 67 mm (2.637 in) | 67 mm (2.637 in) | 75 mm (2.952 in) | 84 mm (3.307 in) |
| Stroke length | 64 mm (2.519 in) | 64 mm (2.519 in) | 72 mm (2.834 in) | 90 mm (3.543 in) |
| Swept volume, total | 0.45 litres (27.46 cu.in) | 0.68 litres (41.49 cu.in) | 0.95 litres (57.97 cu.in) | 1.50 litres (91.53 cu.in) |
| Power, see sales literature | | | | |
| Idling speed A/B/C | 850 ±25 rpm | 850 ±25 rpm | 850 ±25 rpm | 850 ±25 rpm |
| Idling speed D | 925 ±25 rpm | 850 ±25 rpm | 850 ±25 rpm | 850 ±25 rpm |
| Deregulation speed/high idling | 3900 ±25 rpm | 3900 ±25 rpm | 3900 ±25 rpm | 3900 ±25 rpm |
| Compression ratio | 23.5:1 | 23.5:1 | 23:1 | 22:1 |
| Compression pressure with starter motor speed | >3000 kPa (>435 psi) | >3000 kPa (>435 psi) | >3000 kPa (>435 psi) | >3000 kPa (>435 psi) |
| Firing order (cyl. No. 2 and 3 closest to flywheel) | 1-2 | 1-2-3 | 1-2-3 | 1-2-3 |
| Direction of rotation see from front | Clockwise | Clockwise | Clockwise | Clockwise |
| Max. permissible angle backwards during operation | 20° | 20° | 20° | 20° |
| Max. side angle during operation | 30° | 30° | 30° | 30° |
| Valve clearance, idle cold engine: inlet and outlet | 0.20 mm (.0078 in) | 0.20 mm (.0078 in) | 0.20 mm (.0078 in) | 0.20 mm (.0078 in) |
| Weight, engine without oil and water | 98 kg (215.9 lb) | 116 kg (255.5 lb) | 129 kg (284.2 lb) | 179 kg (394.3 lb) |
| Max. permissible counter pressure in exhaust pipe .. | 20 kPa (2.9 psi) | 20 kPa (2.9 psi) | 20 kPa (2.9 psi) | 20 kPa (2.9 psi) |

Pistons

| | MD2010 | MD2030 | MD2040 |
|--|---|-----------------------------------|---------------------------------|
| | MD2020 | | |
| Material | Aluminium alloy | Aluminium alloy | Aluminium alloy |
| Height, total in mm | 59.045–59.095 (2.324–2.326 in) | 65.575–65.625 (2.581–2.583 in) | 87.66–87.74 (3.451–3.454 in) |
| Height from gudgeon pin centre to piston top in mm | 33.045–33.095 (1.300–1.302 in) | 35.575–35.625 (1.400–1.402 in) | 47.66–47.74 (1.876–1.879 in) |
| Piston clearance in mm: | 0.048–0.082 (.0018–.0032 in) | 0.0425–0.0665 (.0016–.0026 in) | 0.038–0.072 (.0014–.0028 in) |
| Front marking*, MD2010, MD2020 | The arrow alt. "F" mark on piston top should be turned forwards | | |
| MD2030, MD2040 | The "SHIBAURA" mark in the piston should be turned forwards | | |

* The pistons for certain engines also have an arrow in front of the gudgeon pin hole which should point forwards.

Piston rings

| | MD2010 | MD2030 | MD2040 |
|--|--------------------------------|--------------------------------|-------------------------------|
| | MD2020 | | |
| Compression rings: | | | |
| Number | 2 | 2 | 2 |
| Top compression ring, height in mm | 1.47–1.49 (.0578–.0586 in) | 1.47–1.49 (.0578–.0586 in) | 1.97–1.99 (.0775–.0783 in) |
| 2nd compression ring, height in mm | 1.47–1.49 (.0578–.0586 in) | 1.97–1.99 (.0775–.0783 in) | 1.47–1.49 (.0578–.0586 in) |
| Oil ring: | | | |
| Number | 1 | 1 | 1 |
| Height in mm | 2.97–2.99 (.01169–.1177 in) | 3.97–3.99 (.01562–.1570 in) | 3.90–3.98 (.1535–.1566 in) |

| | MD2010 MD2020 | MD2030 | MD2040 |
|--|-------------------------------|-------------------------------|---------------------------------|
| Piston ring gap in cylinder measured in mm, top compression ring | 0.13–0.25 (.0051–.0098 in) | 0.15–0.27 (.0059–.0106 in) | 0.20–0.35 (.0078–.0137 in) |
| 2nd compression ring | 0.10–0.22 (.0039–.0118 in) | 0.12–0.24 (.0047–.0094 in) | 0.20–0.40 (.0078–.0157 in) |
| Oil ring | 0.10–0.30 (.0039–.0118 in) | 0.20–0.35 (.0078–.0137 in) | 0.20–0.40 (.0078–.0157 in) |
| Piston ring clearance in groove measured in mm top compression ring | 0.06–0.10 (.0023–.0039 in) | 0.06–0.10 (.0023–.0039 in) | 0.065–0.110 (.0025–.0043 in) |
| 2nd compression ring | 0.05–0.09 (.0019–.0035 in) | 0.05–0.09 (.0019–.0035 in) | 0.013–0.035 (.0005–.0013 in) |
| oil ring | 0.02–0.06 (.0007–.0023 in) | 0.02–0.06 (.0007–.0023 in) | 0.030–0.130 (.0011–.0051 in) |

Gudgeons pins

| | MD2010 MD2020 | MD2030 | MD2040 |
|--|---------------------------------------|---------------------------------------|--|
| Clearance, gudgeon pin – gudgeon bushing in mm | 0.013–0.030 (.0005–.0011 in) | 0.006–0.023 (.0002–.0009 in) | 0.010–0.027 (.0003–.0005 in) |
| Gudgeon pin – gudgeon pin hole in mm | -0.004– +0.008 (-.0001– +.0003 in) | -0.004– +0.006 (-.0001– +.0002 in) | -0.001– +0.011 (-.00003– +.0004 in) |
| Gudgeon pin diameter in mm | 18.996–19.002 (.7478–.7481 in) | 20.998–21.002 (.8266–.8268 in) | 27.994–28.000 (1.1021–1.1023 in) |
| Gudgeon bushing's int. diameter in mm | 19.015–19.026 (.7486–.7490 in) | 21.010–21.021 (.8271–.8275 in) | 28.010–28.021 (1.1027–1.1031 in) |
| Gudgeon pin hole's diameter in piston in mm | 18.998–19.004 (.7479–.7481 in) | 20.998–21.004 (.8266–.8269 in) | 27.999–28.005 (1.1023–1.1025 in) |

Cylinder head

| | MD2010 MD2020 | MD2030 | MD2040 |
|-----------------------------------|---------------------------------|-----------------------------------|-----------------------------------|
| Height in mm | 54.9–55.1 (2.161–2.169 in) | 64.6–65.4 (2.543–2.574 in) | 69.7–70.3 (2.744–2.767 in) |
| Valve seats (inlet outlet) | | | |
| Inlet, diameter in mm | 25.35–25.45 (.9980–1.001 in) | 30.35–30.45 (1.194–1.198 in) | 36.35–36.45 (1.431–1.435 in) |
| Outlet, diameter in mm | 21.85–21.95 (.8602–.8641 in) | 26.85–26.95 (1.0570–1.0610 in) | 32.35–32.45 (1.2736–1.2775 in) |
| Depth in mm | 2.05–2.15 (.0807–.0846 in) | 2.25–2.35 (.0885–.0925 in) | 2.05–2.15 (.0807–.0846 in) |

Crankshaft with bearing

| | MD2010 | MD2020 | MD2030 | MD2040 |
|---|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| (Replaceable bearing cups for main and big end bearings) | | | | |
| Crankshaft, axial clearance in mm | 0.1–0.3 (.0039–.0118 in) | 0.1–0.3 (.0039–.0118 in) | 0.05–0.30 (.0019–.0118 in) | 0.1–0.4 (.0039–.0157 in) |
| Main bearing, radial clearance in mm, No. 1 | 0.035–0.072 (.0013–.0028 in) | 0.035–0.072 (.0013–.0028 in) | 0.039–0.106 (.0015–.0041 in) | 0.044–0.116 (.0017–.0045 in) |
| No. 2 | 0.055–0.092 (.0021–.0036 in) | 0.035–0.072 (.0013–.0028 in) | 0.039–0.106 (.0015–.0041 in) | 0.044–0.116 (.0017–.0045 in) |
| No. 3 | — | 0.055–0.092 (.0021–.0036 in) | 0.039–0.092 (.0015–.0036 in) | 0.044–0.102 (.0017–.0040 in) |

Main bearing

Main bearing journals

| | | MD2010 | MD2020 | |
|---|------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Diameter in mm, standard, bearing journal | No. 1 | 42.964–42.975 (1.6915–1.6919 in) | 42.964–42.975 (1.6915–1.6919 in) | |
| | No. 2 | 45.964–45.975 (1.8096–1.8100 in) | 42.964–42.975 (1.8096–1.8100 in) | |
| | No. 3 | — | 45.964–45.975 (1.8096–1.8100 in) | |
| | undersize, No. 1 | 0.25 mm | 42.760–42.786 (1.6834–1.6844 in) | 42.760–42.786 (1.6834–1.6844 in) |
| | | (.0098 in) | | |
| | | 0.50 mm | 42.510–42.536 (1.6736–1.6746 in) | 42.510–42.536 (1.6736–1.6746 in) |
| | undersize, No. 2 | 0.25 mm | 45.764–45.790 (1.8017–1.8027 in) | 42.760–42.786 (1.6834–1.6844 in) |
| | | (.0098 in) | | |
| | | 0.50 mm | 45.514–45.540 (1.7918–1.7929 in) | 42.510–42.536 (1.6736–1.6746 in) |
| undersize, No. 3 | 0.25 mm | — | 45.764–45.790 (1.8017–1.8027 in) | |
| | (.0098 in) | | | |
| | 0.50 mm | — | 45.514–45.540 (1.7918–1.7929 in) | |
| (.0196 in) | | | | |

| | | MD2030 | MD2040 | |
|---|------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Diameter in mm, standard, bearing journal | No. 1 | 45.964–45.975 (1.8096–1.8100 in) | 67.900–67.970 (2.6732–2.6759 in) | |
| | No. 2 | 45.964–45.975 (1.8096–1.8100 in) | 67.900–67.970 (2.6732–2.6759 in) | |
| | No. 3 | 45.964–45.975 (1.8096–1.8100 in) | 67.960–67.986 (2.6755–2.6766 in) | |
| | undersize, No. 1 | 0.25 mm | 45.854–45.934 (1.8052–1.8084 in) | 67.650–67.720 (2.6633–2.6661 in) |
| | | (.0098 in) | | |
| | | 0.50 mm | 45.604–45.684 (1.7954–1.7985 in) | 67.400–67.470 (2.6535–2.6562 in) |
| | undersize, No. 2 | 0.25 mm | 45.854–45.934 (1.8052–1.8084 in) | 67.650–67.720 (2.6633–2.6661 in) |
| | | (.0098 in) | | |
| | | 0.50 mm | 45.604–45.684 (1.7954–1.7985 in) | 67.400–67.470 (2.6535–2.6562 in) |
| undersize, No. 3 | 0.25 mm | 45.714–45.725 (1.7997–1.8001 in) | 67.710–67.736 (2.6657–2.6667 in) | |
| | (.0098 in) | | | |
| | 0.50 mm | 45.464–45.475 (1.7899–1.7903 in) | 67.460–67.486 (2.6559–2.6569 in) | |
| (.0196 in) | | | | |

Big-end bearing

Big-end bearing journals

| | MD2010, MD2020 | MD2030 | MD2040 | |
|---|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Big-end bearing, radial clearance in mm | 0.031–0.068 (.0012–.0026 in) | 0.035–0.083 (.0013–.0032 in) | 0.035–0.085 (.0013–.0033 in) | |
| Bearing journal length in mm | 15.65–16.55 (.6161–.6515 in) | 17.70–18.60 (.6968–.7322 in) | 19.70–20.60 (.7755–.8110 in) | |
| Diameter in mm, standard | 34.964–34.975 (1.3765–1.3769 in) | 38.964–38.975 (1.5340–1.5344 in) | 51.964–51.975 (2.0458–2.0463 in) | |
| undersize, 0.25 mm | 34.714–34.725 (1.3666–1.3671 in) | 38.714–38.725 (1.5240–1.5246 in) | 51.714–51.725 (2.0359–2.0364 in) | |
| | (.0098 in) | | | |
| | 0.50 mm | 34.464–34.475 (1.3561–1.3572 in) | 38.464–38.475 (1.5143–1.5147 in) | 51.464–51.475 (2.0261–2.0266 in) |
| | (.0196 in) | | | |

Big-end bearing shells

| | MD2010, MD2020 | MD2030, MD2040 |
|---------------------------------|---------------------------------|---------------------------------|
| Thickness in mm, standard | 1.484–1.497 (.0584–.0589 in) | 1.482–1.495 (.0583–.0588 in) |
| oversize 0.25 mm | 1.609–1.622 (.0633–.0638 in) | 1.607–1.620 (.0632–.0637 in) |
| (.0098 in) | | |
| 0.50 mm | 1.734–1.747 (.0682–.0687 in) | 1.732–1.745 (.0681–.0687 in) |
| (.0196 in) | | |

Connecting rods

| | MD2010, MD2020 | MD2030 | MD2040 |
|--|-----------------------------------|-----------------------------------|-------------------------------------|
| Fitted with replaceable bearing shells. | | | |
| Diameter, gudgeon bushing's bearing position | 21.000–21.021 (.8267–.8275 in) | 23.000–23.021 (.9055–.9063 in) | 30.500–30.516 (1.2007–1.2014 in) |
| Bearing shell's bearing position | 19.015–19.026 (.7486–.7490 in) | 21.010–21.021 (.827–.8275 in) | 28.010–28.021 (1.1027–1.1031 in) |
| Gudgeon bushing | 19.015–19.026 (.7486–.7490 in) | 21.010–21.021 (.8271–.8275 in) | 28.010–28.021 (1.1027–1.1031 in) |
| Axial clearance, connecting rod – crankshaft | 0.031–0.079 (.0012–.0031 in) | 0.035–0.083 (.0013–.0032 in) | 0.035–0.083 (.0013–.0032 in) |

Timing gears

Camshaft

| | MD2010 | MD2020 | MD2030 | MD2040 |
|----------------------------------|------------|------------|------------|------------|
| Drive | Gear wheel | Gear wheel | Gear wheel | Gear wheel |
| Number of bearings | 3 | 3 | 3 | 3 |
| Valve times: | | | | |
| inlet valves open B.T.D.C. | 13° | 13° | 13° | 16° |
| close A.B.D.C. | 43° | 43° | 43° | 40° |
| outlet valves open B.B.D.C. | 43° | 43° | 43° | 46° |
| close A.T.D.C. | 13° | 13° | 13° | 10° |

Valve system

Valves

| | MD2010, MD2020 | MD2030 | MD2040 |
|--|---------------------------------|---------------------------------|---------------------------------|
| Inlet | | | |
| Spindle diameter in mm | 5.960–5.975 (.2346–.2352 in) | 6.94–6.95 (.2732–.2736 in) | 6.955–6.970 (.2738–.2744 in) |
| Valve disc edge in mm | 0.925–1.075 (.0364–.0423 in) | 0.925–1.075 (.0364–.0423 in) | 0.925–1.075 (.0364–.0423 in) |
| Clearance in mm, valve spindle guide | 0.045–0.072 (.0017–.0028) | 0.050–0.075 (.0019–.0029 in) | 0.03–0.06 (.0011–.0023 in) |
| Seat angle in cylinder head | 45° | 45° | 45° |
| Valve clearance in mm, cold engine | 0.20 (.0078 in) | 0.20 (.0078 in) | 0.20 (.0078 in) |
| Outlet | | | |
| Spindle diameter in mm | 5.940–5.955 (.2338–.2344 in) | 6.94–6.95 (.2732–.2736 in) | 6.94–6.95 (.2732–.2736 in) |
| Valve disc edge in mm | 0.925–1.075 (.0364–.0423 in) | 0.925–1.075 (.0364–.0423 in) | 0.925–1.075 (.0364–.0423 in) |
| Clearance in mm, valve spindle guide | 0.045–0.072 (.0017–.0028 in) | 0.050–0.075 (.0019–.0029 in) | 0.050–0.075 (.0019–.0029 in) |
| Seat angle in cylinder head | 45° | 45° | 45° |
| Valve clearance in mm, cold engine | 0.20 (.0078 in) | 0.20 (.0078 in) | 0.20 (.0078 in) |

| Valve springs | MD2010 | MD2020 | MD2030 | MD2040 |
|--|---|---|---|---|
| Length in mm (in) uncompressed | 33 (1.299) | 33 (1.299) | 35 (1.377) | 35 (1.377) |
| with 79.4 N (58.56 ft.lbf) compression | — | — | 30.4 (1.196) | 30.4 (1.196) |
| with 67.7 N (49.93 ft.lbf) compression | 28.3 (1.114) | 28.3 (1.114) | — | — |
| Push rods | | | | |
| Length in mm (in), total | 146 (5.748) | 146 (5.748) | 157 (6.181) | 195.8–196.2 (7.709–7.724) |
| Outer diameter in mm (in) | 6.3 (.2480) | 6.3 (.2480) | 6.3 (.2480) | 6.2–6.4 (.2441–0.2520) |
| Rocker mechanism | | | | |
| Rocker shaft, diameter in mm | 11.65–11.67 (.4586–.4594 in) | 11.65–11.67 (.4586–.4594 in) | 11.65–11.67 (.4586–.4594 in) | 11.65–11.67 (.4586–.4594 in) |
| Clearance in mm, rocker shaft – bushing | 0.032–0.068 (.0012–.0026 in) | 0.032–0.068 (.0012–.0026 in) | 0.032–0.068 (.0012–.0026 in) | 0.032–0.068 (.0012–.0026 in) |
| Lubrication system | | | | |
| | MD2010 | MD2020 | MD2030 | MD2040 |
| Oil pressure in kPa, hot engine at running speed | 150–500 (21.7–73 lbf/in ²) |
| Oil pressure in kPa, idling | 50–150 (7.25–22 lbf/in ²) |
| Relief valve, opening pressure in kPa | 294–490 (42.6–71 lbf/in ²) | 294–490 (42.6–71 lbf/in ²) | 294–490 (42.6–71 lbf/in ²) | 245–345 (34.4–50 lbf/in ²) |
| Oil pump: | | | | |
| Clearance, inner – outer impeller | 0.01–0.15 mm (.0004–.0059 in) | 0.01–0.15 mm (.0004–.0059 in) | 0.01–0.15 mm (.0004–.0059 in) | 0.01–0.15 mm (.0004–.0059 in) |
| Axial clearance, impeller – cover | 0.01–0.15 mm (.0004–.0059 in) | 0.01–0.15 mm (.0004–.0059 in) | 0.01–0.15 mm (.0004–.0059 in) | 0.01–0.15 mm (.0004–.0059 in) |
| Oil quality | VDS-2 ACEA E5 API CH-4 | VDS-2 ACEA E5 API CH-4 | VDS-2 ACEA E5 API CH-4 | VDS-2 ACEA E5 API CH-4 |
| Viscosity at –5 to +50°C* (+23 to +122°F)* | SAE 15W/40 SAE 20W/50 | SAE 15W/40 SAE 20W/50 | SAE 15W/40 SAE 20W/50 | SAE 15W/40 SAE 20W/50 |
| Max. Oil volume incl. oil filter: | | | | |
| no engine tilt, version A/B litres (US quarts) ... | 1.8 (1.9) | 3.4 (3.6) | 4.3 (4.5) | 6.4 (6.7) |
| no engine tilt, version C/D litres (US quarts) ... | 1.9 (2.0) | 2.8 (3.0) | 3.5 (3.7) | 5.7 (6.0) |
| Min. Oil volume incl. oil filter: | | | | |
| no engine tilt, version A/B litres (US quarts) ... | 1.5 (1.6) | 3.0 (3.2) | 3.2 (3.4) | 5.5 (5.8) |
| no engine tilt, version C/D litres (US quarts) ... | 1.3 (1.7) | 2.1 (2.2) | 2.7 (2.9) | 4.5 (4.8) |

* **Note:** Temperatures with stable ambient temperature.

Fuelsystem

| | MD2010 | MD2020 | MD2030 | MD2040 |
|---|-----------------|-----------------|-----------------|-----------------|
| Injection sequence | 1–2 | 1–2–3 | 1–2–3 | 1–2–3 |
| Feed pump max. induction height in m (ft) | 0.8 (2.62) | 0.8 (2.62) | 0.8 (2.62) | 0.8 (2.62) |
| Feed pressure in kPa (lbf/in ²) | 15–25 (2.1–3.6) | 15–25 (2.1–3.6) | 15–25 (2.1–3.6) | 15–25 (2.1–3.6) |

Injection pump

| | MD2010 | MD2020 | MD2030 | MD2040 |
|---|----------------------|-----------------------------------|-----------------------------------|-------------------------------------|
| Start of injection, crankshaft position | 25.5° ±1° B.T.D.C | 25.5° ±1° B.T.D.C ¹ | 22.5° ±1° B.T.D.C ³ | 21.0° ±1° B.T.D.C ⁵ |
| | | 27.7° ±1° B.T.D.C ² | 21.5° ±1° B.T.D.C ⁴ | 19.0° ±1° B.T.D.C ^{6,7} |
| Pump element, diameter in mm (in) | 4.5 (.1771) | 4.5 (.1771) | 5.5 (.2165) | 5.5 (.2165) |
| stroke length in mm (in) | 6 (.2362) | 6 (.2362) | 6 (.2362) | 7 (.2755) |

¹ up to and including engine number 5101311299

² from engine number 5101311300

³ up to and including engine number 510101938

⁴ from engine number 510101939

⁵ MD2040A/B product number 868748

⁶ MD2040B product number 868778

⁷ MD2040C

Wear tolerances

Note: Unless otherwise stated the given values refer to all engines.

General

Compression pressure at starter motor speed (min. 200 rpm) . min. 25 kp/cm² (355.6 lbf/in²)

Pistons

Piston clearance max. 0.25 mm (.0098 in)

Piston rings

Piston ring clearance in groove:

Compression rings max. 0.25 mm (.0098 in)

Oil ring max. 0.15 mm (.0059 in)

Piston ring gap in cylinder max. 1.0 mm (.0393 in)

Gudgeon pins

Gudgeon pin diameter:

MD2010. MD2020 min. 18.98 mm (.7472 in)

MD2030 min. 20.98 mm (.8259 in)

MD2040 min. 27.98 mm (1.1015 in)

Clearance, gudgeon pin – bushing max. 0.08 mm (.0031 in)

gudgeon pin – hole max. 0.02 mm (.0007 in)

Cylinder head

Distortion max. 0.12 mm (.0047 in)

Cylinder block

Distortion (top plane) max. 0.12 mm (.0047 in)

Cylinder diameter

MD2010. MD2020 max. 67.2 mm (2.6456 in)

0.2 mm (.00787 in) oversize max. 67.7 mm (2.6653 in)

0.5 mm (.01969 in) oversize max. 68.2 mm (2.6850 in)

MD2030 max. 75.2 mm (2.9606 in)

0.5 mm (.01969 in) oversize max. 75.7 mm (2.9803 in)

1.0 mm (.03937 in) oversize max. 76.2 mm (3.0000 in)

MD2040 max. 84.2 mm (3.3149 in)

0.5 mm (.01969 in) oversize max. 84.7 mm (3.3346 in)

1.0 mm (.03937 in) oversize max. 85.2 mm (3.3543 in)

Crankshaft

Curvature max. 0.06 mm (.00236 in)

Connecting rods

Linearity, deviation on 100 mm (3.937 in) measured length max. 0.15 mm (.00590 in)

Distortion on 100 mm (3.937 in) measured length max. 0.2 mm (.00787 in)

Axial clearance, crankshaft – connecting rod max. 0.7 mm (.02755 in)

Valves

Max. valve clearance*, inlet and outlet (cold engine) max. 0.5 mm (.01968 in)

* Maximum permitted valve clearance before adjustment must be carried out

Starter motor

Commutator diameter:

MD2010. MD2020. MD2040 min. 31 mm (1.2204 in)

MD2030 min. 40 mm (1.5748 in)

Brush length min. 11.5 mm (.4527 in)

Brush spring tension MD2010. MD2020. MD2040 min. 8.8 N (2.0 lbf)

Brush spring tension MD2030 min. 13.7 N (3.0 lbf)

Tightening torque in Nm (ft.lbf)

| | MD2010 MD2020 | MD2030 | MD2040 |
|--|-------------------|-------------------|----------------------|
| Cylinder head* | 35–40 (25.8–29.5) | 50–53 (36.9–39.1) | 90–95 (66.4–70.1) |
| Main bearing: | | | |
| top to bottom bearing cap (steel) | 25–30 (18.4–22.1) | 25–30 (18.4–22.1) | 50–55 (36.9–40.5) |
| (aluminium) | 20–25 (14.7–18.4) | 20–25 (14.7–18.4) | – |
| Main bearing cap to cylinder block | 25–30 (18.4–22.1) | 25–30 (18.4–22.1) | 50–55 (36.9–40.5) ** |
| Big-end bearing | – | – | 25–30 (18.4–22.1)*** |
| End-plate/flywheel housing | 21–26 (15.5–19.2) | 30–35 (22.1–25.8) | 50–55 (36.9–40.5) |
| Flywheel housing | 13–17 (9.6–12.5) | 47–55 (34.7–40.6) | 13–17 (9.6–12.5) |
| Flywheel | 24–29 (17.7–21.4) | 24–29 (17.7–21.4) | 24–29 (17.7–21.4) |
| Flexible coupling | 70–80 (51.6–59.0) | 60–70 (44.3–51.6) | 60–70 (44.3–51.6) |
| Adapter plate for flywheel housing | 9–12 (6.6–8.8) | 9–12 (6.6–8.8) | 9–12 (6.6–8.8) |
| Suction strainer, oil pump | 24–29 (17.7–21.4) | 24–29 (17.7–21.4) | 24–29 (17.7–21.4) |
| Bottom plate | 9–13 (6.6–9.6) | 9–13 (6.6–9.6) | 9–13 (6.6–9.6) |
| Sump | 9–12 (6.6–8.6) | 9–12 (6.6–8.6) | 9–12 (6.6–8.6) |
| Drain plug, sump | 9–13 (6.6–9.6) | 9–13 (6.6–9.6) | 9–13 (6.6–9.6) |
| Timing gear casing | 30–40 (22.1–29.5) | 30–40 (22.1–29.5) | 30–40 (22.1–29.5) |
| Crankshaft pulley | 9–12 (6.6–8.6) | 9–12 (6.6–8.6) | 9–12 (6.6–8.6) |
| Injection pump | 90–100 (66–74) | 120–130 (86–96) | 280–340 (206–250) |
| Bearing bracket, rocker shaft | 9–13 (6.6–9.6) | 9–13 (6.6–9.6) | 9–13 (6.6–9.6) |
| Valve cover | 20–25 (14.7–18.4) | 20–25 (14.7–18.4) | 20–25 (14.7–18.4) |
| Pressure oil pipe (cylinder block–cylinder head) | 10–12 (7.4–8.6) | 10–12 (7.4–8.6) | 8–12 (5.9–8.6) |
| Injector | 10–13 (7.4–9.6) | 10–13 (7.4–9.6) | 10–13 (7.4–9.6) |
| Delivery pipe | 60–70 (44.3–51.6) | 80–85 (59.0–62.7) | 60–70 (44.3–51.6) |
| Pressure valve holder | 20–25 (14.7–18.4) | 20–25 (14.7–18.4) | 15–25 (11.0–18.4) |
| Relief valve | 35–39 (25.8–28.8) | 40–45 (29.5–33.2) | 40–45 (29.5–33.2) |
| Lock screw (max. fuel volume) | 60–70 (44.3–51.6) | 60–70 (44.3–51.6) | 60–70 (44.3–51.6) |
| Lock screw (speed) | 20–25 (14.7–18.4) | 20–25 (14.7–18.4) | 20–25 (14.7–18.4) |
| Glow plug | 13–17 (9.6–12.5) | 13–17 (9.6–12.5) | 13–17 (9.6–12.5) |
| Oil pressure relay | 15–20 (11.0–14.7) | 15–20 (11.0–14.7) | 15–20 (11.0–14.7) |
| Refrigerant temperature relay | 15–20 (11.0–14.7) | 15–20 (11.0–14.7) | 15–20 (11.0–14.7) |
| Oil pressure sensor | 25–30 (18.4–22.1) | 25–30 (18.4–22.1) | 25–30 (18.4–22.1) |
| Refrigerant temperature sensor | 15–20 (11.0–14.7) | 15–20 (11.0–14.7) | 15–20 (11.0–14.7) |

* The tightening torque given under respective engine is the final tightening torque.
The cylinder head should be tightened in three stages and in the correct sequence.
See tightening torque diagram on page 34.

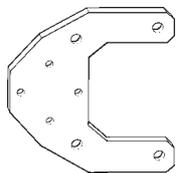
Grease in the cylinder head screw threads with grease containing molybdenum disulphide.

** Hexagonal screws

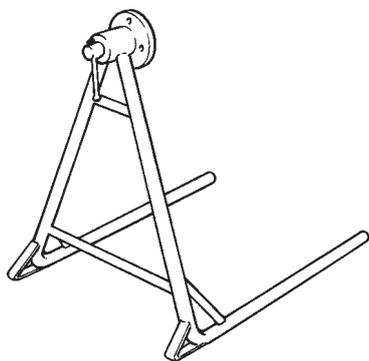
*** Rear cap (socket head screws)

Special tools

Note. If necessary, the workshop should be equipped with 2 deep (minimum 80 mm) hexagonal sockets, 22 mm and 27mm, for removing the injectors. These sockets can be obtained from a well stocked tool supplier and are not stocked by Volvo Penta.

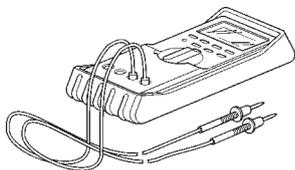


885224-6 Engine fixture. The tool should be supplemented with 4 pcs pin screws 479971-4, 4 pcs nuts 971095-5, 4 pcs screws 970964-3 (M10x140), 4 pcs screws 955311-6 (M8x140), 4 pcs washers 960148-5 (M10), 4 pcs washers 960141-0 (M8) and the arms from engine fixture 885050-5.

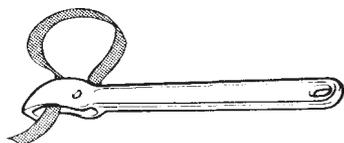


999 2520-8 Overhaul stand

856927-9 Measuring plastic (disposable item)



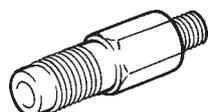
9510060-8 Multimeter



999 9179-6 Key for dismantling of fuel and oil filters.



885251-9 Adapter for measuring compression pressure MD2030.



885252-7 Adapter for measuring compression pressure MD2010, MD2020 and MD2040.

Presentation

General

The engines are in-line, 4-stroke, marine diesel engines fitted with top valves. MD2010 has two cylinders, while MD2020, MD2030 and MD2040 have three cylinders.

The engines are of the pre-chamber type and equipped with glow plugs which are activated before and during starting.

The engines are fitted with thermostat regulated fresh water cooling. The cooling system is divided into a fresh water and a sea water system. The sea water cools the fresh water system via a heat exchanger.

Lubricating takes place by means of an oil pressure system where an oil pump presses oil to all the lubrication point. The oil system is provided with a replaceable oil filter of the full-flow type.

The fuel system is protected from impurities by a replaceable fine filter.

Positioning of rating plates

Your engine and transmission has identification plates with identification numbers. This information should always be quoted when ordering replacement parts. The appearance and location of identification plates is shown below. The figures in brackets refer to the location of the identification numbers on the identification plate.

Engine

Product designation (1)

Serial number (2)

Product number (3)

Certification number (4)

S-drive / reverse gear

Product designation (5)

Serial number (6)

Product number (7)

Gear ratio (8)

Design differences, engine versions

This Workshop Manual applies to all engines MD2010–2040 A, B, C, D

The most important differences are:

MD2010–40A ⇒ MD2010–40B

MD2010–40B has:

- Unipolar electrical system
- The fly wheel cover and the transmission (reverse gear or S-drive) are electrically insulated from the engine

MD2010-40B ⇒ MD2010-40C

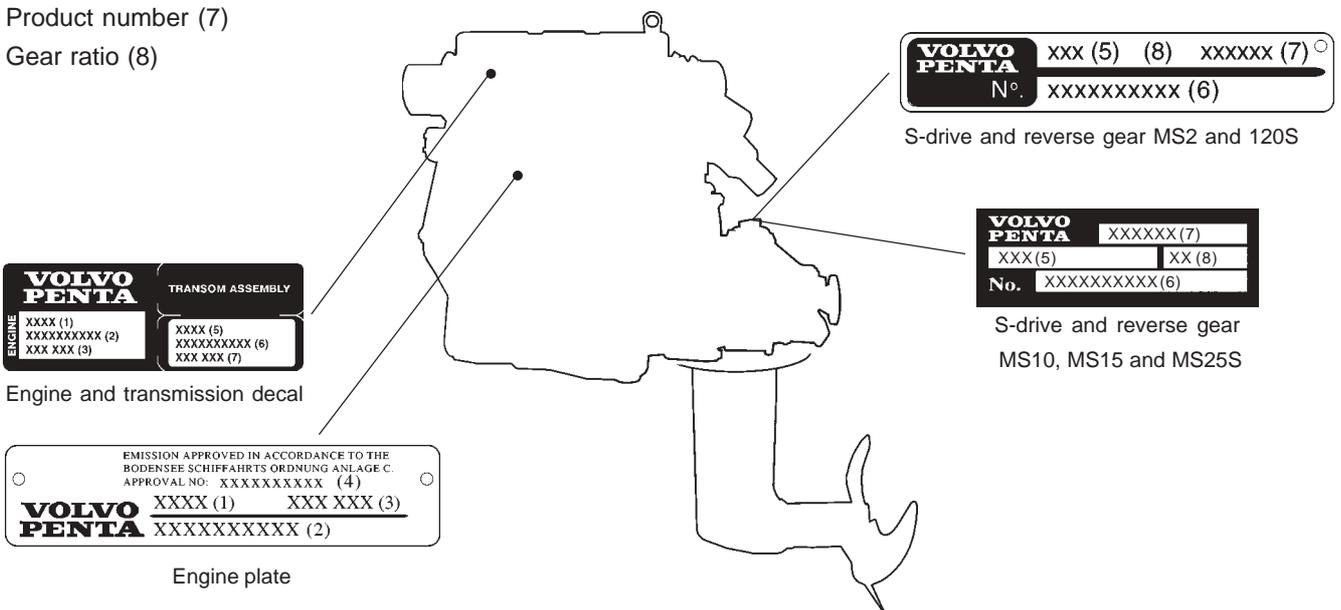
MD2010-40C has:

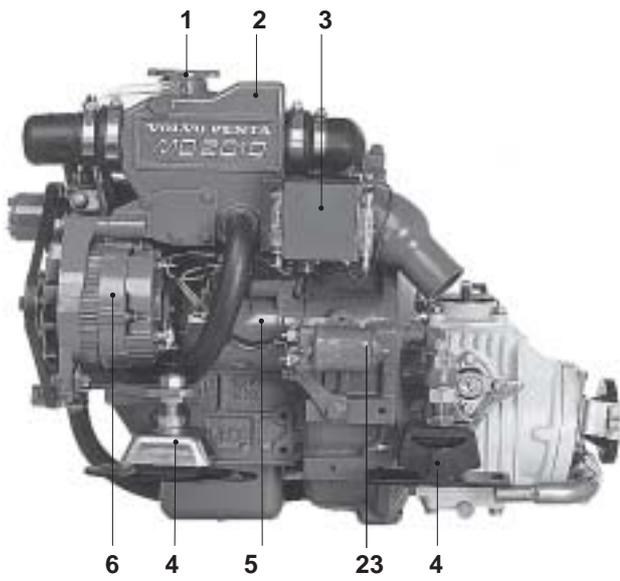
- Heat exchangers with improved cooling performance and extended expansion volume
- Deeper and narrower oil sump
- Reinforced generator mountings for 2010 and 2020
- Common oil filter for 2010–40

MD2010-40C ⇒ MD2010-40D

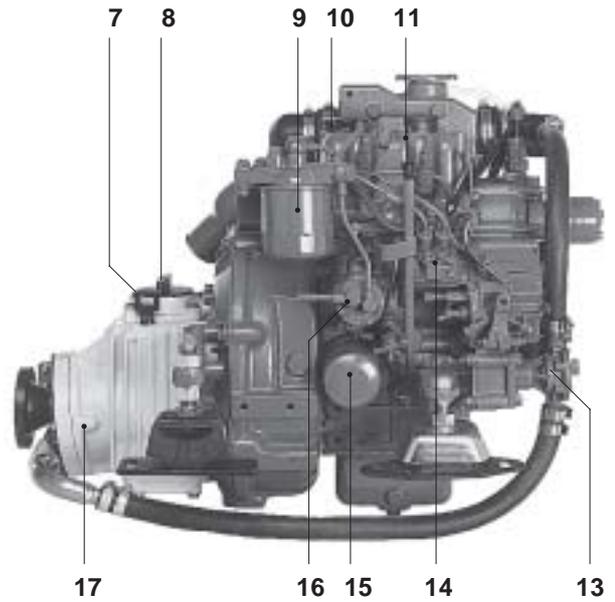
MD2010-40D has:

- New timing gear: MS10, MS15, MS25S
- Raised idling speed for 2010
- Vibration damper

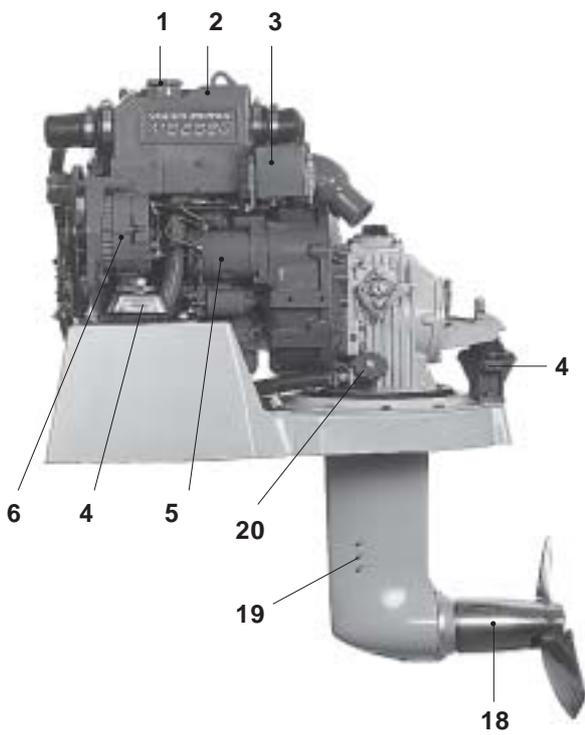




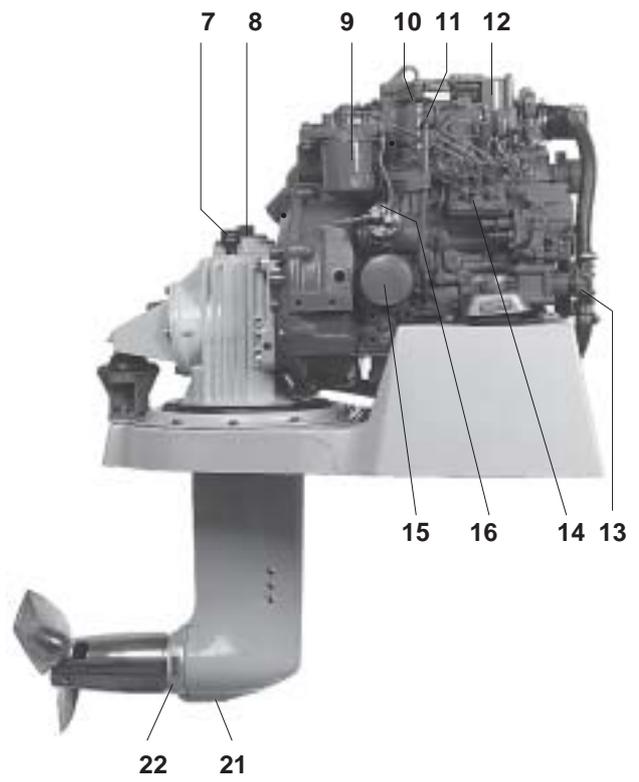
MD2010A/B & MS2L



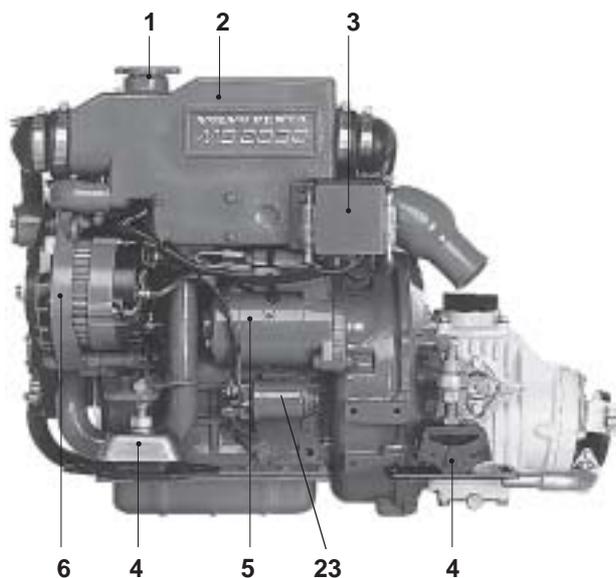
MD2010A/B & MS2L



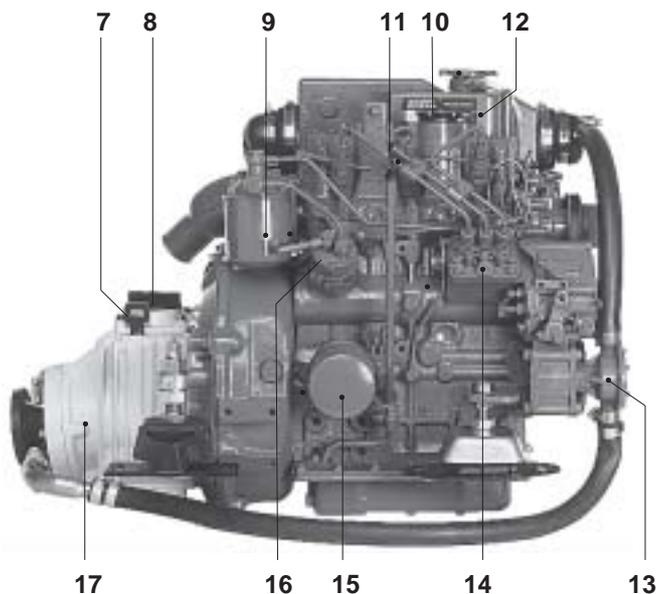
MD2020A/B & 120S



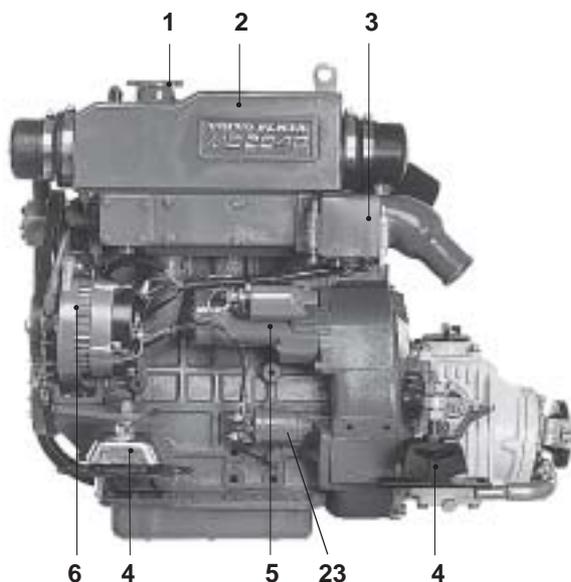
MD2020A/B & 120S



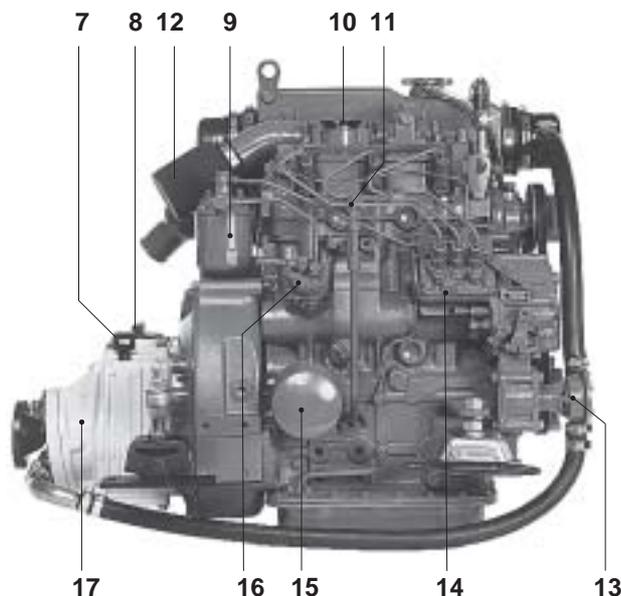
MD2030A/B & MS2A



MD2030A/B & MS2A



MD2040A/B & MS2L

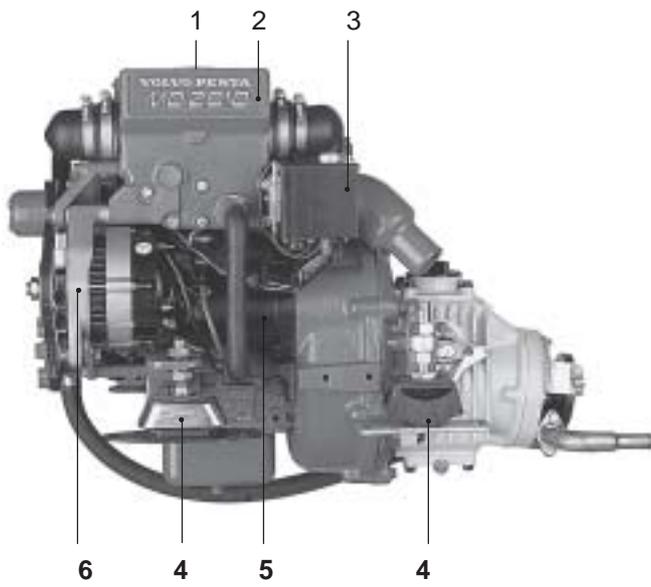


MD2040A/B & MS2L

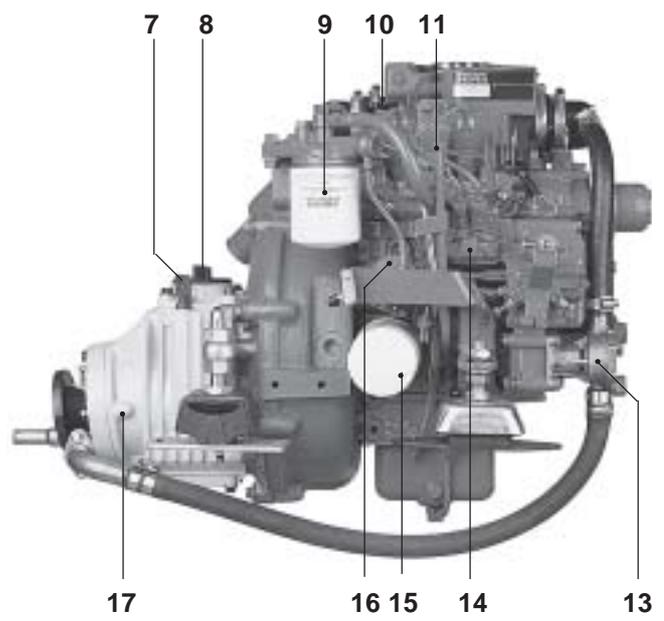
- 1. Cap for replenishing of refrigerant
- 2. Expansion tank
- 3. Relay box with fuses
- 4. Flexible suspension
- 5. Starter motor
- 6. Alternator
- 7. Oil dipstick, reverse gear/S-drive
- 8. Cap for oil dipstick, reverse gear/S-drive
- 9. Fuel filter
- 10. Cap for oil replenishment, engine
- 11. Oil dipstick, engine
- 12. Air filter/Air intake

- 13. Sea water pump
- 14. Injection pump
- 15. Oil filter
- 16. Feed pump (with hand pump)
- 17. Oil cooler, reverse gear
- 18. Folding propeller
- 19. Refrigerant intake, S-drive
- 20. Refrigerant cock (sea water), S-drive
- 21. Oil drain, S-drive
- 22. Zinc anode (zinc ring)*
- 23. MD2010A–2040A: Earthing relay (for starter motor and glow plug)

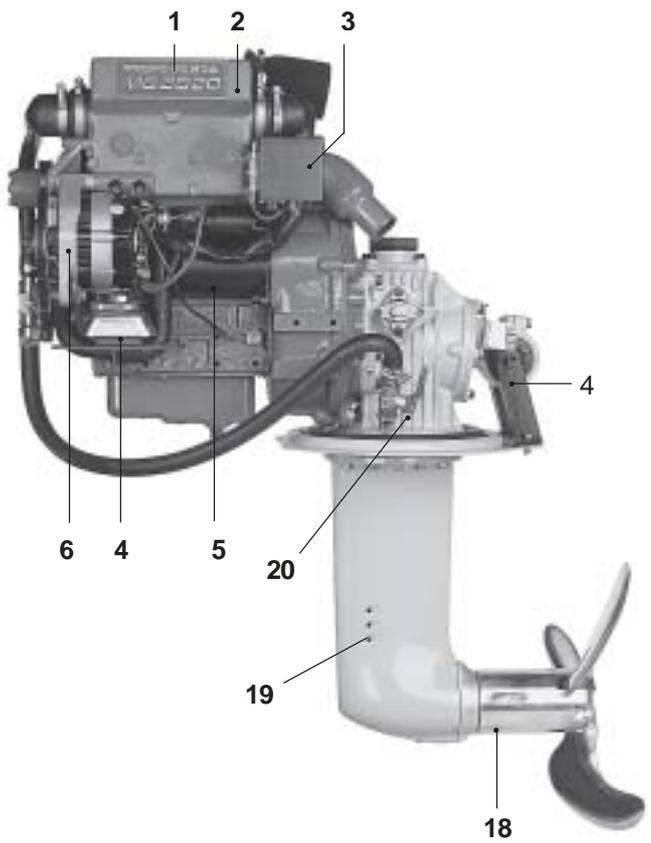
* **Note:** When running in fresh water the **magnesium anode** (magnesium ring) should be used.



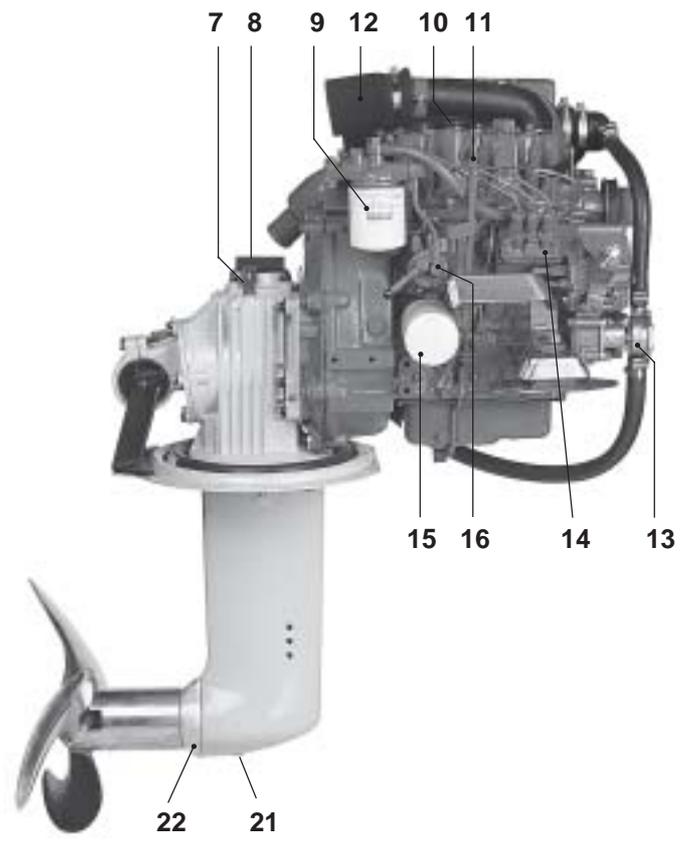
MD2010-C & MS2L



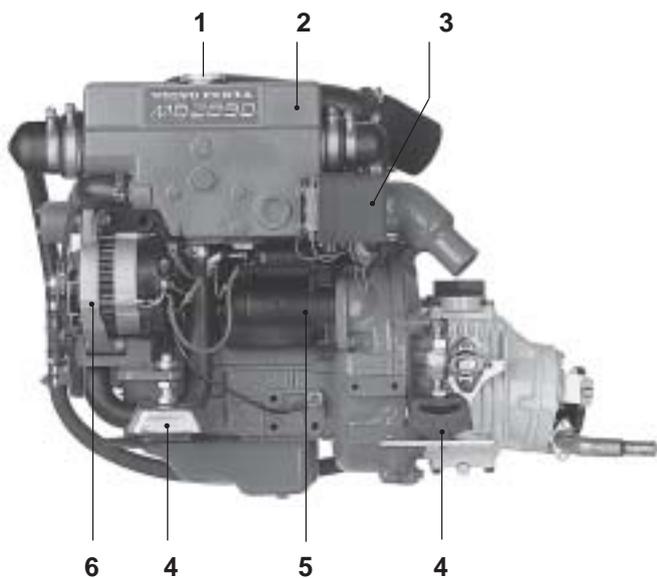
MD2010-C & MS2L



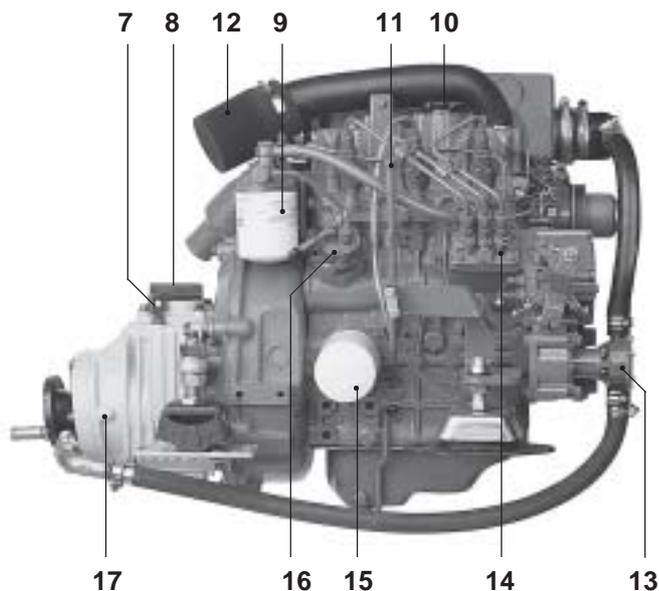
MD2020-C & 120S



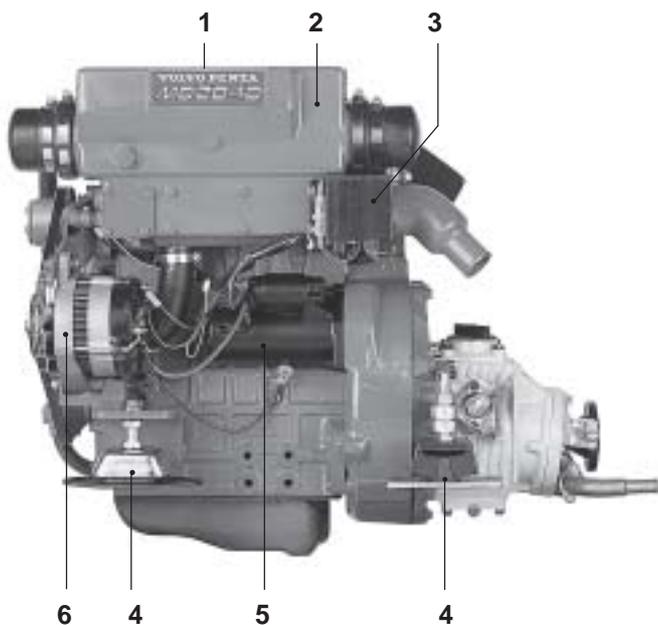
MD2020-C & 120S



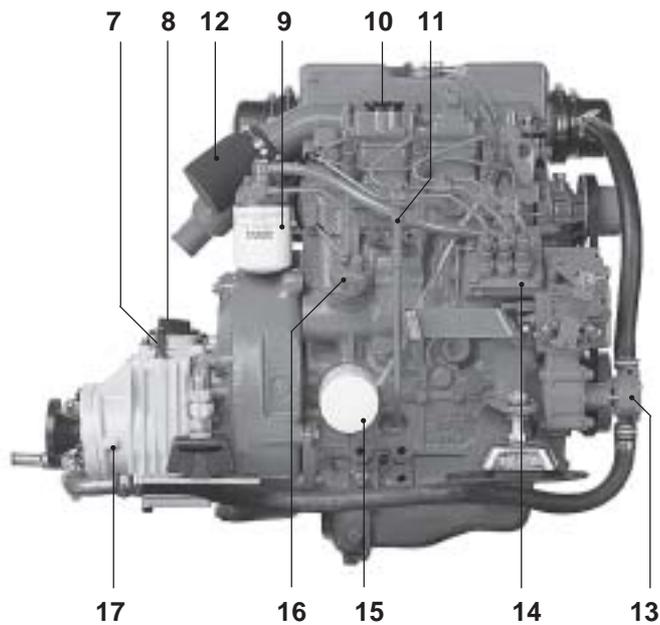
MD2030-C & MS2A



MD2030-C & MS2A



MD2040-C & MS2L

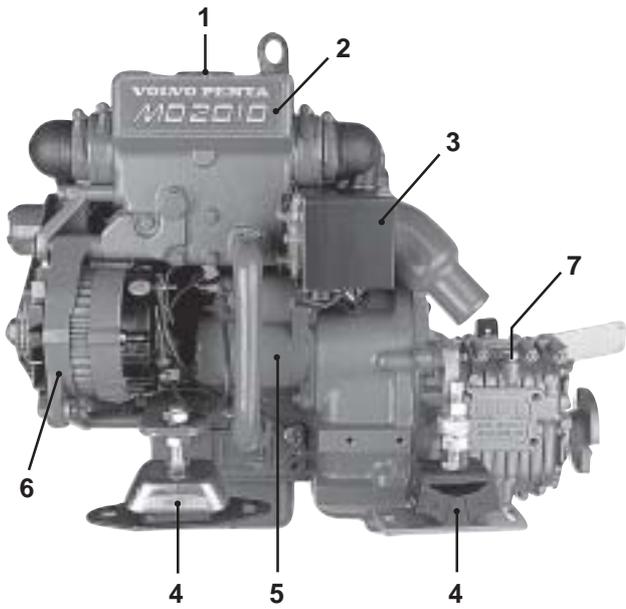


MD2040-C & MS2L

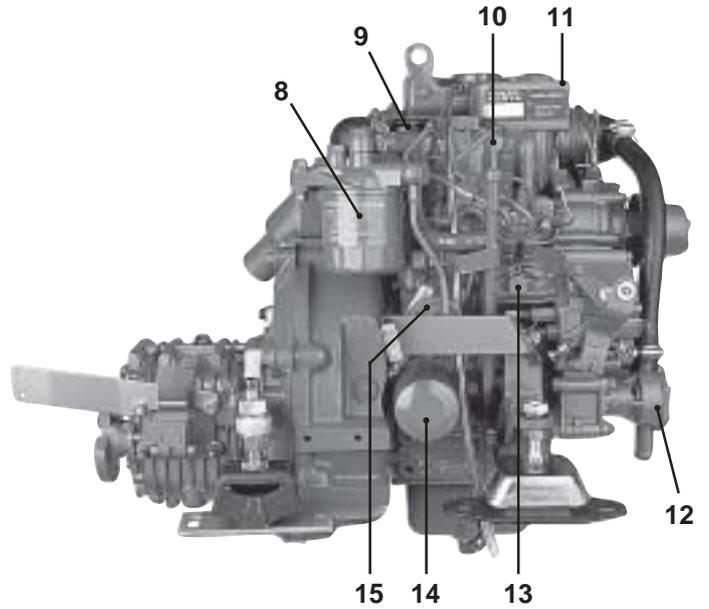
- 1. Cap for replenishing of refrigerant
- 2. Expansion tank
- 3. Relay box with fuses
- 4. Flexible suspension
- 5. Starter motor
- 6. Alternator
- 7. Oil dipstick, reverse gear/S-drive
- 8. Cap for oil dipstick, reverse gear/S-drive
- 9. Fuel filter
- 10. Cap for oil replenishment, engine
- 11. Oil dipstick, engine
- 12. Air filter/Air intake
- 13. Sea water pump

- 14. Injection pump
- 15. Oil filter
- 16. Feed pump (with hand pump)
- 17. Oil cooler, reverse gear
- 18. Folding propeller
- 19. Refrigerant intake, S-drive
- 20. Refrigerant cock (sea water), S-drive
- 21. Oil drain, S-drive
- 22. Zinc anode (zinc ring)*

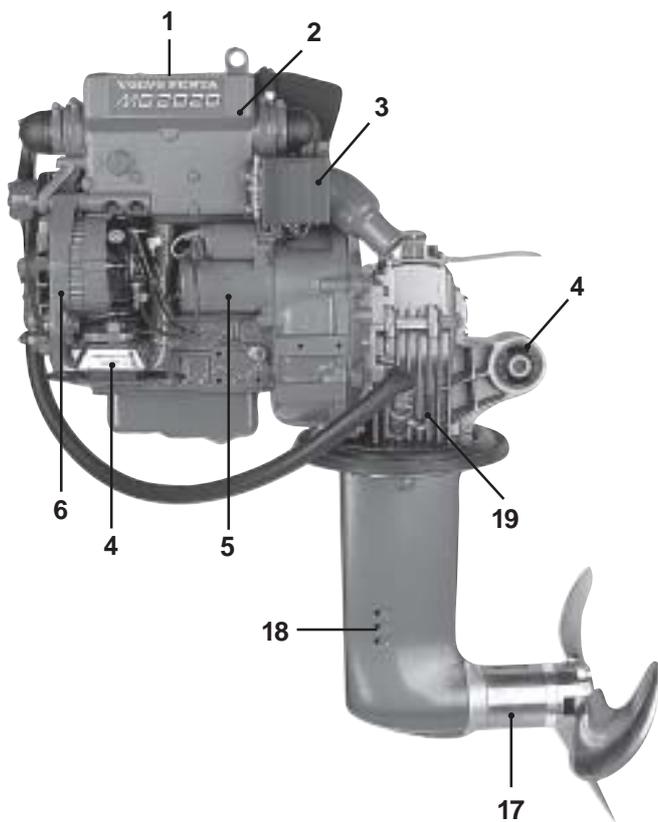
* **Note:** When running in fresh water the **magnesium anode** (magnesium ring) should be used.



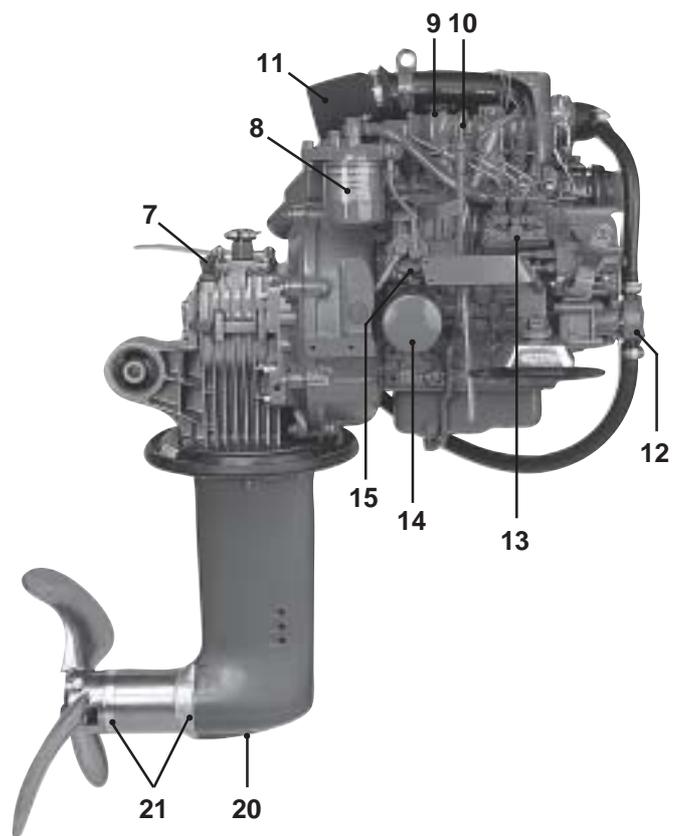
MD2010 D with reverse gear MS10L



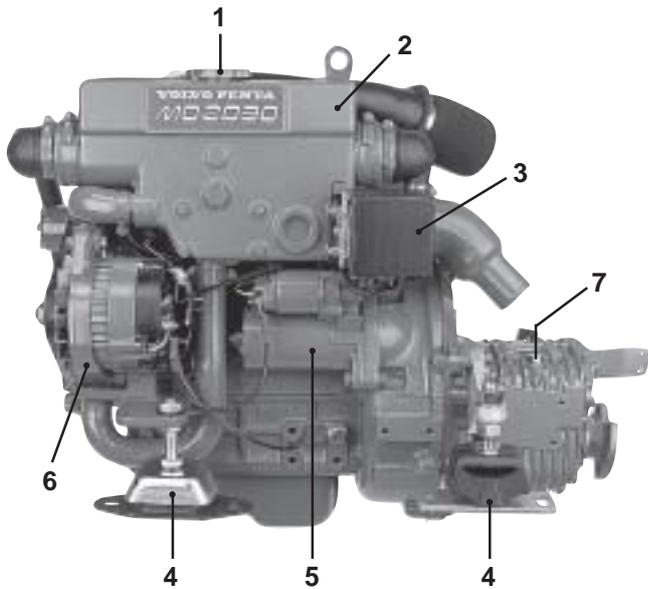
MD2010 D with reverse gear MS10L



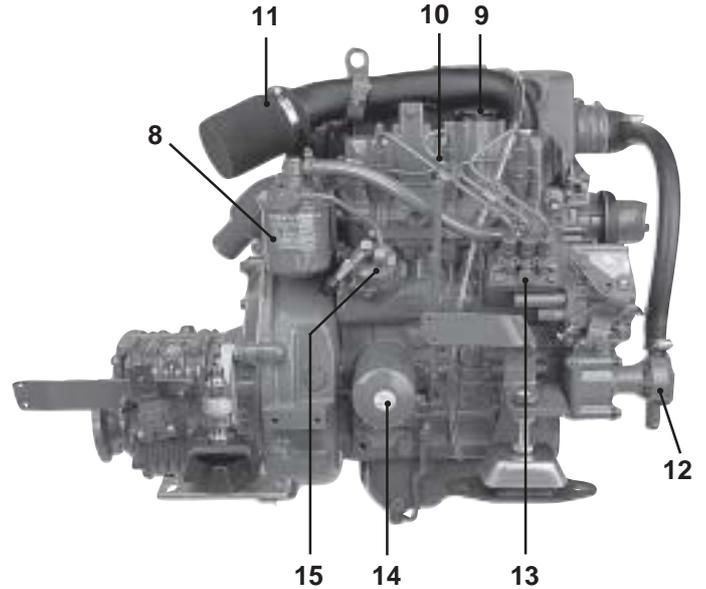
MD2020 D with sailing boat drive MS25S



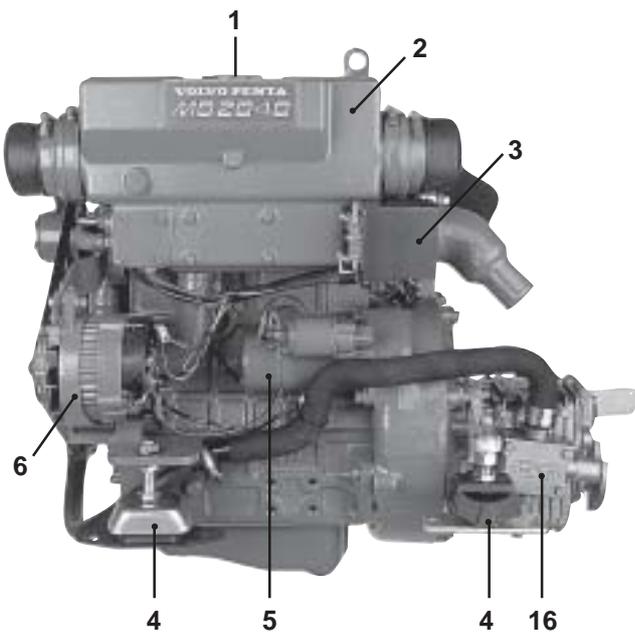
MD2020 D with sailing boat drive MS25S



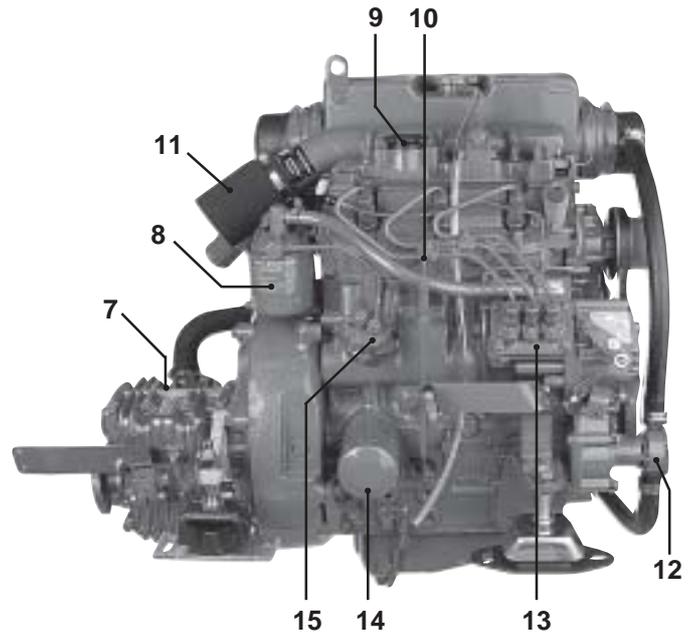
MD2030 D with reverse gear MS10A



MD2030 D with reverse gear MS10A



MD2040 D with reverse gear MS15A



MD2040 D with reverse gear MS15A

- 1. Coolant filler cap
- 2. Expansion tank
- 3. Relay box with fuses
- 4. Flexible mounting
- 5. Starter motor
- 6. AC generator
- 7. Dipstick, reverse gear/S-drive
- 8. Fine fuel filter

- 9. Oil filler cap, engine
- 10. Dipstick, engine
- 11. Air cleaner (ACL)/Air intake
- 12. Seawater pump
- 13. Injection pump
- 14. Lubricating oil filter
- 15. Fuel pump
- 16. Oil cooler, reverse gear

- 17. Folding propeller
- 18. Cooling water intake, S-drive
- 19. Sea cock, S-drive
- 20. Oil drain plug, S-drive
- 21. Sacrificial anode

Engine body

Description

Cylinder head

The cylinder head is manufactured of specially alloyed cast iron. It is provided with replaceable valve seats for the inlet valves.

The cylinder head is screwed onto the cylinder block with screws. The tightening of the cylinder head should be done in three stages.

Cylinder block

The cylinder block is cast in one piece of specially alloyed cast iron.

Pistons, piston rings

The pistons are manufactured of a light-weight metal alloy. They are fitted with three piston rings (chromium-plated) – two compression rings and an oil ring.

Camshaft

The injection pump is driven from the front part of the camshaft by means of two or three separate cams (depending on the number of cylinders).

The feed pump is driven via an eccentric cam from the rear of the camshaft.

Timing gears

The timing gears consists of cylindrical gears with bevelled cogs.

The camshaft and sea water pump are driven from the crankshaft gear via an intermediate gear. The engine's oil pump is built into the intermediate wheel and is driven via this. Regulator weights are suspended in the front edge of the camshaft gear.

Crank mechanism

Crankshaft

The crankshaft is journaled in three main bearings (MD2010), or four main bearings (other engines). The axial bearing on MD2040 consists of loose thrust washers placed at the rear main bearing. On the other engines the rear main bearing cap is made of aluminium and serves as thrust washers. The crankshaft is statically and dynamically balanced and has induction hardened bearing surfaces. At the front the crankshaft is fitted with a key joint and at the rear with a flange on which the flywheel is attached.

Main and big-end bearings

The main and big-end bearings consist of steel shells lined with bearing metal. The bearings are precision milled and ready for installation. Two oversizes are available as spare parts.

Note: The thrust washers for the crankshaft's axial bearing are not available in oversize.

Connecting rods

The connecting rods have I-sections. The piston bolt end is through-drilled for lubrication of the gudgeon pin.

Flywheel

The flywheel is screwed on a flange on the rear of the crankshaft. It is statically balanced and fully processed. The starter ring is shrunk onto the flywheel.

A flexible coupling with damper element of rubber is screwed on the flywheel. The coupling transfers the force to the reverse gear/S-drive.

Repair instructions

Cylinder head

Dismantling of cylinder head

1. Remove both battery leads. Close the fuel cocks.
2. Close the bottom valve and drain off the water in the sea and fresh water system.
3. Release the hose to the heat exchanger from the sea water pump. Release the exhaust pipe from the exhaust hook.
4. Release the thick rubber hose under the heat exchanger. (**Note:** the hose is filled with refrigerant). Release the thin hose from the circulation pump.
5. MD2010, MD2020: remove the drive belt for the alternator/circulation pump. Remove the alternator and clamp.
6. Release the relay box from the heat exchanger housing and hang it up.
7. Release the electric cables to the oil pressure relay and to the coolant temperature relay and sensor (where appropriate).
8. MD2040: remove the cover at the front on the heat exchanger housing's right-hand side. Remove the spacer ring, thermostat and rubber seal.

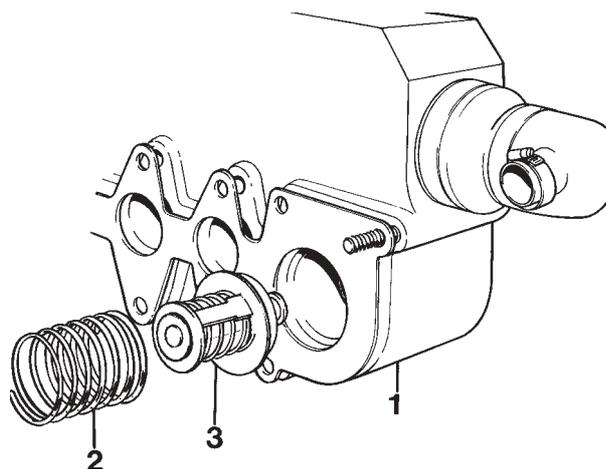


Fig. 9. Dismantling of expansion tank with heat exchanger

1. Heat exchanger complete
2. MD2010, MD2020: Spring
3. MD2010, MD2020: Thermostat

9. Remove the expansion tank complete with heat exchanger.
MD2010, MD2020: Remove the spring, thermostat and rubber seal from the heat exchanger housing.
10. MD2010, MD2020, MD2030:
Remove the induction manifold.
MD2040:
Remove the inlet pipe complete with air filter.
11. Release the delivery pipe at the injection pump and injectors. Lift off the delivery pipes together. Protect the connections from impurities.
12. Remove the nut at the top of respective injectors and lift off the fuel leak pipe.

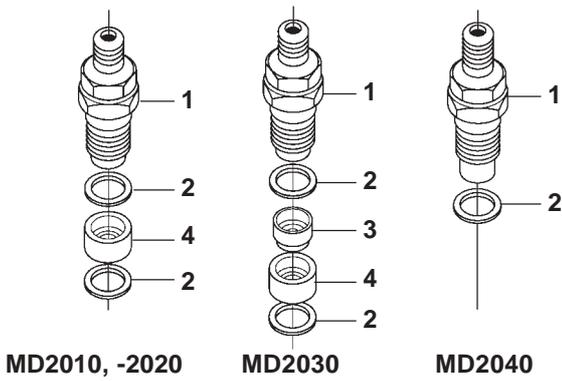


Fig. 10. Dismantling of injectors

- 1. Injector
- 2. Copper gasket
- 3. Heat shield (MD2030)
- 4. Insert (MD2010–2030)

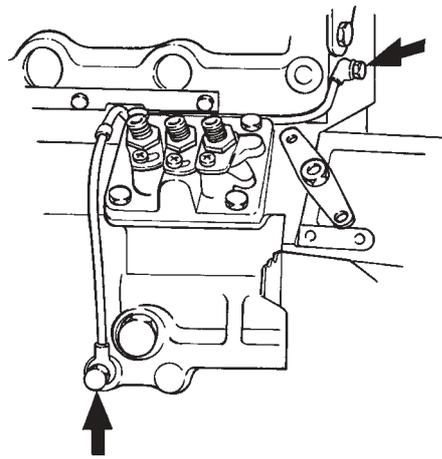


Fig. 12. Dismantling of oil pressure pipe (cylinder block – cylinder head/rocker mechanism)

- 13. Unscrew the injectors. Use a long socket, 80 mm.
 MD2010, MD2020, MD2030 = 22 mm
 MD2040 = 27 mm.
 Remove the copper gaskets under the injectors.
 MD2030: Remove the heat shields (3, Fig. 10).
 MD2010, MD2020, MD2030: Remove the inserts (4) and the lower copper washers.

- 16. Remove the oil pressure pipe between the cylinder block and cylinder head (rocker mechanism on MD2040).
- 17. Remove the valve cover (built together with the inlet pipe on MD2010, MD2020 and MD2030).

- 14. Release the electric cable to the glow plug. Remove the conductor rail and unscrew the glow plug.

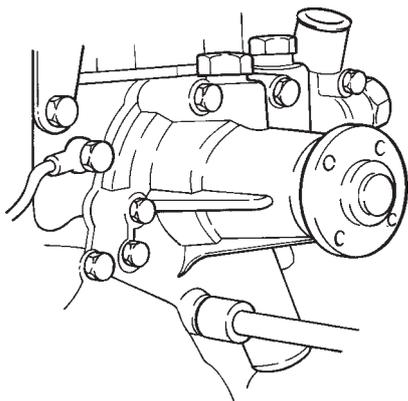


Fig. 11. Dismantling of circulation pump

- 15. MD2010, MD2020, MD2030: Remove the circulation pump.
MD2030: Note. The pump must be released/removed **before** the cylinder head is released. The pump can otherwise be broken. Remove the spring and thermostat.

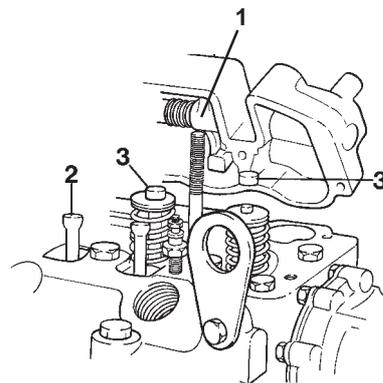


Fig. 13. Dismantling of rocker mechanism (MD2040)

- 1. Rocker mechanism
- 2. Push rods
- 3. Valve caps

- 18. Release the nuts from the rockers' bearing brackets. Remove the rocker mechanism (1, Fig. 13) and push rods (2). Remove the valve caps (3, MD2040) from the valve stem.
- 19. Release the cylinder head screws in several stages.
Note: Begin in the middle of the cylinder head and release the screws in a circle outwards.
 Lift off the cylinder head.

Stripping of cylinder head

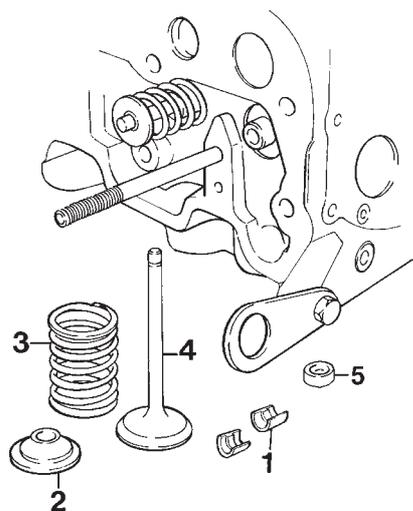


Fig. 14. Dismantling the valves

- | | |
|------------------------|---------------|
| 1. Valve lock | 4. Valve |
| 2. Valve spring washer | 5. Valve cap* |
| 3. Valve spring | |

*MD2040 and later versions of MD2010, 2020, 2030

1. Remove the valves and valve springs. Press the springs together with a valve spring tensioner and remove the valve lock. Place the valves in order in a marked valve rack. Remove the valve stem seals.

2. Clean all parts. Observe special care with the channels for oil and refrigerant.

3. Remove residual soot and impurities from the cylinder head's sealing surfaces.

Note: Do not use steel brush to clean the cylinder head screw threads or under the screw heads.

Inspection of cylinder head

The flatness tolerance for the cylinder head is max. 0.12 mm (.00472"). Check in six positions ("A-F" as per Fig. 15 and 16). Use a feeler gauge and a ruler the sides of which are precision rubbed as per DIN 874/Normal.

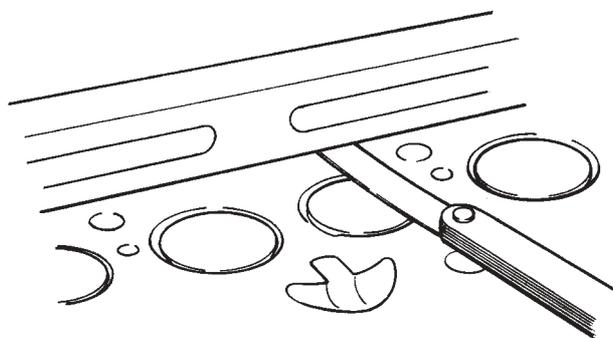


Fig. 15. Checking of cylinder head flatness

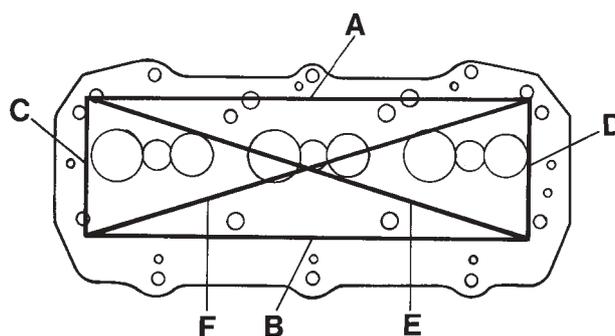


Fig. 16. Checking of cylinder head flatness

If the flatness is not within the permissible tolerance the cylinder head should be replaced. If leakage or blow marks are confirmed it is not necessary to check for flatness since the cylinder head must be replaced.

Check the valve seats and that the pin screws are tight.

For replacement of the valve seats (inlet) see next page.

Replacement of valve seat

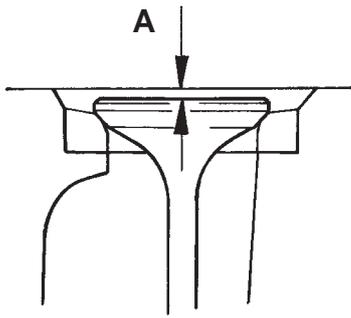


Fig. 17. A = distance between cylinder head plane and valves.

The valve seat should be replaced when the distance "A" in Fig. 17 measured with a **new** valve exceeds 1.8 mm (.0708").

1. Remove the old valve seat by heating it up with a gas jet (600–700°C / 1112–1292°F) diagonally over the seat.

Allow the cylinder head to cool approx. 3–5 minutes in the air. Carefully tap out the seat with mandrel (check that the cylinder head is not damaged).

Alternatively the valve seat can be milled out (check that the cylinder head is not damaged).

2. Clean the seat housing in the cylinder head carefully. Check the head for cracking.
3. Cool down the new seat with liquid nitrogen or the like to minus 60–70°C (140–158°F) and heat up the cylinder head to approx. 60–100°C (140–212°F).
4. Press the seat in the head. Use a hydraulic press (1000–1500 kp / 2204–3307 lbf) and suitable mandrel.
5. Work the seats to the correct angle and width.

Grinding of valves and valve seats

1. Use a valve spring tensioner and dismantle the valve lock. Remove the valve spring washers, springs and valves. Place the parts in the correct order in a valve rack. Remove the valve stem seals.
2. Clean the parts.

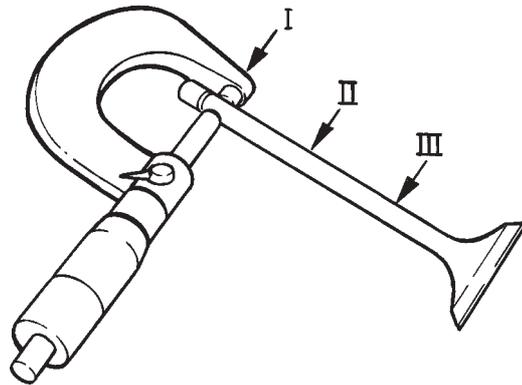


Fig. 18. Checking of valve spindle wear

| Diameter mm: | Inlet | Outlet |
|----------------|-----------------------|-----------------------|
| MD2010, MD2020 | 5.90 mm (.2322 in) | 5.90 mm (.2322 in) |
| MD2030, MD2040 | 6.89 mm (.2712 in) | 6.84 mm (.2692 in) |

3. Check the wear on the valve spindle. Measure the diameter with a micrometer at points I, II and III as per Fig. 18.

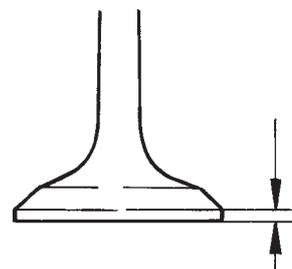


Fig. 19. Valve disc edge

4. Grind the valves in a valve grinding machine
Grind the sealing surface as little as possible, just so that it is "clean". If the the valve disc edge after grinding is less than 0.5 mm (.019 in) the valve should be scrapped (see Fig. 19). The same applies to valves with crooked valve spindles.

5. Check the wear on the valve guides (see "Checking of valve guides") before the valve seats are treated.

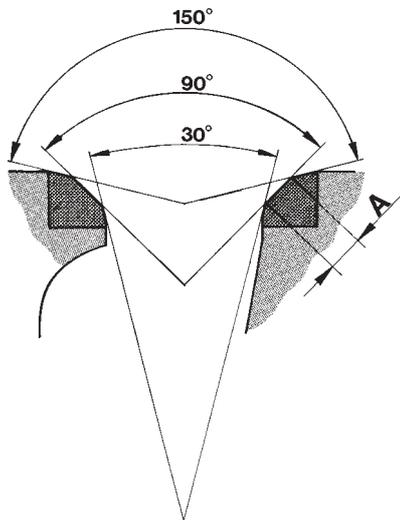


Fig. 20. Grinding of valve seat

A= Max. 2.5 mm (.0984 in)

6. Ream or grind the valve seats (Fig. 20). Grind of just enough material so that the valve seat has the right shape and a good mating surface.

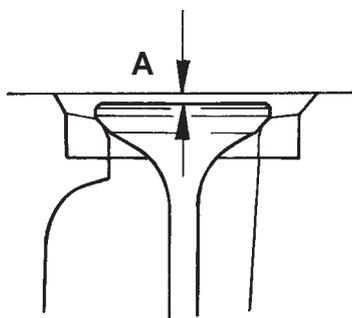


Fig. 21. Checking of valve seat

Replace the valve seat when the distance "A" in Fig. 21, measured with a new valve, exceeds 1.8 mm (.0708 in).

For replacement of the valve seat (inlet) see previous page.

New seats are grind down so that the distance between the cylinder head plane and the valve disc surface "A" is:

MD2010, MD2020: 0.70–0.90 mm (.0275–.0354 in)
 MD2030, MD2040: 0.85–1.15 mm (.0334–.0452 in)

7. Grind in the valves with grinding paste and check the contact with marker dye.

8. Fit the seals, valves, valve springs, spring washers, valve lock and valve caps. See "Assembly of cylinder head" on page 33.

Checking of valve guides*

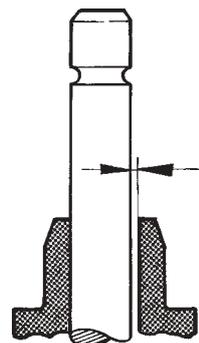


Fig. 22. Clearance, valve – valve guide (cylinder head)

Calculate the clearance between the valve spindle and valve guide.

Wear tolerances:

Inlet valve, max. clearance 0.20 mm (.0078 in)
 Outlet valve, max. clearance 0.25 mm (.0098 in)

* **Note:** Since the valve guides are treated directly in the cylinder head this must be replaced when the clearance is excessive, even when the valve is new.

Checking of valve springs

Check that the springs do not show any signs of damage.

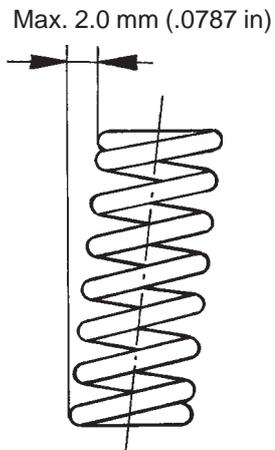


Fig. 23. Checking of linearity

Place the valve springs on a level surface and check the linearity with a square (Fig. 23).

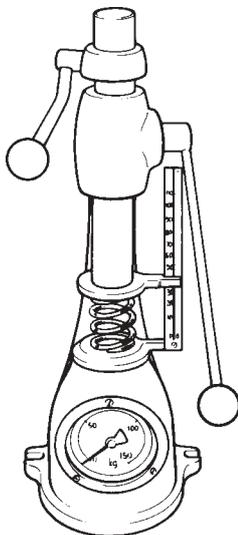


Fig. 24. Spring tester

Place the spring in a spring tester and check its length both compressed and uncompressed.

The springs should maintain the values given in "Technical data".

Renovating the rocker mechanism

1. MD2010, MD2020, MD2030: Remove the screws at the front and rear of the rocker shaft.

MD2040: Screw in a M8 screw in the threaded hole in the front edge of the rocker shaft. Fix the screw head in a vice and pull out the rocker shaft (alt. a withdrawing tool can be used).

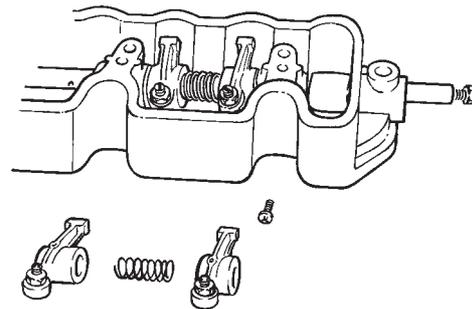


Fig. 25. Dismantling of rocker mechanism (MD2040)

2. Dismantle the rocker mechanism. Remove the rockers, springs and washers.
3. Clean the parts. Observe special care with the rocker shaft's oil channels and oil holes in the rockers.

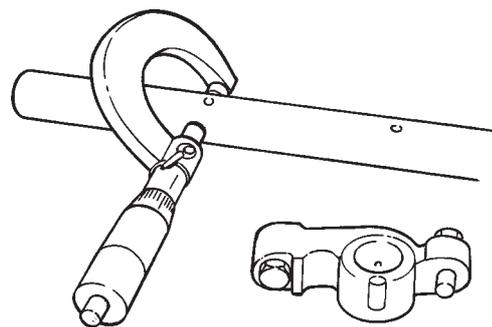


Fig. 26. Measuring of rocker shaft

4. Check the wear on the rocker shaft with a micrometer (Fig. 26). Diameter min. 11.57 mm (.4555 in).

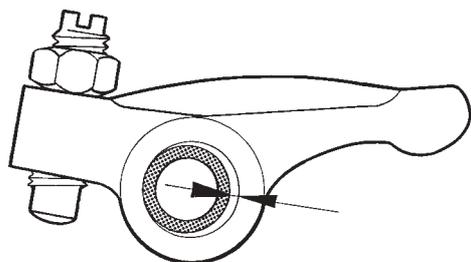


Fig. 27. Clearance rocker – rocker shaft

5. Check that the rocker bearing surfaces are not out-of-round worn.

Calculate the clearance between the rocker and shaft. The clearance must not exceed 0.2 mm (.0078 in).

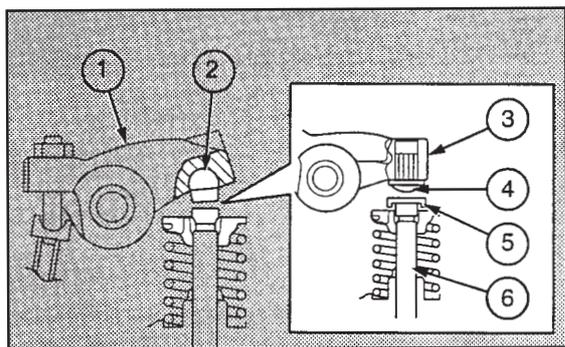
Check that the ball pin's spherical part is not deformed or worn. The threads should be undamaged on the pin and lock nut. The locknut should be in good condition.

The mating sphere of the rockers (against the valve) must not be unevenly worn or concave. Adjustment for minor wear can be made in a grinding machine.

Note: MD2010-2030. A new type of rocker (including valve cap) has been introduced as from engine number:

- MD2010: 5101202984
- MD2020: 5101308898
- MD2030: 5101465653

Only the new type of rocker is available as a spare part. If one or several of the older type of rocker need to be replaced, all the rockers must be replaced at once, and valve caps installed on the valve stems.



Comparison between new and old rockers

1. Earlier rocker
 2. Earlier rocker tip
 3. The new rocker
 4. The new rocker tip
 5. Valve cap
 6. Valve
6. Oil in the rocker mechanism and fit the different parts.

Fitting of cylinder head

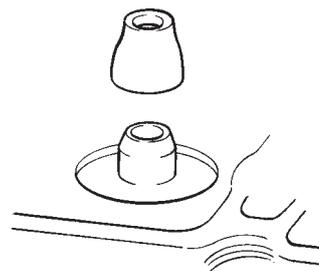


Fig. 28. Fitting of valve stem seals

1. Press down new valve stem seals on the valve guides.

Note: MD2030 and MD2040 have different seals for the guides for the inlet and outlet valves.

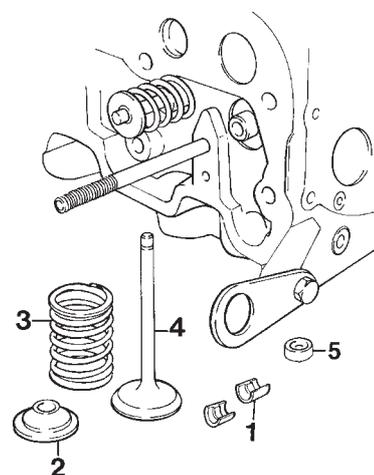


Fig. 29. Fitting of valves

1. Valve lock
2. Valve spring retainer
3. Valve spring
4. Valve
5. Valve cap*

*MD2040 and later versions of MD2010, 2020, 2030

2. The valves should be fitted in the correct order. Oil in the valve spindles and fit the valve in its guide. Place the valve spring and retainer in position and press the spring together with a valve spring tensioner. Fit the valve lock.

Note: Observe care when fitting the valves and compressing the springs so that the valve stem seals are not damaged.

3. Fit the valve caps when all valves are fitted. (Applies to MD2040 and later versions of MD2010, MD2020, MD2030 (Please refer to the note below item 5)).
4. Fit new plugs if these have been removed.

Fitting of cylinder head

1. Clean the surface of the cylinder head and cylinder block. Remove any rust or soot from the screw holes and threads for the cylinder head screws.
2. Fit on the new cylinder head gasket.
3. Check the cylinder head screw "waists" for distortion. Dip the screws completely including the screw heads in rustproofing agent P/N 116 1346-0 and allow them to run off in a net. The screw should not drip during installation (oil can otherwise be forced out and interpreted as leakage).

⚠ IMPORTANT! The screws are phosphated and must not be cleaned with steel brushes. If the cylinder head is painted the contact areas of the cylinder head screws must be free of paint, otherwise the clamping force in the screw union will be adversely affected.

4. Check that the tubular pins (guides) are fitted in the block. Place the two rear cylinder head screws in the cylinder head and fit the head.

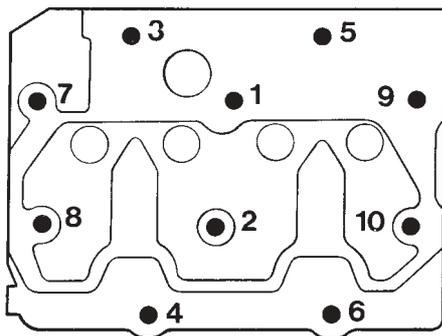


Fig. 30. Tightening diagram, MD2010

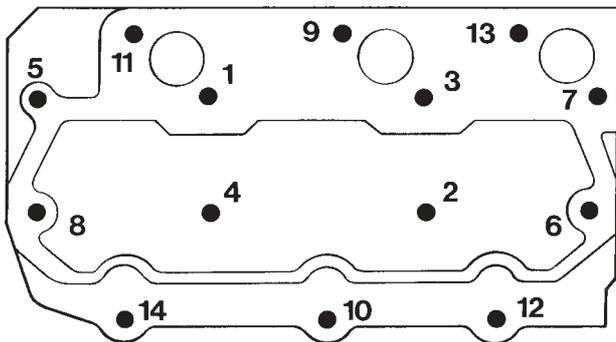


Fig. 31. Tightening diagram MD2020, MD2030, MD2040

5. Tighten the cylinder head screws in three stages as per the following. See tightening diagrams Fig. 30–31.

1st tightening

| | |
|----------------------|----------------------|
| MD2010, MD2020 | 10 Nm (7.40 ft.lbs) |
| MD2030 | 20 Nm (14.80 ft.lbs) |
| MD2040 | 30 Nm (22.10 ft.lbs) |

2nd tightening

| | |
|----------------------|----------------------|
| MD2010, MD2020 | 20 Nm (14.80 ft.lbs) |
| MD2030 | 35 Nm (25.80 ft.lbs) |
| MD2040 | 70 Nm (51.70 ft.lbs) |

Final tightening

| | |
|----------------------|-------------------------|
| MD2010, MD2020 | 35–40 Nm (26–30 ft.lbs) |
| MD2030 | 50–53 Nm (37–39 ft.lbs) |
| MD2040 | 90–95 Nm (66–70 ft.lbs) |

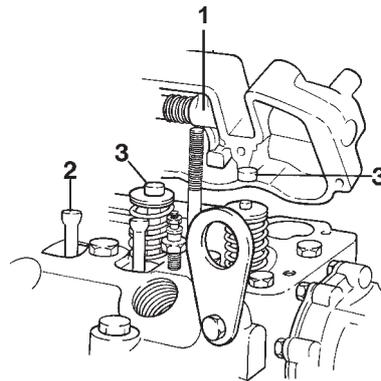


Fig. 32. Fitting of the rocker mechanism (MD2040)

6. Fit the push rods (2), valve caps (3, MD2040 and later versions of 2010, 2020,2030) and rocker mechanism (1).

7. Adjust the valve clearance as per directions on page 34. Fit the valve cover.

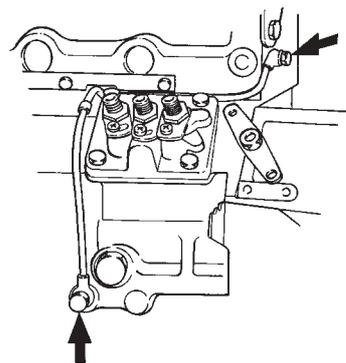


Fig. 33. Fitting of oil pressure pipe (cylinder block – cylinder head / rocker mechanism)

8. Fit the oil pressure pipe between the block and cylinder head (rocker mechanism on MD2040). Tightening torque 10–13 Nm (7.4–9.6 ft.lbs).

9. MD2010, MD2020: Fit the circulation pump.
MD2030: Fit the circulation pump and thermostat and spring (see Fig. 35).
10. Fit the glow plug, Tightening torque: see Technical data. Fit the conductor rail and connect the electric cable.

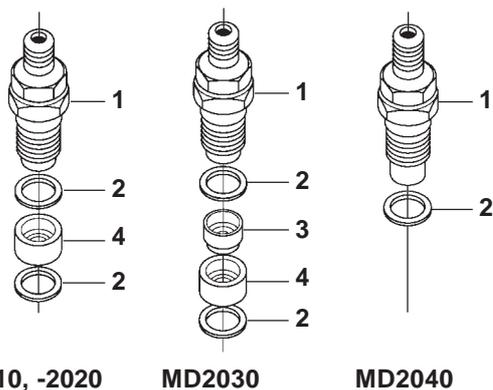


Fig. 34. Fitting of injectors

- | | |
|------------------|-------------------------|
| 1. Injector | 3. Heat shield (MD2030) |
| 2. Copper gasket | 4. Insert (MD2010–2030) |

11. Fit the copper gaskets, heat shields (MD2030) and inserts (MD2010–MD2030) to the injectors as per Fig. 34.

Fit the injectors. Use socket L=80 mm (3.15 in), key width = 22 mm (MD2010–MD2030), and 27 mm (MD2040).

Tightening torque MD2010, MD2030, MD2040:
60–70 Nm (44.3–51.7 ft.lbs)

Tightening torque MD2030:
80–85 Nm (59.0–62.7 ft.lbs).

12. Put on new copper gasket and fit the fuel leak pipe. Tighten the nuts and connect the return pipe.
13. Fit the delivery pipe complete. Tightening torque 20–25 Nm (14.8–18.4 ft.lbs).
14. MD2010, MD2020, MD2030: Fit the induction manifold.
MD2040: Fit the inlet pipe complete with air filter.

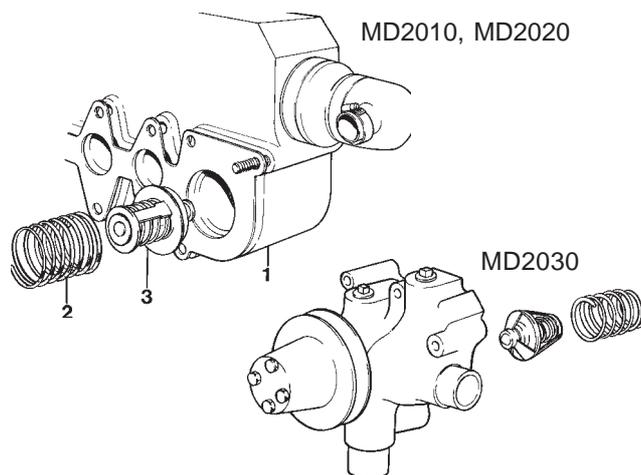


Fig. 35. Fitting of thermostat (MD2010, MD2020, MD2030) and expansion tank.

15. MD2010, MD2020: Fit the rubber seal, thermostat (3) and spring (2) in the heat exchanger housing (1)

16. Fit the expansion tank complete with heat exchanger. Connect the hoses to the heat exchanger housing and refrigerant pump. Tighten the hose clips.

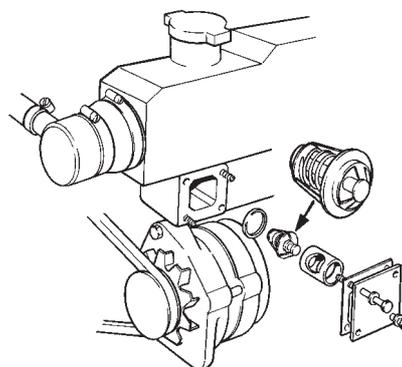


Fig. 36. Fitting of thermostat (MD2040)

17. MD2040: Fit the rubber seal, thermostat and spacer ring in the heat exchanger housing. Fit the cover over the thermostat.
18. Connect the electric cables to the oil pressure relay, and to the refrigerant temperature relay and sensor (where appropriate).

19. Fit the relay box.
20. MD2010, MD2020: Fit the alternator and clamp. Fit the drive belt.
Note: It should be possible to press in the belt approx. 10 mm (.40 in) between the pulleys.
21. Connect the hose to the sea water pump and tighten the clip. Connect the exhaust pipe.
22. Fill with refrigerant. See "Replenishment of refrigerant" on page 66.
23. Connect the battery cables. Open the fuel cocks and bottom valve. Start the engine and check that no leakage occurs.

4. **MD2020. MD2030. MD2040:** Check and adjust if necessary the valve clearance for cylinder No. 1, and the clearance for the outlet valve on cylinder No. 2.
Pull round the crankshaft 240° (2/3 turn) **anti-clockwise** (seen from front) and adjust the clearance for cylinder No. 3 and the clearance for the inlet valve on cylinder No. 2.
5. Clean the valve cover and fit it. Replace the seal if damaged. Test run the engine and check that no leakage occurs.

Adjusting the valves

Note! The clearance must never be checked when the engine is running.

Valve clearance (cold engine):

Inlet and outlet for all engines: 0.20 mm (.0078 in).

1. Dismantle the valve cover.
2. Turn the engine in its normal direction of rotation until both valves for cylinder No. 1 are closed (compression position). Continue turning the engine round until the marking of flywheel shows 0°.

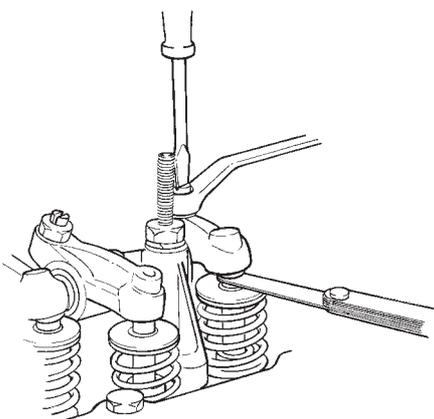


Fig. 37. Adjusting the valves

3. **MD2010:** Check and adjust if necessary the valve clearance for cylinder No. 1.
Pull round the crankshaft 180° (1/2 turn) clockwise (see from front) and adjust the clearance for cylinder No. 2.

Dismantling of piston, piston rings and connecting rod

1. Empty the cooling system and drain or syphon out the engine oil.
2. Dismantle the cylinder head. See "Dismantling of cylinder head" on page 27 and 28.

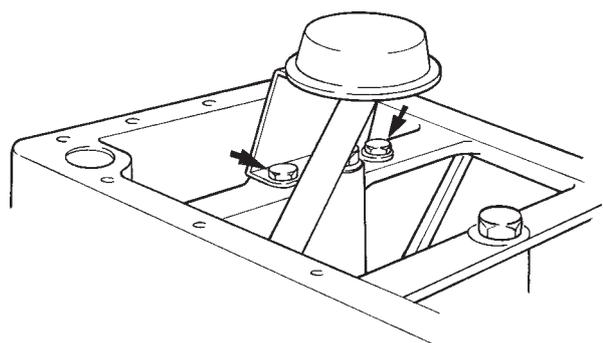


Fig. 38. Dismantling of oil strainer with induction manifold

3. Remove the sump and plate* over the sump. Remove the oil pump's induction manifold.

* There is no plate on the MD2010-40C.

- Turn round the crankshaft until the piston in question is in the lower turning position. Dismantle the main bearing cap with lower bearing cup.

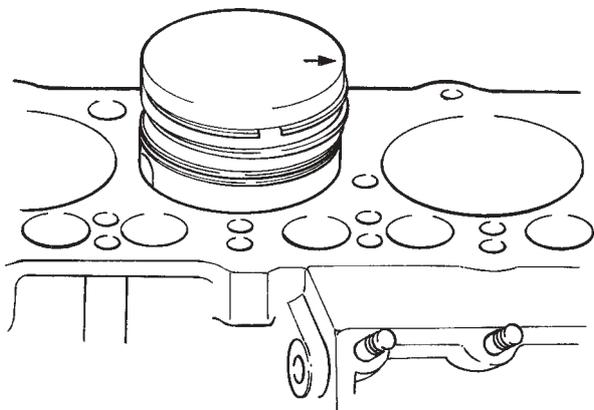


Fig. 39. Dismantling of piston

- Place a pair of plastic hoses as protection over the connecting rod screws. Carefully tap up the connecting rod with piston far enough so that the piston rings are released from the cylinder bore. Lift off the piston together with the connecting rod.

Note: Scrape off the soot strip in the top part of the cylinder bore to simplify dismantling.

- Dismantle piston ring with a piston ring tongs.

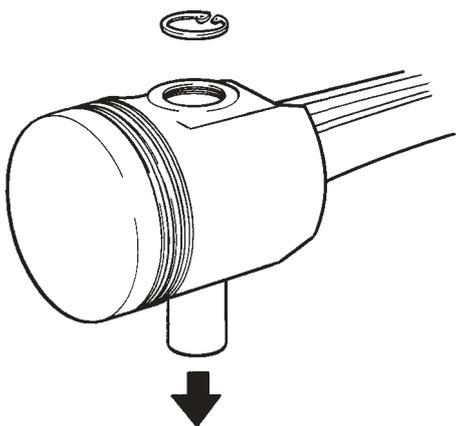


Fig. 40. Dismantling of gudgeon pin

- Remove the circlips for the gudgeon pin and dismantle the gudgeon pin carefully with a suitable mandrel.

Inspection and matching of piston rings

Check the wear surfaces and sides. Black patches on the surfaces imply poor contact and indicate that it is time to change the piston rings. The oil consumption is also a critical factor as to when a piston ring should be replaced.

Check the piston ring gap (Fig. 41). Push down the ring **below the lower turning position** by means of a piston. Replace the piston ring if the gap exceeds 1.0 mm (.039 in).

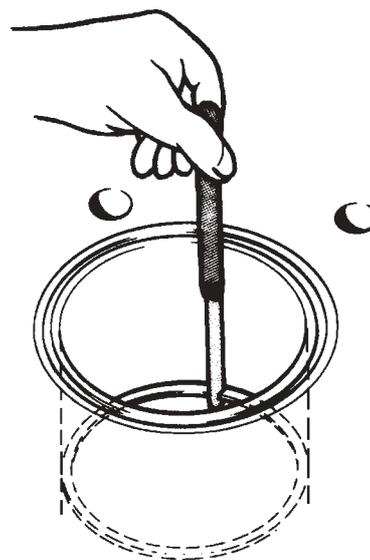


Fig. 41. Checking of piston ring gap

Piston rings should also be replaced if there is noticeable wear or out-of-roundness in the cylinders since the rings seldom have the same position as they had before dismantling.

Check the piston ring gap also on new rings.

See "Technical data" for size info.

Check the clearance in the piston ring groove. Roll the ring in its groove in the piston and measure the clearance at a number of points with a feeler gauge.

Inspection and measuring of piston and cylinder bore

Check the pistons for cracks, cracked piston ring bars and worn piston ring grooves. Replace the piston if it has deep markings in the skirt surface, and similarly if the piston has one or several cracks in the gudgeon pin hole. Testing for cracks is best done as per the lime white method. If such cracks are found the injection equipment should also be checked.

Measure the piston diameter with a micrometer at right-angles to the gudgeon pin hole and 10 mm (.39 in) from the lower edge of the piston (Fig. 42). Measure the cylinder bore (see next paragraph) and calculate the clearance between cylinder and piston.

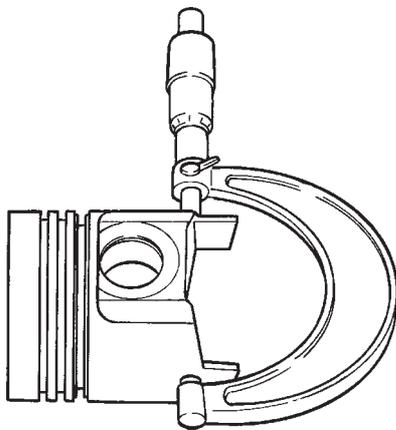


Fig. 42. Measuring of piston

Replace the piston if the clearance exceeds the permissible value, or if the piston diameter is less than the permissible value.

Inspection of cylinder block

Upper block plane

Check that the cylinder block's upper plane does not reveal cracks or other damage. Check also that it is not skew (in the same way as for the cylinder head).

Max. permissible deviation from flatness is 0.12 mm (.0047 in). Replace the cylinder block if it does not lie within this tolerance.

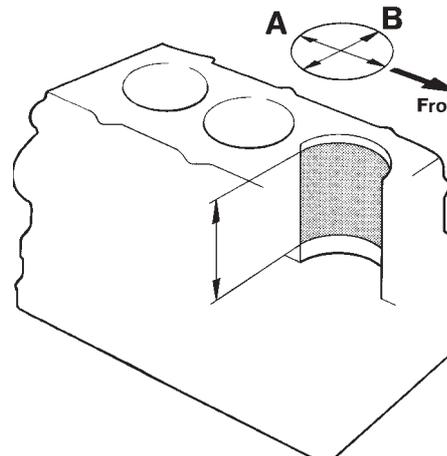


Fig. 43. Measuring of cylinder bore

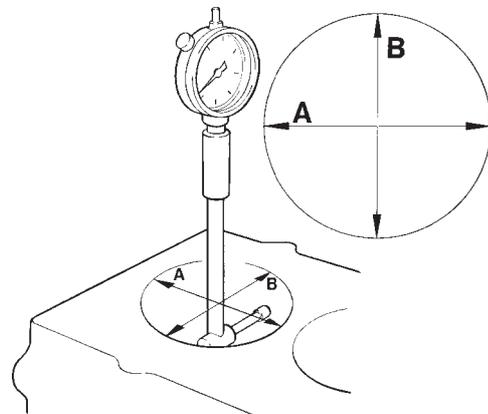


Fig. 44. Measuring of cylinder bore with dial gauge

Cylinder bore

Check that the cylinder bore is not scratched or otherwise damaged.

Measure the cylinder bore at the top and bottom turning points of the piston rings (approx. 10 mm / .40 in and 100 mm / 4.0 in below the cylinder block plane), and also in the middle. The measurements should be made with a dial gauge and both lengthwise and across the cylinder block ("A" and "B", Fig. 43 and 44).

For permissible cylinder diameter see under heading "Wear tolerances" in Technical data on page 15.

Note: The cylinder bore can if necessary be milled to two oversizes: 0.2 mm (.0078 in) and 0.5 mm (.0196 in).

Machining of the cylinder bore

For cylinder diameter see "Technical data".
 Grindstone, size: 100L x 4W
 Speed: 162 rpm
 Feeding (shaft): 13 m/min (42.6 ft/min).
 Pressure: 15 kp/cm² (213 lbf/in²), finish: 5 kp/cm² (71.11 lbf/in²)
 Stroke: 9
 Honing depth: 0.04 mm /.0015 in (diameter)
 Honing angle: 40°
 Surface fineness: 2–4 μm (micron)

Inspection of connecting rod

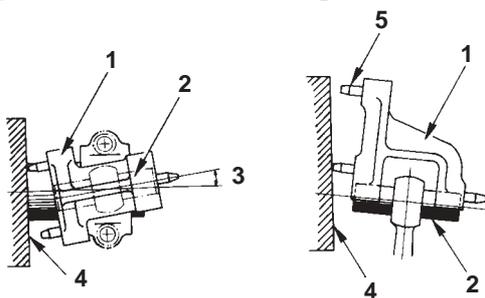


Fig. 45. Checking of connecting rod in fixture

- 1. Indicator
- 2. Gudgeon pin
- 3. Distortion
- 4. Indicating plane
- 5. Pin

Check for cracking. Check linearity and distortion.
 Max. deviation on 100 mm of measured length:

Distortion 0.20 mm (.0078 in)
 Parallelism 0.15 mm (.0059 in)

The measurements are made in a fixture for inspection of connecting rods.

Scrap and replace a connecting rod which is curved or distorted.

Check the axial clearance between the connecting rod and crankshaft. Replace the connecting rod if the clearance exceeds 0.7 mm (.0275 in).

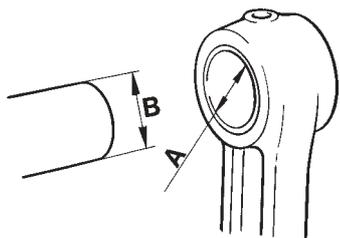


Fig. 46. Clearance, gudgeon pin – bushing

A–B = max 0.08 mm (.0031 in)

Check also the gudgeon bushings. The clearance between the gudgeon pin and bushing must not exceed 0.08 mm (.0031 in).

Replacement of gudgeon bushing

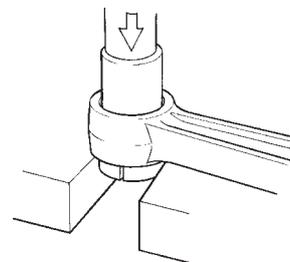


Fig. 47. Pressing out the gudgeon bushing

1. Press out the old bushing as per Fig. 47.

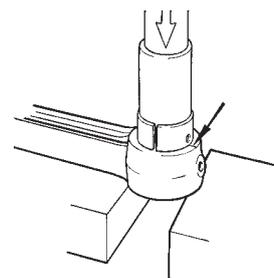


Fig. 48. Fitting of gudgeon bushing

2. Press in the new bushing with the same tool. The bushing is fitted as per Fig. 48.

NOTE! Make sure that the bushing's oil hole corresponds with the hole in the connecting rod. Draw a line over the hole in the bushing and connecting rod with a pen (Fig. 48). Check that the oil channel is open after pressing in.

3. Ream the bushing and mark the connecting rod.

Assembly of piston, piston rings and connecting rod

Note: Check that pistons of the correct oversize are used if the cylinders have been milled to oversize.

1. Fit one circlip in the piston.
2. Oil in the gudgeon pin and bushing.

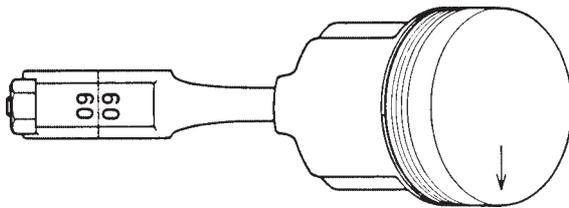


Fig. 49. Assembly of piston and connecting rod (MD2010, MD2020)

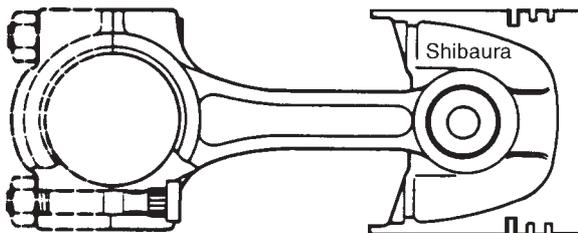


Fig. 50. Assembly of piston and connecting rod (MD2030, MD2040)

3. Heat up the piston to approx. 100°C (212°F). Place the piston and connecting rod so that the markings correspond with Fig. 49 or 50.

MD2010, MD2020: With the marking on the connecting rod's side upwards the arrow on the piston top should be turned in the same direction as per Fig. 49.

MD2030, MD2040: The marking on the connecting rod and the "SHIBAURA" mark in the piston should be turned in the same direction as per Fig. 50.

Push in the gudgeon pin.

NOTE! The gudgeon pin should be able to be pressed in easily. It must not be knocked in.

4. Fit the other circlip.
5. Check that the connecting rod goes easily in the gudgeon pin bearing.

6. Check the big-end clearance. See "Inspection of crankshaft" and "Inspection of main and big-end bearings" on pages 46 and 47.
7. Check the piston ring gap in the cylinder bore (Fig. 41 on page 35) and that the rings do not jam in the piston ring grooves.

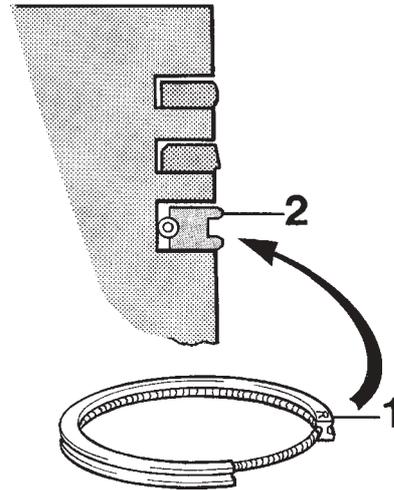


Fig. 51. Placement of piston rings

1. TOP marking
2. Oil scraper with expander spring (MD2010–2030)

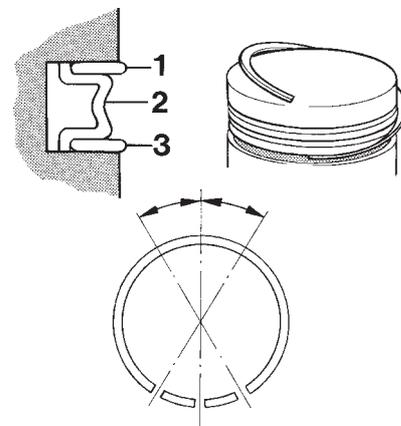


Fig. 52. Fitting of oil ring (MD2040)

1. Top scraper ring
2. Expander
3. Bottom scraper ring

8. Fit the piston rings on the piston with a piston ring tong.

Note: The rings should be turned as per Fig. 51.

MD2010, MD2020, MD2030: Fit the oil ring first (with the marking turned upwards). The opening in the expander spring should be placed 180° from the oil ring gap.

MD2040: Place the expander (2, Fig. 52 on page 40) to the oil scraper rings in the piston ring groove. Check that the ends on the expander do not overlap each other. Fit the top scraper ring (1) over the the expander. Put in one end of the ring in the groove and hold it in place with your thumb. Push the ring in position with your other thumb.

Fit the lower scraper ring (3) in the same way.

Check that the scraper rings run easily in both directions and that the ends on the expander and the rings are in the correct position (Fig. 52).

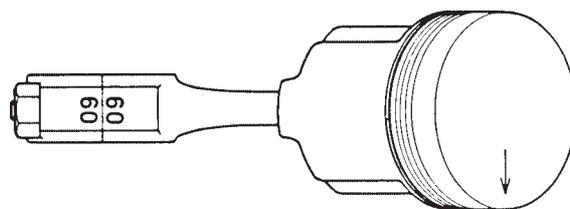


Fig. 53. Number marking on connecting rod and cap

3. Check that the marking on the piston top, alt. in the piston and on the connecting rod, correspond with Fig. 53.

Use a piston ring compressor and fit the piston with connecting rod in the respective cylinder, beginning with cylinder No. 1 (first).

Note: The connecting rod with the **lowest number** should be fitted first (to cylinder No. 1) and subsequently the connecting rod with the highest number closest to the flywheel.

The connecting rod should be turned with the marking (number/colour marking) turned "towards the injection pump" (camshaft side). The arrow on the piston top alt. at the gudgeon pin hole should thereby point forwards.

Fitting of piston in cylinder

Note: After replacing a connecting rod, piston or gudgeon pin the weight difference between the connecting rod complete with piston and piston rings must not exceed 10 g (0.35 oz) between the different cylinders.

1. Lubricate the piston and piston rings with engine oil and turn the rings so that the oil penetrates the piston ring groove. Turn the piston rings so that the piston ring gaps are divided by 90° from each other.

Note: Make sure that no piston ring gap is positioned opposite the piston bolt or at right angles to it.

MD2040: Check that the ends on the expander and scraper rings are in the correct position (Fig. 52).

2. Place the bearing cups in their positions in the connecting rod and cap. Check that the hole in the bearing cups comes opposite the hole in the connecting rod. Oil in the crank pin with engine oil.

4. Fit the bearing cap and tighten the connecting rod screws. See "Technical data" for tightening torque.

Note: The main bearing cap should be fitted so that the number/colour marking on the crankshaft and cap correspond (Fig. 53).

Undamaged connecting rod screws do not need to be changed and can be re-fitted.

Timing gears

Replacement of front crankshaft seal

The seal consists of a rubber ring and can be replaced after the crankshaft pulley has been removed. Use a universal extractor.

1. Tap in one side of the seal so that it goes on edge. Pull out the seal with a hook.

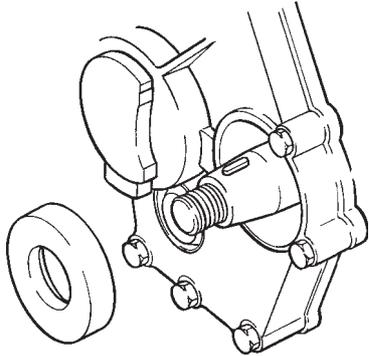


Fig. 54. Fitting of crankshaft seal

2. Oil in the new seal with fit it with a suitable mandrel.

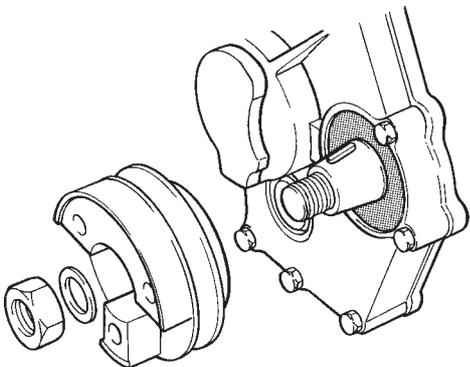


Fig. 55. Fitting of crankshaft pulley

3. Remove the fitting tool. Fit the key and crankshaft pulley.

See Technical data for tightening torque.

Dismantling of the timing gear

WARNING! If the crankshaft and camshaft are turned without being synchronised with each other the valves can go against the pistons and be damaged.

1. Close the fuel cocks. Remove both battery leads.
2. Close the bottom valve. Release the rubber hoses to the sea water pump and drain out the water in the sea water system.
3. Remove the sea water pump.
4. Remove the drive belt for the alternator.

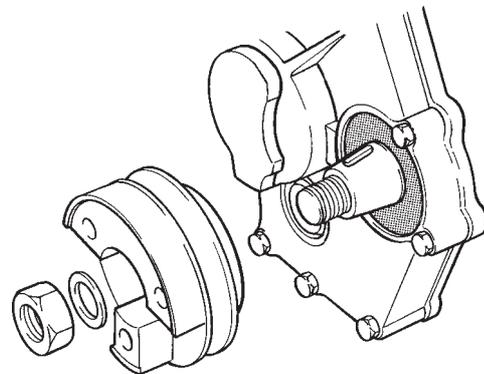


Fig. 56. Dismantling of crankshaft pulley

5. Remove the pulley from the crankshaft. Use a universal extractor (Use an adjustable spanner on the lug on the pulley as a counterhold when the nut is removed)

6. Remove the delivery pipe complete. Release the fuel house and fuel leak pipe at the injection pump.

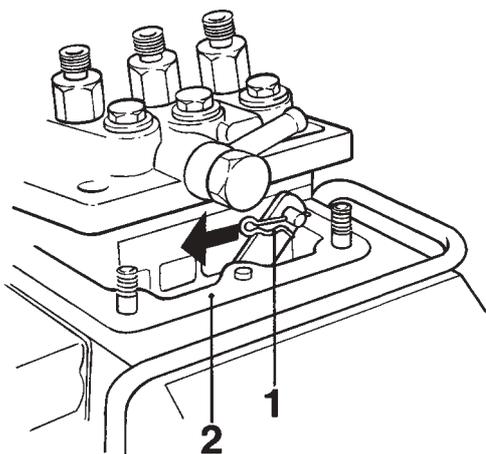


Fig. 57. Dismantling of injection pump

- 1. Lock pin
- 2. Shims

7. Release the injection pump. Turn the stop lever clockwise and carefully lift up the pump so that the lock pin to the regulator arm is accessible (Fig. 57). Remove the lock pin and release the regulator arm. Lift off the injection pump.

NOTE! Take care off the shims under the injection pump flange.

8. Dismantle the timing gear casing.

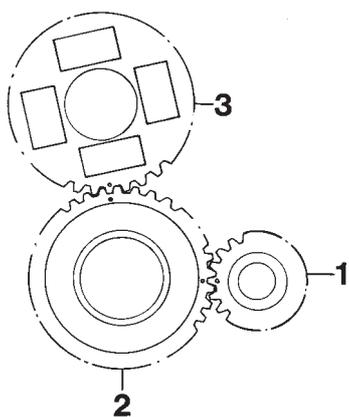


Fig. 58. Timing gears, basic setting

- 1. Crankshaft gear
- 2. Intermediate gear
- 3. Camshaft gear

9. Pull round the engine until the markings on the timing gears correspond.

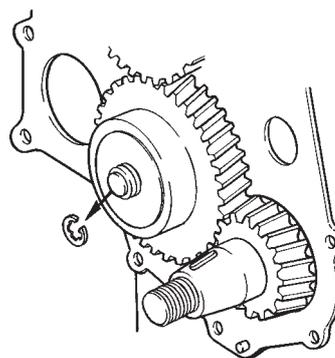


Fig. 59. Dismantling of circlip to cover for the oil pump

10. Remove the circlip for the intermediate gear (Fig. 59). Take care of the sleeve washer, spring and shims.

Lift off the gear complete with cover and oil pump.

11. Dismantle the crankshaft gear with a universal extractor.
12. If the camshaft gear is to be dismantled the camshaft must be removed complete. See under heading "Dismantling of camshaft" on page 44.

Inspection of timing gears

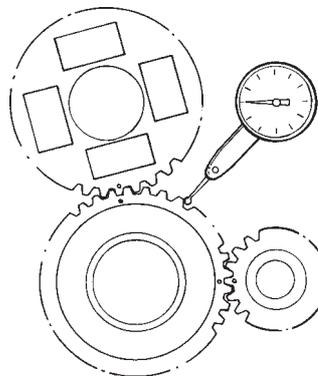


Fig. 60. Checking of gear flank clearance

Clean the gears and other parts of the timing gears and check them carefully. Replace gears which are heavily worn or damaged.

Check the flank clearance with a feeler gauge or a dial gauge.

Max. permissible flank clearance: 0.25 mm (.0098 in).

Note: If the flank clearance exceeds the permissible value all the the gears in the timing gears should be replaced.

Fitting and adjustment

⚠ WARNING! If the crankshaft and camshaft are turned without being synchronised with each other the valves can go against the pistons and be damaged.

Note: The gears in the timing gears which are of importance for adjustment are marked as follows:

Crankshaft gear – the intermediate gear is marked with a punch mark and the intermediate gear – camshaft gear with a circle opposite the tooth and tooth gap (Fig. 61).

1. Put the key in position in the crankshaft and fit the crankshaft gear.
2. Fit the camshaft complete with regulator weights. Carry out work steps to item 4 under the heading "Fitting of camshaft" on page 45.

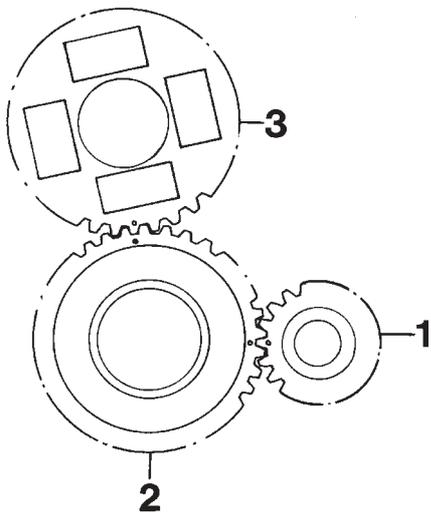


Fig. 61. Timing gears, basic setting

1. Crankshaft gear
2. Intermediate gear
3. Camshaft gear

3. Fit the thrust washer (9, Fig. 62) on the intermediate gear's shaft journal. Fit the intermediate gear as per the markings (Fig. 61).

NOTE! Do not turn the crankshaft before the timing gear casing is fitted.

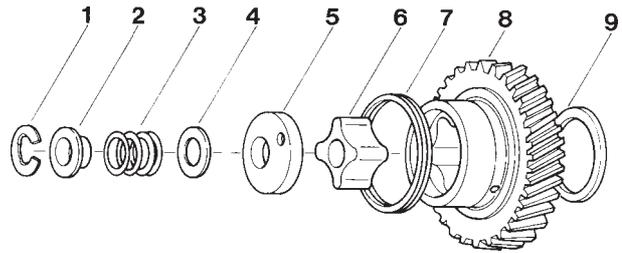


Fig. 62. Intermediate gear complete with oil pump

- | | |
|----------------------|--|
| 1. Circlip | 6. Inner rotor |
| 2. Spring washer | 7. Spring |
| 3. Spring | 8. Intermediate gear complete with outer rotor |
| 4. Shims | 9. Thrust washer |
| 5. Cover to oil pump | |

4. Grease in the oil pump's inner rotor (6, Fig 62) and housing (outer rotor, 8).

Fit the inner rotor and cover to the oil pump. Fit the shims, spring, spring washer and lock washer as per Fig. 62.

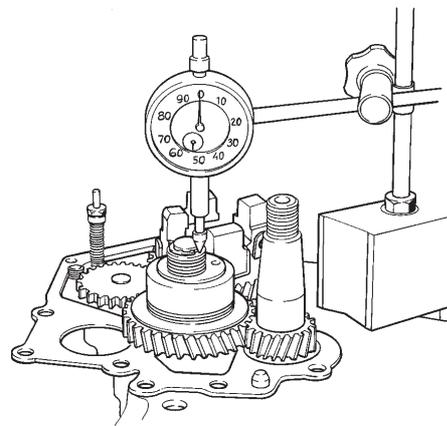


Fig. 63. Checking of oil pump's axial clearance

5. Adjust the oil pump's axial clearance to 0.10–0.15 mm (.0039–.0059 in). Shims are available in sizes 0.10; 0.15; 0.20 and 0.50 mm (.0039, .0059, .0078 and .0196 in)
6. Check the crankshaft seal in the timing gear casing, and replace if necessary. See under heading "Replacement of front crankshaft seal" on page 42.

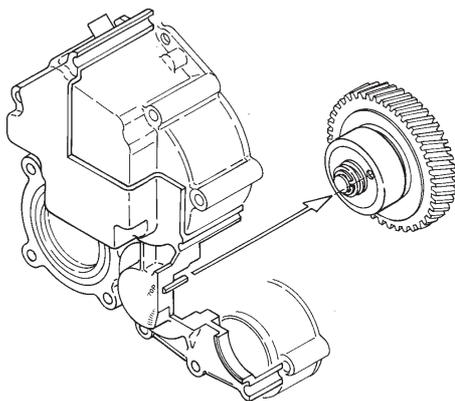


Fig. 64. Fitting of timing gear casing

- 7. Centre the cover in front of the oil pump.

Note: The hole in the cover should be in the position shown in Fig. 64 (which it should if the markings on the gear wheel coincide according to Fig. 61).

- 8. Place the timing gear casing in position with a new gasket. Observe care so that the crankshaft seal is not damaged.

Check that the start spring is in position in the timing gear casing and is connected to the regulator arm (link arm).
Put in the regulator through the hole in the cylinder block.

Note: Check that the tubular pip in the timing gear casing can engage in the hole in the oil pump cover. Turn the cover backwards and forwards and centre it in mid position.

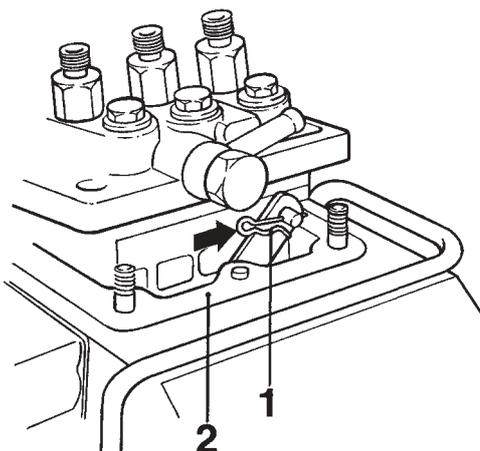


Fig. 65. Fitting of injector pump

- 1. Lock pin
- 2. Shims

- 9. Turn the stop lever clockwise and connect the arm to the injection pump. Fit the lock pin.

NOTE! Make sure that the shims which were placed under the injection pump flange are replaced in position before the pump is placed in the cylinder block (applicable where the pumps has been removed).

- 10. Tighten the timing gear casing and injection pump.

Tightening torque: see Technical data.

- 11. Check the injection start (crankshaft position) in the event that a new injection pump or complete new camshaft is fitted and if a new cylinder block is used.

See directions under the heading "Adjustment of injection angle" on pages 57 and 58.

- 12. Connect the fuel hose to the injection pump.

Fit the delivery pipe.

Tightening torque: see Technical data.

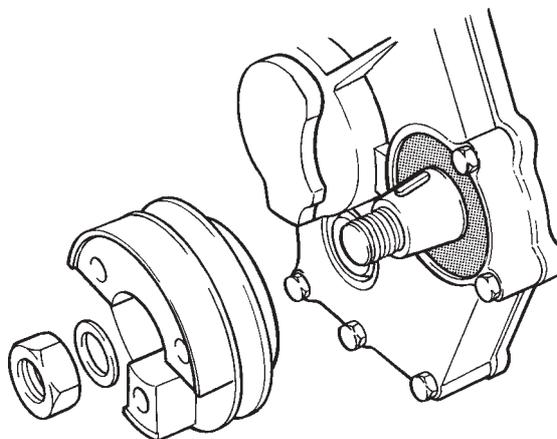


Fig. 66. Fitting of crankshaft pulley

- 13. Put the key in position in the crankshaft and fit the crankshaft pulley.

Tightening torque: see Technical data.

14. Fit the sea water pump on the timing gear casing. Connect the water hoses to the pump.
15. Fit the drive belt to the alternator.
Note: If the tension is correct the belt should be able to be pressed in approx. 10 mm (.40 in) between the pulleys.
16. Open the fuel cocks. Bleed the fuel system as per the directions on page 61.
17. Connect the battery leads.

Camshaft

Dismantling the camshaft

1. Dismantle the cylinder head. See "Dismantling of cylinder head" on page 27. Lift out the valve lifters and place them in order in a rack.
2. Remove the timing gear casing. See under heading "Dismantling of timing gear" on pages 42 and 43.
3. Remove the regulator sleeve from the camshaft.

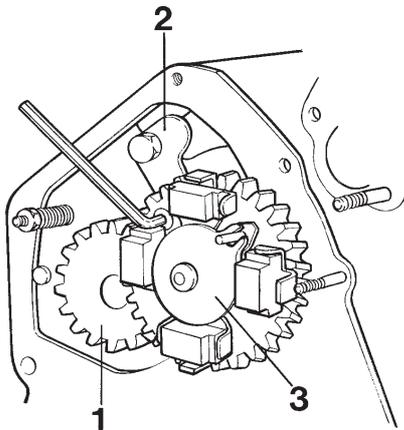


Fig. 67. Dismantling of camshaft

- | | |
|----------------|--------------------|
| 1. Gear | 3. Regulatorsleeve |
| 2. Lock washer | |

4. Remove the screws for the lock plate (one screw is accessible through the hole in the camshaft gear), Fig. 67.
5. Lift out the camshaft complete with gear and regulator weights.

Note: Observe care so that bearings, bearing races or cams are not damaged.

On MD2030 and MD2040 the gear for the mechanical tachometer drive* must be removed together with the camshaft.

6. MD2010, MD2020: Remove the gear for the mechanical tachometer drive*.

* **Note:** Mechanical tachometer driving is not used by Volvo Penta. The gear must, however, be in position.

Inspection of valve lifter and camshaft

NOTE! If the lifter is worn over the lift surface the lifter must be scrapped. The "dike" shows that the lifter has not rotated. A dark stripe on the outer lift surface shows, however, that the surface is not worn.

It is the condition of the valve lifters that determines whether further checking of camshaft wear is necessary.

The cam for example may be skew worn in an axial direction. This can in less severe cases be adjusted by grinding the cams. Replace the camshaft in the event of further damage or wear.

Note: When replacing the camshaft all the valve lifters must be replaced.

Measuring the camshaft

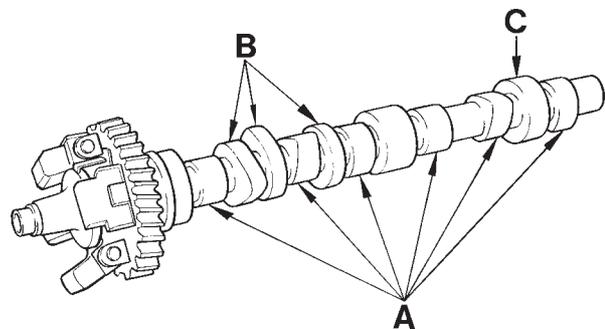


Fig. 68. Measuring the camshaft.

Cam height (inlet and outlet) "A", Fig. 68.

MD2010, MD2020, MD2030: min. 26.1 mm
(1.027 in)

MD2040: 33.7 mm (1.326 in)

Cam height "B" (for injection pump)

MD2010, MD2020: min. 34.3 mm (1.350 in)

MD2030: 33.8 mm (1.330 in)

MD2040: 41.8 mm (1.645 in)

Cam height "C" (for feed pump)

MD2010, MD2020, MD2030: min. 27.0 mm
(1.062 in)

MD2040: 30.0 mm (1.181 in)

Replace the camshaft if the wear tolerances are not maintained.

Fitting the camshaft

Note: If parts have been replaced on the camshaft the fitting of these should take place in the order shown in Fig. 69.

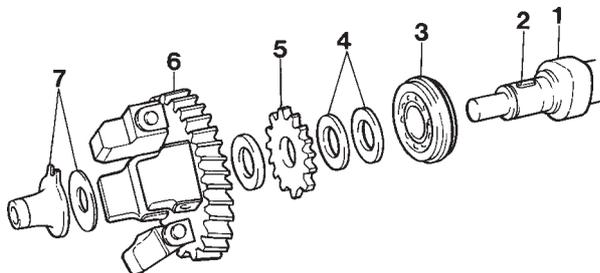


Fig. 69. Camshaft

- | | |
|-------------------|--|
| 1. Camshaft | 5. Gear for drive of mech. tachometer* |
| 2. Key | 6. Camshaft gear |
| 3. Roller bearing | 7. Regulator sleeve |
| 4. Spacer rings | |

* **Note:** Mechanical tachometers are not used by Volvo Penta, but the gear must still be put in position.

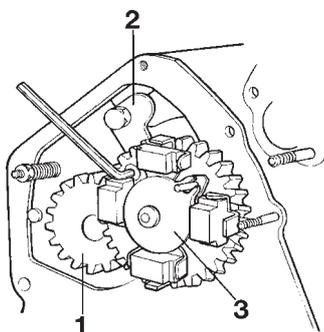


Fig. 70. Fitting the camshaft

- | | |
|----------------|---------------------|
| 1. Gear | 3. Regulator sleeve |
| 2. Lock washer | |

- MD2010, MD2020: Fit the gear (1, Fig. 70) for the mechanical tachometer drive*.
- Oil in the camshaft's bearing races and carefully lift the camshaft in position complete with gear and regulator weights (together with the gear (1) for the mechanical tachometer drive* on MD2030 and MD2040.

Note: Observe care so that bearings, bearing races or cams are not damaged.

- Fit the lock washer (2) for the camshaft in the correct position and tighten it. Tightening torque: 9–13 Nm (6.6–9.6 ft.lbs).

- Fit the regulator sleeve (3). **Note:** The sleeve should engage with the pin on the camshaft gear.
* **Note:** Mechanical tachometers are not used by Volvo Penta, but the gear must still be put in position.

- Check that the markings on the timing gear correspond (Fig. 58 on page 43).

- Carry out the work as per items 8 to 11 under the heading "Fitting and adjustment (timing gears) on page 45.

- Lubricate the mating surface on the valve lifters to the camshaft with molybdenum disulphide and oil in the guides in the cylinder block. Fit the valve lifters in the correct order.

- Fit the pull rods and rocker mechanism. Tightening torque, see Technical data.

- Carry out the work as per items 6 to 8 under the heading "Fitting of cylinder head" on page 34.

- Adjust the valve clearance as per the direction of page 36. Fit the valve cover.

Tightening torque, see Technical data.

- Carry out the work as per items 12 to 17 under the heading "Fitting and adjustment (timing gears) on pages 45 and 46.

Crank mechanism

Dismantling of crankshaft

(engine removed)

1. Dismantle the reverse gear alt. S-drive and adapter plate and coupling, flywheel and flywheel housing.
2. Remove the cylinder head. See under heading "Dismantling of the cylinder head" on pages 27 and 28.
3. Remove the valve lifters and place them in order in a rack.
4. Remove the pistons with connecting rods. Carry out the work steps to item 5 under the heading "Dismantling of piston, piston rings and connecting rod" on pages 36 and 37.
5. Remove the timing gear casing. Carry out the work steps to item 8 and item 10 under the heading "Dismantling of timing gears" on pages 42 and 43.

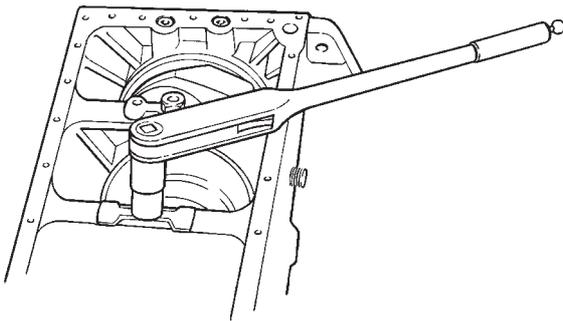


Fig. 71. Dismantling of main bearing cap

6. Remove the lock screws which hold the main bearing cap (Fig. 71). Carefully lift off the crankshaft complete with cap backwards.

Note: Tape the crankshaft gear to protect the bearing surfaces in the block during dismantling.
7. Remove the main bearing cap from the crankshaft. MD2040: Take care of both thrust washers in the rear cap.

Inspection of crankshaft

Clean the crankshaft carefully in all channels after dismantling and inspect it very carefully to confirm whether it really need renovating.

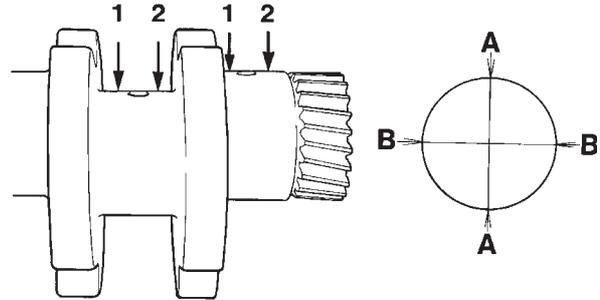


Fig. 72. Check measurement of crankshaft

1. Check the wear and out-of-roundness with a micrometer. Measure the diameters "A-A" and "B-B" in items "1" and "2" (See Fig. 72).

The max. permissible conicity and out-of-roundness on the main and big-end bearings is 0.05 mm (.0019 in). Grind the crankshaft to an appropriate undersize if these values are exceeded. Bearing cups are available in two oversizes.
2. Measure the crankshafts longitudinal curvature (distortion). Place the crankshaft on a pair of V-blocks placed under the front and rear of the main bearing journal. Alternatively the shaft can be braced between spikes. Measuring should be carried out on the middle main bearing journal(s).

Max. longitudinal curvature (distortion): 0.06 mm (.0023 in).

If this value is exceeded the crankshaft must be aligned or replaced.
3. Check that the mating surfaces on crankshaft seals are not worn or damaged.

Grinding of the crankshaft

To achieve satisfactory results in connection with grinding the following factors should be taken into consideration:

1. Grind the crankshaft in a crankshaft grinding machine to the undersize as per "Technical data". Surface fineness 1.6 Z ($\nabla\nabla\nabla$) for bearing races (B, Fig. 73) and recess radius are achieved by rubbing with emery cloth No. 400.

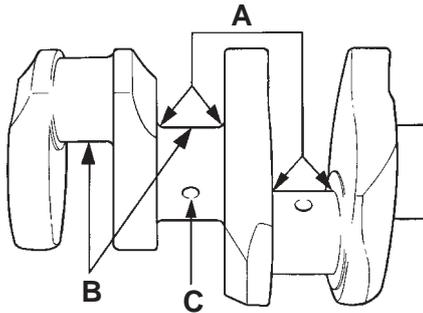


Fig. 73. Checking of recess radius

2. It is very important that the recess radius is the correct size.

Recess radius:

- At main and big-end bearing journals, "A" = 3 ± 0.25 mm (.1181 \pm .0098 in)
- At oil holes, "C" = min. 2 mm (.0787 in), max. 5 mm (.1968 in).

Grinding hacks and sharp edges must be avoided since these can give rise to crankshaft fracture.

3. Clean the crankshaft well from grinding residue and other impurities. Flush and clean the oil channels.

Inspection of main and big-end bearings

Check the main and big-end bearing cups and the front crankshaft busing. Replace worn bearings or those with damaged bearing surfaces.

Inspection of front crankshaft bushing

Check the bearing clearance between the big-end journal and bushing. Use a cylinder indicator and a micrometer.

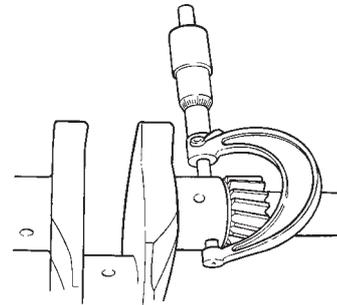


Fig. 74. Checking of bearing clearance

1. Measure the bushing's inner diameter at points 1 and 2 as per Fig. 72 on page 46. Measure in two directions ("A" and "B") at each point.
2. Measure the bearing journal's outer diameter and calculate the bearing clearance (difference between the previous measurement and the bearing journal's max. diameter).
Max. bearing clearance: 0.2 mm (.0078 in).

Replace the bushing if the clearance exceeds the permissible value. Where necessary the crankshaft can be ground to an appropriate undersize and the bushing can be replaced with a corresponding oversize.

Note: Check the bearing clearance again before the crankshaft is fitted if it has been re-ground.

Replacement of front crankshaft bushing

1. Dismantle the bushing from the cylinder block.
2. Check that the bushing's mating surface in the block has no burrs or upset ends.

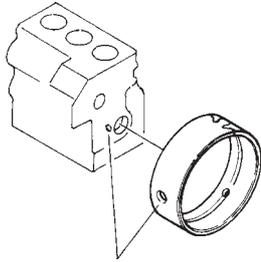


Fig. 75. Marking up of oil hole

3. Draw a line over the hole in the block and bushing with a marker pen (Fig. 75). Oil in the outside of the bushing and its mating surface in the block.

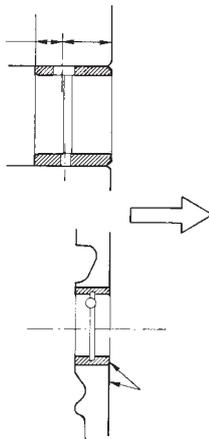


Fig. 76. Fitting of the bushing

4. Make sure that the bushing's oil hole corresponds with the oil channel in the cylinder block and press in the new bushing to the correct depth.

NOTE! The bushing should be pressed in from the front of the block and with the bevelled side of the bushing turned forwards (Fig. 76).

5. Check that the oil channel is open after pressing in. Check also the bushing's inner diameter. See "Technical data" for size.

Checking of big-end bearing clearance

Special tool: 856927-9 (measuring plastic)

The big-end bearing's radial bearing clearance can be checked by means of the measuring plastic (part. No. 856927-9) as follows:

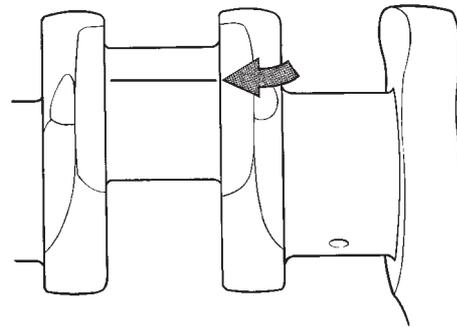


Fig. 77. Application of measuring plastic

1. Wipe clean the big-end bearing and big-end journal from oil. Cut a piece of measuring plastic to the same length as the bearing width and apply the measuring plastic along the big-end journal (Fig. 77).

Note: Avoid the oil hole.

2. Fit the connecting rod and cap (note markings correspond) and tighten the crankshaft screws. Tightening torque, see Technical data.

NOTE! Do not turn the connecting rod or crankshaft since this will destroy the measuring strip.

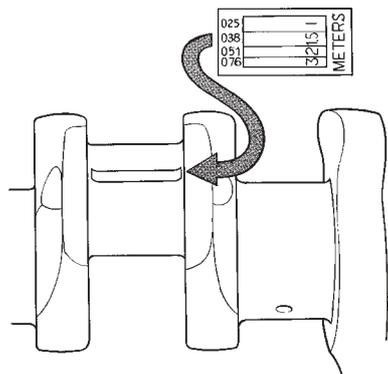


Fig. 78. Check measuring of measuring plastic

- Remove the cap and measure the width on the pressed out measuring plastic at the widest point. Use the scale which accompanies the measuring plastic (Fig. 78).

Max. permissible big-end bearing clearance:
0.2 mm (.0078 in).

Replace the big-end bearing if the bearing clearance exceeds the permissible value. If necessary the journals can be ground to an undersize and oversize bearings fitted. Big-end bearings are available in two oversizes.

NOTE! Check the bearing clearance again before assembly if the journals have been ground.

Fitting of the crankshaft

- Check the cleaning of the crankshaft channels and bearing surfaces, cylinder block and cap. Check also that the bearing cups and their mating surfaces have no burrs or upset ends.
- Place the main bearing in position in the cap. **Check that the lubrication holes in the top bearing cups come opposite the oil channels.**
- Oil in the bearing and main bearing journals and fit the caps on the crankshaft.

Note : The bevelled edge (1, Fig. 79a and 79b) should be turned forwards on all caps.

- Fit the cap which is provided with a groove as per 2, Fig. 79a and 79b.

Note: The bearing cups provided with an oil groove (3, Fig. 79a and 79b) should be placed in the **top** cap.

MD2010, MD2020, MD2030: Fit **aluminium** caps (with integrated thrust washers) at the **far end** (flywheel side).

MD2040: Place both thrust washers in the lower cap at the far end (flywheel side) and with the oil groove turned towards the crankshaft.

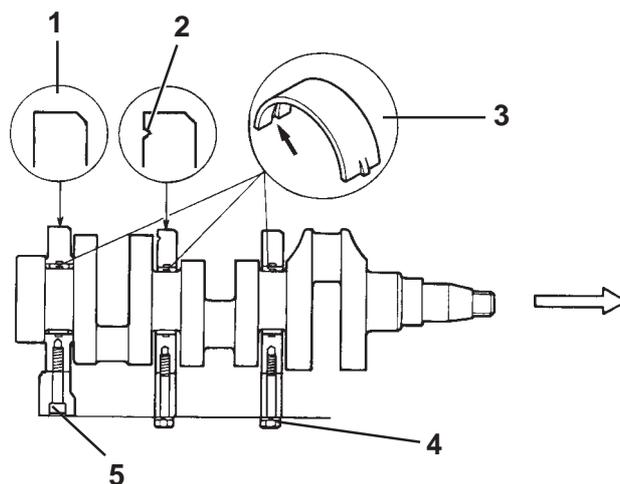


Fig. 79a. Fitting of main bearing cap MD2010, MD2020, MD2030

- | | |
|--|----------------------------------|
| 1. Big-end bearing cap with bevelling | 4. Main bearing cap of cast iron |
| 2. Groove | 5. Main bearing cap of aluminium |
| 3. Top main bearing half with oil groove | |

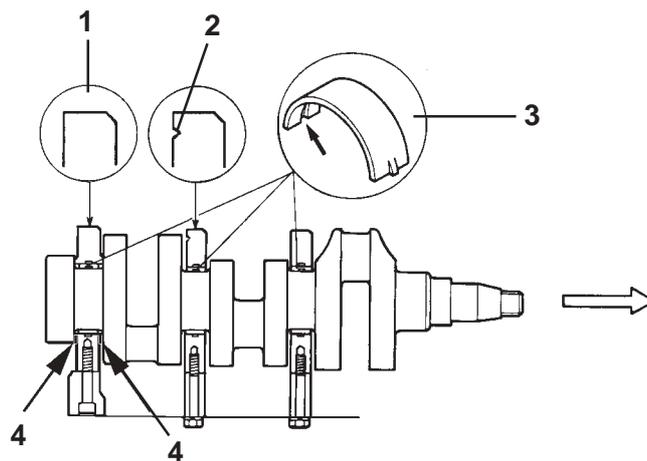


Fig. 79b. Fitting of main bearing cap MD2040

- | | |
|---------------------------------------|--|
| 1. Big-end bearing cap with bevelling | 3. Top main bearing half with oil groove |
| 2. Groove | 4. Thrust washers |

- Carefully lift the crankshaft in position in the cylinder block.

Note: Tape the crankshaft gear before the crankshaft is lifted in. The cogs can otherwise damage the bearing surfaces in the cylinder block.

- Tighten the main bearing cap. Tightening torque, see Technical data.

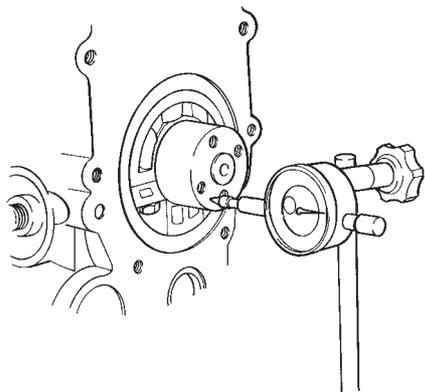


Fig. 80. Checking of axial clearance

- Check that the axial clearance does not exceed 0.5 mm (.0196 in).

Replacement of gear ring on the flywheel

- Mark up the position of the flywheel in relation to the crankshaft (to simplify fitting). Dismantle the flywheel.
- Drill one or a couple of holes in a tooth gap on the gear ring. Split the ring at the drilled hole with a chisel, after which the gear ring can be removed.
- Brush clean the mating surface on the flywheel with a steel brush.
- Heat up the new gear ring in an oven (120–150°C/ 248–302°F) so that the gear ring becomes evenly hot all round.
- Place the heated gear ring on the flywheel and drive on with a hammer and soft mandrel. The gear ring should then cool in the free air.
- Clean the mating surfaces on the flywheel and crankshaft. Check the rear crankshaft seal. Replace if necessary.
- Fit the flywheel in the correct position (guide pin on MD2030 and MD2040).
Tightening torque, see Technical data.

Replacement of rear crankshaft seal

The seal consists of a rubber ring and becomes accessible after the adapter plate at the back of the flywheel housing, the flexible coupling, flywheel* and flywheel housing have been removed.

***Note:** Mark up the position of the flywheel in relation to the crankshaft (simplified fitting).

- Clean the position for the sealing ring in the cylinder block and the mating surface on the flywheel housing.

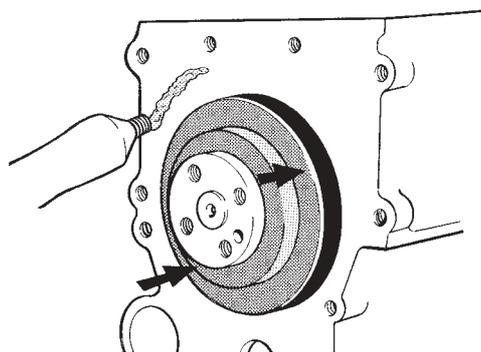


Fig. 81. Fitting of crankshaft seal

- Apply an even layer of sealing compound (VP no. 840 879) round the flywheel housing's mating surface (screw holes).
Apply grease on the sealing lip and fit the seal.
- Fit the flywheel housing, flywheel, the flexible coupling, and the adapter plate.
Tightening torque, see Technical data.

Lubricating system

General

The engines are provided with a pressure lubricating system with an oil filter of the full flow type.

Oil pump

The oil pump is placed in the intermediate gear in the transmission, and from where it is also driven.

The pump is of the rotor type with an inner and outer rotor placed eccentrically in relation to each other. The inner rotor has one "cog" less than the outer rotor.

The function of the pump is based on the increase and decrease of the space between the outer and inner rotor cogs. During the first part of the inner rotor's rotation speed the volume is increased, whereby an underpressure occurs and oil is induced in through the inlet. After approx. 1/2 turn the space is reduced and a pressure condition occurs which presses out oil through the outlet.

Reducing valve

The oil pressure is limited by a reducing valve. The valve is placed in the lubricating system just in front of the oil filter and is fitted on the right-hand side of the cylinder block in front of the oil filter.

The valve opens at excessive high pressure and releases oil back to the sump.

Crankcase ventilation

To prevent overpressure and to separate fuel vapour, steam and other gaseous combustion products, the engine is fitted with enclosed crankcase ventilation.

Oil filter

The oil filter is of the full flow type which implies that all the oil is filtered before it is pressed out to the bearing areas.

The filter is placed on the right-hand side of the cylinder block. The filter element consists of folded filter paper.

In the bottom of the filter there is an overflow valve (A, Fig. 82) which opens and releases oil past the filter if the insert should be blocked.

The filter is of the disposable type and is scrapped after use.

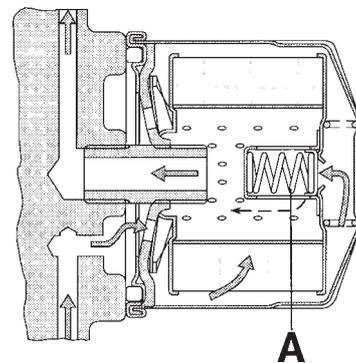


Fig. 82. Oil filter

A. Overflow valve

Repair instructions

Checking of the oil pressure

The oil pressure can be checked by connecting a manometer with hose to the connection for the oil pressure contact (thread size in cylinder head = 1/8"). The oil pressure should at running speed and temperature be 150–500 kPa (1.5–5 kp/cm², 21.3–71.1 lbf/in²).

If the oil pressure is too high or too low the reducing valve can be replaced first and then the oil pressure checked again.

The valve is fitted on the right-hand side of the cylinder block in front of the oil filter (Fig. 83).

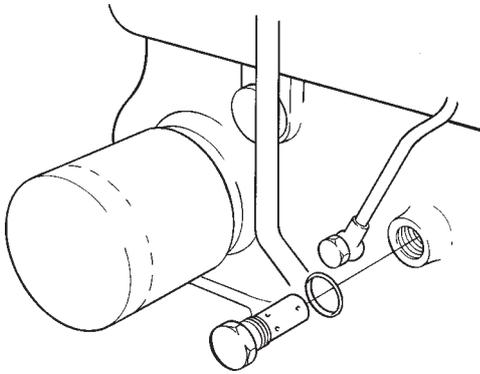


Fig. 83. Replacement of reducing valve

Oil pump

Dismantling of the oil pump

1. See under the heading "Dismantling of the timing gears" on pages 42 and 43. Carry out the work steps 1 to 9.
2. Remove the circlip for the intermediate gear. Take care of the circlip, sleeve washer, spring, shims and oil pump cover.

Inspection of the oil pump

1. Check that the oil pump cover and the inner and outer rotor are not worn or damaged.
2. Check the clearance between the outer and inner rotor (Fig. 84). Max. permissible clearance 0.25 mm (.0098 in).

Note. Contact Volvo Penta service department if the shaft journal for the intermediate gear and oil pump needs to be replaced.

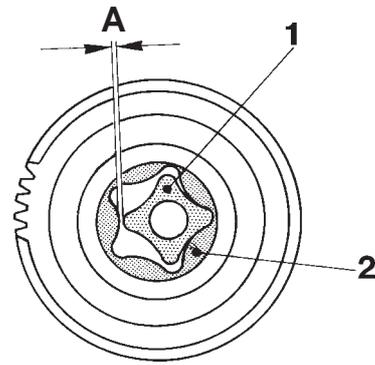


Fig. 84. Checking of oil pump clearance

1. Inner rotor
 2. Outer rotor
- A. Max 0.25 mm (.0098 in)

Fitting of the oil pump

When fitting the oil pump follow the items 4–10 and 12–17 under the heading "Fitting and adjustment" (transmission) on pages 44–46.

Replacing the oil filter



WARNING! Hot oil can result in burn injuries.

1. Place a collection vessel under the oil filter.
2. Unscrew the oil filter and discard (watch out for oil spillage). Use a filter extractor.
3. Moisten the new filter's rubber gasket with oil and check its mating surface on the bracket.
4. Screw on the new filter by hand until the gasket makes contact with the sealing surface, and then tighten the filter an additional 1/2 turn.
5. Replenish if necessary the oil in the engine and start it. Check that no leakage occurs.

Oil channels

Clean up and flush the oil channels in the engine with cleaning liquid and then with steam or flushing oil at a pressure of 300–400 kPa (3–4 kp/cm², 42.6–56.8 lbf/in²) in connection with more extensive engine overhaul.

Note: Do not forget to clean the oil pressure pipe between the cylinder block and cylinder head.

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

Fuel system

General

The fuel is induced by the feed pump from the fuel tank through a water separating pre-filter (accessory) and pressed through the fine filter to the injection pump (Fig. 85).

Return fuel from the injectors is led through the fuel leak pipe/return pipe back to the tank.

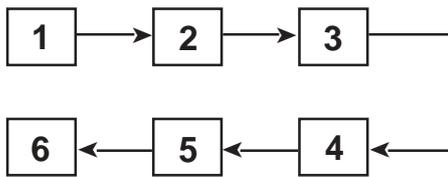


Fig. 85. Fuel system, principle drawing

- | | |
|---------------|---------------------|
| 1. Fuel tank | 4. Fine fuel filter |
| 2. Pre-filter | 5. Injection pump |
| 3. Feed pump | 6. Injector |

Injection pump

The injection pump is a flange-mounted in-line pump placed on the right-hand side of the engine. The pump is driven via cams on the engine's camshaft which directly activate the pump element.

Centrifugal regulator

The regulator is mechanical and works with speed sensing regulator weights. It is fitted at the front on the camshaft gear from where it is also driven.

The regulator weights activate the injection pump's control rod via the regulator sleeve, a lever and a regulator arm. The speed is regulated over the entire engine speed range, from low idling speed to high speed (universal type).

Feed pump

The feed pump is also positioned on the right-hand of the engine and is driven via a cam on the engine's camshaft.

Injectors

The engines are fitted with injectors (Fig. 86). Each injector basically consists of a nozzle holder and a nozzle.

When the fuel pressure has increased to the set value (opening pressure) the nozzle needle (pin) (5) lifts which is held pressed against its seat by the thrust washer (6) and atomised fuel is injected into the engine's precombustion chamber.

The injector's opening pressure is determined by the tension of the thrust washer, which in turn is adjusted with adjuster washers (7).

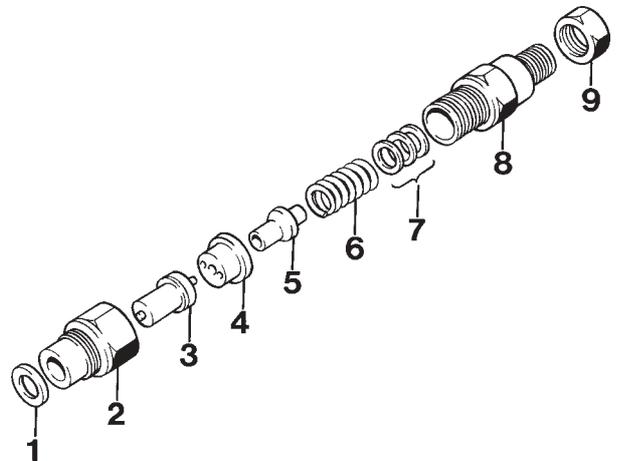


Fig. 86. Injector, complete

- | | |
|------------------------|---------------------|
| 1. Packing | 6. Thrust washer |
| 2. Nozzle nut | 7. Adjuster washers |
| 3. Nozzle sleeve | 8. Nozzle holder |
| 4. Spacer | 9. Nut |
| 5. Nozzle needle (pin) | |

Fuel filter

The fuel filter is of the disposable type. The filter insert consists of a specially wound paper filter.

Repair instructions

Observe the greatest possible cleanliness when working with the fuel system.

Injection pump

Dismantling of the injection pump

NOTE! Repair work on the injection pump which may change its setting should only be carried out by specially trained mechanics which have the requisite equipment at their disposal.

Engine warranties are not longer valid if the seals are broken by unauthorised personnel.

1. Carefully wash clean the injection pump, pipes and the engine around the pump.
2. Close the fuel cocks. Remove the delivery pipe complete. Release the fuel hose from the pump.

Fit protective caps on all connections.

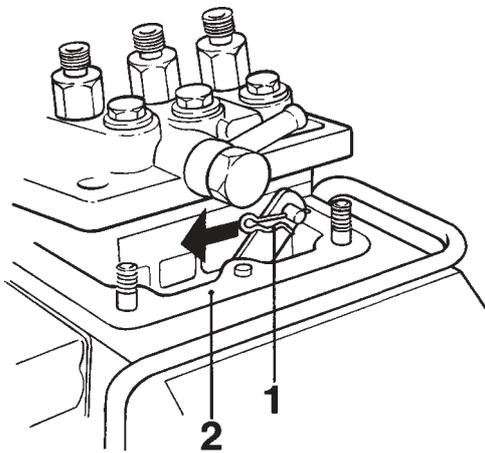


Fig. 87. Dismantling of the injection pump

1. Lock pin 2. Shims

3. Dismantle the pump's attachment screws and nuts. Turn the stop lever clockwise and carefully lift up the pump so that the lock pin to the regulator arm becomes accessible (Fig. 87).

Remove the lock pin and release the regulator arm.

NOTE! Take care of the shims under the injection pump flange when the pump is lifted off the cylinder block.

4. Send the pump to an authorised diesel workshop* for inspection if the workshop does not have specially trained personnel with the necessary testing equipment.

*MD2010, MD2020, MD2030: Nippondenso.
MD2040: Bosch.

Fitting of the injection pump

Check that the pump is in good condition, and if so required also tested and approved before it is fitted.

Note: Do not remove the protective caps before the pipes are connected.

1. Put the injection pump in the cylinder block.

NOTE! Make sure that the shims which were placed under the injection pump flange are put back in place before the pump is put in the block.

Note: The correct pump setting is normally obtained with this method. If the injection pump, camshaft or cylinder block have been replaced the setting of the pump must be adjusted. See next section, "Adjustment of injection angle":

2. Turn the stop lever clockwise and connect the regulator arm to the control rod on the pump. Fit the lock pin (Fig. 87). Screw tight the pump.
3. Connect the fuel hose and fuel leak pipe to the pump. Fit the delivery pipe.
4. Bleed the fuel system and test run the engine.

Adjustment of injection angle

Fit the injection pump as per the previous section with the exception of item 1 which is changed to item 1 below.

1. Place a shim 0.5 mm (.0196 in) in thickness under the injection pump flange.

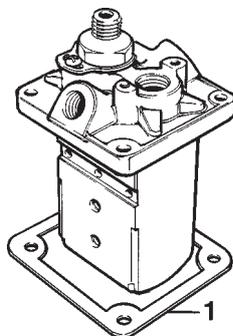


Fig. 88. Fitting of shim

1. Shim

2. Remove the front pressure valve holder from the injection pump.

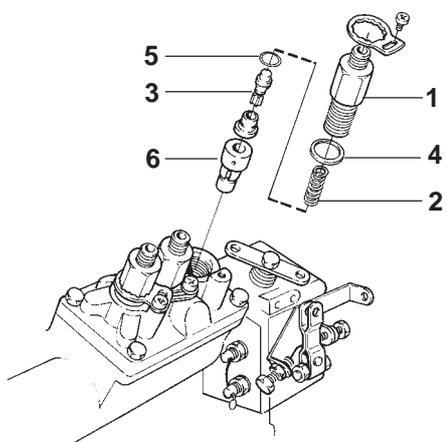


Fig. 89.

- | | |
|--------------------------|-----------------|
| 1. Pressure valve holder | 4. O-ring |
| 2. Spring | 5. Copperwasher |
| 3. Pressure valve | 6. Pump element |

3. Remove the pressure valve and replace the pressure valve holder.
4. Move the throttle arm to max. position. Turn the crankshaft clockwise until the piston in cylinder No. 1 moves upwards in the compression stroke and fuel begins to flow out from the pressure valve (position X in the table below). The work is simplified if an approx. 50 mm (2 in) "observation tube" is fitted on the pressure valve.

Use a scrapped fuel pipe. The pipe makes it easier to see when the fuel begins and stops flowing out from the valve.

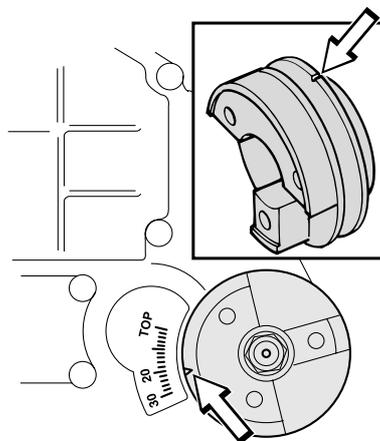


Fig. 90. Marking the pulley and engine block

5. Continue turning the crankshaft slowly clockwise until the fuel stops flowing out from the pressure valve holder. Check the position of the crankshaft to the marking on the pulley and engine block at this point. See Fig. 90.

If the position is after "Y°" (B.T.D.C.) a thinner shims should be used under the injection pump flange. If the position exceeds "Z°" (B.T.D.C.) a thicker shims should be fitted instead. (See table below).

| Engine model | Pos. of crankshaft in ° | | | |
|---|-------------------------|------|------|----------------------------------|
| | X | Y | Z | Injection start, crankshaft pos. |
| MD2010 | 30,0 | 24,5 | 26,5 | 24,5-26,5° B.T.D.C. |
| MD2020 up to * 5101311299 | 30,0 | 24,5 | 26,5 | 24,5-26,5° B.T.D.C. |
| from * 5101311300 | | | | |
| MD2030 up to * 510101938 | 30,0 | 21,5 | 23,5 | 21,5-23,5° B.T.D.C. |
| from * 510101939 | | | | |
| MD2040A MD2040B ** 868748 | 30,0 | 20,0 | 22,0 | 20,0-22,0° B.T.D.C. |
| MD2040B ** 868778 | | | | |
| MD2040C | 30,0 | 18,0 | 20,0 | 18,0-20,0° B.T.D.C. |

* engine number ** product number

Note: A change of shim size by 0.1 mm (.0039 in) implies that the injection start is moved approx. 1°.

An increase in shim size reduces the injection angle and conversely a decrease in shim size increases the angle.

Shims are available in the following sizes: 0.2, 0.3, 0.4 and 0.5 mm (.0078, .0118, .0157 and .0196 in).

NOTE! In the event that no shims are required, liquid sealing compound should be used.

Replace the pressure valve. Screw in the pressure valve holder by hand. If the pressure valve holder will not go in, screw the holder backwards and forwards quickly 1/4–1/2 turn until the pressure valve goes in the pressure valve holder. Screw down the pressure valve fully by hand until the O-ring begins to be pressed together. Tighten after this with a 17 mm spanner.

Tightening torque, see Technical data.



WARNING! The pressure valve holder must be screwed in by hand so that it is possible to feel that the pressure valve goes correctly into the valve holder. Never use force to screw the valve holder down since this can damage the pressure valve. If the pressure valve cannot be turned in the valve holder the pump must be dismantled and the same method applied with the pump in a completely horizontal position.

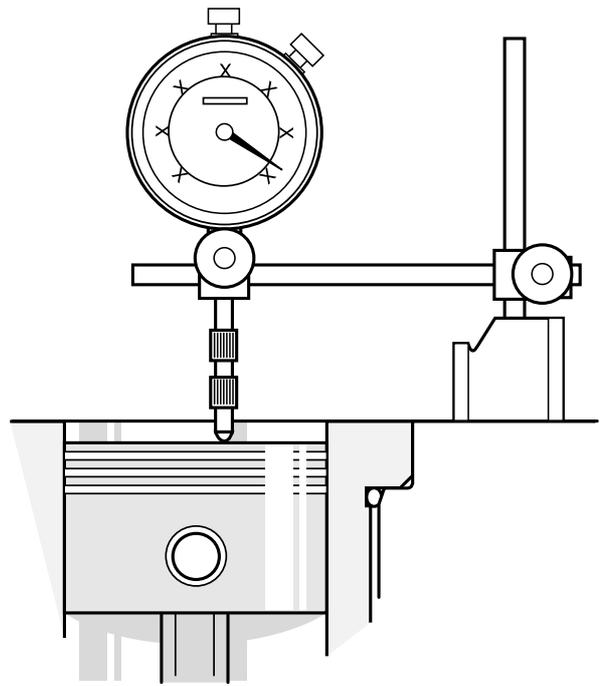


Fig. 91. Measurement of piston position with dial gauge

6. Adjustment of the injection angle can also be made by measuring the piston height with a dial gauge.

The table shows the crankshaft position in degrees when the piston is in a certain position in relation to B.T.D.C.

Carry out the adjustment work as per items 4 and 5.

The table shows the position of the piston in relation to the crankshaft angle (°B.T.D.C.).

| | MD2010, MD2020 | MD2030 | MD2040 |
|------------------|-------------------|-------------|-------------|
| Crankshaft angle | Piston pos. | Piston pos. | Piston pos. |
| 18° B.T.D.C. | – | 2.317 mm | 2.875 mm |
| 19° B.T.D.C. | – | 2.577 mm | 3.199 mm |
| 20° B.T.D.C. | – | 2.851 mm | 3.539 mm |
| 21° B.T.D.C. | – | 3.138 mm | 3.895 mm |
| 22° B.T.D.C. | – | 3.438 mm | 4.267 mm |
| 23° B.T.D.C. | – | 3.750 mm | 4.655 mm |
| 24° B.T.D.C. | 3.636 mm | 4.075 mm | 5.058 mm |
| 25° B.T.D.C. | 3.937 mm | 4.413 mm | 5.477 mm |
| 26° B.T.D.C. | 4.250 mm | 4.763 mm | 5.912 mm |
| 27° BT.D.C. | 4.573 mm | 5.125 mm | – |

| | MD2010, MD2020 | MD2030 | MD2040 |
|------------------|-------------------|-------------|-------------|
| Crankshaft angle | Piston pos. | Piston pos. | Piston pos. |
| 18° BT.D.C. | – | .0912 in. | .1131 in. |
| 19° BT.D.C. | – | .1014 in. | .1259 in. |
| 20° BT.D.C. | – | .1122 in. | .1393 in. |
| 21° BT.D.C. | – | .1235 in. | .1533 in. |
| 22° BT.D.C. | – | .1353 in. | .1679 in. |
| 23° BT.D.C. | – | .1476 in. | .1832 in. |
| 24° BT.D.C. | .1431 in. | .1604 in. | .1991 in. |
| 25° BT.D.C. | .1550 in. | .1737 in. | .2156 in. |
| 26° BT.D.C. | .1673 in. | .1875 in. | .2327 in. |
| 27° BT.D.C. | .1800 in. | .2017 in. | – |

Setting engine speed (RPM)

Check that the throttle mechanism functions normally. Check that the throttle arm (1) (Fig. moves towards low idle (2) when the throttle mechanism is in idling position and moves towards the stop screw at wide open throttle (WOT) (3) when the throttle mechanism is at wide open throttle (WOT). Adjust the throttle mechanism if necessary. Also check that the air filter and air intake are not blocked.



IMPORTANT! The engine speed (RPM) and fuel quantity are factory set to give maximum output and minimum environmental impact. These settings must not be changed.

Seals on the fuel injection pump may only be broken by authorised personnel. Broken seals must always be resealed.

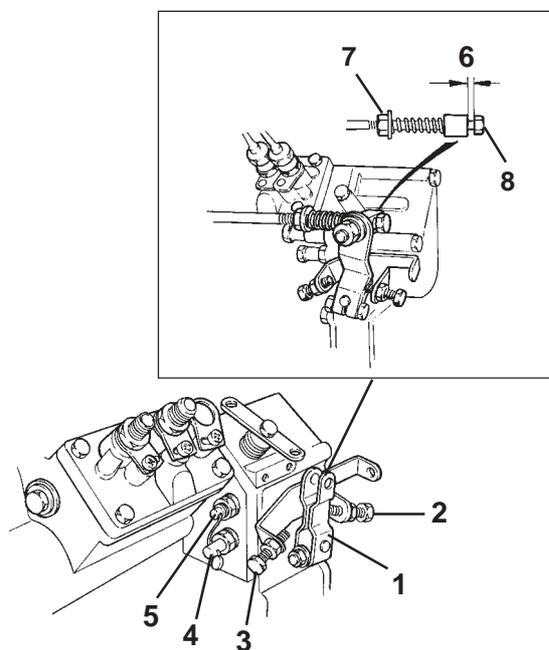


Fig. 92. Setting engine speed (RPM)

1. Throttle arm
2. Adjustment screw, low idling speed
3. Stop screw, wide open throttle (WOT)
4. Adjustment screw, engine racing
5. Adjustment screw, maximum quantity of fuel

Low idle speed

1. Check that gap (6) (Fig. 92) is approximately 3 mm when the throttle mechanism is in the idling position. If necessary: Slacken off the locknut (7) and adjust until the correct gap is obtained with the screw (8).

2. Warm up the engine and check the idling speed using a workshop tachometer (see Technical Data for correct idling speed).
3. If necessary, adjust to the correct idling speed using the adjustment screw (2).
4. Check gap (3) again according to point 1.

Engine racing (high idling speed)

Warm up the engine and check the engine racing speed using a workshop tachometer when the engine has no load at wide open throttle (WOT) (see Technical Data for correct engine racing speed).

Adjust if necessary as follows:

1. Slacken off the stop screw (3) so that it does not limit the movement of the throttle arm (1).
2. Run the engine with no load at wide open throttle (WOT) and adjust to the correct rev speed using the adjustment screw (4) (remember to reseal the screw).
3. Adjust the stop screw (3) so that there is a clearance of 0.1 mm between the stop screw (3) and the throttle arm (1) when the throttle mechanism is at wide open throttle (WOT).

Feed pump

Dismantling of feed pump

1. Wash clean round the pump.
2. Close the fuel cocks. Release the fuel connections from the pump.
3. Dismantle the feed pump from the cylinder block. Empty the pump of fuel.

Stripping and inspection of the feed pump

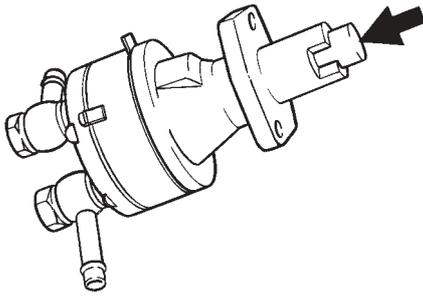


Fig. 93. Checking of piston in the pump housing

1. Check that the piston does not jam in the pump housing.
Note: The feed pump's hand pump only functions when the piston is pressed in.

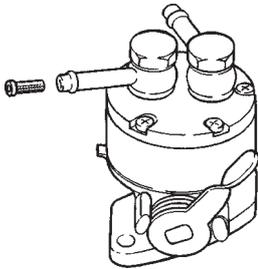


Fig. 94a. Checking the strainer

2. Remove the strainer from the fuel pump inlet pipe and check that it is not blocked by dirt. Re-install the strainer by pressing it in until a "click" is heard.
Note. This strainer has been introduced in production as from engine number:

| | |
|----------------------------|------------------|
| 2010: (Approx.) 5102205900 | 2030: 5102120207 |
| 2020: (Approx.) 5102322000 | 2040: 5102926316 |

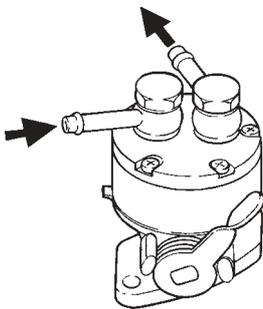


Fig. 94 Checking of the valve housing

3. Check the function of the valve housing (1. Fig. 96) before stripping as follows:
Suck in the inlet (IN) and blow in the outlet (OUT). The function is normal if it seals in both case.

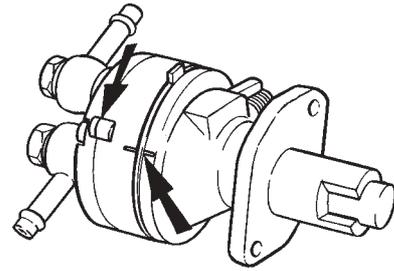


Fig. 95. Placing of markings

4. Mark up the positioning of the cover, valve housing and pump housing with two corresponding markings (fig. 95).

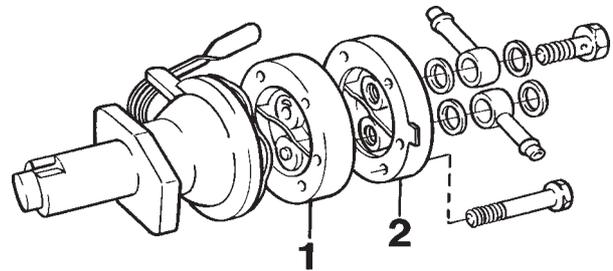


Fig. 96. Feed pump

1. Valve housing 2. Cover

5. Turn the membrane and piston until the pin in the piston comes opposite the groove in the pump housing.

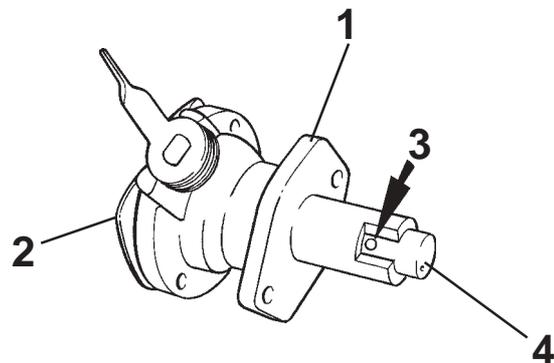


Fig. 97. Pump housing

1. Pump housing 3. Pin
2. Membrane 4. Piston

6. Press in the piston and membrane. Press out the pin from the piston and remove the piston, membrane and springs from the pump housing.

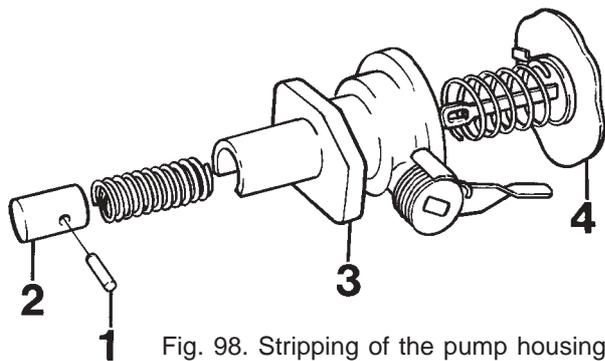


Fig. 98. Stripping of the pump housing

- | | |
|-----------|-----------------|
| 1. Pin | 3. Pump housing |
| 2. Piston | 4. Membrane |

- Remove the screws which hold the cover. Remove the cover and valve housing.

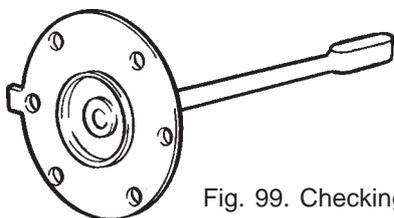


Fig. 99. Checking of the membrane

- Check that the membrane is in good order and does not display any cracks.

Assembly of the feed pump

Assembly takes place in the reverse order to stripping.

Replacing the fuel filter

- Carefully clean the filter bracket.

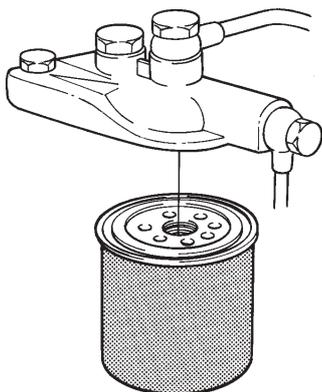


Fig. 100. Replacing the fuel filter

- Screw off the old fuel filter and scrap it. Use if necessary the special tool for dismantling. **Watch out for fuel spillage!**
- Check that the new filter is absolutely clean and that the packing is in good order. Moisten the packing with oil.

- Screw on the new filter by hand until the packing comes in contact with the bracket. Tighten an additional **half turn** by hand.
- Bleed the fuel system as per the instructions on this page. Start the engine and check the tightness round the filter.

Bleeding the fuel system

- Place a collection vessel under the fuel filter.

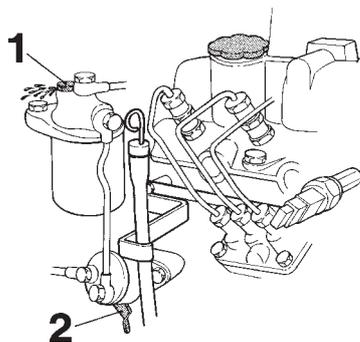
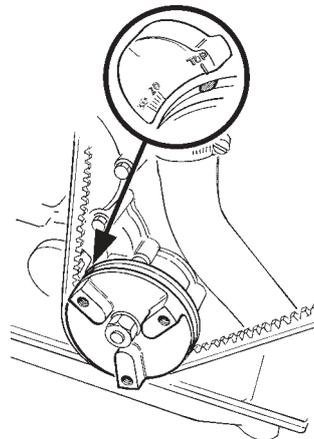


Fig. 101. Bleeding the fuel system

- Open the bleeder screw (1) on the fuel filter's cover and pump with the hand pump (2) until the fuel comes out without bubbles. Tighten the screw while the fuel is flowing out.



Note. If the pump action is low, turn the engine round until the marking on the pulley is adjacent to "Top" (please refer to the figure). If pump action is still low, turn the engine round a further turn to "TOP".

- Further bleeding is not normally required.
- Start the engine. If the engine will not start after a short moment, release the delivery pipe at the injectors a few turns. Set the injection pump's throttle arm in max. position and run round the engine with the starter motor until fuel is pressed forward. Tighten the delivery pipe nuts.

Tightening torque: 20–25 Nm (14.7–18.4 ft.lbs).

Note: The glow plug is connected at the same time as the starter motor. Save the batteries if the starter motor is not used by means of only running the starter motor for short bursts during the bleeding work.

Injectors

Replacement of injectors

1. Wash clean round the injectors.
2. Release the delivery pipes at the injection pump and at the injectors. Lift off the delivery pipes together.
3. Remove the nut on the top of each injector and lift off the fuel leak pipe.

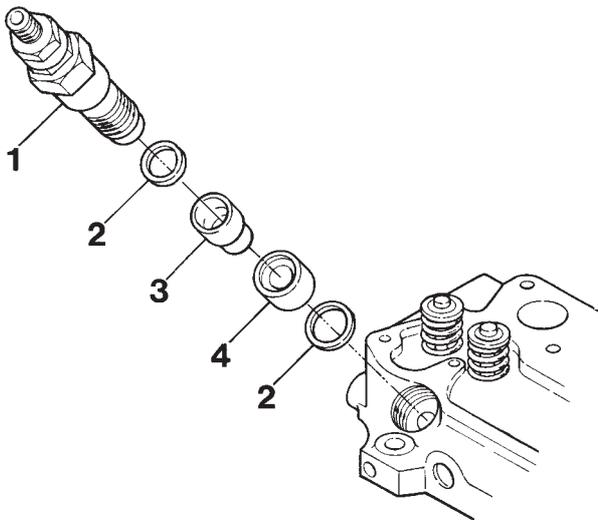


Fig.102. Dismantling of injector

- | | |
|-------------------|-------------------------|
| 1. Injector | 3. Heat shield (MD2030) |
| 2. Copper packing | 4. Insert (MD2010-2030) |

4. Unscrew the injectors. Use socket, L = 80 mm.
Socket width = 22 mm (MD2010, 2020, 2040),
socket width = 27 mm (MD2030)
Remove the copper packings under the injectors.
MD2030: Remove the heat shields (3, Fig. 102).
MD2010, MD2020, MD2030: Remove the inserts
(4) and the inner copper washers.
5. Fit a protective cap on the pipe connections on the injectors over the nozzle if the injector is not to be fitted immediately.
6. Fit the new injector.
Tightening torque: see Technical data.

7. Fit the fuel leak pipe.
8. Fit the delivery pipes. Check that they do not come skew, and tighten the nuts.
Tightening torque: 20–25 Nm (14.7–18.4 ft.lbs).
9. Start the engine and check that no leakage occurs.

Renovating injectors

1. Clean the injector internally.
2. Place the injector (holder) in a vice. Unscrew the nozzle nut and take the injector apart.
Note: Observe care when taking it apart so that the nozzle needle does not drop out.
3. Pull out the nozzle needle from the nozzle sleeve and place the parts in cleaning petrol.

Note: Make sure that the nozzle needles and nozzle sleeves which belong together and are adjusted to each other are not mixed up if several nozzles are cleaned together. To avoid confusion the nozzles should be placed in a nozzle rack or in different compartments.

4. Check the nozzle carefully with a lamp magnifier or in a microscope. Check the other parts also.
5. When fitting a **new nozzle** it is important that preserving oil is washed off the nozzle needle and sleeve before the injector is assembled (avoid skin contact with needle's slide surface).
Clean the parts in pure alcohol. Check that the nozzle needle slides in the sleeve without sticking.
6. Dip the nozzle parts in pure diesel or testing oil and put the injector together. Use the original thickness of adjuster washer(s) to set the opening pressure.
7. Check the opening pressure, jet pattern and tightness in a nozzle testing device.

Testing of injectors

Testing is carried out in a nozzle testing device. The opening pressure and tightness are the most important part of the test. The jet pattern is more difficult to evaluate and does not give a reliable indication of the condition of the nozzle.



WARNING! Observe care when testing the injectors so that unprotected parts of the body are not hit by the fuel jet from a nozzle. The jet has such a powerful impact that it can penetrate into the skin and cause blood poisoning.

Adjusting the opening pressure, injector

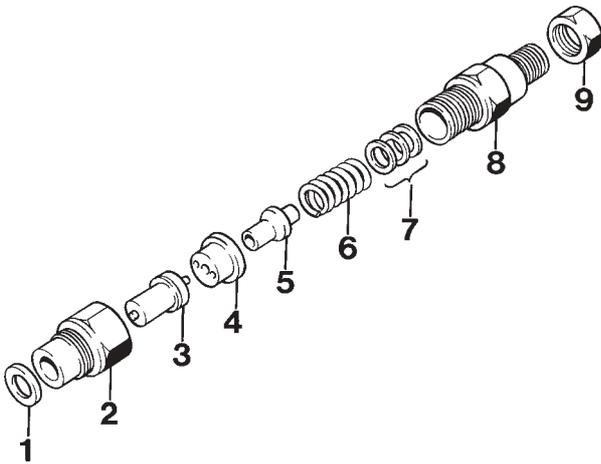


Fig. 103. Adjuster washers (7), injector

Press the nozzle testing device's lever slowly down with the manometer connected until the nozzle opens and releases the fuel. Read off at that precise moment the opening pressure.

If the value read off does not correspond with the prescribed value the setting must be changed. This is done with adjuster washers (Fig. 103).

Note: The opening pressure increases or diminishes with approx. 1 MPa (10 kp/cm², 142.2 lbf/in²) with a change in the thickness of the adjuster washer by 0.1 mm (.0039 in).

Checking of injectors

Jet pattern

1. Pump with the nozzle testing device and check the jet pattern. The fuel jet should be conformed and in line with the centre line of the nozzle.
2. Check that the fuel jet has a circular cross section.

Tightness

Tightness testing examines potential leakage between the seat of the nozzle needle and the conical sealing surface of the nozzle sleeve.

1. Wipe off the nozzle pin so that it is dry.
2. Pump up the pressure to approx. 2 MPa (20 kp/cm², 284.4 lbf/in²) under the injector's opening pressure (see Technical data). Hold the pressure constant for 10 seconds and check if any fuel drips from the nozzle pin. Wet nozzles can be approved.

Fit protective caps on the injector's pipe connections and over the nozzle heads if the injectors are not to be fitted immediately.

Cooling system

General

The engines are fresh water cooled and fitted with an enclosed cooling system. The system is divided into two circuits.

In the inner circuit (fresh water system) the coolant is pumped round by a circulation pump which is driven by a V-belt from the crankshaft pulley.

The fresh water system works at a certain overpressure, whereby the risk of boiling is reduced at high temperatures. A pressure valve opens in the filler cap if the pressure gets higher than normal.

The temperature of the coolant is regulated by a thermostat.

The percolation in the sea water system is handled by a gear driven pump of the blade type.

Heat is transferred from the coolant to the sea water in a heat exchanger.

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

Sea water pump

The sea water pump is fitted on the timing gear housing at the front end of the engine. The pump is driven via the engine's timing gears. The pump wheel (impeller) is manufactured of rubber and is replaceable.

Note: The pump wheel will become damaged if the pump is run dry.

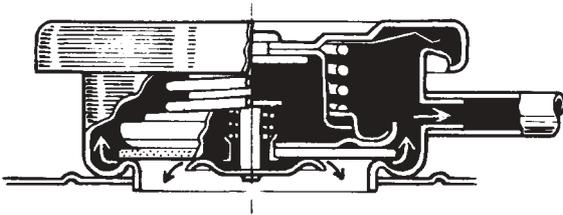


Fig. 104. Filler cap for coolant

Thermostat

The engines are provided with a thermostat, the sensor body of which contains wax.

When the engine is cold the thermostat keeps the channel to the heat exchanger closed. The coolant then passes via a by-pass pipe directly back to the induction side of the pump. As the engine heats up the wax increases in volume and the thermostat gradually opens the channel to the heat exchanger, at the same time as the by-pass pipe is closed.

See "Technical data" for opening temperatures.

Repair instructions

NOTE! Close the bottom valve before working on the cooling system.

Coolant

The coolant has the twin purpose of protecting the cooling system from freezing and preventing corrosion.

Antifreeze

Use a mixture of 50 % Volvo Penta antifreeze (glycol) and 50 % pure water (as neutral as possible). **This mixture prevents freezing down to approx. -40°C (-40°F) and should be used all year round.**

Note: At least 40 % antifreeze should be used in the system to ensure satisfactory corrosion protection.

Mix the antifreeze with water in a separate vessel before filling the cooling system.

For replenishment of the coolant see the instruction on page 66.

 **WARNING!** Antifreeze is hazardous to health (dangerous to consume).

In the event that antifreeze is not necessary it is appropriate to add Volvo Penta anti-corrosion agent 1141526-2.

Draining of the coolant

Stop the engine before draining the cooling system.

The fresh water system

1. Unscrew the filler cap. Turn the cap to the first stop and wait a moment before lifting off the cap.

 **WARNING!** Open the filler cap very carefully if the engine is hot. Steam or hot liquid may spit out.

2. Connect a hose to the drain cock. Open the cock and drain out the coolant in a vessel.

Hand in the mixture to a recovery station if it is not to be used again. Never pollute the water.

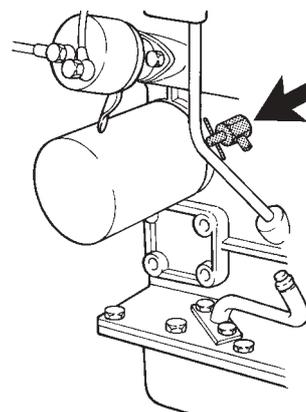


Fig. 105. Draining of the coolant

The sea water system

Watch out for the penetration of water in the boat!

1. **Close the bottom cock or the cock on the S-drive.** Release the cover on the sea water pump and let the water run out.
2. Release the hose from the sea water pump and sea water filter at the reverse gear and tilt down so that the water runs out.
3. Check if there are additional cocks/plugs at low points on the coolant and exhaust pipes.
Check carefully that all the water runs out.
4. Tighten the hoses and cover to the sea water pump.

Pump out the boat and check that there is no leakage.

Replenishment of coolant

Flush the cooling system before filling up with coolant.

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

Filling should be done with an idle engine. The engine must not be started before the system is vented and completely filled. If a heater unit is connected to the engine's cooling system the heat control valve must be fully opened and the unit vented during filling.

Check hoses and connections and seal any leaks.

Note: Fill the system slowly! Filling should not be done too quickly or else air pockets can form in the system. The air should be allowed to flow out through the filling opening. Check the engine coolant level after running the engine for some time. Top up coolant if required.

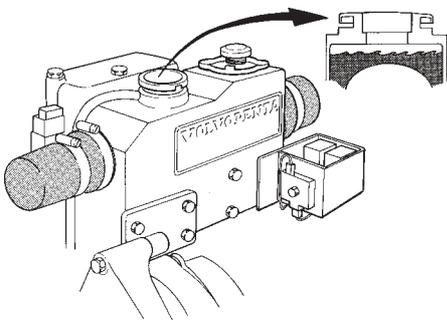
Check the engine coolant level



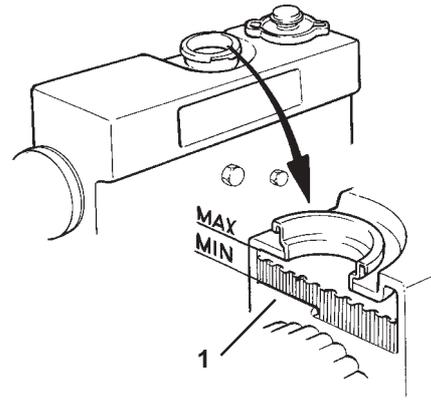
WARNING! Do not open the engine coolant system filler cap when the engine is still hot except in an emergency. Steam or hot coolant may spray out.

Turn the filler cap to the first stop and let any pressure escape from the system before removing the cap. Top up coolant if necessary. For MD2010–2040A/B the level must be just under the neck of the filler opening and for MD2010–2040C between the lower edge of the neck of the filler opening and the level spur (1). Reinstall the filler cap.

If a separate expansion tank is installed (optional extra) the level should be between the MAX and MIN marks.



MD 2010–2040A/B
Coolant level



MD 2010–2040C/D

Coolant level

Coolant temperature too low

If the coolant temperature is too low this may be because of:

- Defective thermostat.
- Defective temperature sensor or instrument.

Coolant temperature too high

If the coolant temperature is too high this may be because of:

- Blocked sea water inlet or sea water filter.
- Defective pump wheel in the sea water pump.
- Too low coolant level, air in the fresh water system.
- Slipping or burst belt for the circulation pump.
- Defective thermostat, temperature sensor or instrument.
- Blocked cooling system.
- Incorrectly set injection pump, i.e. injection angle.

Coolant loss

There are two types of coolant loss:

- Coolant loss when running.
- Coolant after stopping with a hot engine.

Coolant loss when running may be because the cooling system is not tight or because air or combustion gases have been forced into the system.

Checking of pressure valve in filler cap

Special tool: 999 6662

1. Drain off the coolant and connect the pressure testing device with a nipple to one of the plugged holes in the cooling system.
2. Extend the drain hose from the filler pipe with a hose the end of which is placed in a vessel containing water.
3. Apply the pressure and read off the manometer when the valve opens (water bubbles in vessel).
The valve should open at 0.9 kp/cm² (12.8 lbf/in²).
4. Remove the test equipment. Fit the plug and fill up with coolant.

Cleaning of heat exchanger

Clean the heat exchanger insert on signs of blocking (slow rise in coolant temperature).

NOTE! Check/clean the sea water filter first. Check also the sea water pump's impeller and sea water intake.

 **IMPORTANT!** Close the bottom valve before working on the cooling system.

1. Drain off the water in the sea and fresh water systems.

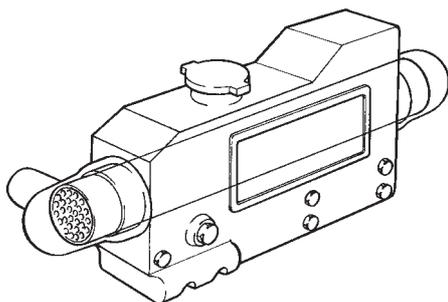


Fig. 106. Heat exchanger insert

2. Release the hose clamps and remove the rubber muffs at the front and back of the heat exchanger. Pull out the insert.
3. Flush and clean the insert inside and outside. Clean also the housing.
Note: If there are loose deposits in the insert a suitable steel rod can be pushed through the tubes in the opposite direction to the flow of water.
NOTE! Make sure that the rod does not damage the tubes.
4. Fit the insert in the heat exchanger. **NOTE! Make sure that the insert is positioned correctly.** Make sure that the hole in the insert casing comes opposite the hole in the housing and that the vent hole comes upwards. The insert is marked with "UP".
Place the insert so that its extruding parts are equal at the front and back.
5. Fit the rubber muffs on the heat exchanger's front and back and tighten the hose clamps. Connect the hose from the sea water pump and tighten the clamp.
6. Fill up with coolant.
7. Open the bottom cock or the cock on the S-drive and start the engine. Check that no leakage occurs.

Replacing the circulation pump

Dismantling

1. Drain off the coolant from the engine (fresh water system).
2. Release the alternator and remove the drive belt.
MD2030, MD2040: Remove the clamp for the alternator.
3. Remove the rubber hoses to and from the pump.
4. Release the electric cables to the temperature relay.

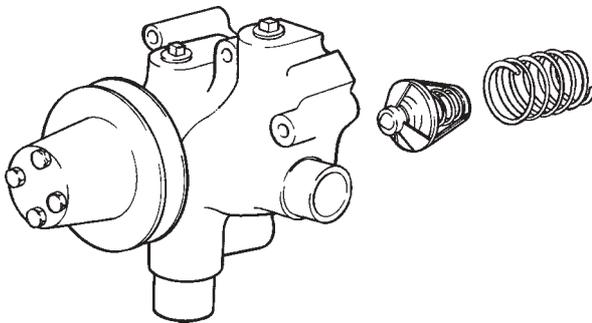


Fig. 107. MD2030. Circulation pump

5. Remove the pump's attachment screws and lift off the pump.
MD2030: Remove the back piece (plate), spring, and thermostat.

Fitting

1. Clean the mating surfaces on the pump and cylinder block.
2. MD2030: Place the thermostat and spring in the pump. Fit the back piece (plate) on the pump with a new gasket.

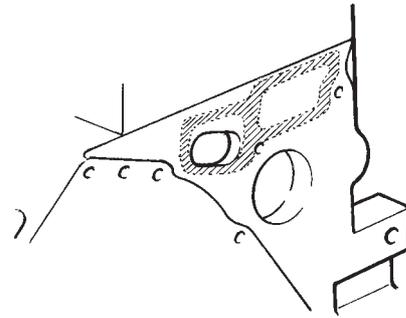


Fig. 108. Application of sealing compound (silicon)

3. Apply sealing compound (silicon, Volvo Penta part No. 1161277-7) on the cylinder block as per Fig. 108, shaded area.
Fit the coolant pump with a new gasket.
4. MD2030, MD2040: Fit the clamp to the alternator.
5. Fit the rubber hoses at the pump's inlet and outlet. Tighten the hose clamps.
6. Fit the drive belt. It should be possible to press the belt down approx. 10 mm (.40 in) between the pulleys.
7. Connect the contact piece to the temperature relay.
8. Fill up with coolant. Start the engine and check that no leakage occurs.

Replacing the pump wheel in the sea water pump

Close the bottom cock, or the cock on the S-drive before working on the cooling system.

1. Dismantle the pump's end cover and drain off the water in the sea water system.

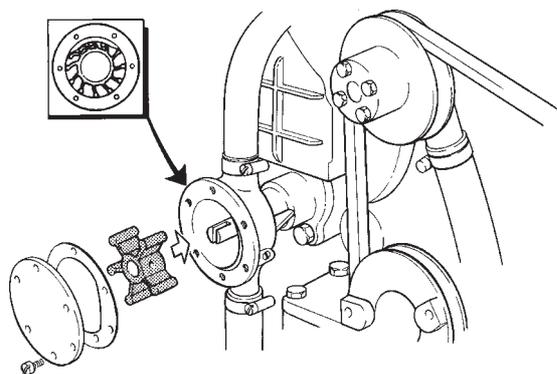


Fig. 109. Replacing the pump wheel

2. Pull and twist out the pump wheel (impeller) with a pair of universal pliers.
3. Clean the housing internally. Grease in the pump housing and inside of the cover with a little grease.
4. Press in the new wheel with a rotational motion (clockwise). Fit the sealing washer on the outer end of the centre of the wheel.
5. Fit the cover together with a new gasket.
6. Open the bottom cock, or the cock on the S-drive. Start the engine and check that no leakage occurs.

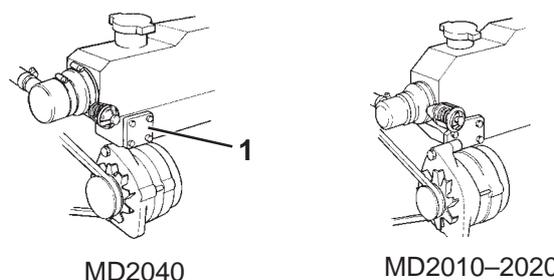
Thermostat

Replacing the thermostat

Note: On MD2030 the thermostat is accessible after the circulation pump has been removed. See under heading "Replacing the circulation pump".

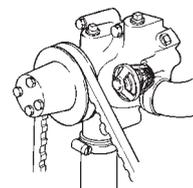
Other engines:

1. Remove both battery leads. Drain off the water in the fresh water system.
2. MD2010, MD2020: Drain off the water in the sea water system. Remove the alternator.



MD2040

MD2010-2020



MD2030

Fig.110. Positioning of the thermostat

1. Cover
3. MD2010, MD2020: Release the exhaust pipe and remove the heat exchanger housing complete. Remove the spring and lift out the thermostat from the housing.
4. MD2040: Remove the cover (1) on the front left-hand side of the heat exchanger. Remove the rubber ring.

Checking the thermostat

1. Check that the thermostat closes completely.
2. Heat up water in a vessel to 68°C / 154.4°F (MD2010, MD2020), or to 75°C / 167°F (MD2030, MD2040).
3. Submerge the thermostat in the water. Check after at least 3-5 minutes that the thermostat is still closed.
4. Raise the temperature to boiling point (100°C / 212°F). Check after 3-5 minutes that the thermostat has opened at least 6 mm / .02362 in (MD2010, MD2020), or to 8 mm / .3149 in (MD2030, MD2040).

Replace the thermostat if these specifications are not met. **NOTE!** If the thermostat does not close completely the engine will run at too low a temperature.

Electrical system

General

The engines are fitted with AC generators. The system voltage is 12V.

MD2010A, -2020A, -2030A and -2040A are fitted with a 1,5-pole* electrical system, while MD2010B/C/D, 2020B/C/D, 2030B/C/D and 2040B/C/D have a one-pole system. Presentation Presentation

* **Note:** One-pole during the start procedure via an earthing relay.

The electrical system includes optional sensors for monitoring engine coolant temperature and oil pressure.

The electrical system is illustrated in two ways. The wiring diagram (page 82) shows the wiring, cable areas and colours.

Where respective parts are positioned on the engine is shown in the figures below.

Positioning of electrical components on the engine

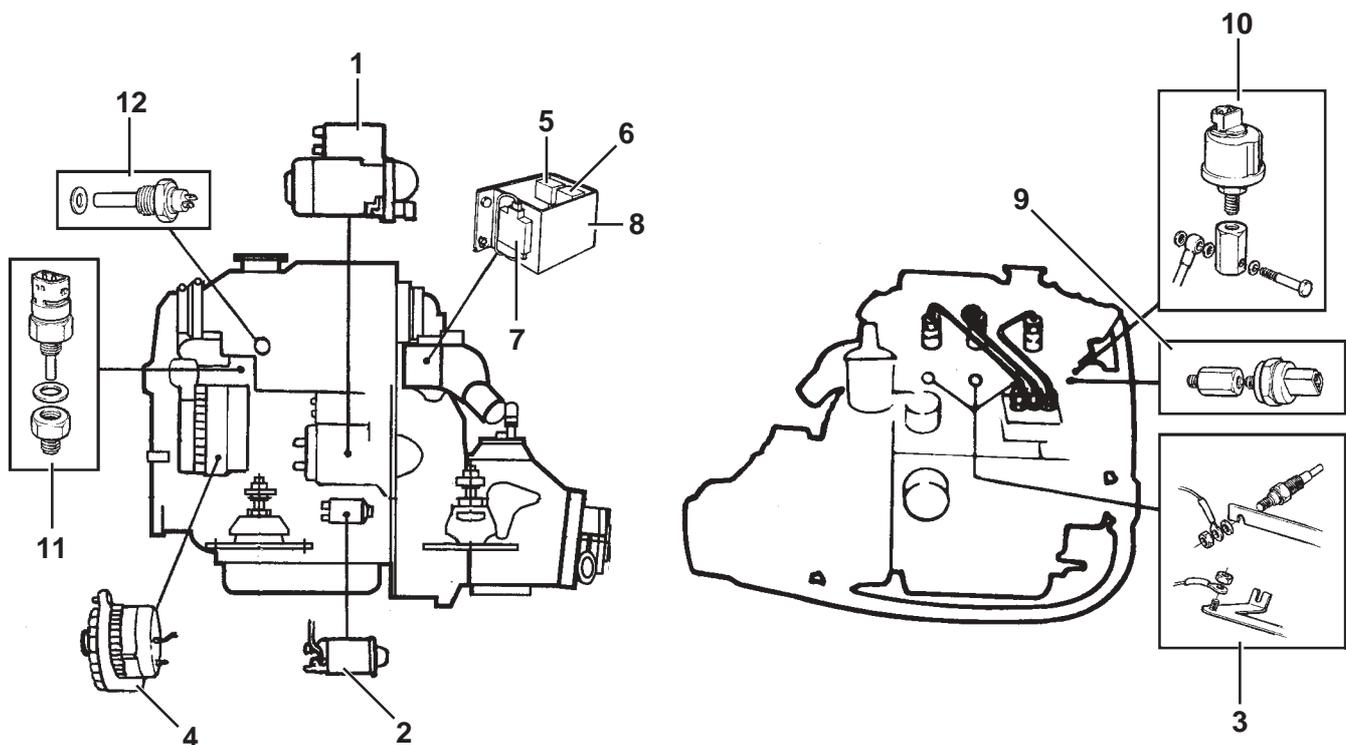


Fig. 111. Positioning of electrical components on the engine

- | | |
|-----------------------------------|---|
| 1. Starter motor | 8. Fuses (4 pcs), max. 15A (-) (A-version) |
| 2. Earthing relay (A-version) | 9. Oil pressure relay, (accessory) |
| 3. Glow plug | 10. Oil pressure sensor |
| 4. Alternator | 11. Coolant temperature relay (accessory) |
| 5. Starter relay | 12. Coolant temperature sensor |
| 6. Glow relay | |
| 7. Fuses (4 pcs), max. 15A (+) | |

Fuses

The fuses are placed in the relay box at the rear left-hand side of the engine. The fuses disconnect the current when overloaded.

MD2010A, -2020A, -2030A and -2040A are fitted with two fuse blocks each with four fuses (15A) for plus (+) and minus (-).

MD2010B/C/D, -2020B/C/D, -2030B/C/D and -2040B/C/D have only one fuse block with four fuses (15A) for plus (+).

Re-connect the electrical system, after inspection and work, if one fuse has triggered by moving the cable connection to the next contact.

Relays

The relays are placed in the relay box on the rear left-hand of the engine.

The start and glow functions are controlled via their own switching relay. These relays are identical and therefore if necessary can be interchanged.

Alternator

Voltage regulator with sensor system

The voltage regulator to the standard alternator (14V/60A) is provided with a sensor system.

The sensor system compares the charge voltage between the alternator's connections B+ and B- with that between the batteries' plus and minus poles. The voltage regulator then compensates any voltage drop in the cables between alternator and batteries by increasing the charge voltage when necessary from the alternator.

On delivery from Volvo Penta the sensor system is not activated. Connection has, however, in all probability been carried out in connection with the installation of the engine.

Connection of sensor system

⚠ IMPORTANT! Stop the engine and then switch off the current with the main switches before working on the electrical system.

1. Release the yellow sensor conductor from connection B+ on the alternator.
2. Splice the conductor (yellow, 1.5 mm², 16 AWG) and connect it to the batteries' plus pole (+).

Charging distributor

As an accessory the engine's standard alternator can be provided with a charging distributor. Two separate battery circuits can thereby be charged simultaneously. The charging distributor separates both groups from each other so that the engine's start battery is maintained fully charged even if the "accessory batteries" are weak or almost flat.

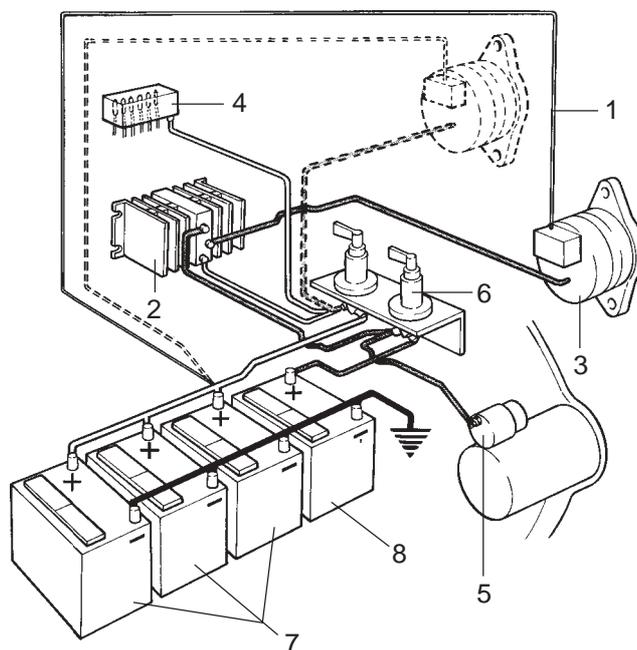


Fig. 112. Connection of sensor system to standard alternator, principle drawing

1. Sensor conductor (yellow, 1.5 mm², 16 AWG)
2. Charging distributor (accessory)
3. Alternator
4. Fuse panel (accessory)
5. Starter motor
6. Main switch
7. Accessory batteries (accessory)
8. Start battery (engine)

Important information on the electrical system



IMPORTANT! Stop the engine and switch off the current with the main switch before working on the electrical system.

1. Main switch

Never break the current circuit between the alternator and battery when the engine is running. The main switch must never be switched off before the engine has stopped. If the current is broken while the engine is running the voltage regulator can be destroyed and the alternator seriously damaged.

For the same reason the charging circuits must not be switched over when the engine is running. For simultaneous charging of two separate battery circuits it is possible to fit a Volvo Penta charging distributor to the standard alternator (accessory).

2. Batteries

Never switch the batteries plus and minus poles when fitting the batteries. This can result in serious damage to the electrical equipments. Compare with the wiring diagram. The battery poles should be well cleaned and the lead lugs always tight and well greased to ensure good contact.

Quick charging of batteries should be avoided. If quick charging must be used, then both battery leads should always be removed first.

NOTE! Follow the relevant safety instructions when charging batteries. During charging the cell plugs should be unscrewed but remain in the plug holes. Ventilate well, especially if the batteries are charged in a closed room. Always switch off the charging current **before** the charge clamps are released.



WARNING! The battery compartment must never be exposed to a naked flame or electrical sparks. Never smoke in the vicinity of batteries. Hydrogen gas develops during charging which when mixed with air forms oxyhydrogen gas. This gas is highly inflammable and very explosive.

Always use protective goggles when charging and handling batteries.

The battery electrolyte contains strongly corrosive sulphuric acid. In the event of skin contact, wash with soap and plenty of water. If battery acid gets in your eyes, rinse immediately with plenty of water and contact a doctor immediately.

3. **For starting with auxiliary battery, see instructions of page 73.**

4. Electric cables

Never make holes in the cable insulation to conduct measurements. In a corrosive environment such as in a boat it takes approx. 2 years for thin cables to oxidise off via the hole.

If a hole must be made in the insulation, it should be sealed with an appropriate glue afterwards.

5. Connection of extra equipment

All extra equipment should be connected to a separate terminal box and be fused. Extra power points directly from instrument panels should be avoided. Permissible extra outlets are a **total of max. 5A** (for all instrument panels together).

Galvanic corrosion

MD2010B/C/D, MD2020B/C/D, MD2030B/C/D,
MD2040B/C/D

The engine's flywheel housing and transmission (reverse gear/S-drive) are electrically insulated from the engine. Note the fitting sequence on the screw union (Fig. 113). The insulation sleeve pos. 1 is only fitted on one of the screws (optional screw).

⚠ WARNING! The flywheel housing or transmission (reverse gear alt. S-drive) must under no circumstances be earthed. Earthing of these components can result in serious damage as a result of galvanic corrosion.

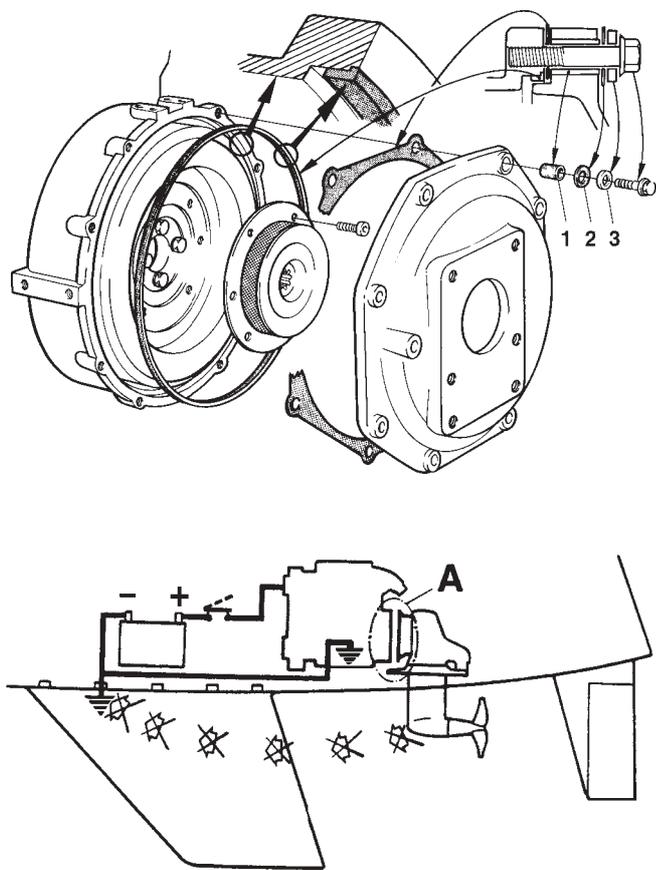


Fig. 113. Electrical insulation (A) of the flywheel housing and transmission

1. Insulation sleeve 2. Insulation washer
3. Washer

Electric welding

Remove the plus and minus leads from the batteries, and then remove all cables to the alternator.

Always connect the welding clip to the component which is to be welded and as close to the weld point as possible. The clip must never be connected to the engine or so that the current can pass over a bearing.

⚠ WARNING! On completion of welding: Always connect the cables to the alternator **before** the battery leads are replaced.

Repair instructions

Starting with auxiliary battery

⚠ WARNING! The batteries (especially the auxiliary battery) contain oxyhydrogen gas which is very explosive. A spark, which can occur if the auxiliary battery is incorrectly connected, is sufficient to cause the battery to explode and result in injury.

Note: If the start battery has frozen it must be thawed first before a start attempt is made with the auxiliary battery. Check that the battery is not damaged before connecting it again.

1. Check that the auxiliary battery's rated voltage corresponds to the engine's system voltage (12V).
2. Connect the red auxiliary lead (+) to the auxiliary battery and then to the flat battery. Then connect the black auxiliary lead (-) to the auxiliary battery, and finally to a point **some distance from the flat batteries**, e.g. at the main switch on the minus lead or at the minus lead's connection on the starter motor (2-pole electrical system), or at the minus lead's connection on the engine (one-pole system).
3. Start the engine. **NOTE!** Do not touch the connection during the attempt to start (risk for sparks) and do not lean over any of the batteries.
4. Remove the leads in exactly the reverse order to the way they were connected. **NOTE!** The ordinary leads to the standard battery must absolutely not be disconnected.

Troubleshooting on the glow plug

Special tool: Multimeter 95100060-8

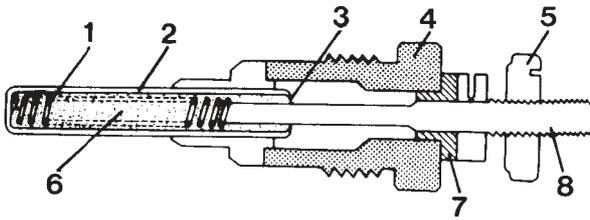


Fig. 114. Glow plug

- | | |
|--------------|--------------------|
| 1. Glow wire | 5. Nut |
| 2. Casing | 6. Magnesium oxide |
| 3. Seal | 7. Insulation |
| 4. Sleeve | 8. Core |

1. Remove both battery leads.
2. Remove the current rail between the glow plugs
3. Measure the resistance between each glow plug and the engine block with an ohmmeter. The resistance should be $1.6 \pm 0.16 \Omega$.
If the instrument shows 0 the glow plug is short-circuited and must be replaced.

Replacing a glow plug

1. Remove both battery leads.
2. Wash clean round the glow plug.
3. Release the electric cable from the current rail to the glow plug.
4. Remove the current rail and unscrew the glow plug.
5. Fit the new glow plug.
Tightening torque, see Technical data.
6. Fit the current rail and connect the electric cable.
Fit the battery leads.

Troubleshooting of the charging system

General

The engines are provided with a rectified three-phase triangular connect AC alternator of 14V/60A (840W).

The generator's type designation is indicated on a rating plate on the rear end of the alternator.

Checking and renovation

Before the alternator is dismantled the battery circuit should be inspected to eliminate other possible faults. When testing the alternator it should "warm". Run the engine at 2000 rpm for approx. 3 minutes before testing.

⚠ WARNING! The connections of the alternator, voltage regulator or battery circuit should not be dismantled when the engine is running. Carefully check that the measuring instrument is set on the voltage supply (V) so that short circuiting between the alternator connection does not occur.

⚠ WARNING! Observe extreme care so that the measuring cables, clothes or the like do not come into contact with the drive belt or with pulleys on the engine or alternator when the engine is running.

Check the alternator belt's voltage and the condition of the belt. Replace the belt if it is cracked, worn or oily. Adjust the belt tension if necessary. With the correct tension it should be possible to push in the belt approx. 10 mm (.40 in) between the pulleys.

Troubleshooting of the battery circuit

Special tool: Multimeter 9510060-8

Note that other instruments may differ in terms of the symbols shown for set measuring function.

Current loss check

Wash clean the battery with lukewarm water and wipe clean. Release the battery leads and clean the poles.

Connect the plus pole (+) again.

Switch off the key switch or disconnect the current to the instrument panel and to all other current consuming components connected to the start battery.

Set the multimeter to measure currents (+20A). Connect the multimeter between the battery's minus pole (-) and the minus lead. The current loss must not exceed 0.1 A with the key switch or instrument panel disconnected.

If the current loss is greater than 0.1 A:

Check that no short-circuiting or overconduction occurs at any connection point. Overconduction occurs from dirty or salt coated electrical components.

Clean and check all connection points.

If the current loss is less than 0.1 A:

Check the charging condition of the battery.

Checking of charging condition

Check the charging condition with an acid testing device. Measure the acid specific weight in all the cells at +25°C (+77°F). Measuring must not be made immediately after charging or replenishment of the battery water.

The acid specific gravity of a fully charged battery at +25°C (+77°F) should 1.28 g/cm³. Charge the battery with a less than 1.24 g/cm³ specific gravity (approx. 75% charging degree). Charge with 5–6A for approx. 10 hours.



WARNING! The battery generates hydrogen gas which is highly inflammable and explosive. The battery must never be exposed to a naked flame or spark. Ventilate the battery area well, especially after charging.

Checking 2 hours after charging

Acid specific gravity of the cells uneven. Difference between the cells 0.04 g/cm³ or more (e.g. 1.28–1.24 g/cm³):

Cells probably short-circuited: replace the battery.

Acid specific gravity even between the cells: battery not fully charged.

Battery sulphated. Mild sulphating can be broken down by an additional 10 hours charging. Replace the battery if this does not help.

Load-testing the battery

Note: The battery's acid specific gravity must not be less than 1.21 g/cm³.

Connect a voltmeter over the battery poles.

Pull out the stop control and run the starter motor for approx. 10 seconds with the glow plug connected and read off the start voltage. This must not be less than 9.5 V.

Check if there is any bubbling in the cells when the starter motor is run (short-circuiting in the cell).

If the voltage is less than 9.5 V or if there is bubbling in a cell:

Replace the battery and re-test.

The voltage is 9.5 V or higher:

The battery is in good condition. Check the charging voltage (see next section).

Checking the battery leads

Set the multimeter for voltage testing and then connect the multimeter between the battery's plus and minus pole. Run the engine at approx. 2000 rpm. Read off and note the voltage over the battery poles.

The alternator provides approx. 14.0 V:

Conduct test as follows:

Connect the multimeter between the alternator's B+ and B- connections.

Run the engine at approx. 2000 rpm. The alternator should provide 14.0–14.4 V. The total voltage drop must not exceed 0.4 V.

Voltage drop less than 0.2 V:

Battery leads in good condition.

Voltage drop more than 0.3 V:

Conduct check of battery leads.

The alternator provides more than 14.4 V:

See items "Checking and troubleshooting of alternator" and "Checking of the regulator".

Checking of positive battery lead

Connect the multimeter between the alternator's B+ connection and the battery's plus pole.

Run the engine at approx. 2000 rpm. The voltage drop must not exceed 0.2 V. If the voltage drop exceeds this value the lead connections must be rectified as per the "Procedure" below.

After this carry out a test as per "Checking of negative battery charging".

Checking of negative battery lead

Connect the multimeter between the alternator's B- connection and the battery's minus pole (-).

Run the engine at approx. 2000 rpm. The voltage drop must not exceed 0.2 V. If the voltage drop exceeds this value the lead connections must be rectified as per the "Procedure" below.

Procedure



WARNING! Disconnect the current and remove both battery leads before working on the charging circuit.

If the voltage drop during any of the tests as per the items above exceeds 0.2 V the lead connections must be removed and cleaned from oxide etc. Spray the connections with a moisture repellent contact oil (Volvo Universal oil, part. No. 1161398-1) or the like and tighten the connection again.

Rectify the connections at the battery, main switch, starter motor, alternator, glow relay and glow plug.

Alternator

Checking and troubleshooting of the alternator

Dismantle the alternator's electrical connections.

Spanner widths 8 and 10 mm.

Remove the alternator belt. Dismantle the alternator. Spanner widths 1 1/16"; 5/8"; 12 mm and 13 mm.

Release the voltage regulator's connections at the alternator's B+ connection. Remove the flat pin at connection B+ and D+. Remove the cap on the W connection.

Bend the plastic guard's attachment lugs alternately off the alternator. Release the regulator's two connection cables to the diode bridge. Use long-nose pliers or poke out the cable lugs with a screwdriver. Do not pull the cables!

Replacement of carbon brushes in the alternator

Unscrew the voltage regulator. Unscrew the brush holder. Check the length of the carbon brushes. Replace the brushes if they are 5 mm (.1968 in) or shorter. Carbon and holder are replaced as one unit. Unsolder the connection cables and solder on the new ones with an acid-free soft solder.

Checking of the regulator

Special tool: Regulator tester 884892-1

Check before testing that the instrument's batteries have the correct voltage. Press in the button "Test" and check that the green lamp ("Batt.") lights. Replace the batteries (2 pcs alkaline, 9 V) if the lamp does not light.

The batteries are in a compartment underneath the instrument.

Connect the tester's grey cables to the carbon.

Connect the tester's brown cable to the regulator's yellow and brown cables which should be put together during the test.

Connect the tester's black cable to the regulator's black cable.

Press the "Test" button and at the same time turn the rheostat from the "0" marking to the "1" marking.

Regulator in good condition

The red and green lamps should light from "0". The red lamp should go off at the "1" marking.

Faulty regulator

Replace the regulator if the red lamp lights constantly when the rheostat is turned, or if it does not light in any position.

Note: The "2" marking on the tester is not used for this type of regulator.

Check measurement of rotor winding

After the regulator and carbon brushes have been removed it is possible to measure the resistance of the rotor.

Set the measuring instrument in position Ω . Make sure that the probes have good contact between the slip rings. The resistance of the rotor should be 3.0–5.0 Ω .

Check also that no earth fault occurs by measuring between slip ring and earth.

Dismantling the diode bridge

In order to check the diode bridge and stator windings the diode bridge should be dismantled.

Unsolder the three stator windings. Avoid excessive heat since this can damage the diodes. Release the nuts (note how the washers and nuts are fitted).

Check measurement of the diode bridge

Set the multimeter in the position "Diode test". Be very careful to obtain good contact with the probes during all measurements.

Checking of the B+ diodes

Connect the measuring instrument's positive probe to one of the stator winding connections (1–2–3). Connect the instrument's negative probe to the diode plate's B+. Read off the instrument. A normal value should lie between 450 and 650 mV, which is the voltage drop over the diode. An other value indicates a defective diode.

Check the other B+ diodes by moving the positive probe to the respective connection (1–2–3).

Check the B+ diodes in the opposite direction of current flow by switching the position of the positive and negative probes. Carry out the same measurement procedure as above. The instrument should during this measurement show a one "1" (to far left). If the instrument shows another value the diode is defective.

Checking of the B– diodes

Connect the instrument's positive probe to the diode plate's B– connection and the instrument's negative probe to the respective stator winding connection (1–2–3)

Read off the instrument as before. A normal value should lie between 450 and 650 mV. Another value indicates a defective diode.

Check the B– diodes in the opposite direction of current flow by switching the position of the positive and negative probes. Carry out the same measurement procedure as above.

The instrument should during this measurement show a one “1” (to far left). If the instrument shows another value the diode is defective.

Note: If any diode is defective the entire diode plate must be replaced.

Checking of the D+ diodes

The diode plate's three magnetising diodes are checked according to the same principle as above.

Connect the measuring instrument's positive probe to the respective connection for the stator winding (1–2–3) and the instrument's negative probe to D+. The voltage drop for the respective diode should be between 450 and 650 mV.

Check the D+ diodes in the opposite direction of current flow and switch the positions of the positive and negative probes. Carry out the same measuring procedure as above. The instrument should show a one “1” (to far left). If the instrument shows another value the diode is defective.

Note: If any diode is defective the entire diode plate must be replaced.

Check measurement of the stator windings

When the diode bridge is removed it is possible to measure the stator windings with the multimeter set to the “Buzzer” position.

Measure the resistance between respective windings.

NOTE! Check first the inner resistance in the measuring cables. When the measurement between the stator windings is carried out the measuring cable's inner resistance (e.g. 0.10 Ω) must be deducted from the value obtained.

Measure between all winding connections (three measurements). The resistance should lie at 0.10 Ω.

Measure also against the alternator material by connecting the instrument in position Ω. Measure between the respective winding and the material. The instrument should during this measurement show a one “1” (which implies infinite).

If the instrument shows another value the stator winding is defective.

Note: If any stator winding is defective the stator must be replaced as a complete unit.

Starter motor

General

The stator motor is a DC series motor. The starter gear is controlled by a magnet and is moveable in an axial direction on the rotor shaft.

On engine MD2040 the starter motor is provided with a reduction gear. This enables a higher torque.

Dismantling of the starter motor

1. Remove both battery leads.
2. Release the electric cables to the starter motor.
3. Dismantle the starter motor's attachment screws and lift off the starter motor.

Stripping of the starter motor

1. Clean the exterior of the starter motor.

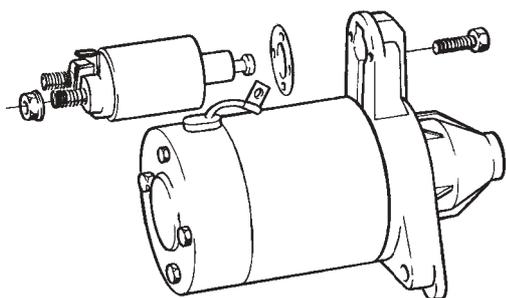


Fig. 115. Stripping of the starter motor

2. Remove the magnet.
3. Remove the protective cover from the rear bearing shield. Remove the lock ring and where appropriate the intermediate washer(s).

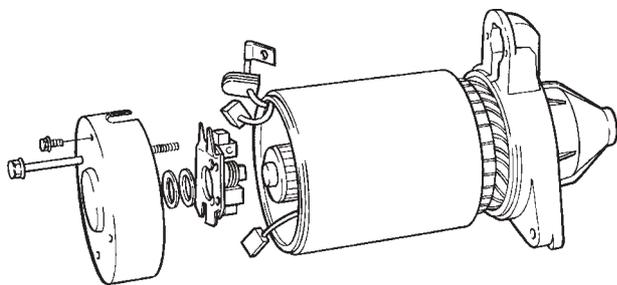


Fig. 116. Dismantling of the bearing shield

4. Remove the rear bearing shield.

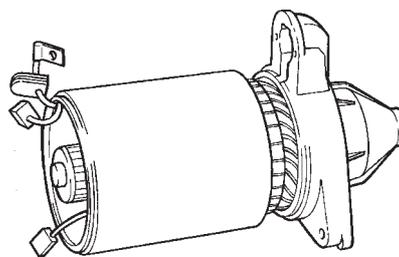


Fig. 117. Dismantling of the stator housing

5. Remove the brush holder plate. Remove the stator housing from the rotor and front bearing shield; on 2040 from the gear housing.

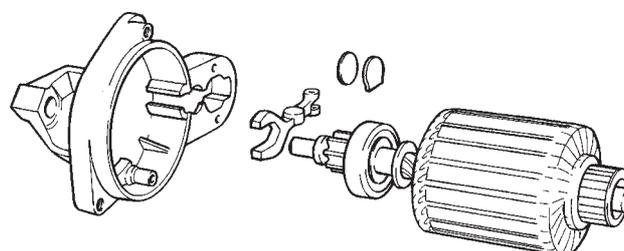


Fig. 118. Dismantling of the rotor

6. Remove the coupling arm and rotor.
MD2040: The coupling arm is fitted in the gear housing.

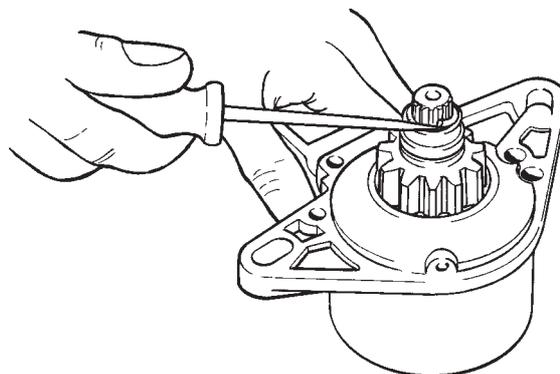


Fig. 119. Dismantling of the starter gear

7. Remove the starter gear as per Fig. 119. First remove the lock ring by tapping down the contact ring with a suitable mandrel.

MD2040: The starter gear is fitted in the gear housing.

Inspection of the starter motor

Troubleshooting on the starter motor should be handed over to an authorised electrical workshop which disposes over the necessary test equipment.

1. Test the rotor with respect to winding flash-over and failure with the test equipment for this purpose.



Fig. 120. Checking of the commutator

2. Check that the mating surfaces for the electric brushes on the commutator are smooth and free from dirt and oil. If the commutator is damaged or burnt it can be polished with sandpaper No. 500 or 600.
Measure the commutator with a dial gauge. Max. permissible radial distortion is 0.05 mm (.0019 in).
3. Check that the commutator's insulation lies at least 0.2 mm (.0078 in) below the laminated surface. Correct if necessary. See Fig. 120.
4. Check the linearity of the rotor. Brace the rotor between spikes and measure the radial distortion on the rotor frame with a dial gauge. Max. permissible radial distortion is 0.08 mm (.0031 in).
Note: The radial distortion is half of the read value.
5. Check the cogs on the starter gear. Replace damaged gear. Check also the starter gear ring if the gear is damaged.

Field winding

Check with a test instrument that there is no failure in the winding. If the field winding is defective it should be replaced.

Assembly of the starter motor

Assembly is carried out in the reverse order to stripping.

Connect + and – from a 12 V battery to the terminal on the magnet and check that the starter gear is pushed forward to the gear stop.

Fitting of the starter motor

1. Place the starter motor in position in the flywheel housing and tighten it.
2. Connect the electric cables to the starter motor. See the wiring diagram on page 80–86.
3. Connect both battery leads.

Electrical components

Relay box with fuses

The A-version has two fuse blocks each with four fuses (15A) for plus (+) and minus (–) placed on the relay box at left-hand rear side of the engine.

The B/C-version has one fuse block.

The fuses disconnect the current in the event of overloading.

Re-connect the electrical system of a fuse has blown by moving the cable connection to the next contact.

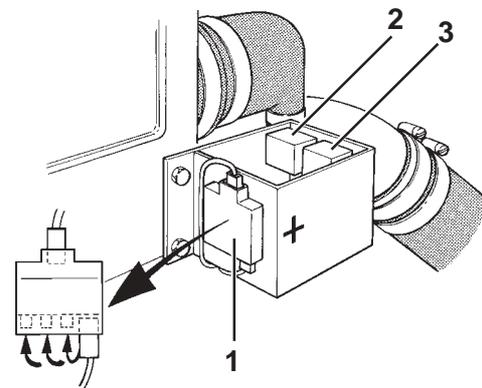


Fig. 121. Relay box with fuses

1. Fuse block + (15A)
2. Starter relay
3. Glow relay

Relays

Oil pressure relay – alarm

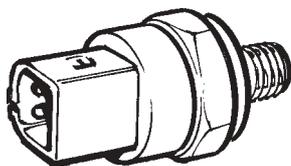


Fig. 122. Oil pressure relay

Contact type: Normally open. The contacts close if the oil pressure in the engine drops below 0.3 ± 0.15 bar (4.18 ± 2 psi).

Note: Checking of the closing point should be conducted with **falling** pressure.

Coolant temperature relay – alarm

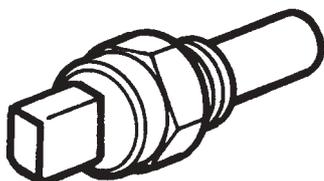


Fig. 124. Coolant temperature relay

Contact type: Normally open. The contact closes if the coolant temperature rises over $95^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($203^{\circ}\text{F} \pm 5.6^{\circ}\text{F}$).

Note: Checking of the break point should be conducting with **rising** temperature.

Sensors

Note: Sensors are only available with “De Luxe” instrument panels.

Oil pressure sensor

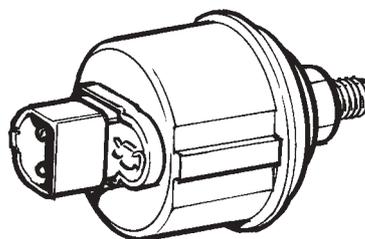


Fig. 125. Oil pressure sensor

Resistance testing: Measure with falling pressure and with instrument connected. Measure with ohmmeter class 1 at $+20^{\circ}\text{C}$ ($+68^{\circ}\text{F}$)

| | | |
|----------|-------------------|--------------------------|
| Pressure | 0 bar (0: | 10 ± 3 / -5Ω |
| | 2 bar (27.9 psi): | 52 $\pm 4 \Omega$ |
| | 4 bar (55.8 psi): | 88 $\pm 4 \Omega$ |
| | 6 bar (83.7 psi): | 124 $\pm 5 \Omega$ |

Coolant temperature sensor

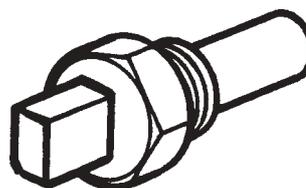
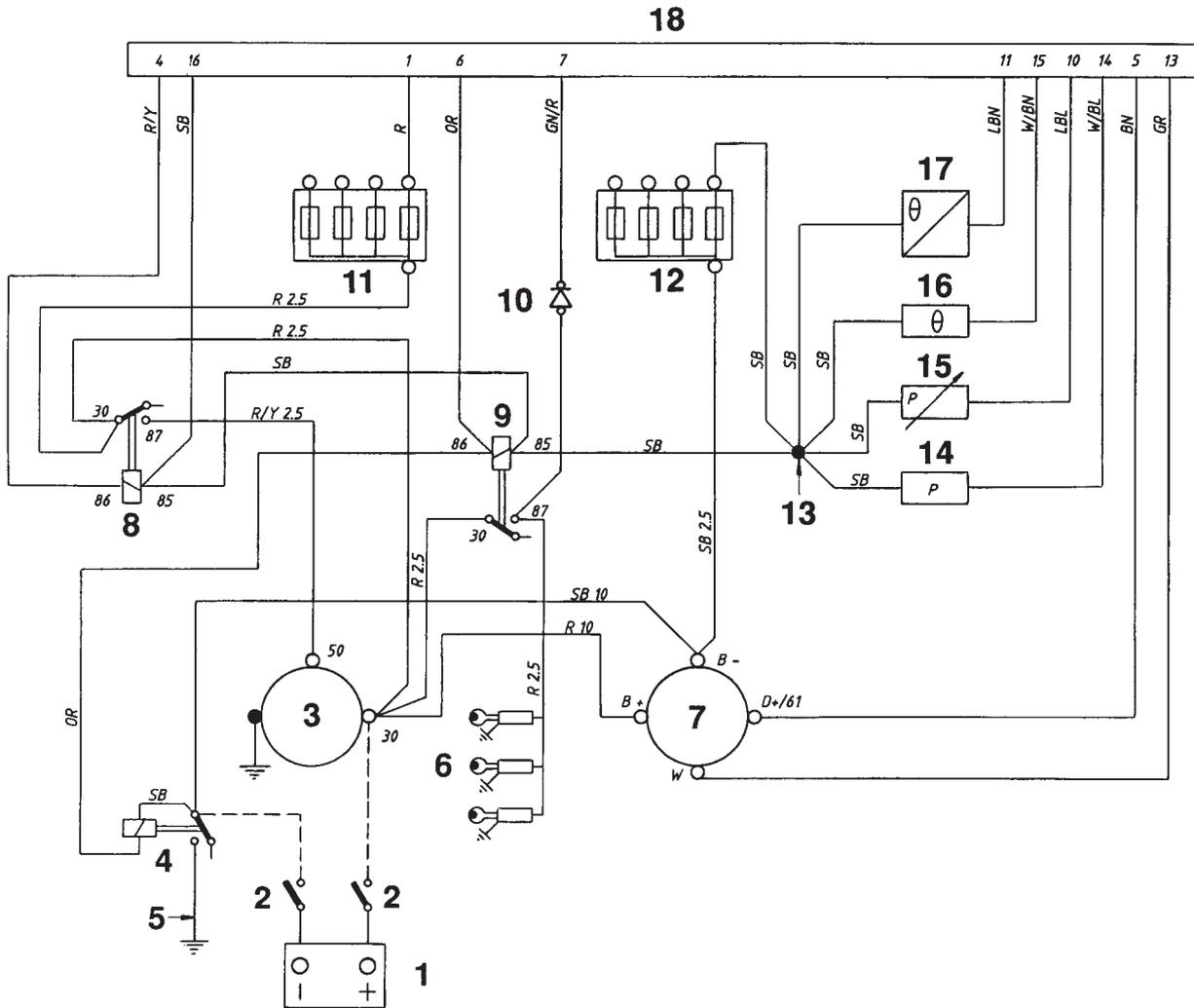


Fig. 126. Coolant temperature sensor

Resistance sensor: Measure with the sensor submerged to the hexagonal screw for three minutes in circulating liquid and with the current switched on.

| | | | |
|-------|-----------------|-------------------------|---|
| Temp. | 60°C (+140°F): | 134.0 $\pm 13.5 \Omega$ | ($\pm 4^{\circ}\text{C}$, $\pm 7.2^{\circ}\text{F}$) |
| | 90°C (+194°F): | 51.2 $\pm 4.3 \Omega$ | ($\pm 4^{\circ}\text{C}$, $\pm 7.2^{\circ}\text{F}$) |
| | 100°C (+212°F): | 38.5 $\pm 3.0 \Omega$ | ($\pm 4^{\circ}\text{C}$, $\pm 7.2^{\circ}\text{F}$) |

Engine MD2010A, MD2020A, MD2030A, MD2040A



- | | | |
|-------------------|--|---|
| 1. Battery | 9. Glow relay | 16. Coolant temperature relay (normally open, closes at 95°C ±3°C, 203,2 °F ±5.6°F) |
| 2. Main switch | 10. Protective diode | 17. Coolant temperature sensor |
| 3. Starter motor | 11. Fuses (4 pcs), max. 15A (+) | 18. Connector, 16-pole |
| 4. Earthing relay | 12. Fuses (4 pcs), max. 15A (-) | |
| 5. Earth rail | 13. Splice | |
| 6. Glow plug* | 14. Oil pressure relay, engine (normally open, closed at 0.3 bar ±0.1 bar) | |
| 7. Alternator | 15. Oil pressure sensor | |
| 8. Starter relay | | |

*MD2010: 2 pcs. Other engines: 3 pcs

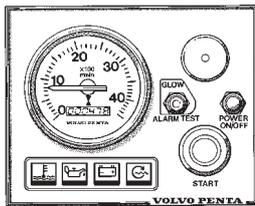
Cable colours

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

Cable areas in mm² are given after the colour code in the wiring diagram.

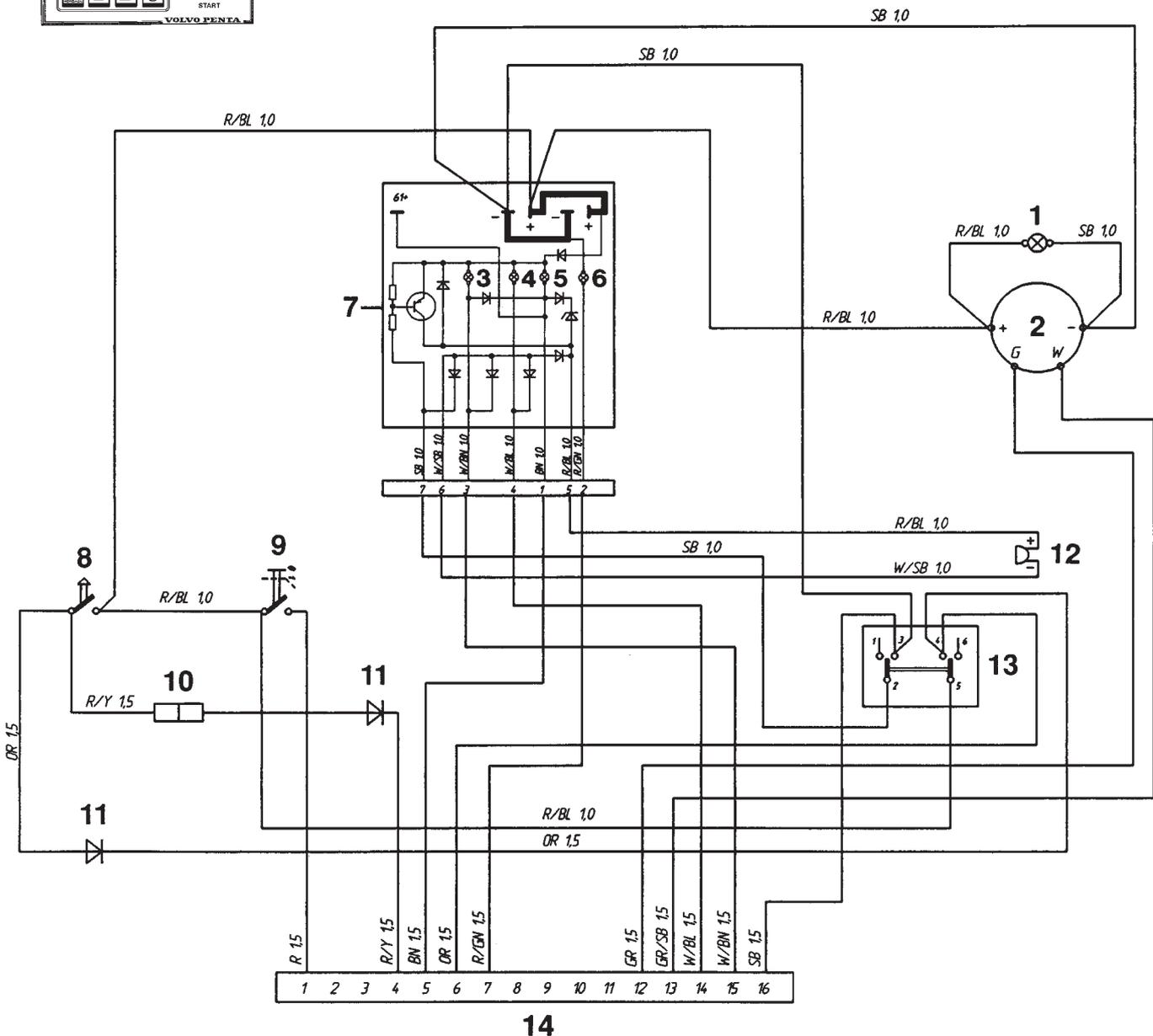
Areas not given = 1.0 mm².

Dashed cables are not included from Volvo Penta.



Instrument panel, alternative "A" and "B"* MD2010A, MD2020A, MD2030A, MD2040A

* ("A" = with tachometer, "B" = without tachometer, blind plug)



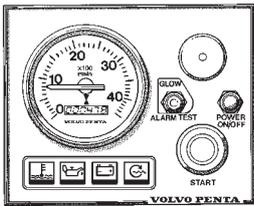
1. Instrument lighting
2. Tachometer / blind plug*
3. Warning lamp, coolant temperature
4. Warning lamp, oil pressure
5. Warning lamp, charging
6. Control lamp, glowing
7. Electronics unit (alarm)
8. Starter button
9. Pressure switch, instrument panel On/Off
10. Connector for connection of neutral position switch (accessory)
11. Semi conductor diode
12. Alarm
13. Toggle switch. Glowing – Alarm test
14. 16-pole connection

Cable colours

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

Cable areas in mm² are given after the colour code in the wiring diagram.

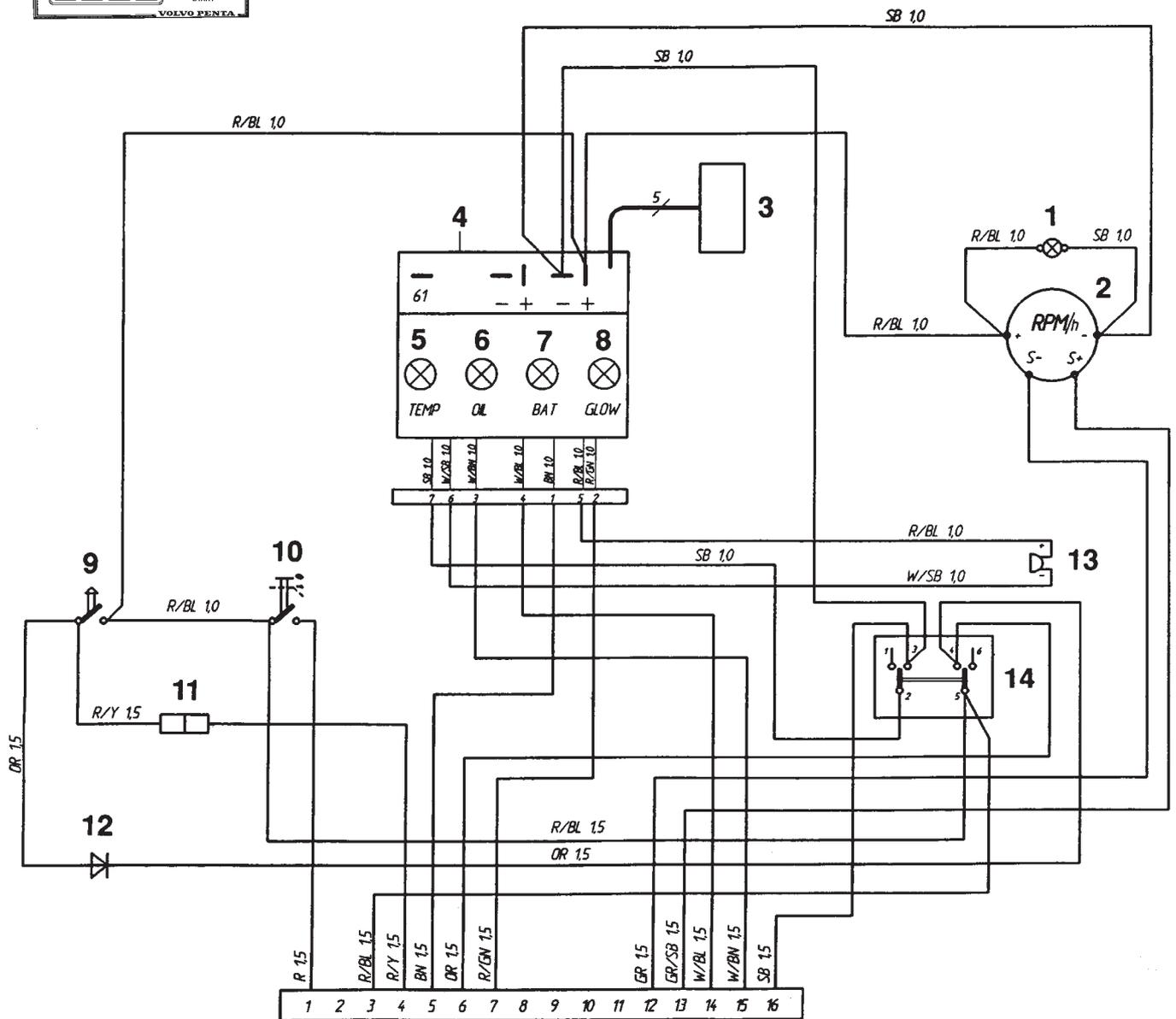
* Blind plug refers to instrument panel "B".



Instrument panel, alternative "A" *

MD2010B/C/D, MD2020B/C/D, MD2030B/C/D, MD2040B/C/D

*** (without key switch)**



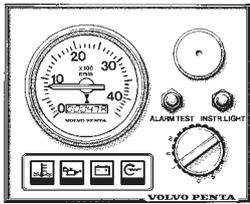
15

1. Instrument lighting
2. Tachometer with built-in hour counter (accessory), alt. blind plug
3. Connector for connection of extra warning display (accessory)
4. Electronics unit (alarm)
5. Warning lamp, coolant temperature
6. Warning lamp, oil pressure
7. Warning lamp, charging
8. Control lamp, glowing
9. Starter button
10. Pressure switch, instrument panel On/Off
11. Connector for connection of neutral position switch (accessory)
12. Semi conductor diode
13. Alarm
14. Toggle switch. Glowing – Alarm test/Acknowledging
15. 16-pole connection

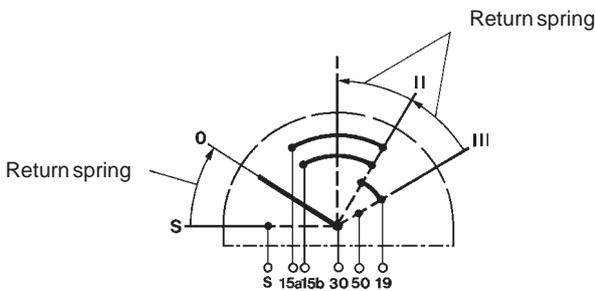
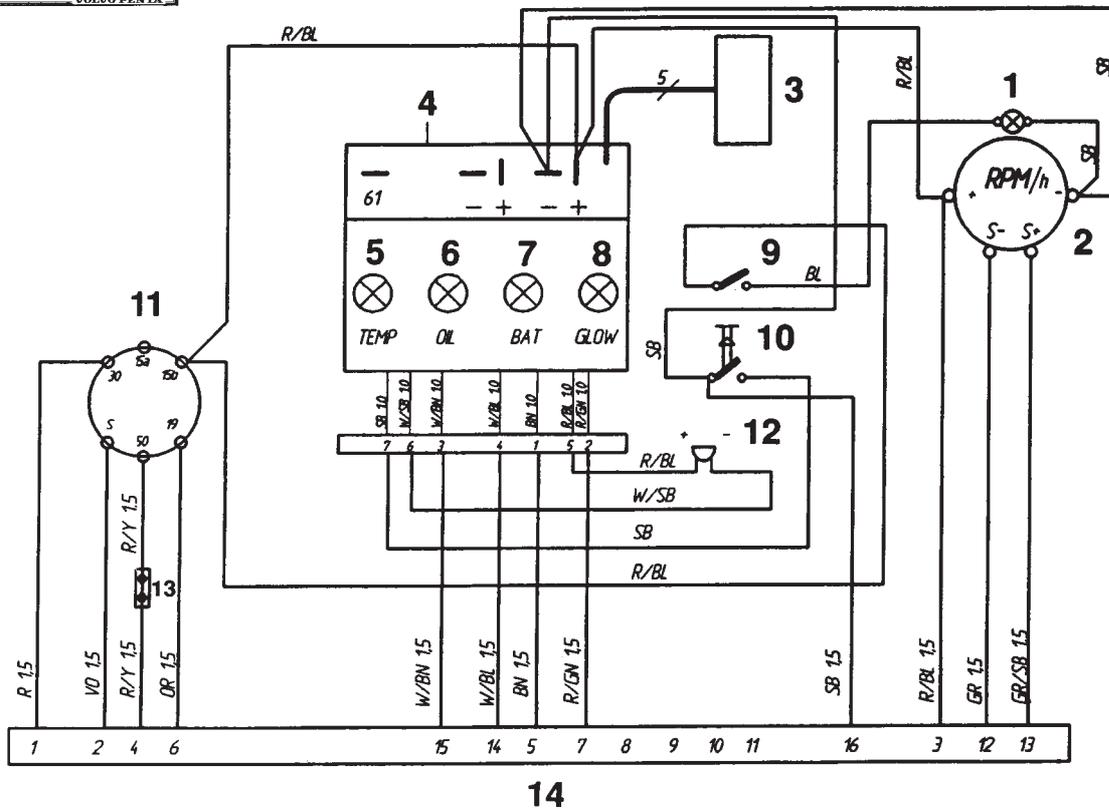
Cable colours

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

Cable areas in mm² are given after the colour code in the wiring diagram.



Instrument panel, alternative "B" *
MD2010B/C/D, MD2020B/C/D, MD2030B/C/D, MD2040B/C/D
 * (with key switch)



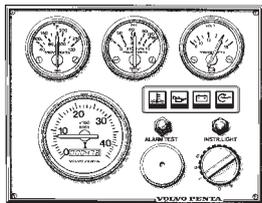
1. Instrument lighting
2. Tachometer with built-in hour counter (accessory), alt. blind plug
3. Connector for connection of extra warning display (accessory)
4. Electronics unit (alarm)
5. Warning lamp, colant temperature
6. Warning lamp, oil pressure
7. Warning lamp, charging
8. Control lamp, glowing
9. Switch, instrument lighting
10. Switch – Alarm test/Acknowledging
11. Key switch
12. Alarm
13. Connector for connection of neutral position switch (accessory)
14. 16-pole connection

Cable colours

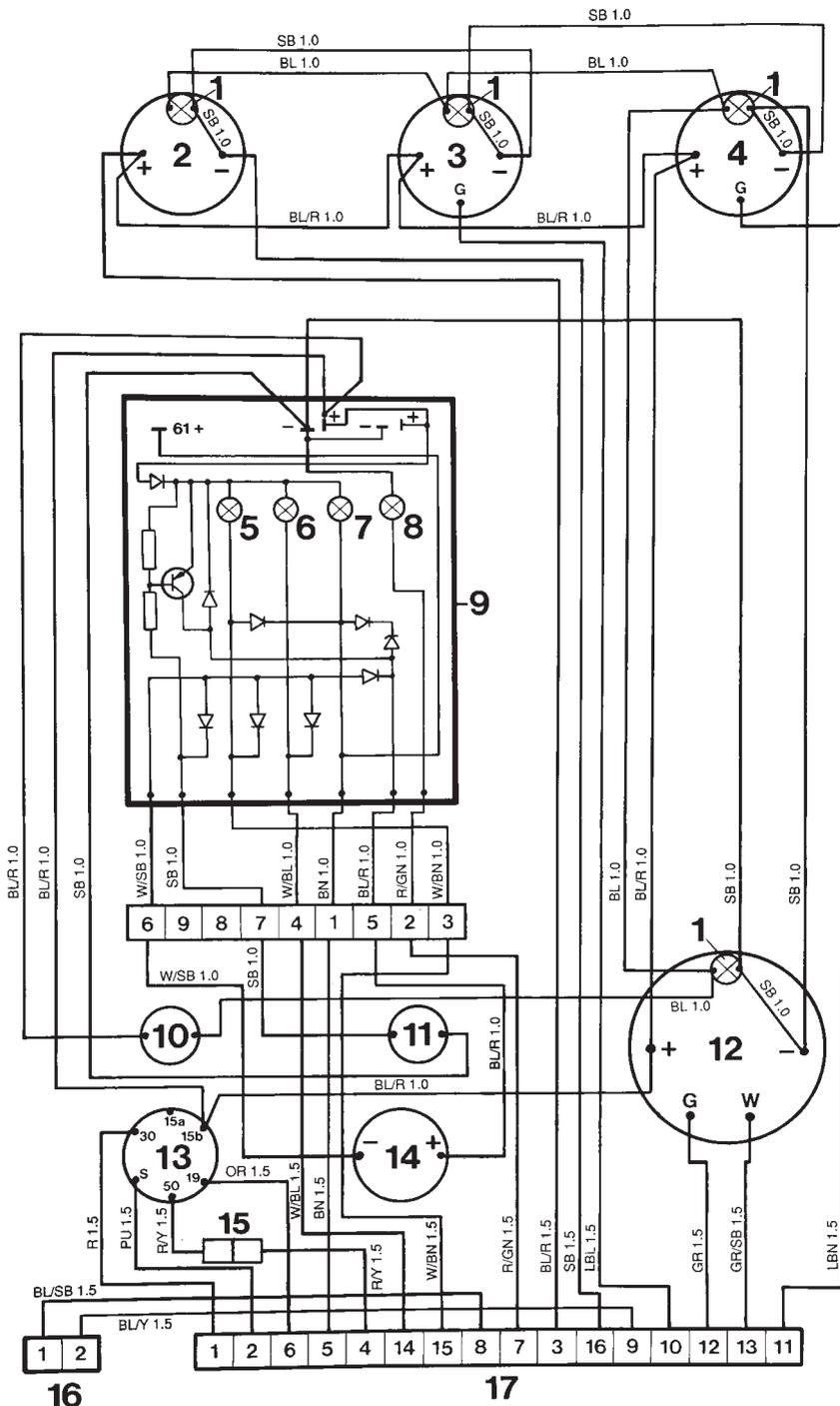
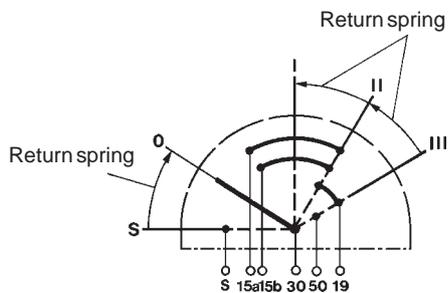
- BL = Blue
- BN = Brown
- GN = Green
- GR = Grey
- OR = Orange
- R = Red
- SB = Black
- VO = Violet
- W = White
- Y = Yellow

Cable areas in mm² are given after the colour code in the wiring diagram.

Areas not given = 1.0 mm²



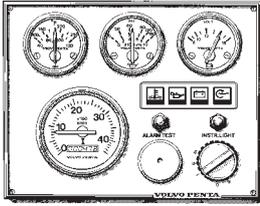
Instrument panel, alternative "C" MD2010A, MD2020A, MD2030A, MD2040A



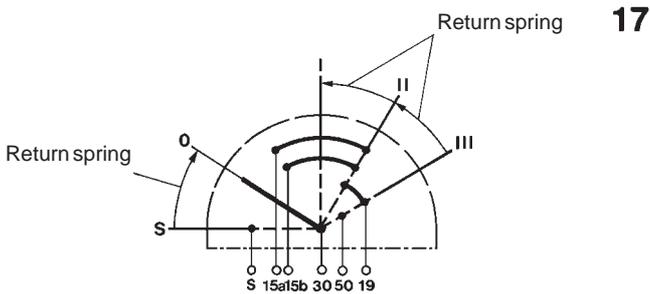
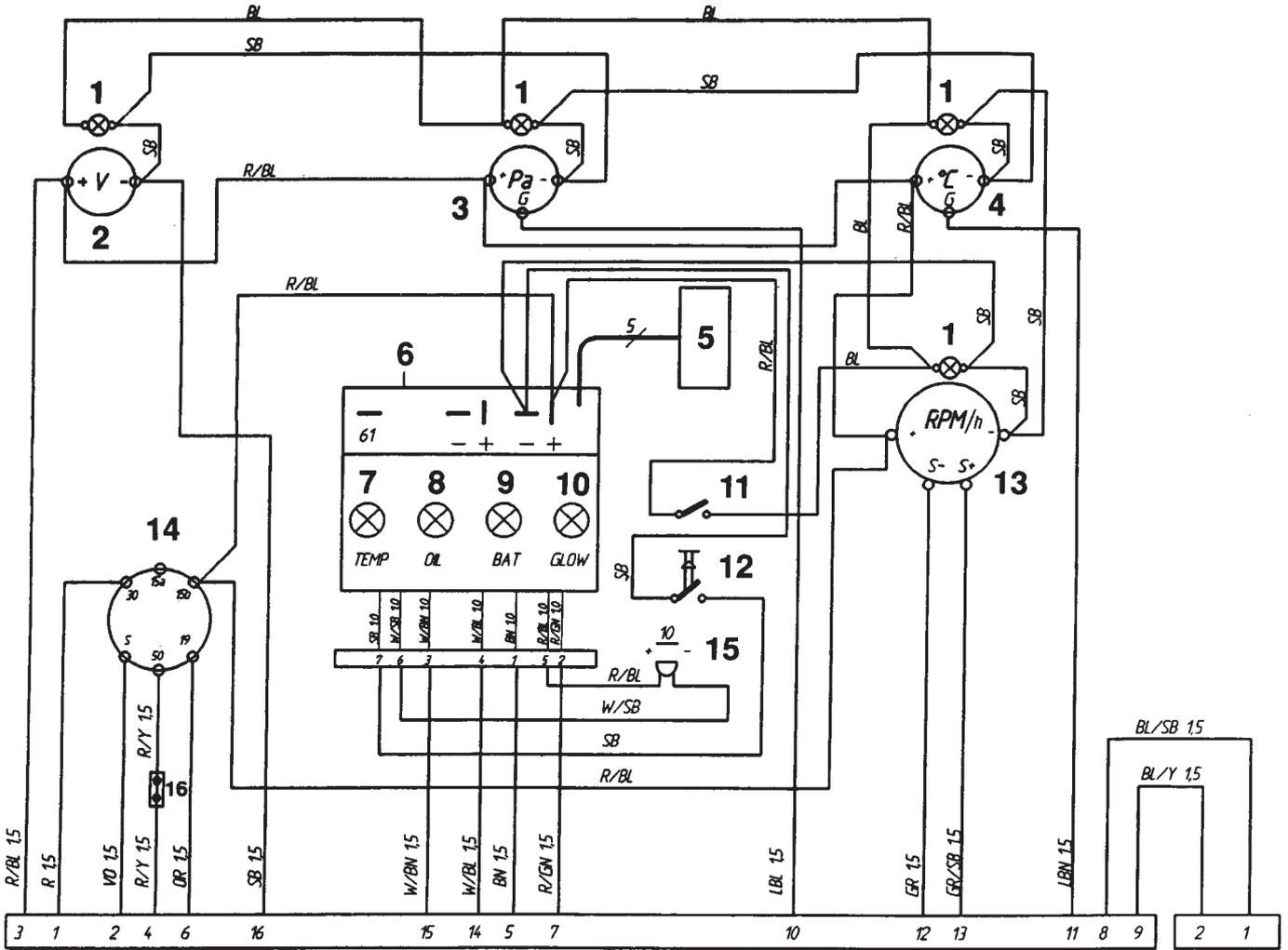
1. Instrument lighting
2. Voltmeter
3. Oil pressure gauge
4. Coolant temperature gauge
5. Warning lamp, coolant temperature
6. Warning lamp, oil pressure
7. Warning lamp, charging
8. Control lamp, glowing
9. Electronics unit, alarm
10. Switch, instrument lighting
11. Switch - alarm test
12. Tachometer
13. Key switch
14. Alarm
15. Connector for connection of neutral position switch (accessory)
16. 2-pole connection (for extra panel)
17. 16-pole connection

Cable colours

- BL = Blue
- BN = Brown
- GN = Green
- GR = Grey
- OR = Orange
- R = Red
- SB = Black
- VO = Violet
- W = White
- Y = Yellow



Instrument panel, alternative "C" MD2010B/C/D, MD2020B/C/D, MD2030B/C/D, MD2040B/C/D



Cable colour

- BL = Blue
- LBL = Light blue
- BN = Brown
- LBN = Light brown
- GN = Green
- GR = Grey
- OR = Orange
- R = Red
- SB = Black
- VO = Violet
- W = White
- Y = Yellow

- 1. Instrument lighting
- 2. Voltmeter
- 3. Oil pressure gauge
- 4. Coolant temperature gauge
- 5. Connector for connection of extra warning display (accessory)
- 6. Electronics unit (alarm)
- 7. Warning lamp, coolant temperature
- 8. Warning lamp, oil pressure
- 9. Warning lamp, charging
- 10. Control lamp, glowing
- 11. Switch, instrument lighting
- 12. Switch – alarm test/Acknowledging
- 13. Tachometer with built-in hour counter (accessory), alt. blind plug
- 14. Key switch
- 15. Alarm
- 16. Connector for connection of neutral position switch (accessory)
- 17. 16-pole connection
- 18. 2-pole connection (for extra panel)

**Cable areas in mm² are given after the colour code in the wiring diagram.
Areas not given = 1.0 mm²**

Extra equipment (accessories)

General

Extra equipment which is driven with V-belts via the engine's crankshaft result in an increased load on the crankshaft. It is therefore important that the axial position of the pulley on the crankshaft and the positioning of the equipment in relation to the crankshaft are adjusted to the power takeout of the extra equipment.

The following diagram shows the permissible power takeout at a certain positioning of the pulley and extra equipment.

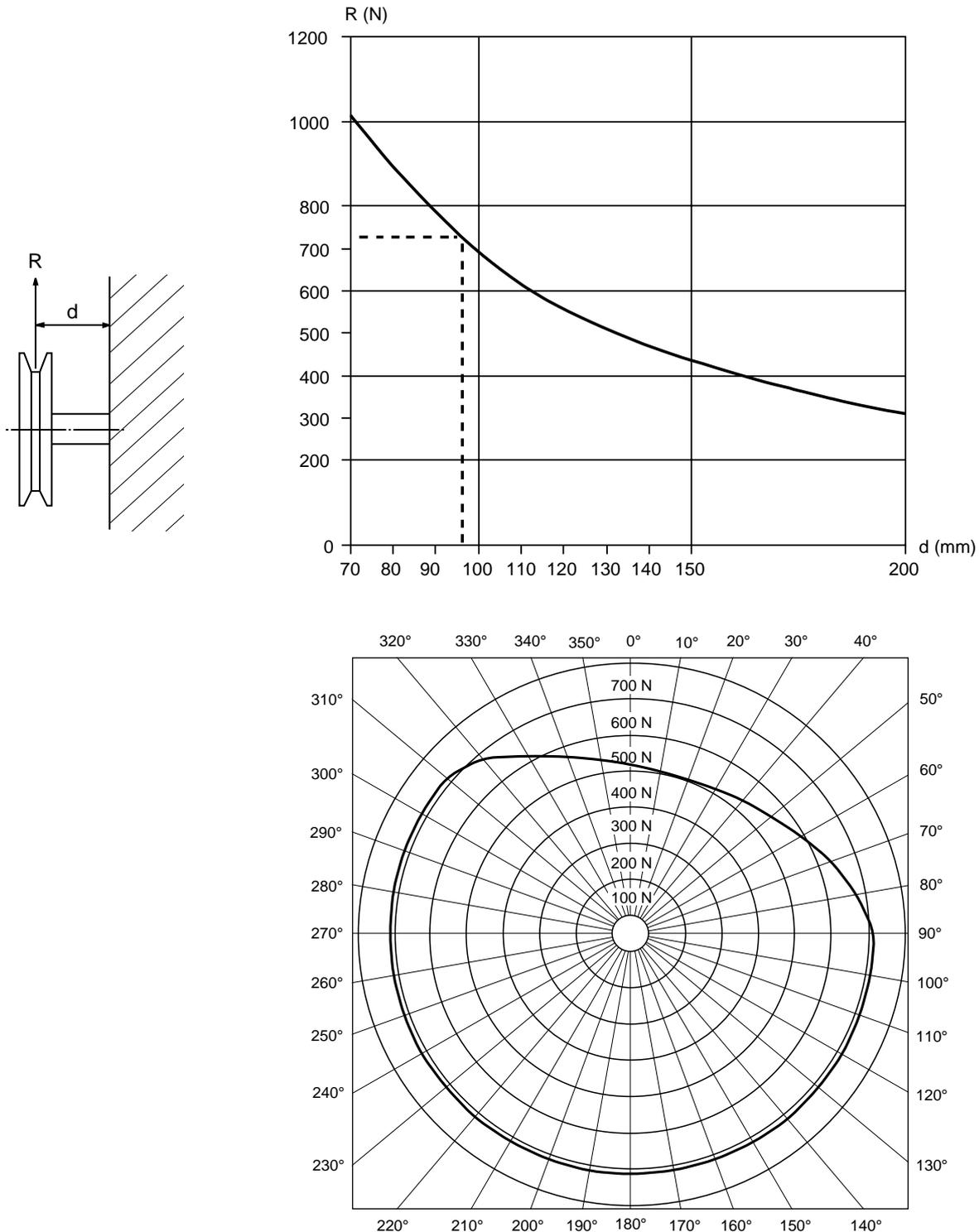


Fig. 127. MD 2010.

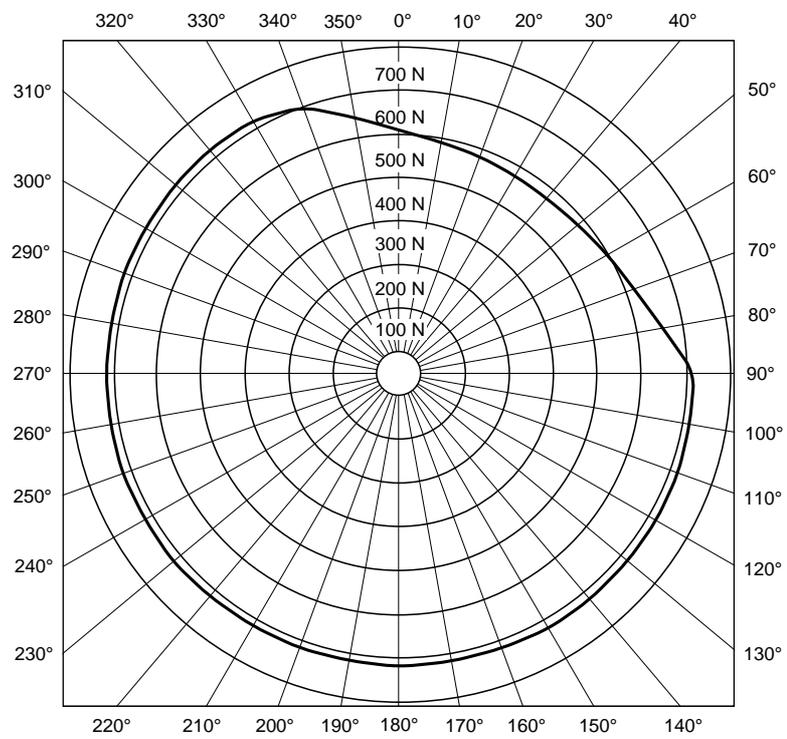
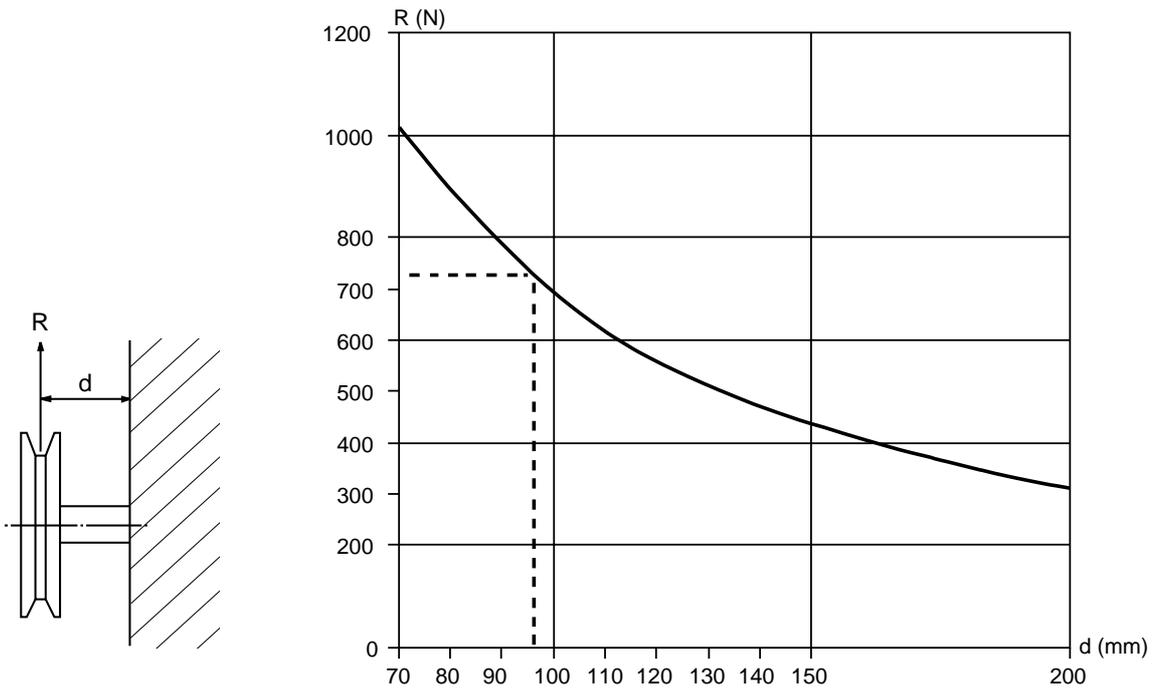


Fig. 128. MD 2020.

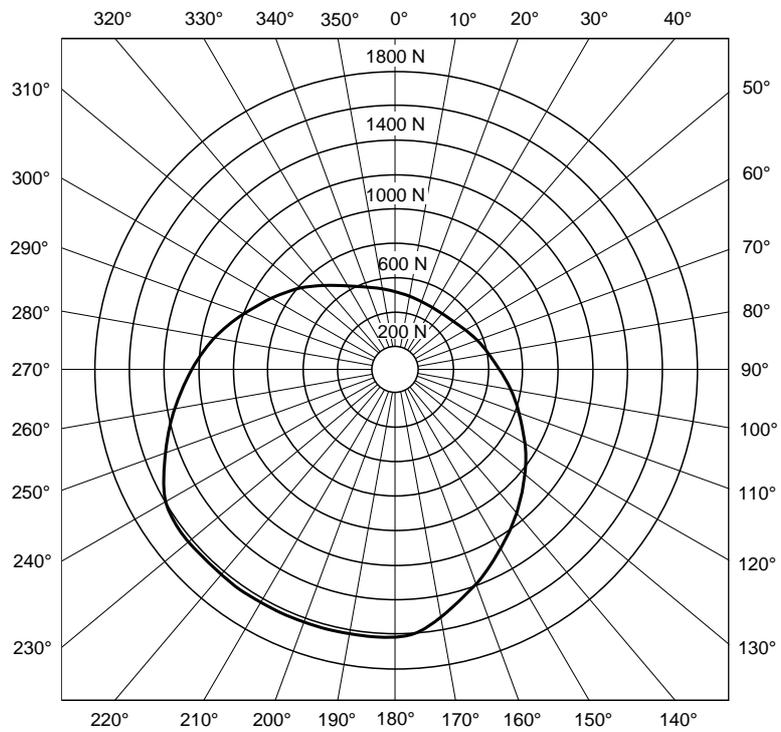
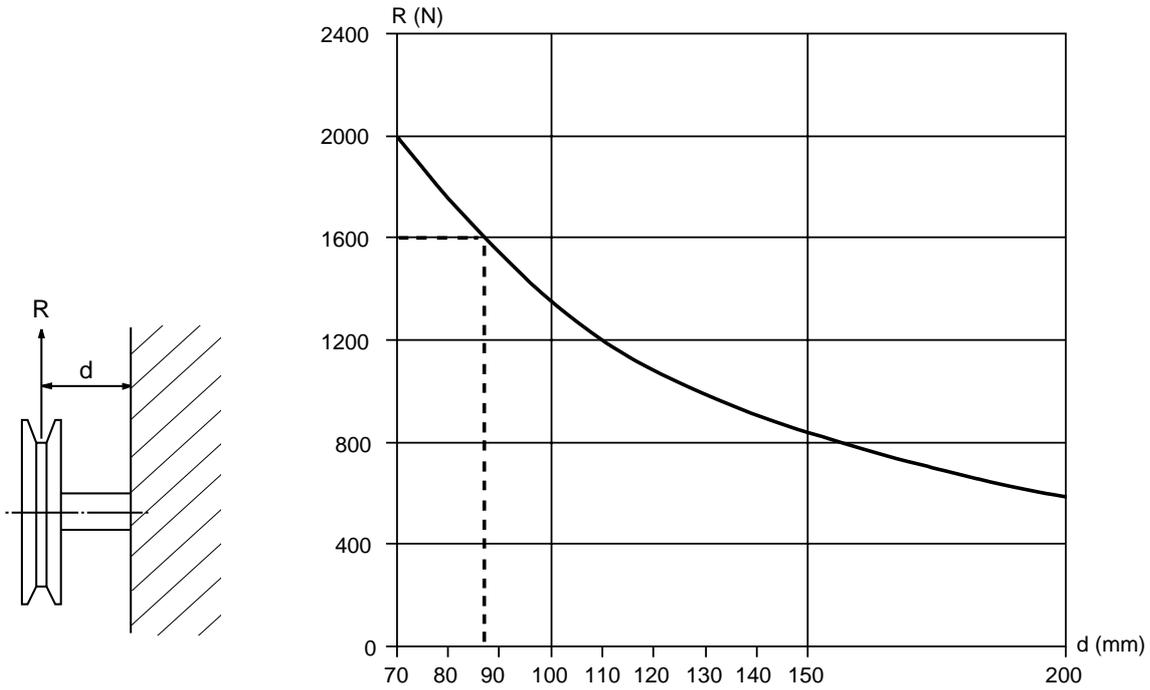


Fig. 129. MD 2030.

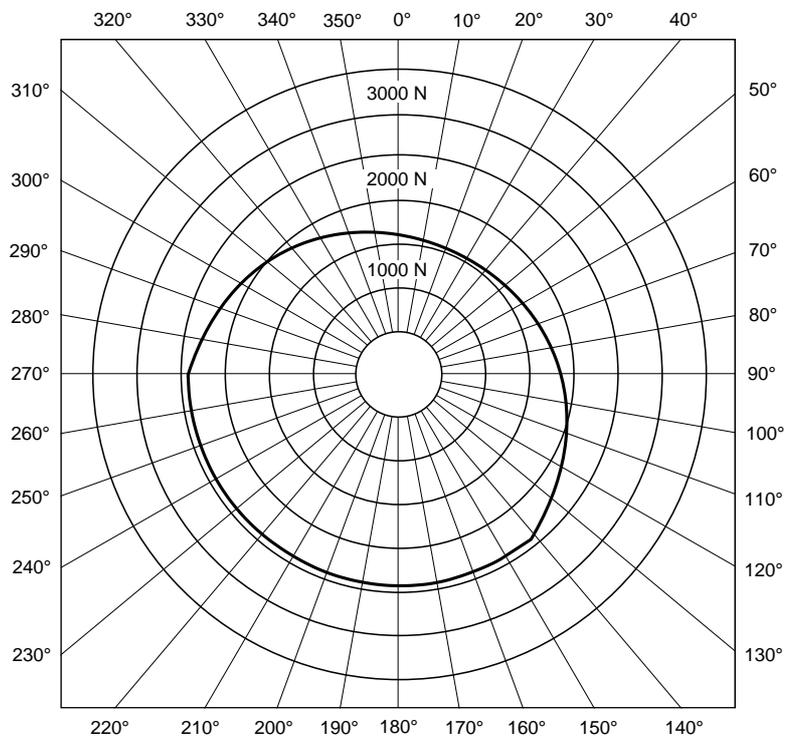
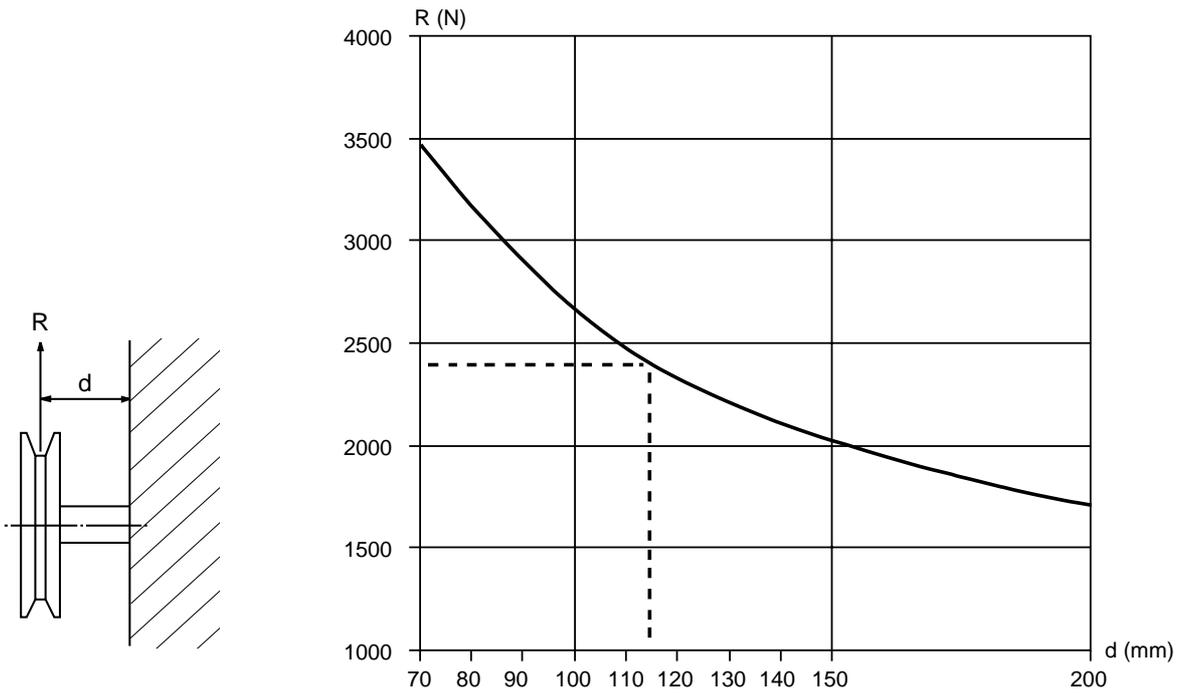


Fig. 130. MD 2040.

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