INSTRUCTION BOOK

MD22L, MD22, TDM22

⚠ California

Proposition 65 Warning
Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Owner's Manual

Marine Diesel Engines

MD22L, MD22, TMD22

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CALIFORNIA
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Safety precautions

Introduction

This Owner's Manual contains the information you will need to operate the engine correctly. Check that you have the correct Owner's Manual for your engine.

Read the book carefully before operating or servicing the engine. Incorrect operation or servicing of the engine could result in personal injury or material damage as well as damaging the engine itself. **If you do not understand or are uncertain on any operation in this book, contact your dealer who can explain or demonstrate the procedure for you.**

Important

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

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

Read the Owner's Manual.

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

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

Always turn the engine off before starting service procedures. Avoid burns. Take precautions to avoid hot surfaces and liquids in supply lines and hoses when the engine has been turned off immediately prior to starting work on it and it is still hot.

Reinstall all protective parts removed during service operations before starting work on the engine. Make a point of familiarizing yourself with other risk factors, such as rotating parts and hot surfaces (exhaust manifold, Turbo unit, charge pipe, starter heater etc.).

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 the service operation requires that the engine is operating let your Penta authorized dealer carry out the work. If working in proximity of an engine which is operating, careless movements or a dropped tool can result in personal injury.

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

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

Engines with intake air pre-heating: Never use starting spray in the air intake. Use of such products could result in an explosion in the air intake pipe due to the hot-spot pre-heater. Danger of personal injury.

Do not open the filler cap for the engine coolant (freshwater cooled engines) when the engine is hot. Steam or hot engine coolant can be ejected and any pressure in the system will be lost. Open the filler cap slowly and release coolant system pressure (freshwater cooled engines), if the filler cap or drain cock must be opened, or if a plug or engine coolant line must be removed on a hot engine. Steam or hot coolant can be ejected.

Stop the engine and close the bottom valve before carrying out operations on the cooling system.

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

Anti-corrosion agents are hazardous to health. Read the instructions on the product packaging!

Anti-freeze agents are hazardous to health. Read the instructions on the product packaging!

Certain engine conservation oils are inflammable. Some of them are also dangerous if breathed in. Ensure good ventilation in the work place. Use a protective mask when spraying.

⚠ 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.

⚠ Never allow an open flame or electric sparks near the battery area. 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. This gas is easily ignited and highly volatile. Incorrect connection of the battery can cause sparks 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. Refer to instructions in the Owner's Manual.

⚠ Always ensure that the Plus (positive) and Minus (negative) battery leads are correctly installed on the corresponding terminal posts on the battery. 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. The battery electrolyte contains extremely corrosive sulfuric acid. If this should come in contact with the skin, immediately wash with soap and plenty of water. If battery acid comes in contact with the eyes, immediately flush with water and obtain medical assistance.

⚠ Turn the engine off and turn off the power at the main switches (breakers) before carrying out work on the electrical system.

⚠ Clutch adjustments, where a clutch is fitted, must be carried out with the engine turned off.

⚠ 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).

To ensure safe lifting and avoid damage to components installed on the top of the engine use an adjustable lifting beam. All chains and cables must run parallel to each other and as perpendicular as possible to the upper side 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.

⚠ The components in the electrical system, the ignition system (gasoline/petrol engines) and in the fuel system on Volvo Penta products are designed and manufactured to minimize risks of fire and explosion.

Using parts that are not Original Volvo Penta parts which do not correspond to the demands above, can result in fire or explosion on board. 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.

⚠ Fuel filter replacement should be carried out on a cold engine in order to avoid the risk of fire caused by fuel spillage on the exhaust manifold. Always cover the alternator, if it is located under the fuel filter. The alternator can be damaged by spilled fuel.

⚠ Always use protective gloves when detecting leaks. Liquids ejected under pressure can penetrate the body tissues and cause serious injury. Danger of blood poisoning.

⚠ Always use fuels recommended by Volvo Penta. Refer to the Owner's 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 hang 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.

⚠ Observe the following when cleaning with high-pressure water jets. Never point the water jet at seals, rubber hoses or electrical components. Never use high pressure jets when washing the engine.

General Information

Welcome aboard

Thank you for choosing a Volvo Penta marine engine.

Volvo Penta have been building marine engines since 1907. Quality, operating reliability and innovation have made Volvo Penta a world leader in the marine engine industry.

As owner of a Volvo Penta marine engine we would also like to welcome you to a worldwide network of dealers and service workshops to assist you with advice, service requirements and spare parts. Please contact your nearest authorized Volvo Penta dealer for assistance.

We would like to wish you many pleasant voyages.

AB VOLVO PENTA

Technical Information

Your new boat

Every new boat has it own special characteristics. Even experienced boat owners are advised to note carefully how the boat behaves at different speeds, weather conditions and loads. If your boat and engine combination permit high-speed use, we strongly recommend that a safety breaker is fitted, regardless of the type of boat. If your boat is not fitted with a safety breaker contact your Volvo Penta dealer who can assist you in selecting one.

Running-in

A new marine engine requires a running-in period of 20 operating hours. Run the engine at varying engine speeds, but not over a maximum of 3/4 throttle opening for the first two hours. For the next 8 hours run the engine in the same way, but with max. 2 minute periods at wide open throttle (WOT). During the final 10 hours increase wide open throttle periods to 5–10 minutes at a time. Reduce the throttle opening to idle periodically to allow the engine temperature to drop. During the running-in period never run the engine for long periods at a constant engine speed. It is normal for the engine to use more engine oil during the running-in period. Make a point of checking the engine oil level more frequently during the running-in period than during normal operation. Carry out the First Service Inspection after the initial 20-hour running-in period.

Fuel and lubricants

Only use lubricants and fuels recommended under “Technical Data”. Use of other classifications can cause malfunctions and reduced service life.

Spare parts

WARNING! The components in the electrical system and in the fuel system on Volvo Penta products are designed and manufactured to minimize the risk of fire and explosion.

Using parts that are not Original Volvo Penta parts and which do not correspond to the demands above, can result in fire or explosion on board. 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.

Safety

Everyone wants and expects to have a problem-free and pleasant time when they take their boat out. To help you do this we have provided a check-list below which can of course be added to according personal experience. A major area is naturally the engine, its equipment and that the boat in general is properly maintained.

Planning your trip

– Get out up-to-date charts for the route planned
– Calculate distance and fuel consumption
– Note down if there are fuel points on your planned course
– Tell friends or relatives about your trip plans

Boat equipment

– Rescue and emergency items such as life-vests and signal rockets. Does everyone know where they are?
– Spare parts on board, for example: Kit with water pump impeller etc.
– Proper tools for the equipment
– Fire extinguisher (checked and charged)

Our joint responsibility

Volvo Penta continually commits a considerable part of its development resources towards minimizing the environmental impact of its products. Examples of areas where we are always looking for improvements are; exhaust emissions, sound levels and fuel consumption.

Regardless of whether your Volvo Penta engine is installed in a boat used for pleasure or in commercial operation, incorrect operation or improper maintenance of the engine will result in disturbance or damage to the environment.

In this Owner's Manual there are a number of service procedures, which, if not followed will lead to a deterioration of engine characteristics with regard to how it effects the environment, its service life and cost of operation. Always follow the recommended service intervals and make a habit of checking that the engine is operating normally every time you use it. One example is excessively smoky exhaust. Contact an authorized Volvo Penta workshop if you cannot correct the fault yourself.

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. Always dispose of engine and transmission oil waste, old paint, degreasing agents and cleaning residue etc. at proper disposal areas so they do not harm the environment.

Adapt speed and distance during your boat trips so that swell and noise generated by the boat do not disturb or harm wildlife, moored boats, landing stages etc. Wherever you land or cruise, please show consideration and always leave the areas you visit as you would like to find them yourself.

Warranty and guarantee

A Service and Warranty Book with conditions for Volvo Penta's International Limited Warranty is supplied with every engine. Contact your nearest Volvo Penta dealer or importer for your copy if you have not received one.

Some markets can have other warranty conditions depending on national legislation and regulations. These conditions are provided by the Volvo Penta importer or distributor for the market in question. If you wish to have a copy of the conditions please contact your local Volvo Penta representative.

Warranty Registration Card

The Warranty Registration Form (North American market) or Warranty Card (other markets) should always be filled out and sent in by the vendor. Make sure that this has been done, since refusal of warranty can occur if no proof of the delivery date can be provided.

Maintenance and care

– PDC (Pre Delivery Commissioning) delivery undertaking, for marine engines: PDC enables us to ensure that Volvo Penta products operate correctly after installation in a boat, and further that the end-user gets acquainted with the product, its functions and care (refer to the Warranty and Service book). Delivery undertaking "PDC" is carried out at the time of the delivery of the boat to the end-user. The cost of this work is covered by the Volvo Penta International Limited Warranty.

– First Service inspection, for marine engines: A first Service Inspection must be carried out after operating the engine for 20–50 hours or within 180 days from the delivery date, or the end of the first season, whichever occurs first. Labor and material costs in connection with the First Service Inspection are **no**t covered by the Volvo Penta International Limited Guarantee (for checklist see your Warranty and Service book).

Regular maintenance should be carried out after the First Service Inspection in accordance with the maintenance scheme in this book. Any work carried out in addition to maintenance services should be documented (refer to the Warranty and Service book)

It is an absolute condition for the Volvo Penta International Limited Warranty to apply that the PDC Delivery undertaking and First Service Inspection have been carried out by an authorized Volvo Penta Service dealer.

Volvo Penta Service

Volvo Penta has a comprehensive dealer network that offers both service and spare parts for Volvo Penta engines. Volvo Penta dealers are carefully selected and then trained in order to provide customers with professional assistance on engine service and repairs. These dealers have the special tools required to carry out the work and the test equipment that ensures a high service standard. They are required to keep a stock of Volvo Penta Original Spare Parts and accessories that cover most requirements. When ordering service or spare parts always quote the complete engine and/or drive/reverse gear model designation and serial number. These are stated on the engine product plate and on a label on the engine valve cover.

Certificated engines

Important information for engines certificated for Lake Constance and Switzerland

All Volvo Penta engines and products are developed to minimize environmental impact.

National and regional legislation is not identical in all the markets where Volvo Penta sells its products. Occasionally legislation requires that we build special engine variants, or that an engine must be approved in advance, that is, certificated by the local authorities.

An engine with certification means that we, as the manufacturer, guarantee that all engines manufactured are of the same type as the certificated and approved example. Certification is not only a requirement covering engines from the factory, but also that engines in use must meet the environmental demands set for that engine. In order for Volvo Penta as the manufacturer to take responsibility for engines in use, certain requirements pertaining to service and spare parts must be met. We do not wish to discourage owners from carrying out service work themselves, rather the opposite since an owner can quickly notice if an engine is not operating normally. However, a number of service operations demand access to special expertise, workshop manuals, special tools and other equipment designed for the engines. These service operations may only be carried out by an authorized Volvo Penta Service workshop. Always contact your Volvo Penta dealer if you are not sure about anything concerning your engine's function or maintenance.

As an owner or operator of a certificated Volvo Penta engine it is important that you are aware of the following:

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

IMPORTANT! Use only VOLVO PENTA original spare parts. **The use of spare parts other than VOLVO PENTA original spare parts will invalidate AB VOLVO PENTA's responsibility for the engine specification being in accordance with the certificated variant.** VOLVO PENTA accepts no responsibility or liability for any damage or costs arising through the use of replacement parts other than original VOLVO PENTA replacement parts for the product in question.

Identifying Numbers

Immediately after you have taken delivery of your boat, make a note of the serial number and model designation of the engine and drive as well as the shield or reverse gear. Include the serial number and model designation of the boat and any extra equipment. This information is necessary when you contact your Volvo Penta or boat sales representative for service and spare parts. Take a copy of the information and keep it in a safe place so it is available should the boat be stolen.

Engine type .....

Serial No. .....

Drive type .....

Serial No. .....

Reverse gear type .....

Serial No. .....

Propeller designation .....

Boat type .....

Serial No. .....

Other equipment .....

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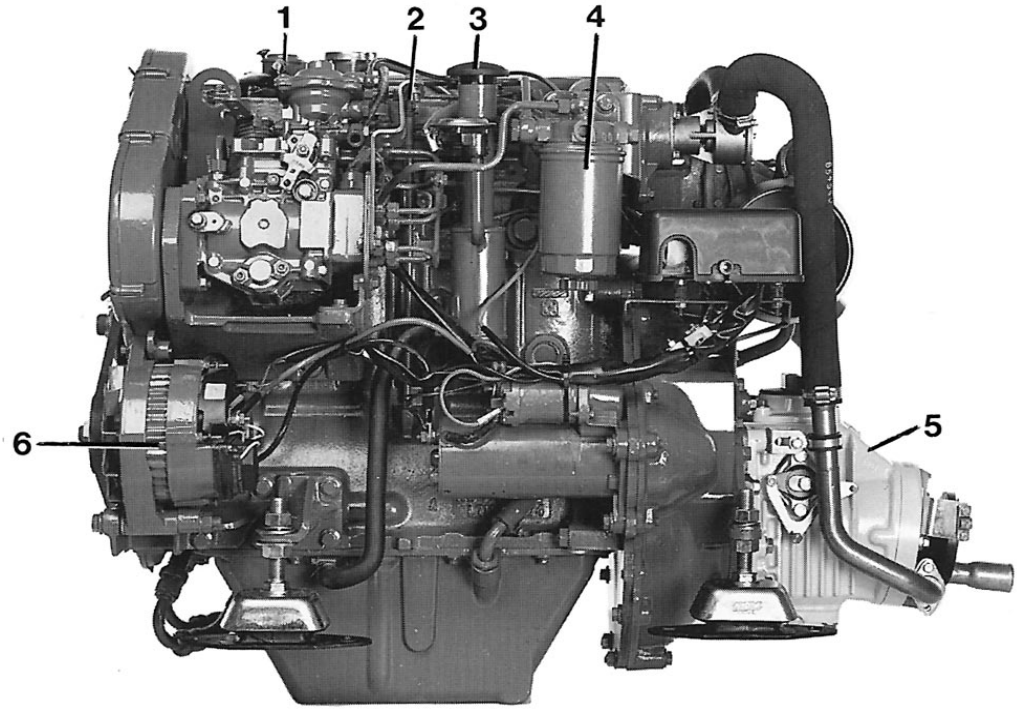
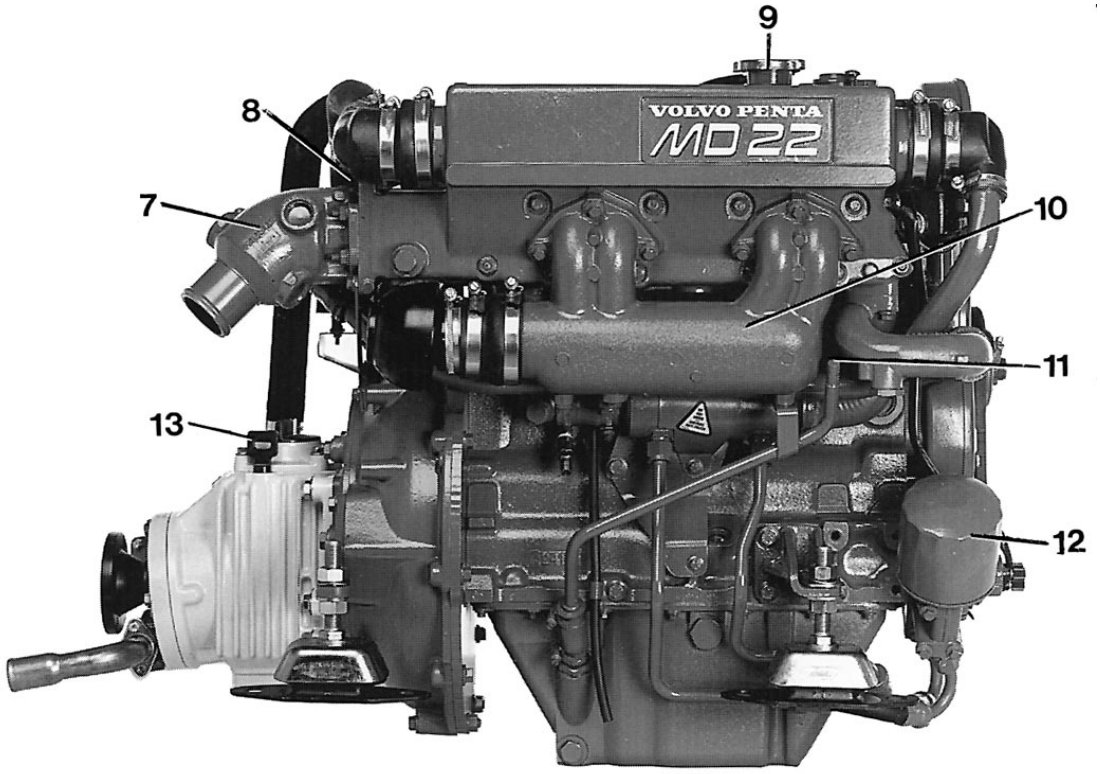
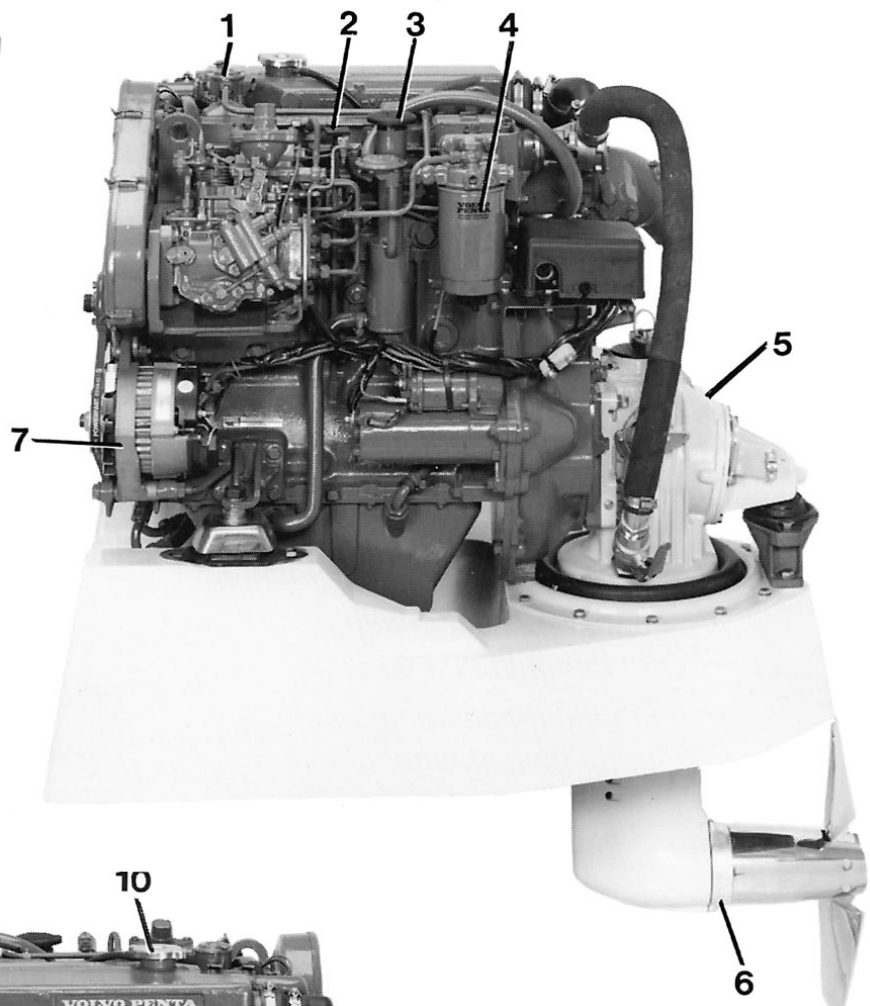
Introduction

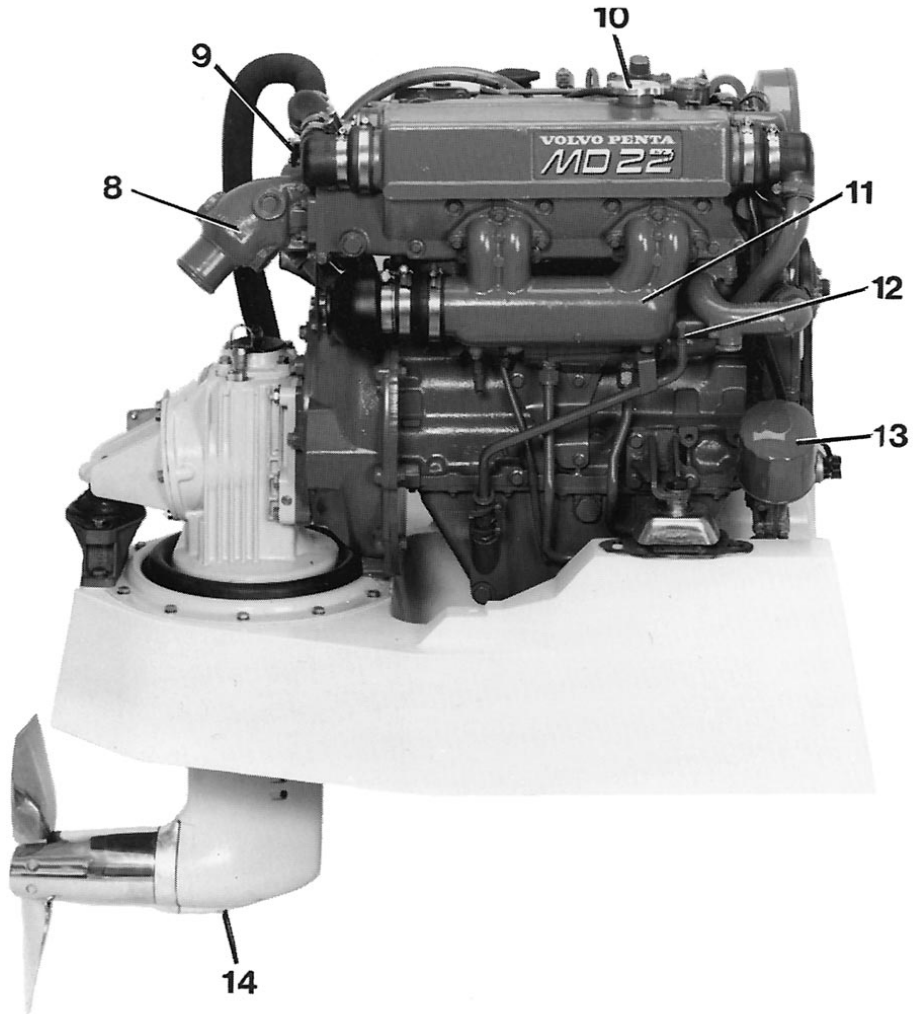




MD 22L, MD 22, TMD 22 / MS2L, MS2A

1. Fuel liftpump
2. Oil dipstick
3. Filler cap for lubricating oil
4. Fuel filter
5. Reverse gear serial number
6. Alternator
7. Exhaust outlet
8. Raw water pump
9. Filler cap
10. Induction manifold
11. Pipe for oil bilge pump
12. Oil filter
13. Oil dipstick, reverse gear





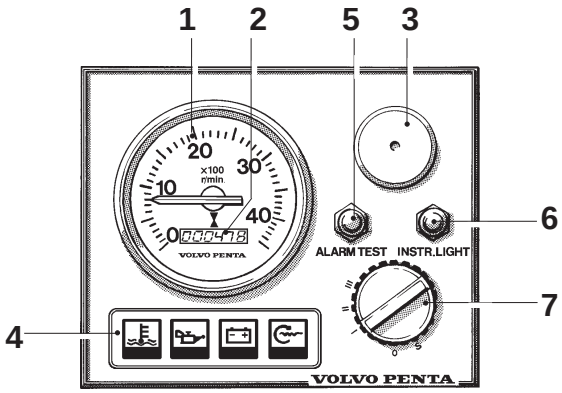
MD 22L, MD 22, TMD 22 /120S

1. Fuel liftpump
2. Oil dipstick
3. Filler cap for lubricating oil
4. Fuel filter
5. S-drive serial number
6. Zinc anode
7. Alternator
8. Exhaust outlet
9. Raw water pump
10. Filler cap
11. Induction manifold
12. Pipe for oil bilge pump
13. Oil filter
14. Oildrainage, drive

Instruments

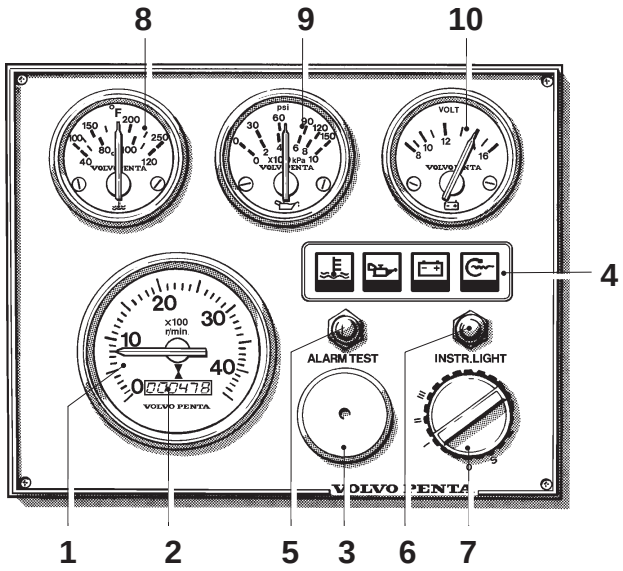
There are two types of instrument panels, “Standard” and “De luxe”.

Standard



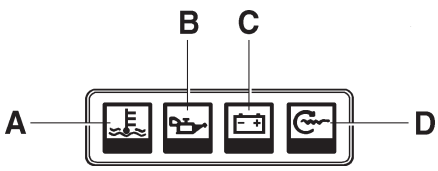
Instrument panel (standard)* with key switch

***Note.** Rev. counter with built-in hour counter is optional.



Instrument panel De luxe

***Note.** Rev. counter with built-in hour counter is optional.



Warning display

1. Rev. counter

The rev. counter shows the engine speed. Multiply the value by 100 to calculate revolutions per minute.

Full throttle: operating range,

MD22: 3200–4000r/min.

MD22L: 2700–3000 r/min.

TMD22 : 4100–4500 r/min.

2. Hour counter

Shows the engine operating time in hours and tenth of an hour.

3. Alarm (siren)

Sounds when lubricating oil pressure is too low (engine), when coolant temperature is too high or there is a loss of charge.

4. Warning display

The display has four “windows”. If the acoustic alarm comes on, one of windows “A–C” starts to blink (red) to show the cause of the alarm.

A. Coolant too hot. **Reduce the speed to idling (in neutral) until the temperature decreases. Investigate the cause of the alarm** (e.g. restricted water supply to the engine). **Stop the engine if the temperature does not decrease.**

B. Lubricating oil pressure too low. **Stop the engine immediately and locate the cause of the alarm.**

C. Alternator not charging.

D. Pre-heating (indicator lamp comes on when glow plugs are on).

NB. This lamp also works as a filament guard for the glow plugs. This will also be lit when the key switch is in position **I** (operating position) if there is a fault in the system (break).

Lamp Test (before starting):

All the warning lights will be on but will not flash (for a maximum of 20 seconds) after the key switch has been put in the “Running” position (I). The warning light for high coolant temperature (A) will then go off.

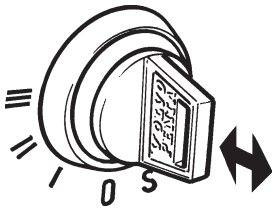
5. Pressure switch – Alarm test / Acknowledge

No alarm: Alarm test (all warning lights on – not flashing– and the siren sounding).

Alarm: Acknowledgement of alarm.*

*The siren stops sounding, but the warning light continues to flash until the fault has been rectified. If a new alarm condition arises, the siren will sound again and the next warning light will also start to flash, and so on.

6. Pressure switch–instrument lighting



7. Key switch

The key switch has five positions, including 0:

Pos. **0** = Key can be inserted and removed.

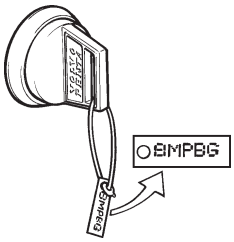
S = The mechanical restart block disengages. The key springs back automatically to 0.

I = Running position. Key springs automatically back to running position after starting.

II = "Glow" position.

III = Start position (starter motor comes on). Let the key go as soon as the engine has started.

See also the starting instructions on page 13.



A disc is provided with the **keys** which gives the key code. This code must be stated when ordering new keys. Do not keep the number disc on the boat. Do not allow unauthorised persons access to the code.

8.Temperature gauge

The temperature gauge should normally show approx. 75-95°C (167-203°F) during normal operation. The acoustic alarm comes on when the coolant is too hot.

If an alarm is emitted, reduce the speed to idling (in neutral) until the temperature decreases. Investigate the cause (e.g. restricted water supply to the engine). **Stop the engine if the temperature does not decrease.**

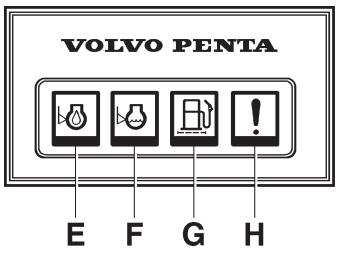
9. Oil pressure gauge

The oil pressure gauge should normally show approx. 150-500 kPa (1.5-5 kp/cm^2 = 21-71 lbf/in^2) during operation. It is normal for the gauge to show a lower value when the engine is idling.

The acoustic alarm comes on when the oil pressure is too low. **When the alarm sounds, stop the engine immediately and locate the cause.**

10. Voltmeter

The voltmeter shows the voltage in the starter battery circuit. The voltage should be about 14V during operation. The voltage is about 12V when the engine is off.



Supplementary warning display

The display has four “windows”. If the acoustic alarm comes on, one of the windows starts to blink (red) to show the cause of the alarm.

E. Lubricating oil level too low.* Top up with oil to the correct level before start.

F. Coolant level too low.* Top up with coolant to the correct level before start.

G. Water in extra fuel pre-filter.** Drain the water in the filter.

H. Extra alarm for monitoring any optional function.***

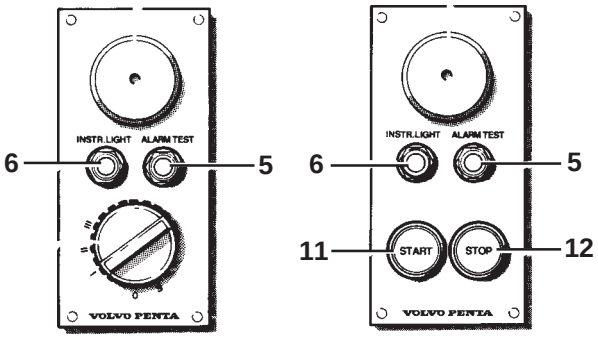
* Warning function only when engine is stopped and key switch is in position **I**

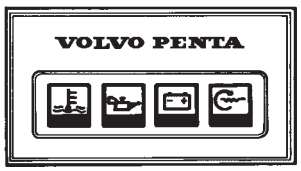
** Warning function both when engine is stopped and running. Key switch in position **I**

*** Warning function only when engine is running. Key switch in position **I**

Instrument sets

The instrumentation is also supplied separately in sets. These sets include the following three smaller panels for starting and stopping and for utilising the alarm functions.





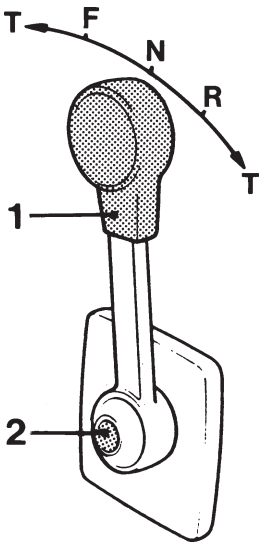
Control panel for pilot house (main panel)

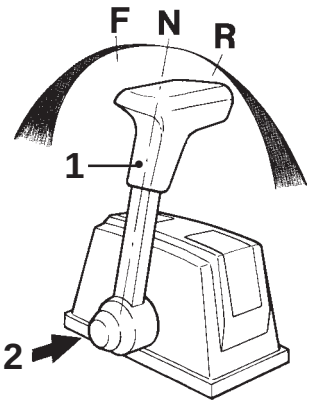
Control panel for alt. operating position

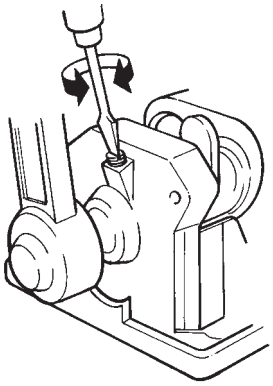
N.B.: The key switch in the pilot house control panel must be in position I (operating position) for starting to be carried out from the alt. operating position. The pre-heating can only be engaged via the key switch on the panel in the pilot house.

11. Starter button. The starter motor is engaged when this button is pressed. Release the button as soon as the engine has started.

12. Stop button. The stop solenoid is engaged when this button is pressed.







Controls

The Volvo Penta single-lever control combines the throttle and gear shift functions in one lever. When starting, for example, the gear change function can easily be switched off so only the engine speed is affected by the lever. When manoeuvring the boat backwards or forwards, the control mechanism makes the engine speed drop to idling speed when the gears are changed.

The control lever has an adjustable friction brake. A neutral position switch which allows the engine to be started only when reverse gear is not engaged is available as an extra.

Manoeuvring takes place as follows:

Lever (1) for reverse gear/S-drive manoeuvres and engine speed control.

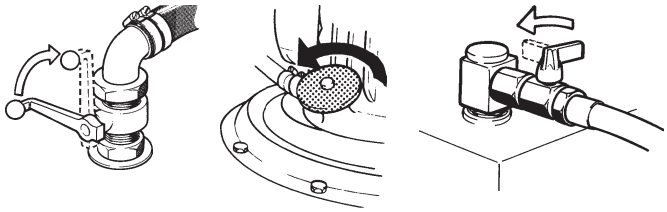
Position N = neutral position.
From N to F – reverse gear engaged for forward running.
From N to R – reverse gear engaged for reversing.
T = affects engine speed.

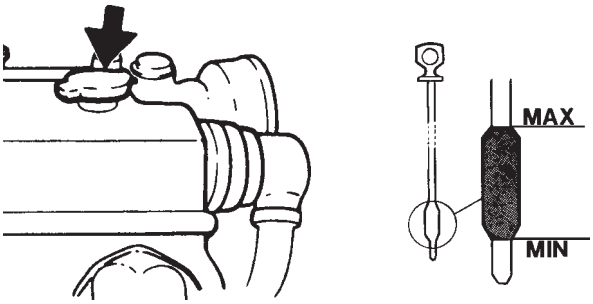
Disengaging the reverse gear from the control:

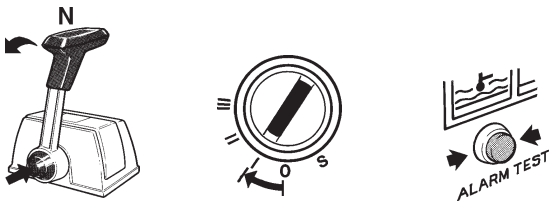
Place the lever (1) in the neutral position **“N”**. Press the button (2), push the lever forwards slightly and release the button. The lever will now only affect the speed.

The lever automatically reconnects the reversing function when it is moved back to the neutral position. The speed can then be adjusted and forward/reverse manoeuvres executed. **Ensure that the reverse gear/S-drive is not engaged unintentionally.**

Operation







Measures to be taken before starting

1. Open the bottom cock for the cooling water intake.

2. Open the fuel cocks.

3. Check that no leakage of water, fuel or oil occurs.

4. Check the level of coolant. The level should reach filler pipe.

WARNING: Closed fresh water system is under pressure. If pressure cap is removed when engine is at operating temperature, turn cap to first stop and allow pressure to escape before completely removing cap.

5. Check the engine oil level. This should be within the area marked on the dipstick. Fill with oil when necessary through the oil filler.

The oil level must never drop below the lower mark.

6. Engage the main switch.

7. Start the engine room blower (if fitted). Let it run for at least four minutes before starting the engine.

8. Check the amount of fuel.

Starting

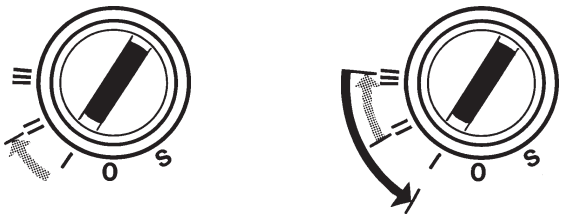
Warning! Never use starting spray or similar products to help you start the engine. The glow plugs may cause an explosion in the inlet manifold. Risk of personal injury.

9. Disengage the control lever. Place the lever in the full speed position.

NB. Less throttle can be used when starting to reduce exhaust emissions.

10. Turn the key switch to position “I” (running position). The warning lights come on in this position (not flashing – max. 20 sec.). After that the warning light for high coolant temperature goes out.

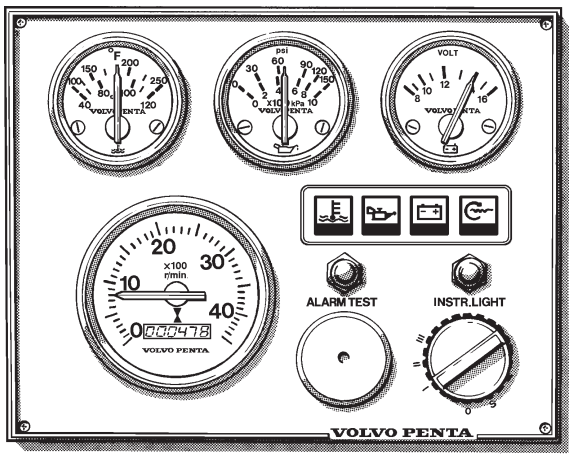
Press the “Alarm Test” button and check that the alarm sounds (warning lights on).



11. Turn the key switch to position “II” (“glow” position) and hold it there for maximum 7 seconds. Warm engine do not need pre-heating.

12. Turn the key to position “III” to start. Release the key immediately once the engine has started* (it will spring back automatically to the running position). Reduce the engine speed to idle.

***NB.** Do not run the starter motor for more than 20 sec. The key switch has a restart lock. Therefore, the starting procedure must always begin from the “S” position when repeated attempts are made to start the engine.



WARNING! The starter motor must **never** be switched on when the engine is running. The starter motor and the flywheel ring gear may be seriously damaged.

13. Warm up the engine at low speed and under low load. **Do not race the engine when it is cold.**

14. Monitor the instruments/warning display during operation. Stop the engine and check the cause of any abnormal readings or if a warning light comes on.

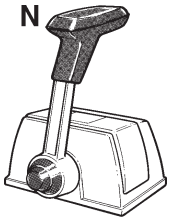
The engine must not be run if the oil pressure is too low or the coolant temperature too high.

NB. For maximum fuel economy, avoid running on full throttle. The maximum cruising speed is the maximum speed reached minus approx. 300 r/min.

When under sail, the control lever should be in the neutral position if the propeller is a fixed propeller. If the propeller is a folding propeller, the control lever should be in the reverse position. Start the engine and run for five minutes every ten hours when on long-distance cruises.

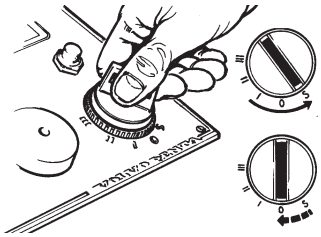
WARNING! Manoeuvring of the reverse gear/S-drive should be done at **idling** speed. Manoeuvring at higher engine speed can damage the reverse gear/S-drive.

NB: Never switch off the power using the main switch when the engine is running. If you do, the voltage regulator and alternator may be seriously damaged.

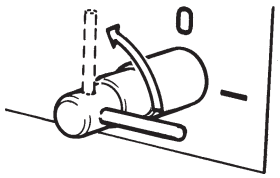


Shutdown procedure

1. Let the engine run at idling speed for about 1 min after operation (with reverse gear/S-drive in the neutral position). This will ensure an equalisation of temperature in the engine and prevent “after-boiling”.



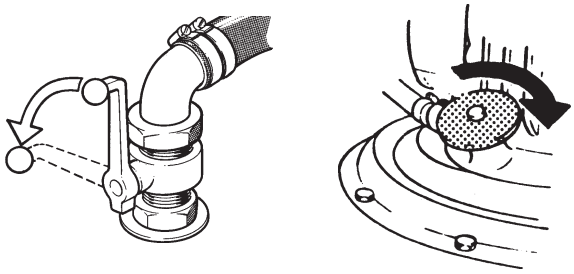
2. Stop the engine by turning the key switch to the “S” position. Hold the key in stop position until engine is of and release it (the key will automatically spring back into the “0” position). You may then remove the key.



Safety measures:

3. Disconnect the main switch if the boat is not to be used for some time.

WARNING! Never disconnect the main switch when the engine is running. If you do, the voltage regulator and alternator may be seriously damaged.

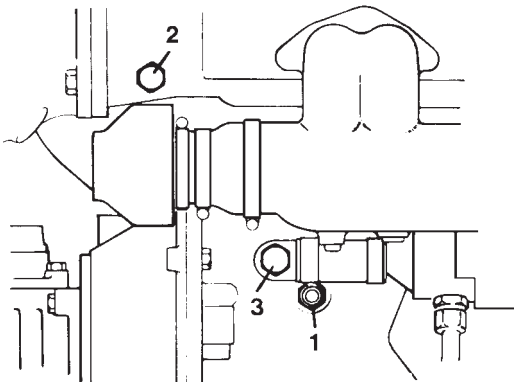


4. Check there are no leaks around the engine and that everything in the engine room looks normal.

5. Close the sea cock (cooling water intake) and the fuel cocks.

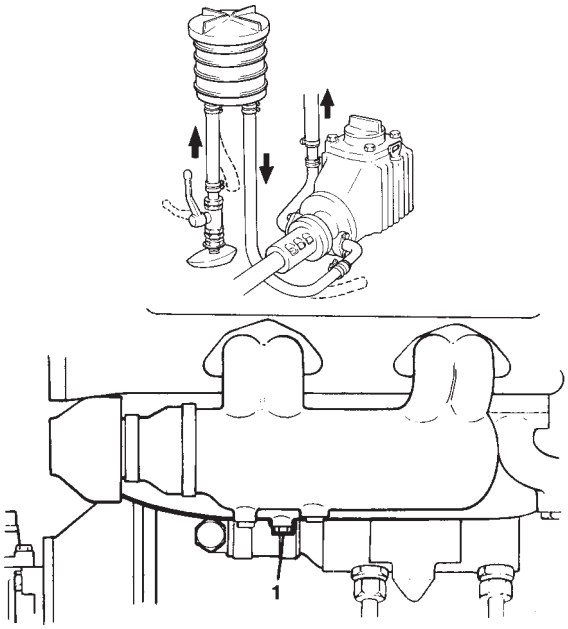
In risk of frost

In cold weather, where there is a risk of freezing, it is important that the coolant in the freshwater system has sufficient antifreeze and that the sea water system is drained.



The fresh water system shall, if filled with a liquid without any frost protection, be drained through the plug (1) on the right hand side of the engine block and through the plug (2) at the exhaust pipe. The oil cooler is drained through the plug (3), (not MD22L). Remove the heat exchanger filler cap to allow the water to run out more quickly. If the system is filled with a liquid with frost protection then it does not need to be drained.

!CAUTION: Refit the plugs and replace the cover before you leave the boat.

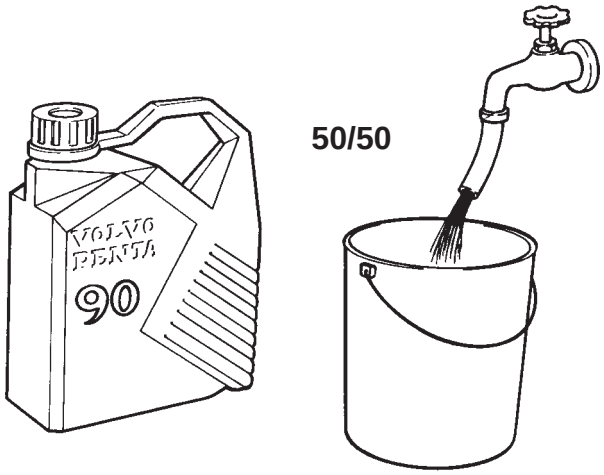


The sea-water system. Close the sea-water cock. Loosen both the hose connections from the sea-water pump and seawater filter (optional) at the reverse gear/S-drive and point them downwards so that the water runs out.

Remove the plug (1) in the heat exchanger's pipe. Turn the engine so that all the water is pressed out of the sea-water pump. Connect the hoses and tighten the plug in the heat exchanger's pipe before you leave the boat.

Idle engine.

In order to prevent damage to the engine caused by corrosion, the engine should be run warm at least every 14 days as long as the boat is in the water. If the boat is not to be used for more than 90 days, long-term inhibiting should be carried out.



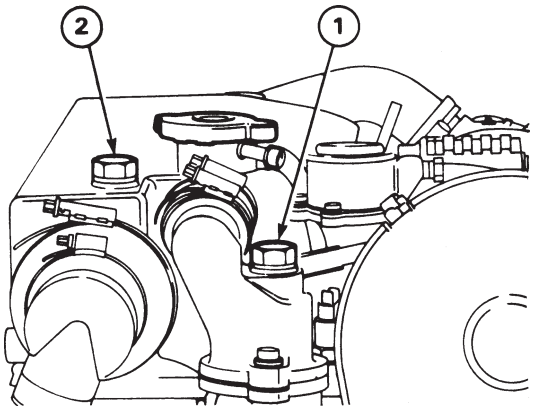
General engine information

Coolant

The coolant system is to be filled with a corrosion-protective anti-freeze mixture, 50% anti-freeze and 50% fresh water. Alternatively a mixture of fresh water with about 1 litre corrosion protective additive. (Volvo Penta accessory.)

If there is a risk of freezing, an anti-freeze mixture must be filled or the system must be drained after each use. Regarding draining of fresh water and sea water system, see “Shoutdown Procedure”.

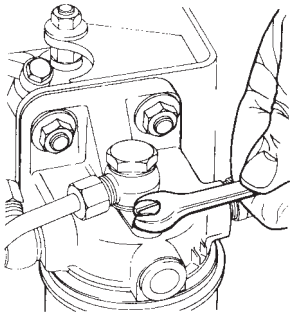
Fresh water system should be drained and flushed once per year. (See lay-up procedure.)

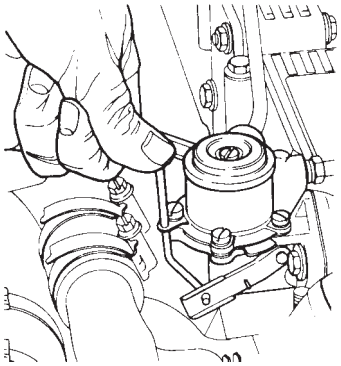


Filling the system

1. Loosen the venting plug in the water pipe (1) or the plug (2) at the heat exhanger and remove the filler cap.
2. Fill with coolant until the level reaches the filler pipe.
3. Tighten the venting plug and refit the filler cap.
4. Start the engine and let it run until it reaches normal operating temperature. Stop the engine and let it cool.
5. Remove the filler cap and top-up with coolant until the level reaches the filler pipe.

WARNING: Closed fresh water system is under pressure. If pressure cap is removed when engine is at operating temperature, turn cap to first stop and allow pressure to escape before completely removing cap.





Venting the fuel system

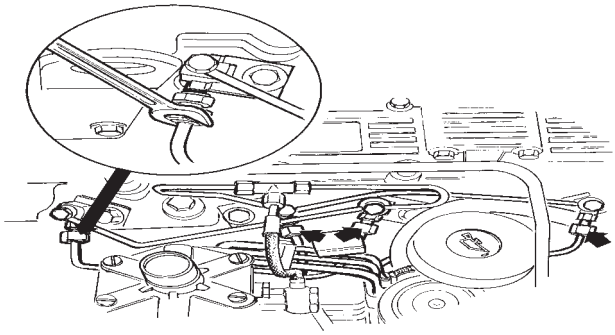
Air can enter the system if:

- The fuel tank is drained during normal operation.
- The low-pressure fuel pipes are disconnected.
- A part of the low-pressure fuel system leaks during engine operation.

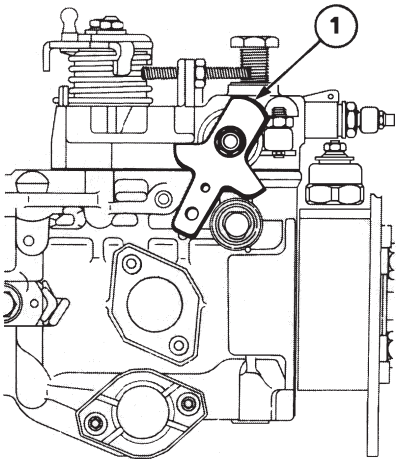
In order to eliminate air from the fuel system, proceed as follows:

Open the venting screw on the fuel filter approx. 3 turns. Watch out for fuel spillage. Use rags or similar around the venting screw.

Pump out fuel using the manual primer pump until fuel free from air bubbles starts to flow out. Close the venting screw. Note! If the pumping effect seems poor, turn the engine somewhat so that the drive cam for the pump changes position.



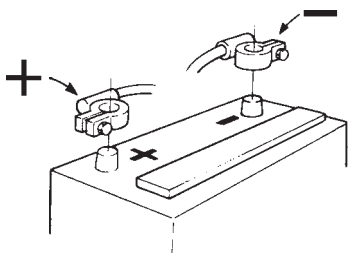
Loosen the fuel pressure pipe nuts at the injectors and set the speed control to full speed. Turn the engine at full starter motor speed until fuel flows from the fuel pressure pipes. Watch out for fuel spillage. Use rags or similar around the venting screw. Tighten the fuel pressure pipe nuts and start the engine.



Emergency stop

A diesel engine is not dependent on a power supply for its operation. Should a serious electrical fault occur, the engine can continue to run but the normal stop function of the ignition switch is inoperative. Emergency stopping of the engine can always be done by pulling the injection pump lever (1) backwards.

Electrical system



CAUTIONS FOR ALTERNATOR

The engine is equipped with an alternator. If the alternator and the regulator are to function without interference, it is important that the following instructions are observed.

1. **The main battery switch must not be switched off until the engine has stopped.**

   Never disconnect battery cables or wiring in the charging system when the engine is running. Disconnecting any part of the charging circuit when engine is running will result in failure of the voltage regulator and serious damage to the alternator.

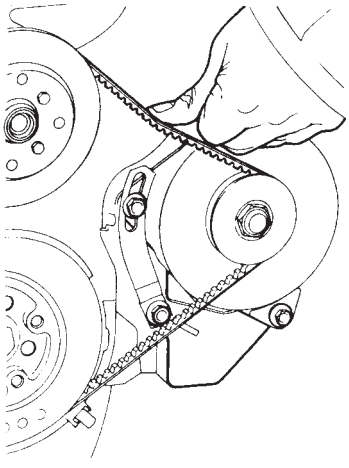
2. **Battery terminals polarity must never be mixed up, as improper will cause damage or equipment failure.** The battery terminals have a plus and a minus sign respectively. The cable clamps must be well tightened and then greased.

3. **Do not switch the charging circuits while the engine is running.**

   Install a Volvo Penta charging distributor (accessory) to the alternator when more than one battery is connected.

4. In the event the engine has to be started with the help of a spare battery, proceed as follows:

   Let the ordinary battery remain connected. Connect the spare battery to the battery with plus to plus and minus to minus. When the engine has started, remove the spare battery but under no circumstances may the circuit to the ordinary battery be broken.

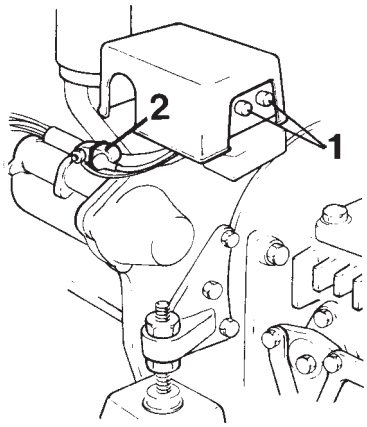


5. Do not use a rapid charger when the alternator is connected to the battery. Never use a rapid charger as a booster to provide starting voltage.

6. Disconnect both battery cables before doing any work on the alternator or electrical system.

7. Before carrying out any electrical welding on the engine or boat components, disconnect the charging regulator cables at the alternator and insulate the cable ends.

8. Check the belt tension and the cable connections regularly.



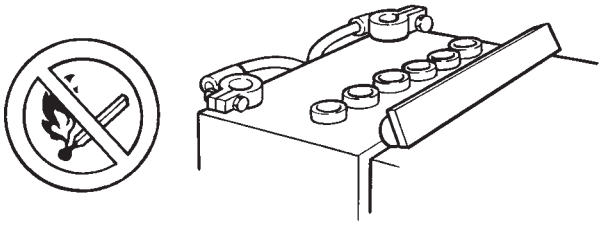
Reset button for the fuses

The engine is equipped with two automatic fuses (1) that break the electrical circuit when overloaded. Press in the two reset buttons for the automatic fuses. Always identify the reason for the overloading.

Ground-fault fuse

The engine also has a 55 A ground-fault fuse (2) attached to the cable harness. Always carry a spare fuse onboard.

Battery



WARNING: To prevent possible explosion, never expose battery to open flame or electrical spark. Do not smoke near battery. Batteries generate hydrogen gas which is flammable and explosive. Battery fluid contains sulfuric acid.

Do not allow battery to contact eyes, skin or painted surface. If contact occurs, flush affected area immediately with water. Obtain medical attention if eyes are affected.

Checking the state of charge

The battery will be maintained in top operating condition only by regular routine inspection and maintenance. When not in use, the battery will discharge slowly.

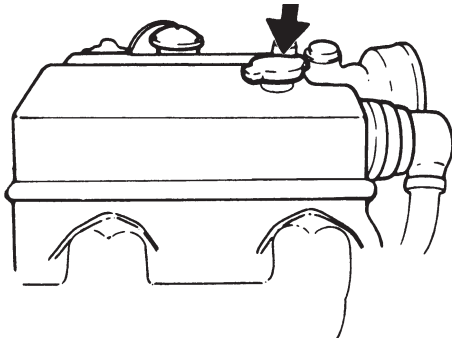
Electrolyte level

Electrolyte is checked every 14 days or 25 hours. The correct level is approximately 5 to 10 mm 3/16"–3/8") above the battery plates. Add distilled water to bring to proper level, do not overfill. After adding water, battery should be charged for at least 30 minutes by running the engine at high idle. This will ensure proper mixing of distilled water and electrolyte.

Routine cleaning

Batteries should be kept clean and dry. Battery connections must be clean and tight. A light film of grease applied to the battery connections will help to minimize corrosion.

Check daily before starting

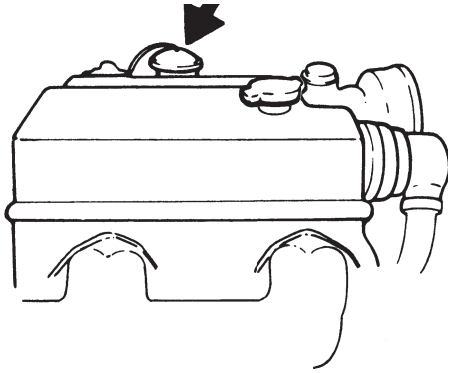


Check the coolant level.

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

Turn the cap to the first stop and wait a moment before removing the cap. The level should reach the filler pipe.

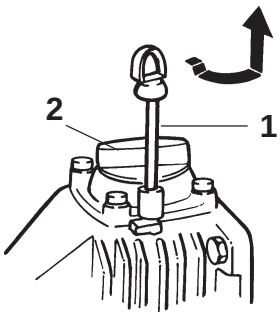
A solution which is the same as that already in the cooling system should be used to replenish the system.

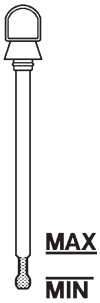


Check the engine oil level. This should be within the area marked on the dipstick. Fill with oil when necessary through the oil filler.

NOTE! The oil level must never drop below the lower mark. Do not exceed the maximum mark. See “Technical Data” for choice of oil.

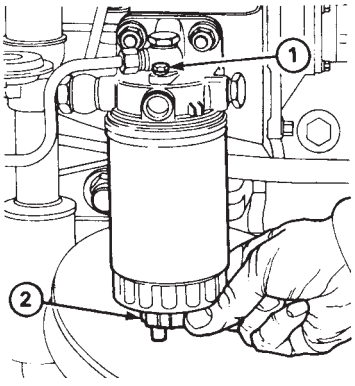
Check every 14 days



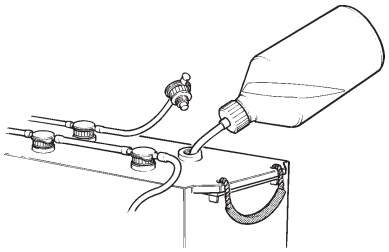


Check the oil level in the reverse gear or S-drive

The oil level is checked by using the dipstick (1). The level should be between the marks on the dipstick. If necessary the oil can be topped up through the oil filler (2). See “Technical Data” for type of oil to be used.



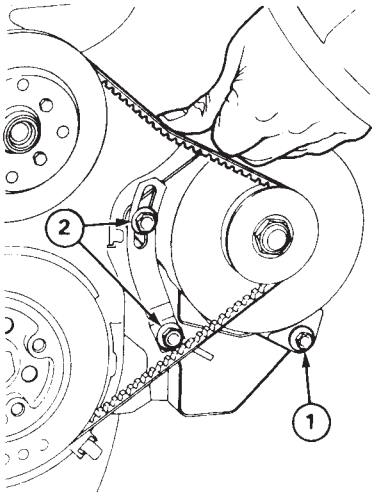
Drain water from the fuel filter. Open the venting screw (1) approx. 3 turns. Then open the drain screw (2) and drain the fuel/water into a suitable container. Tighten the drain screw and vent the fuel system. See “Venting the fuel system”.
If an extra fuel filter with water separator is fitted, check the transparent bowl to see if there is any water in the fuel. If necessary, drain the filter into a suitable container via the cock in the bottom of the bowl.



Check the level of electrolyte in the battery (batteries).The level should be 5–10 mm (3/16"–3/8") above the cell plates in the battery. If necessary, top-up with distilled water.

WARNING! Use protective goggles. The batteries contain oxyhydrogen gas and extremely corrosive sulphuric acid. A spark or naked flame in the vicinity of the battery can cause an explosion.

WARNING! Some maintenance-free batteries have special inspection instructions which should be followed.



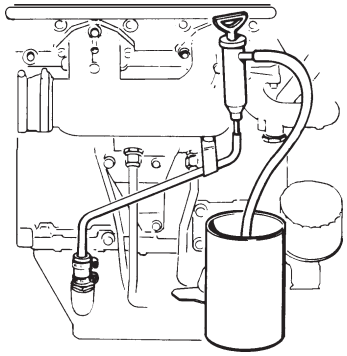
Check/tension the drive belt. Tension the belt in such a way that it can be depressed 10 mm (3/8") between the pulleys. Change the belt if it looks worn or is cracked. Loosen the alternator mounting bolts 1 and 2 when tensioning or changing the belt.

Check every 50 hours of operation

Check the seawater filter (optional). Close the sea valve. Open the filter, clean it if necessary.

WARNING! Take care not to let in water.

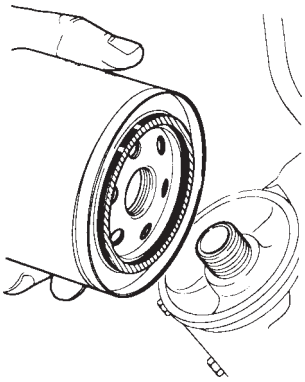
NB. When to check the seawater filter should be determined from experience after running the boat for a time. Check the filter more often should there be a danger that it will get blocked.



Change the engine oil. The oil is to be changed in new or reconditioned engines after the first 20 hours of operation and then after every 200 hours of operation.

Run the engine until it is hot. Suck up the oil through the tube for oil drain pump.

Fill up with oil to the correct level. See “Technical Data” for choice of oil.



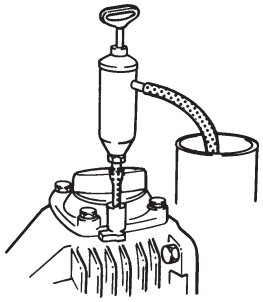
Change the oil filter.The oil filter is to be changed the first time after 20 hours of operation and then after every 200 hours of operation. Screw off the old filter. If the oil filter is difficult to unscrew, there is a special tool which can be used.

CAUTION: Be careful not to spill oil.

Fill the new filter with new oil. The canister contains a valve to ensure that lubricating oil does not drain from the filter.

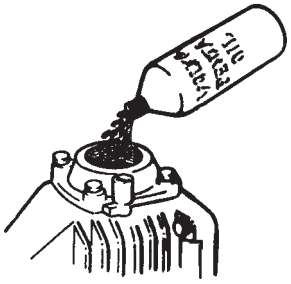
Coat the rubber seal of the new filter with oil. Check the contact surface on the engine and screw on the filter **by hand** until it touches the contact surface. Turn the filter a further **half turn, not more.**

Start the engine, run at idling and check immediately that the oil pressure-gauge shows normal values.

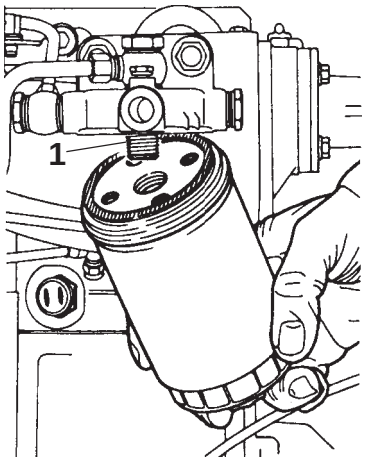


Check the oil-level and check also for leakage around the filter.
Change the oil in the reverse gear.The oil can be sucked up through the hole for the dipstick (1) by using an oil suction pump. When refilling the oil (2) the reverse gear should be filled up to the upper level marking on the dipstick. Start the engine and run it for a few minutes at idling, so that the reverse gear’s oil cooler becomes filled with oil. Stop the engine and check the oil level. Top up, if necessary.

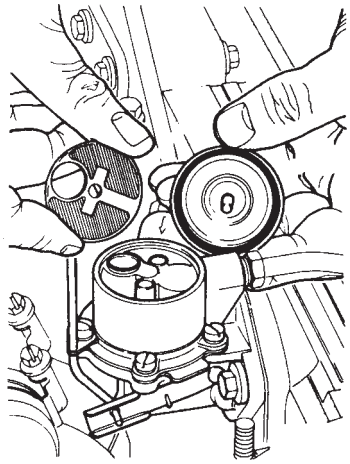
Change the oil in the S-drive. Remove the dipstick. Remove the plug under the propeller gear housing and allow the oil to run out.



Then reinsert the plug and fill up with oil. Make sure that the oil level is between the maximum and minimum levels indicated on the dipstick. Note: do not exceed the maximum level. See “Technical Data” for type and volume of oil to be used.

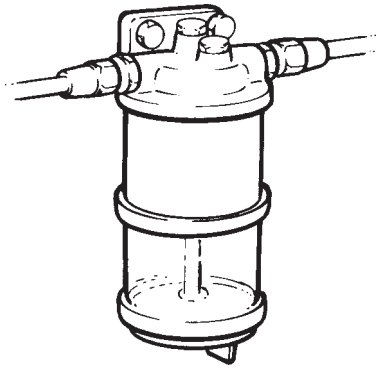


Change the fuel filter. Unscrew the fuel filter using a filter remover or other suitable tool. Ensure that the nipple (1) is firmly seated in the filter head. Screw on the new filter and tighten by hand. Vent the system, start the engine and check for any leakage



Clean the feed pump filter. Remove the cover and remove the filter.

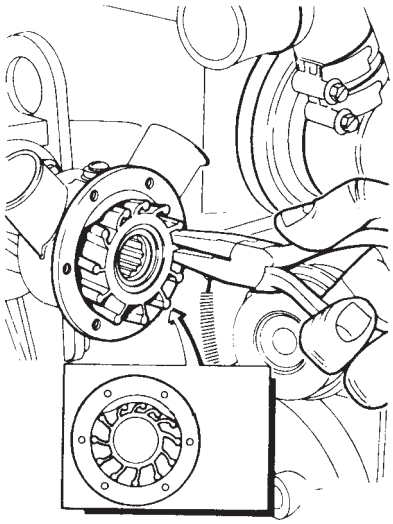
Carefully clean the filter, the filter housing, and the internal components. Assemble in the reverse order. Vent the fuel system. See “Venting the fuel system”. **CAUTION.** Check for any leakage immediately after starting.



Change the insert in any extra fuel filter fitted. Close the fuel cocks at the tank. Be careful not to spill fuel!

Clean the filter bowl. Fit a new filter insert and tighten it. Open the fuel cocks and vent the filter.

Check for leakage.

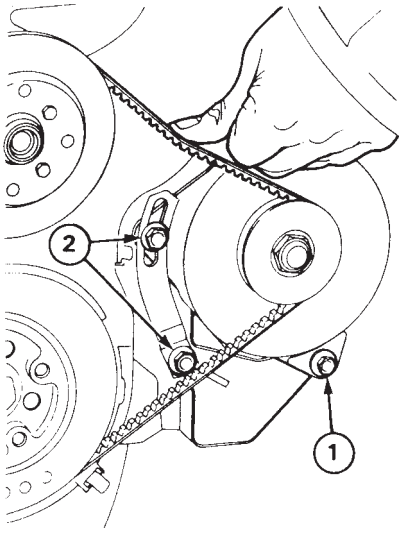


Check the impeller. The impeller can be damaged, mostly because of lack of water in the pump due to blocked intake or because of inproper winter storage.

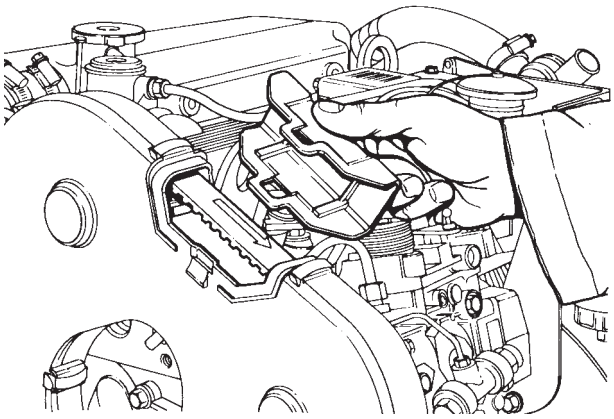
WARNING: Watch out for water entry into boat. Close the sea-water cock.

Inspect the impeller. If the impeller is damaged, it must be replaced.

Remove the rubber disc from the front of the impeller and pull out the impeller. Fit the new impeller so that the blades are turned as shown in the illustration. Fit the rubber disc at the front of the impeller and fit the cover with a new gasket. Open the sea-water cock.

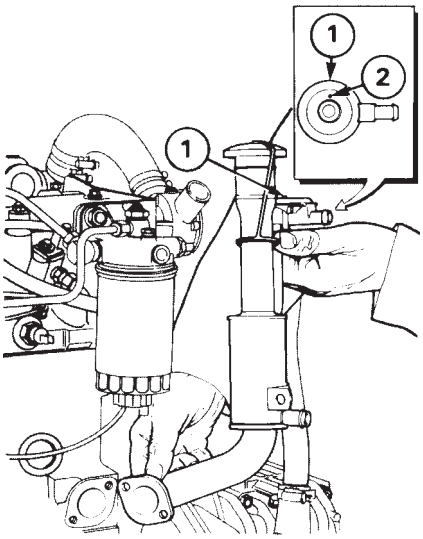


Repace the v-belt. Loosen the alternator mounting bolts 1 and 2 and slip off the belt. Clean the belt groove on the pulley before fitting the new belt. Tension the belt in such a way that it can be depressed 10 mm
(3/8") between the pulleys. After a few hours of running recheck the belt tension and adjust if necessary. The most accurate belt tension can be objected if belt is adjusted while warm and flexible after engine has been run.



Checking the overhead camshaft drive belt. The toothed drive belt which drives the camshaft should be checked and adjusted by an authorized workshop.

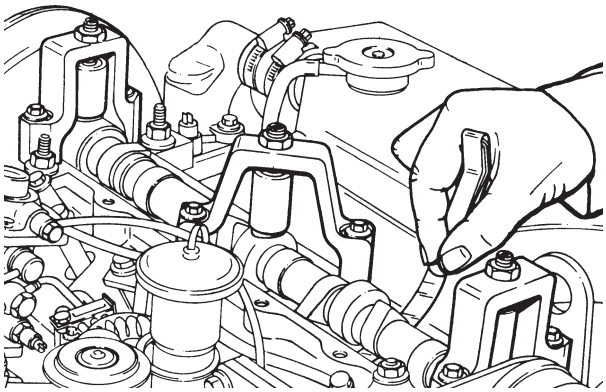
Service every other season



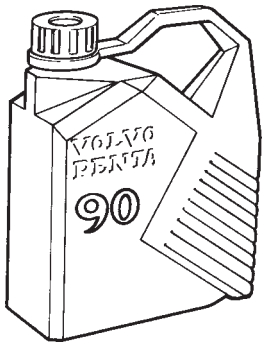
Cleaning the crankcase ventilation

WARNING! Remove the battery leads before carrying out work.

1. Remove the starter motor.
2. Loosen the connecting hoses.
3. Loosen the oil filler pipe's fastening bolts and remove the oil filler pipe. Remove the ventilation valve (1) from the oil filler pipe.
4. Stick some water-resistant tape over the small hole (2) in the ventilation valve.
5. Clean the ventilation valve and oil filler pipe with paraffin and blow dry using low-pressure compressed air. Remove the tape from the venting valve.
6. Check that the sealing surfaces between the filler pipe and engine block are clean.
7. Fit the ventilation valve on the oil filler pipe and install the oil filler pipe to the engine using a new gasket.
8. Fit the connecting hoses.
9. Fit the starter motor and connect the electrical cables.

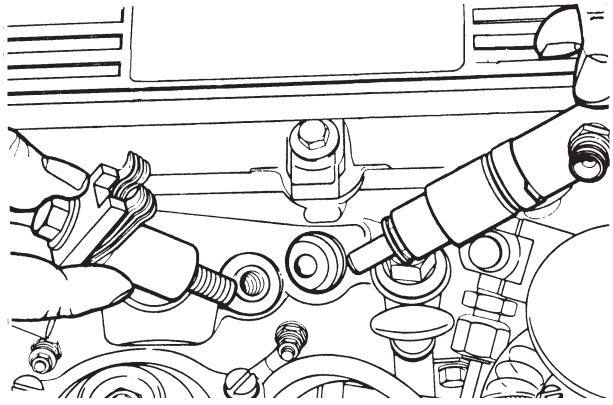


Checking the valve clearence. Checking and adjusting the valve clearance should be carried out by an authorized Volvo Penta Dealer. See “Valve Clearance Value” under “Technical Data”.

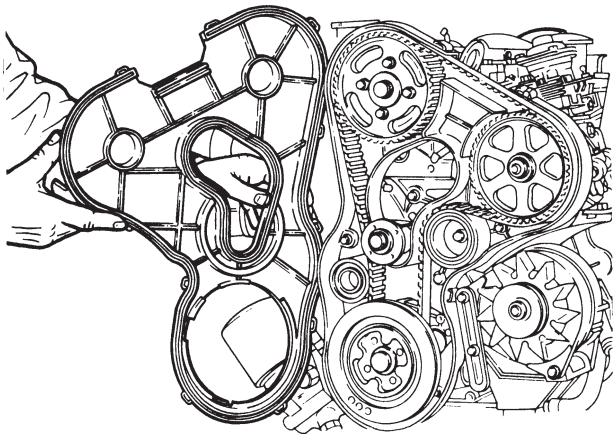


Clean the fresh-water cooling system and change the coolant. See “Inhibiting”

Other service intervals



Checking the fuel injectors. All work on the engine fuel injectors must be carried out by an authorized dealer. Check the opening pressure, spray pattern and also check for leakage **every 600 hours of operation.**

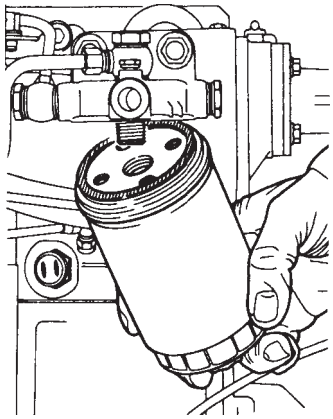


Replacement of the camshaft drive belt should be carried out **every third year**. This action requires specialist knowledge and special tools, why we recommend you to consult an authorised Volvo Penta service workshop.

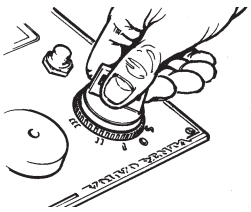
Inhibiting

An authorized dealer should test and inspect the engine and equipment before inhibiting the engine for a long period. It is advisible to test the compression to find out the condition of the engine. If anything is not in good condition let the shop repair it now while the boat is not used.

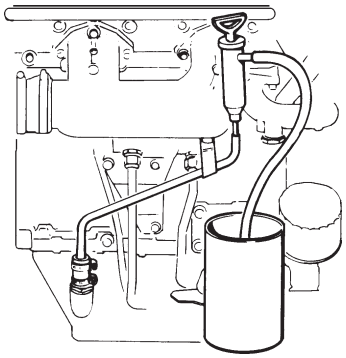
Carried out with the boat in water



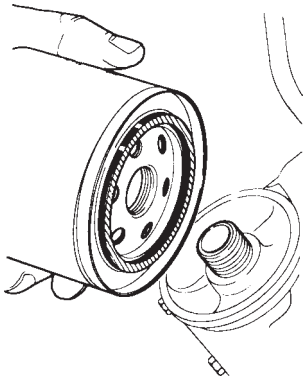
Change the fuel filter. Pump fuel and vent the system. See “Venting the fuel system”. Check the fuel hoses as well as the complete fuel system for leakages. If an extra fuel filter is fitted, this filter cartridge must also be changed.



Start the engine after venting and allow it to run at high idle until warm. Stop the engine.



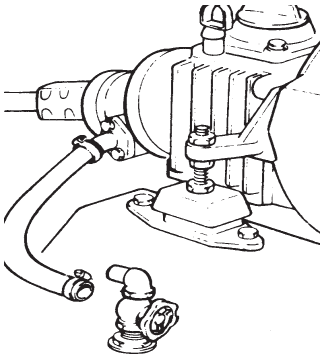
Pump out all oil from the engine and reverse gear. Use an oil suction pump or electric type pump designed for this job.



Change the oil filter.* If the engine is fitted with an S-drive this should be drained when the boat is laid up. Fill up the engine and reverse gear to the correct level with Volvo Penta diesel engine oil*, which also has corrosion protective properties. Start the engine and check for leaks. The engine is now ready to run on this oil next season.

* NOTE! For long-time inhibiting, exceeding normal of-season laying-up, preservative oil must be used. In this case the oil filter shall not be replaced until launching.

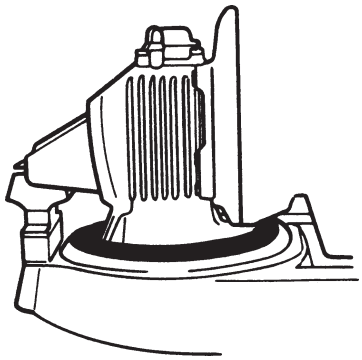
To be done when the boat is on land



Loosen the hose between the sea-water intake and the reverse gear/S-drive. Connect a hose and put the other end in a bucket with fresh water. Provide for the topping-up of fresh water into the bucket. Run the engine at fast idle a few minutes.

WARNING! The impeller must not run dry.

Drain the sea-water system.



In boats fitted with S-drive, the rubber seal between the drive and the bedding should be checked carefully. **The seal should be changed every seven years.** This should be done by an authorized Volvo Penta dealer.

If the boat has a folding propeller, it should be dismounted and taken indoors while the boat is laid up.

See “Propellers”. The shaft should be greased after cleaning. Use Volvo Penta grease p/n 828250.

Inhibiting the fresh-water system

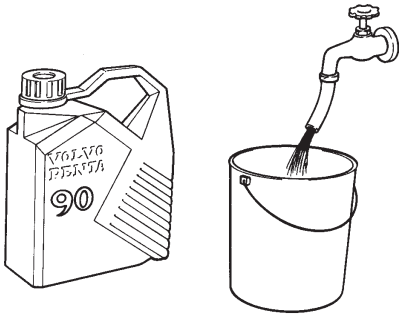
Inhibiting can be carried out according to 2 alternatives.

Alt. I. In case the fresh-water system is already filled with a mixture of ethylene glycol, which is also corrosion protective the freezing point of the mixture should be checked.
NOTE: The coolant should be changed at least once every two years. Use a mixture of 50% Volvo Penta antifreeze type 90 and 50% clean water.

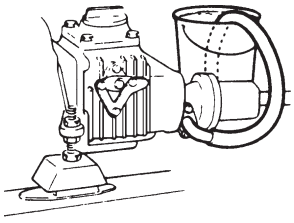
Alt. II. If the system is filled with fresh water and a corrosion protective mixture, this must be changed once each season.

WARNING! There is no protection against freezing and it is therefore recommended that the system be drained now and refilled when launching boat.

Inhibiting the seawater system

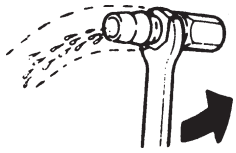


Mix a 50% mixture of fresh water and corrosion-protective anti-freeze.



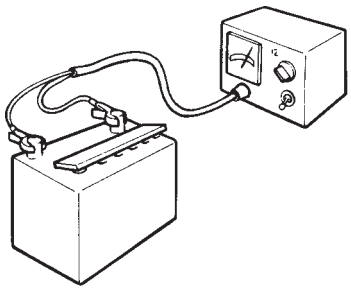
Put the end of the hose into the anti-freeze mixture. Arrange collection of the outgoing mixture. Start the engine and let run idle until the mixture is finished.

WARNING: The water pump must not be allowed to run dry.

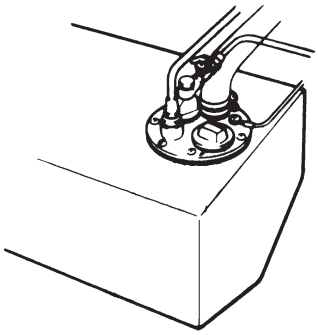


There is no need to drain off this combined anti-corrosion and anti-freezing mixture. If inhibiting is done with emulsifying oils, there is no protection against freezing, and the seawater system must therefore be drained off. Check that the water runs out, since dirt can block the cocks. Then close all cocks. Remove the cover from the seawater pump. Remove the impeller and rinse it in freschwater. Keep the impeller in a sealed plastic bag during laying-up if it is in good condition. (Otherwise fit a new impeller when launching the boat)

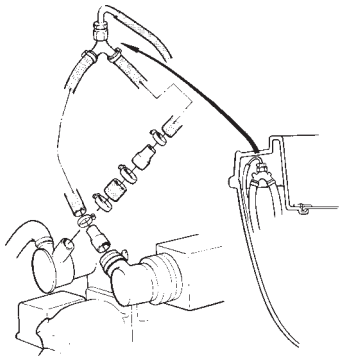
Clean the outside of engine, and reverse gear/S-drive. Touch-up any bare patches in the paintwork with Volvo Penta original paint. Spray the components of the electrical system, and all the control components with anti-moisture spray. All engine control linkages should be inspected for wear, properly adjusted and protected from corrosion.



Remove the batteries from the boat. Clean them and store them in a cool, dry place. Check that the batteries are well charged. Trickle charge them according to the manufacturer's instructions (a flat battery can easily be damaged as a result of freezing).

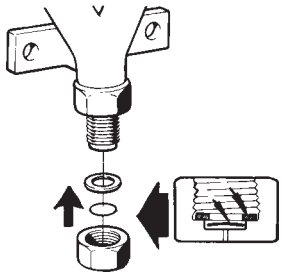


Drain off any water or sediment from fuel tanks. Top up all fuel tanks to prevent condensation during storage period.



If the engine has a vacuum valve it must be taken apart twice a season or whenever leaks occur.

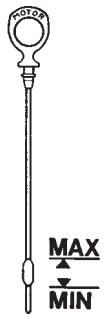
Remove the entire valve from the bulkhead where it is fitted.
Loosen the valve cover and remove the gasket and diaphragm and clean out any deposits. Deformed diaphragms must be replaced.



Installation should be done with the valve upside down. Place the diaphragm in the cover. Ensure that the entire diapragm is placed in the right location. The diaphragm must not be trapped by the gasket. Insert the gasket and screw on the cover.
CAUTION: Tighten torque 2 Nm (1.47 ft.lbs). If the cover is tightened too hard the valve will stop working.

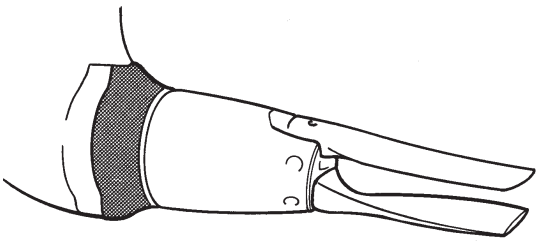
Launching

Measures in connection with recommissioning - launching



If Volvo Penta engine oil has been used during lay up only the level needs to be checked.

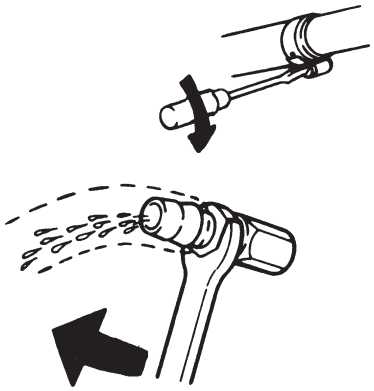
If a inhibiting oil has been used, both the oil and the filter must be changed. See under “Service every 200 hours of operation”.



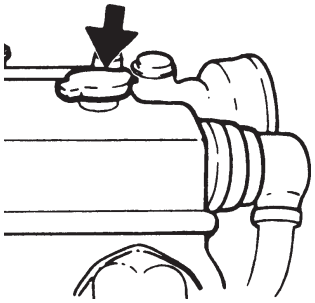
Check the zinc ring* on the S-drive and replace if it is consumed more than 50%. Otherwise clean the anode (also a new one) with an emery cloth to remove the oxide layer. NB. This should be done shortly before launching.

NOTE! Steel brushes or other steel tools must not be used for cleaning, as these may reduce the galvanic contact between the anodes and the drive.

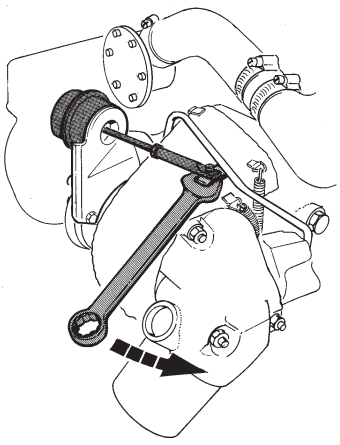
*** NB: A magnesium anode** should be used when running in freshwater.



Check the tightening of all hose-clamps. Check that all drain-cocks are closed and tight. Clean the engine and reverse gear on the outside. Check the exhaust-hoses. Install the impeller.



Fill-up the freshwater system to the correct level. Fill-up through the filler-hole on top of the heat exchanger with a 50% mixture of freshwater and rust-proofing ethylene glycol or additive.



Check the turbochargers wast gate valve (TMD22) by turning the shaft according to the picture.

Painting

Check the painting of the S-drive. Touch up damaged areas using Genuine Volvo Penta drive Paint. Then coat the drive with a Teflon®* agent for aluminium drives. We recommend the Volvo Penta Anti-fouling Agents (part No. 1141593-2 or 1141594-0). These products are specially designed for the S-drive and are at the same time as kind to the environment as possible.

Paint the bottom of the boat and the propeller using a suitable anti-fouling paint or with a pure Teflon® agent.

All anti-fouling paints are poisonous and by definition more or less harmful to our marine environment. Avoid such products. Most countries have a legislation which controls the usage of anti-fouling boat bottom paints. **Always make sure you follow these regulations!** In some countries it is forbidden to use anti-fouling paints on leisure crafts, e.g. in freshwater.

We recommend simple Teflon® treatment in combination with mechanical cleaning a few times during the season, especially in the case of smaller boats which are easy to lift.

This may be impractical for larger boats. Also, if the boat is in water which promotes fouling, an anti-fouling paint may need to be used after all. In this case, use a pure copper-based anti-fouling paint which contains copper thiocyanate **(not copper oxide).**

Tin-based paints (TBT paints) must not be used!

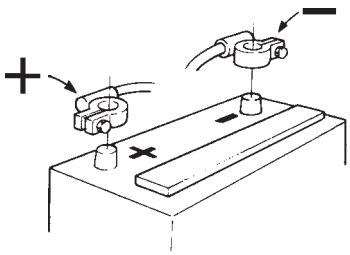
Bear in mind the legislation in force for the area in which the boat is used.

NB. Unsuitable bottom paints may cause great corrosion damage to the S-drive.

WARNING! Do not paint the zinc anode (zink ring) in front of the propeller. Leave a 10 mm (0.4 in) margin without anti-fouling paint around the S-drive.

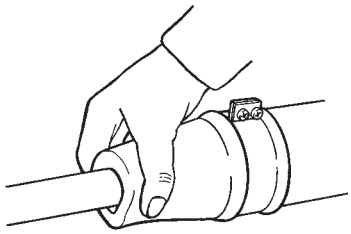
Launch the boat when the paint has dried.

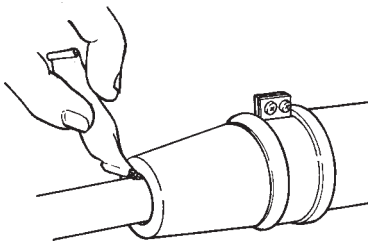
***NB.** Teflon is a registered trademark of Du Pont.



Check that the batteries are fully charged. Smear the terminals with pole grease. Connect the battery cables.

WARNING! Do not reverse the polarity. Tighten the cable terminals firmly.

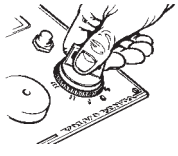




If the boat is equipped with a propeller shaft seal of rubber, the following procedure should be observed after launching:

Vent the tubular sleeve and seal by pressing them together and pressing the seal down against the shaft until water emerges. Then press about 1 cm^3 of water resistant grease into the seal.

WARNING! The propeller shaft seal must be **replaced after 500 hours or 5 years.**



Start the engine. Check and make sure there is no fuel, water and exhaust gas leakage in the boat. Check also that all steering and control functions are in order.

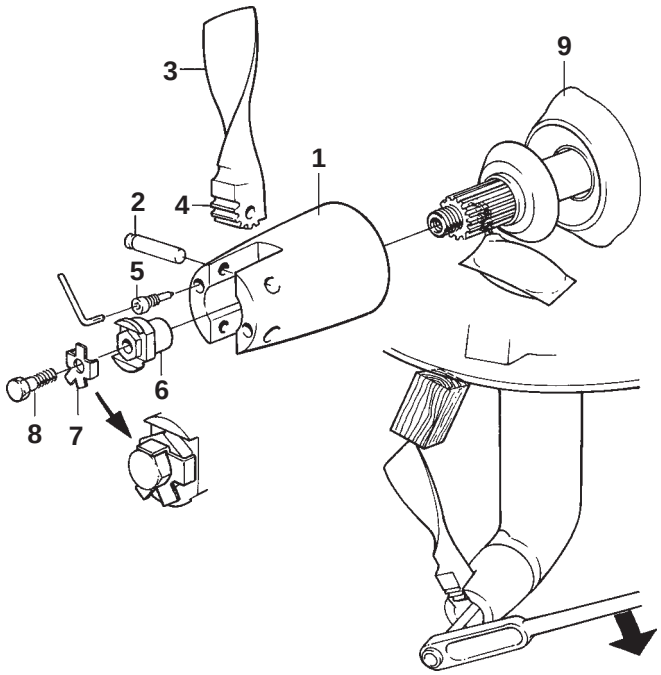
When necessary, contact an authorized Volvo Penta dealer. Let them service your engine and reverse gear/S-drive according to the instructions given in the servicing schedule.

Propellers

When fitting a propeller to specific boat-engine combination it is sometimes hard to select the proper sized propeller for varying load and weather conditions. Therefore Volvo Penta offers a wide range of propeller sizes and types. In some boats there are advantages to selecting a propeller that limits engine rpm including lower fuel consumption, lower noise, lower vibration and better propeller efficiency.

WARNING! Remove the key from the instrument panel or cut the power using the main switch before starting work on the propeller.

Fitting S-drive propeller



1. Proppeller hub
2. Pin
3. Propeller blade
4. Propeller blade gear
5. Locking screw
6. Locking nut
7. Tab washer
8. Locking screw
9. Zinc anode*

***NB:** Check the zinc ring before fitting the propeller. A **magnesium anode** should be used when running in freshwater.

1. Carefully clean the propeller shaft and propeller hub (1).
2. Lubricate the shaft pivot and hub (grease pad 828250-1).
3. Fit the propeller hub to the shaft. Place one propeller blade in the propeller hub and clamp a wooden wedge between the propeller blade and the hull of the boat. Tighten the lock nut (6). Tightening torque 70 Nm. (7.0 kpm, 53 ft.lbs). Use 24 mm socket.
4. Locate the tab washer (7) on the nut so that the tabs are easily accessible.
5. Install the locking screw (8). Tightening torque 20 Nm. (2.0 kpm, 15 ft.lbs).
6. Bend the tab which is in the best position up against the screw head.
7. Apply water resistant grease on the shaft pins (2) and the propeller blade gears (4).
8. Install one propeller blade in the propeller hub and push in the shaft pin so that it is positioned with the machined groove centered on the locking screw hole.
9. Screw in and tighten the locking screw (5) using a 6 mm hexagon key. Tightening torque 20 Nm. (2.0 kpm, 15ft.lbs).
10. Repeat the procedure for the other propeller blade and check the blades have the same angle in relation to the propeller shaft.

Note: The internal socket screw (5) and tab washer (7) (see illustration) **must be replaced every fourth year.** Only Volvo Penta Original locking screws (8) may be used.

Troubleshooting

Problem	Checks by the user	Checks by the workshop
The starter motor turns the engine too slowly	1, 2, 4	3
The engine does not start	5, 6, 7, 8, 9, 10, 12, 14, 15, 17	13, 32, 33, 34, 36, 37, 41, 42, 43
The engine is difficult to start	5, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 19	13, 32, 34, 36, 37, 39, 41, 42, 43
Not enough power	8, 9, 10, 11, 12, 16, 17, 18, 19, 20, 21	13, 32, 34, 36, 37, 38, 41, 42, 43
Misfire	8, 9, 10, 12, 15, 20	13, 32, 34, 35, 36, 37, 38, 39, 40, 42
High fuel consumption	11, 17, 19, 21	13, 32, 34, 35, 36, 37, 38, 39, 41, 42, 43
Black exhaust smoke	11, 17, 19, 21	13, 32, 34, 35, 36, 37, 38, 39, 41, 42, 43
Blue or white exhaust smoke	4, 15, 21	34, 36, 37, 38, 41, 43, 44, 51, 57
The oil pressure is to low	4, 22, 23, 24	45, 46, 47, 49, 50, 58
The engine knocks	9, 15, 17, 20	13, 34, 35, 36, 39, 41, 43, 45, 51, 53, 59
The engine runs erratically	7, 8, 9, 10, 11, 12, 15, 16, 18, 20	13, 32, 35, 37, 39, 40, 43, 51, 59
Vibration	18, 20, 25	13, 32, 37, 38, 39, 40, 43, 51, 53
The oil pressure is too high	4, 23	48
The engine temperature is too high	11, 15, 19, 26, 28, 29, 30, 31	13, 32, 34, 36, 38, 51, 54, 55, 56
Crankcase pressure	27	38, 41, 43, 44, 51
Bad compression	11	35, 36, 38, 39, 41, 42, 43, 52, 59
The engine starts and stops	10, 11, 12	

Code list of possible causes

1. Battery capacity low.
2. Bad electrical connections.
3. Fault in starter motor.
4. Wrong grade of lubricating oil.
5. Starter motor turns engine too slowly.
6. Fuel tank empty.
7. Fault in stop control.
8. Restriction in a fuel pipe.
9. Fault in fuel lift pump.
10. Dirty fuel filter element.
11. Restriction in air induction system.
12. Air in fuel system.
13. Fault in atomisers or atomisers of an incorrect type.
14. Cold start system used incorrectly.
15. Fault in cold start system.
16. Restriction in fuel tank vent.
17. Wrong type or grade of fuel used.
18. Restricted movement of engine speed control.
19. Restriction in exhaust pipe.
20. Engine temperature is too high.
21. Engine temperature is low.
22. Not enough lubricating oil in sump.
23. Defective gauge.
24. Dirty lubricating oil filter element.
25. Fault in engine mounting or flywheel housing.
26. Too much lubricating oil in sump.
27. Restriction in breather system.
28. Restriction in seacock or raw water strainer.
29. Insufficient coolant in circuit.
30. Restriction in heat exchanger or oil coolers.
31. Drive belt for water pump is loose.
32. Fault in fuel injection pump.

33. Broken drive on fuel injection pump.
34. Timing of fuel injection pump is incorrect.
35. Tappet clearances are incorrect.
36. Valve timing is incorrect.
37. Bad compression.
38. Cylinder head gasket leaks.
39. Valves are not free.
40. Wrong high-pressure pipes.
41. Worn cylinder bores.
42. Leakage between valves and seats.
43. Piston rings are not free or they are worn or broken.
44. Valve stems and/or guides are worn.
45. Crankshaft bearings are worn or damaged.
46. Lubricating oil pump is worn.
47. Relief valve does not close.
48. Relief valve does not open.
49. Relief valve spring is broken.
50. Fault in suction pipe of lubricating oil pump.
51. Piston is damaged.
52. Piston height is incorrect.
53. Flywheel housing or flywheel is not aligned correctly.
54. Fault in thermostat or thermostat is of an incorrect type.
55. Restriction in coolant passages.
56. Fault in water pump.
57. Valve stem seal is damaged.
58. Restriction in sump strainer.
59. Valve spring is broken.

Emergency procedures

If the engine stops

1. Check that the fuel supply control (if fitted) is in the open position.
2. Check the amount of fuel in tank. If the engine has run until the tank is empty, there can be dirt or air in the fuel pipes. Change the fuel filter, fill the tank, eliminate air from the system and start the engine again. If the engine still will not start, disconnect the electrical stop solenoid of the fuel injection pump and start the engine. The mechanical stop lever of the pump can be used to stop the engine.

If there is a reduction in engine speed or a loss of power

1. Check that the propeller is free of debris, etc.
2. Check that the induction system is not restricted and that the engine compartment has a good supply of air.

If the engine coolant is at boiling point

1. Reduce the engine speed.
2. Check the seacock and strainer to ensure that there is a good supply of water to the cooling system.
3. Check the raw water pump operation for impeller failure, check for coolant leakage.
4. Check for air in the fresch water system, slipping or broken drive belt for the circulation pump, blocked heat exchanger, faulty thermostat or faulty instrument or sender.

Normally, coolant leakage can be stopped temporarily with adhesive tape, hose and hose clips.

If a bad leakage occurs from a high pressure fuel pipe

Disconnect the pipe, let the fuel flow into a container and operate the engine at a reduced speed on the remainder of the cylinders.

If leakage occurs from a low pressure fuel pipe

Temporarily stop the leak with adhesive tape, hose and hose clips.

If a bad lubricating oil leakage occurs

1. Stop the engine immediately and try to find the cause.
2. If the main flow can be reduced, put a suitable container under the leakage point.
3. Fill the engine with new lubricating oil at the same rate as the less of oil and frequently check the lubricating oil pressure.

Technical data

Engine designation	**MD22, MD22L, TMD22**
Output, see sales literature	
Operation	4-stroke direct injection
Bore/Stroke mm (inch)	84.4/89.0 mm (3.33/3.50)
Displacement litres	1.994 litres (122 in^3)
Firing order	1-3-4-2
Direction of rotation (viewed from front)	Clockwise
Idling speed	775–825 rpm
Compression ratio, MD22	18.1:1
MD22L	17.0:1
TMD22	17.2:1
Max. rearward inclination under way	20°
Max. sideways inclination under way	30°
Engine weight incl. reverse gear kg (lbs)	224 (492)
Engine weight incl. S-drive kg (lbs)	238 (524)

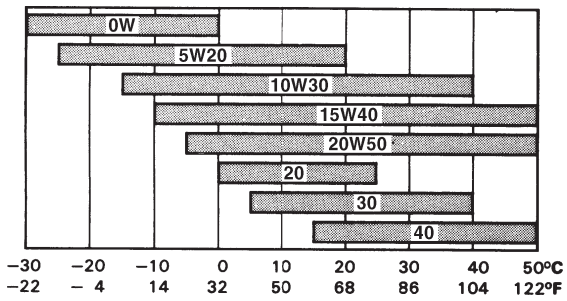
Valves

Valve clearance, adjustment cold engine	
Inlet, mm (in)	0.20–0.40 (0.008–0.016)
Exhaust, mm (in)	0.30–0.50 (0.012–0.020)
Valve clearance, check cold engine	
Inlet, mm (in)	0.25–0.35 (0.010–0.014)
Exhaust, mm (in)	0.35–0.45 (0.014–0.018)

Lubricating system

Oil capacity, engine	6 litres (10.5 UK pints) 6.3 US quarts
Oil quality MD22, MD22L (API)	CC or CD[1)]
Oil quality, TMD22 (API)	CD

Recommended SAE viscosity grades



[1)]CD-oil is not recommended during the first 20/40 hours of operation.

Oil pressure, hot engine at full speed	2.5 kp/cm^2, 250 kN/m^2 (36 lbf/in^2)

Fuel specifications

The fuel must be approved according to national and international standards for commercial fuels, for example:

– EN 590 (With environmental and sub-zero temperature specifications according to national requirements)
– ASTM D 975 No. 1-D and 2-D
– JIS KK 2204

Sulfur content: According to current legislation in the respective country.

Cooling system

Fresh water system, capacity	8 litres (14.1 UK pints) 8.5 US quarts

Electrical system

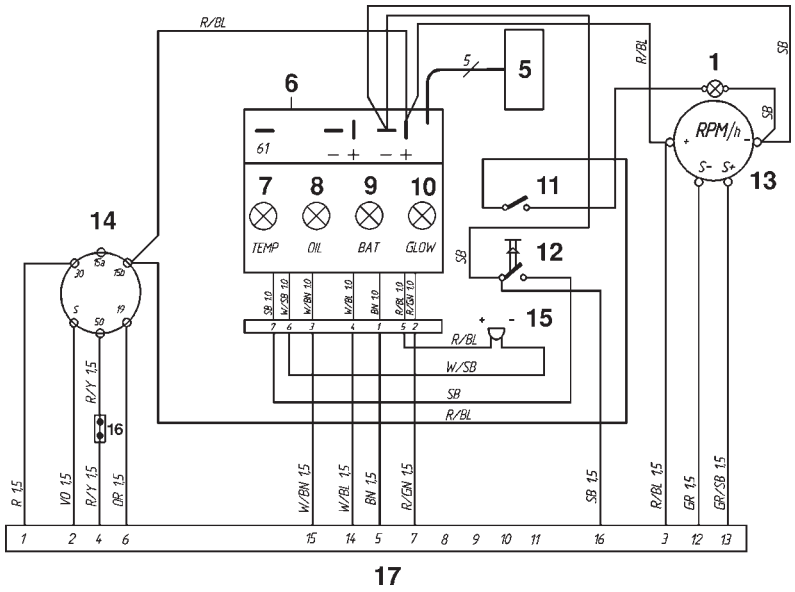
System voltage	12 V
Battery capacity (starter battery)	70 Ah
Alternator, voltage/max. amperage	14V/60A
Output approx.	840W
Starter motor, output approx.	1.8 kW

Reverse gear

Type designations	**MS2L-E**	**MS2A-E**
Gear ratios	2.3:1	2.4:1 or 3.0:1
Angle (out put shaft)	0°	7°
Oil volume	0.8 litres (1.4 UK pints) 0.84 US quarts	
Oil quality	VP P/N 1141572-6 (API GL5 SAE 75W/90 synthetic)	
Tightening torque, oil drain plug	20 ±5 Nm (14.5 ±4 lbf.ft)	

S-drive

Type designations	**120S-E**
Gear ratios	2.2:1
Oil volume, approx	2.8 litres (4.9 Imp pints/3.0 US quarts)
Volume difference min. -max	0.07 litre (0.12 Imp pints/0.07 US quarts)
Oil quality	VP P/N 1141572-6 (API GL5 SAE 75W/90 synthetic)
Tightening torque, oil drain plug	20 ±5 Nm (14.5 ±4 lbf.ft)



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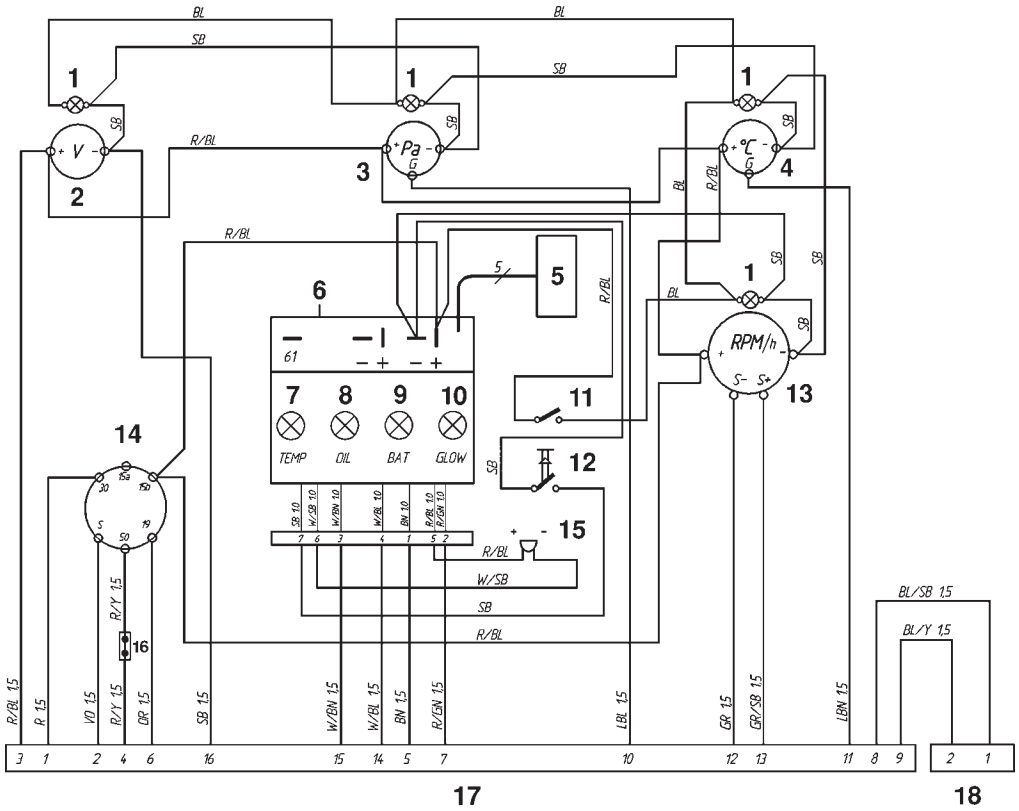
“Standard” panel



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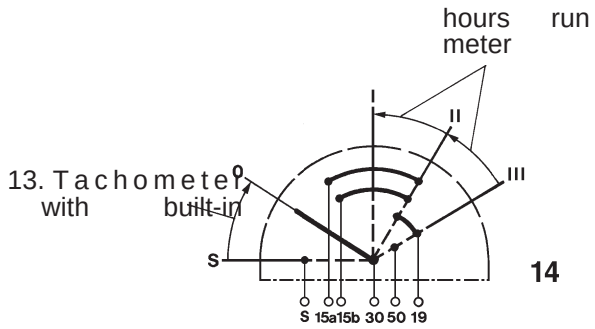
“De luxe” panel

Instrument panels

1. Instrument lightning
2. Voltmeter
3. Oil pressure gauge
4. Coolant temperature gauge
5. Connector for extra warning display
6. Electronic unit (alarm)
7. Warning light, coolant temperature
8. Warning light, oil pressure
9. Warning light, charging
10. Control light, preheating
11. Switch, instrument lightning
12. Switch, alarm test/acknowledgement



13. Tachometer with built-in

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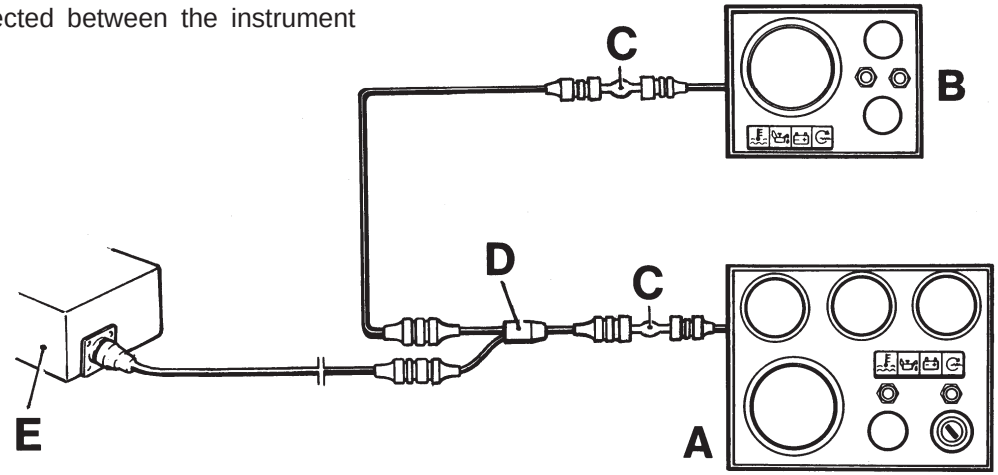
Spring loaded

Spring loaded

Diode kit

A diode kit is connected between the instrument



panel and the engine

(see the block diagram)

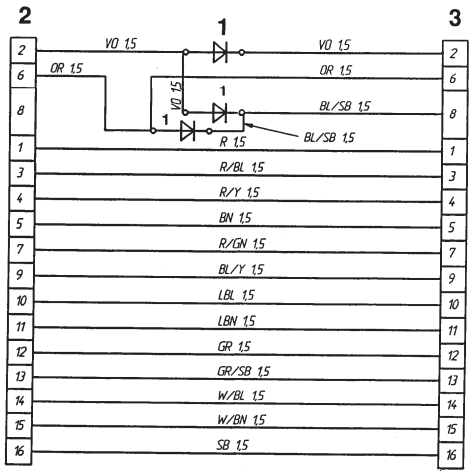
Block diagram - Connection of diode kit

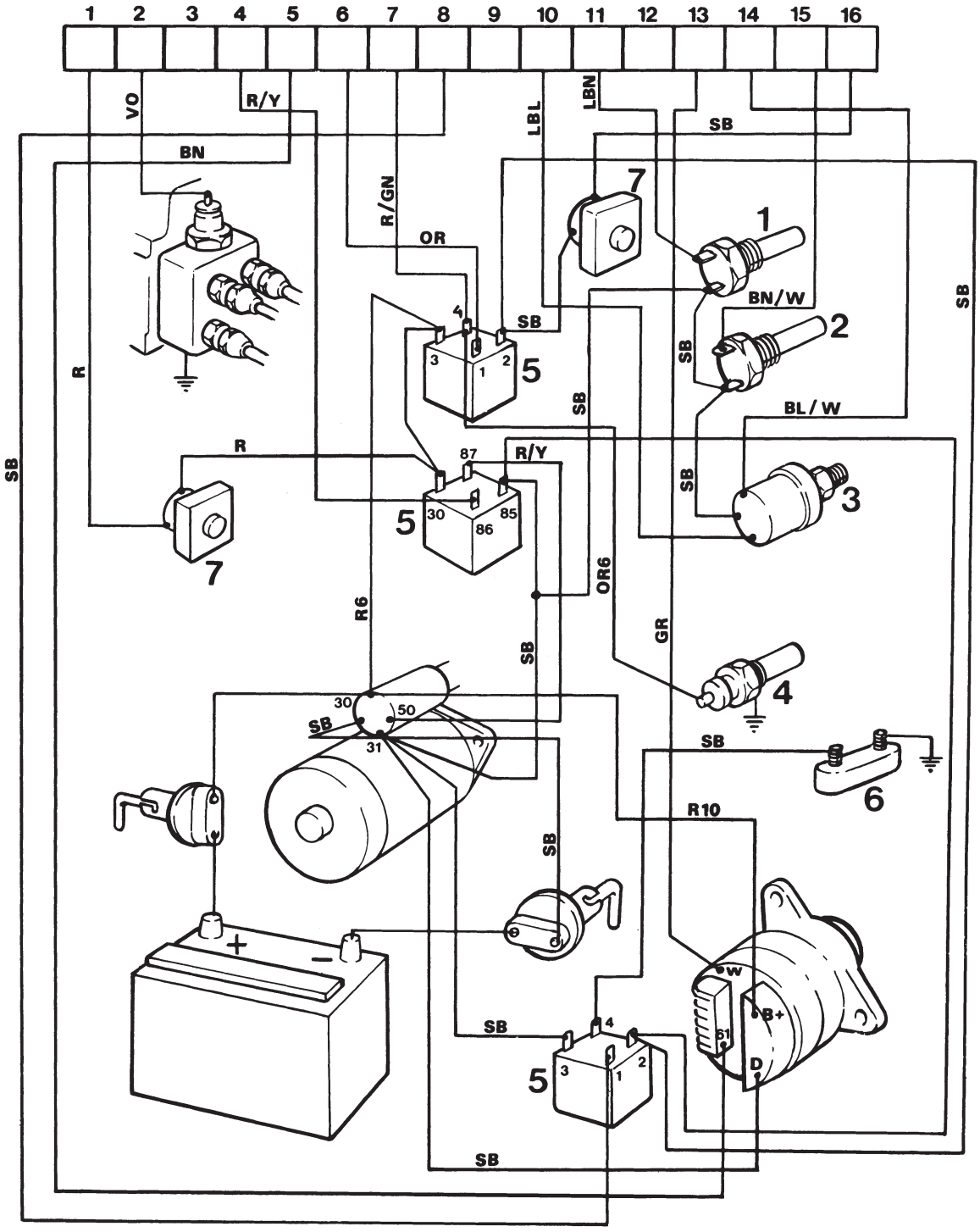
A. De luxe panel
B. Standard panel
C. Diode kit
D. Y-connection
E. Junction box on engine

1. Diode
2. 16-pole connection (to the instrument panel)
3. 16-pole connection (to the engine)

Cable colors

14. Key switch
15. Alarm
16. Connector for neutral position switch (accessory)
17. 16-pole connection
18. 2-pole connection for supplementary panel (accessory)





GR = Gray
SB = Back
BN = Brown
LBN = Light brown
R = Red
VO = Violet
GN = Gree

Cable areas in mm² are given after the color code in the wiring diagram

Engine wiring diagram

1. Coolant temperature sender
2. Coolant temperature check
3. Oil pressure sender
4. Preheating
5. Relay
6. Ground fuse
7. Fuses

Wire color

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

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